CS 25.1423 Public address system

ED Decision 2006/005/R

A public address system required by operational rules must –

(a) Be powerable when the aircraft is in flight or stopped on the ground, after the shutdown or failure of all engines and auxiliary power units, or the disconnection or failure of all power sources dependent on their continued operation, for –

(1) A time duration of at least 10 minutes, including an aggregate time duration of at least 5 minutes of announcements made by flight and cabin crew members, considering all other loads which may remain powered by the same source when all other power sources are inoperative; and

(2) An additional time duration in its standby state appropriate or required for any other loads that are powered by the same source and that are essential to safety of flight or required during emergency conditions.

(b) The system must be capable of operation within 3 seconds from the time a microphone is removed from its stowage by a cabin crew member at those stations in the passenger compartment from which its use is accessible.

(c) Be intelligible at all passenger seats, lavatories, and cabin crew member seats and work stations.

(d) Be designed so that no unused, un-stowed microphone will render the system inoperative.

(e) Be capable of functioning independently of any required crewmember interphone system.

(f) Be accessible for immediate use from each of two flight-crew member stations in the pilot compartment.

(g) For each required floor-level passenger emergency exit which has an adjacent cabin crew member seat, have a microphone which is readily accessible to the seated cabin crew member, except that one microphone may serve more than one exit, provided the proximity of the exits allows unassisted verbal communications between seated cabin crew members.

[Amdt 25/2]

MISCELLANEOUS EQUIPMENT

CS 25.1431 Electronic equipment

ED Decision 2003/2/RM

(a) In showing compliance with CS 25.1309(a) and (b) with respect to radio and electronic equipment and their installations, critical environmental conditions must be considered

(b) Radio and electronic equipment must be supplied with power under the requirements of CS 25.1355(c).

(c) Radio and electronic equipment, controls and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other radio or electronic unit, or system of units, required by this CS-25.

(d) Electronic equipment must be designed and installed such that it does not cause essential loads to become inoperative, as a result of electrical power supply transients or transients from other causes.

CS 25.1433 Vacuum systems

ED Decision 2003/2/RM

There must be means, in addition to the normal pressure relief, to automatically relieve the pressure in the discharge lines from the vacuum air pump when the delivery temperature of the air becomes unsafe.

CS 25.1435 Hydraulic Systems

ED Decision 2006/005/R

(See AMC 25.1435)

(a) *Element design.* Each element of the hydraulic system must be designed to:

(1) Withstand the proof pressure without permanent deformation that would prevent it from performing its intended function, and the ultimate pressure without rupture. The proof and ultimate pressures are defined in terms of the design operating pressure (DOP) as follows:

Element		Proof (x DOP)	Ultimate (xDOP)
1.	Tubes and fittings	1.5	3.0
2.	Pressure vessels containing gas High pressure (e.g. accumulators) Low pressure (e.g. reservoirs)	 3.0 1.5	 4.0 3.0
3.	Hoses	2.0	4.0
4.	All other elements	1.5	2.0

(2) Withstand, without deformation that would prevent it from performing its intended function, the design operating pressure in combination with limit structural loads that may be imposed;

(3) Withstand, without rupture, the design operating pressure multiplied by a factor of 1.5 in combination with ultimate structural loads that can reasonably occur simultaneously;

(4) Withstand the fatigue effects of all cyclic pressures, including transients, and associated externally induced loads, taking into account the consequences of element failure; and

(5) Perform as intended under all environmental conditions for which the aeroplane is certificated.

(b) *System design.* Each hydraulic system must:

(1) Have means located at a flight crew member station to indicate appropriate system parameters, if

(i) It performs a function necessary for continued safe flight and landing; or

(ii) In the event of hydraulic system malfunction, corrective action by the crew to ensure continued safe flight and landing is necessary;

(2) Have means to ensure that system pressures, including transient pressures and pressures from fluid volumetric changes in elements that are likely to remain closed long enough for such changes to occur, are within the design capabilities of each element, such that they meet the requirements defined in CS 25.1435(a)(1) through CS 25.1435(a)(5) inclusive;

(3) Have means to minimise the release of harmful or hazardous concentrations of hydraulic fluid or vapours into the crew and passenger compartments during flight;

(4) Meet the applicable requirements of CS 25.863, 25.1183, 25.1185 and 25.1189 if a flammable hydraulic fluid is used; and

(5) Be designed to use any suitable hydraulic fluid specified by the aeroplane manufacturer, which must be identified by appropriate markings as required by CS 25.1541.

(c) *Tests.* Tests must be conducted on the hydraulic system(s), and/or subsystem(s) and element(s), except that analysis may be used in place of or to supplement testing where the analysis is shown to be reliable and appropriate. All internal and external influences must be taken into account to an extent necessary to evaluate their effects, and to assure reliable system and element functioning and integration. Failure or unacceptable deficiency of an element or system must be corrected and be sufficiently retested, where necessary.

(1) The system(s), subsystem(s), or element(s) must be subjected to performance, fatigue, and endurance tests representative of aeroplane ground and flight operations.

(2) The complete system must be tested to determine proper functional performance and relation to other systems, including simulation of relevant failure conditions, and to support or validate element design.

(3) The complete hydraulic system(s) must be functionally tested on the aeroplane in normal operation over the range of motion of all associated user systems. The test must be conducted at the relief pressure or 1.25 times the DOP if a system pressure relief device is not part of the system design. Clearances between hydraulic system elements and other systems or structural elements must remain adequate and there must be no detrimental effects.

[Amdt 25/2]

AMC 25.1435 Hydraulic Systems - Design, Test, Analysis and Certification

ED Decision 2016/010/R

1. PURPOSE

This AMC (Acceptable Means of Compliance), which is similar to the FAA Advisory Circular AC 25.1435-1, provides advice and guidance on the interpretation of the requirements and on the acceptable means, but not the only means, of demonstrating compliance with the requirements of CS 25.1435. It also identifies other paragraphs of the Certification Specifications (CS) that contain related requirements and other related and complementary documents.

The advice and guidance provided does not in any way constitute additional requirements but reflects what is normally expected by the EASA.

2. RELATED REGULATORY MATERIAL AND COMPLEMENTARY DOCUMENTS

(a) Related Certification Specifications

CS-25 Paragraphs (and their associated AMC material where applicable) that prescribe requirements related to the design substantiation and certification of hydraulic systems and elements include:

CS 25.301	Loads
CS 25.303	Factor of safety
CS 25.863	Flammable fluid fire protection
CS 25.1183	Flammable fluid-carrying components
CS 25.1185	Flammable fluids
CS 25.1189	Shutoff means
CS 25.1301	Function and installation
CS 25.1309	Equipment, systems and installations
CS 25.1322	Warning, caution and advisory lights
CS 25.1541	General: Markings and Placards

Additional CS-25 paragraphs (and their associated AMC material where applicable) that prescribe requirements which can have a significant impact on the overall design and configuration of hydraulic systems are, but are not limited to:

CS 25.671	General: Control systems
CS 25.729	Extending retracting mechanisms
CS 25.903	Engines
CS 25.131525	Negative acceleration

(b) Complementary Documents

Documents, which are considered to provide appropriate standards for the design substantiation and certification of hydraulic systems and system elements may include, but are not limited to:

(i) CS-European Standard Orders (CS-ETSO's)

ETSO-C47 Pressure Instruments - Fuel, Oil and Hydraulic

ETSO-2C75 Hydraulic Hose Assemblies

(ii) Society of Automotive Engineers (SAE) Documents

ARP 4752 Aerospace - Design and Installation of Commercial Transport Aircraft Hydraulic Systems

Note: This document provides a wide range of Civil, Military and Industry document references and standards, which may be appropriate.

(iii) International Organisation for Standardisation (ISO) Documents

ISO 7137 Environmental Conditions and Test Procedures for Airborne Equipment

(iv) US Military Documents

MIL-STD-810 Environmental Test Methods and Engineering Guidelines

(v) European Aviation Safety Agencies Publication

Certification Specification No. 20

AMC 20.6 Temporary Guidance Material for Extended Range Operation with Two-Engine Aeroplanes

ETOPS Certification and Operation

(vi) The European Organisation for Civil Aviation Equipment Documents

ED-14G/RTCA DO-160G Environmental Conditions and Test Procedures for Airborne Equipment

3. ADVICE AND GUIDANCE

(a) Element Design

(1) Ref. CS 25.1435(a)(1) The design operating pressure (DOP) is the normal maximum steady pressure. Excluded are reasonable tolerances, and transient pressure effects such as may arise from acceptable pump ripple or reactions to system functioning, or demands that may affect fatigue. Fatigue is addressed in sub-paragraph (a)(4) of this paragraph.

The DOP for low-pressure elements (e.g., return, case-drain, suction, reservoirs, etc.) is the maximum pressure expected to occur during normal user system operating modes. Included are transient pressures that may occur during separate or simultaneous operation of user systems such as slats, flaps, landing gears, thrust reverses, flight controls, power transfer units, etc. Short term transient pressures, commonly referred to as pressure spikes, that may occur during the selection and operation of user systems (e.g., those pressure transients due to the opening and closing of selector/control valves, etc.) may be excluded, provided the fatigue effect of such transients is addressed in accordance with sub-paragraph (a)(4) of this paragraph.

In local areas of systems and elements the DOP may be different from the above due to the range of normally anticipated aeroplane operational, dynamic and environmental conditions. Such differences should be taken into account.

At proof pressure, seal leakage not exceeding the allowed maximum in-service leak rate is permitted. Each element should be able to perform its intended functions when the DOP is restored.

For sub-paragraphs (a)(1), (a)(2) and (a)(3) of this paragraph, the pressure and structural loads, as applicable, should be sustained for sufficient time to enable adequate determination that compliance is demonstrated. Typically a time of 2 minutes for proof conditions and 1 minute for ultimate conditions will be considered acceptable.

The term "pressure vessels" is not intended to include small volume elements such as lines, fittings, gauges, etc. It may be necessary to use special factors for elements fabricated from non-metallic/composite materials.

(2) Ref. CS 25.1435(a)(2) Limit structural loads are defined in CS 25.301(a). The loading conditions of CS-25, subpart C to be considered include, but are not limited to, flight and ground manoeuvres, and gust and turbulence conditions. The loads arising in these conditions should be combined with the maximum hydraulic pressures, including transients that could occur simultaneously. Where appropriate, thermal effects should also be accounted for in the strength justification. For hydraulic actuators equipped with hydraulic or mechanical locking features, such as flight control actuators and power steering actuators, the actuators and other loaded elements should be designed for the most severe combination of internal and external loads that may occur in use. For hydraulic actuators that are free to move with external loads, i.e. do not have locking features, the structural loads are the same as the loads produced by the hydraulic actuators. At limit load, seal leakage not exceeding the allowed maximum in-service leak rate is permitted.

(3) Ref. CS 25.1435(a)(3) For compliance, the combined effects of the ultimate structural load(s) as defined in CS 25.301 and 25.303 and the DOP, which can reasonably occur simultaneously, should be taken into account with a factor of 1.5 applied to the DOP. In this case the overall structural integrity of the element should be maintained. However, it may be permissible for this element to suffer leakage, permanent deformation, operational/functional failure or any combination of these conditions. Where appropriate, thermal effects should also be accounted for in the strength justification.

(4) Ref. CS 25.1435(a)(4) Fatigue, the repeated load cycles of an element, is a significant contributor to element failure. Hydraulic elements are mainly subjected to pressure loads, but may also see externally induced load cycles (e.g. structural, thermal, etc.). The applicant should define the load cycles for each element. The number of load cycles should be evaluated to produce equivalent fatigue damage encountered during the life of the aeroplane or to support the assumptions used in demonstrating compliance with CS 25.1309. For example, if the failure analysis of the system allows that an element failure may occur at 25% of aeroplane life, the element fatigue life should at least support this assumption.

(5) Ref. CS 25.1435(a)(5) Aeroplane environmental conditions that an element should be designed for are those under which proper function is required. They may include, but are not limited to temperature, humidity, vibration, acceleration forces, icing, ambient pressure, electromagnetic effects, salt spray, cleaning agents, galvanic, sand, dust and fungus. They may be location specific (e.g., in pressurised cabin vs. in unpressurised area) or general (e.g. attitude). For further guidance on environmental testing, suitable references include, but are not limited to, Military Standard, MIL-STD-810 "Environmental Test Methods and Engineering Guidelines", The European Organisation for Civil Aviation Equipment Document ED-14G "Environmental Conditions and Test Procedures for Airborne Equipment" or International Organisation for Standardisation Document No. ISO 7137 "Environmental Conditions and Test Procedures for Airborne Equipment".

(b) System Design

Ref. CS 25.1435(b) Design features that should be considered for the elimination of undesirable conditions and effects are:

(a) Design and install hydraulic pumps such that loss of fluid to or from the pump cannot lead to events that create a hazard that might prevent continued safe operation. For example, engine driven pump shaft seal failure or leakage in combination with a blocked fluid drain, resulting in engine gearbox contamination with hydraulic fluid and subsequent engine failure.

(b) Design the system to avoid hazards arising from the effects of abnormally high temperatures, which may occur in the system under fault conditions.

(1) Ref. CS 25.1435(b)(1) Appropriate system parameters may include, but are not limited to, pump or system temperatures and pressures, system fluid quantities, and any other parameters which give the pilot indication of the functional level of the hydraulic systems.

(2) Ref. CS 25.1435(b)(2) Compliance may be shown by designing the systems and elements to sustain the transients without damage or failure, or by providing dampers, pressure relief devices, etc.

(3) Ref. CS 25.1435(b)(3) Harmful or hazardous fluid or vapour concentrations are those that can cause short term incapacitation of the flight crew or long term health effects to the passengers or crew.

Compliance may be shown by taking design precautions, to minimise the likelihood of releases and, in the event of a release, to minimise the concentrations. Suitable precautions, based on good engineering judgement, include separation of air conditioning and hydraulic systems, shut-off capability to hydraulic lines, reducing the number of joints and elements, shrouding, etc. In case of leakage, sufficient drainage should be provided.

(4) Ref. CS 25.1435(b)(4) Unless it has been demonstrated that there are no circumstances which can exist (on the aeroplane) under which the hydraulic fluid can be ignited in any of its physical forms (liquid, atomised, etc.), the hydraulic fluid should be considered to be flammable.

(5) Ref. CS 25.1435(b)(5) If more than one approved fluid is specified, the term "suitable hydraulic fluid" is intended to include acceptable mixtures. Typical nameplate marking locations for hydraulic fluid use, are all hydraulic components having elastomer seals such as cylinders, valves, reservoirs, etc.

(c) Tests

Ref. CS 25.1435(c) Test conditions should be representative of the environment that the element, subsystem or system may be exposed to in the design flight envelope. This may include loads, temperature, altitude effects, humidity, and other influences (electrical, pneumatic, etc.). Testing may be conducted in simulators, or stand-alone rigs, integrated laboratory rigs, or on the aeroplane. The test plan should describe the objectives and test methods. All interfaces between the aeroplane elements and the test facilities should be adequately represented.

(1) Ref. CS 25.1435(c)(1) Testing for performance should demonstrate rates and responses required for proper system operation. Testing for fatigue (the repeated

load cycling of an element) and endurance (the ability of parts moving relative to each other to continue to perform their intended function) should be sufficient to show that the assumptions used in demonstrating compliance with CS 25.1309 are correct, but are not necessary to demonstrate aeroplane design life. As part of demonstrating that the element(s), sub-system(s), or system(s) perform their intended functions, the manufacturer (applicant) may select procedures and factors of safety identified in accepted manufacturing, national, military, or industry standards, provided that it can be established that they are suitable for the intended application. Minimum design factors specified in those standards or the requirements may be used unless more conservative factors have been agreed with the Agency.

An acceptable test approach for fatigue or endurance testing is to:

(a) Define the intended element life;

(b) Determine the anticipated element duty cycle;

(c) Conduct testing using the anticipated or an equivalent duty cycle.

(2) Ref. CS 25.1435(c)(2) The tests should include simulation of hydraulic system failure conditions in order to investigate the effect(s) of those failures, and to correlate with the failure conditions considered for demonstrating compliance with CS 25.1309. Relevant failure conditions to be tested are those, which cannot be shown to be extremely improbable, and have effects assessed to be major, hazardous, or have significant system interaction or operational implications.

(3) Ref. CS 25.1435(c)(3) Compliance with CS 25.1435(c)(3) can be accomplished by applying a test pressure to the system using aeroplane pumps or an alternate pressure source (e.g. ground cart). The test pressure to be used should be just below the pressure required to initiate system pressure relief (cracking pressure). Return and suction pressures are allowed to be those, which result from application of the test pressure to the pressure side of the system.

Some parts of the system(s) may need to be separately pressurised to ensure the system is completely tested. Similarly, it may be permissible that certain parts of the system need not be tested if it can be shown that they do not constitute a significant part of the system with respect to the evaluation of adequate clearances or detrimental effects.

[Amdt 25/2]
[Amdt 25/12]
[Amst 25/18]

CS 25.1436 Pneumatic systems – high pressure

ED Decision 2016/010/R

(See AMC 25.1436)

(a) *General*. Pneumatic systems which are powered by, and/or used for distributing or storing, air or nitrogen, must comply with the requirements of this paragraph.

(1) Compliance with CS 25.1309 for pneumatic systems must be shown by functional tests, endurance tests and analysis. Any part of a pneumatic system which is an engine accessory must comply with the relevant requirements of CS 25.1163.

(2) No element of the pneumatic system which would be liable to cause hazardous effects by exploding, if subject to a fire, may be mounted within an engine bay or other designated fire zone, or in the same compartment as a combustion heater.

(3) When the system is operating no hazardous blockage due to freezing must occur. If such blockage is liable to occur when the aeroplane is stationary on the ground, a pressure relieving device must be installed adjacent to each pressure source.

(b) *Design*. Each pneumatic system must be designed as follows:

(1) Each element of the pneumatic system must be designed to withstand the loads due to the working pressure, P_w, in the case of elements other than pressure vessels or to the limit pressure, P_L, in the case of pressure vessels, in combination with limit structural loads which may be imposed without deformation that would prevent it from performing its intended function, and to withstand without rupture, the working or limit pressure loads multiplied by a factor of 1·5 in combination with ultimate structural loads that can reasonably occur simultaneously.

(i) P_w. The working pressure is the maximum steady pressure in service acting on the element including the tolerances and possible pressure variations in normal operating modes but excluding transient pressures.

(ii) P_L. The limit pressure is the anticipated maximum pressure in service acting on a pressure vessel, including the tolerances and possible pressure variations in normal operating modes but excluding transient pressures.

(2) A means to indicate system pressure located at a flight-crew member station, must be provided for each pneumatic system that –

(i) Performs a function that is essential for continued safe flight and landing; or

(ii) In the event of pneumatic system malfunction, requires corrective action by the crew to ensure continued safe flight and landing.

(3) There must be means to ensure that system pressures, including transient pressures and pressures from gas volumetric changes in components which are likely to remain closed long enough for such changes to occur –

(i) Will be within 90 to 110% of pump average discharge pressure at each pump outlet or at the outlet of the pump transient pressure dampening device, if provided; and

(ii) Except as provided in sub-paragraph (b)(6) of this paragraph, will not exceed 125% of the design operating pressure, excluding pressure at the outlets specified in sub-paragraph (b)(3)(i) of this paragraph. Design operating pressure is the maximum steady operating pressure.

The means used must be effective in preventing excessive pressures being generated during ground charging of the system. (See AMC 25.1436(b)(3).)

(4) Each pneumatic element must be installed and supported to prevent excessive vibration, abrasion, corrosion, and mechanical damage, and to withstand inertia loads.

(5) Means for providing flexibility must be used to connect points in a pneumatic line between which relative motion or differential vibration exists.

(6) Transient pressure in a part of the system may exceed the limit specified in sub-paragraph (b)(3)(ii) of this paragraph if –

(i) A survey of those transient pressures is conducted to determine their magnitude and frequency; and

(ii) Based on the survey, the fatigue strength of that part of the system is substantiated by analysis or tests, or both.

(7) The elements of the system must be able to withstand the loads due to the pressure given in Appendix L, for the proof condition without leakage or permanent distortion and for the ultimate condition without rupture. Temperature must be those corresponding to normal operating conditions. Where elements are constructed from materials other than aluminium alloy, tungum, or medium-strength steel, the Authority may prescribe or agree other factors. The materials used should in all cases be resistant to deterioration arising from the environmental conditions of the installation, particularly the effects of vibration.

(8) Where any part of the system is subject to fluctuating or repeated external or internal loads, adequate allowance must be made for fatigue.

(c) Tests

(1) A complete pneumatic system must be static tested to show that it can withstand a pressure of 1·5 times the working pressure without a deformation of any part of the system that would prevent it from performing its intended function. Clearance between structural members and pneumatic system elements must be adequate and there must be no permanent detrimental deformation. For the purpose of this test, the pressure relief valve may be made inoperable to permit application of the required pressure.

(2) The entire system or appropriate sub-systems must be tested in an aeroplane or in a mock-up installation to determine proper performance and proper relation to other aeroplane systems. The functional tests must include simulation of pneumatic system failure conditions. The tests must account for flight loads, ground loads, and pneumatic system working, limit and transient pressures expected during normal operation, but need not account for vibration loads or for loads due to temperature effects. Endurance tests must simulate the repeated complete flights that could be expected to occur in service. Elements which fail during the tests must be modified in order to have the design deficiency corrected and, where necessary, must be sufficiently retested. Simulation of operating and environmental conditions must be completed on elements and appropriate portions of the pneumatic system to the extent necessary to evaluate the environmental effects. (See AMC 25.1436(c)(2).)

(3) Parts, the failure of which will significantly lower the airworthiness or safe handling of the aeroplane must be proved by suitable testing, taking into account the most critical combination of pressures and temperatures which are applicable.

[Amdt 25/1]
[Amdt 25/18]