AMC 25.1302 APPENDIX 1: Related regulatory material and documents

ED Decision 2007/010/R

The following is a list of requirements, acceptable means of compliance and other documents relevant to flight deck design and flight crew interfaces which may be useful when reviewing this AMC.

1.1 Related EASA Certification Specifications

Table 1.1 List of related regulations and AMCs referenced in this document:

CS-25 BOOK 1 Requirements	General topic	CS-25 BOOK 2 Acceptable Means of Compliance
CS 25.785 (g)	Seats, berths, safety belts and harnesses	AMC 25.785 (g)
CS 25.1309(c)	Minimising flight crew errors that could create additional hazards.	AMC 25.1309
CS 25.1523	Minimum flight crew and workload.	AMC 25.1523
CS 25.1321	Arrangement and visibility	
CS 25.1322	Colours for warning, caution, or advisory lights.	AMC 25.1322
CS 25.1329	Autopilot, flight director, autothrust	AMC 25.1329
	Electronic displays	AMC 25-11
CS 25.1543	Instrument markings - general	AMC 25.1543

Note: The table above does not list all requirements associated with flight deck design and human performance. This AMC does not provide guidance for requirements that already have specific design requirements, such as CS 25.777(e), which states that "Wing flap controls and other auxiliary lift device controls must be located on top of the pedestal, aft of the throttles, centrally or to the right of the pedestal centerline, and not less than 25 cm (10 inches) aft of the landing gear control."

1.2 RESERVED

1.3 FAA Orders and Policy

— Policy Memo ANM-99-2, Guidance for Reviewing Certification Plans to Address Human Factors for Certification of Transport Airplane Flight Decks.

— Policy Memo ANM-0103, Factors to Consider When Reviewing an Applicant's Proposed Human Factors Methods of Compliance for Flight Deck Certification.

— FAA Notice 8110.98, Addressing Human Factors/Pilot Interface Issues of Complex, Integrated Avionics as Part of the Technical Standard Order (TSO) Process.

1.4 Other documents

Following is a list of other documents relevant to flight deck design and flight crew interfaces that may be useful when reviewing this AMC. Some contain special constraints and limitations, however, particularly those that are not aviation specific. For example, International Standard ISO 9241-4 has much useful guidance that is not aviation specific. When using that document, applicants should consider environmental factors such as the intended operational environment, turbulence, and lighting as well as cross-side reach.

— SAE ARP 4033 (Pilot-System Integration), August 1995

— SAE ARP5289, Electronic Aeronautical Symbols

— SAE ARP-4102/7, Electronic Displays

— FAA Human Factors Team report on: The Interfaces Between Flightcrews and Modern Flight Deck Systems, 1996

— DOT/FAA/RD –93/5: Human Factors for Flight Deck Certification Personnel

— ICAO 8400/5, Procedures for Air Navigation Services ICAO Abbreviations and Codes. Fifth Edition, 1999

— ICAO Human Factors Training Manual: DOC 9683 – AN/950

— International Standards ISO 9241-4, Ergonomic Requirements for Office Work with Visual Display Terminals (VDTs)

[Amdt 25/3]

AMC 25.1302 Appendix 2: Definitions and acronyms

ED Decision 2011/004/R

Following is a list of terms, abbreviations, and acronyms used throughout this advisory material and in CS-25.

2.1 Abbreviations and acronyms

AC – Advisory circular

AMC – Acceptable Means of Compliance

CS – Certification Specifications

DOT – Department of Transportation

EASA – European Aviation Safety Agency

FAA – Federal Aviation Administration

ICAO – International Civil Aviation Organization

ISO – International Standards Organization

JAR – Joint Aviation Requirements

JAR OPS – Joint Aviation Requirements (Commercial Air Transportation - Aeroplanes)

MOC – Means of Compliance

SAE – Society of Automotive Engineers

STC – Supplemental Type Certificate

TAWS – Terrain Awareness Warning System

TCAS – Traffic Collision Avoidance System

TSO – Technical Standards Order

VOR – Very High Frequency Omnidirectional Range

2.2 Definitions

Following is a list of terms and definitions used in this AMC.

Alert – A generic term used to describe a flight deck indication meant to attract the attention of the flight crew, and identify to them a non-normal operational or aeroplane system condition. Warnings, Cautions, and Advisories are considered to be alerts. (Reference definition in AMC 25.1322)

Automation – The autonomous execution of a task (or tasks) by aeroplane systems started by a high-level control action of the flight crew.

Conformity – Official verification that the flight deck/system/product conforms to the type design data. Conformity of the facility is one parameter that distinguishes one means of compliance from another.

Control Device (Flight Deck Control) – Device used by the flight crew to transmit their intent to the aeroplane systems.

Cursor Control Device – Control device for interacting with virtual controls, typically used with a graphical user interface on an electro-optical display.

Design Philosophy – A high-level description of human-centred design principles that guide the designer and aid in ensuring that a consistent, coherent user interface is presented to the flight crew.

Display – Device (typically visual but may be auditory or tactile) that transmits data or information from the aeroplane to the flight crew.

Multifunction Control – A control device that can be used for many functions as opposed to a control device with a single dedicated function.

Task Analysis – A formal analytical method used to describe the nature and relationship of complex tasks involving a human operator.

[Amdt 25/3]
[Amdt 25/11]

CS 25.1303 Flight and navigation instruments

ED Decision 2018/005/R

(a) The following flight and navigation instruments must be installed so that the instruments are visible from each pilot station:

(1) A free-air temperature indicator or an air-temperature indicator which provides indications that are convertible to free-air temperature.

(2) A clock displaying hours, minutes, and seconds with a sweep-second pointer or digital presentation.

(3) A magnetic direction indicator.

(b) The following flight and navigation instruments must be installed at each pilot station:

(1) An airspeed indicator. If airspeed limitations vary with altitude, the indicator must have a maximum allowable airspeed indicator showing the variation of V_{MO} with altitude.

(2) An altimeter (sensitive).

(3) A rate-of-climb indicator (vertical speed).

(4) A gyroscopic rate of turn indicator combined with an integral slip-skid indicator (turn-and-bank indicator) except that only a slipskid indicator is required on aeroplanes with a third attitude instrument system usable through flight attitudes of 360° of pitch and roll, which is powered from a source independent of the electrical generating system and continues reliable operation for a minimum of 30 minutes after total failure of the electrical generating system, and is installed in accordance with CS 25.1321(a).

(5) A bank and pitch indicator (gyroscopically stabilised). (See AMC 25.1303(b)(5).)

(6) A direction indicator (gyroscopically stabilised, magnetic or non-magnetic).

(c) The following flight and navigation instruments are required as prescribed in this paragraph:

(1) A speed warning device which must give effective aural warning (differing distinctively from aural warnings used for other purposes) to the pilots whenever the speed exceeds V_{MO} plus 11.1 km/h (6 knots) or M_{MO} + 0·01. The upper limit of the production tolerance for the warning device may not exceed the prescribed warning speed. (See AMC 25.1303(c)(1).)

(2) A mach meter is required at each pilot station for aeroplanes with compressibility limitations not otherwise indicated to the pilot by the airspeed indicating system required under sub-paragraph (b)(1) of this paragraph.

[Amdt 25/18]
[Amdt 25/21]

AMC 25.1303(a)(3) Direction indicators

ED Decision 2018/005/R

In this AMC, 'primary direction indicator' refers to the direction indicator required by CS 25.1303(b)(6) and 'standby direction indicator' to the one required by CS 25.1303(a)(3).

When designing and installing a standby direction indicator, the applicant should follow the guidelines below:

(a) Independence between the primary direction indicator and the standby direction indicator should be established in all foreseeable operating conditions. Failure conditions and subsequent switching to the backup source of direction should be carefully considered;

(b) The reliability of the standby direction indicator should be commensurate with the identified hazard level. Consideration should be given to CS 25.1333(b) and AMC 25-11, Chapter 4, Table 6;

(c) Additional availability assessments should be provided:

(1) Direction indications should be available immediately following the loss of the primary direction source without additional crew member action, and after any single failure or combination of failures. Consideration should be given to CS 25.1333(b);

(2) Direction indications should not be adversely affected following a loss of normal electrical power. Consideration should be given to CS 25.1351(d);

(3) Operation during and after exposure to a high-intensity radiated field (HIRF) environment should be demonstrated. Consideration should be given to CS 25.1317(a);

(4) Operation after exposure to indirect effects of lightning should be established. Consideration should be given to CS 25.1316(a).

[Amdt 25/21]

AMC 25.1303(b)(5) Attitude Displays

ED Decision 2003/2/RM

1 *Attitude Displays*

1.1 For turbo-jet aeroplanes each display should be usable over the full range of 360° in pitch and in roll. For propeller-driven aeroplanes the pitch range may be reduced to ± 75° provided that no misleading indication is given when the limiting attitude is exceeded.

1.2 Paragraph 1.1 is not intended to prohibit the use of vertical references having controlled gyro precession, or its equivalent in the case of a stable platform, but precession should not occur at a pitch attitude closer to the horizontal than 70°, and should be completed within an attitude change of 15°.

1.3 The display should take the form of an artificial horizon line, which moves relative to a fixed reference aeroplane symbol so as to indicate the position of the true horizon.

NOTES:

1 It is acceptable for the fixed reference aeroplane symbol to be positioned so that it is aligned with the horizon line during cruising flight.

2 If a variable index is provided in addition to the fixed aeroplane symbol it should be so designed that it will not introduce any risk of misinterpretation of the display.

1.4 There should be no means accessible to the flight crew of adjusting the relationship between the horizon line and the reference aeroplane symbol.

1.5 The artificial horizon line should move in roll so as to remain parallel to the true horizon, i.e. when the aeroplane rolls through an angle of 30° the artificial horizon line should also rotate through 30° relative to the fixed index.

1.6 The artificial horizon line should remain in view over a range of pitch attitudes sufficient to cover all normal operation of the aeroplane plus a margin of not less than 2° in either direction. Additional 'ghost' horizon lines should be provided parallel to the main horizon line so that beyond this range at least one such line is in view at an attitude with the range of the display.

1.7 The pitch attitude scale should be sensibly linear while the main horizontal line is in view, but may become non-linear beyond this range.

All the attitude displays in the aeroplane should have a similar presentation so as to prevent any risk of confusion in transferring attention from one display to another.

1.9 Sufficient pitch and bank angle graduations and markings should be provided to allow an acceptably accurate reading of attitude and to minimise the possibility of confusion at extreme attitudes.

1.10 A bank angle index and scale should be provided. The index may be on the fixed or moving part of the display.

1.11 The 'earth' and 'sky' areas of the display should be of contrasting colours or shades. The distinction should not be lost at any pitch or roll angle.

1.12 Any additional information (e.g. flight director commands) displayed on an attitude display should not obscure or significantly degrade the attitude information.

1.13 The display should be clearly visible under all conditions of daylight and artificial lighting.

1.14 Words that may be ambiguous (e.g. 'climb', 'dive', 'push', 'pull') should not be used.

2 *Attitude Display Systems* (Acceptable Means of Compliance)

2.1 The probability of indication of dangerously incorrect information without a warning being given should be Extremely Remote.

2.2 The warning may be provided by means of self- or comparison-monitoring and should be clear and unambiguous, e.g. a flashing light. Instrument flags are unlikely to be acceptable as a comparator warning unless they exclude a significant portion of the display in which case means should be provided to permit the removal of the flag from the display, which is not in error.

2.3 The definition of dangerously incorrect information depends to some extent on the characteristics of the aeroplane, but in general an error greater than 5° in pitch or 10° in roll will be considered to be dangerous.

AMC 25.1303(c)(1) Flight and navigation instruments

ED Decision 2003/2/RM

In the absence of warning through the inherent aerodynamic qualities of the aeroplane (e.g. buffeting) it should be shown that no single faults can result both in misleading airspeed information and in operation of the warning system outside its tolerances, such as would be likely to lead to exceedance of V_{MO}/M_{MO}.

CS 25.1305 Powerplant instruments

ED Decision 2021/015/R

(See AMC 25.1305)

The following are required powerplant instruments:

(a) *For all aeroplanes*

(1) A fuel pressure warning means for each engine, or a master warning means for all engines with provision for isolating the individual warning means from the master warning means.

(2) Fuel indication system(s) which:

(i) Provide(s) to the flight crew a full-time display of the total quantity of usable fuel on board;

(ii) Is (are) capable of indicating to the flight crew the quantity of usable fuel in each tank in accordance with CS 25.1337(b);

(iii) Provide(s) fuel quantity and availability information to the flight crew, including alerts, to indicate any fuel system condition (e.g. misconfiguration or failure) that, if not corrected, would result in no fuel being supplied to one or more engine(s). This includes:

(A) Abnormal fuel transfer between tanks;

(B) Trapped fuel;

(C) Fuel leaks including in the engines.

(iv) Provide(s) a low fuel level cockpit alert for any tank and/or collector cell that should not become depleted of fuel.

Each alert is such that:

(A) It is provided to the flight crew when the usable quantity of fuel in the tank concerned reaches the quantity required to operate the engine(s) for 30 minutes at cruise conditions;

(B) The alert and the fuel quantity indication for that tank are not adversely affected by the same single failure. (See AMC 25.1305(a)(2))

(3) An oil quantity indicator for each oil tank.

(4) An oil pressure indicator for each independent pressure oil system of each engine.

(5) An oil pressure warning means for each engine, or a master warning means for all engines with provision for isolating the individual warning means from the master warning means.

(6) An oil temperature indicator for each engine.

(7) Fire-warning devices that provide visual and audible warning.

(8) An augmentation liquid quantity indicator (appropriate for the manner in which the liquid is to be used in operation) for each tank.

(b) Reserved.

(c) *For turbine engine-powered aeroplanes.* In addition to the powerplant instruments required by sub-paragraph (a) of this paragraph, the following powerplant instruments are required:

(1) A gas temperature indicator for each engine.

(2) A fuel flow meter indicator for each engine.

(3) A tachometer (to indicate the speed of the rotors with established limiting speeds) for each engine.

(4) A means to indicate, to the flight crew, the operation of each engine starter that can be operated continuously but that is neither designed for continuous operation nor designed to prevent hazard if it failed.

(5) An indicator to indicate the functioning of the powerplant ice protection system for each engine.

(6) An indicator for the fuel strainer or filter required by CS 25.997 to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with CS 25.997(d).

(7) A warning means for the oil strainer or filter required by CS 25.1019, if it has no bypass, to warn the pilot of the occurrence of contamination of the strainer or filter screen before it reaches the capacity established in accordance with CS 25.1019(a)(2).

(8) An indicator to indicate the proper functioning of any heater used to prevent ice clogging of fuel system components.

(9) A vibration indication system that indicates unbalances in engine rotor systems and, when applicable, in propeller rotating assemblies.

(d) *For turbo-jet engine-powered aeroplanes.* In addition to the powerplant instruments required by sub-paragraphs (a) and (c) of this paragraph, the following powerplant instruments are required:

(1) An indicator to indicate thrust, or a parameter that is directly related to thrust, to the pilot. The indication must be based on the direct measurement of thrust or of the parameters that are directly related to thrust. The indicator must indicate a change in thrust resulting from any engine malfunction, damage or deterioration. (See AMC 25.1305(d)(1).)

(2) A position indicating means to indicate to the flight crew when the thrust reversing device –

(i) Is not in the selected position, and

(ii) Is in the reverse thrust position, for each engine using a thrust-reversing device.

(e) *For turbo-propeller-powered aeroplanes*. In addition to the powerplant instruments required by sub-paragraphs (a) and (c) of this paragraph, the following powerplant instruments are required:

(1) A torque indicator for each engine.

(2) Position indicating means to indicate to the flight crew when the propeller blade angle is below the flight low pitch position, for each propeller.

(3) Reserved

(f) *For aeroplanes equipped with fluid systems (other than fuel) for thrust or power augmentation*, an approved means must be provided to indicate the proper functioning of that system to the flight crew.

[Amdt No: 25/12]
[Amdt No: 25/18]
[Amdt No: 25/27]

AMC 25.1305(a)(2) Fuel indication system(s)

ED Decision 2012/008/R

0. Related references

AMC 25-11 Electronic Flight Deck Displays

1. Purpose

This AMC provides guidance and means of compliance for demonstrating compliance with CS 25.1305(a)(2) when designing a fuel indication system(s).

2. General objective

a. The primary function of fuel indication system(s) is indicating the usable fuel quantity on board an aircraft. Additionally, the fuel indication system(s) provide(s) any alert and information to the flight crew to assist them in the task of managing the fuel quantity on board.

b. Service experience indicates that scenarios leading to impending fuel starvation of one or more engines have developed into an unsafe system operating condition. Therefore, such scenarios have to be identified and, as required per CS 25.1309(c), appropriate

information should be provided to the flight crew to enable them to take corrective action.

This information, including alerts, is provided in a timely manner so that any unsafe fuel starvation situation can be avoided.

c. The fuel indication system(s) alerts as a minimum inform the flight crew of:

— any abnormal fuel transfer;

— a trapped fuel situation;

— the existence of a fuel leak;

— a low fuel level situation.

For each alert, corrective actions are made available to the flight crew. This should include for instance:

— procedure(s) to identify and isolate the fuel leak;

— procedure(s) to correct the abnormal fuel transfer and/or to manage the trapped fuel situation;

— diversion procedure or the instruction to land as soon as possible;

— any required procedure to avoid additional hazard (for instance: fuel coming into contact with wheel brakes during landing when a fuel leak is not isolated; exceeding centre of gravity or fuel imbalance limits).

3. Usable fuel quantity

a. The total usable fuel quantity is considered essential information. Operational regulations require the flight crew to regularly check the remaining total usable fuel quantity. This quantity is then evaluated when comparing the actual quantity of fuel used to the planned fuel consumption, and to ensure that sufficient fuel is available to complete the flight with the required fuel reserve. The total usable fuel quantity is therefore displayed full-time and it is easily and directly readable by the flight crew.

b. As required per CS 25.1337(b), there is a means to indicate to the flight crew the usable fuel quantity in each fuel tank. It is considered acceptable that these individual tank quantities be only displayed when required. This may be displayed either at pilot discretion (on demand) or automatically as determined to support operational procedures associated with fuel system alerts.

4. Abnormal fuel transfer between tanks

The fuel indication system(s) provide(s) any alert and information enabling identification of abnormal fuel transfer between tanks.

Abnormal fuel transfer between tanks is a fuel transfer that - if no corrective action is taken - can lead to no fuel becoming available to an engine and/or fuel imbalance. This may result either from a fuel management system failure or from inappropriate flight crew action.

5. Trapped fuel

The fuel indication system(s) provide(s) any alert and information enabling identification of trapped fuel situations.

Trapped fuel means any fuel quantity (above the unusable fuel quantity) gauged by the FQIS that cannot be supplied to the engine.

For instance, failure of an isolation valve in an auxiliary tank, failure of a transfer pump, fuel pipe failure inside a tank could result in trapped fuel. Also, inappropriate selection of fuel system configuration by the flight crew has to be considered.

6. Fuel leaks

The fuel indication system(s) provide(s), as early as practical, any alert and information enabling the crew to identify a fuel leak.

Fuel leaks can be caused by a loss of integrity of the fuel system (for instance, fuel pipes failures, leakage of connections) and result in fuel being drained overboard the aircraft.

The fuel leaks analysis will identify all foreseeable leakage sources from the aircraft fuel tank(s) to the engine fuel nozzles. For the engines, it means that the effects of leaks upstream and downstream of the engine fuel flow meter have to be considered.

The leak detection may be performed by monitoring and comparing several sources of information (for instance fuel flows, fuel used computation, usable fuel quantities per tank(s) and total usable fuel on board before take-off).

7. Low fuel level alert

a. The fuel indication system(s) trigger(s) an alert in case of low fuel level. The low fuel level cockpit alert is applicable to any tank or collector cell that is not expected to be depleted in flight because otherwise this situation would lead to an engine fuel starvation. Fuel tanks that may normally be depleted during flight do not require a low fuel level alert.

b. The alert is triggered when the quantity of usable fuel in the tank concerned reaches the quantity required to operate an engine for 30 minutes with the aircraft operated in optimum cruise conditions. When defining the 30 minutes under optimum cruise conditions the applicant will consider the mission profile for which the aircraft is designed.

c. The safety analysis in accordance with CS 25.1309(b) and (c) includes as a minimum the following failure scenarios:

— Erroneous high fuel quantity indication system (FQIS) readings;

— Loss of FQIS gauging information.

No single failure of the FQIS (including total loss of FQIS power supply) or total loss of the primary basic FQIS information will lead to the fuel low level alert not being correctly triggered.

[Amdt 25/12]

AMC 25.1305(c)(5) Powerplant ice protection system functioning indication

ED Decision 2018/005/R

In addition to an indication of the functioning of each nacelle ice protection system, an indication of the functioning of each engine ice protection system should be provided under the following conditions:

1. If the engine ice protection system requires a flight crew action to operate it (i.e. the system is manual), and