Certification Memorandum

Guidance on smoke propagation and smoke penetration tests

EASA CM No.: CM–CS-011 Issue 02 dated 28 June 2023

Regulatory requirement(s): CS 25.855(h)(2)

In accordance with the EASA Certification Memorandum procedural guideline, the European Union Aviation Safety Agency proposes to issue an EASA Certification Memorandum (CM) on the subject identified above.

All interested persons may send their comments, referencing the EASA Proposed CM Number above, to the e-mail address specified in the 'Remarks' section, prior to the indicated closing date for consultation.

EASA Certification Memoranda clarify the European Union Aviation Safety Agency's general course of action on specific certification items. They are intended to provide guidance on a particular subject and, as non-binding material, may provide complementary information and guidance for demonstrating compliance with the current standards. Certification Memoranda are provided for information purposes only and must not be misconstrued as formally adopted Acceptable Means of Compliance (AMC) or as Guidance Material (GM). Certification Memoranda are not intended to introduce new certification requirements or to modify existing certification requirements, and do not constitute any legal obligation.

EASA Certification Memoranda are living documents into which either additional criteria or additional issues can be incorporated as soon as a need is identified by EASA.

Log of issues

Issue	Issue date	Change description
01	25.10.2019	First issue
02	28.06.2023	Final Issue post consultation.

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1. Introduction

1.1. Purpose and scope

The purpose of this Certification Memorandum is to provide specific clarifications and additional guidance regarding the certification testing to be conducted to evaluate the entry of hazardous quantities of smoke into compartments occupied by the crew or passengers as a result of an in-flight fire event in the pressurized areas of the fuselage of a large aeroplane.

1.2. References & requirements

This Certification Memorandum refers to several CS-25certification specifications. The guidance of this CM is equally applicable to those aeroplanes having in their certification basis specifications that are identical or equivalent to the referenced certification specifications.

It is intended that the following reference materials should be considered in conjunction with this Certification Memorandum:

Reference	Title	Code	Issue	Date
CS 25.795 (b)(1) and (2)	Security considerations		27	24.11.2021
CS 25.831 (d)	Ventilation		27	24.11.2021
CS 25.854	Lavatory fire protection		27	24.11.2021
CS 25.855	Cargo or baggage compartments		27	24.11.2021
CS 25.857	Cargo compartment classification		27	24.11.2021
CS 25.858	Cargo or baggage compartment smoke or fire detection systems		27	24.11.2021
CS 25.1309	Equipment, systems and installations		27	24.11.2021
S25.10(c)	General Cabin Arrangement, Isolated Compartments		27	24.11.2021
AMC 25.795(b)(1)	Flight deck smoke protection		27	24.11.2021
AMC 25.795(b)(2)	Passenger cabin smoke protection		27	24.11.2021

Reference	Title	Code	Issue	Date
AMC to CS 25.855 and 25.857	Cargo or baggage compartments		27	24.11.2021
FAA AC 25-17A, Change 1	TRANSPORT AIRPLANE INTERIORS CRASHWORTHINESS HANDBOOK			25.5.2016
FAA AC 25-9A	SMOKE DETECTION, PENETRATION, AND EVACUATION TESTS AND RELATED FLIGHT MANAUAL EMERGENCY PROCDURES			6.1.1994
FAA AC 25.857-1	Class B and F Cargo Compartments			3.2.2016

1.3. Abbreviations

AC	**A**dvisory **C**ircular
AMC	**A**cceptable **M**eans of **C**ompliance
CS	**C**ertification **S**pecification
CM	**C**ertification **M**emorandum
CRI	**C**ertification **R**eview **I**tem
EASA	**E**uropean **U**nion **A**viation **S**afety **A**gency
FAA	**F**ederal **A**viation **A**dministration

2. Background

According to CS 25.855(h)(2), flight tests must be conducted to show compliance with the provisions of CS 25.857 concerning the entry of hazardous quantities of smoke into compartments occupied by the crew or passengers.

CS 25.831(d) requires smoke evacuation to be readily accomplished if the accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable.

CS-25 explicitly requires the installation of smoke detection systems in Class B, C, E and F cargo compartments, and, for each aeroplane with a passenger capacity of 20 or more, in the lavatories. The installation of smoke detection systems in other areas of the pressurized fuselage may be

proposed as a means to mitigate the fire risk, based on the outcome of the Zonal Safety Analysis and Particular Risk Analysis conducted to demonstrate compliance with CS 25.1309.

CS 25.795(b)(1) specifies that means must be provided to limit entry of smoke, fumes, and noxious gases into the flight deck. According to CS 25.795(b)(2), except for aeroplanes intended to be used solely for the transport of cargo, means must be provided to prevent passenger incapacitation in the cabin resulting from smoke, fumes, and noxious gases.

CS-25 Appendix S (applicable to non-commercially operated aeroplanes and low-occupancy aeroplanes) requires smoke detection systems for isolated compartments, as described in paragraph S25.10(c) and its related AMC material.

EASA issues special conditions that are applicable for the installation of certain cabin compartments (e.g. crew rest compartments, high wall mini-suites, etc.) which include requirements that address smoke detection and the accumulation of hazardous quantities of smoke in occupied areas.

EASA considers FAA AC 25-9A as providing acceptable means of compliance and guidance for the purpose of showing compliance with the above-mentioned certification specifications dealing with smoke detection, penetration and evacuation tests to be conducted for the evaluation of the performance of fire protection systems of large aeroplanes. Any compliance approach proposed as an alternative to the guidance given in the AC should be justified by the applicant and agreed with EASA.

In particular, AC 25-9A clarifies that performing smoke penetration tests is an acceptable means to demonstrate that smoke will not enter the occupied compartments of the aeroplane from the cargo, storage or baggage compartments, equipment bays, equipment cooling systems or other non-continuously occupied areas (e.g., galleys, lavatories, or crew rest areas), which could contain large quantities of smoke.

AC 25-9A also clarifies that: '…fires in inaccessible areas (e.g. equipment bays, Class C cargo compartments) should be assumed to be continuous, i.e., capable of continuously generating products of combustion until it can be visually verified that the fire has been extinguished. This is required for the development of fire suppression procedures and to show compliance with the control and containment (as well as continued safe flight and landing) requirements specified in 25.831, 25.869, and 25.1309. The adequacy of the smoke control and containment means should be demonstrated during airplane flight tests'.

In certification projects, appropriate test conditions to show compliance with the EASA certification specifications related to the accumulation of hazardous quantities of smoke in occupied compartments are extensively discussed. Therefore, this CM provides specific clarifications and additional guidance regarding certification testing.

3. EASA Certification Policy

3.1. General

Even though the guidance provided by FAA AC 25-9A is found to be adequate by EASA, the intention of this CM is to provide specific guidance for compartments in pressurized areas, taking into account the specificities of their design (e.g. cabin compartments versus cargo compartments).

According to FAA AC 25-9A, smoke penetration tests are required for cargo compartments and for equipment bays, but are only recommended for other compartments such as lavatories, crew rest areas, etc. Smoke penetration tests are conducted to show that no penetration of smoke into occupied areas occurs from a compartment in which a fire originates. In general, a smoke penetration test is successful only if the compartment is provided with effective isolation means (e.g. smoke barriers, airtight liners) to prevent smoke penetration into the surrounding areas, and if the ventilation system available in the compartment may be isolated upon detection of a fire event. However, an in-flight fire may originate in other compartments (e.g. equipment bays, Class A cargo compartments, lavatories, crew rest compartments, remote areas of the cabin, etc.) that may not be equipped with the above-mentioned isolation features.

For the latter types of compartments, EASA finds it appropriate to conduct smoke propagation tests rather than smoke penetration tests. In addition, some compartments that rely upon a crew member fighting a fire or conducting a post-fire inspection (e.g., Class B cargo compartments) may require smoke propagation testing during the time that the compartment is being accessed by the crew member, and some quantity of smoke may enter the occupied areas due to the opening of the access provisions.

EASA defines as a smoke propagation test any test that is conducted to evaluate the movement of smoke from an area (e.g. a lavatory, avionic compartment, etc.) that cannot be isolated from other occupied areas, or that requires a crew member to enter it to manually fight a fire (e.g., a Class B cargo compartment, crew rest compartment, etc.). The amount of smoke to be generated in smoke propagation tests should be defined taking into account the available fire protection systems and the applicable emergency procedures. If an emergency procedure is implemented to suppress/extinguish a fire, the time interval in which the continuous generation of smoke occurs in the compartment can be assumed to be limited.

The table below summarises the cases in which EASA may accept a smoke propagation test being conducted to evaluate the entry of hazardous quantities of smoke into occupied areas, in addition to, or as an alternative to, conducting smoke penetration tests as per FAA AC 25-9A (ref. Table 1-Smoke tests in paragraph 9).

No.	Compartment	Smoke Propagation Test
1	Equipment Bays (e.g. Avionics)	Yes
2	Class B Cargo or Baggage Compartment	Yes*

3	Class C Cargo or Baggage Compartment	No
4	Class E Cargo Compartment	No
5	Class F Cargo or Baggage Compartment (with built-in fire extinguishing system)	No
6	Class F Cargo or Baggage Compartment (without built-in fire extinguishing system)	Yes*
7	Lavatories	Yes
8	Crew Rest Compartments (with built-in fire extinguishing system)	No
9	Crew Rest Compartment (without built-in fire extinguishing system)	Yes*
10	Galley Areas	Yes
11	Assessment of migration of smoke between decks of double-deck passenger aeroplanes	Yes
12	High wall mini-suites	Yes*

YES = smoke propagation testing may be performed as a substitute for smoke penetration testing

YES* = the main scope of the smoke propagation test is to evaluate the accumulation of hazardous quantities of smoke, flames or extinguishing agents in compartments occupied by the crew or passengers when the access provisions of the compartment in which the fire is located are used.

NO = smoke propagation testing is not appropriate

Table A: Smoke Propagation Tests

3.2. Smoke propagation test

In a smoke propagation test, the affected compartment does not necessarily need to be smoke-filled as is required in a smoke penetration test, although a larger amount of smoke should be generated than that used in a smoke detection test.

The smoke propagation test conditions should be discussed and agreed with EASA.

EASA expects applicants to submit dedicated test plans that define and justify the following:

— The smoke generator type/model;
— The smoke generation method (e.g. paraffin oil);
— The worst-case location for the smoke generator;
— The amount of smoke; and
— The smoke emission time.

Applicants should provide the specific settings of the smoke generator (e.g. the fuel flow rate, orifice pressure ratio, etc.) that will be used during compliance test demonstrations. The locations of the smoke generator should be selected taking into account the likely areas in which a fire may originate, the design of the ventilation system and the design of the smoke detection system, if installed.

The amount of smoke and the emission time should be established considering the applicable emergency procedures. In compartments in which the fire-fighting procedure cannot be implemented, smoke should be generated continuously for an amount of time that is sufficient to reach a steady state, i.e. sufficient to produce evidence that no accumulation of hazardous quantities of smoke would occur in the occupied areas.

If fire-fighting procedures can be implemented, then the smoke emission can be limited in time. For example, if manual fire-fighting is possible in a compartment that is equipped with a smoke detection system, the smoke emission time can be determined by considering the maximum smoke detection time plus the time needed for crew members to react to the smoke alarm and start the fire-fighting procedure, plus a delay to take into account the time needed to extinguish the fire.

The pass/fail criteria specified in Chapter 11, paragraph e. (4) of FAA AC 25-9A for smoke penetration tests should also be considered as a reference for smoke propagation tests. However, as smoke propagation tests are conducted in compartments that are not designed to be smoke-tight (e.g. galleys), or that are designed to be smoke-tight but rely upon firefighting by a crew member and access to the compartment (e.g. Class B cargo compartments), it is acceptable for smoke to enter the occupied areas (e.g., during the time the access door is opened) if it is demonstrated that smoke does not accumulate or create a hazardous condition when the smoke and fire procedures are used. Any accumulation of smoke in an occupied area would not be acceptable. Any smoke entering an occupied compartment when the access door is opened must dissipate within five minutes after the access door is closed.

3.3. Who this Certification Memorandum affects

Applicants for the approval of, and holders of, changes for which it is necessary to show compliance with the EASA certification requirements related to the entry of hazardous quantities of smoke into compartments occupied by the crew or passengers as a result of an in-flight fire event in the pressurized areas of the fuselage of a large aeroplane.

Both EU and non-EU design organisations are affected by this Certification Memo.

4. Remarks

1. This EASA Certification Memorandum was closed for public consultation on 18th November 2019.

2. For any question concerning the technical content of this EASA Certification Memorandum following publication of the final CM, please contact:

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