



# Notice of Proposed Amendment 2017-12

## Regular update of CS-25

RMT.0673

### EXECUTIVE SUMMARY

The specific objective of this Notice of Proposed Amendment (NPA) is to propose amendments to CS-25 following the selection of non-complex, non-controversial and mature subjects.

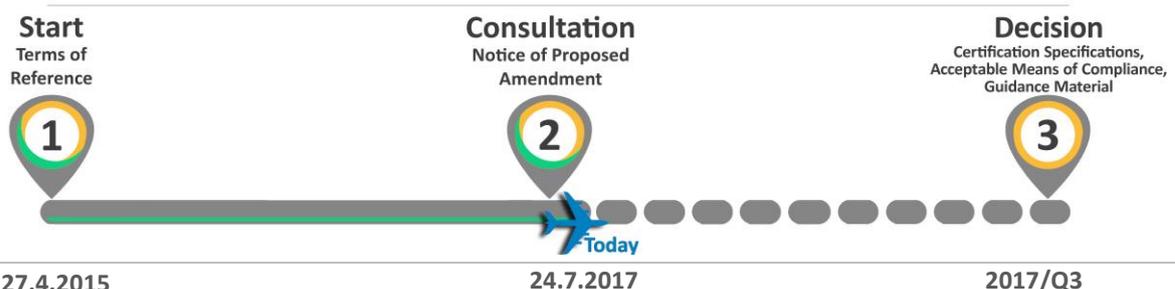
In particular, this NPA proposes amendments to the following items:

- Item 1: Landing in abnormal configurations
- Item 2: Fuel tank vent fire protection
- Item 3: Indication that engine anti-icing systems are functioning
- Item 4: Oxygen fire hazards in gaseous oxygen systems
- Item 5: Flight instrument external probe de-icing test
- Item 6: Flight crew seats
- Item 7: Non-magnetic standby compass
- Item 8: Security requirements
- Item 9: Engine ETOPS capability
- Item 10: Engine cowl retention
- Item 11: Editorial corrections

The proposed amendments are expected to contribute to updating CS-25 (Book 1 and Book 2) to reflect the state of the art of large aeroplane certification and improve the harmonisation of CS-25 with the Federal Aviation Administration (FAA) regulations. Overall, this would provide a moderate safety benefit, would have no social or environmental impacts, and would provide some economic benefits by streamlining the certification process.

<b>Action area:</b>	Regular updates/review of rules		
<b>Affected rules:</b>	CS-25		
<b>Affected stakeholders:</b>	Design approval holders — large aeroplanes		
<b>Driver:</b>	Efficiency/proportionality	<b>Rulemaking group:</b>	No
<b>Impact assessment:</b>	None	<b>Rulemaking Procedure:</b>	Standard

● EASA rulemaking process milestones



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## 1. About this NPA

### 1.1. How this NPA was developed

The European Aviation Safety Agency (EASA) developed this NPA in line with Regulation (EC) No 216/2008<sup>1</sup> (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure<sup>2</sup>. This rulemaking activity is included in the EASA 5-year Rulemaking Programme<sup>3</sup> under rulemaking task (RMT) 0673. The text of this NPA has been developed by EASA. It is hereby submitted to all interested parties<sup>4</sup> for consultation.

### 1.2. How to comment on this NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at <http://hub.easa.europa.eu/crt/><sup>5</sup>.

The deadline for submission of comments is **25 September 2017**.

### 1.3. The next steps

Following the closing of the public commenting period, EASA will review all comments.

Based on the comments received, EASA will develop a decision amending the certification specifications (CSs) and the acceptable means of compliance (AMC) for large aeroplanes (CS-25).

The comments received and the EASA responses thereto will be reflected in a comment-response document (CRD). The CRD will be annexed to the decision.

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<sup>1</sup> Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.3.2008, p. 1) (<http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1467719701894&uri=CELEX:32008R0216>).

<sup>2</sup> EASA is bound to follow a structured rulemaking process as required by Article 52(1) of Regulation (EC) No 216/2008. Such a process has been adopted by the EASA Management Board (MB) and is referred to as the 'Rulemaking Procedure'. See MB Decision No 18-2015 of 15 December 2015 replacing Decision 01/2012 concerning the procedure to be applied by EASA for the issuing of opinions, certification specifications and guidance material (<http://www.easa.europa.eu/the-agency/management-board/decisions/easa-mb-decision-18-2015-rulemaking-procedure>).

<sup>3</sup> <http://easa.europa.eu/rulemaking/annual-programme-and-planning.php>

<sup>4</sup> In accordance with Article 52 of Regulation (EC) No 216/2008 and Articles 6(3) and 7) of the Rulemaking Procedure.

<sup>5</sup> In case of technical problems, please contact the CRT webmaster ([crt@easa.europa.eu](mailto:crt@easa.europa.eu)).



## 2. In summary — why and what

### 2.1. Why we need to change the rules — issue/rationale

The aviation industry is complex and rapidly evolving. Certification specifications (CSs) and acceptable means of compliance (AMC) need to be updated regularly to ensure that they are fit for purpose, cost-effective, and can be implemented in practice.

Regular updates are issued when relevant data is available following an update of industry standards, feedback from certification activities or minor issues raised by the stakeholders.

#### Item 1: Landing in abnormal configurations

The current CS 25.125 landing distance specification is used in conjunction with operational factors to cover reasonably expected operational variations. Procedures and landing distances provided in many aeroplane flight manuals (AFMs) are not always adequate to cover all the significant foreseeable failure cases.

There is no AMC to provide guidance with respect to the scheduling of data for landing in abnormal configurations or following the loss of normal services. A generic certification review item (CRI) interpretative material (IM) document (the content of which was originally drafted by the Joint Aviation Authorities (JAA) Flight Steering Group) has been used. This CRI provides guidance, information and recommendations on how to determine and present in the AFM landing distance information appropriate to abnormal configurations or following the loss of normal services; it also provides guidelines on what failure cases should be considered. This CRI has been applied consistently over the years and its content is considered mature enough to be included in CS-25.

#### Item 2: Fuel tank vent fire protection

On 24 June 2016, the FAA published a final rule<sup>6</sup> amending FAR Part 25, paragraph 25.975, to require fuel tank designs that prevent a fuel tank explosion caused by the propagation of flames, from external fires, through the fuel tank vents. This final rule requires a delay of 2 minutes and 30 seconds between the exposure of external fuel tank vents to ignition sources and explosions caused by the propagation of flames into the fuel tank, thus increasing the time available for passenger evacuation and emergency response.

EASA considers this amendment as a valid improvement, which reflects the state-of-the-art in the fuel tank design area of large aeroplanes, and EASA therefore proposes to harmonise with this amendment, which is No 25-143 of Part 25. Similarly, it is proposed to harmonise with FAA Advisory Circular (AC) No 25.975-1<sup>7</sup>.

<sup>6</sup> FAA Final rule titled 'Fuel Tank Vent Fire Protection' of Federal Register 81 FR 41200, published on 24 June 2016, effective on 23 August 2016 (Docket No.: FAA-2014-0500; Amdt. Nos. 25-142, 21-376, and 129-53):

<https://www.federalregister.gov/documents/2016/06/24/2016-14454/fuel-tank-vent-fire-protection>.

Correction published and effective on 26 July 2016 of Federal Register 81 FR 48693 (Docket No.: FAA-2014-0500; Amdt. Nos. 25-143, 121-375, and 129-52): <https://www.federalregister.gov/documents/2016/07/26/2016-17590/fuel-tank-vent-fire-protection-correction>.

<sup>7</sup> FAA AC 25.975-1 titled 'Fuel Vent Fire Protection', dated 24 June 2016:

[https://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.information/documentID/1029668](https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1029668).



**Item 3: Indication that engine anti-icing systems are functioning**

CS 25.1305(c)(5) requires 'An indicator to indicate the functioning of the powerplant ice protection system for each engine.'

In addition to nacelle ice protection systems (such as air inlet anti-icing systems), engine compressor ice protection systems also exist to protect the engine core against icing conditions. In most cases, engine ice protection systems are automatically controlled by the engine control systems, taking into account environmental, aircraft and engine conditions.

A literal application of CS 25.1305(c)(5) means that an indicator is required to show whether or not any engine ice protection system is functioning, knowing that such a system may be permanently or intermittently activated through manual and/or automatic means. This rule has been the subject of discussions with stakeholders for a long time and even before the creation of EASA, with different interpretations being proposed.

EASA has issued a generic CRI providing IM to clarify how CS 25.1305(c)(5) should be applied. The EASA position provided in this CRI is that an indication of the correct functioning of each engine ice protection system should not be solely and uniquely related to a manual crew action, but potentially to permanently or intermittently activated systems that have a means of regulation. The CRI also recognises that, on aeroplanes adhering to the 'dark cockpit' philosophy, there might be some situations where the functioning of an automatic engine ice protection system might not need to be indicated. Finally, the CRI provides the conditions under which an indication should be provided.

This CRI is considered mature and not controversial, and it is proposed to introduce its content into CS-25 with the creation of AMC 25.1305(c)(5).

**Item 4: Oxygen fire hazards in gaseous oxygen systems**

There is no means to control an oxygen fire in flight and such a fire can lead to the combination of aircraft depressurisation and the non-availability of an oxygen supply to protect the occupants. Therefore an oxygen fire in flight is potentially catastrophic.

To initiate an oxygen fire, there is a need to combine oxygen, fuel (i.e. flammable material) and an ignition mechanism. In an oxygen-enriched environment, most materials ignite at lower temperatures than in ambient air and combustion rates are higher. Oxygen equipment consisting of pressurised cylinders, regulators, valves, tubing and fittings is made out of metallic and non-metallic materials. All of these materials can combust in the presence of 100 % pressurised oxygen.

Because most materials, including metal, burn in an oxygen-enriched environment, the risk of ignition from all factors should be assessed and kept as low as possible.

Ignition within an oxygen-enriched environment can occur due to various sources, in particular contamination and compression heating. Ignition is also possible from outside sources, such as arcing from electrical equipment.

Even if no ignition source is identified, pressure shocks may provide the energy to generate an auto-ignition. A quantity of any gas can generate a considerable amount of heat if rapidly compressed. This happens when a gas is quickly released through a hose to a dead end or from a higher-pressure to a lower-pressure location and the gas encounters a restriction such as a pressure regulator. A temperature rise is associated with the compression of oxygen in such a location. Since oxygen is

necessary to support combustion, the temperature rise associated with the compression of oxygen can readily ignite polymers or flammable contaminants. Lubricants, tapes and gaskets can increase the possibility of ignition in oxygen systems.

CSs for fire protection applicable to oxygen systems are provided in CS 25.869(c). These specifications cover the installation aspects and specify in particular that oxygen equipment and lines shall not be located in any designated fire zone; shall be protected from heat that may be generated in, or escape from, any designated fire zone; and shall be installed so that escaping oxygen cannot cause the ignition of grease, fluid or vapour accumulations that are present during normal operation or as a result of a failure or malfunction of any system. AMC 25.869(c) provides further guidance related to design precautions to be taken for oxygen system installations.

However, CS 25.869(c) and the associated AMC do not sufficiently address oxygen system design and the precautions to be taken to minimise the risk of fire originating from the oxygen system itself.

In addition, CS 25.1453(e) requires pressure-limiting devices to be provided to protect parts of the system from excessive pressure. It is furthermore required that such devices must prevent the pressures from exceeding the applicable maximum working pressure multiplied by 1.33 in the event of a malfunction of the normal pressure-controlling means (e.g. a pressure-reducing valve). Experience has shown that such devices are not necessarily checked when installed in a complete system and may not release the pressure quickly enough to avoid an unacceptable pressure built-up in the oxygen system.

Furthermore, CS 25.1441(b) requires that the oxygen system must be free from hazards in itself, in its method of operation, and in its effect upon other components.

Experience from products in service has shown that unsafe conditions may develop and EASA believes that CS 25.869(c) and CS 25.1453 need to be clarified with respect to oxygen fire hazards in gaseous oxygen systems — whether centralised, decentralised or portable. A generic CRI has been issued by EASA to provide IM and proposed means of compliance on this subject. It is now proposed to introduce the related content into CS-25.

#### **Item 5: Flight instrument external probe de-icing test**

The current wording of paragraph 9.b of AMC 25.1324 may be confusing and could lead applicants not to perform de-icing tests when installing probe heating systems that are automatically activated and may not be operated manually. This has been experienced by EASA in the frame of certification projects with two manufacturers.

It is proposed to add a sentence at the end of the paragraph to clarify that failure conditions not demonstrated to be extremely improbable, which may lead to a probe heating supply interruption, should be considered when assessing the need for a de-icing test. For example, on some projects, failure conditions leading to an electrical system reconfiguration that induces a probe heating system power interruption have been considered.

#### **Item 6: Flight crew seats**

To protect aeroplane occupants during an emergency landing, CS 25.562(b) requires, with the exception of flight deck crew seats, each seat type design approved for occupancy to successfully

complete dynamic tests or be demonstrated to be acceptable by rational analysis based on dynamic tests of a similar type of seat.

This exception granted to flight deck crew seats does not exist in the equivalent FAR Part 25.562(b) rule. In practice, large aeroplane manufacturers do not follow this exception and they qualify flight crew seats according to FAR/CS 25.562. It is therefore proposed to amend CS 25.562(b) to delete this exception, which will improve harmonisation with FAR Part 25.

CS 25.562(b)(2), related to changes in forward longitudinal velocity, requires that 'where floor rails or floor fittings are used to attach the seating devices to the test fixture, the rails or fittings must be misaligned with respect to the adjacent set of rails or fittings by at least 10 degrees vertically (i.e. out of parallel) with one rolled 10 degrees'. This requirement, which exists to take into account the floor deformation during an emergency landing, is not considered necessary to be applied to flight deck crew seats that are mounted in the forward conical area of the fuselage, because the forward conical area of the fuselage has a higher stiffness and a different floor structure compared to the rest of the fuselage. EASA is also aware that the FAA has granted exemptions to this requirement for flight crew seats. It is therefore proposed to amend CS 25.562(b)(2) to reflect this situation.

#### **Item 7: Non-magnetic standby compass**

CS 25.1303(a)(3) specifies the following:

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

(...)

(3) A direction indicator (non-stabilised magnetic compass).'

The intent is to provide to the flight crew a supplementary, independent and highly available direction indicator which is not affected by the failure modes of the primary direction indicator required by CS 25.1303(b)(6). This intent is conveyed by CS 25.1333(b) and AMC 25-11, Chapter 4, Table 6, which provide safety objectives regarding the availability of direction indications in the cockpit.

Compliance with CS 25.1303(a)(3) is usually fulfilled by installing a so-called 'Whiskey' compass in the cockpit. This typically magnetic, non-stabilised and thus non-powered direction indicator is totally independent from the primary, gyro-stabilised direction indicators and not subject to the same failure modes.

However, direction indicators based on a technology that differs from the one mentioned by CS 25.1303(a)(3) (i.e. a 'non-stabilised magnetic compass') have emerged (for instance, magnetometer indicators). These direction indicators can be installed and they comply with the intent of CS 25.1303(a)(3). EASA has already certified such direction indicators on several large aeroplanes by means of equivalent safety findings (ESFs). The FAA has also certified this kind of direction indicator in a similar way.

It is proposed to amend CS 25.1303(a)(3) and create AMC 25.1303(a)(3) to reflect the content of the ESF, which is considered sufficiently mature to be introduced into CS-25.



As a matter of consistency, it is proposed to amend AMC 25.1327 to delete paragraph 5, which refers to the ‘standby compass instruments’ technology and which is more restrictive than CS 25.1327(b) (as CS 25.1327(b) takes into account non-stationary flight conditions, whereas AMC paragraph 5 does not).

Finally, it is also proposed to amend AMC 25-11, Chapter 4, Table 6, which refers to a ‘loss of stabilised heading in the flight deck’ in its first row. The intent of referring to stabilised heading is to designate the heading displayed on both pilots’ primary displays. As CS 25.1303(a)(3) will no longer require a ‘non-stabilised direction indicator’, this row of Table 6 should directly refer to primary displays.

### Item 8: Security requirements

During the public consultation period of NPA 2015-19 ‘Executive interior accommodation’<sup>8</sup> related to RMT.0264 (MDM.066), several stakeholders commented that the security requirements of CS 25.795 are not appropriate for non-commercially operated and low-occupancy aeroplanes. They recommended that compliance with these requirements be exempted by Appendix S in a manner similar to that of FAA Special Federal Aviation Regulation (SFAR) No. 109 (Special Requirements for Private Use Transport Category Airplanes), article 16. Unfortunately, the stakeholder group who drafted the NPA did not address this topic during its deliberations, and it was not included in NPA 2015-19. As a result of these comments, EASA decided that it was not appropriate to issue a decision amending CS-25 without conducting a public consultation. In order not to delay the publication of CS-25 Amendment 19 (containing the outcome of RMT.0264 (MDM.066)), it was agreed within the review group to complete this action in a future rulemaking task. As this topic is not considered controversial, it has been selected for this NPA.

EASA reviewed the FAA notice of proposed rulemaking (NPRM)<sup>9</sup> which proposed the SFAR No. 109 exemption, and in it, the following statement is provided:

‘Generally, airplanes in private use carry heads of state, business leaders, and ordinary citizens. In contrast to commercial passenger airplanes, access to airplanes in private use is limited to specific individuals, namely, the owner and guests. For this reason, these airplanes typically are not targets of onboard terrorists. We believe that applying the proposed requirements to airplanes in private use would not provide significant improvement in security. We welcome comments regarding applicability of the proposed rule.’

According to the FAA final rule<sup>10</sup>, although the FAA specifically sought input on this subject, they received no comments on it.

EASA agrees with the FAA position and the comments received on NPA 2015-19, and it is therefore proposed to amend CS-25 Appendix S to exempt non-commercially operated aeroplanes certified in accordance with Appendix S from the CS 25.795(b), (c) and (d) requirements. The applicability of CS 25.795(a) will remain driven by operating rules; the current applicability (see point ORO.SEC.100 of Annex III to Commission Regulation (EU) No 965/2012<sup>11</sup>) is for aeroplanes of a maximum certified

<sup>8</sup> <http://www.easa.europa.eu/document-library/notices-of-proposed-amendment/npa-2015-19>

<sup>9</sup> Notice of Proposed Rulemaking (NPRM), Notice No. 07-13, entitled ‘Special Requirements for Private Use Transport Category Airplanes’ (72 FR 38732): <https://www.federalregister.gov/documents/2007/07/13/E7-13582/special-requirements-for-private-use-transport-category-airplanes>.

<sup>10</sup> Final rule, SFAR No. 109, entitled ‘Special Requirements for Private Use Transport Category Airplanes’ (74 FR 21533):

<https://www.federalregister.gov/documents/2009/05/08/E9-10807/special-requirements-for-private-use-transport-category-airplanes>.

<sup>11</sup> Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (OJ L 296, 25.10.2012, p. 1).



take-off mass exceeding 45 500 kg, or with a maximum operational passenger seating configuration (MOPSC) of more than 60 engaged in the commercial transportation of passengers.

This would almost harmonise with SFAR No. 109. The remaining difference is that SFAR No. 109 limits the passenger capacity to a maximum of 60; CS-25 Appendix S provides a limit of 150 passengers per deck.

#### **Item 9: Engine ETOPS capability**

CS 25.1535 'ETOPS Design approval' does not explicitly identify the prerequisite for an engine to be approved for ETOPS capability in accordance with CS-E 1040, although this is required for an aeroplane to be eligible for ETOPS approval.

It is proposed to amend CS 25.1535 to clarify this requirement.

In addition, a correction is made in the current sub-paragraph (b) which requires to consider 'the flight crew's and passengers' physiological needs of continued operations with failure effects for the longest diversion time for which approval is being sought'. As the intent of this requirement is to also include cabin crew members, the word 'flight' is deleted. This change allows to harmonise with the equivalent text in FAA FAR 25, Appendix K – Extended Operations (ETOPS), paragraph 1.2.

#### **Item 10: Engine cowl retention**

A number of engine fan cowl separation occurrences have been reported on various types of large aeroplanes/engines. Most of the time, it has been possible to trace the initiating factor of the cowl separation as being a maintenance error, generally resulting from a failure of maintenance staff to properly close the fan cowl latches. Flight crews were not able to detect this situation during their preflight walk-around or check, and the cowl(s) became detached during the subsequent take-off run or during climb.

An engine fan cowl separation can result in hazards to third parties on the ground (people, buildings, airport infrastructure, vehicles, including other aircraft) and to the aeroplane itself. In this latter case, for instance, the cowl may become wrapped around the engine pylon, the wing or the leading edge of the tailplane, causing unforeseen aerodynamic perturbations, or causing severe damage to the airframe as a result of the impact, including depressurisation. An occurrence has shown that damage to the engine itself may result in a potentially uncontrolled fire.

Such occurrences are therefore normally considered to be potentially unsafe conditions, prompting EASA and other aviation authorities to issue airworthiness directives (ADs) mandating the introduction of design improvements, generally intended to increase the visibility of latches that are left open, in order to alert maintenance staff or flight crews.

#### *Human-factor considerations*

Since most of the occurrences appear to be associated with a 'maintenance error' (typically a failure to properly and completely close the fan cowl latching system), addressing the issue by relying on training or improved maintenance procedures and standards could appear to be the solution. Some operators have introduced improved procedures and have reinforced maintenance staff training and awareness; some operational authorities have mandated double, independent checking of the effective closure of the cowl after any maintenance action involving their opening. Despite those measures, fan cowl separations are still happening and it appears that, along with proper maintenance practices and



procedures, the solution to this issue involves action at design level. It cannot be expected that a design will be able to cope with any type of maintenance abuse; however, it shall minimise the risk associated with the normal maintenance practices in the airline environment.

#### *Practical design solutions*

The in-service experience accumulated with recent aeroplane designs, or with aeroplanes that have been retrofitted with modifications mandated by ADs, still shows fan cowl separation occurrences, despite the changes introduced. This indicates that relying on the visibility of latches left open, even if they have specific design features (such as hold-open devices, dedicated weight, special painting), does not provide a sufficient indication to maintenance staff and/or flight crews that allows them to detect that the fan cowl is partially or totally unlatched. A larger or more obvious indication is required.

Some nacelles feature more conspicuous devices, for instance doors covering the fan cowl latches (e.g. latch access panels (LAPs)), and these have proved to provide a far better level of safety. However, LAPs, or similar design features, might not be feasible on all nacelles, depending for instance on the geometry of the nacelle and/or its ground clearance.

Cockpit indications of fan cowl latching/unlatching have not yet been introduced. They might nevertheless prove to be a viable alternative if the above-mentioned design features, such as LAPs, are not feasible.

#### *Special condition*

CS-25 does not currently contain any specifications addressing engine cowl latching systems or cowl retention. Taking into account the number of occurrences reported, as well as the potential consequences associated with engine cowl separations, as per the provision of Part 21A.16B(a)3, EASA issued a generic special condition (SC) introducing specific requirements for protection against the risk of engine cowl separation, which is considered to be an unsafe condition. This SC has been applied to three different types of large aeroplanes and is considered mature enough to be introduced into CS-25.

#### **Item 11: Editorial corrections**

AMC 25.21(g), paragraph 4.1.1: the first sentence refers to EU-OPS 1.345 as an example of operating rules. As EU-OPS (Annex III to Council Regulation (EEC) No 3922/91<sup>12</sup>) has been repealed, the reference should be replaced by a reference to the corresponding point in Annex IV (Part-CAT) to Commission Regulation (EU) No 965/2012, i.e. CAT.OP.MPA.250.

## **2.2. What we want to achieve — objectives**

The overall objectives of the EASA system are defined in Article 2 of the Basic Regulation. This proposal will contribute to the achievement of the overall objectives by addressing the issues outlined in Chapter 2.1.

The specific objective of this NPA is to propose amendments to CS-25 based on the above selection of non-complex, non-controversial and mature subjects, with the ultimate goal being to increase safety.

<sup>12</sup> Council Regulation (EEC) No 3922/91 of 16 December 1991 on the harmonization of technical requirements and administrative procedures in the field of civil aviation (OJ L 373, 31.12.1991, p. 4).



### 2.3. How we want to achieve it — overview of the proposals

#### *Item 1: Landing in abnormal configurations*

It is proposed to create subparagraph CS 25.1587(c) and create AMC 25.1587(c) entitled 'Landing distances in abnormal configurations'.

#### *Item 2: Fuel tank vent fire protection*

It is proposed to amend CS 25.975 ('Fuel tank vents') and create AMC 25.975(a)(7).

#### *Item 3: Indication that engine anti-icing systems are functioning*

It is proposed to create AMC 25.1305(c)(5).

#### *Item 4: Oxygen fire hazards in gaseous oxygen systems*

It is proposed to create AMC 25.1441(b) to address the risk assessment related to oxygen fire hazards in gaseous oxygen systems.

#### *Item 5: Flight instrument external probe de-icing test*

It is proposed to amend paragraph 9.b of AMC 25.1324 on flight instrument external probes.

#### *Item 6: Flight crew seats*

It is proposed to amend CS 25.562(b) to remove the exception for flight deck crew seats.

#### *Item 7: Non-magnetic standby compass*

It is proposed to amend CS 25.1303(a)(3), to create AMC 25.1303(a)(3), and to amend AMC 25.1327 and AMC 25-11.

#### *Item 8: Security requirements*

It is proposed to amend Appendix S by creating paragraph S25.60 on security requirements.

#### *Item 9: Engine ETOPS capability*

It is proposed to amend CS 25.1535.

#### *Item 10: Engine cowl retention*

It is proposed to amend CS 25.1193 ('Cowling and nacelle skin') and create AMC 25.1193(e)(4) and (f).

#### *Item 11: Editorial corrections*

It is proposed to amend AMC 25.21(g), paragraph 4.1.1, to update the example reference to the operating rules.

#### 2.4. What are the expected benefits and drawbacks of the proposals

The proposed amendments are expected to contribute to updating CS-25 (Book 1 and Book 2) to reflect the state of the art of large aeroplane certification and improve the harmonisation of CS-25 with the FAA regulations. Overall, this would provide a moderate safety benefit, would have no social or environmental impacts, and would provide some economic benefits by streamlining the certification process.



### 3. Proposed amendments and rationale in detail

The text of the amendment is arranged to show deleted text, new or amended text as shown below:

- deleted text is ~~struck through~~;
- new or amended text is highlighted in grey;
- an ellipsis ‘(...)’ indicates that the rest of the text is unchanged.

#### 3.1. Draft Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes (draft EASA decision amending CS-25)

##### Item 1: Landing in abnormal configurations

CS 25.1587 is amended as follows:

##### **CS 25.1587 Performance information**

(See AMC 25.1587)

(...)

(c) Each aeroplane flight manual (AFM) must contain the performance information associated with abnormal landing configurations (see AMC 25.1587(c)).

AMC 25.1587(c) is created as follows:

##### **AMC 25.1587(c)**

##### **Landing distances in abnormal configurations**

###### 1. Purpose

This AMC provides guidance and recommendations on how to determine and present in the aeroplane flight manual (AFM) landing distance information appropriate to abnormal configurations or following the loss of normal services, and guidelines on which failure cases should be considered.

###### 2. Related certification specifications

CS 25.125 Landing

CS 25.1585 Operating procedures

CS 25.1587 Performance information

###### 3. Background

When a failure occurs in flight, the flight crew has to analyse the consequences of this failure on the landing. Some failures cause an increase in the landing distance, which must be evaluated. A diversion may be necessary if the destination aerodrome runway is no longer appropriate due to the increased landing distance.

For the production of AFM data, the applicant considers all failures and assesses their probability of occurrence. In addition, the question of the best presentation of the relevant data should be addressed.



This AMC does not consider configuration deviation list (CDL) items or any unserviceabilities identified in the master minimum equipment list (MMEL) that are known prior to dispatch.

#### 4. Performance information

Information on the landing distance likely to be needed for landings in abnormal configurations, and following the loss of normal services, should be determined. This information should be the horizontal distance necessary to land and come to a complete stop from a point 50 feet above the landing surface for standard temperatures at each weight, altitude and wind within the operational limits established by the applicant for landing on a dry runway. This information should be established in accordance with CS 25.125(b)(4) and (5), CS 25.125(c)(1) and (2), CS 25.125(f) and with the following conditions:

- (a) The aeroplane is in the landing configuration appropriate to the failure case being considered;
- (b) A steady approach is maintained down to the 50-ft height, at not less than the recommended approach speed, and using the recommended approach procedure, appropriate to the failure case being considered. (See paragraph 5 below);
- (c) Changes to configuration, power or thrust, and speed are made in accordance with the recommended procedure appropriate to the failure case being considered; and
- (d) All deceleration devices with which the aeroplane is fitted, including reverse thrust, may be used during the on-ground part of the landing, to an extent dependent both on the characteristics of the aeroplane and on the recommended use of deceleration devices, provided that:
  - (1) a practical procedure for their use has been established;
  - (2) the controllability of the aeroplane during their use has been shown to be satisfactory (see paragraph 8 below); and
  - (3) they would be available, and their use is recommended for the failure case being considered.

#### 5. Operating procedures

It is intended that the procedures, used in deriving the landing distance of paragraph 4 above and required by CS 25.1585(a) to be included in the AFM, should generally be based on the application of conventional stall and controllability margins. Where the procedure uses less than the normal margin, this should be based on flight evaluation and stated in the AFM, along with advice on how this might affect the way the approach is conducted (e.g. reduced pitch manoeuvre capability and the ability to counteract wind shear). For some configurations which cannot be easily flight-tested, a combination of flight test, simulation and analysis may be acceptable.

#### 6. Effect of failures on landing distance

Information on landing distances in abnormal configurations should cover the normal and non-normal procedures for single failures and combinations of failures provided in the AFM which:

- (a) have a probability of occurrence greater than approximately  $10^{-7}$ ; and
- (b) result in more than a 10 % increase in landing distance.

If a procedure is included in the AFM for a failure case that:

- (a) has a probability of occurrence less than  $10^{-7}$ ; and
- (b) results in an increase in the landing distance of more than 10 %,

then information about the increase in landing distance should also be included in the AFM.

### 7. Effect of overspeed and wet runway

Information on the separate effects of a 10-kt overspeed and of a wet runway should be provided.

Note: Overspeed in the above context refers to speed in excess of the approach speed recommended for the abnormal condition, which itself may be greater than the normal approach speed.

### 8. Deceleration devices

Deceleration devices may be used during the on-ground part of the landing to the extent that directional control can be maintained readily during their use on a wet runway, with a crosswind component of not less than 10 kt from the adverse side.

### 9. Data derivation and AFM presentation

The performance information described in paragraph 4 may be derived from calculations conservatively based on the best available information, on simulation or flight test, or any combination of these. The recommended operating procedures discussed in paragraph 5 should be derived from flight test results. They should be presented in a simple manner (e.g. as increments in the landing distance, or approach speeds). The effects of overspeed and a wet runway may be presented as generalised information covering a variety of abnormal configurations.

## **Item 2: Fuel tank vent fire protection**

CS 25.975 is amended as follows:

### **CS 25.975 Fuel tank vents**

(See AMC 25.975)

(...)

(5) There may be no point in any vent line where moisture can accumulate with the aeroplane in the ground attitude or the level flight attitude, unless drainage is provided; ~~and~~

(6) No vent or drainage provision may end at any point –

(i) Where the discharge of fuel from the vent outlet would constitute a fire hazard; or

(ii) From which fumes could enter personnel compartments; ~~and~~

(7) Each fuel tank vent system must prevent explosions, for a minimum of 2 minutes and 30 seconds, caused by propagation of flames from outside the tank through the fuel tank vents into fuel tank vapour spaces when any fuel tank vent is continuously exposed to flames. (See AMC 25.975(a)(7))

AMC 25.975(a)(7) is created as follows:

### **AMC 25.975(a)(7)**

#### **Fuel tank vent fire protection**

##### 1. Purpose

This AMC provides guidance and acceptable means of compliance with CS 25.975(a)(7) and the related specifications for preventing fuel tank explosions caused by the ignition of vapours outside the fuel tank vents.

##### 2. References

###### 2.1. Related certification specifications

- CS 25.863 Flammable fluid fire protection
- CS 25.867 Fire protection: other components
- CS 25.901 Installation (paragraphs (b)(2) and (c))
- CS 25.954 Fuel system lightning protection
- CS 25.963 Fuel tanks: general (paragraphs (d) and (e)(2))
- CS 25.981 Fuel tank ignition prevention

###### 2.2. Technical Publications

- Hill, Richard and George R. Johnson, Investigation of Aircraft Fuel Tank Explosions and Nitrogen Inerting Requirements During Ground Fires, FAA Technical Report No. FAA-RD-75-119. Washington, D.C.: U.S. Department of Transportation, 1975
- FAA Technical Report ADS-18, National Technical Information Service (NTIS), Lightning Protection Measures for Aircraft Fuel Systems. Springfield, VA: U.S. Department of Commerce, 1964
- Military Standard, Environmental Engineering Considerations and Laboratory Test Methods, MIL-STD-810G w/Change1, Method 511.6 Procedure II. Philadelphia, PA: U.S. Department of Defense, 2014
- RTCA, Inc., Environmental Conditions and Test Procedures for Airborne Equipment, RTCA/DO-160G. Washington DC: RTCA, Inc., 2010
- Coordinating Research Council, Inc., Handbook of Aviation Fuel Properties. Atlanta, GA: CRC, Inc., 2004
- Kuchta, Joseph M., Summary of Ignition Properties of Jet Fuels and Other Aircraft Combustible Fluids, Technical Report AFAPL-TR-75-70. Springfield, VA: U.S. Department of Commerce, 1975



### 3. Definitions

- **Autogenous Ignition (Auto-Ignition) Temperature (AIT).** The minimum temperature at which an optimised flammable vapour and air mixture will spontaneously ignite when heated to a uniform temperature in a normal atmosphere without an external source of ignition, such as a flame or spark.
- **Flammability Limit.** The highest and lowest concentration of fuel-in-air-by-volume per cent that will sustain combustion. A fuel-to-air mixture below the lower limit is too lean to burn, while a mixture above the upper limit is too rich to burn. The flammability limit varies with altitude and temperature and is typically presented on a temperature-versus-altitude plot.
- **Flash Point.** The minimum temperature at which a flammable liquid will produce flammable vapour at sea level ambient pressure.
- **Flame Holding.** The ability of a flame arrestor to halt the propagation of a flame front through a passage.
- **Ignition Source.** A source of sufficient energy to initiate combustion of a fuel-air mixture. Hot surfaces that can exceed the auto-ignition temperature of the flammable vapour under consideration are considered to be ignition sources. Electrical arcs, electrical sparks, and friction sparks are also considered to be ignition sources if sufficient energy is released to initiate combustion.
- **Stoichiometric Ratio.** The ratio of fuel to air corresponding to the condition in which the available amounts of fuel and oxygen completely react with each other, thereby resulting in combustion products containing neither fuel nor oxygen.

### 4. Acceptable means of compliance

Acceptable means of compliance with CS 25.975(a)(7) include:

- flame arrestors in the fuel tank vents that prevent flame propagation into the fuel tank (see paragraph 5 of this AMC);
- fuel tank inerting systems, exceeding the basic requirements of CS 25.981, that prevent fuel tank explosions\* (see paragraph 7.1 of this AMC);
- fuel tank pressurisation systems or features of the system that result in a closed vent system that are effective in preventing a fuel tank explosion during all operating conditions (e.g. taxi, take-off, landing, refuelling, etc.) and post-crash fire conditions (see paragraph 7.2 of this AMC); and
- fuel tank or vent system fire suppression systems that prevent a fuel tank explosion with a fire present at the fuel tank vent outlet for the required 2 minutes and 30 seconds (see paragraph 7.3 of this AMC).

\* Fuel tank inerting systems meeting CS 25.981 would not necessarily be adequate for demonstrating compliance with CS 25.975 because CS 25.981 does not require the fuel tank ullage to be fully inert at all times. If inerting is used as the means of compliance with CS 25.975, the inerting system must be effective in preventing flame that is present at the vent outlet from propagating to the fuel tank. The applicant should show this during normal operating conditions, all foreseeable ground fire conditions (e.g. from refuelling, refuelling overflow, etc.), and post-crash ground fire conditions.

## 5. Flame arrestors

5.1. This paragraph describes the use of flame arrestors as a means of meeting the 2-minute and 30-second time requirement defined in CS 25.975(a)(7). The guidance is based on evaluating the flame arrestor performance during critical case conditions anticipated to occur when fire is adjacent to the fuel tank vent outlet. The flame arrestor should meet the performance described in this AMC during post-crash ground fires or other fire scenarios such as those resulting from fuel leakage due to fuel tank damage or fuel spilled during refuelling mishaps.

5.2. Flame arrestors meeting the standards defined in this AMC may not be effective in preventing the propagation of fires that may occur following lightning strikes near the fuel tank vent outlet. Ignition of fuel vapours near the vent outlet caused by lightning results in a high-speed pressure wave that can travel through the flame arrestor without sufficient time for the heat transfer necessary for the flame arrestor to quench the flame front. Instead, fuel tank vent lightning protection may be addressed as discussed in AMC 25.954 'Fuel System Lightning Protection', which is based on locating vents outside the lightning strike zones of the aeroplane. While aeroplane manufacturers have used flame arrestors to address lightning protection in several instances, they needed dedicated testing considering the unique design features to demonstrate the effectiveness of the installation. The guidance in this AMC is intended to address compliance with CS 25.975(a)(7) and is not intended to be used as guidance for showing compliance with the lightning protection requirements in CS 25.954.

5.3. The installation of flame arrestors in the aeroplane fuel vent system will impact the fuel tank vent system performance. The applicant should account for factors such as the introduction of a flow restriction and the associated increase in pressure drop during refuelling system failure conditions, as well as the impact of environmental conditions such as icing and lightning, when requesting approval of the fuel tank installation. Compliance means for these considerations are not addressed in this AMC. General fuel system guidance is provided in AMC 25.963 and AMC 25.981.

5.4. Past flame arrestor performance test results indicate that the critical condition for evaluating the effectiveness of the flame arrestor occurs when the flame front contacts the surface of the flame arrestor, which results in heating of the flame arrestor. As the flame arrestor is heated, the ability of the flame arrestor to absorb energy may be reduced, resulting in its inability to quench the flame. Once this occurs, the flame will then pass through the flame arrestor, resulting in flashback. It is important to realise that flashback through heated flame arrestor channels, which are normally quenching, should not be confused with auto-ignition or hot surface ignition. Flashback will occur when the rate of heat loss to the channel wall is insufficient to quench the flame. In this case, the wall acts as an inadequate heat sink and not as an ignition source. The flame retains sufficient heat energy to pass to the upstream side of the flame arrestor.

5.5. Flame propagation past the flame arrestor may also occur due to the ignition of flammable vapours by hot surfaces. The time it takes for the assembly surfaces on the internal side of the flame arrestor, including the line and housing, to be heated above the AIT of the flammable vapour mixture could be the limiting factor in establishing the effectiveness of the flame arrestor assembly. The ignition of combustible mixtures by hot surfaces (auto-ignition) involves different phenomena from the phenomena involved in flashback as discussed in paragraph 5.4 of this AMC. For auto-ignition to occur, a portion of the combustible gas must dwell near a hot surface for a time, such that the amount of chemical heat produced is greater than the heat dissipated to the surroundings. The maximum dwell time (commonly termed the 'ignition lag') is a function of the heat transfer characteristics of the gas and the heat source, as well as the kinetics of the combustion process. For this reason, the surface area and the shape of the hot surface, and the flow field around the heat source, are critical factors in determining whether ignition will occur.

5.6. The test conditions defined in this AMC are intended to evaluate the effectiveness of flame arrestors during two conditions. The first condition is the ignition, by an external source, of flammable

vapours at the fuel tank vent outlet. The flame arrestor should be effective in stopping the initial propagation of flames. The second condition is a continuous flow of vapour exiting the fuel vent. The flame arrestor should hold the flames without passing the flames to the upstream portion of the vent system. The applicant should determine the critical test conditions following a review and analysis of the particular flame arrestor installation and its characteristics.

5.7. The conditions under which the flame arrestor should be effective include those where flammable fluid vapours are exiting the fuel tank at flow rates varying from no flow, typically occurring during normal ground operations, to high-flow conditions, typically occurring during refuelling or when the fuel tank is heated due to ground fire following an accident.

5.8. The applicant should conduct an analysis to determine the pass/fail criteria for the aeroplane-specific flame arrestor installation. The analysis should include consideration of hot surface ignition when determining whether the flame arrestor assembly meets the explosion prevention requirement of 2 minutes and 30 seconds. The maximum flame arrestor installation surface temperatures and the flame arrestor surface temperatures should be established when meeting the requirement. The applicant should consider the velocity of the flammable fluid vapour on the surface of the flame arrestor and the duct sidewall upstream (tank) side of the flame arrestor. Provided that a uniform vapour velocity is present (no stagnation areas), a heat source whose temperature exceeds the AITs quoted for static conditions (typically 230 °C/450 °F) will not cause ignition in the flame arrestor installation. Data in the Handbook of Aviation Fuels Properties (see Chapter 2.2 of this AMC) show the relationships between velocity and AITs. Test results from developmental testing of flame arrestors installed in fuel vent lines have shown that ignition will not occur provided the centre of the flame arrestor remains below 370 °C/700 °F. However, this temperature limit may not be appropriate for other surfaces in the flame arrestor installation where a uniform flammable vapour flow is not present. The applicant should analyse the flame arrestor design to determine the critical locations and fuel vapour flow conditions that result in the highest surface temperatures, and run an adequate number of test conditions to validate the analysis.

## 6. Demonstrating compliance using flame arrestors

6.1. Flame arrestor performance is influenced by installation effects that may cause variations in critical parameters such as the speed of the flame front and the temperature of surfaces. The applicant should account for installation effects in demonstrating compliance. The applicant may choose to show compliance with CS 25.975(a)(7) by testing a complete, conformed production installation of the flame arrestor (including the upstream and downstream ducting). Alternatively, the applicant may request EASA approval to use other tests and analysis of the flame arrestor and the installation as a means of compliance.

6.2. The applicant may propose using flame arrestor elements from a supplier. The supplier may have previously qualified an element to flame propagation requirements without consideration of the design of the aeroplane into which the flame arrestor will be installed. The applicant should conduct tests to show that they have accounted for any effects of installation, including flame front speeds and duct sidewall temperatures. Fuel types for these tests differ and should be established as discussed in paragraph 6.3.1.3 of this AMC prior to conducting any testing.

### 6.3. Flame Arrestor Installation Test.

#### 6.3.1. Test Set-up.

Figure A-1 shows a schematic of the test set-up. The test set-up involves mounting the flame arrestor element in a tube configuration representative of the aeroplane installation. The speed of the flame front that travels down the fuel vent system tubing toward the flame arrestor is a critical factor in the flame propagation performance of the flame arrestor. The flame front will accelerate down the tubing,

so higher velocities will occur as the flame arrestor is located farther away from the fuel tank vent outlet. Therefore, the shape and diameter of the tubing and its length from the fuel tank vent inlet to the flame arrestor should be representative of the production configuration, unless the flame arrestor element was previously found to comply in an installation where the flame speed reaching the flame arrestor was higher. In addition, the orientation of the flame arrestor in the fixture is a critical parameter for the compliance demonstration. For instance, a flame arrestor installation that faces downward, so a ground fire impinges on its face, will have a shorter duration flame-holding capability than a flame arrestor that is mounted horizontally.

#### 6.3.1.1. Test Fixture Features.

The applicant should consider the following features in designing the flame arrestor test fixture:

1. Orient the element to simulate the actual aeroplane installation.
2. Cut viewing sections into the pipe upstream and downstream of the flame arrestor element and cover them with transparent material to provide visual access to the element.
3. Locate igniters upstream and downstream of the element.
4. Locate thermocouples in the duct to measure the incoming flammable mixture temperature and the vapour temperatures downstream of the flame arrestor element.
5. Install thermocouples on the surface of the centre of the flame arrestor element's upstream face and on the surface of the upstream side of the duct.
6. Incorporate a pressure-relief feature in the upstream portion of the system to relieve explosive pressures when ignition of the upstream flammable fluid vapour occurs.
7. Mix air that is at a temperature higher than the boiling point of the fuel being used (see paragraph 6.3.1.3 of this AMC) with fuel, and introduce it at the inlet of the tube.
6. Vary fuel-air ratios by adjusting the respective fuel-vapour and air-supply rates.

#### 6.3.1.2. Test Equipment.

The test equipment should include:

1. The test article, including the flame arrestor and the downstream section of the vent system assembly that meets production specifications.
2. A section of ducting representative of the production flame arrestor installation.
3. A means of generating a supply of fuel vapour at preselected fuel-to-vapour air ratios and various flow rates.
4. A window for observing upstream and downstream conditions during the test. This means should allow determination of the location of the flame front relative to the flame arrestor.
5. A means to measure temperatures on the upstream duct surfaces and the flame arrestor.
6. A means to measure fuel vapour mixture temperatures both upstream and downstream of the flame arrestor.
7. A means to relieve explosive pressure upstream of the flame arrestor.
8. Ignition sources for igniting the explosive mixture upstream and downstream of the flame arrestor.

#### 6.3.1.3. Fuel Type.

6.3.1.3.1. The applicant should establish the critical fuel type for the test based on a review of the approved fuels for the aeroplane model. The applicant should use fuels in the test that have representative characteristics of the critical fuel approved for use in the aeroplane. The use of hexane

as a representative fuel for kerosene fuels such as Jet A and TS-1 has been found acceptable. Hexane ( $C_6H_{14}$ ) is readily available and easily manipulated in the gaseous state, so it is typically a fuel of choice. The AIT for hexane of 223 °C/433 °F closely simulates that of Jet A kerosene fuel, with an AIT of 224 °C/ 435 °F, and JP-4 with an AIT of 229 °C/445 °F.

Note: The applicant should not use fuels with higher AITs, such as propane, for the flame arrestor element test because ignition on the back side of the flame arrestor would not be adequately evaluated.

6.3.1.3.2. Table A-1 summarises the properties of hexane and provides an example of the method for calculating the stoichiometric relationship of hexane needed for the test.

6.3.1.3.3. The applicant may use propane for flame arrestor installation testing where AIT is not a critical parameter for the test. For example, testing of a simulated production flame arrestor installation to validate that temperatures of portions of the installation within the fuel tank remain below the maximum permitted fuel tank surface temperature (typically 200 °C/400 °F) would be acceptable, provided the applicant or supplier has previously shown the flame arrestor element meets the flame-holding requirements.

6.3.1.3.4. Table A-3 summarises the properties of propane as provided in the FAA Technical Report ADS-18, Lightning Protection Measures for Aircraft Fuel Systems (see Chapter 2.2 of this AMC) and provides an example of the method for calculating the stoichiometric ratio of propane.

#### 6.3.1.4. Thermocouples.

The applicant should use bare junction 1/16- to 1/8-inch metal-sheathed, ceramic-packed, chromel-alumel thermocouples with nominal 22 to 30 AWG (American wire gage) size conductors or equivalent. The applicant should not use an air-aspirated, shielded thermocouple. Experience has shown that 1/16-inch thermocouples may provide more accurate calibration than 1/8-inch thermocouples; the 1/16-inch thermocouples are therefore recommended.

#### 6.3.1.5. Test Specimen.

The test specimen should be a production component that conforms to the type design intended for certification.

#### 6.3.2. Test Conditions.

Two types of tests are typically needed to demonstrate compliance: one for flame propagation prevention in a static vent vapour flow condition, and one for flame holding in a continuous vapour flow condition. These conditions provide a conservative demonstration of fuel tank vent fire protection capability with respect to delaying flame front propagation through the fuel vent flame arrestor installation during ground fire conditions.

##### 6.3.2.1. Flame Propagation Tests (Static).

This test demonstrates the element's flame-arresting performance in a static condition at the critical fuel mixture condition of  $1.15 \pm 0.05$  stoichiometric. This mixture is based on FAA-sponsored tests done by Atlantic Research, documented in the Lightning Protection Measures for Aircraft Fuel Systems report. The report shows curves of flame arrestor equilibrium temperature for various air-flow ratios as a function of per cent stoichiometric fuel-air ratio (see Figure A-2 in this AMC). These curves maximise at about 1.10 to 1.20 stoichiometric. The curves indicate that higher temperatures occur at lower flow rates.

##### 6.3.2.1.1. Establish the Mixed Flow.

Close the fuel and air valves. Ignite the mixture downstream of the element. Verify that flames did not propagate through the flame arrestor by observation through the viewing window. Verify the upstream mixture is combustible by energising the upstream igniter and observing the ignition of the

upstream mixture. The applicant should repeat this test a minimum of 5 times at this mixture as is done with explosion proof testing.

#### 6.3.2.1.2. Flame Front Velocity.

The velocity of the flame front as it reaches the flame arrestor can significantly influence the effectiveness of the flame arrestor in preventing flame propagation. The flame front velocity increases as the flame travels down a vent line containing flammable vapours. The velocity of the flame front is installation-dependent and influenced by the vent line length, diameter, and flow losses between the ignition source and flame arrestor. The test configuration should include consideration of these critical features. If an applicant proposes to use a previously approved flame arrestor element in a new installation with a different vent line length and diameter than previously tested, the applicant should account for these installation differences in the compliance demonstration. The applicant may need to conduct a separate test to demonstrate that the flame arrestor is effective in the installed configuration.

#### 6.3.2.2. Flame-Holding Tests.

The purpose of this test is to show that a flame present at the fuel tank vent outlet, when a continuous flow of flammable vapour is exiting the vent, will not propagate into the fuel tank. The test conditions for this test are based on test results documented in the Lightning Protection Measures for Aircraft Fuel Systems report that resulted in the highest flame arrestor temperature. Run this test at a 1.15 stoichiometric fuel-air ratio. The flammable vapour flow rate that achieves a velocity of 0.75 to 1.0 feet per second (ft/s) across the flame arrestor is the range where flame arrestor failure occurred in the shortest time in development testing. Adjust the flow to achieve a velocity of 0.75 ft/s (+ 0.25, - 0 ft/s) across the flame arrestor and ignite it downstream of the flame arrestor. Determine and establish the location of the flame front by viewing it through the viewing window. Determine the position of the flame front and adjust the vapour flow rate such that the flame front contacts the downstream flame arrestor face, resulting in the greatest rate of heating of the flame arrestor surface. Take care to maintain the flammable vapour flow rate at a constant value throughout the test so as to maintain the correct fuel-to-air ratio.

##### 6.3.2.2.1. Flame Arrestor Element Maximum Surface Temperatures.

Monitor the temperature at the upstream centre of the flame arrestor during the flame-holding test; it is required to stay below 370 °C/700 °F for 2 minutes and 30 seconds. Data from developmental testing show that the temperature of the centre of the upstream flame arrestor face at which failure (propagation of the flame) occurred was typically above 370 °C/700 °F, which is well above the AIT of JP-4 fuel vapour of 229 °C/445 °F as established during no-flow conditions. The upstream flame arrestor temperature can go well above the AIT without causing upstream ignition because of the high local velocity. For this reason, hexane, with an AIT of 223 °C/433 °F, is used for the flame arrestor element test.

##### 6.3.2.2.2. Flame Arrestor Installation and Vent System Maximum Surface Temperatures.

The compliance demonstration must show that flames present at the vent outlet will not propagate into the fuel tank for 2 minutes and 30 seconds. If the flame arrestor installation or any vent system components that are exposed to the flame are installed in locations where the ignition of flammable vapours could result in the propagation of the fire into the fuel tank, the applicant must show that ignition of the fuel vapours will not occur. This may require the installation of additional surface temperature instrumentation as part of the compliance demonstration test. The applicant should establish temperature limits for any components of the vent or flame arrestor assembly that are located in spaces where flammable vapours may be present, based on the location of the components in relation to the fuel tank. AMC 25.981 provides guidance for establishing a maximum allowable surface temperature within the fuel tank (the tank walls, baffles, or any components) that provides a safe margin, under all normal or failure conditions, that is at least 30 °C/50 °F below the lowest

expected AIT of the approved fuels. The AIT of fuels will vary because of a variety of factors (e.g. ambient pressure, dwell time, fuel type, etc.). The AIT accepted by EASA without further substantiation for kerosene fuels, such as Jet A, under static sea level conditions, is 232 °C/450 °F. This results in a maximum allowable surface temperature of 200 °C/400 °F for an affected surface of a fuel tank component. Higher surface temperature limits in flammable fluid leakage zones may be allowed in certain cases where the applicant can substantiate the higher temperature limits. The applicant should monitor and record surface temperatures for any components where the analysis-established limits were required and show that the surface temperatures remain below the established limits.

#### 6.3.3. Pass/Fail Criteria.

6.3.3.1. The flame arrestor installation should meet the following performance criteria, as described in paragraph 6.3.2 of this AMC:

- It should pass the static propagation test;
- It should have a minimum flame-holding time of 2 minutes and 30 seconds;
- Installation-dependent maximum surface temperature limits should be established for any flame arrestor and vent system components located in fuel tanks or flammable fluid leakage zones that are determined to be a potential source of propagating the external vent flame to the fuel tank.

6.3.3.2. After completing the flame arrestor tests noted above, the applicant should carefully examine the integrity of the flame arrestor structure. Suppliers have constructed flame arrestors from one flat and one corrugated stainless steel sheet that are rolled up and placed into a flanged casing. This construction produces a series of small passages. Structural integrity of the coiled sheet metal is maintained by either rods that cross at the front and rear face of the coil or by brazing or welding of the coiled sheet metal at various points around the surface. Flame arrestors have failed the test when the flame passed across the flame arrestor because structural integrity was lost during the test due to weld or brazed joint failures. Damage to flame arrestor assembly components is acceptable if the flame arrestor installation prevents flame propagation during the test, and the maintenance requirements specify that the flame arrestor must be repaired or replaced following an event where the flame arrestor was exposed to flame.

#### 6.3.4. Related Qualification and Installation Considerations.

This paragraph does not contain an all-inclusive list of applicable qualification considerations. The tests should show that each component performs its intended function within the environment where it is installed. The applicant should establish design-specific qualification requirements in addition to the items listed in this paragraph.

##### 6.3.4.1. Vibration.

Test the flame arrestor in the vibration environment of the installation.

##### 6.3.4.2. Icing.

Installation of a flame arrestor will probably introduce a point in the vent system where icing is likely. The applicant should account for this effect in the vent system design by either installing pressure-relief provisions that protect the tank from excessive pressure differentials, or by showing that icing or clogging of the flame arrestor with ice is not possible.

##### 6.3.4.3. Fuel Tank Bottom Pressures.

In many cases, applicants have established the size of fuel tank vent systems, and the associated fuel tank refuelling rates, based on the bottom pressure of the fuel tank after failure of the refuelling system shut-off system and the resulting fuel overflow of the tank through the vent system. However, installation of a flame arrestor or modifications to the vent system may result in increased tank bottom

pressures. Therefore, if an applicant adds a flame arrestor to a fuel vent, or modifies an existing flame arrestor, the applicant should evaluate the effects of these changes on the tank bottom pressure, and adjust the refuelling rates to maintain the fuel tank bottom pressures within the limits that were established by the fuel tank structural analysis.

#### 6.3.4.4. Lightning.

The applicant must show that the fuel tank vent system installation complies with CS 25.954. AMC 25.954 provides guidance in meeting those requirements. FAA Technical Report ADS-18 (see paragraph 2.2 of this AMC) provides factors that the applicant should consider when developing fuel tank vent lightning protection features.

### 7. Demonstrating compliance using fuel tank inerting, fuel tank pressurisation, and fire suppression systems

#### 7.1. Fuel Tank Inerting.

An applicant's use of fuel tank inerting systems to show compliance with CS 25.975(a)(7) requires them to demonstrate that the design prevents fuel tank explosions during all operating conditions (e.g. taxi, take-off, landing, refuelling, etc.) and post-crash fire scenarios. To comply with CS 25.981, inerting systems are not required to inert the fuel tanks during all operating conditions. Therefore, if an applicant proposes an inerting system as the means of compliance with CS 25.975(a)(7), the system would need to have additional capability to prevent fuel tank explosions during all operating conditions. For example, inerting systems found compliant with CS 25.981 typically allow the fuel tanks to become flammable during refuelling operations, and when the inerting system is inoperative. The applicant would need to address these conditions in order to ensure that the system continues to meet the requirements of CS 25.975(a)(7).

#### 7.2. Fuel Tank Pressurisation Systems.

Fuel tank pressurisation systems or features of the system that result in a 'closed' vent system may become inoperative during an accident or the subsequent post-crash fire scenario. If the applicant proposes fuel tank inerting or pressurisation as the means of compliance with CS 25.975(a)(7), the applicant must show that these means are effective in preventing a fuel tank explosion during all operating conditions (e.g. taxi, take-off, landing, refuelling, etc.) and post-crash fire conditions.

#### 7.3. Fire Suppression Systems.

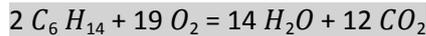
Fuel tank or vent system fire suppression systems are typically activated by a light sensor, and they discharge a fire-suppressant agent that is only effective for a short period of time. Demonstrating compliance using this technology would require showing its effectiveness in preventing a fuel tank explosion with a fire present at the fuel tank vent outlet for a minimum of 2 minutes and 30 seconds.

## Appendix A. Example of Calculation for Fuel-to-Air Ratio

Table A-1. Combustion Properties of Hexane

Property	Value
Heat of combustion, BTU/lb.	19 200
Molecular weight	86.17
Limits of inflammability in air (% by volume) per cent:	
Lower	1.2
Upper	7.4
Flash point	- 22 °C/- 7 °F
Boiling point	69 °C/156 °F
Auto-ignition temperature (AIT)	223 °C/433 °F
Vapour pressure at 21 °C/70 °F (Pa/psia)	17 237/2.5

Note: The combustion of hexane and oxygen is written as:



For every 2 moles of hexane consumed, 19 moles of oxygen are required for complete combustion with no residual oxygen. Thus, 172.34 g of hexane require  $19 \times 32.00 = 608$  g of oxygen or 2 627.48 g of air, which is 23.14 per cent by weight oxygen. Hence, the weight of air to weight of hexane required for stoichiometric burning (i.e. complete combustion of hexane with no excess oxygen) is 15.24. A 1.15 fraction of stoichiometric mixture of air and hexane has an air-to-fuel weight ratio of:

$$\frac{2627.48}{1.15 \times 172.37} = 13.2$$

Table A-2. Fuel-to-Air Mixtures for Flame Arrestor Tests

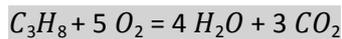
Condition	JP-4 Per cent by Volume	JP-4 Fuel-Air Mass Ratio	Hexane Per cent by Volume	Hexane Fuel-Air Mass Ratio
Lean limit	0.90	0.035	1.3	0.04
Between lean limit and stoichiometric	1.10	0.045	1.7	0.05
Stoichiometric	1.58	0.065	2.2	0.0658
1.15 Stoichiometric	1.82	0.074	2.5	0.07567
Between stoichiometric and rich limit	3.0	0.15	6.3	0.2
Rich limit	6.16	0.23	8.0	0.26

**Table A-3. Combustion Properties of Propane**

Property	Value
Heat of combustion (298 °K), kcal/g-mole	530.6
Flammability limits in air (% by volume), per cent:	
Lower	2.2
Upper	9.5
Flame temperature (stoichiometric in air, STP)	1 925 °C/3 497 °F
Quenching diameter,* cm/in	0.28/0.11
Minimum spark ignition energy,* millijoules	0.027
Critical velocity gradient for flashback,* sec <sup>-1</sup>	600
Laminar flame speed,* cm-sec	40

\*Applicable to 1.1 stoichiometric propane-to-air at standard temperature and pressure (STP).

Note: The combustion of propane and oxygen is written as:



For every mole of propane consumed, 5 moles of oxygen are required for complete combustion with no residual oxygen. Thus, 44.09 g of propane require  $5 \times 32.00 = 160$  g of oxygen or 691.44 g of air, which is 23.14 per cent by weight oxygen. Hence, the weight of air to weight of propane required for stoichiometric burning (i.e. complete combustion of propane with no excess oxygen) is 15.7. A 1.15 fraction of stoichiometric mixture of air and propane has an air-to-fuel weight ratio of:

$$\frac{691.44}{1.15 \times 44.09} = 13.7$$

Figure A-1. Fuel Tank Vent Flame Arrestor Test Schematic

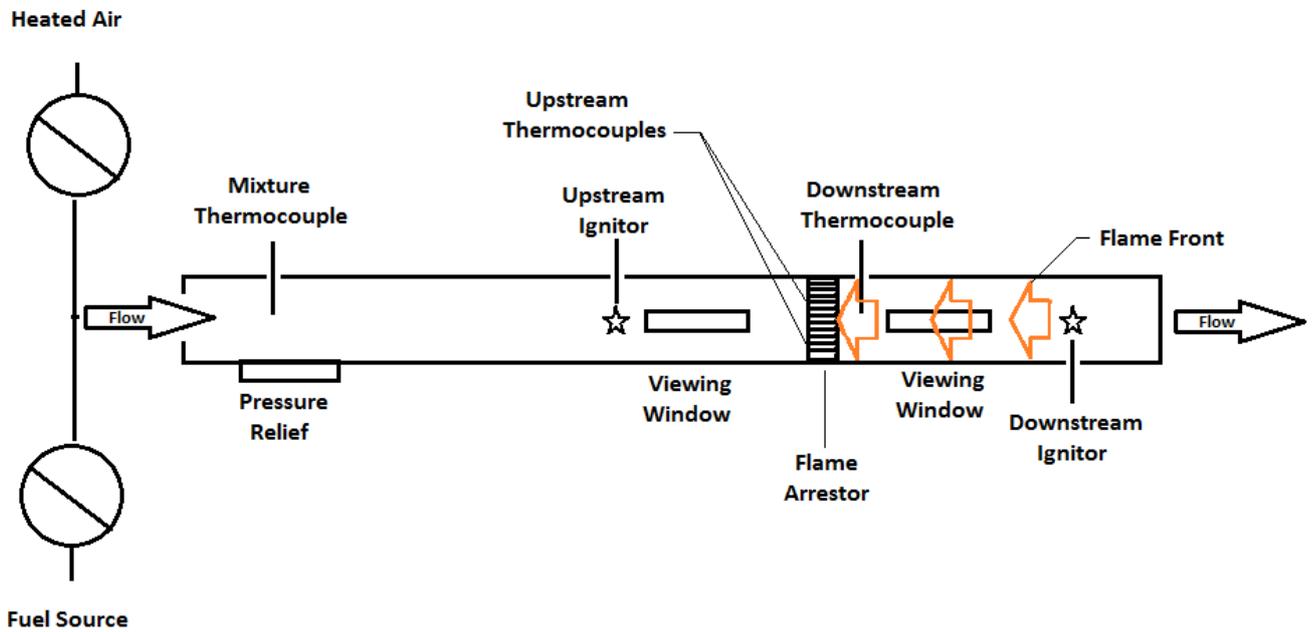
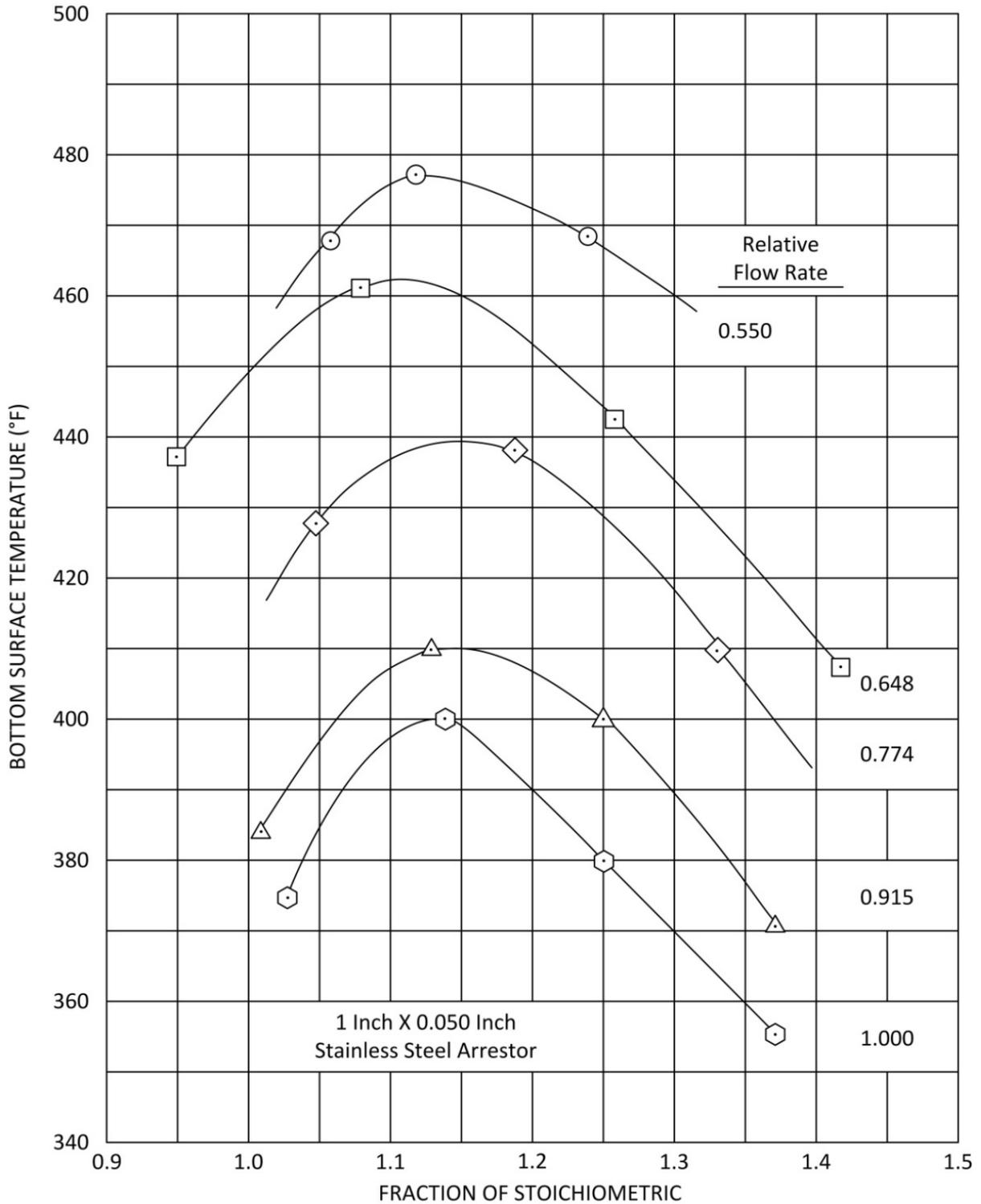


Figure A-2. Flame Arrestor Surface Temperature at Various Flow Rates and Stoichiometric Mixture Ratios\*



\* FAA Technical Report ADS-18, Lightning Protection Measures for Aircraft Fuel Systems (see paragraph 2.2 of this AMC).

**Item 3: Indication that engine anti-icing systems are functioning**

AMC 25.1305(c)(5) is created as follows:

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

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. When the engine ice protection system requires a flight crew action to operate (manual), and
2. When the engine ice protection system does not require a flight crew action to operate it (i.e. the system is automatic, or it functions permanently), unless all of the following conditions are met:
  - The engine thrust/torque and aircraft performance are not significantly affected by the engine ice protection system switching on/off;
  - There is no significant effect of the engine ice protection system switching on/off on the flight deck instruments, controls (such as the throttle lever) and the flight deck environment (such as noise);
  - The engine ice protection system failures are indicated to the flight crew; and
  - The indication of the functioning of the engine ice protection system is not used to indicate to the flight crew that the aircraft is operating in an icing environment, requiring, for example, the flight crew to apply an AFM procedure to protect the engine against the effects of the icing environment.

**Item 4: Oxygen fire hazards in gaseous oxygen systems**

CS 25.1441(b) is amended as follows:

**CS 25.1441 Oxygen equipment and supply**

(See AMC 25.1441)

(...)

(b) The oxygen system must be free from hazards in itself, in its method of operation, and in its effect upon other components. (See AMC 25.1441(b))

AMC 25.1441(b) is created as follows:

**AMC 25.1441(b)****Risk Assessment related to Oxygen Fire Hazards in Gaseous Oxygen Systems****1. Purpose**

This AMC provides guidance material and acceptable means of compliance for demonstrating compliance with CS 25.1441(b), which requires an oxygen system to be free from hazards in itself, in its method of operation, and in its effect upon other components.

This AMC applies to centralised, decentralised or portable oxygen systems. Those systems may be installed in an occupied compartment or in a remote inaccessible area.



## 2. Related certification specifications

CS 25.869(c) Fire protection: systems — Oxygen equipment and lines

CS 25.1301 Function and installation

CS 25.1309 Equipment, systems and installations

CS 25.1441(b) Oxygen equipment and supply

CS 25.1453 Protection of oxygen equipment from rupture

## 3. Installation

CS 25.869(c) specifies that oxygen system equipment and lines must:

(1) not be located in any designated fire zone;

(2) be protected from heat that may be generated in, or may escape from, any designated fire zone; and

(3) be installed so that escaping oxygen cannot cause the ignition of grease, fluid, or vapour accumulations that are present in normal operation or as a result of a failure or malfunction of any system.

In addition, the following analysis and precautions should be considered.

### 3.1. External ignition sources

An analysis should be performed to identify all possible external ignition sources and their mechanisms. If an ignition source exists in the vicinity of the oxygen system installation, it should be demonstrated that in normal operation or in conditions that result from a failure or malfunction of any system, the risk of ignition is minimised and that all design precautions have been taken to minimise this risk.

### 3.2. Contamination

The compartments in which oxygen system components are installed should provide adequate protection against potential contamination by liquids, lubricants (grease, etc.), dust, etc.

### 3.3. Ventilation

The compartments in which oxygen system components are installed should be ventilated in such a way that, should a leak occur or should oxygen be discharged directly into the compartment (not overboard) from any protective device or pressure-limiting device, the likelihood of ignition of the oxygen-enriched environment would be minimised. The applicant should substantiate that the ventilation rate of the compartment is adequate. Analytically determined ventilation rates should be validated by flight test results or their equivalent.

CS 25.1453(f) provides additional specifications related to ventilation.

This paragraph does not apply to portable oxygen systems, such as systems used to provide first-aid oxygen to passengers or supplemental oxygen for cabin crew mobility, usually stowed in overhead bins, provided that it is confirmed that the shut-off means mounted on the oxygen container is always closed when the system is stowed and not used.

### 3.4. Routing

The installation of the system should be such that components and pipelines are:

- adequately separated from electrical and fluid systems;
- routed so as to minimise joints and sharp bends;
- clear of moving controls and other mechanisms.

CS 25.1453(b) provides additional specifications related to oxygen pressure sources and tubing installation.

#### 4. Oxygen hazards analysis (OHA)

The applicant should demonstrate that the oxygen systems and their components are designed so that the occurrence of an uncontrolled oxygen fire at aircraft level is extremely improbable and does not result from a single failure.

To assess the consequences of system/component failures, an oxygen hazards analysis (OHA) should be provided. This analysis may be conducted in a qualitative or quantitative manner. The conclusion of the OHA should be included in the oxygen systems system safety analysis (SSA).

The applicant should provide an OHA with a detailed assessment of the potential ignition and combustion mechanisms. The OHA should consider the following:

##### 4.1. Equipment failures

A detailed failure modes and effects analysis (FMEA) at component level should be used as the input for the OHA. Quality/production issues or human errors during assembly should not be included in this OHA.

All single failures, and failure combinations not shown to be extremely improbable, should be taken into account.

##### 4.2. Operating conditions

The worst-case operating conditions should be taken into consideration, including failures determined from paragraph 4.1 that are not shown to be extremely improbable.

##### 4.3. Components and materials

The analysis should contain all component designations and the materials of construction, including compounds and non-metallic material.

Most materials ignite at lower temperatures in an oxygen-enriched environment than in air; the auto-ignition temperature should be established assuming a 100 % oxygen-enriched environment. The materials used should be evaluated to determine whether they are flammable under the conditions specified in paragraph 4.2.

##### 4.4. Ignition mechanisms

The assessment should address the identification of the possible internal ignition mechanisms. As a minimum, the following mechanisms should be assessed:

- adiabatic compression (pneumatic impact) (see Note 1 below)
- frictional heating
- mechanical impact
- particle impact
- mechanical stress or vibration
- static discharge
- electric arc
- chemical reaction
- resonance.

Under the conditions specified in paragraph 4.2, each ignition mechanism should be evaluated to determine whether it exists in the component and in the system considered.



Note 1: In calculating the temperature elevation due to oxygen compression, the transient peak pressures measured under paragraph 5.2 should be used, unless other values are duly demonstrated.

#### 4.5. Kindling chain

The ability of a fire to propagate and burn through a component, i.e. the kindling chain, should be evaluated. The ignition and burning of a single component may produce sufficient heat to ignite the surrounding materials, leading to a burn-through of the component.

Therefore, if any of the ignition mechanisms assessed under paragraph 4.4 exists, an analysis should assess the kindling chain, based on the ability of the materials of construction to contain a fire.

### 5. Design considerations

#### 5.1. High-pressure shut-off

As required by CS 25.1453(c), parts of the system subjected to high-pressure oxygen must be kept to a minimum and must be remote from occupied compartments to the extent practicable.

High-pressure shut-off valves should be designed to open and close slowly enough so as to avoid the possible risk of fire or explosion.

#### 5.2. Pressure-limiting devices (e.g. relief valves)

As required by CS 25.1453(e), the pressure-limiting devices (e.g. relief valves), provided to protect parts of the system from excessive pressure, must be designed to prevent the pressures from exceeding the applicable maximum working pressure multiplied by 1.33 in the event of a malfunction of the normal pressure-controlling means (e.g. a pressure-reducing valve).

In addition, the performance of pressure-limiting devices should be tested on a complete system under the conditions specified in paragraph 4.2 but limited to failures which are not shown to be extremely improbable.

If any single failure identified in paragraph 4.1 that affects the pressure-regulation device (such as but not limited to poppet/shaft/diaphragm blockages or ruptures, seal leakages, etc. of a pressure reducer) is excluded from the transient pressure level (TPL) assessment for design consideration (such as a safety factor on the yield strength, size of damage, etc.) or due to an estimated low-probability occurrence, a detailed rationale should be provided in the certification documents and should be agreed with EASA.

For testing purposes, oxygen can be replaced by an inert gas (e.g. nitrogen); however, the relationship between the pressure and the temperature would not be simulated by the inert gas and should be analysed separately. The TPL should be measured at various locations and each component of the oxygen system exposed to the TPL should be demonstrated to sustain the pressure level.

CS 25.1453(d) provides additional specifications related to the protection of oxygen pressure sources (e.g. tanks or cylinders) against overpressure.

#### 5.3. Isolation

When the system includes multiple bottles as oxygen sources, each source should be protected from reverse flow or reverse pressure should a failure occur on one source. Such isolation can be achieved by installing check valves or an equivalent means in an appropriate manner.

#### 5.4. Non-metallic hoses

Except for flexible lines from oxygen outlets to the dispensing units, or where shown to be otherwise suitable for the installation, non-metallic hoses should not be used for any oxygen line that is normally pressurised during flight.

If non-metallic hoses with anti-collapse springs are used due to installation constraints, it should be ensured that inadvertent electrical current cannot reach the spring which could cause the hose to melt or burn, leading to an oxygen-fed fire. As an example, correctly grounded metallic braid may be considered to prevent inadvertent electrical current from reaching the spring.

In addition, non-metallic oxygen distribution lines should not be routed where they may be subjected to elevated temperatures, electric arcing, or released flammable fluids that might result from normal operation, or from a failure or malfunction of any system.

#### 5.5. Grounding

All the oxygen lines and hoses should be grounded.

#### 5.6. Joints

Joints should, as far as possible, be assembled dry. However, where compounds are used for sealing, they should be approved for that purpose.

#### 5.7. Recharging systems

Recharging systems, if installed, should be provided with means to prevent excessive rates of charging, which could result in dangerously high temperatures within the system. The recharging system should also provide protection from contamination.

Where in situ recharging facilities are provided, the compartments in which they are located should be accessible from outside the aircraft and as remote as possible from other service points and equipment. Placards should be provided, located adjacent to the servicing point, with adequate instructions covering the precautions to be observed when the system is being charged.

### **Item 5: Flight instrument external probe de-icing test**

AMC 25.1324 is amended as follows:

#### **AMC 25.1324**

##### **Flight instrument external probes**

(...)

##### **9. Mode of Operation**

(...)

##### **b. De-icing test:**

During this test, the icing protection of the probe (typically resistance heating) should be 'off' until 0.5 inch of ice has accumulated on the probe. For ice crystal tests in de-icing mode, since no accretion is usually observed, an agreed 'off' time duration should be agreed before the test. In the past, a ~~one~~ <sup>one</sup> 1-minute time duration without heating power has been accepted. This mode need not be tested if, in all operational scenarios (including all dispatch cases), the probe heating systems are activated automatically at aircraft power 'On' and cannot be switched to manual operation later during the flight. Furthermore, in assessing whether or not this

mode needs to be tested, any failure conditions not demonstrated to be extremely improbable, which may lead to probe heating supply interruptions, should be considered.

#### **Item 6: Flight crew seats**

CS 25.562(b) is amended as follows:

##### **CS 25.562 Emergency landing dynamic conditions**

(See AMC 25.562)

(...)

(b) ~~With the exception of flight deck crew seats,~~ Each seat type design approved for occupancy must successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar ~~type seat type~~, in accordance with each of the following emergency landing conditions. The tests must be conducted with an occupant simulated by a 77 kg (170 lb) anthropomorphic test dummy sitting in the normal upright position:

(...)

(2) A change in forward longitudinal velocity ( $\Delta v$ ) of not less than 13.4 m/s (44 ft/s) with the aeroplane's longitudinal axis horizontal and yawed 10 degrees either right or left, whichever would cause the greatest likelihood of the upper torso restraint system (where installed) moving off the occupant's shoulder, and with the wings level. Peak floor deceleration must occur in not more than 0.09 seconds after impact and must reach a minimum of 16 g. ~~With the exception of flight deck crew seats that are mounted in the forward conical area of the fuselage,~~ where floor rails or floor fittings are used to attach the seating devices to the test fixture, the rails or fittings must be misaligned with respect to the adjacent set of rails or fittings by at least 10 degrees vertically (i.e. out of parallel) with one rolled 10 degrees.

#### **Item 7: Non-magnetic standby compass**

CS 25.1303(a)(3) is amended as follows:

##### **CS 25.1303 Flight and navigation instruments**

(See AMC 25.1303)

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

(...)

(3) A ~~non-stabilised magnetic compass~~ magnetic direction indicator.

(...)

AMC 25.1303(a)(3) is amended as follows:

##### **AMC 25.1303(a)(3)**

##### **Direction indicator**



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 following guidelines should be followed:

- (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 indication 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 indication 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).

AMC 25.1327 is amended as follows:

**AMC 25.1327**  
**Direction indicator**

(...)

~~5. For standby compass instruments, the accuracy of the magnetic heading indications after correction should be better or equal to 10°.~~

(...)

AMC 25-11 is amended as follows:

(...)

**4 Heading. (...)**

**Table 6**  
**Example Safety Objectives for**  
**Heading Failure Conditions**

Failure Condition	Safety Objective
Loss of stabilised heading in the flight deck on both pilots’ primary displays	Remote (2)
Loss of all heading displays in the flight deck	Extremely Improbable
(...)	(...)

Notes

(1) System architecture and functional integration should be considered in determining the classification within this range. This failure may result in a sufficiently large reduction in safety margins to warrant a hazardous classification.

(2) This assumes the availability of an independent, ~~non-stabilised~~ heading required by CS 25.1303 (a)(3).

(...)

**Item 8: Security requirements**

Appendix S is amended as follows:

**Appendix S****Airworthiness requirements for non-commercially operated aeroplanes and low-occupancy aeroplanes**

(...)

**S25.60 Security**

Non-commercially operated aeroplanes do not need to comply with the security specifications of CS 25.795(b), (c) and (d).

**Item 9: Engine ETOPS capability**

CS 25.1535 is amended as follows:

**CS 25.1535 ETOPS Design approval**

To determine For an aircraft configuration to be capable of ETOPS, the following must be complied with are required:

(a) Compliance with the requirements of CS-25 considering the maximum flight duration and the longest diversion time for which approval is being sought.

(b) Approval of the engine for ETOPS capability in compliance with CS-E 1040.

(~~b~~c) Consideration must have been given to the crew workload and operational implications and the flight crew's and passengers' physiological needs during continued operations with failure effects for the longest diversion time for which approval is being sought.

(~~e~~d) Establish The appropriate capability and limitations must have been established. (See AMC 20-6.)

**Item 10: Engine cowl retention**

CS 25.1193 is amended as follows:

**CS 25.1193 Cowling and nacelle skin**

(See AMC 25.1193)

(...)

(e) Each aeroplane must -

(...)



(4) Be designed and constructed to minimise any in-flight opening or loss of a cowling which could prevent continued safe flight and landing.

(f) The retention system of each removable or openable cowling must—

(1) Keep the cowling closed and secured under the operational loads identified in subparagraph (a) of this paragraph following either of the following conditions:

- (i) Improper fastening of any single latching, locking, or other retention device; or
- (ii) The failure of any single latch or hinge;

(2) Have readily accessible means to close and secure the cowling that do not require excessive force or manual dexterity; and

(3) Have a reliable means for effectively verifying that the cowling is secured prior to each take-off.

AMC 25.1193(e)(4) and (f) is created as follows:

#### **AMC 25.1193(e)(4) and (f)**

##### **Engine cowling retention**

###### **a. Purpose and scope**

CS 25.1193(e)(4) requires design precautions to be taken to minimise the risk of any in-flight opening or loss of an engine cowling which could prevent continued safe flight and landing, and CS 25.1193(f) requires the retention system of each removable or openable cowling to have a means, which is demonstrated to be reliable and effective, to verify that the cowling is closed and latched prior to each take-off.

Reported occurrences of engine cowling separation revealed that features like latch handles hanging down, cowling gaps, and detection capabilities offered by walk-arounds and/or checks at the completion stage of maintenance activities, had not been reliable or effective in preventing aeroplanes from taking off with unclosed/unlatched cowlings.

For turbofan engines, these occurrences have concerned fan cowls only. Thrust reverser cowls have shown satisfactory in-service experience with regard to the risk of cowling separation. Therefore, specifications CS 25.1193(e)(4) and (f) are intended to be applicable to engine fan cowls only.

All dispatch configurations, as permitted by the master minimum equipment list (MMEL) and the configuration deviation list (CDL), should be considered when showing compliance with CS 25.1193(e)(4) and (f).

###### **b. Selection of appropriate design features**

The following guidelines are provided to help the applicant in selecting design features appropriate to the engine/nacelle characteristics and in showing compliance with CS 25.1193(e)(4) and (f).

###### **Human factors**

In determining the most appropriate design features to cope with the human-factor aspects that contribute to the risk of an aeroplane being released with unclosed or unlatched cowlings, attention should be placed on the following aspects of cowling latched/unlatched indications:



- Their verification by personnel should not necessitate unusual physical effort (e.g. bending down or kneeling on the ground);
- Their verification by personnel should take into account the variability in the physical capabilities of personnel;
- The provision of these indications should take into account a possible lack of diligence of personnel in conducting walk-arounds and in completing their maintenance activities;
- The indications should draw the attention of personnel without ambiguity (e.g. by paint effects) and should not be affected by lighting conditions (night/day), weather conditions, or the operational environment.

#### Design considerations

The following considerations should be taken into account when selecting design features to mitigate the risk of cowling separation:

- A wing-mounted engine/nacelle presents a higher risk than a rear-mounted engine/nacelle, therefore requiring more noticeable cowling latched/unlatched indications and/or a combination of them;
- An engine/nacelle with a small ground clearance presents a higher risk than one with a large ground clearance, therefore requiring more noticeable indications and/or a combination of them;
- A forced hanging heavy/large piece or part on an engine/nacelle with a large ground clearance may draw the attention of personnel;
- A unique indication on the lower part of an engine/nacelle that has a small ground clearance may not be sufficient to draw attention to it;
- The noticeability of a forced gap between the fan cowl and the surrounding structure may be adversely affected by its environment, such as the ambient lighting conditions, external painting or the condition of the surrounding structure, and may not be sufficient to draw attention to it;
- A flashing light in an open gap or outside the nacelle skin may draw the attention of personnel. In such cases, the reliability of the flashing light should be investigated and substantiated, taking into account the effects of the engine/nacelle environment;
- A mechanical flag on the outside of the nacelle skin may draw the attention of personnel;
- A latch which is locked by a key equipped with a red flag may draw the attention of personnel, however a duplicate key without a flag could be used, and therefore the use of a flag may not be sufficient;
- A design with a remote indication (i.e. on the flight deck) of the unlatched/unclosed fan cowl condition may effectively draw the attention of the flight crew.

#### Lessons learned

EASA has gathered experience from the use of some of these design features, and the lessons learned include the following:

- Procedural control measures may not always be followed as a result of the pressure to dispatch the aeroplane, and because of routine issues;
- Improper Instructions for Continuing Airworthiness may be issued, which may lead to:
  - Improper rigging of the cowls and the associated latches;
  - Poor maintenance of design features intended to prevent aeroplane dispatch with unlatched cowlings, such as bright paint fading over time (or becoming soaked with the dirt accumulated at the bottom of the nacelle), hold-open cowl devices not performing their intended function, etc.;
- Some nacelle painting can defeat the design precautions:
  - Red or orange nacelle colours may negate the visibility of red/dayglow latches;
  - Specific tools may be improperly defined and maintained (e.g. keys required to open cowls, normally fitted with a red flag, being used without a flag);
  - A dark nacelle colour may reduce the noticeability of gaps.

In order to address the human factors contributing to the risk, it might be necessary to conduct an in-service and practical evaluation of the proposed design.

#### **Item 11: Editorial corrections**

AMC 25.21(g) is amended as follows:

##### **AMC 25.21(g)**

##### **Performance and Handling Characteristics in Icing Conditions**

(...)

4.1.1 Operating rules for commercial operation of large aeroplanes (e.g. ~~EU-OPS 1.345~~Part-CAT, CAT.OP.MPA.250) require that the aeroplane is free of any significant ice contamination at the beginning of the take-off roll due to application of appropriate ice removal and ice protection procedures during flight preparation on the ground.

(...)



#### 4. Impact assessment (IA)

The proposed amendments are expected to contribute to updating CS-25 (Book 1 and Book 2) to reflect the state of the art of large aeroplane certification and improve the harmonisation of CS-25 with the FAA regulations. Overall, this would provide a moderate safety benefit, would have no social or environmental impacts, and would provide some economic benefits by streamlining the certification process. There is no need to develop a regulatory impact assessment (RIA).



## 5. Proposed actions to support implementation

- Focused communication for advisory body meeting(s) (TeB, STeB)  
N/A
- Providing supporting clarifications in electronic communication tools EASA - NAAs (CIRCABC, SINAPSE or equivalent)  
N/A
- EASA Circular  
N/A
- Detailed explanation with clarification and indicated hints on the EASA website  
N/A
- Dedicated thematic workshop/session  
N/A
- Series of thematic events organised on the regional principle  
N/A
- Combination of the above selected means  
N/A



## 6. References

### 6.1. Related regulations

N/A

### 6.2. Affected decisions

Decision No. 2003/2/RM of the Executive Director of the Agency of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes ('CS-25')

### 6.3. Other reference documents

- FAA Final rule titled 'Fuel Tank Vent Fire Protection' of Federal Register 81 FR 41200, published on 24 June 2016, effective on 23 August 2016 (Docket No.: FAA-2014-0500; Amdt. Nos. 25-142, 21-376, and 129-53).

<https://www.federalregister.gov/documents/2016/06/24/2016-14454/fuel-tank-vent-fire-protection>

Correction published and effective on 26 July 2016 of Federal Register 81 FR 48693 (Docket No.: FAA-2014-0500; Amdt. Nos. 25-143, 121-375, and 129-52):

<https://www.federalregister.gov/documents/2016/07/26/2016-17590/fuel-tank-vent-fire-protection-correction>

- FAA AC 25.975-1 titled 'Fuel Vent Fire Protection', dated 24 June 2016:

[https://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.information/documentID/1029668](https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1029668)

- Notice of Proposed Rulemaking (NPRM), Notice No. 07-13, entitled 'Special Requirements for Private Use Transport Category Airplanes' (72 FR 38731):

<https://www.federalregister.gov/documents/2007/07/13/E7-13582/special-requirements-for-private-use-transport-category-airplanes>

- Final rule, SFAR No. 109, entitled 'Special Requirements for Private Use Transport Category Airplanes' (74 FR 21533):

<https://www.federalregister.gov/documents/2009/05/08/E9-10807/special-requirements-for-private-use-transport-category-airplanes>

