Consultation Paper Deviation UK.DEV.E.0002 Issue 1

Proposed: ☒ Final ☐
Deadline for comments: 4 July 2024

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SUBJECT :	Fuel Feed Icing Threat
REQUIREMENTS incl. Amdt.:	CS 25.951(c) at Amdt. 23 CS 25.952(a) at Amdt. 23 CS 25J951(c) at Amdt. 23 CS 25J952(a) at Amdt. 23
ASSOCIATED IM/MoC:	Yes☐ / No ☒
ADVISORY MATERIAL:	

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Introductory Note

The UK CAA has received the following request for Deviation from applicable CS-25 requirements in accordance with the provisions of Part 21.A.15.

In accordance with the UK CAA Design and Certification procedures, such Deviation requests shall be assessed by the authority and be subject to a period of public consultation of not less than 2 weeks except if they have been previously agreed and published by the UK CAA.

All interested persons may submit their comments on this Deviation Proposal online Deviation UK.DEV.E.0002 Consultation. The consultation period will close on 4 July 2024.

The final decision shall be published by the UK CAA.

Acronyms and Abbreviations

AC	Aircraft
AFM	Aircraft Flight Manual
AMM	Aircraft Maintenance Manual
APU	Auxiliary Power Unit
CAA	Civil Aviation Authority
CS	Certification Specification
DEV	Deviation
EASA	European Union Aviation Safety Agency
EU	European Union
FAA	Federal Aviation Administration
Reg	Regulation
SC	Special Condition
TC	Type Certificate
UK	United Kingdom of Great Britain and Northern Ireland

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Identification of Issue

CS 25.951(c) requires the following:

Each fuel system must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 26.7°C (80°F) and having 0.20 cm3 of free water per litre (0.75 cm3 per US gallon) added and cooled to the most critical condition for icing likely to be encountered in operation.

CS 25.952 (a) requires the following:

Proper fuel system functioning under all probable operating conditions must be shown by analysis and those tests found necessary by the Agency. Tests, if required, must be made using the aeroplane fuel system or a test article that reproduces the operating characteristics of the portion of the fuel system to be tested.

CS 25J951(c) requires the following:

Each fuel system for an essential APU must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 26.7 °C and having 0.20 cm3 of free water per litre added and cooled to the most critical condition for icing likely to be encountered in operation.

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CS 25J952(a) – requires the following:

Proper fuel system functioning under all probable operating conditions must be shown by analysis and those tests found necessary by the Agency. Tests, if required, must be made using the aeroplane fuel system or a test article that reproduces the operating characteristics of the portion of the fuel system to be tested.

Background

On January 17, 2008, a Boeing Model 777-200 series aeroplane equipped with Rolls-Royce Model RB211 TRENT 895-17 turbofan engines crash landed short of the runway at London Heathrow Airport. It was determined that an un-commanded reduction in thrust occurred on both engines as a result of reduced fuel flows. The investigation conducted by UK Air Accidents Investigation Branch (AAIB) determined that under certain conditions, over a period of low fuel temperatures, ice may accumulate in the aeroplane fuel feed system and then be fed or released downstream to the engines. Ice may also collect and create a restriction within the engine fuel system because of insufficient fuel heating to melt the ice. A restriction in fuel flow to the engine(s) may result in failure to achieve a commanded thrust level, which is considered an unsafe condition due to thrust loss leading to forced landing.

UK AAIB issued the following safety recommendation to EASA (EASA reference UNKG-2008-049):

“review the current certification requirements to ensure that aircraft and engine fuel feed systems are tolerant to the potential build-up and sudden release of ice in the fuel feed system”.

In reaction to this safety recommendation the UK CAA issued special condition (SC) E-01UK on the GVIII-G700 project which requires, in addition to the above mentioned CS-25 specifications, that the applicant establish that:

1) The free water (or ice) remains evenly dispersed in the fuel under all operating conditions, or

2) The applicant must establish the threat(s) (quantity of ice, temperature) that can be released. The complete fuel system (including the engine) must be shown to be tolerant to such sudden release of ice, without significant adverse effect(s) on the powerplant system.

Note: this issue is also applicable to the APU, if the installation is essential (ref. CS 25J951(c)).

These additional requirements address the potential additional issue that ice may accrue (and be hazardously released) instead of being evenly dispersed (as it is assumed by CS 25.951(c), CS 25.952(a), CS 25J951(c) and CS 25J952(a)).

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The applicant designed the GVIII series of aeroplanes to fully comply with the requirements and originally planned to demonstrate compliance via analysis using an approach similar to past programmes. This analysis would establish the fuel system icing threat has been adequately mitigated based on the GVIII fuel system installation and operating environment with consideration of operating temperatures, tubing surface finishes, fuel flow rates, and entrained water content. However, it has been determined that previous analytical methods did not account for fuel system routing. The applicant therefore determined that compliance with the above CS-25 specifications, complemented with the SC (E-01UK), will be done by full-scale testing of the fuel system to demonstrate that the fuel system is capable of sustained operation and functions properly under probable operating conditions where ice may form in the fuel system.

Because the test methodology has not yet been developed and the activity requires extensive rig building, the applicant has not completed the demonstration of compliance and requested a time-limited deviation from the above requirements using mitigating factors based on stringent inspection instructions that will reduce the risk of icing forming in the fuel system. The applicant has additionally stated that the design of the aeroplane has been assessed against the potential threat and it incorporates design features that would prevent such threat and it is similar to other aeroplane design with positive service experience.

FAA issued Exemption 21744A to address the same non-compliance, which is considered for the issuance of this deviation.

Considering all the above, the following Deviation is proposed and supported.

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UK.DEV.E.0002 Deviation: Fuel Feed Icing Threat

1 Applicability

This DEV is applicable to CS-25 Large Aeroplanes that have not completed the compliance demonstration to the requirements in 1.1, but for which a partial assessment is available.

1.1 Affected CS

CS 25.951(c) at Amdt. 23
CS 25.952(a) at Amdt. 23
CS 25J951(c) at Amdt. 23
CS 25J952(a) at Amdt. 23

As modified by the following conditions from SC E-01UK:

The applicant shall establish that:

1) The free water (or ice) remains evenly dispersed in the fuel under all operating conditions, or

2) The applicant must establish the threat(s) (quantity of ice, temperature) that can be released. The complete fuel system (including the engine) must be shown to be tolerant to such sudden release of ice, without significant adverse effect(s) on the powerplant system.

Note: this issue is also applicable to the APU, if the installation is essential (ref. CS 25J951(c)).

1.2. Pre-Conditions for Application of the Deviation

The certifications basis of the aeroplane must include the references provided in section 1.1 above.

The applicant must demonstrate compliance with the mentioned CS-25 specifications, although the demonstration of compliance with the SC is not completed.

An analysis must be available to demonstrate that the aeroplane incorporates design features to help mitigate ice accretion in the fuel system.

An analysis must demonstrate that the aeroplane is similar to other aeroplane models which have an excellent in-service history with neither engine nor APU performance anomalies that could have been attributed to fuel icing.

An analysis and representative fuel system tests must be available to show that, despite compliance to the Special Condition in 1.1 is not yet completed,

substantiated safety margins (to be assessed by the UK CAA) exist between the identified ice threat and the demonstrated engine ice ingestion capability. The mitigating factors in 4 shall be adequately defined to support the points not addressed by the above analysis and test.

2 Applicable Essential Requirements for Airworthiness of UK Reg (EU) 2018/1139 (Annex II)

The following paragraphs of the “Essential Requirements for Airworthiness” as defined in Annex II to UK Reg (EU) 2018/1139 are related to the SC identified in 1.1 for which a non-compliance exists:

1.2. Propulsion

1.2.2. The propulsion system must produce, within its stated limits, the thrust or power demanded of it at all required flight conditions, taking into account environmental effects and conditions.

1.3. Systems and equipment (other than non-installed equipment)

1.3.1. The aircraft must not have design features or details that experience has shown to be hazardous.

1.3.2. The aircraft, including those systems, and equipment required for the assessment of the type design, or by operating rules, must function as intended under any foreseeable operating conditions, throughout and sufficiently beyond, the operational envelope of the aircraft, taking due account of the system or equipment operating environment. Other systems or equipment not required for type-certification, or by operating rules, whether functioning properly or improperly, must not reduce safety and must not adversely affect the proper functioning of any other system or equipment. Systems and equipment must be operable without needing exceptional skill or strength.

1.3.4. Information needed for the safe conduct of the flight and information concerning unsafe conditions must be provided to the crew or maintenance personnel, as appropriate, in a clear, consistent and unambiguous manner. Systems, equipment and controls, including signs and announcements must be designed and located to minimise errors which could contribute to the creation of hazards.

3 Statement of Deviation

To address the non-compliance with the affected SC in 1.1, the mitigating factors in section 4 below shall be met. Compliance with the mitigating factors

ensures compliance with the applicable essential requirements for airworthiness and to minimise the compliance demonstration gap identified in the pre-conditions.

4 Mitigating Factors

The following mitigating factors have been identified as alternative means to ensure compliance with the above identified essential requirements and to minimise the compliance demonstration gap identified in the pre-conditions.

a) The Aircraft Maintenance Manual (AMM) must instruct a mandatory task to check and drain the fuel sump drains for the presence of water within a maximum periodicity of 10 days. This check must be performed before the first flight of the day.
b) The Deviation has been exceptionally granted for 3 years from the date of approval.