

Proposed Temporary Deviation on CS 25.1305(c)(5) (Amdt 2) : Operation in Ice Crystal Icing for GENx Engines – Applicable to Boeing 747-8/-8F

Introductory note:

The hereby presented Deviation to the EASA Certification Basis shall be subject to public consultation, in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) of which states:

"2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency."

Statement of issue

The GENx-2B engines installed on 747-8/-8F airplanes have been shown to be susceptible to operation in Ice Crystal Icing (ICI) conditions in-service resulting in a range of engine responses.

To eliminate any effects of ICI on engine operation, within the engine limitation envelope, the incorporation of the ICI Variable Bleed Valve (VBV) door logic associated to the GENx-2B EEC software version C065 enable to detect the presence of ice crystals and, by cycling the ICI VBV system, minimize ice crystal ingestion into the engine core.

This capacity would constitute a 'powerplant ice protection system', thus invoking the indication requirements of EASA CS 25.1305(c)(5).

Although the GENx-2B EEC software version C065 has already been certified the ICI VBV system remains to be substantiated as effective in identifying ICI conditions and eliminating the ICI threat, within the associated GENx-2B / C065 ICI engine limitation envelope.

The Airplane Flight Manual (AFM) limitation for avoidance of ICI conditions will have also to be modified to reflect the new GENx-2B / C065 engine limitation.

The ICI VBV Engine Indication And Crew Alerting (EICAS) indication will not be active at the time the AFM limitation for avoidance of ICI conditions is issued. Due to the identified non-compliance, Boeing has requested an EASA time-limited deviation to allow sufficient time to develop, validate, and certify an Integrated Display System (IDS) software incorporating an ICI VBV indication compliant to CS 25.1305(c)(5) (Amdt 2). Likewise, Boeing is requesting a FAA time-limited deviation to 14 CFR 25.1305(c)(5).

**Boeing 747-8 / -8F – Temporary Deviation E-23
Operation in Ice Crystal Icing for GENx Engines**

The requested time-limited deviation will provide relief from the ICI VBV powerplant ice protection system indication requirement of CS 25.1305(c)(5), for new production and in-service Boeing Models 747-8F and 747-8, incorporating EEC C065 software and upon modification of the AFM to reflect the new GEnx-2B / C065 engine ICI limitation.

The activation of the ice protection feature of the ICI VBV system logic is completely automated, with no flight crew input or control.

The EEC automatically determines when ICI conditions exist and automatically provides engine ice protection when required. Accurately detecting the conditions that require engine protection for ICI encounters is not possible for the flight crew, as it involves internal engine measurements not available to the flight crew and complicated computations. Visible detection clues associated with ICI are not as consistent as they are with natural icing.

The EEC ICI VBV fault detection and accommodation logic is robust.

All logic inputs for the ICI VBV control are monitored continuously to ensure proper engine operation. Each of the engine sensed parameters used in the ICI VBV logic is a dual channel sensor. Failure or loss of any single channel's input is detected and accommodated by the EEC, does not affect ICI VBV system functionality and results in a 10 day time-limited dispatch condition (ENG C1 EICAS latched status message). Detection of a dual failure by the automatic health checks for any of the critical control signals will result in a non-dispatchable ENGINE CONTROL EICAS latched Status message, requiring resolution prior to the next flight. Hence, there is protection against latent faults to the ICI VBV ice protection feature for each individual engine and the airplane's exposure to that failure would be the remainder of that flight. This type of EEC fault detection logic is common to all GE EECs. The fault detection and accommodation of the sensors used in the ICI VBV logic has not changed, as these parameters were already considered critical parameters required to control the engine.

Proposed Deviation

As the fully automated system without an indication provides no adverse effect on airplane safety, the compensating factors are:

- The EEC continuously monitors the health of all parameters used to command and control the GEnx-2B ICI VBV ice protection system.
- Loss of any input parameter must be fixed before the next flight.
- The EEC prevents latent faults, ensuring maximum system availability.

The compensating factors are considered to show there is no adverse effect on airplane safety to that intended by CS 25.1305(c)(5) because:

- 1) The flight crew has no means to independently and accurately determine the ICI threat,
- 2) Even once the ENGINE CONTROL EICAS logic will be fully implemented / retrofitted, there would be no crew action required based on the indication showing or not showing,
- 3) The ICI VBV logic uses sensors that are constantly monitored for errors. The detection and accommodation logic is fault tolerant for single failures. Multiple failures that disable the system are corrected before the next flight.

- 4) The AFM provides adequate information to the flight crews to explain engine parameter fluctuations when the ICI VBV logic is active.

The relief sought is limited to 747-8/-8F airplanes prior to the incorporation of the IDS software incorporating an ICI VBV indication compliant to CS 25.1305(c)(5). Certification of the ICI VBV indication will be accomplished by 31 March 2015. A service bulletin will be available no later than 30 June 2015 such that all 747-8F and 747-8 airplanes covered by this temporary deviation can order parts and install a compliant configuration. The Boeing service bulletin will recommend that all airplanes be retrofitted by 31 March 2016.

Prior to the expiration of this time-limited deviation, Boeing intends to comply with the indication requirements of CS 25.1305(c)(5) by providing a flight deck indication of ICI VBV system operation