TERMS OF REFERENCE

Task Nr:	E.009
Issue:	1
Date:	3 November 2008
Regulatory reference:	CS-E 780[1]
Reference documents:	FAA AC 20-147[2]

1. Subject:

Ice Protection

2. Problem / Statement of issue and justification; reason for regulatory evolution (regulatory tasks):

The ARAC Ice Protection Harmonisation Working Group and its engine sub-group (IPHWG/EHWG) have identified, as part of on-going studies, an enhanced threat to engines due to ice crystal icing. Although ice crystal icing is not new, an analysis of reported in-service events, supported by research evidence, has determined that mixed-phase/ice crystal icing was the primary causal factor in approximately 60 commuter/transport aeroplane events of various airframe/engine combinations between 1989 and 2003. The identified events contain some serious incidents, including multiple engine flame-outs and have led to at least one power-off forced landing. These events are also associated with various other engine effects including: surge, rollback, out-of-balance running and engine damage beyond acceptable limits. In many cases, the atmospheric conditions conducive to ice crystal icing could not be readily detected by the flight crew as aircraft surfaces often do not ice and ice detection systems consequently may not provide a warning. Engine operating procedures to be applied for such icing conditions may therefore not be followed, resulting in potential engine repercussions. To prevent further events from occurring, the Agency and some non-EU national aviation authorities have issued ADs requiring additional operating procedures to be put in place (e.g. selection of anti-icing on during visible moisture/convective storm activity, selection of continuous ignition).

Recent aircraft certification experience has also identified issues regarding icing on newly type certificated engines. These issues have only come to light during the aircraft flight test programme or in service and are associated with encounters with natural ice forming conditions. Unacceptable levels of engine damage, operability effects, flameout, or high out-of-balance effects have been experienced, resulting in the need for engine redesign.

In both cases, this experience has brought into question the adequacy of the existing CS-E 780 and its advisory material, which is intended to provide a margin for ice protection beyond that required by the aircraft certification requirements.

CS-E 780 (d) provides the certification standard for ice crystal cloud conditions and requires additional testing to be performed where an engine is considered to be

[1] See Agency Decision 2007/15/R of 3 December 2007 on Certification Specifications for Engines, Amendment 1, p. 64 and 158.

[2] FAA AC 20-147 of 2 February 2004 on Turbojet, Turboprop, and Turbofan Engine Induction System Icing and Ice Ingestion

vulnerable to such conditions. Guidance is provided in AMC E 780 (paragraph 11). However, this guidance has not been substantially altered since JAR-E Change 7 (January 1986).

The mechanism for ice crystal icing effects on engines is not fully understood. Recent research has shown that ice accretion on warm surfaces in glaciated or mixed-phase conditions can occur. It is postulated that although surfaces inside the engine core are above freezing point, the heat transfer processes that occur due to impacting ice crystals can result in local temperatures at or below freezing point, with the consequence that significant ice accretion can take place. This is of concern as ice can form further aft in the engine core than was previously anticipated and may result in effects not previously seen in current certification testing. Furthermore, the susceptibility of engines and intake types to ice crystal icing may be more widespread than had previously been shown.

As the trend for aircraft to encounter such adverse conditions is likely to increase due to increasing air traffic limitations and the inability to avoid environmental conditions conducive to ice crystal formation, action should be taken to mitigate the identified threat from ice crystal icing. A more practical and effective solution is to enhance engine design requirements to ensure engines, at entry into service, are robust to all forms of icing when operated in accordance with the approved operating instructions.

Note: The Agency is proposing to initiate a research activity with the aim of engaging with the international community (IPHWG/EHWG) to further study the ice crystal phenomenon. This may result in recommendations to further develop harmonised rules and AC/AMC material at a later date.

3. Objective:

This task aims to review the current knowledge base and certification experience relating to compliance with CS-E 780 and to update the certification specification and AMC to reflect the state-of-the-art and current best practice.

4. Specific tasks and interface issues (Deliverables):

- Determine, from existing certification experience and through 1-on-1 discussions with TC holders (engine & aircraft), best practice relating to engine icing certification.
- Review activities currently on-going within the IPHWG/EHWG and identify areas where additional AMC could be readily developed.
- Review and incorporate existing mature CRIs related to icing into CS-E (e.g. Freezing Fog)
- Review FAA AC 20.147 and identify elements that could be incorporated into AMC E.780 (e.g. Critical point analysis).
- Ensure the compatibility of engine and airframe icing standards.
- Amend AMC to CS-E to remove obsolete/incorrect material.
- Develop AMC material to address derivation of test conditions for non-altitude testing.

5. Working Methods (in addition to the applicable Agency procedures)**:**

Agency task

6. Time scale, milestones:

NPA planned for publication 2nd quarter 2009

CRD planned to be issued 4th quarter 2009

Final publication planned for 2nd quarter 2010