EUROPEAN AVIATION SAFETY AGENCY
AGENCE EUROPÉENNE DE LA SÉCURITÉ AÉRIENNE
EUROPÄISCHE AGENTUR FÜR FLUGSICHERHEIT

10TH ANNIVERSARY

Non-desired Effects of the Anti-icing Fluids on the Performance of the Aircraft and Other Effects

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INTRODUCTION

- Any deposit of ice, snow or frost on external surfaces of an aeroplane may affect its performance and handling qualities.
- It can also cause aeroplane moving parts – such as elevator, ailerons and others – to jam and create potentially hazardous situations.
- Also, engine operations may be seriously affected by the ingestion of snow or ice.
- In order to prevent take-offs with contaminated aeroplanes, Authorities have established rules that, with the exceptions sometimes allowed in the AFM, can be summarized in the:

"Clean Wing Concept".

OPERATIONAL REGULATION BACKGROUND

- EASA OPS (in force since Oct. 28th , 2012) at paragraph **CAT.OP.MPA.250 "Ice and other contaminants – ground procedures"** prescribes that:

  (a) The operator shall establish procedures to be followed when ground de-icing and anti-icing and related inspections of the aircraft are necessary to allow the safe operations of the aircraft.

  (b) The commander shall only commence take-off if the aircraft is clear of any deposit that might adversely affect the performance or controllability of the aircraft, except as permitted under (a) and in accordance with the AFM.

- Moreover, regarding the above paragraph, also EU OPS 1.345 (still in force for those MSs that elected to opt-out until 28th Oct. 2014) is essentially equivalent.

OPERATIONAL REGULATION BACKGROUND

- FAA, at the moment, at 14 CFR paragraph **"121.629 (b) Operation in icing conditions"** states that:

(c) No person may take off an aircraft when frost, ice, or snow is adhering to the wings, control surfaces, propellers, engine inlets, or other critical surfaces of the aircraft …omissis…. Take-offs with frost under the wing in the area of the fuel tanks may be authorized by the Administrator.

OPERATIONAL REGULATION BACKGROUND

- In essence, when aircraft surfaces are contaminated by frozen moisture they must be de-iced prior to dispatch.

- Furthermore, when there is the risk of freezing precipitation adhering to the aircraft surfaces at the time of dispatch, they must also be anti-iced for the necessary "holdover time".

  Note: *holdover time is the estimated period of protection against precipitation adhering to a/c surfaces in the prevailing ambient conditions, starting from the beginning of the anti-icing treatment.*

- In general practice, airplane surfaces contamination removal/prevention is carried out using de-icing/anti-icing fluids applied in a one-step or two-step process depending on the actual circumstances.

DE/ANTI-ICING FLUIDS PROPERTIES - BRIEF RECAP-

In general, de-icing/anti-icing fluids are mixtures of glycol, water, inhibitors and wetting agents.

They can be divided in two classes:

- un-thickened (type I fluids);
  - *No thickener additives*
  - *Minimum 80% of glycol content*
  - *Newtonian fluid - μ=f(OAT)*
  - *Relatively short holdover time.*
- thickened (type II, III and IV fluids).
  - *Thickener additives*
  - *Minimum 50% of glycol content*
  - *Non –Newtonian fluid - μ=f(OAT, Shear Forces)*
  - *Relatively long holdover time.*

Note: type III fluids are intended for use on a/c with low rotation speeds.

DE/ANTI-ICING FLUIDS PROCEDURES - BRIEF RECAP-

According to the prevailing conditions, aircraft can be de-iced/anti-iced using the following procedures:

- **One step process:**

  de-icing and anti-icing are carried out at the same time using a mixture of anti-icing fluid and water.

- **Two step process:**

  The airplane is first de-iced using heated water only or a heated mixture of de-icing fluid and water. After the completion of the 1st step, a layer of a mixture of anti-icing fluid and water or of plain anti-ice fluid is sprayed over the clean aeroplane surfaces.

Note: the second step must be applied before the first step fluid freezes.

DE/ANTI-ICING FLUIDS PROCEDURES - BRIEF RECAP-

Provided appropriate fluid availability, the correct selection of the proper de-icing/anti-icing fluid and procedure is very much dependent on:

- the atmospheric conditions;
- aircraft characteristics;
- holdover time required.

This is due to the fact that the fluids must de-ice or anti-ice the aircraft surfaces, but they must also flow off during the take-off run in order not to cause undesirable effects when the aircraft becomes airborne.

Unfortunately, in some instances, the improper application of anti-icing fluids has caused some serious consequences.

BAe 146, D-AEWA, 12 March 2005, Germany

- Serious incident during the initial climb after Frankfurt departure

- No injury, no damage
- Probable cause: **frozen rehydrated residue blocking the control surfaces**
- Source: BFU
- 3 safety recommendations

Similar events with similar "Probable Cause" were recorded on same type.

Bae ATP, SE-MAP, Jan. 2010
Helsinki/Vantaa Airport, Finland

- Serious incident
- No fatality, no damage
- Probable cause: **elevator restriction caused by a phenomenon which occurs following the use of anti-icing fluids on a/c where the stabiliser and elevator are too close together.**
- Source: SHK

- 2 safety recommendations concerning the subject of this presentation.

AREAS OF CONCERN

The presented events showed that the most important "non-desired" effects of anti-icing fluids on a/c and their performance can be summarized as follows:

- Aerodynamic surface blockage or hindrance on non-powered flight control aircraft;
- Performance and/or manoeuvrability and/or controllability degradation due to the presence of anti-icing fluids on top of the aerodynamic surfaces.

Other potential problems might be the followings:

- Vibration and buffeting problems;
- Corrosion and even system failures;
- Fluid ingestion into ECS;
- Pilot's vision affected by fluid contamination on windscreens.

AREAS OF CONCERN

The areas on which special attention is required can be summarized as follows:

- Fluids regulation;
- **Aircraft design**;
- Certification of de/anti-icing service providers;
- Crew training;
- **Aircraft operations and fluids usage**.

INITIATIVES AND ACTIONS
AIRCRAFT DESIGN

The SRs suggest that EASA should:

- Investigate the possibility of having the manufacturer demonstrate full a/c manoeuvrability after the application of de/anti-icing fluids;

- Improve the certification specifications to require the analysis of a/c behaviour when, the wings surfaces are contaminated on ground and to guarantee the maintaining of acceptable safety margins, in case of slight contamination.

INITIATIVES AND ACTIONS
AIRCRAFT DESIGN

The contaminations to be considered should be:

- Slight ice contamination, difficult to detect by visual observation;
- Contamination caused by cold soaked fuel frost;
- Residual ice contamination after de-icing procedure;
- Contamination due to fluids residue.

INITIATIVES AND ACTIONS
AIRCRAFT OPERATIONS AND FLUIDS USAGE

The SRs suggest that EASA should:

- impose mandatory requirements on non-powered FCS manufacturers to develop procedures to ensure the identification and removal of re-hydrated de-icing fluid residues;
- strongly encourage a/c operators of those kind of aircraft to use type I fluids only;
- ensure that operators of non-powered FCS a/c, who cannot avoid using thickened fluids, invoke appropriate maintenance procedures for frequent inspections of accumulations of fluid residues and their removal;
- Promote wider use of type III fluids.

INITIATIVES AND ACTIONS
AIRCRAFT OPERATIONS AND FLUIDS USAGE

EASA, taking into account its legal remit, addressed the above SRs publishing a certain number of documents that produced some concrete actions:

- On April 4th, 2008, the Agency issued the SIN 2008-29;
- CRD to A-NPA 2007-11.

INITIATIVES AND ACTIONS
AIRCRAFT OPERATIONS AND FLUIDS USAGE

The CRD to A-NPA 2007-11 is a very important document, since it contains a short and a medium/long-term action plan:

- In April 2009, a letter was sent to TC holders requiring them to review all the information acquired on fluids re-hydration and amend, as necessary, their instructions and procedures for the correct application of de/anti-icing fluids and their maintenance actions upon use of such fluids;

- The Agency intends to make, as far as possible, provisions in the implementing rules on the safety of aerodromes with the view to make operations, of all service providers, safer.

INITIATIVES AND ACTIONS
AIRCRAFT OPERATIONS AND FLUIDS USAGE

Moreover:

- on September 07th 2010, ED Decision 2010/006/R entered into force.

Finally, the Agency is about to sign a contract for a research study in order to better understand:

- the effects of anti-icing fluids on the horizontal stabilizer during the take-off rotation phase;

- the effects of some amount of ice underneath of the horizontal stabilizer.

CONCLUSIONS

The Agency believes that the above elements, when constantly pursued, provide a good basis for contrasting the non-desired effects of anti-icing fluids on the performance and handling qualities of the a/c.

However, is this sufficient?

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