Proposed Special Condition on Tyre Debris vs. Fuel Leakage for CFRP Fuel Tank

Applicable to Airbus A350

Introductory note:

The following Special Condition has been classified as an important Special Condition and as such shall be subject to public consultation, in accordance with EASA Management Board decision 02/04 dated 30 March 2004, 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

CS 25.963(e), and associated Acceptable Means of Compliance (AMC) text, requires that only fuel tank access covers be shown minimize penetration and deformation due to tyre fragments and other likely debris in relation to fuel leaks, the resistance of the conventional surrounding metallic wing structure, typical of previous aircraft designs, being assumed, largely by experience, to be resistant to such impacts.

A350 introduces the extensive use of Carbon Fibre Reinforced Plastics (CFRP) to Primary Structure & Primary Structure Element (PSE) applications, e.g. wing, fuselage etc, within the trajectory of tyre debris.

No service experience, or guidance material, is available regarding the performance of such material and structure with respect to tyre debris.

In the absence of applicable composite specific rule and guidance material, the applicant is required to show that the use of these materials does not reduce the level of safety relative to existing experience with metallic structure. This requires consideration of all issues, e.g. for this subject, considerations should include, but are not limited to, penetration, fuel leaks, fatigue and damage tolerance, and the effects of shock waves generated by impact.

CS 25.963(e) and associated AMC define the threat, i.e. tyre mass etc. It needs to be mentioned that, although the current AMC does not explicitly name the consideration of “other likely debris”, the EASA NPA 21-2005 (and the original JAA NPA 25E-304 Comment Response Document) considered the majority of cases for “other likely debris” to be covered by the tyre and engine debris models now used under AMC 25.963(e) for aircraft design with wing mounted engines and normal landing gear configuration (e.g. the A350).

However, this only addressed fuel tank access covers in the past, but the EASA team considers that the above threat is similarly applicable to the remainder of the fuel tank, if

made from CFRP, in order to demonstrate that the level of safety relative to existing experience with metallic structure is not reduced.

Furthermore, with the introduction of CFRP wings and fuel tanks, EASA considers that the threat of larger debris (e.g. as defined in Temporary Guidance Material (TGM), ref: TGM/25/08 Issue 2 on “Wheel and Tyre Failure Models” or equivalent definition for larger tyre/wheel debris agreed with Airbus) is applicable to those areas of fuel tanks which are exposed to the associated debris trajectories.

Note : A similar Special Condition (SC) was raised by FAA on an other product, ref. 25-07-04-SC, to extend consideration of tyre debris beyond access covers to the fuel tanks in the context of fuel leaks.

Airbus A350 - Special Condition C-05

- Tyre Debris vs. Fuel Leakage for CFRP Fuel Tank -

The applicant is requested to address the following :

1- Tyre Debris Impacts to Fuel Tanks

(a) Impacts by tyre debris to any fuel tank or fuel system component located within 30 degrees to either side of wheel rotational planes may not result in penetration or otherwise induce fuel tank deformation, rupture (for example, through propagation of pressure waves), or cracking sufficient to allow a hazardous fuel leak. A hazardous fuel leak results if debris impact to a fuel tank surface causes:

(1) a running leak,

(2) a dripping leak, or

(3) a leak that, 15 minutes after wiping dry, results in a wetted airplane surface exceeding 6 inches in length or diameter.

The leak must be evaluated under maximum fuel head pressure.

(b) Compliance with paragraph (a) must be shown by analysis or tests assuming all of the following:

(1) The tyre debris fragment size is 1 percent of the tyre mass.

(2) The tyre debris fragment is propelled at a tangential speed that could be attained by a tyre tread at the airplane flight manual airplane rotational speed (VR at maximum gross weight).

(3) The tyre debris fragment load is distributed over an area on the fuel tank surface equal to 1.5 percent of the total tyre tread area.

(c) Fuel leaks caused by impact from tyre debris larger than that specified in paragraph (b)(1), from any portion of a fuel tank or fuel system located within the tyre debris impact area (see also Interpretative Material (IM) indicated here

below), may not result in hazardous quantities of fuel entering any of the following areas of the airplane:

(1) Engine inlet

(2) Auxiliary Power Unit (APU) inlet, or

(3) Cabin air inlet.

This must be shown by test or analysis, or a combination of both, for each approved engine forward thrust condition and each approved reverse thrust condition.

Note:
Text ‘or fuel system’ has been added to the original text of para. (c) of the FAA Special Condition 25-07-04-SC to maintain clear consistency of intent.

2- Interpretative Material

TGM/25/08 Issue 2 on “Wheel and Tyre Failure Models” is an acceptable definition for larger tyre debris and trajectories as referenced in paragraph (c) of Special Condition C-05.

Any other equivalent definition for larger tyre debris should be agreed between EASA and Airbus.

The tyre debris size as defined in the TGM should not be used to calculate specific impact energy in order to support an assessment of whether the “larger debris” will finally penetrate the structure and cause leakage or not. It should rather be used to define the opening size of structural damage only, while the fuel leakage is assumed to occur whenever fuel tank structure is struck by larger tyre debris.