Equivalent Safety Finding E-29MAX on CS 25.1309(b)(1), 25.901(c) and 25.981(a)(3): Fuelling Float Switch Installation

Applicable to Boeing 737-7, B737-8 and 737-9

Introductory Note:

The hereby presented Equivalent Safety Finding has been classified as an important Equivalent Safety Finding and as such 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 Boeing Model 737-7, 737-8 and 737-9 (737 MAX) airplanes will use a fuelling float switch in each fuel tank to provide automatic shutoff of pressure fuelling, via a fuelling shutoff valve, when the fuel tanks have reached full capacity. The wiring from the fuelling shutoff valve to the float switch is routed through aluminium conduit in the fuel tank.

Contamination of the fuelling float switch by moisture or fuel, and chafing of the float switch wiring in the conduit could present an ignition source inside the fuel tank that could cause a fire or explosion.

The wiring carries voltage and current levels that do not meet the intrinsically safe levels provided in Advisory Circular (AC) 25.981-1C. The float switch wiring and conduit installation on the Model 737 MAX airplanes is not a failsafe design, and therefore, it does not directly comply with CS 25.901(c), 25.981 (a)(3) and 25.1309(b)(1).

25.981(a)(3) requires that no ignition source be present in the fuel tank or fuel tank system where catastrophic failure could occur due to ignition of fuel or vapours. This is shown by an ignition source not resulting from each single failure and from all combinations of failures not shown to be Extremely Improbable.

25.1309(b)(1) requires that a catastrophic failure condition be extremely improbable and does not result from a single failure.

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Applicant Proposal:

Boeing believes that the following compensating factors can support an equivalent level of safety :

1. Non-conductive convoluted conduit liner design is essentially a dual conduit similar to that discussed in AC 25.981-1C. The convoluted conduit liner has been shown through qualification testing to eliminate the wear and contact concern.

2. Non-conductive convoluted conduit liner design centres wires in the conduit which eliminates contact with the conduit and provides multiple support points that eliminate the wear concern seen with wires routed in conduits without the convoluted liner.

3. Float switch wiring is more flexible compared to the boost pump wiring that has been seen to chafe in the conduit, because it has only two wires verses 3 and is a smaller gage wire. These differences reduce contact pressure in the conduit liner bend areas. The convoluted liner distributes the contact pressure across 4 convolutes per inch rather than have point loads at isolated locations in the conduit.

4. Float switch conduit liner is fully qualified. Qualification tests included vibration testing simulating more than airplane life and exposure to fluids such as fuel, water, hydraulic fluid, etc. with no wear or degradation observed.

5. Inspection of float switch assemblies from 737NG airplanes with over 40,000 hours of service confirms the qualification test results showing no wear.

6. Enhanced, independent, manufacturing and maintenance controls assure the convoluted liner is installed properly.

7. The current Critical Design Configuration Control Limitation (CDCCL) will be carried forward to the 737 MAX.

8. A new Airworthiness Limitation (AWL) Airworthiness Limitation Instruction (ALI) will require periodic replacement of the main tank fuelling float switch assemblies and the centre tank float switch and liner system.

Applicant Safety Equivalency Demonstration:

A change to make the design compliant could require a system change to reduce the voltage and current to intrinsically safe levels or a change to the refuel system that eliminates the use of a float switch. Elimination of the float switch would likely impact the Fuel Quantity Indication System (FQIS) and may require addition of single point sensors in each tank and/or surge tank. Based on the service history of the 737 NG which currently uses the same float switch conduit assembly design, these changes would not have an appreciable effect on airplane safety.