Proposed Equivalent Safety Finding on "Use of Single Fire Suppression Bottle Protection of APU and Baggage Compartment"

Applicable to Cessna 680 BPC

Introductory Note:

The hereby presented Equivalent Safety Findig has been classified as an important Equivalent Safety Findig 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:

JAR 25A1195 requires the APU designated Fire Zone to be equipped with at least a single shot fire extinguishing system. In the Cessna 680 BPC, the APU single shot fire extinguishing aims to also extinguish fires in the baggage compartment.
An equivalent level of safety shall be demonstrated to JAR 25A1195, that requires an individual one shot system for the APU.

Cessna 680 BPC – Equivalent Safety Finding to JAR 25A1195 -

Use of Single Fire Suppression Bottle Protection of APU and Baggage Compartment

Design Proposal:

The Cessna Model 680 uses a single High Discharge Rate (HDR) fire extinguisher bottle (FIREX) for supplying extinguishing agent (Halon) to either the Class C baggage or auxiliary power unit (APU) compartments.

The Model 680 HDR FIREX bottle is discharged when an APU or baggage compartment fire is detected. A Metered Discharge Rate (MDR) fire extinguisher (Halon) is discharged following a HDR discharge into the baggage compartment. The MDR bottle capacity has been shown (tested) to hold a 3% concentration of extinguishing agent (Halon) in the baggage compartment for over 190 minutes (at an altitude of FL330 to FL390). Upon descent from high flight levels, the concentration was found to decrease. To assure adequate concentrations were maintained, an additional squib was added to the MDR bottle that increases the extinguishing agent flow. The increased extinguishing flow must be pilot activated (following airplane flight manual (AFM) procedure) on initiating a descent. An annunciation is automatically generated if the aircraft descends below FL250 without activation. The slightly increased flow was shown (tested) to be adequate to hold the 3% requirement for Halon. The dual flow MDR design changes were introduced prior to first delivery of the Model 680.
Using this data, Cessna developed separate Model 680 AFM procedures for an APU or baggage compartment fire:

1. Following a FIREX discharge for an APU fire, the AFM instructs the pilot to land as soon as possible.
2. Following a FIREX discharge for a baggage compartment fire:
    a. If within 15 minutes of a suitable airport, the AFM instructs the pilot to land as soon as possible (within 15 minutes).
    b. If a suitable airport is beyond 15 minutes, the AFM instructs the pilot to climb to FL330 to FL390 (if possible). When a descent is initiated, the pilot is instructed to fire the secondary MDR bottle to increase the MDR bottle flow, then the AFM instructs the pilot to land as soon as possible. A maximum cruise time of 180 minutes is allowed.

Justification:

In the Model 680 BPC design, Cessna proposes to continue utilizing the Class C baggage compartment single HDR Halon bottle as the source of extinguishing agent for either the Class C baggage compartment or the APU installation, as the common suppressant supply for the APU and cargo compartment was previously certified for the original Model 680 type certificate project.
However, to allow the use of a common source of suppressant, the design should have adequate reliability such that the design is basically equivalent to those systems which are independent. Thus, to achieve an equivalent level of safety to that provided by independent systems, the concerns of common failures or inappropriate actions by the flight crew should be addressed.

Safety Equivalency Demonstration:

The method of documenting certification should not affect Cessna's proposed design as the compliance with respect to the use of a common suppressant source would be the same as if the interpretation is to comply with current regulations or comply by equivalency. Equivalency can be found when Cessna's design has been shown to comply with the conditional items listed below:

1. The APU and the baggage compartment shall have separate fire/smoke detection systems. No failure or malfunction in one system shall adversely affect function of the other.
2. If the APU provides bleed air for cabin and baggage compartment heating/cooling, the cabin system shall be isolated from the baggage compartment by at least a check valve. Any fire originating in the APU compartment shall be isolated to that compartment by the firewall and the APU bleed air shutoff valve.
3. The APU and the baggage compartment shall have no common wiring. Additionally, it shall be shown that no single electrical fault can cause a fire in both compartments.

4. The shared fire bottle, its plumbing and controls shall be entirely outside the APU rotor non-containment zone. An APU rotor non-containment shall not affect the APU compartment fire protection system.

5. The baggage compartment shall be entirely outside the APU rotor non-containment zone. An APU rotor non-containment shall not cause a fire in the baggage compartment, which could necessitate fire extinguishing in both compartments.

6. An engine rotor non-containment shall not cause an APU compartment fire and baggage compartment fire simultaneously, which could necessitate fire extinguishing in both compartments.

7. The probability of either a baggage compartment fire or an APU fire is remote. The probability of a fire protection system failure shall be shown improbable. Consequently, the probability of an uncontrolled fire on the same flight in either compartment shall be extremely improbable.

8. There shall be no common cause failures that could result in a simultaneous baggage compartment fire and APU fire.

9. There shall be no shared cockpit controls. Each system shall be provided with separately located, appropriately labelled controls. Shared annunciation shall be limited to the common Baggage/ APU (HDR) fire bottle status.

10. In the event of a Baggage/APU (HDR) Fire Bottle Low message, both the baggage compartment heat and APU systems shall be rendered inoperative.

11. The shared fire extinguishing bottle shall be provided with two separate discharge fittings and squibs. Each squib shall have a dissimilar electrical connector, which prevents electrical cross-connection. The bottle mounting and discharge fitting arrangement shall be deliberately asymmetric, which prevents mechanical cross-connection of the two systems.

12. While the probability of a baggage compartment fire and APU fire on the same flight is extremely improbable, AFM procedures shall specify that the APU not be operated if the HDR fire extinguisher has been fired. Alternately, AFM procedures shall specify that the baggage compartment heating system not be operated if the APU baggage compartment fire extinguisher has been fired.

13. In the event the Baggage/APU (HDR) fire extinguisher bottle is discharged for either a baggage compartment fire or APU fire, AFM procedures shall specify to land as soon as possible at nearest suitable airport.

14. In the event the Baggage/ APU (HDR) fire extinguisher bottle is discharged for a baggage compartment fire, the minimum extinguishing concentration (3% metered for Halon) shall be maintained for a duration (time) equal to (or greater than) the maximum diversion time for the routes allowed in service and that time entered into the AFM limitations.