

Equivalent Safety Finding on CS 25.1181 (Designated fire zones : regions included) & 25.1182 (Nacelle areas behind fire walls and engine pods attaching structures containing flammable fluid lines).

Applicable to Large Aeroplane

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:

CS 25.1181 provides the definition of a Designated Fire Zones (DFZ). Once a DFZ is defined, first a set of fire prevention / protection rules are becoming imposed onto that zone (25.863, 25.867, 25.869, and 25.1185 to 25.1203) but also, this definition conditioned the applicability of CS 25.1182 on the zones surrounding a DFZ.

Indeed, for pylon zones and nacelle zones containing flammable fluids, when in the vicinity of a DFZ, CS 25.1182 is imposing to take precautions against fire migration from the engine DFZ to these surrounding zones.

As for CS 25.1181, CS 25.1182 is calling for applicability of a set of fire prevention / protection rules, namely CS 25.1103 (b), 25.1165 (e), 25.1183, 25.1185 (c), 25.1187, 25.1189 and 25.1195 to 25.1203, with some variations of applicability depending whether a pylon or a nacelle zone is being looked at.

Several situations have been encountered recently :

- non-applicability of CS 25.1181 (i.e a DFZ fan treated as a Flammable Fluid Leakage Zone (FFLZ));
- non-applicability of CS 25.1182 (i.e fan zone containing Flammable Fluid (FF) adjacent to a DFZ);
- partial applicability of the invoked rules by CS 25.1181 in portions of an engine core compartment zone (i.e no fire detection / no fire extinguishing in localized areas of a DFZ);
- partial applicability of the invoked rules by CS 25.1182 in an nacelle zones (i.e no fire detection/no fire extinguishing in an hydraulic thrust reverser zone adjacent to a DFZ);
- partial applicability of the invoked rules by CS 25.1182 in pylon (i.e no fire resistant hydraulic pipes in pylon zones).

It is EASA opinion that this list is not exhaustive and some other scenarios may have been overseen in past certified product or either been subject of inconsistent treatment (i.e no records / no CRI) or inconsistent interpretations (i.e no use of AMC 25.1182).

The concern is the degradation of the aircraft fire prevention / protection by losing / reducing / diminishing the presence of design features mitigating:

- the engine fire threat likely to occur in a DFZ (CS 25.1181) and
- the potential risk for engine fire spread and resulting hazards if fire does spread in surrounding zones where FF are present (CS 25.1182).

Applicability of the rule:

In one of the above problematics, EASA became aware of a difference of interpretation in the CS 25.1182 applicability in the Pylon with the FAA.

Indeed, CS 25.1182(a) states:

(a) Each nacelle area immediately behind the firewall, and each portion of any engine pod attaching structure containing flammable fluid lines, must meet each requirement of CS 25.1103 (b), 25.1165 (e), 25.1183, 25.1185 (c), 25.1187, 25.1189 and 25.1195 to 25.1203, including those concerning designated fire zones. However, engine pod attaching structures need not contain fire detection or extinguishing means.

There are several ways of interpreting the applicability of the CS 25.1182 rule for an engine pod attaching structure:

- 1) effective on the whole engine pod attaching structure : its complete volume and any sub volumes/compartments within the pylon volume (where flammable fluid are);
- 2) effective only on the engine pod attaching structure zones immediately behind firewall only (where flammable fluid are)

EASA had been more in the interpretation 2).

The way the wording is presented : coma separating the definition for the nacelle area from the engine pod attaching structure area definition - and – the wording itself : *each portion of any engine pod attaching structure* is giving grounds to interpretation 1).

The notion of engine pod attaching structure may nowadays fit more with an engine strut or pylon definition where pod is assimilated to nacelle/cowlings.

Reviewing the rule historic, the CS 25.1182 did not evolve from initial CS25 introduction which was itself a re-conduction of JAR 25. This latest took genesis in FAR 25.1182. The rule was indeed introduced by FAA with FAR-25 Sec 25.1182 that was created with Amdt 25-11, in May 5, 1967. It was not a full new rule in the way that FAR-25 with 25.1181(c) (pre Amdt 25-11) was already provided with considerations for fire prevention/protections of areas located around firewall and stated:

Sec. 25.1181

Designated fire zones: regions included.

....

(c) The nacelle area immediately behind the fire wall must meet the requirements of Secs. 25.863, 25.1103(b), 25.1165 (d) and (e), 25.1183, 25.1185(c), 25.1187, 25.1189, and 25.1195 through 25.1203. If there is a retractable landing gear in this area, compliance with this paragraph need be shown only with the landing gear retracted.

Notice of Proposed Rulemaking 65-43 (31 FR 93, January 5, 1966) that proposed the revision of this section offered some explanations of the main changes:

First, the cross-reference to Sec. 25.863 would be deleted because (1) the remaining cross-references provide adequate fire protection for the portion of the aircraft now covered by Sec. 25.1181 (c), and (2) the cross-reference to Sec. 25.863 has caused confusion since that section applies, on its face, only to situations involving the likelihood of fluid system leakage whereas the likelihood of such leakage should not control the applicability of the fire protection provisions intended to be applied under present Sec. 25.1181(c).

Note: EASA had considered the CS 25.863 applicability in any aircraft areas where flammable fluids are present (including DFZ and adjacent zones to DFZ). This on the basis that despite specific precautions are taken in given areas (i.e. DFZ), minimization of occurrence and consequences of flammable fluid fire remains a safety objective at the whole aircraft level (CS 25.865 is in Subpart D : Construction).

Second, provisions now in paragraph (c) of Sec. 25.1181 would be rephrased to make it clear that the sections referred to in that paragraph apply even though the portion of the aircraft covered by that paragraph is not a designated fire zone. Certain of these referenced sections apply on their face to designated fire zones only. Literal interpretation of these requirements would defeat the intent of the cross-references, which is to give the nacelle area immediately behind the firewall certain fire protective features required in designated fire zones.

Third, the applicability of present paragraph (c) of Sec. 25.1181 to "the nacelle area immediately behind the firewall" would be broadened to include the area that serves the same purpose on airplanes with podmounted turbine engines. For these airplanes, the portion of the pod attach structure that contains flammable fluid lines serves the same purpose as the nacelle area immediately behind the firewall on other airplanes, and should be similarly regulated.

Finally, the provisions now in paragraph (c) of Sec. 25.1181, together with the amendments in this proposal, would be separated from the rest of Sec. 25.1181 and designated as new Sec. 25.1182. The purpose of Sec. 25.1181 is to cover designated fire zones. The areas covered by present Sec. 25.1181 (c) and this proposal share certain requirements with, but are not, designated fire zones.

Some interesting grounds are found with Amendment 25-11 (32 FR 6906, May 5, 1967) that followed Notice 65-43 where comments received to Notice 65-43 were discussed in the preamble to Amendment 25-11 as follows:

The notice proposed to delete § 25.1181 (c) and place its provisions, with certain amendments, in a new § 25.1182. One commenter objects, stating that the fire protection requirements applicable to nacelle areas behind firewalls need not be extended to engine pod attaching structures because the current requirements have provided a superior level of safety for turbojet-powered large airplanes and no record of fires in these structures is known. The Administrator agrees concerning the superior level of safety and good service record of engine pod attaching structures with respect to fire. However, this level of safety has resulted through the voluntary incorporation by industry of engine pod attaching structure design provisions meeting the fire protection provisions of §§ 25.1195 through 25.1201 (except those requiring fire detection and extinguishing). The Administrator agrees with one comment stating that safety does not require that engine pod attaching structures have fire detection and extinguishing provisions, and that those structures may be distinguished from nacelle areas behind the firewall in this regard. To this extent, the Industry comment is accepted and this amendment is revised accordingly.

The commenter also states that the "firewall definition" paragraphs are not relevant for the fire zone, that the "internal boundaries" are not clearly defined, and that this will lead to ventilation, containment, and fire extinguishing system difficulties. The Administrator finds intent of this comment not to be clear.

However, there should be no difficulty in defining the area covered by the term "engine pod attaching structure." Further, the Administrator does not agree that the firewall provisions are

irrelevant to this structure. For this structure, as well as for reciprocating engine installations, the firewall separates the engine nacelle from the airframe in compliance with the provisions of § 25.1191. Finally, the claimed relationship between the firewall defining provisions and possible future difficulties in ventilation, containment, and fire extinguishing is neither supported nor evident. This comment cannot, therefore, be accepted.

One commenter requests that an exception should be provided (1) for engine pod attaching structures where the firewall between pod and pylon extends enough beyond the profile of the pylon to prevent propagation of fire from the pod area around the firewall to the pylon zone; and (2) for installations that have means to prevent contact of leaking flammable fluid with a hot firewall. The Administrator agrees that these safety provisions may be relevant in individual showings of equivalent safety that may justify design alternatives to the sections referenced in § 25.1182. However, within the terms framed by the commenter, these safety provisions are not sufficiently definable to permit a general exception in the regulation. This comment cannot, therefore, be accepted.

The rule evolution (1966–1967) was performed whereas the civil jetliner with turbojet/turbofan had already started to develop years before, thus gradually taking over the relatively sole existing reciprocating engine propeller installation. Turbojet/turbofan installation were either embedded into wing and/or fin or placed on pods (fuselage rear mounted or wing mounted) whereas propeller engines were mainly attached on wing embedded nacelle or aircraft fuselage nacelle. Some clarification on the interpretation could be found when looking at *the area that serves the same purpose on airplanes with pod mounted engines*. The referenced area being “*The nacelle area immediately behind the fire wall*”, and this rule being relatively old (likely to be introduced with CAR 4b-6, effective 5 March 1952 (adopted 28th Jan 1952)), the purpose of that area (in relation to the design/technology at time of the rule in place) was mainly to provide fuel from the tanks and routing for any engine/aircraft interfaces. Since the strut/pylon is doing that purpose, and from the comments/responses in the rule historic (Notice 65-43 and preamble to Amdt 25-11), it is concluded that any portion of the strut/pylon are falling under the intend to prevent fire migration from a DFZ towards the aircraft due to presence of flammable fluids. Interpretation 1) is therefore more appropriate.

Compensating Factors Identification:

For some partial applicability of invoked rules by either CS 25.1181 or CS 25.1182, applicants have attempted to use compensating factors, for instance, from presence of ventilation, drainage, minimization of ignition source or consequences if igniting the flammable fluids or limiting quantities of flammable fluid were compensating factors, This approach had been rejected by EASA since those mitigations were already enforced by the remaining rules imposed by either CS 25.1181 or CS 25.1182 and relatively prescriptive.

In the situation of treating DFZ with FFLZ fire mitigation means, the EASA perspective is that these areas are DFZ by regulation and remain DFZ by definition but could be treated as FFLZ provided there is an equivalent level of safety.

Due to the cascading effect, the zones containing flammable fluids (pylon, nacelle) might no longer be considered under the applicability of CS 25.1182 because a zone could be interpreted no longer under CS 25.1181 applicability (i.e. FFLZ mitigations means). This results in a loss of fire risk mitigations means that were inherently addressing the fire occurrence risk/fire hazards within the zone and not the fire risk from a spreading fire from a surrounding DFZ zone. With that respect, EASA considers that while the area DFZ is no longer treated as a DFZ, all adjacent areas must be addressed as if it were a DFZ and ESF requested if any adjacent areas will not comply.

It is also EASA opinion that use of CS 25.863 fire risk mitigation means may offer some alternatives in compensating rules normally enforced by CS 25.1182. This will be reviewed on

case-by-case basis since the minimization objectives of CS 25.863 does not allow to frame systematics sets of mitigation means as opposed to strict applicability of CS 25.1182. This is illustrated for instance for flammable fluid components that shall be at least fire resistant per CS 25.1182/25.1183 but might have been qualified fire proof for CS 25.863.

**Equivalent Safety Finding to CS 25.1181 and CS 25.1182
Applicable to Large Aeroplane.**

EASA Proposal:

In order to assess the compensating factors for non-compliance to CS 25.1181 / CS25.1182, it is expected to have a thorough description of the engine, nacelle and pylon zoning in showing the physical partitioning between the different areas, their nature (fluid tight/air tight) and the respective identification of CS 25.1181 / CS 25.1182 applicability per CS-25.

Subsequently, it is expected applicants to identify among these, the areas intended not to be shown compliant to CS 25.1181/CS 25.1182, as well as those where partial compliance demonstration to CS 25.1181/CS 25.1182 is intended to be shown. For this latest situation, a clear identification of rule where non-compliance is, should be identified.

EASA Safety Equivalency Demonstration proposal:

It is proposed to take credit of specific and detailed design features that mitigates fire occurrence and resulting hazard either at the zone (where rule are not/partially applied), at component/system and at the surrounding zones level. Since situations of non-compliance could differs, the herebelow generic list of compensating factors could be extended/reduced upon the specific non-compliance.

1. General:

- Retained compensating factors are design features generally in excess of those required by the remaining fire prevention/protection applicable rules;
- Retained compensating factors for not meeting requirements for areas adjacent to a DFZ may differ from those for not meeting requirements for a designated fire zone;
- Retained compensating factors shall match the non-compliant rule(s) intend
- Retained compensating factors shall adress the cascading effect of loosing fire prevention/protection requirements leading to increased aircraft risk.

2. Zone fire threat occurrence minimization:

- no accessory gearbox presence
- remote location or isolation from DFZ
- segregation between wet and dry sides
- oversized drainage and ventilation (increased cooling)
- ignition risk
 - no nominal ignition sources (ambient temperature below FF Auto Ignition Temperature, component explosion proof qualification, bleed pipe insulation, anti chaffing material on electrical harness, low power harnesses, limiting temperature devices)

- minimization of ignition occurrence under failure (component explosion proof qualification, bleed leak monitoring, minimization of connections, limited power exposition, ignition spark limiting devices)
- minimization of firewall backside ignition sources under failure conditions for zone interfaces with surrounding zones (Firewall insulation)
- low level ignition energy
- flammable fluid leak risk
 - drainage
 - ventilation (vapor elimination)
 - protection from leaks
 - technology eliminating the leaks occurrence
 - limitation of high AIT flammable fluids use
 - limited quantities of flammable fluids release
 - shut/off means to limit quantity of flammable fluid
 - flammable fluid component fire withstanding capability
 - flammable fluid system installation precautions
 - limited fluid pressure exposure (i.e not pressurized in flight)
 - double walled piping
 - elimination of flammable fluid components (Dry Bay)

3. Zone fire hazard minimization:

- drainage/ventilation (minimization of O2)
- material fire withstanding capability (bulkheads, partitions, seals) – including intrinsic capability due to material thickness
- partitioning constructions principles
- self extinguishing / non flammable materials
- component qualification – fire withstanding capability
- fire detection and fire extinguishing

4. Zone interfaces with surrounding zones:

- A design where a FFLZ zone (equivalently safe to a DFZ) is only surrounded by DFZ zones offers intrinsic mitigations thanks to the fire prevention/protection rules applied to the DFZ that would likely limit fire spreading.
- Any other configuration shall identify compensating factor preventing fire occurrence risk / fire hazards (item 1 to 3).