

ESF on Fire Protection

Proposed ESF on Fire Protection – Engine attachment points applicable to Piston Engines

EASA

Commentor:	UK CAA
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Paragraph No: Proposed ESF	
<p>Comment: Paragraph (2) of the ESF should clarify whether the ‘other features of the engine mount structure’, have been subject to 5 mins of fire testing and so have degraded strength properties, or can they be considered to have been unaffected by fire.</p> <p>Justification: the applicant and regulator need to know whether the remaining structure has degraded strength or not, when assessing the ability to carry the get-you-home loads.</p> <p>Proposed Text (if applicable): Add sentence at end of paragraph (2) – ‘These can be considered to be unaffected by the fire’.</p>	
Author’s Response:	The applicant has to analyse whether a fire applied to the most critical feature of the engine mount structure (attachment point) will also affect the remaining structure. It depends from the design of this structure (geometry, distance between attachment points etc.) whether the other features of the mount structure are affected or not.

Commentor:	UK CAA
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Paragraph No: Proposed ESF	
<p>Comment: Paragraph (2) of the ESF should make reference to specific load levels expected during the completion of the flight.</p> <p>Justification: The load levels will remain subjective and vary between certification exercises.</p> <p>Proposed Text (if applicable): Add sentence at end of Para (2) –“Loads expected during the completion of the flight are to be taken from AC 25-571-1C, Discrete Source damage”.</p>	
Author’s Response:	Noted. AC 25-571-1C is one acceptable means for determining the loads but not the only one.

Commentor:	David Soul, Diesel Air
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Comment: We believe the Proposed ESF is acceptable but unnecessary, bearing in mind	

that additional costs will be associated with the test. In our view if the mountings are considered as safety critical items then the failure of one should not compromise the flight. A simple physical test therefore to determine the integrity of the installation with failure of one mount should be an acceptable alternative.

We believe the last Applicant's Position therefore is acceptable. ie the proposal that an installation can cope with the loss of one engine mount and that the others will continue to support the engine.

Justification:

Proposed Text (if applicable):

Author's Response:	Operating the engine with failure of one mount is not a general design requirement and therefore not applicable to all of the new projects. In addition, in a fire case more than one attachment point might be affected.
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Commentor:	David Soul, Diesel Air
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Comment:	
It should also be borne in mind that the engine cowling, although not specifically designed as part of the engine mounting system, can act as a redundant supporting structure and if this can be demonstrated as an alternative then that should be an acceptable means of compliance in our view. A redundant fire proof strap incorporated into the design of the engine or cowling to support the engine in case of failure of the engine mounts would be a belt and braces solution.	
Justification:	
Proposed Text (if applicable):	
Author's Response:	Partly accepted. If the cowling can act as redundant supporting structure this should be declared by applicant. Fireproofness has to be shown either by design (materials spec) or test.

Commentor:	Burkhard Jäger, Diamond/Austro Engine
Page No:	2
Paragraph No: Proposed ESF	
Comment: Referring on the proposed ESF given above and considering the intend of AC23-17B, 23.865 "Fire protection of flight controls, engine mounts, and other flight structure" the following comment should be considered:	
<ul style="list-style-type: none"> The whole engine mounting structure should be considered when determining fire resistance. During fire application on a certain feature of the mounting structure deformation and consequently load redistribution will occur (all materials affected by this ESF get weak when being heated). This effect and the possibility of demonstration that the entire mounting 	

structure can sustain limit flight loads (considered as ultimate loads) when testing the most critical feature should be addressed in the ESF under (1).

- All loads during fire application should be defined as “limit loads considered as ultimate loads” as deformation might occur during load application under fire conditions.

Justification:

Proposed Text (if applicable):

Author’s Response:	Accepted.
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Commentor:	Austro Control GmbH
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Paragraph No: Proposed ESF

Comment:

- 1) The CRI should cover the structural components covered by this ESF more consistently.
- 2) A description should be added to give some explanation of the terms mounting structure and attachment points.
- 3) The ESF proposal does not specify if the loads to be considered are only mechanical loads or also thermal effects have to be taken into account during load application.
- 4) Shutdown loads are not considered in this CRI
- 5) Essential boundary conditions to be considered during application of the ESF are not defined, e.g. time of fire detection, time of engine shutdown, time of heat application, etc.

Justification:

- 1) The proposal document refers to attachment points only in its Introduction/Statement of Issue section, the proposed ESF includes all the components which make up the structure which holds the engine in place (engine mounting structure + attachment points)
- 2) In small general aviation industry different interpretation of mounting structure, attachment points, engine mounts, etc. exist. To achieve a uniform application of this ESF some guidance should be added to this ESF.
- 3) Minimum load conditions to be fulfilled should be part of the ESF to avoid different levels of safety throughout the GA community.
Furthermore in the case of non-fireproof structure the applicant should be required to analyse, supported by test, possible fire conditions and take their resulting thermal effects on the remaining structural members into account.
- 4) Diesel engines might introduce significant shut down loads. They should be assessed and if relevant taken into consideration also.
- 5) To achieve a uniform application of this ESF it would be beneficial to establish some minimum assumptions for the boundary conditions to be taken into account.
These boundary conditions are:
Time of fire detection
Time of shut down

Time of heat application

Proposed Text (if applicable):

Add to the title:

Proposed ESF on Fire Protection – Engine *mounting structure and attachment points*

Introductory note:

The hereby presented Equivalent Safety Finding has been classified as an important ESF 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."

Background:

Crankcases of piston engines as well as the brackets fixing the engine mounts are usually made from aluminium. Aluminium is considered to be only fire resistant by definition, depending of the actual design of the parts.

Previously JAR-E initial issue up to amendment 11 did not require fire proof engine attachment points for piston engines. However, by moving the former turbine requirement of JAR-E 530 into the general section – applicable to all engines – of JAR-E amendment 12 piston engines were also required to have fire proof attachment points. The development of CS-E was based on JAR-E amendment 12.

FAR-33 does not include a similar requirement. In AC23-17B, 23.865 "Fire protection of flight controls, engine mounts, and other flight structure" states:

"The intent of the regulations on engine mounts is the engine remains in place with a fire heating an engine mount. We do not intend to cover the case of a general conflagration where the entire engine compartment is burning. Therefore, an applicant should design enough load paths for the engine to remain in place with a localized fire."

EASA want to achieve a comparable safety objective for the piston engine certification.

Statement of Issue:

Several new common rail diesel piston engines are in development in Europe intended to be installed on CS-23 aeroplanes.

The engine attachment points are integral parts of these engines. They do not directly comply with CS E 130 (h) (initial issue of CS-E) as the engine attachment points are made from cast aluminium (the crankcase itself is made of cast iron in some cases).

Furthermore some of these new engine designs incorporate also sleek, beam-type structural supporting members, extending from the crank case attachment points and being part of the engine type design. In addition those mounting structures are often designed of aluminium alloys.

Typically such supporting structures were not part of type designs of traditional aircraft piston engines and were therefore not considered under the engine airworthiness requirements.

Historically those structures were mostly steel truss type structures and therefore recognised as fireproof by definition.

Applicant's Position

The applicants are requesting an equivalent safety finding under the provisions of Part 21 21A.21(c)(2), by showing that non-compliance with CS-E130(h) is compensated for by factors that provide an equivalent level of safety.

Information was provided that engine mount systems on different engine types and variants of conventional design experienced a million flight hours service without any fire related failures in the last 45 years. No cases of engine fires where there was evidence of failure of the piston engine mount system with any piston engine release out of an aircraft were known.

One applicant proposes to show by analysis the capability of the engine mounting system to provide redundant load sustaining paths versus nominal flight loads. In addition it is proposed to demonstrate by fire testing the capability of the attachment points (attachment pads) to be fire resistant.

Another applicant proposes to show by method agreed by the agency that the engine can cope with the loss of the affected engine attachment points and that the remaining ones are still able to hold the engine in its position under consideration of the maximum occurring static and dynamic loads in the relevant flight conditions.

EASA Position:

EASA accepts the need for an Equivalent Safety Finding and proposes the following:

Proposed ESF:

In the case that an applicant can not demonstrate fireproofness of the engine mounting structure and its associated attachment points following conditions have to be fulfilled:

(1) The engine mounting structure must be designed fail safe so that in the case of a failure of one load path the remaining mounting structure is able to support the engine under the loads and thermal conditions as specified under (2) and (3).

(2) Those features of the engine which form part of the mounting structure or engine attachment points shall at least meet the fire-resistant criteria.

(a) The mounting structure and engine attachment points have to be able to sustain the limit flight loads which are appropriate for a typical aircraft installation for which the engine is intended, including engine thrust and torque for maximum continuous power, without failure for 5 minutes under the fire test conditions of AMC E 130 (4)..

This ability has to be demonstrated by analysis or by tests for all mounting structures and attachment points.

For the most critical mounting feature of the engine tests under the loads specified above and in accordance with the fire test conditions of AMC E 130 (4) have to be performed.

(b) At the end of the 5 min period it is assumed that the engine will be shut down.

Shutdown loads have to be evaluated.

Under the fire conditions as specified in (2)(a) the mounting structure and the engine attachment point shall be able to sustain flight loads of -0,5g/1,5 g superimposed with the evaluated shutdown loads without failure. This has to be demonstrated by analysis or test.

(3) After 5 minutes of fire application according to (2) and until the end of 15 minutes the engine is assumed to be shutdown. Under the fire conditions of (2)(a) above, the remaining other features of the engine mounting structure must have sufficient static strength to withstand the maximum loads expected during the completion of the flight. In the absence of a more rationale analysis a load factor of 70 percent of manoeuvre loads and (separately) 40 percent of gust loads may be applied.

All loads referenced in (2) and (3) shall be considered as ultimate loads.

Author's Response:	Accepted. The proposed text will be used for the final ESF.
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