Federal Aviation Administration
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Loads and Dynamics Harmonization Working Group

Task 16 – Fire Protection of Structure

Task Assignment

[Federal Register: August 27, 1998 (Volume 63, Number 166)]
[Notices]
[Page **45895**-45896]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr27au98-158]

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues--New Tasks

AGENCY: Federal Aviation Administration (**FAA**), DOT.

ACTION: Notice of new task assignments for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: Notice is given of new tasks assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT: Stewart R. Miller, Transport Standards Staff (ANM-110), Federal Aviation Administration, 1601 Lind Avenue, SW., Renton, WA 98055-4056; phone (425) 227-1255; fax (425) 227-1320.

SUPPLEMENTARY INFORMATION:

Background

The **FAA** has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the **FAA** Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the **FAA**'s rulemaking activities with response to aviation-related issues. This includes obtaining advice and recommendations on the **FAA**'s commitment to harmonize its Federal Aviation Regulations (FAR) and practices with its trading partners in Europe and Canada.

One area ARAC deals with is Transport Airplane and Engine Issues. These issues involve the airworthiness standards for transport category airplanes and engines in 14 CFR parts 25, 33, and 35 and parallel provisions in 14 CFR parts 121 and 135.

The Tasks

This notice is to inform the public that the **FAA** has asked ARAC to provide advice and recommendation on the following harmonization tasks:

Task 15: Structural Integrity of Fuel Tanks for Emergency Landing Conditions and Landing Gear

Review the current standards of Secs. 25.721, 25.963 and 25.994 as they pertain to the strength of fuel tanks and protection from rupture during emergency landing conditions including landing gear break-away. Review also any related **FAA** and JAA advisory material. In the light of this review, recommend changes to harmonize these sections and the corresponding JAR paragraphs, recommend new harmonized standards, and develop related advisory material as necessary.

The **FAA** expects ARAC to submit its recommendation(s) resulting from this task by July 31, 1999.

Task 16: Fire Protection of Structure

Review the current standards of Sec. 25.865 and those for corresponding JAR 25.865 as they pertain to the protection of Loads and Dynamics and structures from fires in designated fire zones. Review also **FAA** issue papers issued for engine support structures made of materials other than steel, and any related JAA advisory material. In the light of this review, recommend changes to harmonize this section and the corresponding JAR paragraph, recommend new harmonized standards, and develop related advisory material as necessary.

The **FAA** expects ARAC to submit its recommendation(s) resulting from this task by March 31, 2001.

The **FAA** requests that ARAC draft appropriate regulatory documents with supporting economic and other required analyses, and any other related guidance material or collateral documents to support its recommendations. If the resulting recommendation(s) are one or more notices of proposed rulemaking (NPRM) published by the **FAA**, the **FAA** may ask ARAC to recommend disposition of any substantive comments the **FAA** receives.

Working Group Activity

The Loads and Dynamics Harmonization Working Group is expected to comply with the procedures adopted by ARAC. As part of the procedures, the working group is expected to:

1. Recommend a work plan for completion of the tasks, including the rationale supporting such a plan, for consideration at the meeting of ARAC to consider transport airplane and engine issues held following publication of this notice.

2. Give a detailed conceptual presentation of the proposed

recommendations, prior to proceeding with the work stated in item 3 below.

3. Draft appropriate regulatory documents with supporting economic and other required analyses, and/or any other related guidance material or collateral documents the working group determines to be appropriate; or, if new or revised requirements or compliance methods are not recommended, a draft report stating the rationale for not making such recommendations. If the resulting recommendation is one or more notices of proposed rulemaking (NPRM) published by the **FAA**, the **FAA** may ask ARAC to recommend disposition of any substantive comments the **FAA** receives.

4. Provide a status report at each meeting of ARAC held to consider transport airplane and engine issues.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the **FAA** by law.

Meetings of ARAC will be open to the public. Meetings of the Loads and Dynamics Harmonization Working Group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on August 20, 1998.

Joseph A. Hawkins,
Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 98-22999 Filed 8-26-98; 8:45 am]
BILLING CODE 4910-13-M

Recommendation Letter

ACTION ...

Pratt & Whitney
A United Technologies Company

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

control
20021650

April 29, 2002

Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Attention: Mr. Nicholas Sabatini, Associate Administrator for Regulation and Certification

Subject: ARAC Recommendation

Reference: ARAC Tasking, Federal Register, August 27, 1998

Dear Nick,

The Transport Airplane and Engine Issues Group is pleased to submit the attached "Fast Track" report (25.865, Fire Protection of Structure) to the FAA as an ARAC recommendation. This report contains a proposed Advisory Circular which contains concepts that are to be validated by upcoming fire tests at the FAA Technical Center. The FAA is requested to accomplish the requested testing and suggest changes to the AC if the test results warrant.

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant Chair, Transport Airplane and Engines Issues Group

Cc: Mike Kaszycki – FAA-NWR
Dionne Krebs – FAA-NWR
Larry Hanson – Gulfstream
Effie Upshaw – FAA-Washington, D.C.

ANM-98-430-A - Loads + Dynamics

Acknowledgement Letter

SEP 20 2004

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking
Advisory Committee
Pratt & Whitney
400 Main Street, Mail Stop 162-14
East Hartford, CT 06108

Dear Mr. Bolt:

This letter acknowledges receipt of several letters that you sent for the Aviation Rulemaking Advisory Committee (ARAC) on Transport Airplane and Engine (TAE) Issues.

Date of Letter	Description of Recommendation	Working Group
01/06/2003	Proposed rule and draft advisory material on bird ingestion capability (§ 33.76)	Engine Harmonization Working Group (HWG)
10/22/2003	Final report and position statements on bird strike requirements (§ 25.631)	General Structures HWG
10/22/2003	Final report and draft advisory material on alternative composite structure material (§ 25.603)	General Structures HWG
05/14/2004	Final report, proposed rule language, and draft advisory material on warning, caution, and advisory alerts installed in the cockpit (§ 25.1322)	Avionics Systems HWG
06/17/2004	Final report and draft advisory material on fire protection of flight controls, engine mounts and other flight structures (§ 25.865)	Loads and Dynamics HWG
06/22/2004	Final report, proposed rule, and draft advisory material on installed systems and equipment for use by the flight crew (§ 25.1302)	Human Factor HWG

I wish to thank the ARAC and the working groups for the resources that industry gave to develop these recommendations. The recommendations from the Avionics Systems HWG, the Human Factor HWG, and the Loads and Dynamics HWG will remain open until these working groups complete a Phase 4 review. The remaining recommendations have been closed, as we consider submittal of the reports as completion of the tasks. All of these recommendations will be placed on the ARAC website at **http://www.faa.gov/avr/arm/arac/index.cfm**.

We will continue to keep you apprised of our efforts on the ARAC recommendations and the rulemaking prioritization at the regular ARAC TAE issues meetings.

Sincerely,

Original Signed By
Margaret Gilligan

Nicholas A. Sabatini
Associate Administrator for Regulation
and Certification

cc: ARM-1/20/200/204/207; AIR-100, ANM-110

ARM-207:JLinsenmeyer:fs:8/12/04:PCDOCS # 21644
Control Nos. 20041855-0; 20041944-0; 20042001-0

Recommendation

ARAC WG Report

Report from the Loads and Dynamics Harmonization Working Group

Rule Section: FAR/JAR 25.865

1 - What is underlying safety issue to be addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why should the requirement exist? What prompted this rulemaking activity (e.g., new technology, service history, etc.)?]

FAR 25.865 is intended to ensure adequate structural load carrying capabilities at elevated temperatures of essential flight controls, engine mounts, and other flight structure in, or adjacent to, designated fire zones when subjected to fire conditions in order for them to continue to perform their intended functions.

Historically, FAR 25.865 was added to Part 25 by amendment 23 in 1970, although the same requirement had existed for rotorcraft for many years. The need for this rule for transport category airplanes was highlighted when airplane control problems were experienced on a jet transport airplane after aluminum control rods located outside of the fire zone became distorted due to heat from an engine fire. Aviation safety release No. 453, dated November 9, 1961, states that a helicopter component necessary for controlled landing in the event of fire must sustain the loads and perform the function for which it was designed when subjected to a test flame of 2000° F for 15 minutes. This document formed the basis of the current advisory material for transport and utility helicopters and has been applied to various transport category airplane certifications before the advent of Advisory Circular (AC) 20-135. Although the AC 20-135, "Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria", contains the protection criteria for powerplant installations, it does not address any means of compliance with FAR 25.865, particularly for the load carrying engine mount systems.

2 - What are the current FAR and JAR standards relative to this subject?

The current FAR and JAR standards are identical.

Current FAR/JAR text: Essential flight controls, engine mounts, and other flight structures located in designated fire zones or in adjacent areas which would be subjected to the effects of fire in the fire zone must be constructed of fireproof material or shielded so that they are capable of withstanding the effects of fire.

2a – If no FAR or JAR standard exists, what means have been used to ensure this safety issue is addressed?

Not applicable.

3 - What are the differences in the FAA and JAA standards or policy and what do these differences result in?

The definition of "fireproof" used in both standards differs in their FAR 1/JAR 1 definitions.

FAR 1 fireproof definition:

(1) With respect to materials and parts used to confine fire in a designated fire zone, means the capacity to withstand at least as well as steel in dimensions appropriate for the purpose for which they are used, the heat produced when there is a severe fire of extended duration in that zone; and

(2) With respect to other materials and parts, means the capacity to withstand the heat associated with a fire at least as well as steel in dimensions appropriate for the purpose for which they are used.

JAR 1 fireproof definition:

With respect to materials, components and equipment, means the capacity to withstand the application of heat by flame, for a period of 15 minutes without any failure that would create a hazard to the aircraft. The flame will have the following characteristics:

Temperature	1100°C ± 80°C
Heat Flux Density	116 KW/m² ± 10 KM/m²

Note: For materials this is considered to be equivalent to the capability of withstanding a fire at least as well as steel or titanium in dimensions appropriate for the purpose for which they are used.

The JAR 1 definition contains the fire threat to be addressed, i.e. temperature, time, and heat flux. The FAR definition is a more objective based rule, with the same fire threat contained in the advisory material AC 20-135, and reflects general material types that are deemed acceptable. In this aspect, the JAR definition also includes titanium as well as steel as a fireproof material within the rule.

The FAR 1/JAR 1 definitions for fireproof are used throughout the FARs and JARs. Although the JAR 1 definition incorporates the flame temperature, duration, and heat flux, the definition also includes a note that accepts both steel and titanium as fireproof.

Recently, the FAA has been presented several certification programs where applicants have complied with the JAR fireproof definition, as contained in JAR 25.865, using titanium engine mounts. The FAA has considered that the engine mount structures made of titanium may not be equivalent to steel in terms of load carrying capability at elevated temperatures, and therefore, under current policy does not accept titanium mount structures as meeting the requirements of FAR 25.865 without substantiation by a fire test and/or analysis.

As a result, in 1987-88 timeframe, the FAA developed an issue paper for FAR 25.865 to address the need to show that titanium and other non-steel engine mounts will perform their intended function under fire conditions and appropriate loads. The assessment of the engine mount configuration does take into account such features as shielding and redundant load paths.

The differences in FAA and JAA policy on 25.865 compliance described above have not resulted in design changes to current generation titanium engine mounts submitted to the authorities for certification.

4 - What, if any, are the differences in the current means of compliance? [Provide a brief explanation of any differences in the current compliance criteria or methodology (e.g., issue papers), including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

As stated above, the FAA considers that the engine mount structures made of titanium may not be equivalent to steel in terms of load carrying capability at elevated temperatures, and has therefore not accepted titanium as meeting the requirements of FAR 25.865 without substantiation by test and/or analysis. The FAA developed an issue paper to address the need to demonstrate that the particular engine mount installations will perform their intended function under fire conditions and appropriate flight loads.

5 – What is the proposed action?

Advisory Material

The proposed action is to publish new harmonized AC/ACJ advisory material that will provide a methodology for establishing a "fireproof" material structural standard/rating; see attachment, and also item 13 below. This rating threshold would allow acceptance of load carrying materials capable of withstanding the effects of fire at least as well as a reference steel classification in dimensions appropriate for the purpose for which they are to be used without fire tests and/or analysis. Additionally, assessments at the component and installation level can be made when the structural materials cannot be shown to be "fireproof" , i.e. meet the fireproof structural standard, considering such items as shielding and redundancy (fail-safe features).

In addition, the advisory material will define the extent of applicability of 25.865 to engine-side and airframe-side mount structure.

There would not be any change to the existing harmonized requirement.

Test Program

Certain testing is necessary to validate the proposed fireproof rating methodology, as well as to determine certain fireproof rating values, as outlined in the AC/ACJ. The FAA Technical Center, Fire Safety Section - AAR-422, has been contacted and is prepared to conduct this testing. The FAA is requested to proceed with this test program as outlined in the attachment. It is anticipated that the FAA representative to the LDHWG will work with the Technical Center throughout the test program and provide information to, and seek assistance from the working group as necessary. Upon completion of the test program, the LDHWG will regroup to finalize details in the advisory material associated with the material fireproof ratings.

6 - What should the harmonized standard be?

The standard is currently harmonized. There are no changes being proposed to the current standard.

7 - How does this proposed standard address the underlying safety issue (identified under #1)?

Since there would be no change to the existing standard, this proposal would continue to address the underlying safety issue in the same manner as it does currently.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The proposed new policy/advisory material will maintain the level of safety intended by the existing standard and for installations previously approved.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

Maintain. Current industry practice, while not completely uniform, is generally consistent with the proposed means of compliance in the advisory material.

10 - What other options have been considered and why were they not selected?

One option that was considered was defining a "foreseeable" or realistic fire condition which could replace the standard flame definition for use in component or part analyses. This was proposed as a 2000° F temperature flame as the fire "source" on the various components individually, with representative, lower zonal temperatures (800° -1000°F) on redundant components of the engine mount installation.

Under this approach, the basic "intent" of the rule - to provide a sufficient strength capability in a foreseeable fire - would be met. A foreseeable fire is not necessarily 2000°F nor does it last for precisely 15 minutes, and there may be some installations for which this performance criterion might not be met, but the installation is sufficiently protected against the foreseeable fire.

The task group did not feel that a "foreseeable" fire could be defined at this time due to the lack of actual nacelle fire data concerning heat flux, temperature, and size, and supported the current standard flame definition as the appropriate requirement for providing consistent results. Thus, the use of the standard AC 20-135 or ISO 2685 flame has been found to be an acceptable representation of a foreseeable fire condition for the purposes of compliance with paragraph 25.865.

11 - Who would be affected by the proposed change?

Manufacturers of transport category airplanes and engine, and APU manufacturers could be affected by the proposed advisory material. With the establishment of a new fireproof structural rating for materials in the proposed advisory material, and after initial specimen tests and/or analyses of more commonly utilized materials are conducted, no testing or analysis would be required for the acceptable materials. New or changed materials would require test or analysis to define their rating levels.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does any existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

AC 20-135 is adequate in providing guidance for the standard flame properties definition for fire test methods. The JAR standard currently reflects the same properties definition.

FAA Policy Memo 96-ANM-112-14, "Engine-Airplane Regulatory Interface", dated November 13, 1996, describes the consideration for engine-side hardware during mount assessment for damage tolerance and failsafe design. This philosophy is used in application to mount fire requirement under 25.865 and is clarified in the attached advisory material.

Generic Issue Paper, "Fire Protection of Structure and Systems in Fire Zones" describes the current FAA position on non-steel engine mount structures.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

There is no existing advisory material for the rule. New advisory material for § 25.865 is proposed; see attachment.

In showing compliance to the proposed advisory material, the "materials structural rating" concept is a simplified approach for validating structural materials against those that have historically been shown as having acceptable resistance to the effects of fire. The materials structural rating will ensure that an acceptable level of safety will be maintained irrespective of the detail configuration of the components and parts when they are sized to comply with the other relevant certification requirements.

This alternative approach, where the installation is accepted without further evaluation, will be based on an appropriately conservative level consistent with industry experience. It is possible that even some steel classifications might fall below the acceptable rating level. This does not mean that materials falling below the acceptable rating level are "prohibited", but they would not receive the "no further evaluation" approach, but must be evaluated with respect to the installation.

14 - How does the proposed standard compare to the current ICAO standard?

The ICAO standards are higher level standards that do not go into the detail of this proposed change. This proposal does not conflict with the current ICAO standards.

15 - Does the proposed standard affect other HWG's?

The PPIHWG has forwarded a new FAR1/JAR1 fireproof definition that no longer includes a provision for equivalence to steel or titanium. The guidance material forwarded herewith is based on the provision for equivalence to steel in the existing FAR1/JAR1 definition. The LDHWG believes it is appropriate to proceed without waiting for a new fireproof definition, which may be years in the making, and which may change before finally published. Furthermore, in the event the new definition is published, the LDHWG believes the approach outlined in the proposed AC/ACJ will remain valid.

The EHWG is also impacted due to harmonization activity related to FAR 33.17 and the equivalent JAR. The latter contains a fireproof engine mount requirement, which is not contained in FAR 33.17. After the LDHWG makes its recommendation with regard to FAR/JAR 25.865, the EHWG intends to revisit the fireproof engine mount criteria and determine how it should be covered by engine regulations.

16 - What is the cost impact of complying with the proposed standard?

The overall cost to manufacturers should be equal to or lower because adoption of the proposed, harmonized advisory material would allow applicants to demonstrate compliance with acceptable materials relative to the fireproof structural rating without additional tests or analyses. For other materials ("non-fireproof" materials), assessments can be done at the component and installation level as is currently practiced. However, in some specific instances certification costs may increase due to more uniform application of the standard for these instances.

17 - If advisory or interpretive material is to be submitted, document the advisory or interpretive guidelines. If disagreement exists, document the disagreement.

The proposed advisory material is attached. There are no disagreements on this submittal.

18 - Does the HWG wish to answer any supplementary questions specific to this project?

Yes.

Question: What is the service experience for engine mounts relative to the safety issue expressed in question 1?

Answer: The HWG examined all available data regarding fires and their effect on engine mounts. The task group examined manufacturer data provided by Boeing, Airbus, Pratt & Whitney, General Electric, Rolls Royce, Snecma, Cessna, and Honeywell. While the data confirmed that engine fires occurred generally at a rate of 10-6 per flight hour over approximately a billion installation hours, there were no recorded instances of a mount ever being compromised on any transport aircraft installation due to fire.

The HWG also reviewed the experience accumulated on various mount materials for Boeing, Airbus and Cessna installations of Pratt & Whitney, General Electric, Rolls Royce – Allison, Honeywell, CFM, and IAE engines. The numbers presented represent a rough, conservatively low estimate of the experience using these materials in components of mount applications and does not represent the entirety of the industry experience. Information was not immediately available for several installations with significant experience, notably DC-9, MD-80, L-1011 and Rolls Royce installations on Boeing airplanes. The most widely used materials experience is summarized in the table below:

Material	Front mount hours (Million)	Aft mount hours (Million)
15-5 PH Steel	314	90
4000 Series Steel	343	unknown
410 Steel	525	0
Inco 718	124	392
Greek Ascolloy	0	746
6-4 Titanium	392	11
6-2-4-2 Titanium	0	12

19 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes

20 - In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process? Explain.

Yes, the "Fast Track" process is appropriate for this project.

Proposed FAA Technical Center Test Program

Objective

Certain testing is necessary to validate the proposed testing methodology, as well as to determine certain fireproof rating values, as outlined in the AC/ACJ. The FAA Technical Center, Fire Safety Section - AAR-422, is requested to conduct this testing, in cooperation with the FAA representative to the LDHWG. It is anticipated that the FAA representative to the LDHWG will work with the Technical Center throughout the test program and provide information to, and seek assistance from the working group as necessary.

Basic Assumptions

1. The proposal is to compare the loss of ultimate tensile strength (UTS) of a standardised specimen (comparison bar) to a reference steel bar of 4000 series steel material when subject to 5 and 15 minutes exposure to a standard flame. Those materials exhibiting the same or lesser degradation than the reference steel are considered acceptable as "fireproof" without further validation. The materials used for comparison to the reference steel should be taken from the list of materials provided in the AC/ACJ.

2. The reference steel bar will be tested as defined below. Conduct the same test with the comparison bar except that the diameter should be adjusted so that the ultimate static load carrying ability in tension at room temperature between the comparison bar and the reference bar are the same.

3. It is proposed that the testing be restricted to a single external size and shape and hence present a uniform set of heat input characteristics with respect to the flame. In order to allow for some limited effects of thermal conductivity and density effects it is proposed that the reference steel sample be a tube 1.5" OD and 1.0" ID*. On this basis, lower strength materials have a potential increase in cross sectional area to achieve the same operating temperature UTS as the reference steel bar, without increasing its diameter.

   *The dimensions provided may need to be adjusted in order to be able to successfully complete the testing. The FAA should determine the best dimensions to use for the reference bar, possibly based on some testing, and also based on the availability of materials of the appropriate dimensions.

4. The test bar length is proposed as 30".

5. Using material strength vs. temperature data (average properties) for the reference bar material and the comparison bar material, determine the minimum ratio of the comparison material strength to the reference steel strength during the 15 minute time period. This will be considered the "structural fireproof rating". Structural materials demonstrating a fireproof rating greater than 1.0 may be considered compliant with the intent of § 25.865 without further substantiation.

Proposed FAA Technical Center Test Program, cont.

Proposed test procedure

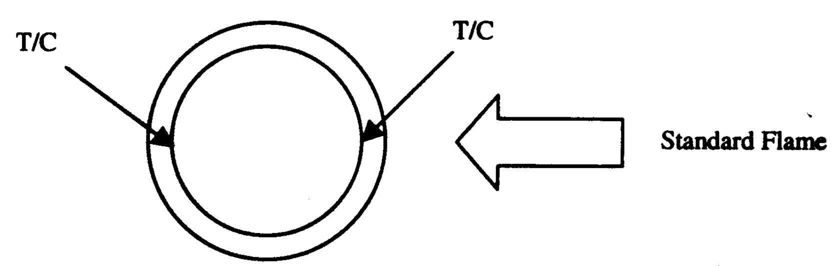
1. A 30" test specimen for each material would be prepared having a UTS equal to that of the reference steel material sample of 1.5" OD and 1.0" ID (or appropriate dimensions). The specimen would be instrumented with 2 thermocouples installed at the center to read the wall temperature of the bar at two points on the diameter. The lead out should be ideally within the tube, or failing that along the rear of the section to minimize aerodynamic impact of the lead outs on the wire.

2. The bar should be fire tested to the requirements of AC 20-135 or ISO 2685 with the burner positioned such that the calibrated section of the flame impacts centrally on the test specimen. The bar should be held in position is such a way that the impact of the mounting on the bar installation is minimal (the ideal would be a bar in free space). The thermocouple positions should be such that they are front and back (see figure 1).

3. Time temperature data during the fire test should be recorded.

4. For the assessment, the average temperature of the front and rear thermocouples should be used to determine from test sample or available data, the strength of the material at both the 5 and 15 minute points. Note: for novel materials these temperature/UTS levels should not result in significant creep within this test period.

FIGURE 1



DRAFT ADVISORY CIRCULAR No. 25.865-1
Fire protection of flight controls, engine mounts, and other flight structure

1. PURPOSE. This advisory circular (AC) sets forth an acceptable means, but not the only means, of demonstrating compliance with the provisions of part 25 of the Federal Aviation Regulations (FAR) related to the protection of flight controls, engine mounts and other flight structure from fires in designated fire zones on transport category airplanes.

   This advisory material applies to zonal fires and to low pressure fires and does not apply to "torching" fires resulting from engine casing burn through.

2. RELATED FAR SECTIONS AND ADVISORY MATERIAL.

   FAR 1, FAR 33.17, AC 20-135

3. BACKGROUND.

a. Section 25.865 "Fire protection of flight controls, engine mounts and other flight structure" was added to Part 25 by amendment 25-23 in 1970, although the same requirement had existed for rotorcraft since the early 1960's. The need for this rule for transport category airplanes was highlighted when control problems were experienced on a jet transport airplane after aluminum control rods located outside of the fire zone became distorted due to heat from an engine fire.

b. The rule was set forth by amendment 25-23 with essentially the same text that was used for transport (Category A) rotorcraft. The specific flight controls that were of concern for rotorcraft were those that were essential for making a controlled landing. For transport airplanes it was recognized that making a landing was not as simple and immediate as it could be for a rotorcraft so the rule was written to apply to "essential" flight controls without further qualification. Since engine mounts and other flight structures could also be affected, the rule was made to apply to those components as well.

c. FAA Flight Standards Service Release No. 453, dated November 9, 1961 (a forerunner of the current Advisory Circular system) stated that a component (structure, control, mechanism or other essential part) must resist flame penetration and remain capable of carrying the loads and satisfactorily performing the function for which they are designed when subjected to a standard test flame of 2000 degrees F for 15 minutes. Service Release No. 453 formed the basis of the current advisory material for transport and utility helicopters (AC 29-2A and AC 27-1) and has also been accepted for transport category airplane certification after the rule was adopted for transports.

d. Advisory circular AC 20-135 "Powerplant installation and propulsion system component fire protection test methods, standards, and criteria" contains acceptable information for compliance with the several fire protection requirements and includes the methods and criteria for conducting fire tests on components to establish that they are fireproof. When developing AC 20-135, it was recognized that to establish the fire integrity of structural elements and flight controls, the expected external loads during the fire event would need to be defined and considerations of fail-safety and redundancy would need to be addressed. Since these considerations would take more time to develop, the AC was published excluding applicability to § 25.865. The FAA has continued to rely on the criteria of Service Release No. 453 as the basic means of compliance, although the methods of fire testing and flame definition were slightly changed to be consistent with the fire definitions of AC 20-135.

e. The term "fireproof" is defined in AC 20-135 (for components other than firewalls) as the capability of a material or component to withstand as well as steel, a 2000 °F flame (± 150 °F) for 15 minutes minimum while still fulfilling its design purpose. FAR part 1 defines "fireproof" (for components other than firewalls) as the capacity to withstand the heat associated with fire at least as well as steel in dimensions appropriate for the purpose for which they are used. Other definitions have been proposed and used which do not refer to any specific material but require the component to withstand the 2000° F flame (± 150° F) for 15 minutes fire condition. Irrespective of what definition is used for the term "fireproof" for a structural member, the capability to withstand the fire condition is integrally tied to the loads expected to be applied to the structural member during the time of exposure to the fire. Experience has shown that essential flight structures, when constructed of steel, are capable of withstanding the loads likely to be applied during the exposure to the fire condition (2000° F flame (± 150° F) for 15 minutes). The use of materials that are equivalent to steel for structural members has been accepted.

f. For materials not shown to be equivalent to steel it has been necessary to consider the installation as a whole. This has required the consideration of shielding, redundancy and the available heat transfer mechanisms in combination with a set of design flight loads. Advisory Circular 25.571-1C, "Damage Tolerance and Fatigue Evaluation of Structure", provides design loads associated with discrete source damage conditions which would exist until landing. The design loads as described and contained in Section 7 are greater than the flight loads expected during the shorter duration of an in-flight fire, but nevertheless have been considered appropriate for conducting the evaluation of the complete structural installations exposed to the prescribed fire condition (2000° F flame (± 150° F) for 15 minutes).

4. <u>DEFINITIONS:</u>

a. <u>Foreseeable fire condition</u>: A realistic fire condition that is assumed for the purposes of qualitatively determining if a component or part could be affected by a fire in the fire zone.

b. <u>Designated fire zone</u>: A fire zone as defined in § 25.1181.

c. <u>Engine Mount</u>: For purposes of compliance to 25.865, the engine mount is considered to consist of the airframe engine mounting structure and engine-side attachment points and adjacent essential structure.

d. <u>Essential:</u> Necessary for continued safe flight and landing.

e. <u>Fire test condition</u>: The conditions associated with the standard fire test described in Advisory Circular AC 20-135 or ISO 2685.

f. Structural Fireproof rating: A fireproof rating relative to a selected standard steel which takes into account the specific heat capacity, conductivity, and strength variation with temperature.

5. DISCUSSION: This section provides several alternatives for addressing components that could be affected by fire in a fire zone. Note that firewalls used to contain the fire zone are considered to remain intact. Within a fire zone, the "effects of fire" relate to the direct flame impingement on the component or shielding if applicable. In areas adjacent to the fire zone the heat generated by the fire in the fire zone is the primary effect for consideration.

- They can be constructed of materials considered to be "fireproof".
- The design (arrangement and redundancy) can be such that the intended function can still be performed under the heat and other conditions likely to occur when there is a fire in the fire zone.
- The component can be shielded so that it is capable of withstanding the effects of fire.

For each of the assessments in the advisory circular, including the application of fire test conditions, validated analyses may be used to represent the transient temperature conditions and strength.

6. FIREPROOF STRUCTURAL MATERIALS.

a. Structural components. Engine mounts and other essential flight structures constructed of steel are considered capable of withstanding the expected flight loads during exposure to the fire condition (2000 °F flame (± 150 °F) for 15 minutes). For other materials intended to carry loads and resist failure in the fire condition, equivalency to steel may be accomplished by the following analytical or test demonstration designed to take into account the specific heat capacity, conductivity, and strength variation with temperature:

1) Unless other dimensions are agreed upon, consider a specimen of round bar of 4000 series steel (exact material TBD), 1.5 inches outside diameter (OD), 1.0 inches inner diameter (ID), and 30 inches long (i.e. 5 times the burner flame diameter). This is considered the reference bar.

2) The bar should be held in position in such a way that the impact of the mounting on the bar installation is minimal (the ideal would be a bar in free space).

3) Using a standard burner defined in AC 20-135 or ISO 2685, apply the heat to the center of the bar and determine the highest average cross section temperature vs. time during a 15 minute exposure.

4) Conduct the same test with the comparison bar except that the diameters (TBD) of the comparison bar should be adjusted so that the comparison bar and the reference bar have the same ultimate tensile strength.

5) Using material strength vs. temperature data (average properties) for the reference bar material and the comparison bar material, determine the minimum ratio of the comparison material strength to the reference steel strength during the 15 minute time period. This is the structural fireproof rating. Structural materials demonstrating a fireproof rating greater than 1.0 may be considered compliant with the intent of § 25.865 without further substantiation.

The following are the fireproof ratings for materials that have been found acceptable by the Administrator for demonstrating compliance with § 25.865:

(These materials will have to be further specified.)

Material	Fireproof rating
4000 series steel (reference)	TBD
Nickel Alloy 718	TBD
410 Steel	TBD
PH13-8Mo Steel	TBD
15-5 PH Steel	TBD
Titanium 6Al-4V	TBD
Titanium 6Al-2Sn-4Zr-2Mo	TBD
IMI 550	TBD
Greek Ascolloy	TBD

7. NON-FIREPROOF MATERIALS USED IN STRUCTURAL COMPONENTS AND INSTALLATIONS.

When the structural materials cannot be shown to be fireproof by paragraph 6, the following assessments at the component and installation level should be made.

Engine mounts and other essential flight structures should be able to sustain expected flight loads with a positive margin of safety for any foreseeable fire in a fire zone. In the absence of a rational definition of a foreseeable fire event and expected flight loads, each structural element should be individually subjected (as per paragraph 9b.) to the fire test conditions described in AC 20-135 (2000° F for 15 minutes) while sustaining the following loads:

- limit flight loads without failure for at least five minutes, and
- after 5 minutes and until the end of 15 minutes, the engine may be assumed to be shut down and the structure must be able to support the discrete source damage loads described in AC 25.571-1C.

8. FIRE ASSESSMENT OF ESSENTIAL FLIGHT CONTROLS. Essential flight controls that could be affected by a fire in the fire zone should be able to perform their intended function during any foreseeable fire in an adjacent fire zone.

a. Essential flight control structural components should be subjected to the effects of the prescribed fire test condition in the fire zone while assessing their capability to continue to perform their function. The assessment of mechanical components should include any tendency to warp, seize, jam or fail under anticipated control system loads with the prescribed fire test condition.

b. Essential hydraulic components including lines, actuators, seals and valves should be assessed to assure that the function they are intended to perform can still be accomplished under any foreseeable fire condition in the adjacent fire zone.

9. SHIELDING AND REDUNDANCY AND OTHER CONSIDERATIONS.

a. Shielding: Shielding may be provided to protect a component against the effects of fire. The adequacy of the shielding should be determined under paragraphs 7 and 8 with the defined fire conditions by assessing the results of applying the flame on the most critical location of the shielded component(s) with representative impingement.

b. Redundancy: All components and parts that could be affected by a fire in a fire zone should be fireproof or protected from the effects of fire. However, the fail-safe features of the design may be taken into account if it can be shown that no foreseeable fire condition could cause the loss of function of the alternate load paths or alternate control elements. The use of the standard AC20-135 flame has been found to be an acceptable representation of a foreseeable fire condition for assessment of redundancy. The effect of this flame impinging on a target loadpath should be assessed on the alternate loadpaths.

c. Aeroelastic stability: When, due to the effect of temperature, significant changes in stiffness and damping properties of parts occur, such as with elastomeric or non-fireproof materials, aeroelastic stability should be addressed accounting for those changes. The aeroelastic assessment should include flutter and whirlmodes and consider the most critical properties that could exist in a fire condition. It should be shown that the airplane is free from aeroelastic instability within the aeroelastic stability envelope of 25.629(b)(2).

Recommendation Letter

Action: ARM

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Pratt & Whitney
A United Technologies Company

AVR-1 Sign

June 17, 2004

Federal Aviation Administration
800 Independence Avenue, SW
Washington, D.C. 20591

Attention: Mr. Nicholas Sabatini, Associate Administrator for Regulation and Certification

Subject: ARAC Recommendation, FAR 25.865, Fire Protection of Flight Controls, Engine Mounts and Other Flight Structures

Reference: ARAC Tasking, Federal Register, August 27, 1998.

Dear Nick,

The Transport Airplane and Engine Issues Group is pleased to submit the following as a recommendation to the FAA in accordance with the reference tasking. This information has been prepared by the Loads and Dynamics Harmonization Working Group.

- Working Group Report – FAR/JAR 25.865
- Proposed Advisory Circular – 25.865-1, Fire Protection of Flight Controls, Engine Mounts and Other Flight Structures

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant Chair, TAEIG

Copy: Dionne Krebs – FAA-NWR
Mike Kaszycki – FAA-NWR
Alicia Douglas– FAA-Washington, D.C.
Larry Hanson - Gulfstream

Recommendation

ARAC WG Report

Report from the Loads and Dynamics Harmonization Working Group

Rule Section: FAR/JAR 25.865

1 - What is underlying safety issue to be addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why should the requirement exist? What prompted this rulemaking activity (e.g., new technology, service history, etc.)?]

FAR 25.865 is intended to ensure adequate structural load carrying capabilities at elevated temperatures of essential flight controls, engine mounts, and other flight structure in, or adjacent to, designated fire zones when subjected to fire conditions in order for them to continue to perform their intended functions.

Historically, FAR 25.865 was added to Part 25 by amendment 23 in 1970, although the same requirement had existed for rotorcraft for many years. The need for this rule for transport category airplanes was highlighted when airplane control problems were experienced on a jet transport airplane after aluminum control rods located outside of the fire zone became distorted due to heat from an engine fire. Aviation safety release No. 453, dated November 9, 1961, states that a helicopter component necessary for controlled landing in the event of fire must sustain the loads and perform the function for which it was designed when subjected to a test flame of 2000° F for 15 minutes. This document formed the basis of the current advisory material for transport and utility helicopters and has been applied to various transport category airplane certifications before the advent of Advisory Circular (AC) 20-135. Although the AC 20-135, "Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria", contains the protection criteria for powerplant installations, it does not address any means of compliance with FAR 25.865, particularly for the load carrying engine mount systems.

2 - What are the current FAR and JAR standards relative to this subject?

The current FAR and JAR standards are identical.

Current FAR/JAR text: Essential flight controls, engine mounts, and other flight structures located in designated fire zones or in adjacent areas which would be subjected to the effects of fire in the fire zone must be constructed of fireproof material or shielded so that they are capable of withstanding the effects of fire.

2a – If no FAR or JAR standard exists, what means have been used to ensure this safety issue is addressed?

Not applicable.

3 - What are the differences in the FAA and JAA standards or policy and what do these differences result in?

The definition of "fireproof" used in both standards differs in their FAR 1/JAR 1 definitions.

FAR 1 fireproof definition:

(1) With respect to materials and parts used to confine fire in a designated fire zone, means the capacity to withstand at least as well as steel in dimensions appropriate for the purpose for which they are used, the heat produced when there is a severe fire of extended duration in that zone; and

(2) With respect to other materials and parts, means the capacity to withstand the heat associated with a fire at least as well as steel in dimensions appropriate for the purpose for which they are used.

JAR 1 fireproof definition:

With respect to materials, components and equipment, means the capacity to withstand the application of heat by flame, for a period of 15 minutes without any failure that would create a hazard to the aircraft. The flame will have the following characteristics:

Temperature	1100°C ± 80°C
Heat Flux Density	116 KW/m^2 ± 10 KM/m^2

Note: For materials this is considered to be equivalent to the capability of withstanding a fire at least as well as steel or titanium in dimensions appropriate for the purpose for which they are used.

The JAR 1 definition contains the fire threat to be addressed, i.e. temperature, time, and heat flux. The FAR definition is a more objective based rule, with the same fire threat contained in the advisory material AC 20-135, and reflects general material types that are deemed acceptable. In this aspect, the JAR definition also includes titanium as well as steel as a fireproof material within the rule.

The FAR 1/JAR 1 definitions for fireproof are used throughout the FARs and JARs. Although the JAR 1 definition incorporates the flame temperature, duration, and heat flux, the definition also includes a note that accepts both steel and titanium as fireproof.

Recently, the FAA has been presented several certification programs where applicants have complied with the JAR fireproof definition, as contained in JAR 25.865, using titanium engine mounts. The FAA has considered that the engine mount structures made of titanium may not be equivalent to steel in terms of load carrying capability at elevated temperatures, and therefore, under current policy does not accept titanium mount structures as meeting the requirements of FAR 25.865 without substantiation by a fire test and/or analysis.

As a result, in 1987-88 timeframe, the FAA developed an issue paper for FAR 25.865 to address the need to show that titanium and other non-steel engine mounts will perform their intended function under fire conditions and appropriate loads. The assessment of the engine mount configuration does take into account such features as shielding and redundant load paths.

The differences in FAA and JAA policy on 25.865 compliance described above have not resulted in design changes to current generation titanium engine mounts submitted to the authorities for certification.

4 - What, if any, are the differences in the current means of compliance? [Provide a brief explanation of any differences in the current compliance criteria or methodology (e.g., issue papers), including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

As stated above, the FAA considers that the engine mount structures made of titanium may not be equivalent to steel in terms of load carrying capability at elevated temperatures, and has therefore not accepted titanium as meeting the requirements of FAR 25.865 without substantiation by test and/or analysis. The FAA developed an issue paper to address the need to demonstrate that the particular engine mount installations will perform their intended function under fire conditions and appropriate flight loads.

5 – What is the proposed action?

<u>Advisory Material</u>

The proposed action is to publish new harmonized AC/ACJ advisory material. Assessments at the component and installation level can be made when the structural materials cannot be shown to be "fireproof", considering such items as shielding and redundancy (fail-safe features).

In addition, the advisory material will define the extent of applicability of 25.865 to engine-side and airframe-side mount structure.

There would not be any change to the existing harmonized requirement.

6 - What should the harmonized standard be?

The standard is currently harmonized. There are no changes being proposed to the current standard.

7 - How does this proposed standard address the underlying safety issue (identified under #1)?

Since there would be no change to the existing standard, this proposal would continue to address the underlying safety issue in the same manner as it does currently.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The proposed new policy/advisory material will maintain the level of safety intended by the existing standard and for installations previously approved.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

Maintain. Current industry practice, while not completely uniform, is generally consistent with the proposed means of compliance advisory material.

10 - What other options have been considered and why were they not selected?

A. Fire testing was conducted at the FAA Technical Center in an effort to assess and compare the characteristics of certain materials (steel, titanium, aluminum and inconel), as well as to evaluate a methodology by which other materials could also be tested. It had been proposed that with this testing, we would be able to establish a "fireproof" material structural standard/rating. This rating would be used to identify materials that would be considered "fireproof," and therefore compliant with FAR/JAR 25.865 without further substantiation.

The primary goal of this testing was the evaluation of titanium in comparison to steel. Based on the test results, it could not be concluded that titanium was a "fireproof" material per the FAR Part 1 definition. Also, it was decided that the fireproof rating scheme should not be included in the AC/ACJ. However, to reflect the results of the testing on Inconel 718, the following text was added to the AC, "In research conducted for development of this advisory circular, fire tests were conducted at the FAA Technical Center. In those tests, Inconel 718 performed as well as steel, and therefore, Inconel 718 may be considered a fireproof engine mount material, without further substantiation."

B. Paragraph 9.b. Redundancy

One option that was considered was defining a "foreseeable" or realistic fire condition which could replace the standard flame definition for use in component or part analyses. This was proposed as a 2000° F temperature flame as the fire "source" on the various components individually, with representative, lower zonal temperatures (800° -1000°F) on redundant components of the engine mount installation.

Under this approach, the basic "intent" of the rule to provide a sufficient strength capability in a foreseeable fire would be met. A foreseeable fire is not necessarily 2000°F nor does it last for precisely 15 minutes, and there may be some installations for which this performance criterion might not be met, but the installation is sufficiently protected against the foreseeable fire.

The task group did not feel that a "foreseeable" fire could be defined due to the lack of actual nacelle fire data concerning heat flux, temperature, and size, and the group supported the current standard flame definition as the appropriate requirement for providing consistent results. Thus, the use of the standard AC20-135 or ISO 2685 flame was found to be an acceptable representation of a foreseeable fire condition for the purposes of compliance with paragraph 25.865.

With this in mind, the text for paragraph 9.b. was drafted as follows:

Redundancy: All components and parts that could be affected by a fire in a fire zone should be fireproof or protected from the effects of fire. However, the fail-safe features of the design may be taken into account if it can be shown that no foreseeable fire condition could cause the loss of function of the alternate load paths or alternate control elements. The use of the standard AC 20-135 flame has been found to be an acceptable representation of a foreseeable fire condition for assessment of redundancy. The effect of this flame impinging on a target load path should be assessed on the alternate load paths.

The FAA subsequently raised an objection to this wording, and proposed going back to the idea of including a minimal zonal temperature with a change to the last sentence above. The FAA proposal was to change the last sentence in the above paragraph to:

The effect of this flame impinging on a target load path should be assessed on the alternate load paths *considering, in addition, a minimum zonal temperature of 500° C*

The FAA proposal was discussed and two alternate proposals were submitted by GE and Airbus.

The task group was then asked to formally express their opinions regarding the three proposals.

Baseline Proposal:

Redundancy: All components and parts that could be affected by a fire in a fire zone should be fireproof or protected from the effects of fire. However, the fail-safe features of the design may be taken into account if it can be shown that no foreseeable fire condition could cause the loss of function of the alternate load paths or alternate control elements.

Alternative Version 1 (FAA proposal):

Add the following text: "The use of the standard AC 20-135 flame has been found to be an acceptable representation of a foreseeable fire condition for assessment of redundancy. The effect of this flame impinging on a target loadpath should be assessed on the alternate loadpaths, considering, in addition, a minimum zonal temperature of 500° C."

Alternative Version 2 (GE proposal):

Add the following text: "The use of the standard AC 20-135 flame has been found to be an acceptable representation of a foreseeable fire condition for assessment of redundancy. The effect of this flame impinging on a target loadpath should be assessed on the alternate loadpaths, considering, in addition, the effect of this flame on the air temperature surrounding the alternate load paths."

Alternative Version 3 (Airbus proposal):

Add the following text: "The use of the standard AC 20-135 flame has been found to be an acceptable representation of a foreseeable fire condition for assessment of redundancy. The effect of this flame impinging on a target loadpath should be assessed ~~on the alternate loadpaths~~. If the target loadpath cannot sustain the load conditions from §7, the effect on the alternate loadpaths should be assessed, considering the effect of the flame on the target loadpath and assuming a minimum zonal temperature in the fire zone. This minimum zonal temperature should either be 500°C or the value of the fire detection average temperature setting for the fire zone."

The responding engine manufacturers, Pratt & Whitney, GE, Honeywell, and Rolls-Royce, all rejected the FAA proposal regarding a minimal zonal temperature.

Pratt & Whitney responded:

Pratt & Whitney can not support the need for an additional test. Service experience of 30 plus years and millions of flight hours demonstrates the additional test would not provide enhanced safety margins. It is Pratt & Whitney's position that the standard burner test to the most critical location of the engine mount provides the correct level of validation to meet the requirements of 25.865.

GE Aircraft Engines responded:

You recently requested the views of the 25.865 team on the proposed elevated zonal temperature. This elevated zonal temperature is envisaged as being applied to the redundant load path(s) of engine mounts in addition to the standard fire test conditions applied to one of the load paths.

GEAE opposes the imposition of any elevated zonal temperature, and maintains that the application of the standard test burner to the most critical location of the engine mount provides an excellent standard of functional safety for certification purposes, as demonstrated by thirty years of service experience and hundreds of undercowl fires. (Material supporting this position has already been supplied to the task group.) A change in the standard of fire qualification for engine mounts is both unnecessary and burdensome, as pointed out by Mr. Handley of Rolls-Royce.

If standardization of the certification approach requires imposing unwarranted changes in the fire qualification standard, GEAE would propose that the historical variation in certification approaches be considered *de facto* acceptable.

GEAE also withdrew their Version 2 proposal.

Honeywell Engines S&S responded:

You recently requested the views of the 25.865 team as well as the engine and Auxiliary Power unit manufacturers on the proposed elevated zonal temperature. This elevated zonal temperature is envisioned as being applied to the redundant load path(s) of engine and APU mounts in addition to the standard fire test condition applied to one of the mounts.

Honeywell Engines, S&S opposes the imposition of any elevated zonal temperature, and maintains that the application of the standard test burner to the most critical location of the engine mount provides an excellent standard of functional safety for certification purposes as demonstrated by thirty years of service experience and hundreds of undercowl fires. A change in the standard of fire qualification for engine and APU mounts is both unnecessary and is especially burdensome to those companies that manufacture APUs and relatively small engines for business aircraft as pointed out by other engine manufacturers.

Rolls-Royce responded:

It is not possible to use zone air temperatures without a heat transfer coefficient, which is extremely difficult to predict so it would need to be defined and presumably justified by the definer for the AC. With regard to assuming all alternate load paths at 500C, this would eliminate a whole range of engines with aluminum casings as they would certainly fail and probably melt at that sort of temperature. That level of excessive assumption would make the whole approach difficult to justify. A change in the standard of fire qualification for engine mounts is both unnecessary and burdensome

Boeing responded:

Boeing would like to add a caveat to the 500C zonal temperature that allows the manufacturer to use a lower value if the 2000 degree flame is applied to the aft mount you may be able to use a zonal temperature below 500C in the forward part of the compartment provided all ventilation flows from forward to aft in the compartment. With this one exception Boeing agrees with the FAA proposal.

Airbus

Airbus retained their recommendation as stated above.

Transport Canada responded:

Transport Canada has arrived at the following consensus:
The FAA proposal is acceptable. In a recent certification program the FAA has used the zonal temperature concept as well as the value of 500C for Part 23 aircraft as has the JAA.

It is suggested that a definition be added for zonal temperature in Section 4 –DEFINITIONS of the draft AC using the GE proposal as a guide as follows:

Zonal Temperature: The peak temperature in the zone surrounding and at the alternate load paths over 15 minutes when the standard test fire test flame has impinged on the target critical load path for a maximum duration of 5 minutes

Even though it is clear from the preamble that this is advisory material it might be appropriate to provide an AMOC in the AC permitting an applicant to predict zonal temperatures by the means of heat transfer calculations, etc. This might mean that accepted heat transfer rates must be defined.

Also one small editorial change is recommended. Instead of the phrase .... "AC20-135 flame has been found to be an acceptable ...," it is preferable that the phrase be changed to "AC20-135 is an acceptable..." as no experiment has been identified to conclude that it has been found to be a representation of a foreseeable fire condition; it is an assumption.

FAA responded:

After extended internal discussion between the FAA representatives on the Task Group and other FAA power plant installation specialists there is no uniform support within the FAA for the specification of a minimum zonal temperature in regards to the evaluation of alternate load paths. Therefore in lieu of the specification of a minimal zonal temperature, the FAA could accept the baseline proposal as it reflects existing FAA issue papers.

JAA

The JAA did not provide a formal response.

Summary

The responding engine manufacturers uniformly do not support the concept of minimal zonal temperatures in regards to the evaluation of alternate load paths. Also no additional support was provided for the GE or Airbus proposals and GE withdrew their proposal. The original draft for paragraph 9.b. is therefore retained in the draft AC 25.865-1 with the change suggested by Transport Canada as follows:

> Redundancy: All components and parts that could be affected by a fire in a fire zone should be fireproof or protected from the effects of fire. However, the fail-safe features of the design may be taken into account if it can be shown that no foreseeable fire condition could cause the loss of function of the alternate load paths or alternate control elements. The use of the standard AC 20-135 flame ~~has been found to be~~ is an acceptable representation of a foreseeable fire condition for assessment of redundancy. The effect of this flame impinging on a target load path should be assessed on the alternate load paths.

11 - Who would be affected by the proposed change?

Manufacturers of transport category airplanes and engine, and APU manufacturers could be affected by the proposed advisory material.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does any existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

AC 20-135 is adequate in providing guidance for the standard flame properties definition for fire test methods. The JAR standard currently reflects the same properties definition.

FAA Policy Memo 96-ANM-112-14, "Engine-Airplane Regulatory Interface", dated November 13, 1996, describes the consideration for engine-side hardware during mount assessment for damage tolerance and failsafe design. This philosophy is used in application to mount fire requirement under 25.865 and is clarified in the attached advisory material.

Generic Issue Paper, "Fire Protection of Structure and Systems in Fire Zones" describes the current FAA position on non-steel engine mount structures.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

There is no existing advisory material for the rule. New advisory material for § 25.865 is proposed; see attachment.

14 - How does the proposed standard compare to the current ICAO standard?

The ICAO standards are higher level standards that do not go into the detail of this proposed change. This proposal does not conflict with the current ICAO standards.

15 - Does the proposed standard affect other HWG's?

The PPIHWG has forwarded a new FAR1/JAR1 fireproof definition that no longer includes a provision for equivalence to steel or titanium. The guidance material forwarded herewith is based on the provision for equivalence to steel in the existing FAR1/JAR1 definition. The LDHWG believes it is appropriate to proceed without waiting for a new fireproof definition, which may be years in the making, and which may change before finally published. Furthermore, in the event the new definition is published, the LDHWG believes the approach outlined in the proposed AC/ACJ will remain valid.

The EHWG is also impacted due to harmonization activity related to FAR 33.17 and the equivalent JAR. The latter contains a fireproof engine mount requirement, which is not contained in FAR 33.17. After the LDHWG makes its recommendation with regard to FAR/JAR 25.865, the EHWG intends to revisit the fireproof engine mount criteria and determine how it should be covered by engine regulations.

16 - What is the cost impact of complying with the proposed standard?

The overall cost to manufacturers should be equal to or lower because adoption of the proposed, harmonized advisory material would allow applicants to demonstrate compliance with acceptable materials (steel and Inconel 718) without additional tests or analyses. For other materials ("non-fireproof" materials), assessments can be done at the component and installation level as is currently practiced. However, in some specific instances certification costs may increase due to more uniform application of the standard for these instances.

17 - If advisory or interpretive material is to be submitted, document the advisory or interpretive guidelines. If disagreement exists, document the disagreement.

The proposed advisory material is attached. The FAA would prefer that the last two sentences of the Draft AC paragraph 9.b. regarding redundancy be deleted as without those sentences the paragraph reflects existing FAA issue papers. Transport Canada, Airbus, and Boeing prefer to have additional wording regarding the use of minimum zonal temperatures in paragraph 9.b.

18 - Does the HWG wish to answer any supplementary questions specific to this project?

Yes.

Question: What is the service experience for engine mounts relative to the safety issue expressed in question 1?

Answer: The HWG examined all available data regarding fires and their effect on engine mounts. The task group examined manufacturer data provided by Boeing, Airbus, Pratt & Whitney, General Electric, Rolls Royce, Snecma, Cessna, and Honeywell. While the data confirmed that engine fires occurred generally at a rate of 10-6 per flight hour over approximately a billion installation hours, there were no recorded instances of a mount ever being compromised on any transport aircraft installation due to fire.

The HWG also reviewed the experience accumulated on various mount materials for Boeing, Airbus and Cessna installations of Pratt & Whitney, General Electric, Rolls Royce – Allison, Honeywell, CFM, and IAE engines. The numbers presented represent a rough, conservatively low estimate of the experience using these materials in components of mount applications and does not represent the entirety of the industry experience. Information was not immediately available for several installations with significant experience, notably DC-9, MD-80, L-1011 and Rolls Royce installations on Boeing airplanes. The most widely used materials experience is summarized in the table below:

Material	Front mount hours (Million)	Aft mount hours (Million)
15-5 PH Steel	314	90
4000 Series Steel	343	unknown
410 Steel	525	0
Inco 718	124	392
Greek Ascolloy	0	746

6-4 Titanium	392	11
6-2-4-2 Titanium	0	12

19 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes

20 - In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process? Explain.

Yes, the "Fast Track" process is appropriate for this project.

DRAFT ADVISORY CIRCULAR No. 25.865-1
Fire protection of flight controls, engine mounts, and other flight structure
June, 2004

1. PURPOSE. This advisory circular (AC) sets forth an acceptable means, but not the only means, of demonstrating compliance with the provisions of part 25 of the Federal Aviation Regulations (FAR) related to the protection of flight controls, engine mounts and other flight structure from fires in designated fire zones on transport category airplanes.

   This advisory material applies to zonal fires and to low pressure fires and does not apply to "torching" fires resulting from engine casing burn through.

2. RELATED FAR SECTIONS.

   FAR 1, FAR 33.17, AC 20-135

3. BACKGROUND.

a. Section 25.865 "Fire protection of flight controls, engine mounts and other flight structure" was added to Part 25 by amendment 25-23 in 1970, although the same requirement had existed for rotorcraft since the early 1960's. The need for this rule for transport category airplanes was highlighted when control problems were experienced on a jet transport airplane after aluminum control rods located outside of the fire zone became distorted due to heat from an engine fire.

b. The rule was set forth by amendment 25-23 with essentially the same text that was used for transport (Category A) rotorcraft. The specific flight controls that were of concern for rotorcraft were those that were essential for making a controlled landing. For transport airplanes it was recognized that making a landing was not as simple and immediate as it could be for a rotorcraft so the rule was written to apply to "essential" flight controls without further qualification. Since engine mounts and other flight structures could also be affected, the rule was made to apply to those components as well.

c. FAA Flight Standards Service Release No. 453, dated November 9, 1961 (a forerunner of the current Advisory Circular system) stated that a component (structure, control, mechanism or other essential part) must resist flame penetration and remain capable of carrying the loads and satisfactorily performing the function for which they are designed when subjected to a standard test flame of 2000 degrees F for 15 minutes. Service Release No. 453 formed the basis of the current advisory material for transport and utility helicopters (AC 29-2A and AC 27-1) and has also been accepted for transport category airplane certification after the rule was adopted for transports.

d. Advisory circular AC 20-135 "Powerplant installation and propulsion system component fire protection test methods, standards, and criteria" contains acceptable information for compliance with several fire protection requirements and includes the methods and criteria for conducting fire tests on components to establish that they are fireproof. When developing AC 20-135, it was recognized that to establish the fire integrity of structural elements and flight controls, the expected external loads during the fire event would need to be defined and considerations of fail-safety and redundancy would need to be addressed. Since these considerations would take more time to develop, the AC was published excluding applicability to § 25.865. The FAA has continued to rely on the criteria of Service Release No. 453 as the basic means of compliance, although the methods of fire testing and flame definition were slightly changed to be consistent with the fire definitions of AC 20-135.

e. The term "fireproof" is defined in AC 20-135 (for components other than firewalls) as the capability of a material or component to withstand as well as steel, a 2000 °F flame (± 150 °F) for 15 minutes minimum while still fulfilling its design purpose. FAR part 1 defines "fireproof" (for components other than firewalls) as the capacity to withstand the heat associated with fire at least as well as steel in dimensions appropriate for the purpose for which they are used. Other definitions have been proposed and used which do not refer to any specific material but require the component to withstand the 2000° F flame (± 150° F) for a 15 minute fire condition. Irrespective of what definition is used for the term "fireproof" for a structural member, the capability to withstand the fire condition is dependent on the loads expected to be applied to the structural member during the time of exposure to the fire. Experience has shown that essential flight structures, when constructed of steel, are capable of withstanding the loads likely to be applied during the exposure to the fire condition (2000° F flame (± 150° F) for 15 minutes). The use of materials that are equivalent to steel for structural members has been accepted.

f. For materials not shown to be equivalent to steel it has been necessary to consider the installation as a whole. This has required the consideration of shielding, redundancy and the available heat transfer mechanisms in combination with a set of design flight loads. Advisory Circular 25.571-1C, "Damage Tolerance and Fatigue Evaluation of Structure," provides design loads associated with discrete source damage conditions which would exist until landing. The design loads as described and contained in Section 7 are greater than the flight loads expected during the shorter duration of an in-flight fire, but nevertheless have been considered appropriate for conducting the evaluation of the complete structural installations exposed to the prescribed fire condition (2000° F flame (± 150° F) for 15 minutes).

g. <u>Service Experience of Undercowl Fires for Engine Mounts:</u> According to a major engine manufacturer, there have been approximately 270 undercowl fires in the large transport high bypass turbofan fleet since 1970. At least 14 of these were in the same fire zone as a titanium engine mount. No functional failure or distress of an engine mount was observed for any event. Also, the incidence of undercowl fires has decreased greatly since the earliest high bypass turbofans entered service.

4. DEFINITIONS:

a. Foreseeable fire condition: A realistic fire condition that is assumed for the purposes of qualitatively determining if a component or part could be affected by a fire in the fire zone.

b. Designated fire zone: A fire zone as defined in § 25.1181.

c. Engine Mount: For purposes of compliance to 25.865, the engine mount is considered to consist of the airframe engine mounting structure and engine-side attachment points and adjacent essential structure.

d. Essential: Necessary for continued safe flight and landing.

e. Fire test condition: The conditions associated with the standard fire test described in Advisory Circular AC 20-135 or ISO 2685.

5. DISCUSSION: This section provides several alternatives for addressing components that could be affected by fire in a fire zone. Note that firewalls used to contain the fire zone are considered to remain intact. Within a fire zone, the "effects of fire" relate to the direct flame impingement on the component or shielding if applicable. In areas adjacent to the fire zone the heat generated by the fire in the fire zone is the primary effect for consideration.

- They can be constructed of materials considered to be "fireproof".
- The design (arrangement and redundancy) can be such that the intended function can still be performed under the heat and other conditions likely to occur when there is a fire in the fire zone.
- The component can be shielded so that it is capable of withstanding the effects of fire.

For each of the assessments in the advisory circular, including the application of fire test conditions, validated analyses may be used to represent the transient temperature conditions and strength.

6. FIREPROOF STRUCTURAL MATERIALS.

a. Structural components. Engine mounts and other essential flight structures constructed of steel are considered capable of withstanding the expected flight loads during exposure to the fire condition (2000 °F flame (± 150 °F) for 15 minutes). For other materials intended to carry loads and resist failure in the fire condition, equivalency to steel may be accomplished by analytical or test demonstration.

b. In research conducted for development of this advisory circular, fire tests were conducted at the FAA Technical Center. In those tests, Inconel 718 performed as well as steel, and therefore, Inconel 718 may be considered a fireproof engine mount material, without further substantiation.

7. <u>NON-FIREPROOF MATERIALS USED IN STRUCTURAL COMPONENTS AND INSTALLATIONS.</u>

When the structural materials cannot be shown to be fireproof by paragraph 6, the following assessments at the component and installation level should be made.

Engine mounts and other essential flight structures should be able to sustain expected flight loads with a positive margin of safety for any foreseeable fire in a fire zone. In the absence of a rational definition of a foreseeable fire event and expected flight loads, each structural element should be individually subjected (as per paragraph 9b.) to the fire test conditions described in AC 20-135 (2000° F for 15 minutes) while sustaining the following loads:

- limit flight loads without failure for at least five minutes, and
- after 5 minutes and until the end of 15 minutes, the engine may be assumed to be shut down and the structure must be able to support the discrete source damage loads described in AC 25.571-1C.

8. <u>FIRE ASSESSMENT OF ESSENTIAL FLIGHT CONTROLS.</u> Essential flight controls that could be affected by a fire in the fire zone should be able to perform their intended function during any foreseeable fire in an adjacent fire zone.

a. Essential flight control structural components should be subjected to the effects of the prescribed fire test condition in the fire zone while assessing their capability to continue to perform their function. The assessment of mechanical components should include any tendency to warp, seize, jam or fail under anticipated control system loads with the prescribed fire test condition.

b. Essential hydraulic components including lines, actuators, seals and valves should be assessed to assure that the function they are intended to perform can still be accomplished under any foreseeable fire condition in the adjacent fire zone.

9. SHIELDING AND REDUNDANCY AND OTHER CONSIDERATIONS.

a. Shielding: Shielding may be provided to protect a component against the effects of fire. The adequacy of the shielding should be determined under paragraphs 7 and 8 with the defined fire conditions by assessing the results of applying the flame on the most critical location of the shielded component(s) with representative impingement.

b. Redundancy: All components and parts that could be affected by a fire in a fire zone should be fireproof or protected from the effects of fire. However, the fail-safe features of the design may be taken into account if it can be shown that no foreseeable fire condition could cause the loss of function of the alternate load paths or alternate control elements. The use of the standard AC 20-135 flame is an acceptable representation of a foreseeable fire condition for assessment of redundancy. The effect of this flame impinging on a target loadpath should be assessed on the alternate loadpaths.

c. Aeroelastic stability: When, due to the effect of temperature, significant changes in stiffness and damping properties of parts occur, such as with elastomeric or non-fireproof materials, aeroelastic stability should be addressed accounting for those changes. The aeroelastic assessment should include flutter and whirlmodes and consider the most critical properties that could exist in a fire condition. It should be shown that the airplane is free from aeroelastic instability within the aeroelastic stability envelope of 25.629(b)(2).