NOTICE OF PROPOSED AMENDMENT (NPA) No 21/2005

DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE AGENCY

AMENDING
DECISION NO. 2005/06/R OF THE EXECUTIVE DIRECTOR OF THE AGENCY
of 12 December 2005

on Certification Specifications, including airworthiness codes and acceptable means of compliance, for Large Aeroplanes (CS-25)

"FUEL TANK STRUCTURAL INTEGRITY / FUEL TANK ACCESS COVERS"

TABLE OF CONTENTS.

Explanatory Note

I. General

1. The purpose of this Notice of Proposed Amendment (NPA) is to envisage amending Decision 2005/06/R of the Executive Director of the Agency of 12 December 2005 on Certification Specifications, including airworthiness codes and acceptable means of compliance, for Large Aeroplanes (CS-25). The scope of this rulemaking activity is outlined in ToR CS-25/002 and is described in more detail below.

2. The Agency is directly involved in the rule-shaping process. It assists the Commission in its executive tasks by preparing draft regulations, and amendments thereof, for the implementation of the Basic Regulation[1] which are adopted as “Opinions” (Article 14.1). It also adopts Certification Specifications, including Airworthiness Codes and Acceptable Means of Compliance and Guidance Material to be used in the certification process (Article 14.2).

3. When developing rules, the Agency is bound to following a structured process as required by article 43.1 of the Basic Regulation. Such process has been adopted by the Agency’s Management Board and is referred to as “The Rulemaking Procedure”[2].

4. This rulemaking activity is included in the Agency’s rulemaking programme for 2005. It implements the rulemaking task 25.002 **“**Fuel Tank Structural Integrity/Fuel Tank Access Covers”**.**

5. The text of this NPA was originally developed under the JAA rulemaking activities. It was adapted to the EASA regulatory context by the Agency. It is submitted for consultation of all interested parties in accordance with Article 43 of the Basic Regulation and Articles 5(3) and 6 of the EASA rulemaking procedure.

[1] Regulation (EC) No 1592/2002 of the European Parliament and of the Council of 15 July 2002 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency. OJ L 240, 7.9.2002, p.1.
[2] Management Board decision concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material (“rulemaking procedure”), EASA MB/7/03, 27.6.2003.

II. Consultation

6. To achieve optimal consultation, the Agency is publishing the draft decision of the Executive Director on its internet site. As the content of this NPA was already agreed for adoption in the Joint Aviation Authorities (JAA) system and was the subject of a full worldwide consultation, the transitional arrangements of Article 15 of the EASA rulemaking procedure apply. This allows for a shorter consultation period of six weeks instead of the standard 3 months and exempts this proposal from the requirement to produce a full Regulatory Impact Assessment. Comments on this proposal may be forwarded *(preferably by e-mail)*, using the attached comment form, to:

By e-mail: **NPA@easa.eu.int**

By correspondence: Process Support Unit
Rulemaking Directorate
EASA
Ref: NPA 21-2005
Postfach 10 12 53
D-50452 Köln
Germany

Comments should be received by the Agency before 23rd February 2006. If received after this deadline they might not be treated. Comments may not be considered if the form provided for this purpose is not used.

III. Comment response document

7. All comments received in time will be responded to and incorporated in a comment response document (CRD). This may contain a list of all persons and/or organisations that have provided comments. The CRD will be widely available on the Agency's website.

   The review of comments will be made by the Agency unless the comments are of such a nature that they necessitate the establishment of a review group.

IV. Content of the draft decision

Background

8. The initial issue of CS-25 was based upon JAR-25 at amendment 16. During the transposition of airworthiness JARs into certification specifications the rulemaking activities under the JAA system were not stopped. In order to assure a smooth transition from JAA to EASA the Agency has committed itself to continue as much as possible of the JAA rulemaking activities. Therefore it has included most of the JAA rulemaking programme in its own rulemaking programmes. This NPA is a result of this commitment and a transposed version of the JAA NPA 25E-304 "Fuel Tank Structural Integrity/Fuel Tank Access Covers".

9. The text of the JAA NPA 25E-304 is based on the texts originally developed by the ARAC Loads and Dynamics Harmonisation Working Group (LDHWG) and General Structures Harmonisation working group (GSHWG) tasked by ARAC to develop requirements and interpretative material related to fuel tanks structural integrity and fuel tank covers respectively. Following tasking by the JAA, these texts were then reviewed and further developed by the JAA

Structures Steering Group (SSG) and circulated as NPA 25E-304 worldwide for comments from 2nd April 2002 till 2nd July 2002.

10. The SSG reviewed the comments received and responded them in the JAA comment / response document. As a consequence, the proposed final rule was modified to take into account the conclusions of the JAA comment / response document provided in Appendix II of this NPA.

11. The JAA proposed final rule text and the comment / response document were then reviewed and adapted by an EASA Working Group and the Agency to conform to EASA regulatory context and procedures. The result is this EASA NPA.

Affected paragraphs

12. CS-25 Book 1: CS 25.721, CS 25. 963 (d)(e) and (g), CS 25.994, CS 25J994
CS-25 Book 2 : AMC 25.963(d), AMC 25.963(e), AMC 25.963(g)

Justification of the proposed amendments to CS-25

13. As stated above, the original proposals were already circulated for comments as a JAA NPA. See the Appendix I below for the original JAA NPA 25E-304 proposals justification which remains valid. The proposed amendments to CS-25 as presented in part B of this NPA is a transposition of the proposals from NPA 25E-304, as amended by the changes introduced into the related draft final rule due to acceptance of some comments as indicated in the JAA NPA 25E-304 comment / response document (see Appendix II).

B DRAFT DECISION

I. PROPOSED AMENDMENTS TO CS-25

The text of the amendment is arranged to show deleted text, new text or new paragraph as shown below:

1. ~~Text to be deleted is shown with a line through it.~~
2. New text to be inserted is highlighted with grey shading.
3. New paragraph or parts are not highlighted with grey shading, but are accompanied by the following box text:

Insert new paragraph / part *(Include N° and title)*, or replace existing paragraph/ part

4. ….
   Indicates that remaining text is unchanged in front of or following the reflected amendment.
   ….

Book 1
SUBPART D - DESIGN AND CONSTRUCTION

Proposal 1: To amend CS 25.721 to read as follows:

CS 25.721 General
(See AMC 25.963(d))

(a) The ~~main~~ landing gear system must be designed so that ~~if~~ when it fails due to overloads during take-off and landing ~~(assuming the overloads to act in the upward and aft directions)~~, the failure mode is not likely to cause spillage of enough fuel to constitute a fire hazard. The overloads must be assumed to act in the upward and aft directions in combination with side loads acting inboard and outboard. In the absence of a more rational analysis, the side loads must be assumed to be up to 20% of the vertical load or 20% of the drag load, whichever is greater.

~~(1) For aeroplanes that have a passenger seating configuration, excluding pilots seats, of nine seats or less, the spillage of enough fuel from any fuel system in the fuselage to constitute a fire hazard.; and~~

~~(2) For aeroplanes that have a passenger seating configuration, excluding pilots seats, of 10 seats or more, the spillage of enough fuel from any part of the fuel system to constitute a fire hazard.~~

(b) ~~Each aeroplane that has a passenger seating configuration, excluding pilots seats, of 10 or more must be designed so that with the aeroplane under control it can be landed on a paved runway with any one or more landing gear legs not extended without sustaining a structural component failure that is likely to cause the spillage of enough fuel to constitute a fire hazard.~~

The aeroplane must be designed to avoid any rupture leading to the spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway, under the following minor crash landing conditions:

(1) Impact at 1.52 m/s (5 fps) vertical velocity, with the aeroplane under control, at Maximum Design Landing Weight, all gears retracted and in any other combination of gear legs not extended.

(2) Sliding on the ground, all gears retracted up to a 20° yaw angle and as a separate condition, sliding with any other combination of gear legs not extended with 0° yaw angle.

(c) ~~Compliance with the provisions of this paragraph may be shown by analysis or tests, or both.~~

For configurations where the engine nacelle is likely to come into contact with the ground, the engine pylon or engine mounting must be designed so that when it fails due to overloads (assuming the overloads to act predominantly in the upward direction and separately predominantly in the aft direction), the failure mode is not likely to cause the spillage of enough fuel to constitute a fire hazard.

Book 1
SUBPART E - POWERPLANT

Proposal 2: To amend CS 25.963, subparagraphs (d), (e) and (g) to read:

CS 25.963 Fuel tanks: general

….

(d) Fuel tanks must, so far as it is practicable, be designed, located, and installed so that no fuel is released, ~~in or near the fuselage or near the engines~~ in quantities sufficient to start a serious fire, in otherwise survivable ~~crash~~ emergency landing conditions~~.~~; and:

(1) Fuel tanks must be able to resist rupture and to retain fuel under ultimate hydrostatic design conditions in which the pressure P within the tank varies in accordance with the formula:

$$\mathbf{P = K\rho gL}$$

where:

P = fuel pressure in Pa (lb/ft^2) at each point within the tank
L = a reference distance in m (ft) between the point of pressure and the tank farthest boundary in the direction of loading.
ρ = typical fuel density in kg/m^3 (slugs/ft^3)
g = acceleration due to gravity in m/s^2 (ft/s^2)
K = 4.5 for the forward loading condition for fuel tanks outside the fuselage contour
K = 9 for the forward loading condition for fuel tanks within the fuselage contour
K = 1.5 for the aft loading condition
K = 3.0 for the inboard and outboard loading conditions for fuel tanks within the fuselage contour
K = 1.5 for the inboard and outboard loading conditions for fuel tanks outside of the fuselage contour
K = 6 for the downward loading condition
K = 3 for the upward loading condition

(2) For those (parts of) wing fuel tanks near the fuselage or near the engines, the greater of the fuel pressures resulting from subparagraphs (i) and (ii) must be used:

(i) the fuel pressures resulting from subparagraph (d)(1) above, and:

(ii) the lesser of the two following conditions:

(A) Fuel pressures resulting from the accelerations as specified in CS 25.561(b)(3) considering the fuel tank full of fuel at maximum fuel density. Fuel pressures based on the 9.0g forward acceleration may be calculated using the fuel static head equal to the streamwise local chord of the tank. For inboard and outboard conditions, an acceleration of 1.5g may be used in lieu of 3.0g as specified in CS 25.561(b)(3); and:

(B) Fuel pressures resulting from the accelerations as specified in CS 25.561(b)(3) considering a fuel volume beyond 85% of the maximum permissible volume in each tank using the static head associated with the 85% fuel level. A typical density of the appropriate fuel may be used. For inboard and outboard conditions, an acceleration of 1.5g may be used in lieu of 3.0g as specified in CS 25.561(b)(3).

(3) Fuel tank internal barriers and baffles may be considered as solid boundaries if shown to be effective in limiting fuel flow.

(4) For each fuel tank and surrounding airframe structure, the effects of crushing and scraping actions with the ground should not cause the spillage of enough fuel, or generate temperatures that would constitute a fire hazard under the conditions specified in CS 25.721(b).

(5) Fuel tank installations must be such that the tanks will not rupture as a result of an engine pylon or engine mount or landing gear, tearing away as specified in CS 25.721(a) and (c).

(See ~~also~~ AMC 25.963(d).)

(e) ~~Fuel tanks within the fuselage contour must be able to resist rupture, and to retain fuel, under the inertia forces prescribed for the emergency landing conditions in CS 25.561. In addition, these tanks must be in a protected position so that exposure of the tanks to scraping action with the ground is unlikely.~~

Fuel tank access covers must comply with the following criteria in order to avoid loss of hazardous quantities of fuel:

(1) All covers located in an area where experience or analysis indicates a strike is likely, must be shown by analysis or tests to minimise penetration and deformation by tyre fragments, low energy engine debris, or other likely debris.

(2) All covers must have the capacity to withstand the heat associated with fire at least as well as an access cover made from aluminium alloy in dimensions appropriate for the purpose for which they are to be used, except that the access covers need not be more resistant to fire than an access cover made from the base fuel tank structural material.

(See AMC 25.963(e).)

(f) ….

(g) ~~Fuel tank access covers must comply with the following criteria in order to avoid loss of hazardous quantities of fuel:~~

~~(1) All covers located in an area where experience or analysis indicates a strike is likely, must be shown by analysis or tests to minimise penetration and deformation by tyre fragments, low energy engine debris, or other likely debris.~~

~~(2) Reserved~~

~~(See AMC 25.963 (g).)~~ (Reserved)

Proposal 3: To amend CS 25.994 to read as follows:

CS 25.994 Fuel system components
Fuel system components in an engine nacelle or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway under each of the conditions prescribed in CS 25.721(b).

SUBPART J - AUXILIARY POWER UNIT INSTALLATIONS

Proposal 4: To amend CS 25J994 to read as follows:

CS 25J994 Fuel system components
Fuel system components in ~~the~~ an APU compartment or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway under each of the conditions prescribed in CS 25.721(b).

Book 2
AMC SUBPART E

Proposal 5: To replace the existing AMC 25.963(d) by a new AMC 25.963(d) to read as follows :

AMC 25.963(d)
Fuel Tank Strength in Emergency Landing Conditions

~~Fuel tank installations should be such that the tanks will not be ruptured by the aeroplane sliding with its landing gear retracted, nor by a landing gear, nor an engine mounting tearing away.~~
~~Fuel tanks inboard of the landing gear or inboard of or adjacent to the most outboard engine, should have the strength to withstand fuel inertia loads appropriate to the accelerations specified in CS 25.561(b)(3) considering the maximum likely volume of fuel in the tank(s). For the purposes of this substantiation it will not be necessary to consider a fuel volume beyond 85% of the maximum permissible volume in each tank. For calculation of inertia pressures a typical density of the appropriate fuel may be used.~~

1. <u>PURPOSE</u>. This AMC sets forth an acceptable means, but not the only means, of demonstrating compliance with the provisions of CS-25 related to the strength of fuel tanks in emergency landing conditions.

2. <u>RELATED CERTIFICATION SPECIFICATIONS</u>.

CS 25.561 “Emergency Landing Conditions – General”,
CS 25.721 “Landing Gear – General”
CS 25.994 “Fuel System Components”
CS 25J994 “Fuel System Components”

3. BACKGROUND. For many years the JAA/EASA has required fuel tanks within the fuselage contour to be designed to withstand the inertial load factors prescribed for the emergency landing conditions as specified in JAR/CS 25.561. These load factors have been developed through many years of experience and are generally considered conservative design criteria applicable to objects of mass that could injure occupants if they came loose in a minor crash landing.

a. A minor crash landing is a complex dynamic condition with combined loading. However, in order to have simple and conservative design criteria, the emergency landing forces were established as conservative static ultimate load factors acting in each direction independently.

b. Recognising that the emergency landing load factors were applicable to objects of mass that could cause injury to occupants and that the rupture of fuel tanks in the fuselage could also be a serious hazard to the occupants, § 4b.420 of the Civil Air Regulations (CAR) part 4b (the predecessor of FAR 25) extended the emergency landing load conditions to fuel tanks that are located within the fuselage contour. Even though the emergency landing load factors were originally intended for solid items of mass, they were applied to the liquid fuel mass in order to develop hydrostatic pressure loads on the fuel tank structure. The application of the inertia forces as a static load criterion (using the full static head pressure) has been considered a conservative criterion for the typical fuel tank configuration within the fuselage contour. This conservatism has been warranted considering the hazard associated with fuel spillage.

c. CS 25.963 has required that fuel tanks, both in and near the fuselage, resist rupture under survivable crash conditions. The advisory material previously associated with CS 25.963 specifies design requirements for all fuel tanks that, if ruptured, could release fuel in or near the fuselage or near the engines in quantities sufficient to start a serious fire.

d. In complying with this CS requirement for wing tanks, several different techniques have been used by manufacturers to develop the fuel tank pressure loads due to the emergency landing inertia forces. The real emergency landing is actually a dynamic transient condition during which the fuel must flow in a very short period of time to re-establish a new level surface normal to the inertial force. For many tanks such as large swept wing tanks, the effect is that the actual pressure forces are likely to be much less than that which would be calculated from a static pressure based on a steady state condition using the full geometric pressure head. Because the use of the full pressure head results in unrealistically high pressures and creates a severe design penalty for wing tanks in swept wings, some manufacturers have used the local streamwise head rather than the full head. Other manufacturers have used the full pressure head but with less than a full tank of fuel. These methods of deriving the pressures for wing tanks have been accepted as producing design pressures for wing tanks that would more closely represent actual emergency landing conditions. The service record has shown no deficiency in strength for wing fuel tanks designed using these methods.

e. FAR 25 did not contain a requirement to apply fuel inertia pressure requirements to fuel tanks outside the fuselage contour, however, the FAA (like the JAA) has published Special Conditions to accomplish this for fuel tanks located in the tail surfaces. The need for Special Conditions was justified by the fact that these tanks are located in a rearward position from which fuel spillage could directly affect a large portion of the fuselage, possibly on both sides at the same time.

4. GENERAL. CS 25.963(d) requires that fuel tanks must be designed, located, and installed so that no fuel is released in quantities sufficient to start a serious fire in otherwise survivable emergency landing conditions. The prescribed set of design conditions to be considered is as follows:

a. Fuel tank pressure loads. CS 25.963(d)(1) provides a conservative method for establishing the fuel tank ultimate emergency landing pressures. The phrase “fuel tanks outside the fuselage contour” is intended to include all fuel tanks where fuel spillage through any tank boundary would remain physically and environmentally isolated from occupied compartments by a barrier that is at least fire resistant as defined in CS-Definitions. In this regard, cargo compartments that share the same environment with occupied compartments would be treated the same as if they were occupied. The ultimate pressure criteria are different depending on whether the fuel tank under consideration is inside, or outside the fuselage contour. For the purposes of this paragraph a fuel tank should be considered inside the fuselage contour if it is inside the fuselage pressure shell. If part of the fuel tank pressure boundary also forms part of the fuselage pressure boundary then that part of the boundary should be considered as being within the fuselage contour. Figures 1 and 2 show examples of an underslung wing fuel tank and a fuel tank within a moveable tailplane, respectively, both of which would be considered as being entirely outside of the fuselage contour.

The equation for fuel tank pressure uses a factor L, based upon fuel tank geometry. Figure 3 shows examples of the way L is calculated for fuel pressures arising in the forward loading condition, while Figure 4 shows examples for fuel pressures arising in the outboard loading condition.
For Jet A(-1) fuel, a typical density of 785.0 kg/m^3 (6.55 lb/US gallon) may be assumed.

Any internal barriers to free flow of fuel may be considered as a solid pressure barrier provided:

(1) It can withstand the loads due to the expected fuel pressures arising in the conditions under consideration; and

(2) The time “T” for fuel to flow from the upstream side of the barrier to fill the cell downstream of the barrier is greater than 0.5 second. “T” may be conservatively estimated as:

$$T = \frac{V}{\sum_{i=1}^{j} C_{di} a_i \sqrt{2 g h_i K}}$$

where:

V= the volume of air in the fuel cell downstream of the barrier assuming a full tank at 1g flight conditions. For this purpose a fuel cell should be considered as the volume enclosed by solid barriers. In lieu of a more rational analysis, 2% of the downstream fuel volume should be assumed to be trapped air;

j = the total number of orifices in baffle rib;

Cd_i = the discharge coefficient for orifice i. The discharge coefficient may be conservatively assumed to be equal to 1.0 or it may be rationally based upon the orifice size and shape;

a_i = the area for orifice i;

g = the acceleration due to gravity;

h_i = the hydrostatic head of fuel upstream of orifice i, including all fuel volume enclosed by solid barriers;

K = the pressure design factor for the condition under consideration.

b. Near the fuselage/near the engines (Compliance with CS 25.963(d)(2).)

(1) For aircraft with wing mounted engines:

(i) The phrase “near the fuselage” is addressing those (parts of) wing fuel tanks located between the fuselage and the most inboard engine;

(ii) The phrase “near the engine” is addressing those (parts of) wing fuel tanks as defined in AMC 20-128A, figure 2, minimum distance of 10 inches (254 mm) laterally from potential ignition sources of the engine nacelle.

(2) For aircraft with fuselage mounted engines, the phrase “near the fuselage” is addressing those (parts of) wing fuel tanks located within one maximum fuselage width outside the fuselage boundaries.

c. Protection against crushing and scraping action (Compliance with CS 25.963(d)(4) and CS 25.721(b) and (c).).

Each fuel tank should be protected against the effects of crushing and scraping action (including thermal effects) of the fuel tank and surrounding airframe structure with the ground under the following minor crash landing conditions:

(i) An impact at 1.52 m/s (5 fps) vertical velocity on a paved runway at maximum landing weight, with all landing gears retracted and in any other possible combination of gear legs not extended. The unbalanced pitching and rolling moments due to the ground reactions are assumed to be reacted by inertia and by immediate pilot control action consistent with the aircraft under control until other structure strikes the ground. It should be shown that the loads generated by the primary and subsequent impacts are not of a sufficient level to rupture the tank. A reasonable attitude should be selected within the speed range from V_{L1} to 1.25 V_{L2} based upon the fuel tank arrangement.
V_{L1} equals to V_{S0} (TAS) at the appropriate landing weight and in standard sea-level conditions, and V_{L2} equals to V_{S0} (TAS) at the appropriate landing weight and altitudes in a hot day temperature of 22.8 degrees C (41 degrees F) above standard.

(ii) Sliding on the ground starting from a speed equal to V_{L1} up to complete stoppage, all gears retracted and with up to a 20° yaw angle and as a separate condition, sliding with any other possible combination of gear legs not extended and with a 0° yaw angle. The effects of runway profile need not be considered.

(iii) The impact and subsequent sliding phases may be treated as separate analyses or as one continuous analysis. Rational analyses that take into account the pitch response of the aircraft may be utilised, however care must be taken to assure that abrasion and heat transfer effects are not inappropriately reduced at critical ground contact locations.

(iv) For aircraft with wing mounted engines, if failure of engine mounts, or failure of the pylon or its attachments to the wing occurs during the impact or sliding phase, the subsequent effect on the integrity of the fuel tanks should be assessed. Trajectory analysis of the engine/pylon subsequent to the separation is not required.

(v) The above emergency landing conditions are specified at maximum landing weight, where the amount of fuel contained within the tanks may be sufficient to absorb the frictional energy (when the aircraft is sliding on the ground)without causing fuel ignition. When lower fuel states exist in the affected fuel tanks these conditions should also be considered in order to prevent fuel-vapour ignition.

d. Engine / Pylon separation. (Compliance with CS 25.721(c) and CS 25.963(d)(5).)
For configurations where the nacelle is likely to come into contact with the ground, failure under overload should be considered. Consideration should be given to the separation of an engine nacelle (or nacelle + pylon) under predominantly upward loads and under predominantly aft loads. The predominantly upward load and the predominantly aft load conditions should be analysed separately. It should be shown that at engine/pylon failure the fuel tank itself is not ruptured at or near the engine/pylon attachments.

e. Landing gear separation. (Compliance with CS 25.721(a) and CS 25.963(d)(5).)
Failure of the landing gear under overload should be considered, assuming the overloads to act in any reasonable combination of vertical and drag loads, in combination with side loads acting both inboard and outboard. In the absence of a more rational analysis, the side loads must be assumed to be up to 20% of the vertical load or 20% of the drag load, whichever is greater. It should be shown that at the time of separation the fuel tank itself is not ruptured at or near the landing gear attachments. The assessment of secondary impacts of the airframe with the ground following landing gear separation is not required. If the subsequent trajectory of a separated landing gear would likely puncture an adjacent fuel tank, design precautions should be taken to minimise the risk of fuel leakage.

f. Compliance with the provisions of this paragraph may be shown by analysis or tests, or both.

5. OTHER CONSIDERATIONS

a. Supporting structure. In accordance with CS 25.561(c) all large mass items that could break loose and cause direct injury to occupants must be restrained under all loads specified in CS 25.561(b). To meet this requirement, the supporting structure for fuel tanks, should be able to withstand each of the emergency landing load conditions, as far as they act in the 'cabin occupant sensitive directions', acting statically and independently at the tank centre of gravity as if it were a rigid body. Where an empennage includes a fuel tank, the empennage structure supporting the fuel tank should meet the restraint conditions applicable to large mass items in the forward direction.

Figure 1: Diagram of Fuel Tank in Underslung Wing that is Outside of the Fire Resistant Boundary

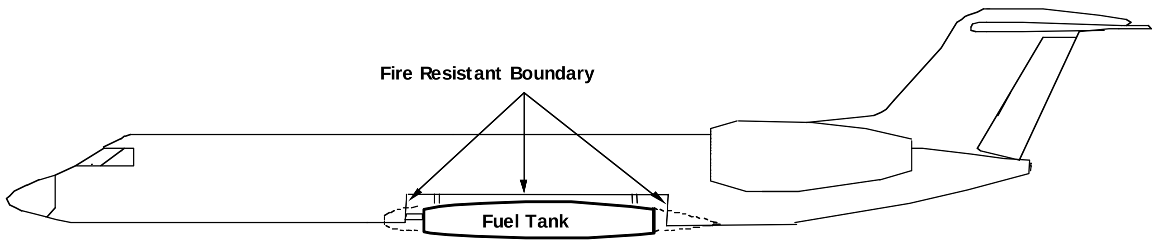


Figure 2: Diagram of Fuel Tank Within a Movable Tailplane

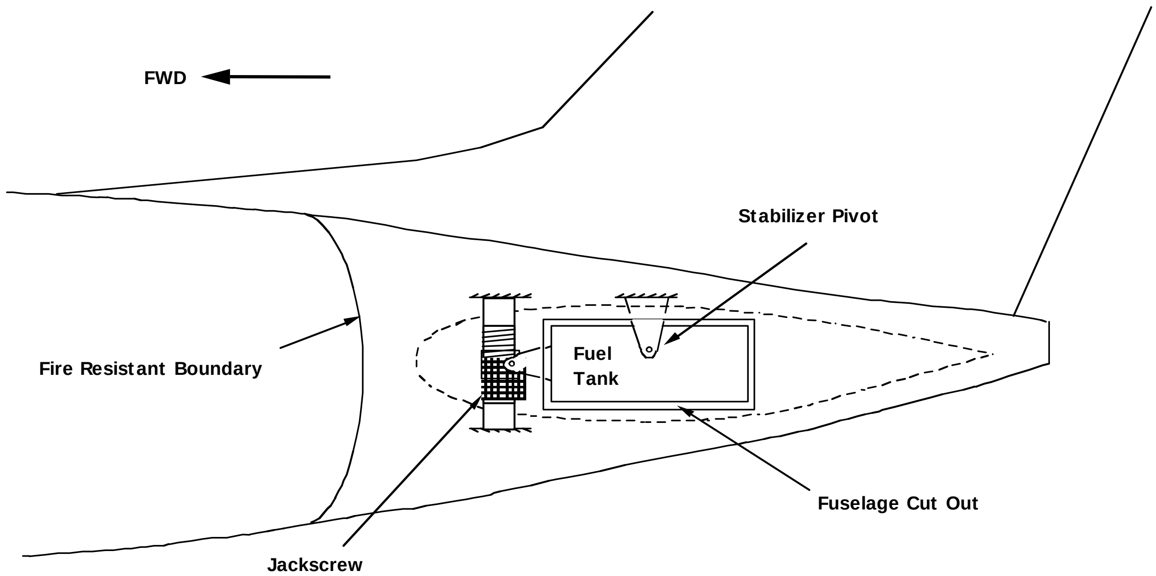


Figure 3- Example of Distances For Fuel Forward Acting Design Pressure Calculations

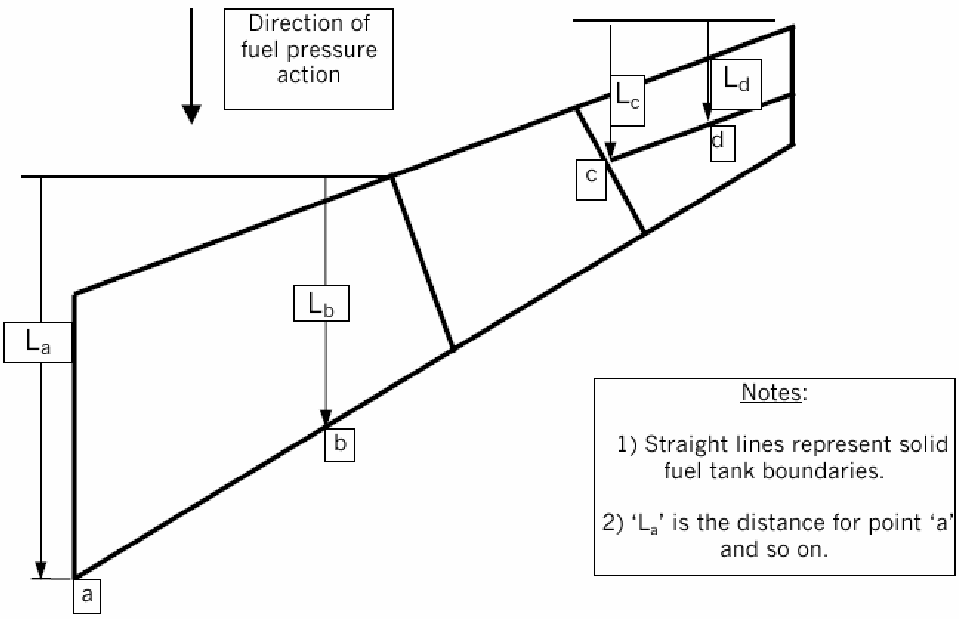
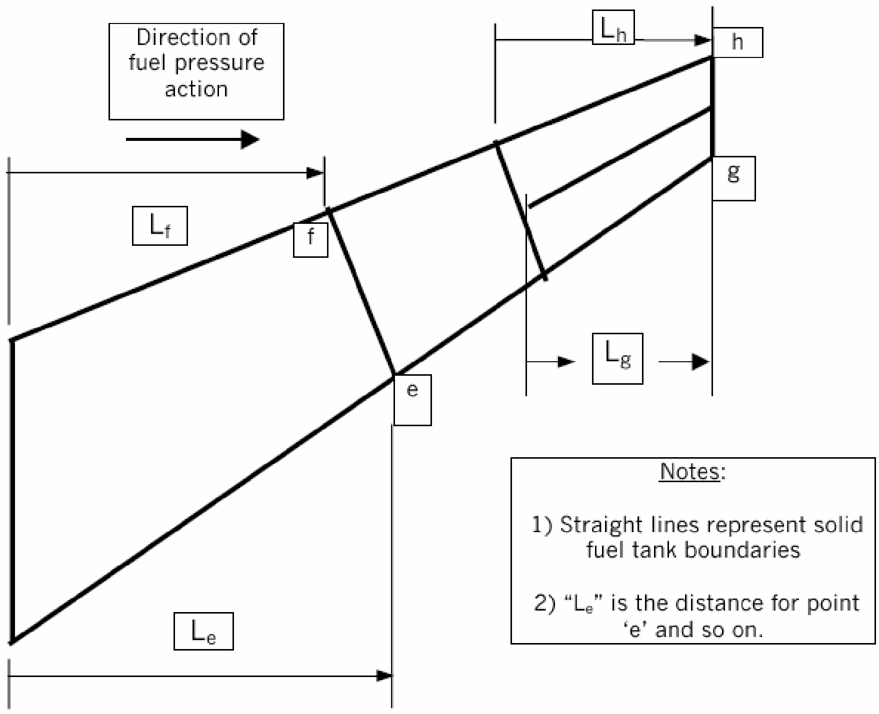


Figure 4 - Example of Distances For Fuel Outboard Acting Design Pressure Calculations



Proposal 6: To add a new AMC 25.963(e) to read as follows:

AMC 25.963(e)
Fuel Tank Access Covers

1. PURPOSE. This AMC sets forth a means of compliance with the provisions of CS-25 dealing with the certification requirements for fuel tank access covers on large aeroplanes. Guidance information is provided for showing compliance with the impact and fire resistance requirements of CS 25.963(e).

2. BACKGROUND. Fuel tank access covers have failed in service due to impact with high speed objects such as failed tyre tread material and engine debris following engine failures. Failure of an access cover on a fuel tank may result in loss of hazardous quantities of fuel which could subsequently ignite.

3. IMPACT RESISTANCE.

a. All fuel tanks access covers must be designed to minimise penetration and deformation by tyre fragments, low energy engine debris, or other likely debris, unless the covers are located in an area where service experience or analysis indicates a strike is not likely. The rule does not specify rigid standards for impact resistance because of the wide range of likely debris which could impact the covers. The applicant should, however, choose to minimise penetration and deformation by analysis or test of covers using debris of a type, size, trajectory and velocity that represents conditions anticipated in actual service for the aeroplane model involved. There should be no hazardous quantity of fuel leakage after impact. It may not be practical or even necessary to provide access covers with properties which are identical to those of the adjacent skin panels since the panels usually vary in thickness from station to station and may, at certain stations, have impact resistance in excess of that needed for any likely impact. The access covers, however, need not be more impact resistant than the average thickness of the adjacent tank structure at the same location, had it been designed without access covers. In the case of resistance to tyre debris, this comparison should be shown by tests or analysis supported by test.

b. In the absence of a more rational method, the following may be used for evaluating access covers for impact resistance to tyre and engine debris.

(i) Tyre Debris - Covers located within 30 degrees inboard and outboard of the tyre plane of rotation, measured from centre of tyre rotation with the gear in the down and locked position and the oleo strut in the nominal position, should be evaluated. The evaluation should be based on the results of impact tests using tyre tread segments equal to 1 percent of the tyre mass distributed over an impact area equal to 1.5 percent of the total tread area. The velocities used in the assessment should be based on the highest speed that the aircraft is likely to use on the ground under normal operation.

(ii) Engine Debris - Covers located within 15 degrees forward of the front engine compressor or fan plane measured from the centre of rotation to 15 degrees aft of the rearmost engine turbine plane measured from the centre of rotation, should be evaluated for impact from small fragments. The evaluation should be made with energies referred to in AMC 20-128A "Design Considerations for Minimising Hazards Caused by Uncontained Turbine

Engine and Auxiliary Power Unit Rotor Failure". The covers need not be designed to withstand impact from high energy engine fragments such as engine rotor segments or propeller fragments. In the absence of relevant data, an energy level corresponding to the impact of a 9·5 mm (3/8 inch) cube steel debris at 213·4 m/s (700 fps), 90 degrees to the impacted surface or area should be used.
For clarification, engines as used in this advisory material is intended to include engines used for thrust and engines used for auxiliary power (APU's).

4. RESISTANCE TO FIRE. Fuel tank access covers meet the requirements of CS 25.963(e)(2) if they are fabricated from solid aluminium or titanium alloys, or steel. They also meet the above requirement if one of the following criteria is met.

a. The covers can withstand the test of AC 20-135, "Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria", issued 2/9/90, or ISO 2685-1992(E), "Aircraft Environment conditions and test procedures for airborne equipment - Resistance to fire in designated fire zones", for a period of time at least as great as an equivalent aluminium alloy in dimensions appropriate for the purpose for which they are used.

b. The covers can withstand the test of AC 20-135, Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria, issued 2/9/90, or ISO 2685-1992(E), Aircraft - Environment conditions and test procedures for airborne equipment - Resistance to fire in designated fire zones, for a period of time at least as great as the minimum thickness of the surrounding wing structure.

c. The covers can withstand the test of AC 20-135, Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria, issued 2/9/90, or ISO 2685-1992(E), Aircraft - Environment conditions and test procedures for airborne equipment - Resistance to fire in designated fire zones, for a period of 5 minutes. The test cover should be installed in a test fixture representative of actual installation in the aeroplane. Credit may be allowed for fuel as a heat sink if covers will be protected by fuel during all likely conditions. The maximum amount of fuel that should be allowed during this test is the amount associated with reserve fuel. Also, the static fuel pressure head should be accounted for during the burn test. There should be no burn-through or distortion that would lead to fuel leakage at the end of the tests; although damage to the cover and seal is permissible.

Proposal 7: To delete the text of existing AMC 25.963(g) and mark as "(Revoked)":

AMC 25.963(g)
Fuel Tanks: General

~~1 *Purpose*. This AMC sets forth an acceptable means of showing compliance with the provisions of CS 25 dealing with the certification requirements for fuel tank access covers. Guidance information is provided for showing compliance with the impact resistance requirements of 25.963(g).~~

~~2 *Background*. Fuel tank access covers have failed in service due to impact with high speed objects such as failed tyre tread material and engine debris following engine failures.~~

~~Failure of an access cover on a wing fuel tank may result in the loss of hazardous quantities of fuel which could subsequently ignite.~~

~~3 *Impact Resistance*~~

~~a. All fuel tank access covers must be designed to minimise penetration and deformation by tyre fragments, low energy engine debris, or other likely debris, unless the covers are located in an area where service experience or analysis indicates a strike is not likely. The rule does not specify rigid standards for impact resistance because of the wide range of likely debris which could impact the covers. However, 'minimise penetration and deformation' should be achieved by testing covers using debris of a type, size, trajectory, and velocity that represents conditions anticipated in actual service for the aeroplane model involved. There should be no hazardous quantity of fuel leakage after impact. The access covers, however, need not be more impact resistant than the contiguous tank structure.~~

~~b. In the absence of a more rational method, the following criteria should be used for evaluating access covers for impact resistance.~~

~~i. Covers located within 15° inboard and outboard of the tyre plane of rotation, measured from the centre plane of tyre rotation with olco strut in the nominal position, should be evaluated. The evaluation should be based on the results of impact tests using tyre tread segments having width and length equal to the full width of the tread, with thickness of the full tread plus casing. The velocities used in the assessment should be based on the highest speed that the aircraft is likely to use on the ground. Generally, this will be the higher of the aircraft rotation speed (V_R) and the flapless landing speed.~~

~~ii. Covers located within 15° forward of the front compressor or fan plane measured from the centre of rotation to 15° aft of the rearmost turbine plane measured from the centre of rotation, should be evaluated for impact from small fragments (shrapnel). The covers need not be designed to withstand impact from high energy engine fragments such as rotor segments.~~

(Revoked)

C. APPENDICES.

I ORIGINAL JAA NPA 25E-304 PROPOSALS JUSTIFICATION.

Note: Where reading this Appendix I in the context of the proposed amendments to CS-25 as presented in part B, the references to JAR-25 and its paragraphs/ACJs should be understood as references to EASA CS-25 and its corresponding paragraphs/AMCs.

1. Explanatory note

The Aviation Rulemaking Advisory Committee (ARAC) was established in 1991, with the purpose of providing information, advice, and recommendations to be considered in rulemaking activities. The FAA and JAA are continuing to work toward the harmonisation of JAR-25 and FAR 25 by assigning ARAC specific tasks.

One of the tasks assigned to the ARAC General Structures Harmonisation Working Group (GSHWG) concerned the requirements and interpretative material related to fuel tank access covers. One of the tasks assigned to the ARAC Loads and Dynamics Harmonisation Working Group (LDHWG) concerned the requirements and interpretative material related to the structural integrity of fuel tanks. Both tasks have one main requirement in common (JAR 25.963); hence the results of both activities are combined in this P-NPA. This also allows restructuring of JAR 25.963 to align the paragraph numbering with FAR 25.

Both the GSHWG and the LDHWG have completed their tasks (ref. GSHWG Fast Track Report (June 2000) and LDHWG Fast Track Report (June 2000)). This NPA contains the proposals necessary to achieve harmonisation of the requirements and interpretative material related to fuel tank access covers and the structural integrity of fuel tanks, by adopting the GSHWG and LDHWG agreed text - with one notable exception: the text of INT/POL/25/9 (issue 2) “Fuel Tank Crashworthiness” is inserted in lieu of the LDHWG agreed text (for more explanation see below).

2. Safety justification / explanation

(a) Fuel Tank Structural Integrity

(i) Regulatory Background

The existing FAR 25.963(d) includes a requirement to account for fuel inertia loads in the design of fuel tanks within the fuselage contour, and requires those tanks to be protected such that they are not exposed to scraping action with the ground. JAR-25 has the same requirement, but annotated as JAR 25.963(e). In addition JAR 25.963(d) specifies design requirements for all fuel tanks that, if ruptured, could release fuel in or near the fuselage or near the engines in quantities sufficient to start a serious fire. FAR 25.721 contains conditions to protect fuel tanks from the effects of a landing gear breaking away and also to protect fuel tanks in a wheels-up landing. FAR 25.994 contains a requirement to protect fuel systems and components in engine nacelles and the fuselage in a wheels-up landing on a paved runway. Although 25.721 and 25.994 are identical in the JAR and FAR, there have been differences in interpretations and application of these requirements between and within the civil aviation authorities.

The current FAR 25.963(d) prescribe conditions that the structure of fuel tanks located within the fuselage contour must be designed to withstand during an emergency landing. These conditions cover the resistance to the inertia forces prescribed by FAR/JAR 25.561 and protection such that exposure to scraping action with the ground is unlikely. However, the rule does not apply to other fuel tanks, such as wing fuel tanks, that are outside the fuselage contour. Adequate strength and protection against rupture for fuel tanks outside the fuselage contour has been achieved on existing aeroplanes by application of other design requirements.

For many years the British Civil Airworthiness Requirements (BCAR) have included a design condition that requires fuel tanks inboard of the landing gear or inboard of, or adjacent to, the most outboard engine to have the strength to withstand fuel inertia loads appropriate to the emergency landing conditions. The BCAR also addresses protection of fuel tanks against rupture by the aeroplane sliding with its landing gear disarranged and against engine mounts tearing away. In developing the common European airworthiness requirements, the Joint Aviation Authorities (JAA) also recognised that crashworthiness criteria for wing fuel tanks are necessary to ensure an adequate level of safety and since October 1988, the European Joint Aviation Requirements (JAR-25) have included a design requirement for fuel tanks outside of the fuselage contour, that now supersedes the previously cited BCAR requirement.

Service experience with respect to rupture of fuel tanks due to fuel inertia pressure loads is good. From this service experience, it is concluded that current aeroplanes should have adequate strength to meet this condition. However, this may not always be the case, especially if new aeroplane designs are significantly different from past conventional configurations in terms of length and breadth of the wing fuel tanks, or design and location of engines, or other sources of ignition. Without specific emergency landing conditions for fuel tanks outside of the fuselage contour, the current fuel tank crashworthiness requirements may not guarantee that adequate levels of fuel tank structural integrity will always be present.

FAR/JAR 25.721 “Landing gear – general”, contains two design requirements. The first requirement in paragraph 25.721(a) provides for protection of fuel systems from a landing gear breaking away. This is considered a local component design criterion to protect fuel tanks from rupture and puncture due to the failure of the landing gear and its supports. This requirement applies only to fuel systems inside the fuselage for aeroplanes with 9 seats or less and to all fuel systems for aeroplanes with 10 seats or more. Experience has shown that the landing gear malfunctions can lead to landing on the engine nacelles for some configurations, and this can result in the engine nacelle breaking away, creating much the same fuel tank rupture potential as the landing gear breaking away.

FAR/JAR 25.721(b) provides for the protection of fuel systems in a wheels-up landing due to any combination of gear legs not extended. This condition is not intended to treat a collapsed gear condition, but is intended to cover cases in which one or more gears do not extend for whatever reason and the aeroplane must make a controlled landing on a paved runway in this condition. This requirement only applies to aeroplanes with 10 seats or more. At the time this paragraph was adopted FAR/JAR 25.561 “Emergency landing conditions - General” contained a landing descent speed of 5 feet per second as an alternative criteria that could allow a reduction in the specified vertical emergency landing design load factor. This alternative was removed by Amendment 25-64 / Change 13 in order to make the specified vertical design load factor the minimum design condition. However, the 5 feet per second descent speed of FAR/JAR 25.561 had, by design practice and interpretation, become the design descent velocity for the wheels-up landing conditions of FAR/JAR 25.721 and 25.994. By removing it, the quantitative definition of the wheels-up landing condition on a paved runway was lost.

FAR/JAR 25.994 clarifies that the wheels-up landing condition is on a paved runway.

<u>(ii) Background to the Proposals</u>

Investigation of various types of accidents that result in high impact forces on the airframe shows that it is necessary to consider only three flight phases in which accidents could have a potential for occupant survival. These are final approach, landing and take-off.

In 1982, the National Aeronautics and Space Administration (NASA) completed a study, of commercial transport aircraft accidents. This study, reported in FAA Report No. DOT-FAA-CT-82-70, "Transport Aircraft Accident Dynamics" by A. Cominsky, records a total of 109 impact survivable accidents in the period between 1960-1980. The breakdown of these accidents is reproduced in Table 1. An impact survivable accident is defined by NASA as one in which there were fatalities, but not all occupants received fatal injuries as a result of impact forces imposed during the crash sequence. Since aircraft impact during approach is likely to be equivalent to the aircraft flying into the ground, FAA considers that this is too severe a condition to be the subject of design requirements. Nevertheless the figures for approach accidents are given in Table 1 for completeness.

TABLE 1

Injury Survey - Survivable Accidents

Period 1960 to 1980, Commercial Transport Aircraft

Accident Group	Number Of Accidents	Number of Passengers and Crew					
		Total	Injuries	Fatalities			
			Serious/ Minor/ None	Impact Trauma	Fire	Drowned	Unknown
Approach	27	2,113	1,078	434	298	15	288
Landing	33	3,058	2,637	157	227	23	14
Take-off	49	4,798	4,419	92	146	78	63
Total	109	9,969	8,134	683	671	116	365

A significant conclusion drawn from study of these accident statistics is that there are 50 percent more fatalities due to fire than to impact trauma in the survivable landing and take-off accidents. The FAA and JAA believe that it is proper, therefore, that post impact fire accidents merit attention in respect of airworthiness action aimed at protection of occupants.

In regard to FAR 25.963(d) and JAR 25.963(e), ARAC has determined that the safety record with respect to fuel tank rupture due solely to fuel inertia loads is excellent. Manufacturers' records of accidents and serious incidents to large transport aeroplanes show no event where significant loss of fuel occurred due to fuel inertia pressure. Fuel losses that did occur were due mainly to direct impact and to puncturing by external objects.

Nevertheless, ARAC believes, and the JAA agrees, that a fuel inertia criterion for wing fuel tanks is still needed to ensure that future designs meet the same level of safety achieved by the current fleet. In setting an appropriate standard for this proposal, ARAC have reviewed the structural capability of the existing fleet. In that review it was shown that the outboard fuel tanks of a large part of the fleet could not be shown, theoretically, to be able to withstand the fuel inertia pressures generated by a wing full of fuel, combined with the emergency landing load factors of FAR/JAR 25.561(b)(3). In fact the wing fuel tanks of many aircraft types were designed to a simple criterion in which fuel pressure was calculated using an inertia head equal to the local geometrical streamwise distance between the fuel tank solid boundaries. Service experience has shown this criterion to produce fuel tank designs with an acceptable safety level. Therefore it is appropriate that the future airworthiness standards for fuel tanks should require a similar level of design fuel pressure for similar fuel tank designs.

For fuel tanks within the fuselage contour, the existing fuel inertia load criterion as generally applied covers up to a full fuel tank, an inertia head equal to maximum pressure head, and inertia load factors equal to those of FAR/JAR 25.561(b)(3). ARAC believes, and the JAA accepts, that this level of rupture resistance for fuel tanks is entirely justified based upon occupant survivability considerations. Any fire occurring due to spilled fuel inside the fuselage poses an almost immediate threat to the occupants. Therefore the current minimum level of rupture resistance is proposed to be retained for fuel tanks within the fuselage contour. In this regard, the design factors specified for the fuel tank pressure boundaries inside the fuselage are equivalent to those that would be developed with the emergency landing load factors of FAR/JAR 25.561(b)(3). The phrase "within the fuselage contour" in paragraph 25.963(d) has been subject to a variety of interpretations in the past. Fuel tanks "not within the fuselage contour**"** are all fuel tanks where fuel spillage through any tank boundary would remain physically and environmentally isolated from occupied compartments by a barrier that is at least fire resistant. In this regard, cargo compartments that share the same environment with occupied compartments would be treated the same as if they were occupied.

ARAC has determined, and the JAA concurs, that the fuel pressure requirement of FAR 25.963(d) and JAR 25.963(e) should not reference the emergency landing load factors of FAR/JAR 25.561(b)(3). The rationale is that the emergency landing load factors of FAR/JAR 25.561(b)(3) are based upon the restraint of fixed mass items and the response of a fluid during emergency landings is different and much more complex to quantify. Therefore, the proposed requirements for fuel tanks both within and outside of the fuselage contour have been simply formulated in terms of equations with factors that are justified based upon the satisfactory service experience of the existing fleet.

FAR/JAR 25.721 would be completely rewritten to include a wheels up landing condition, an engine nacelle breakaway condition, and a landing gear breakaway condition. The new proposed paragraph 25.721(b) defines the descent velocity, aeroplane configurations, and sliding conditions for a wheels-up landing on a paved runway. Paragraph 25.721(c) would prescribe a new requirement for consideration of the engine nacelle(s) breaking away if they are likely to come into contact with the ground in a wheels-up landing condition. The new proposed paragraph 25.721(a) would contain the landing gear breakaway condition which is similar to the existing landing gear breakaway condition except it would apply to all landing gear, not just the main gear, and it would apply to all transport aeroplanes without regard to seating capacity.

FAR/JAR 25.994 and JAR 25A994 would be revised to reference FAR/JAR 25.721(b) for the conditions that must be considered for the protection of fuel systems and components in engine nacelles, APU compartments and in the fuselage in a wheels-up landing on a paved runway.

FAR/JAR 25.561(c) would be revised in order to provide a requirement to consider cargo in the cargo compartment. This revision would require that if cargo in the cargo compartment located below or forward of all occupants in the aeroplane were to break loose, it would be unlikely to penetrate fuel tanks or lines or cause fire or explosion hazards by damaging adjacent systems. The current requirement only addresses items of cargo in the passenger compartment.

The new proposed requirements for fuel tank protection would apply to all transport/ large aeroplanes. ARAC has determined, and the JAA concurs, that there is no technical justification for limiting the applicability of any of the fuel tank protection provisions based on a passenger seating capacity.

(iii) INT/POL/25/9

When the above FAA/JAA harmonised material was applied by means of a Certification Review Item (CRI) to a particular JAA certification program, objections were raised by some members of the JAR-25 Power Plant Study Group (PPSG). Their concern was that the proposed material did not sufficiently address the fuel tanks near the fuselage and the near the engines. It was felt that the proposed material could lower the fuel tank pressure loads in those areas below acceptable levels. Therefore, for those areas, additional design considerations were added (ref. 25.963(d)(2)) plus clarification of the terms “near the fuselage” and “near the engines” (ref. ACJ 25.963(d), paragraph 4.b.). These additional design considerations plus associated clarifications (as further amended in SSG meeting 108) are reflected in INT/POL/25/9, issue 2, and are presented in paragraph 4 of this P-NPA.

(b) Fuel Tank Access Covers

Compared to the existing JAR 25.963(g) and ACJ 25.963(g), the main differences with the proposed JAR 25.963(e) and ACJ 25.963(e) are as follows.

(i) Removing JAR 25.963(g) (plus ACJ) and relocating as JAR 25.963(e) (plus ACJ), to align the paragraph numbering of JAR 25.963 with FAR 25.963.

(ii) The addition of a new paragraph JAR 25.963(e)(2). The JAR-25 PPSG considered, but rejected the adoption of the existing FAR 25.963(e)(2) text, that would require fuel tank access covers to be fire resistant (per the definition contained in JAR-1). It was strongly felt that such a requirement that would apply only to the fuel tank access covers but not to the whole wing, would not be sensible. Instead, the proposed text in paragraph 4 of this P-NPA was developed.

(Note: It is recognised that the FAA does not support the proposed text of JAR 25.963(e)(2) and associated advisory material. Nevertheless it was decided to publish this text to provoke further discussions on this subject.)

(iii) For impact resistance to tyre debris, the adoption of the text of the existing AC 25.963-1 in terms of weight (tyre tread segments equal to 1 percent of the tyre mass), spread angle (30 degrees inboard and outboard of the tyre plane of rotation) and impact area (1.5 percent of the total tread area).

Based on data from a tread survey performed by Boeing (1985 -1987) it was determined that the tyre debris model contained in the existing ACJ 25.963(g) is too conservative in terms of tyre debris weight. An important additional consideration is that the tyre debris model of AC 25.963-1 has been applied for many years to the current fleet of large/transport aeroplanes, and it is the opinion of the GSHWG that the application of this model has provided an adequate level of safety. Hence this tyre debris model is proposed in favour of the tyre debris model contained in the existing ACJ 25.963(g).

The velocities used in the tyre debris assessment is proposed as the highest speed that the aircraft is likely to use on the ground under normal operation, in lieu of the text of the existing ACJ 25.963(g) (“the higher of the aircraft rotation speed V_R and the flapless landing speed”). The GSHWG has determined that the probability of occurrence of a flapless landing is sufficiently low to no longer consider the flapless landing speed in the tyre debris assessment.
The definition of the tyre debris spread angle was clarified by adding the words “with the gear in the down and locked position”.

(iv) The addition, for impact resistance to engine debris, of a reference to AMC 20-128A in relation to engine debris energies. In the absence of relevant data, an energy corresponding to the impact of a 3/8 inch steel cube travelling at 700 fps may be used. This criterion has been used by some aircraft manufacturers in the past, and the GSHWG (including the JAA) believes that this level of energy would provide an acceptable level of safety.

(v) The addition, in paragraph 4 of the proposed ACJ 25.963(e), of acceptable means of compliance to the proposed JAR 25.963(e)(2).

3. Cost / Safety Benefit Assessment

The proposals contained in this NPA are intended to achieve common requirements and interpretative material related to fuel tank access covers and the structural integrity of fuel tanks, without reducing the safety provided by the regulations below the level that is acceptable to Authorities and Industry. Harmonisation of JAR-25 and FAR 25 on this subject would yield cost savings by eliminating duplicate certification activities.

II ORIGINAL JAA NPA 25E-304 COMMENT RESPONSE DOCUMENT

Note: Where reading this Appendix II in the context of the proposed amendments to CS-25 as presented in part B, the references to JAR-25 and its paragraphs/ACJs should be understood as references to EASA CS-25 and its corresponding paragraphs/AMCs.

Introduction

NPA 25E-304 was published for comment on April 2, 2002. This NPA is a result of a harmonisation activity between JAA and FAA.
For more details on the background of this NPA is referred to the NPA itself.

Comments & Responses

The following (seven) organisations have commented on this NPA:
- AECMA
- CAA, NL
- DGAC, France
- ACG, Austria
- CAA, UK
- Embraer, Brasil
- FAA.

All, except AECMA, CAA/UK and FAA, have stated to have no (adverse) comments on this NPA. The AECMA, CAA/UK and FAA comments are addressed as follows:

Comment 001 (AECMA)

Affected paragraph: JAR 25.721(a)
Position: Change second sentence from 25.721(a)
Proposed text:
"The overloads must be assumed to act in the upward and aft directions in combination with side loads acting inboard or outboard. In the absence of a more rational analysis, the side loads must be assumed to be up to 20% of the vertical load or 20% of the drag load, whichever is greater."

Reason for proposed text: The 20% side load criteria is just one simplified criteria chosen arbitrarily, to account for the side load effects. Manufacturers should have the ability to select more rational criteria.

Response: Comment accepted.
In cases where the vertical load at rupture is very high then the arbitrary assumption of 20% of this vertical load as a side load may lead to an unrealistic condition.
Paragraph 25.721(a) will be amended accordingly. For consistency, paragraph 4.e. of the proposed ACJ 25.963(d) will also be amended.

Comment 002 (AECMA)

Affected paragraph: JAR 25.963(d)(1)
Position: Propose different text
Proposed text:

P = KρgL

where:
P = fuel pressure in Pa (lb/ft^2) ~~psi~~ at each point within the tank
L = a reference distance in m (ft) ~~feet~~ between ….
ρ = typical fuel density in kg/m^3 (slugs/ft^3)
g = acceleration due to gravity in m/s^2 (ft/s^2)
K = 4.5 for the forward loading condition …

Reason for proposed text:
The formula in the NPA is not dimensionally correct, is not valid with the use of SI units, and is not correct if fuels with different densities are considered. The proposed alternative text, which does not change the intent of the requirement, eliminates each of these disadvantages.

Response: Comment accepted.
While recognising the original intent (to avoid confusing this formula with a fully rational calculation of pressure), the balance of the argument is in favour of a dimensional formula in order to improve understanding and to introduce the appropriate units.
For clarity, a sentence will also be added to the proposed advisory material (paragraph 4.a. of ACJ 25.963(d)) to provide an example of typical density for Jet A(-1) fuel (the factor of 0.34 matches a density of 6.55 lbs/US gallon, which is equal to 785.0 kg/m^3).
Paragraph 25.963(d)(1) and ACJ 25.963, paragraph 4.a. will be amended accordingly.

Comment 006 (CAA/UK)

Affected paragraph: JAR 25.561 (c)
Comment:
The current requirements of JAR 25.787 "Stowage Compartments" already address the inertia cases for design for "Each compartment for the stowage of cargo…" (ref. JAR 25.787(a) which also mentions cargo, baggage, carry-on articles and equipment such as life rafts). Thus the CAA understanding is that "Stowage Compartments" is a more generic term that embraces both cargo compartments (situated on the main deck and under-floor) and cabin compartment stowages (e.g. overhead bins and wardrobes etc.,). On this basis, JAR-25.787(a)(1), (2), (3) already covers the design to loads resulting from cargo under flight and ground cases where there is direct injury to occupants, fire/explosion hazard, and also accounts for emergency alighting conditions of 561(b)(3) where there is potential to nullify escape facilities.

The NPA text proposed for JAR 25.561(c) last sentence therefore conflicts with JAR 25.787 and should be deleted.

Reason for comment:
The existing text of JAR 25.787 "Stowage Compartments" compared with revised text proposed in JAR 25.561(c) leads to a possible contradiction and duplication of requirements.

Response: Comment accepted.
JAR 25.787 addresses each compartment for the stowage of cargo, baggage, carry-on articles and equipment, and any other stowage compartment, regardless of its location in the aircraft (in the passenger cabin, under-floor, etc.). Therefore the changes to JAR 25.561(c) as proposed in this NPA will be withdrawn and not incorporated because of the possible contradiction with JAR 25.787.

(Note: In this respect FAR 25.787 is different from JAR 25.787. Contrary to JAR-25, consideration of the emergency landing conditions of 25.561 is not required by FAR 25 if the cargo compartment is located below, or forward, of all occupants in the aeroplane.)

Comment 007 (CAA/UK)

Affected paragraph: JAR 25.963 (d)(1)
Comment:
Imperial units are used in the pressure equation of JAR 25.963(d)(1). An equation quoting SI units should also be in the requirement.

Reason for comment: Editorial

Response: See comment 002.

Comment 008 (CAA/UK)

Affected paragraph: JAR 25.963 (d)(2)
Comment:
It is proposed that applicability of this sub-para be widened by revising the "wing tanks" to "wing, tail and conformal body tanks" – all these fuel tanks are located near the fuselage and can also be near to engines, (particularly for fuselage mounted engines).

Response: Comment not accepted.
The proposed JAR 25.963(d)(1) addresses all fuel tanks, within or outside the fuselage contour. In addition, the proposed JAR 25.963(d)(2) addresses wing fuel tanks near the fuselage or near the engines. As explained in section 2 of the NPA this is a later addition to the proposals, on the specific request of the JAA Powerplant Study Group, in order not to degrade the criteria below what is currently included in JAR 25.963(d) and associated ACJ.
Therefore the change proposed by the commenter is not agreed.
For other configurations, e.g. rear mounted engines in combination with tail tanks, the need for a Special Condition should be evaluated on a case by case basis.

The words "near the fuselage and near the engines" in the proposed JAR 25.963(d)(2) will be changed to "near the fuselage or near the engines".

Comment 009 (CAA/UK)

Affected paragraph: JAR 25.963 (d)(3)
Comment:
Serious reservations exists regarding the credit given for fuel tank baffles as proposed in paragraph JAR 25.963(d)(3). In addition to being "effective in limiting flow", the baffles also need to be capable of preventing the transmission of fuel pressure between adjacent fuel volumes.

It is proposed that an additional sentence be inserted after the current proposed text:

> *"In addition, the fuel tanks baffles should be shown by rational analysis to be capable of preventing the transmission of fuel pressure between the bodie of fuel on each side of the baffle."*

Reason for proposed text/ comment: Clarification of intent.

Response: Comment not accepted.

While it is recognised that more factors than are represented by the proposed quasi-static formula may influence a dynamic event, the state of the art in hydrostatic analysis in flexible containers does not provide a sufficiently robust method of compliance for a regulation. The proposed formula, although simplistic, is considered to provide an acceptable and consistent safety standard, taking account that the safety record with respect to rupture of fuel tanks due to fuel pressure is good.

Comment 010 (CAA/UK)

Affected paragraph: ACJ 25.963 (d)
Comment:
Paragraph 4 c (ii) refers to V_{L1} for the sliding condition, this is considered inappropriate. The upper limit of normal landing speeds is more appropriate for the emergency landing condition to be compatible with the thinking of using normal operating speeds for the access covers requirement. Therefore it is proposed that V_{L2} (TAS) is more appropriate for the sliding condition.

Response: Comment not accepted.
For the impact phase, a reasonable attitude should be selected within the speed range from VL1 to 1.25 VL2, based on the fuel tank arrangement. For the sliding phase however, only VL1 is chosen as a condition consistent with previous industry practice.

To anticipate future rulemaking, and for clarity, the definitions of VL1 and VL2 are added to the proposed ACJ 25.963(d), paragraph 4.c.(i).

Comment 011 (CAA/UK)

Affected paragraph: ACJ 25.963(e)
Comment:
CAA is fully supportive of the requirement proposal for JAR 25.963(e), and in particular the need to minimize penetration and deformation by tyre fragments, low energy debris, or other likely debris. The ACJ gives very good guidance on acceptable standards that should be used in evaluating access covers for impact resistance to tyre and engine debris. However, no guidance at all is given on what should be considered in evaluating access covers for impact resistance to **other likely debris**. This is a disappointing omission since without such guidance each applicant will be left to decide what constitutes "likely debris" and thus it is not possible to assure an acceptable, harmonised design standard will be achieved. Some discussion of debris to be considered should be added to the ACJ.
In that regard, Continues Airworthiness investigation associated with the recent tragic Concord accident revealed examples of fuel tank penetrations caused by a failed wheel tie bolt, and, separately, a piece of wheel rim. These are two examples of "other likely debris" that should be included in the evaluation.

Response: Comment not accepted.
It is correct that the proposed advisory material on Fuel Tank Access Covers does not address "other likely debris". The GSHWG discussed this subject at some length, but failed to agree on a general definition of likely debris (other than tyre and engine fragments) mainly because of the variety of shapes and sizes (and orientation and speed of impact) involved.
It is believed that the tyre and engine debris as defined in this NPA would cover the majority of cases. Potential exceptions include configurations with airframe (rear) mounted engines and configurations where fuel is carried in the empennage. In these cases additional consideration of other likely debris seems warranted*.

* *Note:* EASA plans to further address this issue with the task 25.028 “Fuel Tank Protection From Debris and Fire” which is in the 2007-2010 rulemaking inventory.

Comment 012 (CAA/UK)

Affected paragraph: Safety Justification/Explanation
Comment:
The Safety Justification/Explanation Table 1 data refers to a study done on accidents between 1960 and 1980, and reaches the important conclusion that 50% more fatalities occur due to fire, in survivable accidents than due to impact trauma. CAA accident analysis work has shown that many of the modifications and improvements to the requirement standards introduced since 1980 have significantly altered the chances of survivability. There have been substantial improvements in survivability over the past 20 years, aerodrome standards have improved, there are more wide-body aircraft, approach aids have improved, as have evacuation provisions.
This study, which was valid at the time, in 1982, should not be quoted as evidence in the NPA for the reasons above and that either it should be deleted as a reference or work should be done to bring it up to date.

Response: Comment noted.
While recognising the benefits of improvements already made, it is believed that the statistical data still have sufficient merit to be used as justification for this NPA.

Comment 014 (FAA)

Affected part: Fuel Tank Structural Integrity

Comment:
The FAA participated in the ARAC development of the fuel tank structural integrity proposal, and plans to propose similar requirements and advisory material as found in NPA 25E-304. Like the JAA, the FAA believes the ARAC proposal represents a significant improvement over the existing regulations and advisory material. However, recent certification projects have indicated certain deficiencies in the ARAC proposal, as indicated in the FAA comments below.

JAR 25.561: The FAA concurs with the proposed amendment to JAR 25.561.

JAR 25.721: The FAA supports the proposed amendment to JAR 25.721, but believes that additional criteria are needed to address landing gear failures. The proposed JAR 25.721(a) would be considered a local design criterion to protect fuel tanks from rupture and puncture due to the failure of any landing gear unit and its supports. Compliance to this requirement may be considered assuming that all other landing gear units are extended and do not fail. The FAA believes, however, that this does not adequately address multiple landing gear failures, which have occurred in service. Therefore, the FAA believes that an additional requirement is necessary to ensure that fuel tanks are designed and located to withstand failures of any one or more landing gears.

JAR 25.963(d): The FAA believes the clause “so far as is practical” should be deleted from the first sentence of the proposed JAR 25.963(d).

Also in reference to the first sentence of the proposed JAR 25.963(d), the FAA believes that “emergency landing conditions” should be changed to “ground impact conditions.” Specifying “ground impact conditions” would not only require consideration of a wheels up landing on a paved runway, as described in the proposed JAR 25.721(b), but would also require consideration of off-runway events, such as RTO overruns.

While the FAA recognizes that off-runway events cannot be quantified in terms of specific structural loading criteria, we believe that certain design principles and precautions can be incorporated in the fuel tank design that would greatly improve the capability to withstand these events. For example, the use of internal bladders and structural crush zones, and the consideration of fuselage break points are all ways to reduce the likelihood of a fuel tank rupture during an off-runway event.

FAA Advisory Circular 25-8, "Auxiliary Fuel System Installation", dated May 2, 1986, provides design considerations for auxiliary fuel tanks, and includes criteria for structural integrity and crashworthiness. The FAA believes that the guidance material in this AC is largely applicable to any fuel tank, and that the structural integrity and crashworthiness provisions should be included, as appropriate, in the proposed ACJ 25.963.

<u>JAR 25.994:</u> The FAA concurs with the proposed amendment to JAR 25.994.

Response: Comment noted.
It is understood that the FAA does not fully support the contents of this NPA. Nevertheless, the JAA has decided to move forward with this NPA. It is believed that the contents of this NPA are an improvement to the existing INT/POL/25/9 (issue 2) and generic CRI on Landing Gear and Emergency Landing Conditions. As such, this NPA could replace both documents in the interim as the basis for Special Conditions.
JAA will continue to work with the FAA and Industry to harmonise on this subject.

<u>**Comment 015** (FAA)</u>

Affected part: Fuel Tank Access Covers

Comment:
The ARAC recommendation is to incorporate wording directly into the rule (FAR/JAR 25.963(d)) that would allow the fuel tank access panels to be "equivalent to the adjacent / surrounding skin," rather than meet the fire resistant standard stated in the current FAR. This proposal is a step backward in fuel tank safety, particularly in the post crash fire environment.

The current transport fleet post crash safety record is based upon use of aluminum structures. These structures conduct heat well and are "fire resistant" as defined in FAR 1.1. The fire resistance requirement in FAR 25.963 was introduced because of the use of nylon fuel tank access panels by one manufacturer. These panels suffered severe damage when exposed to underwing fires. The doors were replaced with cast aluminum doors to provide appropriate fire resistance. The impact resistance of fuel tank panels made of cast aluminum, however, was found to cause a safety concern. Therefore, the cast aluminum doors were replaced by doors with improved impact resistance in areas of the wing exposed to tire and uncontained engine debris. FAR 25.963 was amended to require both fire resistance and impact resistance for fuel tank access panels. While this rulemaking addressed the adverse service experience of conventional transport airplanes with fuel tank structures that were made of impact and fire resistant aluminum, the FAA did not foresee the future use of composite structures nor possible development of non-conventional delta wing designs that may significantly reduce the inherent safety of conventional fuel tank designs. Looking back, FAR 25.963 should have established an objective standard for fuel tanks integrity for impact and fire resistance.

The Concorde and other accidents have highlighted the safety implications of damage to fuel tanks from debris or fire. The delta wing design of the Concorde allows the use of lower wing skins made of 1.2 mm titanium. While this material offers excellent fire resistance, the impact resistance was found to be inadequate. The British Midlands 737 event also underscores the need to provide impact resistance for fuel tanks.

In addition, the evolution of airplane structures has resulted in the use of new materials for fuel tank structures. One aspect of these new materials is a possible lessening of their resistance to fire, (e.g. composite horizontal stabilizer fuel tanks).

Based upon the use of new materials and the need to assure fuel tank integrity from both fire and impact damage, the FAA position is that the current FAR 25.963 requirement for the fuel tank access panels to be impact and fire resistant should be applied to the entire external surfaces of the fuel tank. The harmonized rule should not reduce the current level of safety and allow use of doors made of materials that do not meet fire resistance standards, as defined in FAR/JAR Part 1. The FAA intends to apply special conditions to future airplane designs requiring that both impact resistance and fire resistance are addressed on fuel tanks located in the wing and stabilizer, etc. so that the level of safety achieved by the current transport fleet is not inadvertently reduced by introduction of newer technology materials, or the evolution of airplane designs such as the "Sonic Cruiser".

Response: Comment noted.
It is understood that the FAA does not support the contents of this NPA related to resistance to fire. Nevertheless, the JAA has decided to move forward with this NPA. Currently JAR-25 has no requirement related to resistance to fire for the access covers. As such, this NPA can be seen as an (interim) improvement to JAR-25.
JAA will continue to work with the FAA and Industry to harmonise on this subject*.

* *Note:* EASA plans to further address this issue with the task 25.028 "Fuel Tank Protection From Debris and Fire" which is in the 2007-2010 rulemaking inventory.