European Aviation Safety Agency

8 Apr 2009

COMMENT RESPONSE DOCUMENT (CRD) TO NOTICE OF PROPOSED AMENDMENT (NPA) 2008-19

for amending the Executive Director Decision No. 2003/02/RM of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes (« CS-25 »)

and

for amending the Executive Director Decision No. 2003/01/RM of 17 October 2003 on acceptable means of compliance and guidance material for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations ("AMC and GM to Part-21")

"Fuel tank flammability reduction"

Explanatory Note

I. General

1. The purpose of the Notice of Proposed Amendment (NPA) 2008-19, dated 17 July 2008, was to propose an amendment to the following Executive Director Decisions:

- No. 2003/02/RM of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes ("CS-25"),

- No. 2003/01/RM of 17 October 2003 on acceptable means of compliance and guidance material for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations ("AMC and GM to Part 21").

II. Consultation

2. The draft Executive Director Decision amending Decision No. 2003/02/RM and Decision No. 2003/01/RM was published on the web site (http://www.easa.europa.eu) on 18 July 2008.

By the closing date of 18 October 2008, the European Aviation Safety Agency ("the Agency") had received 89 comments from 15 National Aviation Authorities, professional organisations and private companies.

III. Publication of the CRD

3. All comments received have been acknowledged and incorporated into this Comment Response Document (CRD) with the responses of the Agency.

4. In responding to comments, a standard terminology has been applied to attest the Agency's acceptance of the comment. This terminology is as follows:

- **Accepted** – The comment is agreed by the Agency and any proposed amendment is wholly transferred to the revised text.
- **Partially Accepted** – Either the comment is only agreed in part by the Agency, or the comment is agreed by the Agency but any proposed amendment is partially transferred to the revised text.
- **Noted** – The comment is acknowledged by the Agency but no change to the existing text is considered necessary.
- **Not Accepted** - The comment or proposed amendment is not shared by the Agency

The resulting text at the end of the document highlights the changes as compared to the current rule.

5. The Agency's Decision will be issued at least two months after the publication of this CRD to allow for any possible reactions of stakeholders regarding possible misunderstandings of the comments received and answers provided.

6. Such reactions should be received by the Agency not later than 8 June 2009 and should be submitted using the Comment-Response Tool at http://hub.easa.europa.eu/crt.

IV. CRD table of comments, responses and resulting text

(General Comments)	-

comment	2	comment by: *CAA-NL*
	CAA- NL agrees with the NPA	
response	*Noted*	

comment	30	comment by: *Luftfahrt-Bundesamt*
	The LBA accepts and supports the contents of the NPA.	
response	*Noted*	

comment *72* comment by: *Boeing*

<u>GENERAL COMMENT #1 -- from Boeing Commercial Airplanes</u>

Boeing agrees with EASA that new airplane and fuel tank designs should address flammability exposure. The NPA considers two approaches available to address this -- heat-limiting vs. active flammability reduction means (FRM), and proscribes differing requirements for each approach.

Boeing requests that EASA <u>apply the heat limiting regulations only to those designs that show compliance with flammability measures solely resulting from heat limitation, and without further actions such as FRM</u>. Once FRM is required, heat limiting designs are no longer effective at improving flammability. The contribution to overall fleet safety is not significantly improved with additional heat limiting once FRM is applied.

Our request is justified, based on the following information:

With regard to conventionally designed aluminum wing tanks, these have been accepted to have a satisfactory safety record by both regulators and industry. Contributing factors include the change to Jet A/A1 from JP-4 fuel, significant cooling from the air stream, and minimal heating from systems such as hydraulics or the environment. Addressing and limiting heat input should be sufficient to minimize flammability for aluminum wing fuel tanks not exposed to significant heat sources.

Where designs result in marginally heated fuel tanks, heat-limiting approaches may be practical when no other action is required to reach a satisfactory flammability exposure level.

Where practical airplane and fuel tank designs result in higher fuel tank flammability requiring active FRM, specific flammability reduction performance measures are appropriate.

A configuration that meets these performance measures should be considered

	on its own merits. The application of FRM (Nitrogen Generating Systems, NGS, in particular) results in flammability exposures well below that of "conventional unheated aluminum wing tanks," and below 3% fleet-wide exposure, even including time when the FRMs are on the MMEL for up to10-day periods. In the NPA, it is proposed that aircraft with active FRM should have an additional requirement to limit temperature increase to 20°C during dispatch with an inoperative FRM. The apparent justification for this is the theory that the events that led to this rulemaking occurred in fuel tanks that were flammable to the extent that they were susceptible to ignition by low energy levels. However, 4 of the 5 "possible causes" for the 5 events noted in the NPA involve high energy levels. The fifth stated "probable cause" refers to metal shavings in a dry running pump which, if correct, might represent a low or high energy source. However, while the dry running pump remains a potential cause for this event (and, accordingly, auto-shutoff changes have been mandated), extensive testing done did not support an ability to cause ignition by ingestion of small (or even large) metal shavings in a fuel pump. An active FRM is far more effective at precluding flammability exposure, especially during warm day ground and climb conditions cited in the NPA, than are passive cooling systems, whose flammability exposure occur primarily during these very conditions. Boeing does not agree that operators of aircraft with NGS should be penalized with carrying additional insulation or cooling systems that provide minimal benefit, when on MEL. Note that the rule proposes (and Boeing concurs), to limit exposure due to MEL periods to less than 1.8%, whereas aircraft with passive systems are allowed 3% exposure. To further evaluate whether high flammability tanks that use an active FRM have a higher exposure to low energy sources as theorized in NPA Section 2.2 (first paragraph), Boeing has compared the time for "delta T above the lower flammability limit" for a conventional unheated wing tank, to a heated center tank using NGS to comply with 3% exposure requirements. Using Monte Carlo models, the delta T in "1 degree - 1 minute increments" was summed and a plot of the results is shown below. The example is based on an aircraft with a center tank NGS with an expected MEL time of ~5%; hence, the center tank exposure times (run without NGS operating) use a factor of 5%. The results show that an unheated wing tank actually has a higher exposure time at all delta Ts, than does the NGS center tank. These data show that tanks that use FRM (NGS) to mitigate flammability exposure actually have less exposure to high delta T than conventional unheated wing tanks, even assuming the NGS is on the MEL 5% of all flights. Therefore, additional MEL restrictions on aircraft with FRM (NGS) are not justified. (Please see explanatory table on attached file.)
response	*Not accepted* EASA agrees that the introduction of FRM systems brings a significant improvement in the flammability exposure of some aircraft designs. However, EASA remains concerned with the basic principle of allowing large energy transfers into the fuel tank for the following reasons: • From our engineering judgment, the principle of heating a fuel tank (and hence lowering the energy necessary to create an explosion) and to mitigate this temperature increase by installing another system is not the simplest and soundest one.

- The FRM system certified using the material provided in FAR 25 Appendices N/M or the material proposed in this NPA or the Special Conditions, is a simplex system with no redundancy. Some basic checks may exist but it remains the FRM system can be inoperative, as a latent failure or under MMEL. For those flights, controlling the heat transfer is essential.

Moreover, most aircraft manufacturers have successfully minimised (in fact, nearly eliminated) heat transfer within the fuel system.

EASA therefore consider that the first step in fuel tank flammability mitigation is controlling the heat and energy transfer into the fuel tank. The introduction of active system such as FRM can only come as a second step; FRM is given due credit through the AMC which does not set a specific temperature limit if such a system is fitted and operative.

comment *73* comment by: *Boeing*

GENERAL COMMENT #2 - from Boeing Commercial Airplanes:

Boeing appreciates the efforts made by EASA and the FAA to harmonize the regulations. The importance of harmonization has never been more important. Regulations that are not harmonized drive additional cost into the industry at all levels.

Boeing requests the EASA proposed change be harmonized to the extent possible with the FAA's Fuel Tank Flammability Reduction final rule and the FAA and EASA Special Conditions and CRIs in place for the Boeing Model 737, 747, and 777 aircraft. When harmonizing the EASA Flammability Reduction rule changes with the FAA, Boeing requests that EASA retain the Monte Carlo requirements as stated in the EASA Special Conditions.

Additionally, the FAA final rule, as reflected in the harmonized Special Conditions and CRIs, focuses on performance-based solutions, allowing the applicant the option to use flammability reduction means, heat limiting designs, and other possible solutions to meet the regulations. Boeing requests that EASA adopt a performance-based flammability reduction rule that allows the applicant to choose the solution without additional temperature restriction, which effectively mandates the design approach.

response *Not accepted*

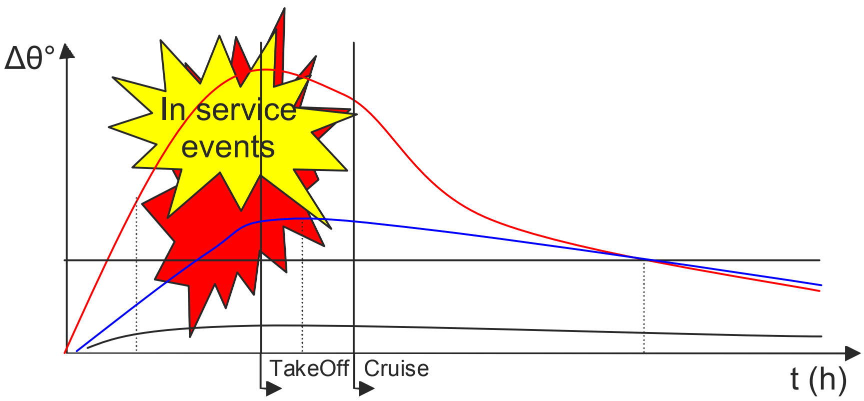
EASA and FAA have attempted to harmonise on this subject for years. Some success has been achieved, for instance regarding the criteria to certify the FRM system. It has to be recognised that some significant differences remain, particularly regarding the criteria governing the decision to introduce or not a FRM system.

For instance, FAA adopted the ARAC FTHWG view that 7% was the limit between high and low flammability. It is unclear why it evolved to 3% late in the process, in the absence of any accident or incident supporting this change. Using the Monte Carlo method, EASA considered an approach based upon actual in-service record, possible with 3 thresholds: low flammability exposure below 7%, medium flammability between 7 and 15%, high flammability exposure above. For harmonisation purpose, the 3% was retained.

Looking at the FAA rule, EASA is concerned with the following issues:

- The final FAA rule is effectively mandating FRM systems for all transfer tanks located within the fuselage contour. While we understand it is intended to address the Centre Wing Tank of Boeing or Airbus aircraft types, it will also impact other fuel tanks, either on those products (tanks located in the horizontal stabilizer, or in the cargo compartments), but also on smaller aircraft such as business jets. EASA has yet to see a justification for such rulemaking action. At this date, there is not a single accident justifying this action.

- The Monte Carlo method, used to determine if a FRM is required, is a statistical tool averaging the risk over a large numbers of flights which needs to be bounded. To illustrate this concern, the following graphs illustrate two different designs, having two very different temperature profiles for their fuel tank. While the average risk is the same, one of the two designs (possibly with less thermal insulation around the fuel tank) features much higher temperature on the ground and during the initial phases of flights. Hence, the energy necessary to cause a catastrophic ignition is lower in the riskier phases (systems start up, for instance). This is supported by the in-service experience: all Jet A/A-1 accidents have occurred on the ground or during the climb phase).
- In order to mitigate this high temperature effect over short time periods, EASA require limiting the temperature increase.



The Monte-Carlo method averaging out a critical area related to on ground situation with heat input into the tanks. Red line and blue line might result in same flammability exposure using FAA Monte Carlo flammability exposure model, however redline results in critical high flammability in certain ground conditions.

comment 91 comment by: *AEA*

General Comment + specific references to pages 20, 11

There are still many open questions concerning the need of a Flammability Reduction Means and the reliability and the safety of this.
Is it really secured, that the installation of a FRM will increase the safety of airplanes?

With the installation of a FRM, additional parts like oxygen sensors in the fuel tanks and modules (Turbo Compressor, Air Separation Module) close to the

	centre tank, increasing the risk for the flammability exposure (see also NPA Page 20: (4) Effects of failure of the FRM that could increase the flammability exposure of the fuel tank). The reliability of a FRM is inconsistent with the improvement of safety (Page 11: It should be noted that FRM might introduce new potentially hazardous or catastrophic failure conditions (for example: over pressurising the fuel tank, contaminating the passenger and crew compartments with nitrogen-enriched air)). It could also come to accidents with nitrogen-enriched atmospheres on ground during maintenance. In addition the arising maintenance costs per year for operators for a still instable system (FRM) are excessive. The results of the analysis are questionable with regard to these facts With these failure possibilities, the necessity of such an expensive and maintenance intensive System is than questionable.
response	*Not accepted* The introduction of a FRM system is not mandatory; it is required when a fuel tank still shows high flammability exposure despite heat and energy transfer minimisation. The FRM is an additional available layer of protection; the overall safety benefit brought by this system is indeed conditioned to the demonstration by the manufacturer that the associated new failure cases are extremely remote (for hazardous consequences) or extremely improbable (for catastrophic consequences).

comment	*92* comment by: *AEA* After having spent so much to comply with SFAR88 (retrofit but also forward fit by the OEM) it is not explainable that an expensive system as the FRM inevitably needs be added (Not only the equipment itself but also the maintenance cost which includes spare parts etc.) Therefore the European airlines question the necessity for FRMs.
response	*Not accepted* SFAR88 relates to fuel tank ignition source prevention, though FRM relates to fuel tank flammability reduction. When a tank has a high flammability it is not deemed sufficient to work only on the ignition sources prevention, because in this case a low energy source can ignite the vapours, and demonstrating the efficiency of the ignition source prevention is very difficult. Thus the solution is to prevent the flammability. The FRM is not mandatory: refer to answer to comment 91. In addition, the study of flammability reduction means contracted by EASA evaluated the efficiency of SFAR88 to 50%.

comment	*93* comment by: *AEA* By requiring the FRM, additional weight is added to each aircraft resulting in additional fuel usage, fuel cost and additional emissions with its related environmental effects. This might have further (economic) consequences with the introduction of the European system for Emissions Trading Scheme (ETS)

	by which airlines will have to pay for the CO2 emitted. In this case airlines would be force to emit more CO2 (because of the FRM system weight) with harmful environmental consequences and far reaching economic penalties.
response	*Noted* Aeroplane manufacturers are not obliged to install a FRM, refer to answer to comment 91. If the FRM is required and installed, it is true that it will induce a small increase of emissions (estimated around 0.1 %); but this increase is very low, and it is balanced by the safety benefit which will permit to avoid accident occurrences.

comment	*96* comment by: *Gulfstream Aerospace Corp* The EASA and FAA should work to a single harmonized standard such that compliance with one standard will ensure compliance with both. This NPA makes assumptions about the FAA proposed rule but since the NPA was issued the FAA final rule has been published. EASA should either ensure their proposal meets the FAA's 14 CFR Part 25 Amendment 25-125 requirements or identify those areas not harmonized and establish impact on equity and fairness.
response	*Noted* EASA and FAA have attempted to harmonise on this subject for years. Some success has been achieved, for instance regarding the criteria to certify the FRM system. It has to be recognised that some significant differences remain, particularly regarding the criteria governing the decision to introduce or not a FRM system. Please refer to response to comment 73 for more explanation on this aspect.

A. Explanatory Note - I. General p. 3

comment	*71* comment by: *DGAC France* the French DGAC has no comment on this NPA 2008-19 dated 18 July 2008
response	*Noted*

A. Explanatory Note - IV. Content of the draft decision - 1. Introduction p. 4

comment	*16* comment by: *AIR SAFETY GROUP* NPA Text: "The criteria to delineate high and low flammability exposure tanks are based upon a maximum temperature rise in any part of the tank under the most critical conditions during a 4 hours ground operation and the FAA proposed Monte Carlo statistical analysis." • It is not clear to the ASG why there needs to be two different criteria

	(temperature rise over 4 hours and the FAA Monte Carlo statistical analysis) for determining whether a tank is flammable or not. With two methods, which takes precedence - the one that predicts the lower flammability, or the higher flammability? For reasons mentioned below (see underlined section in attached letter to US DOT), the ASG would recommend avoiding any use of the Monte Carlo method for determining flammability. NPA Text: "If a fuel tank still displays high flammability exposure despite the minimisation of heat and energy transfers, the specification then requires the introduction of FRM. • Under what circumstances is it likely that tanks will be considered to be 'high flammability', after heat and energy transfers have been minimised? • Or is it really to accommodate existing configurations where, apparently, it is not possible to minimise these heat transfers? • NOTE: In the comments below, use of the word 'heated' refers to the unwanted transfer of heat from aircraft systems to the fuel tank.
response	*Not accepted* For some designs it may prove unpractical to mitigate all heat transfers, as a result of their configuration or construction. For instance, composite aircraft may, despite heat source minimisation, remain high temperature exposure as the composite wings offer lower heat transfer. Supersonic aircraft could present other challenges. EASA recognise that the judgment that best efforts have been made to minimise heat inputs can be subjective - a problem shared by all rules based upon minimisation. However, by introducing objective criteria in terms of temperature increase in the AMC and by using the Monte Carlo method should help alleviate this issue. Refer also the response provided to comment 73.

A. Explanatory Note - IV. Content of the draft decision - 2. Background - 2.1 Accident history p. 4

comment	*18* comment by: *AIR SAFETY GROUP* • In the list of accidents, the B707 accident is not relevant to this NPA, since the fuel (JP4) is hardly ever used today and has a much higher flammability. In addition as the NPA notes, lightning protection has been improved since then. • Also the DC-8 accident was the result of the separation of an engine from the wing, releasing fuel that subsequently ignited. It is doubtful that the provisions of this NPA could offer assurance that in similar circumstances, an aeroplane would land safely. • The remaining events listed are the three classic 'fuel tank explosion' accidents, caused by an ignition source within the tank, igniting fuel that was more flammable than it should be.
response	*Partially accepted* EASA concur with this comment; it shall be noted that the B707 and DC-8 accidents are quoted only for record purpose and have not really been taken

into account for determining the rulemaking action.

comment | 37 comment by: *Airbus S.A.S.*

Airbus proposes to remove the two first accidents from the table of page 5 and introduce 'A table listing the civil center tank explosions (non-maintenance related) caused by undetermined ignition sources

Justification:
The two first accidents listed in the table page 5 are not really pertinent to this EASA NPA since they were not caused by unforeseen/un-identified ignition causes within the fuel tank but by external causes which occurrence are covered by other existing CS rules (e.g. 25.954 for the lightning strike cause)

response | *Partially accepted*

EASA concurs with this comment; it shall be noted that the B707 and DC-8 accidents are quoted only for record purpose and have not really been taken into account for determining the rulemaking action.

comment | 74 comment by: *Boeing*

Page: 5
Paragraph: *2.1 Accident History*

Boeing suggests that the following two changes be made to this paragraph:

1. Delete the following sentence from the end of the second paragraph: "A further explosion occurred in May 2006 on a Boeing 727 in India."

2. Delete Table or remove accidents 1 and 2 from the table.

JUSTIFICATION:

1. The Boeing 727 event mentioned occurred during maintenance and in a wing tank.

2. The first 2 accidents noted in the Table on page 5 were wing tank events using JP-4 fuel. Boeing recommends that the accident history be consistent with the 2008 RIA working group recommendations.

response | *Accepted*

A. Explanatory Note - IV. Content of the draft decision - 2. Background - 2.2 Existing Design Principles p. 5-6

comment | 19 comment by: *AIR SAFETY GROUP*

NPA Text: "Contributing factors to these accidents were the design and certification concept that fuel tank explosions could be prevented solely by precluding all ignition sources."

- Note that for every other manufacturer of turbine powered civil

	aeroplanes, this principle has provided a good experience (no tank explosions) over the past 40 years. The ASG agrees with EASA that the real risk for 'high flammability (heated) tanks is that they are susceptible to low energy ignition sources.
response	*Noted*

A. Explanatory Note - IV. Content of the draft decision - 3. The Agency policy regarding flammability p. 7

comment	*11* comment by: *UK CAA* **Paragraph:** 3 and CS-25 Book 2 **Page:** 7 and 24 **Comment:** The AMC includes a 20°C limit for the temperature rise of a heated tank during extended ground operation. As the intent of the new rule is to minimise the temperature rise of a tank from external heating, then it is expected that any temperature rise would be significantly less than this value. **Justification:** This value would mean that a tank could become flammable if the initial temperature was above 20°C (with a fuel flash point equalling 40°C). This would include most summer period operations in any country. For periods when an FRM was inoperative this would expose the aircraft to risk of explosion, bearing in mind such conditions prevailed prior to the explosion on the TWA B747 aircraft.
response	*Not accepted* The value of 20 °C has been retained after a review of current designs; it takes into account some environmental factors (for instance solar heating). EASA concurs with the commenter that most aircraft designs will see significantly lower temperature increases. On the opposite, designs at risk will have higher values; hence, the 20 °C appears as a correct threshold.

comment	*75* comment by: *Boeing* Page: 7 Paragraph: *3. The Agency Policy regarding Flammability* Boeing suggests that the following change be made: Require heat-limiting designs only for those fuel tanks that do not require FRM to meet flammability performance regulations. **JUSTIFICATION:** Boeing agrees that the primary cause of high flammability fuel tanks is the introduction of heat and/or the lack of sufficient cooling. But reducing flammability of fuel tanks by attempting to limit heat input or cool fuel tanks within the fuselage is limited in effectiveness. Once FRM (specifically NGS) is introduced, the fuel tank is typically much lower than a conventional aluminum wing tank in flammability. The result is that the efforts to limit heat input or cool the tank no longer contribute a significant amount toward flammability reduction. (See our General Comment #1 for further details.)

response	*Not accepted* Refer to response to comment 72.

A. Explanatory Note - IV. Content of the draft decision - 3. The Agency policy regarding flammability - 3.1 Limiting heat transfer	p. 7-8

comment	*13* comment by: *UK CAA* **Paragraph:** 3 **Page:** 8 **Comment:** Page 7 has a typo "This 20 °C limitation applies if dispatch with inoperative is requested." should presumably state: "This 20 °C limitation applies if dispatch with inoperative FRM is requested".
response	*Accepted*

comment	*22* comment by: *AIR SAFETY GROUP* NPA Text: "The Agency has not set any hard figure to evaluate heat transfer. In some cases, a 20 °C limit has been found acceptable. 20 °C is the maximum allowed temperature rise ..." • This figure may need to be revised, if ever the information is released about the temperature rises on the aircraft that have had explosions.
response	*Not accepted* Refer to response to comment 11.

comment	*23* comment by: *AIR SAFETY GROUP* NPA Text: "For tanks fitted with Flammability Reduction Means (FRM), no temperature limit is set ..." • The ASG strongly disagrees with the principle that tanks with an FRM can apparently be ‘heated'.
response	*Not accepted* EASA proposed text results from a balance between the ideal case where none source of heating would be accepted and the constraints of design faced by the industry particularly in the case of the centre wing tanks.

comment	*38* comment by: *Airbus S.A.S.* In the second paragraph, Airbus proposes to replace the sentence: ‘This 20°C limitation applies if dispatch with inoperative is requested' by: ‘For fuel tanks fitted with an FRM, EASA will request applicants to check their design against this criterion if dispatch with inoperative FRM is requested' Justification: Word 'FRM' missing in the proposed text; Airbus also suggests to precise that

	the temperature rise check is not to be performed before each dispatch with an FRM inoperative.
response	*Partially accepted* The correct sentence is: "This 20 °C limitation applies if dispatch with inoperative FRM is requested". There is no intention to require a pre-flight check for each dispatch with a failed FRM; EASA believes that adding this clarification is however un-necessary as if it had been the case it could have been explicitly mentioned in the rule.

A. Explanatory Note - IV. Content of the draft decision - 3. The Agency policy regarding flammability - 3.2 Assessing the flammability exposure p. 8

comment	*14* comment by: *UK CAA* **Paragraph: 3** **Page: 8** **Comment:** The explanation of the Monte Carlo method on page 8 is not very helpful as it does not relate to its use in flammability assessment. **Justification:** There are plenty of good references to the generic MC method on the web. Either this explanation should be related to how the MC applies to flammability assessment of fuel tanks or deleted with perhaps a web reference.
response	*Not accepted* Web references are not adequate - they are not permanent. Considering the Monte Carlo methodology has raised questions and concerns, it is considered worthwhile having some basic explanation about the methodology. This certainly does not prevent readers to perform a library or web research on this method.

comment	*24* comment by: *AIR SAFETY GROUP* NPA Text: "For assessing flammability the FAA (sponsored) Monte Carlo method can be used." • The ASG has no confidence in the use of the Monte Carlo method for determining the flammability of fuel tanks. See the ASG response to the FAA Final Rule on Fuel Tank Flammability attached at the end of these comments.
response	*Not accepted* The Monte-Carlo method is considered as a valid statistical tool adapted to the issue at stake, keeping in mind that EASA has defined a temperature limitation on top of the Monte Carlo exposure. Moreover, the Monte Carlo tool has also been chosen by FAA. Defining and choosing another tool would have been difficult and the end result would have been an unnecessary burden on the industry.

comment	*76* comment by: *Boeing*
	Page: 8 Paragraph: *3.2 Assessing the flammability exposure* Boeing suggests that the following change be made: Fuel tank flammability should be limited to 3% for new designs. **JUSTIFICATION:** All tanks should meet the flammability of a conventional aluminum wing tank for new designs. The recently published FAA Fuel Tank Flammability Reduction final rule requires new designs meet 3% fleetwide. EASA and FAA rules should be harmonized.
response	*Noted* EASA has adopted the 3 % requirement for new designs as well.

A. Explanatory Note - IV. Content of the draft decision - 3. The Agency policy regarding flammability - 3.3 Mitigating flammability p. 8

comment	*77* comment by: *Boeing*
	Page: 8 Paragraph: *3.3. Mitigating flammability* Boeing suggests that the following change be made: Remove sentence not allowing dispatch inoperative, which reads: *"Such systems are simplex systems, they can be dispatched inoperative under MMEL and are therefore not acceptable as a sole means of compliance to CS 25.981."* **JUSTIFICATION:** EASA's focus should be on system performance in reducing flammability exposure. Even with MEL dispatch, the current proposed FRM (NGS) reduces the flammability exposure time of the center fuel tanks in question significantly below that of conventional unheated aluminum wing tanks. The warm day requirements of 3% for ground and takeoff/climb drive the fleet-wide exposure with FRM to below 3%. Requiring additional measures to cover for MEL dispatch of FRM only adds to the cost and weight of the overall change. Additional Heat limiting components will not reduce the overall flammability exposure on a fleet-wide basis. See our General Comment, above, for further details.
response	*Not accepted* The statement that FRM system (at least, those certified until now) are simplex and dispatch able under MMEL is factual. Hence, it is EASA position that those systems are coming only after heat and energy transfer minimisation.

A. Explanatory Note - IV. Content of the draft decision - 4. Flammability Reduction means (FRM) requirement	p. 9

comment	*39*	comment by: *Airbus S.A.S.*
	In the last sentence, Airbus proposes to replace the wording "Appendix K" with "Appendix M". Justification: Editorial comment (typographic mistake).	
response	*Accepted*	

comment	*43*	comment by: *Airbus S.A.S.*
	In the first paragraph, Airbus proposes to replace the wording 'Compressed cabin outflow air' with the wording 'Conditioned air'. Justification: Design characteristics of IGGS/NGS that are too specific to one aircraft manufacturer	
response	*Accepted*	

comment	*44*	comment by: *Airbus S.A.S.*
	In the first paragraph, Airbus proposes to remove the the last sentence: 'The FRM will also include a fuel vent system which prevents dilution of the nitrogen enriched ullage in the centre tank due to crossventing characteristics of typical existing tank vent designs'. Justification: Design characteristics of IGGS/NGS that are too specific to one aircraft manufacturer	
response	*Accepted*	

A. Explanatory Note - IV. Content of the draft decision - 5. EASA related actions	p. 9-10

comment	*25*	comment by: *AIR SAFETY GROUP*
	NPA Text: "Last but not least, the Agency is considering the issue of retrofit to the existing fleet." • In their Final Rule, the FAA confirm that there will be no Airworthiness Directives or Mandatory requirements to address the unsafe condition arising from the Boeing 737 and 747 aeroplanes that have had the fuel	

	tank explosions, except for those aeroplanes which operate on the US Register. The FAA are apparently content to protect their own aeroplanes (and passengers), but not to require the same protection to the rest of the world. The ASG considers that EASA now needs to consider retrofitting the European B 737 and 747 fleets either with FRM or some other (operational?) means to ensure that these aeroplanes do not fly with heated tanks. This point was the subject of two recent ASG letters to EASA - to Dr Lohl on 22 January 2008 and to C Probst on 15 April 2008. This is probably the most important point in the ASG's comments, since these aeroplanes continue to have the same flammability risk as the ones that have had the explosions and despite known improvements in ignition source probability, current thinking predicts that ignition sources will continue to occur.
response	*Noted* This comment addressing retrofit is not directly relevant to NPA 2008-19. This NPA is modifying CS-25 and should be applicable only to new designs. However, EASA takes this opportunity to present its position regarding aeroplanes in production and in-service fleets. Background: While there is general consensus that flammability reduction means (FRM) should be required from future designs, the issue of mandating FRM to in production aeroplanes (the so-called production cut-in) and to in service aeroplanes is more controversial, particularly the issue of retrofit. Based on a regulatory impact assessment (RIA) done in 2004, the Agency's recommended option was to require the production cut-in. Regarding retrofit action as proposed by the FAA in its NPRM (Notice of Proposed RuleMaking 2005-22997), EASA's position, expressed to the FAA, was as follows: *After a careful review of the NPRM and its justification, of the Sandia report and taking into consideration its own technical appraisal of the issue, the Agency is not in a position to conclude at this stage that systematic retrofitting of flammability reduction systems in all cases would be a proportionate mitigating measure. It considers however necessary to conduct an independent study aimed at better assessing when and how retrofit should be required.* The above-mentioned study was carried out by RGW Cherry and Associates in 2007. An EASA rulemaking group (Task 25.056 (a)) was established to review the RIA done in 2004 using the study, comments received by the FAA on its NPRM and validated cost data coming from manufacturers of aircraft or FRM. The group finalized its work in November 2008, concluding that it was not necessary to recommend additional EASA actions beyond modifying CS-25 and mandating a production cut-in. This recommendation is based on an evaluation for the European fleet of a statistical risk of 1 accident between now and 2030 and an estimation of the cost of retrofit to be around 2.8 billions Euros. However, EASA regards the above risk of accident that implies a very high probability of loss of all lives on board as critical to its decision making process. As a result EASA has determined that it will launch a rulemaking task envisaging as a preferred option mandating a production cut-in and the retrofit

to the existing fleet in a manner closely following the FAA final rules (Amendments 25-125; 26-2; 121-340; 125-55 and 129-46 reduction of fuel tank flammability in transport category airplanes dated 21 July 2008).

The new rulemaking task:

The task will anticipate on the concept of safety directive and associated CS-26 introduced by NPA 2009-01. 'Safety Directive' is a decision issued by EASA to ensure safe operation of already certificated products. It constitutes a mandatory amendment to the type certificate, supplemental type certificate, operational suitability certificate or supplemental operational suitability certificate with which individual products or operations shall conform.

The schedule for the rulemaking task is as follows:

- 'High level' meeting with Stakeholders to further explain the intentions (End-March/ early April 2009)
- NPA to be published by 2nd quarter 2009
- Safety Directive(s) and CS-26 to be adopted by 4th quarter 2010. The compliance dates mentioned above will be introduced in the safety directive (s).

The date of publication of the safety directive (s) has been planned taking into account two factors:

- Anticipated adoption by the Commission of the concept of safety directive mid-2010
- The need for EASA to take full account of the comments received on such significant issue.

EASA has no intentions to be more severe than the FAA:

- comparable compliance dates for both issues will be provided taking into account that EASA rules will be published later than the FAA ones,
- Cargo aircraft will be excluded from retrofit as well as aircraft that have received a first certificate of airworthiness before 1993.

Arguments supporting the agency's decision:

- A statistical risk of 1 accident between now and 2030 exists. This evaluation is based on a rate of 10^{-8} fuel tank explosion per flight hour which is ten times the accepted risk for a catastrophic event due to a system in CS-25.1309.
- Nature of the potential accident: it is a catastrophic one; there are no operational measures to mitigate its effects; it can be triggered by a single low energy event. In addition such events may be difficult to foresee (e.g. human factors issues)
- The incorporation of a FRM may protect from other threats (e.g. a bomb exploding close to a fuel tank),
- The decision of the FAA to mandate the retrofit on a major part of their type certificated aeroplanes will likely be followed by other countries; Europe should not appear to be lagging behind in safety standards.
- Foreign operators may use as a commercial argument the fact that they are equipped with FRM.
- Leasing companies are pushing for harmonised regulation on this issue.

Conclusion:

EASA has put in place and is further developing a comprehensive plan to address the risk of fuel tank explosion. It fully realises that the issue of retrofit of flammability reduction means to the aircraft in service as envisaged above has far reaching technical and economic consequences. EASA wishes to stress that it considers the NPA process described above as truly open and will fully consider all comments received during the process to make its final decision.

A. Explanatory Note - V. Regulatory Impact Assessment - 4. Impacts -a. All identified impacts - i. Safety p. 11

comment *63* comment by: *Airbus S.A.S.*

The accident prediction figures should be updated to reflect the current statistics. Since 2004, more flight hours have been accumulated by the worldwide fleet and no further fatal fuel tank explosion occurred. Therefore the number accident prevented by FRM introduction has decreased compared to the 2004 RIA.

Justification:
Consistency/validity of the NPA RIA uses 2008 figures for the cost evaluation. It should therefore use 2008 figures for the safety benefit as well.

response *Accepted*

The NPA was drafted before the 2008 RIA was finalised.

A. Explanatory Note - V. Regulatory Impact Assessment - 4. Impacts - a. All identified impacts - ii. Economic p. 11-12

comment *65* comment by: *Airbus S.A.S.*

At the end of the first paragraph, Airbus proposes to replace the sentence:
'Concerning future TC, the following estimates can be provided'
by
'Concerning future TC, the following 2008 estimates can be provided'

Justification:
Clarity. Clearly identify that the figures are based on latest available data, not on 2004 data.

response *Accepted*

See response to comment 63.

A. Explanatory Note - V. Regulatory Impact Assessment - 4. Impacts -a. All identified impacts - iii. Environmental p. 12

comment *26* comment by: *AIR SAFETY GROUP*

NPA Text: "It is clear that additional fuel vapour will be vented into the atmosphere as a result of the introduction of FRM but we have no evidence

	that this would have adverse effects." • What efforts have been made to look for evidence about adverse effects?
response	*Noted* No specific research was conducted. Both FAA and EASA engineering judgement is that this additional venting is negligible.

comment	*40* comment by: *Airbus S.A.S.* In the second paragraph, Airbus proposes to remove the sentence: 'After maintenance involving fuel tank entry, it is likely that some increase in APU or engine running time may be necessary to ensure FRM is fully recharge before operating the aeroplane'. Justification: There is no requirement in the rule that a tank be inert for the first flight following maintenance operation involving fuel tank entry. A non-inert flight (or portion of a flight) are factored-in within the Monte-Carlo assessment in order to show compliance with the Appendix M fleet average flammability exposure criteria and the FRM reliability criteria. Airbus considers therefore not justified EASA assertion about APU/engine ground running.
response	*Accepted*

A. Explanatory Note - V. Regulatory Impact Assessment - 4. Impacts -a. All identified impacts - v. Other aviation requirements ouside the Agency scope p. 12-13

comment	*42* comment by: *Airbus S.A.S.* In the second paragraph, Airbus proposes to replace the sentence: 'The 20 °C limits is however applicable if dispatch with the FRM inoperative is requested' by 'For fuel tanks fitted with an FRM, EASA will request applicants to check their design against this criterion if dispatch with inoperative FRM is requested' Justification: Airbus recommends to precise that the temperature rise check is not to be performed before each dispatch with an FRM inoperative
response	*Accepted*

B. Draft Decision p. 15

comment	*27* comment by: *AIR SAFETY GROUP* • Presumably, the current CS 25.981(c) and AMC 25.981(c) will be deleted in favour of the new CS 25.981(b) and AMC 25.981(b).

response	*Accepted* The current CS25.981 (c) and the associated AMC shall disappear.

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - 25.981 Fuel tank ignition prevention p. 16

comment	*46* comment by: *Airbus S.A.S.* In paragraph (b)(2)(ii), Airbus proposes to replace following sentence: 'the exposure achieved in a fuel tank within the wing of the aeroplane model being evaluated' by 'the exposure achieved in a fuel tank within the wing of the aeroplane model being evaluated whichever is greater'. Justification: Sake of clarity and harmonization with FAA amendment 25-125
response	*Partially accepted* The text will be revised to clarify taking into account this suggestion.

comment	*66* comment by: *Embraer engeneer* 25.981(b)(1) Embraer does not believe it is necessary to have both a requirement to limit heat input into the fuel tanks (paragraph (b)(1)), and a separate requirement that limits fuel tank Fleet Average Flammability Exposure to either three percent or an exposure equivalent to a equivalent conventional unheated aluminum wing (paragraph (b)(2)). The acceptable flammability limits were principally determined by comparison to unheated wing tanks that have been shown to be safe by their good service history. Embraer believes that the requirements in paragraph (b)(2) are adequate without also requiring the applicant to show that all "practicable" design precautions have been taken, and that paragraph (b)(1) should be deleted.
response	*Not accepted* Refer to response to comment 72.

comment	*67* comment by: *Embraer engeneer* 25.981(b)(2) To prevent ambiguity, it would be preferable to say ". . . not fuel tank Fleet Average Flammability Exposure level may exceed *the greater of* . . ." In addition, Embraer believes that the requirement to use the methods of Appendix N to CS 25 should be applicable only to an applicant that must show the flammability exposure level of three percent of less. Compliance with paragraph (b)(2)(ii) should be able to shown by design reviewing demonstrating equivalence to an conventional unheated wing. The last sentence in paragraph (b)(2) should be removed.

response *Accepted*

The text will be revised.

comment *78* comment by: *Boeing*

Page: 16
Paragraph: *25.981(b)(1)*

Boeing recommends limiting this requirement only to those designs that meet the flammability requirements without the addition of FRM.

JUSTIFICATION: This requirement imposes additional cost and weight in addition to an FRM, which will not improve the fleet-wide flammability exposure. (See our General Comment #1 for further details.)

response *Not accepted*

Refer to response to comments 72.

comment *79* comment by: *Boeing*

Page: 16
Paragraph: *25.981(b)(2)*

Boeing agrees with the requirement as stated.

JUSTIFICATION: EASA should retain the 3% flammability requirement as harmonized with FAA regulations. EASA should not allow up to 7% for new designs. Allowing up to 7% would allow further heat input into currently safe design practices, which would degrade fleet safety. Boeing also agrees with the allowance to use the "conventional unheated aluminum wing."

response *Noted*

comment *80* comment by: *Boeing*

Page: 16
Paragraphs: *25.981(b)(1) and (b)(2)(ii)*

Boeing requests that EASA ensure that the AMCs referenced are consistent with CS 25.981 requirements, and do not introduce additional requirements. Specifically, Boeing questions whether requiring additional 20°C restrictions on some methods of compliance, is increasing the requirements beyond that written in the rule itself.

JUSTIFICATION: AMCs should clarify requirements and provide guidance on means of compliance. AMCs should not introduce additional requirements.

response *Not accepted*

The AMC does not introduce a requirement but only gives the current EASA interpretation.

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix M - Fuel Tank Flammability Reduction Means (FRM)	p. 16

comment 29 comment by: *AIR SAFETY GROUP*

THE CONTENT OF AN AIR SAFETY GROUP LETTER TO THE US DEPARTMENT OF TRANSPORTATION IS SHOWN BELOW:

Dear Sir,

FAA Docket No. FAA-2005-22997
Reduction of Fuel Tank Flammability in Transport Category Airplanes
Air Safety Group comments on the Final Rule published on 21 July 2008.
I am writing this letter to you as the Chairman of the 'Air Safety Group' (ASG) of Great Britain. The ASG is an independent, voluntary organisation whose aim is to promote safety in civil airline operations and Fuel Tank Flammability is one of the subjects in which we have been taking an interest, in recent years. The ASG was actually founded as the result of a campaign in the early 1960s, to stop the use of wide-cut kerosene (Jet B) in transport aeroplanes. The ASG concern was that the higher vapour pressure of Jet B fuel meant that it was more likely to cause a fuel tank explosion and in particular, constituted a significantly greater risk of fire following a crash or emergency landing. It is somewhat ironic now to remember that, at the time of the Jet B debate, Jet A fuel was seen as a 'safety fuel'.

The ASG shares the general FAA concerns about fuel tank flammability, but we have widely differing views about the accident history and what needs to be done. As you know, we provided comments on the Fuel Tank Flammability NPRM and following the recent publication of the Final Rule, we have included our view of the FAA responses (see Attachment below). This letter gives our overall position on how the FAA is failing to acknowledge the most likely reason for the series of fuel tank explosions, is creating a huge economic burden for the aircraft and airline industry and yet leaves operators in the rest of the world to cope with unsafe conditions on their Boeing 737 and 747 aeroplanes.

Fuel Tank Flammability.

The Final Rule mentions 17 aeroplanes lost since 1960, as a result of fuel tank explosions. However of these 17, only three are relevant to the application of the Final Rule. The remaining 13 explosions can be attributed to the use of wide-cut fuel (more flammable than current Jet A fuel), significant external events (e.g. release of engine(s) from wings, external wing fires etc) or occurrences during maintenance. It is the ASG's view that the fuel tank explosions that need to be considered are: Philippine Airlines, B737, May 1990; TWA, B747, July 1996; Thai Airways, B737, March 2001. This is also the view of the Aviation Rulemaking Advisory Committee, mentioned in their Fuel Tank Inerting Harmonization Working Group Final Report in February 2002.

It is known that the temperature in all three of the above aeroplane's centre wing tanks was considerably higher than the ambient temperature at the time of the explosions; the additional heating occurring as a result of heat transfer from the aeroplane's air-conditioning system. Despite the fact that this Final Rule imposes some significant penalties on aeroplanes deemed by the FAA to have 'high flammability exposure', there seems to be very little science (or logic) behind it. The ASG understands that the centre fuel tank heating

experienced on the B737 and B747 is significantly higher than on any other aeroplane type. This of course is significant, since the hotter the fuel is (up to a point), the lower the ignition energy is needed to make it explode. We have seen information that shows increasing the temperature by 20ºC above the fuel Flashpoint can reduce the ignition energy needed to cause an explosion by a factor of 1000 times. It is not surprising to find that aeroplanes with this level of tank heating have had more fuel tank explosions than those with little or no heating of the tanks. It is not just Airbus aeroplanes that we are talking about; on one hand there are the three Boeing aeroplanes that have had fuel tank explosions and on the other hand there is the whole civil fleet of turbine powered aeroplanes operating over the past 40 years that have not had explosions. Unfortunately, the FAA appears to have hidden behind unsubstantiated statements about the apparent fuel tank shortcomings of the Airbus aeroplanes, in order to justify the application of the new Rule to them, but the FAA has provided NO evidence that demonstrates these aeroplanes have an equivalent level of flammability as the Boeing 737 and 747 models.
Even in the Final Rule disposition of NPRM comments, where a number of commenters have queried the FAA assumption: "That Boeing and Airbus have an equal risk of an explosion", the FAA justification is an unconvincing - "We concluded that all airplanes with HCWT (heated centre wing tanks) had similar levels of fuel tank flammability" and then lists a number of potential ignition source similarities. Where is the evidence about the 'similar flammability'? If this statement is correct, it should be justified. The whole purpose of the new Rule is to reduce fuel tank flammability; how is it acceptable to apply these new requirements to aeroplanes, for which no high flammability has been evident or demonstrated?

Now it could be seen that the above ASG position is an attempt to argue the Airbus case, but there is a much more important point that we need to make.
It is the ASG's view that the FAA has failed to recognise that heating the fuel tanks is almost certainly the most important factor in the three accidents. In their summary of the probable cause of the TWA B747 accident, the NTSB states that "heat sources located beneath the centre wing tank" is the number one (design) contributing factor. How are we sure that the FAA fails to recognise this? The clue can be found in a section of the Final Rule, titled 'Heat Sources Located in or near Fuel Tanks'. Here the FAA states: "While locating heat sources in or near fuel tanks increases the tanks' flammability, specifically prohibiting this design practice may not be the most efficient and effective way to address this problem." We find this statement to be quite extraordinary. Apparently the FAA is quite content to allow significant heat sources near tanks, even for new designs.

The ASG is pleased to see that EASA will be retaining its current position, which is to stop heat sources reaching fuel tanks and we shall be supporting EASA in applying these requirements during Validations of any new aircraft from outside the European area.

There is yet further evidence that the FAA has not recognised the main issue with fuel tank flammability from the way in which 'flammability' is to be assessed. In complying with the new Rule, applicants are required to make an evaluation to determine the fleet 'flammability exposure' for the aeroplane type. The evaluation generally takes the form of a Monte Carlo analysis that enables the average flammability exposure to be determined over a large number of representative flights. The calculation is based on the premise that any fuel tank is 'flammable' if the bulk fuel temperature is anywhere in the range from the lower flammability limit (LFL) to the upper flammability limit

(UFL) for the fuel type under evaluation. At present, this will normally be Jet A or Jet A-1. The LFL is defined as 10ºF below the fuel flashpoint and the UFL is 63.5ºF above the flashpoint. So for Jet A or Jet A-1, the LFL is 90ºF and the UFL is 163.5ºF. For the purposes of the calculation, the tank is flammable in this range, but crucially no weighting is attached to the degree of flammability across this temperature range. In reality, over this temperature range, the spark ignition energy will vary by as much as 10 000 times; at the LFL the energy required to ignite the fuel vapour will be up to 100 Joules (a very low risk); at higher temperatures, the spark energy will drop to as low as 0.01 Joule (a much higher risk). It appears that the FAA has no interest in preventing operations at the higher temperatures, where the risks of an explosion are much higher.

Under the New Rule, any 'high exposure to flammability' (above a given percentage), will require further precautions to be taken, including the possibility of a nitrogen enrichment system, to bring the flammability exposure down to an acceptable level. The ASG considers that this type of analysis (Monte Carlo) will give only the broadest indication about whether there is a risk of an explosion. It will not be able to detect whether any tanks are as flammable as those seen in the Boeing 737 or Boeing 747. Furthermore, the analysis is flawed by determining a fleet average flammability. It is the high flammability on an individual aeroplane that is the problem, not an abstract high flammability exposure for a fleet. To be rigorous, the required analysis should determine whether there is any 'exposure to high flammability' over the declared operational limits for each aeroplane and this level of exposure should be reduced to zero.
FAA New Rule.

The new basic design rule (FAR 25) requires: "... no fuel tank Fleet Average Flammability Exposure on an airplane may exceed three percent ..." and the (Monte Carlo) methodology is given. As stated above, this will, despite all the complexity of the calculation, only give a general indication of the tank flammability. It cannot be considered to be a precise means for making sure that each aeroplane doesn't operate with tanks that the FAA considers to be 'flammable'. Would the FAA consider that a 'fleet mean engine oil pressure' would be an acceptable means for making sure that engine oil pressure was within the required limits?

If the aeroplane fuel tank design has any significant heat sources, almost certainly some active system - possibly a nitrogen enriched air (NEA) generator - will be needed to counteract the adverse effects of high fuel tank temperatures. The ASG is concerned that adding new safety systems to mitigate the effects of poor initial design very rarely achieves the safest result and for aeroplanes, usually becomes a cost, weight, performance and maintenance burden for the airline operator.

The FAA has determined that an oxygen concentration of 12% is sufficiently low to provide the necessary low level of flammability although previously, oxygen levels down to 9% or even 5% have been thought necessary by other researchers. The ASG is concerned that the 12% level is set more by what can practically be achieved on an aeroplane, rather than what is required to prevent explosions. In the tests carried out by the FAA to establish the oxygen concentrations needed, reported in DOT/FAA/AR-TN02/79, we note that a relatively small tank (10 m^3) was used for the experiments. Nevertheless, a fan was used to ensure that the mixture of gases in the tank vapour space was uniform. This is good practice for testing, but the results achieved will only be relevant to tank vapour spaces having a similarly uniform mixture in the vapour spaces. Actual wing centre tanks are clearly much larger, have baffles, ribs and many other discontinuities, as well as (probably) having limited NEA entry points and tank vent exits. We have doubts that the required 12% oxygen level will be experienced in all parts of the tank, with consequent diminution of the effectiveness of the flammability reduction. If, as seems likely, the NEA system is extended to wing tanks, we do not see how the required oxygen concentration will be achieved over the whole wing span.

Application of the New Rule.

The ASG understands that the Final Rule provides for: (1) FAR 25 design rules, for all Type Certificate (inc. Supplements) applicants, (2) similar rules in FAR 26, which need to be complied with by the existing holders of (and applicants for) FAA Type Certificates (inc. Supplements) for products manufactured after 1991 (also applies to newly produced Boeing models after two years) and (3) Rules to be met by air carriers and operators of US registered aeroplanes.

However the ASG is amazed and disappointed to see that the Final Rule offers no improvement to the flammability of B737 and B747 aeroplanes operated by many airlines around the world, some of which will be operating to/from the USA carrying American citizens For the FAA to be prepared to commit the spending of huge amounts of money on its own fleet, implies that an 'unsafe condition' currently exists. In this event, the ASG understanding is that ICAO would require that the unsafe conditions for the world-wide fleet of aeroplanes should be mitigated.

It is even more surprising to see that the FAA is requiring the application of the flammability rules to Airbus aircraft (for which NO high flammability justification has been made) for US operation, when no similar application is applied to B737 and B747 aeroplanes operated in the rest of the world? Despite the FAA's (unsubstantiated) allegation 'that the risk of an explosion was equal for Boeing and Airbus airplanes, it seems indefensible not to mitigate the high flammability levels on all the Boeing aeroplane types that have already had fuel tank explosions.

Conclusions.

1. The ASG considers that the underlying flammability problem causing explosions is that fuel tanks on some Boeing aeroplanes can become too hot, with the consequence that they become susceptible to low energy ignition sources.

2. The FAA has failed to recognise this as the main flammability problem.

3. All other manufacturers of turbine powered aeroplanes have had an acceptable level of safety (no fuel tank explosions) over the past 40 years, at least partly by keeping tanks cool.

4. It appears to the ASG that by making the issue complicated and promoting the fitment of another system to compensate for poor initial design, the FAA are seeking to implicate other manufacturers with the same problem, despite offering NO evidence of equivalent flammability.

5. The ASG has doubts as to whether the nitrogen enrichment system will be as effective as the FAA expects and there will be some periods when it offers

no protection at all.

6. The FAA offers no flammability improvement for the rest of the world's Boeing 737 and 747 fleets, but ensures that the US citizen is safe, when travelling on US registered aeroplanes only.

A note on the Transmile B 727 Fuel Tank Explosion at Bangalore.

Since the publication of the Flammability NPRM, another fuel tank explosion has occurred on a Boeing 727. This has been attributed to arcing of the electrical power supply to the fuel pump, which burned through the protective aluminium conduit, creating an ignition source within the tank. In this case, flammability has not been implicated, but it does highlight another design deficiency in a number of Boeing aeroplane types. Unlike most other aeroplanes, the high-power electrical supply for the fuel pump passes through the fuel tanks in a conduit (believed to be usually Aluminium). Normally electrical circuits within fuel tanks are limited to a maximum of 200 micro Joules (intrinsically safe), but on some Boeing aeroplanes much higher electrical energies have been permitted, by using a conduit, through which the wires pass. This event shows that this is not a safe practice. We note that the FAA is introducing a requirement for Ground Fault Interrupters (GFI) to prevent repetition of this type of fuel tank ignition; this event may hasten the fitment of GFI's to all relevant models.

We hope that you will forgive the frank comments expressed in this letter, but these are matters that we consider are not being properly acknowledged and corrected, with a very real danger that good design practice will be ignored for the sake of expediency.

Yours faithfully

Captain Russell Williams FRAeS
Chairman, Air Safety Group
c.c. EASA, CAA, NTSB, AAIB, ICAO

Attachment to ASG letter to the FAA, dated 19 August 2008

ASG VIEW OF THE FAA RESPONSES TO THE FUEL TANK FLAMMABILITY NPRM

ASG COMMENT 1: The FAA has over-emphasised the frequency of fuel tank explosion events. The preamble to the Final Rule should be changed to reflect accurately only those accidents, for which application of the provisions of this NPRM can be expected to prevent in the future. Any Cost/Benefit analysis should also be amended.

FAA RESPONSE: In the light of comments received, the FAA has made a small alteration in the "historical accident rate for heated centre wing tank airplanes" from 1 accident per 60 million hours of flight to 1 accident in 100 million hours of flight, but they consider that this rate continues to support the need for the new rule.

ASG VIEW: The FAA appears to be content to include accidents, where the initiating event does not relate to fuel tank flammability (external fires, penetration of the tank, crash landing etc) or where the event does not relate to current design or operation (plastic fuel tank access covers susceptible to lightning strikes, use of wide-cut fuel etc.). FAA position still not acceptable to ASG.

ASG COMMENT 2: The ES [Executive Summary of the NPRM] gives the false impression that design considerations to reduce the presence of flammable vapours was a new concept when this is definitely not true.

FAA RESPONSE: The FAA does not appear to have provided any response to this ASG point.
ASG VIEW: FAR 25,967 has required for many years that fuel tank external surfaces must be ventilated to prevent fume accumulation. Better attention to this requirement would also prevent excessive heat transfer to the tank. FAR 25.981 Fuel tank ignition prevention. This requirement has required that the fuel temperature must be shown to not exceed the 'auto-ignition' temperature.
These two requirements show that fuel tanks should not be heated.

ASG COMMENT 3: If the NPRM is not intended to address terrorist action, there should be no mention of possible benefits, nor should there be any credit taken for explosion prevention in the current NPRM. Note: ASG is not credited with making this comment, but the FAA responded to the similar comment from ATA and FedEx.

FAA RESPONSE: "ATA and FedEx objected to the FAA's including the Avianca 727 accident in its justification of this rule. They stated that this accident, which resulted from a small bomb placed above the center wing fuel tank on the previous flight, would not have been prevented by the requirements of this rule." However the FAA does not acknowledge their error, but does conclude that: "Based upon the comments received and our review of historical evidence, we have not quantified any potential benefits from an FRM (Flammability Reduction Means) system preventing a fuel tank explosion caused by a terrorist missile or an on-board bomb."

ASG VIEW: Acceptable response.

ASG COMMENT 4: This footnote - 'explanation' as to why there have not been any fuel tank explosions to Airbus aircraft - should be removed, unless supporting evidence can be produced and validated by an independent body.

FAA RESPONSE: The FAA continues to contend that the probability of an explosion to a Heated Centre Wing Tank (HCWT) is the same for both Boeing and Airbus types, "based on similarities in their fuel tank designs and service history." The FAA cites the design similarities as: air conditioning systems below the center wing tank, use of capacitance fuel gauging systems in the tanks, use of high-energy fuel pumps in the tanks.
For service history, the FAA mentions "As for the service history and design reviews of Airbus airplanes, we found numerous situations that indicate a risk of an explosion similar to those aboard Boeing airplanes, including:

- The electrical bonding straps used on Airbus airplanes have been reported to degrade due to corrosion; the bonding jumpers used by Boeing are made of a different material that does not corrode.
- All fuel pumps on Boeing airplanes are being modified to incorporate ground fault power interrupters, whereas only pumps that can arc directly into the fuel tank ullage are being modified to incorporate ground fault power interrupters on Airbus airplanes.
- The safety assessments conducted by both manufacturers resulted in

very similar numbers of ignition sources that required modifications to their airplanes."

ASG VIEW: The FAA does NOT mention that the Airbus aeroplanes have features to minimize heat transfer to the fuel tanks, which results in significantly lower tank temperatures, nor does the FAA mention that the Boeing fuel pump wires run INSIDE the fuel tanks and in fault conditions, can result in a high-energy ignition source, as evidenced on the Boeing 727 accident at Bangalore in May 2006 (see Attachment 2). These two differences are almost certainly at the heart of the fuel tank explosion accidents, which have already occurred. ASG reject the FAA response.

ASG COMMENT 5: THE FAA HAS FAILED IN THIS NPRM TO ADDRESS THE FUNDAMENTAL PROBLEM OF HIGH FUEL TANK TEMPERATURES. RWB Note: The comment was in capitals, because the FAA has not acknowledged that heating the fuel tanks to temperatures above the flash point makes them very susceptible to even very low energy ignition sources.

FAA RESPONSE: In their Final Rule, the FAA has confirmed that they still have not accepted the above point. This is the text of their reply:
"Transport Canada and the UK Air Safety Group suggested we prohibit the placement of heat sources within or near fuel tanks. Transport Canada questioned why we would allow such an undesirable design practice to continue. The UK Air Safety Group contended the NPRM failed to address the contribution of high fuel tank temperature to fuel tank explosions. The commenter noted that the Boeing 737 and 747 have air conditioning units that raise the fuel tanks' temperature well above the outside ambient temperature because these units are located beneath the center fuel tanks. We agree with the commenters' underlying concern about controlling fuel tank temperature. While locating heat sources in or near fuel tanks increases the tanks' flammability, specifically prohibiting this design practice may not be the most efficient and effective way to address the problem. This rule is performance-based and is seeking innovative design solutions which could permit locating heat sources near or in fuel tanks. For example, designers may wish to develop an FRM based upon managing the fuel tank temperature by transferring heat between tanks. These designs may provide flammability exposures well below that of a tank that complied with the proposal made by the commenters. Risk is directly proportionate to the flammability exposure of a tank. Therefore, we have developed a flammability performance standard that is independent of the design details of a tank installation."
In their response, the FAA now say that they agree with the concern, but consider that there may be more efficient and effective ways to address the problem! And their prime ‘more efficient and effective way' is a nitrogen enrichment system that, by design, will not be operational all the time.
And they still have not acknowledged that there is a fundamental problem with the way in which they assess flammability exposure, where no account has to be taken to prevent operation at the highest flammability levels and by using a fleet averaging method of calculation, aeroplanes operating in colder climates apparently ‘reduce' the flammability exposure of those operating in hotter climates.

ASG VIEW: It is difficult to comprehend how any informed position could conclude that it is acceptable to continue to allow fuel tanks to be significantly heated by aeroplane systems. However, with B737 and B747 developments still being proposed, commercial considerations may be being taken into account. The highlighted sentence in the FAA response is breathtaking in its disregard for fuel tank safety. ASG reject the FAA response.

ASG COMMENT 6: Have estimates about the likely increase in hydro-carbon emissions been given to the Environmental Authorities (EPA etc) and what are their responses?

FAA RESPONSE: The FAA determined that the increased release of hydrocarbons will be negligible. This is based upon tests with a B737, equipped with a nitrogen based flammability reduction means (FRM). The fuel tank venting system on the B737 is cross-connected to vent outlets at both wing tips so that there is a constant flow of air through the vent system, which results in a release of fuel vapours. For the FRM to operate efficiently, the cross flow of air is prevented and thus compensates for the hydrocarbon release caused by the FRM system.

ASG VIEW: Point noted for the B737, but for any tank configuration having an independent vent, fitting an FRM will increase hydrocarbon emissions. ASG await further test results and/or measurements.

ASG COMMENT 7: How does the FAA justify not regulating aircraft with less than 30 seats against this potential hazard?

FAA RESPONSE: The new FAR 25 design requirements will apply to all new designs, regardless of size, but on the basis that "because those [smaller] airplanes generally do not have high flammability tanks.", the FAA did not include them in the Design Approval Holder requirements.

ASG VIEW: Acceptable response.

ASG COMMENT 8.1: Why do the FAA not consider that the EASA fuel tank flammability requirement (CS 25.981) is sufficient to control the flammability concerns for new aircraft design? Why have the demonstrated flammability short-falls in the Boeing 737 and 747 (and possibly other Boeing models) not been mitigated by AD action, in the normal way?

FAA RESPONSE: The FAA does not appear to have recognised our questions in 8.1, but noted the following: "BAE and two individuals suggested that we address fuel tank flammability by issuing ADs to address specific design shortfalls in the two airplane types that have experienced fuel tank explosions (i.e., the Boeing 737 and 747 series airplanes)." However, this question also was not answered; instead, the FAA gives the unsubstantiated statement that the risk of an explosion was the same for Airbus as for Boeing.

ASG VIEW: ASG find that the FAA did not answer the question about the design shortfalls in the Boeing aeroplanes.

ASG COMMENT 8.2: What assistance is the FAA planning to give the Industry to help them with compliance issues? NOTE: A flow chart should be provided in the preamble to the Final Rule to give some overall guidance.

	FAA POSITION: Commenters to the NPRM had made a number of requests for clarification on compliance issues and the FAA has made a number of helpful changes and clarifications in the Final Rule document, which should assist Applicants. ASG VIEW: Acceptable response. ASG COMMENT 9 The cost/benefit analysis should be revised to take a more realistic account of the additional operational costs. FAA RESPONSE: The FAA note that Boeing's comments include revised estimates for these costs and they are now included in the final regulatory evaluation. ASG VIEW: Acceptable response. ASG COMMENT: In his Paper, included as a part of the ASG comment, Frank Taylor asks whether the use of JP-5 (a high Flash Point fuel) could be envisaged as a means to improve safety. FAA RESPONSE: The FAA stated that they welcome the potential use of any flammability reduction means, but noted that such fuels may be more expensive and if adopted could delay the implementation of the new rule. However, if these fuels ever become readily available, this could be an acceptable means of compliance. ASG VIEW: Acceptable response. ASG COMMENT: Another of Frank Taylor's points was that, given the extremely low frequency of fuel tank explosion events, any modification must not introduce additional failure conditions that could have an adverse safety benefit. FAA RESPONSE: The FAA note the concern and claim to have introduced new requirements, which together with the existing airworthiness standards, should avoid this possibility. However, as seen with the Transmile explosion, their track record is not good at correcting these basic bad designs. ASG VIEW: Only time will tell.
response	*Noted* EASA has noted this letter addressed to US DOT. It addresses the whole issue of fuel tank safety and goes beyond the NPA 2008-19 which addresses only CS-25. EASA takes this opportunity to outline its general strategy on fuel tank safety: • EASA has addressed the issue of ignition by modifying CS-25 and publishing Airworthiness Directives for aeroplanes in service. • EASA, as a follow up of this NPA, will modify CS-25 to address FRM on future aeroplane designs. • Concerning production and in-service aeroplanes, EASA will launch a Rulemaking task envisaging as a preferred option mandating a production cut-in and the retrofit to the existing fleet in a manner

closely following the FAA final rules (Amendments 25-125; 26-2; 121-340; 125-55 and 129-46 reduction of fuel tank flammability in transport category airplanes dated 21 July 2008).

Please refer to EASA response to comment 25 for more details.

comment *81* comment by: *Boeing*

Page: 16-17
Paragraph: *M25.1(b), M25.1(b)(2)*

Boeing requests that EASA combine takeoff and climb into one phase (takeoff/climb), or just climb, where the phase begins when the wheels lift off the runway.

JUSTIFICATION: The FAA Fuel Tank Flammability Reduction final rule has been revised to combine takeoff and climb into one phase. The FAA and EASA Special Conditions/CRIs consistently combine these phases.

response *Accepted*

The text will be modified accordingly; it shall be noted that the FAA final rule was not available when the NPA 2008-19 was drafted.

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix M - Fuel Tank Flammability Reduction Means (FRM) - M25.1 Fuel Tank Flammability exposure requirements p. 16-17

comment *47* comment by: *Airbus S.A.S.*

- In sub-paragraph M25.1(b), Airbus proposes to change the wording:

'the fleet average flammability exposure as defined in appendix N of this part, of each fuel tank for ground, takeoff and climb phases of flight during warm days [...]'
to read:
'the fleet average flammability exposure as defined in appendix N of this part, of each fuel tank for ground and takeoff/climb phases of flight during warm days [...]';

- In sub-paragraph M25.1(b)(2), to change wording

'For the ground, takeoff, and climb phases of flight, the average flammability exposure [...]'
to read:
'For the ground and takeoff/climb phases of flight, the average flammability exposure [...]'

Justification:
Harmonization with FAA amendment 25-125. Airbus supports Boeing comment made to the FAA NPRM and accepted by FAA. Refer to Section F.2 of the FAA final rule preamble, page 42466

response *Accepted*

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix M - Fuel Tank Flammability Reduction Means (FRM) - M25.2 Showing compliance p. 17

comment	*31*	comment by: *Walter Gessky*
	M25.2 (a) (1) Please verify if the reference to paragraph K25.1 is correct.	
response	*Accepted* The correct reference is M25.1	

comment	*32*	comment by: *Walter Gessky*
	M.2(c)(2) add the following: (2) Identify critical features of the fuel tank system to prevent an auxiliary fuel tank installation from increasing the flammability exposure of main tanks above that permitted under paragraphs 1.3(a)(1), (2) and (b) of this appendix and to prevent degradation of the performance and reliability of the **Nitrogen Generating System** (NGS). **Justification:** When abbreviations are used in the text, the first time the full text should be used.	
response	*Partially accepted* NGS is replaced by FRM which is more neutral.	

comment	*48*	comment by: *Airbus S.A.S.*
	In sub-paragraph M25.2(a)(1), Airbus proposes to replace the wording 'paragraph K25.1' by ‘paragraph M25.1' Justification: Editorial comment (typographic mistake).	
response	*Accepted* The correct reference is M25.1.	

comment	*49*	comment by: *Airbus S.A.S.*
	Airbus proposes to: • Remove paragraphs M25.2(c)(1) and M25.2(d); • Move paragraph M25(c)(2) to M25(a)(4) to read as follows: ‘Identify critical features of the fuel tank system to prevent an auxiliary fuel tank installation from increasing the flammability exposure of a main tank equipped with an FRM above that permitted under paragraph M25.1(a)	

	& (b) of this appendix' Justification: The considerations of paragraphs M25.2(c)(1) & (d) are covered by CS 25.901(c) and CS 25.1309. § M25.1(c)(2) was wrongly placed. The requirement is not for an FRM failure analysis but more for a verification that specific fuel systems configurations will not impair the performance of an FRM.
response	*Partially accepted* The content of paragraphs M25.2(c)(1) and M25.2(d) are maintained, but the structure of M25 is revised. Reminding the safety assessment requirement can be useful for instance in the context of a derivative certification. EASA accepts to move M25(c)(2) to M25(a)(4).

comment	*82* comment by: *Boeing* Page: 17 Paragraph: *M25.2(a)(3)* Boeing recommends this paragraph be deleted as it is unnecessary. **<u>JUSTIFICATION</u>:** Manufacturers are already required to supply System Description documents that describe system function. There is no relationship here with data, analysis, or ground and flight testing.
response	*Not accepted* EASA prefers to keep a harmonised text.

comment	*83* comment by: *Boeing* Page: 17 Paragraph: *M25.2(b)* Boeing requests that EASA either: 1 . Revise this paragraph to read the same as the equivalent paragraph in the FAA Fuel Tank Flammability Reduction final rule, as follows: *"The applicant must validate that the FRM meets the requirements of paragraph M25.1 of this appendix with any airplane or engine configuration affecting the performance of the FRM for which approval is sought."* **Or** 2. Delete the term "fuel type" from the proposed sentence. **<u>JUSTIFICATION</u>:** Boeing requests that EASA harmonize with the parallel FAA rule to the extent possible. Adopting the same language is ideal and will result in an FRM that meets the intent. Removing the term "fuel type" from the regulation will also meet the intent. The Monte Carlo analysis of fuel tank flammability is based on an average risk approach. Given that Jet A/A1 fuel is the predominant fuel type by far, there is no need to analyze or design the FRM to comply with other fuel types. Those fuel types are not used enough to justify the effort.

response	*Accepted* The text will be modified in accordance with the FAA sentence.

comment	*84* comment by: *Boeing* Page: 17 Paragraph: *M25.2(c)* Boeing recommends deleting paragraph M25.2(c) in its entirety. **JUSTIFICATION:** These requirements are covered by 14 CFR/CS 25.1309 and 25.979. There is no need to duplicate those regulations with this new rulemaking. The FAA Fuel Flammability Reduction final rule does not include this requirement. Boeing requests EASA minimize or eliminate all differences between CS and 14 CFR requirements.
response	*Not accepted* As pointed out by the commenter, this requirement shall not be a burden on applicants, because it is a basic reminder of other applicable rule. EASA considers this reminder has some benefit and it shall remain. Refer also to response to comment 49.

comment	*85* comment by: *Boeing* Page: 17 Paragraph: *M25.2(d)* Boeing recommends deleting paragraph M25.2(d) in its entirety. **JUSTIFICATION:** This requirement is covered by 14 CFR/CS 25.863. The FAA Fuel Tank Flammability Reduction final rule does not include this requirement. Boeing requests EASA minimize or eliminate all differences between CS and 14 CFR requirements to the extent possible.
response	*Not accepted* Historically, compliance to 25.863 has focussed on flammable fluid/vapour drainage and ventilation; addressing oxygen has not been part of compliance finding to 25.863. Hence, EASA considers there is some benefit in pointing out to the FRM system designers the risk associated with oxygen.

comment	*97* comment by: *Gulfstream Aerospace Corp* Page 17, M25.2 Showing compliance (a)(1): validate the parameters used in the analysis required by paragraph K25.1. It is believed that this is a typo. Please clarify if K25.1 should be M25.1.
response	*Accepted* The typo in page 17 has been corrected (M25.1 instead of K25.1).

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix M - Fuel Tank Flammability Reduction Means (FRM) - M25.3 Reliability indications and maintenance acceess p. 17

comment	*50*	comment by: *Airbus S.A.S.*
	In paragraph M25.3(a), Airbus suggests to change the wording 'reliability indications must be provided to identify latent failures of the FRM' to read: 'reliability indications must be provided as necessary to identify FRM failures which latency would otherwise prevent to meet the fleet average flammability exposure requirements listed in paragraph M25.1 of this appendix' Justification: The ultimate objective is to design a Flammability Reduction Means that meets the performance criteria of Appendix M. Those criteria may be met considering failure indications or maintenance checks or high inherent reliability. Failure indications are not mandatory, the applicant should have the possibility to use other means to limit latency of failures if necessary to meet the performance and reliability criteria	
response	*Partially accepted* The comment is taken into account but EASA will use the FAA text which is very close to Airbus proposal.	

comment	*68*	comment by: *Embraer engeneer*
	<u>M25.3 Reliability indications and maintenance access</u> The proposed M25.3(a) requires reliability indications to identify latent failures of the FRM system. A literal interpretation of this requirement would require any latent failure to be detected and indicated even though the preamble correctly states that the designer is allowed to make a trade-off between system failure probability and failure detection/annunciation to show compliance with the system performance requirements. Because the requirement for failure detection is inherent in the flammability exposure requirement, and in the 1.8 percent limit on system failure contribution to flammability exposure, M25.3(a) is already addressed and should not be repeated here. Similarly any failure detection/annunciation means would not be effective in limiting latent failures if the appropriate flight or maintenance crew does not have access to the failure indication. Therefore, M25.3(b) should be deleted also. FAA made a similar modification to Amendment 25-125.	
response	*Not accepted* M25.3 (a) and (b) are maintained and M25.3(a) is revised to follow the FAA text.	

comment	*86*	comment by: *Boeing*
	Page: 17 Paragraph: *M25.3(a)*	

Boeing recommends either:

1. Deleting paragraph M25.3(a) in its entirety;

or

2. Rewording the paragraph to read as follows: *"Maintenance actions must be incorporated to address latent failures in order to meet the requirements of M25.1(a)."*

JUSTIFICATION: Latent failures are those failures that are not indicated. Once a failure is indicated, the failure is no longer latent. The requirements of paragraph M25.1(a) of the NPA, requiring the inoperative time of the FRM not to cause flammability exposure exceeding 1.8%, drives inspections for latent failures to limit their latency. There is no need, nor is it even possible, to design indications that can detect all failures.

response *Not accepted*

M25.3(a) is maintained and harmonised with FAA text.

comment *87* comment by: *Boeing*

Page: 17
Paragraph: *M25.3(c)*

Boeing suggests revising paragraph M25.3(c) as follows, or allow appropriate wording:

"***Adjacent to*** the access doors and panels to the fuel tanks ..."

JUSTIFICATION: We do not consider it appropriate to require the warning to be placed on the removed panel, thus leaving the access open with no warning.

response *Partially accepted*

The wording of M25.3(c) has been revised taking into account this principle that the warning shall be permanently visible.

comment *98* comment by: *Gulfstream Aerospace Corp*

Page 17, M25.3 Reliability indications and maintenance access (a):
Requirement
states Reliability indications must be provided to identify latent failures of the FRM.

Clarification should be provided; if the failure is indicated it is not latent.
Gulfstream recommends that rewording similar to the FAA's 14 CFR Part 25 M25.3(a) should be utilized. I.e. "Reliability indications must be provided to identify
failures of the FRM that would otherwise be latent and whose identification is necessary to ensure the fuel tank with an FRM meets the fleet average flammability
exposure requirements listed in paragraph M25.1 of this appendix, including when
the FRM is inoperative."

response	*Accepted* EASA accept to use the FAA wording and will update the text.

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix M - Fuel Tank Flammability Reduction Means (FRM) - M25.4 Airworthiness limitations and procedures	p. 18

comment	*69* comment by: *Embraer engeneer* <u>M25.4 Airworthiness Limitations and Procedures</u> While Embraer does not disagree with anything in the introductory paragraph of this section, it is a description of the relationship between the system safety analysis and the associated maintenance program rather than a separate requirement. It would be more appropriate as an acceptable means of compliance rather than a regulation
response	*Noted* In the absence of a disagreement from the commenter, EASA takes the occasion to remind a basic principle. Questions were already raised during FRM certification regarding the ICA (Instructions for Continuing Airworthiness) establishment. The proposed text intends to clarify this matter.

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix N - Fuel Tank Flammability Exposure - N25.1 General	p. 18

comment	*33* comment by: *Walter Gessky* **N25.1 (a)** Please verify if the reference to paragraph L25.1 is correct
response	*Accepted* The correct reference is AMC to Appendix N, N25.1(a) (new paragraph N25.1(b) created).

comment	*51* comment by: *Airbus S.A.S.* In Paragraph N25.1(a), Airbus proposes to move the 'aeroplane descent rate' from the list of parameters that affect all aeroplanes in the fleet to the factors that are specific to the aeroplane model being evaluated. Justification: Airlines will fly their aircraft in accordance with the capabilities of the aircraft. In some instances, Airbus established that the profiles defined by the FAA in the Fuel Tank Flammability Assessment Method Users Manual are outside of the operational envelope of the aircraft and performance data could not be obtained to determine fuel consumption. Airlines normally operate the aircraft with the objective to reach the highest altitude as quickly as possible for economic reasons. The resulting flight profiles do not match those mandated in the FTFM users manual. It is unclear to Airbus how these latter have been determined. Therefore Airbus proposes that manufactures be permitted to use

	profiles that are specific to their aircraft types as defined in the AFM - Comment also valid for Appendix N25.3 (b) & (c)
response	*Accepted* EASA will accept that the manufacturers use the descent rate published in the AFM.

comment	*52* comment by: *Airbus S.A.S.* At the end of paragraph N25.1(a), Airbus proposes to replace the wording: '(see AMC to appendix L25.1)' by: '(See AMC to appendix N25.1(a))' Justification: Editorial comment (typographic mistake).
response	*Accepted*

comment	*53* comment by: *Airbus S.A.S.* Airbus proposes to add a paragraph N25.1(b) to read: 'For fuel tanks installed in aluminum wings, a qualitative assessment is sufficient if it substantiates that the tank is a conventional unheated aluminum wing tank (see AMC to Appendix N25.1(b))' Justification: The new CS25 rule should give the flexibility to applicants to not being compelled to perform a numerical Monte-Carlo flammability analysis in certain cases.
response	*Accepted*

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix N - Fuel Tank Flammability Exposure - N25.2 Definitions p. 18-19

comment	*1* comment by: *Francis Fagegaltier Services* There is a definition of "hazardous atmosphere" in N25.2 (g). (1) This wording is only used in M25.3 (c), in relation to access doors to fuel tanks. But, its definition refers also to risk for passengers. It would be difficult to imagine passengers entering fuel tanks : could the Agency explain why there is reference to passengers in the definition ? (2) In CS-E 510 (g)(2)(ii), one hazardous engine effect is defined as "Concentration of toxic products in the Engine bleed air for the cabin sufficient to incapacitate crew or passengers". The issue for demonstrating compliance with CS-E is that there is no general definition of "toxic products" and no published values for the concentration "sufficient to incapacitate crew or

	passengers". May be nowadays there is new information available on this subject. In relation to the N25.2 definition of hazardous atmosphere, has the Agency determined the constituants and concentration which would create a risk of death, incapacitation, impairment of ability to self-rescue, injury or acute illness ? This might be useful for interpreting CS-E as well as CS-25.
response	*Not accepted* (1) As mentioned in the NPA chapter A.V.4.a.i, Flammability Reduction Means might introduce new potentially hazardous or catastrophic failure conditions, for example contaminating the passenger and crew compartments with nitrogen enriched air. For this reason, the passengers are mentioned in the definition of a "hazardous atmosphere". Note: Appendix N to FAR Part 25 uses the same N25.2 (g) definition. (2) No new limit has been identified for toxic products. Besides, N25.2 (g) purpose is the concentration of inert gas such as Nitrogen, which is not an issue for compliance to CS-E 510 (g) (2) (ii).

comment	*54* comment by: *Airbus S.A.S.* In paragraph N25.2(b), Airbus proposes to replace the wording '(Table 3)' by '(Table 2)' Justification: Editorial comment (typographic mistake).
response	*Accepted*

comment	*55* comment by: *Airbus S.A.S.* In paragraph N25.2 a definition for Oxygen evolution should be provided. Airbus suggests to use the definition included in the FAA final rule (Appendix N to FAR 25 at amendment 125) Justification: Sake of clarity and harmonization with FAA
response	*Accepted*

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix N - Fuel Tank Flammability Exposure - N25.3 Fuel tank flammability exposure analysis p. 19-21

comment	*4* comment by: *Air France - Maintenance Quality Assurance* (c)(5). Last sentence: read "Input values for **this** data must be..." in lieu of "these data"
response	*Accepted*

	Note: The remark is correct: "this" should be used instead of "these". However the FAA text shows "these".

comment	*10* comment by: *EADS CASA* Appendix N25.3 Fuel Tank falmmability exposure analysis subparagraph (a) This paragraph should be aligned with FAA policy (Appendix N25.1 (a) - FAA rule) to establish that "For fuel tanks installed in aluminum wings, a qualitative assessment is sufficient if it substantiates that the tank is a conventional unheated wing tank"
response	*Accepted* The text will be modified accordingly. The new text is introduced as a new paragraph N25.1 (b).

comment	*34* comment by: *Walter Gessky* **N25.3(c) (2) last sentence** The reference to "**or the approved FAA fuel management procedures"** should be deleted. Add the following AMC to N25(c)(2) CS-25 Book 2:: **The FAA approved fuel management procedures contained in FAA document ....,** **are an acceptable means of compliance to Appendix N25.3 (c) (2).** **Justification:** EU rules should not include a direct reference to third country rules procedures, because there is no direct influence to the content of this rules or procedures. It is recommended to add an AMC to N25.3(c)(2), but a FAA document number where the procedures are published should be mentioned. Third country documents or procedures referenced in a CS or AMC should be officially published in the third country system. Third country documents or procedures not officially published should not be referenced in a CS or AMC.
response	*Accepted* This is a typo. It should be read "EASA approved fuel management procedures."

comment	*35* comment by: *Walter Gessky* **N25.3(d)(5)** The oxygen evolution rate that must be used is defined in the **users' manual.** **Comment:** It should be clarified in what kind of Manual the oxygen evolution rate has to be defined? (Flight Manual (Supplement), Installation Manual/Instructions, ICA....?)
response	*Accepted* The reference is made to FAA document "Fuel Tank Flammability Assessment Method User's Manual, dated May 2008, document number DOT/FAA/AR-05/8.

comment	*56* comment by: *Airbus S.A.S.* In paragraph N25.3, Airbus suggests following changes: • - § 25.3(a): remove the reference to AMC N25.3(a); • - § 25.3(b): remove item (5); • - § 25.3(c): add a new item (6) to read: 'Aeroplane climb & descent profiles in accordance with the aircraft performance data documented in the Aircraft Flight Manual '; • § 25.3(c)(2): replace the sentence: 'Input values for this data must be obtained from ground and flight test data or the approved FAA fuel management procedure' by the sentence: 'Input values for this data must be in accordance with the approved fuel management procedures for the aircraft model being evaluated' Justification: Airlines will fly their aircraft in accordance with the capabilities of the aircraft. In some instances, Airbus established that the profiles defined by the FAA in the Fuel Tank Flammability Assessment Method Users Manual are outside of the operational envelope of the aircraft and performance data could not be obtained to determine fuel consumption. Airlines normally operate the aircraft with the objective to reach the highest altitude as quickly as possible for economic reasons. The resulting flight profiles do not match those mandated in the FTFM users manual. It is unclear to Airbus how these latter have been determined. Therefore Airbus proposes that manufactures be permitted to use profiles that are specific to their aircraft types as defined in the AFM. Fuel management procedures should not be restricted to the FAA one. In addition, some aircraft may have automatic tank transfer procedures. Airbus therefore believe that the EASA rule wording should give more flexibility than the proposed text. In addition, Airbus consider that it is very difficult to determine the fuel tank quantity input through flight test.
response	*Partially accepted* The first three bullets proposals are accepted. The N25.3(c) new item (Aeroplane climb and descent profile) is added as (8). Concerning the proposal in the fourth bullet about N25.3(c)(2) sentence, FAA is replaced by EASA, the rest remains unchanged and harmonised.

comment	*57* comment by: *Airbus S.A.S.* In paragraph 25.3(c), Airbus suggests to add a new item (7) to read: 'Airplane Utilization. The applicant must provide data supporting the number of flights per day and the number of hours per flight for the specific airplane model under evaluation. If there is no existing airplane fleet data to support the airplane being evaluated, the applicant must provide substantiation that the number of flights per day and the number of hours per flight for that airplane model is consistent with the existing fleet data they propose to use.' Justification: Harmonization with FAA final rule Appendix N at Amendment 25-125
response	*Accepted*

comment	88 comment by: *Boeing*
	Page: 20 Paragraph: *N25.3(b)(5)* Boeing requests that EASA allow the use of substantiated operational data, as is allowed in the harmonized FAA and EASA Special Conditions/CRIs on this subject. **JUSTIFICATION:** The harmonized FAA and EASA Special Conditions/CRIs allow the applicant to propose and substantiate alternative data for descent rates. The application of the Monte Carlo analysis as an average risk assessment is consistent with the use of distributions of parameters such as descent rate. The descent rate provided in the FAA model is faster than all but the very fastest descent rates. The rate actually exceeds FAA speed limit at times during descent. The rate was selected arbitrarily early in the FAA's research into inerting systems, and has no basis in reality. The application of the proposed descent rate will increase the cost and weight of an FRM without providing any additional benefit. In addition, the application of the FAA descent rate may result in FRM designs that can show compliance with the rule, but do not actually meet the intent. The FRM may be optimized for a descent rate that is not real, and therefore, would not function optimally under real circumstances.
response	*Accepted* The N25.3(b)(5) is moved to N25.3(c) in the list of parameters specific to the aeroplane model.

comment	89 comment by: *Boeing*
	Page: 20 Paragraph: *N25.3(c)* Boeing requests that EASA incorporate the appropriate paragraph regarding aircraft utilization (flights per day, hours per flight) from the FAA Fuel Tank Flammability Reduction final rule. **JUSTIFICATION:** The Monte Carlo model must be based on expected aircraft utilization (hours per flight, flights per day). For new designs, utilization can be predicted based on the model being replaced.
response	*Accepted*

comment	94 comment by: *Transport Canada Civil Aviation Standards Branch*
	Upon reviewing EASA NPA 2008-19 - "Fuel Tank Flammability Reduction", Transport Canada Civil Aviation would like to submit the following comment regarding Page 20, Appendix N, paragraph N25.3(c)(2) - " Under Appendix N, paragraph N25.3(c)(2) on page 20 of the NPA, reference

	was made to the approved FAA fuel management procedures. It is believed that reference should be made to approved fuel management procedures of the Agency instead. A similar comment is that AMC 21A.3(b) on page 26 of the NPA required providing a report to the FAA every six months... It is believed that the report should be provided to the Agency instead."
response	*Accepted*

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix N - Fuel Tank Flammability Exposure - N25.4 Variables and data tables p. 21

comment	*15* comment by: *UK CAA* **Paragraph:** N 25.4 **Page:** 21 **Comment:** The MC input data for fuel only includes Jet-A. **Justification:** Jet-A is only used in the USA. Jet A-1 should be referenced and it may also be useful to include some advice about at least partial use of Russian TS-1 fuel.
response	*Partially accepted* Jet A and Jet A-1 have similar characteristics, from a flammability point of view. Jet A-1 reference is added to N25.4(a)(3). Taking into account "regional" fuels may introduce the need for applicants to predict their market share in a given market. The assessment will be more complex without any added value.

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 1 - Appendix N - Fuel Tank Flammability Exposure - N25.4 Variables and data tables - Table 1. p. 22

comment	*5* comment by: *Air France - Maintenance Quality Assurance*
response	*Noted* Nothing to respond (field is empty).

comment	*6* comment by: *Air France - Maintenance Quality Assurance* In the table, converted values from °C to °F are wrong. 15.36 is 59.65 in lieu of 59.95 -73.3 is -99.94 in lieu of -70 48.8 is 119.84 in lieu of 120
response	*Partially accepted*

The temperature values in Deg F are correct, and they are identical to Appendix N to FAR Part 25, N25.4 - Table 1.

However, errors in the temperature conversion from Deg F to Deg C need to be corrected; here are the correct conversions:

59.95°F is 15.53°C; -70°F is -56.67°C; 120°F is 48.89°C.

The standard deviation values are correct.

comment | *7* comment by: *Air France - Maintenance Quality Assurance*

15.36 is 59.65 in lieu of 59.95
-73.3 is -99.94 in lieu of -70
48.8 is 119.84 in lieu of 120

response | *Partially accepted*

Refer to answer to comment 6 (identical) above.

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 2 - AMC 25.981(b)(1) p. 24

comment | *8* comment by: *Air France - Maintenance Quality Assurance*

Closing bracket is alone.

response | *Accepted*

The bracket after "ground operation" is removed.

comment | *12* comment by: *UK CAA*

Paragraph: 3 and CS-25 Book 2
Page: 7 and 24
Comment:
The AMC includes a 20°C limit for the temperature rise of a heated tank during extended ground operation. As the intent of the new rule is to minimise the temperature rise of a tank from external heating, then it is expected that any temperature rise would be significantly less than this value.
Justification:
This value would mean that a tank could become flammable if the initial temperature was above 20°C (with a fuel flash point equalling 40°C). This would include most summer period operations in any country. For periods when an FRM was inoperative this would expose the aircraft to risk of explosion, bearing in mind such conditions prevailed prior to the explosion on the TWA B747 aircraft.

response | *Not accepted*

With the data available it appears 20 °C is a valid threshold.

Refer to response to comment 11.

comment | *58* comment by: *Airbus S.A.S.*

Airbus proposes to replace following sentence in third paragraph:

	'A critical parameter is the maximum temperature rise in any part of the tank under the most critical conditions..' by: 'A critical parameter is the maximum temperature rise in any part of the tank under warm day conditions...'. Justification: Airbus believes that 'warm day conditions are the pertinent conditions to be used for this analysis and therefore propose this change for the sake of clarity of the proposed rule, thus minimizing the room for future interpretation of the requirement'
response	*Accepted*

comment	*70* comment by: *Embraer engeneer* AMC 25.981(b)(1) Notwithstanding our previous comment that Embraer believes that 25.981(b)(1) should be deleted, we offer the following comments in the event that EASA retains that requirement and the associated AMC. HIRF is a fuel tank explosion threat because it is a potential ignitions source, not because of fuel tank heating. It should be addressed as part of compliance with CS 25.981(c), not this regulation. The NPA does not describe how the four hour ground operation criteria were developed but Embraer believes that this scenario is not representative of day-to-day operation, and that, while it may be suitable for some previously approved FRM systems, it is not appropriate for smaller airplanes. In addition, the AMC guidance needs to provide more information on how to establish the most critical conditions including the following points: What equipment should be operated during this four hour ground operation period? How is the solar heating effect applied during the four hour operation, i.e., does sun angle change during that period, and if so, how are the critical angles established? What considerations need to be made to establish the critical measurement point(s) in each part of the tank? Since this evaluation presumably considers ullage temperature, unlike the criteria used by FAA, it is not clear how to determine where in the ullage to place the temperature sensors. Since flight with the FRM inoperative is already evaluated by Appendix M, Embraer believes that it is not necessary to also apply the 20 deg. C limit to operations with the system unavailable.
response	*Not accepted* Refer to response to comment 72. The actual difficulties identified by the commenter will eventually be overcome and are minor compared to the challenge presented by the Monte Carlo method.

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 2 - AMC 25.981(b)(2)	p. 25

comment	*9* comment by: *Air France - Maintenance Quality Assurance* AMC 25.981(b)(2), last sentence: A space is missing between "N" and "and" in the sentence "...defined in Appendix N and means the percentage..."
response	*Accepted*

comment	*59* comment by: *Airbus S.A.S.* Airbus proposes to modify the 'Equivalent Conventional Unheated Aluminium Wing' to read: '[...] is an unheated semi-monocoque aluminium wing of a subsonic aeroplane [...]' Justification: Editorial comment (omission)
response	*Partially accepted* EASA harmonise with the FAA text: "an integral tank in an unheated semi-monocoque aluminium wing".

B. Draft Decision - I. Draft Decision amending CS-25 - CS-25 Book 2 - a new AMC to Appendix N - Fuel Tank Flammability Exposure	p. 25

comment	*60* comment by: *Airbus S.A.S.* Airbus proposes to merge both proposed AMC (to Appendix N25.1 and appendix N25.3) into one single AMC to Appendix N25.1(a). This AMC would read as follows: 'The Monte-Carlo program as well as the method and procedures set forth in FAA document Fuel Tank Flammability Assessment Method Users Manual DOT/FAA/AR-05/8 dated May 2008 (or later revisions) constitute an acceptable means to conduct the flammability assessment specified in Appendix N25.1(a).' Justification: Clarification
response	*Accepted* As proposed, both texts have been merged into one AMC to Appendix N, N25.1(a).

comment	*61* comment by: *Airbus S.A.S.* Airbus proposes to create an AMC to the proposed appendix N25.1(b) to

	provide guidelines on how to conduct a qualitative analysis showing a tank is a conventional unheated aluminium wing tank. Airbus proposes that this AMC read as § 10.a.(1)(a) & (b) of the FAA AC 25.981-2A dated September 19, 2008. The concerned text is copied below for convenience: '*(a) A conventional unheated aluminum wing tank is a conventional aluminum structure, integral tank of a subsonic transport airplane wing, with minimal heating from airplane systems or other fuel tanks and cooled by ambient airflow during flight. Heat sources that have the potential for significantly increasing the flammability exposure of a fuel tank would preclude the tank from being considered "unheated." Examples of such heat sources that may have this effect are heat exchangers, adjacent heated fuel tanks, transfer of fuel from a warmer tank, and adjacent air conditioning equipment. Thermal anti-ice systems and thermal anti-ice blankets typically do not significantly increase flammability of fuel tanks. For these tanks, a qualitative assessment showing equivalency to the unheated aluminum wing fuel tank may be acceptable when considered with the following:* *1 A description of the airplane configuration, (including subsonic, wing construction, etc.),* *2 A listing of any heat sources in or adjacent to the fuel tank,* *3 The type of fuel approved for the airplane,* *4 The tank operating pressure relative to ambient static pressure,* *5 The tank is uninsulated and made of aluminum, and* *6 The tank has a large aerodynamic surface area exposed to outside air to transfer heat from the tank.* *(b) Fuel tanks with an aerodynamic surface area to volume ratio (surface area/volume) greater than 1.0 have been shown to meet these criteria. Fuel tanks with a ratio less than 1 are not considered conventional unheated aluminum wing tanks. The aerodynamic surface area includes the area of the integral aluminum wing fuel tank that is exposed to outside air. It does not include any portion of a fuel tank that is shielded from free stream airflow, such as the front and rear spar, or an area under a fairing or wing thermal blanket.*' Justification: Airbus believes that applicants should have the flexibility to show compliance for certain tanks without having to perform a Monte-Carlo assessment. Guidelines should be provided to these applicants on how to conduct a qualitative assessment
response	*Accepted* The proposed text has been added as an AMC to Appendix N, N25.1(b).

B. Draft Decision - II Draft decision amending AMC and GM to Part-21 - AMC 21A.3 (a) Collection, investigation and analysis of data related to FRM reliability	p. 26

comment	*28*	comment by: *AIR SAFETY GROUP*
	• The ASG is not familiar with the concept and use of reliability reporting to the Agency. Under what circumstances is reliability reporting required? There are many failures that can have significant consequences; what is the intended benefit for specifically requiring	

	FRM reliability to be reported? What will the Agency do with the data? Are there any target reliability levels, which need to be reached and what would be the consequence of failing to meet those targets?
response	*Partially accepted* The reporting requirement emphasizes the need to gather data. Justified for the first introductions in service of FRM system, it is technically unjustified on the long term but was introduced for the sake of harmonisation with FAA.

comment	*36* comment by: *Walter Gessky* **AMC 21A.3 (a) Collection, investigation and analysis of data related to FRM reliability:** Change the text in the first sentence:. (b) Unless alternative reporting procedures are approved **provide a report every six months for the first five years after service introduction to** ~~by~~ the Agency, ~~provide a report to the FAA~~ every six months for the first five years after service introduction**.** **Comment:** Delete the reference with regard to reporting to FAA. Reporting of unsafe conditions to FAA could not be automatically an alternative reporting procedure. EASA has the obligation with regard control of failure, malfunction and defects. Automatic delegation of this obligation with regard to third country products might only be possible when covered in a bilateral agreement. Alternarive reporting procedures to FAA for products shall bew approved by the Agency on a case to case basis.
response	*Accepted* Reference to FAA was a typo. EASA is the correct reference.

comment	*62* comment by: *Airbus S.A.S.* In sub-paragraph (b), Airbus proposes to replace the wording 'every six months' by the wording 'every year'. Justification: The proposed reporting requirement is anticipated to be excessively burdensome for both Operators and EOM. Therefore Airbus requests extension of the data collection period from six months to one year.
response	*Not accepted* The reporting requirement has been introduced to mirror FAA rule, for the sake of harmonisation.

resulting text	***The changes here below show the changes between the current regulation and this CRD (amendment proposal of the current rules)***

I. Draft Decision amending CS-25

CS-25 Book 1

25.981 Fuel tank ignition prevention.

Replace paragraph 25.981 (b) "Reserved" by:

(b) Fuel tank flammability

(1) To the extent practicable, design precautions must be taken to prevent the likelihood of flammable vapours within the fuel tanks by limiting heat and energy transfer (See AMC 25.981(b)(1)).

(2) Except as provided in sub-paragraph (4) of this paragraph, no fuel tank Fleet Average Flammability Exposure level may exceed the greater of:

(i) three percent, or

(ii) the exposure achieved in a fuel tank within the wing of the aeroplane model being evaluated. If the wing is not a conventional unheated aluminium wing, the analysis must be based on an assumed Equivalent Conventional Unheated Aluminium Wing (see AMC 25.981(b)(2)).

The Fleet Average Flammability Exposure is determined in accordance with appendix N of CS-25.

(3) Any active Flammability Reduction means introduced to allow compliance with sub-paragraph (2) must meet appendix M of CS-25.

.

(4) Sub-Paragraph (2) does not apply to a fuel tank if following an ignition of fuel vapours within that fuel tank the aeroplane remains capable of continued safe flight and landing.

Delete current paragraph 25.981(c) as following:

~~(c) Design precautions must be taken to achieve conditions within the fuel tanks which reduce the likelihood of flammable vapours. (See AMC 25.981(c)).~~

CS-25 Book 1

Add a new appendix M to read:

Appendix M – Fuel Tank Flammability Reduction Means (FRM)

M25.1 Fuel tank flammability exposure requirements

(a) The Fleet Average Flammability Exposure level of each fuel tank, as determined in accordance with Appendix N of CS-25, must not exceed 3 percent of the Flammability Exposure Evaluation Time (FEET), as defined in Appendix N of CS-25. If flammability reduction means (FRM) are used, neither time periods when any FRM is operational but the fuel tank is not inert, nor time periods when any FRM is inoperative may contribute more than 1.8 percent to the 3 percent average fleet flammability exposure of a tank.

(b) The Fleet Average Flammability Exposure, as defined in Appendix N of this part, of each fuel tank for ground, takeoff/climb phases of flight during warm days must not exceed 3 percent of FEET in each of these phases. The analysis must consider the following conditions.

(1) The analysis must use the subset of flights starting with a sea level ground ambient temperature of 26.7°C [80° F] (standard day plus 11.7°C (21° F) atmosphere) or more, from the flammability exposure analysis done for overall performance.

(2) For the ground, takeoff/climb phases of flight, the average flammability exposure must be calculated by dividing the time during the specific flight phase the fuel tank is flammable by the total time of the specific flight phase.

(3) Compliance with this paragraph may be shown using only those flights for which the aeroplane is dispatched with the flammability reduction means operational.

M25.2 Showing compliance

(a) The applicant must provide data from analysis, ground testing, and flight testing, or any combination of these, that:

(1) validate the parameters used in the analysis required by paragraph M25.1;

(2) substantiate that the FRM is effective at limiting flammability exposure in all compartments of each tank for which the FRM is used to show compliance with paragraph M25.1; and

(3) describe the circumstances under which the FRM would not be operated during each phase of flight.

(4) identify critical features of the fuel tank system to prevent an auxiliary fuel tank installation from increasing the flammability exposure of main tanks above that permitted under paragraphs 1.3(a)(1), (2) and (b) of this appendix and to prevent degradation of the performance and reliability of the FRM.

(b) The applicant must validate that the FRM meets the requirements of paragraph M25.1 of this appendix with any aeroplane or engine configuration affecting the performance of the FRM for which approval is sought.

(c) Any FRM failures or failures that could affect the FRM, with potential catastrophic consequences shall not result from a single failure or a combination of failures not shown to be extremely improbable.

(d) It must be shown that the fuel tank pressures will remain within limits during normal operating conditions and failure conditions.

(e) Oxygen-enriched air produced by the FRM must not create a hazard during normal operating conditions.

M25.3 Reliability indications and maintenance access

(a) Reliability indications must be provided to identify failures of the FRM that would otherwise be latent and whose identification is necessary to ensure the fuel tank with an FRM meets the fleet average flammability exposure listed in paragraph M25.1 of this appendix, including when the FRM is inoperative.

(b) Sufficient accessibility to FRM reliability indications must be provided for maintenance personnel or the flight crew.

(c) The accesses to the fuel tanks with FRMs (including any tanks that communicate with a tank via a vent system), and to any other confined spaces or enclosed areas that could contain hazardous atmosphere under normal conditions or failure conditions must be permanently stencilled, marked, or placarded to warn maintenance personnel of the possible presence of a potentially hazardous atmosphere. Those stencils, markings or placards must be installed such as to remain permanently visible during maintenance operations.

M25.4 Airworthiness limitations and procedures

The FRM shall be subject to analysis using conventional processes and methodology to ensure that the minimum scheduled maintenance tasks required for securing the continuing airworthiness of the system and installation are identified and published as part of the CS 25.1529 compliance. Maintenance tasks arising from either the Monte Carlo analysis or a CS 25.1309 safety assessment shall be dealt with in accordance with the principles laid down in AMC 25.1309.

(a) If FRM is used to comply with paragraph M25.1, Airworthiness Limitations must be identified for all maintenance or inspection tasks required to identify failures of components within the FRM that are needed to meet paragraph M25.1.

(b) Maintenance procedures must be developed to identify any hazards to be considered during maintenance of the fuel system and of the FRM. These procedures must be included in the instructions for continued airworthiness (ICA).

CS-25 Book 1

Add a new Appendix N to read:

Appendix N – Fuel Tank Flammability Exposure

N25.1 General

(a) This appendix specifies the requirements for conducting fuel tank fleet average flammability exposure analyses required to meet CS 25.981(b) and Appendix M. This appendix defines parameters affecting fuel tank flammability that must be used in performing the analysis. These include parameters that affect all aeroplanes within the fleet, such as a statistical distribution of ambient temperature, fuel flash point, flight lengths, and aeroplane descent rate. Demonstration of compliance also requires application of factors specific to the aeroplane model being evaluated. Factors that need to be included are maximum range, cruise mach number, typical altitude where the aeroplane begins initial cruise phase of flight, fuel temperature during both ground and flight times, and the performance of an FRM if installed (See AMC to appendix N, N25.1(a)).

(b) For fuel tanks installed in aluminium wings, a qualitative assessment is sufficient if it substantiates that the tank is a conventional unheated aluminium wing tank (See AMC to Appendix N25.1(b)).

N25.2 Definitions

(a) Bulk Average Fuel Temperature means the average fuel temperature within the fuel tank or different sections of the tank if the tank is subdivided by baffles or compartments.

(b) Flammability Exposure Evaluation Time (FEET). The time from the start of preparing the aeroplane for flight, through the flight and landing, until all payload is unloaded, and all passengers and crew have disembarked. In the Monte Carlo program, the flight time is randomly selected from the Flight Length Distribution (Table 2), the pre-flight times are provided as a function of the flight time, and the post-flight time is a constant 30 minutes.

(c) Flammable. With respect to a fluid or gas, flammable means susceptible to igniting readily or to exploding (ref. CS-Definitions). A non-flammable ullage is one where the fuel-air vapour is too lean or too rich to burn or is inert as defined below. For the purposes of this appendix, a fuel tank that is not inert is considered flammable when the bulk average fuel temperature within the tank is within the flammable range for the fuel type being used. For any fuel tank that is subdivided into sections by baffles or compartments, the tank is considered flammable when the bulk average fuel temperature within any section of the tank, that is not inert, is within the flammable range for the fuel type being used.

(d) Flash Point. The flash point of a flammable fluid means the lowest temperature at which the application of a flame to a heated sample causes the vapour to ignite momentarily, or "flash." Table 1 of this appendix provides the flash point for the standard fuel to be used in the analysis.

(e) Fleet average flammability exposure is the percentage of the flammability exposure evaluation time (FEET) the fuel tank ullage is flammable for a fleet of an aeroplane type operating over the range of flight lengths in a world-wide range of environmental conditions and fuel properties as defined in this appendix.

(f) Gaussian Distribution is another name for the normal distribution, a symmetrical frequency distribution having a precise mathematical formula relating the mean and standard deviation of the samples. Gaussian distributions yield bell shaped frequency curves having a preponderance of values around the mean with progressively fewer observations as the curve extends outward.

(g) Hazardous atmosphere. An atmosphere that may expose maintenance personnel, passengers or flight crew to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from a confined space), injury, or acute illness.

(h) Inert. For the purpose of this appendix, the tank is considered inert when the bulk average oxygen concentration within each compartment of the tank is 12 percent or less from sea level up to 10,000 feet altitude, then linearly increasing from 12 percent at 10,000 feet to 14.5 percent at 40,000 feet altitude, and extrapolated linearly above that altitude.

(i) Inerting. A process where a non-combustible gas is introduced into the ullage of a fuel tank so that the ullage becomes non-flammable.

(j) Monte Carlo Analysis. The analytical method that is specified in this appendix as the compliance means for assessing the fleet average flammability exposure time for a fuel tank.

(k) Oxygen evolution occurs when oxygen dissolved in the fuel is released into the ullage as the pressure and temperature in the fuel tank are reduced.

(l) Standard deviation is a statistical measure of the dispersion or variation in a distribution, equal to the square root of the arithmetic mean of the squares of the deviations from the arithmetic means.

(m) Transport Effects. For purposes of this appendix, transport effects are the change in fuel vapour concentration in a fuel tank caused by low fuel conditions and fuel condensation and vaporization.

(n) Ullage. The volume within the fuel tank not occupied by liquid fuel.

N25.3 Fuel tank flammability exposure analysis

(a) A flammability exposure analysis must be conducted for the fuel tank under evaluation to determine fleet average flammability exposure for the aeroplane and fuel types under evaluation. For fuel tanks that are subdivided by baffles or compartments, an analysis must be performed either for each section of the tank, or for the section of the tank having the highest flammability exposure. Consideration of transport effects is not allowed in the analysis.

(b) The following parameters are defined in the Monte Carlo analysis and provided in paragraph N25.4:

(1) Cruise Ambient Temperature – as defined in this appendix.

(2) Ground Temperature – as defined in this appendix.

(3) Fuel Flash Point – as defined in this appendix.

(4) Flight length Distribution –that must be used is defined in Table 2 of this appendix.

(c) Parameters that are specific to the particular aeroplane model under evaluation that must be provided as inputs to the Monte Carlo analysis are:

(1) Aeroplane Cruise Altitude

(2) Fuel Tank quantities. If fuel quantity affects fuel tank flammability, inputs to the Monte Carlo analysis must be provided that represent the actual fuel quantity within the fuel tank or compartment of the fuel tank throughout each of the flights being evaluated. Input values for this data must be obtained from ground and flight test data or EASA approved fuel management procedures.

(3) Aeroplane cruise Mach Number.

(4) Aeroplane maximum Range

(5) Fuel Tank Thermal Characteristics. If fuel temperature affects fuel tank flammability, inputs to the Monte Carlo analysis must be provided that represent the actual bulk average fuel temperature within the fuel tank throughout each of

the flights being evaluated. For fuel tanks that are subdivided by baffles or compartments, bulk average fuel temperature inputs must be provided either for each section of the tank or for the section of the tank having the highest flammability exposure. Input values for this data must be obtained from ground and flight test data or a thermal model of the tank that has been validated by ground and flight test data.

(6) Maximum aeroplane operating temperature limit as defined by any limitations in the Aeroplane Flight Manual.

(7) Aeroplane Utilization. The applicant must provide data supporting the number of flights per day and the number of hours per flight for the specific aeroplane model under evaluation. If there is no existing aeroplane fleet data to support the aeroplane being evaluated, the applicant must provide substantiation that the number of flights per day and the number of hours per flight for that aeroplane model is consistent with the existing fleet data they propose to use.

(8) Aeroplane climb & descent profiles in accordance with the aircraft performance data documented in the Aircraft Flight Manual.

(d) Fuel Tank FRM Model. If FRM is used, an Agency approved Monte Carlo program must be used to show compliance with the flammability requirements of CS 25.981 and Appendix M of this part. The program must determine the time periods during each flight phase when the fuel tank or compartment with the FRM would be flammable. The following factors must be considered in establishing these time periods:

(1) Any time periods throughout the flammability exposure evaluation time and under the full range of expected operating conditions, when the FRM is operating properly but fails to maintain a non-flammable fuel tank because of the effects of the fuel tank vent system or other causes,

(2) If dispatch with the system inoperative under the Master Minimum Equipment List (MMEL) is requested, the time period assumed in the reliability analysis shall be consistent with the proposed rectification interval, depending on aeroplane utilisation,

(3) Frequency and duration of time periods of FRM inoperability, substantiated by test or analysis, caused by latent or known failures, including aeroplane system shut-downs and failures that could cause the FRM to shut down or become inoperative,

(4) Effects of failures of the FRM that could increase the flammability exposure of the fuel tank,

(5) Oxygen Evolution: If an FRM is used that is affected by oxygen concentrations in the fuel tank, the time periods when oxygen evolution from the fuel results in the fuel tank or compartment exceeding the inert level. The applicant must include any times when oxygen evolution from the fuel in the tank or compartment under evaluation would result in a flammable fuel tank. The oxygen evolution rate that must be used is defined in the FAA document “Fuel Tank Flammability Assessment Method User's Manual”, dated May 2008 (or latest revision), document number DOT/FAA/AR–05/8.

(6) If an inerting system FRM is used, the effects of any air that may enter the fuel tank following the last flight of the day due to changes in ambient temperature, as defined in Table 4, during a 12-hour overnight period.

N25.4 Variables and data tables

The following data must be used when conducting a flammability exposure analysis to determine the fleet average flammability exposure. Variables used to calculate fleet flammability exposure must include atmospheric ambient temperatures, flight length, flammability exposure evaluation time, fuel flash point, thermal characteristics of the fuel tank, overnight temperature drop, and oxygen evolution from the fuel into the ullage.

(a) Atmospheric Ambient Temperatures and Fuel Properties.

(1) In order to predict flammability exposure during a given flight, the variation of ground ambient temperatures, cruise ambient temperatures, and a method to compute the transition from ground to cruise and back again must be used. The variation of the ground and cruise ambient temperatures and the flash point of the fuel is defined by a Gaussian curve, given by the 50 percent value and a ± 1-standard deviation value.

(2) Ambient Temperature: Under the program, the ground and cruise ambient temperatures are linked by a set of assumptions on the atmosphere. The temperature varies with altitude following the International Standard Atmosphere (ISA) rate of change from the ground ambient temperature until the cruise temperature for the flight is reached. Above this altitude, the ambient temperature is fixed at the cruise ambient temperature. This results in a variation in the upper atmospheric temperature. For cold days, an inversion is applied up to 10,000 feet, and then the ISA rate of change is used.

(3) Fuel properties:

(a) For Jet A and Jet A-1 fuel, the variation of flash point of the fuel is defined by a Gaussian curve, given by the 50 percent value and a ± 1-standard deviation, as shown in Table 1.

(b) The flammability envelope of the fuel that must be used for the flammability exposure analysis is a function of the flash point of the fuel selected by the Monte Carlo for a given flight. The flammability envelope for the fuel is defined by the upper flammability limit (UFL) and lower flammability limit (LFL) as follows:

(i) LFL at sea level = flash point temperature of the fuel at sea level minus 5.5°C (10° F). LFL decreases from sea level value with increasing altitude at a rate of 0.55 °C (1º F) per 808 feet.

(ii) UFL at sea level = flash point temperature of the fuel at sea level plus 19.5°C (63.5º degrees F). UFL decreases from the sea level value with increasing altitude at a rate of 0.55°C (1º F) per 512 feet.

(4) For each flight analyzed, a separate random number must be generated for each of the three parameters (ground ambient temperature, cruise ambient temperature, and fuel flash point) using the Gaussian distribution defined in Table 1.

Table 1. Gaussian Distribution for Ground Ambient Temperature, Cruise Ambient Temperature, and Fuel Flash Point

	Temperature in Deg C/Deg F		
Parameter	Ground Ambient Temperature.	Cruise ambient Temperature.	Fuel Flash Point (FP)
Mean Temp	15.53/59.95	_ -56.67/ -70	48.89/ 120
Neg 1 std dev	11.18/ 20.14	4.4/ 8	4.4/ 8
Pos 1 std dev	9.6/ 17.28	4.4/ 8	4.4/8

(b) The Flight Length Distribution defined in Table 2 must be used in the Monte Carlo analysis.

Table 2. Flight Length Distribution

		Aeroplane Maximum Range – Nautical Miles (NM)									
		1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Flight Length (NM)		Distribution of flight lengths (Percentage of total)									
From	To										
0	200	11.7	7.5	6.2	5.5	4.7	4.0	3.4	3.0	2.6	2.3
200	400	27.3	19.9	17.0	15.2	13.2	11.4	9.7	8.5	7.5	6.7
400	600	46.3	40.0	35.7	32.6	28.5	24.9	21.2	18.7	16.4	14.8
600	800	10.3	11.6	11.0	10.2	9.1	8.0	6.9	6.1	5.4	4.8
800	1000	4.4	8.5	8.6	8.2	7.4	6.6	5.7	5.0	4.5	4.0
1000	1200	0.0	4.8	5.3	5.3	4.8	4.3	3.8	3.3	3.0	2.7
1200	1400	0.0	3.6	4.4	4.5	4.2	3.8	3.3	3.0	2.7	2.4
1400	1600	0.0	2.2	3.3	3.5	3.3	3.1	2.7	2.4	2.2	2.0
1600	1800	0.0	1.2	2.3	2.6	2.5	2.4	2.1	1.9	1.7	1.6
1800	2000	0.0	0.7	2.2	2.6	2.6	2.5	2.2	2.0	1.8	1.7
2000	2200	0.0	0.0	1.6	2.1	2.2	2.1	1.9	1.7	1.6	1.4
2200	2400	0.0	0.0	1.1	1.6	1.7	1.7	1.6	1.4	1.3	1.2
2400	2600	0.0	0.0	0.7	1.2	1.4	1.4	1.3	1.2	1.1	1.0
2600	2800	0.0	0.0	0.4	0.9	1.0	1.1	1.0	0.9	0.9	0.8
2800	3000	0.0	0.0	0.2	0.6	0.7	0.8	0.7	0.7	0.6	0.6
3000	3200	0.0	0.0	0.0	0.6	0.8	0.8	0.8	0.8	0.7	0.7
3200	3400	0.0	0.0	0.0	0.7	1.1	1.2	1.2	1.1	1.1	1.0
3400	3600	0.0	0.0	0.0	0.7	1.3	1.6	1.6	1.5	1.5	1.4
3600	3800	0.0	0.0	0.0	0.9	2.2	2.7	2.8	2.7	2.6	2.5
3800	4000	0.0	0.0	0.0	0.5	2.0	2.6	2.8	2.8	2.7	2.6
4000	4200	0.0	0.0	0.0	0.0	2.1	3.0	3.2	3.3	3.2	3.1
4200	4400	0.0	0.0	0.0	0.0	1.4	2.2	2.5	2.6	2.6	2.5
4400	4600	0.0	0.0	0.0	0.0	1.0	2.0	2.3	2.5	2.5	2.4
4600	4800	0.0	0.0	0.0	0.0	0.6	1.5	1.8	2.0	2.0	2.0
4800	5000	0.0	0.0	0.0	0.0	0.2	1.0	1.4	1.5	1.6	1.5
5000	5200	0.0	0.0	0.0	0.0	0.0	0.8	1.1	1.3	1.3	1.3

5200	5400	0.0	0.0	0.0	0.0	0.0	0.8	1.2	1.5	1.6	1.6
5400	5600	0.0	0.0	0.0	0.0	0.0	0.9	1.7	2.1	2.2	2.3
5600	5800	0.0	0.0	0.0	0.0	0.0	0.6	1.6	2.2	2.4	2.5
5800	6000	0.0	0.0	0.0	0.0	0.0	0.2	1.8	2.4	2.8	2.9
6000	6200	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.6	3.1	3.3
6200	6400	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.4	2.9	3.1
6400	6600	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.8	2.2	2.5
6600	6800	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	1.6	1.9
6800	7000	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	1.1	1.3
7000	7200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.8
7200	7400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.7
7400	7600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.6
7600	7800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.7
7800	8000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.8
8000	8200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.8
8200	8400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0
8400	8600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.3
8600	8800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1
8800	9000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8
9000	9200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
9200	9400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
9400	9600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9600	9800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9800	10000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

(c) Overnight Temperature Drop. For aeroplanes on which FRM is installed, the overnight temperature drop for this appendix is defined using:

(1) A temperature at the beginning of the overnight period that equals the landing temperature of the previous flight that is a random value based on a Gaussian distribution; and

(2) An overnight temperature drop that is a random value based on a Gaussian distribution.

(3) For any flight that will end with an overnight ground period (one flight per day out of an average of number of flights per day, depending on utilization of the particular aeroplane model being evaluated), the landing outside air temperature (OAT) is to be chosen as a random value from the following Gaussian curve:

Table 3. Landing Outside Air Temperature

Parameter	Landing Outside Air Temperature °C/ °F
Mean Temperature	14.82/ 58.68
negative 1 std dev	11.41/ 20.55
positive 1 std dev	7.34/ 13.21

(4) The outside ambient air temperature (OAT) overnight temperature drop is to be chosen as a random value from the following Gaussian curve:

Table 4. Outside Air Temperature (OAT) Drop

Parameter		OAT Drop Temperature °C/ °F
Mean Temp		-11.11/ 12.0
1 std dev		3.3/ 6.0

(d) Number of Simulated Flights Required in Analysis. In order for the Monte Carlo analysis to be valid for showing compliance with the fleet average and warm day flammability exposure requirements, the applicant must run the analysis for a minimum number of flights to ensure that the fleet average and warm day flammability exposure for the fuel tank under evaluation meets the applicable flammability limits defined in Table 5.

Table 5. Flammability Exposure Limit

Minimum Number of Flights in Monte Carlo Analysis	Maximum Acceptable Monte Carlo Average Fuel Tank Flammability Exposure (%) to meet 3% requirements	Maximum Acceptable Monte Carlo Average Fuel Tank Flammability Exposure (%) to meet 7% requirements
10,000	2.91	6.79
100,000	2.98	6.96
1,000,000	3.00	7.00

CS-25 Book 2

Add a new AMC 25.981 (b) (1) to read:

AMC 25.981(b)(1)
Fuel tank flammability design precautions

The intention of this requirement is to introduce design precautions, to avoid unnecessary increases in fuel tank flammability. These precautions should ensure:

(i) no large net heat sources going into the tank,
(ii) no unnecessary spraying, sloshing or creation of fuel mist,
(iii) minimization of any other energy transfer such as HIRF;

Applicants should limit the heat inputs to the maximum extent. Heat sources can be other systems, but also include environmental conditions such as solar radiation. The following design features have been found acceptable:

- heat insulation between a fuel tank and an adjacent heat source (typically ECS packs),
- forced ventilation around a fuel tank,
- fuel transfer logic leaving sufficient fuel in transfer tanks exposed to solar radiations on the ground in order to limit their effects
- heat rejecting paintings or solar energy reflecting paints to limit the heat input by solar radiation.

A critical parameter is the maximum temperature rise in any part of the tank under warm day conditions during a 4 hours ground operation. Any physical phenomenon, including environmental conditions such as solar radiation, should be taken into account. A temperature increase in the order of 20°C limit has been found acceptable for tanks not fitted with an active Flammability Reduction Means and therefore unable to meet the exposure criteria as defined in M25.1(b)(1).

Note 1: for tanks fitted with Flammability Reduction Means, applicants should limit heat and energy transfers to the maximum extent. No maximum temperature increase limit is defined; however the 20 °C limit is applicable in case of dispatch with the active Flammability Reduction Means inoperative.

Note 2: the maximum temperature increase under the conditions described above should be quantified whether or not the affected tank is fitted with a Flammability Reduction Means.

Add a new AMC 25.981 (b) (2) to read:

AMC 25.981(b)(2)
Fuel tank flammability definitions

Equivalent Conventional Unheated Aluminium Wing is an integral tank in an unheated semi-monocoque aluminium wing of a subsonic aeroplane that is equivalent in aerodynamic performance, structural capability, fuel tank capacity and tank configuration to the designed wing.

Fleet Average Flammability Exposure is defined in Appendix N and means the percentage of time the fuel tank ullage is flammable for a fleet of an aeroplane type operating over the range of flight lengths.

Deletion of current AMC 25.981(c) as following:

~~AMC 25.981(c)~~
~~Flammability precautions~~
~~The intention of this requirement is to introduce design precautions, to avoid unnecessary increases in fuel tank flammability. These precautions should ensure:~~

~~(i) no large net heat sources going into the tank,~~
~~(ii) no unnecessary spraying, sloshing or creation of fuel mist.~~

CS-25 Book 2:

Add a new AMC to Appendix N to read:

AMC to Appendix N- **Fuel Tank Flammability Exposure**

AMC to Appendix N, N25.1(a)
Fuel tank flammability assessment method

The Monte-Carlo program as well as the method and procedures set forth in FAA document, "Fuel Tank Flammability Assessment Method Users Manual" DOT/FAA/AR-05/8 dated May 2008 (or the latest existing revision on the condition that it is accepted by EASA), is an acceptable means of compliance to conduct the flammability assessment specified in Appendix N25.1(a). A copy may be obtained from the Office of the Federal Register, 800 North Capitol Street, N.W., Suite 700, Washington, D.C. The following definitions, input variables, and data tables that are used in the program to determine fleet average flammability exposure for a specific aeroplane model are the ones included into paragraph N25.2 Definitions and N25.4 Variables and data tables.

AMC to Appendix N, N25.1(b)

Qualitative fuel tank flammability assessment

(a) A conventional unheated aluminium wing tank is a conventional aluminium structure, integral tank of a subsonic transport aeroplane wing, with minimal heating from aeroplane systems or other fuel tanks and cooled by ambient airflow during flight. Heat sources that have the potential for significantly increasing the flammability exposure of a fuel tank would preclude the tank from being considered "unheated." Examples of such heat sources that may have this effect are heat exchangers, adjacent heated fuel tanks, transfer of fuel from a warmer tank, and adjacent air conditioning equipment. Thermal anti-ice systems and thermal anti-ice blankets typically do not significantly increase flammability of fuel tanks. For these tanks, a qualitative assessment showing equivalency to the unheated aluminium wing fuel tank may be acceptable when considered with the following:

1 A description of the aeroplane configuration, (including subsonic, wing construction, etc.),

2 A listing of any heat sources in or adjacent to the fuel tank,

3 The type of fuel approved for the aeroplane,

4 The tank operating pressure relative to ambient static pressure,

5 The tank is uninsulated and made of aluminium, and

6 The tank has a large aerodynamic surface area exposed to outside air to transfer heat from the tank.

(b) Fuel tanks with an aerodynamic surface area to volume ratio (surface area/volume) greater than 1.0 have been shown to meet these criteria. Fuel tanks with a ratio less than 1.0 are not considered conventional unheated aluminium wing tanks. The aerodynamic surface area includes the area of the integral aluminium wing fuel tank that is exposed to outside air. It does not include any portion of a fuel tank that is shielded from free stream airflow, such as the front and rear spar, or an area under a fairing or wing thermal blanket.

II Draft decision amending AMC and GM to Part-21

Introduce a new subparagraph as follows:

AMC 21A.3(a)

Collection, investigation and analysis of data related to Flammability Reduction Means (FRM) reliability

Holders of a type-certificate, restricted type certificate, supplemental type certificate and of any other relevant approval deemed to have been issued under Part-21 and which have included a FRM in their design should assess on an on-going basis the effects of aeroplane component failures on FRM reliability. This should be part of the system for collection, investigation and analysis of data required by 21A.3 (a). The applicant/holder should do the following:

(a) Demonstrate effective means to ensure collection of FRM reliability data. The means should provide data affecting FRM reliability, such as component failures.

(b) Unless alternative reporting procedures are approved by the Agency, provide a report to EASA every six months for the first five years after service introduction. After that period, continued reporting every six months may be replaced with other reliability tracking methods found acceptable to the Agency or eliminated if it is established that the reliability of the FRM meets, and will continue to meet, the exposure specifications of paragraph M25.1 of appendix M to CS-25

(c) Develop service instructions or revise the applicable aeroplane manual, according to a schedule approved by the Agency, to correct any failures of the FRM that occur in service that could increase any fuel tank's Fleet Average Flammability Exposure to more than that specified by paragraph M25.1.