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Position Paper

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AEA COMMENTS TO

FEDERAL AVIATION ADMINISTRATION (FAA)

NOTICE OF PROPOSED RULEMAKING (NPRM)

14 CFR Parts 25, 91, 121, 125, and 129

[Docket No. FAA–2005–22997; Notice No. 05–14]

RIN 2120–A123

REDUCTION OF FUEL TANK FLAMMABILITY IN TRANSPORT CATEGORY AIRPLANES

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PREAMBLE

On November 23, 2005 the Federal Aviation Administration (FAA) issued Notice of Proposed Rulemaking (NPRM) 14 CFR Parts 25, 91, 121, 125, and 129 [Docket No. FAA–2005–22997; Notice No. 05–14] RIN 2120–A123, Reduction of Fuel Flammability in Transport Category Airplanes. The FAA invites the public to comment to this NPRM.

This NPRM is the FAA response to the National Transportation Safety Board (NTSB) recommendation in the wake of the TWA 800 accident, which occurred on July 17, 1996. Shortly after take-off the center wing fuel tank exploded, with 230 casualties. The NTSB determines that the probable cause of the TWA flight 800 accident was an explosion of the center wing fuel tank (CWT), resulting from ignition of the flammable fuel/air mixture in the tank. The source of ignition energy for the explosion could not be determined with certainty, but, of the sources evaluated by the investigation, the most likely was a short circuit outside of the CWT that allowed excessive voltage to enter it through electrical wiring associated with the fuel quantity indication system.

The European airlines, while not directly affected by the FAA FAR 121 operating requirements of this proposed rule, have a substantial interest in the outcome of this rulemaking. Any non-US operator of an N-registered aircraft would have to comply with the new requirements proposed in 14 CFR 129. If the FAA has unique fuel tank flammability reduction requirements, the ability for European operators to sale or short term lease airplanes to US airlines or return airplanes to US leasing companies, is threatened, and would not be possible without modification to comply with the proposed FAA NGS retrofit requirements.

The Association of European Airlines (AEA) is the trade organization representing 30 major European Airlines, many of which fly to/from the United States of America (USA). We write representing these 30 European Airlines to provide comments on the subject NPRM. We wish to express our appreciation to FAA for its willingness to engage in a public discussion of the proposed rule.

This single letter represents comments from all AEA member Airlines and should be considered as 30 comments by the FAA and not a single AEA comment. In addition it should be noted that the AEA encouraged its members to submit comments directly to the docket which should be considered as supplemental to this letter.

EXECUTIVE SUMMARY

The Association of European Airlines (AEA) appreciates the efforts taken by all the airworthiness agencies and aviation industry to improve fuel tank safety in the wake of the TWA 800 tragedy. Safety is an issue of the highest priority for all our members.

However, incorporation of a flammability reduction system, and in particular the nitrogen generating system, being proposed by the FAA, appears to be driven by NTSB statements and public opinion. Consequently the focus on safety initiatives based on factual statistical data has been overlooked. The AEA supports continuing improvements in aviation safety however, it should be noted that the accident record shows that fuel tank explosions are not a major cause of aviation accidents (statistically the percentage of both accidents and fatalities due to fuel tank explosions is approximately 1.2% over the last 20 years). Industry has already and continues to take significant steps to address these safety issues. It is our opinion that the proposals in this rulemaking, taking into account the work that has already been carried out on ignition reduction, cannot be justified.

We have seen a substantial improvement in our understanding of heated center wing tank (HCWT) explosion risk by the cooperative efforts of FAA, European Aviation Safety Agency (EASA) and other authorities and industry worldwide. As a direct result of the TWA 800 tragedy, FAA has issued over 100 airworthiness directives, additionally FAA has issued SFAR 88, which has provided the basis in the US for a very substantial reduction of fuel tank ignition sources through issuance of ADs and improved maintenance procedures. EASA has issued similar requirements, refer to JAA INT/POL/25/12, generally harmonized with FAA. We have participated actively in the FAA Aviation Rulemaking Advisory Committee activities since the late 1990's and all activities that promote the development of a better understanding of HCWT flammability, and reduction of the associated risks. The world airlines have invested an estimated $750 million to achieve the safety improvements associated with SFAR 88 and similar national regulations. All of this activity on the part of the airworthiness authorities and the industry has resulted in a substantial risk reduction with regard to the threat of ignition sources for HCWT explosions.

Our analysis shows that the safety benefits of the proposed regulation are overestimated by FAA. In general, FAA has chosen to make assumptions or choices in the analysis that are more favorable for the NPRM proposed mitigation measures. The FAA assumes that one accident (HCWT explosion) per 60 million flight hours will occur. Based on historical records it is actually 1 in 140 million. The FAA accident rate used in the NPRM analysis, erroneously overstates the safety benefit by a factor of 2.33.

The NPRM provides no substantiation for the assumed effectiveness of 50% for SFAR 88 initiatives, furthermore, the specifically commissioned Sandia Laboratory Report also fails to clearly substantiate this value. In a previous NPRM on SFAR 88 the FAA states that the effectiveness is between 75% and 90%. No explanation is provided, by either the FAA or Sandia Laboratory, for this substantial difference. The AEA members are convinced that the Airworthiness Directives issued on fuel tank safety combined with SFAR 88 initiatives, will be at least 75% effective.

The FAA have assumed that all future HCWT explosions will occur in the air, however, 2 of the 3 accidents occurred on the ground, with the result that 90% of the persons on board were able to evacuate the airplane. This results in a further correction of a factor of 2.5 to the FAA analysis.

Our analysis shows that this rule would prevent only 0.84 accidents and 47 statistical fatalities as opposed to the 7.8 accidents and 546 fatalities claimed by the FAA over the next 50 years. It should be noted that, in the more hazardous environment created by the presence of Nitrogen we have estimated that 70 statistical fatalities will occur during maintenance due to working in this new Nitrogen enriched environment over the same period of time.

FAA indicates that the "present value" of the cost of the retrofit of Boeing and Airbus aircraft in its base case is $530 million, and the benefit of retrofit is estimated at a present value of only $278 million. The benefit/cost ratio by FAA's calculation is 0.59, or 59% for retrofit. For forward fit, the benefit/cost ratio is 65%. However, as we have discussed above, the FAA has overstated the benefits of the proposal. Using corrections for the accident rate (2.33), SFAR 88 effectiveness (factor of 2 above 50% effectiveness), and the fraction of accidents that historically have occurred in the air (2.5), the present value benefit is actually $38 million for retrofit, and $20 million for forward fit. Thus, the corrected FAA benefit/cost ratios are 5.1% for retrofit and 5.6% for forward fit.

The costs of implementing this proposal are substantial. We discuss in our detailed comments, our disappointment at the lack of consideration by FAA of European cost estimates provided by EASA in 2004 and 2005, despite the NPRM not being published until November 2005. The European cost estimates are significantly higher than those used by FAA in this proposal. Using our members' assessment of estimated costs, the benefit/cost ratio for the retrofit case is 2.5%, and for the forward fit case is 2.8%. This means that the investment required to achieve the safety benefit promised by this proposal is 23 times higher than the value of the benefit.

Based on the data amplified in this document the AEA members cannot support the retroactivity requirement of the proposed rule. Furthermore, the AEA members have serious doubts over the introduction of a forward fit, as the safety benefits are minimal.

The Part 25 regulations are missing safety targets for this subject. We propose that the rulemaking, for example under FAR 25.981, a fuel tank explosion target is included (and not a specific target for both ignition and flammability reduction). This target could be achieved by ignition source prevention in combination with flammability reduction. The combination of the two has to show that the probability of a fuel tank explosion is beyond this level. We would propose that this target be the same as for any other catastrophic event in transport category aircraft of 1×10^{-9}.

Harmonization of this subject with foreign authorities, especially the EASA, is essential for the worldwide aviation industry. Further our recommendation is that the FAA initiates additional research to better understand flammability and SFAR 88 effectiveness prior to embarking on rule making and we encourage the FAA to have more open communication with the industry on this very important subject.

ACCIDENT RATE

Summary
Our analysis shows the FAA's accident rate prediction of 8 accidents in the next 50 years is overestimated by a factor 2.33.

Comments[1]

The following comments specifically relate to the analysis of the accident rate statistics used in the NPRM. The flowing paragraphs of docket No. FAA-2005-22997 refers to this subject: -

> **I. Executive Summary,** NPRM Page 70923
>
> "Since 1960, some 17 airplanes have been destroyed as the result of a fuel tank explosion. Four fatal airplane accidents have been caused by fuel tank explosions just since 1989. Two of the more recent accidents—one involving a Boeing Model 747 (TWA Flight 800) off Long Island, New York in 1996 and the other, a Boeing Model 727 accident (Avianca Flight 203) in Bogotá´, Columbia in 1989—occurred during flight and led to catastrophic losses, including the deaths of 337 individuals. The two other recent explosions occurred on the ground but led to nine fatalities."
>
> "A statistical evaluation of these accidents has led the FAA to project that nine more transport category airplanes will likely be destroyed by a fuel tank explosion in the next 50 years, unless remedial measures are taken."
>
> **II. Background**, NPRM page 70927
>
> "Terrorist initiated accidents were also excluded from consideration in the earlier ARAC reports and the possible benefits in the regulatory evaluation within this notice. While the proposed FRM requirements are not intended to address terrorist initiated explosions, such as the Bogotá 727 accident discussed earlier, inerting fuel tanks may provide other significant secondary safety benefits by addressing flammability exposure."
>
> **III. Proposed Requirements Relating to Fuel Tank Flammability,** NPRM Page 70927
>
> "Some airplane models have center tanks with a fleet average flammability exposure level that does not exceed 7 percent, including to the best of our information the Lockheed L–1011, and Boeing MD–11, DC10, MD80, and Boeing Model 727, and Fokker F28 MK100. At this time we do not believe that these airplanes would need FRM or IMM for their center tanks, unless the certificate holder has also installed an auxiliary fuel tank that is found to be affected."
>
> **IV. Rulemaking Analyses and Notices**, NPRM pages 70944 and 70945
>
> "We estimated that the proposed rule would prevent an expected 4 catastrophic passenger accidents over the analysis period."
>
> "• The type of accident that would be prevented is a catastrophic accident in …
> …
> • The explosion rate calculation does not include explosions caused by terrorist activity.
> • An explosion is estimated to occur every 60 million hours of flight by heated center wing tank airplanes. …"

[1] Detailed explanation of the corrections can be found in Appendix A of this document

A review of the accident record shows that fuel tank explosions are not a major cause of aviation accidents (statistically the percentage of both accidents and fatalities due to fuel tank explosions is approximately 1.2% over the last 20 years), and it has not been identified as such by either the US CAST initiative or European JSSI. Nevertheless, as part of its commitment to safety, the AEA shares the FAA's overall objective to avoid fuel tank explosion related accidents.

The historical data shows that there have been three potential accidents related to centre wing tank explosions (PAL-1990, TWA-1996 and Thai-1998), which could be of relevance to this NPRM, two of which occurred on the ground with limited causalities (9 fatalities).

The FAA's analysis makes the assumption that one HCWT explosion will occur every 60 million flight hours. (NPRM page 70945; Initial Regulatory Evaluation (IRE) page 6) This accident rate is unsupported by the existing data, which shows that 3 accidents have occurred in over 420 million flight hours for aircraft with HCWT, and the historical accident rate is therefore approximately 1 in 140 million flight hours.

FAA supporting material placed in the docket included an independent review of the FAA accident prediction/avoidance model done by the Mitre Corporation dated 22 December 2003. This independent review noted that the version of the FAA HCWT accident analysis then extant used a mean accident interval of 1 in 160 million hours. Mitre agreed with using that accident rate, saying that it was conservative "because it includes fleet hours for models that do not contain high flammability tanks". Correcting this value by eliminating those non-HCWT fleet hours shows that the Mitre recommended accident rate value is consistent with the historical rate of 1 HCWT explosion per 140 million flight hours of the HCWT fleet.

FAA is committed to "data based" decision making, and the data show an HCWT fuel tank explosion has occurred no more often that 1 in 140 million flight hours. FAA has provided no basis for its assumed accident rate of 1 in 60 million flight hours. The FAA in the NPRM and its analyses supporting the proposed rule has overestimated the safety benefit of the proposal by a factor of about 2.33. With this factor the number of accident prevented is reduced from 7.8 to 3.34 accidents.

SFAR 88 Effectiveness

Summary

This docket assumes an effectiveness of 50% for SFAR 88. The FAA substantiated SFAR 88 at 75% (and up to 90%) in a previous NPRM (Docket No FAA-1999-6411) later it was further substantiated by the ARAC team (with the support of the FAA) at the same value. No explanation has been provided for this discrepancy by this NPRM, or the Sandia report, as it has been previously substantiated we have used 75% effectiveness in our calculations.

Comments

The following comments relate to the analysis of the effectiveness of SFAR 88 used in the NPRM. The flowing paragraphs of docket No. FAA-2005-22997 refer to this subject:

> **II. Background,** Page 70924
>
> "For a variety of reasons, SFAR 88, though a significant advancement in safety, will never provide a complete safeguard against fuel tank explosions; thus our analysis has assumed that SFAR 88 will not reduce the possibility of a fuel explosion occurring by more than 50 percent."
>
> **IV. Rulemaking Analyses and Notices,** NPRM pages 709244 - 709248
>
> Comment below apply to all sections wherein FAA mentions "SFAR 88 effectiveness".

The NPRM does not provide substantiation for the effectiveness of SFAR 88 being 50%. The effectiveness of the SFAR 88 initiative is fundamental to this NPRM. Since the TWA 800 accident over 100 Airworthiness Directives (ADs) have been issued on the worldwide fleet and according to the European Aviation Safety Agency (EASA) Regulatory Impact Assessment (RIA) it is estimated that the cost to industry of SFAR 88 will be 600 Million Euros (US$750 Million). This represents significant effort and cost from the industry in improving safety standards.

It is also noted that in a previous NPRM (Docket No. FAA–1999–6411) issued May 7th 2001, which was issued to introduce SFAR 88, on page 23122, the FAA states: -

In the notice, the FAA had assumed that compliance with the proposal would prevent between **75 percent and 90 percent** of the future fuel tank explosions. The basis for this prevention is derived primarily from the incorporation of design changes to enhance fail-safe features of design and enhanced fuel tank system inspections that will discover conditions that could result in an ignition source before ignition of flammable fuel vapors could occur.

For years the international airline and manufacturing industries have worked under the auspices of the FAA Aviation Rulemaking Advisory Committee expert opinion, where this effectiveness factor was actively discussed and debated. Industry, with the presence of the FAA, concluded that the best estimate of the effectiveness of SFAR 88 ADs was at least 75%.

FAA commissioned an independent review of the effectiveness of SFAR 88 with the Sandia Laboratory and an estimate of the residual risk after application of the ADs. The Sandia report was placed in the docket for this rulemaking. In the following paragraph we provide specific comments to this document as well to the peer review and FAA disposition to the peer review, which all are included in the docket.

Comments to the Sandia National Laboratory Report

The AEA members have reviewed the Sandia National Laboratories “Assessment of the Effectiveness of Special Federal Aviation Regulation (SFAR) 88 Airworthiness Directives (ADs) in Preventing Ignition Sources”; Peer Review Report: Assessment of Preventing Ignition Sources with SFAR 88 Airworthiness Directives; and the FAA disposition of ‘Peer Review of Sandia National Laboratories ‘Assessment of Preventing Ignition Sources with SFAR 88 Airworthiness Directives’” and we provide the following initial response.

We strongly disagree with the FAA interpretation of the Peer Review conclusions, as stated in the FAA disposition letter (Docket item FAA-2005-22997-69): -

“Overall, the three peer reviewers determined that the conclusions of the Sandia report were acceptable. The primary conclusion of the Sandia report was that “the effectiveness of SFAR 88 ignition source reduction actions, which was assumed by ARAC to be 75 percent, is overly optimistic.””

We are extremely disappointed to note that the FAA Peer Review Charge (Docket item FAA-2005-22997-30) appears to have forced the reviewers into drawing an **‘Acceptable’** conclusion to their report. The Peer Review Charge was written to ‘assist’ the review of the Sandia report. The final recommendation of the charge states: -

> ‘Based on your reading and analysis of the information provided, please identify and submit an explanation of your overall recommendation for the Fuel Tank Safety Study.
>
> 1) **Acceptable** as is
> 2) **Acceptable** with minor revision (as indicated)
> 3) **Acceptable** with major revision (as outlined) ’

The FAA disposition letter states the reviewers agree with the major conclusion of the Sandia report (75% effectiveness) based on an ‘acceptable’ finding. As shown above the FAA gave the reviewers no choice to draw any conclusion other than ‘acceptable’. This peer review report cannot therefore be considered as an independent review.

We also note that in a separate peer review charge for the Monte Carlo model (Docket item FAA-2005-22997-33) the FAA allows the reviewers to conclude: -

> ‘1) Acceptable as is
> 2) Needs minor revision (as indicated)
> 3) Needs major revision (as outlined)’

We cannot see any merit in constraining the conclusions of reviewers, which effectively negates the object of an independent review.

Two out of the three reviewers gave the ‘worst’ conclusion allowable, item ‘3) Acceptable with major revision’ the third requested minor revision.

In his conclusion reviewer No 3, Mr. R Cherry states: -

> ‘On this basis it cannot be concluded by the reviewer that the assumptions used in determining the effectiveness of SFAR 88 in reducing the potential for ignition sources causing future center tank explosions and the quantitative and qualitative methods and analyses in this report are adequately developed.
>
> However it is considered that the methodology and data collection are appropriate even though the reviewer **cannot agree that they support what appear to be the report’s conclusions.**’

The AEA interpretation of the Reviewers conclusions is that they accept the approach and methodology, but that the data used by Sandia is inaccurate and therefore cannot support the outcome of the report.

We submit the following in response to question 2 of the FAA charge.

> ‘2) Were the data collected in support of the methodology and /or analytical methods appropriate to support the reports conclusions.’

The Sandia Report on page 9 paragraph ‘3.4 Scenarios Exercised’ states the following: -

> “The full models were then run with uncertainty bounds applied to get a sense of distribution spread. Individual or overall AD effectiveness was then estimated with ADs turning on or off in a change set for pre- and post-AD differences. Finally, several scenarios were run with threats from human errors and aging issues applied.”

On page 10 and 11 of the report Sandia provides two tables of airworthiness directives (ADs), which they have reviewed and used in their model to determine the effectiveness of SFAR 88.

It should be noted that **only one** AD (B737 – 2005-05-17) is SFAR 88 related. No other SFAR 88 related changes were mandated or available at the time Sandia preformed the study and therefore not included in this study. Boeing and Airbus are still today preparing changes as a result of SFAR 88 regulations. Indeed some have been issued very recently.

The report states that improvements on high system levels are very effective in prevention of ignition sources and that fuel pumps and the fuel quantity indicating system are seen as the main drivers in safety. Good improvements are seen as:-

- Auto shut-off of fuel pumps
- Ground Fault Interrupters
- Transition Suppression Devises (such as : TSU/TSD/IFQT)

Boeing is working on SFAR 88 driven changes that are not mentioned at all in the report. For example they have recently issued SB 737-28-1208, Wing Center Tank Wire Bundles Inspection and Clamps Change (NPRM 2004-NM-166-AD). Boeing has 14 other changes in preparation on the 737 series airplane, such as: Auto Shutoff System of the CWT Fuel Boost Pumps and Installation of Ground Fault Interrupters on the Fuel Pumps, which are addressing the two first bullets.

On the A320, four more ADs have been issued in 2005, which are not incorporated in the report. Airbus has approximately five additional changes in work.

The report states (section 5.3) that ‘the overall AD effectiveness showed a factor 10 improvement, but this is still a factor of 100 – 1000 away from the goal’ and that ‘this factor of 100 – 1000 is likely over reporting’. These estimates, which are fundamental to the study and have been used to discredit the 75% effectiveness, are by Sandia’s own admission likely to be inaccurate and are in themselves orders of magnitude away from each other. It appears that only a very rudimentary attempt was made to adjust the figures for over reporting. With this in mind and the fact that a small reduction in the number of reported events will have a dramatic effect on the overall safety figure, leads the AEA to conclude that this data is unreliable.

If in fact the risk of explosion of an HCWT were on the order of 10^{-7} (“a factor of 100 from the 10^{-9} goal”), as Sandia cites (1 in 10 million hours of operation), history would dictate that we should have had something on the order of 42 HCWT explosions. The accident data shows 3 such explosions, and therefore Sandia’s estimate of the residual risk being a factor of 100-1000 from the 10^{-9} goal is unsupported by existing data. We note, however, that the **actual accident history** shows that the industry is **less than a factor of 10** away from a risk factor of 1 in 10^{-9} (per hour of operation) for an accident arising from an HCWT explosion. This factor is supported by the Reviewer Mr. Ray Cherry on pages 20 and 21 of the Peer Review Report.

Reviewer Mr. Robert Clodfelter says on page 10:-
"In this reviewer's opinion, SFAR 88 should reduce the risk of a CWT explosion by a factor of about 10, in agreement with both Sandia and ARAC 2."

The combination of these two shows that historic data + SFAR 88 improvements, would project an explosion rate of 1 in 1.4 billion flight hours. The Sandia estimates of the fleet being 100 to 1000 times short of the 10-9 goal of 25.1309 are simply unsupported and unsupportable.

Conclusion

The AEA members support the approach and methodology used by the Sandia National Laboratories to determine the effectiveness of several mandatory actions, however, we cannot support the data used in these models. This is in line with the comment of Reviewer Mr. Robert G. Clodfelter, who cites:

> “The approach and methodology of Sandia are reasonable. This Reviewer can not suggest anything better except **including some real world historical accident statistics** as a checkpoint on the results. The quality of the results [is] dependent on the quality of the base data. The input numbers provided by Boeing are more realistic than Airbus numbers, however both have limitations. The Sandia results are a step in the right directions, **but much better input data is needed.**”

The Sandia report has overlooked fundamental SFAR 88 modifications in its analysis and therefore one of its main findings of not supporting a 75% effectiveness of SFAR 88 has not been properly substantiated. The FAA assumed an effectiveness of 50% in the NPRM. No explanation has been provided for this discrepancy, between this and the previously substantiated 75%, in either the NPRM, or the Sandia report. We continue to use 75% which has been substantiated by the ARAC team of industry experts as being accurate.

Recommendation

The AEA suggests an independent investigation, supported by the industry, into the added safety benefit, per aircraft model, of an FRS system compared to the implemented and planned SFAR 88 improvements would further strengthen the FAA position on this issue.

EFFECTIVENESS OF THE FLAMMABILITY REDUCTION RULE

Summary

The AEA's opinion is that overall reduction in the flammability potential of the applicable airplanes of approximately 95 percent cannot be achieved.

Comments[2]

FAA notes (page 70927) that

> "Lowering the flammability levels of these fuel tanks in the existing fleet and limiting the permissible level of flammability on new production airplanes would result in an overall reduction in the flammability potential of these airplanes of approximately 95 percent."

This statement provides insight into the foundations of FAA's analysis and sets expectations for the safety improvements (95%) to be expected by enactment of this rule.

This NPRM proposes, for the high flammability tanks affected by the rulemaking, that the fuel tank flammability be reduced to 3% or less. In order to achieve the 95% effectiveness that FAA expects, the baseline flammability must be at least 60%. Reducing a 60% flammability to 3% would provide 95% effectiveness.

ARAC data upon which FAA may have relied in setting this expectation (ARAC FTIHWG 2001 Final Report, page 1-6) shows that small, medium and large aircraft HCWT flammability estimated at that time were, respectively, 30.6%, 23.5%, and 36.2%. Thus, the best effectiveness FAA could have expected was [100-(3/36.2*100)] or a bit less than 92%. In fact, however, since that report was written the manufacturers have invested substantial effort to accurately estimate, and validate by flight test measurements, the flammability of their HCWT. Data provided in the FAA docket (Appendix C to Initial Regulatory Evaluation) show that the HCWT flammability of Boeing aircraft ranges from about 16 to 18%, and for Airbus aircraft the corresponding values are 13 to 24%. However, at an EASA meeting on this subject held on February 6, Airbus presented data showing that their most recent detailed studies had demonstrated flammability levels of 8-12% for their fleets. Using these data, the best effectiveness that could be achieved, by reducing flammability of Boeing aircraft to 3%, ranges from 83 to 83%; for Airbus aircraft the best effectiveness of this proposal ranges from 75% to 63%. The factor of 20 improvement implied by a 95% effectiveness cannot be achieved. Rather, for Boeing aircraft, using these data, an improvement of a factor ranging from 6.0 to 5.3 might be achieved; for Airbus aircraft an improvement of only between a factor of 4 and a factor of 2.7 might be achieved. It is clear that the achievable safety improvements based on these data alone are substantially below those contemplated by FAA in both the NPRM itself and the accompanying Initial Regulatory Evaluation.

We are quite disappointed that this independent method of evaluating the value of the safety improvement that can be expected from this rulemaking is so much less than FAA assumes in its NPRM and Initial Regulatory Evaluation.

[2] Detailed explanation of the corrections can be found in Appendix A of this document

SAFETY BENEFIT

Summary

The FAA has overestimated the safety benefits of this rulemaking by a factor of almost 12. The FAA predicts that this rule making will save 546 lives, while we have estimated that this rule only will prevent 47 statistical fatalities on both retrofit and forward fit, however, we also have estimated that 70 statistical fatalities will occur during aircraft maintenance, due to the introduction of the proposed flammability reduction system.

Comments[3]

The safety benefit of this proposal is measured in terms of lives saved by accident avoidance. Data from the 3 accidents that form the basis for corrective action proposed show that 2 accidents (both B737) occurred on the ground, resulting in a total of 9 fatalities, and one B747 explosion occurred in the air, with the loss of all 230 persons and crew aboard. After reviewing this historical data, and reviewing the theoretical flammability model that calculates the percentage of time a fuel tank is flammable and is used in determining compliance requirements for the proposal, FAA "decided that the predicted severity of a future fuel tank explosion should be based on these [theoretical flammability model] percentages rather than on the history that two of these accidents have occurred while the aircraft was on the ground." FAA goes on to say that "we assumed that all future fuel tank explosions would be in-flight explosions. Although this assumption overestimates the average expected benefits from preventing a HCWT explosion, we believe this overestimate would not be substantial." (Initial Regulatory Evaluation, page 52)

FAA's selection of this approach to measuring the expected future safety benefit of enacting the proposal does indeed produce an overestimate of the expected safety benefits. If we use actual historical accident record instead of the theoretical projection of FAA, the benefits in terms of projected lives saved in future accidents is reduced by about a factor of 2.5. This, in such projections, appears to us to be a substantial overestimate produced by the methodology chosen by FAA. The reason for this great disparity between the safety benefits of in-flight and on-ground explosions is that the "explosion" is really a very low overpressure and, while presenting an extremely dangerous situation, even a relatively full single-aisle airplane has been shown in real accident history (Manila, 1990) to be capable of being evacuated after an "explosion" of the HCWT on the ground with very low loss of life. In the two on-ground "explosions" that have occurred, over 90% of the passengers and crew aboard were able to successfully evacuate the airplane.

FAA rightly urges data based analysis and decision making in safety regulatory matters. The data available in this case do not support the FAA decision to assume that all future HCWT explosion accidents would occur in flight, with the loss of all passengers and crew. We see no reason to reject the actual data in the historical record, and suggest that FAA should instead use that data to project that only 1 accident in 3 will occur in flight, as has occurred in the past. By using actual historical data, and taking the 10% of persons that are not evacuated in time into account, the FAA's projected safety benefit of the proposal will be reduced by a factor 2.5.

FAA predicts, based upon its models that at an accident rate of 1 per 60 million hours the rule will prevent 7.8 accidents in the next 50 years or so (Tables 11 and 12 of Interim Regulatory Analysis, pp. 62 and 63). Of these, 3.7 accidents would be prevented by the retrofit provisions of the rule, and 4.1 would be prevented by the new production requirements for Airbus aircraft. (FAA does not include Boeing aircraft costs or safety benefits for new production aircraft because Boeing has stated its intention to provide inerting systems in new production aircraft that comply with the proposed rule, even if the proposal is not enacted into regulations.) If we apply a 75% effectiveness of SFAR 88 ADs (instead of the 50% assumed by FAA), and the 2.33 correction factor arising from FAA's overestimate of the accident rate,

[3] Detailed explanation of the corrections can be found in Appendix A of this document

then we see that instead of preventing 7.8 accidents, the requirements for both forward fit and retrofit would prevent only 0.84 accidents over the next 50 years. Of these, 0.40 accidents would be avoided by the retrofit proposal, and 0.44 would be avoided by the forward fit proposal.

The FAA estimated that this rule, with a 50% SFAR 88 effectiveness will save 546 statistical fatalities. Using FAA data and applying the correction factors we have enumerated so far, the FAA proposal could be expected to result in the avoidance of only 47 statistical fatalities, with 24.6 statistical fatalities from the forward fit, and 22.4 statistical fatalities from the retrofit, of flammability reduction systems. This should be compared to FAA's estimate of 287 statistical fatalities avoided by forward fit and 259 fatalities avoided by retrofit.

Workplace Safety Concerns

FAA provides a discussion of workplace safety issues (page 70942) that conveys the impression that FAA does not believe that the presence of nitrogen enriched air in fuel tanks presents a significant increase in workplace hazard. FAA notes in some detail that placards and markings would be required to address this issue.

Despite the use of such placards and markings, the US Chemical Safety and Hazard Investigation Board (CSHIB) reported (Bulletin 2003-10-B, June 2003) that between 1992 and 2002 they had identified 85 nitrogen asphyxiation incidents that occurred in the workplace in which 80 people were killed and 50 were injured.

FAA does not address, and appears to ignore, the data provided by ARAC (ARAC FTIHWG 2001 Final Report, page 1-8):

> "The FTIHWG lacks the expertise to assess these risks with confidence. However, a simple extrapolation of available data from the Occupational Safety and Health Administration (OSHA) and National Institute of Occupational Safety and Health (NIOSH) would suggest a rate of 1.4 to 4.7 fatalities per year worldwide. Based on assumed annual fleet growth rates and inerting system implementation assumptions, it is forecast that from 24 to 81 lives may be lost over the 2005–2020 study period as a result of this hazard."

We have not seen any data from FAA that contravenes the ARAC concerns, and believe that the US CSHIB data supports the ARAC concern for worker safety, data that is not refuted by FAA. Indeed,

> "[FAA] determined that mechanics would face a minimal risk as long as they followed the OSHA (US Occupational Safety and Health Administration) regulations. Thus we did not include this possibility of airplane mechanic fatalities in the risk analysis." (Interim Regulatory Analysis, page 54)

We do not understand why FAA does not rely on historical data such as that presented in the above cited CSHIB report to estimate the likelihood of future workplace hazards arising from this new technology, as was done by ARAC. This is a substantial unaccounted cost of this rulemaking. We regret that the FAA did not consider an estimation of the magnitude of the additional workplace hazard that this proposal would introduce, which could result in the unintended consequence of worker deaths from asphyxiation. It is a substantial risk whose mitigation would at the very least require substantial recurring training and workplace hazard mitigation costs throughout the airline and maintenance industries. At worst, the cost will be measured in lives lost, as estimated by ARAC above.

If we take the conservative side of the ARAC estimation of 1.4 fatalities per year, this will result in 70 statistical fatalities over the next 50 years. Compare this with the 47 lives saved as described above, and we see that there is a negative case in safety benefit of this rule.

COST BENEFIT ANALYSES

Summary

The FAA cost benefit analyses has been reviewed and corrected with the factors provide in the previous sections. We have concluded that the corrected cost benefit ratio, using the FAA cost figures, will be 5.1% for retrofit and 5.6% for forward fit. When using the cost figures provided in the EASA Regulatory Impact Assessment (RIA), the cost / benefit ratio will be respectively 2.5% and 2.8%.

Comments[4]

Safety is the most important priority of the airline industry. Safety improvements are always welcome, provided they can be achieved at a cost that represents value for money spent. Resources of all airlines are finite, and we therefore must prioritize our expenditures to ensure that they provide the most safety return for each euro (or dollar) spent. It is with this in mind that we have carefully considered the Initial Regulatory Evaluation provided in the docket and the cost analysis provided in the NPRM.

Cost of Hardware and Installation
We are disappointed that FAA has not included any reference to cost estimates provided to it by Europeans well in advance of the publication of this proposal. At a June, 2005, EASA meeting attended by FAA, EASA summarized its Regulatory Impact Assessment of a proposal similar to this one, which has been provided to FAA, published, and made available on the internet. Despite these data being provided to FAA well in advance of the NPRM publication, no reference to these data has been made by FAA, even though it was not until November, 2005, that the NPRM was published.

The RIA data shows cost estimates for both forward fit and retrofit that are substantially higher than FAA estimates. Our review of these data indicates that perhaps the RIA estimates are somewhat high, but relatively no higher than the FAA estimates are low. Member evaluations of the complexity of the flammability reduction system and its installation support substantially higher cost estimates than made by FAA. We believe that the FAA cost estimates are low by at least a factor of 2, and that a factor of 2 increase in the estimated costs associated with this NPRM is a reasonable basis for regulatory evaluation. We note that EASA data would support even higher cost estimates than those we recommend.

Cost of Fuel
The FAA estimates of cost of operation of the new systems were obviously made prior to it becoming clear that the recent rise in fuel costs is a long term change. We believe that the FAA estimate of fuel costs at $1.00 per gallon is quite low compared to what our experts believe is reasonable. A fuel cost of at least $1.50 per gallon should be used for the purposes of regulatory evaluation, and is a very conservative (i.e., low) value based on our experience and all forecasts available to us. This factor is not taken into account in our correction, but it would reduces the cost / benefit ratio further.

Retrofit Installation Time
FAA makes the assumption that 85% of the retrofit could be done in a “heavy” (“D”) check with an additional one day of aircraft down time. While we do not disagree with the required hourly labor estimate made by FAA, our members’ experience would indicate that retrofit of a complex system like this would require at least 2 and more likely 3 days of additional down time during the heavy check. In addition, the scheduling of the retrofit to achieve 85% of them being accomplished during heavy checks appears to us to be quite optimistic, given the logistics and heavy check line capacity constraints involved. Our estimate is that more like 60% of the retrofits on average would be accomplished during the “D” checks. These factors contribute to our overall estimate of the costs of hardware and installation discussed above.

[4] Detailed explanation of the corrections can be found in Appendix A of this document

This factor is not taken into account in our correction, but it would reduce the cost / benefit ratio further.

Cost Benefit Analyses

FAA indicates (Table 4, page 70946 NPRM) that the “present value” of the costs of the retrofit of Boeing and Airbus aircraft in its base case is $530 million, and the benefit of retrofit is estimated at a present value of only $278 million. The benefit/cost ratio by FAA’s calculation is 0.59, or 59% for retrofit. For forward fit, the benefit/cost ratio (Table 5, page 70946) is 65%. However, as we have discussed above, the FAA has overstated the benefits of the proposal. Using corrections for the accident rate (2.33), SFAR 88 effectiveness (factor of 2 above 50% effectiveness), and the fraction of accidents that historically have occurred in the air (factor 2.5), the present value benefit is actually $38 million for retrofit, and $20 million for forward fit. Thus, the corrected FAA benefit/cost ratios are 5.1% for retrofit and 5.6% for forward fit.

If we continue to correct this analysis by taking the EASA RIA into account then we can see that the benefit/cost ratio for the retrofit case is 2.5%, and for the forward fit case is 2.8%. This means that the investment required to achieve the safety benefit promised by this proposal is 23 times higher than the value of the benefit depending on whether we consider forward fit or retrofit, respectively.

In this case based on FAA’s estimate of the undiscounted cost of retrofit (Table 95, page 168 of the Initial Regulatory Evaluation), the retrofit would cost over $1 billion between 2008 and 2030. Considering only the immediate future, using these same FAA estimates, for the period to 2015 the cash outlay for the affected airlines would be nearly $600 million. Using AEA cost estimating, this cash outlay would be nearly $1.2 billion through 2015, and the total cost to 2030 would be $2.1 billion. This cost of retrofit would prevent, by our estimates as detailed above, only 0.4 statistical accidents and avoid only 22.4 statistical fatalities.

For the forward fit case, the costs are spread over the next several decades as an incremental increase in the price of new aircraft borne by those who can afford to purchase them. For the period 2008 to 2030, FAA estimates a cost for forward fit of $196 million (present value), or an undiscounted cost of $523 million for this rulemaking. Even accounting for the AEA cost estimated difference, it is clear that this cost, spread over the next several decades as an incremental price increase for new aircraft is far more affordable, though its low benefit/cost ratio is similar to that of the retrofit. We have estimated that only 0.44 statistical accidents and 24.6 statistical fatalities would be prevented by this rule.

EASA REGULATORY IMPACT ASSESSMENT

Certain sections of our comment document refer to the EASA Regulatory Impact Assessment (RIA). In order to clarify the EASA position this chapter provides the full extract of the executive summary of the EASA "Regulatory Impact Assessment for the Introduction of a Flammability Reduction System", published on the EASA website in November 2005.

> "The purpose of this Regulatory Impact Assessment (RIA) is to evaluate, from a European perspective, the potential consequences of introducing Flammability Reduction System (FRS) on large transport airplanes featuring high flammability exposure fuel tanks. JAA/EASA tasked this RIA following the FAA Administrator press announcement made on 17th of February 2004 regarding the mandatory retrofit of a FRS. This would affect centre tanks on most of Airbus and Boeing products.
>
> The Flammability Reduction System is based upon a concept proposed by the FAA, it derived from proposals made by an ARAC working group, the 2001 FTIHWG. It uses an Air Separation Module fed with engine bleed air to obtain nitrogen-enriched air, which is discharged into the fuel tank, thus reducing flammability.
>
> The RIA was conducted according to the guidelines of NPA 11-2. The group was chaired by CAA-UK and DGAC-France personnel working on behalf of EASA. Technical information was provided by participants from both affected manufacturers as well as representatives of the airline industry and the FAA. Draft copies of the RIA were provided to the participants for their comments; however, the RIA text, conclusions and recommendations are those of the JAA/EASA team and are not necessarily shared by the other RIA participants.
>
> Out of six options identified at the beginning of the process, two were reviewed in detail: a production cut-in (from 2008 all new production airframes would be required to be delivered with FRS) and a full retrofit starting in 2008 (in conjunction with a production cut-in) and ending in 2015.
>
> Both options are in addition to ignition prevention measures already being adopted following JAA Recommendation 04/00/02/07/03-L024 or SFAR 88 reviews, for which it is estimated around 600 Million Euros will be required to be spent by the industry.
>
> The period studied is 2004-2030. There are 11,000 affected aircraft in service today in the world, and assuming an annual fleet growth of 4%, there will be 13,000 aircraft in service in 2008 and 30,500 in 2030. A retrofit would address 11,600 airframes. Approximately one third of the world fleet is in Europe.
>
> The safety benefit has been assessed using three scenarios: no action beyond ignition prevention measures, production cut-in, and full retrofit. With application of ignition prevention measures only, depending upon their effectiveness (25% to 75%), there will be between 4 and 12 accidents. With ignition prevention measures complemented by an FRS 2008 production cut-in, the number of accidents is reduced by between 2 and 5. Ignition prevention measures complemented by an FRS 2008 production cut-in combined with a full retrofit completed by 2015, the accidents are reduced by a further 1 to 4. Current predictions indicate there could be between 500 and 600 accidents due to other causes in the same period.
>
> The cost of introducing a FRS has been evaluated from data provided by both manufacturers. For some figures (cost of installation and retrofit) there is a factor of up to 4 between them. Some attempt has been made to identify the reasons for the discrepancy but it is not possible to identify a definitive value for the real cost. It has therefore been decided to present calculations using both sets of data, giving a range of the potential costs. Non-recurring, production/retrofit and ownership costs have been taken into account, some other cost elements have been identified but could not be estimated accurately.

The production cut -in costs range from 11 Billion Euros to 25.7 Billion Euros (or a 2004 Net Present Value with a 10% discount of 1.9 Billion Euros to 4.7 Billion Euros). It should be noted that this cost is driven directly by the number of aircraft produced in the period under consideration. A shorter study period reduces the cost dramatically and vice versa. It should also be noted that much of the cost will be accounted into the price of a new aircraft, and is likely to be inseparable from that price in the later years of the study. A significant part of the production cut-in cost will, therefore, be amortised over the life of the airframe. In addition, the actual cost of an FRS may be slightly reduced, because no credit has been taken for improved FRS technologies or airplane configuration changes.

The retrofit costing ranges from 7.5 Billion Euros to 13.6 Billion Euros (or a 2004 Net Present Value with a 10% discount of 2.2 Billion Euros to 5.1 Billion Euros), to be added to the production cut-in cost.

Other elements of the RIA (sector impacted, harmonization with FAA, impact on other aviation requirements outside of the EASA scope) have been reviewed. Environmental and social impacts have been identified, but are not significant.

A review of the accident record shows that fuel tank explosions are not a major cause of aviation accidents (statistically the percentage of both accidents and fatalities due to fuel tank explosions is approximately 1.2% over the last 20 years), and it has not been identified as such by either the CAST initiative or JSSI. The question must, therefore, be raised: "Is committing the required level of resource on a single safety intervention justified?"

On the basis of this RIA, it is considered that a production cut-in is justified, with regard to the safety benefit. It is, therefore, recommended that the necessary rulemaking be initiated, as quickly as possible, to require the introduction of FRS into all new production aircraft with high flammability fuel tanks by 2008. At this time, a full retrofit is not considered justified. The additional costs to industry (in addition to the production cut-in costs of FRS) are high when compared to the additional safety benefit in terms of hull losses prevented. However, in the absence of a case for mandating a full retrofit program, further consideration could be given to a solution based on each affected manufacturer's position for their individual models."

RULEMAKING FOR FUTURE DESIGNS

Summary
The FAA fails to address the basis of high flammability tanks for new designs. Furthermore, current FAR 25 rule and the proposed rulemaking fail to address safety targets for preventing fuel tank explosions.

Comments

The essence of this rulemaking, and all previous actions (100+ ADs, SFAR 88), which took place after the TWA 800 tragedy, all have the same goal which is to prevent fuel tank explosions.

A **combination** of Ignition Source Reduction (SFAR 88) and Flammability Reduction Means provides a multi-layered approach to preventing future fuel tank explosions. Therefore, we agree with the FAA statement on page 70922: -

> "The new rules, if adopted, would **not actually direct the adoption of specific inerting technology** either by manufacturers or operators but would establish a performance-based set of requirements that do not specifically direct the use of fuel-inerting but rather set acceptable levels of flammability exposure in tanks most prone to explosion or require the installation of an ignition mitigation means in an affected fuel tank. **Technology now provides a variety of commercially feasible methods to accomplish these vital safety objectives.**"

However, the majority of the NPRM describes one method of compliance, which is the Boeing Nitrogen Inerting System. This is contradictory to the statement above. It is noted that AC 25.981-2A, which is included in the docket for review, also concentrates on the Boeing Inerting system.

As we have described in one of the previous sections, we see a real hazard with the introduction of inerting systems in the aviation industry. We are convinced that the introduction of these systems represents an increased hazard to the maintenance personnel. There may also be failure modes that represent a risk to the aircraft, passengers and cabin crew safety, for example tank overpressure or a nitrogen leak. Therefore we would like to see the introduction of these systems is reduced to an absolute minimum.

We are convinced that, with the combination of ignition source reduction and flammability reduction, we are able to reach an acceptable level of risk, without the installation of inerting systems. There are various ways to address the combination of the two regulations for new designed airplanes which could be:-

Ignition Source Reduction Examples:-

- moving fuel pumps out side the tanks and include multi flame traps inside the pumps,
- advanced fuel quantity indicating system, which do not have any wiring within the tanks,

Flammability Reduction Examples:-

- no air-conditioning packs under the CWT,
- Cooling pack bays.

We recognize that it is preferable for the manufacturers to opt only for the inerting system, as this would comply with the NPRM's proposed acceptable level of risk in a single modification, however, this does not address the core safety issue. Future designs have the benefit of hindsight. We would like to encourage more innovation from the manufacturers.
Therefore, we regret to hear that Boeing has opted for an all wing Nitrogen Inerting System on their newly designed, B787 airplanes. The core issue of flammability is not addressed on this model. In addition the air-conditioning packs have again been positioned directly

underneath the CWT creating a heat source for this tank. Airbus on their A380 airplane has chosen to move the packs away from the center wing box. As we understand it, Airbus will design the A350 in the same spirit as the A380. However, if the rule becomes more stringent (3% flammability exposure target, instead of the 7% for existing airplanes) for new airplanes this, combined with the use of composites, will make it difficult for the manufactures to comply.

We are disappointed that the FAA fails to address the basis of high flammability in tanks for newly designed airplanes. The EASA has a rule for flammability precautions to prevent large net heat transfers into the tanks. EASA Advisory Material AMC 25.981(c), Flammability precautions, states:

> **AMC 25.981(c), Flammability precautions**.
>
> The intention of this requirement is to introduce design precautions, to avoid unnecessary increases in t 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.

In our opinion this is a step in the right direction to address flammability, however the FAR regulations are still deficient in providing essential safety targets. We would like to see in the rulemaking, for example under FAR 25.981, a safety target against fuel tank explosion included (and not a specific target for both ignition and flammability reduction). This target could be achieved by ignition source prevention in combination with flammability reduction. We propose to set the fuel tank explosion target to 10-9, in accordance with FAR 25.1309.

The method for showing compliance to these regulations could be achieved with the Sandia National Laboratory Model for ignition prevention and with the Monte Carlo model for flammability reduction means. Both models should therefore become “live” models and updated with the latest designs and technologies.

COMMENTS TO SPECIFIC FAA REQUESTS

Throughout the NPRM, FAA has requested that the public comment on specific issues it raises. The following discussion responds in turn to each of those requests.

a) Fuel Tankering (pages 70924-70925):
"FAA does not believe that current fuel carrying practices are likely either to change significantly or to have a measurable impact on the overall risk of an explosion."

We agree that tankering, or carrying more fuel than is required, would not significantly mitigate the risk of HCWT explosions once all SFAR 88 ADs are implemented.

b) Security Benefits of FRM (page 70927):
"FAA invites comments related to the potential additional security benefits that may be achieved by imposing FRM."

Any benefit from FRM systems related to deliberate attempts to sabotage an aircraft must be very speculative, since each terrorist scenario is different. We note that it is not clear that the aircraft systems and structure themselves could survive a terrorist's attempt to shoot down or bring down by explosion a civil aircraft if the HCWT is breached, since it is in a highly protected area compared to the wing tanks. While in theory there may be some benefit that accrues to improving security by installing FRM for the HCWT, we have no basis for estimating that amount of that benefit and do not believe it to be substantial enough to consider in this rulemaking.

c) New Requirements for TC Holders (page 70930):
"[FAA] specifically request[s] comments from the public, including foreign authorities, on the appropriate place for these airworthiness requirements for type certificate holders."

AEA members often have contracts that require compliance with European JAR-25 or CS 25 standards of EASA and 14 CFR Part 25 requirements of FAA. Each of the "Parts 25" provide a ready means of defining the type certification basis for an aircraft, and those requirements remain static throughout the life of the aircraft (with a few notable exceptions that have been made by FAA). This is a useful and readily understood means of defining design standards for a given aircraft.

It is normal that retroactive requirements are imposed by standards contained in JAR 26 in Europe, or FAR operational rules of Parts 91, 121, 125, 129 and 135 for FAA. We would prefer that, instead of incorporating these new requirements in 14 CFR 25, that some other placement of the requirements be made. This does not change the substance of what FAA seeks to do, but avoids the loss of a convenient means for defining type design requirements and also for harmonization of the approach to setting new standards and preserving comparability of type design requirements.

d) Unique Compliance Challenges (page 70931):
"If the public knows of other airplanes that may present unique compliance challenges, the FAA is interested in receiving comments. These comments may result in additional airplane models being excluded from the requirements of this proposed rule."

The FAA, in its Initial Regulatory Evaluation, excludes from its estimates the A310 series, presumably because there are no passenger carrying A310 aircraft in service in the US. (See, e.g., Table 15, page 67) We believe that this exclusion from retrofit requirements should be made specific in the proposed rule.

In the Initial Regulatory Evaluation, FAA states (page 45) that "…we assumed … that American Airlines would sell or not renew its leases on all of its A300-600 passenger airplanes by 2008." But elsewhere, tables of data used in FAA's calculations of costs and benefits appear to include the A300-600 fleet. While we cannot claim to be privy to the fleet plans of American Airlines, the age of this fleet indicates that they will all be at least 25 years old (and therefore likely retired) between May, 2013 and February, 2018. The safety benefit of retrofitting this small fleet is very small. The cost of designing, developing, testing and evaluating retrofit kits for this fleet would be extraordinary. This circumstance warrants explicit exclusion of the A300-600 fleet from applicability of the retrofit requirements of the proposed rule.

Similarly, there appears to be some confusion on the part of FAA related to the design of the Airbus A330 aircraft. There are only 11 A330-200 aircraft on the US registry today, not 27 (as noted on Table 3, page 41). The A330-200 is the only A330 model with HCWT; the A330-300 aircraft do not have a HCWT and, therefore, should have been excluded from the FAA cost and benefit calculations. Moreover, there are no A340 aircraft on the US registry. In view of the fact that there are only 11 A330 aircraft with HCWT on the US registry, and no A340 aircraft, it would seem appropriate that the A330 and A340 aircraft be explicitly excluded from the requirements for retrofit in the proposed rule.

In summary, for the reasons discussed above, we recommend that specific exclusion from retrofit requirements be made for the A300-600, A310, A330 and A340 aircraft models. Doing so will have exceedingly small effects on the safety benefit to be achieved by any rulemaking that results from this proposal. Their age (in the case of the A300-600) and small numbers (in the case of the A330-200) would make compliance with the rule economically impractical, as FAA has stated (page 70931) is the case with other aircraft already explicitly excepted by FAA. There are no A310 or A340 passenger carrying aircraft on the US registry, and the A330-300 does not have a HCWT. Also including them on the list of models explicitly excluded from any future retrofit requirement is recommended for clarity, to avoid any future misunderstandings.

e) <u>Applicability to All-Cargo Airplanes (page 70932):</u>
"[FAA] request[s] comment on whether, given the costs involved, the design rules, the production cut-in rules, or the operating rules, if adopted, should be applied to all-cargo airplanes."

The AEA recognizes the very small safety / cost benefit contribution of the all-cargo airplanes when all-cargo airplanes are excluded for this rulemaking. However, the FAA as presented, in the NPRM and in the Initial Regulatory Evaluation, with the analysis of the potential safety benefits of applying this rule to all-cargo airplanes. FAA concluded that the very small safety benefits that would accrue from application of this proposal to all-cargo airplanes was the avoidance of only 0.15 accidents over the next 50 years. Our comments discussed herein would support that as a very conservative estimate, and in fact our analysis would indicate avoidance of less than 0.02 accidents over the next 50 years.

At the same time we recognize that all-cargo airplanes have identical fuel system designs as passenger airplanes, however, if the FAA decided to include all-cargo airplanes the cost/benefit ratio will change. The FAA has predicted a cost / benefit ratio of 59% for retrofit and 65% for forward, with our correction, the ratio was reduced respectively to 2.5% and 2.8%. Including the all-cargo airplanes the benefit according FAA's prediction reduces from 61% (for both retrofit and forward fit) to 53%, when we apply our corrections this figure is reduced to 2.3%.

Our conclusion is that it does not matter whether the FAA includes or excludes all-cargo airplanes in this rulemaking, as our calculations show there is no case for either retrofit or forward fit for passenger airplane models.

f) <u>Other Suggested Exclusions or Distinctions (page 70932) :</u>
"To ensure that this rule is as cost effective as possible, [FAA] specifically request[s] comments on whether there are other categories of airplanes or ways to distinguish among airplanes that would focus this rule on those where the benefits would be greatest."

Under paragraph (d), we have provided discussion of data that supports explicit exclusion of the Airbus A300-600, A310, A330 and A340 fleets in any regulatory language resulting from this proposal. As previously stated, there are no A310 or A340 passenger aircraft on the US registry. The age or limited number of the A300-600 and A330-200 fleets would make compliance with the rule economically impractical for these fleets, as FAA has stated (page 70931) is the case with other aircraft already explicitly excepted by FAA.

g) <u>Auxiliary Fuel Tanks (page 70932):</u>
"[T]he FAA specifically requests comments on including these auxiliary fuel tanks in the proposal. Information on the number of fuel tanks installed in the fleet and the remaining useful life of the affected airplanes should be provided."

AEA does not have accurate information on the number of auxiliary fuel tanks installed in the US fleet, but we believe that the number of these tanks is quite small. Given that the limited number of aircraft equipped with these tanks makes compliance with the rule economically impractical, and these types of tanks should be excluded from requirements for compliance with retrofit requirements, as is the case with other small or aging fleets already excluded by FAA.

h) <u>Other Categories of Operations to be Excluded (page 70932):</u>
"[I]n an effort to enhance the cost effectiveness of this rule, [FAA] specifically request[s] comments on whether other categories of operations should be excluded."

While not applicable to a large number of aircraft, 14 CFR 121.153 permits the operation, by US airlines, of airplanes registered in another ICAO member state country if

> "The aircraft is of a type design which is approved under a U.S. type certificate and complies with all of the requirements of this chapter (14 CFR Chapter 1) that would be applicable to that aircraft were it registered in the United States."

FAA and EASA have worked hard to harmonize requirements of this proposal insofar as it applies to newly produced aircraft. However, there remains a significant disagreement about the FAA's proposed retrofit requirements, which are not supported by EASA for reasons made clear in the Regulatory Impact Assessment they have provided to FAA.

If compliance with the proposed retrofit requirements are applied as proposed, the existing language of 14 CFR 121.153 would preclude "leasing in" by US airlines of aircraft that have not been retrofitted with FRS. This presents a burden to US operators, who would lose the flexibility provided by 14 CFR 121.153, and also a burden to non-US operators, for whom the value of their aircraft not retrofitted in accordance with US requirements would be reduced.

History shows that the use of the 14 CFR 121.153 provisions is relatively rare, but it can be an important flexibility when unusual circumstances dictate the urgent need of replacement lift for US carriers. Given the small effect of excluding airplanes leased in under the provisions of 14 CFR 121.153 from any requirements of the proposed rule, we recommend that they be excluded from applicability provisions of the proposed rule.

i) <u>Quantitative or Qualitative Standard for Wing Tanks (page 70933):</u>
"[FAA] is proposing to establish a numerical flammability exposure standard of 3 percent that can be used [to set compliance limits for the proposal]. This approach may have implementation advantages and should achieve the safety level intended by the ARAC recommendation and the current approach of § 25.981(c). [FAA] specifically request[s] comments on which approach would be more workable and effective."

The quantitative regulatory performance requirements can be superior to qualitative expressions of performance intent. However, as this is a compliance matter, we expect it to be addressed by manufacturers, and do not have a specific position on the matter at this time.

j) <u>Compliance Schedule (page 70939):</u>
"[FAA] recognize[s] that compliance intervals may need to be adjusted and will consider [public] comments on this condition."

FAA does not clearly lay out a compliance schedule, in the NPRM, despite its proposing specific dates by which compliance with various aspects of the rule would be required. This apparent contradiction is understood by recognizing the language of the NPRM (page 70939):

> "The dates in the proposal were based on the assumption that it would be adopted well before the end of 2005. However, the rulemaking process took longer than originally anticipated. Consequently, given the specific compliance dates [in] the proposed rulemaking and the likelihood that finalization of the rules will be later than expected, there may not be as much time allowed for compliance as originally planned. We recognize that compliance intervals may need to be adjusted and will consider your comments on this condition." [emphasis added]

Boeing designs, for commercial reasons, are well underway at this writing, and FRS for the 747 and 737 are undergoing in service evaluation. Absent the specifications that may result from this rulemaking, Airbus has not yet undertaken the effort required to design, develop, test and provide in-service evaluation of flammability reduction systems. Given this, we are concerned that the compliance schedule proposed is unrealistic to accommodate all manufacturers. Specifically, we believe that a period of 30 months from the effective date of this rule is required to fix the design of the flammability reduction system, and a minimum 6 month period of in-service evaluation following this is necessary. Fitting this new equipment could begin at that point, 36 months after the effective date of the rule, for deliveries occurring beginning 42 months after the effective date of the rule. In parallel, though we do not support a retrofit requirement, retrofit kits could begin to be made available to airlines 36 months after the effective date of the rule.

While we recognize the acknowledgement of the difficulties sometimes encountered by airlines when manufacturer development schedules slip, the FAA should recognize the need to accommodate FAA deliberation times in the schedules. Milestones that follow a requirement for FAA approval of action should be tied to the date of receipt of FAA approval for that action, and not to calendar dates or fixed times. This provides FAA the flexibility it may need to evaluate a proposed method of compliance, and does not put the industry in a position of having compliance schedules adversely affected by slippage in receipt of FAA approval.

<u>Hangar & Maintenance Personnel capacities</u>: The ARAC2 FTIHWG report in the Airplane Operation and Maintenance Task Team Report it is stated on page F-12 that: -

The Team estimated that approximately 100 dedicated hangars would be necessary for modification of the existing fleet during the proposed compliance period. When the operators need to do the modification in a special modification line extra slots are necessary, this may result in insufficient hangar space. Because of the number of airplanes effected, the Airplane Operations & Maintenance team has serious concerns about the availability of enough trained Airplane Maintenance Technicians that would be required to modify the airplanes in the proposed compliance period. Completing the modification of all the effected airplane in a seven-year period would require 3000 - 4000 trained Maintenance Technicians working full time.

The AEA concurs with this statement, with the given compliance period in this NPRM, and therefore has serious concerns regarding hangar availability and man-power.

k) <u>MMEL Intervals (page 70941):</u>

"[FAA] specifically request[s] public comment on the proposal to allow the current FOEB process to establish the MMEL interval rather than requiring a specific maximum interval [in the proposed regulation]."

We concur with the FAA proposal to allow the existing FOEB process to establish MMEL intervals for any equipment required by new regulations stemming from this NPRM. We hope that this relief can be harmonized by the FAA FOEB with requirements of the EASA JOEB. Specifically, we believe that newly introduced equipment like this should, for a reasonable period of time (say 2 or 3 years) should be subject to FAA "Category D" MMEL relief initially.

Thereafter, a minimum of FAA "Category C" MMEL relief should be entertained by the FOEB. We do not support the NTSB suggestion that an FRS be subject to more stringent relief such as that provided for flight data recorders. We cannot understand how one can justify the burden of such short MMEL relief, especially in view of the lack of in-service experience with these complex systems, and the absence of a threat to flight safety when they are inoperative for flight. Brief periods during which this type of back-up safety system is inoperative do not significantly contribute to flight safety risk. On the other hand, artificially short MMEL relief can create substantial economic burden on operators because of AOG situations, especially in the first few years of system operations.

AEA supports the FAA approach, and requests that establishment of MMEL relief intervals be established by the FOEB and JOEB working together for a harmonized decision.

l) Elimination of Need for Transient Suppression Devices and Digital FQIS Systems (page 70941):

"[FAA] specifically request[s] comments regarding the savings that would be achieved if electrical energy limiting devices were not required on wiring entering high flammability fuel tanks affected by this proposal."

B737-100/-200/-300/-400/-500 series airplanes are fitted with various types of Transient Suppression Devices (TSDs) to show compliance with AD 99-03-04. B747-100/-200/-300 series airplanes are fitted with similar TSDs to comply with AD 98-20-40. These devices have proven to be a good method of reducing ignition sources in these models. Furthermore, the Sandia National Laboratory Report states that these devices offer high level of protection in fuel tank ignition source prevention. Therefore we will not remove these installations as a tradeoff for a FRS. In fact, far from being a cost saving, the removal of these devices will incur additional costs for certification, service bulletins, manpower, and hanger space.

m) Paperwork Reduction Act (page 70943)

"The proposed reporting requirement applies to applicants and holders of the affected certificates. There is no proposed additional requirement within this rulemaking for operators to report FRM reliability information. We intend for certificate holders to gather the needed data from operators using existing reporting systems that are currently used for airplane maintenance, reliability and warranty claims. The operators would provide this information through existing or new business arrangements between the certificate holders and the airlines…. [FAA] is seeking comments to [e]valuate whether the proposed information requirement is necessary for the proper performance of the roles of the agency, including whether the information will have practical utility; [e]valuate the accuracy of the agency's estimate of the burden …."

FAA's proposed requirement for certificate holders to report reliability information to the FAA is said not to impose a new obligation for operators. While this may be true in the narrowest sense, as a practical matter the FAA is placing operators in a position of having an obligation to report this information to the type or supplemental type certificate holder where such an obligation did not previously exist. To be completely open and transparent about the obligations imposed by this rulemaking, we suggest that FAA not rely on technicalities and recognize the new obligation it is imposing on the airlines to record and report this information to the certificate holder.

n) Comments and Information (page 70945):

"[FAA] request[s] comments and information about all of our assumptions, values, and results." Our detailed comments in response to this request are provided below.

Contrary to the FAA statement on page 70925, Jet A fuel flammability is in the range of 100-175 degrees F at sea level under static conditions, not "once the fuel temperature reaches approximately 175 degrees F" under those conditions. (CRC Handbook of Aviation Fuel Properties, page 2-29)

Contrary to the FAA statement on page 70925, footnote 4, most transport category airplanes used in air carrier service are not approved for operation at altitudes to 45,000 feet, but are approved to operate at lower maximum altitudes.

As noted above, the ARAC flammability exposure data cited on page 70926 are incorrect, and have been updated by both Boeing and Airbus. The reduction in baseline flammability levels from those assumed by ARAC is important since the lower levels that have been documented by the manufacturers reduce the maximum safety improvement that can be achieved by enactment of this proposal from the FAA's intended "order of magnitude" (factor of 10) to a safety improvement in the range of only a factor of 7.7 to 2.7, depending on model.

FAA mischaracterizes the recommendations contained in the ARAC 1 report of July, 1998. That report did not recommend both the reduction of fuel tank flammability in newly designed aircraft to 7% and the incorporation of fuel tank ignition mitigation means as stated by FAA on page 70926, but recommended those actions in the alternative.

Contrary to the notion expressed on page 70927 footnote 7, by the FAA definition of "auxiliary fuel tanks" these tanks are not only "'aftermarket' installations not contemplated by the original manufacturer." Many aircraft of today's designs produced by Boeing and Airbus incorporate tanks that, according to FAA definition, are "auxiliary" fuel tanks.

FAA, on page 70930, indicates that "[w]ith the adoption of subpart I rules, we must ensure that safety improvements that result from TC holder compliance with these requirements are not undone by later modifications. Therefore, even when we determine under § 21.101 that an applicant need not comply with the latest airworthiness standards, it will be required to demonstrate that the change would not degrade the level of safety provided by the TC holder's compliance with the subpart I rule. In the context of today's proposal, for example, this will mean that an applicant for approval of a design change would have to show that it would not increase the fuel tank flammability above the limits defined in this proposal or adversely affect the FRM or IMM established by the TC holder." It is not clear whether this means that the TC holder applying for a design change, or the STC applicant, must achieve a flammability level equal to or better than that existing on the unmodified aircraft, or if the TC holder or STC applicant will be held to flammability limits specified in the rule. FAA should clearly define which the case is.

FAA, on page 70931, indicates that it will "require holders of existing type certificates to incorporate FRM or IMM into all new production aircraft if the fleet average flammability exposure exceeds permissible levels." We do not understand this concept. Manufacturers can sell aircraft to non-US operators that fully comply with FAA certification regulations, or aircraft that comply with FAA certification regulations with specified exceptions. There is no US regulation that forbids export of aircraft from US, or from countries of non-US manufacturers holding FAA type certificates, when those aircraft do not fully comply with FAA certification requirements. It is FAA practice to permit such exports as long as the importing authority is willing to accept those aircraft with the specified exceptions. Of course, such aircraft would not fully comply with 14 CFR 25 requirements and the specific non-compliance(s) would be noted on the export certificate of airworthiness.

On page 70931, FAA indicates its intention "to apply this rule to airplanes for which a passenger capacity of 30 or more has been approved at any time." We do not agree with this requirement if its application extends beyond commercial passenger airline operations. If a used aircraft is purchased for executive conversion and use, we see no reason that the proposed regulations should be applied to that operator. Just as FAA recognized in its analysis and decision not to apply this requirement to all-cargo operations, the benefit of applying the NPRM requirements would be vanishingly small. Yet the additional cost can be significant, especially if the aircraft in question has never been fitted with a flammability reduction system (as would be the case if a prospective executive operator in the US purchased an aircraft that had not been subject to this rule. We recommend that FAA confine its application of the proposed requirements to US registered aircraft engaged in commercial passenger carrying operations involving a "holding out" to the public. In other words we recommend that FAA exclude Part 91 and Part 125 operations from the scope of the amendment. To do otherwise would make compliance with the rule economically impractical for these aircraft, as FAA has stated (page 70931) is the case with other aircraft already explicitly excluded by FAA.

On page 70933 FAA says that this "proposal would require production cut-in for all airplanes manufactured after the required design changes are available. This section would apply only if the FAA has jurisdiction over the organization responsible for final assembly of the airplane. Section 25.1821(a) uses the same terminology as Annex 8 to the Convention on International Civil Aviation, which defines the limits of the FAA's authority under international law. In most cases, this refers to final assembly within the United States; there are limited circumstances where final assembly may occur in United States, but the responsible organization is under the jurisdiction of a foreign authority. It is also possible that final assembly could be done in another country by an organization over which the FAA has jurisdiction, such as a production certificate holder." It is quite clear that US authority has limits, and the US does not have the authority to apply 14 CFR 25 requirements to airplanes produced outside the US unless those aircraft are imported to the US or for other reasons seek certification by FAA to the requirements of 14 CFR 25. We would appreciate FAA clarification of the practical effect of this interpretation and the reason FAA has highlighted it in this discussion.

On page 70934, FAA notes that "STC holders or applicants for an amended TC affected by the proposed rule would need to conduct a flammability analysis using the ''Monte Carlo'' method defined in proposed Appendix L and discussed later in this document. A number of inputs are required to conduct this analysis. Airplane specific data, such as fuel management, fuel tank thermal characteristics, or airplane climb rate may not be readily available from the original TC holder. We intend the STC holders to obtain the information by working with the TC holder and operators of airplanes that have their tanks installed." We note that the realities of our business are such that STC applicants are often competitors with the original TC holder, and it may be difficult if not impossible as a practical matter for STC applicants in the US to reach a business agreement to obtain these data. In Europe, STCs for such major modifications are not granted by EASA without evidence that such a cooperative arrangement has already been reached.

Further in this discussion on page 70934, it is noted that "[o]perators have business agreements with the original TC holders and in many cases access to TC holder information they obtained when they purchased the airplane." We are somewhat surprised to hear the belief that many operators have access to TC holder information. In fact, it is our members' experience that such TC holder information is highly proprietary, and is the rare exception, rather than the rule, that access to this data is available to operators.

On page 70934 FAA discusses the requirement imposed on applicants in the proposal to use a specific methodology, also used by ARAC, to determine the flammability exposure of fuel tanks. We note, however, that the ARAC 2 (2001) report made a specific recommendation (page 1-10) that the FAA "[i]nitiate a project to thoroughly document and substantiate the flammability model used in this study." This recommendation has not, to our knowledge, been carried out. The flammability model that is so central to this proposal has not been thoroughly documented and substantiated as to its accuracy and reasonableness in the application for which FAA requires its use.

On page 70939, FAA makes mention of Airbus having flown a "prototype FAA inerting system" in August 2003. The implication of this statement may be understood to reflect a relatively advanced state of development of the FRS. In fact, as explained in the FAA report DOT/FAA/AR-03/58 that can be found in the docket, the equipment flown by Airbus in 2003 was a laboratory demonstration for research and development purposes that in no way represented a "prototype" FRS system. We mention this to eliminate any idea that the equipment development in August 2003 had reached any but the conceptual stage. Our specific comments on the amount of time required to design, develop, test and conduct in-service evaluation of a FRS are given above.

On pages 70944-70945, FAA lists a number of assumptions on which it requests comments. Many of these have already been addressed above, but we provide the following additional comments:

FAA assumes that the effectiveness of SFAR 88 is 50%. Industry representatives to the ARAC have concluded that a more appropriate effectiveness for SFAR 88 is 75%. FAA commissioned Sandia National Laboratories to evaluate the effectiveness of the SFAR 88 ADs and, though declining to concur with the 75% effectiveness recommended by industry for reasons of "residual risk" not related to the SFAR 88 ADs themselves, "Sandia estimates AD effectiveness at a factor of 10 improvement overall." (Sandia report, page v) It is difficult to accept, without any substantiation, FAA's assumption that the effectiveness of the SFAR 88 ADs, at a cost of hundreds of millions of dollars for US airlines alone, is only 50%, in light of these contrary findings by two independent groups.

FAA assumes that Boeing and Airbus airplanes have an equal risk of HCWT explosion. This is inconsistent with the historical data and the large differences FAA has seen in designs through the SFAR 88 analysis process. There are a number of design differences that have been seen in SFAR 88 analyses, and in the Sandia analysis, and the age of the accident aircraft designs is at least a decade more than that of the designs approved in newer type certificates that have incorporated lessons learned. The fuel tank designs are different, and the accident history of the two manufacturers is different. FAA should substantiate its assertion that the Boeing and Airbus designs have an equal risk of explosion in the future.

FAA assumes that an explosion is estimated to occur every 60 million hours of flight. We have shown above that this is inconsistent with the historical record, which shows an explosion no more often that once every 140 million hours of flight. FAA's assumption overstates the safety benefit of this rulemaking by a factor of about 2.33.

FAA assumes, for the purposes of regulatory evaluation, that the value of a statistical fatality averted is $3 million. We concur with this estimate, which is in line with DOT guidelines and past FAA practice. There is no basis for use of a higher value.

On page 70947 - 79948, FAA discusses its rationale for not adopting its "Alternative One: Apply the Proposed Rule Only to Production Airplanes – Excluding Retrofit Requirements." FAA's reasoning is as follows:

> "As shown in Table 6, the benefit-cost ratios of the present values are lower for retrofitted airplanes than they are for production airplanes. However, at a 7 percent discount rate, the ratios are very close. Using the standard values, there is only a 6-percentage point difference (about 10 percent) between the 59 percent ratio for retrofitted passenger airplanes and the 65 percent ratio for production passenger airplanes. This same result is observed for all benefit/cost ratios calculated using a 7 percent discount rate. The difference becomes more pronounced (about 30 percent to 40 percent) when a 3 percent discount rate is used. This apparent conflict is resolved by noting that a far greater percentage of the total benefits for retrofitted airplanes would occur in the more immediate future than it would for production airplanes that have more of its benefits occurring farther out in time. Thus, a lower discount rate has a greater positive impact (relatively) on present value calculations for longer-term benefits than for shorter-term benefits. That is, retrofitted airplanes would incur the vast bulk of these airplanes flight hours and the relatively greater overall risk until about 2030. In light of these results, we determined that the benefit-cost analysis does not justify requiring production airplanes to have fuel tank inerting systems while not requiring these systems on retrofitted airplanes. Both airplanes need these systems."

The use of a 7% discount rate, and comparing things in terms of present value, artificially discounts the long-term benefits of retrofit, that stretch many years into the future in FAA's analysis. If a lower discount rate, say 3%, is used as shown in Table 6 of the NPRM, the benefit/cost ratio of forward fit is over 50% greater than that of retrofit. The "equality" of the benefit/cost ratios that FAA has used as its sole justification for not adopting the forward fit-only option (Option 1) is quite sensitive to the discount rate used in the analysis method chosen by FAA. We submit that this justification in and of itself is an insufficient basis to reject Option 1.

We suggest that deciding whether or not to require retrofit of flammability reduction means is more complex than simply comparing the benefit/cost ratios of forward fit and retrofit. We believe that correction of the error in FAA's estimated accident rate (a factor of 2.33 reduction in safety benefit); use of the 75% SFAR 88 effectiveness (a factor of 2 reduction in safety benefit); use of the historical rate of 1 accident in 3 occurring in the air, instead of FAA's assumption that all will occur in the air (a factor of 2.5 reduction in safety benefit); and use of a higher estimated cost of the proposal, in line with (but still well below) EASA cost estimate (a factor of 2 increase in costs), all of which have been discussed in more detail above, are more reasonable assumptions for this regulatory analysis. If full compliance is shown to the NPRM using these figures, an estimated avoidance of only 0.84 accidents over the analysis period of 50.would result

The safety benefits in terms of fatalities avoided calculated by FAA from its assumed 4 accidents avoided would be 546 lives saved. However, application of the above cited factors would result in avoidance of only 47 fatalities, an overall reduction in safety benefit of about a factor of 12. This is because the FAA has substantially overstated the safety benefits from complying with the proposed rule.

Increasing the projected airline cost by the factor of 2 we suggest above results in a benefit/cost ratio a factor of 23 below that estimated by FAA, or about 2%. This avoidance of 0.84 accidents and about 47 fatalities over the next 50 years comes at a cost of the rule of some $808 million in present value terms. Of this, $530 million (present value) cost is attributed to the accidents to be avoided by retrofit of Boeing and Airbus airplanes (Table 121 of the Interim Regulatory Evaluation) and $278 million is the FAA estimated cost of compliance for the Airbus new production aircraft.

Note however, that the use of "present value" dollars hides understanding of the magnitude of the actual short term airline cash outlay required to retrofit the US fleet. In the short 7 year retrofit time (all of which would occur in the next decade), this NPRM would require US airlines to spend almost $600 million, by FAA estimate (Interim Regulatory Evaluation page 168, Table 95), in 2006 dollars. If our estimated cost is accepted, the actual retrofit expenditure would instead be about $1.2 billion in the next 10 years, to achieve avoidance by means of FRS retrofit alone of 0.4 accidents and about 22 fatalities over the next 32 years. FAA should evaluate this $1.2 billion expenditure in the next decade by a beleaguered airline industry against the estimated benefit of less than ½ an accident avoided over the next 32 years to determine if this is the most appropriate expenditure of finite safety improvement resources.

Comparison of benefit/cost ratio figures should not be dispositive of the question of whether of not to retrofit. A requirement to equip new production airplanes with FRS does not result in an "up front" expenditures like that required to support retrofit. The cost of accommodating a new production rule as proposed here is spread out over about the next 28 years (for the purposes of this analysis) in a relatively small incremental addition to the cost of each new aircraft acquired over that period. This long term incremental cost increase is far more affordable than the more immediate $1.2 billion cash outlay required to finance a fleet retrofit.

o) <u>Transient Suppression Devices (page 70945)</u>
"In particular, [FAA] request[s] information concerning the potential cost savings from not requiring airplanes to install transient suppression devices. [FAA] also reques[s] t that you provide documentation for the comments."

B737-100/-200/-300/-400/-500 series airplanes are fitted with various types of Transient Suppression Devices (TSDs) to show compliance to AD 99-03-04, B747-100/-200/-300 series airplanes are fitted with similar TSDs to comply to AD 98-20-40. These devices have proven to be a good method of reducing ignition source in these models. Furthermore, the Sandia National Laboratory Report states that these devices offer high level of protection in fuel tank ignition source prevention. Therefore we will not remove these installations as a tradeoff for a FRS. In fact, far from being a cost saving, the removal of these devices will incur additional costs for certification, service bulletins, manpower, and hanger space.

ADDITIONAL COMMENTS

a) Reliability reporting and control (page 70936)

How does the FAA envisage this be carried out? The complex nature of this kind of reporting system suggested by the FAA in order to monitor the fleet level of exposure cannot be achieved through current operator / TC reliability reporting channels. This will be a significant added cost to industry which is currently very difficult for us to quantify within the timescales of the NPRM comment period. This requires further investigation.

b) Ignoring recommendations
FAA have performed testing into the oxygen levels which required to make a fuel tank inert, refer FAA document DOT/FAA/AR-TN02/79, Limiting Oxygen Concentration Required to Inert Jet Fuel Vapors Existing at Reduced Fuel Tank Pressures. In the executive summary of the report it states:

> "Further experiments to examine the trend of peak pressure rise as a function of both altitude and oxygen concentration are needed".

However, the FAA appeared to have transferred the results from this report into the NPRM with out acknowledging the above fundamental statement.
Similarly this was has been done with the Sandia National Laboratory Report. In their conclusion they state:

> At this time, Sandia cannot directly support the 75 percent reduction in future tank explosions assumed by ARAC 2. The SFAR 88- related ADs have positively affected transport safety, yet unsafe conditions remain that need to be addressed.

Without taking into consideration that Sandia did not include SFAR 88 related changes, since they were not available at the time Sandia wrote the report, Sandia does not concur either with the 50% SFAR 88 effectiveness that the FAA assumes in the NPRM.

We also note that the ARAC 2 (2001) report made a specific recommendation (page 1-10) that the FAA "[i]nitiate a project to thoroughly document and substantiate the flammability model used in this study." This recommendation has not, to our knowledge, been carried out.

All reports that FAA uses to substantiate, were conducted by FAA itself or subcontracted, but it is clear that FAA disregards these recommendations or full conclusions of these reports.

The above demonstrates more than once that further study into flammability of aviation fuel and the effectiveness of ignition prevention means is necessary. This study should be fully independent and supported by a committee of participants of every sector within the worldwide aviation industry (authorities, manufactures, operators, aviation fuel suppliers, fire experts, etc.).

c) Human Errors (Page 70924)
Finally, human error creates continuing risk. Each attempt to fix an electrical system presents the possibility of an inadvertent introduction of a new ignition source. Maintenance oversights, such as the failure to properly install electrical bonds or improper installation or overhaul of components, compound the possibility of an ignition source developing.

Human errors are always possible for any system on an aircraft. Type Certificate holders are obliged consider these factors during aircraft design to mitigate errors. In addition continuing airworthiness instructions (maintenance manuals) highlight safety considerations where necessary. This is not new for the industry and should not be used as justification for introducing a rule based on unknowns. In the 17 accidents used by the FAA has been no evidence to suggest that any of them was has been caused by the introduction of an ignition source through human error. It should be noted that human errors will always be a factor in aviation safety particularly when introducing added complexity such as an inerting system.

d) New Ignition Sources (NPRM Page 70924)

> ''Past experience, moreover, shows that it is not possible to pinpoint and remove every ignition source from a large, complex transport aircraft. For example, the FAA is aware of one case where a manufacturer had conducted an exhaustive design review to identify possible sources of arcing within the fuel tank after a fuel tank exploded due to lightning. The manufacturer identified several possible sources of the arcing, and the FAA issued ADs to correct these deficiencies. The same airplane design was then evaluated as a result of SFAR 88, and additional sources of lightning-induced ignition were identified. In another instance, a TC holder submitted a safety analysis to the FAA claiming that certain airplane models met existing system safety requirements of § 25.1309 and thus that the likelihood of an ignition source developing was extremely improbable (one in a billion flight hours). When the requirements of the SFAR 88 safety review and unsafe condition criteria were applied, however, approximately 80 new unsafe conditions were found. These conditions will now be addressed by AD for those airplane models but, in retrospect, it was clear that the manufacturer's claims were erroneous.''

The SFAR 88 philosophy is based on a significant change in the way ignition sources were traditionally assessment. Prior to SFAR 88, aircraft design analysis was based on FAR 25.981 (heat sources) and FAR 25.1309 (probability). The SFAR 88 introduced additional requirements of latencies known and unknown failures (latent failure +1 approach, ref. FAA memo 2003-112-15 – Titled SFAR 88 – Mandatory Action Decision Criteria). Therefore it is not surprising that new potential secondary sources of ignition were found.

The NPRM should have a paragraph which highlighting the benefits of introducing SFAR 88 and the improvements it has contributed to the over all fuel tank safety initiative.

APPENDIX A – CORRECTIONS FACTORS

Accident rate (page 6)

FAA assumption is 1 per 60 million flight hours (FH) and predicts 7.8 accidents in the next 50 years. The accumulated flight hours for the applicable fleet will be then: 60 million FH x 7.8 = 468 million FH.

Historical data shows 3 accidents in 420 million FH, resulting in an accident rate of 1 per 140 million FH (420 / 3 = 140).

The corrected predicted number of accidents is then 468/140 = 3.34 accidents

This is a correction factor of **2.33** (factor **a**)

SFAR 88 Effectiveness (page 7)

FAA assumes 50% SFAR 88 effectiveness.
AEA is accepting 75% SFAR 88 effectiveness as predicted by the FAA in a previous NPRM.

The figure below shows going from 50% to 75% SFAR 88 effectiveness that this is a factor 2 change. Going from 0% (i.e. no modifications or start point) to 75% SFAR 88 effectiveness then this result in a factor 4 change.

Effectiveness (%)	0	25	50	75	100
Reference number (8)	8	6	4	2	0

factor of **2**
(factor **b1**)

factor of **4**
(factor **b2**)

Flammability Effectiveness (page 11)

$$\frac{X - Y}{X} \times 100 = Z$$

X = Current flammability exposure level
Y = Level of exposure to be reached (goal)
Z = Flammability Effectiveness

FAA wants to reach 95% Effectiveness (Z) by gaining a 3% exposure (Y). Using the formula above this will provide us a base level of 60% (X). This is a factor 20 (60/3) improvement.

Boeings current levels are between 16 – 18 % (X), to reach the 3% (Y) level the effectiveness will be between 81.3 – 83.3 % (Z). The factor of improvement will be 5.3 to 6 (16/3 – 18/3).

Airbus current levels are between 8 – 12 % (X), to reach the 3% (Y) level the effectiveness will be between 63 – 75 % (Z). The factor of improvement will be 2.7 to 4 (8/3 – 12/3).

Safety Benefit (page 12)

Number of fatalities

FAA assumption for each accident

- Rule will prevent 3.9 accidents
- 140 fatalities per flight
- All happens in the air

FAA number of fatalities = 3.9 x 140 = 546 fatalities.

AEA correction:
Historical data shows 3 accidents of these 3 only 1 happened in the air. The other 2 on ground, of these 2, 90% of the persons on board were able to evacuate on time.

Air :	1/3	x	546	=	182
Ground :	2/3	x	54.6 (10%)	=	36
Total :					218

Correction factor = 546 / 218 = **2.5** (factor **c**)

Predicted Safety Benefit

FAA basis:
- Number of accidents: 7.8
- FAA assumes 50 % of these accidents will prevented by SFAR 88.

FAA predicts that 7.8 / 2 = 3.9 accidents would be prevented by this rule.

AEA corrections:
- Number of accidents, factor **a = 2.33**
- SFAR 88 75%, factor **b1 = 2**

Corrected number of accidents prevented by this rule is:

$$\frac{FAA\_accidents}{(a \times b1)} = \frac{3.9}{(2.33 \times 2)} = 0.84$$

Number of lives saved by this rule is according the FAA:

$$Accidents \times Fatalities\_per\_flight = 3.9 \times 140 = 546\, fatalities$$

Corrected number of lives saved by this rule is:

$$Corrected\_Accidents \times \frac{Fatalities\_per\_flight}{c} = 0.84 \times \frac{140}{2.5} = 47\, fatalities$$

Maintenance fatalities (page 13)

ARAC 2 committee estimated that 1.4 to 4.7 fatalities per year worldwide will occur, with the extensive use of nitrogen gas. Assuming the lower end of this estimate of 1.4 fatalities per year would result (over the next 50 years) in:

$$fatalities\_per\_year \times period = 1.4 \times 50 = 70\, fatalities$$

Cost Benefit Analyses (page 15)

Retrofit:

FAA indicates 59% benefit/cost ratio.

Corrected ratio:

$$\frac{FAA\_ratio}{(factor\_a \times factor\_b1 \times factor\_c)} = \frac{59\%}{2.33 \times 2 \times 2.5} = 5.06\%$$

Further corrected with the EASA RIA will get: 5.1% / 2 = 2.53%

Forward fit:

FAA indicates 65% benefit/cost ratio.

Corrected ratio:

$$\frac{FAA\_ratio}{(factor\_a \times factor\_b1 \times factor\_c)} = \frac{65\%}{2.33 \times 2 \times 2.5} = 5.58\%$$

Further corrected with the EASA RIA will get: 5.6% / 2 = 2.79%

Total Correct value (page 15)

$$factor\_a \times factor\_b1 \times factor\_c \times factor\_EASA\_RIA = 2.33 \times 2 \times 2.5 \times 2 = 23.3$$