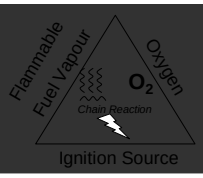
ENGINEERING February 2006

Presented by

Name Ross WALKER

JobTitle Engineering Progam Manager
Fuel Tank Safety



FAA NPRM 2005-22997

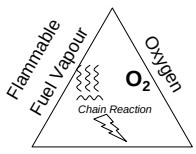
Reduction of Fuel Tank Flammability

Contents

IGNITION MITIGATION

Ignition Mitigation

COMBUSTION TRIANGLE



Aviation Fuel Tank Safety has traditionally considered fuel tanks to always contain flammable fuel vapours and oxygen and has mitigated the risk of a fuel tank explosion by addressing potential ignition sources.

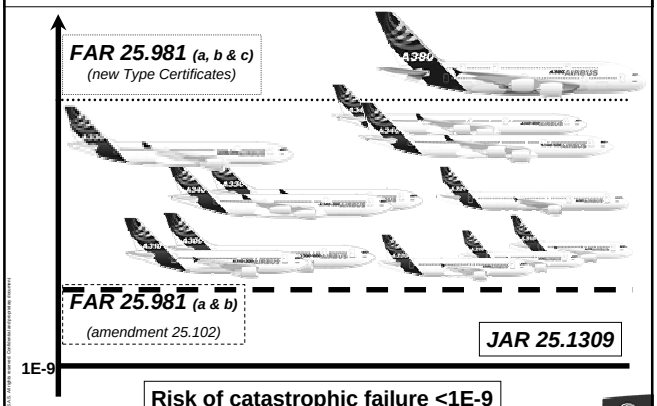
Following TWA-800, the FAA and EASA significantly enhanced the requirements addressing ignition sources with regulatory changes, SFAR 88 and JAA INT-POL-25-12.

Ignition Mitigation

ENHANCEMENT

- All fuel tank designs are at risk to some potential ignition sources. The level of risk is dependent on the specific design. There has been no published data comparing the risk of various fuel tank designs
  - The FAA initiated an independent assessment by Sandia Laboratories and were actively support by Airbus and Boeing. The results of this assessment have not been published by the FAA.
- The efficiency of SFAR 88 / INT-POL-25-12 was assessed by the ARAC FTIHWG as 75%, however the FAA are using 50% in the NPRM
- The benefits of SFAR 88 are based on the significant change in the assessment of ignition sources.
  - Traditionally based on FAR/JAR 25.981 (heat sources) and FAR/JAR 25.1309 (probability)
  - SFAR 88 introduced specific issues of latencies, known and unknown failures etc and enhanced maintenance.
- Mandated modifications, identified by SFAR 88 / INT-POL-25-12, will cost the industry in access of $600 million, not the $200 million identified in the IRE page 28.

Ignition Mitigation



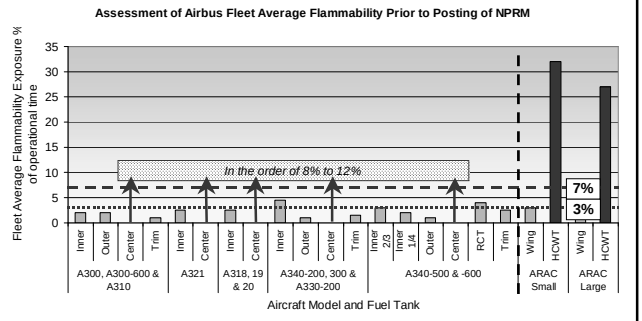
FLAMMABILITY REDUCTION

Flammability Reduction

HISTORY

- There have been three unexplained fuel tank explosions in the last 20 years.
  - 1990 Manila 737
  - 1996 Long Island 747
  - 2001 Bangkok 737
- 1998 FAA ARAC looked into fuel tank flammability and identified that some Center Wing Tank (CWT) designs could be flammable up to 36% of operational time compared to less than 3% for many wing tanks.
- The ARAC concluded that wing tanks had an acceptable safety record (risk) and that if CWT flammability could be reduced to similar levels then the risk would also be acceptable.
  - The ARAC was not allowed to investigate ignition source mitigation
- More recent data indicates that depending on manufacturer CWT may only be exposed between 8% to 18% of time. Therefore the potential reduction in risk is a half to a quarter of that considered by the 1998 ARAC.

Flammability Reduction



Since the FAA posted NPRM 22997 Airbus has begun assessing the flammability values with the analysis requirements proposed.

The differences with the analysis methodology used previously are small and therefore the results of the assessment are anticipated to be similar to those above.

Flammability Reduction

RISK

- The 1998 ARAC concluded that the risk of a wing tank explosion was acceptable.
  - There have been no un explained wing tank explosions to change this position.
- SFAR 88 has reduced the risk of explosion for CWT by a factor of two *(50% FAA)* to three *(75% ARAC FTIHWG)*.
- Therefore CWT with flammability of 9% with SFAR 88 applied *(75% effective)* are at a similar level of safety as wing tanks assessed by ARAC in 1998,
- Consequently there is no reason to discriminate between wing tanks and CWT.
- Airbus has not identified an unsafe condition that would necessitate fitting a Flammability Reduction System (FRS) to any Airbus fuel tank.

FAA NPRM 2005-22997

FAA NPRM 2005-22997

HISTORY

- June 2001 FAA Amendment 25-102 (SFAR 88) became effective require new TC to minimise the development of flammable vapours (or use IMM)
- August 2002 the FAA proposed that FRS could be used as part of SFAR 88 compliance as an alternative to certain ignition mitigation modifications
- February 2004 the FAA made a press statement that they would introduce a regulatory change to require FRS to be fitted to certain HCWT
- February 2005 the FAA posted the proposed Special Condition 25-03-08-SC to fit FRS on B747.
- November 2005 FAA NPRM 2005-22997 “Reduction of Fuel Tank Flammability in Transport Category Airplanes” was published in the Federal Register.

FAA NPRM 2005-22997

SYNOPSIS:

- The FAA state that the risk of a HCWT explosion is one in 60 million
- The FAA estimate that the proposed rule would prevent four accidents over the next 50 years.
- The FAA state 12% O_2 will inert fuel tanks
- The FAA propose forward and retrofit of FRS on all fuel tanks of passenger aircraft that have a fleet average flammability exposure >7%
- The FAA propose that flammability exposures should be reduced to
  - 7% for wing tanks and 3% for CWT for Type Certificates (TC) applied for before June 2001 and
  - 3% for all new TC.
- The FAA state FRS will provide a 95% reduction in risk for HCWT.
- The FAA provide cost estimates for retrofit of FRS but discount forward fit as FAA only have jurisdiction over US manufacturers and Boeing have already volunteered to install FRS on most HCWT.
- The FAA propose the compliance schedules including model specific deadlines for Airbus and Boeing products.

FAA NPRM 2005-22997

FAA COSTS ESTIMATES

Cost in $	System cost & installation in production	System cost in retrofit	Retrofit in a D check + 1 days	Retrofit out of D check (4days)
Small	90,000	104,500	140,000 (416 hrs)	163,000 (527 hrs)
Medium	115,000	134,000	184,000 (409 hrs)	235,000 (507 hrs)
Large	145,000	178,800	227,00 (356 hrs)	276,000 (467 hrs)

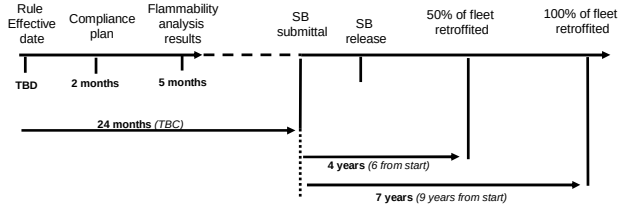
FAA NPRM 2005-22997

EASA RIA COSTS ESTIMATES

(costs in € per airframe)	Cost for installing a FRS in production		
($1 = €0.83)	Manufacturer A	Manufacturer B	*FAA NPRM*
Single aisle	392 000	81 225	*75,000*
Medium size	545 000	101 582	*96,000*
Large wide body	640 000	131 357	*121,000*
(costs in € per airframe)	Cost of retrofitting a FRS		
	Manufacturer A	Manufacturer B	*FAA NPRM*
Single aisle	505 000	136 879	*87,000*
Medium size	715 000	179 270	*112,000*
Large wide body	840 000	238 176	*149,000*

FAA Position

- FAA Proposed Compliance Timescales



FAA Proposal	SB submital	50% fleet	100% fleet	
A320 etc	> Dec 2006 ?	> Dec 2010 ?	> Dec 2013 ?	***Dates as if rule was issued in 2005, dates shift to be negotiated with FAA***
A300 etc	> Jun 2007 ?	> Jun 2011 ?	> Jun 2014 ?	
A340 etc	> Dec 2007 ?	> Dec 2011 ?	> Dec 2014 ?	

FAA NPRM 2005-22997

COMMENTS ON NPRM

- Historical Accident Rate
  - The world fleet of has flown over 450 million flight hours and experienced three unexplained fuel tank explosions. This is an accident rate of approximately one in 150 million.
  - The independent "Mitre" assessment states the accident rate is in the one in 160 million.
  - The FAA use one in 60 million.
- Effectiveness of the Proposed Rule
  - The FAA predict that without SFAR 88 or FRS there would be 8 future accidents & with SFAR 88 the number prevented would be 4.
  - The projected effectiveness is based on SFAR 88 being 50% effective. If a figure of 75% *(ref. ARAC 2)* is taken for SFAR 88 then the projected number of accidents prevented by SFAR 88 would be 6.
  - When combined with an error of 2.5 in the historical accident rate the projected rate will be less than one accident prevented if FRS is also applied.

FAA NPRM 2005-22997

COMMENTS ON NPRM

- Ignition Risk
  - The FAA assessments consider all fuel tanks have an equal risk of ignition.
  - The risk of ignition of a fuel tank is dependent on several factors which are not the same for all fuel tanks:
    - Exposure to potential energy sources, e.g. lightning
    - Number of pieces of equipment installed
    - E.g. Airbus A321 HCWT is no exposed to direct lightning strikes, has no electrical-mechanical fuel pumps and has fewer pieces of FQI equipment than the wing tanks on the same aircraft. The flammability of the HCWT is in the order of 3 time s greater than the wing tanks.
      Therefore with respect to ignition source mitigation it is better than the wing tanks but with respect to flammability wing tanks are better.
      Overall the risk of an explosion are similar.
    - The presence high power electrical/mechanical fuel pumps and the operational procedures associated to them has been identified as a ***potential*** cause of ignition in the case of two of the accident aircraft.

FAA NPRM 2005-22997

COMMENTS ON NPRM

- Oxygen Concentration
  - 12% O_2 does not render fuel tanks inert.
  - Combustion *(oxidation)* is possible as long as oxygen is present
  - 12% O_2 will reduce the risk by reducing the number of potential ignition sources that can initiate combustion.
- Flammability Exposure
  - The FAA have based there proposal on the preliminary flammability assessments made in the 1998 ARAC which showed a difference in the order of ten between wing and HCWT *(3% & 32%)*.
  - Validated models have shown that the actual difference in flammability is in the order of three to six
  - FAA FRS does not reduce flammability by 95%
    - 9% to 3% is an improvement of ≈66%, or,
    - 15% to 3% is an improvement of ≈80%

FAA NPRM 2005-22997

COMMENTS ON NPRM

- Costs
  - The FAA costs are approximately half those assessed by both the FAA 2001 ARAC and EASA 2004 RIA.
  - The differences with the EASA RIA are not explained
- Schedule
  - The FAA state the proposed compliance schedule for Airbus aircraft is based on the final rule having been issued in 2005. Therefore the dates given will need to be revised in the final rule.
  - The FAA state that they assume Airbus in advance stages of developing an FRS system. This is not true.
    Airbus is involved with several potential suppliers but has not at this time launched modifications to install FRS on any fuel tanks.

FREQUENTLY ASKED QUESTIONS

Frequently Asked Questions

1. Kit cost, quoting suppliers
   - FAA cost estimates are considered to be on the low side.
   - Airbus cost estimates are in the same order of magnitude as those assessed by EASA RIA in 2004. Airbus is not in a position to provide more precise data as the specific design solutions have not been finalised.
   - Airbus is working with three suppliers but has not made final selection at this time.
   - Airbus has also investigated alternative means of FRS to oxygen depletion proposed by the FAA.
2. Aircraft down time for installation
   - The FAA down time estimates are shorter than those of Airbus in the order of two days. Airbus estimate that all the work may not be completed during a standard heavy maintenance visit.

Frequently Asked Questions

3. Man Hours
   - The FAA estimate of man hours is of the same magnitude as those of the EASA RIA and Airbus
   - However Airbus estimate that the elapsed time will be one or two days longer than a standard heavy maintenance visit.
4. System weight
   - Until a final design solution is defined Airbus weights unknown. However the FAA estimates on weight are considered to be in the correct order of magnitude.
5. Fuel Burn penalty
   - Initial assessments of the fuel burn penalty indicate that it will be small.
6. Reliability figures of test system installed on airbus aircraft.
   - The only FRS that has been installed on Airbus aircraft was the FAA prototype and was installed in the cargo hold of an A320 and required two full time flight test engineers to operate.

SUMMARY

SUMMARY

- Ignition risk is not the same for all fuel tanks. The specific design of each tank needs to be considered.
- Airbus fuel tanks include specific design features that are not on some other aircraft models, these include:
  - No fuel pump wiring routed through the fuel tanks
  - Forced ventilation/vapour seals between ECS packs and CWT.
  - Automatic fuel pump shut-off
- Airbus fuel tank designs have evolved and the latest models have even higher safety levels.
- Airbus has not identified an unsafe condition that necessitates the fitting of FRS on any Airbus fuel tank.
- Airbus will assist the FAA and comment on the NPRM to correct inaccuracies, to ensure that the FAA have the appropriate data to use in developing the final rule to enable them to addresses the question of fuel tank safety in an appropriate and proportionate manner.