Fuel Tank Flammability Assessment Method – Version 11 Update

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Background

- The Fuel Tank Flammability Assessment Method (FTFAM) is an Excel© based macro based on work originally performed by the 1998 ARAC Fuel Tank Harmonization Working Group.

- It is a comparative analysis tool to examine airplane fuel tank flammability.

- The program utilizes Monte Carlo statistical methods to determine several unknown variables, using standardized distributions in order to calculate the fleet average flammability exposure time of a given fuel tank.

- From 1998 – Present, the FAA has utilized input from industry and information gained from various research activities to help refine and improve the model's capabilities.

Background

- The current version 10 FTFAM was released with the Fuel Tank Flammability Reduction Rule in July, 2008.

- Since the release of version 10, there have been several minor corrections needed to the model.
  - The descent profile used in the model did not match what was in the regulation
  - There was a typo in the temperature lapse rate calculations
  - There were some calculation errors on the “FRM” worksheet
  - The FRM flammability time was not transferred onto the “Summary of n Cases” worksheet

Version 11 Changes

- Descent Profile
  - Regulation states a descent rate of 2500 ft/min down to 4000 ft, and 500 ft/min from 4000 ft to touchdown.
  - Version 10 calculated the descent time based on this profile, but then utilized a constant descent rate throughout based on this calculated descent time. This resulted in a varying descent rate from flight to flight.
  - The code in V.11 has been corrected so that the model now utilizes the prescribed descent rates as in the regulation.
  - The effect of this change over 1,000 flights, using a set of standardized inputs, is a flammability exposure of 55.72% vs. 52.90% prior to the change.

Version 11 Changes

- Temperature Lapse Rate Calculation
  - The lapse rate calculation in V.10 used 3.57°F/1000 ft up to 10,000 ft and then 3.75°F/1000 ft above 10,000 ft.
  - This was a typo and was corrected in V.11 to 3.57°F/1000 ft throughout.
  - The effect of this change over 1,000 flights, using a set of standardized inputs, is a flammability exposure of 52.64% vs. 52.90% prior to the change.

Version 11 Changes

- FRM Worksheet Errors
  - In the FRM Results table, the column labeled “Contribution to whole” was miscalculated. It has now been adjusted so that the results are displayed properly.
  - This error has no impact on flammability results, as the information in this table is displayed for informational purposes only.

FRM Performance results

Summary data for specific portions of the flights

•Ex:
•23.1=66/286
•23.1=(flam time)/(total flam time)

All flights

	total time	flam time	% Flam	Contrib to whole
ground	3210	0	0.0	0.0
climb	2307	66	2.9	23.1
Cruise1	3663	47	1.3	16.4
Cruise2	1878	0	0.0	0.0
Cruise3	384	0	0.0	0.0
descent	2163	173	8.0	60.5
taxi-in	3000	0	0.0	0.0
total	16605	286	1.7	100.0

) Deg F

	total time	flam time	% Flam
ground	3210	0	0.0
climb	2313	66	2.9
Cruise1	3686	47	1.3
Cruise2	1874	0	0.0
Cruise3	382	0	0.0
descent	2140	173	8.1
taxi-in	3000	0	0.0
total	16605	286	1.7

Corrected Table as Seen in Model

Version 11 Changes

- FRM Flammability Time
  - There was an error in the Visual Basic code which made it so that the total FRM flammability time was not transferred onto the 'Summary of n Cases' worksheet.
  - This error was corrected, and has no impact on results.

- Net effect of all changes:
  - Using a set of standardized inputs, over 1,000 flights these changes resulted in a flammability exposure of 55.45% as compared to 52.90% prior to the implementation of the changes.

Release of Version 11

- An internal review of the updates to the model is in the process of being conducted.
- Once complete, the updated model will be released and available on the FAA Fire Safety website (www.fire.tc.faa.gov).
- Until that time, users should continue to use V.10

Standardized Inputs Used for Comparison Purposes

Airplane Data

Maximum Range		10000	NM
Number of Engines		4	
Resultant Maximum Flight Time=		1320	minutes
OAT cutoff (AFM Limitation)	OAT Limit=	130	Deg F

Flight Data

		Tank Ram Recovery	
Cruise Mach Number	0.81	0	% of Ptotal
Cruise Altitude Steps	31000		ft
	35000		ft
	39000		ft

Fuel Tank Usage Data

Tank Full any time before	230	minutes before touchdown
Tank empty any time after	10	minutes before touchdown
Engines or equipment started at	90	minutes prior to takeoff

Body Tank Input Data

Set all values to zero if tank is not a body tank.

Tank in the fuselage with no cooling from outside air	0	1=Yes, 0=No
Tank pressurized in flight,	0	1=Yes, 0=No
Pressure differential relative to ambient	0	psi
Tank is pressurized	0	minutes before takeoff
Temperature of compartment surrounding tank	0	Deg F

Fuel Tank Thermal Data

The fuel is assumed to be loaded at ambient temperature

Tank Constants, Ground Conditions:	Eng.OFF	EngON	
Equilibrium DeltaTemp	45	45	Deg F
Exponential time Constant -Tank near Empty	280	280	Minutes
Exponential time Constant -Tank near Full	35	35	Minutes

Tank Constants, Flight Conditions:		
Equilibrium DeltaTemp	80	Deg F
Exponential time Constant -Tank near Empty	280	Minutes
Exponential time Constant -Tank near Full	155	Minutes