The Impact of Low Flashpoint Fuels on FAA Flammability Requirements

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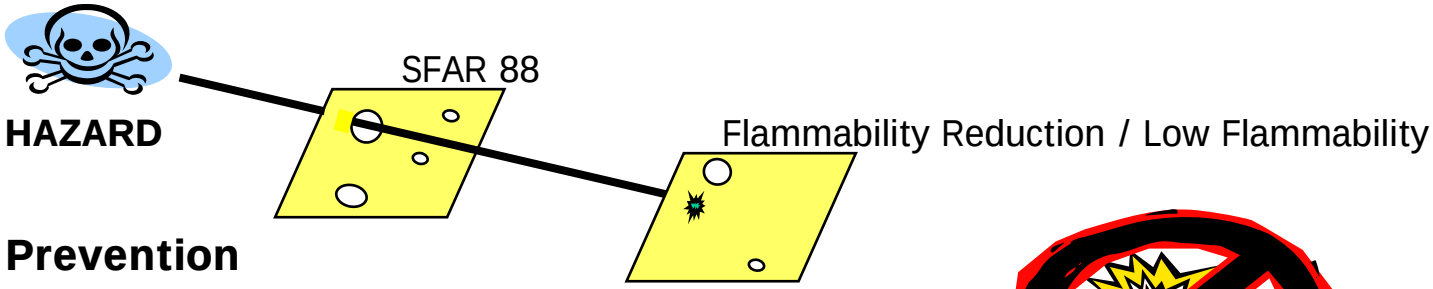
International Aircraft Systems Fire Protection Working Group
Atlantic City, NJ
November 17-18, 2009

Fuel Tank Flammability - Background

- Since 1960, 18 airplanes have been damaged or destroyed by fuel tank explosions
- Previous rules attempted to prevent ignition sources but this has not been completely effective
- New rule published July 21, 2008 to significantly reduce the likelihood of fuel tank explosions in:
  - Existing fleet
  - Newly produced airplanes
  - Future airplane designs
- The goal is to prevent fuel tank explosions by establishing a performance-based set of requirements that set acceptable flammability exposure values in tanks most prone to explosion

Balanced approach to fuel tank safety

- Flammability reduction significantly reduces hole size in flammability layer, significantly reducing the likelihood of future accidents.



Ignition Prevention Layer

- Some holes eliminated (e.g. design changes to preclude single failures)
- Other holes reduced in size (human factors/ maintenance issues, unknowns, etc.)

Flammability Layer

-Reducing flammability exposure significantly reduces holes (flammability reduction)

-Small holes remain due to system performance, dispatch relief, system reliability, etc.

ACCIDENT PREVENTED !

FTFAM - 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.

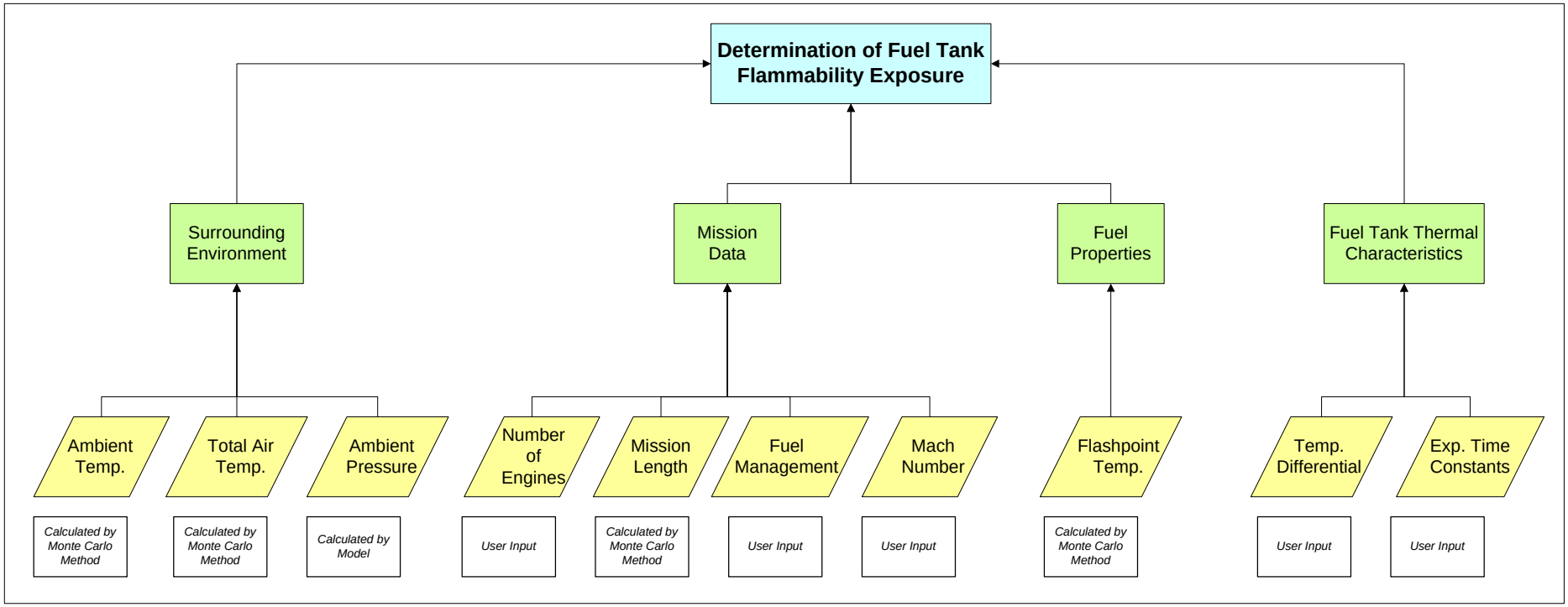
- From 1998 – Present, the FAA has utilized input from industry and information gained from various research activities to help refine and improve the model's capabilities.

FTFAM - Background (cont.)

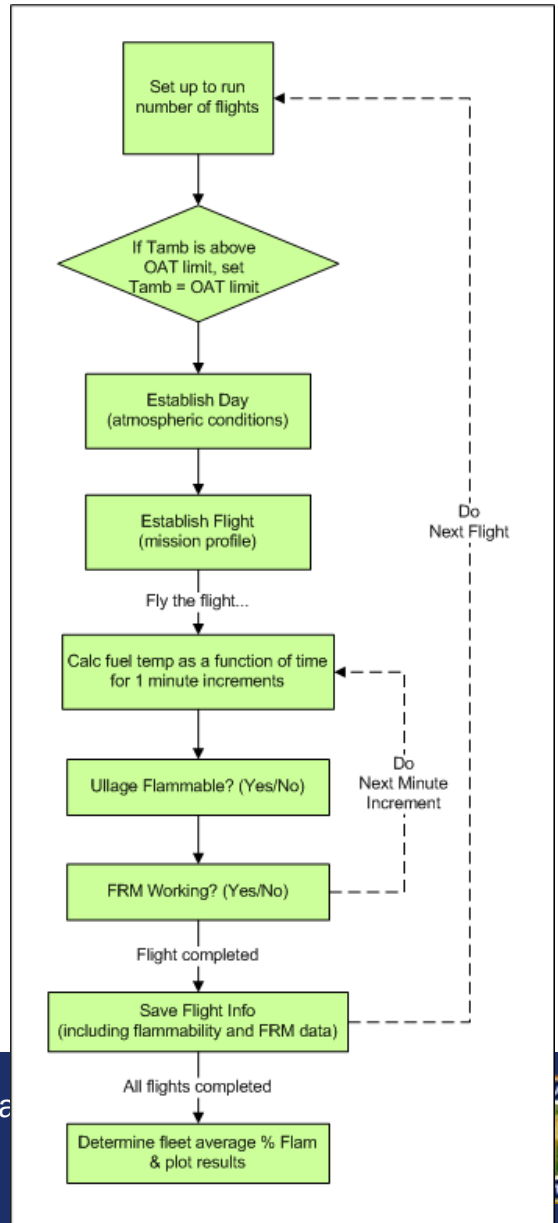
- The FTFAM utilizes these techniques to generate values for several unknown variables, utilizing standardized distributions.
  - Fuel flashpoint temperature
  - Ambient ground temperature
  - Ambient cruise temperature
  - Flight mission length

- Additional functionality of the program:
  - Single flight analysis (for troubleshooting)
  - Random Number Freeze (for troubleshooting)
  - Warm day analysis
  - Flammability Reduction Method (FRM) effectiveness analysis

FTFAM - Overview



FTFAM – Overview (cont.)



Flashpoint Distribution

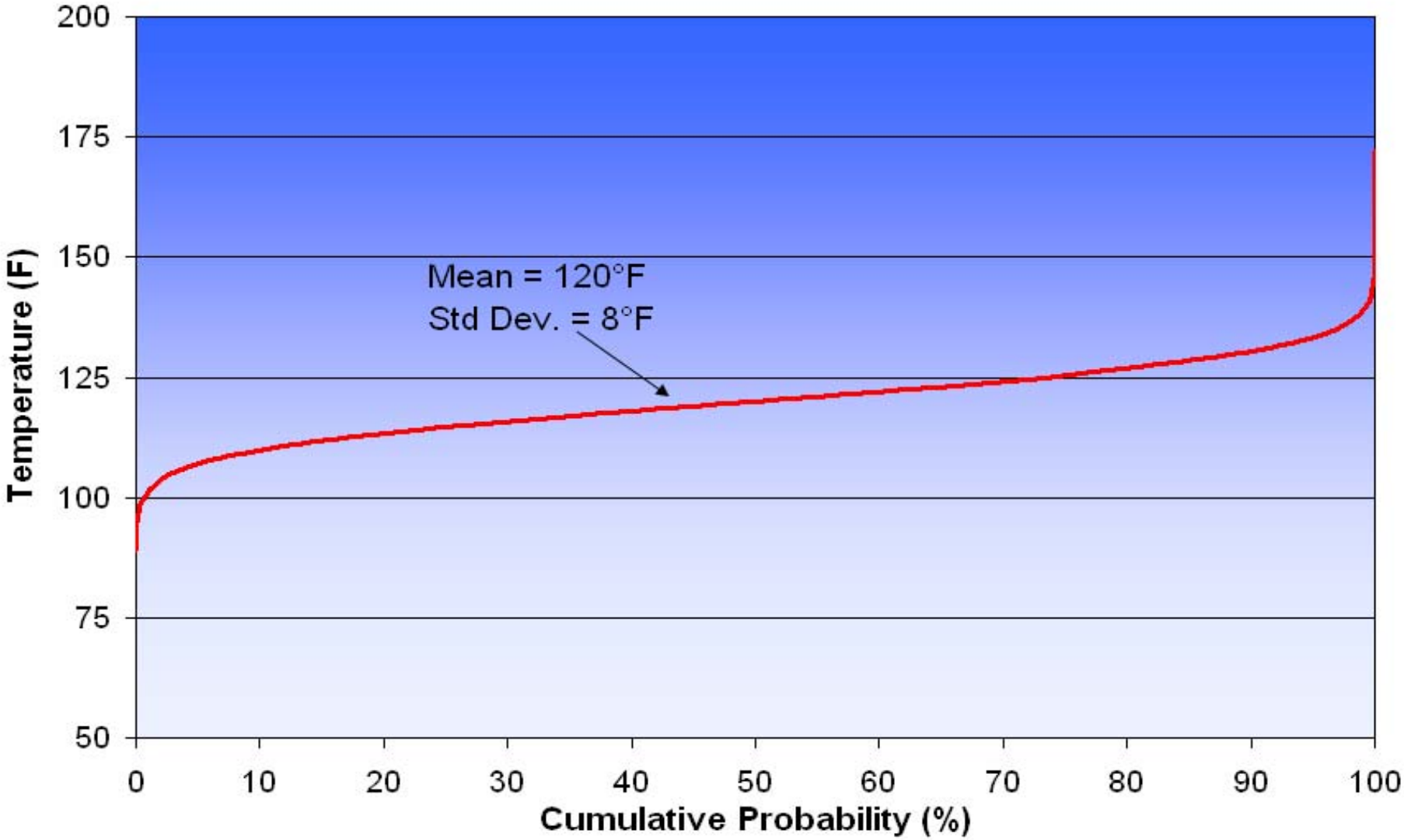
- The Standard Specification for Aviation Turbine Fuels (ASTM D 1655), specifies a minimum flashpoint value of 100 °F for Jet A fuel.

- Similar standards for other aviation fuels also only specify a minimum value.

- In attempt to determine the actual flashpoint of jet fuel as used in service, the FAA conducted a study in which 293 samples were taken from both domestic and international flights. Results of this study are published in FAA report DOT/FAA/AR-07/30.

- The results of that study are used by the program to develop the standardized distribution of flashpoints from which a Monte Carlo analysis can be performed.

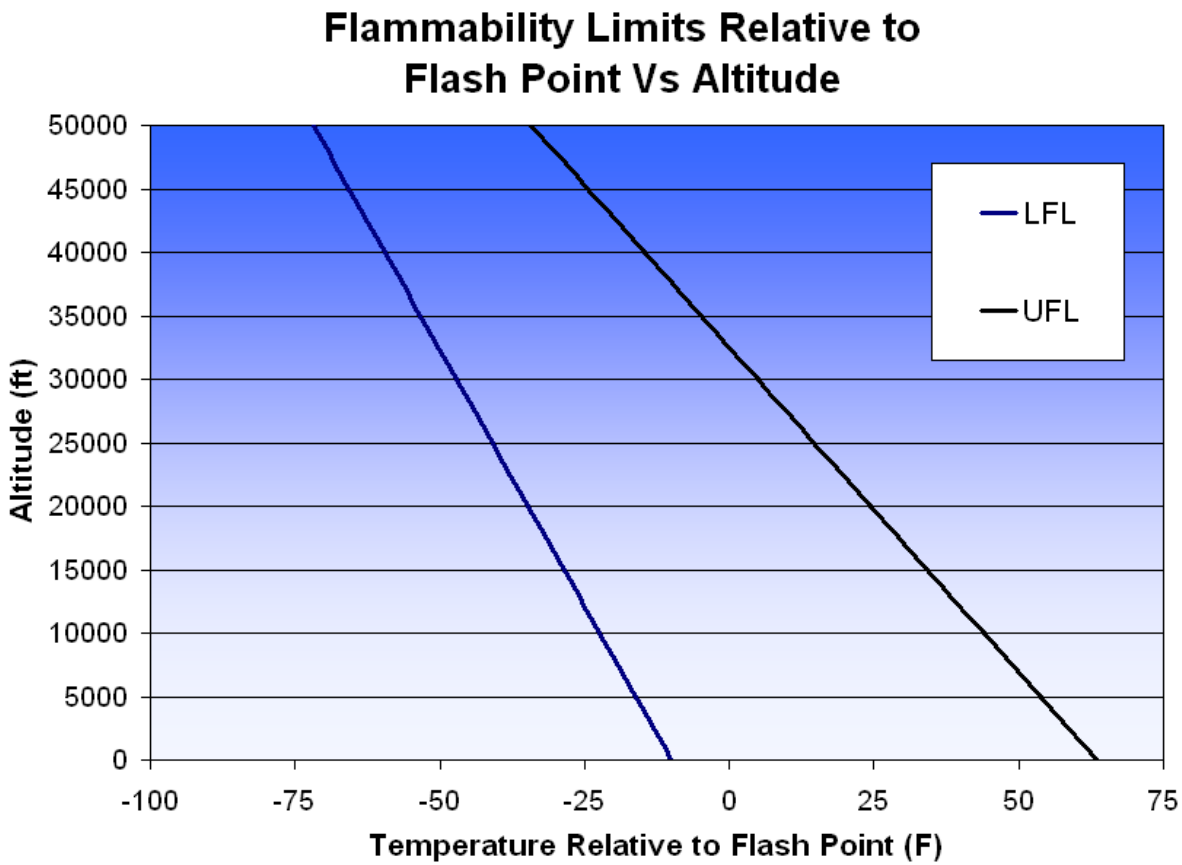
Probability Distribution of Flashpoint Temperature

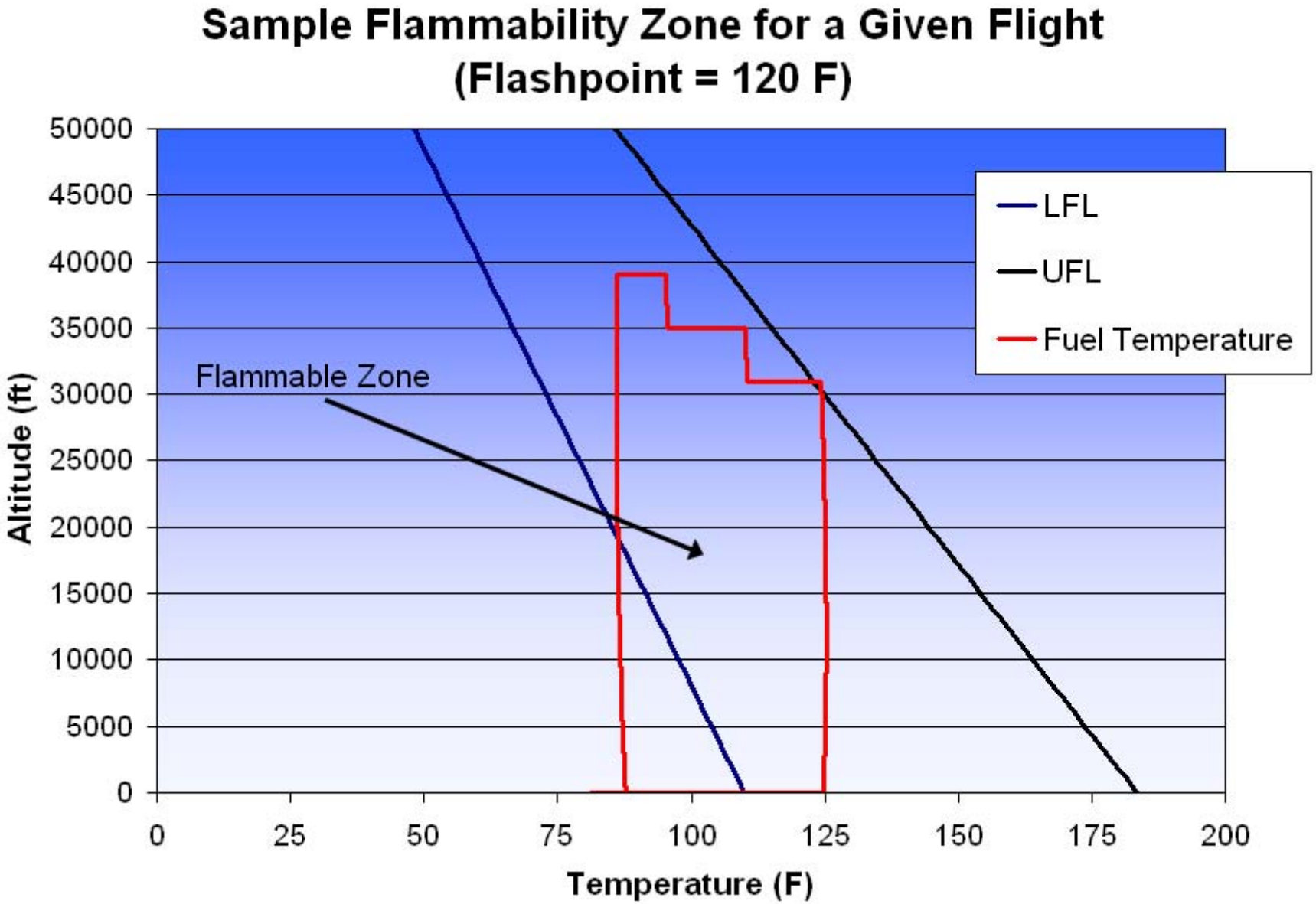


The Utilization of Flashpoint in the FTFAM

- Previous work has shown that the LFL and UFL can be defined, in terms of temperature as:
  - LFL= (Flash Point - 10) - Altitude/808,
  - UFL=(Flash Point + 63.5) - Altitude/512

  (where temperature is in Deg F and altitude is in ft.)



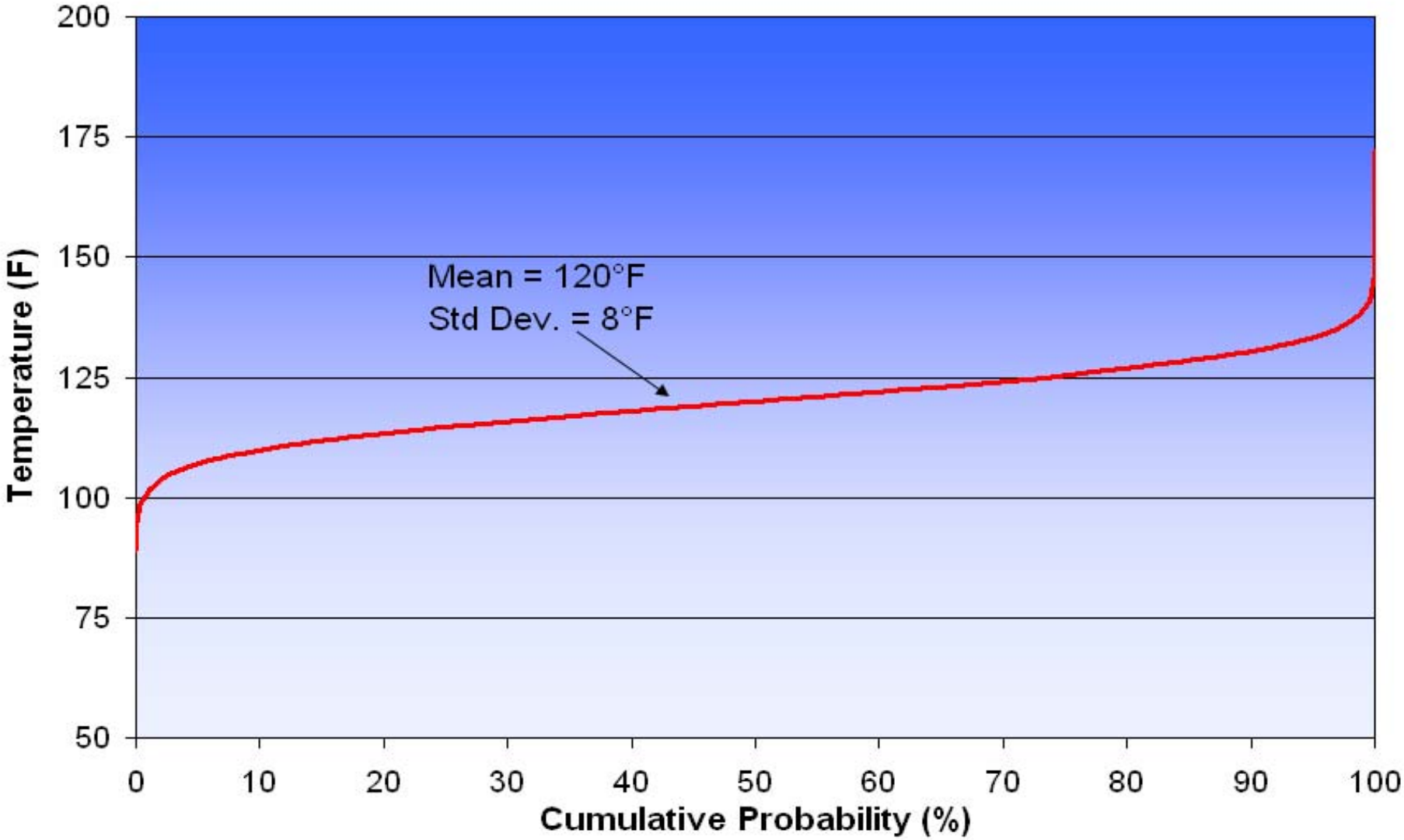

Sample Flammability Zone for a Given Flight
(Flashpoint = 120 F)
Altitude (ft)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0
25
50
75
100
125
150
175
200
Temperature (F)
Flammable Zone
LFL
UFL
Fuel Temperature

Flashpoint Distribution - Potential Impact

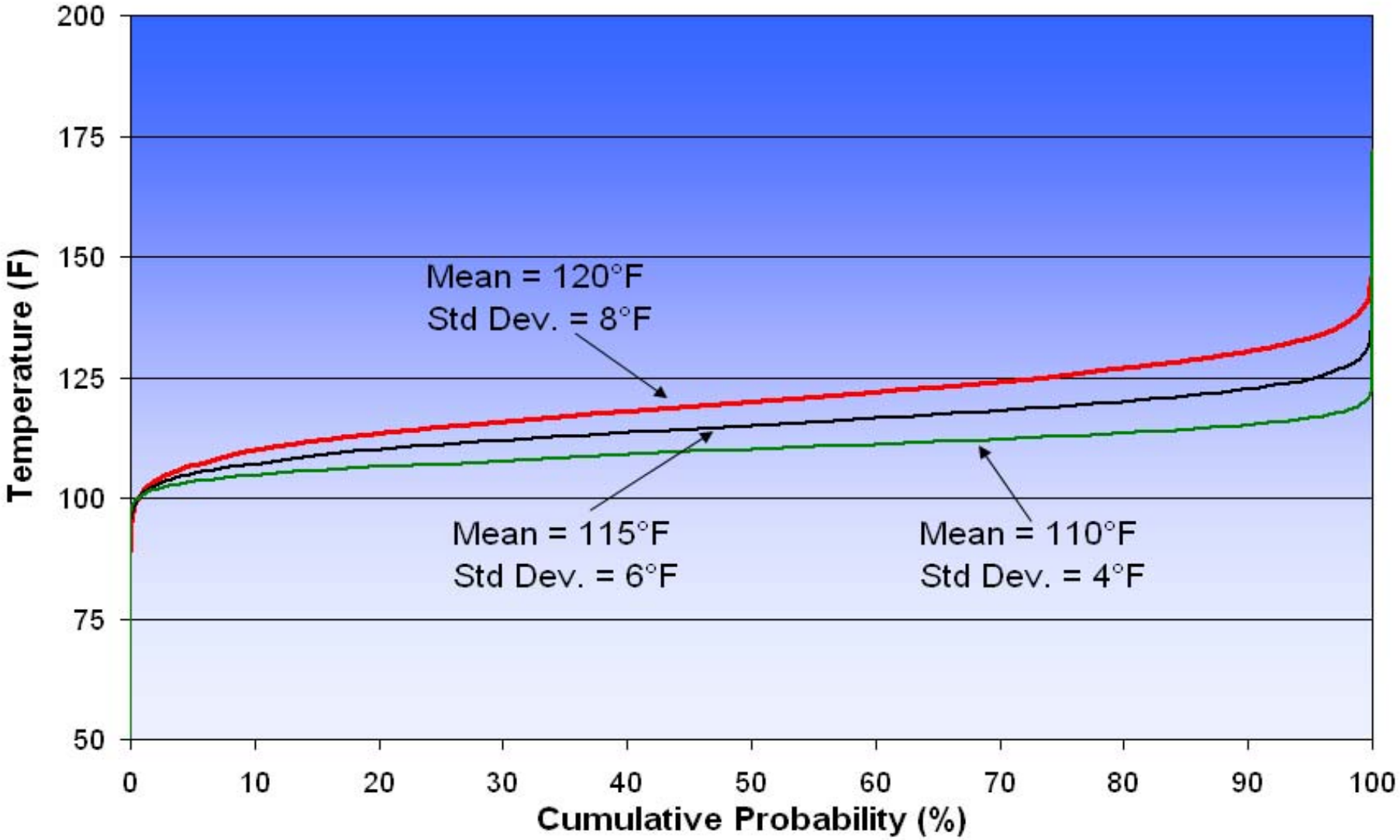
- With the introduction of new fuels, there is a potential for a shift in this flashpoint distribution, despite the fact that the minimum specifications are the same as for Jet-A fuel.

- Any shift in this distribution, has a direct effect on the overall fuel tank flammability exposure and on the sizing and design of any Flammability Reduction Means (FRM) that is utilized.

Probability Distribution of Flashpoint Temperature



Probability Distribution of Flashpoint Temperature



FAA Fuel Tank Flammability Exposure Monte Carlo Version 10 June 28, 2007

Please read the Instrucitons document before use

Airplane Data

Enter/Change input ONLY in Yellow cells

Maximum Range	4500	NM
Number of Engines	2	
Resultant Maximum Flight Time=	610	minutes
OAT cutoff (AFM Limitation) OAT Limit=	130	Deg F

Flight Data

		Tank Ram Recovery
Cruise Mach Number	0.81	0.35 % of Ptotal
Cruise Altitude Steps	31000	ft
	35000	ft
	39000	ft

Fuel Tank Usage Data

Tank Full any time before	610	minutes before touchdown
Tank empty any time after	500	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

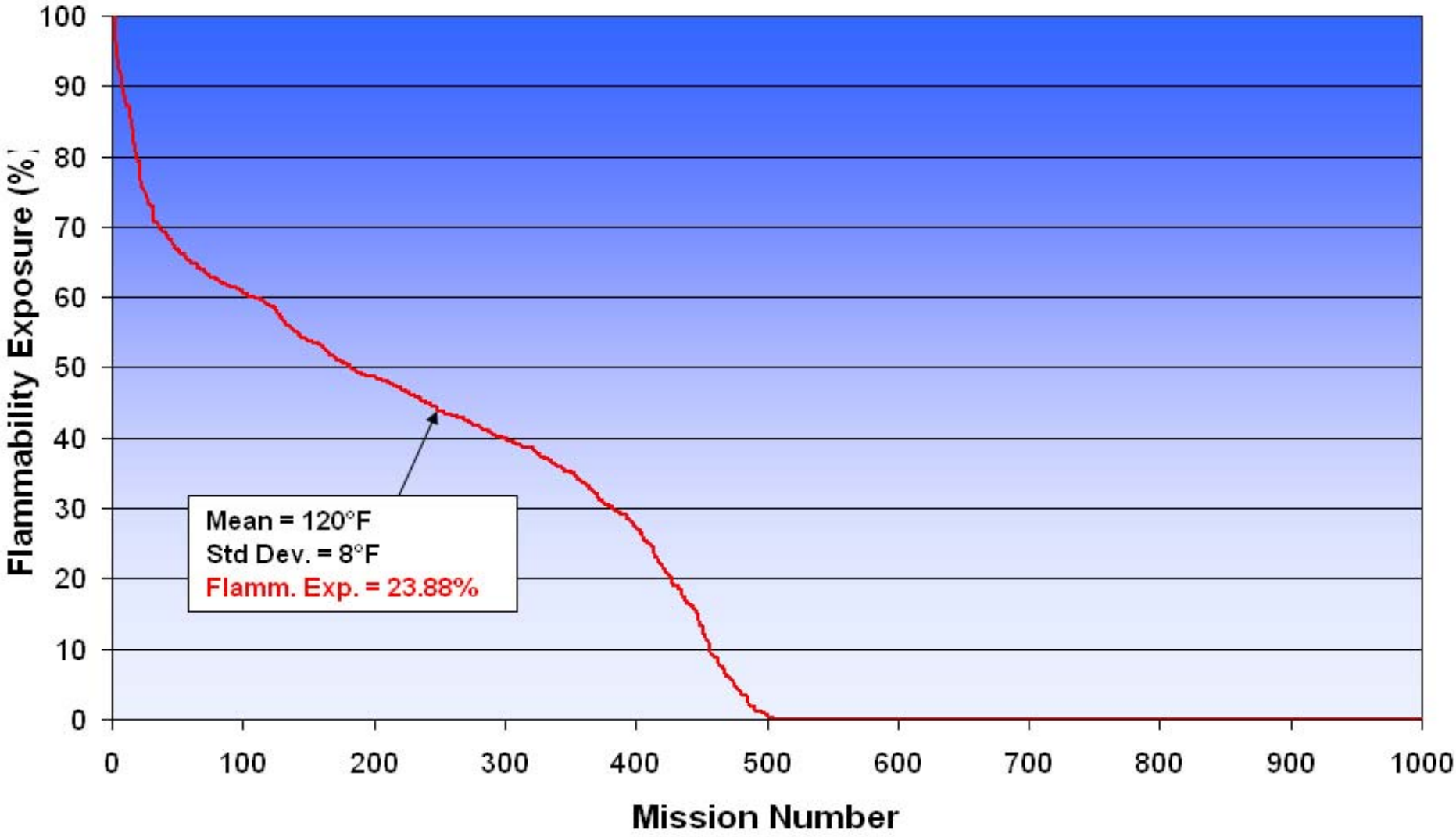
The fuel is assumed to be loaded at ambient temperature

Tank Constants, Ground Conditions:	Eng.OFF	EngON	
Equilibrium DeltaTemp	60	60	Deg F
Exponential time Constant -Tank near Empty	200	200	Minutes
Exponential time Constant -Tank near Full	400	400	Minutes
Tank Constants, Flight Conditions:			
Equilibrium DeltaTemp	60		Deg F
Exponential time Constant -Tank near Empty	200		Minutes
Exponential time Constant -Tank near Full	400		Minutes

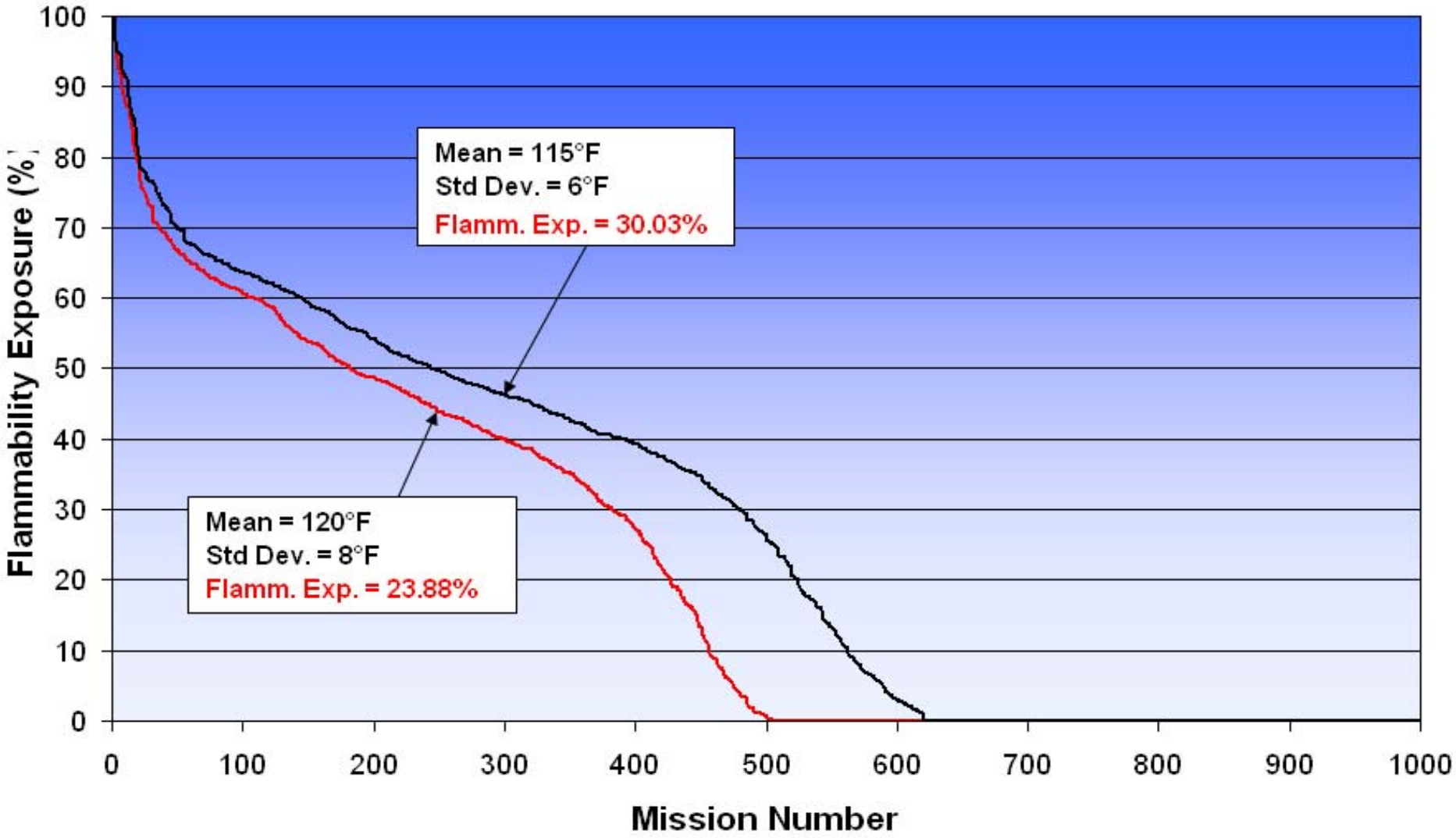
Multiflight Monte Carlo: Number of Flights

Number of Flights	100,000	Freeze random numbers	1 1=Yes, 0=No
		Warm day analysis only	0 1=Yes, 0=No

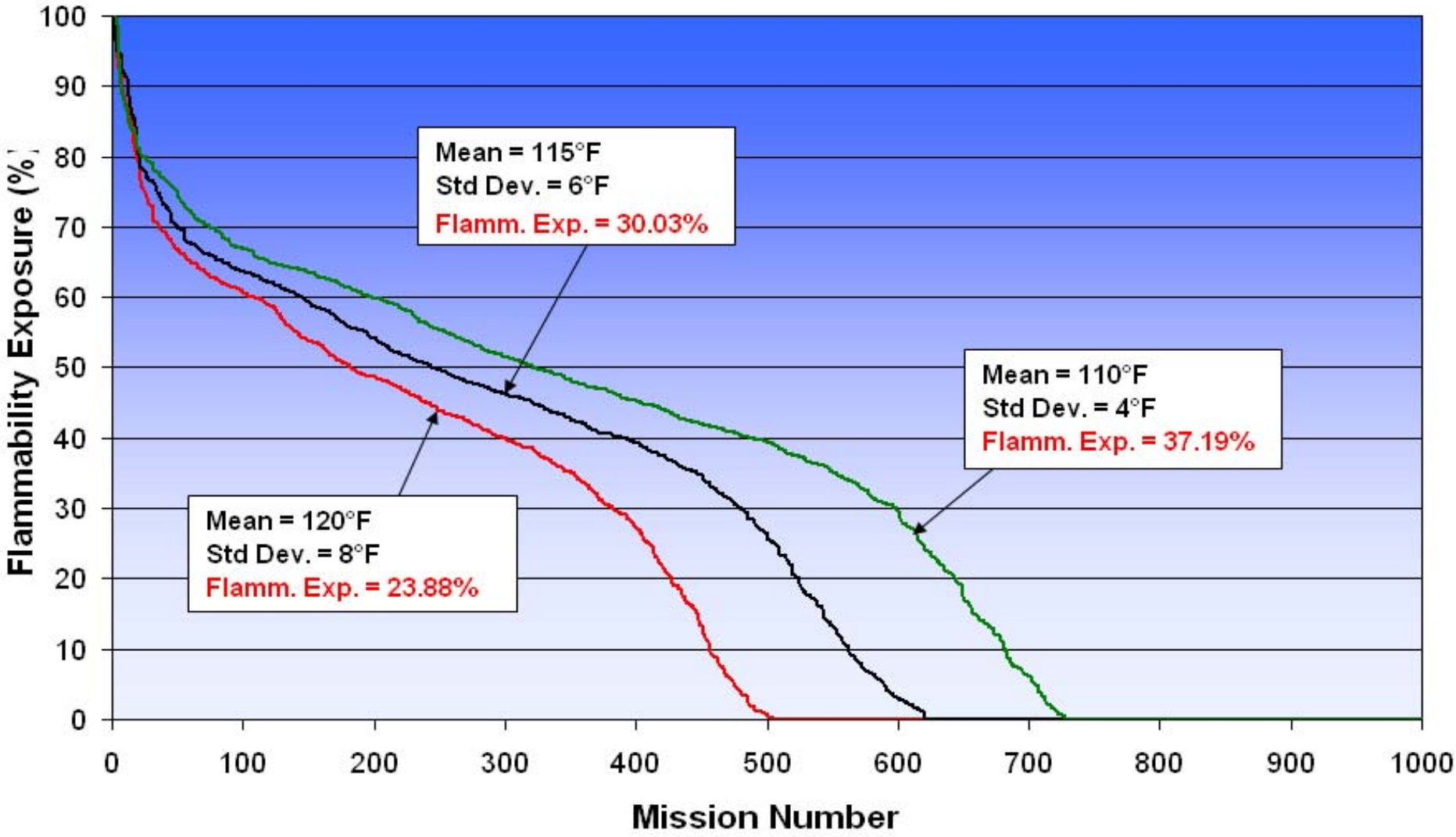
Flammability Exposure



Flammability Exposure



Flammability Exposure



Summary

- The introduction of new fuels into the fleet poses a potential shift in the flashpoint distribution, which leads to significant changes in the overall flammability analysis of a fuel tank.

- These changes have a direct impact on determining if an FRM is required, and on the sizing and design of any FRM that is utilized.

- Maintaining the same minimum spec value as Jet A is not sufficient. To avoid this issue, the actual flashpoint distribution of in service fuel needs to be monitored as new fuels are introduced into the fleet.

For further details regarding the Fuel Tank Flammability Reduction Rule or the Fuel Tank Flammability Analysis Method:

http://www.fire.tc.faa.gov/systems/fueltank/FTFAM.stm