

tank thermal characteristics specified as exponential heating/cooling time constants, and equilibrium temperatures for various fuel tank conditions. Single flights may be studied, or a multi-flight Monte Carlo analysis may be run. This model is intended to provide comparison trends and not absolute numbers. The general methodology for conducting a Monte Carlo model is described in AC 25.981-2.

The FAA has developed a specific model for calculating fleet average flammability exposure using the Monte Carlo methodology. The FAA model, or one with modifications approved by the FAA, must be used as the means of compliance with these special conditions. The accepted model can be downloaded from the Web site <http://qps.airweb.faa.gov/sfar88flamex>. On this Web site, the model is located under the page "Flam Ex Resources," and is titled "Monte Carlo Model Version 6a." The "6a" represents Version 6A. Only version 6A or later of this model can be used. The following procedures, input variables, and data tables must be used in the analysis if the applicant develops a unique model to determine fleet average flammability exposure for a specific airplane type.

## II. Monte Carlo Variables and Data Tables

Fleet average flammability exposure is the percent of the mission time the fuel ullage is flammable for a fleet of an airplane type operating over the range of actual or expected missions and in a world-wide range of environmental conditions and fuel properties. Variables used to calculate fleet flammability exposure must include atmosphere, mission length (as defined in Special Condition I(g), Definitions, as Operational Time), fuel flash point, thermal characteristics of the fuel tank, overnight temperature drop, and oxygen evolution from the fuel into the ullage. Transport effects, including mass loading, flammability lag time, and condensation of vapors due to cold surfaces, are not to be allowed as parameters in the analysis.

### Atmosphere

In order to predict flammability along a given flight, the variation of ground ambient temperatures, cruise ambient temperatures, and a method to compute the transition from ground to cruise and back again must be used. The variation of the ground and cruise temperatures and the flash point of the fuel can be defined by a Gaussian curve, given by the 50 percent value and a  $\pm 1$ -sigma value.

The ground and cruise temperatures are linked by a set of assumptions on the atmosphere. The temperature versus altitude follows a standard lapse rate from the ground temperature until the cruise temperature is reached. Above this altitude, the temperature is fixed at the cruise temperature. This gives a variation in the tropopause altitude. For cold days, an inversion is applied up to 10,000 feet, and then the standard lapse rate is applied.

The analysis must be able to execute a number of flights, and for each flight a separate random number must be generated for each of the three parameters (*i.e.*, ground ambient temperature, cruise ambient temperature, and fuel flash point) using the Gaussian distribution defined in Table 1. The applicant can verify the output values from the Gaussian distribution using Table 2. Table 2 is based on typical use of Jet A type fuel. If an airplane is approved for use of lower flash point fuels such as JP-4, Russian, and Chinese fuels, and it is expected to be used for more than 1 percent of the fleet operating time, then the Monte Carlo analysis must include fuel property variation acceptable to the FAA for the approved fuels.

TABLE 1.—GAUSSIAN DISTRIBUTION FOR GROUND AMBIENT, CRUISE AMBIENT, AND FLASH POINT

Temperature in Deg F			
Parameter	Ground amb.	Cruise amb.	Flash point (FP)
Mean Temp .....	59.95	−70	120
neg 1 std dev .....	20.14	8	8
pos 1 std dev .....	17.28	.....	.....

TABLE 2.—VERIFICATION OF TABLE 1

% probability of temps & flash point being below the listed values	Ground amb. Deg F	Cruise amb. Deg F	Flash point Deg F	Ground amb. Deg C	Cruise amb. Deg C	Flash Point (FP) Deg C
1 .....	13.1	−88.6	101.4	−10.5	−67.0	38.5
5 .....	26.8	−83.2	106.8	−2.9	−64.0	41.6
10 .....	34.1	−80.3	109.7	1.2	−62.4	43.2
15 .....	39.1	−78.3	111.7	3.9	−61.3	44.3
20 .....	43.0	−76.7	113.3	6.1	−60.4	45.1
25 .....	46.4	−75.4	114.6	8.0	−59.7	45.9
30 .....	49.4	−74.2	115.8	9.7	−59.0	46.6
35 .....	52.2	−73.1	116.9	11.2	−58.4	47.2
40 .....	54.8	−72.0	118.0	12.7	−57.8	47.8
45 .....	57.4	−71.0	119.0	14.1	−57.2	48.3
50 .....	59.9	−70.0	120.0	15.5	−56.7	48.9
55 .....	62.1	−69.0	121.0	16.7	−56.1	49.4
60 .....	64.3	−68.0	122.0	18.0	−55.5	50.0
65 .....	66.6	−66.9	123.1	19.2	−55.0	50.6
70 .....	69.0	−65.8	124.2	20.6	−54.3	51.2
75 .....	71.6	−64.6	125.4	22.0	−53.7	51.9
80 .....	74.5	−63.3	126.7	23.6	−52.9	52.6
85 .....	77.9	−61.7	128.3	25.5	−52.1	53.5
90 .....	82.1	−59.7	130.3	27.8	−51.0	54.6
95 .....	88.4	−56.8	133.2	31.3	−49.4	56.2
99 .....	100.1	−51.4	138.6	37.9	−46.3	59.2