FPL.

L-2011-337
10 CFR 52.3

August 24, 2011

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Re: Florida Power & Light Company
Proposed Turkey Point Units 6 and 7
Docket Nos. 52-040 and 52-041
Response to NRC Request for Additional Information Letter No. 025 (eRAI 5414) - Standard Review Plan Section 3.5.1.6 Aircraft Hazard

Reference:

1. NRC Letter to FPL dated June 29, 2011, Request for Additional Information Letter No. 025 Related to SRP Section 3.5.1.6 – Aircraft Hazard for the Turkey Point Nuclear Plant Units 6 and 7 Combined License Application

2. FPL Letter to NRC dated July 26, 2011, Schedule for Response to NRC Request for Additional Information Letter No. 025 (eRAI 5414) - Standard Review Plan Section 3.5.1.6 Aircraft Hazard

3. FPL Letter to NRC dated August 9, 2011, Second Schedule for Response to NRC Request for Additional Information Letter No. 025 (eRAI 5414) - Standard Review Plan Section 3.5.1.6 Aircraft Hazard

Florida Power & Light Company (FPL) provides, as an attachment to this letter, its response to the Nuclear Regulatory Commission's (NRC) Request for Additional Information (RAI) 03.05.01.06-1 provided in the referenced letter (Reference 1). The attachment identifies changes that will be made in a future revision of the Turkey Point Units 6 and 7 Combined License Application (if applicable).

If you have any questions, or need additional information, please contact me at 561-691-7490.

D097
NRO

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 24, 2011.

Sincerely,

William Maher
Senior Licensing Director – New Nuclear Projects

WDM/ETC

Attachment 1: FPL Response to NRC RAI No. 03.05.01.06-1 (RAI 5414)

cc:
PTN 6 & 7 Project Manager, AP1000 Projects Branch 1, USNRC DNRL/NRO
Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Plant 3 & 4

NRC RAI Letter No. 25 Dated June 29, 2011

SRP Section: 03.05.01.06 – Aircraft Hazards

Application Section: 3.5.1.6 – Aircraft Hazards

Question from Siting and Accident Conseq Branch (RSAC)

NRC RAI Number: 03.05.01.06-1 (eRAI 5414)

RG 1.206 provides guidance regarding the information that is needed to ensure potential hazards in the site vicinity are identified and evaluated to meet the siting criteria in 10 CFR 100.20 and 10 CFR 100.21. FSAR Section 2.2.2.7.1.2 and Section 3.5.1.6 do not provide enough information needed by the NRC staff to perform an independent evaluation of aircraft impact probability.

Clarify whether the total probability of 3.86×10^{-6} per year (which exceeds the acceptable probability of an order of magnitude of 10^{-7} per year) includes the probability due to flight operations at airports (2.56×10^{-7} per year) and in airway V3 (3.61×10^{-6} per year). Provide the breakdown of the flight operations used for various phases and types of aircrafts considered. Provide the calculations with the details of aircraft crash rates, the assumptions for effective areas calculations, and the parameters for aircraft crash location conditional probability (per square mile) for each aircraft type and for each flight phase used in determining this total annual aircraft crash impact probability (F).

The discussion, rationale and application of the conditional core damage frequency (CCDF) to the total annual aircraft crash impact probability, which results in the final probability of 4.86×10^{-7} per year should also be addressed in FSAR Chapter 19.

FPL RESPONSE:

For ease of review, the response is divided into subsections. Each subsection includes the portion of the requested additional information repeated in bold and underline followed by the response.

<u>Subsection A: Clarify whether the total probability of $3.86\text{x}10^{-6}$ per year (which exceeds the acceptable probability of an order of magnitude of 10^{-7} per year) includes the probability due to flight operations at airports ($2.56\text{x}10^{-7}$ per year) and in airway V3 ($3.61\text{x}10^{-6}$ per year).</u>

The total aircraft crash impact frequency, $3.86\text{x}10^{-6}$ per year, is a sum of the airport operations annual impact frequency, $2.56\text{x}10^{-7}$, and the non-airport crash frequency (i.e., inclusive of operations in airway V3), $3.61\text{x}10^{-6}$. Therefore, the total impact probability of $3.86\text{x}10^{-6}$ does include both airport flight operations and non-airport operations, including airway V3. For sites not meeting the proximity criteria, SRP Acceptance Criteria (NUREG-0800, Section 3.5.1.6, SRP Acceptance Criteria 2.) provides the following criteria:

- "...Aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR Part 100 with a probability of occurrence greater than an order of magnitude of 10^{-7} per year should be considered in the design of the plant..."; and
- "The expected rate of exposure identified in 10 CFR 50.34(a)(1) dose guideline as it relates to the requirements identified in 10 CFR 100.20(b) should be about an order of magnitude of 10^{-6} per year. If it can be shown with rigorous analysis, using realistic assumptions and reasonable arguments that the estimated probability could be lower, then, in accordance with SRP Section 2.2.3, it is acceptable."

The total annual aircraft crash frequency, which may result in radiological consequences in excess of the exposure guidelines of 10 CFR Part 100, is shown in Subsection C of this response to be within an order of magnitude of 10^{-7} per year. Further, the assumptions and conservatisms used at determining the annual aircraft crash frequency, which detail that the estimated probability could be lower, are also presented in Subsection C of this response.

Subsection B: Provide the breakdown of the flight operations used for various phases and types of aircrafts considered.

As identified in FSAR Section 2.2.2.7, one airport, Homestead Air Reserve Base, located approximately 4.76 miles from Turkey Point Units 6 & 7, did not meet the SRP proximity criteria (NUREG-0800 Section 3.5.1.6, SRP Acceptance Criteria 1.) The total number of operations for each runway and the number of airport flight operations for each type of aircraft were obtained from Homestead Air Reserve Base and the resultant inputs are provided in Table 1.

Table 1: Aircraft Flight Operation Numbers[a]

Aircraft	Reported Number of Operations	Assumed Number of Operations for Runway 05 (N)	Assumed Number of Operations for Runway 23 (N)
F-16C and F-15A (small military)	**24,902**--22,302 (F-16C) and 2,600 (F-15A)	**18,678**--9,339 takeoffs and 9,339 landings	**6,226** –3,113 takeoffs and 3,113 landings
U.S. CBP (large military)	**7,430**	**5,574**—2,787 takeoffs and 2,787 landings	**1,858**—929 takeoffs and 929 landings
Transient Aircraft (General Aviation)	**4,097**	**3,074**—1,537 takeoffs and 1,537 landings	**1,026**—513 takeoffs and 513 landings

[a]Due to rounding, the sum of the assumed number of operations for an aircraft type for each runway may be slightly larger than the total number of operations for that aircraft type.

Note, it was conservatively assumed that 50 percent of the operations were takeoffs and 50 percent were landings. According to Department of Energy (DOE) methodology, this assumption will result in very conservative numbers because total operations include activities other than takeoff and landing, such as an aircraft contacting the tower for a change of vector (DOE, 2006; p.40).

Subsection C: Provide the calculations with the details of aircraft crash rates, the assumptions for effective areas calculations, and the parameters for aircraft crash location conditional probability (per square mile) for each aircraft type and for each flight phase used in determining this total annual aircraft crash impact probability (F).

To determine the annual aircraft crash impact frequency for both airport and non-airport operations for Turkey Point Units 6 & 7 per year, F, the four factor formula, originating from DOE Standard 3014-2006, was used (DOE, 2006; p. 38). The four factor formula and input parameters into the equation are:

Four Factor Formula: $F = \sum_{ijk} N_{ijk} P_{ijk} f_{ijk}(x,y) A_{ijk}$ (1)

Where,

F= estimated annual aircraft crash impact frequency for the facility of interest (no./year);

N_{ijk} = estimated annual number of site-specific aircraft operations (i.e., takeoffs, landings, and in-flights) for each applicable summation parameter (no./year);

P_{ijk} = aircraft crash rate (per takeoff or landing for near-airport phases and per flight for the in-flight (non-airport) phase of operation) for each applicable summation parameter;

f_{ijk} (x,y)= aircraft crash location conditional probability (per square mile) given a crash evaluated at the facility location for each applicable summation parameter;

A_{ijk} = the site-specific effective area for the facility of interest that includes skid and fly-in effective areas (square miles) for each applicable summation parameter;

i= (index for flight phases): i=1, 2, and 3 (takeoff, in-flight, and landing);

j= (index for aircraft category or subcategory): j=1, 2, ..., 11;

k= (index for flight source): k=1, 2, ..., k (there could be multiple runways, and non-airport operations);

$$\sum_{ijk} = \sum_i \sum_j \sum_k$$

ijk= site-specific summation over flight phase, i; aircraft category or subcategory, j; and flight source, k.

For this standard, the four-factor formula is implemented in two different ways, depending on the flight phase:

1. For airport operations, or near airport activities, which consist of takeoffs and landings, the four factor formula is implemented through a combination of site-specific information and data from the DOE standard.
2. For non-airport operations, DOE site specific values or estimates applicable throughout the continental United States, for the expected number of crashes per square mile per year in the vicinity of the site (the value of the product N*P*f(x,y)), are provided. The four factor formula is then implemented by combining these with the facility effective areas to assess annual crash frequencies.

Effective area calculation (A_{ijk}):
The effective area calculation is used for input into both airport and non-airport operations impact frequency analyses. To calculate the effective area (A_{ijk}), methods provided in the DOE Standard (DOE, 2006; pp. B-26 through B-30) were employed:

$$A_{eff} = A_f + A_s \quad (2)$$

Where,

A_{eff} = effective area (mi^2)

$$A_f = (WS+R)H\cot\phi + (2L * W * WS)/R + L * W \quad (3)$$

$$A_s = (WS + R) * S \quad (4)$$

Where,

A_f = effective fly-in area (mi^2);

WS = aircraft wingspan (ft);

H = facility height (ft);

L = length of the facility (ft);

S = aircraft skid distance (ft, mean value).

A_s = effective skid area (mi^2);

R = length of the diagonal of facility = $(L^2+W^2)^{0.5}$ (ft);

$\cot\phi$ = cotangent of the aircraft impact angle;

W = width of the facility (ft);

The assumptions for the effective area (A_{ijk}) calculations are provided below:

1. A rectangular bounding building (representing the entire nuclear island consisting of the Containment or Shield Building and the Auxiliary Building) was determined. This included calculating an equivalent width (W), length (L), height (H), and building diagonal (R), from the total footprint area and volume for the included safety-related structures. In making these estimations, the following was assumed:
    1. When determining the length, L, of the bounding building, the actual length of the buildings contained on the nuclear island, 254 feet, was used.
    2. The volume of the cylinder (Containment Building) was taken from the height of the tallest building (80.75 ft) to the height of the Containment Building (148 ft).
2. The 78 foot wingspan (high performance) was conservatively used for small military aircraft wingspan in calculating their respective effective areas. The high performance wingspan includes fighters, attackers, and trainers. Homestead Air Reserve Base indicated that the military aircraft on-site consisted of F-16C's with a wingspan of 32 feet-10 inches and F-15A's with a wingspan of 42 feet-9 inches.

The resultant effective areas (A_{ijk}) for each aircraft type are provided in Table 2.

Table 2: Resulting Effective Areas

Aircraft Type	Effective Area (mi^2)
General Aviation	0.01730
Air Carrier	0.04309
Air Taxi	0.03859
Military (Large/Takeoff)	0.03775
Military (Large/Landing)	0.03660
Military (Small/Takeoff)	0.02166
Military (Small/Landing)	0.02824

Airport Operations Annual Impact Frequency:

The remaining factors ($f_{ijk}(x,y)$ and P_{ijk}) are calculated as follows for airport operations:

Aircraft crash location conditional probability (per square mile) ($f_{ijk}(x,y)$):
Equations (5) and (6) from the DOE Standard (DOE, 2006; p. B-6) were used to determine the x and y values for the aircraft crash location conditional probability term, f(x, y):

$$x = -R \cos(\theta - \Phi), \text{ and} \quad (5)$$

$$x = R \sin(\theta - \Phi) \quad (6)$$

Where,

R = distance from the facility (miles)

Θ = bearing from the facility to the airport (degrees)

Φ = runway bearing as an angle with respect to magnetic north = runway number times ten (degrees)

The bearing angle, Θ, for each runway and the distance, R, from the facility to the midpoint of each runway was determined using Geographic Information System (GIS) software. The bearing angle from the facility to the midpoint of the runway was determined by measuring the angle in degrees in a clockwise direction from true north at the reference point (facility) to the straight line joining the two points together. The x and y values determined from the bearing angles and equations (5) and (6) were verified using a second graphical method presented in the DOE Standard (DOE, 2006; pp. B-37 through B-38), as depicted in Figure 1. The graphical method consists of placing the origin in the center of the runway and then drawing a line splitting the runway in half lengthwise—this represents the x-axis. Next, a line is drawn from the facility perpendicular to and intersecting the x-axis. The x and y values for Runways 05 and 23 are calculated below in Tables 3 and 4, respectively.

Table 3: Runway 5 x and y values

x = -R cos (θ – Φ)	y = R sin (θ - Φ)
x = -5.38 cos (133.3°-50°)	y = 5.38 sin (133.3°-50°)
x = -0.63	y = 5.34

Θ--Bearing Angle (degrees): 133.3°

R = 5.38 miles

Table 4: Runway 23 x and y values

x = -R cos (θ – Φ)	y = R sin (θ - Φ)
x = -5.38 cos (133.3°-230°)	y = 5.38 sin (133.3°-230°)
x = 0.63	y = -5.34

Θ--Bearing Angle (degrees): 133.3°

R = 5.38 miles

Note: An R value of 5.3857 miles was rounded down to 5.38 miles (for conservatism) in the x and y value calculations.

Now that the (x, y) values have been obtained for each runway, the $f_{ijk}(x, y)$ values (aircraft crash location conditional probabilities (per square mile)) were obtained from Tables B-2 through B-13 of the DOE standard for each aircraft type and runway as detailed in Table 1 (DOE, 2006; pp. B-12 through B-23). Note that the traffic patterns for Runway 05 are right and traffic patterns for Runway 23 are left.

Crash Rate (P_{ijk}):

The crash rate (P_{ijk}) values are obtained from Table B-1 of the DOE Standard (DOE, 2006; p.B-3).

The effective area, A_{ijk}, for each aircraft class and the aircraft crash rate, P_{ijk}, by aircraft type for a takeoff and landing, are summarized in Table 5 for input into the four factor formulas and in Tables 6 and 7:

Table 5: Resulting Effective Areas (A) and Crash Rates (P)

Category/Subcategory	Effective Area (A) (mi^2)[a]	Crash rate (P) Takeoff[b]	Crash Rate (P) Landing[b]
General Aviation	0.01730	1.10×10^{-5}	2.00×10^{-5}
Air Carrier	0.04309	1.90×10^{-7}	2.80×10^{-7}
Air Taxi	0.03859	1.00×10^{-6}	2.30×10^{-6}
Military (Large/Takeoff)	0.03775	5.70×10^{-7}	-
Military (Large/Landing)	0.03660	-	1.60×10^{-6}
Military (Small/Takeoff)	0.02166	1.80×10^{-6}	-
Military (Small/Landing)	0.02824	-	3.30×10^{-6}

[a]See Table 2.
[b]Obtained from Table B-1 of the DOE Standard (DOE, 2006; p. B-3).

The impact frequency for each flight phase (i), aircraft category (j), and each runway (k) were then determined for input into the four factor formula. The summary of the input data is presented by Runway in Tables 6 and 7, and are similar to the data collection tables presented in the DOE Standard (DOE, 2006; pp. B-35 and B-36).

Table 6: Runway 5 Data Collection for the Four Factor Formula

Aircraft type and flight phase	N, Number of Operations/ Year[a]	X[b]	Y[b]	f(x,y)[c]	P, crash rate[d]	A, Effective Area[e]	Impact Frequency N*P*f(x, y)*A
General Aviation-Takeoff	1537	-0.63	5.34	0	1.10×10^{-5}	0.01730	0
General Aviation-Landing	1537	-0.63	5.34	3.50×10^{-4}	2.00×10^{-5}	0.01730	1.86082×10^{-7}
Commercial/Air Carrier- Takeoff	0	-0.63	5.34	0	1.90×10^{-7}	0.04309	0
Commercial/Air Carrier- Landing	0	-0.63	5.34	0	2.80×10^{-7}	0.04309	0
Commercial/Air Taxi- Takeoff	0	-0.63	5.34	0	1.00×10^{-6}	0.03859	0
Commercial/Air Taxi- Landing	0	-0.63	5.34	0	2.30×10^{-6}	0.03859	0
Military Aviation Large- Takeoff-Right	2787	-0.63	5.34	0	5.70×10^{-7}	0.03775	0
Military Aviation Large- Landing-Right	2787	-0.63	5.34	9.60×10^{-5}	1.60×10^{-6}	0.03660	1.56687×10^{-8}
Military Aviation Small- Takeoff-Right	9339	-0.63	5.34	0	1.80×10^{-6}	0.02166	0
Military Aviation Small- Landing-Right	9339	-0.63	5.34	0	3.30×10^{-6}	0.02824	0
						Total	**2.0175×10^{-7}**

[a]See Table 1.
[b]See Table 3.
[c]Obtained from the DOE Standard (DOE, 2006; Tables B-2 through B-13).
[d]Obtained from the DOE standard (DOE, 2006; Table B-1).
[e]Derived from Equation (2) and summarized in Table 5.

Table 7: Runway 23 Data Collection for the Four Factor Formula

Aircraft type and flight phase	N, Number of Operations/ Year[a]	X[b]	Y[b]	f(x,y)[c]	P, crash rate[d]	A, Effective Area[e]	Impact Frequency N*P*f(x, y)*A
General Aviation-Takeoff	513	0.63	-5.34	0	$1.10x10^{-5}$	0.01730	0
General Aviation - Landing	513	0.63	-5.34	$3.00x10^{-4}$	$2.00x10^{-5}$	0.01730	$5.32354x10^{-8}$
Commercial/Air Carrier- Takeoff	0	0.63	-5.34	0	$1.90x10^{-7}$	0.04309	0
Commercial/Air Carrier- Landing	0	0.63	-5.34	0	$2.80x10^{-7}$	0.04309	0
Commercial/Air Taxi- Takeoff	0	0.63	-5.34	0	$1.00x10^{-6}$	0.03859	0
Commercial/Air Taxi- Landing	0	0.63	-5.34	0	$2.30x10^{-6}$	0.03859	0
Military Aviation Large- Takeoff- Left	929	0.63	-5.34	0	$5.70x10^{-7}$	0.03775	0
Military Aviation Large Landing-Left	929	0.63	-5.34	$1.00x10^{-5}$	$1.60x10^{-6}$	0.03660	$5.44051x10^{-10}$
Military Aviation Small- Takeoff Left	3113	0.63	-5.34	0	$1.80x10^{-6}$	0.02166	0
Military Aviation Small-Landing Left	3113	0.63	-5.34	0	$3.30x10^{-6}$	0.02824	0
						Total	**$5.37795x10^{-8}$**
				Homestead Air Reserve Base Total Impact Frequency			**$2.5553x10^{-7}$**

[a]See Table 1.
[b]See Table 4.
[c]Obtained from the DOE Standard (DOE, 2006; Tables B-2 through B-13).
[d]Obtained from the DOE standard (DOE, 2006; Table B-1).
[e]Derived from Equation (2) and summarized in Table 5.

Next, the Four Factor Formula, Equation (1), was employed to determine the total impact frequencies for each aircraft category by summing the impact frequency results from Tables 6 and 7. Table 8 provides a summary of the summation of the total impact frequencies for each aircraft category.

Table 8: Total Impact Frequencies by Class for Airport Operations

Category/Subcategory	Airport Operations Impact Frequency (number/year)
General Aviation	$2.39x10^{-7}$ (=$1.86082x10^{-7}$ [a] + $5.32354x10^{-8}$ [b])
Commercial Aviation Air Carrier	0
Commercial Aviation Air Taxi	0
Military Aviation—Large Aircraft	$1.62\ x10^{-8}$ (=$1.56687x10^{-8}$ [c] + $5.44051x10^{-10}$ [d])
Military Aviation—Small Aircraft	0
Total (All Aircraft)	**$2.56x10^{-7}$ (=$2.39x10^{-7}$ + $1.62x10^{-8}$)**

[a]See "Impact Frequency" column of Table 6 for "General Aviation – Landing".
[b]See "Impact Frequency" column of Table 7 for "General Aviation – Landing".
[c]See "Impact Frequency" column of Table 6 for "Military Aviation Large Landing – Right".
[d]See "Impact Frequency" column of Table 7 for "Military Aviation Large Landing – Left".

Non-airport (in-flight phase) Annual Impact Frequency:

For non-airport operations, or the in-flight phase, methods provided in the DOE Standard were used. Note, this method was utilized in lieu of the method provided in NUREG-0800, Section 3.5.1.6 for airways. The selection of this methodology was based on the following:

1. General Aviation aircraft flying under either visual flight rules (VFR) or instrument flight rules (IFR) conditions are included. Except for restricted airspace, a General Aviation aircraft can fly almost anywhere in the continental U.S. (DOE, 2006; p. 42);
2. The assumption that non-airport commercial and military aircraft will fly point to point under new Federal Aviation Administration (FAA) regulations rather than on specific airways (DOE, 2006; p. 43);
3. The generic N*P*f(x, y) values from the DOE standard (DOE, 2006; pp. B-24 and B-25) provide more conservative in-flight crash probabilities than those of NUREG-0800 (SRP 3.5.1.6). NUREG-0800 (SRP 3.5.1.6) suggests using a crash rate of $4x10^{-10}$ for commercial aircraft—crash probabilities for other aircraft categories are not provided in the SRP. For example, as presented in NUREG/CR-2859, the crash rate presented in the SRP ($4x10^{-10}$ for commercial aircraft) was derived "based on the assumption that one catastrophic in-flight failure will occur in the U.S. per year, an event characterized by loss of altitude with no pilot directional control of the aircraft. This is certainly an accident subset smaller than the total fatal accident subset..." (NUREG/CR-2859 derives an average fatal Air Carrier accident rate of about $3x10^{-9}$ per aircraft-mile). Further, in-flight crash rates presented in NUREG/CR-2859 for other aircraft categories are significantly larger than $4x10^{-10}$.

Thus, the impact frequency of aircraft during the in-flight phase is calculated using the Four Factor Formula, Equation (1), in the following manner:

$$F_j=N_j * P_j * f_j (x,y) * A_j \quad (1)$$

Where;

$N_j*P_j*f_j(x, y)$ = a generic value for each aircraft type in Tables B-14 and B-15 of the DOE Standard (DOE, 2006; pp. B-24 and B-25).

A_j = effective area

The following table summarizes the total annual aircraft impact frequency for non-airport operations:

Table 9: Total Annual Impact Frequencies for Non-Airport Operations

Category/Subcategory	Generic Value for NPf(x,y)[a]	A, Effective Area, Square Miles[b]	Non-Airport Crash Frequency (number/year)[c]
General Aviation	2×10^{-4}	0.01730	3.46×10^{-6}
Commercial Aviation Air Carrier	4×10^{-7}	0.04309	1.72×10^{-8}
Commercial Aviation Air Taxi	1×10^{-6}	0.03859	3.86×10^{-8}
Military Aviation - Large Aircraft	2×10^{-7}	0.03775	7.55×10^{-9}
Military Aviation - Small Aircraft	4×10^{-6}	0.02166	8.66×10^{-8}
		Total	**3.61×10^{-6}**

[a]Obtained from the DOE Standard (DOE, 2006; pp. B-24 and B-25).
[b]Derived from Equation (2) and summarized in Table 2.
[c]Values derived by multiplying the Generic NPf(x, y) value by the effective area, A.

The airport operations and non-airport operations frequencies are then summed together, for each respective aircraft type, to determine the total impact frequency. These calculations are summarized in Table 10 below:

Table 10: Total Impact Frequencies

Category/Subcategory	Airport Operations Frequency[a]	Non-Airport Operations Frequency[b]	Impact Frequency (per year)[c]
General Aviation	2.39×10^{-7}	3.46×10^{-6}	3.70×10^{-6}
Commercial Aviation Carrier	0	1.72×10^{-8}	1.72×10^{-8}
Commercial Aviation Air Taxi	0	3.86×10^{-8}	3.86×10^{-8}
Military Aviation - Large Aircraft	1.62×10^{-8}	7.55×10^{-9}	2.38×10^{-8}
Military Aviation - Small Aircraft	0	8.66×10^{-8}	8.66×10^{-8}
		Total	**3.86×10^{-6}**

[a]See the Airport Operations Frequencies from Table 8.
[b]See the Non-Airport Crash Frequencies from Table 9.
[c]Values derived by summing Airport Operations Frequencies and Non-Airport Operations Frequencies.

Conservatism in the Calculation:

The calculation of the total aircraft impact frequency contained conservatisms, including:

(1) Shielding by adjacent structures, topographical features, and barriers were not credited. The skid distance (S) in the effective area calculation would be significantly reduced if this were credited—the nuclear island is shielded on three sides and partially on the fourth side by other structures.

(2) DOE methodology results in a conservative estimation, e.g., impact angle, takeoff/landing assumption, and bounding building calculations.

(3) The assumption in the frequency analysis that each general aviation aircraft impact is capable of causing damage significant enough to cause a release. (As presented in NUREG/CR-4839, less than 2 percent of general aviation aircraft have a gross takeoff weight greater than 12,500 pounds.)

Subsection D: The discussion, rationale and application of the conditional core damage frequency (CCDF) to the total annual aircraft crash impact probability, which results in the final probability of 4.86 x 10^{-7} per year should also be addressed in FSAR Chapter 19.

As presented in the response to eRAI 5889 (PTN-RAI-LTR-032, RAI number 19-1), a discussion of the conditional core damage evaluation will be presented in Subsection 19.58.2.3.1. This evaluation concludes that no further evaluation of aircraft impact is required, given that the core damage frequency associated with aircraft impacts is less than $1E^{-08}$ per year.

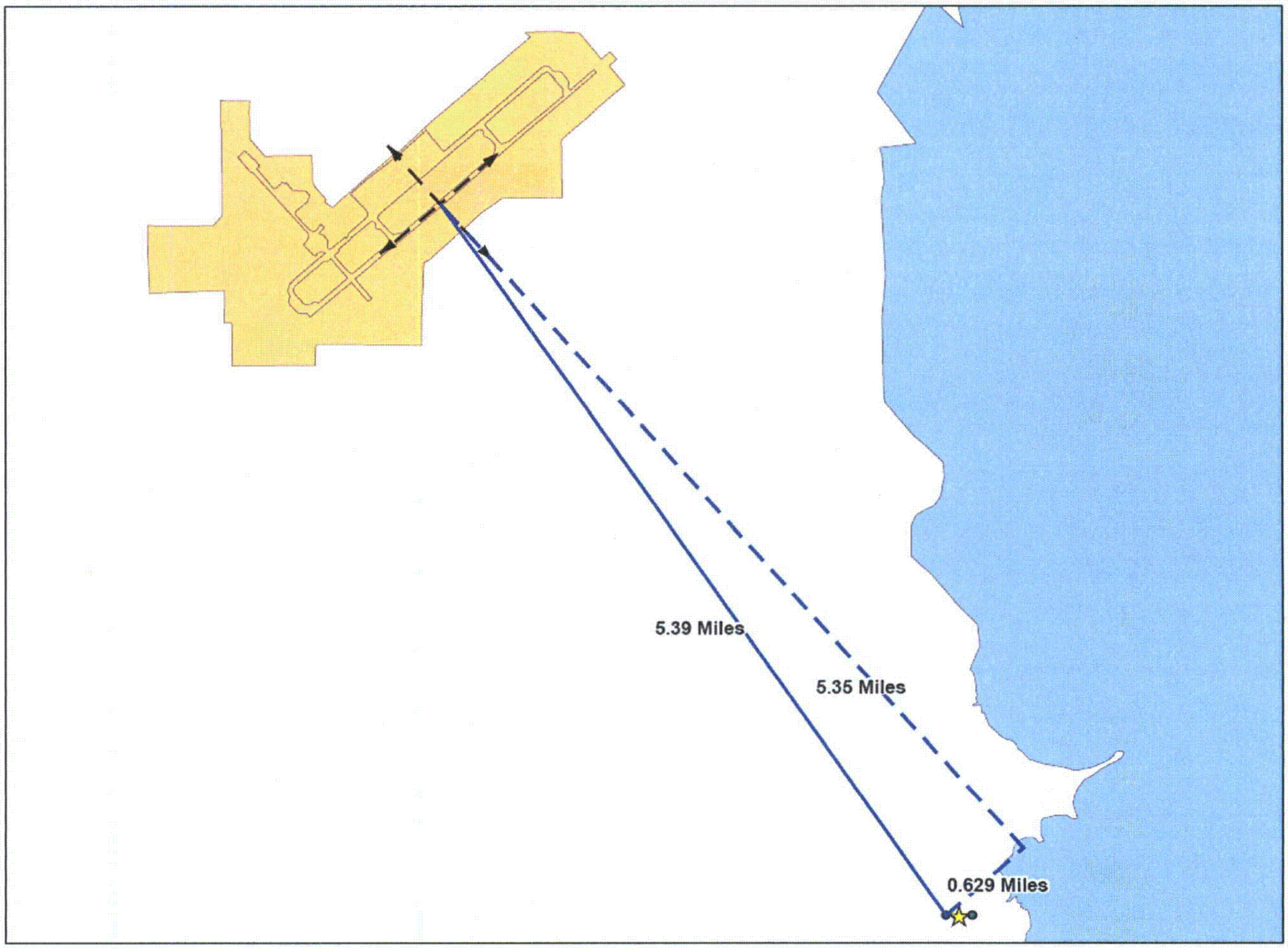

Figure 1: Bearing Angle Graphical Method Verification

This response is Plant Specific

References:

(DOE, 2006) U.S. Department of Energy, *Accident Analysis for Aircraft Crash into Hazardous Facilities, DOE Standard, DOE –STD-3014-2006*, October 1996, Reaffirmation May 2006.

(Mizuno, 2005) Mizuno, et. al., *Investigation on Impact Resistance of Steel Plate Reinforced Concrete Barriers against Aircraft Impact: Part 3 Analyses of Full-Scale Aircraft Impact,* 18th International Conference on Structural Mechanics in Reactor Technology (SMiRT 18), August 2005.

(Sugano, 1993) Sugano, T. et. al., *Local Damage to Reinforced Concrete Structures Caused by Impact of Aircraft Engine Missiles*, Nuclear Engineering and Design 140, pp. 387-423, 1993.

ASSOCIATED COLA REVISIONS:

FSAR Section 2.2.2.7 will be revised, for consistency with changes to FSAR Section 19.58 for the response to RAI 19-1, in a future COLA revision as follows:

Total Impact Frequency
This assessment led to a total impact frequency of 3.86E-06 per year when considering both the airport and non-airport operations, which is greater than an order of magnitude of 1E-07 per year. **Therefore, an evaluation against a second criterion (core damage frequency, CDF, less than 1E-08 per year) was performed. This evaluation is presented in Subsection 19.58.2.3.1 and concludes that no further evaluation of aircraft impact is required, given that the core damage frequency associated with aircraft impacts is less than 1E-08 per year.** ~~Therefore, consideration of whether the damage from the aircraft crash may result in radiological releases in excess of the exposure guidelines in 10 CFR Part 100 was considered for general aviation and commercial aircraft categories. The General Aviation category dominates the impact frequency results. Studies of General Aviation and Commercial Aircraft categories conclude that impacts from these categories are not likely to result in core damage. In these instances (General Aviation and Commercial Aircraft categories), crash probabilities are multiplied by appropriate conditional probabilities of a radioactive material release exceeding 10 CFR Part 100 guidelines to obtain the consequence probabilities of such a release. The impact of aircraft and aircraft missiles on substantial concrete structures has been extensively studied and a core damage probability can reasonably be applied to the calculated total impact frequency for the General Aviation and Commercial Aircraft categories (References 227 and 228). NUREG/CR-4839 cites a conditional core damage probability of 0.1 as a conservative estimate. Therefore, for this calculation, a conditional core damage probability of 0.1 was conservatively applied to the General Aviation and Commercial Aircraft categories. Conservatively, a conditional core damage probability of 1.0 was applied to the small and large military aviation categories.~~

~~Taking into account the conditional core damage probability, the rate of aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR 50.34(a)(1) is 4.86E-07 crashes per year. This includes the following inherent conservatisms:~~

- ~~Shielding by adjacent structures, topographical features, and barriers was not credited. The skid distance would virtually be eliminated, reducing the effective area, if this were credited, because the nuclear island is shielded on three sides and partially on the fourth side by other structures.~~

- ~~A conservative value of the conditional core damage probability was used. General Aviation aircraft was not screened out, that is, a core damage probability of zero was not applied to the general aviation class, even though studies have shown they are not considered a significant hazard to nuclear power stations because of their low weight and low penetration hazard.~~

- ~~DOE methodology has conservatisms built in. One example is in determining the effective area of the bounding building where the heading of the crashing aircraft with respect to the facility is assumed to be the worst case which is perpendicular to the diagonal of the bounding rectangle regardless of direction of actual flights.}~~

~~Therefore, a value of 4.86E-07 aircraft crashes per year that may lead to radiological consequences meets the guidance in NUREG-0800, Section 3.5.1.6 which states that 10 CFR 100.1, 10 CFR 100.20, 10 CFR 100.21, 10 CFR 52.17, and 10 CFR 52.79 requirements are met if the probability of aircraft accidents resulting in radiological consequences greater than the 10 CFR Part 100 exposure guidelines is less than an order of magnitude of 1E-07 per year. The value of 4.86E-07 aircraft crashes per year that may lead to radiological consequences also meets RG 1.206 guidance, which states that plant design should consider aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR 50.34(a)(1) and 10 CFR 52.79 with a probability of occurrence greater than an order of magnitude of 1E–07 per year.~~

ASSOCIATED ENCLOSURES:

None