UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUN 8 1984

Docket No. 50-352/353

MEMORANDUM FOR: A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing

FROM: R. E. Martin, Project Manager
Licensing Branch No. 2
Division of Licensing

SUBJECT: FORTHCOMING MEETING WITH PHILADELPHIA ELECTRIC COMPANY ON THE ANALYSIS OF TORNADO MISSILE EFFECTS ON THE ULTIMATE HEAT SINK

DATE & TIME: Friday, June 15, 1984
9:00 - 5:00

LOCATION: Maryland National Bank Building
Room 6110
Bethesda, Maryland

PURPOSE: The applicant and the staff will discuss the applicant's analysis of tornado missiles dated March 22, 1984 focussing on the notes in the enclosure.

PARTICIPANTS*:

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J. Wilson	T. Robb
F. Clemenson	
J. Ridgely	
E. Markee	
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*Meetings between NRC technical staff and applicants for licenses are open for interested members of the public, petitioners, intervenors, or other parties to attend as observers pursuant to "Open Meeting and Statement of NRC Staff Policy," 43 Federal Register 28058, 6/28/78.

Questions and Comments Concerning Report NUS-4507 Limerick Generating Station, Ultimate Heat Sink Extreme Wind Hazard Analysis

1. Hurricane Winds

The hurricane wind statistics proposed in the Report are based on the assumption that the friction coefficient accounting for terrain roughness is 0.45 (p. 3-3, first paragraph). It is noted in NWS 23 (Schwerdt, et al., 1979), from which this coefficient is taken, that the value of 0.45 was based upon the factor observed at Brookhaven National Laboratory, "considered a rough site" (Schwerdt, et al., 1979, p. 268).

The roughness at Brookhaven has been estimated to be of the order of $z_o = 1.00$ m, owing, notably, to the presence of wooded areas (see I.A. Singer, et al., "The Micrometeorology of the Turbulent Flow Field in the Atmospheric Boundary Surface Layer," in Proceedings of the International Research Seminar on Wind Effects on Buildings and Structures, Vol. 1, Univ. of Toronto Press, 1968, pp. 557-594). On the other hand, the terrain roughness at Limerick appears to be lower, i.e., $z_o \approx 0.4$ m (see Appendix A). It would then follow that the friction coefficient, rather than being 0.45, would have a value close to the average of the values 0.45 and 0.78 (see Fig. 15.4 of NWS 23, attached herewith), i.e., 0.61, say. Use of this factor would increase the hurricane wind speeds at Limerick by about 35 percent. This would cause a shift to the right of the curves in Figs. 3-1(a) and 3-3(b) of the Report, even if gust factors with values less than 2.2 were used for the 2-sec wind.

What is the effect of such a shift upon the frequencies of exceeding 10CFR Part 100 limits?

2. Sampling Errors in Estimation of Extreme "Straight" and Hurricane Winds

The probability distribution of extreme "straight" winds is estimated in the Report on the basis of a sample of only ten largest yearly wind speed data. The precision of the estimates based on a 10-data sample is, as a rule, unsatisfactory. For example, in the case of the Philadelphia Airport, the method of moments yields, for the estimated 2000-yr wind based on a 10-data sample, the 95 percent confidence interval 83.2±23.0 mph (fastest mile) - see Extreme Wind Speeds at 129 Stations in the United States, NBS BSS 118, p. 235. The precision of the estimates would increase by a factor of $(23/10)^{1/2} = 1.52$ if all the 23 data available for the Philadelphia Airport station were used.

Sampling errors also are inherent in hurricane wind speed estimates (see Batts, et al., "Sampling Errors in Estimation of Extreme Hurricane Winds," J. Str. Div., ASCE, Oct. 1980, pp. 2111-2115).

What is the expected effect of accounting for sampling errors in estimating "straight" and hurricane wind speeds upon the estimated frequencies of exceeding 10CFR Part 100 limits?

3. Area Used in Calculation of Tornado Wind Speed Frequencies

It is indicated on p. 3-10 of the Report that the area used in estimating tornado wind speed frequencies (the target area) consists of an envelope enclosing the spray pond networks and cooling towers. An explanation is requested as to: (a) why the target area does not consist of the entire missile origin area, rather than of the above mentioned envelope, and (b) what would be the effect of such an extension of the target area upon the estimates of the frequency of exceeding 10CFR Part 100 limits.

4. Effect of High Winds Upon Spray Pond Network Pipes

For the sake of completeness, brief calculations should be included indicating the magnitude of stresses induced in distribution pipes and their connections by winds assumed to be acting in a direction normal to the 200 ft side of the pond.

5. Design and Failure Wind Speeds for Cooling Towers

It is indicated on p. 4-29 of the Report that the towers have been designed for a basic wind of 90 mph at 30 ft above grade and up to 135 mph at 500 ft above grade.

a. What is the Report's definition of the basic wind speed? Is it the fastest-mile wind speed over open terrain?

b. What is the precise definition of "designed for," i.e., was an allowable stress, or an ultimate stress approach used in the design of the tower for a basic wind of 90 mph?

c. What are the heights of the towers? From p. 4-7 one might infer that they are 485 ft. Is this inference correct? What does the 500 ft elevation mentioned in line 2, Sect. 4.4.3.1 represent? A simple sketch of the towers should be included, indicating: the elevations of the top and bottom of the towers; the curb wall; and the fill areas.

d. Is the 140 mph speed at which the towers are assumed to fail a speed averaged over 2 seconds?

Answers to these question are needed to allow the estimation of the load factor for the wind load.

6. Equivalence Between Straight or Hurricane Winds and Tornado Winds Used in Risk Analysis

It is indicated on p. 3-13 of the Report that nontornadic winds were treated by adjusting the tornado F-scale occurrence rates according to Fig. 3-3(b) and that "it will be seen later that the results of this study are insensitive to these approximations."

What is the number of the page or of the section where this is shown? Explain why this approximation is acceptable.

7. Direction of Translation of Tornadoes

Has the probability distribution of the direction of tornado translation been accounted for in the calculations? If not, and if there is a predominant direction of tornado translation (e.g., most tornadoes moving in the northeast direction), what would be the effect of taking this factor into account on the estimated frequency of exceeding 10CFR Part 100 limits? This question is asked because it appears, intuitively, that tornadoes moving in the northeast direction could destroy the towers and hurl missiles on the spray ponds.

Appendix A

Table A1 shows wind speeds measured at Limerick (from Table 3-1 of the Report), and wind speeds at the Philadelphia Airport.

The friction velocity is given by the expression

$$u_* = u^{hourly}(z)/2.5 \ \ln (z/z_o).$$

At the Philadelphia Airport (open terrain, $z_o \approx 0.05$ m)

$$u_*^P \approx 41.17/2.5 \ \ln (30 \times 0.3048/0.005) \approx 3.11 \text{ mph}.$$

If the roughness length at Limerick was $z_o \approx 0.4$ m, then

$$u_*^L \approx 29/2.5 \ \ln 30 \times 0.3048/0.4 = 3.706$$

and $u_*^L/u_*^P \approx 1.19$. This ratio is consistent with experimental results given in (Bietry, et al., "Mean Wind Profiles and Change of Terrain Roughness," J. Struct. Div., ASCE, Oct. 1978) for $z_o \approx 0.4$ m or so ($u_*/u_*^{open} \approx 1.15$ for $z_o = 0.3$ m; $u_*/u_*^{open} \approx 1.33$ for $z_o = 1$ m; $u_*/u_*^{open} \approx 1.46$ for $z_o = 2.5$ m).

On the other hand, if the roughness length at Limerick was z_o 1.0 m (i.e., close to the roughness of the Brookhaven site), then

$$u_*^L = 29/2.5 \ \ln 30 \times 0.3048/1.0 \approx 5.24$$

and

$$u_*^L/u_*^P = 1.68 > 1.33.$$

It is concluded that the wind speeds measured at Limerick and at the Philadelphia Airport are not compatible with the hypothesis that $z_o \cong 1.0$ m.

Table A1. Wind Speeds at Limerick and at Philadelphia Airport, in MPH

	Limerick	Philadelphia Airport		
	30 ft. elev. (hourly speed)	20 ft. elev. (fastest-mile speed)[a]	30 ft. elev. (fastest-mile speed)[a]	30 ft. elev. (hourly speed)[b]
	(1)	(2)	(3)	(4)
1972	30	43	47	38
1973	27	47	51	42
1974	28	40	44	36
1975	30	47	51	42
1976	32	50	55	45
1977	27	49	54	44
Mean	29 mph			41.17 mph

[a]From Extreme Wind Speeds at 129 Stations in the Contiguous United States, NBS BSS 118, 1979.

[b]Based on Wind Effects on Structures by E. Simiu and R.H. Scanlan (Eq. 2.3.30, p. 62) and the assumption z_o = 0.05 m (open terrain).

A schematic portrayal of adjustments is shown in figure 15.4. The k_e values shown are for overwater wind speeds $\geq$ 73 kt (135 km/hr). Figure 15.2 shows that k_e varies with wind speed < 73 kt.

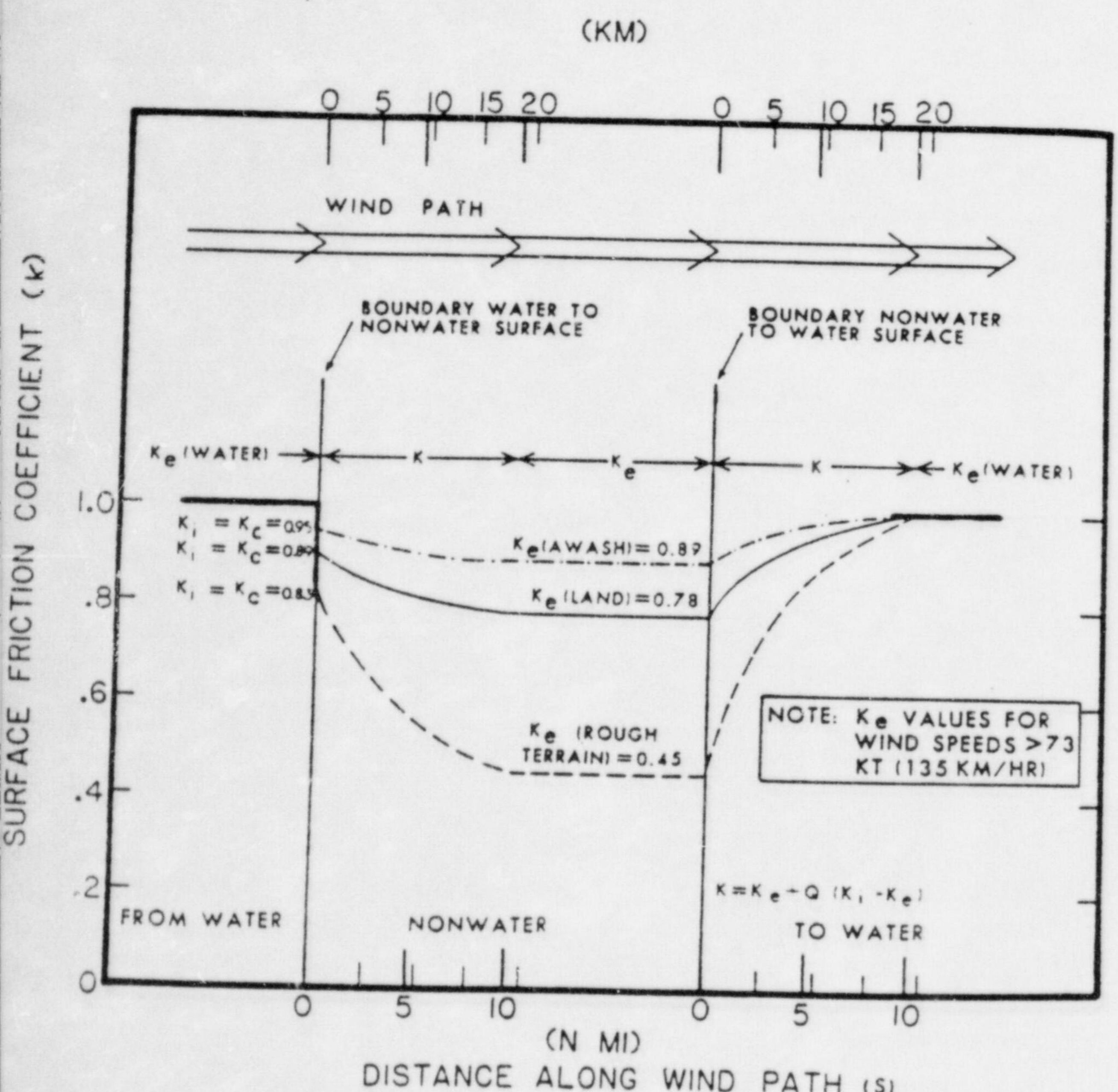

Figure 15.4. Schematic of nearshore frictional adjustments.

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DATE	6/8/84	6/8/84					

Date: June 8, 1984

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