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Robert L. Mittl General Manager
Nuclear Assurance and Regulation

February 22, 1985

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, MD 20814

ATTN: Mr. Albert Schwencer, Chief
Licensing Branch 2
Division of Licensing

Gentlemen:

HOPE CREEK GENERATING STATION
DOCKET NO. 50-354
RIVERBORNE MISSILES SUPPLEMENTAL INFORMATION

On January 31, 1985, we transmitted responses to questions raised in your January 9, 1985 letter on information PSE&G submitted on September 17, 1984 on potential riverborne missiles. We indicated in our January 31, 1985 submittal that some analyses would be forwarded at a later date.

Attached are our responses to questions 5, 6, 7, 8, 20 and 24. We are still completing some detailed probability analyses required to respond to question 3. We anticipate submitting a response to question 3 on or about March 20, 1985.

Very truly yours,

R L Mittl

Attachments

C D. H. Wagner (w/5 sets of attach.) X
USNRC Project Licensing Manager

A. R. Blough (w/attach.)
USNRC Senior Resident Inspector

HOPE CREEK GENERATING STATION
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
RESPONSES TO QUESTIONS IN JANUARY 9, 1985, LETTER
RIVERBORNE MISSILES

Questions 5, 6, 7, 8

5. Provide the uncertainty associated with the extrapolation of an 11-year data base to represent return periods of up to 200 years, particularly in the development of a relationship between extreme wind speed and wind direction.

6. Provide further justification of the use of the 'Fisher-Tippett Type 2' distribution when other analyses of extreme winds (e.g., NUREG/CR-2639, 'Historical Extreme Winds for the United States-Atlantic and Gulf of Mexico Coastlines') suggest use of a mixed distribution, with all Type I distribution fitting non-tropical storms and the Weibull distribution fitting tropical storms.

7. The statement is made on page 2 that 'the particularly open exposure of this site is not adequately duplicated at any of the National Weather Service (NWS) stations in the region,' implying that extreme wind speeds at the site may be higher than at the NWS stations. Provide a discussion of the exposure of NWS stations in the region, particularly at Wilmington, DL, and provide comparable estimates of extreme winds at the NWS stations for return periods of 20, 50, 100, and 200 years as in Table 2.

8. Typically, extreme winds are represented by the fastest mile windspeed Provide a comparison of fastest mile wind speeds for return periods of 20, 50, 100, and 200 years between regional NWS stations and the site.

Response to Questions 5, 6, 7, 8

These four questions are interrelated, all bearing either on the representativeness of the onsite data or on the methods used in the processing and extrapolation of the results to very long return periods by Meteorological Evaluation Services, Inc. (MES) in their reports relating meteorological conditions to site flooding. The reports dated July 6, 1984, and August 1984 were transmitted, via R. L. Mittl to A. Schwencer letters dated July 27, 1984, and September 17, 1984, respectively.

Response to Questions 5, 6, 7, 8 (Cont'd)

Rather than attempting to re-explain the reasons for believing that the analysis performed earlier was reliable, Mr. Michael Changery of NOAA's National Climatic Data Center was contacted directly by MES for both for his opinions and his assistance with the handling of such data. Mr. Changery is the author of "Historical Extreme Winds for the United States - Atlantic and Gulf of Mexico Coastlines." The center then processed the most pertinent fastest-mile wind data, from Cape May and the Delaware Breakwater. These two stations have records extending over 44 and 59 years, respectively.

On Mr. Changery's advice, the data were subjected to a Fisher-Tippet (FT) Type 1 analysis, even though he prefers a hybrid FT-1 and Weibull approach[1]. The use of the FT-1 method alone permits a reasonable evaluation of the uncertainty of the results, whereas estimation of probable error or sigma values is difficult with the joint distributions.

Based on discussion with NRC staff members and their consultant, held on December 18, 1984, in Bethesda, MES first suggested an analysis encompassing the entire set of fastest-mile data at each station, regardless of the direction from which the observations came. This approach provides the most reliable estimation of the variability of the data at long return periods because all of the data points are used, and presumably it should also yeild the highest wind speed estimates possible from the data sets.

The second step in the procedure, which was discussed and verbally agreed to at the December meeting, was to apply the ratios that were obtained from the site data to reduce the fastest-mile estimates to one-hour and six-hour time periods.

The results of this new analysis are summarized in two tables and one figure. Table 1 shows Mr. Changery's fastest-mile estimates together with the standard deviations of the sampling errors. The formula used to obtain the sigma values is also shown. The estimated values for lengthy return periods are lower than those which were derived in the MES August, 1984 report. At the 20,000 year return period, for example, the comparison is:

Response to Questions 5, 6, 7, 8 (Cont'd)

MES Estimate Hope Creek	NCDC Estimates Delaware Breakwater	Cape May
130-150 mph	110 mph	123 mph

In order to reduce these fastest-mile estimates to the one-hour and six-hour periods needed for the major storm surge study, we returned to the fastest-mile/average ratios shown in Table 1 and Figure 1 of the MES August 1984 report[2]. These data showed an unmistakable tendency for the ratios to increase as the fastest-mile figures increased, and MES therefore obtained formulas for the relationship based on a linear least-squares fitting process. The data seem quite linear over the range of observed fastest-mile data (22-59 mph), but it seemed unwise to assume that this linearity would maintain at much higher speeds. Therefore the ratios shown for the one-hour and six-hour adjustments that remained constant at 2.0 and 2.25, respectively were used, rather than to extrapolate the values as suggested by the formulas. Figure 1 summarizes all of the ratio data and depicts as solid lines the ratios that MES considered reliable.

Table 2 summarizes all of the data from Artificial Island, Delaware Bay and Cape May, presenting estimates of fastest-mile one-hour and six-hour maximum winds from the different sources. From this comparison, it seems evident that MES's prior estimate of fastest-mile winds of 130-150 mph, at a 20,000 year return period was conservative. Similarly, it seems most unlikely that one-hour and six-hour sustained winds would exceed 75 and 65 mph respectively at this same return period.

Questions 20 and 24

20. In any given storm, wind speeds over water are higher than wind speeds over ground. It appears this was not taken into account in the estimate of annual probabilities of extreme 6-hour wind speeds at 33 ft. elevation. Is this the case. If so, why?

Questions 20 and 24 (Cont'd)

24. Page 7 of the August 1984 MES report reproduces estimates of directional fastest-mile wind speeds from the NBS BSS-124 Report. However, the estimates of NBS BSS-124 pertains to winds blowing from a 360°/16 = 22.5° sector, rather than from the 79°-170° sector. Using data on which the NBS BSS-124 Report is based (which are available on tape at NBS), the fastest-mile wind speeds at 22 feet over ground is estimated as 36 mph, 73 mph, and 85 mph for the 10, 50, and 100 year means recurrence intervals, respectively, rather than 24 mph, 57 mph, and 70 mph, as indicated on page 7 of the August 1984 MES Report."

Response to Questions 20 and 24

The over-water winds would exceed those over land by a small fraction, but with the extremely flat terrain at Artificial Island, it is not expected that the difference would exceed a few percent. The use of the NBS data mentioned in Question 24 may have been inappropriate, but the new study reported as a response to Questions 5-8 supersedes any of the earlier work, either on the part of MES or on that of the National Climatic Data Center.

It is important to note that even a 10% increase in the estimates of the maximum winds over six-hour periods would not produce surges capable of developing significant flooding on a 20,000 year return period.

REFERENCES

[1]Changery, M: Personal Communication, Feb. 7, 1985

[2]Smith, M.E. & Castelli F. P.: Hope Creek Generating Station Extreme Event Site Flooding, Supplemental Report on Meteorology, August 31, 1984.

Table 1

DELAWARE BAY ENTRANCE

FASTEST - MILE WIND SPEED ESTIMATES*

Return Period (years)	Delaware Breakwater		Cape May	
	Wind Speed (mph)	Standard Deviation of Sampling Error	Wind Speed (mph)	Standard Deviation of Sampling Error
50	77	2.9	74	4.8
100	81	3.4	80	5.7
200	85	3.9	85	6.6
500	90	4.6	93	7.7
1000	94	5.2	99	8.6
10,000	107	6.9	117	11.5
20,000	110	8.3	123	13.9

*From Michael Changery, Acting chief, Applied Climatology Branch, National Climatic Data Center, Asheville, North Carolina, February 1985.

$$SD = \left[\frac{\pi^2}{\sigma} + \frac{1.396(y - .5772)}{\sqrt{\sigma}} + 1.1(y - .5772)^2 \right]^{1/2} \frac{\sigma}{\sqrt{n}}$$

Where: SD = Standard deviation of the sampling error
$y = -\ln(-\ln(1-1/n))$
N = Return period
n = Sample size
σ = Estimated value of scale parameter

Table 2

ESTIMATES OF MAXIMUM WINDS (MPH)

Return Period (years)	FASTEST MILE		HIGHEST 1-HOUR		HIGHEST 6-HOUR	
	MES	DBCM	MES	DBCM	MES	DBCM
50	55	77	28	39	24	34
100	67	81	34	41	30	36
200	74	85	37	43	33	38
500	90	93	45	47	40	41
1000	101	99	51	50	45	44
10,000	132	117	66	59	59	52
20,000	145	123	73	62	64	55

MES - Estimates derived from Fig. 4 plot, 8/84 report.

DBCM - Delaware Breakwater or Cape May, whichever was higher (Changery, 2/85).

Figure 1

RATIOS OF FASTEST-MILE TO LONG-TERM AVERAGES HOPE CREEK