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

March 25, 1988

Project No. 669

Mr. Edwin E. Kintner, Chairman
ALWP Utility Steering Committee
GPU Nuclear Corporation
100 Interpace Parkway
Parsippany, New Jersey 07054

Dear Mr. Kintner:

SUBJECT: ALWR DESIGN BASIS TORNADO

On page 2-8 of the Draft Safety Evaluation Report on Chapter 1 of EPRI's Advanced Light Water Utility Requirements Document, we informed you that the staff was considering modification of its criteria for design basis tornadoes. Since there is no current effort under way to revise Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants", the staff has developed an interim position in response to the ALWR Optimization proposal that was submitted by Mr. C. F. Sears on March 24, 1986.

The staff's interim position is stated in the enclosed safety evaluation based upon R.G. 1.76 methodology, but using new tornado data. This position constitutes a conservative reduction of the design basis winds which can be used by EPRI and standardized plant designers until a revised R.G. 1.76 is available.

Sincerely,

L. S. Rubenstein

Lester S. Rubenstein, Director
Standardization and Non-Power
Reactor Project Directorate
Division of Reactor Projects - III, IV,
V and Special Projects
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc: J. DeVine, Jr., EPRI

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION OF RECOMMENDED MODIFICATION TO THE R.G. 1.76 TORNADO DESIGN BASIS FOR THE ALWR

1.0 INTRODUCTION

EPRI proposed that the tornado design of the Advanced Light Water Reactor (ALWR) be based upon the ANSI-ANS 2.3-1983 standard. However, the staff has not accepted the ANSI document as a replacement for R.G. 1.76, "Design Basis Tornado For Nuclear Power Plants," because the ANSI design parameters are largely based upon subjective judgement. However, a considerable quantity of tornado data is now available that was not available when R.G. 1.76 was developed. The following evaluation is based upon R.G. 1.76 methodology, using the new data.

2.0 EVALUATION

Regulatory Guide 1.76 has been utilized since 1974 by industry and the staff. The Guide provides a regional breakdown of design basis tornadoes (DBT) for the contiguous United States and it includes the following guidance:

"1. Nuclear power plants should be designed to withstand the Design Basis Tornado (DBT). The values of the parameters specified in Table I for the appropriate regions of Figure 1 (in R.G. 1.76) are generally acceptable to the Regulatory staff for defining the DBT for a nuclear power plant. Sites located near the general boundaries of adjoining regions may involve additional consideration.

2. If a DBT proposed for a given site is characterized by less conservative values for the parameters than the regional values in Table I, a comprehensive analysis should be provided to justify the selection of the less conservative design basis tornado."

TABLE I - DESIGN BASIS TORNADO CHARACTERISTICS

Region	Maximum Wind Speed (mph)[a]	Rotational Speed (mph)	Translational Speed (mph) Maximum	Translational Speed (mph) Minimum[b]	Radius of Maximum Rotational Speed (feet)	Pressure Drop (psi)	Rate of Pressure Drop (psi/sec)
I	360	290	70	5	150	3.0	2.0
II	300	240	60	5	150	2.25	1.2
III	240	190	50	5	150	1.5	0.6

[a] The maximum wind speed is the sum of the rotational speed component and the maximum translational speed component.

[b] The minimum translational speed, which allows maximum transit time of the tornado across exposed plant features, it to be used whenever low travel speeds (maximum transit time) are a limiting factor in the design of the ultimate heat sink. The ultimate heat sink is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the sources with, but not including, the intake structures of nuclear reactor units. Regulatory Guide 1.27 (Safety Guide 27), "Ultimate Heat Sink," describes a basis that may be used to implement General Design Criterion 44 of Appendix A to 10 CFR Part 50 with regard to the ultimate heat sink.

The technical basis for R.G. 1.76 was presented in WASH 1300, "Technical Basis for Interim Regional Tornado Criteria." Due to the fact that very little area specific data on the damage areas and tornado intensity was available, generalized conservative estimates of these parameters were utilized in the development of the DBT. Since the publication of WASH 1300, the National Severe Storms Forecast Center (NSSFC) has developed a data base which provides specific information when available on the damage areas, and intensity of the tornadoes which have occurred in the U.S. since 1950. The majority of the tornadoes that have occurred have been characterized by damage area and tornado intensity.

Battelle Memorial Institute, Pacific Northwest Laboratories (PNL) was awarded a contract to reevaluate the viability of R.G. 1.76, utilizing the new data and whatever other data were available. PNL completed its study and the results were published in NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," dated May 1986. At the heart of this study is the tornado data tape prepared by the NSSFC with thirty years of data, 1954 through 1983. This data tape contains the data for the approximate 30,000 tornadoes that occurred during the thirty year period.

The contractor compared its analysis of the thirty years of data with the findings in WASH-1300. Based on this comparison the contractor made the following findings:

> "Revisions to the WASH-1300 methodology for estimating maximum wind speeds, tornado areas and intensities have been proposed. These revisions include the use of the expected tornado area in computation of strike probability as is done in the TORNADO code, which is used by the NRC staff; use of affected areas rather than number of occurrences in computation of conditional probabilities of tornado intensities; use of a Weibull rather than a log-normal form to represent the intensity distribution; and use of regional intensity distributions in the estimation of design speeds.
>
> Using the revised methodology, the tornado strike probabilities range from near 10^{-7} yr^{-1} for much of the western United States to about 10^{-3} yr^{-1} in the central United States. The 10^{-7} yr^{-1} wind speeds estimated using local strike probabilities and regional intensity probability distributions range from less than 153 mph to 332 mph. These wind speed estimates are 50 to 100 mph lower than the speed estimates presented in WASH-1300 and Regulatory Guide 1.76 for most of the United States. On the basis of this analysis, it would appear to be reasonable to reduce tornado design basis wind speeds to 200 mph for the United States west of the Rocky Mountains and to 300 mph for the United States east of the Rocky Mountains."

The staff has reviewed the contractor's study and found agreement with the proposed revisions to the WASH-1300 methodology but believes that, in order to take into account uncertainties in the data base and analyses, the upper 90% strike probability confidence level should be utilized for estimating the probability of tornado occurrence. In keeping with the R.G. 1.76 regulatory position which allows for lessening of the DBT based upon a comprehensive analysis to justify less conservative DBT parameters, the staff concluded that the 10^{-7}/yr probability of occurrence at the upper 90% confidence level from the contractor report may be utilized as the DBT. Fig. 1, which is identical to Figure 30 in NUREG/CR-4461, shows the associated wind speed by 5-degree latitude/longitude sectors throughout the United States. These sectors may be assigned to four regions (see Figure 2), which can be characterized by the following DBT parameters:

TABLE II - DESIGN BASIS TORNADO CHARACTERISTICS

Region	Maximum Wind Speed (mph)[a]	Rotational Speed (mph)	Maximum Translational Speed (mph)	Radius of Maximum Rotational Speed (feet)	Pressure Drop (psi)	Rate of Pressure Drop (psi/sec)
I	330	260	70	150	2.4	1.7
II	300	240	60	150	2.0	1.2
III	220	170	50	150	1.0	0.5
IV	200	160	40	150	0.9	0.3

[a] When a plant site falls near, or on, boundary lines separating two or three velocity zones, either (1) the higher of the two or three regional wind velocities should be used or, (2) the lower of the two or three wind velocities may be used with appropriate justification (see Figure 2 for example).

3.0 CONCLUSION

Based on its review described above, the staff concludes that the tornado design criteria in Table II and Figure 2 are acceptable on an interim basis for ALWRs until such time as R.G. 1.76 is revised.

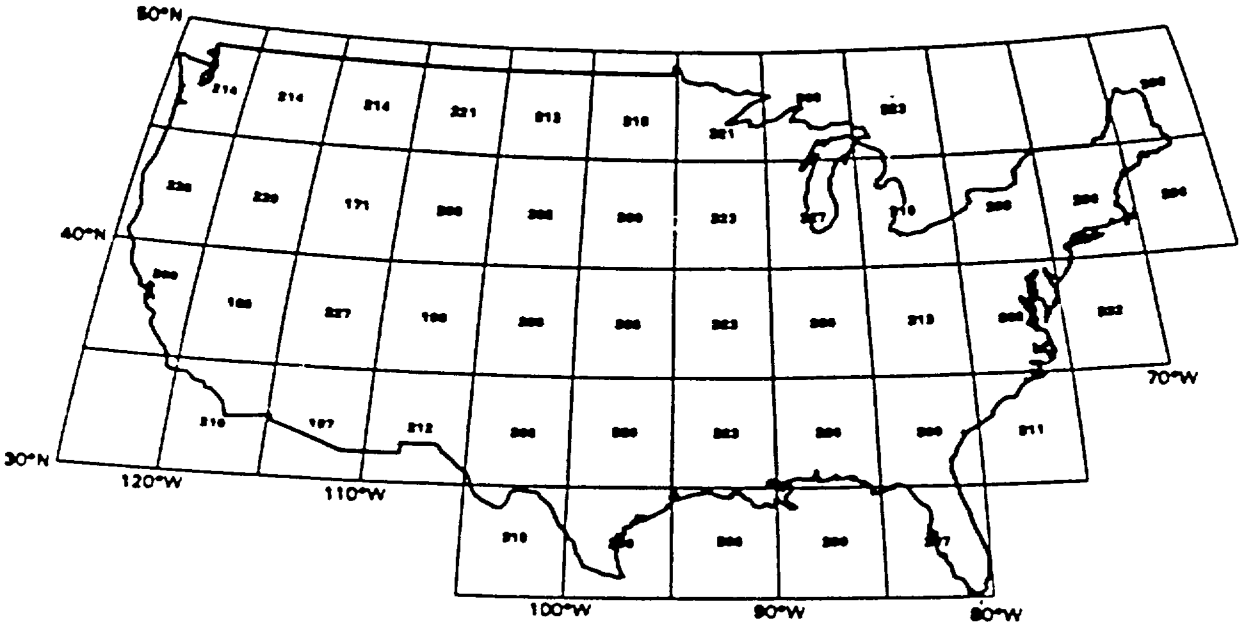

FIGURE 1 (Fig. 30 from NUREG/CR4461) Wind Speeds (mph) with a 10^{-7} Probability of Occurence Estimated from the Upper End of the 90% Strike Probability Confidence Interval

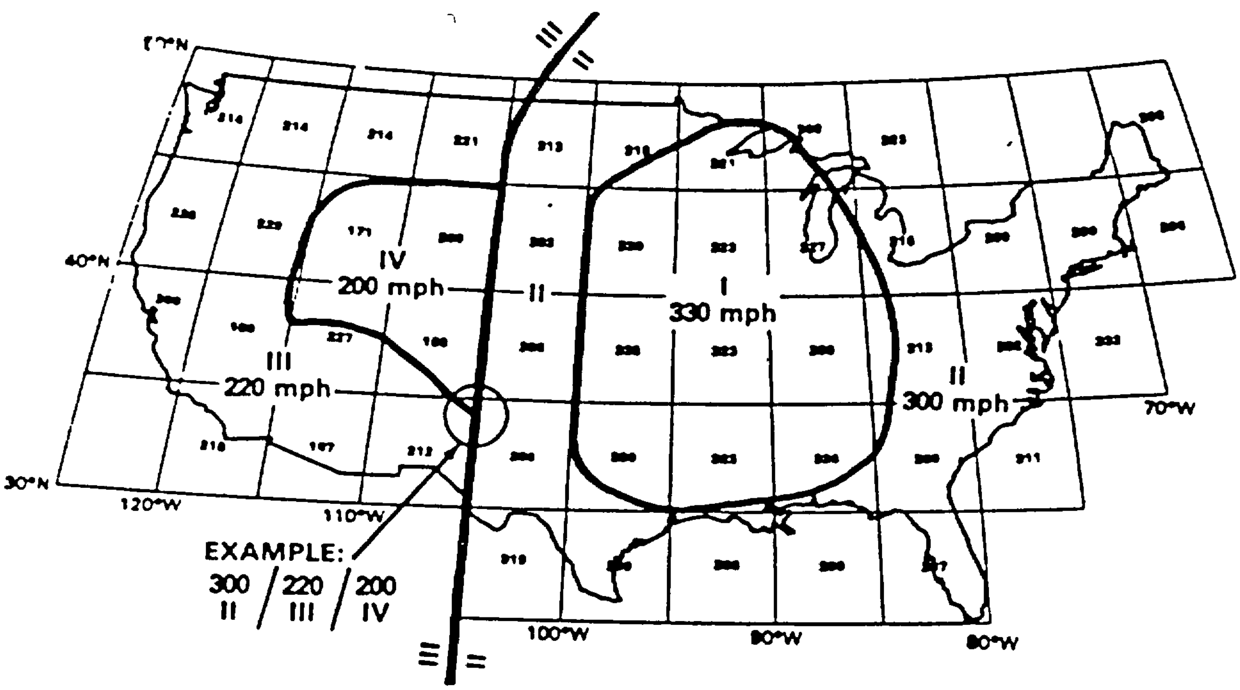

Figure 2 Maximum Wind Speed is indicated for each of 4 regions of the United States. The circled area illustrates boundaries where a lower wind speed can be selected if justified.