TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

June 1, 1981

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Ms. Adensam:

In the Matter of the Application of) Docket Nos. 50-327
Tennessee Valley Authority) 50-328

As requested by NRC, TVA has reevaluated the issue concerning the potential for tornado generated missiles to compromise plant safety at Sequcyah Nuclear Plant by damaging the 480-V shutdown board transformers in the Auxiliary Building.

In order to place this issue in proper prospective, a study has been done to determine an upper limit for the probability of tornado missiles damaging the subject transformers. A writeup discussing this study is enclosed. The conclusion of this study is that the probability of a tornado missile damaging the subject transformers is extremely low and is not a credible event worthy of further study. Concurrently, postulating the occurrence of this highly improbable event, it is our position, based on the results of the simulated loss of all ac power test performed during the Sequoyah unit 1 natural circulation test, that safe shutdown could be achieved.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills, Manager
Nuclear Regulation and Safety

Sworn to and subscribed before me
this 1st day of June 1981
Bryant M. Lowery
Notary Public
My Commission Expires 4/4/82

Enclosure

8106050183

ENCLOSURE

ASSESSMENT OF THE POTENTIAL FOR DAMAGE TO THE 480V SHUTDOWN TRANSFORMERS FROM TORNADO MISSILES

The total event probability, P_t, of a vertical tornado missile impacting any safety-related roof surface can be calculated as the product of three component probabilities:

$$P_t = P_s * P_n * P_v$$

where P_s is the probability of a tornado striking the plant

P_n is the probability of a missile striking a safety-related barrier

P_v is the probability of a vertical strike on a horizontal roof surface

Tornado Strike Probability (P_s)

The total event probability, P_s, is computed using the information contained in references 1 and 2. The tornado strike probability for the Sequoyah area is given in WASH-1300 as 1×10^{-3} per year for any tornado intensity assuming an average path area of 2.8 square miles (approximately 3.6×10^{-4} per year per square mile). This value is confirmed in reference 2 which gives the probability of a tornado strike in the Sequoyah area as 4.0×10^{-4} per year per square mile.

Missile Strike Probability (P_n)

The estimation of missile strike probabilities is based on the data presented in reference 2. Table 1 summarizes the calculation of the missile strike probabilities. Column C presents the probability of impact on any barrier at a representative one unit nuclear plant site for a sampling population of 6000 NRC-spectrum missiles and a particular tornado intensity. Reference 2 considered a range of from F2 to F6 Only tornado intensities 2 through 6 (greater than 113 mi/h windspeed) were considered.* Column D is the weighted probability of impact on a safety-related barrier when the frequency of occurrence of each tornado classification is considered. The frequency of occurrence of the tornadoes intensities considered in the studies discussed in reference 2 are taken from Table 2. The weighted total probability of an intensity 2 through intensity 6 intensity tornado impacting any safety-related barrier is 1.68×10^{-5} per year.

Vertical Strike Probability(P_v)

In order for a missile to pass through a roof opening and damage a transformer, its orientation requires a vertical strike of the missile on a roof opening. The missile histories developed in reference 2 show that approximately ten percent of all barrier impact events are for vertical missiles on roof surfaces. From this, one can conclude that the probability of a vertical strike on a roof opening, P_v, is 1×10^{-1}.

*Table 2 gives a frequency distribution based on observed tornadoes. No intensity 6 tornadors have been observed to date. However, for the purposes of this study a conservative frequency of 0.1 percent of the total.

Applicability to Sequoyah

It is recognized that the studies presented in reference 2 are for a representative one-unit nuclear plant site and that the probability values presented in reference 2 are not developed specifically for Sequoyah. However, the representative site layout used in reference 2 does consider the basic safety features of the Sequoyah plant with similar sizes and distances. Also, the representative site is oriented with respect to the wind field in order to maximize potential missile trajectories. This is a conservatism due to the fact that not all tornado strikes at a specific site will be oriented in a similar manner.

The studies in reference 2 further estimate the probability of a missile strike for a representative two-unit plant. The results for this site configuration show only a five to ten percent increase over the values for a representative one-unit site. This demonstrates the strike probabilities are not sensitive to variations in the specific plant target area. Therefore, the calculation of site-specific probability values for Sequoyah would not differ radically from those found in the representative site study.

Conclusion

For the conditions discussed above, the total event probability , P_t, is:

$$P_t = (4 \times 10^{-4}) (1.68 \times 10^{-5}) (1.0 \times 10^{-1})$$

$$= 6.7 \times 10^{-10}/\text{year (missile striking any roof surface in typical plant)}$$

This is the probability of a vertical strike for a one-unit representative site given a sample missile population of 6000. The probability of a vertical missile striking the opening is much less than 6.7×10^{-10}, the probability of a strike on a safety-related roof surface. The probability of the missile entering the opening at the exact trajectory to hit a safety-related comonent is extremely unlikely. Postulating a double strike event occuring in such a manner as to damage redundant transformers would reduce the probability even further; therefore, this is not considered to be a credible event for the Sequoyah Nuclear Plant.

We recently completed a review of this concern regarding the presence of roof openings over the transformer rooms. The review focused on the damage which could result from the passage of a single missile through one of the roof openings. Due to the presence of separation barriers between transformers and separation of electrical cables and conduits, no interaction of losses were found which could result in the loss of both trains of safety-related systems. The impact of a second missile in another transformer room was not considered credible for the reasons discussed above.

TABLE 1

Column	A Intensity of Tornado	B[1] Frequency of Tornado Class (%)	C[2] Probability of Multiple Missile Strike (Pn)	D Weighted Probability of Multiple Missile Strike
	2	26.6	4.71×10^{-5}	1.25×10^{-5}
	3	7.2	5.52×10^{-5}	3.97×10^{-6}
	4	2.1	1.61×10^{-5}	3.04×10^{-7}
	5	.12	6.68×10^{-6}	8.02×10^{-9}
	6	.1	2.17×10^{-6}	2.17×10^{-9}
			Total	1.68×10^{-5}

(1) WASH-1300, "Technical Basis for Interim Regional Tornado Criteria"

(2) L. A. Twisdale, Tornado Missile Risk Study, EPRI NP-768, May 1978

TABLE 2[1]

WINDSPEED DISTRIBUTION

Windspeed Classification	No. of Tornadoes	Percent of Total
6 (windspeed 318 mi/h)	*	(.1)**
5 (windspeed 260 to 318 mi/h)	2	0.12
4 (207 to 260 mi/h)	34	2.11
3 (158 to 206 mi/h)	115	7.13
2 (113 to 157 mi/h)	430	26.68
1 (73 to 112 mi/h)	710	44.05
0 (40 to 72 mi/h)	321	19.91

*None has been observed.

**Assumed. See note on page 2.