SELECTED REQUESTS FOR ADDITIONAL INFORMATION
FOR LICENSE AMENDMENT APPLICATIONS
USING THE TORMIS METHODOLOGY
(TAC NO. MD5964)

The enclosed Requests for Additional Information are from recent applications to use the TORMIS methodology. All RAIs noted are in ADAMS except for those noted as either informally transmitted to the licensee or discussed during telephone conversations.

Enclosure:
As stated

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SUMMARY OF RAIs ON
APPLICATIONS TO USE TORMIS

POINT 1
Data on tornado characteristics should be employed for both broad regions and small areas around the site. The most conservative values should be used in the risk analysis or justification for those values selected.

The submittal states that the [Plant] analysis will use the Fujita (F-scale) wind speed and regional data for tornado characteristics in lieu of the values in FSAR Section 2.3.1.3. Point One of the NRC staff safety evaluation report (SER) states that “the most conservative values should be used or justification provided for those values selected.” Verify that the regional data is the most conservative data to use or justify why it is acceptable.

In Section 4.0 of the Submittal, in response to the TORMIS SE plant specific item 1 regarding the use of the most conservative value for tornado frequency, it states that the [Plant] TORMIS evaluation used probability of tornado occurrence of 2.1 E-03 per year. Provide a discussion as to how this value was determined to represent the most conservative tornado frequency characteristics for both broad and small areas around the plant, including consideration of the tornado regions represented in WASH-1300, the EPRI TORMIS code, and trending of local tornado characteristics.

The October 26, 1983, TORMIS SE issued by the NRC specified that data on tornado characteristics should be employed for both broad regions and small areas around the site, and that the most conservative values should be used in the risk analysis.

(a) With respect to tornado frequency, the Updated Safety Analysis Report (USAR) value of 6.3×10^{-4} per year is proposed as the more conservative value compared to the estimate for the broader region defined by WASH-1300, “Technical Basis for Interim Regional Tornado Criteria,” (NRC Region 1). The following additional information is required in order to demonstrate that the selected frequency estimates meet Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants,” General Design Criterion 2, “Design bases for protection against natural phenomena,” for SSCs important to safety is designed to withstand the effects of a natural phenomenon as a tornado:
   i. Explain how a tornado frequency of 4.25×10^{-4} per year was determined based upon the NRC Region 1 tornado data.
   ii. The TORMIS methodology defines four broad regions, A through D, and [Plant] is located on the border between Regions A and B. Region A and B are a more discrete partitioning of Region 1. Determine the tornado frequency for [Plant] for Both Region A and Region B, and explain how these values were calculated.
   iii. The response that was provided to Item 1 of the October 23, 1983 TORMIS SE regarding input parameters indicates that the annual probability of a tornado will be determined for the Fujita wind speeds using regional data available in TORMIS for NRC Tornado Region 1; and that the more conservative of these two values (the other value being the USAR tornado frequency) will be utilized in the [Plant] analysis.

      Since Regions A and B are a discrete partitioning of a broad area, the analysis over a broader region (Region 1) could result in different strike probabilities. Explain how this analysis differs from the NRC Region 1 tornado frequency estimate and, to assure that the most conservative value is used, perform this analysis for TORMIS Regions A and B, and for the local site area described in the USAR. Provide the results of these analyses, including an explanation of how these values were calculated.

(b) Aside from the tornado frequency estimates discussed above, explain how the most conservative values will be determined for the tornado characteristics that are used in TORMIS based upon regional (WASH-1300 and TORMIS) and local tornado data, including a discussion of how more recent tornado that is not reflected in TORMIS will be accounted for.

Note that the use of values for tornado characteristics that are not the most conservative based upon available data must be identified and justification provided for NRC review and approval.

POINT 3
Reduction in tornado wind speed near the ground due to surface friction effects are not sufficiently documented in the EPRI study. Such reductions were not consistently accounted for when estimating tornado wind speeds at 33 feet above grade on the basis of observed damage at lower elevations. Therefore, users should calculate the effect of assuming velocity profiles with ratios of v_0 (speed at ground level) / v_{33} (speed at 33 feet elevation) higher than that in the EPRI study. Discussion of sensitivity of the results to changes in the modeling of the tornado wind speed profile near the ground should be provided.

In regards to [Plant's] response to Point 3 in the SER on the EPRI TORMIS analysis concerning tornado missiles, provide information to justify that "the injection height above the surface of the ground" is equivalent or more conservative than using the ratio of (speed at ground level / speed at 33 feet elevation), as specified in the SER.

In your resolution to point 3 of the TORMIS safety evaluation, you stated that the tornado windfield parameters in the [Plant] TORMIS analysis were adjusted to increase the windfield profile in the lowest 10 meters over the original profile in TORMIS, and that this adjustment applied the ratio of V_0/V_{33} in a conservative manner, in accordance with the TORMIS SER. However, the TORMIS SE does not provide a specific threshold for the ratio, only that it should be higher than in the EPRI study. Provide actual ratios used in the analysis performed at [Plant].

POINT 4
The assumptions concerning the locations and numbers of potential missiles presented at a specific site are not well established in the EPRI studies. However, the EPRI methodology allows site specific information on tornado missile availability to be incorporated in the risk calculation. Therefore, users should provide sufficient information to justify the assumed missile density based on site specific missile sources and dominant tornado paths of travel.

In regards to Point 4 of the SER for EPRI TORMIS analysis concerning tornado missiles,

provide information to demonstrate that the number of missiles used is a “conservative value” as stated in the submittal.
In Section 4.0 of the Submittal, in response to the TORMIS SE plant specific item 1 regarding the assumed locations and number of potential missiles, it states that “a probabilistic approach was utilized to demonstrate that the probability of a tornado missile striking Barrier-2 is so small that it is not a design basis event.” Since tornado missile strike, in themselves, are not considered design basis events, please explain this statement.
The response to the fourth item of the TORMIS SE states that the results of sensitivity study indicates that the probability values are not significantly adversely impacted by an increase in missile population. Discuss the results of this sensitivity analysis, including the basis for the conclusion that was reached.
Regarding the response to Issue 5, the missile spectrum described in SRPP 3.5.1.4 and approved [Plant] FSAR is based on a deterministic analysis, which only considers a limited missile spectrum that represents the most severe tornado missile strike, and therefore bounds the analysis. This ensures that either the protective barriers or the SSCs themselves are able to withstand any potential missile strike. The approved use of TORMIS is to demonstrate probability that the likelihood of a missile strike to components required for safe shut down is low enough such that additional costly protective barriers are not justified. Therefore, the analysis must consider missile strikes from any possible source. In its SER, dated October 26, 1983, which approves the use of TORMIS, the staff found that the spectrum described in the EPRI methodology was acceptable for this purpose. Please revise your analysis to include all missiles required by the TORMIS methodology. **(see NOTE)**
POINT 5 **Once the EPRI methodology has been chosen, justification should be provided for any deviations from the calculational approach.**
In Section 4.0 of the Submittal, in response to the identification and justification for deviations from the EPRI methodology, it states that “there will not be any deviation from the EPRI methodology contained in References 4 through 7 except those noted above in the resolution of concerns 1 through.” Please explain the extent of these deviations.
The submittal states that the acceptance criterion is probability of less than 10^{-6} per year. If the probability is a median value, the probability should be 10^{-7} per year. Clarify whether the 10^{-6} per year criterion is a mean or median for [Plant].
Proposed FSAR Section 3.5.1.2.2.2 states “For [Plant] the specific acceptance criterion for systems and components required for a tornado event is a probability of system failure from tornado damage of less than 10^{-6} per year for each system.” Clarify if the total (cumulative) probability from all unprotected systems, structures and components for the whole plant will be maintained below the 10^{-6} per year threshold. If not, provide justification why this deviation is acceptable.
In Section 1.0, “Description,” and 3.0, “Background,” in Attachment 1 of the license amendment submittal provided in the letter from [Plant] to U. S. NRC, ‘Request for License Amendment Related to the Application of the TORMIS Methodology,” dated June 16, 2006, there is a

statement that the methodology will be used to determine if physical protection from tornado generated missiles (TGM) is necessary for portions of certain safety related or non-safety related systems. Describe how the non-safety related components were evaluated for consideration.
Explain how the TORMIS analyses assure that the criteria specified by 10 CFR 100, "Reactor Site Criteria," will not be exceeded, including a discussion of why the actual offsite release from a tornado event is expected to be less than the calculated results.
In Section3.0, of the Submittal there is a discussion of tornado-missile protection issues regarding the Essential Service Water system cooling towers (ESWCT). The Submittal states that approval of the TORMIS methodology as applied to components of the ESWCT, including the ESWCT fans would resolve open NRC inspection issues. Please explain the effect that a single tornado-missile could have on multiple ESWCT fans (i.e., the physical dependence or independence that exists between fans).
In Section 4.0, "Technical Analysis," of the Submittal the following statement is made regarding the Tornado-Generated Missiles (TGMs). "The missile types considered in the TORMIS evaluation covered the spectrum of design basis TGMs currently listed in the [Plant] UFSAR Table 3.5-3, "Tornado-Generated Missiles and Their Properties." Explain how the spectrum of design basis TGMs meets the requirements of the TORMIS methodology regarding the number and types of postulated TGMs. (Issue 5)
Explain why two evaluations were required to address the ESWCT and the RSH. The explanation should include a discussion of path lengths and predominant directions of travel for tornados in the vicinity of the [Plant] station in demonstrating that a given tornado will only affect one of these areas. Also, explain the discrepancy between the 0.9 square mile zone selected for the [Plant] evaluation and the recommended 1.0 square mile in the TORMIS methodology.
In Section 4.0 of the Submittal, page 6 of 12, the fourth bulleted item states: "The probability of TGM strike on a component was determined by reducing the surface probabilities using reduction factors calculated from ratio of the surface area of the target to the surface area of the TORMIS model surface, or the ratio of the volume of target to the volume surrounded by the TORMIS model surface area, as appropriate based on configuration." Please explain the details of how this surface area and volume ratio reduction was performed and the extent of these applications, and how this approach satisfies the plant specific modeling for applying the TORMIS code. (Issue 10)
In reference to Issue 10 of your supplement to the LAR, your methodology for area ratioing assumes a uniform hit distribution. That is, the size of the larger surface area is such that it is reasonable to assume that the strike probability for the smaller target is the same, regardless of its location. In other words, small targets in very large walls (e.g., turbine building) may have different strike probabilities depending on its location relative to missile sources and tornado paths. Explain why assuming a uniform hit distribution is adequate and how you will verify it in your analysis. **(see NOTE)**

In Section 4.0 of the Submittal, page 6 of 12, it states that for buried piping evaluation, the thickness of soil was converted to an equivalent thickness of concrete by using the methodology of References 9 and 10. Please explain the acceptability of using this equivalency, and how tornado wind and differential pressure effects on the soil were accounted for. (issue 11)
The licensee's response to issue 11 in its letter dated September 14, 2006, explains the methodology for conversion of the soil thickness to an equivalent thickness of concrete. Please provide the minimum soil thickness, as well as equivalent concrete thickness, which is adequate to protect the buried piping from tornado generated missiles.
The licensee's response to issue 11 also indicates that the tornado wind and differential pressure effects on the soil are not accounted for. Since a soil barrier, which cannot be modeled in TORMIS, is not as stable as concrete or steel barriers, the vortex of the tornado can remove some amount of the soil over the area in question. Regulatory Guide 1.76 calls out design-basis tornado characteristics including pressure drop due to tornadoes. Please address the possibility that the tornado vortex may remove a certain amount of the soil cover and provide an estimate of the soil thickness that can be removed.
As provided in Table 4-1, "[Plant] Tornado Missile Targets Evaluated by TORMIS Methodology," of the submittal, the total of TGM strike probabilities for all 20 [Plant] targets is 5.345 E-07 per reactor year. SRP Section 2.2.3 identifies an acceptance criterion of 10 E-06 per year for the expected rate of occurrence for potential exposures in excess of 10 CFR Part 100 guidelines when combined with the reasonable qualitative arguments that show the realistic probability is lower. Please explain how the criterion specified in SRP 2.2.3 is satisfied by the TORMIS results for the [Plant].
Describe how variance reduction techniques were used in the modeling and explain why the parameters are appropriate. **(see NOTE)**
Explain why the number of tornado simulations and histories used in the modeling is adequate and how did you ensure convergence in the results. **(see NOTE)**
Regarding the selection of the wind field parameters such that the ratio of near ground wind velocity to velocity at 33 feet elevation (V_0 / V_{33}) is equal to a value 0.82; confirm whether this is a variable or fixed value in the model. **(see NOTE)**
The TORMIS manual specifies that dimensions of targets be increased to account for the uncertainty due to tumbling of the missiles (impact offset effect) and suggests to increase free surface area by its length divided by 8 (L / 8). Discuss how the tumbling of missiles was considered when modeling the targets, consistent with Section 4.2.3 of EPRI Report NP-769, "Tornado Missile Risk Analysis Apendixes – Analytical Models and Databases." **(see NOTE)**
The application reported that the [Plant] subregion had a total land area of 186,847 square miles and was comprised "essentially all of Wisconsin, Michigan, and Minnesota. It also includes northern Illinois, and a small portion of Indiana and Ohio." Please provide the center coordinates and a box domain (length x width) in degrees for this reported subregion. **(see NOTE)**

The tornado data set examined was composed of 54 years total. A review of the data reported in Table 1, "Number of Reported Tornadoes – [Plant] SubRegion (1950-2003)," reveals that the total tornado occurrence for this 54-year period was 3,135. By NRC staff calculations, this would equate to 58.01 tornado occurrences per square mile per year, as reported in paragraph 1 on page 2 of the license amendment submittal. Thus the process is clearly understood. However, in Table 2, the methodology implemented to derive the occurrence rates for each Fuji Scale (F0-F5) category has apparently changed. It is generally stated that "The F-scale distribution was adjusted for local tornado occurrence rates and the path length, width, and directional data from the [Plant] subregion was statistically analyzed." The NRC staff assumes that the equation provided on page 2.7-3 of Attachment 3 in the LAR, P= (z)(t)/A, is used for this analysis. However, in order to verify the data presented in Table 2, the values of mean tornado path area, mean number of tornadoes per year, and the local subregion (in square miles) must also be provided for each F-scale category in the 2005 tornado evaluation (1950-2003). Please define the steps used in determining the "local tornado occurrence rates" as listed in Table 2. Also, please provide a detailed calculation for at least one of the F-scale occurrence rates, including all parameters and their values. **(see NOTE)**
Please justify the application of SRP Section 2.2.3 siting criteria as the acceptance criteria for a tornado-generated missile impact evaluation in lieu of SRP Section 3.5.1.4. **(see NOTE)**
Please provide the following additional information: a. The layout of the Turbine Building with respect to the other buildings b. Direction of the tornadoes considered c. Identification of missiles from SRP Section 3.5.1.4 that are located in Table 3 if the request **(see NOTE)**
The amendment request states that the missile origin zones extend approximately 1,600 feet from the targets of concern. However, the TORMIS Code user's manual suggests that missile origin zones do not need to extend more than 2,000 ft. In addition, the NRC staff noted that the estimated number of missiles identified in the amendment request varies significantly with those used in the EPRI methodology and previous license amendment requests [Plant]. Consistent with the EPRI TORMIS methodology, confirm that the missile origin zone will extend at least 2,000 feet from the affected structure. Also, explain why the number of missiles is much less for [Plant] than for most other plants that have used TORMIS methodology. Describe how many missiles of each type exist, where they are located, and measures that are proposed to assure that the assumed number of missile will not be exceeded. **(see NOTE)**
Clarify which tornado region, within the NRC or the EPRI classification scheme, was chosen in the TORMIS analysis; provide a justification to demonstrate that this selection provides the most conservative results. **(see NOTE)**
Provide a basis for area reduction methods that were used in the TORMIS methodology analysis. **(see NOTE)**
The amendment request states that for windspeed exceedance calculations, six speeds were analyzed in the simulations. Clarify what these six velocities represent and how do they fit into your analysis. **(see NOTE)**

The amendment request provides a description of the methodology used to evaluate target damage due to tornado missile impact. The methodology is used to calculate damage probability to the EDG exhaust vents and fuel oil tank vent lines by assuming that structural damage is the result of crushing the components to a critical closure. However, this is not consistent with the EPRI methodology in that the TORMIS structural damage probability model is limited to reinforced concrete structures with steel rebars. In addition, the staff notes that the amendment request relies on the results of the crush probabilities per year to meet the acceptance criteria of NUREG 0800, Section 2.2.3, and by extension the requirements of 10 CFR Part 100. The staff also noted that the licensee did not consider cumulative probabilities for all possible failure cutsets (i.e., all possible combinations in TABLE 4 of the request). Further, the proposed amendment is not consistent with the guidelines of RG 1.117 because it does not consider non-safety related nor important to safety components which could adversely impact safe shutdown and long term cooling. The licensee's approach is not consistent with other applications of the TORMIS methodology that have been approved by the NRC and does not provide the level of conservatism that is typical of other applications. Revise the analysis to provide the conservative results consistent with other applications that have been approved by the NRC or provide appropriate justification for the deviation from the precedents that have been established in this regard. **(see NOTE)**
In the licensee's request dated January 11, 2005, the licensee referenced NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Report for Nuclear Power Plants," Section 2.2.3, Revision 2. Section II, "Acceptance Criteria," states that the expected rate of exposure in excess of 10 CFR Part 100, "Reactor Site Criteria," guidelines of approximately 10^{-6} per year is acceptable if, when combined with reasonable quantitative arguments, the realistic probability can be shown to be lower. The proposed change indicates that a tornado missile strike on the limited portion of a system or component that is exposed is assumed to result in a radioactive release that exceeds 10 CFR Part 100 guidelines, rather than performing specific evaluations as to whether the strike can actually cause damage and release. Confirm that this logic will apply to all SSCs that are listed in proposed USAR Table 3.5-3, "TORMIS Analysis – Essential Safe Shutdown System Tornado Missile Targets," including (for example) the auxiliary building roll up and main doors, auxiliary building emergency diesel generator roof, auxiliary building roof penetrations, and auxiliary building roof drains. Also, revise the USAR to include this clarification.
Describe how the exposed areas of unprotected SSCs will be determined to assure conservative results.

Use of TORMIS Outside Approved Scope
In Section 1.0 of the Submittal it states: "The changes do not include the allowance to permanently remove existing missile barriers unless it can be shown that the existing barriers unnecessarily challenge or hinder the operation of the plant; however, temporary removal of a protective feature is permitted under administrative controls, if removal is determined to be necessary for plant maintenance or configuration change." Also on page 8 of 12 in the Submittal there is a discussion on the use of the TORMIS application to allow removal of the currently installed steel plate structure covering the Essential Service Water Blowdown Valve Pits. The TORMIS Safety Evaluation (i.e., Letter from L. S. Rubenstein (U. S. NRC) to F. J. Miraglis (U. S. NRC), "Safety Evaluation Report – Electric Power Research Institute (EPRI) Topical Reports Concerning Tornado Missile Probabilistic Risk Assessment (PRA) Methodology," dated October 26, 1983) stated that the use of TORMIS should be limited to the evaluation of specific plant features where additional costly tornado missile protective barriers or alternative systems are under consideration. Therefore, in order to assure that the use of TORMIS will be consistent with the position that was stated in the TORMIS Safety Evaluation (SE), confirm that: a) TORMIS will not be used to temporarily or permanently eliminate existing barriers that are credited for providing tornado missile protection; b) its use will be limited to demonstrating adequate protection for existing SSCs that were originally required to be protected from tornado missiles in accordance with the plant design basis due to some oversight, are not adequately protected; and c) identify the specific criteria that will be used for future applications of TORMIS in determining whether or not modifications that are required for protecting SSCs from tornado missiles are too costly such that the use of TORMIS is justified consistent with NRC approval of the TORMIS methodology. Also revise the [Plant] UFSAR to include clarification.
The amendment request to approve the EPRI methodology states: "The proposed amendment would allow the use of a different methodology for determining the design requirements necessary for protecting safety-related equipment from damage by tornado generated missiles. Currently, [Plant] uses a deterministic methodology to establish these design requirements. The proposed amendment would allow the use of a probabilistic methodology in place of the current deterministic methodology for specifically identified plant equipment." However, in its safety evaluation (SE) approving the use of the EPRI tornado missile probabilistic [m]ethodology (October 26. 1983), the NRC staff determined that the use of this methodology should be limited to the evaluation of specific plant features where additional costly tornado missile protective barriers or alternative systems are under consideration. Further, the staff determined in SEs for [Plant] … that the TORMIS methodology is not recognized by the NRC as an approved method for justifying the elimination of existing tornado protected structures, systems and components (SSC) or tornado barriers, nor for justifying the elimination or relaxation of technical specification (TS) (or other) requirements that have been established for those SSCs and barriers. Clarify the extent of the proposed amendment request. Specifically, clarify if it is intended as a one-time application to address tornado missile protection for the EDG exhaust ducts and EDG

fuel oil tank vent lines. **(see NOTE)**
The Technical Analysis section on the proposed change indicates that upon NRC approval, existing plant conditions, as well as future changes to the facility, could be evaluated using TORMIS. However, the TORMIS SE stated that the use of TORMIS should be limited to the evaluation of specific plant features where additional costly tornado missile protective barriers or alternative systems are under consideration. Therefore, in order to assure that the use of TORMIS will be consistent with the position that was stated in the TORMIS SE, confirm that: a) TORMIS will not be used to temporarily or permanently eliminate existing barriers that are credited for providing tornado missile protection; b) its use will be limited to demonstrating adequate protection for existing SSCs that were originally required to be protected from tornado missiles in accordance with the plant design basis but due to some oversight, are not adequately protected; and c) identify the specific criteria that will be used for future applications of TORMIS in determining whether or not modifications that are required for protecting SSCs from tornado missiles are too costly such that the use of TORMIS is justified consistent with NRC approval of the TORMIS methodology. Also, revise the UFSAR to include clarification.

NOTE: RAIs/Questions were either informally transmitted to the licensee or discussed during telephone conversations.