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SOUTHERN COMPANY
Energy to Serve Your World℠

August 31, 2001

Docket Nos.: 50-348
50-364

NEL-01-0206

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Joseph M. Farley Nuclear Plant
Facility Operating License Amendment Request
Design Basis for Tornado-Generated Missiles

Ladies and Gentlemen:

In accordance with 10 CFR 50.59 and 10 CFR 50.90, Southern Nuclear Operating Company (SNC) proposes to amend the Farley Nuclear Plant (FNP) Unit 1 and Unit 2 design basis as described in the Final Safety Analysis Report (FSAR) to add a description of the methodology utilized for determining the systems and components considered to require protection from tornado missiles.

During the design inspection of the Farley Nuclear Plant in March 1997, two issues arose regarding the design basis for tornado-generated missiles. These issues were identified as Unresolved Items (URIs) 50-348; 50-364/97-201-08 and -09 in the resultant May 13, 1997 NRC Inspection Report. URI -08 stated that SNC would prepare an analysis to evaluate the effects of applicable tornado missiles, while URI -09 stated that the NRC would determine if the tornado missile protection in the Farley design and licensing bases included missile spectra other than horizontal missiles. An FSAR amendment was proposed in our letter of June 29, 2000 as a result of an evaluation that considers these two issues and incorporates risk information from a tornado missile risk analysis performed for FNP utilizing the TORMIS methodology developed for the Electric Power Research Institute. Subsequent discussion with the NRC staff has led SNC to revise the proposed changes (particularly the Farley specific tornado damage acceptance criterion) and clarify their technical basis, hence this letter revises SNC's original June 29, 2000 submittal. The conclusions of our previous 10CFR 50.92 evaluation contained in the June 29, 2000 submittal continue to remain valid.

Enclosure I is a safety analysis explaining the technical basis for the proposed changes.
Enclosure II is a 10 CFR 50.92 Significant Hazards Evaluation for the proposed changes.
Enclosure III provides the affected FSAR pages annotated with the proposed changes.
Enclosure IV provides a clean-typed copy of the FSAR pages incorporating the changes.
Enclosure V responds to NRC requests for additional information.

This letter constitutes a formal NRC commitment to revise the FSAR as approved. Additionally, implementation of the revised acceptance criterion will require installation of tornado barriers for

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selected equipment yet to be determined. SNC commits to install the necessary tornado barriers and, after these design modifications have been completed, to list in the FSAR the remaining (unprotected) equipment subject to the tornado damage acceptance criterion.

SNC requests an implementation date of December 31, 2004 for this license amendment, consistent with the projected completion date for the required design modifications. This will allow SNC to appropriately determine the equipment to be protected and to develop and implement design modifications within existing budget planning cycles.

SNC has determined that the proposed changes will not significantly affect the quality of the human environment and that the conclusions of the previous Significant Hazards Evaluation remain acceptable. A copy of the proposed changes has been sent to Dr. D. E. Williamson, the Alabama State Designee, in accordance with 10 CFR 50.91(b)(1).

If there are any questions, please advise.

Respectfully submitted,

SOUTHERN NUCLEAR OPERATING COMPANY

Dave Morey

Sworn and subscribed before me this 31st *day of* August *2001*

Notary Public

My Commission Expires: 9-14-02

DWD/kaw: newTORMISltr.doc

Enclosures:

I - Basis for Final Safety Analysis Report Changes to Design Basis for Tornado-Generated Missiles

II - 10 CFR 50.92 Significant Hazards Evaluation for Final Safety Analysis Report Changes to Design Basis for Tornado-Generated Missiles

III - Annotated Pages for Final Safety Analysis Report Changes to Design Basis for Tornado-Generated Missiles

IV - Clean-Typed Pages for Final Safety Analysis Report Changes to Design Basis for Tornado-Generated Missiles

V - Response to NRC Requests for Additional Information Regarding FSAR Changes to Design Basis for Tornado-Generated Missiles

cc: <u>Southern Nuclear Operating Company</u>
Mr. L. M. Stinson, General Manager

<u>U. S. Nuclear Regulatory Commission, Washington, D. C.</u>
Mr. F. Rinaldi, Licensing Project Manager – Farley
Mr. L. B. Marsh, NRR - Chief, Plant Systems Branch

<u>U. S. Nuclear Regulatory Commission, Region II</u>
Mr. L. A. Reyes, Regional Administrator
Mr. T. P. Johnson, FNP Senior Resident Inspector

<u>Alabama Department of Public Health</u>
Dr. D. E. Williamson – State Health Officer

ENCLOSURE I

Joseph M. Farley Nuclear Plant

Basis for Final Safety Analysis Report Changes
to
Design Basis for Tornado-Generated Missiles

Summary Description of the Proposed FSAR Changes

Changes are proposed to FSAR Sections 3.2, 3.3, and 3.5 to reflect FNP's conformance to 10 CFR 50 Appendix A, General Design Criteria 2 and 4, which pertain to protection against natural phenomena and environmental effects. These revisions entail:

- The use of the probabilistic approach outlined in regulatory guidance to determine if the limited portions of "important" systems and components that are currently unprotected need to have unique tornado missile barriers permanently installed.
- The FNP-specific acceptance criterion that will be utilized for evaluating the results of tornado missile damage probability analyses, and
- The commitment to reduce or maintain the probability of tornado-generated missile damage to below the FNP-specific acceptance criterion.

The primary changes are made in FSAR Table 3.2-1, which contains the description of conformance to Branch Technical Position AAB 3-2 and to SRP Section 3.5.1.4, Rev. 0, "Missiles Generated by Natural Phenomena". Other changes are made in Sections 3.2 and 3.5 to add a description of the methodology used and to add and cite references. Following NRC approval, these changes will be incorporated into the FSAR (see markups in Enclosure III) in accordance with 10 CFR 50.71 (e).

Detailed Description of FSAR Section 3.5 Changes

The proposed FNP design basis is summarized in new subsections (reproduced below) added within the tornado missile protection discussions of FSAR Section 3.5 "Missile Protection". For the complete changes proposed for the FSAR, refer to the markups in Enclosure III.

New text added to FSAR 3.5:

3.5.1.2.1 Missile Protection Methods

Those systems or components listed in Table 3.2-1 that are required for safe shutdown, for immediate or long term core cooling or to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines are provided with tornado missile protection by location within Category I structures, burial underground, missile barriers/shielding or have been analyzed as discussed in Section 3.5.1.2.2.

3.5.1.2.2 Components Not Requiring Unique Missile Protection

Certain Seismic Category I systems and components located outside of Seismic Category I structures are evaluated as not requiring unique tornado missile protection by burial or barriers. The following two approaches are used in the evaluation of these systems and components relative to a tornado event.

3.5.1.2.2.1 Components Not Required for a Tornado Event

The probability of occurrence of a tornado event coincident with another low probability design basis event is so small that no protection from tornado missiles is required for certain Seismic Category I structures, systems and components which are not otherwise needed for safe shutdown, for immediate or long term core cooling, to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines, or to support other systems or components which are required for one of those functions.

3.5.1.2.2.2 Components with Acceptable Probability of Survival

Safety related systems and components required for safe shutdown, for immediate or long term core cooling or to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines required for a tornado event are generally protected. A limited amount of unprotected portions of these systems and components are analyzed using probabilistic missile damage analysis as permitted in Standard Review Plan 3.5.1.4 "Missiles Generated By Natural Phenomena." This analysis is conducted to determine the probability per year of missiles generated by postulated tornadoes striking and damaging these systems and components beyond their failure point. For FNP, the specific acceptance criterion for tornado damage for the unprotected systems and components required for a tornado event is that the cumulative sum of the mean failure probabilities for these systems and components be less than 10^{-6} per year per unit. The allowable level of less than 10^{-6} per year per unit for the cumulative probability of failure of such systems and components is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The analysis used for FNP is the computer program TORMIS[3][5], developed by the Electric Power Research Institute (EPRI)[4] and accepted by the NRC.

Systems and components whose analysis using the TORMIS methodology yields results that cause the less than 10^{-6} per year per unit acceptance criterion to be exceeded will be provided with unique barriers to reduce the total failure probability value to below the acceptance criterion.

3.5.1.2.3 <u>TORMIS Methodology</u>

TORMIS[3][4][5] is a methodology developed to predict the probability of damage to nuclear power plant structures and components from tornadoes. There are four fundamental models in the TORMIS analysis: wind hazard, site facility, load effects and system models. Monte Carlo simulation is used to produce numerical estimates of hit and damage probabilities based on the site-specific models.

The wind hazard analysis for the Farley Plant Units 1 & 2 uses a site specific analysis to generate a tornado hazard curve specifically for Farley.

The site facility model was conservatively developed based on a site area walkdown and the specific characteristics, materials and failure points for Farley structures and components.

Load effects are determined based on the TORMIS model missiles, missile transport model, and component characteristics. The missiles utilized in the TORMIS model encompass the 3 design basis missiles described in Section 3.3.2.1.

TORMIS implements a methodology developed by the Electric Power Research Institute. TORMIS determines the probability of striking walls and roofs of buildings on which penetrations or exposed portions of systems/components are located. The probability is calculated by simulating a large number of tornado strike events at the site for each tornado wind speed intensity scale. After the probability of striking the walls or roof is calculated, the exposed surface area of the particular components are factored in to compute the probability of striking and consequently damaging a particular item.

The following provisions apply to the TORMIS analysis for FNP:

1. FSAR Section 2.3.1.3 estimates an occurrence rate of 3 tornadoes per year per 1 degree square (approximately 4000 square miles), or 7.5 E-04 tornadoes per square mile. This occurrence rate was based on conservative treatment of data from 1955-67. As part of the FNP TORMIS analysis, the annual probability of a tornado was determined for the Fujita F-scale wind speeds using regional data available in TORMIS for NRC Region II. A site-specific analysis was performed to generate a tornado data set for the TORMIS analysis of Farley.

The National Climatic Data Center (NCDC) files for the years 1950-1996 were used as the basic source of data for this investigation. This data was screened to eliminate coding errors in the record fields. In addition, corrections were introduced to account for reporting efficiency and time series, or other potential errors resulting from the indirect characteristics of the available data. The overall tornado occurrence rate computed from the updated regional data in TORMIS is 6.00 E-04 tornadoes per square mile per year. While this rate is slightly lower than the rate in FSAR Section 2.3.1.3, it is a more accurate figure based on conservative treatment of the best available data and will therefore be used in lieu of the data cited in FSAR Section 2.3.1.3 for those components or portions of systems analyzed in TORMIS.

2. The Fujita scale (F-scale) wind speeds will be used in lieu of the TORMIS wind speeds (F-scale) for the F0 through F5 intensities.

3. The tornado windfield parameters in the FNP TORMIS analysis were adjusted to increase the wind profile in the lowest 10 m over the original profile in TORMIS. This adjustment applied the ratio of V_0/V_{33} in a conservative manner in accordance with the NRC's October 26, 1983 TORMIS SER.

4. Detailed surveys of the plant site were performed to characterize and quantify potential missiles for use in the FNP TORMIS analysis. To ensure conservatism, these surveys were performed during a refueling outage when large amounts of material were temporarily stored in outside laydown areas around the site. Additionally, ground and aerial photographs were reviewed to estimate the number and type of missiles which could originate from remote areas of the site. The total number of missiles used in the FNP TORMIS analysis was 51,864.

5. The FNP analysis will not deviate from the TORMIS program as described in reference (4) of FSAR Section 3.5, except as noted in items 1 through 4 above.

New references added to FSAR 3.5:

3. TORMIS Missile Risk Analysis for Farley Nuclear Plant Units 1 and 2, ARA Report 4733, March 1999.

4. EPRI NP-2005, Tornado Missile Simulation and Methodology, Volumes I and II, Final Report, August 1981.

5. REA 97-1409 response, SCS to SNC letter FP 99-0429, "Tornado Missile Broadness Review and PRA Analysis," August 6, 1999.

Background

The Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (NRR), performed a design inspection of the Farley Nuclear Plant Units 1 and 2 (Farley) from January 27 through March 14, 1997. According to the NRC Inspection Report, "The purpose of the inspection was to evaluate selected systems regarding their capability to perform safety functions in accordance with their design and licensing bases, and consistency of the as-built configuration and system operations with the final safety analysis report."

Resulting from that audit was NRC Inspection Report No. 50-348; 364/97-201, dated May 13, 1997. Two issues raised in the report were Unresolved Items 50-348; 50-364/97-201-08 and -09, "Tornado Protection of TDAFW Vent Stack" and "Tornado Missile Spectra." The specific questions asked or actions required by the NRR inspection team were: 1) "An analysis will be prepared to evaluate the effects of the applicable tornado missiles striking the exposed vent stack. This analysis would determine if the TDAFW pump would remain operable after the event. If this analysis shows that the TDAFW pump would remain operable, a safety evaluation will be prepared to revise the FSAR" and 2) "Whether the plant's design bases distinguished between horizontal and vertical/non-horizontal tornado missiles."

In addition to the two portions of safety-related systems cited above, FNP has evaluated the applicability of other systems and components throughout the plant which are located outside the containment but are neither housed in category I structures nor buried underground. This review considered systems or portions of systems such as Auxiliary Feedwater, Service Water, Reactor Makeup Water, Chemical Volume Control, Emergency Diesel Fuel Oil, Refueling Water and Main Steam Safety Valves.

Farley was designed to meet the then-proposed General Design Criteria (GDC) in 10 CFR 50, Appendix A. Like other plants of similar vintage, Farley's missile design basis protects its structures, systems and components (SSC) against certain tornado-generated missiles which were determined to be bounding cases. These bounding missiles, and the criteria for determining that these missiles were bounding, were specifically questioned, evaluated and approved by the NRC during the original licensing review. Farley received its Safety Evaluation Report in May 1975, predating the original version of the NRC's Standard Review Plan, which was issued in November 1975. The NRC found that these bounding assumptions provide reasonable assurance that the safety function of seismic SSC at Farley will not be impaired by missiles and that Farley's approach to tornado missile protection complies with GDC 2 and 4. These remain the bounding missile cases for Farley. (A more complete timeline of events is included as Table 1 of this enclosure, along with a list of references in Table 2.)

Not withstanding past interpretations of the design/licensing basis, the proposed changes for the Farley Nuclear Plant comply with the intent of GDC-2 and 4 by specific analysis, using the TORMIS tornado risk analysis methodology. This analysis supports FNP's design basis, as approved by the NRC, and is based on bounding missile cases driven by a defined horizontal tornado wind force. This methodology is based on Electric Power Research Institute (EPRI) Report NP-2005 and is well conceived, well developed, versatile, and utilizes state-of-the-art probabilistic Monte

Carlo techniques. This analysis studied specific safety-related plant features and provides additional risk information to demonstrate that the probability of damage to unprotected safety-related features, either individually or in required combination, is sufficiently small.

Proposed Design Basis Changes for Farley

As permitted in the NRC Standard Review Plan (NUREG-0800), the combined individual probability of damage to safety-related structures, systems and components will be maintained below an allowable level, i.e., an acceptance criterion threshold, which reflects an extremely low probability of occurrence. Specifically, the FNP results would be evaluated per Standard Review Plan (SRP) Section 3.5.1.4 "Missiles Generated By Natural Phenomena," using an acceptance criterion consistent with, or more conservative than, the value specified in SRP Section 2.2.3 "Evaluation Of Potential Accidents." SRP Section 3.5.1.4, Revision 2 notes in Section II, "Acceptance Criteria," that the "methodology of identification of appropriate design basis missiles generated by natural phenomena shall be consistent with the acceptance criteria defined for the evaluation of potential accidents from external sources in SRP Section 2.2.3." SRP Section 2.2.3, Revision 2, in Section II, "Acceptance Criteria," notes that the acceptance criteria are based on meeting "the relevant requirements of 10 CFR Part 100 which indicates that reactors should reflect through their design, construction and operation an extremely low probability for accidents that could result in the release of significant quantities of radioactive fission products." It also notes that "the expected rate of occurrence of potential exposures in excess of the 10 CFR Part 100 guidelines of approximately 10^{-6} per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower."

The proposed FNP-specific acceptance criterion to be incorporated into the FSAR is considered to contain inherent qualitative conservatism. This conservatism stems from the FNP assumption that in all cases a tornado missile strike on the limited portion of a system or component that is exposed results in damage causing a radioactive release, rather than performing specific evaluations as to whether the damage can actually cause releases. The proposed FNP-specific acceptance criterion is also considered to contain inherent quantitative conservatism in that the individual system or component mean damage probabilities for each unit are arithmetically summed, even though these damage probabilities may result from mutually exclusive tornado events and in some cases apply to redundant equipment (i.e. redundancy is penalized).

No credit is taken for other-unit equipment in responding to licensing basis events or in the probabilistic risk analyses at FNP. Therefore it is appropriate to consider the acceptance criterion on a per unit basis. This approach assumes that if the probability calculation for each unit identifies that the sum of the probabilities of tornado missiles striking and damaging unprotected portions of "important" systems or components is greater than or equal to 10^{-6}, then it will be conservatively determined that unique missile barriers must be installed to lower the cumulative probability to less than 10^{-6}. Further discussion of these topics, and of the conservatism which makes the 10^{-6} criterion "acceptable" as described in SRP Section 2.2.3, are contained in the text to be added into the FNP FSAR (see markups in Enclosure III). The FSAR text addressing the probability analysis technique, the acceptance criterion, and the commitment to reduce or maintain the probability of tornado-generated missile damage to below the FNP-specific acceptance criterion will become part of the FNP licensing basis for conformance to 10 CFR 50 General Design Criteria 2 and 4.

The NRC concluded in their Safety Evaluation Report dated October 26, 1983 that the EPRI TORMIS approach is an acceptable probabilistic approach for demonstrating compliance with the requirements of the General Design Criteria regarding protection of specific safety related plant features from the effects of tornado and high wind generated missiles, subject to five additional specific concerns primarily related to input parameters. Appendix I of this enclosure repeats and responds to these concerns, and text addressing all five NRC points is included in the material proposed to be added to FSAR Section 3.5.

The NRC also noted that use of the EPRI TORMIS methodology, or of any other tornado missile probabilistic study, should be limited to the evaluation of specific plant features where additional costly tornado missile protective barriers or alternative systems are under consideration. Use of TORMIS is appropriate in this case since the cost to add new permanent barriers would be significant. Also, new barriers are not considered to be cost-justified based on the extremely low probability of tornado missile damage to important plant systems and components required to bring the plant to a safe shutdown, and the even lower probability of any resultant radiological release of sufficient quantity to compromise the health and safety of the public.

CONCLUSION

Utilization of the proposed methodology, which employs the probabilistic approach permitted in appropriate regulatory guidance and the proposed acceptance criterion detailed above, is a sound and reasonable method of addressing the tornado missile protection subject at FNP for the limited portions of important systems and components that are not protected by tornado missile barriers. The FSAR would be revised, making this an established part of the FNP licensing basis for conformance to 10 CFR 50 General Design Criteria 2 and 4. Existing plant conditions, as well as future changes to the facility, would be evaluated using the probabilistic approach.

Table 1
Timeline of Events

10-10-69	APC	Submitted PSAR for Unit 1 of Farley to NRC
03-12-70	Bechtel	Issued B-TOP-3, "Design Criteria for Nuclear Power Plants Against Tornadoes"
03-16-70	Bechtel	Conference notes issued for March 5, 1970 meeting with M. A. Suarez about tornado missile analysis
03-17-70	SCS	Letter to Bechtel requesting a recommendation as to what, if any, missile design criteria should be applied to the roofs of the Diesel Generator Building and Control Room
04-27-70	Bechtel	Responded to SCS that no particular missile criteria need be applied to the D/G or Control Room roofs
06-26-70	APC	Submitted PSAR for Unit 2 of Farley to NRC
10-14-70	APC	Response to AEC Question 5.36 with identification of design basis missiles
02-20-71	NRC	Published 10 CFR 50 Appendix A, General Design Criterion (GDC) in the *Federal Register*
08-16-72	NRC	Issued Construction Permit for Farley
08-29-73	APC	Submitted original FSAR to NRC
03-06-74	APC	Response to Auxiliary and Power Conversion System Branch Question APC-1 reconfirming the design basis missiles identified in AEC Question 5.36
04-01-74	NRC	Issued Reg. Guide 1.76, Rev. 0, "Design Basis Tornado for Nuclear Power Plants"
08-01-74	Bechte	Issued BC-TOP-3A, Rev. 3, "Tornado and Extreme Wind Design Criteria for Nuclear Power Plants"
09-01-74	Bechtel	Issued BC-TOP-9A, Rev. 2, "Topical Report - Design of Structures for Missile Impact"
10-04-74	NRC	Reviewed and endorsed BC-TOP-3A, Rev. 3, "Tornado and Extreme Wind Design Criteria for Nuclear Power Plants"
05-02-75	NRC	Issued NUREG-75/034, "Safety Evaluation Report for Joseph M. Farley Nuclear Plant, Units 1 and 2"
11-24-75	NRC	Issued NUREG -75/087, Standard Review Plan, Section 3.5.1.4, "Missiles Generated by Natural Phenomena," Rev. 0
02-17-97	NRC	NRC A&E Inspection at Farley, asked Question # Q046 about Farley design basis tornado missile spectra; Question # Q034 about FSAR Section 3.5.4 "Category I equipment exposed to Natural Phenomena."

05-13-97	NRC	Issued Inspection Report 50-348; 364/ 97-201 with Unresolved Item 97-201-08 and Unresolved Item 97-201-09.
05-28-97	Bechtel	Issued letter AP-21568, reiterating tornado-generated missiles design basis for FNP.
05-28-97	SNC	Issued Tornado-generated Missile Design Basis for NRC review.
07-11-97	SNC	60-day response to NRC's design inspection report.
12-29-97	NRC	Issued Notice of Violation VIO 97-14-05, "Failure to Provide Tornado Missile Protection for TDAFW Pump Vent Stack", in response to Inspection Report 50-348; 364/97-201 Unresolved Item 97-201-08.
01-23-98	SNC	Issued letter to NRC denying VIO 97-14-05.
03-23-98	NRC	Issued Integrated Inspection Report 50-348; 364/98-01 closing Unresolved Item 97-201-09 regarding susceptibility of the safety-related emergency diesel generators exhaust silencers to non-horizontal tornado-generated missiles. NRC states, *"while non-horizontal tornado-generated missiles were part of FNPs design and licensing basis, the EDG exhaust silencers were adequately protected."*
08-12-98	NRC	Issued letter adjusting records to reflect that no violation of regulatory requirements occurred with respect to VIO 97-14-05, "Failure to Provide Tornado Missile Protection for TDAFW Pump Vent Stack." NRC states in part, *"...we do not agree with the statements in your 1/23/98 letter that the Farley design and licensing basis does not require the postulation of a single active failure in conjunction with consequential failures which are the direct result of a design basis tornado."*
10-16-98	SNC	Issued letter to NRC reiterating FNP's design and licensing basis regarding design basis tornadoes.

Table 2
List of References

1. Unresolved Item 50-348; 50-364/97-201-08 and -09, "Tornado Protection of TDAFW Pump Vent Stack" and "Tornado Missile Spectra"

2. AEC Question 5.36 on Farley PSAR regarding tornado-generated missiles & Farley's response

3. B-TOP-3, "Design Criteria for Nuclear Power Plants Against Tornadoes" (March 12, 1970)

4. Bechtel - Civil and Structural Design Criteria, Joseph M. Farley Nuclear Plant, Unit 1 & 2, Rev. 2 (May 1971)

5. BC-TOP-3A, Rev. 3, "Tornado and Extreme Wind Design Criteria for Nuclear Power Plants" (August 1974)

6. Auxiliary and Power Conversion System Branch Question APC-1 & FNP response - March 6, 1974

7. NUREG-75/034, "Safety Evaluation Report for Joseph M. Farley Nuclear Plant, Units 1 and 2" (May 1975)

8. Standard Review Plan, Section 3.5.1.4, "Missiles Generated by Natural Phenomena," Rev. 0 (November 24, 1975)

Appendix I

Response to NRC's Five Points in the TORMIS Safety Evaluation Report

The following information provides the FNP-specific responses to the five points the NRC raised in the evaluation of the EPRI TORMIS methodology in their Safety Evaluation Report dated October 26, 1983. These points deal primarily with input parameters to the analyses.

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 provided for those values selected."

Response:

FSAR Section 2.3.1.3 estimates an occurrence rate of 3 tornadoes per year per 1 degree square (approximately 4000 square miles), or 7.5 E-04 tornadoes per square mile. This occurrence rate was based on conservative treatment of data from 1955-67. As part of the FNP TORMIS analysis, the annual probability of a tornado was determined for the Fujita F-scale wind speeds using regional data available in TORMIS for NRC Region II. A site-specific analysis was performed to generate a tornado data set for the TORMIS analysis of Farley. The National Climatic Data Center (NCDC) files for the years 1950-1996 were used as the basic source of data for this investigation. This data was screened to eliminate coding errors in the record fields. In addition, corrections were introduced to account for reporting efficiency and time series, or other potential errors resulting from the indirect characteristics of the available data.

The overall tornado occurrence rate computed from the updated regional data in TORMIS is 6.00 E-04 tornadoes per square mile per year. While this rate is slightly lower than the rate in FSAR Section 2.3.1.3, it is a more accurate figure based on conservative treatment of the best available data and will therefore be used in lieu of the data cited in FSAR Section 2.3.1.3 for those components or portions of systems analyzed in TORMIS.

2. "The EPRI study proposes a modified tornado classification, F scale, for which the velocity ranges are lower by as much as 25% than the velocity ranges originally proposed in the Fujita F-scale. Insufficient documentation was provided in the studies in support of the reduced F scale. The F-scale tornado classification should therefore be used in order to obtain conservative results."

Response:

The Fujita scale (F-scale) wind speeds will be used in lieu of the TORMIS wind speeds (F-scale) for the F0 through F5 intensities.

3. "Reductions 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 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."

Response:

The tornado windfield parameters in the FNP TORMIS analysis were adjusted to increase the wind profile in the lowest 10 m over the original profile in TORMIS (Twisdale, *et. al.*, 1981). This adjustment applied the ratio of V_0/V_{33} in a conservative manner in accordance with the NRC SER.

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."

Response:

Detailed surveys of the plant site were performed to characterize and quantify potential missiles for use in the FNP TORMIS analysis. To ensure conservatism, these surveys were performed during a refueling outage when large amounts of material were temporarily stored in outside laydown areas around the site. Additionally, ground and aerial photographs were reviewed to estimate the number and type of missiles which could originate from remote areas of the site. The total number of missiles used in the FNP TORMIS analysis was 51,864.

5. "Once the EPRI methodology has been chosen, justification should be provided for any deviations from the calculational approach."

Response:

The FNP analyses will not have any deviations from EPRI NP-2005, except as noted in items 1 through 4 above.

ENCLOSURE II

Joseph M. Farley Nuclear Plant

10 CFR 50.92 Significant Hazards Evaluation
for
Final Safety Analysis Report Changes
to
Design Basis for Tornado-Generated Missiles

10 CFR 50.92 Significant Hazards Evaluation

1. The proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

Proposed for NRC review and approval are changes to the Farley Nuclear Plant (FNP) Final Safety Analysis Report (FSAR) which in essence constitute a license amendment to incorporate use of an NRC approved methodology to assess the need for additional positive (physical) tornado missile protection of specific features at FNP. The FSAR changes will reflect use of the Electric Power Research Institute (EPRI) Topical Report "Tornado Missile Risk Evaluation Methodology" (EPRI NP-2005), Volumes I and II. As noted in the NRC Safety Evaluation Report on this topic dated October 26, 1983, the current licensing criteria governing tornado missile protection are contained in Standard Review Plan (SRP) Sections 3.5.1.4 and 3.5.2. These criteria generally specify that safety-related systems be provided positive tornado missile protection (barriers) from the maximum credible tornado threat. However, SRP Section 3.5.1.4 includes acceptance criteria permitting relaxation of the above deterministic guidance, if it can be demonstrated that the probability of damage to unprotected essential safety-related features is sufficiently small.

As permitted in NRC Standard Review Plan (NUREG-0800) sections, the combined probability will be maintained below an allowable level, i.e., an acceptance criterion threshold, which reflects an extremely low probability of occurrence. The FNP approach assumes that if the sum of the individual probabilities calculated for tornado missiles striking and damaging portions of important systems or components is greater than or equal to 10^{-6} per year per unit, then installation of unique missile barriers would be needed to lower the total cumulative probability below the acceptance criterion of 10^{-6} per year per unit. Considering the cumulative tornado damage probability on a per unit basis is appropriate since no credit is taken at FNP for other-unit equipment in responding to licensing basis events or in probabilistic risk analyses.

With respect to the probability of occurrence or the consequences of an accident previously evaluated in the FSAR, the possibility of a tornado reaching the FNP site and causing damage to plant structures, systems and components is a design basis event considered in the Final Safety Analysis Report. The changes being proposed do not affect the probability that the natural phenomenon (a tornado) will reach the plant, but from a licensing basis perspective they do affect the probability that missiles generated by the winds of the tornado might strike and damage certain plant systems or components. There are a limited number of safety-related components that could theoretically be struck and consequently damaged by tornado-generated missiles. The probability of tornado-generated missile strikes on "important" systems and components (as discussed in Regulatory Guide 1.117) is what is to be analyzed using the probability methods discussed above. The combined probability of damage will be maintained below an extremely low acceptance criterion to ensure overall plant safety. The proposed change is not considered to constitute a significant increase in the probability of occurrence or the consequences of an accident, due to the extremely low probability of damage due to tornado-generated missiles and thus an extremely low probability of a radiological release. Therefore, the proposed changes do not involve a significant increase in the probability or consequences of previously evaluated accidents.

2. The proposed change will not create the possibility of a new or different kind of accident from any accident previously evaluated.

The possibility of a tornado reaching the FNP site is a design basis event considered in the Final Safety Analysis Report. This change involves recognition of the acceptability of performing tornado missile probability calculations in accordance with established regulatory guidance. The change therefore deals with an established design basis event (the tornado). Therefore, the proposed change would not contribute to the possibility of a new or different kind of accident from those previously analyzed. The probability and consequences of such a design basis event are addressed in Question 1 above. Based on the above discussions, the proposed change will not create the possibility of a new or different kind of accident than those previously evaluated.

3. The proposed change will not involve a significant reduction in a margin of safety.

The existing licensing basis for FNP with respect to the design basis event of a tornado reaching the plant, generating missiles and directing them toward safety-related systems and components is to provide positive missile barriers for all safety-related systems and components. With the change, it will be recognized that there is an extremely low probability, below an established acceptance limit, that a limited subset of the "important" systems and components could be struck and consequently damaged. The change from protecting all safety-related systems and components to ensuring an extremely low probability of occurrence of tornado-generated missile strikes and consequential damage on portions of important systems and components is not considered to constitute a significant decrease in the margin of safety due to that extremely low probability. Therefore, the changes associated with this license amendment request do not involve a significant reduction in the margin of safety.

CONCLUSION

Utilization of the proposed methodology, which employs the probabilistic approach permitted in appropriate regulatory guidance and the proposed acceptance criterion detailed above, is a sound and reasonable method of addressing the tornado missile protection subject at FNP for the limited portions of important systems and components that are not protected by tornado missile barriers. The FSAR would be revised, making this an established part of the FNP licensing basis for conformance to 10 CFR 50 General Design Criteria 2 and 4. Existing plant conditions, as well as future changes to the facility, would be evaluated using the probabilistic approach.

Based on the analysis presented above and in Enclosure I, the conclusions reached with respect to 10 CFR 50.92 determine that the proposed change does not involve a significant hazard.

ENCLOSURE III

Joseph M. Farley Nuclear Plant

Final Safety Analysis Report Change Markups
Proposed to Incorporate
Risk-Based Methodology for Tornado-Generated Missiles

3.2 CLASSIFICATION OF STRUCTURES, COMPONENTS AND SYSTEMS

3.2.1 SEISMIC CLASSIFICATION

A two-level system is used for the Seismic Classification of the structures, components, and systems of the facility.

1. Category I structures, components, and systems.

2. Category II structures, components, and systems.

3.2.1.1 Definitions

Structures, components, and systems required for safe shutdown, for immediate or long term core cooling, or for radioactive material confinement following a loss-of-coolant accident (LOCA) to ensure that the public is protected in accordance with 10 CFR 100 guidelines are designed Category I.

Category I structures, components, and systems are designed to withstand the effects of the safe shutdown earthquake (SSE) and 1/2 safe shutdown earthquake (1/2 SSE) as discussed in section 3.7.

When a system as a whole is referred to as Category I, portions not associated with loss of function of the system may be designated as Category II.

Category II structures, components, and systems are those whose failure would not result in the release of significant radioactive material and would not prevent reactor shutdown. All equipment not specifically listed as Category I is included as Category II.

The failure of Category II structures, components, and systems may interrupt power generation.

All Category II structures are designed to conform to Section 2.3.1.4 of the 1970 edition of the Uniform Building Code.

Seismic Classification of structures, systems, and components is in accordance with Regulatory Guide 1.29.

3.2.1.2 Category I Structures

1. Containment.
2. Auxiliary building, including all fuel handling equipment storage areas.
3. Diesel generator building.
4. River intake structure.[a]
5. Intake structure at storage pond.
6. Storage pond dam and dike.
7. Vent stack.(a)
8. Pond spillway structure.
9. Electrical cable tunnel structure.
10. Category I outdoor tanks.
11. Trisodium phosphate baskets in Containment.

3.2.1.3 Category I Mechanical Components and Systems

Refer to table 3.2-1 for Category I seismic mechanical components and systems.

3.2.1.4 Category I Electrical Equipment

1. 4160-v switchgear (engineered safeguard buses).
2. 4160-v to 600-v transformers (associated with engineered safeguard systems).
3. 600-v load centers (engineered safeguard buses).
4. 600-v and 208-v motor-control centers (associated with engineered safeguard systems).
5. Direct-current electrical distribution system (Auxiliary Building and Service Water Building):
    a. 125-v dc station batteries.
    b. Inverters, 125-v dc to 120-v ac (vital ac instrumentation distribution panels).
    c. 125-v dc distribution panels.

a. Not required for safe shutdown of the plant. The original design (Category I) requirements for the river intake structure are no longer required.

   d. 125-v dc switchgear.

   e. 125-v dc battery chargers.

6. Vital ac instrumentation and regulated ac distribution panels.

7. Control panels and control boards:

   a. Auxiliary relay racks.

   b. Solid-state protection system cabinets.

   c. Nuclear instrumentation system cabinets.

   d. Process protection and control system cabinets.

   e. Emergency power board.

8. Cable tray and conduit supports (associated with engineered safeguard systems).

9. Containment penetration assemblies.

10. Direct-current emergency lighting (except for an 8-hour rated DC battery pack, emergency lighting is installed per Appendix R to 10 CFR 50 referenced in FSAR section 9B.4.1.19).

11. Diesel generators.

12. Diesel generator control panels.

13. Diesel generator sequencers.

14. Boric acid heat-tracing equipment.

15. Turbine driven auxiliary feedwater pump uninterruptable power supply.

3.2.1.5 <u>Category I Instrumentation and Control Systems Equipment</u>

1. Penetration room filtration system.

2. Radiation monitors for containment purge exhaust lines.

3. Radiation monitors for fuel handling area ventilation exhaust line.

4. Post-accident containment combustible gas control system.

5. Component cooling water system.

6. Service water system.

7. Auxiliary feedwater system.

8. Power supply inverters for balance of plant instrument panels.

9. Balance of plant instrument panels.

10. Portions of the sampling system which provide containment isolation and which interface with other Category I systems. (See drawings D-175009, sheet 1, D-175009, sheet 2, D-175009, sheet 3, D-205009, sheet 1, D-205009, sheet 2 and D-205009, sheet 3.)

11. Diesel generator control equipment.

3.2.1.6 Structures and Systems of Mixed Category

None of the structures in the Farley Nuclear Plant have classifications that are partially Category I and partially Category II. The boundaries of the nuclear classes of piping systems are shown on the Piping and Instrumentation Diagrams (P&ID) in sections as listed in table 3.2-3.

Nuclear Safety Classes 1, 2a, 2b, and 3 are designed as Seismic Category I systems. Systems that are Nuclear Safety Class NNS, and all piping systems not otherwise indicated as Category I, are non-seismic. The P&ID legend is shown on drawings D-175016, sheet 1, D-175016, sheet 2, and figure 1.7-1.

3.2.2 SYSTEM QUALITY GROUP CLASSIFICATION

The design criteria are tabulated in table 3.2-1 for all mechanical system components.

The design in general complies with the intent of Regulatory Guide 1.26. The actual design standards, however, conform to the standards of the American Nuclear Society, "Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants," August 1970 draft. Regulatory Guide 1.26 was not available at the time of initial equipment design and purchase. Whenever practicable, equipment has been purchased to meet ASME Section III standards. When equipment was purchased before ASME Section III became effective, other design codes, as indicated in table 3.2-1, were used.

The relationship between Safety Class and the ASME Section III Nuclear Class is indicated below.

ANS SAFETY CLASS	ASME SECTION III NUCLEAR CLASS
1	1
2a	2
2b	3
3	3
NNS (Non-nuclear safety)	-

The system quality group classifications are delineated on the piping and instrumentation diagrams in chapters 5.0, 6.0, 9.0, 10.0, and 11.0.

TABLE 3.2-1 (SHEET 1 OF 15)

SUMMARY OF CRITERIA - MECHANICAL SYSTEM COMPONENTS

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Rad Seismic (6)	Tornado (7)
REACTOR COOLANT SYSTEM							
Reactor vessel	W	1	III A	C	S	X	X
Full length CRDM housing	W	1	III A	C	S	X	X
Reactor coolant pump assembly (8)	W	1		C	S	X	X
Reactor coolant pump casing	W	1	P&V I	C	S	X	X
Reactor coolant pump internals	W	1	P&V I	C	S	X	X
Steam generator (tube side)	W	1	III A	C	S	X	X
(shell side including integral steam flow restrictor)	W	2a	III A	C	S	X	X
Pressurizer	W	1	III A	C	S	X	X
Reactor coolant piping to pressure boundary	W	1	III 1	C	S	X	X
RC system supports	W	-	-	C	N	X	X
Surge pipe and fittings	W	1	III 1	C	S	X	X
RC thermowells	W	1	III 1	C	S	X	X
Safety valves (16)	W	1	III A	C	S	X	X
Relief valves	W	1	III A	C	S	X	X
Valves to RC system boundary	W	1	P&V I	C	S	X	X
Pressurizer relief tank (11)	W	NSS	VIII	C	S	-	X
CRDM head adapter plugs	W	1	B31.7 I	C	S	X	X
CHEMICAL & VOLUME CONTROL SYSTEM							
Regenerative HX	W	2a	III C	C	S	X	X
Letdown HX (tube side)	W	2a	III C	AB	S	X	X
(shell side)		2b	VIII		P	X	X

TABLE 3.2-1 (SHEET 2 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Mixed bed demineralizer (11)	W	3	VIII	AB	S	X	X
Cation bed demineralizer (11)	W	3	VIII	AB	S	X	X
Reactor coolant filter	W	2a	III C	AB	S	X	X
Volume control tank	W	2a	III C	AB	S	X	X
Charging/high head safety injection pump (8)	W	2a	P&V II	AB	S	X	X
Seal water injection filter	W	2a	III C	AB	S	X	X
Letdown orifices	W	2a	III 2	C	S	-	X
Excess letdown HX (tube side) (shell side)	W	2a 2b	III C VIII	C	S P	X X	X X
Seal water return filter	W	2a	III C	AB	S	X	X
Seal water HX (tube side) (shell side)	W	2a 2b	III C VIII	AB	P	X X	X X
Boric acid tanks (19)	A	2b	API 650	AB	P	X	X
Boric acid filter (11)	W	2b	III C	AB	P	X	X
Boric acid transfer pump	W	2b	P&V III	AB	P	X	X
Boric acid blender	W	2b	III 3	AB	P	X	X
Resin fill tank (12) (13)	A	NNS	VIII	AB	N	-	X
Boric acid batching tank (13)	W	NNS	VIII	AB	N	-	X
Chemical mixing tank (12) (13)	W	NNS	VIII	AB	N	-	X
Chemical mixing tank orifice	A	NNS	-	AB	N	-	X
RCP No. 1 seal bypass orifice	W	1	III 1	C	S	-	X
Reactor makeup water storage tank	A	2b	III 3	O	-	X	X[23]
Reactor makeup water pump	A	2b	III 3	O	-	X	X[23] [26]
Demineralized water storage tank	A	NNS	-	O	-	-	-
EMERGENCY CORE COOLING SYSTEM							
Accumulators	W	2a	III C	C	P	X	X

ADD

TABLE 3.2-1 (SHEET 3 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
RESIDUAL HEAT REMOVAL SYSTEM							
Residual heat removal/low head safety injection pump (8)	W	2a	P&V II	AB	S	X	X
Residual heat exchanger (tube side)	W	2a	III C	AB	S	X	X
(shell side)		2b	VIII	AB	P	X	X
CONTAINMENT SPRAY SYSTEM							
Containment spray pump	W	2a	P&V II	AB	P	X	X
Eductor	W	2a	III 2	AB	P	X[(a)]	X
CONTAINMENT ISOLATION SYSTEM							
Valves	A	2a	P&V II	C,AB	S,P	X	X
CONTAINMENT COOLING SYSTEM							
Fans	A	2b	AMCA (14)	C	N	X	X
Heat exchanger	A	2b	VIII	C	N	X	X
COMPONENT COOLING SYSTEM							
Pumps	A	2b	P&V III	AB	P	X	X
Unit 1 Heat exchangers (tube side)	A	2b	VIII	AB	N	X	X
(shell side)	A	2b	VIII	AB	P	X	X
Unit 2 Heat exchangers (tube side)	A	2b	III	AB	N	X	X
(shell side)	A	2b	III	AB	P	X	X
Surge tank (21)	A	2b	API 620	AB	P	X	X
SPENT FUEL POOL COOLING SYSTEM							
Spent fuel pool heat exchanger (tube side) (8)	W	2b	III C	AB	S	X	X
(shell side)	W	2b	VIII	AB	P	X	X

a. The components are included as part of the respective piping system model and seismic analysis.

TABLE 3.2-1 (SHEET 4 OF 15)

Component		Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Spent fuel pool pump		W	2b	P&V III	AB	S	X	X
Spent fuel pool strainers		W	NNS		AB	S	-	X
Skimmer pump		W	NNS		AB	P	-	X
Spent fuel pool filter (10)(11)		W	NNS	III C	AB	S	-	X
Spent fuel pool demineralizer (10)(11)		W	NNS	III C	AB	S	-	X
BORON THERMAL REGENERATION SUBSYSTEM								
Moderating HX	(tube side)	W	3	VIII	AB	S	X	X
	(shell side)		3	VIII	AB	S	X	X
Letdown chiller HX	(tube side)	W	3	VIII	AB	S	X	X
	(shell side) (10)		NNS	VIII	AB	P	X	X
Letdown reheat HX	(tube side)	W	2a	III C	AB	S	X	X
	(shell side)		3	VIII	AB	S	X	X
Thermal regeneration demineralizer		W	3	III 3	AB	S	X	X
Chiller (8)		W	NNS	VIII	AB	N	-	X
Chiller surge tank (10)		W	NNS	VIII	AB	N	-	X
Chiller pumps		W	NNS	P&V III	AB	N	-	X
LIQUID RECYCLE AND WASTE SUBSYSTEM								
Recycle holdup tank (19)		A	NNS	API 650	AB	S	-	X
Recycle evap. feed pump		W	NNS	MS	AB	S	-	X
Recycle evap. feed demineralizer		W	NNS	VIII	AB	S	-	X
Recycle evap. feed filter		W	NNS	VIII	AB	S	-	X
Recycle evaporator		W	NNS	VIII	AB	S	-	X
Recycle evap. condensate demineralizer (10)		W	NNS	VIII	AB	P	-	X
Recycle evap. condensate filter (10)		W	NNS	VIII	AB	P	-	X
Recycle evap. concentrate filter (10)		W	NNS	VIII	AB	S	-	X
Recycle evap. reagent tank (13)		W	NNS	VIII	AB		-	X

TABLE 3.2-1 (SHEET 5 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
R.C. drain tank	W	NNS	VIII	C	S	-	X
R.C. drain tank pump	W	NNS	MS (N2G21P001A-N) API-610 (N2G21P001B-N)	C	S	-	X
R.C. drain tank HX (tube side) (10)	W	NNS	VIII	C	S	-	X
(shell side)		2b	III C	C	P	X	X
Waste holdup tank (12)(13)	W	NNS	VIII	AB	S	-	X
Waste evap. feed pump	W	NNS	MS	AB	S	-	X
Waste evap. reagent tank	W	NNS	VIII	AB		-	X
Waste evap. feed filter	W	NNS	VIII	AB	S	-	X
Waste evaporator	W	NNS	VIII	AB	S	-	X
Waste evap. condensate demin. (10)	W	NNS	VIII	AB	P	-	X
Waste evap. condensate filter (10)	W	NNS	VIII	AB	P	-	X
Waste evap. condensate tank (10)(12)	W	NNS	VIII	AB	P	-	X
Waste evap. condensate tank pump	W	NNS	MS	AB	P	-	X
Chemical drain tank (12)(13)	W	NNS	VIII	AB	S	-	X
Chemical drain tank pump	W	NNS	MS	AB	S	-	X
Spent resin storage tank	W	NNS	VIII	AB	S	-	X
Spent resin sluice pump	W	NNS	MS	AB	S	-	X
Spent resin sluice filter	W	NNS	VIII	AB	S	-	X
Laundry and hot shower tank (10)(12)(13)	W	NNS	VIII	AB	P	-	X
Laundry and hot shower tank pump	W	NNS	MS	AB	P	-	X
Laundry and hot shower strainer (10)	W	NNS		AB	P	-	X
Laundry and hot shower filter (10)	W	NNS	VIII	AB	P	-	X
Floor drain tank (10)(12)(13)	W	NNS	VIII	AB	P	-	X
Floor drain tank pump	W	NNS	MS	AB	P	-	X
Waste monitor tank (10)(12)(13)	W	NNS	VIII	AB	P	-	X

TABLE 3.2-1 (SHEET 6 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Waste monitor tank pump	W	NNS	MS	AB	P	-	X
Waste monitor tank demineralizer (10)	W	NNS	VIII	AB	P	-	X
Waste monitor tank filter (10)	W	NNS	VIII	AB	P	-	X
Containment sump pump	A	NNS	MS	C	P	-	X
ES room sump pump	A	NNS	MS	AB	P	-	X
Drumming header strainer (10)	W	NNS		AB	S	-	X
Floor drain tank filter (10)	W	NNS	VIII	AB	P	-	X
Floor drain tank strainer (10)	W	NNS		AB	P	-	X
Disposable demineralizers	A	NNS	MS	AB	S	-	X
Disposable demineralizer pumps	A	NNS	MS	AB	S	-	X
GAS HANDLING SUBSYSTEM							
Gas compressor	W	NNS	VIII/MS	AB	S	-	X
Gas decay tanks	W	NNS	VIII	AB	S	X(D)	X
Hydrogen recombiner	W	NNS	VIII	AB	S	-	X
EMERGENCY DIESEL FUEL OIL SYSTEM							
Transfer pumps	A	2b	P&V III	DB	N	X	X
Fuel oil tanks	A	2b	API 620	B	N	X	X (27)
SERVICE WATER SYSTEM							
Pumps	A	2b	P&V III	S	N	X	X
Strainers	A	2b	VIII	S	N	X	X
Recirc pipe to wetpit	A	2b	VIII	O	N	X	(26)
RIVER WATER SYSTEM							
Pumps	A	2b(25)	P&V III	R	N	X	X
FUEL HANDLING SYSTEM							
Fuel manipulator crane	W	3	-	AB	N	X	X
Fuel transfer tube (17)	W	2a	-	C/AB	N	X	X

ADD

TABLE 3.2-1 (SHEET 7 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Underwater fuel conveyor car and rail system (18)	W	3	-	AB	N	X	X
Fuel pool bridge crane	W	3	-	AB	N	X	X
Polar crane	A	NNS	(9)	C	N	X	X
Crane supports	A	NNS	-	C	N	X	X
SAMPLING SYSTEM							
Sampler heat exchanger	A	NNS	VIII	AB	S	-	X
Sampler vessel	A	NNS	VIII	AB	S	-	X
Delay coil	A	2a	B31.7 II	C	S	X	X
REFUELING WATER SYSTEM							
Pump	A	NNS	-	AB	P	-	X
Storage tank (20)	A	2a	III 2	O	P	X	X(23) (27)
FIRE PROTECTION SYSTEM							
Fire pumps	A	NNS	(15)	O	N	-	-
CONTAINMENT PURGE SYSTEM							
Fans	A	NNS	-	AB	N	-	X
Filters	A	NNS	-	AB	P	X	X
REACTOR VESSEL SUPPORT COOLING SYSTEM							
Fans	A	NNS	-	C	N	-	X
CONTROL ROD DRIVE MECHANISM COOLING SYSTEM							
Fans	A	NNS	-	C	N	-	X
AUXILIARY BUILDING VENTILATION SYSTEM							
Fan/coil units	A	NNS	-	AB	N	-	X
Filters	A	NNS	-	AB	P	-	X
Pump room air cooling units	A	2b	-	AB	P	X	X
Battery room exhaust fans	A	NNS	AMCA	AB	N	X	X

ADD

TABLE 3.2-1 (SHEET 8 OF 15)

	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Battery charger room air cooling units	A	2b	III-3, AMCA	AB	N	X	X
Motor control center and 600 V load center air cooling units	A	2b	III-3, AMCA	AB	N	X	X
600-V load center cooling system fire damper	A	NNS	UL	AB	N	X	X
Battery room motor operated dampers	A	NNS	AMCA	AB	N	X	X
<u>PENETRATION ROOM FILTRATION SYSTEM</u>							
Fans	A	2b	AMCA(14)	AB	N	X	X
Filters (HEPA and charcoal)	A	2b	ORNL-NSIC	AB	P	X	X
Backdraft dampers	A	NNS	AMCA	AB	N	X	X
Spent Fuel Pool Area Duct	A	2b	AMCA	O	P	X	(26)
<u>CONTROL ROOM VENTILATION SYSTEM</u>							
Fans	A	2b	AMCA(14)	AB	N	X	X
Filters	A	2b	ORNL-NSIC	AB	P	X	X
Air conditioning unit	A	2b	AMCA, III-3	AB	N	X	X
Motor-operated dampers/valves	A	2b	AMCA, III-3	AB	N	X	X
Balancing dampers	A	NNS	AMCA	AB	N	X	X
Fire dampers	A	NNS	UL	AB	N	X	X
<u>DIESEL BUILDING VENTILATION SYSTEM</u>							
Fans	A	2b	AMCA(14)	DB	N	X	X
Filters	A	2b	-	DB	N	X	X
<u>MAIN STEAM SYSTEM</u>							
Isolation valves	A	2a	P&V II	AB	N	X	X
<u>FEEDWATER SYSTEM</u>							
Isolation valves	A	2a	P&V II	AB	N	X	X
<u>AUXILIARY FEEDWATER SYSTEM</u>							
Auxiliary feedwater pumps Motor driven	A	2b	P&V III	AB	N	X	X

ADD

TABLE 3.2-1 (SHEET 9 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Steam turbine driven	A	2b	P&V III	AB	N	X	(26)
Condensate storage tank	A	2b	III 3	O	P	X	(24) (27)
STEAM DUMP SYSTEMS							
Turbine bypass	A	NNS	-	TB	N	-	-
Relief valves	A	2a	P&V II	AB	N	X	X (27)
Safety valves (16)	A	2a	P&V II	AB	N	X	X (27)
STEAM GENERATOR BLOWDOWN TREATMENT SYSTEM							
Blowdown surge tank	W	NNS	VIII	AB	P	-	X
Blowdown inlet filters	W	NNS	VIII	AB	P	-	X
Blowdown outlet filter	W	NNS	VIII	AB	P	-	X
Blowdown discharge-recycle pumps	W	NNS	VIII	AB	P	-	X
Blowdown heat exchangers	W	NNS	VIII	AB	P	-	X
Blowdown cation demineralizers	W	NNS	VIII	AB	P	-	X
Blowdown mixed bed demineralizers	W	NNS	VIII	AB	P	-	X
Spent resin storage tank	W	NNS	VIII	AB	P	-	X
Spent resin sluice pump	W	NNS	VIII	AB	P	-	X
Spent resin sluice filter	W	NNS	VIII	AB	P	-	X
CONDENSER CIRCULATING WATER SYSTEM							
Circulating water pumps	A	NNS	-	O	N	-	-
COMPRESSED AIR SYSTEM(22)							
Compressors	A	NNS	-	TB	N	-	-
After coolers	A	NNS	-	TB	N	-	-
Air tanks	A	NNS	VIII	TB	N	-	-
Air dryers	A	NNS	-	TB	N	-	-
Piping to safety grade component safety boundary	A	NNS	B31.1	TB/C/AB/O	N	-	-

ADD

TABLE 3.2-1 (SHEET 10 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Rad Location (4)	Source (5)	Seismic (6)	Tornado (7)
Air filter	A	NNS	-	TB	N	-	-
Piping to within safety grade component safety boundary	W/A	(SAME AS COMPONENT - SEE APPROPRIATE COMPONENT DESCRIPTION)					
HYDROGEN SYSTEM							
Hydrogen vessels	A	NNS	VIII	O	N	-	-
NITROGEN SYSTEM							
Nitrogen vessels	A	NNS	VIII	O	N	-	-
POST-LOCA HYDROGEN CONTROL SYSTEM							
Post-LOCA hydrogen recombiners	W	2b	-	C	N	X	X
Containment post-LOCA hydrogen mixing system	W	2b	AMCA(14)	C	N	X	X
Post-LOCA, containment hydrogen monitoring equipment	W	2b	III-2	C	P	X	X
MISCELLANEOUS COMPONENTS							
Diesel generators	A	3	-	DB	N	X	X (27)
Spent fuel pool	A	NNS	-	AB	S	X	X
Vent stack	A	NNS	-	O	N	X	X(D)
Spent fuel pool H & V system isolation dampers	A	NNS	AMCA	AB	P	X	X
Containment venting filter units	A	2b	III-3, ORNL	AB	P	X	X

ADD

TABLE 3.2-1 (SHEET 11 OF 15)

NOTES

(1)	A	Alabama Power Company
	W	Westinghouse
(2)	1	Safety Class 1 (ANS)
	2a	Safety Class 2a (ANS)
	2b	Safety Class 2b (ANS)
	3	Safety Class 3 (ANS)
	NNS	Non Nuclear Safety (ANS)
(3)	III A	ASME Boiler and Pressure Vessel Code - Section III, Class A
	III C	ASME Boiler and Pressure Vessel Code - Section III, Class C
	VIII	ASME Boiler and Pressure Vessel Code - Section VIII
	P&V I	ASME Code for Pumps and Valves for Nuclear Power, Class I
	P&V II	ASME Code for Pumps and Valves for Nuclear Power, Class II
	P&V III	ASME Code for Pumps and Valves for Nuclear Power, Class III
	III 1	ASME Boiler and Pressure Vessel Code - Section III, Class 1
	III 2	ASME Boiler and Pressure Vessel Code - Section III, Class 2
	III 3	ASME Boiler and Pressure Vessel Code - Section III, Class 3
	B31.1	ANSI B31.1 - Power Piping
	B31.7 I	ANSI B31.7 - Nuclear Power Piping, Class I
	B31.7 II	ANSI B31.7 - Nuclear Power Piping, Class II
	B31.7 III	ANSI B31.7 - Nuclear Power Piping, Class III

TABLE 3.2-1 (SHEET 12 OF 15)

	D100	American Waterworks Association, Standard for Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage, AWWA, D100
	API 610	American Petroleum Institute, Centrifugal Pumps for General Refinery Services
	API 620	American Petroleum Institute Recommended Rules for Design and Construction of Large Welded Low Pressure Storage Tanks
	API 650	American Petroleum Institute, Welded Steel Tanks for Oil
	AMCA	Air Moving and Conditioning Association
	MS	Manufacturer's Standard
	ORNL-NSIC	Oak Ridge National Laboratory, Nuclear Information Center - Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Application.
	UL	Underwriters Laboratory
(4)	C	Containment
	AB	Auxiliary Building
	TB	Turbine Building
	B	Buried in Ground
	DB	Diesel Generator Building
	R	River Water Intake Structure
	S	Service Water Intake Structure
	O	Outside
(5)	S	Source of radiation
	N	No source of radiation
	P	Possible source of radiation
(6)	X	Category I, (Methods used for seismic analysis of Category I systems and components are presented in table 3.7-4).

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INFORMATION ONLY

TABLE 3.2-1 (SHEET 13 OF 15)

	X(D)	Designed and constructed to the seismic requirements given in Regulatory Guide 1.143, Revision 1 with the exception of the seismic design criteria given in Regulatory Position C.5. The components, systems, and structures are designed to the seismic design criteria given in FSAR section 3.7.
	-	Category II
(7)	X	Protected by virtue of location in a structure designed for tornado wind.
	X(D)	Designed for tornado wind loads.
	-	No protection required
(8)		Portions of equipment containing component cooling water will be analyzed for seismic requirements.
(9)		Crane Manufacturers Association of America Specification No. 70 of 1971.
(10)		National Fire Underwriters and Underwriters Laboratory Certification.
(11)		Designed and fabricated to ASME III C, radiographed and so stamped; however, compliance with ASME VIII would be sufficient for this use.
(12)		Outside jurisdiction of ASME, but designed, fabricated, examined, and tested according to ASME Boiler and Pressure Vessel, Section VIII.
(13)		Built to code but not tested
(14)		Performance test required
(15)		National Fire Protection Association Standard No. 20.
(16)		Will meet pressure-relieving requirements of ASME Section III, Article 9.
(17)		That part which is part of the containment pressure boundary.

TABLE 3.2-1 (SHEET 14 OF 15)

(18)	Protect against seismic overturning and possible impaling of fuel.
(19)	Quality control requirements include sidewall and nozzles to tank welds examined by magnetic-particle or liquid-penetrant methods; roof, roof-to-sidewall, and bottom welds visually examined; bottom and bottom-to-sidewall welds vaccum box tested
(20)	Quality control requirements include 100% radiograph of sidewall welds; roof, roof-to-sidewall, and bottom welds visually examined; bottom and bottom-to-sidewall welds vacuum box tested; bottom-to-sidewall and nozzles-to-tank welds examined by magnetic-particle or liquid penetrant methods.
(21)	Quality control requirements include sidewall welds 3/16 in. or under examined by magnetic-particle or liquid-penetrant methods; 100-percent radiograph of sidewall welds over 3/16 in.; roof, roof-to-sidewall, bottom, bottom-to-sidewall, and nozzles-to-tank welds examined by magnetic-particle or liquid-penetrant methods; roof and roof-to-sidewall welds soap tested; bottom and bottom-to-sidewall welds vacuum box tested.
(22)	The compressed air system includes the instrument air system.
(23)	This equipment is surrounded by a concrete wall to protect it from tornado missiles.
(24)	In order to ensure the 150,000 gallon reserve required by Technical Specifications, the lower twelve feet of the tanks are designed to withstand ruptures caused by missiles generated by tornadoes. Certain connections to the Unit 1 and Unit 2 CSTs, however, are not missile protected. The subject connections are: CST drain, vacuum degasifier pump suction line on Unit 1 and tank connection on Unit 2, and the sensing lines for the level transmitters. Reference section 9.2.6.2 for a discussion of these connections.
Replace with Insert A	
(25)	The river water system has been downgraded to Non-Nuclear Safety. System components are to be maintained to their original classification (2b) for maintenance purposes only.
(26)	This equipment or portions of this system are located outside a Category I structure and are not provided with protection from tornado wind effects including tornado generated missiles

ADD Insert B Here

TABLE 3.2-1 (SHEET 15 OF 15)

GENERAL NOTES:

1. The safety-related systems outside the reactor coolant pressure boundary may have more than one quality class of piping and valves. Individual valves and sections of piping are assigned quality classes and codes appropriate to their locations and functions and consistent with the assignments of quality classes of system components in table 3.2-1.

2. All pressure-retaining cast parts of Safety Class 1a and 2a pumps and valves are radiographed (or ultrasonically tested to equivalent standards). Where size or configuration does not permit effective volumetric examination, magnetic-particle or liquid-penetrant examination is substituted. Examination procedures and acceptance standards are at least equivalent to those specified in the applicable class in the code.

3. The reactor coolant system code requirements, including the applicable addenda, are presented in table 3.2-4.

INSERTS FOR SECTION 3.2

Insert A Section 3.2

(26) This component or portions of this system are not required to be protected from tornado generated missiles per section 3.5.1.2.2.1.

Insert B Section 3.2

(27) This component or portions of this system have been analyzed for vulnerability to tornado generated missiles and found to have an acceptable probability of survival per section 3.5.1.2.2.2.

3.3 WIND AND TORNADO LOADINGS

3.3.1 WIND LOADINGS

Wind loadings for Category I structures have been selected on the basis of ASCE Paper No. 3269, "Wind Forces on Structures"[1] or as provided in "TORMIS Missile Risk Analysis for Farley Nuclear Plant Units 1 and 2."[3]

ADD

3.3.1.1 Design Wind Velocity

Category I structures are designed to withstand a basic wind velocity of 115 mph. The recurrence interval of this wind velocity is estimated to be at least 100 years.[1] The variation of wind velocity with height is shown in table 3.3-1.

3.3.1.2 Basis for Wind Velocity Selection

The "fastest mile of wind" at the Farley Plant site is shown, according to Figure 1 (b) and the ASCE paper,[1] to be 90 mph. As a result of recent hurricane experiences on the Gulf Coast, a design velocity of 105 mph at ground level was selected. For additional conservatism, to account for uncertainties in historical data, this margin of safety has been increased and a ground level wind of 115 mph has been used as the basic design wind.

3.3.1.3 Vertical Velocity Distribution and Gust Factor

The wind pressures resulting from the wind velocities shown in table 3.3-1 incorporate the shape factors in both horizontal and vertical directions. A gust factor of 1.1 has been selected for the design and has been incorporated into the wind pressures shown in table 3.3-1.

The gust factor of 1.1 is selected on the basis of ASCE paper No. 3269, "Wind Forces on Structures."[1] This paper recommends that appropriate gust factors be used for structures that are small enough to be responsive to gusts involving less than 1 mile of passing wind, and that the gust factors bear some relation to the minimum size of gust necessary to envelop the structure and its accompanying pattern of flow. A gust factor of 1.1 will allow for gust of approximately 10-second duration which, in a 115-mph basic wind, would have a length downwind of about 1,700 ft; this factor is adequate for structures having a horizontal dimension, transverse to the wind, of 125 ft and larger.

3.3.1.4 Determination of Applied Forces

The design wind dynamic pressure is calculated by

$$q = 0.002558 V^2$$

where q = pressure in psf

V = velocity in mph

A shape coefficient of 1.3 is applied for building wind loads. Of the total of 1.3 q , 0.9 q is applied as positive pressure to the windward walls, and 0.4 q is applied as negative pressure on the leeward walls, where applicable. A shape factor of 0.6 is applied for plant vent stack wind loads.

Wind loads are applied to the structures as uniform static loads on the surface area normal to the wind.

The applied force magnitude and distribution calculated for Category I structures are shown in figure 3.3-1.

3.3.2 TORNADO LOADINGS

All above ground Category I structures required to ensure the integrity of the reactor coolant pressure boundary, safe shutdown of the plant, long-term core cooling or to prevent radioactive releases resulting in offsite exposures comparable to 10 CFR 100 guidelines are also designed to withstand tornado loadings and tornado generated missiles[2] ~~or have been analyzed as discussed in Section 3.5.1.2.~~

ADD

3.3.2.1 Applicable Design Parameters

For Category I structures designed to withstand tornadoes and tornado generated missiles, the three following parameters are applied concurrently, in combinations producing the most critical conditions:

a) Dynamic Wind Pressure

The dynamic wind pressure is caused by a tornado funnel having a peripheral tangential velocity of 300 mph and a forward progression of 60 mph. The applicable portions of wind design methods described in ASCE Paper No. 3269 are used, particularly for shape factors. The provisions for gust factors and variation of wind velocity with height are not applied. The average tornado design dynamic wind pressure is q = 230 psf based on an average wind velocity of 300 mph.

b) Pressure Differential

The structure interior bursting pressure is taken as rising 1 psi/s for 3 seconds, followed by a 2-second calm, them decreasing at 1 psi/s for 3 seconds. This cycle accounts for reduced pressure in the eye of a passing tornado. All fully enclosed Category I structures are designed to withstand the full 3 psi pressure differential.

c) Missile Impingement

A tornado missile is defined as any object set in motion and propelled by a tornado. Three types of tornado missiles are considered; each type is assumed to act independently and only one type may be generated at any one time. It is also assumed that the missiles do not tumble while in flight, and are at any time oriented to have the maximum value:

$$\frac{C_d A}{W}$$

where

C_d = Drag coefficient

A = Projected area of missile exposed to wind

W = Weight of missile

The three types of missiles are as follows:

1. A 12-ft-long piece of wood 8 in. in diameter (114 lb) traveling end-on at a speed of 300 mph and striking the structure at any elevation.

2. A 10-ft-long steel pipe, schedule 40, 3 in. in diameter (75.8 lb), traveling end-on at a speed of 100 mph and striking the structure at any elevation.

3. A 4,000-lb automobile, traveling end-on at a speed of 50 mph and striking the structure on an impact area of 20 sq ft, with any portion of the impact area being not more than 25 ft above grade.

3.3.2.2 Determination of Forces on Structures

Tornado loads are applied to the Category I structures in the same manner as the wind loads described in subsection 3.3.1.4 with the exception that gust factor and variation of wind velocity with height do not apply. The load combinations involving tornadoes are given in subsections 3.8.1.3, 3.8.4.3, and 3.8.5.3.

The load factor selected for tornado loadings is 1.0, based on the short duration of the loading condition, the low probability of a tornado striking a specific geographic point, and the degree of conservatism in the selection of design tornado velocity. This subject is discussed in B-TOP-3.

3.3.2.3 Ability of Category I Structures to Perform Despite Failure of Structures Not Designed for Tornado Loads

Failure of Category II structures not designed for tornado loads will not affect the ability of Category I structures to perform their functions for the following reasons:

a. Tornado missiles that may be formed by the failure of Category II structures will not exceed the force of those postulated and described in subsection 3.3.2.1, against which Category I structures are designed.

b. The structural frame of the Category II turbine building in the vicinity of the auxiliary building has been designed against collapse when subjected to tornado loadings.

REFERENCES

1. "Wind Forces on Structures", Transactions of the ASCE, Paper No. 3269, 1961.

2. "Design Criteria for Nuclear Power Plants Against Tornadoes", Bechtel Topical Report, B-TOP-3, March 1970.

3. "TORMIS Missile Risk Analysis for Farley Nuclear Plant Units 1 and 2, ARA Report 4733, March 1999."

ADD

3.5 MISSILE PROTECTION

Category I structures are designed to protect safety related equipment and components from being damaged by internal and external missiles.

3.5.1 MISSILE BARRIERS AND LOADINGS

The missile barriers are designed to resist the missiles selected in subsection 3.5.2.

3.5.1.1 Accident/Incident Generated Missiles Inside Containment

A tabulation of barriers and the missiles they have been designed to contain is given in table 3.5-1. The postulated missile loadings are derived from the physical characteristics of the components involved and their respective kinetic energy levels. They are given in tables 3.5-2 through 3.5-5. The analytical method used to convert energies into forces and depths of penetration necessary to barrier design is described in subsection 3.5.4.

3.5.1.2 Environmental Load Generated Missiles

Insert C Here 3.5.1.2.1 Missile Protection Methods

Category I structures housing equipment and components vital to a safe shutdown have been designed against penetration by the tornado missiles described in subsection 3.3.2.1 (c). These structures, having at least 2-ft thick concrete exterior walls and roof slabs, constitute barriers against missile penetration. Calculations show that the deepest missile penetration of the concrete barriers would be 10 in. Therefore, the 2-ft thick slabs provide ample protection. Where concrete spalling due to missile impact is considered, the inside surfaces of the following areas have been protected with corrugated sheet metal:

- Control room.
- HVAC equipment room for the control room.
- Component cooling water surge tank room.
- Spent fuel pool area.

Insert D Here 3.5.1.2.2 Components Not Requiring Unique Missile Protection

Insert E Here 3.5.1.2.3 TORMIS Methodology

No Changes
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3.5.1.3 Site Proximity Missiles

There are no guided missile installations in the vicinity of the Farley Nuclear Plant.

At the time of construction of Farley Nuclear Plant the only landing strip within a radius of 5 miles from the Farley site was a 3000-ft landing strip for the paper company at Cedar Springs, Georgia, approximately 3.5 miles south of the plant site. Aircraft using the strip were light, twin-engined business planes comparable to a Cessna 401-A, which has a gross weight of 6300 lb. The orientation of this landing strip was N 30 degrees E; therefore, takeoffs and landing approaches were not in the direction of the Farley Nuclear Plant site. The landing strip is now abandoned.

A new 5400-ft landing strip, capable of handling jet engined aircraft, has been constructed by the paper company at Cedar Springs, Georgia. The new strip is located approximately 4 to 5 miles south of the old landing strip and 7 to 8 miles from the Farley site. The strip has approaches oriented NW and SE and is used by jet aircraft as well as conventional aircraft. The jet aircraft are six-to-eight-passenger business jets comparable to a Lear Jet Model 23, which has a gross weight of 12,500 lb. The paper company at Cedar Springs, Georgia, has indicated that pilots will be instructed to avoid the Farley Nuclear Plant site area during both takeoffs and landing operations.

For these reasons, aircraft generated missiles are not considered.

3.5.1.4 Accident/Incident Generated Missiles Inside Category I Structures Other than Containment

A tabulation of barriers and the missiles they have been designed to contain is given in table 3.5-6. The postulated missile loadings for the rod drive motor generator sets are derived from the physical characteristics of these components and their respective kinetic energy levels, as given in table 3.5-7.

3.5.2 MISSILE SELECTION

3.5.2.1 Missile Selection Within the Containment

The systems located inside the containment have been examined to identify and select potential missiles. The basic approach was to ensure design adequacy against generation of missiles, rather than allow missile formation and then contain their effects.

The following components have been considered to have a potential for missile generation:

a. Control rod drive mechanism housing plug, drive shaft, and the drive shaft and drive mechanism latched together.

b. Certain valves defined below.

c. Temperature and pressure element assemblies.

The worst case considered for design is that the top plug on the control rod drive mechanism might become loose and be forced upward by the water jet. The following sequence of events is assumed: The drive shaft and control rod cluster are forced out of the core by the differential pressure of 2500 psi across the drive shaft. (The drive shaft and control rod cluster, latched together, are assumed fully inserted when the accident starts.) After approximately 12 feet of travel, the rod cluster control spider hits the underside of the upper support plate. Upon impact the flexure arms in the coupling joining the drive shaft and control cluster fracture, completely freeing the drive shaft from the control rod cluster. The control cluster would be completely stopped by the upper support plate; however, the drive shaft would continue to be accelerated upward to hit the missile shield structure provided.

The valves considered for missile potential are those in the region where the pressurizer extends above the operating deck, such as the pressurizer safety valves, the motor operated isolation valves in the relief line, the air operated relief valves, and the air operated spray valves. Although failure of these valves is considered improbable, failure of the valve bonnet body bolts, nevertheless, has been considered and provisions made to ensure integrity of the containment liner from the resultant bonnet missile.

The only probable source of jet propelled missiles from the reactor coolant piping and piping systems connected to the reactor coolant system is the type represented by the temperature and pressure element assemblies. The resistance temperature element assemblies can be of two types: "with well" and "without well". Two rupture locations have been assumed for each type of temperature element assembly: one around the weld between the boss and the pipe wall for each assembly, and another at the weld (or thread) between the temperature element assembly and the boss for the "without

No Changes
INFORMATION ONLY

well" element or the weld (or thread) between the well and the boss for the "with well" element.

A temperature element is installed on the reactor coolant pumps close to the radial bearing assembly. A hole is drilled in the gasket and sealed on the internal end by a steel plate. In evaluating missile potential, it is assumed that this plate could break and the pipe plug on the external end of the hole could become a missile.

In addition, it is assumed that the welding between the instrumentation well and the pressurizer wall could fail and the well and sensor assembly could become a jet propelled missile.

Finally, it is assumed that the pressurizer heaters could become loose and become jet propelled missiles.

3.5.2.2 Missiles Selected Outside the Containment

The tornado generated missiles selected for the design of the Farley Plant structures are described in subsection 3.3.2.

3.5.2.3 Missile Selection Within Category I Structures Other Than Containment

The systems located inside Category I structures other than the containment have been examined to identify potential missiles. The following components are considered to have a potential for missile generation:

a. Flywheels of two rod drive power supply motor generator sets.

The electric motors of the rod drive power supply motor generator sets are designed to operate at 1800 rpm. In the unlikely event of an overspeed generated flywheel missile, the steel protective shield which closely encircles the flywheel would contain the missile and prevent it from impacting any safety-related components.

The steel protective shields are designed to contain a spectrum of probable flywheel fragment missiles generated at an overspeed of 150 percent of the operating speed as indicated in table 3.5-7. For conservation, the initial translational energy of the governing missile is increased by 10 percent for the design of the steel protective shield.

3.5.3 SELECTED MISSILES

The missiles selected inside the containment are given in tables 3.5-1 through 3.5-5.

The origin, weight, impact velocity, impact area, and all other parameters necessary to determine the missile penetration are listed in these tables. The calculated depth of penetration into a 2-ft-thick concrete slab is also given.

The missiles selected outside the containment are given in paragraph 3.3.2.1(c).

3.5.4 BARRIER DESIGN PROCEDURES

The internal and external missile barriers have been designed to resist missile penetration in order to protect systems and components so that the failure of one system or component cannot cause the failure of another system or component.

Missile barriers are constructed of concrete, steel or a combination of concrete and steel in order to provide protection from the effects of missiles.

Barriers are designed based on the pertinent characteristics of the potential targets, postulated missiles, and barrier materials including the materials ability to provide protection from penetration, perforation, and spalling. The methods and procedures used to evaluate missile impact on structures and barriers and the analytical methods used to convert energies into forces and depths of penetration necessary for barrier design are described in NAVDOCKS P-51[1] and Bechtel Topical Report BC-TOP-9A[2].

The analysis for the depth of missile penetration in reinforced concrete was carried out using the following modified Petry formula as presented in NAV DOCKS P-51.

$$D = KA_pV' \quad (3.5\text{-}1)$$

$$V' = \log_{10}[1 + V^2/215000] \quad (3.5\text{-}2)$$

$$D' = D \quad [1 + e^{-4} \ (a'-2)] \quad (3.5\text{-}3)$$

$$a' = T/D$$

where

D = depth of penetration of an infinitely thick slab (inches)

k = an experimentally obtained materials coefficient for penetration (k = 0.0022 for 5000 psi reinforced concrete)

A_p = sectional pressure, obtained by dividing the weight of the missile by the maximum cross sectional area (expressed as pounds per square foot)

V' = velocity factor

V = terminal or striking velocity in feet per second

D' = actual depth of penetration in a slab of finite thickness (inches)

T = thickness of resisting slab (inches)

The design basis for concrete barrier thickness within the reactor containment is planned to provide a barrier approximately three times thicker than the depth of missile penetration. As a result, 2 ft of concrete was chosen to satisfy the above criterion. Substituting the value of 2 ft for T in equation 3.5-3, the actual depth of penetration, D', was calculated as shown in tables 3.5-2 through 3.5-5.

For the external missiles, a minimum of 2 ft of concrete has also been used in the plant design, providing protection against penetration. A summary of Category I structures utilizing concrete designed against missile penetration and the thickness provided is given below:

	Thickness (in.)
Auxiliary building, Exterior walls and roof slabs (see note 1)	24
Containment dome	39
Containment wall	45
Diesel generator building	24
River intake structure	24
Intake structure at storage pond	24
RWST & RMWST shield walls	24

Note 1: The walls of the main steam room venting structure are heavy welded steel grating which provides protection against penetration of tornado-generated missiles.

Equipment and piping located outside the containment which are required for safe shutdown, long-term core cooling or to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines are provided with tornado missile protection either by location within Category I structures, burial under- ground, ~~or~~ designed missile barriers/shielding , or have been analyzed as discussed in Section 3.5.1.2.2.

3.5.5 MISSILE BARRIER FEATURES

Figure 3.8-2, drawing D-176151, figures 3.8-9, 3.8-10, 3.8-11, 3.8-13, 3.8-14, drawings D-205205, D-205206, D-205207, and figures 3.8-23, 3.8-24, 3.8-25, 3.8-26, 3.8-27, 3.8-28, and 3.8-29 show the layout and principal design features of the barriers and structures designed to resist missiles.

REFERENCES

1. NAVDOCKS P-51 - "Design of Protective Structures," Bureau of Yards and Docks, Dept. of the Navy, August 1950.

2. BC-TOP-9A - "Design of Structures for Missile Protection," Revision 2, September 1974.

3. "TORMIS Missile Risk Analysis for Farley Nuclear Plant Units 1 and 2," ARA Report 4733, March 1999.

4. EPRI NP-2005, "Tornado Missile Simulation and Methodology," Volumes I and II, Final Report, August 1981.

5. REA 97-1409 response, SCS to SNC letter FP 99-0429, "Tornado Missile Broadness Review and PRA Analysis," August 6, 1999.

ADD

INSERTS FOR SECTION 3.5

Insert C

3.5.1.2.1 Missile Protection Methods

Those systems or components listed in Table 3.2-1 that are required for safe shutdown, for immediate or long term core cooling or to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines are provided with tornado missile protection by location within Category I structures, burial underground, missile barriers/shielding or have been analyzed as discussed in Section 3.5.1.2.2.

Insert D

3.5.1.2.2 Components Not Requiring Unique Missile Protection

Certain Seismic Category I systems and components located outside of Seismic Category I structures are evaluated as not requiring unique tornado missile protection by burial or barriers. The following two approaches are used in the evaluation of these systems and components relative to a tornado event.

3.5.1.2.2.1 Components Not Required for a Tornado Event

The probability of occurrence of a tornado event coincident with another low probability design basis event is so small that no protection from tornado missiles is required for certain Seismic Category I structures, systems and components which are not otherwise needed for safe shutdown, for immediate or long term core cooling, to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines, or to support other systems or components which are required for one of those functions.

3.5.1.2.2.2 Components with Acceptable Probability of Survival

Safety related systems and components required for safe shutdown, for immediate or long term core cooling or to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines required for a tornado event are generally protected. A limited amount of unprotected portions of these systems and components are analyzed using probabilistic missile damage analysis as permitted in Standard Review Plan 3.5.1.4 "Missiles Generated By Natural Phenomena." This analysis is conducted to determine the probability per year of missiles generated by postulated tornadoes striking and damaging these systems and components beyond their failure point. For FNP, the specific acceptance criterion for tornado damage for the unprotected systems and components required for a tornado event is that the cumulative sum of the mean failure

INSERTS FOR SECTION 3.5

Insert D (continued)

probabilities for these systems and components be less than 10^{-6} per year per unit. The allowable level of less than 10^{-6} per year per unit for the cumulative probability of failure of such systems and components is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The analysis used for FNP is the computer program TORMIS[3][5], developed by the Electric Power Research Institute (EPRI)[4] and accepted by the NRC.

Systems and components whose analysis using the TORMIS methodology yields results that cause the less than 10^{-6} per year per unit acceptance criterion to be exceeded will be provided with unique barriers to reduce the total failure probability value to below the acceptance criterion.

Insert E

3.5.1.2.3 <u>TORMIS Methodology</u>

TORMIS[3][4][5] is a methodology developed to predict the probability of damage to nuclear power plant structures and components from tornadoes. There are four fundamental models in the TORMIS analysis: wind hazard, site facility, load effects and system models. Monte Carlo simulation is used to produce numerical estimates of hit and damage probabilities based on the site-specific models.

The wind hazard analysis for the Farley Plant Units 1 & 2 uses a site specific analysis to generate a tornado hazard curve specifically for Farley.

The site facility model was conservatively developed based on a site area walkdown and the specific characteristics, materials and failure points for Farley structures and components.

Load effects are determined based on the TORMIS model missiles, missile transport model, and component characteristics. The missiles utilized in the TORMIS model encompass the 3 design basis missiles described in Section 3.3.2.1.

INSERTS FOR SECTION 3.5

Insert E (continued)

TORMIS implements a methodology developed by the Electric Power Research Institute. TORMIS determines the probability of striking walls and roofs of buildings on which penetrations or exposed portions of systems/components are located. The probability is calculated by simulating a large number of tornado strike events at the site for each tornado wind speed intensity scale. After the probability of striking the walls or roof is calculated, the exposed surface area of the particular components are factored in to compute the probability of striking and consequently damaging a particular item.

The following provisions apply to the TORMIS analysis for FNP:

1. FSAR Section 2.3.1.3 estimates an occurrence rate of 3 tornadoes per year per 1 degree square (approximately 4000 square miles), or 7.5 E-04 tornadoes per square mile. This occurrence rate was based on conservative treatment of data from 1955-67. As part of the FNP TORMIS analysis, the annual probability of a tornado was determined for the Fujita F-scale wind speeds using regional data available in TORMIS for NRC Region II. A site-specific analysis was performed to generate a tornado data set for the TORMIS analysis of Farley.

   The National Climatic Data Center (NCDC) files for the years 1950-1996 were used as the basic source of data for this investigation. This data was screened to eliminate coding errors in the record fields. In addition, corrections were introduced to account for reporting efficiency and time series, or other potential errors resulting from the indirect characteristics of the available data. The overall tornado occurrence rate computed from the updated regional data in TORMIS is 6.00 E-04 tornadoes per square mile per year. While this rate is slightly lower than the rate in FSAR Section 2.3.1.3, it is a more accurate figure based on conservative treatment of the best available data and will therefore be used in lieu of the data cited in FSAR Section 2.3.1.3 for those components or portions of systems analyzed in TORMIS.

2. The Fujita scale (F-scale) wind speeds will be used in lieu of the TORMIS wind speeds (F-scale) for the F0 through F5 intensities.

INSERTS FOR SECTION 3.5

Insert E (continued)

3. The tornado windfield parameters in the FNP TORMIS analysis were adjusted to increase the wind profile in the lowest 10 m over the original profile in TORMIS. This adjustment applied the ratio of V_0/V_{33} in a conservative manner in accordance with the NRC's October 26, 1983 TORMIS SER.

4. Detailed surveys of the plant site were performed to characterize and quantify potential missiles for use in the FNP TORMIS analysis. To ensure conservatism, these surveys were performed during a refueling outage when large amounts of material were temporarily stored in outside laydown areas around the site. Additionally, ground and aerial photographs were reviewed to estimate the number and type of missiles which could originate from remote areas of the site. The total number of missiles used in the FNP TORMIS analysis was 51,864.

5. The FNP analysis will not deviate from the TORMIS program as described in reference (4) of FSAR Section 3.5, except as noted in items 1 through 4 above.

ENCLOSURE IV

Joseph M. Farley Nuclear Plant

Clean-Typed Pages
for
Final Safety Analysis Report Changes
to
Design Basis for Tornado-Generated Missiles

3.2 CLASSIFICATION OF STRUCTURES, COMPONENTS AND SYSTEMS

3.2.1 SEISMIC CLASSIFICATION

A two-level system is used for the Seismic Classification of the structures, components, and systems of the facility.

1. Category I structures, components, and systems.

2. Category II structures, components, and systems.

3.2.1.1 Definitions

Structures, components, and systems required for safe shutdown, for immediate or long term core cooling, or for radioactive material confinement following a loss-of-coolant accident (LOCA) to ensure that the public is protected in accordance with 10 CFR 100 guidelines are designed Category I.

Category I structures, components, and systems are designed to withstand the effects of the safe shutdown earthquake (SSE) and 1/2 safe shutdown earthquake (1/2 SSE) as discussed in section 3.7.

When a system as a whole is referred to as Category I, portions not associated with loss of function of the system may be designated as Category II.

Category II structures, components, and systems are those whose failure would not result in the release of significant radioactive material and would not prevent reactor shutdown. All equipment not specifically listed as Category I is included as Category II.

The failure of Category II structures, components, and systems may interrupt power generation.

All Category II structures are designed to conform to Section 2.3.1.4 of the 1970 edition of the Uniform Building Code.

Seismic Classification of structures, systems, and components is in accordance with Regulatory Guide 1.29.

3.2.1.2 Category I Structures

1. Containment.
2. Auxiliary building, including all fuel handling equipment storage areas.
3. Diesel generator building.
4. River intake structure.[a]
5. Intake structure at storage pond.
6. Storage pond dam and dike.
7. Vent stack.(a)
8. Pond spillway structure.
9. Electrical cable tunnel structure.
10. Category I outdoor tanks.
11. Trisodium phosphate baskets in Containment.

3.2.1.3 Category I Mechanical Components and Systems

Refer to table 3.2-1 for Category I seismic mechanical components and systems.

3.2.1.4 Category I Electrical Equipment

1. 4160-v switchgear (engineered safeguard buses).
2. 4160-v to 600-v transformers (associated with engineered safeguard systems).
3. 600-v load centers (engineered safeguard buses).
4. 600-v and 208-v motor-control centers (associated with engineered safeguard systems).
5. Direct-current electrical distribution system (Auxiliary Building and Service Water Building):
    a. 125-v dc station batteries.
    b. Inverters, 125-v dc to 120-v ac (vital ac instrumentation distribution panels).
    c. 125-v dc distribution panels.

a. Not required for safe shutdown of the plant. The original design (Category I) requirements for the river intake structure are no longer required.

d. 125-v dc switchgear.

e. 125-v dc battery chargers.

6. Vital ac instrumentation and regulated ac distribution panels.

7. Control panels and control boards:

a. Auxiliary relay racks.

b. Solid-state protection system cabinets.

c. Nuclear instrumentation system cabinets.

d. Process protection and control system cabinets.

e. Emergency power board.

8. Cable tray and conduit supports (associated with engineered safeguard systems).

9. Containment penetration assemblies.

10. Direct-current emergency lighting (except for an 8-hour rated DC battery pack, emergency lighting is installed per Appendix R to 10 CFR 50 referenced in FSAR section 9B.4.1.19).

11. Diesel generators.

12. Diesel generator control panels.

13. Diesel generator sequencers.

14. Boric acid heat-tracing equipment.

15. Turbine driven auxiliary feedwater pump uninterruptable power supply.

3.2.1.5 Category I Instrumentation and Control Systems Equipment

1. Penetration room filtration system.

2. Radiation monitors for containment purge exhaust lines.

3. Radiation monitors for fuel handling area ventilation exhaust line.

4. Post-accident containment combustible gas control system.

5. Component cooling water system.

6. Service water system.

7. Auxiliary feedwater system.

8. Power supply inverters for balance of plant instrument panels.

9. Balance of plant instrument panels.

10. Portions of the sampling system which provide containment isolation and which interface with other Category I systems. (See drawings D-175009, sheet 1, D-175009, sheet 2, D-175009, sheet 3, D-205009, sheet 1, D-205009, sheet 2 and D-205009, sheet 3.)

11. Diesel generator control equipment.

3.2.1.6 Structures and Systems of Mixed Category

None of the structures in the Farley Nuclear Plant have classifications that are partially Category I and partially Category II. The boundaries of the nuclear classes of piping systems are shown on the Piping and Instrumentation Diagrams (P&ID) in sections as listed in table 3.2-3.

Nuclear Safety Classes 1, 2a, 2b, and 3 are designed as Seismic Category I systems. Systems that are Nuclear Safety Class NNS, and all piping systems not otherwise indicated as Category I, are non-seismic. The P&ID legend is shown on drawings D-175016, sheet 1, D-175016, sheet 2, and figure 1.7-1.

3.2.2 SYSTEM QUALITY GROUP CLASSIFICATION

The design criteria are tabulated in table 3.2-1 for all mechanical system components.

The design in general complies with the intent of Regulatory Guide 1.26. The actual design standards, however, conform to the standards of the American Nuclear Society, "Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants," August 1970 draft. Regulatory Guide 1.26 was not available at the time of initial equipment design and purchase. Whenever practicable, equipment has been purchased to meet ASME Section III standards. When equipment was purchased before ASME Section III became effective, other design codes, as indicated in table 3.2-1, were used.

The relationship between Safety Class and the ASME Section III Nuclear Class is indicated below.

ANS SAFETY CLASS	ASME SECTION III NUCLEAR CLASS
1	1
2a	2
2b	3
3	3
NNS (Non-nuclear safety)	-

The system quality group classifications are delineated on the piping and instrumentation diagrams in chapters 5.0, 6.0, 9.0, 10.0, and 11.0.

TABLE 3.2-1 (SHEET 1 OF 15)

SUMMARY OF CRITERIA - MECHANICAL SYSTEM COMPONENTS

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Rad Seismic (6)	Tornado (7)
REACTOR COOLANT SYSTEM							
Reactor vessel	W	1	III A	C	S	X	X
Full length CRDM housing	W	1	III A	C	S	X	X
Reactor coolant pump assembly (8)	W	1		C	S	X	X
Reactor coolant pump casing	W	1	P&V I	C	S	X	X
Reactor coolant pump internals	W	1	P&V I	C	S	X	X
Steam generator (tube side)	W	1	III A	C	S	X	X
(shell side including integral steam flow restrictor)	W	2a	III A	C	S	X	X
Pressurizer	W	1	III A	C	S	X	X
Reactor coolant piping to pressure boundary	W	1	III 1	C	S	X	X
RC system supports	W	-	-	C	N	X	X
Surge pipe and fittings	W	1	III 1	C	S	X	X
RC thermowells	W	1	III 1	C	S	X	X
Safety valves (16)	W	1	III A	C	S	X	X
Relief valves	W	1	III A	C	S	X	X
Valves to RC system boundary	W	1	P&V I	C	S	X	X
Pressurizer relief tank (11)	W	NSS	VIII	C	S	-	X
CRDM head adapter plugs	W	1	B31.7 I	C	S	X	X
CHEMICAL & VOLUME CONTROL SYSTEM							
Regenerative HX	W	2a	III C	C	S	X	X
Letdown HX (tube side)	W	2a	III C	AB	S	X	X
(shell side)		2b	VIII		P	X	X

TABLE 3.2-1 (SHEET 2 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Mixed bed demineralizer (11)	W	3	VIII	AB	S	X	X
Cation bed demineralizer (11)	W	3	VIII	AB	S	X	X
Reactor coolant filter	W	2a	III C	AB	S	X	X
Volume control tank	W	2a	III C	AB	S	X	X
Charging/high head safety injection pump (8)	W	2a	P&V II	AB	S	X	X
Seal water injection filter	W	2a	III C	AB	S	X	X
Letdown orifices	W	2a	III 2	C	S	-	X
Excess letdown HX (tube side)	W	2a	III C	C	S	X	X
(shell side)		2b	VIII		P	X	X
Seal water return filter	W	2a	III C	AB	S	X	X
Seal water HX (tube side)	W	2a	III C	AB	P	X	X
(shell side)		2b	VIII			X	X
Boric acid tanks (19)	A	2b	API 650	AB	P	X	X
Boric acid filter (11)	W	2b	III C	AB	P	X	X
Boric acid transfer pump	W	2b	P&V III	AB	P	X	X
Boric acid blender	W	2b	III 3	AB	P	X	X
Resin fill tank (12) (13)	A	NNS	VIII	AB	N	-	X
Boric acid batching tank (13)	W	NNS	VIII	AB	N	-	X
Chemical mixing tank (12) (13)	W	NNS	VIII	AB	N	-	X
Chemical mixing tank orifice	A	NNS	-	AB	N	-	X
RCP No. 1 seal bypass orifice	W	1	III 1	C	S	-	X
Reactor makeup water storage tank	A	2b	III 3	O	-	X	X(23)
Reactor makeup water pump	A	2b	III 3	O	-	X	X(23) (26)
Demineralized water storage tank	A	NNS	-	O	-	-	-
EMERGENCY CORE COOLING SYSTEM							
Accumulators	W	2a	III C	C	P	X	X

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TABLE 3.2-1 (SHEET 3 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
RESIDUAL HEAT REMOVAL SYSTEM							
Residual heat removal/low head safety injection pump (8)	W	2a	P&V II	AB	S	X	X
Residual heat exchanger (tube side)	W	2a	III C	AB	S	X	X
(shell side)		2b	VIII	AB	P	X	X
CONTAINMENT SPRAY SYSTEM							
Containment spray pump	W	2a	P&V II	AB	P	X	X
Eductor	W	2a	III 2	AB	P	X[(a)]	X
CONTAINMENT ISOLATION SYSTEM							
Valves	A	2a	P&V II	C,AB	S,P	X	X
CONTAINMENT COOLING SYSTEM							
Fans	A	2b	AMCA (14)	C	N	X	X
Heat exchanger	A	2b	VIII	C	N	X	X
COMPONENT COOLING SYSTEM							
Pumps	A	2b	P&V III	AB	P	X	X
Unit 1 Heat exchangers (tube side)	A	2b	VIII	AB	N	X	X
(shell side)	A	2b	VIII	AB	P	X	X
Unit 2 Heat exchangers (tube side)	A	2b	III	AB	N	X	X
(shell side)	A	2b	III	AB	P	X	X
Surge tank (21)	A	2b	API 620	AB	P	X	X
SPENT FUEL POOL COOLING SYSTEM							
Spent fuel pool heat exchanger (tube side) (8)	W	2b	III C	AB	S	X	X
(shell side)	W	2b	VIII	AB	P	X	X

a. The components are included as part of the respective piping system model and seismic analysis.

FNP-FSAR-3
TABLE 3.2-1 (SHEET 4 OF 15)

Component		Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Spent fuel pool pump		W	2b	P&V III	AB	S	X	X
Spent fuel pool strainers		W	NNS		AB	S	-	X
Skimmer pump		W	NNS		AB	P	-	X
Spent fuel pool filter (10)(11)		W	NNS	III C	AB	S	-	X
Spent fuel pool demineralizer (10)(11)		W	NNS	III C	AB	S	-	X
BORON THERMAL REGENERATION SUBSYSTEM								
Moderating HX	(tube side)	W	3	VIII	AB	S	X	X
	(shell side)		3	VIII	AB	S	X	X
Letdown chiller HX	(tube side)	W	3	VIII	AB	S	X	X
	(shell side) (10)		NNS	VIII	AB	P	X	X
Letdown reheat HX	(tube side)	W	2a	III C	AB	S	X	X
	(shell side)		3	VIII	AB	S	X	X
Thermal regeneration demineralizer		W	3	III 3	AB	S	X	X
Chiller (8)		W	NNS	VIII	AB	N	-	X
Chiller surge tank (10)		W	NNS	VIII	AB	N	-	X
Chiller pumps		W	NNS	P&V III	AB	N	-	X
LIQUID RECYCLE AND WASTE SUBSYSTEM								
Recycle holdup tank (19)		A	NNS	API 650	AB	S	-	X
Recycle evap. feed pump		W	NNS	MS	AB	S	-	X
Recycle evap. feed demineralizer		W	NNS	VIII	AB	S	-	X
Recycle evap. feed filter		W	NNS	VIII	AB	S	-	X
Recycle evaporator		W	NNS	VIII	AB	S	-	X
Recycle evap. condensate demineralizer (10)		W	NNS	VIII	AB	P	-	X
Recycle evap. condensate filter (10)		W	NNS	VIII	AB	P	-	X
Recycle evap. concentrate filter (10)		W	NNS	VIII	AB	S	-	X
Recycle evap. reagent tank (13)		W	NNS	VIII	AB		-	X

TABLE 3.2-1 (SHEET 5 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
R.C. drain tank	W	NNS	VIII	C	S	-	X
R.C. drain tank pump	W	NNS	MS (N2G21P001A-N) API-610 (N2G21P001B-N)	C	S	-	X
R.C. drain tank HX (tube side) (10)	W	NNS	VIII	C	S	-	X
(shell side)		2b	III C	C	P	X	X
Waste holdup tank (12)(13)	W	NNS	VIII	AB	S	-	X
Waste evap. feed pump	W	NNS	MS	AB	S	-	X
Waste evap. reagent tank	W	NNS	VIII	AB		-	X
Waste evap. feed filter	W	NNS	VIII	AB	S	-	X
Waste evaporator	W	NNS	VIII	AB	S	-	X
Waste evap. condensate demin. (10)	W	NNS	VIII	AB	P	-	X
Waste evap. condensate filter (10)	W	NNS	VIII	AB	P	-	X
Waste evap. condensate tank (10)(12)	W	NNS	VIII	AB	P	-	X
Waste evap. condensate tank pump	W	NNS	MS	AB	P	-	X
Chemical drain tank (12)(13)	W	NNS	VIII	AB	S	-	X
Chemical drain tank pump	W	NNS	MS	AB	S	-	X
Spent resin storage tank	W	NNS	VIII	AB	S	-	X
Spent resin sluice pump	W	NNS	MS	AB	S	-	X
Spent resin sluice filter	W	NNS	VIII	AB	S	-	X
Laundry and hot shower tank (10)(12)(13)	W	NNS	VIII	AB	P	-	X
Laundry and hot shower tank pump	W	NNS	MS	AB	P	-	X
Laundry and hot shower strainer (10)	W	NNS		AB	P	-	X
Laundry and hot shower filter (10)	W	NNS	VIII	AB	P	-	X
Floor drain tank (10)(12)(13)	W	NNS	VIII	AB	P	-	X
Floor drain tank pump	W	NNS	MS	AB	P	-	X
Waste monitor tank (10)(12)(13)	W	NNS	VIII	AB	P	-	X

TABLE 3.2-1 (SHEET 6 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Waste monitor tank pump	W	NNS	MS	AB	P	-	X
Waste monitor tank demineralizer (10)	W	NNS	VIII	AB	P	-	X
Waste monitor tank filter (10)	W	NNS	VIII	AB	P	-	X
Containment sump pump	A	NNS	MS	C	P	-	X
ES room sump pump	A	NNS	MS	AB	P	-	X
Drumming header strainer (10)	W	NNS		AB	S	-	X
Floor drain tank filter (10)	W	NNS	VIII	AB	P	-	X
Floor drain tank strainer (10)	W	NNS		AB	P	-	X
Disposable demineralizers	A	NNS	MS	AB	S	-	X
Disposable demineralizer pumps	A	NNS	MS	AB	S	-	X
GAS HANDLING SUBSYSTEM							
Gas compressor	W	NNS	VIII/MS	AB	S	-	X
Gas decay tanks	W	NNS	VIII	AB	S	X(D)	X
Hydrogen recombiner	W	NNS	VIII	AB	S	-	X
EMERGENCY DIESEL FUEL OIL SYSTEM							
Transfer pumps	A	2b	P&V III	DB	N	X	X
Fuel oil tanks	A	2b	API 620	B	N	X	X (27)
SERVICE WATER SYSTEM							
Pumps	A	2b	P&V III	S	N	X	X
Strainers	A	2b	VIII	S	N	X	X
Recirc pipe to wetpit	A	2b	VIII	O	N	X	(26)
RIVER WATER SYSTEM							
Pumps	A	2b(25)	P&V III	R	N	X	X
FUEL HANDLING SYSTEM							
Fuel manipulator crane	W	3	-	AB	N	X	X
Fuel transfer tube (17)	W	2a	-	C/AB	N	X	X

TABLE 3.2-1 (SHEET 7 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Underwater fuel conveyor car and rail system (18)	W	3	-	AB	N	X	X
Fuel pool bridge crane	W	3	-	AB	N	X	X
Polar crane	A	NNS	(9)	C	N	X	X
Crane supports	A	NNS	-	C	N	X	X
SAMPLING SYSTEM							
Sampler heat exchanger	A	NNS	VIII	AB	S	-	X
Sampler vessel	A	NNS	VIII	AB	S	-	X
Delay coil	A	2a	B31.7 II	C	S	X	X
REFUELING WATER SYSTEM							
Pump	A	NNS	-	AB	P	-	X
Storage tank (20)	A	2a	III 2	O	P	X	X(23) (27)
FIRE PROTECTION SYSTEM							
Fire pumps	A	NNS	(15)	O	N	-	-
CONTAINMENT PURGE SYSTEM							
Fans	A	NNS	-	AB	N	-	X
Filters	A	NNS	-	AB	P	X	X
REACTOR VESSEL SUPPORT COOLING SYSTEM							
Fans	A	NNS	-	C	N	-	X
CONTROL ROD DRIVE MECHANISM COOLING SYSTEM							
Fans	A	NNS	-	C	N	-	X
AUXILIARY BUILDING VENTILATION SYSTEM							
Fan/coil units	A	NNS	-	AB	N	-	X
Filters	A	NNS	-	AB	P	-	X
Pump room air cooling units	A	2b	-	AB	P	X	X
Battery room exhaust fans	A	NNS	AMCA	AB	N	X	X

TABLE 3.2-1 (SHEET 8 OF 15)

	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Battery charger room air cooling units	A	2b	III-3, AMCA	AB	N	X	X
Motor control center and 600 V load center air cooling units	A	2b	III-3, AMCA	AB	N	X	X
600-V load center cooling system fire damper	A	NNS	UL	AB	N	X	X
Battery room motor operated dampers	A	NNS	AMCA	AB	N	X	X
<u>PENETRATION ROOM FILTRATION SYSTEM</u>							
Fans	A	2b	AMCA(14)	AB	N	X	X
Filters (HEPA and charcoal)	A	2b	ORNL-NSIC	AB	P	X	X
Backdraft dampers	A	NNS	AMCA	AB	N	X	X
Spent Fuel Pool Area Duct	A	2b	AMCA	O	P	X	(26)
<u>CONTROL ROOM VENTILATION SYSTEM</u>							
Fans	A	2b	AMCA(14)	AB	N	X	X
Filters	A	2b	ORNL-NSIC	AB	P	X	X
Air conditioning unit	A	2b	AMCA, III-3	AB	N	X	X
Motor-operated dampers/valves	A	2b	AMCA, III-3	AB	N	X	X
Balancing dampers	A	NNS	AMCA	AB	N	X	X
Fire dampers	A	NNS	UL	AB	N	X	X
<u>DIESEL BUILDING VENTILATION SYSTEM</u>							
Fans	A	2b	AMCA(14)	DB	N	X	X
Filters	A	2b	-	DB	N	X	X
<u>MAIN STEAM SYSTEM</u>							
Isolation valves	A	2a	P&V II	AB	N	X	X
<u>FEEDWATER SYSTEM</u>							
Isolation valves	A	2a	P&V II	AB	N	X	X
<u>AUXILIARY FEEDWATER SYSTEM</u>							
Auxiliary feedwater pumps Motor driven	A	2b	P&V III	AB	N	X	X

TABLE 3.2-1 (SHEET 9 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Location (4)	Rad Source (5)	Seismic (6)	Tornado (7)
Steam turbine driven	A	2b	P&V III	AB	N	X	(26)
Condensate storage tank	A	2b	III 3	O	P	X	(24) (27)
STEAM DUMP SYSTEMS							
Turbine bypass	A	NNS	-	TB	N	-	-
Relief valves	A	2a	P&V II	AB	N	X	X (27)
Safety valves (16)	A	2a	P&V II	AB	N	X	X (27)
STEAM GENERATOR BLOWDOWN TREATMENT SYSTEM							
Blowdown surge tank	W	NNS	VIII	AB	P	-	X
Blowdown inlet filters	W	NNS	VIII	AB	P	-	X
Blowdown outlet filter	W	NNS	VIII	AB	P	-	X
Blowdown discharge-recycle pumps	W	NNS	VIII	AB	P	-	X
Blowdown heat exchangers	W	NNS	VIII	AB	P	-	X
Blowdown cation demineralizers	W	NNS	VIII	AB	P	-	X
Blowdown mixed bed demineralizers	W	NNS	VIII	AB	P	-	X
Spent resin storage tank	W	NNS	VIII	AB	P	-	X
Spent resin sluice pump	W	NNS	VIII	AB	P	-	X
Spent resin sluice filter	W	NNS	VIII	AB	P	-	X
CONDENSER CIRCULATING WATER SYSTEM							
Circulating water pumps	A	NNS	-	O	N	-	-
COMPRESSED AIR SYSTEM(22)							
Compressors	A	NNS	-	TB	N	-	-
After coolers	A	NNS	-	TB	N	-	-
Air tanks	A	NNS	VIII	TB	N	-	-
Air dryers	A	NNS	-	TB	N	-	-
Piping to safety grade component safety boundary	A	NNS	B31.1	TB/C/AB/O	N	-	-

TABLE 3.2-1 (SHEET 10 OF 15)

Component	Design Responsibility (1)	ANS Safety Class (2)	Code (3)	Rad Location (4)	Source (5)	Seismic (6)	Tornado (7)
Air filter	A	NNS	-	TB	N	-	-
Piping to within safety grade component safety boundary	W/A	(SAME AS COMPONENT - SEE APPROPRIATE COMPONENT DESCRIPTION)					
HYDROGEN SYSTEM							
Hydrogen vessels	A	NNS	VIII	O	N	-	-
NITROGEN SYSTEM							
Nitrogen vessels	A	NNS	VIII	O	N	-	-
POST-LOCA HYDROGEN CONTROL SYSTEM							
Post-LOCA hydrogen recombiners	W	2b	-	C	N	X	X
Containment post-LOCA hydrogen mixing system	W	2b	AMCA(14)	C	N	X	X
Post-LOCA, containment hydrogen monitoring equipment	W	2b	III-2	C	P	X	X
MISCELLANEOUS COMPONENTS							
Diesel generators	A	3	-	DB	N	X	X (27)
Spent fuel pool	A	NNS	-	AB	S	X	X
Vent stack	A	NNS	-	O	N	X	X[D]
Spent fuel pool H & V system isolation dampers	A	NNS	AMCA	AB	P	X	X
Containment venting filter units	A	2b	III-3, ORNL	AB	P	X	X

NOTES

(1)	A	Alabama Power Company
	W	Westinghouse
(2)	1	Safety Class 1 (ANS)
	2a	Safety Class 2a (ANS)
	2b	Safety Class 2b (ANS)
	3	Safety Class 3 (ANS)
	NNS	Non Nuclear Safety (ANS)
(3)	III A	ASME Boiler and Pressure Vessel Code - Section III, Class A
	III C	ASME Boiler and Pressure Vessel Code - Section III, Class C
	VIII	ASME Boiler and Pressure Vessel Code - Section VIII
	P&V I	ASME Code for Pumps and Valves for Nuclear Power, Class I
	P&V II	ASME Code for Pumps and Valves for Nuclear Power, Class II
	P&V III	ASME Code for Pumps and Valves for Nuclear Power, Class III
	III 1	ASME Boiler and Pressure Vessel Code - Section III, Class 1
	III 2	ASME Boiler and Pressure Vessel Code - Section III, Class 2
	III 3	ASME Boiler and Pressure Vessel Code - Section III, Class 3
	B31.1	ANSI B31.1 - Power Piping
	B31.7 I	ANSI B31.7 - Nuclear Power Piping, Class I
	B31.7 II	ANSI B31.7 - Nuclear Power Piping, Class II
	B31.7 III	ANSI B31.7 - Nuclear Power Piping, Class III

	D100	American Waterworks Association, Standard for Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage, AWWA, D100
	API 610	American Petroleum Institute, Centrifugal Pumps for General Refinery Services
	API 620	American Petroleum Institute Recommended Rules for Design and Construction of Large Welded Low Pressure Storage Tanks
	API 650	American Petroleum Institute, Welded Steel Tanks for Oil
	AMCA	Air Moving and Conditioning Association
	MS	Manufacturer's Standard
	ORNL-NSIC	Oak Ridge National Laboratory, Nuclear Information Center - Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Application.
	UL	Underwriters Laboratory
(4)	C	Containment
	AB	Auxiliary Building
	TB	Turbine Building
	B	Buried in Ground
	DB	Diesel Generator Building
	R	River Water Intake Structure
	S	Service Water Intake Structure
	O	Outside
(5)	S	Source of radiation
	N	No source of radiation
	P	Possible source of radiation
(6)	X	Category I, (Methods used for seismic analysis of Category I systems and components are presented in table 3.7-4).

No Changes
INFORMATION ONLY

TABLE 3.2-1 (SHEET 13 OF 15)

	X(D)	Designed and constructed to the seismic requirements given in Regulatory Guide 1.143, Revision 1 with the exception of the seismic design criteria given in Regulatory Position C.5. The components, systems, and structures are designed to the seismic design criteria given in FSAR section 3.7.
	-	Category II
(7)	X	Protected by virtue of location in a structure designed for tornado wind.
	X(D)	Designed for tornado wind loads.
	-	No protection required
(8)		Portions of equipment containing component cooling water will be analyzed for seismic requirements.
(9)		Crane Manufacturers Association of America Specification No. 70 of 1971.
(10)		National Fire Underwriters and Underwriters Laboratory Certification.
(11)		Designed and fabricated to ASME III C, radiographed and so stamped; however, compliance with ASME VIII would be sufficient for this use.
(12)		Outside jurisdiction of ASME, but designed, fabricated, examined, and tested according to ASME Boiler and Pressure Vessel, Section VIII.
(13)		Built to code but not tested
(14)		Performance test required
(15)		National Fire Protection Association Standard No. 20.
(16)		Will meet pressure-relieving requirements of ASME Section III, Article 9.
(17)		That part which is part of the containment pressure boundary.

TABLE 3.2-1 (SHEET 14 OF 15)

(18)	Protect against seismic overturning and possible impaling of fuel.
(19)	Quality control requirements include sidewall and nozzles to tank welds examined by magnetic-particle or liquid-penetrant methods; roof, roof-to-sidewall, and bottom welds visually examined; bottom and bottom-to-sidewall welds vacuum box tested
(20)	Quality control requirements include 100% radiograph of sidewall welds; roof, roof-to-sidewall, and bottom welds visually examined; bottom and bottom-to-sidewall welds vacuum box tested; bottom-to-sidewall and nozzles-to-tank welds examined by magnetic-particle or liquid penetrant methods.
(21)	Quality control requirements include sidewall welds 3/16 in. or under examined by magnetic-particle or liquid-penetrant methods; 100-percent radiograph of sidewall welds over 3/16 in.; roof, roof-to-sidewall, bottom, bottom-to-sidewall, and nozzles-to-tank welds examined by magnetic-particle or liquid-penetrant methods; roof and roof-to-sidewall welds soap tested; bottom and bottom-to-sidewall welds vacuum box tested.
(22)	The compressed air system includes the instrument air system.
(23)	This equipment is surrounded by a concrete wall to protect it from tornado missiles.
(24)	In order to ensure the 150,000 gallon reserve required by Technical Specifications, the lower twelve feet of the tanks are designed to withstand ruptures caused by missiles generated by tornadoes. Certain connections to the Unit 1 and Unit 2 CSTs, however, are not missile protected. The subject connections are: CST drain, vacuum degasifier pump suction line on Unit 1 and tank connection on Unit 2, and the sensing lines for the level transmitters. Reference section 9.2.6.2 for a discussion of these connections.
(25)	The river water system has been downgraded to Non-Nuclear Safety. System components are to be maintained to their original classification (2b) for maintenance purposes only.
(26)	This component or portions of this system are not required to be protected from tornado generated missiles per section 3.5.1.2.2.1.
(27)	This component or portions of this system have been analyzed for vulnerability to tornado generated missiles and found to have an acceptable probability of survival per section 3.5.1.2.2.2.

TABLE 3.2-1 (SHEET 15 OF 15)

GENERAL NOTES:

1. The safety-related systems outside the reactor coolant pressure boundary may have more than one quality class of piping and valves. Individual valves and sections of piping are assigned quality classes and codes appropriate to their locations and functions and consistent with the assignments of quality classes of system components in table 3.2-1.

2. All pressure-retaining cast parts of Safety Class 1a and 2a pumps and valves are radiographed (or ultrasonically tested to equivalent standards). Where size or configuration does not permit effective volumetric examination, magnetic-particle or liquid-penetrant examination is substituted. Examination procedures and acceptance standards are at least equivalent to those specified in the applicable class in the code.

3. The reactor coolant system code requirements, including the applicable addenda, are presented in table 3.2-4.

3.3 WIND AND TORNADO LOADINGS

3.3.1 WIND LOADINGS

Wind loadings for Category I structures have been selected on the basis of ASCE Paper No. 3269, "Wind Forces on Structures"[1] or as provided in "TORMIS Missile Risk Analysis for Farley Nuclear Plant Units 1 and 2."[3]

3.3.1.1 Design Wind Velocity

Category I structures are designed to withstand a basic wind velocity of 115 mph. The recurrence interval of this wind velocity is estimated to be at least 100 years.[1] The variation of wind velocity with height is shown in table 3.3-1.

3.3.1.2 Basis for Wind Velocity Selection

The "fastest mile of wind" at the Farley Plant site is shown, according to Figure 1 (b) and the ASCE paper,[1] to be 90 mph. As a result of recent hurricane experiences on the Gulf Coast, a design velocity of 105 mph at ground level was selected. For additional conservatism, to account for uncertainties in historical data, this margin of safety has been increased and a ground level wind of 115 mph has been used as the basic design wind.

3.3.1.3 Vertical Velocity Distribution and Gust Factor

The wind pressures resulting from the wind velocities shown in table 3.3-1 incorporate the shape factors in both horizontal and vertical directions. A gust factor of 1.1 has been selected for the design and has been incorporated into the wind pressures shown in table 3.3-1.

The gust factor of 1.1 is selected on the basis of ASCE paper No. 3269, "Wind Forces on Structures."[1] This paper recommends that appropriate gust factors be used for structures that are small enough to be responsive to gusts involving less than 1 mile of passing wind, and that the gust factors bear some relation to the minimum size of gust necessary to envelop the structure and its accompanying pattern of flow. A gust factor of 1.1 will allow for gust of approximately 10-second duration which, in a 115-mph basic wind, would have a length downwind of about 1,700 ft; this factor is adequate for structures having a horizontal dimension, transverse to the wind, of 125 ft and larger.

3.3.1.4 Determination of Applied Forces

The design wind dynamic pressure is calculated by

$$q = 0.002558\ V^2$$

where q = pressure in psf

V = velocity in mph

A shape coefficient of 1.3 is applied for building wind loads. Of the total of 1.3 q , 0.9 q is applied as positive pressure to the windward walls, and 0.4 q is applied as negative pressure on the leeward walls, where applicable. A shape factor of 0.6 is applied for plant vent stack wind loads.

Wind loads are applied to the structures as uniform static loads on the surface area normal to the wind.

The applied force magnitude and distribution calculated for Category I structures are shown in figure 3.3-1.

3.3.2 TORNADO LOADINGS

All above ground Category I structures required to ensure the integrity of the reactor coolant pressure boundary, safe shutdown of the plant, long-term core cooling or to prevent radioactive releases resulting in offsite exposures comparable to 10 CFR 100 guidelines are also designed to withstand tornado loadings and tornado generated missiles[2] or have been analyzed as discussed in Section 3.5.1.2.

3.3.2.1 Applicable Design Parameters

For Category I structures designed to withstand tornadoes and tornado generated missiles, the three following parameters are applied concurrently, in combinations producing the most critical conditions:

a) Dynamic Wind Pressure

The dynamic wind pressure is caused by a tornado funnel having a peripheral tangential velocity of 300 mph and a forward progression of 60 mph. The applicable portions of wind design methods described in ASCE Paper No. 3269 are used, particularly for shape factors. The provisions for gust factors and variation of wind velocity with height are not applied. The average tornado design dynamic wind pressure is q = 230 psf based on an average wind velocity of 300 mph.

b) Pressure Differential

The structure interior bursting pressure is taken as rising 1 psi/s for 3 seconds, followed by a 2-second calm, them decreasing at 1 psi/s for 3 seconds. This cycle accounts for reduced pressure in the eye of a passing tornado. All fully enclosed Category I structures are designed to withstand the full 3 psi pressure differential.

c) Missile Impingement

A tornado missile is defined as any object set in motion and propelled by a tornado. Three types of tornado missiles are considered; each type is assumed to act independently and only one type may be generated at any one time. It is also assumed that the missiles do not tumble while in flight, and are at any time oriented to have the maximum value:

$$\frac{C_d A}{W}$$

where

C_d = Drag coefficient

A = Projected area of missile exposed to wind

W = Weight of missile

The three types of missiles are as follows:

1. A 12-ft-long piece of wood 8 in. in diameter (114 lb) traveling end-on at a speed of 300 mph and striking the structure at any elevation.
2. A 10-ft-long steel pipe, schedule 40, 3 in. in diameter (75.8 lb), traveling end-on at a speed of 100 mph and striking the structure at any elevation.
3. A 4,000-lb automobile, traveling end-on at a speed of 50 mph and striking the structure on an impact area of 20 sq ft, with any portion of the impact area being not more than 25 ft above grade.

3.3.2.2 Determination of Forces on Structures

Tornado loads are applied to the Category I structures in the same manner as the wind loads described in subsection 3.3.1.4 with the exception that gust factor and variation of wind velocity with height do not apply. The load combinations involving tornadoes are given in subsections 3.8.1.3, 3.8.4.3, and 3.8.5.3.

The load factor selected for tornado loadings is 1.0, based on the short duration of the loading condition, the low probability of a tornado striking a specific geographic point, and the degree of conservatism in the selection of design tornado velocity. This subject is discussed in B-TOP-3.

3.3.2.3 Ability of Category I Structures to Perform Despite Failure of Structures Not Designed for Tornado Loads

Failure of Category II structures not designed for tornado loads will not affect the ability of Category I structures to perform their functions for the following reasons:

a. Tornado missiles that may be formed by the failure of Category II structures will not exceed the force of those postulated and described in subsection 3.3.2.1, against which Category I structures are designed.

b. The structural frame of the Category II turbine building in the vicinity of the auxiliary building has been designed against collapse when subjected to tornado loadings.

REFERENCES

1. "Wind Forces on Structures", Transactions of the ASCE, Paper No. 3269, 1961.

2. "Design Criteria for Nuclear Power Plants Against Tornadoes", Bechtel Topical Report, B-TOP-3, March 1970.

3. "TORMIS Missile Risk Analysis for Farley Nuclear Plant Units 1 and 2, ARA Report 4733, March 1999."

3.5 MISSILE PROTECTION

Category I structures are designed to protect safety related equipment and components from being damaged by internal and external missiles.

3.5.1 MISSILE BARRIERS AND LOADINGS

The missile barriers are designed to resist the missiles selected in subsection 3.5.2.

3.5.1.1 Accident/Incident Generated Missiles Inside Containment

A tabulation of barriers and the missiles they have been designed to contain is given in table 3.5-1. The postulated missile loadings are derived from the physical characteristics of the components involved and their respective kinetic energy levels. They are given in tables 3.5-2 through 3.5-5. The analytical method used to convert energies into forces and depths of penetration necessary to barrier design is described in subsection 3.5.4.

3.5.1.2 Environmental Load Generated Missiles

3.5.1.2.1 Missile Protection Methods

Those systems or components listed in Table 3.2-1 that are required for safe shutdown, for immediate or long term core cooling or to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines are provided with tornado missile protection by location within Category I structures, burial underground, missile barriers/shielding or have been analyzed as discussed in Section 3.5.1.2.2.

Category I structures housing equipment and components vital to a safe shutdown have been designed against penetration by the tornado missiles described in subsection 3.3.2.1 (c). These structures, having at least 2-ft thick concrete exterior walls and roof slabs, constitute barriers against missile penetration. Calculations show that the deepest missile penetration of the concrete barriers would be 10 in. Therefore, the 2-ft thick slabs provide ample protection. Where concrete spalling due to missile impact is considered, the inside surfaces of the following areas have been protected with corrugated sheet metal:

- Control room.
- HVAC equipment room for the control room.
- Component cooling water surge tank room.
- Spent fuel pool area.

3.5.1.2.2 Components Not Requiring Unique Missile Protection

Certain Seismic Category I systems and components located outside of Seismic Category I structures are evaluated as not requiring unique tornado missile protection by burial or barriers. The following two approaches are used in the evaluation of these systems and components relative to a tornado event.

3.5.1.2.2.1 Components Not Required for a Tornado Event

The probability of occurrence of a tornado event coincident with another low probability design basis event is so small that no protection from tornado missiles is required for certain Seismic Category I structures, systems and components which are not otherwise needed for safe shutdown, for immediate or long term core cooling, to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines, or to support other systems or components which are required for one of those functions.

3.5.1.2.2.2 Components with Acceptable Probability of Survival

Safety related systems and components required for safe shutdown, for immediate or long term core cooling or to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines required for a tornado event are generally protected. A limited amount of unprotected portions of these systems and components are analyzed using probabilistic missile damage analysis as permitted in Standard Review Plan 3.5.1.4 "Missiles Generated By Natural Phenomena." This analysis is conducted to determine the probability per year of missiles generated by postulated tornadoes striking and damaging these systems and components beyond their failure point. For FNP, the specific acceptance criterion for tornado damage for the unprotected systems and components required for a tornado event is that the cumulative sum of the mean failure probabilities for these systems and components be less than 10^{-6} per year per unit. The allowable level of less than 10^{-6} per year per unit for the cumulative probability of failure of such systems and components is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The analysis used for FNP is the computer program TORMIS[3][5], developed by the Electric Power Research Institute (EPRI)[4] and accepted by the NRC.

Systems and components whose analysis using the TORMIS methodology yields results that cause the less than 10^{-6} per year per unit acceptance criterion to be exceeded will be provided with unique barriers to reduce the total failure probability value to below the acceptance criterion.

REV

3.5.1.2.3 TORMIS Methodology

TORMIS[3][4][5] is a methodology developed to predict the probability of damage to nuclear power plant structures and components from tornadoes. There are four fundamental models in the TORMIS analysis: wind hazard, site facility, load effects and system models. Monte Carlo simulation is used to produce numerical estimates of hit and damage probabilities based on the site-specific models.

The wind hazard analysis for the Farley Plant Units 1 & 2 uses a site specific analysis to generate a tornado hazard curve specifically for Farley.

The site facility model was conservatively developed based on a site area walkdown and the specific characteristics, materials and failure points for Farley structures and components.

Load effects are determined based on the TORMIS model missiles, missile transport model, and component characteristics. The missiles utilized in the TORMIS model encompass the 3 design basis missiles described in Section 3.3.2.1.

TORMIS implements a methodology developed by the Electric Power Research Institute. TORMIS determines the probability of striking walls and roofs of buildings on which penetrations or exposed portions of systems/components are located. The probability is calculated by simulating a large number of tornado strike events at the site for each tornado wind speed intensity scale. After the probability of striking the walls or roof is calculated, the exposed surface area of the particular components are factored in to compute the probability of striking and consequently damaging a particular item.

The following provisions apply to the TORMIS analysis for FNP:

1. FSAR Section 2.3.1.3 estimates an occurrence rate of 3 tornadoes per year per 1 degree square (approximately 4000 square miles), or 7.5 E-04 tornadoes per square mile. This occurrence rate was based on conservative treatment of data from 1955-67. As part of the FNP TORMIS analysis, the annual probability of a tornado was determined for the Fujita F-scale wind speeds using regional data available in TORMIS for NRC Region II. A site-specific analysis was performed to generate a tornado data set for the TORMIS analysis of Farley.

   The National Climatic Data Center (NCDC) files for the years 1950-1996 were used as the basic source of data for this investigation. This data was screened to eliminate coding errors in the record fields. In addition, corrections were introduced to account for reporting efficiency and time series, or other potential errors resulting from the indirect characteristics of the available data. The overall tornado occurrence rate computed from the updated regional data in TORMIS is 6.00 E-04 tornadoes per square mile per year. While this rate is slightly lower than the rate in FSAR Section 2.3.1.3, it is a more accurate figure based on conservative treatment of the best available data and will therefore be used in lieu of the data cited in FSAR Section 2.3.1.3 for those components or portions of systems analyzed in TORMIS.

2. The Fujita scale (F-scale) wind speeds will be used in lieu of the TORMIS wind speeds (F-scale) for the F0 through F5 intensities.

3. The tornado windfield parameters in the FNP TORMIS analysis were adjusted to increase the wind profile in the lowest 10 m over the original profile in TORMIS. This adjustment applied the ratio of V_0/V_{33} in a conservative manner in accordance with the NRC's October 26, 1983 TORMIS SER.

4. Detailed surveys of the plant site were performed to characterize and quantify potential missiles for use in the FNP TORMIS analysis. To ensure conservatism, these surveys were performed during a refueling outage when large amounts of material were temporarily stored in outside laydown areas around the site. Additionally, ground and aerial photographs were reviewed to estimate the number and type of missiles which could originate from remote areas of the site. The total number of missiles used in the FNP TORMIS analysis was 51,864.

5. The FNP analysis will not deviate from the TORMIS program as described in reference (4) of FSAR Section 3.5, except as noted in items 1 through 4 above.

3.5.1.3 Site Proximity Missiles

There are no guided missile installations in the vicinity of the Farley Nuclear Plant.

At the time of construction of Farley Nuclear Plant the only landing strip within a radius of 5 miles from the Farley site was a 3000-ft landing strip for the paper company at Cedar Springs, Georgia, approximately 3.5 miles south of the plant site. Aircraft using the strip were light, twin-engined business planes comparable to a Cessna 401-A, which has a gross weight of 6300 lb. The orientation of this landing strip was N 30 degrees E; therefore, takeoffs and landing approaches were not in the direction of the Farley Nuclear Plant site. The landing strip is now abandoned.

A new 5400-ft landing strip, capable of handling jet engined aircraft, has been constructed by the paper company at Cedar Springs, Georgia. The new strip is located approximately 4 to 5 miles south of the old landing strip and 7 to 8 miles from the Farley site. The strip has approaches oriented NW and SE and is used by jet aircraft as well as conventional aircraft. The jet aircraft are six-to-eight-passenger business jets comparable to a Lear Jet Model 23, which has a gross weight of 12,500 lb. The paper company at Cedar Springs, Georgia, has indicated that pilots will be instructed to avoid the Farley Nuclear Plant site area during both takeoffs and landing operations.

For these reasons, aircraft generated missiles are not considered.

3.5.1.4 Accident/Incident Generated Missiles Inside Category I Structures Other than Containment

A tabulation of barriers and the missiles they have been designed to contain is given in table 3.5-6. The postulated missile loadings for the rod drive motor generator sets are derived from the physical characteristics of these components and their respective kinetic energy levels, as given in table 3.5-7.

3.5.2 MISSILE SELECTION

3.5.2.1 Missile Selection Within the Containment

The systems located inside the containment have been examined to identify and select potential missiles. The basic approach was to ensure design adequacy against generation of missiles, rather than allow missile formation and then contain their effects.

The following components have been considered to have a potential for missile generation:

a. Control rod drive mechanism housing plug, drive shaft, and the drive shaft and drive mechanism latched together.

b. Certain valves defined below.

c. Temperature and pressure element assemblies.

The worst case considered for design is that the top plug on the control rod drive mechanism might become loose and be forced upward by the water jet. The following sequence of events is assumed: The drive shaft and control rod cluster are forced out of the core by the differential pressure of 2500 psi across the drive shaft. (The drive shaft and control rod cluster, latched together, are assumed fully inserted when the accident starts.) After approximately 12 feet of travel, the rod cluster control spider hits the underside of the upper support plate. Upon impact the flexure arms in the coupling joining the drive shaft and control cluster fracture, completely freeing the drive shaft from the control rod cluster. The control cluster would be completely stopped by the upper support plate; however, the drive shaft would continue to be accelerated upward to hit the missile shield structure provided.

The valves considered for missile potential are those in the region where the pressurizer extends above the operating deck, such as the pressurizer safety valves, the motor operated isolation valves in the relief line, the air operated relief valves, and the air operated spray valves. Although failure of these valves is considered improbable, failure of the valve bonnet body bolts, nevertheless, has been considered and provisions made to ensure integrity of the containment liner from the resultant bonnet missile.

The only probable source of jet propelled missiles from the reactor coolant piping and piping systems connected to the reactor coolant system is the type represented by the temperature and pressure element assemblies. The resistance temperature element assemblies can be of two types: "with well" and "without well". Two rupture locations have been assumed for each type of temperature element assembly: one around the weld between the boss and the pipe wall for each assembly, and another at the weld (or thread) between the temperature element assembly and the boss for the "without well" element or the weld (or thread) between the well and the boss for the "with well" element.

A temperature element is installed on the reactor coolant pumps close to the radial bearing assembly. A hole is drilled in the gasket and sealed on the internal end by a steel plate. In evaluating missile potential, it is assumed that this plate could break and the pipe plug on the external end of the hole could become a missile.

In addition, it is assumed that the welding between the instrumentation well and the pressurizer wall could fail and the well and sensor assembly could become a jet propelled missile.

Finally, it is assumed that the pressurizer heaters could become loose and become jet propelled missiles.

3.5.2.2 Missiles Selected Outside the Containment

The tornado generated missiles selected for the design of the Farley Plant structures are described in subsection 3.3.2.

3.5.2.3 Missile Selection Within Category I Structures Other Than Containment

The systems located inside Category I structures other than the containment have been examined to identify potential missiles. The following components are considered to have a potential for missile generation:

a. Flywheels of two rod drive power supply motor generator sets.

The electric motors of the rod drive power supply motor generator sets are designed to operate at 1800 rpm. In the unlikely event of an overspeed generated flywheel missile, the steel protective shield which closely encircles the flywheel would contain the missile and prevent it from impacting any safety-related components.

The steel protective shields are designed to contain a spectrum of probable flywheel fragment missiles generated at an overspeed of 150 percent of the operating speed as indicated in table 3.5-7. For conservation, the initial translational energy of the governing missile is increased by 10 percent for the design of the steel protective shield.

3.5.3 SELECTED MISSILES

The missiles selected inside the containment are given in tables 3.5-1 through 3.5-5.

The origin, weight, impact velocity, impact area, and all other parameters necessary to determine the missile penetration are listed in these tables. The calculated depth of penetration into a 2-ft-thick concrete slab is also given.

The missiles selected outside the containment are given in paragraph 3.3.2.1(c).

3.5.4 BARRIER DESIGN PROCEDURES

The internal and external missile barriers have been designed to resist missile penetration in order to protect systems and components so that the failure of one system or component cannot cause the failure of another system or component.

Missile barriers are constructed of concrete, steel or a combination of concrete and steel in order to provide protection from the effects of missiles.

Barriers are designed based on the pertinent characteristics of the potential targets, postulated missiles, and barrier materials including the materials ability to provide protection from penetration, perforation, and spalling. The methods and procedures used to evaluate missile impact on structures and barriers and the analytical methods used to convert energies into forces and depths of penetration necessary for barrier design are described in NAVDOCKS P-51[1] and Bechtel Topical Report
BC-TOP-9A[2].

The analysis for the depth of missile penetration in reinforced concrete was carried out using the following modified Petry formula as presented in NAV DOCKS P-51.

(3.5-1) $$D = KA_pV'$$

(3.5-2) $$V' = \log_{10}[1 + V^2/215000]$$

(3.5-3) $$D' = D \quad [1 + e^{-4} \ (a'-2)]$$

$$a' = T/D$$

where

D = depth of penetration of an infinitely thick slab (inches)

k = an experimentally obtained materials coefficient for penetration (k = 0.0022 for 5000 psi reinforced concrete)

A_p = sectional pressure, obtained by dividing the weight of the missile by the maximum cross sectional area (expressed as pounds per square foot)

V' = velocity factor

V = terminal or striking velocity in feet per second

D' = actual depth of penetration in a slab of finite thickness (inches)

T = thickness of resisting slab (inches)

The design basis for concrete barrier thickness within the reactor containment is planned to provide a barrier approximately three times thicker than the depth of missile penetration. As a result, 2 ft of concrete was chosen to satisfy the above criterion. Substituting the value of 2 ft for T in equation 3.5-3, the actual depth of penetration, D', was calculated as shown in tables 3.5-2 through 3.5-5.

For the external missiles, a minimum of 2 ft of concrete has also been used in the plant design, providing protection against penetration. A summary of Category I structures utilizing concrete designed against missile penetration and the thickness provided is given below:

	Thickness (in.)
Auxiliary building, Exterior walls and roof slabs (see note 1)	24
Containment dome	39
Containment wall	45
Diesel generator building	24
River intake structure	24
Intake structure at storage pond	24
RWST & RMWST shield walls	24

Note 1: The walls of the main steam room venting structure are heavy welded steel grating which provides protection against penetration of tornado-generated missiles.

Equipment and piping located outside the containment which are required for safe shutdown, long-term core cooling or to prevent a radioactive release resulting in offsite exposures comparable to 10 CFR 100 guidelines are provided with tornado missile protection either by location within Category I structures, burial under- ground, designed missile barriers/shielding, or have been analyzed as discussed in Section 3.5.1.2.2.

3.5.5 MISSILE BARRIER FEATURES

Figure 3.8-2, drawing D-176151, figures 3.8-9, 3.8-10, 3.8-11, 3.8-13, 3.8-14, drawings D-205205, D-205206, D-205207, and figures 3.8-23, 3.8-24, 3.8-25, 3.8-26, 3.8-27, 3.8-28, and 3.8-29 show the layout and principal design features of the barriers and structures designed to resist missiles.

REFERENCES

1. NAVDOCKS P-51 - "Design of Protective Structures," Bureau of Yards and Docks, Dept. of the Navy, August 1950.

2. BC-TOP-9A - "Design of Structures for Missile Protection," Revision 2, September 1974.

5. "TORMIS Missile Risk Analysis for Farley Nuclear Plant Units 1 and 2," ARA Report 4733, March 1999.

6. EPRI NP-2005, "Tornado Missile Simulation and Methodology," Volumes I and II, Final Report, August 1981.

7. REA 97-1409 response, SCS to SNC letter FP 99-0429, "Tornado Missile Broadness Review and PRA Analysis," August 6, 1999.

ENCLOSURE V

Joseph M. Farley Nuclear Plant

Response to NRC Requests for Additional Information regarding Final Safety Analysis Report Changes to Design Basis for Tornado-Generated Missiles

Response to NRC Requests for Additional Information

SNC received five questions resulting from NRC staff review of SNC's original June 29, 2000 license amendment request submittal. These NRC questions are repeated below along with SNC's response to each.

NRC Question #1 (concerning SNC's response to NRC's TORMIS SER Point 1)

The submittal states that the FNP analysis will use 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.

SNC Response

A revised response to NRC Point 1 is provided below to better justify why use of the regional tornado data is acceptable. This new response has been incorporated into SNC's revised license amendment request submittal.

Revised Response to NRC Point 1:

FSAR Section 2.3.1.3 estimates an occurrence rate of 3 tornadoes per year per 1 degree square (approximately 4000 square miles), or 7.5 E-04 tornadoes per square mile. This occurrence rate was based on conservative treatment of data from 1955-67. As part of the FNP TORMIS analysis, the annual probability of a tornado was determined for the Fujita F-scale wind speeds using regional data available in TORMIS for NRC Region II. A site-specific analysis was performed to generate a tornado data set for the TORMIS analysis of Farley. The National Climatic Data Center (NCDC) files for the years 1950-1996 were used as the basic source of data for this investigation. This data was screened to eliminate coding errors in the record fields. In addition, corrections were introduced to account for reporting efficiency and time series, or other potential errors resulting from the indirect characteristics of the available data.

The overall tornado occurrence rate computed from the updated regional data in TORMIS is 6.00 E-04 tornadoes per square mile per year. While this rate is slightly lower than the rate in FSAR Section 2.3.1.3, it is a more accurate figure based on conservative treatment of the best available data and will therefore be used in lieu of the data cited in FSAR Section 2.3.1.3 for those components or portions of systems analyzed in TORMIS.

NRC Question #2 (concerning SNC's response to NRC TORMIS SER Point 3)

In regards to FNP'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.

SNC Response:

A revised response to NRC Point 3 is provided below to clarify adjustment of the wind profile in TORMIS. This new response has been incorporated into SNC's revised license amendment request submittal.

Revised Response to NRC Point 3:

The tornado windfield parameters in TORMIS were adjusted to increase the wind profile in the lowest 10 m over the original profile in TORMIS (Twisdale, *et. al.,* 1981). This adjustment applied the ratio of V_0/V_{33} in a conservative manner in accordance with the NRC SER.

NRC Question #3 (concerning SNC's response to NRC TORMIS SER Point 4)

In regards to FNP's response to Point 4 in 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.

SNC Response:

A revised response to NRC Point 4 is provided below to substantiate the conservative basis of the number of missiles used in the TORMIS analysis. This new response has been incorporated into SNC's revised license amendment request submittal.

Revised Response to NRC Point 4:

Detailed surveys of the plant site were performed to characterize and quantify potential missiles for use in the TORMIS analysis. To ensure conservatism, these surveys were performed during a refueling outage when large amounts of material were temporarily stored in outside laydown areas around the site. Additionally, ground and aerial photographs were reviewed to estimate the number and type of missiles which could originate from remote areas of the site. The total number of missiles used in the FNP TORMIS analysis was 51,864.

NRC Question #4 (concerning SNC's proposed text for FSAR 3.5.1.2.2.2)

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 FNP.

SNC Response:

The system or component damage probabilities computed by TORMIS are mean values. In SNC's revised license amendment request submittal the proposed text for FSAR 3.5.1.2.2.2 which explains FNP's specific acceptance criterion for tornado damage has been changed to add the word "mean" before "failure probabilities" to make this clear.

NRC Question #5 (concerning SNC's proposed text for FSAR 3.5.1.2.2.2)

Proposed FSAR Section 3.5.1.2.2.2 states "For FNP 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.

SNC Response

It was SNC's intent in the original license amendment submittal to apply an acceptance criterion of less than 10^{-6} per year to the probability of tornado damage on a system basis by combining individual component damage probabilities for unprotected equipment (using Boolean algebra where applicable). However, subsequent discussions with the NRC staff have led SNC to eliminate the deviation noted by the staff by changing the proposed FNP specific acceptance criterion for tornado damage. The proposed text for FSAR 3.5.1.2.2 now requires that the cumulative sum of the mean failure probabilities for the unprotected systems and components required for a tornado event be less than 10^{-6} per year per unit.

In addition to the qualitative conservatism provided by the FNP assumption that any tornado missile strike on an unprotected system or component results in damage causing a radioactive release, the proposed FNP-specific acceptance criterion contains additional inherent quantitative conservatism. This additional conservatism is created by arithmetically summing the individual system or component mean damage probabilities for each unit, even though these damage probabilities may result from mutually exclusive tornado events and in some cases apply to redundant equipment (i.e. redundancy is penalized). Applying this acceptance criterion on a per unit basis is appropriate since no credit is taken at FNP for other-unit equipment in responding to licensing basis events or in the probabilistic risk analyses.