UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
1600 E LAMAR BLVD
ARLINGTON, TX 76011-4511

April 25, 2014

EA-13-222

Louis P. Cortopassi, Vice President
and Chief Nuclear Officer
Omaha Public Power District
Fort Calhoun Station FC-2-4
P.O. Box 550
Fort Calhoun, NE 68023-0550

SUBJECT: FORT CALHOUN STATION – MANUAL CHAPTER 0350 INSPECTION REPORT AND FINAL SIGNIFICANCE DETERMINATION OF WHITE FINDING AND NOTICE OF VIOLATION; NRC INSPECTION REPORT NO. 05000285/2013017

Dear Mr. Cortopassi:

On March 13, 2014, the U.S. Nuclear Regulatory Commission (NRC) completed a team inspection at the Fort Calhoun Station. The inspection focused on the station's actions involving the identification, evaluation, and corrective actions associated with providing adequate tornado missile protection for plant structures, systems, and components. The enclosed inspection report presents the results of this inspection. A final exit briefing was conducted with you and other members of your staff on March 14, 2014.

The enclosed inspection report discusses one finding that was preliminarily determined to be White, having low to moderate safety significance. This finding involved the failure to provide adequate tornado missile protection for equipment important to safety. The station implemented plant modifications correcting all identified deficiencies. These corrective actions were reviewed by the NRC and found acceptable prior to plant restart that occurred in December of 2013. On March 18, 2014 you informed Mr. Anton Vegel and Mr. Michael Hay of NRC, Region IV, that the Fort Calhoun Station agreed with the low to moderate risk significance (White) characterization of this finding and that you declined an opportunity to discuss this issue in a Regulatory Conference or provide a written response.

After considering all available information, the NRC has concluded that the finding is appropriately characterized as White, having low to moderate safety significance. The NRC has also concluded that the failure to adequately protect the facility from tornado generated missiles is a violation of NRC requirements, as cited in the attached Notice of Violation (Notice). The circumstances surrounding this violation are discussed in detail in the enclosed inspection report. In accordance with the NRC Enforcement Policy, the Notice is considered escalated enforcement action because it is associated with a White finding.

The NRC has concluded that the information regarding the reason for the violation, the corrective actions implemented to correct the violation and prevent recurrence, and the date when full compliance was achieved was obtained by the NRC during our inspection activities. Therefore, you are not required to respond to this letter unless the description contained in the enclosed report does not accurately reflect your corrective actions or your position. Additionally, since this issue was identified and resolved by the station during the extended shutdown, under increased NRC oversight of the Inspection Manual Chapter 0350 Process, this issue will not be used for future plant performance assessment inputs and is considered closed.

There were three NRC identified findings identified during this inspection that were determined to be of very low safety significance (Green), and involved violations of NRC requirements. Additionally, the NRC determined that one traditional enforcement Severity Level IV violation of 10 CFR 50.59, “Changes, tests, and experiments,” occurred. The NRC is treating these violations as non-cited violations (NCVs) consistent with Section 2.3.2.a of the NRC Enforcement Policy.

Although these findings were determined to be of very low safety significance, they are of concern to the NRC because they reflect a continuing pattern of station personnel failing to understand and use design and licensing basis information when evaluating degraded and non-conforming conditions and implementing changes to the facility. The NRC understands the station has long term corrective actions to address these areas and plans to review the effectiveness of the actions during future NRC inspections. Additionally, the NRC looks forward to having discussions on this topic during the next public meeting currently scheduled for May 13, 2014.

If you contest these violations, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001; with copies to the Regional Administrator, Region IV; the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001; and the NRC Resident Inspector at the Fort Calhoun Station.

If you disagree with a cross-cutting aspects assignment in this report, you should provide a response within 30 days of the date of this inspection report, with the basis for your disagreement, to the Regional Administrator, Region IV; and the NRC Resident Inspector at the Fort Calhoun Station.

In accordance with 10 CFR 2.390 of the NRC's “Rules of Practice and Procedures,” a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS)

component of NRC's Agencywide Document Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Tony Vegel
Director, Division of Nuclear Materials Safety

Docket No.: 50-285
License No.: DPR-40

Enclosure:
1. Notice of Violation
2. Inspection Report 05000285/2013017
   w/Attachments:
   1. Supplemental Information
   2. Task Interface Agreement 2013-07, “Concurrence on Fort Calhoun Tornado Missile Protection Licensing Basis”
   3. Detailed Risk Assessment

cc w/ encl: Electronic Distribution

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File located: R:_Reactors\2014_FCS 0350 IR 050002852013017.pdf

SUNSI Rev Compl.	☒ Yes ☐ No	ADAMS	☒ Yes ☐ No	Reviewer Initials	MCH
Publicly Avail	☒ Yes ☐ No	Sensitive	☐ Yes☒ No		MCH

SRI:DRP/C	BC:DRP/F	C:ORA/ACES	SRA	DD:DNMS
JJosey	MHay	RBrowder	DLoveless	AVegel
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NOTICE OF VIOLATION

Omaha Public Power District (OPPD) Docket No. 50-285
Fort Calhoun Station License No. DPR-40
EA-2013-222

During a U.S. Nuclear Regulatory Commission (NRC) inspection conducted from July 8 through March 13, 2014, a violation of NRC requirements was identified. In accordance with the NRC Enforcement Policy, the violation is listed below:

> 10 CFR Part 50, Appendix B, Criterion III, “Design Control,” states, in part, that, “measures shall be established to assure that applicable regulatory requirements and the design bases, as defined in 10 CFR 50.2 and as specified in the license application, for those components to which this appendix applies, are correctly translated into specifications, drawings, procedures, and instructions.”
>
> Contrary to the above, from initial construction through July 2013, measures established by the licensee failed to assure that applicable regulatory requirements and the design bases, as defined in 10 CFR 50.2 and as specified in the license application, for those components to which 10 CFR 50, Appendix B, applies, were correctly translated into specifications, drawings, procedures, and instructions. Specifically, the licensee failed to fully incorporate applicable tornado missile protection design requirements for components needed to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition.

This violation is associated with a White Significance Determination Process Finding. (Section 4OA4.1)

The NRC has concluded that information regarding the reason for the violation, the corrective actions taken and planned to correct the violation and prevent recurrence, and the date when full compliance will be achieved was obtained by the NRC during our inspection activities and discussed in the enclosed report. However, you are required to submit a written statement or explanation pursuant to 10 CFR 2.201 if the description therein does not accurately reflect your corrective actions or your position. In that case, or if you choose to respond, clearly mark your response as a "Reply to a Notice of Violation," include the EA number, and send it to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001 with a copy to the Regional Administrator, Region IV, and a copy to the NRC Resident Inspector at the Fort Calhoun facility, within 30 days of the date of the letter transmitting this Notice of Violation (Notice).

If you choose to respond, your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. Therefore, to the extent possible, the response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information).

Dated this 25th day of April 2014.

U.S. NUCLEAR REGULATORY COMMISSION

REGION IV

Docket:	05000285
License:	DPR-40
Report:	05000285/2013017
Licensee:	Omaha Public Power District
Facility:	Fort Calhoun Station
Location:	9610 Power Lane Blair, NE 68008
Dates:	July 8 through March 13, 2014
Inspectors:	J. Josey, Senior Resident Inspector, Cooper Nuclear Station J. Kirkland, Senior Resident Inspector, Fort Calhoun J. Wingebach, Resident Inspector, Fort Calhoun
Approved By:	Tony Vegel, Director Division of Nuclear Material Safety

SUMMARY OF FINDINGS

IR 05000285/2013017; 07/08/2013 – 03/13/2014; Fort Calhoun Station, Supplemental Inspection for Repetitive Degraded Cornerstones, Multiple Degraded Cornerstones, Multiple Yellow Inputs or One Red Input.

The report covered an eight month period of inspection by an Inspection Manual Chapter 0350 inspection team. One White and three Green, non-cited violations were identified. Additionally, one traditional enforcement Severity Level IV violation was identified. The significance of most findings is indicated by their color (Green, White, Yellow, or Red) using Inspection Manual Chapter 0609, "Significance Determination Process." The cross-cutting aspect is determined using Inspection Manual Chapter 0310, "Components Within the Cross Cutting Areas." Findings for which the significance determination process does not apply may be Green or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 4, dated December 2006.

A. NRC-Identified Findings and Self-Revealing Findings

Cornerstone: Mitigating Systems

- White. The team identified multiple examples of a violation of 10 CFR 50, Appendix B, Criterion III, "Design Control," involving the failure to establish applicable tornado missile protection design requirements for components needed to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition. Specific examples included the steam driven auxiliary feedwater pump exhaust stack, auxiliary feedwater components located in Room 81, raw water pump electrical pull boxes PB-128T and PB-129T, and diesel generator fuel oil storage tank fill and vent lines. The licensee implemented plant modifications to adequately protect all affected equipment from tornado generated missiles and entered the deficiencies into its corrective action program for resolution as Condition Reports CR 2013-03839, 2013-03842, 2013-14117, and 2013-14246.

  The failure to ensure that station components were adequately protected from tornado missiles was a performance deficiency. In accordance with NRC Inspection Manual Chapter 0612, Appendix B, "Issue Screening," the performance deficiency was determined to be more than minor, and therefore a finding, because it was associated with the design control attribute of the Mitigating Systems Cornerstone, and affected the associated cornerstone objective to ensure availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Specifically, the finding affected the reliability of required components following a postulated tornado-generated missile impact. The team evaluated the finding using Inspection Manual Chapter (IMC) 0609, Appendix A, "The Significance Determination Process (SDP) for Findings at Power," Exhibit 4, "External Events Screening Questions." The finding required a detailed risk evaluation because it involved the lack of equipment specifically designed to mitigate a severe weather initiating

event (tornado) and could have degraded two or more trains of a multi-train system.

The Region IV senior reactor analyst performed a detailed risk evaluation in accordance with Appendix A, Section 6.0, "Detailed Risk Evaluation." The NRC concluded the finding was characterized as having low to moderate safety significance (White). The calculated change in core damage frequency of 2.6×10^{-6} was dominated by a tornado-induced non-recoverable loss of offsite power with the failure of the emergency power supply system. The analyst determined that the finding did not affect the internal events initiator risk and would not involve a significant increase in the risk of a large early release of radiation.

The finding has a cross-cutting aspect in the area of problem identification and resolution associated with the corrective action program component because the licensee failed to thoroughly evaluate problems such that the resolutions address the causes [P.1(c)](Section 4OA4.1).

- Green. The team identified a non-cited violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Actions," involving the failure to promptly identify and correct a condition adverse to quality. Specifically, from August 2005 to July 15, 2013 the licensee failed to promptly identify and correct inadequate Class 1 structures wall thickness deficiencies to protect systems and components contained within from tornado generated missiles. The licensee resolved this issue by implementing changes to the facility through a licensing amendment that was reviewed and approved by the NRC. This issue has been entered into the corrective action program as Condition Report CR 2013-14363.

  The licensee's failure to promptly identify and correct conditions adverse to quality was a performance deficiency. This performance deficiency is more than minor, and therefore a finding, because it is associated with the design control attribute of the Mitigating Systems Cornerstone, and affected the cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Using Inspection Manual Chapter 0609, Appendix A, "The Significance Determination Process for Findings at Power," the finding was determined to have very low safety significance (Green) because it: (1) was not a deficiency affecting the design or qualification of a mitigating structure, system, or component, and did not result in a loss of operability or functionality; (2) did not represent a loss of system and/or function; (3) did not represent an actual loss of function of at least a single train for longer than its technical specification allowed outage time, or two separate safety systems out-of-service for longer than their technical specification allowed outage time; (4) did not represent an actual loss of function of one or more non-technical specification trains of equipment designated as high safety-significance in accordance with the licensee's maintenance rule program; and (5) did not involve the loss or degradation of equipment or function specifically designed to mitigate a seismic, flooding, or severe weather event.

The team determined this finding has a cross-cutting aspect in the area of human performance associated with the decision-making component involving the failure to use conservative assumptions in decision-making and adopt a requirement to demonstrate that the proposed action is safe in order to proceed rather than a requirement to demonstrate it is unsafe in order to disapprove the action. Specifically, in 2005 the licensee identified that wall thicknesses for areas of the auxiliary building and intake structure were less than design requirements. The licensee failed to enter this deficiency into the corrective action process and inappropriately used an alternate acceptance criteria that was not part of the facility licensing basis [H.1(b)](Section 4OA4.2).

- Green. The inspectors identified two examples of a non-cited violation of 10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," associated with the licensee's failure to follow Station Procedure NOD-QP-31, "Operability Determination Process," when evaluating deficiencies associated with inadequate tornado missile protection for required components. Specifically, Step 4.3.15 required, in part, that, "A positive determination of operability must be justified, including … a technical discussion of why the concern identified does not prevent the item from fulfilling its intended safety function." In each example, the team identified that the operability determination lacked adequate technical justification for why the item was operable with the degraded or nonconforming condition. The licensee addressed these issues by taking corrective actions that provided adequate tornado missile protection in accordance with design basis requirements. The licensee entered this deficiency into its corrective action program for resolution as Condition Reports CR 2013-15429 and 2013-14006.

  The failure to properly assess and document the basis for operability when a degraded or nonconforming condition was identified was a performance deficiency. This performance deficiency is more than minor, and therefore a finding, because it is associated with the equipment performance attribute of the Mitigating Systems Cornerstone, and affected the cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Since the finding involving inadequate operability determinations occurred while in a shutdown condition, the team used Manual Chapter 0609, Appendix G, "Shutdown Operations Significance Determination Process," and determined the finding to have very low safety significance (Green) because the finding did not increase the likelihood of a loss of reactor coolant system inventory, the finding did not degrade the licensee's ability to terminate a leak path or add reactor coolant system inventory when needed, and the finding did not degrade the licensee's ability to recover decay heat removal once it was lost. This finding has a cross-cutting aspect in the area of human performance associated with the decision-making component because the licensee failed to use conservative assumptions in decision making when performing operability determinations [H.1(b)](Section 4OA4.3).

- Green. The team identified a non-cited violation of 10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," associated with the licensee's failure to provide adequate instructions or procedures for the construction of temporary barriers to protect raw water pump electrical pull boxes PB-128T and PB-129T from tornado generated missiles in temporary modification EC 60183. The licensee addressed this issue by modifying the temporary barriers. This issue has been entered into the licensee's corrective action program as Condition Report CR 2013-13955.

  The failure to provide adequate instructions for construction of temporary barriers to protect the raw water pump electrical pull boxes from tornado generated missiles was a performance deficiency. This performance deficiency is more than minor, and therefore a finding, because it is associated with the equipment performance attribute of the Mitigating Systems Cornerstone, and affected the cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Since the finding involving inadequate operability determinations occurred while in a shutdown condition, the team used Manual Chapter 0609, Appendix G, "Shutdown Operations Significance Determination Process," and determined the finding to have very low safety significance (Green) because the finding did not increase the likelihood of a loss of reactor coolant system inventory, the finding did not degrade the licensee's ability to terminate a leak path or add reactor coolant system inventory when needed, and the finding did not degrade the licensee's ability to recover decay heat removal once it was lost. This finding has a cross-cutting aspect in the area of human performance associated with the work practices component because the licensee failed to ensure supervisory and management oversight of work activities, including contractors, such that nuclear safety was supported [H.4(c)](Section 4OA4.4).

Other Findings

- SL-IV. The team identified three examples of a non-cited violation of 10 CFR 50.59, "Changes, Test, and Experiments," associated with the licensee's failure to adequately evaluate changes to determine if prior NRC approval is required. Specifically, from April 19, 2011, through August 17, 2012, the licensee failed to obtain a license amendment pursuant to Section 50.90 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would result in a departure from a method of evaluation described in the Updated Safety Analysis Report. The licensee addressed these issues by submitting a license amendment which was reviewed and approved by the NRC. This issue has been entered into the licensee's corrective action program as Condition Reports CR 2013-03839, 2013-04266, 2013-05210, 2013-14363, and 2013-14665.

  The licensee's failure to implement the requirements of 10 CFR 50.59 and adequately evaluate changes to requirements for tornado missile protection described in the Updated Safety Analysis Report was a performance deficiency.

Because this performance deficiency had the potential to impact the NRC's ability to perform its regulatory function, the team evaluated the performance deficiency using traditional enforcement. In accordance with Section 2.1.3.E.6 of the NRC Enforcement Manual, the team evaluated this finding using the significance determination process to assess its significance. Using Inspection Manual Chapter 0609, Appendix A, "The Significance Determination Process for Findings At-Power," the finding was determined to have very low safety significance (Green) because it: (1) was not a deficiency affecting the design or qualification of a mitigating structure, system, or component, and did not result in a loss of operability or functionality; (2) did not represent a loss of system and/or function; (3) did not represent an actual loss of function of at least a single train for longer than its technical specification allowed outage time, or two separate safety systems out-of-service for longer than their technical specification allowed outage time; (4) did not represent an actual loss of function of one or more nontechnical specification trains of equipment designated as high safety-significance in accordance with the licensee's maintenance rule program; and (5) did not involve the loss or degradation of equipment or function specifically designed to mitigate a seismic, flooding, or severe weather event. Therefore, in accordance with Section 6.1.d.2 of the NRC Enforcement Policy, the team characterized this performance deficiency as a Severity Level IV violation. The team determined that a cross-cutting aspect was not applicable to this performance deficiency because the failure to adequately evaluate changes in accordance with 10 CFR 50.59 was strictly associated with a traditional enforcement violation (Section 4OA4.5).

REPORT DETAILS

4. OTHER ACTIVITIES

4OA4 IMC 0350 Inspection Activities (92702)

The inspection team continued the NRC Inspection Manual Chapter 0350 inspection activities, which included follow-up on the Restart Checklist contained in Confirmatory Action Letter (CAL) EA-13-020 issued February 26, 2013. The purpose of this inspection was to perform an assessment of the causes of the performance decline at the Fort Calhoun Station (FCS), to assess whether planned corrective actions are sufficient to address the root causes and contributing causes and to prevent their recurrence, and to verify that adequate qualitative or quantitative measures for determining the effectiveness of the corrective actions are in place. These assessments were used by the NRC to independently verify that plant personnel, equipment, and processes were ready to support the safe restart and continued safe operation of the Fort Calhoun Station that occurred in December of 2013.

The team used the criteria described in baseline and supplemental inspection procedures, various programmatic NRC inspection procedures, and Inspection Manual Chapter 0350 to assess Omaha Public Power District's (the licensee) performance and progress in implementing its performance improvement initiatives. The team performed on-site and in-office activities, which are described in more detail in the following sections of this report. This report covers inspection activities from July 8, 2013, through March 14, 2014. Specific documents reviewed during this inspection are listed in the attachment.

The following inspection scope, observations and findings, and assessments, are documented by Confirmatory Action Letter restart checklist (CL) item number.

1. Assessment of NRC Inspection Procedure 95003 Key Attributes

Section 5 of the restart checklist assessed the key attributes of NRC Inspection Procedure 95003. The key attributes are listed as separate subsections below. In addition, the NRC reviewed the effectiveness of licensee short term and long term corrective actions associated with these areas to ensure they were adequate to support sustained plant performance improvement.

Item 5.a: Design

(1) Inspection Scope

a. The team independently assessed the extent of risk significant design issues associated with the protection of multiple essential structures, systems, and components from tornado generated missiles. This review verified the capability of these structures, systems, and components to perform their intended functions with a sufficient margin of safety. The inspection focused on licensee controls for implementing changes to the facilities licensing and design basis. Information from

this inspection was used to assess the licensee's ability to maintain and operate the facility in accordance with the design basis. (CL Item 5.a.1)

The team's review included the following:

- Assessment of effectiveness of corrective actions for deficiencies involving tornado missile protection design requirements.

- Evaluation of the interfaces between engineering, plant operations, maintenance, and plant support groups while resolving tornado missile protection design deficiencies.

b. Open items (Licensee Event Reports), specifically related to the tornado missile issue, were reviewed by the team. The team verified the adequacy of the licensee's causal analysis and extent of condition evaluations. In addition, the team verified that adequate corrective actions were identified associated with the licensee's root and contributing causes and extent of condition evaluations, and that, implementation of these corrective actions are either implemented or appropriately scheduled for implementation.

(2) Observations

a. Tornado Missile Assessment

A previous NRC Team inspection, NRC Inspection Report 05000285-2013, noted that the licensee had identified several components that were not adequately provided tornado missile protection and placed these conditions in the site corrective action process for review. Condition Report CR 2013-03839 documented concerns that the control room air conditioning condensers and the steam driven auxiliary feedwater (AFW) pump exhaust were not adequately protected from tornado generated missiles. Condition Report CR 2013-03842 documented concerns that the emergency feedwater storage tank was not adequately protected from tornado generated missiles. The NRC noted that the licensee had performed inappropriate operability determinations for these condition reports that incorrectly concluded the components were operable based on engineering judgment that the missile impact probability for the components was low. The team determined the use of probabilities of occurrence of accidents or external events is not consistent with the design assumption that the event occurs, and is not acceptable for making operability decisions. The licensee, recognizing that these components were not meeting facility design requirements for tornado missile protection, conducted an extent of condition review and identified that a total population of 37 components were not appropriately protected.

This NRC inspection performed an in depth assessment of the facilities actions in resolving the tornado missile protection deficiencies.

Root Cause Assessment

The inspectors reviewed the licensee's root cause analysis and determined it was adequately performed. The licensee determined the root cause stemmed from organizational work practices that lacked technical rigor resulting in personnel incorrectly concluding that a probability methodology for tornado missile protection could be applied without obtaining a license amendment.

Extent of Condition

As previously discussed, following the licensee recognizing that multiple inadequately protected components existed they performed an extent of condition review. This review consisted of evaluating all systems, structures, and components at the facility and resulted in the licensee identifying a population of 37 inadequately missile protected components. The NRC determined the licensee's extent of condition review was thorough.

Operating Experience Review

The licensee identified multiple examples where both internal and external operating experiences were not effectively used to identify that equipment was not adequately being protected for tornado missile design requirements. These included similar examples identified at other facilities resulting in event reports being submitted to the NRC, and generic communications such as NRC Regulatory Issue Summary RIS 2008-14, "Use of TORMIS computer code for assessment of tornado missile protection." The inspectors determined the licensee did a thorough review of operating experience and noted that the site currently has improvement initiatives established to more effectively implement operating experience reviews.

Corrective Actions to Prevent Recurrence

The licensee developed a number of corrective actions to address the identified Root Cause that included:

- Performing a design bases reconstitution to identify and define the licensing and design bases to assure documentation remains current, accurate, complete, and retrievable,
- Conduct training with engineering personnel to address proper use of design and licensing bases information, and
- Strengthen the function of the oversight group that reviews documentation of 50.59 reviews, modifications, operability evaluations, and other documents developed that utilize design bases information.

The inspectors determined the licensee had adequately addressed corrective actions for the identified Root Cause.

Corrective Actions for Specific Components Not Adequately Protected from Missiles

The inspectors reviewed the licensee actions to address the 37 identified components that were not adequately protected from tornado missiles.

The inspectors noted that the licensee elected to change the facilities design and licensing basis and adopt the requirements of Regulatory Guide 1.76 (RG 1.76), "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1, as the method for restoring compliance. The licensee also began implementing temporary modifications to the facility to provide the required protection to systems and components. The modifications were designed to the standards specified in Regulatory Guide 1.76.

The licensee performed two separate 10 CFR 50.59 evaluations to incorporate the use of Regulatory Guide 1.76 into the facilities current licensing basis. The team, in consultation with the Office of Nuclear Reactor Regulation, determined that both of these evaluations were inappropriate and therefore did not support the use of Regulatory Guide 1.76 without prior NRC approval. This issue is discussed in detail in Section 4, "Findings" of this report and is documented as:

- NCV 05000285/2013017-05, "Failure to Obtain Prior NRC Approval for a Change in Method of Evaluation"

Following the determination that the 10 CFR 50.59 evaluations did not establish a basis to change the facilities current licensing basis without prior NRC approval, the licensee generated an operability evaluation to allow the use of Regulatory Guide 1.76. The team, in consultation with the Office of Nuclear Reactor Regulation, determined that this operability evaluation was not adequate. This issue is discussed in detail in Section 4, "Findings" of this report and is documented as:

- NCV 05000285/2013017-03, "Failure to Follow Operability Procedure"

During the NRC reviews of the licensee's 50.59 and operability evaluations the support from NRC headquarters experts was obtained. The NRC's determination that the licensee's 10 CFR 50.59 evaluations and the subsequent operability determination did not support the use of Regulatory Guide 1.76 without prior NRC approval was documented as Task Interface Agreement 2013-07, "Task Interface Agreement – Concurrence on Fort Calhoun Tornado Missile Protection Licensing Basis (TIA 2013-07)." This document is provided as Attachment 2 of this report.

The licensee subsequently submitted an exigent amendment request to incorporate the use of Regulatory Guide 1.76 into the facilities design and licensing basis. This exigent amendment request was reviewed and approved by the NRC on July 26, 2013.

The team reviewed the temporary modifications being implemented by the licensee to protect the identified equipment pending final resolution of the identified

vulnerabilities. During these reviews the team determined that one of the modifications did not provide the required protection. Additionally, the team determined that the subsequent operability determination for the temporary modification did not establish a technically sound basis for operability. These issues are discussed in detail in Section 4, "Findings" of this report and are documented as:

- NCV 05000285/2013017-04, "Inadequate Temporary Modification to Protect Against Tornado Generated Missiles"

- NCV 05000285/2013017-03, "Failure to Follow Operability Procedure"

b. The NRC reviewed the licensee's causal analyses, corrective actions, and extent of condition associated with Licensee Event Reports 2013-005-1, "Control Room HVAC Modification Not Properly Evaluated," and 2013-009, "Tornado Missile Vulnerabilities." In addition, the team verified that adequate corrective actions were identified associated with the causes and extent of condition evaluations and that implementation of these corrective actions were either implemented or appropriately scheduled for implementation.

(3) Assessment

a. The NRC reviewed the licensee's extent of condition results and performed an independent assessment to validate that all potentially susceptible components had been identified. Based on these reviews, the team determined that the licensee had adequately identified all susceptible components in their extent of condition review. The team also reviewed the modifications installed by the licensee and concluded that, for the most part, the modifications were adequate. However, the team identified that the temporary modification installed for the raw water pump pull boxes was inadequate. The licensee captured this in the corrective action program and redesigned the installed temporary modification so that it provided adequate protection.

The inspectors concluded that the licensee continues to demonstrate weaknesses associated with implementation of 10 CFR 50.59, and with the application of the operability determination process. The team noted that these areas are being addressed by the licensee under long term corrective actions that will be reviewed by the NRC during future inspections.

b. Licensee Event Reports 2013-005-1, "Control Room HVAC Modification Not Properly Evaluated," and 2013-009, "Tornado Missile Vulnerabilities," is closed.

(4) Findings

(1) Failure to Ensure Tornado Missile Protection for Site Components

Introduction. The team identified multiple examples of a White violation of 10 CFR Part 50, Appendix B, Criterion III, "Design Control," associated with the licensee's failure to fully incorporate applicable tornado missile protection design

requirements for components needed to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition.

Description. During the extended shutdown and associated recovery activities the licensee contracted a vendor to perform a design evaluation of the auxiliary feedwater system. The vendor's assessment, as well as the licensee's responses to the concerns identified by the assessment, was documented in Condition Report CR 2012-4470.

During the team's review of the vendor's assessment they noted that the vendor had identified concerns with regard to tornado missile protection. Specifically, the vendor questioned whether the auxiliary feedwater components in Room 81 had been analyzed to show protection from tornado generated missiles with respect to plastic blowout panels in the roof, and whether the exhaust stack for the turbine driven auxiliary feedwater (AFW) Pump FW-10 was adequately protected for tornado missiles. The licensee's responses to the vendor's questions were documented in Attachment 3, "Self-Assessment Findings and Observation Matrix," of the vendor's report. For the auxiliary feedwater components in Room 81, the licensee described its basis for not requiring tornado missile protection to be the reliance upon probabilistic evaluations contained in the station's Individual Plant Examination of External Events (IPEEE), and for the exhaust stack for the turbine driven auxiliary feedwater pump, the licensee cited Station Calculation FC06081, "Tornado Missile Hazard for FW-10 Auxiliary Feed Pump Turbine Exhaust." Both of these responses were based on the low probability of a missile impacting the components of interest.

The team questioned the licensee's basis for not requiring tornado missile protection for the identified components. The team reviewed the facilities Updated Safety Analysis Report and noted that Appendix G specified that the licensee complied with Draft General Design Criteria GDC-2, published July 11, 1967. Draft General Design Criteria GDC-2 requires that the systems and components needed for accident mitigation remain fully functional before, during, and after a tornado event. The team reviewed Section 5.8.2 of the Updated Safety Analysis Report, which describes that design basis for tornado generated missiles was for protection of the facility during a severe accident and to ensure safe shutdown and isolation of the reactor. Finally, Section 5.11 of the Updated Safety Analysis Report describes that Class 1 structures were also designed to withstand the spectrum of tornado generated missiles, listed in Section 5.8.2.2. Based on this information the team determined that the Updated Safety Analysis Report did not incorporate probabilistic methodologies as part of the licensing basis for the Fort Calhoun Station.

The team reviewed the pertinent sections of the station's IPEEE and Calculation EA06-006. The team determined that the station's IPEEE had been performed in accordance with Generic Letter 88-20, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," Supplement 4. The IPEEE was a probabilistic evaluation with a stated purpose of:

- developing an appreciation of severe accident behavior;

- understanding the most likely severe accident sequences that could occur at the plant under full power operating conditions;

- gaining a qualitative understanding of the overall likelihood of core damage and radioactive material release; and

- reducing, if necessary, the overall likelihood of core damage and radioactive material release by modifying hardware and procedures that would help prevent or mitigate severe accidents.

Based on the licensee's stated purpose, the team determined that the IPEEE was to be used as a tool for systematically searching for and identifying vulnerabilities associated with external events. These vulnerabilities were to be reviewed to determine whether changes were needed to be made to the facility. Therefore, the team determined that the licensee's use of the station's IPEEE as a basis for not protecting components in Room 81 was not appropriate. The team noted that a similar issue had been evaluated under Task Interface Agreement 2011-011, "Final - Task Interface Agreement (TIA) – Evaluation of Point Beach Nuclear Plant Tornado Missile Protection Licensing Basis (TIA 2011-011)," dated August 16, 2011, (ML11228A257). It had been determined that non-licensing basis documentation, and judgments of low probability to demonstrate compliance with the licensing basis, are not acceptable without submitting the respective material for NRC staff review and inclusion in the Updated Safety Analysis Report.

With respect to Station Calculation FC06081, the team determined that this calculation had been developed using non-licensing basis information and used probabilistic methodologies. Specifically, the licensee used information from NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," and Regulatory Guide 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1, to deviate from the station's licensing basis for tornado wind speed and postulated missiles. This information was then used to develop the probability of a missile striking the exhaust stack of the turbine driven auxiliary feedwater pump.

The team noted that Regulatory Issue Summary (RIS) 2008-14, "Use of Tormis Computer Code for Assessment of Tornado Missile Protection," (ML080230578) contained information that was applicable to this issue. The team determined that while the main focus of this regulatory issue summary dealt with the use of TORMIS, the section titled, "Other Ways of Addressing Tornado Missile Protection," was applicable to the turbine driven auxiliary feedwater pump issue. Specifically, this section specified that TORMIS was not a risk informed approach, but goes on to state:

> A licensee may submit a license amendment application proposing other means for modifying the current licensing basis for tornado missile protection. Such an application could utilize a risk-informed change process consistent with the guidelines of Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decision on Plant-Specific

Changes to the Licensing Basis." Likewise, a licensee can submit a license amendment to revise plant technical specifications, associated with tornado missile features, in accordance with Regulatory Guide 1.177, "An Approach for Plant-Specific Risk-Informed Decision Making: Technical Specifications," issued August 1998. If a risk-informed process was proposed, it would have to meet the five key principles of risk informed regulation called out in Regulatory Guide 1.174, including the need for possible exemptions to the regulations or GDC requirements. Sufficient probabilistic risk assessment quality with respect to modeling of tornado initiators would have to be demonstrated. A topical report consistent with the above guidelines could be submitted for NRC staff review.

Based on this, the team determined that the licensee had not received a license amendment to use the probabilistic methodology employed in Station Calculation FC06081. Therefore, the team concluded that the use of non-licensing basis documentation, and judgments of low probability to demonstrate compliance with the licensing basis, were not acceptable without submitting this material for NRC staff review and approval.

The team informed the licensee of its concerns and the licensee initiated Condition Reports CR 2013-03839, 2013-03842, 2013-14117, and 2013-14246 to address these issues.

Subsequent extent of condition reviews by the licensee identified additional components that were inadequately tornado missile protected. Specifically, 37-unprotected components were identified. They identified components included emergency diesel generator fuel oil supplies, auxiliary feedwater pumps, raw water system cabling and components, the intake structure sluice gates, the main steam relief valve stacks, control room HVAC condensers, the boric acid storage tank, and the emergency feedwater storage tank.

The licensee applied for an exigent license amendment and implemented facility modifications to protect the identified components.

Analysis. The licensee's failure to ensure that station components were adequately protected from tornado missiles was a performance deficiency. In accordance with NRC Inspection Manual Chapter 0612, Appendix B, "Issue Screening," the performance deficiency was determined to be more than minor because it was associated with the design control attribute of the Mitigating Systems Cornerstone, and affected the associated cornerstone objective to ensure availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Specifically, the performance deficiency affected the reliability of multiple systems following a postulated tornado-generated missile impact. The team evaluated the finding using Inspection Manual Chapter (IMC) 0609, Appendix A, "The Significance Determination Process (SDP) For Findings at Power," Exhibit 4, "External Events Screening Questions." The finding required a detailed risk evaluation because it involved the lack of equipment specifically designed to mitigate

a severe weather initiating event (tornado), and could have degraded two or more trains of a multi-train system.

The Region IV senior reactor analyst made the following influential assumptions in assessing the risk of the subject performance deficiency:

- Selection of Tornado Hazard
- Use of Missile Impact Parameter Method
- Population of Potential Missiles
- Selection of Tornado Intensity
- Loss of Offsite Power
- Failure of Condensate Storage Tank
- Selection of Relative Target Size

There were three dominant accident sequence cutsets associated with this performance deficiency. All involved a non-recoverable loss of offsite power. In order of significance, these sequences are:

1. Loss of all auxiliary feedwater and failure of once-through cooling;

2. Loss of the emergency power system with failure to recover a diesel generator prior to battery depletion; and

3. Loss of Diesel Generator 1 from tornado missile impact and random loss of Diesel Generator 2 with failure to recover prior to battery depletion.

The total change in core damage frequency is 2.6×10^{-6} (WHITE).

This finding did not involve a significant increase in the risk of a large, early release of radiation, because Fort Calhoun Station has a large, dry containment. The significance of this finding is considered to be core damage frequency-dominant.

The detailed risk evaluation is documented in Attachment 3 to this inspection report.

The finding has a cross-cutting aspect in the area of problem identification and resolution associated with the corrective action program component because the licensee failed to thoroughly evaluate problems such that the resolutions address the causes [P.1(c)].

Enforcement. Title 10 CFR Part 50, Appendix B, Criterion III, “Design Control,” states, in part, that, “measures shall be established to assure that applicable regulatory requirements and the design bases, as defined in 10 CFR 50.2 and as specified in the license application, for those components to which this appendix applies, are correctly translated into specifications, drawings, procedures, and instructions.” Contrary to the above, from initial construction through July 2013, measures established by the licensee failed to assure that applicable regulatory requirements and the design bases, as defined in 10 CFR 50.2 and as specified in

the license application, for those components to which this appendix applies, were correctly translated into specifications, drawings, procedures, and instructions. Specifically, the licensee failed to fully incorporate applicable tornado missile protection design requirements for components needed to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition. The licensee addressed this deficiency by implementing plant modifications that protected the affected equipment from tornado generated missiles. This finding is associated with a Notice of Violation attached to this report: VIO 05000285/2013017-01, "Failure to Ensure Tornado Missile Protection for Site Components."

(2) Failure to Promptly Identify and Correct a Condition Adverse to Quality

Introduction. The team identified a non-cited violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Actions," associated with the licensee's failure to promptly identify and correct a condition adverse to quality associated with Class I structures.

Description. During the team's review of the station's USAR, they determined that USAR, Section 5.11, required that the facilities Class I structures be designed to withstand the spectrum of tornado generated missiles, the most critical of which, is a pipe, 3 inches in diameter and 10 feet long, moving at a velocity of 640 feet per second. The team determined that the licensing basis approved methodology for determining the required concrete wall thickness of Class I structures to show protection for tornado generated missiles was NavDocs P-51, "Design of Protective Structures," dated August 1950.

Station Calculation FC07012, "External Missiles Due to Tornado Winds and Turbine Generator Overspeed," Revision 0, dated August 2005, was generated to evaluate Class I structures' ability to withstand missiles. The team reviewed Station Calculation FC07012 and noted that the analysis established that the Class I structure wall thickness was required to be 2.42 feet thick to show protection from a projectile moving at 640 feet per second based on the licensing basis methodology. However, the analysis went on to state that the wall thickness of the Auxiliary Building ranges from 1.5 feet to 2 feet thick, and the wall thickness of the Intake Structure below 1007 feet 6 inches is 2 feet to 2 feet 10 inches (some of the Intake Structural wall below 1007 feet 6 inches is exposed above grade and subject to tornado missiles). The calculation identified that this was a nonconformance and was in conflict with the requirements derived from the licensing basis detailed in the facilities Updated Safety Analysis Report. However, the calculation went on to state that the auxiliary building walls were sufficient at 1.5 feet thick when evaluated against other acceptance criteria, an example of which was NUREG CR-4461, "Tornado Climatology of the Contiguous United States Pacific Northwest National Laboratory," Revision 1.

The team determined that the licensee had identified a condition adverse to quality, in that, the facility was not adequately protected from tornado generated missiles as described in the Updated Safety Analysis Report, Section 5.11. However, the

licensee did not enter this issue into the corrective action program for evaluation and resolution. Instead, the licensee used alternate acceptance criteria that were not part of the licensing basis. Based on this, the team determined that the licensee had failed to promptly identify and correct a condition adverse to quality.

The team informed the licensee of their concerns and the licensee initiated Condition Report CR 2013-14363 to capture this issue in its corrective action program.

Analysis. The licensee's failure to promptly identify and correct conditions adverse to quality was a performance deficiency. This performance deficiency is more than minor, and therefore a finding, because it is associated with the design control attribute of the Mitigating Systems Cornerstone, and affected the cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Using Inspection Manual Chapter 0609, Appendix A, "The Significance Determination Process for Findings at Power," the finding is determined to have very low safety significance (Green) because it: (1) was not a deficiency affecting the design or qualification of a mitigating structure, system, or component, and did not result in a loss of operability or functionality; (2) did not represent a loss of system and/or function; (3) did not represent an actual loss of function of at least a single train for longer than its technical specification allowed outage time, or two separate safety systems out-of-service for longer than their technical specification allowed outage time; (4) did not represent an actual loss of function of one or more nontechnical specification trains of equipment designated as high safety-significance in accordance with the licensee's maintenance rule program; and (5) did not involve the loss or degradation of equipment or function specifically designed to mitigate a seismic, flooding, or severe weather event. The team determined that although this finding occurred more than three years ago, this finding is representative of current plant performance. Therefore, this finding has a cross-cutting aspect in the area of human performance associated with the decision-making component, because the licensee failed to use conservative assumptions in decision-making and adopt a requirement to demonstrate that the proposed action is safe in order to proceed rather than a requirement to demonstrate it is unsafe in order to disapprove the action [H.1(b)].

Enforcement. 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Actions," requires, in part, that measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformance's are promptly identified and corrected. Contrary to the above, from August 2005 to July 15, 2013, measures established by the licensee failed to assure that an identified condition adverse to quality was corrected. Specifically, the licensee failed to promptly identify and correct inadequate Class 1 structures wall thickness deficiencies to protect systems and components contained within from tornado generated missiles. The licensee resolved this issue through the licensing amendment process. Because the finding was of very low safety significance (Green) and has been entered into the corrective action program as Condition Report CR 2013-14363, this violation is being treated as a non-cited violation consistent with Section 2.3.2.a of the NRC Enforcement Policy:

NCV 05000285/2013017-02, “Failure to Promptly Identify and Correct a Condition Adverse to Quality”.

(3) Failure to Follow Operability Procedure

Introduction. The inspectors identified two examples of a non-cited violation of 10 CFR Part 50, Appendix B, Criterion V, “Instructions, Procedures, and Drawings,” associated with the licensee’s failure to follow Station Procedure NOD-QP-31, “Operability Determination Process,” for evaluating tornado missile protection deficiencies.

Description. In each of the following examples, the team identified that the operability determination lacked adequate technical justification for why the item was operable with the degraded or nonconforming condition.

Example 1:

Condition Report CR 2013-13955 documented that the temporary barriers installed to protect raw water pump pull boxes PB-128T and PB-129T from tornado generated missiles was not adequate. Specifically, a gap at the top of the barrier could allow a missile to damage the pull boxes which could prevent the pumps from performing their specified safety function. The immediate operability determination for this condition report did not provide an adequate technical basis for concluding that these pull boxes would remain operable for the identified condition. The licensee’s operability determination failed to adequately address the lack of protection from tornado generated missiles. This issue was entered into the corrective action program as Condition Report CR 2013-14006.

Example 2:

The operability evaluation NOD-QP-31.1-2013-14363, documented in Condition Report CR 2013-14363, did not demonstrate compliance with the current licensing basis. Specifically, the licensee evaluated the station’s systems and components that were needed to support Mode 4 and Mode 5 operations with respect to tornado generated missiles against the requirements contained in Regulatory Guide (RG 1.76) 1.76, “Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants,” Revision 1. This standard was not part of the facilities current licensing basis and relaxed current licensing basis requirements contained in the Updated Safety Analysis Report with respect to tornado generated missiles. After consultation with the Office of Nuclear Reactor Regulation, the team determined that this operability determination did not provide an adequate technical basis for concluding that these structures would remain operable following a tornado generated missile impact. The NRC’s review of this evaluation is contained in Attachment 2 of this letter. This issue was entered into the corrective action program as Condition Report CR 2013-15429.

The team determined that for each of the above examples, the operability determination lacked adequate technical justification for why the structure, system, or component was operable with respect to the identified degraded or nonconforming condition. The team noted that Station Procedure NOD-QP-31, "Operability Determination Process," Step 4.3.15, required, in part, that, "A positive determination of operability must be justified, including…a technical discussion of why the concern identified does not prevent the item from fulfilling its intended safety function(s). This should demonstrate that the item is not exceeding its design basis specified in the reference documents."

Analysis. The failure to properly assess and document the basis for operability when a degraded or nonconforming condition was identified was a performance deficiency. This performance deficiency is more than minor, and therefore a finding, because it is associated with the equipment performance attribute of the Mitigating Systems Cornerstone, and affected the cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Since the finding involving inadequate operability determinations occurred while in a shutdown condition, the team used Manual Chapter 0609, Appendix G, "Shutdown Operations Significance Determination Process," and determined the finding to have very low safety significance (Green) because the finding did not increase the likelihood of a loss of reactor coolant system inventory, the finding did not degrade the licensee's ability to terminate a leak path or add reactor coolant system inventory when needed, and the finding did not degrade the licensee's ability to recover decay heat removal once it was lost. This finding has a cross-cutting aspect in the area of human performance associated with the decision-making component because the licensee failed to use conservative assumptions in decision making when performing operability determinations [H.1(b)].

Enforcement. 10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures and Drawings," requires, in part, that activities affecting quality shall be prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Station Procedure NOD-QP-31, "Operability Determination Process," a procedure that is appropriate to the circumstances of evaluating the operability of safety-related components, Step 4.3.15, required the licensee to properly assess and document the basis for operability when a degraded or nonconforming condition is identified. Contrary to the above, on July 8, and July 15, 2013, the licensee failed to complete activities affecting quality in accordance with prescribed procedures. The licensee addressed these issues by taking corrective actions that provided adequate tornado missile protection in accordance with design basis requirements. Because the finding was of very low safety significance (Green) and has been entered into the corrective action program as Condition Reports CR 2013-15429 and 2013-14006, this violation is being treated as a non-cited violation consistent with Section 2.3.2.a of the NRC Enforcement Policy: NCV 05000285/2013017-03, "Failure to Follow Operability Procedure."

(4) Inadequate Temporary Modification to Protect Against Tornado Generated Missiles

Introduction. The team identified a non-cited violation of 10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," associated with the licensee's failure provide adequate instructions or procedures for the construction of temporary barriers to protect raw water pump electrical pull boxes PB-128T and PB-129T from tornado generated missiles associated with temporary modification EC 60183.

Description. While performing walk downs of the facility to inspect modifications being implemented to address issues identified with tornado missile protection, the team inspected the temporary barriers constructed to protect raw water pump electrical pull boxes PB-128T and PB-129T. During this inspection, the team noted that a gap existed at the top of the barrier which could allow a tornado generated missile to damage the pull boxes.

The team subsequently reviewed temporary modification package EC 60183 and determined that it did not provide sufficient guidance to ensure that there were no gaps/openings which would allow missiles to impact the pull boxes. The team informed the licensee of this concern. The licensee reviewed this issue, and stated that the cabling in the pull box was located at the bottom and if a missile were to impact the box it would not damage the cabling and the pumps would not be affected.

The team questioned the licensee's response and asked the licensee to verify this configuration. Subsequently, the licensee determined that the cables were not configured as previously stated, and therefore, the barriers would not protect the pull boxes as intended. The licensee initiated Condition Report CR 2013-13955 to capture this issue in the station's corrective action program for resolution.

Analysis. The failure to provide adequate instructions for construction of temporary barriers to protect the raw water pump electrical pull boxes from tornado generated missiles was a performance deficiency. This performance deficiency is more than minor, and therefore a finding, because it is associated with the equipment performance attribute of the Mitigating Systems Cornerstone, and affected the cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Since the finding occurred while in a shutdown condition, the team used Manual Chapter 0609, Appendix G, "Shutdown Operations Significance Determination Process," and determined the finding to have very low safety significance (Green) because the finding did not increase the likelihood of a loss of reactor coolant system inventory, the finding did not degrade the licensee's ability to terminate a leak path or add reactor coolant system inventory when needed, and the finding did not degrade the licensee's ability to recover decay heat removal once it was lost. This finding has a cross-cutting aspect in the area of human performance associated with the work practices component because the licensee failed to ensure supervisory and

management oversight of work activities, including contractors, such that nuclear safety was supported [H.4(c)].

Enforcement. 10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," requires, in part, that activities affecting quality shall be prescribed by documented instructions, procedures, or drawings, of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Contrary to the above, from April 27 through July 8, 2013, the licensee failed to adequately prescribe documented instructions or procedures for activities affecting quality. Specifically, the licensee failed to provide adequate instructions or procedures to ensure proper construction of temporary barriers to protect the raw water pump electrical pull boxes from tornado generated missiles. The licensee addressed this issue by modifying the temporary barriers. Because the finding was of very low safety significance (Green) and has been entered into the corrective action program as Condition Report CR 2013-13955, this violation is being treated as a non-cited violation, consistent with Section 2.3.2.a of the NRC Enforcement Policy: NCV 05000285/2013017-04, "Inadequate Temporary Modification to Protect Against Tornado Generated Missiles."

(5) Failure to Obtain Prior NRC Approval for a Change in Method of Evaluation

Introduction. The team identified a Severity Level IV, non-cited violation of 10 CFR 50.59, "Changes, Test, and Experiments," associated with the licensee's failure to adequately evaluate changes to determine if prior NRC approval is required.

Description. The team identified the following examples of inadequate 10 CFR 50.59 evaluations performed by the licensee.

Example 1: While reviewing the Updated Safety Analysis Report, the team noted that Updated Safety Analysis Report, Section 5.8.2, described the specific requirements for tornado missile protection for the facility. While reviewing Sections 5.8.2, "External Missiles," the team noted that this section had incorporated probabilistic requirements for tornado missile protection. Specifically, it stated:

> 5.8.2.2, "Tornado Generated Missiles," states, in part, no tornado missile protection is provided for the control room air conditioning condensers (Section 9.10) and the AFW pump turbine exhaust, due to the low probability of tornado missile damage.

Upon review of Section 9.10, "Heating, Ventilating and Air Conditioning Systems," the team noted it too incorporated probabilistic requirements for tornado missile protection. Specifically, it stated:

> Section 9.10.1, "Design Bases," states, in part, the air cooled condensers located on the auxiliary building roof for the refrigeration units are protected from 360 mph tornado winds. Standard Review Plan (SRP), Section 2.2.3, was used to design the air cooled condensers windscreen. The SRP criteria was

met, therefore, no tornado missile shielding for the air cooled condensers is required. (Reference Station Calculation FC06375)

The team questioned the licensee's use of probabilistic methodologies and the reference to the use of the Standard Review Plan.

The team reviewed the licensee's original licensing basis documented in the Safety Evaluation Report, dated August 9, 1972. Through this review, the team determined that Fort Calhoun Station was designed and licensed using a deterministic methodology associated with tornado missile protection. Based on this, the team questioned by what method the licensee had incorporated these changes into the current licensing basis.

During discussions with the licensee, the team determined that the licensee had used NUREG 0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," as the basis for using a probabilistic approach for determining if tornado missile protection was required based on impact probabilities. The licensee indicated that they understood that NUREG 0800 constituted guidance from the NRC, which allowed the option for a licensee to choose which methodology was to be used for assessing tornado missile protection requirements.

The licensee indicated that based on this understanding they had generated Calculations FC06375, "Calculation of Tornado Strike for FCS Control Room HVAC Air Condensers," Revision 0, and EA06-006, "Tornado Design/Licensing Basis," Revision 1, to establish the probabilistic basis for the control room air conditioning condensers and the auxiliary feedwater pump turbine exhaust to not require tornado missile protection. Subsequently, the licensee used 10 CFR 50.59 to change the licensing basis to incorporate this probabilistic methodology. The licensee's evaluations determined that the use of a probabilistic evaluation did not require prior NRC approval. The NRC has stated by memorandum dated November 7, 1983, (ML080870278) and in Task Interface Agreement (TIA) Response dated August 16, 2011, (ML11228A257) that licensee's may use probabilistic analysis for tornado missile evaluations. However, these documents further state that the use of this methodology requires prior NRC approval.

The team questioned the licensee's determination that this modification did not require prior NRC approval. Specifically, the team determined that the licensee had inappropriately interpreted the information contained in NUREG 0800 as being generically applicable to Fort Calhoun Station without prior approval. Specifically, the original licensing basis had used a deterministic methodology and the change incorporated by the licensee was to use probabilistic methodology.

Based on this, the team determined that the licensee's use of a probabilistic evaluation methodology constituted a departure from a method of evaluation described in the Updated Safety Analysis Report used in establishing the design bases or in the safety analyses.

The licensee entered this issue into the corrective action program as Condition Reports CR 2013-03839, 2013-04266, and 2013-05210.

Example 2: The station's Updated Safety Analysis Report states that the Fort Calhoun Station is committed to complying with Draft General Design Criteria (GDC) 2, published July 11, 1967, which required that the systems and components needed for accident mitigation remain fully functional before, during, and after a tornado event. Updated Safety Analysis Report, Section 5.8.2.2, "Tornado Generated Missiles," identified that the design basis tornado wind speed was 500 miles per hour which resulted in the most critical projectile being a 3 inch diameter, 10 feet long pipe moving at a velocity of 640 feet per second.

Following identification of the inadequately protected equipment identified in VIO 2013017-01, "Failure to Ensure Tornado Missile Protection for Site Components," the licensee elected to change the facilities design and licensing basis and adopt the requirements of Regulatory Guide 1.76 (RG 1.76), "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1, as the method for restoring compliance with Draft General Design Criteria (GDC) 2 relative to tornado generated missiles.

On June 27, 2013, the licensee approved a 10 CFR 50.59 evaluation as part of EC 60974, "Tornado Missile Protection Methodology Change," Revision 0, as the means of adopting Regulatory Guide 1.76. In this evaluation, the licensee determined that the information contained in Regulatory Guide 1.76 constituted a new method of evaluation, and went on to identify that this method had been previously reviewed and approved for use at another facility via a safety evaluation report. Based on this, the licensee determined that Regulatory Guide 1.76 could be implemented without prior NRC approval.

The team, in consultation with the Office of Nuclear Reactor Regulation, reviewed the licensee's evaluation. Through this review it was concluded that Regulatory Guide 1.76 was not a method of evaluation, rather it was an element of a method of evaluation. Therefore, the information contained in Regulatory Guide 1.76, when used in an NRC approved method of evaluation, should demonstrate that the facilities design basis requirements would be met. Based on this, the staff determined that the licensee's evaluation failed to properly address the requirements of 10 CFR 50.59(a)(2)(i) and the guidance contained in NEI 96-07, "Guidelines For 10 CFR 50.59 Implementation," dated November 2000, Sections 3.8 and 4.3.8.1. In general, licensees can make changes to elements of a methodology without first obtaining a license amendment if the results are essentially the same as, or more conservative than, previous results. In this example the licensee proposed to use a tornado wind speed, referenced in Regulatory Guide 1.76, as a design input that was less than the wind speed described in the CLB. Based on this, the NRC cannot determine whether or not the change results are essentially the same, or more conservative than, previous results using the CLB wind speed. The licensee entered

this issue into the corrective action program as Condition Report CR 2013-14363. The NRC's review of this evaluation is contained in Attachment 2 of this letter.

Example 3: On July 12, 2013, the licensee approved a 10 CFR 50.59 evaluation as part of EC 61354, "VA-71A & B Battery Room Ventilation Tornado Missile Protection," Revision 0. In this evaluation, the licensee took the position that while Draft GDC 2 stated that licensee's would protect systems and components, the station's response documented in both Appendix G to the USAR, and to NRC questions, stated that only structures would resist the forces of tornados and tornado missiles. Therefore, the licensee concluded that the adoption of the requirement to protect systems and components constituted a new method of evaluation, and in adopting this method, the station did not require prior NRC approval. The licensee also concluded that with the adoption of this new method of evaluation and the modifications being made to the facility they included:

- Creation of Calculation EA 130-014, "Tornado Safe Shutdown Analysis," Revision 0, to provide mode specific target selection criteria to support the expansion of design and performance requirements to additional structures, systems, and components

- Adoption of RG 1.76, to provide the methodology to select the tornado winds and tornado missiles and their velocities, and in what directions to apply them, in a manner that is approved by the NRC

- Adoption of Bechtel Topical Report BC-TOP-9A, "Design of Structures for Missile Impacts," Revision 2, to provide an approved methodology for evaluating the effect of missiles on concrete and steel barriers

- Use of NUREG 800, Section 3.5.3, Revision 3, to provide the acceptance criteria necessary to meet the relevant requirements of GDC 2, which have been shown by review to be similar enough to the Draft GDC 2 to be acceptable

The team, in consultation with the Office of Nuclear Reactor Regulation, reviewed the licensee's evaluation. Through this review the staff concluded the following:

- The licensee's determination that Draft GDC 2 does not apply to the facilities systems and components was not correct and was unsupported by the criterion's wording. Specifically, Draft GDC 2 required the protection of systems and components, and the licensee's Final Safety Analysis Report/Update Safety Analysis Report stated that Draft GDC 2 is met, and then described some of the structures used to protect systems and components. Based on this, the staff concluded that the means of protecting many of the systems and components essential to the prevention of accidents was the use of structures, but the protection of such systems and components is still a requirement of the criterion and was not limited to the structures. Therefore, the staff determined that the facilities current licensing

basis required the protection of systems and components and the licensee's position that this was a new method of evaluation was incorrect.

- The staff determined that calculation EA 13-014 constituted a method of evaluation, and this method was not included in the Final Safety Analysis Report/Updated Safety Analysis Report. Therefore, this method was required to be evaluated using 10 CFR 50.59.

- As previously expressed, RG 1.76 is an element of a method of evaluation, and the licensee's current evaluation does not address the requirements of 10 CFR 50.59(a)(2)(i) and the guidance contained in NEI 96-07, Sections 3.8 and 4.3.8.1, with respect to determining whether this change yields results that are conservative or essentially the same as the current licensing basis.

- The staff noted that Topical Report BC-TOP-9A, Revision 2, is an approved methodology by the AEC that provides general procedures and criteria for the design of structures and components against the effects of missiles. However, the staffs noted that in approving the Topical Report methodology, the AEC stated that this methodology could be used in future instances provided that input parameters to the methodology are reviewed and approved by the staff, and are included in the facilities Safety Analysis Report. Therefore, the staff determined that the licensee's evaluation did not meet the requirements of 10 CFR 50.59(a)(2)(ii) and the guidance in NEI 96-07, Section 4.3.8.2, which requires licensee's to evaluate new methodologies and document in the 10 CFR 50.59 evaluation the basis for determining that a method is appropriate and approved for the intended application.

- NUREG 0800, Section 3.5.3, Revision 3, does not provide an approved methodology for licensee's to reference or use in the context of 10 CFR 50.59 (NUREG 0800 does not have a Safety Evaluation Report associated with it). Therefore, the staff determined that the use of NUREG 0800 to substitute acceptance criteria other than that documented in the Updated Safety Analysis Report was not appropriate.

Based on the above the team determined that this was an inadequate evaluation and the changes proposed by the licensee required prior NRC approval. The NRC's review of this evaluation is contained in Attachment 2 of this letter. The licensee entered this issue into the corrective action program as Condition Report CR 2013-14665.

Analysis. The licensee's failure to implement the requirements of 10 CFR 50.59 and adequately evaluate changes to requirements for tornado missile protection described in the USAR was a performance deficiency. Because this performance deficiency had the potential to impact the NRC's ability to perform its regulatory function, the team evaluated the performance deficiency using traditional enforcement. In accordance with Section 2.1.3.E.6 of the NRC Enforcement Manual

the team evaluated this finding using the significance determination process to assess its significance. Using Inspection Manual Chapter 0609, Appendix A, "The Significance Determination Process for Findings At-Power," the finding is determined to have very low safety significance (Green) because it: (1) was not a deficiency affecting the design or qualification of a mitigating structure, system, or component, and did not result in a loss of operability or functionality; (2) did not represent a loss of system and/or function; (3) did not represent an actual loss of function of at least a single train for longer than its technical specification allowed outage time, or two separate safety systems out-of-service for longer than their technical specification allowed outage time; (4) did not represent an actual loss of function of one or more nontechnical specification trains of equipment designated as high safety-significance in accordance with the licensee's maintenance rule program; and (5) did not involve the loss or degradation of equipment or function specifically designed to mitigate a seismic, flooding, or severe weather event. Therefore, in accordance with Section 6.1.d.2 of the NRC Enforcement Policy, the team characterized this performance deficiency as a Severity Level IV violation. The team determined that a cross-cutting aspect was not applicable to this performance deficiency because the failure to adequately evaluate changes in accordance with 10 CFR 50.59 was strictly associated with a traditional enforcement violation.

Enforcement. Title 10 CFR 50.59, "Changes, Tests, and Experiments," Section (c)(1) states, in part, that a licensee may make changes in the facility as described in the Updated Safety Analysis Report without obtaining a license amendment pursuant to 10 CFR 50.90 only if: (i) a change to the technical specifications incorporated in the license is not required, and (ii) the change, test, or experiment does not meet any of the criteria in paragraph (c)(2). Title 10 CFR 50.59, Section (c)(2) states, in part, that a licensee shall obtain a license amendment pursuant to Section 50.90 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would have resulted in a departure from a method of evaluation described in the USAR used in establishing the design bases or in the safety analyses. Contrary to the above, from April 19, 2011, through August 17, 2013, on June 27, 2013, and July 12, 2013, the licensee failed to obtain a license amendment pursuant to Section 50.90 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would result in a departure from a method of evaluation described in the Updated Safety Analysis Report. The licensee addressed these issues by submitting a license amendment which was reviewed and approved by the NRC. Because this violation was entered into the corrective action program as Condition Reports CR 2013-03839, 2013-04266, 2013-05210, 2013-14363, and 2013-14665, to ensure compliance was restored in a reasonable amount of time, and the violation was not repetitive or willful, this Severity Level IV violation is being treated as a non-cited violation, consistent with Section 2.3.2.a of the Enforcement Policy:
NCV 05000285/2013017-05, "Failure to Obtain Prior NRC Approval for a Change in Method of Evaluation."

4OA6 Meetings, Including Exit

Exit Meeting Summary

On September 5, 2013, the team conducted an inspection debrief with Mr. Louis P. Cortopassi, Vice President and Chief Nuclear Officer, and other members of the licensee staff. The licensee acknowledged the issues presented. The team asked the licensee whether any materials examined during the inspection should be considered proprietary.

On October 25, 2013, the team conducted an inspection debrief with Mr. Louis P. Cortopassi, Vice President and Chief Nuclear Officer, and other members of the licensee staff. The licensee acknowledged the issues presented. The team asked the licensee whether any materials examined during the inspection should be considered proprietary.

On March 13, 2014, the team presented the inspection results to Mr. Louis P. Cortopassi, Site Vice President and Chief Nuclear Officer, and other members of the licensee staff. The licensee acknowledged the issues presented. The team asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel

J. Adams, Principle Engineer Design Engineering (Retired Supplemental Worker)
L. Cortopassi, Site Vice President
M. Frans, Manager, Engineering Programs
M. Greeno, NRC Inspection Readiness Team Contractor
W. Hansher, Supervisor, Nuclear Licensing
R. Haug, Senior Consultant
K. Ihnen, Manager, Manager, Site Nuclear Oversight
R. Hugenroth, Supervisor, Nuclear Assessments
E. Matzke, Senior Licensing Engineer
J. McManis, Manager, Projects
S. Miller, Manager, Design Engineering
V. Naschansy, Director, Site Engineering
B. Obermeyer, Manager, CAP
T. Orth, Director, Site Work Management
A. Pallas, Manager, Shift Operations
M. Prospero, Division Manager, Plant Operations
B. Rash, Recovery Lead
K. Root, Regulatory
R. Short, Manager, Recovery
T. Simpkin, Manager, Site Regulatory Assurance
M. Smith, Manager, Operations
S. Swanson, Operations Director
K. Wells, Nuclear Design Engineer Design Electrical/I&C
J. Wiegand, Manager, Operations Support
G. Wilhelmsen, Exelon Nuclear Partners
J. Zagata, Reliability Engineer

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened and Closed

05000285/2013017-01	VIO	Failure to Ensure Tornado Missile Protection for Site Components (Section 4OA4)
05000285/2013017-02	NCV	Failure to Promptly Identify and Correct a Condition Adverse to Quality (Section 4OA4)
05000285/2013017-03	NCV	Failure to Follow Operability Procedure (Section 4OA4)
05000285/2013017-04	NCV	Inadequate Temporary Modification to Protect Against Tornado Generated Missiles (Section 4OA4)
05000285/2013017-05	NCV	Failure to Obtain Prior NRC Approval for a Change in Method of Evaluation (Section 4OA4)

Closed

05000285/2013-005-1	LER	Control Room HVAC Modification Not Properly Evaluated
05000285/2013-009	LER	Tornado Missile Vulnerabilities

LIST OF DOCUMENTS REVIEWED

Section 4OA4: IMC 0350 Inspection Activities (92702)

PROCEDURES

NUMBER	TITLE	REVISION / DATE
PED-QP-13	Design Basis Document Control	
PB-1	Writer's Guide for Plant Level Design Basis Documents	
SG-1	Writers Guide for System Design Basis Documents	
SO-G-21	Modification Control	
00314218-01	Flow Path Verification of Auxiliary Feedwater System	December 11, 2009
SO-O-25	Temporary Modification Control	81
NOD-QP-19	Cause Analysis Program	43
FCSG-24-5	Cause Evaluation Manual	5
FCSG-24-4	Condition Report and Cause Evaluation	3

PROCEDURES

NUMBER	TITLE	REVISION / DATE
FCSG-24-4	Condition Report and Cause Evaluation	5
NOD-QP-19	Cause Analysis Program	43
FCSG-24-1	Condition Report Initiation	3
FCSG-24-3	Condition Report Screening	6a
FCSG-24-4	Condition Report and Cause Evaluation	6a
NOD-QP-31.5	Degraded and Non-Conforming Evaluation	0

ENGINEERING ANALYSIS

NUMBER	TITLE	REVISION
EA06-006	Tornado Design/Licensing Basis	1
EA13-014	Tornado Safe Shutdown Analysis	0

CONDITION REPORTS

NUMBER

2012-15661	2012-15666	2013-03839	2013-03842	2013-14363
2013-15429	2013-14006	2013-13955	2013-03839	2013-04266
2013-05210	2013-14665	2013-01960	2013-02063	2013-05420
2013-14264	2013-14117	2013-13950		

EC

NUMBER

61354	60974	60183	61233	61199
60975				

CALCULATIONS

NUMBER	TITLE	REVISION
FC08269	Secondary Tornado Missile Impact on Irradiated Fuel Stored in Spent Fuel Rack	0
FC08258	Perform Check and Global Effects of Tornado Pipe Missile Impact on Auxiliary Building Roof	1
FC08250	Tornado Protection for Pull Boxes PB-128T and PB-129T	0

CALCULATIONS

NUMBER	TITLE	REVISION
FC08272	Tornado Missile Protection for Auxiliary Building Battery Room Vent Openings	0
FC08281	Tornado Missile Impact Evaluation of Sluice Gate Operators	0
FC08262	Tornado Missile Protection for Intake Structure Pull Boxes PB-95T and PB-98T	0
FC08282	RW Pipe in Room 81 and Room 69 Subjected to Tornado Generated Missiles – Temp Calc	0
FC08265	Multiple Steel Barrier for Tornado-Generated Pipe Missile Impact	0
FC08273	Tornado Protection for Exposed 6” RW Branch Line in Service Building	0
FC08284	Missile Barrier for Room 81 Barrier 5	0
FC08263	Tornado Protection for Intake Structure Pumps AC-10C and AC-10D	A
FC08274	Tornado Missile Protection for Intake Structure Stair S-16	0
FC08276	Tornado Protection Barrier 3” and 16” RW Supply in Rm 81	0
FC06081	Tornado Missile Hazard for FW-10 Auxiliary Feedwater Turbine Exhaust	0
FC06633	FCS Tornado Depressurization Modeling Common Assumptions	0
FC07012	External Missiles Due to Tornado Winds and Turbine Generator Overspeed	0
FC08285	Manhole MH 3125 Tornado Missile Barriers	0

LERS

NUMBER

2013-009

MISCELLANEOUS

NUMBER	TITLE	REVISION / DATE
	10 CFR 50.59 Evaluation of VA-71A & B Battery Room Ventilation for Tornado Missile Protection	
	10 CFR 50.59 Evaluation of Tornado Missile Protection Methodology Change	
LIC-93-0278	NRC Generic Letter 88-20 Submittal for Fort Calhoun Station Individual Plant Examination for Severe Accident Vulnerabilities	December 1, 1993
LIC-95-0130	Phase II Response to Generic Letter 88-20, Supplement 4 Individual Plant Examination of External Events	June 30, 1995
NavDocs P-51	Design of Protective Structures	August 1950
	Auxiliary Feedwater System Component Design Basis Inspection Assessment Report RA 2012-4470	0

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
1600 E LAMAR BLVD
ARLINGTON, TX 76011-4511

April 24, 2014

MEMORANDUM TO: Sher Bahadur, Deputy Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

FROM: Kriss M. Kennedy, Director ***/RA/***
Division of Reactor Projects
Region IV

SUBJECT: TASK INTERFACE AGREEMENT – CONCURRENCE ON FORT CALHOUN TORNADO MISSILE PROTECTION LICENSING BASIS (TIA 2013-07)

This Task Interface Agreement (TIA) documents Region IV's position regarding Omaha Public Power District's (OPPD) evaluations performed in accordance Title 10 of the *Code of Federal Regulations* (10 CFR) 50.59, "Changes, tests, and experiments," related to proposed plant modifications and associated changes to the current licensing basis (CLB) for tornado missile protection for Fort Calhoun Station (FCS), as well as, the FCS Operability Form NOD-QP-31, 2013-14393. Concurrence on this memo by the Office of Nuclear Reactor Regulation (NRR) indicates their review and approval of Region IV's regulatory position. The NRC staff concludes that the 10 CFR 50.59 evaluations performed by OPPD do not provide an adequate basis for making changes to the tornado missile protection as described in the FCS Updated Safety Analysis Report (USAR) without prior NRC approval. Further, the staff disagrees with the FCS conclusion in NOD-QP-31 2013-14363 that the affected non-conforming systems and components are operable.

Introduction

To address a number of identified tornado missile protection deficiencies, the licensee proposed implementing plant modifications to protect plant equipment using a different design methodology than that described in their USAR. Specifically, the licensee proposed to replace its CLB methodology for evaluating the impact of tornado generated missiles on plant equipment with the "methodology" of RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants." Following review of this evaluation, the NRC concluded that the licensee had inappropriately concluded that prior NRC review and approval was not required for the change. The licensee performed another 50.59 evaluation for implementing plant modifications to protect equipment. This evaluation concluded that the original design was based on the premise that only structures were required to survive impacts of tornado missiles. Protecting plant equipment located outside the structures would be an upgrade to improve plant safety margins. To protect the equipment, the licensee planned to use a different design methodology than that described in the USAR and concluded that prior NRC review and approval was not required. The NRC reviewed this evaluation and again determined that the licensee inappropriately concluded that prior NRC review and approval was not required for the change. Subsequently, the license performed an operability evaluation that concluded the

affected equipment was operable on the basis that tornado missile protection was limited to structures and not equipment located outside these structures. The NRC reviewed this evaluation and concluded the licensee's basis for operability was not adequate and that certain equipment located outside structures are required to be tornado missile protected to ensure a safe shutdown following a tornado. The licensee then submitted an exigent licensing amendment request to change the tornado missile protection design basis requirements described in the USAR. The NRC approved the license amendment on July 26, 2013 (ADAMS Accession No. ML13203A070). The amendment revised the USAR for the design basis tornado (DBT) and tornado missiles to include NRC Regulatory Guide 1.76, Revision 1, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," and Bechtel Power Corporation, Topical Report BC-TOP-9A, Revision 2, September 1974, "Design of Structures for Missile Impact." The changes revised the current licensing basis pertaining to protection from tornadoes and tornado-generated-missiles.

The following background information provides the NRC's assessment of the licensee's evaluations.

Background

The following provides background information regarding the licensee's current licensing bases related to tornado missile protection design requirements.

The FCS USAR, Appendix G, FCS Design Criteria, Criterion 2 – Performance Standards, states in part:

> The systems and components of the Fort Calhoun Station, Unit No. 1 reactor facility that are essential to the prevention or mitigation of accidents that could affect public health and safety are designed, fabricated, and erected to withstand without loss of capability to protect the public, the additional forces that might be imposed by natural phenomena such as tornadoes. The facility is designed so that the plant can be safely shutdown and maintained in a safe shutdown condition during a tornado.

The FCS USAR, Section 5.8.2.2, "Tornado Generated Missiles," states, in part, that the design basis tornado wind speed was 500 miles per hour which resulted in the most critical projectile being a 3 inch diameter, 10 feet long pipe moving at a velocity of 640 feet per second. As with the turbine generated missiles, using the present state-of-the-art missile penetration data, it is determined that the tornado generated missiles would not perforate the containment.

The FCS USAR, Section 5.11.3, "Design Criteria, Class 1 Structures," states, in part that Class I structures, other than the containment, were designed to withstand a tornado with a maximum wind velocity of 300 miles per hour.

eNRC Review of Licensee's 50.59 and Operability Evaluations

Licensee June 27, 2013, 50.59 Evaluation

On June 27, 2013, the licensee approved a 10 CFR 50.59 evaluation as part of Engineering Change EC 60974, "Tornado Missile Protection Methodology Change," Revision 0, as the means of adopting Regulatory Guide 1.76. In this evaluation, the licensee determined that the information contained in Regulatory Guide 1.76 constituted a new method of evaluation, and went on to identify that this method had been previously reviewed and approved for use at another facility via a safety evaluation report. Based on this evaluation, the licensee determined that Regulatory Guide 1.76 could be implemented at FCS without prior NRC approval.

This change would consist of different types of tornado generated missiles than those described in the licensee's USAR and different missile velocities. For example, the FCS USAR, Section 5.11.3, "Design Criteria, Class 1 Structures," states, in part that Class I structures, other than the containment, were designed to withstand a tornado with a maximum wind velocity of 300 miles per hour. This change would reduce the tornado wind speed velocity to 230 miles per hour.

NRC Conclusion of the June 27, 2013, 50.59 Evaluation

Consistent with the Statements of Consideration (SOC) for the Final Rule for 10 CFR 50.59 and RG 1.187, which endorses NEI 96-07, Revision 1, "Guidelines for 10 CFR 50.59 Implementation," the staff concludes that the licensee's June 27, 2013, evaluation did not provide an adequate basis for making changes to the tornado missile protection as described in the FCS USAR without prior NRC approval.

RG 1.76 describes how to select the values for the design-basis tornado and tornado-generated missile spectrum for use in a licensee's USAR described method of evaluation. Consistent with the SOC for the 50.59 rule, the values in RG 1.76 are an element of a method of evaluation. As such, these values, when used in an NRC-approved method of evaluation, should demonstrate that margins that exist from the conservatisms in the method of evaluation ensure that design basis requirements are met.[1]

Additionally, in accordance with Section 3.8 of NEI 96-07, RG 1.76 values are an *element of a methodology* because:

> The development or approval of a methodology was predicated on the degree of conservatism in a particular input parameter or set of input parameters. In other words, if certain elements of a methodology [method of evaluation] or model were accepted on the basis of the conservatism of a selected input value, then that input value is considered an element of the methodology.

[1] 64 FR 53599, SOC examples 1, 4, and 5 provide additional insight on changes to elements of a method of evaluation described in the USAR.

The staff concludes that the licensee's evaluation fails to properly address the requirements of 10 CFR 50.59(a)(2)(i) and the guidance in NEI 96-07, Sections 3.8 and 4.3.8.1. In general, licensees can make changes to elements of a methodology without first obtaining a license amendment if the results are essentially the same as, or more conservative than, previous results. In this example the licensee proposed to use a tornado wind speed, referenced in Regulatory Guide 1.76, as a design input that was less than the wind speed described in the CLB. Based on this, the NRC cannot determine whether or not the change results are essentially the same, or more conservative than, previous results using the CLB wind speed.

Licensee July 12, 2013, 50.59 Evaluation

Following the June 27, 2013, 50.59 evaluation, and based on discussions with the NRC, on July 12, 2013, the licensee approved a 10 CFR 50.59 evaluation as part of EC 61354, "VA-71A & B Battery Room Ventilation Tornado Missile Protection," Revision 0. In this evaluation, the licensee took the position that while USAR Draft Criterion 2 stated that licensee's would protect systems and components, the station's response documented in both Appendix G to the USAR, and to NRC questions, stated that only structures would resist the forces of tornados and tornado missiles. Therefore, the licensee concluded that the adoption of the additional requirement to protect systems and components did not require prior NRC approval. The licensee concluded that this new method of evaluation for modifications being made to the facility included:

1. Adoption of Regulatory Guide 1.76 Revision 1, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," that provides the regionalized selection of the design basis tornado and tornado missiles.

2. Use of Bechtel Topical Report (TR) BC-TOP-9A Revision 2, "Design of Structures for Missile Impacts," dated November 25, 1974. This topical report provides the general procedures and criteria for design of structures and components against the effects of impact of missiles, including the evaluation of local effects due to missiles impacting both concrete and steel structural elements, and procedures used to evaluate the overall structural response to missile impact loads. The TR was approved by the Atomic Energy Commission (AEC) staff in November 1974.

3. Use of Standard Review Plant (SRP) Section 3.5.3, Revision 3, that provide NRC endorsed acceptance criteria for the design basis tornado missile impact, e.g., verification that FCS provides adequate barrier thickness to prevent perforation and to prevent spalling or scabbing when protection from spalling or scabbing is considered necessary.

NRC Conclusion of the July 12, 2013, 50.59 Evaluation

The licensee's conclusion that USAR Draft Criterion 2 does not apply to systems and components is unsupported by the criterion wording requiring the protection of systems and components and the licensee's USAR statement that Draft Criterion 2 is met. The means of protecting many of the systems and components essential to the prevention of accidents was the use of structures, but the protection of such systems and components

is still a requirement of the criterion. The licensee contends that the CLB requires tornado missile protection only for *structures*. However, based on its review of the CLB, the staff concludes that the CLB requires tornado missile protection for *structures, systems, and components.*

Consistent with Regulatory Guide 1.187, which endorses NEI 96-07, Revision 1, the staff concludes that the licensee's July 12, 2013, evaluation does not provide an adequate basis for making changes to the tornado missile protection as described in the FCS USAR without prior NRC approval. Specifically, the staff concludes that:

> As previously discussed, RG 1.76 is an element of a method of evaluation. The licensee's evaluation does not properly address the requirements of 10 CFR 50.59(a)(2)(i) and the guidance in NEI 96-07, Sections 3.8 and 4.3.8.1, specifically, whether or not the change yields results that are conservative or essentially the same.
>
> Topical Report BC-TOP-9A, Revision 2, is an AEC-approved methodology that provides general procedures and criteria for design of nuclear power plant structures and components against the effects of impact of missiles, including the evaluation of local effects due to missiles impacting both concrete and steel structural elements, and procedures used to evaluate the overall structural response to missile impact loads. The AEC Regulatory Position in its approval of the TR states that the report may be referenced in future case applications provided that the following specific information reviewed and approved by the Regulatory staff is included in the individual safety analysis report:
>
> a. Parameters that define postulated missiles such as striking velocity, weight, missile configurations and impacting area, etc.
> b. Structures, shields and barriers that are required to be designed for missiles with their pertinent characteristics.
> c. Information justifying the use of a ductility ratio greater than 10.
> d. The evaluation of punching shear effect due to the impact of unconventional missiles...should be adequately addressed in the individual plant SAR.
>
> The licensee's evaluation does not address the staff's conditions for using the Topical Report methodology, as would be necessary to conform to Section 4.3.8.2 of NEI 96-07. In addition, the licensee's evaluation appears to substitute alternatives to the conditions of use. For example: (1) in lieu of the CLB values in the USAR, the licensee's evaluation substitutes the input values from RG 1.76, and (2) in lieu of the TR BC-TOP-9A conditions of use, the licensee's evaluation substitutes the acceptance criteria of SRP 3.5.3. The licensee's evaluation does not fully address the requirements of 10 CFR 50.59(a)(2)(i) and the guidance in NEI 96-07, Section 4.3.8.2, that states that, "The licensee should address these and similar considerations, as applicable, and document in the 10 CFR 50.59 evaluation the basis for determining that a method is appropriate and approved for the intended application."

> SRP Section 3.5.3, Revision 3, does not provide an approved methodology for licensees to reference or use in the context of 10 CFR 50.59, as evidenced by the fact that the SRP does not have an associated safety evaluation report. The licensee asserts that the CLB requires tornado missile protection only for *structures*. However, the SRP includes acceptance criteria that require protection of *structures, systems, and components*.

In summary, 10 CFR 50.59(a)(2)(ii) permits licensees to change from a method of evaluation described in the USAR to an NRC-approved method of evaluation without a license amendment provided that the method of evaluation was approved for the type of analysis being conducted, generically approved for the type of facility using it, and that all terms and conditions for use of the method are satisfied. The licensee proposes to combine RG 1.76, TR BC-TOP-9A, and SRP Section 3.5.3 to create a replacement method of evaluation for tornado missile protection as described in the FCS USAR. Based on the NRC staff's review, it is not apparent that the licensee is referencing an NRC-approved method of evaluation comprised of these components. Thus, the licensee's proposal is inconsistent with the requirements of 10 CFR 50.59 and the guidance in NEI 96-07, Section 4.3.8.2.

Licensee July 20, 2013 Operability Determination

Following the July 12, 2013, 50.59 evaluation, and based on discussions with the NRC, on July 20, 2013, the licensee completed an operability evaluation documented as NOD-QP-31.1. This evaluation evaluated the non-conforming condition that systems and components required for safe shutdown do not meet the USAR Draft Criterion 2 for tornado missile protection. This evaluation concluded that affected systems and components that were not adequately protected from tornado generated missiles are OPERABLE but degraded, nonconforming, or unanalyzed, and that compensatory measures must be implemented to maintain operability. The compensatory measures consisted of protecting the affected equipment with tornado missile protection features using the methodology contained in the 50.59 evaluation dated July 12, 2013.

NRC Conclusion of the July 20, 2013, Operability Evaluation

Operable or operability is defined in the FCS Technical Specifications as:

> A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified safety function(s) and when all necessary attendant instrumentation, controls, normal or emergency electrical power sources, cooling and seal water, lubrication, and other auxiliary equipment that are required for the system, subsystem, train, component or device to perform its specified safety function(s) are also capable of performing their related support function(s).

The following definitions are provided in Inspection Manual Chapter Part 9900: Technical Guidance, "Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety:"

Current Licensing Basis (Section 3.1)

The current licensing basis (CLB) is the set of NRC requirements applicable to a specific plant, plus a licensee's docketed and currently effective written commitments for ensuring compliance with, and operation within, applicable NRC requirements and the plant-specific design basis, including all modifications and additions to such commitments over the life of the facility operating license.

Fully Qualified (Section 3.4)

A structure, system or component (SSC) is fully qualified[2] when it conforms to all aspects of its CLB, including all applicable codes and standards, design criteria, safety analyses assumptions and specifications, and licensing commitments. An SSC is considered "not fully qualified," i.e., degraded or nonconforming, when it does not conform to all aspects of its CLB, including all applicable codes and standards, design criteria, safety analyses assumptions and specifications, and licensing commitments.

The SSCs that TS require to be operable are designed and operated, as described in the CLB, with design margins and engineering margins of safety to ensure, among other things, that some loss of quality does not result in immediate failure to meet a specified function. The CLB includes commitments to specific codes and standards, design criteria, and some regulations that also dictate margins.

Operable/Operability (Section 3.8)

Operable/Operability is defined and its meaning is discussed in the context of the CLB design by the following statement:

> In order to be considered operable, an SSC must be capable of performing the safety functions *specified by its design*, *within the required range of design physical conditions*, initiation times, and mission times.

Compensatory Measures (Section 7.3)

Compensatory measures may be used to restore "inoperable SSCs to an operable but degraded or nonconforming status. In general, these measures should have minimal impact on the operators or plant operations and should be relatively simple to implement."

Change to Facility or Procedures in Lieu of Full Restoration (Section 7.4.1)

In this situation, the licensee's proposed final resolution of the degraded or nonconforming condition includes other changes to the facility or procedures to

[2] The NRC does not have specific qualification requirements for SSCs, except for electric equipment important to safety, as set forth in 10 CFR 50.49.

cope with the uncorrected or only partially corrected degraded or nonconforming condition. Rather than fully correcting the degraded or nonconforming condition, the licensee decides to restore capability or margin by making another change. In this case, the licensee must evaluate the change from the UFSAR-described condition to the final condition in which the licensee proposes to operate its facility. If the 10 CFR 50.59 screening and/or evaluation concludes that a change to the TSs is involved or the change meets any of the evaluation criteria specified in the rule for prior NRC approval, a license amendment must be requested, and the corrective action process is not complete until the approval is received or some other resolution occurs.

Use of Alternative Analytical Methods in Operability Determinations (Appendix C.4)

When performing operability determinations, licensees sometimes use analytical methods or computer codes different from those originally used in the calculations supporting the plant design. This practice involves applying engineering judgment to determine if an SSC remains capable of performing its specified safety function during the corrective action period. The use of alternative methods is not subject to 10 CFR 50.59 unless the methods are used in the final corrective action. Section 50.59 is applicable upon implementation of the corrective action.

The NRC staff disagrees with the FCS conclusion that the affected systems and components are "OPERABLE**,** but degraded, nonconforming or unanalyzed…" Systems and components required to be operable by FCS TS must be capable of performing their specified safety functions before, during, and after postulated tornado events as defined in the FCS current licensing basis.

The discovery of a degraded or nonconforming condition may call the operability of one or more SSCs into question. A subsequent determination of operability should be based on the licensee's "reasonable expectation," from the evidence collected, that the SSCs are operable and that the operability determination will support that expectation. In order to be considered operable, a structure, system or component must be capable of performing the safety functions specified by its design, within the required range of design physical conditions, initiation times, and mission times. Therefore, upon discovery that safety systems and components required to be operable by FCS TS are unprotected against natural phenomena, FCS cannot conclude, based on a reasonable expectation of operability, that the affected systems and components are capable of performing their specified safety functions during and after a postulated tornado event as defined in the FCS current licensing basis.

With respect to the corrective action to construct barriers to correct the identified nonconforming conditions, FCS may implement compensatory measures to establish the operability of affected systems and components. Standards for constructing tornado missile barriers should be consistent with the current licensing basis. If the compensatory measure involves a change to the facility, as was the case with FCS, then the change must be evaluated in accordance with 10 CFR 50.59. If the screening and/or evaluation of the compensatory measure concludes that a change to the TSs is involved

or the change meets any of the evaluation criteria specified in the rule for prior NRC approval, a license amendment must be requested, and NRC approval received before the compensatory measure can be implemented. The corrective action process is not complete until the approval is received or some other resolution occurs.

NRC Overall Conclusion

In summary, the NRC staff reviewed the June 27 and July 12, 2013, 10 CFR 50.59 evaluations performed by the licensee and concluded that these evaluations do not provide an adequate basis for making changes to the tornado missile protection as described in the FCS USAR without prior NRC approval. Further, the NRC staff disagrees with the FCS conclusion in the July 20, 2013 Operability Evaluation that the affected systems and components are "OPERABLE**,** but degraded, nonconforming or unanalyzed..." Systems and components required to be operable by FCS TS must be capable of performing their specified safety functions before, during, and after postulated tornado forces as defined in the FCS current licensing basis.

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Attachment 3
Detailed Risk Evaluation
Failure to Ensure Tornado Missile Protection for Site Components

(1) The detailed risk evaluation model revision and other PRA Tools used

The analyst utilized the Standardized Plant Analysis Risk Model for Fort Calhoun Station, Revision 8.21 and hand calculation methods to quantify the risk of the subject performance deficiency.

(2) Influential assumptions

1. The risk impact of the subject performance deficiency was limited to tornado-induced initiators and potential damage to site systems, structures, and components.

2. The subject performance deficiency impacted plant risk from initial reactor startup through July 2013. Therefore, in accordance with the Risk Assessment of Operational Events Handbook, Volume 1, "Internal Events," Revision 2, Section 2.6, "Exposure Time Greater than 1 Year," the maximum exposure time was set to the 1-year assessment period.

3. The best available source of information related to tornadic activity around the Fort Calhoun Site is the site tornado hazard curve developed for the Individual Plant Examination of External Events for Fort Calhoun Station in accordance with the methods described in NUREG/CR-2944, "Tornado Damage Risk Assessment," September 1982.

4. The missile impact parameter method used in the Individual Plant Examination of External Events for Fort Calhoun Station is the best available method for evaluating the frequency of missile impacts.

5. The best estimate population of potential missiles is 30,000 representing the mean value used in NUREG/CR-2944.

6. Based on the definitions from the Fujita-Pearson Scale, only F2 and greater intensity tornados are capable of producing missiles.

7. All postulated F2 or greater tornados and/or their associated storm fronts would likely result in a loss of offsite power that is not recoverable within 24 hours. This loss of offsite power may be caused by either onsite switching or offsite grid-related damage.

8. Thirty-five of the thirty-seven unprotected targets were considered small targets. The Main control room air conditioning condensers were considered medium targets, and the Room 81 blowout panels were considered large targets.

9. The best available model to assess the conditional core damage probabilities for equipment damaged by postulated tornado missiles was the Standardized Plant Analysis Risk Model for Fort Calhoun Station, Version 8.21.

10. The condensate storage tank at Fort Calhoun Station represents a large target that is not designed for tornado-force winds or missiles. Therefore, the analyst assumed that any tornado with high enough wind velocities to cause a loss of offsite power and damage unprotected equipment would damage the condensate storage tank.

(3) Calculation discussion

A detailed risk evaluation was performed consistent with NRC Inspection Manual Chapter (IMC) 0609 Appendix A, Section 6.0, "Detailed Risk Evaluation." To conduct a risk assessment and determine the change in core damage frequency (ΔCDF) an analyst must solve the following equation:

$$\Delta CDF = [(IEF_{case} * CCDP_{case}) - (IEF_{base} * CCDP_{base})] * EXP$$

Where:

- IEF_{case} ≡ Initiating Event Frequency of the case being evaluated
- $CCDP_{case}$ ≡ Conditional Core Damage Probability of the case
- IEF_{base} ≡ Initiating Event Frequency of the baseline
- $CCDP_{base}$ ≡ Conditional Core Damage Probability of the baseline
- EXP ≡ The Exposure Period including repair time

Using the best available tools to the analyst, the conditional core damage probability of the case needs to be broken down into three parts:

1. Missile Impact Probability (P_{MS});
2. Conditional Core Damage Probability (CCDP); and
3. Applied Nonrecovery Factor (P_{NR}).

The conditional core damage probabilities can then be calculated as:

$$CCDP_{case} = P_{MS} * CCDP * P_{NR}$$
$$CCDP_{base} = P_{MS} * CCDP_{SPAR\text{-}Base} * P_{NR}$$

Initiating Event Frequency

Tornado Occurrence Rate: As discussed under Assumption 1, the risk impact of the subject performance deficiency was limited to tornado-induced initiators and potential damage to site systems, structures, and components. The analyst performed a review of following three data sources:

1. National Severe Storms Forecast Center database (1950 – 1990)

a. Collected by the licensee
b. 125 nautical mile radius around plant site
c. Evaluated and documented in the IPEEE
d. Used wind speed-adjusted average tornado area

2. Tornado History Project database (1950 – 2013)

    a. Collected by the agency
    b. 16,445 miles^2 in 30 counties surrounding the plant

3. US Geologic Survey (1957 – 2006)

    a. Collected by the agency
    b. Utilized SeverePlot software
    c. 150 mile radius around plant site

The analyst calculated the occurrence rate (F_O) for all tornados in a data set. The appropriate equation is as follows:

$$F_O = (z * t) \div A$$

Where:

$z \equiv$ Average Tornado Area
$t =$ Total Events $\div$ Statistical Sample Size
$A \equiv$ Regional Area

The analysts noted that the results of each study were the same within a factor of 2. Therefore, the licensee's analysis of the National Severe Storms Forecast Center database was selected as the best available information because the analysis was performed in a more rigorous manner.

Tornado Data Correction:

In evaluating the data set, the analysts and the licensee accounted for missing data and variations in intensity across the tornado length and path. Missing data was accounted for as documented in Table 1. The intensity of these tornados was categorized based on the weighted average intensity of the properly classified observations. Intensity adjustments were made using a correction factor.

The analyst noted that observations assigned a Fujita-Pearson intensity are based on the worst damage observed along the damage path. Random encounter errors occur when the tornado travels along a path that is not populated by structures, vehicles or vegetation with damage potential. Length and width of a tornado represent the dimensions of the tornado damage track. Random encounter errors and variations in intensity need to be accounted for in developing the hazard. The analyst observed the variations of intensity in Figure 1. The analyst determined that the methodology used in

the Fort Calhoun Individual Plant Evaluation of External Events was appropriate for correcting these errors.

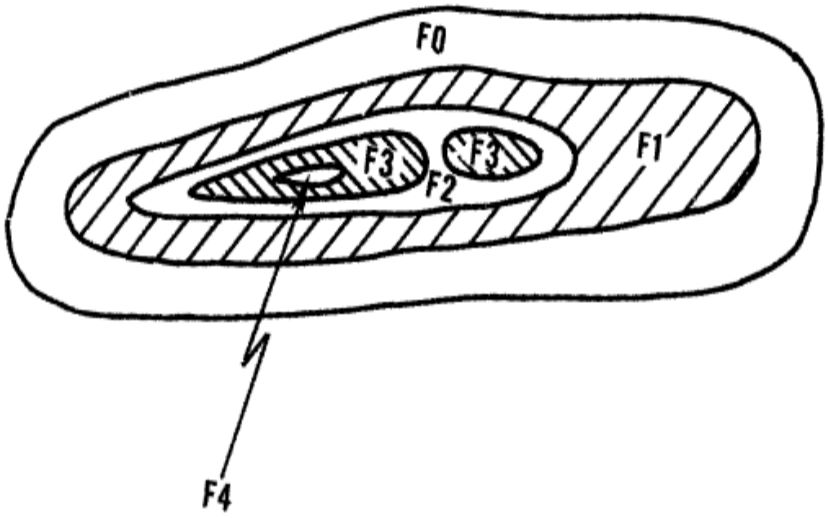


Figure 1

Finally, the analyst noted that the point strike frequency should be adjusted for the characteristic width of the site. The licensee considered the auxiliary, intake, service and turbine buildings to be the facilities under hazard. According to the Fort Calhoun Nuclear Power Station Tornado Risk Assessment, Science Applications International Corporation, December 1993, the characteristic width was calculated to be 547.88 feet, as shown in Figure 2.

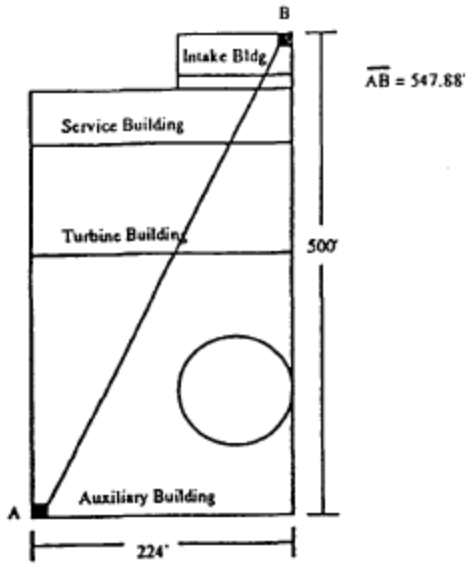


Figure 2

Tornado Hazard Occurrence Rate:

The tornado strike intensity was evaluated for the National Severe Storms Forecast Center database. The data was assessed and the analyst calculated the conditional probability of a tornado strike at an intensity equivalent to each of the bins in the Fujita-Pearson Intensity Scale. These conditional probabilities are documented in Table 2.

Using these parameters and the results of the licensee's Reinhold aerial strike model, the analyst calculated the hazard for Fort Calhoun Station. Figure 1 shows a graph of the hazard with the frequency of exceedance for each of the bins, as updated by the licensee in July 2011.

As stated in Assumption 6, the analyst assumed that only F2 and greater intensity tornados are capable of producing missiles. This was based on the definitions from the Fujita-Pearson Intensity Scale. Therefore the exceedance values for F2 tornados were used during quantification.

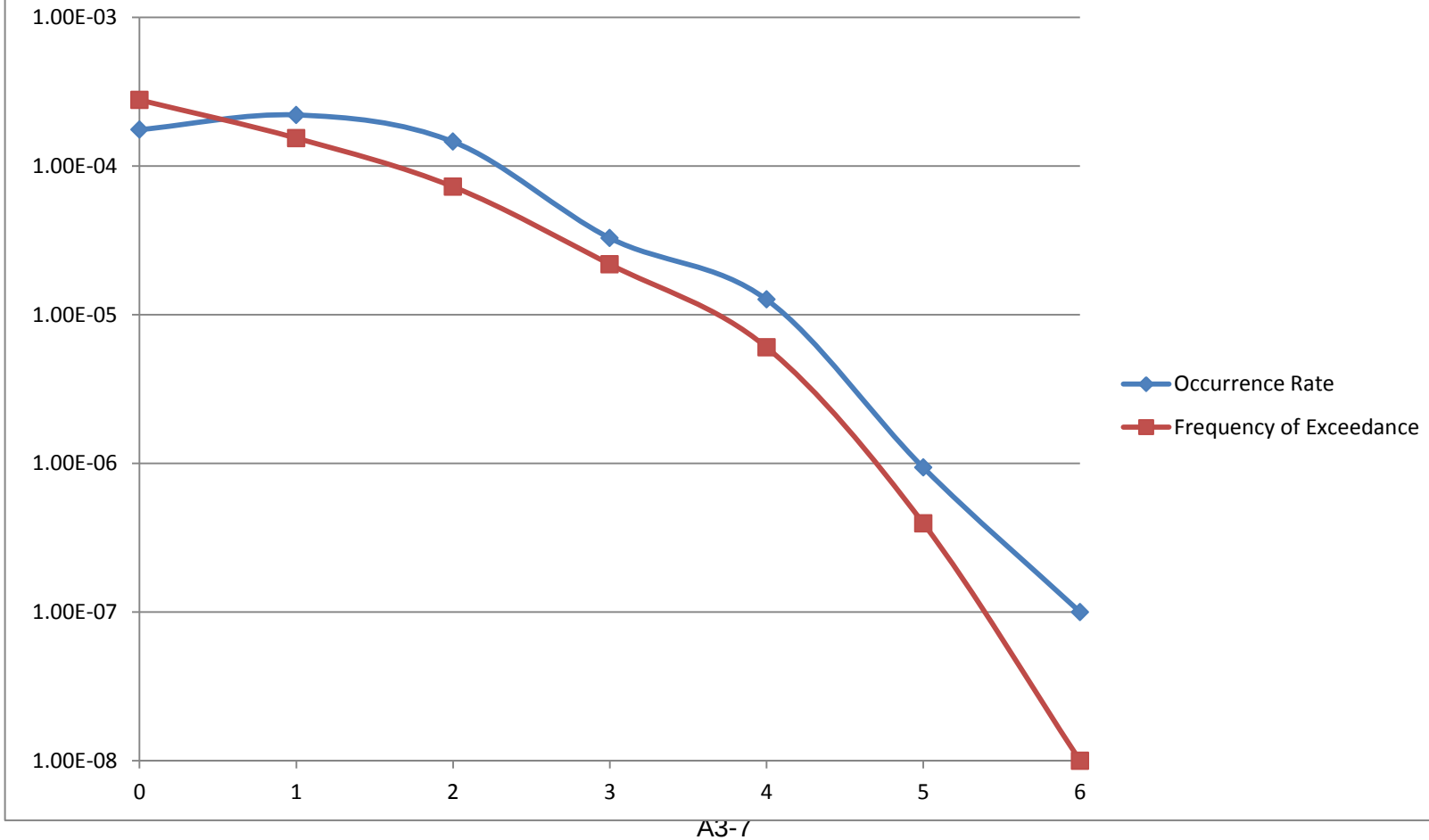
Table 1 provides the results of these reviews:

Data Source	Regional Area (miles^2)	Sample Size (years)	Tornado Area (miles^2)	Events	Missing Data	Occurrence Rate (per year)
IPEEE	64,918	37	0.67	1412	156	3.94e-4
Tornado History Project	16,445	63	0.5	784	43	3.99e-4
SeverePlot	70,686	50	0.4	2458	0	2.82e-4

Table 2
Tornado Hazard at Fort Calhoun Station

Intensity	Conditional Probability	Frequency of Exceedance
		Overall Site
F0	29.9%	2.78E-04
F1	37.5%	1.54E-04
F2	24.8%	7.25E-05
F3	5.6%	2.18E-05
F4	2.1%	6.03E-06
F5	0.2%	3.95E-07
F6	0.0%	1.00E-08

Figure 3
Tornado Frequency
Hazard for Fort Calhoun Station



Conditional Core Damage Probability of the Event

Baseline: The analyst utilized the Standardized Plant Analysis Risk Model for Fort Calhoun Station, Version 8.20, to quantify the baseline conditional core damage probability for a tornado strike at Fort Calhoun. Given Assumptions 7 and 10, the analyst established a baseline tornado-strike model by calculating the probability of core damage from an unrecoverable loss of offsite power with failure of the condensate storage tank. The analyst noted that the condensate storage tank was not modeled in the standardized plant analysis risk model. Therefore, the analyst used the failure-to-start basic event for Auxiliary Feedwater Pump FW-54 as a surrogate. Table 3 documents the changes in basic event parameters used for this calculation.

Table 3
Baseline Change Set

Basic Event	Event Description	Original Value	Modified Value
AFW-EDP-FS-FW54	AFW Diesel-Driven Pump FW-54 Fails to Start	5.09E-03	TRUE
IE-********	All Initiating Events	various	FALSE
IE-LOOP	Loss of Offsite Power	2.84E-02	1.0
OEP-XHE-XL-NR01H	Operator Fails to Recover Power in 1 hour	5.46E-01	TRUE
OEP-XHE-XL-NR02H	Operator Fails to Recover Power in 2 hours	3.39E-01	TRUE
OEP-XHE-XL-NR04H	Operator Fails to Recover Power in 4 hours	1.73E-01	TRUE
OEP-XHE-XL-NR06H	Operator Fails to Recover Power in 6 hours	1.10E-01	TRUE
OEP-XHE-XL-NR24H	Operator Fails to Recover Power in 24 hours	2.31E-02	TRUE

Based on this approach, the baseline conditional core damage probability was quantified as 4.32×10^{-3}.

Case Quantification: Based on similarities in the ultimate plant damage state between many of the tornado-strike targets, the analyst created nine model change sets to quantify the risk associated with each postulated impact. Table 4 documents the conditional core damage probability calculated for each of the nine change sets, given the failure of front-line systems.

Table 4 Conditional Core Damage Probabilities			
Change Set	Front-Line Systems Failed	CCDP	Change in CCDP
Baseline	Baseline Change Set from Table 3	4.23E-03	
1	One Raw Water Pump	4.34E-03	2.00E-05
2	Loss of All Raw Water	5.07E-03	7.50E-04
3	Two Raw Water Pumps	4.44E-03	1.20E-04
4	Both Diesel Generators	1.00E-00	9.96E-01
5	Emergency Diesel Generator 1	9.70E-02	9.27E-02
6	Emergency Diesel Generator 2	4.62E-02	4.19E-02
7	Main Steam and Auxiliary Feedwater	1.19E-01	1.15E-01
8	Auxiliary Feedwater Pump FW-10	4.93E-02	4.50E-02
9	Bus 1A3 and Bus 1A1	8.87E-02	8.35E-02

Missile Strike Probability:

As documented in the Fort Calhoun Nuclear Power Station Tornado Risk Assessment, Science Applications International Corporation, December 1993, the missile impact parameter (ψ) is 1.23×10^{-10} per tornado per missile per ft^2 for large targets and 2.42×10^{-9} per tornado per missile per ft^2 for small targets. The analyst assumed that targets larger than 2000 ft^2 were large. Additionally, for several hardened targets, the analyst used the licensee's adjusted value of 3.21×10^{-9} per tornado per missile per ft^2 to indicate a higher probability that the component could survive tornados of strength F2 and F3.

The analyst then calculated the missile impact probability by multiplying the total target area, the applicable missile impact parameter, and the selected number of postulated missiles from Assumption 5.

Exposure Period

As stated in Assumption 2, the subject performance deficiency impacted plant risk from initial reactor startup through July 2013. The analyst evaluated the time frame over which the finding was reasonably known to have existed. The analyst determined that a tornado could have resulted in failure of the unprotected components at any time during this period.

Therefore, in accordance with the Risk Assessment of Operational Events Handbook, Volume 1, "Internal Events," Revision 2, Section 2.6, "Exposure Time Greater than 1 Year," the maximum exposure time was set to the 1-year assessment period.

Results

The analyst calculated the change in core damage frequency for each of the non-protected components. The results are documented in Table 5.

Table 5
Tornado Missile Evaluation Results

Components:	Tornado Frequency (/year)	Area (ft^2)	Applicable ψ ($/ft^2$)	Missile Strike Probability	$CCDP_{Base}$	$CCDP_{Case}$	$CCDP_{Delta}$	Nonrecovery	Change in Frequency
EFWST	1.54E-04	800	3.21E-09	7.71E-02	4.32E-03	1.19E-01	1.15E-01	1.00E+00	1.36E-06
DG Fuel Fill Line FO-10	1.54E-04	225	2.42E-09	1.63E-02	4.32E-03	1.00E+00	9.96E-01	1.00E-01	2.50E-07
DG Fuel Vent FO-1	1.54E-04	0.6	2.42E-09	4.36E-05	4.32E-03	1.00E+00	9.96E-01	1.00E+00	6.68E-09
CR AC Condensers	1.54E-04	256.5	3.21E-09	2.47E-02	4.32E-03	1.00E+00	9.96E-01	4.01E-03	1.52E-08
Sluice Gate Operators	1.54E-04	190.74	2.42E-09	1.38E-02	4.32E-03	1.10E-02	6.67E-03	1.00E+00	1.42E-08
Boric Acid Tank	1.54E-04	120	2.42E-09	8.71E-03	4.32E-03	6.39E-03	2.07E-03	1.00E+00	2.78E-09
Battery Room Vents	1.54E-04	5.21	2.42E-09	3.78E-04	4.32E-03	1.00E+00	9.96E-01	1.00E+00	5.80E-08
Room 81 Blow Out	1.54E-04	2163	1.23E-10	7.98E-03	4.32E-03	1.19E-01	1.15E-01	1.00E+00	1.41E-07
Aux Building Door	1.54E-04	35	2.42E-09	2.54E-03	4.32E-03	8.78E-02	8.35E-02	1.00E+00	3.27E-08
Room 81 Ducts	1.54E-04	12	2.42E-09	8.71E-04	4.32E-03	1.19E-01	1.15E-01	1.00E+00	1.54E-08
Penthouse VA-42	1.54E-04	18	2.42E-09	1.31E-03	4.32E-03	1.19E-01	1.15E-01	1.00E+00	2.31E-08
Room 81 Roof Openings	1.54E-04	26	2.42E-09	1.89E-03	4.32E-03	1.19E-01	1.15E-01	1.00E+00	3.33E-08
Barrier 49	1.54E-04	157	2.42E-09	1.14E-02	4.32E-03	9.70E-02	9.27E-02	1.00E+00	1.63E-07
CR Door 1036-1	1.54E-04	35	2.42E-09	2.54E-03	4.32E-03	1.00E+00	9.96E-01	1.67E-01	6.49E-08
CR Door 1036-2	1.54E-04	35	2.42E-09	2.54E-03	4.32E-03	1.00E+00	9.96E-01	1.67E-01	6.49E-08
HVAC Conduit	1.54E-04	0.5	2.42E-09	3.63E-05	4.32E-03	1.00E+00	9.96E-01	4.01E-03	2.23E-11
DG Ventilation Louvers	1.54E-04	32	2.42E-09	2.32E-03	4.32E-03	9.70E-02	9.27E-02	1.00E+00	3.31E-08
DG-1 Exhaust	1.54E-04	88	2.42E-09	6.39E-03	4.32E-03	9.70E-02	9.27E-02	1.00E+00	9.12E-08
DG-2 Exhaust	1.54E-04	44	2.42E-09	3.19E-03	4.32E-03	4.62E-02	4.19E-02	1.00E+00	2.06E-08

RW Branch Line	1.54E-04	2	2.42E-09	1.45E-04	4.32E-03	5.07E-03	7.50E-04	1.00E+00	1.68E-11
Strainer Opening A	1.54E-04	28	2.42E-09	2.03E-03	4.32E-03	5.07E-03	7.50E-04	1.00E+00	2.35E-10
Strainer Opening B	1.54E-04	28	2.42E-09	2.03E-03	4.32E-03	5.07E-03	7.50E-04	1.00E+00	2.35E-10
Pull Box A	1.54E-04	41	2.42E-09	2.98E-03	4.32E-03	4.34E-03	2.00E-05	1.00E+00	9.16E-12
Pull Box B	1.54E-04	41	2.42E-09	2.98E-03	4.32E-03	4.34E-03	2.00E-05	1.00E+00	9.16E-12
Pull Box C	1.54E-04	41	2.42E-09	2.98E-03	4.32E-03	4.34E-03	2.00E-05	1.00E+00	9.16E-12
Pull Box D	1.54E-04	41	2.42E-09	2.98E-03	4.32E-03	4.34E-03	2.00E-05	1.00E+00	9.16E-12
Intake East Stairwell	1.54E-04	63	2.42E-09	4.57E-03	4.32E-03	5.07E-03	7.50E-04	1.00E+00	5.28E-10
Intake West Stairwell	1.54E-04	63	2.42E-09	4.57E-03	4.32E-03	5.07E-03	7.50E-04	1.00E+00	5.28E-10
Manhole MH-31	1.54E-04	7	2.42E-09	5.08E-04	4.32E-03	4.44E-03	1.20E-04	1.00E+00	9.39E-12
Manhole MH-5	1.54E-04	7	2.42E-09	5.08E-04	4.32E-03	4.44E-03	1.20E-04	1.00E+00	9.39E-12
RW Pull Boxes	1.54E-04	80	2.42E-09	5.81E-03	4.32E-03	5.07E-03	7.50E-04	1.00E+00	6.71E-10
Pump Cover A	1.54E-04	4	2.42E-09	2.90E-04	4.32E-03	4.34E-03	2.00E-05	1.00E+00	8.94E-13
Pump Cover B	1.54E-04	4	2.42E-09	2.90E-04	4.32E-03	4.34E-03	2.00E-05	1.00E+00	8.94E-13
Pump Cover C	1.54E-04	4	2.42E-09	2.90E-04	4.32E-03	4.34E-03	2.00E-05	1.00E+00	8.94E-13
Pump Cover D	1.54E-04	4	2.42E-09	2.90E-04	4.32E-03	4.34E-03	2.00E-05	1.00E+00	8.94E-13
Room 66 from Room 65	1.54E-04	80	2.42E-09	5.81E-03	4.32E-03	9.70E-02	9.27E-02	1.00E+00	8.29E-08
Room 81 Door	1.54E-04	35	2.42E-09	2.54E-03	4.32E-03	1.19E-01	1.15E-01	1.00E+00	4.49E-08
Aux Building Stack	1.54E-04	13	2.42E-09	9.44E-04	4.32E-03	1.19E-01	1.15E-01	1.00E+00	1.67E-08

(4) Analysis of Dominant Cut-sets / Sequences

All accident sequences involved a tornado-induced non-recoverable loss of offsite power with missiles impacting one of the subject unprotected targets. The dominant sequence included the failure of the emergency feedwater storage tank. These sequences are documented in Table 6.

Table 6
Core Damage Sequences
Failure of Emergency Feedwater Storage Tank

Sequence	Description	Point Estimate	% of Total	Cut Set Count
LOOP-21	IELOOP-AFW-OTC	1.16E-1	97.5	50
LOOP-22-30	IELOOP-EPS(SBO)-AFW-OPR01H-DGR-01H	2.16E-3	1.8	38
LOOP-19	IELOOP-AFW-OPR06H-HPR	3.22E-4	0.3	515
Others	All Additional Sequences Combined	5.18E-4	0.4	3,348
Total CCDP	All Sequences	1.19E-1	100.0	3,951

Abbreviations:

AFW	Auxiliary Feedwater
DGR01H	Nonrecovery of Diesel Generator in 1 Hour
EPS	Emergency Power System
HPR	High Pressure Recirculation
IELOOP	Initiating Event: Loss of Offsite Power
OPR01H	Nonrecovery of Offsite Power in 1 Hour
OPR06H	Nonrecovery of Offsite Power in 6 Hours
OTC	Once-Through Cooling
SBO	Station Blackout

(5) Sensitivity Analysis

The SRA performed a variety of uncertainty and sensitivity analyses on the results and modeling as shown below. The results confirm the recommended White finding.

Sensitivity Analysis 1 – Selection of Tornado Hazard.

As stated above, the analyst noted that the results of each tornado study were the same within a factor of 2. Using this range, the analyst calculated the sensitivity of the evaluation to the selection of the tornado hazard. The change in core damage frequency range was 1.3×10^{-6} – 4.1×10^{-6} (White).

Sensitivity Analysis 2 – Population of Potential Missiles.

The analyst determined the sensitivity of the results to the number of postulated missiles assumed. To establish a range, the analyst calculated the change in core damage frequency assuming 15,000 missiles then 60,000. The range of change in core damage frequency was 1.3×10^{-6} – 5.1×10^{-6} (White).

Sensitivity Analysis 3 – Selection of Tornado Intensity.

The analyst determined the sensitivity of the results to the selection of tornado intensity at which missiles of concern could be generated. To establish a range, the analyst calculated the change in core damage frequency assuming F1 tornados could affect the unprotected components then assuming an F3 or larger tornado would be required to negatively impact the site. The range of change in core damage frequency was 5.2×10^{-7} – 4.6×10^{-6} (White).

NOTE: The lower value, while Green, is less than a factor of 2 from the White threshold.

(6) Contributions from External Events (Fire, Flooding, and Seismic)

This performance deficiency only impacts the risk of the plant to a postulated tornado, which is an external event. The response of the plant to other external events, or to any internal initiators, was not affected.

(7) Potential Risk Contribution from LERF

In accordance with the guidance in NRC Inspection Manual Chapter 0609, Appendix H, "Containment Integrity Significance Determination Process," this finding would not involve a significant increase in risk of a large, early release of radiation because Fort Calhoun Station has a large, dry containment and the dominant sequences contributing to the change in the core damage frequency did not involve either a steam generator tube rupture or an inter-system loss of coolant accident.

(8) Total Estimated Change in Core Damage Frequency

The total change in risk caused by this performance deficiency is the sum of the internal and external events change in core damage frequencies. This value was 2.6×10^{-6} (WHITE).

(9) Licensee's Risk Evaluation

The licensee did not have an independent evaluation of the overall risk associated with this performance deficiency. However, licensee analysts noted that the methods described in NUREG/CR-2944 are intended for bounding screening analyses and are conservative for the Fort Calhoun Station application. More sophisticated tornado analysis methods exist which explicitly treat the stochastic processes of missile release, transport, and impact. An example is the TORMIS computer code (ref. NRC regulatory issue summary 2008-14). However, these tools were not readily available to the utility or the NRC analyst.

In discussing the target vulnerabilities, the licensee provided arguments as to why they believed the selected analysis approach to be conservative. The licensee analysts noted that many of the targets associated with the performance deficiency are protected on at least one side by structures some distance from a source of credible penetrating missiles. For example, one significant target is a buried fuel oil storage tank with

structures on two sides, making the likelihood of a penetrating missile reaching the target very low. The licensee contended that missiles with the potential to cause damage to the tank were sufficiently remote from the target and unlikely to reach the target area.

The licensee asserted that the NUREG does not differentiate between horizontal and vertical impact velocities and the stochastic nature of the missile orientation. They also noted that some postulated missiles would be limited in the angle of impact to hit their respective targets, and it is particularly improbable that heavy missiles could achieve impact angles.

The NRC analyst determined that the NUREG/CR-2944 method developed the missile impact parameter representing a missile flux (ψ) with units of per missile per ft^2 per tornado strike frequency. Adjustment of such a parameter using a z-axis angle, or for surrounding structures, would provide results that were beyond the capabilities and limitations of the method. The existence of such structures may actually focus the impact of postulated missiles.

(10) Summary of Results and Impact

The NRC's quantitative risk assessment was determined to represent a risk estimate in the "White" region. This represents a preliminary finding of low to moderate safety significance (White based on external event initiated change in core damage frequency).

(d) Peer Review:

The analyst requested that two analysts from NRC Region III perform a peer check on this analysis. As a result of this review, the analyst performed additional sensitivity studies to assess the variation of the results based on varying assumptions in the selection of the normalized tornado missile impact parameter (Ψ). The results are shown in Table 7.

Table 7			
Tornado Missile Impact Parameter Sensitivities			
Sensitivity Number	Changes	New Value	Results
1	No Changes		2.57E-06
2	Use FCS IPEEE value for EFWST	4.02E-10	1.38E-06
3	Use FCS IPEEE value for BlowOuts	3.21E-09	6.11E-06
2 & 3			4.92E-06
4	Medium - Small Ψ	8.64E-11	1.55E-06
2 & 4			3.64E-07

2, 3, & 4			3.90E-06
5	Conservative Distribution	2.84E-10	1.64E-06
6	All Medium Targets	4.02E-10	1.36E-06
5 & 6			4.36E-07
2, 3, 5 & 6			3.97E-06

(e) References:

The analysts used the following generic references in preparing the risk assessment:

- NUREG/CR-5042, "Evaluation of External Hazards to Nuclear Power Plants in the United States"
- NUREG/CR-2944, "Tornado Damage Risk Assessment"
- NUREG/CR-4710, "Shutdown Decay Heat Removal Analysis of a Combustion Engineering 2-Loop Pressurized Water Reactor" – Appendix G
- NUREG/CR-6883, "The SPAR-H Human Analysis Method." August 2005
- NUREG-1842, "Good Practices for Implementing Human Reliability Analysis." April 2005
- NUREG/CR-6595 Revision 1, "An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events." October 2004
- INL/EXT-10-18533 Revision 2, "SPAR-H Step-by-Step Guidance." May 2011
- "RASP Manual Volume 1 – Internal Events," Revision 2.0 date January 2013
- Risk Assessment of Operational Events, Volume 2 – "External Events," Revision 1.01, January 2008
- NUREG/CR-1278, "Handbook of HRA with Emphasis on Nuclear Power Plant Applications," August 1983
- UCRL-CR-135687, "Rationale for Wind-Borne Missile Criteria for DOE Facilities
- NRC Inspection Manual Chapter 0609, "Significance Determination Process"

The analysts used the following plant specific references:

- Standardized Plant Analysis Risk model for Fort Calhoun Station, Version 8.21

- LTR-RAM-II-10-030, “Assessment of Post–EPU Risk from Fire, Flood, Other External Events, and Shutdown Operation for Fort Calhoun Station,” Revision 0
- National Severe Storms Forecast Center Tornado Database (1950 – 1990)
- Tornado History Project (1950 – 2013)
- United States geologic survey SeverePlot (1957 – 2006)
- Fort Calhoun Station Unit No. 1, Updated Safety Analysis Report
- Phase II Response to Generic Letter 88-20, Supplement 4, ‘Individual Plant Examination of External Events,’ “Seismic, Fire, Tornado, Flooding, Transportation and Nearby Facilities Accidents, and Others Including Updates on Flooding, Transportation and Nearby Facilities Accidents”