

HIGH WIND GENERATED MISSILE HAZARDS (REDACTED VERSION)

CORNERSTONE: INITIATING EVENTS
 MITIGATING SYSTEMS

OpESS 2012/01-01 APPLICABILITY

01.01 This OpESS applies to all licensed operating commercial nuclear reactors.

01.02 Supports informing sample selection for Inspection Procedure (IP) 71111.01, “Adverse Weather Protection” and IP 71111.21, “Component Design Basis Inspection.”

01.03 Performance of this OpESS is voluntary.

OpESS 2012/01-02 OBJECTIVES

02.01 Provide support and focus for NRC inspector efforts during the conduct of baseline inspections associated with high wind generated missile hazards.

02.02 Provide guidance and examples of inspection findings related to missile hazards or the failure to protect safety-related structures, systems and components (SSCs) from potential missile hazards.

OpESS 2012/01-03 BACKGROUND

During the past 3 years (2008-2011), NRC inspections have identified approximately 30 findings and violations of NRC requirements (including 1 greater than green inspection finding) related to inadequate protection from potential missile hazards. Some of these issues involved failure to ensure that SSCs identified in the updated final safety analysis report (UFSAR) as functioning, following a tornado, or were protected from tornado-induced missiles. Other issues involved failure to ensure that potential missile hazards were accounted for and appropriately secured.

During the 12 month period from June 2010 to June 2011, tornado events resulted in three emergency declarations and automatic reactor trips of six units (Fermi – [EN 45979](#), Surry 1 & 2 – [EN 46761](#), and Browns Ferry 1, 2, & 3 – [EN 46793](#)). In all three cases, the tornados affected the switchyard and offsite electrical power supplies.

The following inspection guidance may be applied as appropriate to support baseline inspection activities. Inspector judgment should be used when determining the extent to which this OpESS should be used to inform inspection activities under the applicable baseline IPs.

04.01 Walkdowns. The recommended inspection activities described below support IP 71111.01, “Adverse Weather Protection.”

- a. Ensure that the licensee has adequate protection of equipment and outside structures from high winds (tornados and/or hurricanes) and high wind generated missiles. SSCs that may be vulnerable to tornado-induced missile hazards include offsite power, emergency diesel generator (EDG) ventilation, fuel oil storage tank and day-tank vents, the ultimate heat sink and service water system, above ground piping for safety-related systems, and any interface between safety-related and non-safety related components. [Supports IP 71111.01, Sections 02.02d, 02.05]
- b. During high wind conditions (or when high winds are forecast), does the licensee secure all portable equipment, shrouds, housings, siding, roofing, and any other miscellaneous loose material, that could be at high risk for damage/missile generation (particularly when work areas are unattended)? [Supports IP 71111.01, Sections 02.01b.2, 02.03a, 02.03b, 02.03d, 02.05]
- c. Is the following equipment protected from potential missile hazards: Outdoor power supplies in the switchyard, fuel/air lines for diesel operated equipment, piping associated with condensate and refueling water storage tanks, essential spray ponds, cooling towers and associated equipment (e.g., tower fans), and any other equipment that, if damaged by high winds or missile generation, could cause further damage, plant transient or scram, or exacerbate the mitigation of any accident? [Supports IP 71111.01, Sections 02.01b.2, 02.02a, 02.02c, 02.02d, 02.05]
- d. Walkdown the refueling floor to look for loose materials stored there that could become missiles during a tornado strike. [Supports IP 71111.01, Sections 02.02d, 02.05]
- e. For equipment required to operate/function after a tornado (check approved licensing assumptions), ensure that tornado missile protection is adequate. This includes components as well as structures located in outside environments. [Supports IP 71111.01, Sections 02.02a, 02.05]
- f. Ensure that any high pressure cylinders stored onsite are not located in proximity to safety-related equipment and piping. Check in overhead spaces and other off-path locations. [Supports IP 71111.01, Sections 02.02d, 02.05]

04.02 Procedures. The recommended inspection activities described below support IP 71111.01, “Adverse Weather Protection and IP 71111.21, “Component Design Basis Inspection.”

- a. Has the licensee correctly translated the regulatory requirements and design basis information into specifications, drawings, procedures and instructions for consideration

of tornado and high impact on safety related equipment? Note that the use of probabilistic codes (e.g., TORMIS) to justify operability of structures, systems, or components may not be adequate and are not allowed unless specifically approved for that site (see [Regulatory Issue Summary \(RIS\) 2008-014](#), “Use of TORMIS Computer Code for Assessment of Tornado Missile Protection” for more guidance on acceptable use of TORMIS).

[Supports IP 71111.01, Section 02.02a; and IP 71111.21, Sections 02.01c, 02.02a]

- b. Review use of procedures during adverse weather events to ensure that the licensee adheres to guidance concerning the identification of potential missile hazards (e.g., around transformer yards and the EDG building) and that they enter the correct procedure when adverse weather is forecast.
[Supports IP 71111.01, Sections 02.02a, 02.02c, 02.03a, 02.03b]
- c. Ensure that the licensee does not have a narrowly defined definition of a missile. Some licensee procedures identify specific types of materials that have the potential to become missiles. An unintended consequence may be that potential missiles aren't identified because they are not sufficiently similar to the examples provided in the licensee's procedure.
[Supports IP 71111.01, Section 02.02a]
- d. Ensure that the licensee can shut all normally open tornado doors in a timely manner.
[Supports IP 71111.01, Section 02.02a]

04.03 Design Basis. The recommended inspection activities described below support IP 71111.21, “Component Design Basis Inspection.”

- a. Does the licensee have calculations with respect to tornado wind loadings and missile generation for safety related equipment, such as the EDG fuel oil storage tanks (either above or below grade) and vents associated with the EDGs (fuel oil storage tanks, EDG crankcase, exhaust, and day tank vents)?
[Supports IP 71111.21, Sections 02.01c, 02.02a]
- b. Does the license have appropriate calculations with respect to tornado wind loadings and missile generation for all cranes, fuel transfer casks, condensate storage tank piping, and protective enclosures for structures or equipment (e.g., service water pump greenhouse covers)?
[Supports IP 71111.21, Sections 02.01c, 02.02a]
- c. Has the licensee used TORMIS (Agencywide Document Access Management System (ADAMS) Accession No. [ML080870291](#)), which is a tornado probabilistic methodology developed by EPRI and approved by the NRC in 1983, to justify not providing positive protection against tornado or missile generation based on this code? Note that [RIS 2008-014](#) provides NRC guidance on acceptable use of the program. Inspectors may consider identifying instances where the licensee has submitted a license amendment to not provide positive protection against missile generation based on this code.
[Supports IP 71111.21, Sections 02.01c, 02.02a]

04.04 Though most inspection effort for missile protection is directed through IP 71111.01, “Adverse Weather Protection,” and IP 71111.21, “Component Design Basis Inspection,” actual missile events may originate from a variety of causes, including catastrophic transformer failure, high energy line break, turbine failure, or steam release. It may be appropriate to consider other IPs for follow up inspection activities. Examples of previous findings identified through other inspection activities are provided in the ‘Reference’ section below.

OpESS 2012/01-05 REFERENCES

05.01 Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50

- a. [Appendix A, “General Design Criteria for Nuclear Power Plants,”](#) Criterion 2, “Design bases for protection against natural phenomena,” requires that SSCs important to safety be designed to withstand the effects of tornados without loss of their ability to perform their safety function.
- b. [Appendix A, “General Design Criteria for Nuclear Power Plants,”](#) Criterion 4, “Environmental and dynamic effects design bases,” requires that SSCs important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.
- c. [Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,”](#) Criterion 3, “Design control,” requires that regulatory requirements are correctly translated into specifications, drawings, procedures, and instructions.

05.02 Regulatory Documents and Communication.

- a. [Regulatory Guide \(RG\) 1.76,](#) “Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants”
- b. [RG 1.117,](#) “Tornado Design Classification”
- c. [Generic Letter 88-20, Supplement 4,](#) “Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities,” requested that licensees perform an assessment the impact on plant risk of, among other external events, high winds and tornados.
- d. [NUREG 1742,](#) “Perspectives Gained From the Individual Plant Examination of External Events (IPEEE) Program,” summarizes the results of licensee IPEEE submittals.
- e. [RIS 2008-014,](#) “Use of TORMIS Computer Code for Assessment of Tornado Missile Protection,” provides NRC guidance on acceptable use of TORMIS.
- f. [Information Notice 2011-14,](#) “Component Cooling Water System Gas Accumulation and Other Performance Issues,” describes the Prairie Island white finding in more detail.
- g. Task Interface Agreement 2011-011, “Evaluation of Point Beach Nuclear Plant Tornado Missile Protection Licensing Basis” (ADAMS Accession No. [ML11228A257](#)).

05.03 Previous inspection findings (grouped by IP applied in the identification of the finding).

a. IP 71111.01 “Adverse Weather Protection”

1. [ANO 2010-003](#) The inspectors identified a Green, Non-Cited Violation (NCV) of Technical Specification 5.4.1.a for failure to follow Procedure OP-1203.025, “Natural Emergencies,” Revision 30. Specifically, on April 23, 2010, the licensee entered the before mentioned procedure due to a tornado watch/warning and failed to identify and control potential missile hazards in and around the Unit 1 transformer yard.
2. [Kewaunee 2010-003](#) A finding of very low safety significance was identified by the inspectors for an inadequate operability determination performed for the emergency diesel generators. Specifically, the licensee used TORMIS for assessing tornado missile protection and confirming operability of their emergency diesel generator fuel oil day tank vents and storage tank vents. Probabilistic risk assessments were not allowed for confirming operability under both NRC guidance and the licensee’s procedures.

b. IP 71111.18 “Plant Modifications”

1. [Surry 2009-004](#) The inspectors identified a Green NCV of 10 CFR 50, Appendix B, Criterion III, “Design Control.” The design change for the emergency service water pumps was not adequate to protect the diesel-driven emergency service water pumps from damage resulting from a tornado missile as required by the UFSAR. The lack of tornado missile protection for the diesel engine exhaust pipes was initially identified on March 22, 2007.

c. IP-71111.21 “Component Design Bases Inspection”

1. [Robinson 2010-011](#) The team identified a Green NCV of 10 CFR Part 50, Appendix B, Criterion III, “Design Control,” for the licensee’s failure to have calculations supporting the design bases of safety related components, specifically for the EDG fuel oil storage tank with respect to tornado wind loadings, and the net positive suction head (NPSH) of the service water pumps. No immediate operability issues were identified.
2. [Cooper 2010-007](#) The team identified a Green NCV of 10 CFR Part 50, Appendix B, Criterion III, “Design Control,” for the failure to verify the adequacy of the service water system design. Specifically, prior to August 10, 2010, the licensee did not have a calculation to support storage of an ice deflector pontoon barge in the service water discharge canal during design tornado or high wind conditions.
3. [Davis Besse 2009-007](#) A finding of very low safety-significance and associated NCV of 10 CFR Part 50, Appendix B, Criterion XVI, “Corrective Action,” was identified by the inspectors for the failure to take interim corrective actions to address potential tornado missile damage to unprotected structures, systems, and components (SSCs) such as the EDG exhaust vent stacks.

d. IP 71111.22 “Surveillance Testing”

1. [Palisades 2008-004](#) The inspectors identified a finding of very low safety significance (Green) and an associated NCV of 10 CFR Part 50, Appendix B, Criterion III, "Design Control," for the failure to protect the auxiliary feedwater (AFW) pumps from damage due to the loss of the condensate storage tank (CST) due to tornado born missiles. The setpoints are designed to remove the AFW pumps from service prior to being damaged if the CST is lost or damaged in a tornado. The inspectors concluded that during a tornado, wind and missiles could damage the CST in a manner that the low pressure trip might not remove the pump from service prior to ingestion of air or severe vortexing.

e. IP 71152 “Problem Identification and Resolution”

1. [Watts Bar 2009-003](#) The NRC identified a Green NCV of 10 CFR 50, Appendix B, Criterion V, Instructions, Procedures, and Drawings, for the licensee’s failure to adequately implement work order instructions to maintain the integrity of the intake pumping station missile shield, as designed. The failure to assure adequate tornado missile protection had a credible impact on reactor safety because of the potential exposure of both trains of the ERCW system to tornado induced damage.
2. [Braidwood 2009-003](#) A finding of very low safety significance was identified by the inspectors associated with the failure to control or remove material adjacent to the Unit 1 main power transformers, station auxiliary transformers and unit auxiliary transformers. Plant personnel failed to identify these discrepant conditions during the performance of a plant surveillance procedure with the purpose of identifying and removing potential missile hazards from areas where they could damage important plant electrical equipment during adverse weather conditions.

05.04 Previous inspection findings (grouped by finding subject).

a. Findings Involving Equipment Vulnerable to a Potential Missile.

1. [Prairie Island 282/2009-010](#) The inspectors identified an apparent violation of 10 CFR Part 50, Appendix B, Criterion III, “Design Control,” for Unit 2 due to the licensee’s failure to implement design control measures to ensure that the design of the Unit 2 CCW system was adequate to mitigate licensing basis events (such as high energy line break, seismic and tornado events) which could occur in the turbine building. The events in the turbine building could cause a loss of CCW inventory and a loss of safety function.
2. [Byron 2009-004](#) A finding of very low safety significance and associated NCV of 10 CFR 50, Appendix A, Criterion 2, “Design Basis for Protection Against Natural Phenomena,” and Criterion 4, “Environmental and Natural Effects Design Bases,” was identified by the inspectors for the failure to seismically support and protect the EDG fuel oil storage tank vent lines from tornado generated missiles. Specifically, the licensee installed the vent lines as non-safety related and as such they were not seismically supported and not protected from tornado generated missiles.

b. Findings Involving Potential Missile Hazards

1. [Fermi 2010-003](#) The inspectors identified a Green finding for the licensee's failure to adequately control loose materials near the 345kV switchyard. The licensee had a reactive procedure for tornado watches and warnings, which directed plant personnel to verify all outside equipment, cranes, etc., were properly secured or other compensatory measures were taken for equipment use. However, the inspectors did not identify any procedures to prepare for adverse weather conditions with respect to tornado and high wind conditions, nor did the inspectors identify any preparatory procedures to control loose materials in the protected area or switchyard.
2. [Point Beach 2009-006](#) A finding of very low safety significance was identified by the inspectors for the licensee's failure to maintain control over the proper storage and placement of materials within the risk significant areas of the outdoors protected area, classified as high winds/tornado hazards in accordance with station procedures. Specifically, these unsecured items were identified near the Unit 1 and Unit 2 main transformer lines, auxiliary transformers, and the G-03/G-04 emergency diesel generator building.

c. Findings Involving the Misapplication of TORMIS

1. [Prairie Island 2010-009](#) The inspectors identified an NCV of 10 CFR 50, Appendix B, Criterion III, design control. Specifically, the licensee failed to design the D1/D2 diesel generators to survive impact from the design basis missiles. Although the NRC approved the use of TORMIS in a Safety Evaluation Report (ML080870291), the approval did not incorporate the use of TORMIS into the license basis of Prairie Island. 10 CFR 50.59(c)(2)(viii) requires a license amendment for the use of the TORMIS methodology. Prairie Island Nuclear Power Plant did not receive NRC approval for the use of TORMIS.
2. [Fermi 2008-004](#) The inspectors identified a finding of very low safety significance (Green) with an associated severity level IV NCV for an inadequate 10 CFR 50.59, "Changes, Tests, and Experiments," evaluation resulting in failure to receive prior NRC approval for changes in licensed activities associated with protection of safety-related equipment against tornado generated missiles. Specifically, the licensee failed to demonstrate that the proposed change did not result in an increase in the probability of a malfunction of equipment important to safety previously evaluated in the UFSAR.

d. Findings Involving Actual Missile Events

1. [Braidwood 2010-010](#) A finding of very low safety significance was identified by the inspectors for the inadequate evaluation of operating experience (OE). Specifically, review of an event at another plant where building material was dislodged during a steam release and caused a loss of off-site power concluded that event was not applicable to Braidwood station. During the dual unit trip on August 16, 2010, reactor building flashing was dislodged during a steam release and was found on power lines and in the vicinity of the off-site power supplies. While there was no effect on the offsite power supply, the increased risk should

have been fully evaluated and addressed as a result of the operating experience review.

2. [River Bend 2008-004](#) A self-revealing finding was identified for wind induced turbine building siding failure that occurred significantly below design specified stress levels as a result of design and installation deficiencies. This resulted in a forced outage to repair transformer damage and to repair the turbine building siding. The licensee missed prior opportunities to identify turbine building siding design and installation deficiencies following damaging wind events in 1992 and 2005 which resulted in siding detaching from the turbine building. In both cases, the licensee concluded that the siding released as designed and did not conduct an apparent cause analysis to determine the appropriate failure mechanism.
3. [Fort Calhoun 2007-010](#) A self-revealing NCV of Technical Specifications occurred for an inadequate procedure that narrowly defined the definition of a missile. This inadequacy resulted in the loss of 161 kilovolt power to the safety-related busses on August 20, 2007 during a high wind event when debris not meeting the definition of a missile struck a transformer relay cabinet.

OpESS 2012/01-06 REPORTING RESULTS/TIME CHARGES/ADDITIONAL ISSUES

If information from this OpESS is used to inform the sample selection for a baseline IP, include the OpESS number and title in the 'List of Documents Reviewed' section of the relevant inspection report.

In addition, if any findings or violations are identified in conjunction with this OpESS, include a statement similar to the following in the description section of the finding write-up:

This [finding or violation] was identified in connection with a review of Operating Experience Smart Sample [number and title].

Inspection time for this OpESS is to be charged to the normal baseline procedure under which it is being documented.

OpESS 2012/01-07 CONTACTS

For technical support regarding the performance of this OpESS and emergent issues, contact Edward Smith (NRR/DSS/SBPB) at 301-415-1548 or Edward.Smith@nrc.gov, or Rebecca Sigmon (NRR/DIRS/IOEB) at 301-415-4018 or Rebecca.Sigmon@nrc.gov, or John Thompson (NRR/DIRS/IOEB) at 301-415-1011 or John.Thompson@nrc.gov.

For administrative, reporting, or documentation questions, contact Jeremy Bowen (NRR/DIRS/IRIB) at 301-415-3471 or Jeremy.Bowen@nrc.gov.

Revision History for OpESS 2012/01

Commitment Tracking Number	Issue Date	Description of Change	Training Needed	Training Completion Date	Comment Resolution Accession Number
N/A	ML 12003A118 12/29/11	Initial issuance.	N/A	N/A	ML11339A064