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U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTENTION: Document Control Desk

SUBJECT: Oconee Nuclear Station Units 1, 2 and 3
Docket Nos: 50-269, 270 and 287
Future Oconee Tornado Mitigation Strategy

As requested, Duke Power Company LLC d/b/a Duke Energy Carolinas, LLC (Duke), is responding to a portion of the information requested in the Nuclear Regulatory Commission's (NRC) February 28, 2006, letter regarding Duke's intended mitigation strategies for tornado and HELB related events. In that letter, the NRC further requested that Duke include key risk and/or event assumptions, the intent/concept behind the planned analyses, and the major milestones toward timely resolution for each event. This submittal addresses the requested information for tornado events only. Similar information will be submitted for HELB events in a separate letter.

Four (4) attachments are provided. Attachment 1 describes the future Oconee Nuclear Site (ONS) tornado mitigation strategy, key event assumptions, the structures, systems and components (SSCs) necessary to support the strategy, and the physical protection afforded for the mitigating SSCs. Attachment 2 summarizes an evaluation of SSCs that are not fully protected from tornado missiles. Attachment 3 includes previous Duke Responses to NRC questions on tornado design and licensing basis issues. Attachment 4 outlines major milestones associated with the development, review, transmittal and approval of License Amendment Requests (LARs) to incorporate the tornado mitigation strategy.

As shown in Attachment 4, two LARs are scheduled. The first LAR will be submitted in June 2006 and will seek approval for the use of Fiber Reinforced Polymer (FRP) to reinforce block walls. The second LAR is scheduled to be submitted in October 2006, and will revise the ONS UFSAR to describe the tornado mitigation strategy that will apply after the modifications outlined in Duke's January 31, 2006 letter to the NRC and in Attachment 1 to this letter, are completed.

Associated modification schedules were previously outlined in Duke's letter dated January 31, 2006. A representative modification schedule was provided in Duke's letter dated March 9, 2006. Schedules for additional modifications outlined in this letter will be finalized at a later date.

Although implementation of the physical activities associated with the proposed LARs will significantly improve the clarity of Oconee's tornado CLB and enhance the mitigation strategies, full completion of the planned modifications and accompanying documentation will require a significant investment of Duke resources. Accordingly, to

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assure complete resolution of the regulatory issues, Duke is prepared to discuss any questions the NRC might have regarding this letter in a follow-up meeting scheduled at your convenience. Following that meeting, Duke will seek Staff assurance that the approach described herein will lead to resolution of outstanding issues with the Oconee tornado CLB.

If future tornado-related issues are identified that may adversely affect SSC operability, those issues will be promptly entered into the Oconee corrective action program. For the remainder of the tornado upgrade project, Duke requests that the NRC exercise enforcement discretion in accordance with Section VII of the NRC Enforcement Policy. This will allow Duke to evaluate and correct each identified issue in an expeditious manner as an integral part of the overall project plan. This concept is similar to the process being employed in the fire protection area for transition to NFPA-805.

In addition, as discussed at the February 7, 2006 meeting at NRC headquarters, the Staff requested Duke to consider employing a Failure Modes and Effects Analysis (FMEA) to evaluate the ONS tornado mitigation strategy. Duke has carefully considered this approach and determined that the existing ONS tornado probabilistic risk analysis (PRA) model has the necessary detail and sophistication to properly model the effects of potential component failures; therefore, the development of a FMEA is not planned at this time. Duke processes ensure that future plant modifications are reviewed for PRA impact and the model revised accordingly.

If you have any questions or comments regarding this letter, please contact Stephen C. Newman of the Oconee Nuclear Site Regulatory Compliance Group at 864-885-4388.

Sincerely,

Henry B. Barron

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Attachments

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Attachment 1

Oconee Nuclear Site Tornado Mitigation Strategy

INTRODUCTION

The Oconee tornado mitigation strategy described herein is based on the configuration that will exist after implementation of the modifications outlined in Duke's letter to the NRC dated January 31, 2006. The strategy assumes that a large tornado engulfs the Oconee Nuclear Station (ONS) during full power operation and disables the emergency electrical buses located in the turbine building of all three units. A further assumption is that a tornado will not cause concurrent damage to the Keowee Hydro Units and the station.

The ONS tornado mitigation strategy will rely on two redundant and largely separate systems to restore secondary heat removal (SHR) and reactor coolant pump seal injection (RCP SI) subsequent to a tornado. The objective of the mitigation strategy will be to maintain the plant in mode 3 until damage control measures are implemented to cool the plant to a cold shutdown condition. Either the Standby Shutdown Facility (SSF) systems or the upgraded station auxiliary service water (renamed protected service water - PSW) and high pressure injection (HPI) systems will have the capability to perform this objective.

The components that perform the functions to support the mitigation strategy will be 1) protected from tornado wind, differential pressure, and missile damage per ONS UFSAR criteria, 2) physically separated so that it can be assumed that multiple components that perform the same function are not damaged and the function is achieved, <u>or</u> 3) protected from tornado wind, and differential pressure, and demonstrated to have a low probability of missile damage using TORMIS.

The mitigation strategies, as related to SHR and RCP SI, are described in further detail as follows:

1. SECONDARY HEAT REMOVAL

SHR will be provided by the SSF auxiliary service water (ASW) or the PSW systems.

1.1 Protected Service Water

Duke's letter to the NRC, dated January 31, 2006, outlines Station ASW mechanical and electrical system modifications to be implemented. The modifications will allow the renamed PSW system to be actuated, aligned and controlled from each of the Oconee control rooms so that secondary heat removal can be promptly and concurrently established to each steam generator on all three units. PSW alignment and control will be accomplished in time to prevent two phase discharge of water through the pressurizer safety valves (PSVs) and to establish natural circulation assuming the RCPs are lost as a consequence of the event. Only one steam generator per unit will be required to maintain adequate cooling to the reactor coolant system (RCS). PSW related isolation and control valves will be located below grade in the auxiliary building and will therefore be protected from tornado damage. The PSW system will be upgraded to a high pressure system so that water can be introduced to a fully pressurized steam generator (SG). Steam relief will be accomplished through the main steam relief valves (MSRVs) located on the main steam piping downstream of the SGs. Subsequently, the steam pressure will be controlled using the atmospheric dump valves (ADVs) to limit the number of MSRV cycles. The PSW pump will receive water from the unit 2 condenser circulating water (CCW) inlet piping. The majority of this piping is embedded. The portion of the piping that is not embedded is below grade in the turbine building. There is limited susceptibility to tornado missiles through equipment openings located in the third and fifth floor of the turbine building

The PSW pumps will receive power from new switchgear that will be located in a tornado protected enclosure. The switchgear will receive power from the Keowee Hydro Station through the underground path. The Keowee Hydro Station is located approximately ¾ of a mile away from the Oconee Station.

1.2 Standby Shutdown Facility Auxiliary Service Water

The SSF ASW system provides an alternate secondary heat removal mitigation path. Operators are dispatched to the SSF upon receipt of a tornado warning from the National Weather Service. Tornado warnings are monitored using a weather radio in the unit 1 and 2 control room and work control center. The SSF ASW system is actuated, aligned and controlled from the SSF control room. All system components are powered from the SSF diesel generator. Should the SSF diesel fail, the new switchgear will be capable of providing power to the SSF power system. Water is supplied to the SSF ASW pump via the unit 2 CCW inlet piping. The SSF ASW pump is sized to provide sufficient flow to all 3 units. Flow can be controlled from the SSF control room to each steam generator. Only one steam generator per unit is required to maintain adequate decay heat removal. The SSF ASW pump is a high pressure pump and is designed to provide flow to a fully pressurized steam generator. Steam is relieved from each generator through the MSRVs. Subsequently, the steam pressure will be controlled using the atmospheric dump valves (ADVs) to limit the number of MSRV cycles.

1.3 Secondary Heat Removal Systems – Feedwater Pipe Routing

The piping for both secondary heat removal systems enters the reactor building through the penetration rooms. The two penetration rooms, east and west, are separated to a large degree, by the reactor building. Between the rooms, there is a connecting corridor for transversing pipes and cables.

The PSW system feeds both SGs on each unit. One feedwater header enters the reactor building from the west penetration room and the other enters the reactor building from the east penetration room. The feedwater path to each SG is redundant to and separate from the other. The east penetration room is largely protected from tornado missiles by adjacent structures. The probability of missile damage to equipment located in the east penetration room is unlikely. Additionally, much of the west penetration room is shielded from missiles by the Borated Water Storage Tank (BWST).

The SSF ASW system also feeds both SGs. The piping enters the reactor building from the west penetration room and from the cask decontamination room below it. The SSF ASW piping in the west penetration room is largely contained in metal guard pipes or shields and largely shielded from tornado missiles by the BWST. Additionally, the exterior west penetration room and cask decontamination room block walls will be upgraded to withstand ONS UFSAR Class I wind and differential pressure (see Section 1.6 for additional details), to ensure that the walls do not fail and damage nearby equipment.

1.4 Secondary Heat Removal Systems – Instrumentation

The 'A' and 'B' SG level transmitter cables, that support level indication in the control room, enter the reactor building from the east and west penetration rooms. The cables that travel through the west penetration room also pass through the east penetration room. Much of the east penetration room is protected from tornado missiles by adjacent structures. However, in the unlikely scenario in which both of the cables in the east penetration room that support level indication in the control room are damaged, the SSF can still be used to mitigate the event since its cables enter containment from the west penetration room. 'A' and 'B' SG level cables that support indication in the SSF control room both enter the reactor building from the west penetration rooms. The west penetration room cables to the SSF control room are largely protected from missiles by the BWST. Nonetheless, a metal missile shield will be added directly to or in front of a portion of the west penetration room wall to provide additional protection for the SSF cables.

Similar separation and redundancy is provided for RCS temperature indication. RCS core exit thermocouples and hot leg temperature transmitter cables that support indication in the control room enter the reactor building through the east penetration room. Cables that support SSF RCS temperature indication pass through the west penetration room. As previously stated, all SSF cables will be provided additional protection using a metal missile shield.

1.5 Secondary Heat Removal – Auxiliary Building Penetration Room Exterior Walls

The auxiliary building west penetration room and cask decontamination room exterior, block walls were not constructed to the Class I tornado wind and differential pressure standards. A bounding analysis was performed to determine the most probable tornado wind and differential pressure capacity of these exterior walls. The analysis used the same approach that Duke applied to the resolution of IEB 80-11 "Masonry Wall Design". The analysis concluded that the bounding, mean capacity of the walls coincided with a 324 mph tornado. The results of this analysis significantly improve the risk to the wall from a tornado when compared to that reported in the IPEEE. Nonetheless, a fiber reinforced polymer (FRP) will be applied to the west penetration room block walls to further enhance the safety factor of the walls. This will ensure, with FRP installed, the west penetration room/cask decontamination walls will remain intact at wind speed and differential pressures applied to Class 1 structures in the ONS UFSAR.

The exterior east penetration room walls are constructed of metal blowout panels. Consequently, there are no exterior block walls that could fail and damage adjacent equipment.

1.6 Secondary Heat Removal – Main Steam

The steam lines that are external to the reactor building are not fully enclosed. The main steam lines pass from the reactor building to the turbine building up to the turbine stop valves. Branch lines extend from the main steam line to various components located in the turbine building. The main steam piping outside the turbine building is elevated. For this reason, large missiles, such as automobiles, are unlikely to strike the piping. Additionally, the main and branch steam piping insulation and metal provide a measure of protection against other tornado missiles. The vast majority of the branch piping is located below the concrete floor of the turbine deck which further protects the lines from tornado missiles.

An analysis of the unit 1 main steam and moisture separator branch lines indicates that these lines are capable of withstanding ONS UFSAR Class I wind loads. The analysis credits snubber activation (or lock-up) in response to the tornado. Pipe and pipe support stresses were compared to B31.1 code allowables in the faulted condition or current design allowables for acceptability. The results of these analyses will be further evaluated to ensure that they bound all other configurations.

1.7 Secondary Heat Removal- Power Supply

The SSF ASW components receive power from the SSF diesel which is protected from the effects of a tornado by the SSF structure. PSW components receive power from Keowee Hydro through the underground path to the protected switchgear.

PSW instrument and control power is received from the station's vital instrument buses. These buses are powered from the 125VDC control battery chargers via the protected switchgear and the 125 VDC control batteries. The vital instrument buses can also receive power from the alternate unit.

There is currently no analysis to confirm that the control battery room exterior block walls are capable of withstanding ONS UFSAR Class I tornado wind and differential pressure criteria. An analysis will be performed to determine if the wall is capable of withstanding Class I wind and differential pressure loads. The analysis will be performed using a method that Duke employed to resolve IEB 80-11, "Masonry Wall Design". The method credits arching action. If the analysis is unable to confirm that the walls are capable of withstanding the Class I loads; the walls will be upgraded to sustain these loads.

The north wall of the unit 1 control battery room and the south walls of the unit 2 and 3 control battery room are located just above the roof line of the third floor of the auxiliary building and therefore have some exposure to tornado missiles. The east walls of all three battery rooms are protected by the turbine building deck and equipment located in the turbine building. The west walls of the battery rooms face into the east penetration rooms for the respective unit. These walls are reinforced with metal for the high energy line break (HELB) event.

SSF ASW instrument and control power is received from the SSF 125VDC power system. This system is protected by the SSF structure.

2 RCP SEAL INJECTION (RCP SI)

RCP SI can be provided by either the Standby Shutdown Facility (SSF) reactor coolant (RC) makeup pumps or one high pressure injection (HPI) pump per unit.

2.1 High Pressure Injection

Duke's letter to the NRC, dated January 31, 2006, outlined modifications that are to be made to the HPI system, RCS high point vent valves and pressurizer electrical power supplies and controls. The modifications will allow one HPI pump from each unit to be aligned and controlled from the control rooms in a timely manner to provide seal injection to the RCP seals. Borated water is supplied to the HPI pumps from the BWST. The critical portion of the BWST will be protected from tornado damage to meet the Class I ONS UFSAR criteria. Restoration of seal injection will be performed in time to prevent seal degradation, consistent with current deterministic standards. The modifications will also allow the RCS high point vents and pressurizer heaters to be operated from the control room. The HPI pump can provide seal injection in excess of that required to offset losses through the RCP seals. Increases in pressurizer level are controlled by aligning letdown through the high point vents or by increasing secondary heat removal. All components will receive power from new switchgear located in a tornado protected structure. The switchgear will receive power from the Keowee Hydro units through the underground path.

2.2 Standby Shutdown Facility RC Makeup

The SSF RC makeup system to the RCP seals is an alternate seal injection path. A SSF RC makeup pump is located in the reactor building of each unit. Operators are dispatched to the SSF upon receipt of a tornado warning from the National Weather Service (same as for SSF ASW). If the RCP seal cooling function is lost, the SSF RC makeup pumps are energized and aligned to the RCP seals from the SSF control room. All system components are powered from the SSF diesel generator. Should the SSF diesel fail, the new switchgear will have the capability to provide power to the SSF power system. Borated water is supplied to the SSF RC makeup pumps from the spent fuel pool (SFP) for the respective unit. The SSF RC makeup pump is sized to provide makeup in excess of that required to offset losses through the RCP seals. Increases in pressurizer level are controlled by aligning letdown from the RCS to the SFP or by increasing SHR. RCS letdown to the SFP is accomplished from the SSF control room. Sufficient pressurizer heaters can be energized from the SSF control room and powered from the SSF diesel to offset ambient heat losses and steam leakage from the pressurizer.

2.3 RCS Seal Injection- Pipe Routing

RCP SI from HPI to two of the RCP seals enters the reactor building from the west penetration room. RCP seal injection to the other two RCP seals enters the reactor building from the east penetration room. The RCP seal injection to the west penetration room is supplied from a header that also runs through the east penetration room. This header supplies the RCP seal injection lines in the east penetration room. There are portions of the HPI makeup piping that interconnect between the east and west penetration rooms that must remain intact for HPI seal injection to function. Missile damage in the east penetration room is remote because of its proximity to adjacent structures. Additionally, most of the west penetration room is shielded from potential tornado missile damage by the BWST.

RCP SI from the SSF is located in the reactor buildings with the exception of electrical supply, instrumentation and control cables. These cables run through the west penetration and cask decontamination room before entering the reactor building and are largely shielded from potential tornado missile damage by the BWST.

The reactor building does not form a barrier between the HPI RCP seal injection lines and SSF related cables that pass through the west penetration room. Although there is significant spatial separation between the HPI and RC makeup lines and SSF cables at most points, the degree of separation is more limited than that afforded the SHR systems. For this reason, Duke will add a metal missile shield to a portion of the west penetration room wall to provide additional protection for the SSF cables. This modification will ensure that the likelihood of missile damage to the SSF RC makeup function satisfies the TORMIS acceptance criteria.

2.4 RCS Seal Injection– Instrumentation

Pressurizer level transmitter cables, that support level indication in the control room, enter the reactor building through the east penetration room. Pressurizer level transmitter cables, that support level indication in the SSF control room, enter the reactor building through the west penetration room. Consequently, there is redundant and separate pressurizer level indication in the control room and SSF.

Similarly, pressurizer heater cables that support heater control from the control room, enter the reactor building through the east penetration room. Cables that support heater control from the SSF enter the reactor building from the west penetration room. Consequently, there is redundant and separate pressurizer heater control in the control room and SSF.

2.5 RCS Seal Injection– Power Supply

Refer to Section 1.7.

3 Protection Against the Effects of a Tornado

The protection against the effects of a tornado will be discussed in terms of 1) wind and differential pressure and 2) missiles.

3.1 Protection Against Tornado Wind and Differential Pressure

In general, components that support the SHR and RCP SI tornado mitigation functions will be capable of withstanding the tornado wind and differential pressure defined in the ONS UFSAR for Class I structures. An analysis of the unit 1 main steam and the unit 1 moisture separator reheater branch line has been performed. The results of the analysis will be validated to ensure they bound all other steam line configurations. The results of the analysis indicate that these lines can withstand the ONS UFSAR Class I wind criteria. If other configurations are found to be more limiting at a later date, those configurations will be analyzed and upgraded to the Class I criteria as necessary. An analysis will also be performed to determine if the control battery room exterior block walls can withstand the ONS UFSAR Class I wind and differential pressure criteria. The analysis will be performed using the method that Duke employed to resolve the IEB 80-11, "Masonry Wall Design", issue. The walls will be upgraded to the Class I standard if the analysis indicates that the walls are not capable of withstanding the associated load.

3.2 Protection Against Tornado Missiles

Components that support the SHR and RCP SI tornado mitigation functions are either fully protected from tornado missiles, physically separated from a redundant component that can continue to perform the tornado mitigation function or evaluated using TORMIS for the probability of missile damage. An evaluation is performed in Attachment 2 of those components that are not fully protected from the tornado missiles. The evaluation concludes that the majority of the components are physically separated from a redundant component that can continue to perform the tornado mitigation function. The TORMIS methodology will be employed to evaluate the probability of damage to components in only three cases. The results of the TORMIS analysis will be considered acceptable if the mean failure probability of the SHR function is less than 1E-6/rx-yr and the mean failure probability of the RCP SI function is less than 1E-6/rx-yr. The three cases that will be analyzed are as follows:

- Unit 2 CCW line- This line provides the source of inventory to SHR systems. The majority of the line is embedded. Portions of the line that are not embedded are largely protected from missiles by the third and fifth floor of the turbine building.

Equipment openings located in the floors allow some exposure of the line to tornado missiles. TORMIS will be used to evaluate the probability of losing the SHR function due unit 2 CCW line damage.

- HPI RCP SI lines and SSF Cables in the West Penetration/Cask Decontamination Rooms- 2 of the 4 HPI RCP SI lines and the SSF cables that support SSF RC makeup pass through the west penetration and cask decontamination rooms. The lines and the cables are largely shielded from missiles by the BWST. Although there is a large amount of spatial separation between the HPI RCP SI lines and SSF cables at most locations, there is a limited amount of separation in one location. Metal shielding will be added in front of the SSF cables to limit the likelihood of damage to both components. TORMIS will be used to evaluate the probability of losing the RCP SI function due to HPI RCP SI line and SSF cable damage in the west penetration and cask decontamination rooms.
- Steam Lines- The steam lines outside containment have some exposure to tornado missiles. The main steam lines are largely elevated and therefore, not susceptible to large missiles such as automobiles. The branch steam lines are largely located below the turbine deck and, therefore, afforded protection by the concrete floor. Additionally, all of the steam lines are afforded some protection from missiles by the insulation and metal wall of the pipe. TORMIS will be used to evaluate the probability of damage to the SHR function resulting from steam line damage.

The SHR and RCP SI functions will be evaluated for missile damage using the TORMIS methodology. If the analysis indicates that missile damage is greater than the probability allowed by the methodology, then additional missile protection will be constructed.

4 Emergency Operating Procedures

The ONS tornado mitigation strategy relies on timely alignment and control of redundant SHR and RCP SI systems:

- Alignment and control of SSF ASW and RC makeup from the SSF
- Alignment and control of PSW and HPI RCP seal injection from the control room

The SSF will be manned upon receipt of a tornado warning. If the SHR and/or RCP SI functions are lost, action will be taken to concurrently activate both sets of SHR and/or RCP SI systems subsequent to a tornado. Specific details of these actions will be delineated in emergency operating procedures. The ultimate means of providing SHR and RCP SI will be coordinated between the control room and SSF operators.

Operator actions will be performed in accordance with the response times outlined in Table 4.1 and 4.2. All response times will be tested in accordance with existing ONS requirements.

Table 4.1 Control Room Operator Actions[1]		
Action No.	Description of Operator Action	Response Time After Function Loss (min)
1	PSW established to at least one steam generator	15
2	HPI RCP seal injection established to all four RCPs	20

Table 4.2 SSF Operator Actions[1]		
Action No.	Description of Operator Action	Response Time After Function Loss (min)
1	SSF ASW flow is established to both steam generators	14
2	SSF RC makeup seal injection established to all four RCPs	20

Notes: 1) Response time assumes concurrent actions for all three units

Attachment 2

Tornado Missile Protection Evaluation of SSCs

EVALUATION OF SSCs NOT FULLY PROTECTED FROM TORNADO MISSILES

Item No.	Component	Redundant Components?[1]	Physical Separation?[1]	TORMIS?[3]	Comments
	Secondary Heat Removal (SHR)				
1	Unit 2 CCW supply header	N	N	Y	Unit 2 CCW header is mostly embedded piping; however, some portions are located above the basement floor. There is limited exposure to tornado missiles through equipment hatches located in the turbine bldg floor.
2	PSW and SSF ASW piping	Y	Y	N	PSW piping to one SG enters containment from the east penetration room. SSF ASW piping enters containment from the west penetration/cask decon rooms. Only 1 of 2 SGs is required to remove decay heat.
3	SSF ASW cables to FDW-347 and CCW-269	Y	Y	N	SSF ASW cables pass through east penetration/case decon rooms; however, PSW valve control cables will be located below grade in the auxiliary building.
4	Control battery power to PSW switchgear and components.	Y	Y	N	Control battery rooms are not completely protected from tornado missiles; however, vital control power can be provided from the alternate unit (ref. TS Bases 3.8.3). Additionally, SSF control power is protected in the SSF.

EVALUATION OF SSCs NOT FULLY PROTECTED FROM TORNADO MISSILES					
Item No.	Component	Redundant Components?[1]	Physical Separation?[1]	TORMIS?[3]	Comments
5	SG level indication cable	Y	Y	N	Cable that supports Station ASW (as outlined in item 2) enters containment from east penetration room. Cable that supports SSF ASW enters containment from west penetration/cask decon rooms.
6	Steam lines	N	N	Y	Main steam lines are well above grade and are less likely to be struck by large missiles such as automobiles. Branch steam lines are largely below the concrete floor of the turbine deck. Main and branch steam lines are largely afforded protection by insulation and metal of the pipe.
7	RCS temperature indication cables	Y	Y	N	'A' and 'B' core exit T/C and RCS hot leg temperature indication cables that support PSW enter containment from east penetration room. Associated SSF cables enter containment from west penetration/cask decon rooms.
8	Primary power supply to PSW and SSF ASW components	Y	Y	N	SSF ASW is powered from SSF diesel which is protected by SSF structure. PSW is powered from Keowee Hydro through underground path to protected switchgear on south side of station. Keowee is located ¾ of a mile away.
	RCP Seal Injection (RCP SI)				

EVALUATION OF SSCs NOT FULLY PROTECTED FROM TORNADO MISSILES					
Item No.	Component	Redundant Components?[1]	Physical Separation?[1]	TORMIS?[3]	Comments
9	BWST	Y	N	N	The critical portion of the BWST will be protected from missiles. The unprotected portion is not likely to be struck by large missiles such as automobiles due to its elevation. SSF RC makeup from the SFPs is also available.
10	RCP SI pipe and cables	Y	N[2]	Y	The SSF RC makeup cables and HPI seal injection pipe both pass through the west penetration room. The SSF cables that run through the west penetration room will be further protected with metal shielding to minimize the likelihood of concurrent damage to both the SSF RC makeup cables and the HPI RC seal injection pipe.
11	Control battery power to HPI switchgear and components.	Y	Y	N	Same as item 4.

EVALUATION OF SSCs NOT FULLY PROTECTED FROM TORNADO MISSILES

Item No.	Component	Redundant Components?[1]	Physical Separation?[1]	TORMIS?[3]	Comments
12	RCS letdown	Y	Y	N	There are 3 RCS letdown pathways. There is at least one pathway whose cables enter the RB through each penetration room. At some point, all cables pass through the east penetration room. SSF cables to SSF letdown valves enter containment from the west penetration room. Metal shielding will be installed in front of the SSF cables to provide additional protection against tornado missiles. Additionally, RCS level can be controlled by increasing SHR.
13	Pressurizer level indication cable	Y	Y	N	The pressurizer level indication cable that supports HPI enters containment from the east penetration room. The level indication cable that supports SSF RC makeup enters containment from the west penetration/cask decon rooms.
14	Pressurizer heater cable	Y	Y	N	The pressurizer heater cables controlled from the SSF enter containment from the west penetration/cask decon rooms. The pressurizer heater controlled from the control room enter containment from the east penetration room.

EVALUATION OF SSCs NOT FULLY PROTECTED FROM TORNADO MISSILES					
Item No.	Component	Redundant Components?[1]	Physical Separation?[1]	TORMIS?[3]	Comments
15	RCS pressure indication	Y	Y	N	2 runs of impulse tubing that support RCS pressure indication in the control room enter containment from the east penetration room. Associated SSF cables enter containment from the west penetration/cask decon rooms.
16	Primary power supply to HPI and SSF RC makeup components	Y	Y	N	Same as item 8.

Notes:

1. If components are redundant and physically separated by a large distance or by the presence of a large obstruction such as containment, there is no need to apply TORMIS to determine the likelihood of missile damage. This approach is consistent with Section 6.2 of the 1970 ONS unit 1 SER. The SER stated that "with regard to both tornado and turbine generated missiles, Class 1 (seismic) components in the auxiliary building will either be protected by concrete walls and roofs designed to prevent potential missile penetration, or be separated to prevent failures in redundant systems from such missiles."
2. The majority of the SSF RC makeup cable and the HPI seal injection piping in the west penetration room are separated by a large distance; however, there is one location where the separation is less than 15 feet. For this reason, the SSF RC makeup cable and the HPI seal injection piping are not considered physically separate.
3. The TORMIS method (EPRI topicals NP-768, 769 and 2005) was generically reviewed and approved by the NRC in a SER dated November 29, 1983. Application of TORMIS at ONS was previously reviewed and approved by the NRC in a SER dated July 28, 1989.

Attachment 3

Disposition of Tornado Vulnerabilities

The proposed ONS tornado strategy addresses each of the licensing basis tornado mitigation issues and discrepancies and tornado mitigation vulnerabilities documented by the NRC in Section 2.2 of an attachment to a letter dated November 4, 2004 (Adams No. ML042990009) and in an attachment to an email dated February 22, 2005 (Adams No. ML050530094). The specifics of this correspondence and the disposition of each issue/vulnerability are provided below [Note: NRC issue given in italics followed by Duke's response].

Licensing Basis Tornado Issues and Discrepancies

1. The current 45 day allowed outage time (AOT) for the SSF failed to consider the current role of the SSF that is credited for tornado mitigation and therefore, the 45 day AOT has not been adequately justified and should be reconsidered.

The 45 day AOT for the SSF was selected to support the refurbishment of the SSF diesel generator. The average availability of the SSF is maintained at or above 95 percent by the maintenance rule in accordance with Station Blackout (SBO) requirements.

The proposed change provides a new PSW system and power supplies to various HPI and RCS components that will provide the capability to control in a timely manner and align SHR and RCP SI from the control room subsequent to a tornado. Selected Licensee Commitments (SLCs) will be revised to introduce surveillances for the new systems, to maximize the availability of the new systems and to discourage unavailability of these systems when the SSF is out of service or vice versa.

2. Because the main steam lines outside containment are not fully protected from tornadoes and the Oconee units do not have main steam isolation valves, multiple failures of the steam lines could occur as a consequence of tornado-induced damage to the shared turbine building and enclosed main steam lines. Failure of the main steam lines due to a tornado could result in excessive steam generator (SG) tube stresses and an unanalyzed radiological release to the environment via the shared turbine building.

The turbine building is not anticipated to fail due to the ONS UFSAR Class I wind. The metal sheathing on the building would be removed by the tornado. The associated wind would then move unimpeded through the remaining structural frame. Existing analysis is being refined to provide additional justification for this conclusion.

Analysis indicates that the main and branch steam lines are capable of withstanding the ONS UFSAR Class I winds. An evaluation will be performed to ensure the analysis is bounding for all configurations. Upgrades will be implemented accordingly.

The steam lines will be evaluated for missile damage using the TORMIS methodology. If the analysis indicates that missile damage is greater than the probability allowed by the methodology, then additional missile protection will be constructed.

3. When relying on the station auxiliary service water (ASW) system for secondary side heat removal (SSHR) in accordance with existing licensing-basis criteria, high pressure injection (HPI) pump makeup to the reactor coolant system (RCS) is relied upon to prevent exceeding SG tube stresses. Because HPI is not an assured means of providing reactor coolant makeup following a tornado, SG tube ruptures and unanalyzed radiological releases are a potential consequence of a tornado.

The low pressure station ASW system will be replaced by the new, high pressure PSW system. The new system will eliminate the need to depressurize the SGs thus eliminating tube-to-shell differential temperature concerns.

4. When relying on the station ASW system for SSHR in accordance with the existing Oconee licensing basis, the licensee relies upon the pressurizer Power-Operated Relief Valve (PORV) and safety valves to relieve RCS pressure while making the necessary preparations for using the station ASW system. During this evolution, there is some likelihood that the pressurizer PORV and/or safety valves will stick open resulting in a small break loss-of-coolant (LOCA).

The actuators of the PORV and PORV block valve (which would be relied on to isolate a failed open PORV) are not QA-1 and control power to the actuators is not tornado protected.

The pressurizer Code safety valves could be challenged multiple times, passing hot liquid reactor coolant during the later stages of this event scenario. Although the licensee believes that the probability of the pressurizer Code safety valves failing open during these multiple actuations is on the order of 0.1, this relatively low failure probability has not been justified and is inappropriate. It is not clear why the licensee did not calculate the failure probability of the pressurizer Code safety valves in a manner that is similar to how the licensee calculated the failure probability for the pressurizer PORVs (based on the number of actuations).

The pressurizer Code safety valves have not been qualified for multiple cycles of liquid reactor coolant discharge and testing that has been performed to date is insufficient to substantiate such a low failure probability (0.1) over multiple cycles of the liquid reactor coolant discharge.

The station ASW system is manually and locally aligned and controlled. These operator actions delay the restoration of secondary heat removal and result in two phase relief through the PORVs and/or PSVs. The station ASW system is being replaced with the PSW system. The new PSW system can be aligned and controlled in a timely manner from the control room, precluding two phase relief through the PORVs and PSVs.

The PORVs, PORV solenoid valves, and PORV block valves are QA-1. Additionally, the valves are periodically tested. The PORVs receive power from vital I&C panel boards that are located in the auxiliary building and protected from the effects of tornadoes. The proposed change provides power to the vital I&C panel boards via the new protected switchgear, that receives power from the Keowee underground path. The PORVs can be opened from the control room. The block valves will continue to be controlled from the SSF.

5. Because the East and West Penetration Rooms are not protected from tornado missiles, system piping that transverse these rooms and communicate directly with the RCS could be subject to tornado missile damage and consequential LOCA; and damage to other penetrations could result in containment failure.

The proposed change will reinforce the west penetration room exterior block walls with FRP to ensure that these walls can withstand ONS UFSAR Class I winds and differential pressures. The proposed change also provides redundant SHR and RCP SI systems for the mitigation of a tornado.

The redundant SHR systems, SSF ASW and PSW, are physically separated by containment. The SSF ASW provides feedwater to containment through the west penetration room. The PSW can provide feedwater to at least one SG through the east penetration room.

The redundant RCP SI systems are SSF RC makeup and HPI (one pump to each of the RCP seal injection lines). Since SSF RC makeup cables and two of the four HPI seal injection lines pass through the west penetration room, metal missile shields will be added in front of the SSF cables to ensure that the likelihood of failure of both paths due to missile penetration satisfies the TORMIS acceptance criteria.

RCS letdown exits containment and enters the east penetration room. There is a short portion of line between containment and a check valve that, if damaged, could result in SBLOCA. However, this event is not postulated in the CLB due to the configuration of this portion of the line in the east penetration room relative to containment and auxiliary building support columns. This will remain the case in the future mitigation strategy.

6. The tornado vulnerability associated with the cask decontamination rooms was not previously recognized and allowed by the NRC, and is therefore contrary to the existing Oconee licensing basis.

SSF cables and piping enter the west penetration room from the cask decontamination room below. The proposed change will reinforce the cask decontamination room exterior walls to withstand ONS UFSAR Class I winds and differential pressures. Additionally, metal shielding will be added in front of the location where the SSF pipe and cable enters the room and passes into the west penetration room to provide additional protection to the cables.

7. The capability to cool the plant down to residual heat removal (RHR) system entry conditions was established as a licensing basis criterion for the Oconee units during the *resolution of post-TMI Action Plan II.E.1.1, and the licensee failed to recognize and address this capability.*

The objective of the proposed tornado mitigation strategy will be to maintain the plant in mode 3 until damage control measures are implemented to cool the plant to a cold shutdown condition.

8. The Updated Final Safety Analysis Report (UFSAR) description was "supplemented" by a 1990 update to explain how reactor makeup would be provided following a tornado. While this supplementary information appears to be a relaxation of the licensing-basis criteria that were established for the Oconee units, the change was not submitted for NRC review and approval.

A license amendment request (LAR) is being prepared for submittal to the NRC that will revise the UFSAR. The LAR schedule is included as an attachment to this letter.

Tornado Mitigation Vulnerabilities

1. Turbine-Driven Emergency Feedwater (TDEFW) Pump Cooling- A tornado-induced failure of the unit 1 safety-related 4KV buses would de-energize the support systems (condenser circulating cooling and high pressure and low pressure service water cooling) for the TDEFW pump. This previously unrecognized failure mechanism resulted in an increase in CDF of about 1E-6 per reactor year.

Test results indicate that the TDEFW pump can run without jacket water cooling indefinitely and without bearing cooling for at least 4 hours. However, the ONS tornado strategy will not rely on the TDEFW system for SHR subsequent to a tornado. SHR will be provided by the SSF ASW and new PSW system.

2. Operation of the Atmospheric Dump Valves- Damage and debris due to tornado effects could render the ADVs unavailable for SG depressurization, thereby eliminating use of the tornado-protected station ASW system for SHR. This previously unrecognized failure mechanism resulted in an increase in CDF of about 9E-7/rx-yr.

The existing, Station ASW system, is a low pressure system. The SGs must be depressurized to support operation of the system. Operation of the ADVs is required to depressurize the SGs. The proposed change replaces the existing Station ASW system with a new PSW system. The PSW system will be a high pressure system and will not require SG depressurization. As such, the ADVs will only be operated later in the event to limit the number of MSRV cycles.

3. Access to Valve LP-28- In the event that the borated water storage tank (BWST) is damaged by a tornado, the Oconee design basis credits operator action to align the HPI pump to take suction from the SFP for a source of reactor coolant system (RCS) makeup water. The manually operated BWST isolation valve, which is located only a few feet *from the tank, must be closed to avoid diverting water from the SFP to the damaged BWST. Damage and debris due to tornado effects may render the valve inaccessible. This previously unrecognized failure mechanism resulted in an increase in CDF of about 7E-9/rx-yr.*

The proposed change adds a missile shield to protect the critical portion of the BWST against the tornado missiles given for Class I structures in the ONS UFSAR. The flow path from the SFP to the HPI pumps will no longer be required or credited.

4. Tornado-Protected Station ASW Pump Flow Control- Duke identified that there are potential run-out and flow control difficulties with the tornado-protected station ASW pump when feeding multiple SGs. Initial feeding of three or more SGs (multiple units) would place the pump in a run-out flow condition. If tornado related damage occurred to discharge piping in the unprotected west penetration room, pump run-out conditions would worsen. Such piping damage would make it even more difficult to establish and maintain proper flow when feeding multiple SGs. In addition, the complex communications between remote locations for feeding multiple SGs would also tend to increase the failure probability. The licensee concluded that using the tornado-protected ASW pump to provide SG feedwater to more that one unit was not considered credible. This previously unrecognized failure mechanism resulted in an increase in CDF of about 5E-8/rx-yr.

The proposed change replaces the existing Station ASW system with the new PSW system. The PSW pump discharge piping will be normally isolated by an isolation valve to each unit and flow control valves to each steam generator. Valves and instrumentation will be located below grade in the auxiliary building, thus protected from tornado damage. The PSW pump will initially be started on recirculation and then aligned to each unit by opening the associated discharge isolation valves. Once the isolation valves are open, the flow controls valves will be throttled open to achieve the desired flow. Each of these operations will be accomplished from the control room. Run-out concerns due to pipe damage or concurrent delivery of feedwater to each unit will therefore be eliminated.

5. SG Tubes Differential Temperature Issue- Due to the time necessary to evaluate alternate core cooling strategies and to place the tornado-protected station ASW pump into service, the compressive SG tube stresses were calculated to exceed the manufacturers design limits. The licensee established a new differential temperature limit of 108 °F based on initiating station ASW pump flow within 40 minutes. Duke was continuing to evaluate the effect of the new temperature on SG tube compressive stresses. The report did not include an estimation of the resultant change in CDF due to this deficiency.

Duke completed its analysis related to SG tube compressive stresses. The analysis found that the maximum expected differential tube temperature for the subject scenario could be accommodated. However, the proposed change replaces the existing Station ASW system with the new PSW system. The PSW system will be capable of being aligned and controlled from the control rooms in a timely manner. Timely restoration of high-pressure SHR will minimize the tube-to-shell differential temperature that results from the heat-up of the RCS.

6. SFP Suction for High Pressure Injection- The water inventory in the SFP was not sufficient to ensure a 24-hour mission time for a HPI pump during all conditions and the ability of the SFP to perform this function is limited. Assuming that operators could wait for nine hours before aligning the HPI pump suction to the SFP, the licensee estimated that the SFP would be unable to perform this function for about 10 percent of the time. This previously unrecognized failure mechanism resulted in an increase in CDF of about 6E-7/rx-yr.

The proposed change includes modifications that provide missile shielding for the critical portion of the BWST and that allows an HPI pump from each unit to be aligned and controlled in a timely manner to provide seal injection to the RCPs. For this reason, the SFP to HPI suction path will no longer be required or credited.

7. Pressurizer Safety Valve Reseating- Design documents for the pressurizer Code safety valves did not include qualification for being able to reseat after passing 500°F reactor coolant. Scenarios that rely on use of the tornado-protected station ASW pump for SHR could involve a 40-minute delay in establishing feedwater to the SGs. During this 40-minute delay, the RCS will heat up, causing reactor pressure to increase and lift the pressurizer Code safety valves. Steam would be released initially, followed by reactor coolant. If the pressurizer Code safety valves failed to reseat when reactor pressure eventually subsided, the tornado-protected station ASW pump and HPI pump combination would not be able to maintain adequate cooling with the continuous loss of reactor coolant through the failed open safety valves. Based on industry testing that has been completed indicating (according to Duke) that valves of the type used at Oconee could pass hot water and reseat successfully, Duke concluded that the originally assigned failure probability of the Oconee pressurizer Code safety valves to close was acceptable. Consequently, no change in CDF due to this deficiency was reported.

Duke continues to conclude that the failure probability assigned to the PSVs subsequent to two phase water discharge is appropriate. However, the new PSW system will be capable of being aligned in a timely manner to each SG and controlled from the control rooms. The timely response afforded by this system will preclude two-phase discharge of water through the PSVs subsequent to a tornado.

8. Unit 3 North Control Room Wall- The north wall of the unit 3 control room was not originally designed and constructed to withstand the effects of the design-basis tornado (i.e. tornado missiles and differential pressure). In the submittal dated June 18, 2003, in response to question 21, Duke indicated that a modification would be made to enable the wall in question to be able to withstand the necessary differential pressure loads caused by the design basis tornado, and that the missile impact would be evaluated using the

TORMIS compute code. To the extent that this condition is corrected, no change in CDF is expected.

This condition was identified by ONS as a non-conformance in its problem identification program. Modifications to resolve the problem were outlined in Duke's January 31, 2006 letter and presented in a February 7, 2006 meeting with the NRC. This condition will be eliminated by the scheduled modification.

9. Additional Tornado Mitigation Deficiencies- Inspection Report 02-07 indicated that the following additional limitations in the Oconee mitigation strategy were identified by the licensee:

- *Postulated tornado events could cause the loss of electrical power to the battery chargers of multiple units, which would lead to loss of the vital instrumentation that is necessary for operating the EFW and tornado-protected station ASW systems. This previously unrecognized failure mechanism resulted in an increase in CDF of about 6E-7/rx-yr.*

The proposed change provides a new protected power supply to the battery chargers. The power supply will be from the new protected switchgear. This switchgear will receive power from Keowee underground. Vital instrumentation power will be capable of being supplied indefinitely from this source.

- *Postulated tornado events could result in a loss of the 4160 VAC standby bus feeders that pass from the units 1 and 2 tornado-protected block house to the unit 3 main feeder bus. This previously unrecognized failure mechanism resulted in an increase in CDF of about 2.5E-6/rx-yr.*

The new, protected switchgear will be directly powered from Keowee underground rather than the standby bus. The modification will ensure that damage to the main feeder bus has no adverse impact on the new power supply.

- *Postulated tornado events could result in collective effects that fail the BWST and the west penetration room of a particular unit coupled with the failure of electrical connections between the standby and main feeder bused for multiple units. This previously unrecognized failure mechanism resulted in an increase in CDF of about 2.8E-6/rx-yr.*

The proposed tornado mitigation strategy includes the construction of a missile shield to protect a critical portion of the BWST, use of FRP to ensure the west penetration room walls can withstand the UFSAR, Class I wind and differential pressure, new, protected switchgear, two redundant and physically separated SHR systems, two redundant and largely, spatially separated RCP SI systems and additional missile shielding to protect SSF cables that pass through the west penetration room. The coupled effect described as part of the concern will no longer be plausible after these changes are made.

Attachment 4

License Amendment Request Major Milestones

License Amendment Request (LAR) - Major Milestones		
Item No.	Description of Activity	Anticipated Complete Date
1	**Tornado Mitigation LAR**	**October 2007**
◆	Duke/NRC agreement on direction based on NRC response to this letter	May 2006
◆	Draft LAR, solicit comments from Tornado/HELB Design Basis Group supervision & senior management - incorporate comments	June 2006
◆	Circulate LAR for site review and incorporate comments	July 2006
◆	Complete LAR verification package	July 2006
◆	Complete Plant Operating Review Committee (PORC) review and incorporate comments	August 2006
◆	Complete Nuclear Oversight Review Committee review (NSRB) and incorporate comments	September 2006
◆	Transmit LAR	October 2006
◆	NRC acceptance review received	November 2006
◆	RAI response target date	January 2007
◆	Receive NRC approval of LAR	October 2007
2	**Fiber Reinforced Polymer (FRP) LAR**	**December 2006**

License Amendment Request (LAR) - Major Milestones		
Item No.	Description of Activity	Anticipated Complete Date
♦	Hold working level session with NRC	March 23, 2006
♦	Draft LAR, solicit comments from Tornado/HELB Design Basis Group and Oconee Major Projects supervision & senior management	April 2006
♦	Incorporate supervision/management comments into draft LAR	April 2006
♦	Circulate LAR for site review	April 2006
♦	Incorporate site comments into LAR	May 2006
♦	Complete LAR verification package	May 2006
♦	Complete Plant Operating Review Committee (PORC) review / Incorporate PORC comments	May 2006
♦	Complete Nuclear Oversight Review Committee review (NSRB)/ Incorporate NSRB comments	May 2006
♦	Transmit LAR	June 2006
♦	NRC acceptance review received	July 2006
♦	RAI response target date	September 2006
♦	Receive NRC approval of LAR	December 2006