

**Manual Chapter 0609.02 Appeal Panel Review of Oconee Standby Shutdown Facility**  
**White Finding (EA-06-199)**

**Overview of Finding**

On August 13, 2003, the licensee removed an access cover that surrounds the CO<sub>2</sub> supply piping located on the south side of the Standby Shutdown Facility (SSF). This 4.5" x 7.25" cover is a passive flood protection barrier and was removed to route temporary power cables into the SSF for an SSF outage.

On June 2, 2005, as a result of inspector observations, the licensee generated Problem Investigation Process report (PIP) O-05-3820 to document that the flood protection barrier was breached to route temporary power cables into the SSF in support of modification work. On August 3, 2005, the licensee generated PIP O-05-4978, which once again documented that the deficient condition still existed. The temporary power cables were still routed through the breached flood protection barrier, located on the South wall of the SSF and below the top of the flood barriers at the North and South entrances to the SSF. Report PIP O-05-4978 states that, "Based on discussions with. . . Severe Accident Analysis Group, the bolted cover over the CO<sub>2</sub> supply pipe should be installed because it is part of the flood barrier that protects the SSF. While this flood barrier is not required for SSF operability, it is important to PRA [Probabilistic Risk Assessment] (similar to flood gate at the South Entrance to the SSF)." On August 3, 2005, the temporary power cables were removed and the flood protection barrier was restored to its design configuration.

As a result of a licensee investigation into the breached flood protection barrier, the licensee updated section 2.2.5.2.2 of the SSF Auxiliary Service Water (ASW) design basis document (DBD), External Flooding Due To Jocassee Dam Failure, to read, "In order to protect the SSF from flooding due to a Jocassee Dam failure which results in flood levels < the 5' SSF flood barrier [at the South entrance of the SSF], . . . The bolted cover that surrounds the CO<sub>2</sub> supply pipe located in the Southwest corner of the SSF Response Room must be installed. The bolted access panel that is located on the CO<sub>2</sub> supply pipe bolted cover must also be installed." Additionally, the licensee posted a sign next to the access cover which states, "Do not remove bolted cover that surrounds CO<sub>2</sub> supply pipe in SSF Response Room when the SSF is operable. Bolted cover is a flood barrier for the SSF."

PIPs O-05-4978 and O-05-6642 document that the licensee's Maintenance Rule expert panel changed the maintenance rule function of providing external flood protection barriers for the SSF to High Safety Significance, and included the bolted cover that surrounds the CO<sub>2</sub> supply pipe and its access cover in this function. The licensee classified this event as a maintenance preventable functional failure for external flood

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protection of the SSF. The Maintenance Rule portion of PIP O-05-4978 states that, "When the flood barrier for the CO<sub>2</sub> supply pipe located inside the SSF Response Room is not installed, the SSF is vulnerable to external flood water that exceeds the height of the resulting opening. Since the height of the opening that is present when the flood barrier . . . is removed is below the height of the flood gate provided at the South entrance to the SSF, a functional failure of the SSF flood protection barrier would occur for flood levels that reach the height of the opening."

Section 9.6.4.7 of the UFSAR discusses "Flooding Reviews" with respect to SSF System Evaluations, and states that, "The structure meets the requirements of GDC 2 [Design bases for protection against natural phenomena], and the guidelines of Regulatory Guide 1.102 [Flood Protection for Nuclear Power Plants] with respect to protection against flooding."

However, section 2.2.5.2.2 of the SSF ASW DBD, External Flooding Due To Jocassee Dam Failure, states that, ". . . a 5' external flood wall was added around the SSF entrances to reduce the consequences of a Jocassee Dam failure. This 5' wall was not intended to bound all flood scenarios, but was deemed adequate to protect the SSF from the more likely flood scenarios. A recently completed flood analysis indicates that a Jocassee Dam failure could result in an external flood height of at least 10'." In this case, the deficient flood protection barrier was located below the top of the 5-foot flood protection wall located at the South entrance of the SSF, and would have provided a flowpath for external flood waters whose depth was greater than 4.6 feet to enter the SSF.

Additionally, a December 10, 1992, Jocassee Dam Failure Inundation Study (Federal Energy Regulatory Commission Project No. 2503) predicted that a Jocassee Dam failure could result in flood waters of approximately 12.5 to 16.8 feet deep at the Oconee Nuclear Site.

During an external flooding event, the breached flood protection barrier could have provided a flowpath for flood waters to enter the SSF. This could impact the safety function of the SSF during accident scenarios that require the use of SSF equipment to mitigate the consequences of the event, as the flood waters could have rendered the SSF equipment inoperable.

The staff determined that the failure to effectively control and perform a risk assessment for the SSF maintenance activity resulted in the following failures to manage risk:

- The failure to expeditiously remove the temporary power cables from the SSF as soon as conditions permitted, and the failure to reinstall the CO<sub>2</sub> supply access cover plate, a passive flood protection barrier, located in the Southwest corner of the SSF Response Room.

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- The failure to post and maintain various plant equipment as protected equipment to ensure the operability of the remaining safety-related equipment was not jeopardized.
- The failure to effectively communicate the elevated risk associated with planned work activities to station personnel to ensure changes in work scope or schedules were elevated to the appropriate personnel for review and assessment.

Consequently, for almost two years (from August 13, 2003, to August 3, 2005) an uncompensated for and uncontrolled flowpath existed through the SSF wall, which could have rendered the SSF unable to perform its intended functions in the event of an external flood in excess of 4.6 feet (800.625 feet above mean sea level (msl)).

The staff concluded that the licensee's failure to maintain adequate design control of the SSF CO<sub>2</sub> access cover (south wall breach) while routing temporary power cables through the breached cover (a flood barrier), thereby, creating a flood flowpath through the SSF south wall was a performance deficiency. Per recent licensee calculation, OSC-2240, rev. 1 (dated 6-29-05), ~1.37 gpm of leakage into the SSF pump room would render the SSF unable to perform its intended functions.

The licensee, in its letter dated December 20, 2006, appealed the staff's final significance determination (FSD) on the basis that it lacked sufficient justification to support the conclusion reached. The licensee stated that the NRC FSD letter of November 22, 2006, "provided minimal insight in to the reasoning and logic leading to the summary dismissal of the most crucial points" made in licensee's response to the Choice letter.

The two main considerations involved in the licensee's appeal are: (1) whether a performance deficiency occurred and (2) whether the reduction of 3.5 inches (from 5.0 to 4.71 feet) in the actual external flood height that could impact the SSF created and warranted a WHITE finding.

The licensee's primary points in support of their appeal are:

- The SDP Phase III risk analysis was performed in an overly conservative manner and failed to acknowledge key limitations of the analysis such that the results more closely represent a bounding analysis rather than an expected mean value.

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- The 1999 Maintenance Rule Expert Panel evaluation of the SSF flood function was appropriately evaluated in accordance with the provisions of NUMARC 93-01 as endorsed by NRC in Regulatory Guide (RG) 1.160 and 1.182. The licensee stated in their October 5, 2006, Response to Preliminary White Finding, that, "This conclusion was based on the fact that the probability of a Jocassee flood was low, the probability of wall failure was negligible and the likelihood that a breach in the water tight doorway, which is the major opening, would be immediately recognizable. The focus of the evaluation was on the water tight door located at the south end of the SSF."

#### **Licensee Contention #1**

The routing of cables through the access cover on the south wall of the SSF did not constitute a performance deficiency. The basis for the licensee's contention is that this issue did not meet the Manual Chapter 0612 definition of a performance deficiency; the 1983 best estimate calculation for a worst case flood determined that a flood would not have exceeded the bottom of the access port opening and would not have entered the SSF; and that the 1999 judgement of the Oconee Maintenance Rule Expert Panel classifying the SSF wall as low safety significance was sound. The licensee refers to the guidance contained in NUMARC 93-01 as the basis for the Expert Panel's conclusion.

#### **Appeal Panel Response:**

The NRC Appeal Panel's review of the NRC FSD letter of November 22, 2006, found that the staff in the FSD letter responded to the licensee's contention that a performance deficiency did not exist and concluded that a performance deficiency did in fact exist under the definition of MC 0612. However, the staff's response in the FSD letter did not clearly address the licensee's concern that the NUMARC guidance supported the Maintenance Rule Expert Panel's decision of making the SSF low safety significance and therefore not subject to 10CFR50.65(a)(4). This, in the Appeal Panel's opinion, provided a basis for the licensee to appeal the White finding.

The NRC Appeal Panel reviewed the sections of the NUMARC guidance the licensee referred to in their response to the preliminary White finding and appeal letter. The Maintenance Rule guidelines contained in NUMARC 93-01, "Industry Guideline For Monitoring The Effectiveness Of Maintenance At Nuclear Power Plants," Revision 3, set forth specific risk importance measure criteria for determining whether a Structure, System, or Component (SSC) is of high safety significance. The Appeal Panel agreed that an evaluation solely against these specific criteria, exclusive of external events, would result in the conclusion that the SSF was of low safety significance. However, as the NUMARC guidance states, the use of an expert panel would compensate for the limitations of using only the risk importance measures derived exclusive of external events. Since the purpose of the flood barrier was to protect from external flood, the

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maintenance rule expert panel should have evaluated the flood barrier function with respect to this function. Based on the significance of the SSF flood barrier in Oconee's risk studies, the panel should have concluded the flood barrier function to be of high safety significance. Also Regulatory Guide (RG) 1.160, Monitoring The Effectiveness Of Maintenance At Nuclear Power Plants, Revision 2, Section 1.5, Monitoring Structures, states that experience with the maintenance rule and with the NUMARC 93-01 guidance indicated that specific guidance for monitoring the effectiveness of maintenance of structures was needed as structures present a different situation than do systems and components.

Since the SSF is a very important structure in providing defense-in-depth for the plant and there are large uncertainties associated with the postulated external flooding event the expert panel should have broadened its review of the risk significance of the SSF. As the licensee stated, the final part of a proper Maintenance Rule significance determination is for the expert panel to review the PRA results for the SSC. The purpose of the review would be to consider the limitations of the PRA and other qualitative factors that could affect safety significance. The expert panel has the authority to override the PRA criteria results based on its qualitative judgement of these factors. In this case, the NRC Appeal Panel concluded that the NRC staff's decision in the FSD was correct and that the licensee's expert panel decision in July 1999 was non-conservative. The expert panel failed to recognize that the function being evaluated was that of flood protection, not just of the active parts of the wall (i.e. the gate). As events have shown, the access cover was susceptible to maintenance which could create a bypass around the wall and degrade the function of the SSF wall. The licensee's process allowed the SSF wall to be breached for an extended period of time because of the low safety significance they assigned to the barrier. This failure of the expert panel to maintain the appropriate risk significance resulted in the failure to effectively control maintenance activities which impacted the flood protection function of the SSF wall. As previously stated in the NRC FSD letter the Duke expert panel failed to act in consideration of the best available information at the time.

In addition to the missed opportunity due to the non-conservative classification of the SSF barrier, additional maintenance rule guidance was addressed in Regulatory Issue Summary (RIS) 2001-009, Control of Hazard Barriers, dated April 2, 2001. This RIS addressed guidance on the control of hazard barriers that is consistent with the provisions of the Maintenance Rule, RG 1.182, Section 11 of NUMARC 93-01, and other regulatory guidance. A hazard barrier is considered a plant feature or structure that is credited with protecting plant equipment from external and internal hazards such as flooding, tornado missiles, and the effects of design basis events. The RIS explains that prior to removing a hazard barrier for maintenance purposes (either to facilitate plant maintenance or to perform maintenance on the barrier), the risk associated with the maintenance activity must be controlled and managed in accordance with paragraph 50.65(a)(4) of the maintenance rule. Removal of a hazard barrier is considered a temporary alteration under Section 11 of NUMARC 93-10. The RIS also states that the

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NUMARC 93-01 guidance points out that during power operations, if temporary alterations associated with maintenance are expected to be in effect for more than 90 days, the temporary alteration should be screened and, if necessary, evaluated in accordance with 10 CFR 50.59 prior to implementation.

### **Licensee Contention #2**

The NRC SDP Phase III risk analysis was performed in an overly conservative manner and failed to acknowledge key limitations of the analysis such that the results more closely represent a bounding analysis rather than an expected mean value. Assumptions regarding percentage of floods occurring in the 3.5 inch band between the bottom of the access opening and top of the 5 foot wall lack justification and were unreasonable. The licensee disagreed that the reduction of 3.5 inches (from 5.0 to 4.71 feet) in the actual external flood height that could impact the SSF created an increase in CDF of greater than  $1E-6$ .

The licensee contends that the staff's Phase 3 SDP analysis used assumptions that lack justification and are unreasonable. They also contend the analysis produced a bounding risk value and not one reflecting the median risk.

The Phase 3 analysis used a linear scaling of the height of the wall and the distance from the top of the wall to determine the proportion of risk to assign to the performance deficiency. This method can be used only if the boundary conditions and the failure mechanisms are well defined.

### **Appeal Panel Response:**

The Appeal Panel found that the staff in the FSD letter acknowledged the uncertainty associated with the results of an external events analysis and that consideration of quantitative and qualitative approaches was more appropriate. The staff performed a bounding analysis using the best available information to determine the significance of the issue. The bounding analysis indicated that the finding was potentially greater than GREEN.

The Appeal Panel confirmed that a great deal of uncertainty exists between methods and assumptions used in the quantitative evaluation of the violation. However, this uncertainty was identified by the staff and prompted NRC management and staff in their November 22, 2006, FSD letter to Duke Energy to apply an approach that considered qualitative as well as quantitative aspects of the deficiency in order to arrive at the final assessment of WHITE. As the FSD letter mentioned the NRC considered other

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attributes that would have a bearing on safety including defense in depth, the period of time this deficiency existed, and the ability to protect the public.

As part of the appeal process, the NRC Appeal Panel re-visited the SDP determination and agreed with the licensee, in that, there may have been a lack of justification in performance of the analysis using quantitative methods. However, the qualitative argument holds sufficient justification to sustain the conclusion drawn by NRC staff in the November 22, 2006, letter that this finding is of WHITE severity. This is further substantiated by an examination of the Oconee IPEEE submittal<sup>1</sup> showing that the SSF itself is important to safety and that any opening made in it below the 5-foot level leaves it vulnerable to analyzed floods from failure of the Jocasee dam.

In the Oconee IPEEE submittal, external flooding which could impact the SSF can arise from failures in the Jocasee dam. Three initiating event classes contributed to dam failure – the random failure of the dam, seismically induced failure, and probable maximum precipitation (PMP) events. For simplicity of calculation, an evaluation of random failure of the dam was made to determine the importance the Duke model places on the flood protection function of the SSF.

A review of minimal cutsets was performed using Table 5.13 of the IPEEE submittal which presented 47 cutsets with a combined frequency of  $7.01\text{E-}6$  per year. The first cutset involved a random dam failure initiating event (XFLOOD) and split fraction of floods exceeding 5 feet (XEFLOODDEX). This cutset will be excluded since there is no impact from the performance deficiency. Cutsets 2 through 47 all consisted of the random dam failure initiator (XFLOOD) with successful pressurizer relief valve closure (TRCSRV0DEX) and various SSF-related failures. For these 46 cutsets, their sum is the SSF-related base CDF of  $4.41\text{E-}6$  per year. To evaluate the importance of the SSF for random Jocasee dam failures, each of the SSF-related terms in the base 46 cutsets were set to unity (1.0) and then subsumed. This resulted in one SSF failure cutset consisting of the XFLOOD initiator and event TRCSRV0DEX. This is the increase in CDF for failure of the SSF given a flood of less than 5-feet as described below.

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<sup>1</sup> Duke Power Company, "Oconee Nuclear Station, Individual Plant Examination of External Events (IPEEE) Submittal", December 21, 1995.

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CDF contribution (per year)	Probability / Frequency (per year)	Event	Description
1.17x 10 <sup>-5</sup>	1.30 x 10 <sup>-5</sup>	XFLOOD	Random failure of the Jocasee Dam.
	9.00 x 10 <sup>-1</sup>	TRCSRVODEX	RCS safety relief valve does not stick open after relieving liquid.
	1.00	SSF	SSF-related failure

The increase in CDF from the base is 1.17E-5 – 4.41E-6, or 7.29E-6 per year. This represents the value of the flood protection function of the SSF walls. If this function were not assured, a WHITE finding would result for a greater than one year exposure.

The other initiators of seismic and PMP will only tend to exacerbate this increase in CDF. Since this computation assumes complete SSF failure for all floods which accumulate below 5-ft, it serves to provide a WHITE upper bound for complete failure of the function.

A more complete answer would subtract additional value for the Base Case where the flood was less than the lower opening of the breached flood barrier. As stated in the Duke letter, the uncertainties for the various calculational methods are too high for a precise answer to be derived. The original Phase 3 analysis used a method where a linear correlation between flood protection and the height of the wall was made. The panel performed other calculations examining ratios between maximum flood height and the top of the wall. The variation between the calculation was an order of magnitude, showing that the answer can vary greatly, depending on the assumed boundary conditions, and the nature of the extrapolation. The panel also realized that the basis of the probability of exceedance of the wall used in the Duke model was an expert judgement, based on many factors, and by its nature is not a high precision input to the calculation. All of these factors cause the appeal panel to agree with the staff's decision to use a qualitative decision making process to assess the significance of the finding.

During the qualitative decision process, the importance of the flood barrier was discussed. Based on this panel's interviews of some of the original SERP members, the exact value of the quantitative evaluation for the change in risk was not the dominant factor in the SERP's decision of the finding's significance. Due to the large degree of uncertainty associated with flooding events that could challenge the SSF flood barrier, the panel agreed with the staff's (SERP) consideration of quantitative information consistent with risk informed decision making concerning defense in depth, the period of time the deficiency existed, and the ability to protect the public. The panel concluded that the staff's consideration of the qualitative factors was clearly articulated in the choice letter to the licensee.

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**Appeal Panel Conclusion**

Based on the appeal panel's review of the performance deficiency, the inspection finding, its significance characterization and basis, and the licensee's points of contention the panel concluded that the performance deficiency and finding as stated in the NRC's letter of November 22, 2006, Final Significance Determination For A White Finding And Notice Of Violation (Oconee Nuclear Station - NRC Inspection Report Nos. 05000269/2006017, 05000270/2006017, and 05000287/2006017) to Duke Power Company, LLC were correct. The panel recommends no further action and the significance determination remain unchanged.

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Timeline	
1967	Construction Permit issued for Oconee
1971	Appendix A of CFR, Part 50, issued with the GDC. GDC2 says to protect from flood, earthquakes.
1972-1973	Jocassee Dam built
November 1982 study/memo	internal Duke study set flood level @ 4.71 feet above grade. 3 cases. 0 feet (Jocassee fails, but no failure of Keowee), [4.1 feet, 4.7 feet (Jocassee fails, Keowee fails, timing of break at Jocassee)
June 1984	NSAC-60 published. Oconee PRA study. No credit is given for SSF to survive Jocassee Dam Failure. Impact is set at 2.5E-5/yr based on Dam failure rate (non seismic). Fragility curves for the Jocassee Dam come from a 1981 seismic report included in NSAC-60. Seismic contribution due to Dam failure 2.6E-6/yr.
1987 - 1988	Rev. 0/1 PRA issued to update NSAC study. SSF barriers credited for protection up to 5 feet in Rev 1. Uses IE frequency from NSAC for random failure.
1988	SSF flood barriers built to be > design flood of 4.71 feet
March 1992	access cover with penetration created at >4.71 feet
1992	Duke FERC EAP study set flood level @12 feet above grade (more conservative assumptions)
Dec 1994	Duke PSA group set 80%/20% prob of exceedance for 5 foot wall. Engineering judgement . 60/40 for seismic.
December 1996	Rev. 2 PRA issued. Credit is given for the 80/20 split for the 5 foot wall. Uses 1.3E-5/yr for random failure prob of Jocassee (more years without failures in database = lower prob). Excludes seismic and overtopping. Study emphasizes the importance of the flood barrier. Jocassee Flood from random failure = 7.5E-6. Jocassee seismic fragilities are same as NSAC.
December 1996	IPEEE recognizes significance of flood barrier.
July 15, 1999	Mx rule meeting says provide flood protection barrier (considered door latch problems) is low risk significance
Aug 13, 2003	penetration breached
June 2, 2005	PIP generated in response to inspectors questions
Aug 3, 2005	penetration restored
October 5, 2005	Mx rule says provide flood protection barrier as High significance
Aug 17, 2006	SERP

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### Review of Violation Denial

#### Statement of Violation

Technical Specification 5.4.1 requires that written procedures shall be established implemented and maintained as recommended in Regulatory Guide 1.33, Revision 2, Appendix A, February 1978. Regulatory Guide 1.33, Section 9, Procedures for Performing Maintenance, requires that maintenance which can affect the performance of safety-related equipment should be properly preplanned and performed in accordance with written procedures, documented instructions, or drawings appropriate to the circumstances.

10 CFR 50.65 (a)(4), "Requirements for monitoring the Effectiveness of Maintenance at Nuclear Power Plants" requires in part, that prior to performing maintenance activities, the licensee shall assess and manage the increase in risk that may result from the proposed maintenance activities.

Contrary to the above, on August 13, 2003, while performing planned maintenance involving the opening of a penetration in the Standby Shutdown Facility (SSF) exterior wall to route temporary electrical power cables, the licensee failed to use an adequate procedure to open and control a penetration through a passive flood protection barrier and route temporary power cables. Specifically, the procedure used, IP/O/A/3010/006, Cable Pulling Procedure, Revision 16, did not address the installation of temporary power cables, and did not address breaching and restoring a flood barrier. As a result, the licensee failed to assess and manage the increase in risk associated with the degradation of the flood protection capability of the SSF's exterior wall from August 13, 2003 to August 3, 2005.

#### Licensee Basis For Violation Denial

The licensee states in their response that inherent to the violation is the assumption that the SSF access plate is with the scope of 10CFR50.65(a)(4). The licensee contends that the NRC staff's determination that the maintenance rule expert panel's risk evaluation should have concluded that this opening was high safety significance and therefore within the scope of 10CFR50.65(a)(4) was incorrect. The licensee uses the same reasoning in the violation denial as in disputing the existence of a performance deficiency. The licensee states that the staff's conclusion failed to consider the significance of the SSC in accordance with the approve guidelines in Section 9.3.1 of NUMARC 93-01.

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### **Appeal Panel Conclusion**

The conclusions of the NRC Appeal Panel in response to Contention #1 of the finding support the panel's conclusion that the SSF access cover should have been high safety significance and therefore within the scope of 10CFR50.65(a)(4). Therefore, a violation of (a)(4) occurred. It was also the appeal panel's conclusion that it was appropriate to cite the licensee's failure to have adequate procedures. The finding impacted the reactor safety mitigating systems cornerstone for ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The procedures ensure that facility changes due to maintenance and or temporary modifications are returned to normal configuration upon completion.

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