December XX, 2006

TIA

Regarding the licensing basis for external flooding (GDC-2) for the Oconee Nuclear Station Standby Shutdown Facility (SSF)

A. Summary

Region II NRC inspectors identified an external flood concern at the Oconee Nuclear Site, in that, a failure of the upstream Jocassee Dam could result in significant flooding at the site. Prior to the issuance of the SER for the SSF, the licensee completed several Jocassee Dam failure flood studies, and a full scope PRA with internal and external events, but failed to inform the NRC of the potential of site flooding from this event.

The single train SSF is licensed to mitigate the consequences of an Appendix R fire, turbine building flood, station blackout and security events and although not credited in the UFSAR, the SSF is relied on by the licensee as the last line of defense for numerous accident scenarios such as aux building flood, control room flooding, high-energy line breaks, tornados, and external flood. During these events, the SSF's safety function is two-fold: 1) the auxiliary service water pump must supply water to the affected units' steam generators; and 2) the reactor building makeup pumps must supply seal injection to the affected units reactor coolant pumps' seals.

As an indicator of its potential consequences of a Jocassee Dam failure on the Oconee Nuclear Station, 12 of the top 100 external CDF cutsets in the licensee PRA are the result of a Jocassee Dam failure. Per the licensee's December 21, 1995 IPEEE submittal, the random failure frequency of the Jocassee Dam is 1.3 E-05, while the seismic failure frequency is XXX . Assuming that the 5 foot high external flood wall protects the SSF and its equipment from 80% of the random Jocassee failures, the random Jocassee Dam, external flood CDF is XXX. Additionally, if the 5 foot flood wall is assumed to protect the SSF and it equipment from 60% of seismically induced Jocassee failures, the seismic Jocassee Dam, external flood CDF is XXXX (Can Walt check and add more about the risk aspects of the Jocassee Dam Failure?)

The licensee contends that flooding resulting from a Jocassee Dam failure is not a design basis event, and so they are not required to protect against it.

Relevant Correspondence and Details

- On **October 9, 1976**, the Oconee turbine building (Unit 1, 2 and 3) was partially flooded to a depth of approximately 24 inches. The event occurred while Unit 3 was in an RFO and Units 1 and 2 were at 100% RTP. The flooding was the result of a loss of the DID static inverter which supplied 125 VAC to the vital instrumentation, thereby resulting in a loss of power to the CCW vacuum priming system which controlled the four way solenoid valves that direct air pressure to the opening or closing side of the condenser isolation valves (pneumatic, piston operated). This resulted in the 6 condenser waterbox isolation valves attempting to open and override their respective "locked/hold closed" jackscrews. The opening force applied to 3CCW-20, the discharge isolation valve for waterbox 3A1, was sufficient to bend the "locked/hold closed" jackscrew resulting in flooding via the open condenser manways.

- On **May 18, 1978**, the NRC sent the licensee a RAI regarding the proposed SSF design. Question 6 asked, "Some equipment appears to be below grade. Provide the design features needed to prevent flooding. Provide the maximum limiting flood elevation at the structure location."

- On **June 19, 1978**, the licensee responded to question 6 of the May 18, 1978, RAI as follows:

  > "Normal groundwater infiltration of the Safe Shutdown Facilities Equipment Enclosure will be limited by standard waterproofing techniques. **Flood studies documented in the Oconee FSAR, Section 2.4.3 show that Lake Keowee and Jocassee are designed with adequate margins to contain and control floods so as to pose *no risk* to the Oconee Station site.** The Safe Shutdown Facility is within the site boundary, southwest of the Unit 2 Reactor Building, therefore, it is not subject to flooding from lake waters. The Safe Shutdown Facility will be waterproofed to an elevation slightly above yard grade to prevent inflow of yard surface waters."

- A **May 16, 1980** licensee memo to file, subject: ONS Meeting to Discuss PRA, documented a May 15, 1980 meeting between Duke, NSAC and consultant representatives to outline the schedule and scope of the oconee PRA. "The major objectives will be to (1) develop a meaningful assessment of the risk associated with oconee, rather than supporting NRC's IREP; (2) provide a benchmark for PRA's incorporating the advances made since WASH-1400; and (3) improve nuclear utility capabilities in this area.

- A **February 2, 1982**, licensee study, found in OSC-631 (Standby Shutdown Facility), using the National Weather Service DAMBRK program concludes that a Jocassee Dam failure would overtop the Keowee Dam by 4 feet for 2.4 hours, **resulting in 32.5 feet of flood water on site.** However, the Keowee Dam, an earthen structure, was assumed to remain intact despite being significantly overtopped for such a long period of time.

- A **March 15, 1982,** licensee memo to file regarding "OPRA - Jocassee Dam Failure" stated that, "Additional studies have recently been completed on the most reasonable failure of Jocassee Dam and its effect on Oconee Nuclear Station." This statement implies that other studies have been completed on this subject (not just the February 2, 1982 study mentioned above). Case 2 of the study concludes that the a failure of the Jocassee Dam with a number of non-conservative assumptions and inputs could overtop the Keowee Dam by 1.2 feet and flood the Oconee Nuclear Station.

- An **April 4, 1982**, licensee memo to file regarding "OPRA - Jocassee Dam Failure" stated that, "... the extreme cases ... are not detailed because they are not based on valid assumptions and would not provide a basis for interpretation of likely events." As such, the Keowee Dam is deemed to be capable of withstanding a Jocassee Dam failure without flooding the Oconee nuclear Station.

- An **April 26, 1982,** licensee letter discussed the Duke/NSAC PRA Project and the Preliminary Results of the Core Melt Frequency Analysis. The letter stated that, "On February 26, 1982, the Oconee PRA project team presented the preliminary results of the Oconee 3 probabilistic risk assessment study at a Duke management briefing session." During the meeting Duke management requested that NSAC provide Duke with summary report of the core melt accident sequences. "Accordingly, NSAC has issued to us the enclosed report for our consideration."

  Section 8 of the enclosed NSAC report documented the Core Melt Accident Sequences resulting from External Flooding, that is, both precipitation induced external flooding (Section 8.1) and flooding due to a failure of the Jocassee Dam (Section 8.2). Section 8.2 of the report stated that the conditional frequency of Oconee site flooding given a failure of the Jocassee Dam is quite complex, as is the conditional probability of core melt given site flooding. In the end, assuming a Jocassee Dam failure, a conditional probability of site flooding of 0.5 was assigned, while the conditional probability of core melt given site flooding was assigned to be 1.0

- A **July 2, 1982,** licensee memo to file documented the "Oconee PRA - Evaluation of Jocassee Dam Failure", and stated that, "The purpose of this memo is to summarize recent efforts in evaluating the likelihood that core melt could occur at Oconee as a result of Jocassee Dam failure, and to resolve the treatment of this issue relative to the Oconee PRA."

  The memo discussed in detail, "The May 15, 1982 verison of Section II.11.4 of the Oconee PRA draft report (penitent portion attached) provides a detailed summary of the derivation of the frequency of catastrophic failure of the dam. This evaluation goes to (and perhaps slightly beyond) the limits of the data and assumptions available for characterizing this failure rate, and the value of 2.5E-5/yr represents a best estimate of this frequency."

  The memo also concluded that the conditional probability of site flooding of 0.5 discussed in Section 8.2 of the NSAC Core Melt Frequency Analysis (see April 26, 1982 item, above) was incorrect and should have been 1.0. This is due to:

  - the short warning time available for an impending Jocassee Dam failure,
  - no rapid, effective mitigating actions (i.e., lowering lake levels),
  - initial lake levels have little overall impact, and
  - the time to failure is relatively short.

  The attached, draft Oconee PRA, dated May 15, 1982, discussed numerous points of interest including: Dam Failure, Frequency of Dam Failure, Dam Failure Data, Method of Estimating Dam Failure Frequency, Results and the Jocassee Dam Failure's impact on Core-Melt Frequency. Specifically, the Dam Failure portion of the draft PRA stated that, "If a sudden failure of Jocassee Dam were to occur, and a rapid enough release of the impounded water from Lake Jocassee into Lake Keowee resulted, the flood wave generated in lake Keowee would overtop Keowee Dam and the Oconee intake dike, flooding the plant."

- On **July 17, 1982**, the NRC sent the licensee a RAI regarding the SSF. Question 8 of the RAI asked, "State the elevation of the grade level entrance to the SSF. If this elevation is below the maximum lake levels, provide a discussion of the means by which the equipment within the SSF is protected from the effects of flooding caused by an unisolable break of the non-seismic CCW system/piping located in the Turbine Building. The discussion should also state the maximum expected water level within the site boundary should such an event occur."

<u>**(Comment)**</u> Following the TB flood of 1976, numerous communications between the licensee and the NRC occurred concerning possible flooding of the TB and the potential loss of safety-related equipment located in the TB basement. As such, the licensee had convinced the NRC reviewers that the only flooding of concern would be from a turbine building circulating water pipe failure. So during the licensing of the SSF (a facility which was supposed to mitigate the consequences of losing safety-related equipment located in the TB basement), the reviewers never, directly inquired about flooding from a Jocassee Dam failure, nor did the licensee provide the information despite possessing it.

Question 19 of the RAI asked "Describe those features of the design that assure that single failures within SSF components or that **design basis events do not result in consequential failures of the SSF** that would lead to conditions which exceed that for which safety systems have been designed."

- On **September 20, 1982**, the licensee responded to question 8 and 19 of the July 17, 1982, RAI, as follows:

Q8) "The elevation of the grade level entrance to the SSF is EL 797 + 0. This elevation is below Keowee full pond elevation of 800 as well as the maximum lake elevation of 808. (Ref. Oconee FSAR, Section 2.4.3). In the event of flooding due to a break of the non-seismic CCW system/piping located in the Turbine Building, the maximum expected water level within the site boundary is EL 796.5. Since the maximum expected water level is below the elevation of the grade level entrance to the SSF, the structure will not be flooded by such an incident."

<u>**(Comment)**</u> Despite possessing information that a Jocassee Dam failure could inundate the Oconee Nuclear Station and flood the same safety-related equipment as a rupture of the non-seismically qualified CCW system piping located in the TB, the licensee failed to disclose this accident scenario and its details to the NRC.

Q19) "Interconnections to essential plant systems have been inherently minimized by the SSF design objective (alternate means to achieve hot shutdown). The only ties to essential systems are the interconnection of the power and control "swap over" for selected valves and the piping tie to the Emergency Feedwater System and reactor coolant pump seals. SSF ties to the existing plant are such that no SSF failure will result in consequence more severe than those analyzed in the FSAR.".

- A **January 17, 1983**, licensee memo to file documents that a Jocassee Dam failure would overtop the Keowee Dam by 2.45 feet, resulting in 4.71 feet of water on site. **The flood study was completed as part of the Oconee PRA study, NSAC-60.** The memo also states that, "Similar dam failure studies were done for the Oconee PRA study [NSAC-60 study] as documented in the March 15, 1982 Memo to File and April 5, 1982 letter to K S Canady."

(Comment) This study was performed with the use of numerous non-conservative assumptions, as will be described in several 1993 and 1994 memos. Two of which are:

- For all cases studied, Lake Jocassee and Lake Keowee were not assumed to be a full pond levels.
- For all cases studied, the minimum Keowee Dam elevation used was 815 feet msl. However, in 1996 it was discovered that the intake dike elevation is actually 813.5 feet above msl.

- On **April 28, 1983**, the NRC sent the SSF SER to the licensee, which contained the following:

Section 4.8 Flooding Review

<u>**DPC** has concluded that the most likely reason for flooding of the turbine building would be from a condenser circulating water pipe break resulting from a seismic event</u>. The licensee therefore decided that the SSF would be a seismic Category 1 structure [which implies it is designed to withstand the effects of tornadoes]. The missile & spectrum upon which their analysis is based, is in conformance with the guidelines of the SRP Section 3.5.1.4, Revision 1, for a tornado Zone 1 site. The grade level entrance elevation of the SSF is 797.0 feet above mean sea level (msl). This elevation is below Keowee full pond elevation of 800 ft. as well as the maximum lake elevation of 808 ft. However, in the event of flooding due to a break in the non-seismic condenser circulating water (CCW) system piping located in the turbine building, the maximum expected water level

within the site boundary' is 796.5 ft. Since the maximum expected water level below the elevation of the grade level entrance to the SSF, the structure will not be flooded by such an incident. In addition, the structure will be water proofed to prevent infiltration of normal ground water. **Thus, the structure meets the requirements of GDC 2, and the guidelines of Regulatory Guide 1.102 with respect to protection against flooding.**

- Per OSC-631 (Standby Shutdown Facility) rev. 8, the initial design of the North and South, SSF exterior flood walls (NSM ON-2347) was completed on **June 8, 1984** and checked on November 29, 1984. Per drawing O-320-Z-3 and O-0320-Z-5, NSM ON-2347 was implemented on **June 26, 1986**.

(Comment) The licensee considered the Jocassee flood threat significant enough to install flood barriers around the SSF, but not significant enough to inform the NRC prior to licensing of the SSF despite possessing all of the information over a year before the SSF's SER was issued.

- A **January 11, 1984** licensee letter contained an attached SSF Commitment index. The letter stated that, "Attached is a marked copy of the oconee SSF Commitment Index indicating additions for the Civil Environmental Divisions. If you have any questions concerning these additions, place call ...." Commitment # CAEA00058 stated that, "Provide the Maximum limiting flood elevation at the structure location and the design features needed to prevent flooding." The source document is given as the RCS RAI dated May 18, 1978.

- In **June of 1984**, NSAC-60, A Probabilistic Risk Assessment of Oconee Unit 3, was completed by Duke Power and the Nuclear Safety Analysis Center of Palo Alto, CA. The study was a complete PRA with both internal and external events (including the Jocassee Dam failure and the resultant flooding of the Oconee Nuclear Station).

- An **August 14, 1985**, NRC letter to the licensee acknowledging the review of the Oconee PRA (with internal and external events). The cover letter stated that, "Particularly, we focused on the analysis of core damage sequences and dominant contributors, to core damage accidents to check whether the results, as published, provide any new insights of safety significance. Although the PRA includes both internal and external events analysis, our overview focused only on core damage accident sequence analysis."

  The Dominant Sequences to Core Damage portion of the letter contained a section on an External Flooding Sequence, which stated that, "**The sequence involves large scale flooding of the entire Oconee site due to the failure of Jocassee Dam located about 12 miles upstream from the Oconee site.** Although initial cold shutdown is achieved successfully, site flooding is expected to cause a loss of the ability to maintain long term decay heat removal. The sequence mean frequency is about 2.5 x10^{-5} per reactor year."

  The Overview on Generic Safety Concerns portion of the letter stated that, "An initial reading of the PRA dominant sequences and systems failures contributing to the dominant sequences has highlighted the relative contribution to core damage from large scale external flooding. **A seismically induced failure of the upstream Jocassee dam could cause a large scale flooding of components required for long term decay heat removal from the core. The dam is located 12 miles upstream of the Oconee site at a higher elevation than turbine-building safety equipment.** Using very simple and approximate techniques to assess the impact of such dam failures at the Oconee site, the PRA has obtained an estimate of 2.5x10-5 per reactor year (10%) for the external flooding contribution of the core damage frequency. Although, the above estimate seems to have a very large uncertainty, the potential exists that of external flooding could be significant at other nuclear facilities depending on the plant construction, its elevation relative to upstream dams, and the seismicity at that site."

- On **October 9, 1987**, IN 87-49, Deficiencies in Outside Containment Flooding Protection was issued.

  This IN was "...provided to alert recipients to a potentially significant problem pertaining to the flooding of safety-related equipment as a result of the inadequate design, installation, and maintenance of features intended to protect against flooding."

  The IN discusses "... the potential for the loss of safe shutdown capability as a consequence of potential flooding of safety-related equipment outside containment."

  The IN goes on to state that, "Serious consequences may result if the design features of the plant are not adequate to direct the resulting flood water safely away from important equipment. Such design inadequacies may result from (1) the inadvertent use of non-conservative assumptions in the flooding design analysis, (2) the failure to recognize all possible flooding flow paths, (3) the failure to install flood protection features that have been determined to be necessary, or (4) the failure to properly maintain installed flood protection features."

- A **March 3, 1988,** licensee letter concerning Fire, Flood and Pressure Boundaries drawings, stated, "As requested by your letter of February 11, 1988, please find attached a set of red-marked drawings showing the flood boundaries. **The four identified boundaries are as follows: ... 2) Barriers around the standby shutdown facility doors. 3) The Sump Pump discharge piping in the SSF between the exterior wall and the check valve. 4) The SSF cable trench where it enters the SSF. In addition, at the suggestion of RC Bucy, please show the maximum water height in the Oconee yard due to a Jocassee Dam break as 4.71 feet."**

- An **October 30, 1989**, licensee letter to the NRC discussed GL 88-20 and it supplement. Specifically that, "...in **June 1984 Duke and EPRI completed a Level 3 PRA, with external events on Oconee Unit 3**. This PRA (NSAC-60) has been reviewed by NRC and its contractors. Subsequently, in 1987 Duke began a program to update the NSAC-60 PRA to take into account a number of changes made to the plant since 1980, the original PRA baseline. For satisfying the IPE requirement, Duke intends to utilize the updated Oconee PRA, which is a level 3 PRA with analysis for external events."

- A **March 20, 1990,** internal licensee letter and a **April 16, 1990**, followup internal licensee letter document the Duke sites attempt to use IN 87-49 and design studies to identify flooding deficiencies. Oconee's design study is identified as ONDS-268, Identification of Outside containment Flood Protection Barriers.

- A **June 21, 1990,** internal licensee letter discusses the scope of Oconee's effort for ONDS-268, and that the results of the study will be used to create a DBD on flooding. The letter specifically states that, "A review of all applicable design documents (drawings, specifications, calculations, etc.) will be made in order to compile a list of flooding protection features. A review of the applicable Station Probabilistic Risk Assessment (PRA) will be made to determine flood sources or flood events associated with each flood protection feature. Features identified will have their function described and their relation to flooding states." The letter goes on to state areas of responsibility and a schedule for completion of the study with a final due date of December 31, 1991.

- On **November 30, 1990**, the licensee submitted a complete level 3 PRA to the NRC with a systematic treatment of internal and external events. The submittal discusses the failure of the Jocassee Dam and its expected impact on the various PRA sequences, which range in frequency from 1.6E-06 per year to 2.9E-05 per year

  The submittal also discusses actions which have been taken due to the NSAC-60 study. In that, "...Duke recognized certain vulnerabilities to severe accidents which were identified by the dominant sequences. Therefore, Duke implemented plant modifications to improve Oconee's ability to respond to severe accident events. These modifications include hardware/configuration changes and procedural changes. While most of these changes were implemented to reduce the likelihood and effect of Turbine Building flooding sequences, the likelihood and effect of other sequences have also been reduced. The major modifications implemented to date are described below:

  13. The maximum credible, water height in the Oconee yard following a Jocassee Dam break is 4.7 feet. To ensure SSF survivability following an external flood of this magnitude, 8 foot high hydostatic barrier walls have been installed around the grade level doors. Platforms and stairways enable entrance to and exit from the SSF."

- A **February 15, 1991,** internal licensee letter documents the completion of identifying the flood events for ONDS-268 (Identification of Outside containment Flood Protection Barriers) and high risk areas derived from the Oconee PRA. With respect to the SSF, the letter states that, "**The SSF is equipped with 5 ft. flood barriers at its two entrances, <u>and has otherwise been made impervious to site flooding</u>. Therefore, the SSF would be available to mitigate all external flooding sequences.** Two sump pumps in the basement of the SSF building eliminate <u>**interior flooding**</u> of the SSF safety related equipment."

- On **December 18, 1991**, the licensee responded to the NRC regarding supplement 4 of

GL 88-20. The response stated that, "As described in our November 1, 1989 response to the IPE program, Duke has completed Level 3 PRAs with analyses of external events for all three of the Duke plants. The Oconee and McGuire IPE submittals have been completed with updated PRAs."

- A **December 20, 1991,** internal licensee letter documents the discovery of an unsealed flood penetration surrounding the CO_2 piping entering SW corner of the SSF. The deficiency was discovered during the Oconee Design Study, ONDS-268, Identification of Outside containment Flood Protection Barriers. PIR (Problem Investigation Report) 4-092-0052 was generated for the deficiency, on March 30, 1992.

  An attachment to the letter discusses "**Features for Protection from External Floods**" and states that, "The Oconee PRA identifies two potential events that could lead to external flooding of the Oconee site. The first is a general flooding of the rivers and reservoirs in the area due to a rainfall in excess of the Probable Maximum Precipitation (PMP). The FSAR addressees Oconee's location as on a ridge 100' above maximum known floods. Therefore, external flooding due to rainfall affecting rivers and reservoirs is not a problem. **The second source of external flooding is a failure of the Jocassee Dam. Failure of the Jocassee Dam would result in a postulated wave height of 4.71 feet in the yard at the Oconee site. The SSF provides Oconee's most secure method of safely shutting down the plants following an external flood due to a Jocassee Dam failure." With regards to the SSF, the attachment also discusses the 5 foot flood wall at the North and South entrances to the SSF, along with the SSF sump and its pumps and level control switches.**

- A **December 10, 1992**, Jocassee Dam Failure Inundation Study (FERC Project No. 2503) was completed and predicted that a Jocassee Dam failure could result in flood levels at the Keowee Dam (815 feet msl elevation) of:

  1) 823.28 feet msl for a random/"sunny day" failure of Jocassee (overtopped by 8.28 feet)
  2) 824.13 feet msl for a PMF induced failure of Jocassee (overtopped by 9.13 feet).

  As such, the Keowee Dam is expected to fail; consequently, the study predicted flood levels at the tailrace (0.6 miles downstream from Keowee) to be :

  1) 808.51 feet msl for a random/"sunny day" failure of Jocassee
  2) 812.82 feet msl for a PMF induced failure of Jocassee.

  The Oconee Nuclear Site yard grade elevation is 796 feet msl.

- On **December 31,1992**, the licensee implemented a FSAR update which added the Jocassee Dam failure to SSF portion of the FSAR (applicable pages of December 31, 1992 have been provided as part of attachment 2 of this TIA).

  The update stated, among other things, that, " The second source of external flooding is a rapid failure of the Jocassee Dam. Failure of the Jocassee Dam would result in a postulated wave height of 4.71 feet in the yard at the Oconee site. The SSF protect's Oconee's most secure method of safely shutting down the plant following an external flood due to a Jocassee Dam failure.

Protection from flood at the SSF is provided by five foot flood walls at the entrances to the SSF supplemented by a watertight door at the south end entrance of the SSF." Taken from the SSF Flood Design section of the FSAR (section 9.6.3.1).

"The SSF will not be affected by the following postulated flood events: .... 3. Jocassee Dam Failure. The structure meets the requirements of GDC 2 and the guidelines of Regulatory Guide 1.102 with respect to protection against flooding." Taken from the SSF Flooding Review section of the FSAR (section 9.6.4.7).

- A **December 14, 1993**, licensee memo to file documents the results of the Jocassee Dam Failure Inundation Study and discusses the differences in predicted flood levels between the January 1983 flood study and the December 1992 flood study. The memo discusses the differences between the 1992 FERC and the 1983 PRA study (12.5 to 16.8 feet of water on site, compared with 4.71 feet of water). **The memo also states that the Oconee FSAR and PRA will be revised to reflect the potential loss of the SSF during a Jocassee Dam failure.**

Some key differences discussed in the memo are as follows:

1) "For the PRA study, routing of flood wave was predicted by a step approach using an older verison of National Weather Service DAMBRK program."

2) "For the FERC study, a later version of the DAMBRK program was used for routing the flood wave, using a full dynamic routing that makes use of downstream information."

3) "The PRA study takes full credit for the Little River basin acting as a storage basin in the event of a Jocassee Dam failure. Flooding of the Oconee yard would result from overtopping of the Oconee intake dike from the Little River basin. Keowee Dam is also overtopped but assumed not to fail. The FERC EAP [Emergency Action Plan] study assumes the flood wave from the Jocassee dam failure will overtop and fail the Keowee Dam before a significant amount of the flood volume can be spread into the Little River basin. Water from both the Jocassee and Keowee reservoirs will flood the Keowee tailrace area and enter the oconee yard prior to dissipating downstream."

4) "The 4.71 feet flood heights in the PRA study cannot be duplicated with the current models. The backup documentation and calculations for the work supporting the PRA study cannot be found to verify previous modeling, assumptions, and calculations, etc."

5) " Warning time to lower water levels in the reservoirs will not significantly affect flood height unless the time is in terms of days rather than hours."

6) "Depth of failure will not affect the flood height since most of the water is released above mid-height of the dam."

7) "The FERC study predicts the Keowee Dam will fail as a result of the Jocassee dam failure while the original PRA study did not predict failure of the Keowee Dam. It should be noted that **previous FERC studies** also predicted a Keowee Dam failure."

8) "The FERC study considered consequences of flow restrictions downstream of Keowee Dam while the PRA study did not."

The memo concludes by stating that, "More exhaustive studies could be undertaken to address this problem but were deemed inappropriate from a cost/benefit perspective. Therefore, the Oconee PRA and FSAR will be revised to reflect potential loss of SSF function resulting from a Jocassee Dam failure. PIP Number O-G93-0181 has been written to document this process."

Comment: December 1993 memo states that, "...**previous FERC studies** also predicted a Keowee Dam failure." The licensee has not provided any previous FERC studies for this event.

- On **December 14, 1993**, PIP O-G93-0181 was generated, which documented that, "The latest Jocassee Dam failure study indicates the maximum credible water height could be much higher than the 5-foot wall."

  Proposed corrective action #1 states that, "The external flood portion of the oconee PRA will be revised to reflect potential loss of SSF function resulting from a Jocassee Dam failure. The actual corrective action was a "Re-analysis is scheduled by Dec. 1995."

- On **February 11, 1994**, the NRC issued a Notice of Violation and Notice of Deviation (Report number 50-269,270,287 / 93-25). This report contained a discussion of the Jocassee Dam failure. The discussion centered around two points:) the inability of the SSF to mitigate the worst case Jocassee Dam failure per the recently completed FERC study and the inaccurate IPE submittal, which stated that the SSF flood walls were 8 feet in height.

- A **March 14, 1994** licensee response letter to Service Water Inspection, report dated February 11, 1994. The response states that, "Duke's Fossil/Hydra Department conducted an inundation study of Duke dams in 1993, in response to the FERC Emergency Action Plan (EAP) requirement. This study utilize, the latest computer models for inundation evaluation, including a number of FERC required conservative assumptions. In this analysis, the Keowee Dam was also assumed to fail due to overtopping of Keowee from the Jocassee failure. The resulting Oconee yard level flood was estimated to be 12 ft. This result is understandably different from the assessment made as part of the PRA study. **An attempt was made to reproduce the results of the PRA study using assumptions consistent with original Civil Engineering evaluation in support of the PRA. This was unsuccessful since the details of the analysis could not be located and the responsible engineer was no longer employed at Duke.** Key differences in the methodology and assumptions used for the two studies are as follows:

For the PRA study, routing of flood wave was accomplished by a step approach using an older version of National Weather Service DAMBRK program. For the FERC study, a later version of the DAMBRK program was used for routing the flood wave, using a full dynamic routing that makes use of downstream information. The FERC study considered consequences of flow restrictions downstream of Keowee Dam while the PRA study did not.

The Keowee reservoir consists of the Keowee basin and the Little River basin that are connected by a man-made channel. Fifty-six percent of the storage volume for the Keowee reservoir is in the Little River basin. The man-made channel is located immediately upstream and west of the Keowee Dam. The PRA study takes full credit for the Little River basin acting as a storage basin in the event of a Jocassee Dam failure. Flooding of the Oconee yard would result from overtopping of the Oconee intake dike from the Little River basin. Keowee Dam is also overtopped but assumed not to fail. The FERC EAP study assumes the flood wave from the Jocassee dam failure will overtop and fail the Keowee Dam before a significant amount of the flood volume can be spread into the Little River basin. Water from both the Jocassee and Keowee reservoirs will flood the Keowee tailrace area and enter the Oconee yard prior to dissipating downstream.

In summary, a recent analysis for the Jocassee Dam failure using FERC-required modeling and assumptions produced more severe flooding than the magnitude considered in the PRA analysis. The Oconee yard flood level estimated in the PRA analysis cannot be reproduced as stated above. Nevertheless, it is believed that the 5 ft. SSF flood wall would provide some protection for best estimate types of dam failure modes. Considering that the estimated dam failure frequency is very small (1.58E-0A 5/yr.), additional analytical effort to more precisely quantify the flood level is considered not warranted."

- A **March 28, 1994** licensee letter discussed a commitment to the NRC "...to complete a reanalysis of a postulated Jocassee flood with the available information on flood frequency, SSF availability, and SSF serviceability, as part of the IPEEE effort."

- On **March 31, 1994**, IN 94-27, Facility Operating Concerns Resulting From Local Area Flooding was issued. This IN was issued "... to alert addressees to emergency preparedness, equipment operability and radiological control problems that may result from local area flooding."

  The IN discusses that, "This event demonstrates that flooding problems and degradation of equipment may be caused by water inleakage even though flood waters are not above grade elevations. Water leaking through underground walls may impinge on electrical equipment or may enter radiologically controlled areas and spread contamination to other areas. Underground cable and pipe tunnels may become flooded and serve as pathways for water to enter plant buildings. Management and plant personnel attention to these conditions is important to ensure that equipment is protected and unsafe facility conditions are not created."

Comment: The licensee should've used this IN to ensure that the flood protection studies commissioned in response to IN 87-49, Deficiencies in Outside Containment Flooding Protection, were adequate. No evidence on this could be found. If the licensee verified the earlier flood protection studies, it is likely that the inadequate SSF sanitary system design (URI 2006002-02) would've be identified by the licensee and corrected some 13 years sooner.

- On **June 2, 1994**, OSC-5781, USQ Evaluation for Change in FSAR Concerning SSF and Jocassee Flood (see attachment #2), was approved. The calculation discusses the rationale behind using 50.59 to remove information in the SSF portion of the FSAR with regards to external flood protection of the site during a Jocassee Dam failure (using 1983 PRA study flood level of 4.71 feet on site). The calculation states that, "**FSAR Section 9.6 was revised in the 1992 Update of the FSAR to address external flood protection of the yard as a result of the rapid failure of the Jocassee Dam.** The information was determined to describe a PRA study and is not part of the design basis for Oconee. The FSAR statements are to be revised or removed to correct the information in the FSAR and reflect the existing licensing basis of Oconee."

- On **June 13, 1994**, Flooding from External Sources Design Basis Document was issued by the licensee. Section 2 discusses GDC 2 and that SSCs important to safety shall not be effected by flooding and maximum precipitation. Section 3.2.6, Potential Dam Failure, states that, "Dam breaks have no bearing on the design basis flood."

- A **December 16, 1994** licensee memo to file regarding the "Seismic PRA Analysis - Jocassee Dam Flooding Factors" states that, "The current Oconee seismic PRA analysis includes the failure of the Jocassee Dam as a sequence leading to core-melt. Based upon a calculation performed in Jan. 1983 for the PRA analysis, a maximum resulting yard level of 4.71 ft. was determined using 'best estimate' - type assumptions. As a plant safety enhancement, a 5ft. wall was erected at the SSF doorway to provide flood protection. The wall was deemed adequate to protect the SSF from the more likely flood scenarios but was not intended to bound all flood scenarios. Following completion of the SSF wall installation, credit for SSF operation following a Jocassee Dam failure was taken for random and seismic failures of Jocassee since the flood analysis **was not performed using conservative assumptions**." The memo also states that, "**An attempt was made to reproduce the results of the PRA study using the assumptions made in that analysis. This was unsuccessful since the details of the analysis could not be located and the responsible engineer was no longer employed at Duke.**"

- On **February 2, 1995**, the licensee generated PIP O-95-0139, which discussed the fact that the requirements for mitigating a Jocassee Dam break are unknown.

  The PIP stated that, "At the time of the writing of the MS DBD, requirements for mitigating the failure of Jocassee dam are being re-investigated. The upcoming SSF DBD will provide the details on the investigation."

- On **December 28, 1995**, the licensee submitted the IPEEE Submittal Report to the NRC. The submittal discusses the postulated Jocassee Dam failure and its impact on the site. Section 5.2.1.2, External Flooding From Jocassee Dam Failures tates that, "The Jocassee Dam is an earth-rockfill structure approximately 400 feet high. The dam was completed in 1972 and the reservoir was filled by April 1974." The section goes on to state that, "Size, type of construction, realistic failure modes, period of construction, and age were the major consideration used to define a data base for use in estimating te failure frequency of the Jocassee Dam." After collecting data from various sources and excluding non applicable data, the random failure frequency is estimated to be $1.3x10^{-5}$. "To the extent that this is....representative of the Jocassee Dam, these results can be interpreted as the predicted annual random failure frequency of the Jocassee Dam from causes other than earthquakes or overtopping.

  The Oconee external flood core damage frequency is dominated by floods that exceed the 5 ft. SSF flood barriers, and thus render the SSF inoperable. The estimated external flooding core damage frequency from this analysis is 7.0E-6/yr. The dominant cut set involves floods that exceed the 5 ft. SSF flood barriers, thus rendering the SSF inoperable.

- On **February 13, 1996,** the licensee generated PIP O-96-0298, which documented the discovery of a low point in the dike which forms the Oconee intake.

  The detailed problem description discusses that the top of the intake dike was found to be at 814 feet above msl instead of 815 feet msl. The description goes on to state that,"Flood routing Studies performed by Hydroelectric Engineering Group for Keowee only predict that the water can rise to elevation 809 at the Intake Dike under Maximum flood conditions which would result from a Probable Maximum Flood (PMF) of the Little River ARM of Lake Keowee. Elevation 814 still provides 5 ft of Freeboard which provides an adequate margin of safety. <u>However the PRA analysis group uses an **outdated** analysis based on the failure of Jocassee Dam that calculates the overtopping of the Intake Dike at the 815 elevation with a resulting flow across the Plant Yard at a depth of 4.72 ft. The 814 elevation would result in a much deeper flow at the SSF than the previously calculated 4.72 ft for the same flooding analysis</u>."

  The remarks section of the PIP states that, "The change in the Oconee Intake Dike crest elevation from el. 815' to el 814' will not have any significant impact on he PRA flood analysis pertaining to a Jocassee Dam failure."

  The PIP was closed with no corrective actions taken.

  UFSAR Section 2.4 states that the Keowee Dam and associated dikes were constructed to 815 ft. msl.

- In **December 1996**, Revision 2 of the Oconee Station PRA Summary Report was issued. The External Flood portion of the report (section 3.3.4) stated that, **"The second source of external flooding is a possible random failure of the Jocassee Dam. Random dam failures include all causes other than a rain-induced failure or an**

earthquake-induced failure." The report lays out the Top 100 CDF Cut Sets for External Initiators, with 12 of the top 100 being Jocassee Dam failure-related events.

Appendix B of the report, External Events Analysis, goes on to state that, "The seismic capacities of most plant structures and components were developed by Structural Mechanics Associates for the original PRA. That study (Ref. B-3) gives a detailed description of how the seismic capacities were derived. The seismic capacities of the Keowee and Jocassee Dams were developed by Dr. Daniel Veneziano of MIT, a consultant to Law Engineering Testing Company. The results of that study are reported in Reference B-4. **References B.3 and B.4 were published in 1981 and included in NSAC 60, the original Oconee PRA**. References B-5 and B-6 are later revisions to some of the original capacities based on additional data and a more in-depth evaluation." Appendix Section B.4 discussed, at great lengths, the possible failure of the Jocassee Dam and its ramifications on the Oconee site.

Appendix B of the Summary Report also cited several flooding and dam failure-related references ranging in date from 1966 to 1995.

- On **December 18, 1997**, the licensee submitted a Supplemental IPEEE Submittal Report to the NRC which discussed the results of the USI A-46 relay review as it affects the previously submitted seismic analysis as well as other enhancements to the seismic analysis. The report documents, in several locations, that a failure of the Jocassee Dam would result in significant site flooding with a large portion of the seismically-induced core melt frequency being dominated by flood heights greater than the 5 foot SSF flood walls (i.e. 40%).

- On **January 5, 1999**, the NRC sent the licensee a RAI on regarding the licensee's IPEEE submittals.

Question 3 stated, "Cut sets obtained from the updated seismic analysis are presented in Table 5-l of the 1997 Supplemental Report. However, analysis result summaries which could provide insights on dominant contributors to the IPEEE are not provided in the report. Please provide summary information for the updated results similar to that provided in Table 3-6 of the 1995 IPEEE submittal for sequence CDF, and to that discussed in Section 3.1.5.4 of the 1995 IPEEE submittal for dominant contributors (e.g., the contribution of dam failure to total CDF). If the results have changed due to the response to Question 1 above, please provide these revised results as well."

While Part C, HIGH WINDS, FLOODING, AND OTHER EXTERNAL EVENTS, of the RAI stated, "As noted in NUREG-1407, Section 2.4, the latest probable maximum precipitation (PMP) criteria published by the National Weather Service calls for higher rainfall intensities over shorter time intervals and smaller areas than have previously been considered; this could result in higher site flooding levels and greater roof ponding levels. Please assess the effects of applying these new PMP criteria to Oconee. Additional information is given in Generic Letter 89-22."

- On **March 31, 1999**, the licensee responded to question 3 and part C of the January 5, 1999 RAI as follows:

Q3) "The total annual seismically-induced core damage frequency, as reported in the 1997 submittal, is 3.47E-05 / yr. A flooding event (resulting from the seismically-induced failure of the Jocassee Dam), which exceeds the 5 ft. SSF flood barriers, makes up the dominant cut set. The greatest concentration of failures is shown to occur approximately between 0.6g and 0.9g. Sequences involving a total loss of power coupled with the SSF response comprise approximately 70% of the core damage frequency. (Cut sets with Jocassee Dam failures resulting in flood levels less than 5 ft. represent 4%, while cut sets with the failure of power system components make up roughly 66%.) Sequences involving the SSF (both seismically-induced and independent failures) contribute approximately 72% to the seismic core damage frequency. Cut sets involving the Auxiliary Building and SSF surrogate events contribute 5% and 30%, respectively. Recall also that several sensitivity studies were performed on the seismic results to determine the effects of various factors, components, and fragilities (see Table 5-2 of the 1997 submittal). These results, combined with the information above, provide several insights into the analysis. Even though no one failure truly dominates the results, clearly, sequences involving a total loss of power (station blackout events) as well as the SSF make up a majority of the seismic core damage frequency. A plot of the mean plant fragility is shown in Figure 2. This chart shows the cumulative probability of failure vs. ground acceleration level as well as the mean failure acceleration levels for the top two seismic cut sets. The above results have NOT changed due to the response to Question 1 above".

Part C) "An updated flood study for the Oconee site, which includes the Keowee dam and reservoir, was performed in 1995 [Ref. 151]. This study used the criteria contained in the hydrometerological reports listed in Generic Letter 89-22. The results of this study were comparable to the results of the previous study referenced in the Oconee IPEEE report. Both studies demonstrated that the Keowee reservoir could accommodate the reservoir flooding that could result from a PMP."

- On **October 4, 1999**, the licensee submitted additional information concerning part C of the January 5, 1999 RAI. The response was silent with respect to potential failure of the Keowee or Jocassee Dams and resultant site flooding.

- On **March 15, 2000**, IPEEE was reviewed (no SER was issued by the NRC).

- On **September 3, 2002,** the licensee generated PIP O-02-4678, which documented a Level 2 assessment to improve the design basis of the plant.

The PIP's executive Summary states that, "The objective of the design basis focus area at Oconee is to identify improvements that will reduce plant risk, increase design margins, and reduce regulatory risk. The objective of this assessment was to perform a broad review of the design basis to determine if new areas, not currently in Oconee design basis or system health plans, require review. As is evident from the assessment, the scope of design work at Oconee since the Recovery Plan has been extensive. Most of the significant differences between Oconee and a Standard Review

Plan (SRP) plant were evaluated through these initiatives. The assessment considered insights from a DC Cook design basis benchmarking trip and a review of nonconforming item (NCI) PIPs. In addition, an industry consultant (Mr. Don Prevatte) performed an independent review of the Oconee design basis. Recommended focus areas from Mr. Prevatte's independent review are factored into this Level II assessment."

"No strengths, findings, or deviations were identified through the assessment. Although many areas of the design basis have been or are being addressed at Oconee, this assessment identified sixteen items that warrant additional review. These sixteen items are listed as areas for improvement (AFIs) in the assessment results section."

"It is believed that completion of the currently identified design work at Oconee, along with resolution of the sixteen AFIs from this assessment, will achieve the objectives of the Oconee design basis focus area."

"The Assessment purpose and scope state that, "Also, based on a recommendation from the Oconee Engineering Manager, an industry consultant performed an independent review of the Oconee design basis. The consultant selected for this review was Mr. Don Prevatte, president of Powerdyne Corporation. Mr. Prevatte is a registered professional engineer with more than 30 years of engineering and management experience in the nuclear industry. He has participated in 82 technical team assessments of a wide variety of designs and vintages of nuclear power facilities for the NRC, utility licensees, and the DOE over the last 15 years. Of these 82 assessments, 59 were as a contractor for NRC team inspections. Recommended focus areas from Mr. Prevatte's independent review are factored into this Level II assessment."

"The following Areas for Improvement were noted in the PIP (related to the issue at hand)."

"1) <u>Seismic risk should be assessed.</u> The SQUG project is significantly improving Oconee's shutdown capability by resolving many seismic outliers through modifications. However, as with the tornado PRA model, it appears justified to focus on a detailed review of the seismic PRA model to determine if any further improvements to the risk calculations or plant are warranted. A SITA would be a good mechanism to evaluate seismic risk, including engineering design elements such as response spectra for the Turbine Building and Auxiliary Building, procedures for achieving shutdown, and the primary sequences that contribute to core damage. The Design Review Board has requested a SITA on seismic risk in 2003."

"2) The SSF is critical in terms of risk reduction."

"12) **External flooding** is a very high risk event that has not been analyzed in detail. The scenario of interest is the **Jocassee dam failure**. It is recommended that all facets of this event be revisited, including credible causes, flood levels and associated consequences, methods of analysis, preventative and mitigative measures, and updated risk analyses. It is recommended that the DBG develop a project plan to thoroughly review external flooding risk."

The assessment conclusions section states that, "This assessment has performed a broad review of the Oconee design basis. As is evident from the assessment, the scope of design work at Oconee since the Recovery Plan has been extensive. Most significant differences between Oconee and an SRP plant were evaluated through these initiatives. The assessment also considered insights from a DC Cook design basis benchmarking trip and a review of NCI PIPs."

"No strengths, findings, or deviations were identified through the assessment. <u>Although many areas of the design basis have been or are being addressed at Oconee, the following areas for improvement are identified:</u>

<u>12. External flooding</u> is a very high risk event that has not been analyzed in detail. The scenario of interest is the Jocassee dam failure. It is recommended that all facets of this event be revisited, including credible causes, flood levels and associated consequences, methods of analysis, preventative and mitigative measures, and updated risk analyses. It is recommended that the DBG develop a project plan to thoroughly review external flooding risk."

"In summary, the objective of the design basis focus area at Oconee is to identify improvements that will reduce plant risk, increase design margins, and reduce regulatory risk. The objective of this assessment was to perform a broad review of the design basis to determine if new areas, not currently in Oconee design basis or system health plans, require review. It is believed that completion of the currently identified design work at Oconee, along with resolution of the sixteen AFIs from this assessment, will achieve the objectives of the Oconee design basis focus area."

<u>Proposed Corrective Action #12:</u>
"External flooding is a very high risk event that has not been analyzed in detail. The scenario of interest is the Jocassee dam failure. It is recommended that all facets of this event be revisited, including credible causes, flood levels and associated consequences, methods of analysis, preventative and mitigative measures, and updated risk analyses.

Based on the 9/16/02 DRB meeting, a completion time of 12/31/03 is requested."

<u>Actual Corrective Action #12:</u>
Priority: O3c Actual CAC: E Status: Closed Due Date: 07/06/2006

"This issue is being addressed by PIP 04-863." [see below]

Originated By: GKM7309: MC ANINCH, GEORGE K Team: GKM7309 Group: DBG
Date: 05/11/2006

- On **February 21, 2004,** the licensee generated PIP O-04-0863, which again documents the licensee's belief that a Jocassee Dam failure is a beyond design basis event.

The PIP goes on to state that, "...readily available engineering documentation does not clearly capture the various potential failure modes of the dam, the resulting water release rates, the potential impacts to the surrounding geography and any necessary plant response to this beyond design basis event.

Engineering should review the existing analyses and documentation to determine what, if any, upgrades in analyses, procedures and other documentation should be made.

The PIP's only corrective action has been delayed 8 times "due to other higher priority work". The latest due date for this corrective action is April 25, 2007.

- On **July 20, 2004**, the licensee generated PIP O-04-4733, which documents a Level 2 Assessment from a Regulatory Brainstorming Workshop on April 22 and 23, 2004. The workshop was led by the former Reg Compliance Manager, and attended by the new Reg Compliance manager, the SSF system Engineer, 2 GO PRA experts, and the Oconee Design Basis Group Manager among others.

  One item proposed by the "SSF Team", considered by the attendees and documented in the PIP was item "E(4). **Raise the SSF flood wall to handle the maximum Jocassee Flood. (ENG)**

  Benefit - SSF would be available to mitigate the "worst case" Jocassee dam failure. This would improve margin in PRA calculations.

  Action - SAA Group should provide the maximum elevation of the Jocassee flood. This elevation should be used as an input to a design study that determines the options for providing SSF flood protection. **Based on the results to this study, a modification should be installed to protect the SSF from the worst case Jocassee dam failure"**

  The PIP contains no corrective actions related to this item.

- On **September 29, 2004**, the licensee generated PIP O-04-6365, which documents the discovery of the need for a calculation to validate the adequacy of the SSF sump during an SSF event concurrent with the loss of the SSF sump pumps (discovered by a Cornerstone Inspection Calculation Team review).

  Proposed corrective action #8 states that "The flood wall surrounding the SSF provides protection from some but not all postulated Jocassee Dam failures. **SSF Risk Reduction Team recommendations to increase the height of the flood wall surrounding the SSF should be considered when the replacement sump pumps are chosen."**

  However, actual corrective action #8 states that "**Based on discussions with the Severe Accident Analysis Group, modifications to increase the height of the flood wall around the SSF will not be pursued at this time.** Therefore, the proposed replacement SSF Sump pump should be based on operating with flood levels up to the height of the existing flood wall surrounding the SSF."

- On **August 3, 2005**, the licensee generated PIP O-05-4978, which documents, for the second time, that the SSF CO_2 access cover is breached.

  The PIP's detailed problem description states that, "The SSF access port for CO_2 delivery is normally covered by a bolted on cover. During SSF Housekeeping tour it was noticed that the panel was swung away in order to route temporary power cables into the SSF. The access port if located about waist high which is below the top of the flood barriers. Engineering was consulted to determine if there is an operability issue with the access port open. <u>There is no SSF Operability issue but Engineering stated that from a PRA standpoint, it is not good to have the access port open unnecessarily.</u> Maintenance is removing the cables and replacing the access panel today."

  PIP Corrective action #2 states that, "Based on discussions with Lee Kanipe (Sever Accident Analysis Group), the bolted cover over the CO_2 supply pipe should be installed because it is part of the flood barrier that protects the SSF. <u>While this flood barrier is not required for SSF operability, it is important to PRA (similar to flood gate at the South Entrance to the SSF).</u> Therefore, a sign, that states the importance of the bolted cover over the CO_2 supply pipe, should be installed."

  PIP corrective action #3 states that, "The SSF ASW DBD describes why the watertight door at the South entrance to the SSF is important. The CO_2 supply pipe flood barrier should be included in this discussion."

  Proposed corrective action #4 states that, "Perform expert panel review of MR function 8094.3, Provide flood protection barrier (external flood) for SSF, to determine if bolted cover over CO_2 supply pipe in SSF Response Room is included. Also, review risk significance of flood barrier. Assign additional corrective actions as needed to revise MR function 8094.3."

  Actual corrective action #4 states that, "In its meeting on 10/05/05, the Maintenance Rule expert panel determined that function 8094.3 should be changed to High Safety Significant (HSS). Also, the panel agreed that the bolted cover is included in this function. The SSC Function Scoping database was updated accordingly."

  The Maintenance Rule functional failure portion of the PIP states that, "The problem identified in this PIP is related to Maintenance Rule Function 8094.3-Provide a flood protection barrier (external flooding event). When the flood barrier for the CO_2 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 (bolted cover that surrounds the CO_2 supply pipe in the SSF Response Room) 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. The bottom of the opening that is present when the CO_2 supply pipe flood barrier is removed is approximately 43.5" (~800.625') above the floor in the SSF Response Room. The top of the flood gate installed at the South entrance to the SSF is 801.75' (Ref O-320Z-3)."

- On **October 5, 2005**, the MR expert panel re-examined the safety significance of function 8904.3. "Lee Kanipe proposed that the SSF flood barrier (function 8094.3) should be high safety significance based on the external flood frequency and the fact that the SSF is the only mitigating system for this event. Since the Civil representative was not available, this decision must be reviewed by him. Update: On 10/17/05, the Civil representative on the expert panel (Bob Hester) agreed that this function should be HSS [high safety significance]."

- On **April 26, 2006**, Oconee Integrated Inspection Report 2006002 was issued. The report contains two URIs related to the SSF and this initiating event- namely:

  - URI 05000269,270,287/2006002-01, Failure to Maintain Design Control of SSF Flood Protection Barrier
  - URI 05000269,270,287/2006002-02, Failure to Promptly Identify an Inadequate SSF Building Sewer System Design

- On **October 5, 2006**, the licensee submitted a written response to a choice letter for a preliminary white finding in lieu of a regulatory conference (see IR 50-269,270,287/2006002 and 2006016). The violation concerns the failure to effectively control maintenance activities, and therefore assess and manage the risk, associated with removing the CO_2 access cover (a passive NRC committed flood protection barrier as indicated on Oconee drawing O-310 K-22) in the south wall of the SSF to facilitate installation of temporary electrical power cables.

  The background portion of the licensee's response letter discusses the SSF, its flood barriers and the January 1983 flood study. Specifically, the letter states that, "As stated in the UFSAR, as a PRA enhancement, the SSF is provided with a 5 foot external wall which is equipped with a water tight door near the south entrance of the SSF. Additionally, the UFSAR states that maximum expected water level, caused by a break of the non-seismic Condenser Circulating water system piping, located in the turbine Building, will be below the elevation of the grade level of the entrance to the SSF."

  "Flood walls were not part of the original SSF structure upon completion in the 1983 time frame. Flood walls were added to both the north and south entrances of the SSF in 1988 as a result of insights from an NSAC-60 relative to externally initiated flooding events."

  Once again, per licensee calculation, OSC-631 (Standby Shutdown Facility) rev. 8, the Initial design of the North and South, SSF exterior flood walls (NSM ON-2347) was completed on **June 8, 1984** and checked on November 29, 1984. Per drawing O-320-Z-3 and O-0320-Z-5, NSM ON-2347 was implemented on **June 26, 1986**.

  The letter goes on to state that, "In 1983, an internal Duke study was completed which calculated a flood height of 4.71 feet above grade in the Oconee yard. This evaluation is referred to as a "best estimate" calculation because it assumed many inputs to be at their nominal values. The use of this "best estimate" method of evaluation is in accordance with EPRI PSA Applications Guide, EPRI TR-105396, and the ASME Standard for PRA."

"In 1992, Duke's hydro department conducted an inundation study of Duke dams in response to the FERC Emergency Action Plan Requirement. **This evaluation used many conservative, worst case assumptions. The results of this study showed that flood heights in the Oconee yard could reach a level as high as 12 feet above grade."** The letter also states that, **"The best estimate calculation performed in 1983 established a worst case flood height of 4.71 feet above grade."**

(Comment) If the "best estimate" study used many inputs at their nominal values, flawed, non-conservative assumptions, outdated computer modeling techniques and can not be replicated, then that study can not accurately predict the worst case flood height (i.e., 4.71 feet above grade).

- Currently revision 23 of the SSF ASW System DBD, Section 2.1.2.2.2, External Flooding Due To Jocassee Dam Failure states the following verbatim:

The SAR documents for the SSF contain no specific requirements, commitments, or statements concerning the need for external flood protection features for the SSF. (Reference 2.5.2.1.20) **Therefore, there is currently no commitment for the SSF ASW System to provide flow to the SG's for decay heat removal if flooding from a Jocassee Dam failure disables the feedwater and the emergency feedwater systems.**

Based on information from the Oconee Probabilistic Risk Assessments (PRA), a 5' external flood wall was added around the SSF entrances to reduce the consequences of a Jocassee Dam failure. (Reference 2.5.2.4.6) 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'. (Reference 2.5.2.1.20) Since the SSF ASW System is located inside the SSF Building, the SSF ASW System is not protected from a Jocassee Dam failure which results in an external flood height > the 5' wall.**

Oconee had several PRAs performed and submitted to the NRC which addressed the Jocassee Dam failure. The NRC's review of the first PRA (Reference 2.5.1.9.38) addressed the potential for core damage from a Jocassee Dam failure. No commitments concerning the construction of an SSF wall to reduce Oconee's vulnerability to a Jocassee Dam failure were mentioned.

A second PRA (Reference 2.5.1.9.59) was submitted to the NRC in response to Generic Letter 88-20. The Generic Letter requested each licensee submit Individual Plant Examinations (IPE) and the Generic Letter states that the licensee's examination was to initially be for internal events only. The Oconee PRA that was submitted addressed both internal and external events. The NRC's review of this PRA addressed internal events only. In the NRC's response, the NRC stated that their review of external events would be reviewed separately, within the framework prescribed in Generic Letter 88-20, Supplement 4. (References 2.5.1.9.59 and 2.5.1.9.81) Generic Letter 88-20, Supplement 4 (Reference 2.5.1.9.94) addresses Individual Plant Examination of External Events (IPEEE).

The potential for the SSF to withstand an external flood due to the Jocassee Dam failure was also addressed by the NRC in their notice of violation and deviation for the Service Water Inspection. The NRC noted as a finding that the SSF could not withstand the Jocassee Dam failure, which they stated was inconsistent with the IPE submittal. Their conclusions were based on the SSF having a 5' external wall and Duke's recently completed flood analysis which resulted in flood heights of at least 10 feet. The NRC indicated that their concerns were with the Oconee IPE submittal. (Reference 2.5.1.9.88) The Duke response to this finding (Reference 2.5.1.9.89) indicated that the 5' wall was not intended to bound all flood scenarios, but was deemed adequate to protect the SSF from the more likely flood scenarios. (Reference 2.5.1.9.89)

A third PRA (Reference 2.5.1.9.98, IPEEE Submittal Report) was submitted to the NRC on December 21, 1995 as Oconee's response to Generic Letter 88-20, Supplement 4. Per the IPEEE Submittal Report, there is a significant reduction in core damage frequency due to successful operation of the SSF for Jocassee Dam failures which result in flooding that does not exceed the 5' flood barrier which protects the SSF. A Jocassee Dam failure that results in flood levels which exceed the top of the 5' SSF flood barrier is the dominant accident sequence (2.6 E-06) leading to core damage resulting from an external flooding event. The estimated core damage frequency due to all external flooding sequences is 7.0E-06/yr. The IPEEE submittal concludes that the Oconee plant risk due to external flooding does not pose a severe accident vulnerability since a 7.0E-06/yr core damage frequency is of the same magnitude as other potential accidents such as seismic event, fires, tornadoes, and other events.

The estimated core melt frequency due to a seismically induced Jocassee Dam failure which results in flood levels that exceed the top of the 5' SSF flood barrier is of the same order of magnitude as core melt frequencies caused by external flooding. Therefore, a seismically induced Jocassee Dam failure does not pose a severe accident vulnerability.

In order to protect the SSF from flooding due to a Jocassee Dam failure which results in flood levels < the 5' SSF flood barrier, the following flood barriers are required:

1. The water tight flood door located at the South entrance to the SSF must be closed with all seven dogs latched before flood water reaches the SSF.

2. The bolted cover that surrounds the CO_2 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_2 supply pipe bolted cover must also be installed.

<u>If the 5' flood barrier which protects the SSF becomes inoperable, the SSF is not considered to be inoperable.</u> However, the 5' flood barrier should be repaired in a timely manner to ensure that assumptions made in the Oconee PRA analysis remain valid.

Could you please provide answers to the following questions in relation to the licensing basis for external flooding of the SSF?

Question 1. Should the licensee have provided any known information regarding the potential to flood the Oconee Nuclear Station from the failure of the Jocassee Dam prior to the issuance of the April 1983 SSF SER?

Question 2. If the licensee had submitted the information regarding the potential to flood the Oconee Nuclear Station from the failure of the Jocassee Dam, would the licensing basis have included a Jocassee dam break and the resulting Oconee Nuclear Station flooding?

Question 3. Does the failure to provide all flooding related information to the NRC prior to issuance of the SSF's SER constitute a violation of either 10 CFR 50.9, the Atomic Energy Act, or the Atomic Energy Act for failure to provide complete and accurate information?

Question 4. Should the failure of the Jocassee Dam and resulting flooding scenarios of the Oconee Nuclear Station, postulated in the licensee's IPE with external events or the licensee's IPEEE, constitute an "analysis requested by the Commission" which would require the updated information be included in the next update to the UFSAR?

Question 5. The failure of the Jocassee Dam and resulting flooding scenarios of the Oconee Nuclear Station were included in the attached 1992 update to the UFSAR. This update also discussed the of the 5 foot walls at the entrances to the SSF to preclude flooding of the SSF. Was it appropriate to use the 50.59 process to remove the Jocassee Dam failure flood from the UFSAR in 1994?

Question 6. Currently, the Oconee Nuclear Site is unable to defend against a Jocassee Dam failure which results in flood waters of greater than 5 feet on site. Such an event would result in meltdown of all three Oconee units due to the loss of all safety-related equipment in the Turbine Building, Auxiliary Building, and SSF. The licensee has asserted that the currently installed SSF flood barriers are not required to maintain SSF operability, as they were only installed as a PRA enhancement. Should a backfit analysis be performed for the Jocassee Dam failure?

Attachment #1, Section 9.6 of Oconee FSAR prior to 1992 update

1991 UFSAR Section 9.6.1

Received from Lefty

June 11, 1992

D. B. Coyle
System Engineering

Subject: FSAR Section 9.6, Standby Shutdown Facility

The subject FSAR section (attached) contains very little information about the SSF. Instead, it references several submittals to the NRC. This is undesirable since the submittals are not readily accessible to someone at the NRC or Duke who may need to review this information.

The annual FSAR update for 1991 will be distributed in a couple of weeks with no changes in this section. However, we would like to change this in the 1992 update. To do this, we will need a narrative description of the SSF by approximately February 1, 1993 for the update next year. This narrative should include information from the referenced submittals plus any changes that have been made since those submittals.

Thanks for your help. Call me at 3419 if you have any questions.

Ron Harris

R. E. Harris
Regulatory Compliance

REH/(fsar.ssf)

9.6 STANDBY SHUTDOWN FACILITY

June 2, 1994

S. G. Benesole

Subject: Oconee Nuclear Station, Units 1, 2, and 3
FSAR Change to Address SSF External Flood Protection Features
10 CFR 50.59 Evaluation
File: OS-192.6

The attached 10 CFR 50.59 evaluation on changing the FSAR to correct information determines that no unreviewed safety questions exist. FSAR Sections 9.6.3.1 and 9.6.4.7 are to be revised to reflect the existing licensing basis of Oconee concerning an external flooding event and protection of the SSF from this event. No specific requirements, commitments, or statements concerning the need for external flood protection features for the SSF were found. No technical specification changes are required. No other FSAR changes are required.

If you have any questions, please contact me at 885-4382.

Ken Sandel

K. W. Sandel, Design Engineer
Oconee Engineering Division

Attachment

KWS/

xc: T. A. Saville (w/o attachment)
P. C. Gurley
W. K. Grayson
H. L. Lefkowitz
D. A. Nix
R. T. Farish
NSRB Staff (EC12A)
Document Management

Form 01077 (R3-92)

FORM 101.1 | REVISION 14

CERTIFICATION OF ENGINEERING CALCULATION

STATION AND UNIT NUMBER: Oconee Nuclear Station, Units 1, 2, and 3

TITLE OF CALCULATION: USQ Evaluation for Change in FSAR Concerning SSF and Jocassee Flood (S/E*, SSF*)

CALCULATION NUMBER: OSC - 5781

ORIGINALLY CONSISTING OF:

PAGES 1 THROUGH 6

TOTAL ATTACHMENTS 1 TOTAL MICROFICHE ATTACHMENTS 0

TOTAL VOLUMES 1 TYPE I CALCULATION/ANALYSIS YES ☐ NO ☑

TYPE I REVIEW FREQUENCY -

THESE ENGINEERING CALCULATIONS COVER QA CONDITION 1 ITEMS. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED AND I CERTIFY THAT THE ABOVE CALCULATION HAS BEEN ORIGINATED, CHECKED OR APPROVED AS NOTED BELOW:

ORIGINATED BY K W Sandel DATE 5/31/94

CHECKED BY P C [illegible] DATE 5/31/94

APPROVED BY [illegible] DATE 6/2/94

ISSUED TO DOCUMENT CONTROL ________ DATE ________

RECEIVED BY DOCUMENT CONTROL ________ DATE ________

MICROFICHE ATTACHMENT LIST: ☐ YES ☑ NO SEE FORM 101.4

REV. NO	CALCULATION PAGES (VOL)			ATTACHMENTS (VOL)			VOLUMES		ORIG	CHKD	APPR	ISSUE DATE
	REVISED	DELETED	ADDED	REVISED	DELETED	ADDED	DELETED	ADDED	DATE	DATE	DATE	REC'D DATE

Attachment #2, 10 CFR 50.59 Evaluation to remove Jocassee Dam Failure language from the SSF portion

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Sheet 1
By KWS Date 5/31/94

Purpose

The purpose of this calculation is to determine if the FSAR changes described below concerning Standby Shutdown Facility (SSF) external flood protection will create any unreviewed safety questions (USQs) using the criteria of 10 CFR 50.59, paragraph (a) (2). This calculation is QA Condition 1 because it determines the presence or absence of a USQ.

Description of Change

FSAR Sections 9.6.3.1 and 9.6.4.7 are to be changed to reflect the existing licensing basis of Oconee concerning an external flooding event and protection of the SSF from this event. Currently, the FSAR has several statements concerning Jocassee Dam failure flooding events and SSF protection features for external flooding events (Reference 4).

FSAR Section 9.6 was revised in the 1992 Update of the FSAR to address external flood protection of the yard as a result of the rapid failure of the Jocassee Dam. The information was determined to describe a Probabilistic Risk Assessment (PRA) study and is not part of the design basis for Oconee. The FSAR statements are to be revised or removed to correct the information in the FSAR and reflect the existing licensing basis of Oconee. A mark up of the proposed FSAR changes is included as Attachment 1 (Reference 4).

This calculation will investigate whether any commitments or requirements associated with the SSF exist concerning protection of the SSF during an external flood event involving failure of the Jocassee Dam.

Safety Review

The Standby Shutdown Facility (SSF) is designed as a standby system for use under extreme emergency conditions. The FSAR lists these conditions as fire, sabotage, or flooding events with concurrent loss of power. The SSF Safety Evaluation Report (SER) lists the flooding condition as turbine building flooding. The level of Keowee is considered in the turbine building flooding level (References 1 and 5).

Reference 6 states that the flood wall around the SSF was added to reduce the consequence of a Jocassee Dam failure, based on information from the Oconee Probabilistic Risk Assessments (PRA). Oconee had several PRAs performed and submitted to the NRC which addressed the Jocassee Dam failure. The NRC's reviews of these PRAs were examined to determine if installation of a flood wall was required or any commitments were made concerning the wall or protection of the SSF from external flood events. The NRC reviewed the first Oconee PRA in reference 7. This PRA included both internal and external events analysis, but the NRC's overview focused only on core damage accident sequence analysis. The potential for core damage from the failure of the Jocassee Dam was addressed, but the NRC did not address any SSF wall as modifications that Duke was to implement to reduce dominant accident sequence vulnerabilities (Reference 7).

A second PRA was submitted to the NRC in response to Generic Letter 88-20. The NRC reviewed this PRA in reference 9. The Generic Letter requested each licensee submit Individual Plant Examinations (IPE) and the Generic Letter states that the licensee's examination was to initially be for internal events only. The Oconee PRA that was submitted addressed both internal and external events. This review by the NRC addressed internal events only. In this NRC's response, the NRC stated that their review of external events would be reviewed separately, within the framework prescribed in Generic Letter 88-20, Supplement 4 (References 8 and 9). Generic Letter 88-20, Supplement 4 (Reference 10) addresses Individual Plant Examination of External Events (IPEEE). Duke's response to Generic Letter 88-20, Supplement 4 has not been submitted to the NRC (Reference 11).

The potential for the SSF to withstand an external flood due to the Jocassee Dam failure was also addressed by the NRC in their notice of violation and deviation for the Service Water Inspection. The NRC noted as a finding that the SSF could not withstand the Jocassee Dam failure, which they stated was inconsistent with the IPE submittal. Their conclusions were based on the SSF having a 5 foot external flood wall and Duke's recently completed flood analysis which resulted in flood heights of at least 10 feet. The NRC indicated that their concerns were with the Oconee IPE submittal (Reference 12). Duke responded to this finding in reference 13. The Duke response indicated that the 5 foot wall was not intended to bound all flood scenarios, but was deemed adequate to protect the SSF from the more likely flood scenarios (Reference 13). No response from the NRC on the Duke's response submittal has been received. Again, as stated in the previous paragraph, the NRC has not received the final submittal from Duke on external events analysis for the IPEEE.

A review of other Safety Analysis Report (SAR) documents resulted in finding no specific requirements, commitments, or statements

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concerning the need for a external flood protection features around the SSF. The Selected Licensee Commitments and Technical Specifications were reviewed as part of the SAR review and no specific requirements were found that address external flood protection for the SSF (References 2 and 3). Although some aspects of the Jocassee Dam's design and failure consequence are addressed in some SAR documents, the flood wall and protection of the SSF from the external flood are not addressed. The design of the Jocassee dam is addressed in the FSAR (Reference 1). Effects of an upstream dam failure are addressed concerning the effect of the failure on Keowee. This information was in response to Generic Letter 88-20, which, as stated above, was only reviewed by the NRC for internal events (Reference 14). Many SAR documents refer to the SSF considering the mitigation of a Turbine Building flooding event. Flooding due to excessive rainfall is also addressed in some SAR documents.

<u>USQ Evaluation</u>

May the FSAR change:

1) Increase the probability of an accident evaluated in the SAR?

   No. The FSAR change is to correct the FSAR wording to reflect the existing licensing basis requirements for the SSF. The NRC has not formally reviewed the external flood assumptions and protection measures for the SSF.

2) Increase the consequences of an accident evaluated in the SAR?

   No. See the response to question 1.

3) Create the possibility for an accident of a different type than any evaluated in the SAR?

   No. No accidents different than already evaluated in the SAR are postulated.

4) Increase the probability of a malfunction of equipment important to safety evaluated in the SAR?

   No. The design of the Jocassee Dam has been evaluated by the NRC and it is not more likely to fail due to this FSAR change. The SSF has been evaluated by the NRC for certain design event. These design events do not currently include the failure of the Jocassee Dam and external flooding. Thus, these FSAR changes do not increase the potential for equipment failure that has been previously evaluated.

5) Increase the consequences of a malfunction of equipment important to safety evaluated in the SAR?

No. The requirements for the structures, systems, and components that are needed for the SSF to mitigate accidents and events previously evaluated by the NRC have not been changed.

6) Create the possibility for a malfunction of a different type than any evaluated in the SAR?

No. No new failure modes are postulated.

Will the FSAR Change:

7) Reduce the margin of safety as defined in the basis to any technical specification?

No. This change does not adversely affect any plant safety limits, set points, or design parameters.

Conclusions

No specific requirements, commitments, or statements concerning the need for external flood protection features for the SSF were found. The described changes to FSAR Sections 9.6.3.1 and 9.6.4.7 do not involve any USQs or safety concerns. No technical specification changes are required. No other FSAR changes are required.

Summary for 10 CFR 50.59 Annual Report

FSAR Sections 9.6.3.1 and 9.6.4.7 are to be changed to reflect the existing licensing basis of Oconee concerning an external flooding event and protection of the SSF from this event. Currently, the FSAR has several statements concerning Jocassee flooding events and SSF protection features for external flooding events.

FSAR Section 9.6 was revised in the 1992 Update of the FSAR to address external flood protection of the yard as a result of the rapid failure of the Jocassee Dam. The information was determined to describe a Probabilistic Risk Assessment study and is not part of the design basis for Oconee. The FSAR statements are to be revised or removed to correct the information in the FSAR and reflect the existing licensing basis of Oconee.

The described changes to FSAR Sections 9.6.3.1 and 9.6.4.7 do not involve any USQs or safety concerns. No technical specification changes are required. No other FSAR changes are required.

References

1) Oconee Nuclear Station Final Safety Analysis Report (FSAR), 1992 Update, Sections 2.4.2, 2.4.4, 3.4, 9.6.3.1, 9.6.4.7, 15.0. Also 1991 update for Section 9.6.

2) Oconee Nuclear Station Technical Specifications, as amended to 2/9/94, Sections 3.18, 4.20, Page 6.1-6a.

3) Oconee Nuclear Station Selected Licensee Commitments, as amended to 5/2/94, Section 16.5.3.

4) Letter dated 5/31/94 from P. C. Gurley to T. A. Saville, specifying changes to FSAR and providing background information (Attachment 1).

5) Letter dated 4/28/83 from J. F. Stolz (NRC) to H. B. Tucker (Duke Power Company), providing SSF SER.

6) Letter dated 12/20/91 from J. L. Herrick to D. A. Smith, File: ONDS-268, providing final report for design study ONDS-268.

7) Letter dated 8/14/85 from J. F. Stolz (NRC) to H. B. Tucker (Duke Power Company), providing review of the Oconee PRA that was performed in conjunction with NSAC of EPRI.

8) Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities", dated 11/23/88.

9) Letter dated 4/1/93 from L. A. Weins (NRC) to J. W. Hampton (Duke Power Company), providing review of Oconee's IPE submittal.

10) Generic Letter 88-20, Supplement 4, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities", dated 6/28/91.

11) Letter dated 9/10/92 from H. B. Tucker (Duke Power Company)

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to the NRC, sending projected submittal dates for the response to Generic Letter 88-20, Supplement 4 (IPEEE).

12) Letter dated 2/21/94 from A. F. Gibson (NRC) to J. W. Hampton (Duke Power Company), sending notice of violation and deviation for Service Water Audit.

13) Letter dated 3/14/94 from J. W. Hampton (Duke Power Company) to the NRC, providing response to several findings from the Service Water Audit.

14) Letter dated 8/21/91 from M. S. Tuckman (Duke Power Company) to the NRC, providing responses to NRC questions on Generic Letter 88-20.

15) Memo dated 5/23/84 by W. H. Rasin, File: OS-192, with attached evaluation 82-21, "Flood Protection Cost Estimates for the Oconee Nuclear Station SSF", Revision 1.

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Attachment 1
Sheet 2 of 4

2. Cold shutdown must be achievable within seventy-two hours following the fire accident. Credit can be taken for reasonable damage control measures.
3. No credit is allowed for fire protection equipment in developing shutdown scenarios.

TURBINE BUILDING FLOOD CRITERIA

Components of the SSF systems and the associated structures are designed to achieve and maintain hot shutdown conditions in the event the Turbine Building is subjected to flooding.

ELECTRICAL SEPARATION CRITERIA

Selected motor operated valves and the pressurizer heater bank are capable of being powered and controlled from either the normal station electrical systems or the SSF electrical system. Suitable electrical separation is provided in the following manner. Electrical distribution of the SSF is identified in Figure 9-40 and Figure 9-41 is provided by the SSF motor control centers (MCC's). These MCC's are capable of being powered from either an existing plant load center or the SSF load center through key interlocked breakers at the MCC's. These breakers provide separation of the power supplies to the SSF loads.

During normal operation, these loads are powered from a normal (non-SSF) load center via the SSF MCC's.

During operation of the SSF, these loads are powered from the SSF diesel generator via the SSF load center and SSF MCC's.

9.6.3 SYSTEM DESCRIPTIONS

9.6.3.1 Structure

The Standby Shutdown Facility (SSF) is a reinforced concrete structure consisting of a diesel generator room, electrical equipment room, mechanical pump room, control room, central alarm station (CAS), and ventilation equipment room. The general arrangement of major equipment and structures is shown in Figure 9-30, Figure 9-31, Figure 9-32, Figure 9-33 and Figure 9-34.

The SSF has a seismic classification of Category 1. The following load conditions are considered in the analysis and design:

1. Structure Dead Loads
2. Equipment Loads
3. Live Loads
4. Normal Wind Loads
5. Seismic Loads
6. Tornado Wind Loads
7. Tornado Missile Loads
8. High Pressure Pipe Break Loads
9. Flooding Potential

Turbine Building

WIND AND TORNADO LOADS

The design wind velocity for the SSF is 95 mph. at 30 ft. above the nominal ground elevation. This velocity is the fastest wind with a recurrence interval of 100 years. A gust factor of unity is used for 14

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May 31, 1994

Tracey A. Saville

Re: Revision to FSAR, 9.0 Standby Shutdown Facility
Section 9.6.3.1 System Descriptions, Structure, Section 9.6.4.7 Flooding Review
Deletion of References to Jocassee Dam Failure
10CFR50.59 Evaluation

Don Dalton has advised that a 10CFR50.59 Evaluation is required by 6/30/94 for the proposed change to the FSAR deleting reference to the Jocassee Dam failure as a design condition for the SSF. The revision to the FSAR issued in 1993 added statements in the Standby Shutdown Facility System Descriptions Section referring to external flooding of the yard as a result of the rapid failure of the Jocassee Dam. The sequence of events referred to describes a PRA study and is not part of the Design Basis for Oconee. As a result, the FSAR needs to be revised to clearly state that the wall around the SSF only protects the SSF from external flooding of the powerhouse yard up to a depth of five feet. We can not claim that the wall will protect the SSF from all rapid failures of the Jocassee Dam. The original study only considered a very specific failure which was by no means a worse case event. The current statements added in 1993 and the proposed changes are listed below:

1993 Statement: (9.6.3.1 Structure) "9. Flooding Potential"
Proposed Change: "9. Turbine Building Flooding Potential"

1993 Statement: (9.6.3.1 Structure, Flood Design) "The second source of external flooding is a rapid failure of the Jocassee Dam. Failure of the Jocassee Dam would result in a postulated wave height of 4.71 feet in the yard at the Oconee site. The SSF protects Oconee's most secure method of safely shutting down the plant following an external flood due to a Jocassee Dam failure."
Proposed Change: Remove Statement

1993 Statement: (9.6.3.1 Structure, Flood Design) "Protection from flood at the SSF is provided by five foot walls at the entrances to the SSF supplemented by a watertight door at the south end entrance of the SSF."
Proposed Change: Remove Statement

1993 Statement: (9.6.4.7 Flooding Review) "3. Jocassee Dam Failure"
Proposed Change: Remove Statement

Please provide a 10CFR50.59 Evaluation for the revisions as described above and marked on the attached copy. If additional information is required, contact P C Gurley at extension 4331, profs ID PCG8363.

C

PC Gurley
P C Gurley, Engineer
Modification Engineering, Civil Section

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Attachment 1
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2 determining wind forces. The design tornado used in calculating tornado loadings is in conformance with
2 Regulatory Guide 1.76 with the following exceptions:

2 1. Rotational wind speed is 300 mph.
2 2. Translational speed of tornado is 60 mph.
2 3. Radius of maximum rotational speed is 240 ft.
2 4. Tornado induced negative pressure differential is 3 psi, occurring in three seconds.

2 The spectrum and characteristics of tornado-generated missiles is covered in a later section.

2 **FLOOD DESIGN**

2 Flood studies show that Lake Keowee and Jocassee are designed with adequate margins to contain and
2 control floods. The first is a general flooding of the rivers and reservoirs in the area due to a rainfall in
2 excess of the Probable Maximum Precipitation (PMP). The FSAR addresses Oconee's location as on a
2 ridgeline 100' above maximum known floods. Therefore, external flooding due to rainfall affecting rivers
2 and reservoirs is not a problem. The SSF is within the site boundary and, therefore, is not subject to
2 flooding from lake waters.

2 The grade level entrance of the SSF is 797.0 feet above mean sea level (msl). In the event of flooding due
2 to a break in the non-seismic condenser circulating water (CCW) system piping located in the Turbine
2 Building, the maximum expected water level within the site boundary is 795.5 ft. Since the maximum
2 expected water level is below the elevation of the grade level entrance to the SSF, the structure will not be
2 flooded by such an incident.

2 ~~The second source of external flooding is a rapid failure of the Jocassee Dam. Failure of the Jocassee~~
2 ~~Dam would result in a postulated wave height of [illegible] feet in the yard at the Oconee site. The SSF~~
2 ~~protects Oconee's most secure method of safely shutting down the plant following an external flood due~~
2 ~~to a Jocassee Dam failure.~~

2 The SSF will stabilize the plant at hot shutdown condition. Damage to any other (outside of
2 containment) equipment required to maneuver the plant to cold shutdown will need to be evaluated and
2 repaired following such an external flood. ~~Protection from flood at the SSF is provided by floorwalls~~
2 ~~at the entrances to the SSF supplemented by a watertight door at the south end entrance of the SSF.~~

2 **MISSILE PROTECTION**

2 The only postulated missiles generated by natural phenomena are tornado generated missiles. The SSF is
2 designed to resist the effects of tornado generated missiles in combination with other loadings. Table 9-17
2 lists the postulated tornado generated missiles.

2 Penetration depths are calculated using the modified NDRC formula and the modified Petry formula.
2 Table 9-18 lists the calculated penetration depths and the minimum barrier thicknesses to preclude
2 perforation and scabbing, hence eliminating secondary missiles.

2 **SEISMIC DESIGN**

2 The design response spectra correspond to the expected maximum bedrock acceleration of 0.1 g. The
2 design response spectra were developed in accordance with the procedures of Reg. Guide 1.60. The
2 seismic loads as a result of a base excitation are determined by a dynamic analysis. The dynamic analysis 4
2 is made utilizing the STRUDL-DYNAL computer program. The base of the structure is considered
2 fixed.

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Attachment 3, Applicable portions of the current Oconee FSAR with the regards to the SSF and a Jocassee Dam failure (5 pages total)

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Attachment 1
Sheet 4 of 4

makeup and boration following transfer of control to the SSF RCM is from the spent fuel pool. Thus, boron dilution events are highly unlikely.

Oconee Units 1, 2, and 3 can achieve and maintain controlled cooling to hot shutdown conditions safely from the SSF without the need for remote SG pressure instrumentation, indication of SG pressure, and remote source range monitor, and, thus, this instrumentation for the Oconee Nuclear Station is not required. The objectives of Sections III.G.3 and III.L.2 of Appendix R to 10CFR Part 50 are met and the exemption from the requirement to provide remote steam generator pressure and source range monitor instrumentation in the SSF has been granted.

9.6.4.6.3 Instrumentation Guidelines

10CFR 50, Appendix R Section III.L.6 requires that, "Shutdown systems installed to ensure post-fire shutdown capability need not be designed to meet seismic Category I criteria, single failure criteria, or other design basis accident criteria, except where required for other reasons, e.g., because of interface with or impact on existing safety systems, or because of adverse valve actions due to fire damage." Since the monitors for the above listed parameters, in Section 9.6.4.6.2, "Performance Goals" on page 9-89, will not interface with or impact on existing safety systems, the monitors need not be "safety grade".

9.6.4.6.4 Repairs within the 72 Hour Requirement

The use of the dedicated shutdown method for hot shutdown permits the capability of achieving all necessary repairs to achieve cold shutdown within 72 hours after a fire accident. Repairs, including replacement of power cabling or pump motors associated with LPI, HPI, or LPSW may be required for cold shutdown. Stored on-site are all components necessary to achieve all repairs. Guidelines are available to implement the required repairs and replacements.

9.6.4.6.5 Fire Protection Conclusion

The ONS design has provided one train of systems necessary to achieve and maintain safe shutdown conditions by utilizing either the main unit's control room or the SSF in conjunction with undamaged systems in the fire-affected unit, and thus will meet the requirements of Appendix R to 10CFR 50, Sections III.G.3 and III.L with respect to safe shutdown in the event of a fire.

9.6.4.7 Flooding Review

The SSF will not be affected by the following postulated flood events:

1. Turbine Building Flood caused by a break in the non-seismic condenser circulating water (CCW) piping system.
2. Infiltration of normal groundwater.
3. ~~Jocassee Dam Failure~~

The structure meets the requirements of GDC 2, and the guidelines of Regulatory Guide 1.102 with respect to protection against flooding.

9.6.5 OPERATION AND TESTING

The SSF will be placed into operation following total loss of equipment due to the following:

1. Flooding
2. Fire
3. Sabotage

electrical separation is provided in the following manner. Electrical distribution of the SSF is identified in Figure 9-40 and Figure 9-41 is provided by the SSF motor control centers (MCC's). Loads fed from MCC's 1XSF, 2XSF, 3XSF, and XSF are capable of being powered from either an existing plant load center or the SSF load center through key interlocked breakers at the MCC's. These breakers provide separation of the power supplies to the SSF loads.

Loads fed from MCC PXSF are capable of being powered from either Unit 2 B2T or the SSF Diesel via switchgear OTS1. Breakers feeding OTS1 are electrically interlocked and provide separation of the power supplies to the SSF loads.

During normal operation, these loads are powered from a normal (non-SSF) load center via the SSF MCCs 1XSF, 2XSF, 3XSF (Group B) or switchgear OTS1 via SSF MCC PXSF (Group C).

During operation of the SSF, these loads are powered from the SSF diesel generator via the SSF load center/switchgear and SSF MCCs.

9.6.3 System Descriptions

9.6.3.1 Structure

The Standby Shutdown Facility (SSF) is a reinforced concrete structure consisting of a diesel generator room, electrical equipment room, mechanical pump room, control room, central alarm station (CAS), and ventilation equipment room. The general arrangement of major equipment and structures is shown in Figure 9-30, Figure 9-31, Figure 9-32, Figure 9-33 and Figure 9-34.

The SSF has a seismic classification of Category I. The following load conditions are considered in the analysis and design:

1. Structure Dead Loads
2. Equipment Loads
3. Live Loads
4. Normal Wind Loads
5. Seismic Loads
6. Tornado Wind Loads
7. Tornado Missile Loads
8. High Pressure Pipe Break Loads
9. Turbine Building Flooding Potential

WIND AND TORNADO LOADS

The design wind velocity for the SSF is 95 mph. at 30 ft. above the nominal ground elevation. This velocity is the fastest wind with a recurrence interval of 100 years. A gust factor of unity is used for determining wind forces. The design tornado used in calculating tornado loadings is in conformance with Regulatory Guide 1.76 with the following exceptions:

1. Rotational wind speed is 300 mph.
2. Translational speed of tornado is 60 mph.
3. Radius of maximum rotational speed is 240 ft.
4. Tornado induced negative pressure differential is 3 psi, occurring in three seconds. 4

The spectrum and characteristics of tornado-generated missiles are covered later in this section.

FLOOD DESIGN

Flood studies show that Lake Keowee and Jocassee are designed with adequate margins to contain and control floods. The first is a general flooding of the rivers and reservoirs in the area due to a rainfall in excess of the Probable Maximum Precipitation (PMP). The FSAR addresses Oconee's location as on a ridgeline 100' above maximum known floods. Therefore, external flooding due to rainfall affecting rivers and reservoirs is not a problem. The SSF is within the site boundary and, therefore, is not subject to flooding from lake waters.

The grade level entrance of the SSF is 797.0 feet above mean sea level (msl). In the event of flooding due to a break in the non-seismic condenser circulating water (CCW) system piping located in the Turbine Building, the maximum expected water level within the site boundary is 796.5 ft. Since the maximum expected water level is below the elevation of the grade level entrance to the SSF, the structure will not be flooded by such an incident.

The SSF will stabilize the plant at mode 3 with an average Reactor Coolant temperature ≥ 525°F. As a PRA enhancement the SSF is provided with a five foot external flood wall which is equipped with a water tight door near the south entrance of the SSF. A stairway over the wall provides access to the north entrance.

MISSILE PROTECTION

The only postulated missiles generated by natural phenomena are tornado generated missiles. The SSF is designed to resist the effects of tornado generated missiles in combination with other loadings. Table 9-12 lists the postulated tornado generated missiles.

Penetration depths are calculated using the modified NDRC formula and the modified Petry formula.

Modified N.D.R.C Formula:

$$\text{Penetration depth, }(x) = \sqrt{4KNWd\left(\frac{v_o}{1{,}000d}\right)^{1.80}} \text{ for } x/d \le 2.0$$

$$= \sqrt{KNWd\left(\frac{v_o}{1{,}000d}\right)^{1.80}} + d \text{ for } x/d > 2.0$$

Where:

N = missile shape factor = 0.72 for flat nosed bodies, 1.14 for sharp nosed bodies

K = concrete penetrability factor = $\frac{180}{\sqrt{f'_c}}$

W = Weight in pounds

v_o = striking velocity

D = effective projectile diameter = $\sqrt{4Ac/\pi}$

A_c = projectile contact Area in in^2

Modified Petry Formula:

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9.6.4.6.5 Fire Protection Conclusion

The ONS design has provided one train of systems necessary to achieve and maintain safe shutdown conditions by utilizing either the main unit's control room or the SSF in conjunction with undamaged systems in the fire-affected unit, and thus will meet the requirements of Appendix R to 10CFR 50, Sections III.G.3 and III.L with respect to safe shutdown in the event of a fire.

9.6.4.7 Flooding Review

The SSF will not be affected by the following postulated flood events:

1. Turbine Building Flood caused by a break in the non-seismic condenser circulating water (CCW) piping system.
2. Infiltration of normal groundwater.

The structure meets the requirements of GDC 2, and the guidelines of Regulatory Guide 1.102 with respect to protection against flooding.

9.6.5 Operation and Testing

The SSF will be placed into operation to mitigate the consequences of the following events:

1. Flooding
2. Fire
3. Sabotage
4. Station Blackout

For fire events that start in the Control Room, Cable Room, Equipment Room or Turbine Building of the unit affected, following local confirmation of the fire, the operator will staff the SSF and perform the electrical isolation/control transfer of the 600VAC Motor Control Center in the SSF within 10 minutes of the confirmation of the fire. Following the control transfer, the operator will start the SSF Diesel Generator and establish continuous communications with the Control Room of the unit affected awaiting instructions regarding the need to start and utilize the available SSF systems and equipment. When directed by the shift supervisor, the operator will start the RCM system and establish SSF Auxiliary Service Water flow to the steam generators as needed and close all of the Reactor Building isolation valves that are controlled from the SSF.

For Flooding, Sabotage, Station Blackout and all other fire events where the SSF is the credited safe shutdown path, if the normal shutdown equipment is inoperable, operators will be sent to the SSF. When directed by the shift supervisor, the operator will start the diesel and establish service water to the diesel generator, start the Auxiliary Service Water Pump and the RCM system as needed and close all of the Reactor Building isolation valves that are controlled from the SSF.

Damage control measures, if necessary, will be taken to restore limited operability to the Low Pressure Injection System, Low Pressure Service Water System, and the HP Injection System to bring a RC System to a cold shutdown condition following an Appendix R fire. Pump motors for each of the above systems may be restored to an operable status and the valves will be manually operated to re-establish the above systems to operation.

In-service testing of pumps and valves will be done in accordance with the provision of ASME Section XI except for the Submersible Pump which is used to supply makeup water to the Unit 2 embedded condenser circulating piping. This pump should be tested every other year to verify flow capability. A recirculating flow path with flow and pressure instrumentation is available for SSF ASW pump testing. 4

The electrical power system components will be tested consistent with Duke Power's Testing Philosophy as described in the nuclear station directives.

9.6.6 References

1. Safety Evaluation by the Office of Nuclear Reactor Regulation Oconee Nuclear Station Standby Shutdown Facility, Docket Nos. 50-269, 50-270, and 50-287, April 28, 1983.
2. Safety Evaluation for Station Blackout (10 CFR 50.63) - Oconee Nuclear Station, Units 1, 2, and 3 (TACS M68574/M68575/M68576), Docket Nos. 50-269, 50-270, 50-287, March 10, 1992
3. Safety Evaluation for Station Blackout (10 CFR 50.63) - Oconee Nuclear Staton, Units 1, 2, and 3 (TACS M68574/M68575/M68576), Docket Nos. 50-269, 50-270, 50-287, December 3, 1992
4. Safety Evaluation Report on Effect of Tornado Missiles on Oconee Emergency Feedwater System (TACS 48225, 48226, and 48227), July 28, 1989
5. Safety Evaluation Report for Implementation of Recommendation for Auxiliary Feedwater Systems, August 25, 1981
6. Evaluation of the Oconee, Units 1,2,&3 Generic Safety Issues (GSI-23 & GSI-105) Resolution, March 24, 1995
7. Letter from WO Parker (Duke) to EG Case (NRC), dated 1/25/78, Response to NRC Questions.
8. Letter from WO Parker (Duke) to EG Case (NRC), dated 2/1/78, SSF System Description
9. Letter from WO Parker (Duke) to EG Case (NRC), dated 6/19/78, Response to Staff Questions Concerning Oconee Nuclear Station Safe Shutdown System
10. Letter from WO Parker (Duke) to HR Denton (NRC), dated 3/28/80
11. Letter from WO Parker (Duke) to HR Denton (NRC), dated 2/16/81, Response to NRC Request for Information
12. Letter from WO Parker (Duke) to HR Denton (NRC), dated 3/18/81, Modifications Needed to Meet Appendix R Requirements
13. Letter from WO Parker (Duke) to HR Denton (NRC), dated 3/31/81, Response to NRC Request for Information
14. Letter from WO Parker (Duke) to HR Denton (NRC), dated 4/30/81, Cable Routing and Separation
15. Letter from WO Parker (Duke) to HR Denton (NRC), dated 1/25/82, Response to NRC Concerns for Source Range Instrumentation and Steam Generator Pressure
16. Letter from HB Tucker (Duke) to HR Denton (NRC), dated 9/20/82, Response to NRC Request for Information
17. Letter from HB Tucker (Duke) to HR Denton (NRC), dated 12/23/82, Requested Supplemental Information
18. Letter from HB Tucker (Duke) to HR Denton (NRC), dated 7/15/83, Request for Exemption from 10CFR50 Appendix R, Section III.L.2
19. Letter from JF Stolz (NRC) to HB Tucker (Duke), dated 8/31/83, Exemption from Source Range Flux and Steam Generator Pressure Instrumentation for the SSF
20. OSC-7350, Oconee Nuclear Station Penetration Seal Database and 86-10 Evaluations

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21. DPS 1435.00-00-0002, Design Specification for Mechanical and Electrical Penetrations Fire, Flood and Pressure Seals

22. DPC 1435.00-00-0006, Calculation for the Technical Basis of Fire Barrier Penetration Seals

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