NRC FORM 757
NRC MD 10.158
(3-2009)

U.S. NUCLEAR REGULATORY COMMISSION

NON-CONCURRENCE PROCESS

SECTION A - TO BE COMPLETED BY NON-CONCURRING INDIVIDUAL

TITLE OF DOCUMENT **Confirmatory Action Letter - Oconee Commitments to Address External Flooding Concerns**	ADAMS ACCESSION NO. **ML103280043**
DOCUMENT SPONSOR **Meena Khanna** / George Wilson (NRR/DE)	SPONSOR PHONE NO. **301-415-2150**
NAME OF NON-CONCURRING INDIVIDUAL **Jeff Mitman**	PHONE NO. **301-415-2843**

☐ DOCUMENT AUTHOR ☑ DOCUMENT CONTRIBUTOR ☐ DOCUMENT REVIEWER ☑ ON CONCURRENCE

TITLE **Senior Reliability and Risk Analyst**	ORGANIZATION **Office of Nuclear Reactor Regulation**

REASONS FOR NON-CONCURRENCE

See Attached

Note; ~~Docucment is Official Use Only - Security Related Information~~

☐ CONTINUED IN SECTION D

SIGNATURE	DATE **01/10/2011**

SUBMIT FORM TO DOCUMENT SPONSOR AND COPY TO YOUR IMMEDIATE SUPERVISOR AND DIFFERING VIEWS PROGRAM MANAGER

NRC FORM 757
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SECTION B - TO BE COMPLETED BY NON-CONCURRING INDIVIDUAL'S SUPERVISOR
(THIS SECTION SHOULD ONLY BE COMPLETED IF SUPERVISOR IS DIFFERENT THAN DOCUMENT SPONSOR.)

NAME Veronica Rodriguez

TITLE Acting Chief

PHONE NO. 301-415-3703

ORGANIZATION NRR - Division of Risk Assessment, PRA Operational Branch (DRA / APOB)

COMMENTS FOR THE DOCUMENT SPONSOR TO CONSIDER

- [x] I HAVE NO COMMENTS
- [ ] I HAVE THE FOLLOWING COMMENTS

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NON-CONCURRENCE PROCESS

TITLE OF DOCUMENT	ADAMS ACCESSION NO.
Confirmatory Action Letter - Oconee Commitments to Address External Flooding Concerns	**ML103280043**

SECTION C - TO BE COMPLETED BY DOCUMENT SPONSOR

NAME
George Wilson

TITLE	PHONE NO.
NRC DAM SAFETY OFFICER	301-415-1711

ORGANIZATION
NRR: Division of Engineering

ACTIONS TAKEN TO ADDRESS NON-CONCURRENCE (This section should be revised, as necessary, to reflect the final outcome of the non-concurrence process, including a complete discussion of how individual concerns were addressed.)

SEE ATTACHED

☐ CONTINUED IN SECTION D

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	1/25/11		1/28/11

NON-CONCURRING INDIVIDUAL *(To be completed by document sponsor* when process is complete, i.e., after document is signed):

- ☐ CONCURS
- ☒ NON-CONCURS
- ☐ WITHDRAWS NON-CONCURRENCE (i.e., discontinues process)
- ☐ WANTS NCP FORM PUBLIC
- ☒ WANTS NCP FORM NON-PUBLIC

Khanna, Meena

From: Mitman, Jeffrey
Sent: Friday, January 28, 2011 3:35 PM
To: Khanna, Meena
Cc: Rodriguez, Veronica; Lee, Samson; Cunningham, Mark; Wilson, George; Ferrante, Fernando
Subject: Oconee Non-Concurrence

Meena, as we discussed, after reviewing the response to my non-concurrence, I've decided to continue to non-concur. Please mark the letter appropriately.

As far as marking the non-concurrence packages as OUO, I have no problems with it being so marked.

A final note, at Jack's request I discussed my non-concurrence with him today. I do not know what his decision will be.

Jeff

NON-CONCURRENCE PROCESS

TITLE OF DOCUMENT	ADAMS ACCESSION NO.
Confirmatory Action Letter - Oconee Commitments to Address External Flooding Concerns	**ML103280043**

SECTION D: CONTINUATION PAGE

CONTINUATION OF SECTION ☐ A ☐ B ☐ C

Introduction and Summary

The NRC is preparing to issue a letter to Duke Energy Carolinas, LLC.[1] The draft of this letter states "that the parameters chosen by the licensee and the analysis performed bound the inundation of the ONS (Oconee Nuclear Station) site resulting from a potential failure of the Jocassee Dam." I am non-concurring on the conclusion that the parameters chosen, specifically the reservoir levels, are bounding.

In a NRC letter to Duke in April 2009,[2] the NRC states that:

> The NRC staff agrees that a study with more advanced model and sensitivity analyses would be beneficial because of the uncertainty involved in predicting dam failure and resultant flood levels at Oconee. Dam design operating parameters, including *reservoir level*, should be used as input to the inundation study to support the safety of the Oconee facility. The sensitivity analysis should include varying key parameters that can affect the on-site flood height (e.g., breach size, *reservoir levels*, and time to dam failure) individually and in combination over a sufficient range to provide an understanding of how changes impact the flood height estimates. [emphasis added]

In the resultant studies, Duke has not varied the reservoir levels as required by the April 30, 2009, letter. All of the analysis was performed assuming a "sunny day" failure with the Jocassee Reservoir at a level of 1110 ft. mean sea level (msl) and with Keowee Reservoir at a level of 800 ft. msl (e.g., Duke's letter dated August 2, 2010[2]). Prior to accepting any inundation analysis results, Duke should be required, as the April 2009 letter stated, to conduct and submit additional sensitivity analysis varying Jocassee and Keowee Reservoir levels up to and including a defendable most severe level.

Background

Lake Jocassee was created in 1973 with the construction of the Jocassee Dam on the Keowee River. The lake provides pump storage capacity to the reversible turbine-generators of the Jocassee Hydroelectric Station, located approximately 11 miles north of the plant. At full pond, elevation 1110 ft. msl, Lake Jocassee has a surface area of 7565 acres, a shoreline of approximately 75 miles a volume of 1.16 million acre-ft., and a total drainage area of about 148 square miles.[3]

The Jocassee Dam is a rockfill earthen dam 385 ft. in height and a length of 1800 ft. At a reservoir level of 1125 ft. it impounds approximately 1.28 million acre-ft. It has 2 spillway Tainter gates, each 38 ft. wide and 33 ft. high, and a crest elevation of 1110 ft. msl. It has 4 hydro-electric units with a total capacity of approximately 600 MWs.

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[1] NRC letter E.J. Leeds to T.P. Gillespie, *Confirmatory Action Letter - Oconee Nuclear Station, Units 1, 2, and 3 (ONS) Commitments to Address External Flooding Concerns Closure of Inundation Results (TAC Nos. ME3065, ME3066, and ME3067)* (ML103280043), draft December 2010

[2] NRC letter to Duke titled "Evaluation of Duke Energy Carolinas, LLC (Duke), September 26, 2008 Response to Nuclear Regulatory Commission (NRC) Letter Dated August 15, 2008, Related to External Flooding at Oconee Nuclear Station, Units 1, 2, and 3 (Oconee) (TAC Nos. MD8224, MD8225, and MD8226)" dated April 30, 2009 (ML090570779)

[3] ONS UFSAR Section 2.4 Hydrologic Engineering

Lake Keowee was created in 1971 with the construction of the Keowee Dam on the Keowee River and the Little River Dam on the Little River. Its primary purpose is to provide cooling water for the plant and water to turn the turbines of the Keowee Hydroelectric Station. At full pond, elevation 800 ft. msl, Lake Keowee has a surface area of 18,372 acres, a shoreline of approximately 300 miles, a volume of 955,586 acre-ft., and a total drainage area of about 439 square miles. The Jocassee and Keowee Reservoirs and the hydroelectric stations located at these reservoirs are owned and operated by Duke.[3]

In analysis leading up to the NRC's 50.54(f) letter,[4] the NRC staff identified an adequate protection issue. The NRC's concern involved a Jocassee Dam failure, which inundates the ONS. In this scenario, flooding of the site leads to a failure of all emergency core cooling systems (ECCS), all balance of plant (BOP) equipment and both onsite and offsite electrical power systems. If the inundation overtops the protective wall around the standby shutdown facility (SSF) all means of cooling the three reactor cores and the two spent fuel pools will be lost. In subsequent analysis and correspondence, Duke has confirmed this scenario and its impact. The one- and two-dimensional (1-D and 2-D) analysis indicates that a Jocassee Dam breach will inundate the ONS. At the SSF yard, water depth will rise to approximately 18.5 ft., overtopping the floodwall protecting the SSF (which is currently 7.5 ft. in height).[5] Per Duke's analysis, without mitigation this will lead to core damage in 8 to 9 hours (the conditional core damage probability or CCDP is 1.0) and containment failure in 59 to 68 hours.[6] As the introduction states, this flood height is based on a Jocassee Reservoir level of 1110 ft. msl and a Keowee Reservoir level of 800 ft. msl.

The reservoir levels are significant for several reasons. First, a dam's failure likelihood is highly sensitive to reservoir level.[7] The higher the reservoir level the more likely the dam is to fail. Second, higher water levels in Jocassee and Keowee at the time of failure will lead to higher inundation levels at ONS. Finally, higher levels can lead to more rapid dam failure and more rapid inundation, allowing less time for warning and preparation.

Addressing the first of these reasons, Duke has stated that, in the approximately 38 years of Jocassee Dam operation, the reservoir has never exceeded the normal operating level of 1110 ft. The reservoir has operated up to a level of 1110 ft. However, Duke's analysis of a probable maximum participation (PMP) event, assuming operation of both spillways and all four hydro units, water level will reach approximately 1122 ft.[8] Studies performed by the NRR Division of Risk Assessment (DRA) indicate that a large storm equivalent to 30% of a PMP event with failure of the hydro units will raise water level to approximately 1111 ft. msl. Additional DRA results for various storm sizes and combinations of unavailability of spillways and hydro units are given in Table 1 below. This combination of Duke and NRC staff analysis clearly indicates that water levels higher than 1110 ft. can be anticipated with large storms.

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[4] NRC letter to Duke dated August 15, 2008 (ML081640244)
[5] Duke letter to NRC dated August 2, 2010 (ML102170006)
[6] Duke letter to NRC dated September 26, 2008 (ML082750106)
[7] *The Status of Methods for Estimation of the Probability of Failures of Dams for Use in Quantitative Risk Assessment*, R. Fell, D.S. Bowles, et. el. International Commission on Large Dams 20th Congress Beijing, China. September 2000
[8] *Jocassee Dam Hydrologic Analysis*, Law Environmental, January 1991 and updated through June 2009

DRA analysis also indicates that the Jocassee Dam could overtop given a large storm with combinations of failures of the Jocassee spillways and hydro turbines. A review of the Duke 1-D analysis commissioned by NRR and performed by the US Bureau of Reclamation also recommended that scenarios leading to overtopping be considered: "If the spillway was for some reason, not able to operate, overtopping of the dam could occur. It would be worth performing a level pool flood routing analysis to determine the depth and duration of overtopping at Jocassee Dam assuming PMP inflow and inoperable or partially blocked spillway gates."[9]

Table 1

Storm Size (PMP fraction)	Assumed Number of Operational Spillways	Assumed Number of Operational Hydro Units	Estimated Jocassee Reservoir Level (ft. msl)
100%	2	4	1122
100%	2	0[1]	1125
100%	1	2[2]	1125
100%	0	0[1]	Dam overtops
90%	0	0[1]	Dam overtops
40%	2	4	1111
30%	2	0	1111

Table Notes:
1 – In these scenarios the hydro units are assumed to be available early but not during storm peak conditions possibly due to storm causing a loss of hydro units' switchyard
2 – Law Environmental analysis indicates hydro unit unavailability was approximately 8% between 1985 and 1989

The NRR Division of Engineering (DE) has suggested that the probability of a large storm concurrent with an independent dam failure would be a highly improbable event. However, neither Duke nor NRC staff has developed a PMP Jocassee Dam hazard curve to determine the probabilities of various large storms. Additionally, because the Jocassee Reservoir has never exceeded 1110 ft. the dam performance above 1110 ft. is an unknown. The dam was designed for these conditions, but has never experienced these conditions. Any existing design or construction flaws may manifest themselves for the first time under these high stress conditions. It should be understood that hydrostatic loads on the dam at 1125 ft. will be approximately 10% greater than the loads at normal peak level of 1110 ft.

The second reason reservoir level is important is that it significantly increases the potential water volume and flow to which the ONS is subjected. At normal full pond elevations, Keowee at 800 ft. and Jocassee at 1110 ft., these two reservoirs hold approximately a combined 2.1 million acre-ft. With Keowee at 815 ft. (the crest of Keowee Dam) and Jocassee at 1125 ft. the combined impoundment is approximately 2.5 million acre-ft. This 20% increase will change the flood conditions at ONS.

As stated previously, the flood conditions at ONS with a Jocassee Reservoir level of 1110 ft. will lead to a flood height at the SSF of approximately 18.5 ft. above grade. Duke's completed 1-D analysis determined that peak flow rates across the Keowee Dam are between 2.3 and 2.8 million cubic feet per second (cfs) and peak flow rates across the Oconee Intake Canal Dike are

[9] *Jocassee Dam, South Carolina Inundation Study Review Comments*, US Bureau of Reclamation. July 2009

between 0.65 and 0.84 million cfs.[10] As a point of reference, the average flow in the Mississippi River at New Orleans is approximately 0.6 million cfs.[11]

The third reason that reservoir levels are significant is due to their impact on warning and response times. With a dam failure at higher reservoir levels, the failure is likely to proceed at a faster pace. Also, waters released from the reservoir may travel faster down river. In both cases, this will lead to less warning time and therefore, less time to prepare ONS for inundation. Duke's current 1-D and 2-D analysis (based on 1110 ft. and 800 ft.) indicates that the Keowee Dam will overtop between 2.1 and 2.2 hours and the intake canal in about 2.9 hours after failure of the Jocassee Dam. Peak water level at the SSF will be reached in about 3.7 hours.[10] These times define the limiting constraints under which the licensee personnel must understand the size, speed and consequence of the dam breach, make the difficult decisions to shutdown the reactors, rapidly cooldown and depressurize the primary and secondary systems so that the Hale pumps and the mitigating strategies can be used to inject lake water into the steam generators. Higher initial reservoir levels will potentially decrease the time available for these responses.

To date, only a partial consequence analysis has been performed. As previously discussed, a Jocassee Dam failure with a reservoir level of 1110 ft., will lead to a failure of the ECCS, BOP and all electrical power and to an inundation height at the SSF of approximately 18.5 ft. Duke has also determined that because all three access roads cross bridges that will be destroyed by the flooding, access to the site will only be available via helicopter. Duke's interim compensatory measures (ICM) direct utility personnel to mitigate the flood using "Hale" pumps (Hale pumps are skid mounted portable fire pumps) and hoses by injecting lake water into the units' steam generators and/or containments. However, Duke has not addressed the feasibility of these ICMs given the very large flow rates across the site. These flow rates may lead to significant scouring on the site which can lead to "floating" of buried piping that are relied upon by the ICMs. A third potential consequence is illustrated by the ONS' UFSAR that states that the wall separating the Turbine and Auxiliary Buildings (the "N" line) "is capable of withstanding a flood to a depth of 20 ft. above elevation 775 + 0."[12] A flood of this magnitude will direct approximately 40 ft. of water against this wall. The turbine and auxiliary building are a mixture of reinforce concrete and block walls. It is unclear what the consequences of these loads will be to this and other structures, systems and components (SSC). There may be other types of consequences beyond the three examples presented. A thorough investigation for all consequences should be performed given the uncertainty in the Jocassee Dam breach analysis.

Defense-in-Depth Analysis

Regulatory Guide 1.174[13] supplies a concise definition of defense-in-depth. Each of the defense-in-depth attributes is discussed. The Regulatory Guide 1.174 attribute definitions are underlined below.

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[10] Duke letter to NRC dated August 2, 2010 (ML102170006)
[11] http://www.nps.gov/miss/riverfacts.htm
[12] ONS UFSAR Revision 18 Section 3.4.1.1.1, Internal Flooding
[13] *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,* Revision 1. November 2002

- Reasonable balance is preserved among prevention of core damage, containment failure and consequence mitigation: A single failure, i.e., a failure of the Jocassee Dam, can lead to core damage and containment failure. Thus the required balance does not exist.

- Over-reliance on programmatic activities to compensate for weaknesses in plant design is avoided: The only current means of preventing consequences are Duke's ICMs. These by definition are programmatic activities.

- System redundancy, independence, and diversity are preserved commensurate with the expected frequency, consequences of challenges, and uncertainties: Because the flooding scenarios outlined above will lead to loss of all ECCS, BOP, electrical systems and the SSF, ONS has little system redundancy. Duke has supplied two "Hale" pumps as part of the ICM strategy. Thus there is no independence, or diversity of the systems to deal with the inundation. This limited capability is not commensurate with risk given the current best estimate Jocassee Dam failure frequency of approximately 2E-4 per year.[14] Nor is it commensurate with the consequences of challenges given the Duke estimated CCDP (without mitigating strategies) of 1.0. Finally, it is not commensurate with the high uncertainty. The uncertainty is described in a peer review of the Duke 1-D and 2-D analysis: "I want to emphasize that applications of complex hydraulic models is an art. The objective of ... modeling is to simplify an impossibly complex natural system so that it can be simulated... Not all of the laws of physics are even represented in the extreme conditions such as those associated with a dam breach. The models cannot be calibrated using observed data because the regulated stream system has never exceeded full pond elevation."[15]

- Defenses against potential common cause failures are preserved, and the potential for the introduction of new common cause failure mechanisms is assessed: A failure of the Jocassee Dam is a common cause failure of the ECCS, BOP, all electrical power systems and the SSF. Thus this criterion is not met.

- Independence of barriers is not degraded: The reactor coolant system is expected to fail, core damage is expected as is containment failure - all caused by the Jocassee Dam failure - unless the ICM mitigating strategies succeed. Thus there is no independence of barriers.

- Defenses against human errors are preserved: The only line of defense completely rests on human actions as directed by ICM mitigating strategies.

- The intent of the General Design Criteria (GDC) in Appendix A to 10 CFR 50 is maintained: ONS was licensed prior to the issuance of the GDCs. However, the ONS licensing basis includes a design criterion titled "Criterion 2 – Performance Standards (Category A),"[16] which is similar to GDC 2. It states in part, "Those systems and components of reactor facilities which are essential to the prevention of accidents which could affect the public health and safety or to mitigation their consequences shall be designed, fabricated and erected to performance standards that will enable the facility to withstand, without loss of the

[14] *Generic Failure Rate Evaluation for Jocassee Dam* (ML100780084) March 15, 2010
[15] Independent Technical Review HEC-RAS and SRH-2D Hydraulic Modeling Wilson Engineering Project WE10009. June 14, 2010
[16] ONS UFSAR Section 3.1.2

capability to protect the public, the additional forces that might be imposed by natural phenomena such as earthquakes, tornadoes, *flooding conditions*, winds, ice, and other local effects. The design bases so established shall reflect: (a) appropriate consideration of the most severe of these natural phenomena that have been recorded for the site and the surrounding area and (b) an appropriate margin for withstanding forces greater than those recorded to reflect uncertainties about the historical data and their suitability as a basis for design [emphasis added]." This design criterion clearly requires safety grade SSC capable of dealing with flooding. ONS lacks those SSCs.

In summary, I conclude that ONS lacks defense-in-depth against a Jocassee Dam failure. This agrees with the DE memo to The NRR Division of Operating Reactor Licensing (DORL) dated October 26, 2010,[17] which states in part: "Thus, if a flooding event from a Jocassee Dam failure occurred at the ONS site, all three units have no defense-in-depth to prevent core damage. The remaining intact element of defense-in-depth of containment integrity will be severely challenged, if unmitigated, resulting in the potential for radionuclide release to be highly probable. These results have led the NRC to conclude that the licensee lacks defense-in-depth to ensure that there is adequate protection at the ONS site against such floods."

Conclusions

The Duke suggested levels of 1110 ft. at Jocassee and 800 ft. at Keowee are at the top of the normal operating limits for the respective reservoirs. As such they are not bounding. They are neither most severe as required by ONS design "Criterion 2" nor worst case. Inundation from a large and rapid Jocassee Dam failure from these suggested level limits will, in approximately 2 to 3 hours after dam failure, lead to a simultaneous loss of defense-in-depth. Without mitigation, core damage on three units can be expected in 8 to 9 hours, containment failure in 59 to 68 hours and a simultaneous loss cooling on both spent fuel pools. The mitigating strategies supply a single line of defense using non-safety related equipment against a hazard that currently has a likelihood of occurrence approximately ten times higher than a large loss of coolant accident. Failure of the Jocassee Dam from a higher starting reservoir levels will worsen these impacts.

Without sensitivity analysis from higher reservoir levels the inundation depth, timing and consequences of a Jocassee Dam failure are not adequately understood or addressed. Duke should be required to perform the inundation sensitivity analysis as originally required in the NRC's letter of April 30, 2009, [2] to a technically defendable most severe level limit.

[17] NRC Memo Wilson to Persinko, NRC Staff Assessment of Duke Energy Carolinas, LLC., Oconee External Flooding Issue (TAC Nos. ME4441, ME4442, and ME4443), (ML102990064) October 26, 2010

STAFF RESPONSE TO NON-CONCURRENCE ON THE INITIAL STARTING RESERVOIR LEVEL OF THE JOCASSEE DAM FOR THE FLOODING INUNDATION STUDY OF THE OCONEE NUCLEAR SITE FOR DEMONSTRATING REASONABLE ASSURANCE

January 25, 2011

I. INTRODUCTION

On January 10, 2011, a non-concurrence was submitted by Jeffrey Mitman, associated with the Staff's Assessment Letter of the flooding inundation study for the Oconee Nuclear Site (ONS). In accordance with the non-concurrence process (draft Management Directive 10.158, "NRC Non-Concurrence Process"), the staff is providing the following: (1) summary of the dissenting view, (2) a summary of the staff's response to the dissenting view, and (3) a detailed response to the specific conclusions and statements provided in the non-concurrence.

During the staff's review of the flooding inundation study of the Oconee Nuclear Site, Mr. Mitman was assigned to evaluate the overall risk of the random failure of the Jocassee Dam. He also attended some of the meetings and discussions associated with the analysis of the flooding scenario. Veronica Rodriguez is his current supervisor and George Wilson, who is the Nuclear Regulatory Commission (NRC) Dam Safety Officer, is the document sponsor for the memo titled, "STAFF ASSESSMENT OF CONFIRMATORY ACTION LETTER ACTION- ONS UNITS 1, 2, AND 3 COMMITMENTS TO ADDRESS EXTERNAL FLOODING CONCERNS CLOSURE OF INUNDATION RESULTS (TAC NOS. ME3065, ME3066, AND ME3067) (ADAMS Accession No. ML103280043)."

II. SUMMARY OF NON-CONCURRENCE

The non-concurrence states that the 1110 feet (ft) mean sea level (msl) value for the Jocassee Reservoir level and the 800 ft msl for the Keowee Reservoir level are not bounding values for the flooding inundation study of the ONS. The non-concurrence notes that the reservoir levels are significant factors, due to the overall impact on the potential failure of the dam, flooding levels, and mitigation of the flooding event. In addition, the non-concurrence states that ONS lacks defense-in-depth against a Jocassee Dam failure.

A. SAFETY SIGNIFICANCE OF ISSUES ASSOCIATED WITH THE NON-CONCURRENCE

The non-concurrence states the initial reservoir levels are significant factors because higher initial reservoir levels for the Jocassee Reservoir and Keowee Reservoir could impact several parameters associated with the licensee's flooding inundation study. Higher initial water levels could lead to higher inundation levels at the ONS, or could cause a more rapid dam failure, thereby causing less warning for mitigation of the flooding event, and/or could increase the likelihood of a dam failure. If a flooding event were to occur, all three units at the ONS have no defense-in-depth to prevent core damage.

B. SYNOPSIS/SUMMARY OF NON-CONCURRENCE STATEMENTS ADDRESSING NON-BOUNDING RESERVOIR LEVELS, THE EFFECTS OF THE RESERVOIR LEVELS, AND THE LACK OF DEFENSE-IN-DEPTH AT THE ONS

The probable maximum precipitation (PMP) analysis for the Jocassee Reservoir, which was performed by the Division of Risk Assessment, indicates that the reservoir level can exceed 1110 ft msl, during a 40 percent PMP storm with maximum outflow from the turbines and spillways. The same rationale could be applied to the Keowee Reservoir level, but no studies have been presently performed. This analysis demonstrates that the reservoir levels could go above the top of the maximum operating band, during certain events.

The initial height of the reservoir levels for the Jocassee and Keowee Dams impact the likelihood of the dams failing, the amount of flooding at the ONS, and diminish the warning and response times to mitigate the flooding event. The overall potential effects, demonstrate the significance of the initial reservoir levels.

The licensee evaluated the results of a Jocassee Dam failure. The evaluation showed that the outcome without mitigation was core damage within 8 to 9 hours, followed by a containment failure in 59 to 68 hours. This evaluation demonstrates the lack of defense-in-depth for the mitigation of the flooding event at the site.

III. Background

The Jocassee and Keowee Dams were licensed and are regulated by the Federal Energy Regulatory Commission (FERC). FERC performs annual inspections at these facilities to evaluate the operating condition of the dams. Any abnormal condition that is identified during these inspections is evaluated and remediated accordingly. In addition, an independent evaluation by a consultant is required every five years by Part 12 subpart D of Title 18 of the Code of Federal Regulations, on the overall condition and capability of the dam. The Duke Staff performs weekly dam safety inspections; inspections following any 2-inch or greater rainfall or felt seismic event, annual dam inspections, and five year underwater inspections. In addition, Duke conducts the following monitoring activities: remote monitoring from the Hydro Central Operating Center, which is manned around the clock; monthly monitoring of the observation wells, weekly monitoring of seepage; and annual surveys of displacement monuments. All of these monitoring and inspection activities help to ensure that any abnormality is remediated to maintain the overall health and safety of the dams.

In response to the potential external flooding issue at ONS, the NRR Deputy Director directed the staff to develop a closure plan in 2009 to address the external flooding issue at Oconee. The Oconee closure plan is attached. The purpose of the closure plan was to ensure that reasonable assurance of adequate protection for the health and safety of the public is provided by the Oconee licensee in response to the overall external flooding inundation analysis. The plan was discussed with the NRR Deputy Director, before being approved by the Oversight Group, consisting of the Deputy Director of Engineering in NRR, and first line supervisors from other offices and NRR Divisions.

The proposed assessment letter on which the staff received the non-concurrence, documents the staff's evaluation of the licensee's initial parameters for the Jocassee Dam failure that were utilized for the inundation study. It does not address the evaluation of the licensee's planned actions to mitigate the potential effects of a dam failure, because that evaluation will be performed during the staff's review of the final mitigation strategy, and any associated design changes proposed by the licensee.

Based on the staff's review of the non-concurrence, the staff realized that there is a need to clarify the meaning of the word "bounding," as used in the proposed Assessment Letter, in order to avoid any misunderstanding. The use of the word "bounded," as used in the Confirmatory Action Letter (CAL), refers to conditions that bound the random sunny day failure of the Jocassee Dam. Therefore, the bounding reservoir levels would be taken at the FERC maximum allowable operating levels, which are 1110 ft msl for the Jocassee Dam and 800 ft msl for the Keowee Dam. The staff's technical experts determined that using the maximum allowable operating levels allowed by FERC were appropriately conservative to bound the consequences of a random sunny day failure of the Jocassee Dam, since dam failure at higher reservoir levels would not be considered a "random" sunny day failure event. The above clarification of the word "bounding" will be added to the assessment letter.

IV. RESPONSE TO CONCLUSION AND STATEMENTS IN THE NON-CONCURRRENCE

The following is a response to the conclusion and statements in the non-concurrence.

1. The reservoir levels of 1110 ft at Jocassee and 800 ft at Keowee are at the top of the normal operating limits for the respective reservoirs. As such, they are not bounding. Higher initial water levels could lead to higher inundation levels at the ONS, or could cause a more rapid dam failure, thereby causing less warning and preparation for mitigating the flooding event, and/or could increase the likelihood of a dam failure.

Response: The Jocassee Reservoir level of 1110 ft msl level and Keowee Reservoir level of 800 ft msl used in the flooding inundation study of the ONS were evaluated by the staff's technical experts in hydrology and ground water hydrology, as well as the Bureau of Reclamation acting as a contractor to NRC, and determined to be appropriate for the failure scenario of concern, i.e. a random sunny day failure of the Jocassee Dam. The random sunny day failure scenario was selected after the NRC technical experts' evaluation of the failure modes determined that the potential failure of the Jocassee Dam from either an overtopping event or a seismic event was not credible.

The non-concurrence has been reviewed and evaluated by NRC staff hydrologists and geologists, who are subject matter experts. The major point in the non-concurrence is that the initial reservoir levels for Jocassee and Keowee are not bounding. This point will be addressed by providing a technical evaluation for why the initial reservoir level of 1110 ft msl for the Jocassee Reservoir and 800 ft msl for the Keowee Reservoir are conservative and therefore, provide a reasonable starting point for the flooding inundation study of the ONS for a random sunny day failure of the Jocassee Dam.

The additional points discussed in the non-concurrence regarding the effects or consequences of reservoir levels being above the top of the maximum operating level allowed by FERC, will be addressed by providing a technical evaluation on why the random sunny day failure provides the credible failure scenario for the Jocassee Dam.

Early in the evaluation of the flooding scenario, the staff agreed that the flooding inundation study would be based on a random sunny day failure scenario. The reason for basing the potential dam failure only on a random sunny day failure was based on the staff's assessment of the potential failure of the Jocassee Dam, specifically due to overtopping and seismic events. The Probable Maximum Flood (PMF) is the extreme flood for the dam design or evaluation. It is based on the assumption of the most severe hydrologic and meteorological conditions considered to be reasonable at a site. The NRC staff subject matter experts evaluated the Jocassee Dam to ensure that it could safely capture and release a PMF resulting from a probable maximum precipitation (PMP). The PMP is theoretically defined as, the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographic location at a certain time of the year.

There are two engineered features for discharging water from the Jocassee Dam. There is a large deep spillway with two control gates, and there are also two tunnels beneath the dam that convey water to the four hydroelectric turbines. The spillway gates have been evaluated by FERC, to ensure that they are designed to safely pass a PMF discharge. FERC accepted Duke's 1991 and 1993 PMF analyses, which demonstrate that the Jocassee Dam can receive and release a PMF without overtopping, including consideration of an antecedent storm and antecedent soil moisture values. Also, FERC put together a Core Team consisting of subject matter experts from FERC, Duke, and independent dam consultants to perform a Potential Failure Mode Analysis (PFMA) in 1984. In the FERC Core Team's evaluation of the potential failures of the dam, they could not envision a likely scenario for overtopping, given the current programs of inspection, testing, maintenance and backup power, as well as the project surveillance (the reservoir level is monitored by Duke's Hydro Central group in Charlotte, North Carolina, around the clock). Therefore, the FERC Core Team ruled out overtopping as a failure mode, since it was considered to be a non-credible event.

In addition to the analyses performed by the licensee and FERC in 1984, a consultant to the Atomic Energy Commission (AEC) during the initial licensing of ONS (LBC&W Associates) issued a November 15, 1972, letter stating that an overtopping failure would not occur due to a PMF. The NRC staff, consisting of subject matter experts in hydrology and ground water geology, also performed an independent analysis of the potential for an overtopping event in 2010, based on the runoff model approved by FERC. This model demonstrated that a PMF with an antecedent storm can be safely contained and released in the Jocassee Reservoir without overtopping the dam. In the staff's analysis, the moisture infiltration (runoff) rates were increased and different combinations of available dewatering equipment were altered to add conservatism to the model.

The staff also noted that there are two earthen saddle dikes at the Jocassee Dam that could provide additional defense-in-depth against an overtopping failure of the Jocassee Dam. The grass covered earthen saddle dikes only have riprap on the lake side to prevent wave erosion. Riprap is a permanent, erosion-resistant ground cover of large, loose, angular stone with filter fabric or granular underlining. The saddle dike crest is at the same level as the Jocassee Dam

at 1125 ft msl, and If overtopped for any reason, it is expected that the saddle dikes would fail much more quickly than the main dam, due to their earthen design. Most importantly, if the saddle dikes fail, they would drain the lake down to a stage elevation of ~1090 ft, which is still in the operating range of the spillway gates.

Thus, a failure of a saddle dike would avert an overtopping failure of the Jocassee Dam. Failure of a single saddle dike would drain the lake down to an elevation of approximately1090 ft msl, fully averting a catastrophic draining of the entire lake, thereby protecting the Keowee Dam and the ONS from damage. Based on the discussion above, the NRC staff concluded that overtopping of the Jocassee Dam is not a credible event.

FERC stated that based on the evaluation of the design of the Jocassee Dam, it would not fail due to a seismic event. In a 2009 conversation with NRC staff, Dr. Steve Collins, who is the overall lead geotechnical engineer for FERC, stated that the evaluation takes into consideration the low peak ground acceleration, dam design, and rock filled dam performance. The FERC Core Team, as described above, also ruled out the seismic failure as a credible event during the PFMA evaluations in 1984. This was based on performing a pseudodynamic analysis utilizing a ground response spectrum at the Jocassee Dam location, which was the same as that used for the analysis of the nearby ONS by the NRC (PSAR response spectrum). The pseudo-dynamic analysis indicated that the body stresses during a seismic event were below the allowable limits. In addition, the post earthquake analysis was conducted using the base cracking predicted by the pseudo-dynamic portion of the analysis. The resultant factors of safety are in excess of those currently required by the FERC Guidelines, where a reasonable cohesion value is assumed. Duke has also performed two different fragility studies on the Jocassee Dam in 1981 and 2007. Both evaluations demonstrated that the amount of sliding displacement that occurs during a seismic event ensures that the ratio of shear stress to effective overburden pressure is sufficiently low. This ratio will limit any potential liquefaction in the compacted sand regions of the dam; therefore, the Jocassee Dam will not fail due to seismic events. Liquefaction is the transformation of a granular material (soil) from a solid state into a liquefied state as a consequence of increased pore-water pressure induced by earthquakes, thereby allowing the material to flow.

The NRC staff, consisting of subject matter experts in geotechnical engineering and geology, performed a qualitative evaluation of the seismic stability of the Jocassee Dam. The qualitative evaluation was based on the following: a review of the available information in the technical literature pertaining to the performance of rock filled dams; the review and certification by Duke's Consulting Board of the quality control performed during construction; and finally based on the overall condition of the Jocassee Dam as certified by FERC's annual inspections. The NRC staff verified that the original construction data, including the compaction data, were reviewed and approved by FERC at the time of construction. The licensee's ongoing monitoring of monuments and piezometers in the Jocassee Dam core and abutments indicates no significant movement of the dam, either in the vertical or in the horizontal direction even though the dam has experienced several seismic events during its life time over the last 30 years. The NRC staff also visited the ONS on June 15, 2009, and reviewed the material records provided by Duke. The staff assessment of the dam concluded that the dam appeared to be a well-constructed, stable, and a well-maintained engineering structure, that it is regularly monitored for any significant change in seepage rates and embankment or foundation stability. Past work to minimize and control seepage appears to have been successful. The liquefaction potential for well compacted saturated sands within the dam is low. Rock-fill dams have high resistance to seismic loads. Furthermore, the seismic hazard for western South Carolina, where the Jocassee Dam is located, has been reduced since the time the dam was designed and

constructed. The 2002 mapping data suggested that for a probability of recurrence of 2 percent in 50 years, the peak ground acceleration at the dam site would be 0.197 g. The latest update from the United States Geological Survey (USGS) (Petersen et al., 2008, Fig. 28) lowers this estimate to less than 0.1 g, which significantly reduces the risk of dam failure due to a postulated seismic event. The seismic attributes of the Jocassee Dam were analyzed by the NRC staff experts, and they have determined that a seismic failure of the Jocassee Dam is not a credible event.

The overtopping and seismic failure evaluations discussed above are key points to the Staff's overall assessment of the ONS flooding inundation. The FERC Core Team in the PFMA concluded that the most likely Jocassee Dam failure would be from a piping failure in one of the abutments.

After reviewing the data, the NRC staff experts also concluded that the most credible failure scenario for a random sunny day failure of the Jocassee Dam was due to a piping failure in one of the abutments. The random sunny day failure of the Jocassee Dam results in the failure of the Keowee Dam and associated structures, thereby flooding the ONS. Since the evaluation is based on a random sunny day failure of the Jocassee Dam, it is appropriate and conservative to assume that the Jocassee and Keowee Reservoir levels are at the top of the maximum allowable operating band. To assume the initial reservoir levels to be greater than the top of the operating band, additional equipment failures or natural phenomena have to be combined, as described below, thereby resulting in a "non-random" sunny day failure event. As stated above, this is a key point, since the non-concurrence also describes the potential effects of a higher initial reservoir level. The staff acknowledges the concern that the higher reservoir levels for the Jocassee Reservoir and Keowee Reservoir could potentially have an impact on the outcome of various parameters such as: higher inundation levels at the ONS; a more rapid dam failure, thereby resulting in less warning and preparation for the mitigation of the flooding event; and/or increase the likelihood of a dam failure. However, as stated above, in order for the initial reservoir levels to be above the normal operating pool levels, additional equipment failures or natural phenomena have to occur, thereby making the event a "non-random" sunny day failure, which would be less likely to occur due to the conditions necessary for water to be above the maximum operating range.

FERC has stipulated the normal operating range of the Jocassee Reservoir as 1080 to 1110 ft msl. The Keowee Reservoir has a normal operating range from 794 to 800 ft msl. FERC also approved the random sunny day failure analysis at a starting reservoir of 1108 ft msl for the Jocassee Reservoir in the 1992 FERC Study performed by Duke Energy. The same rationale applies for the Keowee Reservoir level for being below the top of the operating band. Duke Hydro operates the dams in accordance with the "Keowee – Toxaway Project High-Water Operations Process" procedure. The procedure covers normal and contingency actions for the operation of the dams, specifically the control of the reservoir levels. The contingency actions include lowering the reservoir levels for abnormal rises in lake level and any anticipated significant precipitation. The normal operating pool level of the Jocassee Dam Reservoir is 1108 ft msl, which is 2 ft below the top of the two spillway flood gates, which are at an elevation of 1110 ft msl. Any water level above this elevation would flow over the top of the two spillway flood gates (see figure below). In addition, the maximum allowable operating level during the hurricane season is reduced to 1108 feet msl, to account for any unanticipated sudden heavy

rainfall. This would be the same rationale for the Keowee Dam except it has four gated spillways at 800 ft msl.

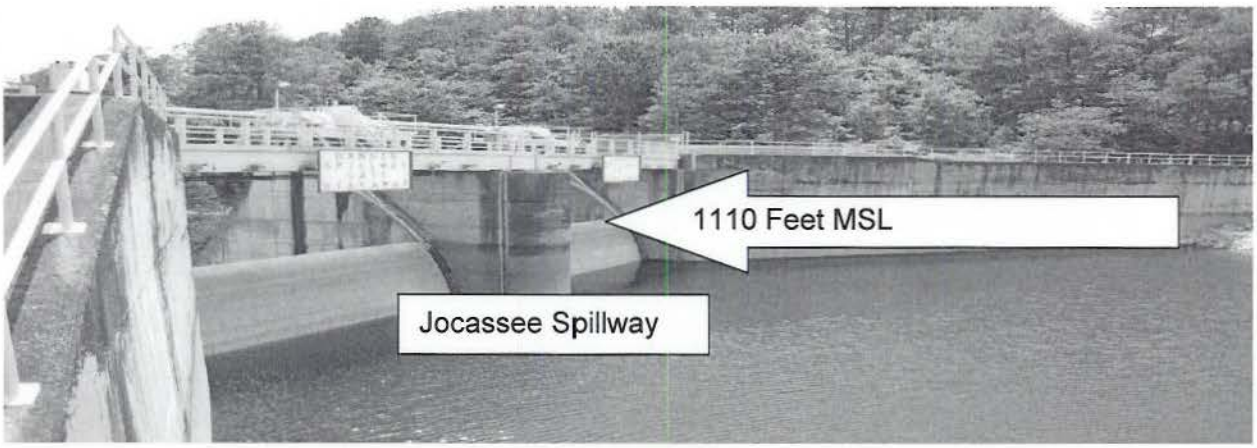

Figure 1: Jocassee Spillway

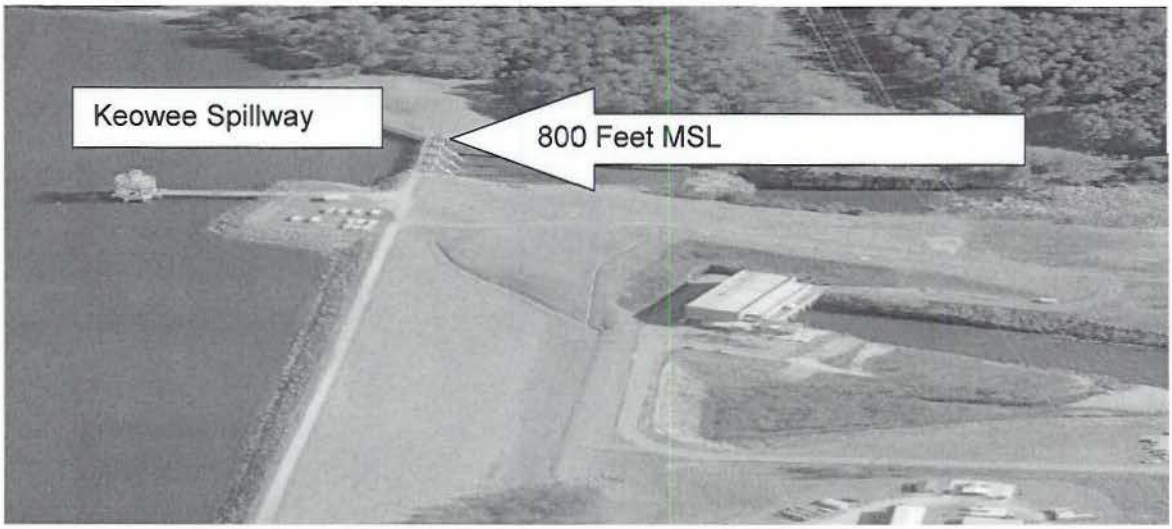

Figure 2: Keowee Spillway

The NRC staff contracted with the Bureau of Reclamation to perform an independent evaluation of the Jocassee Dam flooding scenario, and their evaluation was submitted to the NRC staff on July 6, 2009. That study stated that, if the Jocassee Reservoir is operated at 1,110 feet on a regular basis, or if reservoir elevation 1,110 is considered to be a normal maximum operating level, then 1,110 feet should be used as an initial reservoir level for the sunny day breach analysis. There would be a water storage volume difference between 1,108 and 1,110 feet, and this volume difference will likely affect the flooding impacts at the Keowee Dam and the ONS. The Bureau of Reclamation routinely evaluates the sunny day dam failure flood inundation studies for Reclamation dams. These studies typically use an initial reservoir level at the normal maximum operating levels for Reclamation dams; therefore, a sunny day analysis for the Jocassee Dam should be based on a normal maximum operating level for the reservoir. The same rationale would apply to the Keowee Reservoir, since the normal maximum operating level for the Keowee Reservoir is 800 ft msl.

Based on the operating procedures and monitoring of the Jocassee and Keowee Reservoir levels, any increase over 1110 ft msl or 800 ft msl excluding an over pumping event (Jocassee Reservoir) would probably involve a flood. The standard for evaluating flooding at nuclear sites is American Nuclear Society (ANS) 2.8 (1992), Determining Design Basis Flooding at Power Reactor Sites. Section 9.2.4 of ANS 2.8 (1992) does not address or require event combinations with non-hydrologic and non-seismic dam failures. The ANS standards are consistent with the requirements in Title10 of the Code of Federal Regulations (CFR) Part 50, Appendix A, C*riterion 2--Design bases for protection against natural phenomena*. Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena. Therefore, there is no regulatory requirement to combine two different severe events, a flooding scenario followed by the dam failure into one initial starting scenario.

One of the reasons that different severe events are not required to be combined is due to the initiating frequency of those individual events. For example, one set of potential conditions that could result in the Jocassee reservoir level exceeding 1110 ft msl could be a storm consisting of at least 40 percent PMP or the combination of a 40 percent PMP storm with additional dam equipment (spillway gates) malfunctioning. Duke's operating procedures require that all the turbines and spillway gates be operated to maintain the reservoir levels. It is more likely that it would take a combination of a storm and an equipment malfunction to result in the water levels going above the maximum operating level. The initiating frequency for a storm of 40 percent PMP rainfall storm based on Point Precipitation frequency estimates for South Carolina (NOAA Atlas 14) would have an exceedance probability of less than 10^{-3} per year. This frequency was approximated from the rainfall frequency analysis described as follows: The PMF for the Jocassee reservoir basin was determined from the 72 hour (hr) PMP in Hydro meteorological Report No. 51. The 10 square mile 72 hour (hr) PMP from Hydro meteorological Report 51 is about 46.5 inches; therefore the 40 percent value is about 18.6 inches of rain. The 1000 year recurrence interval point values for 48 hr and 96 hr rainfalls are 14.47 and 15.00 inches, respectively. Therefore, 18.6 inches is greater than the amount of rainfall that could be expected from a 1000 year storm. The failure rate for the spillway flood gates is derived from actual historical data of the gates. Each of the Jocassee spillway flood gates have been tested twice a year for about 30 years with no failures. Consequently, each gate has a probability of failure on demand of 4×10^{-3} per gate. Therefore, to have a combination of a 40 percent PMP storm with a failure of a spillway flood gate, the event would be less than 4×10^{-6} per year, which is a very low occurrence event. The same rationale applies to the Keowee Reservoir level.

The goal of the staff's overall assessment is to ensure that reasonable assurance of adequate protection for the health and safety of the public is provided by the overall flooding inundation analysis. The initial reservoir level is just one of the input parameters for the flooding inundation study. The other input parameters chosen for the inundation study, such as breach time, breach height, breach width, etc., also included conservatism. With the conservatisms included in each parameter used in the inundation study, the staff believes there is sufficient margin in the study to provide reasonable assurance that public health and safety will be adequately

protected, if the ONS can take measures to mitigate the estimated flood that results from the postulated random sunny day failure of the Jocassee Dam.

2. ONS Lacks Defense-In-Depth Against a Jocassee Dam Failure

Response: The non-concurrence comments on defense-in-depth are outside of the scope of the Assessment Letter. The scope of the Assessment Letter only addresses the evaluation and assessment of the licensee's initial conditions or parameters to be used in the flooding inundation study of the ONS. The licensee's interim mitigation strategy was evaluated by NRC regional and headquarters staff during an inspection of the interim compensatory measures performed June 7 -10, 2010, and the results are contained in Inspection Report 05000269/2010-002, 05000270/2010006, 05000287/2010006 (ADAMS ML1018807680). However, the defense-in-depth comments from the non-concurrence may be relevant to the staff's evaluation of the licensee's final mitigation strategy, and will be considered during the staff's review of the licensee's final mitigation and any associated plant design changes.

V. CONCLUSIONS AND RECOMMENDATIONS

The staff's review and documented conclusions were evaluated to ensure that the review was of sufficient scope and provided reasonable assurance of adequate protection of the health and safety of the public. Based on the staff's review of the non-concurrence, the staff realized that there is a need to clarify the meaning of the word "bounding," as used in the proposed Assessment Letter, in order to avoid any misunderstanding. The use of the word "bounded," as used in the CAL, refers to conditions that bound the random sunny day failure of the Jocassee Dam. Therefore, the bounding reservoir levels would be taken at the FERC maximum allowable operating levels, which is 1110 ft msl for the Jocassee Dam and 800 ft msl for the Keowee Dam. The bounding conditions would not be the absolute worst case for the dams. The above clarification of the word "bounding" will be added to the assessment letter.

The concerns in the non-concurrence involved the Jocassee Dam Reservoir level of 1110 ft msl and Keowee Reservoir level of 800 ft msl, not being bounding. As discussed above, the licensee demonstrated that the initial starting reservoir levels for Jocassee and Keowee reservoirs are conservative and provide reasonable assurance for the flooding inundation study for ONS during a random sunny day failure of the Jocassee Dam. Therefore, the staff's conclusion that the selected reservoir levels provide reasonable assurance is still valid.

Defense-in-depth is not addressed in the Assessment Letter. The assessment letter documents the staff's evaluation of the licensee's initial parameters utilized for the inundation study. It does not address the evaluation of the mitigation of the event itself. That evaluation will be performed during the staff's review of the licensee's final mitigation and any associated designs. The interim mitigation strategy was evaluated by NRC staff personnel during an inspection of the compensatory measures performed June 7-10, 2010, and the results are contained in Inspection Report 05000269/2010-002, 05000270/2010006, 05000287/2010006 (ADAMS ML1018807680).

NRR ACTION PLAN
Closure Plan for Dam/Hydrology Issues
7/15/2009
(Updated: January 19, 2011)

Purpose:

The purpose of this action plan is to address: (1) the question of reasonable assurance of adequate protection for the Oconee site based on the external flooding issues, (2) impact of TVA hydrology modeling errors on operating plants, and (3) potential generic issues which arise from the Oconee and TVA issues.

Process:

The process that will be used in addressing the dam and hydrology issues is LIC-502, "Procedure for Development, Implementation, and Management of Action Plans." Other guidance documents will be used as necessary.

Scope of Project Plan:

- Assess Duke's dam breach report and supplemental information to determine if reasonable assurance is provided for Oconee for adequate protection against external flooding, taking into consideration various staff insights and independent reviews (USBR, FERC, and staff independent reviews). (See Enclosure 1)

- Address TVA hydrology issues that resulted from the recent findings associated with the discrepancies of the Bellefonte SOCH Code that could impact Browns Ferry, Sequoyah, and Watts Bar. (See Enclosure 2)

- Pursue any generic issues, as applicable, that result from the reviews of the Oconee external flooding issues and the TVA hydrology issues. (See Enclosure 3)

ATTACHMENT

ENCLOSURE 1

Closure Plan for Duke's Oconee External Flooding Issues

TAC Nos.: MD8224, MD8225, and MD8226	Last Update: January 19, 2011 Lead Division: DE Supporting Divisions: DRA, DORL, DPR Supporting Offices: OGC, OE, NMSS, and RII

Historical Background:

The Oconee Nuclear Station (ONS) is located in eastern Oconee County, South Carolina, approximately 8 miles northeast of Seneca, South Carolina. The ONS licensee, Duke Power Company (Duke), owns Lake Keowee, which occupies the area immediately north and west of the site. Duke also owns Lake Jocassee, which lies approximately 11 miles to the north of the site. The Jocassee Dam was completed in 1967. It is 385 ft high above the deepest point of its foundation (not counting the excavation of about 40 ft of weathered rock and backfilling beneath the core of the dam). The dam is 1825 ft long at the crest and has a volume of 11 million cu yd of rock and earth fill. The dam includes a central earth core and transition filters supported by zoned rock fill shells.

As part of its national program of Emergency Action Plans (EAPs), in 1992, FERC required Duke to perform the Jocassee Dam inundation study which indicated that the flooding caused by a "sunny day" failure of the dam could cause the flood water level at the Oconee site to rise 12.5 ft above the plant grade level, and that a combination of a sunny day failure and the probable maximum flood (PMF) at the Jocassee Dam would increase the water level to 16.8 ft above grade.

In addition, while reviewing an inspection finding during 2007, the staff identified an error in the random dam failure analysis for site flooding which increased the failure frequency by approximately an order of magnitude. Since a flood of such magnitude could jeopardize the safety of the Standby Shutdown Facility (SSF) at the Oconee site if it were not adequately protected, the NRC requested that Duke provide an explanation for concluding that the site was still protected against external flooding, given the results of the 1992 study performed for FERC. In response to the NRC's request, the licensee is performing a new inundation study, using a more advanced computer model (HEC-RAS) for the specific purpose of determining the effect of flood waters on the SSF. Duke provided the preliminary results of its analysis for the staff's review on April 27, 2009. A meeting was held on May 11, 2009, whereby Duke discussed its analysis with the NRC and FERC. In June 2009, Duke will provide the schedule for completing the study and will identify any modifications by November 2009.

Regulatory Basis:

The requirements that apply to the Oconee external flooding issues include the following:

Oconee's Pre-GDC 2 criterion requires that:

> Those systems and components of reactor facilities which are essential to the prevention of accidents which could affect the public health and safety or to mitigation of their

> consequences shall be designed, fabricated and erected to performance standards that will enable the facility to withstand, without loss of the capability to protect the public, the additional forces that might be imposed by natural phenomena such as earthquakes, tornadoes, flooding conditions, winds, ice, and other local site effects. The design bases so established shall reflect: (a) appropriate consideration of the most severe of these natural phenomena that have been recorded for the site and the surrounding area and (b) an appropriate margin for withstanding forces greater than those recorded to reflect uncertainties about the historical data and their suitability as a basis for design.

Other NRC Guidance Associated with Dams:

Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," Rev. 2, 1977: This Regulatory Guide describes acceptable methods of determining design basis floods, referencing the American National Standards Institute (ANSI) Standard N170-1976 (ANS 2.8), "Standards for Determining Design Basis Flooding at Power Reactor Sites" almost in its entirety as the source for estimating Probable Maximum Floods (PMF), with the exception of specific portions related to the evaluation of erosion failure. GDC 2 is explicitly mentioned in RG 1.59.

> Nuclear power plants should be designed to prevent the loss of capability for cold shutdown and maintenance thereof resulting from the most severe flood conditions that can reasonably be predicted to occur at a site as a result of severe hydrometeorological conditions, seismic activity, or both.
>
> The conditions resulting from the worst site-related flood probable at the nuclear power plant (e.g., PMF, seismically induced flood, seiche, surge, severe local precipitation) with attendant wind-generated wave activity constitute the design basis flood conditions that safety-related structures, systems, and components identified in Regulatory Guide 1.291 should be designed to withstand and retain capability for cold shutdown and maintenance thereof.
>
> For sites along streams, the PMF generally provides the design basis flood. For sites along lakes or seashores, a flood condition of comparable severity could be produced by the most severe combination of hydrometeorological parameters reasonably possible...or a reasonable combination of less severe phenomenologically caused flooding events should be considered in arriving at design basis flood conditions comparable in frequency of occurrence with a PMF on streams.
>
> The material previously contained in Appendix A has been replaced by American National Standards Institute (ANSI) Standard N170-1976, "Standards for Determining Design Basis Flooding at Power Reactor Sites," with the following exception:

Sections 5.5.4.2.3 and 5.5.5 of ANSI N170-1976 contain references to methods for evaluating the erosion failure of earth fill or rock fill dams and determining the resulting outflow hydrographs. The staff has found that some of these methods may not be conservative because they predict slower rates of erosion than have historically occurred. Modifications to the models may be made to increase their conservatism. Such modifications will be reviewed by the NRC staff on a case-by-case basis.

Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants", Rev. 1, 1976, describes the acceptable types of flood protection for the structures, systems and components (see also SRP 2.4.10).

> For purposes of this guide, the Design Basis Flooding Level (DBFL) is defined as the maximum water elevation attained by the controlling flood, including coincident wind-generated wave effects. The wind-generated wave component of elevation is generally controlled by fetch and water depth and may differ at locations around the plant. Further distinction must be made between estimates of "structural" effects (i.e., static and dynamic forces) and flooding or inundation effects. Additionally, the controlling flood event may be different for evaluating structural effects than for evaluating inundation effects. For example, the Probable Maximum Flood (PMF) may produce the highest water level and static forces on a given structure, but the total static and dynamic forces on the structure may be greater during a smaller (in elevation) flood wave from the seismically induced failure of an upstream dam.

Originating Document/Regulatory Assessment:

Duke Energy Carolinas, LLC (the licensee) performed an inundation study[1] in 1992 to meet a Federal Energy Regulatory Commission (FERC) requirement for formulating an emergency action plan in the event that the Jocassee Dam failed. This study showed that approximately 16.5 ft. of water would inundate the site.

In April 2006, while performing a Reactor Oversight Process (ROP) evaluation, the NRC staff questioned the licensee's maintenance of the SSF flood protection barrier. During the subsequent ROP Significance Determination Process (SDP), the NRC identified that the licensee had incorrectly calculated the Jocassee Dam failure frequency and had not adequately addressed the potential consequences of flood heights predicted at the Oconee Nuclear Station (ONS) site, based on the 1992 inundation study. The NRC staff also recognized that the licensee's 1992 inundation study did not follow the guidelines for the probable maximum flood (PMF) evaluation, as described in Regulatory Guides 1.59[2] and 1.102[3].

The NRC sent a 10 CFR 50.54 (f) request for information on August 15, 2008[4,5]. In response to this letter, in 2009, the licensee conducted additional inundation analyses[6] consisting of one- and two-dimensional studies. These studies indicated that the resultant flood, which results in approximately 18.5 feet of water on the site, would cause the site to be inundated with flood waters. The licensee, in its response to the 10 CFR 50.54 (f) letter, stated that the inundation will lead to core damage, containment failure, and the loss of spent fuel pool cooling at all three units. Thus, if a flooding event from a Jocassee Dam failure occurred at the ONS site, all three units have no defense-in-depth to prevent core damage. The remaining intact element of

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[1] "Jocassee Hydro Project, Dam Failure Inundation Study," Federal Energy Regulatory Commission (FERC) Projects No. 2503, December 1992.
[2] Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, (Rev. 2) August 1977.
[3] Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, (Rev. 1) September 1976.
[4] Letter to D. Baxter of Duke Energy Carolinas, LLC, dated August 15, 2008, Information Request Pursuant to 10 CFR 50.54(f) related to External Flooding, Including Failure of the Jocassee Dam at ONS, (ML0816402440).
[5] Letter from D. Baxter of Duke Energy Carolinas, LLC, to US NRC, dated September 26, 2008.
[6] See Duke's presentation to NRC dated October 28, 2009.

defense-in-depth of containment integrity will be severely challenged, if unmitigated, resulting in the potential for radionuclide release to be highly probable. These results have led the NRC to conclude that the licensee lacks defense-in-depth to ensure that there is adequate protection at the ONS site against such floods.

As a result, the NRC expressed, via the aforementioned 10 CFR 50.54(f) letter, a concern that the licensee has not demonstrated "...overall adequacy of the flood protection of Oconee given the Jocassee Hydro Project...Specifically, the NRC is seeking information ... whether Oconee lacks appropriate and adequate compensating engineering safeguards for such an event."

Subsequent to the licensee's response to the 10 CFR 50.54(f) letter, the NRC, in its April 20, 2009, letter[7] stated, in part, "the NRC staff remains concerned that the licensee has not demonstrated that Oconee will be adequately protected in the long term from external flooding events."

By letter dated January 15, 2010[8], the licensee submitted a letter to the NRC which provided its compensatory measures (CMs) to ensure that ONS will be adequately protected from external flooding events until the final mitigating strategies have been implemented and all site modifications have been completed. The NRC staff plans to perform a further review of the CMs and will perform a future inspection.

Then, by letter dated January 29, 2010[9], the staff issued its response to the licensee regarding its November 30, 2009, response to the NRC letter dated April 30, 2009, related to external flooding at ONS. The staff indicated that although the licensee provided a more accurate estimate of the flooding caused by a failure of the Jocassee Dam, the staff found that additional information was needed. The information was needed for the staff to determine if the analyses performed to date will demonstrate, for the entire Jocassee earthen works, that the ONS site will be adequately protected from external flooding events. The licensee submitted a preliminary set of responses to the staff's questions by letter dated March 5, 2010[10].

On June 22, 2010[11], the staff issued a Confirmatory Action Letter (CAL) to the licensee, requesting the following: (1) that the compensatory measures remain in place until final resolution has been agreed upon between the licensee and the NRC staff, (2) the licensee to submit to the NRC all documentation necessary to demonstrate that the inundation of the Oconee site from the failure of the Jocassee Dam has been bounded, (3) licensee to submit a list of all necessary modifications to mitigate the inundation by November 30, 2010, and (4) licensee to make all necessary modifications by November 30, 2011.

To date, the licensee has committed to keep the CMs in place until final resolution has been agreed upon between the licensee and the NRC staff and the licensee has adequately

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[7] Letter to D. Baxter, Evaluation of Duke Energy Carolinas, LLC, September 26, 2008 Response to NRC Letter Dated August 15, 2008 Related to External Flooding at ONS (ML0905707791).
[8] Letter from D. Baxter of Duke Energy Carolinas, LLC, to US NRC, dated January 15, 2010 that addresses the Interim Compensatory Measures at ONS.
[9] Letter to D. Baxter of Duke Energy Carolinas, LLC, dated January 29, 2010, Evaluation of Duke's Response to NRC Letter Dated April 30, 2009 Related to External Flooding at ONS (ML100271591).
[10] Letter from D. Baxter of Duke Energy Carolinas, LLC, to US NRC, dated March 5, 2010, Partial Response to NRC RAI dated February 3, 2010, Related to External Flooding at ONS.
[11] Confirmatory Action Letter from L. Reyes (NRC) to D. Baxter (Duke), dated June 22, 2010 (ML101730329)

submitted to the NRC all documentation necessary to demonstrate that the inundation of the Oconee site from the failure of the Jocassee Dam has been bounded.

Goals and Objectives:

- Assess and evaluate all input (from FERC, USBR, and NRC Safety Review Group) associated with the review of Duke's site inundation study and any supplemental information that may be submitted by Duke at a later date.

- Develop the agency's position regarding reasonable assurance of adequate protection, considering all inputs, and finalize a summary report describing the path forward with concurrence from OGC.

- Ensure the licensing basis is updated to clearly address the external flooding hazard, and associated protective features.

- Consider any generic implications identified through this site-specific Oconee work or other ongoing related activities within the framework described in Enclosure 3.

Outcomes:

- Resolve Oconee-specific issues identified in NRC's letters dated August 15, 2008, and April 30, 2009, and take appropriate regulatory action, as necessary.

- Ensure that the licensing basis of the Oconee Nuclear Station with respect to external flooding hazards is clearly documented in accordance with applicable regulatory processes (e.g., adequate protection backfit, if appropriate).

Current Status:

The project plan was shared with all parties involved at a meeting that was held on June 10, 2009, to discuss roles and responsibilities and projected milestones.

Process:

1. An Oversight Group (OG) was created to provide guidance and oversight to the Safety Review Group regarding assessments and final recommendation. The OG also provided all briefings to upper level management. The (OG), which was led by Deputy Division Director of DE, and will consist of the following folks: Dam Safety Officer, DE/EMCB BC, DE/SLA, DRA/APOB BC, DORL/LPL 2-1 BC, NRO/RHEB BC, and RGN II/DRP/RPB1 BC; the Safety Review Group (SRG), which will be led by the Dam Safety Officer and will consist of the following folks: DE/SLA, DE/EMCB Geotechnical Engineer, NMSS and ACRS Hydrologists, FERC reps, USBR contractor, Region II reps, and NRR/DRA and NRO representatives, as determined by the Oversight Group. OGC and OE will be involved, as necessary. (Completed)

2. A Safety Review Group (SRG) was created to assess Duke's dam breach report and any supplemental information on sensitivity analyses, etc, to address the question of reasonable assurance of adequate protection from external flooding for the Oconee site. NRC Dam Safety Officer to lead the SRG and will conduct routine status meetings with the team. The

SRG will be comprised of DE/SLA, DE/EMCB Geotechnical Engineer, NMSS and ACRS Hydrologists, other hydrologists, if needed, with additional support from FERC representatives, USBR contractor, Region II representatives as assigned by Division Director, and NRR/DRA and NRO representatives, as determined by the Oversight Group. OGC and OE will be involved, as necessary. SRG will address any previously identified issues. SRG status meetings will be conducted bi-weekly and the SRG will be responsible for providing monthly status reports. (Completed)

3. NRC Dam Safety Officer or EMCB Branch Chief to serve as Liaison between the OG and the SRG. (Completed)

4. Conduct a review of Duke's site inundation study and supplemental information. (Completed)

5. Develop and issue questions regarding Duke's site inundation study and supplemental information. (Completed)

6. Conduct monthly management status conference calls with Duke. (Completed)

7. Conduct monthly "working level" scheduled meetings with the licensee to facilitate resolution of the technical issues. (Completed)

8. Conduct site visit. (Completed)

9. Develop the agency's position regarding reasonable assurance of adequate protection of the Oconee site from external flooding, taking into consideration all parties' inputs. (Ongoing – Document is currently in concurrence.)

Roles and Responsibilities (Enclosure 1):

Division of Engineering: Has overall responsibility for coordination, implementation and execution of Closure Plan. Responsible for performing or reviewing all technical evaluations within the scope of this work, including evaluating input from other Divisions and Offices regarding Duke's inundation analyses. Responsible for overseeing all activities associated with this project, including overseeing the USBR contractor and the OG and SRG. Will lead the SRG meetings and facilitate resolution of issues and will serve as liaison between all stakeholders and communicate overall recommendation to management. Will ensure proper communications occur within and between all stakeholders to ensure a comprehensive and all inclusive evaluation is performed. DE, with input from the associated working groups, will write the overall summary report for the evaluation and assessment on Duke's inundation study to ensure reasonable assurance of adequate protection is provided at the Oconee site. The Dam Safety Officer will concur on all dam safety related work. (See attached Charter)

Division of Risk Assessment: Responsible for providing support in the area of risk assessment associated with dam failure frequency.
Office of New Reactors: Participates for technical consistency by providing insights on how the issue would be evaluated for new reactor licensing to DE regarding review of dam breach report and other information submitted by Duke regarding inundation and sensitivity analyses.

Region II: Responsible for providing operating plant input and assessment to DE regarding review of dam breach report and other information submitted by Duke regarding inundation and sensitivity analyses.

Division of Operating Reactor Licensing: Provide project management support to overall plan. Provide technical analysis and support on issues related to regulatory framework and the plant's licensing basis. DORL will serve as a point of contact with the licensee, including the coordination of meetings and calls and request for information/clarification. Maintain and update the sharepoint website related to this issue.

Office of General Counsel: Responsible for advising staff on legal acceptability of potential staff actions. OGC will also provide support on backfit decisions, as needed.

Office of Research: Provide support to DE with regards to the Generic Issues Process to determine potential generic implications.

Actions/Milestones Proposed:

Issue Interagency Agreement and Task Order to USBR for contract support of External Flooding Issues and conduct conference call with USBR to provide guidelines on reviews	Complete
Sr. Management Alignment regarding scope of May 11th meeting with Duke	Complete
Staff Alignment regarding scope of May 11th meeting with Duke	Complete
Develop questions from NRO's Assessment to address at May 11th meeting with Duke for input to USBR	Complete
Obtain preliminary Jocassee Dam inundation analysis results and calculations from Duke and NRO evaluation and send them to USBR and FERC	Complete
ADES/AD Prep. Meeting/Develop talking points for ADES	Complete
Conduct pre-meeting with FERC	Complete
Conduct meeting with Duke and FERC at Headquarters	Complete
Coordinate with FERC (Dan Mahoney) to obtain FERC review results of Duke's analysis and NRO input	Complete
Create an Oversight Group (OG) to provide guidance and oversight to the Safety Review Group regarding assessments and final recommendation.	Complete
Create the Safety Review Group (SRG) to assess Duke's dam breach report and any supplemental information on sensitivity analyses, etc, to address the question of reasonable assurance of adequate protection from external flooding for the Oconee site, in concert with ensuring technical consistency between NRR and NRO.	Complete
Conduct conference calls with USBR on review status and additional review items, such as NRO's Assessment	Complete
USBR complete review/SRG complete review	Complete
SRG review FERC's and USBR's analyses	Complete
Duke to provide letter to address interim compensatory measures (ICMs)	Complete
Region 2 to conduct audit of ICMs and document results in an inspection report.	Complete

Obtain final results from Duke regarding Jocassee Dam Inundation Study	Complete
DE, with input from the SRG and OG, to develop final position and write closeout safety assessment/package regarding reasonable assurance of adequate protection.	Ongoing/document is in concurrence
DORL and DE to determine appropriate path forward regarding justification for continued operation	TBD
Duke to submit permanent mitigation resolution	April 2011
Staff to review Duke's permanent mitigation resolution and to address defense-in depth issue raised by DRA.	TBD

Actions/Milestones Proposed:

Safety Review Group Milestones

Develop preliminary set of questions regarding Oconee Jocassee Dam Breach Report	Complete
Conduct Oconee/Jocassee Dam Site Visit	Complete
Conduct meeting with OG and SRG to discuss definition of reasonable assurance of adequate protection, key parameters to be included in sensitivity analysis, and "what does success look like."	Complete
Provide high level assessment of Oconee Jocassee Dam Breach Report	Complete
Participate in meeting to discuss all assessments (developed by FERC, USBR, and Dam Safety Team) and develop recommendation for overall assessment considering all views.	Complete
Review additional information submitted from Duke (responses to questions from meeting, April 30th letter (modeling/sensitivity studies)	Complete
Develop 2nd set of questions, as appropriate	Complete
Meeting with all parties to discuss assessments and develop justification for varying positions	Complete
Submit recommendation to management including reasonable assurance of adequate protection determination	Ongoing/In concurrence

Schedule Changes Since Last Update: N/A

Resource Expenditure:

FTE: 5 FTE
Contract Dollars: USBR $43,100 (FY 2009)

Plan Closure:

A determination of reasonable assurance of adequate protection related to external flooding issues at the Oconee site will represent successful completion of this plan.

Contacts:

Name	**Position**	**Phone No.**
David Skeen	OG Lead	415-3298
George Wilson	Dam Safety Officer	415-1711
Kamal Manoly	DE POC	415-2765
Meena Khanna	DE POC	415-2150
Melanie Wong/Gloria Kulesa	DORL POC	415-2911
Name	**Position**	**Phone No.**
Mike Franovich/Veronica Rodriguez	DRA POC	415-1067
Richard Raione	NRO POC	415-7190
Jonathon Bartley	Region II POC	404-562-6334
Raman Pichumani/Juan Uribe	EMCB POC	415-3621
Neil Coleman	SRG POC	415-7656

Rex Wescott	SRG POC	492-3107
Bill Ott	RES POC	251-7407
John Wray	OE POC (as necessary)	415-1288
Kimberly Sexton/Marcia Simon	OGC POC	415-1151

References:

1. NRC letter to Duke dated August 15, 2008, "Information Request Pursuant to 10 CFR 50.54(f) Related to External Flooding, Including Failure of the Jocassee Dam, at Oconee Nuclear Station, Units 1/2/3.

2. NRC Communication Plan for Information Request Pursuant to 10 CFR 50.54(f) Related to External Flooding, Including Failure of the Jocassee Dam, at Oconee Nuclear Station.

3. NRC letter to Duke dated April 30, 2009, "Evaluation of Duke Energy Carolinas, LLC, September 26, 2008, Response to NRC Letter Dated August 15, 2008, Related to External Flooding at Oconee Nuclear Station.

4. Oconee Nuclear Station Jocassee-Keowee Dam Breach Model Report from Duke Energy Carolinas, dated March 2009.

5. Jocassee Main Dam Design, Construction and Performance Report, dated April, 1987, G.F. Sowers, Hon. Member, ASCE.

6. Figures of Jocassee Dam (including the cross section of the dam showing the weak base Filled with concrete) provided by FERC.

7. 2004 Part 12 Inspection Report - Jocassee Pumped Storage Development dated December, 2004, provided by FERC.

8. NRC Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," dated August, 1977.

9. ANSI/ANS 2.8, "Determine Design Basis Flooding at Power Reactor Sites," dated July 28, 1992.

10. SRP Sections 2.4.1, "Hydrology Description," 2.4.2, "Floods," 2.4.3, "Probable Maximum Flood on Streams and Rivers," and 2.4.4, "Potential Dam Failures," dated March 2007.

ENCLOSURE 2

Path Forward in Addressing TVA's Hydrology Issues

TAC Nos.:	Last Update: January 19, 2011 Lead Division: DE Supporting Divisions: DORL Supporting Offices: NRO, RII

Historical Background:

On February 19-22, 2008, the NRC staff conducted an inspection at BLN. The purpose of the inspection was to verify that quality assurance processes and procedures were effectively implemented with regards to the Simulated Open Channel Hydraulics (SOCH) model for the BLN combined license application (COLA). The SOCH model was used to calculate the design basis flood presented in the BLN Safety Analysis Report Sections 2.4.3, Probable Maximum Flood on Streams and Rivers, and 2.4.4, Potential Dam Failures. The NRC inspectors reviewed the relevant quality assurance (QA) procedures for design control, software verification and validation, and QA records related to the SOCH model, and reviewed the 1998 Flood Reassessment for the Effects of Dam Safety Modifications calculation package. The verification and validation of the SOCH model, and all the design data inputs to the SOCH model, including the supporting FORTRAN programs, used as a basis for the BLN COLA were not available for review. Based on the results of this inspection, the NRC issued three violations of NRC requirements.

Starting in June 2008, the NRC staff conducted several calls with TVA to discuss the identified BLN non-compliances and the applicability of these concerns to operating units. The NRC staff expressed a concern that the significance of the BLN issues on the design basis had not been analyzed for the operating units, and requested a copy of their operability/functionality evaluation. On June 17, 2008, the licensee forwarded the original corrective action document [problem evaluation report (PER)] and a functionality assessment. The NRC staff identified that the licensee relied on the same QA controls that were not followed at BLN in support of establishing the acceptability of this condition on the operating units. As a result, the NRC staff remained concerned that the significance of this issue remained indeterminate. TVA notified the NRC staff that the V&V efforts on the SOCH code would not be complete until ~April 2009.

Subsequent opportunities have been provided to TVA to appropriately address the safety significance of the input and SOCH code errors identified by the NRC in February 2008. TVA has continually represented to the NRC, that the V&V efforts of both the SOCH code and the data for the Tennessee River's 46 watersheds were being conducted and completed as part of the Bellefonte Units 3 and 4 COLA review. Since then, TVA has submitted requests to reschedule the hydrology COLA review to as late as Fiscal Year 2010. The letter indicated that TVA has not been able to meet many of the milestones established in its plan to correct the problems identified in the inspection. As a result of TVA's request, the NRC suspended the hydrology COLA review for Section 2.4, *Hydrologic Description*. However, TVA has yet to provide an analysis which provides reasonable assurance that the operating units are within

their current design bases. The NRC staff is assessing whether the changes to the Tennessee Valley watersheds and operation of the associated dams and spillways has affected the original site flood protection measures for the operating units.

The Updated Final Safety Analysis Report (UFSAR) for each site states that the principal design criteria for each site was developed in consideration of the seventy General Design Criteria (GDC) for Nuclear Power Plant Construction Permits proposed by the Atomic Energy Commission (AEC) in a proposed rule-making published in 10 CFR 50 in the Federal Register of July 11, 1967. For SQN and WBN, the current GDC contained in Appendix A to 10 CFR 50 addresses the design bases, while BFN used the earlier AEC version. Regardless, the design criterion is essentially the same. The criterion requires systems and components of reactor facilities which are essential to the prevention of accidents which could affect public health and safety or to mitigation of their consequences to be designed, fabricated and erected to performance standards that will enable the facility to withstand, without loss of the capability to protect the public, the additional forces that might be imposed by natural phenomena such as earthquakes, tornadoes, flooding conditions, winds, ice, and other local site effects.

The NRC staff has identified that the data input and hydrology code (SOCH) does not accurately reflect the existing configuration and operation of the Tennessee River, and TVA has not provided sufficient information to demonstrate that the design basis for these facilities has been properly maintained. Therefore, the NRC staff seeks additional information from TVA to identify all errors in the code, the sites that are affected by those errors, and confirmation that existing flood mitigating measures are adequate to bound any errors identified to date with the current design basis data inputs and the SOCH code for all three operating facilities.

The NRC staff is assessing whether the changes to the Tennessee River watershed and operation of associated dams has adversely affected the original site flood protection measures for safety-related SSC, and important-to-safety components, on the operating units. In addition, the staff is concerned that: (1) the loss of design bases information prevents the licensee from accurately addressing the safety significance of errors in the SOCH Code; (2) the licensee is not within current design bases; and (3) the licensee has not maintained design bases [50.59(d)(1)].

Regulatory Basis:

The regulations that apply to the TVA hydrology issues include the following:

Pursuant to 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2 (or the Atomic Energy Commission (AEC) equivalent), nuclear power plant structures, systems and components (SSCs) important to safety be designed to withstand the effects of natural phenomena such as earthquake, tornado, hurricane, flood, tsunami, and seiche without loss of capability to perform their safety functions. The criterion further specifies that the design bases for these SSCs shall reflect the following:

A. Appropriate consideration of the most severe natural phenomena historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and time period in which the historical data have been accumulated;

B. Appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena; and

C. The importance of the safety functions to be performed.

Section 50.71(e) requires that the licensee shall update periodically, the final safety analysis report (FSAR) originally submitted as part of the application for the license, to assure that the information included in the report contains the latest information developed.

Originating Document:

The staff originally identified the TVA hydrology issues based on the Bellefonte Combined License Application – Nuclear Regulatory Commission Inspection of the Implementation of the Quality Assurance Program Governing the Simulated Open Channel Hydraulics Model, as documented in the Inspection Report Numbers 05200014/2008-001 and 05200015/2008-001 and Notice of Violation.

Scope of Project:

- To address the operability and safety concerns related to the hydrology issues at the TVA sites (Watts Bar, Sequoya, and Browns Ferry).

Outcome:

- The overall goal is for the staff to determine if there are any safety concerns related to the TVA hydrology issues and determine the correct vehicle to convey our concerns and obtain information from TVA regarding status of their corrective action programs at each of the sites.

Goals and Objectives:

1. Based on status of corrective actions taken by TVA for each of their sites, determine whether adequate and timely actions have been taken to address the hydrology issues and to ensure that there are no safety implications.
2. If it is determined that a need for additional information is needed, determine proper vehicle to use in obtaining the information (e.g., letter, audit, etc.)
3. Assess the proposed initiative and revise as necessary.

Roles and Responsibilities (Enclosure 2):

NRC Dam Safety Officer (George Wilson): Responsible for overseeing all activities associated with this project. Will ensure proper communications occurs within and between the groups to ensure an overall encompassing and all inclusive evaluation and assessment occurs. All dam-related work will be channeled through and concurred by the Dam Safety Officer.

Division of Engineering: Responsible for performing or reviewing all technical evaluations associated within the scope of this work. DE, with input and concurrence from the associated working groups, will also write the overall summary and conclusion report for the evaluation and assessment associated with TVA's hydrology issues.

Office of New Reactors: Responsible for providing insights on how the issue would be evaluated present day for new reactor licensing to DE regarding review of information submitted by TVA.

Region II: Responsible for providing operating plant input and assessment to DE regarding review of to DE regarding review of information submitted by TVA.

Division of Operating Reactor Licensing: Provide technical analysis and support related to regulatory framework and the plant's licensing basis. Serves as the point of contact with the licensee, including the following: coordinating meetings and calls and request for information/clarification.

Proposed Actions/Milestones:

Obtain inspection reports from the Resident Inspectors that address the PERs; request information regarding corrective action program and copies of all the PERs issued to date.	Complete
DE and DORL to review information to determine whether TVA's timeline for corrective actions for each plant is reasonable	Complete
Conduct meeting with RES, NRO, Region II, to determine TVA's actions/initiatives that are ongoing with regards to hydrology issues. Share NRR's assessment for the purpose of technical consistency and to ensure that duplicative efforts are not being done.	Complete
Conduct Conference Call with Regional BCs, TVA Plants, Gene Guthrie (Region II)	Complete
Identify any additional issues to be included in a letter to TVA. As needed, Region to submit TIA for HQ assistance for up to 6 months.	Complete
Conduct meeting with DORL and DE management to discuss the Region's concerns, and to agree on the text for a proposed letter to TVA identifying staff's concerns and requesting responses to questions as well as completion schedule for each plant.	Complete

Current Status:

The closure plan regarding the TVA hydrology issues was shared with all parties involved at a meeting that was conducted on July 16, 2009.

Schedule Changes Since Last Update: Milestone dates were updated on January 19, 2011.

Resource Expenditure:

FTE: 1.0 FTE

Contacts:

Name	Position	Phone No.
Pat Hiland/ Anne Boland/ Dave Skeen Joe Giitter/Allen Howe	SES Contacts	415-3298 415-1453
George Wilson	Dam Safety Officer	415-1711
Kamal Manoly	DE Contact	415-2765
Gene Guthrie	RII POC	404-562-4662
NRO	Richard Raione	415-7190
Meena Khanna	EMCB POC	415-2150
Raman Pichumani	EMCB POC	415-3621
Eva Brown	DORL POC	415-2315
Tom Boyce	DORL POC	415-0184

References:

1. Bellefonte Combined License Application – Nuclear Regulatory Commission Inspection of the Implementation of the Quality Assurance Program Governing the Simulated Open Channel Hydraulics Model - Inspection Report Numbers 05200014/2008-001 and 05200015/2008-001 and Notice of Violation
2. Meeting Summary from September 12, 2008 Meeting with TVA regarding TVA Hydrology Code.
3. Problem Evaluation Reports for Watts Bar, Sequoya, and Browns Ferry

ENCLOSURE 3

IN CONJUNCTION WITH THE INDEPENDENT ASSESSMENTS, THE STAFF WILL DETERMINE THE NEED AND PROCESSES TO RESOLVE GENERIC ISSUES

Process:

Evaluate issuance of Information Notice for dam failure frequency error.

Identify potential generic issues and needed external coordination for input to Generic Issues Process as an outcome of the Oconee and TVA reviews.

Roles and Responsibilities:

DRA will lead the effort associated with the Information Notice for dam failure frequency error.

DE will lead the effort in filling out the form and contacting RES to determine entry to the GIP. (Complete)

Proposed Actions/Milestones:

Incorporate potential external flood sources in existing USI/GSI programs.	TBD
Develop Generic Communication	TBD

Current Known Generic Issues:

1. RESOLVE DAM FAILURE FREQUENCY

Background: In its review of the Oconee issue, NRC staff identified an error in dam failure frequency estimates used by Duke. It is likely that this error has been propagated into subsequent technical studies performed by other operating reactors and by the NRC staff. The implications of this error are not yet clear. Duke disagrees that their dam failure frequency estimates are in error.

Purpose: Assess impact of dam failure frequency estimate error on other NRC studies and actions.
Communicate dam failure frequency estimate error to other licensees via Information Notice.

Responsibility: DRA responsible for all activities associated with dam failure frequency estimate error.

Proposed Actions/Milestones: [DRA TO PROVIDE ADDITIONAL DETAILS]

Define relative risk reduction of various modifications compared to addressing external flooding	TBD
Assess studies using IPEEE information Address what the implications to other plants that are down-stream of dams, generically. As a generic issue, RES will have a role in its resolution.	TBD

Other generic issues will be added, as necessary.