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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 19, 2013

MEMORANDUM TO: File

FROM: John P. Boska, Senior Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

SUBJECT: OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3, DOCUMENTATION OF STAFF DECISION REGARDING IMPLEMENTATION OF PERMANENT MODIFICATIONS FOR PROTECTION FROM EXTERNAL FLOODING

The purpose of this memorandum is to document a staff decision regarding the length of time given to the licensee, Duke Energy Carolinas, LLC, to complete permanent plant modifications at Oconee Nuclear Station to demonstrate protection from external flooding caused by a failure of the Jocassee Dam. The Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-504, "Integrated Risk-Informed Decision-Making Process for Emergent Issues," provided guidance for this process.

The NRR staff concluded that the licensee should be permitted to follow the U.S. Nuclear Regulatory Commission's process for external flooding using the Fukushima lessons-learned process, with a somewhat accelerated time schedule which would result in the implementation of the permanent plant modifications by the end of 2016. The staff's evaluation is in the enclosure.

Docket Nos. 50-269, 50-270, and 50-287

Enclosure:
As stated

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LIC-504 ASSESSMENT, INTEGRATED RISK-INFORMED DECISION MAKING PROCESS FOR EMERGENT ISSUES REGARDING EXTERNAL FLOODING RESULTING FROM DAM FAILURE

DUKE ENERGY CAROLINAS, LLC

OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3

DOCKET NOS. 50-269, 50-270, AND 50-287

1.0 ISSUE SUMMARY

1.1 Background

The Oconee Nuclear Station (ONS) is located on Lake Keowee in western South Carolina, approximately 8 miles northeast of Seneca, South Carolina. The ONS licensee, Duke Energy Carolinas, LLC (Duke or the licensee), owns Lake Keowee, which occupies the area immediately north and west of the site. Duke also owns Lake Jocassee, which lies approximately 11 miles upstream. Duke constructed the Jocassee Dam and the Keowee Dam on the Keowee River to provide hydroelectric power and to provide cooling water for ONS. Both dams have hydroelectric generators, and the Jocassee hydro units can provide pumped storage when electricity demand is low by reversing the direction of water flow. The Federal Energy Regulatory Commission (FERC) licenses both dams. The Jocassee Dam was completed in 1967. It is 385 ft high above the deepest point of its foundation and is an earth-rockfill structure. A catastrophic failure of the Jocassee Dam would flood the ONS site and result in reactor trips, loss of all AC power, and loss of cooling for decay heat removal. The licensee has proceduralized recovery actions for this event. The licensee has stated that the three reactor containment buildings would remain intact during the initial flooding.

While reviewing an inspection finding during 2007, the NRC staff determined that Duke's assumed failure rate for earthen dams was too low. The staff's recalculation increased the dam failure frequency by approximately an order of magnitude. Since a dam failure could jeopardize the safety of the Standby Shutdown Facility (SSF) at the Oconee site, in August 2008 the NRC issued a 10 CFR 50.54(f) letter (Reference [Ref.] 1) requesting that Duke describe the bounding flood hazard and the effect it would have on the plant. The SSF has some flood protection, but it is insufficient to give credit for maintaining safe shutdown during a large dam failure. In response to the NRC's request, the licensee performed a new inundation study and proposed interim compensatory measures (ICMs) to reduce the probability of dam failure and provide a method of decay heat removal while plant modifications were developed. The NRC affirmed the ICMs in a confirmatory action letter (CAL) issued in June 2010 (Ref. 2). The NRC staff accepted the new inundation study in a safety evaluation issued in January 2011 (Ref. 3). The ground elevation at the SSF is 796.0 feet above mean sea level (msl). The SSF flood protection extends to 7.5 feet above the ground elevation. The predicted water height at the SSF in the new inundation study

was 815.0 feet above msl, 11.5 feet higher than the flood protection for the SSF. The licensee is developing permanent plant modifications in accordance with the CAL, and so far has installed one permanent flood structure, a swale wall near the visitor's center, and one temporary flood structure, a wall at the intake dike.

1.2 Licensing and Regulatory Basis

During initial licensing, the Atomic Energy Commission accepted the licensee's position that the Jocassee Dam was constructed using sound civil engineering methods and to the same seismic standards as the plant, and that the probability of dam failure was very low. Therefore, the licensee did not have to demonstrate protection for a failure of the Jocassee Dam.

In 1991, the NRC asked all power reactor licensees to provide additional information on external events through the issuance of Generic Letter 88-20, Supplement 4, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities." Oconee submitted the information in 1995. Oconee's conclusion on dam failures was that the core damage frequency (CDF) was too low, at 7E-06/year, to require any further action. The low CDF was primarily due to the low failure frequency the licensee determined was applicable to the Jocassee Dam. In 2000, the NRC issued a review (Ref. 4) of the Oconee IPEEE report and did not identify any safety concerns related to external flooding.

The following information is from the Oconee Updated Final Safety Analysis Report (UFSAR, Ref. 5):

1. There is a statement on external flood protection in UFSAR Section 3.1.2, Design Criterion 2, which states:

> 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 for the most severe of these natural phenomena that have been recorded for the site and the surrounding areas 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.

The licensee's position is that the initial design and licensing bases did not require consideration of a failure of the Jocassee Dam.

2. UFSAR Section 2.4.4 on seismically induced dam failures states:

> Duke has designed the Keowee Dam, Little River Dam, Jocassee Dam, Intake Canal Dike, and the Intake Canal Submerged Weir based on sound Civil Engineering methods and criteria. These designs have been reviewed by a board of consultants and reviewed and approved by the Federal Power Commission in

accordance with the license issued by that agency. The Keowee Dam, Little River Dam, Jocassee Dam, Intake Canal Dike, and the Intake Canal Submerged Weir have also been designed to have an adequate factor of safety under the same conditions of seismic loading as used for design of Oconee. The construction, maintenance, and inspection of the dams are consistent with their functions as major hydro projects. The safety of such structures is the major objective of Duke's designers and builders, with or without the presence of the nuclear station.

3. UFSAR Section 3.4.1.1, "Flood Protection Measures for Seismic Class 1 Structures" states:

> The plant yard elevation is 796.0 ft. msl [above mean sea level]. All of the man-made dikes and dams forming the Keowee Reservoir rise to an elevation of 815.0 ft. msl with a full pond elevation of 800.0 ft. msl. See Section 2.4.2.2 for exceptions to the elevation of 815.0 ft. However, Class 1 structures and components are not subject to flooding since the Probable Maximum Flood (PMF) would be contained by the Keowee Reservoir. The minimum external access elevation for the Auxiliary, Turbine, and Service Buildings is 796.5 ft. msl which provides a 6 inch water sill. Also, the plant site is provided with a surface water drainage system that protects the plants facilities from local precipitation.

This section has no mention of possible flooding from dam failures.

4. UFSAR Section 9.6.3.1 on the Standby Shutdown Facility (SSF) flood design states:

> Flood studies show that Lake Keowee and Jocassee are designed with adequate margins to contain and control floods. The first is a general flooding of the rivers and reservoirs in the area due to a rainfall in excess of the Probable Maximum Precipitation (PMP). The FSAR addresses Oconee's location as on a ridgeline 100' above maximum known floods. Therefore, external flooding due to rainfall affecting rivers and reservoirs is not a problem. The SSF is within the site boundary and, therefore, is not subject to flooding from lake waters.
>
> The grade level entrance of the SSF is 797.0 feet above msl. In the event of flooding due to a break in the non-seismic condenser circulating water (CCW) system piping located in the Turbine Building, the maximum expected water level within the site boundary is 796.5 ft. Since the maximum expected water level is below the elevation of the grade level entrance to the SSF, the structure will not be flooded by such an incident.
>
> The SSF will stabilize the plant at mode 3 with an average Reactor Coolant temperature ≥ 525 °F. <u>As a PRA enhancement the SSF is provided with a five foot external flood wall which is equipped with a water tight door near the south entrance of the SSF</u>. A stairway over the wall provides access to the north entrance. The yard elevation at both the north and the south entrance to the SSF is 796.0 feet above mean sea level (msl). Based on the as-built configuration of the 5' flood wall provided at the north entrance and a flood wall at the south entrance to the SSF, SSF external flood protection is provided for flooding that does not exceed 801 feet above mean sea level.

There are some things to note about this section of the UFSAR. The first is that the reference to the site's location on a ridgeline located 100 feet above maximum known floods describes the site prior to flooding the valley to create Lake Keowee. The meaning was that the historical records of floods at the site was not useful, since with an unflooded valley the historical floods never got close to the site. (Refer to Section 2.4 of the UFSAR). Although the SSF flood wall has been extended to 7.5 feet above ground level, that is not described in the UFSAR.

In 2011, Duke stated that they plan to incorporate external flooding resulting from a postulated Jocassee Dam failure into the Oconee licensing basis (Ref. 12).

The NRC staff has not found that the licensee is in violation of any NRC regulations on external flooding. However, the NRC staff believes that a case could be made for a backfit exception using a documented evaluation under 10 CFR 50.109. Because the licensee has been cooperative in working at improving the site protection from external flooding, the staff has not seen the need to issue a backfit evaluation, which would provide the basis for a safety order to the licensee. Based on the licensee's commitments, Region II issued a CAL in June 2010 (Ref. 2), which remains the major regulatory basis for the licensee's actions. Following the Fukushima nuclear reactor accident, the NRC staff also issued a request for information (Ref. 6) to all commercial power reactor licensees, which included additional walkdowns and evaluations of flooding vulnerabilities. Duke has been complying with this request for information.

1.3 Previous NRC Evaluations

The NRC staff has previously prepared evaluations that accepted certain timelines for the installation of permanent modifications to protect against external flooding from dam failure at Oconee. The first was issued August 12, 2009 (Ref. 7), and justified continued operation of the Oconee units through November 2010. At the time, the licensee had not fully implemented the ICMs, and the assumption was that a catastrophic failure of the Jocassee Dam would result in core damage and, after a period of time, the failure of the reactor containment buildings. The second evaluation was issued March 5, 2011 (Ref. 8, the memo itself has an incorrect date), and justified continued operation of the Oconee units to November 30, 2011. The primary basis for extending the date was the new ICMs implemented by the licensee, which had been inspected by the NRC staff, and provided a method of maintaining the reactors in a safe shutdown condition following a flooding event. In the second evaluation it was also stated that:

> Further, the staff's conclusion, as documented in the August 12, 2009, memo, that short-term operation of the Oconee units is acceptable, which was based principally on risk consideration, is still valid. Specifically, the conditional CDF and conditional LERF for the external flooding of the Oconee units are substantially below the conditional CDF and conditional LERF guidelines of 10^{-3}/yr and 10^{-4}/year, respectively that are noted in LIC-504, "Integrated Risk-Informed Decision-Making Process for Emergent Issues, Rev. 3, April 12, 2010.

1.4 Current Status

Prior to the CAL, the licensee had no particular ICMs or procedures in place for external flooding.

Now the licensee has diesel driven pumps located out of the flood zone which would be moved into place, and could add water to the steam generators after the steam generator pressure was reduced by opening the manual atmospheric dump valves. This would allow for decay heat removal. The licensee has calculated that there is about a two hour interval from the failure of the Jocassee Dam, to when the water reaches ONS. The Jocassee Dam is continuously manned and also has remote instrumentation that feeds the Duke Hydro center in a separate location. The hydro operators are trained to contact ONS as soon as they recognize indications of impending dam failure. The licensee expects to have about a two hour interval to trip the reactors and line up the alternate feedwater to the steam generators.

2.0 OPTIONS CONSIDERED

The following options were considered by the staff:

Option	Description
1	Allow the licensee additional time to complete the permanent modifications for external flooding, until the end of 2016.
(b)(5)	

3.0 EVALUATION AND ASSESSMENT OF OPTIONS

3.1 Option 1

Option 1 was developed in consideration of the Fukushima lessons-learned process. The licensee is already in the process of responding to the request for information, issued by the NRC in Ref. 6. On November 27, 2012, Duke submitted the flooding walkdown report for ONS. Duke reports that they are planning to submit the flooding hazard evaluation by March 12, 2013, and the flooding integrated assessment before the end of 2013 (although the standard NRC timeline has the integrated assessment due two years after the flooding hazard evaluation, so the Oconee timeline is accelerated compared to the standard timeline). Duke had previously committed to a timeline for implementing permanent modifications of 30 months plus the regulatory review period following the NRC's approval of the design standards for the flood walls (Ref. 9). The Federal Energy Regulatory Commission (FERC) licenses the Jocassee Dam and the Keowee Dam, along with other flood control structures at the site. Any changes made to these structures will require prior review and approval by both FERC and the NRC, which is referred to as the regulatory review period. Assuming a maximum of 12 months for the regulatory review period, then 3 ½ years (42 months) following the NRC's approval of the design standards in September 2012 places the end date at about April 2016. It is likely that NRC reviews of the reports submitted in response to the Fukushima request for information may generate additional discussions with the licensee which may lead to revisions in the configuration and design of flood control structures, which may further delay the process. Therefore, the staff selected Option 1 as extending through the end of 2016, which would allow the licensee to substantially follow the Fukushima lessons-learned process, along with all the other power reactor licensees, some of which also are addressing NRC concerns on external flooding.

(b)(5)

4.0 FINAL DECISION

The staff considered the risk guidance as stated in LIC-504, "Integrated Risk-Informed Decision-Making Process for Emergent Issues, Rev. 3, April 12, 2010. LIC-504 discusses CDF of 10^{-3}/year and large early release frequency (LERF) of 10^{-4}/year as guidelines for considering immediate plant shutdown. In 2010, the NRC staff issued a calculation of the failure rate for large rockfill dams, which might be considered as similar to Jocassee Dam (Ref. 10), although it is noted that the NRC staff had performed similar calculations in 2007 and 2008 in support of the 10 CFR 50.54(f) letter issued in 2008 (Ref. 1). The mean value of the failure rate was calculated to be 2.8×10^{-4}/dam-year. Duke had challenged some of the staff's assumptions for this calculation in a letter dated September 26, 2008 (Ref.11). Duke's primary concern was that the NRC staff was including dam failures in the staff's calculations that Duke argued were not representative of the Jocassee Dam. The staff notes that, as stated above, the Jocassee Dam is periodically inspected, continuously manned, and instrumented.

Although the NRC staff has not calculated a CDF based on dam failure which accounts for the ICMs the licensee has in place, the CDF must be less than the frequency of the initiating event. Therefore, the CDF for the failure of the Jocassee dam does not exceed the value of 10^{-3}/year used as a guideline in LIC-504. The NRC staff has also not calculated a LERF for the failure of the Jocassee dam. However, it is not possible to have a large early release without significant core damage, so the LERF is always less than the CDF.

In evaluating defense-in-depth, the NRC staff notes that Duke has significant amounts of B.5.b-type equipment, used to respond to beyond design basis events, either onsite or within a several hour radius that can be brought to the site and used to provide injection water to the steam generators or the reactor coolant system, or cooling for the reactor containment buildings. The NRC staff recognizes that there is some probability that the ICMs and the B.5.b equipment would not mitigate the event, but in the judgment of the staff, that probability, with consideration of the probability of the initiating event, does not warrant an immediate plant shutdown.

In a meeting of the NRR executive team (ET) on August 29, 2012, the ET was briefed on the staff's recommendation to permit the licensee to respond to the concerns on external flooding by following the Fukushima lessons-learned process, which was initiated by the NRC's 10 CFR 50.54(f) letter dated March 12, 2012 (Ref. 6), providing that the plant modifications were completed before the end of 2016. This is Option 1 as stated above. The NRR ET agreed with the staff's recommendation. On September 20, 2012, the staff issued a letter to the licensee (Ref. 13) stating that the structures the licensee had proposed to mitigate external floods could be designed and constructed in accordance with FERC-accepted codes and standards, and that the licensee could follow the Fukushima lesson-learned process but with accelerations to the process which would result in the completion of plant modifications by about June 2016.

This completes the documentation of the staff's decision.

5.0 REFERENCES

1. Letter from Joseph Giitter, NRC, to Dave Baxter, Duke, "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, and 3, (TAC Nos. MD8224, MD8225, and MD8226)," August 15, 2008, ADAMS Accession No. ML081640244.

2. Letter from Luis Reyes, NRC, to David Baxter, Duke, Confirmatory Action Letter - Oconee Nuclear Station, Units 1, 2, and 3, "Commitments To Address External Flooding Concerns (TAC Nos. ME3065, ME3066, and ME3067)," June 22, 2010, ADAMS Accession No. ML101730329.

3. Letter from John Grobe, NRC, to Preston Gillespie, Duke, "Staff Assessment of Duke's Response to Confirmatory Action Letter Regarding Duke's Commitments to Address External Flooding Concerns at the Oconee Nuclear Station, Units 1, 2, and 3 (ONS) (TAC Nos. ME3065, ME3066, and ME3067)," January 28, 2011, ADAMS Accession No. ML110280153.

4. Letter from David LaBarge, NRC, to W.R. McCollum, Duke, Oconee Nuclear Station, Units 1, 2, and 3, Re: Review of Individual Plant Examination of External Events (TAC Nos. M83649, M83650, and M83651)," March 15, 2000, ADAMS Accession No. ML003694349.

5. Duke Energy Carolinas, LLC, Oconee Updated Final Safety Analysis Report, Revision 21, June 29, 2012, ADAMS Accession No. ML121930543.

6. Letter from Eric Leeds, NRC, and Michael Johnson, NRC, to all power reactor licensees, "Request For Information Pursuant To Title 10 Of The Code Of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, Of The Near-Term Task Force Review of Insights From The Fukushima Dai-Ichi Accident," March 12, 2012, ADAMS Accession No. ML12053A340.

7. Memo from Mark Cunningham, Patrick Hiland, and Joseph Giitter, NRC, to Bruce Boger, Victor McCree, and Michele Evans, NRC, "Technical Basis for Allowing Oconee Nuclear Station To Remain In Operation Through November 2010," August 12, 2009, ADAMS Accession No. ML090570117.

8. Memo from Patrick Hiland and Joseph Giitter, NRC, to John Grobe, Bruce Boger, and Leonard Wert, NRC, "Technical Basis For The Timeline To Resolve External Flooding Issues At Oconee," March 5, 2011, ADAMS Accession No. ML103410042.

9. Letter from Preston Gillespie, Duke, to USNRC, "Response to Requests for Additional Information Regarding Necessary Modifications to Enhance the Capability of the ONS Site to Withstand the Postulated Failure of the Jocassee Dam," October 17, 2011, ADAMS Accession No. ML11294A341.

10. Memo from Jeffrey Mitman, NRC, to Mark Cunningham, NRC, "Generic Failure Rate Evaluation for the Jocassee Dam," April 14, 2010, ADAMS Accession Nos. ML100760109 and ML100780084).

11. Letter from Dave Baxter, Duke, to USNRC, "Response to 10 CFR 50.54(f) Request," September 26, 2008, ADAMS Accession No. ML082750106.

12. Letter from Preston Gillespie, Duke, to USNRC, "Response to Requests for Additional Information Regarding Necessary Modifications to Enhance the Capability of the ONS Site to Withstand the Postulated Failure of the Jocassee Dam," October 17, 2011, ADAMS Accession No. ML11294A341.

13. Letter from Michele Evans, NRC, to Preston Gillespie, Duke, "Oconee Nuclear Station, Units 1, 2, and 3 – Modifications To Address External Flooding Hazards (TAC Nos. ME7970, ME7971, and ME7972)

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ADAMS Accession No. ML13063A110 *** Via email**

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