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ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

10 CFR 50.54(f)

Duke Energy Carolinas, LLC (Duke Energy)
Oconee Nuclear Station, Units 1, 2 and 3
Docket Numbers 50-269, 50-270, 50-287
Renewed License Numbers DPR-38, DPR-47, and DPR-55

Subject: Supplement 1 to ONS Response to Request for Additional Information Regarding Fukushima Flood Hazard Reanalysis Report (Questions 1c and 14)

References:

1. NRC Letter, *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*, dated March 12, 2012, (ADAMS Accession No. ML12053A340)
2. Duke Energy Letter, *Flood Hazard Reevaluation Report in response to NRC letter, "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,"* dated March 12, 2013
3. NRC Letter, Oconee Nuclear Station, Units 1, 2, and 3, Request for Additional Information Regarding Fukushima Lessons Learned Flood Hazard Reevalution Report (TAC Nos. MF1012, MF1013, AND MF1014), dated March 20, 2014, (ADAMS Accession No. MLML14064A591)
4. Duke Energy Letter, *ONS Response to Request for Additional Information Regarding Fukushima Flood Hazard Reanalysis Report,* dated April 25, 2014

Ladies and Gentlemen,

Oconee Nuclear Station (ONS) submitted its Flood Hazard Reevaluation Report (HRR) (Reference 2) to the NRC on March 12, 2013 pursuant to the NRC's 10 CFR 50.54(f) letter (Reference 1).

By letter dated March 20, 2014 (Reference 3), the NRC submitted a request for additional information (RAI) regarding the Flood HRR consisting of 15 questions. By letter dated April 25, 2014 (Reference 4), Duke Energy provided a response to RAIs 2 - 13 and 15, and a plan for the balance of the RAIs (RAIs 1 and 14).

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The response to RAIs 1 and 14 requires Duke Energy to engage seismic, geological and hydrological expertise for support. Due to the current demand for these experts, a delayed response was required for these RAIs. In accordance with the plan provided in Reference 4, Enclosure 1 to this letter provides a response to RAI 1c and RAI 14.

This letter does not create or revise any Regulatory Commitments.

Should you have any questions concerning this letter, or require additional information, please contact David Haile at (864) 873-4742.

I declare under penalty of perjury that the foregoing is true and correct. Executed on June 13, 2014.

Sincerely,

Scott L. Batson
Vice President
Oconee Nuclear Station

Enclosure

1. Duke Energy Response to RAIs 1c and 14, Oconee Nuclear Station Units 1, 2, and 3, Regarding Fukushima Flood Hazard Reevaluation Report (HRR)

cc:
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Enclosure 1

Duke Energy Response to RAIs 1c and 14, Oconee Nuclear Station Units 1, 2, and 3 Regarding Fukushima Flood Hazard Reevaluation Report (HRR)

Background

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a "Request for Information pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 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" (ADAMS Accession No. ML 12053A340) to all power reactor licensees. By letter dated March 12, 2013, Duke Energy submitted the "Oconee Flood Hazard Reevaluation Report," (FHRR) (ADAMS Accession No. ML 13079A227), for the Oconee Nuclear Station (ONS), Units 1, 2, and 3.

The NRC staff has determined that it needs additional information in order to complete its review and has submitted 15 questions (RAIs) to Duke energy. The responses to RAIs 2 - 13, and 15 were provided by letter dated April 25, 2014. Response RAIs 1 and 14 required Duke Energy to engage seismic, geological and hydrological expertise for support. Due to the current demand for these experts, a delayed response was required. Duke Energy plans to provide responses to RAIs 1a and 1b by November 7, 2014. The following response addresses RAIs 1c and 14.

Responses to RAIs 1c and 14

RAI-1: Seismic Dam Performance

Background and Discussion

The March 12, 2012, 50.54(f) letter requests that licensees reevaluate flooding hazards using present-day guidance and methodologies applicable to new reactors. For flooding hazards, the 50.54(f) letter indicates that NUREG/CR-7046, "Design Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America," documents present-day methodologies used by the NRC to review early site permit and combined license applications. Consistent with ANSI-ANS-2.8 (1992), NUREG/CR-7046, Appendix H defines the following load combinations for evaluation of floods caused by seismic dam failures:

Alternative 1 - Combination of:

- *A 25-year flood*
- *A flood caused by dam failure resulting from a safe shutdown earthquake (SSE), and coincident with the peak of the 25-year flood*
- *Waves induced by 2-year wind speed applied along the critical direction.*

Alternative 2 - Combination of:

- *The lesser of one-half of the probable maximum flood (PMF) or the 500-year flood*
- *A flood caused by dam failure resulting from an operating basis earthquake (OBE), and coincident with the peak of the flood selected above*
- *Waves induced by 2-year wind speed applied along the critical direction.*

Present-day NRC requirements and guidance with respect to characterizing seismic hazards use a probabilistic approach in order to develop a risk-informed, performance-based ground motion response spectrum (GMRS) for a site. This approach is described in Regulatory Guide (RG) 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion." The GMRS represents the first part of the development of the SSE for a site as a characterization of the regional and local seismic hazard. The steps necessary to develop the final SSE are described in Chapter 3, "Design of Structures, Components, Equipment, and Systems," of NUREG-0800, "Standard Review Plan." The OBE is not defined in Regulatory Guide 1.208, but is typically taken as one-half the SSE when used as a design input.

Recognizing that development of a GMRS is a resource intensive effort, supplemental guidance was developed by NRC staff to support the evaluation of dam failures as part of the NTTF R2.1 flood hazard reevaluations. This supplemental guidance is contained in JLD-ISG-2013-01, "Interim Staff Guidance for Estimating Flooding Hazards due to Dam Failure." JLD-ISG-2013-01 provides some "relief" with respect to definition of the dam-specific GMRS and specifies the following load combinations for evaluation of floods caused by seismic dam failures:

- *Ground motion corresponding to 10^{-4} annual frequency of exceedance combined with a 25-year flood*
- *Ground motion corresponding to half of the 10^{-4} ground motion combined with a 500-year flood.*

In the above combinations, the 10-4 ground motion is defined using data and software tools available from the U.S. Geological Survey rather than being developed using the methods of RG 1.208. When using tools from USGS, it is still necessary to account for site effects when defining the site-specific seismic hazard. The final version of JLD-ISG-2013-01 was issued in July 2013, which was after a subset of licensees (including Oconee Nuclear Station) submitted their flood hazard reevaluation reports in March 2013. However, ONS may, at its discretion, exercise the option to define the seismic hazard at the site using USGS 2008 software and tools rather than developing a site-specific hazard using the methodologies of RG 1.208 in responding to this request for additional information.

In its flood hazard reevaluation report (FHRR), Duke Energy summarized an evaluation of the seismic performance of Jocassee Dam using a deterministic assessment that demonstrated factors of safety ranging from 1.13 to 1.24 based on an "earthquake acceleration of 0.12g horizontal at the base on the dam" for three loading scenarios. Duke Energy also summarized a fragility study performed of the dam in which the fragility of the dam is represented as "the median peak ground acceleration of a scaled uniform hazard motion, which represents the median hard rock hazard motion of the ONS site as given in the 1989 EPRI uniform hazard study." The fragility of the dam was characterized by the fragility of the downstream embankment slope. The cover letter for the fragility study indicates that "[i]f the Oconee seismic hazard is revised in the future, the seismic fragility of Jocassee Dam must be reassessed."

In light of the above discussion, the licensee is requested to provide the following:

<u>Requested information-1a: Evaluation of seismic hazard for Jocassee Dam</u>
To be addressed in a later submittal

<u>Requested information-1b: Seismic Dam Performance</u>
To be addressed in a later submittal

<u>Requested information-1c: Use of existing analyses</u>

Considering the existing evaluations described in the licensee's FHRR to demonstrate seismic performance of the dam and its appurtenances, the licensee is requested to provide the following information:

a) *An explanation of the consistency of existing evaluations with present-day guidance and methods as well as current data.*

b) *A comparison of the seismic hazard characterization defined in response to item (1) with the seismic hazard characterization utilized in existing studies.*

c) *An evaluation of the effects of the seismic hazard characterization defined in response to item (1) on the factors of safety that are identified in Section 2.3.2 of the ONS FHRR.*

d) *Evaluation of the implications of changes in spectral shape and amplitude on the results of the fragility studies summarized in Section 2.3.2 of the FHRR and described in the Jocassee fragility study, particularly in light of the statement contained in the fragility study that*

indicates "[i]f the Oconee seismic hazard is revised in the future, the seismic fragility of Jocassee Dam must be reassessed."

e) *Explanation of the comprehensiveness of failure modes (for dam and appurtenances) considered in assessment of dam performance.*

f) *Demonstration that the seismic fragility evaluation accounts for the contribution of all relevant seismic failure modes to the composite/aggregate seismic fragility of the dam and its appurtenances.*

Note: Item b) and c) above make reference to "item (1)", this is appears to be a formatting error and is assumed to be actually referring to item a) in the list

Response to RAI 1c

General response:
The FHRR was based on a seismic evaluation of Jocassee dam using current FERC seismic requirements, and a 2007 updated fragility analysis with seismic inputs based on the 1989 EPRI uniform hazard study. Subsequent evaluations consisted of qualitative fragility assessments performed relative to the 2007 USGS UHS, and the 2013/2014 Oconee site specific GMRS supplied by EPRI as part of NTTF 2.1. The qualitative assessment concluded that a Jocassee specific fragility evaluation would likely produce similar results to that obtained from the 2007 updated fragility analysis. However, due to the qualitative nature of these subsequent assessments, Duke has opted to calculate a seismic hazard specific to the Jocassee site (ref. RAI 1a) and evaluate seismic dam performance for this hazard (ref. RAI 1b). Duke will also update the seismic fragility for Jocassee as part of the overall NTTF 2.1 seismic response for Oconee (to support the June 30, 2017 submittal).

The performance of the upcoming Jocassee site seismic evaluations will supersede answers that could currently be provided to subpart a, b, c, d, & f of RAI 1c. The answer to subpart e is not affected by the evaluations and is provided below.

Considering the existing evaluations described in the licensee's FHRR to demonstrate seismic performance of the dam and its appurtenances, the licensee is requested to provide the following information:

a) An explanation of the consistency of existing evaluations with present-day guidance and methods as well as current data.

   See General Response above

b) A comparison of the seismic hazard characterization defined in response to item (1) with the seismic hazard characterization utilized in existing studies.

   See General Response above

c) An evaluation of the effects of the seismic hazard characterization defined in response to item (1) on the factors of safety that are identified in Section 2.3.2 of the ONS FHRR.

   See General Response above

d) Evaluation of the implications of changes in spectral shape and amplitude on the results of the fragility studies summarized in Section 2.3.2 of the FHRR and described in the Jocassee fragility study, particularly in light of the statement contained in the fragility study that indicates "[i]f the Oconee seismic hazard is revised in the future, the seismic fragility of Jocassee Dam must be reassessed."

   See General Response above

e) Explanation of the comprehensiveness of failure modes (for dam and appurtenances) considered in assessment of dam performance.

A comprehensive potential failure modes analysis (PFMA) report has been performed and is required by the regulator of the dam. This PFMA report can be found as Attachment I to the document titled "Jocassee Development: FERC No. 2503-02 Supporting Technical Information Revision No. 1" dated 2009. This report is available for NRC viewing on the Electronic Reading Room (ERR) website. The document is titled 2009 STI_Jocassee Dam.pdf on the ERR website. The comprehensiveness of failure modes considered in assessment of dam performance is in full compliance with the regulator's, FERC, expectations and requirements.

f) Demonstration that the seismic fragility evaluation accounts for the contribution of all relevant seismic failure modes to the composite/aggregate seismic fragility of the dam and its appurtenances.

See General Response above

RAI-14: Hazard input to the integrated assessment: Flood event duration parameters

Background:
The March 12, 2012, 50.54(f) letter, Enclosure 2, requests the licensee to perform an integrated assessment of the plant's response to the reevaluated hazard if the reevaluated flood hazard is not bounded by the current design basis. Flood scenario parameters from the flood hazard reevaluation serve as the input to the integrated assessment. To support efficient and effective evaluations under the integrated assessment, the NRC staff will review flood scenario parameters as part of the flood hazard reevaluation and document results of the review as part of the staff assessment of the flood hazard reevaluation. The licensee has provided reevaluated flood hazards at the site including local intense precipitation flooding, probable maximum flooding on contributing watershed, flooding in streams and rivers, and flooding from breach of dams. The local intense precipitation flooding is reported to exceed the current licensing basis and subsequently the licensee has committed to perform integrated assessment.

Request:
The licensee is requested to provide the applicable flood event duration parameters (see definition and Figure 6 of the Guidance for Performing an Integrated Assessment, JLDISG-2012-05) associated with mechanisms that trigger an integrated assessment using the results of the flood hazard reevaluation. This includes (as applicable):

1) the warning time the site will have to prepare for the event (e.g., the time between notification of an impending flood event and arrival of floodwaters on site) and*

2) the period of time the site is inundated for the mechanisms that are not bounded by the current design basis.*

The licensee is also requested to provide:
3) the basis or source of information for the flood event duration,*

4) which may include a description of relevant forecasting methods (e.g., products from local, regional, or national weather forecasting centers) and/or timing information derived from the hazard analysis.*

*(* Item numbers added for clarity)*

Response to RAI 14

RAI-14 is requesting flood event duration parameters including duration from the FHRR to define key inputs to the Integrated Assessment (IA). Oconee has two external flooding events included in the FHRR that will be addressed in the IA. Below are the requested parameters for each of the external flooding hazards:

Upstream Dam Failure (Sunny Day failure) Flood Duration Parameters

1. **The warning time the site will have to prepare for the event:**
   Based on the HEC-RAS model there will be 14.75 hours of warning time available for a Sunny Day failure at the Jocassee dam. The failure precursors would be recognized well in advance, due to an aggressive monitoring program for the dam. A minimum of 12 hours warning time accounts for the time from detection of emergence of the piping through the dam, until the eventual piping collapse occurs. An additional 2.75 hours accounts for travel time to the site, resulting in a total warning time of 14.75 hours.

2. **The period of time the site is inundated:**
   The period of time that the flood impacts the site is 6.6 hours as defined by the time Keowee dam is overtopped, until the floodwaters recede below the turbine building drain invert. The site grade at a nominal elevation of 796 ft msl is not inundated by floodwaters from an upstream dam failure.

3. **The basis or source of information for the flood event duration:**
   The duration was derived from the hydrograph for the breach and the HEC-RAS model that routes the flood waters to the site and beyond.

4. **Relevant forecasting methods:**
   FERC and NRC requirements for upstream dam monitoring include video camera monitoring of the dam/abutments and at seepage leak off points, forebay and tailrace alarms, 24 hour staffing at Jocassee and at Hydro Central, inspections performed immediately after receiving 2 inches or more rainfall, inspections following any felt seismic event, and weekly dam safety inspections. Monitoring and site notifications are included in Duke Energy Hydro and Oconee Nuclear Station procedures.

Local Intense Precipitation Flood Duration Parameters

1. **The warning time the site will have to prepare for the event:**
   A major storm, capable of producing 18.95 inches of rain for the maximum 1 hour period, must carry an amount of atmospheric moisture such that they can be reliably forecast at least 24 hours in advance of the storm's arrival. The storm types that can carry this amount of moisture include; Tropical Cyclones, Synoptic Storms, and Mesoscale Convective Complexes. Due to Oconee's location, where orographic lift is not present, isolated thunderstorms are not capable of sufficient rainfall amounts to create a Local Intense Precipitation (LIP) event

2. **The period of time the site is inundated:**
   For a 72 hour duration rainfall event modeled using a two-thirds loaded distribution, analysis indicates that water accumulation will start developing in and around the power block early in the event. Water levels are projected to decline to nominal levels within 1 hour after the rainfall has subsided.

3. **The basis or source of information for the flood event duration:**
   The 72 hour event was based on the event that produced the most conservative precipitation for the site drainage basin, and the most conservative temporal distribution based on the results of the runoff model.

4. **Relevant forecasting methods;**
   The forecasting for the LIP magnitude storms is based on using the National Weather Service (NWS) Quantitative Precipitation Forecasts (QPF's) for medium range forecast and Probabilistic Quantitative Precipitation Forecasts (PQPF's) for short range forecast.

   Six inches of rainfall in 24 hours is considered an extreme rainfall event with a return rate of less than 1 in 1000 years for the basin where Oconee is located. This rainfall is used as a monitoring threshold for medium range (3 to 7 day) QPF forecasts. If the threshold is met, fleet meteorologist (staffed 7 days a week) will notify the Oconee site. Site procedures then initiate a once-per-shift site monitoring process. Site mitigation actions are triggered when the short range (Day 1), 95th percentile PQPF forecast predicts 6 inches of rainfall in 24 hours. This rainfall amount is conservatively based on one half of the maximum historical 24 hour precipitation event, which ensures that actions will be in place well in advance of the arrival of a storm capable of delivering LIP rainfall. The flooding response actions initiated include securing flood gates and doors.

   Note: The maximum historical precipitation event in the upstate of South Carolina from 1973 to 2012 was 12.32" in 24 hours and occurred on August 27, 1995 (Tropical Storm Jerry), based on the highest recorded levels at Greenville, SC. The highest 48 hour and 72 hour total was 14.47" and was for the same event. No consequential flooding resulted at the Oconee site during this event.