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~~Attachments 1-4 contain confidential information~~
~~Withhold from public disclosure under 10 CFR 2.390~~

September 26, 2008

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555-0001

Subject: Duke Energy Carolinas, LLC
Oconee Nuclear Site, Units 1, 2, and 3
Renewed Facility Operating License, DPR-38, DPR-47, and DPR-55;
Docket Numbers 50-269, 50-270, and 50-287
Response to 10 CFR 50.54(f) Request

Reference: NRC Letter from Joseph G. Giitter to Dave Baxter, "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, MD8226)", dated August 15, 2008

Duke Energy Carolinas, LLC (Duke) hereby provides our response to the referenced letter received on August 15, 2008. This letter requested information be provided to the NRC pursuant to the provisions of 10 CFR 50.54(f) regarding external flood consequences at the Oconee site resulting from a failure of the Jocassee dam. The letter focused on three specific questions to be addressed in writing within 45 calendar days following its receipt.

Attachment 1 provides general information related to the design, construction, and operation of the Jocassee Project along with a discussion of the Oconee external flooding licensing basis history. Attachment 2 provides the Duke response to the three specific questions posed in the August 15 letter. Attachment 3 discusses current and planned actions, while Attachment 4 is a listing of regulatory commitments being made as a result of this response.

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Per PM

In accordance with the provisions of 10 CFR 2.390(d)(1), information presented in the attachments to this letter is considered to be commercially sensitive as it relates to the physical protection of the Oconee site. Accordingly, it is requested that the attachments to this letter be withheld from the public.

Duke shares the NRC mission of protecting the health and safety of the public and takes this concern seriously. We look forward to engaging your Staff in productive discussions to seek and implement the most appropriate permanent solutions. With that objective in mind, we are in the process of scheduling a meeting at NRC headquarters, either the week of October 13 or October 20, 2008, to discuss our response and address any additional questions that may be generated from that response.

If you have any questions regarding this matter, please contact Graham Davenport of the Oconee Regulatory Compliance Group at (864) 885-3044.

I declare under penalty of perjury that the foregoing is true and correct. Executed on September 26, 2008.

Sincerely,

Dave Baxter, Vice President
Oconee Nuclear Site

Attachments:

1. Jocassee Project Description and Oconee Flooding Licensing Basis History
2. Duke Response to NRC Questions
3. Current and Planned Actions
4. Regulatory Commitments

cc w/ Attachments:

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ATTACHMENT 1

JOCASSEE PROJECT DESCRIPTION

AND

OCONEE FLOODING LICENSING BASIS HISTORY

Jocassee Project Description

The Jocassee Hydroelectric Project is located on the Keowee River in Pickens County, South Carolina. The dam was completed in 1972. Commercial operation of Units 1 and 2 began on December 19, 1973, and commercial operation of Units 3 and 4 began on May 1, 1975. The plant generates electricity through a combination of four turbines fed from the two intake structures and tunnels during peak demands (typically during the day) and pumps water from Lake Keowee back to Lake Jocassee during low demand periods (typically at night). For Units 1 and 2, the flow through each Allis Chalmers turbine/pump during power operations (at normal pond conditions) ranges between 8,000 to 8,600 cubic feet per second (cfs). For Units 3 and 4, the flow through each of the new Voith turbine/pumps during power operations (at normal pond conditions) ranges between 9,100 to 9,400 cfs. In the pumping mode, the flow is 6,200 cfs per turbine/pump. The Units 1 and 2 turbine/pumps are scheduled to be replaced with the new Voith models in 2011. The full pond elevation is 1,110 ft mean sea level (msl) with a minimum Federal Energy Regulatory Commission (FERC) licensed drawdown elevation of 1,080 ft msl. The reservoir can be drawn down further to the lip of the intake structures at elevation 1,043 ft msl for maintenance purposes.

The reservoir impounds over a million acre-feet with a surface area of 7,565 acres at normal full pond conditions. The drainage basin upstream is small, only 148 square miles.

The main dam is a 385 foot tall earthen core dam with transitional filters contained by rock-fill shells on the upstream and downstream sides. The crest of the main dam is approximately 1,800 feet long, 15 to 30 feet wide at elevation 1,125 ft msl, providing 15 feet of freeboard for the reservoir. The dam axis is slightly curved into the reservoir with a general axis strike of northeast to southwest.

There are two saddle dikes that were constructed west of the main dam to fill topographical low areas around the reservoir rim. Saddle Dike 1 is closest to the main dam (about 3,000 feet southwest), with an axis that strikes northwest to southeast. Saddle Dike 1 is about 35 feet high and 825 feet long. Saddle Dike 2 is located about 8,000 feet west of the main dam with an axis that strikes east-west. Saddle Dike 2 is about 25 feet high and 500 feet long. Both dikes retain little water during normal full pond conditions, and mostly serve to provide flood freeboard.

The service spillway is a concrete gravity structure containing two, 38 feet wide by 33 feet high radial gates. The spillway is located approximately 1,800 feet southwest of the main dam. The structure was constructed in an excavated bedrock channel with steep sidewalls. The spillway is wedged into the rock excavation, and it is not physically possible for the spillway structure to

slide downstream. The gate hoists are electric motor driven that can also be driven with portable air compressor backups. The gates rest on the crest of steep concrete ogees at elevation 1,077 ft msl. The top of the gates are at the full pond elevation of 1,110 ft msl.

There are two intake towers located on the reservoir rim, about 330 feet and 550 feet respectively, to the east of the main dam. The intakes are circular structural steel and reinforced concrete structures with eight openings per intake with an invert elevation of 1,043 ft msl.

Standard Operating Procedures

The Jocassee project is staffed 24 hours per day, 7 days per week. The project is also monitored by the Hydro Central operating center in Charlotte, NC, which is also staffed 24 hours per day, 7 days per week.

The standard reservoir operation during an extreme flood event is to maintain the pool elevation between 1,106 ft msl and 1,110 ft msl using the four turbines. Above elevation 1,110 ft msl, the spillway gates are operated to match inflow. If the lake level continues to rise, the gates are opened further to the full open position. Between the operations of at least three of the four turbines and the spillway gates, the project can sustain and pass a Probable Maximum Flood (PMF) without overtopping the dam.

The spillway gates are tested once a year by raising the gates approximately one foot as part of the annual FERC inspection. Five-year interval full lift gate testing was initiated in 1993 in response to a FERC recommendation. The gates are opened approximately 33 feet after upstream stop-logs are installed. The gates have never been opened for actual flood discharge. Due to the very small watershed, the reservoir elevation is primarily a function of project operations (pumped storage) rather than by flood inflow.

Inspection and Monitoring

The Jocassee project has periodic safety inspections performed by Duke Energy personnel, FERC representatives, and independent consultants. Annual inspections are performed independently by FERC representatives and Duke Energy personnel. Five-Year safety inspections are performed in accordance with FERC Order No. 122, by an independent consultant approved in advance of the inspection by FERC. Underwater inspections are also performed every five years. Duke Energy personnel visually inspect the dam and spillway bi-weekly and after a 2 inch or greater rainfall or felt seismic event.

Since pre-construction, an extensive instrumentation and monitoring program has been established for the Jocassee Project. The program includes monitoring of observation wells, seepage collection weirs, Parshall Flume, discharge pipes, and vertical/horizontal monument points. There are ten observation wells that are monitored once a month for changes in the phreatic water surface. There are twelve seepage collection points that are monitored twice a week for changes in flow and turbidity. There are seventeen surface monuments that are surveyed annually for vertical and horizontal displacement changes of the main dam and the abutments.

The Jocassee project has a camera mounted to monitor the forebay. This video feed is monitored in the Jocassee station control room. This camera has the capability to view a staff gage which measures the reservoir elevation. A second camera is dedicated to monitor only the reservoir staff gage. The video feed for the second camera is monitored in the Jocassee station control room as well as by Hydro Central in Charlotte. In addition to the cameras, electronic forebay elevation instruments are monitored in the Jocassee station control room and by Hydro Central in Charlotte.

Seismic events are recorded by two strong-motion seismographs located around the reservoir. Following a felt seismic event, inspections are performed on all observation wells and seepage collection points.

Design Margins

Revised stability analyses of the main dam and abutments, and the spillway were completed in 1990 and 1994 respectively. Both analyses used generally accepted engineering calculation methods. The analyses included a seismic evaluation with input ground accelerations greater than or equal to those used in the Oconee Nuclear Site (ONS) seismic analyses. Results of the analyses indicate than the factors of safety against sliding or tipping of the structural components was greater than required by FERC regulations for normal conditions, PMF conditions, and seismic conditions.

As noted before, overtopping of the main dam and abutments does not occur during the PMF scenario because of the ability of the project to contain the increased inflow due to the available freeboard and due to the combined discharges of the turbine and spillway gates. In addition, overtopping of the main dam and abutments from excessive pump back from Lake Keowee to Lake Jocassee is considered not credible due to the redundant monitoring capabilities provided from the Jocassee main control room and Hydro Central in Charlotte. Finally, overtopping of the Jocassee dam, following a postulated failure of the main dam of the Bad Creek Pump Storage

Project upstream of the Jocassee reservoir, is not possible due to the freeboard available to hold the Bad Creek reservoir volume.

Emergency Procedures

FERC regulations require that a licensee develop and file an Emergency Action Plan (EAP) unless provided with a written exemption. The FERC regulations further require a comprehensive review of EAP and annual testing and training of personnel. Duke complies with all FERC requirements in this regard by maintaining an EAP, training personnel, and holding annual tests.

Potential Failure Modes

An exhaustive study was conducted in 2004 of the potential failure modes of the Jocassee project. This study, "Potential Failure Modes Analysis (PFMA)," was completed in response to FERC requirements related to a new program noted as Dam Safety Performance Monitoring Program (DSPMP). The intent of the analysis was to identify the potential failure modes of the project and to recommend what monitoring and/or surveillance would be warranted to alleviate or mitigate that failure mode. The analysis results have been incorporated into Jocassee project inspection programs.

The analysis classified the failure modes into following four categories based on the probability and significance of their occurrence:

- Category I – Highlighted – These failure modes have the greatest significance, considering the need for awareness, potential, and consequences.
- Category II – Considered but not Highlighted – These failure modes are less significant than Category I, but still were fully developed to weigh factors making the failure mode more or less likely.
- Category III – More Information or Analysis Needed – This failure mode requires additional information and/or analysis to allow proper classification.
- Category IV – Ruled Out – There is not a physical possibility that this failure mode could occur, that concern is eliminated by considered information, and/or the possibility that the failure mode could occur is so remote as to be non-credible.

The study noted no Category I or III failure modes for the Jocassee Project. Only two Category II failure modes were noted. The remaining failure modes were noted as Category IV.

The two failure modes noted as Category II regarded the possible seepage at the east and west abutments to the main dam that could result in piping/landslides and possibly a breach. For the east abutment, the failure mode was classified as Category II because high seepage could result in rock slope instability, resulting in damage to the switch yard and possibly personnel, if the slide were extensive. The classification was also made to point out the importance of continued monitoring and treatment if seepage were to increase significantly. For the west abutment, the failure mode was classified as Category II because high seepage could result in slope instability, possibly piping and breach in the soils above the bedrock. The classification was also made to point out the importance of continued monitoring and treatment if seepage were to increase significantly. The report recommended continuation of periodic surveillance and monitoring of inspection wells, and seepage collection points, as well as visual surveillance. All of these recommendations have been implemented.

Of particular interest are the failure modes assigned to the main dam and embankments and the spillway. Four failure modes (all classified as Category IV) were discussed; three for the main dam and embankments and one for the spillway. Each of these failure modes are discussed below:

<u>Main Dam and Embankments</u>

1) Aggregate of Slope Stability Issues at Project Embankments for Normal, Seismic, PMF, and Rapid Drawdown (noted as Potential Failure Mode (PFM) 2 in the study): This PFM was classified as Category IV because the analyses, embankment geometry, construction, and historic performance do not indicate that slope instability is a viable potential failure mode.
2) Embankment Internal Piping Causes Breach of the Dam (noted as PFM 3 in the study): The study noted that this is not a viable failure mode, since there is a wide (8-feet) filter designed using modern filter criteria that separates the core from the shell. Also, the first few lifts of the core were specified to be more plastic material. There is also a core trench which puts the core on sound bedrock. The foundation surface was treated during construction by slush grouting and dental concrete. In addition there was curtain grouting of the bedrock below the core. This mitigates piping into the foundation as a viable failure mode. This PFM was classified as Category IV.
3) Overtopping Causes Breach of Embankment or Reservoir Rim (noted as PFM 6 in the study): The study evaluated the possibility of overtopping the main dam and embankments from pump-back operations and flooding. It noted the existence of redundant monitoring capabilities to detect the forebay elevation and alert personnel to potential overtopping events. It also noted that it would take a long time (60 hours) to

overtop the main dam and embankments from pump-back operations, neglecting the fact that the spillway gates would actually be overtopped first, and the resulting discharge would slow the reservoir rise. The other possibility evaluated was the failure of the spillway gates to operate during a PMF scenario. The study noted that the gates are maintained, inspected, and tested under FERC regulations, and therefore are in good operating condition. The study further noted that there are redundant means to raise the gates. Thus the PFM was classified as Category IV.

Regarding the spillway, the study evaluated the aggregate of stability issues at the spillway under Normal, Flood, and Post-Earthquake loading conditions. This PFM sequence involves failure of the spillway by seismic loading, sliding, excessive base pressures, or uplift under the normal, PMF, and post-earthquake loading conditions. This postulated failure mode would result in a breach and an uncontrolled release of the reservoir through the spillway channel. This PFM was classified as Category IV without development since the analysis indicates adequate stability and appears to have been conservatively conducted in accordance with accepted engineering practices.

In summary, the PFMA study illustrates the remote possibility of a catastrophic failure of the Jocassee main dam in the manner assumed in the 1992 Inundation Study. The 1992 Inundation Study was conducted in a conservative manner for emergency management planning purposes. A future risk assessment of the Jocassee project is planned for 2009.

Oconee Flood Licensing Basis History

The ONS current licensing basis (CLB) addresses protection from external flooding caused by a PMF applicable to ONS. Flooding, due to the potential failure of the Jocassee dam, is not addressed and is not currently considered part of the CLB. External flooding due to a postulated Jocassee dam failure has been considered as a beyond design basis event and managed as a risk assessment issue. Following installation of the Standby Shutdown Facility (SSF), the NRC released a Safety Evaluation Report (SER) on April 28, 1983, that approved the SSF design without any discussion of external flooding. External flooding effects were evaluated in 1983 for risk assessment purposes, with a determination that a postulated failure of the Jocassee dam would result in a projected flood height of 4.71 feet in the ONS yard. In 1984 a nominal five foot high flood wall was constructed around the SSF access and equipment doors as a risk reduction measure.

In 1992, Duke performed a FERC requested inundation study to evaluate the downstream affects of a postulated Jocassee dam failure. This worst case study resulted in postulated flood heights

greater than five feet. Differences between the 1983 and 1992 inundation studies were evaluated in 1993, resulting in a conditional failure probability being selected for a postulated flood overtopping the SSF walls as a result of a random failure of the Jocassee dam. This conditional failure probability took into consideration multiple conservative assumptions in the flooding routing analysis. In 1994, the NRC Service Water System Operational Performance Inspection (SWSOPI) identified a finding that the SSF could not withstand a postulated Jocassee dam failure. The finding was subsequently closed based on UFSAR changes that removed the requirement for SSF mitigation for a postulated Jocassee dam failure and a commitment to include the Jocassee dam failure in the Individual Plant Examination of External Events (IPEEE). ONS's subsequent IPEEE submittal in 1995 recognized the potential for SSF failure for certain postulated failures of the Jocassee dam. The IPEEE estimated the core damage frequency (CDF) as 7E-6/year for a seismic failure of the Jocassee dam. The NRC reviewed and approved the IPEEE submittal in 2000, noting that the submittal met the intent of Supplement 4 to Generic Letter 88-20, for high winds, floods, transportation, and other external events.

In December, 2004, an independent engineering company (Findlay Engineering) completed a FERC-requested potential failure modes analysis (PFMA) for the Jocassee project. The PFMA concluded that there are no Category I (scale of 1 to 4, with 1 being the most significant) failure mechanisms applicable to the Jocassee project. Further, the PFMA recommended actions (which were adopted by Duke) for continued performance monitoring of Jocassee dam commensurate with identified potential failure modes.

In November 2006, the NRC issued a White Finding related to a breach in the SSF flood wall. The initiating event was a seismic failure of the Jocassee dam causing flooding of the SSF. In December 2006, Duke appealed the White Finding based on a seismic fragility study that noted the probability of a seismic initiated failure of the dam was negligible. In March 2007, the NRC reaffirmed the White Finding noting that is was necessary to consider all information that was pertinent to the determination of the Jocassee dam failure, including the 'sunny day' failure. In a subsequent November 2007 letter, the NRC, based on information publicly available, though not shared with Duke, stated that the failure frequency of the Jocassee dam was 1.8E-4/year.

In August 2008, Duke initiated contracts with two engineering firms (RAC Engineers & Economists and Devine Tarbell & Associates) to develop a formal risk analysis of potential failure modes of the Jocassee and Keowee dams, resulting potential flooding levels, and their potential effects on the operations of the SSF. This evaluation is in progress and is expected to complete by February 2010.

ATTACHMENT 2

DUKE REPONSE TO NRC QUESTIONS

1) ***Explain the bounding external flood hazard at Oconee and the basis for excluding consideration of other external flood hazards, such as those described in the Inundation Study, as the bounding case.***

Response

The current licensing basis for external flood hazards at Oconee Nuclear Site (ONS) is addressed in Chapter 3.4.1.1 of the Updated Final Safety Analysis Report (UFSAR). This chapter describes how flooding from a Probable Maximum Flood (PMF) event is mitigated by the ability of the Keowee dam to sustain and pass the PMF. Chapter 3.1.2 of the UFSAR describes the Performance Standards for mitigation of natural phenomena. This chapter notes that the facility should be designed to withstand additional forces that might be imposed by natural phenomena such as flooding conditions. The chapter further notes that the design basis so established shall reflect appropriate consideration of the most severe of these natural phenomena that have been recorded for the site and the surrounding area. Furthermore, UFSAR Chapter 9.6.3.1 notes that the Keowee and Jocassee reservoir have adequate margins to contain and control floods. In addition, UFSAR Chapter 2.4.2.2 notes that the spillway capacities at Keowee and Jocassee have been designed to pass the design flood with no surcharge on the full pond. The dams and other hydraulic structures have been designed with adequate freeboard and structural safety factors to safely accommodate the effects of probable maximum precipitation (PMP). As such, ONS is designed to withstand flooding caused by the PMF. In addition, UFSAR Chapter 2.4.4 indicates that Jocassee was designed to the same seismic input conditions as ONS. Therefore, seismic failures of the Jocassee project are not considered credible.

In 1983, a Jocassee dam failure study was completed to determine the maximum credible water height around the Standby Shutdown Facility (SSF). This study was completed using the National Weather Service DAMBRK program. The study assumed a Jocassee reservoir elevation of 1107 ft mean sea level (msl), with the Keowee reservoir elevation of 798 ft msl. The study further assumed a failure time of two hours and an anticipated breach size. In addition the study assumed the volume passed through the breach would be equally distributed over the entire surface area of the Keowee reservoir, including the Little River branch of the lake. The results of the study noted a peak flood elevation of 817.45 ft msl at the Keowee dam, and an ONS yard flood level of 4.71 feet. The postulated ONS yard flooding was the result of overtopping the ONS Intake dike, not

from the Keowee tailrace. In response to this study, ONS erected several walls approximately 5 feet tall around the personnel and equipment entrances to the SSF as a risk reduction measure.

In 1992, in response to a FERC request, the Duke Hydro Department initiated a second flooding study that assumed a complete failure of the main dam at Jocassee, in accordance with FERC guidelines. This study used the DAMBRK program, Rev. 4, and evaluated two conditions: (1) a 'sunny day' break in the main dam at normal pond conditions, and (2) a break in the dam during PMF conditions. The purpose of the study was to determine the worst possible case flooding in downstream reservoirs for inclusion in the Emergency Action Plans (EAP) for these hydro-electric facilities. The resulting inundation provided the extent to which evacuation plans were developed. The purpose of this study was not to assess credible flood heights for ONS.

In case (1) the study used as input a Jocassee reservoir elevation of 1108 ft msl, a Keowee reservoir elevation of 798 ft msl, and a conservative trapezoidal breach size. The base of the trapezoid was input as 250 feet wide at elevation 800 ft msl, the full pond elevation of the Keowee reservoir. The sides of the trapezoid were sloped 1:1 to the crest, or elevation 1125 ft msl. The case (1) results indicated a flood elevation of 808.5 ft msl at the Keowee tailrace. Case (2) used as input a Jocassee reservoir elevation of 1106 ft msl, a Keowee reservoir elevation of 798 ft msl, and the same breach size considered in Case (1). In addition, case (2) considered a peak in-flow of 522,734 cubic feet per second (cfs) for the PMF. This produces a Jocassee reservoir elevation of 1122 ft msl, still below the crest of the Jocassee dam. For comparison purposes the peak in-flow rate ever recorded in the Jocassee area is approximately 21,000 cfs. The case (2) results indicated a flood elevation of 812.8 ft msl at the Keowee tailrace.

Duke considers a random 'sunny day' failure of the Jocassee dam not credible because of the nature of its design, its construction, the inspections conducted during its construction, and those periodic inspections that have occurred, and continue to occur, since its construction. Jocassee was designed using the current state of practice technology, employing conservative assumptions and margin. The design was created with two distinct oversight organizations, FERC and an Independent Board of Consultants. The construction of the dam utilized a standardized quality control process. The dam is subject to a comprehensive monitoring program and an extensive inspection program. Its performance history is well documented through periodic inspection reports as required by the FERC.

Duke considers a random 'sunny day' failure of the Jocassee dam with the PMF not credible. As noted previously, Jocassee is designed and inspections are in place to prevent failure of the dam. The dam can hold and pass a PMF. The dam is designed for seismic ground motions greater than or equal to that used in the design of ONS. Features are in place to prevent overtopping failures due to excessive pump-back operations. Piping failures are mitigated by periodic monitoring of seepage collection points. These attributes provide assurance that the dam will not fail in the manner assumed in the 1992 Inundation Study.

Duke conducted a review of industry operating experience using the National Performance of Dams Program (NPDP) database to obtain additional insights regarding dam reliability and important failure modes.

An initial review of experience for rock-fill dams identified eight failures dating from 1890 to 1981. Of these failures, three events are associated with dams built prior to 1940; one failure event was associated with a small dam (< 50 feet high); and, one failure involved a partially constructed dam that was washed away by a flood. Duke does not consider any of these failures to be relevant to the Jocassee dam. No relevant piping failure events were found in the population of large US rock-fill dams built since 1940.

The remaining three failures involve the Cascade dam failure in 1981 due to an earthquake and the failures of Frenchman dam (1952) and Skagway dam (1965) due to flooding events. However, as noted elsewhere in this response, Jocassee is designed to withstand both a PMF and a design basis seismic event; therefore these historical dam failures do not represent credible failure modes for Jocassee. When considering the overall performance history of modern rock-fill dams, there is no evidence to suggest that a Jocassee dam failure is credible.

There are two broad categories of failure modes for consideration: (1) externally initiated events that challenge a dam's structural integrity such as earthquakes and hydrological inflow (flooding) events, and (2) internally initiated failures such as excessive seepage and piping. An important distinction between these two types of failure modes is that the likelihood of failure from an external event is a function of the frequency/intensity relationship of the external hazard and the capacity of the dam and spillway structures; where as the likelihood of an internal failure is a function of the operational experience (exposure time) for the dam.

Duke understands that the NRC included the Frenchman and Skagway failures, based on limited operating experience of rock-fill dams, when determining the credibility of a Jocassee dam failure. However, Duke maintains inclusion of these two dam failures in assessing the likelihood of a Jocassee dam failure is inappropriate since it compares a set of externally initiated failures against the operating years of experience for rock-fill dams. As an example, the occurrence of a dam failure due to an earthquake in California does not predict the likelihood of an earthquake in western SC exceeding the seismic capacity of the Jocassee dam. Similarly, flooding events in Montana and Colorado in 1952 and 1965, respectively, do not predict the likelihood of an inflow flood in excess of the capacity of Jocassee to successfully pass.

In an effort to estimate the likelihood of a piping failure, Duke independently conducted a review of earthen dam experience for relevant failures. The potential relevance of earthen dams stems from the fact that Jocassee dam is constructed with an earthen core, and thus certain seepage or piping failures in earthen dams could be applicable to the Jocassee dam. Most rock-fill dams built since 1940 are constructed with either a central earthen core (like Jocassee) or an inclined earthen core. Most rock-fill dams built prior to 1940 were constructed with a concrete face on the upstream slope instead of an earthen core. Therefore, a search of the NPDP database was conducted for failures of large earthen dams (≥ 50 feet) built since 1940 involving either seepage or piping.

The following considerations were then used in determining whether historical piping failure events are relevant to Jocassee:

- Tailings dams should be excluded entirely from consideration because they are typically designed and constructed very differently than typical earthen dams.
- Failures of dams during the early operational history should be excluded. These so called "infantile" failures often occur during or just after the first filling of the reservoir due to design problems or faulty construction.
- Dam failures that occur around conduits or other penetrations through the core of a dam should be excluded. Many dams have these conduits for outlet pipes, sluice lines, or irrigation lines; however, these penetrations create a discontinuity in the material of the dam's core which can be favorable to the formation of internal piping. Jocassee does not have any such conduits through the dam. The intake tunnels for the Jocassee hydroelectric units are excavated though solid bedrock underneath the left abutment and are lined with concrete and thereby not susceptible to a piping failure through this mechanism.

From this review, Duke can identify only a very small number of piping failures that are potentially relevant to Jocassee; however, even in these cases there are additional factors to suggest that Jocassee dam has adequate design features, quality of construction, and inspection and monitoring programs to prevent similar failures. Duke maintains that previous risk assessments of the likelihood of Jocassee dam failure were appropriate for use in the Individual Plant Examination of External Events (IPEEE) studies and the current ONS Probabilistic Risk Assessment (PRA).

In previous discussions, the NRC staff has stated that it had identified 35 potentially relevant earthen dam failures. Significant differences in the assessment of operating experience could be the result of differing interpretation of important qualitative factors such as those described above, and may have counted flooding (PMF) events as discussed earlier. These differences may reduce the population of relevant dam failures that should be considered. Duke noted that many of the NPDP records were incomplete and required additional information from other sources to determine whether these failures are applicable to Jocassee. This was a common problem for many small dams. Also, Duke believes failures involving embankment slides should be excluded based on the characteristics of the rock-fill shells and the favorable results of slope stability analysis conducted for Jocassee.

In conclusion, a failure of Jocassee dam is not considered credible because it is designed to withstand design basis seismic and PMF events. Jocassee dam has the necessary design features, quality controls, and the appropriate surveillance, maintenance, and inspection programs to prevent a catastrophic failure of the dam for all potential failure modes seen in industry experience and those evaluated in the 2004 Potential Failure Modes Analysis (PFMA). Thus, the failure of the Jocassee dam in the manner assumed in the 1992 Inundation Study is not considered credible, and further, the flood resulting from the assumed failure, while bounding, is likewise not considered credible.

2) ***Provide your assessment of the Inundation Study and why it does or does not represent the expected flood height following a Jocassee Dam Failure.***

Response

The 1992 Inundation Study is the only flood study on record with the NRC. Although the study predicts a bounding flood height due to the catastrophic 'sunny day' failure of Jocassee, the study results are not directly applicable to ONS since the purpose of the study was to determine the scope of evacuation plans, as a part of Jocassee's EAP, and

not for determining credible flood heights at ONS. FERC methodology focuses on worst case dam failure consequences, not probability of failures. The resulting flood height in the Keowee tailrace has been acknowledged to be the result of repeated conservative assumptions made in the 1992 study, as stated in Duke's December 20, 2006, letter to the NRC regarding the SSF flood barrier issue. Both Duke and the NRC have acknowledged the resulting flood hazard in the SWSOPI (Service Water System Operational Performance Inspection) assessment and the IPEEE submittal. The credibility of this event has consistently been considered so low that it is not included as part of the Current Licensing Basis (CLB) for ONS. The results were conservatively applied to ONS to assess potential flooding consequences. The results of the inundation study were applied without extensive investigation into the assumptions, parameters etc. since the event's consequences were being assessed in a non-licensing probability realm. As such, the current PRA model for external flooding at ONS is adequate for the original purpose of determining the presence or absence of a severe accident vulnerability.

The 1992 Inundation Study used a 'DAMBRK' Rev. 4 computer model to determine the anticipated flood elevations at specific locations along the anticipated flood route. A summary of inputs to the 1992 FERC Inundation Study is shown below:

1. Jocassee dam breach is initiated by 'piping' within the dam. The Potential Failure Modes Analysis (PFMA) completed in 2004 notes that a failure mode of this type is not viable for the Jocassee dam.
2. A trapezoidal breach of the Jocassee dam with a bottom width of 250 ft, side slope of 1-1, and a bottom elevation of 800 ft (breach parameters follow FERC guideline). The breach size, the breach shape, the time it takes to develop the full breach, and the location of the breach have a role in determining the release flow rate to the tailrace and eventually, the resulting flood heights. These variables characterizing the postulated failure are important in determining the input flow to the model software. The failure modes, time, shape, or size of a possible breach on a rock fill dam are not well established. Differentiation and refinement of dam failure parameters for rock-fill dams verses soil dams requires more investigation and research.
3. A modeled temporary storage area was used to limit the flow between the Keowee River branch of the lake and the Little River branch of the lake. The DAMBRK results indicate that the modeled storage area was filled to its capacity, indicating that the temporary storage area could be increased. Increasing the temporary storage area could decrease the flood heights at ONS.
4. A conservative selection of Manning's 'n' value was chosen for the inundation study to determine a fast wave arrival time (focus of the Inundation Study), but may be punitive when determining realistic flood heights at ONS. More accurate 'n' values

both upstream and downstream of the location in question can influence the water height in the ONS yard.

5. Keowee dam was assumed to fail in this event due to overtopping. The Keowee dam failure was modeled as a trapezoidal breach of the dam with a bottom width of 500 ft, side slope of 1:1, and a bottom elevation of 670 ft. A re-evaluation of this failure mechanism may be warranted. This is another key factor in determining the final water height in the yard.

Duke currently has plans to use a more accurate modeling tool, Hydrologic Engineering Center – River Analysis System (HEC-RAS). This software is recognized by FERC as a standard tool for this type of work. The inflow to the flood routing, the cross-section details, the number of cross-sections, the available storage areas along the flood route, the general shape of the flow channel, and the 'roughness values' used for the channel are all representative of key values used in the flood routing software. A more precise modeling of the actual conditions will result in more accurate predicted flood heights. Therefore, the capabilities of HEC-RAS would more accurately represent the anticipated flood heights in the yard at ONS following the postulated failure of the Jocassee dam.

In summary, the 1992 Inundation Study is the only flood study on record. This study predicts a bounding flood height due to a catastrophic failure of Jocassee. The results are not directly applicable to ONS because the purpose of the study was to determine the scope of evacuation plans, as a part of Jocassee's EAP, and not for determining credible flood heights at ONS. The resulting flood height in the ONS yard has been acknowledged to be the result of repeated conservative assumptions made from this 1992 assessment. The associated flood heights were derived from an effort not directly related to ONS, yet were conservatively applied to ONS to assess potential flooding consequences. These results were applied without extensive investigation into the inputs, assumptions, parameters, etc. since the event's consequences were being assessed in a non-licensing probability realm. In conclusion, while Duke agrees that the flood heights reported in the 1992 Inundation Study represent bounding flood heights, these results are not considered credible and as such, should not be used to determine credible flood levels at the SSF.

3) Describe in detail the nuclear safety implications of floods that render unavailable the SSF and associated support equipment with a concurrent loss of all Alternating Current Power.

Response

For postulated Jocassee dam failures that result in a flood height ≤ 801 ft msl on the ONS yard, the flood wall surrounding the SSF provides adequate protection of the SSF. Therefore the SSF remains available to achieve and maintain stable Mode 3 conditions for each ONS unit. However, the nuclear safety implications of postulated floods that render the SSF and associated support equipment unavailable with a concurrent loss of all AC Power would be significant.

As stated in the December 21, 1995 ONS IPEEE Submittal Report:

- Once secondary side heat removal is lost, a potential failure of Reactor Coolant System (RCS) integrity can occur if an RCS safety relief valve fails to reseat after relieving liquid.

- IPEEE sequences involve a flood-induced failure of Secondary Side Decay Heat Removal (SSDHR), Reactor Coolant Pump (RCP) seal cooling, and High Pressure Injection (HPI). Neither the Auxiliary Service Water Pumps (Both Station & SSF) nor Reactor Coolant Makeup (RCM) pumps are available. The seal failures are assumed to produce the equivalent of a small-break LOCA leakage rate. The failure of both SSDHR and HPI leads to early core damage. Currently, the effects of flooding events resulting in ONS inundation depths greater than 5 ft fall into this category.

Duke has taken actions to prepare for a Keowee dam failure. Procedures and drill scenarios have been developed to respond to this event and address the expected impacts. However, similar procedures and scenarios for a postulated Jocassee dam failure do not exist.

In the scenario involving a postulated total catastrophic and sudden failure of the Jocassee dam and the resultant loss of the SSF, remaining credited defense-in-depth for the ONS units includes the reactor containment(s) and Oconee Severe Accident Guideline (OSAG). Additionally, other recovery actions will be directed by the Emergency Response Organization (ERO).

The following flood timeline is based on the results of the 1992 Inundation Study. In this scenario the dam is assumed to fail at time zero. Notification from Jocassee would occur before a total failure of the dam; however, for purposes of this timeline, notification is assumed to be at the same time the dam fails. Following notification from Jocassee, the reactor(s) are shutdown within approximately 1 hour. The predicted flood would reach ONS in approximately 5 hours, at which time the SSF walls are overtopped. The SSF is assumed to fail, with no time delay, following the flood level exceeding the height of the SSF wall. The failure scenario results are predicted such that core damage occurs in about 8 to 9 hours following the dam break and containment failure in about 59 to 68 hours. When containment failure occurs, significant dose to the public would result.

The scenario description above does not acknowledge that the postulated flood arrives at the site and then recedes rather quickly. In the above scenario, ONS is no longer flooded approximately 5 hours after the onset of initial flooding (10 hours following failure of the dam). At this point, recovery actions can begin to mitigate the loss of AC power and thus extend the time to a potential containment breach.

<u>Emergency Action Plan Scenario</u>

Since Jocassee and Keowee Hydro Stations are FERC regulated and inspected, EAP(s) exist for both facilities. EAP(s) for both Jocassee and Keowee identify two conditions related to the status of the dams: Condition A – Failure is Imminent or Has Occurred; Condition B- Potentially Hazardous Situation is Developing. These conditions are determined and communicated by Area Hydro Group personnel. For the postulated Jocassee 'sunny day' break scenario, Condition A initiates a call tree that notifies offsite agencies to implement specific actions to protect/warn the public as well as notifications to the Operations Shift Manager (OSM) and Keowee Hydro Operator. If the Keowee Hydro Operator determines that the failure of the Keowee dam is imminent or has occurred, or potentially hazardous situation is developing, the determination of a Condition A or B for Keowee will be declared.

Once the OSM has been informed that a Condition A or B exists for the Keowee Hydro

Station, the ONS Emergency Plan (EP) and associated response procedures are implemented. The site will progress through the response procedures and implement actions that include: activation of the Emergency Response Organization (ERO); notification to offsite agencies including specific protective action recommendations (as described in the Keowee Hydro Project EAP); and site specific protective actions (e.g., relocation of personnel in low lying areas to the World of Energy/Ops Training Center).

As the situation evolves, OSAG guidance will be utilized to identify and implement appropriate strategies. The flood induced loss of AC power limits the success of mitigation strategies; however, the ERO will determine the best way to implement the appropriate strategies based on the given conditions.

Site Operations Personnel Actions

Concurrent with entry into the ONS EP, site operations personnel also enter existing site procedures. Once the Jocassee EAP declares Condition A and the notifications are made to Keowee Hydro and the OSM, Keowee enters the Keowee Hydro Station natural disaster procedure and the site enters into a site natural disaster procedure.

Subsequent to entry into the site natural disaster procedure, Operations will enter the site dam failure procedure. Major actions taken per this procedure include:

- Trip respective Unit's reactor (applies to all three units in this case)
- Stop all Reactor Coolant Pump(s)
- Conserve Condenser Circulating Water (CCW) inventory
- Align CCW recirculation
- Implement the SSF Emergency Operating Procedure when secondary heat sink is near depletion

As conditions develop, OSAG procedures go into effect, but the lack of AC power in the postulated Jocassee scenario limits effectiveness of OSAG strategies. Due to the projected destruction from the flood and the flood's departure, mitigation efforts as initiated in OSAG phase of the event would be complicated. Additional strategies under consideration include use of fire trucks to maintain Spent Fuel Pool levels, controlled venting of the reactor buildings to maintain integrity, use of portable pumping equipment to spray the containment structures, and securing additional equipment for mitigation as directed by the ERO.

Summary

As has been demonstrated herein, the Jocassee project was designed and constructed in accordance with current state of practice technology, employing conservative assumptions and margin. The project is designed for seismic ground acceleration equal to or greater than those used in the design of ONS. The project is designed to hold and pass a PMF. The project is maintained in accordance with stringent FERC requirements, including periodic inspections by FERC personnel, Duke personnel, and independent investigators. Periodic monitoring of seepage collection weirs, wells, and monuments are also performed by plant personnel. For the determination of failure probabilities, it is important that these attributes be appropriately considered.

The 1992 Inundation Study provided conservative flooding results for the determination of evacuation plans as part of the Jocassee EAP. The inputs and assumptions used in the analysis were conservatively selected to provide the bounding flood levels. The results of the study cannot be effectively applied to the credible flooding of the ONS yard and the SSF without first evaluating the appropriateness of those inputs and assumptions. As such, the bounding flood level predicted by the study does not represent the credible flood level at the SSF.

Results from the 2004 PFMA indicate that failure of the Jocassee dam in the manner assumed in the 1992 Inundation Study is remote. The PFMA study notes that other failure modes, not associated with failure of the main dam, are more probable. However, the PFMA study continues that even for these failure modes, effective inspection and monitoring strategies are in place to prevent these failures. As such Duke views the failure of the Jocassee dam as not credible.

Additional effort is needed to determine the predominant failure modes and resulting credible flood level. To this end, Duke has commissioned several engineering vendors that possess the appropriate knowledge and experience to provide a risk assessment of each failure mode, determine the breach size, and the resulting flooding levels at ONS. These efforts will result in assigning a probability for each failure mode/breach size/flooding level. These results will allow Duke to determine the appropriate level of protection for the SSF.

While this longer term work is being completed, Duke has initiated additional short term sensitivity studies to validate credible flood levels at the SSF given the current Jocassee and Keowee reservoir levels, their projected levels, the Little River basis storage capacity,

and postulated Jocassee dam failure breach sizes. In addition, the height of the SSF flood protection walls will be conservatively increased in the short term to gain margin against the highly improbable flooding of the SSF due to non-credible postulated floods. These activities are described in Attachment 3. These activities provide added assurance that the SSF will not be adversely affected in the unlikely event of a Jocassee dam failure. Finally, Attachment 4 provides a list of regulatory commitments to determine the credible flooding level that should be applied to the SSF and the appropriate flooding protection that should be provided.

References

1. Duke internal memorandum from K. A. Anthony to file, "Oconee Nuclear Station Turbine Building Flood, File Nos: OS-10, J-133, OS-203," dated January 17, 1983
2. Letter from J. F. Stolz, NRC, to H. B. Tucker, (transmit NRC Staff Safety Evaluation Report of the Oconee Standby Shutdown Facility), dated April 28, 1983
3. Jocassee Hydro Project, Dam Failure Inundation Study, "Federal Energy Regulatory Commission (FERC) Projects No. 2503, dated December 10, 1992
4. Duke internal memorandum from R. W. McAuley, Jr. to file, "Oconee Nuclear Station, Jocassee Dam Failure Inundation Studies, File No: OS-203," dated December 14, 1993
5. Letter from Albert F. Gibson, NRC, to J. W. Hampton, Duke, "Notice of Violation and Notice of Deviation (NRC Inspection Report Nos. 50-269/93-25, 50-270/93-25, and 50-287/93-25)," dated February 11, 1994 (SWSOPI)
6. Letter from Albert F. Gibson, NRC, to J. W. Hampton, Duke, "Notice of Violation (NRC Inspection Report Nos. 50-269/94-31, 50-270/94-31, and 50-287/94-31)," dated December 19, 1994
7. IPEEE Submittal Report, Duke Power Company, Oconee Nuclear Station, December 21, 1995
8. Potential Failure Modes Analysis, Jocassee Development, Keowee-Toxaway Project, FERC Project No. 2503-SC, dated December 2004
9. Oconee calculation OSC-9540, "MAAP Analysis to Determine Timing Estimates Following a Jocassee Dam Failure at Oconee Nuclear Station", dated September 25, 2008
10. Letter from B. H. Hamilton, Duke, to NRC Document Control Desk, "Appeal of Final Significance Determination for a White Finding and Reply to a Notice of Violation; EA-06-199", dated December 20, 2006
11. Emergency Action Plan, Jocassee Hydro Station, FERC Project No: 2503, dated December 31, 2007

12. Emergency Action Plan, Keowee Hydro Station, FERC Project No: 2503, dated December 31, 2007
13. Letter from Joseph Giitter, NRC, to Dave Baxter [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, (TAC NOS. MD8224, MD8225, AND MD8226)], dated August 15, 2008
14. Oconee Nuclear Station Updated Final Safety Analysis Report, Chapters 3.4.1, 3.1.2, 2.4.2.2, 2.4.4 and 9.6.3.1, dated December 31, 2007
15. National Performance of Dams Database (NPDP), <npdp.stanford.edu/index.html>
16. Oconee Unit 3 Probabilistic Risk Assessment, Rev. 1, November 1990
17. Oconee Nuclear Station AP/0/A/1700/006, "Natural Disaster"
18. Keowee Hydro Station AP/0/A/2000/001, "Keowee Hydro Station - Natural Disaster"
19. Oconee Nuclear Station AP/*/A/1700/013, "Dam Failure" (* Unit specific)
20. Oconee Nuclear Station AP/0/A/1700/025, "Standby Shutdown Facility Emergency Operating Procedure"
21. Letter from David E. LaBarge, NRC, to W.R. McCollum Jr. (Duke), "Oconee Nuclear Station, Units 1, 2, & 3, Re: Review of Individual Plant Examination of External Events (TAC Nos. M83649, M83650, and M83651)", dated March 15, 2000
22. Letter from William D. Travers, NRC, to Bruce H. Hamilton (Duke), "Final Significance Determination for a White Finding and Notice of Violation (Oconee Nuclear Station – NRC Inspection Report Nos. 05000269/2006017, 05000270/2006017, and 05000287/2006017)", dated November 22, 2006
23. Letter from Victor McCree, NRC, to Bruce H. Hamilton (Duke), "Reconsideration of Final Significance Determination Associated with Standby Shutdown Facility Flood Barrier White Finding", dated November 20, 2007
24. STI 2503-JO-01 "Jocassee Pumped Storage Project (FERC No. 2503-SC) Supporting Technical Information", Rev. 0 dated December 3, 2004
25. Email from Ed Luttrell (DTA) to Chris Ey (DTA) and Ray McCoy (Duke), Re: FERC Standards, dated September 9, 2008

ATTACHMENT 3

CURRENT AND PLANNED ACTIONS

Current

Actions already in place to properly characterize the credibility of the flood and address the resultant damage from a flood include:

1. Inspections and Monitoring

Federal Energy Regulatory Commission (FERC) Inspections

- Annual inspections performed independently by FERC
- Five-Year underwater inspections of concrete structures (e.g., intake towers, access bridge piers, spillway training walls and ground line, gate faces and piers, tailrace training walls, face of discharge structure, racks)

Duke Inspections and Monitoring

- Annual inspections by Duke Energy personnel
- Bi-weekly inspections of dam and spillway
- Dam and spillway inspections after a two inch or greater rainfall or felt seismic event
- Monthly monitoring of ten observation wells for changes in the phreatic water surface
- Bi-weekly monitoring of twelve seepage collection points for changes in flow and turbidity
- Annual survey of seventeen surface monuments for vertical and horizontal displacement changes of the main dam and the abutments
- Jocassee Control Room Monitoring
  - Forebay elevation (camera and instrumentation)
  - Staff gage measuring reservoir elevation
  - Seismic events by two strong-motion seismographs
- Hydro Central Monitoring (Charlotte, NC)
  - Staff gage measuring reservoir elevation
  - Forebay elevation instrumentation

Independent Contractor Inspections

- Five-Year safety inspections are performed in accordance with FERC Order No. 122, by an independent consultant approved in advance of the inspection by FERC.

2. Emergency Action Plan (EAP) Guidance

The Jocassee dam is regulated and inspected by FERC. FERC requires an EAP for each of their regulated dams. EAPs exist for both Jocassee and Keowee. The Jocassee EAP requires implementation of a call tree that notifies offsite agencies to implement specific actions to protect/warn the public as well as notifications of the ONS Operations Shift Manager (OSM) and Keowee Hydro Operator.

3. ONS Standby Shutdown Facility (SSF) Flood Protection

After the 1983 evaluation of external flooding effects for risk assessment purposes, the nominal five foot high flood wall was constructed around the SSF access doors. This wall was constructed to mitigate the flood of the Oconee yard as postulated at that time.

4. DAMBRK Assessments

The original DAMBRK model used for the 1992 Inundation Study has been restored in order to assess the sensitivity of the input data used in the 1992 work with regard to determining anticipated flood heights at ONS. All the cross sections, Jocassee Reservoir Area Curve, Cross Section Storage Areas and routing parameters have remained the same as the original work. The only differences between the current assessments and the original work are:

a) DAMBRK is now being executed on a PC versus the original Mainframe version.

b) The entire model downstream of Lake Hartwell was not used since the focus was on ONS; therefore, the storage area below ONS (Lake Hartwell) was used, but the storage areas below the Hartwell dam were not used versus the entire drainage basin.

c) The modeled flood plain compartment used to simulate the constriction associated with the Little River Arm of the Keowee Lake in the original work was increased. This was to permit more storage in that modeled feature so that the storage surface elevation equaled the resulting flood elevation seen in the model results.

d) Current lake level in the storage area downstream of the Oconee site (Lake Hartwell) was used versus full pond in the original work.

e) Initial lake levels were varied in both Keowee and Jocassee Lakes and resulting flood heights in the ONS yard were determined.

DAMBRK Analysis results are given below:

Case	Reservoir Elev. (msl)	Breach Size	Flood Elev. (ft msl)
Orig. 1992 (sunny day)	1108 (Jocassee) 798 (Keowee)	1992 Study	808.5
* Restored 1992	1108 (J) 798 (K)	1992 Study	807.2
* Current Lake Levels	1085 (J) 797 (K)	1992 Study	802.7
* Sensitivity Case 1	1090 (J) 796 (K)	1992 Study	803.6
* Sensitivity Case 2	1090 (J) 797 (K)	1992 Study	803.8
* Sensitivity Case 3	1090 (J) 797 (K)	Original 1983	792.2
* Sensitivity Case 4	1108 (J) 798 (K)	Original 1983	795.2

* Completed in September 2008

Result conclusions: For current lake levels, predicted flood level is below the height of SSF wall that can be extended short term (803.5 ft msl). See below for description of the short term modifications. For cases where the Jocassee reservoir elevation is 1090 ft msl, predicted flood level is slightly above height of SSF wall that can be extended short term. This is considered acceptable, given the very conservative breach size. Although the assumed reservoir level has some effect on the resulting flood levels, changes in the breach size has a pronounced effect (see sensitivity cases 3 and 4). This result supports the importance of the RAC work.

Short Term

Duke believes that the Jocassee dam will not fail in the way described in the 1992 Inundation Study. Regardless, Duke is expeditiously pursuing short term actions to gain margin until such time as the confirmatory, long term study is complete.

1. Modifications

   The height of the existing SSF flood walls will be increased to elevation 803.5 ft msl. This represents an approximate 2.5 foot increase in the current wall height. This increase is the maximum that can be achieved in the short term given the design limitation of the current walls. The increase will be accomplished by the addition of steel brackets and plates that will extend from the top surface of the existing walls. In addition to the steel brackets, steel braces will be added to the inside base of the walls at appropriate spacing to provide margin against overturning of the walls due to the increased water pressure pressing on the exterior of the walls. The existing personnel access gate on the south side of the SSF will be modified for the increased height. These modifications will provide flood protection given current DAMBRK results considering current Jocassee and Keowee reservoir levels, and short term projected levels.

2. Hydrologic Engineering Center – River Analysis System (HEC-RAS)

   Efforts are currently underway to update the flood routing model for the Jocassee dam break from the original 1992 efforts using DAMBRK to use of the current version of HEC-RAS developed by the US Department of Defense and the US Army Corps of Engineers. This software is widely used and accepted by government agencies for assessing hydraulic flows. The purpose of this software conversion is to compare the outputs (resulting flood heights) of the two software tools while using the same input parameters used in the 1992 DAMBRK. This model will also be used to support and assess the results determined in the long-term work related to the Jocassee and Keowee risk analysis study being performed by RAC Engineers and Economists (RAC).

3. Interim Guidance

   Duke will create interim guidance to address mitigation of postulated flood events which render the SSF inoperable. Guidance may be revised depending on the results of the RAC study.

Long Term

RAC Initiative

Duke has employed RAC to perform a Jocassee dam fragility study to determine the probability of potential failure modes of the dam and assess potential adverse effects to the SSF. RAC has more than two decades of experience with applying dam safety risk assessment for decision support in North America, Australia, and Europe. They have assisted the Bureau of Reclamation during their transition to using risk assessment as a predictive tool. Along with a determination of the failure probabilities, the study will assess the probable breach size given the failure mode. This work will then be used as input by Devine Tarbell & Associates (DTA) to construct a flooding evaluation using the HEC-RAS tool to determine appropriate flooding levels at the SSF. DTA is staffed by engineering personnel well acquainted with the Jocassee and Keowee projects.

ATTACHMENT 4

REGULATORY COMMITMENTS

The following commitment table identifies those actions committed to by Duke Energy Carolinas, LLC (Duke) in this letter. Other actions discussed in this letter represent intended or planned actions by Duke. They are described to the Nuclear Regulatory Commission (NRC) for information and are therefore not regulatory commitments.

Commitment	Completion Date
Perform flooding studies using the HEC-RAS model for comparison with previous DAMBRK models.	December 2008
Create interim guidance to address mitigation of postulated flood events which render the SSF inoperable.	February 2009
Implement short-term modifications to extend the height of existing SSF flood walls to 803.5 ft msl.	February 2009
Complete RAC Engineers & Economists (Utah State University) risk study to provide quantitative risk analysis of postulated dam failure modes and resulting breach sizes of the Jocassee and Keowee dams. Included within the study will be the use of the new inundation model (HEC-RAS) to predict the flood elevations at ONS, based on the postulated break sizes.	February 2010