NRC Relicensing Crisis at Oconee Nuclear Station:

Stop Duke from Sending Safety Over the Jocassee Dam

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Submitted to U.S. Nuclear Regulatory Commission
on Behalf of Beyond Nuclear, Inc. and the Sierra Club, Inc.
In Subsequent License Renewal Proceeding for Oconee Nuclear Power Plant, Units 1, 2, and 3

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LIST OF ACRONYMS

AEC	Atomic Energy Commission
CCDP	conditional core damage probability
CDF	core damage frequency
CFR	Code of Federal Regulations
FERC	Federal Energy Regulatory Commission
GDC	General Design Criterion
GL	Generic Letter
ECCS	emergency core cooling system
EAP	Emergency Action Plan
EPRI	Electric Power Research Institute
FOIA	Freedom of Information Act
HEC-RAS	U.S. Army Corps of Engineers River Analysis System
IEF	Initiating Event Frequency
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination for External Events
kv	kilovolt
LERF	large early release frequency
LOCA	loss of coolant accident
LPI	low pressure injection
MSL	mean sea level
NRC	U.S. Nuclear Regulatory Commission
NSAC	Nuclear Safety Analysis Center
NTTF	Near Term Task Force
ONS	Oconee Nuclear Station
ORNL	Oak Ridge National Laboratory
PMP	Probable Maximum Precipitation
PRA	probabilistic risk assessment
ROP	Reactor Oversight Process

SAMA	Severe Accident Mitigation Alternatives
SDP	Significance Determination Process
SLR	subsequent license renewal
SSF	Safe Shutdown Facility

1. INTRODUCTION

This purpose of this report is to explain and provide the basis for my expert opinion, as a nuclear engineer and risk analyst, regarding the safety of Duke Energy Corporation's (Duke's) current operation of Oconee Units 1, 2 and 3, and its proposal to extend the reactors' operating license terms by 20 years until 2053 (Units 1 and 2) and 2054 (Unit 3). The report is based on my extensive experience as a nuclear engineer and safety regulator with the U.S. Nuclear Regulatory Commission (NRC), including evaluation of Oconee's safety in relation to potential failure of the upstream Jocassee Dam. My curriculum vitae is attached.

In my expert opinion, and as discussed in more detail below, Oconee's current operation, and proposed operation under an additional twenty-year subsequent license renewal (SLR) term, pose an unacceptable risk to public health and safety, due to Duke's failure to fully implement flood-protective measures required by the NRC in a 2011 Safety Evaluation.[1] The NRC deemed those flood protection measures necessary to protect against a core melt accident in the event the Oconee site becomes inundated by failure of the Jocassee Dam.

While the NRC has not sought to force Duke to implement those flood protection measures, neither has it withdrawn or repudiated the 2011 Safety Evaluation in which it found those measures were necessary to provide adequate protection to public health and safety. Instead, the regulatory agency has kept silent with respect to the Safety Evaluation for the past ten years.

Now that Duke's SLR application has come before the NRC, it is time for the agency to break its silence and address the significant safety and environmental issues raised by Duke's bid for another 20 years of unprotected operation. The NRC should not accept Duke's erroneous and outdated risk assessment, and require Duke to provide a thorough and accurate estimate of the core melt risk posed by Jocassee Dam failure. In addition, the NRC should require Duke to implement the flood protection measures required ten years ago by NRC.

In my professional opinion as a recently retired regulator, the NRC has the authority to impose these requirements in order to protect public health and safety. In the event the NRC fails to do so, my report is intended to assist two environmental organizations, Beyond Nuclear and the Sierra Club, to force an accounting by Duke and the NRC under the National Environmental Policy Act (NEPA). As required by NEPA, Duke and the NRC should fully and accurately evaluate the environmental risks of continuing to operate Oconee in spite of the accident risk, which is now known to be higher than what Duke has presented in its SLR application.

A note about secrecy: A significant portion of the information relied on in this report was not available publicly until members of the public forced NRC to release it by requesting it under

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[1] 2011.01.28 "Safety Evaluation on Confirmatory Action Letter to Address External Flooding Concerns," (ML110280153) ("2011 NRC Safety Evaluation Letter").

the Freedom of Information Act (FOIA). I am grateful to Jim Riccio for FOIA Request FOIA/PA-2012-0325 (submitted on behalf of Greenpeace) and Dave Lochbaum for FOIA Request FOIA/PA-2018-0010 (submitted on behalf of the Union of Concerned Scientists), which generated some of the key information relied on this report. The NRC never attempted to justify withholding this critical, "damming," and now-public safety information from the public eye, nor is any justification evident.

While Duke and the NRC have continued to withhold some information relevant to this report, the information now in the public record is more than sufficient to show that Duke has failed to provide the public with an accurate, up-to-date, and thorough risk analysis of the potential for a serious core melt accident at Oconee Units 1, 2, and 3 during the second license renewal term. In addition, publicly available information is more than sufficient to show that for the past ten years, the NRC has considered the risk of a core melt accident caused by Jocassee Dam failure to implicate the adequacy of protection to public health and safety and require significant measures to prevent catastrophe. By assembling this information into a single document, the author seeks to ensure a measure of accountability by Duke and the NRC that they previously eluded through secrecy.

Finally, while some nonpublic documents are cited in the footnotes to this report, the report does not rely on the content of any of those nonpublic documents. Citations of those documents are provided for completeness of the record, not for their content. When the content of the IPEEE or any other nonpublic document is described in this report, that description is taken from descriptions in publicly available documents.

2. BACKGROUND

2.1 <u>Integrated Design and Operation of Oconee Nuclear Reactors and Upstream Dams</u>

Duke Energy Corp.'s three-unit Oconee Nuclear Plant is located in the mountains of northwestern South Carolina, at the confluence of the Keowee and Little Rivers. Licensed by the U.S. Nuclear Regulatory Commission (NRC) in 1973 and 1974. Oconee is uniquely designed as a pumped storage facility: at the same time the reactors were built, Duke also built two upstream dams, for the purpose of generating additional hydro-powered electricity. When demand for electricity from the reactors was low, the plant could be used to pump water into Jocassee Lake behind the Jocassee Dam. When demand was high, Duke would then allow flow through hydroelectric generators in the dam generating power.

The Jocassee Dam's tailwaters were dammed by the Keowee Dam, below which Duke built the Oconee reactor complex. Two hydrogenerators, built into the side of the Keowee Dam, were designed to provide the nuclear plant with an emergency power supply in the event of a loss of offsite power. The Oconee design did not and does not include diesel-powered emergency generators, which are at every other U.S. nuclear power plants.

Thus, the Jocassee Dam and the Keowee Dam, as well as the lakes behind them, constitute an integral part of the Oconee nuclear power plant, including its backup emergency power supply.

2.2 Jocassee and Keowee Dam Characteristics

Completed in 1971 and licensed by the Federal Energy Regulatory Commission (FERC), the Keowee Dam is a 170 foot-high rock-filled earthen dam about 3,500 feet in length. The Oconee nuclear power plant complex is built into the side of the dam, which contains two hydroelectric generators with a combined output of about 150 MW.[2] These hydroelectric generators provide emergency power to Oconee.

The Keowee Dam lies about 14 miles downstream of the Jocassee Dam. It impounds about one million acre-feet of water and has a surface area of about 18,000 acres. The top of the dam is at 815 feet above mean sea level (MSL). Full pond or normal operating level of Keowee Lake is at 800 ft. Construction of the Keowee Dam was completed in 1971.

Completed in 1975[1] and also licensed by FERC, Jocassee Dam is a rock-filled earthen dam 385 feet high and about 1,000 feet long. It also impounds about a million acre-feet of water in the Jocassee Lake, with an area of 7,565 acres. The lake's pumped storage capability is supplied by four hydroelectric turbines that can be reversed to pump water from below the Jocassee Dam to above the dam.

The top of the Jocassee dam is at 1,125 ft. Full pond operating level of Jocassee Lake (i.e., normal operating level) is 1,110 ft.

2.3 Oconee Nuclear Plant Design and Construction

2.3.1 NRC Safety Requirements for Nuclear Plant Design and Construction

All nuclear power plants constructed after 1973 are required to meet 10 Code of Federal Regulations (CFR) Part 50 Appendix A "General Design Criteria for Nuclear Power Plants," including Criterion 2 – Design Bases for Protection Against Natural Phenomena. General Design Criterion (GDC) 2 states in part:

> Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. …

[2] https://www.duke-energy.com/community/lakes/hydroelectric-relicensing/keowee-toxaway/keowee-toxaway-project.

While Oconee was built prior to 1973 and therefore was not required to meet GDC 2, it was required to meet a similar draft version of the criterion.[3]

2.3.2 Design and Construction of Oconee Units 1, 2 and 3

During initial Oconee licensing, Duke convinced the Atomic Energy Commission (the AEC was the predecessor to the NRC) that a Jocassee Dam failure was not credible. Duke has repeatedly stated that they believe a Jocassee Dam failure is not credible.[4]

Thus, at the earliest point of design and construction, the NRC did not require Duke to protect Oconee from a Jocassee Dam failure. For instance, the turbine building, located at a grade of 796 feet mean sea level MSL), houses portions of the emergency core cooling system (ECCS) and other safety related and important to safety systems, including the service water systems and the 4kv emergency buses. But the NRC did not require Duke to build the turbine building as a watertight structure. As a result, all of the safety equipment inside the turbine building, including the ECCS and the emergency electric power supply to the ECCS, is vulnerable to failure in an external flood that exceeds 796 ft.

2.3.3 Post-construction addition of Safe Shutdown Facility

Sometime prior to 1983, in order to address other Oconee design weakness not related to flooding, Duke decided to install additional equipment to improve Oconee's safety. Duke completed the installation of the safe shutdown facility (SSF) prior to 1983. The SSF is designed to address events including fire, sabotage, turbine building floods, station blackouts and tornado missile events. It contains a single diesel generator capable of supplying sufficient power only for the SSF equipment. It contains pumps capable of supply water to the steam generators and to the reactor coolant systems of all three units and a service water pump only

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[3] The pre-GDC 2 version for Oconee provided that:

> Those systems and components of reactor facilities which are essential to the prevention of accidents which could affect the public health and safety or to mitigation of their consequences shall be designed, fabricated, and erected to performance standards that will enable the facility to withstand, without loss of the capability to protect the public, the additional forces that might be imposed by natural phenomena such as earthquakes, tornadoes, flooding conditions, winds, ice, and other local site effects. The design bases so established shall reflect: (a) appropriate consideration of the most severe of these natural phenomena that have been recorded for the site and the surrounding 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.

FOIA-2013-0239, Oconee Non-concurrence (ML13340A179), Applicable Regulatory Guidance, Page 2

[4] 2008.09.26, Duke Response to 50.54(f) Request (ML082750106), ("2008 Duke 50.54(f) Response Letter") Attachment 2, Page 6. 2009.04.30, NRC Letter to Duke Evaluation of Duke Responses to NRC Letter Dated August 15, 2008, Related to External Flooding at Oconee (ML090570779), Page 2.

capable of cooling the SSF loads. None of this equipment is safety related, single failure proof or redundant. It is manually controlled and operated only locally from the SSF itself. The SSF is at a grade of 796 ft.[5] because the SSF was not intended to be used for external floods, it was not protected from them.

2.4 Flood Risk Studies

2.4.1 1983 Flood Study for FERC and Construction of Wall around SSF

Duke in a 1983 hydrological analysis determined as follows:

"[T]he impacts of flooding from a postulated sunny-day failure of the Jocassee Dam. The results of the study indicated an estimated peak flood elevation of 817.45 ft (249.159 m) MSL at Keowee Dam, and a resulting ONS powerblock flood depth of 4.71 ft (1.436 m). In order to reduce the risk of flooding, the licensee erected walls around the entrances to the Standby Shutdown Facility (SSF) with average wall height of 5 ft (1.5 m). The construction of the walls was not part of the design-basis."[6]

Thus, by 1983 Duke recognized that external flooding was possible and that if Oconee experienced a flood above grade, the flood would incapacitate the ECCS. In that event, Duke would have no way to mitigate the flood.

2.4.2 NSAC-60 Probabilistic Risk Assessment

In the late 1970s and early 1980s Duke initiated one of the first industry-conducted nuclear power plant probabilistic analyses (PRA). The study was prepared by the Nuclear Safety Analysis Center [7] and was called "NSAC-60." NSAC-60 was a full-scope PRA, meaning it included both internal hazards such as loss of coolant accidents (LOCA) and external events such as earthquakes. It included an analysis of core damage frequency (referred to as a "Level 1" analysis), containment failure frequency (referred to as a "Level 2" analysis), and impacts on the surrounding population (referred to as a "Level 3" analysis).

The NSAC-60 analysis included contributions to core melt frequency by failures of the Jocassee and Keowee Dams.[8] As described by Duke, the study "determined the failure frequency for the

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[5] 2018.06.18 NRC Staff Assessment Related to Focused Evaluation for Oconee, Page 3 (ML18141A755).

[6] 2016.04.14 NRC Staff Assessment by the Office of NRR Related to flooding Hazard Reevaluation Report NTTF Recommendation 2.1 Oconee (ML16273A128).

[7] NSAC initially was a separate legal entity, collocated with the Electric Power Research Institute (EPRI). About 1990 it was folded into EPRI.

[8] Nuclear Safety Analysis Center, NSAC-60, "A Probabilistic Risk Assessment of Oconee Unit 3," June 1984.

Jocassee Dam by compiling data for dams with similar attributes." It considered three time periods and derived three median annual failure frequencies for causes other than earthquakes and overtopping:

- 1900 to 1981 2.3x10-5 per year
- 1940 to 1981 1.6x10-5 per year
- 1960 to 1981 1.4x10-5 per year[9]

2.4.3 IPE/IPEEE for Severe Accident Vulnerabilities

In 1988 the NRC issued Generic Letter (GL) 88-20, requesting all reactor licensees submit a "systematic examination" in order to "identify any plant-specific vulnerabilities to severe accidents and report the results to the Commission."[10] Initially, GL-88-20 requested licensees to analyze only internal events such as loss of coolant accidents (LOCA) and transients. The NRC subsequently issued 5 revisions. Among other changes, the revisions, expanded the scope to include external events such as tornados, seismic events and external floods.

In response, in December 1990, Duke submitted an Individual Plant Examination (IPE) that evaluated internal events.[11] In December 1995, Duke submitted an Individual Plant Examination for External Events (IPEEE) that evaluated external events.[12] In 1997, in a nonpublic document, Duke updated the IPE and IPEEE and resubmitted the results.[13]

In the 1995 IPEEE, Duke considered whether and how to evaluate the risks of external flooding at Oconee. First, Duke considered evaluating the risk of a "probable maximum precipitation" (PMP) event at the Oconee site, *i.e.,* a large storm in the direct vicinity of the plant. But Duke screened out a PMP event based on the large size of the reservoirs above the Keowee and Jocassee Dams.

Duke also considered whether to evaluate a Jocassee Dam failure in the IPEEE. In making this evaluation, Duke focused on three types of dam failures: seismic dam failure, random (*i.e.,* "sunny day") dam failure, and a dam failure caused by a PMP above the Jocassee Dam that overtopped the dam (*i.e.,* a dam breach caused by water flowing over the top of the dam).

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[9] US NRC Information Notice 2012-02, Potentially Nonconservative Screening Value for Dam Failure Frequency in PRA, March 5, 2012, Page 2, (ML090510269).

[10] 1988.11.23, NRC Generic Letter 88-20, "Individual Plant Examinations for Severe Accident Vulnerabilities."

[11] 1990.12, Duke IPE (nonpublic). As discussed above in my Note on Secrecy, the IPEE is cited here for purposes of identification. This report does not rely directly on the content of the IPEEE, or any other nonpublic document. When the content of the IPEEE or any other nonpublic document is described in this report, it is taken from descriptions in publicly available documents.

[12] 1995.12.21, Duke IPEEE (nonpublic).

[13] 1996.12, Duke Oconee Nuclear Station PRA Revision 2 Summary Report (ML080780111) (nonpublic).

The IPEEE found that a seismic failure of Jocassee Dam was a dominant contributor to the total Oconee CDF, and calculated the contribution to core damage frequency from a seismic failure of Jocassee at 7.2E-6 per year (i.e., 20% of the total seismic CDF of 3.6E-5).[14]

In evaluating a random or "sunny day" failure, the IPEEE found a CDF of 7.0E-6 per year.[15] In making this estimate, Duke used a dam failure frequency of 1.3E-5 per year, an insignificant decrease from the values derived and used in NSAC-60. [16]

With respect to a PMP-induced Jocassee Dam failure, Duke concluded that such a failure was not credible.[17] Therefore, Duke did not evaluate a PMP-induced Jocassee Dam failure.

2.4.4 1992 Flood Study for FERC

In 1992, Duke performed an "inundation study" to meet a FERC requirement for formulating an emergency action plan in the event that the Jocassee Dam failed. This study showed that approximately 16.5 feet of water would inundate the yard area surrounding the SSF, thereby rendering "inoperable" Oconee's "all systems necessary to shut down and maintain all three units in a safe and stable condition."[18]

2.5 Initial Oconee License Renewal and Severe Accident Mitigation Alternatives Analysis

In July 1998, Duke submitted a license renewal application to NRC, requesting an extension of the Oconee reactors licenses terms by 20 years. The NRC renewed Duke's licenses in May 2000.[19] Duke's Environmental Report for the license renewal application included a Severe Accident Mitigation Alternatives (SAMA) analysis, containing "a review of potential design alternatives … along with any procedural, non-hardware, alternatives." [20] For its risk estimates,

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[14] 1995.12.05, Oconee IPEEE Submittal Report (nonpublic). *See also* 2008 Duke 50.54(f) Response Letter; 1996.07.08, NRC Letter: Draft Reports Related to the Keowee Hydro Station Emergency Electrical System Supply to Oconee (ML15118A442). Total seismic CDF is 3.6E-5 per year (see Page 106) while 20% of this is from a Jocassee Dam failure (Page 107), i.e., 3.6E-5 x 0.2 = 7.2E-6 per year.

[15] 2000.03.15, NRC Letter: Oconee Review of IPEEE (ML003694349), Staff Evaluation at Page 2.

[16] FOIA Response 2012-0325 at Page 17 of 308, (ML15156A702) ("FOIA Response 2012-0325"). *See also* 1996.07.08, NRC Letter: Draft Reports Related to the Keowee Hydro Station Emergency Electrical System Supply to Oconee (ML15118A442), at Page 110.

[17] 1996.07.08, NRC Letter: Draft Reports Related to the Keowee Hydro Station Emergency Electrical System Supply to Oconee (ML15118A442) Section 6.4.1, Page 110. *See also* FOIA Response 2012-0325.

[18] While the inundation study is not a public document, the NRC described it in its 2011 NRC Safety Evaluation Letter.

[19] 2000.05.23, NRC Renews License of Oconee for an Additional 20 Years (ML003718834).

[20] 1998.04, Environmental Report, Application for Renewed Operating Licenses, Oconee Nuclear Station, Units 1, 2, and 3, Attachment K, Page 1 ("1998 SAMA Analysis"). This document appears to be the

the SAMA analysis relied on the IPE/IPEEE risk analyses, as well as a non-public revised IPE/IPEEE submitted in December of 1997, also referred to as "Oconee PRA Revision 2" and "Oconee PRA/IPE Revision 2."[21]

The SAMA analysis started with the total core damage frequency from the IPE/IPEEE of 8.9E-5 per year, with 2.6E-5 per year (29%) from internal events and 6.3E-5 per year (71%) from external events. The external events were broken down as follows:

CDF from External Events[22]

Initiating Events	Frequency (per reactor-year)
Seismic	3.9E-05
Tornado	1.4E-05
External Flood	5.9E-06
Fire	4.5E-06
Total External	6.3E-05

The SAMA analysis considered flooding hazards from a Jocassee Dam failure, apparently in reliance on the NSAC-60 and IPEEE studies.[23] The discussion about a Jocassee Dam failure describes it in the context of "random failures."[24] Based on this statement, it is reasonable to assume that Duke only considered random sunny-day dam failures, ignoring seismic and overtopping, failures. This approach of excluding seismic and overtopping-related dam failures was consistent with the IPEEE.

But the SAMA analysis differed from the IPEEE in the respect that it estimated the external flooding contribution at 5.9E-6 per year, whereas the IPEEE estimated the external flooding contribution at 7E-6. The SAMA analysis did not address or explain this difference.
The SAMA analysis evaluated two alternatives that would impact Jocassee Dam failure consequences. The first alternative was to staff the SSF continuously with a trained operator, and the second was to increase the height of the 5-foot wall protecting the SSF from floods to 10 feet.[25] But Duke determined these alternatives were not cost-effective.[26] Duke also identified a third alternative: strengthening the Jocassee Dam and thus lowering the random

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document identified in Reference 2.8 of the Environmental Report (Page 31), although it is not clear. Reference 2.8 is not a public document.

[21] 1998 SAMA Analysis, Pages 4, 9, 10.

[22] 1998 SAMA Analysis, Page 10.

[23] 1998 SAMA Analysis, Pages 7, 15, 19.

[24] 1998 SAMA Analysis, Page 15.

[25] 1998 SAMA Analysis, Page 16.

[26] 1998 SAMA Analysis, Page 28.

failure frequency. But Duke rejected this alternative without evaluating it, on the ground that the cost would "far exceed the benefit of core damage frequency reduction."[27]

The NRC reviewed the SAMA analysis and concluded: "Based on its review of SAMAs for ONS (Oconee Nuclear Station), the staff concurs that none of the candidate SAMAs are cost beneficial."[28] This included the two evaluated alternatives addressing a Jocassee Dam failure.

2.6 Updated Dam Failure and Flood Routing Evaluations and Related Regulatory Actions

2.6.1 NRC 2006 Significance Determination Process on Oconee Flooding Issue

In November 2006, the NRC completed a "Significance Determination Process" (SDP) evaluation related to a performance deficiency involving a missing covering in the wall protecting the SSF.[29] NRC characterized the missing flood barrier as a violation and determined its significance as a "White" finding.[30] After Duke's appeals of the finding, the NRC affirmed the finding.[31]

Duke's repeated appeals prompted the NRC to re-evaluate the flooding risk at Oconee from a Jocassee Dam failure. While Duke had previously estimated the dam failure rate in the range of 2.3E-5 to 1.4E-5 per year (NSAC-60) and had revised it to 1.3E-5 per year (IPEEE), the NRC found these estimates of failure frequency of the Jocassee dam were too low. In the SDP appeal process the NRC calculated a Jocassee Dam failure rate of 1.8E-4 per year.[32]

2.6.2 NRC 50.54(f) Letter

In 2008, in light of its new understanding from the previously discussed SDP that the Jocassee Dam failure frequency was significantly larger than what Duke had previously represented, NRC issued Duke a 10CFR50.54(f) letter requesting additional information.[33] First, the 50.54(f) letter

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[27] 1998 SAMA Analysis, Page 15.

[28] 1999.12, Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 2, Regarding Oconee, NUREG-1437, Page 5-19.

[29] 2006.11.22, NRC Final Significance Determination for White Finding and Violation (ML063260282) ("2006 NRC White Finding"). The SDP is part of the NRC's reactor oversight process (ROP). The ROP is the NRC's program to inspect, measure and assess the safety performance of operating plants. The SDP is the NRC's process for assessing the significance of findings identified in the ROP.

[30] 2006 White Finding, at Page 1.

[31] 2007.11.20, NRC Reconsideration of Final Significance Determination Associated with SSF Flood Barrier White Finding, (ML073241045) ("2007 NRC Reconsideration of Significance Determination").

[32] 2007 NRC Reconsideration of Significance Determination, Page 1.

[33] 2008.08.15, NRC letter to Duke: Information Request Pursuant to 10CFR50.54(f) Related to External Flooding Including Failure of the Jocassee Dam at Oconee (ML081640244) ("2008 NRC 50.54(f) Letter").

laid out the regulatory requirements applicable to Oconee, and described the status of Duke's flood protection measures:

> Section 3.1.2 of the UFSAR, "Criterion 2 – Performance Standards (Category A)," states, "Those systems and components of reactor facilities which are essential to the prevention of accidents which could affect public health and safety or to mitigation of their consequences 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 current UFSAR discusses 5-foot walls that are used for flood protection at the SSF. However, it does not include the effects of a Jocassee Dam failure, nor does it include the flood protection features to mitigate the consequences of such an event. We further note that in the mid-1990's, the UFSAR was revised by removing the reference to the Jocassee Dam failure and postulated wave height of 4.7 feet in the yard at the Oconee site.*[34]

The letter also references the flood heights calculated from the 1992 FERC analysis. This letter characterizes the 1992 FERC analysis as "12.5 to 16.8 feet,"[35] while the previous discussion of the FERC analysis characterized the same analysis as having a 16.5 foot flood height.[36]

In addition, the NRC's letter requested Duke to address three specific issues:

> 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.
> 2) Provide your assessment of the Inundation Study (the 1992 study conducted for FERC) and why it does or does not represent the expected flood height following a Jocassee Dam failure.
> 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.[37]

In subsequent discussions with Duke, the NRC compared the Jocassee Dam hazard with other hazards considered in the design and licensing basis. It observed that a Jocassee Dam failure frequency of about 2E-4 per year was less than the hazard from general transients, losses of

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[34] 2008 NRC 50.54(f) Letter, Page 1, 9 (emphasis added).

[35] 2008 NRC 50.54(f) Letter, Page 2.

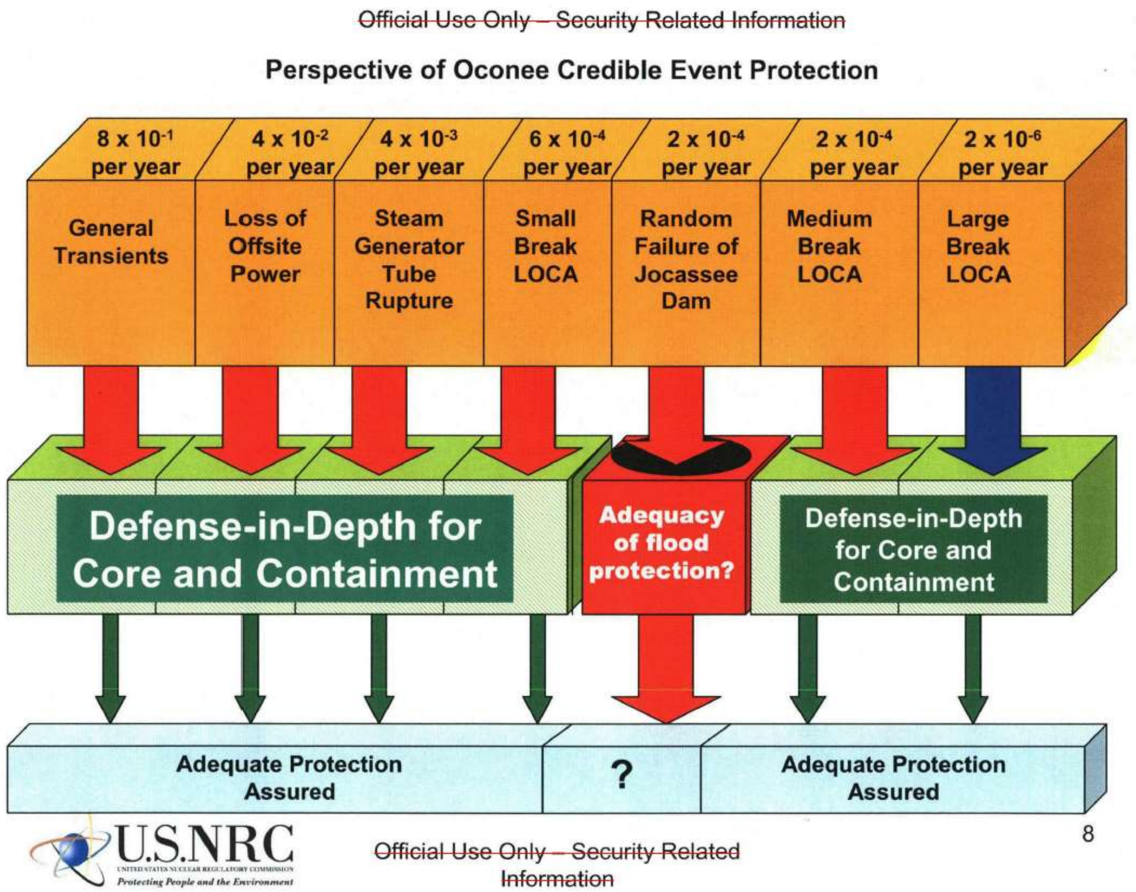
[36] 2011 Safety Evaluation Letter, Safety Evaluation, Page 1.

[37] 2008 NRC 50.54(f) Letter, Page 2.

offsite power, etc., but greater than the hazard from medium and large break LOCAs (see Figure 1 below).[38]

It should be noted here that for all of the other hazards listed, Oconee -- as well as every other US nuclear power plant -- is required to have safety grade, fully redundant, single failure proof ECCS capable of responding. For the Jocassee Dam failure, Oconee had the SSF which is non-safety grade, has no redundancy, is not single failure proof and is not part of the ECCS. Even if the original Jocassee Dam failure rate of 1.3E-5 was correct, this is still an order of magnitude greater than the large LOCA rate of 2E-6 per year which is in the design basis and requires the ECCS to protect the public. At this point in time (2008) the SSF was protected from a Jocassee Dam failure by a 5-foot wall that Duke from its previous analysis knew was inadequate because the hydraulic analysis showed that there was a potential for over 16 feet of water at the SSF.

Figure 1 Oconee Hazard (or Initiating Event) Frequency Comparison Credible Events [39]



[38] 2008.08.28, NRC Presentation Oconee Flood Protection and Jocassee Dam Hazard ("2008 NRC Presentation Oconee"), Slide 8 (ML082550290).

[39] 2008 NRC Presentation Oconee), Slide 8.

2.6.3 Duke's Response to 50.54(f) Letter

Duke responded to NRC's 50.54(f) letter that: "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."[40]

Duke further argued that the higher flood elevations posited by NRC in the 50.54(f) letter were not applicable to Oconee, because they came from the 1992 study Duke had conducted for FERC to establish an Emergency Action Plan (EAP) for the population downstream of Jocassee, and thus was intended to provide a "worst case" analysis rather than "credible" flood levels.[41] After considerable discussion with Duke, the NRC sent a letter in the spring of 2009. This letter states in part: "The NRC staff's position is that a Jocassee Dam failure is a credible event and needs to be addressed deterministically."[42] The letter clearly articulates that the NRC is concerned about adequate protection. For example, it states: "When the inundation study and sensitivity analyses are completed, the NRC staff will evaluate the results to determine whether further regulatory actions are necessary to ensure there is adequate protection against external flooding at Oconee."[43] Finally, the NRC states its expectation of receiving analyses "which would establish an adequate licensing basis for external flooding . . . "[44]

In response to the NRC's concerns, and after further analysis, Duke decided to raise the wall height protecting the SSF by 2.5 feet to a total height of 7.5 feet. It completed this work in February of 2009.[45]

Duke also responded to the NRC's inquiries by performing an additional hydrological analysis of the failure of Jocassee Dam and propagating the resulting flood onto the Keowee Lake and Dam and then onto Oconee. Building on the model in the 1992 study for FERC, Duke modified it and increased the level of detail. Duke reported its preliminary results to the NRC in a presentation on October 28, 2009.[46] Duke had expected the flood heights to decrease by using the new

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[40] 2008.09.26, Duke Letter in Response to 10CFR50.54(f) Request, Attachment 2 Page 3 (ML082750106) ("2008 Duke 50.54(f) Response Letter").

[41] 2008 Duke 50.54(f) Response Letter, Attachment 2 Page 3.

[42] 2009.04.09, NRC letter to Duke Evaluation of Duke September 26, 2008, Response to NRC Letter Dated August 15, 2008, Related to External Flooding at Oconee (ML090570779), Page 2 ("2009 NRC External Flooding Letter").

[43] 2009 NRC External Flooding Letter, Page 3.

[44] 2009 NRC External Flooding Letter, Page 3.

[45] 2009.05.11, Duke Presentation on Oconee External Flood (ML091380424).

[46] 2009.10.28, Duke Presentation on Oconee External Flood with Initial HEC-RAS Results (ML093080034) ("2009 Duke Presentation with Initial HEC-RAS Results").

software and model. However, flood heights increased. The new model, using a conservative but not worst-case scenario, predicted a flood height at the SSF of about 18.5 feet.[47] To resolve this adequate protection issue, NRC required Duke to re-perform the Jocassee Dam failure analysis using conservative input parameters (*i.e*., assumptions) and methods.[48] In response, Duke revised its 1D and 2D analysis. And Duke committed to protecting the SSF based on results from its revised analysis.[49] Protective measures would include increasing the height of the flood barriers protecting the site, protecting an offsite power line from the expected flood conditions and other improvements.[50]

2.6.4 2011 NRC Safety Evaluation

In January of 2011, the NRC transmitted to Duke a Safety Evaluation confirming Duke's approach to the issue resolution. This safety evaluation concluded:

> The NRC staff evaluated the information provided by Duke in their August 2, 2010, letter. The unmitigated Case 2 dam breach parameters that were used in the flooding models, provided by Duke for the ONS site, demonstrated that the licensee has included conservatisms of the parameters utilized in the dam breach scenario. These conservatisms provide the staff with additional assurance that the above Case 2 scenario will bound the inundation at ONS, therefore providing reasonable assurance for the overall flooding scenario at the site. This new flooding scenario is based on a random sunny-day failure of the Jocassee Dam. This Case 2 scenario will be the new flooding basis for the site.[51]

The NRC's Safety Evaluation required Duke to protect the Oconee site from random sunny day failures of the Jocassee Dam to a flood depth of 19.5 feet in order to ensure adequate protection.[52] The requirement was based on conservative deterministic analysis.[53] However, the Safety Evaluation was silent to other relevant Jocassee Dam failure mechanisms including seismic and overtopping even though these mechanisms had been constantly discussed both internally within the NRC and with Duke.

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[47] 2009 Duke Presentation with Initial HEC-RAS Results, Slide 26.

[48] 2010.01.29, NRC letter Evaluation of Duke Response to Related to External Flooding at Oconee (ML100271591), See Enclosure. Using a conservative approach would supply margin and account for uncertainty, and is the norm for design basis and licensing basis issues -- which this adequate protection issue had become.

[49] 2009 Duke Presentation with Initial HEC-RAS Results. Duke had presented examples of these preliminary results in its previous meeting with NRC.

[50] 2010.11.29, Duke Letter: Oconee Response to CAL, Page 2 (ML103490330).

[51] 2011 NRC Safety Evaluation Letter.

[52] 2011 NRC Safety Evaluation Letter, Safety Evaluation at Page 12.

[53] 2011 NRC Safety Evaluation Letter.

In 2010, NRC finalized its own generic dam failure frequency analysis for the Jocassee Dam. [54] The staff estimated generic dam failure rates for large rock-fill dams, "which it considers applicable to the Jocassee Dam," as 2.8E-4 per year.[55] The authors of that analysis and other members of the NRC Staff subsequently performed additional analyses exploring and confirming those results.[56]

In 2012, because the demonstrably erroneous NSAC-60 dam failure rate was widely referenced and used throughout the nuclear industry at that time, the NRC issued an information notice warning of the inadequacies in the dam failure rate found in the NSAC-60 report.[57] According to Information Notice 2012-02, NSAC-60 "provide(d) an insufficient basis for estimating site-specific dam failure frequency."[58]

In 2019, in a more detailed study commissioned by the NRC, Oak Ridge National Laboratory (ORNL) stated:

> NRC has estimated the likelihood of failure of Jocassee dam, upstream of the Oconee Nuclear Station in South Carolina, at approximately 2.8×10-4 per year. This estimate aligns with historical dam failure rates found in literature.[59]

In addition, Duke's own risk analysis calculated that the SSF had a failure probability of about 0.27 or 27%.[60] This is a very high failure probability, orders of magnitude greater than the failure probability estimated by Duke for safety related equipment found in the ECCS.

Thus, the outcome of the multi-year NRC safety evaluation was to increase the flood protection from a Jocassee Dam failure from approximately 5 feet to a new licensing basis height of about 19 feet.

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[54] 2010.03.15, "Generic Failure Rate Evaluation for Jocassee Dam" (ML13039A084). The NRC's generic analysis was published internally and subsequently released via a Freedom of Information Act request. ("2010 Generic Failure Rate Evaluation for Jocassee Dam").

[55] 2010 Generic Failure Rate Evaluation for Jocassee Dam, Page 6.

[56] 2013.07.17, "Uncertainty Analysis for Large Dam Failure Frequencies Based on Historical Data" (ML13198A170); Ferrante, *et al.,* "An Assessment of Large Dam Failure Frequencies Based on Us Historical Data" ANS PSA 2011 International Topical Meeting on Probabilistic Safety Assessment and Analysis, March 13-17, 2011, Wilmington, NC, USA.

[57] NRC Information Notice 2012-2.

[58] NRC Information Notice 2012-02, Page 4.

[59] 2019.12.14, "Current State-of-Practice in Dam Safety Risk Assessment," https://www.osti.gov/servlets/purl/1592163/.

[60] FOIA Response 2012-0325 at Pages 110, 115 of 308.

Ten years later, the 2011 Safety Evaluation and the safety requirements it imposed remain in effect. Duke has not appealed the 2011 Safety Evaluation, nor has the NRC retracted or repudiated it. Yet, there is no record that Duke has completed the required modifications to protect the plant to a flood depth of 19 feet. Nor has the NRC sought to ensure its completion.

2.7 Fukushima – Lessons Learned 50.54(f) Letter and Staff Assessment

In 2011, the Fukushima Dai-chi disaster occurred, with waves as high as 45 feet, leading to core damage and containment failures at three of the six nuclear power plants on the site. A year later, the NRC issued 10CFR50.54(f) letters to all licensees, requesting them to "reevaluate the flooding hazards at their sites against present-day regulatory guidance and methodologies being used for early site permits and combined license reviews."[61]

After Duke submitted responses in 2013 and 2015, the NRC issued a "Staff Assessment."[62] By titling the document a "Staff Assessment" rather than a "Safety Evaluation," the NRC Staff indicated that the document did not have the regulatory equivalence of safety findings. And indeed, the conclusions of the Staff Assessment do not measure Duke's submittal against an NRC safety standard of "reasonable assurance of adequate protection" or "no undue risk." Instead, the Staff measured Duke's submittal against a reasonableness standard. The Staff, for instance, found that "[s]eismically-induced failure of the Jocassee Dam is not a reasonable mode of failure based on current information, present-day methodologies and regulatory guidance."[63] Similarly, the Staff found that [o]vertopping-induced failure of the Jocassee Dam is not reasonable model of failure based on current information, present-day methodologies and regulatory guidance." [64] The NRC also approved Duke's conclusion that a random sunny-day failure was "an unlikely, although reasonable, failure mode."[65]

Because the Staff Assessment did not repudiate or even address the 2011 Safety Evaluation's issues, because it applied the distinctly different and weaker (albeit undefined) standard of "reasonableness" rather than adequate protection, and because it did not even purport to be a

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[61] 2012.03.12 Letter from NRC to all Power Reactor Licensees and Construction Permit Holders re: 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 (ML12053A340), Enclosure 2, Page 1 ("NRC Post-Fukushima 50.54(f) Letter").

[62] 2016.04.14, NRC letter re Oconee Staff Assessment of Response to Request for Information Pursuant to 50.54(f) Flood-Causing Mechanisms Reevaluation (ML15352A207), enclosing NRC Staff Assessment by the Office of NRR Related to flooding Hazard Reevaluation Report NTTF Recommendation 2.1 (M16273A128) ("2016 NRC Letter re 50.54(f) Response"). A redacted version of this document was released in Interim Response 3 to FOIA-2018-0010 on October 26, 2017.

[63] 2016 NRC Letter re 50.54 Response, Enclosure 2, Page 3.

[64] 2016 NRC Letter re 50.54 Response, Enclosure 2, Page 3.

[65] 2016 NRC Letter re 50.54 Response, Enclosure 2, Page 3.

Safety Evaluation, the Staff Assessment cannot be compared to the 2011 Safety Evaluation or presumed to override it in any way.

2.8 Duke's 2021 Subsequent License Renewal Application and SAMA Analysis

In March 2021, Duke submitted a subsequent license renewal application to NRC, requesting an extension of each of the three Oconee reactors' operating licenses terms by an additional 20 years. Like Duke's initial license renewal application in 1998, Duke's SLR application relied on its PRA to look for "insights" into whether there was "new and significant information" that "would provide a significantly different picture of the impacts from severe accidents during the second license renewal period."[66]

Duke first discussed the question of whether it had new and significant information regarding design-basis accidents, and concluded that it identified no new and significant information that would change the conclusion of the 2013 Revised License Renewal Generic Environmental Impact Statement (GEIS) that impacts of design-basis accidents are not significant because "a licensee is required to maintain the plant within acceptable design and performance criteria, including during any license renewal term."[67]

Next, Duke discussed the question of whether it had new and significant information about severe accident impacts.[68] According to Duke, "[p]eriodic updates" to the Oconee PRA have ensured that the PRA includes "relevant changes" to the "plant design, operation and maintenance practices. In addition, PRA updates "include updates to the plant-specific initiating events and equipment data utilized, and improvements in state-of-the-art analysis of severe accidents."[69]

Duke also asserted that it had considered "developments" since the initial license renewal decision which could have "changed the assumptions made concerning severe accident consequences after SAMAs were previously evaluated."[70] Duke then provides a list of six "areas" of "developments" that it reviewed, including internal events, external events, and "risk-beneficial changes in response to the NRC's Fukushima Daiichi Near Term Task Force

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[66] Oconee Environmental Report, Section 4.15, Severe Accident Mitigation Alternatives Analysis ("2021 SAMA Analysis", Page 4-75.

[67] 2021 SAMA Analysis, Page 4-78, citing Generic Environmental Impact Statement for License Renewal, Rev. 1 (NUREG-1437, 2013).

[68] 2021 SAMA Analysis, Page 4-75. In this context, Duke stated that it interprets the term "significance" to relate to both the cost-effectiveness of SAMAs and their "potential to significantly reduce risk to the public." *Id.*

[69] 2021 SAMA Analysis, Page 4-74.

[70] 2021 SAMA Analysis, Page 4-76.

(NTTF)."[71] According to Duke, "[n]o new and significant information was determined" for any of these areas.[72]
Duke provided additional explanation with respect to each of these three areas. With respect to internal events, Duke characterized its updated PRA results as decreasing total CDF for internal events by a small 8% to a value of 2.4E-5 per year.[73] But Duke did not provide any references for this decreased risk estimate.

With respect to external events, Duke asserted that "ONS fire, seismic, high winds, and external flood PRA models have been developed and have been utilized in the quantitative PRA calculation that demonstrated the absence of any potentially significant SAMAs."[74] But Duke supplied no quantitative information regarding the value of the assertedly insignificant change in the external events CDF, nor did it cite any references.

With respect to risk-beneficial changes in response to the NRC's Fukushima Daiichi NTTF, Duke asserted that changes it has made in response to the NTTF recommendations "have not been credited in ONS PRA models.[75]

Thus, according to Duke, "no further analysis is needed" of the NRC's conclusion in the NRC's 2013 Revised License Renewal GEIS that the probability-weighted consequences from severe accidents are small and "no further analysis is needed."[76]

Duke also described its methodology for evaluating whether new and significant information existed that would affect its SAMA analysis. According to Duke, it looked for changes such as identification of new hazards and updated plant risk models using as an example the fire PRA that replaces the IPEEE analysis.[77] Duke also asserted that it determined which changes were significant by using the internal and external Oconee PRA. In addition, the Oconee "fire, seismic, external flood and high wind models are capable of determining impacts to the CDF and (large early release frequency) LERF."[78]

According to Duke, the SAMA analysis evaluated 283 industry SAMAs. All but 45 were qualitatively screened out. ONS-specific SAMAs further "were reviewed to determine if they are

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[71] 2021 SAMA Analysis, Page 4-76.

[72] 2021 SAMA Analysis, Page 4-76.

[73] 2021 SAMA Analysis, Page 4-77.

[74] 2021 SAMA Analysis, Page 4-77.

[75] 2021 SAMA Analysis, Page 4-78.

[76] 2021 SAMA Analysis, Page 4-78, citing Generic Environmental Impact Statement for License Renewal, Rev. 1 (NUREG-1437, 2013).

[77] 2021 SAMA Analysis, Page 4-79.

[78] 2021 SAMA Analysis, Page 4-80.

still applicable.[79] Ultimately, "all SAMAs were screened out either qualitatively or quantitatively," and therefore "the Level 3 PRA was not updated."[80]

3. ANALYSIS

Duke's operating licenses for Oconee Units 1, 2 and 3 will expire in 2033 (Units 1 and 2) and 2034 (Unit 3) unless the NRC approves Duke's SLR application. In that case, Duke will be allowed to operate Oconee until 2053 (Units 1 and 2) and 2054 (Unit 3). In my expert opinion as a nuclear engineer and risk analyst, Duke is now operating Oconee at an unacceptable risk to public health and safety, due to its failure to fully implement flood-protective measures required by NRC in its 2011 Safety Evaluation. The NRC deemed those flood protection measures to be necessary to protect against a core melt accident in the event the Oconee site becomes inundated by failure of the Jocassee Dam. While the NRC has not sought to force Duke to implement those measures, neither has it withdrawn or repudiated the 2011 Safety Evaluation in which it found those measures were necessary to provide adequate protection to public health and safety.

In my years of experience as a NRC safety regulator, this is one of the most serious safety issues I have encountered. Yet, it is my understanding that NRC regulations for license renewal exclude it from the scope of safety issues that may be reviewed, because it does not relate to the aging of Oconee's safety equipment. However, the NRC must also review Duke's SLR application under the National Environmental Policy Act (NEPA), which requires NRC to fully evaluate the environmental impacts of its proposed actions, including the environmental impacts of reasonably foreseeable accidents. Duke must also evaluate the relative costs and benefits of Severe Accident Mitigation Alternatives. Therefore, I have applied my expert skills as a risk analyst to evaluate whether Duke has taken into account all relevant data regarding the likelihood and consequences of a core melt accident caused by failure of the Jocassee Dam. I have also evaluated the adequacy of Duke's SAMA analysis to consider all relevant data. Evaluation of accidents under NEPA, including SAMA analysis, requires the evaluation of the frequency of severe accidents, the consequences of those severe accidents and the evaluation of potential cost-effective mitigation strategies to deal with those consequences.

Level 1 PRA is used to evaluate the frequency of severe accidents while Level 2 and 3 PRA is used to evaluate the consequences. To perform the Level 1 analysis the basic PRA Equation is used:

$$\text{CDF (/yr.)} = \text{IEF (/yr.)} \times \text{CCDP} \quad [81] \qquad \text{[Eq. 1]}$$

[79] 2021 SAMA Analysis, Page 4-81.

[80] 2021 SAMA Analysis, Page 4-79.

[81] Oconee Nuclear Site Adequate Protection Backfit Documented Evaluation (circa 2010), Page 6 (ML14058A015).

Where CDF is the core damage frequency (in events per year), IEF is the initiating event frequency (in events per year) and CCDP is the conditional core damage probability (all probabilities are unit-less). PRA is always intended to be a "best estimate" analysis.

Typical PRA projects start with evaluation of IEF. In the case of external flooding, a thorough analysis would include flooding from all sources. Each hazard (e.g., local intense storms, dam failures, etc.) would be characterized with a hazard curve that supplies a range of intensities (*e.g.*, flood height and flood inundation timing) and the corresponding frequency (in some reports it is characterized as "annual exceedance probabilities"). An example of a flooding hazard curve is shown in Figure 2.

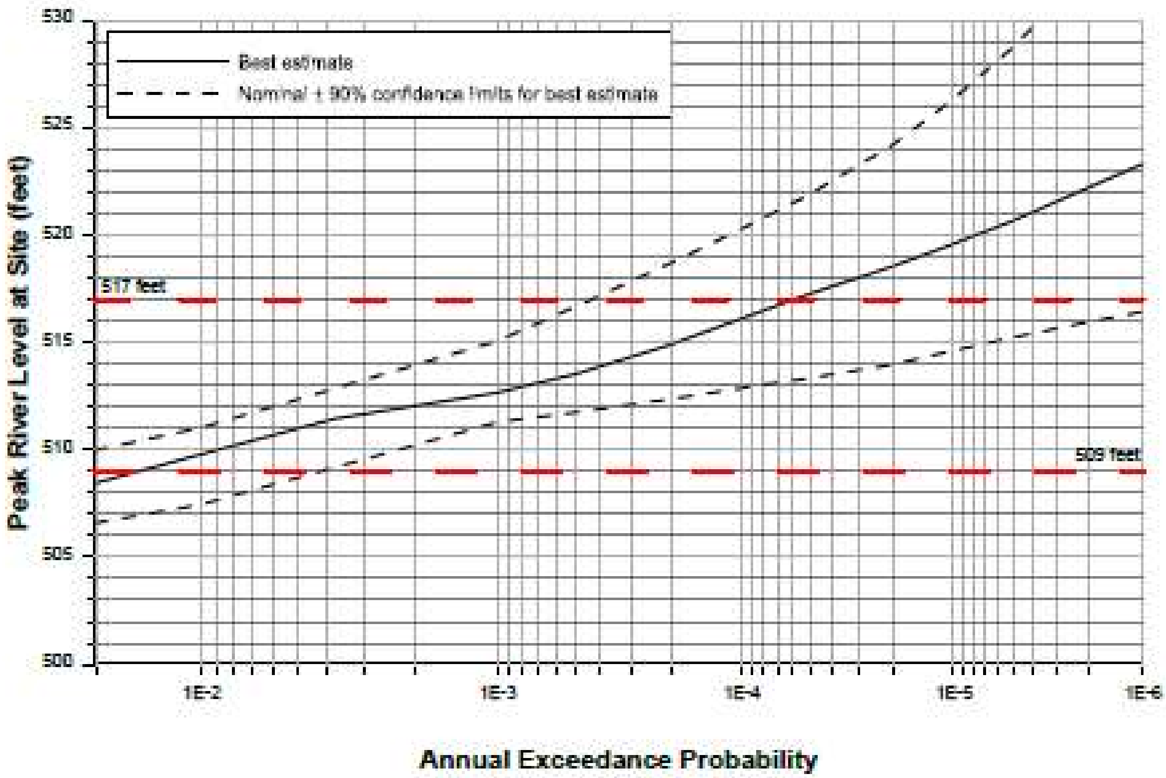

Figure 2 Best Estimate and Approximate 90% Uncertainty Bounds of Peak River Level on the Kankakee River at the Nuclear Plant Site [82]

Duke supplied no flooding hazard information in its SAMA analysis. It simply referred back to the 1998 SAMA, which in turn refers back to the IPEEE. The 1998 SAMA, however, supplied a single value, in contrast to more detailed example hazard curve illustrated in Figure 2. The single value supplied is for a Jocassee Dam failure with a rate of 1.3E-5 per year.[83] That is the only information supplied by Duke about flooding initiating events. But this one data point is insufficient information to obtain any insights from the likelihood of dam failure events.

[82] 2014.08 EPRI Riverine Probabilistic Flooding Hazard Analysis, Figure 8-10, Page 8-9 (3002003013).

[83] FOIA Response 2012-0325 at Page 17 of 308.

Equally important, the limited initiating event information provided in Duke's SAMA analysis is **wrong**. While Duke presents a Jocassee Dam failure rate of 1.3E-5 per year, NRC calculated a best generic failure rate for Jocassee of 2.8E-4 per year – more than twenty times greater.[84] This information is well-known to Duke, because NRC shared its conclusions with Duke in 2008 and followed up with an Information Notice to alert the industry in 2012.[85] This differs from the Duke value by over a factor of 20.

A middle ground between a single point estimate and a comprehensive analysis for each flood hazard would derive a range of flood hazards that would explore the possible spread of risks. Duke could have (but did not) evaluate the range that would capture the spread of postulated outcomes as follows:

1. Flood depths that do not come above grade have the least impact and there is the probability that much of the ECCS will be available for mitigation.

2. Flood depths that come above grade but stay below the top of the protective SSF wall have an intermediate mitigation impact as the ECCS will be incapacitated but SSF should survive and then assigned a random failure probability based on the best available equipment database.

3. Flood depths that rise above the SSF wall have the most severe impact as these floods incapacitate all permanently install mitigation equipment.

After deriving IEF information, thorough PRA practices evaluate a range of mitigating capabilities for each and every previously identified initiating event sequence. In PRA terminology these mitigating strategies are characterized as conditional core damage probabilities (CCDP). The CCDP evaluates the probabilities of each combination of equipment available to cope with the associated hazard. For example, for a large LOCA the associated CCDP would evaluate the failure probabilities of both division of low pressure injection (LPI). It would cover all the combinations that would fail both trains. A few examples combinations that would fail both trains of LPI are:

LPI Train 1 Fails	LPI Train 2 Fails
Train 1 pump fails	Train 2 injection valve fails
Train 1 pump motor fails	Train 2 pump suction valve fails
Train 1 power fails	Train 2 injection valve fails

If Duke had evaluated the three initiating event scenarios described above, it would have derived CCDPs for each scenario. For the first scenario, with Jocassee flooding below grade,

[84] Generic Failure Rate Evaluation for Jocassee Dam.

[85] NRC Information Notice 2012-2.

Duke could have evaluated the failure probability of the ECCS, the SSF and any other equipment that might be available. For the middle scenario where the flood waters come above grade but not to the top of the SSF wall, the ECCS fails (and is given a failure probability of 1.0), but the SSF would not be incapacitated by the flood and thus would be assigned a random failure rate based on historical data. In the final scenario where the flood water come above the SSF wall, the SSF also fails and it would be given a failure probability of 1.0.
Neither Duke's 2021 SAMA analysis nor its 1998 SAMA analysis supplied any information about mitigating equipment failure probabilities. In fact, neither SAMA analysis supplies any CCDP information at all.

However, a minimal amount of CCDP information can be extracted from the limited amount of information that Duke supplied. Equation 1 from above (reproduced below) can be used as a starting point to extract the composite CCDP.

CDF (/yr.) = IEF (/yr.) X CCDP [Eq. 1]

Solving for the CCDP gives us Equation 2:

CCDP = CDF (/yr.) / IEF (/yr.) [Eq. 2]

From the 1998 SAMA analysis, we know that Duke used a flooding external event IEF value of 1.3E-5[86] per year. The corresponding external event flooding CDF is also supplied by the 1998 SAMA analysis in the table reproduced below:

CDF from External Events [87]

Initiating Events	Frequency (per reactor-year)
Seismic	3.9E-05
Tornado	1.4E-05
External Flood	5.9E-06
Fire	4.5E-06
Total External	6.3E-05

Plugging the external flooding IEF and CDF into Equation 2 allows us to find the associated CCDP:

CCDP = CDF (/yr.) / IEF (/yr.) [Eq. 3]

4.5E-1 = 5.9E-6 / 1.3E-5

[86] FOIA Response 2012-0325 at Page 17 of 308.

[87] 1998 SAMA Analysis, Page 10.

Thus, Duke's CCDP for external flooding is 4.5E-1.

If we assume this composite CCDP is correct, we can calculate a corrected best estimate CDF for external flooding events using this CCDP and the NRC's best estimate IEF of 2.8E-4 per year and Equation 1.[88]

CDF (/yr.)	=	IEF (/yr.)	X	CCDP	[Eq. 4]
1.3E-4	=	2.8E-4	X	4.5E-1	

Thus, a corrected external flooding event CDF has value of 1.3E-4 per year, which is more than 20 times higher than Duke's wrong value of 5.9E-6 per year. It should be noted that the data used as input into the NRC's generic Jocassee Dam failure rate calculation does include failures from seismic and overtopping. *See* Section 2.7. Thus, my calculation includes seismic and overtopping contributions.

But the CDF of 1.3E-4 per year assumes that the CCDP of 4.5E-1 derived from the Duke analysis is appropriate. However, in 2008, Duke told the NRC that based on the 1992 inundation study, if the dam fails:

> [T]he 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.[89]

Hidden in this statement is the fact that even Duke believes that if the SSF walls are overtopped, all mitigation fails, including the SSF -- thus resulting in core damage and containment failure. In other words, Duke is saying that the conditional core damage probability (CCDP) given a Jocassee Dam failure which overtops the SSF wall is a given, or has a value of 1.0, not the value of 4.5E-1. If we use this CCDP, i.e., a value of 1.0 then the CDF from a Jocassee Dam failure is equal to the Jocassee Dam failure rate or from Equation 1:

CDF (/yr.)	=	IEF (/yr.)	X	CCDP	[Eq. 5]
2.8E-4	=	2.8E-4	X	1.0	

Revisiting the Jocassee Dam failure rate, we can compare it to other initiating events. The NRC calculated a Jocassee Dam failure rate of 2.8E-4 per year. This value is in the range of LOCAs.

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[88] Generic Failure Rate Evaluation for Jocassee Dam.

[89] 2008 Duke 50.54(f) Response Letter, Attachment 2.

Even the Duke value of 1.3E-5 per year is larger than the value for large LOCA (see Figure 1 above).

Therefore, a reasonable best estimate CDF from a Jocassee Dam failure is 2.8E-4 per year based on the available PRA information, *i.e.,* information supplied by Duke and NRC. This CDF is larger than the total CDF from all Oconee internal events of 2.4E-5 per year.[90] It is also larger than Duke's estimate of 6.3E-5 per year for all external events.[91] In fact, the CDF from Jocassee Dam failure is greater than the sum all Oconee internal and external events of 8.7E-5 per year reported by Duke.

In addition, Duke has ignored the risk contribution from shutdown operations. It is widely understood in the nuclear industry and by the NRC that the risks from shutdown are comparable to those during power operations. But this factor is not addressed in Duke's environmental analysis. Again, this omission significantly undercuts the credibility of the risk analysis.

Like the 2021 SAMA CDF information, the 2021 SAMA analysis supplied almost no information on the large early release frequency (LERF) analysis. But again, we can use the information supplied by Duke elsewhere. In the same quote from the 2008 Duke letter that is provided above, Duke also supplied relevant information about LERF:

> (T)he 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.[92]

It is important to note that Duke presented containment failure as inevitable after the SSF walls are overtopped. Duke did not say the containment might fail, nor did it estimate the probability of containment failure. Duke is telling the NRC that the conditional failure probability of containment given a flood induced core damage event is 1.0. This is PRA language for a LERF multiplier of 1.0. Multiplying the CDF by the LERF multiplier gives us the LERF. With a LERF multiplier of 1.0, the LERF is equal to the CDF.[93] Thus, not only is the CDF from an external flooding event 2.8E-4 per year but the LERF from an external flooding event is 2.8E-4 per year.

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[90] 2021 SAMA Analysis, Page 4-77.

[91] 1998 SAMA Analysis, Page 10.

[92] 2008 NRC 50.54(f) Letter (emphasis added).

[93] 2013.09.23 NRC letter, NMP1 Integrated Inspection Report and Preliminary Greater than Green. Finding, Page A-8 (ML13266A237).

All of the preceding impact discussion is based on Duke's 2008 conclusion of core damage in 8 to 9 hours and a flood height at the SSF between "12.5 to 16.8 feet," which comes from the 1992 inundation analysis performed for FERC.[94] However, the NRC required Duke to perform a new dam failure and flood routing analyses. Duke's new analysis increased the flood height at the SSF to about 19.5 feet.[95]

It is helpful to put these flooding results into perspective. Duke's August 2010 analysis indicated a peak flow across the Keowee Dam and significantly onto the Oconee site, of between 2.3 and 2.8 million cubic feet per second (cfs) and a peak flow across the Oconee intake canal structure of between 0.7 and 0.8 million cfs.[96] As a point of reference, the average flow of the Mississippi River at New Orleans is approximately 0.6 million cfs.[97] The 2010 Duke analysis also tells us that the Keowee Dam is overtopped to an elevation between 834.8 and 839.6 feet msl.[98] Bear in mind that the top of the Keowee Dam and the intake dike are at 815 feet msl, thus the dam is overtopped by some 20 to 25 feet.[99] This is a lot of water on the Oconee site, a site that was never designed to handle any water on site.

These significantly higher CDFs and LERFs would lead to significantly higher risks to the public and the environment. Yet, there is no evidence that Duke's 2021 Environmental Report has considered this new and significant flooding hazard information, the information from the more current dam failure and flood routing study that concluded with the 19.5 feet flood depth or how this would impact the corresponding CDFs or LERFs. Nor has it considered the significant uncertainty on the timing, flood heights and flows, which should be part of any thorough risk assessment.

Furthermore, Duke's SAMA analysis does not reflect any consideration of the extensive work done to incorporate the Jocassee Dam failure and flood routing analysis, even though this work has supplied significant insights into possible additional severe accident mitigating strategies. For instance, although the NRC required significant flood control measures in the 2011 Safety Evaluation, Duke does not mention them at all – either to take credit for them or, if they have not been installed, to explain why not. Duke has also failed to mention some other obvious ways to reduce the flood hazard from Oconee, such as preemptively shutting down the reactors when reservoir water levels get too high, lowering the water levels in the lake behind the Jocassee and Keowee Dams, or lowering the crest elevation of some of the surround earthworks such that they overtop before the Jocassee Dam, thus lowering the flood impacts at

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94 2008 NRC 50.54(f) Letter, Page 1.

95 2011 NRC Safety Evaluation Letter, Page 12.

96 2010.08.02 Duke letter Oconee Response to CAL, Attachment 1, Table 1, Page 4 (ML102170006) ("2010.08.02 Duke Oconee Response to CAL").

97 National Park Service, "Mississippi River Facts," https://www.nps.gov/miss/riverfacts.htm.

98 2010.08.02 Duke Oconee Response to CAL, Attachment 1, Table 2, Page 9.

99 2011 NRC Safety Evaluation Letter, Page 12.

ONS. PRA is a valuable tool for identifying vulnerabilities (and suggesting associated corrective measures), evaluating the costs and benefits of these measures, and also prioritizing them for their effectiveness. Unfortunately, the public has not benefited from a thorough and comprehensive external events flooding PRA.

Another significant shortcoming of Duke's risk analysis is Duke's failure to consider other Jocassee Dam failure mechanisms besides random sunny-day failures. Duke ignores seismic failures and overtopping failures, although they are both comparable contributors to public and environmental risk. Seismic failure could cause the dam to fail faster and overtopping failures would include additional water volumes behind the Jocassee Dam and potentially the Keowee Dam both scenarios could increase the flood volumes and heights at Oconee.

Therefore, not only has Duke's Environmental Report failed to address new and significant information, of which it is fully aware and which significantly bears on its environmental impact analysis and SAMA analysis but it has failed to correct probability estimates that are demonstrably **wrong.** Duke should be required to update its Environmental Report, taking in the new and significant information that significantly affects its previous conclusions that the environmental impacts of renewing the Oconee license are insignificant and that no cost-effective mitigative measures exist.

4. CONCLUSION

The history of the NRC's regulation of the Oconee reactors presents grave concerns in several significant respects.

First and foremost, from a regulatory perspective, it is unacceptable that the NRC has allowed Duke to operate for the past ten years without completing flood protection measures that NRC required ten years ago in 2011 to protect the public from the undue risk of a core melt accident caused by failure of the Jocassee Dam.

Second, the NRC's silence on this matter for the past ten years is inexcusable. The NRC should stand by its judgment, which it has never repudiated or withdrawn, that protection of public health and safety requires installation of substantial additional flood protection measures.

Finally, Duke has consistently downplayed the severity of the risk posed by the Jocassee Dam, to the point that it now seeks approval of a second license term for its three Oconee reactors, based on flood risk estimates that are demonstrably incorrect, incomplete, and poorly conducted. Duke has ignored data in its own possession showing that the risk of a core melt accident with subsequent containment failure caused by Jocassee Dam failure is significantly higher than Duke asserts. Duke has also ignored significant additional contributors to core damage frequency, including seismically induced dam failure, overtopping, and outages. Of course, climate change will only make the flood results and effects worse.

SLR Proceeding: a moment of crisis and opportunity: The NRC's SLR proceeding provides the agency with an opportunity to restore public confidence in its commitment to ensure public health and safety, by ending its silence regarding the crucially important 2011 Safety Evaluation, and by requiring Duke to complete the flood protection measures required ten years ago. The NRC should also require Duke to prepare a new environmental risk analysis that uses correct, complete, and up-to-date methods and data. Finally, Duke should account for its failure to implement mitigative measures required by the NRC ten years ago for adequate protection, and now ignored in Duke's SLR application.

MITMAN DECLARATION

EXHIBIT 2

CURRICULUM VITAE FOR JEFFREY T. MITMAN

Rockville, MD

Project Management / PRA Position in the Nuclear Industry

QUALIFICATIONS

Senior Reliability and Risk Analyst with more than 35 years experience in the Nuclear Industry. Responsible for managing risk analysis projects and teams. Solid record of bringing projects in on schedule and budget.

MAJOR ACCOMPLISHMENTS

- Transitioned NRC to detailed PRA models for low power and shutdown significance determinations process evaluations.
- Guided development of and managed industry's first configuration risk management software tool.
- Obtained regulatory approval of EPRI's RI-ISI methodology.
- Managed first PRA of bolted spent fuel storage cask.

EXPERIENCE

US NUCLEAR REGULATORY COMMISSION (Rockville, MD) 2005 - 2021

Senior Reliability and Risk Analyst (NRC Office of Nuclear Reactor Regulation)

- Conducted Significance Determination Process (SDP) evaluations of reactor events including development and/or modification of required models.
- Lead analyst for low power and shutdown event issues and concerns.
- Guided development of shutdown Standardized Plant Analysis Risk (SPAR) models.
- Conducted Human Reliability Analysis (HRA).
- Evaluated external event risk from dam failures.
- Participated in post NRC's Fukushima NTTF flooding guidance development.
- Developed NRC's guidance on crediting FLEX in risk-informed regulatory applications.
- Advised NRC NFPA-805 team on issues related to shutdown fire risk.
- Performed evaluations of risk informed license applications.

Reliability and Risk Analyst (NRC Office of Nuclear Regulatory Research)

- Project Manager for the development of shutdown SPAR models

ERIN ENGINEERING AND RESEARCH, INC. (Walnut Creek, CA) 2004 - 2005

Lead Senior Engineer

- Configuration risk management evaluation of at-power fire risk.
- Configuration risk management evaluation of loss of offsite power.

ABE STAFFING SERVICES (Palo Alto, CA) 2003 - 2005

Consultant to EPRI

- Brought project to closure involving Dry Cask Storage PRA project and team, involving Transnuclear bolted cask containing PWR fuel.

EPRI (Palo Alto, CA) 1998 - 2003

Project Manager

- **Outage Risk Assessment and Management** (ORAM-Sentinel): Grew first of a kind software application for performing configuration risk management in nuclear power plants.
    - Conducted research in low power and shutdown risk; shutdown initiating event and event frequency derivation.
    - Delivered multiple versions (including alpha, beta & production), testing and full documentation.
    - Administered utility user group, marketing, contract preparation, technology transfer, technical report publication and training.
    - Actively managed both development and application contracts with multiple suppliers and customers. Managed annual $1M budget.

- **Dry Cask Storage PRA**: Initiated innovative analysis of Transnuclear cask containing PWR fuel.
  - Managed unique team with diverse experience in both cask design and PRA backgrounds.
- **Risk Informed In-service Inspections** Project (RI-ISI): Lead team in obtaining regulatory approval of methodology to safely reduce piping weld inspection requirements using combination of probabilistic and degradation analysis.
  - Responsible for methodology finalization and acceptance by industry and U.S. NRC.
  - Conducted marketing, sales, contract preparation, technology transfer, training and technical report publication.
  - Actively managed both development and application contracts with both suppliers and customers. Managed annual $1M budget.
- **Human Reliability Analysis Project**: Managed project to bring consistency to on industry use of HRA methods.
  - Responsible for EPRI HRA area, including development of HRA Calculator software and establishment of associated users group.

ERIN ENGINEERING AND RESEARCH, INC. (Palo Alto, CA) 1992 - 1998
Lead Senior Engineer
Collaborated with EPRI ORAM-SENTINEL Project Manager in project development and administration, user group administration, contract preparation, technology transfer workshops, technical report generation and editing. Performed ORAM analysis of the Diablo Canyon plant. Performed ORAM Probabilistic Analysis of Perry spent fuel pool. Drafted and edited ORAM V2.0 User's Manual. Assisted in ORAM-SENTINEL software design, performed software debugging. Principle researcher and author of BWR outage contingency report. Prepared marketing and training, materials.

ABB IMPELL CORPORATION (King of Prussia, PA) 1990 - 1992
Lead Senior Engineer

- **Design Basis Documentation**: directed team of three engineers to review PECO Feedwater System Design. Wrote Design Basis Documentation reports for Limerick and Peach Bottom power plants, identifying licensing and design concerns by reviewing the system design as documented in drawings, calculations, vendor manuals, Technical Specifications, UFSAR, SER, SRP, 10CFR50.59 safety evaluations etc. and by interfacing with utility engineering personnel. Prepared Engineering Change Requests as necessary.
- **Shift Outages**: during Limerick Nuclear Power Plant refueling / maintenance outage. Coordinated all shift maintenance work and testing. Collaborated with all groups in power plant, allocating resources as needed to maintain schedule and reporting to senior plant outage management. Performed system reviews prior to placing them back in service. Conducted shift outage meetings. Tracked work group performance against schedule. Advised utility management on techniques for schedule and outage organizational improvements.

GENERAL ELECTRIC COMPANY (San Jose, CA) Experience Prior to 1990
Startup-Test Engineer

- **Shift Startup Engineer:** During power ascension phase coordinated all system testing on shift and startup interface with operations. During preoperational phase, acted as operations shift supervisor responsible for coordinating all system testing and flushing on shift from main control room. Updated senior utility management daily on testing status.
- **Additional positions:** Shift Technical Advisor, Test Engineer, Lead QC / Welding Inspector

EDUCATION / PROFESSIONAL DEVELOPMENT

- BSE, Nuclear Engineering, University of Michigan, Ann Arbor, MI
- Introductory VBA class, University of California, Berkeley, CA
- Misc. business courses at various colleges and universities
- Senior Reactor Operator Certified
- GE Station Nuclear Engineering
- Effective Utilization of PSA, ERIN Engineering & Research, Walnut Creek, CA.

PROFESSIONAL ASSOCIATIONS

- American Nuclear Society (ANS) member since 1978
- ANS Risk Informed Standards Committee (RISC)
- ANS Risk Informed Standards Writing Group on Shutdown PRA Standard
- ASME Section XI, Working Group on Implementation of Risk Based Examination
- MIT Professional Summer Programs Guest Lecturer at Risk-Informed Operational Decision Management Course

Reports and Papers

by

Jeffrey T. Mitman

As of September 2021

Papers:

1. Technical Challenges Associated with Shutdown Risk when Licensing Advanced Light Water Reactors, PSAM12 2014. Co-author.
2. Potentially Non-conservative Screening Value for Dam Failure Frequency in PRA, US NRC Information Notice 2012-02 (ML090510269). Co-author and technical point of contact.
3. Comparing Various HRA Methods to Evaluate Their Impact on the results of a Shutdown Risk Analysis during PWR Reduced Inventory, PSAM11 2012. Co-author.
4. Uncertainty Analysis for Large Dam Failure Frequencies Based on Historical Data, PSAM11 2012. Co-author.
5. An Assessment of Large Dam Failure Frequencies Based on US Historical Data, PSA 2011. Co-author.
6. Generic Failure Rate Evaluation for Jocassee Dam, US NRC (ML13039A084), 2010. Co-author.
7. Development of PRA Model for BWR Shutdown Modes 4 and 5 Integrated in SPAR Model, to be presented at PSAM10 2010. Co-author.
8. Development of Standardized Probabilistic Risk Assessment Models for Shutdown Operations Integrated in SPAR Level 1 Model, PSAM9 2008. Co-author.
9. Probabilistic Risk Assessment of Bolted Dry Spent Fuel Storage Cask, Presented at ICONE12. 2004. Co-author.
10. Low Power and Shutdown Risk Assessment Benchmarking, Presented at PSA 02 2002. Co-author.
11. EPRI Human Reliability Analysis Guidelines, Presented at PSA 02 2002. Co-author.
12. Derivation of Shutdown Initiating Event Frequencies, Presented at PSAM5 2000. Co-author.
13. Quantitative Assessment of a Risk Informed Inspection Strategy for BWR Weld Overlays, Presented at ICONE 8 2000. Co-author.
14. EPRI RI-ISI Methodology and the Risk Impacts of Implementation, Presented at SMiRT 11 1999. Co-author.
15. Application of Markov Models and Service Data to Evaluate the Influence of Inspection on Pipe Rupture Frequencies published. PVP 1999. Co-author.
16. Progress in Risk Evaluation of Outages, International Conference on the Commercial and Operational Benefits of PSA. 1997. Co-author.
17. Control of Reactor Vessel Temperature/Pressure during Shutdown, GE SIL 357. June 1981. Co-author.

Software:

1. HRA Calculator Version 2.0, EPRI 2003. 1003330. Project Manager (PM).
2. ORAM-Sentinel Version 3.4, EPRI 2001. 1002958. PM and co-author.

Reports/Standards:

1. "Requirements for Low Power and Shutdown PRA - ANS/ASME-58.22-2014 (Trial Use Standard)."
2. "Probabilistic Risk Assessment (PRA) of Bolted Storage Casks: Quantification and Analysis Report," EPRI 2003. 1002877. PM.
3. "Low Power and Shutdown Risk Assessment Benchmarking Study," EPRI, Palo Alto, CA and U.S. DOE. 2002. 1003465. PM and principal investigator.
4. "Dry Cask Storage PRA Scoping Study," EPRI 2002. 1003011. PM.
5. "Guidance for Incorporating Organizational Factors into Nuclear Power Plant Risk Assessments: Phase 1 Workshop." EPRI and U.S. DOE 2002. 1003322. PM.
6. "An Analysis of Loss of Decay Heat Removal Trends and Initiating event Frequencies (1989-2000)": EPRI 2001. 1003113. PM.
7. "Piping System Failure Rates and Rupture Frequencies for Use in Risk Informed In-service Inspection Applications": TR-111880-NP, EPRI 2000. 1001044. PM
8. "Application of Risk-Informed Inservice Inspection Alternative Element Selection Criteria." EPRI, Charlotte NC: 2000. TE-11482. PM.
9. "Revised Risk-Informed Inservice Inspection Evaluation Procedure," EPRI 1999. TR-112657 Revision B-A. PM & co-author.
10. "Piping System Failure Rates and Rupture Frequencies for Use in Risk Informed In-service Inspection Applications," EPRI 1999. TR-111880. PM
11. "Comparison between EDF and EPRI of Pipe Inspection Optimization Methods," EPRI Palo Alto, CA; Electricite de France, Paris, France: 1999. TR-113315. PM.
12. "Economic Feasibility Study of Implementing RBISI at 2-loop PWR," EPRI 1998. TR-107613. PM.
13. "Evaluation of Pipe Failure Potential via Degradation Mechanism Assessment," EPRI Palo Alto, CA: 1998. TR-110157. PM.
14. "Piping Failures in U.S. Nuclear Power Plants: 1961-1997," EPRI 1998.TR-110102. PM.
15. "Piping System Reliability Models and Database for used in Risk Informed Inservice Inspection Applications," EPRI 1998. TR-110161. PM.
16. "Use of Risk Informed Inspection Methodology for BWR Class 1 Piping," EPRI 1998. TR-110701. PM.
17. "ORAM v4.0 Functional Specification Outline," EPRI 1999. TR-111652. PM.
18. "Survey on the Use of Configuration Risk and Safety Management Tools at NPPs," EPRI, 1998. TR-102975. PM.
19. "ORAM-SENTINEL Demonstration at Diablo Canyon," EPRI 1998. TR-110739. PM.
20. "ORAM-SENTINEL Development at Indian Point 3,"EPRI 1999, TR-110716. PM.
21. "ORAM-SENTINEL Development and ORAM Integration at Oconee," EPRI 1998. TR-111207. PM.
22. "ORAM-SENTINEL Development at Fitzpatrick," EPRI 1998. TR-110505. PM.
23. "ORAM-SENTINEL Demonstration at Sequoyah," EPRI 1998. TR-110771. PM.
24. "SENTINEL Technical Basis Report for Limerick," EPRI 1998. TR-108953. PM.
25. "Outage Risk Assessment and Management Implementation at Fermi 2," EPRI 1997. TR-109013. Co-author.
26. "Contingency Strategies for BWRs during Potential Shutdown Operations Events," EPRI 1993. TR-102973. Principal investigator.
27. "Generic Outage Risk Management Guidelines for BWRs," EPRI 1993. TR-102971. Co-principal investigator.

PETITIONERS' HEARING REQUEST AND WAIVER PETITION

ATTACHMENT 2A

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE SECRETARY

In the Matter of	)	
Duke Energy Carolinas, LLC	)	Docket Nos. 50-269/270/287 SLR
Oconee Nuclear Station,	)	
Units 1, 2 and 3	)	

DECLARATION OF JANE F. POWELL

Under penalty of perjury, Jane F. Powell declares as follows:

1) My name is Jane F. Powell. I am a member of the Beyond Nuclear.

2) I live at 1098 Doug Hollow Road, Seneca, SC 29672.

3) My home is located within the 50-mile emergency planning zone (EPZ) of the Oconee Nuclear Power Station, for which Duke Energy Carolinas LLC (Duke) has submitted an application to the U.S. Nuclear Regulatory Commission for the Subsequent License Renewal of its operating license. All three Oconee units have previously received a 20-year license extension on their original 40-year operating licenses.

4) Based on the historical experience of nuclear power stations, I believe that these facilities are inherently dangerous. Continued operations of Oconee Nuclear Power Station for an additional 20 years beyond the three reactors' current license expiration dates could cause a severe nuclear accident in the reactor(s) and/or irradiated fuel storage pool(s) thereby causing death, injury, illness, dislocation, and economic damage to me and my family. It could also cause devastating environmental damage.

5) I believe that Duke's application to extend operations of Oconee Nuclear Station from 60 to 80 years is inadequate to reasonably assure the protection of my health, safety and the environment. Therefore, I have authorized the Beyond Nuclear to represent my interests in this proceeding.

Jane F Powell (signature) — 9/21/21

Jane F. Powell — DATE

PETITIONERS' HEARING REQUEST AND WAIVER PETITION

ATTACHMENT 2B

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

In the Matter of	)	
Duke Energy Carolinas, LLC	)	Docket Nos. 50-269/270/287 SLR
Oconee Nuclear Station,	)	
Units 1, 2 and 3	)	

DECLARATION OF FRANK M. POWELL

Under penalty of perjury, Frank M. Powell declares as follows:

1) My name is Frank M. Powell. I am a member of the Sierra Club.

2) I live at 1098 Doug Hollow Road, Seneca, SC 29672.

3) My home is located within the 50-mile emergency planning zone (EPZ) of the Oconee Nuclear Power Station, for which Duke Energy Carolinas LLC (Duke) has submitted an application to the U.S. Nuclear Regulatory Commission for the Subsequent License Renewal of its operating license. All three Oconee units have previously received a 20-year license extension on their original 40-year operating licenses.

4) Based on the historical experience of nuclear power stations, I believe that these facilities are inherently dangerous. Continued operations of Oconee Nuclear Power Station for an additional 20 years beyond the three reactors' current license expiration dates could cause a severe nuclear accident in the reactor(s) and/or irradiated fuel storage pool(s) thereby causing death, injury, illness, dislocation, and economic damage to me and my family. It could also cause devastating environmental damage.

5) I believe that Duke's application to extend operations of Oconee Nuclear Station from 60 to 80 years is inadequate to reasonably assure the protection of my health, safety and the environment. Therefore, I have authorized the Sierra Club to represent my interests in this proceeding.

Frank M. Powell (signature) — 9/21/21

Frank M. Powell — DATE

PETITIONERS' HEARING REQUEST AND WAIVER PETITION

ATTACHMENT 2C

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE SECRETARY

In the Matter of Duke Energy Carolinas, LLC Oconee Nuclear Station, Units 1, 2 & 3	)))))	Docket Nos. 50-269/270/287 SLR

DECLARATION OF ROSELLEN ALEGUIRE

Under penalty of perjury, Rosellen Aleguire declares as follows:

1) My name is. Rosellen Aleguire. I am a member of the Sierra Club.

2) I live at 145 Gladys Circle, Fair Play, SC 29643.

3) My home is located within the 50-mile emergency planning zone (EPZ) of the Oconee Nuclear Power Station, for which Duke Energy Carolinas LLC (Duke) has submitted an application to the U.S. Nuclear Regulatory Commission for the Subsequent License Renewal of its operating license. All three Oconee units have previously received a 20-year license extension on their original 40-year operating licenses.

4) Based on the historical experience of nuclear power stations, I believe that these facilities are inherently dangerous. Continued operations of Oconee Nuclear Power Station for an additional 20 years beyond the three reactors' current license expiration dates could cause a severe nuclear accident in the reactor(s) and/or irradiated fuel storage pool(s) thereby causing death, injury, illness, dislocation, and economic damage to me and my family. It could also cause devastating environmental damage.

5) I believe that Duke's application to extend operations of Oconee Nuclear Station from 60 to 80 years is inadequate to reasonably assure the protection of my health, safety and the environment. Therefore, I have authorized the Sierra Club to represent my interests in this proceeding.

Rosellen Aleguire [signature] — Rosellen Aleguire

09/23/2021 — DATE

PETITIONERS' HEARING REQUEST AND WAIVER PETITION

ATTACHMENT 3

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE SECRETARY

In the Matter of	)	
Duke Energy Carolinas, LLC	)	Docket Nos. 50-269/270/287 SLR
Oconee Nuclear Station,	)	
Units 1, 2 & 3	)	

DECLARATION OF DIANE CURRAN IN SUPPORT OF PETITION FOR WAIVER OF 10 C.F.R. §§ 51.53(c)(3)(i), 51.53(c)(ii)(L), 51.71(d), 51.95(c)(1), AND 10 C.F.R. SUPBART A, APPENDIX B, TABLE B-1 TO ALLOW CONSIDERATION OF CATEGORY 1 NEPA ISSUES AND SAMA ISSUES

Under penalty of perjury, I, Diane Curran state as follows:

1. I am an attorney for Petitioners Beyond Nuclear, Inc. and Sierra Club, Inc. in the above-captioned subsequent license renewal proceeding.

2. I am qualified by my legal training and professional experience as an expert on the Atomic Energy Act, the National Environmental Policy Act ("NEPA"), judicial opinions interpreting those statutes, and regulations and decisions of the U.S. Nuclear Regulatory Commission ("NRC") interpreting those statutes. My expertise extends to NRC regulations and decisions regarding reactor license renewal and subsequent license renewal. I also have a general understanding of technical issues related to nuclear reactor safety and environmental impact analysis, at a level that is sufficient for me to make a reasonable evaluation of NRC technical correspondence and reports on safety and environmental issues.

3. My legal training consists of a Juris Doctor degree from the University of Maryland. My professional experience consists of more than 35 years of providing legal representation to citizen groups and state and local governments in NRC licensing and enforcement proceedings, including license renewal proceedings and subsequent license renewal proceedings.

4. The purpose of my declaration is to support Petitioners' Petition for Waiver of 10 C.F.R. §§ 51.53(c)(3)(i), 51.53(c)(ii)(L), 51.71(d), 51.95(c)(1), and 10 C.F.R. Part 51, Subpart A, Appendix B, Table B-1 to Allow Consideration of Category 1 NEPA Issues ("Waiver Petition"). The Petition is presented in Section V of Hearing Request and Petition to Intervene by Beyond Nuclear and the Sierra Club (Sept. 27, 2021) ("Hearing Request"), which has been submitted to the NRC.

5. I am responsible for the contents of the Waiver Petition, including its assertion that application of the regulations from which Petitioners seek an exemption would not serve the purposes for which the rules were adopted. I am also responsible for identifying, with particularity, the specific aspects of the subject matter of this proceeding that should be

considered in a full environmental analysis that is compliant with the procedural requirements of the National Environmental Policy Act ("NEPA").

6. The factual assertions in the Waiver Petition and Hearing Request are based on the expert opinion of Mr. Jeffrey Mitman, as set forth in his Declaration (Attachment 1 to Petitioners'Hearing Request) and his Expert Report, NRC Relicensing Crisis at Oconee Nuclear Station: *Stop Duke From Sending Safety Over the Jocassee Dam* (Sept. 2021) (Exhibit 1 to Mr. Mitman's Declaration). Mr. Mitman's Expert Report, in turn, is based on publicly available documents generated by Duke Energy Corp. ("Duke") and the NRC.

7. I have no reason to question the veracity of the facts recited by Mr. Mitman or the reliability of his expert opinion. Thus, my representation of the content of his Expert Report and the documents he relies on is true and correct to the best of my knowledge. And the legal opinions expressed in the Waiver Petition are based on my best professional judgment.

______________________________ September 27, 2021

Diane Curran