Oconee Nuclear Site
Adequate Protection Backfit
Documented Evaluation

~~**OBJECTIVES OF THE MODIFICATION**~~

~~The licensee of the Oconee Nuclear Site (ONS) has not demonstrated that the site has adequate protection against external floods arising from dam rupture.~~
Adequate Protection Backfit Discussion
[add fuller discussion to further flesh out this intro topic/paragraph]

This evaluation is a backfit exception which is defined in 10 CFR 50.109 (a) (4) (ii) as, "*That regulatory action is necessary to ensure that the facility provides adequate protection to the health and safety of the public and is in accord with the common defense and security*". ~~The objective is for the licensee to provide the necessary engineering modifications to ensure adequate protection against such external floods to allow for safe shutdown and spent fuel pool cooling of all three ONS units.~~

OBJECTIVES OF THE MODIFICATION

The licensee of the Oconee Nuclear Site (ONS) has not demonstrated that the site has adequate protection against external floods arising including dam rupture. The objective is for the licensee to provide the necessary engineering modifications to ensure adequate protection against such external floods to allow for safe shutdown and spent fuel pool cooling of all three ONS units.

REASON FOR THE LICENSE MODIFICATION

An external flood at the Oconee site is expected to render the switchyard and Keowee Dam unavailable which are the only sources of offsite and emergency onsite ac power, respectively. Under this condition, the Standby Shutdown Facility (SSF) was designed to be the sole source of makeup, cooling, and power to shut all three Oconee units down and maintain them in a Mode 3 (hot standby) condition as well as provide spent fuel pool cooling. [provide a fuller discussion of the importance of the SSF—take Jeff M's early writeup that was proposed as input to the letter to Duke] The entrances to the SSF are protected by a 5 foot wall [now 7.5 foot] for external flood protection. One such source of flood to the ONS is from rupture of the Jocassee Dam, a pumped storage hydro-electric facility located approximately 18 miles [check this—think it's 11 miles] upstream of the site. A Jocassee Dam failure inundation study [1992] was performed ~~as part of~~ the to comply with a Federal Energy Regulatory Commission (FERC) ~~license of the dam as a~~ requirement to develop an appropriate ~~of the~~ Emergency Action Plan (EAP) for areas surrounding the dam. It takes into account rupture of the dam due to random "sunny day" failure and Probable Maximum Flood (PMF), a worst-case condition. The predicted resultant water levels, ranging from 12.5 feet to 16.8 feet at SSF grade, ~~were found~~ to be in excess of the existing flood mitigation barrier wall height for the SSF when floodwater reaches the Oconee site. The subsequent failure of the SSF, based on current analyses and without ~~further mitigation~~, will lead to failure of the only means to shut down and maintain all three Oconee units in a Mode 3 condition as well as cool the spent fuel pools. Therefore, without the

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ability to shut down and cool the spent fuel pools, the Oconee site does not have adequate protection against external flood from a rupture of Jocassee Dam.

BASIS FOR INVOKING BACKFIT EXCEPTION

At our LIC-504 meeting, we defined 2 reasons that this was an AP backfit: (1) lack of defense in depth—this needs to be developed fully here or some other appropriate place in the evaluation rather than being mentioned for the first timein the closing paragraph and (2) failure to meet our current regulations which define the floor for AP—it would be useful to quote some of the key statements from Fernando's document on applicable regulatory standards in addition to the draft GDC. Both of these reasons need to be fully developed in the assessment.

1. To account for external flood protection, Oconee is licensed to a draft General Design Criterion (GDC) 2 which states:

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

2. The Oconee UFSAR[1] further states that: [not clear to me why this quote is here—if it adds value, that needs to be clearly explained]

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

[1] Duke Energy Company Updated Final Safety Analysis Report, Revision 17, December 31, 2007.

*provided for **flooding that does not exceed 801 feet above mean sea level**." [801 feet above mean sea level corresponds to 5 feet above SSF entrance grade level].*

"Duke has designed the Keowee Dam, Little River Dam, Jocassee Dam, Intake Canal Dike, and the Intake Canal Submerged Weir based on sound Civil Engineering methods and criteria. These designs have been reviewed by a board of consultants and reviewed and approved by the Federal Power Commission in accordance with the license issued by that agency. The Keowee Dam, Little River Dam, Jocassee Dam, Intake Canal Dike, and the Intake Canal Submerged Weir have also been designed to have an adequate factor of safety under the same conditions of seismic loading as used for design of Oconee. The construction, maintenance, and inspection of the dams are consistent with their functions as major hydro projects. The safety of such structures is the major objective of Duke's designers and builders, with or without the presence of the nuclear station."

The licensee does not directly address the failure of Jocassee Dam in the UFSAR. Instead, the licensee has made the assumption [where?] that failure of Jocassee Dam can not occur based on the robustness of methods used in the design, construction, and operation of the dam. There is no evidence to suggest that Jocassee Dam has unique features which make its failure incredible. The NRC ~~staff~~ [delete staff each time—this is an NRC document] has concluded that such failure is indeed a credible event which is well-documented in industry failure data on dams. The frequency, which is within 10^{-4} per year, places dam failure in the range of the frequency of other events considered in the accident analyses and licensing basis of the plant. In the Oconee licensing basis, it is specifically called out that protection be provided against natural phenomena and flooding events. The regulatory position on external flooding was clarified in Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants". The regulatory position of dam failure states in part, "*Where upstream dams or other features that provide flood protection are present, in addition to the analyses of the most severe floods that may be induced by either hydrometeorological or seismic mechanisms, reasonable combinations of less-severe flood conditions and seismic events should also be considered to the extent needed for a consistent level of conservatism. The effect of such combinations on the flood conditions at the plant site should be evaluated in cases where the probability of such combinations occurring at the same time and having significant consequences is at least comparable to the probability associated with the most severe hydrometeorological or seismically induced flood.*"

The ~~FERC EAP~~ inundation study [don't refer to it as FERC evaluation—that's a lightening rod] evaluation performed for Jocassee Dam has demonstrated that such a Probable Maximum Flood (PMF) is likely to occur during a random "sunny day" failure of the dam which will produce an Oconee site flood beyond the flood mitigation capability of the SSF [I don't understand—are we saying that they need to consider both sunny day and PMF concurrently?]. Since the licensing basis of ONS clearly specifies an ability to withstand flood without regard to source, the random failure of the Jocassee Dam needs to be included as a credible source of flood. [don't just restrict to sunny day—also need to account for the fact that seismic and overtopping aren't off the table] Calculations for random dam failure must include the most severe case [same for seismic and overtopping] with margin to properly account for uncertainties. Since it has been demonstrated that there is no adequate protection against floods that are greater than 5 feet at the grade level outside of the SSF and a rupture of Jocassee Dam will produce such a flood, the site does not have adequate protection and the licensee must ensure adequate protection against floods.

ASSESSMENT OF SAFETY SIGNIFICANCE

[need to discuss as low prob, high consequence event with CDF of 1.0 over 3 units if the SSF is unprotected and fails]

Should an external flood occur, it is postulated to fail both the Oconee switchyard and Keowee Dam resulting in a Station Blackout (SBO) condition. If this flood level exceeds the existing flood protection at the SSF as demonstrated by the inundation study, it will result in the loss of all functions of the SSF which will result in core damage due to failure of core cooling and inventory control to all three Oconee units. Spent fuel pool cooling will also be lost. At the onset of core damage, containment integrity will be the only remaining initially intact defense-in-depth barrier which will be severely challenged under these conditions due a lack of power to spray containment. Due to the nature of the catastrophic flood at the site, recovery of containment and spent fuel pool cooling to mitigate a release will be difficult at best to accomplish due to accumulated debris and damage to surrounding infrastructure at the site.