


~~Official Use Only - Sensitive Internal Information~~

 ~~Official Use Only - Sensitive Internal Information~~

**Final Regulatory Assessment of Oconee
Flood Barrier Issue**

October 1, 2007


October 1, 2007 ~~Official Use Only - Sensitive Internal Information~~ 1



Overview

- **Objective**
 - Reach agreement on path forward for Oconee flood barrier regulatory issues.
- **Success**
 - Understanding the flood barrier finding and related scenarios.
 - Understanding the associated regulatory issues.
 - Define and agree to path forward for resolution of each regulatory issue.

October 1, 2007

 **U.S. NRC**
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Official Use Only - Sensitive Internal Information

Timeline of SDP

- August 17, 2006 - SERP meeting assessed as preliminary WHITE based on a blended qualitative and quantitative risk-informed approach (pre-MC 0609 App M).
- August 31, 2006 - Choice letter sent to licensee.
- October 5, 2006 - Licensee provided written response to choice letter and waived regulatory conference.
- Nov. 22, 2006 - Final significance determination issued. WHITE based on qualitative erosion of defense-in-depth, but includes quantitative CDF based on apportioning flood frequency to flood height.
- December 20, 2006 - Licensee appeals the final significance determination. Requests NRC to accept incomplete, un-docketed new information.
- January 9, 2007 - Appeal panel convened
- March 1, 2007 - Appeal panel upholds WHITE finding.
- May 3, 2007 - Licensee requests reassessment of final significance determination.
- June, 2007 - Assembled a team to review new information. Flooding expert review of data on random dam failure.
- June 22, 2007 - Reassessment of final significance determination assigned to RII.
- June 28, 2007 - Follow up telecom with Licensee on dam failure questions and comments.
- July 17, 2007 - Licensee response to analysis questions by email.

October 1, 2007

Official Use Only - Sensitive Internal Information

3

Official Use Only - Sensitive Internal Information

U.S. NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

The Flood Scenario Rupture of Jocassee Dam

October 1, 2007

Official Use Only - Sensitive Internal Information

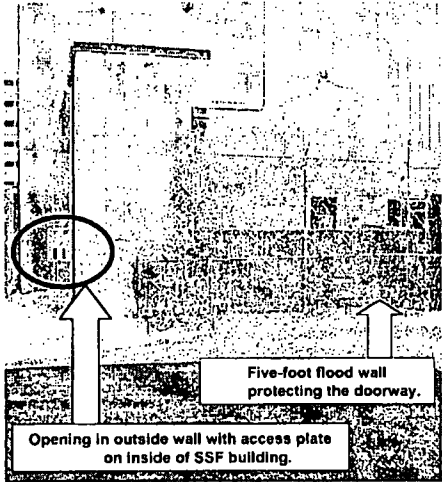
4

River miles are approximately 14 miles.

Official Use Only - Sensitive Internal Information

USNRC
U.S. Nuclear Regulatory Commission
Protecting People and the Environment

The Flood Barrier Finding



Opening in outside wall with access plate on inside of SSF building.


Five-foot flood wall protecting the doorway.

- Licensee opened an access cover uncovering a previously cut hole in the wall on August 13, 2003.
 - Should have done a 10CFR50.65 (a)(4) assessment immediately.
 - Should have done a 10CFR50.59 evaluation after 90 days.
- Licensee opportunities to identify issue
 - June 2, 2005 NRC inspectors notified the licensee of condition. Licensee issued PIP (condition report in their corrective action system). Corrective action not taken.
 - August 3, 2005 NRC inspectors questioned lack of corrective action and licensee issued a further PIP.
- Opening sealed on August 3, 2005.

October 1, 2007

Official Use Only - Sensitive Internal Information

5



Official Use Only - Sensitive Internal Information

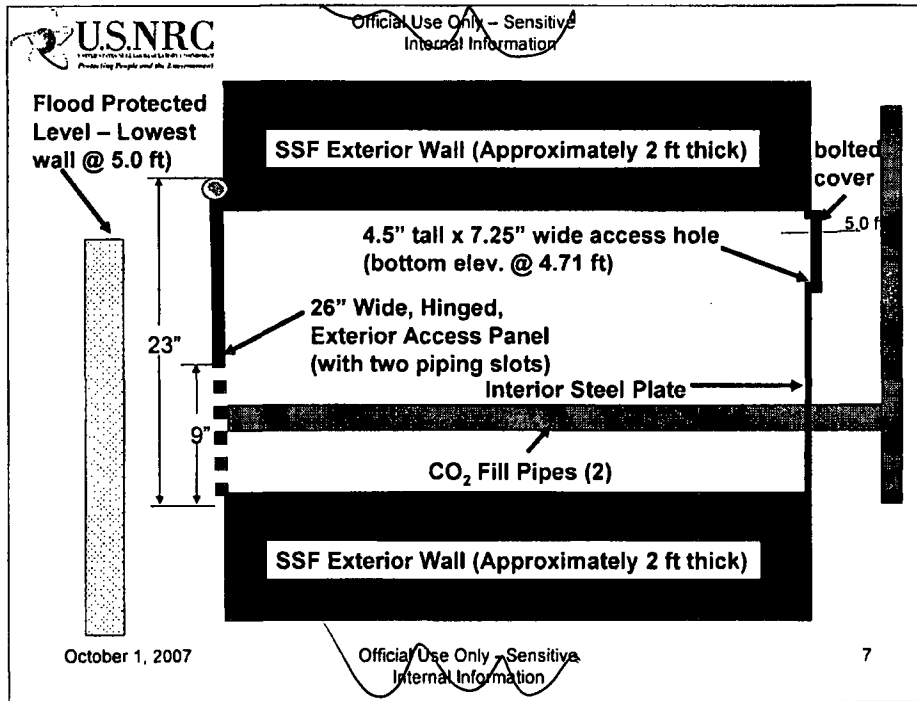
- Photo 3 (Flood Flowpath #1): Hinged, Exterior Access Panel for SSFCO-14 and SSF-CO-17

- Photo 4 (Flood Flowpath #1): View of 6" x 10" interior access panel (flood barrier), signage and 208V MCC 3XSF-1

October 1, 2007

Official Use Only - Sensitive Internal Information

6



Note: The licensee surveyed the SSF and associated flood walls and provided an estimate that the lowest level of protection was at 801.0' msl. There was some initial discrepancies on the dimensions when NRC sent the preliminary white finding to the licensee in 2006. In order to resolve these differences, the licensee removed the interior bolted cover last October, and the resident inspectors verified the elevations and dimensions noted above.

Reference points	Elevation (feet msl)
Ocone Yard Grade	796.00
Ground floor of SSF	797.00
Bottom of breached flood barrier	800.71
Top of SSF North flood wall	801.00
Top of SSF South flood wall	801.75

~~Official Use Only - Sensitive Internal Information~~

USNRC
U.S. Nuclear Regulatory Commission
Protecting People and the Environment

Assessment of Proposed Violation

<ul style="list-style-type: none">• Quantitative ROP evaluation<ul style="list-style-type: none">- Using ROP process<ul style="list-style-type: none">• (b)(7)(F)• Likelihood of floodwater entering the SSF.<ul style="list-style-type: none">- Poor state of documentation for basis of flood height protection- Distribution of flood height highly uncertain• Probability of core damage<ul style="list-style-type: none">- If floodwater enters the SSF, the probability of core damage is essentially unity.• Recovery<ul style="list-style-type: none">- No timely recovery possible.- Quantitative evaluation not dispositive for significance determination.<ul style="list-style-type: none">• Sensitivity studies using estimated and uniform distributions to inform qualitative assessment (Slides 10 and 11)	<ul style="list-style-type: none">• Qualitative evaluation<ul style="list-style-type: none">- Using ROP process<ul style="list-style-type: none">• Defense in depth<ul style="list-style-type: none">- SSF only mitigating system for preventing core damage at all three units.- No redundancy or diversity of mitigation.- Loss of multiple barriers to protect public• Safety margins<ul style="list-style-type: none">- None left.• Recovery<ul style="list-style-type: none">- No timely recovery possible.
---	--

October 1, 2007

~~Official Use Only - Sensitive Internal Information~~

8

- Qualitative decision-making attributes are in accordance with numerous NRC guidance documents on risk-informed integrated decision-making (e.g., Regulatory Guide 1.174, SDP Appendix M, SDP IMC 308 (SDP basis document), LIC504, etc...).

Official Use Only - Sensitive Internal Information

U.S. NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Review of Data of Random Jocassee Dam Failure

- Licensee
 - Assumed 3 failures in 220,080 dam-years which yielded a frequency of $\sim 1.4 \times 10^{-5}$ per year.
- NRC
 - Reviewed the licensee dam failure data.
 - Licensee inappropriately used data for all rockfill, composite rockfill-earthen, and earthen dams over 50-ft matching Jocassee in the denominator with failures of rockfill only dams in the numerator.
 - (b)(7)(F)

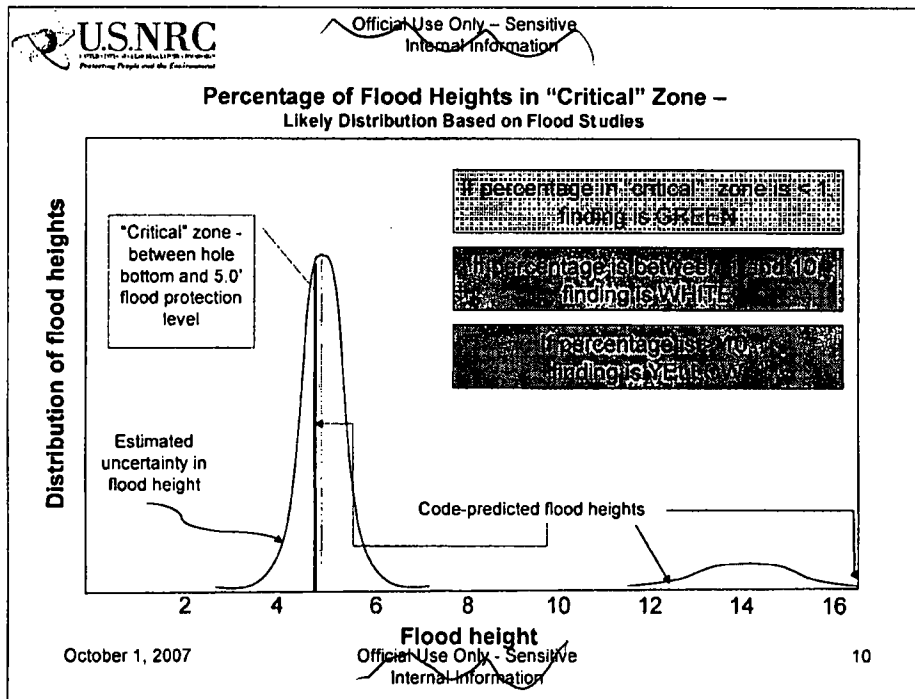
October 1, 2007

Official Use Only - Sensitive Internal Information

9

- Correcting Duke's calculation results in a point-estimate of $1.92e-4$ /yr frequency when properly matching the numerator definition to what Duke used in the denominator of all Dams over 50 ft.

- The staff's best estimate is the Bayesian mean (state of the art approach). The 90 percent credible interval is the [5th, 95th] values. Assessment assumes rockfilled dams only.



Note: The 1983 study estimated flood level at 4.7 ft. Using the DAMBRK code, the Duke/FERC study in 1992 cited values for the sunny day dam break at 12.51 ft and for the probable maximum flood at 16.82 ft.

Total area under both curves = 1.0. Area under the curve for the 5' flood height approximately 0.8. Area under the curve for the 12' to 16' flood height approximately 0.2.

Change in CDF in terms of $Pr_{\text{flood critical zone}}$, probability of floods occurring in the "critical zone" using simplified risk calc:

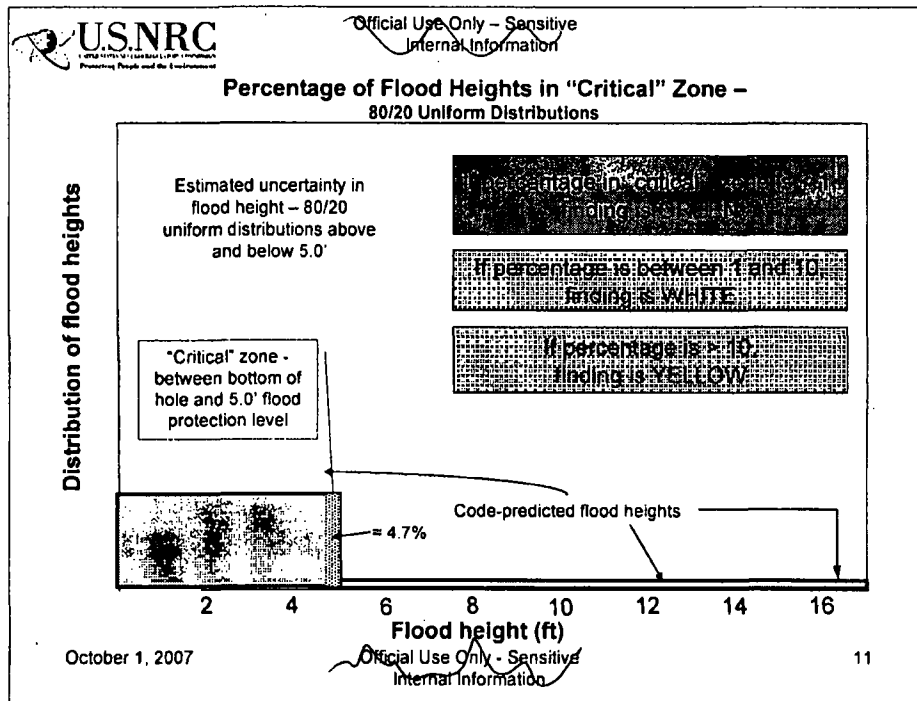
$$\begin{aligned} \Delta CDF &= CDF_{\text{non-conforming}} - CDF_{\text{baseline}} \\ &= (IEF_{\text{Jocasee Break}} * Pr_{\text{flood critical zone}} * CCDP_{\text{SSF flood unprotected}}) - \\ &\quad (IEF_{\text{Jocasee Break}} * Pr_{\text{flood critical zone}} * CCDP_{\text{SSF flood protected}}) \\ &= IEF_{\text{Jocasee Break}} * Pr_{\text{flood critical zone}} * (CCDP_{\text{SSF flood unprotected}} - CCDP_{\text{SSF flood protected}}) \\ &= 1.8E-4/\text{yr} * Pr_{\text{flood critical zone}} * (1.0 - 0.3) \end{aligned}$$

$$\Delta CDF = 1.26E-4/\text{yr} * Pr_{\text{flood critical zone}}$$

SDP color thresholds in terms of $Pr_{\text{flood critical zone}}$:

White: $1e-6/1.26e-4 = 0.0079$ or ≈ 1 percent

Yellow: $1e-5/1.26e-4 = 0.079$ or ≈ 10 percent



80 percent of flood distributed below 5.0' mark. The 80/20 split is based on the Duke PRA assessment (1990s). The assumption of uniform distributions is provided here only for a relative non-conservative perspective to the previous slide that has a bimodal distribution.

Likelihood of flood between 4.71' and 5.0' is:

$$0.8 * (3.5''/60'') = 0.0466$$

Using $1.8e-4/\text{yr}$ for Jocassee Dam break frequency and a 0.047 probability of floods in the critical zone, and a nominal SSF unavailability of the SSF (test & maintenance, system unreliability, or human error) yields an estimated delta CDF (full calc not shown) of:

$$\underline{1.26e-4/\text{yr} * 0.047 = 5.9e-6/\text{yr}} \quad \text{White finding}$$

Likely distribution of flood height expected to be greater than 4.7% in the "critical zone."

U.S. NRC
Nuclear Regulatory Commission
Protecting People and the Environment

Official Use Only - Sensitive Internal Information

Recommended Path Forward

- Proposed resolution of significance determination
 - Affirm White significance determination based on quantitative sensitivity study and qualitative considerations
- Pursue additional regulatory issues:
 - Pursue backfit evaluation regarding flood barrier height (NRR lead, Region II support)
 - Ensure licensing basis reflects flood hazards and protection (NRR lead, Region II support)
 - Coordinate with NSIR on security/Comprehensive Review concern (NRR)
 - Evaluate lessons learned from this significance determination (NRR, Region II)
 - Initiation event frequency
 - Application of qualitative factors
 - Evaluate impact of dam failure initiating event frequency issue on industry IPEEE

October 1, 2007

Official Use Only - Sensitive Internal Information

12

NUREG-1742 identified only two IPEEEs that addressed dam failure floods quantitatively – Ft. Calhoun and Diablo Canyon. Everyone else only addressed probable maximum precipitation and screened out dam failure as low probability. Unfortunately, there were few dam failure data sources around back then, so many plants used the estimate published in NUREG/CR-5042. The data source for the estimate in NUREG/CR-5042 was the Oconee PRA - NSAC/60. The calculation in NSAC/60 was done in error and it propagated throughout the industry.

References:

NUREG/CR-5042, "Evaluation of External Hazards to Nuclear Power Plants in the United States.

NUREG-1742, "Perspectives Gained From the Individual Plant Examination of External Events (IPEEE) Program

NSAC/60, "Oconee PRA"