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15

Insights from Regulatory Assessments of Oconee Flood Barrier Issue

Presentation to...

All-hands DRA meeting

December 5th 2007

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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.

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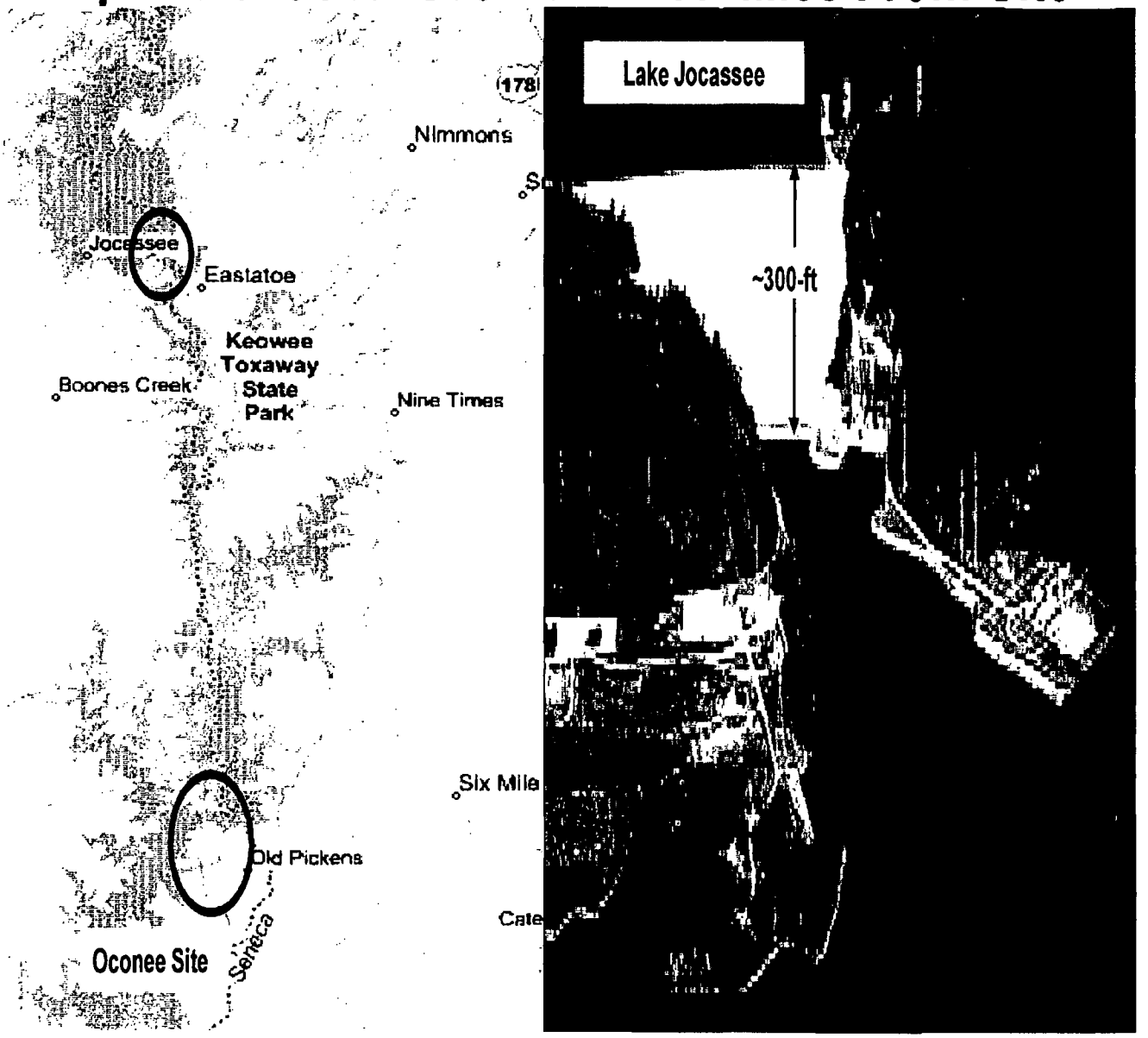
The Flood Scenario

Rupture of Jocassee Dam – 11 Miles From Site



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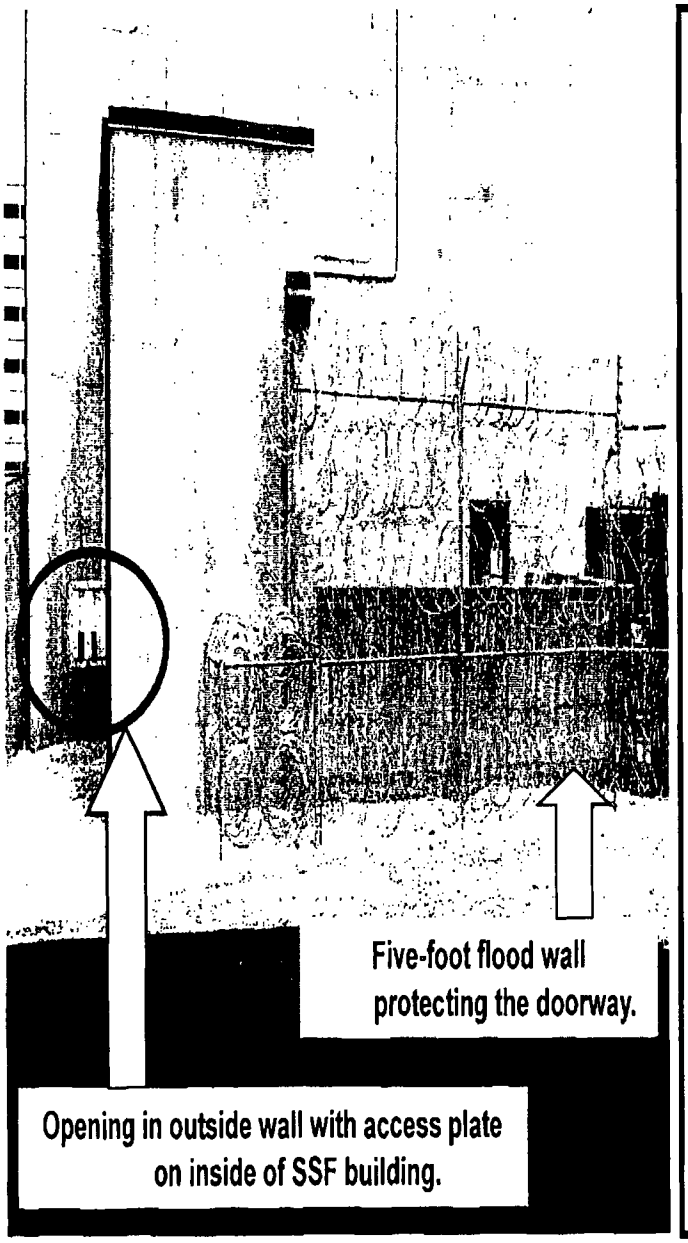
The Flood Barrier Finding



- 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 licensee issued a further PIP.
- Opening sealed on August 3, 2005.

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Assessment of Proposed Violation

- Quantitative ROP evaluation
  - Using ROP process
    - (b)(7)(F)
    - Likelihood of floodwater entering the SSF.
      - Poor state of documentation
      - Distribution of flood height highly uncertain.
    - Probability of core damage
      - If floodwater enters the SSF, the probability of core damage is essentially unity.
    - Recovery
      - No timely recovery possible.
  - Quantitative evaluation not dispositive for significance determination.
    - Sensitivity studies using uniform distributions to inform qualitative assessment

- Qualitative evaluation
  - Using ROP process
    - Defense in depth
      - 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
      - None left.
    - Recovery
      - No timely recovery possible.

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Review of Data of Random Jocassee Dam Failure

- Licensee
  - Assumed 3 failures in 220,080 dam-years which yielded a frequency of ~1.4 x 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)

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Dam and Dike Failure

Dam failure is well documented and can be characterized by type of dam.

Of the 79,777 dams in the US, 72% are embankment type and 28 % are concrete.

- Nineteenth century dams would fail at 5% in the first five years after construction but would settle out to a 1 to 4% additional failure by 20 years of life.
- This failure rate was reduced to 2% in the first 5 years for dams built after 1930.
- By 1960, dam failure rates were less than 0.01% due to better engineering.

Whatever the era, half of all dams that ever fail, do so in the first five years. This high infant mortality is often due to piping in the soil around the dam or underneath it. Even concrete dams are not immune. However, dam construction dropped dramatically after 1980 so that nearly all dams are older than 5 years.

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Dam Failure Frequencies

http://crunch.tec.army.mil/nid/webpages/nid.cfm

http://npdp.stanford.edu/index.html

	Failures	Dam-years	Mean
All Arch Dams	2	9101	2.055E-04
All Buttress Dams	2	9819	1.941E-04
All Concrete Dams	10	110227	9.268E-05
All Earth Dams	366	2240403	1.634E-04
All Gravity Dams	28	122798	2.264E-04
All Masonry Dams	5	21692	2.222E-04
All Multi-Arch Dams	0	240	1.514E-04
All Rockfill Dams	7	55872	1.273E-04
All Stone Dams	2	11365	1.733E-04
All Timber Crib Dams	3	6536	3.646E-04
Total	425	2605987	1.633E-04

	Failures	Dam-years	Mean
Buttress Dams Over 50 Feet	0	1876	2.007E-04
Arch Dams Over 50 Feet	2	5667	2.793E-04
Concrete Dams Over 50 Feet	0	19215	8.197E-05
Earth Dams Over 50 Feet	56	144810	3.770E-04
Gravity Dams Over 50 Feet	7	19542	3.173E-04
Masonry Dams Over 50 Feet	0	1987	1.989E-04
Multi-Arch Dams Over 50 Feet	0	77	2.362E-04
Rockfill Dams Over 50 feet	4	19900	2.135E-04
Total	69	213184	2.380E-04

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Licensee Evaluations

- External flood was qualitatively screened out of all IPEEE submittals with the exception of 12 that used a PRA process. Those 12 treated external flood as the initiator of a LOOP or turbine building damage with no other direct impact on the plant. CDFs were between 2E-8/ry to 7E-6/ry. All plants screened out all external floods.

- Several plants were very optimistic about their countermeasures such as 9 foot sandbag dikes rapidly built or barriers with only a few inches of freeboard.

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Licensee Evaluations (cont.)

- Only two IPEEEs 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 estimate of 2.5E-05/dam-year in NSAC/60 was done in error by an order of magnitude and it propagated throughout the industry.

References:

NUREG/CR-5042, "Evaluation of External Hazards to Nuclear Power Plants in the United States.
NSAC/60, "Oconee PRA"

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SPAR Considerations for External Flood

- Dams as far up or downstream as 300 miles should be considered for both flood and loss of heat sink. It is noteworthy that all forms of dams have a failure rate between 1E-4 and 4E-4, even for blue sky events.

- Determining flood levels, however, is a complex matter. The USACOE has software named HEC RAS that when combined with GIS geographical data will model river flow and flooding in great detail.

- Weather based floods remain in the deterministic world because the input conditions are always from the same source as was used in the original plant design basis. Besides, the growth of the maximum precipitation only increases about 20% when a 100 year interval is compared to a 1000 year interval. With only 100 years of data available in many locations, projecting beyond a 1E-3/yr event is very uncertain anyway.