Boska, John

From: Boska, John
Sent: Friday, May 03, 2013 11:26 AM
To: Hicks, Susan
Cc: Pascarelli, Robert
Subject: FW: change in public availability of slide package
Attachments: 2013-03-25 Revised Duke slides (non-public).pdf

Importance: High

Susie, the email string below discusses a set of slides used by the licensee at a public meeting, and the licensee later informed us that one of the slides had sensitive information. Those slides are in ADAMS at ML13084A022. You had changed this document profile to non-public. The licensee has now provided us the same set of slides, but with the "Withhold from public disclosure under 10 CFR 2.390" added to the bottom of all the slides. Please replace ML13084A022 with the attached pdf file. The licensee has also provided a set of public slides, which I added to ADAMS as ML13123A204. Thanks.

John Boska
Oconee Project Manager, NRR/DORL
U.S. Nuclear Regulatory Commission
301-415-2901
email: john.boska@nrc.gov

From: ADAMS IM
Sent: Tuesday, April 23, 2013 10:14 AM
To: Boska, John; Pascarelli, Robert
Cc: Monninger, John; CS_IRT; McCarthy, James
Subject: RE: change in public availability of slide package

John,

Thank you for the information – document ML13084A022 has now been set for "Sensitive-Security – Related-Periodic review required/MD Code A.3.

Thanks
Susie Hicks
On Behalf of ADAMS IM

(b)(6) *I can be reached at* (b)(6)

From: Boska, John
Sent: Tuesday, April 23, 2013 9:50 AM
To: ADAMS IM; Pascarelli, Robert
Cc: Monninger, John; CS_IRT; McCarthy, James
Subject: RE: change in public availability of slide package
Importance: High

Susie, I have talked to Bob Pascarelli about the document sensitivity. Please label the sensitivity as Sensitive, and MD 3.4 Non-Public A.3 (sensitive- security-related- periodic review required). Thanks.

C-7

John Boska
Oconee Project Manager, NRR/DORL
U.S. Nuclear Regulatory Commission
301-415-2901
email: john.boska@nrc.gov

From: ADAMS IM
Sent: Tuesday, April 23, 2013 8:51 AM
To: Pascarelli, Robert
Cc: Boska, John; Monninger, John; CS_IRT; McCarthy, James
Subject: RE: change in public availability of slide package
Importance: High

Robert/James,

ADAMS IM has changed the availability for ML13084A022 to Non-Public, which will automatically remove this file from Public Access once the synch occurs.

For now this file is Non-Public/Non-Sensitive with "Non-Public Pending Review" added to the keyword file.

Per our previous email request – please provide the proper document sensitivity selected from the attached MD Code Chart.

Thanks
Susie Hicks
On Behalf of ADAMS IM

(b)(6) *I can be reached at* (b)(6)

From: McCarthy, James
Sent: Monday, April 22, 2013 2:06 PM
To: ADAMS IM; Pascarelli, Robert
Cc: Boska, John; Monninger, John; CS_IRT
Subject: RE: change in public availability of slide package

ADAMS IM,

Thank you for the notification. CSIRT will perform all necessary information spill reporting.

Jim McCarthy
US Nuclear Regulatory Commission
Computer Security Office
Office: 301-415-5871
Mobile: (b)(6)

From: ADAMS IM
Sent: Monday, April 22, 2013 2:03 PM
To: Pascarelli, Robert

Cc: Boska, John; Monninger, John; CS_IRT
Subject: RE: change in public availability of slide package

Hello Robert,

Below are guidelines to change Released Public files to Non-Public. Also, please provide us with the proper document sensitivity which you can select from the attached MD Code Chart, so we can render this file ML13084A022 Non-Public?

Before we can process your request to withdraw a document(s) from the ADAMS Public Library (WBA), we need written authorization and justification (an e-mail message is fine) from a Division Director or above in the originating or responsible organization. This requirement is documented in an August 28, 2002, memo from Stuart Reiter, Chief Information Officer, to all NRC Office Directors and Regional Administrators. See ML022340277. Please have the appropriate Division Director or above send the authorization and justification to the e-mail address ADAMS IM. If you have been given the authority required by ML022340277, have those manager(s) provide us with the delegation.

If the document(s) to be removed from WBA contains classified, safeguards, or privacy information, please let us know and we will take actions to immediately remove the document(s) prior to receiving the written authorization. However, we still require the appropriate written authorization. Please note that if this document is part of a publicly available ADAMS Package, we will change the Package's Public availability to A Non-Publicly Available status if appropriate.

Also note that in accordance with Management Directive 3.4, A Release of Information to the Public, the Office Directors and Regional Administrators are required to take corrective action in the event that any information for which they are responsible is released contrary to NRC policy and must inform the EDO and the Office of the Inspector General in writing of the occurrence.

The authorizing official or office requestor should e-mail WEBWork to remove the document or any links if they exist on any external Web pages. If your office maintains an external Web site separate from the official NRC Web page, you are responsible for the removal of the document from the site.

Thanks
Susan Hicks
On Behalf of ADAMS IM

I work at an alternate location on (b)(6) ***and I can be reached at*** (b)(6)

From: Pascarelli, Robert
Sent: Monday, April 22, 2013 12:33 PM
To: ADAMS IM
Cc: Boska, John; Monninger, John
Subject: change in public availability of slide package

On 03/25/2013, Duke Energy provided the staff with a slide presentation (ML13084A022) that we placed in ADAMS as publically available. Duke Energy subsequently informed the NRC that one of the slides contained SUNSI information (slide 18). Please change the profile of this document to non-publically available. Thank you.

Bob Pascarelli, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Duke Energy

Agenda

- Current Dam Failure Analysis - January 28, 2011
  - Breach Analysis Summary
  - Model Development
- Updated Dam Failure Evaluation – submitted March 12, 2013
  - Models Considered
  - Selection of Xu & Zhang
  - Update Breach Parameters
  - Sensitivity Analysis
  - Independent Review
  - Comparative Analysis - Large Modern Dam Failures
- Modifications Scope

2011 Breach Analysis Summary

- Breach parameters developed using regression methodology and technical papers:
  - Froehlich 2008
  - Walder & O'Connor
  - MacDonald & Langridge-Monopolis
- Breach analysis focused on maximizing flooding levels to provide a very conservative and bounding analysis:
  - Breach dimensions maximized to assume loss of most of the dam embankment.
  - Froehlich breach time of 5 hours was reduced to 2.8
  - Maximum peak outflow was selected from all methods
  - Breach times of Keowee dams/dikes adjusted to maximize water directed at the site
  - Tailwater effect below Jocassee dam was not considered

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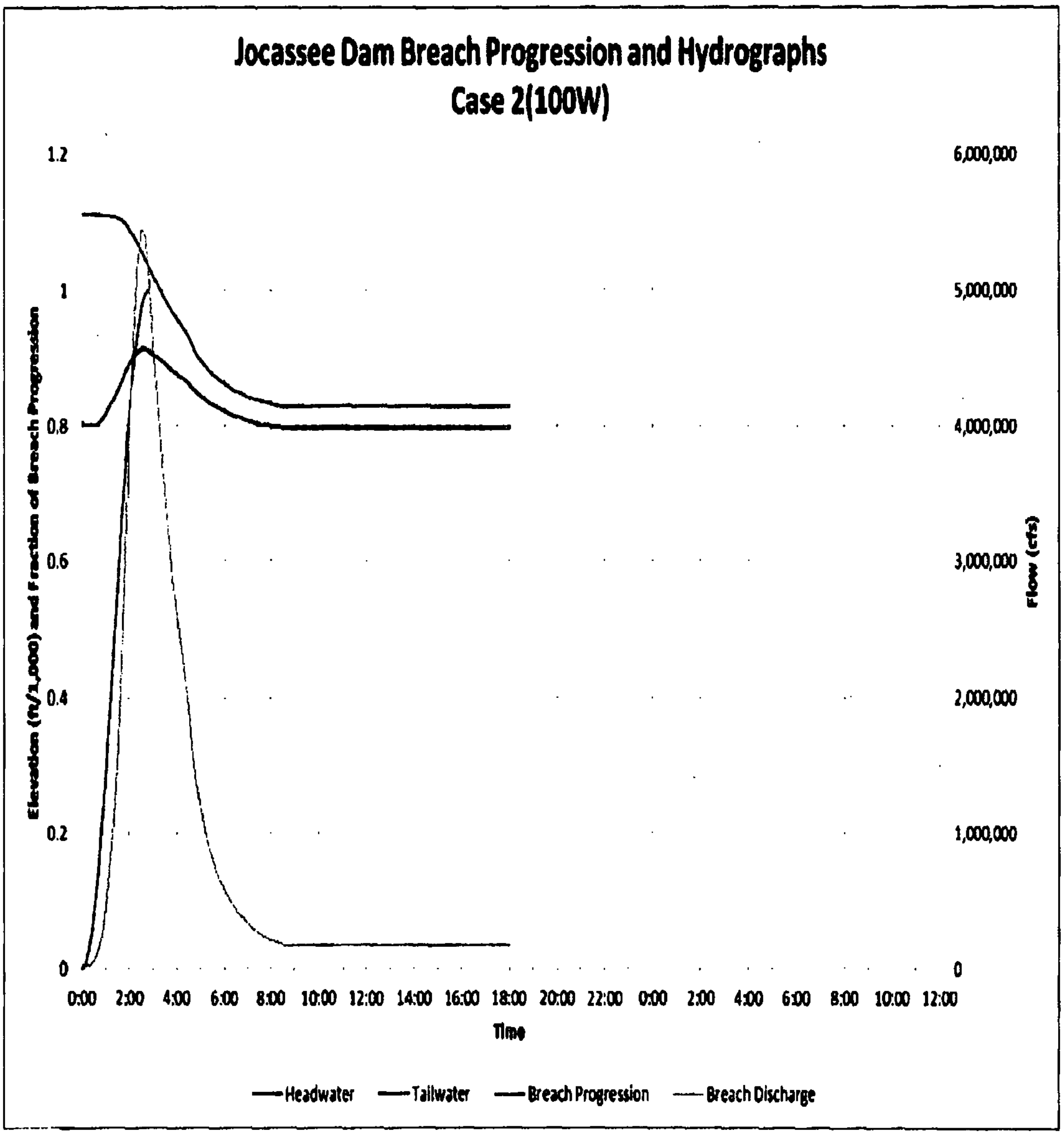
2011 Breach Analysis Summary

Jocassee Dam (postulated dam failure)

- Initial breach derived primarily from Froehlich regression equations.
- Breach dimensions were adjusted based on physical constraints of natural valley
- Jocassee breach parameters:
  - Top Width - 1156 (64% of overall crest)
  - Bottom Width – 431 feet
  - Bottom Elevation – 800 msl
  - Breach Formation Time - 2.8 hrs,
  - Peak outflow 5,400,000 cfs

2011 SE Jocassee Dam Breach Progression and Stage-Discharge Hydrographs



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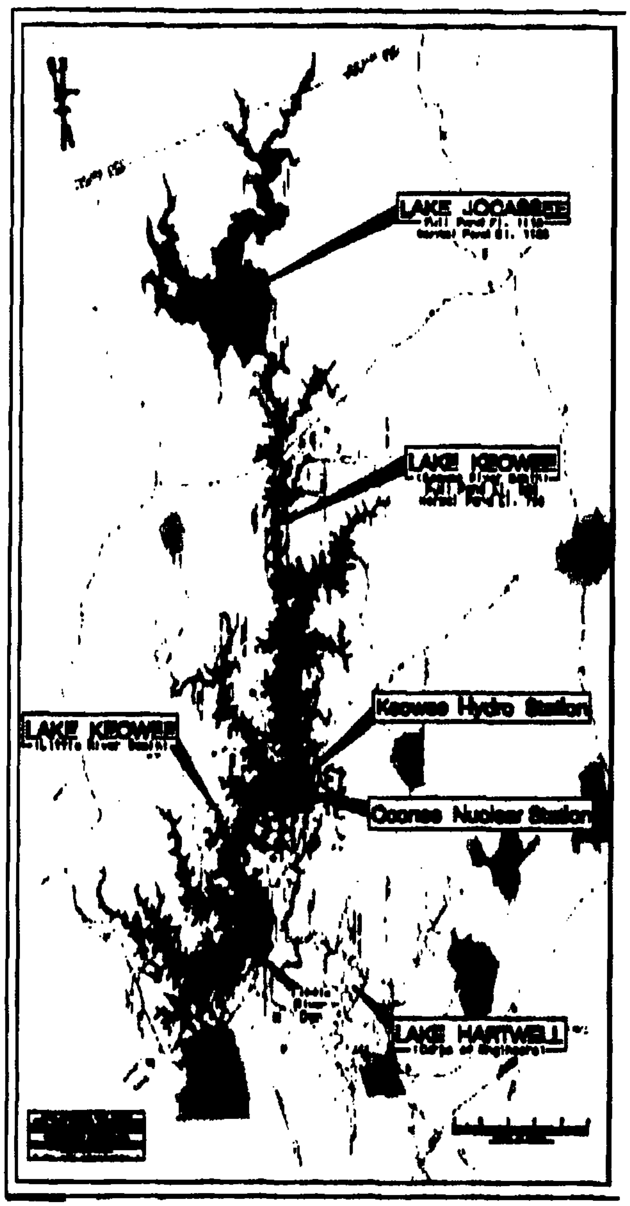
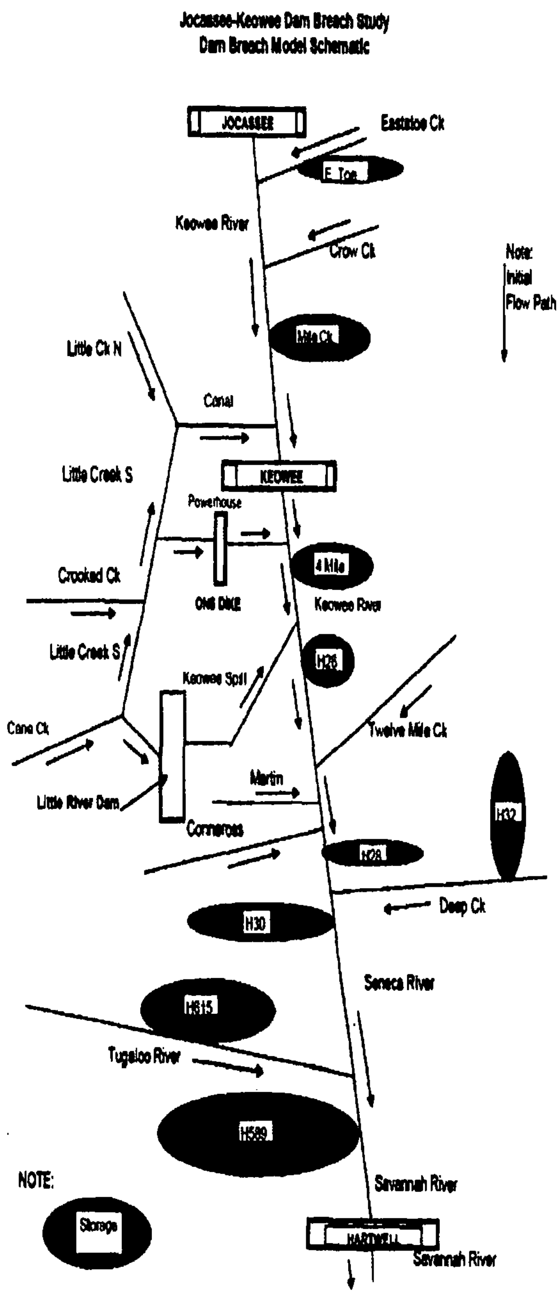
Duke Energy — 2011 Breach Analysis Summary

Keowee Dam/Dikes (postulated cascading dam failures)

- Overtopping failure trigger of two feet over the crest
- Cascading dam/dike failure on Keowee
  - Keowee main dam- 2.8 hrs
  - West Saddle Dam - 0.5 hrs
  - Intake Canal Dike- 0.9 hrs
  - Little River Dam – 1.9 hrs
- Conservative assumptions were made to maximize the water directed toward the power block

Model Development
HEC-RAS 1D Model





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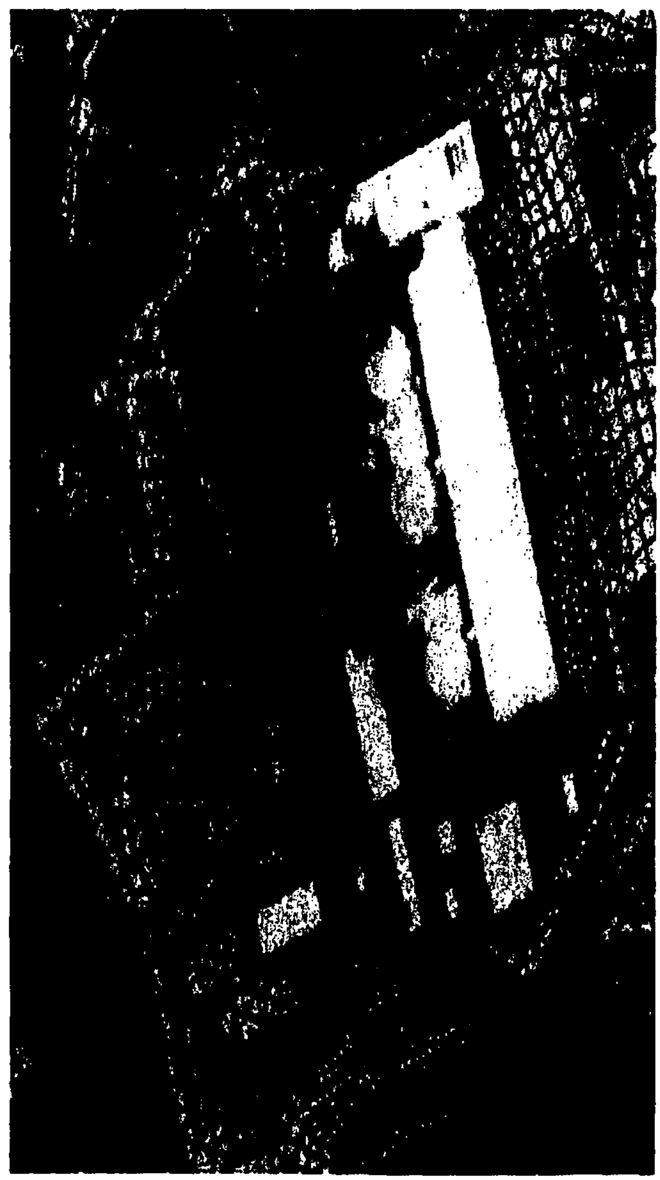
Model Development
SRH 2D Model

(57 thousand elements)

REVISED COMPUTATIONAL MESH



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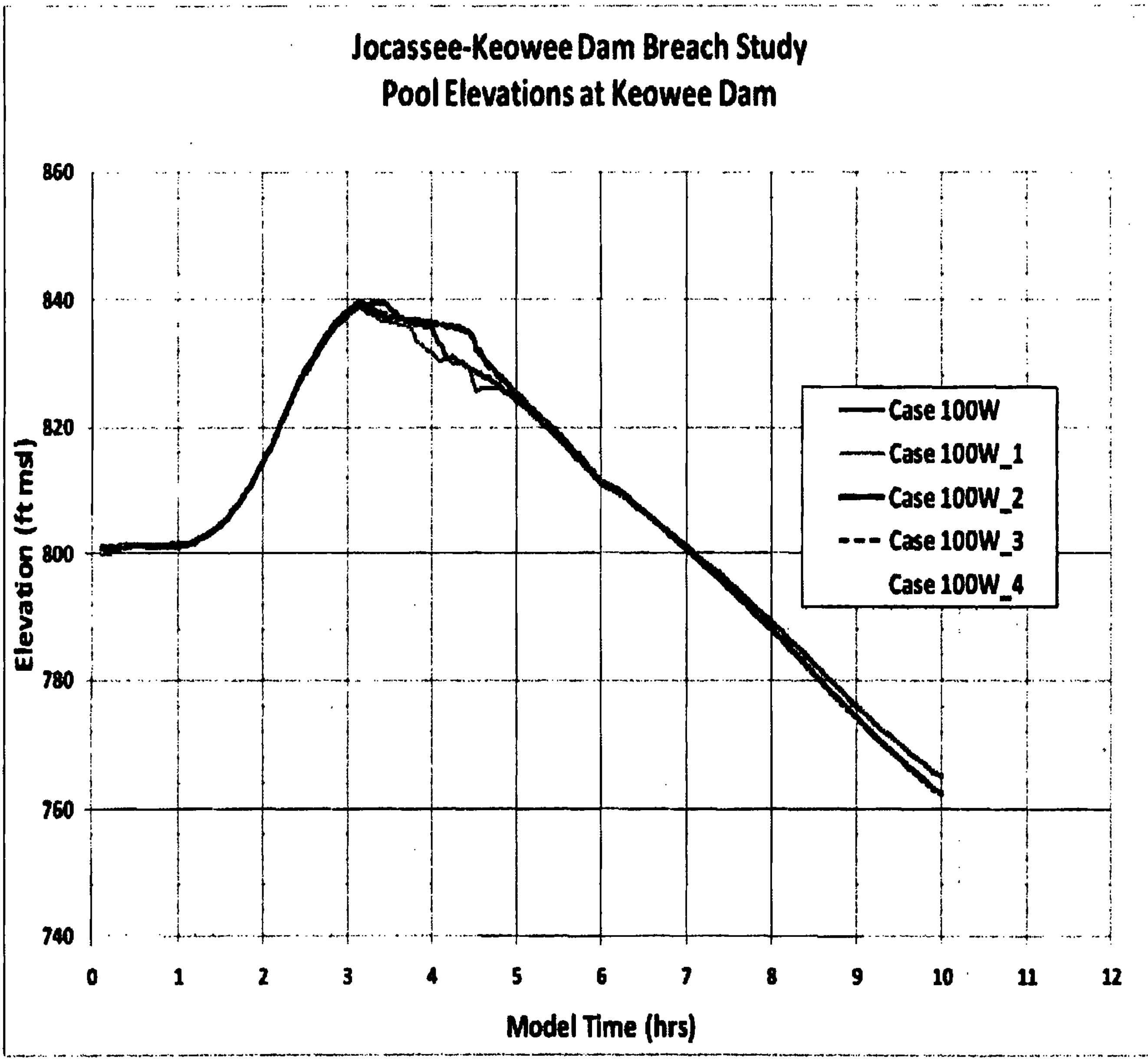
2011 Breach Analysis Summary
2D Model

WATER SURFACE ELEVATIONS AT KEOWEE DAM



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Updated Dam Failure Evaluation

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Updated Dam Failure Evaluation
Fukushima 2.1

Attributes of updated and refined dam failure analysis

- Updated methodology and present day regulatory guidance
- Performed to meet NUREG CR/7046, 2011 & ANS 2.8, 1992
- Realistic but still conservative assumptions
- Physical characteristics of the dams/dikes recognized including materials and method/quality of construction
- Overtopping and Seismic are confirmed from the 2011 SE as not being credible failure modes

Updated Dam Failure Evaluation
Fukushima 2.1

Duke Energy

Overtopping of the Jocassee dam was confirmed not to be a credible failure mode

- The Jocassee dam and dikes include 15 feet of freeboard
- The Jocassee watershed is small relative to storage capacity – 148 square miles
- The top of the spillways are located at 1110 (full normal level)
  - Four diverse methods of assuring spillway gate operation
  - Rigorous spillway gate maintenance and surveillance testing as required and monitored by FERC
- Lake management procedures require consideration of lower level to anticipate additional storage needs for significant storms
  - Weekly rain forecast are prepared by Duke Energy to project rainfall for the basin
  - Precipitation monitoring has assured that no overtopping of the spillway gates has occurred in 40 + years of operation
- PMF using current HRR-51,52 results in 3 feet of freeboard margin
- 2011 SE also concluded that overtopping was not credible

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Updated Dam Failure Evaluation
Fukushima 2.1

Seismic Failure of the Dam was confirmed not to be a credible failure mode

- Seismic evaluation based on current FERC criteria using the 1989 EPRI Hazard Curves
  - The Jocassee dam is designed to a **0.12 g** horizontal ground acceleration (Oconee site is designed to a **0.1g** horizontal ground acceleration).
- 2007 Updated Fragility Analysis
  - High Confidence of a Low Probability of Failure (HCLPF) of the dam by sliding **0.305 g**
  - Evaluation was performed by Applied Research & Engineering Sciences (ARES) Corp., formerly EQE, a respected consulting firm in the area of seismic fragility
  - The ARES report concluded the median centered fragility value for failure of the dam is **1.64 g**.
  - Maximum Probabilistic Peak Ground Acceleration for a 2% probability of being exceeded within a 50 year period is **0.197** g (using the United States Geologic Service hazard maps applicable to Jocassee).
- Jocassee dam is included in the seismic model of the Oconee Probable Risk Assessment.
  - The combination of the updated seismic fragility with the seismic hazard curve results in a negligible risk contribution from seismic events.
  - In a letter dated 11/20/07 and in the 1/28/11 SE report, the NRC concluded that there is a negligible risk

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Models Considered

Regression Analysis

- Froehlich 2008
- Walder & O'Connor
- MacDonald & Langridge-Monopolis 1984
- Xu & Zhang 2009

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Selection of Xu & Zhang 2009
Basis

- Most current regression method developed and validated with the largest data base of dam failures:
  - 182 earth and rockfill dam failures compiled
  - 75 failures w/ sufficient info to develop breach regression models
- Empirical formulas that account for physical characteristics of dam/reservoir: dam type, failure mode, height, dam erodibility, reservoir shape/storage)
- 33 of the 75 failures were on large dams ($\geq$ 15 meters)
- Applies to multi-zoned dams
- Method yields realistic but conservative breach parameters
- Recognized by industry experts

Breach Parameters
Fukushima Update

- Jocassee Dam – Xu & Zhang
  - Starting reservoir elevation 1110 (normal full pond)
  - Rockfill dam with low erodibility classification
  - Piping failure initiating at 1020 feet msl (Sunny Day Failure)
  - Breach parameters:
    - ✓ Top Width - 701' (39% of overall crest)
    - ✓ Bottom Width – 431'
    - ✓ Bottom Elevation – 870'
    - ✓ Breach Formation Time:
      - Xu & Zhang – 29.2 hrs.(13.2 hours piping +16.0 open weir)
      - Froehlich – 16.0 hours (open weir)
    - ✓ Peak outflow: 1,760,000 cfs

Jocassee Dam
Low Erodibility Classification

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Fukushima Model

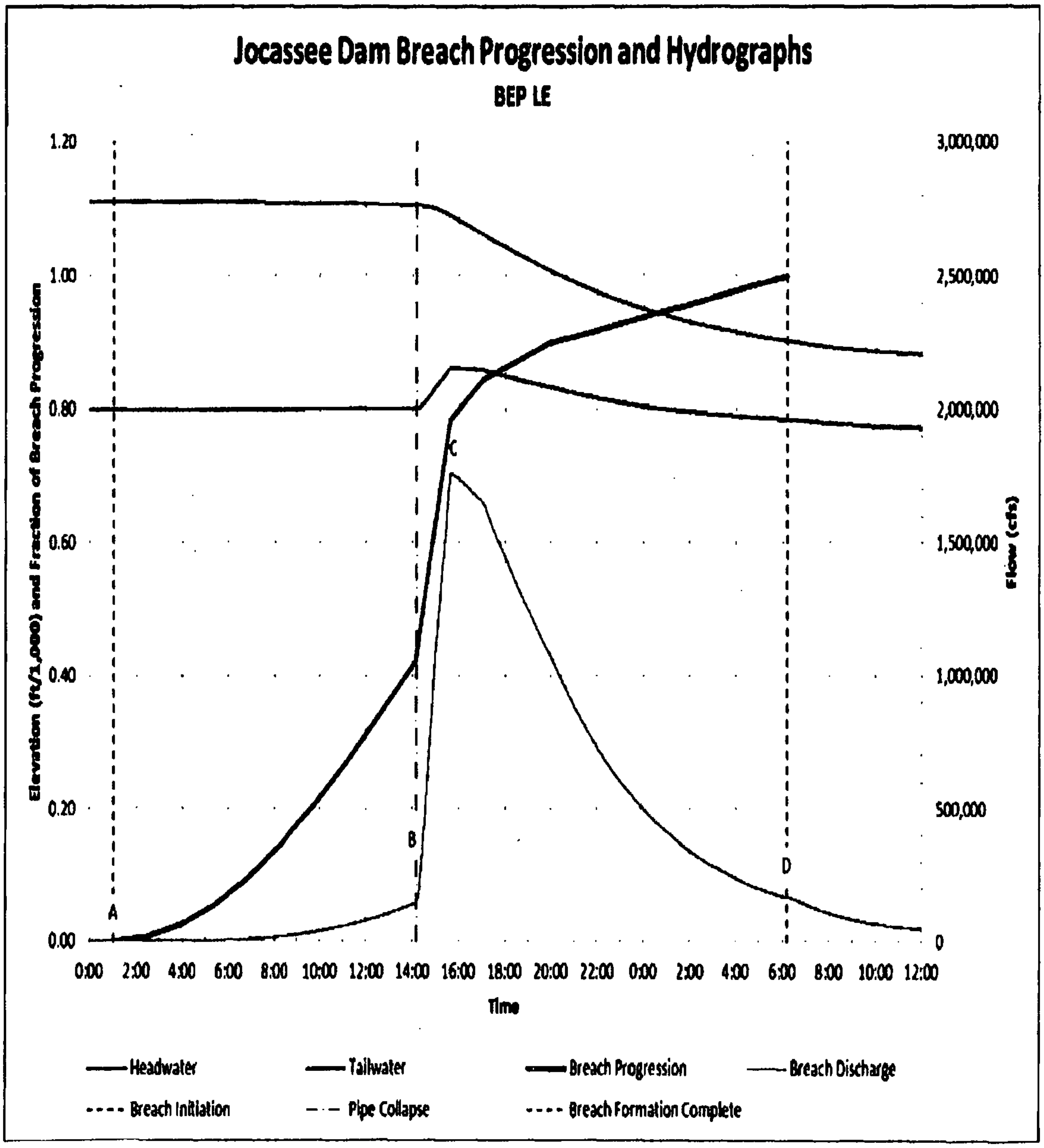
JOCASSEE DAM BREACH PARAMETERS												
Structure	Crest Elevation (ft msl)	Reservoir Starting Elevation (ft msl)	Failure Mode	Bottom Breach Elevation (ft msl)	Bottom Breach Width (ft)	Average Breach Width (ft)	Right Side Slope (Zr)	Left Side Slope (Zl)	Time to Failure (Hr)	Top of Breach Width (ft)	Breach Progression	Breach Initiation Elevation (ft msl)
Jocassee Dam	1125	1,110	Piping	870	431	566	0.53	0.53	29.2	701	Sine Wave	1,020

Breach Formation Time

Xu & Zhang definition: 29.2 (13.2 hours piping + 16.0 hours open weir)

Froehlich definition: 16.0 hours open weir

Fukushima Model Jocassee Dam Breach Progression and Stage-Discharge Hydrographs



<u>Breach Formation Time</u>; **Xu & Zhang definition:** - 29.2 (13.2 hours piping + 16.0 hours open weir) **Froehlich definition:** -16.0 hours open weir

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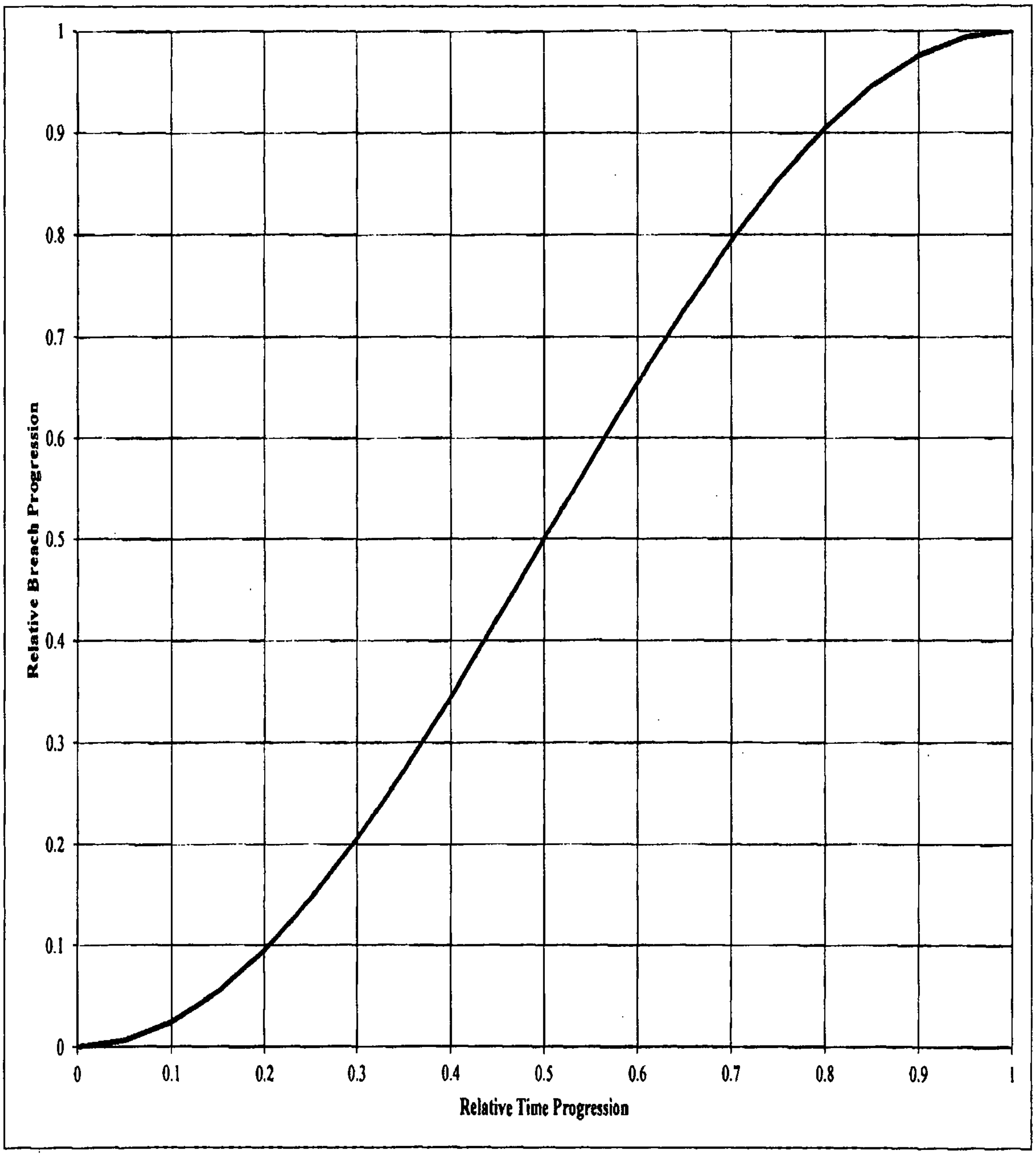
Breach Parameters
Fukushima Update

- Keowee Dam
  - Starting reservoir elevation 800 (normal full pond)
  - Homogeneous earth fill dam
  - Overtopping failure trigger of two feet over the crest at 817 msl by rapid rise of Keowee reservoir over the crest
  - Multiple simultaneous breach initiation formation points across the Keowee dam and West Saddle dam
- Cascading dam/dike failure on Keowee
  - Keowee main dam- 0.75 hrs
  - West Saddle Dam - 0.5 hrs (shorter than main dam, ratio of height)

Fukushima Model Keowee Dam Breach Progression HEC-RAS



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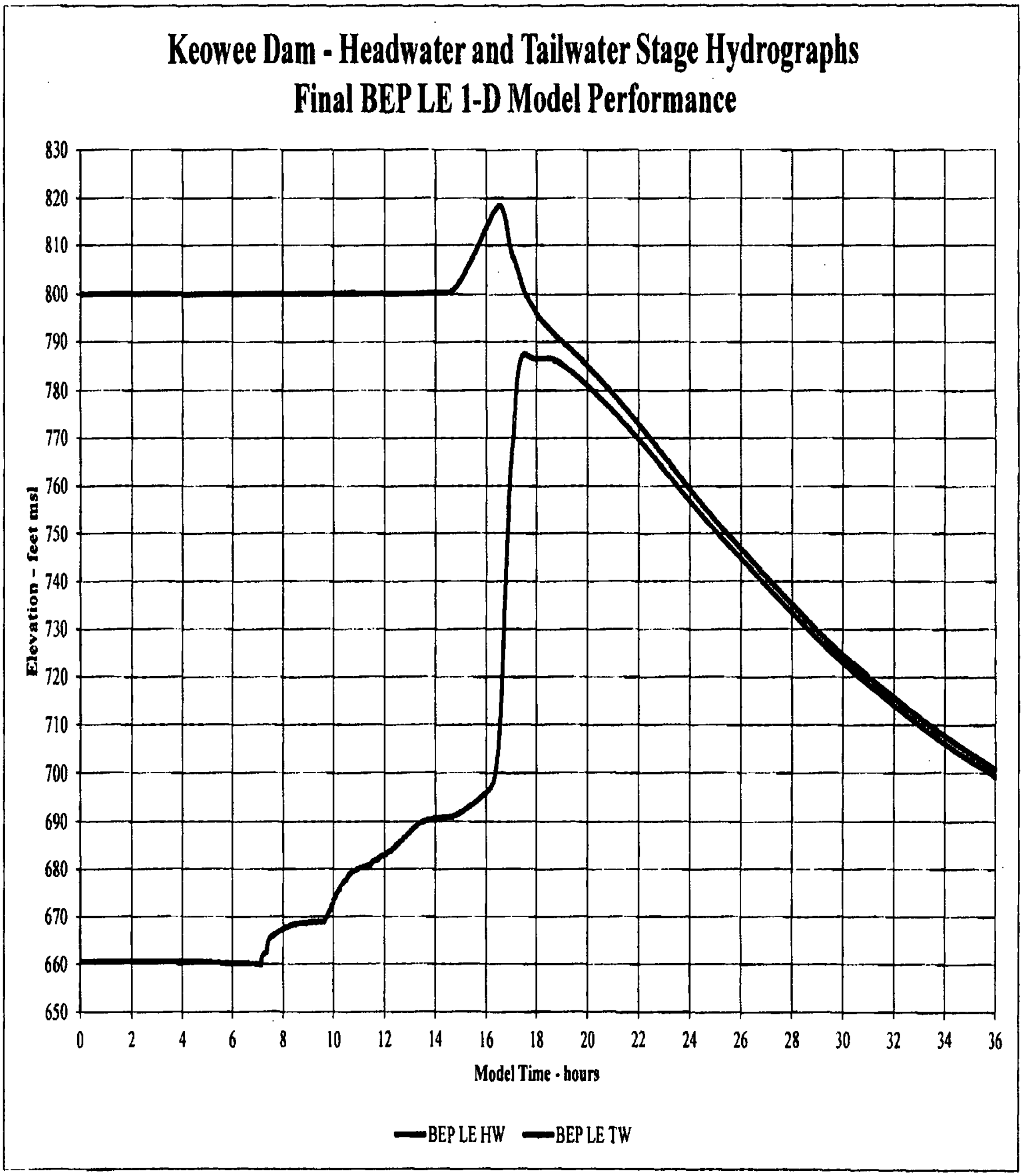
Fukushima 1D Modeling



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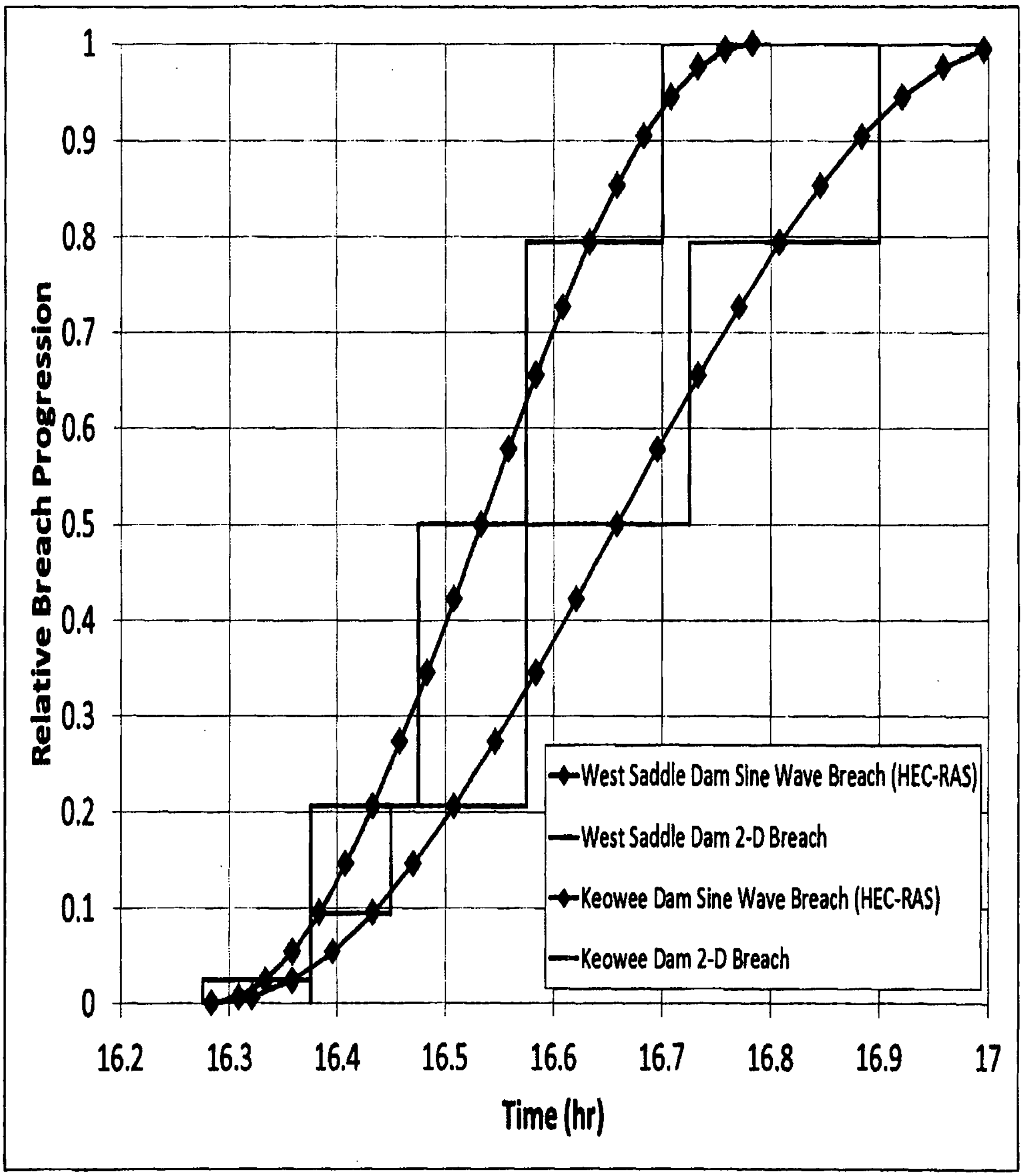
Fukushima 2.1 2D Modeling
Keowee Dam Breach Progression



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Fukushima 2D Modeling Velocity and Flow Pattern at 17 hrs.

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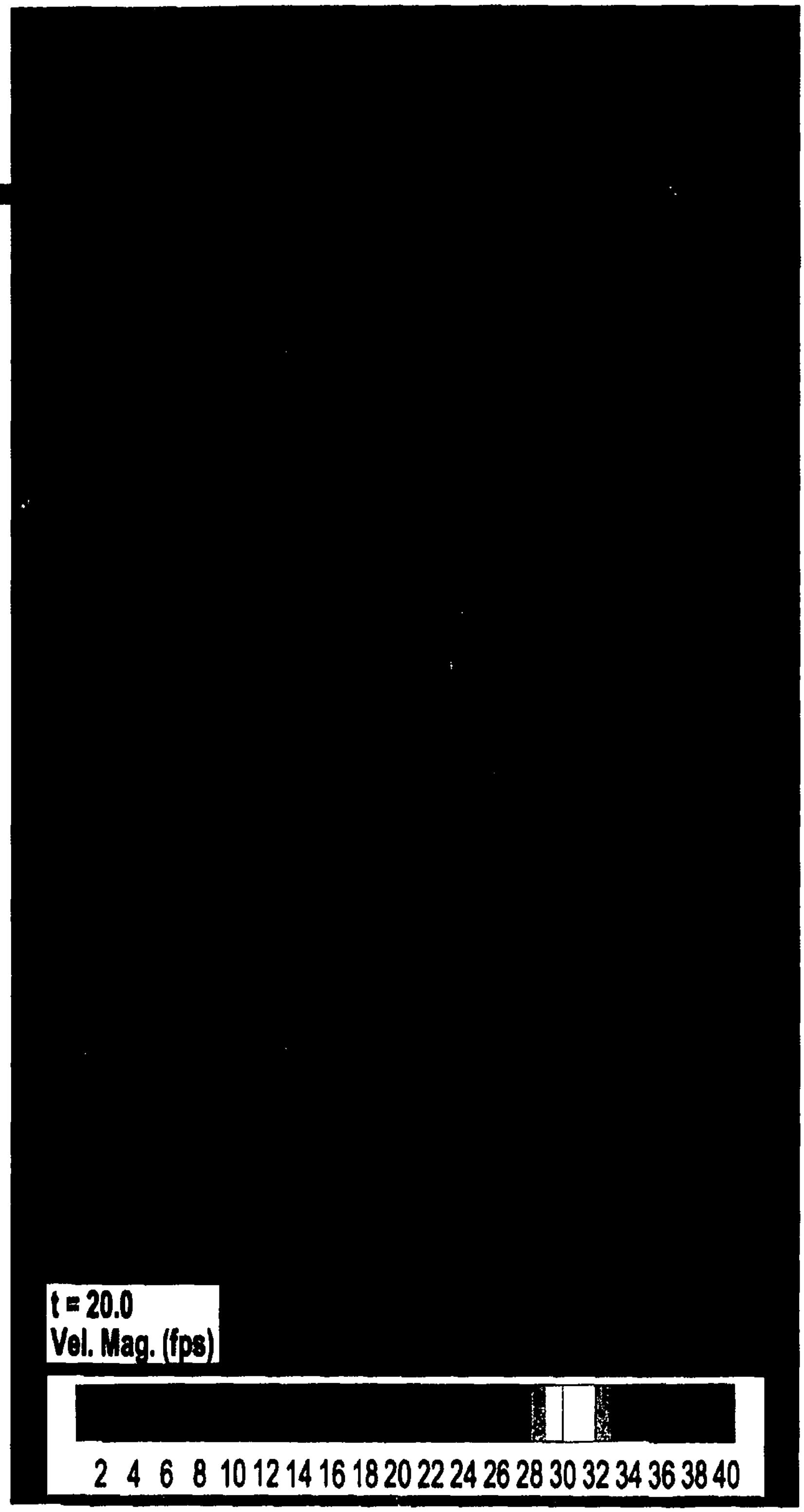
Fukushima 2D Modeling Velocity and Flow Pattern at 20 hrs.



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Fukushima 1D-2D Modeling Results

Breaching							
Keowee Dam				Intake Dike			
HEC-RAS		2-D		HEC-RAS		2-D	
Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time
817	16.28	817	16.24	n/a	n/a	n/a	n/a
Maximum Water Surfaces							
Keowee Dam				Intake Dike			
HEC-RAS		2-D		HEC-RAS		2-D	
Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time
818.4	16.53	820.1	16.58	810	17.17	807.2	17.67
Maximum Water Surfaces							
Swale				Tailwater			
HEC-RAS		2-D		HEC-RAS		2-D	
Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time
817.5	16.55	815.5	16.53	787.4	17.52	790.4	18.41

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Sensitivity Analysis

Model	Peak Outflow (cfs)
McDonald & Langridge-Monopolis 1984	1,566,381
Costa, 1985	1,634,480
Xu & Zhang, 2009	1,760,000
Evans, 1986	1,803,331
SCS, 1981	2,647,711
Bureau of Reclamation, 1982	3,046,462
McDonald & Langridge-Monopolis 1984	5,093,603 (upper envelope)
Froehlich (with additional conservatism), 2008	5,440,000

Data in this table based on Wahl 2004, January 28, 2011 SE and updated Xu & Zhang data

100+ HEC-RAS studies performed with varied breach parameters and control variables

Erodiblity was the most significant factor influencing the breach parameters for Xu & Zhang 2009

Bias of conservatism with realism

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Independent Review Breach Parameters

- **Independent Peer Review**

  Joe Ehasz, P.E.

  David Bowles, Ph. D P.E. P.H.

- **FERC Board of Consultant Review**

  Gonzalo Castro, Ph.D., P.E.

  James Michael Duncan, Ph.D., P.E.

  James F Ruff, Ph.D., P.E.

  Gabriel Fernandez, Ph.D., P.E.

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Comparative Analysis Large Modern Dam Failures

❖ Taum Sauk

- Overtopping failure initiated by human error (previous overtopping events had occurred)
- Random rockfill embankment supporting the inner concrete liner loosely placed by end dumping the material without compaction except for the top 16' of 84' height
- The embankment was constructed on a very steep downstream slope of 1.3H to 1V with a 10 high concrete parapet wall along the crest of the dam
- Embankment was highly erodible and contained over 45% sand sized material (also evident in unusual level of surface erosion from rain events)

❖ .Teton

- earthen dam with majority of dam constructed of highly erodible windblown silt (infant mortality event)
- No transition zones (sand and/or fine filters) were included between the silt core and the sand & gravel
- Thin layer of small rock fill on both up and downstream faces with a majority of protection relied upon mix of sand, gravel and cobble
- Piping failure at 130' below the crest due to inadequate protection of impervious core trench material
- Breach top width 781' (~25% of overall crest)

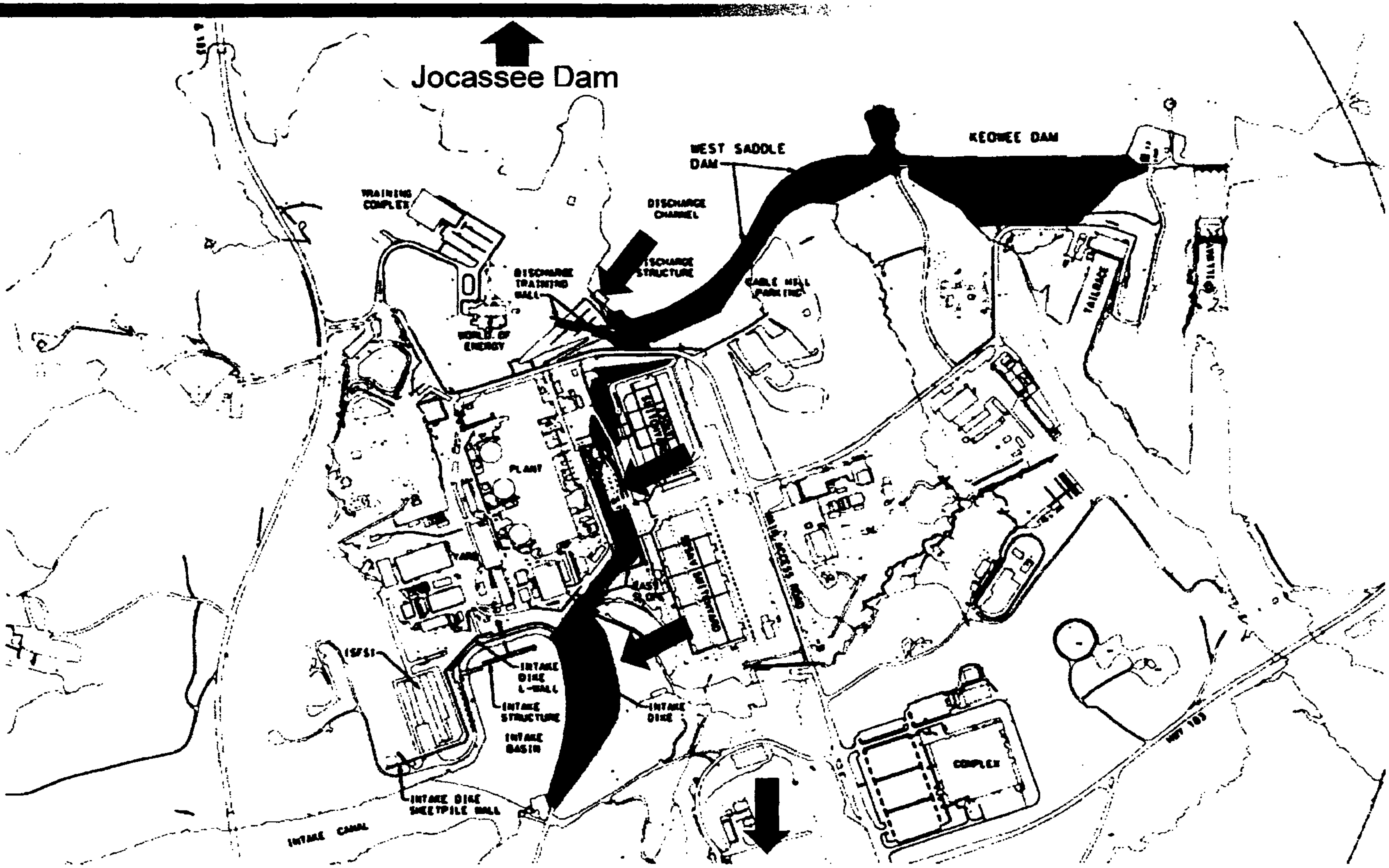
❖ Hell Hole

- True rockfill dam,with upstream sloping impervious core with massive rock fill sections up and down stream to support and protect the core.
- Failure caused by overtopping during construction due to an intense rain event that could not be passed through the construction diversion tunnel
- After overtopping of the core started, the dam took 26 hours to complete the breach and empty the upstream reservoir

Modification Scope Updated

- Modifications for protection from dam failure (under review):
  1. Relocation of external backup power transmission line
  2. Intake Dike embankment protection
  3. East embankment protection
  4. Discharge Diversion wall
- Modifications for Local Intense Precipitation (under review):
  - Transformer relocation
  - Diversion walls and drainage canals
  - Aux building and Turbine building protection

Modification Options



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Duke Energy

Questions and Feedback