FOIA/PA NO: 2012-0325

RECORDS BEING RELEASED IN THEIR ENTIRETY

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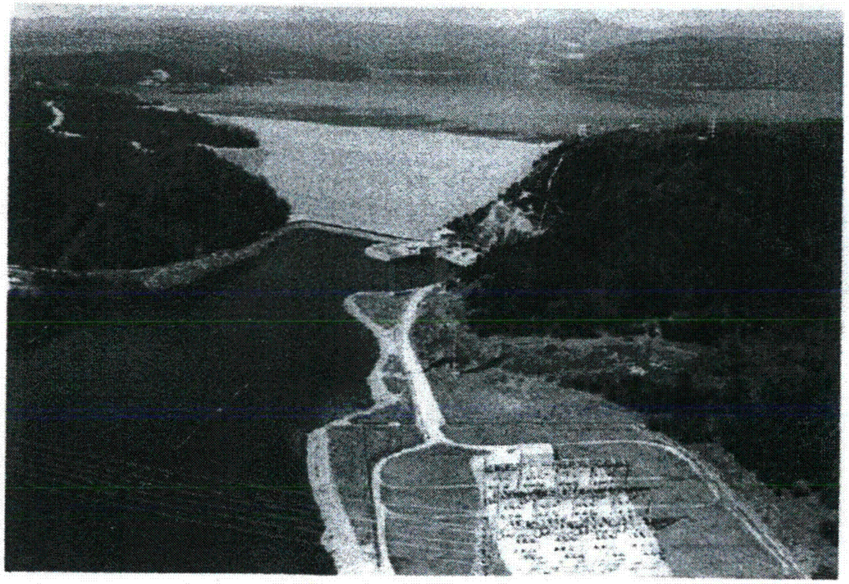
Duke Energy®



Oconee Nuclear Station

External Flood Overview

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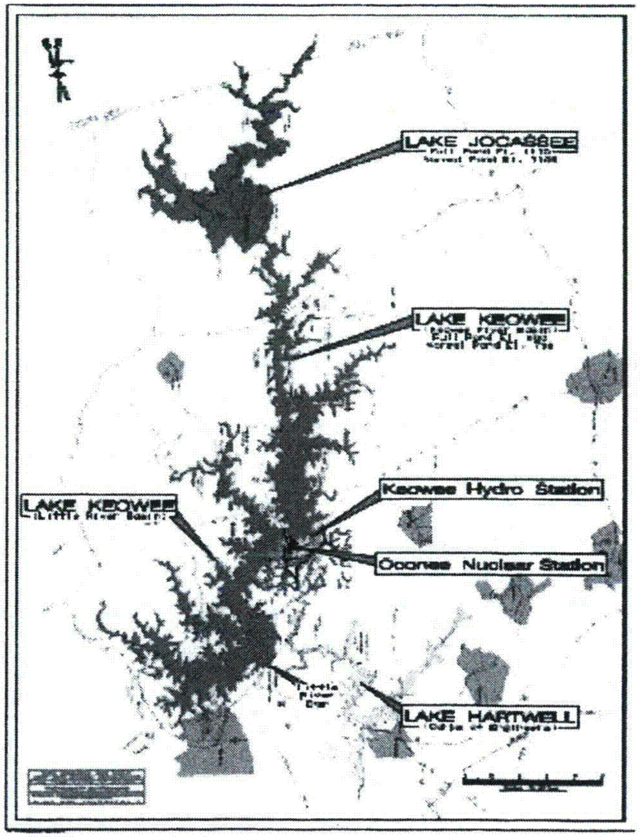
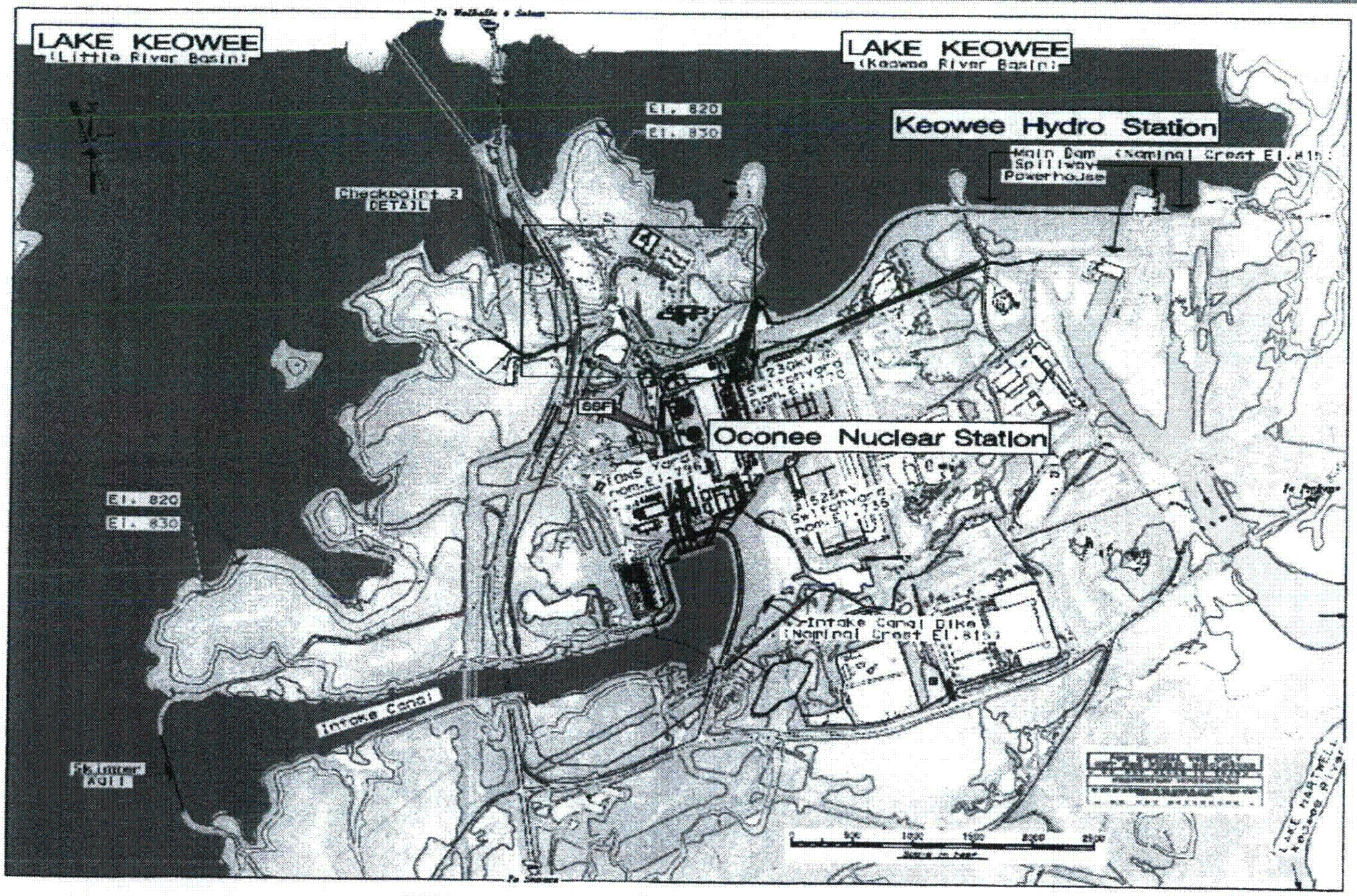
1/7

Background



LAKE JOCASSEE
LAKE KEOWEE
Keowee Hydro Station
LAKE KEOWEE
Oconee Nuclear Station
LAKE HARTWELL

Background



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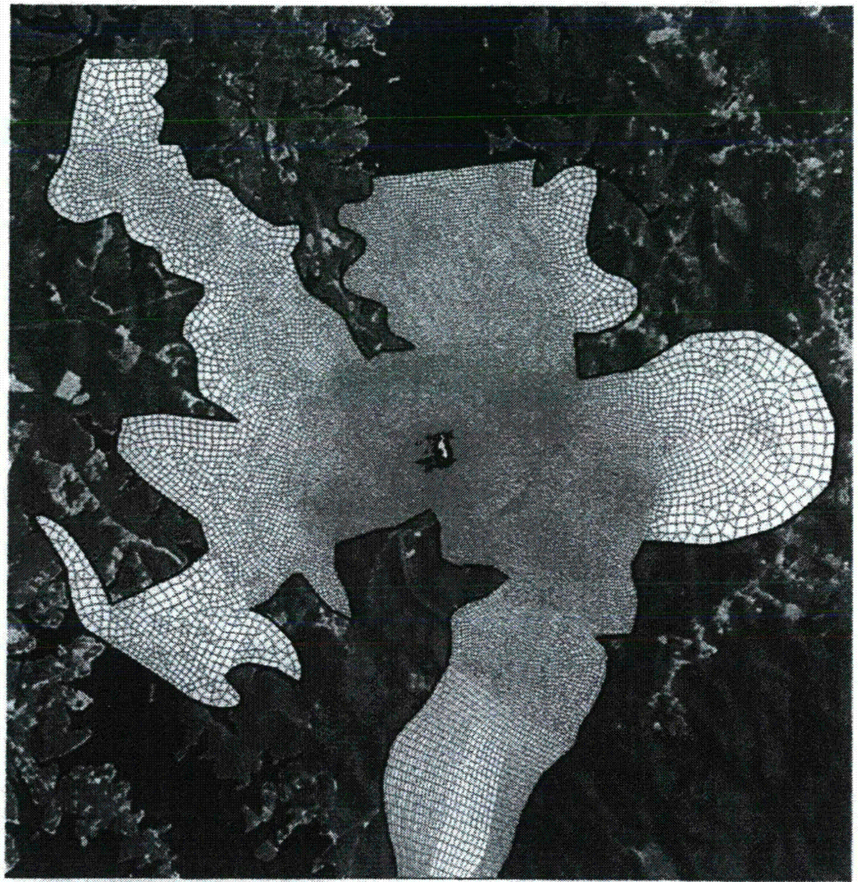
Background
2D Model

2D Model Highlights



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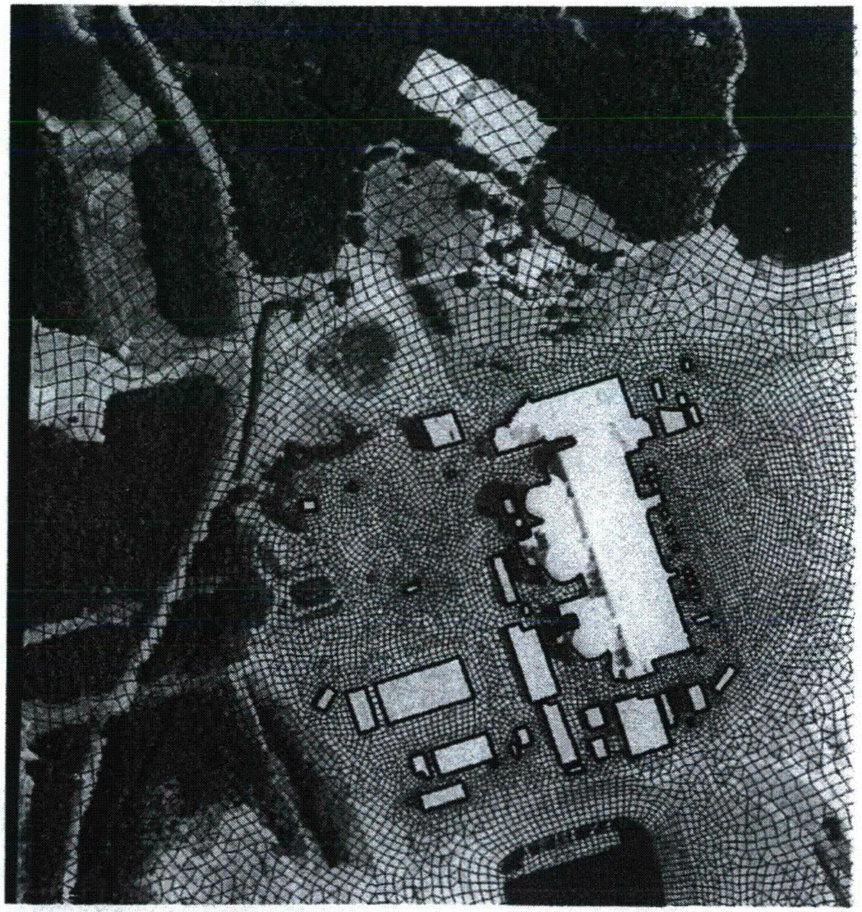
Background
2D Model

2D Model Highlights



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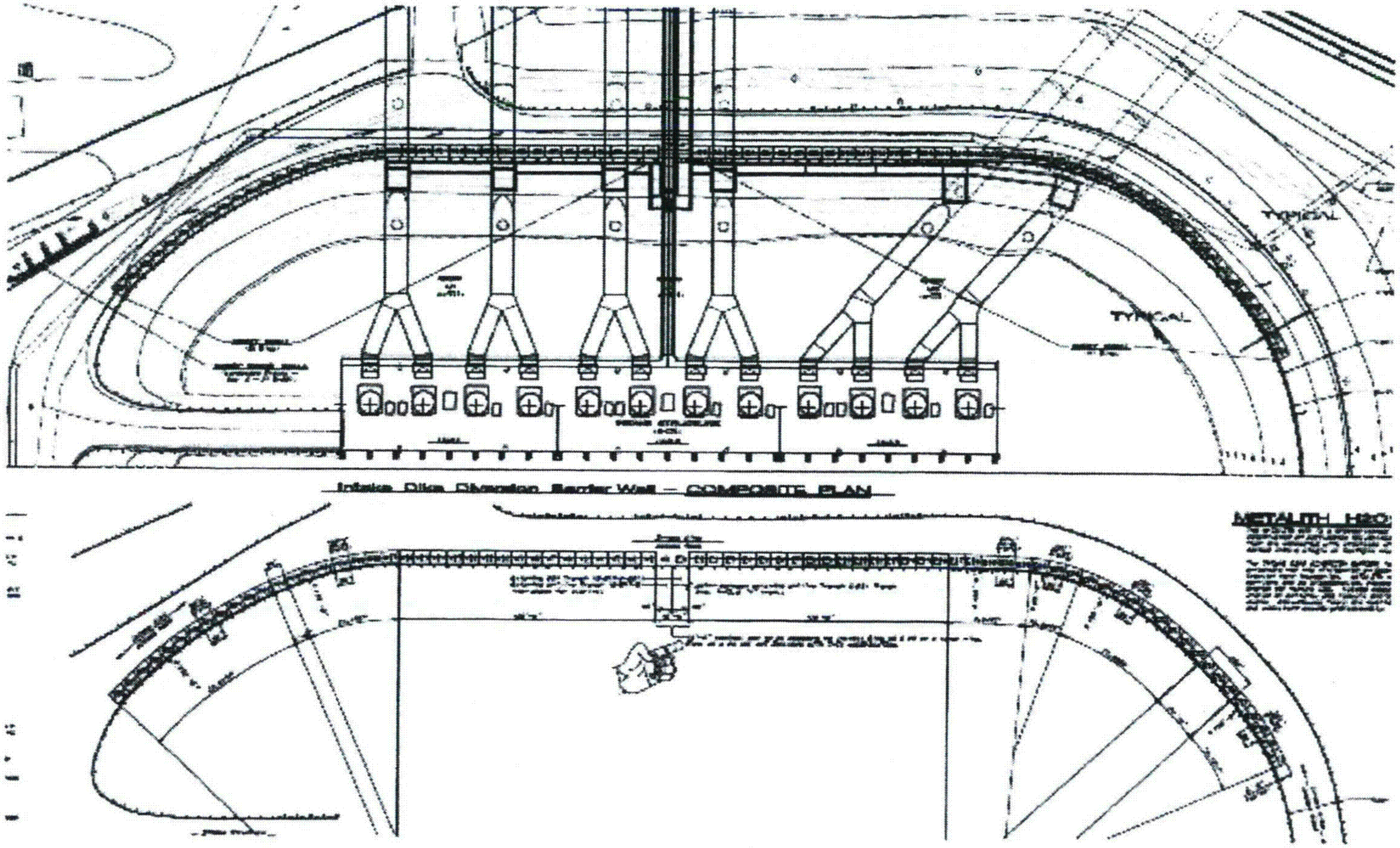
Intake and Swale Walls

- ➢Additional means to manage flood consequences
- ➢Swale wall stops peak floodwaters and assure integrity of secured water source (pond)
- ➢Intake Canal Wall to divert water from entering ONS yard and reduce peak water heights
- ➢Intended as Temporary

Duke Energy®

Intake and Swale Walls



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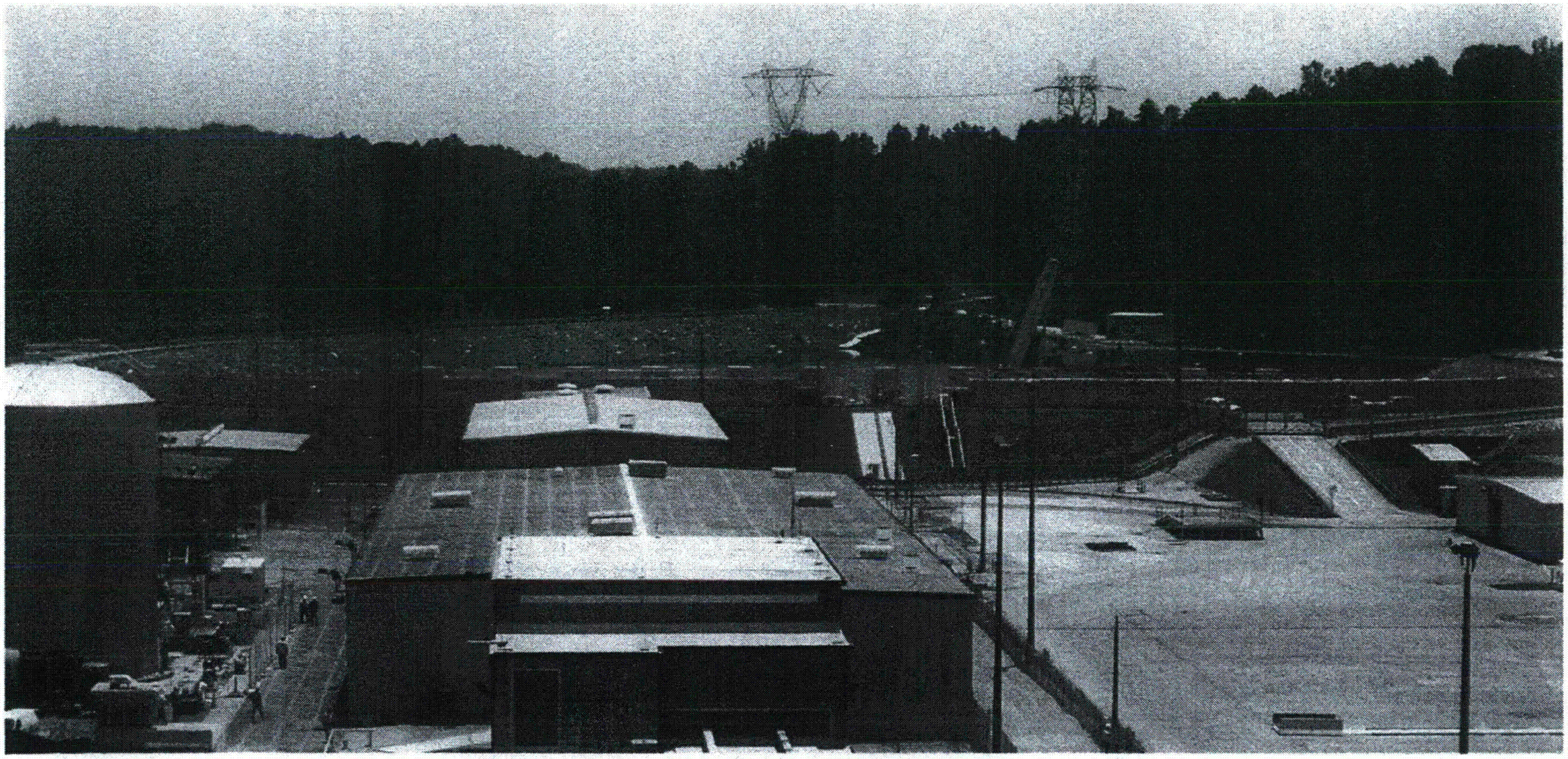
Intake and Swale Walls



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Intake and Swale Walls

VIEW LOOKING EAST BEFORE

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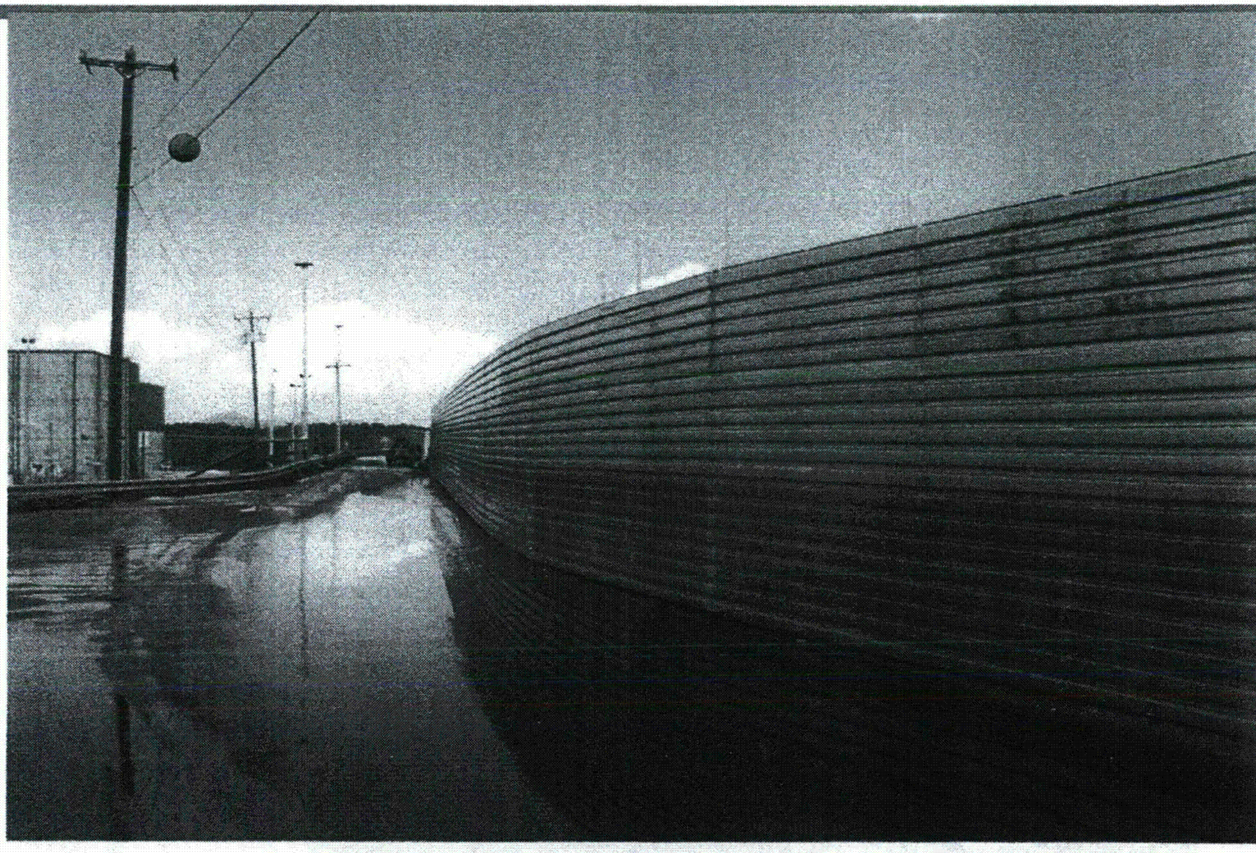
Intake and Swale Walls



VIEW LOOKING EAST AFTER

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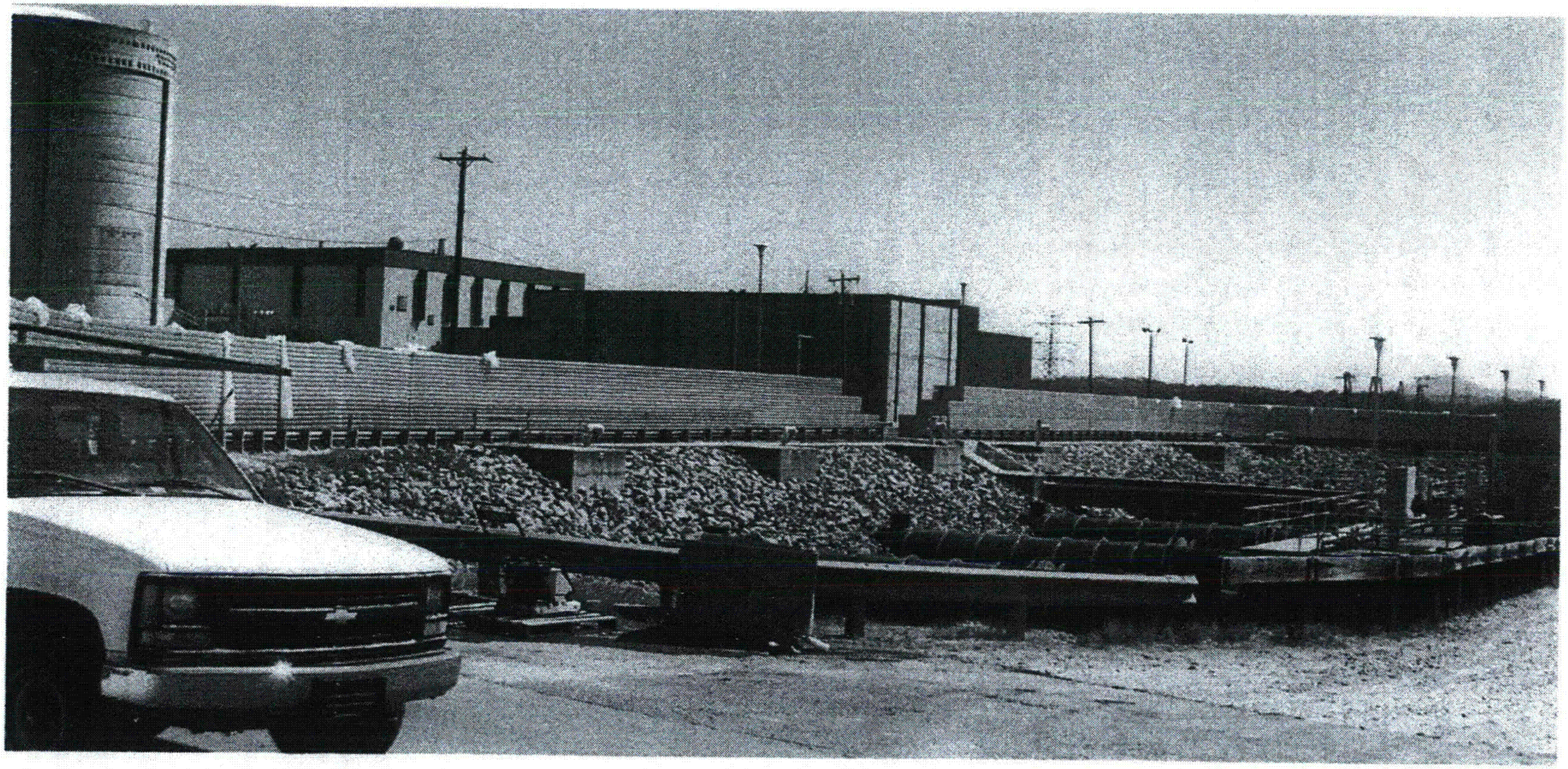
Intake and Swale Walls



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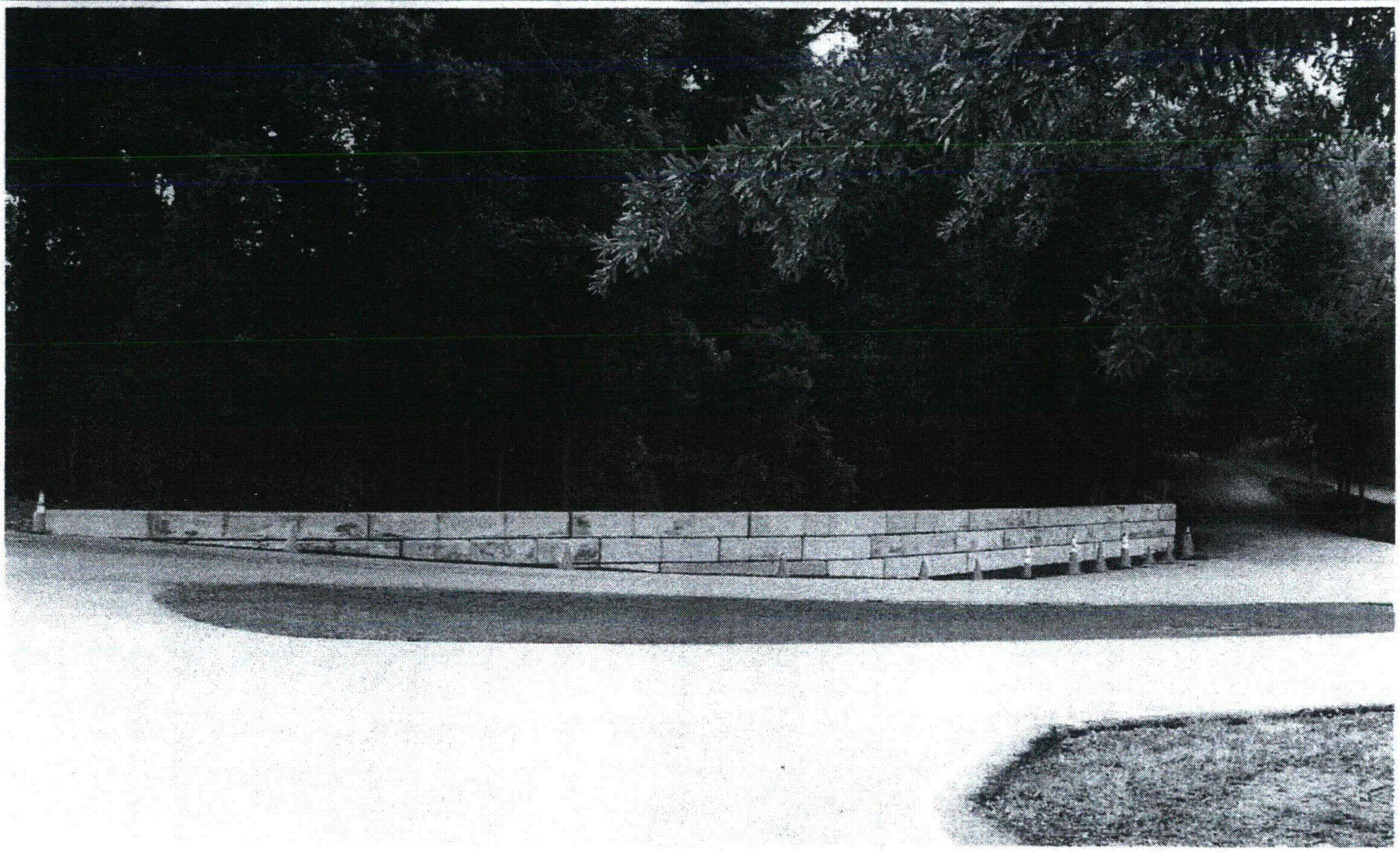
Intake and Swale Walls



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Model Results

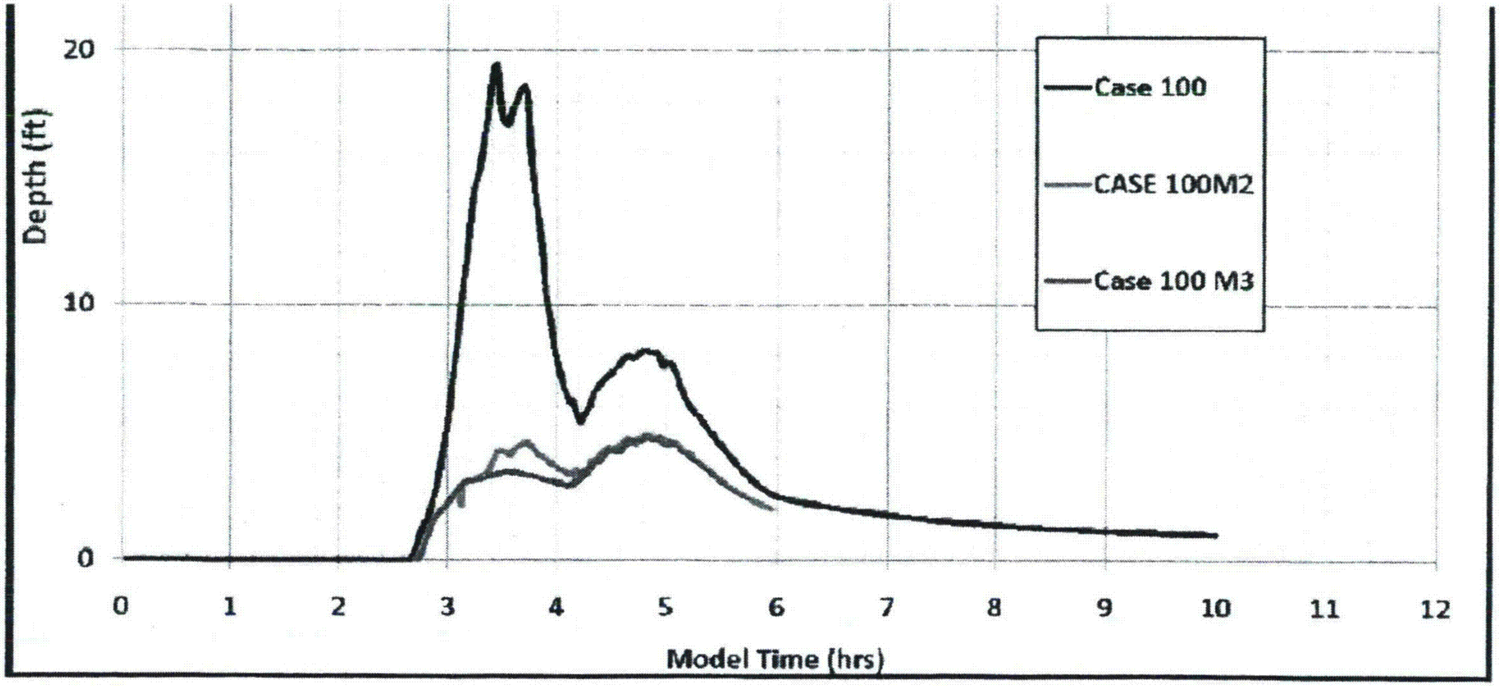

Figure 4 Depth of Inundation Near the SSF

Preliminary Results

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See, Kenneth

From: Jeff Circle
Sent: Monday, December 08, 2008 9:44 PM
To: Melanie Galloway; Robert Schaaf; David Skeen; James Vail; Raman Pichumani; John Stang; Goutam Bagchi; Kenneth See
Cc: Mike Franovich
Subject: FW: FYI - A Duke Presentation on the SSF
Attachments: SSF Refresher 2-22-08.ppt

Here is a Duke presentation on the SSF courtesy of Eric Riggs (the RI at Oconee). In addition to outlining its function, they cover the infamous White finding of 2007.

From: Eric Riggs
Sent: Monday, December 08, 2008 1:22 PM
To: Walt Rogers; Robert Carroll; Jeff Circle
Subject:

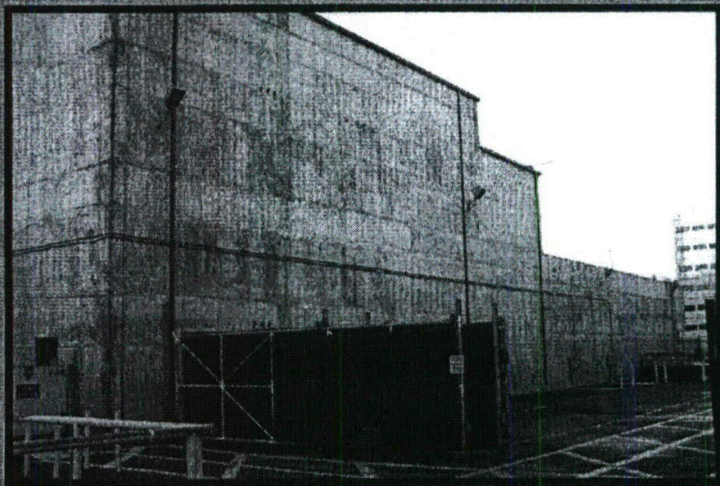
Gentlemen,

Attached is a licensee presentation created earlier this year for refresher training on the SSF. It condenses a lot of info into one presentation, including the SSF's limitations and provides a few pictures of the inside of the facility.

Thanks,
Eric

Eric T. Riggs
Resident Inspector, Oconee Nuclear Station
US Nuclear Regulatory Commission
7812B Rochester Highway
Seneca, SC 29672
(864) 882-6927 (Desk)
(864) 882-0189 (Fax)

L/2



SSF Refresher

1

OBJECTIVES

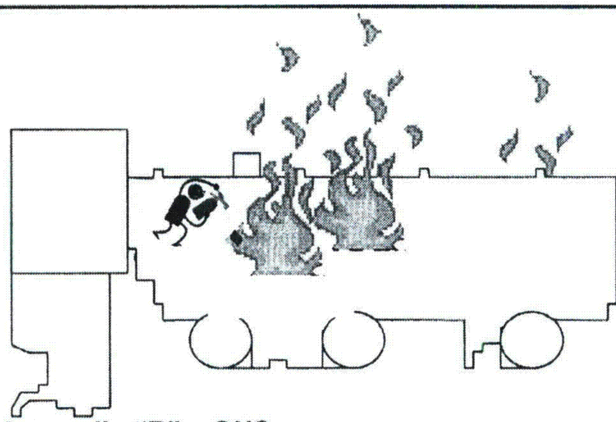
1. State what MODE and temperature the SSF is designed to achieve and maintain.
2. List the purpose of the SSF and the eight events that would cause activation of the SSF.
3. List the four external events in the PRA that the SSF can help mitigate.
4. List the eight SSF "supersystem" functions.
5. Describe the purpose of the SSF-RCMU system.
6. Describe the purpose of the SSF Aux Service Water system.
7. Describe from a personal safety standpoint the important aspects of the SSF CO_2 system.

2

Why did we build the SSF?

And why are we training on it?

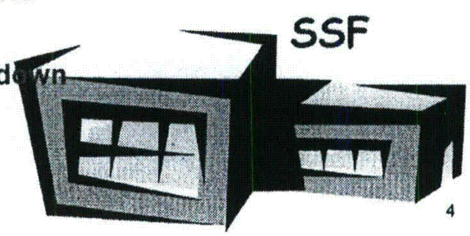
3



10CFR50 Appendix "R" – ONS SSF:

-Controls plant @ Hot Shutdown

-<u>After</u> fire damage repairs, supports plant cooldown



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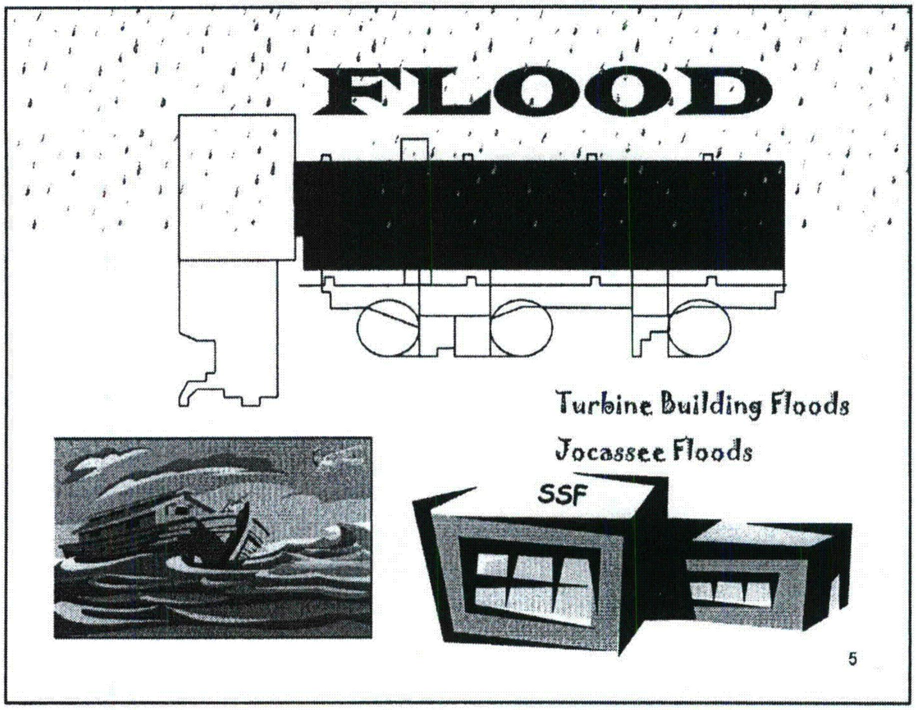
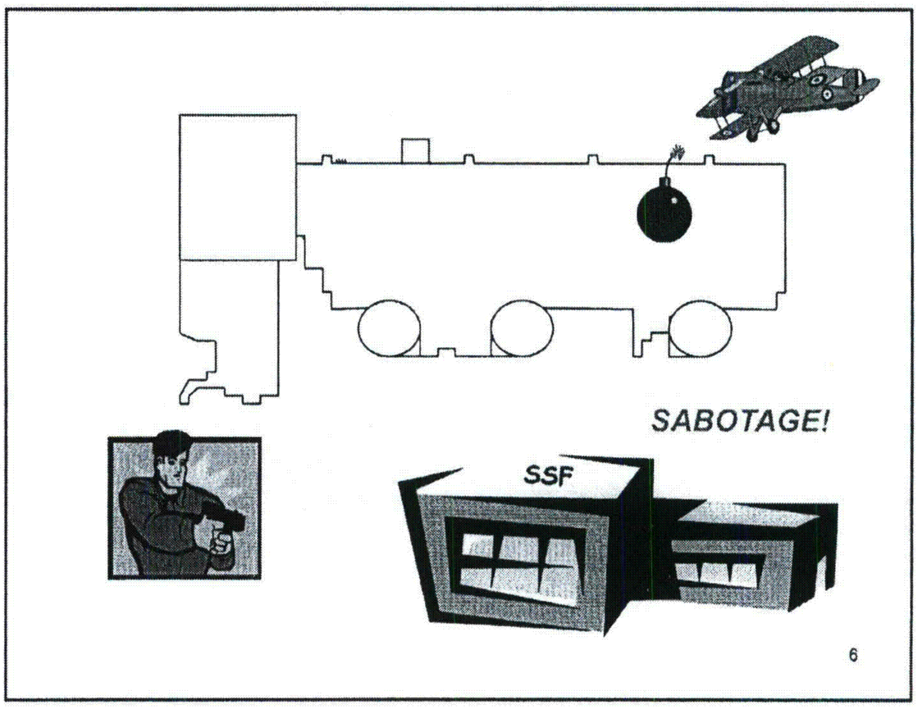
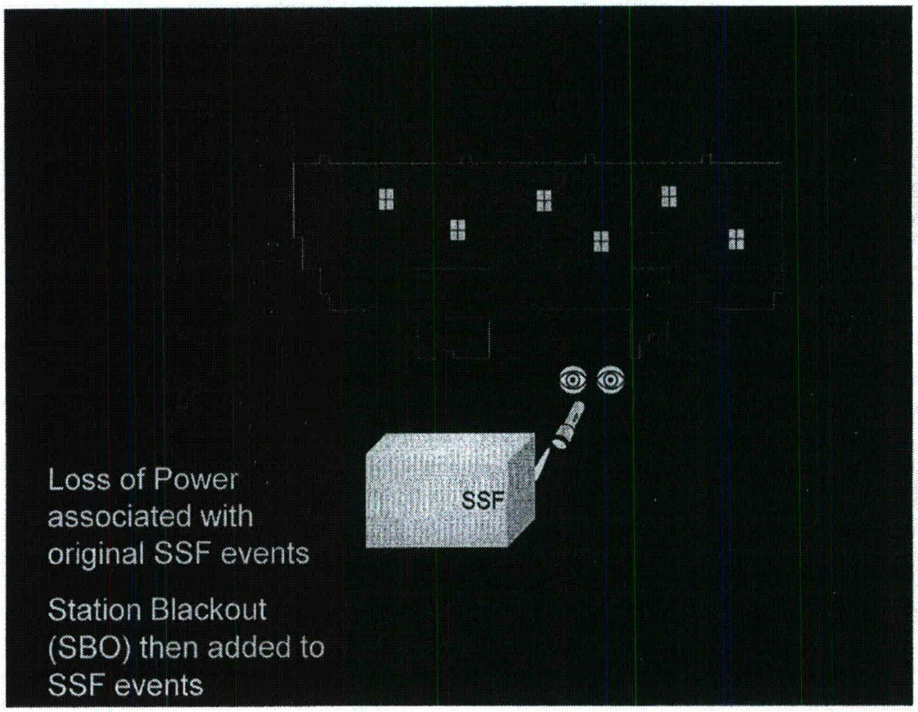
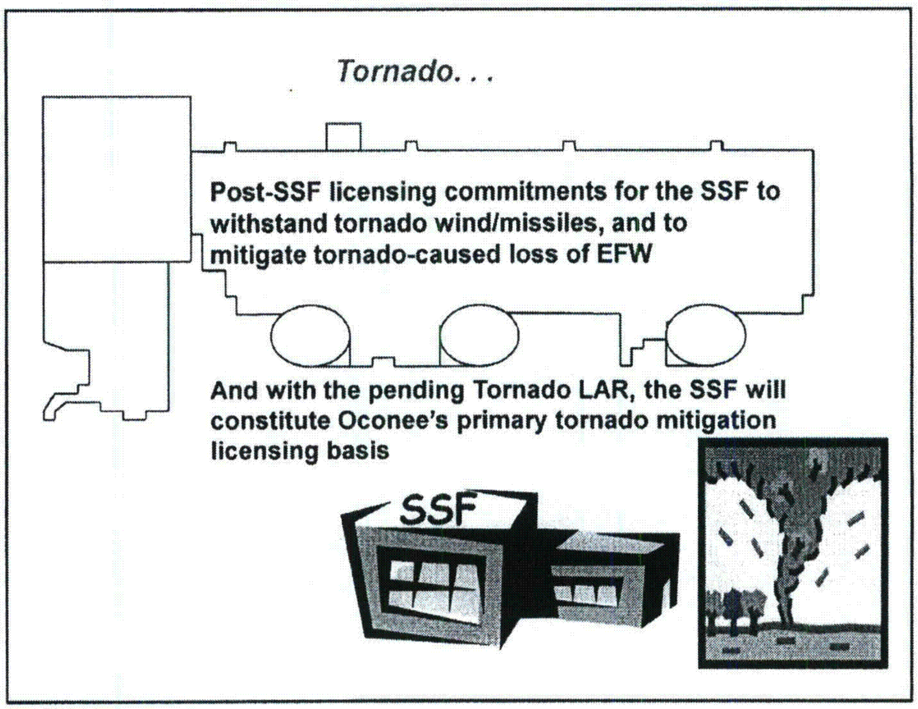

FLOOD
Turbine Building Floods
Jocassee Floods
SSF
5


SABOTAGE!
SSF
6


SSF
Loss of Power associated with original SSF events
Station Blackout (SBO) then added to SSF events


Tornado. . .
Post-SSF licensing commitments for the SSF to withstand tornado wind/missiles, and to mitigate tornado-caused loss of EFW
And with the pending Tornado LAR, the SSF will constitute Oconee's primary tornado mitigation licensing basis
SSF

The Standby Shutdown Facility (SSF) serves as a backup for existing safety systems to provide an alternate and independent means to achieve and maintain MODE 3 (Tave $\geq$ 525° F) conditions for all three units for 72 hours. The following events would be expected to result in SSF activation:

- #*1. Appendix "R" Fire
- 2. Turbine Building Flood
- 3. Security Event
- #+4. Station Blackout (& Turbine Driven EFW pump inoperable)
- #*+5. Tornado which renders FDW/EFW inoperable
- #+6. Single failure that causes hotwell to be unavailable to EFW
- #+7. High Energy Line Break (HELB) causing loss of EFW
- #*+8. Jocassee flood (non-Tech Spec)

These events have variations on the 72 hours @ Mode 3 SSF basis.

* These are external events. Also, seismic events lead to floods.

+ These were added after initial SSF licensing.

9

SSF Supersystem Functions

SSF+.1 Provide an independent emergency source of electrical power to support essential SSF loads
SSF+.2 Provides water for OTSG secondary side cooling (SSF ASW)
SSF+.3 Provides makeup to RCS inventory and RCP seal cooling (SSF RCMU)
SSF+.4 Provides instrumentation for monitoring RCS, OTSG, and SSF Systems
SSF+.5 Provides limited RCS pressure control via SSF-powered PZR heaters
SSF+.6 Provides RCS letdown capability (SSF RCMU letdown)
SSF+.7 Provides isolation of RCS boundary valves to prevent inventory loss
SSF+.8 SSF HVAC and other support functions to ensure SSF Super System functions are not lost

Also

8094.3	Provide barrier to external flooding of the SSF
MS	Controls MS pressure to provide controlled RCS heat removal
SSF	Supports security systems

10

What the SSF does for plant control

- Removes core heat via RCS <u>subcooled natural circulation</u>.
- SSF ASW carries heat from SGs out through the MS Relief Valves.
- SSF RCMU maintains RCS inventory and shutdown margin for a cooldown to 525ºF, and protects the RCP seals.
- SSF-powered Pressurizer heaters maintain RCS pressure.

What the SSF can NOT do

- It cannot mitigate a LOCA.
- It cannot independently cool the plant to cold shutdown.
  - For Appendix R Fires, the SSF is used to support plant cooldown AFTER some other systems are restored.

SSF RCMU system limitations are important

- 29 gpm makeup (further reduced by seal leakage)
- Limited boron addition
- Letdown fully functional only at high RCS pressure

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SSF and the PRA

Probabilistic Risk Assessment (PRA) answers 3 basic questions:

What can happen or go wrong?
How likely are these events or sequences?
What are the consequences?

We protect ourselves from things we consider to be risky – to a large extent with the SSF.

12

PRA Risk Definitions

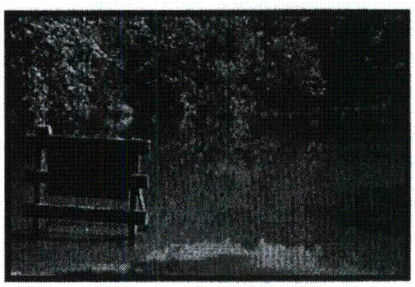
Two Most Common Measurements of Risk:

- Core Damage Frequency (**CDF**) is the annual frequency of uncovery and heatup of the reactor core to the point where severe fuel damage is anticipated.
- Large Early Release Frequency (**LERF**) is the annual frequency of those accidents leading to significant, unmitigated radioactive releases from containment in a time frame prior to effective evacuation of the population such that there is significant potential for early fatalities. (LERF is a subset of CDF)

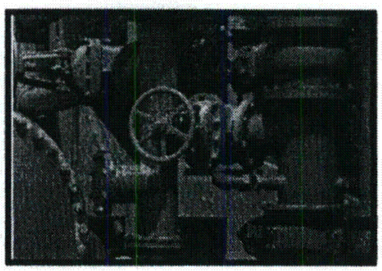
13

Initiating Events

Initiating events are events which cause the failure of plant systems or equipment resulting in a plant transient or emergency shutdown. Initiating events are separated into internal and external events.



External Events



Internal Events

14

Internal Events include all types of plant transients and loss of coolant accidents.

Rx/Turbine Trip Loss of Load Loss of Off-Site Power Loss of Main Feedwater Excessive Main Feedwater Fdw/Steam Line Break Inside Cont. Fdw Line Break Outside Cont. Steam Line Break Outside Cont. Total Loss of Service Water Total Loss of Component Cooling Water Loss of Operating 4160 V Essential Bus Loss of Instrument Air Inadvertent Safeguards Actuation Loss of Vital Instrumentation and Control	Large LOCA Medium LOCA Small LOCA S/G Tube Rupture Interfacing-Systems LOCA Rx Pressure Vessel Rupture

15

External Events

External Events include all types of natural and man-made disasters.

External Events in the Oconee PRA

- **Seismic Events**
- **Tornado Strikes**
- **Fire**
- **External Flood (Jocassee)**

★ The PRA is not limited to design basis assumptions for external events. For example, PRA seismic analysis is not limited to design basis accelerations.

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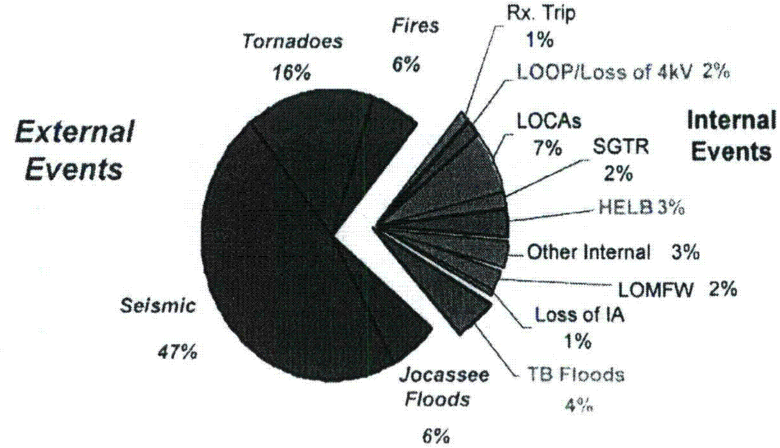
Oconee PRA Results - Events



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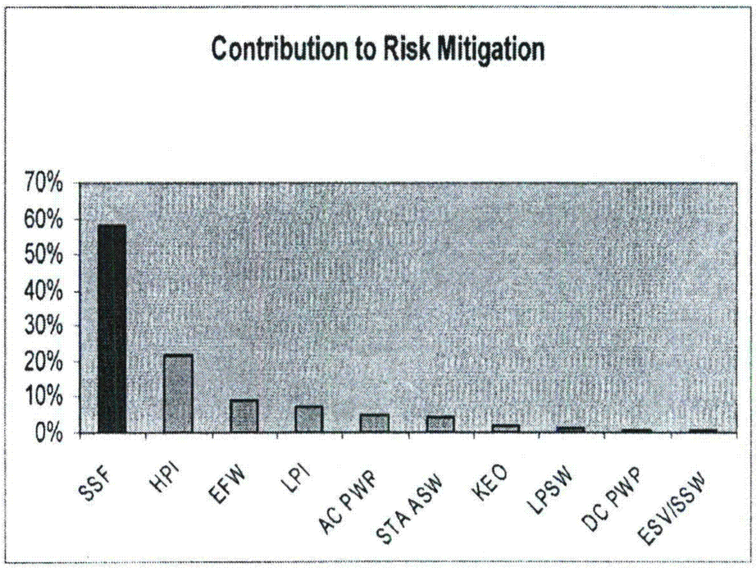
"At-Power" Risk Only



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SSF Emergency Operating Procedure
Entry Conditions

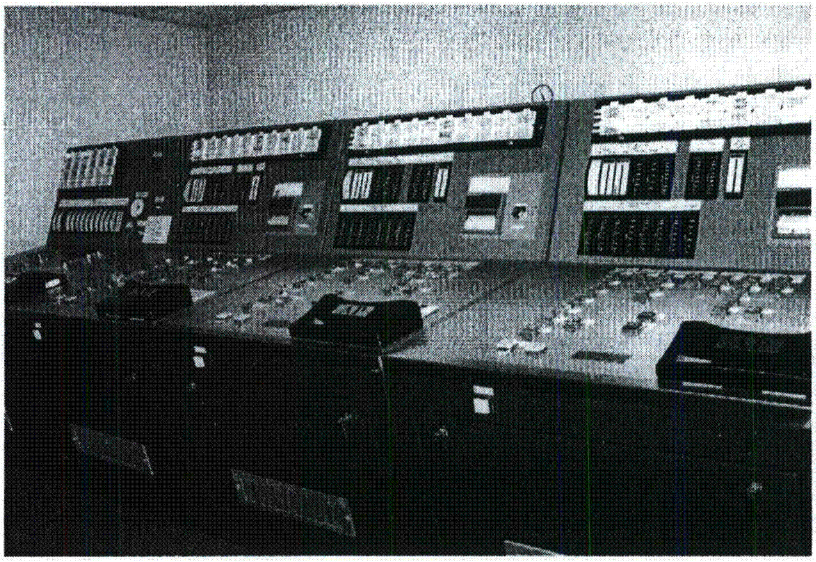
- Directed by another AP or EOP, or Security
- Confirmed "Challenging Fire" in Control Room, Equipment Room, or Turbine Bldg
  - MS branch lines must be isolated from the main control room within 10 minutes.
- 10 minutes to activate SSF, including electrical breaker swap @ SSF and SSF diesel start
  - Start SSF ASW: 14 minutes
  - Start SSF RCMU: 20 minutes

SUBSEQUENT ACTIONS

DETERMINE WHICH SSF SYSTEMS ARE REQUIRED for affected unit(s)

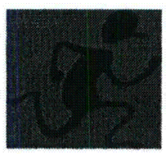
- SSF RCMU required when Component Cooling and HPI seal injection are lost to RCPs
- SSF ASW feed required to SGs when NO source of feedwater is available

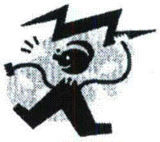
SSF Control Room



Operating Experience: SSF Activation

- Since the SSF's installation in the 1980s, training, drills and procedure refinements have been required to demonstrate 10 minute SSF activation
- PIP O-04-6342: (NRC White Finding) Appendix R / SSF 10 minute activation basis incorrect
  - Corrected to start 10 min clock @ discovery of challenging fire
- PIP O-06-7655: Appendix R licensing basis to isolate MS branch lines during SSF 10 minute activation interval not maintained in SSF EOP, calcs and UFSAR.
  - Procedures/calcs/UFSAR corrected.
  - MS Isolation Project targeted to resolve OBD/NCIs





SSF Electrical Power

- SSF is normally supplied power from the Unit 2 Main Feeder Bus.
  - This is automatically disconnected (breaker OTS1-1 trip) upon ES-1 or 2 actuation on any unit. After ~ 1 hour, the SSF becomes unavailable.
- In an SSF event, the SSF D/G independently provides power.
- The SSF or the plant can power certain equipment (e.g., RCS boundary valves; RCS/SSF instrumentation). In order for SSF power to be independent / separate, during SSF activation the operators must manually swap Kirk-key-interlocked breakers on MCCs 1/2/3XSF (top floor of SSF).
- Engineering changes are in progress/planned to:
  - Restrict conditions where normal power to the SSF would be tripped.
  - Provide another source of power to the SSF (PSW Project).
  - Provide SSF Control Room–controlled breaker swaps.

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SSF Electrical Power

- The SSF provides power to some Pressurizer Heaters.
- The SSF has two sets of batteries (normal & standby), inverters (KSF1&2) and low voltage AC & DC distribution systems for control power and other loads.
  - The batteries, along with the air start system, provide SSF activation capability (diesel start) when outside power sources are not available.

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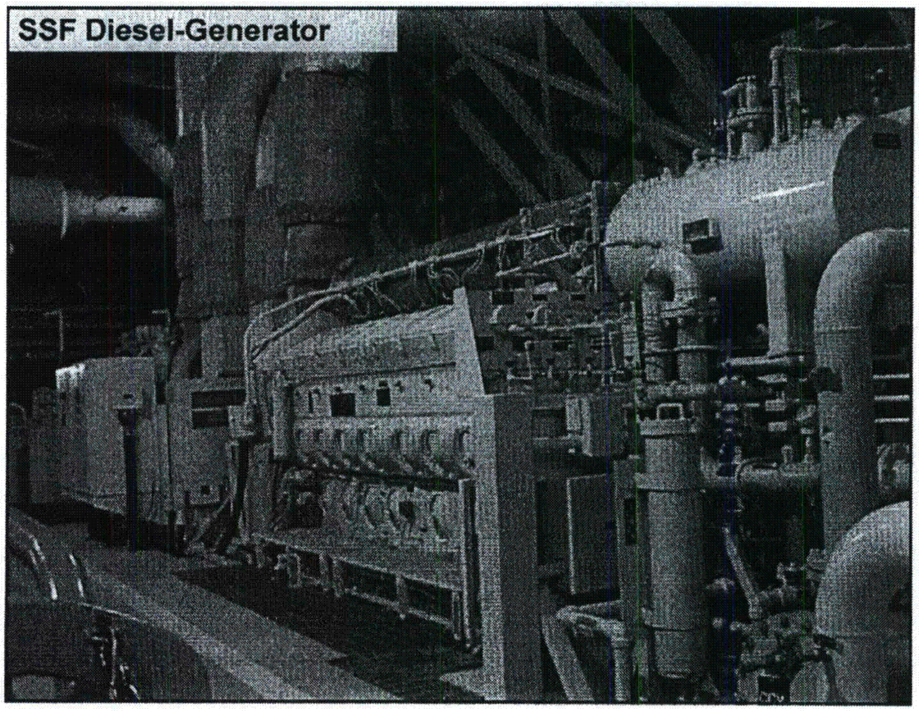


Operating Experience: SSF Electrical Power

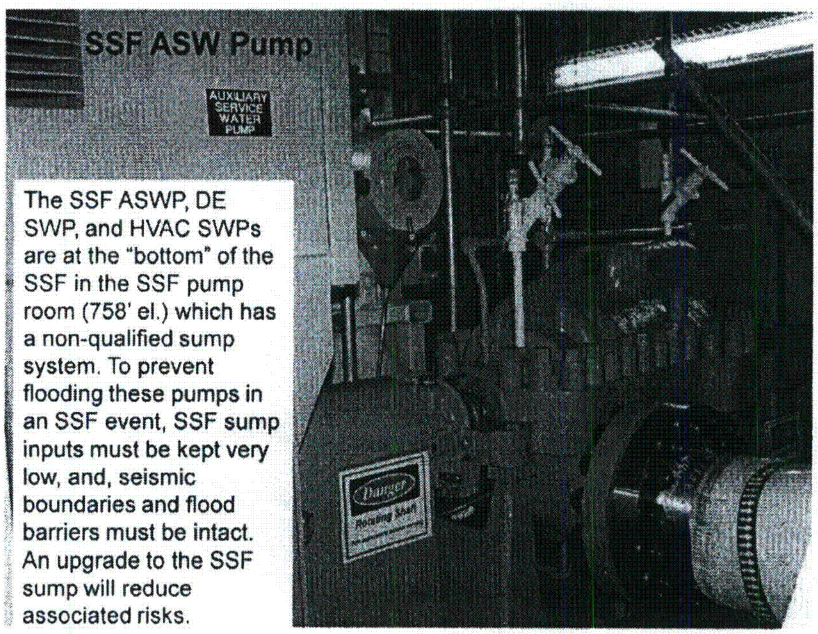
- PIP O-02-1066: (NRC White Finding) Inadequate # of SSF-powered Pzr Heaters
  - Engineering changes provided more heaters.
- PIP O-03-5354: Fire in SSF Diesel Exhaust
  - Repaired/improved insulation & exhaust bellows
  - Earlier roof fire required mod to exhaust stack
- 2003/2004: Both KSF1&2 inverters OOS
  - Replaced 2004 (JIT for Keowee refurb outages)
- Industry OE: Electrical generator (Parsons Peebles) crimped stator end turns can fail
  - Spare generator being purchased

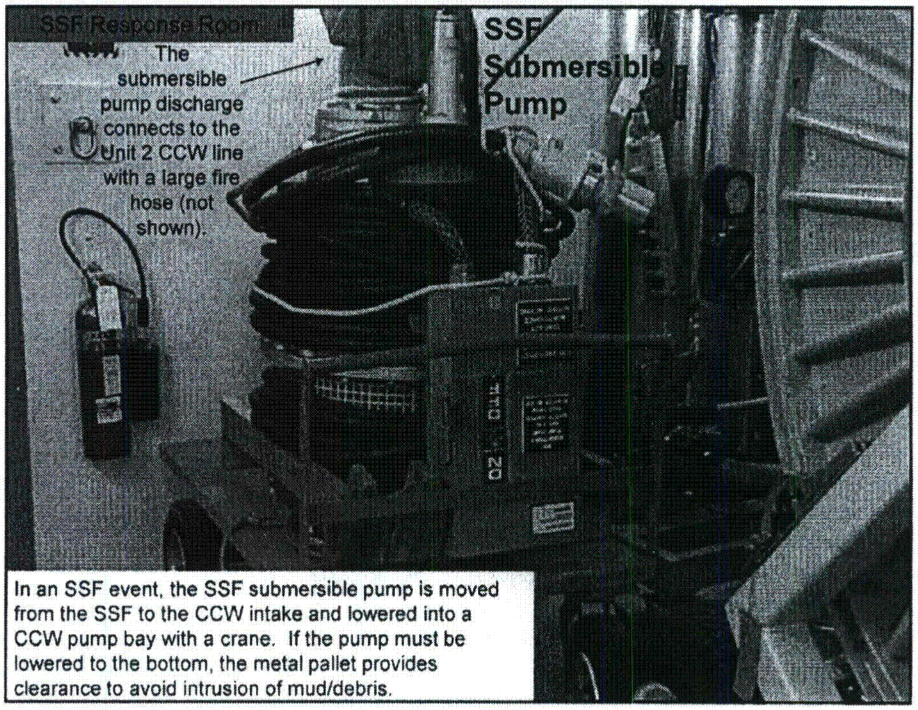
26

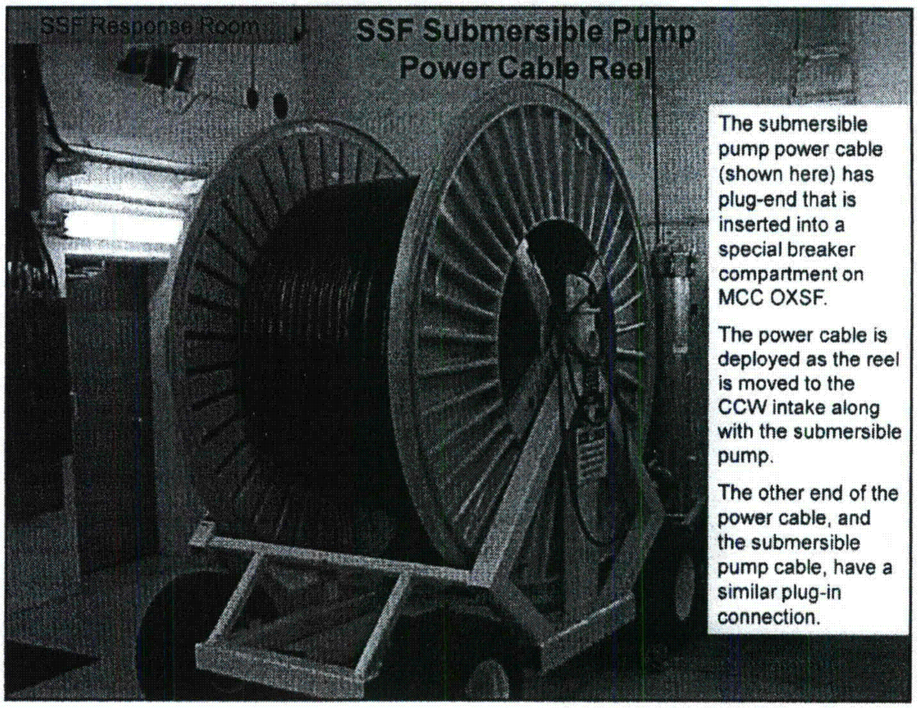
SSF ASW SYSTEM

- COOL RCS IN CONJUNCTION WITH A LOSS OF THE NORMAL & EMERGENCY FDW SYSTEM

- PROVIDE SG COOLING BY MAINTAINING SECONDARY SIDE VOLUME
  - Also necessary: control MS pressure & ASW flow



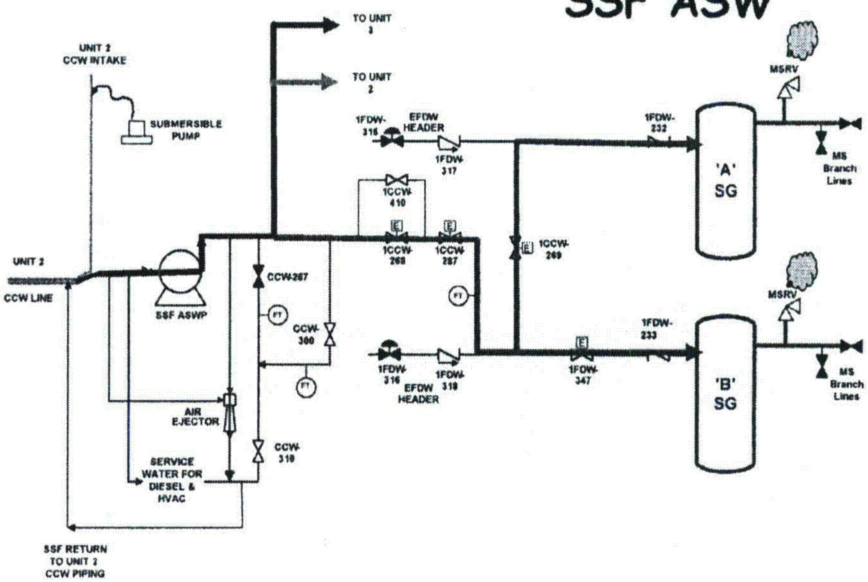

SSF Response Room
SSF Submersible Pump
The submersible pump discharge connects to the Unit 2 CCW line with a large fire hose (not shown).
In an SSF event, the SSF submersible pump is moved from the SSF to the CCW intake and lowered into a CCW pump bay with a crane. If the pump must be lowered to the bottom, the metal pallet provides clearance to avoid intrusion of mud/debris.


SSF Response Room
SSF Submersible Pump Power Cable Reel
The submersible pump power cable (shown here) has plug-end that is inserted into a special breaker compartment on MCC OXSF.
The power cable is deployed as the reel is moved to the CCW intake along with the submersible pump.
The other end of the power cable, and the submersible pump cable, have a similar plug-in connection.

Pathways for Submersible Pump Deployment Have Been Painted

SSF-to-CCW Intake

SSF ASW



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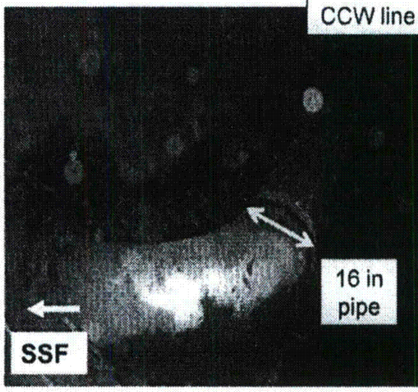
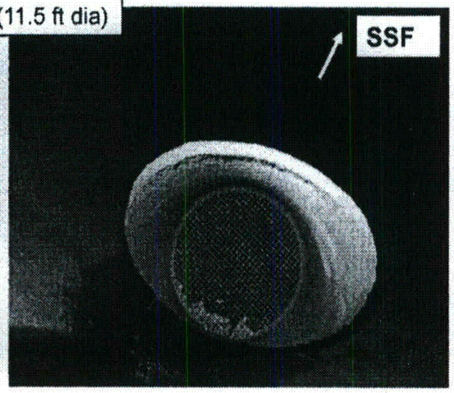
SSF Suction – Pipe in a Pipe

Inside the Unit 2 CCW line (11.5 ft dia)





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Operating Experience: SSF ASW

- 1986/1987: SSF inoperable ~ 6 months due to SSF CCW suction inadequacies & potential runout of SSF ASWP
  - Submersible pump added; ASW air ejector added; Diesel Service Water diversion capability provided
  - Discharge throttle valves 1/2/3 CCW-268 upgraded & motor operators added; low flow throttle valves 1/2/3 CCW-410 installed
- PIP O-05-3770: (SSF Risk Reduction) Unit 2 CCW unwatering outages create excessive SSF unavailability & outage/SSF problems
  - Proposed project: SSF 2nd suction from U1 CCW, using weirs to impound ~ 300,000 gallons @ elevation above SSF pump room
- PIP O-07-3533: (MR a1) SSF inoperable 18 days due to SSF ASWP motor failure
  - Motor repaired; spare motor obtained

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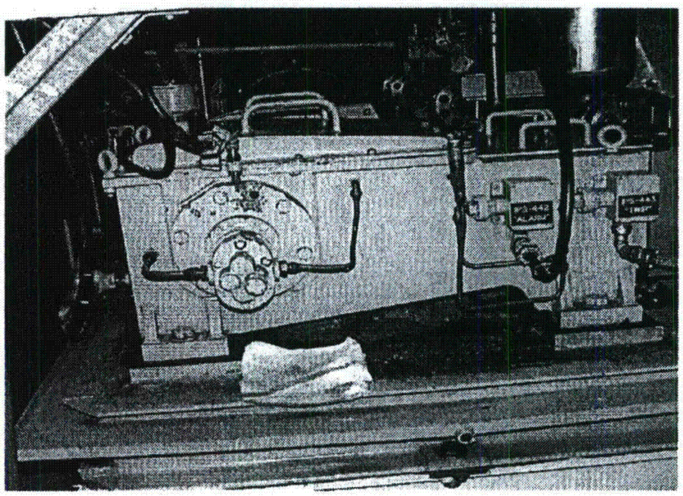
SSF RCMU SYSTEM

SUPPLY RCP SEALS & RCS MAKEUP IF NORMAL SYSTEMS ARE INOPERABLE. RCMU IS ADDED TO:

- ✓SUPPLY AND COOL RCP SEALS TO AVOID SEAL DEGRADATION OR FAILURE
- ✓RECOVER RCS VOLUME LOSS DUE TO SHRINKAGE DURING COOLDOWN
- ✓RECOVER NORMAL RCS LEAKAGE
- ✓ADD NEGATIVE REACTIVITY (SFP BORON)
- ✓PREVENT LOSS OF PZR LEVEL (PREVENT VOID FORMATION)

All this is done with very limited makeup capability (29 gpm). Letdown capability is also limited.

SSF RCMU Pump



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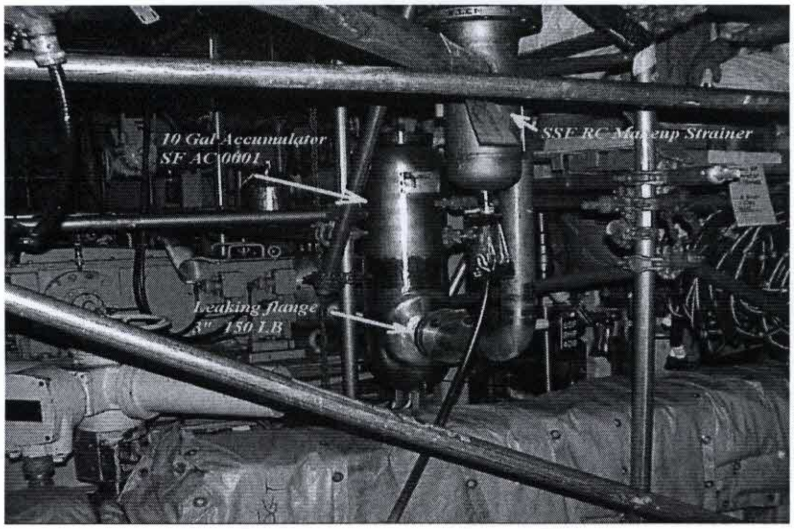
SSF RCMU Pump



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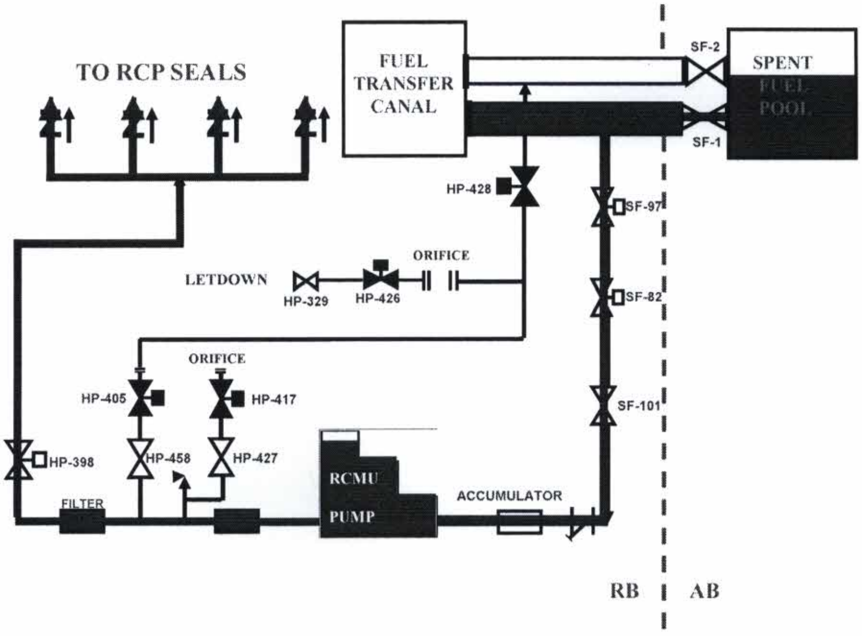

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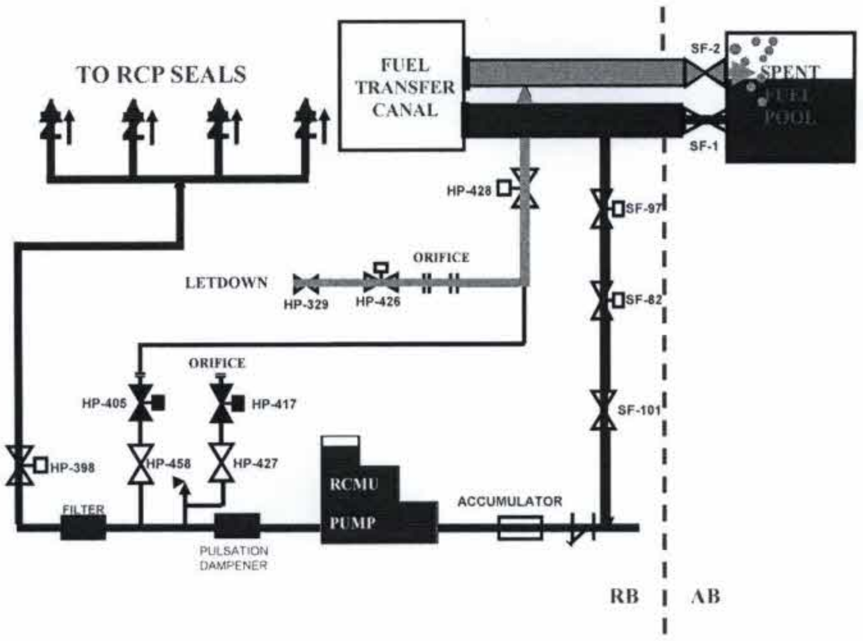

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Operating Experience: SSF RCMU

- 1990s: Licensee Event Reports on SSF RCMU support of RCP seals
  - SSF-RCS leakage limits established
  - Unit 1 RCP seals replaced with cartridge seals
  - SSF RCMU pressure orifices reworked
- PIP O-06-2968 (and earlier PIPs): RCMU pump discharge relief valve lifting/damaged
  - Relief valve setpoint increased
  - Starting interlock on RCS pressure to be installed

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Other SSF SSCs

Diesel Support
- Starting Air; Fuel Oil; Lube Oil; Jacket Cooling Water

HVAC
- Constant Ventilation; Summer Ventilation; Diesel Ventilation
- Upgrades being pursued progress: Decreased requirements; refurbishment of SSF air conditioner

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Flood Barriers

Flood Barriers
- 796.5' el – Turbine Building Flood / Tech Spec
- 801' el (5' above grade) – Jocassee Flood / Non-Tech Spec

Operating Experience:
- 1976 ONS Turbine Building Flood was a driver for the SSF
- During SSF construction, the diesel room flooded from yard drains
  - SSF Sump check valves credited
- 2005 & 2006 - PIP O-07-1662 (NRC White Finding) Jocassee flood barrier breached - CO2 fill line; SSF sewer
  - Barriers corrected via minor engineering changes
  - Civil Passive Features (Hazard Barriers) program established
  - Project to upgrade & credit SSF sump pumps will provide margin

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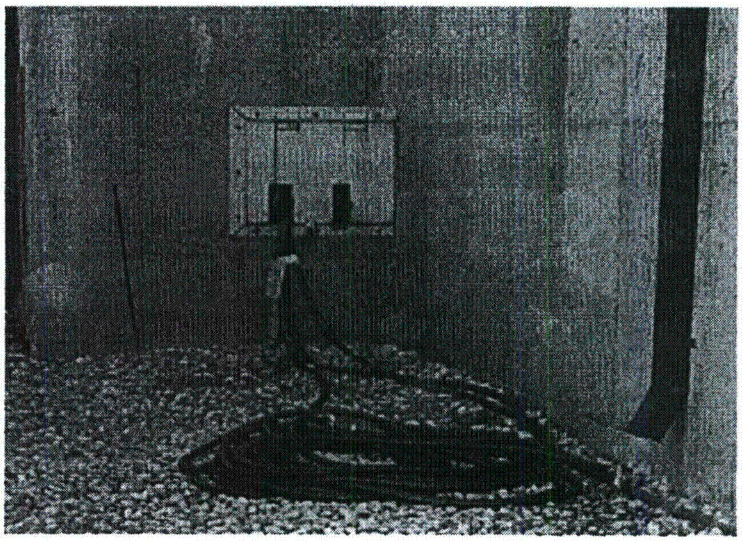

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SSF Challenges

A high risk (PRA) a single train system support of all three units
- Equipment failures & issues become significant occurrences
- Repairs, PMs, tests and upgrades require SSF unavailability

Reliability (Maintenance Rule Functional Failures) and unavailability of the SSF have been unsatisfactory (Maintenance Rule a1)

Weaknesses from the original SSF design

Operator actions for the SSF are challenging

SSF licensing & design bases continue to evolve

On-going regulatory Issues – current examples
- NRC concern over MS Relief Valve cycling
- "Green" violations on SSF HVAC problems, SFP temperature

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UNIT	OVERALL RATING
Shared	
1	Y
2	Y
3	

M/R #	Maintenance Rule Function Description	Risk Cat.	Unit Rating			
			S	1	2	3
8094.3	Provide barrier to external flooding of SSF.	A	Y	n/a	n/a	n/a
SSF+.1	Provide an independent emergency source of electrical power to support essential SSF loads.	A		Y	Y	Y
SSF+.2	Provides a source of water for OTSG secondary side cooling.	A	Y	Y	Y	Y
SSF+.3	Provides makeup water for RCS inventory control and for RCP seal cooling.	A	n/a	Y	Y	Y
SSF+.4	Provides instrumentation required for monitoring RCS, OTSG, and SSF Systems.	A	n/a	Y	Y	
SSF+.5	Provides limited RCS pressure control via Bank 2, Group B pressurizer heaters.	A	n/a	Y	Y	Y
SSF+.6	Provides RCS letdown capability.	A	n/a			
SSF+.7	Provides isolation of RCS boundary valves to prevent RCS inventory loss.	A	n/a	Y	Y	Y
SSF+.8	SSF HVAC and other support functions to ensure SSF Super System functions are not lost.	A		n/a	n/a	n/a
(TBD)	(proposed per PIP O-06-7655) Controls MS pressure to provide controlled RCS heat removal.	A	n/a	Y	Y	Y

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Unplanned Tech Spec Entries

Status for Unit 1, 2 & 3

During 2007: Unplanned entries into TS 3.10 (Standby Shutdown Facility)

Unit 1	**3**
Unit 2	**2**
Unit 3	**5**

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Operable-but Degraded/Non-conforming Items (OBD/NCI)

Shared
Unit 1
Unit 2
Unit 3

As of 12/31/07, a total of seven OBD/NCIs on SSF systems

- National Fire Protection Association (NFPA)-805 Project:
  - Potential for spurious actuation of 1,2,3LP-19&20 during a control room fire, which could flood the RCMU pump
  - TB fire could spuriously actuate RCS boundary valves
- MS Isolation Project:
  - (App R) Actions in fire area to isolate some MS lines
  - (TB Flood) Credit taken for non seismic TB drain
  - (SBO) Credit taken for instrument air for AFIS
- SSF CO_2 piping supports could interact with safety related systems during seismic event
- ASW/3CCW-287 pipe supports not to code – FIXED 01/2008!
- (SSF fuel oil vent & elevated cable trench tornado-missile vulnerability - FIXED in 2007)

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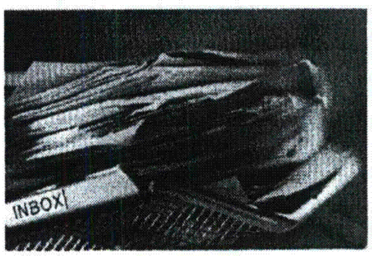
2005 SSF Risk Reduction Review Areas for Improvement

1. Improve reliability of Critical Equipment	60 recommendations
2. Improve Design Margin	36 recommendations
3. Improve Operating Margin	12 recommendations
4. Improve the SSF PRA score	5 recommendations
5. Decrease reliance upon SSF submersible pump	7 recommendations
6. Improve SSF availability	11 recommendations
7. Miscellaneous improvements	13 recommendations



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Improve SSF reliability through SSF Team Action Plan

What will success look like @ 12/31/08?

- SSF overall health rating improved from [redacted] to "yellow" by progress in three SSF Supersystem functions: electrical system (generator); HVAC; I&C
- MRa(1) plan implemented regarding SSF critical spare motors
- SSF On-Line work & 2EOC23 (CCW Unwatering) optimized
- Progress on projects: MS Isolation; NFPA-805; Tornado; Second Suction; PSW
- Progress in the SSF Action Plan across the board

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Action Plan:
The One-List has 59 steps from the 2007 4th Quarter SSF Action Plan.
Key examples:

- ✓ OMP: Issue purchase contract for spare SSF electrical generator (3/08).
- ✓ MCE/MNT/WC: Provide MP for SSF Air Conditioner PM (3/08); budget/schedule SSF Air Conditioner Refurb (5/08). Testing + changes to DBD, T.S. & procedures for SSF operability with portions of HVAC OOS (8/08).
- ✓ MOD: Issue packages for SSF CR Breaker Swap (3/08), Sump Upgrade (6/08).
- ✓ RES: Plan replacement of beyond-service-life RTD signal conditioners (4/08).
- ✓ MCE/MRa(1): Obtain spare motors for SSF DE SWP & HVAC fans (4/08) & for diesel fuel oil pumps & lube oil pumps (11/08).
- ✓ MCE/MNT: Assure parts for SSF ASW air-ejector (04/08) and replace (2EOC23).
- ✓ RES/MNT/WC: Optimize IPs for SSF on-line PMs (03/08); Set SSF On-Line/ 2EOC23 work scope (04/08); SSF unavailability=planned (2EOC23).
- ✓ DBG/OMP: MS Isolation Project approved (5/08); SSF Second Suction detailed cost estimate (5/08)
- ✓ DBG/RGC: Tornado LAR submitted (6/08).

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PERSONNEL SAFETY: SSF FIRE PROTECTION

Water system-fire protection for the entire SSF
- Normally isolated (HPSW-388)

CO_2 system provided to extinguish all fires that may occur in the D/G room
- Eight ton storage unit (enough for two complete auto discharges)
- Ten thermostatic detectors
- One control panel
- Two manual pushbuttons (PBM & PBS)
- Garlic odorizer

<u>CO_2 concentrations can cause unconsciousness/death</u>

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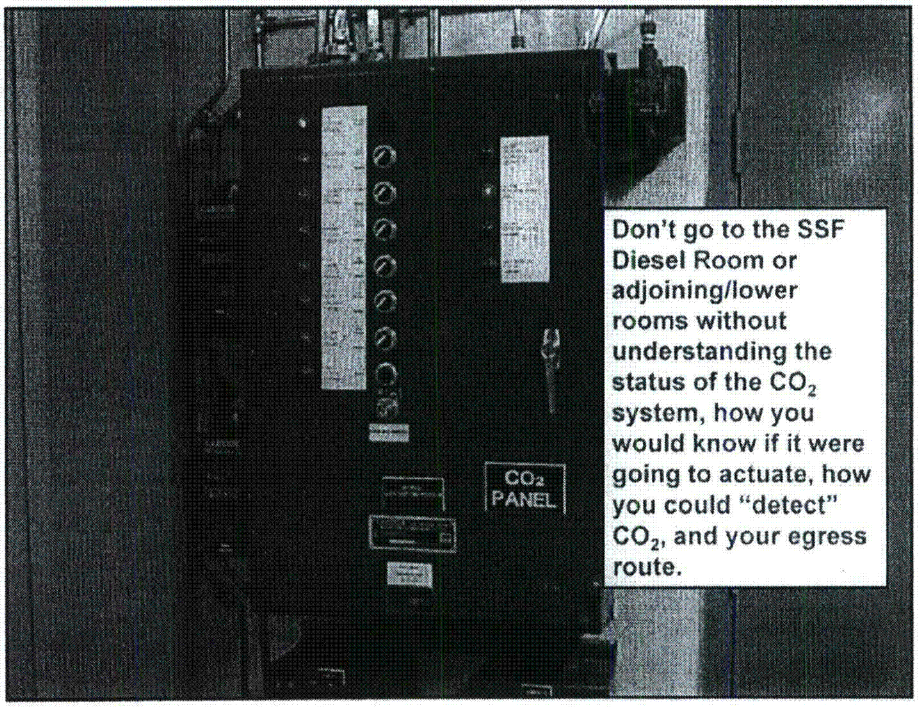

OBJECTIVES

1. State what MODE and temperature the SSF is designed to achieve and maintain.

   MODE 3 (Tave ≥ 525° F) conditions simultaneously for all three units

2. List the purpose of the SSF and the 7 events that would cause activation of the SSF.

   The Standby Shutdown Facility (SSF) serves as a backup for existing safety systems to provide an alternate and independent means to achieve and maintain MODE 3 (Tavc ≥ 525° F) conditions for all three units for 72 hours. The following events would be expected to result in SSF activation:
   1. Appendix "R" Fire
   2. Turbine Building Flood
   3. Security Event
   4. Station Blackout (& Turbine Driven EFW pump inoperable)
   5. Tornado (which renders FDW/EFW inoperable)
   6. Single failure that causes HW inventory to EFW
   7. High Energy Line Break (HELB) causing loss of EFW
   8. Jocassee flood

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OBJECTIVES

3. List the four external events that the SSF can help mitigate

   - Fire
   - Flood
   - Tornado
   - Seismic

4. List the eight SSF "supersystem" functions.

SSF+.1 Provide an independent emergency source of electrical power to support essential SSF loads
SSF+.2 Provides water for OTSG secondary side cooling (SSF ASW)
SSF+.3 Provides makeup to RCS inventory and RCP seal cooling (SSF RCMU)
SSF+.4 Provides instrumentation for monitoring RCS, OTSG, and SSF Systems
SSF+.5 Provides limited RCS pressure control via SSF-powered PZR heaters
SSF+.6 Provides RCS letdown capability (SSF RCMU letdown)
SSF+.7 Provides isolation of RCS boundary valves to prevent inventory loss
SSF+.8SSF HVAC and other support functions to ensure SSF Super System functions are not lost

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OBJECTIVES

5. Describe the purpose of the SSF-RCMU System.

   Supply & cool RCP seals to avoid seal degradation or failure

   Recover RCS volume loss due to shrinkage during cooldown

   Recover normal RCS leakage

   Add negative reactivity (SFP boron)

   Prevent loss of PZR level (prevent void formation)

6. Describe the purpose of the SSF Aux Service Water System.

   Cool RCS on loss of the normal & emergency FDW system
   Provides S/G cooling by maintaining secondary side volume

7. Describe from a personal safety standpoint the important aspects of the SSF CO2 system.

   CO2 concentrations can cause unconsciousness/death

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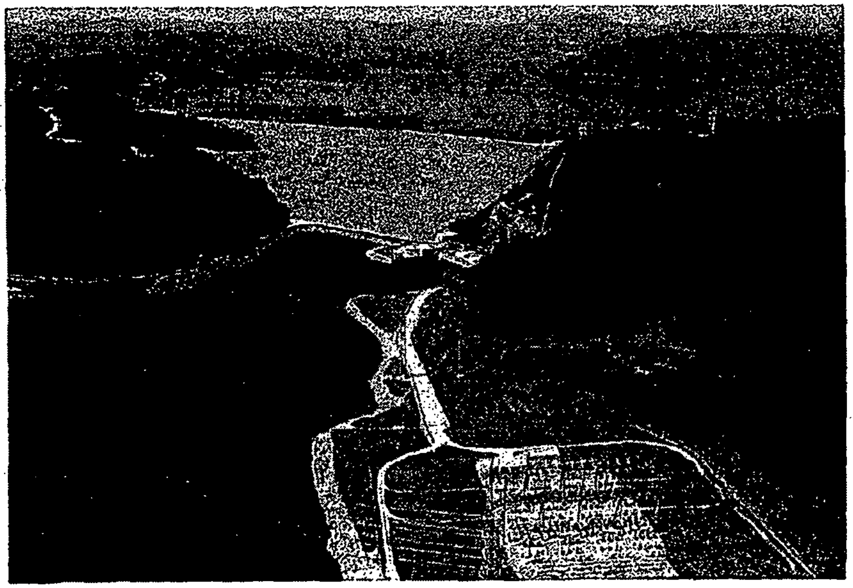

Oconee Nuclear Station

External Flood Status Update

NRR Meeting

Rockville, MD

June 11, 2009

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Duke Attendees

- David Baxter, ONS Site Vice President
- Scott Batson, ONS Engineering Manager
- Mike Glover, ONS General Manager, Nuclear Plant Projects
- Rich Freudenberger, ONS Safety Assurance Manager
- Jeff Thomas, Corporate Regulatory Compliance Manager
- Tim Brown, ONS Project Manager
- David Cummings, Duke Assistant General Counsel
- John Whittaker, Winston & Strawn Attorney

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Agenda

- Opening Remarks
- Project Milestone Schedule
- Key Parameters
- **Role of Realistic Conservatism**
- Closing Remarks

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Opening Remarks

- Duke continues to work expeditiously to respond to NRC concerns regarding the external flood potential to the Oconee site
- We have developed a project milestone schedule for completing the final inundation studies and sensitivity analyses and formulating our corrective action plan
- The schedule calls for key parameter selection by late June, determination of key parameter variation by mid July, and documented technical justification for the selection of parameters to be varied and the range of variability by early August
- The HEC-RAS Sensitivity Inundation Analysis is scheduled for completion by mid October

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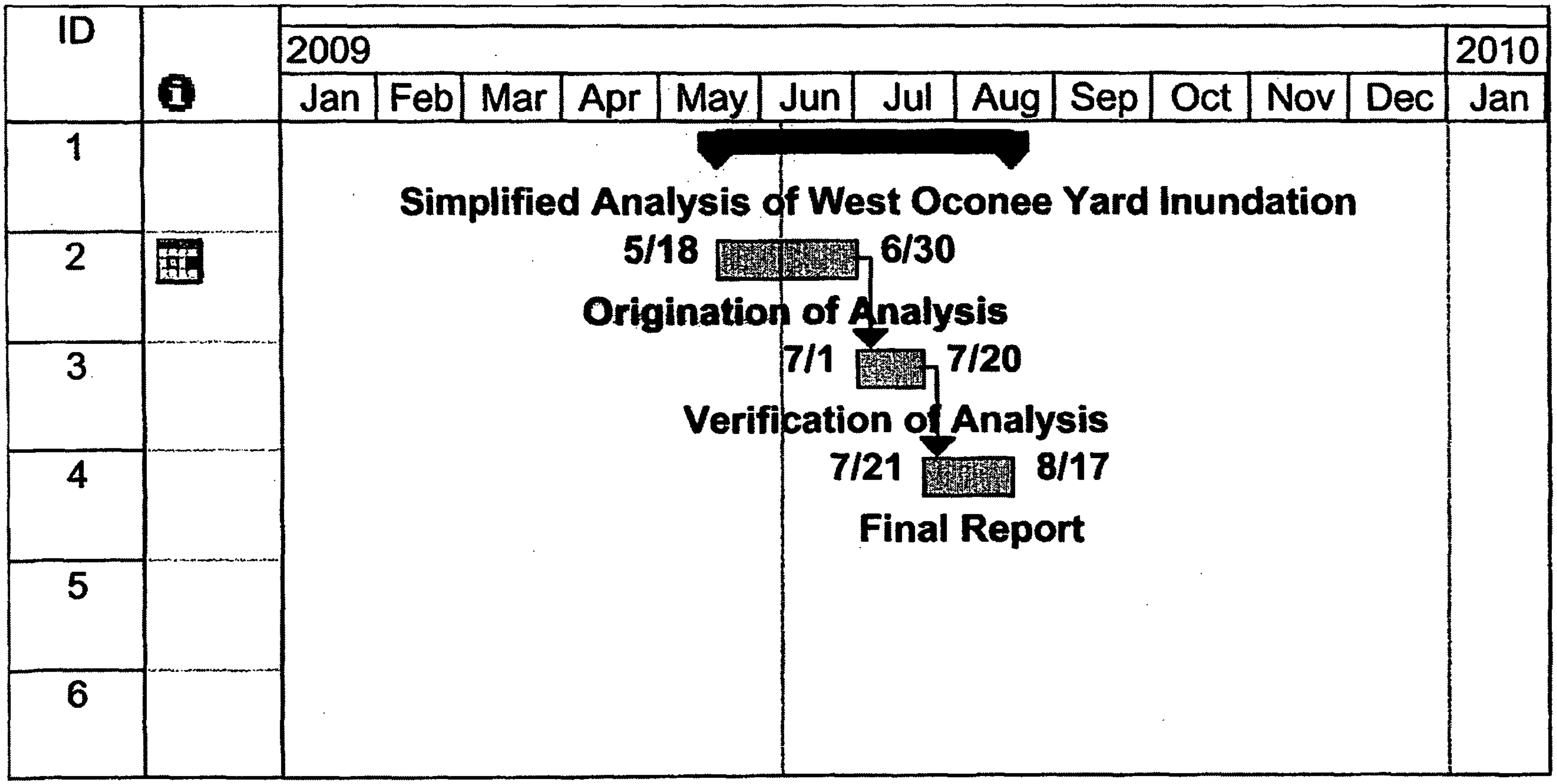
Opening Remarks

- The project milestone schedule is designed to meet your request for a corrective action plan by November 2009
- Overall project philosophy is to use realistic conservatism to ensure that decisions are realistic in the sense of being informed by "real world" science and conservative with respect to preserving adequate safety margins

Project Milestone Schedule



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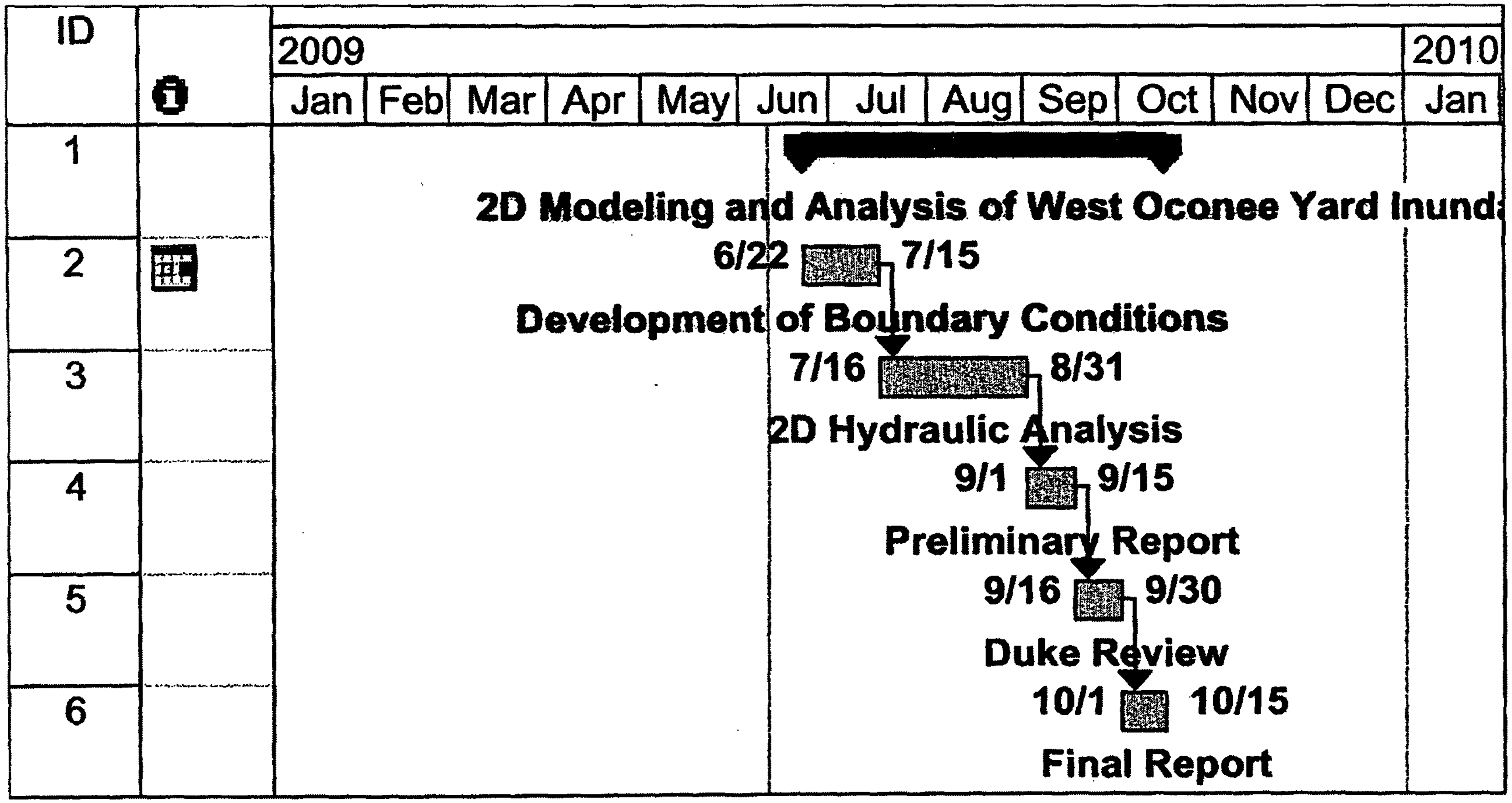
Project Milestone Schedule



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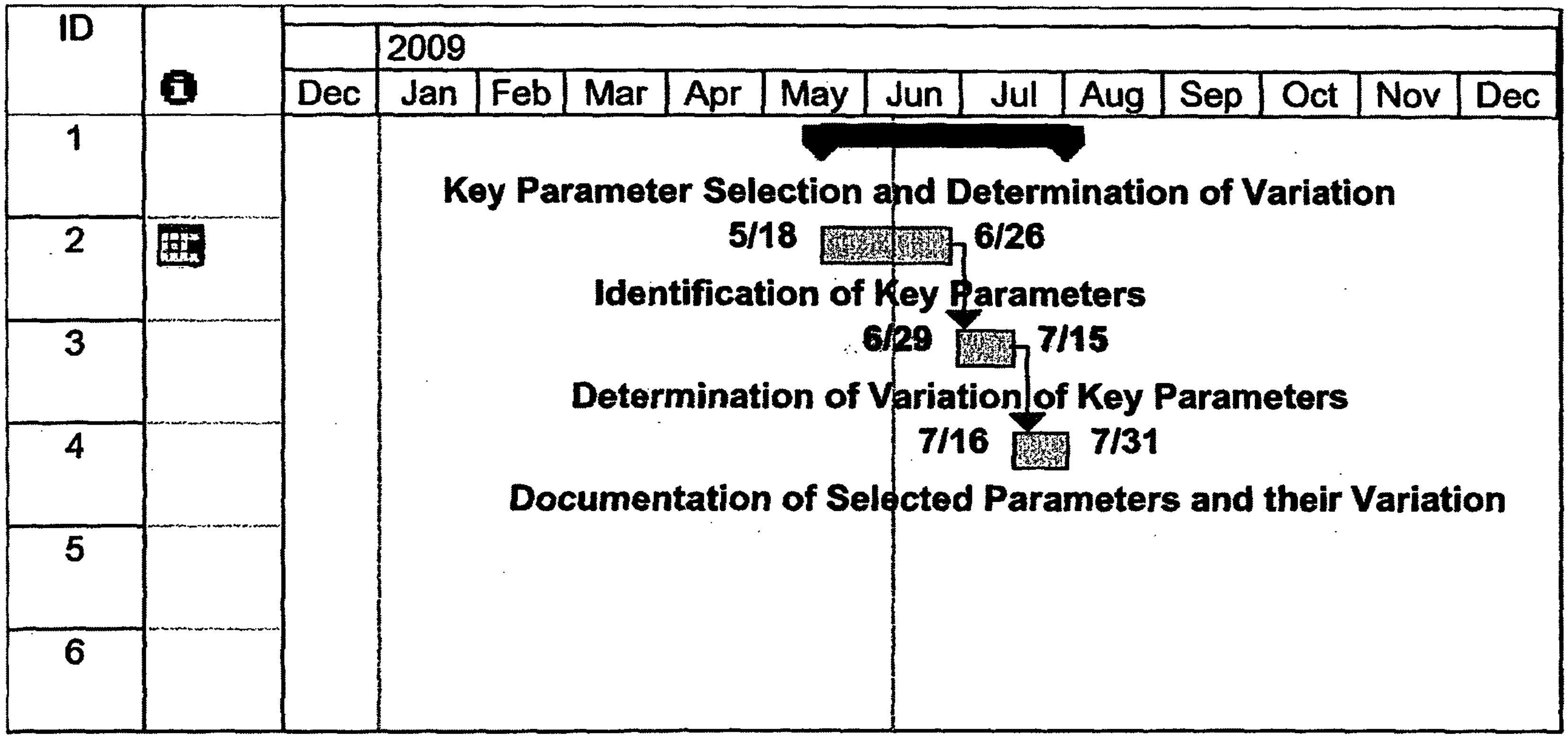
Project Milestone Schedule



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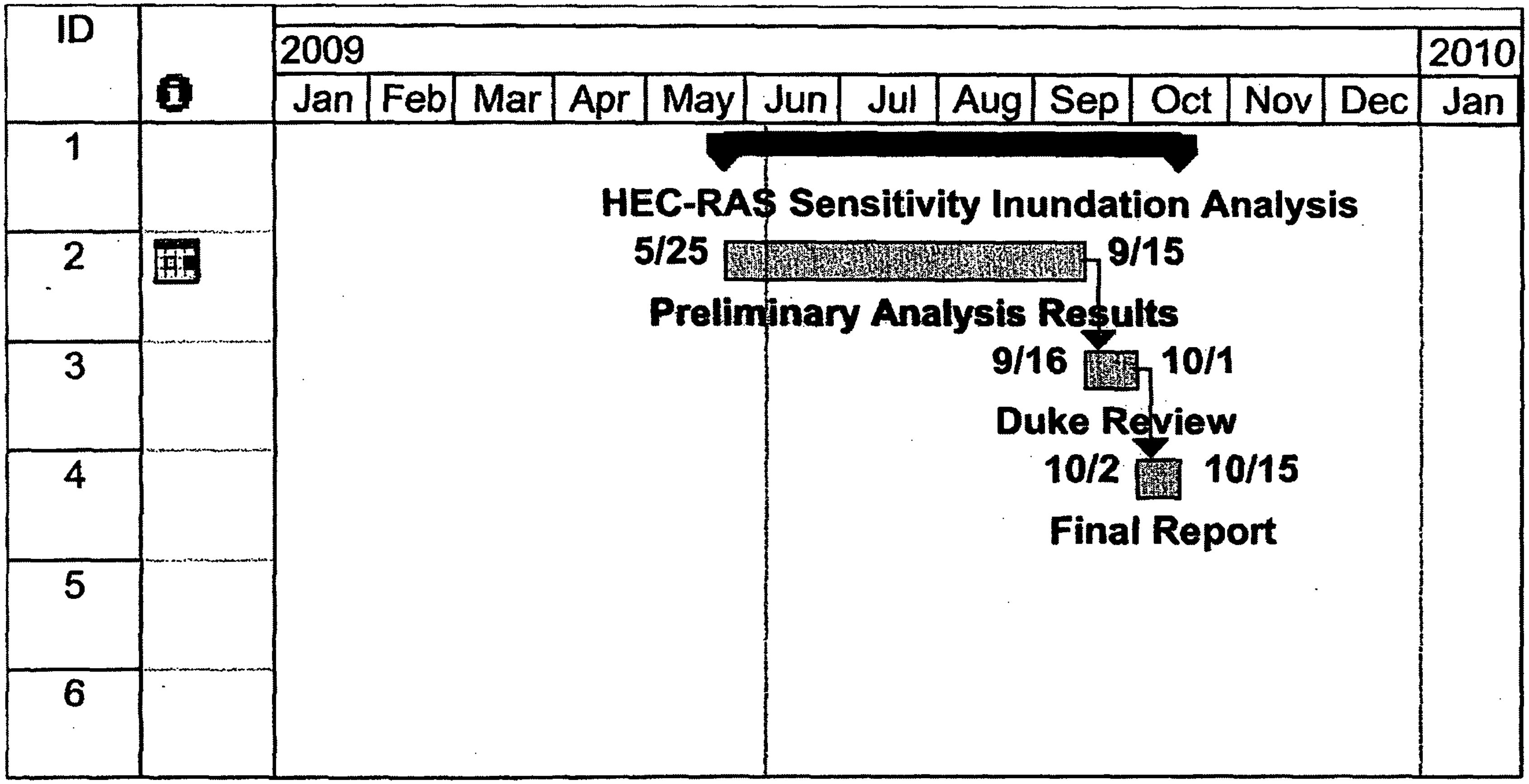
Project Milestone Schedule



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Project Milestone Schedule

- We have developed a project milestone schedule for completing the final inundation studies and sensitivity analyses and formulating our corrective action plan
- The schedule calls for key parameter selection by late June, determination of key parameter variation by mid July and documentation by early August
- The HEC-RAS Sensitivity Inundation Analysis is scheduled for completion by mid October
- The project schedule is designed to meet your request for a corrective action plan by November 2009
- The proposed activities will be both detailed and comprehensive and will enlist expert opinion

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Key Parameters

- Selection of parameters to be varied and the range of variability for those parameters will be technically justified
- Preliminary list of key parameters to be varied in the sensitivity analysis include (for Jocassee):
  - ➢ **Breach bottom elevation**
  - ➢ Breach bottom width
  - ➢ Breach side slope
  - ➢ Breach progression
  - ➢ Time to failure
- Judicious selection of parameters is required to prevent unrealistic complexity

Role of Realistic Conservatism

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- NRC position is that a random failure of Jocassee Dam is a credible event that should be addressed deterministically
- Duke plans to evaluate the random failure of the Jocassee Dam using realistic conservatism
- **Realistic conservatism is a balanced approach that** uses deterministic methods in concert with realism to ensure that decisions are informed by "real world" science, expert opinion, operating experience, and state-of-the-art technology
- It preserves appropriate and prudent safety margins and facilitates decisions

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Role of Realistic Conservatism

- The sensitivity analyses will include varying input parameters supported by the work of dam industry experts
- Using this approach, uncertainties will be understood to the extent practicable and considered appropriately in **the decision process**
- This approach is preferred because it facilitates timely closure of this issue by allowing us to make decisions that correspond to the safety significance presented which must be realistically conservative

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Closing Remarks

- The project milestone schedule is designed to meet your request for a corrective action plan by November 2009
- We will use realistic conservatism - a balanced approach that uses deterministic methods in concert with realism to ensure that decisions are informed by "real world" science, expert opinion, operating experience, and state-of-the-art technology
- Discussion topics for the next meeting will be finalized with the Staff following the June 15 technical audit at Oconee by representatives from NRR and the Bureau of Reclamation

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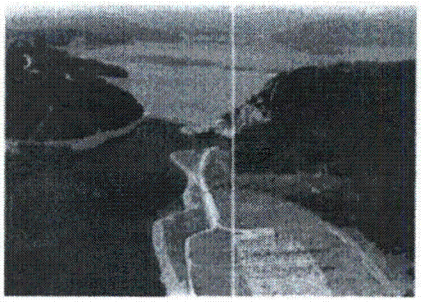
Oconee Nuclear Station



External Flood NRC Technical Meeting

Rockville, MD

06/29/10

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Duke Attendees

- Rich Freudenberger, Manager ONS Regulatory Affairs
- Jeff Thomas, Corporate Regulatory Compliance Manager
- Ray Mc Coy, ONS Principal Engineer
- Chris Ey, Manager Civil Engineering, HDR
- Andy Mc Coy, Ph.D., Water Resources Engineer, HDR

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L/4

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Agenda

- Activities since March 5, 2010
- Interim RAIs Status and Results
- Intake and Swale Wall Installations
- Independent Review of Models
- Summary

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Activities Since March 5, 2010

- 6 Additional HEC-RAS runs assessing Keowee embankment failure times
- 2 Additional 2-D runs to assess sensitivity
- Interim Action review and update
- Self-Assessment of Interim Actions
- Interim Action Improvements
- Diversion Wall and related assessments

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Interim RAI Status
RAI#1

➢Question: Justify the assumptions used for parameters (breach dimension, breach time, and breach location) associated with the Jocassee Dam, Keowee Main Dam, Keowee West Saddle Dam, Intake Dike, and the Little River Dam. Also include the assumptions associated with the operation and capacity of the turbines and discharge gates for the Jocassee Dam. Specifically, describe how the values selected for each parameter represent a conservative value.

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Interim RAI Status
RAI#1, cont'd.

➢Interim RAI Objectives: Evaluate Case 2 embankment failure time parameters using a sensitivity approach to confirm the selected parameters represent conservative values. RAI#4 supports this effort. Structures assessed include: Keowee Dam, Intake Dike, and Little River Dam

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Interim RAI Status
RAI#1, cont'd.

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- 'Cascading Dam Failures'
- 1975 Chinese Dam Failures examined
- Time Sensitivity Option was pursued
- 2 stepped approach, HEC-RAS / 2-D
- RAI#4 scope is a common scope

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Interim RAI Status
RAI#1, cont'd.

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- Preliminary Response:

Although the Case 2 embankment failure times were determined using the same approach as used for Jocassee, the evaluations done in support of RAI#4 demonstrate these times are conservative values in determining water heights in the Oconee Yard.

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Interim RAI Status
RAI#4

➢Question: The 2-dimensional (2-D) model shows a second surge of water at the Oconee site due to a backup of water from the Keowee tailrace. Describe the effect of the overall water level at the Oconee site, following a faster breach time of the Keowee Main Dam.

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Interim RAI Status
RAI#4, cont'd.

➢Interim RAI Objectives: Examine the sensitivity of the projected Oconee yard water heights due to potential faster failures of Keowee Main Dam, Oconee Intake Canal Dike, and Little River Dam and determine if Case 2 envelopes all possible water heights.

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Interim RAI Status
RAI#4, cont'd.

- Examine Case 2, or Run 100 (HEC-RAS reference)

CASE 2 BREACH PARAMETERS

Case	Bottom Breach Elevation (ft msl)	Bottom Breach Width (ft)	Side Slopes (ft per ft)	Failure Time (hrs)	Initial Piping Elevation (ft msl)	Overtopping Breach Initiation Elevation (ft msl)
Jocassee Dam						
2	800	425	1.55:1 & 0.7:1	2.8	1020	NA
Keowee Dam						
2	670	500	1:1	2.8	NA	817
ONS Intake Canal Dike						
2	715.5	200	1:1	0.9	NA	817
Little River Dam						
2	670	290	1:1	1.9	NA	817

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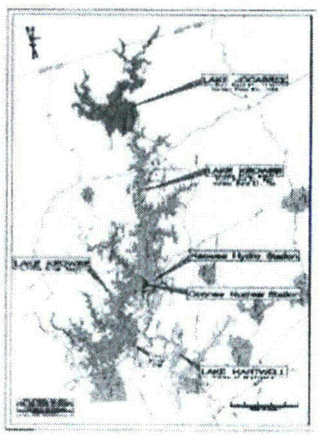
Interim RAI Status
RAI#4, cont'd



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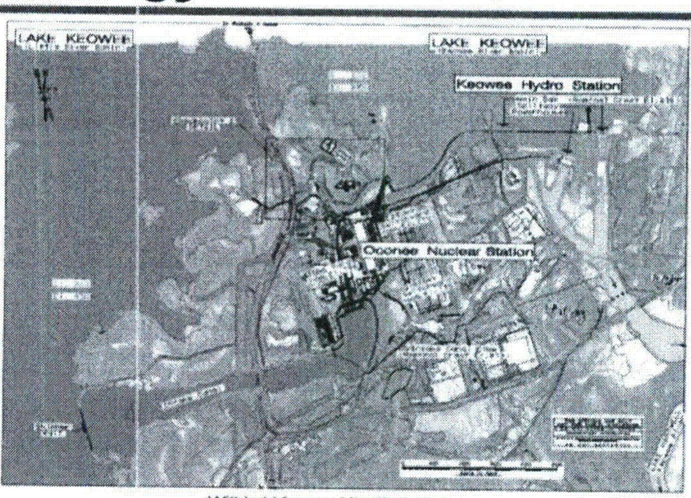
Interim RAI Status
RAI#4, cont'd



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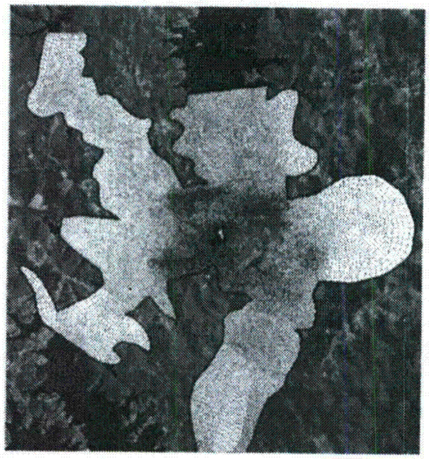
Interim RAI Status
RAI#4, cont'd

2D Model Highlights



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Interim RAI Status
RAI#4, cont'd

2D Model Highlights

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Interim RAI Status
RAI#4, cont'd

- **Model Run 100A** - Rapid failure (.5hrs) for Keowee Dam
- **Model Run 100B** - Median failure (1.65hrs) for Keowee Dam
- **Model Run 100C** - Rapid failure (.5hrs) for ONS Intake Canal Dike (East)
- **Model Run 100D** - Rapid failure(.5hrs) of additional breach width (North) at ONS Intake Canal Dike
- **Model Run 100E** - Rapid failure(.5hrs) of both East and West portions at ONS Intake Canal Dike
- **Model Run 100F** - Rapid failure (.5hrs) for all Keowee structures: Keowee Main and West Saddle Dams, ONS Intake Canal Dike (East and North), and Little River Dam

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Interim RAI Status
RAI#4, cont'd

➢HEC-RAS Preliminary results (discharge focus - B and F)

	Keowee Dam						Oconee Intake Dike			
Model Count	Headwater Elevation (ft msl)	Time (Hrs)	Discharge (mcfs)	Time (Hrs)	Tailrace Elevation (ft msl)	Time (Hrs)	Headwater Elevation (ft msl)	Time (Hrs)	Discharge (mcfs)	Time (Hrs)
100	835.3	0330	2.34	0420	776.7	0500	822.7	0320	0.79	0400
100A	828.9	0300	2.79	0300	777.7	0410	821.0	0320	0.74	0400
100B	834.2	0300	2.81	0350	780.5	0350	822.7	0320	0.78	0400
100C	834.9	0330	2.31	0430	776.5	0500	820.0	0310	0.79	0400
100D	835.2	0330	2.34	0420	777.1	0500	821.8	0320	0.84	0400
100E	834.9	0330	2.32	0430	776.7	0500	819.5	0310	0.81	0400
100F	828.9	0300	2.79	0300	777.4	0330	818.8	0310	0.65	0330

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Interim RAI Status
RAI#4, cont'd

➢2-D Preliminary Results

Scenario	Breaching							
	Keowee Dam				Intake Dike			
	HEC-RAS		2D		HEC-RAS		2D	
	Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time
Case 100	817	2.25	817	2.12	817	2.93	817	2.93
Case 100B	817	2.25	817	2.12	817	2.92	817	2.95
Case 100F	817	2.25	817	2.13	817	2.96	817	3.02

Scenario	Maximum Water Surfaces							
	Keowee Dam				Intake Dike			
	HEC-RAS		2D		HEC-RAS		2D	
	Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time
Case 100	835.3	3.50	838.7	3.05-3.50	822.7	3.33	823.2	3.43
Case 100B	834.2	3.00	836.2	3.25	822.7	3.33	822.6	3.40
Case 100F	828.9	3.00	827.1 - 828.0	3.0 - 3.5	818.8	3.17	819.6	3.25

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Interim RAI Status
RAI#4, cont'd

- 2-D Preliminary Results

Scenario	Maximum Water Surfaces							
	Swale				Tailwater (2nd Peak)			
	HEC-RAS		2D		HEC-RAS		2D	
	Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time	Elevation	Decimal Time
Case 100	828.8	4.00	829.0	4.33	776.7	5.00	804.30	4.4-5.0
Case 100B	826.2	4.00	827.6	4.00	780.5	3.83	801.24	4.0-5.0
Case 100F	821.0	3.33	822.7	3.35	777.4	3.50	802.02	3.8-4.8

Scenario	Maximum Water Surfaces			
	SSF			
	HEC-RAS		2D	
	Depth	Decimal Time	Depth	Decimal Time
Case 100	N/A	N/A	19.5 - 18.2	3.45 - 3.75
Case 100B	N/A	N/A	18.6	3.58
Case 100F	N/A	N/A	13.4	3.40

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Interim RAI Status
RAI#4, cont'd

- Preliminary Response:

The additional sensitivity studies using faster breach times for the Keowee Main Dam and other Keowee impoundment structures support the use of Case 2. The evaluations demonstrate the Case 2 failure times are conservative in determining water heights in the Oconee Yard. Therefore, faster breach times for the Keowee Main Dam do not produce higher water levels for the Oconee site for both the 'first peak' and the 'second peak'.

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Interim RAI Status
RAI#7

- Question: Provide a copy of the final HEC-RAS models and 2-D models that were used for the runs to justify the proposed modifications that will be made to protect the Oconee site from external flooding.

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Interim RAI Status
RAI#7, cont'd.

- Interim RAI Objective: Achieve 'final' model status by resolving all outstanding RAIs with no additional RAIs expected.

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Interim RAI Status
RAI#7, cont'd.

➢Preliminary Response:

Submit the Case 2 HEC-RAS and 2-D models as the 'models of record' meeting the RAI.

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Intake and Swale Walls

➢Additional means to manage flood consequences

➢Swale wall stops peak floodwaters and assure integrity of secured water source (pond)

➢Intake Canal Wall to divert water from entering ONS yard and reduce peak water heights

➢Wall details

➢Design Considerations for both wall and dike

➢Intended as Temporary

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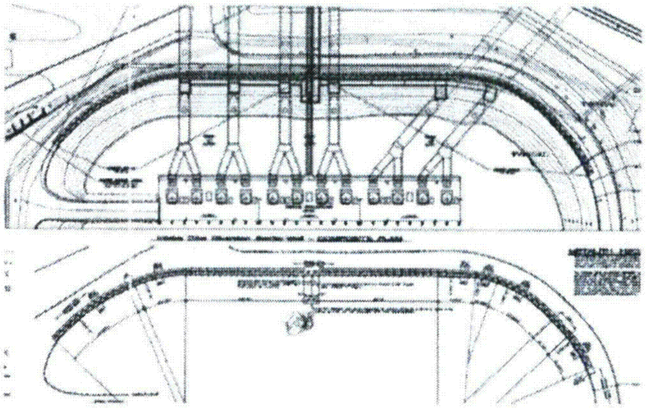
Intake and Swale Walls



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Intake and Swale Walls

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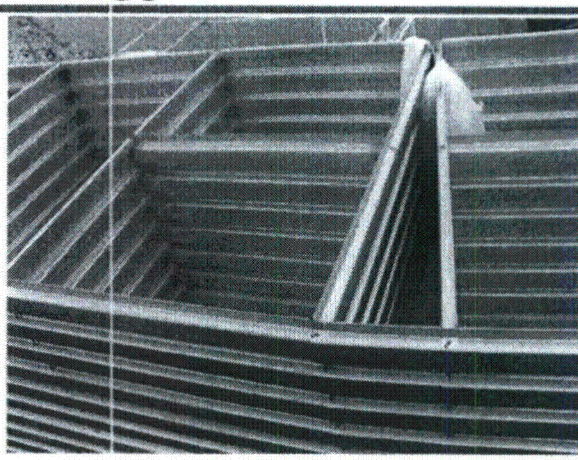
Intake and Swale Walls



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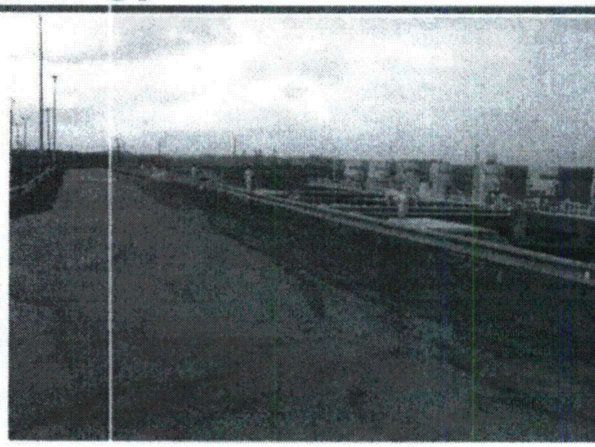
Duke Energy®

Intake and Swale Walls



VIEW LOOKING EAST BEFORE

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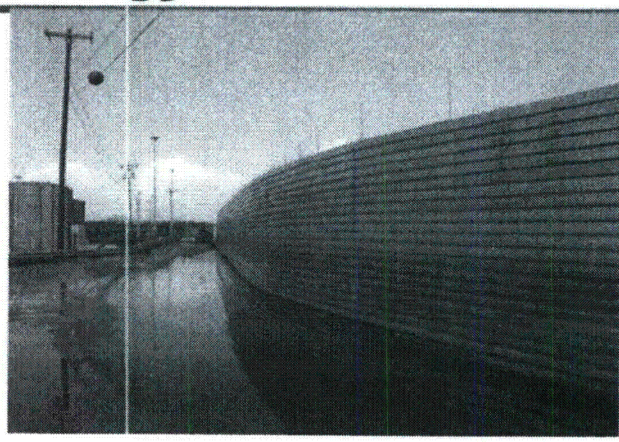
Intake and Swale Walls



VIEW LOOKING EAST AFTER

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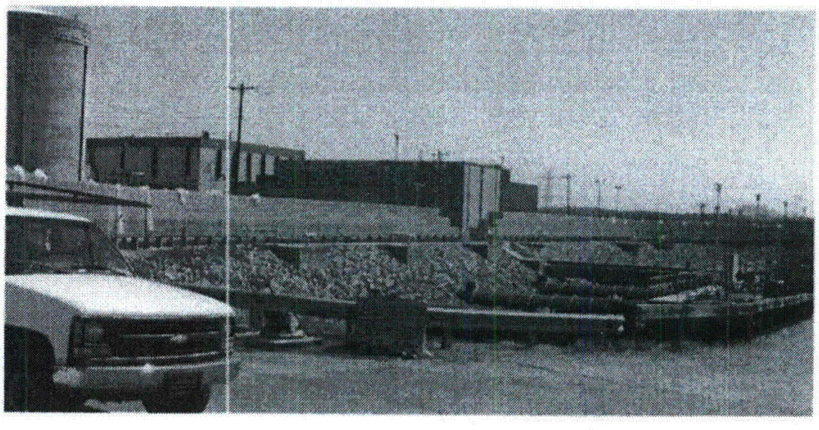
Intake and Swale Walls



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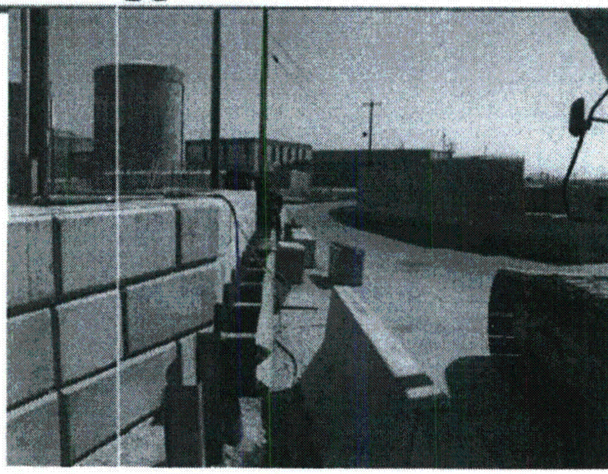
Intake and Swale Walls



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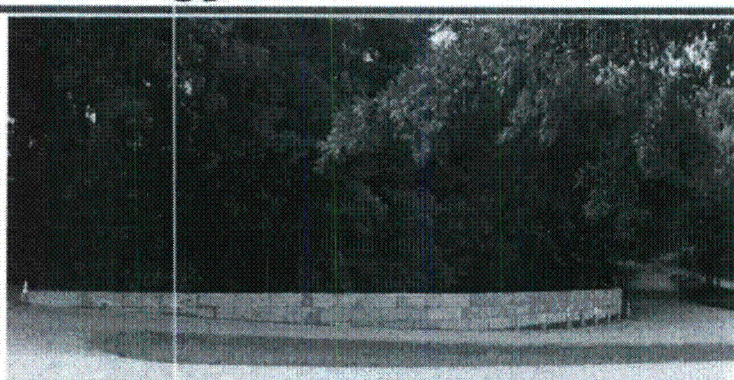
Intake and Swale Walls



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Intake and Swale Walls

Case 2
(no walls)

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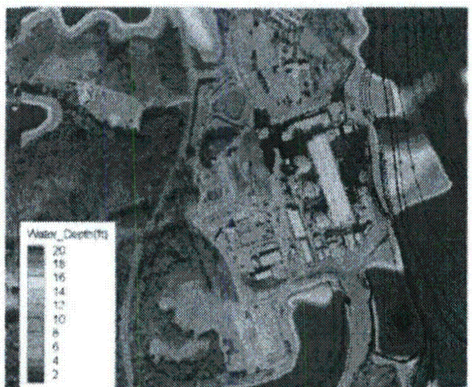
Intake and Swale Walls

Case M2
(walls with openings)



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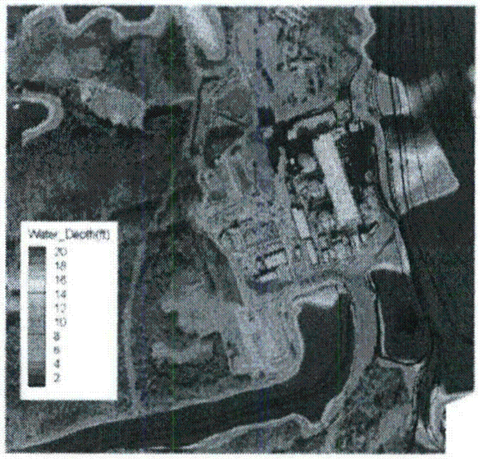
Intake and Swale Walls

Case M3
(walls with no openings)



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Intake and Swale Walls

Table 1. Maximum Water Surface Elevations for M2 and M3

Time, hrs. (decimal time)	Flood Model Consequences Mitigation Alternative M2
3.43	Maximum Intake Canal WS is 824.3 ft-msl
3.73	Maximum Depth at SSF - (Primary) is 4.65 ft + 796 = 800.7 ft-msl
4.95	Maximum Depth at SSF - (Secondary) is 4.90 ft + 796 = 800.9 ft-msl

Time, hrs. (decimal time)	Flood Model Consequences Test Scenario M3
3.43	Maximum Intake Canal WS is 824.4 ft-msl
3.54	Maximum Depth at SSF - (Primary) is 3.53 ft + 796 = 799.5 ft msl
4.90	Maximum Depth at SSF - (Secondary) is 4.90 ft + 796 = 800.9 ft-msl

Preliminary Results

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Intake and Swale Walls

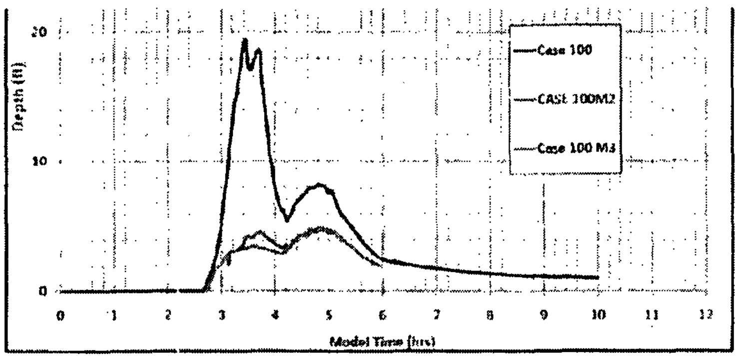

Figure 4 Depth of Inundation Near the SSF

Preliminary Results

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Independent Review of Models

- Independent Review of both models
  (Dr. Chris Wilson, Duke requested)
- HEC-RAS model:
  - Geometry
  - cross section parameters (density and construction)
  - boundary conditions
  - Roughness parameters
  - range of proposed breach parameters
  - mass conservation

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Independent Review of Models

- 2-Dimensional Model:
  - computational mesh density and construction
  - boundary conditions
  - selection of 2-D model and assumptions
  - mesh updates during breach
  - selection of time step and modeling parameters
  - and mass conservation

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Independent Review of Models

- Documentation for both the HEC-RAS and 2-D models to include:
  - Relationship between the models
  - Appropriateness of model geometry (including cross-sections, frequency and mesh size and density)
  - Boundary conditions
  - Appropriateness of assumed inputs for both models (including Manning's n and range of proposed breach parameters)
  - Appropriateness of HEC-RAS model results to assumed key input parameters

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Independent Review of Models

- Documentation (cont'd):
  - Conservation of mass at connecting canal and Keowee River
  - Limitations of the tools/models to achieve desired outputs
  - Output from all runs for HEC-RAS regarding model performance (high level)
  - Output from Case 1, 2 & 3 for 2-D model regarding model performance (high level)
  - Output from scenario 100A through 100F which includes six HEC-RAS and one of the 2-D scenarios.

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Independent Review of Models

- Current Status:
  - Initial Reviews completed on both models and preliminary comments have been shared and supporting evaluations are in progress by HDR.
  - Intent is to have Dr. Wilson's final comments addressed in HDR's work and our long-term documentation.

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Duke Energy® — Independent Review of Models

- Preliminary Overall Conclusions of Review:
  - Model development reflect a high level of diligence
  - Models reflect a good representation of the hydraulic system
  - Study was performed in accordance with generally accepted engineering practice
  - An unbiased appraisal of the impacts of a wide range of breach scenarios

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Duke Energy® — Independent Review of Models

- Preliminary HEC-RAS Conclusions:

- •Differences in the TW elevations could be the result of cross-sections within the 1-D model.
- •Modify tailrace and stream cross sections through the Ox-Bow to seek better agreement.
- •Selection of Manning's n coefficients was generally reasonable but some assignments should be checked based on location of banks
- •Breach parameter selection approach was thorough and appropriate

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Independent Review of Models

➢Current HEC-RAS Actions:

•Perform sensitivity analysis on numerical stability variables using mixed flow exponent "m"

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Independent Review of Models

➢Preliminary 2-D Conclusions:

➢Review found good agreement between 1D and 2D cross section results

➢2D roughness coefficients were verified to the HEC-RAS values. 2D model coefficients used correct bank assignments

➢Boundary assignments are a reasonable approach

➢HDR's extent and density of the 2D model mesh is as large as can be practically applied

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Duke Energy — Independent Review of Models

- Current 2-D Actions:
  - Rerun current 2-D model with updated boundary values from the latest HEC-RAS boundary conditions

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Duke Energy — Summary

- Interim Actions in place
- Progress on RAIs
- Long-term solutions being studied

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Ferrante, Fernando

From:	Mitman, Jeffrey
Sent:	Wednesday, December 02, 2009 6:39 PM
To:	James, Lois; Galloway, Melanie
Cc:	See, Kenneth; Ferrante, Fernando
Subject:	Duke Presentation to NRC on 12-02-2009 on OFI
Attachments:	ONS External Flood NRC Mtg Duke Presentation12-02-2009.pdf

See attached subject document. I've not yet absorbed its significance.

Jeff

L15

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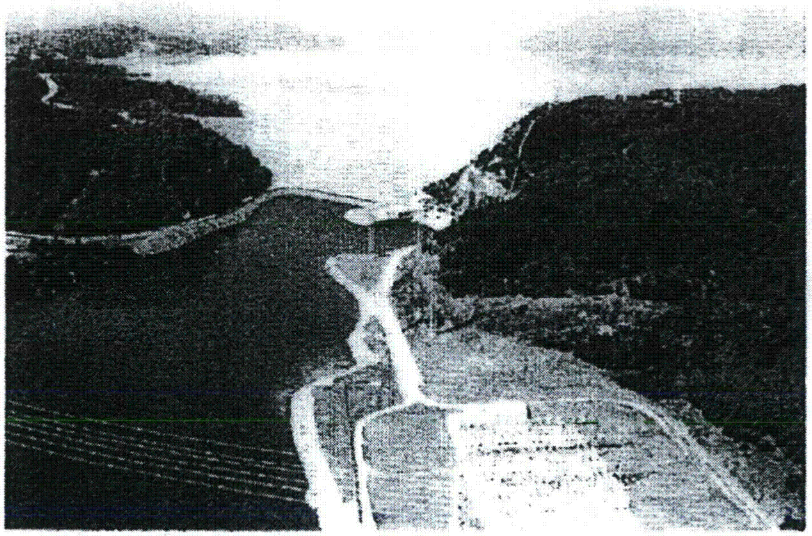

Oconee Nuclear Station

External Flood

NRC Management Meeting

Rockville, MD

12/02/09

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Duke Attendees

- Dave Baxter, ONS Site Vice President
- Rich Freudenberger, ONS Safety Assurance Manager
- David Cummings, Duke Corporate Assistant General Counsel
- Jeff Thomas, Duke Corporate Regulatory Compliance Manager
- Kent Alter, ONS Regulatory Compliance Manager
- Tim Brown, ONS Project Manager

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Agenda

- Duke's Commitment to Operational Safety
- Overview of Completed Activities
- Summary of Case 2 Inundation Analysis
- Potential Changes to the Oconee Site
- Engineering Change Design & Planning
- Feasibility / Constructability Schedule
- Summary

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Duke's Commitment to Operational Safety

- Duke is committed to site changes that improve operational safety.
- Refurbishment Project (examples)
  - ECCS/EOP Improvement
    - High Pressure Injection Recirculation Flow
    - Low Pressure Injection Cross Tie / Flow Restrictors
    - Reactor Building Spray Passive Resistance
  - Digital Upgrades (examples)
    - Integrated Control System
    - Automatic Feedwater Isolation
    - Keowee Hydroelectric Station's Exciters and Governors
- Steam Generator/Reactor Vessel Head Replacements
- Tornado/HELB/NFPA-805
  - Protected Service Water
  - Natural Phenomena Barrier System
- Duke will continue to pursue actions to address the external flood issue.

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Completed Activities

- Extended height of the SSF flood walls and gate.
- Provided interim external flood guidance for TSC personnel.
- Converted original DAMBRK analysis model to HEC-RAS.
- Completed 101 sensitivity studies using HEC-RAS.
- Completed preliminary 2D inundation studies.

Summary of Case 2 Inundation Analysis

Input	Bottom Breach Elev. (ft. MSL)	Bottom Breach Width (ft.)	Side Slopes (ft. per ft.)	Time to Failure (hrs.)	Initial Piping Elev. (ft. MSL)	O/T Breach Initiation Elev. (ft. MSL)
Jocassee	800	425	1.55:1 (W); 0.7:1 (E)	2.8	1020	NA
Keowee Main Dam	670	500	1:1	2.8	NA	817
West Saddle Dam	795	1680	0:1	0.5	NA	817
Oconee Intake Dike	715.5	200	1:1	0.9	NA	817
Little River Dam	670	290	1:1	1.9	NA	817

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Summary of Case 2 Inundation Analysis

Max. Water Level	Elevation (ft. MSL)	Decimal Time (hrs.)
Keowee Headwater (Crest Elev. 815 ft. MSL)	837.7	3.05-3.50
Intake Dike (Crest Elev. 815 ft. MSL)	822.5	3.35
SSF (Top of Wall Elev. 803.5 ft. MSL)	814.5	3.5
WOE (Swale) (Invert Elev. 827 ft. MSL)	827.7	4.05
Keowee Tailrace (Oconee Yard Elev. 796 ft. MSL)	803.2	4.48

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Potential Changes to ONS Site

- Flood mitigation device located in the Oconee Intake Canal.
- Flood wall located on the north rim of the Oconee Intake Canal Dike.
- Assured integrity of portion of the Oconee Intake Canal Dike to preclude failure of the dike toward the SSF.
- Water retaining structure/wall/raised roadbed in swale adjacent to the World of Energy Visitor's Center.
- Downstream modifications (earth removal) to flood zone to smooth flow through the Keowee Tailrace.
- Protection of the SSF for higher inundation levels.

Engineering Change Design & Planning

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- Implications to the site for potential changes of this scope must be evaluated in a deliberate and structured manner.
- Planning horizons for projects of this scope could take several years.
- Duke has developed an expedited schedule for determining the scope of the changes and whether they can be constructed.
- Planning steps describe the feasibility/constructability of the potential changes.
- Future status meeting(s) with the NRC to gauge progress will be scheduled as needed.
- Interim guidance to be reviewed and updated as necessary in parallel with the design and planning activities.

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Feasibility / Constructability Schedule

2010: Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec — 2011: Jan | Feb | Mar

ID			
1	Finalize Breach Parameters	12/3	12/15
2	Determine Level of Protection for Safe Shutdown SSCs	12/16	2/1
3	Initial Feasibility / Constructability Analysis	2/2	4/1
4	Evaluate Design Concepts vs. Required Level of Protection	4/2	5/1
5	Evaluate Design Concepts vs Non Flood Related Design Basis	5/3	7/1
6	Finalize Feasibility / Constructability Analysis	7/2	10/1
7	Secure Corporate Approval of Project	10/4	11/1
8	Set Mod. Design and Implementation Sch.	11/2	11/15

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Summary

- Duke is committed to site changes that improve operational safety.
- Duke, with our consultants, have made significant progress toward understanding the inundation of the ONS site following a postulated failure of the Jocassee Dam.
- The scope of changes to the ONS site to address this postulated threat are significant.
- Prudence dictates that we evaluate potential alternatives in a deliberate and structured manner.
- Changes to the site will be implemented commensurate with their safety significance.
- Implementation dates for these changes must be prioritized relative to other significant risk reduction construction projects currently in progress at ONS.