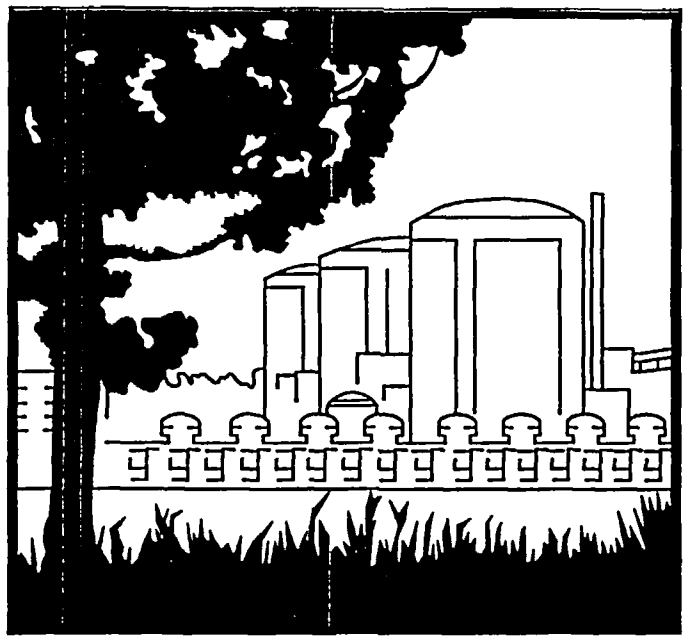
Duke Power®
A Duke Energy Company

Oconee Nuclear Station High Energy Line Break Outside Containment



NRC Management Update

June 30, 2005

Attachment 2

Duke Power
A Duke Energy Company

Agenda

- Introduction / Purpose of Meeting
- Background / History
- HELB Revalidation Project
- Current Licensing Basis
- Risk Reduction Modifications
- Summary

Duke Power®
A Duke Energy Company

Purpose of Meeting

- Provide background of the Issue and Project
- Describe the HELB Project and provide current status
- Discuss the Current Licensing Basis
- Discuss philosophy on how we intend to treat issues discovered during the ongoing project
- Describe the risk reduction modifications that will help reduce HELB mitigation risks

Duke Power.
A Duke Energy Company

Background

- The Giambusso letter was released in December of 1972. An errata sheet, known as the Schwencer letter, was released in January 1973.
- Oconee's first response to the issue was released December 29, 1972.
- The original HELB analysis was completed and submitted to the staff in April of 1973.
- Supplement to the analysis was submitted in June of 1973.
- An SER approving the report was received in July of 1973. SER noted that 'the staff agrees with applicant's selection of pipe failure locations'....

Duke Power.
A Duke Energy Company

Background / cont.

- A 1998 Self-Assessment identified issues with the original 1973 HELB analysis. Some of the issues identified are as follows:
  - Calculations substantiating the conclusions reached in the analysis cannot be located.
  - The configuration of the plant has changed since the original report.
  - No revisions to the HELB analysis was completed to reflect the revised configuration of the plant.
- Plan communicated to Region II management, during a January 26, 1999, meeting to revalidate the HELB design basis for Oconee.

Duke Power®
A Duke Energy Company

Background / cont.

- Study began in October 1999, to determine scope and extent of issue.
- In a letter dated October 15, 2001, Duke submitted methodology for postulating new break locations and assumptions to be employed in the revalidation work.
- The NRC provided comments to the letter and asked for additional information in a January 7, 2002, fax.
- Duke met with the NRC (NRR) March 20, 2002, to answer questions and gain consensus regarding the methodology and assumptions.
- In a letter dated April 5, 2002, NRC provided additional comments, but noted that the methodology met the intent of the Standard Review Plan.

Duke Power
A Duke Energy Company

Background / cont.

- In a letter dated July 3, 2002, Duke responded with a revised letter incorporating comments received and documenting the common understanding reached with the NRC.
- HELB Revalidation Project began in October of 2002.
- On August 5, 2003, a conference call was held with NRC to further discuss the methodologies and assumptions.
- In a letter dated August 20, 2003, Duke, based on the conference held on August 5th, provided a revised methodology and assumptions.
- An HELB Project Update Presentation was given June 29, 2004, to Region II Management.
- In a letter dated July 14, 2004, the NRC concurred with the methodology and assumptions to be employed to the extent that they satisfy the current licensing basis. Further, it was noted that the concurrence does not constitute NRC approval pursuant to the 10 CFR 50.59 process.

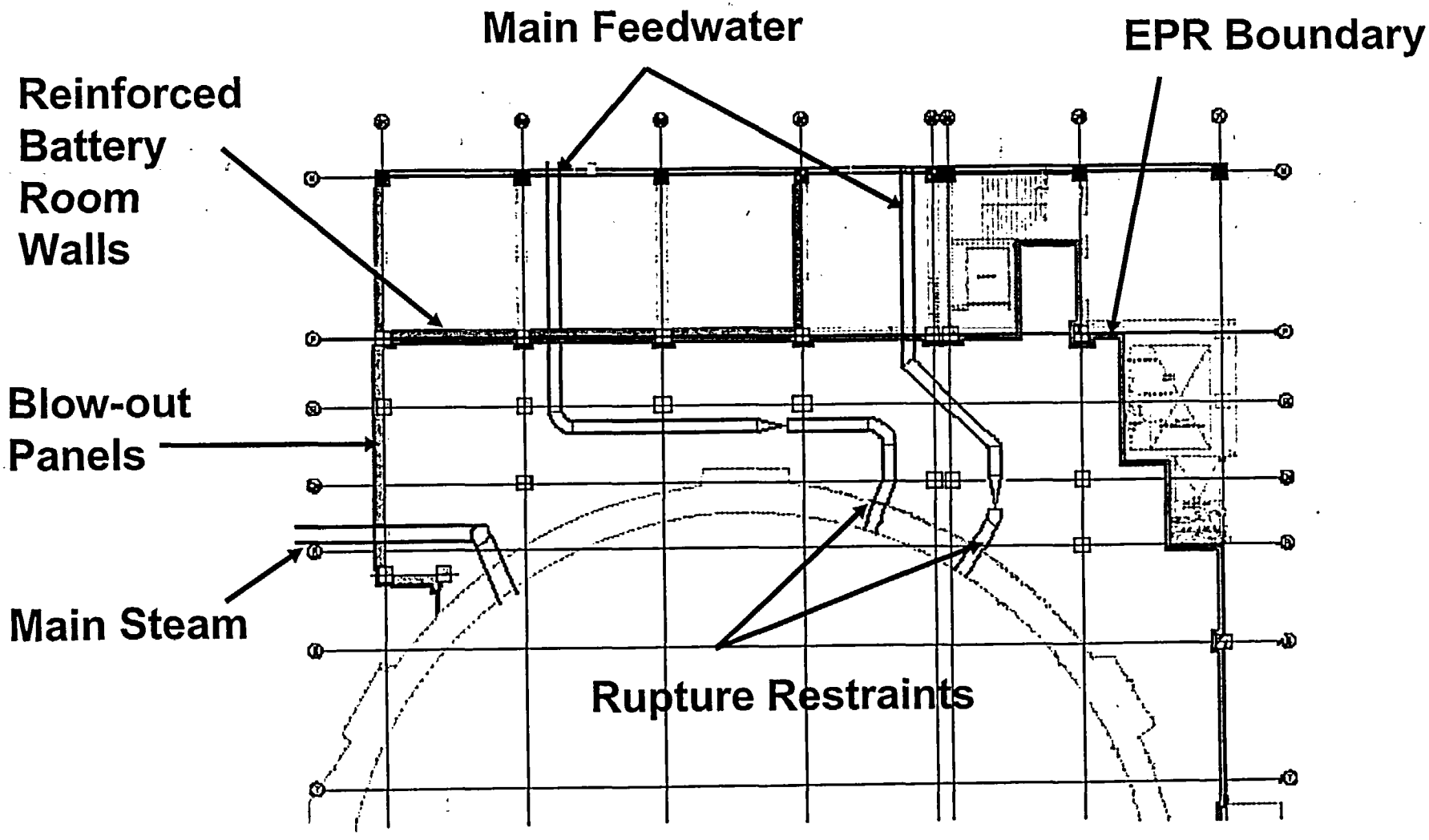
Duke Power
A Duke Energy Company

HELB Revalidation Project

- Objective of the project is to revalidate and update as necessary the conclusions reached in the original 1973 report for the current plant configuration.
- The project is divided into two parts: Part 1 addresses the East and West Penetration Rooms for MS and MFDW line breaks. Part 2 addresses other postulated breaks in the EPR, the WPR, the remainder of the Auxiliary Building, and the Turbine Building.

Duke Power
A Duke Energy Company

MFDW and MS HELPs in EPR (typ. for all 3 Units)



Duke Power
A Duke Energy Company

MFDW and MS HELBs in EPR

Break Scenario

- Main feedwater breaks at Reactor Building wall.
- Main steam break at Reactor Building wall.
- No other MFDW or MS breaks postulated in the EPR in the original 1973 report. No other MFDW or MS breaks will be postulated in the revalidation due to stress criteria allowed by GL 87-11.
- There are no MFDW or MS breaks in the West Penetration Room (WPR).

Duke Power
A Duke Energy Company

Main Feedwater HELBs in EPR

Piping Data:

- 24" OD x 1.219" thick.
- Material ASTM A-106 Gr. B.
- Normal Operating Conditions: 950 psig. and 460 degrees F.
- ASME Section XI ISI Class B downstream of containment isolation check valves.
- ASME Section XI ISI Class C upstream of containment isolation check valves.

Duke Power
A Duke Energy Company

Main Feedwater HELBs in EPR

Piping Inspections:

- All longitudinal and girth butt welds received radiograph inspection during initial construction.
- ASME XI Class B pipe receives periodic volumetric inspections (UT) in accordance with site ISI plan.
- ASME XI Class C pipe receives periodic visual inspection (VT-3) in accordance with site ISI plan.
- MFW piping is included in the site Flow Accelerated Corrosion (FAC) detection program. No significant FAC degradation noted to date.
- Recently updated ISI plan to perform UT inspection on all MFDW welds in EPR during each interval.

Duke Power
A Duke Energy Company

Main Feedwater HELBs in EPR

Piping Stress Analysis Results

- MFW piping in EPR received full stress analysis in accordance with IEB 79-14 for all applicable load cases including seismic.
- Maximum longitudinal pressure + dead weight + seismic stresses remain less than break threshold stress (per GL 87-11) for all the MFDW piping in EPR.
- Certain MFDW locations within EPR exceed the crack threshold stress per MEB 3-1 and these locations have been evaluated from an environmental and flooding perspective.

Duke Power
A Duke Energy Company

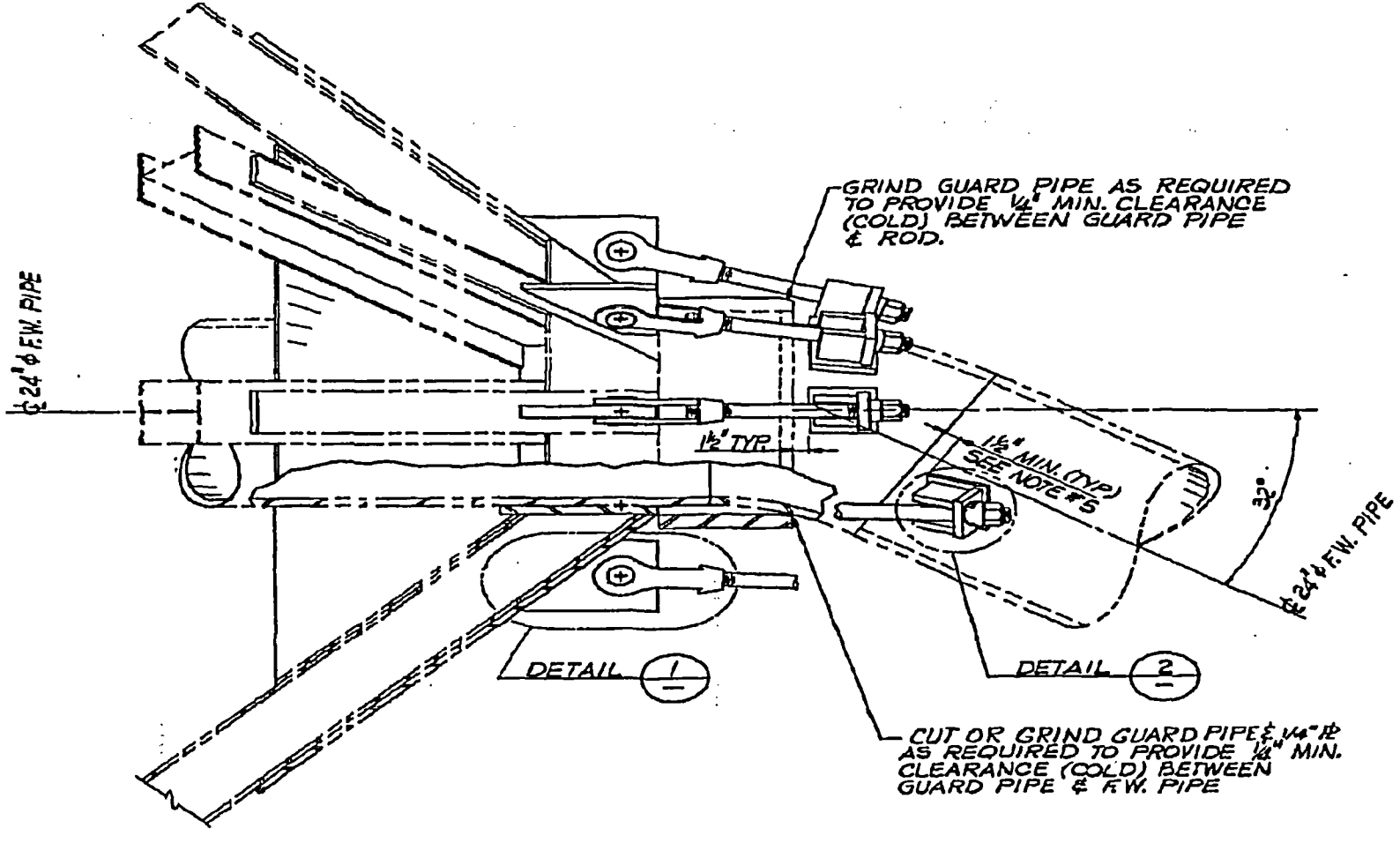
Main Feedwater HELBs in EPR

Main Feedwater Terminal End Break

- Each MFW break location at the RB wall is restrained by a rupture restraint.
- The rupture restraint design prevents pipe whip.
- The rupture restraint limits the double ended break gap to 0" insofar as possible based on structural elongation of the rupture restraint threaded rods.
- The rupture restraint prevents, by the design of the guard pipe, jet impingement and directs flow away from vulnerable mechanical and electrical equipment.

Duke Power.
A Duke Energy Company

MFW Rupture Restraints



Duke Power
A Duke Energy Company

Main Steam HELB in EPR

Piping Data:

- 36-1/2" OD x 1.164" thick.
- Material ASTM A-155 Gr. KC70 Class 1 & ASTM A-515 Gr. 70 FB.
- Normal Operating Conditions: 900 psig. and 595 degrees F.
- All piping ASME Section XI ISI Class B.

Duke Power
A Duke Energy Company

Main Steam HELB in EPR

Piping Inspections:

- All longitudinal and girth butt welds received radiograph inspection during initial construction.
- ASME XI Class B pipe receives periodic volumetric inspections (UT) in accordance with site ISI plan.
- MS piping is included in the site Flow Accelerated Corrosion (FAC) detection program. No significant FAC degradation noted to date.

Main Steam HELB in EPR

Piping Stress Analysis Results

- MS piping in EPR received full stress analysis in accordance with IEB 79-14 for all applicable load cases including seismic.
- MS piping was 'cold pulled' such that thermal stress at operating conditions is essentially zero.
- Maximum longitudinal pressure + dead weight + seismic stresses remain less than break threshold stress (per GL 87-11) and crack threshold (per MEB 3-1) for all the MS piping in EPR.

Main Steam HELB in EPR

Main Steam Terminal End Break

- The one MS break location at the RB wall is not restrained by a rupture restraint.
- Due to the MS piping location within the room and the orientation of the piping, a pipe whip would be directed away from vulnerable mechanical and electrical equipment.
- Likewise, jets from the break would be directed away from vulnerable mechanical and electrical equipment.

Duke Power.
A Duke Energy Company

MFDW and MS HELBs in EPR

Completed Tasks

- Mass & Energy Release calculations performed for:
  - 36" MSLB
  - 24" FWLB (crediting the guard pipe and conservatively assumed a gap opening of .5")
- EPR Blowout panels strength evaluated for AS-FOUND condition.
- The mass and energy release results, as well as the blowout panel strength were used as input into a GOTHIC model of the EPR.
- Results of the GOTHIC model work provided the bounding environmental profiles from a MFDW or MS break (Pressure and Temperature). These results have been documented in a plant calculation.
- Results for MS HELB bounded pressure and temperature response. Results for MFDW break bounded flooding response.

Duke Power
A Duke Energy Company

MFDW and MS HELBs in EPR

Completed Tasks / continued

- Temperature and Pressure results did not challenge the environmental qualification envelope for critical equipment and instrumentation located in EPR.
- Bounding pressure-time history results from GOTHIC were used as input to EPR structural components evaluation.
- Conclusions of the structural evaluation indicated that the structural envelope of the EPR was not threatened. Some damage is predicted to occur to the masonry walls, and the non structural wall between the EPR and WPR is predicted to fail.

Duke Power®
A Duke Energy Company

MFDW and MS HELBs in EPR

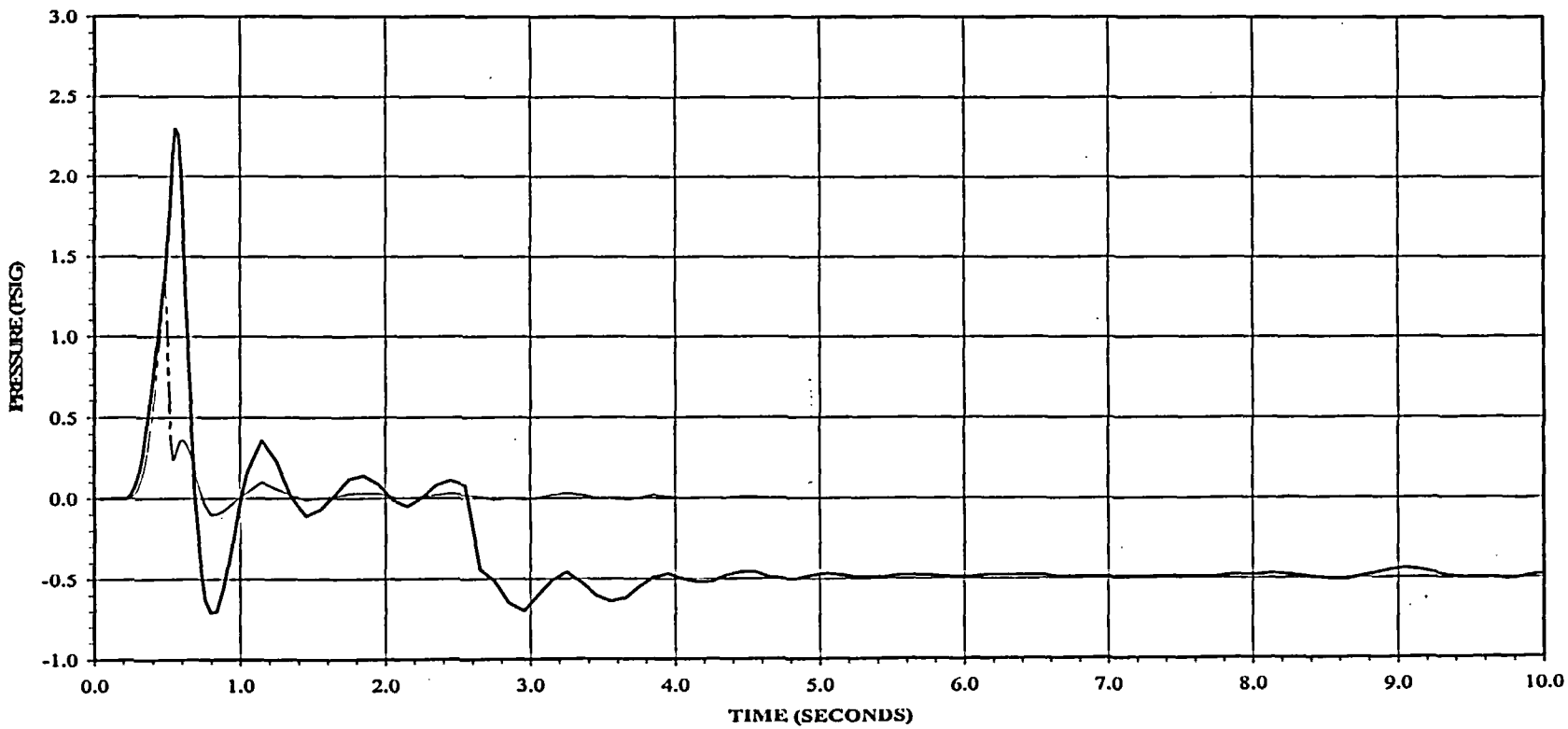
Completed Tasks / continued

- Prediction that EPR/WPR wall would fail led to extending GOTHIC model to include the WPR.
- Similar temperature and pressure response was determined for WPR.
- Preliminary structural evaluation of WPR has been completed. Preliminary conclusion: No damage to main structural components of WPR. Damage expected to masonry components.
- Flooding calculation of EPR due to bounding Main Feedwater break is currently being checked.
- Design Change Request has been completed and forwarded to Modification Engineering to modify flooding panels, and waterproof room up to the point required to actuate panels.

Duke Power.
A Duke Energy Company

MFDW .5" Gap Break Pressure Results

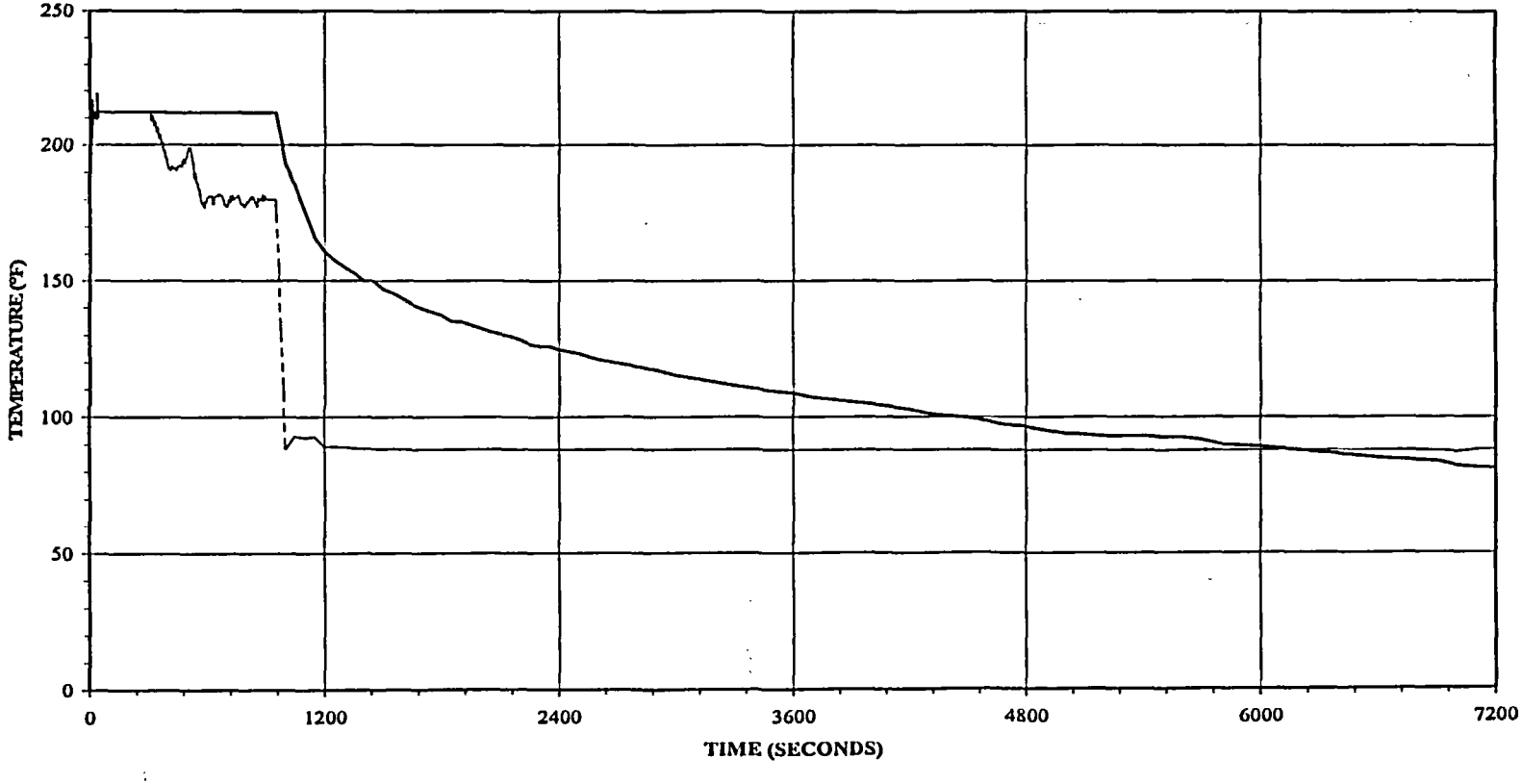
MFDW Break in EPR Pressure Response



Duke Power
A Duke Energy Company

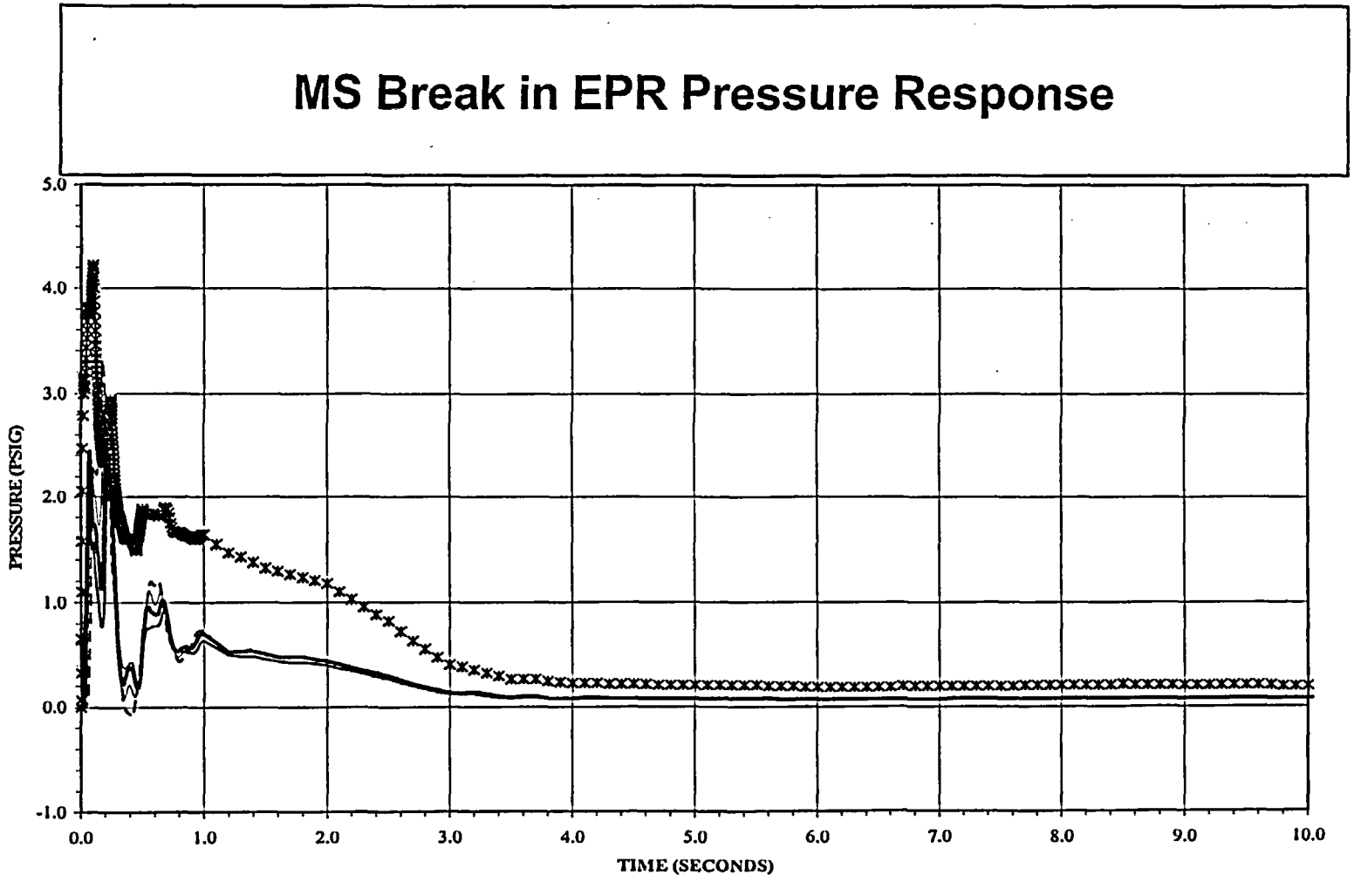
MFDW .5" Gap Break Temperature

MFDW Break in EPR Temperature Response



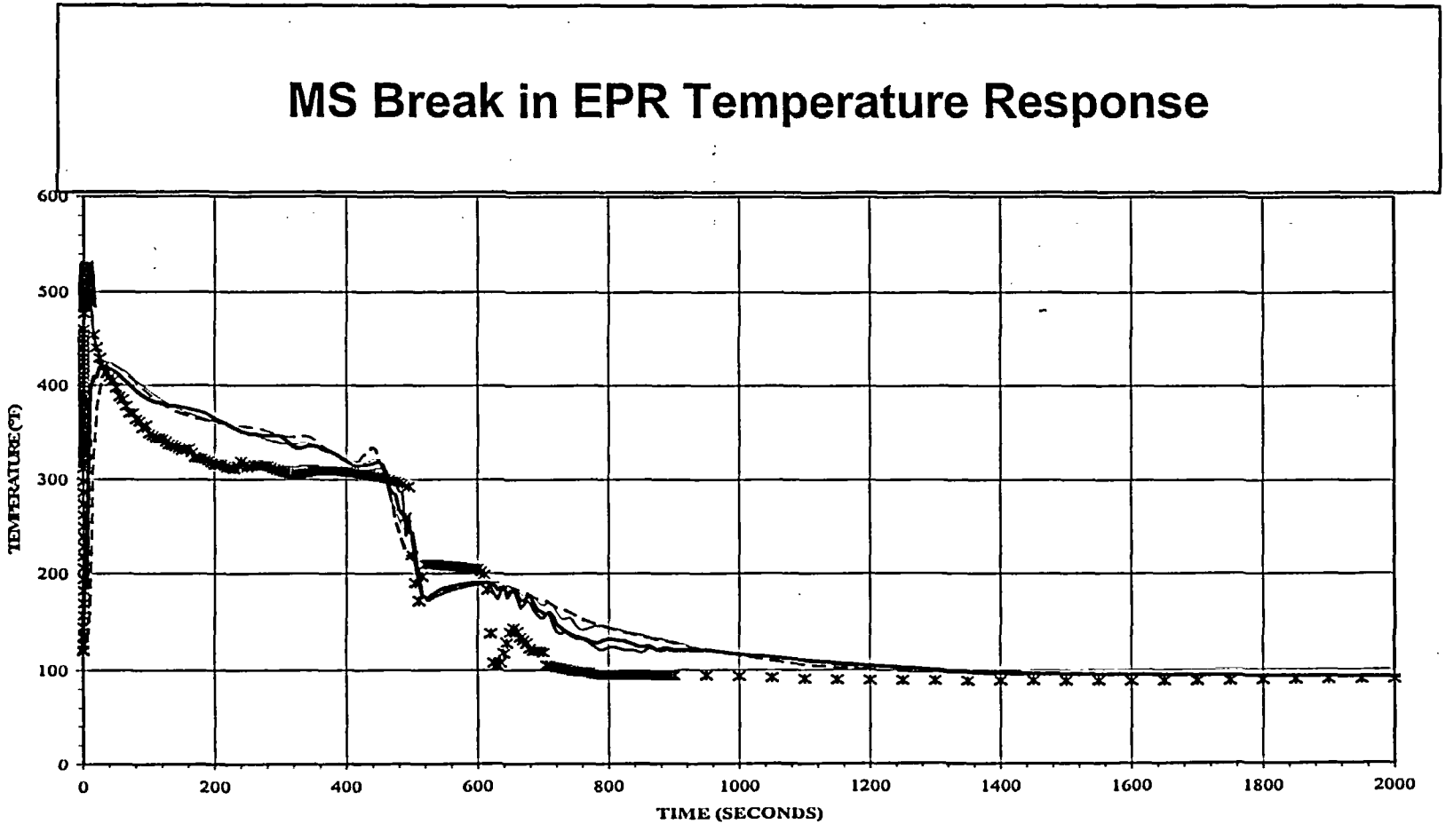
Duke Power
A Duke Energy Company

MS HELB Pressure Results



Duke Power.
A Duke Energy Company

MS HELB Temperature Results



Duke Power.
A Duke Energy Company

MFDW and MS HELBs in EPR

Future Tasks

- Completion of the structural evaluation of WPR (AREVA-FANP).
- Elective inspections (UT) of all MFDW welds in EPR every ISI interval. Elective inspections (VT-3) of all MFDW and MS piping supports every ISI interval.
- Design and implementation of flooding abatement modification.

Duke Power
A Duke Energy Company

MFDW and MS HELBs in EPR

EPR Flood Abatement Modification

- Install passive EPR flooding panels below blowout panels in corner of rooms ('Doggie doors')
- Waterproof EPR to level required to actuate flooding panels. Provide protection for all openings up to predetermined level, including doors.
- Conceptual Modifications will ensure that the resulting water level will not cover critical instrumentation.

Duke Power
A Duke Energy Company

Main HELB Project Overview

Major Activities for HELB Review:

1) Postulate HELB Locations using a methodology acceptable to the NRC (invoking GL 87-11 and portions of MEB 3-1).

2) Identify systems, structures, and components necessary for safe unit shutdown and plant cool-down to cold shutdown conditions.

3) Identify HELB interactions with systems, structures, and components necessary for safe shutdown and plant cool-down.

4) Assess safe shutdown and plant cool-down capability for each HELB.

Duke Power
A Duke Energy Company

Main HELB Project Overview

Major Activities for HELB Review / continued:

5) Verify no structural failures will result in either loss of capability to safely shutdown the unit(s) or place the unit(s) in a cold shutdown condition.

6) Verify equipment relied upon for safe shutdown can withstand the resulting environmental conditions from the HELB.

7) Verify the Control Room will remain habitable and its equipment functional, or capability to shutdown and cool-down the unit(s) exists in another habitable area.

Duke Power
A Duke Energy Company

Activity 1: HELB Locations

- For Seismically Analyzed Piping:
  - All Terminal Ends.
  - Any intermediate location where stress exceeds defined limits (per GL 87-11).
- For Non-seismically Analyzed Piping:
  - All Terminal Ends.
  - At each pipe fitting (e.g. elbow, tee, cross, flange, and non-standard fitting), welded attachment, and valve.
- Critical Crack locations:
  - Based on stress criteria for seismically analyzed piping (MEB 3-1).
  - Based on proximity to vital equipment for non-seismic piping.

Duke Power®
A Duke Energy Company

Status of Activity 1 (HELB Locations)

- Activity 1 is complete.

  All postulated HELB locations have been determined and documented in plant calculations.

Duke Power
A Duke Energy Company

Activity 2: SSCs needed for Safe S/D & Plant C/D

- Review plant documents to determine systems and components required for safe shutdown / plant cooldown.

- Determine structures required to protect the above equipment.

Duke Power.
A Duke Energy Company

Status of Activity 2 (SSC Identification)

- Activity 2 is complete.

  Systems and Components used to establish safe shutdown and provide for plant cooldown to cold shutdown conditions and the structures required to protect them have been identified and documented in plant calculations.

Duke Power
A Duke Energy Company

Activity 3: HELB Interactions with SSC's

- Perform plant walk-downs to identify interactions on structures, systems, and components required for safe shutdown/plant cool-down.

- Interactions created by the following:
  - Pipe whip
  - Jet Impingement

Duke Power.
A Duke Energy Company

Status of Activity 3 (HELB Walkdowns)

- Activity 3 is complete.

  All HELB interaction walk-downs have been completed. The interaction walk-down results are documented in plant calculations.

Duke Power®
A Duke Energy Company

Activity 4: Assessment of Interactions on Systems & Components

- Identify safe shutdown equipment affected by impacted cable trays, terminal boxes, & panels.
- Perform first screen review of interactions to show safe shutdown not adversely affected.
- Perform more detailed analysis of breaks where safe shutdown may be affected.
  - Pipe break geometry analysis
  - Detailed Cable Routing analysis
  - FMEA for affected cabling
  - Safety Analysis

Duke Power®
A Duke Energy Company

Status of Activity 4 (Interaction Assessment)

- Safe Shutdown Cabling for all three units has been identified with the associated routes.
- Unit 1 walk-down of 586 field routed cables has been completed.
- Unit 2 walk-down of 454 field routed cables has been completed.
- Unit 3 walk-down of 279 field routed cables has been completed.

Duke Power®
A Duke Energy Company

Status of Activity 4 (Interaction Assessment)

- Created data base that relates the cable routing and tracking data base to the safe shutdown equipment and component list. This allows determining the location of safe shutdown related control and power cables.

Duke Power
A Duke Energy Company

Status of Activity 4 (Interaction Assessment)

- First Screen Assessment of Unit 1 Breaks is complete.

- For Unit 1, approximately 1080 breaks were evaluated. It was demonstrated, through screening criteria, that safe shutdown could be achieved for the majority of these breaks. 97 of the total await further evaluation.

Duke Power®
A Duke Energy Company

Status of Activity 4 (Interaction Assessment)

- First Screen Assessment of Unit 2 Breaks is also complete.
- For Unit 2, approximately 1320 breaks were evaluated. It was demonstrated, through screening criteria, that safe shutdown could be achieved for the majority of these breaks. 245 of the total await further evaluation.
- The Unit 3 screening is in progress.

Duke Power
A Duke Energy Company

Activity 5: Assessment of Structural Interactions

- Original 1973 report noted the possible yielding of steel floor beams and columns in the Turbine Building for a number of breaks.
- Current effort seeks to validate the 1973 report conclusions regarding structural yielding. To that end the following tasks have been initiated:

Duke Power
A Duke Energy Company

Activity 5: Assessment of Structural Interactions

- Develop Turbine Building Structural Model.
- Evaluate interactions on structures.
- Review/Validate any possible structural failures.
- Evaluate any possible overall structural damage.
- Identify collateral damage to systems and components required for safe shutdown / plant cooldown.

Duke Power
A Duke Energy Company

Status of Activity 5 (Structural Assessments)

- Initial evaluation of the break interactions have been completed for all three units.
- Turbine Building Structural Model completed for Units 2 & 3.
- Unit 1 Turbine Building Structural Model scheduled for completion later this year

Duke Power.
A Duke Energy Company

Activity 6: Assessment of Environmental Effects

- Calculate HELB Mass & Energy Release Rates.
- Determine environmental conditions in break areas.
- Determine flooding/spray conditions in break areas.
- Evaluate environmental, flooding, and spray effects on equipment required for safe shutdown.

Duke Power.
A Duke Energy Company

Status of Activity 6 (Assessment of Environmental Effects)

- Mass and Energy (M&E) Release calculations for Turbine Building breaks scheduled to begin later this year.

Duke Power
A Duke Energy Company

Activity 7: Control Room Habitability

- Evaluate effects on control area cooling.
- Perform room heat-up calculations for control areas:
  - Control Rooms
  - Cable Rooms
  - Equipment Rooms
- Evaluate Control Areas for equipment and personnel habitability
- Evaluate use of SSF as alternate means for safe shutdown/plant cool-down.

Duke Power®
A Duke Energy Company

Status of Activity 7 (Control Room Habitability)

- Equipment used for control area cooling identified and included in the list of SSC's required for safe shutdown / plant cool-down.

- Activity 7 is scheduled to begin after environmental conditions are determined.

Duke Power.
A Duke Energy Company

HELB Project Schedule

Milestone	Unit 1	Unit 2	Unit 3
Safe Shutdown Assessment (Act. 4)	Fourth Qtr. 2004	First Qtr. 2005	Third Qtr. 2005
Structural Evaluations (Act. 5)	Fourth Qtr. 2005	Second Qtr. 2006	Fourth Qtr. 2006
EQ Evaluations (Act. 6)	Third Qtr. 2005	Third Qtr. 2005	Third Qtr. 2005
HELB LAR Submittal	Fourth Qtr. 2006	First Qtr. 2007	Second Qtr. 2007

Duke Power
A Duke Energy Company

Current Licensing Basis

- The current licensing basis is predicated on the postulated break locations contained in the original 1973 report.
- The NRC accepted those break location in the 1973 SER, noting, "The staff agrees with the applicant's selection of pipe failure locations".....

Duke Power
A Duke Energy Company

Current Licensing Basis

- The current project seeks to understand the basis of those break locations originally postulated and validate that those locations remain bounding, given the current plant configuration.
- In order to determine whether the break locations originally postulated are still bounding, a comprehensive review of all potential break locations and the ramifications of those break must be fully understood.
- This understanding cannot be be determined until the complete set of analyses are completed.

Duke Power®
A Duke Energy Company

Current Licensing Basis

- When these analyses are completed, it is possible that interactions resulting from the new break locations, other than those originally postulated, will be more bounding. The culmination of the project will report any new bounding locations in the License Amendment Request (LAR).
- Should any new interactions be discovered, they will be entered into our corrective action program. Our operability process will be followed. If it is determined that these interactions impact the ability to reach safe shutdown, then appropriate compensatory actions, if needed, will be implemented.

Duke Power®
A Duke Energy Company

Current Licensing Basis - Commitments

- As a result of the 1973 analysis, Duke committed to perform a series of modifications, and perform a series of periodic inspections.

  Listed below are those commitments and their status:

  - ❑ Removal of certain walls in the EPR and installation of blow out panels to relieve internal pressure from a MS or MFDW break.
  - ❑ Reinforcement of the battery room walls adjacent to the EPR.

Duke Power®
A Duke Energy Company

Current Licensing Basis - Commitments

- Shield Low Pressure Injection line and electrical cables for valve HP-26 in the EPR from MS and MFDW jet impingement.
- Install EFDW bypass lines around postulated break locations in the Turbine Building.
- Install MFDW line rupture restraints between Reactor Building anchor, and isolation check valves.

Duke Power
A Duke Energy Company

Current Licensing Basis - Commitments

- Install EFDW cross connects between the Units.
- Install MS restraints between both trains upstream of MS safety relief valves.

Duke Power
A Duke Energy Company

Current Licensing Basis - Commitments

- Duke committed to inspect the MFDW and MS support system prior to initial operations, at the end of the 1st year of operation, and every four years afterwards. Status: Duke inspected all safety related MDW & MS supports prior to plant operations. However, not all of the supports were inspected during the following years. Duke has recently begun an elective ISI program for these supports.

Duke Power®
A Duke Energy Company

Current Licensing Basis - Issues

- Is ONS in compliance with their licensing basis?

  As noted before, our current licensing basis is predicated on the break locations listed in the original HELB report. With a few exceptions, there is no evidence today that suggests that the results of those breaks is different than that described in the original report. We have identified a few issues in our corrective action program and are working to clear the associated OBD / NCI. The HELB revalidation project will evaluate all potential break locations and their effect on the ability to reach safe shutdown. Any new or different effects discovered will be evaluated via our corrective action program and included in the LAR.

Duke Power
A Duke Energy Company

Current Licensing Basis - Issues

Duke is committed to the safe operation of the plant. Should an interaction be discovered that affects our ability to reach safe shutdown, we will enter the issue into our corrective action program, and compensatory actions, if necessary, will be initiated to insure the safe operations of the plant.

Duke Power.
A Duke Energy Company

Current Licensing Basis - Issues

EPR Blowout Panels

The failure strength of the EPR blow out panels, in their AS-FOUND condition has been evaluated and documented in a plant calculation. The calculation demonstrates that enough of the panels will fail to alleviate the internal pressure and prevent challenging the structural integrity of the Auxiliary building. In addition, we are currently working on modifications to improve the ability of the panels to fail and alleviate both flooding and internal pressure.

Duke Power®
A Duke Energy Company

Current Licensing Basis - Issues

- MFDW Rupture Restraints should be encapsulated.

The MFDW rupture restraints are designed to prevent any separation of the pipe for a full circumferential break. The postulated break location is protected by a guard pipe that directs any resulting flow away from components located in the EPR. All components located in the EPR, needed to mitigate a MFDW break, are environmentally qualified for conditions resulting from the break.

Duke Power®
A Duke Energy Company

Current Licensing Basis - Issues

- Where were pipe cracks taken?

The locations chosen for break locations in the 1973 report bound any affects from cracks. The 1973 report did postulate a MFDW break in the TB that resulted in loss of the 4160 V switchgear. MFDW cracks in the EPR were likewise bounded by the postulated break location at the RB wall.

Duke Power®
A Duke Energy Company

Current Licensing Basis -Issues

- Definition of Safe Shutdown

Event mitigation is typically divided into two parts. The first part is accident mitigation to bring the unit to a stable safe shutdown condition. The second part is to cool-down the plant to a safe-end state as defined by the ONS licensing basis for that accident.

Duke Power
A Duke Energy Company

Current Licensing Basis - Issues

- Definition of Safe Shutdown / cont.

- Safe Shutdown –
  - Bring the reactor to a sub-critical condition and maintain adequate shutdown margin.
  - Maintain reactor coolant inventory at a sufficient level to protect the core
  - Control reactor coolant pressure within acceptable limits
  - Control reactor coolant temperature within acceptable limits by removing core decay heat

Duke Power
A Duke Energy Company

Current Licensing Basis - Issues

- Definition of Safe Shutdown / cont.

- Safe-End states defined for HELBs Outside Containment:
  - Some HELBs define plant cool-down with long term shutdown using the Low Pressure Injection (LPI) system.
  - Some HELBs define plant cool-down with long term shutdown cooling using Steam Generators (SGs).
  - Some HELBs define plant cool-down with either LPI or the SGs providing long term shutdown cooling.
  - Some HELBs do not specify any safe end state (no plant cool-down or long term shutdown cooling)

Duke Power®
A Duke Energy Company

Risk Reduction Modifications

- Duke is currently working on three separate modifications as a part of the risk reduction work. These modification will enhance the overall safety of the plant, and as a added benefit, reduce HELB mitigation risks. The following gives a brief description of each modification and the intended benefit:

Duke Power
A Duke Energy Company

Risk Reduction Modifications

- Single Failure Proof MFDW Isolation

Mitigates overcooling type scenarios associated with postulated MS HELBs. May be used to reduce the likelihood of flooding the EPR following a MFDW line break in the EPR.

Duke Power
A Duke Energy Company

Risk Reduction Modifications

- Upgraded Station Auxiliary Service Water (ASW) system

  System will be capable of feeding all of the steam generators of all the units without using atmospheric dumps to depressurize the generators. Will reduce reliance on the SSF ASW system.

Duke Power®
A Duke Energy Company

Risk Reduction Modifications

- Upgraded Electrical System for HPI and Station ASW.

  System will provide a protected source of power to one HPI pump per unit and a protected source to the upgraded Station ASW system.

Duke Power
A Duke Energy Company

Summary

- Significant Self Initiated Project underway.
- Due to their importance, the evaluation of MS and MFDW breaks in EPR is being treated as a separate project.
- Unit specific LARs are expected be submitted, with Unit 1 expected to be complete in late 2006, Unit 2, early 2007, and Unit 3, mid year 2007.

Duke Power®
A Duke Energy Company

Summary

- Current Licensing Basis is predicated on the postulated break locations described in the original 1973 report. The results described in the report apply today.
- Should the Revalidation project discover any new or different result, the effect on operability will be evaluated. Compensatory actions, if needed, will be implemented as part of the operability evaluation.

Duke Power®
A Duke Energy Company

Summary

- Phase 1 of the design process is in progress for three modifications that will enhance the safety of the plant, and have the added benefit of reducing HELB mitigation risks.