NRC FORM 658
(9-1999)

U.S. NUCLEAR REGULATORY COMMISSION

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DATE OF MEETING
04/30/2003

The attached document(s), which was/were handed out in this meeting, is/are to be placed in the public domain as soon as possible. The minutes of the meeting will be issued in the near future. Following are administrative details regarding this meeting:

Docket Number(s)	**50-269, 50-270, 50-287**
Plant/Facility Name	**OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3**
TAC Number(s) (if available)	**MB6651, MB6652, AND MB6653**
Reference Meeting Notice	**APRIL 3, 2003**
Purpose of Meeting (copy from meeting notice)	**TO DISCUSS NON-SEISMIC PIPING IN THE OCONEE AUXILIARY BUILDING**

NAME OF PERSON WHO ISSUED MEETING NOTICE	TITLE
L. N. OLSHAN	**PROJECT MANAGER**

OFFICE
NRR

DIVISION
DLPM

BRANCH
PD II-1

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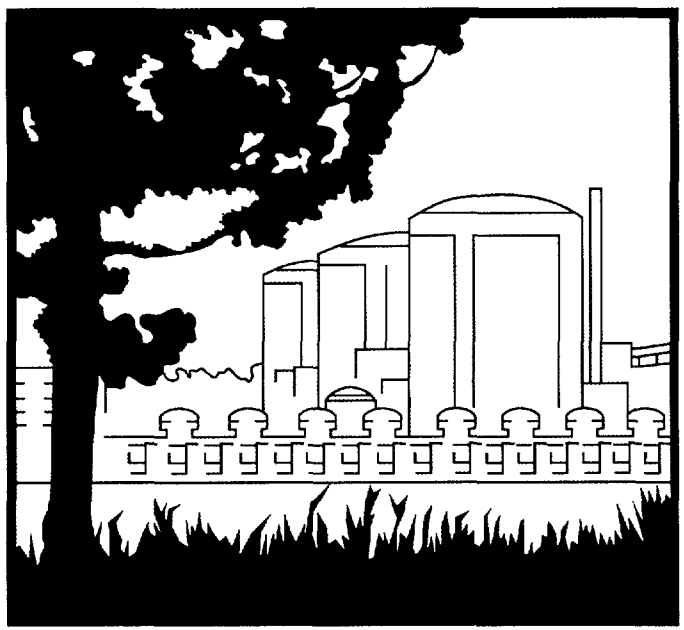

Auxiliary Building Flooding Licensing Amendment Request – RAI Responses

Oconee Nuclear Station

April 30, 2003

Duke Attendees

Larry Nicholson, Regulatory Compliance Manager
Reene' Gambrell, Regulatory Compliance Engineer
Boyd Shingleton, Regulatory Compliance Engineer
Duncan Brewer, Severe Accident Analysis Group Manager
Steve Nader, SAAG Engineer
Ed Burchfield, Engineering Supervisor
Jeff Robertson, Senior Engineer
George Mc Aninch, Engineering Supervisor
John Richards, Sr. Civil Engineer

AB Flooding LAR – RAI Response

Introduction

- Duke met with NRC on 8/22/02 to describe licensing strategy to resolve non-conforming condition related to the impact of non-seismic piping failure in the Auxiliary Building on safety-related equipment

- Duke submitted LAR on 11/1/02 requesting NRC to allow certain portions of the non-seismic piping in the Auxiliary Building to remain non-seismic based on low risk significance

Introduction (continued)

- Duke received Request for Additional Information (RAI) on the PRA justification for the change on 1/16/03; provided response on 2/11/03

- Duke received another RAI related to HSPW and LPSW piping design and the ABS calculation on 2/13/03 & 3/6/03; provided response on 4/3/03

AB Flooding LAR – RAI Response

PRA Discussion – Steve Nader

Civil Discussion – John Richards

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PRA Evaluation-Overview

- Overview
  - Piping has been identified that could have an effect on safety related equipment if it failed in a seismic event
  - Solution: Design study concluded that upgrading piping to seismic is the most practical solution
    - Estimated cost ~ $1 million
  - PRA Task: Evaluate the decreased risk if the pipe is upgraded to seismic

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PRA Evaluation-Overview

- Base Seismic PRA model
  - Part of IPEEE submittal
  - Submitted to NRC 12-28-95
  - SER received 3-15-00
  - Model periodically updated (2003)
  - Self initiated internal audit Spring 2003
    - Reviewed model, inputs, etc.
    - Conclusion: Model is complete, thorough
    - No items identified that affect AB flood issues

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PRA Evaluation-Overview

- Base Seismic PRA model (continued)
  - Based on internal events PRA
  - Internal events PRA evaluated internal flooding (from pipe breaks)
  - Internal events PRA concluded that the important consequence of flooding in the AB is failure of the HPI pumps (piping failures from any cause)
  - Internal events PRA flooding analysis also concluded that TB floods were much more important than AB floods; therefore AB floods screened out

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PRA Evaluation-Overview

- Base Seismic PRA model (continued)
  - Internal events PRA conclusions were carried forward into the seismic PRA
  - No AB floods due to pipe breaks are modeled
  - Piping breaks are modeled as one input to the system reliability
  - TB floods are modeled (Condenser expansion joints)
  - TB floods fail equipment in TB basement (e.g., EFW , cooling water to HPI)

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PRA Evaluation-Overview

- Base Case Risk Calculation
  - Start with the base seismic model
  - Add AB piping failures to the model
  - Determine consequences
  - Input appropriate fragilities for the piping
  - Run the seismic model with new failure mode(s)
- Results: AB piping failures contribute <1% to total CDF

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PRA Evaluation-Overview

- Modified Plant Risk Calculation
  - Input new fragility value for piping based on ONS seismic design requirements
  - Re-run the seismic PRA model
- Results: CDF decreased by 3E-07

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PRA Evaluation- Important Inputs

- Assumption: AB Piping Failures Fail HPI Pumps
  - Internal events PRA :
    - Plant layout, physical arrangement of AB
    - AB drain system
    - Walkdown results
  - Most rooms of AB screened out
    - Minimal flood potential (rate, volume)
    - Adequate drainage
  - HPI, LPI, RBS located in basement
    - Vulnerable to flood

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PRA Evaluation- Important Inputs

- Assumption: AB Piping Failures Fail HPI Pumps (continued)
  - RBS, LPI used to mitigate large LOCA
    - Probability of large LOCA and seismic failure of this piping is very small- screened out
  - LPI, RBS used in other transients- however always with HPI
- Conclusion: HPI pumps are important for evaluation of AB piping failure. HPI bounds failure of other AB equipment.

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PRA Evaluation- Important Inputs

- Assumption: AB Piping Failures Fail HPI Pumps (continued)
  - Are other important safety functions potentially lost?
  - Use same screening methods as IPEEE model
    - Secondary side heat removal- no
    - Ability to trip reactor- no
    - Loss of power – no
    - Standby Shutdown Facility - no
    - Component cooling water – possibly lost

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PRA Evaluation- Important Inputs

- Assumption: AB Piping Failures Fail CC Pumps
  - Large floods (high flow rate, unisolated)
  - 500,000 gallons to fill to next level
    - Operating experience shows the largest AB flood is 164,000 gallons at WNP-2 (June 1998)
  - IPEEE concluded CC Pump motor control centers <u>would not be</u> flooded
  - LAR evaluation conservatively assumed <u>CC is lost</u> as a consequence of the flood

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PRA Evaluation- Important Inputs

- HPI, CC Important For Seal LOCAs
  - ONS mitigates seal LOCAs with
    - HPI seal injection
    - Component Cooling of RCP thermal barrier
    - Standby Shutdown Facility primary make-up

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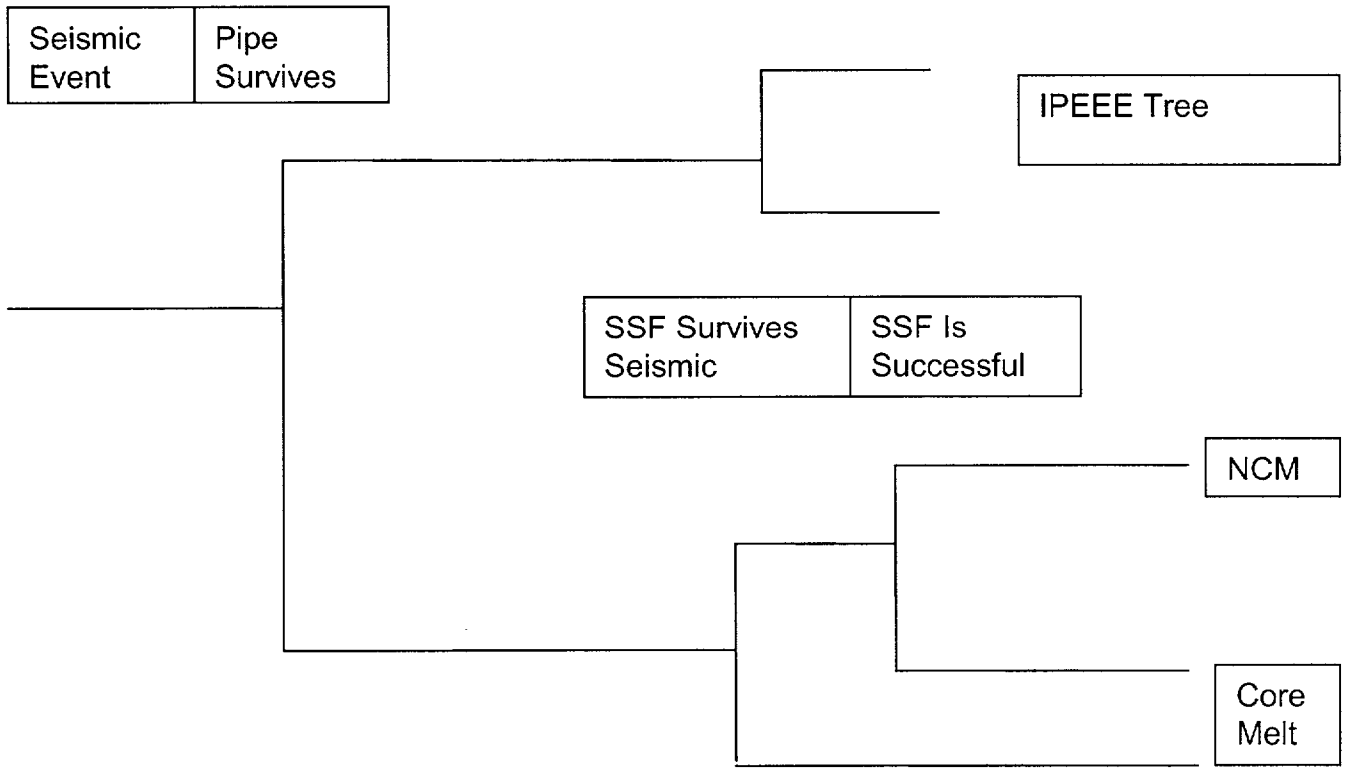
PRA Evaluation- Important Inputs

- New Core Melt Sequences Added to the Seismic PRA Model
  - Seismic Pipe Break
    - Assume large, unisolated- HPI, CC fails
  - SSF fails
    - Could fail due to seismic event
    - Could fail randomly

PRA Evaluation-Event Tree



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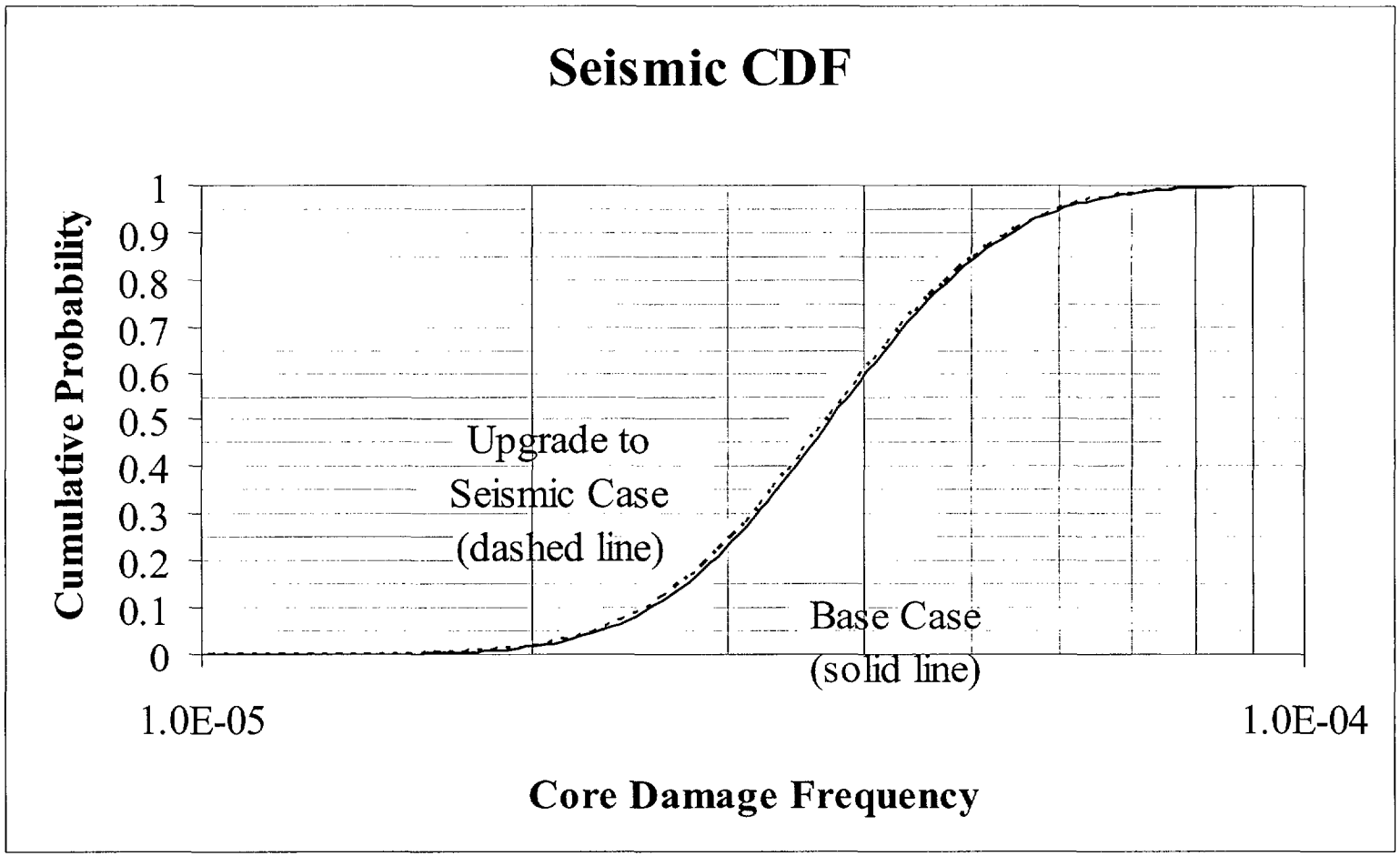
PRA Evaluation-Uncertainties

- Uncertainties
  - Base Case Results
    - Mean = 3.89E-05
    - Std Dev = 1.16E-05
    - Best Estimate = 3.25E-05
  - Upgrade to Seismic Case
    - Mean = 3.86E-05
    - Std Dev = 1.17E-05
    - Best Estimate = 3.23E-05
  - Delta: 3.89E-05 – 3.86E-05 = <u>3E-07</u>

PRA Evaluation-Uncertainties



Computation of Piping Fragilities

- Compute piping fragilities to support two cases
  - Currently installed piping
  - Upgraded piping consistent with Oconee design requirements

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Currently Installed Piping

- Primarily rod hung piping
- Does not include seismic design
- Large diameter piping (≥ 3") is welded carbon or stainless steel
- Small diameter piping (≤ 2½") is threaded or welded carbon or stainless steel

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Currently Installed Piping

- Fragility Calculations
  - Performed walkdowns of installed piping with contract technical experts (Bob Campbell, ABS)
  - Confirmed installed piping consistent with piping in earthquake experience data
    - Materials, design and construction similar
    - Vulnerabilities leading to failures evaluated
  - Selected controlling supports for analysis

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Currently Installed Piping

- Fragility Calculations (continued)
  - Computed fragility using UHS for Oconee
  - Controlling fragilities based on experience of Fire Protection Piping in the Loma Prieta earthquake
  - $A_m = 0.85g \quad \beta_R = 0.3 \quad \beta_U = 0.46$
  - HCLPF = 0.24g (ONS SSE is 0.10g)

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Upgraded Piping

- Computed fragility assuming existing piping is upgraded to comply with Oconee design requirements
- Considered piping, supports, anchors
- Computed fragility using UHS for Oconee

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Upgraded Piping

- Fragility Calculations
  - Investigated numerous components to determine governing element (pipe, supports, anchors, welds, etc.)
  - Controlling fragilities conservatively based on welds in the supports
  - $A_m = 1.95g$ $\beta_R = 0.33$ $\beta_U = 0.59$
  - HCLPF = 0.43g
  - Upgraded piping would be approximately twice as rugged as the installed piping

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Follow-Up Questions

- Received follow-up questions on 2/13/03 and 3/6/03
- Responded on 4/3/03
- Key outstanding issues from conference call on 4/10/03
  - Haven't shown experience is applicable to ONS piping
  - Experience vertical spectrum doesn't envelope ONS UHS spectrum at high frequencies
  - Uncertainty for the analysis case seems unreasonably high
  - Reports of corrosion problems

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Applicability of Experience Data

- Experience data primarily from about 20 sites in the 1989 Loma Prieta earthquake (NUREG/CR-5580, Appendix C)
- Includes experience from 1,000 water sprinkler systems
- Construction dates range from about 1930 to the present
- Construction generally complies with pre-1989 versions of NFPA-13
- Some piping included lateral bracing and some did not

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Applicability of Experience Data

- Only 13 Direct Piping Related Failures Including
  - Inadvertent actuation of deluge valves
  - Minor pipe leaks
  - Support failures not resulting in leaks
  - Connection failures
  - Sprinkler head interaction failures
- Other Failures Not Considered Direct Piping Related
  - Several failures due to soil liquefaction
  - Several pipe connection and sprinkler head failures in extensively damaged buildings

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Applicability of Experience Data

- Primary Causes of Damage
  - Soil liquefaction
  - Large deformation and damage to structures poorly designed for earthquakes
  - Groove type victaulic couplings
  - Loss of support from C-clamp supports
- None of these conditions exist in the Service Water piping at Oconee

Distribution of Experience vs. Peak Ground Acceleration

	Peak Ground Acceleration # Systems / # Failures							
Facility	**0.1g**		**0.2g**		**0.3g**		**0.4g**	
Almeda Navel Air Station					90	2		
Oakland Army Base					22	1		
Oakland Naval Station					9	9[1]		
Port of Oakland					50	3[2]		
Treasure Island/Hunters Pt			34	2				
San Francisco Airport					80	1		
California Hospitals	61	0	26	1			4	0
Lockheed			300	0			20	1
Moffett Navel Air Station			280	0				
Hewlett Packard			20	2			23	2
Totals	**61**	**0**	**660**	**5**	**251**	**5**	**47**	**3**
Failure Rate	0.00%		0.76%		1.99%		6.38%	

Notes: 1) Failures due to soil liquefaction or C-Clamp supports (therefore, not included in totals)
2) Two of these failures are related to structure failures (therefore, not included in totals)

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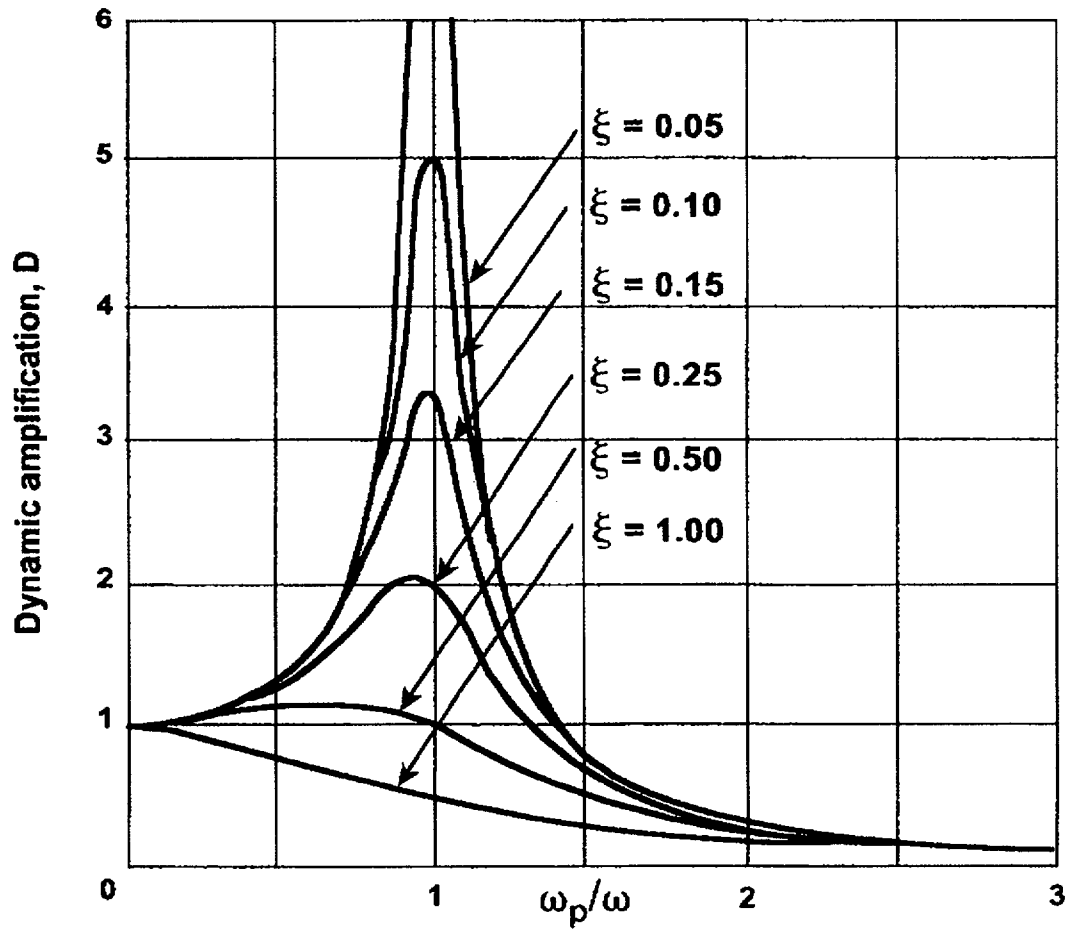
Applicability of Experience Data

- Huge volume of data permits development of generic fragility
- Support design considerations at Oconee (vertical and lateral) evaluated by separate analyses of bounding cases
- From that analysis, Oconee supports have higher fragility than experience data results, therefore, supports were not controlling
- Experience data is an acceptable estimate of Oconee Service Water Piping fragility

Response to High Frequency Accelerations

High frequency input does not excite low frequency modes



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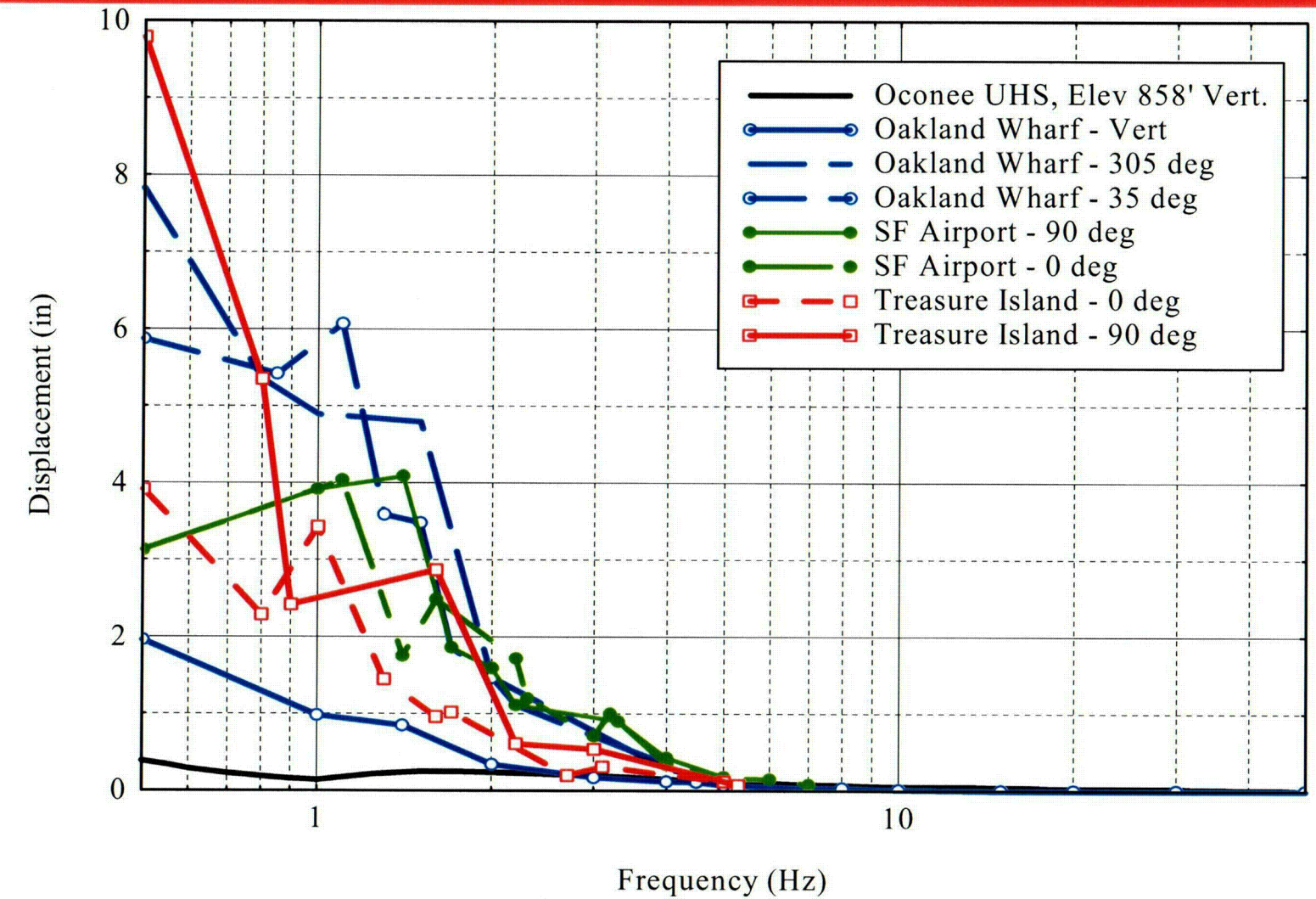
Response to High Frequency Accelerations

- Analysis of multi-degree of freedom systems shows that
  - response (amplification, stress, etc) is typically dominated by lower frequency modes where
    - the majority of the system mass is vibrating
    - participation factors are largest
- Higher frequency modes have low participation and do not significantly contribute to displacements and stresses

Spectral Displacement Comparison



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Uncertainty for the Analysis Case

- β_U in the analysis case doesn't significantly affect the final results
- Performed sensitivity analysis assuming knowledge about the analyzed piping was near perfect ($\beta_R = 0.10$ $\beta_U = 0.10$)
- This conservatively increases the seismic capacity (HCLPF would be 1.40g, >300% increase)
- Negligible impact on CDF
- Therefore, even if the β_U was significantly reduced, the results would be the same

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Corrosion Concerns

- Corrosion concerns from conference call on 4/10/03
  - Picture of valve LPSW-373 which shows corrosion
  - Question regarding leaks in system
  - Question regarding piping replacement

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SW Corrosion

- Internal Pitting
  - Lake water (clean by most standards)
  - Crud Corrosion Products collect over many years of operation
- LPSW surface corrosion
  - Anti sweat insulation
  - Anti corrosion paint
  - Moisture intrusion over many years

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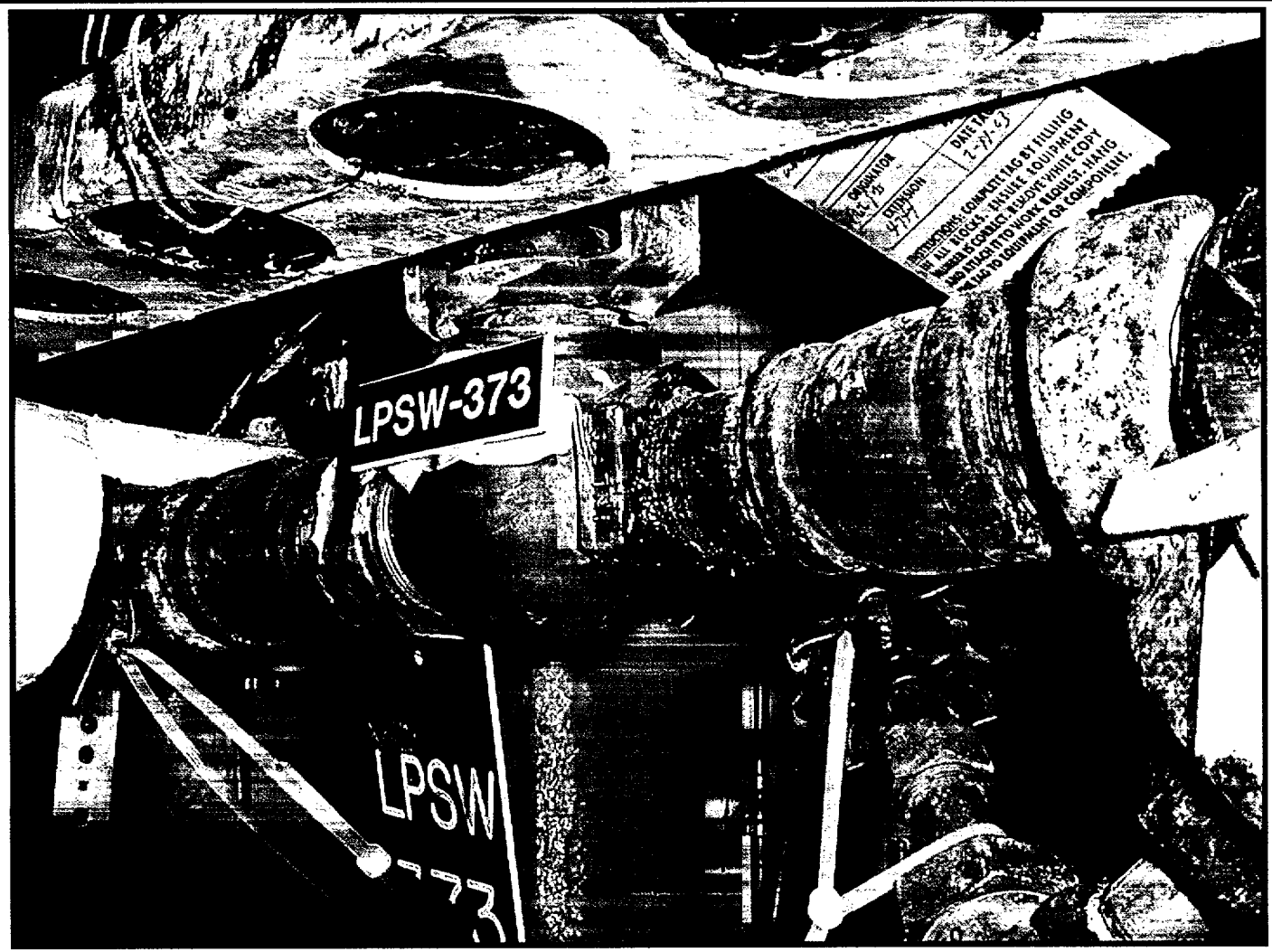
Leakage Past Threads



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Leakage Past Threads

- Drops per minute
- Liquid Management goal is 0 leakage
  - Work order to replace nipple
  - Leak management to evaluate
    - Corrosion
    - Structural

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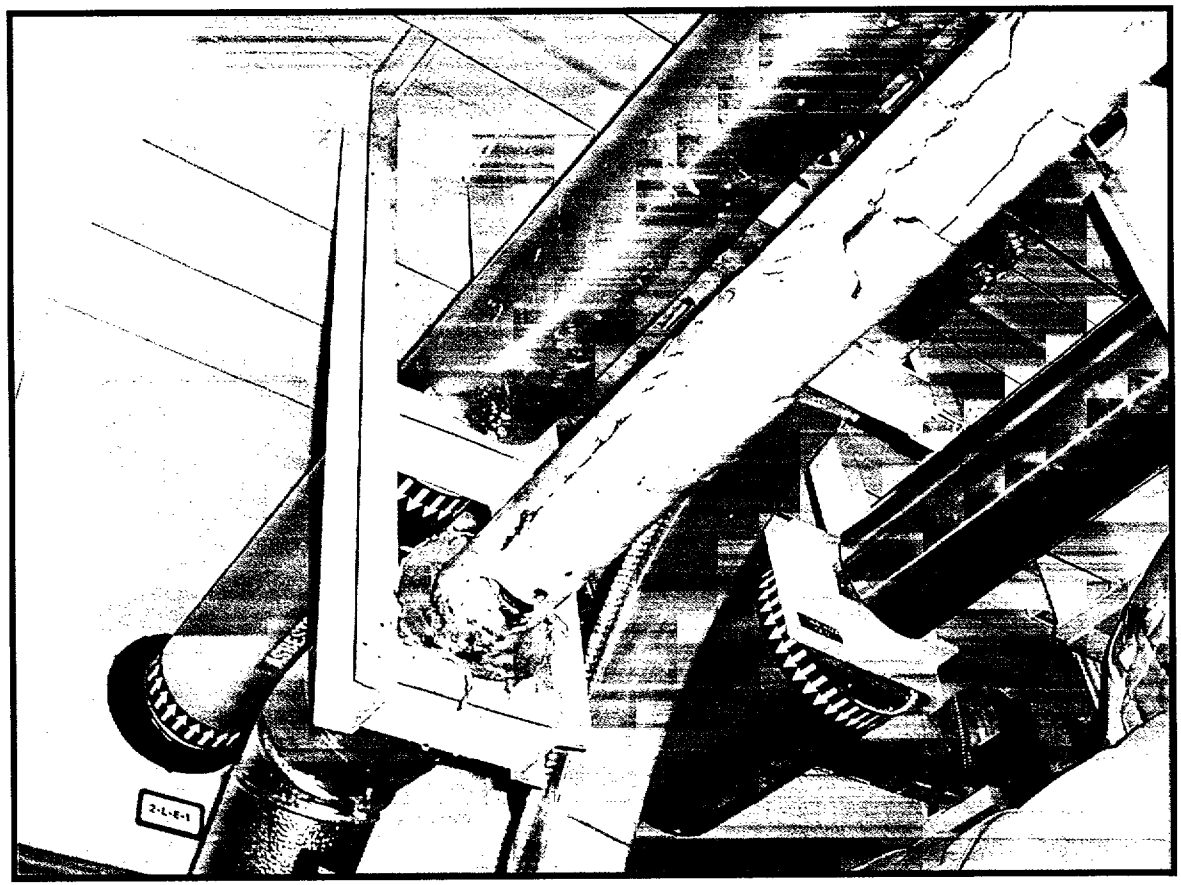
Pin Leak on Pipe



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Pin Leak on Pipe

- Not a structural issue
- Work order written to replace pipe
- PIP written to evaluate pipe
  - Required by NSD-413
  - Screened using pre-established criteria

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Pipe Replacement

- Leaking components are replaced
- SW Inspection Program performs UT
- Small bore piping refurbishment
  - Life extension
  - To minimize resistance to flow
  - Not related to structural integrity

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Leakage Summary

- Zero Leakage Threshold
- SW Inspection Program
- Isolated pin hole leaks
  - Evaluated via PIP
  - Screened using pre-existing criteria
- Not a structural issue

AB Flooding LAR – RAI Response

Conclusion - Larry Nicholson