Dominion
North Anna Power Station
Restart Readiness

October 21, 2011 Briefing

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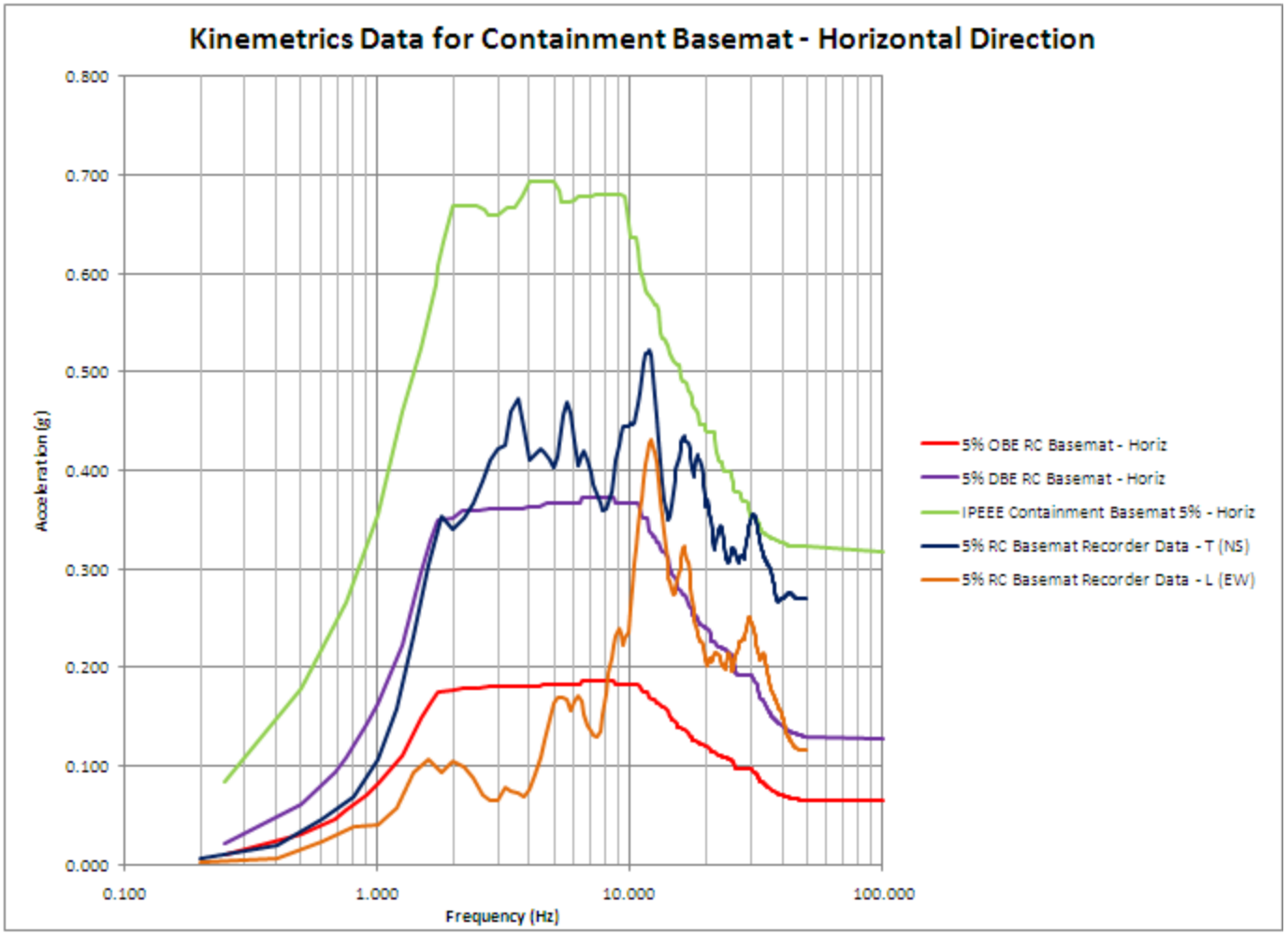
Dominion Assessment

Consistent With Part 100, Appendix A:

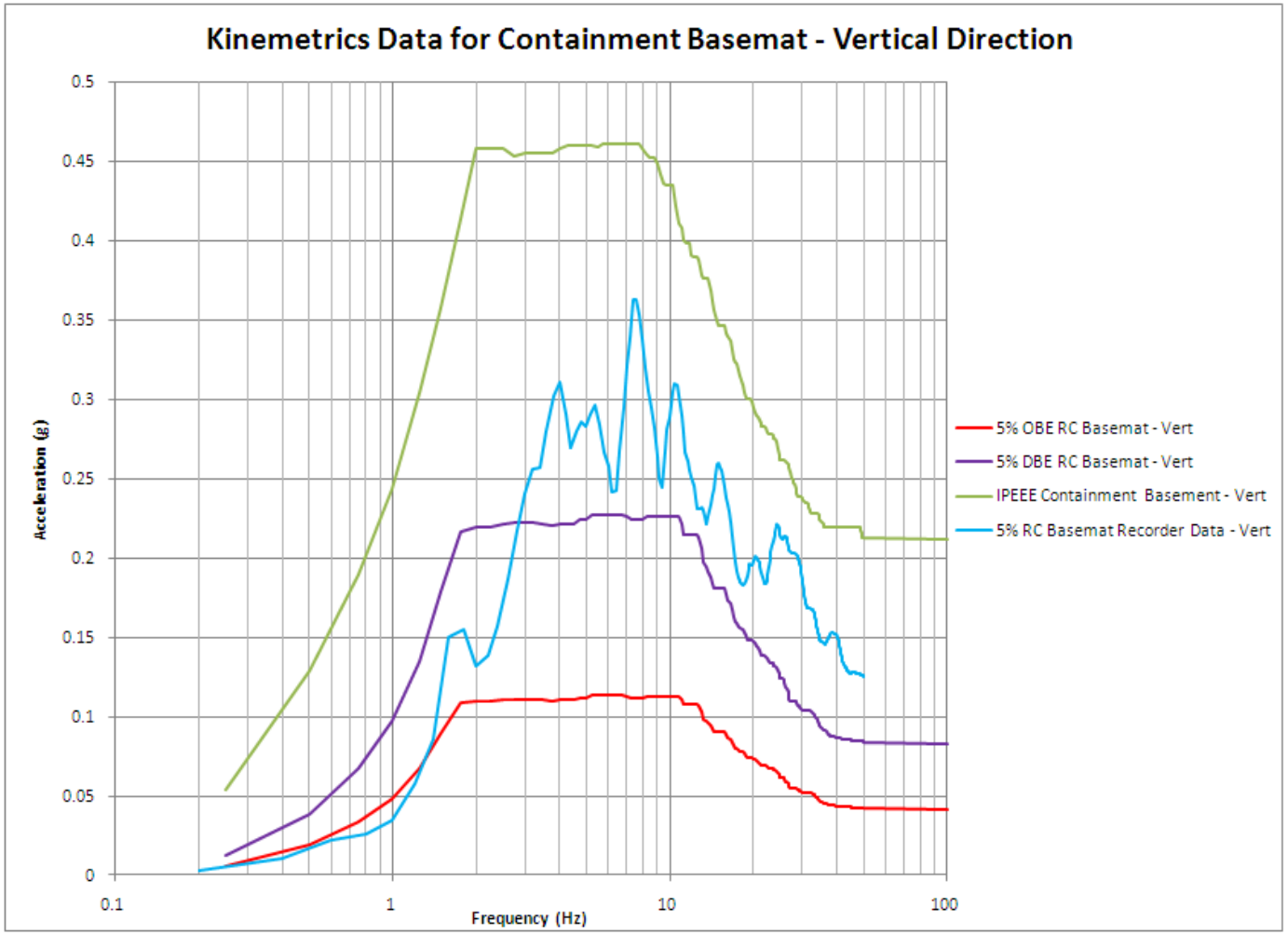
- No Functional Damage to Safety SSCs
- No Undue Risk to Health and Safety
- Restart Readiness Demonstrated

Event Perspective & Margins

Response Spectra Comparisons



Response Spectra Comparisons

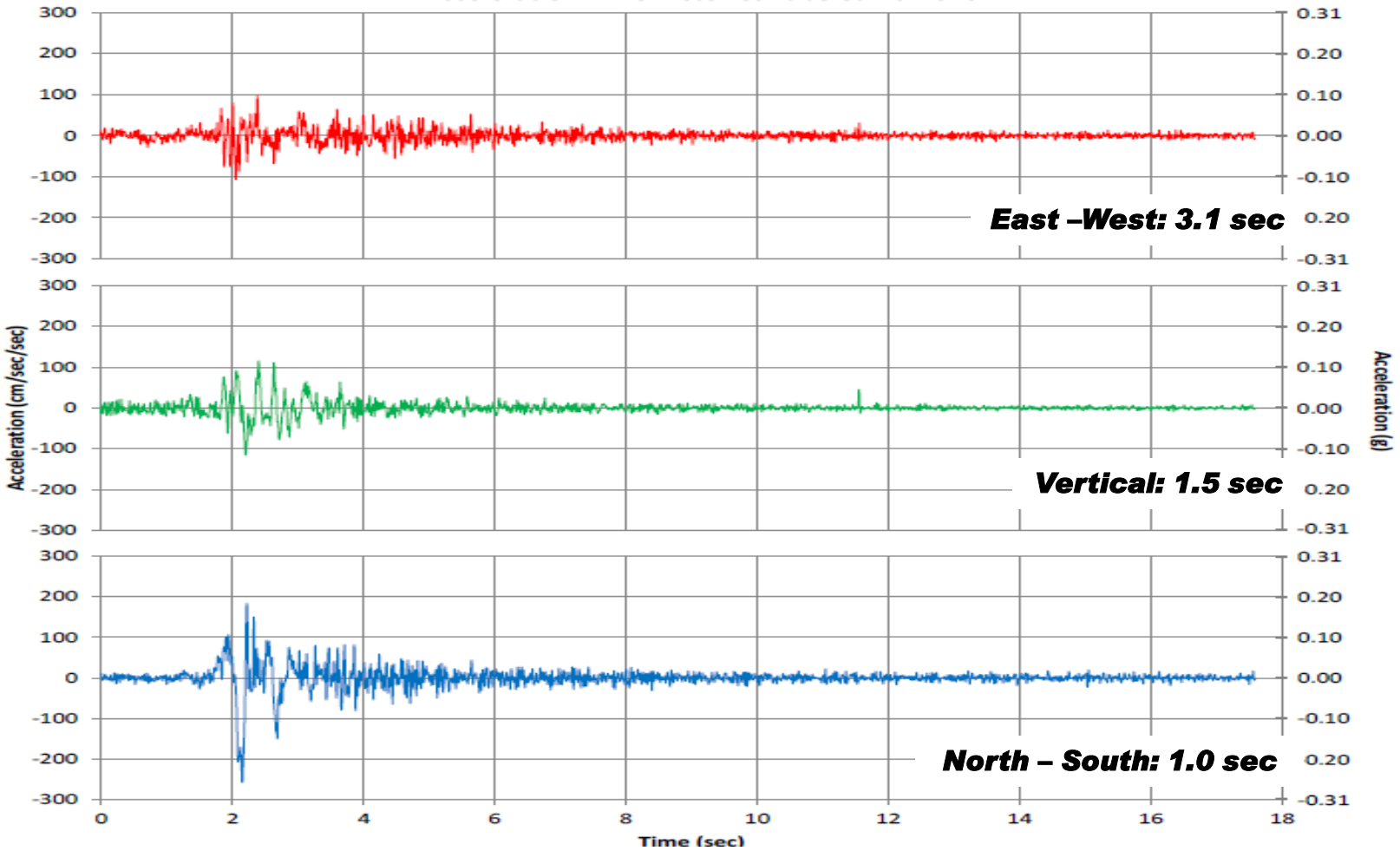


Response Spectra Considerations

- Seismic Acceleration Response Spectra
  - Used To Conservatively Design Plants
  - Poor Indicators of Plant Damage
  - Does Not Account for Duration
- Cumulative Absolute Velocity (CAV) takes Duration and Acceleration into Account
  - Best Single Indicator of Energy Imparted
  - Best Single Indicator of Damage

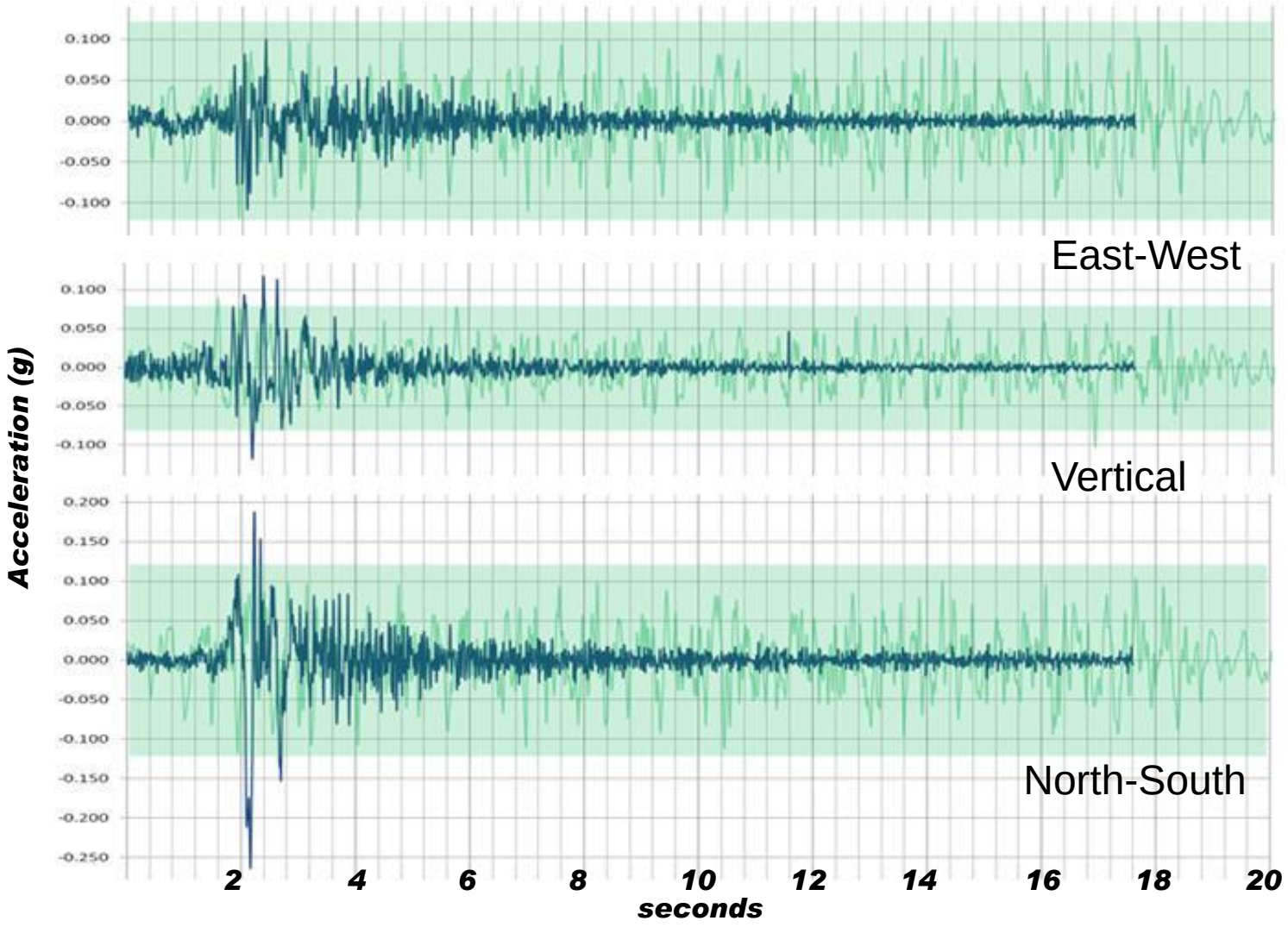
Acceleration Time Histories

(very short, strong motion)



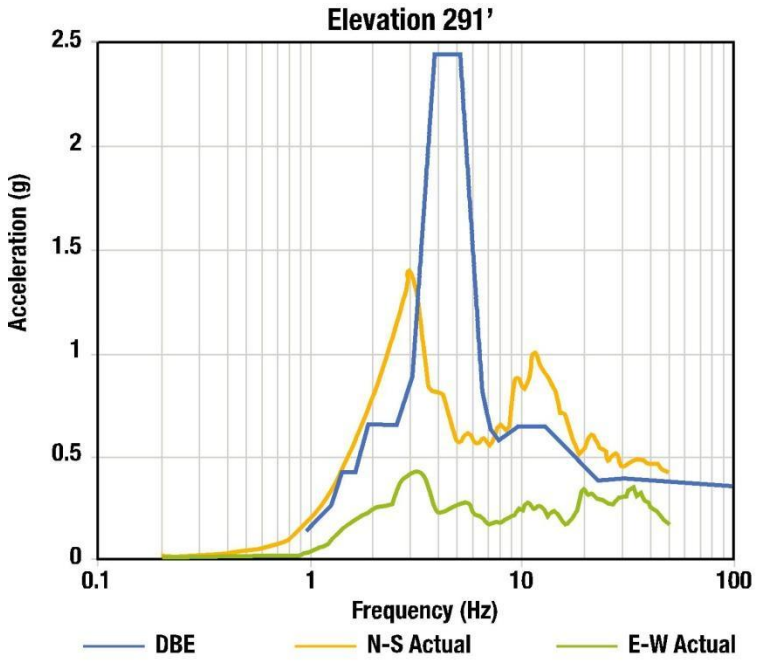
Containment Basemat (elevation 216')

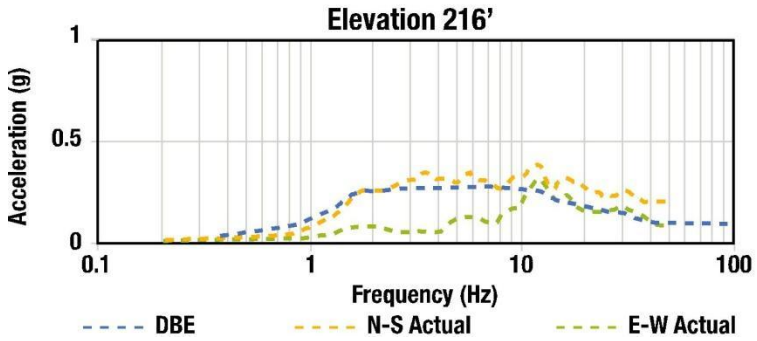
Time Histories With DBE Superimposed

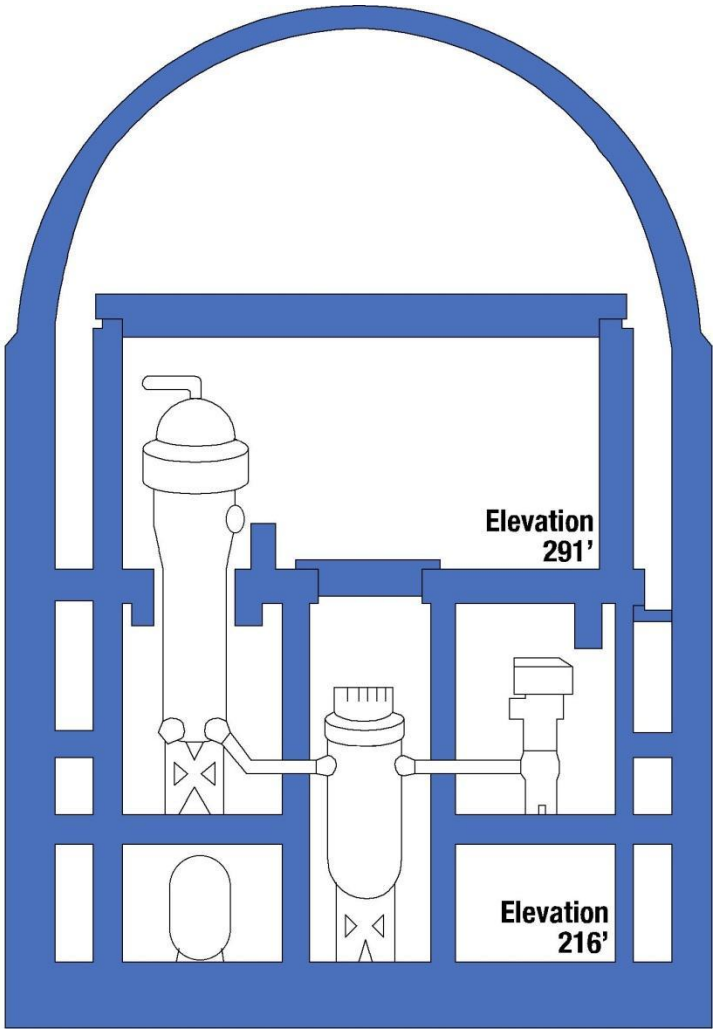


Conservatism In Modeling Structures

Horizontal Response Spectra vs. DBE @ Basemat & Elevation 291’



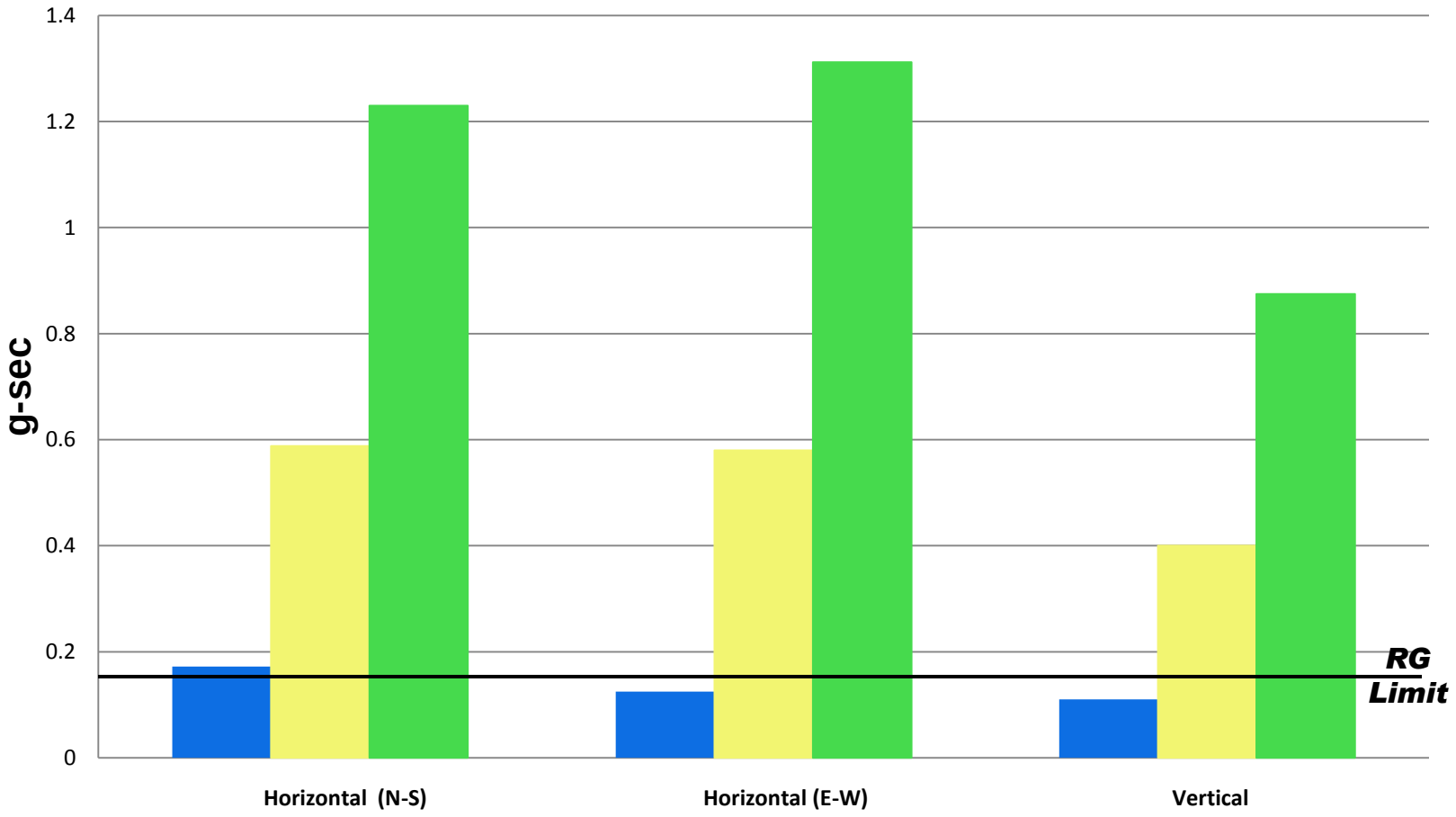




CAV Comparisons

Seismic Case	CAV North – South Direction (g-sec)	CAV East – West Direction (g-sec)	CAV Vertical Direction (g-sec)
August 23, 2011 Seismic Event (data from containment basemat)	0.172	0.125	0.110
Design Base Earthquake (rock-founded; synthetic time-history used for containment structure)	0.588	0.580	0.400
IPEEE Review Earthquake (rock-founded; synthetic time-history used for containment structure)	1.230	1.312	0.875
OBE exceedance criterion is CAV > 0.16 g-sec (EPRI TR – 100082 & RG 1.166)			

CAV Comparisons



August 23, 2011 Earthquake Containment Basemat

DBE – Rock-founded for Containment Basemat

IPEEE Review – Rock-founded for Containment Basemat

Significant Design Margins

- Conservatism In Analytical Methods
- Conservatism in ASME Code
- Accident Load of Greater Capacity
- Seismic Test Standards

Seismic Margin Evaluated

- Safe Shutdown Components Previously Evaluated Capable in Excess of DBE
- GL 88-20 (IPEEE) & GL 87-02 (A46) results:
  - Inspected ~ 1800 Safe Shutdown Components
  - IPEEE evaluated to withstand $\geq$ 0.3g
  - Exceptions (~ 50) capable to $\geq$ 0.16g

The Plant Tells the Story

Unit 2 Turbine Building

Non-Safety Related Powdex Demineralizer Tanks

U2 Turbine Building

Powdex Demineralizer Tanks Base Pedestal

Turbine Building Hallway

Crack In Unreinforced Non–Safety Related Block Wall

Unit 1 Containment

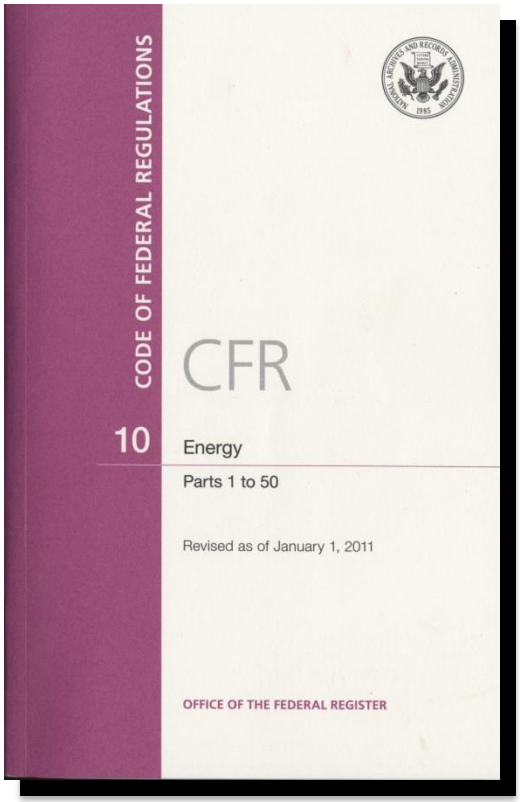
Surface Crack In Interior Containment Wall

Dry Cask Storage

TN-32 Cask Movement

Application of Regulatory Guidance

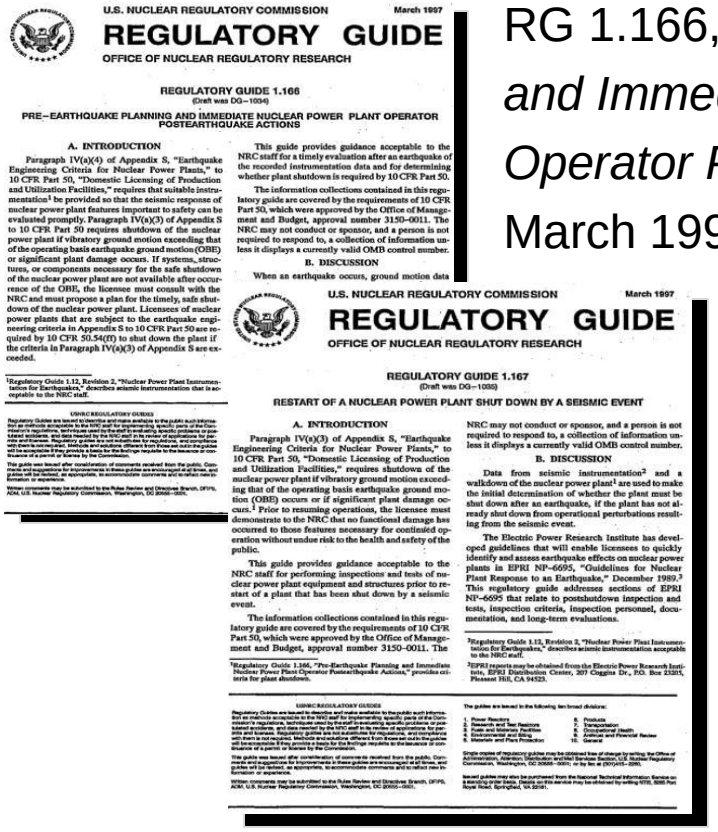
10 CFR 100, Appendix A



"Prior to resuming operations, the licensee will be required to demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public."

Regulatory Guidance

Station restart readiness assessment actions based on NRC endorsed guidance



U.S. NUCLEAR REGULATORY COMMISSION March 1997

REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 1.166
(Draft was DG–1034)

PRE–EARTHQUAKE PLANNING AND IMMEDIATE NUCLEAR POWER PLANT OPERATOR POSTEARTHQUAKE ACTIONS

A. INTRODUCTION

Paragraph IV(a)(4) of Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that suitable instrumentation[1] be provided so that the seismic response of nuclear power plant features important to safety can be evaluated promptly. Paragraph IV(a)(3) of Appendix S to 10 CFR Part 50 requires shutdown of the nuclear power plant if vibratory ground motion exceeding that of the operating basis earthquake ground motion (OBE) or significant plant damage occurs. If systems, structures, or components necessary for the safe shutdown of the nuclear power plant are not available after occurrence of the OBE, the licensee must consult with the NRC and must propose a plan for the timely, safe shutdown of the nuclear power plant. Licensees of nuclear power plants that are subject to the earthquake engineering criteria in Appendix S to 10 CFR Part 50 are required by 10 CFR 50.54(ff) to shut down the plant if the criteria in Paragraph IV(a)(3) of Appendix S are exceeded.

This guide provides guidance acceptable to the NRC staff for a timely evaluation after an earthquake of the recorded instrumentation data and for determining whether plant shutdown is required by 10 CFR Part 50.

The information collections contained in this regulatory guide are covered by the requirements of 10 CFR Part 50, which were approved by the Office of Management and Budget, approval number 3150–0011. The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

B. DISCUSSION

When an earthquake occurs, ground motion data

[1]Regulatory Guide 1.12, Revision 2, "Nuclear Power Plant Instrumentation for Earthquakes," describes seismic instrumentation that is acceptable to the NRC staff.

USNRC REGULATORY GUIDES

Regulatory Guides are issued to describe and make available to the public such information as methods acceptable to the NRC staff for implementing specific parts of the Commission's regulations, techniques used by the staff in evaluating specific problems or postulated accidents, and data needed by the NRC staff in the review of applications for permits and licenses. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.

This guide was issued after consideration of comments received from the public. Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience.

Written comments may be submitted to the Rules Review and Directives Branch, DFIPS, ADM, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001.

RG 1.166, *Pre-earthquake Planning and Immediate Nuclear Power Plant Operator Post-earthquake Actions,* March 1997

U.S. NUCLEAR REGULATORY COMMISSION March 1997

REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 1.167
(Draft was DG–1035)

RESTART OF A NUCLEAR POWER PLANT SHUT DOWN BY A SEISMIC EVENT

A. INTRODUCTION

Paragraph IV(a)(3) of Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires shutdown of the nuclear power plant if vibratory ground motion exceeding that of the operating basis earthquake ground motion (OBE) occurs or if significant plant damage occurs.[1] Prior to resuming operations, the licensee must demonstrate to the NRC that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public.

This guide provides guidance acceptable to the NRC staff for performing inspections and tests of nuclear power plant equipment and structures prior to restart of a plant that has been shut down by a seismic event.

The information collections contained in this regulatory guide are covered by the requirements of 10 CFR Part 50, which were approved by the Office of Management and Budget, approval number 3150–0011. The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

B. DISCUSSION

Data from seismic instrumentation[2] and a walkdown of the nuclear power plant[1] are used to make the initial determination of whether the plant must be shut down after an earthquake, if the plant has not already shut down from operational perturbations resulting from the seismic event.

The Electric Power Research Institute has developed guidelines that will enable licensees to quickly identify and assess earthquake effects on nuclear power plants in EPRI NP–6695, "Guidelines for Nuclear Plant Response to an Earthquake," December 1989.[3] This regulatory guide addresses sections of EPRI NP–6695 that relate to postshutdown inspection and tests, inspection criteria, inspection personnel, documentation, and long-term evaluations.

[1]Regulatory Guide 1.12, Revision 2, "Nuclear Power Plant Instrumentation for Earthquakes," describes seismic instrumentation acceptable to the NRC staff.

[2]EPRI reports may be obtained from the Electric Power Research Institute, EPRI Distribution Center, 207 Coggins Dr., P.O. Box 23205, Pleasant Hill, CA 94523.

[1]Regulatory Guide 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Postearthquake Actions," provides criteria for plant shutdown.

USNRC REGULATORY GUIDES

Regulatory Guides are issued to describe and make available to the public such information as methods acceptable to the NRC staff for implementing specific parts of the Commission's regulations, techniques used by the staff in evaluating specific problems or postulated accidents, and data needed by the NRC staff in the review of applications for permits and licenses. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.

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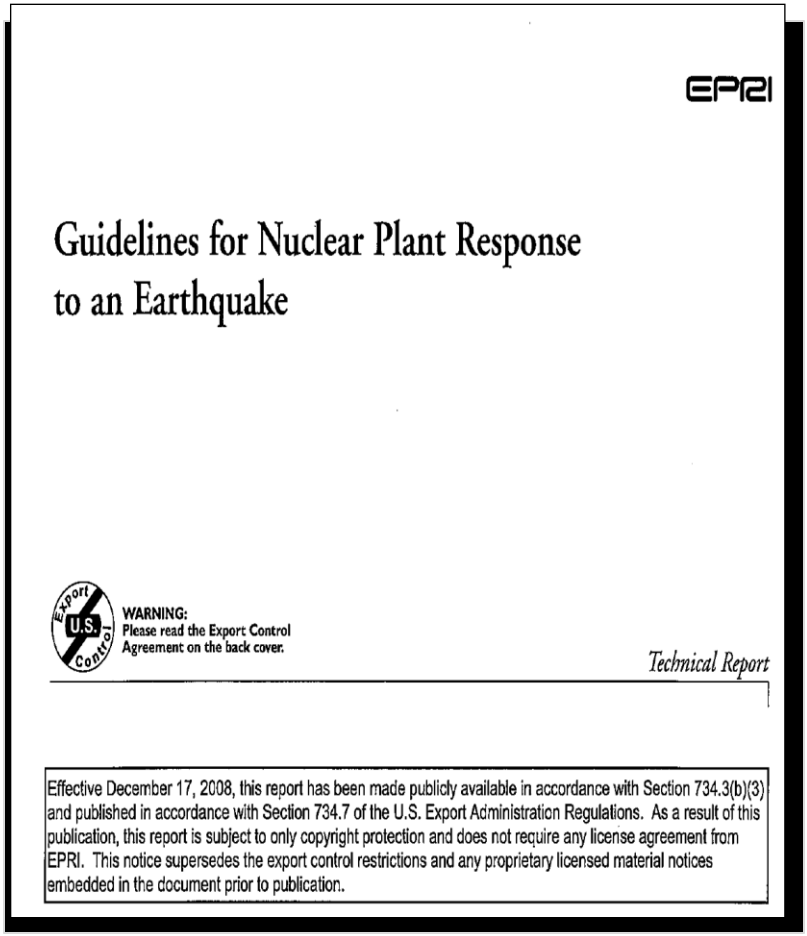
Issued guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161.

RG 1.167, *Restart of a Nuclear Power Plant Shut Down by a Seismic Event,* March 1997

Regulatory Guidance


EPRI

Guidelines for Nuclear Plant Response to an Earthquake

WARNING:
Please read the Export Control Agreement on the back cover.

Technical Report

Effective December 17, 2008, this report has been made publicly available in accordance with Section 734.3(b)(3) and published in accordance with Section 734.7 of the U.S. Export Administration Regulations. As a result of this publication, this report is subject to only copyright protection and does not require any license agreement from EPRI. This notice supersedes the export control restrictions and any proprietary licensed material notices embedded in the document prior to publication.

EPRI NP-6695,

Guidelines for Nuclear Plant Response to an Earthquake, December 1989

EPRI NP 6695 Guidance

Definition of Functional Damage:

"Significant damage to plant systems, components, and structures, either physical or other, which impairs the operability or reliability of the damaged item to perform its intended function. Minor damage such as slight or hairline cracking of concrete elements in structures does not constitute functional damage."

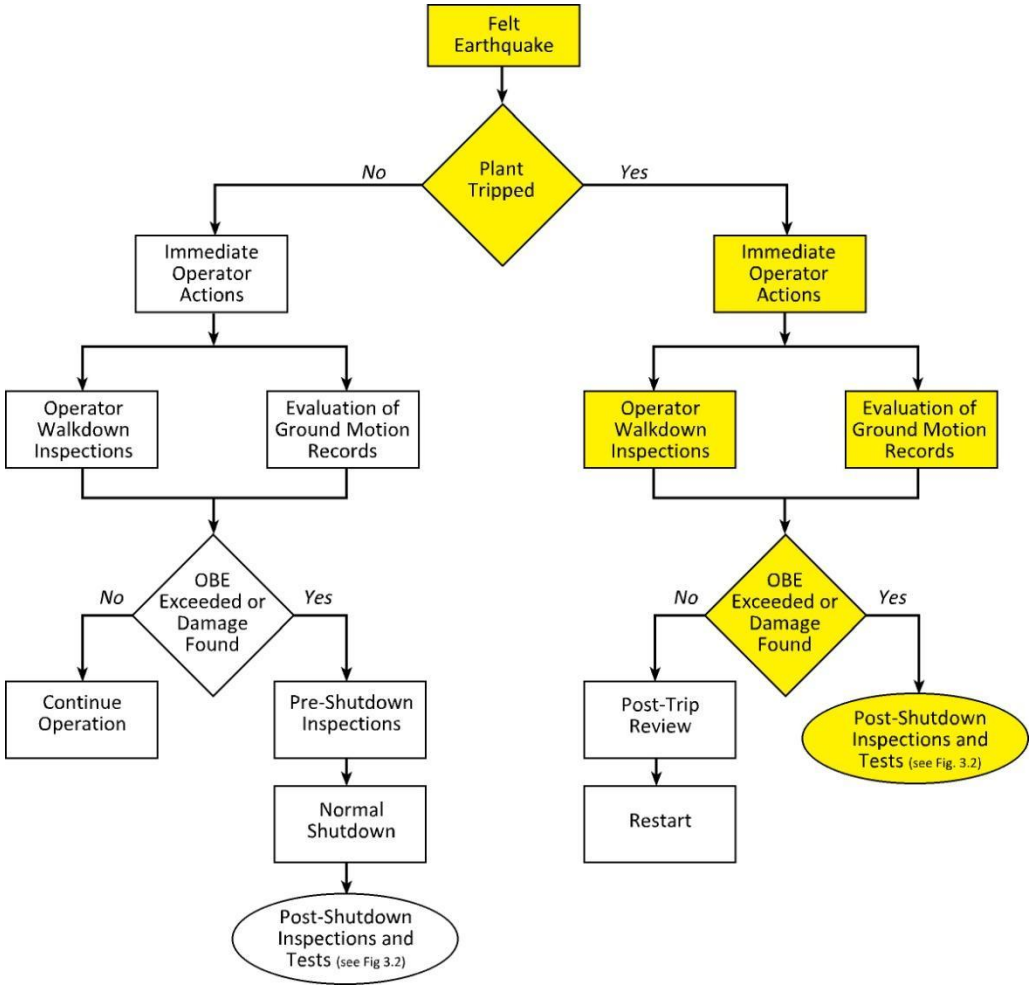
EPRI NP 6695 Guidance

Recommended actions … are based on the following concepts:

"The plant itself, not damage information from nearby communities or recorded distant ground motion, is the best indicator of the severity of the earthquake at the plant site."

EPRI NP-6695 Figure 3-1

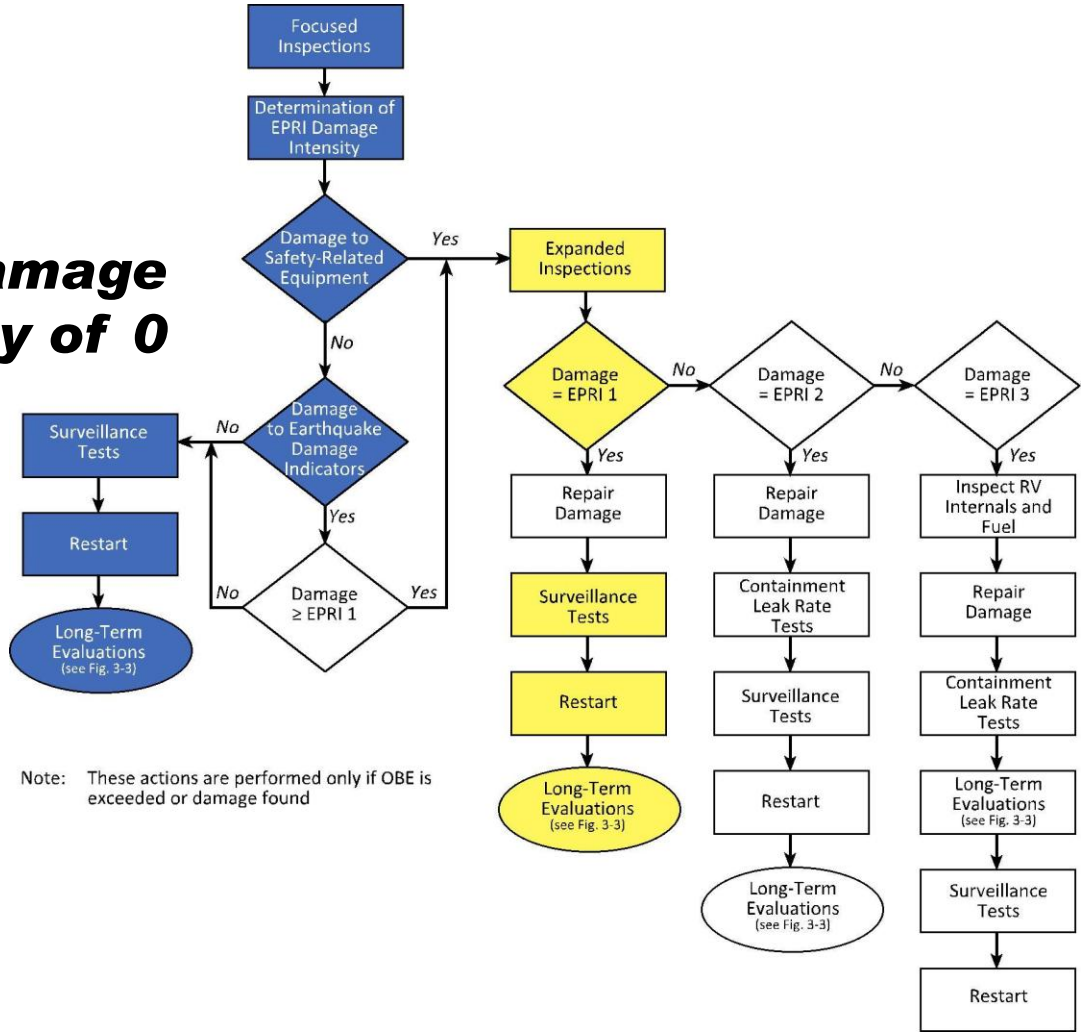
Short-Term Actions



EPRI NP-6695 Figure 3.2

Flow Diagram of Post-Shutdown Inspections and Tests

EPRI Damage Intensity of 0



Expanded Inspections

- Structural Component Inspections
- Inspections of Low HCLPF Items
- Electrical Inspections
- Hidden Damage Considerations
- Reservoir & Main Dam Inspections
- System Inspections
- Surveillance & Functional Testing
- Fuel & Vessel Internals Inspections
- ISFSI Pads and Casks

Demonstration Plan

- Conservatively Inspected Beyond EPRI Damage Intensity “0” Classification
- Assessments & Evaluations for NRC
  - Requests for Additional Information (~ 130)
  - Onsite Inspections
    - Augmented Inspection Team
    - Restart Readiness Inspection Team
- Root Cause Evaluation of Reactor Trip

Demonstration Plan

Restart Readiness Assessment:

- ✓Completion of Demonstration Plan
- ✓Review and Disposition of Open CRs Associated with Earthquake
- ✓FSRC Review/Approval of Evaluations Demonstrating SSC Operability, Functionality, and Restart Readiness

What We Inspected/Tested

Inspection Effort

Dominion Effort Expended:

• Coordination	2376 hrs
• Walk down teams	4320 hrs
• Civil inspections	3552 hrs
• Electricians	1440 hrs
• I&C Technicians	192 hrs
Total (as of Oct 9th)	~ 11880 hrs

Extensive Contractor Resources

Multiple External Consultants

Chemical Addition Tank

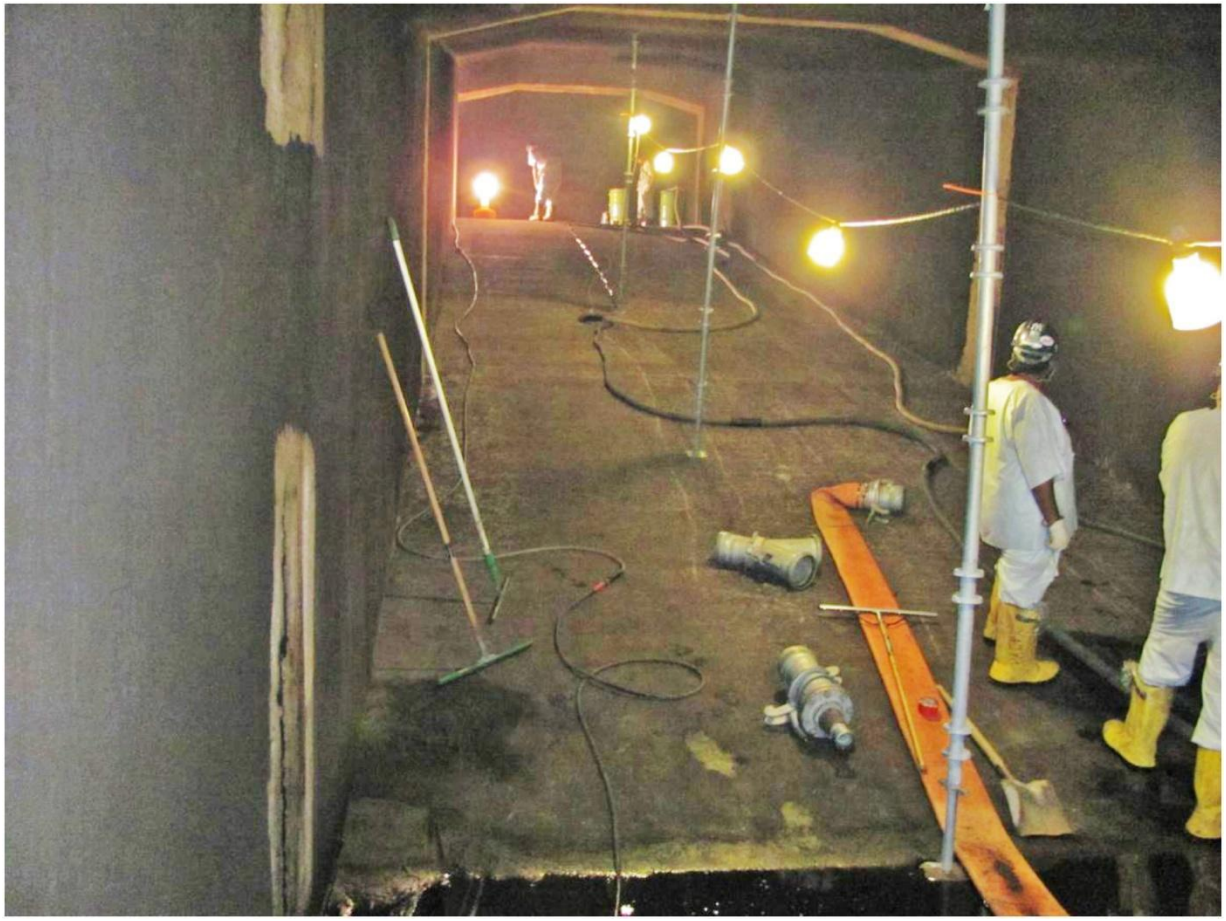
HCLPF value = 0.19

No seismic damage identified

Boric Acid Storage Tank

HCLPF value
= 0.21
No seismic
damage
identified

Circulating Water Discharge



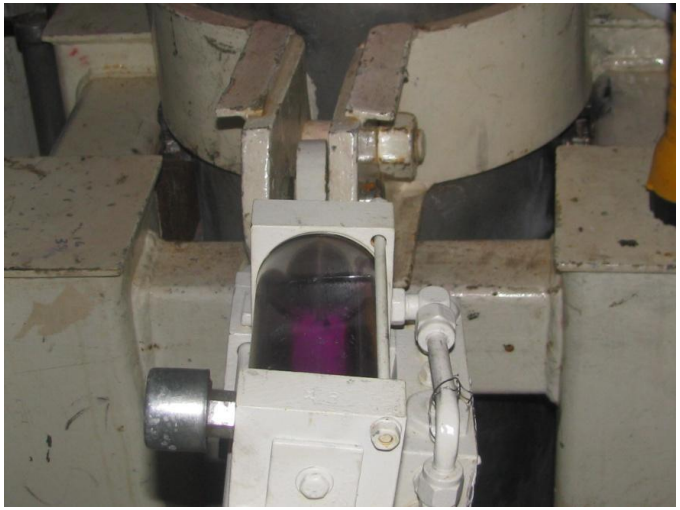
Unit 2 Tunnel Inspection

Pump In-service Test & Verification

Pump verification included assessing:

- Motor current
- Pump / motor vibration
- Pump flow
- Pump discharge pressure
- Oil analysis
- Bearing temps

Snubber Testing



Visual Inspections:

- 326 small bore Unit 1
- 362 small bore Unit 2
- 12 large bore per unit

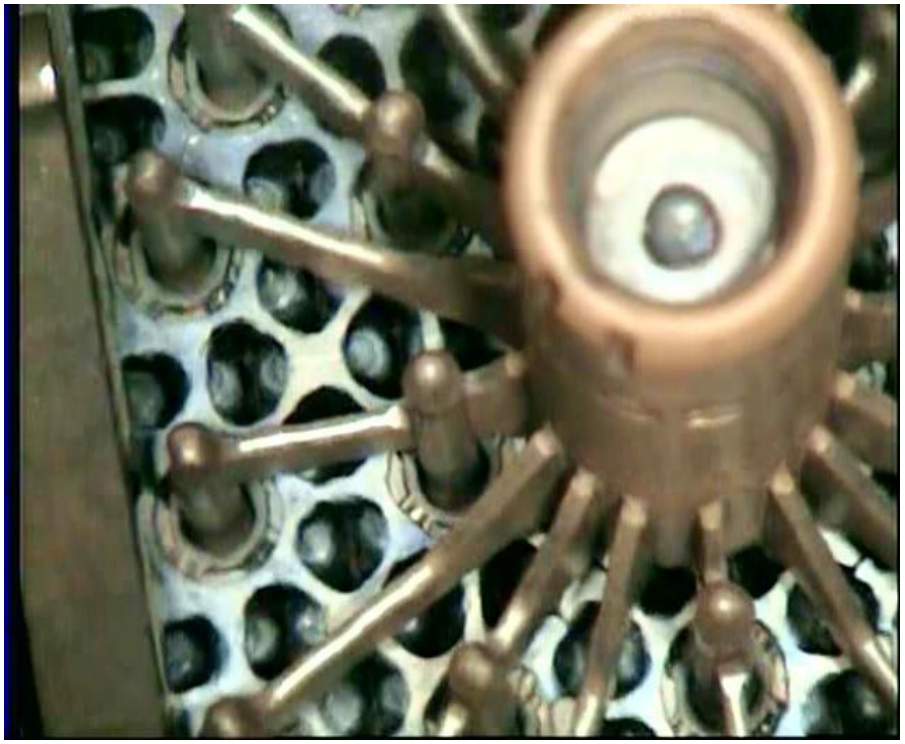
Unit 1 Functional Testing:

- 4 tested due to visual – satisfactory
- 12 additional small bore
- 2 large bore

Unit 2 Functional Testing:

- 5 tested due to visual – satisfactory
- 61 small bore for outage
- 2 large bore for outage

Fuel Inspections



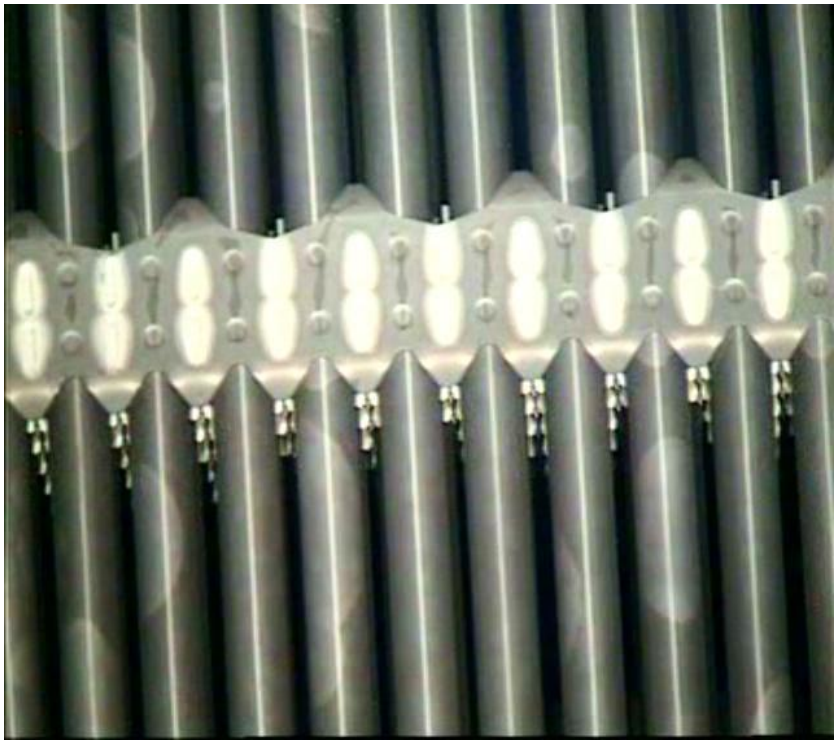
Visual inspection of RCCA hubs

Unit 2 Refueling:

Visually inspected
- 35 fuel assemblies
- 20 most seismic susceptible

RCCA drag load testing
- 48 fuel assemblies with rods from Cycle 21
- 48 assemblies with rods for Cycle 22

Fuel Inspections



Examining the underside of
a mid-span mixing grid

New Fuel Storage Area:

Visually inspected
- 18 new fuel assemblies
- 12 burnable poison assemblies

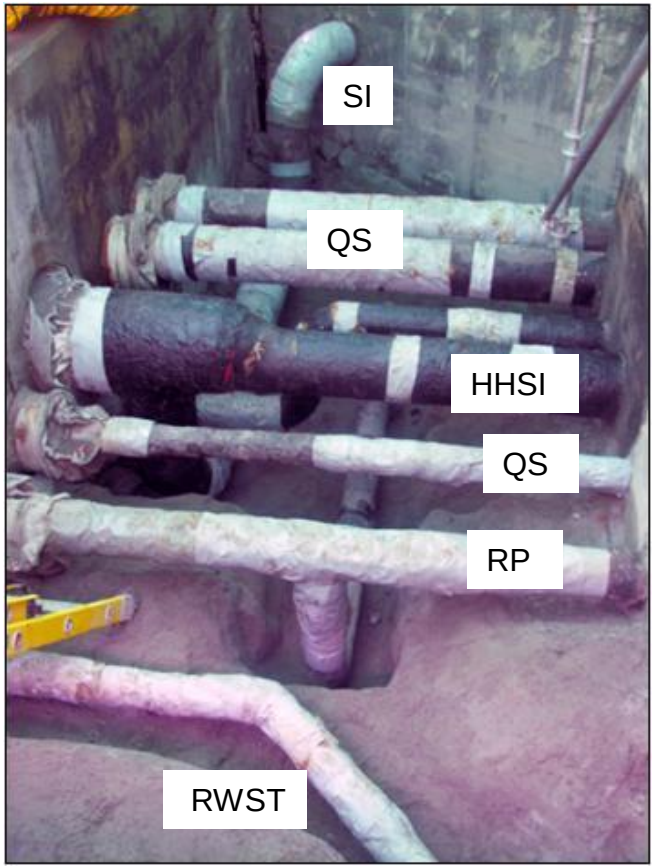
Verified self seating of
- 11 burnable poison assemblies

Measured RCCA insertion force
- 7 new fuel assemblies

Spent Fuel Pool:

Visually inspected
- 5 new fuel assemblies
- 5 burnable poison assemblies
- 10 irradiated fuel assemblies

Buried Piping



~ 100 ft of safety related buried pipe visually inspected with wall thickness verified by UT

Buried Piping

~ 50 feet of Fire Protection piping visually inspected

Steam Generator Examinations

- Unit 1 - A S/G and Unit 2 - A & C S/Gs
  - Inspected ~3300 tubes per S/G
  - Video examined channel heads
- Structural & material condition of secondary
  - Steam Drum, Feedring, & J tubes
  - Upper support plates
- No evidence of degradation due to event

NDE Inspections & Testing on Welds

Outage scheduled weld inspections

- 34 PTs conducted
- 22 PT/UTs conducted
- 38 UTs conducted
- 14 VTs conducted

Post-earthquake weld inspections

- 14 PTs at expected high stress locations
- 2 UTs of previously identified welds with embedded flaws

No seismic damage identified

Inspection Results

- ✓ 134 System inspections completed
- ✓ 141 Structure inspections completed
- ✓ 46 Low HCLPF inspections completed
- ✓ ~ 445 Surveillance Tests/unit through Mode 5
- ~ 29 tests/unit after exceeding Mode 4

Inspections Confirm EPRI Damage Intensity of “0”

Going Forward

Short-Term Actions

- ✓ Installed Temporary Free Field Seismic Monitor
- ✓ Installed Qualified UPS to Seismic Monitoring Panel in MCR
- ✓ Revised Abnormal Procedure 0-AP-36
- Complete Start-Up Surveillances

Long-Term Actions

- Install permanent free-field seismic monitoring instrumentation
- Re-evaluate safe shutdown equipment identified in IPEEE review with HCLPF capacity < 0.3g
- Commit to RG 1.166 and 1.167

Long-Term Actions

- Perform seismic analysis of recorded event consistent with EPRI NP-6695
  - Develop floor response spectra at various building levels based on recorded input motion
  - Assess new floor spectra for exceedances with design base floor spectra
  - Evaluate selected equipment based on exceedances identified with new floor spectra

Long-Term Actions

- Revise UFSAR to document:
  - Recorded event
  - Seismic analysis of recorded event
  - Design controls on seismic margin
  - Commitment to RG 1.166 and 1.167
- Perform seismic evaluation for NRC GI-199

Summary

- OBE and DBE acceleration criteria were exceeded in certain directions and for certain frequencies by a very short duration earthquake
- CAV calculations indicate that no significant damage should be expected
- Effective strong motion duration indicates no damage should be expected
- Inspections confirm an EPRI Damage Intensity of “0”

Summary

- IPEEE and A46 evaluations demonstrate safe shutdown SSCs capable of peak accelerations in excess of DBE
- No safety related SSCs have required repair due to the earthquake
- Results of expanded inspections and tests have confirmed expectations

Conclusions

Part 100, Appendix A, Requirement Met

- ✓ No Functional Damage to Safety SSCs
- ✓ No Undue Risk to Health and Safety
- ✓ Restart Readiness Demonstrated

Acronyms

CAV - Cumulative Absolute Velocity
CR – Condition Report
DBE – Design Base Earthquake
EPRI – Electric Power Research Institute
FSRC – Facility Safety Review Committee
HCLPF – High Confidence of Low Probability of Failure
IPEEE – Individual Plant Examination of External Events
MCR – Main Control Room
PT – Penetrant Test
S/G – Steam Generator
SSC – Systems, Structures and Components
RCCA – Rod Cluster Control Assembly
RG – Regulatory Guide
UPS – Uninterruptible Power Supply
UT – Ultrasonic Test
VT – Visual Test