



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, D.C. 20555-0001

October 1, 2001

MEMORANDUM TO: ACRS Members  
FROM: *Michael T. Markley*  
Michael T. Markley, Senior Staff Engineer  
ACRS  
SUBJECT: CERTIFICATION OF THE MINUTES OF THE MEETING OF THE  
ACRS SUBCOMMITTEE ON RELIABILITY AND PROBABILISTIC  
RISK ASSESSMENT - JUNE 22, 2001 - ROCKVILLE, MARYLAND

The minutes of the subject meeting, issued September 12, 2001, have been certified as the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc: via E-mail  
J. Larkins  
S. Bahadur  
H. Larson  
S. Duraiswamy  
ACRS Staff Engineers  
ACRS Fellows



UNITED STATES  
**NUCLEAR REGULATORY COMMISSION**  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, D.C. 20555-0001

MEMORANDUM TO: Michael T. Markley, Senior Staff Engineer

FROM: George E. Apostolakis, Chairman  
Reliability and Probabilistic Risk Assessment Subcommittee

SUBJECT: CERTIFICATION OF THE SUMMARY/MINUTES OF THE MEETING  
OF THE MEETING OF THE ACRS SUBCOMMITTEE ON  
RELIABILITY AND PROBABILISTIC RISK ASSESSMENT - JUNE 22,  
2001 - ROCKVILLE, MARYLAND

I do hereby certify that, to the best of my knowledge and belief, the minutes of the subject meeting on June 22, 2001, are an accurate record of the proceedings for that meeting.

   
\_\_\_\_\_  
George E. Apostolakis, Chairman      Date  
Reliability and PRA Subcommittee

CERTIFIED BY:  
G. Apostolakis - 9/21/01

Date:9/12/01

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
MEETING OF THE ACRS SUBCOMMITTEE ON  
RELIABILITY AND PROBABILISTIC RISK ASSESSMENT  
MEETING MINUTES - JUNE 22, 2001  
ROCKVILLE, MARYLAND

**INTRODUCTION**

The ACRS Subcommittee on Reliability and Probabilistic Risk Assessment met on June 22, 2001, at 11545 Rockville Pike, Rockville, MD, in Room T-2B3. The purpose of this meeting was to discuss the staff's draft NUREG-1742, Vols. 1 and 2, "Perspectives Gained From the Individual Plant Examination of External Events (IPEEE) Program," otherwise known as the "IPEEE Insights Report."

The Subcommittee received no written comments from members of the public regarding the meeting. The entire meeting was open to public attendance. Mr. Michael T. Markley was the cognizant ACRS staff engineer for this meeting. The meeting was convened at 8:30 a.m. and adjourned at 4:05 p.m.

**ATTENDEES**

ACRS Members

G. Apostolakis, Chairman	D. Powers, Member
M. Bonaca, Member	W. Shack, Member
T. Kress, Member	R. Uhrig, Member
G. Leitch, Member	M. Markley, ACRS Staff

Principal NRC Speakers

B. Harden, RES*	J. Ridgely, RES
J. Lehner, BNL*	A. Rubin, RES
S. Nowlen, SNL*	

Principal Industry Speakers

None

RES	Office of Nuclear Regulatory Research
BNL	Brookhaven National Laboratory
SNL	Sandia National Laboratories

There were approximately 3 members of the public in attendance at this meeting. A complete list of attendees is in the ACRS Office File, and will be made available upon request. The presentation slides and handouts used during the meeting are attached to the office copy of these minutes.

## **OPENING REMARKS BY THE SUBCOMMITTEE CHAIRMAN**

Dr. George Apostolakis, Chairman of the ACRS Subcommittee on Reliability and Probabilistic Risk Assessment convened the meeting at 8:30 a.m. He introduced the Subcommittee members in attendance and stated that the purpose of this meeting was to discuss the staff's draft NUREG-1742, Vols. 1 and 2, "Perspectives Gained From the Individual Plant Examination of External Events (IPEEE) Program," otherwise known as the "IPEEE Insights Report." Dr. Apostolakis noted that the Subcommittee had received no written comments from members of the public regarding the meeting.

## **DISCUSSION OF AGENDA ITEMS**

### **NRC Staff Presentation**

Messrs. Alan Rubin, RES, led the discussion for the NRC staff. Mr. John Lehner, NRC contractor from Brookhaven National Laboratories presented the IPEEE seismic perspectives. Mr. Steve Nowlen, NRC contractor from Sandia National Laboratories presented the IPEEE fire insights. Mr. Brad Hardin, RES presented the IPEEE high winds, floods, and other (HFO) external events insights. Mr. John Ridgely, RES, presented the IPEEE-related insights for unresolved safety issue (USIs) and generic safety issue (GSIs). Significant points raised during the presentation include:

- The staff requested a letter/report from the ACRS on the effectiveness of the IPEEE program in meeting the objectives of Generic Letter 88-20, Supplements 4 and 5 entitled, Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10 CFR 50.54(f). Objectives included:
  - Develop an appreciation of severe accident behavior.
  - Understand most likely severe accident vulnerabilities under full-power operating conditions.
  - Gain qualitative understanding of overall likelihood of core damage and fission product release.
  - Reduce likelihood of core damage and fission product release by modifying hardware and procedures to prevent or mitigate accidents.
- Licensees utilized the guidance provided in NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities."
- The staff review process included:
  - Initial screening reviews focused on the quality and completeness of licensee submittals.
  - Second-level reviews were conducted for some plants whose IPEEEs were poorly documented or had technical deficiencies. Some reviews typically involved site visits and discussions with cognizant licensee personnel.
  - Senior review board reviews were conducted to assess the scope and

consistency of staff IPEEE reviews and to provide additional assurance that vulnerabilities were not overlooked.

- The staff did not attempt to validate licensee quantitative analysis. The staff did, however, perform in-depth reviews for plants that appeared to be outliers relative to the general population of IPEEE submittals (e.g., Quad Cities fire analysis). The staff also performed walkdowns to address the causes of variances. In some cases licensee assumptions an analysis were found to be overly conservative while others were overly optimistic with respect to human performance.
- Almost all licensees reported that no seismic vulnerabilities were. Numerous plants identified weaknesses and anomalies and initiated improvements to address them.
- NUREG-1742 was issued for a 60-day public comment period ending July 31, 2001. The staff plans to issue its proposed final version of the subject document in October 2001.

### **SUBCOMMITTEE COMMENTS, CONCERNS, AND RECOMMENDATIONS**

The ACRS Subcommittee on Reliability and PRA met with the staff on June 22, 2001, to discuss this matter. Significant points raised by members of the Subcommittee include:

- Dr. Powers questioned the extent the extent to which NUREG-1742 met the objectives of providing insights for use by the industry and staff since most insights appear to be qualitative. The staff state that they believed that the objectives of Generic Letter 88-20, Supplements 4 and 5 were met. The staff also stated that one must examine the content of the technical evaluations as numbers only represent one piece of the picture.
- Mr. Leitch questioned the extent to which licensees learned from each other's experience in making hardware and other plant changes in response to IPEEEs and GSIs. Dr. Bonaca questioned whether vulnerabilities, e.g., fire, were shared from plant-to-plant and/or sister-plants. He suggested that utilities could benefit from these changes. The staff stated that much was learned from the vulnerabilities identified at Quad Cities Nuclear Power Station. The staff stated that their effort focused mostly on better understanding IPEEE outliers such as Quad Cities (very conservative) and Susquehanna (non-conservative). The staff noted that, although not all plants identified vulnerabilities, about 70% of licensees made plant improvements based on their analysis.
- Drs. Powers questioned the use of simplified seismic fragility curves as compared with actual earthquakes. Dr. Kress noted that nearly all licensees used the Electric Power Research Institute (EPRI) seismicity hazard curves. The staff noted that only two licensees used the NRC seismic margins analysis (SMA) approach and reiterated that licensees used guidance provided in NUREG-1407. The staff's contractor stated that it does not make much difference which methodology is used, the results are similar.
- Dr. Apostolakis noted that SMA does not provide results in terms of core damage frequency (CDF). Thus, there is a limit for the use of Regulatory Guide 1.174 in decision making. Dr. Apostolakis suggested that two options are available: 1) go back and state

that Regulatory Guide 1.174 does not apply, or 2) make the IPEEE a better product. He further questioned how much effort is required to bring an SMA closer to a PRA-type analysis. The staff stated that Generic Letter was issued more than 10 years ago and suggested that it would be unrealistic to apply new expectations to what was requested of licensees for that request.

- Dr. Powers questioned how 61 licensees resolved concerns related to common-cause failures when only 6 were considered to have provided adequate information. He requested the staff to provide an example illustrating an acceptable submittal during the full ACRS meeting. The staff agreed but also provided supplemental information later during the Subcommittee meeting.
- Mr. Leitch questioned the extent to which licensee analysis reflects actual conditions in plants and cited the incident at San Onofre involving missing fire barriers. The staff stated they were unaware of the San Onofre incident but acknowledged that human performance is a very difficult issue. Dr. Apostolakis discussed the issue of human error probabilities and suggested that there should be some discussion of the sequences. Dr. Powers requested and the staff agreed to provide copies of the requests for additional information associated with the Waterford Nuclear Power Plant submittal.

#### **STAFF AND INDUSTRY COMMITMENTS**

Dr. Apostolakis requested the staff to elaborate on the NRR suggestion that the time spent in risk significant conditions be evaluated as a function of plant outage time. Likewise, Dr. Kress expressed reservation over this method of risk evaluation. The staff agreed to discuss the analysis that supports this suggestion during the May 2001 ACRS meeting. Dr. Apostolakis requested and the staff agreed to provide a more meaningful discussion of Appendix F, "Statistical Methods and Results," during the May 2001 ACRS meeting.

#### **SUBCOMMITTEE DECISIONS**

At the conclusion of the meeting, the Subcommittee expressed mixed opinions regarding the need to prepare a report during the July 11-13, 2001 ACRS meeting. Dr. Powers stated that it may be worthwhile to think in terms of two letters: an interim letter on the adequacy of NUREG-1742 in meeting GL 88-20 and later report on GSI closure credited to the IPEEE Insights Report. Dr. Bonaca agreed. Dr. Kress stated that the letter should go beyond the GL and address issues such as research needs that may have been realized and the fact that plant age does not seem to make any difference in the results. He expressed concern over vulnerability of older plants. Drs. Apostolakis and Shack suggested that a report may be appropriate when the staff reconciles public comments in a proposed final version of NUREG-1742. Mr. Leitch expressed the desire to better understand what actual plant changes were made as a result of the IPEEEs, separate from the report.

## **FOLLOW-UP ACTIONS**

Dr. Apostolakis requested ACRS staff engineer, Michael Markley to obtain copies of NUREG-1407, Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities, for consideration by the Committee during the July 11-13, 2001 ACRS meeting. NUREG-1407 was forwarded to the Committee on June 29, 2001.

## **BACKGROUND MATERIALS PROVIDED TO THE SUBCOMMITTEE PRIOR TO THIS MEETING**

1. Subcommittee agenda.
2. Subcommittee status report.
3. U. S. Nuclear Regulatory Commission, NUREG-1742, Vols. 1 and 2, "Perspectives Gained From the Individual Plant Examination of External Events (IPEEE) Program," Draft Report for Public Comment, April 2001.
4. U.S. Nuclear Regulatory Commission, NRC Generic Letter No. 88-20, Supplement 4, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10 CFR 50.54(f)," dated June 28, 1991.
5. U. S. Nuclear Regulatory Commission, NRC Generic Letter No. 88-20, Supplement 5, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10 CFR 50.54(f)," dated September 8, 1995.
6. Report dated June 6, 1996, from T. S. Kress, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: Potential Use of IPE/IPEEE Results to Compare the Risk of the Current Population of Plants With the Safety Goals.
7. Report dated March 8, 1996, from T.S. Kress, Chairman, Advisory Committee on Reactor Safeguards, to Shirley Ann Jackson, Chairman, NRC, Subject: Use of Individual Plant Examinations in the Regulatory Process.
8. U.S. Nuclear Regulatory Commission, NUREG-1635, Vol. 4, "Review and Evaluation of the Nuclear Regulatory Commission Safety Research Program," May 2001.

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Note: Additional details of this meeting can be obtained from a transcript of this meeting available for downloading or viewing on the Internet at "<http://www.nrc.gov/ACRSACNW>" or can be purchased from Neal R. Gross and Co., Inc., (Court Reporters and Transcribers) 1323 Rhode Island Avenue, N.W., Washington, DC 20005 (202) 234-4433.

REVISED 6/21/01

**ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
MEETING OF THE SUBCOMMITTEE ON  
RELIABILITY AND PROBABILISTIC RISK ASSESSMENT  
ROOM T-2B3, 11545 ROCKVILLE PIKE, ROCKVILLE, MD  
JUNE 22, 2000**

ACRS Contact: Michael T. Markley (301) 415-6885  
E-mail: mtm@nrc.gov

**- PROPOSED SCHEDULE -**

	<u>TOPIC</u>	<u>PRESENTER</u>	<u>TIME</u>
1)	<b>Introduction</b>		8:30-8:35 am
•	Review goals and objectives for this meeting; past ACRS deliberations on Generic Letter 88-20, Supplement 4 concerning Individual Plant Examination of External Events (IPEEE)	George Apostolakis, ACRS	
2)	<b>NRC Staff Presentation</b>		8:35-10:30 am
•	Introduction and overview of draft NUREG-1742, Perspectives Gained from the IPEEE Program	Alan Rubin, RES (835-900am)	
•	Seismic Insights	John Lehner, BNL (900-1025am)	
	<b>** BREAK **</b> <i>continued</i>		<sup>25</sup> <del>10:30-10:45 am</del> (1045-1145 am)
3)	<b>NRC Staff Presentation - continued</b>		<del>10:30-12:30 pm</del> 11:45-12:15 pm
•	Fire Insights	Steve Nowlen, <sup>S</sup> BNL	
	<b>** LUNCH **</b>		12:15-1:15 pm 12:30-1:30 pm
4)	<b>NRC Staff Presentation - continued</b> <i>continued</i>	(125-220 pm)	4:30-3:00 pm
•	High Winds, Floods, and Other External Events	Brad Harden, RES (220-250 pm)	
•	IPEEE-Related Unresolved Safety Issue (USI) and Generic Safety Issue (GSI) Resolution	John Ridgely, RES (250-345 pm)	
•	Closing Remarks	Alan Rubin, RES (3145 - <del>3:00</del> <sup>4:00 pm</sup> )	



~~\*\* BREAK \*\*~~

~~3:00-3:15 pm~~

5) **General Discussion and Adjournment**

~~3:15-3:30 pm~~  
4:05

- General discussion and comments by Members of the Subcommittee; items for June 6-8, 2000 ACRS meeting George Apostolakis, ACRS

**Note: Presentation time should not exceed 50% of the total time allocated for a specific item. Number of copies of presentation materials to be provided to the ACRS - 35.**

The entire meeting will be open to public attendance, with the exception of a portion that may be closed pursuant to 5 U.S.C. 552b(c) (2) and (6) to discuss organizational and personnel matters that relate solely to internal personnel rules and practices of ACRS, and information the release of which would constitute a clearly unwarranted invasion of personal privacy.

The agenda for the subject meeting shall be as follows:

*Wednesday, June 6, 2001—12:15 p.m. Until 1:00 p.m.*

The Subcommittee will discuss proposed ACRS activities and related matters. The purpose of this meeting is to gather information, analyze relevant issues and facts, and to formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Oral statements may be presented by members of the public with the concurrence of the Subcommittee Chairman; written statements will be accepted and made available to the Committee. Electronic recordings will be permitted only during those portions of the meeting that are open to the public, and questions may be asked only by members of the Subcommittee, its consultants, and staff. Persons desiring to make oral statements should notify the cognizant ACRS staff person named below five days prior to the meeting, if possible, so that appropriate arrangements can be made.

Further information regarding topics to be discussed, the scheduling of sessions open to the public, whether the meeting has been canceled or rescheduled, the Chairman's ruling on requests for the opportunity to present oral statements, and the time allotted therefor can be obtained by contacting the cognizant ACRS staff person, Dr. John T. Larkins (telephone: 301/415-7360) between 7:30 a.m. and 4:15 p.m. (EDT). Persons planning to attend this meeting are urged to contact the above named individual one or two working days prior to the meeting to be advised of any changes in schedule, etc., that may have occurred.

Dated: May 15, 2001.

**James E. Lyons,**

*Associate Director for Technical Support ACRS/ACNW.*

[FR Doc. 01-13017 Filed 5-22-01; 8:45 am]

BILLING CODE 7590-01-P

## NUCLEAR REGULATORY COMMISSION

### Advisory Committee on Reactor Safeguards; Meeting of the ACRS Subcommittee on Reliability and Probabilistic Risk Assessment; Notice of Meeting

The ACRS Subcommittee on Reliability and Probabilistic Risk Assessment will hold a meeting on June 22, 2001, Room T-2B3, 11545 Rockville Pike, Rockville, Maryland.

The entire meeting will be open to public attendance.

The agenda for the subject meeting shall be as follows:

*Friday, June 22, 2001—8:30 a.m. until 12 p.m.*

The Subcommittee will review the staff's draft Individual Plant Examination of External Events (IPEEE) Insight Report (draft NUREG-1742). The purpose of this meeting is to gather information, analyze relevant issues and facts, and to formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Oral statements may be presented by members of the public with the concurrence of the Subcommittee Chairman; written statements will be accepted and made available to the Committee. Electronic recordings will be permitted only during those portions of the meeting that are open to the public, and questions may be asked only by members of the Subcommittee, its consultants, and staff. Persons desiring to make oral statements should notify the cognizant ACRS staff engineer named below five days prior to the meeting, if possible, so that appropriate arrangements can be made.

During the initial portion of the meeting, the Subcommittee, along with any of its consultants who may be present, may exchange preliminary views regarding matters to be considered during the balance of the meeting.

The Subcommittee will then hear presentations by and hold discussions with representatives of the NRC staff, and other interested persons regarding this review.

Further information regarding topics to be discussed, whether the meeting has been canceled or rescheduled, and the Chairman's ruling on requests for the opportunity to present oral statements and the time allotted therefor can be obtained by contacting the cognizant ACRS staff engineer, Mr. Michael T. Markley (telephone 301/415-6885) between 7:30 a.m. and 4:15 p.m. (EDT). Persons planning to attend this meeting are urged to contact the

above named individual one or two working days prior to the meeting to be advised of any potential changes to the agenda, etc., that may have occurred.

Dated: May 17, 2001.

**James E. Lyons,**

*Associate Director for Technical Support, ACRS/ACNW.*

[FR Doc. 01-13018 Filed 5-22-01; 8:45 am]

BILLING CODE 7590-01-P

## POSTAL SERVICE

### Changes in Domestic Rates and Fees on Modification

**AGENCY:** Postal Service.

**ACTION:** Notice of implementation of changes to domestic rates and fees.

**SUMMARY:** This notice sets forth the changes to domestic rates and fees to be implemented as a result of the Decision of the Governors of the United States Postal Service on the Recommended Decision on Further Reconsideration of the Postal Rate Commission on Postal Rate and Fee Changes, Docket No. R2000-1, dated May 7, 2001.

**EFFECTIVE DATE:** July 1, 2001.

**FOR FURTHER INFORMATION CONTACT:**

Daniel J. Foucheaux, Jr., (202) 268-2989.

**SUPPLEMENTARY INFORMATION:** On January 12, 2000, pursuant to its authority under 39 U.S.C. 3621, *et seq.*, the Postal Service filed with the Postal Rate Commission (PRC) a Request for a Recommended Decision on Proposed Changes in Rates of Postage and Fees for Postal Services (Request). The PRC designated the filing as Docket No. R2000-1. On November 13, 2000, pursuant to its authority under 39 U.S.C. 3624, the PRC issued its Recommended Decision on the Postal Service's Request to the Governors of the Postal Service.

Pursuant to 39 U.S.C. 3625, the Governors of the United States Postal Service acted on the PRC's recommendations on December 4, 2000. In one decision, the Governors rejected the PRC's recommendations regarding Courtesy Envelope Mail, Information-Based Inidicia Program Mail, a flat-rate envelope for Priority Mail, and maximum weight figures for Standard Mail letters and breakpoint figures for Standard Mail. Decision of the Governors of the United States Postal Service on the Recommended Decision of the Postal Rate Commission on Selected Mail Classification Matters, Docket No. R2000-1. In the second decision, the Governors acted on the remainder of the PRC's recommendations. Decision of the







**United States Nuclear Regulatory Commission**

**PERSPECTIVES GAINED FROM  
INDIVIDUAL PLANT EXAMINATION OF EXTERNAL  
EVENTS (IPEEE) PROGRAM**

**by**

**A. Rubin, B. Hardin, J. Ridgely  
Probabilistic Risk Analysis Branch, RES  
J. Lehner, Brookhaven National Laboratory  
S. Nowlen, Sandia National Laboratories**

**Presentation to ACRS Subcommittee on Reliability and  
Probabilistic Risk Assessment**

**June 22, 2001**

# **OUTLINE OF PRESENTATION**

- **Introduction**
  - **Background/status**
  - **IPEEE objectives**
  - **Submittal review process**
  - **IPEEE insights report**
- **IPEEE seismic perspectives**
- **IPEEE fire perspectives**
- **High winds, floods and other (HFO) external events**
- **IPEEE-related generic safety issues (GSIs/USI)**
- **Uses of IPEEE information**
- **Conclusions and observations**

# **IPEEE PROGRAM - BACKGROUND**

- **Generic Letter 88-20, Supplement 4 with guidance (NUREG-1407), issued on June 28, 1991, requested all licensees to perform an IPEEE to identify plant-specific vulnerabilities to severe accidents caused by external events.**
  
- **External events included in IPEEE program**
  - **Seismic events**
  
  - **Internal fires**
  
  - **High winds and tornadoes**
  
  - **External floods**
  
  - **Transportation and nearby facility accidents**

# **IPEEE PROGRAM - STATUS**

- **Preliminary IPEEE report sent to Commission (Jan. 1998)**
- **Five presentations to ACRS (Jan. 1998 - Sept. 1999)**
- **Completed reviews of IPEEE submittals for all operating nuclear plants and issued plant-specific SERs (May 2001)**
- **Draft NUREG-1742, "Perspectives Gained From the Individual Plant Examination of External Events (IPEEE) Program," issued for public comment (April 2001)**
- **Comment period ends (July 31, 2001)**
- **Issue final NUREG-1742 (October 2001)**



# OBJECTIVES OF IPEEE PROGRAM

- **Develop an appreciation of severe accident behavior**
- **Understand the most likely severe accident sequences that could occur at nuclear plants under full-power operating conditions**
- **Gain a qualitative understanding of the overall likelihood of core damage and fission product release**
- **Reduce, if necessary, the overall likelihood of core damage and fission product releases by modifying, where appropriate, hardware and procedures that would help prevent or mitigate severe accidents**

← Voluntary

# IPEEE REVIEWS

- **IPEEE submittals reviewed to determine whether licensee met intent of Generic Letter (i.e., achieved IPEEE objectives, followed NUREG-1407 guidance)**
- **IPEEE review process**
  - **Initial Screening Reviews**  
**Focused on quality and completeness of the submittals**
  - **Second Level Review of Selected Plants**  
**Additional reviews (i.e., site visits) performed for some IPEEEs which were poorly documented or had technical deficiencies**
- **Senior Review Board**
  - **Comprised of NRC staff and contractors with PRA/external events expertise**
  - **Provided technical advice on scope/consistency of IPEEE reviews**
  - **Additional assurance that vulnerabilities were not overlooked**

# IPEEE INSIGHTS REPORT

- **Provide information and perspectives to NRC, industry, and public**
  - **Description of overall IPEEE process and findings (seismic/fire/HFO events)**
  - **Identified vulnerabilities**
  - **Quantitative findings (e.g., ranges of CDF estimates) and dominant contributors to plant risk**
  - **Plant modifications and improvements**
  - **Overall strengths and weaknesses in implementation of various methods, models and assumptions**
  - **Resolution of external-event-related Generic/Unresolved Safety Issues**
  - **Plant-specific data base of IPEEE-related information**
  - **Success in meeting intent of objectives in Supplement 4 to GL 88-20**
  - **Examples of uses of IPEEE information for NRC and industry activities**

# **IPEEE Seismic Perspectives**

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**by**

**J. Lehner, CC Lin, J. Xu, R. Morante  
Brookhaven National Laboratory**

**Presentation to  
ACRS Subcommittee on Risk and Reliability  
June 22, 2001**

**Brookhaven Science Associates  
U.S. Department of Energy**

**BROOKHAVEN**  
NATIONAL LABORATORY

# OUTLINE

- **Introduction and Background**
- **Vulnerabilities and Plant Improvements**
- **Seismic Analyses Perspectives**
  - Common Elements to Analyses
  - Seismic Probabilistic Risk Assessment (SPRA) Perspectives
  - Seismic Margin Analysis (SMA) Perspectives
- **Methodology Perspectives**
- **Conclusions**

# INTRODUCTION

## Objectives of Seismic Insights

- Description of the overall seismic IPEEE process, findings, and impacts
- Overview of plant improvements related to the seismic portion of the IPEEE program
- Identification and assessment of the impacts of site-specific seismic hazards, plant-specific design and operational features, and modeling and screening
- Description of the overall strengths and weaknesses of IPEEE seismic evaluation methodologies, including the implications of assumptions made
- Summary of the extent to which the licensees have met the intent of Supplement 4 to GL 88-20 as it pertains to seismic analyses

**The seismic insights program did not attempt to validate the results of the licensees' submittals.**

# **BACKGROUND**

## **Regulatory basis for seismic design of NPPs:**

- 10 CFR Part 50, Appendix A, GDC 2: requirements for protection against natural phenomena
- 10 CFR Part 100, Appendix A: codified concept of Safe Shutdown Earthquake (SSE)
- Standard Review Plan, Numerous Regulatory Guides

## **Important seismic related programs undertaken by NRC and industry:**

- Systematic Evaluation Program (SEP)
- Inspection and Enforcement Bulletin (IEB) 80-11
- EUS Seismicity Issue (Charleston Earthquake Issue)
- Unresolved Safety Issue A-46

## **Individual Plant Examination for External Events - Seismic Hazard**

# **SEISMIC ANALYSIS METHODS USED IN THE IPEEES**

**Guidance provided in NUREG-1407 and Supplements 4 and 5 to GL 88-20 for two acceptable methodologies, both include:**

- Comprehensive walkdown of plant
- Capability to identify vulnerabilities
- Qualitative containment performance analysis

## **1. Seismic Probabilistic Risk Assessment (SPRA)**

Seismic CDF, dominant contributors, probabilistic plant capacity (fragility curve)

## **2. Seismic Margin Analysis (SMA)**

High confidence of low probability of failure (HCLPF) capacity of each critical system, structure and component (SSC); overall plant capacity

NRC SMA: event tree/fault tree approach to estimate plant HCLPF

EPRI SMA: success path approach to estimate plant HCLPF



## SEISMIC ANALYSIS METHODS (Continued)

NUREG-1407 relates scope of seismic analysis to seismic hazard associated with plant site

Acceptable “minimum” methodologies, in order of increasing hazard are:

- Reduced Scope SMA: SSCs evaluated against safe shutdown earthquake (SSE)
- Focused Scope SMA: SSCs evaluated against review level earthquake (RLE) (usually 0.3g), relay evaluation, soil failure evaluation
- Full Scope SMA: SSCs evaluated against RLE, detailed relay evaluation, full soil failure evaluation
- Seismic PRA

## SEISMIC ANALYSIS METHODS (Continued)

**Actual Methods Used in IPEEEs**

<b>NUREG-1407 Minimum Bins (No. of Plants)</b>	Plant Specific	Reduced Scope	Focused Scope	Full Scope	SPRA
Reduced Scope (10)	2	7			1
Focused Scope (49)		3	29 <sup>1</sup>		18 <sup>1</sup>
Full Scope (8)				4	4
SPRA (4)					4
<i>Total (71)</i>	2	10	29	4	27

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<sup>1</sup> One plant performed both a Focused Scope SMA and an SPRA

# VULNERABILITIES

## **What constituted a vulnerability?**

- Definitions of a seismic vulnerability varied widely
- Many licensees did not define vulnerability but stated they had none
- Some avoided the term altogether

## **Almost all licensees reported no seismic vulnerabilities**

- Of the 71 plants with seismic IPEEE submittals, 45 plants were also USI A-46 plants
- Numerous seismic weaknesses were identified and rectified under the A-46 program

## **Most licensees did identify ‘anomalies’, ‘outliers’, or ‘open issues’**

- Most licensees identified some IPEEE related improvements to enhance the seismic ruggedness of their plants

## IMPROVEMENTS

Improvements in hardware, maintenance/housekeeping, and procedures/training

Not all improvements credited in the analyses were already implemented. Some were still being planned or under consideration

<i>Type of Improvement</i>	<i>Examples</i>	<i>Number of Plants Reporting This Type of Improvement</i>
Hardware	adding or strengthening anchorage or support; connecting cabinets, panels or racks; eliminating spatial interaction; eliminating relay chatter; reinforcement of masonry walls; fixing control room ceilings and fixtures	43
Maintenance/ Housekeeping	improving conduct of maintenance/maintenance training; new housekeeping standards; corrective action for loose or missing fasteners; restraint of gas bottles, scaffolding, ladders, etc.	32
Procedures/ Training	addition of new seismic procedures; added training; added simulator drills	11
No IPEEE Related Improvements	NA	20

## ELEMENTS COMMON TO ALL SEISMIC IPEEES

- Screening** SSCs screened based on seismic capacity and importance to safety, criteria varied, usually based on RLE g level, and applied EPRI NP-6041 criteria, most SPRAs screened out majority of components
- Walkdowns** Included (1) determining seismic capacity versus seismic demand, (2) looking for outliers based on earthquake experience and generic testing data bases, (3) checking anchorage, and (4) identifying seismic spatial interaction concerns  
Significant product of IPEEE process, led to many of the insights gained by licensees, i.e., identification of outliers and anomalous conditions
- Identification of dominant contributors (SPRA) or weak links (SMA)** (discussed below)
- Relay evaluation** Few significant low ruggedness relays were identified solely as a result of the IPEEE program since important low ruggedness relays were typically fixed under the A-46 program
- Soil evaluation** Consideration depended on type of site and analysis level assigned in NUREG-1407  
Soil analyses concerns included: (1) the potential for, and effects of, liquefaction, (2) slope instability, (3) settlement, (4) displacement, and (5) stresses in buried piping  
Currently no general recommendations (or even a consensus) on the best approach to estimating liquefaction-induced soil displacement

## **ELEMENTS COMMON TO ALL SEISMIC IPEEES (Continued)**

### **Non-seismic failures and human actions**

In SPRAs included in event tree and fault tree models; for human actions used wide variety of approaches

In SMAs timing and location of human actions reported, along with qualitative comments on their reliability

### **Seismic fire and seismic flood**

Evaluation included seismically initiated fires, seismic actuation of fire suppression system; degradation of fire suppression system from seismic events

Evaluations revealed a number of concerns and in some cases resulted in significant plant improvements

### **Containment performance**

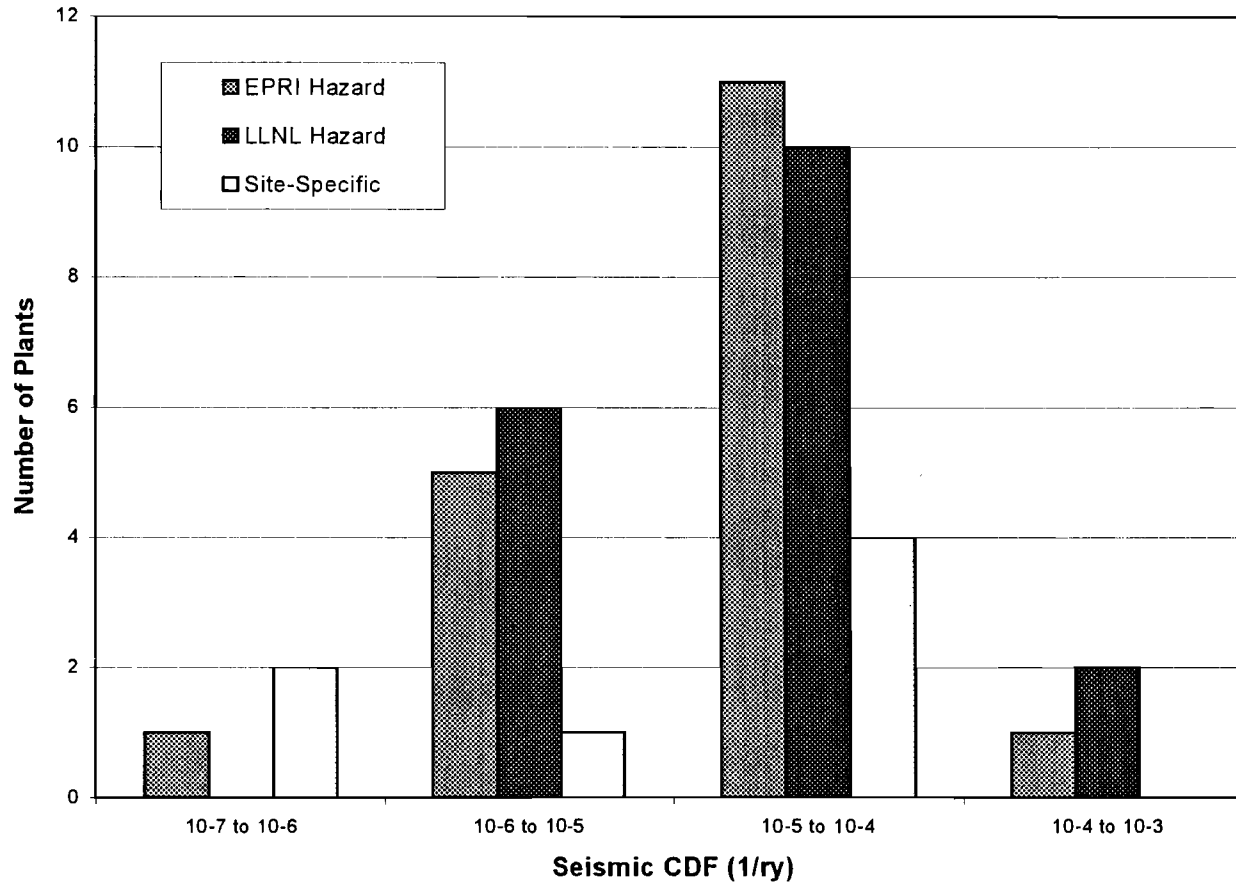
Most assessments only qualitative for integrity, isolation, bypass;

A few SPRAs performed a level 2 PRA, LERF varied from  $1E-7$  to  $1.6E-5/ry$

### **Independent peer review**

All IPEEES had such a review to ensure overall quality and to confirm that the IPEEE conformed with GL 88-20 Supplement 4

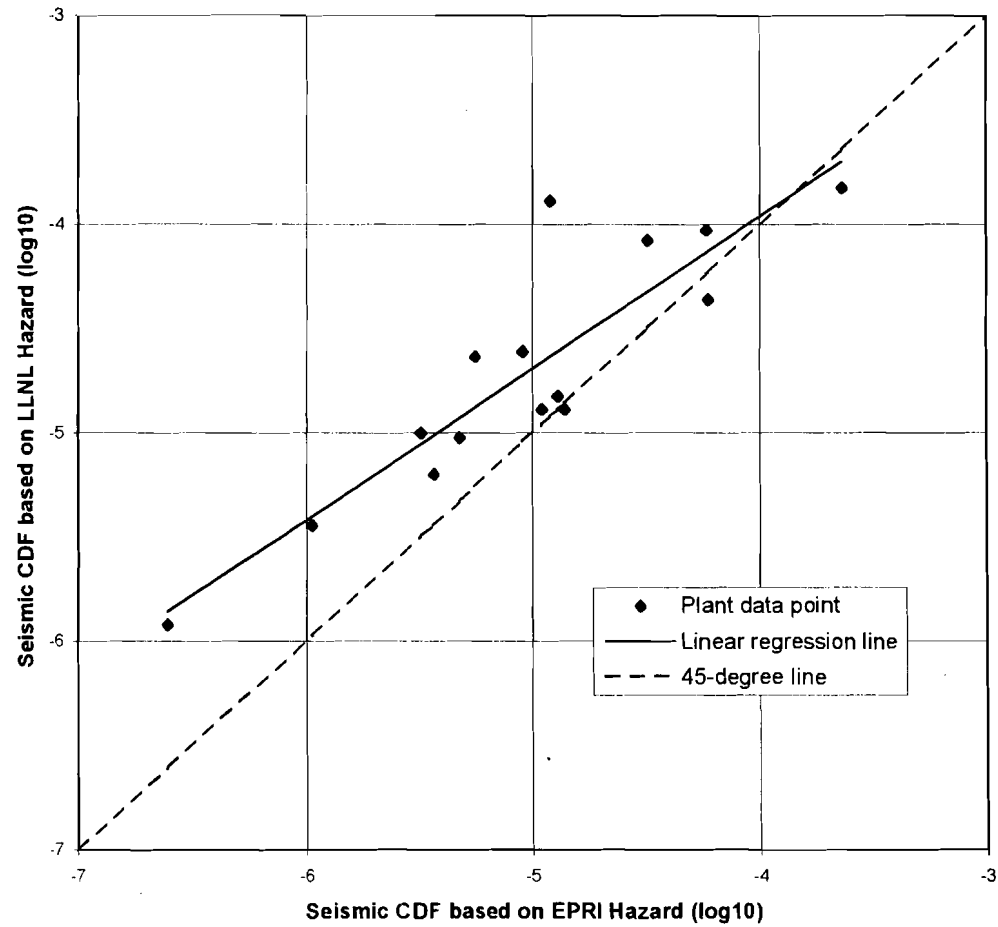
# SPRA RESULTS



(15 plants used both EPRI and LLNL seismic hazard data)

## Distribution of Seismic CDFs

# SPRA RESULTS



Comparison of CDF based on EPRI vs. LLNL hazard



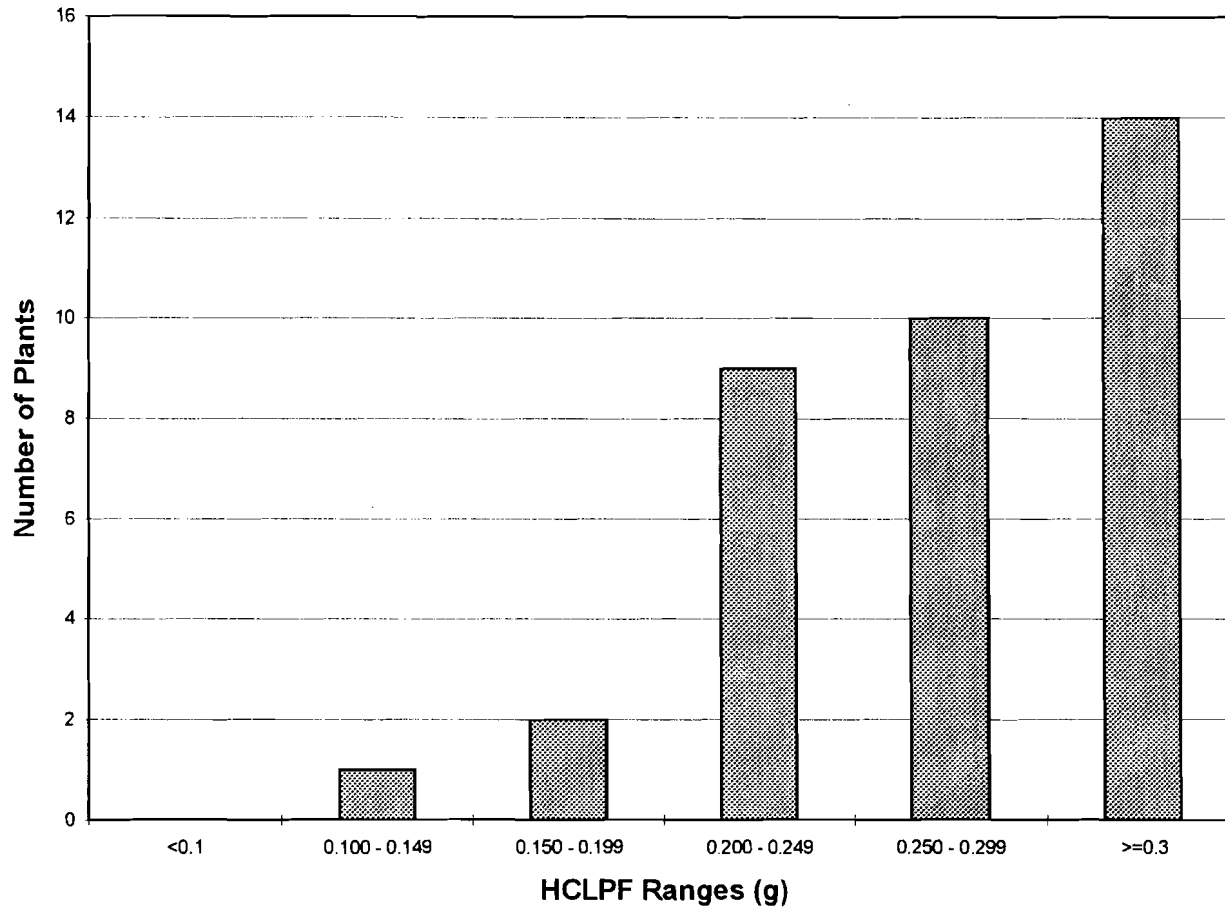
## DOMINANT CONTRIBUTORS FROM SPRAs

Seismic Failures	Random Failures	Operator Action Errors
<p><i>Most Frequently Observed</i></p> <ul style="list-style-type: none"> <li>• Offsite power</li> <li>• Electrical system components (panels, MCCs, load centers, switchgear, etc.)</li> <li>• Emergency diesel generators (EDG failure due to failure of EDG or components such as battery, oil tank, control panel, cooler, etc.)</li> <li>• Surrogate elements</li> <li>• DC batteries (due to failure of battery, fans, inverters)</li> </ul> <p><i>Frequently Observed</i></p> <ul style="list-style-type: none"> <li>• Auxiliary building</li> <li>• Block walls</li> <li>• Service water system</li> <li>• Turbine building</li> <li>• CCW system</li> <li>• CST</li> <li>• Pump house/pump intake structure</li> <li>• Control building/room</li> <li>• Auxiliary feedwater system</li> <li>• RHR System</li> </ul>	<p><i>Most Frequently Observed</i></p> <ul style="list-style-type: none"> <li>• Diesel generators</li> </ul> <p><i>Frequently Observed</i></p> <ul style="list-style-type: none"> <li>• Relief valves</li> <li>• Auxiliary feedwater pumps</li> <li>• Long term heat removal</li> </ul>	<p><i>Most Frequently Observed</i></p> <ul style="list-style-type: none"> <li>• Align for AFW flow</li> </ul> <p><i>Frequently Observed</i></p> <ul style="list-style-type: none"> <li>• Initiate cooling/recirculation</li> <li>• Diesel generator operation</li> <li>• Station units cross-tie</li> <li>• Reset relays</li> </ul>

## SPRA INSIGHTS

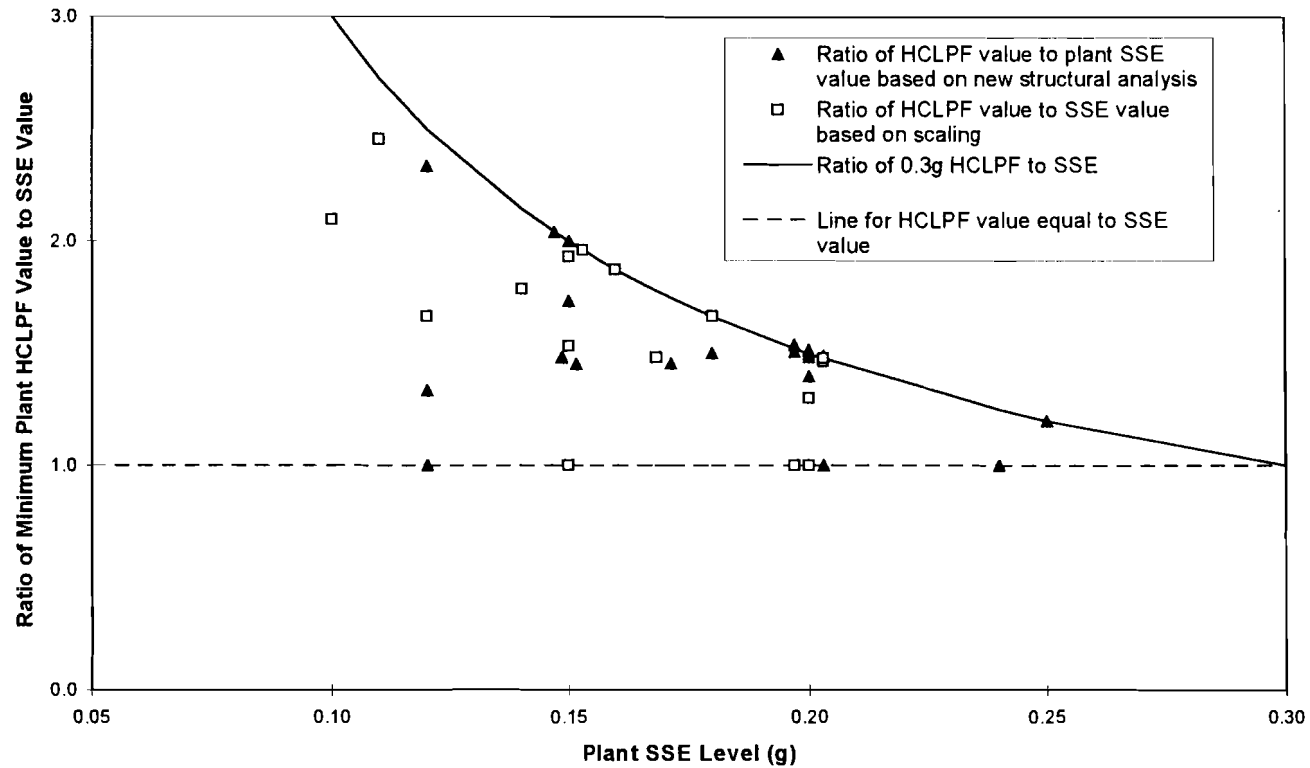
- **Electrical system components most frequent contributors (about 50% of occurrences)**
- **Building and structural failures also significant (about 21% of occurrences)**
- **Other contributors are frontline & support systems and tanks (about 22% of occurrences)**
- **In some SPRAs the surrogate element is a major contributor (about 6% of occurrences)**
- **Use of EPRI vs LLNL hazard curves did not significantly alter CDF or list of dominant contributors**
- **CDF values did not increase with plant vintage, i.e., with different seismic design standards**

# SMA RESULTS



Distribution of Plant HCLPF Values

# SMA RESULTS



Ratio of Plant HCLPF to SSE level plotted versus SSE level

# **MOST COMMON WEAK LINKS, OUTLIERS FROM SMAs**

## **Electrical Systems**

- Emergency Diesel Generator
- Diesel oil tank
- Bus, switch, transformer, breaker, MCC
- Battery board, electric equipment anchorage

## **Buildings and Structures**

- Turbine building
- Block walls (near MCC, diesel fuel day tank, electric bay, reactor building)

## **Frontline & Support Systems**

- RHR system (MOV, heat exchanger)
- HPI (valve)
- Suppression pool shell inlet valve,
- Containment spray raw water pump
- CCW (Heat exchanger, pump)
- SW pump
- Spent fuel pool heat exchanger,
- Chiller unit,
- Event recorder

## **Tanks**

- CST
- RWST
- Other (Boric acid tank, refueling water chemical addition tank)

## **SMA INSIGHTS**

- **Electrical system components are frequently the governing outliers (about 31% of occurrences)**
- **Building and structural failures, especially block walls, also significant (about 10% of occurrences)**
- **Balance of weak links found among frontline and support systems (36%), and major tanks (22%)**
- **Seismic margins, in terms of RLE HCLPF values above the SSE, vary significantly among plants**
- **No observable correlation between plant HCLPF values and plant vintage, i.e., with different seismic design standards (calculated HCLPF values cannot be higher than 0.3g because of screening)**
- **With proposed improvements taken into account, no plants reported HCLPF values below their SSE value**

## METHODOLOGY PERSPECTIVES

- **Use of Uniform Hazard Spectrum (UHS)**
  - Uncharacteristic as compared to conventional spectrum shapes
  - Reduced energy content
  - Reduction in seismic demand
- **Use of Surrogate Elements in SPRA**
  - Problem if a dominant risk contributor
  - Implications of use not investigated
- **Use of New SSI Versus Scaling**
  - Comparison of HCLPF of plants using different approaches could be misleading
- **Component Fragility Calculations**
  - Quality varied

# CONCLUSIONS

- **Almost all licensees reported in their IPEEE submittals that no plant “vulnerabilities” were identified with respect to seismic risk, but most licensees did report at least some seismic “anomalies,” “outliers,” and/or other concerns.**
- **Most licensees identified a number of improvements to enhance the seismic ruggedness of their plants. In some cases these plant improvements were only proposed in the submittals, while in others the submittals indicated the improvements were already implemented. Seventy percent of the plants proposed improvements as a result of their seismic IPEEE analyses.**
- **A common benefit of the seismic IPEEE evaluations was a well-conducted, detailed walkdown to find as-designed, as-built, and as-operated seismic weaknesses in plants. Regardless of the specific approach used, all plants performed a detailed seismic walkdown, and many of the insights gained by licensees resulted from the walkdowns.**
- **The weak link components identified in the SMA analyses in general were similar to the SSCs listed as dominant contributors in the SPRAs.**
- **Seismic risk or margin for older plants was in general found comparable to that of newer plants.**
- **The IPEEE submittals indicate that the IPEEE program has been generally successful in meeting the overall intent of GL 88-20, Supplement 4. Licensees have carried out numerous modifications to reduce the likelihood of core damage and fission product releases. The IPEEE program clearly has had a notable impact on improving plant safety. The degree of success achieved by licensees varied, depending on the methods and assumptions used.**



# IPEEE Fire Insights

Presented by:

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Risk & Reliability Analysis Dept.  
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A presentation to:

ACRS Subcommittee on Reliability and PRA  
June 22, 2001

*Exceptional Service in the National Interest*



# Presentation Outline

- Introduction
- Vulnerabilities
- Plant improvements
- CDF perspectives
- Dominant contributors
- Methods and modeling perspectives
- Conclusions

# Introduction

- All of the IPEEE submittals included an assessment internal plant fire scenarios
- All licensees chose some form of a probabilistic method to assess fire
- Level of analysis varied:
  - Qualitative/quantitative screening (e.g., FIVE)
  - Various forms of fire PRA (new and updates)
  - Fire event tree approach (updates of early analyses)

# Vulnerabilities

- A range of criteria were applied by licensees to define vulnerability
  - NEI Severe Accident Closure Guidelines
  - Similar criteria without specific citation
  - Compare to fire CDF for other plants
  - “Outliers” - balanced contributions imply no vulnerabilities
  - High risk scenarios (CDF>1E-4, LERF>1E-6)
  - Singles - scenarios leading directly to core damage

# Vulnerabilities (cont.):

- Two licensees identified potential fire vulnerabilities at some stage of the IPEEE process

## Quad Cities:

- Initial analysis concluded that potential fire vulnerabilities did exist
  - Turbine building fires - postulated large oil fires
  - Loss of safe shutdown equipment & cables routed through TB
  - Proximity to remote shutdown panels also located in TB
  - Low reliability of operator actions
  - Outages that would render sister unit equipment unavailable
- Re-quantification analysis revealed no fire vulnerabilities
  - Some analysis conservatism relaxed, e.g.:
    - additional cable tracing
    - relax assumption that system function is lost on loss of any associated cable
    - refinement of various aspects of the quantification
  - Some plant changes were implemented and credited in the re-analysis

# Vulnerabilities (cont.):

## Millstone Unit 2:

- Initial analysis revealed one fire-related “outlier”:
  - Storage of transient combustibles (protective clothing) in open racks near concentration of cable trays (in the Aux. Bld.)
  - Three potential resolutions identified - to be assessed:
    - reduce quantity - store in enclosed fire lockers - remove items
  
- USNRC review process questioned Turbine Building analysis
  - Licensee acknowledged importance of TB to safe shutdown
  - Re-examination revealed a potential vulnerability
    - focused in on two scenarios, each at about  $4E-4$  (“as found” “very conservative CDF estimate)
    - CCDP’s had been under-estimated in original analysis
      - 0.002 vs 0.1
  - Plant improvements to resolve vulnerability identified and implemented
    - “TDAFW vulnerability fixed”
  - Final CDF estimates  $\approx 2E-8/ry$  and  $2E-7/ry$  for the two cited scenarios
  - (Final total fire-induced CDF estimate for plant is  $7E-6/ry$ )

# Plant Improvements

- A wide range of plant improvements were identified by licensees
- Actual status of improvements is not always specified but includes:
  - Considered and rejected
  - Considered and implemented
  - Being considered
  - To be considered in the future
  - Identified as a potential benefit
- A majority of licensees identified at least one plant improvement
  - 44 plants representing 62 units
  - 64% of submittals
- Plant improvements fell into common categories:
  - Operating procedures and training practices (~45%)
  - Maintenance procedures and practices (~12%)
  - Physical Design Changes (~43%)

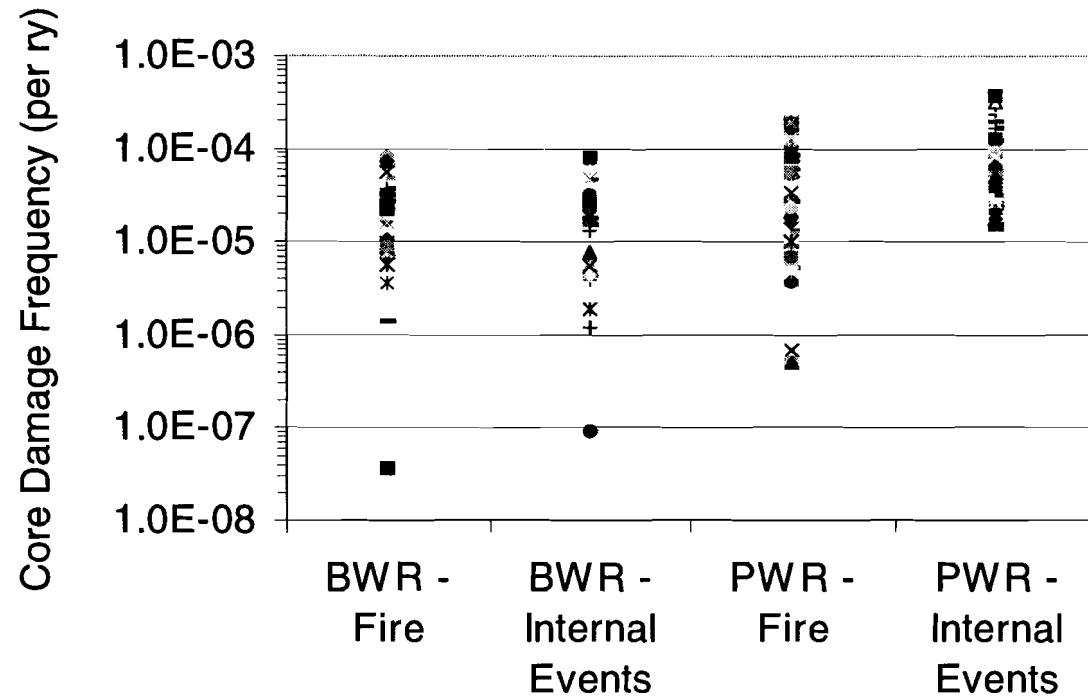
# Plant Improvements (cont.)

- Specific improvements addressed a range of issues:
  - Emergency procedures - enhancements to address identified fire risk scenarios
  - Operator training - use of insights from fire analysis in future training
  - Fire brigade training - additional attention to fire fighting in dominant fire areas, pre-planning, additional fire drills
  - General maintenance procedures - housekeeping, transient combustible control, fire watches, reduction of fire hazards, etc.
  - Relocating equipment or cables - removal from a critical fire area to reduce hazard/risk
  - Fire protection system modifications/upgrades
  - Barrier changes or upgrades
  - System design changes - e.g. circuit design changes to reduce spurious operation potential



# CDF Perspectives

By and large, IPEEE fire CDF estimates are in the same range as IPE internal events values



(Note that plotted symbols do not correlate from column to column.)

## CDF Perspectives (cont.)

- The vast majority of submittals report fire CDF values that are within one order of magnitude of the IPE internal events CDF
- A small number of licensees (pure FIVE analysis) did not report CDF
- No definitive trend in CDF versus plant vintage (age)
- No definitive trend based on method applied
  - FIVE studies that included CDF quantification generally saw marginally higher CDF, but trend is weak
  - The various methods applied appear to have yielded nominally similar results

# Dominant Contributors

- By fire area/zone
- By initiating event
- By fire source

# Dominant Fire Areas/Zones

Most frequently represented among top 5 contributors:

- Main control room
  - Typically dominated by abandonment scenarios
- Switchgear rooms
  - Emergency switchgear
  - Panel fires leading to damage to overhead cables
- Turbine building
  - Various fires - often assumed to involve large oil fires

# Dominant Fire Areas/Zones (cont.)

- Cable spreading rooms
  - Number of CSRs was critical factor:
    - Not typically found to be important CDF contributors if more than one CSR with divisional separation
  - Type and nature of fire sources also a critical factor
    - if cables and transient fuels only, then low likelihood of damaging fires and low CDF
    - if control panels or other electrical equipment present then CSR was typically a significant contributor
- Electrical equipment rooms
  - various types
  - often rooms associated with MCR equipment and/or cable spreading support areas

# Dominant Fire Areas/Zones (cont.)

- Diesel generator rooms
  - often related to loss of off-site power scenarios
- Cable vault/tunnel/chase areas
  - contribution typically dependent on fuel sources and treatment
    - treatment of self-ignited cable fires
    - treatment of transients
    - presence of other fire/ignition sources
- Battery/charger rooms

# Dominant Accident Sequences

- Information in this area was sparse
  - accident sequences considered are typically identified
  - did not typically break out risk contribution by accident sequence
  - did not typically specify which accident sequence was initiated in each scenario analyzed
- Where information is provided, general plant transients appear to be dominant
  - this may not be a robust conclusion due to sparsity of information
- Some transient-induced LOCAs were identified as important
  - stuck PORVs
  - some limited cases of spurious actuation
  - RCP seal LOCA for Westinghouse PWRs

# Dominant Fire Sources

- Considerable attention to electrical panel fires
  - Tended to dominate analysis of various areas
    - MCR, CSR, switchgear rooms, electrical equipment rooms
  - Potential for damage to overhead cables critical factor
    - dependent in part on fire size assumed
- Large oil fires dominant for some areas
  - e.g., for turbine hall, pump areas
- Transient fires rarely found to be important
  - Typical exception was areas devoid of fixed fire sources
- Vast majority of licensees screened self-ignited cable fires based on low-flammability cables (per FIVE)
  - newer plants with newer cables
  - older plants that “back qualified” their cables as a part of Appendix R compliance efforts



# Methods and Modeling

- Virtually all licensees applied a probabilistic method of analysis
  - FIVE
  - FIVE + Fire PRA Implementation Guide
  - FIVE + PRA (other sources)
  - PRA (including event tree approach)
- Selected method did not appear to have an overriding impact on CDF estimates
  - no distinctive trends evident for submittals overall
  - variations within any selected method were widespread
- One or more minor weaknesses exist in virtually all of the submittals; e.g.:
  - Most submittals did not include a detailed human factors analysis
    - most common exception is MCR abandonment
    - IPEEEs typically credit recovery actions based on IPEEE model
    - staff asked RAIs if licensees failed to consider the affect of fire (e.g., heat, smoke, stress) on credited operator actions

# Methods and Modeling (cont.)

- Many specific methods and assumptions were scrutinized in the review process
  - focused on areas that might impact the identification of vulnerabilities
- Methodological concerns arose during the IPEEE process, e.g.:
  - The EPRI Fire PRA Implementation Guide
    - used widely by licensees
    - led to development of 17 generic RAIs
    - EPRI provided revised guidance to assist licensees in responding to these RAIs
  - Severity factor approaches
    - wide-spread use by licensees (about half of the submittals)
    - used to account for various factors (fire severity, fire suppression, likelihood of damage, self-extinguishment, etc.)
    - often derived from PRA Guide
    - use of multiple severity factors for a single scenario
    - tend to drive analysis to a generic rather than case specific solution

# Methods and Modeling (cont.)

- While all such concerns were resolved in the IPEEE context (identification of fire vulnerabilities), some areas remain open in the broader context of fire PRA
  - panel fires
    - fire severity
    - damage potential outside the panel
    - energetic faults
  - use of severity factor approaches
    - when, how and what are the values
    - consistency with fire frequency and fire suppression credit
  - barrier reliability
    - failure of active barriers
    - room to room fire/smoke spread
  - fire fighting credit
    - timing and reliability
  - effectiveness of fixed detection and suppression systems
    - timing and reliability
    - non-code compliant systems

# Conclusions

- Many prior fire risk perspectives were confirmed
  - reported fire CDFs nominally of the same order as IPE values
  - main control room important for most plants
  - emergency switchgear areas also important for most plants
  - single versus multiple cable spreading rooms
  - plant specific configuration issues important to fire risk
- A few surprises:
  - turbine building significant for some plants
  - diesel generator rooms for some plants
  - battery/charger rooms for a few plants
- Several concerns arose on points of methodology
  - resolved in IPEEE context
  - some remain open in broader PRA context

## Conclusions (cont.)

- All licensees have been found to have met the intent of the IPEEE with regard to their fire analyses
- Fire vulnerabilities were identified at some point in the IPEEE process by two licensees
  - in both cases the vulnerabilities have been addressed by those licensees
- Most licensees identified at least one fire-related plant improvement as a result of the IPEEE process
  - 64% of all submittals



**United States Nuclear Regulatory Commission**

# **HIGH WINDS, FLOODS, AND OTHER (HFO) EXTERNAL EVENTS**

**by**

**B. Hardin**

**Probabilistic Risk Analysis Branch  
Division of Risk Analysis and Applications  
Office of Nuclear Regulatory Research**

**Presentation to ACRS Subcommittee on Reliability and  
Probabilistic Risk Assessment  
June 22, 2001**

# **HIGH WINDS, FLOODS, AND OTHER (HFO) EXTERNAL EVENTS**

## **TOPICS TO BE COVERED:**

- **Types of events included in IPEEE HFO reviews**
- **Screening methodologies for conducting HFO reviews**
- **Summary of results**
  - **Methodologies**
  - **Overall results (qualitative)**
  - **Quantitative results**
  - **Plant improvements**
- **Conclusions**

# **TYPES OF EVENTS INCLUDED IN IPEEE HFO REVIEWS**

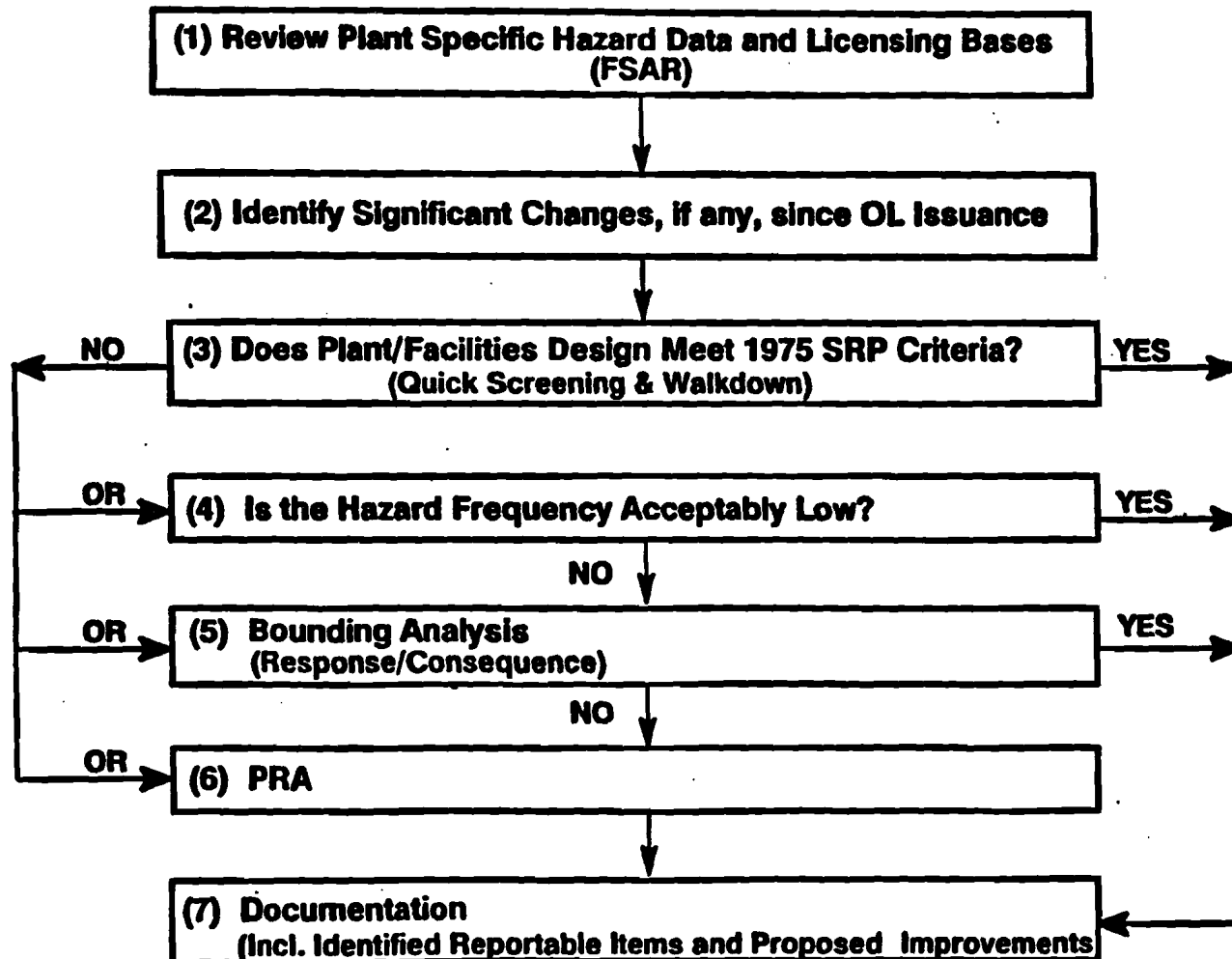
- **High winds, including tornadoes, tornado missiles, and hurricanes**
- **External floods, including intense rainfall, flooding from nearby bodies of water including wave runup, and postulated dam failures**
- **Transportation accidents (e.g., highway, aircraft, train, barge)**
- **Accidents at nearby industrial and military facilities**



# **TYPES OF EVENTS INCLUDED IN IPEEE HFO REVIEWS (cont.)**

- **Other types of external events**
  - **Nearby pipeline accidents**
  - **Release of hazardous materials from onsite storage**
  - **Effects of temperature extremes**
  - **Blockage of drains and intakes by debris**
  - **Plant-unique hazards**

# SCREENING METHODOLOGIES FOR CONDUCTING HFO REVIEWS



# **HFO METHODOLOGIES USED BY LICENSEES**

- **Most HFO studies (approximately 80%) were performed using the qualitative screening method involving a comparison with the Standard Review Plan (consistent with NUREG-1407).**
- **Approximately 15% of the licensees performed a PRA (including full, partial, bounding, or best estimate PRAs).**
- **Less than 5% of the HFO studies utilized the initiating event hazard frequency approach.**

# **SUMMARY OF RESULTS**

- **Vulnerabilities**
  - **None of the 70 licensee submittals identified any HFO- related vulnerabilities.**
  - **Most submittals did not define what constituted a vulnerability.**
- **Plant improvements**
  - **34 submittals (approx. half of the plants reviewed) reported that plant improvements had either been implemented or were being considered as a result of the HFO reviews. Both procedural and plant hardware improvements were noted.**
  - **A total of 64 IPEEE-related improvements were cited. (about 50% procedural, 50% plant hardware)**

## **SUMMARY OF RESULTS (cont.)**

- **Plant improvements (cont.)**
  - **Sixteen plants reported more than one improvement (e.g., Turkey Point with 5 improvements).**
  
  - **Overall summary of improvements by topic (i.e., % of total improvements):**
    - **External flooding: 50%**
    - **High winds: 27%**
    - **Transportation or nearby facility accidents: 8%**
    - **Other external events: 15%**
  
  - **Some improvements were implemented as a result of other activities but were IPEEE related (e.g., the addition of a backup cooling water intake structure as additional protection against barge accidents).**
  
  - **Licensees for 36 plants reported that they had determined that no improvements were necessary.**

## **SUMMARY OF RESULTS (cont.)**

- **All licensees screened out accidents involving transportation and nearby facilities.**
- **Plant-unique hazards were also screened out in all cases.**
- **Most licensees indicated that some form of walkdown had been performed during the HFO review.**
- **None of the 70 submittals identified any containment performance issues unique to the IPEEE (external events).**

# **EXAMPLES OF PLANT IMPROVEMENTS**

- **Protection against high winds:**
  - **Special plant procedures to cope with high winds**
  - **Additional sheltering plans for plant personnel**
  - **Protection of the diesel generator exhaust system from tornadoes**
  - **Addition of tornado missile shield in door of Technical Support Center**
  - **Strengthening of exhaust stacks of a nearby fossil plant to protect against collateral damage**
- **Protection against external floods:**
  - **Improved emergency procedures for flooding conditions**
  - **Increased inspection of roof drains**
  - **Improved emergency procedures in the event of dam failure**

# **EXAMPLES OF PLANT IMPROVEMENTS (cont.)**

- **Protection against external floods (cont.):**
  - Addition of scuppers in roof parapet walls to aid drainage and reduce roof loading during heavy rainfall
  - Upgrading flood-resistant doors
  - Improved penetration seals between service and auxiliary buildings
- **Protection against accidents involving transportation or nearby facilities:**
  - Addition of plant guidelines excluding all flights over plant including overflights by company pilots.
  - Prevention of barge shipping of explosives in nearby shipping channel



# **EXAMPLES OF PLANT IMPROVEMENTS (cont.)**

- **Protection against accidents involving transportation or nearby facilities (cont.):**
  - **Addition of backup cooling water intake structure to protect against barge accidents**
  - **Addition of concrete barriers surrounding propane tank near diesel generators to protect against possible vehicle impact**
- **Protection against other external events:**
  - **Guidance regarding onsite storage and transportation of hazardous materials**
  - **Review of control room habitability as affected by onsite storage of hazardous materials**
  - **Modifications to prevent ice formation on diesel generator service water pumps**

# **EXAMPLES OF PLANT IMPROVEMENTS (cont.)**

- **Protection against other external events (Cont.):**
  - **Addition of screens on drains to prevent foreign material intrusion into safety-related equipment spaces**
  - **Modifications to ventilation exhaust systems to protect against potential combustible gas explosions**
  - **Modifications to plant intake structure to prevent blockage from debris**

# **SUMMARY OF QUANTITATIVE RESULTS**

- **Estimates of core damage frequency (CDF)**
  - **High winds and tornadoes: 2E-7/ry to 6E-5/ry**
  - **External floods: 2E-8/ry to 7E-6/ry**
    - **Salem reported a plant improvement that resulted in reducing the CDF contribution from flooding from approximately 1E-4/ry to 1E-7/ry (involved improvement of door penetration seals between the service and auxiliary buildings).**
  - **Transportation and nearby facility accidents: all reported results were below the NUREG-1407 screening criterion of 1E-6/ry.**

# **SUMMARY OF QUANTITATIVE RESULTS (cont.)**

- **Other external events:**
  - **Haddam Neck reported bounding results of  $8E-6/ry$  for lightning events and  $7E-6/ry$  for accidents resulting from snow and ice.**
  - **South Texas reported  $8E-6/ry$  for a chemical release from a nearby chemical facility.**

# **HFO-RELATED UNRESOLVED SAFETY ISSUES AND GENERIC SAFETY ISSUES**

- **GSI-103, “Probable Maximum Precipitation”**
- **GSI-156, “Systematic Evaluation Program”**
  - **Dam Integrity and Site Flooding**
  - **Site Hydrology and Ability to Withstand Floods**
  - **Industrial Hazards**
  - **Tornado Missiles**
  - **Severe Weather Effects on Structures**
- **GSI-172, “Multiple System Responses Program”**
  - **Effects of Flooding and/or Moisture Intrusion on Non-Safety-Related and Safety-Related Equipment**

# CONCLUSIONS

- **No HFO-related vulnerabilities were identified.**
- **Approximately 50% of the plants made HFO-related improvements.**
- **Relative to other external event challenges, such as seismic and fire, the HFO events contribute significantly less to the overall plant CDF.**
- **Based on the extent of the documentation submitted by the licensees related to their evaluation of HFO events, and the number of HFO-related improvements cited, it is apparent that this review has contributed significantly to the licensees' understanding of, and preparation for, potential HFO events.**



**United States Nuclear Regulatory Commission**

**IPEEE-RELATED  
UNRESOLVED SAFETY ISSUE (USI)  
AND GENERIC SAFETY ISSUES (GSIs)**

by

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Probabilistic Risk Analysis Branch  
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Office of Nuclear Regulatory Research**

**Presentation to ACRS Subcommittee on Risk and Reliability**

**June 22, 2001**

# OUTLINE OF PRESENTATION

- List of issues
- USI/GSI review evaluation process
- Summary discussion of each issue (description, findings, related plant improvements)
- Overall summary and conclusions



## Licensees were specifically requested to address the following issues

- USI A-45, “Shutdown Decay Heat Removal Requirements”
- GSI-103, “Design for Probable Maximum Precipitation”
- GSI-131, “Potential Seismic Interaction Involving the Movable In-Core Flux Mapping System Used in Westinghouse Plants”
- GSI-57, “Effects of Fire Protection System Actuation on Safety-Related Equipment”
- Sandia Fire Risk Scoping Study (FRSS) issues

## IPEEE information could be used to evaluate

- GSI-147, “Fire-Induced Alternate Shutdown/Control Room Panel Interactions”
- GSI-148, “Smoke Control and Manual Fire-Fighting Effectiveness”
- GSI-156, “Systematic Evaluation Program” (SEP)
- GSI-172, “Multiple System Responses Program” (MSRP)

Generic Safety Issues Addressed in the IPEEE Program

Generic Safety Issue (GSI)	Area <sup>1</sup>	USI/GSI	FRSS	GSI-156	GSI-172	Remark <sup>2</sup>
Shutdown Decay Heat Removal Requirements	S,F	USI A-45				EX
Potential Seismic Interaction Involving the Movable In-Core Mapping System	S	GSI-131				C
Effects of Fire Protection System Actuation on Safety-Related Equipment	S,F	GSI-57	X		X	P
Fire-Induced Alternate Shutdown/Control Room Panel Interaction	F	GSI-147	X			C
Smoke Control and Manual Fire-Fighting Effectiveness	F	GSI-148	X			P
Seismic/Fire Interactions	F		X		X	C
Adequacy of Fire Barriers	F		X			C
Effects of Hydrogen Line Ruptures	S,F				X	C
Settlement of Foundations and Buried Equipment	S			X		P
Dam Integrity and Site Flooding	S,HF O			X		C
Seismic Design of Structures, Systems, and Components	S			X		C
Common Cause Failures Related to Human Errors	S,F				X	EX
Non-Safety-Related Control System/Safety-Related Protection System Dependencies	S,F				X	EX
Effects of Flooding and/or Moisture Intrusion on Non-Safety-Related and Safety-Related Equipment	F,HF O				X	EX
Seismically Induced Spatial and Functional Interaction	S				X	C
Seismically Induced Flooding	S				X	C
Seismically Induced Relay Chatter	S				X	C
Evaluation of Earthquake Magnitudes Greater than Safe Shutdown Earthquake	S				X	C
Design for Probable Maximum Precipitation	HFO	GSI-103				C
Site Hydrology and Ability to Withstand Floods	HFO			X		P
Industrial Hazards	HFO			X		C
Tornado Missiles	HFO			X		C
Severe Weather Effects on Structures	HFO			X		C
Design Codes, Criteria, and Load Combinations	S,HF O			X		C
Shutdown Systems and Electrical Instrumentation and Control Features	F			X		EX

<sup>1</sup>S=seismic, F=internal fires, HFO=high winds, floods, and other external events

<sup>2</sup>C=issue covered by IPEEE; EX= only external event-related aspects of issue covered; P=partially covered (refer to specific section of the text for details)

# USI/GSI Staff Review Evaluation Process

- The licensee's IPEEE is complete with regard to USIs and GSIs coverage.
- The licensee's assessment demonstrated an in-depth knowledge of the external events aspects and plant characteristics relevant to the issues discussed.
- The licensee's assessment results are reasonable given the design, location, features, and operating history of the plant.

An issue is thus considered resolved if no potential vulnerabilities associated with its related concerns were identified in the submittal, or plant-specific improvements to eliminate or reduce the significance of the identified potential vulnerabilities were implemented at the plant.

# USI/GSI Information

- Most submittals contain information that address most of the generic issues.
- If information on an issue was incomplete:
  - The SRB and the reviewers determined whether or not the missing information could result in the licensee overlooking a potential vulnerability at their plant (e.g., based on reviews of other similar plants).
  - RAIs were sent to licensees if a potential vulnerability could have been missed or if information in response to the RAI would be likely to uncover a significant problem with the IPEEE results.

## USI/GSI Information (Con't)

- If a potential vulnerability was not missed, SER would identify that as a “weakness.”
- In such a case, the submittal would still meet the intent of Supplement 4 to Generic Letter 88-20, but the GSI may not be “resolved” for that plant.
- NRC staff will determine (separately from IPEEE program) if any additional actions are needed to close out issues for plants with “open” issues.

# USI A-45, “Shutdown Decay Heat Removal (DHR) Requirements”

**Objective:** To determine whether the decay heat removal function is adequate and wherever cost-beneficial improvement(s) could be identified.

**Findings:**

- Adequate information was provided in the submittals.
- Decay heat removal equipment was included in seismic and fire PRAs.
- Decay heat removal equipment was included in seismic margin analysis (SMA) safe shutdown equipment list (SSEL).
- For SMA, each component’s high confidence of low probability of failure (HCLPF) value was determined.

**Conclusion:**

- All plants have adequately addressed USI A-45.
- All plants have identified at least one method of removing decay heat.
- No vulnerabilities were found.

# GSI-57, “Effects of Fire Protection System Actuation on Safety-Related Equipment”

Objective: Evaluate potential risks from:

- Seismically induced fire plus seismically induced suppression diversion
- Seismically induced actuation of the fire protection system (FPS)

Findings:

- Some submittals noted the plant’s FPS fire protection system was designed per Category II/I criteria.
- Pre-Action Type: requires two diverse actions for initiation, smoke detector to open a supply valve and fusible link in the sprinkler head.
- Deluge Type: relies on spatial relationship between the FPS and safety-related components, seals, drainage systems.
- CO<sub>2</sub> or Halon: reviewed for potential effects on personnel (e.g., control room operators) and equipment (e.g., diesel generators operation).



# GSI-57, “Effects of Fire Protection System Actuation on Safety-Related Equipment” (Con’t)

## Conclusions:

- Licensees conclude the impact was negligibly small.
- No plant vulnerabilities were identified.
- All but four plants have adequately addressed this issue.

# GSI-103, “Design for Probable Maximum Precipitation” (PMP)

**Objective:** Evaluate potential effects of new PMP criteria on site flooding and roof ponding

**Findings:**

- Typically, roofs can withstand the additional loads because the excess rainfall overflows the roof parapets.
- In some cases, scuppers were installed in the parapets.
- To credit roof drains, licensees referred to procedures to periodically inspect the roof drainage system for potential blockage.
- Typically, site flooding from PMP effects on nearby rivers and streams (potential dam and levy failures) did not adversely affect the plant.

## GSI-103, “Design for Probable Maximum Precipitation” (PMP) (Con’t)

- If flooding could adversely affect the plant, plant changes were made (sand bags, timely shutdown).
- Site drainage adequately removed very intense local precipitation or:
  - insignificant water accumulation.
  - significant water accumulation, but no adverse affect on components .
  - components operate submerged.
- Confirmatory walkdowns to identify:
  - doors and penetrations vulnerable to moisture intrusion.
  - ability of roof drain systems and site drainage.

# GSI-103, “Design for Probable Maximum Precipitation” (PMP) (Con’t)

## Conclusions:

- Original design and construction of the plants included sufficient margin to allow for variations of up to two to three times the original design basis PMP without adversely impacting safe operation of the plant.
- No plant vulnerabilities were identified.
- One plant (Salem) installed new penetration seals between the service and auxiliary buildings. Reduced estimated CDF from external floods from 1E-4/ry to 1E-7/ry.
- All but three plants resolved all aspects of GSI-103.

# GSI-131, “Potential Seismic Interaction Involving the Movable In-Core Flux Mapping System (ICFM) Used in Westinghouse Plants”

**Objective:** Failure of the ICFM system in a seismic event could potentially result in multiple failures at the seal table and could produce a small-break LOCA (SBLOCA) from instrument tube failure(s).

**Findings:**

- Applicable to all but 3 Westinghouse plants with immobile flux mapping cart.
- Already resolved for 19 plants.
- For 6 plants, as-found condition was adequate.
- Adequate restraints added by 4 plants (installation of angle iron welded to the seal table to bolt the transfer table in place).

## GSI-131, “Potential Seismic Interaction Involving the Movable In-Core Flux Mapping System (ICFM) Used in Westinghouse Plants” (Con’t)

- Administrative controls at 1 plant (procedures to restrain a chain from falling).
- Walkdowns performed to verify the installation of previous improvements.

### Conclusions:

- No plant vulnerabilities were identified.
- All plants resolved GSI-131.

# GSI-147, “Fire-Induced Alternate Shutdown and Control Room Panel Interactions”

**Objective:** A fire in the main control room might lead to loss of control or power to alternate systems before transfer, total loss of system function, or spurious operation (leading to LOCA). Alternate shutdown systems to be electrically independent.

**Findings:**

- Many relied, in part, on compliance with Appendix R.
- Alternate shutdown locations (varies from 1 to 14 locations to SSF) are electrically independent of control room.
- No unrecoverable LOCAs would be created.
- Spurious hot shorts considered (1 to 6 at a time).
- No total loss of system function was identified.

# GSI-147, “Fire-Induced Alternate Shutdown and Control Room Panel Interactions” (Con’t)

## Conclusions:

- No plant vulnerabilities were identified.
- 94% of all plants resolved GSI-147.



# GSI-148, “Smoke Control and Manual Fire-Fighting Effectiveness”

**Objective:** Buildup of smoke could hamper efforts of the fire brigade and operators, potentially damage equipment (e.g., misdirected suppression), or inadvertently initiate fire suppression systems.

- Findings:**
- 65% credited manual fire-fighting actions.
  - 15% did not explicitly discuss, but could be evaluated based on review of the FRSS issues.
  - 20% took no credit for manual fire-fighting activities.
- Conservative assumption from PRA standpoint (i.e., higher CDF estimate).

# GSI-148, “Smoke Control and Manual Fire-Fighting Effectiveness” (Con’t)

- Did not consider potential effects of misdirected spray (GSI-148 not considered fully closed).
- Even those that took no credit discussed fire brigade training, simulation exercises, equipment, and timing.
- Because of insufficient data to evaluate equipment damage from smoke, this aspect of GSI-148 was not addressed.

## Conclusions:

- No plant vulnerabilities were identified.
- Resolved for 71% of the plants.
- Partially resolved for 25% of the plants.
- Not resolved for 4% of the plants.

# GSI-156, “Systematic Evaluation Program” (SEP)

Objective: To review the 31 plants that were licensed prior to issuance of the 1975 SRP (i.e., without explicitly addressing the information in the 1975 SRP)

- 1) Site Hydrology and Ability to Withstand Floods
- 2) Industrial Hazards
- 3) Tornado Missiles
- 4) Severe Weather Effects on Structures
- 5) Design Codes, Criteria, and Load Combinations
- 6) Dam Integrity and Site Flooding
- 7) Settlement of Foundations and Buried Equipment
- 8) The Seismic Design of the Structures, Systems, and Components
- 9) Shutdown Systems and Electrical Instrumentation and Control Features

# GSI-156, “Systematic Evaluation Program” (Con’t)

## Findings:

- No improvement specific for GSI-156, other improvements overlap some SEP areas.
- External flooding resolved site hydrological issues 1, 4, & 6.
- Seismic evaluation resolved seismic design issues 5, 7, & 8.
- HFO evaluation resolved wind-related & other issues 2, 3, & 4.
- USI A-45 resolved shutdown issue 9.

## Conclusions:

- No plant vulnerabilities were identified.
- All 31 plants resolved GSI-156.

# GSI-172, “Multiple System Response Program” (MSRP)

Objective: To address 11 IPEEE-related MSRP concerns raised by the ACRS regarding safety issues that might exist and which might not be addressed by the NRC’s existing generic safety issues.

## (1) Effects of Fire Suppression System Actuation on Non-Safety-Related and Safety-Related Equipment.

- Overlaps GSI-57.
- Part of seismic walkdown.
- Addressed impact on safe shutdown equipment or safety-related equipment.
- Most considered non-safety-related equipment unnecessary for safe shutdown or drains adequate to prevent unacceptable flooding.
- Resolved for all but 2 plants.

## (2) Seismically Induced Fire Suppression System Actuation

- Addressed by GSI-57.
- Part of seismic walkdown.
- 66 submittals evaluated potential effects of inadvertent actuation.
- Many did not include seismically induced loss of fire protection system.
- Some included evaluation of the potential effects of fire protection system component failures.
- Plant improvements: replacing relays & switches, strengthening component anchorages, and implementing procedures to properly secure transient fire protection equipment.
- Resolved for all but 3 plants.

### (3) Seismically Induced Fires

- Related to Sandia Fire Risk Scoping Study.
- A few licensees performed PRA for initiating events.
- Most addressed issue as part of seismic walkdown.
- Most evaluations limited to impact on safe shutdown equipment.
- Some included piping & tanks containing flammable materials.
- Plant improvement: restraining gas cylinders.
- Resolved for all but 3 plants.

#### (4) Effects of Hydrogen Line Ruptures

- H<sub>2</sub> line failures did not contribute significantly to CDF.
- Typically addressed with walkdowns following EPRI's FIVE methodology.
- Two licensees addressed hydrogen lines but not tanks.
- Resolved for all but 5 plants.



(5) Non-Safety-Related Control System/Safety-Related Protection System Dependencies

- Related to GSI-147.
- Safe shutdown can be done at MCR or ASPs with only safety-related equipment; non-safety-related equipment failures would not inhibit shutdown.
- All but 4 licensees provided adequate information to close this issue.
  - 1 licensee did not address hot shorts.
  - 3 licensees did not discuss this issue.

## (6) Effects of Flooding and/or Moisture Intrusion on Non-Safety-Related and Safety-Related Equipment

- HFO evaluation resolves flooding aspect.
- Moisture intrusion:
  - Evaluation of potential effects of seismically induced failure/activation of fire protection system and misdirected spray from manual fire-fighting.
  - Resolved for all but 3 plants.

## (7) Seismically Induced Spatial/Functional Interactions

- Part of seismic walkdown.
- Most cases limited to direct impact on safe shutdown equipment.
- Plant improvements: strengthening component anchorages, anchoring cabinets together, procedures to secure transient fire protection equipment.
- Resolved for all but 2 plants.

## (8) Seismically Induced Flooding

- A few licensees evaluated using a PRA.
- Most used seismic walkdown.
- Most evaluations limited to safe shutdown equipment.
- Plant improvements: adding seals to waterproof electrical cabinets, enhanced drain inspection procedures.
- Resolved for all but 6 plants.

## (9) Seismically Induced Relay Chatter

- A few plants had low-ruggedness relays in IPEEE success paths (not redundant to USI A-46).
- 27 licensees performed seismic PRAs.
  - 14 included relays in their PRA.
  - Recovery actions not modeled.
- 42 licensees performed separate evaluations.
- Low-ruggedness relays found in alarm circuitry, negligible consequences, or operators would provide effective reset.
- Plant improvement: limited replacement of relays.
- All licensees resolved this issue.

## (10) IPEEE-Related Aspects of Common Cause Failures Related to Human Errors

- IPEEE issue focused on human errors involving operator recovery following the occurrence of an external event (i.e., fire, earthquake).
- Errors modeled in PRAs by using:
  - IPE model,
  - Modified IPE model using judgmental scaling factors, or
  - Simplified operator error fragilities.
- In SMAs, reliance placed on most familiar success paths and most reliable equipment with qualitative discussion on operator reliability.

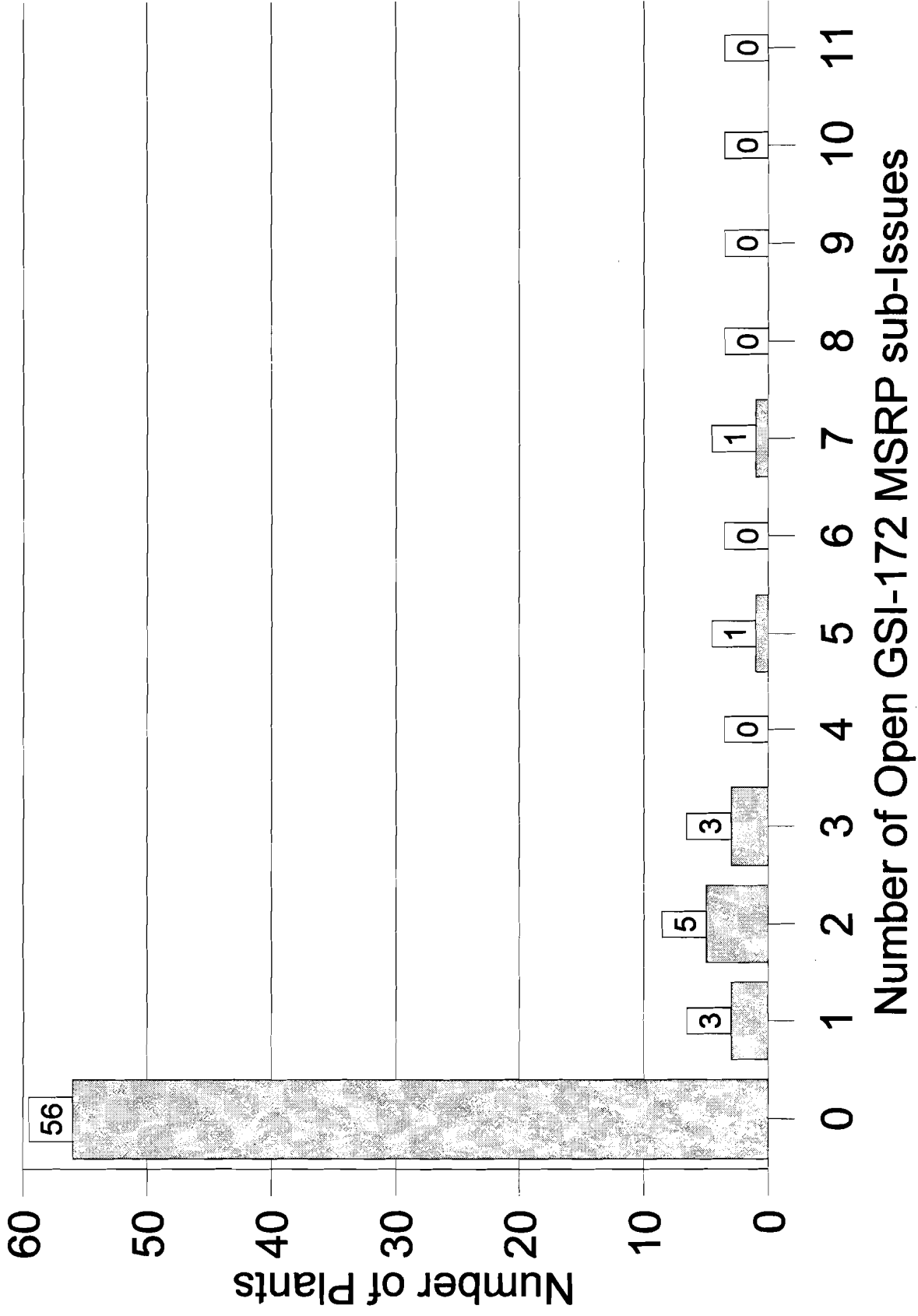
## (10) IPEEE-Related Aspects of Common Cause Failures Related to Human Errors (Con't)

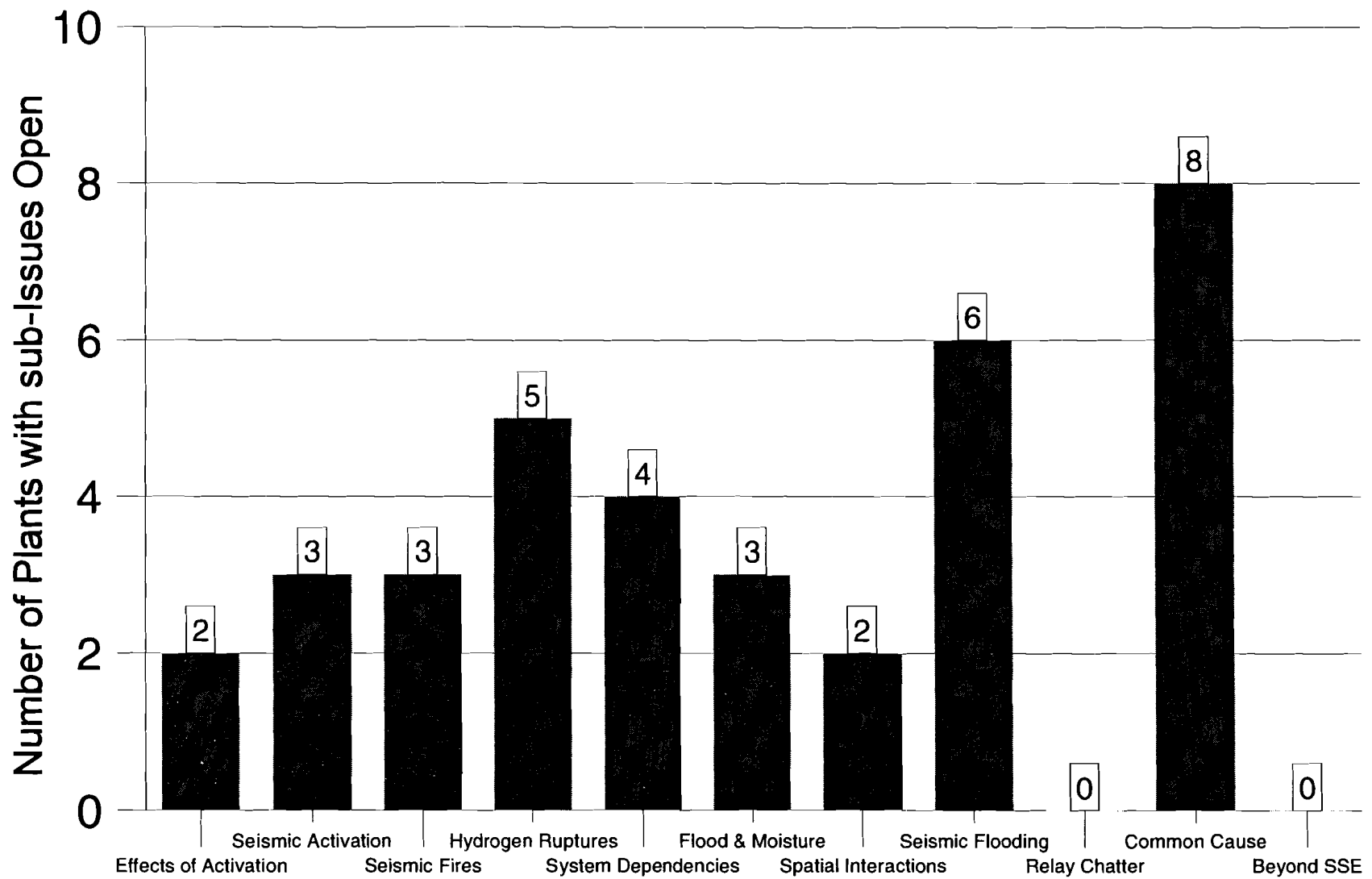
- In fire evaluations, the licensees used the:
  - IPE model,
  - IPE model with a performance shaping factor,
  - Expert judgement to determine a factor for each action,
  - A conservative screening factor (0.1), or
  - Some re-evaluated and re-quantified all error rates.
- Resolved for all but 8 plants.

## (11) Evaluation of Earthquake Magnitudes Greater Than Safe Shutdown Earthquake

- Acceptable seismic IPEEE resolved this issue.
  - All licensees resolved this issue.
- 
- **MSRP Issues - Conclusions**
    - No plant vulnerabilities were identified.
    - 56 plants resolved all 11 MSRP issues.







Number of Open GSI-172 MSRP sub-Issues by Issue

# Sandia Fire Risk Scoping Study Issues

**Objective:** To evaluate potential risks of 5 previously unaddressed fire risk issues that were identified in NUREG/CR-0588.

## **Findings:**

### **(1) Seismic/Fire Interactions.**

- Part of the seismic and fire walkdowns.
- Evaluated induced failure and activation of fire protection system.
- Plant improvement: ensure existing procedures for securing cylinders were followed.
- 66 licensees provided adequate information to resolve this issue.

## (2) Adequacy of Fire Barriers.

- Discussed inspection, surveillance, and maintenance procedures (seals & doors).
- Fire watches identified for welding activities.
- Multi-zone fires were not a significant contributor to fire CDF.
- Smoke through a penetration would be diluted and not inhibit fire-fighting activities.
- 66 licensees provided adequate information to resolve this issue.

### (3) Smoke Control and Manual Fire-Fighting Effectiveness

- Issue became GSI-148.
- Most submittals discussed consideration of smoke in the fire brigade training.
- 55 licensees provided adequate information to resolve this issue.

#### (4) Equipment Survival in a Fire-Induced Environment

- Issue addressed by GSI-57.
- 65 licensees provided adequate information to resolve this issue.

## (5) Fire-Induced Alternate Shutdown/Control Room Panel Interactions

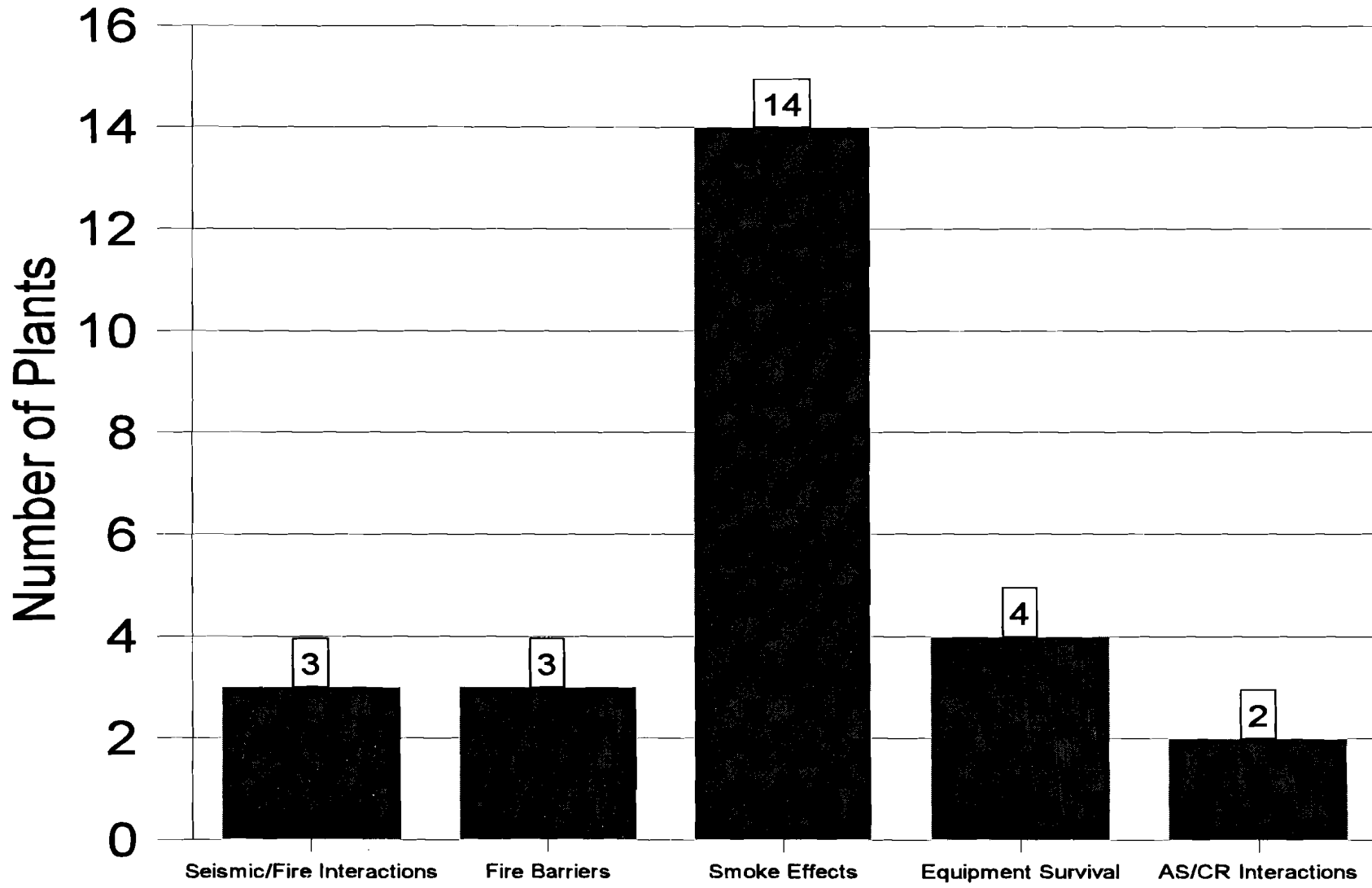
- Issue became GSI-147.
- Transfer control from control room to alternate location(s).
- Electrically independent (source, fuse, breakers).
- Spurious actuations considered.
- 67 licensees provided adequate information to resolve this issue.

## FRSS Issues (Con't)

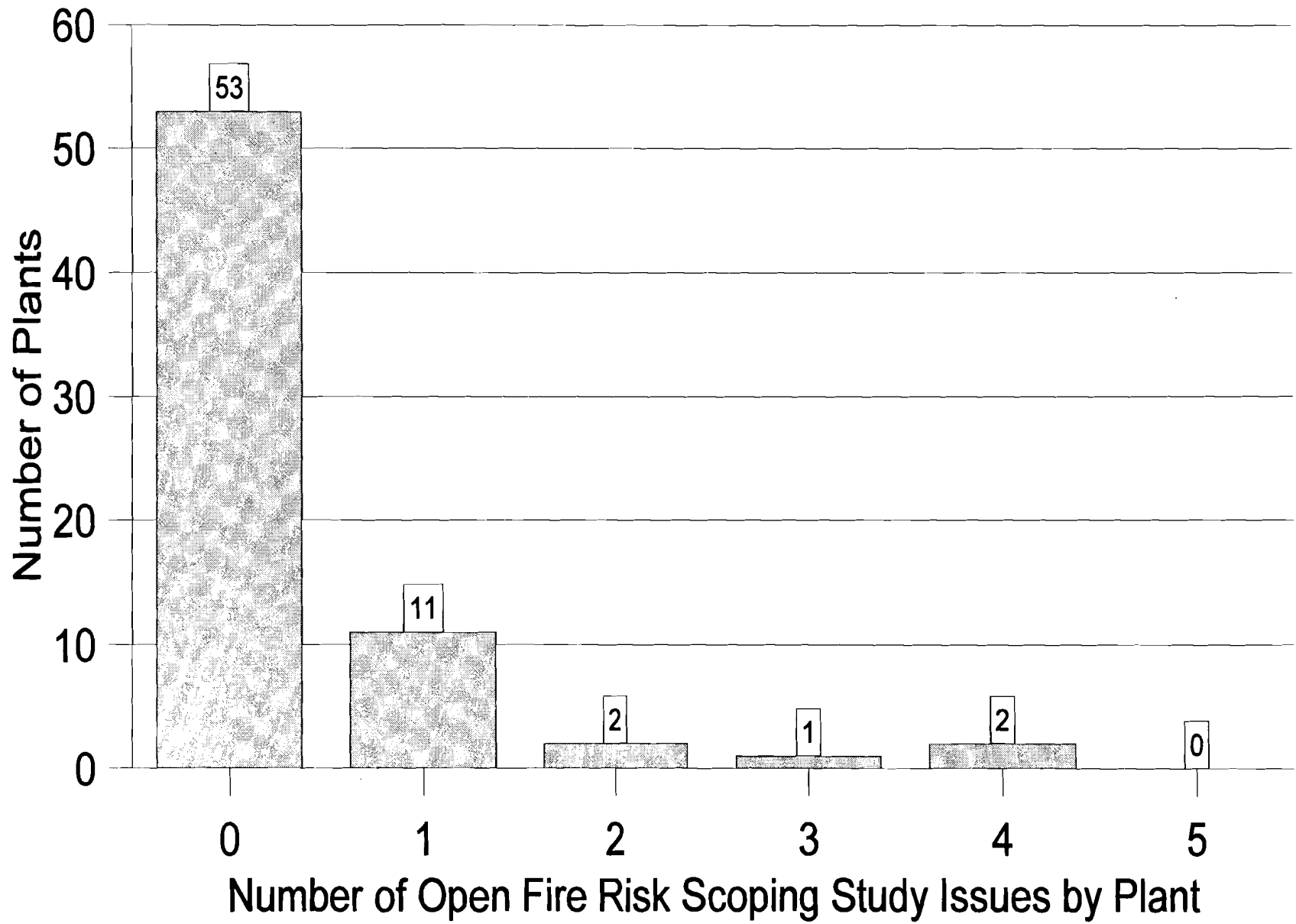
### Observations:

- 25 licensees used EPRI's FIVE methodology.
- No plant vulnerabilities were identified.
- 53 licensees resolved all aspects of this issue.





**Number of Open FRSS Issues by Issue**

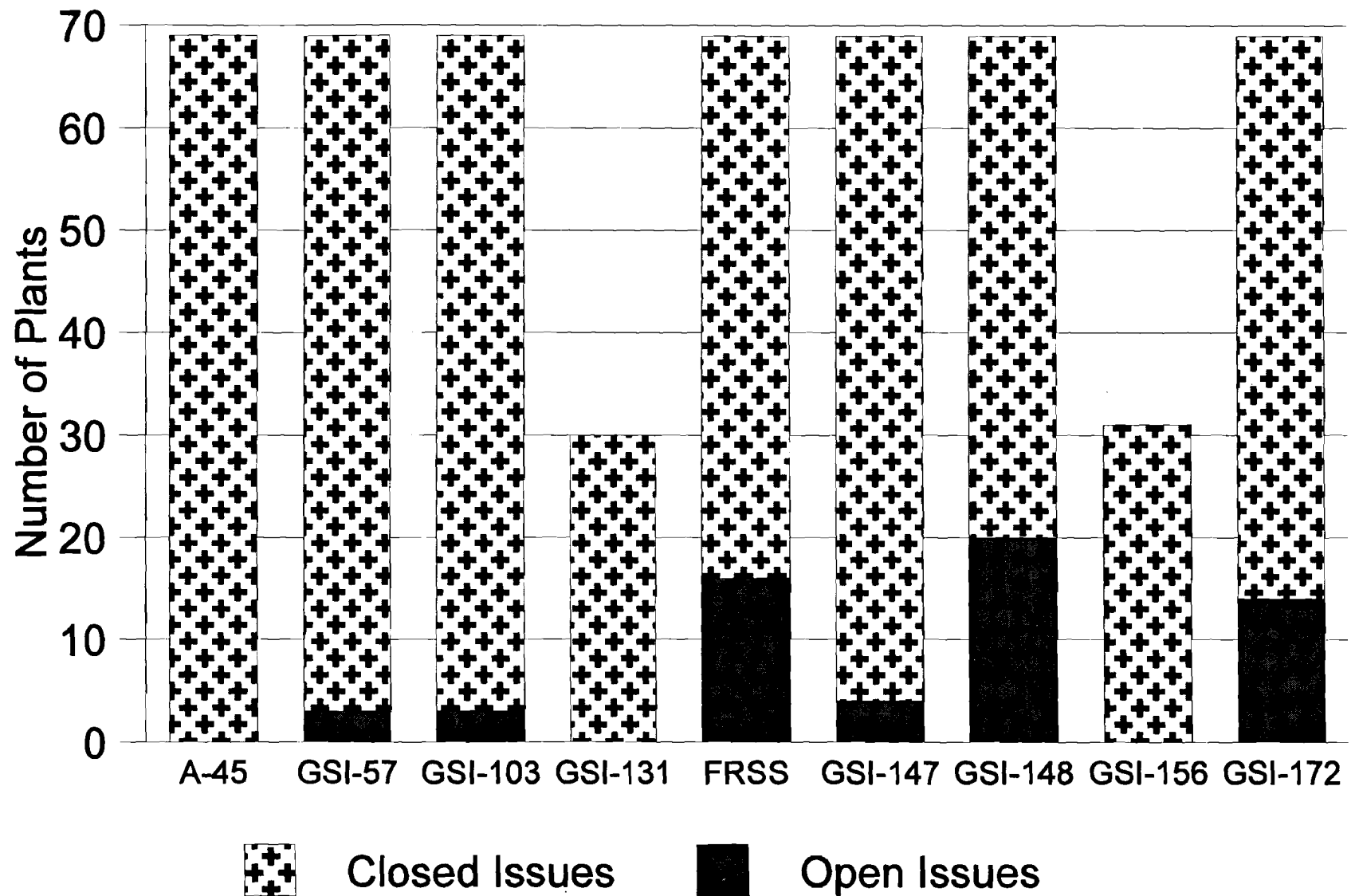


# Summary and Conclusions

- 31 IPEEE-related unresolved safety issues and generic safety issues (issues and sub-issues).
  - 9 explicitly discussed in Supplement 4 to Generic Letter 88-20 and NUREG-1407.  
(USI A-45, GSI-57, GSI-103, GSI-131, and 5 FRSS issues)
  - 22 issues were not explicitly discussed in the Generic Letter or NUREG-1407.  
(GSI-147, GSI-148, GSI-156 [9 issues], and GSI-172 [11 issues].)
- Major achievement is resolution of a large majority of these generic issues
  - 44 licensees provided sufficient information to resolve all 31 USIs and GSIs.
  - 25 submittals had one or more generic issue(s) or sub-issue open or only partially resolved.

## Summary and Conclusions (Con't)

- Resolved:
  - 100% USI A-45, GSI-131, and GSI-156
  - 95% GSI-57, GSI-103, and GSI-147
  - 80% GSI-172 and Sandia FRSS
  - 70% GSI-148
- For those issues not fully resolved:
  - Potential “vulnerability” not missed.
  - Identified as “weakness” in plant-specific SER.
  - Need for additional actions or assessments to close these issues will be determined separately from IPEEE program.



Number of Open Unresolved and Safety Generic Issues by Plant  
(not resolved or partially resolved)



**United States Nuclear Regulatory Commission**

**IPEEE PROGRAM  
OVERALL CONCLUSIONS AND OBSERVATIONS**

**by**

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**Presentation to ACRS Subcommittee on Reliability and  
Probabilistic Risk Assessment**

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# USES OF IPEEE INFORMATION

- **Implementing plant-specific improvements**
- **Resolving external-event related generic safety issues**
- **Prioritizing areas for plant inspections (e.g., fire protection, seismic)**
- **Providing insights on risk importance of inspection findings (e.g., significance determination process for reactor oversight program)**
- **Incorporating fire risk insights into Regulatory Guide 1.189 and NFPA 805**
- **Identifying topics and providing basis to prioritize topics for fire risk research program (e.g., importance of turbine building fires)**

# **USES OF IPEEE INFORMATION (cont.)**

- **Assessing the cumulative effect of exemptions to Appendix R fire protection requirements on fire core damage frequency**
- **Prioritizing research needs for age-degraded structures and passive components using insights from IPEEE program and aging data from operating plants**
- **Evaluation of severe accident mitigation alternatives (SAMAs) for license renewal**



# CONCLUSIONS AND OBSERVATIONS

- **IPEEE program successful in meeting intent of Supplement 4 to GL 88-20**
- **Over 90% of licensees implemented or proposed plant improvements (i.e., hardware and procedural changes) based on IPEEE**
- **Seismic and fire events are important contributors to plant CDF for a majority of plants**
  - **Range of seismic CDF: 2E-7 to 9E-5 per reactor-year (ry)**
  - **Range of fire CDF: 4E-8 to 2E-4/ry**
  - **Range of high winds/tornadoes CDF: 2E-7 to 6E-5/ry**
- **Comparison of quantitative CDF and seismic capacity estimates between plants is not straightforward because of variability in: (1) methods, (2) input and modeling assumptions by analysts, and (3) level of detail in analyses.**

## **CONCLUSIONS AND OBSERVATIONS (cont.)**

- **Licensees developed appreciation of severe accident behavior associated with external events.**
- **Licensees gained qualitative understanding of most likely severe accident sequences that may occur as a result of external events.**
- **Licensees gained improved understanding of likelihood of core damage associated with external initiating events.**
- **Licensees implemented or proposed plant modifications that have a beneficial effect on plant safety in response to external events.**