PDR

JAN 0 6 1994

MEMORANDUM FOR: Lawrence C. Shao, Director
Division of Engineering, RES

FROM: Andrew J. Murphy, Chief
Structural and Seismic Engineering Branch
Division of Engineering, RES

SUBJECT: SUMMARY OF A PUBLIC MEETING ON THE REVISION OF APPENDIX A "SEISMIC AND GEOLOGIC SITING CRITERIA FOR NUCLEAR POWER PLANTS" TO 10CFR PART 100

A meeting was held on November 30, 1993, among the NRC and its consultants, and the Nuclear Management and Resources Council (NUMARC) and other representatives from the nuclear industry. A list of attendees is attached as Enclosure 1. The purpose of the meeting was to provide NUMARC the opportunity to clarify its comments on the proposed revision of Appendix A to 10 CFR Part 100 and several regulatory guides which were published in November, 1992. Enclosure 2 is the meeting agenda.

Introductory remarks were made by A. Murphy, N. Farukhi, and L. Shao during which the purpose of the meeting and the expected accomplishments from it, for both the NRC and NUMARC, were laid out. The importance of determining what are the differences between the NUMARC proposed methodology and the staff proposed methodology and their impact was stressed.

Dr. M. McCann, representing NUMARC, presented an overview of the NUMARC probabilistic analysis. The methodology is similar to the probabilistic part of the staff's method in concept. The major difference between the two methods is that the NUMARC method specifies that the SSE ground motion spectrum derived from the probabilistic analysis be scaled to the ground motion level corresponding to the reference probability, while the NRC method utilizes the technique described in SRP 2.5.2 at that stage of the Probabilistic Seismic Hazard Analysis (PSHA). The staff also proposes to perform a simplified deterministic evaluation as part of its review process. The viewgraphs used in this presentation are attached as Enclosure 3.

Dr. McCann next described the way in which NUMARC proposes to apply the reference probability developed from the combined probabilities of exceedance of the SSEs of nuclear power plant sites in the eastern and central U.S., and how to modify that value to accommodate western sites located near active faults. The illustrations used in this talk are attached as Enclosure 4.

Dr. Murphy, NRC, briefly summarized the staff's Hybrid approach, the details of which have not been completely worked out, particularly how the staff will perform the deterministic analysis and the way the results will be used to check the PSHAs. The probability part will be described in DG 1015 and the

070010

DF05

deterministic part will be detailed in the revised SRP 2.5.2. Enclosure 5 illustrates the steps of the Hybrid approach. (The Hybrid approach was presented to the Commissioners at a public briefing on August 3, 1993.)

The remainder of the public meeting, led by Dr. C. Stepp, NUMARC, was spent discussing NRC's questions regarding NUMARC's comments on the Appendix A revision package. The earth sciences documents (Appendix B and DG 1015) were addressed first and the major issues that are still outstanding are identified in the suggested action items summarized below.

NUMARC's comments on the engineering documents (Appendix S and Draft Guides DG 1016, 1017, and 1018) were discussed next.

R. Whorton, representing NUMARC, presented information supporting control room location of the seismograph, and J. Schneider, also representing NUMARC, described studies that are underway with respect to developing guidelines for implementing OBE criteria, which includes instrumentation. Dr. Schneider's viewgraphs are attached as Enclosure 6.

The NRC staff and its consultants held a caucus and suggested that NUMARC accomplish the following tasks, on a voluntary basis, to support the modifications of the proposed Appendix B and DG 1015 that it is advocating:

(1) During the meeting, NUMARC gave a verbal explanation that only the seismic sources are modified based on the site/regional investigations. However, ground motion models will not be revised. NUMARC was requested to document its rationale for not revising ground motion models.

2) NUMARC was requested to describe, in greater detail, the integration and decision processes, and exactly what is done at each of the three decision levels of its probability analysis. The criteria on which the decisions are based was also requested.

(3) NRC requested the basis, in the form of results from numerical calculations, to support NUMARC's recommendation that scaling the effective ground motions to the reference probability is the appropriate method to derive the SSE ground motions in place of the NRC staff's method of using SRP 2.5.2, which results in about the 84th percentile. NUMARC was asked to determine the fractiles that result from using its method. The Staff's consultants suggested several schemes for investigations to adjust the magnitudes and distances of controlling earthquakes to implement the fractile required by SRP 2.5.2, and at the same time keep it compatible with scaling to the reference probability level. The staff is performing some of these calculations. NUMARC was also informed that the staff was considering using the median of plants designed to R.G. 1.60 or similar spectra for the reference probability, and that NUMARC may find the calculations based on this choice useful. The staff suggested that it may also be instructive to perform these calculations by deaggregating both mean and median hazard curves as the NUMARC and the staff proposed approach differ in this area.

(4) Justification was requested for reducing the distances for regional and site area investigations from the 320km and 40km proposed by the NRC staff, to 200km and 25km, respectively. It is the staff's understanding that this modification is based on new attenuation relationships. If that is the case, documentation is needed before the staff will alter the distances specified in DG 1015.

(5) Finally NUMARC was told that the presentation that demonstrated the way in which the reference probability may be adjusted for application to a site in the western U.S. located near a fault on which the controlling may occur, needs to be documented with the hazard curves on which it is based and a much stronger writeup description. It is the staff's understanding that the database was obtained from various DOE installations and petroleum company facilities. The staff needs to examine at least a representative part of that database.

In conclusion, it is the staff's perception that there is a significant similarity in the use of the probabilistic concepts in both the staff proposed hybrid approach and the NUMARC's method. As discussed earlier, one of the most significant differences is in determining the ground motion for SSE once the probabilistic calculations are completed. Some of the information discussed above will assist the staff in developing the final position on this issue.

Original Signed by
Andrew J. Murphy

Andrew J. Murphy, Chief
Structural and Seismic Engineering Branch
Division of Engineering, RES

Enclosures: As stated

cc w/enclosures:
E. Beckjord, RES
T. Speis, RES
T. Murley, NRR
W. Russell, NRR
J. Wiggins, NRR
G. Bagchi, NRR
R. Rothman, NRR
P. Sobel, NMSS
G. Giese-Koch, NRR
C. Ader, RES
A. Ibrahim, NMSS
E. Igne, ACRS
N. Farukhi, NUMARC

DISTRIBUTION: PDR RESReading Circ/Chron RMcMullen EZurflueh NChokshi AMurphy JCraig LShao

SSEB/DE/RES	SSEB/DE/RES	SSEB/DE/RES	DD:DE/RES	D:DE/RES
RMcMullen	NChokshi	AMurphy	JCraig	LShao
RBM	1/4/94	4Jan94	1/4	1/4/94

January 4, 1994 G:\NM30

Part 1

ATTENDEES

PUBLIC MEETING
NUMARC COMMMENTS ON THE REVISION OF APPENDIX A, SEISMIC AND GEOLOGIC SITING CRITERIA FOR NUCLEAR POWER PLANTS, TO 10 CFR PART 100

November 30, 1993
NRC Headquarters, OWFN, 1F7/9
8:00 AM

NAME	AFFILIATION
Roger M. Kenneally	NRC/RES
Nilesh C. Chokshi	NRC/RES
Richard McMullen	NRC-RES
David F. Fenster	OCRWM-M&O/Woodward-Clyde
Tom H. Rogers	OCRWM-M&O/Woodward-Clyde
J. CARL STEPP	EPRI
William U. Savage	PG+E
LARRY SHAO	NRC/RES
Andrew J. Murphy	NRC/RES/DE
PAUL W POMEROY	NRC/ADVISORY COMM
Robert J. Budnitz	Future Resources Assoc. Inc.
Robert P. Kennedy	Struct. Mech. Consulting
Allin Cornell	CAC, Co
NAYEEM FARUKHI	NUMARC
Kevin Coppersmith	Geomatrix/NRC Advisory Comm.
Jim York	Weston
SAM STONE	TVA
BOB TRIPATHI	SAIC
ANN BIENIAWSKI	DOE
Antony Pfeffer	SERCH LICENSING/BECHTEL
John Schneider	EPRI
Asa Hadjian	DNFSB
Candace Miller	Stone & Webster

ATTENDEES

PUBLIC MEETING
NUMARC COMMMENTS ON THE REVISION OF APPENDIX A, SEISMIC AND GEOLOGIC SITING CRITERIA FOR NUCLEAR POWER PLANTS, TO 10 CFR PART 100

November 30, 1993
NRC Headquarters, OWFN, 1F7/9
8:00 AM

NAME	AFFILIATION
Carl Snyder	NUS
Ernst G. Zurflueh	NRC-RES
ROBERT ROTHMAN	NRC/NRR
Bakr Ibrahim	NRC/NMSS
John Jacobsen	Yankee Atomic
David Modeen	NUMARC
ROBIN McGUIRE	RISK ENGINEERING INC
BOB WHORTON	SO. CAROLINA ELEC & GAS
Donald P. Moore	Southern Company Services Inc
Phyllis Sobel	NRC/NRR
GUS GIESE-KOCH	NRC/NRR
Auguste Boissonnade	LLNL
Walter W. Hays	USGS
Jean SAVY	LLNL/FESSP
GOUTAM BAGCHI	NRC/NRR/DE/ECGB
Khawaja Akhtar	DOE
Martin McCANN	JBA
DENNIS OSTROM	SCE
P.A. Gmella	N&H

5--1 3

NRC/NUMARC MEETING
ON REVIEW OF NUMARC COMMENTS
10 CFR PARTS 50 AND 100

November 30, 1993
11555 Rockville Pike
Rockville, MD
RM 1F7/9

AGENDA

8:00 am	Introduction	Dr. A. Murphy, NRC Dr. N. Farukhi, NUMARC
8:15 am	Industry's Integrated Seismic Siting Decision Process Overview	Dr. M. McCann, JBA Dr. W. Savage, PG&E
10:15 am	Discussion on Response to NRC Questions	Dr. C. Stepp, EPRI and NUMARC Seismic Ad Hoc Advisory Committee
12:00 noon	Lunch	
1:00 pm	Discussion (Continued)	
4:00 pm	Other 10 CFR Parts 50, 52, 100 Items	All
4:30 pm	Summary, Action Items	NRC/NUMARC

Encl 3

NUMARC/AHAC

Seismic and Geologic Siting Rulemaking
10 CFR Part 100
Appendix B

Integrated Seismic Siting Decision Methodology

NUMARC/NRC Meeting
Rockville, MD
November 30, 1993

SCOPE OF PRESENTATION

- Overview of Industry's recommendations/ proposed revisions to 10 CFR Part 100 Appendix B and DG-1015

- Application (standardizing) of the DG-1015 procedure to *all* regions of the U.S.

NUMARC RECOMMENDATIONS - FEATURES

- Seismic hazard (seismic design basis) at a site is determined on the basis of:

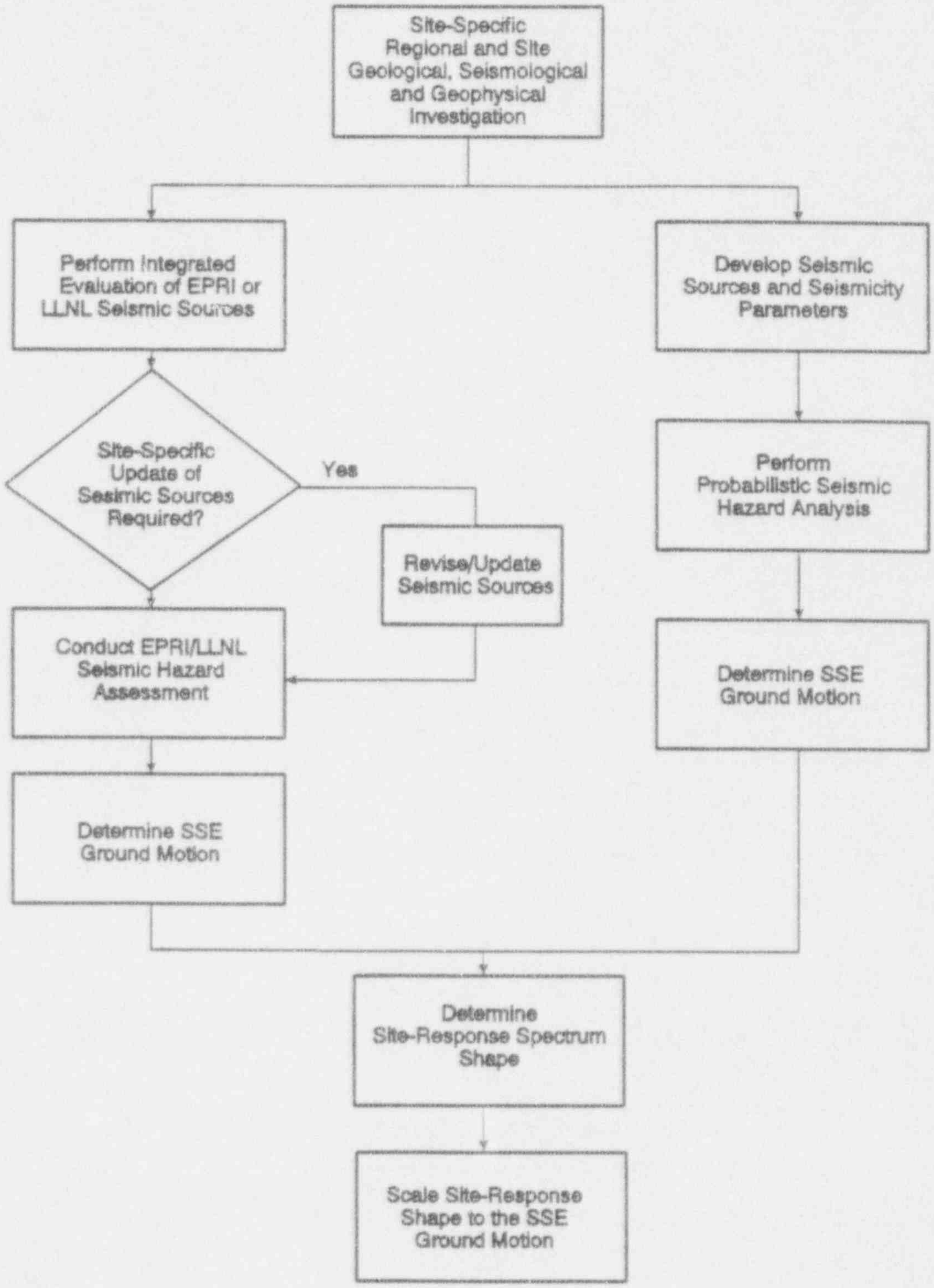
  - up-to-date earth science information in the local vicinity and region of a site

  - an acceptable probabilistic seismic hazard analysis (PSHA)

- Existing plants are acceptably safe and establish a stable Reference Probability level for determining seismic design motions for future plants from PSHA results

- Application to sites east of the Rocky Mountains utilizes the existing, accepted PSHA methodologies and interpretations

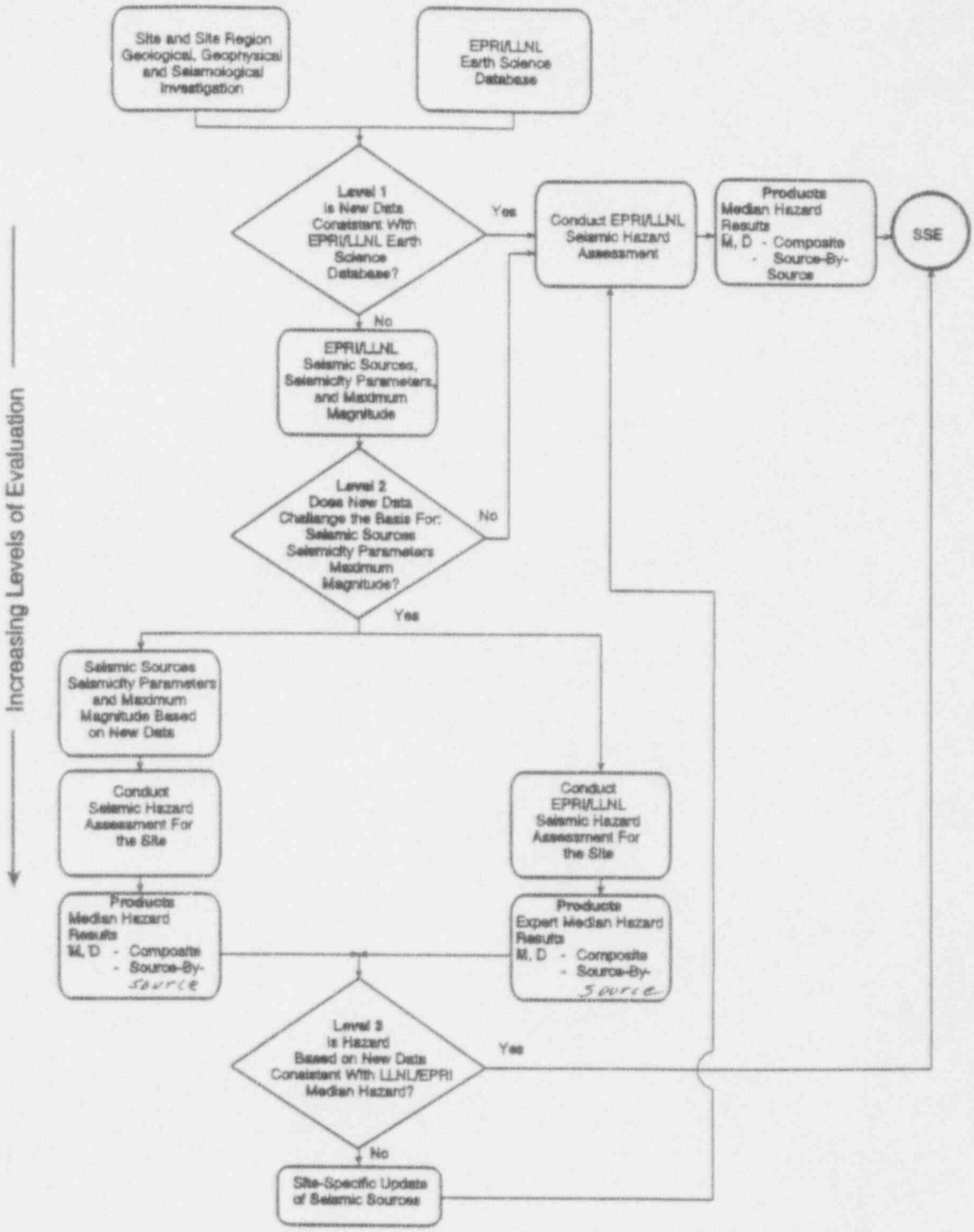
INTEGRATED DECISION PROCESS



NUMARC

3

INTEGRATED DECISION PROCESS APPLICATION TO EUS



NUMARC

#4

SITE-SPECIFIC GEOLOGICAL, SEISMOLOGICAL AND GEOPHYSICAL INVESTIGATION

- Develop a comprehensive, state-of-the-art database for the site

    -- EPRI database

    -- Detailed investigations within 8 km

    -- Reconnaissance investigation within 40 km of the site

    -- Regional review and update within 200 km of the site

INTEGRATED EVALUATION

- Assess consistency of <u>new</u> site and site region data and interpretations with existing source characterizations

  -- Level 1: consistency of each site-specific data set with existing data set

  -- Level 2: consistency of new data with the range of interpretations incorporated in existing multiple seismic source characterizations

  -- Level 3: consistency of the EPRI/LLNL median hazard with an estimate of the hazard based on seismic sources modified by new data or interpretation

LEVEL 1 EVALUATION OF NEW DATA

- Compare each new data set with equivalent data set from EPRI database
- Assess differences in spatial patterns, deformation rates, relationships to significant earthquake activity, etc.
- Perform quantitative evaluations as appropriate
- If consistent, use existing seismic sources

LEVEL 2 EVALUATION OF NEW DATA AND INTERPRETATIONS

- Evaluate the implications of significant new data on existing seismic source interpretations

- Assess if implications are adequately bracketed by the range of existing interpretations

    - -- alternative seismic source boundaries

    - -- alternative maximum magnitudes

    - -- alternative recurrence rates or models

- Perform quantitative evaluations as appropriate

- Use existing sources if no significant implications

LEVEL 3 EVALUATION OF NEW DATA AND INTERPRETATIONS

- If new data and interpretations are not adequately addressed by existing seismic sources at Level 2, compare the hazard computed using existing seismic sources to the hazard computed using seismic sources based on new data and interpretations

- Compare derived median hazard with median hazard based on existing seismic sources

#9

see · 2 pages forward

DETERMINATION OF SEISMIC DESIGN MOTIONS

1. Perform a deaggregated PSHA using an acceptable methodology.

2. Determine from the median hazard the $S_{V,5\text{-}10Hz}$ and $S_{V,1\text{-}2.5Hz}$ ground motions that correspond to the Reference Probability level.

3. Determine the controlling earthquakes, mean magnitude and distance, for the ground motions from Step 2 based on the mean seismic hazard.

4. Evaluate the site-response spectra based on the site response characteristics and the mean magnitude and distance for each ground motion level.

DETERMINATION OF SEISMIC DESIGN MOTIONS (cont.)

5. Scale the site response spectra to corresponding SSE ground motions determined in Step 2.

6. The SSE ground response spectrum is the envelope of the two spectra, or optionally the two are retained as the seismic design motion.

ILLUSTRATION OF THE PROCEDURE TO ESTIMATE THE SSE GROUND MOTION

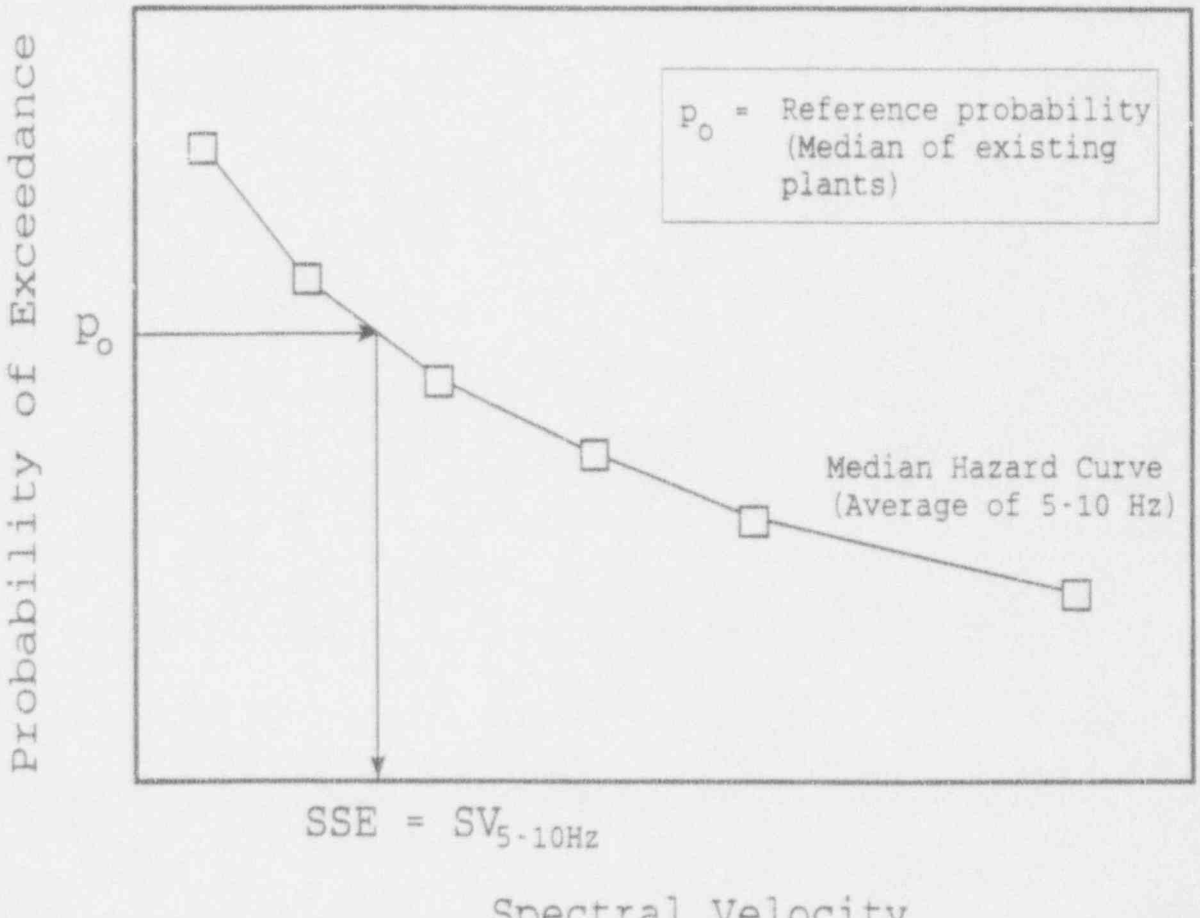
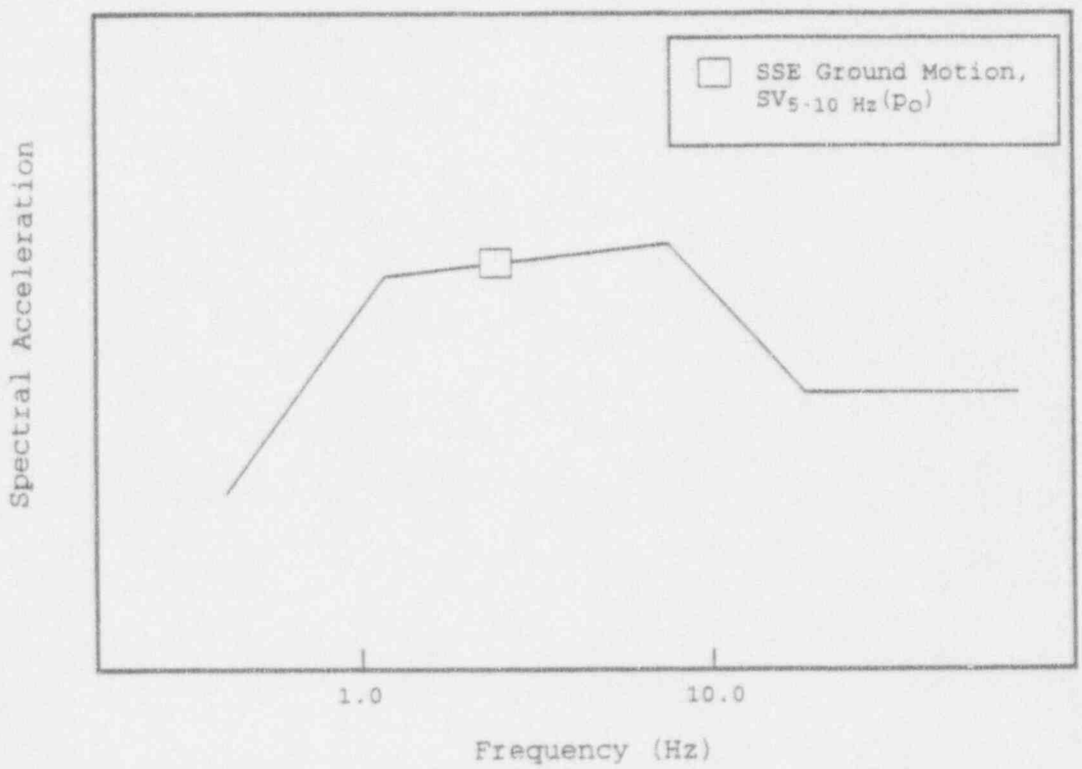


ILLUSTRATION OF THE SSE GROUND RESPONSE SPECTRUM



LEVEL 3 EVALUATION OF NEW DATA AND INTERPRETATIONS

- If new data and interpretations are not adequately addressed by existing seismic sources at Level 2, compare the hazard computed using existing seismic sources to the hazard computed using seismic sources based on new data and interpretations

- Compare derived median hazard with median hazard based on existing seismic sources

- If the median hazard results are consistent, then the existing seismic source interpretations can be used to determine the SSE, if not the interpretations must be updated

STABLE FEATURES OF THE NUMARC APPROACH

- Use of the median hazard curve to obtain a direct estimate of the SSE

- For sites in the EUS, the SSE is predictable, assuming new information does not require modification of the EPRI/LLNL seismic sources or seismicity parameters

PRODUCTS OF THE INTEGRATED SEISMIC SITING PROCESS

- Up-to-date, site-specific earth science database

- Confirmation, or site-specific revision, of the EPRI/LLNL seismic source interpretations

- SSE ground response spectrum

- Seismic hazard information base that provides quantitative insight to the seismic sources and earthquakes that dominate the seismic design motions

STANDARDIZATION OF THE DG-1015 PROCESS

Objective: To establish the DG-1015 procedure as the method for determining the SSE at sites in the U.S.

STATUS OF DG-1015 AS A STANDARDIZED PROCEDURE

- USNRC (publicly released version)

  EUS - dual deterministic/probabilistic approach

  WUS - *"In a region of active tectonics there is less uncertainty about the significant contributors to the seismic hazard and the controlling earthquakes can generally be defined deterministically."*

STATUS OF DG-1015 AS A STANDARDIZED PROCEDURE

- NUMARC

  Probabilistic approach is applied to all areas of the U.S.

ATTRIBUTES OF DG-1015

1. Existing plants in the U.S. are safe

2. Based on the population of existing plants, a consistent basis for determining the seismic design basis of future commercial reactors can be established: Reference Probability and SSE

3. The procedure described in DG-1015 (NUMARC) to determine the SSE is applicable to all tectonic environments and geographic locations in the U.S.

ATTRIBUTES OF DG-1015 (cont.)

4. The seismic and geologic siting procedure must provide the same level of acceptable safety, plant-to-plant

5. The seismic siting procedure must provide regulatory and licensing stability

ISSUES TO ESTABLISH THE DG-1015 APPROACH FOR ALL TECTONIC REGIONS

- Site-to-site consistency in methodology application

- Reference Probability - a single, accepted value is required

- Site and Site Region Investigation - acquisition of adequate earth science information for seismic siting of commercial nuclear power plants is required

NUMARC

#20

ISSUES TO ESTABLISH THE DG-1015 APPROACH FOR ALL TECTONIC REGIONS (cont.)

- Sources of uncertainty with respect to seismic source characterization are similar regardless of tectonic environment - key is the quantification of uncertainty

- Sources of uncertainty are similar, and independent of tectonic environment

- For some sites single dominant fault-specific seismic sources may control the site hazard and the seismic design motions

---

REFERENCE PROBABILITY LEVEL

- For purposes of establishing a stable seismic siting procedure, a single, accepted Reference Probability ~~must~~ should be established

- Given the population of existing plants is safe, the Reference Probability is a surrogate measure of plant safety. It is the basis for assuring uniform seismic safety at future plants (coupled with seismic design requirements)

- EPRI and LLNL ('92) median seismic hazard results are in general agreement and provide a basis to establish a single Reference Probability

REFERENCE PROBABILITY LEVEL

- Initial evaluations of the LLNL '92 hazard results indicates that the LLNL and EPRI Reference Probability values will show greater consistency

- It is anticipated that a single Refernce Probability can be established that will be applicable to the results of a PSHA that has been performed using an accepted methodology

SITE AND SITE REGION INVESTIGATIONS

- Comprehensive investigations must be conducted at all sites as specified in 10 CFR Part 100, Appendix B and described in DG-1015, Appendix D

- Results of the investigation must be included in the PSHA used to determine the SSE.

SUMMARY - SEISMIC SITING PROCESS

- DG-1015 procedure is applicable to all locations and potential NPP sites in the U.S.

- Seismic siting process requires:

  - Comprehensive site and site region earth science investigation

  - site-specific PSHA based on an accepted methodology or use of an existing accepted methodology and data

  - Use of the accepted Reference Probability to determine the SSE

NUMARC/AHAC

Seismic and Geologic Siting and Rulemaking 10CFR Part 100 Appendix B

Special Assessment of Plant Seismic Safety for Sites near Single, Dominant, High-Activity Faults

NUMARC/NRC Meeting

Rockville, MD

November 30, 1993

REFERENCE PROBABILITY - ALTERNATIVE

- Generally, consistent plant to plant seismic safety can be achieved by a Reference Probability based on PSHA results available for the existing population of plants

- For certain tectonic environments, some adjustment of the Reference Probability may be considered by an applicant

- These opportunities are likely limited to certain site-source configurations and seismicity conditions

- Modification of the Reference Probability may be possible at sites where the slope of the hazard curve is steep, relative to the average hazard curve slope for the population of operating plants

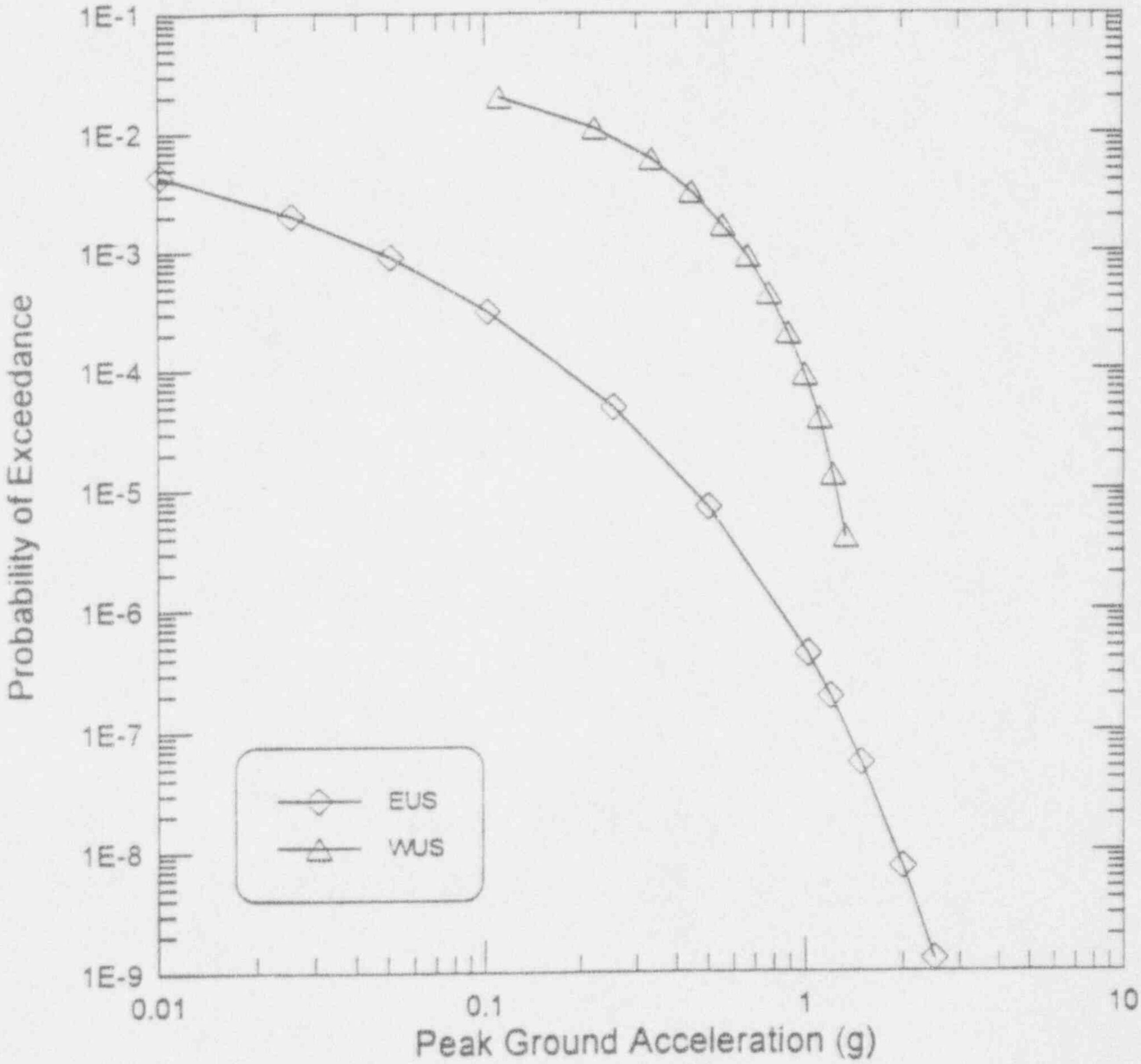
REFERENCE PROBABILITY - ALTERNATIVE (cont.)

- Premise - For sites whose hazard curves are steep, as compared to the population of hazard curves used to determine the Reference Probability, a higher SSE probability can be determined

- This may provide some relief at sites where the SSE is high

- Criterion - Level of plant safety should be the same for all plants (future)

Comparison of Hazard Curve Shapes



ISSUES TO ESTABLISH THE DG-1015 APPROACH FOR ALL TECTONIC REGIONS (cont.)

- Site-to-site consistency in methodology application

- Reference Probability - a single, accepted value is required

- Site and Site Region Investigation - acquisition of adequate earth science information for seismic siting of commercial nuclear power plants is required

- Sources of uncertainty with respect to seismic source characterization are important regardless of tectonic environment - key is quantification of uncertainty

BASIS AND DEMONSTRATION

- Examined the sensitivity of plant safety levels as a function of the hazard curve slope and capacity of future reactors as a function of their design basis.

- Used the Risk Equation[1] to examine the role of the hazard curve slope in the assessment of plant safety and to make comparisons between sites in contrasting tectonic environments (sites where the hazard curve slope may be steep)

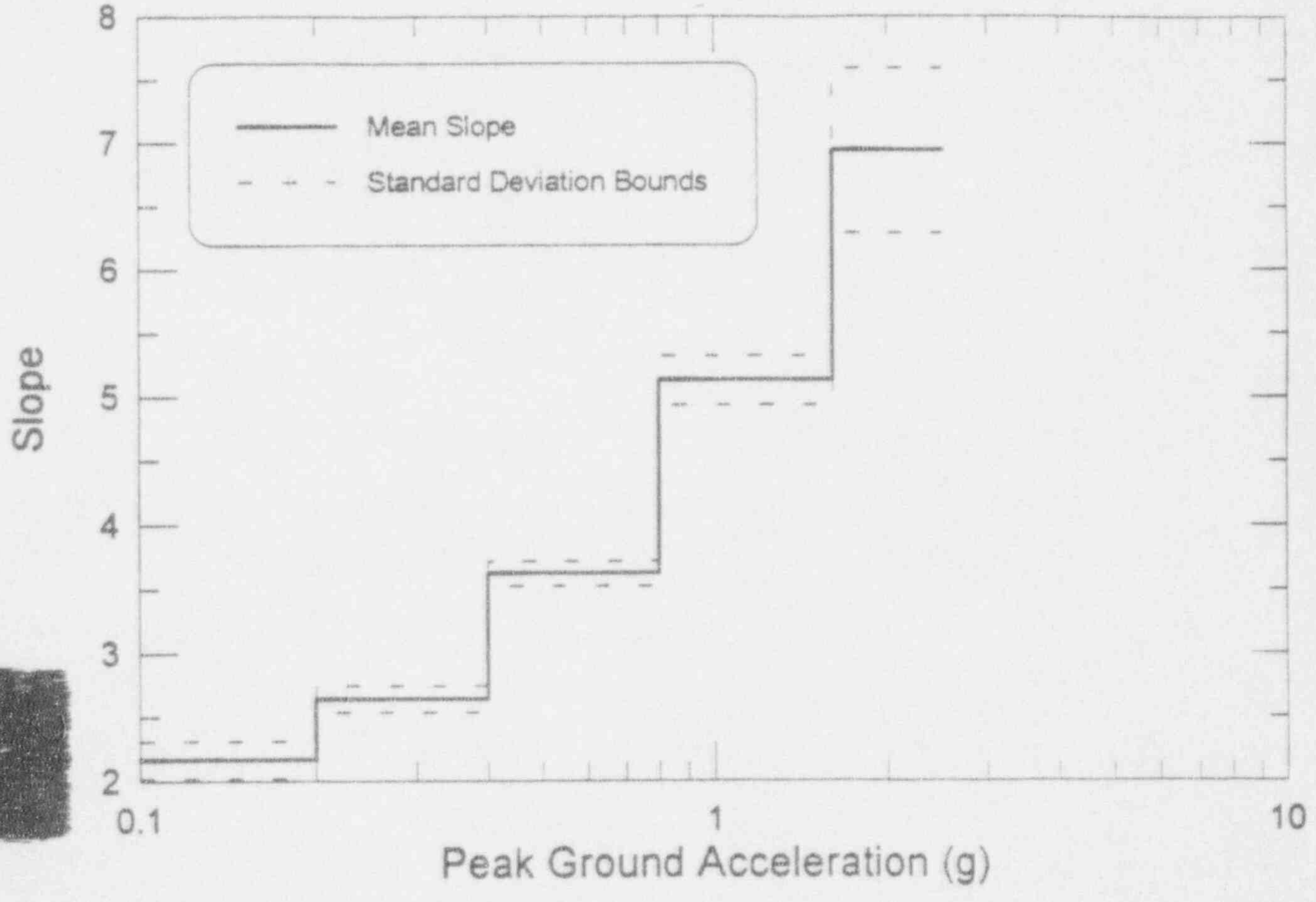
[1]The risk Equation has been used by Cornell, Kennedy and others as part of efforts to establish consistent seismic design standards

BASIS AND DEMONSTRATION (cont.)

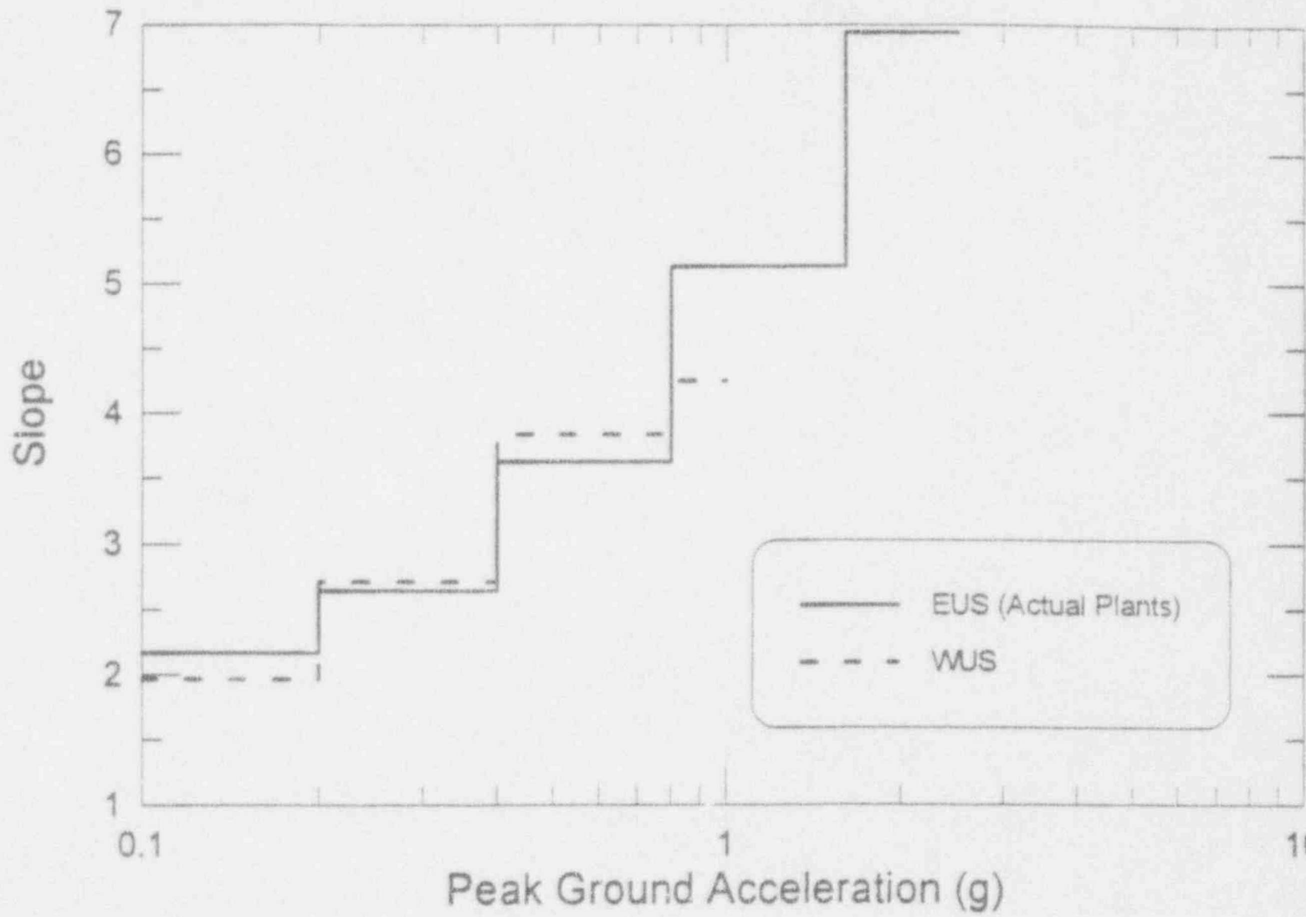
- From existing hazard assessments, we can determine
  - typical hazard curve slopes,
  - ground motions that dominate plant risk (challenge plant safety)

- For essentially all tectonic environments in the U.S., hazard curve slopes and ground motions that dominate risk (for future reactors) are reasonably consistent, site to site

Summary of Hazard Curve Slopes (EPRI, Existing Plant Sites)



Comparison Hazard Curve Slopes



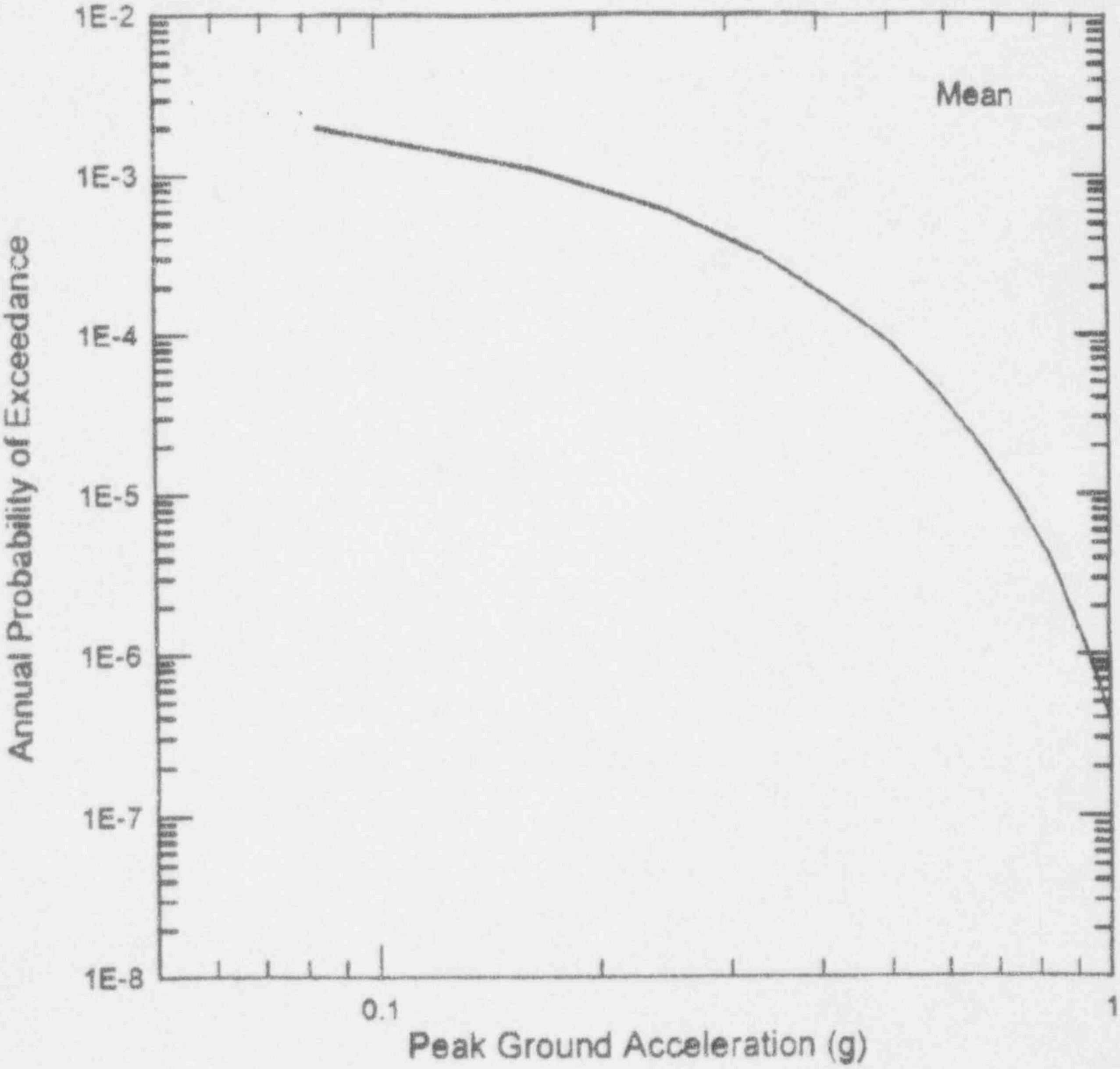
NUMARC

REFERENCE PROBABILITY - MODIFICATION

- Slope Criterion - If $|K_H| \gtrsim 5$, the applicant has the option to perform an evaluation to assess the possible modification of the SSE probability

- Observation - There are a limited number of sites where K_H will be steep

- A review of hazard results at different sites suggests the hazard must be dominated by a well-defined fault-specific seismic source with a rate of seismicity that dominates the site hazard



Mean
1E-2
1E-3
1E-4
1E-5
1E-6
1E-7
1E-8
Annual Probability of Exceedance
0.1
1
Peak Ground Acceleration (g)

ILLUSTRATION

- Site Hazard Curve Slope (K_H) = 10.2

- $$\frac{P_{SSE}}{RP_s} = 18.3$$

  Based on: $F = 1/4$

  $\beta_c = 0.33$

- SSE probability = 3.7×10^{-4}

PROPOSED HYBRID APPROACH - KEY ELEMENTS

- TARGET EXCEEDANCE PROBABILITY SET BY EXAMINING CURRENT NUCLEAR POWER PLANTS
- CONDUCT PROBABILISTIC SEISMIC HAZARD ANALYSIS
- CONDUCT SITE SPECIFIC AND REGION SPECIFIC GEOSCIENCE INVESTIGATIONS
- CHECK TO DETERMINE IF GEOSCIENCE INVESTIGATION CHANGE PROBABILISTIC RESULTS
- CALCULATE SITE SPECIFIC GROUND MOTION FOR PLANT
- INDEPENDENT STAFF CHECK OF PROBABILISTIC RESULTS AGAINST SIMPLIFIED DETERMINISTIC ANALYSIS
- UPDATE OF DATA BASE AND PROBABILISTIC METHODOLOGY EVERY TEN YEARS

OBE EXCEEDANCE

- For future plants, industry agrees that the NRC staff proposed wording in DG-1016 with respect to measuring OBE Exceedance in the free field is acceptable.
  - Future plants should use a free-field location to compare with their design basis.

OBE EXCEEDANCE

- For operating plants, industry is currently evaluating the OBE Exceedance criteria. Recommendations will be incorporated into "Implementation Guidelines" for utilities to use in adding and/or upgrading instrumentation.
  - Industry maintains that instrumentation for determining OBE Exceedance should be located at the ground surface in the free-field for soil sites and may be located on the containment foundation if the plant is founded on rock. This position is consistent with the existing requirements of 10 CFR 100 Appendix A: "Suitable seismic instrumentation shall be provided so that the seismic response of nuclear power plant features important to safety can be determined promptly to permit comparison of such response with that used as the design basis."

OBE EXCEEDANCE

Sensitivity of CAV and response spectrum at rock sites

- Rock shear-wave velocity profiles
  - soft: 3,000 ft/sec
  - medium: 6,000 ft/sec
  - hard: 9,000 ft/sec
- Free-field horizontal ground motion
  - M 5.5 typical EUS earthquake
  - EPRI stochastic simulation method
- Soil-structure interaction
  - Prototypical nuclear containment structure embedded 20'
  - Horizontal SASSI (finite element) analysis
    - » stick model, rigid foundation
    - » with and without incoherence effect
- Analysis
  - Develop transfer functions
  - Convolve with free-field motions
  - Measure CAV and response spectrum
  - Compare