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Comanche Peak Nuclear Power Plant Units 3 and 4

Integrated Seismic Closure Plan (ISCP) Part 2: Seismic Input

Presented by
Osman El Menchawi, Fugro
May 24, 2012

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Agenda

- Sequencing of ISCP and IHCP Activities
- Current Seismic Source Model in FSAR
- Summary of CEUS SSC Model and Key Features
- Summary of Changes from CPNPP FSAR Model to CEUS SSC Model
- New CEUS Model Implementation
- Updated Ground Motion Analysis
- GMRS and FIRS Framework
- Potentially Related RAIs
- Summary and Conclusion

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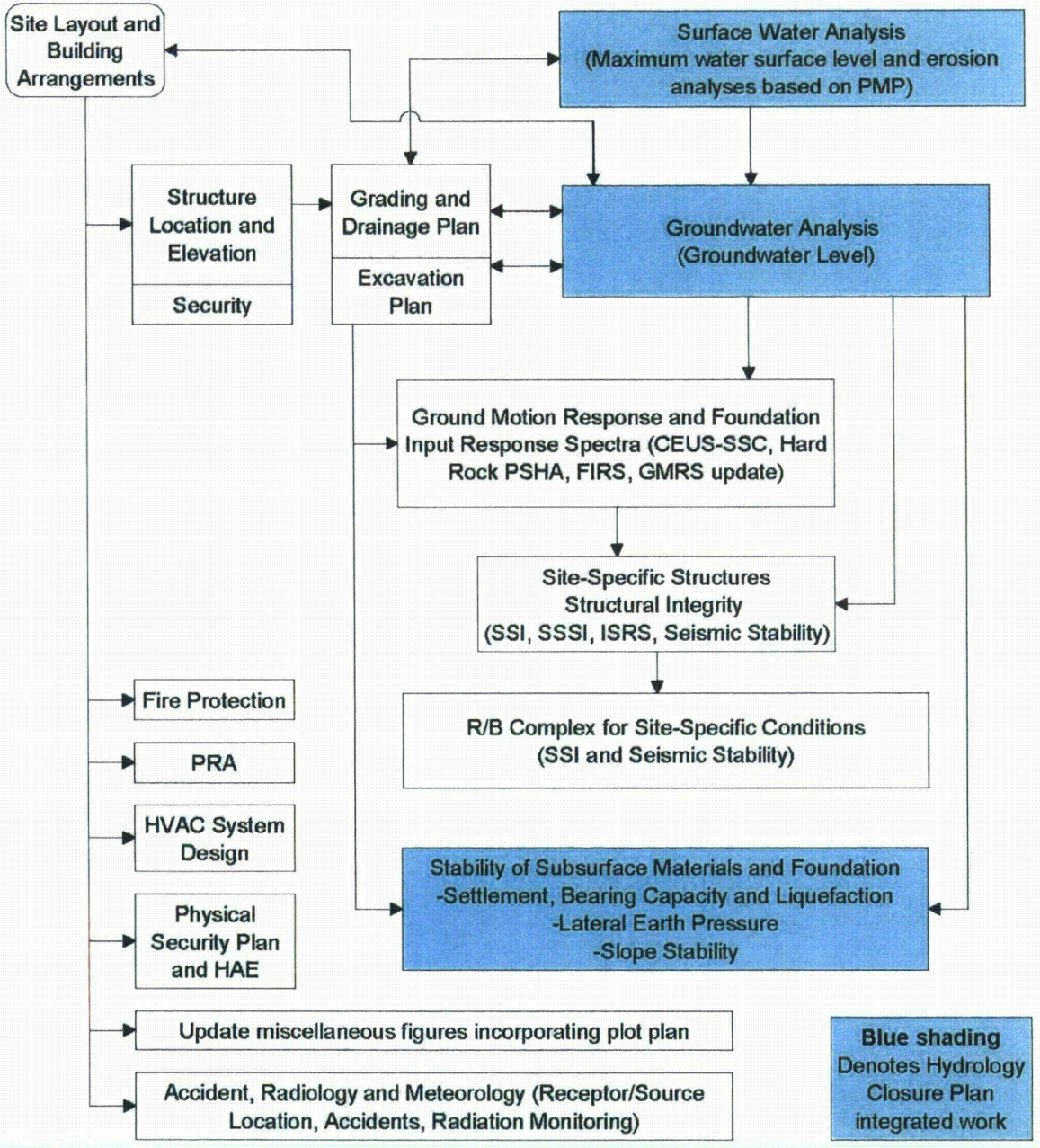
Sequencing of ISCP and IHCP Activities

- ISCP
- IHCP



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Current Seismic Source Model in FSAR

- Seismicity hazard was primarily modeled using EPRI-SOG (1989) Seismic Source Characterization (SSC)
  - Six expert teams developed sets of seismic sources covering the Central and Eastern United States (CEUS): Bechtel Corporation, Dames & Moore, Law Engineering, Rondout Associates, Weston Geophysical Corporation, and Woodward-Clyde Consultants
  - Each team's model was modeled separately and then combined by providing equal weights for each team

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Current Seismic Source Model in FSAR (cont.)

- Revisions and checks to the EPRI-SOG (1989) as incorporated in FSAR were as follows:
  - EPRI-SOG's earthquake recurrence parameters were maintained as they were found to be more conservative than those calculated from the updated seismicity catalog encompassing events from 1985-2006
  - Mmax was changed in two source zones due to updated information: Dames and Moore's South Coastal Margin and Law Engineering's New Mexico-Texas Block
  - Mmax distribution was updated for the Bechtel, Rondout, and Weston Gulf Coast zones due to higher magnitude events occurring in 2006
  - New seismic source characterizations were developed for four tectonic features: New Madrid Seismic Zone (NMSZ), Meers fault, Rio Grande Rift (RGR), and Cheraw fault
  - EPRI (2004) ground motion model was used with revised aleatory uncertainties presented in EPRI (2006)

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Summary of CEUS SSC Model

- Update to the older EPRI CEUS SSC model (EPRI, 1989)
- Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 (NUREG/CR-6372)
- EPRI, NRC, and DOE
- Uniform processing of earthquake catalog
- New definition of seismic source zones
  - Conceptual framework
  - Maximum magnitude evaluation
  - Rates (updated seismicity catalog)

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Summary of CEUS SSC Model Key Features

- Seismotectonic sources
  - Faulting, depth, Mmax, recurrence, geologic structure
- Mmax Zones
  - Mesozoic-and-younger extended crust (MESE)
  - Non-Mesozoic-and-younger crust (NMESE)
- Repeated Large Magnitude Earthquake (RLME) Zones
  - Have generated earthquakes of $M \geq 6.5$
  - Based mostly on historic record and paleoliquefaction evidence

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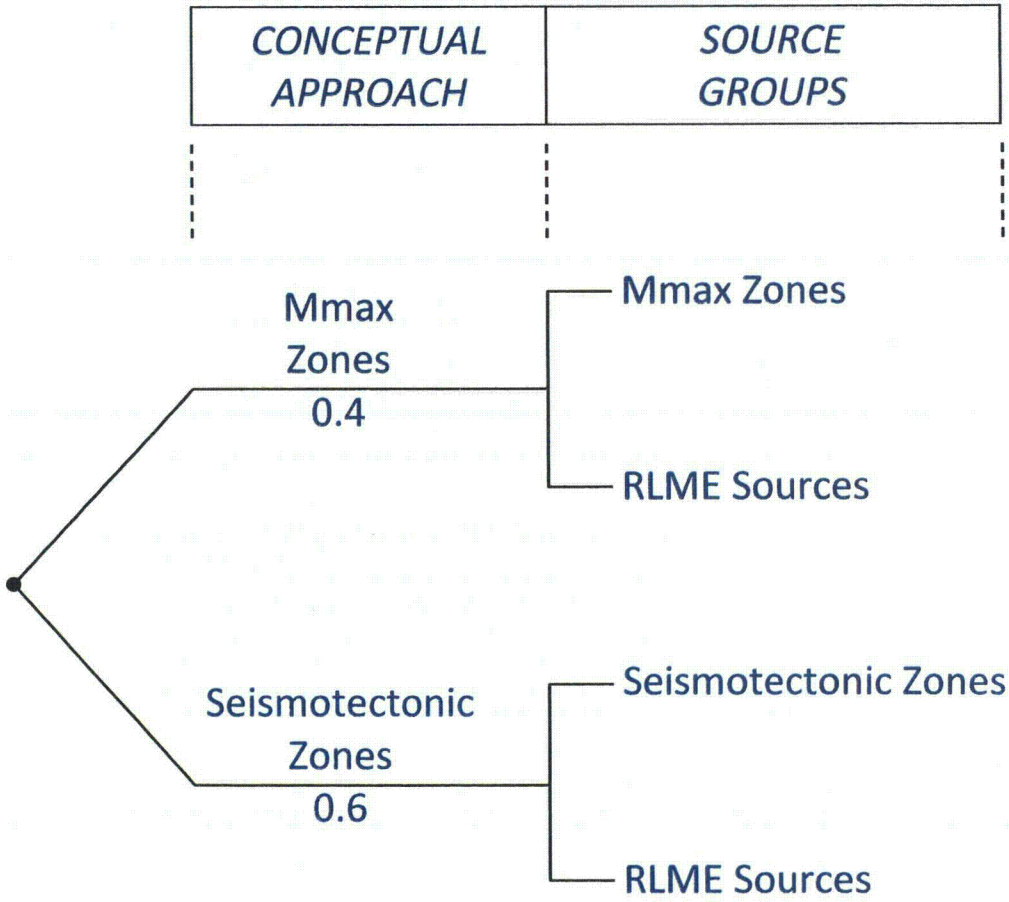
Summary of CEUS SSC Model Key Features (cont.)

- Master Logic Tree



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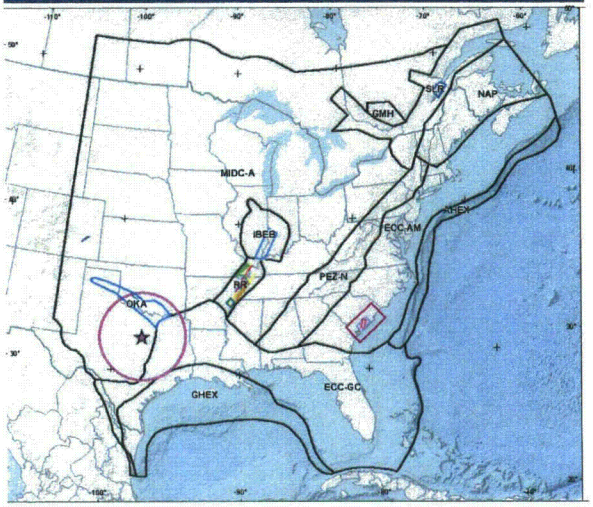
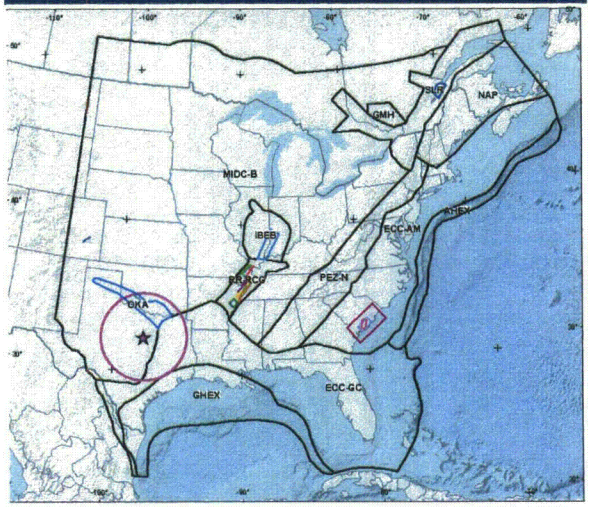
Seismotectonic Sources

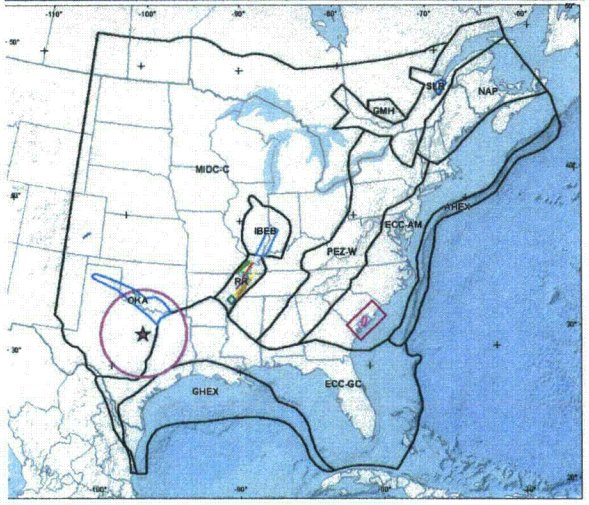
NARROW PEZ – NO RCG in RR



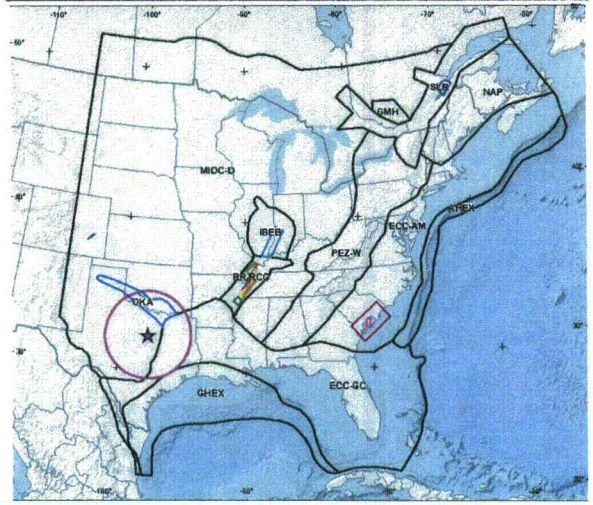
NARROW PEZ –RCG in RR



WIDE PEZ – NO RCG in RR



WIDE PEZ – RCG in RR



- Four Interpretations
  - NARROW PEZ – NO RCG in RR
  - NARROW PEZ –RCG in RR
  - WIDE PEZ – NO RCG in RR
  - WIDE PEZ – RCG in RR
- PEZ: Paleozoic Extended Zone
- RCG: Rough Creek Graben
- RR: Reelfoot Rift
- RLME Sources are Shown

MIDC: Midcontinent-Craton

OKA: Oklahoma Aulacogen

ECC-GC: Extended Continental Crust – Gulf Coast

GHEX: Gulf Highly Extended Crust

IBEB: Illinois Basin Extended Basement

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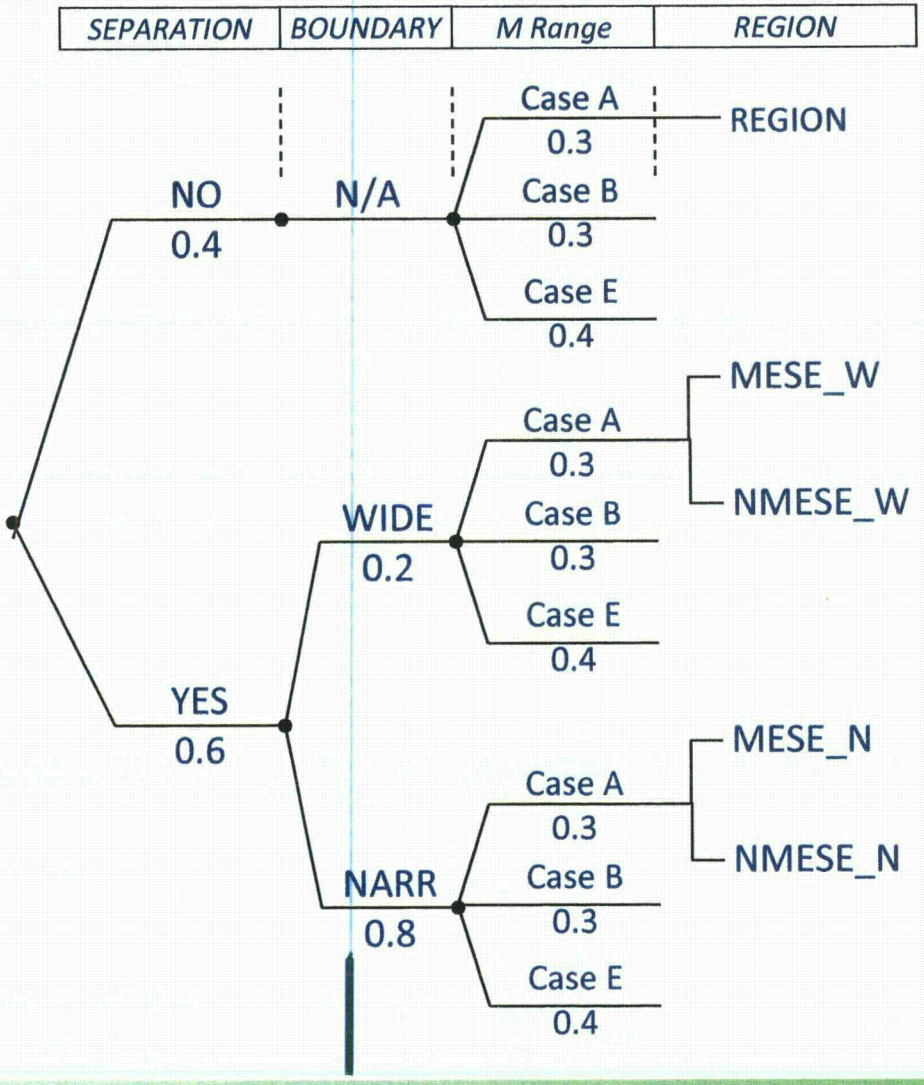
Summary of CEUS SSC Model Key Features (cont.)

- Mmax Zones



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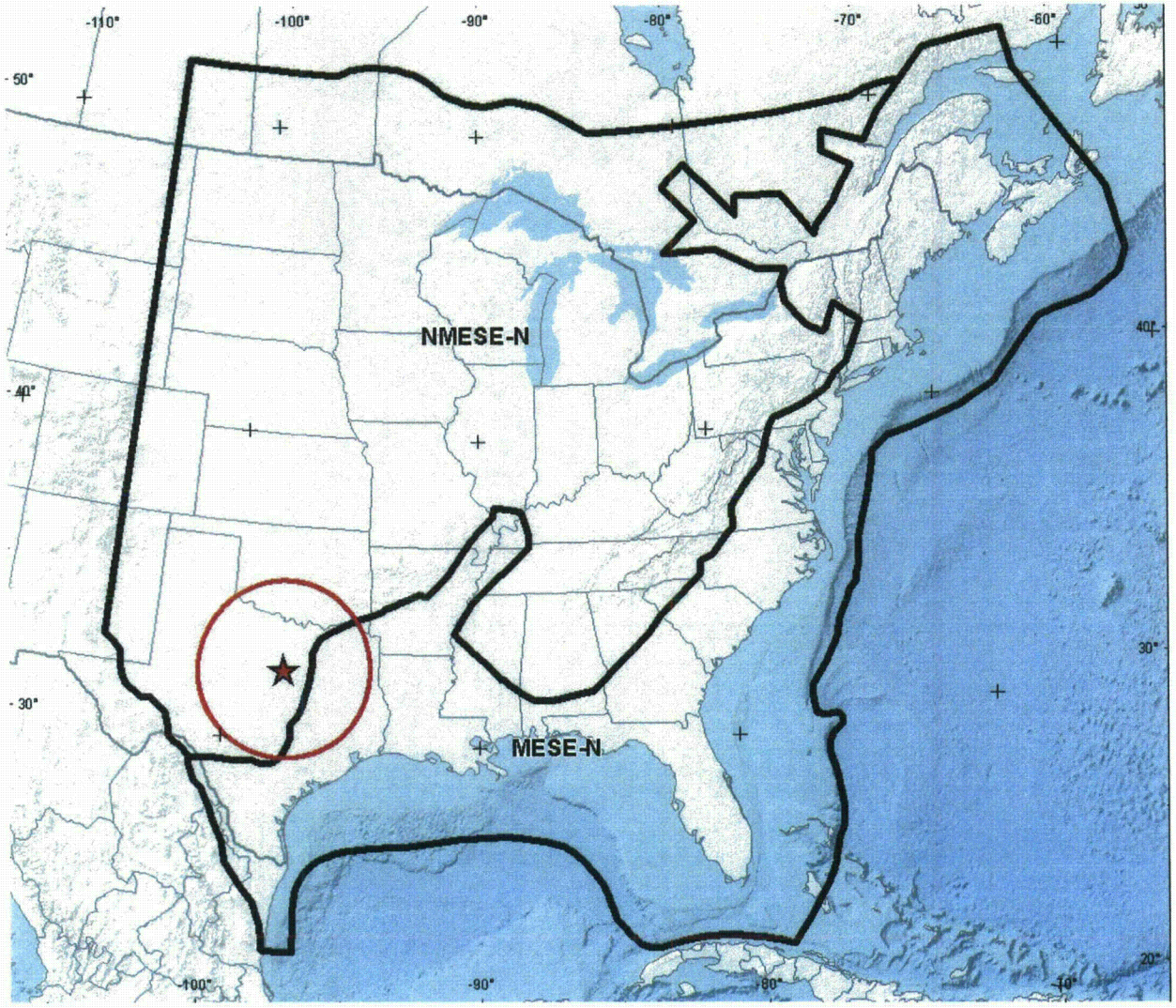
Mmax Zones (Narrow MESE)



Explanation

- Comanche Peak site
- 200 mile radius
- Mesozoic and Non-Mesozoic zones for the CEUS - narrow interpretation

Abbreviations:

MESE-N = Mesozoic and younger extended prior - narrow

NMESE-N = Non-Mesozoic and younger extended prior - narrow

Source: 1. CEUS SSC Project

Base map: GEBCO_08 Grid, (BODC, 2009)

N 0 400 mi.
0 600 km

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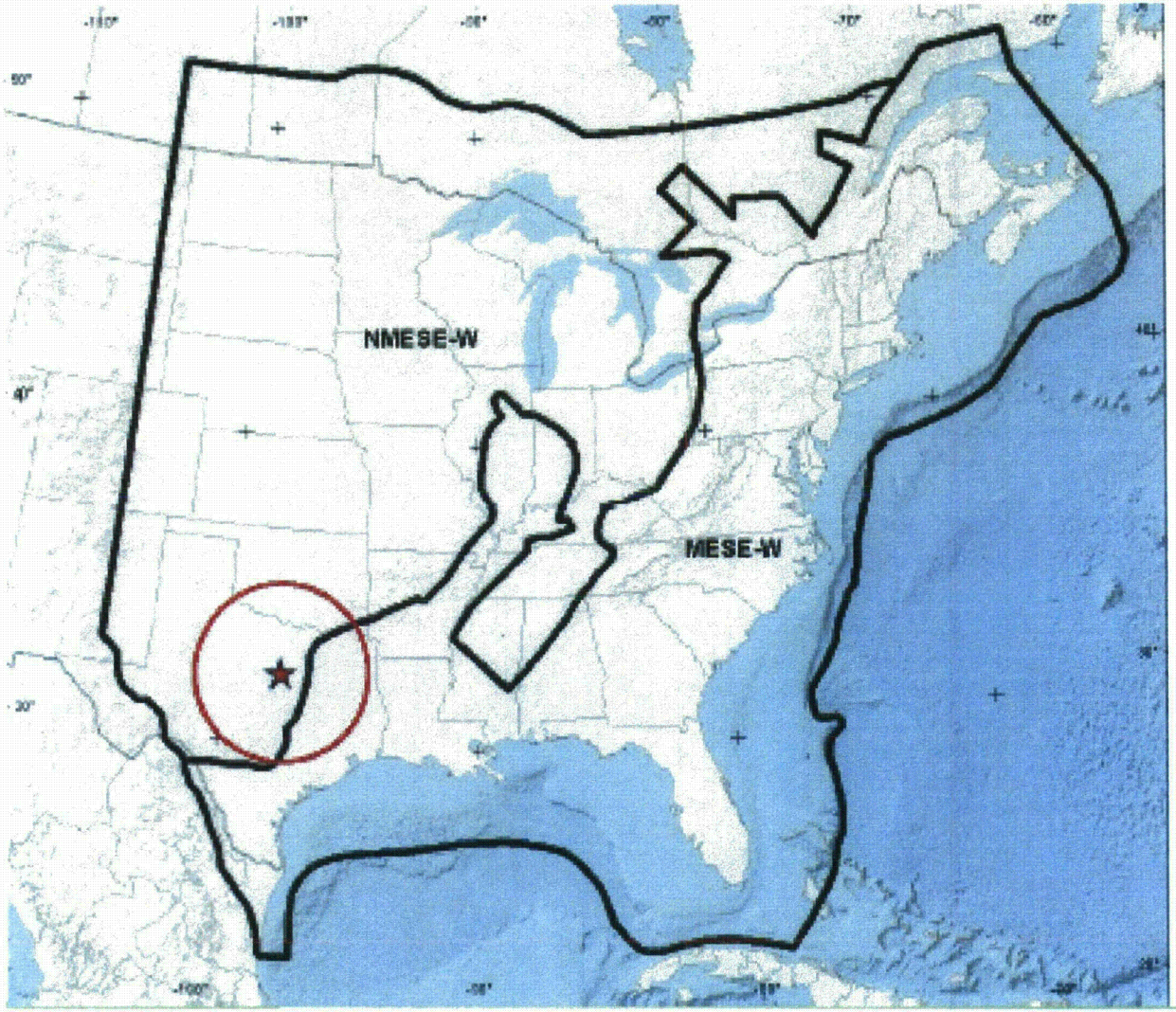
Mmax Zones (Wide MESE)



Explanation

Comanche Peak site

200 mile radius

Mesozoic and Non-Mesozoic zones for the CEUS - wide interpretation

Abbreviations

MESE-N = Mesozoic and younger extended prior - wide

NMESE-N = Non-Mesozoic and younger extended prior - wide

Source: 1 CEUS-SSC Project

Base map: GEBCO_08 Grid, (BODC 2009)

N 0 400 mi
0 800 km

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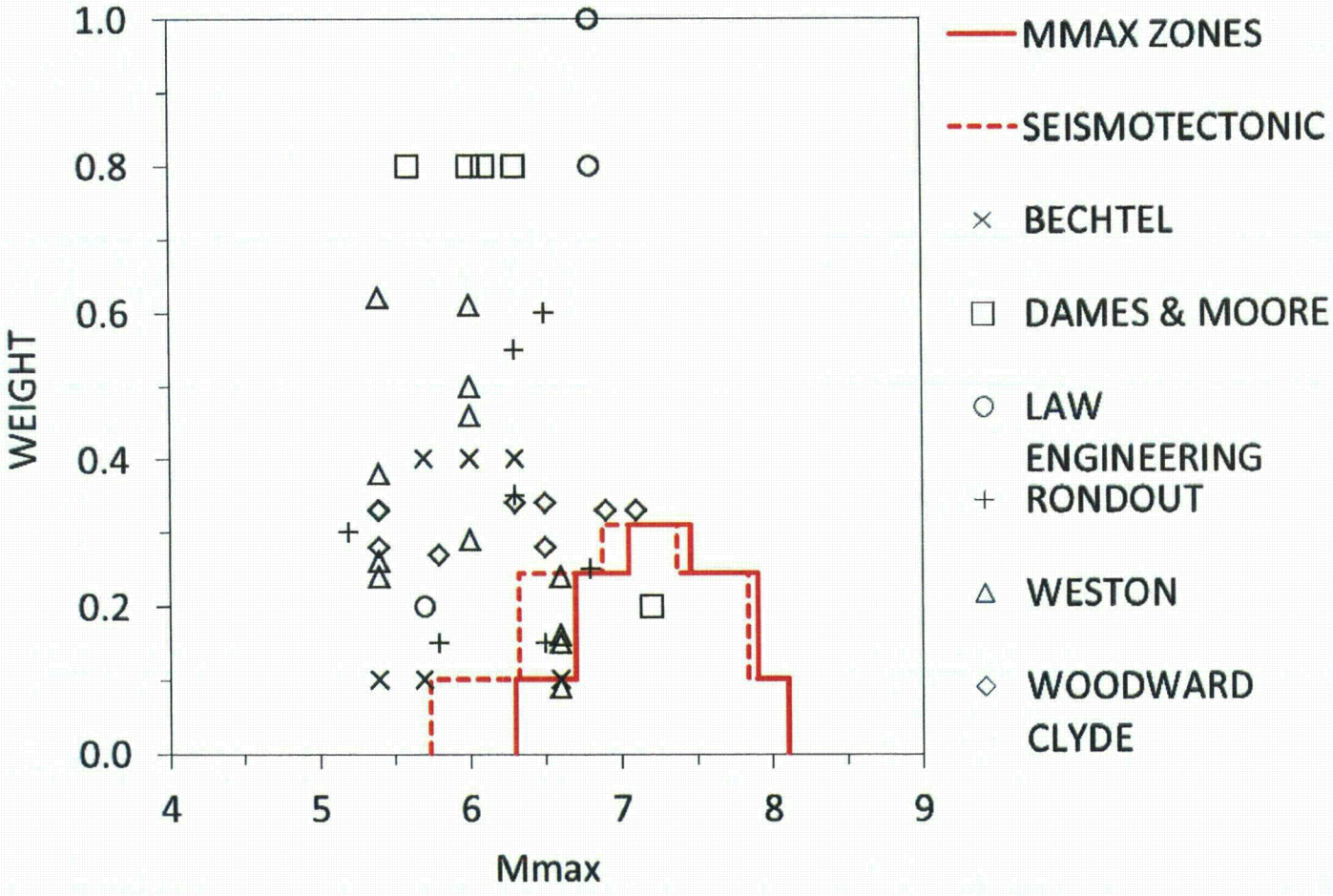
Mmax Comparison



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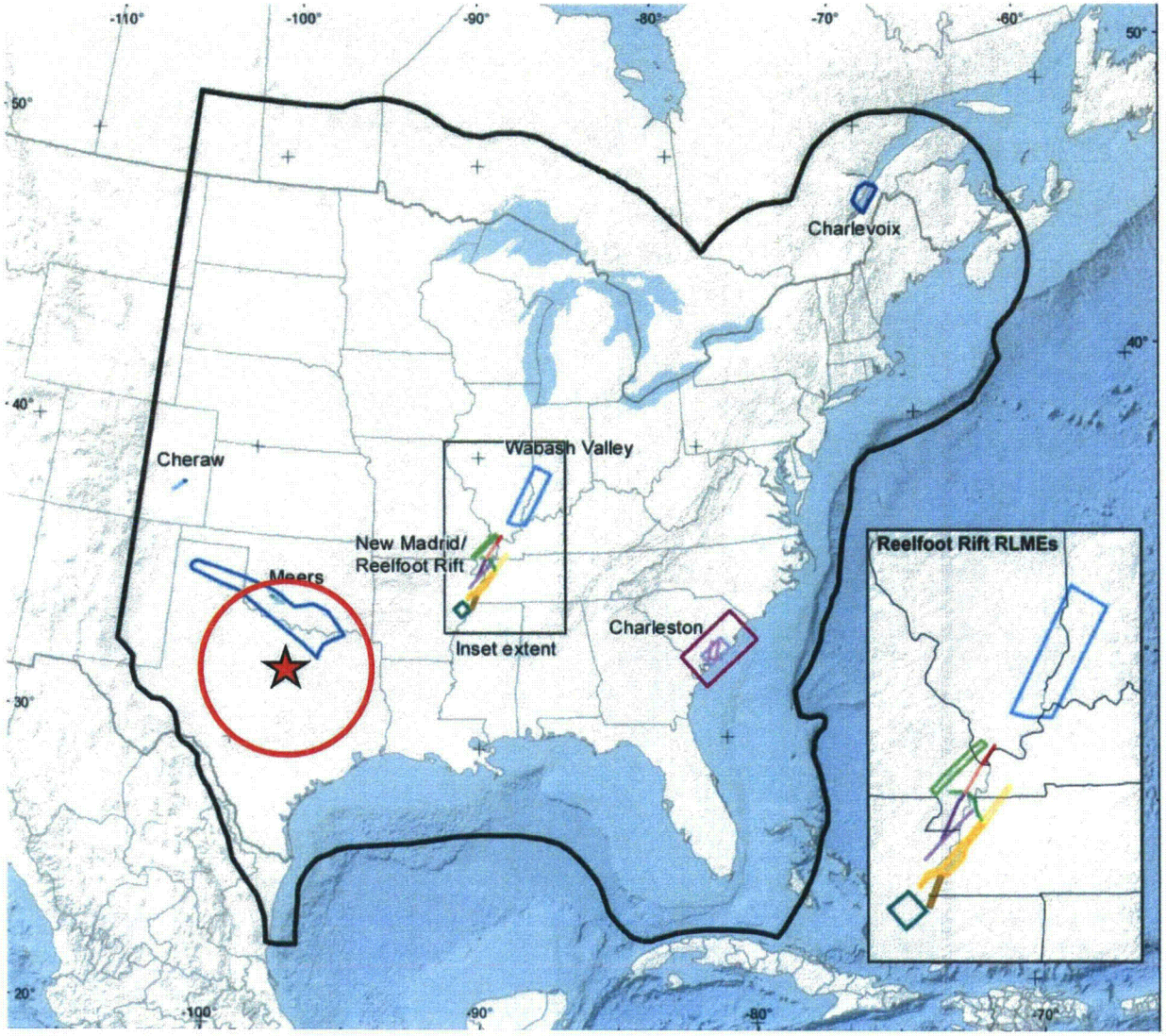
RLME Sources



Explanation

- CEUS study area (1)

RLME Sources (1)

- Charleston–local
- Charleston–narrow
- Charleston–regional
- Charlevoix
- Cheraw fault
- Cheraw fault–extended
- Meers fault–Quaternary
- Meers fault–extended
- Oklahoma Aulacogen

Reelfoot Rift (see inset map)

- NMN–short
- NMN–extended
- NMS–Blytheville fault zone
- NMS–Bootheel lineament
- Reelfoot thrust–short
- Reelfoot thrust–extended
- Commerce fault zone
- Eastern rift margin–north
- Eastern rift margin–south/Crittenden Co
- Eastern rift margin–south/river picks
- Marianna
- Wabash Valley

Source: 1. CEUS SSC Project

Base map: GEBCO_08 Grid (BODC, 2009)

N

0 400 mi

0 800 km

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Summary of Changes from CPNPP FSAR Model to CEUS SSC Model – Distributed Seismicity Sources

- Sources
  - EPRI-SOG – 6 alternative source zone models
  - CEUS SSC – 1 model with 4 different interpretations
- Seismicity Rates
  - EPRI-SOG – spatially varying, 1° x 1° cells, based on mb
  - CEUS SSC – spatially varying, 1/4° x 1/4° or 1/2° x 1/2° cells, based on Mw
- Maximum Magnitude Distributions
  - EPRI-SOG – various qualitative methods
  - CEUS SSC – Bayesian approach using updated Stable Continental Region prior distributions with somewhat higher mean values

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New CEUS Model Implementation

- FRISK88 is V&V/qualified under the Fugro 10 CFR Part 50 Appendix B QA program
- Used for more than 65% of the U.S. New Build ESP and COLA licensing studies, and past industry studies for index operating plants (e.g., EPRI). It was the primary software used in CEUS SSC model development
- The new CEUS source model is currently implemented in FRISK88

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Updated Ground Motion Analysis Primary Objective

- Address Recommendation 2.1 of the Fukushima Near-Term Task Force recommendations contained in SECY-12-0025 as it pertains to seismic hazard evaluation
- Recommendation 2.1 is covered under 10 CFR 50.54(f) letter of 3/12/12 issued by the NRC regarding Recommendation 2.1 of the Near-Term Task Force review of Insights from the Fukushima Dai-Ichi Accident (NRC Adams Accession No. ML12053A340)
- Evaluate the potential impacts of the newly released CEUS-SSC model, with potential local and regional refinements, on the GMRS/FIRS
- Modify the site-specific GMRS and FIRS if changes are necessary based on the evaluation performed

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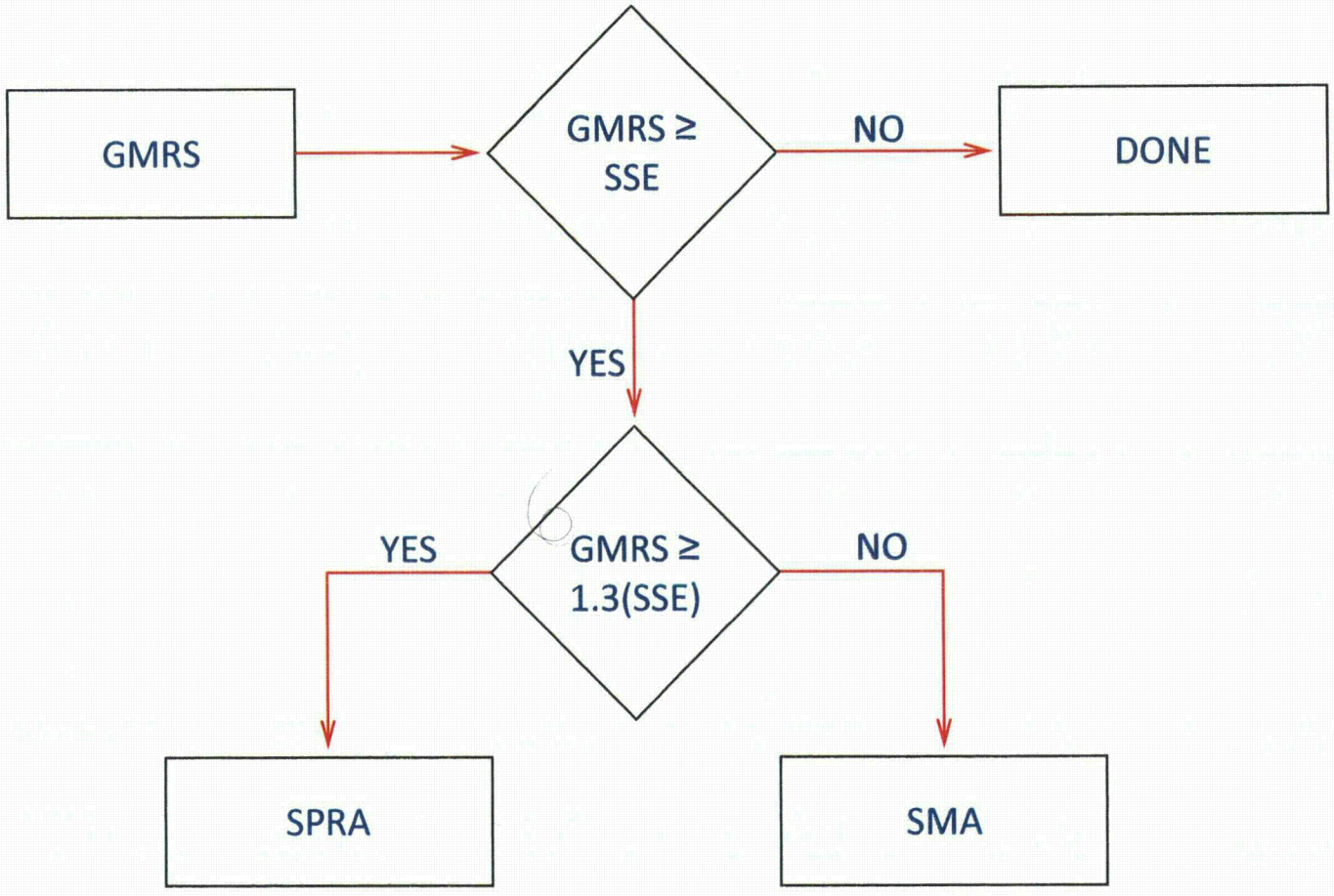
Summary of Recommendation 2.1 Flow Chart



GMRS: ***Ground Motion Response Spectra***

SPRA: ***Seismic Probabilistic Risk Assessment***

SSE: ***Safe Shutdown Earthquake***

SMA: ***Seismic Margin Analysis***

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SSI Consistency

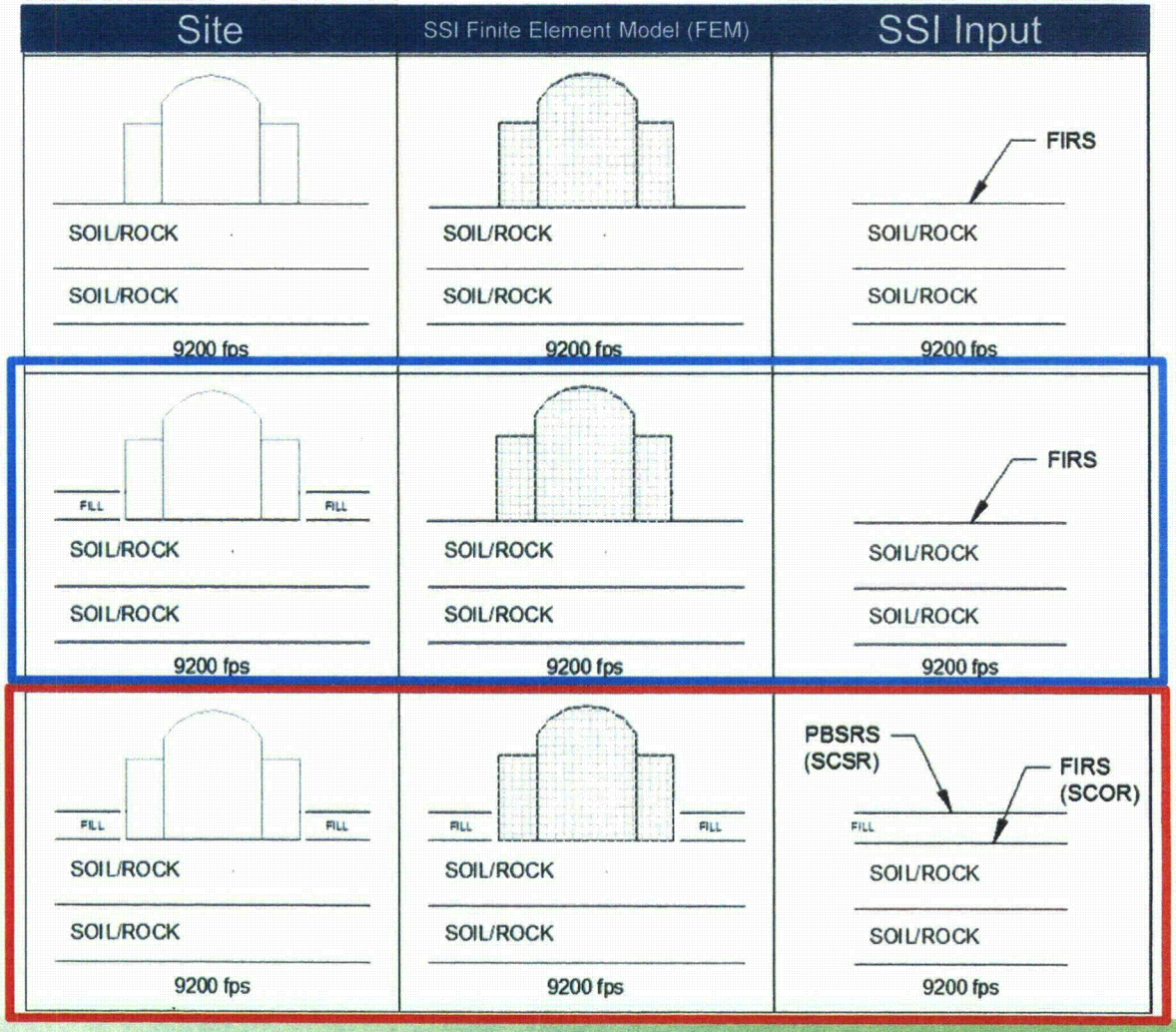
based on Nuclear Energy Institute (NEI) White Paper, "Consistent Site-Response/Soil-Structure-Interaction Analysis and Evaluation," NEI, June 12, 2009. (ADAMS Accession No. ML091680715)

1. Surface Structure
2. Embedded Structure Analyzed as Surface

Previous

3. Embedded Structure Analyzed as Embedded

New



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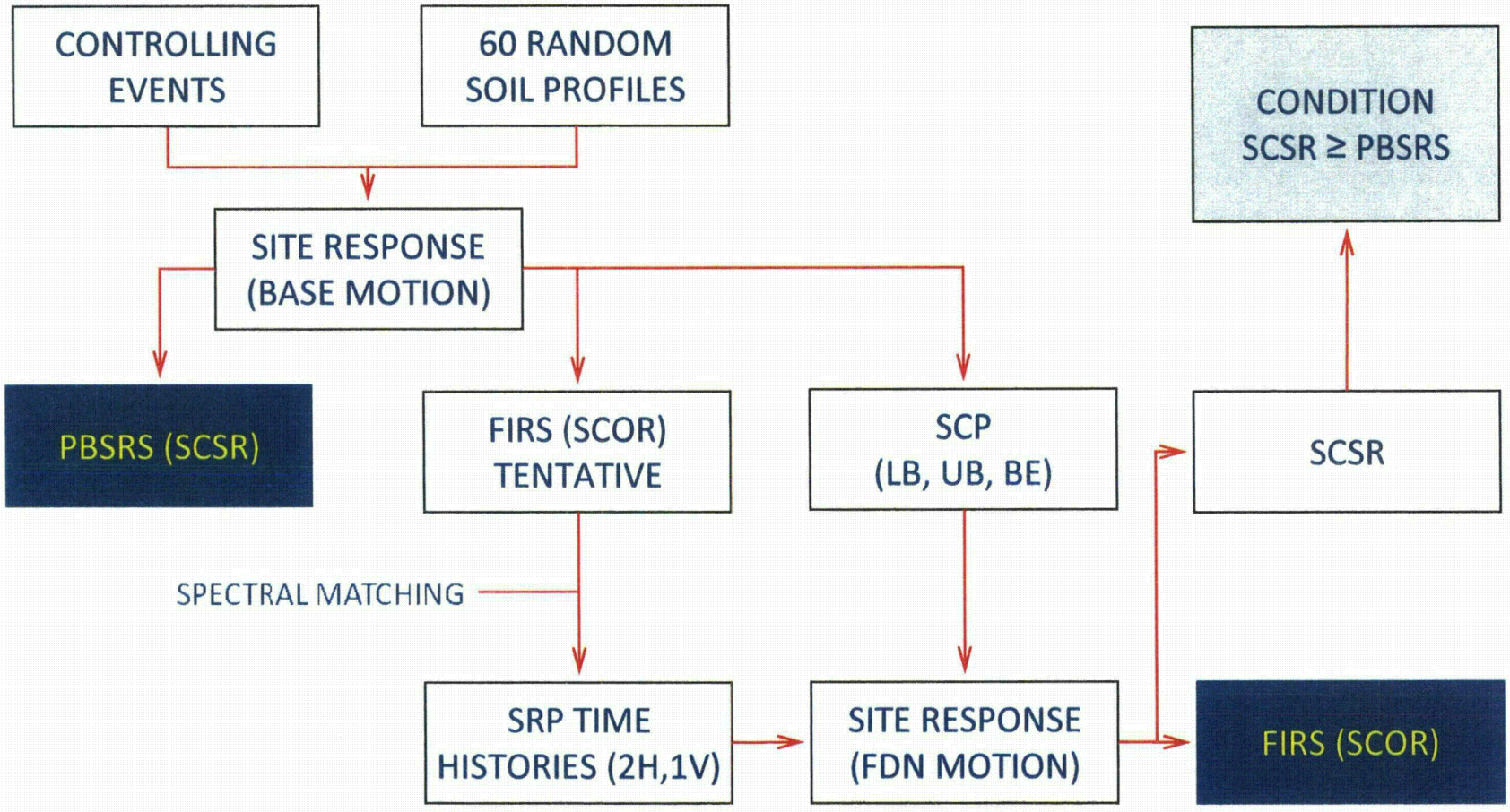
FIRS Development



FIRS:	***Foundation Input Response Spectra***	***SCSR:***	***Soil Column Surface Response***
PBSRS:	***Performance Based Surface Response Spectra***	***SRP:***	***Standard Review Plan***
SCOR:	***Soil Column Outcrop Response***	***SCP:***	***Strain Compatible Profiles***
		FDN:	***Foundation***

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Summary of Analysis Framework

- Compute rock hazard curves and Uniform Hazard Response Spectrum (UHRS) at 10-4, 10-5, and 10-6 hazard levels at the CPNPP site using the new CEUS SSC model and the EPRI (2004, 2006) GMPEs using FRISK88
  - Expectation is that net effect will be minimum change to the UHRS
- Perform deaggregation at low response frequency and high response frequency for the 10-4 and 10-5 hazard levels, and develop corresponding response spectral shapes according to RG 1.208 and NUREG/CR-6728
- The 60 randomized synthetic strain-compatible profiles of site characteristics will be updated based on the new control elevations and groundwater level for the GMRS/FIRS

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Summary of Analysis Framework (cont.)

- Linear-equivalent site response analysis will be performed using Fugro's software RVTSite to obtain the site amplification factors at the GMRS/FIRS control elevations in accordance with ISG-17 and related NEI White Paper
- The seismic hazard for horizontal motion is calculated by integrating the site amplification factors with the rock hazard and applying the CAV filter (for Mw<5.5), which corresponds to Approach 3 in NUREG/CR-6769
- The GMRS and FIRS are then developed per RG 1.208
- Time histories will be generated compatible with the envelope of new FIRS and minimum earthquake based on SRP 3.7.1 Option 1, Approach 2

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Potentially Related RAIs

- EPRI-SOG and additional features incorporated in the FSAR SSC model will be superseded by the CEUS SSC model (NUREG-2115) and updated site profiles based on the new control elevations including updated synthetic profiles impacting RAIs 11, 14, 15, 18, 19, 21 (Question 2.5.1-13), 22, and 168

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Summary and Conclusion

- The updated analysis for CEUS model will:
  - Follow the guidelines of ISG-017 in accordance with NEI White Paper
  - Address Recommendation 2.1 of the Fukushima Near-Term Task Force recommendations contained in SECY-12-0025 as it pertains to seismic hazard evaluation
  - Result in a major rewrite of FSAR Sections 2.5.1, 2.5.2 and 2.5.3. Changes pertaining to FSAR Sections 2.5.4 and 2.5.5 are related building configuration changes rather than the CEUS update, and will be processed via RAI 233
- The updated analysis will produce new GMRS, FIRS, time histories, and strain-compatible soil profiles to be used as input to FSAR Sections 3.7 and 3.8 SSI and SSSI analysis
- Luminant will not revise responses to RAIs 11, 14, 15, 18, 19, 21 (Question 2.5.1-13), 22, and 168 but will supersede them by updating the FSAR tables, text, and figures in UTR Rev. 2