William States Lee III Nuclear Station

NRC Technical Exchange
NUREG-2115 (CEUS) Plans
June 6, 2012

Introduction and Agenda

Kickoff	NRC/Duke
Overview	Thrasher
CEUS Update Methods	McGuire
Actions Based on Results	Thrasher
Projected Schedule Milestones	Thrasher

NRC Letter 105, RAI 01.05-1

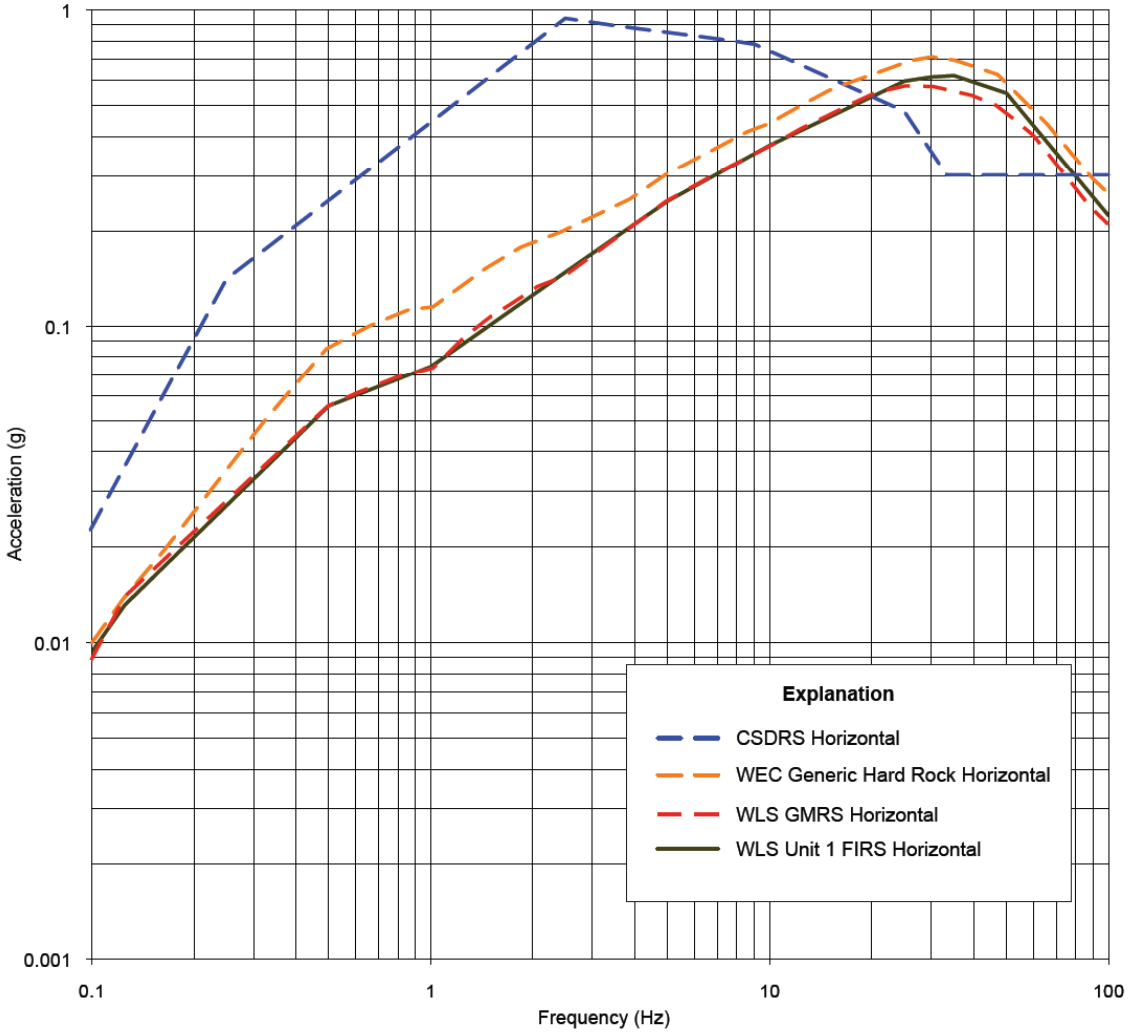
a) Evaluate the potential impacts of the newly released CEUS-SSC model, with potential local and regional refinements as identified in the CEUS-SSC model, on the seismic hazard curves and the site-specific ground motion response spectra (GMRS) / foundation input response spectra (FIRS). For re-calculation of the PSHA, please follow either the cumulative absolute velocity (CAV) filter or minimum magnitude specifications outlined in Attachment 1 to Seismic Enclosure 1 of March 12, 2012 50.54(f) letters (ML12053A340).

b) Modify the site-specific GMRS and FIRS if you determine changes are necessary given the evaluation performed in part a) above.

Overview

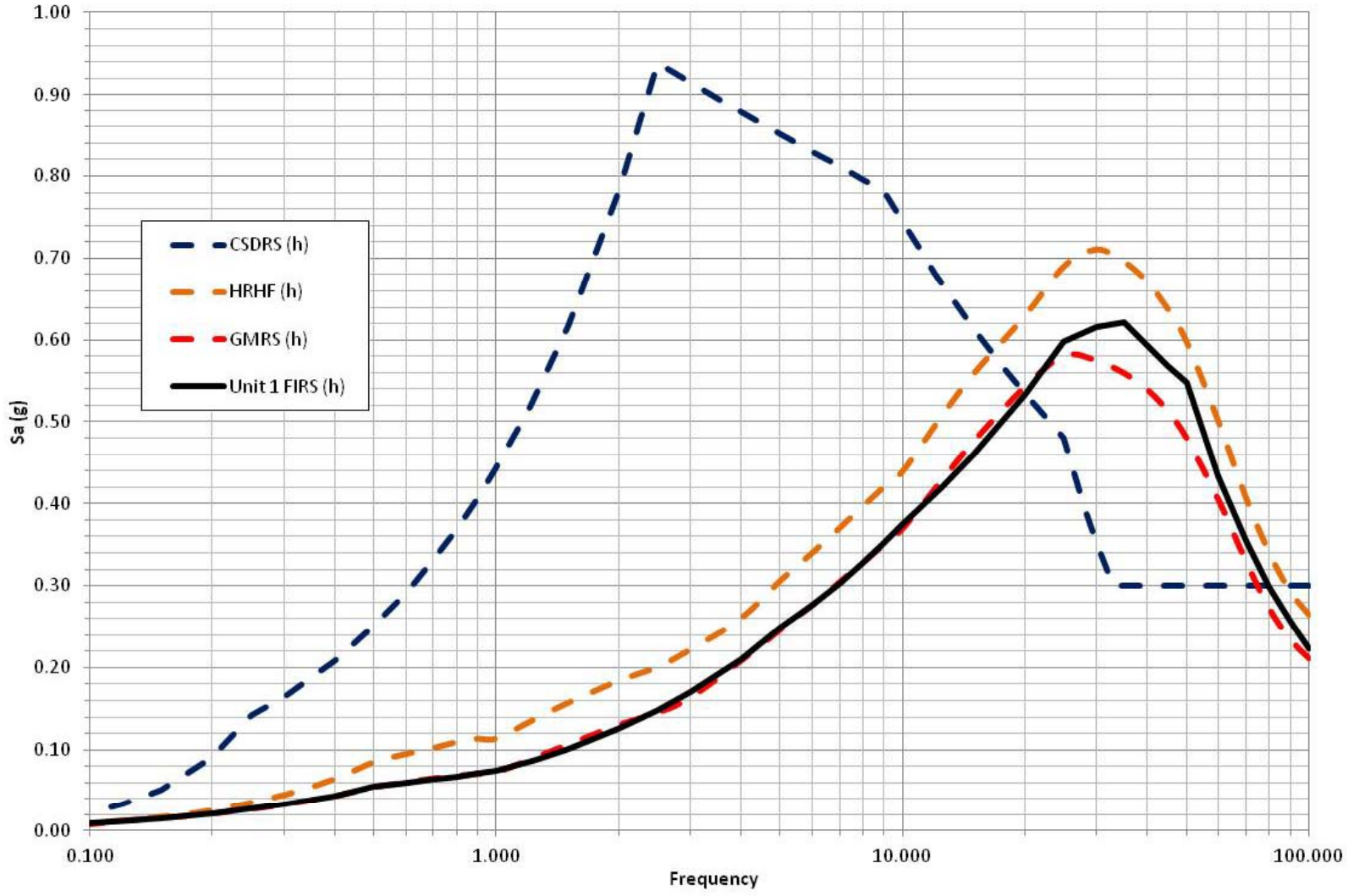
- WLS Site Characteristics (FSAR)
- Comparison to AP1000 DCD Envelopes
- Conclude That Preliminary Study Is Not Appropriate
- General Insights From Current (EPRI-SOG-based) PSHA
- General Insights From AP1000 Design
- Possible Outcomes

WLS Design Ground Motion Response Spectrum and Unit 1 FIRS



Ref: WLS FSAR Figure 3.7-201

WLS Design Ground Motion Response Spectrum and Unit 1 FIRS (Linear Scale)



Ref: Information from WLS FSAR Figure 3.7-201

Insights from WLS FSAR / Potential CEUS

- WLS is a hard-rock site
- Site-Specific analysis of AP1000 at WLS has demonstrated margin against DCD requirements
- WLS Seismic Hazard has three significant contributions:
  - Charleston
  - New Madrid
  - Local Sources
- Anticipate small changes in Charleston and New Madrid
- Interpretation of local sources and Mmax zone distributions are different in current PSHA (based on EPRI-SOG) and NUREG-2115 CEUS-SSC – Don't know outcome

Insights from AP1000 DCD

- CSDRS is a robust design basis for AP1000
- Designing AP1000 for CSDRS results in configuration and equipment that also satisfies HRHF
  - Structural loads
  - Equipment Qualification
  - FSAR Chapter 19 HCLPF
- HRHF spectrum selected based on customers' GMRSs

Insights from AP1000 DCD (cont'd)

- Site-specific analysis and equipment qualification likely could also demonstrate that input somewhat greater than HRHF is also acceptable (similar to TR-115 Section 5.2)
- This would require site-specific work similar to that required for TR-115

Possible Outcomes

- Path A: WLS GMRS and Unit 1 FIRS less than HRHF
  - Demonstrate the margin shown in current site-specific analysis of nuclear island.
  - Compare to SC-II assessment (pending)
- Path B: WLS GMRS and Unit 1 FIRS greater than HRHF
  - More Work, Significant Time
  - Comparable to DCD TR-115 effort for nuclear island
  - Exceedances will be evaluated and justified.
  - Update needed for many site-specific supporting products
  - For small exceedances of HRHF, we are optimistic for eventual success

William States Lee III Nuclear Station

CEUS Update Methods

Robin McGuire, PhD.

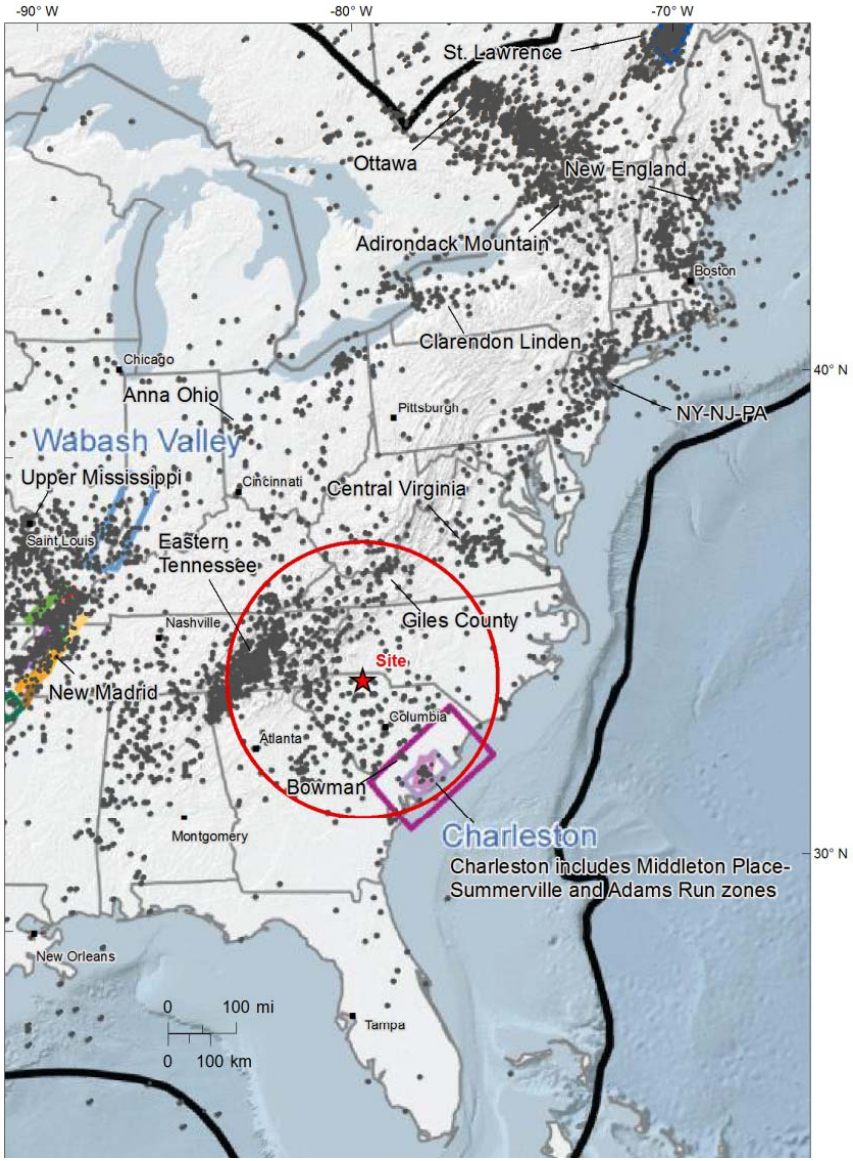
Lettis Consultants International, Inc.

June 6, 2012

Purpose

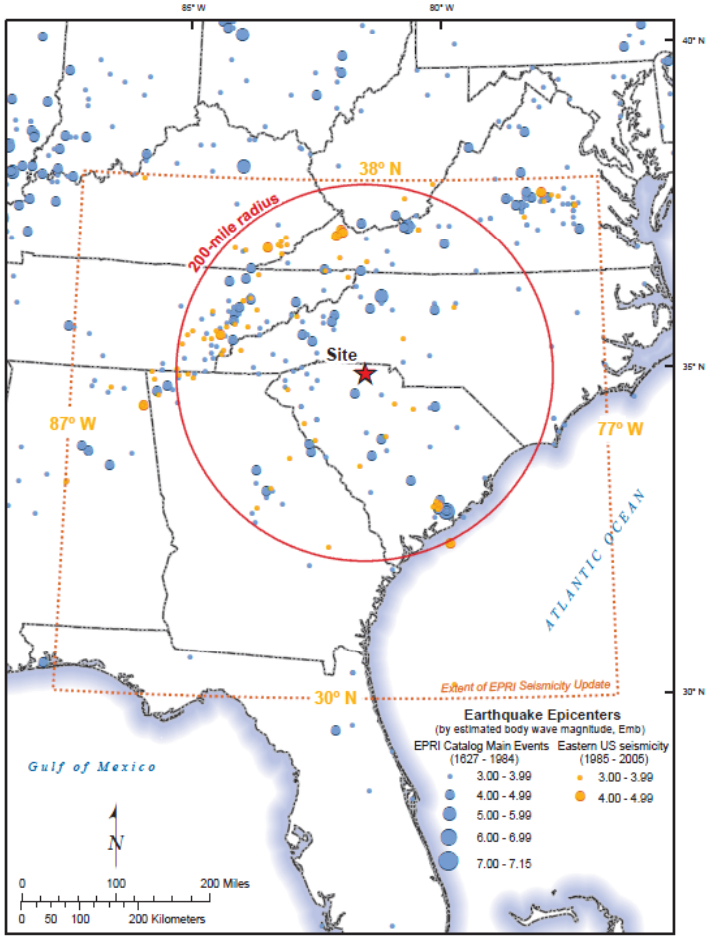
- Describe FSAR seismic hazard model and potential effects associated with CEUS SSC Model
- EPRI-SOG (1988) seismic source characterization
- Six Earth Science Teams (EST) for Central and Eastern United States
- Hazard calculation computed based on 99% contribution for each EST
- Three primary hazard sources
  - Repeated large magnitude earthquakes
    - Charleston (UCSS)
    - New Madrid Seismic Source Zone
  - Local moderate magnitude earthquakes

RLME Sources and Seismicity - CEUS SSC Catalog

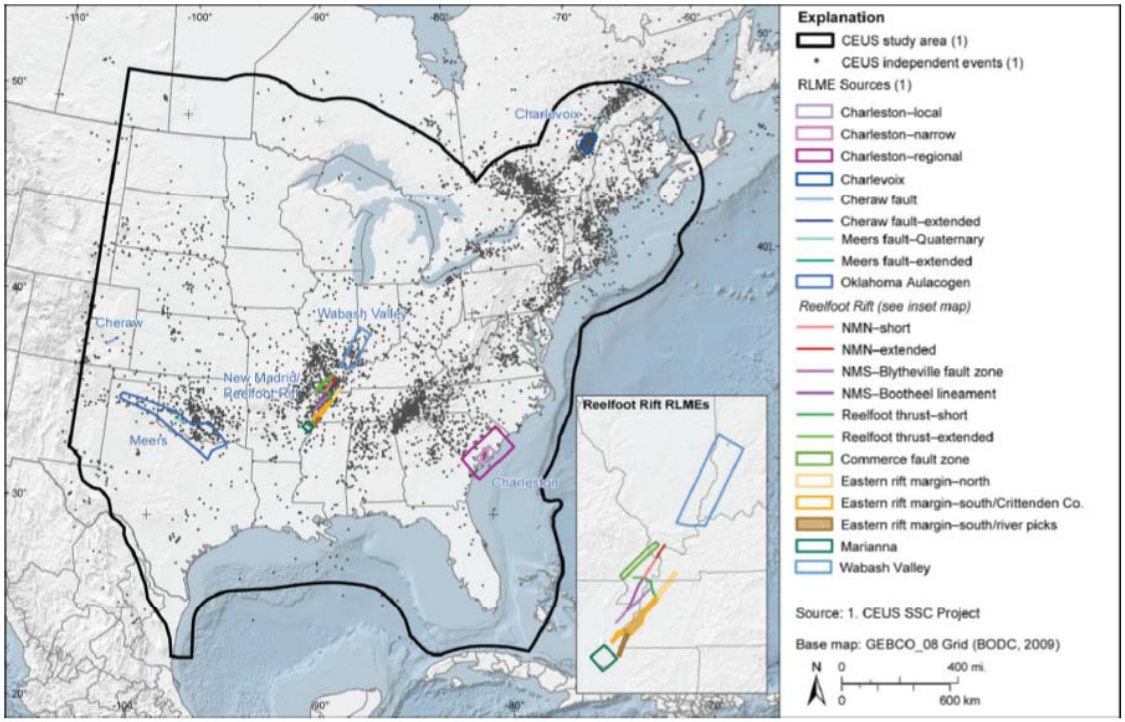


Sources: FSAR Figure 2.5.1-214 and -CEUS Figure 6.1-2a

Updated Seismicity for Site Project Region EPRI-SOG and CEUS SSC RLME Sources with Seismicity

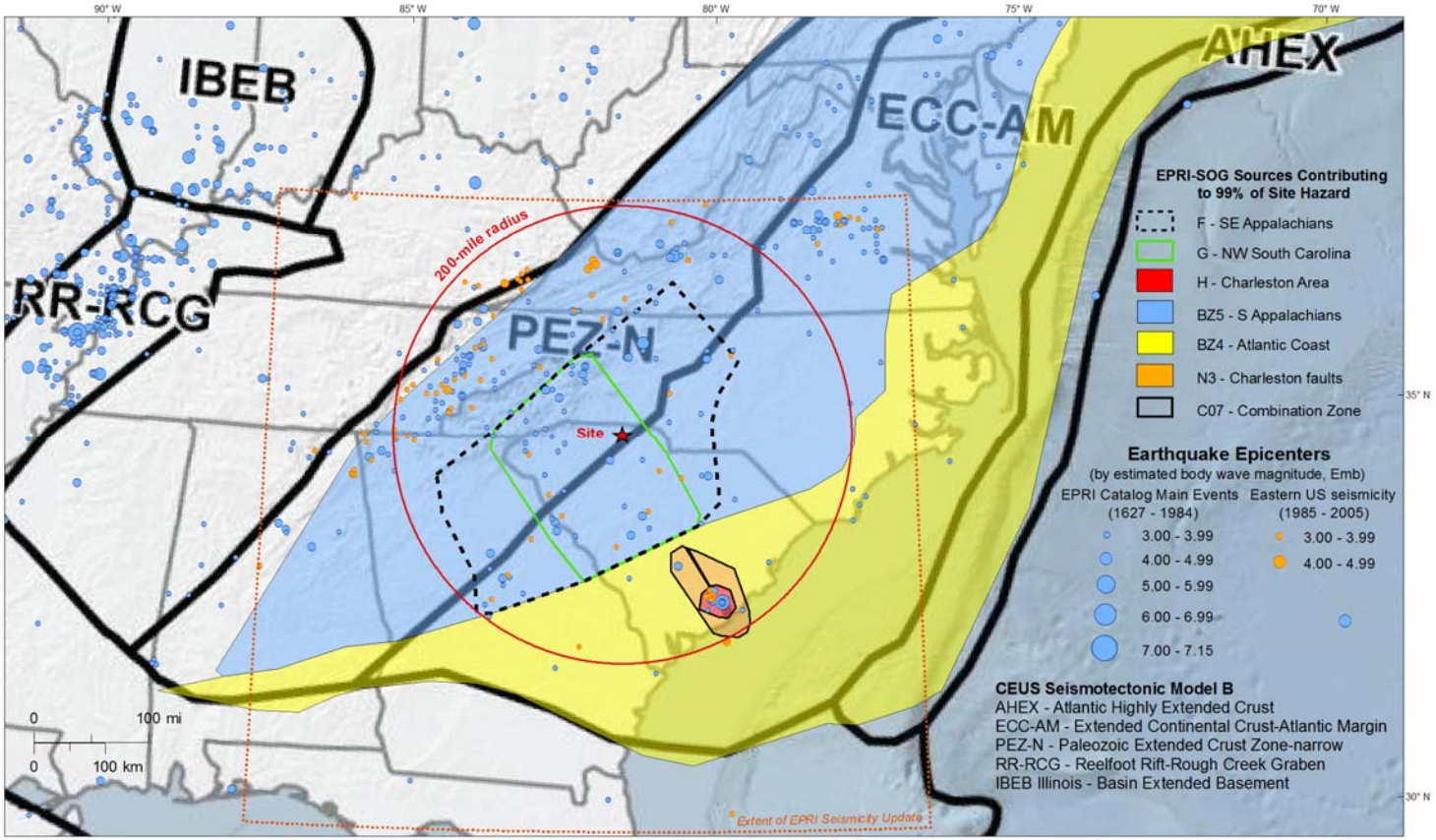


Source: FSAR Figure 2.5.2-201



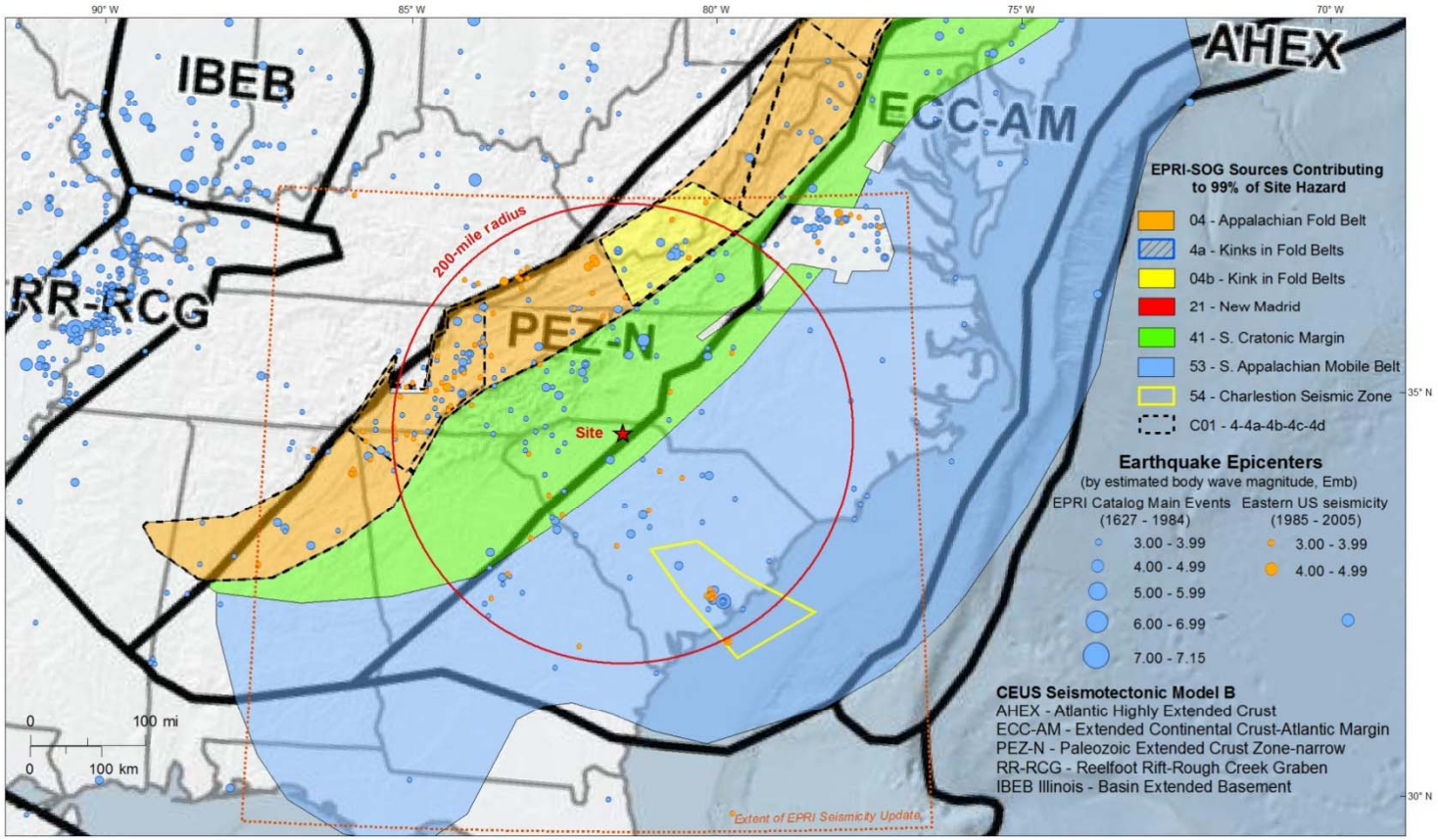
Source: CEUS Figure 6.1-2a

Bechtel Team Sources



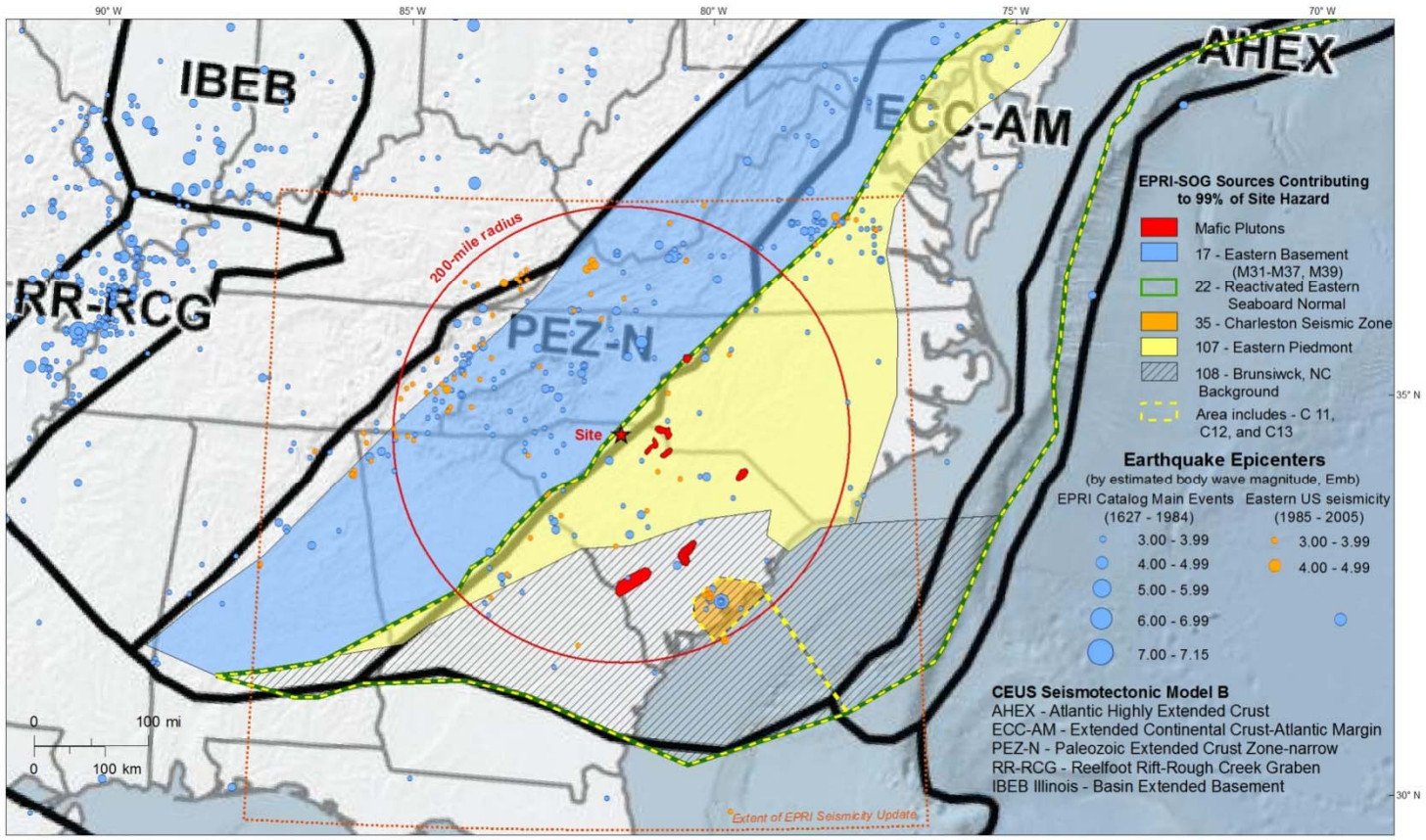
Sources: FSAR Figure 2.5.2-203 and CEUS Figure 7.1-2

Dames & Moore Team Sources



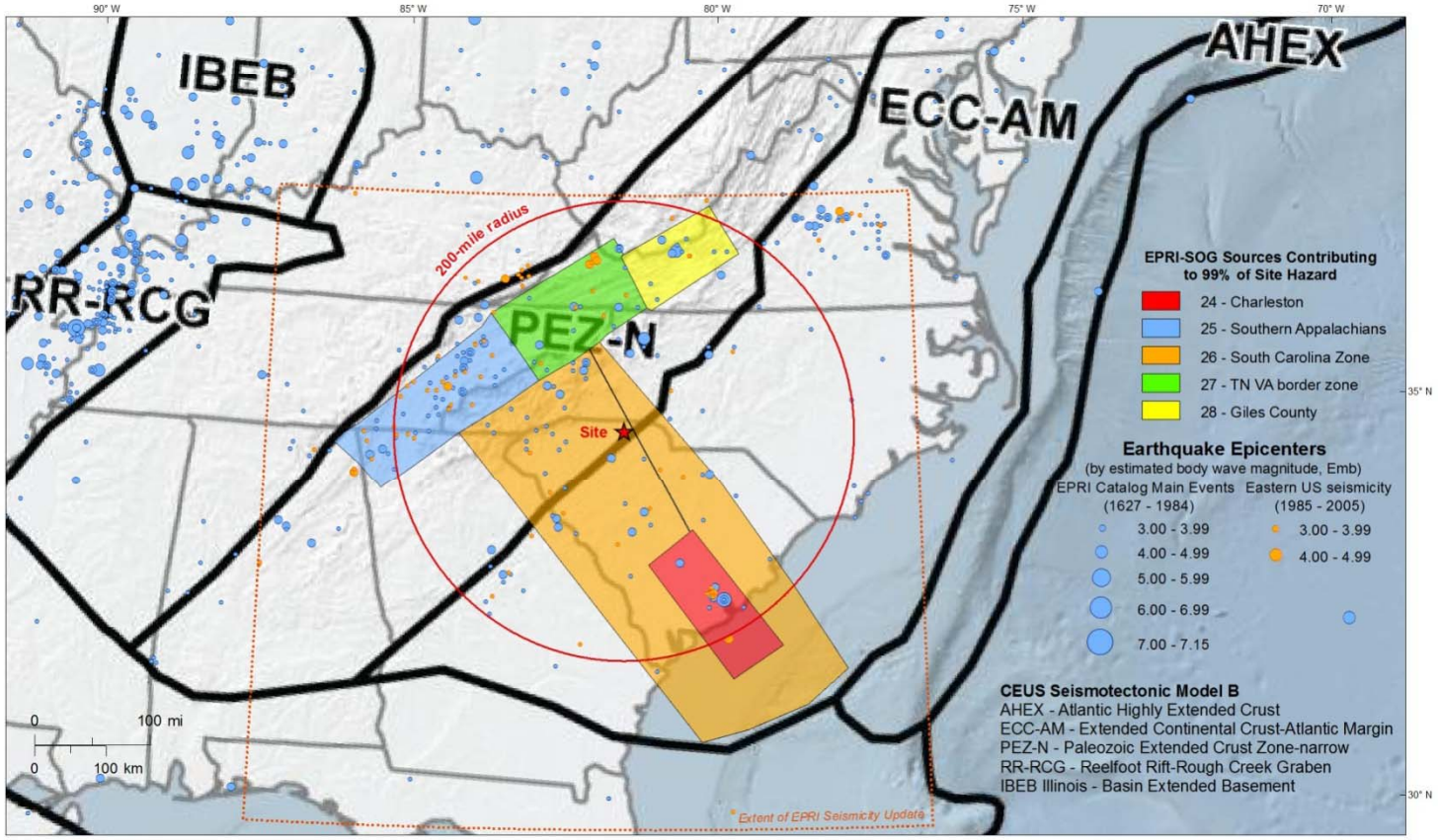
Sources: FSAR Figure 2.5.2-204 and CEUS Figure 7.1-2

LAW Engineering Team Sources



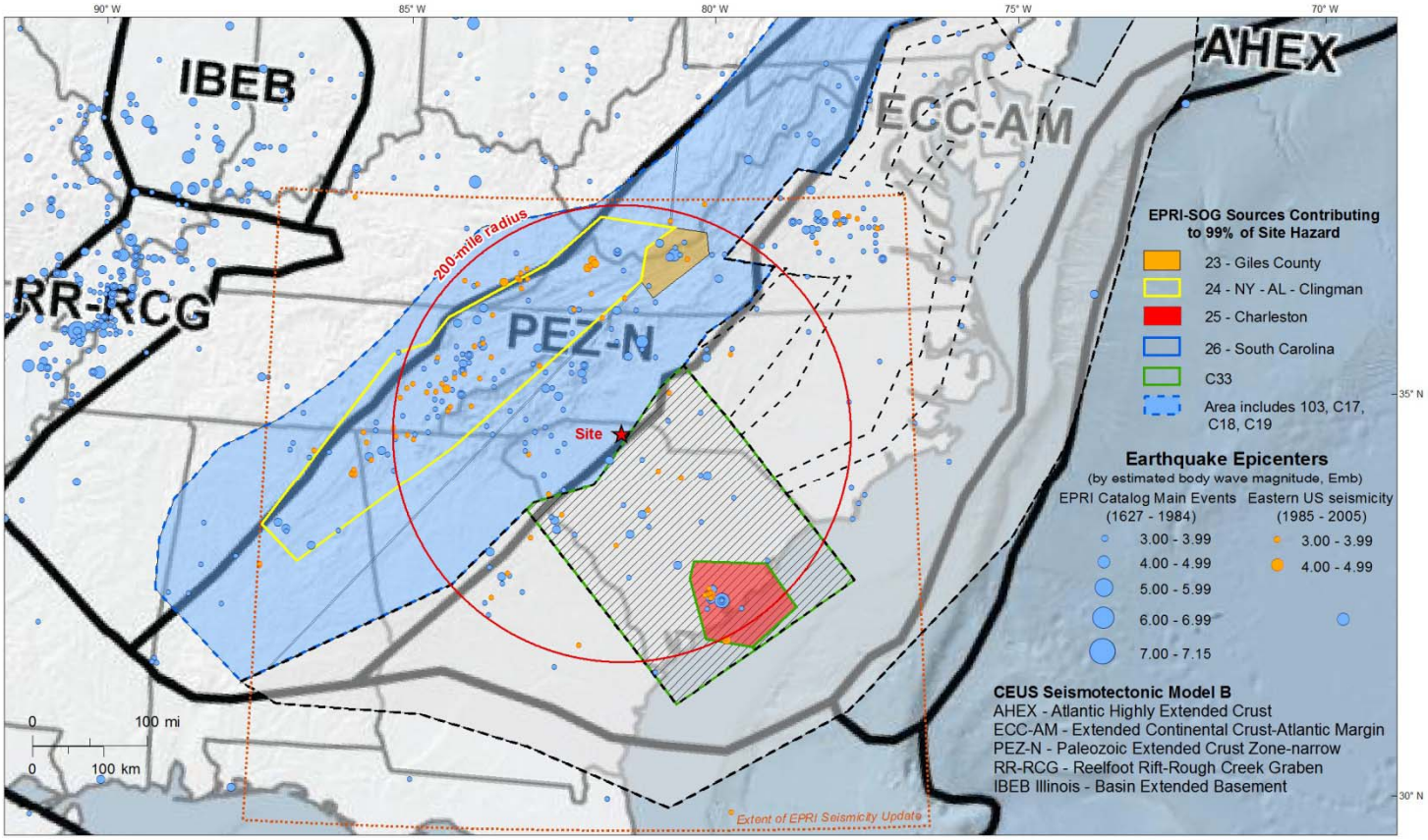
Sources: FSAR Figure 2.5.2-205 and CEUS Figure 7.1-2

Rondout Associates Team Sources



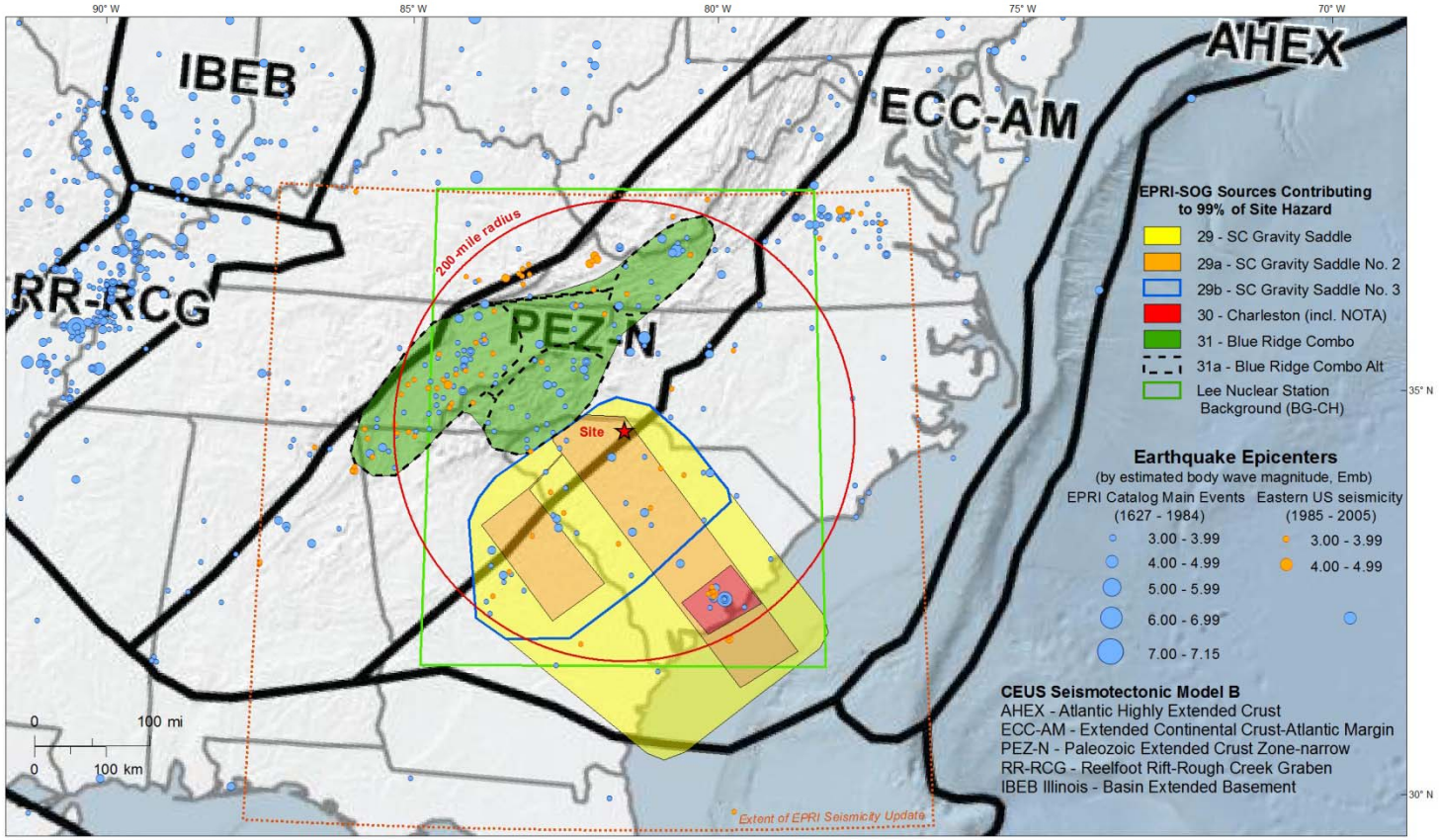
Sources: FSAR Figure 2.5.2-206 and CEUS Figure 7.1-2

Weston Geophysical Team Sources



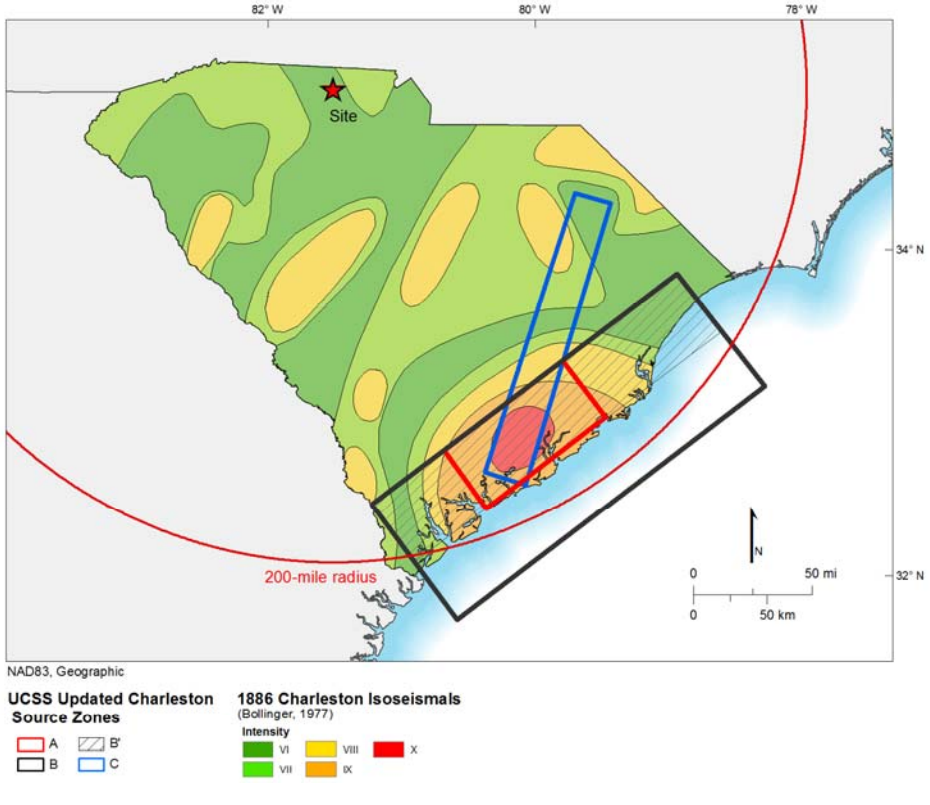
Sources: FSAR Figure 2.5.2-207 and CEUS Figure 7.1-2

Woodward-Clyde Team Sources

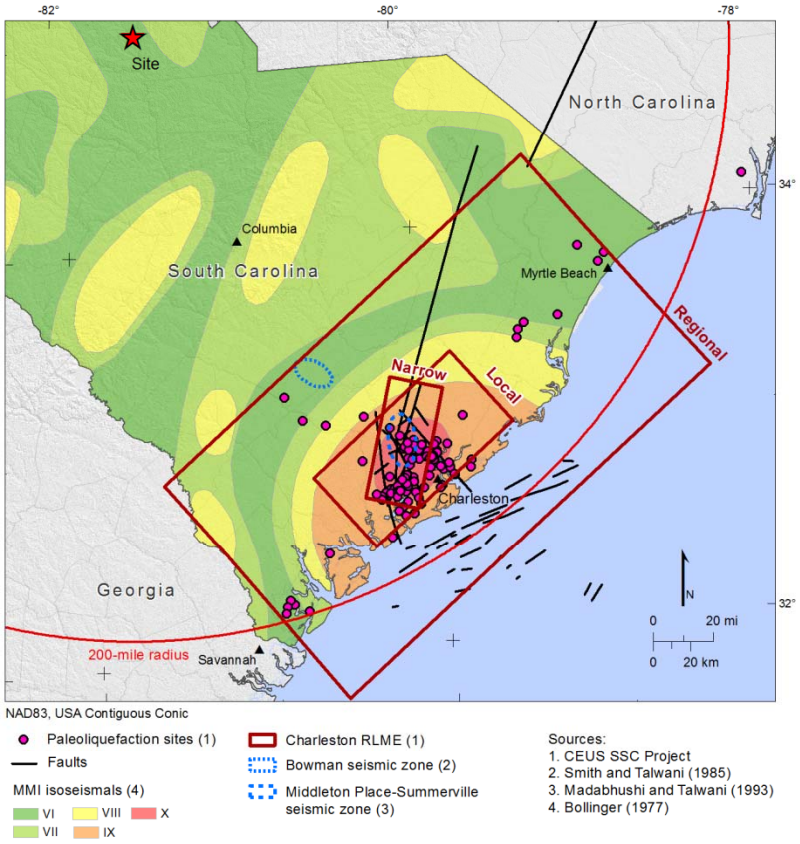


Sources: FSAR Figure 2.5.2-208 and CEUS Figure 7.1-2

Comparison of Updated Charleston Seismic Source (UCSS) and CEUS Models

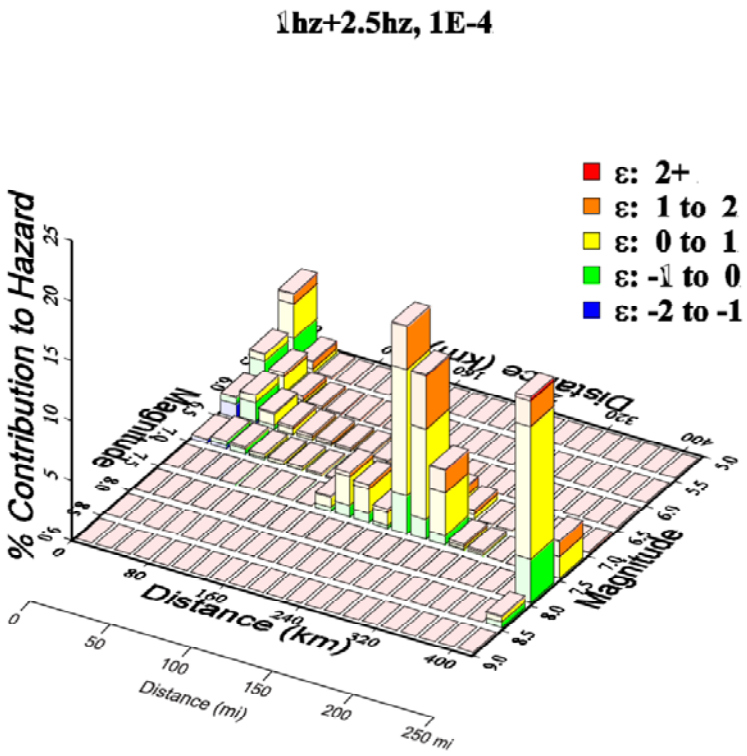


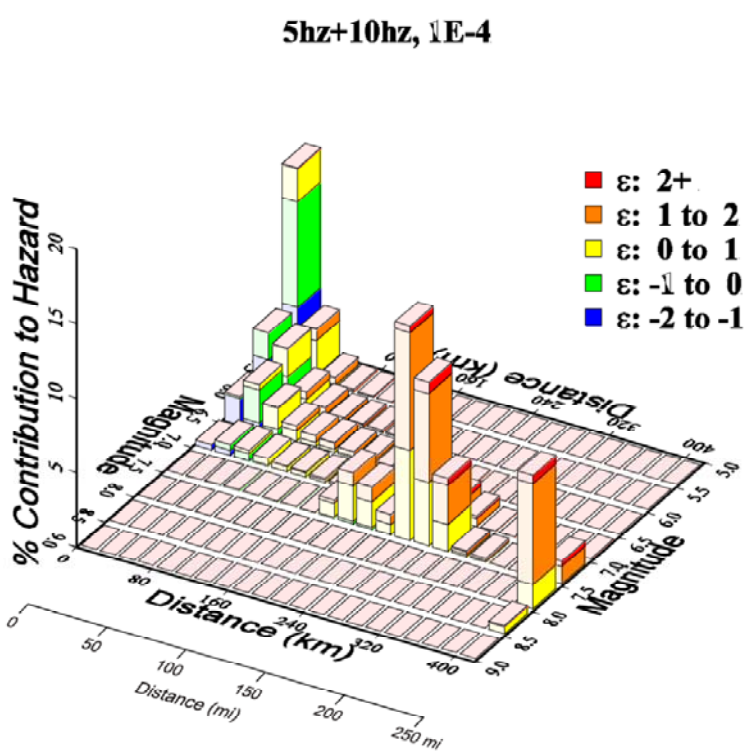
Source: FSAR Figure 2.5.2-209



Source: CEUS Figure 6.1.2-5a

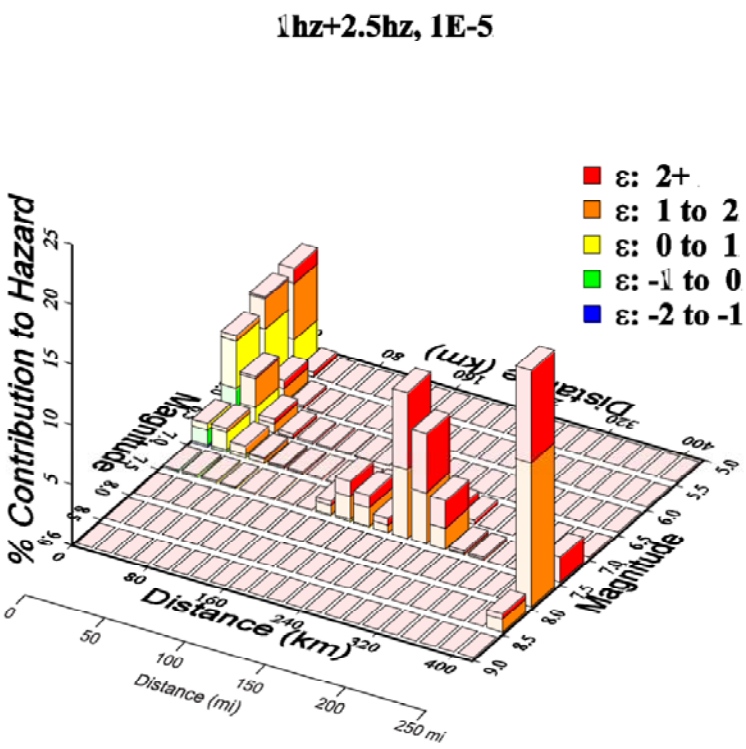
Combined Deaggregation of Mean Rock Hazard for 10^{-4}

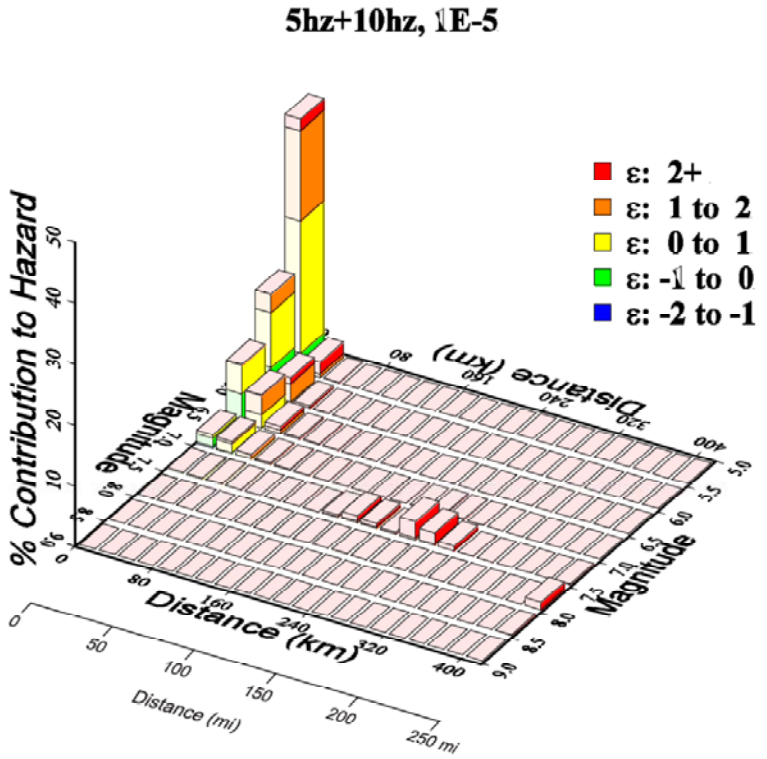




Ref: WLS FSAR Figures 2.5.2-231 and -232

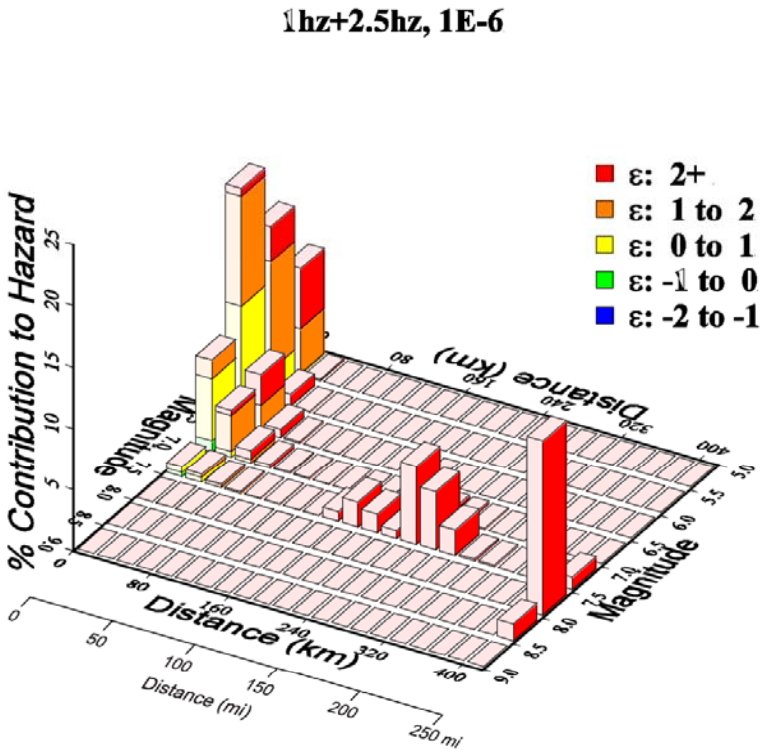
Combined Deaggregation of Mean Rock Hazard for 10^{-5}

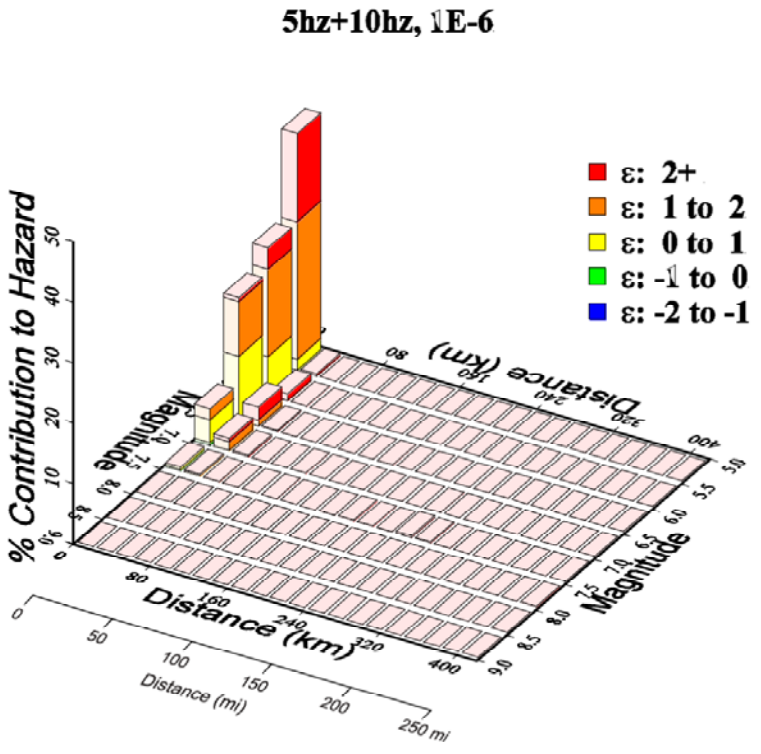




Ref: WLS FSAR Figures 2.5.2-233 and -234

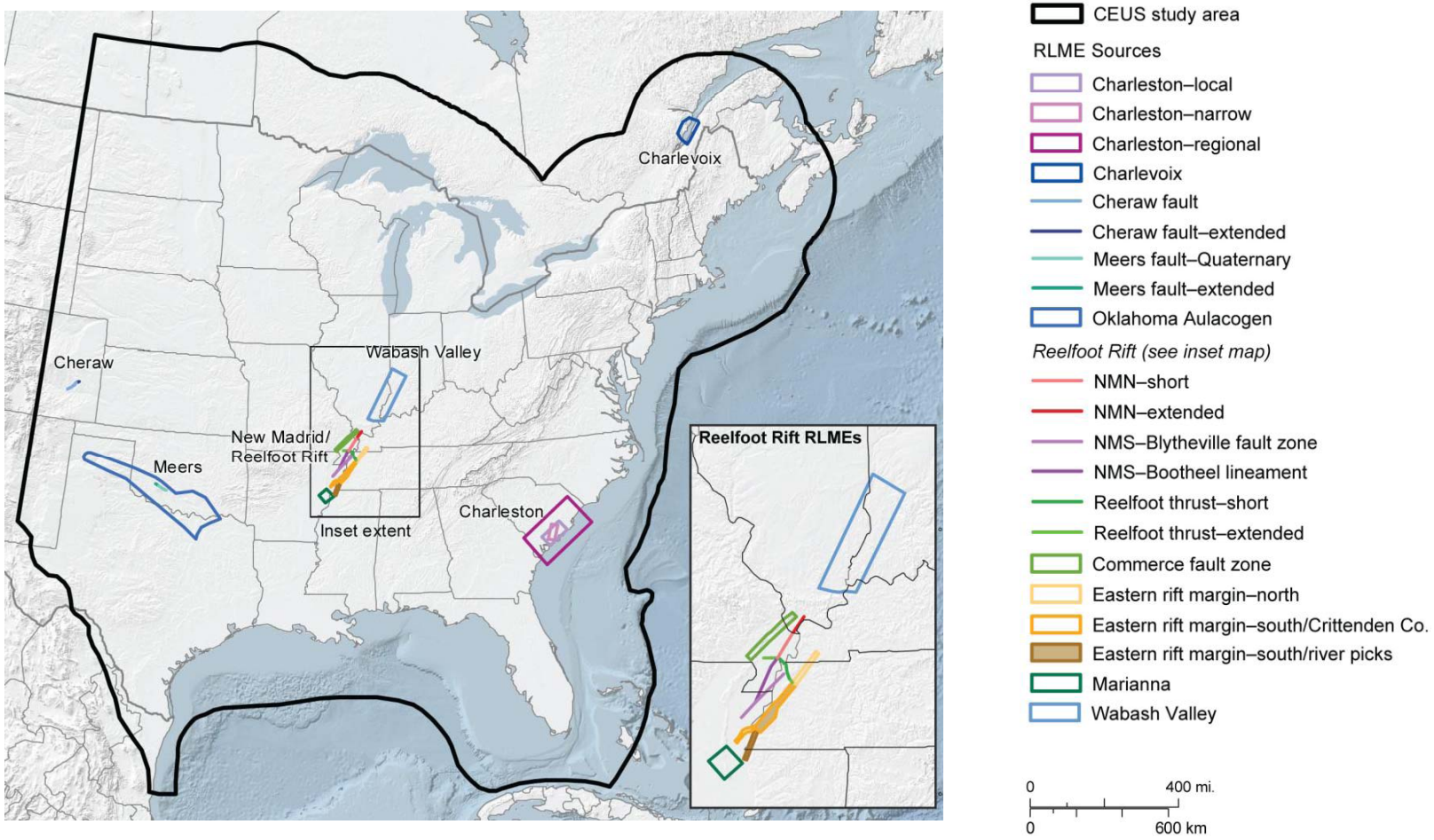
Combined Deaggregation of Mean Rock Hazard for 10^{-6}





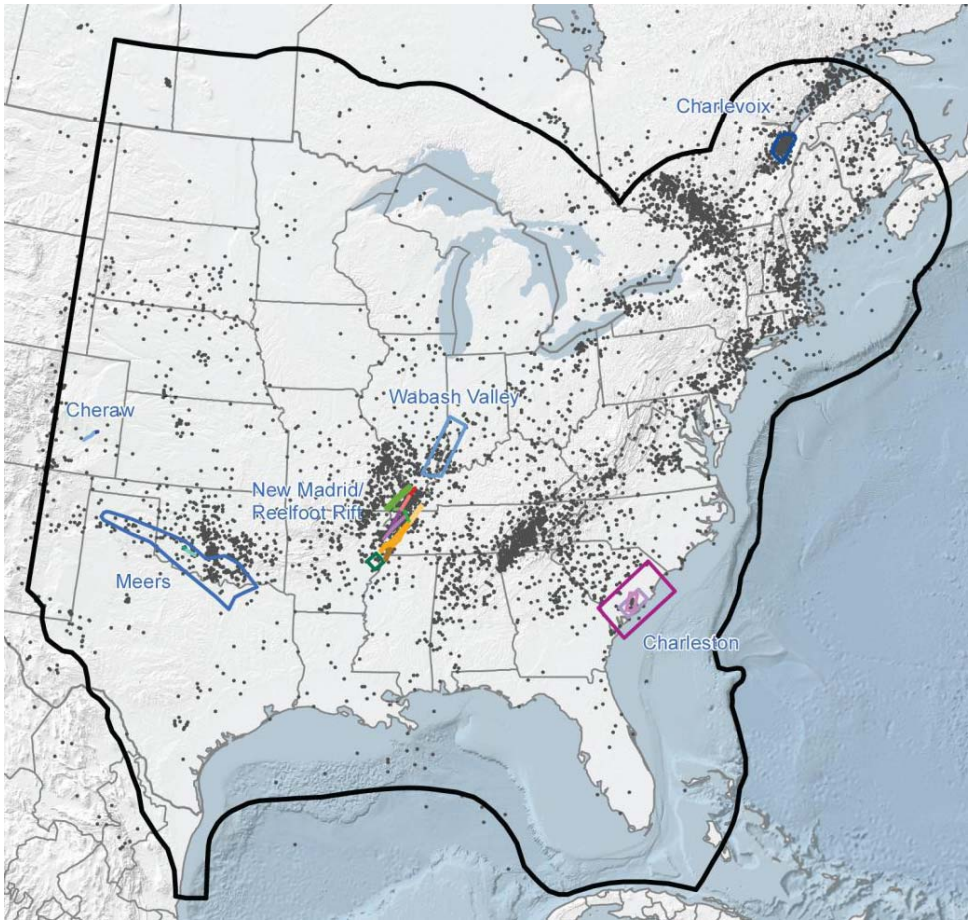
Ref: WLS FSAR Figures 2.5.2-235 and -236

RLME sources in CEUS SSC model



Source: CEUS Figure 6.1-1

RLME sources and seismicity CEUS SSC earthquake catalog

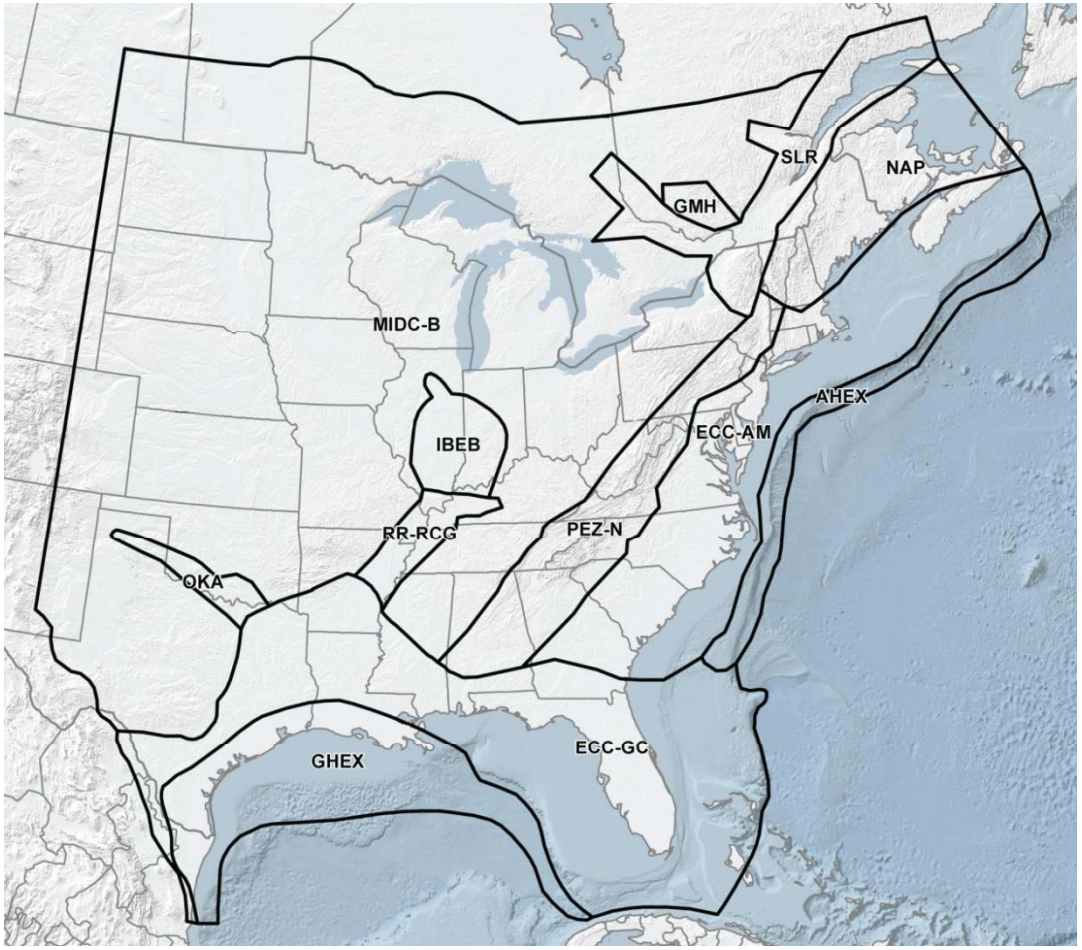


CEUS independent events
CEUS study area
RLME Sources
Charleston–local
Charleston–narrow
Charleston–regional
Charlevoix
Cheraw fault
Cheraw fault–extended
Meers fault–Quaternary
Meers fault–extended
Oklahoma Aulacogen
Reelfoot Rift (see inset map)
NMN–short
NMN–extended
NMS–Blytheville fault zone
NMS–Bootheel 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

0 400 mi.
0 600 km

Source: CEUS Figure 6.1-2a

Seismotectonic Zones within PEZ-N



Seismotectonic Model B

Abbreviations:

AHEX = Atlantic Highly Extended Crust

ECC-AM = Extended Continental Crust–Atlantic Margin

ECC-GC = Extended Continental Crust–Gulf Coast

GHEX = Gulf Coast Highly Extended Crust

GMH = Great Meteor Hotspot

IBEB = Illinois Basin Extended Basement

MIDC-B = Midcontinent-Craton

NAP = Northern Appalachian

OKA = Oklahoma Aulacogen

PEZ-N = Paleozoic Extended Crust Zone–narrow

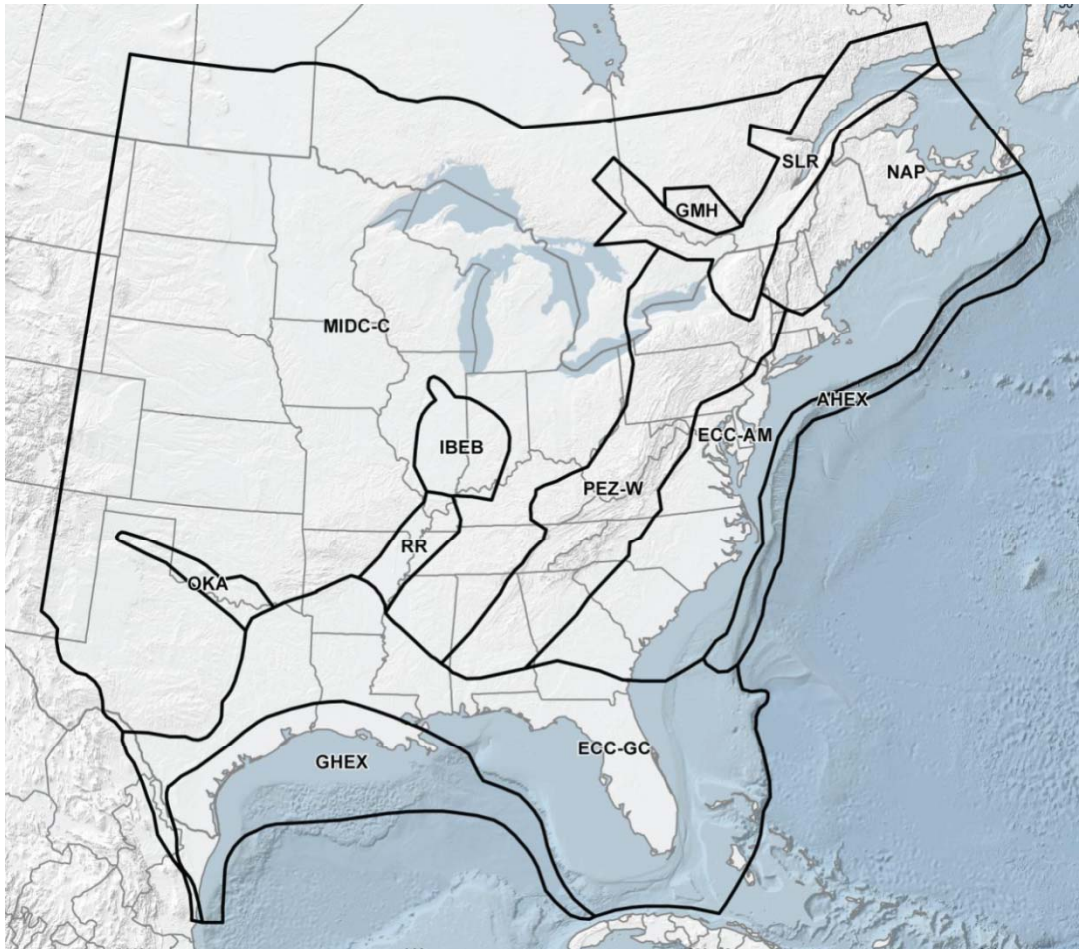
RR-RCG = Reelfoot Rift–Rough Creek Graben

SLR = St. Lawrence Rift

0 400 mi.
0 600 km

Source: CEUS Figure 7.1-2

Seismotectonic Zones with PEZ-W



Seismotectonic Model C

Abbreviations:

AHEX = Atlantic Highly Extended Crust

ECC-AM = Extended Continental Crust–Atlantic Margin

ECC-GC = Extended Continental Crust–Gulf Coast

GHEX = Gulf Coast Highly Extended Crust

GMH = Great Meteor Hotspot

IBEB = Illinois Basin Extended Basement

MIDC-C = Midcontinent-Craton

NAP = Northern Appalachian

OKA = Oklahoma Aulacogen

PEZ-W = Paleozoic Extended Crust Zone–wide

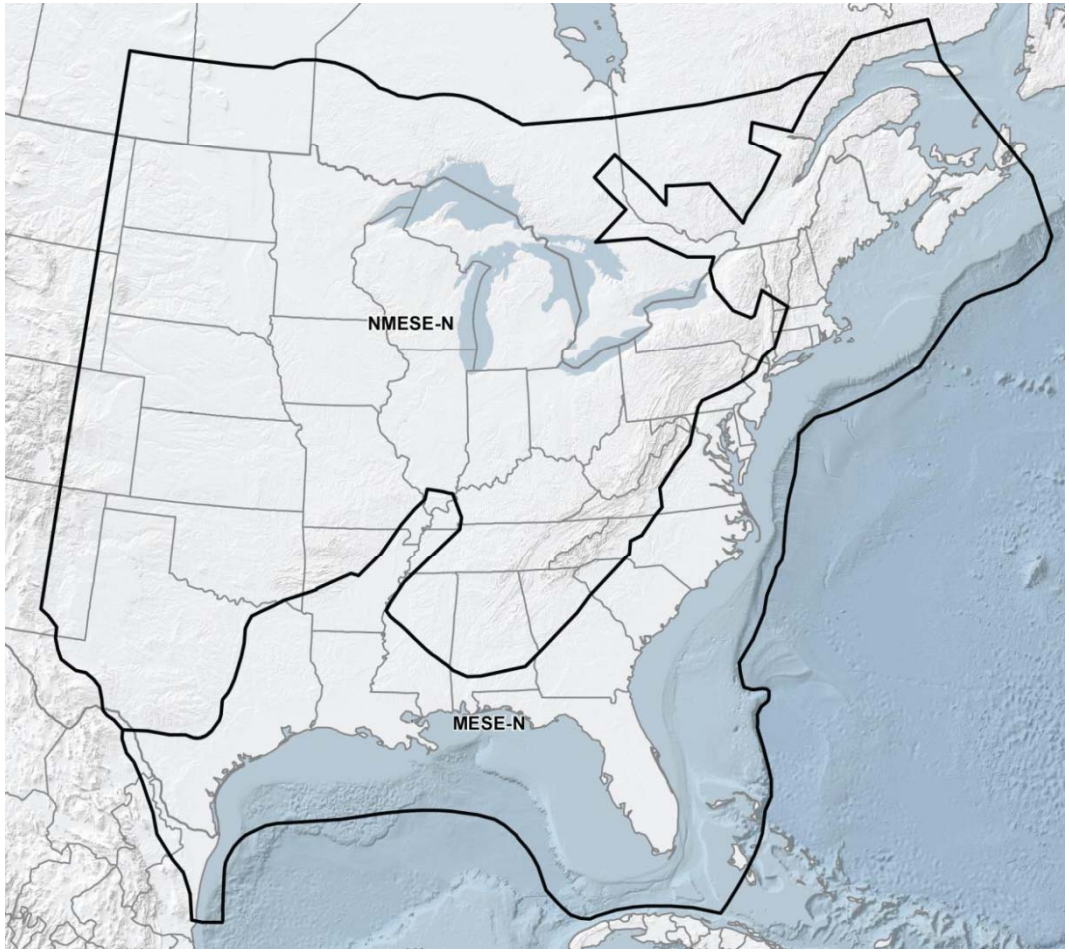
RR = Reelfoot Rift

SLR = St. Lawrence Rift

0 400 mi.
0 600 km

Source: CEUS Figure 7.1-3

CEUS SSC Mmaz Zones



Mesozoic and non-Mesozoic–narrow

Abbreviations:
MESE-N = Mesozoic and younger extended prior–narrow

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

0 400 mi.
0 600 km

Source: CEUS Figure 6.2-1

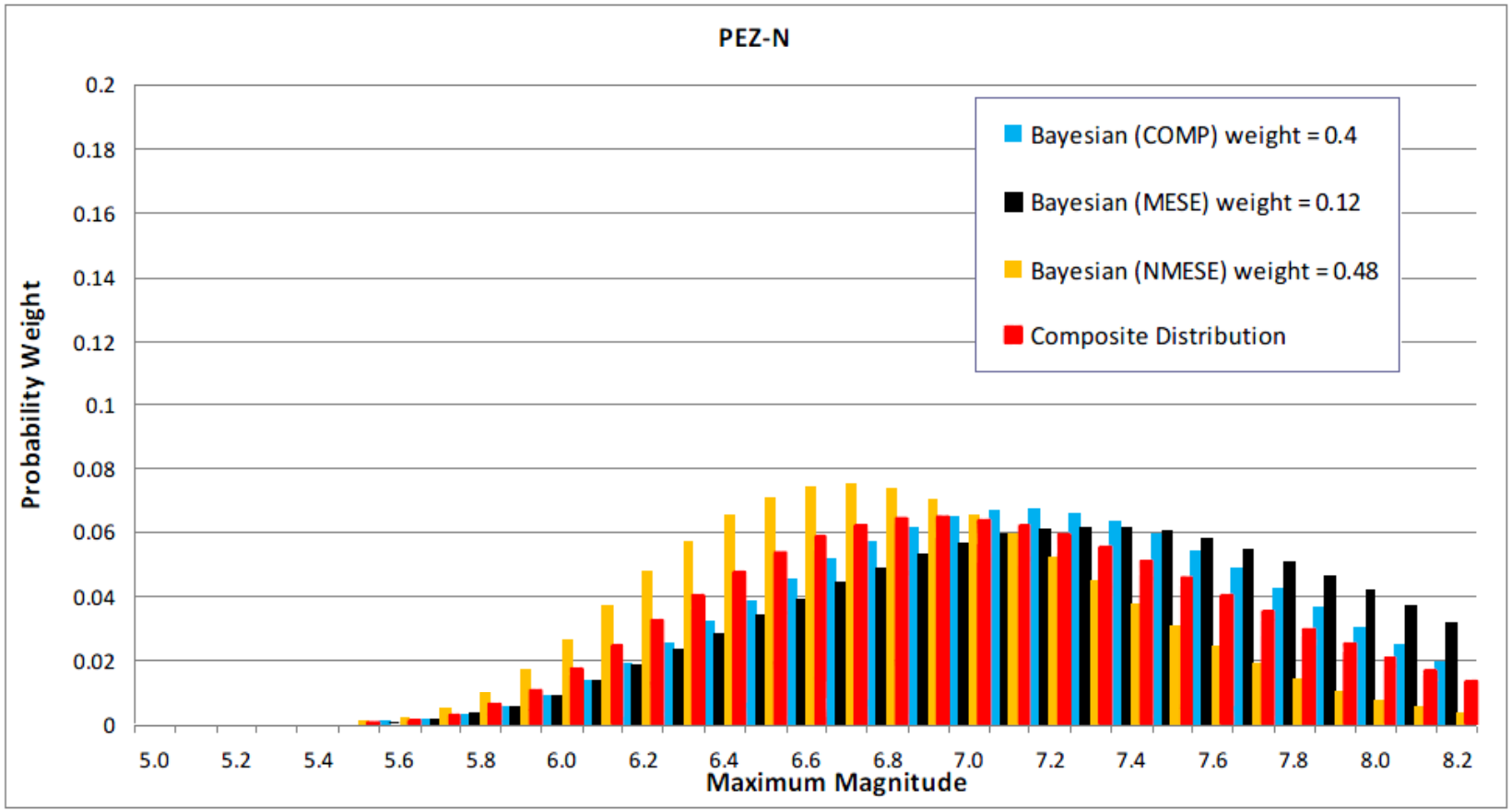
Significant Changes WLS FSAR to CEUS Model

- Seismic Sources
  - EPRI-SOG (1988) – Six ESTs with varying source interpretations
  - CEUS SSC – single set of alternative sources, larger with similar area of coverage
- Seismicity Rates
  - EPRI SOG – body wave magnitude scale (m_b), spatially varying cells at 1˚X1˚
  - CEUS SSC – moment magnitude (M), spatially varying cells at 1/4˚X1/4˚ to 1/2˚X1/2˚
- Mmax Distributions
  - EPRI- SOG various with differing methods
  - CEUS SSC-Bayesian approach applied to SCR prior distribution
    - Increased mean Mmax with broader distribution

Seismic Source Evaluation

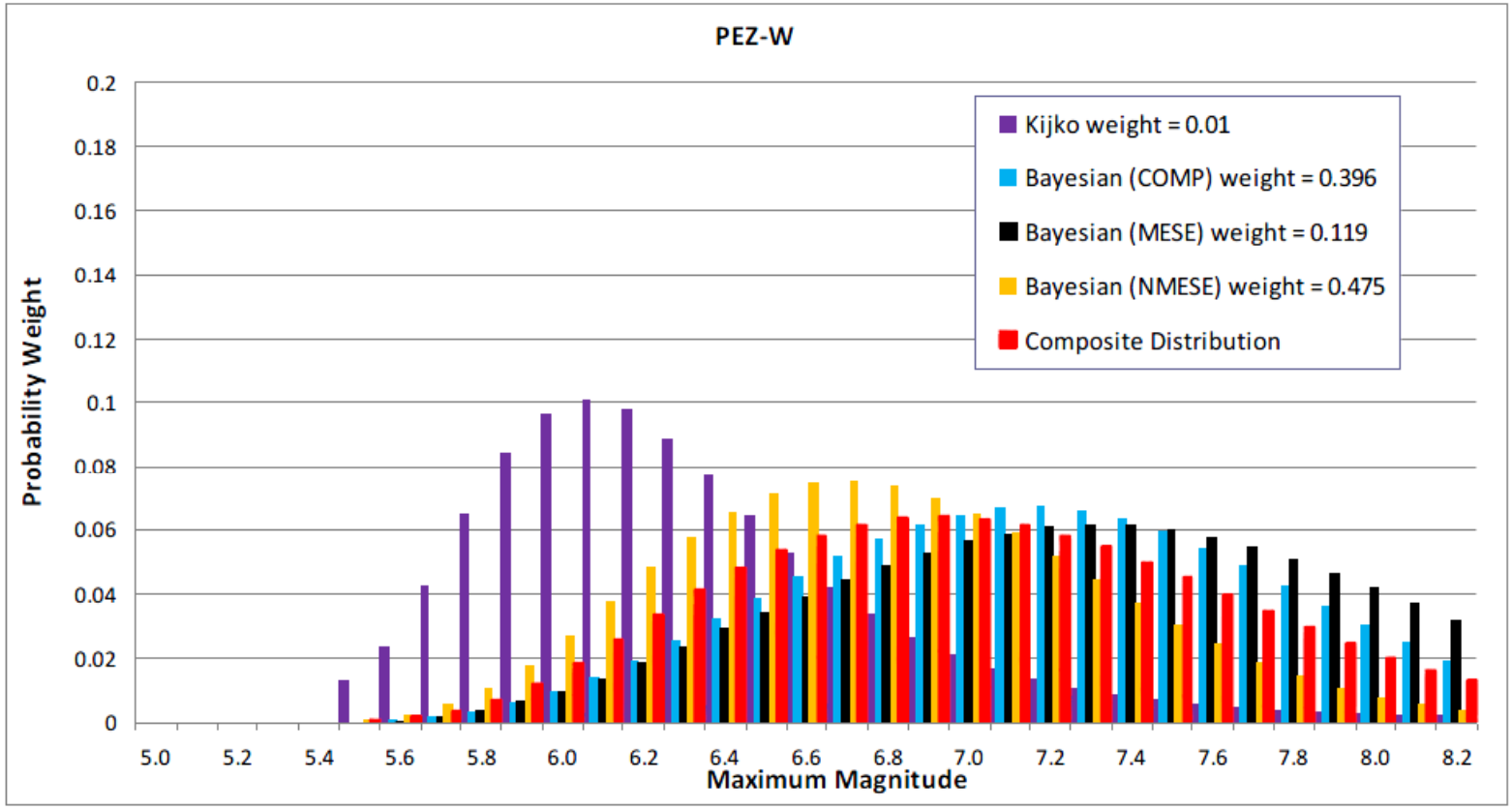
- WLS seismic sources of significance are covered by CEUS SSC PEZ-N and PEZ-W
- WLS lies within two Mmax zones
  - NMSES-N Mmax zone - narrow interpretation of Non-Mesozoic and younger extended prior – narrow, and
  - MESE-W Mmax zone Mesozoic and younger extended prior-wide

Mmax Distributions for PEZ-N



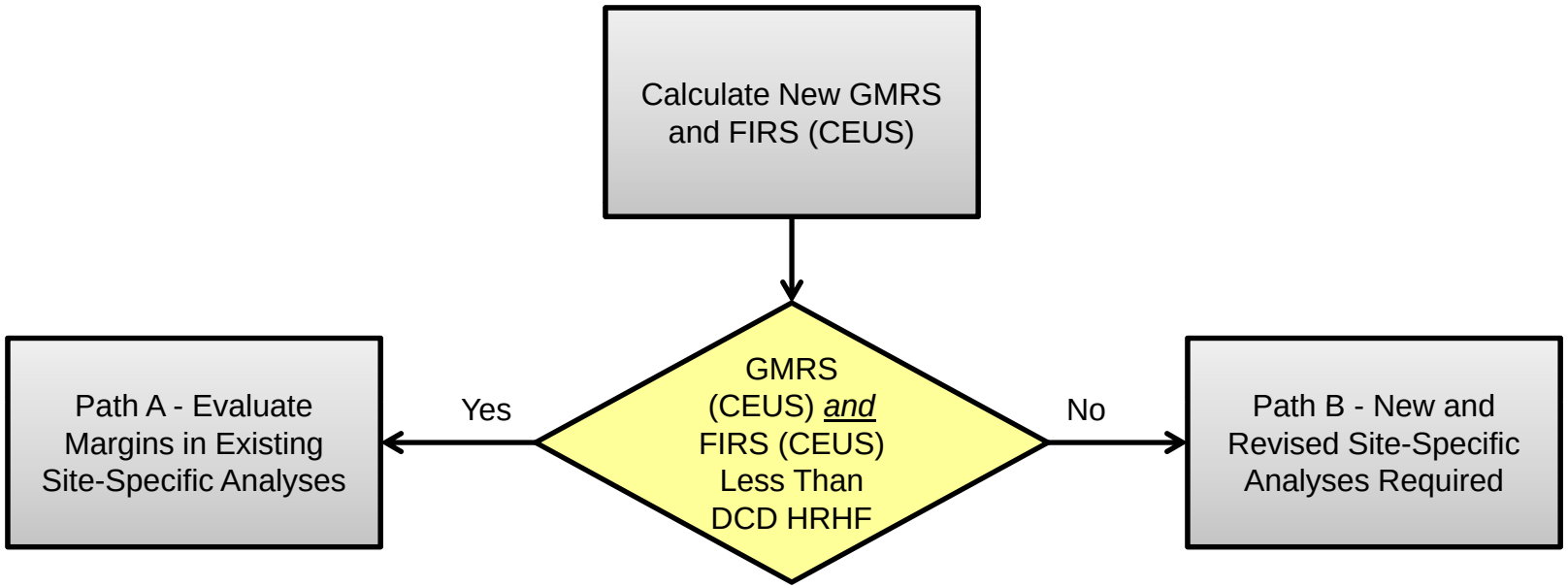
Source: CEUS Figure 7.4.1-12

Mmax Distributions for PEZ-W



Source: CEUS Figure 7.4.1-14

Actions Based on Results



Projected Schedule Milestones

- CEUS Hazards and GMRS and Unit 1 FIRS (Horizontal and Vertical) – mid-November 2012
- CEUS GMRS and Unit 1 FIRS < HRHF - 4 Months (est.)
  - Update FSAR 2.5 content
  - Comparisons to margin in existing products
  - Evaluations, update of FSAR 3.7 content
- CEUS GMRS and Unit 1 FIRS > HRHF – takes longer