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CEUS Seismic Source Characterization (SSC) Project

2012 EERI Annual Meeting and National Earthquake Conference
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L. A. Salomone
CEUS SSC Project Manager

DRIVERS:

CEUS SSC Project and NGA-East Project

LLNL (1993) and EPRI (1986)
Hazard Studies

NRC RG 1.208 | **DOE Order 420.1B**

10 Yr. Review

Development of Regional Seismic Source Model for Central & Eastern United States

Development of Next Generation Attenuation Models for Central & Eastern United States

PSHA

Early Site Permit and Combined Operating License Applications for Commercial Nuclear Reactors

Design of DOE Critical Mission Nuclear Facilities

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SPONSORS' EXPECTATIONS

- Consistency
- Stability
- Greater Longevity
- Engagement of all Stakeholders
- Transparency
- Eliminate Delays

- Reduce Time

- Save Dollars

Study Area and Test Sites

SSHAC ASSESSMENT PROCESS

- The fundamental goal of a SSHAC process is to carry out properly and document completely the activities of evaluation and integration, defined as:
  - Evaluation: The consideration of the complete set of data, models and methods proposed by the larger technical community that are relevant to the hazard analysis.
  - Integration: Representing the center, body, and range of technically defensible interpretations in light of the evaluation process informed by the assessment of existing data, models, and methods.

Technical Advancements

- Study to Identify Source Characteristics that Affect Seismic Hazard
- Study to Provide Level of Precision Associated with Seismic Hazard Estimates
- Updated Conceptual Seismic Source Characterization (SSC) Framework that Provides a Consistent Basis for Identifying and Characterizing CEUS Seismic Sources
- New Earthquake Catalog That Merges and Reconciles Several Catalogs and Provides Uniform Moment Magnitude for All Events
- Updated Approach for Assessing Maximum Magnitude
- Updated Approach for Spatial Smoothing of Recurrence Parameters
- Paleoliquefaction Database With Criteria for Considering Paleoliquefaction Data and Guidance for Determining Recurrence Rates and Magnitudes
- New approaches to systematically document all data considered and to evaluate their use for increased transparency
- Use of a Hazard Input Document (HID) to provide basic elements of model for hazard calculations

General Description of CEUS SSC Model

- Unique seismic sources are defined to account for distinct differences in the following criteria:
  - Earthquake Recurrence Rate
  - Maximum Earthquake Magnitude (M_{max})
  - Expected Future Earthquake Characteristics (e.g. style of faulting, rupture orientation, depth distribution)
  - Probability of Activity of Tectonic Feature(s)
- Alternative Models for Distributed Seismicity Zones that serve as "Background Zones" to the RLME Sources
  - M_{max} Zones consider possible subdivisions of the CEUS based on considerations of M_{max}.
  - Seismotectonic Zones consider potential differences in future earthquake characteristics.

Sensitivity of Hazard to Source Characteristics

Source Characteristic	Sensitive	Non-Sensitive
Geometry	X	
Rupture Size		X
Rupture Scenario		X
M_{char}	X	
Earthquake Rate	X	
In or Out of Cluster	X	
Paleoliquefaction Data	X	
Earthquake Recurrence Model	X	
Fault Rupture Extension		X

GOALS FOR BRIEFING

- To briefly review the technical assessments that occurred
- To present source model comparisons for the seven (7) test sites
- To present the quality assurance program for the CEUS SSC Project
- To provide information on the CEUS SSC website

Catalog Refinement Activities

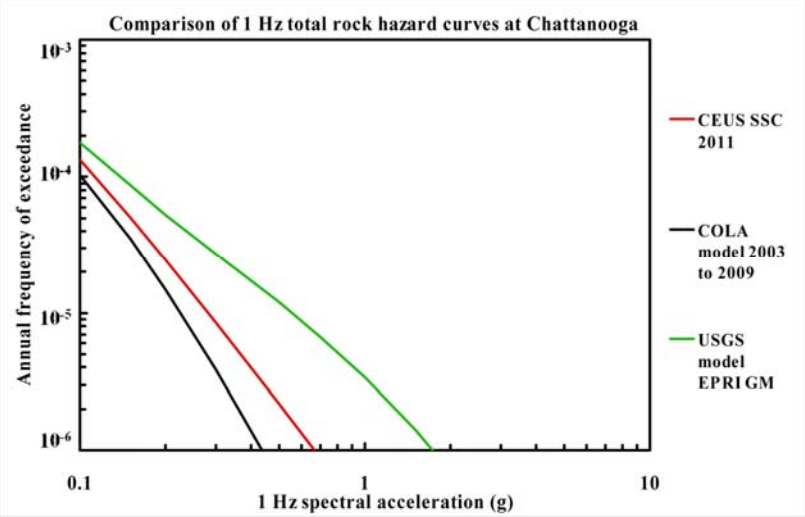
- Zone by zone comparisons with other catalogs
- Review of process used for magnitude conversion, including bias corrections
- Review of declustering
- Review of completeness regions
- Provide regional assessment of b-value priors for recurrence calculations

Changes in Earthquake Catalog and Recurrence Analysis Since Draft Report

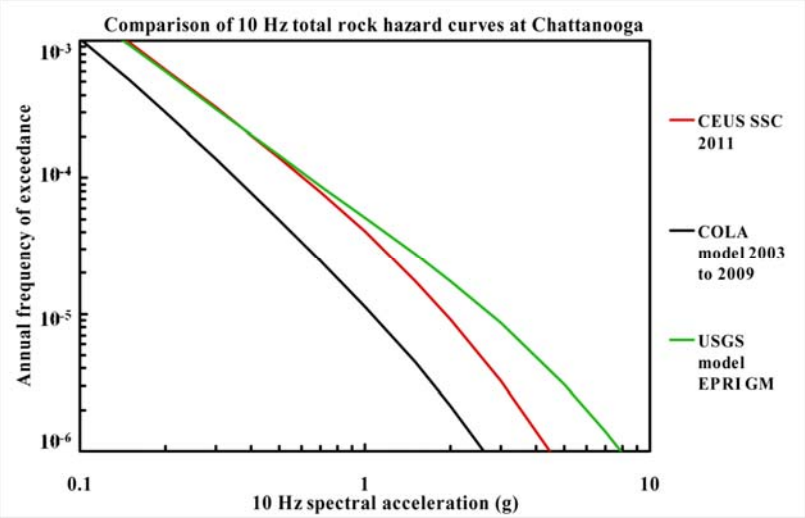
- **New Earthquake Catalog and Completeness Model**:
  - Compensated for nonlinearity in the intensity versus magnitude relationship (significant effect found)
  - Achieved consistency in magnitude conversions (I_o to **M** and I_o to m_b to **M**) (significant effect found)
  - Removed duplicate earthquakes (effect is minor)
  - Adjusted completeness regions in $EPRI_{SOG}$ to reflect new catalog data (Completeness regions represent better the new earthquake catalog)
  - Evaluated sensitivity to de-clustering model used (No effect found except in lower magnitude bin)
  - Compared CEUS SSC earthquake catalog with USGS earthquake catalog (More earthquakes in CEUS SSC catalog)

CEUS SSC Model Assessment: Test Sites

Chattanooga: Comparison of 1 Hz rock hazard curves



Chattanooga: Comparison of 10 Hz rock hazard curves



Summary

- Ground Motion at 10^{-4} Annual Frequency of Exceedance:
  - The approximate % increase from the COLA Ground Motion averages about 11% for the CEUS SSC Model and 22% for the USGS (2008) source model at 1 Hz for the seven test sites
  - The approximate % increase from the COLA Ground Motion averages about 31% for the CEUS SSC Model and 25% for the USGS (2008) source model at 10 Hz for the seven test sites
  - The hazard curves for each test site should be reviewed to understand the significance of these results and the variability of results among the seven test sites
  - The hazard results presented are not intended for engineering design

Summary (continued)

- Ground Motion at 10^{-5} Annual Frequency of Exceedance:
  - The approximate % increase from the COLA Ground Motion averages about 17% for the CEUS SSC Model and 62% for the USGS (2008) source model at 1 Hz for the seven test sites
  - The approximate % increase from the COLA Ground Motion averages about 46% for the CEUS SSC Model and 65% for the USGS (2008) source model at 10 Hz for the seven test sites
  - The hazard curves for each test site should be reviewed to understand the significance of these results and the variability of results among the seven test sites
  - The hazard results presented are not intended for engineering design

SUMMARY (continued)

- The approximate % increase from the COLA Ground Motion is generally higher for the USGS (2008) source model when compared to the CEUS SSC model
- The difference from the COLA Ground Motion for the USGS (2008) source model is largest at the 10^{-5} Annual Frequency of Exceedance, as expected
- Review of the hazard curves for the three source models show that the hazard results for the CEUS SSC source model are generally between the COLA source model and the USGS (2008) source model
- Review of the hazard curves for the three source models generally show that differences in ground motion are least at 1 Hz as expected because of the similarity of modeling of the repeated large magnitude earthquakes in each source model
- Comparison of the hazard results from the three source models show that the hazard results from the CEUS SSC Model at the seven test sites appear to be reasonable when compared to the hazard results from the COLA source model and the USGS (2008) source model

QUALITY ASSURANCE

- Embedded in the SSHAC PSHA process is “participatory peer review” defined as both process and technical review of the PSHA starting at an early stage and continuing through the life of the project
- Participatory peer review is a fundamental element of ensuring the quality of the resulting PSHA product
- Majority of existing information utilized in the conduct of a SSHAC Level 3 or 4 PSHA have been published after review by the broad technical community
- Data, methods and models considered underwent what effectively constitutes peer review by the TI Team

CEUS SSC Website

- Domain name is http://www.ceus-ssc.com
- Homepage (Overview)
- Report for downloading
- Answers to Frequently Asked Questions (FAQs)
- SSHAC Level 3 Documentation (Final)
  - Project Plan
  - Workshops 1-3 Documentation (Agenda, List of Participants, Presentations, Summary and Photo Album)
  - Stakeholder Correspondence

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BACKUP SLIDE

- ADDITIONAL BACKGROUND INFORMATION

CEUS SSC Project: Organization Chart