

A Probabilistic Seismic Hazard Analysis Update Review for Two DOE Sites and NGA-East Project Overview and Status

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Seismic Lessons-Learned Panel Meeting
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Project Description

■ Project Goals:

- Review licensee reports submitted to the NRC for existing CEUS plant sites in response to the NRC Request for Information dated March 12, 2014
- Evaluate the latest PSHAs performed at the Savannah River Site (SRS) and Oak Ridge (OR)
- Make recommendations requiring further actions that are needed

□ Approach

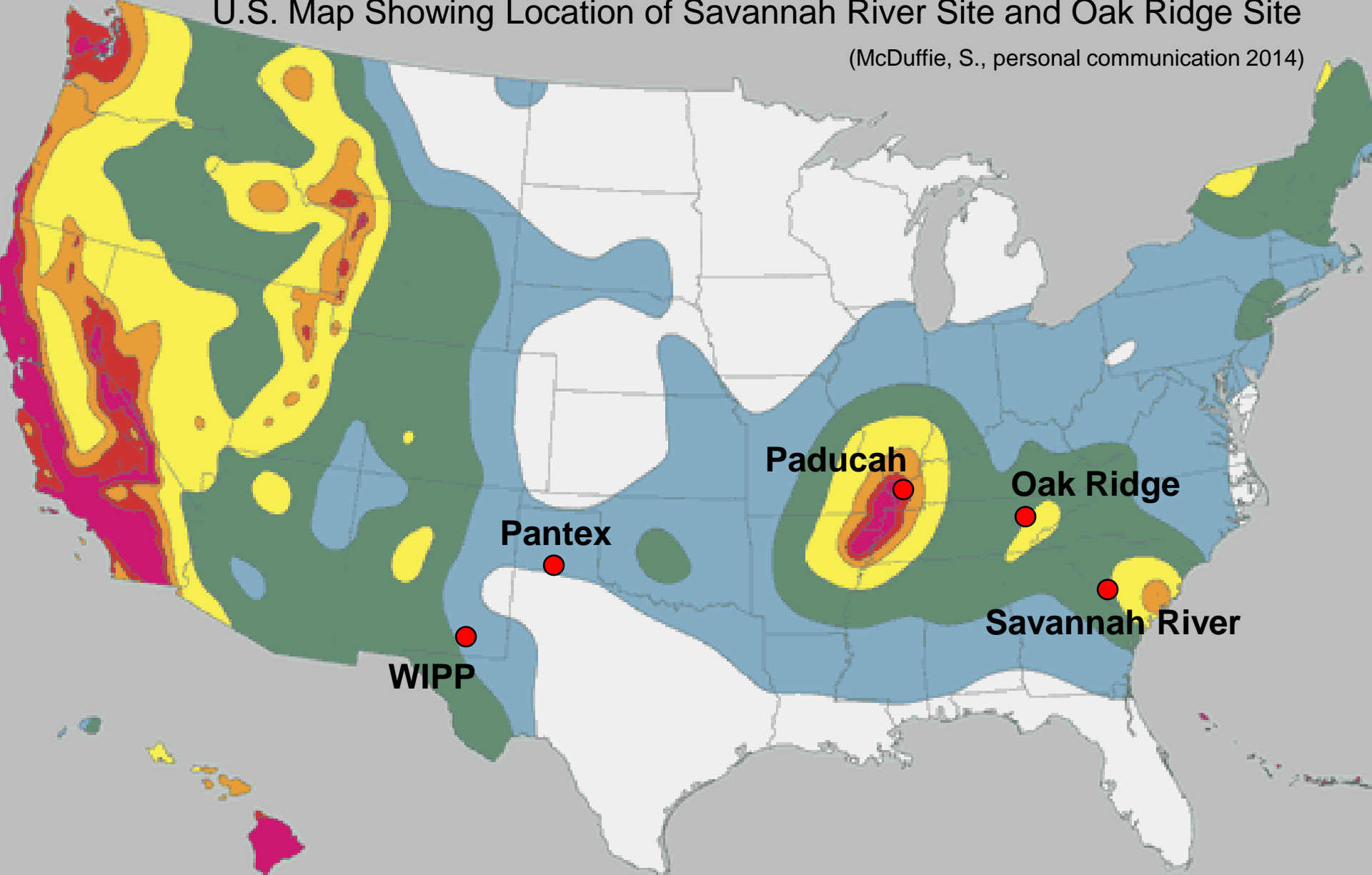
- Consider DOE O 420.1C and SSHAC assessment guidance to conduct reviews
- Assess PSHA updates by reviewing the process used and the technical aspects of the PSHA Updates for the SRS and OR
- Provide Summary Tables for ease of reference of findings
- Provide recommendation for future actions

■ Schedule

- Review based on information available as of April 7, 2014
- Report completed June 2014.

U.S. Map Showing Location of Savannah River Site and Oak Ridge Site

(McDuffie, S., personal communication 2014)



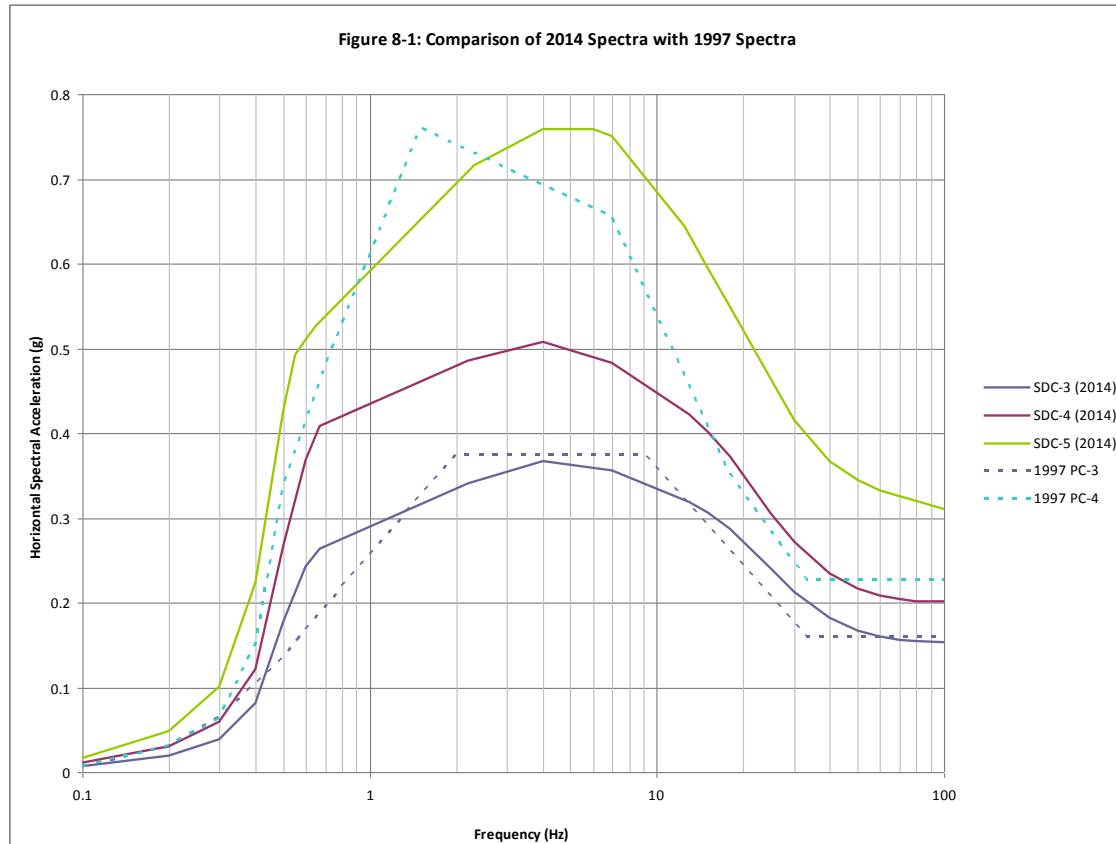
SRS Supporting Documents

- Fugro Consultants, Inc., *Probabilistic Seismic Hazard Analyses (PSHA) for the Savannah River Site (SRS)*, prepared for Savannah River Nuclear Solutions, Draft, December 27, 2013.
- Peer Review Panel, *SRS PSHA Update Review of Probabilistic Seismic Hazard Assessment (PSHA) for the Savannah River Site (SRS)*, PR No. 2131-PR-03, Rev.0, dated 9/30/13 by Fugro Consultants.
- Peer Review Panel Memorandum from Kevin Coppersmith to Rucker Williams, dated February 8, 2014.
- Peer Review Panel Letter Report, *SRS PSHA Update Project, Meeting #1, Key Issues and Available Data, August 11, 2010, August 20, 2010*.
- Salomone, Lawrence, *SRS PSHA Update Project Presentation, Meeting #1, August 11, 2010*.

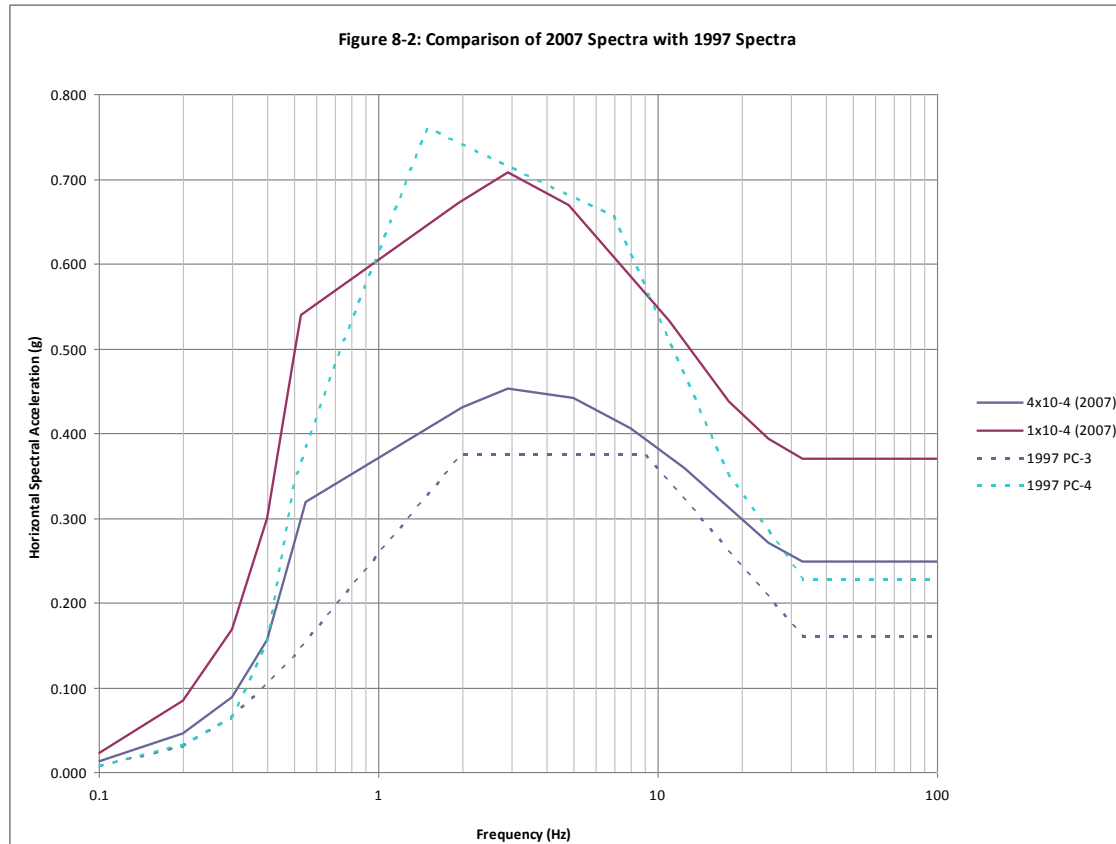
Oak Ridge Supporting Documents

- Facility Design Engineering, *Update of the Seismic Hazard at the Department of Energy National Nuclear Security Administration Y-12 National Security Complex*, September 2003.
- Design Engineering, Engineering Division, *Update of the Seismic Hazard at the Department of Energy National Nuclear Security Administration Y-12 National Security*, August 2012.
- Litehiser, Joe, *Y-12 Seismic Hazards Overview Presentation*, February 25-26, 2014.
- Memorandum from Joe Hunt to Basant Dilodare, *Seismic Mitigation Working Group-Action Status Meeting, Clinch River Site Investigations*, December 3, 2013.

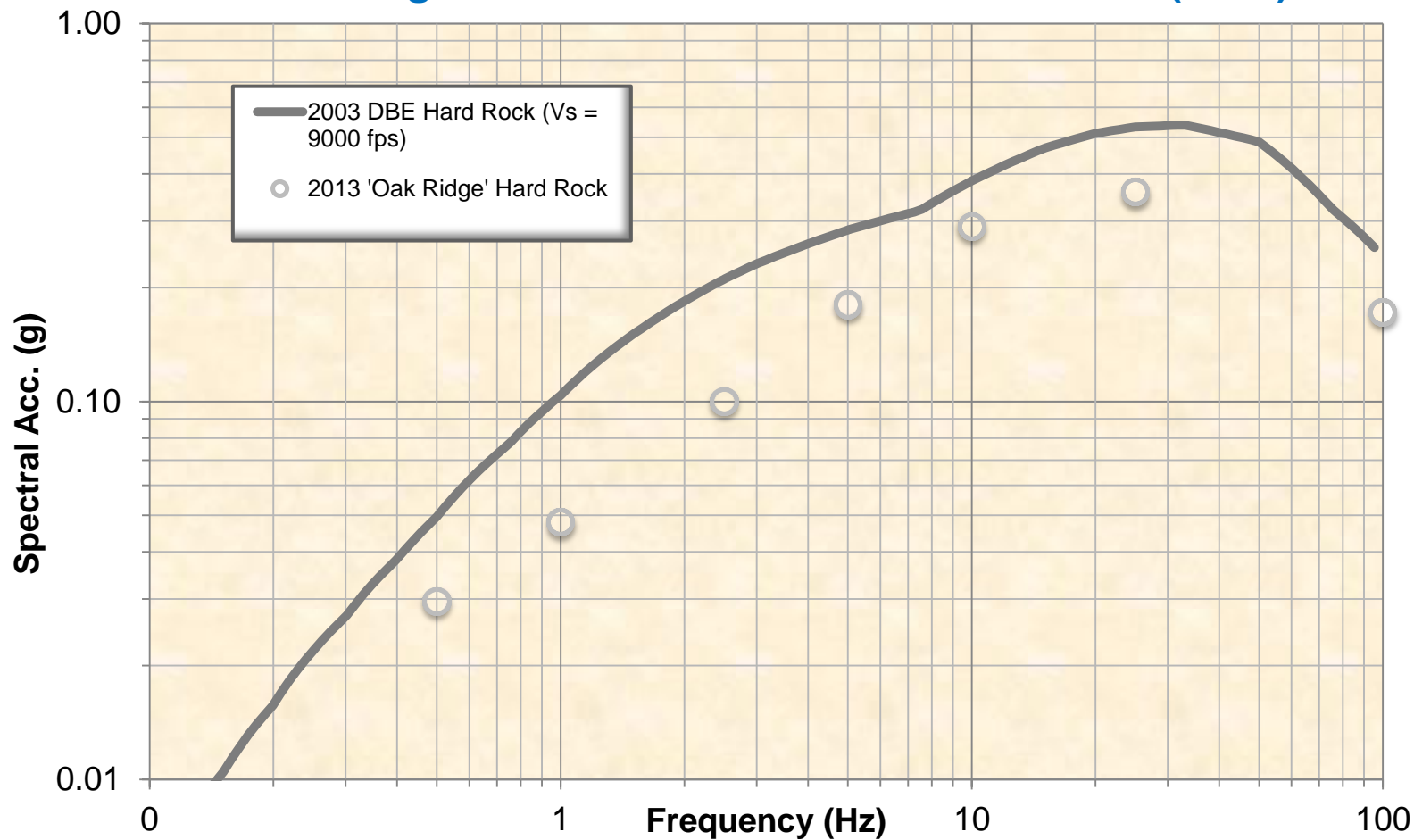
Comparison of SRS PSHA Update Spectra and 1997 Existing SRS PSHA Spectra



Comparison of 1997 Existing SRS PSHA Spectra and 2007 SRS Spectra Using 2002 USGS Hazard at Rock



Comparison of 2,500-year UHRS from Frankel et al. (2003) and PSHA using CEUS SSC Source Model and EPRI (2013) GMM



Conclusions (as of April 7, 2014)

- **Savannah River Site**

- As of April 7, 2014, SRS needed to incorporate PPRP comments into the PSHA Update Report, and the PPRP closure report assessing whether the SSHAC goals were met needed to be completed and also incorporated.
- Following a SSHAC Level 2 outline for the final report would improve project documentation and transparency.
- SRS should replace the EPRI (2004, 2006) GMM but wait for the NRC's review and approval of the NGA-East GMMs.
- SRS should update the earthquake catalog using the changes made by the V.C. Summer Nuclear Station, Unit 1 in 2014 and adding any earthquakes from January 1, 2009 to the time when the PSHA update is performed.
- Incorporate SRS PSHA Update using NGA-East GMMs into SRS Site Standard 01060 and develop a plan for reassessment of SRS facilities for the SRS Qualification Plan.

- **Oak Ridge**

- The feedback from the advisory panel was not documented in the 2003 seismic hazard assessment. The 2003 assessment was based on a PSHA performed by USGS for the Y-12 site-specific rock conditions and the USGS (2002 hazard model.
- OR Design Engineering reviewed in a 2012 report changes in site-specific information and hazard methodologies and concluded that the 2003 PSHA results for the OR site are "sufficiently conservative and acceptable for use".

Concluding Remarks (as of April 7, 2014) **(continued)**

■ **Oak Ridge (continued)**

- Assessed impact of EPRI (2013) GMM and examined changes in catalog for periods 2009 to mid-December 2011 and mid-December 2011 to mid-June 2013.
- Update the OR PSHA after the NGA-East GMMs have been reviewed and approved by the NRC.
- Begin discussions with the Clinch River Project to explore how the planned PSHA for the Clinch River Project would benefit the need to update the PSHA for the three OR sites (ETTP, ORNL and Y-12).

Post-Model Development Process: Approach

- Categorize Changes
 - Book-keeping or Corrections Involving Process Implementation
 - Exclusion of Reservoir-Induced Earthquakes
 - Selecting Mmax numbers from a spread sheet
 - Technical (Evaluating Present-Day Relevant Data and Technical Knowledge with Uncertainties)
 - Selection of Appropriate SSHAC Level Assessment Process (e.g. SSHAC Level 2)
- Implementation of Method Used for Change
- Documentation of Change
- Posting Change on CEUS SSC website for End Users



SSHAC Level 2 Assessment Process

- The SSHAC Guidance tasks the Technical Integrator (TI) with thoroughly evaluating present-day relevant data, and technical knowledge, together with uncertainties in both data and technical knowledge.
- The SSHAC guidance prescribes interactive process and technical review by a designated PPRP.
- The TI Team and Project Manager document the process as implemented in a draft project report, which is reviewed by the PPRP and revised as needed considering PPRP recommendations to prepare the final report.

Precision in Seismic Hazard Estimates

- Reference: Technical Report: *Central and Eastern United States Seismic Source Characterization for Nuclear Facilities*. EPRI, Palo Alto, CA, U.S. DOE, and U.S. NRC:2012, page 9-20.
 - *“If an alternative assumption or parameter is used in a seismic hazard study, and it potentially changes the calculated mean hazard (mean annual frequency of exceedance) by less than +/- 25% for ground motions corresponding to 10^{-4} annual frequency of exceedance, and it potentially changes the calculated hazard by less than +/- 35% for ground motions corresponding to 10^{-6} annual frequency of exceedance, then that potential change is less than the best (highest) level of precision with which we can calculate mean seismic hazard.*
 - *Under these circumstances, the potential change could be deemed not significant. For many sites we cannot be this precise, and the uncertainty in mean hazard will be higher than this, but the above interpretation gives a reasonable lower-bound guideline with which to evaluate the significance of potential changes in mean hazard.”*
- Regulators may (appropriately) require action even if potential changes are less than the guidelines given above.

Status of CEUS SSC Maintenance Plans

- Development of an industry-government post-CEUS SSC model development plan to manage changes identified for the CEUS SSC model is required at this time.
 - Two Plans Have Been Developed:
 - Maintenance of CEUS SSC Website (completed)
 - Maintenance of CEUS SSC Model (Draft)
- Industry-Government funding sought using the post-CEUS SSC model development plans to manage change.
 - DOE Has Funded Annual Maintenance of CEUS SSC Website (\$20K/yr.)
 - Sponsor Funding Will Be Sought To Implement Maintenance of CEUS SSC Model Plan When Required
- Funding will include activation of the CEUS SSC website to post CEUS SSC model changes.

NGA-East Project Overview and Status

■ Hazard-Critical Issues:

- Regionalization of Source and Path Parameters
- Geometrical Spreading in first 40 km
- Stress Drop (or Parameter) and extrapolation of ground motions to large M_w
- Standard Deviation of Ground Motions
- Quantification of Site Effects
- Development of a model for distribution of depths needed to perform hazard calculations using the NGA-East Ground-Motion Models (GMMs) and the CEUS SSC (2012) model

■ Solutions:

- 1) run a multi-disciplinary project with working groups focused on specific research tasks
- 2) build models making extensive use of seismological constraints (simulations)
- 3) perform the evaluation and integration under the SSHAC Level 3 umbrella



NGA-East Project Roles in addition to SSHAC Roles

- Joint Management Committee
- Working Groups
 - Database
 - Geotechnical
 - GMPE
 - Random Vibration Theory (RVT)
 - Sigma
 - Simulations
 - Source/Path Studies

Representative NGA-East Products

■ 2014

- PEER NGA-East Database Report (2014-17)
- PEER NGA-East Reference Rock Report: Part 1: Velocity (2014-12)
- PEER NGA-East Reference Rock Report: Part 2: Kappa (2014-12)
- PEER NGA-East Regionalization Report (2014-15)
- PEER NGA-East Magnitude-Area Report (2014-14)

■ 2015

- Peer NGA-East Median GMPE Report (April 2015))
- PEER NGA-East Random Vibration Theory Report (2015-XX)
- PEER NGA-East Median Epistemic Uncertainty Report (2015-XX)



2014 Highlights

- **NGA-East SSHAC Workshop 2 - Proponent Discussions and Remaining Critical Issues and Data Needs (July 14-16, 2014)**
- **NGA-East SSHAC Workshop 2c and 3a - Proponent Discussions and Feedback (October 29-30, 2014)**
- **Completed PPRP reports and Project Team responses for each workshop**
- **Completed NGA-East Database Report**
- **Completed NGA-East Reference Rock Reports, Part 1 (Velocity) and 2 (Kappa)**
- **Completed NGA-East Regionalization Report**
- **Completed NGA-East Magnitude-Area Report**

2014 Highlights (continued)

- **Developers submitted predictions from their models and computer codes with a short summary of the technical basis for their models (PPRP Feedback)**
- **Began development of data-driven representative profiles to be used in the development of site amplifications for reference rock ($V_s = 3,000$ m/s) (PPRP Feedback)**
- **Began preparation of paper on the use of Sammon's maps for assessing median ground motion uncertainty (PPRP Feedback)**
- **Completed Ground Motion Characterization Report Outline and Attachment Reports Delivery Schedule (PPRP Feedback)**

PPRP Feedback Regarding EPRI (2013) Ground-Motion Models and TI Team Response

- **PPRP:** PPRP believes the full application of the Sammon's approach to the EPRI (2013) Ground-Motion Models and data is a valuable exercise and recommends that this analysis be performed and presented to the PPRP. PPRP requests the results from the complete Sammon's map analysis all the way to the generation of Ground Motion Prediction Equations (GMPEs) and weights using the EPRI (2013) data and candidate models.
- **TI Team Response:** 1) The candidate models used by EPRI (2013), as well as the clusters developed by the project, were included in the preliminary Sammon's maps shown at the October workshop. This comparison showed how the different clusters used by EPRI (2013) compared (well) in ground motion space. 2) All GMPEs considered by EPRI (2013) will be considered in the NGA-East evaluation as candidate models. 3) TI Team will provide the PPRP with Sammon's maps that only include the EPRI (2013) models for comparison before the March workshop.

2015 Highlights

- **Working Meeting: PPRP, TI Team and JMC meeting to focus on GMPE evaluations (January 22, 2015)**
- **Workshop 3: Presentation of Models and Hazard Sensitivity Feedback (March 4-5, 2015)**
- **Completed PEER NGA-East Median GMPE Report (April 2015)**
- **Working Meeting Webinar: PPRP, TI Team and JMC Meeting to discuss results and recommendations for epistemic uncertainty, standard deviations and hazard sensitivity analyses (April 13, 2015)**

CHALLENGES

■ Administrative:

- Much work needs to be done to complete technical work and prepare a draft NGA-East SSHAC Report on or before late June 2015
- Aggressive schedule to complete project on or before December 2015
- Report Format and Requirements Must Be Obtained to obtain a NUREG number from the NRC and numbers from DOE and EPRI
- Obtain funding to complete the project and obtain depth distributions for implementation of Rrupture distance used in NGA-East Ground-Motion Models and the Joyner-Boore distance used in the CEUS SSC model
- Identify Funding for Proposed Implementation Workshops Planned for last half of 2016

CHALLENGES (continued)

■ Technical:

- Extension and verification of NGA-East GMMs from 400 km to 1,200 km
- Implement Plan to Account for Depth and Effect of Kappa
- Add Table With Gulf Adjustments
- Complete Hazard Calculation Feedback for Seven (7) Test Sites including comparisons of hazard using NGA-East GMMs and the EPRI (2013) GMM

May 2015 Progress: Technical Issues

■ Technical Issues:

- Development of two independent approaches for Gulf Coast adjustment factors
- Development of final “sigma” models
- Inclusion of source depth effects
- Development of models to account for the extension of median models within 10 km and up to 1500 km
- Refinement on Sammon’s map space and discretization
- Computation of alternative weighing schemes for median Ground-Motion Models (GMMs)



May 2015 Progress: Reports

■ Reports:

- Project SSHAC Report is being drafted
- PEER Report on site effects is being finalized
- PEER “Sigma” Report is being reviewed
- New PEER Report is being drafted to address GMM adjustments (for extensions of GMMs for shorter and longer distances, effects of source depth and the Gulf Coast Region adjustments)

WHAT'S NEXT

- Final NGA-East Workshop (June 17 and 18, 2015)
- Complete Draft NGA-East SSHAC Report and Provide Report to PPRP (June 30, 2015)
- PPRP Discuss PPRP Report Comments with TI Team and JMC as Observers (TBD: August 2015 – 1 day)
- TI Team Incorporate PPRP Report Comments in second draft of report (TBD: October 2015)
- Complete NGA-East SSHAC Report (December 31, 2015)
- NRC Review of NGA- East Project Report (January to June, 2016)
- Proposed Implementation Workshops in Various Cities (second half of 2016 - tentative)