US NRC Approach for
Seismic Hazard Assessments

INTERNATIONAL WORKSHOP ON LESSONS LEARNED FROM STRONG EARTHQUAKES

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Overview

- NRC Framework

- Key NRC documents on Probabilistic Seismic Hazard Assessment (PSHA) methods

- New NRC initiatives to update PSHA tools for Central and Eastern US

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NRC Framework

- In 1998, the Commission issued a policy decision to move towards a risk-informed and performance-based regulatory framework

- Risk-informed frameworks use probabilistic methods and require not only a specification of "what can go wrong", but also "how likely is it". Deterministic methods provide no explicit information about how likely the events are.

- The overall goal is hazard assessments that are accurate, defensible, and lead to regulatory stability

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US NRC Objectives for PSHA

- The NRC objective is to produce a defensible, unbiased estimate of the mean seismic hazard at a specified site.

- Because the mean seismic hazard is sensitive to uncertainties in the component pieces that together form the hazard model, as secondary objective is to reduce uncertainties through strong scientific research.

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US NRC Objectives for PSHA

- A modern, detailed PSHA includes:
  - All relevant uncertainties
  - The range of diverse technical interpretations that are consistent with the available data
  - Any site-specific data and knowledge
  - Clear and complete documentation
  - A detailed peer review process

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US NRC Key Guidance on PSHA

- Regulatory Guide 1.208 (March 2007)
  - Guidance on undertaking site-specific PSHA
- NUREG/CR-6372
  - Provides a framework for undertaking large, complex, or regional PSHA
- NUREG/CR-6728
  - Integrates site response into PSHA methods
- Publically available at www.nrc.gov

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US NRC Key Guidance on PSHA

- Regulatory Guide 1.208 (March 2007)
  - "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion"
  - Basis of NRC risk-informed, performance-based approach for analysis and design
  - Probabilistic framework for development of site-specific ground motion response spectra with the 10^{-4} to 10^{-6} annual probabilities of exceedance
  - Clarifies and defines various response spectra related to framework for Certified Designs

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US NRC Key Guidance on PSHA

- ## NUREG/CR-6728
  - "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-consistent Ground Motion Spectra Guidelines"
  - Discusses framework for developing ground motions spectra; including for sites that must consider site response
  - NRC Currently undertaking research on various methods to incorporate site response directly into PSHA (implementation of framework)

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US NRC Key Guidance on PSHA

- NUREG/CR-6372
  - "Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts"
  - Commonly called the "SSHAC guidelines"
  - Provides framework for undertaking large PSHA
  - Used in recent large assessment projects
    - Yucca Mountain PSHA
    - Yucca Mountain PVHA
    - PEGASOS study in Switzerland
  - Currently developing additional recommendations for application of the guidelines

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New US NRC Projects to Assess Seismic Hazard in Central and Eastern US

Source Characterization →

Central and Eastern US Seismic Source Characterization project for Nuclear Facilities (CEUS SSC)

Ground motion prediction equations →

Next Generation Attenuation Relationships for the Central and Eastern (NGA-East)

Framework for large PSHA studies →

Recommendations for Application of the SSHAC Guidelines

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Recommendations for Application of the SSHAC Guidelines

- Developing companion document to NUREG/CR-6372

- Provides framework for undertaking large PSHA using multiple levels of complexity

- Provides unbiased representation of the informed scientific community's view of the technically supportable interpretations of the important input components (both data and models), as well as the site-specific hazard.

- Incorporates uncertainty to provide an unbiased estimate of the mean and range of hazard levels.

- Leads to long-term regulatory stability by assessing and weighting all scientifically supportable interpretations

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Recommendations for Application of the SSHAC Guidelines

- New project created to develop practical recommendations for application of the SSHAC guidelines
  - Lessons learned
  - How and when to update
  - Understanding and characterizing uncertainties (epistemic and aleatory)
- Will develop a NUREG document to accompany the SSHAC guidelines

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Central and Eastern US Seismic Source Characterization project for Nuclear Facilities

- Major study with participation from NRC, DOE, EPRI, USGS, and other US specialists

- NRC SSHAC guidelines level-3 study

- 3 year project starting summer 2008

- Project to develop a seismic source database for the CEUS to be used as a baseline for all PSHA

- NPP applications will still study local sources

- Coordinating a CEUS SSC "International Observers Program" to allow international specialists to observe the US project firsthand

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Next Generation Attenuation Relationships for the Central and Eastern US (NGA-East)

- Follows and expands the framework of the successful NGA project recently completed for California

- Will develop a set of state-of-the-art ground motion prediction equations (attenuation relationships) for the CEUS

- Sponsored by multiple US agencies, led by the NRC

- Combined with the source database of the CEUS SSC project, will allow for highly advanced state-of-the-art PSHA to be undertaken in the CEUS and will bring long-term regulatory stability
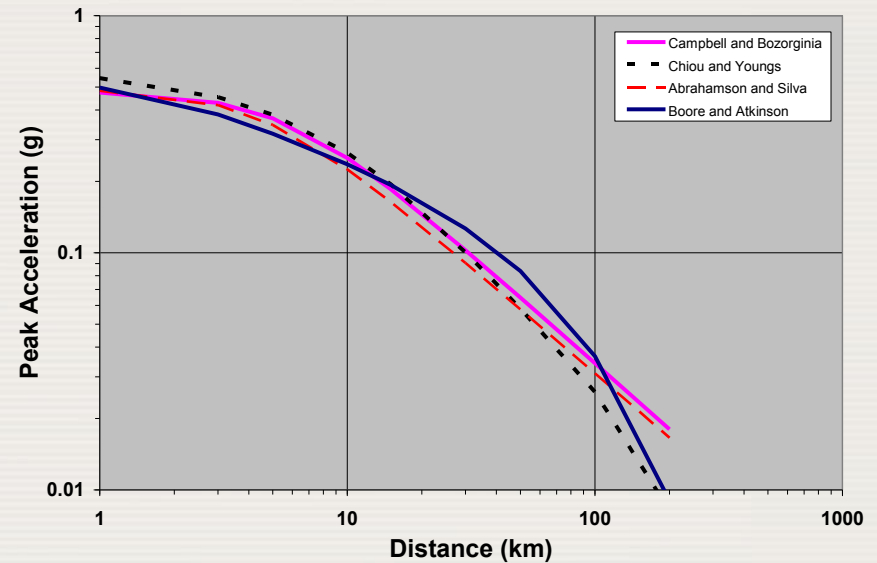
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Next Generation Attenuation Relationships for the Central and Eastern US (NGA-East)

Before NGA-West **After**

1997 Attenuation Relations, SS, M=7, Generic Rock
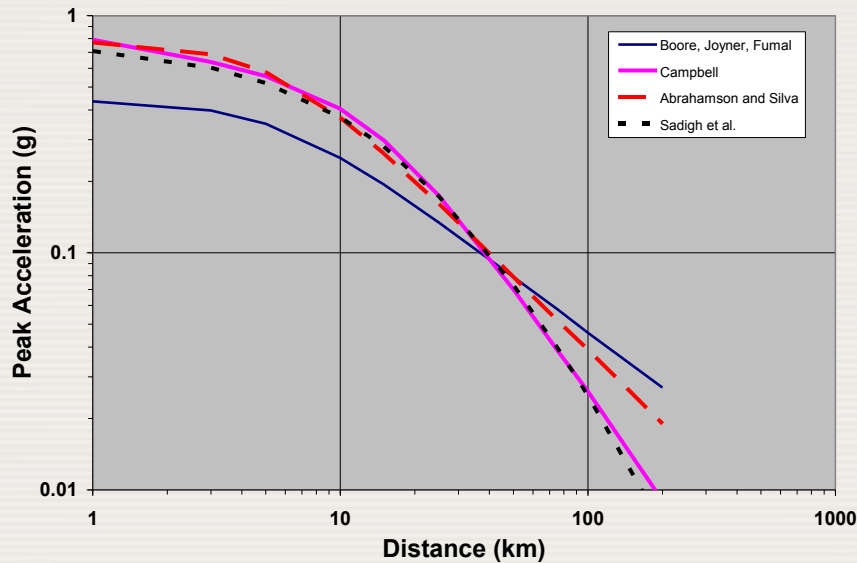
NGA 2006, SS, M=7, Vs=760

Significant reduction in uncertainty

CONCLUSIONS

- **US NRC uses a probabilistic risk-informed performance-based framework for assessing seismic hazard**

- **Several publically-available documents are in use currently and more are in development**

- **The NRC has initiated several large integrated multi-year, multi-agency projects to create the next generation of state-of-the-art seismic hazard assessment tools for the CEUS**

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