The Nuclear Renaissance & the NRC Seismic Research Program

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NIST HQ
March 2011
• History of nuclear in the US and the current nuclear renaissance
• Overview of the NRC & where research fits
• The purpose and structure of NRC seismic research program
• Current & upcoming research topics
• The next generation of advanced reactors

Presentation Contents
• Atomic Energy Commission (1954)
• Energy Reorganization Act of 1974
  • Department of Energy
    • Nuclear weapons, promotion of nuclear power, care of low-level radioactive waste, and other energy-related work
  • Nuclear Regulatory Commission
    • Regulation of the civilian uses of nuclear materials including power production, medical and other uses

• Nuclear Non-Proliferation Act of 1978
  • Limits the spread of nuclear weapons. Established criteria governing U.S. nuclear exports licensed by the NRC and strengthened international safeguards system

History
- 1950s to 1970s US built plants
- 1979 Three Mile Island Accident
- 1986 Chernobyl Nuclear Disaster
- 435 nuclear plants in 30 countries generating 16% of total power (104 in US)
- Changes in energy policy
  - New financial incentives in US energy policy
  - Certified design concept becomes law
  - Time limits on NRC response
• Possibly 35 new reactors in coming years
• Approximately 23 applications have already come into the NRC
  • Early site permits
  • New plant Combined Operating Licenses
  • Design Certification Documentation
• 3 Early site permits and 1 Certified Design already issued
• Pre-submission meetings on advanced reactors designs

Now – “the nuclear renaissance”
Submitted applications
NRC Organization

5 Commissioners
(Presidential Appointments)

Oversight Committees

Existing and New Reactor Licensing Offices

Resident Inspectors

Materials & Safeguards

Research
• Research undertaken to develop technical basis for NRC regulatory decisions and regulatory guidance
• Regulatory infrastructure development
• Development of new approaches and tools
• Evaluation of operating experience
• Confirmatory analysis & review assistance
• Special regulatory programs
• Codes & Standards

NRC Research Program Activities
• Publicly available plan (currently outdated and being revised for 2011-2016)
• Growing program through 2010, leveling off
• The primary users of NRC research are always NRC staff (and the industry) and the primary objective is always related to make the NRC a stronger regulator
• Research is conducted both in-house and through contractors (including universities, national labs, and private firms)

**NRC Seismic Research Program**
• Most outside research is conducted through performance-based contracts, although grant requests are now accepted at grants.gov

• Heavily targeted towards short to medium-term regulatory needs, but includes longer-term efforts to assess & reduce uncertainties in order to increase regulatory stability

• Strong stakeholder interaction
  • Other NRC offices
  • Industry (EPRI), other national & international agencies, and the technical community

NRC Seismic Research Program
Chapter 2 Earth Science & Natural Hazards

Chapter 3 Earthquake Engineering

Chapter 4 International Activities

Chapter 5 Regulatory Guides
• Certified Design Documentation
• Site Analysis
  • $10^{-4}$ annual probability ground motion (with design factors) compared to certified design
  • Geotechnical properties assessed for compliance with requirements
• Combine with other information in COL

US Regulation

GRMS is based on site characterization and it is determined from detailed seismic hazard studies

CSDRS is based on engineering design of a plant
Seismic Hazard Assessment

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)

PSHA process guidance
- Practical Application of the SSHAC Guidelines
Current Research

• Site Response
• Seismic Isolation
• Small Modular Reactors
• SSI modeling of NPPs under non-traditional loads
• Correlated seismic performance of similar SSCs
• Technology-neutral performance-based risk-informed framework for seismic design and review

New Topics (RFPs in winter 2010)

• Dynamic earth pressures on deep foundations
• Testing and modeling of multidirectional cohesionless soils

Earthquake Engineering
Identified future NRC research topics

- Fully probabilistic SSI analyses
- True dispersion of SSC response
- Ground motion selection for NPPs
- Fully randomized geologic profiles
- Response of deep soil sites
- Next generation seismic probabilistic risk assessments
- Improved plant-level fragility and HCLPF assessments

Earthquake Engineering
Plant designs are diverging greatly
- Small (and very small) modular reactors
- Pebble bed reactors
- Sodium cooled gas reactors
- Etc.

- Deeply embedded designs
- Some base-isolated designs
- SSCs must be assessed for extreme loads (design basis and beyond)

**Advanced Plants – Generation 4**
Thank You

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