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Earthquake Hazards Reduction

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**The Nuclear Renaissance  
& the NRC Seismic Research Program**

- 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

## **History**

- 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



\*Review Suspended by Applicant

\*\* COL Application Amended by Applicant to ESP on 03/25/2010

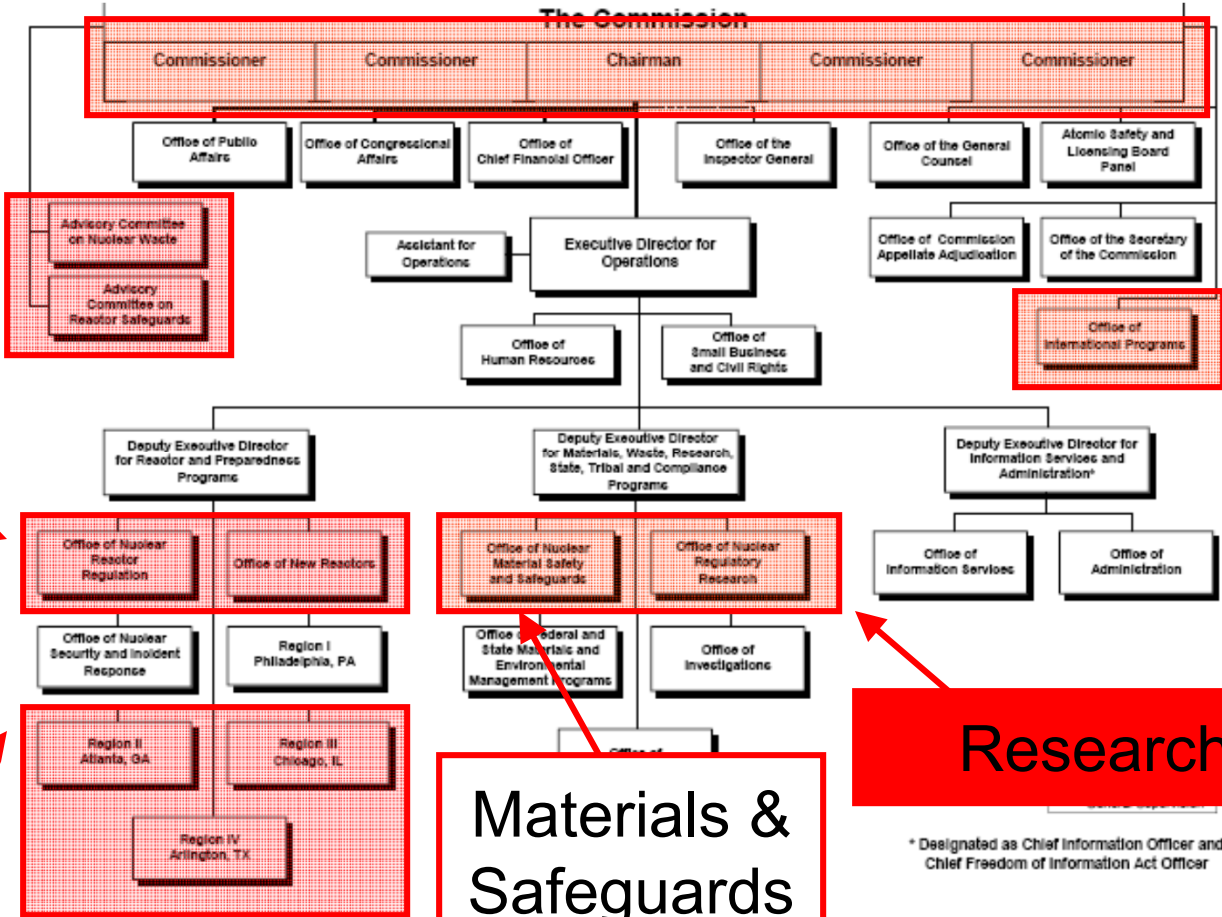
# NRC Organization

5 Commissioners  
(Presidential Appointments)

Oversight  
Committees

Existing and  
New Reactor  
Licensing  
Offices

Resident  
Inspectors



Materials &  
Safeguards

Research

\* Designated as Chief Information Officer and Chief Freedom of Information Act Officer

- **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**



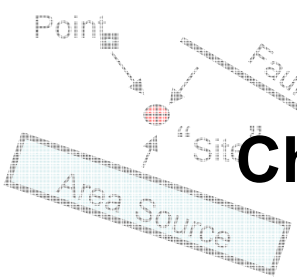
- Publicly available plan (currently outdated and being revised for 2011-2016)
- Growing program through 2010, leveling off
- The primary users of NRC research are always NRC staff (and the industry) and the primary objective is always related to make the NRC a stronger regulator
- Research is conducted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

## **NRC Seismic Research Program**

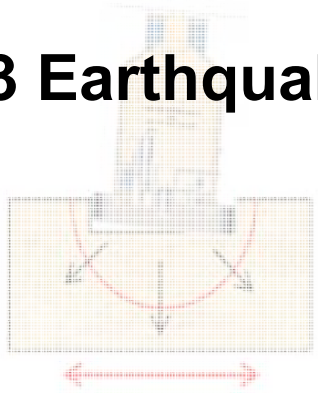
- Most outside research is conducted through performance-based contracts, although grant requests are now accepted at grants.gov
- Heavily targeted towards short to medium-term regulatory needs, but includes longer-term efforts to assess & reduce uncertainties in order to increase regulatory stability
- 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

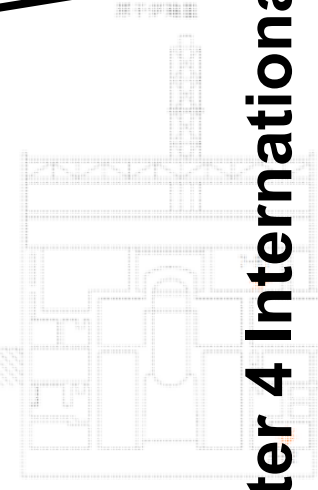
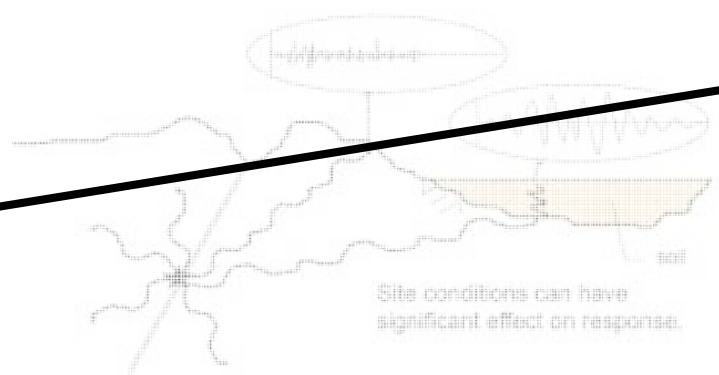
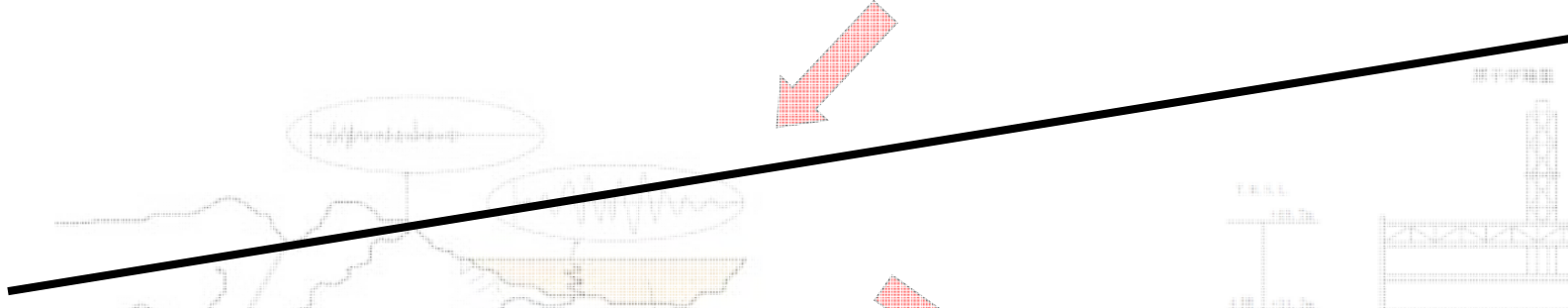


# Chapter 3 Earthquake Engineering



**Chapter 4 International Activities**  
**Chapter 5 Regulatory Guides**

SSCs

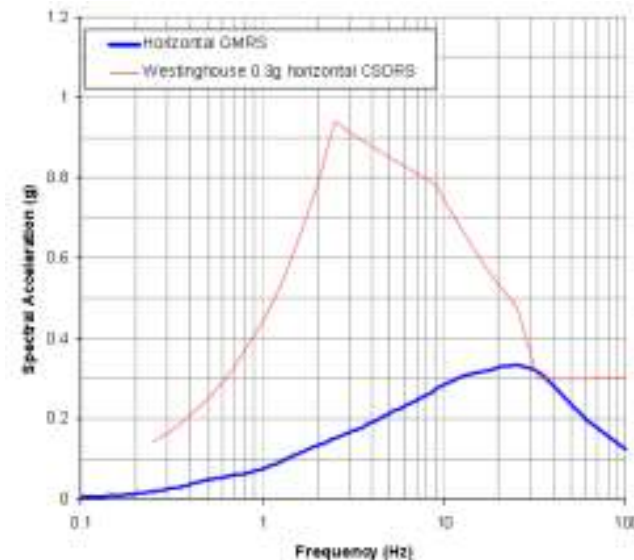


- Certified Design Documentation
- Site Analysis
  - $10^{-4}$  annual probability ground motion (with design factors) compared to certified design
  - Geotechnical properties assessed for compliance with requirements
- Combine with other information in COL

## 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



## 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

# Seismic Hazard Assessment

## 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**

The Nuclear Renaissance  
& the NRC Seismic Research Program

