Overview of NRC Advanced Manufacturing Objectives and Activities

Jason Christensen
Division of Engineering
Office of Nuclear Regulatory Research

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U.S.NRC
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Disclaimer

The findings and conclusions in this presentation are those of the author(s) and do not necessarily reflect the views of the agency. This presentation does not constitute NRC policy or guidance.

Discussion Topics

- Background on NRC
- NRC technical topics of interest
- NRC AM action plan

U.S. Nuclear Regulatory Commission

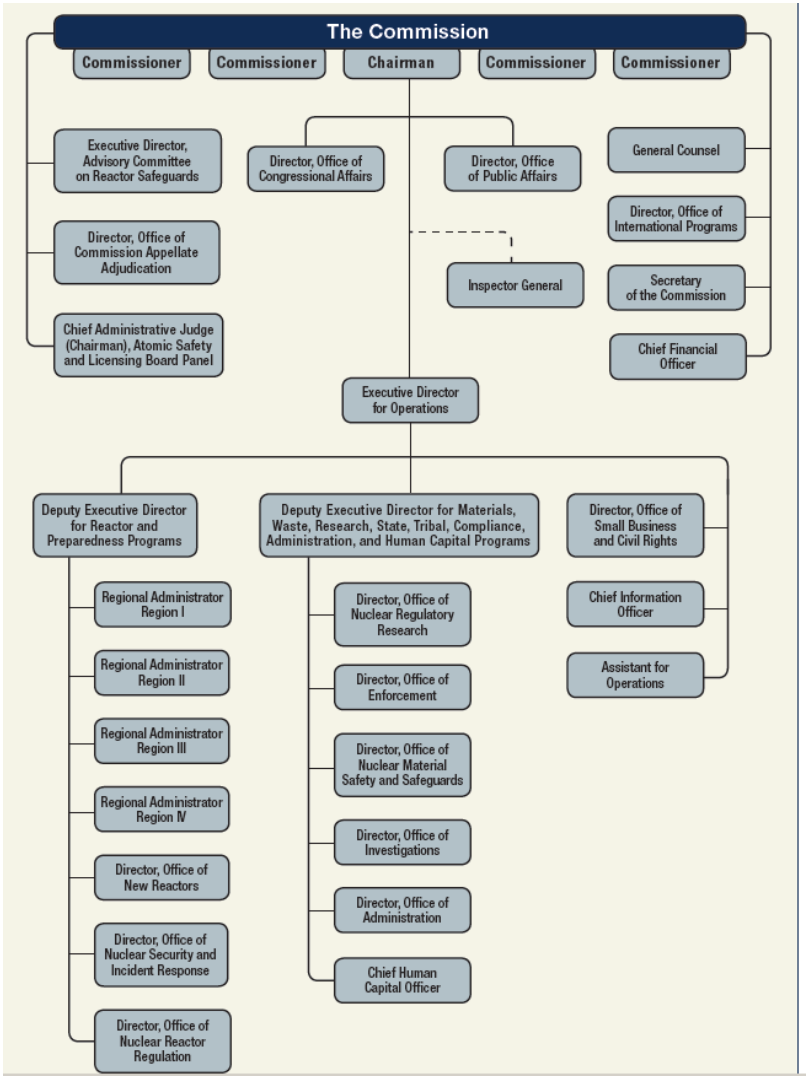
- The Energy Reorganization Act of 1974 established the independent U.S. NRC to regulate commercial uses of nuclear material; other duties of the former Atomic Energy Commission were assigned to Department of Energy.

- The NRC is headed by four Commissioners and a Chairman, all appointed by the President and confirmed by the Senate for staggered five-year terms. No more than three can be from the same political party.

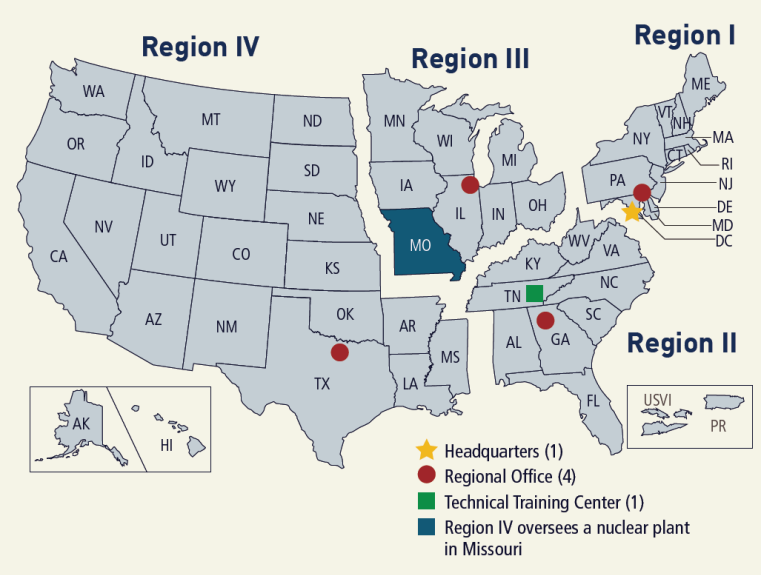
Our Mission

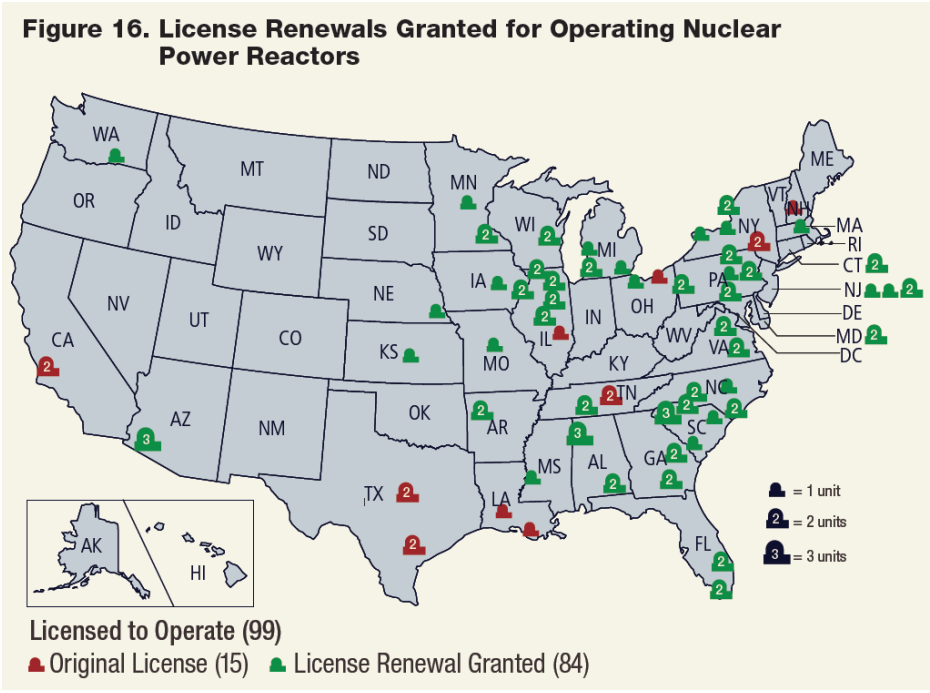
To license and regulate the nation's civilian use of byproduct, source and special nuclear materials to protect the public health and safety, promote the common defense and security, and protect the environment.

NRC Organization



NRC Locations & Operating Reactors





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Nuclear Industry Plans

- Additive Manufacturing (AM)
  - Currently limited items in non-safety related applications
  - Developing test samples for discussion in code committees
- Powder Metallurgy-HIP
  - DOE / EPRI SMR reactor pressure vessel
  - 2/3 scale – upper and lower head
  - Electron Beam Welding
  - Diode Laser Cladding
  - Cryogenic machining

Technical Topic Areas

- Quality/reliability of processes, materials, and components for NPPs
- Codes and standards aspects of AM
- Properties and structural performance
- Service performance / aging degradation

Quality of AM Parts for NPPs

- AM Build Process
  - Critical parameters
  - Directionality
  - Uniformity
  - Surface roughness
  - Density
  - Feed stock and powder reuse
- Post-Build Processing
  - Densification (e.g., Hot Isostatic Pressing)
  - Annealing and heat treatment
  - Surface processing
  - Residual stresses and geometric stability

Codes and Standards Aspects of AM

- American Society of Mechanical Engineers (ASME)
- ASTM International
  - formerly American Society for Testing and Materials
- American National Standards Institute (ANSI)
- American Society for Nondestructive Testing (ASNT)
- NACE International
  - formerly National Association of Corrosion Engineers

Properties and Structural Performance

- Properties
  - As-built
  - After post-build processing
  - Coupons vs. component
  - Fatigue performance
  - Comparison to conventional manufacturing methods
- Defect Characteristics/Populations
  - Type
  - Size
  - Density
  - Impact on structural integrity

Properties and Structural Performance

- Inspectability
  - In-process examinations
  - Methods capable of finding structurally relevant defects
  - Pre-service inspections
  - Inservice inspections
- Component residual stresses

Service Performance / Aging Degradation

- In various service environments
  - Aqueous (BWR/PWR/Raw)
    - Corrosion
    - Stress corrosion cracking (SCC)
    - Environmental fatigue life
    - Environmental fatigue crack growth
  - Neutron effects
    - Loss of fracture toughness
    - Swelling
    - IASCC
  - Thermal effects
    - Loss of fracture toughness
    - Thermal expansion

NRC Action Plan

- Early stages of development
- To address preparation of NRC readiness for review of AM parts
- Provide for interoffice coordination - reactor side, waste management, research
- Address involvement in standards and codes organizations
- A subject of NRC “Innovation and Transformation” initiative
- Draft expected January 2019

External Communications

- Developing MOU addenda with the Electric Power Research Institute, Inc. (EPRI) and the Department of Energy Office of Nuclear Energy (DOE-NE) to share research results and activities related to Advanced Manufacturing

- Regular contact with DOE-NE and EPRI to discuss progress of research efforts

NRC Research Actions

- Perform research anticipating the submittal of applications for the use of AM products
- Participate in codes and standards activities
- Coordinate research activities with EPRI and DOE to maximize efficiency
- Participate in NRC Action Plan development

Summary

- Advanced manufacturing has been identified as an area of potential future utilization by the nuclear industry – "when" and "how many" are the questions
- NRC interest areas
  - The reliability of AM processing and quality of AM parts
  - The properties of AM parts
  - The structural performance of AM parts, including their inspectability
  - The service performance and aging degradation of AM parts
- Codes and standards aspects of AM is a key to successful implementation
- Comparison of performance of parts from AM and conventional manufacturing process (benchmarking)
- Draft Action Plan expected by January 2019