



*United States Nuclear Regulatory Commission*

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## **SMiRT 16**

**NEW DESIGNS AND TECHNOLOGIES  
ISSUES AND IMPLICATIONS**

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**OVERVIEW**

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- ◆ **Changing Environment**
- ◆ **Recent Developments**
  - New Reactor Designs**
  - New Technologies**
- ◆ **Policy and Technical Issues**
- ◆ **Infrastructure Needs and Requirements**
- ◆ **What NRC is doing to get ready**
- ◆ **Role of Structural Mechanics**

# Changing Environment

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- ◆ Demand for Power
- ◆ Deregulated Industry
- ◆ Environmental Considerations
- ◆ Recent Developments

# **Commission Policy**

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- ◆ **Encourages Innovative Designs**
- ◆ **Expects Increased Safety Margins**
- ◆ **Allows for Innovative Safety Criteria**
- ◆ **Licensability to be Supported by New Technology Demonstrations**
- ◆ **Less Prescriptive or Performance - Based Criteria can be Considered**
- ◆ **Encourages Early Interaction Between Applicant and NRC**

# Recent Developments

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## New Reactor Designs

- ◆ **Light Water Reactors**

  - AP 1000 Design**

  - International Reactor Innovative and Secure (IRIS)**

- ◆ **Non-Light Water Reactors**

  - Pebble Bed Modular Reactor (PBMR)**

  - Gas Turbine- Modular Helium Reactor (GT-MHR)**

- ◆ **Generation IV**

# Recent Developments

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## New Technological Changes (Impacting Operating Reactor & New Designs)

- ◆ Risk-Informed Approaches
- ◆ Materials and Structures - Aging Management, Longer Life, High Temp.
- ◆ Power Uprates/High Burnup/Longer Cycle
- ◆ New Fuel Designs (e.g. New Cladding Materials, MOX, Pebble Bed)
- ◆ Use of Digital Systems
- ◆ Application of Advances in Technology and Analytical Tools

# **Policy and Technical Issues**

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## **◆ Is a New Design Independent Safety Framework Needed?**

**Role of the Safety Goals (Limited Surrogate, Modular Plants)**

**Defense - In - Depth**

**Development of General Design Criteria (GDCs) for Each Design?**

**Risk Informed, Performance - Based Approach for:**

- Design Basis Accident Selection**
- Safety Classification**

**Role of PRA (e.g. Replace Single Failure Criterion?) and Deterministic Approach**

## **Policy and Technical Issues (continued)**

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- ◆ **Legal and Financial**

  - Anti-trust**

  - Price Anderson**

  - Decommissioning Trust Fund**

# **Policy and Technical Issues**

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- ◆ **Fuel Performance and Qualifications (e.g., Ability to Retain Fission Products at High Temperatures)**
- ◆ **High-Temperature Application of Materials (Creep Behavior, Failure Modes, Long-Term Performance)**
- ◆ **Different Approaches to Safety Assurance**
  - Increased Emphasis on Accident Prevention**
  - Containment Robustness**
  - Source Term and Emergency Planning**
- ◆ **Passive Systems - Performance and Reliability**

# **Policy and Technical Issues**

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- ◆ **Demonstration Testing**
- ◆ **Use of New Analytical Tools and International Data**
- ◆ **Greater Use of Digital Systems**
- ◆ **Human Performance Associated with Multi-Modular Designs**
- ◆ **Fuel Cycle Safety and Safeguards**
- ◆ **PRA Methodology and Data**

# **Infrastructure Needs and Requirements**

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## **◆ NRC**

**Framework (e.g. Guidance, Review Plans)**

**Resources (Staff and Funds)**

**Expertise and Experience (e.g. Natural Hazard, Designs, Construction Inspection)**

**Scope of Independent Testing**

- **Probe Fringes (Severe Accident Knowledge)**
- **Critical Areas (e.g., Fuel)**

**Experimental Programs and Facilities**

**Analytical Capabilities for Independent Assessment**

# **Infrastructure Needs and Requirements**

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## **◆ Industry**

**Adequate R&D by the Industry**

**Expertise and Experience**

**Codes and Standards**

**Construction/Fabrication**

## **What NRC is doing to get Ready?**

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- ◆ **Created Advanced Reactor Groups in Both Licensing and Research Offices**
- ◆ **Engage Early in Process - Pre-Application Reviews**
- ◆ **Advance RES/Agency's Expertise in Evolving Technology**
- ◆ **Advance International Collaboration**
  - **Sharing of Information and Experiences**
  - **Joint Research Programs**
  - **Optimize Use of Resources and Facilities**
  - **Applicability of Codes and Standards**
- ◆ **Work with DOE and Industry**
- ◆ **Work with Codes and Standards Organizations**

# **Role of Structural Mechanics**

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- ◆ **Critical Role for Aging Management of Existing Plants and New Designs**
- ◆ **At the Forefront in Building New Plants -  
Siting, Design and Construction**
- ◆ **Implementation of Advanced Technologies**
  - Materials - High Temperature Applications**
  - Design/Analysis - Improved Modeling and Computational Capability**
  - Construction/Fabrication - Modular Construction**
  - Inspection/Maintenance - On-Line Monitoring**
- ◆ **Codes and Standards for above and Consideration of Risk Informed Applications**

## **Role of Structural Mechanics (continued)**

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- ◆ **Advances Required for Integration in Risk Assessment Methodology**

**Probabilistic Methods  
Realistic vs. Conservative  
Failure Modes and Margins  
Characterization of Uncertainties**

- ◆ **International Forums, Like SMiRT, Important for Sharing Information, Establishing Needs, and Establishing Programs**