



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

**Nuclear Energy University Programs (NEUP) Fiscal Year (FY)
2013 Annual Planning Webinar**

Instrumentation, Information and Controls (II&C)

**RC-6.1: Online Monitoring Technologies for Standby Safety
Systems**

RC-6.2: Monitoring Technologies for Severe Accident Conditions

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LWRS Vision and Goals

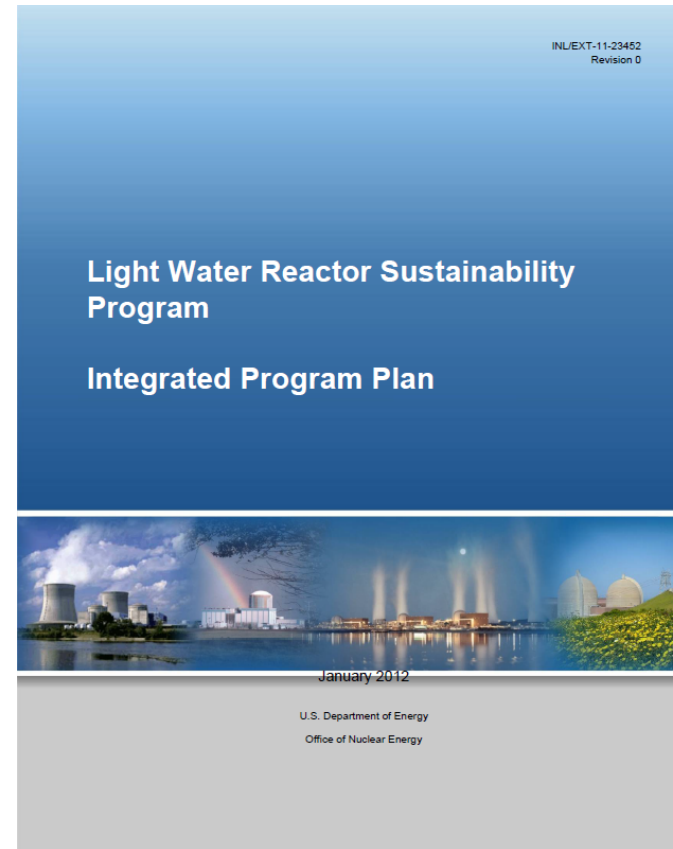
Nuclear Energy

Vision

- Enable existing nuclear power plants to safely provide clean and affordable electricity beyond current license periods (beyond 60 years)

Program Goals

- Develop fundamental scientific basis to understand, predict, and measure changes in materials as they age in reactor environments
- Apply this knowledge to develop methods and technologies that support safe and economical long-term operation of existing plants
- Research new technologies that enhance plant performance, economics, and safety





Technical Focus Areas Summary

■ Nuclear Materials Aging and Degradation

- Develop scientific basis for understanding and predicting long-term environmental degradation behavior of materials in nuclear power plants
- Provide data and methods to assess performance of systems, structures, and components essential to safe and sustained nuclear power plant operations
- Develop means to detect and characterize aging degradation processes

■ Risk-Informed Safety Margin Characterization:

- Develop a significantly improved safety analysis tool (RELAP-7) and a framework (RAVEN and Grizzly codes) to analyze the safety margin of aging plants.
- RELAP-7 is a “systems” code that will model the whole plant compared to existing codes (including the Hub) that are focused on highly localized phenomena in great detail.
- RAVEN is the simulation controller.
- Grizzly is the component aging and damage evolution model



Technical Focus Areas Summary

- **Advanced Instrumentation, Information, and Control Systems Technologies**
 - Address long-term aging and obsolescence of existing instrumentation and control technologies and develop and test new technologies
 - Establish a strategy to implement long-term modernization of I&C systems
 - Develop advanced condition monitoring technologies for reliable plant operation
- **Advanced LWR Nuclear Fuel**
 - Improve scientific basis for understanding and predicting fundamental nuclear fuel performance at existing nuclear power plants
 - Develop high-performance, higher burn-up fuels with improved safety, cladding, integrity, and economics for existing LWR applications
 - Closely coordinated with the Fuel Cycle R&D program activities, which are oriented toward applications in advanced reactors
- **Systems Analysis and Emerging Issues**
 - Address high impact emerging issues such as potential backfit of cooling towers
 - Review potential research needs in response to Fukushima lessons learned



Advanced Instrumentation, Information, and Control (II&C) Systems Technologies

- ***Address long-term aging and reliability concerns of existing II&C technologies and develop and test new technologies***
- ***Establish a strategy to implement long-term modernization of II&C systems.***
- ***Develop advanced condition monitoring technologies for reliable plant operation and develop the means to detect and characterize aging degradation processes.***





II&C Work Related to NEUP call RC-6.1

Planned II&C projects for On Line Monitoring of Active Components

Desired Outcomes: Develop the diagnostic and prognostic analysis framework for two active plant components, including the ability to predict the Remaining Useful Life.

Work Scope:

- Research on monitoring active aging and degradation phenomena for a Generator Step-Up (GSU) Transformer, including the diagnostic and prognostic analysis framework to support utility implementation of on-line monitoring.
- Research on monitoring active aging and degradation phenomena for an Emergency Diesel Generator (EDG), including the diagnostic and prognostic analysis framework to support utility implementation of on-line monitoring.

Schedule: FY 2012 – FY 2016

Host Utilities: Exelon Nuclear, Progress Energy





Online Monitoring Capabilities for standby safety systems (RC-6.1)

- **Methods for monitoring of active electro-mechanical systems in service at nuclear power plants are under development emphasizing advanced pattern recognition techniques to characterize system behavior.**
- **Research is sought that enhances the efficiency of advanced pattern recognition techniques to improve the accuracy and reduce the computing resources needed to achieve pattern definition and device state recognition, especially for transient device states.**
- **Standby systems - systems normally in a presumed 'ready' state until demanded or placed in service - pose unique challenges for characterizing their readiness to perform when demanded.**
- **Techniques are also sought to improve the ability to estimate the readiness and reliability of active systems in a standby mode (e.g., emergency diesel generators), especially safety systems.**



Severe Accident Monitoring Technologies (RC-6.2)

- **The recent events at Fukushima demonstrate that current monitoring capabilities are challenged during severe accident conditions.**
- **Many existing instruments used to monitor the condition of plants may fail during the harsh environments of severe accidents.**
- **Sensors are needed that could monitor conditions such as water level, temperatures, pressures, radiation levels, chemicals, visual and acoustic monitoring, and others.**
- **To address this need, novel approaches and technologies are sought to reduce the challenges associated with harsh environments. Examples may include:**
 - Remote (stand-off or deployable) sensors
 - Wireless sensor network technologies
 - Self powered instruments
 - Hardened sensors
- **Given the high cost to backfit hardened conventional sensors into existing plants, novel approaches should be focused on simple, more economic solutions.**