

LWRS Status Highlights

Program Mission

The Light Water Reactor Sustainability (LWRS) is a Department of Energy (DOE) program conducting research to develop technologies and other solutions to improve the economics and reliability, sustain the safety, and extend the operation of our nation's fleet of nuclear power plants. The NRC and the DOE has a [Memorandum of Understanding](#) (MOU) on Nuclear Innovation that allow the entities to share expertise and knowledge on advanced nuclear reactor technologies and nuclear energy innovation which extend to the area of light water reactor long-term operation and proposed modification for light water reactor sustainability

Program Update Meeting

On January 18, 2023 the LWRS Program Update Meeting was held at the NRC Headquarters. The main purpose of this meeting was to discuss the latest updates regarding program initiatives for all five pathways. Slides from the meeting can be found [here](#).

Plant Modernization Pathway

Main Goal: enable plant efficiency improvements through a strategy for long-term modernization

Human & Technology Integration

Conceptual Verification Project:

- Consists of an evaluation of human system interface (HSI) in support of manual operator actions impacted by the safety-related digital instrumentation and control (I&C) upgrade.
- Constellation, Idaho National Laboratory, and Sargent & Lundy worked together in this project. The report "Human Factors Engineering Conceptual Verification Results Summary Report" will be submitted by February 2023.

Development of an Assessment Methodology That Enables the Nuclear Industry to Evaluate Adoption of Advanced Automation- This work presents a methodology to address these barriers and support the industry in adopting advanced automation and digital technology through developing a transformative vision and implementation strategy that will address the human-technology integration element.

Materials Research Pathway

Main Goal: understand and predict long-term behavior of materials in nuclear power plants

Updates on Metals Research Projects:

Reactor Pressure Vessel –

- **Embrittlement trend curve development** with University of Wisconsin at Madison, University of California Santa Barbara, Pressurized Water Reactor Owners Group (PWROG), ASTM, and ASME will provide the scientific basis for NRC in revising Regulatory Guide 1.99 Rev. 2 (expected to be completed by FY25)

Crack Initiation in Ni-based Alloys

- **Long-term stress corrosion cracking (SCC) initiation testing** on cold-worked Alloy 690 is providing useful data to NRC and EPRI to assess the long-term aging and cracking behavior of the second-generation structural material for LWR pressure boundary components (expected to be completed by FY25)
- **Long-term SCC initiation testing on blunt notch high Cr Ni-based weld metals** under collaboration between LWRs and NRC is providing key data for NRC to evaluate the efficacy of welding repair techniques on mitigating SCC in LWR pressure boundary components (expected to be completed by FY25)

Risk Informed System Analysis (RISA) Pathway

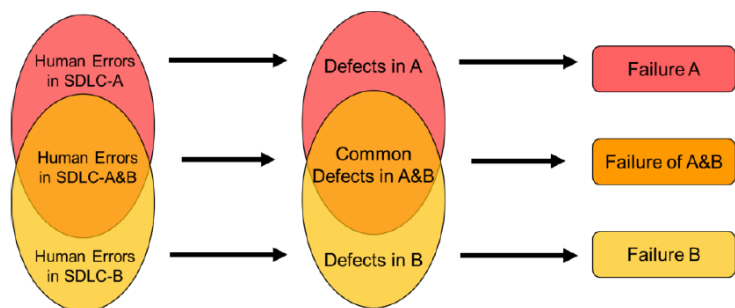
Main Goal: develop safety analysis methods and tools to optimize the safety, reliability, and economics of nuclear power plants

Research Areas:

Integrated Risk Assessment for Digital Instrumentation and Control:

Risk Analysis of Various Design Architectures for High Safety-Significant Safety-Related Digital Instrumentation and Control Systems of Nuclear Power Plants During Accident Scenarios.

This report develops a risk assessment strategy for delivering a technical basis to support effective, and secure digital instrumentation and control (DI&C) technologies for digital upgrades/designs.



Common errors tracking example

An Integrated Framework for Risk Assessment of High Safety-Significant Safety-Related Digital Instrumentation and Control Systems in Nuclear Power Plants: Methodology and Demonstration

This research presents a methodology to improve the framework for risk assessment and design optimization of safety-critical DI&C systems. This framework was further developed with a capability to trace software failures in digital feedback pathways in highly redundant safety-critical DI&C systems; potential failures of a DI&C system are organized in a fault tree for clear visual and linear traceability.

Physical Security Pathway

Main Goal: develop technologies and technical bases to optimize physical security

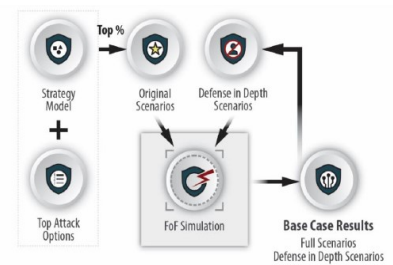
The Physical Security Pathway will have two half-day Stakeholder Meetings on January 31, 2023 and February 1, 2023. If someone is interested in attending, please contact Al Tardiff at al.tardiff@nrc.gov. Meeting Agenda [here](#).

Research Areas

Risk Informed Physical Security –

Integration of FLEX Equipment and Operation Actions in Plant Force-On-Force Models with Dynamic Risk Assessment-

This report presents a modeling and simulation framework for integrating Diverse and Flexible Mitigation Capability (FLEX) portable equipment performance with Force-on-Force models of a plant's physical security posture. The generic framework is described in details, followed by a case study of modeling an adversarial attack aimed at causing a radiological release by sabotaging the plant's power supply and its ultimate heat sink capabilities at a hypothetical nuclear power plant.



Flow for creating base case comparison results

Flexible Plant Operation & Generation (FPOG) Pathway

Main Goal: enable diversification and increase revenue of light water reactors to produce non-electrical products

Latest Report:

Co-simulation of Hydrogen Production with Nuclear Power Plants- This report documents the implementation of a data link between the Idaho National Laboratory (INL) Human Systems Simulation Laboratory (HSSL) and the INL Energy Systems Laboratory (ESL) connecting a small-scale high temperature electrolysis (HTE) pilot plant and an electricity grid simulation capability.

Hydrogen Production Demonstration Projects

- Constellation: Nine Mile Point Plant
 - ⇒ H₂ production beginning in 2023
 - ⇒ NEL Hydrogen PEM module
- Energy Harbor: Davis-Besse Plant
 - ⇒ H₂ production in 2024
 - ⇒ 2 MW_{eDC} Cummins PEM module
- Xcel Energy: Prairie Island Plant
 - ⇒ H₂ production beginning in 2024
 - ⇒ Bloom Energy HTE modules
- Pinnacle Northwest Hydrogen
 - ⇒ Project award in discussion
 - ⇒ 20 MW_{eDC} PEM Electrolysis
 - ⇒ H₂ storage for gas turbine combustion test
 - ⇒ Combustion in Saguaro NCGG plant

[Past Issues](#)