

Advanced Instrumentation, Information, and Control Systems Technologies



LWRS Advanced II&C R&D Overview

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Advanced Sensors and Instrumentation Webinar
2017 NE I&C Review
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Light Water Reactor Sustainability R&D Program



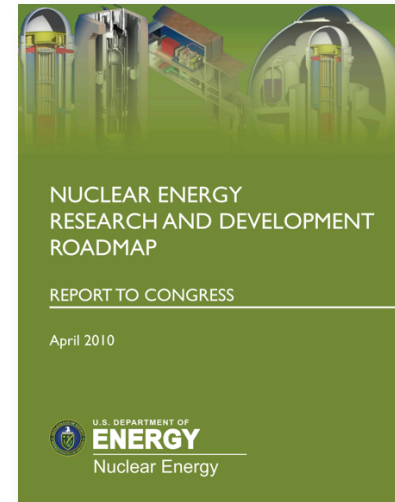
US Department of Energy LWRS Program Goals and Scope

- Goals

- Develop the fundamental scientific basis to understand, predict, and measure changes in materials and systems, structures and components (SSCs) as they age
- Apply this knowledge to develop and demonstrate methods and technologies that support safe and economical long-term operation of existing reactors
- Research new technologies that enhance plant performance, economics, and safety

- Scope

- Materials Aging and Degradation
- Risk-Informed Safety Margin Characterization
- Advanced Instrumentation, Information, and Control Systems Technologies
- Reactor Safety Technologies



- Subsequent License Renewal (SLR) – a second 20 year license extension for the current US fleet

- The process for SLR will be the same as for the first 20 year license extensions (NRC decision)
- Lead plants for the SLR process have been announced (Surry and Peach Bottom)
- The LWRS Program is engaged in discussions on SLR through EPRI; R&D underway in the LWRS Program has ties to the SLR process



Advanced Instrumentation, Information, and Control Systems

- Address long-term aging and reliability concerns of existing II&C technologies:
 - Establish a strategy to implement long-term modernization of II&C systems.
 - Develop, test, and deploy advanced technologies.
 - Promulgate technologies, lessons learned, and foster industry standardization.
 - Reduce technical, financial, & regulatory risks.
 - Develop advanced condition monitoring technologies to monitor, detect, and characterize aging and degradation processes.



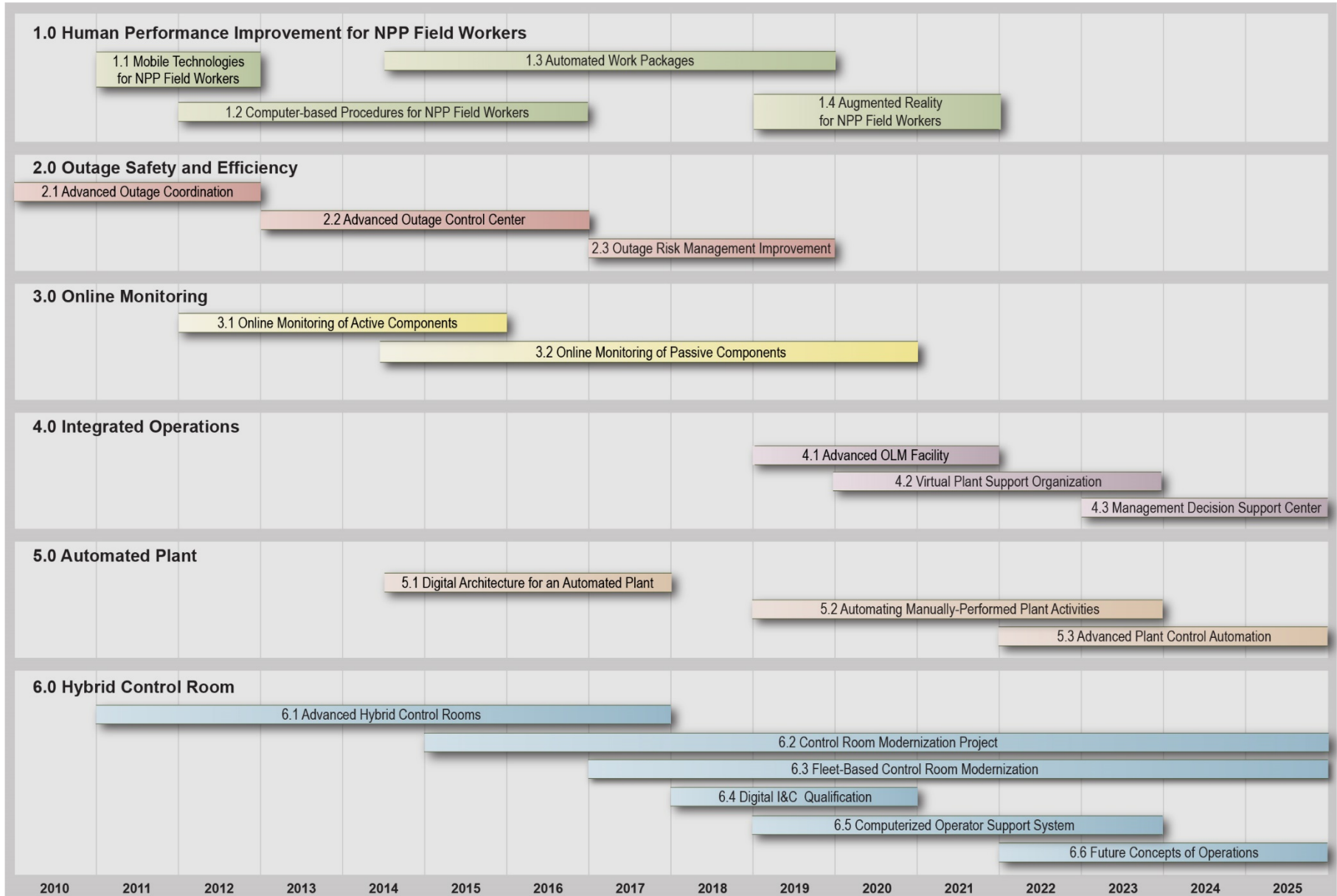
Industrial Engagement

The purpose of the Working Group is to define and sponsor research projects that will collectively enable significant plant performance gains and minimize operating costs as part of the larger national effort to ensure long-term sustainability of the LWR fleet. The Working Group Charter is as follows:

- Develop agreements with host utilities to demonstrate near-term beneficial digital applications that improve performance at lower cost.
- Obtain funding for projects through LWRS program funding and industry cost-sharing.
- Coordinate project development among research organizations associated with the U.S commercial nuclear industry, to the degree practical, to minimize duplication of effort.

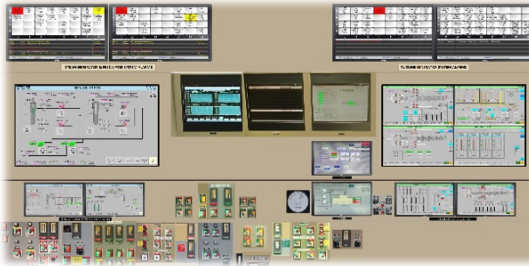


II&C Pathway Overview



Control Room Modernization

- Completing stepwise modernization activities that demonstrate 'How To' and lessons learned and now have moved to broader, long-term control room modernization projects with first movers.



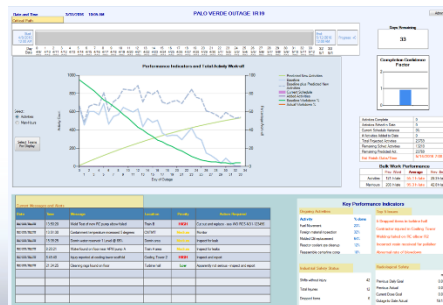
Computer Based Procedures

- Developed, tested, and are commercializing technology to transform static paper based procedures into interactive, status-informed and status-reporting tools that assist work and reduce error.



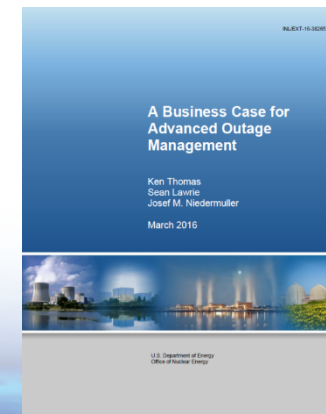
Outage Control Centers

- Developed technologies deployed at 10 utilities and recognized in APS' TIP Award for managing and coordinating outages with new technologies.



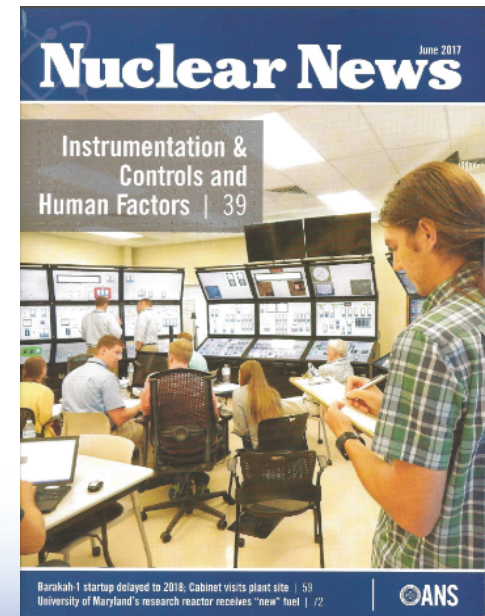
Business Case Studies

- Work with Scott Madden & Associates to evaluate the cost benefit of II&C Pilot Project Technologies with host utilities to provide confidence and insights into methods to best leverage gains.



Control Room Modernization

- Nuclear plants dealing with declining analog technology in their control rooms. Unable to take advantage of new digital technologies for operational performance improvement.
- Leveraging digital upgrades in plant I&C systems to modernize these control rooms.
- Working with two major nuclear utility partners – Exelon and Arizona Public Service for Advance Hybrid Control Rooms.
- I&C Pathway resources for this are unequaled:
 - Human System Simulation Laboratory
 - Human Factors/Human Reliability Experts
 - Advanced Performance Measurement Technology
 - Nuclear Plant Operational Experience
 - Collaborating with World-Leaders in This Field
- Significant industry recognition for this work.



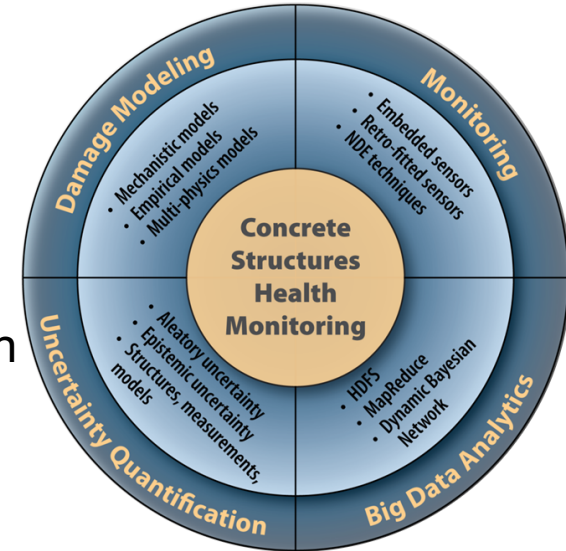
Control Room Modernization



Separate presentation on Control Room Modernization this
Thursday, 3:45 PM

Nuclear Power Plant Concrete SHM Research

- Age-related deterioration of nuclear plant concrete structures might lead to **premature closure** or prevent **second license renewal** process
- Current structural health monitoring (SHM) in the nuclear industry is strictly an **offline process** and lacks application of **advanced technology solutions**
- **Multi-institute concrete SHM** research effort is would be integrating monitoring techniques to
 - Detect, localize, and estimate Alkali-Silica Reaction degradation mode in concrete structures
 - Develop diagnostic and prognostic models
 - Apply Bayesian technique to integrate different sources of uncertainties
- Concrete SHM research would enable **science-** and **data-** based **decision-making** on structural health



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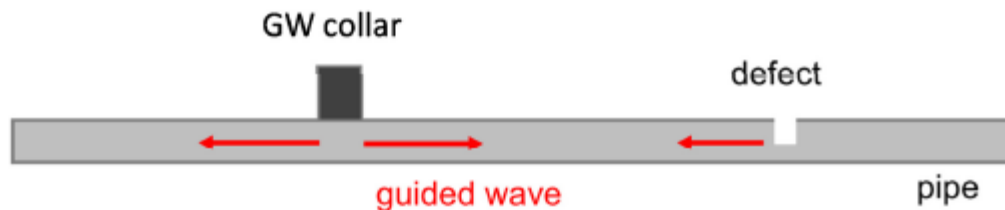


ELECTRIC POWER
RESEARCH INSTITUTE



On-Line Monitoring for Piping Systems

- Very expensive to conduct sample-based testing for NPP piping systems, especially raw water and buried pipe applications.
- II&C Pathway is collaborating with EPRI in applying guided wave (GW) technology for condition-based monitoring of NPP secondary pipe.
- Challenge is in extending the range of expensive GW collars due to the typical geometry of nuclear plant piping with many bends and in-line components (unlike straight pipe runs for oil and gas industry).
- Developing advanced analytical capabilities to filter out wave reflections from the pipe geometry and isolate data that represents degrading pipe.



Mobile Technology for NPP Field Work

- Addresses worker efficiency and human error reduction as part of much needed cost reduction.
- Led industry effort in defining specifications for smart procedures – now being adopted by major nuclear utilities.
- Conducting similar research for automated work packages – separate presentation on this in the Webinar (Thursday, 4:15 PM)
- Mobile technologies are being integrated into all other aspects of NPP modernization, including control room use and outage management.



Data Analytics for NPP Performance Improvement

- Nuclear plants generate enormous volumes of operational data. Highly labor-intensive to process for critical operational intelligence.
- Traditional information management systems are at their limits in finding the subtle plant configuration and work interactions that represent the residual challenges to nuclear safety and electric generation.
- II&C Pathway is working with a utility partner in applying advanced data analytics to identify potential component failures.

Anomaly Events

S M M Start Date: Today - 7 days End Date: System Unit Program *DCID Search* CR W I

Severity	Unit - Sys Points	Start	End	Status
Moderate	U1 - MT Condenser Pressure, Condenser Temperature	2017/03/01 13:15	2017/03/06 04:00	-
Severe	U3 - RC RCP1B Bearing Temp	2017/03/04 15:15		CR Generated
Mild	U1 - MT Condenser Pressure, Condenser Temperature	2017/03/01 13:15	2017/03/06 04:00	Ignored
Mild	U2 - CW Condenser Pressure, Condenser Temperature	2017/03/01 13:15	2017/03/06 04:00	-
Mild	U3 - MT Condenser Pressure, Condenser Temperature	2017/03/01 13:15	2017/03/06 04:00	Watch
Mild	U1 - MT Condenser Pressure, Condenser Temperature	2017/03/01 13:15	2017/03/06 04:00	-
Mild	U1 - MT Condenser Pressure, Condenser Temperature	2017/03/01 13:15	2017/03/06 04:00	-
Mild	U1 - MT Condenser Pressure, Condenser Temperature	2017/03/01 13:15	2017/03/06 04:00	-
Mild	U1 - MT Condenser Pressure, Condenser Temperature	2017/03/01 13:15	2017/03/06 04:00	-
Mild	U1 - MT Condenser Pressure, Condenser Temperature	2017/03/01 13:15	2017/03/06 04:00	-

Anomaly - Unit 1 MT | 2017/03/01 Status: -

CAP (CRs, EVALS) 12 | P6/WOs 4 | Recent Mods 0
 ST Results 3 | PM Results 2 | Design Docs 6
 Plant IQ - CNRs 3 | Plant IQ - Asses. 3

When user clicks dataset here, related data is presented here

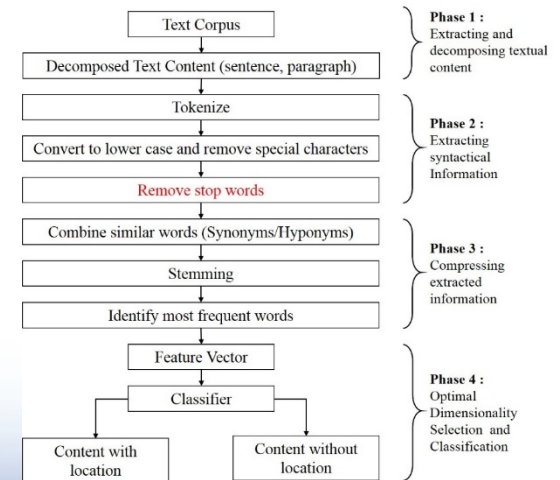
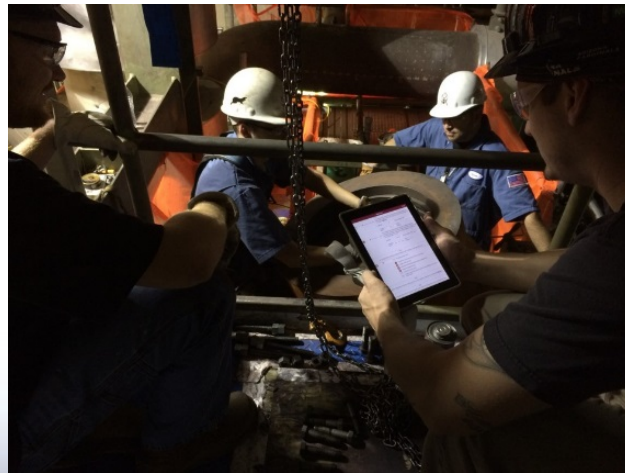
Unit	CR ID	Status	Class	Cond. Exp. Excess	Reported	Document	Operability/Functionality
U01	1	0	0	03/06/2017 14:30	03/06/2017 14:34		
						Initiator's Disp.	
						Added by:	Added Date
						Comment	
						Leader Comment	
U01	2	0	0	03/06/2017 13:37	03/06/2017 13:38		
						Initiator's Disp.	
						Added by:	Added Date
						Comment	
						Leader Comment	
U01	3	0	0	03/06/2017 13:03	03/06/2017 13:03		
						Initiator's Disp.	
						Added by:	Added Date
						Comment	
						Leader Comment	

Acknowledge Add to Watchlist Generate CR



Outage Risk Management Improvement

- With nuclear plant capacity factors at an all-time high, shortening nuclear refueling outages is the largest opportunity to increase electric production and thereby lower operational cost.
- The II&C Pathway has worked with leading utilities to introduce new digital technologies into their outage control centers.
- Now the focus is on reducing outage risk through new analytical capabilities that will “mine” text documents (procedures, work orders, clearances, etc.) to detect undesirable interactions.
- This has potential for significant reduction in labor cost and safety challenges.



Information on the LWRS Program is available on our website (<https://lwrs.inl.gov/>)



LIGHT WATER REACTOR SUSTAINABILITY PROGRAM

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INTRODUCTION

The Light Water Reactor Sustainability (LWRS) Program is the primary programmatic activity that addresses Objective 1 (develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of the current reactors) described in the U.S. Department of Energy Office of Nuclear Energy's [2010 Research and Development Roadmap](#). For the purpose of the LWRS Program, "sustainability" means the prudent use of resources – in this case, our nation's commercial nuclear power plants.

Sustainability is defined as the ability to maintain safe and economic operation of the existing fleet of nuclear power plants for a longer-than-initially-licensed lifetime. It has two facets with respect to long-term operations: (1) manage the aging of plant systems, structures, and components so that nuclear power plant lifetimes can be extended and the plants can continue to operate safely, efficiently, and economically; and (2) provide science-based solutions to the industry to implement technology to exceed the performance of the current labor-intensive business model.

Operation of the existing plants to 60 years, extending the operating lifetimes of



LWRS Program Accomplishments Report 2016

Archive

