US Department of Energy Light Water Reactor Sustainability Program – Advanced Instrumentation, Information and Controls R&D Overview

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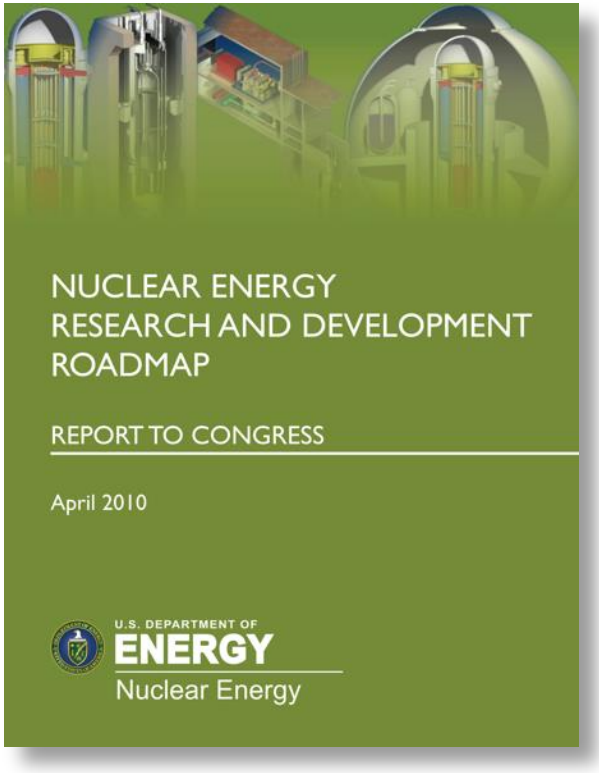
Light Water Reactor Sustainability R&D Program

US Department of Energy Light Water Sustainability 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 in environments
  - 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



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.*
  - *Develop advanced condition monitoring technologies to monitor, detect, and characterize aging and degradation*

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.**

aps

Duke Energy

SOUTHERN COMPANY

Xcel Energy

TVA

STP Nuclear Operating Company
Clean. Safe. Reliable.

PG&E

Constellation Energy

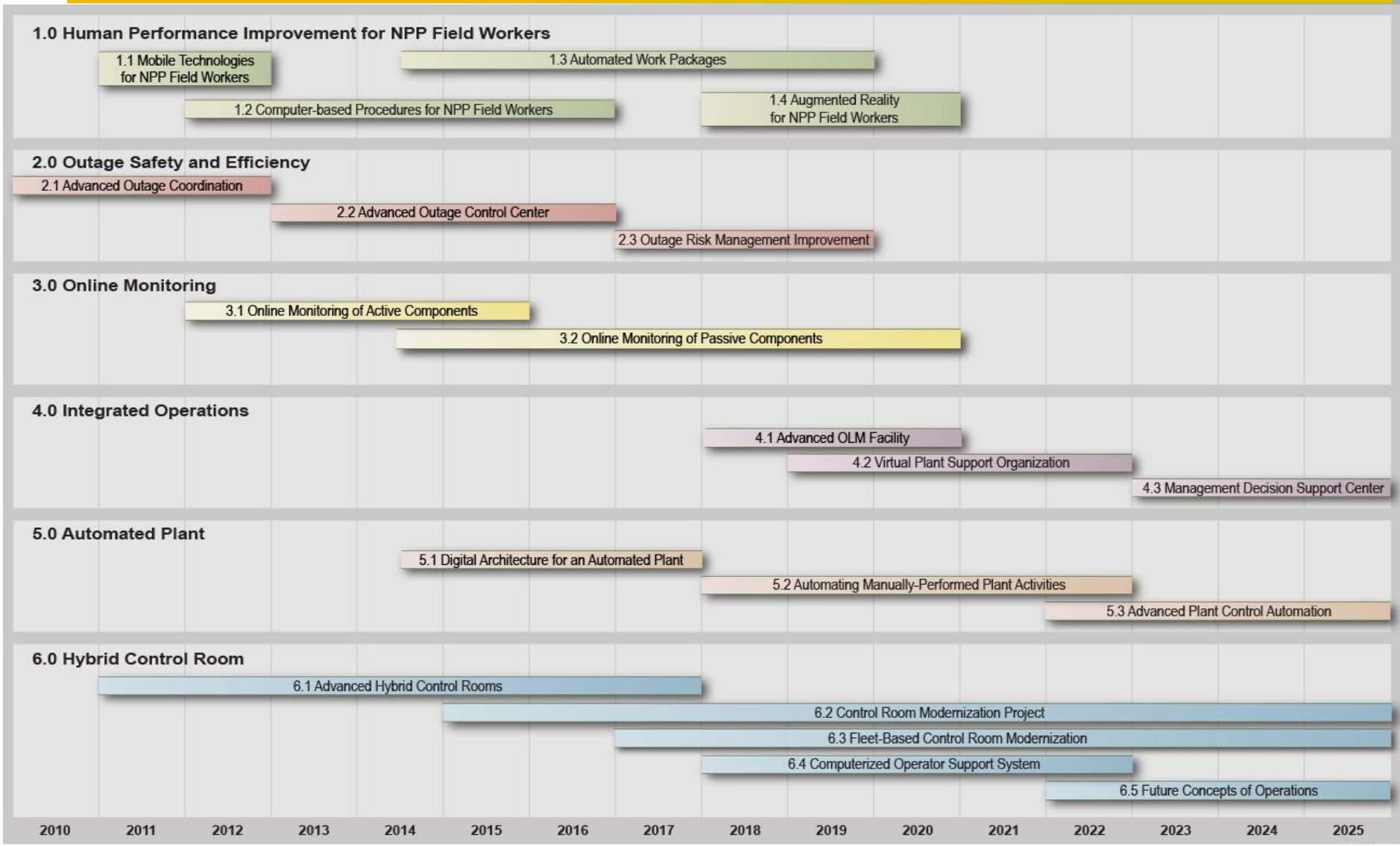
Luminant

Exelon

EPRI ELECTRIC POWER RESEARCH INSTITUTE

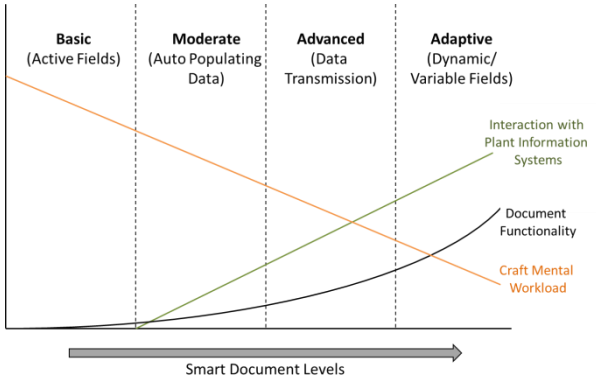
Entergy
THE POWER OF PEOPLE

LWRS I&C Pilot Projects



Computer Based Procedures

- **Supporting the Nuclear Electronic Work Packages - Enterprise Requirements (NEWPER) initiative**
  - First NEWPER workshop, December 8-10, 2015 in Avondale, AZ
    - *Hosted by APS Palo Verde, and facilitated and organized by LWRS*
    - *Communicated utilities requirements to vendors*
    - *Standardized terminology related to electronic work packages (eWP) and smart procedures & sharing lessons learned*
  - Compiling design guidance from 3-year project
  - Second NEWPER workshop, March 22-23, 2016 in Charlotte, NC

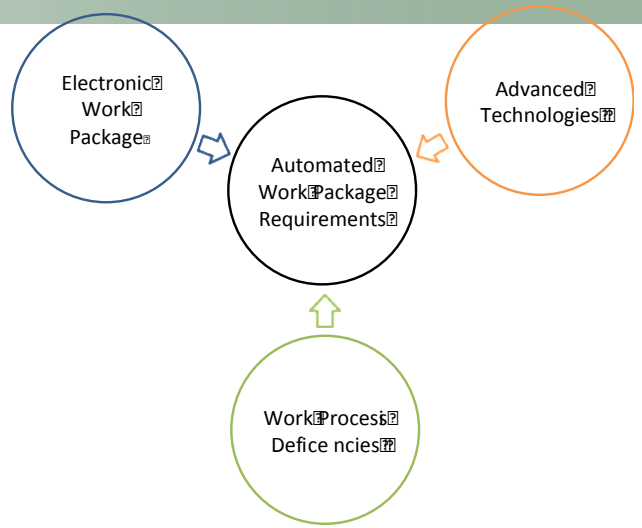


Computer Based Procedures

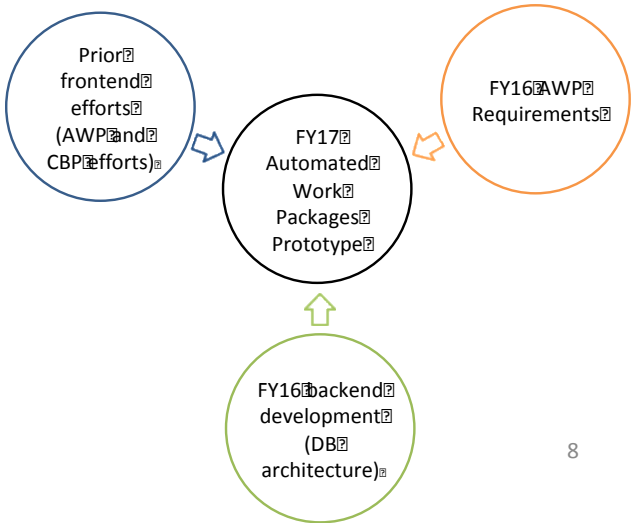
- **Seamless Digital Environment**
- **Collaborating with NextAxiom and Palo Verde Nuclear Generating Station**
  - Scope: Conduct a feasibility study for data mining and analytics for employing information from computer-based procedures enabled technologies for use in developing improved business analytics.
  - Study will be hosted by Palo Verde in FY16

Electronic Work Packages

- *Studying current application with work process in a nuclear power plant.*
- *Studied the current eWP requirements and how they address some of the work process deficiencies.*
- *Determined the non-addressed issues associated by eWPs.*
- *Developed a list of requirements for EWP to address these non-addressed deficiencies*
- *Developed envisioned EWP requirements and surveyed their need in the industry (survey in progress)*
- *Commenced the development of a prototype EWP that incorporates these requirements to enable their future evaluations and performance testing*



AWP Prototype Developed

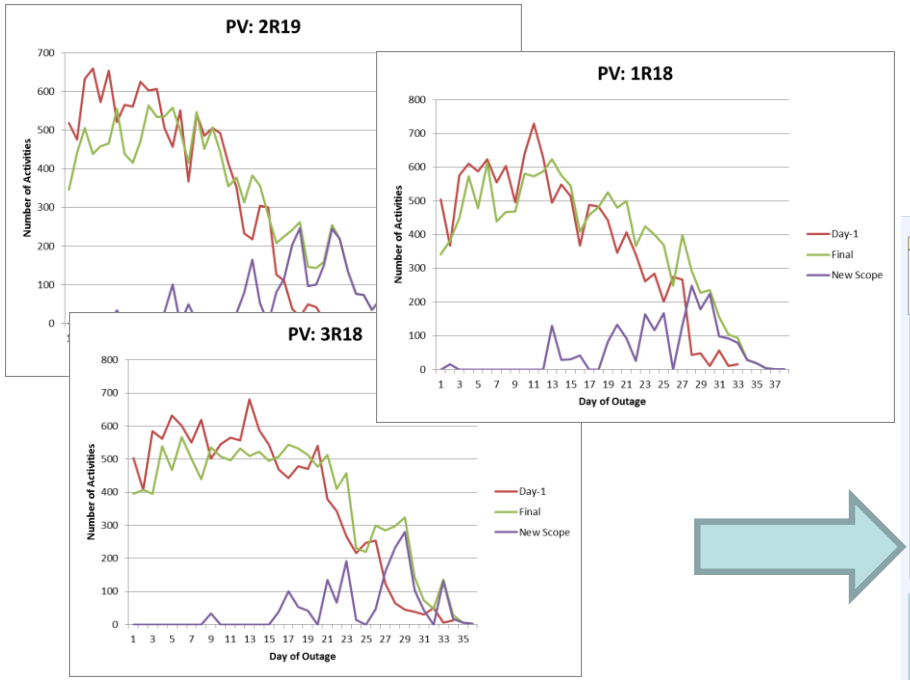


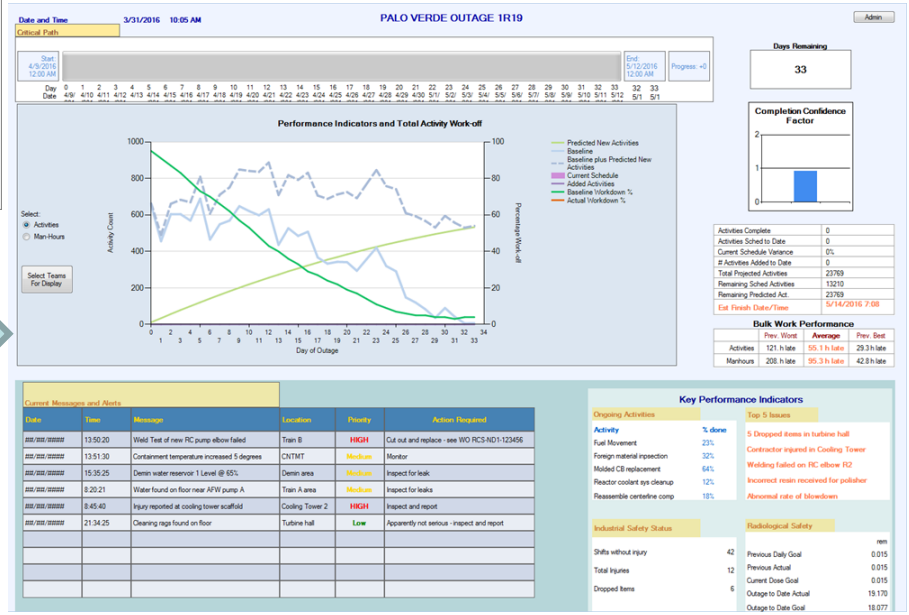
Advanced Outage Control Center

- **Objective: Improve management of nuclear power plant outages by developing an advanced outage control center (OCC) and supporting technologies to achieve real-time coordination and oversight of many distributed efforts**
- **Successful technology deployments at a number of nuclear plant sites.**
- **Arizona Public Services included their AOCC in a Nuclear Energy Institute Top Industry Practice (TIP) that was awarded.**

Incorporating Advanced Analytics

- *Developed a software application that incorporates historical outage data into a predictive dashboard for outage management*





Long Term Control Room Modernization

- *A step-wise approach to address aging and obsolescence is likely to produce a control room with 1) islands of automation 2) differing approaches to user interface management 3) non-optimized design through a lack of integration among individual upgrade / replacement projects.*
- *Project begun with Arizona Public Services' Palo Verde Nuclear Generating Station to develop an end state for long term control room modernization informed by the plant's strategic modernization plan.*
- *Addresses feasibility and benefits of adopting a longer term outcome as a part of strategic modernization*
- *Designed employing best available technology optimized for safe and efficient operator use through widespread inclusion of human factors principles.*
- *Serves as input to planning, providing design options that can be developed and tested in the DOE's Human System Simulation Laboratory.*

Conceptual design studies

- *Before and after images of Palo Verde Control Room Board 6 – including main feedwater and turbine-generator controls*

Integral Human Factors Engineering

3-D Model of the Palo Verde conceptual design control room – 95th percentile male and 5th percentile female figures are used to check ergonomic aspects for anthropometric aspects of conceptual design using automated software tool.

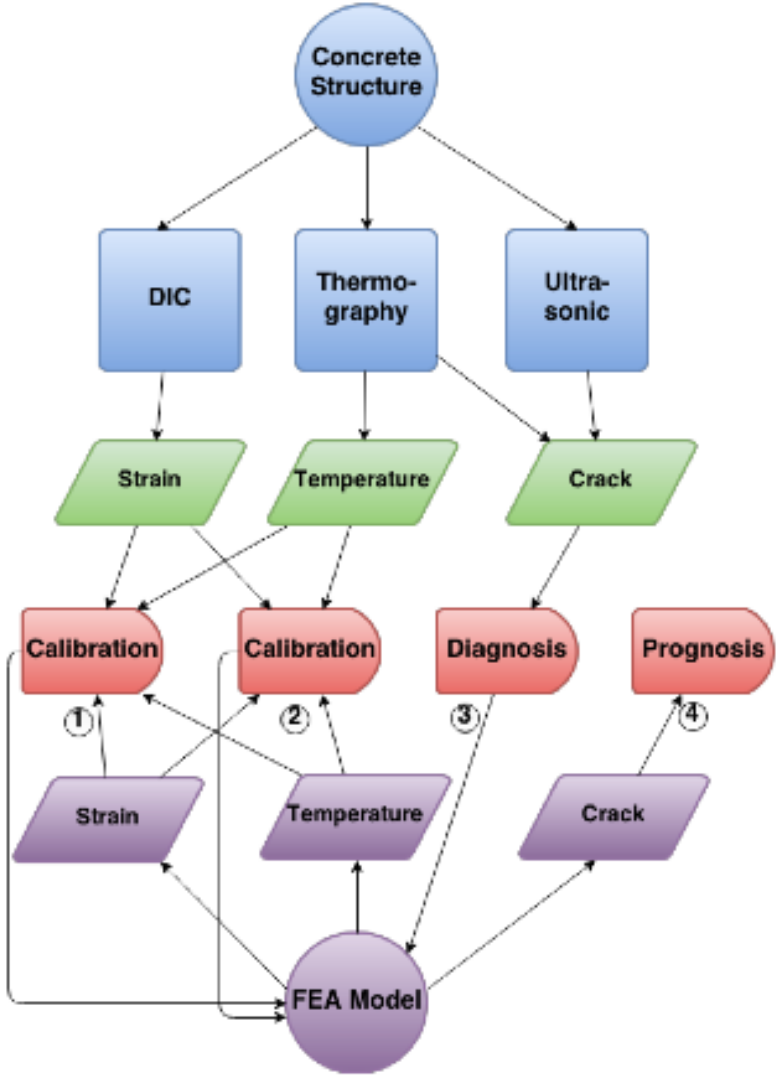
Online Monitoring of Passive Components, Systems, & Structures

Objective

- Integrate models from materials science with data from plant operation to monitor the performance of physical systems as they age.
- Supports long term operation by providing real time information to inform future material models and plant aging assessments using dynamic PRA (e.g., risk informed safety margin assessments)
- Components: Concrete, specifically alkali-silica reaction (ASR); Degradation Mechanisms of piping.

Impact

- Improved models of material behavior during long term operation.
- Enhanced monitoring capabilities to detect indicators of degradation earlier than without advanced sensors (goal)



The LWRS Program Website Provides a Range of Program Information (www.inl.gov/lwrs)

LIGHT WATER REACTOR SUSTAINABILITY PROGRAM

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Program Pathways

- General Information
- Materials Aging and Degradation
- Risk-Informed Safety Margin Characterization
- Advanced II&C Systems Technologies
- Reactor Safety Technologies

Program Documents

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.

What's new

Light Water Reactor Sustainability Program Accomplishments Report, 2015

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LWRS Newsletter

LWRS Newsletter July 2016

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