

Light Water Reactor Sustainability Program

2015 Summary Report on Industrial and Regulatory Engagement Activities



September 2015

U.S. Department of Energy

Office of Nuclear Energy

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2015 Summary Report on Industrial and Regulatory Engagement Activities

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September 2015

**Prepared for the
U.S. Department of Energy
Office of Nuclear Energy**

Executive Summary

The Advanced Instrumentation, Information, and Control (II&C) Systems Technologies pathway of the Light Water Reactor Sustainability(LWRS) Program conducts a vigorous engagement strategy with the U.S. nuclear power industry, including the nuclear operating companies, major support organizations, the Nuclear Regulatory Commission (NRC), and suppliers. The goal of this engagement strategy is to develop a shared vision and common understanding across the nuclear industry of the need for II&C modernization, the performance improvement that can be obtained, and the opportunities for collaboration to enact this vision.

The primary means of engaging the nuclear operating companies is through a Utility Working Group (UWG), composed of utility representatives that participate in formal meetings and bi-monthly phone calls to provide input on nuclear plant needs and priorities for II&C technologies. The 2015 UWG Summer Meeting was held in Idaho Falls, Idaho, August 11-13, which was a joint meeting with the EPRI's Strategy Group on Performance Improvement through Advanced Technology. This annual summer meeting featured presentations and demonstrations of the technologies that were developed by the II&C Pathway during FY 2015. In addition, there were presentations by the Electric Power Research Institute, Halden Reactor Project, the Nuclear Energy Institute, and Argonne National Laboratory.

Two working groups were initiated during FY 2015 to provide a means for UWG members to focus on particular technologies of interest. The Outage Improvement Working Group consists of eight utilities that participate in periodic conference calls and have access to a share-point web page for access to project materials developed in the Advanced Outage Control Center pilot project. In the area of computer-based procedures and automated work packages, the II&C Pathway has worked with the Nuclear Information Technology Strategic Leadership (NITSL) to set up a monthly conference call with interested utility members to discuss various aspects of mobile worker technologies.

Twenty-two technical and project reports were delivered to the UWG during FY 2015, reflecting the work of the II&C Pathway pilot projects during the year. Distribution of these reports is one of the primary means of transferring to the nuclear industry the knowledge and experience gained during the development of advanced II&C technologies in support of LWR sustainability.

Site visits to discuss pilot project activities and future plans were made to Arizona Public Service, Exelon, Duke Energy, Pacific Gas & Electric, SCANA, Southern Nuclear, South Texas Project, STARS Alliance, Tennessee Valley Authority, and Xcel. Discussions were also held on the pathway goals and activities with major industry support organizations during FY 2102, including the Institute of Nuclear Power Operations (INPO), the Nuclear Information Technology Strategic Leadership (NITSL), the Nuclear Energy Institute (NEI), and the Electric Power Research Institute.

The Advanced II&C Pathway work was presented at seven major industry conferences and informal discussions were held with key NRC staff at industry conferences. In addition, discussions were held with NRC senior managers on digital regulatory issues through participation on the NEI Digital I&C Working Group.

Meetings were held with major industry suppliers and consultants, to explore opportunities for collaboration and to provide a means of pilot project technology transfer. These companies included Altran, Westinghouse, Rolls Royce, Schneider Electric, Devonway, Curtis-Wright Scientech, and Scott Madden Management Consultants.

In the international area, discussions were held with Electricite' de France (EdF) concerning possible collaboration in the area NPP configuration control using intelligent wireless devices. In addition, collaboration was conducted with IFE Halden Reactor Project and Korea Atomic Energy Research Institute.

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Acronyms

AOCC	Advanced Outage Control Center
DCS	distributed control system
EdF	Electricité de France
EPRI	Electric Power Research Institute
FPGA	Field Programmable Gate Arrays
HRP	Halden Reactor Project
HSI	human-system interface
II&C	Instrumentation, Information and Control
INPO	Institute of Nuclear Power Operations
IRT	Issues Resolution Team
ISA	International Society of Automation
LWRS	Light Water Reactor Sustainability
NEI	Nuclear Energy Institute
NITSL	Nuclear Information Technology Strategic Leadership
NRC	Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation
R&D	research and development
TVA	Tennessee Valley Authority
UWG	Utility Working Group

1. Introduction

The Advanced Instrumentation, Information, and Control (II&C) Systems Technologies pathway of the Light Water Reactor Sustainability (LWRS) Program conducts a vigorous engagement strategy with the U.S. nuclear power industry, including the nuclear operating companies, major support organizations, the Nuclear Regulatory Commission (NRC), and suppliers. The goal of this engagement strategy is to develop a shared vision and common understanding across the nuclear industry of the need for II&C modernization, the performance improvement that can be attained, and the opportunities for collaboration to enact this vision.

In FY 2015, the vision, strategy, and project work was communicated to a number of key organizations, including the Advanced II&C Utility Working Group, the major industry support organizations, and a number of important industry conferences that are attended by leaders in nuclear plant instrumentation and controls as well as human performance and process improvement.

This paper presents the specific engagement activities that occurred in FY 2015 to promote awareness and participation by the nuclear power industry in the activities of the II&C Pathway.

2. Utility Working Group

2.1 Background and Purpose

The Advanced II&C Systems Technologies Pathway sponsors a Utility Working Group (UWG) to define and host a series of pilot projects that together will enable significant plant performance gains and minimize operating costs in support of the long-term sustainability of the LWR fleet. At this time, the UWG consists of 14 leading U.S. nuclear utilities, representing over 70% of the U.S. LWR fleet. Additional membership will be pursued for the UWG with the goal of involving every U.S. nuclear operating fleet in the program.

The UWG is directly involved in defining the objectives and research activities of this pathway. The research is conducted within a set of defined pilot projects that develop digital technologies to address the specific II&C modernization needs within the plant II&C systems and operational processes. Criteria have been developed for identifying, prioritizing, and selecting potential advanced II&C pilot projects performed by II&C Pathway.

UWG members serve as host utilities for the pilot projects when their internal performance improvement objectives align with the goals of a particular pilot project. The pilot project hosts make their facilities available for the research and development (R&D) activities and allows other nuclear utilities to observe the technology demonstrations. Host utilities regularly make presentations in key industry technical meetings to describe their motivations and efforts in the pilot projects and to communicate important findings to the industry.

To allow utilities to focus on specific pilot projects of interest, the UWG sponsors working groups in two broad areas: 1) outage improvement and 2) mobile work packages and procedures. The purpose of the working groups is to provide a means of focused engagement for

utilities around the technologies of their particular interests and to provide a forum for peer review of the technologies developed within the working group areas.

2.2 Membership

The nuclear utilities participating in the UWG during FY 2015 were:

1. Arizona Public Service
2. DTE Energy
3. Duke Energy
4. Entergy
5. Exelon Nuclear
6. First Energy Nuclear Operating Company
7. Luminant
8. NextEra
9. Pacific Gas & Electric
10. Public Service Electric and Gas
11. Southern Nuclear
12. South Texas Project
13. Tennessee Valley Authority
14. Xcel Energy

In addition, the Electric Power Research Institute (EPRI) and the IFE Halden Reactor Project (HRP) were full participants in the UWG, as well as development partners in the pilot projects.

2.3 Long-Term II&C Systems Technologies Future Vision and Strategy

An update to the *Advanced Instrumentation, Information, and Control Systems Technologies Technical Program Plan for FY 2016 (INL/EXT-13-28055 Rev. 4)* [1] was published in September of 2015. This is a comprehensive description of the II&C modernization strategy and the related pilot projects. The document reflects the needs and priorities as expressed by the UWG in the August, 2015 meeting. It also provides the background on why the II&C Pathway research is needed and it discusses certain drivers for II&C automation in the nuclear power industry.

The Technical Program Plan provides detailed descriptions of the 20 pilot projects that compose the current research scope. The performance improvement and modernization needs are presented for each of the pilot projects, along with descriptions of what technologies will be produced. This document has been widely distributed among the UWG, industry support organizations, and other interested parties. It is available on the INL LWRS web site for access.

The Technical Program Plan will be updated annually as refinements are made to the scope and schedule of the II&C Pathway research program based on utility priorities and available project funding.

2.4 2015 Summer Utility Working Group Meeting

The 2015 Utility Working Group (UWG) Summer Meeting was held at INL August 11-13. This was a joint meeting with the EPRI Strategy Group on Productivity Improvement through Technology. A series of presentations and demonstrations were conducted the II&C Pathway research team in the areas of human performance and process improvement, outage improvement, on-line monitoring, control room upgrades, digital architecture, and cyber security.

EPRI presented their current efforts in technology development for nuclear power plants, which included human factors guidelines, online monitoring technologies, quadcopter applications, and a general review of all current EPRI I&C projects.

IFE Halden Reactor Project presented research topics of interest in the areas of integrated operations, virtual reality, resilient procedure use for operators, and digital safety case.

Argonne National Laboratory presented their work on Plant Fault Detection and Diagnosis.

The Nuclear Energy Institute (NEI) provided a summary on their activities to engage the Nuclear Regulatory Commission (NRC) in issues related to digital I&C implementation.

Other organizations represented at the meeting included Duke Energy, Southern Nuclear, Exelon, TVA, Arizona Public Service, INPO, EI, and KAERI (Korea). The meeting also featured a tour of INL's Advanced Test Reactor and MFC facilities.

At the end of the meeting, feedback and comments were solicited from the Utility Working Group in terms of current project priorities and potential unaddressed utility priorities. This feedback will be included in the continuing refinement of the long-term vision and strategy for the II&C research program.

For a complete description of the presentations, see Appendix A.

2.5 Bi-monthly UWG Conference Calls

A conference call was held with the UWG on the first Tuesday of every other month in FY 2015, to communicate ongoing status of the pilot projects, to discuss project deliverables, communicate UWG and industry meeting information, and to provide information on the overall II&C Pathway. The UWG members were able to ask questions about the specific technologies being developed as well as provide their own ideas on how to make them more useful to the industry. The calls also served as a forum for UWG members to share information among themselves related to their own II&C needs and plans.

2.6 AOCC Pilot Project Working Group

The AOCC Pilot Project Working Group was established as a means for nuclear utilities to focus specifically on the II&C Pathway research that relates directly to improving outage management and performance. The Working Group has periodic phone calls to provide status on the pilot project development activities and products. It provides access to the technologies, reports, and other documents that are produced by the research. It also provides opportunities for

member companies to participate in the research activities where they have matching development objects. Finally, it also serves as a means for the utilities to share best practices in outage management technology applications. Participating utilities at this time are Arizona Public Services, Duke Energy, Entergy, Exelon Nuclear, Southern Nuclear, South Texas Project, Tennessee Valley Authority, and Xcel.

The AOCC Pilot Project Working Group Sharepoint Site link is <https://lwrs.inl.gov/AOCC>. Those interested in participation in the Working Group and use of the Sharepoint Site can use this link to establish an ID for access to project materials, status reports, and utility best practices.

2.7 Mobile Work Packages and Procedures Working Group

In the area of computer-based procedures and automated work packages, the II&C Pathway has worked with the Nuclear Information Technology Strategic Leadership (NITSL) to set up a monthly conference call with interested utility members to discuss various aspects of mobile worker technologies. Nuclear utilities that are currently participating include Arizona Public Service, Duke Energy, Pacific Gas & Electric, SCANA, and Southern Nuclear. Additional participation is being solicited through the NITSL Infrastructure and Application Subcommittee.

On several occasions the II&C Pathway presented various aspects of the research from the Computer-Based Procedures (CBP) and Automated Work Packages (AWP) Pilot Projects. The group has sponsored web casts with current CBP and AWP suppliers to understand current technology states and to identify technology gaps for future research. The Working Group will sponsor future meetings to develop an industry consensus on utility needs and requirements for future CBP and AWP research.

2.8 Distribution of Project Deliverables to the UWG

Research pathway and pilot project deliverables have been distributed to the UWG as they have become available throughout FY 2015, as follows:

1.	Cyber Security Evaluation of II&C Technologies	INL/EXT-14-33609
2.	Implementation of Software Tools for Hybrid Control Rooms in the Human Systems Simulation Laboratory	INL/EXT-14-33710
3.	A Research Framework for Demonstrating Benefits of Advanced Control Room Technologies	INL/EXT-14-33901 Revision 1
4.	A Distributed Control System Prototyping Environment to Support Control Room Modernization	INL/EXT-14-33957
5.	Operator Performance Metrics for Control Room Modernization: A Practical Guide for Early Design Evaluation	INL/EXT-14-31511 Revision 1
6.	A Simple Demonstration of Concrete Structural Health Monitoring Framework	INL/EXT-15-34729

7.	Digital Architecture Requirements	INL/EXT-15-34696
8.	Requirements for Control Room Computer-Based Procedures for use in Hybrid Control Rooms	INL/EXT-15-35284
9.	Benefits of Advanced Control Room Technologies: Phase One Upgrades to the HSSL and Performance Measures	INL/EXT-15-35381
10.	Pilot Project Technology Business Case: Mobile Work Packages	INL/EXT-15-35327
11.	Automated Work Package Prototype: Initial Design, Development, and Evaluation	INL/EXT-15-35825
12.	A Pilot Study Investigating the Effects of Advanced Nuclear Power Plant Control Room Technologies: Methods and Qualitative Results	INL/EXT-15-36432
13.	2015 Summary Report on Industrial and Regulatory Engagement Activities	INL/EXT-15-36705
14.	Advanced Instrumentation, Information, and Control Systems Technologies Technical Program Plan for FY 2016	INL/EXT-13-28055 Revision 4
15.	Online Monitoring of Induction Motors	INL/EXT-15-36681
16.	Digital Architecture – Results From a Gap Analysis	INL/EXT-15-36662
17.	Monitoring, Modeling, and Diagnosis of Alkali-Silica Reaction in Small Concrete Samples	INL/EXT-15-36683
18.	Development of Improved Graphical Displays for an Advanced Outage Control Center, Employing Human Factors Principles for Outage Schedule Management	INL/EXT-15-36489
19.	Verification and Validation of Digitally Upgraded Control Rooms	INL/EXT-15-36704
20.	Computer-Based Procedures for Field Workers—Result and Insights from Three Usability and Interface Design Evaluations	INL/EXT-15-36615
21.	Flow-Assisted Corrosion in Nuclear Power Plants	INL/EXT-15-36611
22.	HSI Prototypes for Human Systems Simulation Laboratory	INL/EXT-15-36839

3. Meetings with Individual Nuclear Utilities

3.1 Duke Energy

Ken Thomas met with Duke Energy Information Technology leadership on October 14th in Charlotte, North Carolina, on the goals and expected products of the Digital Architecture Pilot Project. The Duke Energy Nuclear Information Technology Strategic Leadership (NITSL) representative is the current chair of the NITSL Infrastructure and Applications (I&A) Committee, the primary interface for NITSL. Discussions were held on how Duke would benefit

from being involved in the project. Duke confirmed their desire to participate in the effort to advise the project on utility information technology deployment status and requirements.

Ken Thomas and Shawn St. Germain met with the Duke Energy Outage Managers functional area group on December 18th at the Duke Energy Corporate Office in Charlotte, NC. The scope, objectives, project activities, and project deliverables of the Advanced Outage Control Center Pilot Project were presented to the outage managers of the six Duke Energy nuclear stations (McGuire, Catawba, Oconee, Robinson, Harris, and Brunswick). The Duke Outage Managers expressed interest in becoming involved in the work beginning with observations in their spring outages followed by implementation of the AOCC collaboration technology that is now deployed by the Palo Verde, Farley, and Sequoyah nuclear stations. They agreed to participate in the AOCC Working Group and to consider additional opportunities to develop or demonstrate technologies for outage improvement.

The Digital Architecture team visited Duke Energy on July 23rd to conduct a benchmark of their current information technology infrastructure for the Duke nuclear plants. Duke was represented by corporate and plant managers and staff. Duke provided considerable information for the project and agreed to continue to support in future phases.

As a result of the visit to Duke in October of 2014, Shawn St Germain had opportunity to participate in the Duke Catawba Nuclear Station Outage Performance Assessment in March as a means of benchmarking current industry technology needs. He visited the Duke Robinson and Harris Nuclear Stations in September to benchmark their outage technology requirements and to convey the research findings of the pilot project to-date. The Duke McGuire Nuclear Station has requested a future visit to explore potential participation in the pilot project.

3.2 Arizona Public Service

Shawn St. Germain conducted a utility visit at Palo Verde Nuclear Generating Station to observe outage activities October 13-16. Palo Verde continues to deploy and evaluate technology solutions for outage management. During this refueling outage, a new voice-over-IP (VoIP) communication system was used as well as new schedule monitoring software. Palo Verde continues to improve the use of collaboration software for OCC status displays.

Shawn St. Germain facilitated a demonstration of electronic work packages at Palo Verde including real time status monitoring from the Outage Control Center (OCC) during their spring refueling outage. One of Palo Verdes work packages was rendered to a tablet device and deployed in the field to mirror the paper work package. The shop supervisor and OCC were able to monitor job status remotely and in real time. Feedback from Palo Verde staff was extremely positive, both from the workers in the field and from the supervisors.

Shawn St. Germain visited Palo Verde during April 6-8 and April 13-16 to observe use of the pilot project technologies at selected times during their spring refueling outage, which included the outage issue management technology and advanced graphical displays for the outage control center.

Ken Thomas and Bruce Hallbert met with station management representatives at the Palo Verde Nuclear Generating Station on December 16th to present an opportunity to participate in the upcoming Hybrid Control Room Upgrades Benefit Study. As a result, Palo Verde agreed to participate and will supply their control room simulator software for installation in the HSSL and

will provide operators for control room human factors studies both at INL (HSSL) and in their operator training simulator (for baseline studies). Palo Verde also expressed specific interest in the Westinghouse Computerized Procedure System (CPS) that will be used as part of the HSSL simulator configuration. The next steps are to develop a project plan for the Palo Verde participation and present that to broader set of Palo Verde station managers.

Ken Thomas met with Arizona Public Service (APS) – Palo Verde Nuclear Generating Station managers on July 7th on a proposal to conduct a major study for control room modernization involving substantial funding in a cost-share arrangement. APS expressed interest in exploring this opportunity and asked for a project plan to be presented in a larger meeting with their station management in the August-September timeframe. There was consensus on pursuing two to three options for an end-point vision and conducting the first phase engineering and human factors studies to develop a working concept for each selected option. The follow-up meeting has been tentatively scheduled for the week of September 7th.

Digital Architecture Gap Analysis benchmark visits were conducted with the staff of Arizona Public Service (Palo Verde Nuclear Generating Station on July 7th, South Carolina Electric & Gas (VC Summer Nuclear Station) on July 22nd, and Duke Energy (representing the six Duke nuclear stations) on July 23rd. Ken Thomas, Johanna Oxstrand, and Kirk Fitzgerald represented INL in these one day visits to investigate the current information technology infrastructures of the nuclear plants of the respective companies and how they compare with what is anticipated to be needed for the full implementation of the pilot project technologies. This information will be used to identify what gaps exist between the current and future information technology infrastructures and will be a key input to next year's project activity of developing a Digital Architecture Planning Model. Each utility provided panel of experts to participate in the discussions and the desired data was collected to support the project purpose. A fourth benchmark visit has been arranged with Southern Nuclear and will be scheduled for late August.

An initial project outline for a First-of-a-Kind (FOAK) Control Room Modernization Design Project with Arizona Public Service (APS) was developed. Project tasks, schedules, and rough costs were defined. This information was presented to a representative of APS in a meeting on August 13th. It was agreed to follow-up with a meeting with senior managers at Palo Verde Nuclear Generating Station in September.

Bruce Hallbert, Kathy McCarthy, and Ken Thomas, along with Tom Miller and Richard Reister of the Department of Energy, visited Palo Verde on September 10th to present a proposal for the FOAK Control Room Modernization Design Project to the senior management, including Randy Edington, Chief Nuclear Officer; Bob Bement, Senior Vice-President; Chuck Kharl, General Plant Manager; Michael Grigsby, Assistant Plant Manager; and Panos Paramithas, Director of Engineering Projects. A second meeting was held with Jack Cadogan, Vice-President of Nuclear Engineering and John Hernandez, Senior Engineer and Project Manager of the Strategic Modernization Program for I&C Systems. The result of these meetings was that Palo Verde agreed to enter into an agreement to work together to develop concepts for a modernized control room, along with a business case that would support the investment. Project planning and execution will begin in FY 2016.

Ken Thomas visited Palo Verde on September 21-24 to participate in a review of obsolescence and reliability issues for the Palo Verde I&C systems as part of the FOAK Control

Room Modernization Design Project. The information gained in this meeting will be used to develop the end-state concept for the modernized control room for Palo Verde.

3.3 SCANA

Ken Thomas visited the V. C. Summer Nuclear Station in Jenkinsville, SC on January 8th to meet with station managers on the developments of the pilot projects and potential collaboration opportunities. There were 14 participants in the meeting from Summer, including the Site Vice President and the Vice President for New Nuclear Development (i.e. there two new AP-1000 units). Other representative included Operations, Outage Management, Materials & Procurement, Organization Development, Emergency Planning, and Information Technology. The representatives of Summer indicated interest in learning more about the II&C pilot projects, particularly in the areas of mobile technologies, outage management and control room upgrades. They indicated that they would like to send a representative team to INL to see the technologies demonstrated. There have been ongoing communications with Summer to arrange this visit.

The Digital Architecture team visit the V.C. Summer Nuclear Station on July 22nd to benchmark information technology infrastructure for the station. Contacts included:

- Ed Greco – IT Manager
- Guy Bradley – IT Director
- Candy McFarland – IT Technology Consultant
- Khuzema Bhagat – IT Supervisor AD
- Shirley Counts – IT Technology Consultant
- Jan Geib – Nuclear Cyber Compliance Specialist
- Dennis Gehr – Engineer IV
- Willie Vogt – Engineer IV

The Summer IT staff provided needed data related to the present and future structure of their information technology for the station. They are interested in a number of the pilot project technologies and expressed interest in further discussions on opportunities to participate in the projects.

3.4 Southern Nuclear

Efforts continued in early FY 2105 on the development of the Cooperative Research and Development Agreement (CRADA) for the proposed pilot project work with Southern Nuclear, involving several conference calls. The CRADA was approved by Southern on January 6th for the proposed pilot project in the areas of computer-based procedures (Vogtle Nuclear Station), outage improvement (Farley Nuclear Station), and control room human factors (Farley Nuclear Station). Several conference calls were held with Southern to coordinate the start of these activities.

Shawn St. Germain and Ron Farris traveled to Plant Farley on November 3-6 to document Farley's implementation of AOCC concepts during their upcoming refueling outage. Plant Farley has implemented AOCC concepts for outage communication and collaboration and lessons learned during the implementation were documented.

Discussions were held with Southern Nuclear on participating in the development of a business case for computer-based procedures (CBPs) in conjunction with the CBP validation study at Vogtle Nuclear Station. Southern expressed preliminary interest and asked for more detailed information to provide to their management. Contact was also made with ScottMadden Management Consultants about extending the FY 2014 contract to conduct the next phase of the Digital Technology Business Case.

A conference call with Southern Nuclear was held on February 3rd to define the FY 2015 activities for the computer-based procedure validation study to be conducted at Vogtle Nuclear Station. This included INL pilot project staff and Southern Nuclear personnel representing Vogtle Nuclear Station and the corporate IT support staff. It was decided that INL would visit Vogtle in early March to observe procedure use and set the parameters of the study, with the study to be conducted in the spring.

Shawn St. Germain travelled to Plant Farley on March 30 – April 2 to evaluate technology implementation during their spring outage to evaluate process improvements in outage communication that have been developed through the AOCC pilot project. Farley indicated that the process improvements significantly improve plant communication and situational awareness during refueling outages. Farley indicated that these process improvements will likely be implemented fleet wide at Southern Company. In fact, the use of the technology has now expanded to Plant Hatch and Plant Vogtle, including the use of OneNote beyond the OCC and the Issues Resolution Teams (IRTs). Plant Farley and Plant Hatch have started using it for project related communications.

The Business Case Methodology exercise with Southern Nuclear's Vogtle Nuclear Station began the week of April 13th with a kick-off meeting on-site with key department managers. The focus of the business case was site-wide deployment of computer-based procedure and automated work package technologies. Ken Thomas conducted the meeting along with representatives of ScottMadden Management Consultants, who were contracted to perform the detailed business case analysis. ScottMadden continued the on-site work analysis for three successive weeks in April, with off-site procedure analysis and project support provided by Ken Thomas. During the last week of April, ScottMadden developed a data model of the efficiency and error reduction factors provided by the technologies, that can be scaled up to the complete site work activity levels to derive the total projected benefits of the business case.

Work was completed on the Business Case Development Study with Southern Nuclear at Vogtle Nuclear Plant and the report Pilot Project Technology Business Case: Mobile Work Packages was published on May 28 in support of Milestone M4LW-15IN0603054, Complete a report on the Pilot Project Technology Business Case that documents the quantitative and qualitative performance improvement potential. Five work sessions were conducted with the project consultant, ScottMadden Management Consultants, including a visit to Vogtle on May 19-20 to review all project results and findings with Vogtle management representatives. The study resulted in the identification of approximately \$6.5M in annual savings for the plant with full implementation of mobile work packages, including computer-based procedures. This represents a net present value of over \$21M through the expected 15 year life of the technology. This value is considered to be on the low end of the range of expected benefits due to conservative assumptions that were made in the analysis. In addition to the cost savings, considerable benefits were identified in reduced human error, with positive impacts on a number of important plant key performance indicators (KPIs).

A close-out briefing (by conference call) was held for Southern Nuclear on the Business Case Development Exercise. Representatives of Vogtle Nuclear Station and the Corporate Office Information Technology staff participated in the call. Ken Thomas and Sean Lawrie (of ScottMadden Management Consultants) reviewed the objectives, methodology, and key findings of the recently completed Business Case Study that was performed at Vogtle. Southern Nuclear took the action to determine whether additional briefings are desired.

The LWRS Automated Work Package (AWP) project conducted a plant visit at Southern Nuclear Company's Vogtle site, in Georgia, March 10-12, 2015. The goals of the visit were to select a task and procedure to use in the upcoming field evaluation study, to observe the task being performed in the field, and to talk to point of contacts (including senior management). All the goals were successfully achieved.

The project team conducted a second plant visit at Vogtle 1 and 2 the week of June 8-9, 2015. During this week the AWP prototype system and the plant's work orders loaded in the AWP system were validated through talk-throughs and walk-downs. A procedure writer, a maintenance supervisor, and a maintenance technician conducted talk-throughs to verify the computerized versions of the work packages met the intentions of the original paper versions. Two maintenance technicians conducted walkdowns of the work orders at the actual work site at the plant to verify the work flow using the AWP system match the intended work flow. The conclusion from the activities was that the work orders in the AWP system match the intent of the original work orders and that the work flow becomes more efficient when using the AWP system compared to paper. By the end of the week two mobile devices (one 10" Samsung tablet and one 7" Nexus tablet) were handed off to the plant, to mark the official start of the field evaluation study.

3.5 South Texas Project

Shawn St. Germain visited South Texas Project in August to assist in setting up a standard issues package and new OCC display concepts for their upcoming fall outage. Future meetings are planned with South Texas Project to extend their use of the pilot project technologies.

3.6 Exelon Nuclear

Shawn St. Germain visited Byron Nuclear Station in August to assist in setting up a standard issues package and new OCC display concepts for their upcoming fall outage. The results of this implementation will be obtained through future visits with the station.

3.7 Xcel Energy

Shawn St. Germain conducted outage observations and utility outreach at the Xcel Energy's Prairie Island Nuclear Station. Xcel Energy committed that both the Prairie Island and Monticello Nuclear Stations will participate in the AOCC Pilot Project Working Group. Additionally, Prairie Island is building a new outage control center in 2015 and will incorporate AOCC concepts into the design. The AOCC pilot project staff will assist Prairie Island in implementing AOCC concepts into their new OCC and evaluate the results during the next Prairie Island refueling outage in the fall of 2015.

3.8 Tennessee Valley Authority (TVA)

Shawn St. Germain conducted an assist visit at TVA's Sequoyah on December 8-11 to help them establish the standard issues package and use of collaboration software to support OCC displays. This visit also provided the opportunity to present the AOCC concepts to TVA work management corporate manager for as well as outage managers from other TVA nuclear plants (Browns Ferry and Watts Bar).

Shawn St. Germain travelled to Sequoyah on April 27 - 30 to evaluate technology implementation during their spring outage. Shawn St. Germain also visited Plant Farley and Sequoyah Nuclear Plant to evaluate process improvements in outage communication that have been developed through the AOCC pilot project. Both plants have indicated the process improvements significantly improve plant communication and situational awareness during refueling outages. Plant Farley and Sequoyah are both fleet plants and these process improvements will likely be implemented fleet wide at Southern Company and TVA respectively.

The OCC process improvements at Sequoyah proved to be very successful. Both the staff in the OCC and the craft shops quickly embraced the new tools. They estimated that phone calls to the OCC were at least 50% lower than previous outages and printed paper was similarly reduced. TVA indicated that they expect the other TVA plants will follow suit for the fall outages based on the success at Sequoyah.

3.9 Pacific Gas & Electric (PG&E)

The LWRS Computer-Based Procedure (CBP) for Field Workers project conducted two plant visits to Diablo Canyon Power Plant (DCPP) during FY15.

During February 10-12, the CBP project team conducted a plant visit at Diablo Canyon Power Plant (DCPP) to initiate a new collaboration with P&GE. The goal of the visit was to identify points of contacts at the plant and select procedure to use for an upcoming computer-based procedure (CBP) field evaluation study, to be hosted by DCPP.

During the three days at the plant, the II&C team met with the Nuclear Operations Services Director, the Nuclear Operations Planning Manager, the Procedures and Document Services Manager (the main POC), a Nuclear Unit Control Supervisor, a Shift Operations Supervisor, a Nuclear Operator, a Sr. Advising Nuclear Procedure Writer, a Nuclear Procedure Writing Supervisor, and the Human Performance Coordinator. All the managers were already aware of the development effort and were very supportive of collaborating with INL.

During the week the team identified two tasks of interest for the upcoming field evaluation study and conducted walk-downs of the procedures related to these tasks. At least one of the selected tasks is shared between the main control room and the operators in the field. Combined, the two selected tasks provide the opportunity to demonstrate the design concepts currently in the CBP system and to incorporate new functionality such as sharing procedure between different organizations (control room and field ops), context sensitive OVIDs (simplified P&IDs), dynamic pre-job briefs and task reviews, and the use of optical character recognition for digital correct component verification.

The CBP team conducted a second plant visit to Diablo Canyon Power Plant (DCPP), April 13-17. The purpose of the visit was to provide training to both field and control room operators on how to use the CBP system and to validate the CBP version of the plant procedures to be used in the field evaluation. The team successfully trained operators, the procedures were validated, and technical issues identified were resolved onsite by the II&C team. The team left two seven inch tablets (for field procedures) and one ten inch tablet (for control room procedures) at DCPP. The field evaluation began Monday April 20th when the CBP system was successfully used for the task of swapping of auxiliary salt water pumps. The field evaluation study continued through early August 2015.

During the plant visit the CBP team had the opportunity to meet with the Senior Vice President and Chief Nuclear Officer (Ed Halpin) and the Vice President of Nuclear Services (Barry Allen). The team demonstrated the CBP system to Mr. Halpin and Mr. Allen. In communications after the visit, Mr. Halpin extended an invitation for the II&C Pathway to participate in DCPP's Human Performance/Safety/Wellness EXPO in May (which proved not to be possible). He also suggested that DCPP inform INPO about the work conducted in collaboration with the II&C Pathway.

The II&C Pathway hosted two representatives from Diablo Canyon Power Plant on August 24-15 due to their interest in possible collaboration in their control room upgrade projects, and more specifically, the upgrade of the plant process computer. Dan Blount, Lead Digital Systems Engineer, and Michael Whiting, Senior Reactor Operator, toured the Human Systems Simulation Laboratory and learned about II&C research efforts. The Diablo Canyon representatives stated that they were very impressed with the capabilities and developments of the Pathway and expressed a desire to collaborate in the Control Room Modernization Pilot Project as part of their digital control room upgrades beginning in early FY 2016.

3.10 STARS Nuclear Alliance

Ken Thomas met with STARS Nuclear Alliance representative Tony Harris in Goodyear, Arizona on December 16th to discuss possible opportunities to present the II&C Pathway work to the STARS nuclear plants, which consists of Calloway, Comanche Peak, Diablo Canyon, Palo Verde, and Wolf Creek. STARS Nuclear Alliance provides a means for these single plant utilities to cooperate on identifying and implementing performance improvement initiatives and to jointly monitor key performance indicators. Mr. Harris was highly supportive of facilitating interactions with their functional area groups (e.g. operations, maintenance, chemistry, radiation protection, etc.).

The first opportunity to pursue opportunities with STARS Nuclear Alliance will be on the FOAK Control Room Modernization Design Project. Palo Verde has offered to sponsor interactions with STARS in the area of control room upgrades, exploring the possibility that the control room modernization efforts could complement cooperative I&C upgrade efforts across the Alliance. This will be pursued in FY 2016.

4. Meetings with Major Industry Support Groups

4.1 Nuclear Information Technology Strategic Leadership (NITSL)

A status report on the Digital Architecture Pilot Project was provided to the NITSL Executive Committee for their planning meeting held the week of October 24th in Minneapolis. The status report was presented to the Executive Committee by Bruce Gordon of APS – Palo Verde, a member of the II&C Utility Working Group as well as the NITSL Executive Committee. Following the meeting, Bruce reported that the status report was well-received and that the Executive Committee had requested a full-day technical session and a project presentation as part of their annual workshop, to be held the week of July 13th.

Ken Thomas participated in joint conference call between the II&C Pathway – Automated Work Package pilot project and the Nuclear Information Technology Strategic Leadership (NITSL) Subcommittee on computer-based procedures. These calls will be ongoing to share information on CBP development and implementation concerns. NITSL stated on the call that the II&C Pathway will be instrumental in providing needed technical guidance to this group based on the pilot project results.

A meeting (conference call) was held with the Chair of the Infrastructure and Application (I&A) Committee of the Nuclear Information Technology Strategic Leadership (NITSL) in which agreement was reached for the I&A Committee to support the work of the Digital Architecture pilot project. This includes technical input and guidance for the development of a Gap Analysis Report, comparing the current state of nuclear plant IT infrastructure to what is projected to be needed (via the previously developed Digital Architecture Requirements Report) for the eventual full implementation of the pilot project technologies.

A utility workshop on Digital Architecture was held in conjunction with the Nuclear Information Technology Strategic Leadership (NITSL) Workshop, Minneapolis, MN, on July 13th. There were twenty utility/industry representatives in attendance. The goals and objectives of the Digital Architecture Gap Analysis were presented, including the results of the first benchmark visit. The workshop participants provided excellent input on the project objectives and methodology, as well as positive feedback on the usefulness of this project to the utilities. During the workshop, a survey of the participants was conducted to collect additional data with respect to the digital implementation plans of the utilities.

4.2 Electric Utility Cost Group (EUCG)

A conference call was conducted with Mr. David Ward, current chair of the Electric Utility Cost Group (EUCG) – Nuclear Committee. David holds a position at Duke Energy Nuclear Generation that is responsible for cost and workforce management. The recently published Digital Technology Business Case Methodology Workbook and Guide were provided to David and the Workbook was demonstrated during the call. Several ideas on EUCG participation in the continuing Business Case project were discussed, including 1) being a participant in the project, 2) providing a peer review of the numbers produced in the technology business cases, and 3) host a presentation of the results at the 2015 Fall EUCG Workshop. A follow-up meeting will be held with David in December to plan EUCG roles in the Business Case project.

Ken Thomas met with the current chair of the Electric Utility Cost Group (EUCG) – Nuclear Committee on December 18th (David Ward of Duke Energy) on possible collaboration in developing a pilot project business case. The meeting took place at the Duke Energy Corporate Office in Charlotte, NC. The discussion centered on the FY 2015 work in business case development for pilot project technologies. David expressed interest both in EUCG involvement, as well as the possibility of Duke hosting one of the business case development exercises. A proposal for their participation will be developed and forwarded to David for consideration by Duke. David also agreed that EUCG would review and provide feedback on the business case development, as well as host a presentation on the effort at their annual fall workshop.

4.3 Institute of Nuclear Power Operations

Ken Thomas and Bruce Hallbert visited the Institute of Nuclear Power Operations (INPO) on February 4th in Atlanta, GA. The purpose of the visit was to present the work of the II&C Pathway and to explore potential collaboration with INPO in applying pilot project technologies to a nuclear power industry initiative (known as Cumulative Impact) being led by INPO to reduce the work requirements burden on nuclear workers that has been imposed by decades of corrective actions for performance deficiencies. Michael Grigsby of Arizona Public Service – Palo Verde Nuclear Station also attended the meeting to represent the pilot project work that his station is conducting with the II&C Pathway.

Attendance for INPO included:

- Bob Duncan – Vice President for Cumulative Impact Initiative
- Steve Nichols – Vice President, Engineering
- Phil Russell – Manager, Operations
- Bob Willard – INPO CEO (part-time)
- Bill Nowicki – INPO Lead for Digital Technology

Collaboration was discussed in the following area:

- Pursuing solutions for the most common and frequent NPP worker performance deficiencies.
- Ensuring that new technology implementation is consistent with the INPO Performance Objectives and Criteria (PO&C).
- Engaging utilities in technology-based performance improvement through assistance and transfer of best practices.

Follow-up discussions will be held to determine specific opportunities for collaboration. In addition, a potential visit to INL by key INPO managers to see technology demonstrations will be pursued.

Coordination calls were held with the Institute of Nuclear Power Operations (INPO) to discuss the ongoing status of the pilot projects and to promote attendance by INPO managers at the Utility Working Group in August.

4.4 Nuclear Energy Institute

Ken Thomas is representing the LWRS Program on the newly-formed Nuclear Energy Institute (NEI) Digital I&C Working Group, the purpose of which is to engage the NRC on certain issues that are considered by industry to be barriers to digital technology implementation for nuclear power plants. A conference call was held on June 22nd to cover the current status of these issues, which include new rulemaking for digital (10 CFR 50.55 a(h), the use of 10 CFR 50.59 for digital modifications without requiring NRC review, embedded digital devices, and use of Interim Staff Guidance (ISG) – 06 for digital modification license amendments.

Ken Thomas attended a second meeting of the NEI Digital I&C Working Group Meeting in Washington, DC on August 6, representing LWRS II&C in opportunities to resolve barriers for nuclear plant I&C modernization. Topics discussed included new digital rulemaking, new regulatory guidance for conducting digital upgrades without prior NRC approval under 10 CFR 50.59.

4.5 Electric Power Research Institute

The Electric Power Research Institute (EPRI) is a key partner for the II&C Pathway, with collaboration made possible by a Memorandum of Understanding adopted in 2010 that links the Department of Energy Light Water Reactor Sustainability Program with the EPRI Long Term Operations (LTO) Program. Since that time, EPRI and the II&C Pathway have collaborated in a number of technology developments, as well as jointly sponsoring meetings and other industry collaboration opportunities. The relationship with EPRI is particularly beneficial to the II&C Pathway because of this organizations research activities, staff expertise, and extensive relationship with utility staff in plant functions that are related to the pilot project technologies.

Monthly phone calls are held with the II&C Pathway leadership and the Senior Program Manager and key staff for the EPRI I&C research area. These phone calls are used to coordinate research activities and to share information of research activities, utility technology requirements, and nuclear plant performance needs. Periodic meetings are conducted on specific topics related to the joint research activities. For example, II&C Pathway staff working on online monitoring applications met with EPRI representatives in Charlotte, NC on April 7th and at Idaho National Laboratory on July 8th. The annual Utility Working Group Meeting held each August at Idaho National Laboratory is designated a joint meeting with the EPRI Strategy Group on Productivity Improvement through Technology. EPRI program managers participate in some of the pilot project utility studies, an example being their participation in a control room upgrade operator workshop on March 3rd.

EPRI has provided a number of important research reports to the II&C Pathway that are relevant to the pilot project activities, particularly in the area of human factors engineering for nuclear plant control rooms. In addition, the Control Room Modernization Pilot Project contributed a lengthy experience report on control room upgrade work with Duke Energy which was published as an appendix to EPRI report Guidance for Developing a Human Factors Engineering Program for an Operating Nuclear Power Plant (Report No. 3002002770) which was published in December of 2014.

Finally the II&C Pathway leadership participates in the semi-annual EPRI Nuclear Power Council Advisory Meetings – I&C Committee, in which there is opportunity to provide this

important industry leadership group with periodic updates on the work and technology developments of the II&C Pathway.

5. General Industry Meetings and Conferences

5.1 2014 American Nuclear Society Winter Meeting

The 2014 American Nuclear Society Winter Meeting was held in Anaheim, CA, on November 9-13. This meeting included a session dedicated to the Light Water Reactor Sustainability Program. A paper was presented by Shawn St. Germain on behalf of the II&C Pathway entitled Implementation of an Advanced Outage Control Center. This presentation highlighted the work that this pilot project has done with Palo Verde Nuclear Station in upgrading their outage control center.

5.2 9th International Topical Meeting on Nuclear Plant Information, Control, and Human-Machine Interface Technologies (NPIC & HMIT 2015)

NPIC & HMIT is a bi-annual topical meeting sponsored by the American Nuclear Society and is a forum for nuclear instrumentation and control (I&C) and human factors engineering professionals to present their research and development and exchange information on new digital technology for nuclear plant I&C and human factors. It attracts a national and international audience due to the quality of research and development papers that are presented. The meeting in 2015 was held in Charlotte, NC on February 23-26. Several of the II&C Pathway research staff presented paper or participated in panel discussions at this meeting, including Bruce Hallbert, Ron Boring, Shawn St. Germain, Johanna Oxstrand, and Vivek Agarwal.

The II&C Pathway papers that were presented at this conference included:

- The Next Step in Deployment of Computer Based Procedures For Field Workers: Insights And Results From Field Evaluations at Nuclear Power Plants
- Computer-Based Procedures For Nuclear Power Plant Field Workers: Design Implications Based On Three Evaluation Studies
- Standardized Procedure Content And Data Structure Based on Human Factors Requirements For Computer-Based Procedures
- Baseline Evaluations to Support Control Room Modernization at a Nuclear Power Plant

5.3 2015 INPO Digital Workshop

The INPO Digital Workshop is an annual meeting of nuclear plant I&C professionals that provides an opportunity to learn about significant developments potentially benefitting the operating nuclear plants in plant controls and control room upgrades, as well as pertinent licensing and engineering process issues.

Ken Thomas presented an update on the II&C Pathway activities and technology developments at the 2015 INPO Digital Workshop, held at INPO in Atlanta, GA, on May 12-13. The presentation was entitled Control Room Upgrades and Related Digital Applications. There was good interest in the work of the II&C Pathway based on comments and questions received during the presentation. There were about 85 representatives of nuclear utilities (including a few supplier representatives) at the meeting. Several new contacts were made for follow-up for possible participation in the Utility Working Group.

5.4 2015 Procedure Professional Association Workshop

A presentation on the accomplishments and results from the field evaluation studies conducted in the LWRS Computer-Based Procedure (CBP) for Field Workers project along with a detailed demonstration of the CBP system were conducted at the Nuclear Procedure Professional Association annual symposium on June 24, 2015, in St. Petersburg, Fl. The CBP researchers also conducted a small user interface study during the conference inviting the conference participants to participate in the study. The main result of the 2015 symposium is the addition of Florida Power and Light's Point Beach Nuclear Plant as a collaboration partner to the CBP for Field Workers project. Point Beach has expressed great interest in hosting a field study in FY16.

There were 60 participants present at the 2015 Nuclear Procedure Professional Association annual symposium. The participants represented eight research entities (including DOE, INL, IFE, INPO, and EPRI), nineteen utilities, thirteen vendors, and one nuclear weapons laboratory. Three international entities were represented; the Canadian Nuclear Laboratories, IFE, and Horizon Nuclear Power.

The Nuclear Procedure Professional Association promotes the development of nuclear utility procedure standards and the exchange of information among procedure development professionals to increase reliability, improve performance, and ensure the safe and efficient operation of nuclear facilities. Several attendees expressed interest in collaborating with the computer-based procedure project specifically and the Utility Working Group in general.

5.5 2015 Human Performance and Root Cause Trending (HPRCT) Conference

The LWRS Computer-Based Procedures (CBPs) for Field Workers project was invited to demonstrate the CBP prototype system at the Human Performance, Root Cause, and Trending (HPRCT) conference on June 16th, in Delray Beach, Florida. This presentation was made by Johanna Oxstrand. The mission of the HPRCT conference is to provide a collaborative setting for participants to share concepts and best practices relating to continuous improvement initiatives – including human performance improvement, data analysis, root cause analysis, corrective action and other organizational effectiveness assessment tools and techniques.

In addition, Shawn St. Germain presented the AOCC Pilot Project research and results of the utility implementations at the Human Performance and Root Cause Trending Conference.

5.6 2015 NITSL Workshop

Ken Thomas made a presentation entitled “INL Update: Digital Technologies for Nuclear Plant Cost” Management for 2015 Nuclear Information Technology Strategic Leadership (NITSL) Workshop, held in Minneapolis, MN, July 7-9. The meeting was well-attended by nuclear utility representatives, with approximately 150 in attendance. Several new contacts were made for the Utility Working Group.

5.7 2015 Westinghouse Outage Optimization Workshop

The Westinghouse Outage Optimization Workshop is an annual meeting for nuclear utility outage managers to hear technical presentations on various aspects of outage performance improvement, including new technology developments. The 2015 meeting was held in Las Vegas, NV in July 26-30. Shawn St. Germain presented to research and technology developments of the AOCC Pilot Project, which was well-received by the attendees and resulted in three new nuclear plants expressing interest in getting involved in the research activities.

6. Meetings with Suppliers

6.1 Altran

Ken Thomas met with Altran Corporation in Cary, North Carolina on October 21st to discuss opportunities for technology development assistance on a contract basis. Altran has personnel with extensive experience in nuclear plant maintenance and outage management, and therefore potential opportunities for assistance on the Advanced Outage Control Center pilot project will be explored in the coming months. Also, Altran has experience in control room human factors, including human factors verification and validation (V&V). This will also be explored for potential assistance.

6.2 ScottMadden Management Consultants

Ken Thomas met with ScottMadden Management Consultants in Raleigh, North Carolina on October 24th to discuss possible assistance on the FY 2015 work on the Digital Technology Business Case Methodology, and specifically conducting work with Utility Working Group members in developing actual business cases. ScottMadden later (October 31st) provided a proposal for conducting this work, which will be evaluated during November as a possible approach to this work.

Discussions were held with ScottMadden Management Consultants to develop a proposal for their support of the Business Case Methodology Exercise at Vogtle Nuclear Plant. As a result, ScottMadden provided a proposal that will be the basis of amending a previous contract with them to conduct the work.

6.3 Rolls Royce

Ken Thomas, Bruce Hallbert, Johanna Oxstrand, and Vivek Agarwal, met with Rolls Royce Nuclear Engineering Services on potential pilot project collaborations in the areas of computer-based procedures, automated work processes, technology business cases, computerized operator support systems and on-line instrument calibration monitoring. Detailed discussions were held on mutual development interests in these areas. Several information items (reports, papers, etc.) have or will be forwarded as follow-up on the discussions. Additional discussions will be held in December to agree on a proposed scope of collaboration, leading to the development of a CRADA to conduct the joint work. The following individuals represented Rolls Royce.

Paul Tobin	Executive Vice President, Nuclear Engineering Services
Robert Santoro	Vice President – Programs, Nuclear Engineering Services
Eric Petersen	Vice President, Business Development
Bradford Mabry	Product Manager, R&D
Michael Archer	Program Manager, Nuclear Engineering Services
James Tahler	Senior Engineer
Jeffrey Ogilbee	Sr. Software Engineer, Nuclear Engineering Services
Rob Felix	Nuclear Engineering Services

Supplier engagement activities were conducted with Rolls Royce, hosting two conference calls with Argonne National Laboratory (ANL) and Pacific Northwest National Laboratory (PNNL) respectively, on aspects of sensor monitoring that relate to on-line monitoring activities being conducted under the II&C Pathway. Rolls Royce expressed interest in collaboration with the work at PNNL, including possibly providing actual nuclear plant sensor data that they are able to obtain. Discussions of this arrangement are ongoing.

A conference call with representatives of Rolls Royce was held on February 19th to continue discussions on the pilot project technologies of interest (Computer-Based Procedures, Advanced Outage Control Center, and On-Line Monitoring). This call involved two members of the research staff based in the UK. Rolls Royce is continuing to evaluate potential collaboration opportunities in one or more of these areas.

6.4 Westinghouse

Ken Thomas and Bruce Hallbert met with Westinghouse in Pittsburgh, PA, on February 5th. In addition, representatives of Arizona Public Service – Palo Verde Nuclear Station attended. The purpose of the meeting was to review Westinghouse advanced control room digital technologies for use in the upcoming Control Room Upgrades Benefits Study. Palo Verde has agreed to serve as a partner in this study and to supply operating crews to conduct the studies in the DOE Human Systems Simulation Laboratory at INL. Palo Verde is also interested in potentially acquiring computer-based procedure (CBP) technology for both control room and field applications. Discussions will continue among the three parties on possible collaboration on requirements to adapt Westinghouse CBP technology for field applications.

A sales agreement was finalized in late September with Westinghouse to procure the AP-1000 Computer-Based Procedure System and the Advanced Alarm Management System, culminating a lengthy negotiation period.

6.5 Curtis-Wright Scientech

Curtis-Wright Scientech participated in the AOCC Pilot Project field study for real-time progress updates through automated work packages connected wirelessly to outage coordinators in the outage control center. This work was performed under contract to the II&C Pathway. A limited license of this technology was provided under the contract to the II&C Pathway for the purposes of demonstrating this technology in the Human Systems Simulation Laboratory at Idaho National Laboratory.

Curtis-Wright Scientech has been a collaborator in past pilot projects, notably the previous Advanced Outage Coordination Pilot Project that was conducted at Exelon Nuclear's Byron Nuclear Station. This relationship is an example where it is cost-effective certain commercial products are used in the development of pilot project technologies as opposed to developing similar capabilities in-house.

6.6 Devonway

Devonway is a recognized developer of software for nuclear work processes such as the corrective action program and field work observation applications. Devonway expressed interest in learning more about the technology developments of the II&C Pathway, and therefore visited Idaho National Laboratory on May 27th. Representing Devonway were:

- Rob Trounce, President and CEO
- Wade Watts, Vice President – Delivery
- Steven Johnson, Chief Technology Officer
- Matt Sacks, Vice President – Sales
- Sally White, Senior Vice President – Business Development & Strategy

As a result of the meeting, several conference calls were conducted with Devonway to explore possible collaboration activities. These discussions will continue into FY 2016 in view of the new project opportunities with the II&C pilot projects.

6.7 Schneider Electric

Several discussions were held with Schneider Electric on possible collaboration in the area of extending nuclear power plant instrument surveillances by crediting on-line monitoring self-diagnostic features and on-line calibration monitoring technology in performing nuclear plant Technical Specification surveillances, and non-Technical Specification surveillance for non-safety systems. Representing Schneider Electric in these discussions has been Brian Haynes, Senior Director – Global Nuclear Engineering, as well as other staff and consultants. This is potentially an important development to reduce I&C maintenance cost for operating nuclear plants as well as enhance safety margins. It could potentially leverage developments by Schneider Electric with technology concepts being developed at several national laboratories.

In addition to Schneider Electric, a representative of Pacific Gas & Electric's Diablo Canyon Nuclear Station, Ken Schrader participated in the call and expressed interest in being a potential host plant for the development. Diablo Canyon, like many other nuclear plants, have implemented an NRC approved program for managing the frequency of certain Technical Specification surveillances based on performance data and engineering analysis, based on NEI 04-10, Rev 1, "Risk-Informed Technical Specification Initiative 5b, Risk-Informed Method for Control of Surveillance Frequencies." If successful at Diablo Canyon, there would be considerable interest by the other nuclear utilities in adopting the technologies as a way of managing O&M costs, which is an important element in ensuring the long-term operation of the LWR fleet.

Discussions on this proposed project, in addition to other possible collaborations with Schneider Electric, will continue in FY 2016.

7. Regulatory Engagement

7.1 Informal Discussions with NRC I&C Managers

Mr. David Rahn, Senior Electronics Engineer, Nuclear Regulatory Commission, participated in the 2015 INPO Digital Workshop and observed the II&C Pathway presentation on Control Room Upgrades and Related Digital Applications. Mr. Rahn took part in a panel discussion entitled Panel Discussion: regulatory Framework Status for Digital Upgrades, and in addition made a presentation on NRC regulatory activities. Afterwards this presentation, Ken Thomas had the opportunity to discuss the research activities with Mr. Rahn in more detail, and in particular how the regulatory activities relate to the technology developments. Mr. Rahn expressed interest in learning more about the II&C research activities and a willingness to conduct follow-up discussions at a later time.

7.2 Other Communication Opportunities with the NRC

As stated in Section 4.4, the II&C Pathway is participating in the NEI Digital I&C Working Group, which is tasked to resolve long-standing regulatory issues in digital implementation for NPPs. During the Working Group meeting on August 6, 2015, an interface meeting with the NRC was included as part of the agenda. [2] The NRC was represented by:

- Jennifer Uhle, Deputy for Reactor Safety Programs, Office of Nuclear Reactor Regulation
- John Lubinski, Director, Division of Engineering, Office of Nuclear Reactor Regulation
- John Tappert, Engineering Branch Chief, Office of New Reactors
- Richard Stattel, Senior Electronics Engineer in the Electrical and Instrumentation and Controls Engineering Branch, Office of Nuclear Reactor Regulation
- Terry Jackson, Branch Chief, Instrumentation, Controls, and Electronics Engineering Branch, Division of Engineering, Office of New Reactors

The NRC prioritized the regulatory issues in two major categories [3]:

- Priority I issues are those which the staff believes can be realistically accomplished in a relatively shorter time frame, or have a greater licensing efficiency improvement payback for which activities should begin soon because additional research to establish a regulatory basis is needed. The Priority I issues are:
 1. NRC Assistance in Updating Industry Guidance for DI&C 10 CFR 50.59 Modifications
 2. Content and Schedule of DI&C Application Submittals
 3. Evaluation of NRC Policy on Software CCF
 4. Guidance for Evaluation of Proposed Alternatives to Regulatory Criteria and Standards

- Priority II issues have been identified as having less efficiency improvement payback than Priority I issues, or require a significantly longer time and research commitment to accomplish in order to realize the efficiency improvement, or are considered as “continual long term improvement” areas. The Priority II issues are:
 1. Guidance for Evaluation of Highly Integrated Digital Technologies
 2. Regulatory Infrastructure Improvements
 3. Improvement in Technical Consistency Among NRC Headquarters and Regional Offices
 4. Early-Development Stage Evaluation of Security Aspects of Proposed DI&C Designs
 5. DI&C Topical Report Evaluation and Update Process

To the extent possible, each item has been mapped to the issues identified by the NEI Digital I&C Executive Working Group. These items were: High Review Cost, Regulatory Uncertainty, Human Factors Engineering, Common Cause Failure Evaluations, Scheduling/Factory Acceptance Test reliance, and use of Commercial Grade Dedication processes.

The NRC and the Working Group expressed confidence in the process that has been established to resolve these regulatory issues. It was noted that there will be appreciable operational and safety benefits for the operating plants once these issues are resolved and nuclear utilities are more willing to pursue digital upgrades. Following the formal portion of this meeting, there was time for informal discussions with the NRC attendees on the developments of the II&C Pathway and the relationship of these technologies to the regulatory issues.

8. International

8.1 IFE Halden Reactor Project

IFE Halden Reactor Project is highly-respected leader in nuclear energy technology, and particularly in the field of control room modernization and nuclear control room operator human performance. The II&C Pathway contracts Halden to perform certain research tasks for the Control Room Modernization Pilot Project. The task for 2015 was to complete a report documenting the implementation of prognostic software for control indicators in the Human Systems Simulation Laboratory documenting the software development and functionality. The technology developed under this task was delivered to the II&C Pathway in August and a report summarizing the development effort was completed in September.

Halden also collaborates with the II&C Pathway in other pilot projects, such as the Advanced Outage Control Center Pilot Project and the Control Room Upgrades Benefit Pilot Project. As a member of the Halden Programme Group, the II&C Pathway is able to access the research reports produced by Halden under this program, which are very relevant to many of the pilot project technologies.

Halden also supported the 2015 Utility Working Group Summer Meeting, sending four representatives and providing five presentations.

8.2 Electricite' de France (EdF)

Ken Thomas, Shawn St. Germain, and Kelly Estes held a call with Electricite' de France (EdF) to discuss possible usage of their Wireless Padlock technology for controlling plant configuration. This is being investigated as part of the Advanced Outage Control Center pilot project, with a possible opportunity to demonstrate the technology at the Advanced Test Reactor at INL. The EdF representative will follow-up with their development partners to explore this possible collaboration and will advise sometime in March.

8.3 Korea Atomic Energy Research Institute

The Korea Atomic Energy Research Institute (KAERI) is a world leader in nuclear plant development and an important partner of the II&C Pathway in control room human factors research, under the Department of Energy I-NERI R&D Program. Specifically, Bruce Hallbert and Ron Boring have teamed with Jinkyun Park and Wondea Jung of KAERI on an I-NERI proposal to work on hybrid control rooms together. This project complements the existing work on the Control Room Upgrades Benefits Study by gaining international experience from South Korea, which has completed several digital upgrades in recent years.

As part of this collaboration, the II&C Pathway developed a report with KAERI in May entitled Methods and Measures of Characterizing Nuclear Power Plant Operator Performance to Support LWR Control Room Modernization.

KAERI also supported the 2015 Utility Working Group Summer Meeting, sending Dr. Wondea Jung to represent the organization.

In FY 2016, the Control Room Modernization Pilot Project team will meet with research staff from KAERI to develop a report on different types of control room modernization, ranging from hybrid analog-digital control rooms now underway in the U.S. to advanced all-digital control rooms in South Korea. The purpose of the joint report is to provide a cross-section of control room upgrade options that will allow U.S. utilities to consider more comprehensive digital upgrades.

9. References

1. Hallbert, Bruce and Thomas, Ken, Advanced Instrumentation, Information, and Control Systems Technologies Technical Program Plan for FY 2016 (INL/EXT-13-28055 Rev. 4), Idaho National Laboratory, September, 2015
2. Remer, Jason, Meeting Notes Summary of NEI Digital I&C Working Group Meeting on August 6, 2015, Washington, DC, August 25, 2015
3. U.S. Nuclear Regulatory Commission, Digital I&C Licensing Process Improvement Issue Prioritization, July 31, 2015

Appendix A

2015 II&C Utility Working Group Summer Meeting Agenda

DOE Light Water Reactor Sustainability Program
Instrumentation, Information, and Control (II&C) Systems Technologies Pathway

Joint Meeting
2015 II&C Utility Working Group Summer Meeting
EPRI Productivity Improvement Through Technology Strategy Group
August 11-13, 2015

Presentation Descriptions

Mobile Work Packages and Computer-Based Procedures

(Tuesday, August 11, 0830)

Results of three recent validation studies involving mobile work packages and computer-based procedures (CBP) will be presented. In February, a study was completed at Palo Verde involving the use of the CBP prototype in conducting a HVAC Surveillance Test. In April, a study was conducted at Diablo Canyon which marked the first time a computer-based procedure was used from the control room for a plant evolution. In this case, it was a procedure to swap auxiliary salt water pumps. In June, the CBP prototype was used at Vogtle to conduct a 92-Day Battery and Charger Surveillance. Insights from these studies will be discussed, including the efficiencies gained with new CBP features as well as new understandings in the human factors considerations for mobile work packages.



Technology Business Case Results: Mobile Work Packages

(Tuesday, August 11, 0945)

Performance advantages of the new pilot project technologies are widely acknowledged, but it has proven difficult for utilities to derive business cases for justifying investment in these new capabilities. Lack of a business case is often cited by utilities as a barrier to pursuing wide-scale application of digital technologies to nuclear plant work activities. The decision to move forward with funding usually hinges on demonstrating actual cost reductions that can be credited to budgets and thereby truly reduce operating and maintenance (O&M) or capital costs.



Working with a partner utility and ScottMadden Management Consultants, a business case study was conducted to determine the economic benefits of implementing mobile work packages, including computer-based procedures, across all site organizations that could benefit from them. The result was a positive business case with a substantial cost savings. Additional benefits were determined in reduced human error and positive impacts on key performance indicators. The business case is readily adaptable to other utilities, and is available for their use. The basis for the various types of cost savings will be reviewed.

Outage Improvement

(Tuesday, August 11, 1030)



A new study was conducted at Palo Verde to demonstrate automatic work status updates from a mobile work package. A CBP was used to conduct periodic maintenance on a large feedwater check valve. The application automatically provided continuous status to supervisors and outage managers on the progress of the job, without burdening the work crew. There was a positive response from all groups involved in the work. The results of this study will be presented along with future plans to use a suite of technologies for enhanced work monitoring for the Outage Control Center (OCC).

In other developments, several utility partners have successfully implemented the Issues Management software that enables the entire outage organization to have direct current access to all information about a particular outage issue. Other utility partners are working with the II&C Pathway on advanced OCC design. Recent experience from APS, Duke, Southern, TVA, and Xcel will be presented.

Integrated Operations

(Tuesday, August 11, 1130)

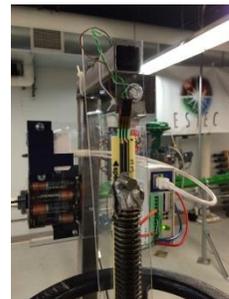
Integrated Operations (IO) is an organizational concept that highly-leverages the use of technology that enables various organizational functions and disciplines to interact in a real-time manner from remote locations. It creates considerable work and organizational efficiencies. IFE, a key development partner of the II&C Pathway (through the Halden Reactor Project), will describe their ongoing work with the Norwegian North Sea Off-Shore Petroleum Industry to use these techniques to lower operating costs, and improving efficiency by making faster and better decisions. How can lessons learned from the petroleum industry benefit nuclear power plants in adopting more efficient organizations and supplier alliances for plant support functions? The II&C Pathway has a series of pilot projects beginning in FY 2017 to apply IO concepts to nuclear plant operations and support.



Intelligent Plant Configuration Management Using Wireless Sensors

(Tuesday, August 11, 1215)

Considerable plant labor is expended in running valve line-up procedures and similar activities to ensure that manual plant components are in the correct position for work clearances, Tech Spec requirements, and changing plant conditions. This work is often error prone in spite of concurrent and independent verifications. EPRI has sponsored work undertaken by INL to develop technology for wireless remote position indication for a variety of valve types. This work has been conducted in the Idaho State University flow loop laboratory. The results of this work will be presented, along with plans to expand the use of wireless sensors to replace more manual labor requirements for nuclear plant operations and maintenance.



Change Detection Software (CDS)

(Tuesday, August 11, 1315)



INL has developed a remarkable software application that can compare two photographs (before and after) on a pixel basis to highlight changes, even if the pictures are taken from different angles. It can use photographs from virtually any camera, including those on cell phones and tablets. CDS was originally developed for security purposes, but it now being considered for nuclear plant configuration control and other applications.

This could become an important tool in mobile worker technologies – to take a picture of the work zone before the start of work and then after, to ensure that all changes are intended. CDS could verify that all breakers are in their correct positions following maintenance. It could identify small foreign material being left in a work area. It could identify piping and hanger displacements following a water hammer event. CDS will be demonstrated along with a discussion of the range of potential plant applications.

EPRI Quadcopter Plant Applications

(Tuesday, August 11, 1400)

A prototype quadcopter has been developed by EPRI to evaluate a number of potential beneficial nuclear plant uses such as visual inspections of a containment dome area (e.g. containment spray piping), dose monitoring of the site following a severe accident, security applications, and others. Features of the prototype include radiation and water resistant materials. EPRI will bring the quadcopter to the meeting and fly it as a demonstration of these capabilities. A discussion will follow on the types of applications being considered and the path to deployment.



3D Visualization for Plant Maintenance and Upgrade

(Tuesday, August 11, 1500)

Modification and upgrade projects are integral part of the operational lifetime of nuclear plants for ensuring a safe and feasible process. Modern technologies, like 3D modelling, simulation and visualisation offer very effective new opportunities for improving decision making, subcontractor



involvement, job planning and documentation, regulatory compliance, as well as briefing, training and in-the-field information support for field workers in such projects. In addition, 3D visualisation of plant information and radiation can also improve plant maintenance. Halden is in the forefront of research and application of novel 3D based support systems for a safer and more feasible operation of nuclear plants and will present the results of their ongoing research and development activities.

On-line Monitoring (OLM) Applications

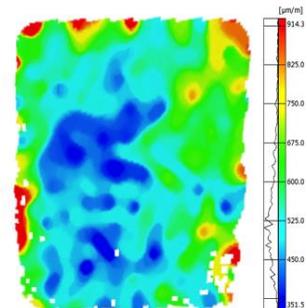
(Tuesday, August 11, 1600)

EPRI and the II&C Pathway have collaborated on several OLM applications over the past three years.

This research goes beyond the typical Advanced Pattern Recognition (APR) technologies on the market today to more advance capabilities of fault diagnostics (what caused the degradation or fault) and prognostics (what is the remaining useful life of the component or structure). These activities have been focused on active components (large transformers, emergency diesel generators, and large motors) as well as passive components (concrete and piping).

This presentation will focus on the more recent developments of motor prognostics, new detection and diagnostic capabilities for large concrete structures, and flow-accelerated corrosion (FAC) management for piping.

These developments have the potential to reduce significant plant labor costs in conducting manual material condition monitoring and testing, and can also detect degradation much earlier than otherwise possible. The capabilities of EPRI's Fleet Wide – Prognostics and Health Management (FW-PHM) will be demonstrated and the early results of the current projects will be discussed.



Fleet-wide Prognostic and Health Management

Control Room Upgrades Human Factors Methodology: Simulator Demonstration

(Wednesday, August 12, 0800)

Operators of nuclear power control rooms must contend with highly complex systems, procedures, and regulations. Developing human-machine interfaces (HMIs) that better support operators is a high priority for ensuring the safe and reliable operation of critical processes. Human factors engineering (HFE) provides a rich and mature set of tools for evaluating the performance of HMIs, however the set of tools for developing and designing HMIs is still in its infancy. The II&C Pathway has developed a rapid



prototyping approach for integrating proposed HMIs into their native environments before a design is finalized. This approach allows engineers and operators to jointly test design ideas and eliminate human factors problems prior to fully developing the new system. The design and validation process will be demonstrated in the DOE Human Systems Simulation Laboratory, simulating a typical operator workshop that would be conducted with one of our utility partners.

Prognostic Displays for Control Room Operators

(Wednesday, August 12, 0945)

IFE Halden will provide a discussion and demonstration of displays for control room operators to provide good visual indications to the operators on how well they are performing a power ramp compared to the target ramp rate. The displays provide additional information on projected time of completion of the ramp based on the current rate of the power ramp. The displays capture many of the important plant indications the operator monitors while conducting the ramp. There is also a display to document that the RCS heat-up or cool-down was carried out within the set boundary conditions by automatically producing snapshots of the display at regular intervals. Trends are used to plot hot-leg and cold-leg temperatures over time. The rate-of-change ($^{\circ}\text{F}/\text{hour}$) for these variables is calculated based on the recent 60, 30 and 15 minutes history, and projections based on the calculated rate-of-change are included in the trend diagram. The final display provides good visual indications to the operators to help them restore levels or pressures before automatic or required manual actions are activated. Trend curves with extensions for the projected future towards the limit and dedicated time-to-limit indications are essential parts of these prototypes. The predictions are based on the current rate-of-change and will estimate time-to-limit unless corrective action is taken.



Halden Resilient Procedure Use Experiment with U.S. Control Room Operators

(Wednesday, August 12, 1045)

This will be a follow-up discussion and presentations of some results from the past year's Resilient Procedure Use Experiment carried out by the Halden Reactor Project. It will include discussion on the role of the STA and how his independence is related to the success of the shift crew to handle difficult scenarios. It will present the effectiveness of the Large Screen Display and the use of the EOP Tool in support of the crews and STA. It will also describe the next stage of the Resilient study, which is introducing the Large Screen Display as an Overview display on a tablet in a conventional (non-digital) control room. This will include performing similar scenarios (difficult scenarios for beyond design bases events), in a NPP simulator control room supporting the crew with an overview display and EOP Tool on tablets. These scenarios will again focus on the use of the STA and how the tablet tools support the crew. This study will also serve as an example of one method to modernize the control room by introduction of portable information screens and procedures.

Control Room Benefits Study

(Wednesday, August 12, 1145)



Presently, aging and obsolescence are the primary drivers of main control room systems replacement and refurbishment projects. System replacements provide opportunities to incorporate new technologies and create new efficiencies. The replacement systems may incorporate new functions in control systems using embedded digital technologies. Complex, labor-intensive, and sometimes error-prone operational evolutions can be programmed into digital systems, reducing demands on control room staff and creating more reliable 'human-machine' systems. The technologies can also enhance plant monitoring and situational awareness. This has the potential for significant improvement in operator performance, safety margins, and work efficiencies.

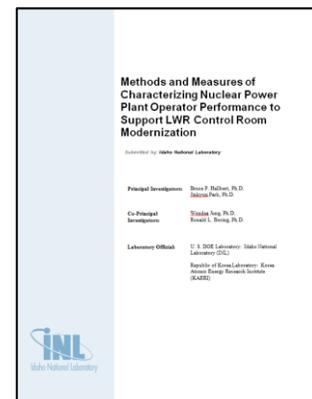
A business case to implement these types of technologies has proven to be a significant barrier for nuclear utilities, due to the uncertainty of both the cost and benefits. Beginning this year, the II&C Pathway will conduct a series of studies to investigate the benefits of these technologies. The HSSL is being configured to represent a series of future stages in modernization of a typical control room of today. The scope and time line of these studies will be presented, along with what types of new control room technologies will be included.

Methods and Measures of Characterizing Nuclear Power Plant Operator Performance to Support LWR Control Room Modernization

(Wednesday, August 12, 1230)

A new project will be presented that builds the needed technical bases to support main control room modernization using experience from Korea and recent efforts in the US concerning operator performance measurement characterization in control room modernization. It consists of three primary tasks over three years:

- Identification of key human performance issues that are affected by control room modernization – the transition from analog I&C technologies to digital I&C technologies, and mixtures thereof;
- Development of methods and measures for characterizing key aspects of operator and crew performance affected by control room modernization;
- Conduct simulator based studies to pilot proposed methods and measures and evaluate their suitability and effectiveness for use in assessing new control room technologies in the resulting mixed analog-digital control room architectures.



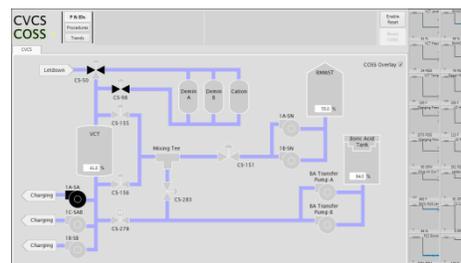
A series of technical reports will be jointly authored on an annual basis corresponding to the three primary tasks. The primary outcomes of research will be technical basis documents for main control room modernization including:

- Potential impacts on operator and crew performance and opportunities to leverage technology to achieve gains and improvement in control room performance and safety;
- Proposed methods and measures for conducting tests and evaluations as required by current regulation to demonstrate the safety and acceptability under current regulations;
- Data to support the qualified use of the proposed methods and data collection techniques by utilities and vendors to support long term incremental modernization of main controls rooms.

Computerized Operator Support System (COSS)

(Wednesday, August 12, 1315)

A COSS is a collection of capabilities to assist operators in monitoring overall plant performance and making timely, informed decisions on appropriate control actions for the projected plant condition. It is able to 1) detect off-normal conditions, 2) diagnose plant faults, 3) predict future plant states, 4) recommend mitigative actions, and 5) monitor for effectiveness of actions. This is an emerging control room technology that has great promise in improving operator performance, reducing human error, and reducing burden on operators. These types of systems have been very successful in other industries, such as aviation and process plants.

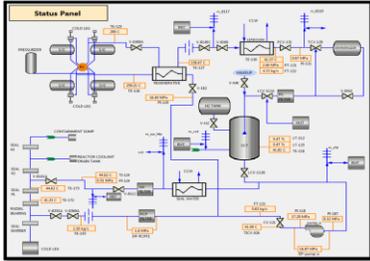


INL is partnering with Argonne National Laboratory under the DOE Nuclear Energy Enabling Technologies Program to develop a prototype of a COSS that can assist operators in detecting and

managing plant transients and faults. The initial prototype will be demonstrated in the HSSL for selected plant faults.

Plant Fault Detection and Diagnostics

(Wednesday, August 12, 1415)



In support of the COSS development work, a novel approach is being taken in plant fault detection and diagnostics, using what are known as “confluence equations” rather than complicated physics models of plant systems which would be cost-prohibitive to develop and maintain. Confluence equations can be written with no more than knowledge of the Piping and Instrument Diagram (PID) of the systems. The sensed process variable values and the confluence equations are then used to determine through an automated reasoning process a mutually

consistent plant state. The reasoning process is transparent and familiar to the operator as it is very nearly the same qualitative reasoning process through which he would make a fault diagnosis, given sufficient time and access to instrument readings.

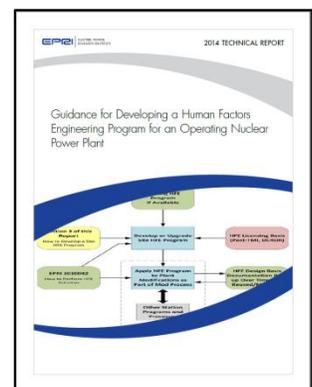
This approach holds promise as an affordable means to augment plant monitoring and reduce operator burden. It can serve as a confirmation to the existing control room protocols for diagnosing an abnormal or emergency condition. It can quickly distinguish between an actual event and a sensor failure. And it can detect and validate a fault well-below typical alarm set points, providing more time for operators to arrest the condition. A demonstration of this technology will be provided.

EPRI Human Factors Guidelines

(Wednesday, August 12, 1500)

Appropriate application of human factors engineering (HFE) principles and guidance in the design of plant modifications has become more important as operating plants modernize their instrumentation and control (I&C) systems, control rooms and human-system interfaces (HSIs). In addition, HFE is being applied extensively in the designs for new plants; and utilities will ultimately have responsibility for maintaining the HFE design basis for the plants over their lifetime once they become operational. Application of HFE principles and methods is required in order to maintain plant safety. It is also important to maintaining plant operability and reliability as modifications are made over time and it applies to all systems, not just safety systems. HFE is good engineering practice and it should be an integral part of modification design, implementation, operation and maintenance.

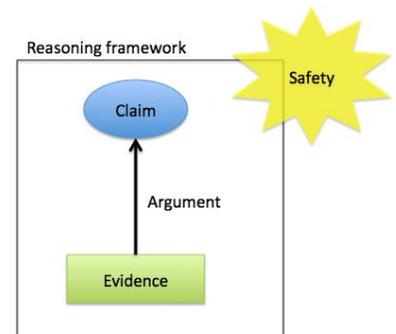
The report “Guidance for Developing a Human Factors Engineering Program for an Operating Nuclear Power Plant”. EPRI 3002002770 was published Dec. 2014. The report includes two case studies, one on the fleet-wide control room modernization at Duke and the second for Comanche Peak. The Duke case study includes activities in the



related LWR pilot project. A second report that will be published in Dec. 2015, “Human Factors Guidance for Control Room and Digital Human-System Interface Design and Modification: Guidelines for Planning, Specification, Design, Licensing, Implementation, Training, Operation, and Maintenance” EPRI 3002004310 is an expansion and update of the same named report EPRI 1010042 that was published in Dec. 2005.

Halden Safety Case –Safety Demonstration of Safety-Critical I&C Applications (Wednesday, August 12, 1600)

For the safety demonstration of Digital Instrumentation & Control (DI&C) systems in nuclear power plants, the Halden Reactor Project (HRP) has identified several challenges in collaboration with nuclear regulators from several countries. The most relevant challenges for the HRP research are reasoning about the satisfaction of the safety property, defining the boundary of a safety-critical system, starting the development of the safety demonstration already in the concept phase of the development life cycle, content of the safety demonstration plan, and organizing the safety demonstration.



A first case study has started with addressing the challenge of reasoning about the satisfaction of the safety property. An existing submittal to the US NRC is used as a case, where the reasoning about the independence of the reactor protection system is investigated. Our current findings show the difficulty of expressing arguments about safety in an explicit manner. Here the pieces of evidence and reasoning about them should be connected together into a logical argument about sufficient safety of the system. A claim-evidence-based reasoning framework is being explored. The reasoning framework will support the authors (utility and vendor) and the reviewers (regulator) to overcome many of the difficulties faced in safety demonstration and justification process.

NEI Activities for Digital I&C Regulatory Changes (Thursday, August 13, 0800)

There is considerable regulatory activity under way at this time for digital I&C systems. These include proposed rulemaking for safety systems [10 CFR 50.55 a(h)], treatment of embedded digital components, changes to regulatory guidance for digital 10 CFR 50.59, and changes to ISG-06 for digital modification reviews. NEI has formed a new Working Group to address these issues with the NRC. NEI will present an overview of these issues and the approach being taken to address them.



Embedded Digital Components – New DOE Project

(Thursday, August 13, 0900)

Existing nuclear power facilities worldwide are facing age-related obsolescence and maintainability issues including issues concerning installed safety-related I&C systems and embedded components. This is due in large part to the relatively short lifecycle relative to fluid and mechanical components, such as



heat exchanges and pumps, and the engineered nature of the components, which depend on lower tier manufactured components for continued repair and refurbishment. These factors have led to the introduction of safety-related digital I&C replacement systems and components that use general purpose programmable logic. This has resulted in an increase in system and component complexity leading to a more complicated reliability, functional design, and failure analyses, particularly Common Cause Failure (CCF) identification and mitigation. The resulting inability to effectively analyze

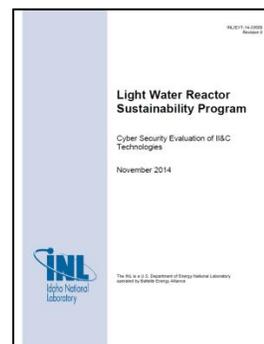
these new technologies and provide technically sound safety evaluations has caused delays in updating aging systems resulting in unknown but potentially negative consequences.

EPRI has been awarded a DOE-sponsored project to address the issue and will discuss the project approach, which would be to use embedded digital components that can be demonstrated to contain no additional capabilities or characteristics other than that specially required for the functional objectives. These “inflexible” devices would have no hidden fabrication or infrastructure to complicate straight forward analysis and validation. While more expensive, they would allow a simple, deterministic validation resulting in dramatically lower total installed cost and a reduction in technical and schedule risk

Cyber Security Evaluation of the Pilot Project Technologies

(Thursday, August 13, 0945)

Cyber security is a common concern among nuclear utilities and other nuclear industry stakeholders regarding the digital technologies that are being developed under the II&C Pathway. To address this concern, a cyber security control assessment was conducted for these technologies. The evaluation was conducted by a cyber security team with expertise in nuclear utility cyber security programs and experience in conducting these evaluations. The evaluation was based on NEI 08-09, which is the industry’s standard program for cyber security programs and evaluations, accepted by the Nuclear Regulatory Commission (NRC) in meeting the requirements found in 10 CFR 73.54. The results of this study will be presented, providing the assessment logic for each of the classes of technologies being developed in the II&C Pathway.



EPRI Technology Projects
(Thursday, August 13, 1030)

The Electric Power Research Institute (EPRI) Instrumentation & Controls program EPRI’s Instrumentation and Control (I&C) Program provides the technical bases to apply advanced I&C and information technologies so existing and new nuclear plants can tap into functionality and capabilities underutilized to date in the nuclear sector. These capabilities enable nuclear plants to maintain safe operation while managing I&C obsolescence with higher equipment reliability and personnel productivity. During this session, EPRI will provide brief synopses of existing and ongoing research that will not be discussed elsewhere during the meeting. Topics include:

- Digital design guide and training modules for digital upgrades
- Radiation monitoring obsolescence guide
- I&C for beyond design basis & severe accidents

Feedback from the Utility Working Group on Technology Needs and Requirements
(Thursday, August 13, 1130)



The II&C Pathway places great value on the input of the Utility Working Group to represent the needs and requirements of nuclear utilities in developing advanced digital technologies. The represented utilities and industry organizations provide a direct understanding of the improvement opportunities and the practical constraints in applying these technologies in a manner that fits well with the nuclear safety culture. This ensures that the technologies can truly contribute to the long-term sustainability of the operating fleet, addressing potential life-limiting technical issues while improving efficiency and cost-effectiveness in ongoing operations.

This segment of the meeting is a time for the participants to reflect on the technologies that have been presented, provide feedback on the direction of these projects, and provide current perspectives on the needs and opportunities facing nuclear utilities.

The II&C Technical Program Plan (TPP) is currently undergoing an annual update to reflect the project plans for the upcoming and out years. Some new projects will be started. This will be an opportunity for the Utility Working Group to see the current draft FY 2016 TPP and provide input on the proposed project objectives and deliverables. It will highlight opportunities for utilities to become more involved in the development activities, contributing to the formulation of the new technologies and serving as host sites for technology studies.



Tour of the INL Site and Other Facilities (Optional)
(Thursday, August 13, 1300)

INL is part of the U.S. Department of Energy's complex of national laboratories. The laboratory performs work in each of the strategic goal areas of DOE: energy, national security, science and environment. INL is the nation's leading center for nuclear energy research and development. INL is the nation's lead laboratory for nuclear energy research, development, demonstration and deployment and we are engaged in the mission of ensuring the nation's energy security with safe, competitive and sustainable energy systems and unique national and homeland security capabilities.

The Advanced Test Reactor Complex lies within INL's 890 square-mile area in a remote part of the Idaho desert. The complex is 47 miles west of Idaho Falls. The complex includes several other advanced nuclear energy capabilities including: the Advanced Test Reactor-Critical Facility; Test Train Assembly Facility; Hot Cell Facility; Radiation Measurements Laboratory; Radiochemistry Laboratory; and the Safety and Tritium Applied Research Facility.



An optional tour of the INL site will be offered to the meeting participants. We will travel by bus to the site to walk through several of the facilities, and upon returning to the Idaho Falls complex, will tour the Computer-Assisted Virtual Environment (CAVE), a virtual reality laboratory.