NPIC HMIT 2015

www.npic-hmit2015.org

CONFERENCE PROGRAM

ANS Conference

9th International Topical Meeting on Nuclear Plant Instrumentation, Control & Human–Machine Interface Technologies (NPIC & HMIT 2015)

WESTIN CHARLOTTE HOTEL • CHARLOTTE, N.C. • FEBRUARY 23–26, 2015

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Welcome from the General Chair

H.M. Hashemian, Ph.D.

It is my great pleasure to serve as the General Chair for the 9th International Conference on Nuclear Plant Instrumentation, Control & Human–Machine Interface Technologies (NPIC & HMIT 2015), held this week at The Westin Charlotte Hotel in Charlotte, North Carolina, USA.

Sponsored by the Human Factors, Instrumentation and Controls Division (HFICD) this topical meeting of ANS is the premier forum for nuclear instrumentation and control (I&C) and human factors engineering professionals to meet with leaders in industry and academia, gauge the state of the technology, exchange information, and discuss future directions.

We anticipate a spectacular turnout for this NPIC & HMIT Conference, with nearly 400 attendees from industry, government, and academia.

We have an exciting opening plenary, featuring keynote addresses from distinguished high-level government officials, and executives of nuclear utilities and vendor organizations.

On behalf of everyone involved with the planning and execution of the NPIC & HMIT 2015, I thank you for your participation in what hopes to be a very successful NPIC & HMIT conference.

Sincerely,

H.M. Hashemian

H.M. "Hash" Hashemian
General Chair, NPIC & HMIT 2015

Sincere thanks and appreciation to our Platinum sponsors for their very generous support of the NPIC & HMIT 2015 Conference

Mr. Clayton Scott
Senior Vice President & Chief Nuclear Officer
Schneider Electric

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International Electrotechnical Commission (IEC)
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Institute of Electrical and Electronics Engineers (IEEE)
IEEE Power & Energy Society
Canadian Nuclear Society (CNS)
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MEDIA

Nuclear Plant Journal
Nuclear Engineering International (UK)

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General Meeting Information

Plenary and Special Session Information

NPIC & HMIT 2015 Keynote and Plenary Speakers

Dr. Peter Lyons
Assistant Secretary
U.S. Department of Energy–NE

Commissioner William Ostendorff
U.S. Nuclear Regulatory Commission

Mr. Stephen Kuczynski
Chairman, President & CEO
Southern Nuclear

Dr. Thom Mason
Director
Oak Ridge National Laboratory

Mr. Mano Nazar
President & CNO
NextEra Energy

Mr. Preston Gillespie
SVP, Nuclear Operations
Duke Energy

Mr. Amir Shahkarami
President & CEO
CASe Global Partners, Inc.

Mr. Gary Mignogna
President & CEO
AREVA

Mr. David Howell
SVP, Automation & Field Systems
Westinghouse

Mr. John Tappert
Director, Division of Engineering–
Office of New Reactors
U.S. Nuclear Regulatory Commission

Mr. David Czufin
SVP, Engineering & Technical Services
TVA

Dr. Michaele Brady Raap
President
American Nuclear Society

Mr. Kenneth Canavan
Director, Plant Technology–Nuclear Sector
EPRI

Mr. Jeffrey Merrifield
Partner
Pillsbury Winthrop Shaw Pittman

NPIC & HMIT 2015 Conference Management

GENERAL CHAIR
H.M. Hashemian, PhD
President and CEO, Analysis and Measurement Services Corporation

TECHNICAL PROGRAM CHAIR
Sacit M. Cetiner, PhD
R&D Scientist, Oak Ridge National Laboratory

Conference Administration and Technical Staff

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TECHNICAL STAFF

Brent Shumaker

Nikki Hashemian

Christopher Key

Chad Kiger

Alex Hashemian

Ryan O'Hagan

Daniel Tobin

Training Course

Fundamentals of Nuclear Power Plant Instrumentation

February 21–22, 2015 ***(on weekend preceding the conference)***
Westin Charlotte Hotel, Charlotte, North Carolina
Providence Ballroom I

Course Overview

The course will cover the basics of critical temperature, pressure, level, flow, and neutron flux measurements in nuclear power plants and how these measurements are used for the control of the plant and assurance of its safety. Furthermore, new methods for online calibration monitoring and in-situ response time testing of process instrumentation systems will be presented. This will be followed by a review of testing and troubleshooting techniques for low voltage and I&C cables, cable insulation aging management for plant life extension, predictive maintenance and equipment condition monitoring using wireless technologies, electromagnetic compatibility (EMC) testing in support of digital I&C upgrades, use of wireless devices for voice and data communication, and methods for reactor diagnostics, prognostics, and residual life estimation of critical components.

Instructors

Based on over 35 years of experience from testing of instrumentation systems in essentially all the U.S. nuclear power plants and many in Europe and Asia, Dr. H.M. Hashemian and his staff from Analysis and Measurement Services Corporation (AMS) will teach a practical training course on the basics of nuclear power plant instrumentation. The course will include actual demonstrations of nuclear-grade instrumentation and testing technologies to verify the performance of these instrumentations.

COURSE SCHEDULE

Saturday, February 21, 2015
1:30 to 5:30 p.m.

1:30–2:00 p.m.	Introduction
2:00–3:30 p.m.	Fundamentals of Instrumentation
3:30–4:00 p.m.	Break
4:00–5:30 p.m.	Hands-on I&C Training

Sunday, February 22, 2015
9:30 a.m. to 5:30 p.m.

9:30 a.m.–12:00 p.m.	Online Monitoring, Diagnostics, and Prognostics
12:00–1:00 p.m.	Working Lunch
1:00–3:00 p.m.	I&C Regulation and Standards
3:00–3:15 p.m.	Break
3:15–4:15 p.m.	EMC Qualification of Digital I&C
4:15–5:30 p.m.	Wireless Technology for Voice and Data Communication

KEY COURSE TOPICS

- Fundamentals of Instrumentation
- Online Calibration Monitoring of Process Instrumentation
- Typical Instrumentation Problems in NPPs
- Cable Condition Monitoring and Aging Management
- Sensor Response Time Testing
- Diagnostics and Prognostics
- EMI / RFI Issues and EMC Testing
- Wireless Technology Implementation in NPPs

CERTIFICATE OF ATTENDANCE

A certificate of attendance for the training course will be presented at the conclusion of the course.

NOTE:

Additional tickets are available for purchase for the Sunday Opening Reception, and the Tuesday NASCAR Hall of Fame Banquet.

NOTICE FOR SPEAKERS:

All Speakers and Session Chairs must sign in at the ANS Registration Desk during registration hours.

EXHIBIT HOURS:

Sunday,	6:00 p.m. - 8:30 p.m.
Monday,	7:00 a.m. - 7:00 p.m.
Tuesday,	7:00 a.m. - 5:00 p.m.
Wednesday,	7:00 a.m. - 3:00 p.m.

MEETING REGISTRATION

The ANS Registration Desk is open Saturday, February 21, 2015 – Thursday, February 26, 2015. Meeting registration is required for all attendees and speakers. Badges are required for admission to all plenaries, technical sessions and events.

REGISTRATION HOURS

Saturday, February 21	• 11:00 a.m. – 5:30 p.m.
Sunday, February 22	• 8:00 a.m. – 5:00 p.m.
Monday, February 23	• 7:00 a.m. – 7:00 p.m.
Tuesday, February 24	• 7:00 a.m. – 6:00 p.m.
Wednesday, February 25	• 7:00 a.m. – 5:00 p.m.
Thursday, February 26	• 7:00 a.m. – 5:00 p.m.

SPECIAL EVENTS

Opening Reception • Sunday, February 22, 2015 • 6:00 –8:30 p.m. • Grand Ballroom ABC
One ticket to the Opening Reception is included in the full meeting registration fee. Additional tickets can be purchased at the ANS Registration Desk for $65.00.

NASCAR Hall of Fame Banquet • Tuesday, February 24, 2015 • 6:30–10:00 p.m.
Located at 400 East Martin Luther King, Charlotte, N.C., the 150,000-square-foot NASCAR Hall of Fame is an interactive, entertainment attraction honoring the history and heritage of NASCAR. The high-tech venue, designed to educate and entertain race fans and non-fans alike, includes artifacts, interactive exhibits, and a 278-person state-of-the-art theater. Also on the property is Buffalo Wild Wings restaurant and the NASCAR Hall of Fame Gear Shop.

The goal of the facility is to honor NASCAR icons and create an enduring tribute to the drivers, crew members, team owners and others that have impacted the sport in the past, present and future.

Enjoy an adventure at the NASCAR Hall of Fame. First test your driving skills at the iRacing simulators with some serious competition. The simulator tracks are laser scanned replicas and the cars have all the setup and feel as their real world counterparts. Then, stroll through the 40,000 square foot exhibit space showcasing the history and heritage of the sport. For more information visit: http://www.nascarhall.com/

The evening includes live entertainment, cocktails, appetizers and dinner. One ticket to the NASCAR Hall of Fame is included with the full meeting registration. Additional tickets can be purchased at the ANS Registration Desk for $95.00 each.

Saturday and Sunday, February 21-22 Schedule at a Glance		Location
11:00 a.m.-5:30 p.m.	**Registration**	Promenade
1:30-2:00 p.m.	**Training Course Welcome and Introduction**	Providence Ballroom I
2:00-3:30 p.m.	Fundamentals of Process Instrumentation	Providence Ballroom I
4:00-5:30 p.m.	Hands-on I&C Training	Providence Ballroom I
8:00 a.m.-5:00 p.m.	**Registration**	Promenade
9:30 a.m.-12:00 p.m.	Online Monitoring, Diagnostics, and Prognostics	Providence Ballroom I
12:00-1:00 p.m.	Working Lunch	Providence Ballroom I
1:00-3:00 p.m.	I&C Regulation and Standards	Providence Ballroom I
3:15-4:15 p.m.	EMC Qualification of Digital I&C	Providence Ballroom I
4:15-5:30 p.m.	Wireless Technology for Voice and Data Communication	Providence Ballroom I
6:00-8:30 p.m.	**Opening Reception in the Exhibit Hall**	Grand Ballroom ABC

Monday, February 23 Schedule at a Glance		Location
7:00 a.m.-7:00 p.m.	**Registration**	Promenade
7:00 a.m.-7:00 p.m.	**Exhibit**	Grand Ballroom ABC
8:00 a.m.-12:00 p.m.	**Opening Plenary Session—I**	Grand Ballroom D
1:00-5:30 p.m.	**Technical Sessions**	
	• Ongoing I&C Regulatory Requirements and Guidance Development–Panel–**Dedicated to the Memory of Jerry Voss**	Providence Ballroom I
	• NPIC.1-Online Condition Monitoring of Nuclear Plant Structures, Systems and Components—I	Providence Ballroom II
	• NPIC.2-Field Programmable Gate Arrays for Digital I&C Applications	Providence Ballroom III
	• NPIC.4-SMR Instrumentation and Controls	Harris
	• HMIT.2-Computerized Procedure Systems	Sharon
	• HMIT.1-HFE Standards and Guidelines Update	Independence
	• NPIC.6-Research Reactor I&C	Trade
	• U.S. Department of Energy Advanced Sensors and Instrumentation Program	Tryon
	• NPIC.6-General I&C Systems	Queens
5:30-6:30 p.m.	**General Chair's Special Session**	Providence Ballroom I

Tuesday, February 24 Schedule at a Glance		Location
7:00 a.m.-6:00 p.m.	**Registration**	Promenade
7:00 a.m.-5:00 p.m.	**Exhibit**	Grand Ballroom ABC
8:00-10:00 a.m.	**Plenary Session—II**	Grand Ballroom D
10:30 a.m.-12:10 p.m.	**Technical Sessions**	
	• NPIC.5-I&C Regulations, Standards and Guidelines—I	Providence Ballroom I
	• NPIC.1-Online Condition Monitoring of Nuclear Plant Structures, Systems and Component—II	Providence Ballroom II

Tuesday, February 24 Schedule at a Glance (Cont'd)		Location
	• NPIC.2-I&C Modernization Experience—I	Providence Ballroom III
	• HMIT.2-Hybrid Control Rooms	Independence
	• Preliminary Report on the NEA/CSNI Workshop on Establishing Reasonable Confidence in the Human Factors Validation of Main Control Room Systems of Nuclear Power Plants–Panel	Tryon
	• NPIC.6-In-Pile Instrumentation	Trade
	• NPIC.3-U.S. Department of Energy Light Water Reactor Sustainability Program	Harris
1:00-5:00 p.m.	**Technical Sessions**	
	• NPIC.5-I&C Regulations, Standards and Guidelines—II	Providence Ballroom I
	• NPIC.1-Advances in Monitoring, Diagnostics and Prognostics Technologies—I	Providence Ballroom II
	• NPIC.2-I&C Modernization Experience—II	Providence Ballroom III
	• NPIC.4-Application of Digital Control Systems	Harris
	• HMIT.2-Control Room Modernization Experience	Sharon
	• HMIT.2-Control Rooms for Small Modular Reactors and Hybrid Energy Systems	Queens
	• HMIT.1-HFE Verification and Validation	Independence
	• NPIC.3-Instrumentation for Advanced Reactors	Tryon
	• Digital I&C Challenges for New Reactors–Panel	Grand Ballroom D
	• Next-Generation Simulator Technology–Panel	Trade
6:30-10:00 p.m.	**NASCAR Hall of Fame Banquet and Awards Ceremony**	

Wednesday, February 25 Schedule at a Glance		Location
7:00 a.m.-5:00 p.m.	**Registration**	Promenade
7:00 a.m.-3:00 p.m.	**Exhibit**	Grand Ballroom ABC
8:00 -10:00 a.m.	**Plenary Session—III**	Grand Ballroom D
10:30 a.m.-12:10 p.m.	**Technical Sessions**	
	• NPIC.5-I&C Regulations, Standards and Guidelines—III	Providence Ballroom I
	• NPIC.1-Advances in Monitoring, Diagnostics and Prognostics Technologies—II	Providence Ballroom II
	• NPIC.2-I&C Modernization Experience—III	Providence Ballroom III
	• Meet Your Human Factors Points of Contact–Round Table Session	Harris
	• HMIT.2-Innovative Solutions to Alarm Overload	Sharon
	• HMIT.3-Advances in Human-Automation Collaboration	Independence
	• NPIC.6-General Topics in Instrumentation and Controls—I	Trade
	• NPIC.5-EMC/EMI	Tryon

Wednesday, February 25 Schedule at a Glance (Cont'd)		Location
1:00-5:00 p.m.	**Technical Sessions**	
	• HMIT.1-Human Factors Lessons Learned from Fukushima Accident	Independence
	• NPIC.1-Advances in Monitoring, Diagnostics and Prognostics Technologies—III	Providence Ballroom II
	• NPIC.4-Digital System Reliability	Harris
	• HMIT.3-Use of Simulation for Human Factors Engineering	Sharon
	• NPIC.3-Wireless Technologies for Nuclear Systems	Tryon
	• NPIC.3-R&D on Nuclear Instrumentation and Control	Queens
	• NPIC.6-General Topics in Instrumentation and Control—II	Trade
	• NPIC.5-Hazard and Failure-Mode Analysis–Panel	Providence Ballroom I
	• Effectively Using Cyber Threat Intelligence and Lessons Learned to Aid in Building the Nuclear Facility Emergency Preparedness Plan–Panel	Providence Ballroom III

Thursday, February 26 Schedule at a Glance		Location
7:00 a.m.-5:00 p.m.	**Registration**	Promenade
8:00 a.m.-12:00 p.m.	**Technical Sessions**	
	• NPIC.5-Safety-Related System Qualification and V&V	Providence Ballroom I
	• NPIC.1-Cable Aging and Cable Condition Monitoring	Providence Ballroom II
	• NPIC.2-Cyber Security Issues Related to Digital I&C Systems—I	Providence Ballroom III
	• NPIC.4-Use of Simulation for Design, Engineering, and Maintenance	Harris
	• HMIT.3-Advances in HFE Design and Analysis Tools	Queens
	• HMIT.3-Computerized Operator Decision and Support Systems	Sharon
	• HMIT.1-Human Performance Assessment	Independence
	• NPIC.6-General Topics in Instrumentation and Control—III	Trade
	• NPIC.3-I&C Lessons Learned from Fukushima—I	Tryon
1:00-5:00 p.m.	**Technical Sessions**	
	• NPIC.5-Modeling Digital I&C Systems in PRA PSA	Providence Ballroom I
	• NPIC.1-Cable Aging Management	Providence Ballroom II
	• NPIC.2-Cyber Security Issues Related to Digital I&C Systems—II	Providence Ballroom III
	• NPIC.4-Requirements Management for Digital I&C System Life Cycle	Harris
	• HMIT.3-Visualization	Queens
	• NPIC.6-General Topics in Instrumentation and Control—IV	Trade
	• HMIT.2-Group-View Wall Panels	Sharon
	• NPIC.3-I&C Lessons Learned from Fukushima—II	Tryon

Continental Breakfast
Grand Ballroom ABC, 7:00 to 8:00 a.m.

Plenary Session—I

Grand Ballroom D, 8:00 a.m. - 12:00 p.m.

Introduction from the General Chairman, Dr. H.M. Hashemian & Conference Inauguration with Mikey Brady Raap, *ANS President*

Speakers:

- Mr. Stephen Kuczynski, *Chairman, President & CEO, Southern Nuclear*–Progress Report on Vogtle 3 and 4 and Its Unique Technical Issues
- Mr. David Howell, *SVP-Automation & Field Services, Westinghouse*–Modernization of Nuclear Plant I&C = Improved Nuclear Safety
- Mr. Mano Nazar, *President and Chief Nuclear Officer, NextEra*–Economics of Nuclear Power in Regulated and Merchant Markets
- Dr. Thom Mason, Director, *Oak Ridge National Laboratory*–The Role of the Department of Energy National Laboratories in Technology Development
- Mr. Gary Mignogna, *President & CEO, Areva Inc. North America*–Digital Upgrade, and Challenges

Lunch
Grand Ballroom ABC, 12:00 – 1:00 p.m.

Ongoing I&C Regulatory Requirements and Guidance Development–Panel–Dedicated to the Memory of Jerry Voss

Chair: Terry Jackson, *(NRC)*

Providence Ballroom I, 1:00 - 5:30 p.m.

1:00 p.m.

Panelists:

- Ian Jung, I&C Branch Chief, Office of New Reactors, *USNRC*
- John Thorp, I&C Branch Chief, Office of Nuclear Reactor Regulation, *USNRC*
- Warren Odess-Gillett, Fellow Engineer, *Westinghouse Electric Corp.*
- James Flowers, Engineering Lead, *Southern Nuclear*

As digital instrumentation and control (I&C) designs continue to evolve and lessons are learned, both nationally and internationally, there is an impetus to update regulations and guidance to meet current and future needs. The panelists will discuss on-going activities to update existing digital I&C requirements and guidance and address the motivators behind these changes. In addition, the panelists will also discuss their viewpoints on any future regulatory framework changes that may be necessary. The audience is encouraged during the question and answer period to provide their insights on current and future I&C regulatory framework changes.

NPIC.1-Online Condition Monitoring of Nuclear Plant Structures, Systems and Components—I

Chairs: Clayton Scott *(Schneider Electric),* Vivek Agarwal *(INL)*

Providence Ballroom II, 1:00 - 5:30 p.m.

1:00 p.m.

Optimization of Inspection Strategy and Status Monitoring for Standby Equipment Availability Enhancement, Sun Min Shin, Hyun Gook Kang *(KAIST)*

1:25 p.m.

On-Line Performance Monitoring; Then and Now, Joseph M. Ashcraft *(NRC)*

1:50 p.m.

MSET-Based Abnormal Condition Monitoring Technology of Nuclear Power Plant, Yingjie Sun, Minjun Peng *(Harbin Eng Univ),* Fan Li *(Altran Solutions)*

2:15 p.m.

Evaluation of a Consumer Electronics-Based Data Acquisition System for Equipment Monitoring, Randall Wetherington, Blake Van Hoy, Larry Phillips, Brian Damiano *(ORNL),* Belle R. Upadhyaya *(Univ of Tennessee)*

2:40 p.m.

On-Line Monitoring and Diagnostics for Rod Control Systems in Nuclear Power Plants, S. D. Caylor, J. B. McConkey, G. W. Morton, H. M. Hashemian *(AMS)*

3:05 p.m.

Online Monitoring of Control Element Drive Mechanism Systems in Pressurized Water Reactors, S. D. Caylor, G. W. Morton, D. E. McCarter, H. M. Hashemian *(AMS),* C. M. Fox, J. R. Gates *(Palo Verde Nuclear Generating Station)*

3:30 p.m.

Integrating Predictive Asset Monitoring into Nuclear Operations and Maintenance Practices to Increase Equipment Reliability, Sean Gregerson *(InStep Software)*

3:55 p.m.

NPP New-Build Technology in Support of Retrofit Process and Condition Monitoring Applications, Vaughn M. Thomas, Thomas J. Spears *(Westinghouse)*

4:20 p.m.

Implementation of On-Line Monitoring to Optimize I&C Maintenance: A Case Study, R. D. O'Hagan, H. M. Hashemian, B. D. Shumaker, E. T. Riggsbee *(AMS)*

NPIC.2-Field Programmable Gate Arrays for Digital I&C Applications

Chairs: Steve Arndt *(NRC),* Oszvald Glockler *(SunPort)*

Providence Ballroom III, 1:00 - 5:30 p.m.

1:00 p.m.
Thoughts on the Technical Basis for Hazard Analysis of FPGA-Based Safety Systems, Bernard F. Dittman *(NRC)*

1:25 p.m.
Design Processes for FPGA Platform and System Application, Joseph T. Root, Stephen G. Seaman *(Westinghouse)*

1:50 p.m.
FPGA-Based I&C Systems: Unraveling Myths from Reality, Alexander-John Wigg, Ludovic Pietre-Cambacedes *(EdF)*

2:15 p.m.
Technical Guidance for the Review of Field Programmable Gate Arrays in the Nuclear Power Industry, Steven A. Arndt, Bernard F. Dittman *(NRC)*

2:40 p.m.
FPGA Platform-Based NPP I&C Systems: Case Study of Diversity Assessment and Selection, Vyacheslav Kharchenko, Eugene Brezhnev *(Centre for Safety Infrastructure-Oriented Research and Analysis),* Vladimir Sklyar *(Research and Production Corporation Radiy),* Vyacheslav Duzhyi *(National Aerospace Univ KhAI)*

3:05 p.m.
FPGA Implementations in Nuclear Digital I&C Applications, Allen Hsu, Ivan Chow, Steve Yang *(Doosan HF Controls)*

3:30 p.m.
FPGA-Based I&C Applications in NPP's Modernization Projects: Case Study, Anton Andrashov, Ievgenii S. Bakhmach, Volodymyr V. Sklyar *(Radiy Research & Production Corp),* Andriy A. Kovalenko *(Centre for Safety Infrastructure-Oriented Research and Analysis)*

3:55 p.m.
The Design and Development of an FPGA-Based Reactor Protection System, Zeng Hai *(SNPAS),* Irene Siedlarczyk, Sean Smith *(Lockheed Martin)*

4:20 p.m.
Assessing the Effectiveness of Self-Monitoring and Fault-Tolerance in FPGA Designs, Nguyen Thuy *(EdF R&D)*

NPIC.4-SMR Instrumentation and Controls

Chairs: Ian Jung *(NRC),* Belle Upadhyaya *(Univ of Tennessee)*

Harris, 1:00 - 5:30 p.m.

1:00 p.m.
Instrumentation and Control Technology Needs for Advanced Small Modular Reactors, Richard T. Wood *(ORNL)*

1:25 p.m.
TRANSFORM: Next Generation End-to-End Simulation Toolset for Control Studies, Sacit M. Cetiner, Richard E. Hale, David L. Fugate, A. Lou Qualls *(ORNL)*

1:50 p.m.
Functional Description and Demonstration of a Supervisory Control System for Advanced Small Modular Reactors, Sacit Cetiner, David Fugate, George F. Flanagan, Roger A. Kisner, Michael D. Muhlheim, Richard T. Wood *(ORNL)*

2:15 p.m.
Evaluation of I&C Design for SMRs, E. T. Riggsbee, C. M. Ritchey, A. H. Hashemian, D. A. Tobin, T. A. Toll *(AMS)*

2:40 p.m.
First Principles Model of a Simulation Flow Loop in Support of On-line Monitoring Implementation in Next Generation Nuclear Power Plants, T. C. Thomasson B. D. Shumaker, H. M. Hashemian *(AMS),* J. R. Kapernick, B. R. Upadhyaya, J. W. Hines, M. Keyhani *(Univ of Tennessee)*

3:05 p.m.
Data-Based Modeling for Monitoring and Fault Detection in Small Modular Reactors, Victor B. Lollar, Belle R. Upadhyaya, J. Wesley Hines, Jamie B. Coble, Dane DeWet *(Univ of Tennessee)*

3:30 p.m.
The Instrumentation and Control System for Small Modular Reactor ACP100, Chen Zhi, Song Dan-rong, Liao Long-tao,You Kai *(Nuclear Power Inst of China)*

3:55 p.m.
Fluxgate Magnetometer Based Control Rod Position Indication for Small Modular Reactors, Joseph M. Maurio, Charlie McCarthy *(Northrop Grumman),* Marie Ann Lawson *(HII Newport News Shipbuilding)*

4:20 p.m.
Integrated Protection System Architecture for Small Modular Reactors, Jason Pottorf *(NuScale Power, LLC),* Gregg Clarkson, Rufino Ayala, Scott Patterson *(Rock Creek Innovations LLC)*

HMIT.2-Computerized Procedure Systems

Chairs: Poong Hyun Seong *(KAIST),* Johanna Oxstrand *(INL)*

Sharon, 1:00 - 5:30 p.m.

1:00 p.m.
Handheld Computerized Procedure Systems—Challenges and Solutions, Svein Nilsen *(OECD Halden Reactor Project),* invited

1:25 p.m.
Formal Validation of Transversal in APR1400 Computerized Procedure System, Yeonsub Jung *(KHNP)*

1:50 p.m.
Computer-Based Procedures for Nuclear Power Plant Field Workers: Design Implications Based on Three Evaluation Studies, Katya Le Blanc, Johanna Oxstrand, Aaron Bly *(INL)*

2:15 p.m.
Smooth Transition to Computer Based Procedures, Mateo Ramos, Julio Méndez, Javier Medrano *(Tecnatom)*

2:40 p.m.
Standardized Procedure Content and Data Structure Based on Human Factors Requirements for Computer-Based Procedures, Aaron Bly, Johanna Oxstrand, Katya Le Blanc *(INL)*

3:05 p.m.
A Task Analysis for Human Reliability Analysis on a Computer-Based MMIS, Wondea Jung, Yochan Kim, Seung Jun Lee *(KAERI)*

3:30 p.m.
Usability of Paper-Based Industrial Operating Procedures, Mario Iannuzzi, Greg A. Jamieson *(Univ of Toronto)*

3:55 p.m.
Why Do Technically Correct Procedures and Work Instructions Fail?, Stephen C. McCord *(Procedure Solutions Management, LLC)*

HMIT.1-HFE Standards and Guidelines Update

Chairs: John O'Hara *(BNL),* Jacques Hugo *(INL)*

Independence, 1:00 - 5:30 p.m.

1:00 p.m.
Regulatory Compliance in HMIT Modernization in Legacy USA Nuclear Power Plants, Joseph DeBor *(DeBor and Assoc),* Michael Donovan *(Nuclear Industry Consultant)*

1:25 p.m.
Revision of Human Factors Engineering Guidance for Conducting Safety Reviews of Nuclear Power Plant Control Rooms: A Status Update and Approach, Stephen Fleger *(NRC),* John O'Hara *(BNL),* invited

1:50 p.m.
Human Factors Engineering Framework for Applying NUREG-0711 to Control Room Retrofits, Charles Weaver *(Pacific Science & Eng)*

2:15 p.m.
Guidance for Developing a Human Factors Engineering Program for an Operating Nuclear Power Plant, Robert Fink, Charles Killian *(CDF Services Inc.),* Lewis F. Hanes *(HFE Consultant),* Joseph Naser *(EPRI)*

2:40 p.m.
Developing a Human Factors Engineering Process for Control Room Upgrades, Leena Salo *(Fortum Power and Heat Ltd),* Jari Laarni, Paula Savioja *(VTT Technical Research Centre of Finland)*

3:05 p.m.
Human Factors Evaluation—Why, What, and When, Alice Salway *(Canadian Nucl Safety Comm)*

3:30 p.m.
The Role of Human Factors in Today's Nuclear Economy, Paris F. Stringfellow *(AREVA INC)*

NPIC.6-Research Reactor I&C

Chairs: Robert Duckworth *(ORNL),* Zane W. Bell *(ORNL)*

Trade, 1:00 - 5:30 p.m.

1:00 p.m.
IAEA Research Reactor Section IAEA Activities in the Operations and Maintenance of Research Reactors With Emphasis on Digital I&C Upgrades, Charles R. Morris *(IAEA)*

1:25 p.m.
The Annular Core Research Reactor Rod Control Modification Project, Joshua Emmer, Patrick Snouffer, Michael Black *(SNL)*

1:50 p.m.
I&C System for Critical Facility Upgrading, V. A. Fedorov, A. V. Kudryavtsev, Yu. A. Parishkin *(National Research Nuclear Univ),* V. E. Jitarev, V. M. Kachanov, A. Yu. Sergevnin *(Kurchatov Inst)*

2:15 p.m.
Engineering Justification for Thermal Stress Test Profile for Class 1E Equipment in MCR with Non-Safety HVAC System, J. Y. Park, S. K. Shin *(KAERI)*

2:40 p.m.
Research Reactors and Embedded Digital Device Issues, Eugene O. Eagle, Jr. *(NRC),* invited

3:05 p.m.
SAFARI-1 Research Reactor: Automatic Flux Controller, Gordon Ian Procter *(NECSA)*

3:30 p.m.
Implementation of Online Data Acquisition and Condition Monitoring Techniques for the TRIGA Mark II Research Reactor of the University of Pavia–Italy, Giovanni Magrotti, Andrea Salvni, Daniele Alloni, Michele Prata *(Univ of Pavia)*

3:55 p.m.
Annular Core Research Reactor (ACRR) NFMS Upgrade, Joshua Emmer *(SNL),* Bernhard Held *(Mirion)*

U.S. Department of Energy Advanced Sensors and Instrumentation Program

Chairs: Suibel Schuppner *(DOE),* Bruce Hallbert *(INL)*

Tryon, 1:00 - 5:30 p.m.

1:00 p.m.
U.S. Department of Energy Advanced Sensors and Instrumentation Research, Suibel H. Schuppner *(DOE),* Bruce Hallbert *(INL)*

1:25 p.m.
A Method for Quantifying the Dependability Attributes of Software-Based Safety Critical Instrumentation and Control Systems in Nuclear Power Plants, Carol S. Smidts, Fuqun Huang, Xiang Li, Chetan Mutha, *(Ohio State),* Edward L. Quinn *(Technology Resources),* invited

1:50 p.m.
Rad Hardening Commercial-Off-The-Shelf Microcontrollers Destined for I&C Applications in Severe Nuclear Environments, Keith E. Holbert, Lawrence T. Clark, Yitao Chen, Ian N. Zavatkay, James W. Adams *(Arizona State Univ)*

2:15 p.m.
Uncertainty Quantification Methods for Robust Online Monitoring and Recalibration Interval Extension, P. Ramuhalli, B. Konomi *(PNNL),* J. Coble *(Univ of Tennessee),* B. Shumaker *(AMS),* G. Lin *(PPNL),* H. Hashemian *(AMS)*

2:40 p.m.
Operator Support Technologies for Fault Tolerance and Resilience, R.Vilim *(ANL),* K. Thomas, R. Boring *(INL)*

3:05 p.m.
Hydrodynamic Effects on Modeling and Control of a High Temperature Active Magnetic Bearing Pump with a Canned Rotor, Alexander M. Melin, Roger A. Kisner, David L. Fugate, David E. Holcomb *(ORNL)*

3:30 p.m.
Enhanced Micro Pocket Fission Detector Evaluations, Troy Unruh, Joshua Daw, Kurt Davis, Darrell Knudson *(INL),* Joy Rempe *(Rempe and Assoc, LLC),* Michael Reichenberger, Phillip Ugorowski, Douglas McGregor *(KSU),* Jean-Francois Villard *(CEA),* invited

3:55 p.m.
Distributed Fiber Optical Sensing Beyond Temperature and Strain Measurements for Nuclear Energy, Rongzhang Chen, Tong Chen, Aidong Yan, Zsolt L. Poole, Kevin P. Chen *(Univ of Pittsburgh)*

4:20 p.m.
Design Considerations for Wireless Sensor Networks in Nuclear Power Applications, Dwight A. Clayton, Richard A. Willems *(ORNL)*

4:45 p.m.
Characterization of Common-Cause Failure Vulnerability and Mitigation in Digital Instrumentation and Control Systems, Richard T. Wood *(ORNL),* invited

NPIC.6-General I&C Systems

Chairs: Benjamin Hayes *(Univ of Toronto),* Jin Jiang *(Univ of Western Ontario)*

Queens, 1:00 - 5:30 p.m.

1:00 p.m.
Nonlinear Adaptive Coordinated Control for MHTGR-Based Nuclear Steam Supply Systems, Zhe Dong *(Tsinghua Univ)*

1:25 p.m.
Classification of Alkali-Silica Reaction Distress with Self-Powered Wireless Remote Sensing, Mohamed ElBatanouny, Marwa Abdelrahman, Paul Ziehl *(Univ of South Carolina),* Jeremiah Fasl, Carl Larosche *(Wiss Janney Elstner Assoc),* invited

1:50 p.m.
Modernization of the RBMK Fuel Assemblies Cladding Tightness, A. V. Kudryavtsev, B. E. Mokhnonozhkin, V. A. Fedorov *(National Research Nuclear Univ "MEPhI")*

2:15 p.m.
Simplification of I&C Upgrades Through the Use of Complementary Non-Digital Logic Solving System, Richard Cobley *(Lockheed Martin)*

2:40 p.m.
Shidaowan HTR Ex-Core Neutron Flux Monitoring Systems, Clark J. Artaud, Shuping Yang *(Thermo Fisher Scientific)*

3:05 p.m.
Application of Clamp-On Ultrasonic Flow Measurements in OPG, Chunlei Zhao, Vi Ton, Jin Kim *(OPG)*

3:30 p.m.
Software Design of Alpha Gamma Radioactive Nuclide Monitoring System, Xu Hongkun, Wang Ge, Mu Changli, Yin Yin, Huang Zihan, Bian Jiang, Zhang Shuo *(Beijing Research Center for Radiation Application)*

General Chair's Special Session: Tutorial on Fundamentals of Advanced Reactors

Providence Ballroom I, 5:30 - 6:30 p.m.

Speakers:

- Alex Hashemian *(AMS)*
- Daniel Tobin *(AMS)*

This is a tutorial covering the basics of advanced reactors, their design, characteristics, and current and future deployment plans. A general overview of the operation and unique aspects of each reactor type will be covered. Advanced reactors in this tutorial include gas cooled, liquid metal, molten salt, and supercritical–water cooled reactors.

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Continental Breakfast
Grand Ballroom ABC, 7:00 to 8:00 a.m.

Plenary Session—II
Grand Ballroom D, 8:00 - 10:00 a.m.

Speakers:

- The Honorable William C. Ostendorff, Commissioner, *U.S. Nuclear Regulatory Commission*–A Com missioner's Perspective on Cyber Security Regulation
- Mr. Preston Gillespie, SVP Nuclear Operations, *Duke*–Digital Applications in a Nuclear Environment
- Mr. Amir Shahkarami, President and CEO, *CASe Global Partners, Inc.*–Industry/Regulatory Digital Application and International Cyber Security
- Mr. Jeffrey Merrifield, *Pillsbury, Winthrop, Shaw, Pittman, LLP*–Perception vs. Reality – Cybersecurity Challenges in a State of Confusion

NPIC.5-I&C Regulations, Standards and Guidelines—I

Chairs: Joseph M. Ashcraft *(NRC),* Gary Johnson *(Retired)*

Providence Ballroom I, 10:30 a.m. - 12:10 p.m.

10:30 a.m.

A Vision for the Design and Licensing of Instrumentation and Control for the Future, Ian C. Jung *(NRC)*

10:55 a.m.

NRC's Small Modular Reactor Design-Specific Review Standard Chapter 7: Instrumentation and Controls, Tim Mossman, Joseph M. Ashcraft *(NRC)*

11:20 a.m.

Nuclear Power Plant Risk-Informed Surveillance Frequency Control Program Implementation With a Focus on Instrumentation and Control Systems, James K. Liming *(ABSG Consulting Inc.),* Edward (Ted) L. Quinn *(Technology Resources)*

11:45 a.m.

Diablo Canyon Power Plant Digital Process Protection System Replacement Licensing Experience Using ISG-06, Kenneth J. Schrader *(PG&E),* John W. Hefler *(ALTRAN),* Edward (Ted) L. Quinn *(Technology Resources)*

NPIC.1-Online Condition Monitoring of Nuclear Plant Structures, Systems and Components—II

Chairs: Sergiy Lebedynskyy *(Priv JSC "Manometr-Kharkiv"),* Troy Janssen *(Sargent & Lundy)*

Providence Ballroom II, 10:30 a.m. - 12:10 p.m.

10:30 a.m.

Development and Application of Loose Parts and Acoustical Structural Monitoring During Plant Startup Following Steam Generator Replacement, E. T. Riggsbee, B. D. Shumaker, H. M. Hashemian *(AMS),* C. W. Mayo *(Independent Consultant)*

10:55 a.m.

Nonlinear Adaptive Observer for Monitoring PWRs, Zhe Dong *(Tsinghua Univ)*

11:20 a.m.

Discriminating Blockage, Void and Leakage in Pressure Sensing Lines, Yang Shen, Keith E. Holbert *(Arizona State Univ)*

NPIC.2-I&C Modernization Experience—I

Chairs: John Thorp *(NRC),* Mehdi Tadjalli *(AREVA)*

Providence Ballroom III, 10:30 a.m. - 12:10 p.m.

10:30 a.m.

Diablo Canyon Power Plant Digital Process Protection System Replacement Overview, Kenneth J. Schrader *(PG&E),* John W. Hefler *(ALTRAN),* Edward (Ted) L. Quinn *(Technology Resources),* invited

10:55 a.m.

IAEA Activities in the Area of NPP I&C Engineering, Janos Eiler *(IAEA),* invited

11:20 a.m.

I&C and HMI Modernization in Operating NPP: Experience From Krško NPP, Slovenia *(NEK),* Damir Mandić *(Krško Nuclear Power Plant)*

11:45 a.m.

The Evaluation of a Digital Upgrade of Safety Instrumentation and Control Systems of the PWR Units of the Paks NPP from 15 years in Hindsight, Tamás Túri *(MVM Paks2, Ltd.)*

HMIT.2-Hybrid Control Rooms

Chairs: Greg Merrifield *(Emerson Process Management/TopWorx),* Tom Foley *(Altran)*

Independence, 10:30 a.m. - 12:10 p.m.

10:30 a.m.

Bridging the Gap: Adapting Advanced Display Technologies for Use in Hybrid Control Rooms, Håkon Jokstad *(Inst for Energy Technology),* Ronald Boring *(INL)*

10:55 a.m.

COSS in Hybrid Control Rooms: Benefits and Challenges, Mateo Ramos, Julio Méndez *(Tecnatom)*

Preliminary Report on the NEA/CSNI Workshop on Establishing Reasonable Confidence in the Human Factors Validation of Main Control Room Systems of Nuclear Power Plants–Panel

Chair: David Desaulniers *(NRC)*

Tryon, 10:30 a.m. - 12:10 p.m.

10:30

Panelists:

- Robert Hall *(REH Technology Solutions)*
- P. O. Braarud *(OECD Halden Reactor Project)*
- Emilie Roth *(Roth Cognitive Eng)*
- Gyrd Skraaning, Jr. *(OECD Halden Reactor)*
- Dina Notte *(ERGODIN)*

In February 2015, immediately preceding the 9th International Conference on Nuclear Plant Instrumentation, Control & Human-Machine Interface Technology, more than 30 professionals with expertise in the human factors validation of complex systems gathered for 3 days of brainstorming sessions to discuss how the nuclear power industry might most effectively address the technical and practical challenges of validating designs and modifications of nuclear plant control rooms. These solution-oriented discussions were focused on four challenge areas:

- Defining the scope and objectives of a control room validation,
- Establishing a rationale for selecting measures and acceptance criteria,
- Construction of validation test scenarios, the test design, and their relationship to the validation framework, and
- Analyzing the results and drawing conclusions.

A panel of experts from this workshop will report on these discussions, highlights preliminary recommendations for validation practices and future research, and solicits comment and additional input from session attendees.

NPIC.6-In-Pile Instrumentation

Chairs: Troy Unruh *(INL),* Josh Daw *(INL)*

Trade, 10:30 a.m. - 12:10 p.m.

10:30 a.m.

Monitoring and Analysis of In-Pile Phenomena in Advanced Test Reactor using Acoustic Telemetry, Vivek Agarwal, James A. Smith, James K. Jewell *(INL),* invited

10:55 a.m.

Ultrasonic Transducer Irradiation Test Results, Joshua Daw *(INL),* Pradeep Ramuhalli, Paul Keller, Robert O. Montgomery *(PNNL),* Bernhard Tittmann, Brian Reinhardt *(Penn State),* Gordon Kohse *(MIT),* Joy L. Rempe *(Rempe and Assoc, LLC),* invited

11:20 a.m.

Measurement of Diameter Changes during Irradiation Testing, K. L. Davis, D. L. Knudson *(INL),* John Crepeau *(Univ of Idaho),* S. Solstad *(Inst for Energy Technology)*

11:45 a.m.

Coolant Flow Measurement using Noise Analysis Method, S. H. Ahn, J. T. Hong, C. Y. Joung, J. B. Kim, K. H. Kim, S. H. Heo *(KAERI)*

NPIC.3- U.S. Department of Energy Light Water Reactor Sustainability Program

Chairs: Kathy McCarthy *(INL),* Bruce Hallbert *(INL)*

Harris, 10:30 a.m. - 12:10 p.m.

10:30 a.m.
The Next Step in Deployment of Computer Based Procedures for Field Workers: Insights and Results from Field Evaluations at Nuclear Power Plants, Johanna Oxstrand, Katya LeBlanc, Aaron Bly *(INL),* invited

10:55 a.m.
Computerized Emergency Operating Procedures for Control Room Shift Technical Advisor, Michael Hildebrandt, Robert McDonald *(OECD Halden Reactor Project)*

11:20 a.m.
Use of Collaborative Software to Improve Nuclear Power Plant Outage Management, Shawn St. Germain *(INL)*

11:45 a.m.
Implementation of Remaining Useful Lifetime Transformer Models in the Fleet-Wide Prognostic and Health Management Suite, Vivek Agarwal, Nancy J. Lybeck, Binh T. Pham *(INL),* Richard Rusaw *(EPRI),* Randall Bickford *(Expert Microsystems)*

Lunch
Grand Ballroom ABC, 12:00 – 1:00 p.m.

NPIC.5-I&C Regulations, Standards and Guidelines—II

Chairs: Joseph M. Ashcraft *(NRC),* Gary Johnson *(Retired)*

Providence Ballroom I, 1:00 - 5:00 p.m.

1:00 p.m.
Safety Assessment of Software Tools Used in Nuclear Safety Systems, Jim Servatius, Steve Alexander, Terry Gitnick *(ISL),* Paul Butchart *(NuScale Power),* Russell Sydnor, Yaguang Yang *(NRC)*

1:25 p.m.
Justifying Acceptable Alternatives to the Digital I&C Regulatory Guides and Standards, Norbert Carte, Steven Arndt *(NRC),* invited

1:50 p.m.
Experience and Lessons Learned in Applying I&C-Based Process Standards, C. Daniel Stiffler, Warren R. Odess-Gillett, Matthew A. Shakun *(Westinghouse)*

2:15 p.m.
The IAEA Safety Principles Applied to NPP Instrumentation and Control, Björn Wahlstrom *(Oy Bewas Ab),* Alex Duchac *(IAEA)*

2:40 p.m.
Safety Case and Implementation of the Independence Conditions for New Reactors in the Proposed 10 CFR 50.55a Rule, Deanna J. Zhang *(NRC)*

3:05 p.m.
Embedded Digital Devices in Critical Applications—Technical and Regulatory Considerations, Dinesh Taneja *(NRC)*

3:30 p.m.
EPRI Digital Design Guide, Bruce J. Geddes *(Southern Engineering Services, Inc.),* Raymond C. Torok *(EPRI)*

3:55 p.m.
Avoiding Unnecessary Functionality to Reduce Complexity in Safety Systems, Royce D. Beacom *(NRC)*

NPIC.1-Advances in Monitoring, Diagnostics and Prognostics Technologies—I

Chairs: Jamie B. Coble *(Univ of Tennessee),* Giovanni Magrotti *(Univ of Pavia)*

Providence Ballroom II, 1:00 - 5:00 p.m.

1:00 p.m.
A Bayesian Statistical Updating Method: Error Reduction in Remaining Useful Life Estimation, Alan Nam, Brien Jeffries, J. Wesley Hines, Belle Upadhyaya *(Univ of Tennessee)*

1:25 p.m.
Supervision, Diagnostics, and Optimization Based on Data Reconciliation and Regression Models, Jiri Pliska, Zdenek Machat *(OT EnergyServices a.s.)*

1:50 p.m.
Fast Flux Test Facility Experience Relevant to Advanced Reactor Enhanced Risk Monitoring, D. W. Wootan, P. Ramuhalli, G. A. Coles, E. H. Hirt, M. F. Brass *(PNNL)*

2:15 p.m.
A Fast PSO Method for Detecting Control Valve Stiction, Guangxin Zhang, Xu Wang, Weidong Zhang, Dongming Zhang *(Shanghai Nucl Eng Research Design Inst),* Lei Xie *(Zhejiang Univ)*

2:40 p.m.
On-Line Condition Monitoring of Boiling Water Reactors: A Symbolic Dynamic Data-Driven Approach, Miltiadis Alamaniotis *(Purdue Univ),* Xin Jin *(National Renewable Energy Lab),* Asok Ray *(PennState)*

3:05 p.m.
Assessment of Algorithms for Prognostics of Fatigue Damage Initiation in Operating Nuclear Power Plants, Surajit Roy, Pradeep Ramuhalli, J. Chai, I. Kim, W. Kim *(PNNL)*

3:30 p.m.
Analysis of High Temperature Ultrasonic Transducer Performance in Small Modular Reactors, Prathamesh N. Bilgunde, Leonard J. Bond *(Iowa State Univ)*

3:55 p.m.
Investigation Into Optimization Techniques for Prognostic Parameter Generation Via Cost Function Analysis, Zachary Welz, Michael Sharp, Wes Hines, Belle Upadhyaya *(Univ of Tennessee)*

4:20 p.m.
Probabilistic Model Selection for Prognostics of Thermal Creep in Advanced Reactors, Surajit Roy, Pradeep Ramuhalli, Evelyn Hirt, Matt Prowant, Al Pardini, Stan Pitman *(PNNL)*

NPIC.2-I&C Modernization Experience—II

Chairs: Janos Eiler *(IAEA),* Tamás Túri *(MVM-Paks II. Ltd.)*

Providence Ballroom III, 1:00 - 5:00 p.m.

1:00 p.m.
Vattenfalls 30 years' Experience from Using Digital I&C in Seven Swedish Nuclear Power Plants, Anders R. Johansson *(Vattenfall AB)*

1:25 p.m.
Evaluating Digital Control Systems in New Reactors: Challenges and Experiences, Wendell Morton, Jr. *(NRC)*

1:50 p.m.
Licensing Experience with SPINLINE 3 Digital I&C Platform, Hélène Jegou *(Rolls-Royce Civil Nuclear),* Mark Burzynski *(Rolls-Royce Instrumentation and Controls)*

2:15 p.m.
Experience of I&C Modernization for WWER-1000 Unit Life Extension, Mykhaylo Yastrebenetsky, Vladislav Inyushev *(SSTC NRS),* Andrei Bindyukov *(SU NPP)*

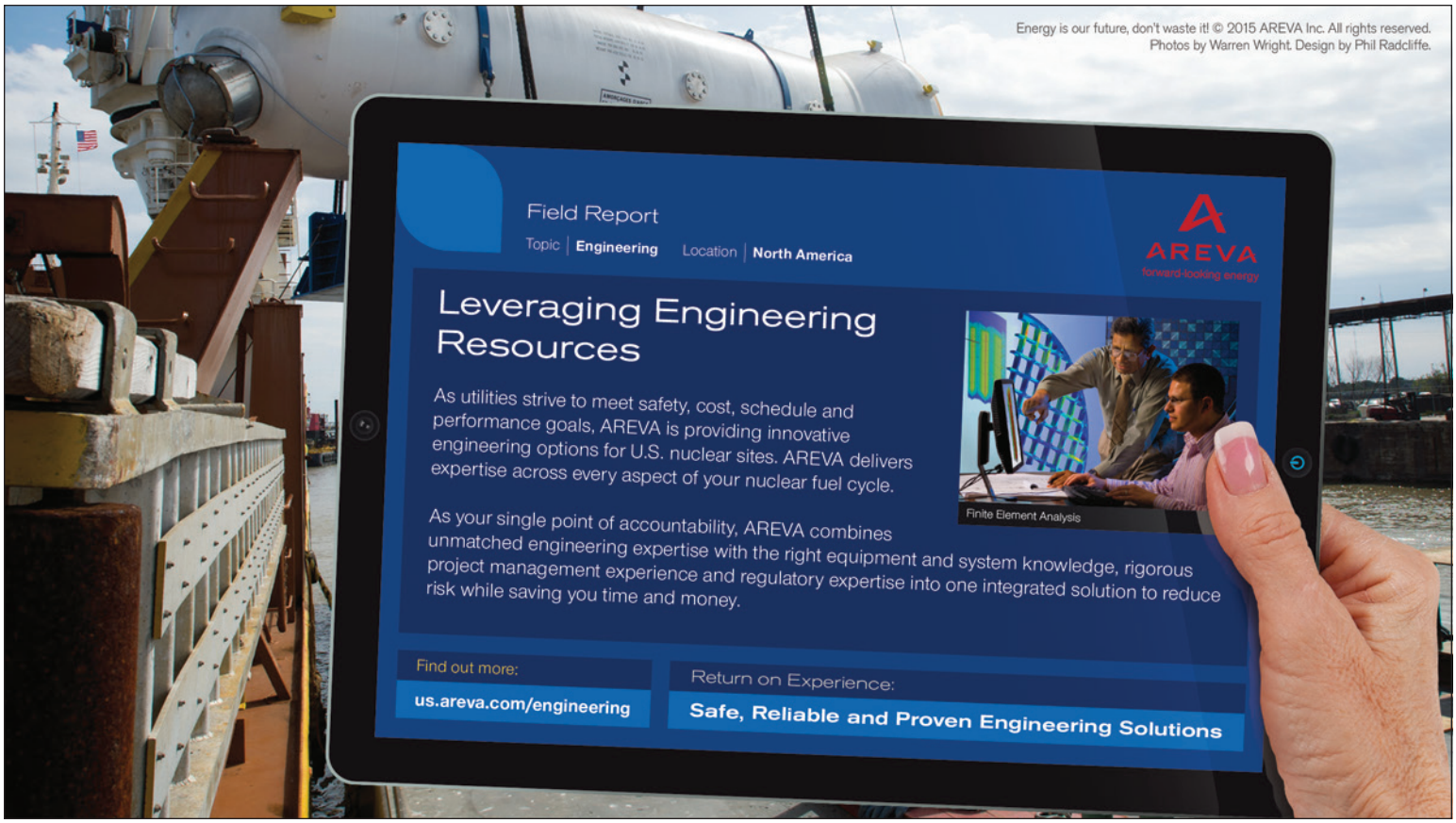
2:40 p.m.
Why are I&C Modernisations So Difficult? Experiences with Requirements Engineering and Safety Demonstration in Swedish NPPs, Sofia Guerra, Catherine Menon *(Adelard LLP)*

3:05 p.m.
Lessons Learned from Modernization of I&C Systems at NPP Dukovany, Jiři Sedlák, Peter Krákora *(UJV Rez)*

3:30 p.m.
Experience with Long Term Performance of Safety Related Pressure and Differential Pressure Transmitters in Ukrainian Nuclear Power Plants, Sergiy Lebedynskyy, Volodymir Lebedynskyy *(Priv JSC "Manometr-Kharkiv")*

3:55 p.m.
Santa Maria de Garoña NPP. I&C Challenges to Long-Term Operation, Jose Ignacio Alutiz, Rene Fernandez *(Nuclenor,S.A.)*

4:20 p.m.
Modernization of NPP's Safety I&C—Challenges and Solutions, Bernd Rudolf *(AREVA GmbH)*



NPIC.4-Application of Digital Control Systems

Chairs: Arndt Lindner *(TUV Rhineland),* Don Blair *(AZZ Nuclear|NLI)*

Harris, 1:00 - 5:00 p.m.

1:00 p.m.

Digital Systems and Reactor Protection System Architectures, Warren Busch *(TechCom International)*

1:25 p.m.

Progress in Design of the Instrumentation and Control of the Tokamak Cooling Water System, Kofi Korsah, Bill DeVan *(ORNL),* David Ashburn, Bradley Crotts, Michael Smith *(Areva Federal Services)*

1:50 p.m.

Design of I&C Architectures for New NPPs, Marion Viel, Patrick Salaun *(EdF/R&D),* Jean-Yves Pierron, Jean-Pierre Gallois *(CEA),* Martine Klein-Jaby *(AREVA)*

2:15 p.m.

Design, Implementation and Experimentation of a Reactor Shutdown System using HFC6000, M. Gverzdys, J. Jiang *(Univ of Western Ontario),* T. Schaefer, S. Yang *(Doosan HF Controls Corp)*

2:40 p.m.

The Equipment of Digital Control Safety Systems for NPPs With VVER, A. V. Kudryavtsev, K. P. Kartsev, V. A. Fedorov *(National Research Nuclear Univ "MEPhI"),* A. G. Jakushev *(OJSC "All-Russian Research Inst for Nuclear Power Plants Operation"),* P. V. Petrov *("SKU-Atom" Ltd.)*

3:05 p.m.

Designing a Simple, Fault Tolerant Protection System using Modern Programmable Logic Chips, Raymond L. Herb *(Southern Nuclear),* invited

3:30 p.m.

Cross-Platform Standardized Design of Instrumentation and Control System in Nuclear Power Plant Projects, Jiajie Pan *(Shanghai Nucl Eng Research Design Inst)*

HMIT.2-Control Room Modernization Experience

Chairs: Ronald L. Boring *(INL),* Kenneth D. Thomas *(INL)*

Sharon, 1:00 - 5:00 p.m.

1:00 p.m.

Software-Based Annunciator Replacement: A Tale of Two Projects, Garry T. Simmons *(Westinghouse)*

1:25 p.m.

A Checklist for Integrating and Planning Human Factors Engineering Activities in Control Room Modernization Projects, Alexandra Fernandes, Per Øivind Braarud, Håkan Svengren, Stine Strand *(Inst for Energy Technology)*

1:50 p.m.

Baseline Evaluations to Support Control Room Modernization at Nuclear Power Plants, Ronald L. Boring, Jeffrey C. Joe *(INL)*

2:15 p.m.

Main Control Room Upgrade for Kori Unit 1 in Korea, Jaetaeg Ha, Jongjae Choi *(KEPCO)*

2:40 p.m.

Design and Modernization of Nuclear Power Plant Control Room and Human-System Interface in LINGAO NPP Units 3&4, Shi Ji *(CGNPC/CNPDC)*

3:05 p.m.

Human Factors Engineering (HFE) Study in Support of Operating Nuclear Power Plant (NPP) Extended Power Uprate (EPU), Lewis F. Hanes, William Scott, Jr., Robert Muzzi *(Consultant)*

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HMIT.2-Control Rooms for Small Modular Reactors and Hybrid Energy Systems

Chairs: Hillel Mashiah *(NRCN ISRAEL),* Jeff Kapernick *(Univ of Tennessee)*

Queens, 1:00 - 5:00 p.m.

1:00 p.m.

Program of Human-Machine Interface Verification and Validation of Htr-Pm in China, Jia Qianqian, Guo Chao, Qu Ronghong, Zhang Liangju *(Tsinghua Univ)*

1:25 p.m.

Human Factors Analysis of the Minimum Staff Complement at a Nuclear Generating Station, Angela Vieira, Jessica Phyland *(AMEC NSS)*

1:50 p.m.

Human Factors Challenges on Control Room Design due to New I&C Safety Requirements, Dina Notte, Cyril Rivere, Jean-Pierre Zalambani *(AREVA NP)*

2:15 p.m.

Nuclear Hybrid Energy Infrastructure, Vivek Agarwal, Magdy S. Tawfik *(INL)*

2:40 p.m.

Significance of Dynamic and Transient Analysis in the Design and Operation of Hybrid Energy Systems, Mayank Panwar, Manish Mohanpurkar, Julian D. Osorio, Rob Hovsapian *(INL)*

3:05 p.m.

An Approach to Identify and Analyze the Most Significant Operator Tasks in a New Built Nuclear Power Plant, Christoph Jordi, Thomas Elsner *(AREVA GmbH)*

3:30 p.m.

Work Domain Analysis and Operational Concepts for Advanced Nuclear Power Plants, Jacques V. Hugo *(INL),* invited

HMIT.1-HFE Verification and Validation

Chairs: Gyrd Skraaning *(OECD Halden Reactor Project),* Richard J. Stattel *(NRC)*

Independence, 1:00 - 5:00 p.m.

1:00 p.m.

Lessons Learned during the Human Factors Guided Validation of Human-System Interfaces in New Built NPPs and Modernization Projects, Thomas Elsner, Timo Freitag *(AREVA GmbH),* Cyril Rivere *(AREVA SAS)*

1:25 p.m.

An Applied Approach to Human Factors Integrated System Validation for Nuclear Power Plants, Michael P. Gibson *(AREVA Inc.)*

1:50 p.m.

Human Factors Engineering Verification and Validation Process of New Nuclear Power Plant Control Room: How to Bridge the Gap from Stepwise V&V to Final ISV, Cyril Rivere *(AREVA NP)*

2:15 p.m.

Integrated System Validation: Models, Methods, and Issues, John O'Hara *(BNL),* Stephen Fleger *(NRC),* invited

2:40 p.m.

Advancing Human Performance Assessment Capabilities for Integrated System Validation—A Human-in-the-Loop Experiment, Matthew W. Demas *(Univ of Virginia),* Nathan Lau *(Virginia Tech),* Carl R. Elks *(Virginia Commonwealth Univ)*

3:05 p.m.

Integrated System Validation (ISV): The Acceptability Analysis Process, Gyrd Skraaning, Jr., Stine Strand *(OECD Halden Reactor Project)*

3:30 p.m.

Exploring Sub-Dimensions of Situation Awareness to Support Integrated System Validation, Nathan Lau *(Virginia Tech),* Gyrd Skraaning, Jr. *(OECD Halden Reactor Project)*

3:55 p.m.

An Overall Framework for the Definition of Requirements, Criteria and Human Engineering Discrepancies for Control Room Validation, Per Øivind Braarud *(OECD Halden Reactor Project)*

NPIC.3-Instrumentation for Advanced Reactors

Chairs: Gyunyoung Heo *(Kyung Hee Univ),* David Holcomb *(ORNL)*

Tryon, 1:00 - 5:00 p.m.

1:00 p.m.

Impact of Passive Safety on FHR Instrumentation System Design and Classification, David E. Holcomb *(ORNL),* invited

1:25 p.m.

FHR Process Instruments, David E. Holcomb *(ORNL)*

1:50 p.m.

Electrochemical Probe for Measurement of Redox Potential of Molten FLiBe Salt for the Fluoride Salt-Cooled Reactor, Brian Kelleher, Guiqiu Zheng, Guoping Cao, Kumar Sridharan, Mark Anderson *(Univ of Wisconsin, Madison)*

2:15 p.m.

High-Temperature Fission Chamber for He- and FLiBe-Cooled Reactors, Z. W. Bell, M. J. Harrison, D. E. Holcomb, R. J. B. Warmack, M. J. Lance, R. G. Miller, D. F. Wilson, D. R. Giuliano *(ORNL),* invited

2:40 p.m.

Analysis of Plant Stability for Improved Inherent Regulation, Stefano Passerini, Richard B. Vilim *(ANL)*

3:05 p.m.

Measurement Challenges due to the Noise Effect for an Eddy Current Probe, Mohammad R. Quddes, Leonard J. Bond, John R. Bowler *(Iowa State Univ)*

3:30 p.m.

High Temperature Infrared Glasses for Optical Sensing in Advanced Reactors, Joshua Raymond Roth, Steve Martin *(Iowa State Univ),* John Ballato *(Clemson Univ),* Hong Amy Qiao, Norm C. Anheier *(PNNL)*

3:55 p.m.

Advanced Reactor Designs and Select Challenges to I&C, Alexander Hashemian, Daniel A. Tobin *(AMS)*

4:20 p.m.

Advanced Control Algorithms for Liquid Metal Reactors, Jamie Coble, Belle Upadhyaya, Chris Briere, Cody Walker, Austin O'Connor, Wes Hines *(Univ of Tennessee),* Yu-Chih Ko, Jun Ding *(TerraPower, LLC),* invited

Digital I&C Challenges for New Reactors–Panel

Chairs: Finis Southworth *(AREVA),* Ted Quinn *(Technology Resources)*

Grand Ballroom D, 1:00 - 5:00 p.m.

1:00 p.m.

Panelists:

- Clayton Scott *(Schneider Electric)*
- Vic Fragonese *(AREVA)*
- Terry Jackson *(U.S. NRC)*
- Steve Seaman *(Westinghouse)*
- Phil Litherland *(EDF Energy)*

This special session will focus on the current issues and challenges with deploying full-scope digital instrumentation, control and protection in the new Generation III, III+ and IV plants under construction or in design and licensing around the world. Speakers from vendors, owner-operators and regulators will address these issues from their own perspectives and address the lessons learned in the I&C and Human Factors disciplines as well as special topics such as vendor supply chain and cyber security.

Next-Generation Simulator Technology–Panel

Chairs: Steven Freel *(Consultant)*, Zen Y. Wang *(Consultant)*

Trade, 1:00 - 5:00 p.m.

1:00 p.m.

Panelists:

- Bruce Hallbert *(INL)*
- Joe Naser *(EPRI)*
- Bob Lutz *(BobLutz-NSC)*
- Phillip G. Ellison *(GE Power & Electric)*
- James Chang *(NRC)*
- Mohammed Modarres *(UMD)*
- Emilie Roth *(Roth Cognitive Engineering)*
- Nam Dinh *(NCSU)*

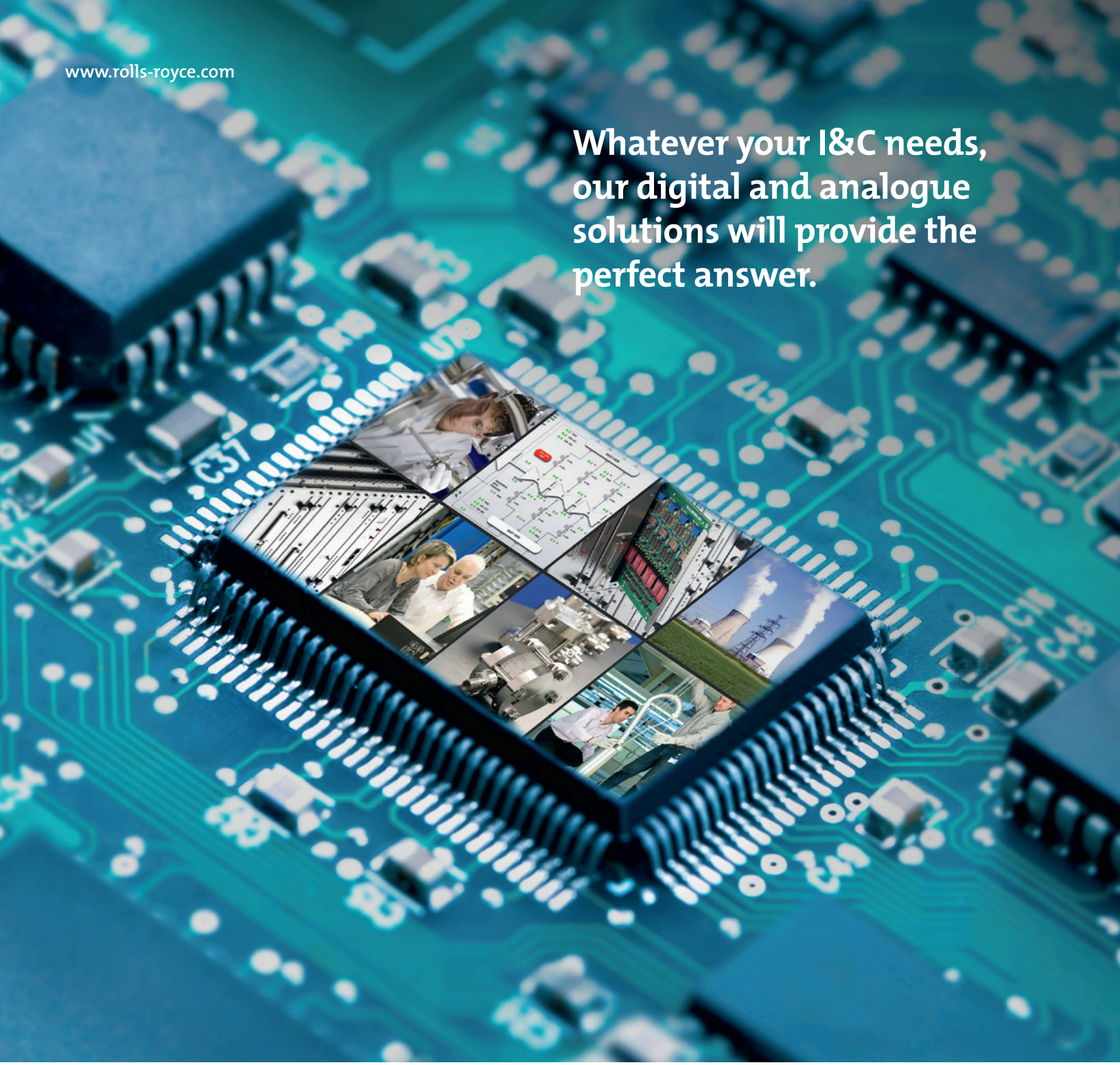
Post-accident monitoring has become a subject of renewed interest after the Fukushima accidents. This is an area that has been stagnant, especially in the monitoring of critical thermodynamic parameters in reactors, containments, and spent fuel pools, the monitoring of hydrogen, and regulating onsite and offsite radiation. An example is the in-core level measurement, which was not available to operators during TMI-2, and was not available during Fukushima Dai-ichi event. It is, however, a critical indicator going from a Design Basis Accident (DBA) to a Beyond Design Basis Accident (BDBA).

Simulator technology is an effective foundational platform bridging the post-accident monitoring information to human actions that mitigate and manage severe accidents. Both reliable instrumentation and upgraded simulator technology need significant developing.

This panel of distinguished experts will discuss the technological gaps and needed advances to meet the challenges of creating the next-generation technology in post-accident monitoring and severe accident management.

NASCAR Hall of Fame Banquet and Awards Ceremony

6:30-10:00 p.m.



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Continental Breakfast
Grand Ballroom ABC, 7:00 to 8:00 a.m.

Plenary Session—III

Grand Ballroom D, 8:00 - 10:00 a.m.

Speakers:

- Dr. Peter Lyons, Assistant Secretary, *Office of Nuclear Energy, U.S. Department of Energy*–Overview of U.S. DOE Nuclear Energy Instrumentation and Control R&D
- Mr. David Czufin, SVP-NPG Engineering & Technical Services, *Tennessee Valley Authority*–Nuclear Cyber Security
- Mr. John Tappert, Director for Division of Engineering, Office of New Reactors, *U.S. Nuclear Regulatory Commission*–Digital I&C Licensing for New Reactors
- Mr. Ken Canavan, Director, Plant Technology, *EPRI*–Advancing Risk Technology to Shape the Future of Nuclear Power

NPIC.5-I&C Regulations, Standards and Guidelines—III

Chairs: Damir Mandic *(Nuclear Power Plant Krško),* Steve Y. Yang *(Doosan HF Controls Corp)*

Providence Ballroom I, 10:30 a.m. – 12:10 p.m.

10:30 a.m.
Safety Principles and I&C Design, Björn Wahlström *(Oy Bewas Ab)*

10:55 a.m.
Finding Solutions to Address Diversity and Defense-In-Depth for I&C Safety Systems, Richard Stattel *(NRC)*

11:20 a.m.
Development of a Diversity and Defense-In-Depth Strategy for the CNNC Fuqing and Fangjiashan and Hainan Nuclear Plants, Gershon Shamay *(Schneider-Electric),* Jerry Mauck *(JLM Engineering and Technology Resources),* Michael Howard *(CSA, Inc.),* Edward L. Quinn *(Technology Resources)*

11:45 a.m.
Alternative Digital System Testability Criteria in the Context of Diversity, Steven A. Arndt *(NRC),* invited

NPIC.1-Advances in Monitoring, Diagnostics and Prognostics Technologies—II

Chairs: Richard Brian Vilim *(ANL),* Pradeep Ramuhalli *(PNNL)*

Providence Ballroom II, 10:30 a.m. – 12:10 p.m.

10:30 a.m.
Predictive Based Monitoring of Nuclear Plant Component Degradation Using Support Vector Regression, Miltiadis Alamanioti *(Purdue Univ),* Vivek Agarwal *(INL)*

10:55 a.m.
Enhancing the Nondestructive Evaluation of Concrete Structures in Nuclear Power Plants, Dwight A. Clayton *(ORNL),* invited

11:20 a.m.
Demonstration of Wireless Sensor Networks Based Fault Diagnosis, Ataul Bari, Jianping Ma, Jin Jiang *(Univ of Western Ontario)*

11:45 a.m.
Addressing Uncertainty in Predictive Estimates of Risk, C. A. Bonebrake, P. Ramuhalli, W. J. Ivans, G. A. Coles, E. Hirt *(PNNL)*

NPIC.2-I&C Modernization Experience—III

Chairs: Robert M. Queenan *(SCIENTECH),* Hidekazu Yoshikawa *(Harbin Eng Univ)*

Providence Ballroom III, 10:30 a.m. – 12:10 p.m.

10:30 a.m.
Technical Challenges and Solutions in I&C Modernization Programs, R. Sommacal, P. Baranek. A. Duthou *(Rolls-Royce Civil Nuclear)*

10:55 a.m.
Limerick BWR Turbine Control and Protection System Upgrade Success, Cal K. Tang, Thomas S. Pietryka, Panfilo A. Federico *(Westinghouse),* Jonathan C. Williams *(Exelon Nuclear)*

11:20 a.m.
Management of Aging and Obsolescence of Traverse In-Core Probe Drive Control Units, J. B. Griffo *(Exelon Corp)*

11:45 a.m.
Resolving Module Obsolescence with an FPGA-Based Replacement, David Herrell, Kyle Dittman *(MPR Assoc),* Bob Cardwell *(Southern Nuclear Operating Co.)*

Meet Your Human Factors Points of Contact–Round Table Session

Chair: David Desaulniers *(NRC)*

Harris, 10:30 a.m. – 12:10 p.m.

10:30 a.m.

Panelists:

- Ray Herb *(Southern Nuclear)*
- Brent Shumaker *(AMS)*
- John O'Hara *(BNL)*
- Joe Naser *(EPRI)*
- Dorian Conger *(HPRCT)*
- Jack Martin *(HPRCT)*
- Chris Kerr *(IEEE SC5)*
- Ron Boring *(INL)*
- Steve Fleger *(NRC)*
- John Kvalem *(OECD Halden Reactor Project)*
- Robert McDonald *(OECD Halden Reactor)*

You have a human factors question for the NRC but you are not sure whom to call. You know EPRI develops human factors guidance and you wonder what they are currently working on. You need some human factors research but are not sure whom to contact. This round table session puts you in the driver's seat. Come with your questions and sit down one-on-one with representatives from organizations dedicated to meeting the human factors and human performance needs of the nuclear power community.

HMIT.2-Innovative Solutions to Alarm Overload

Chairs: Robert Fink *(CDF Services Inc.)*, Gordon Ian Procter *(NECSA)*

Sharon, 10:30 a.m. – 12:10 p.m.

10:30 a.m.

Application of Alarm Inhibition Techniques in Human-Machine Interface Design, Xueqin Chu, Zepeng Cui *(China Nuclear Control System Eng Co., Ltd.)*

10:55 a.m.

Detecting Open Supply Conductors by State Estimation, G. L. Kusic *(Univ of Pittsburgh)*

11:20 a.m.

Directed Attention Support-What an Alarm System Should Actually Provide, William C. Elm, K. Kopren, S. Szymczak *(Resilient Cognitive Solutions LLC)*

HMIT.3-Advances in Human-Automation Collaboration

Chairs: Mateo Ramos *(Tecnatom),* Katya Le Blanc *(INL)*

Independence, 10:30 a.m. – 12:10 p.m.

10:30 a.m.
The Optimized Design and Use of Automated Control Systems—State of the Literature and Proposed Research, Joel M. Haight, Daniel G. Cole, Ervin Sejdic *(Univ of Pittsburgh)*

10:55 a.m.
Levels of Automation for Advanced Small Modular Reactors: Impacts on Performance, Workload, and Situation Awareness, Katya Le Blanc, Johanna Oxstrand, Aaron Bly *(INL)*

11:20 a.m.
Human-Automation Function Allocation, Lewis F. Hanes *(Consultant),* Robert Fink *(CDF Services, Inc),* Joseph Naser *(EPRI)*

NPIC.6-General Topics in Instrumentation and Controls—I

Chairs: Charles R. Morris *(IAEA),* Joshua Emmer *(SNL)*

Trade, 10:30 a.m. – 12:10 p.m.

10:30 a.m.
Pressure Control for a Pressurizer in a Pulsed System, Michael Smith *(AREVA Federal Services LLC),* Sukumar Kamalasadan *(Univ of North Carolina),* Walter Van Hove *(ORNL)*

10:55 a.m.
Reactor Power Control Research on Based on Artificial Immune Algorithm, Maoyao Fang, Shouyu Cheng, Minjun Peng *(Harbin Eng Univ)*

11:20 a.m.
Methods for Identification and Analysis of Safe Operating Boundary of Dynamic Systems, Xirong Ning, Jin Jiang *(Univ of Western Ontario)*

NPIC.5-EMC/EMI

Chairs: Steve Lopez *(EPRI),* Chad Kiger *(AMS)*

Tryon, 10:30 a.m. – 12:10 p.m.

10:30 a.m.
Study of EMI/RFI Impact on Neutron Flux Monitor Signal Transmission Lines, E. S. Martazov, N. A. Selyaev, V. A. Fedorov *(National Research Nuclear Univ "MEPhI"),* V. A. Vorobyev, Y. A. Kashchuk *(Inst "Project Center ITER")*

10:55 a.m.
Electromagnetic Compatibility Concerns of In-Situ Welding on Instrumentation and Control Systems, D. M. Nace, C. J. Kiger *(AMS)*

11:20 a.m.
EMI Shielding of Plant Instrumentation, Akbar Moarefy *(PG&E),* invited

11:45 a.m.
Update to Regulatory Guide 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems", Russell Sydnor *(NRC),* Thomas J. Harrison, Kofi Korsah, Richard T. Wood *(ORNL),* David Dawood *(NRC)*

Lunch
Grand Ballroom ABC, 12:00 – 1:00 p.m.

HMIT.1-Human Factors Lessons Learned from Fukushima Accident

Chairs: Charlie McCarthy *(Northrop Grumman),* Bill Williamson *(TVA)*

Independence, 1:00 - 5:00 p.m.

1:00 p.m.
Post-Facta Review of Emergency Response Support System (ERSS) in Japan—Before and After Fukushima Daiichi Accident, Hidekazu Yoshikawa *(Harbin Eng Univ)*

1:25 p.m.
Assessing Human and Organizational Factors for Implementing Beyond-DBA Strategies in Nuclear Power Plants: Regulatory Activities in Korea, Young S. Yoon, Yun H. Chung, Min C. Kim *(KINS)*

1:50 p.m.
Prediction of Severe Accident Occurrence Time by using SVM, Seung Geun Kim, Young Gyu No, Poong Hyun Seong *(KAIST)*

NPIC.1-Advances in Monitoring, Diagnostics and Prognostics Technologies—III

Chairs: Cristina Corrales Quiros *(Tecnatom),* Noushin Amini *(Texas A&M Univ)*

Providence Ballroom II, 1:00 - 5:00 p.m.

1:00 p.m.
Lifetime Modeling of Equipment at Nuclear Power Plants, Olli Saarela, John Einar Hulsund *(Inst for Energy Technology)*

1:25 p.m.
Comparison of Prognostic Techniques for Estimating the Remaining Useful Life of Nuclear Plant Components, B. D. Shumaker, D. E. McCarter, N. A. Bond, H. M. Hashemian *(AMS)*

1:50 p.m.
Using Pattern Recognition for On-line Sensor Prognostics and Diagnostics in Nuclear Power Plants, Christopher J. D'Angelo, Charles J. Hansen, Daniel G. Cole *(Univ of Pittsburgh)*

2:15 p.m.
Research on Condition Prognostic of Condensate Water System in Nuclear Power Plant, Hang Wang, Minjun Peng, Shouyu Cheng *(Harbin Eng Univ)*

2:40 p.m.
Monitoring the Level Dynamics in a Hydraulic Loop Through the Use of a Coaxial Reflectometric Sensor and a Low Pulsatiliy Pump, Francesco Cordella, Mauro Cappelli, Massimo Sepielli *(ENEA UTFISST)*

3:05 p.m.
Study on Multiple Real-Time Fault Diagnosis with Multilevel Flow Model, Yong Zhang, Yangping Zhou, Yujie Dong, Lei Shi, Xiaojin Huang *(Tsinghua Univ)*

3:30 p.m.
Assessment of Neural Network Capability to Predict the Remaining Useful Life of Electric Motors, Federico Barbieri *(Univ of Ferrara),* J Wesley Hines *(Univ of Tennessee),* Michael Sharp *(Univ of Tennessee),* Mauro Venturini *(Univ of Ferrara)*

3:55 p.m.
Parameters-Free Conservation-Based Equipment Fault Diagnosis, R. Vilim, Y. Park, A. Grelle *(ANL)*

NPIC.4-Digital System Reliability

Chairs: Raymond L. Herb *(Southern Nuclear),* Richard T. Wood *(ORNL)*

Harris, 1:00 - 5:00 p.m.

1:00 p.m.
Application of a Context-Based Statistical Testing Method for Quantifying Software Reliability to an Example System, Tsong-Lun Chu, Athi Varuttamaseni, Joo Seok Baek, Meng Yue *(BNL),* Man Cheol Kim *(KAERI),* Tim Kaser, George Marts, Paul Murray, Bently Harwood *(INL),* Ming Li *(NRC)*

1:25 p.m.
Development of an Approach for the Reliability Analysis of Net-Work Topologies in Digital I&C Systems, Falk Lindner, Ewgenij Piljugin, Pascal Vogt *(GRS)*

1:50 p.m.
Development of an Automatic Fault Injection Simulator for Evaluating the Reliability of Digital I&C Systems, Seung Jun Lee, Wondea Jung *(KAERI)*

2:15 p.m.
Fault Tree Analysis of Nuclear Power Control and Test Facility Shutdown Systems, Sungwhan Cho, Jin Jiang *(Univ of Western Ontario)*

2:40 p.m.
Quantitative Methods for Reliability and Fault Tolerance of Digital Instrumentation and Control Systems, G. W. Morton, B. D. Shumaker, B. H. Cady, H. M. Hashemian *(AMS)*

3:05 p.m.
Design of Advanced RPS Architecture and Reliability Analysis using Markov Model, Kwang Seop Son *(KAERI/KAIST),* Dong Hoon Kim *(KAERI),* Hyun Gook Kang *(KAIST)*

3:30 p.m.
Testing Experience and Reliability Modelling Preparation of Safety Software for Digital Reactor Protection System of HTR-PM, Qianqian Jia, Duo Li, Huasheng Xiong *(Tsinghua Univ)*

3:55 p.m.
Dynamic Data Transmission Frequency Decision for Distributed Control Systems, Qingti Guo, Mike Pietrykowski, Carol Smidts *(Ohio State)*

HMIT.3-Use of Simulation for Human Factors Engineering

Chairs: Julia Ann Forbes *(Altran),* Jacques Hugo *(INL)*

Sharon, 1:00 - 5:00 p.m.

1:00 p.m.
Human Factors Engineering, Simulator and Operator Roadmap to Analysis, Design and Verification and Validation, Charles Weaver *(Pacific Science & Eng Group),* Zen Wang, Steven Freel *(Consultant)*

1:25 p.m.
Applications of the CANDU® Main Control Room Mock-Up, R. Leger, S. Malcolm *(Candu Energy Inc.)*

1:50 p.m.
How to Run a Control Room Simulator Research Study, Ronald L. Boring *(INL),* Wondea Jung *(KAERI),* Nathan Lau *(Virginia Polytechnic Inst & State Univ),* Gyrd Skraaning, Jr. *(OECD Halden Reactor Project)*

2:15 p.m.
Neutron Source Facility Training Simulator Based on EPICS, Young Soo Park, Thomas Wei, Richard Vilim, Austin Grelle, Pawel Dworzanski, Yousry Gohar *(ANL)*

2:40 p.m.
Pre-Validation of a New Interactive Operating Panel System for a Nuclear Power Plant Training Simulator, Hanna Koskinen, Jari O. Laarni *(VTT Technical Research Centre of Finland),* Kalle Torkkeli, Eero Vesaoja *(Fortum)*

3:05 p.m.
Virtual Research Reactor with Interactive Control Room for Reactor Operator Training, Yoshinori Satoh *(Toshiba Corp.),* Xuefeng Zhu, Ye Li, Christopher A. Kuprianczyk, Rizwan-Uddin *(Univ of Illinois at Urbana-Champaign)*

3:30 p.m.
Operator Acceptance of Mobile Data Collection Technology, Greg A. Jamieson, Kent Carlson, Gladys Lee, Benjamin Hayes *(Univ of Toronto)*

3:55 p.m.
Leverage Technology for Innovation: Do Things Better Tomorrow than Done Today, Joseph A. Naser *(EPRI),* invited

NPIC.3-Wireless Technologies for Nuclear Systems

Chairs: John Pericci *(Lockheed Martin),* Joseph Murray *(Mission Technical Services)*

Tryon, 1:00 - 5:00 p.m.

1:00 p.m.
I&C Wireless Practices in French NPPs, Olivier Blas, Rémy Delhomme *(EdF)*

1:25 p.m.
Application of Wireless Communication in the Monitoring System of RBMK Parameters During Maintenance, A. B. Rakhmatulin, N. A. Selyaev, V. A. Fedorov, *(National Research Nuclear Univ"MEPhI")*

1:50 p.m.
Strategy for Implementation of Wireless Technologies in the Electromagnetic Environment of Nuclear Power Plants, C. J. Kiger, C. L. Lowe *(AMS)*

2:15 p.m.
International Activities to Develop Guidance on the Integration of Wireless Devices in Nuclear Power Plants, C. J. Kiger *(AMS)*

2:40 p.m.
A Literature Review on Radiation Effects on Wireless Post-Accident Monitoring Systems and Rad-Hardened Design Techniques, Qiang Huang, Jin Jiang *(Univ of Western Ontario)*

3:05 p.m.
Contol Policy for Shared Objects in HTR-PM: Toward the Collision and Deadlock Avoidance, Shuqiao Zhou, Xiaojin Huang *(Tsinghua Univ)*

3:30 p.m.
Radiation Effects on Commercial Off the Shelf Wireless Transmitter, Jorge V. Carvajal, Nicola G. Arlia, Michael D. Heibel *(Westinghouse)*

NPIC.3-R&D on Nuclear Instrumentation and Control

Chairs: Bjorn Wahlstrom *(Retired),* Brent Shumaker *(AMS)*

Queens, 1:00 - 5:00 p.m.

1:00 p.m.
Supercritical Carbon Dioxide Brayton Cycle Control for a Nuclear Power Plant: Load Following and Decay Heat Removal, Anton Moisseytsev, James J. Sienicki *(ANL)*

1:25 p.m.
Role and Opportunity of Nuclear I&C under the Changing Regulatory Environment in South Korea, Gyunyoung Heo *(Kyung Hee Univ),* Poong Hyun Seong, Hyun Gook Kang *(KAIST)*

1:50 p.m.
Digital Sensor Technology, Ken D. Thomas *(INL),* Edward L.Quinn Jerry L. Mauck, Richard M. Bockhorst *(Technology Resources)*

2:15 p.m.
Construction and Preliminary Testing of an NPP Concrete Containment Wall with Simulated Defects, Kyle Hoegh *(Univ of Minnesota),* Dwight Clayton *(ORNL),* Katelyn Freeseman, Lev Khazanovich *(Univ of Minnesota),* invited

2:40 p.m.
Real-Time Control Systems Simulations for a Molten Salt Nuclear Reactor, Michael Kristufek, Daniel G. Cole *(Univ of Pittsburgh)*

3:05 p.m.
Digital Actuator Technology, Ken D. Thomas *(INL),* Edward L. Quinn, Jerry L. Mauck, Richard M. Bockhorst *(Technology Resources)*

3:30 p.m.
Flow Characteristics Analysis of USC Overload Turbine Control Valve for Nuclear Power Plant, P. K. Bhowmik, Kune Y. Suh, J. A. Shamim, A. Gairola *(Seoul Natl Univ)*

NPIC.6-General Topics in Instrumentation and Control—II

Trade, 1:00 - 5:00 p.m.
Chairs: Julie Irene Reed *(Westinghouse),* Anton Alexandrovich Andrashov *(Radiy Research & Production Corp)*

1:00 p.m.
A Physical Simulator in Supporting of Research and Development for Instrumentation and Control Systems in Nuclear Power Plants, Jin Jiang, Jianping Ma, Ataul Bari, Drew J. Rankin *(Univ of Western Ontario),* invited

1:25 p.m.
Key Developments of a Rod Control System, Marc Pouillot, Hélène Jegou, Jean-Michel Palaric, Arnaud Duthou *(Rolls-Royce)*

1:50 p.m.
Development and Release of an Automated Testing Platform for Non Q Use Software in the U.S. Commercial Nuclear Market, David Kenneth Cory *(Rolls-Royce Nuclear Services)*

2:15 p.m.
Crack Prediction on Concrete Surface Using Optical Nondestructive Evaluation Methods, Longxi Luo, Maria Feng, Yoshio Fukuda *(Columbia Univ),* Chao Zhang *(Nagasaki Univ)*

2:40 p.m.
Evaluation of Increasing Temperature in Reference Leg in Main Control Room Water Level Indication, Alexander Klemptner, Daniel Robori-Carretero *(DTE Energy)*

3:05 p.m.
The Study on the Practical CGID for Hardware and Software Quality Assurance for Nuclear Power Plants, KwangYoung Sohn, ChangHwan Cho *(MIRAE Eng),* JoonKu Lee, GeunOk Park *(KAERI)*

3:30 p.m.
Recent Advances in I&C Tools, Akira Fukumoto *(Toshiba Corp.)*

3:55 p.m.
The Research of a New Radioactive Aerosol Continuous Monitor, Changli Mu, Zihan Huang, Hongkun Xu, Jiang Bian, Yin Yin, Ge Wang *(Beijing Research Center for Radiation Application)*

NPIC.5-Hazard and Failure-Mode Analysis–Panel

Chairs: Ray Torok *(EPRI),* Steve Seaman *(Westinghouse)*

Providence Ballroom I, 1:00 - 5:00 p.m.

1:00 p.m.

Panelists:

- Sushil Birla *(U.S. NRC)*
- John Hernandez *(Arizona Public Service)*
- Phillip Turner *(SNL)*
- Nguyen Thuy *(EDF)*

The panel will address important issues involving the use of various forms of hazard analysis to find and manage potential vulnerabilities in digital instrumentation and control systems before they are put into service in the plant. Software Hazards has taken on a life of its own recently.

Examples of questions and issues the panelists could address include:

- Are new hazard analysis methods, such as systems theoretic process analysis (STPA) sufficiently developed and mature that they deserve mention in standards or regulatory guidance? If so, which methods should be endorsed? If not, what more needs to happen first?
- What about traditional hardware methods such as failure modes and effects analysis? Should they be recommended for software-based systems?
- Should a hazard analysis approach be used to streamline regulatory reviews, focusing them on the issues of greatest safety significance?
- Should BTP-14 be revamped from a hazard analysis/protection perspective to simplify and focus it better?
- What will be needed to bring utility engineers, equipment suppliers, system integrators and NRC reviewers up to speed on the latest hazard analysis approaches? What roles should NRC, NEI, INPO and EPRI play?
- How should Software Hazards be handled? Should they be separate or integrated into that Hazard Analysis for the entire system?

Effectively Using Cyber Threat Intelligence and Lessons Learned to Aid in Building the Nuclear Facility Emergency Preparedness Plan–Panel

Chair: Jason Hollern *(AREVA)*

Providence Ballroom III, 1:00 - 5:00 p.m.

1:00 p.m.

Panelists

- Barry Westreich *(NRC/NSIR)*
- Mark Bristow *(DHS/ICS-CERT)*
- Matt Gibson *(EPRI)*
- Mark Plemmons *(Symantec)*
- Brad Yeates *(Southern Nuclear Co.)*

Cyber threat intelligence (CTI) is "Knowledge and intelligence based on reliable sources and analysis, including context, indicators, reasonable predictions or capabilities, tactics, tools, procedures, and actionable advice about an existing or emerging cyber threat to organizations, equipment, or infrastructure that can be used to inform decision makers regarding the response or preparation to that threat." The panel will explore the importance of current CTI and lessons learned from past cyber security incidents (both in the nuclear sector and other critical infrastructure sectors) to assist in the development of a cyber security incident response program. It will also discuss the opportunities and resources that are available for utilities, vendors, and cyber security service professionals to utilize to gain access to current CTI for application in the nuclear sector.

Continental Breakfast
Grand Ballroom C, 7:00 to 8:00 a.m.

NPIC.5-Safety-Related System Qualification and V&V

Chairs: John W. Hefler *(ALTRAN),* Wendell Morton *(NRC)*

Providence Ballroom I, 8:00 a.m. – 12:00 p.m.

8:00 a.m.
Observations on Qualification of Software in Commercial-Grade Digital instrumentation and Control Systems, Rossnyev Alvarado, Timothy Mossman *(NRC)*

8:25 a.m.
A Development and Qualification Strategy for NPP Digital Safety Systems, Peter H. Feiler *(Carnegie Mellon Univ)*

8:50 a.m.
Progressive Testing of Safety Logic Based on Intermediate Outputs, François Chériaux, Laurence Picci *(EdF R&D)*

9:15 a.m.
t-Wise-Based Multi-Fault Injection Technique for the Verification of Safety Critical I&C Systems, Vyacheslav Kharchenko *(National Aerospace Univ),* Oleksandr Gordieiev *(Univ of Banking of the National Bank of Ukraine),* Sergiy Vilkomir *(East Carolina Univ),* Oleg Odarushchenko *(RPC Radiy)*

9:40 a.m.
Justifying Digital COTS Components when Compliance Cannot be Demonstrated—The Cogs Approach, Sofia Guerra, Nick Chozos, Dan Sheridan *(Adelard LLP)*

10:05 a.m.
Rosemount 3150 Series Pressure Transmitter Qualification Update, Christopher Victor *(Rosemount Nuclear Instruments),* invited

10:30 a.m.
Nuclear Qualified Proximity Position Sensors—Technology Overview and Benefits to Existing Plants and Gen Platforms, Greg Merrifield *(Emerson Process Management/TopWorx)*

10:55 a.m.
Detection of Failures in Floating Point Calculations in Safety I&C—Implementation and Application, Arndt Lindner, Christian Gerst, Josef Maertz, Andreas Moelleken *(TÜV Rheinland ISTec GmbH)*

NPIC.1-Cable Aging and Cable Condition Monitoring

Chairs: Robert Austin *(EPRI),* Robert Leger *(Candu Energy Inc.)*

Providence Ballroom II, 8:00 a.m. – 12:00 p.m

8:00 a.m.
Cable Aging and Condition Monitoring: A Practical Review, Robert Konnik *(Marmon Innovation & Technology Group)*

8:25 a.m.
Cable Aging and Condition Monitoring of Radiation Resistant Nano-Dielectrics in Advanced Reactor Applications, Robert C. Duckworth, M. Parans Paranthaman, Tolga Aytug, Michelle K. Kidder, Georgios Polizos, Keith J. Leonard *(ORNL),* invited

8:50 a.m.
Testing Live Cables in Nuclear Power Plants, J. B. McConkey, D. M. Nace, H. M. Hashemian *(AMS)*

9:15 a.m.
Properties of Cables Exposed to Simultaneous Thermal and Radiation Aging, Xiaoyan Wu, Yuming Li, Zhimin Zhong *(State Nuclear Power Plant Service Co.)*

9:40 a.m.
Research on Advanced Passive Nuclear Power Plant Cable Ageing and Qualification for Harsh Environment in China, Tianyang Lou, Shenjie Gu, Yanyun Lu *(SNERDI),* Fucai Liang *(Jiangsu Shangshang Cable Group)*

10:05 a.m.
Studies on the Variation of the EPR Cable Material Irradiated by the Gamma Irradiation, Weixia Zhong, Sun Jiansheng, Song Shisen *(Shanghai Electric Cable Research Inst)*

10:30 a.m.
Rheological Analysis and Vibrational Spectroscopy for Enhanced Condition Monitoring and Lifetime Prediction of Cable Materials, Brian G. Risch *(Prysmian Cables and Systems)*

10:55 a.m.
Identifying Intermittent DC Grounds on Cables, Matthew B. Budraitis *(Southern Nuclear)*

NPIC.2-Cyber Security Issues Related to Digital I&C Systems—I

Chairs: Ludovic Pietre-Cambacedes *(EdF),* Daniel G. Cole *(Univ of Pittsburgh)*

Providence Ballroom III, 8:00 a.m. – 12:00 p.m

8:00 a.m.
IEC 62859: Towards an International Standard on the Coordination Between Safety and Cybersecurity for Nuclear I&C Systems, Ludovic Pietre-Cambacedes *(EdF),* Edward L. Quinn *(Technology Resources)*

8:25 a.m.
A New International Standard on Cybersecurity for Nuclear Power Plants: IEC 62645—Requirements for Security Programmes for Computer-Based Systems, Edward L. Quinn *(Technology Resources),* Leroy Hardin *(NRC),* Ludovic Pietre-Cambacedes *(EdF)*

8:50 a.m.
Considerations for Integrating Cyber Security Requirements into the Nuclear Facility Emergency Preparedness Plan, Jason M. Hollern, Paris F. Stringfellow *(AREVA)*

9:15 a.m.
Coordination and Interface of Cyber Security and Digital Instrumentation and Control System Review, John Thorp, Karl Sturzebecher, Samir Darball, Steven Arndt *(NRC),* invited

9:40 a.m.
Lessons Learned from Conducting Large Scale Fault Injection Experiments on Safety Critical Digital I&C Systems, Carl R. Elks *(Virginia Commonwealth Univ),* Barry W. Johnson, Ron Williams *(Univ of Virginia),* Nishant George *(Intel),* Michael Reynolds *(Thomas Nelson College)*

10:05 a.m.
Secure Cyber I&C Infrastructure for Multi-Unit Small Modular Reactors, Sacit M. Cetiner, Nageswara S. Rao *(ORNL),* invited

10:30 a.m.
Project Methodology for the Implementation of Cyber Security Controls, Sarosh Muncherji *(Honeywell Process Solutions),* invited

10:55 a.m.
High Assurance Cybersecurity Controls Against Persistent and Targeted Attacks on Instrumentation and Control Systems in Nuclear Facilities, Pavol Zavarsky *(Areva NP Controls)* Karl Waedt, Andrey Kuskov *(Areva GmbH)*

NPIC.4-Use of Simulation for Design, Engineering, and Maintenance

Chairs: Scott Patterson *(Rock Creek Tech LLC),* Bruce Geddes *(Southern Engineering Services, Inc.)*

Harris, 8:00 a.m. – 12:00 p.m

8:00 a.m.
Simulation, Monitoring and Diagnostics for Integral Inherently Safe LWR (I2S-LWR), Matthew R. Lish, Belle R. Upadhyaya, J. Wesley Hines, Ryan A. Tarver *(Univ of Tennessee)*

8:25 a.m.
Development of Dynamic Models for Thermal-Hydraulic Processes Based on Simscape Toolbox, Binggang Cui, Jin Jiang *(Univ of Western Ontario)*

8:50 a.m.
A Study of Analytical Redundancy of the Nuclear Power Control and Test Facility Heater Control Process, Sungwhan Cho, Jin Jiang *(Univ of Western Ontario)*

9:15 a.m.
Dynamic Modeling of a Small Modular Reactor for Control and Monitoring, Jeff R. Kapernick, Belle R. Upadhyaya, Troy A. Eckleberry, J. Wesley Hines *(Univ of Tennessee),* Brent D. Shumaker, Hashem M. Hashemian *(AMS)*

9:40 a.m.
Transient Analysis for HTPBR and PCHE Coupled System, Kushal D. Badgujar, Sangchul Won *(Pohang Univ of Science and Technology),* Om P. Singh *(Indian Inst of Technology),* John C. Lee *(Univ of Michigan)*

10:05 a.m.
Reverse Engineering of Nuclear Electronics, Ibrahim Tarik Ozbolat, Jingzhu Xu, Timothy Marler *(Univ of Iowa)*

10:30 a.m.
System Integration for Simulation of Power Plant Circuit Cards, Tim Marler, Tom Thurman, Mingyu Ma, Ruoyu Zhang, Ross Johnson *(Virtual Systems Eng)*

10:55 a.m.
Assessment of Simulation Advantages on Nuclear DCS Projects, Frezza Krystel, Klein-Jaby Martine *(AREVA NP),* Pascal Gain *(CORYS T.E.S.S.)*

11:20 a.m.
The Use of Simulation Testing for Engineering and Validation of a Safety Related Digital Control System, Jason A. Reed *(AREVA Inc.)*

HMIT.3 -Advances in HFE Design and Analysis Tools

Chairs: Shi Ji *(CGNPC/CNPDC),* Carol S. Smidts *(Ohio State)*

Queens, 8:00 a.m. – 12:00 p.m

8:00 a.m.

New Environment for Human Factors Engineering Analysis, Design and Test, Cristina Corrales, Luis Fernández, Luis Rejas y Fernando Ortega *(Tecnatom)*

8:25 a.m.

Using Virtual Mock-Ups and Automated Assistance to Support Human Factors Engineering Design Evaluation Activities for Control Room Layouts, Michael N. Louka *(OECD Halden Reactor Project)*

8:50 a.m.

An Integrated Suite of Tools to Support Human Factors Engineering, Jacques V. Hugo *(INL)*

9:15 a.m.

Practical Application of a User-Centered Design Management Strategy, Jessica Stevens, Kevin LaFerriere, Jeffrey Jones, *(NuScale Power)*

9:40 a.m.

Progress and Lessons Learned in Establishing the Integrated Control Room and Operator Performance Laboratory (INCONTROL) for Digital Instrumentation and Control and Human Factors Research in Nuclear Power, Bob Bailey *(Center for Advanced Eng & Research),* Carl Elks *(Virginia Commonwealth Univ),* Nathan Lau *(Virginia Tech),* Matt Demas *(Univ of Virginia)*

10:05 a.m.

Development of a New Safety Culture Evaluation Method Using Reliability Analysis Methods, Sangmin Han, Seung Min Lee, Poong Hyun Seong *(KAIST)*

HMIT.3-Computerized Operator Decision and Support Systems

Chairs: Robert M. Bailey *(Center for Advanced Eng & Research),* Kurt L. Davis *(BEA/Irradiation Testing)*

Sharon, 8:00 a.m. – 12:00 p.m

8:00 a.m.

Reduction of Uncertainty of Thermal Performance Calculations in Nuclear Power Plants, E. Wingstedt, O. Saarela *(OECD Halden Reactor Project)*

8:25 a.m.

A Cognitive Engineering Principle for HFE Validation of Computerized HMI's, Vincent Pargade *(AREVA NP)*

8:50 a.m.

An Operator Support System for Reactor Transients using Fuzzy Logic, Stylianos Chatzidakis, Miltiadis Alamaniotis, Lefteri H. Tsoukalas *(Purdue Univ)*

9:15 a.m.

Computerized Operator Support System—Phase–II Development, Thomas A. Ulrich, Ronald L. Boring, Roger T. Lew, Kenneth D. Thomas *(INL)*

9:40 a.m.

A Monitoring and Diagnostic Expert System for Reactor Coolant System, Wenlin Wang, Ming Yang, Jun Yang *(Harbin Eng Univ)*

10:05 a.m.

Current Human Error Studies in Korea After Fukushima and Other Events, Yong Hee Lee *(KAERI)*

10:30 a.m.

A Study on the Automated Accident Response Support for Severe Accident Prevention, Seop Hur, Jong-Gyun Choi, Jae-Chang Park, Kwang-Seop Son, Chang-Hwoi Kim *(KAERI)*

HMIT.1-Human Performance Assessment

Chairs: Franz Altkind *(ENSI),* Arnaud Duthou *(Rolls-Royce)*

Independence, 8:00 a.m. – 12:00 p.m

8:00 a.m.
Development of Guideline to Collect HRA Data with Simulator Data for HRA Data Handbook, Sun Yeong Choi, Jinkyun Park, Yochan Kim, Seunghwan Kim, Wondea Jung *(KAERI)*

8:25 a.m.
Science-Based HRA: Experimental Comparison of Operator Performance to IDAC Simulations, Rachel Shirley, Carol Smidts *(Ohio State),* Ronald Boring *(INL),* Yuandan Li, Ali Mosleh *(Univ of Maryland)*

8:50 a.m.
On-Line Application of Living PSA with Modularization Step by GO-FLOW Method, Jun Yang, Ming Yang, Wang Wenlin *(Harbin Eng Univ)*

9:15 a.m.
A Lesson Learned From Implementing the Final Plant Human Factors Engineering/Human-Systems Interface Design Verification for an Advanced Nuclear Power Plant, Chih-Wei Yang, Tsung-Chieh Cheng, Wen-Wei Kuo *(INER),* Jin-Liang Liou, Tung-Ming Wu *(Taiwan Power Co.)*

9:40 a.m.
"SCORE"—An Integrated Performance Measure for Control Room Validation, P. Ø. Braarud, M. H. R. Eitrheim, A. Fernandes *(OECD Halden Reactor Project)*

10:05 a.m.
Human Factors Engineering (HFE) Training for Nuclear Plant Engineers, Julia Forbes *(Altran-North America)*

10:30 a.m.
Experiments on the Use of Bayesian Inference and Evaluation of Human-Machine Interfaces on Situation Awareness, Seongkeun Kang, Poong Hyun Seong *(KAIST)*

10:55 a.m.
Consideration of a Framework for Evaluating Soft Control Execution Human Error in Advanced MCRs of NPPs, Inseok Jang, Ar Ryum Kim, Poong Hyun Seong *(KAIST),* Wondea Jung *(KAERI)*

NPIC.6-General Topics in Instrumentation and Control—III

Chairs: Mykhaylo Yastrebenetsky *(SSTC NRS),* Lefteri H. Tsoukalas *(Purdue Univ)*

Trade, 8:00 a.m. – 12:00 p.m

8:00 a.m.
Lessons Learned during the Development and Execution of a Recent Hazardous Area Qualification Program, Joe Cheatham, Rick Andersen *(Ultra Electronics)*

8:25 a.m.
Measurement of the Leak Rate From Primary Water Stress Corrosion Cracks in a Pressurized Water Reactor, Jeremy Black Christyn Thornton, Shannon Murray, Luke Pumphrey, Sean Barry, Kathryn Kowis *(Texas A&M Univ),* Craig Harrington *(EPRI),* Noushin Amini *(Texas A&M Univ)*

8:50 a.m.
MSIV Upgrades to Support Plant Operation Following an Extended Power Uprate, Steve Miller *(Zachry Nuclear Eng.)*

9:15 a.m.
TPCW PID Parameter Development, Implementation, and Lessons Learned, Steve Miller *(Zachry Nuclear Engineering)*

9:40 a.m.
A Modular Graphical Toolkit for RELAP5, Haishan Zhu, Minjun Peng, Zhaofei Tian *(Harbin Eng Univ)*

10:05 a.m.
Non Linear, Advanced Pressure Controller for a PWR Pressurizer, Mauro Cappelli *(ENEA),* Bernardino Castillo-Toledo *(CINVESTAV del I.P.N.),* Stefano Di Gennaro *(Univ of L'Aquila)*

10:30 a.m.
Analytically Compensated SGLC Test Facility, Drew J. Rankin, Jin Jiang *(Western Univ of Canada)*

10:55 a.m.
Study on Continuous Monitor Device for Alpha, Beta, Gamma Aerosol, Huang Zihan, Xu Hongkun, Mu Changli, Yin Yin, Bian Jiang, Wang Ge, Zhang Shuo *(Beijing Research Center for Radiation Application)*

ANS Human Factors, Instrumentation and Controls Division

NPIC.3-I&C Lessons Learned from Fukushima—I

Chairs: Christopher M. Wiegand *(EPRI),* Joy L. Rempe *(Rempe and Associates, LLC)*

Tryon, 8:00 a.m. – 12:00 p.m

8:00 a.m.
Lessons Learned from Historical Severe Accidents, Gary Johnson, Dan Welbourne *(Retired)*

8:25 a.m.
Qualification of Data Obtained during a Severe Accident—Illustrative Examples from TMI-2 Evaluations, Joy L. Rempe *(Rempe and Associates, LLC),* Darrell L. Knudson *(INL),* invited

8:50 a.m.
A Case Study for BWR Instrumentation and Control Systems Performance During a Severe Accident, Dwight Clayton, Mike Poore *(ORNL),* Damian Peko *(DOE)*

9:15 a.m.
Contribution of the Transient Recorder (TREDISS) for the Evaluation of the Accident in Fukushima Daiichi Nuclear Power Plants, Osamu Kubota, Manabu Watanabe *(TEPCO Systems Corp),* Shinya Mizokami *(Tokyo Electric Power Co.)*

9:40 a.m.
Instrumentation for Severe Accident Monitoring, James F. Gleason, Patrick J. Gleason *(GLSEQ, LLC)*

10:05 a.m.
IAEA Guidance on Accident Monitoring Instrumentation, Alexander Duchac, Janos Eiler, *(IAEA),* Gary L. Johnson *(Retired)*

10:30 a.m.
Criteria for Enhancing Accident Monitoring Instrumentation to Address Lessons Learned from Fukushima, David L. Rahn *(NRC)*

10:55 a.m.
Instrument Challenges Observed at Fukushima Daiichi from an Operations Point of View, Phillip G. Ellison *(GE Hitachi Nuclear),* Bill T. Williamson *(TVA/BWROG)*

Lunch
Grand Ballroom C, 12:00 – 1:00 p.m.

NPIC.5-Modeling Digital I&C Systems in PRA PSA

Chairs: Darrell Knudson *(INL),* Keith E. Holbert *(Arizona State Univ)*

Providence Ballroom I, 1:00 – 5:00 p.m.

1:00 p.m.
I&V—What Have We Learned, How Can We do Better?, Julia Forbes, David Hooten, Jay Pritchett *(Altran)*

1:25 p.m.
Modeling Digital I&C Systems for PRA With Coloured Petri Nets, Gilles Deleuze *(EDF R&D),* Nicolae Brinzei *(Univ de Lorraine)*

1:50 p.m.
Global Generic Model for Formal Validation of the Digital Instrumentation and Control Systems, Zhanguo Ma, Hidekazu Yoshikawa, Ming Yang *(Harbin Eng Univ)*

2:15 p.m.
Moving Forward with Digital Reliability Assessments, Terry W. Jackson *(NRC),* invited

2:40 p.m.
An Experimental Evaluation of the Automated Reliability Prediction System (ARPS) Tool, Xiang Li, Chetan Mutha, Carol Smidts, *(Ohio State)*

3:05 p.m.
Study on MFM Method for Digital I&C System Reliability Modeling and Analysis, Chao Zhang, Hai Zeng *(State Nuclear Power Automation System Eng Co)*

3:30 p.m.
Design of a Platform for Reliability Analysis of Safety-Critical Digital I&C Software, Ming Yang, Fengjun Li, Bowen Zhou, Hidekazu Yoshikawa *(Harbin Eng Univ),* invited

3:55 p.m.
Test Based Reliability Quantification Method for a Safety Critical Software using Finite Test Sets, Sung Min Shin, Sang Hun Lee, Hyun Gook Kang *(KAIST),* Han Seong Son *(Joongbu Univ),* Seung Jun Lee *(KAERI)*

NPIC.1-Cable Aging Management

Chairs: Leonard J. Bond *(Iowa State Univ),* Nicola Bowler *(Iowa State Univ)*

Providence Ballroom II, 1:00 – 5:00 p.m.

1:00 p.m.
EPRI Cable Research Supporting Current and Long Term Cable Aging Management, Andrew Mantey *(EPRI)*

1:25 p.m.
Effects of a Simulated LOCA on MI Cables and the Associated Signal Processing, Andreas Lautenbacher, Ewald Liebhart *(Mirion Technologies)*

1:50 p.m.
A New Test Method for Cable Insulation Degradation Assessment: Capacitive Sensing, Nicola Bowler, Robert T. Sheldon, Emily M. Arvia *(Iowa State Univ),* invited

2:15 p.m.
Time Window Scheduling Problem Research on Multi-Samples in Cable Ageing Acceleration Experiments, Yu Wenmin *(China Nuclear Power Operation Technology Co.)*

NPIC.2-Cyber Security Issues Related to Digital I&C Systems—II

Chairs: Joseph A. Naser *(EPRI),* Matt Gibson *(EPRI)*

Providence Ballroom III, 1:00 – 5:00 p.m.

1:00 p.m.
Gates, Guards, Guns and Geeks: The Changing Face of Nuclear Security and the IAEA's Leading Role in Promoting Computer Security for Nuclear Facilities, Donald D. Dudenhoeffer, Khammar Mrabit, John Hilliard, Michael T. Rowland *(IAEA)*

1:25 p.m.
Cyber Security Procurement for Digital Instrumentation and Control Systems, Bradley Geddes *(SES),* Matt Gibson *(EPRI)*

1:50 p.m.
Data Communication Strategies and Cyber Security Defenses for a Safety Related Digital Control System, Jason A. Reed *(AREVA Inc.)*

2:15 p.m.
Enhancing Defense-in-Depth and Monitoring Programs to Protect Critical Digital Assets from Tampering, Paul Martyak, Michael Thow *(AREVA)*

2:40 p.m.
Improving Cybersecurity Through the Use of the Cybersecurity Framework, Thomas Conkle, Greg Witte *(G2, Inc.)*

3:05 p.m.
Providing Cyber-Physical Security of Nuclear Power Plants with Heterogeneous Sensors, Jianghai Li, Xiaojin Huang *(Tsinghua Univ)*

3:30 p.m.
Hardware Health Monitoring in a Cyber-Secure Environment: Benefits and Strategies, Colin Bryson *(Rolls-Royce)*

3:55 p.m.
A Test Bed for Digital I&C and Cyber Security for NPPs, Yongkyu An, Calogero Sollima, Rizwan Uddin, Daniel Chen, Zbigniew Kalbarczyk, Tim Yardley, William Sanders *(Univ of Illinois)*

NPIC.4-Requirements Management for Digital I&C System Life Cycle

Chairs: Dwight A. Clayton *(ORNL),* J. Wesley Hines *(Univ of Tennessee)*

Harris, 1:00 – 5:00 p.m.

1:00 p.m.
Energy Management Systems: A Systems Engineering Approach for Managing Complexity, Tareq Ahram, Waldemar Karwowski *(UCF/IASE),* Ben Amaba, Paul Fechtelkotter *(IBM Complex Systems)*

1:25 p.m.
First of a Kind Engineering in Digital I&C Projects, Scott Patterson, Gregg Clarkson *(Rock Creek Tech LLC),* invited

1:50 p.m.
Adapting Requirements Management for Nuclear Power Plant Development, Ted Martens *(Lockheed Martin)*

2:15 p.m.
The Method of Requirement Based System Testing using Testbed, Jang-Yeol Kim, Dong Young Lee *(KAERI)*

2:40 p.m.
Verification of I&C Systems Requirements with FORM-L, a Formal Requirements Modelling Language, Nguyen Thuy *(EdF R&D)*

3:05 p.m.
Vintage I&C Systems Life Cycle Management Planning Sourcebooks, Michael Eidson *(SNC Engineering Systems)*

HMIT.3-Visualization

Chairs: Vladimir Sklyar *(Research and Production Corporation Radiy),* Richard L. Rusaw *(EPRI)*

Queens, 1:00 – 5:00 p.m.

1:00 p.m.

Accelerating Comprehension and Improving Retention with 3D Interactive Visualization, Robert L. Kershner, Paris Stringfellow *(AREVA Inc)*

1:25 p.m.

Beyond Visualization to Decision Support, William C. Elm, K. Kopren *(Resilient Cognitive Solutions LLC)*

1:50 p.m.

Potential of Three-Dimensional Visualisations to Reduce Cognitive Demands and Possible Application Areas in Nuclear Power Industry, Benedikt Petermeier *(GRS)*

2:15 p.m.

Augmented Reality—Informed Procedures for Performing Maintenance in Uncertainty and Hazardous Environments, Young Soo Park *(ANL),* Xiaorui Zhao, Pawel Dworzanski, Scott Korthals, *(Univ of Illinois–Chicago),* Richard Vilim *(ANL)*

NPIC.6-General Topics in Instrumentation and Controls—IV

Chairs: Daniel Stiffler *(Westinghouse),* John A. Stevens *(Doosan HF Controls Corp)*

Trade, 1:00 – 5:00 p.m.

1:00 p.m.

Challenges and Training Needs in NPP Automation Maintenance, Iina Aaltonen, Timo Kuula, Mikael Wahlström, Maiju Aikala, Jari Laarni *(VTT Technical Research Centre of Finland)*

1:25 p.m.

Differences Between Analog and Digital I&C, Björn Wahlstrom *(Retired)*

1:50 p.m.

PWR Reactor Protection System Modification—Remove the Steam Flow/Feed Flow Mismatch/Steam Generator Low Level Reactor Trip Function, David Morin *(Zachry Nuclear Eng, Inc.)*

2:15 p.m.

PWR Reactor Protection System Modification—Install Cold Leg Permissive Signal to SSPS, David Morin *(Zachry Nuclear Eng., Inc.)*

2:40 p.m.

I&C Obsolescence Strategies, Robert Lane, Matt Bowman, John Cestra *(ATC Nuclear)*

3:05 p.m.

A Hybrid Method in Reactor on Line Monitoring, Wang Changhui *(SNPTC)*

3:30 p.m.

Analog to Digital Process and Lessons Learned, Kevin Shaw *(ORNL)*

HMIT.2-Group-View Wall Panels

Chairs: Jon Kvalem *(OECD Halden Reactor Project),* Svein Ragnar Nilsen *(OECD Halden Reactor Project)*

Sharon, 1:00 – 5:00 p.m.

1:00 p.m.

Rethinking Group-View Display Alternatives, William P. Myers, Greg A. Jamieson *(Univ of Toronto)*

1:25 p.m.

Applying Cognitive Work Analysis to Large Screen Display Design, Sean W. Kortschot, Bill Myers, Cole Wheeler, Greg A. Jamieson *(Univ of Toronto)*

1:50 p.m.

The Plant Panel: Feasibility Study of an Interactive Large Screen Concept for Process Monitoring and Operation, Lars Hurlen, Gyrd Skraaning *(Inst For Energy Technology/Halden Reactor Project),* Billy Myers, Greg Jamieson *(Univ of Toronto),* Hanna Carlsson *(KTH)*

2:15 p.m.

Application of HFE Standards to Software Display Navigation for Operating Displays, Luis Rejas, Fernando Ortega *(Tecnatom S.A)*

2:40 p.m.

An Investigation on Glare Issues in the Main Control Room of the Advanced Nuclear Power Plant, Chih-Wei Yang, Tsung-Chieh Cheng, Wen-Wei Kuo *(INER),* Jin-Liang Liou *(Taiwan Power Co.)*

NPIC.3-I&C Lessons Learned from Fukushima—II

Chairs: Christopher M. Wiegand *(EPRI),* Christina Antonescu *(NRC)*

Tryon, 1:00 – 5:00 p.m.

1:00 p.m.
PWROG Severe Accident Management Technical Support Guidance for Instrumentation, Robert J. Lutz, Jr. *(Consultant),* N. Reed Labarge *(Westinghouse),* Roy Linthicum, Steven Pierson *(Exelon),* Jonathan Ford *(AREVA Inc.),* invited

1:25 p.m.
A New Element to Improve the Plant Response Against the ELAP Accident (Extended Loss of Ac Power), Arnaldo Laborda Rami *(ANAV)*

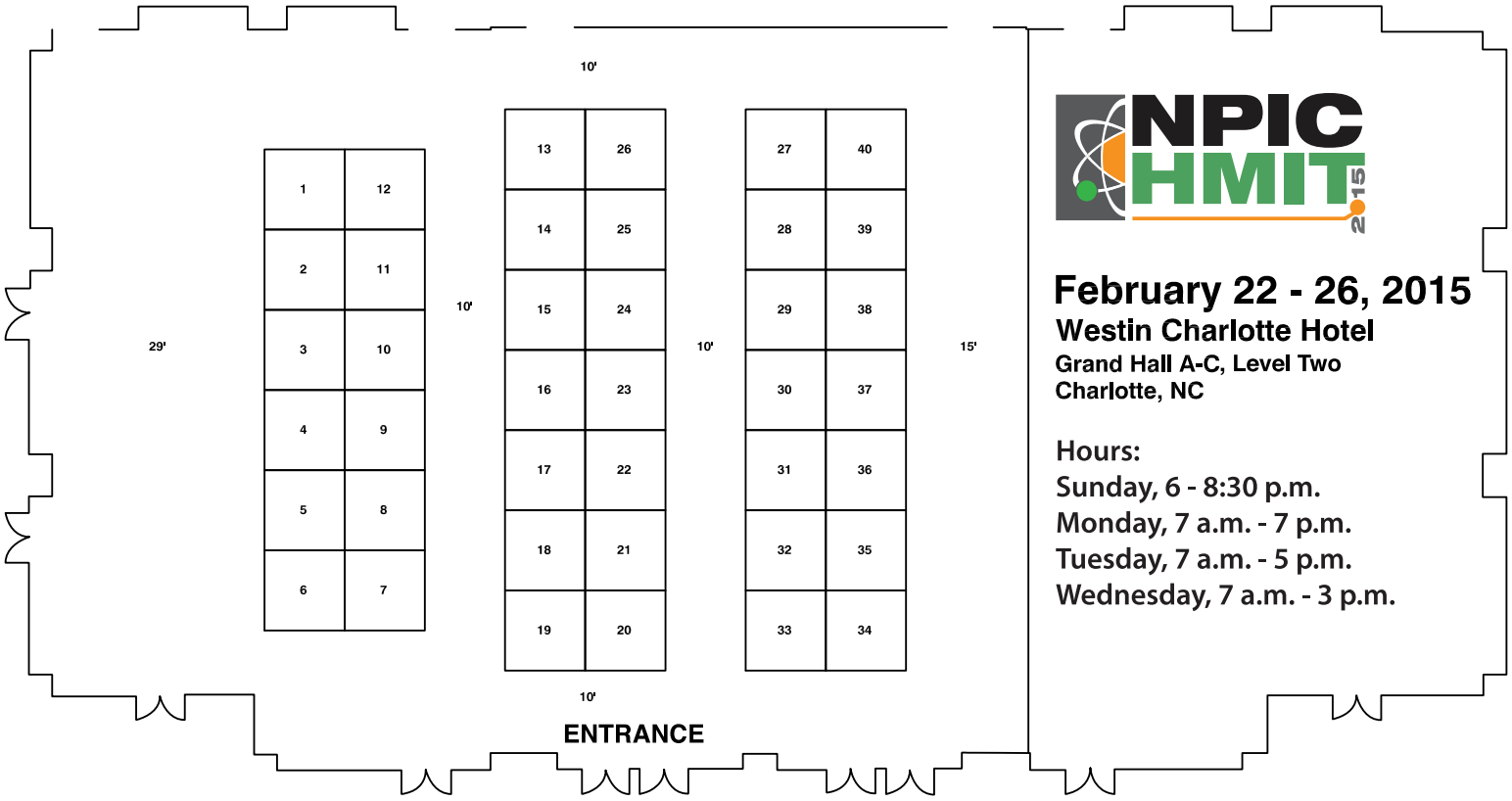
1:50 p.m.
Conceptual Report for Severe Accident Mobile Investigator (SAMI), Stephen M. Lopez *(EPRI),* R. Pedan, S. Beaudry, P. Bluth, T. Ransom, T. Romero, N. Shore, D. Vang *(Univ of North Carolina at Charlotte),* invited

2:15 p.m.
Swiss Solutions for Providing Electrical Power in Cases of Long-Term Black-Out of the Grid, Franz Altkind, Daniel Schmid *(ENSI)*

2:40 p.m.
Implementation of Post-Accident Monitoring Systems (PAMS) in Ukrainian NPP's, Taras Tkach *(National Nuclear Energy Generating Co. of Ukraine "Energoatom")*

3:05 p.m.
Fukushima Lessons Learned: Mitigation and Containment of Severe Accident Conditions by Means of Glass-to-Metal Sealed Electrical Penetration Assemblies, Oliver Wolfgang Fritz, Thomas Fink *(SCHOTT AG),* Joe Hale *(SCHOTT North America, Inc.)*

3:30 p.m.
Fukushima Daiichi Central Remote Monitoring System, Robert C. Ammon *(Curtiss Wright Nuclear Group, Scientech),* Ichiro Akiyama *(Tokyo Electric Power Service Co.)*



NPIC HMIT 2015

February 22 - 26, 2015
Westin Charlotte Hotel
Grand Hall A-C, Level Two
Charlotte, NC

Hours:
Sunday, 6 - 8:30 p.m.
Monday, 7 a.m. - 7 p.m.
Tuesday, 7 a.m. - 5 p.m.
Wednesday, 7 a.m. - 3 p.m.

Altran North America
Bordentown, NJ **(Booth 7)**

Altran North America provides comprehensive engineering, design, and consulting services including: instrumentation and control, electrical, civil/structural, mechanical, material science and cybersecurity. In North America, Altran serves the Power industry out of a network of offices with more than 500 employees.

Analysis and Measurement Services Corporation
Knoxville, TN **(Booths 27 & 28)**

Analysis and Measurement Services Corporation (AMS) is a recognized market leader in providing the worldwide nuclear power industry with equipment, training, and services to verify the performance of process instrumentation systems. Established in 1977, AMS is a principal source for cable testing, EMC qualification services, EMI/RFI troubleshooting, sensor response time testing, rod drop time measurements, rod control system diagnostics, on-line condition monitoring and prognostics, temperature sensor cross calibration, and reactor diagnostics.

AREVA
Lynchburg, VA **(Booth 33)**

As a world leader in nuclear power, AREVA in North America (AREVA Inc.) combines U.S. and Canadian leadership to provide utilities with proven expertise and uncompromising dedication to safety in every stage of the nuclear fuel cycle, reactor design and construction, and operating services. AREVA also invests in renewable energies to develop, via partnerships, high technology solutions. Through the complementary nature of nuclear and renewables, AREVA's nearly 5,000 U.S. and Canadian employees contribute to building tomorrow's energy model: Supplying the greatest number of people with energy that is safer and with less CO2

ATC-Nuclear
Oak Ridge, TN **(Booths 22 & 23)**

ATC Nuclear solves the nuclear industries most pressing issues in Instrumentation & Controls, Commercial Grade Dedication, and Inventory Management. ATC Nuclear is the only company to offer CGD, Sourcing, Warehousing, Reverse Engineering, and Qualification under one roof. We provide cost savings solutions for I&C obsolescence and are recognized industry experts in reverse engineering.

AZZ Nuclear
Ft. Worth, TX **(Booth 21)**

AZZ Nuclear | NLI offers engineered solutions for the nuclear industry. Whether a solution for obsolete equipment, equipment upgrades, digital upgrades, or routine equipment needs, NLI's strength is developing and offering solutions to the most difficult equipment challenges facing nuclear power plants.

Centronic Limited
Croydon, United Kingdom **(Booth 10)**

Design and manufacture of radiation detectors for reactor control. Neutron detectors: Fission Chambers, Ion chambers, BF3 counters and Boron-lined Proportional counters for reactors including PWR, VVER, BWR, CANDU and Advanced Gas-cooled Reactors.

Other products: Radiation Tolerant Cameras, Geiger-Muller tubes, Ion chambers and specialist coils.
This year we celebrate our 70th anniversary!

Curtiss-Wright/Scientech
Idaho Falls, ID **(Booth 1)**

Scientech provides plant process computer, digital control, and annunciator systems; thermal performance software; regulatory information databases and services; nozzle dams and installation services; reactor and steam generator specialized tooling; under-vessel BWR services and equipment; inventory database services (RAPID, OIRD) and supply chain analytics; probabilistic risk assessment (PRA) services; repair, refurbish and reverse engineered I&C services; security and access authorization software; mobile technology applications; and equipment reliability solutions.
http://scientech.cwfc.com

Doosan HF Controls Corp.
Carrollton, TX **(Booth 4)**

Doosan HF Controls is headquartered in Carrollton Texas USA is an I&C solutions provider that has supplied and serviced Instrumentation and Control (I&C) systems to American and International clients for over 50 years across the fossil and nuclear markets. Doosan HF Controls has become a major nuclear supplier as it expands its business portfolio. For more information:
1-866-501-9954 • www.hfcontrols.com

Edwards Analysis and Consulting
State College, PA **(Booth 3)**

Fault-tolerant control of the Steam Plant at EBR-II was demonstrated in 1991 using a Bailey NET90 Multi-Function Controller. Optimal Control was also demonstrated on the PSU Reactor using an MFC. Subsequent research demonstrated BWR instability with a $0.95 control rod. The Bailey NET90 Control System at Oconee was converted to C and interfaced to the NRC Safety Analysis Code TRAC. The company knows digital control and how to get it licensed. (BTW, the 2nd NPIC-HMIT meeting was held in 1996 at the Nittany Lion Inn at PSU).

EXCEL Services Corporation
Rockville, MD **(Booth 39)**

Excel Services Corporation specializes in providing operations, engineering, safety and regulatory services for energy and environmental projects worldwide. These specialized services include: License Renewal, Power Uprate, 24 Month Fuel Cycle Conversions, ITS Conversions, QA Solutions, Training, Spent Fuel Storage Licensing, New Plant Site Permitting and Combined License Support. EXCEL has worked with almost every nuclear plant and most nuclear facilities in the U.S., and has worked with many international facilities and organizations for 30 years.

Fortum & VTT Technical Research Centre of Finland Ltd.
Espoo, Finland **(Booth 14)**

Fortum – Next generation energy company. Fortum generates, distributes and sells electricity and heat, and offers related expert services. We provide control room design and simulator services for ensuring safety, licensability and operational performance in nuclear power plants.

VTT Technical Research Centre of Finland Ltd is the leading research and technology company in the Nordic countries. We provide expert services for domestic and international customers. VTT supports safe and efficient use of nuclear power by developing, validating and applying experimental and theoretical methods and tools.

GLSEQ, LLC
Huntsville, AL **(Booth 35)**

GLSEQ, LLC provides a Severe Accident Hydrogen Monitoring System (HCMS).
HCMS measures hydrogen in containment and outside of containment using intrinsically smart sensors that convert the combustible gas directly to an electronic signal. HCMS is part of the GLS Severe Accident Instrumentation Line (SAIL) of Nuclear Grade Sensors for Design Basis Events and Beyond Design Basis Events.

GSE Systems, Inc.
Sykesville, MD **(Booth 40)**

Since 1971 GSE Systems, Inc. has been solving the industry's needs for high-fidelity simulation and we continue to provide advances in engineering and visualization solutions. With the acquisition of Hyperspring LLC we not only provide the simulator, but also the training courses, instructors, and staff support to help you improve the performance of your plant and your people.

Hurst Technologies Corp.
Angleton, TX **(Booth 9)**

Hurst Technologies Corp. is a professional engineering and consulting organization that has been providing expert assessment, design, licensing, and implementation of conventional and digital based nuclear plant control systems, protection systems and electrical systems to the nuclear power industry nationally and internationally for over 25 years.

Invensys Nuclear by Schneider-Electric
Carlsbad, CA **(Booth 19)**

Invensys is now a part of Schneider Electric. Invensys Nuclear will now utilize the brands available from both Invensys and Schneider Electric to offer fully integrated Digital Upgrade I&C Solutions to the Global Nuclear Power Industry to maximize the availability and utilization of nuclear plant assets. The Invensys/Schneider booth will be displaying the approved 1E TRICON V10 and the latest advancements in Turbine Control and Digital Feedwater Upgrade technology.

Lockheed Martin
Grand Prairie, TX **(Booth 34)**

Headquartered in Bethesda, Maryland, Lockheed Martin is a global security and aerospace company that employs approximately 113,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services. The Corporation's net sales for 2013 were $45.4 billion.

Mirion Technologies
Smyrna, GA **(Booth 5)**

Mirion Technologies is a world leader providing comprehensive radiation detection, measurement, and monitoring solutions. Through its' Radiation Monitoring Systems Division, Mirion incorporates the internationally recognized brands: MGP Instruments and MGPIH&B providing safety and non-safety radiation monitoring and digital proTKtm Neutron Flux monitoring instrumentation to valued customers. Please visit us in booth #5!

Mitsubishi Electric Power Products, Inc.
Warrendale, PA **(Booth 2)**

Mitsubishi Electric Corporation (MELCO) is a world leader in designing, manufacturing and implementing advanced nuclear power plant control solutions, with more than 30 years of experience and plant-wide digital control systems installed in over twenty operating nuclear power reactors worldwide.
Webpage: www.meppi.com/nuclear • Email: NSD@meppi.com

Northrop Grumman Corporation
Linthicum, MD **(Booth 30)**

Northrop Grumman is a leading global security company providing innovative systems, products and solutions in unmanned systems, cyber, C4ISR, and logistics and modernization to government and commercial customers worldwide. Please visit www.northropgrumman.com for more information.

Nuclear News
LaGrange Park, IL **(Booth 13)**

Published by the ANS since 1959, Nuclear News is the flagship publication for the worldwide nuclear power industry. To date, more than 38,000 ad pages have been purchased by more than 1000 nuclear-related companies to promote their capabilities. If you're not doing so already, we invite you to Advertise and Subscribe.
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Public Company Research and Production Corporation Radiy
Kirovograd, Ukraine **(Booth 6)**

For over 20 years, Radiy has been a pioneer in the design, manufacturing and installation of FPGA-based instrumentation and control (I&C) systems for nuclear power plants and research reactors. With SIL-3 certified RadICS platform, Radiy's technological expertise is paving the way for increased safety and efficiency in the nuclear field.

Rolls-Royce
Huntsville, AL **(Booth 20)**

Rolls-Royce provides the highest quality nuclear support services spanning the reactor lifecycle, from concept design through to obsolescence management and plant life extension.

Our focus is on providing utility and reactor vendor customers with integrated long-term support services across the reactor lifecycle, covering safety, licensing and environmental activities, in-service support and ageing management. Our world-class I&C technologies incorporating safety systems, control and monitoring systems, and safety-critical instrumentation, are installed in 200 nuclear reactors across 20 countries worldwide. www.rolls-royce.com/nuclear

Rosemount Nuclear Instruments, Inc.
Chanhassen, MN **(Booth 32)**

Rosemount Nuclear Instruments, Inc. has supported the nuclear industry for over 40 years with qualified pressure measurement solutions. Our fully analog pressure transmitter family provides a full complement of accident profile coverage and accompanying performance specifications to meet the industry's stringent safety related application requirements for all reactor types.

RSCC Wire & Cable, LLC
East Granby, CT **(Booth 17)**

RSCC Wire & Cable, LLC is the premier full line manufacturer of Nuclear Safety cables to the nuclear industry worldwide. Our product line consists of Low Voltage Control, Power & Instrumentation Cables and a variety of specialty cables.

TECNATOM
Madrid, Spain **(Booth 26)**

Tecnatom is an engineering company providing comprehensive training services for the global nuclear industry, with more than 35 years of experience of applying the most advanced training methodologies. Through in-house technological development, we provide to clients the best resources, ensuring improvements in safety, availability and efficiency of their facilities.

THERMOCOAX Inc.
Alpharetta, GA **(Booth 16)**

Main activities are research, design, manufacturing and qualification of solutions based on the mineral insulated cable technology for nuclear power plants & Research Reactors.
Constructions code: ASME , RCC-M , KTA, KBM.
Quality reference: Code 50-C/SG, 10 CFR 50 Appendix B, NQA1, KTA 1401, YVL1.4

Solutions for:
TRANSMISSION CABLES
IN-CORE and EX-CORE SENSORS
HEATING SOLUTIONS

Thermo Scientific
San Diego, CA **(Booth 8)**

Thermo Fisher Scientific is a leading provider of Class 1E Safety-Related Nuclear Plant Instrumentation and Control Systems to the global commercial nuclear power industry. The company offers reactor power monitoring systems, radiation measurement and water analysis systems, radiation hardened cameras, data management and recorders, level instruments, and a full complement of services.

TopWorx/Emerson
Louisville, KY **(Booth 31)**

TopWorx, a division of Emerson™ Process Management, is the global leader in valve position sensing for the process industries including Nuclear Power. Our solutions enable plants, platforms, and pipelines to manage and control operations more intelligently and efficiently under the most extreme conditions.

The TopWorx Nuclear Proximity Position Sensor has a Global Nuclear pedigree and has a Qualified Life that generally exceeds the life of the plant.

Ultra Electronics Nuclear Control Systems
Dallas, TX **(Booth 18)**

Ultra Electronics provides high integrity safety and security products to the nuclear industry. Our strength is built on multiple safety layers including Class 1E safety systems, sensors, radiation monitoring, health physics, and emergency management. We offer a complete portfolio of nuclear services including obsolescence and lifetime management; independent assessment; and repair, refurbishment, and reverse engineering.

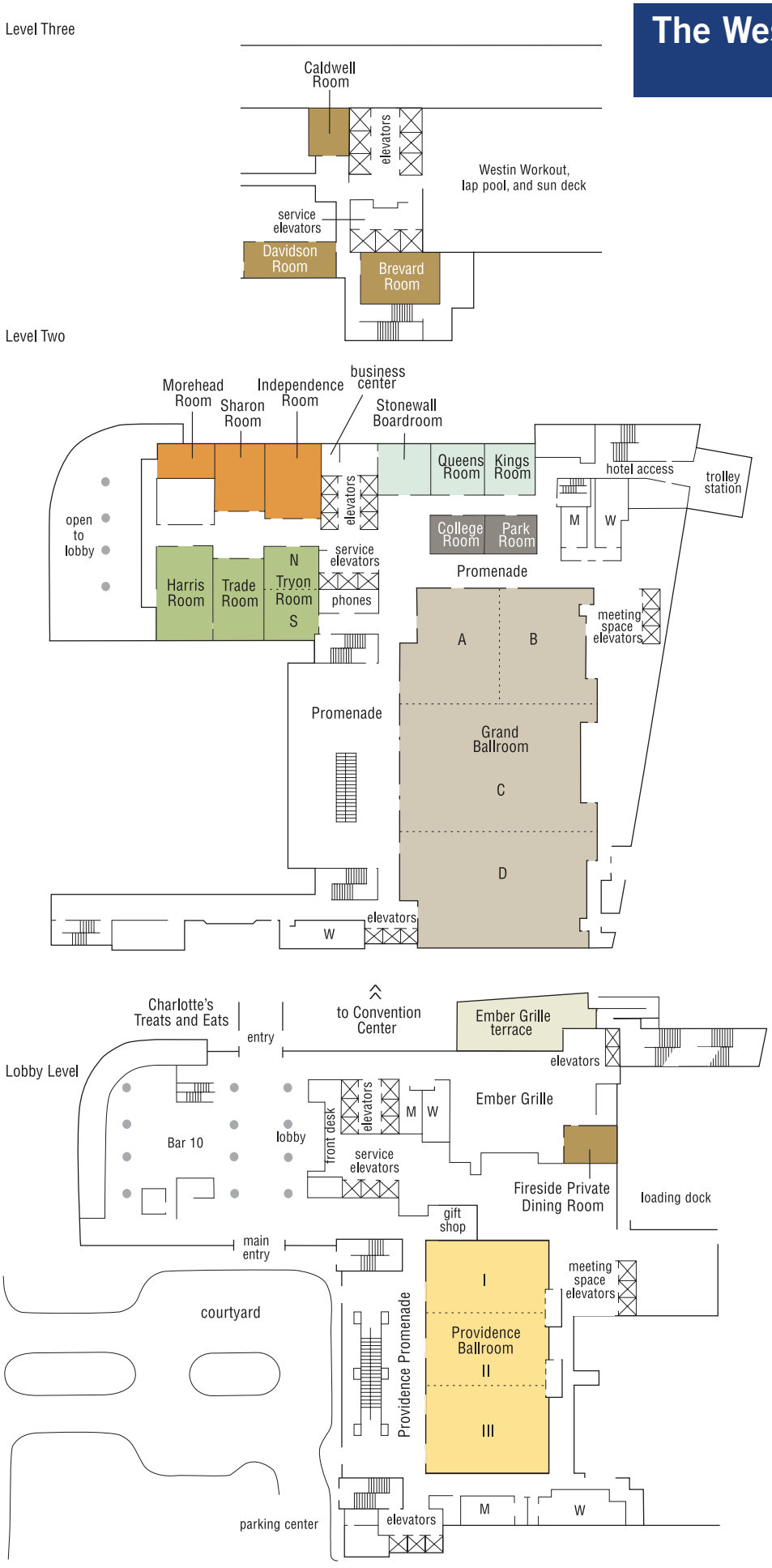
Westinghouse Electric Company
Cranberry Township, PA **(Booths 24 & 25)**

Westinghouse Electric Company offers a wide range of nuclear plant products and services to utilities throughout the world, including fuel, spent fuel management, service and maintenance, instrumentation and control, and advanced nuclear plant designs, including the Generation III+ AP1000 nuclear power plant.

Zachry Nuclear Engineering, Inc.
Stonington, CT **(Booth 12)**

Zachry Nuclear Engineering, Inc. and our Numerical Applications Division is a full service engineering firm that provides Engineering, Analysis, Design, and Project Management services to the Nuclear Power Industry. Zachry offers the services of experienced engineering professionals who are skilled in power plant systems, engineering analysis, and modification package development.

The Westin Charlotte Hotel Map



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