



ANS Meetings

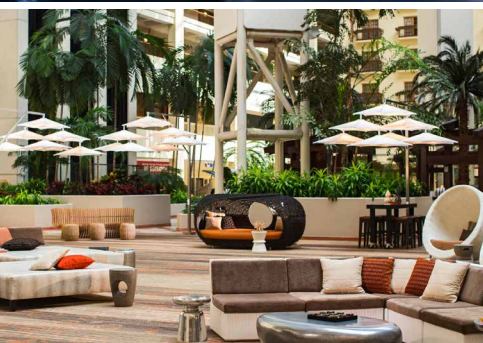
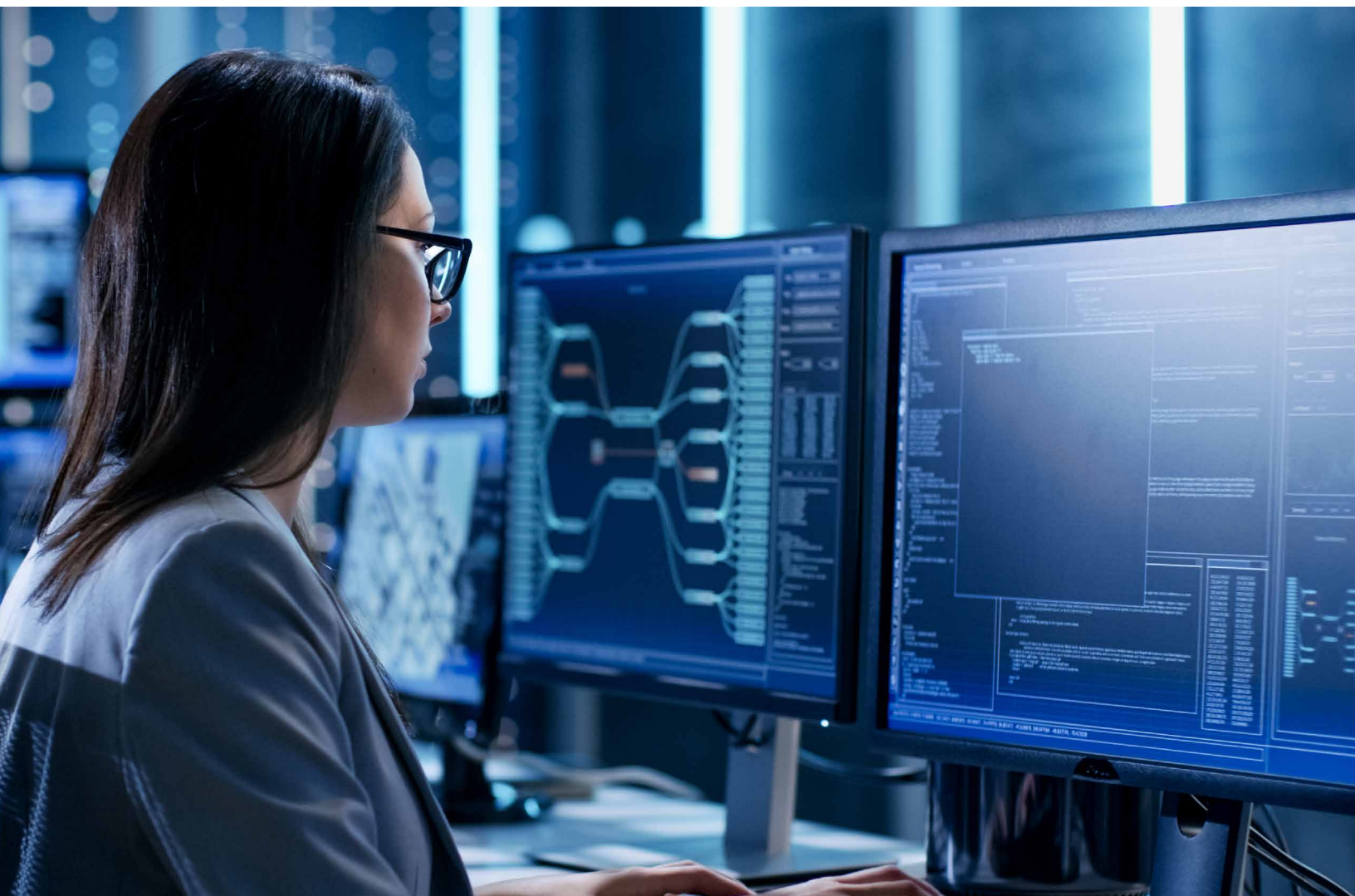


IAEA
International Atomic Energy Agency



11th Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies

Official Program



February 9–14, 2019
Orlando, FL
Renaissance Orlando at SeaWorld



ANS Meetings



11th Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies

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Organizing Committee

11th Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies (NPIC&HMIT2019)



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Daily Schedule


Saturday, February 9

7:30-8:30 am	Workshop Registration	Crystal Foyer Palani
8:00 am-5:00 pm	NPIC&HMIT 2-Day Training Course (Day 1)	

Sunday, February 10

8:00 am-5:00 pm	NPIC&HMIT 2-Day Training Course (Day 2)	Palani
4:00-7:00 pm	Registration	Crystal Foyer
6:00-8:00 pm	Expo	Crystal DE
6:00-8:00 pm	Opening Reception	Crystal DE

Monday, February 11

7:00 am-3:00 pm	Registration	Crystal Foyer
7:30-8:00 am	Continental Breakfast	Crystal DE
7:30 am-2:30 pm	Expo	Crystal DE
8:00-11:00 am	Opening Plenary	Crystal A-C
9:30-9:45 am	Refreshment Break	Crystal DE
11:00 am-12:30 pm	Lunch (Provided)	Crystal DE
	Sponsored by:	
		
12:30-2:15 pm	Technical Sessions <ul style="list-style-type: none"> • I&C Research for LWRs—I • U.S. Department of Energy Advanced Sensors and Instrumentation Program—I • SMR Instrumentation and Control—I • Human Performance and Reliability • Virtual and Augmented Reality Applications • Diversity and Defense in Depth—I 	Palani A Palani B Nomeus Tarpon Walu Zander
2:15-2:30 pm	Refreshment Break	Crystal DE
2:30-4:00 pm	Technical Sessions <ul style="list-style-type: none"> • Instrumentation for Advanced Reactors—I • U.S. Department of Energy Advanced Sensors and Instrumentation Program—II • Safety Critical Software—I • General Topics I&C—I • Cyber Security in Digital I&C—I 	Palani A Palani B Nomeus Tarpon Walu

Daily Schedule

Tuesday, February 12

7:00 am-3:00 pm	Registration	Crystal Foyer
7:30-8:00 am	Continental Breakfast	Crystal DE
7:30 am-2:30 pm	Expo Open	Crystal DE
8:00-9:30 am	Technical Sessions <ul style="list-style-type: none"> • Big Data Analytics for Nuclear Power–Panel • Digital I&C Modernization—I—Barriers to Plant Digital Modernization Are Down–Panel • In-Pile Instrumentation Development for Test Reactor Experiments—Panel • General Topics in I&C—II • Cyber Security in Digital I&C—II: Game Theoretic Approaches 	Palani A Palani B Nomeus Tarpon Walu
9:30-9:45 am	Refreshment Break	Crystal DE
9:45-11:30 am	Technical Sessions <ul style="list-style-type: none"> • Advances in Surveillance, Diagnostics and Prognostics—I • Digital I&C Modernization—II: The Path is Open, So Where Do We Go From Here?–Panel • In-Pile Instrumentation Research and Development—I • Verification and Validation—I • Human Factors for Small Modular Reactors • Advances in Productivity, Efficiency, and Design 	Palani A Palani B Nomeus Tarpon Walu Zander
11:30 am-12:30 pm	Lunch(Provided)	Crystal DE
12:30-2:15 pm	Technical Sessions <ul style="list-style-type: none"> • Advances in Sensing and Control—I • I&C Modernization Experience—I • In-Pile Instrumentation Research and Development—II • Safety Critical Software—II • Advances in Visualization • Diversity and Defense in Depth—II 	Palani A Palani B Nomeus Tarpon Walu Zander
2:15-2:30 pm	Refreshment Break	Crystal DE
2:30-4:15 pm	Technical Sessions <ul style="list-style-type: none"> • Data Analytics—I • I&C Modernization Experience—II • SMR Instrumentation and Control—II • General Topics in I&C—III • Digital Systems Modeling and Reliability—I • What’s Next for Nuclear Energy? A Human Factors Perspective–Panel 	Palani A Palani B Nomeus Tarpon Walu Zander
7:00-10:00 pm	Banquet	Crystal A-C

Daily Schedule

Wednesday, February 13

7:00 am-3:00 pm	Registration	Crystal Foyer
7:30-8:00 am	Continental Breakfast	Crystal DE
7:30 am-2:30 pm	Expo Open	Crystal DE
8:00-9:30 am	Technical Sessions <ul style="list-style-type: none"> • I&C Research for LWRs—II • NRC Integrated Action Plan for Digital I&C and Future Regulatory Modernization—Panel • Advanced Manufacturing for Sensors and Instrumentation—Panel • Verification and Validation—II • Computerized Procedures—I • Online Condition Monitoring for Maintenance Optimization 	Palani A Palani B Nomeus Tarpon Walu Zander
9:30-9:45 am	Refreshment Break	Crystal DE
9:45-11:30 am	Technical Sessions <ul style="list-style-type: none"> • Advances in Surveillance, Diagnostics and Prognostics—II • I&C Regulations, Standards and Guidelines—I • In-Pile Instrumentation Research and Development—III • Control Room Modernization • Cyber Security in Digital I&C—III 	Palani A Palani B Nomeus Tarpon Walu
11:30 am-12:30 pm	Lunch(Provided)	Crystal DE
12:30-2:15 pm	Technical Sessions <ul style="list-style-type: none"> • Transient Test Reactor Instrumentation: New Generation of Transient Testing Data Needs at TREAT—Panel • I&C Regulations, Standards and Guidelines—II • In-Pile Instrumentation Research and Development—IV • Computerized Operator Support Systems • Digital Controls and Automation • Cable Condition Monitoring 	Palani A Palani B Nomeus Tarpon Walu Zander
2:15-2:30 pm	Refreshment Break	Crystal DE
2:30-4:15 pm	Technical Sessions <ul style="list-style-type: none"> • Data Analytics—II • Wireless Technologies—I • In-Pile Instrumentation Research and Development—V • Verification and Validation—III • Digital Systems Modeling and Reliability—II • Cyber Security in Digital I&C—IV 	Palani A Palani B Nomeus Tarpon Walu Zander

Daily Schedule

Thursday, February 14

7:00 am-10:00 am	Registration	Crystal Foyer
7:30-8:00 am	Continental Breakfast	Unicorn Foyer
8:00-9:30 am	Technical Sessions <ul style="list-style-type: none"> • Instrumentation for Advanced Reactors—II • I&C Modernization Experience—III • Computerized Procedures—II • Wireless Technologies—II • Advances in Sensing and Control—II 	Palani A Palani B Nomeus Tarpon Walu
9:30-9:45 am	Refreshment Break	Unicorn Foyer
9:45-11:30 am	Technical Sessions <ul style="list-style-type: none"> • Next-Generation I&C Systems • General Topics in I&C Research—I • State of the Art in Human Factors • Cyber Security in Digital I&C—V 	Palani A Palani B Nomeus Tarpon
11:30 am-12:30 pm	Lunch On Own	
12:30-1:45 pm	Technical Sessions <ul style="list-style-type: none"> • Data Analytics—III • General Topics in I&C Research—II • Advances in Surveillance, Diagnostics and Prognostics—III • Multi-Stage Validation • Wireless Technologies—III 	Palani A Palani B Nomeus Tarpon Walu

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Digital Safety Systems

Scientech, a business unit of Curtiss-Wright Nuclear, provides NRC certified digital safety systems, plant process computers, digital controls, annunciator systems, and Class 1E analog safety systems to the majority of domestic nuclear power utilities. Partnered with RadICS, Curtiss-Wright will provide diverse (CCF free), cyber secure (FPGA & CPLD technology) Digital Safety Systems, locally sourced and configured, that are 100% compliant with current regulations defining safe & secure deterministic plant operation.

Contact Us at 603.773.0003



NPP Pickering, Rivine, Khmelnytsky, South Ukraine

General Information

MEETING INFORMATION

NPIC&HMIT is excited to invite you to join us in Orlando, FL from February 9-14, 2019.

NPIC&HMIT is the de facto forum for nuclear instrumentation and control (I&C) and human factors engineering (HFE) professionals to meet with leaders in industry and academia, discover the state of the technology, exchange information, and discuss future directions. In addition to an impressive list of government and industry leaders, we are also planning several outstanding hot-topic technical sessions and popular plenary speakers, which will attract professionals from across the nation and internationally.

REGISTRATION HOURS & LOCATION

Location: Crystal Foyer

Sunday, February 10	4:00 pm-7:00 pm
Monday, February 11	7:00 am-3:00 pm
Tuesday, February 12	7:00 am-3:00 pm
Wednesday, February 13	7:00 am-3:00 pm
Thursday, February 14	7:00 am-10:00 am

EXPO HOURS & LOCATION

Location: Crystal DE

Sunday, February 10	6:00 pm-8:00 pm
Monday, February 11	7:30 am-2:30 pm
Tuesday, February 12	7:30 am-2:30 pm
Wednesday, February 13	7:30 am-2:30 pm



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Digital Safety Systems

Radics LLC, an international nuclear engineering company, develops and supplies advanced customized Instrument and Control solutions based on the innovative, highly-reliable IEC 61508 SIL 3 and Nuclear Regulatory Commission certified RadICS platform. RadICS applications developed under NQA-1 compliant Quality Assurance Program can be used for digital safety and control systems for NPPs and other process industries with high level of safety requirements during modernization and new build projects. Curtiss-Wright is the U.S. provider for RadICS-based digital instrumentation systems.

Contact Us at 603.773.0003

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NPP Zaporizhzhia, Kozloduy, Nuclear Research Institute, Embalse

General Information

NOTICE TO SPEAKERS & ATTENDEES

All speakers and session chairs must check in at the ANS Registration Desk.

Name badges must be worn during all technical sessions, in the expo and events. Certain events require a ticket, and may entail an additional cost.

SPEAKER ROOM

Location: Unicorn

Computer available to modify presentations and printer for printing biographies. No internet connection is available.

ATTENDEE MEAL FUNCTIONS

Breakfast, Lunch & Breaks will be provided to all registered meeting attendees, Monday – Wednesday in the Expo located in Crystal DE and Thursday (no lunch) in the Unicorn Foyer.

Opening Reception: This reception is a ticketed event. Heavy hors d'oeuvre and beverages are included with a full meeting registration. Additional tickets are available for purchase.

Tuesday Evening Banquet: This is a ticketed event. Dinner and beverages are included with a full meeting registration. Additional tickets are available for purchase.

Consent to Use Photographs and Videos: All attendance of registered participants, attendees, exhibitors, sponsors and guests ("you") at American Nuclear Society ("ANS") meetings, courses, conventions, conferences, or related activities ("Events") constitutes an agreement between you and ANS regarding the use and distribution of your image, including but not limited to your name, voice and likeness ("Image"). By attending the ANS Events, you acknowledge and agree that photographs, videotaping, live feed video and audio, and/or audio recordings may be taken of you and you grant ANS the right to use, in perpetuity, your Image in any electronic or print distribution, or by other means hereinafter created, both now and in the future, for media, art, entertainment, promotional, marketing, advertising, trade, internal use, educational purposes or any other lawful purpose.

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General Information

ABOUT ANS

Mission

ANS provides its members with opportunities for professional development. It also serves the nuclear community by creating a forum for sharing information and advancements in technology, and by engaging the public and policymakers through communication outreach.

Statement on Diversity

The American Nuclear Society (ANS) is committed, in principle and in practice, to creating a diverse and welcoming environment for everyone interested in nuclear science and technology. Diversity means creating an environment – both in ANS and in the profession – in which all members are valued equitably for their skills and abilities and respected equally for their unique perspectives and experiences. Diverse backgrounds foster unique contributions and capabilities, and so creation of an inclusive Society ultimately leads to a more creative, effective, and technically respected Society.

ANS believes that everyone deserves opportunities for learning, networking, leadership, training, recognition, volunteering in Society activities, and all the other benefits that involvement in the Society brings, regardless of age, color, creed, disability, ethnicity, gender identity and expression, marital status, military service status, national origin, parental status, physical appearance, race, religion, sex, or sexual orientation. The selection of a member to serve in ANS's volunteer leadership structure shall be based solely on the member's ability, interest and commitment to serve. In particular, ANS encourages members at each level of the Society and in each Professional Division and Technical Group to make special efforts to recruit underrepresented minorities and women to ensure that they are adequately represented in the Society.

Respectful Behavior Policy (Abbreviated)

The open exchange of ideas, freedom of thought and expression, and productive scientific debate are central to the mission of the American Nuclear Society (ANS). These require an open and diverse environment that is built on dignity and mutual respect for all participants and ANS staff members, and is free of bias and intimidation.

ANS is dedicated to providing a safe, welcoming, and productive experience for everyone participating in Society events and other Society activities regardless of age, color, creed, disability, ethnicity, gender identity and expression, marital status, military service status, national origin, parental status, physical appearance, race, religion, sex, or sexual orientation. Creation of a safe and welcoming environment is a shared responsibility held by all participants. Therefore, ANS will not tolerate harassment of or by participants (including ANS volunteer leaders and staff members) in any form. Disciplinary action for participants found to have violated this principle may include reprimand, expulsion from an event or activity with or without a refund, temporary or permanent exclusion from all ANS events and activities, suspension or expulsion from volunteer leadership positions or groups, and/or suspension or expulsion from Society membership, as appropriate.

If you or someone else experiences harassment, regardless of how you otherwise choose to initially handle the situation, you are encouraged to report the situation to ANS. It is possible that the behavior you experienced is part of a larger pattern of repeated harassment. Please alert ANS to behavior you feel to be harassment regardless of the offender's identity or standing in the Society.

The designated contact for reports at NPIC&HMIT 2019 is this meeting's General Cochair Dan Churchman. Mr. Churchman can be reached by email at dchurchm@southernco.com or phone at 205-757-8376, or you can leave a message at the ANS Registration Desk for him to contact you directly.

The complete Respectful Behavior Policy can be found at www.ans.org/about/rbp. If you have questions about the policy, please contact ANS Executive Director Bob Fine at 708-579-8200 or rfine@ans.org.

ANS CODE OF ETHICS

Preamble

Recognizing the profound importance of nuclear science and technology in affecting the quality of life throughout the world, members of the American Nuclear Society (ANS) are committed to the highest ethical and professional conduct.

Fundamental Principle

ANS members as professionals are dedicated to improving the understanding of nuclear science and technology, appropriate applications, and potential consequences of their use.

To that end, ANS members uphold and advance the integrity and honor of their professions by using their knowledge and skill for the enhancement of human welfare and the environment; being honest and impartial; serving with fidelity the public, their employers, and their clients; and striving to continuously improve the competence and prestige of their various professions.

ANS members shall subscribe to the following practices of professional conduct:

Principles of Professional Conduct

1. We hold paramount the safety, health, and welfare of the public and fellow workers, work to protect the environment, and strive to comply with the principles of sustainable development in the performance of our professional duties.
2. We will formally advise our employers, clients, or any appropriate authority and, if warranted, consider further disclosure, if and when we perceive that pursuit of our professional duties might have adverse consequences for the present or future public and fellow worker health and safety or the environment.
3. We act in accordance with all applicable laws and these Practices, lend support to others who strive to do likewise, and report violations to appropriate authorities.
4. We perform only those services that we are qualified by training or experience to perform, and provide full disclosure of our qualifications.
5. We present all data and claims, with their bases, truthfully, and are honest and truthful in all aspects of our professional activities. We issue public statements and make presentations on professional matters in an objective and truthful manner.
6. We continue our professional development and maintain an ethical commitment throughout our careers, encourage similar actions by our colleagues, and provide opportunities for the professional and ethical training of those persons under our supervision.
7. We act in a professional and ethical manner towards each employer or client and act as faithful agents or trustees, disclosing nothing of a proprietary nature concerning the business affairs or technical processes of any present or former client or employer without specific consent, unless necessary to abide by other provisions of this Code or applicable laws.
8. We disclose to affected parties, known or potential conflicts of interest or other circumstances, which might influence, or appear to influence, our judgment or impair the fairness or quality of our performance.
9. We treat all persons fairly.
10. We build our professional reputation on the merit of our services, do not compete unfairly with others, and avoid injuring others, their property, reputation, or employment.
11. We reject bribery and coercion in all their forms.
12. We accept responsibility for our actions; are open to and acknowledge criticism of our work; offer honest criticism of the work of others; properly credit the contributions of others; and do not accept credit for work not our own.

SATURDAY, FEBRUARY 9

NPIC&HMIT 2-Day Training Course (Day 1)

Chair: Chad Kiger (*AMS Corporation*)

Location: Palani **Time:** 8:00 am-5:00 pm

This course is designed for technical and management personnel in utilities, vendors, government, national labs, and universities to learn the basics of nuclear power plant digital I&C qualification and the licensing process.

KEY COURSE TOPICS - DAY 1

- Digital I&C Qualification Standards and Guidelines Commercial Grade Dedication
- Electromagnetic Compatibility Considerations Common Cause Failures
- Software Reliability Testing
- Cyber Security
- Sensor and Cable Considerations
- Human Factors
- Control Room Design
- Wireless Technology Implementation

SUNDAY, FEBRUARY 10

NPIC&HMIT 2-Day Training Course (Day 2)

Cochairs: Ted Quinn (*ANS Past President, Technology Resources*), Steve Geier (*NEI Director*)

Location: Palani **Time:** 8:00 am-5:00 pm

This course is designed for technical and management personnel in utilities, vendors, government, national labs, and universities to learn the basics of nuclear power plant digital I&C qualification and the licensing process.

KEY COURSE TOPICS - DAY 2

- NRC Strategic Plan
- NEI Overview
- EPRI Update
- Overview of Utility Experiences
 - Westinghouse
 - Framatome
 - Lockheed Martin
 - Rolls Royce
- Overview of Utility Experiences
- Overview of International Experiences

Opening Reception

Location: Crystal DE **Time:** 6:00-8:00 pm

All attendees are invited to enjoy an evening of networking. This event is included in your full meeting registration. Additional tickets are available for purchase at the following cost: \$100 each Ticket.

MONDAY, FEBRUARY 11

Opening Plenary

Location: Crystal ABC **Time:** 8:00-11:00 am

Speakers:

Tim O'Connor (*Senior Vice President and Chief Nuclear Officer, Xcel Energy*)

Eric Benner (*US Nuclear Regulatory Commission/Director, Division of Engineering*)

Suibel Schuppner (*Program Manager, Advanced Sensors and Instrumentation, Office of Nuclear Energy, U.S. Department of Energy*)

Alain Gobert (*Director of Engineering, EPRI*)

Clayton Scott (*Senior Vice President, Framatome*)

TUESDAY, FEBRUARY 12

Banquet

Location: Crystal ABC **Time:** 7:00-10:00 pm

Stan Gibson, Executive with Wells Fargo is also a Life Coach. Come and prepare to be entertained as he shares with us his thoughts on Leading a Rich Life.

Speaker:

Stan Gibson (*Wells Fargo*)

Plenary, Special Sessions & Events



#ANSMeeting

Technical
Sessions:
Monday
February
11

MONDAY, FEBRUARY 11
TECHNICAL SESSIONS - 12:30 PM

I&C Research for LWRs—I

Chair: Ahmad Al-Rashdan (*INL*)

Location: Palani A **Time:** 12:30-1:45 pm

12:30 pm: Emergency Core Cooling System Criteria for Triplex Silicon Carbide Cladding, Robby Christian, Hyun Gook Kang (*RPI*)

12:55 pm: Identification of Nuclear Transient with Clustering Analysis, Junyung Kim, Inseop Jeon, Sanghun Lee, Hyun Gook Kang (*RPI*)

1:20 pm: Risk and Cost Analysis of Utilizing FLEX Equipment During Online Maintenance in Nuclear Power Plants, Vaibhav Yadav Jason K. Hansen, Shawn St. Germain (*INL*), Robby Christian (*RPI*)

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

Cochairs: Suibel H. Schuppner (*DOE*), Craig Primer (*INL*)

Location: Palani B **Time:** 12:30-2:10 pm

12:30 pm: An Approach to Model-Based Testing of Instrumentation with an Embedded Digital Device, Richard T. Wood (*Univ of Tennessee, Knoxville*), Brent D. Shumaker (*AMS*), Carol S. Smidts (*Ohio State*), Carl Elks (*Virginia Commonwealth Univ*)

12:55 pm: Temperature Sensing In Nuclear Facilities: Application of the Phase Change Effect of Chalcogenide Glasses, Al-Amin Ahmed Simon, Karishmae Kadrager, Baharceh Badamchi, Harish Subbaraman, Maria Mitkova (*Boise State Univ*)

1:20 pm: Acoustic Communication over Metal Pipes in Nuclear Facilities, Alexander Heifetz, Xin Huang, Roberto Ponciroli, Sasan Bakhtiari, Richard Vilim (*ANL*), Jafar Saniee (*IIT*)

1:45 pm: Self-Powered Wireless Through-Wall Data Communication for Nuclear Environments, Youngjia Wu, Lei Zuo (*Virginia Tech*), Suresh Kaluvan, Haifeng Zhang (*Univ of North Texas*), Nance Ericson, Kyle Reed, Roger Kisner (*ORNL*)

SMR Instrumentation and Control—I

Chair: Chris Hope (*NuScale*)

Location: Nomeus **Time:** 12:30-2:10 pm

12:30 pm: Improvements on Control Systems of a Small Modular Reactor Under Fault Conditions, Cao Huasong, Peiwei Sun (*Xi'an Jiaotong Univ*)

12:55 pm: Sensor Performance Verification in Small Modular Reactors, A. H. Hashemian, E. T. Riggsbee, S. N. Tyler, T. A. Toll (*AMS*)

1:20 pm: Auxiliary Feedwater Reheating to Mitigate Primary and Secondary Side Thermal Stressors, Konor Frick, J. Michael Doster (*NCSU*), Shannon Bragg-Sitton (*INL*)

1:45 pm: Control and Load Balancing with the IRIS IPWR in a High Renewables Penetration Grid, Richard Bisson, Jamie Coble (*Univ of Tennessee, Knoxville*)

MONDAY, FEBRUARY 11

TECHNICAL SESSIONS - 12:30 PM

Human Performance and Reliability

Chair: Ronald L. Boring (*INL*)

Location: Tarpon **Time:** 12:30-2:10 pm

- 12:30 pm:** Comparison of Operation Characteristics in the Environment of Conventional MCR and Advanced MCR Under Simulated Emergency, Sun Yeong Choi (*KAERI*), Eunchan Lee (*KHNP*)
- 12:55 pm:** A Human Error Detection System in Nuclear Power Plant Operations, Jeeyea Ahn, Junyong Bae, Seung Jun Lee (*UNIST*)
- 1:20 pm:** Human Reliability on Identification Tasks: Effects of Human-System Interface and Cognitive Task Type, Salvatore Massaiu, Alexandra Fernandes (*IFE*), invited
- 1:45 pm:** Human Reliability Considerations for the Transition from Analog to Digital Control Technology in Nuclear Power Plants, Ronald L. Boring, Kateryna Savchenko, Thomas A. Ulrich, Heather D. Medema (*INL*)

Virtual and Augmented Reality Applications

Chair: Mateo Ramos (*Tecnatom S.A.*)

Location: Walu **Time:** 12:30-2:10 pm

- 12:30 pm:** NBSR Virtual Reality Training Simulator, Dağistan Şahin (*NIST*), Kirill Stakhovsky (*Univ of Maryland*), Omar Cavazos (*Univ of North Texas*)
- 12:55 pm:** Simulation and Virtual Reality Applied to the Design's Validation of the Spanish Centralized Interim Storage Facility, Ricardo Garcia, Cristina Corrales, Mateo Ramos (*Tecnatom SA*)
- 1:20 pm:** Study on the Development Method of APR1400 Training Simulator Using Virtual and Emulated MMIS, Sung Kon Kang, Kyung Min Kim, Ki Hwan Kim, Yeon Sub Jung (*KHNP*)
- 1:45 pm:** Individualized Human-Machine Collaboration via User-Calibrated Haptic-Hand Interface, Anthony L. Crawford, Victor Walker (*INL*)

Diversity and Defense in Depth—I

Chair: Richard Wood (*UTK*)

Location: Zander **Time:** 12:30-2:10 pm

- 12:30 pm:** Diversity in FPGA-Based Platform and Platform Based I&Cs Applications: Strategy and Implementation, Anton Andrashov (*RadICS LLC*), Ievgenii Bakhmach, Kostyantyn Leontiiiev (*Radiy Research & Production Corp*), Vyacheslav Kharchenko, Eugene Babeshko, Andriy Kovalenko (*Center for Safety Infrastructure-Oriented Research and Analysis*)
- 12:55 pm:** A Study on How to Reconfigure Integrated Defense-in Depth (DiD) Risk Analysis System to Deal with Specific Risk Issues Flexibly, Hidekazu Yoshikawa (*Kyoto Univ*)
- 1:20 pm:** Best Estimate and Uncertainty Analysis for Safety Analysis and Plant Margins, Alessandro Petruzzi, Marco Cherubini (*NINEENG*), Edward L. Quinn, Jerry Mauck (*Technology Resources*)
- 1:45 pm:** Defence-in-Depth and Diversity: Challenges Related to I&C Architecture, Gregory Droba (*GE Hitachi Nuclear*)

Technical
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Technical
Sessions:
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MONDAY, FEBRUARY 11
TECHNICAL SESSIONS - 2:30 PM

Instrumentation for Advanced Reactors—I

Chair: Pooran Joshi (*ORNL*)

Location: Palani A **Time:** 2:30-3:45 pm

- 2:30 pm:** Load Following Operation and Transient Behavior of Molten Salt Demonstration Reactor, Vikram Singh, Alexander M. Wheeler, Belle R. Upadhyaya, Ondřej Chvá (*Univ of Tennessee, Knoxville*), M. Scott Greenwood (*ORNL*)
- 2:55 pm:** Supervisory Control of Sodium-Cooled Fast Reactor for Electric Power Operation, Taeseung Lee, Richard B. Vilim (*ANL*)
- 3:20 pm:** Development of an In-Situ Corrosion Monitor for Molten Salt Reactors, David E. Holcomb (*ORNL*), Roger A. Kisner (*ORNL (retired)*), K. Kyle Reed, James Bate, James R. Keiser (*ORNL*)

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

Cochairs: Suibel H. Schuppner (*DOE*), Craig Primer (*INL*)

Location: Palani B **Time:** 2:30-4:10 pm

- 2:30 pm:** Versatile Acoustic and Optical Sensing Platforms for Passive Structural System Monitoring, Jiaji He, Zach Hileman, Daniel Homa, Anbo Wang, Gary Pickrell (*Virginia Tech*), Alexander D. Braatz (*ORNL*), Brian Risch (*Prysmian Group*)
- 2:55 pm:** Wireless Reactor Power Distribution Measurement System Utilizing an In-Core Radiation and Temperature Tolerant Wireless Transmitter and a Radiation-Harvesting Power Supply, Jorge V. Carvajal, Shawn C. Stafford, Michael D. Heibel, Paul M. Sirianni, Melissa M. Heagy, Robert W. Flammang, Nicola G. Arlia (*Westinghouse*), James A. Turso, Kenan Unlu (*Penn State*)
- 3:20 pm:** Stress Sensing Technique via Subsurface Longitudinal Wave with Composite Transducer, Ho-Wuk Kim, Taeyang Kim, Daniel Morrow, Xiaoning Jiang (*NCSU*)
- 3:45 pm:** 3-D Chemo Mechanical Degredation State Monitoring, Diagnostics, and Prognostics of Corrosion Processes in Nuclear Power Plant Secondary Piping Structures, Cole Brubaker, Douglas Adams (*Vanderbilt Univ*)

Safety Critical Software—I

Chair: Roger Lew (*Univ of Idaho*)

Location: Nomeus **Time:** 2:30-3:45 pm

- 2:30 pm:** Qualification of Digital Instrumentation and Control Platform for use in Systems Important to Safety— Evaluation Guidance, Ismael L. Garcia (*NRC*)
- 2:55 pm:** Towards Model-Based Specification and Safety Assurance of Nuclear I&C Systems— Applicability of SYSML and AADL, Joonas Linnosmaa, Janne Valkonen (*VTT Technical Research Center of Finland*), Peter Karpati, André Hauge, Fabien Sechi, Bjørn Axel Gran (*OECD*)
- 3:20 pm:** Application of IEEE 1012-2004 IV&V to the Development Life Cycle of FPGA Based I&C Safety Systems for SMRs, Ben Frisk, Christopher Hope (*NuScale Power*)

MONDAY, FEBRUARY 11

TECHNICAL SESSIONS - 2:30 PM

General Topics I&C—I

Chair: Daniel Cole (*Univ of Pittsburgh*)

Location: Tarpon **Time:** 2:30-4:10 pm

- 2:30 pm:** Predictive Execution of Slower-than-Real-Time Software, Michael Pietrykowski, Carol Smidts (*Ohio State*)
- 2:55 pm:** Nuclear Power Plant Risk-Informed Surveillance Frequency Control Program Implementation for Instrumentation and Control Systems, James K. (Jim) Liming (*ABS Consulting*), Edward L. (Ted) Quinn (*Technology Resources*)
- 3:20 pm:** Exelon—Fitzpatrick Nuclear Power Plant Risk-Informed Surveillance Frequency Control Program Implementation for Instrumentation and Control Systems, Karim Habayeb, William Drews, David Poulin, John Raby, Anthony Yost (*Exelon Corp.*), Edward L. (Ted) Quinn (*Technology Resources*)
- 3:45 pm:** Equipment Qualification of FPGA-Based Platform RadICS to Meet U.S. NRC Requirements, Anton Andrashov (*Radics LLC*), Ievgenii Bakhmach (*Research and Production Corporation Rady*), Vyacheslav Kharchenko, Andriy Kovalenko, (*Centre for Safety Infrastructure-Oriented Research and Analysis*)

Cyber Security in Digital I&C—I

Chair: Hyun Gook Kang (*RPI*)

Location: Walu **Time:** 2:30-3:45 pm

- 2:30 pm:** A New International Standard on Cybersecurity for Nuclear Power Plants: IEC 62645—Cybersecurity Requirements, Edward L. Quinn (*Technology Resources*), Ludovic Pietre-Cambacedes (*EdF*), Thomas Walter (*PreussenElektra GmbH*)
- 2:55 pm:** The IEC Standard Series on Cybersecurity for I&C and Electrical Systems in Nuclear Power Plants, Edward L. Quinn (*Technology Resources*), Ludovic Pietre-Cambacedes (*EdF*), Thomas Walter (*PreussenElektra GmbH*), Juergen Bochtler (*Siemens AG*)
- 3:20 pm:** Challenges During the Implementation of Cyber Security at Nuclear Power Plants, Rajeev Kohli, John S. (Sid) Alvis (*Enercon*), invited

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TUESDAY, FEBRUARY 12
TECHNICAL SESSIONS - 8:00 AM

Big Data Analytics for Nuclear Power—Panel

Chair: M. Khafizov (*Ohio State*)

Location: Palani A **Time:** 8:00-9:30 am

Big Data technologies have experienced significant development in the past few years and have seen extensive application in power production, transmission, and distribution. An increasing number of nuclear organizations, i.e. utilities, vendors and research institutions are realizing that Big Data Analytics can provide significant improvements to the economics, efficiency, and safety of nuclear energy utilization. Potential implementations of Big Data Analytics for nuclear power include fault diagnosis and prognosis, maintenance and inventory optimization. Potential uses are also envisioned in reactor safety and performance, physical and cyber security, advanced manufacturing of reactor components, and nuclear regulatory and licensing issues. The panel will discuss opportunities and challenges in the application of Big Data Technologies to nuclear power plants.

Panelists:

Pradeep Ramuhalli (*PNNL*)

Ahmad Al Rashdan (*INL*)

Carol Smidts (*Ohio State*)

Digital I&C Modernization—I—Barriers to Plant Digital Modernization Are Down—Panel

Chair: Raymond L. Herb (*Southern Nuclear*)

Location: Palani B **Time:** 8:00-9:30 am

The last 18 months have seen significant breakthroughs addressing barriers to the design, economics and licensing of digital protection systems. The time is now to upgrade aging analog protection systems. The panel will discuss how the regulatory, design and monetary barriers have fallen, making now the best time in years to leap to an efficient, reliable and cost effective digital solution that enhances safety and reduces operating costs. This will change the complexion of the U.S. Nuclear fleets modernization planning for the next decade. This is Part I of a two-part series on Digital Modernization, stay for Part II and see how three Utilities plan to leverage these opportunities.

Panelists:

Warren Odess-Gillett (*Westinghouse*)

Matt Gibson (*EPRI*)

Pareez Golub (*EXCEL Services Corp*)

In-Pile Instrumentation Development for Test Reactor Experiments—Panel

Chair: Brenden J. Heidrich (*INL*)

Location: Nomeus **Time:** 8:00-9:30 am

The In-Pile Instrumentation program was formed in 2017 to conduct research and development to develop and deploy instrumentation to provide real time, accurate, spatially resolved information regarding test conditions and the performance of fuels and materials during irradiation. The program has developed instrumentation for us in the Advanced Test Reactor and the TREAT facility at INL, but has tested instruments at other reactors in the U.S. and the BR-2 reactor in Belgium. The panel will discuss the R&D activities of the last two years and the path forward for the program, including mitigating the loss of the Halden Reactor capabilities for the nuclear fuels and materials community.

Panelists:

Brenden Heidrich (*INL*)

Patrick Calderoni (*INL*)

Troy Unruh (*INL*)

Joshua Daw (*INL*)

David Hurley (*INL*)

Brian Jaques (*Boise State Univ*)

Kevin Chen (*Univ of Pittsburgh*)

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TUESDAY, FEBRUARY 12

TECHNICAL SESSIONS - 8:00 AM

General Topics in I&C—II

Chair: Ken Thomas (*INL*)

Location: Tarpon **Time:** 8:00-9:15 am

- 8:00 am:** Design and Implement of a Modern Rod Control System, Doo-Hyung Choe, Jae-Hyuk Baeg, Suk-Hwn Jung (*Doosan Heavy Industries & Construction*), Steve Yang (*Doosan HF Controls Corp.*)
- 8:25 am:** Management of Engineering and Safety Knowledge Along Reactor Lifetime, Nguyen Thuy (*EdF R&D*)
- 8:50 am:** Revision of Regulatory Guidance on Electromagnetic Compatibility, David Dawood (*NRC*), Richard T. Wood (*Univ of Tennessee, Knoxville*)

Cyber Security in Digital I&C—II: Game Theoretic Approaches

Chair: Mitch McCrory (*SNL*)

Location: Walu **Time:** 8:00-9:15 am

- 8:00 am:** A Sequential Game-Theoretic Approach to Defending Nuclear Systems from Cyber-Threats, Lee T. Maccarone, Daniel G. Cole (*Univ of Pittsburgh*)
- 8:25 am:** A Game Theoretic Approach for Responding to Cyber-Attacks on Nuclear Power Plants, Yunfei Zhao (*Ohio State*), Linan Huang (*New York Univ*), Carol S. Smidts (*Ohio State*), Quanyan Zhu (*New York Univ*)
- 8:50 am:** A Game-Theoretic Approach to Defending Nuclear Systems from Stuxnet-Type Attacks, Lee T. Maccarone, Daniel G. Cole (*Univ of Pittsburgh*), Nageswara S.V. Rao, Alexander M. Melin, Sacit M. Cetiner (*ORNL*)

TECHNICAL SESSIONS - 9:45 AM

Advances in Surveillance, Diagnostics and Prognostics—I

Chair: Vivek Agarwal (*NL*)

Location: Palani A **Time:** 9:45-11:00 am

- 9:45 am:** Intelligent Support System to Diagnose Abnormal States of Nuclear Power Plants, Jae Min Kim, Gyumin Lee, Seung Jun Lee (*UNIST*)
- 10:10 am:** A Machine Learning Method Integrating Neural Networks and Gaussian Processes for LOCA Identification in BWR, Miltiadis Alamaniotis (*Univ of Texas at San Antonio*), Asok Ray (*Penn State*)
- 10:35 am:** Identification of Transients of Nuclear Power Plants Using Deep Neural Networks, Young Do Koo, Ju Hyun Back, Man Gyun Na (*Chosun Univ*)

Digital I&C Modernization—II: The Path is Open, So Where Do We Go From Here?—Panel

Chair: Pareez Golub (*EXCEL Services Corp*)

Location: Palani B **Time:** 9:45-11:30 am

Building on the first part, this panel will feature three forward thinking Utilities and their plans to capitalize on the new direction in digital modernization to leverage the reduced barriers. Panel session topics will include: fleetwide modernization initiatives, goals, and planning efforts; plans to align industry research initiatives to maximize the benefits of plantwide modernization; and innovative design process efficiencies to take advantage of standard design processes. Come and find out how these utilities plan to take advantage of digital technology to reduce O&M costs, improve plant operations, and prepare for extended plant operation with a modern workforce. Make sure to attend Part I of the two part series on Digital Modernization to get the full picture.

Panelists:

Raymond Herb (*Southern Nuclear*)
John Connelly (*Exelon*)
Neil Archambo (*Duke*)

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TECHNICAL SESSIONS - 9:45 AM

In-Pile Instrumentation Research and Development—I

Chair: Brendan Heidrich (*INL*)

Location: Nomeus **Time:** 9:45-11:25 am

- 9:45 am:** First-Principles Studies of Dopant and Radiation Defect Effects on Optical Fiber Sensors, Thiago H. da Silva, Drew Butler, Austin Biaggne, Nirmala Kandadai, Harish Subbaraman (*Boise State Univ*), Joshua Daw (*INL*), Lan Li (*Boise State Univ/ Center for Advanced Energy Studies*)
- 10:10 am:** Embedded Fiber Optic Sensors for In-Pile Applications, Christian Petrie, Niyanth Sridharan (*ORNL*), Curtis Frederick, Travis McFalls, Sudarsanam Suresh Babu (*Univ of Tennessee*), Adam Hehr, Mark Norfolk (*Fabrisonic LLC*), John Sheridan (*Sheridan Solutions LLC*)
- 10:35 am:** Suitability of Type-II Fiber Bragg Gratings in Silica Optical Fiber for Temperature Sensing in TREAT, Kelly M. McCary, Brandon A. Wilson, Anthony H. Birri, Christian Petrie (*ORNL*), Thomas E. Blue (*Ohio State*)
- 11:00 am:** Suitability of Type-II Fiber Bragg Gratings in Sapphire Optical Fiber for Temperature Sensing in TREAT, Brandon Wilson, Kelly McCary, Christian Petrie (*ORNL*), Thomas Blue (*Ohio State*)

Verification and Validation—I

Chair: Jeffrey Clark Joe (*INL*)

Location: Tarpon **Time:** 9:45-10:35 am

- 9:45 am:** Application of Systems Usability Case in an Integrated System Validation of Control Room, Hanna Koskinen, Jari Laarni, Marja Liinasuo (*VTT Technical Research Centre of Finland*), Leena Salo (*Fortum Power and Heat Oy*)
- 10:10 am:** Enhancement Framework for Human Factors Engineering Review Model on Beyond-Design Basis Events Conditions, Jun Kawai, Yuto Horiuchi (*NSR*)

Human Factors for Small Modular Reactors

Chair: Thomas A. Ulrich (*INL*)

Location: Walu **Time:** 9:45-11:00 am

- 9:45 am:** Integrated Approach to Advanced Reactor Operations and Control Room Design, Roger Lew (*Univ of Idaho*), Chris Poresky (*Univ of California, Berkeley*), Thomas A. Ulrich, Ronald L. Boring (*INL*)
- 10:10 am:** Advanced Reactor Control and Operations (ARCO): A University Research Facility for Developing Optimized Digital Control Rooms, Christopher Poresky, James Kendrick, Per F. Peterson (*Univ of California, Berkeley*), Roger Lew (*Univ of Idaho*), Thomas Ulrich, Ronald L. Boring (*INL*)
- 10:35 am:** Human-Centered Design and Concept of Operations (ConOps) for SMART MCR, Ali Al-Qublan (*KACARE*)

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TECHNICAL SESSIONS - 9:45 AM

Advances in Productivity, Efficiency, and Design

Chair: Shawn St. Germain (*INL*)

Location: Zander **Time:** 9:45-11:00 am

9:45 am: Recent Developments in Implementation of Defense-in-Depth Methodology in the Digital I&C Testbed to Study Protection and Safety Systems in NPPs, Yongkyu An, Rizwan Uddin (*Univ of Illinois*)

10:10 am: Justification of Commercial Industrial Instrumentation and Control Equipment for Nuclear Power Plant Applications, Sofia Guerra (*Adelard LLP*), Steven Arndt (*NRC*), Janos Eiler (*IAEA*), Ron Jarrett (*TVA*), Horst Miedl (*TüV Rheinland*), Andrew Nack (*Paragon*), Paolo Picca (*Office of Nuclear Regulation*)

10:35 am: Robust Design of a Safety Display System, Glenn E. Lang Craig Pfladderer, Alan Slater, Patricia L. Barnes, Micah Drake (*Lockheed Martin Corp.*)

TECHNICAL SESSIONS - 12:30 PM

Advances in Sensing and Control—I

Chair: Jing Jiang (*The Univ of Western Ontario*)

Location: Palani A **Time:** 12:30-1:45 pm

12:30 pm: Development of Automation System Based on Artificial Intelligence for Startup and Shutdown Mode in Nuclear Power Plants, Hyeonmin Kim, Seo-Ryong Koo, Geon-Pil Choi, Jung Taek Kim (*KAERI*)

12:55 pm: A Series of Fiber Optic Radiation Monitoring Systems for Nuclear Power Plant, Keisuke Sasaki, Tooru Shibutani, Takahiro Itou, Takahiro Tadokoro, Shuichi Hatakeyama (*Hitachi*)

1:20 pm: Towards a Time Stable Fiber Optic Sensors for Harsh Environments, Sohel Rana, Bahareh Badamchi, Binay Joshi, Joshua Daw, Patrick Calderoni, James Smith (*INL*), Harish Subbaraman, Nirmala K. Kandadai (*Boise State Univ*)

I&C Modernization Experience—I

Chair: Raymond Herb (*Southern Nuclear*)

Location: Palani B **Time:** 12:30 -2:05 pm

12:30 pm: EPRI Digital Engineering Guide and the Standard Digital Design Process NISP-EN-004, Matt Gibson (*EPRI*)

1:15 pm: Approaches to Planning Activities for Digital I&C Systems Upgrade, Alvin M. Hinson, Roger D. Wyatt (*ENERCON*)

1:40 pm: Owner's Acceptance Reviews for Digital Upgrades, Michael J. Fillian, Roger D. Wyatt (*ENERCON*)

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TUESDAY, FEBRUARY 12
TECHNICAL SESSIONS - 12:30 PM

In-Pile Instrumentation Research and Development—II

Chair: Joshua Daw (*INL*)

Location: Nomeus **Time:** 12:30-1:45 pm

12:30 pm: The Use of X-Ray Inspection in the Development of In-Pile Instrumentation, Kurt Davis, Richard Skifton Josh Daw, Troy Unruh, Ashley Lambson, Patrick Calderoni (*INL*)

12:55 pm: Evaluation of Fast-Response Self-Powered Neutron Detectors in the TREAT Reactor, Kevin Tsai, Austin Fleming, Colby Jensen, Ryan Fronk, Troy Unruh, Eric Larsen, Cody Race (*INL*)

1:20 pm: State Feedback Reactor Control Using a Vanadium and Rhodium Self-Powered Neutron Detectors, Gokhan Corak, James A. Turso, Kenan Ünlu (*Penn State*)

Safety Critical Software—II

Chair: Benjamin Frisk (*NuScale*)

Location: Tarpon **Time:** 12:30-2:10 pm

12:30 pm: Configuration Management Process Using Classified Computer Code, Jang-Yeol Kim, Chang-Hwoi Kim (*KAERI*)

12:55 pm: Qualification of Logic Conversion Tools for Safety Applications, Steve Yang, Allen Hsu (*Doosan HF Controls Corp.*)

1:20 pm: Class-1-Compliant Design and Verification Process for FPGA-Based C&I System Utilizing Resource-Sharing Architecture and Formal Verification Methodology, Takumi Uezono, Toru Motoya, Katsunobu Natori, Satoshi Nishikawa, Keisuke Yamamoto, Tomokazu Takahashi, Shohei Nakamura, Goro Suzuki (*Hitachi*)

1:45 pm: Case Study for Tailoring and Adapting IEEE Std 1012 Software Verification and Validation Requirements for FPGA Technology, Mark Burzynski (*NewClear Day, Inc.*)

Advances in Visualization

Chair: Roger Lew (*Univ of Idaho*)

Location: Walu **Time:** 12:30-1:45 pm

12:30 pm: Interactive Visualization for Advanced Outage Control Center: A Literature Review, Nathan Lau, Hao Wang (*Virginia Tech*), Shawn St. Germain, Andrea S. Harvey (*INL*), Matthew B. Weinger, Shilo Anders (*Vanderbilt Univ Medical Center*)

12:55 pm: Visualization Strategy and Human-Machine Interface Development of a Data Driven Condition Monitoring System for Maintenance, Thomas A. Ulrich, Ronald L. Boring, Ahmad Al Rashdan (*INL*)

1:20 pm: Experience with Group-View, Wall Panel Displays Outside the Nuclear Industry, Richard Turk (*Technology Resources*), Richard Cooper (*A Typical High-End KVM System LLC*)

TUESDAY, FEBRUARY 12

TECHNICAL SESSIONS - 12:30 PM

Diversity and Defense in Depth—II

Chair: Pradeep Ramuhalli (*PNNL*)

Location: Zander **Time:** 12:30-1:45 pm

12:30 pm: Development of a Diversity and Defense-In-Depth Strategy for the TerraPower TWR-300 Advanced Nuclear Power Plant, Baofu Lu, Eric Williams (*TerraPower*), Jerry Mauck (*Technology Resources*), Richard Wood (*Univ of Tennessee, Knoxville*), Edward L. Quinn (*Technology Resources*)

12:55 pm: Reactor Safety System Failures in Historical Severe Accidents: Are Diverse Actuation Systems Barking up the Wrong Tree?, Gary Johnson (*Private Consultant*)

1:20 pm: Implementation of Post-Accident Monitoring Systems (PAMS) in Ukrainian NPP's, Taras Tkach (*NNEGC "Egergoatom"*), Sergiy Lebedynskyy, Volodymyr Lebedynskyy (*Private JSC Manometr-Kharakiv*)

TECHNICAL SESSIONS - 2:30 PM

Data Analytics—I

Chair: Carol S. Smidts (*Ohio State*)

Location: Palani A **Time:** 2:30-3:20 pm

2:30 pm: Automatic Anomaly Detection in Fuel Grab Load Trace Data Using a Knowledge- Based System vs. Multiple Deep Autoencoders, A. T. Young, W. Aylward, P. Murray, G. M. West, S, D. J. McArthur (*Univ of Strathclyde*)

2:55 pm: Monte Carlo Simulations to Evaluate Error Propagation in Computation of Thermal Power, Emil Wingstedt (*IFE*), Olli Saarela (*VTT Technical Research Centre of Finland*)

I&C Modernization Experience—II

Chair: Janos Eiler (*IAEA*)

Location: Palani B **Time:** 2:30 pm-3:45 pm

2:30 pm: Design and Implementation of a Reactor Safety System Digital Upgrade, Normal Air Radiation Monitor, Daniel A. Mattes, Dağistan Şahin (*NIST*)

2:55 pm: Key Success Factors for 2 Neutron Instrumentation Systems Modernization Projects Towards Digital, Arnaud Duthou, Aurélien Mattei (*Rolls-Royce Civil Nuclear*)

3:20 pm: NBSR Refueling Canon Control System Upgrade, Elia Shteimberg (*Nuclear Research Center*), Dağistan Şahin (*NIST*)

SMR Instrumentation and Control—II

Chair: Brian Gardes (*NuScale*)

Location: Nomeus **Time:** 2:30-3:45 pm

2:30 pm: Model Predictive Control for the Thermal Power of Modular High Temperature Gas-Cooled Reactor, Di Jiang, Zhe Dong, Xiaojin Huang (*Tsinghua Univ*)

2:55 pm: Distributed Control System Options for NuScale™, Brian J. Gardes, John M. McLerran (*NuScale*)

3:20 pm: Linear Stability Studies of a Natural Circulation-Based Small Modular Reactor, J. D. Rader, M. S. Greenwood, A. M. Melin, A. J. Wysocki (*ORNL*), G. M. Borza C. D. Lietwiler (*SMR Inventec, LLC*)

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TUESDAY, FEBRUARY 12 TECHNICAL SESSIONS - 2:30 PM

General Topics in I&C—III

Chair: Michael Doster (NCSU)

Location: Tarpon **Time:** 2:30-4:10 pm

- 2:30 pm:** Firmsys: Experiences and Different Architectures for the Application of the Digital Safety System According to International Standards to Nuclear Power Plants, Luis Rejas, Javier Lasierra, Ricardo Moya (*Tecnatom S.A.*)
- 2:55 pm:** Extending Live of Analog Systems Through Reverse Engineering and Repair, Tighe Smith, Robert Lane, Chris Harrington, Joe Garguilo (*Paragon Energy Solutions*)
- 3:20 pm:** Reassessment of the Qualified Life of Aged EDF PWR I&C Relays, Laurent Cretinon, Vivien Ballesio, Georges Wattiez, Dominique Talbourdet (*EDF*)
- 3:45 pm:** Enhanced Electrical Penetration Components Meet High Safety Standards Required for Long-Term Operation of Advanced Reactors Worldwide, Thomas Fink (*SCHOTT AG*), Shi Qi (*Chinergy Co., Ltd.*), Edward L. Quinn (*Technology Resources*), James F. Gleason (*GLSEQ, LLC*)

Digital Systems Modeling and Reliability—I

Chair: Yunfei Zhao (OSU)

Location: Walu **Time:** 2:30-4:10 pm

- 2:30 pm:** Development of Simulation-Based Testing Environment for Safety-Critical Software in Digitalized Nuclear Power Plant, Sang Hun Lee, Hyun Gook Kang (*RPI*), Seung Jun Lee (*UNIST*), Sung Min Shin (*KAERI*), Eun-chan Lee (*Korea Hydro & Nuclear Power Co., Ltd.*)
- 2:55 pm:** On Bayesian Estimation for Software Reliability, Y. Yang (*NRC*)
- 3:20 pm:** Reliability and Fault Tolerance Testing of a Nuclear Power Plant Digital Rod Position Indication Coil Diagnostic System, G. W. Morton, B. D. Shumaker, D. E. McCarter, S. D. Caylor, P. D. Brukiewa (*AMS*)
- 3:45 pm:** Safety Design Assessment for Digitalized Reactor Protection Systems for Research Reactors, Seung Ki Shin, Taekkyu Kim, Sang Mun Seo, Jinkyun Park (*KAERI*)

What's Next for Nuclear Energy? A Human Factors Perspective—Panel

Chair: Ronald Boring (INL)

Location: Zander **Time:** 2:30-4:00 pm

While there is great promise for nuclear energy, there is also the reality of lower cost energy sources that strain the competitiveness of the current fleet of commercial reactors. A 1000 MWe reactor might feature 1000 employees on staff, with 400 on site at all times. A similar combined cycle plant might have a total of 40 employees. Can human factors help ensure a bright future for nuclear energy? Is the key to successful nuclear energy the reduction of the workforce through increased automation? What human-machine interface technologies are on horizon, and what is their role in nuclear energy? This panel will join researcher, vendors, and regulator in a discussion on the promise and challenges of human factors in support of nuclear energy.

Panelists:

David Desaulniers (*NRC*)

Thomas Ulrich (*INL*)

Nathan Lau (*Virginia Tech*)

Kenji Mashio (*Mitsubishi*)

Christopher Poresky (*UC Berkeley*)

Salvatore Massaiu (*IFE*)

WEDNESDAY, FEBRUARY 13

TECHNICAL SESSIONS - 8:00 AM

I&C Research for LWRs—II

Chair: Craig Primer (*INL*)

Location: Palani A **Time:** 8:00-9:15 am

8:00 am: Technology Roadmap to Migrate Nuclear Power Plants to Data Driven Monitoring, Ahmad Al-Rashdan, Shawn St. Germain, Vivek Agarwal, Ronald Boring, Thomas Ulrich, Nancy Lybeck, James Smith, Christopher Ritter, Vaibhav Yadav (*INL*)

8:25 am: Methods of Data Collection for Online Monitoring, Shawn W. St. Germain, Ahmad Al Rashdan (*INL*)

8:50 am: Using Model-Based Fault Detection to Differentiate Transients and Loss of Coolant Accidents, Jacob A. Farber, Daniel G. Cole (*Univ of Pittsburgh*)

NRC Integrated Action Plan for Digital I&C and Future Regulatory Modernization—Panel

Chair: Michael D. Waters (*NRC*)

Location: Palani B **Time:** 8:00-9:30 am

This panel session will focus on improvements to the NRC regulatory program for digital I&C and future challenges to address. Panel session topics will include: recent changes to NRC guidance, industry-led guidance initiatives, perspectives on emergent technical and regulatory challenges, and broader opportunities to transform the NRC regulatory framework.

Panelists:

Strategic Plant Upgrades, Ray Herb (*Southern Nuclear*)

IO CFR 50.59 Upgrades, Neil Archambo (*Duke Energy*)

Advanced Reactor Technologies, Brian Gardes (*NuScale Power*)

Vender and International Perspectives, Mark Burzynski (*SunPort*)

Advanced Manufacturing for Sensors and Instrumentation—Panel

Chair: Christian Petrie (*ORNL*)

Location: Nomeus **Time:** 8:00-9:30 am

This session is focused on advanced manufacturing (AM) technologies for instrumentation and control of nuclear power systems. This includes the use of AM techniques to develop new sensors, embedding of more traditional sensors into nuclear components using AM processes, and in situ process monitoring of additively manufactured components.

Panelists:

Kevin Chen (*Univ of Pittsburgh*)

Matthew Davis (*Luna Innovations, Inc.*)

David Estrada (*Boise State Univ*)

Pooran Joshi (*ORNL*)

Troy Unruh (*INL*)

Verification and Validation—II

Chair: Nathan Lau (*Virginia Tech*)

Location: Tarpon **Time:** 8:00-9:15 am

8:00 am: Fleet Digital Upgrade Program and Control Room Modernization, Paul Hunton, Charles Kiplin Smith, Jason Watts (*Duke Energy*)

8:25 am: Development of a Fleet-Level Human Factors Engineering Program to Support the Digital Modernization of Multiple Turbine Control Systems, Jeffrey C. Joe, Ronald Boring, Thomas Ulrich (*INL*), Lewis Hanes (*Human Factors Independent Consultant*)

8:50 am: A Graded Approach to the Human Factors Validation of Turbine Control System Digital Upgrade and Control Room Modernization, Per Øivind Braarud, Høkan Svengren (*OECD*), Paul Hunton (*Duke Energy*), Jeffrey Joe (*INL*), Lew Hanes (*Independent Consultant*)

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WEDNESDAY, FEBRUARY 13

TECHNICAL SESSIONS - 8:00 AM

Computerized Procedures—I

Chair: Yochan Kim (*KAERI*)

Location: Walu **Time:** 8:00-9:15 am

8:00 am: Computerized Procedures: Field and Control Room Activities Coordination, Mateo Ramos, Javier Gil (*Tecnatom*)

8:25 am: Development of a Computer-Based Work Instruction Tool for Maintenance Workers in Nuclear Power Plants, Yutaka Iwaki, Masami Kamibayashi, Aya Ohori, Haru Ando (*Hitachi*)

8:50 am: Task Engine for Job and User Notification (TEJUN): A Tool for Prototyping Computerized Procedures, Roger Lew (*Univ of Idaho*), Ronald L. Boring, Thomas A. Ulrich (*INL*)

Online Condition Monitoring for Maintenance Optimization

Chair: Vaibhav Yadav (*INL*)

Location: Zander **Time:** 8:00-8:50 am

8:00 am: Resolving the Regulatory Issues with Implementation of Online Monitoring Technologies to Extend the Calibration Intervals of Process Instruments in Nuclear Power Plants, B. D. Shumaker, H. M. Hashemian (*AMS*)

8:25 am: Applications of On-Line Monitoring Within the Southern Nuclear Fleet, Brent D. Shumaker, Ryan D. O'Hagan (*AMS*), Randall C. Olson, Otis Seals (*SNOP*)

TECHNICAL SESSIONS - 9:45 AM

Advances in Surveillance, Diagnostics and Prognostics—II

Chair: Jamie Coble (*UTK*)

Location: Palani A **Time:** 9:45-11:25 am

9:45 am: Experience, Testing and Future Development of an Ultrasonic Inspection Analysis Defect Decision Support Tool for CANDU Reactors, C. Wallace, G. West, P. Zacharis, G. Dobie, A. Gachagan (*Univ of Strathclyde*)

10:10 am: Diagnosis of NPP's Pipe Thinning by Using Machine Learning Algorithms, Young Ho Chae, Poong Hyun Seong (*KAIST*), Jung Taek Kim (*KAERI*)

10:35 am: Fusion of Multiple Sensor Modalities to Detect Structural Degradation in Secondary Systems of Nuclear Power Plants, Andrei Gribok, Vivek Agarwal (*INL*)

11:00 am: Vibro-Acoustic Modulation to Detect and Localize Alkali-Silica Reaction (ASR)-Induced Macro-Cracking in Concrete Structures, Sarah Miele, Pranav Karve, Sankaran Mahadevan (*Vanderbilt Univ*), Vivek Agarwal (*INL*)

I&C Regulations, Standards and Guidelines—I

Chair: Edward Quinn (*Technology Resources*)

Location: Palani B **Time:** 9:45-11:00 am

9:45 am: Modernizing Approaches to Address Common Cause Failure in Digital Instrumentation and Control Systems, Rossnyev Alvarado, Steven A. Arndt (*NRC*)

10:10 am: Use of IEC and Other Alternative Standards in NRC Reviews, Steven A. Arndt (*NRC*)

10:35 am: New Methods of Accounting for the Potential for CCF in Digital I&C Modifications Performed Under the 10 CFR 50.59 Process, Wendell Morton, David L. Rahn (*NRC*)

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TECHNICAL SESSIONS - 9:45 AM

In-Pile Instrumentation Research and Development—III

Chair: Colby Jensen (*INL*)

Location: Nomeus **Time:** 9:45-11:25 am

9:45 am: Integral Fuel Rod Real-Time Wireless Sensor, Jorge V. Carvajal, Shawn C. Stafford, Jeffrey L. Arndt, Paul M. Sirianni, Melissa M. Heagy, Emre Tatli (*Westinghouse*), David M. Carpenter, Yakov Ostrovsky (*MIT*)

10:10 am: Development and Testing of Thermocouples for the Advanced Gas Reactor Fuel Experiment AGR-5/6/7, A. J. Palmer, R. S. Skifton, D. C. Haggard, W. D. Swank (*INL*), M. Scervini (*Univ of Cambridge*)

10:35 am: Infrared Thermography for In-Pile Imaging of Nuclear Fuel Cracking, Kevin Agarwal, Marat Khafizov (*Ohio State*), Robert Schley, Colby Jensen, David Hurley (*INL*), Nirmala Kandadai, Harish Subbaraman (*Boise State Univ*)

11:00 am: A Novel High Temperature Optical Waveguide Sensor for Nuclear Reactors, B. Badamchi, N. Kandadai, A. A. Simon, M. Mitkova, H. Subbaraman (*Boise State Univ*)

Control Room Modernization

Chair: Christopher Poresky (*UC Berkeley*)

Location: Tarpon **Time:** 9:45-11:00 am

9:45 am: Study and Implementation on General Procedure of CPR1000 Main Control Room in China, Shi Ji (*CNPDC*), Huang Qingwu, Zhou Chuangbin, Xu Liangjun (*CNPEC*), Jiang Hui (*CNPDC*)

10:10 am: Evolution of Plant Operation in Main Control Rooms of Nuclear Power Plants as a Consequence of Modernization Programs, Pedro Trueba-Alonso, Cristina Corrales-Quirós, Julio Méndez-Salguero, Luís Rejas-López (*Tecnatom S.A.*)

10:35 am: Development of a Strategy for Full Nuclear Plant Modernization, Jeffrey C. Joe, Casey Kovsdi, Ken Thomas, Craig Primer (*INL*)

Cyber Security in Digital I&C—III

Chair: Nguyen Thuy (*EdF*)

Location: Walu **Time:** 9:45-11:00 am

9:45 am: Quantifying Relative Importance of NPP Cyber Attack Probability Variables Based on Factor Analysis and AHP, Yong Sik Kim, Ho Sun Ryu, Hyun Ki Kim (*KHNP*), Moon Kyoung Choi, Chan Young Lee, Poong Hyun Seong (*KAIST*)

10:10 am: Suggestion of Initiating Threats and Bounding Groups for NPP Cyber Risk Assessment, Sang Min Han, Poong Hyun Seong (*KAIST*)

10:35 am: Development of a Conceptual Framework for Supporting Awareness of Cyber-Attack Situation in NPPs, Chanyoung Lee, Poong Hyun Seong (*KAIST*)

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WEDNESDAY, FEBRUARY 13

TECHNICAL SESSIONS - 12:30 PM

Transient Test Reactor Instrumentation: New Generation of Transient Testing Data Needs at TREAT—Panel

Chair: Colby Jensen (*INL*)

Location: Palani A **Time:** 12:30-2:15 pm

The Transient Reactor Test (TREAT) facility was restarted within the past year to support critical Department of Energy (DOE) missions including transient testing of advanced nuclear fuels and materials. Significant experimental capabilities including instrumentation for in-situ characterization are currently being sponsored under DOE programs. Transient test reactors play an serve various missions but are an essential component of nuclear materials R&D. This session will focus presentations on TREAT Instrumentation & Controls (I&C) for reactor operations and experiment data objectives, the TREAT in-core environment, and I&C for transient reactor applications around the world, including longstanding programs at ACRR and NSRR. The session will emphasize experience, opportunities, and needs and facilitate collaborative discussion in this area.

Panelists:

Randy Crane (*INL*)

Nicolas Woolstenhulme (*INL*)

Colby Jensen (*INL*)

Masaki Amaya (*JAEA*)

William (Billy) Martin (*SNL*)

I&C Regulations, Standards and Guidelines—II

Chair: Steven Arndt (*NRC*)

Location: Palani B **Time:** 12:30-1:45 pm

12:30 pm: Comparison of Internationally Used Terms and Definitions Important to the Safety Classification of Nuclear Power Plant I&C Systems, Gary Johnson (*Private Consultant*)

12:55 pm: Insights and Experience from the NRC Review of the APR1400 Instrumentation and Controls Design, Deanna Jing Zhang, Dawnmathews Kalathiveettil (*NRC*)

1:20 pm: Functional Approach to Nuclear Qualification of Instrumentation and Control, Janne S. Peltonen, Mohamed A. Mahmoud (*Fennovoima Oy*), Timo Latvala (*Space Systems Finland Ltd.*), Kauko Leiviskä (*Univ of Oulu*)

In-Pile Instrumentation Research and Development—IV

Chair: Jorge Carvajal (*Westinghouse*)

Location: Nomeus **Time:** 12:30-2:10 pm

12:30 pm: In-Pile Instrument to Measure Changes in Grain Microstructure, R. S. Schley, D. H. Hurley, Z. Hua, S. J. Reese (*INL*)

12:55 pm: Ultrasonic Sensors for Fuel Dimensional Monitoring During Transient Irradiation, Pradeep Ramuhalli (*PNNL*), Joshua Daw (*INL*), Andrew M. Casella, Richard Jacob, Morris Good, Robert O. Montgomery (*PNNL*)

1:20 pm: Capacitance-Based Dimensional Change Sensors for In-Pile Materials Measurements, Tyler Naughton (*Univ of Tennessee, Knoxville*), Christian Petrie (*ORNL*), Jamie Coble (*Univ of Tennessee, Knoxville*)

1:45 pm: Development of an In-Pile Diameter Gauge Based on an Electrical Impedance Measurement, Austin Fleming, Ahmad Al-Rashdan, Colby Jensen, Patrick Calderoni (*INL*)

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WEDNESDAY, FEBRUARY 13

TECHNICAL SESSIONS - 12:30 PM

Computerized Operator Support Systems

Chair: David Desaulniers (NRC)

Location: Tarpon **Time:** 12:30-2:10 pm

12:30 pm: Operator Support System with Diagnosis Abnormal Status by Convolutional Neural Networks, Yun Goo Kim, Sun Mi Choi, Tae Joon Kim, Jong Seol Moon, Do Hwan Lee (Korea Hydro and Nuclear Power Co. Ltd.)

12:55 pm: Development of Information System to Support Decision Making in Emergency Conditions, Kenji Mashio, Satoshi Hanada, Eisuke Noda, Mizuki Kasamatsu, Tomoyo Oka (MHI)

1:20 pm: Advanced Alarm Management: Implementation of Dynamic Prioritization and Filtering Methodology, José Enrique Gilabert, Jesús La Parra, Mateo Ramos (Tecnatom), Cristian Marciulescu (EPRI)

1:45 pm: Graphical Augmentation Interface for Yoked Overviews (GAIYO): A Tool for Building Overview Screens for Main Control Rooms, Thomas A. Ulrich, Ronald L. Boring (INL), Roger Lew (Univ of Idaho)

Digital Controls and Automation

Chair: Stephen Fleger (NRC)

Location: Walu **Time:** 12:30-1:45 pm

12:30 pm: Estimation of Operator's Required Time in Emergency Operations for Digital Control Rooms, Jinok Lee, Jonghyun Kim (Chosun Univ), Yun Goo Kim (Korea Hydro & Nuclear Power)

12:55 pm: Human Performance Shaping Factors for Micro Nuclear Reactors, Piyush Garg (Ohio State/Indian Inst of Technology (Kharagpur)), Yunfei Zhao, Carol Smidts (Ohio State)

1:20 pm: Level-of-Automation Considerations for Advanced Reactor Control Rooms, Ronald L. Boring, Thomas A. Ulrich, Torrey J. Mortenson (INL)

Cable Condition Monitoring

Chair: Robert Duckworth (ORNL)

Location: Zander **Time:** 12:30-2:10 pm

12:30 pm: Towards a Data Analytics Framework for Medium Voltage Power Cable Lifetime Management, Jose I. Aizpurua, Brian G. Stewart, Stephen D. J. McArthur (Univ of Strathclyde), Nitin Jajware (Bruce Power), Martin Kearns (EdF Energy), Sarajit Banerjee (Kinectrics Inc)

12:55 pm: A Cable Condition Monitoring Strategy for Safe and Reliable Plant Operation, C. Sexton, T. Toll, B. McConkey, G. Harmon (AMS)

1:20 pm: A Holistic Approach to Testing Cables, Connectors, Shielding, and End Devices in Nuclear Power Plants, J. B. McConkey, C. D. Sexton, G. R. Harmon, T. A. Toll (AMS)

1:45 pm: Rod Control System Coil and Cable Testing in Nuclear Power Plants, Bryan McConkey, Nick DeJulia, Trevor Jones (AMS)

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WEDNESDAY, FEBRUARY 13

TECHNICAL SESSIONS - 2:30 PM

Data Analytics—II

Chair: Marat Khafizov (*Ohio State*)

Location: Palani A **Time:** 2:30-3:45 pm

2:30 pm: Development of Data-Driven Classification Methods for Nuclear Fuel Forensic, Gayeon Ha, Sanghwa Lee, Gyunyoung Heo (*Kyung Hee Univ*), Hana Seo, Yujeong Choi (*Korea Inst of Nuclear Nonproliferation and Control*)

2:55 pm: Generalized Singular Value Decomposition for Sensor Anomaly Detection and Diagnostics, Michael Thompson (*Univ of Tennessee, Knoxville*), Benjamin Jordan (*Centrus Energy*), Jamie Coble (*Univ of Tennessee, Knoxville*)

3:20 pm: Uncertainty Error and Drift Evaluation Considerations Involving Analog to Digital Upgrades in Nuclear Power Plants, Richard W. Supler (*ENERCON*), invited

Wireless Technologies—I

Chair: Brent Shumaker (*AMS*)

Location: Palani B **Time:** 2:30-3:45 pm

2:30 pm: Design of a Wireless Sensing System for Deployment in Nuclear Decommissioning Environments, Antonio Di Buono, Peter R. Green, Barry Lennox (*Univ of Manchester*), Neil Cockbain (*NNL*), Xavier Poteau (*Sellafield Ltd*)

2:55 pm: Distributed Antenna Systems for Wireless Connectivity in Nuclear Power Plants, Chad J. Kiger (*AMS*)

3:20 pm: In-Situ Electromagnetic and Radio Frequency Interference Testing of Equipment in the Main Control Room of the Krško Nuclear Power Plant, Chad Kiger (*AMS*), Hrvoje Grganic (*Nukearna Elektrana Krško*)

In-Pile Instrumentation Research and Development—V

Chair: Christian Petrie (*ORNL*)

Location: Nomeus **Time:** 2:30-3:45 pm

2:30 pm: Taking Advantage of Intrinsic Processes for Process Monitoring, Diagnostics, and Prognostics, James A. Smith, Vivek Agarwal (*INL*)

2:55 pm: On the Use of SiC for Peak Irradiation Temperature Measurement, Ahmad Al-Rashdan, Troy Unruh, Mitchell A. Plummer, Patrick Calderoni, Kurt Davis (*INL*)

3:20 pm: In-Pile Applications of Fiber Bragg Grating Sensors and Distributed Fiber Sensors Enabled by Ultrafast Laser Fabrications, Mohamed Zaghoul, Sheng Huang, Mohan Wang, Kevin Chen, (*Univ of Pittsburgh*), Paul Ohodnicki, Michael Burie, Shiwoo Lee (*National Energy Technology Lab*), Cyril Hnatovsky, Dan Grobnic, Stephen Mihailov (*National Research Council Canada*), Ming-Jun Li (*Corning Research and Development Corp.*), David Carpenter, Lin Wen Hu (*MIT*), Joshua Daw (*INL*), invited

Verification and Validation—III

Chair: Casey Kovesdi (*INL*)

Location: Tarpon **Time:** 2:30-3:45 pm

2:30 pm: Experiences in the Application of NUREG -0711 Rev. 3 for Emergency Control Room Design and Verification, Luis Rejas, Borja Hervás (*Tecnatom S.A.*)

2:55 pm: Industry Deployment of Human Factors Engineering at Framatome, Wolfgang Krause, Asriel Eisinger (*Framatome GmbH*)

3:20 pm: Research About Operating Experience Review for HFE in Nuclear Power Plant, Yan Feng (*Ministry of Environmental Protection of the People's Republic of China*)

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WEDNESDAY, FEBRUARY 13

TECHNICAL SESSIONS - 2:30 PM

Digital Systems Modeling and Reliability—II

Chair: Pradeep Ramuhalli (*PNNL*)

Location: Walu **Time:** 2:30-4:10 pm

- 2:30 pm:** A Novel Reliability Model of Safety-Critical Software Based on Fatal-Severity Analysis of Detected Faults, Chao Guo, Shuqiao Zhou, Jianghai Li, Fan Chen, Xiaojin Huang (*Tsinghua Univ*)
- 2:55 pm:** Development of an Update to ISA S67.04 and RP 67.04: “Setpoints for Nuclear Safety-Related Instrumentation for Nuclear Power Plants”, Edward L. Quinn (*Technology Resources*), Wayne Marquino (*Ge Hitachi Nuclear Energy*), Ron Jarrett (*TVA*), Kirklyn Melson (*EXCEL Services Corp.*), David Rahn (*NRC*)
- 3:20 pm:** IAEA Coordinated Research Project on Enhancing Incident Response at Nuclear Facilities, Michael T. Rowland, Scott Purvis (*IAEA*), Rodney Busquim e. Silva (*Univ of Sao Paulo*)
- 3:45 pm:** Ensuring Robust Stability to Varying Control Rod Drive Dynamics in the Penn State Breazeale Nuclear Reactor, Adam Rau, James Turso (*Penn State*)

Cyber Security in Digital I&C—IV

Chair: Carol Smidts (*Ohio State*)

Location: Zander **Time:** 2:30-4:10 pm

- 2:30 pm:** One-Class Anomaly Detection for Instrumentation and Control Systems Based on Replicator Neural Networks, Wen Si, Jianghai Li, Xiaojin Huang (*Tsinghua Univ*)
- 2:55 pm:** Data-Driven Model Application for Attack Detection of SCADA System, Fan Zhang, J. Wesley Hines, Jamie Coble (*Univ of Tennessee, Knoxville*)
- 3:20 pm:** Dynamic Bayesian Networks Based Event-Classifer in Support for Reactor Operators in Case of Cyber-Security Threats, Pavan Kumar Vaddi, Yunfei Zhao, Xiaoxu Diao, Carol S. Smidts (*Ohio State*)
- 3:45 pm:** Enhancing Power Plant Safety Through Simulated Coupling with Digital Architecture, Susan S. Adams, Robert J. Bruneau, Nicholas L. Jacobs, Nicole Murchison, Daniel R. Sandoval, Bibiana E. Seng (*SNL*)

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THURSDAY, FEBRUARY 14

TECHNICAL SESSIONS - 8:00 AM

Instrumentation for Advanced Reactors—II

Chair: Richard Villim (*ANL*)

Location: Palani A **Time:** 8:00-9:15 am

- 8:00 am:** Some Unique Considerations in Supercritical Water-Cooled Reactor Based Nuclear Power Plants, Jin Jiang, Chao Zhang, Binggang Cui (*The Univ of Western Ontario*)
- 8:25 am:** Piezoresistive Characteristics of Silicon Carbide for Integrated Sensor Applications, Pooran Joshi, Tolga Aytug, Shannon Mahurin, Richard Mayes, Sacit Cetiner, Hong Wang, Ivan Kravchenko, Yanwen Zhang, Anton Ilevlev, Lauren Nuckols, Roger Kisner (*ORNL*)
- 8:50 am:** Automatic Generation Control Design for Multi-Modular Nuclear Plant, Zhe Dong, Miao Liu, Xiaojin Huang (*Tsinghua Univ*)

I&C Modernization Experience—III

Chair: Michael Rowland (*IAEA*)

Location: Palani B **Time:** 8:00-9:15 am

- 8:00 am:** I&C Modernization—Current Status and Difficulties, Johannes Pickelmann (*Framatome GmbH*)
- 8:25 am:** Strategic Modernization of Regulatory Framework for Instrumentation and Controls Systems in New and Advanced Reactors, Luis Betancourt, Dinesh Taneja (*NRC*)
- 8:50 am:** Successful Deployment of Safety I&C Modernization Toward Digital, Arnaud Duthou, Clara Pinhas, Aurélien Mattel, Yann Challamel (*Rolls-Royce*)

Computerized Procedures—II

Chair: Rachael Hill (*INL*)

Location: Nomeus **Time:** 8:00-9:15 am

- 8:00 am:** Writing the Future: The Procedure Writer's Perspective on Authoring Dynamic Procedures, Johanna Oxstrand, Rachael Hill, Katya Le Blanc (*INL*)
- 8:25 am:** Partial Procedure Based Automation Using by APR1400 Computerized Procedure System, Nokyu Seong, Yeonsub Jung, Chanho Sung (*Korea Hydro & Nuclear Power Central Research Inst*), Poonghyun Seong (*KAIST*)
- 8:50 am:** Is There a Business Case for a Computerized Procedure System in Nuclear?, Cristina Corrales, Javier Gil, Mateo Ramos (*Tecnatom S.A.*)

Wireless Technologies—II

Chair: Faranook Nekoogar (*Dirac Solutions*)

Location: Tarpon **Time:** 8:00-9:15 am

- 8:00 am:** Wireless Communication System with Self-Adaptive Wave Control and Hash-Based Authentication for Nuclear Power Plants, Hidehiko Kuroda, Takahiro Shirota, Yoshiro Ikeda, Takeshi Hasegawa, Naotaka Oda, Naoki Asano (*Toshiba Energy Systems & Solutions Corp*)
- 8:25 am:** Enhanced and Miniaturized Wireless Valve Position Indicator Prototype for Nuclear Power Plants, Vivek Agarwal, John W. Buttles, Ahmad Al-Rashdan (*INL*), Ryan Pitcher (*Idaho State Univ*), Chad J. Kiger (*AMS*)
- 8:50 am:** Enabling Secure and Cost-Effective Nuclear Power Plant Wireless Communications, Joshua Daley, Kandy Phan, Lon Dawson (*SNL*), Jason A. Abrahamson, Timothy McJunkin (*INL*)

THURSDAY, FEBRUARY 14

TECHNICAL SESSIONS - 8:00 AM

Advances in Sensing and Control—II

Chair: Troy Unruh (*INL*)

Location: Walu **Time:** 8:00-9:15 am

- 8:00 am:** Summary of High Temperature Irradiation Resistant Thermocouple Standardization Tests, Richard S. Skifton, Joe Palmer, Kurt Davis, Patrick Calderoni (*INL*), Ember Sikorski (*Boise State Univ*), Doug Corbett (*Idaho Laboratories Corp.*)
- 8:25 am:** High-Temperature, Dynamic Strain Test Platform to Evaluate Capacitance Based Strain Gauges for In-Pile Deployment, Anthony L. Crawford (*INL*), David Estrada, Kiyo Fujimoto (*Boise State Univ*)
- 8:50 am:** Feedwater Control System Design for Multi-Module Steam Generators in a Sodium-Cooled Fast Reactor, Xianshan Zhang, Peiwei Sun (*Xi'an Jiaotong Univ*)

TECHNICAL SESSIONS - 9:45 AM

Next-Generation I&C Systems

Chair: Ben Frisk (*NuScale*)

Location: Palani A **Time:** 9:45-11:25 am

- 9:45 am:** Templates, Databases and Other Harmonized Approaches to the Safety Justification of Embedded Digital Devices, Gareth Fletcher, Sofia Guerra, Nick Chozos (*Adelard LLP*)
- 10:10 am:** Emphasis Class 1 and Class 2 Assessment of Rosemount Pressure and Temperature Transmitters, Emily Saopraseuth, Nicholas Wienhold (*Emerson*), Eoin Butler, Sofia Guerra, Heidy Khlaff (*Adelard*)
- 10:35 am:** Natural Language Processing for Information Retrieval to Assist Nuclear Power Plant Outages, Glenn T. Gobbel, Ruth M. Reeves (*Vanderbilt Univ*), Shawn St. Germain (*INL*), Mark Pierson, Nathan Lau (*Virginia Tech*)
- 11:00 am:** Developing Next Generation Hardwired Safety I&C Technology, Arnaud Duthou, Aurélien Mattei, Alain Boue (*Rolls-Royce Civil Nuclear*)

General Topics in I&C Research—I

Chair: Miltiadis Alamaniotis (*UTSA*)

Location: Palani B **Time:** 9:45-11:25 am

- 9:45 am:** Tool-Based Method for Verifying the Specifications of I&C Systems, Guirec Audousse, Anne-Sophie Hintzy, Rushil Seewoonarain (*EdF*)
- 10:10 am:** Verifying Evolutions of Nuclear Power Plants Analog Regulations by Using Hardware-In-the-Loop Simulation, Gaëtan Robin, Anne-Sophie Hintzy, Stéphane Marchaud, Rachid Hamadi (*EdF*)
- 10:35 am:** Multi-Area Power System Regulation Based on HTR-PM600, Miao Liu, Zhe Dong (*Tsinghua Univ*)
- 11:00 am:** Justifying PLC-Based Applications with Limited Cooperation from Platform Supplier—The Cogs Approach, Gareth Fletcher, Sofia Guerra, (*Adelard LLP*)

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THURSDAY, FEBRUARY 14
TECHNICAL SESSIONS - 9:45 AM

State of the Art in Human Factors

Chair: Kenji Mashio (*Mitsubishi*)

Location: Nomeus **Time:** 9:45-11:00 am

9:45 am: Cognitive Heuristics and Biases in Process Control and Maintenance Work, Jari Laarni (*VTT Technical Research Centre of Finland*)

10:10 am: Exploring the Psychometrics of Common Post-Scenario Human Factors Questionnaires of Workload, Situation Awareness, and Perceived Difficulty, C. Kovesdi, J. Clark (*INL*)

10:35 am: Technical Specification Online Monitoring Tool, Javier Gil, Mateo Ramos, Luis Rejas, (*Tecnatom*)

Cyber Security in Digital I&C—V

Chair: Robert Bruneau (*SNL*)

Location: Tarpon **Time:** 9:45 -11:00 am

9:45 am: Application of a Graded Approach and Defense in Depth for Computer Security at Nuclear Facilities, Michael T. Rowland, Raja Abdul Raja Adnan, J. Scott Purvis, (*IAEA*)

10:10 am: Cryptographic Algorithm Function Validation Modeling for Nuclear I&C Systems, JunYoung Son, Jung Woon Lee, JongGyun Choi (*KAERI*), Hyunsoo Yoon (*KAIST*)

10:35 am: The Hole in Nuclear Plant Cyber Security—Insecure Process Sensors, Joseph Weiss (*Applied Control Solutions, LLC*), Juan Lopez (*ORNL*)

TECHNICAL SESSIONS - 12:30 PM

Data Analytics—III

Chair: Carol Smidts (*Ohio State*)

Location: Palani A **Time:** 12:30-1:45 pm

12:30 pm: Data Analytics for Data Driven Condition Monitoring, James A. Smith, Vivek Agarwal, Ahmad Al Rashdan (*INL*)

12:55 pm: Scheduling of Nuclear Power Plant Outages and Work During an Outage—A Review, Joseph Cochran, Subhash C. Sarin, Nathan Lau, (*Virginia Tech*)

1:20 pm: Fuzzy Data Fusion Utilizing Relevance Vector Machines with Application to Pressurized Water Reactor Monitoring, Miltiadis Alamaniotis (*Univ of Texas at San Antonio*)

General Topics in I&C Research—II

Chair: Fan Zhang (*UTK*)

Location: Palani B **Time:** 12:30-1:45 pm

12:30 pm: Leak Identification of Reactor Coolant Using an IR Thermography, Ye Ji An, Kwae Hwan Yoo, Ju Hyun Back, Young Do Koo, Man Gyun Na (*Chosun Univ*)

12:55 pm: Impact of CSPE Jackets on Accelerated Aging of Harvested Cable Insulations in Support of Remaining Useful Life Assessments, Sarah Davis (*Univ of Tennessee, Knoxville*), Robert C. Duckworth, Michelle K. Kidder, Tolga Aytug (*ORNL*)

1:20 pm: Thermal Energy Delivery System Operational Characteristics and Control Strategies, Konor Frick, Alexander Duenas, Piyush Sabharwall, JunSoo Yoo, Su-Jong Yoon, Carl Stoots, James E. O'Brien, Thomas O'Brien (*INL*)

THURSDAY, FEBRUARY 14
TECHNICAL SESSIONS - 12:30 PM

Advances in Surveillance, Diagnostics and Prognostics—III

Chair: Jamie Coble (*UTK*)

Location: Nomeus **Time:** 12:30-1:45 pm

12:30 pm: Mitigation Strategy Development Using Functional Modeling Method with Time-Related Information, In Seop Jeon, Sang Hun Lee, Hyun Gook Kang (*RPI*)

12:55 pm: Application of Higher Harmonics Diagnostic Method of Electric Power Source for Rapid Detection of Failed Electric Machine in a Real Nuclear Facility by Field Workers, Hidekazu Yoshikawa (*Non Profit Organization Symbio Community Forum*), Junya Nitta (*Arcadia Systems, Inc.*)

1:20 pm: Prediction of Hydrogen Concentration in Containment Under Severe Accident Conditions Using Deep Neural Networks, So Hun Yun, Young Do Koo, Man Gyun Na (*Chosun Univ*)

Multi-Stage Validation

Chair: Ronald L. Boring (*INL*)

Location: Tarpon **Time:** 12:30-1:45 pm

12:30 pm: Experience, Benefits and Lessons Learned from Multistage Verifications and Validations in the Human Factors Field for Nuclear Power Plants, Pedro Trueba-Alonso, Cristina Corrales-Quirós, Julio Méndez-Salguero (*Tecnatom S.A.*)

12:55 pm: Exploration and Development of Multi-Stage Validation as an Approach to Enhancing Confidence in the Human Factors Validation of Nuclear Power Plant Control Designs and Modifications, David R. Desaulniers (*NRC*)

1:20 pm: HFE Validation Using Multi-Stage Approaches, John O'Hara (*BNL*), Stephen Fleger (*NRC*)

Wireless Technologies—III

Chair: Chad Kiger (*AMS*)

Location: Walu **Time:** 12:30-1:45 pm

12:30 pm: Wireless Sensor Network Reliability for Real-Time Monitoring in Nuclear Power Plants, Madison McCarthy, Ataul Bari, Jin Jiang (*Univ of Western Ontario*)

12:55 pm: Ultra-Small Radiation Hardened Instrumentation for Wireless Radiation Detection Sensor Network, Inyong Kwon, Chang Hwoi Kim (*KAERI*), Gyuseong Cho (*KAIST*)

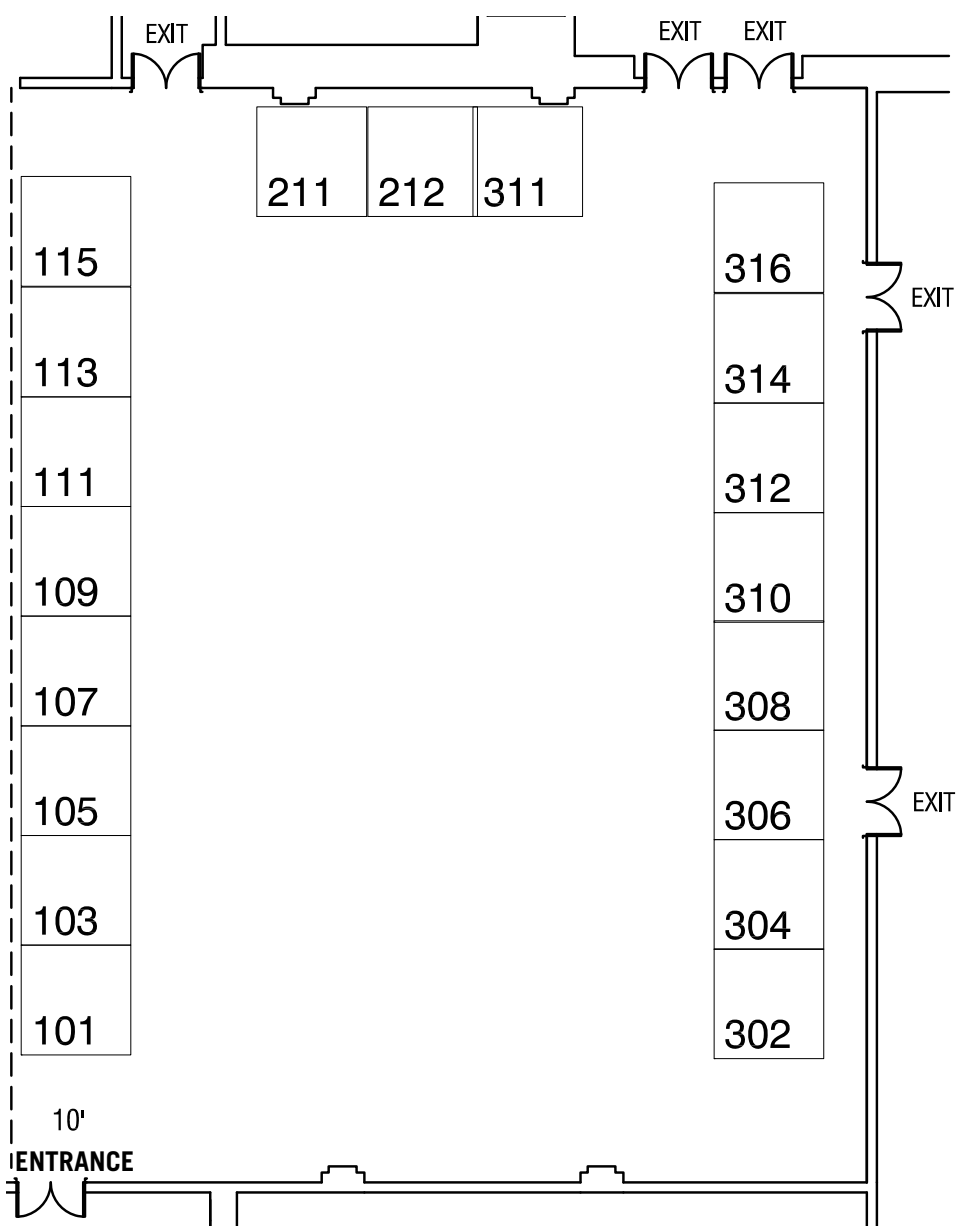
1:20 pm: Reliable Wireless Sensor Communication System for Nuclear Power Plants Using Ultra-Wideband Software-Defined-Radio, Faranak Nekoogar (*Dirac Solutions Inc.*), Farid Dowla (*LLNL*)

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Exhibitors List

Analysis and Measurement Services Corporation Booth 212	Mauell Corporation. Booth 312
Curtiss-Wright Booth 107	Nuclear News Booth 115
Doosan HF Controls Corporation. Booth 310	Otek Corporation Booth 302
EXCEL Services Corporation. Booth 311	Private JSC Manometr-Kharkiv . . . Booth 101
Framatome. Booth 103	RadICS. Booth 109
Idaho National Laboratory - Light Water Reactor Sustainability (LWRS) Program Booth 308	Rolls-Royce. Booth 211
Imperia Engineering Partners. Booth 113	TECNATOM. Booth 304
Lockheed Martin. Booth 306	Thermo Fisher Scientific. Booth 111
	Thinklogical, A Belden Brand Booth 314
	Ultra Electronics, Energy Booth 105

Exhibits



Hours

- Sunday: 6:00-8:00 pm
- Monday: 7:30 am-2:30 pm
- Tuesday: 7:30 am-2:30 pm
- Wednesday: 7:30 am-2:30 pm

Exhibitor & Expo Info

Analysis and Measurement Services Corporation

Knoxville, TN

Booth 212

AMS provides the worldwide nuclear industry with products and services to verify I&C performance. Our work covers in-situ response time testing of temperature and pressure sensors, cable condition monitoring, EMC qualification testing of digital I&C systems, wireless technology implementation for voice and data communication, rod control system testing, and I&C training.

Curtiss-Wright

Stratham, NH

Booth 107

Scientech, a product and service brand of Curtiss-Wright Nuclear, provides NRC certified digital safety systems, plant process computers, digital controls 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; repair, refurbish and reverse engineered I&C services; security and access authorization software; and mobile technology applications.

Doosan HF Controls Corporation

Carrollton, TX

Booth 310

Doosan HF Controls is a major supplier of instrumentation and controls equipment for the nuclear power industry. HFC's customers are located worldwide.

HFC has three product lines: AFS-1000, ECS-1200, and HFC-6000 Controllers.

HFC's product lines adopt the most current microprocessor and FPGA technology and has the highest reliability and safety standard of industrial equivalent products. HFC has also received US NRC SER and TUV SIL3 certifications for its HFC-6000 platform.

EXCEL Services Corporation

Rockville, MD

Booth 311

EXCEL Services Corporation provides operations, engineering, safety/regulatory services for the global energy industry, including License Renewal, Power Uprates, 24-Month Cycle Extensions, ITS Conversions/Upgrades, Training, New Nuclear Build, Critical Infrastructure Protection, and Executive Performance Solutions. In its 33-year history, EXCEL has worked globally and with every nuclear utility in the U.S.

Framatome

Lynchburg, VA

Booth 103

Framatome is a major international player in the nuclear energy market recognized for innovative solutions and value-added technologies for designing, building, maintaining, and advancing the global nuclear fleet. They design, manufacture, and install components, and fuel and instrumentation and control systems for nuclear power plants and offers a full range of reactor services.

Idaho National Laboratory - Light Water Reactor Sustainability (LWRS) Program

Idaho Falls, ID

Booth 308

The Light Water Reactor Sustainability Program, sponsored by DOE and coordinated with industry, vendors, suppliers, regulatory agencies, and other industry research and development organizations, conducts research to develop technologies and other solutions to improve economics and reliability, sustain safety, and extend the operation of nation's fleet of nuclear power plants.

Imperia Engineering Partners

Raleigh, NC

Booth 113

Imperia Engineering Partners provides engineering and technical services to nuclear facilities. We are project driven and understand our client's needs whether they are operational, financial, or strategic. Our Digital I&C group services include life cycle management and replacements with a focus on human factors, requirements engineering, analysis, V&V, and training.

Lockheed Martin

Archbald, PA

Booth 306

Headquartered in Bethesda, Maryland, Lockheed Martin is a global security and aerospace company that employs approximately 100,000 people worldwide. Lockheed Martin provides total systems solutions and services for civil nuclear power applications. Lockheed Martin has provided discrete and digital safety-critical instrumentation and control (I&C) systems for civil and DoD customers for over 60 years.

Mauell Corporation

Dillsburg, PA

Booth 312

Since 1971, Mauell Corporation specializes in simulation and control room equipment for the Nuclear power industry. Projects are purpose-built including glasstop digital simulators, reactor panel simulators, I&C, annunciators, operator workstations and advanced video display systems. Visit www.mauell.com for more information.

Exhibitor & Expo Info

Nuclear News

LaGrange Park, IL (Booth 115)

Celebrating its 60th anniversary in 2019, Nuclear News is the monthly membership magazine of the American Nuclear Society and reaches nearly 11,000 readers throughout 54 countries. News reports cover plant operations, maintenance and security; policy and legislation; international developments; waste management and fuel; and business and contract award news. Advertise or subscribe today at www.ans.org/nn. A complimentary copy of our February issue, featuring a special editorial section on Instrumentation and Controls, can be found in your registration bag.

Otek Corporation

Tucson, AZ (Booth 302)

OTEK Corporation designs and manufactures a comprehensive line of electronic instrumentation for digital process control and measurement. We specialize in replacements for the nuclear industry and maintain a Nuclear Quality Assurance 10CFR50 Appendix B Program. Our NTM Series is NEI 08-09 cyber compliant, while our SSAM Series is cyber exempt!

Private JSC Manometr-Kharkiv

Kharkiv, Ukraine (Booth 101)

Priv. JSC "Manometr- Kharkiv" – leading Ukrainian manufacturer of industrial pressure, level and flow transmitters, founded in 1997. The company has developed series of technical solutions for pressure and level measurement in harsh environments which are qualified for applications in safety related systems and PAMS in nuclear power plants.

RadICS

Kropyvnytskyi, Ukraine (Booth 109)

Radics LLC is a leading nuclear engineering company that develops and supplies advanced customized I&C solutions for international markets based on innovative, highly-reliable SIL 3 and NRC certified RadICS FPGA platform. Radics' applications developed under NQA-1 compliant Quality Assurance Program can be used for digital safety and control systems for NPPs and other process industries with high level of safety requirements during modernization and new build projects.

Rolls-Royce

Meylan, France (Booth 211)

Rolls-Royce pioneers cutting-edge technologies that deliver the cleanest, safest and most competitive solutions to meet our planet's vital power needs.

In the nuclear industry and for some 50 years, Rolls-Royce has been helping half the world's reactors to maximise plant operation.

Today, by combining data science, engineering and long term support solutions, we find new ways to increase nuclear reactor availability, efficiency and safety.

TECNATOM

Madrid, Spain (Booth 304)

Tecnatom S.A. was established in April 1957, and has grown into a multi-group international company with subsidiaries in France, Brazil, USA, China, Mexico and the UAE. The group's nuclear services include (i) training of NPP personnel (ii) Digital operation and asset management (iii) component inspection, Non-destructive Test (NDT) and structural integrity assessment (iv) Simulation and Human Factors Engineering.

Thermo Fisher Scientific

San Diego, CA (Booth 111)

Thermo Fisher Scientific is a leading provider of Class 1E qualified safety-related Nuclear Instrumentation systems and services for nuclear power plants world-wide. We manufacture neutron flux monitoring systems for all ranges of reactor power. Our systems demonstrate high immunity to EMI and noise and meet U.S. NRC RG 1.97 Post Accident Monitoring requirements. The company also offers radiation measurement systems, personnel dosimetry, data recorders, and radiation hardened cameras.

Thinklogical, A Belden Brand

Milford, CT (Booth 314)

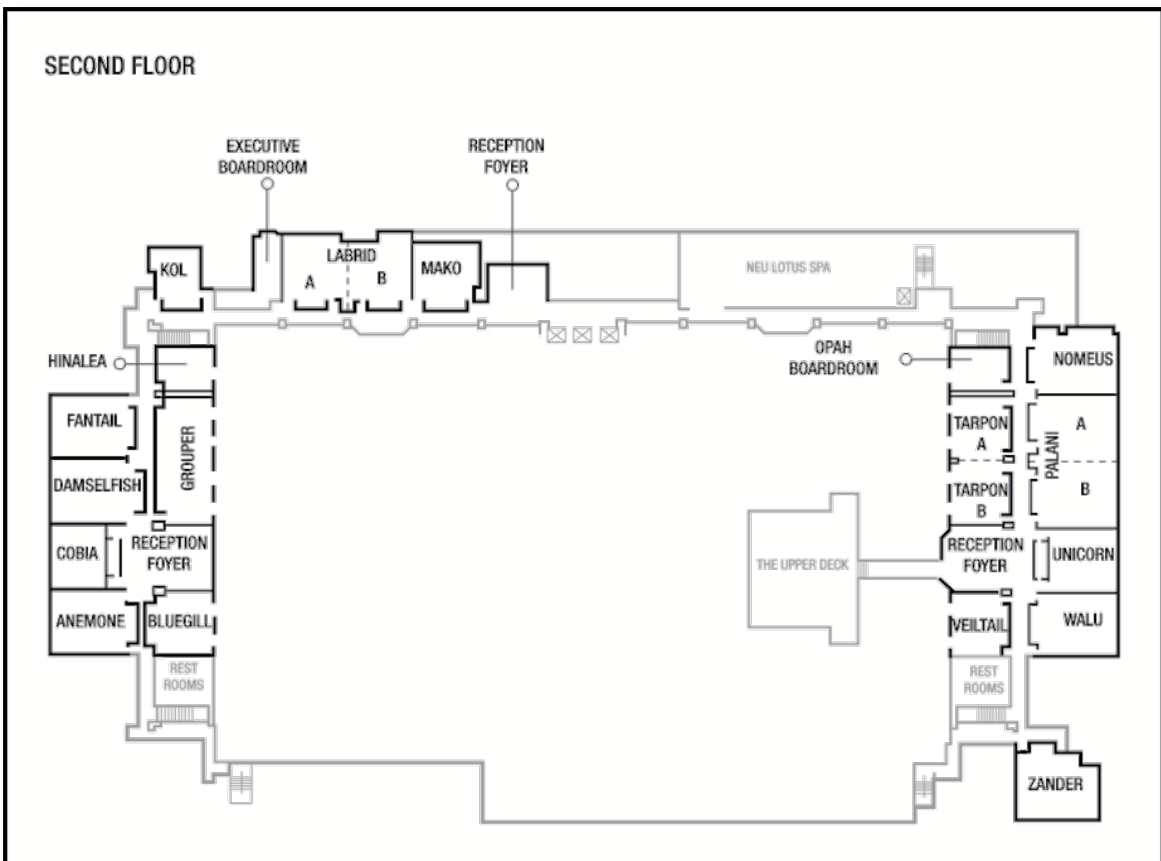
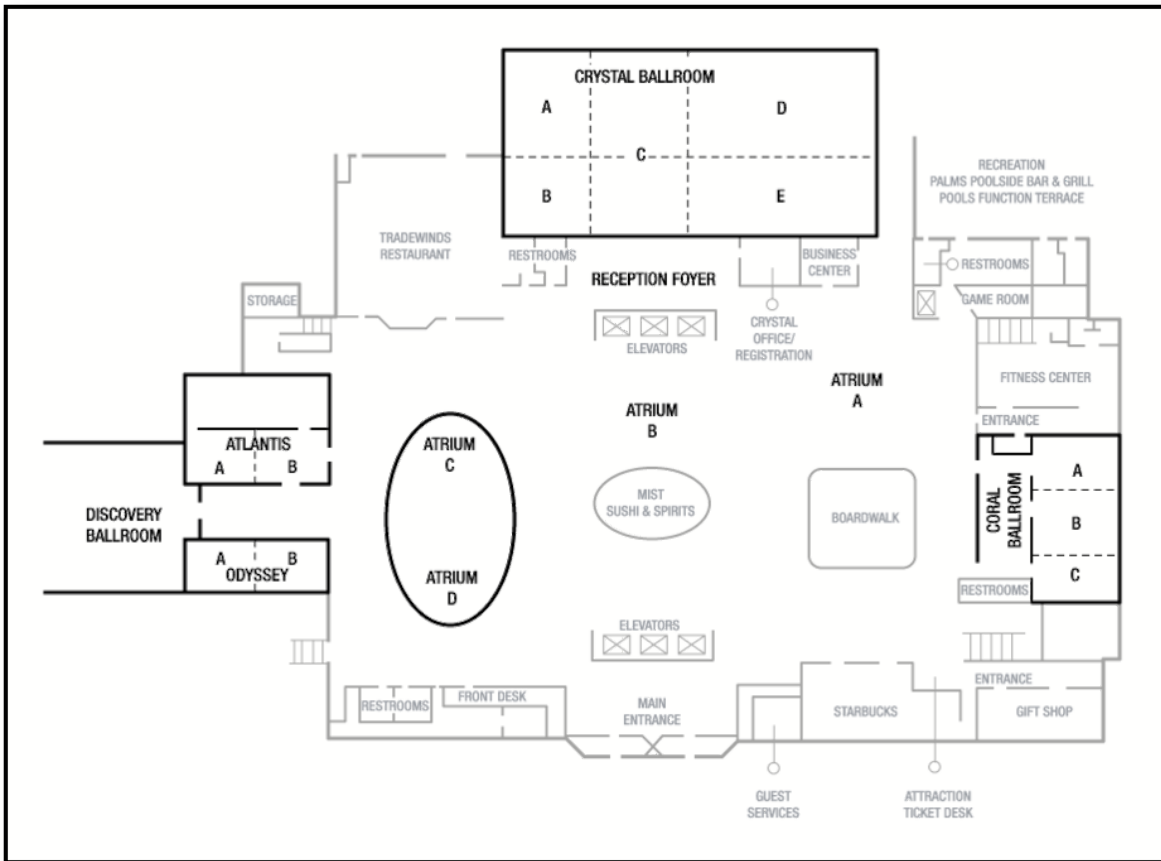
Thinklogical manufactures high-performance video distribution and KVM (keyboard, video and mouse) extension and switching solutions supporting AV and IT requirements for control rooms, operations centers, training, simulation and visualization applications. Thinklogical's highly-secure signal management products help address NERC-CIP cyber requirements, resulting in better data security, reduced costs and increased productivity.

Ultra Electronics, Energy

Dorset, UK (Booth 105)

Ultra Electronics Energy specialise in the supply of radiation detection systems to the nuclear industry. Product supplied include measurement instruments for dose-rate, contamination and the measurement of radioactive concentration in air and liquids. Ultra supports operating NPP's, fuel cycle facilities and decommissioning projects around the World.

Hotel Floorplan





ANS Meetings

NUCLEAR AND EMERGING TECHNOLOGIES FOR SPACE (NETS) 2019
FEB 25-27, 2019 | Richland, WA

INTERNATIONAL HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT 2019 (IHLRWM 2019)
APR 14-18, 2019 | Knoxville, TN | Knoxville Convention Center

2019 INTERNATIONAL TOPICAL MEETING ON PROBABILISTIC SAFETY ASSESSMENT AND ANALYSIS (PSA 2019)
APR 28-MAY 3, 2019 | Charleston, SC | Charleston Marriott

2019 ANS ANNUAL MEETING
JUN 9-13, 2019 | Minneapolis, MN | Hyatt Regency Minneapolis

UTILITY WORKING CONFERENCE AND VENDOR TECHNOLOGY EXPO
AUG 4-7, 2019 | Amelia Island, FL | Omni Amelia Island Plantation

19TH INTERNATIONAL CONFERENCE ON ENVIRONMENTAL DEGRADATION OF MATERIALS IN NUCLEAR POWER SYSTEMS - WATER REACTORS
AUG 18-22, 2019 | Boston, MA | Seaport Hotel & World Trade Center

18TH INTERNATIONAL TOPICAL MEETING ON NUCLEAR REACTOR THERMAL HYDRAULICS
AUG 18-22, 2019 | Portland, OR | Marriott Portland Downtown Waterfront

M&C 2019
AUG 25-29, 2019 | Portland, OR | Marriott Portland Downtown Waterfront

GLOBAL/TOP FUEL 2019
SEP 22-27, 2019 | Seattle, WA | The Westin Seattle

MATERIALS IN NUCLEAR ENERGY SYSTEMS (MINES)
OCT 6-10, 2019 | Baltimore, MD | Hilton Baltimore

2019 ANS WINTER MEETING AND NUCLEAR TECHNOLOGY EXPO
NOV 17-21, 2019 | Washington, DC | Marriott Wardman Park

EMBEDDED TOPICAL MEETING YOUNG PROFESSIONALS CONGRESS (YPC)
NOV 16, 2019 | Washington, DC | Marriott Wardman Park

