

PSAM 14

Probabilistic Safety Assessment and Management

16-21 September 2018 • UCLA Meyer & Renee Luskin Conference Center, Los Angeles, CA



PSAM14 Program Outline

Time	Room	Monday - Sept. 17	Tuesday - Sept. 18	Wednesday - Sept. 19	Thursday - Sept. 20	Friday - Sept. 21
08:00-09:45	Plenary	B. John Garrick	Peter Katona	Ali Moshleh	John Casani	
10:00-10:30		Mid-Morning Break				
	Exploration		T01 Special Session: HRA data analysis	W01 New Measures for HRA	Th01 Flex, Seismic, and Fire HRA	9:00-10:05
	Discovery	M02 Maintenance Modelling and Optimization	T02 Reliability Analysis II		Th02 Reliability Analysis IV	Legacy B
	Illumination	M03 Reliability Analysis I	T03 Uncertainty and Sensitivity Analysis I	W03 Site Level (Multi-Unit, Multi-Source) PSA/PRA II	Th03 Dynamic PSA/PRA IV	Legacy A
	Legacy A	M04 Risk and Hazard Analysis I	T04 Maritime and Offshore Technology I	W04 Oil and Gas Industry I	Th04 Oil and Gas Industry II	Legacy B
	Legacy B	M05 Risk Assessment Methods I	T05 Risk Assessment Methods II	W05 Risk Assessment Methods III	Th05 Risk Assessment Methods IV	
	Pathways	M06 Water and Land Transportation I	T06 Water and Land Transportation II	W06 Water and Land Transportation III		
	Laureate	M07 Risk Informed Applications I	T07 Panel Session: Risk Communication with Mid-Level Decision Makers	W07 Risk Informed Applications III	Th07 Risk Informed Applications IV	
12:00-01:30		Special Luncheon				
	Exploration	M11 Risk Perception and Communication	T11 Special Session: HRA data analysis II	W11 Dynamic HRA	Th11 External Events and Multi-Unit HRA	
	Discovery	M12 Prognostics and System Health Management I	T12 Mathematical Methods in Reliability and Safety II	W12 Mathematical Methods in Reliability and Safety III	Th12 Maritime and Offshore Technology II	
	Illumination	M13 Oil and Gas Industry	T13 Site Level (Multi-Unit, Multi-Source) PSA/PRA I	W13 Uncertainty and Sensitivity Analysis II	Th13 Consequence Modeling and Management II	
	Legacy A	M14 Industrial Safety	T14 Risk and Hazard Analysis II	W14 Internal Hazards PSA/PRA II	Th14 Risk and Hazard Analysis IV	
	Legacy B	M15 External Hazard PSA/PRA I	T15 External Hazard PSA/PRA II	W15 External Hazard PSA/PRA III	Th15 External Hazard PSA/PRA IV	
	Pathways	M16 Aeronautics and Aerospace I	T16 Dependence Modeling and Analysis	W16 Consequence Modeling and Management I	Th16 Aeronautics and Aerospace II	
	Laureate	M17 Special Session: Overview & Progress in NUPRA	T17 Risk Informed Applications II	W17 Nuclear Industry II		
03:00-03:30		Afternoon Break				
	Exploration	M21 HRA for Digital Interfaces	T21 Special Session: What's next for HRA data?	W21 Organizational Factors and Safety Culture		
	Discovery	M22 Structural Reliability Analysis Methods	T22 Health and Medicine	W22 Prognostics & System Health Management II	Th22 New Applications of HRA	
	Illumination	M23 Dynamic PSA/PRA I	T23 Dynamic PSA/PRA II	W23 Dynamic PSA/PRA III	Th23 Dynamic PSA/PRA V	
	Legacy A	M24 Internal Hazards PSA/PRA I		W24 Risk and Hazard Analysis III	Th24 Risk and Hazard Analysis V	
	Legacy B	M25 Accident Analysis and Modeling I	T25 Accident Analysis and Modeling II	W25 Uncertainty and Sensitivity Analysis III	Th25 Risk Assessment Methods V	
	Pathways	M26 Mathematical Methods in Reliability & Safety I	T26 Nuclear Industry I	W26 Water and Land Transportation IV		
	Laureate	M27 Special Session: Global and Catastrophic Risks	T27 Special Session: Population-based risk stratification in health	W27 Resilience Engineering	Th27 Special Session: Which Way SPRAs?	
07:00-10:30	Centennial Ballroom			Gala Dinner		



<http://psam14.org/proceedings.html>

Foreword

Dear Colleagues,

It is our honor to welcome you to Los Angeles, for the fourteenth rendition of the Probabilistic Safety Assessment and Management (PSAM) Conference. We have spent several years coordinating this meeting, and we hope that you take the time to participate in the conference events that we have planned, and that you spend a few days around the conference to enjoy the beautiful UCLA campus and Southern California. We know that many of you have brought your families along and we know they will enjoy the campus and the surrounding area as well.

The planning for PSAM 14 began back in 2014 (during PSAM 12 in Honolulu), when we looked at several locations around the United States, included Arizona, California and Boston, and even considered returning to Honolulu. The PSAM series of conferences began in Southern California, beginning with PSAM 1 held in 1991 in Beverly Hills, not far from the UCLA campus. 1994 saw PSAM 2 in San Diego. Following PSAM 2, the Board of Directors decided to look beyond California and subsequent PSAM conferences were held in Europe, Asia as well as New Orleans, Seattle, Honolulu and Puerto Rico. We decided it was time to return to Southern California. The beautiful new Luskin Conference Center seemed to be a natural choice for the venue, especially since it is right across the street from the recently established B. John Garrick Institute for the Risk Sciences at UCLA.

So after several years of planning, our conference will begin on Sunday, September 16 in the evening with an informal reception event. This will give you the opportunity to get your conference materials before the big opening on Monday, September 17. It will also give you the opportunity to socialize with your colleagues.

Although we will have registration open every day, all day, hopefully we can alleviate any rush handling as many registrations on Sunday.

Starting each day Monday through Thursday of the regular conference, will be a plenary session. We plan on having a variety of speakers from various aspects of the risk sciences. Dr. B. John Garrick, our Honorary Chair will give the opening Plenary and Keynote talk on Monday reflecting on the challenges faced in the risk sciences. Tuesday, Peter Katona, MD, will reflect on bioterrorism. Wednesday, Dr. Ali Mosleh will speak on model risk. Our gala dinner is Wednesday evening; and, Dr Roger McCarthy will, given this is the 30 year anniversary of the accident, reflect on the Piper Alpha tragedy. On Friday Dr. John Casani will reflect on mission assurance of planetary space missions.

On Tuesday we will have the conference luncheon. Lastly, we will close our conference on Friday, September 21, at noon with our customary ice cream.

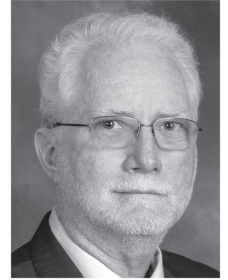
On behalf of the International Association for Probabilistic Safety Assessment and Management Board of Directors, we wish you all an enjoyable learning experience at the conference, a memorable stay in the Los Angeles area, and a safe journey home.

Dr. Enrique Lopez Droguett
Technical Program Chair

Dr. David Johnson
General Chair

Acknowledgement

The task of organizing any successful large meeting, conference, or event, requires the dedicated effort of many people. I would like to recognize three individuals specifically without whom our conference would not have been successful: Ms. Hanna Shapira, Dr. Enrique Lopez Droguett and Dr. Mihai Diaconeasa.



While many people have helped review this program, special recognition is given to Dr. Curtis Smith for his careful, detailed and thoughtful comments as well as his guidance for the conference.

Sponsoring organizations are also key to a successful conference. Once again, Lloyd's Register has stepped forward to be our major sponsor. Their support over many conferences is very much appreciated. The B John Garrick Institute for the Risk Sciences is also a key sponsor and an important source of person-power assuring smoothly running technical sessions. The support given by EPRI, The University of Maryland and ANS is also very much appreciated.

On a personal note, I would like to thank my mentor of more than 35 years, Dr. B John Garrick to agreeing to be our Honorary Chair and to give the keynote talk.

I also thank each of you participating in PSAM 14. The PSAM series of conferences are perhaps unique in that there is no 'sponsoring society' involved. While the conferences are overseen by a Board of volunteers, each of you attending a PSAM conference are its very heart. Without your participation, there would be no PSAM.

Thank you.

David Johnson
PSAM14 General Chair

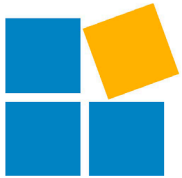
Welcoming Remarks

It is a pleasure to welcome the conferees of PSAM 14 to the UCLA campus. PSAM has become a major player in advancing the risk and safety sciences for the good of the people and the environment. It is fitting that PSAM 14 be located where it had its birth at a time when UCLA has launched an institution totally dedicated to the risk sciences. We hope you not only enjoy the conference, but all the cultural and entertainment this thriving community has to offer. We further hope that the spinoff of the conference will be new found advances in managing risks and the fueling of new collaborations for achieving a safer world.



B. John Garrick

Honorary Chairman, PSAM 14



The B. John Garrick Institute for the Risk Sciences

UCLA ENGINEERING

THE UCLA B. JOHN GARRICK INSTITUTE FOR THE RISK SCIENCES (GIRS) was established with a generous gift by Amelia and B. John Garrick in 2014. GIRS is dedicated to providing methods and technology for assessing and managing risks to society for the purpose of saving lives, protecting the environment, and the overall betterment of society. GIRS is the umbrella organization for the risk, reliability, and resilience research and related educational activities at UCLA. The Institute is home to more than 40 Core, Adjunct, and Affiliate Faculty from various schools and departments of UCLA, actively conducting theoretical and applied research on (a) quantifying the risk of the most serious threats to society to better enable their prevention, reduce their likelihood of occurrence, or limit their consequences, and (b) improving system performance with respect to the capability to perform its intended function while assuring the health and safety of the public and protection of the environment. Disciplines considered within the scope of the Institute include quantitative risk assessment and management, reliability and resilience engineering, system performance assessment, and the social sciences. Domain-specific Research Center within GIRS include Center for Reliability Engineering, Center for SMART Health, and Center for Natural Hazards Risk and Resilience Research. The Institute activities include:

- provide environment for collaboration on research projects with federal agencies, industry partners, and researchers at UCLA and other U.S. and international universities.
- offer resource for independent technical review and assessment of the performance of systems with respect to such performance indicators as risk, reliability, and resilience
- provide repository of risk sciences information
- promote, distribute, and when possible commercialize methods and technologies developed at the Institute
- organize or co-sponsor workshops and conferences on risk, reliability, resilience, and safety engineering,
- publish reports dedicated to fundamental research on theoretical foundations and applications of risk management,
- conduct distinguished lecture series in risk, reliability, and safety, inviting prominent policy makers, researchers, and industry leaders,
- offer awards recognizing excellence in risk research and offer student fellowship programs through industrial affiliates and government agencies

Sponsors



The B. John Garrick Institute for the Risk Sciences

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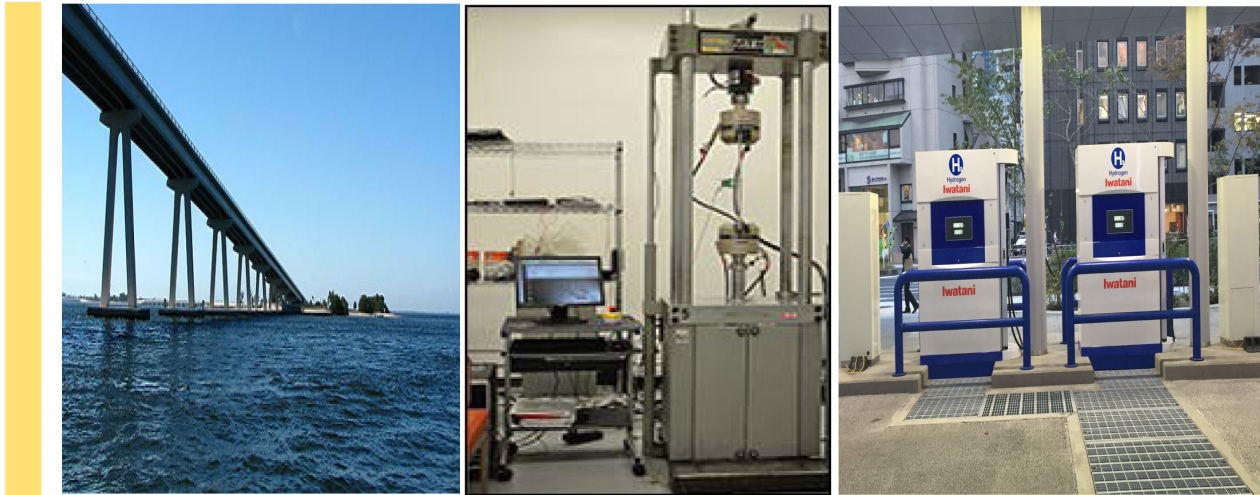


Lloyd's
Register



UNDERSTANDING RISK, RELIABILITY & PROBABILITY

THE CENTER FOR RISK & RELIABILITY



ABOUT CRR

The Center for Risk and Reliability (CRR) was formed in 1985 as the umbrella organization for many of the risk and reliability research and development activities at the UMD Clark School of Engineering. CRR research covers a wide range of subjects involving systems and processes, and include topics on predictive reliability modeling and simulation, physics of failure fundamentals, software reliability and human reliability analysis methods, advanced probabilistic inference methods, system-level health monitoring and prognostics, risk analysis theory and applications to complex systems such as space missions, civil aviation, nuclear power plants, petro-chemical installations, medical devices, information systems, and civil infrastructures. Over 20 core and adjunct faculty from various engineering departments of the Clark School of Engineering form the pool of experts at CRR. Home to numerous research laboratories with extensive state of the art equipment and high performance computers, CRR is the research arm of the Reliability Engineering educational program, one of the largest and most comprehensive degree granting graduate program in the field of reliability and risk analysis of engineered systems and processes. The program offers the MS, PhD, and Graduate Certificate in Reliability Engineering and Risk Analysis. All courses are available both through traditional on-campus and online delivery modes.

For more information visit www.crr.umd.edu, or contact the CRR Director, Dr. Mohammad Modarres, modarres@umd.edu, 301-405-5226, or the CRR Associate Director for Research and Outreach, Dr. Katrina Groth, kgroth@umd.edu, 301-405-5215.



A. JAMES CLARK
SCHOOL OF ENGINEERING



JENSEN HUGHES



Specialty Engineers, Consultants & Scientists

Advancing the Science of Safety

What we do is *essential*...

Founded in 1980, JENSEN HUGHES, Inc. is a global company headquartered in Baltimore, MD. As one of the largest fire protection and life safety engineering and consulting firms with offices worldwide, JENSEN HUGHES is able to provide the support and responsiveness that our clients need. Our technical experts stay on the cutting edge of evolving fire and life safety codes and regulations and are able to provide timely and accurate consulting and design services. We remain committed to providing our clients with cost-effective, high quality services that are crucial to the protection of life, property, and the environment.

We are *passionate* about life safety and fire protection.

If you ask our staff to name the best thing about their jobs, many of them will tell you: **"The work I do will keep people safe,"** and **"I like that my work matters."** Whether that occurs through the engineering of fire protection systems at a brand new building, or as a result of a forensic report investigating why a facility fire occurred and advising how to prevent it from happening again, JENSEN HUGHES plays an integral part in protecting people and the built environment.

We have *technical expertise* and we know the codes.

JENSEN HUGHES consultants, engineers, and scientists are seasoned professionals with in-depth, hands-on experience in their specialties. Their participation in industry and regulatory organizations gives them unique insight into both code requirements and intention. This insight not only enables them to provide practical, cost-saving solutions, but also to act as a powerful advocate for their clients with regulators.

We offer *comprehensive* services.

JENSEN HUGHES collaborates one-on-one or as part of a project team with owners, operators, municipalities, and members of the Architecture, Engineering, and Construction industry in all phases of design and construction. JENSEN HUGHES is a single resource for all of the fire safety and consulting services our clients need for the design, construction, renovation, or assessment of facilities, including expert consulting, engineering, fire modeling, design, and training.

We are a *global leader* of specialty engineering and consulting.

JENSEN HUGHES is a global leader of specialty engineering and consulting services providing **probabilistic risk assessments, risk-informed applications & implementation**, modification engineering, design engineering, plant engineering, emergency response planning & management, regulatory and oversight support, outage and field support, software solutions and training. We are a diverse company of over 1250 employees, with over 300 dedicated to Nuclear Power, who are committed to advancing the science of safety.

Technical Program Committee

Technical Program Chair: Enrique Lopez Droguett, University of Chile, Chile

Associate Technical Program Chairs: Katrina Groth, University of Maryland, USA
Di Zhang, Wuhan University of Technology, China

We would like to thank the members of the PSAM 14 Technical Program Committee. These individuals helped to make PSAM 14 a success by reviewing abstracts, technical papers, organizing sessions, and providing technical leadership for the conference.

Technical Committee Members:

Michelle Bensi	Chung-Kung Lo
Christophe Berenguer	Mohammad Modarres
Emanuele Borgonovo	Márcio Moura
Ronald Boring	Luiz-Fernando Oliveira
Roger Boyer	Nicola Pedroni
Manuel Chiachio-Ruano	Mohammad Pourgol-Mohammad
Matthew Denman	Marilia Ramos
Heitor Duarte	Giovanni Sansavini
Fernando Ferrante	Nathan Siu
Zachary Jankovsky	Sunil Weerakkody
Hyun Gook Kang	Xinping Yan
Tsu-mu Kao	Taotao Zhou
Isis Lins	

Organizing Committee

General Chair: David H. Johnson, B. John Garrick Institute for the Risk Sciences, UCLA, USA

Honorary Chair: B. John Garrick, B. John Garrick Institute for the Risk Sciences, UCLA, USA

Associate General Chairs: Mihai Diaconeasa, B. John Garrick Institute for the Risk Sciences, UCLA, USA
Woody Epstein, Appendix R Solutions, Inc, Japan

Technical Program Chair: Enrique Lopez Droguett, University of Chile, Chile

Webmaster, Registration,
Support for Papers/Abstracts
Submission and Review:

Hanna and Sophia Shapira, Philadelphia, PA, USA

General Information

Onsite Registration

Registration is required for all attendees and presenters. Badges are required for admission to all events.

Full Conference Registration Fee* includes: Technical sessions, morning & afternoon breaks (Monday through Thursday), and proceedings. Special Events included are Sunday Welcome Reception, Tuesday Luncheon, Wednesday Gala Dinner, and Friday Ice Cream Social. (\$ 1,100.00)

1 Day Registration Fee includes: Morning & afternoon breaks and proceedings. (\$ 550.00)

Student Registration Fee includes: Technical sessions, morning & afternoon breaks (Monday through Thursday), and proceedings. Special events included are Sunday Welcome Reception, Tuesday Luncheon, and Friday Ice Cream Social. (\$ 600.00)

Retiree Registration Fee includes: Same as full registration. (\$ 700.00)

Guests: No registration required. Participation in events requires tickets purchase.

Extra Tickets

Sunday Welcome Reception:	\$ 45
Tuesday Luncheon:	\$ 55
Wednesday Gala Dinner:	\$ 100
Friday Ice Cream Social:	\$ 25

Conference Proceedings

Conference Proceedings on Flash Drives and the Program Book are included in your registration bag.

Meeting Registration Desk

At the Centennial Ballroom Prefunction Area

Sunday	2:00 PM - 5:00 PM
Monday	7:00 AM - 3:00 PM
Tuesday	7:30 AM - 3:00 PM
Wednesday	7:30 AM - 3:00 PM
Thursday	8:00 AM - Noon
Friday	8:00 AM - 9:00 AM

Extra Evens

Sunday Welcome Reception:	@ Centennial Terrace 7:00 - 8:30 PM
Tuesday Lunch:	@ Centennial Ballroom 12:00 PM
Wednesday Gala Dinner:	@ Centennial Ballroom 7:00 - 10:00 PM
Friday Ice Cream Social:	@ Registration Area Conference Conclusion

Guidelines for Speakers (Podium Presenters)

After the daily morning plenary session at PSAM14, the conference will transition to seven parallel sessions.

All presenters must provide the electronic file of their presentation at the assigned area by the Registration Desk no later than 3:00 PM the evening prior to the scheduled presentation. If your planned arrival is after that time email your presentation to admin@psam14.org 24 hours prior to the session. You may load and test your presentation slides on the computer at the assigned room during the tea/coffee/lunch break before the session. It is highly encouraged to test the presentation (especially if you have animation) at the lobby area where one to two computers with the same settings as that in the session room will be provided.

All presenters are to report to the Session Chair at the assigned room 10 minutes before the start of the session. Each presenter must hand the session chair a printed short bio for the introduction.

Sessions are 90 minutes long. You have 16 minutes to present your paper plus 4 minutes for questions and answers. We have scheduled 2 minutes at the beginning of each session for Chair introduction as well as 2 minutes between presentation. Do not rush through slides. Having unnecessary animation slows you down. Have no more than one or two slides for every two minutes: # Slides = Time / 2

The conference rooms will be equipped with a laptop computer, an LCD projector, laser pointer and a microphone. Microsoft Windows, MS Office (PowerPoint) 2010, and the latest Adobe Acrobat Reader (PDF reader) will be installed on the computers. Alternatively, speakers may bring their laptops and run the presentation from their computer. In either case, all presenters should make sure they are available ahead of time (see following paragraph) to discuss with the Chair their presentation place (e.g., first, second, etc.) and whether they will run the file from the session room PC or if they plan to use their own computer. Also, take advantage of the speaker breakfast the morning of your presentation to discuss with the session chair how you will run the presentation.

A microphone will be available for the presentation, please make sure that you keep close to the microphone during your talk.

Monday Keynote and Plenary

Dr. B. John Garrick, NAE, Honorary Chair **B. John Garrick Institute for Risk Sciences, UCLA**

The Challenges (and Opportunities) Facing The Risk Sciences

Dr. Garrick is a recognized international authority on the application of the risk sciences to complex technological systems in the nuclear, space, defense, chemical, marine, and transportation fields.

He was appointed by President George W. Bush to the U.S. Nuclear Waste Technical Review Board as Chairman on September 10, 2004 and served two terms ending September 2012. He served for 10 years (1994-2004), 4 years as chair, on the U.S. Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste. His areas of expertise include quantitative risk assessment and nuclear science and engineering. A founder of the firm PLG, Inc., Garrick retired as President, Chairman, and Chief Executive Officer in 1997. Before PLG's acquisition and integration into a new firm, it was an international engineering, applied science, and management consulting firm.



Garrick was elected to the National Academy of Engineering in 1993, the highest honor that can be granted to an engineer; President of the Society for Risk Analysis 1989-90, and recipient of that Society's most prestigious award, the Distinguished Achievement Award in 1994. He has been a member and chair of several National Research Council committees, having served as Vice Chair of the Academies' Board on Radioactive Waste Management and as a member of the Commission on Geosciences, Environment, and Resources. He is Vice Chairman and technical lead of the National Academy of Science's Committee on Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Plants and was Chairman of the National Academy of Engineer's Committee on Combating Terrorism. Among other National Academy committees he has chaired are the Committee on the Waste Isolation Pilot Plant, the Committee on Technologies for Cleanup of High-Level Waste in Tanks in the DOE Weapons Complex, and the Panel on Risk Assessment Methodologies for Marine Systems. Other Academy committee memberships included space applications, automotive safety, proliferation of nuclear materials, and chemical weapons disposal. He is a member of the first class of lifetime national associates of the National Academies.

Garrick's academic experience includes adjunct professorships at UCLA and Vanderbilt University; short course lecturer at MIT; member of Dean's Advisory Council, UCLA's School of Engineering; member of the Leadership Council, College of Physical and Mathematical Sciences, BYU; and serving on the National Commission of the Accreditation Board for Engineering and Technology as well as a past member of other university advisory committees.

Garrick authored the book "Quantifying and Controlling Catastrophic Risks" published by Academic Press; editor of the book, "The Analysis, Communication, and Perception of Risk" published by Plenum Press; lead author of the handbook "Power Plant Availability Engineering" published by the Electric Power Research Institute; author of several book chapters; and published more than 250 technical papers and reports on risk, reliability, engineering, and technology.

Garrick received his Ph.D. in engineering and applied science from the University of California, Los Angeles, in 1968. His fields of study were neutron transport, applied mathematics, and applied physics. He received an M.S. in nuclear engineering from UCLA in 1962, attended the Oak Ridge School of Reactor Technology in 1954-55, and received a B.S. in physics from Brigham Young University in 1952. He is a fellow of three professional societies: the American Nuclear Society, the Society for Risk Analysis, and the Institute for the Advancement of Engineering. He is a registered professional engineer in California.

Tuesday Plenary

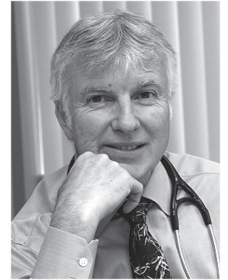
Peter Katona, MD

David Geffen School of Medicine at UCLA

Biological Terrorism: Not a question of IF but WHEN

Dr. Peter Katona is Clinical Professor of Medicine in Infectious Diseases at the David Geffen School of Medicine at UCLA and Adjunct Professor of Public Health at the UCLA Fielding School of Public Health. He has worked at the Centers for Disease Control and Prevention (CDC) as an EIS Officer studying viral diseases and doing epidemic investigation; and at Apria/Corum Healthcare as their Corporate Medical Director.

Dr. Katona has held appointments at Louisiana State University's National Center for Biomedical Research and Training, and the Los Angeles County Emergency Management Services (EMS) Agency. He is a member of the LA County EMS Agency Disaster Coalition Advisory Committee, the Infectious Diseases Society of America's National and Global Public Health Committee, the Pacific Council on International Policy's Homeland Security Committee and served on the FDA's Anti-Infective Drugs Advisory Committee. He served as Chairman of the UCLA Hospital Infection Control Committee. He holds a seat at the Business Operations Center of the LA City Emergency Operations Center. He has authored articles on medical informatics, medical education, influenza, polio, nutrition, bioterrorism, disasters, and the future of health care. He is a member of the Council on Foreign Relations.



He is developing a project to do disease surveillance using social networking in Vietnam, and a project to study healthcare vulnerabilities to catastrophic disasters in Los Angeles.

Dr. Katona is an internationally recognized authority on bioterrorism and has lectured throughout the world on this topic. He teaches a yearly Honors course at UCLA on terrorism, and has edited the books *Countering Terrorism and WMD: Creating a Global Counter-Terrorism Network*, and *Global Biosecurity: Threats and Responses*, with a book on the vulnerability of healthcare to disasters in progress. He maintains a private practice in infectious diseases and sits on the Boards of the LA Emergency Preparedness Foundation, the Good Hope Foundation, the Toffler Trust and the University of Florida School of Medicine.

Tuesday Lunch

The George Apostolakis Fellowship

The George Apostolakis Fellowship is awarded to honor the singular contribution of George Apostolakis to the Science of Risk as well as his vision, energy and guidance generously given to IAPSAM. The award recognizes the potential demonstrated by early career risk management practitioners.

Congratulations to **Mr. Ali Ayoub**, the recipient of the George Apostolakis Fellowship in 2018. Mr. Ayoub is studying at the Swiss Federal Institute of Technology in Zurich. Ali has a special interest in probabilistic studies with a focus on risk of large industrial infrastructures in general and nuclear energy systems in particular.



Wednesday Plenary

Dr. Ali Mosleh, NAE

Institute Director, The B. John Garrick Institute for the Risk Sciences

Risk of Models

Dr. Ali Mosleh is a Distinguished University Professor and Evelyn Knight Chair in Engineering at UCAL where he is also the director of the UCLA Garrick Institute for the Risk Sciences. Previously he was the Nicole J. Kim Eminent Professor of Engineering and Director of the Center for Risk and Reliability at the University of Maryland. He was elected to the US National Academy of Engineering in 2010, and is a Fellow of the Society for Risk Analysis, and the American Nuclear Society, recipient of several scientific achievement awards, and technical advisor to numerous organizations, including appointment by President George W. Bush to the U.S. Nuclear Waste Technical Review Board. He conducts research on methods for probabilistic risk analysis and reliability of complex systems and has made contributions in diverse fields of theory and application. He holds several patents, and has edited and authored over 500 publications.



Wednesday Dinner Gala

Dr. Roger L. McCarthy, NAE

Senior Fellow, The B. John Garrick Institute for the Risk Sciences

Did the US Nonresponse to Piper Alpha Lead Directly to Deepwater Horizon?

Dr. McCarthy is a Senior Fellow at the Garrick Institute for the Risk Sciences as well as an independent engineering consultant and owner of McCarthy Engineering, Palo Alto, California, and Board Member of Shui on Land, Ltd. Until 2008, Dr. McCarthy was chairman emeritus of Exponent, Inc., and chairman of Exponent Science and Technology Consulting Co., Ltd. (Hangzhou). Since joining Exponent (formerly Failure Analysis Associates) in 1978, he served as President, Chief Executive, and Chairman. He took Exponent public in 1990.

Dr. McCarthy has investigated some of the major disasters of the current age, including the grounding of the Exxon Valdez, the explosion and loss of the Piper Alpha oil platform in the North Sea, the fire and explosion on the semi-submersible Glomar Arctic II, the rudder failure and subsequent floundering of the VLCC Amoco Cadiz, the bombing of the Murtaugh Federal Building in Oklahoma city, the collapse of the walkways at the Kansas City Hyatt, and most recently the Deepwater Horizon Explosion, Fire, and Oil Spill in the Gulf of Mexico.

Dr. McCarthy is a member of the National Academy of Engineering (NAE) of the U.S. National Academies.

Dr. McCarthy holds five academic degrees, including a Ph.D. in Mechanical Engineering from MIT. He is based in Palo Alto, California, and is a Registered Professional Mechanical Engineer in the State of California and two other States.



Thursday Plenary

Dr. John Casani **JPL, Retired**

Assuring Mission Success for Planetary Space Missions

John Casani retired from JPL in 2012, his career having spanned the entire beginning of planetary exploration at JPL. Casani initially joined JPL in 1956 to work on inertial guidance systems, and then held various positions throughout the organization before becoming the Assistant Lab Director for Flight Projects in 1989.

Casani led the design teams for both the Ranger and Mariner series of spacecraft and held a senior leadership position on the Mariner Mars '64 project, which obtained the first close-range images of Mars. In 1975 Casani became project manager of the Voyager project, which launched twin spacecraft to explore Jupiter, Saturn, Uranus and Neptune. These spacecraft continued to collect information 40 years after launch and have made many intriguing discoveries, including an ocean of liquid water on Europa, one of Jupiter's moons. After the launch of the two Voyagers in 1977, Casani was named project manager for the Galileo spacecraft project, which sent back to Earth important images of Jupiter and its moons over the course of 14 years.

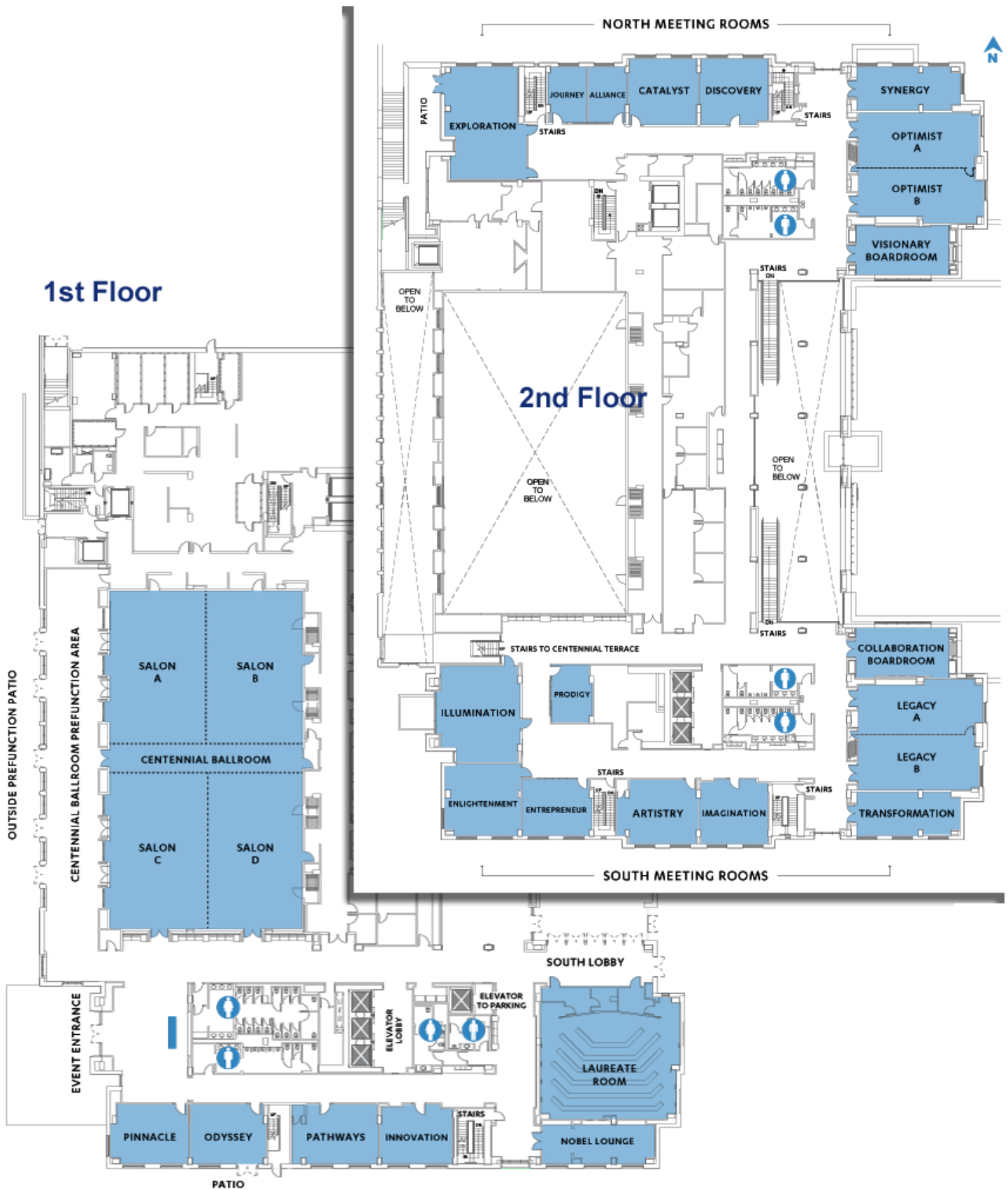


In the early 1990s Casani became project manager of the Cassini-Huygens mission to Saturn and its moon Titan, one of the most complex planetary missions ever designed. Later that decade, he assumed the role of chief engineer at JPL.

Casani holds a B.S. degree in electrical engineering and a Doctor of Science degree from the University of Pennsylvania, and an Honorary Aerospace Engineering degree from the University of Rome. Casani was elected into the National Academy of Engineering for pioneering systems engineering of planetary spacecraft. He is an Honorary Fellow of the AIAA and a member of the International Astronautics Academy.

He is a recipient of several NASA awards, including the Distinguished Service Medal, the Exceptional Achievement Medal, and the Medal for Outstanding Leadership. In addition, Casani received the Management Improvement Award (1974) from the President of the United States for the Mariner Venus Mercury mission, the AIAA Space Systems Award (1979), the National Aerospace Club's Astronautics Engineer Award (1981) for the direction of the Galileo project. He received the von Karman Lectureship (1990), the AAS Space Flight Award (1989), the AAS William Randolph Lovelace II Award (2005), the Air and Space Museum Trophy for Lifetime Achievement (2009), and the NAE Founders Award (2009).

Meeting Rooms



M02 Maintenance Modelling and Optimization

Monday 9/17/2018 10:30 AM Discovery

Chair: M. Pourgol-Mohammad

- 31 **Dynamic Sequential Decision Making for Missions and Maintenances Scheduling for a Deteriorating Vehicle**
Elodie Robert (a,b), Christophe Berenguer (a), Keomany Bouvard, Hoceane Tedie (b), and Romain Lesobre (c)
*a) Univ. Grenoble Alpes, CNRS, Grenoble INP**, GIPSA-lab, F-38000 Grenoble, France, b) Volvo Group Trucks Technology, 69800 Saint-Priest, France, c) ARQUUS, 78284 Guyancourt, France*
- 192 **A Methodology for Railway Track Maintenance Modelling Using Plausible Petri Nets**
Manuel Chiachio (a,b), Juan Chiachio, Darren Prescott, John Andrews (a)
a) Resilience Engineering Research Group, Faculty of Engineering, University of Nottingham, University Park, Nottingham, (UK), b) Dept. of Structural Mechanics & Hydraulics Engineering, University of Granada, Granada, (Spain)
- 256 **Probabilistic Maintenance Optimization for Fatigue-critical Components with Constraint in Repair Access and Logistics**
Guang Zou (a,b), Kian Banisoleiman (a), and Arturo González (b)
a) Lloyd's Register Group Limited, Southampton, UK, b) University College Dublin, Dublin, Ireland

M03 Reliability Analysis I

Monday 9/17/2018 10:30 AM Illumination

Chair: Marcio Moura

- 7 **New Components Reliability Demonstration for Subsea Factory**
A.Di Padova, F.Tallone (a), G.Cassetti, M.Piccini (b)
a) Saipem S.p.A. - Onshore E&C Plant and Floaters Division, Fano, Italy, b) RAMS&E, Torino, Italy
- 30 **Modeling the Effect of Air Temperature and Pressure on the Reliability of a Passive Containment Cooling System**
Yu Yu (a), Francesco Di Maio (b), Enrico Zio (b,c), Bin Wang, Shengfei Wang, Zhangpeng Guo, Xuefeng Lyu, And Fenglei Niu (a)
a) School of Nuclear Science and Engineering, Beijing Key Laboratory of Passive Safety Technology for Nuclear Energy, North China Electric Power University, Beijing, China, b) Energy Department, Politecnico di Milano, Milan, Italy, c) Chair on System Science and Energetic Challenge, European Foundation for New Energy – EDF, Ecole Centrale de Paris and Supélec, Paris, France
- 32 **Development of Software Test-based Reliability Assessment Method for Nuclear Power Plant Safety-critical Software**
Sang Hun Lee (a), Seung Jun Lee (b), Jinkyun Park (c), Eun-chan Lee (d), and Hyun Gook Kang (a)
a) Department of Mechanical Aerospace and Nuclear Engineering, Rensselaer Polytechnic Institute (RPI), Troy, NY, USA, b) School of Mechanical, Aerospace and Nuclear Engineering, Ulsan National Institute of Science and Technology (UNIST), Ulsan, Republic of Korea, c) Integrated Safety Assessment Division, Korea Atomic Energy Research Institute (KAERI), Daejeon, Republic of Korea, d) Korea Hydro & Nuclear Power Co., Ltd., Gyeongsangbuk-do, Republic of Korea
- 74 **System Reliability Analysis and Probabilistic Safety Assessment to Support the Design of a New Containment Cooling System for Severe Accident Management at NPP Paks**
Tamas Siklossy, Attila Bareith, David Hollo, Zoltan Karsa, Gabor Lajtha, Jenő Nigicser, Peter Siklossy
NUBIKI Nuclear Safety Research Institute, Budapest, Hungary

M04 Risk and Hazard Analysis I

Monday 8/17/2018 10:30 Legacy A

Chair: Nathan Siu

- 23 **Assessing Combinations of Hazards in a Probabilistic Safety Analysis**
Halbert Taekema, and Hans Brinkman
NRG, Arnhem, The Netherlands
- 27 **Modelling of Failures of Multiple Redundant Trains of the Electrical Power Supply System of NPPs in PSA**
B. Brück, G. Gänßmantel, A. Kreuser, C. Müller, E. Piljugin, M. Utschick, and J. C. Stiller
Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, Köln, Germany
- 64 **Assessment of Rockfall Hazard Induced by Earthquake for Important Facility**
I.Yoshida, Y.Kasuga (a), M.Sato, H.Nakase (b), and S.Nakamura (c)
a) Tokyo City University, Tokyo, Japan, b) Tokyo Electric Power Services Co.,Ltd, Tokyo, Japan, c) Nihon University, Koriyama, Japan
- 17 **A Tool to Support Improved Outage Risk Management**
Shawn St. Germain and Jaques Hugo
Idaho National Laboratory, Idaho Falls, USA

M05 Risk Assessment Methods I

Monday 8/17/2018 10:30 AM Legacy B

Chair: Luiz Oliveira

- 12 **A Bayesian Solution to Incompleteness in Probabilistic Risk Assessment**
Chris Everett (a), Homayoon Dezfuli (b)
a) ISL, New York, NY, USA, b) NASA, Washington, DC, USA
- 59 **Adapting Traditional Logic Modeling Techniques to Address Cyberattack**
R. Youngblood and K. Le Blan
Idaho National Laboratory, Idaho Falls, Idaho
- 62 **Pathology-Informed Approach in Vulnerability Assessment Methods**
Polinpapilinho F. Katina (a,b,c), Adrian V. Gheorghe (b) and Charles B. Keating (a,b)
a) National Centers for System of Systems Engineering, Norfolk, Virginia, USA, b) Old Dominion University, Norfolk, Virginia, USA, c) Embry-Riddle Aeronautical University, Worldwide Campus
- 403 **Risk Assessment Methods for Comparative Assessment of Options for Decommissioning of Subsea**
Luiz Fernando Oliveir*, Joaquim Domingues, Mariana Bardy, Thábata Maciel, and Silvia Schaffel
DNV GL, Rio de Janeiro, Brazil

M06 Water and Land Transportation I

Monday 8/17/2018 10:30 AM Pathways

Chair: Di Zhang

- 50 **Risk Analysis of Ship Foundering Using the Hybrid Causal Logic Methodology**
Kai Zhang, Di Zhang, Cun-long Fan, Ming-yang Zhang (a,b) and Ali Mosleh (c)
a) Intelligent Transportation Systems Research Center, Wuhan University of Technology, Wuhan, Wuhan, P.R. China, b) National Engineering Research Center for Water Transport Safety, Wuhan, P. R. China, c) The B. John Garrick Institute for the Risk Sciences at UCLA, L.A., USA
- 120 **A Game-Theoretic Method to Efficiently Assess the Vulnerability of a Dynamic Transportation Network**
Venkateswaran Shekar, Lance Fiondella (a), Samrat Chatterjee, and Mahantesh Halappanavar (b)
a) University of Massachusetts Dartmouth, USA, b) Pacific Northwest National Laboratory, Richland, USA
- 186 **Producing Effective Maintenance Strategies to Control Railway Risk**
Claudia Fecarotti and John Andrews
Resilience Engineering Research Group, Faculty of Engineering, University of Nottingham, Nottingham, UK
- 152 **Risk Simulation Analysis of the Vehicle Velocity in Reduced Visibility Conditions at Bridge-Tunnel Transition Sections**
Dianliang Xiao (a), Yujia Tian (b), and Yong Fang (c)
a) Safety and Emergency Research Center, China Academy of Transportation Sciences, Beijing, China, b) School of Highway, Chang'an University, Xi'an, China, c) The Key Laboratory of Road and Traffic Engineering of the Ministry of Education, Tongji University, Shanghai, China

M07 Risk Informed Applications I

Monday 8/17/2018 10:30 AM Laureatte

Chair: Fernando Ferrante

- 21 **Development of Approach to Establishment of Risk Informed Accident Management and Management Class in Severe Accident**
Shinya Kamata (a), Nobuyuki Ueda (b)
a) Japan Nuclear Safety Institute, Tokyo, Japan, b) Central Research Institute of Electric Power Industry, Tokyo, Japan
- 79 **Generic Safety Issue 191: Risk Informed Application at South Texas Project**
Mary Anne Billings, Kristin Kaspar (a), and Ernest John Lowry Kee (b)
a) STP Nuclear Operating Company, Wadsworth, USA, b) University of Illinois, Urbana-Champaign, USA
- 137 **Application of Probabilistic Risk Assessment to Cyber Security of a Nuclear Power Plant**
Jong Woo Park, Seung Jun Lee
Ulsan National Institute of Science and Technology (UNIST), Ulsan, Korea
- 37 **Surveillance Frequency Control Program Implementing Insights**
Zhiping Li (a,b), Mary Anne Billings (b)
a) Ameren Missouri, Fulton, USA, b) STP Nuclear Operating Company, Wadsworth, USA

M11 Risk Perception and Communication

Monday 8/17/2018 1:30 PM Exploration

Chair: Sunil Weerakkody

- 63 **The Dynamics of Risk Perception for Soft Target Terrorism**
Matt Baucum, Richard John (a), Marcus Mayorga(b,c), Paul Slovicbc, William Burns(b), Kent Portney, & Jeryl Mumpower (d)
a) University of Southern California, Los Angeles, CA, U.S.A., b) Decision Research, Eugene, OR, U.S.A., c) University of Oregon, Eugene, OR, U.S.A., d) Texas A&M University, College Station, TX, U.S.A.
- 359 **Risk Analysis of Taiwan Food Import from Japan after the Fukushima Nuclear Accident**
Tsu-Mu Kao
Institute of Nuclear Energy Research, Taiwan
- 429 **The MIT Symposium on Realizing the Value of Nuclear Energy, 26 and 27 March 2018**
Michael W. Golay
Massachusetts Institute of Technology, Cambridge, MA, USA
- 116 **Recognition of Risk Information --- Adaptation of J. Bertin's Ordinal Matrix for Social Communication**
Keiichi Ishida
Hosei University / Zurich Insurance company, Tokyo, Japan

M12 Prognostics and System Health Management I

Monday 8/17/2018 1:30 PM Discovery

Chair: Marcio Moura

- 47 **Reliability-Based Regression Model for Complex Systems Considering Environmental Uncertainties**
Amin Moniri-Morad, Mohammad Pourgol-Mohammad, Hamid Aghababaei (a), Javad Sattarvand (b)
a) Sahand University of Technology, Tabriz, Iran, b) University of Nevada Reno, Reno, USA
- 112 **A Comprehensive Sensor Placement Determination in Condition Monitoring Process Using Combined Fault Detection, Fault Diagnosis and Risk Indexes**
Farzin Salehpour-Oskouei (a), Mohammad Pourgol -Mohammad (b)
a) Department of Mechanical Engineering, Shabestar Branch, Islamic Azad University, Shabestar, Iran, b) Department of Mechanical Engineering, Sahand University of Technology, Tabriz, Iran
- 161 **On the Application of Machine Learning Techniques in Condition Monitoring Systems of Complex Machines**
Marcin Hinz, Dominik Brueggemann, and Stefan Bracke
University of Wuppertal, Wuppertal, Germany
- 139 **Prognostics using Particle filter for Steam Generator Tube Rupture in Nuclear Power Plants**
Gibeom Kim (a), Hyeonmin Kim (b), and Gyunyoung Heo (a)
a) Kyung Hee University, b) Nuclear ICT research division, Korea Atomic Energy Research Institute, Republic of Korea

M13 Oil and Gas Industry

Monday 8/17/2018 1:30 PM Illumination

Chair: Luiz Oliveira

- 118 **Pressure Vessel Fitness-for-Service Evaluation Based on API579 and API581 Standards**
Ramon Sandim Espíndola Gomes, Gilberto Francisco Martha de Souza
University of São Paulo, São Paulo, Brazil
- 361 **Use of Simplified Risk Assessment Methodology in the Process Industry**
Mardy Kazarians, Kirk Busby
Kazarians & Associates, Inc., Glendale, USA
- 260 **Identification of the Main Contributors to the Security of Supply in a Gas Transmission Network**
Vytytis Kopustinskas, Pavel Praks
European Commission, Joint Research Centre (JRC) Directorate C for Energy, Transport and Climate, Ispra, Italy
- 285 **Dragged anchors interaction scenarios: detailed frequency analysis for Pipeline Design**
A. Di Padova, C. Zuliani, and F. Tallone
Saipem S.p.A. - Onshore E&C Plant and Floaters Division, Fano, Italy

M14 Industrial Safety

Monday 8/17/2018 1:30 PM Legacy A

Chair: Jonathan DeJesus

- 15 **Agile Practices When Developing Safety Systems**
Thor Myklebust, Narve Lyngby (a), and Tor Stålhane (b)
a) SINTEF Digital, Trondheim, Norway, c) NTNU, Trondheim, Norway
- 270 **Analysis on Safety Defect of Port Dangerous Goods Enterprise**
Zhiqiang Hou, Xiaoyu Wang, and Yongrui Wen
China Waterborne Transport Research Institute, Beijing, China
- 214 **Multi-Sectioned Predictive Model of Cable Insulation under Reaction- and Diffusion-Controlled Degradation**
Yuan-Shang Chang and Ali Mosleh
B. John Garrick Institute for the Risk Sciences, and Department of Materials Science & Engineering, University of California, Los Angeles (UCLA), USA

M15 External Hazard PSA/PRA I

Monday 8/17/2018 1:30 PM Legacy B

Chair: Ola Bäckström

- 6 **Fragility Evaluation with Aleatory and Epistemic Uncertainty against Fault Displacement for Reactor Buildings**
Hirokazu Tsuji (a), Minoru Kanechika, Yoshinori Mihara, and Kenshiro Ishiki (b)
a) Japan Nuclear Safety Institute, Tokyo, Japan, b) Kajima Corporation, Tokyo, Japan
- 35 **Loss of Offsite Power Frequency Estimates Due to External Events at a Finnish Nuclear Power Plant**
Mikael Biese
Fennovoima Oy, Helsinki, Finland
- 66 **Computation of Annual Strike Probability of a Wind-borne Tumbling Missile using TOMAXI**
Yuzuru Eguchi, Soichiro Sugimoto, Yasuo Hattori, Takahiro Murakami and Hiromaru Hirakuchi
Central Research Institute of Electric Power Industry, Abiko, JAPAN
- 104 **Coupling Large-Scale and Detailed Site Flooding Simulations**
Niels Montanari, Ramprasad Sampath (a), Donna Calhoun (b), Steven Prescott, Curtis Smith (c)
a) Centroid LAB, Inc., Mar Vista, CA, USA, b) Boise State University, Boise, ID, USA, c) Idaho National Laboratory, Idaho Falls, ID, USA

M16 Aeronautics and Aerospace I

Monday 8/17/2018 1:30 PM Pathways

Chair: Roger Boyer

- 20 **Identification of Safety Critical Scenarios for Airlines using Machine Learning in Filter Trees**
Lukas Höhndorf and Florian Holzappel
Institute of Flight System Dynamics, Technical University of Munich, Garching, German
- 244 **Experience Gained from Developing a PRA During the Design Phase of NASA Human Exploration Missions**
Diana L. DeMott (a), Roger L. Boyer, Mark Bigler (b), Courtenay B. Clifford, and C. Joseph Kahn (a)
a) SAIC, Houston, Texas, USA, b) NASA, Houston, Texas, USA
- 277 **Modeling In-Space Aborts for NASA Human Exploration Missions**
Mark A. Bigler
NASA Johnson Space Center, Houston, USA

M17 Special Session: Overview & Progress in MUPRA

Monday 8/17/2018 1:30 PM Laureatte

Chair: Mohammad Modarres

- 38 **A Study for Identifying Multi-Unit Initiating Event and Estimating Frequency**
Seungwoo Lee, Ar Ryum Kim, Namchul Cho, Sokchul Kim, Hyowon Kim, and Dohyoung Kim
Korea Institute of Nuclear Safety(KINS), Daejeon, Korea
- 124 **An Emergency Response Study during Multi-Unit Accidents**
Wonjong Song, Hoyoung Shin, and Moosung Jae
Department of Nuclear Engineering, Hanyang University, Seoul, 04763, Korea
- 125 **A Consideration of the Single Release Location for the Multi-Unit Accidents**
Yein Seo, Hyunae Park, Byeong-Mun Ahn, and Moosung Jae
Department of Nuclear Engineering, Hanyang University, Seoul, Korea
- 113 **A Study of Multi-Unit Seismic Probabilistic Risk Assessment**
Taotao Zhoua, Mohammad Modarres (a), and Enrique López Drogueett (a,b)
a) Center for Risk and Reliability, University of Maryland, College Park, MD, USA, b) Department of Mechanical Engineering, University of Chile, Santiago, Chile

M21 HRA for Digital Interfaces

Monday 8/17/2018 3:30 PM Exploration

Chair: Andreas Bye

- 235 **HRA Data for Performance Shaping Factors Reflecting Digital MCR**
Sun Yeong Choi, Yochan Kim, and Jinkyun Park
Korea Atomic Energy Research Institute, Daejeon, Rep. of Korea
- 72 **Some insights for assessing diagnosis error probabilities of operators in advanced MCRs**
Ar Ryum Kim, Seung Woo Lee, Namcul Cho, Ji Tae Kim, Dohyoung Kim, and Sok Chul Kim
Korea Institute of Nuclear Safety, Daejeon, Republic of Korea
- 227 **Expanding GOMS-HRA from Analog to Digital Human-Machine Interfaces**
Thomas A. Ulrich and Ronald L. Boring
Idaho National Laboratory, Idaho Falls, USA

M22 Structural Reliability Analysis Methods

Monday 8/17/2018 3:30 PM Discovery

Chair: M. Pourgol-Mohammad

- 82 **Comparison of Non-Standard Simulation Methods for Performing Extremely Low Probability Assessments**
Robert E. Kurth, Cédric J. Sallaberry
Engineering Mechanics Corporation of Columbus (Emc2) Columbus, OH, USA
- 178 **Thermodynamic Entropy Generation Model for Metal Fatigue Failure**
Hossein Salimi, Mohammad Pourgol-Mohammad, Mojtaba Yazdani
Sahand University of Technology, Tabriz, Iran
- 103 **Efficient Sampling Strategies to Estimate Extremely Low Probabilities**
Cédric J. Sallaberry, Robert E. Kurth
Engineering Mechanics Corporation of Columbus (Emc2) Columbus, OH, USA
- 381 **A Case Study on Influence of Subgrade Slope Blasting on Existing Bridge Safety**
Haoran Song and Dianliang Xiao
China Academy of Transportation Sciences, Beijing, China

M23 Dynamic PSA/PRA I

Monday 8/17/2018 3:30 PM Illumination

Chair: Matthew Denman

- 48 **Case Study of Major Accident to Demonstrate the Possibility of Prediction of Conditions for Accidents**
Tiantian Zhu, Stein Haugen (a), Yiliu Liu, Kim Hyungju (b)
a) Department of Marine Technology, Norwegian University of Science and Technology, Trondheim, Norway, b) Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, Trondheim, Norway
- 54 **Addressing Critical Dependencies in the Probabilistic Performance Assessments of Multi-Purpose Systems with PyCATSHOO**
Hassane Chraïbi, Dominique Vasseur, Tu Duong Le Duy And Mickaël Hassanaly
EDF, Paris Saclay Lab - PERICLES - Palaiseau, France
- 85 **Mitigation Coverage Evaluation of Passive Systems Based on Causality Estimation Using Multi-Level Flow Model**
In Seop Jeon, Junyung Kim, Robby Christian, Hyun Gook Kang
Rensselaer Polytechnic Institute, Troy, USA
- 76 **EMRALD, Dynamic PRA for the Traditional Modeler**
Steven Prescott, Curtis Smith, and Leng Vang
Idaho National Laboratory, Idaho Falls, USA

M24 Internal Hazards PSA/PRA I

Monday 8/17/2018 3:30 PM Legacy A

Chair: Keiichi Ishida

- 61 **Application of Fire PSA in Defining System Reliability Criteria: Detection and Suppression Systems in I&C Electrical Panel Room**
Marcos Coelho Maturana (a,b), Luciano Lucas Bruno (a), and Marcelo Ramos Martins (b)
a) CTMSP, Sao Paulo, Brazil, b) LABRISCO/USP, Sao Paulo, Brazil
- 92 **Insights from Internal Fire PSA of UK ABWR in Generic Design Phase**
Yuki Ishiwatari, Daichi Shiota (a), and Paul Guymmer (b)
a) Hitachi-GE Nuclear Energy, Ltd., Hitachi, Japan, b) Jacobsen Analytics Ltd, Congleton, United Kingdom
- 100 **Analysis of Turbine Missile & Turbine-Generator Overspeed Protection System Failure Probability at NPPs: A case study from PSA perspective**
Duško Kančev, Stefan Heussen, Jens-Uwe Klügel, Thomas Kozlik, Pere Drinovac
NPP Goesgen-Daeniken AG, Kraftwerkstrasse CH-4658 Daeniken, Switzerland
- 160 **Monte Carlo Simulation of NUREG/CR 6850 Appendix L Model for Main Control Board Fires and Resulting Insights**
Paul Boneham, Paul Guymmer, Mike Wright
Jacobsen Analytics Ltd, Congleton, United Kingdom

M25 Accident Analysis and Modeling I

Monday 8/17/2018 3:30 PM Legacy B

Chair: Futoshi Tanaka

- 164 **Qualitative PRA Insights from Operational Events**
Nathan Siu, Ian Gifford, Zeechung Wang, Meredith Carr, and Joseph Kanney
U.S. Nuclear Regulatory Commission, Rockville, MD, USA
- 215 **MELCOR2.2/SNAP Analysis of Oxidation Response during Spent Fuel Pool Quenching**
Wei-Yuan Cheng, Yu Chiang (a), Jong-Rong Wang (b), Shao-Wen Chen (a), Chunkuan Shih (b)
a) Institute Of Nuclear Engineering And Science, National Tsing Hua University, Hsinchu, Taiwan, b) Nuclear And New Energy Education And Research Foundation, Hsinchu
- 42 **The methodology of Plant Damage State and Containment Event Tree development in the Low Power Shutdown Probabilistic Safety Assessment Level 2 using T/H analysis code**
Jae Gab Kim, Myung Ro Kim, Bae Hyuk Kwon
KEPCO-E&C, Integrated Engineering Department, Korea
- 370 **Containment Isolation System Analysis and its Contribution to Level 2 PSA Results in Doel 3 Unit**
Marius Lontos, Stanislas Mitailé, And Shizhen Yu, Jérémy Bulle
TRACTEBEL ENGIE, Brussels, Belgium

M26 Mathematical Methods in Reliability & Safety I

Monday 8/17/2018 3:30 PM Pathways

Chair: Mihai Diaconeasa

67 Improved Bayesian Update Method for Components Failure Rates

Ali Ayoub (a), Valerio Ariu and Olivier Nusbaumer (b)

a) ETH Zurich, Laboratory of Nuclear Energy Systems, Zurich, Switzerland, b) Kernkraftwerk Leibstadt, Department Support Safety & Engineering, Leibstadt, Switzerland

282 Large Satellite Bus Reliability

Teri Hamlin and Bruce Reistle

NASA Johnson Space Center, Houston, USA

406 A Fault Prediction Approach Based on Bayesian Network for System

Tianyu Si, Weiwei Hu, Yuna Liu, and Jiamin Liu

School of Reliability and System Engineering, Beihang University, Beijing, China

M27 Special Session: Global and Catastrophic Risks

Monday 8/17/2018 3:30 PM Laureatte

T01 Special Session: HRA data analysis I

Tuesday 9/18/2018 10:30 AM Exploration

Chair: Ali Mosleh

- 29 **SACADA Data for HEP Estimates**
Yung Hsien James Chang, Carmen Franklin
U.S. Nuclear Regulatory Commission, Washington DC, USA
- 60 **Analyses Methods and Pilot Applications of SACADA Database**
Mohamad Ali Azarm (a), Inn Seock Kim (b), Clifford Marks, and Faramarz Azarm (a)
a) Innovative Engineering and Safety Solutions, Germantown, MD, USA, b) ISSA Technology Inc., Germantown, MD, USA
- 78 **Methodology for Supporting the Determination of Human Error Probabilities from Simulator Sourced Data**
Pamela F. Nelson (a), C.R. Grantom P.E. (b), and David Quintanar-Gago (a)
a) Universidad Nacional Autónoma de México, Facultad de Ingeniería, Departamento de Sistemas Energéticos, Mexico City, Mexico, b) CRG LLC, Huffman, Texas, USA
- 412 **A framework for Using SACADA to Enhance the Qualitative and Quantitative Basis of HRA**
Katrina M. Groth
Systems Risk and Reliability Analysis Lab, Center for Risk and Reliability, Department of Mechanical Engineering, University of Maryland, College Park, MD

T02 Reliability Analysis II

Tuesday 9/18/2018 10:30 AM Discovery

Chair: Marcio Moura

- 136 **Application of Reliability Analysis in Preliminary Design Stage of Digital I&C System**
Wenjie Qin (a), Xuhong He (b), Xiufeng Tian, Dejun Du (c)
a) Lloyd's Register Consulting - Energy Inc., Shanghai, China, b) Lloyd's Register Consulting AB, Stockholm, Sweden, c) China Nuclear Power Engineering Co., Ltd., Beijing, China
- 145 **Reliability Modeling of Phased Mission Multi-State Systems via a Scenario Inference Method**
Weiyang Men, Ying Chen, Yingyi Li, and Ze Wang
Beihang University, Beijing, China
- 241 **Reliability Analyses of Digital I&C Systems within the Verification and Validation Process**
Mariana Jockenhövel-Bartfeld, Stefan Karg (a), Christian Hessler (b) and Herve Bruneliere (c)
a) Framatome GmbH, Erlangen, Germany, b) AREVA GmbH, Erlangen, Germany, c) Framatome SAS, Paris, France

T03 Uncertainty and Sensitivity Analysis I

Tuesday 9/18/2018 10:30 AM Illumination

Chair: Elaheh Rabiei

- 16 **Application of Bayesian Optimal Experimental Design to Reduce Parameter Uncertainty in the Fracture Boundary of a Fuel Cladding Tube Under LOCA Conditions**
Takafumi Narukawa (a,b), Akira Yamaguchi, Sunghyon Jang (a), and Masaki Amaya (b)
a) The University of Tokyo, Tokyo, Japan, b) Japan Atomic Energy Agency, Ibaraki, Japan
- 22 **A Conceptual Comparative Study of Flex Strategies to Cope with Extended Station Blackout (SBO)**
Hak Kyu Lim
KEPCO International Nuclear Graduate School, Ulsan, Republic of Korea
- 36 **Sensitivity Analysis for the Evaluation of Failure Effects on an I&C Test System**
Christian Müller, Ewgenij Piljugin, Jörg Peschke, Manuela Jopen, Dagmar Sommer
Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, Germany

T04 Maritime and Offshore Technology I

Tuesday 9/18/2018 10:30 AM Legacy A

Chair: Montewka Jakub

- 86 **Probabilistic Decision Support for Offshore Wind Operations: A Bayesian Network Approach to Include the Dependence of the Installation Activities**
Georgios Leontaris (a), Oswaldo Morales-Nápoles (b), and A.R.M. (Rogier) Wolfert (a)
a) Integral Design and Management, Civil Engineering and Geosciences, Delft University of Technology, Delft, the Netherlands, b) Hydraulic Structures and Flood Risk, Civil Engineering and Geosciences, Delft University of Technology, Delft, the Netherlands
- 98 **Reducing Risk in Aquaculture Through Autonomous Underwater Operations**
Ingrid B. Utne, Ingrid Schjøberg, Stian Sandøy, Xue Yang (a), and Ingunn M. Holmen (b)
a) NTNU Department of Marine Technology, 7491 Trondheim, Norway, b) SINTEF Ocean, 7465 Trondheim, Norway
- 177 **Study of Ship Piloting Risk Aversion Based on Human Reliability Analysis**
Wei Hong-Bin
China Waterborne Transport Research Institute, Beijing, China

T05 Risk Assessment Methods II

Tuesday 9/18/2018 10:30 AM Legacy B

Chair: Tsu-Mu Kao

- 143 **Risk Assessment Study of Loss Profit for Integrated Maintenance Policy Based on Power Generation for a Wind Turbine**
Maryem Bouzoubaa, Zied Hajej, and Nidhal Rezzg
LGIPM, UFR-MIM, University of Lorraine, Metz, France
- 149 **Leaving Mission Times Backstage and Taking Repair into Account in Long Term Scenarios**
Anders Olsson
Lloyd's Register, Malmoe, Sweden
- 151 **RASTEP – A Novel Tool for Nuclear Accident Diagnosis and Source Term Prediction based on PSA and Bayesian Belief Networks**
Francesco Di Dedda (a), Anders Olsson (b), Joakim Klug and Anders Riber Marklund (c)
a) Lloyd's Register, Gothenburg, Sweden, b) Lloyd's Register, Malmoe, Sweden, c) Lloyd's Register, Sundbyberg, Sweden
- 165 **Dynamic Modelling of Severe Accident Management for CANDU Reactors in Probabilistic Safety Assessment**
Alexander V. Trifanov
Kinectrics, Toronto, Ontario, Canada

T06 Water and Land Transportation II

Tuesday 9/18/2018 10:30 AM Pathways

Chair: Di Zhang

- 279 **A Collision Risk-Based Ship Domain Method Approach to Model the Virtual Force Field**
Tengfei Wang (a,b,c), Xinpeng Yana (b), Yang Wang and Qing Wu (a,b,c)
a) Intelligent Transportation System Research Center, Wuhan University of Technology, Wuhan Hubei, China, b) National Engineering Research Center for Water Transport Safety, Wuhan Hubei, China, c) School of Logistics Engineering, Wuhan University of Technology, Wuhan Hubei, China
- 287 **Trend and Hotspot Analysis of Waterway Transportation Safety Based on Bibliometrics**
Wang Guobo, Han Chao, Xu Liansheng (a), Wu Jing (b,a)
a) China Waterborne Transport Research Institute, Beijing, China, b) North China Electric Power University, Beijing, China
- 288 **Risk Assessment of Dangerous Goods Areas in Ports**
Wu Jing (a,b), Chen Fengyun, Hu Yuchang, Wang Guobo, Xu Liansheng (b), Mao Xianling (c)
a) North China Electric Power University, Beijing, China, b) China Waterborne Transport Research Institute, Beijing, China, c) Beijing Institute of Technology, Beijing, China
- 290 **A Case of Quantitative Risk Assessment of Dangerous Goods Container Yard in Chinese Port**
Zhijun Chen, Hong Fan, Yuan Gao, Qing Xia, Haiqi Tang, Yafei Zhou
China Waterborne Transport Institute, Beijing, China

T07 Panel Session: Risk Communication with Mid-Level Decision Makers

Tuesday 9/18/2018 10:30 AM Laureatte

T11 Special Session: HRA data analysis II

Tuesday 9/18/2018 1:30 PM Exploration

Chair: James Chang

- 57 **Using Microworlds to Support Dynamic Human Reliability Analysis**
Thomas A. Ulrich, Ronald L. Boring, and Diego Mandelli
Idaho National Laboratory, Idaho Falls, USA
- 183 **Informing HRA by Empirical Data, Halden Reactor Project Lessons Learned and Future Direction**
Andreas Bye
OECD Halden Reactor Project, IFE, Halden, Norway
- 187 **Attempt to Predict Human Failure Rate in Different Industry Sectors Using Data from Major Accidents and Bayesian Networks**
C. Morais (a,b), R. Moura (b,a), M. Beer (c,d) and E. Patelli (a)
a) University Institute for Risk and Uncertainty, University of Liverpool, United Kingdom, b) National Agency for Petroleum, Natural Gas and Biofuels (ANP), Brazil, c) Institute for Risk and Reliability, Leibniz University Hannover, Germany, d) School of Civil Engineering & Shanghai Institute of Disaster Prevention and Relief, Tongji University, China
- 391 **Use of IDHEAS General Methodology to Incorporate Human Performance Data for Estimation of Human Error Probabilities**
Jing Xing and Y. James Chang
U.S. Nuclear Regulatory Commission, Washington DC, USA

T12 Mathematical Methods in Reliability and Safety II

Tuesday 9/18/2018 1:30 PM Discovery

Chair: Enrique Lopez Droguett

- 300 **Comparison of MCUB and MCS BDD Fault Tree Solution Algorithms using Leibstadt Nuclear Power Plant Model**
Pavol Zvonček and Olivier Nusbaumer
Leibstadt Nuclear Power Plant, Leibstadt, Switzerland
- 312 **Predictive Model on the Degradation of the Electrical Resistance of Cable Insulation**
Yuan-Shang Chang and Ali Mosleh
B. John Garrick Institute for the Risk Sciences, and Department of Materials Science & Engineering, University of California, Los Angeles (UCLA), USA
- 313 **Predictive Model on the Reliability of the Insulation Made from Special Heat-Resistant Polyvinyl Chloride**
Yuan-Shang Chang, Yizhen Zhang, and Ali Mosleh
B. John Garrick Institute for the Risk Sciences, and Department of Materials Science & Engineering, University of California, Los Angeles (UCLA), USA
- 25 **Safety Assessments of Nuclear Power Plants I&C Systems Architecture**
Hervé Brunelière, Pierre Lacaille, Jean-Yves Brandelet (a), and Mariana Jockenhoevel-Bartfeld (b)
a) Framatome, Paris La Défense, France, b) Framatome, Erlangen, Germany

T13 Site Level (Multi-Unit, Multi-Source) PSA/PRA I

Tuesday 9/18/2018 1:30 PM Illumination

Chair: *Diego Mandelli*

- 147 **Framatome's lessons learned on Multi-Unit PSA**
Jean-Yves Brandelet, Hervé Brunelière, and Pierre Lacaille
Framatome, Courbevoie, France
- 179 **SITRON - Site Risk Assessment Approach Developed for Nordic Countries**
Ola Bäckström (a), Erik Cederhorn (b), Xuhong He (a), Jan-Erik Holmberg (b), Tero Tyrväinen (c)
a) Lloyd's Register, Stockholm, Sweden, b) Risk Pilot AB, Espoo, Finland, c) VTT Technical Research Centre of Finland Ltd, Espoo, Finland
- 180 **Multi-Unit Dependency Modeling Based on Reported Japanese Nuclear Power Plant Incidents**
Yuki Nakano, Satoshi Takeda, Takanori Kitada (a), Taotao Zhou, Mohammad Modarres (b)
a) Osaka University, 2-1 Yamadaoka, Suita-shi, Osaka, Japan, b) Center for Risk and Reliability, University of Maryland, College Park, MD, USA
- 212 **Framework for Modeling Ground Motion Variability at a Nuclear Power Plant Site for Use in a Seismic Multi-Unit Probabilistic Risk Assessment**
Jonathan DeJesus Segarra (a), Michelle Bensi (b), Mohammad Modarres (a)
a) Center for Risk and Reliability, University of Maryland, College Park, MD, USA, b) Department of Civil and Environmental Engineering, University of Maryland, College Park, MD USA

T14 Risk and Hazard Analysis II

Tuesday 9/18/2018 1:30 PM Legacy A

Chair: *Marcelo Martins*

- 94 **Risk Effectiveness Analysis of FLEX using Plant Specific PRA**
Chun-Chang Chao, Po-Jung Chiu, Chen-Che Hsu, Ching-Tien Huang
Institute of Nuclear Energy Research, Taoyuan, Taiwan
- 99 **A Review of Hazard Identification Techniques for Autonomous Operations in Norwegian Aquaculture**
Xue Yang, Ingrid B. Utne, and Christoph A. Thieme
Norwegian University of Science and Technology, Department of Marine Technology, 7491 Trondheim, Norway
- 101 **Post-Fukushima PSA Modelling: Best-estimate, Plant-Specific Considerations vs. Conservative Requirements**
Jens-Uwe Klügel, Dusko Kancev, Stefan Heussen, Pere Drinovac, Thomas Kozlik
NPP Goesgen-Daeniken AG, Kraftwerkstrasse CH-4658 Daeniken, Switzerland
- 122 **The Study of Spent Fuel Pool Risk at Decommissioning Nuclear Power Plant in Taiwan**
Yicheng Tian, Chun-Chang Chao, Chen-Che Hsua, Po-Jung Chiu, Yu-Ting Chiou and Tzu-Shiu Lin
Institute of Nuclear Energy Research, Taoyuan, Taiwan

T15 External Hazard PSA/PRA II

Tuesday 9/18/2018 1:30 PM Legacy B

Chair: *Sunil Weerakkody*

- 108 **A Method for Inclusion Of Uncertainties in Seismic PSA**
Lavinia Raganelli (a,b), Keith Ardron (b)
a) Corporate Risk Associates, London, UK, b) Imperial College, London, UK
- 115 **Assessing and Modelling Buildings Failures caused by External Events at Ringhals NPP**
Erik Sparre (a), Carl Sunde (b), and Cilla Andersson (c)
a) Risk Pilot, Malmö, Sweden, b) Risk Pilot, Gothenburg, Sweden, c) Ringhals, Varöbacka, Sweden
- 138 **Screening of External Hazards in Belgium**
Bogdan Golovchuk and Filip Van Opstal
Tractebel ENGIE, Brussels, Belgium
- 117 **Oil and Gas Pipeline Third Party Damage (TPD) - A New Way to Model External Hazard Failure**
Christopher Jackson, Ali Mosleh
B. John Garrick Institute for the Risk Sciences, University of California, Los Angeles, United States

T16 Dependence Modeling and Analysis

Tuesday 9/18/2018 1:30 PM Pathways

Chair: Mohammad Modarres

- 28 **Developing Generic Prior Distributions for Common Cause Failure Alpha Factors**
Zhegang Ma, John Schroeder, and Curtis Smith
Idaho National Laboratory, Idaho Falls, USA
- 114 **A Physics-of-Failure Approach for Common Cause Failures Subject to Age-Related Degradation**
Taotao Zhou (a), Enrique López Droguett (a,b), and Mohammad Modarres (a)
a) Center for Risk and Reliability, University of Maryland, College Park, MD, USA, b) Department of Mechanical Engineering, University of Chile, Santiago, Chile
- 246 **Recent Insights from the International Common Cause Failure Data Exchange (ICDE) Project**
Benjamin Brück (a), Gunnar Johanson (b), Michelle Gonzalez (c), Jan Stiller (a)
a) Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, Cologne, GERMANY, b) AF Industry, Stockholm, SWEDEN, c) United States Nuclear Regulatory Commission, Washington, DC, United States

T17 Risk Informed Applications II

Tuesday 9/18/2018 1:30 PM Laureatte

Chair: Fernando Ferrante

- 162 **Framatome's lessons learned on Risk-Informed Applications**
Hervé Brunelière, Jean-Yves Brandelet (a), Heiko Kollasko (b), Pierre Lacaille (a) and Jari Pesonen (c)
a) Framatome, Paris, France, b) Framatome, Erlangen, Germany, c) TVO, Olkiluoto, Finland
- 257 **Level 1 PRA Considering Optimization of Safety Systems for the iB1350**
Go Tanaka, Yuji Komori, Keiji Matsumoto and Takashi Sato
Toshiba Energy Systems & Solutions Co., Yokohama, Japan
- 307 **Review of Risk-Informed Approach and Challenges in its Application for Floating Nuclear Power Plant**
Wang, Jiaqun, Wang Qianglong (a), Yang Linping (b), Qiu Jinrong, Yao Shiwei (a), Wu Jie (c)
a) Wuhan 2nd Ship Design and Research Institute, Wuhan, China, b) Chongqing Huayu Electric Group CO., LTD., Chongqing, China, c) Institute of Nuclear Energy Safety Technology Chinese Academy of Sciences, Hefei, China

T21 Special Session: What's next for HRA data?

Tuesday 9/18/2018 3:30 PM Exploration

Chair: Katrina Groth

T22 Health and Medicine

Tuesday 9/18/2018 3:30 PM Discovery

Chair: Marcelo Martins

- 174 **Validation of the NASA Integrated Medical Model: A Space Flight Medical Risk Prediction Tool**
Jerry Myers (a), Yamil Garcia (b), John Arellano (c), Lynn Boley (b), Debra Goodenow (a), Eric Kerstmand, Matthew Koslovsky (b), David Reyes (d), Lynn Sail (e), Wafa Taiym (b), Millennia Young (e)
a) National Aeronautics and Space Administration, Glenn Research Center, Cleveland, OH, USA, b) KBRwyle, Houston, TX, USA, c) MEIT, Houston, TX, USA, d) University of Texas Medical Branch, Galveston, TX, USA, e) National Aeronautics and Space Administration, Johnson Space Center, Houston, TX, USA
- 408 **A Bayesian Belief Network Model for Risk of Vascular Catheter-Associated Infection**
Reza Kazemi (a), Ali Mosleh (b) and Meghan Dierks (c)
a) University of Maryland, College Park, currently at USFDA, b) University of Maryland, College Park, currently at UCLA, c) Harvard Medical school
- 409 **A Bayesian Belief Network Model for Risk of Pressure Ulcer**
Reza Kazemi (a), Ali Mosleh (b) and Meghan Dierks (c)
a) University of Maryland, College Park, currently at USFDA, b) University of Maryland, College Park, currently at UCLA, c) Harvard Medical school

T23 Dynamic PSA/PRA II

Tuesday 9/18/2018 3:30 PM Illumination

Chair: Zachary Jankovsky

- 87 **Code Surrogate Development for Dynamic PRA Using Anisotropic Taylor Kriging Methodology**
Robby Christian, Hyun Gook Kang
Rensselaer Polytechnic Institute, Troy, USA
- 106 **Development of an Online Operator Tool to Support Real-Time Emergency Planning Based on the Use of Dynamic Event Trees and Deep Learning**
Ji Hyun Lee, Tunc Aldemir, Alper Yilmaz and Richard Denning
The Ohio State University, Columbus, US
- 121 **Pattern Identification of Dynamic Event Tree Scenarios with Clustering**
Junyung Kim
Rensselaer Polytechnic Institute, Troy, USA
- 126 **Severe Accident Scenario Uncertainty Analysis using the Dynamic Event Tree Method**
Xiaoyu Zheng, Hitoshi Tamaki, Jun Ishikawa, Tomoyuki Sugiyama, and Yu Maruyama
Japan Atomic Energy Agency, Ibaraki, Japan

T25 Accident Analysis and Modeling II

Tuesday 9/18/2018 3:30 PM Legacy B

Chair: Marilia Ramos

- 266 **Source Term Prediction Software in Case of Severe Accidents: FaSTPro for Shutdown States**
Michael Hage, Michael Kowalik, Sören Johst and Horst Löffler
GRS, Cologne, Germany
- 296 **Analysis of the Effect of Severe Accident Scenario on the Vessel Lower Head Failure in Nordic BWR using MELCOR code**
Sergey Galushin and Pavel Kudinov
Royal Institute of Technology, Stockholm, Sweden
- 297 **Sensitivity Analysis of the Vessel Lower Head Failure in Nordic BWR using MELCOR Code**
Sergey Galushin and Pavel Kudinov
Royal Institute of Technology, Stockholm, Sweden
- 390 **Confirmatory Thermal-Hydraulic Analysis to Support Success Criteria in NRC's PRA Models**
Suzanne Dennis, Shawn Campbell, Don Helton
U.S. Nuclear Regulatory Commission, Rockville, MD, USA

T26 Nuclear Industry I

Tuesday 9/18/2018 3:30 PM Pathways

Chair: Futoshi Tanaka

- 41 **On the Recent Research Advancements of Cyber Security of Nuclear Power Plants**
Yan-Fu Li, Shou-Zhou Liu
Department of Industrial Engineering, Tsinghua University, Beijing, China
- 44 **Review of Probabilistic Safety Assessment as Part of the Periodic Safety Review for NPP Paks**
Attila Bareith
NUBIKI Nuclear Safety Research Institute, Budapest, Hungary
- 155 **Safety Demonstration – A Strategy for Assessors**
André A. Hauge, Vikash Katta, Peter Karpati (a) and Bjørn Axel Gran (a,b)
a) Department of Risk, Safety and Security, Institute for Energy Technology, Halden, Norway, b) NTNU, Trondheim, Norway
- 131 **Reliability Analysis of Digital Pressurizer Water Level Control System in NPP based on Boolean Logic Driven Markov Process**
Yi-jing Mao (a), Xi-yu Chen, Shi-liang Zhou (a,b), Tong-yu Xu, Irsa Rasheed (a)
a) School of Nuclear Science and Engineering, North China Electric Power University, Beijing, China, b) Beijing Key Laboratory of Passive Safety Technology for Nuclear Energy, Beijing, China

**T27 Special Session: Population-based risk stratification in health:
the opportunity for risk sciences to influence precision medicine**

Tuesday 9/18/2018 3:30 PM Laureatte

W01 New Measures for HRA

Wednesday 9/19/2018 10:30 AM Exploration

Chair: Vinh Dang

- 225 **Performance Shaping Factors as Operator Performance Measures for Validation and the Need for Robust Usability in Human Reliability Analysis**
Torrey J. Mortenson and Ronald L. Boring
Idaho National Laboratory, Idaho Falls, Idaho, USA
- 39 **Toward a Novel Situation Assessment (SA) Measure**
Jinkyun Park, Yochan Kim, and Wondea Jung
Korea Atomic Energy Research Institute, Daejeon, Republic of Korea
- 204 **Real-time SVM Classification for Drowsiness Detection Using Eye Aspect Ratio**
Caio B. Souto Maior, Márcio C. Moura, João M. M. de Santana, Lucas M. do Nascimento, July B. Macedo, Isis D. Lins (a) and Enrique L. Droguett (b)
a) Center for Risk Analysis and Environmental Modeling, Department of Production Engineering, Federal University of Pernambuco, Recife, Brazil, b) Mechanical Engineering Department, University of Chile, Santiago, Chile
- 386 **Drowsiness Detection Using Electroencephalography Signals: A Deep Learning Based Model**
Luis Guarda, Nicolás Astorga, Enrique López Droguett (a), Marcio Moura (b), Marcelo Ramos (c)
a) Mechanical Engineering Department, University of Chile, Santiago, Chile, b) Production Engineering, Federal University of Pernambuco, Recife, Brazil, c) Naval Engineering, University of Sao Paulo, Sao Paulo, Brazil

W03 Site Level (Multi-Unit, Multi-Source) PSA/PRA II

Wednesday 9/19/2018 10:30 AM Illumination

Chair: Jonathan DeJesus

- 430 **IAEA Project: Multiunit Probabilistic Safety Assessment**
Ovidiu Coman, Shahen Poghosyan
International Atomic Energy Agency (IAEA)
- 424 **Update of the Plant-specific Seismic PRA of NPP Goesgen – Risk Model, Results and Insights**
J.-U. Klügel, A. Nykyforchyn and D. Kancev
NPP Goesgen, Daeniken, Switzerland
- 333 **Practical Methods for Composing Multi-unit PSA Model**
Woo Sik Jung
Sejong University, Seoul, Republic of Korea

W04 Oil and Gas Industry I

Wednesday 9/19/2018 10:30 AM Legacy A

Chair: Marcelo Martins

- 185 **On the Development of the Blowout Preventer PRA Model**
Jan Swider (a,c), Charley Gallo (b,c), Gregg Walz, and Jim Raney (c)
a) Cogoto, Inc., Simi Valley, USA, b) The Frontline Group, Houston, USA, c) Anadarko Petroleum Corporation, The Woodlands, USA
- 216 **Probabilistic Model for Internal Uniform/Pitting Corrosion of Gas Pipelines**
Keo Yuan Wu and Ali Mosleh
The B. John Garrick Institute for the Risk Sciences, Department of Materials Science & Engineering, University of California, Los Angeles, USA
- 248 **Probabilistic Risk Analysis (PRA) of a Mobile Offshore Drilling Unit (MODU) Dynamic Positioning System (DPS)**
Eric B. Thigpen (a), Roger L. Boyer, Michael A. Stewart (b)
a) SAIC, Houston, Texas, b) NASA Johnson Space Center, Houston, Texas

W05 Risk Assessment Methods III

Wednesday 9/19/2018 10:30 AM Legacy B

Chair: *Tsu-Mu Kao*

- 206 **What Have We Done Lately? The Current Status of the SAPHIRE Risk Analysis Software**
S. Ted Wood, James K. Knudsen, and Kellie J. Kvarfordt
Idaho National Laboratory, Idaho Falls, United States
- 263 **Feedback on the Use Of Risk Metrics for Level 2 PSAs**
Guillaume Kioseyan, Yves Guigueno, Emmanuel Raimond
IRSN, BP 17, Fontenay-aux-Roses, 92262, France
- 264 **OECD WGRISK – Recently Ongoing and Potential Future International Risk-related Activities**
Marina Roewekamp (a), Kwang-Il Ahn (b), Yolande AKI (c), Attila Bareith (d), Vinh Dang (e), Jeanne-Marie Lanore (f), Markus Porthin (g), Gerhard Schoen (h), Sung Min Shin (b)
a) Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, Köln, Germany, b) Korea Atomic Energy Research Institute (KAERI), Daejeon, Republic of Korea, c) Canadian Nuclear Safety Commission (CNSC), Ottawa, ONT, Canada, d) NUBIKI, Budapest, Hungary, e) Paul Scherrer Institut (PSI), Villigen, Switzerland, f) Institut de Radioprotection et de Sécurité Nucléaire (IRSN), Fontenay-Aux-Roses, France, g) VTT, Espoo, Finland, h) Eidgenössisches Nuklearsicherheitsinspektorat (ENSI), Brugg, Switzerland
- 269 **On the Calculation of Unit Trip Frequency**
James C. Lin
ABSG Consulting Inc., Irvine, USA

W06 Water and Land Transportation III

Wednesday 9/19/2018 10:30 AM Pathways

Chair: *Stein Haugen*

- 291 **Stochastic Programming Decision for Inland Container Liner Route Stowage Planning with Uncertain Container Weight**
Jun Li, Yu Zhanga, Sanyou Ji (a), Jie Ma (b)
a) School of Logistics Engineering, Wuhan University of Technology, Wuhan, China, b) School of Navigation, Wuhan University of Technology, Wuhan, China
- 327 **Optimal Allocation of Emergency Resources for Safety Production in Container Ports**
Ning Chen, Wan Yue, Xiangyu Chen, Jing Ma
Wuhan University of Technology, Wuhan, China
- 332 **System Theoretic Frameworks for Mitigating Risk Complexity in the International Transportation of Spent Nuclear Fuel**
Adam Williams, Douglas Osborn, and Elena Kalinina
Sandia National Laboratories, Albuquerque, NM, USA
- 334 **Comparison of Maritime Safety Management Modes and Measures for Main Inland Waterways in China, US, and EU**
Ma Minglu (a), Wu Jing (b,a)
a) China Waterborne Transport Research Institute, Beijing, China, b) North China Electric Power University, Beijing, China

W07 Risk Informed Applications III

Wednesday 9/19/2018 10:30 AM Laureatte

Chair: Karl Fleming

- 324 **Practical Elimination - Experiences for Units in Use, in Construction and in Design**
I. Niemelä, M. Marjamäki and N. Lahtinen
STUK, Helsinki, Finland
- 325 **NPP Failure Analyses in Finland**
Pia Humalajoki and Ilkka Niemelä
STUK - Radiation and Nuclear Safety Authority, Helsinki, Finland
- 326 **Frequency of Early Release Requiring Protective Actions for the Public at Loviisa VVER-440 NPP**
Taisto Laato, Kalle E. Jänkälä
Fortum Power and Heat Oy, Espoo, Finland
- 356 **2018 Status of “Requirements for Low Power and Shutdown Probabilistic Risk Assessment”, Low Power and Shutdown PRA Standard**
Donald J. Wakefield
ABSG Consulting Inc., Irvine, USA

W11 Dynamic HRA

Wednesday 9/19/2018 1:30 PM Exploration

Chair: Vinh Dang

- 267 **A Method for Modeling Human Behavior as a Dynamic Process in the Context of External and Internal Hazards**
Joerg Peschke (a), Marina Roewekamp (b)
a) GRS, Garching, Germany, b) GRS, Cologne, Germany
- 292 **Functional Requirement Analysis for Severe Accident Management Support System Using Multilevel Flow Modeling**
Sunghoon Lee and Jonghyun Kim
Department of Nuclear Engineering, Chosun University, Gwangju, Republic of Korea
- 230 **Aggregation of Autocalculated Human Error Probabilities from Tasks to Human Failure Events in a Dynamic Human Reliability Analysis Implementation**
Ronald L. Boring (a), Martin Rasmussen (b), Thomas A. Ulrich and Nancy J. Lybeck (a)
a) Idaho National Laboratory, Idaho Falls, Idaho, USA, b) NTNU Social Research, Trondheim, Norway
- 88 **Risk-informed Context-based Human Reliability Assessment Method**
Gueorgui Petkov
Dovre Group Plc, Olkiluoto, Finland

W12 Mathematical Methods in Reliability and Safety III

Wednesday 9/19/2018 1:30 PM Discovery

Chair: Reza Kazemi

- 346 **On the Reliability of Experts' Assessments for Autonomous Underwater Vehicle Risk of Loss Prediction: Are Optimists better than Pessimists?**
Mario P. Brito and Yujia Chang
University of Southampton, Southampton, United Kingdom
- 340 **Concept Development for a Test Rig and Analysis of the Experiments for Standardized Testing of Shape Memory Alloys**
Marcin Hinz, Alexander Czechowicz (b), Dominik Brueggemann (a), Peter Dueltgen (b), and Stefan Bracke (a)
a) University of Wuppertal, Wuppertal, Germany, b) Forschungsgemeinschaft Werkzeuge und Werkstoffe e.V. (FGW), Remscheid, Germany
- 210 **Performance of Empirical Bayes Estimation Techniques Used in Probabilistic Risk Assessment on Failure Data collected in U.S NRC Reactor Operating Experience Database**
Andrei Gribok, Vivek Agarwal, and Vaibhav Yadav
Idaho National Laboratory, P.O. Box 1625, MS 3818, Idaho Falls, ID
- 299 **Commentary on Use of Model-Augmented Data Analytics for Improved Operational Efficiency of Nuclear Power Plants**
Katrina Groth (a) and Michelle Bensi (b)
a) UMD, Department of Mechanical Engineering, College Park, MD, USA, b) UMD, Department of Civil and Environmental Engineering, College Park, MD, USA

W13 Uncertainty and Sensitivity Analysis II

Wednesday 9/19/2018 1:30 PM Illumination

Chair: Elaheh Rabiei

- 49 **Minimal-Dispersion and Maximum-Likelihood Predictors with a Linear Staircase Structure**
Luis G. Crespo, Sean P. Kenny, and Daniel P. Giesy
Dynamic Systems and Controls Branch, NASA Langley Research Center, Hampton, VA, USA
- 56 **Moment-Matching Predictor Models with a Linear Staircase Structure**
Luis G. Crespo, Sean P. Kenny, and Daniel P. Giesy
Dynamic Systems and Controls Branch, NASA Langley Research Center, Hampton, VA, USA
- 102 **Sensitivity Strategy Supporting the Estimate of Extremely Low Probabilities**
Cédric J. Sallaberry, Robert E. Kurth
Engineering Mechanics Corporation of Columbus (Emc2) Columbus, OH, USA

W14 Internal Hazards PSA/PRA II

Wednesday 9/19/2018 1:30 PM Legacy A

Chairs: Zied Hajej, Vivek Agarwal

- 70 **Internal Events Level 1 PSA study of Armenian NPP Spent Fuel Pools**
Gurgen Kanetsyan (a), Armen Amirjanyan, and Zoltan Kovacs (b)
a) Nuclear and Radiation Safety Center, Yerevan, Armenia, b) RELKO Ltd., Bratislava, Slovak Republic
- 320 **Estimation of Fire Frequencies in Low Power and Shutdown Fire Probabilistic Risk Assessment**
Tae-Wook Kang, Dong-Kyu, Myung-Ro Kim, Jae-Gab Kim
KEPCO E&C, Gim-Cheon, Republic of Korea
- 376 **Analysis of Possible Aging Trends in the Estimation of Piping System Failure Rates for Internal Flooding PRA**
B.O.Y. Lydell (a), K.N. Fleming (b), and J-F. Roy (c)
a) Sigma-Phase Inc., Vail, AZ, USA, b) KNF Consulting Services LLC, Spokane, WA, USA, c) Electric Power Research Institute, Palo Alto, CA, USA

W15 External Hazard PSA/PRA III

Wednesday 9/19/2018 1:30 PM Legacy B

Chair: Ola Bäckström

- 146 **A Level 1 Fire PRA on PGSFR**
Kilyoo Kim, Sanghoon Han, KwiLim Lee
Korea Atomic Energy Research Institute, Daejeon, Korea
- 153 **External Event Evaluations for the Design Phase PRA of Hanhikivi 1**
Juho Helander
Fennovoima, Helsinki, Finland
- 237 **Probabilistic Seismic Safety Assessment Concept and Application for Seismic Isolated NPP structures Considering a Clearance to Hard Stop**
Min Kyu Kim (a), Jung Han Kim (b)
a) Korea Atomic Energy Research Institute, Daejeon, Korea, b) Pusan National University, Pusan, Korea

W16 Consequence Modeling and Management I

Wednesday 9/19/2018 1:30 PM Pathways

Chair: Marilia Ramos

- 306 **Application of Resilience Metrics to Nuclear Accident Consequence Assessment**
Kampanart Silva and Wasin Vechgama
Thailand Institute of Nuclear Technology (Public Organization), Nakhon Nayok, Thailand
- 401 **Open Comprehensive Nuclear Events Database**
Spencer Wheatley, Wolfgang Kröger, Lan Chen, and Didier Sornette
ETH Zürich, Zürich, Switzerland
- 128 **A Sensitivity Study on Effective Protection Measures for Consequence Analysis**
Sunghyun Park, Seunghyun Jang, Dohyun Lima and Moosung Jae
Department of Nuclear Engineering, Hanyang University, Seoul, Korea

W17 Nuclear Industry II

Wednesday 9/19/2018 1:30 PM Laureatte

Chair: Matt Denman

- 190 **Evaluation of Operation Strategy of Passive and Active Safety Systems during SBLOCA**
Sang Hee Kang, Sun Heo, Sang Won Lee and Hyun Gook Kang
Korea Hydro & Nuclear Power Co., Ltd, 70,1312 Beongil, Yuseoung-Daero, Yuseong-gu, Daejeon, Republic of Korea
- 358 **Sodium Valve Performance in the NaSCoRD Database**
Matthew R. Denman, Zach Stuart, and Zachary K. Jankovsky
Sandia National Laboratories, Albuquerque, NM, USA
- 366 **Preliminary Study of Automated Analysis of Nuclear Power Plant Event Reports Based on Natural Language Processing Techniques**
Yunfei Zhao, Xiaoxu Diao, and Carol Smidts
Nuclear Engineering Program, Department of Mechanical and Aerospace Engineering, The Ohio State University, Columbus, USA
- 383 **Application of a Method to Estimate Risk in Advanced Nuclear Reactors: A Case Study on the Molten Salt Reactor Experiment**
Brandon Chisholm, Steve Krahn (a), Amir Afzali (b), and Eric Harvey (c)
a) Vanderbilt University, Nashville, TN, USA, b) Southern Company Services, Birmingham, AL, USA, c) Electric Power Research Institute (EPRI), Palo Alto, CA, USA

W21 Organizational Factors and Safety Culture

Wednesday 9/19/2018 3:50 PM Exploration

Chair: Jinkyun Park

109 **Barriers to Proactive Population Relocation in Preparation for Coastal Flooding**

Vicki M. Bier

University of Wisconsin-Madison, Madison, Wisconsin, USA

182 **Mapping Methodical Change in Safety Culture**

Kaupo Viitanen (a), Teemu Reiman (b), Carl Rollenhagen (c), and Nadezhda Gotcheva (d)

a) VTT Technical Research Centre of Finland Ltd, Espoo, Finland, b) Lillkoi Consulting, Lohja, Finland, c) Royal Institute of Technology (KTH), Stockholm, Sweden and Vattenfall AB, Stockholm, Sweden, d) VTT Technical Research Centre of Finland Ltd, Tampere, Finland

194 **Safety Culture Assurance in the Supply Chain of a NPP Construction Project**

Teemu Reiman (a) and Kaupo Viitanen (b)

a) Fennovoima Oy, Helsinki, Finland, b) VTT Technical Research Centre of Finland Ltd, Espoo, Finland

W22 Prognostics & System Health Management II

Wednesday 9/19/2018 3:50 PM Discovery

Chair: M. Pourgol-Mohammad

301 **Fusing More Frequent and Accurate Structural Damage Information from One Location to Assess Damage at another Location with Less Information**

Roohollah Heidary, Katrina M. Groth, and Mohammad Modarres

Systems Risk and Reliability Analysis Lab, Center for Risk and Reliability, Department of Mechanical Engineering, University of Maryland, College Park, MD

348 **A Significance of Condition-Based Probabilistic Risk Assessment Using Data-At-Scale: A Case Study (Presentation Only)**

Vaibhav Yadav, Andrei Gribok, Curtis Smith

Idaho National Laboratory, Idaho, USA

413 **A PHM Architecture Based on Hybrid of Model and Data for Electronic Products**

Jiamin Liu, Weiwei Hu, and Wenjin Zhang

School of Reliability and System Engineering, Beihang University, Beijing, China

427 **Reliability-based Approach to the Assessment of Hydrate Formation Probability in Deep-sea Wet-gas Pipelines**

Chaoyu Ruan, Zhiqiang Hou, Xin Lu (a), Bohui Shi (b)

a) China Waterborne Transport Research Institute, Beijing, China, b) Technology National Engineering Laboratory for Pipeline Safety, China University of Petroleum-Beijing, Beijing, China

W23 Dynamic PSA/PRA III

Wednesday 9/19/2018 3:50 PM Illumination

Chair: Zachary Jankovsky

228 **Integrating Classical PRA Models Into Dynamic PRA**

D. Mandelli, C. Smitha, and A. Alfonsi

Idaho National Laboratory (INL), Idaho Falls (ID), USA

193 **Convergence of Varied Surrogate Models for Seismic Dynamic PRA/PSA**

Brian Cohn (a), Jieun Hur (b), Richard Denning, Tunc Aldemir (a), Halil Sezen (b)

a) Department of Mechanical and Aerospace Engineering, The Ohio State University Columbus, USA, b) Department of Civil, Environmental and Geodetic Engineering, The Ohio State University Columbus, USA

203 **Introduction and Demonstration of the I&AB Quantification Method as Implemented with Risk Spectrum PSA**

Ola Bäckström (a), Marc Bouissou (b), Rory Gamble, Pavel Krčál, Johan Sörman and Wei Wang (a)

a) Lloyd's Register, Stockholm, Sweden, b) EDF, Paris, France

207 **Modelling Component Failure Rates Utilizing Sensor-Based Degradation Data**

Vaibhav Yadav, Vivek Agarwal, Andrei V. Gribok, and Curtis L. Smith

Idaho National Laboratory, Idaho Falls, ID, USA

W24 Risk and Hazard Analysis III

Wednesday 9/19/2018 3:50 PM Legacy A

Chair: Ronald Boring

- 123 **Studying Parameters for Changing the Initial Particle Arrangements of Distinct Element Analysis in Earthquake Response Based on Slope Analysis**
Taiki Yoshida, Masato Nakajima, and Hitoshi Tochigi
Central Research Institute of Electric Power Industry, Abiko, Japan
- 150 **Smart Grids: Challenges of Processing Heterogeneous Data for Risk Assessment**
Michael Pacevicius (a,b), Davide Roverso (a), Pierluigi Salvo Rossi (c) and Nicola Paltrinieri (b)
a) eSmart Systems, Halden, Norway, b) Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology NTNU, Trondheim, Norway, c) Kongsberg Digital, Trondheim, Norway
- 157 **Study on Volcanic Ash Fall Hazard and Road Network Disruption Risk due to Eruption of Fuji Volcano**
Kazuaki Torisawa (a) and Harumi Yashiro (b)
a) Kanto Gakuin University, Yokohama, Japan, b) National Defense Academy, Yokosuka, Japan
- 432 **The Impact of the Number of Experts on Prediction Accuracy**
Ali Mosleh (a), Ellis Feldman (b)
a) The B. John Garrick Institute for the Risk Sciences UCLA, USA, b) Self, Maryland, USA

W25 Uncertainty and Sensitivity Analysis III

Wednesday 9/19/2018 3:50 PM Legacy B

Chair: Reza Kazemi

- 233 **State-of-the-Art Reactor Consequence Analyses Project: Sequoyah Uncertainty Analysis Methods and Insights**
S. Tina Ghosh (a), and Doug Osborn, Nathan Bixler, Kyle Ross, Dusty Brooks (b)
a) U.S. Nuclear Regulatory Commission, Washington, DC, USA, b) Sandia National Laboratories, Albuquerque, NM, USA
- 75 **Sampling Size Issue in PRA Uncertainty Analysis**
Chunrui Deng
Nuclear Power Institute of China, Chengdu, China
- 141 **Uncertainty Analysis for Input Parameters of Electrical Cabinet Fire Simulation by Coupling Latin Hypercube Sampling and CFAST**
Wanhong Wang (a), Dahuan Zhu (b), Hui Bao (c), Yun Guo, Changhong Peng (a)
a) School of Nuclear Science and Technology, University of Science and Technology of China, Hefei, Anhui, China, b) Science and Technology on Reactor System Design Technology Laboratory, Nuclear Power Institute of China, Chengdu, Sichuan, China, c) Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, Anhui, China

W26 Water and Land Transportation IV

Wednesday 9/19/2018 3:50 PM Pathways

Chair: Yang Wang

- 337 **Determination of the Storage Number of LPG Tank Container Based on Quantitative Risk Analysis**
Qing Xia, Jian Guo, Haiqi Tang and Hualing Wu
China Waterborne Transport Research Institute, Beijing, China
- 410 **Research on Application of Holographic Navigation Marks in the Upper Reaches of Yangtze River**
Geng Jiezhua, Hu Yuchang, Jiang Lili, Han Chao
China Waterborne Transport Research Institute, Beijing, China
- 362 **Discussion on Container Dangerous Goods Stockpile Management Based on Quantitative Risk Assessment**
Zhijun Chen, Yuan Gao (a), Hong Fan (b), Qing Xia, Haiqi Tang, Yafei Zhou (a)
a) China Waterborne Transport Institute, b) Beijing Transport Safety and Health Technical Consultation Institute
- 422 **Construction of Safety Risk Management Platform for Storage Tank Concentration Zone in the Port Area**
Yuchang Hu, Liansheng Xu, Tiansheng Xie, Fengyun Chen, Lili Jiang, Baoqing Zhou
China Waterborne Transport Research Institute, Beijing, China

W27 Resilience Engineering

Wednesday 9/19/2018 3:50 PM Laureatte

Chair: John Andrews

- 10 **A Comparative Study of Risk and Resilience and Their Affiliation in Maritime Safety Research**
Tengfei Wang (a,b,c), Yang Wang (a,b), Shanshan Fu (a,b,d) and Bing Wu (a,b)
a) Intelligent Transportation System Research Center, Wuhan University of Technology, Wuhan Hubei, China, b) National Engineering Research Center for Water Transport Safety, Wuhan Hubei, China, c) School of Logistics Engineering, Wuhan University of Technology, Wuhan Hubei, China, and d) College of Ocean Science and Engineering, Shanghai Maritime University, Shanghai, China
- 172 **The Model of Resilience in Situation: Its Contribution to the Crisis Management Analysis and Improvement**
P. Le Bot, C. De la Garza, Q. Baudard
EDF R&D, Palaiseau, France
- 330 **Building Critical Infrastructure Resilience – Cross-Sectoral Comparison of Vital Operational Tasks and Practices**
Miltos Kyriakidis (a), Vinh N. Dang, and Stefan Hirschberg (b)
a) ETH Zurich, Future Resilient Systems, Singapore-ETH Centre, Singapore, b) Laboratory for Energy Systems Analysis, Paul Scherrer Institute, Switzerland
- 385 **Improving Community Resilience through Post-Disaster Temporary Housing Optimization**
Daniel V. Perrucci and Hiba Baroud
Vanderbilt University, Department of Civil Engineering, Nashville, USA

Th01 Flex, Seismic, and Fire HRA

Thursday 9/20/2018 10:30 AM Exploration

Chair: James Chang

90 **Human Reliability Assessment for 'Flex' Equipment**

Martin Reid
EDF Energy, Gloucester, UK

305 **Application of SPAR-H Method in Fire Human Reliability Analysis**

Kunxiu Liu, Xiufeng Tian (a), Xuhong He (b), Xinwei Liu (a)
a) CNNC China Nuclear Power Engineering Co., Ltd, Beijing, China, b) Lloyd's Register Consulting – Energy AB, Sundbyberg, Sweden

425 **Use of Expert Judgment to Support Human Reliability Analysis of Implementing FLEX Equipment**

Michelle Kichline, Jing Xing, John Hughey, and Mathew Hamberstone
U.S. Nuclear Regulatory Commission, Washington DC, USA

Th02 Reliability Analysis IV

Thursday 9/20/2018 10:30 AM Discovery

Chair: Elaheh Rabiei

338 **Quantitative Reliability Demonstration from Production to Operation on the Example of the New Radiation Tolerant Power Converter Controller for the Large Hadron Collider**

Tamer Tevetoğlu (a), Slawosz Uznanski, Benjamin Todd (b), Bernd Bertsche (a)
a) University of Stuttgart, Stuttgart, Germany, b) CERN (TE-EPC), Geneva, Switzerland

140 **Optimization of Test Cases for Experimental Reliability Evaluation of Digital Reactor Protection System**

Jeongil Seo and Seung Jun Lee
Ulsan National Institute of Science and Technology (UNIST), Ulsan, Republic of Korea

357 **Time-Dependent Reliability Analysis of Nuclear Hybrid Energy Systems**

Askin Guler Yigitoglu, Michael S. Greenwood, Thomas J. Harrison
Oak Ridge National Laboratory, Oak Ridge, TN

Th03 Dynamic PSA/PRA IV

Thursday 9/20/2018 10:30 AM Illumination

Chair: Matthew Denman

217 **A Dynamic Coupled-Code Assessment of Mitigation Actions in an Interfacing System Loss of Coolant Accident**

Zachary Jankovsky (a,b), Matthew Denman (b), and Tunc Aldemir (a)
a) The Ohio State University, Columbus, Ohio, USA, b) Sandia National Laboratories, Albuquerque, New Mexico, USA

221 **Performing an Accident Sequence Precursor Analysis with the ADS-IDAC Dynamic PSA Software Platform**

Mihai A. Diaconeasa and Ali Mosleh
The B. John Garrick Institute for the Risk Sciences, Department of Mechanical Engineering, University of California, Los Angeles, USA

223 **Discrete Dynamic Event Tree Uncertainty Quantification in the ADS-IDAC Dynamic PSA Software Platform**

Mihai A. Diaconeasa and Ali Mosleh
The B. John Garrick Institute for the Risk Sciences, Department of Mechanical Engineering, University of California, Los Angeles, USA

189 **The Backtracking Process Algorithm: A Dynamic Probabilistic Risk Assessment Method for Autonomous Vehicle Control Systems**

Mohammad Hejase, Arda Kurt, Tunc Aldemir, and Umit Ozguner
The Ohio State University, Columbus, Ohio, U.S.A.

Th04 Oil and Gas Industry II

Thursday 9/20/2018 10:30 AM Legacy A

Chair: Marilia Ramos

- 345 **A Practical Approach to Risk-Based Gas Monitoring System Design for Oil and Gas Offshore Platforms**
Claudia Vivalda, Raffaella Gerboni, and Andrea Carpignano
Politecnico di Torino, Turin, Italy
- 416 **Development of a Software Platform for Pipeline Health Monitoring and Management**
Mihai A. Diaconeasa and Ali Mosleh
The B. John Garrick Institute for the Risk Sciences, Department of Materials Science and Engineering, University of California, Los Angeles, USA
- 418 **The Impact of Time-Varying Operating Parameters on the Corrosion Rate and Depth of Gas Pipelines**
Keo Yuan Wu, Mihai A. Diaconeasa, Ali Mosleh
The B. John Garrick Institute for the Risk Sciences, Department of Materials Science and Engineering, University of California, Los Angeles, USA

Th05 Risk Assessment Methods IV

Thursday 9/20/2018 10:30 AM Legacy B

Chair: Brandon Chisholm

- 283 **Recent PSA developments and use of PSA applications in Belgium**
Véronique Jacques, Julie Delvax, Luc Kelders, Dries Gryffroy and Pieter De Gelder
Bel V, Brussels, Belgium
- 309 **Development of Probabilistic Safety Assessment Methodology for Autonomous Micro Modular Reactor**
Eun Seo So, Jaesun Ha, and Man Cheol Kim
Chung-Ang university, Seoul, Korea
- 315 **SSM funding of R&D activities related to Probabilistic Safety Assessment**
Per Hellström
Swedish Radiation Safety Authority, Stockholm, Sweden
- 328 **Reconsideration of PRA Framework – Addressing Level 3 PRA Coverage and Multi-unit Issues**
Kampanart Silva (a), Shin-etsu Sugawara (b)
a) Thailand Institute of Nuclear Technology (Public Organization), Nakhon Nayok, Thailand, b) Central Research Institute of Electric Power Industry, Tokyo, Japan

Th07 Risk Informed Applications IV

Thursday 9/20/2018 10:30 AM Laureatte

Chair: Jonathan DeJesus

- 378 **Use of PRA to Select Licensing Basis Events**
Karl Fleming (a), Edward Wallace (b), and Amir Afzali (c)
a) KNF Consulting Services LLC, Spokane, USA, b) GNBC Associates, Inc., Denver, USA, c) Southern Company Services, Birmingham, USA
- 399 **SSC Safety Classification and Performance Requirements for Advanced Non-LWRs**
Jason Redd (a), Karl Fleming (b), and Amir Afzali (a)
a) Southern Company Services, Birmingham, USA, b) KNF Consulting Services LLC, Spokane, USA
- 400 **Risk Informed and Performance Based Evaluation of Defense-in-depth**
Edward G Wallace (a), Karl Fleming (b), and Amir Afzali (c)
a) GNBC Associates, Inc., Denver, CO, USA, b) KNF Consulting Services LLC, Spokane, WA, USA, c) Southern Company Services, Birmingham, AL, USA

Th11 External Events and Multi-Unit HRA

Thursday 9/20/2018 1:30 PM Exploration

Chair: Jinkyun Park

- 341 **Human Reliability Analysis (HRA) Methodologies used in the Canadian Probabilistic Safety Assessment (PSA) for External Events**
Hayat Chatri, Smain Yalaoui, and Yolande Akl
Canadian Nuclear Safety Commission, Ottawa, Canada
- 226 **Analysis of Human-Induced Initiating Events in the LOOP Scenario**
Awwal Mohammed Arigi, Jooyoung Park, and Jonghyun Kim
Department of Nuclear Engineering, Chosun University, Gwangju, Republic of Korea
- 236 **An Approach to Human Reliability Analysis for the Multi-Unit PSA**
Jooyoung Park, Awwal Mohammed Arigi, and Jonghyun Kim
Department of Nuclear Engineering, Chosun University, 309 Pilmun-daero, Dong-gu, Gwangju 501-709, Republic of Korea

Th12 Maritime and Offshore Technology II

Thursday 9/20/2018 1:30 PM Discovery

Chair: Ingrid Utne

- 404 **A Signal Detection Model to Interpret Safety Tests in Offshore Oil Drilling**
Maryam Tabibzadeh (a), Detlof von Winterfeldt, and Najmedin Meshkati (b)
a) California State University, Northridge, Northridge, USA, b) University of Southern California, Los Angeles, USA
- 420 **A Case Study to Analyze Negative Pressure Test Interpretation in Offshore Drilling: Utilizing a Signal Detection Model**
Maryam Tabibzadeh (a), Detlof von Winterfeldt and Najmedin Meshkati (b)
a) California State University, Northridge, Northridge, USA, b) University of Southern California, Los Angeles, USA
- 254 **Modeling the Risk of U.S. Offshore Oil & Gas Exploration-Well Drilling, Commercial Nuclear Plants, and Human Spaceflight**
Roger L. Boyer, Robert B. Cross (a), Forrest E. Shanks, Michael Worden (b), and Robert Youngblood (c)
a) NASA Johnson Space Center, Houston, U.S.A., b) Bureau of Safety and Environmental Enforcement, Houston, USA, c) Idaho National Laboratory, Idaho Falls, USA

Th13 Consequence Modeling and Management II

Thursday 9/20/2018 1:30 PM Illumination

Chair: Claudia Vivalda

- 284 **Korean Ingestion Dose Assessment Model for Level 3 PSA**
Dong-Kwon Keum, In Jun, Kwang-Muk Lim, Yong-Ho Choi, Hyo-Joon Jeong, Seok-Jung Han
Korea Atomic Energy Research Institute (KAERI), Daejeon, Republic of Korea
- 350 **Optimization of Disaster Restoration Plan for Water Supply System using a High-Fidelity Restoration Process Simulation and Genetic Algorithm**
Shungo Koike (a), Taro Kanno (b), Yuji Kawase (c), Hiroyuki Takahashi (d), and Kazuo Furuta (e)
a,b,e) Graduate School of Engineering, The University of Tokyo, Tokyo, Japan, c,d) METAWATER Co., Ltd., Tokyo, Japan
- 119 **The Latest Thinking of SMRs Impact on the Environment - A Probabilistic Approach**
Bernat Cirera, Lavinia Raganelli and Hugh Stephenson
Corporate Risk Associates, London, United Kingdom

Th14 Risk and Hazard Analysis IV

Thursday 9/20/2018 1:30 PM Legacy A

Chair: Jan Stiller

- 211 **Sequoyah SOARCA Uncertainty Analysis of a STSBO Accident**
Nathan Bixler, Matthew Dennis, Dusty Brooks, Doug Osborn (a), S. Tina Ghosh, Alfred Hathaway (b)
a) Sandia National Laboratories, Albuquerque, NM, USA, b) Nuclear Regulatory Commission, Washington, DC, USA
- 250 **Representation of Process Design Rationale for Change Management**
Tetsuo Fuchino (a), Teiji Kitajima (b), and Yukiyasu Shimada (c)
a) Tokyo Institute of Technology, Tokyo, Japan, b) Tokyo University of Agriculture and Technology, Tokyo, Japan, c) National Institute of Occupational Safety and Health, Tokyo, Japan
- 265 **Systematic Approach for Comprehensive Consideration of Hydrological Hazards in Level 1 PSA**
Marina Roewekamp (a), Gerhard Gaenssmantel, Matthias Utschick, Joachim von Linden (b)
a) GRS gGmbH, Cologne, Germany, b) GRS, Garching, Germany
- 431 **A Survey on Human Interaction with Autonomous Vehicles and Vehicles to Vehicles**
Bentolhoda Jafary (a), Elaheh Rabeie, Mihai A. Diaconeasa, Hasan Massoomi (b), Lance Fiondella (a), and Ali Mosleh (b)
a) University of Massachusetts Dartmouth, Dartmouth, USA, b) University of California Los Angeles, Los Angeles, USA

Th15 External Hazard PSA/PRA IV

Thursday 9/20/2018 1:30 PM Legacy B

Chair: Kim Minkyu

- 272 **Hazard Curve Construction for Icing Events of Overhead Power Lines**
Zoltan Kovacs and Pavol Hlavac
RELKO Ltd, Bratislava, Slovakia
- 303 **Improvement of Fault Displacement PRA Methodology and Concept of its Application to a Hypothetical NPP**
Katsumi Ebisawa, Hideaki Tsutsumi (a), Futoshi Tanaka, Daisuke Ochi, Manabu Miyata, Ryusuke Haraguchi, Tetsuhiro Gou, Kunihiro Sato (b) and Sinji Yoshida (c)
a) Central Research Institute Electric Power Industry, Tokyo, Japan, b) Mitsubishi Heavy Industries, Ltd, Kobe, Japan, c) Obayashi Corporation, Tokyo, Japan
- 354 **The Concept of Validation Strategy about Fault Displacement Fragility Evaluation Methodology and its Application to Actual Damaged Structure**
Hideaki Tsutsumi (a), Yuji Nikaido, Yoshinori Mihara (b), Ryusuke Haraguchi (c), Katsumi Ebisawa (a)
a) Central Research Institute of Electric Power Industry, Tokyo, Japan, b) Kajima Corporation, Tokyo, Japan, c) Mitsubishi Heavy Industries, Ltd, Kobe, Japan

Th16 Aeronautics and Aerospace II

Thursday 9/20/2018 1:30 PM Pathways

Chair: Roger Boyer

- 281 **Synthesizing a New Launch Vehicle Failure Probability Based on Historical Flight Data**
Robert B. Cross (a), William E. Vesely (b)
a) NASA Johnson Space Center, Houston, USA, b) NASA, Retired, Arlington, VA, USA
- 421 **A Bayesian Analysis of the Risk of Satellite Collisions and of Space Surveillance Improvements**
M-Elisabeth Paté-Cornell and Richard Kim
Management Science and Engineering, Stanford University
- 411 **Launch Vehicle Reliability and Risk Metrics Definition and Estimation in Relation to Requirements**
Sergio Guarro
The Aerospace Corporation, El Segundo, California, USA

Th22 New Applications of HRA

Thursday 9/20/2018 3:30 PM Discovery

Chair: Ronald Boring

- 134 **Human Reliability Considerations from the Hawaii Ballistic Missile Alert Event**
Heather Medema (a), Harold Blackman (b), Kateryna Savchenko, and Ronald Boring (a)
a) Idaho National Laboratory, Idaho Falls, Idaho, USA, b) Boise State University, Boise, Idaho, USA
- 191 **On factors Affecting Autonomous Ships Operators Performance in a Shore Control Center**
Marilia A. Ramos, Ingrid B. Utne (a), Ali Mosleh (b)
a) NTNU, Trondheim, Norway, b) UCLA, Los Angeles, U.S.A
- 205 **Serious Games & Human Reliability. The Use of Game-Engine-Based Simulator Data for Studies of Evacuation Under Toxic Cloud Scenario**
Marcos V. P. Andrade, Caio B. Souto Maiora, Erika O. Silva, Márcio C. Moura and Isis D. Lins
Center for Risk Analysis and Environmental Modeling, Department of Production Engineering, Federal University of Pernambuco, Recife, Brazil

Th23 Dynamic PSA/PRA V

Thursday 9/20/2018 3:30 PM Illumination

Chair: Martina Kloos

- 295 **Joint Application of Risk Oriented Accident Analysis Methodology and PSA Level 2 to Severe Accident Issues in Nordic BWR**
Sergey Galushin (a), Lisa Ranlöf, Ola Bäckström, Yvonne Adolffsson (b), Dmitry Grishchenko, Pavel Kudinov (a), Anders Riber Marklund (b)
a) Royal Institute of Technology (KTH), Stockholm, Sweden, b) Lloyd's Register Consulting, Stockholm, Sweden
- 247 **Comparison of Dynamic Event Trees with and without a Human Reliability Interface in a PWR Station Blackout using Severe Accident Management Guidelines**
Emily Sandt, Brian Cohn, Yunfei Zhao, Carol Smidts, and Tunc Aldemir
The Ohio State University, Columbus, Ohio, USA
- 262 **Results of an IDPSA Aimed to Assess the Potential of a Thermally Induced Steam Generator Tube Rupture**
Martina Kloos and Joerg Peschke
Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, Garching, Germany
- 355 **Recent Analysis and Capability Enhancements to the ADAPT Dynamic Event Tree Driver**
Zachary Jankovsky (a,b), Matthew Denman (b), and Tunc Aldemir (a)
a) The Ohio State University, Columbus, Ohio, USA, b) Sandia National Laboratories, Albuquerque, New Mexico, USA

Th24 Risk and Hazard Analysis V

Thursday 9/20/2018 3:30 PM Legacy A

Chair: Mihai Diaconeasa

- 268 **Main Results and Conclusions of the OL3 Level 1 and Level 2 PSAs for the Operating License in Connection with the Fulfillment of the Regulatory Requirements**
Heiko Kollasko, Gerben Dirksen (a), Roman Grygoruk (b), Jari Pesonen, Lasse Tunturivuori and Antti Tarkiainen (c)
a) Framatome GmbH, Erlangen, Germany, b) AREVA GmbH, Erlangen, Germany, c) TVO, Olkiluoto, Finland
- 317 **What is Risk and What is Safety?**
Per Hellström
Swedish Radiation Safety Authority, Stockholm, Sweden
- 52 **Economic Risk Analysis for Gamma Irradiator**
Nestor A. López Fernández, Pamela F. Nelson (a), and Florentino A. López Núñez (b)
a) Universidad Nacional Autónoma de México, Mexico City, Mexico, b) Instituto Superior de Tecnologías y Ciencias Aplicadas, La Habana, Cuba
- 382 **A Project to Encourage the Early Integration of Safety Assessment into the Design, License, and Build Process of Nuclear Power Plants – Status Report**
Steve Krahn, Brandon Chisholm (a), and Andrew Sowder (b)
a) Vanderbilt University, Nashville, TN, USA, b) Electric Power Research Institute (EPRI), Charlotte, NC, USA

Th25 Risk Assessment Methods V

Thursday 9/20/2018 3:30 PM Legacy B

Chair: Chris Everett

- 343 **A New Layer to the PRA: Operational Performance Risk Assessment**
Askin Guler Yigitoglu, Michael M. Muhlheim, Sacit M. Cetiner (a), Richard S. Denning (b)
a) Oak Ridge National Laboratory, b) Research Consultant
- 369 **Tractebel's Hydrogen Risk Analyzer : A tool to Assess the Loads and Risks Associated to Hydrogen Combustion Inside Nuclear Buildings**
Jérémy Bulle
Tractebel (ENGIE), Brussels, Belgium
- 380 **Identification and Quantification of Risk Scenarios for a Unique Nuclear Reactor – a Historical Example**
D.H. Johnson (a), M.A. Linn (b), and C.T. Ramsey (b)
a) B John Garrick Institute for the Risk Sciences, Los Angeles, USA, b) Oak Ridge National Laboratory, Oak Ridge, USA
- 298 **Risk Analysis Framework for Decision Support for Severe Accident Mitigation Strategy in Nordic BWR**
Sergey Galushin, Dmitry Grishchenko, Pavel Kudinov
Royal Institute of Technology, Stockholm, Sweden

Th27 Special Session: Which Way SPRA?

Thursday 9/20/2018 3:30 PM Laureatte

F02 New Developments in HRA

Friday 9:00 AM Discovery

Chair: Hyun Gook Kang

- 133 **Overview of the 2017 Revision to IEEE Standard 1082: Guide for Incorporating Human Reliability Analysis into Probabilistic Risk Assessments for Nuclear Power Generating Stations and Other Facilities**
Ronald Laurids Boring
Idaho National Laboratory, Idaho Falls, Idaho, USA
- 142 **Errors of Commission in HRA – NPSAG Phase 1 Project**
Xuhong He (a), Cilla Andersson (b), Anders Olsson (a), Julia Ljungbjörk, Anders Karlsson (c), Lovisa Nordlof, Karl Gustafsson (d), Lasse Tunturivuori (e), Per Hellström (f)
a) *Lloyd's Register Consulting AB, Stockholm, Sweden*, b) *Ringhals AB, Väröbacka, Sweden*, c) *Forsmarks Kraftgrupp AB, Östhammar, Sweden*, d) *OKG AB, Oskarshamn, Sweden*, e) *Teollisuuden Voima Oyj, Olkiluoto, Finland*, f) *Strål S kerhets Myndigheten, Stockholm, Sweden*
- 53 **An Introduction of Simulator Exercises and Operator Interviews in support of C-2 Human Reliability Analysis**
Yongping Qiu, Yucheng Zhuo, Wenjing Lei, Juntao Hu
Shanghai Nuclear Engineering Research & Design Institute Co. Ltd, Shanghai, China

F03 Site Level (Multi-Unit, Multi-Source) PSA/PRA III

Friday 9:00 AM Illumination

Chair: Xue Yang

- 335 **Analysis of Different Quantitative Safety Goals for Nuclear Power Plants**
Ji Suk Kim, Man Cheol Kim
Chung-Ang University, Seoul, Korea
- 394 **Application of Bayes' Theorem for Risk-Informed Decision-Making at the Decommissioning of Fukushima Daiichi Nuclear Power Plant**
Tu Guang Tan, Sunghyon Jang, And Akira Yamaguchi
The University of Tokyo, Tokyo, Japan
- 395 **Development of Multi-Unit Dependency Evaluation Model Using Markov Process and Monte Carlo Method**
Sunghyon Jang, and Akira Yamaguchi
Department of Nuclear Engineering and Management, The University of Tokyo, Tokyo, Japan

F04 Risk and Hazard Analysis VI

Friday 9:00 AM Legacy A

Chair: Nathan Siu

- 371 **Tools and Methods for Assessing the Risk Associated with Consequential Steam Generator Tube Rupture**
Mohamad Ali Azarm (a) and S. Sancaktar (b)
a) *Innovative Engineering and Safety Solutions, Germantown, MD, USA*, b) *Nuclear Regulatory Commission, Rockville, MD, USA*
- 372 **Probabilistic Risk Assessment of the Spent Fuel Pools of Olkiluoto 1 and 2 NPP Units**
Simo Sihvola (a), Lasse Tunturivuori (b)
a) *Platom Oy, Mikkeli, Finland*, b) *Teollisuuden Voima Oyj, Eurajoki, Finland*
- 402 **Analysis of Precursor Accidents in Nuclear Power**
Spencer Wheatley, Wolfgang Kr ger (a), Olivier Nusbaumer (b), & Didier Sornette (a)
a) *ETH Zurich, Zurich, Switzerland*, b) *Leibstadt Nuclear Power Plant, Leibstadt, Switzerland*

F05 Risk Assessment Methods VI

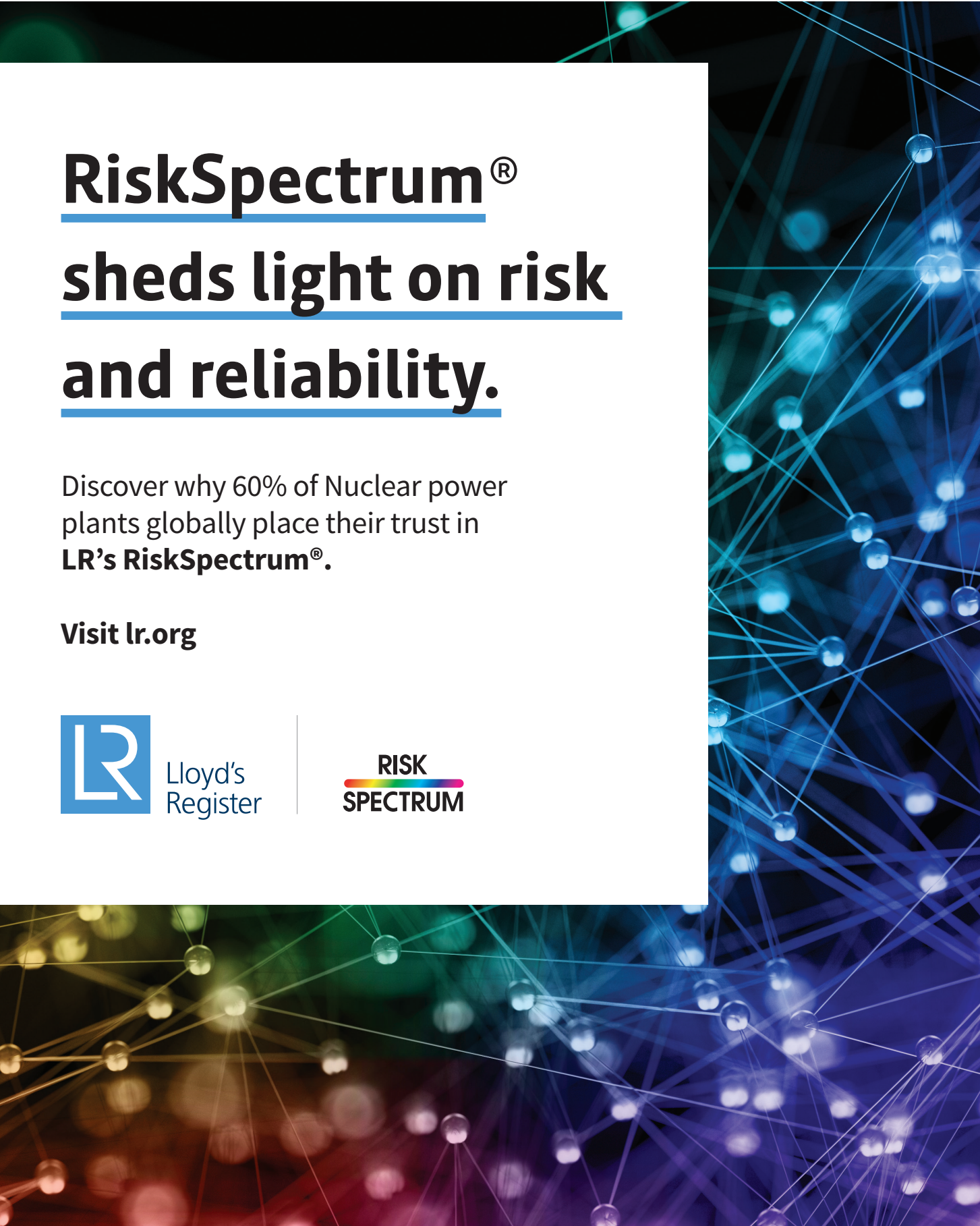
Friday 9:00 AM Legacy B

Chair: *Marina Röwekamp*

- 111 **Perceived Low Risk Processes Can Be Important - Lessons to a Regulator Based on a Nuclear Fuel Facility Process Event**
Donnie Harrison, April Smith
U.S. Nuclear Regulatory Commission
- 426 **Challenges, Solution Proposals and Research Directions in Safety and Risk Assessment of Autonomous Shipping**
J. Montewka (a,c), K. Wróbel (a), E. Heikkilä (b), O. Valdez-Banda (c), F. Goerlandt (d,c), S. Haugen (e)
a) Gdynia Maritime University, Poland, b) VTT Technical Research Centre of Finland Ltd, Tampere, Finland, c) Aalto University, Espoo, Finland, d) Dalhousie University, Halifax, Canada, e) NTNU Trondheim, Norway
- 405 **Fire Source Ignition Frequencies Determined from the International OECD FIRE Database**
Marina Roewekamp (a), Nicholas Melly (b), Andreas Werner (c)
a) Gesellschaft fuer Anlagen- und Reaktorsicherheit (GRS) gGmbH, Koeln, German, b) United States Nuclear Regulatory Commission (NRC), Office of Research, Washington, DC, USA, c) Safety Assessment Consulting (SAC), Breitbrunn, Germany

Conference Summary followed by the Ice Cream Special

Notes



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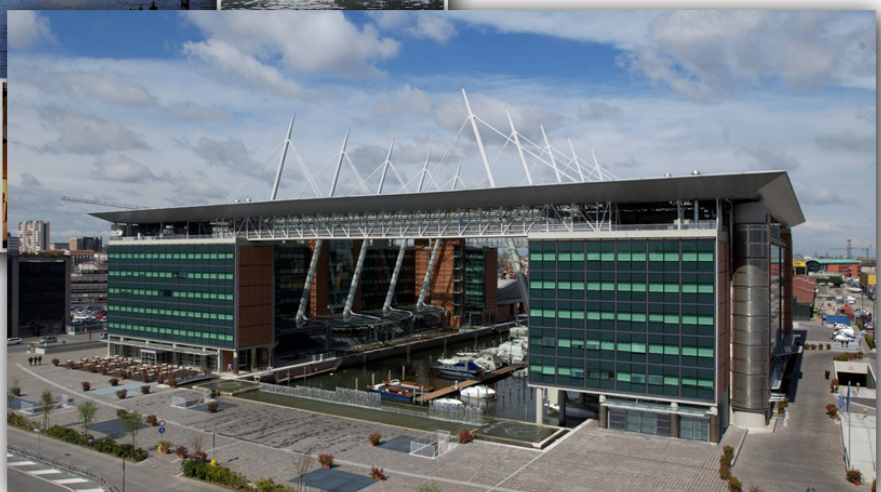
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