2021 International Topical Meeting on Probabilistic Safety Assessment and Analysis (PSA 2021)

Online 7 – 12 November 2021

Volume 1 of 2

ISBN: 978-1-7138-8636-5

Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2021) by American Nuclear Society All rights reserved.

Printed with permission by Curran Associates, Inc. (2024)

For permission requests, please contact American Nuclear Society at the address below.

American Nuclear Society 555 North Kensington Avenue La Grange Park, Illinois 60526 USA

Phone: (800) 323-3044 (708) 352-6611 Fax: (708) 352-0499

www.ans.org

Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA Phone: 845-758-0400 Fax: 845-758-2633 Email: curran@proceedings.com Web: www.proceedings.com

PSA 2021

November 7–12, 2021

1 Monday, November 8, 2021

- 3 Plenary Session: Licensing Modernization Project
- 5 Level 1-3 PRA I
- 6 Checking the Reasonableness of a Bayesian Update— Matthew M. Degonish, Carroll A. Trull, Kenneth L. Kiper
- 15 Research Roadmap to Enhance Industry Legacy Probabilistic Risk Assessment Methods and Tools— Andrew Miller, Stephen M. Hess, Curtis L. Smith
- 25 Categorization of Reactor Sequences for Their Integration Into the SFP PSA Model—*Cristina Israelsson Hilario, Shizhen Yu*
- 35 Use of Severe Accident Codes to Refine Large Early Release Frequency to Support Realism in LERF Estimates—*Ricky Summitt*

45 Non-LWR Licensing

- 46 Satisfying a Risk Limit Curve—*Richard S. Denning*
- 54 Proposed Enhancements to the Risk-Informed and Performance-Based Regulatory Framework for Seismic Hazard Design at NRC Regulated Nuclear Power Plants—*J. Stamatakos, B. Dasgupta, O. Pensado, N. Chokshi, R.* Budnitz, M.K. Ravindra
- 64 Publication of the ASME/ANS Probabilistic Risk Assessment Standard for Advanced Non-Light Water Reactor Nuclear Power Plants—*Karl Fleming, David Grabaskas*
- 71 Licensing Modernization Project for Operating Reactors—*Matthew Humberstone, Alfred Hathaway, Keith Compton, Kurt G. Vedros*

81 Human Reliability Analysis - I

82 Defining Dependency in HRA—*Vincent P. Paglioni, Katrina M. Groth*

- 88 Characterizing Human Performance: Detecting Targets at High False Alarm Rates—*Ann Speed, Jason Wheeler, John Russell, Fred Oppel, Danielle N. Sanchez, Austin Silva, Anna Chavez*
- 98 Extracting Human Reliability Findings From Human Factors Studies in the Human Systems Simulation Laboratory—*Heather Medema, Jeremy Mohon, Ronald Boring*
- 108 Basis for Generic Approach to Human Failure Event Dependent Combination Identification—*Don MacLeod, Huafei Liao*

117 Risk Informed Management - I

- 118 Risk-Informed Process for Evaluations—Antonios M. Zoulis
- 124 Lessons Learned From Surveillance Test Interval Extension of Integrated Safeguards Actuation Test (ISAT) at Sizewell B—*Ray Schneider, Gary Douglas, Kyle Hope, Ashlyn Fornear, Marinos Panayiotou, Christopher Sharrock*
- 131 Research Activities Associated With the Treatment of Potential Common-Cause Failures in Event and Condition Assessment—*Christopher Hunter, Ching Ng, Mehdi Reisi Fard, Zhegang Ma, Sai Zhang*
- 140 OECD Nuclear Energy Agency Working Group WGRISK Current Activities — An Overview—Marina Roewekamp, Attila Bareith, Michelle Gonzalez, Jörg Peschke

147 Advanced Reactors - I

- 148 Demonstration of MACCS Capabilities for Advanced Reactors: Normalized Dose Assessment and Radionuclide Sensitivity Analysis for a High Temperature Gas Reactor Mechanistic Source Term—J. Leute, M. Smith, E. Leonard, N. Andrews, D. Luxat, K. Wagner
- 158 Shutdown Level 2 PSA Methodology for a Small Modular Reactor—Hugo da Costa Romberg Júnior, Nathália Nunes Araújo, Maritza Rodriguez Gual, Marcos Coelho Maturana, Marcelo Ramos Martins
- 168 Sodium Filter Performance in the NaSCoRD Database— Jamal A. Mohmand, Andrew J. Clark

177 Dynamic PRA - I

- 178 Data Post-Processing for Dynamic Probabilistic Risk Assessment—*Yunfei Zhao, Mengfan Zhu, Carol Smidts*
- 188 Dynamic PSA Studies for Advanced Reactor Using RAVEN—M. Hari Prasad, Mahendra Prasad, Mithilesh Kumar, Gopika Vinod, Curtis L. Smith
- 198 Using Operational Experience to Support Dynamic PRA Activities—*Michelle Gonzalez, Nathan Siu*

209 External Event - I

- 210 Risk Applications of Extreme Seismic Hazard Modeling—*Luke McSweeney*
- 220 Challenges and Lessons Learned During the Development of an AP1000® Plant Seismic Probabilistic Risk Assessment—*Rachel Christian, Andrea Maioli, Mustafa Ozkan, Kai Zhang, Parthasarathy Chandran, Benny Ratnagaran*
- 230 Experience Feedback From Implementation of Seismic PSA on EDF 900 MWe Units—*Hugo Jadot, Thi-Lien Do, Emilie Poirier, Olivier Fabre*

241 Aging

- 242 Leveraging Risk Insights Frameworks for Aging Management at Nuclear Reactors—Fernando Ferrante, Emma Wong, Andrew Mantey, Jessica Bock, Justin Hiller, Barry Thurston, Suzanne Lloyd, Nina Lacôme, Seth Rios, Larry Lee, Andrew Williamson
- 252 Evaluation of the Impact of Steam Generator Aging and ATF on Operator Actions During SBLOCA Without HPSI— Jintae Kim, Tunc Aldemir, Asad Ullah Amin Shah, Hyun Gook Kang
- 262 Value of Information-Based Optimal Sensors Positioning by Subset Simulation for Condition-Based PSA—Seyed Mojtaba Hoseyni, Francesco Di Maio, Enrico Zio
- 270 Reliability of Power System Including Renewable Sources With and Without Nuclear Power Plants—*Marko Cepin, Aljaz Spelko*

277 Data Analysis/Artificial Intelligence - I

- 278 Use of Machine Learning to Evaluate Maintenance Rule Functional Failures at Exelon—*Stephen M. Hess, Jonathan L. Hodges, Jenna M. Burr, Scott W. Diven*
- 289 Fault Tree Generation From P&IDs Using Deep Learning—Jaydeep Thik, Xiaoxu Diao, Pavan Kumar Vaddi, Carol Smidts

- 299 Integration of Data Analytics With System Health Programs—D. Mandelli, C. Wang, S. Hess, R. Sugrue, D. Morton, I. Popova, C. Pope, J. Miller, S. Ercanbrack, D. Cole, J. Yurko
- 309 Use of Data Analytics to Evaluate Nuclear Plant Maintenance Historical Data—Stephen M. Hess, Jonathan L. Hodges, Stefan M. Kraft, David Olack, Jeff Greene

319 Tuesday, November 9, 2021

- 321 Plenary Session: Risk Assessment Methods in Non-Nuclear Fields
- 323 Plenary Session: Safety/Reliability for Automotive and Electrified Aviation
- 325 Plenary Session: Tributes and Special Awards
- 327 Non-Nuclear Reactor Risk
- 328 Model-Based Decomposition and Backtracking Framework for Probabilistic Risk Assessment in Automated Vehicle Systems—*Linda Capito, Keith Redmill, Umit Ozguner*
- 340 Quantification of Mission Reliability for Urban Air Mobility Quadcopter Using Dynamic Event Trees—*Gulcin* Sarici Turkmen, Tunc Aldemir, Srujal A. Patel, Matilde D'Arpino, Etienne Demers Bouchard, Jonathan C. Gladin, Cedric Y. Justin
- 349 Safety Assessment of the Novel Distributed/Hybrid Electric Propulsion Architectures for Urban Air Mobility Vehicles—Eddie Li, Srujal A. Patel, Matilde D'Arpino, Metin F. Ozcan, Jonathan C. Gladin, Cedric Y. Justin, Dimitri Mavris

359 Risk Management/Economics - I

- 360 Improved Economics and Reliability While Maintaining High Levels of Safety — Achievements and On-Going R&D Within RISA Pathway—Svetlana Lawrence, Curtis L. Smith, Diego Mandelli, Ronald L. Boring
- 370 The Versatile Economic Risk Tool (VERT)—Jaden Miller, Spencer Ercanbrack, Chad Pope
- 380 Multicriterion Benefit Evaluation of Deploying New Battery Technology With Increased Capacity at a Generic Nuclear Power Plant—Sai Zhang, Zhegang Ma, Hongbin Zhang
- 390 I-PRA Risk- and Cost-Informed Decision-Making Algorithm for Nuclear Power Plants—Sari Alkhatib, Tatsuya Sakurahara, Seyed Reihani, Ernest Kee, Zahra Mohaghegh

399 Dynamic PRA - II

- 400 Dynamic Probabilistic Risk Assessment for Electric Grid Cybersecurity Risk Assessment—*Xiaoxu Diao, Yunfei Zhao, Carol Smidts, Hangtian Lei, Brian K. Johnson*
- 410 Impact of Different Time Discretization Methods on Dynamic Bayesian Network-Based Dynamic Probabilistic Safety Assessments—*Austin D. Lewis, Katrina M. Groth*
- 420 Dynamic PSA Framework With Optimization Algorithm Applied to a Large LOCA Scenario—*Jong Woo Park, Seung Jun Lee*
- 431 Sensitivity Analysis for Effectiveness of Flex Strategy Under Station Blackout Accident Scenario—*Asad Ullah Amin Shah, Hyun Gook Kang, Robby Christian*

441 External Event - II

- 442 Development of Plant-Specific Offsite Power Non-Recovery Factors for High Winds Probabilistic Risk Assessment—*Kyle Hope, Jenifer Avellaneda Diaz, Daniel Tirsun*
- 451 Challenges and Lessons Learned With Using FRANX for Development of High Winds Probabilistic Risk Assessment Fault Trees—*Kyle Hope, Jenifer Avellaneda Diaz, Daniel Tirsun*
- 457 Insights From Straight Winds Validation of the Tornado Missile Strike Calculator—*Kyle Hope, Nicole Gaussa, Chris Rochon*
- 467 Evaluation of Combined External Hazards Research Needs—Stephen M. Hess, Leo B. Shanley, Nicholas Lovelace, Ashley Lindeman

477 Risk Informed Management - II

- 478 IRSN Challenges on Development and Review of PSA—*E. Raimond, N. Rahni, C. Deust, G. Georgescu*
- 487 Accelerating the Adoption of DPRA and Hybrid PRA Analyses Using the RAVEN and EMRALD Tools Deployed Within the Digital Enterprise Platform, FPoli-AAP— Jarrett Valeri, Cesare Frepoli, Curtis Smith, Andrea Alfonsi, Steven Prescott, Cristian Rabiti
- 497 On the Language of Reliability: A System Engineer Perspective—*D. Mandelli, C. Wang, S. Hess*
- 508 Risk-Conscious Operations Management for Nuclear Plants—*Prabhakar V. Varde*

519 Digital I&C and Software Reliability

520 Backward Failure Propagation for Conceptual System Design Using ISFA—*Ali Mansoor, Xiaoxu Diao, Carol Smidts*

- 530 A Bayesian and HRA-Aided Method for the Novel Reliability Analysis of Software—*Tate Shorthill, Heng Ban, Han Bao, Hongbin Zhang*
- 540 Development of Fuel-Specific Leak Frequencies Using a Hierarchical Probability Distribution Model With Bayesian Update—*Dusty M. Brooks, Brian D. Ehrhart, Chris B. LaFleur, Garrett W. Mulcahy*
- 550 Development and Implementation of Risk-Monitor System for the Possibility of Performing Maintenance of Systems Important for Safety for Unit With VVER-1000 Reactor During Operation at Power—V. Demianiuk, M. Hlushchenko

561 Wednesday, November 10, 2021

563 Level 1-3 PRA - II

- 564 Internal Explosion Level 1 PSA: Probabilistic Assessment of Hydrogen Risk in French Nuclear Power Plants— *Yannick Lefebvre, Cécile Luzoir, Hugo Jadot, Jérémy Gaudron*
- 572 Addressing Loss of Room Cooling in PRA Modeling— Joshua S. Beckton
- 582 Development of SAMG-FT/ET Model for Level 2 PRA of OPR-1000 NPPs—Sang Hun Lee, Jaehyun Cho, Jaewhan Kim
- 592 Modeling Portable Equipment in Probabilistic Safety Assessment of Nuclear Power Plants—Ji Suk Kim, Man Cheol Kim, Kibeom Son, Gyunyoung Heo, Gayoung Park, Jonghyun Kim, Meejeong Hwang, Moosung Jae

601 External Event - III

- 602 Review of Operating Experience and Fragility Development During Flooding Incidents at Nuclear Power Stations—*Joy Shen, Michelle Bensi, Mohammad Modarres*
- 620 Development of Generic Fire Ignition Frequency Distributions for Japanese Nuclear Power Plants— Yasunori Nagata, Tsuyoshi Uchida, Tomoaki Yoshida, Koji Shirai
- 630 Effect of Frequency Contents of Seismic Ground Motion on NPP Equipment—*Na-Hyun Kim, Tae-Hyun Kwon, In-Kil Choi*
- 639 Prediction of Floor Response During Earthquakes in Long-Term Operation of Nuclear Power Plant Using Artificial Neural Networks—*Jeong-Gon Ha, Tae-Hyun Kwon*

649 Risk Informed Management - III

650 Insights From Implementing a Fire PRA Training During Extended Telecommuting Situation—*Young G. Jo*

- 655 Visualization and Automation of Fire Modeling Using Fire Risk Investigation in 3D (FRI3D)—*Steven Prescott, Robby Christian, John Biersdorf, Kurt Vedros, Ramprasad Sampath*
- 665 Risk-Informing Nuclear Facility Emergency Preparedness—*F. Gregory Hudson, Ronald J. Markovich*
- 670 Fire Probabilistic Risk Assessment on Pre-Operational Plant—*Michele L. Reed, Young G. Jo*

679 Risk Management/Economics - II

- 680 How to Assess a PSA Involving Passive Systems With a Number of CATHARE Code Runs Within an Industrial Context—*Yann Morvan, Elisabeth Duvillard*
- 690 Development and Application of Risk Analysis Toolkit for Plant Resource Optimization—*D. Mandelli, C. Wang, S. Hess, D. P. Morton, I. Popova*
- 701 Managing Unexpected Failures of Nuclear Power Plants by Incorporating Organizational Factors Into Probabilistic Risk Assessment—*Andrea Roy, Pegah Farshadmanesh, Tatsuya Sakurahara, Ernie Kee, Zahra Mohaghegh*
- 710 Automatic Generation of Event Trees and Fault Trees: A Model-Based Approach—*D. Mandelli, A. Alfonsi, T. Aldemir*

721 Physical Security - I

- 722 Risk-Informed Access Delay Timeline Development— Douglas M. Osborn, Dusty Brooks, Andrew Thompson
- 732 Risk-Informed Approaches for Physical Security— Douglas M. Osborn, Adam Williams, Susan Caskey, Andrew Clark, Gregory Wyss
- 741 Methodology and Application of Physical Security Effectiveness Based on Dynamic Force-on-Force Modeling—*Robby Christian, Vaibhav Yadav, Stephen Prescott, Shawn St. Germain*
- 751 Integrated Safety and Security Analysis of Nuclear Power Plants Using Dynamic Event Trees—*Brian Cohn, Tunc Aldemir, Troy Haskin, Todd Noel, Jeffrey Cardoni, Douglas Osborn*

761 Human Reliability Analysis - II

- 762 Advanced Thermal Hydraulic Simulations for Probabilistic Safety Assessment: Important Data for Human Reliability Quantification—*C. Picoco, V. Rychkov*
- 772 Phoenix Human Reliability Analysis Method: Application to a Feed and Bleed Operation—*Marilia Ramos, Ali Mosleh, Kanoko Nishiono, Haruaki Ueda, Yoshikane Hamaguchi*

- 782 Human Factors Considerations for Automating Microreactors—*Elizabeth S. Fleming, Megan Nyre-Yu, David L. Luxat*
- 792 Analysis of Simulator Data for Human Error Probability Using Coupling Method—*Mahendra Prasad, Vipul Garg, Gopika Vinod*

799 External Event - IV

- 800 External Hazards Screening: Solar Flares—*Kyle Hope, Ray* Schneider, Young G. Jo
- 808 Model-in-the-Loop Control Design for Seismic Testing of Base-Isolated Nuclear Equipment—Sai Sharath Parsi, Mettupalayam V. Sivaselvan, Andrew S. Whittaker
- 818 Partially Correlated Fragilities in Seismic PRA Using Damage Capacity: A General Distribution-Free Approach—Se-Kwon Jung
- 826 Theoretical Analysis and Numerical Simulation of the Seismic Response of Liquid-Filled, Head-Supported Reactor Vessels—*Ching-Ching Yu, Faizan UI Haq Mir, Andrew S. Whittaker*

837 Advanced Reactors - II

- 838 Practical Insights for Assessing Multi-Unit Risk to Support Risk-Informed Decision-Making—*Fernando Ferrante, Andrea Maioli, Ken Kiper, Carrol Trull, Adriana A. Sivori*
- 848 IAEA Safety Report on Multi-Unit Probabilistic Safety Assessment—*Shahen Poghosyan, Ovidiu Coman, Dennis Henneke*
- 857 Analysis of Common Cause Failures With Effects of Degradation and Maintenance—*Taotao Zhou, Mohammad Modarres, Enrique López Droguett*
- 865 PSA-Based Seismic Margin Assessment for a New Reactor Design—*Manuel Pellissetti, Gerben Dirksen, Artem Shevchenko, Hugo Jadot, Romain Tricard*

875 Risk and Reliability Applications for Optimizing Integrated and Hybrid Energy Systems: Finding the Right Mix at the Right Time

- 877 Uncertainty Quantification I
- 878 Analysis of Outlying Simulations for PWR Accidental Transients—*Álvaro Rollón de Pinedo, Bertrand looss, Roman Sueur, Nathalie Marie, Amandine Marrel, Elsa Merle*

- 888 Standardized Probabilistic Safety Assessment Models: Status and First Results of SPAR-CSN Project—*Enrique Meléndez, Cesar Queral, Carlos París, Miguel Sánchez, Marcos Cabezas, Santiago Arrazola, Sergio Courtin, David Castro, Rafael Iglesias*
- 898 Practical Approach for Uncertainty Quantification and Sensitivity Analysis in Fire Probabilistic Risk Assessment Modeling—*Fernando Ferrante, Ashley Lindeman, Marko Randelovic, Georgi Georgiev, Paul Boneham*
- 908 Uncertainty and Sensitivity Analyses With SUSA for a Station Blackout Scenario Calculated by MELCOR— Sören Johst, Michael Kowalik, Michael Hage

921 Thursday, November 11, 2021

923 Plenary Session: Non-LWR Risk Standard

- 925 Level 1-3 PRA III
- 926 Belgian Spent Fuel Pool Internal Events PSA—*Filip Van* Opstal, Bogdan Golovchuk
- 936 Belgian Spent Fuel Pool Internal Hazards PSA—*Bogdan* Golovchuk, Filip Van Opstal
- 944 Development of Level 1 Internal Event Single-Unit PSA Models for Multi-Unit Risk Profiles—*Kibeom Son, Gyunyoung Heo, Ji Suk Kim, Man Cheol Kim, Gayoung Park, Jonghyun Kim, Meejeong Hwang, Moosung Jae*
- 953 Methodological and Computational Developments for Fire Scenario Selection and Analysis in Fire PRA of Nuclear Power Plants—Sari Alkhatib, Tatsuya Sakurahara, Seyed Reihani, Ernest Kee, Zahra Mohaghegh, Brian Ratte, Kristin Kaspar, Mary Ann Billings, Sean Hunt

963 External Event - V

- 964 Screening Process for Individual and Correlated External Hazards — Application on the 1300MWe French Series—Jeremy Gaudron, Cécile Luzoir, Yannick Lefebvre, Hugo Jadot
- 973 Probabilistic Framework for Description of Radioiodine Behavior at Fukushima Accidents—*Adolf Rydl*
- 983 Analysis of Criteria Applicable to the Screening Approach Used in PSA for External Events—*Thiago* Padilha da Silva, Marcos Coelho Maturana, Miguel Mattar Neto, Patricia da Silva Pagetti de Oliveira
- 993 Implementation of Methodology for Maintenance-Induced Internal Floods—*Robert J. Wolfgang, Samuel Falvo*

- 1002 Multi-Unit PRA Advances, Issues, Impediments and Promise
- 1003 Key Challenges in External Hazard Probabilistic Risk Assessment for Nuclear Power Plants
- 1005 Human Reliability Analysis III
- 1006 Benchmarking IDHEAS-ECA Using Data From the Presidential Election Recounts—*Yung Hsien James Chang*
- 1014 A Framework to Extrapolate and Evaluate Human Reliability Causal Models From Event Report Narratives—Andres Ruiz-Tagle, Vincent P. Paglioni, Enrique Lopez-Droguett, Katrina M. Groth
- 1024 Feasibility of the TACOM Measure as a Yardstick to Identify the Level of Task Complexities Under a Procedure Guided Task Environment—*Jinkyun Park, Inseok Jang, Yochan Kim*
- 1033 A Taxonomy and Meta-Analysis Template for Combining Disparate Data to Understand the Effect of Digital Environments on Human Reliability—*Mary Presley, Ronald Boring, Thomas Ulrich, Heather Medema, Jeremy Mohon, Marialaura Delvecchio, Salvatore Massaiu, Andreas Bye, Jinkyun Park, Yochan Kim, Jeffrey A. Julius*

1043 Data Analysis/Artificial Intelligence- II

- 1044 Simplified Adding and Retrieving Nuclear Data To/From LIDAR Models—*Steven Prescott, Michael Ziccarelli, Eric Allen*
- 1055 Limit Surface Search Algorithm With Artificial Neural Network and Monte Carlo Dropout Uncertainty Quantification—*Junyong Bae, Jong Woo Park, Seung Jun Lee*
- 1065 Deep Transformer Network for Time Series Classification: The NPP Safety Case—*Bing Zha, Alessandro Vanni, Yassin Hassan, Tunc Aldemir, Alper Yilmaz*

1075 Graduate Research Lightning Round

1077 Cyber Risk

- 1078 A Case Study in Fault Tree Application for Target Set Selection—*Rachel Christian, Heather Detar, Stephen Reed, Michael Sleigh*
- 1087 A Multilayer Network Approach to Assessing the Impact of Human Performance Shaping Factors on Security for Nuclear Power Plants—*Adam D. Williams, Elizabeth S. Fleming*
- 1097 A Case for Risk-Informing Nuclear Power Plant Cyber Security—*F. Gregory Hudson*

1103 Uncertainty Quantification - II

- 1104 GOFACS: Generator of Fragility Assessment for Coupled Systems, Structures and Components—*Marine Marcilhac, Nadia Rahni, Emmanuel Raimond, El Hadi Moussi, Karina Macocco, Gaëtan Blondet*
- 1112 Simplified Bayesian Network Framework for Beyond-Design-Basis PRA—*Pragya Vaishanav, Saran Srikanth Bodda, Abhinav Gupta*
- 1120 Quantification of Human Error Probability of SBLOCA Mitigation Actions of a Pressurized Water Reactor—*T.C. Wang, M. Lee, Y.M. Chen*
- 1130 Methodology to Streamline Periodic Seismic Safety Evaluations of Nuclear Power Plant (NPP) Structures Systems and Components (SSCs)—Sai Chowdeswara Rao Korlapati, Yigit Isbiliroglu, Yogesh Rathod, Cengiz Erdogan, Piyush Mehta, Nish Vaidya, Olivier Nusbaumer

1139 Friday, November 12, 2021

1141 External Event - VI

- 1142 Research to Develop Flood Barrier Testing Strategies for Nuclear Power Plants—*Zhegang Ma, Sai Zhang, Curtis Smith, Chad Pope*
- 1152 Key Insights, Limits and Projections for EDF's External Flooding PRAs—*Jeremy Gaudron, Cécile Luzoir*
- 1161 Validation of Numerical Models for Seismic Analysis of Submerged Components in Advanced Reactors—*Faizan UI Haq Mir, Ching-Ching Yu, Andrew S. Whittaker*
- 1171 Modeling FLEX Human Actions Using the EMRALD Dynamic Risk Assessment Tool—Jooyoung Park, Thomas A. Ulrich, Ronald L. Boring, Sai Zhang, Zhegang Ma, Hongbin Zhang

1181 Extended Events

- 1182 Discrete-Time Bayesian Networks Applied to Reliability of Flexible Coping Strategies of Nuclear Power Plants— *Elvan Sahin, Victor C. Leite, Juliana P. Duarte*
- 1193 Effectiveness of Accident Mitigation Strategies Based on Mobile Equipment in Nuclear Power Plants—*W. C. Seol, J. W. Heo, H. S. Chang, S. R. Kim, D. I. Choi, M. S. Yang, S.W. Ha*
- 1201 Incorporation of FLEX Strategies and Equipment Into Probabilistic Risk Assessment Models of Nuclear Power Plants—*Ching Ng, Selim Sancaktar, Robert Buell*
- 1210 PSA Model Development for Using Fire Water System and Associated Mobile Equipment in Support of Accident Mitigation—*Tamas Siklossy, Attila Bareith, Nora Eigemann, David Hollo*

1221 Human Reliability Analysis - IV

- 1222 Statistical Study on the Selection of Significant PSF Variables and the Estimation of Their Effects From APR1400 Hurex Data—*Yochan Kim, Jinkyun Park, Mary Presley*
- 1231 IDHEAS Suite for Human Reliability Analysis—Y. James Chang, Jing Xing, Jonathan DeJesus Segarra
- 1239 Human Reliability Analysis (HRA) Relationships What Are They and Best Practices for Defining Them—*Matt Nudi, John Weglian, Kaydee Gunter, Michael Hirt, Jeffery A. Julius*

1247 Physical Security - II

- 1248 Integration of Nuclear Power Plant Safety and Security Codes Through EMRALD—*Brian Cohn, Emily Sandt, Douglas* Osborn, Steve Prescott, Robby Christian
- 1257 Exploring Vital Area Identification Using Systems-Theoretic Process Analysis—*Emily Sandt, Andrew Clark, Adam Williams, Brian Cohn, Douglas Osborn, Tunc Aldemir*-
- 1267 Advantages of Direct Coupling of Dynamic PRA and Physical Security Simulation, Adding Operator Actions and Risk Methodologies—*John Halsema, Christopher Guryan, Ben Russell, Christine Yeager, Steven Prescott*
- 1277 Integrating Human Reliability Analysis With Dynamic Modeling of Physical Security Effectiveness—*Vaibhav Yadav, Tina M. Miyake, Robby Christian, Steven Prescott, Shawn St. Germain, Ronald Boring*

1287 Advances in Level II/III Methods