



NARSIS FINAL WORKSHOP

"Progress in Probabilistic Safety Assessment for nuclear installations"

February 16th & 17th, 2022 - **Online**

February 16 th , 2022			
8.45-12.45 Session#1 - Multi-hazards & Fragility Assessment			
8.45-9.00	Welcome & General introduction	E. Foerster (PI. NARSIS)	CEA
9.00-10.15	Topic#1: Multi-Hazard Assessment for nuclear facilities	NARSIS main speakers	Organization(s)
9.00-9.30	The NARSIS Multi-Hazard Framework	J. Daniell (PI. WP1)	Karlsruhe Institute of Technology
9.30-10.15	Highlights on Probabilistic Hazard Assessment progress for Natural Hazards: - Tsunamis - Extreme weather & Flooding - Extreme earthquake hazard assessment	A. Gailler ¹ , Luca Arpaia ² L. Pheulpin ¹ , J. Daniell ² J. Daniell	¹ CEA, ² BRGM ¹ IRSN, ² KIT KIT
10.15-10.30	Coffee break		
10.30-11.15	Expanding PSA* horizons - IAEA perspective (invited talk)	S. Poghosyan	IAEA
11.15-12.45	Topic#2: Fragility Assessment for nuclear SSC*	NARSIS main speakers	Organization(s)
11.15-11.45	The vector-valued fragility assessment for combined hazards	P. Gehl (PI. WP2)	BRGM
11.45-12.45	Highlights on some impacts of including various effects in the fragility assessment: - Soil-Structure Interactions (earthquakes) - Cumulative effects: fatigue & earthquakes - Human & organizational aspects in fragility assessment - Ageing effects	A. Pavithran ¹ , R. Fares ² PE. Charbonnel P. Van Gelder S. Paci, R. Lo Frano	¹ Framatome, ² CEA CEA Technical Univ. of Delft University of Pisa
12.45-13.45	Lunch Break		
PSA: Probabilistic Safety Assessment; SSC*: Systems, Structures & Components			



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13.45-16.30	Session#2 - Risks & Uncertainties		
13.45-14.30	Surrogate models for uncertainty quantification and structural reliability (invited talk)	M. Maliki	ETH Zürich
14.30-15.45	Topic#3: Multi-Risk integration for PSA of NPP*	NARSIS main speakers	Organization(s)
14.30-15.15	The Bayesian Networks (BN) integration	P. Vardon (Pl. WP3)	TU Delft
15.15-15.45	Highlights on BN integration components: - Comparison of BN with other PSA approaches - Constraining uncertainties: components' modelling & expert-based information	VKD.Mohan J. Rohmer	TU Delft BRGM
15.45-16.30	State-of-the-Art for Multi-Unit and Multi-hazards PSA in the U.S. (invited talk)	D. Henneke	GE-Hitachi Nuclear Energy
16.30-16.45	Coffee Break		
16.45-18.30	Session#3 - Nuclear Safety applications		
16.45-18.30	Topic#4: Applying & comparing various approaches for PSA	NARSIS main speakers	Organization(s)
16.45-17.15	Global S&T synthesis and key outcomes from NARSIS	G. Rastiello (Pl. WP4)	CEA
17.15-18.30	Highlights for nuclear safety analyses: - Metamodeling techniques for seismic & tsunami PSA - PSA methods related to combined earthquake & flooding hazards - Applying the E-BEPU* methodology - Sensitivity&Uncertainty Analyses with uncertainty quantification for Severe Accident	I. Zentner ¹ , C. Feau ² , J. Rohmer ³ A. Kaszko ¹ , VKD.Mohan ² P. Mazgaj ¹ , P. Darnowski ¹ , M. Dusic ² A. Prošek ¹ , P. Darnowski ² , M. Spirzewski ³ , P. Mazgaj ²	¹ EDF, ² CEA, ³ BRGM ¹ NCBJ, ² TU Delft ¹ Warsaw Univ. of Technology, ² Nuccon ¹ Jožef Stefan Institute, ² WUT, ³ NCBJ
PSA: Probabilistic Safety Assessment; NPP: Nuclear Power Plant; E-BEPU: Extended Best Estimate Plus Uncertainty			



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9.00-12.45		Session#4 - Severe Accident	
9.00-9.45	<i>Probabilities in regulatory hazard studies for the chemical industry in France (invited talk)</i>	<i>F. Masse</i>	<i>INERIS</i>
9.45-10.45	Topic#5: Severe Accident Management	NARSIS main speakers	Organization(s)
9.45-10.00	<i>Global S&T synthesis and key outcomes from NARSIS</i>	<i>L. Štrubelj (Pl. WP5)</i>	<i>GEN energja</i>
10.00-10.30	<i>Severa: A New Decision-Support Tool</i>	<i>M. Bohanec</i>	<i>Jožef Stefan Institute</i>
10.30 – 10.45	<i>Coffee break</i>		
10.45-12.45	Topic#6: Possible impacts and wider perspectives		
10.45-11.15	<i>Multi-hazard PSA in the nuclear field: recommendations & perspectives</i>	<i>NARSIS team</i>	
11.15-12.15	<i>Use & perspectives for probabilistic assessment and uncertainty quantification in various high-risk industries (round table)</i>	<i>Invited experts</i>	
12.15-12.45	<i>General discussions and closing of the workshop</i>	<i>All</i>	



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SHAHEN POGHOSYAN (PhD)

Nuclear Safety Officer

International Atomic Energy Agency, Vienna

Safety Assessment Section | Division of Nuclear Installation Safety

Dr. Poghosyan has 20 years of experience of working in the field of Nuclear Safety, focusing on activities related to risk analysis and risk-informed decision making. Heading the risk assessment group at Nuclear and Radiation Safety Center in Armenia, Mr Poghosyan was leading the development of NPP PSA models, PSA applications and national regulations on design safety and safety assessment. Since 2008 Mr Poghosyan holds the Doctorate Degree (PhD) in Nuclear Engineering from the State Engineering University of Armenia. In 2016 he has joined the IAEA, where he is in coordinating the activities related to safety assessment and focusing on the development of IAEA publications on PSA and risk-informed decision making. Mr Poghosyan is actively involved in IAEA activities on SMRs, covering the SMRs risk analysis and Safety, Security and Safeguards interfaces and challenges for innovative reactors. Mr Poghosyan is deeply involved in international topical working groups on risk analysis, in particular he was chairing the VVER PSA Working Group, actively participated in Ageing PSA European Network, as well as currently representing IAEA at OECD/NEA WGRISK and ASME/ANS Joint Committee on Nuclear Risk Management.

Invited Talk: Expanding PSA horizons - IAEA perspective

Probabilistic Safety Assessments (PSA) is a well-established tool that supports design and safety assessment of nuclear installations, and risk-informed decision-making. The development of PSA techniques began decades ago and allowed practitioners to continuously broaden the scope of the PSA models and enhance their applications. IAEA is monitoring the developments in the area of PSA and addresses the needs in the IAEA Member States. The keynote talk is dedicated to the IAEA PSA activities that are driven by the developments and needs in IAEA Member States. It covers various aspects such as expanding the scope of PSA to multi-unit context, application of PSA approaches for SMRs and use of PSA for security purposes. The presentation also provides summary information on upcoming IAEA events in this area.



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MOUSTAPHA MALIKI (PhD)

Senior Scientist

ETH Zürich, Switzerland

*Chair of Risk, Safety and Uncertainty Quantification of the
Institute of structural engineering*

Dr. Maliki studied mechanical engineering at the French Institute for Advanced Mechanics (IFMA, now Sigma Clermont) in France, where he received his master's degree in 2012. He then worked on an industrial PhD thesis with Institut Pascal at Clermont Université, ETH Zurich and PSA Peugeot Citroën, which he defended in 2016. His PhD topic focused on the reliable lightweight design of automotive body structures under frontal impact. Moustapha has joined the Chair of Risk, Safety and Uncertainty Quantification at ETH Zurich in March 2016, first as a post-doc and later as a senior scientist. His research focuses on the use of surrogate models for uncertainty quantification, structural reliability and design optimization under uncertainties. He is one of the main developers of UQLab, the software platform for uncertainty quantification developed at ETH Zurich.

Invited Talk: Surrogate models for uncertainty quantification and structural reliability

Computational models are nowadays a standard tool for the design of manufactured products and structures. Algorithmic advances and a larger availability of computational resources have indeed favoured the systematic use of computational models to simulate with high fidelity the behaviour of engineering systems.

In practice, faithfully predicting the performance of a system requires that its input parameters are well known. However, there are numerous uncertainties related to either the parameters themselves (e.g., manufacturing tolerances) or the system's environment (e.g., loading) that need to be accounted for. This is generally done in the context of uncertainty quantification. More precisely, uncertainty quantification aims at identifying the sources of uncertainty and assessing their impact onto the system's performance. Its scope includes reliability analysis, Bayesian inversion/calibration, design optimization or sensitivity analysis.

Various methods have been developed for solving each of these problems. They however all share the common trait of being computationally intensive. Surrogate models have been increasingly used in the past two decades to propose computationally tractable solutions. They consist in building an inexpensive proxy of the computational model that can be used in subsequent analyses.

In this talk, we will shortly discuss the importance of surrogate models in uncertainty quantification. We will then have a focus on two surrogate model types, namely polynomial chaos expansions and Kriging. Finally, we will show how surrogate models can be used in the so-called active learning framework to efficiently solve complex structural reliability problems.



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DENNIS HENNEKE (MSc. Eng.)

Consulting Engineer

GE-Hitachi Nuclear Energy, USA

Advanced Plants Risk and Reliability

Dennis is a Consulting Engineer in GEH Nuclear Energy, with over 39 years of PSA experience. He is the technical lead for the PSAs supporting the BWRX-300, VTR, and Sodium Reactors, was the Principal Investigator for the DOE Funded project for the PRISM reactor on "Development/Modernization of an Advanced Non-LWR Probabilistic Risk Assessment," and was the Technical Lead for the UK ABWR PRA development completed in 2018. He is currently, supporting the industry initiative for Technical Inclusive Content of Application (TICAP) and supported the pilot application for both TICAP and the Licensing Modernization Project (LMP). Dennis has authored or co-authored more than 100 publications, including the recently issued IAEA Safety Report 96 on Multi-unit PRA, and the PSA 2019 Conference paper on a Simplified Approach for MUPSA. Dennis is currently supporting the development of an IAEA TECDOC on Multi-Hazard Assessments.

Dennis is the ANS-Chairman of the ANS/ASME Joint Committee on Nuclear Risk Management (JCNRM), and has supported PRA standard development since 1999. Dennis has supported PRAs for more than 35 plants around with world. Dennis received his MS and BS in Nuclear Engineering from University of Florida.

Invited Talk: State-of-the-Art for Multi-Unit and Multi-hazards PSA in the U.S.



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FRANÇOIS MASSE (MSc. Eng.)

Functional Safety Engineer

INERIS, France

Head of the Risk Quantification and Barrier Assessment Section

M. Masse has obtained his Master's degree in Optimization and Safety of Systems and MSc. Eng. degree in Industrial Systems Engineering at University of Technology of Troyes, France, in 2005. He has more than 16 years of work experience at INERIS in the field of functional safety for industrial risk management. His studies for the French Ministry in charge of the environment have enabled him to develop knowledge of probabilistic methods in safety studies and technologies used for risk control, particularly digital technologies. He has also developed INERIS expertise in the field of cybersecurity of industrial systems. He performs assessments of compliance with functional safety standards (SIL certification) and conducts studies for various industrial companies on their Technical Safety Barriers and probabilistic assessment methods related to major Hazards.

Invited Talk: Probabilities in regulatory hazard studies for the chemical industry in France

This presentation deals with the consideration of probability in regulatory studies for the chemical industry in France. Chemical facilities, depending on the type of hazardous substances they store and process, are categorised as Classified Installation for Environment Protection which are defined by the Environment code as "factories, workshops, warehouses, construction sites and, in general, installations operated or owned by any individual or legal entity, public or private, which may present dangers [...] for health, safety, [...]".

The French regulation regarding risk prevention and risk management are the result of more than 200 years of legislation, the evolution of which has often been consecutive to industrial accidents.

Two years after the industrial accident of AZF (French initials for Azote Fertilisant), a new law was introduced on July 30, 2003 which described both prevention and repair of the damage caused by industrial and natural disasters. Since then, regulations have been made considerably tighter and the entire approach towards risk assessment has changed. This law has initiated the use of frequency and probability in the French system of risk management. This probabilistic approach is integrated into the safety studies used to obtain operating permits for classified installations. It is also integrated in the land use planning around industrial sites.

This presentation will give general elements on the mandatory risk studies for Classified Installations in France and in particular on how the probability is integrated and used into these studies as well as the advantages and limits of the applied methods. Some points of comparison with other European practices will also be presented.



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