# ESREL 2018

**28th European Safety and Reliability Conference**

**Norwegian University of Science and Technology, Trondheim**

**17th -21st June 2018**


**Stein Haugen (Chair)**

**Anne Barros (Co-chair)** **Coen van Gulijk (Co-chair)**

**Trond Kongsvik (Co-chair)** **Jan Erik Vinnem (Co-chair)**


# PROGRAMME OVERVIEW

| TIME | | MONDAY | TUESDAY | | WEDNESDAY | THURSDAY |
|---|---|---|---|---|---|---|
| Start | End | | | | | |
| 9:00 | 9:10 | REGISTRATION (Room:) | PLENARY SESSION Ali Mosleh (Room: R1) | | PLENARY SESSION Patrick Hudson (Room: R1) | PLENARY SESSION Sam Mannan (Room: R1) |
| 9:10 | 9:20 | | | | | |
| 9:20 | 9:30 | | | | | |
| 9:30 | 9:40 | | | | | |
| 9:40 | 9:50 | OPENING CEREMONY Anne Borg, Terje Aven, Stein Haugen, Geirmund Lykke (Room: R1) | | | | |
| 9:50 | 10:00 | | TRANSITION | | TRANSITION | TRANSITION |
| 10:00 | 10:10 | | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | Exhibitor workshop by BQR Reliability Engineering Ltd. & AEGIS Engineering Systems Ltd (Room: R3) | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) |
| 10:10 | 10:20 | | | | | |
| 10:20 | 10:30 | | | | | |
| 10:30 | 10:40 | PLENARY SESSION Roar Thon (Room: R1) | | | | |
| 10:40 | 10:50 | | | | | |
| 10:50 | 11:00 | | | | | |
| 11:00 | 11:10 | | | | | |
| 11:10 | 11:20 | | | | | |
| 11:20 | 11:30 | COFFE BREAK Outside R1 and outside R7 | COFFE BREAK Outside R1 and outside R7 | | COFFE BREAK Outside R1 and outside R7 | |
| 11:30 | 11:40 | | | | | |
| 11:40 | 11:50 | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | Exhibitor workshop by Aviation Academy (Room: R3) | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | COFFE BREAK Outside R1 and outside R7 |
| 11:50 | 12:00 | | | | | |
| 12:00 | 12:10 | | | | | ESRA PLENARY SESSION (Room: R1) |
| 12:10 | 12:20 | | | | | |
| 12:20 | 12:30 | | | | | |
| 12:30 | 12:40 | | | | | |
| 12:40 | 12:50 | | | | | |
| 12:50 | 13:00 | | | | | |
| 13:00 | 13:10 | LUNCH Cafe Realfagsbygget and Cafe Hangaren | LUNCH Cafe Realfagsbygget and Cafe Hangaren | | LUNCH Cafe Realfagsbygget and Cafe Hangaren | OPENING CEREMONY Anne Borg, Terje Aven, Stein Haugen (Room: R1) |
| 13:10 | 13:20 | | | | | |
| 13:20 | 13:30 | | | | | |
| 13:30 | 13:40 | | | | | |
| 13:40 | 13:50 | | | | | LUNCH Cafe Realfagsbygget and Cafe Hangaren |
| 13:50 | 14:00 | | | | | |
| 14:00 | 14:10 | | | | | |
| 14:10 | 14:20 | | | | | |

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|---|---|---|---|---|---|---|---|
| 14:20 | 14:30 | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | INDUSTRIAL SESSION OFFSHORE (Room: R3) | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | INDUSTRIAL SESSION RAILWAYS (Room: R3) | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | |
| 14:30 | 14:40 | | | | | | |
| 14:40 | 14:50 | | | | | | |
| 14:50 | 15:00 | | | | | | |
| 15:00 | 15:10 | | | | | | |
| 15:10 | 15:20 | | | | | | |
| 15:20 | 15:30 | COFFE BREAK Outside R1 and outside R7 | | COFFE BREAK Outside R1 and outside R7 | | COFFE BREAK Outside R1 and outside R7 | |
| 15:30 | 15:40 | | | | | | |
| 15:40 | 15:50 | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | | PARALLEL SESSIONS (Room: R1, R2, R3, R4, R5, R6, R7, R8, R9, R90) | ESRA TC Maintenance Industrial panel session (Room: R3) |
| 15:50 | 16:00 | | | | | | |
| 16:00 | 16:10 | | | | | | |
| 16:10 | 16:20 | | | | | | |
| 16:20 | 16:30 | | | | | | |
| 16:30 | 16:40 | | | | | | |
| 16:40 | 16:50 | | | | | | |
| 16:50 | 17:00 | | | | | | |
| 17:00 | 17:10 | TRANSITION | | TRANSITION | | TRANSITION | |
| 17:10 | 17:20 | ESRA General assembly meeting (Room: R1) | | | | | |
| 17:20 | 17:30 | | | | | | |
| 17:30 | 17:40 | | | | | | |
| 17:40 | 17:50 | | | | | | |
| 17:50 | 18:00 | | | | | | |
| 18:00 | 18:10 | | SOCIAL EVENT (TOUR) | | | SOCIAL EVENT (TOUR): - City tour: see website - Hiking in the woods: see website | |
| 18:10 | 18:20 | | | | | | |
| 18:20 | 18:30 | | | | | | |
| 18:30 | 18:40 | | | | | | |
| 18:40 | 18:50 | | | | | | |
| 18:50 | 19:00 | ESRA infomal gathering | | | | | |
| 19:00 | 20:00 | | | GALA DINNER Clarion Hotel & Congress Trondheim | | | |

# CONTENTS

# PREFACE

Welcome to Trondheim!

Trondheim is the third largest city in Norway, with a population of more than 193 000. The 30 000 students put their mark on the city, contributing to a large selection of cultural activities and restaurants. The city is surrounded by forests and hills, and has a close proximity to the sea – Trondheimsfjorden. This is a particularly good time to visit Trondheim. At this time of the year, the sun does not set until close to Midnight and it does not get properly dark during the night.

ESREL 2018 is arranged at the Norwegian University of Science and Technology (NTNU). The university has historical roots from 1760, when Det Trondhiemske Selskab (Trondheim Academy), Norway's first academic society, was founded. It is now the largest university in Norway, offering education and performing research within engineering and science, the humanities, and social studies and a variety of profession studies.

The programme for this year's conference includes close to 400 papers, sharing new insights and ideas within different methods and application areas. The traditional areas for the ESREL conference are continued, such as Accident and Incident Modeling, Risk Assessment, and Structural and System Reliability. The programme is also reflecting the multidisciplinary aspects of safety science, involving areas such as organizational and human factors, as well as resilience engineering. Thus, the ESREL conference embrace a variety of safety and reliability issues, and a range of application areas. This will hopefully lay the foundation for the development of new insights across different domains of knowledge, and support the motto for this year conference: 'Safe societies in a changing world'.

Plenary presentations at this year's conference include highly established and leading academics from different fields of research, and also practitioners with special and valuable insights into new challenges.

The close collaboration with industry and working life is a basic foundation for the safety and reliability field. At this year's conference, we are arranging specific industry sessions, where the aim is for industry to present some of their challenges to the academic community. Hopefully, this can form a basis for cooperation about finding solutions for the benefit of everyone.

# ACKNOWLEDGEMENTS

We would like to thank many people for their support and contributions to ESREL 2018.

We gratefully acknowledge the members of the ESREL 2018 Technical Programme Committee for their support of the scientific programme. We gratefully acknowledge the European Safety and Reliability Association Technical Committee Chairs and Co-Chairs to provide feedback as part of the contributed paper review process and we thank session chairs for their expertise at the conference. And last but not least we thank all authors and reviewers who have willingly given some of their time to ensure a high quality of papers for this conference. Every paper was reviewed by anonymous reviewers.

We would like to thank colleagues who organised special sessions of contributed papers and colleagues, ans who organised workshops. We also thank the ESREL 2018 Plenary Speakers for offering their unique perspectives on safety and reliability at this conference.

The support of the ESREL 2018 sponsors and exhibitors is gratefully acknowledged.

Finally, we would like to thank the respective organisations for supporting the conference: It has been made possible by the close collaboration of ROSS Gemini Center, NTNU and the European Safety and Reliability Association.

Stein Haugen

Anne Barros

Coen van Gulijk

Trond Kongsvik

Jan Erik Vinnem

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| System Reliability | Gregory Levitin, Serkan Eryilmaz |
| Uncertainty Analysis | Emanuele Borgonovo, Roger Flage |

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| Security | Sissel H. Jore, Zdenek Vintr |

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## EUROPEAN SAFETY AND RELIABILITY ASSOCIATION

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The European Safety and Reliability Association is a non-profit international association for the advance and application of safety and reliability technology in all areas of human endeavor. It is an "umbrella" organization with a membership consisting more than 100 national professional societies, industrial organizations and higher education institutions. The common interest is safety and reliability. ESRA established the ESREL conference series, and is a co-organiser of each conference.

**Visit the ESRA website at** http://esrahomepage.eu

## NTNU – FACULTY OF ENGINEERING
## NTNU – FACULTY OF ECONOMICS AND MANAGEMENT

Organiser

At NTNU, the Norwegian University of Science and Technology, we create knowledge for a better world and solutions that can change everyday life.

NTNU is a university with an international focus, with headquarters in Trondheim and campuses in Ålesund and Gjøvik. NTNU has a main profile in science and technology, a variety of programmes of professional study, and great academic breadth that also includes the humanities, social sciences, economics, medicine, health sciences, educational science, architecture, entrepreneurship, art disciplines and artistic activities. NTNU has four strategic areas of research in 2014–2023: sustainability, energy, oceans, and health.

NTNU has offices in Japan and Brussels (together with the University of Bergen and SINTEF).

www.ntnu.edu

## ROSS Gemini Centre

Sponsor

ROSS is an acronym for the Norwegian title "Risiko- og sårbarhetsstudier" and may be translated into "Reliability and Safety Studies". ROSS was established as a Gemini Centre in 2007. The ROSS Gemini Centre is a strategic cooperation between NTNU and SINTEF aimed at developing knowledge, methods and tools that can contribute to preventing accidents causing serious harm to people, environment, material values, and critical infrastructures.

www.ntnu.edu/ross

# ORGANISERS, SPONSORS AND EXHIBITORS

## ESRA Norway Chapter

Sponsor

ESRA Norway The Norwegian Association for Risk and Reliability Analysis (ESRA Norway) was established at the annual meeting of 26 May 1994. ESRA Norway is a Norwegian branch of the European Safety and Reliability Association. ESRA Norway is an ideal association, which works for the development of the field of risk and reliability analysis. ESRA Norway generally addresses professionals in industry, government, researchers, consultants, advisors, students, etc., who work with risk and reliability analyses.

ESRA Norway has 25 supporting companies and approximately 400 individual members. ESRA Norway has over the years arranged more than 100 seminars with relevance to ESRA's subject areas. This includes 4-6 seminars each year with 30-50 participants. Presentations given after 2009 are published on the web (with only a few exceptions).

You may find more information, including upcoming events and PDFs of previous presentations on ESRA Norway's web page: www.esra.no

## BQR

Exhibitor

BQR develops software tools in the area of reliability and maintenance engineering based on 25 years of experience. BQR's services and tools serve leading companies in Israel and worldwide, supporting the asset's entire lifecycle, from design, through operation and disposal. BQR solutions help engineers optimize system designs, logistics and maintenance, save design and Life Cycle Costs, and deliver high-quality reliable assets and fleets. BQR solutions enable companies to meet today's demanding market requirements for complex systems and shorter planning and delivery times, furnishing them with a competitive advantage.

BQR provides a variety of software tools:

fiXtress: CAD solution for electronic assemblies, include: Automated Schematic Review, Automatic electrics components Stress Analysis and Derating, MTBF prediction and mini Thermal estimation.

CARE: Computer Aided Reliability Engineering solution for systems, includes, FMEA, FMECA, Safety, Testability, RBD and FTA integrated.

apmOptimizer: Maintenance engineering solution for systems, assets and fleets, including Life Cycle Cost, Level of Repair Analysis, predictive maintenance optimization, spare parts optimization, MSG-3 and RCM.

BQR digital: Provides real time failure analysis for an optimal predictive maintenance concept.

BQR develops solutions for various industries, including oil and gas, military, aerospace and electronics industries. The company's clients include Elbit, Elop, Elisra, Rafael, the Israeli Aircraft Industry, DSO, Cisco, Baker-Hughes, Schiphol Airport, IBM and many others.

www.bqr.com

## AVIATION ACADEMY
Exhibitor

The Aviation Academy offers, next to Bachelor education and doing Research, open course and in-company master classes for professionals. Master class subjects are based on the latest insights resulting from our applied research projects, and focus on Safety and Human Factors, Maintenance Repair and Overhaul, and Airport Capacity.

www.amsterdamuas.com/aviation

## exida
Exhibitor

Founded in 1999 by several of the world's top reliability and safety experts, exida is the world's leading product certification and knowledge company specializing in automation system safety, alarm management, cybersecurity, and availability. Our clients need to cost-effectively implement the requirements of the safety and security standards. exida enables with their integrated lifecycle suite exSILentia that reduces the time and cost of compliance. exida also delivers coaching and training to rapidly develop a knowledge base within the clients organization, offering a full range of lifecycle services to supplement in-house resources, and providing independent assessments to ensure compliance and traceability.

www.exida.com

# PROGRAMME

MONDAY 18th

| 09:00-09:40 | REGISTRATION | | | |
|---|---|---|---|---|
| ROOM | R1 | | | |
| 09:40-10:30 | Opening ceremony: Anne Borg, Prorector for education, NTNU<br>Geirmund Lykke, City Councillor, Trondheim kommune<br>Terje Aven, Chairman of ESRA<br>Stein Haugen, Chairman of ESREL 2018 | | | |
| 10:30-11:20 | Roar Thon | | | |
| 11:20-11:40 | COFFEE BREAK | | | |
| ROOM | R1 | R7 | R5 | R3 |
| SESSION | Risk Assessment | System Reliability | Mathematical Methods in Reliability and Safety | Uncertainty Analysis |
| CHAIRMAN | Henrik Hassel | Nicolae Brinzei | Jørn Vatn | Rui Kang |
| 11:40-12:00 | Development of a qualitative framework for analysing high-impact low-probability events in power systems | Failure rates of safety critical equipment based on inventory attributes | Failure Mode Effects & Criticality Analysis (FMECA) using Bayesian Dirichlet-Multinomial conjugate pair | Interval-based parameters for stress diffusion in granular medium |
| | I.B. Sperstad & E.S. Kiel | S. Håbrekke, S. Hauge , L. Xie & M. A. Lundteigen | W. Baun | D. Boumezerane |
| 12:00-12:20 | Using an enterprise architecture model for assessing the resilience of critical infrastructure | Direct integration of safety analysis in a model based system engineering process: Lessons learned from Ariane 6 control bench family RAMS studies | Reliability assessment model of technical object in aspect of catastrophic damage in the form of jamming - an outline | Bayesian updating with time dependent models |
| | Gonçalo Cadete & Miguel Mira da Silva | R. López , A. Guillén, J.Sanmartí, C. Canart & J. Masfrand | M. Zieja, M. Jasztal, S. Stępień & M. Ważny | P. Beaurepaire |
| 12:20-12:40 | Alternative life-loss rates for failures of large concrete and masonry dams in mountain regions of OECD countries | Preliminary Safety Assessment of Circular Variable Nacelle Inlet Concepts for Aero Engines in Civil Aviation | Maintenance of a Drone Fleet | Accelerated degradation model based on geometric Liu process |
| | A. Kalinina, M. Spada & P. Burgherr | S. Kazula, D. Grasselt, M. Mischke & K. Höschler | A. Segal & Y. Bot | J. -P. Wu, X. -Y. Li & R. Kang |
| 12:40-13:00 | | Towards a systematic evaluation of supplementary protective measures and their quantification for use in functional safety | Multiaxial fatigue life prediction for turbine blades using finite element analysis | Reliability assessment for solid state drive based on measurement errors and fuzzy failure threshold |
| | | J. Zehetner, U. Weber, I. Häring & W. Riedel | J. Zhou, H. -Z. Huang, Y. -F. Li, J. Guo & X. -Y. Li | P. Li, J. Yuan & W. Dang |
| 13:00-14:00 | LUNCH | | | |

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|---|---|---|---|---|---|
| REGISTRATION | | | | | |
| R1 | | | | | |
| Opening ceremony: Anne Borg, Prorector for education, NTNU<br>Geirmund Lykke, City Councillor, Trondheim kommune<br>Terje Aven, Chairman of ESRA<br>Stein Haugen, Chairman of ESREL 2018 | | | | | |
| Roar Thon | | | | | |
| COFFEE BREAK | | | | | |
| R8 | R9 | R6 | R4 | R90 | |
| Occupational Safety | Maintenance Modeling and Applications | Resilience Engineering | Organizational Factors and Safety Culture | Structural Reliability | |
| Marja Ylönen | Antoine Grall | Ivonne Herrera | Stian Antonsen | Karl Breitung | |
| Indicator on the performance of barriers against fatal accidents in construction | Bayesian approaches to lifetime prediction | ISRA: IMPROVER Societal Resilience Analysis for critical infrastructure | The impact of personal liability concerns on incident reporting in engineered systems | Buffered environmental contours | |
| U. Kjellén | F. Marsili, J. Bödefeld, P. Croce & F. Landi | H. Rosenqvist, N.K. Reitan, L. Petersen, D. Lange | J. Hayes, J. Wong, C. Scott-Young & S. Maslen | K. R. Dahl & A. B. Huseby | |
| Information flow and knowledge transfer of accident investigation results in the Norwegian construction industry | Assessing the impact of operational context variables on rolling stock reliability. A real case study | Creating comparable public tolerance and technical performance measures for critical infrastructure resilience evaluation | Interorganizational complexity – main challenges and opportunities in the petroleum industry | Environmental contours for design of ice-capable vessels | |
| K. Wasilkiewicz | J. Izquierdo, A. Crespo, J. Uribetxebarria & A. Erguido | L. Petersen, E. Lundin, J. Sjöström, D. Lange & R. Teixeira | V. Milch & K. Laumann | W. Chai, B. J. Leira & C. Sinsabvarodom | |
| Standardized risk assessment techniques: a review in the framework of occupational safety | Alternative Weibull analysis for road markings: an EM approach | Interdependent infrastructure network restoration from a community resilience perspective | Reorganization and downsizing in the petroleum sector | Subset Simulation and Global Minimization: Any Problems? | |
| F. Brocal, C. González & M.A. Sebastián, G. Reniers & N. Paltrinieri | M. Redondin & N. Faul, L. Bouillaut, A. Samé, D. Daucher | K. Barker, D. B. Karakoc & Y. Almoghathawi | L. I. V. Bergh, R. Høydal, J. E. Tharaldsen, C. Aagestad & T. Sterud | K. Breitung | |
| | Influence of selected external factors on satellite navigation signal quality | Measuring infrastructure and community recovery rate using Bayesian methods: a case study of power systems resilience | Reversing the trend through collaboration in the petroleum industry | Probabilistic fatigue damage prediction of relative short edge crack using Direct Optimized Probabilistic Calculation | |
| | K. Krzykowska & M. Siergiejczyk & A. Rosiński | H. Baroud & S. Murlidar | K. Skarholt & G. M. Lamvik | M. Krejsa, J. Brozovsky, S. Seitl & Z. Kala | |
| LUNCH | | | | | |

MONDAY 18th

| ROOM | R1 | R7 | R5 | |
|---|---|---|---|---|
| SESSION | Risk Assessment | System Reliability | Mathematical Methods in Reliability and Safety | |
| CHAIRMAN | Eric Rigaud | Emmanuel Remy | John Andrews | |
| 14:00-14:20 | An evaluation of the functional resonance analysis method (FRAM) as a practical risk assessment tool within a manufacturing environment. | Digitalization of the power business: How to make this work? | Discussion on probabilistic and interval approaches applied to the Eurocode 7 | |
| | S. Albery, S. Tepe & D. Borys | A. B. Svendsen, T. Tollefsen, T. Gjengedal, M. Goodwin & S. Antonsen | S. H. Marques | |
| 14:20-14:40 | Failure prognosis of discrete events systems based on extended Petri Nets | Network analysis of the European natural gas infrastructure to quantify its performance in long-duration pipeline shutdown scenarios | Discussion on evaluation of probability bounds applied to the Eurocode 7 | |
| | R. Kanazy, S. Chafik & E. Niel | P. Lustenberger, W. Kim, F. Schumacher, M. Spada, P. Burgherr, S. Hirschberg & B. Stojadinović | S. H. Marques | |
| 14:40-15:00 | Enhanced condition monitoring of the machining process using wavelet packet transform | Imprecise reliability analysis of complex interconnected networks | Probabilistic safety assessment and state prediction of cranes based on fuzzy theory | |
| | L. Mao, L. Jackson, P. Goodall & A. West | J. Behrensdorf, M. Broggi & M. Beer | G. Shen, X.J. Zhang, X.L. Tang, S.T. Wang, G. Shen & D. Xiang | |
| 15:00-15:20 | A novel navigational risk analysis method using interval type-2 fuzzy sets | | A study of the relationship between sample size and the confidence level of MTTF for products with exponential failure distribution | |
| | C.L. Fan, D. Zhang, J.F. Zhang & H.J. Yao | | Y. Wang, H. Cheng & D. Xu | |
| 15:20-15:40 | COFFEE BREAK | | | |

| R8 | R9 | R6 | R4 | R90 | R3 |
|---|---|---|---|---|---|
| Occupational Safety | Maintenance Modeling and Applications | Resilience Engineering | Organizational Factors and Safety Culture | Structural Reliability | Industry session |
| Urban Kjellen | Mitra Fouladirad | Joeri Van Laere | Trond Kongsvik | Martin Kresja | - |
| Accident and disease prevention in working life: Common grounds and areas for mutual learning | An opportunistic maintenance policy for heterogeneous components | Checklist for judgement of technical facility safety level and results obtained by its application in practice | Safety climate and compliance in the Norwegian aquaculture industry – employees' perceptions at different company levels | Bayesian updating of stochastic process-based models for corroding gas pipelines based on imperfect inspection information | Major accident collision risk management of DynPos (DP) marine operation<br>Olav Sæter, Bjørn Nygård, Kristian Gould, Statoil ASA, N |
| E. Albrechtsen, R. B. Jørgensen, T. Kongsvik & K. V. H. Svendsen | P.A. Scarf, C.A.V. Cavalcante & R.S. Lopes | D. Prochazkova & J. Prochazka | T.Ø. Kongsvik, T. Thorvaldsen, I.M. Holmen & K.V. Størkersen | K. Pesinis & K.F. Tee | |
| The role of employers, safety engineers and safety reps in the improvement of safety level at enterprises | Optimising the maintenance strategy for a multi-AGV system using genetic algorithms | A Quantitative Approach for Applied Resilience Assessment Audits | Production and protection. Seafarers' handling of pressure in gemeinschaft and gesellshaft | Effect of the manufacturing defects on the reliability of disposal packages for high level radioactive waste | |
| G. Hrenov, K. Reinhold, M.Tint & P.Tint | R.D. Yan & S.J. Dunnett & L.M. Jackson | R. Mock | K. V. Størkersen, A. Laiou, T. O. Nævestad & G. Yannis | A. Persoons, P. Beaurepaire, A. Chateauneuf & F. Bumbieler | |
| Maritime safety culture and safety behaviours in Greece and Norway: comparing professional seafarers and private leisure boat users | Opportunistic maintenance strategy for a train fleet under safety constraints and inter-system dependencies | Novel methodologies for analysing critical infrastructure resilience | Role multiplexity and home-grown resilience: A study of part-time firefighters in rural emergency management. | Reliability Analysis of Structural Health Monitoring Systems | |
| T. Nævestad, A. Laiou, K. Størkersen, R. Phillips, G. Yannis, T. Bjørnskau & A. Amundsen | H. Ghamlouch & A. Grall | K. Storesund, N.K. Reitan, J. Sjöström, B. Rød, F. Guay, R. Almeida, M. Theocharidou | P. Almklov, M. Nilsen & G. Gjøsund | E. Etebu & M. Shafiee | |
| | A modelling methodology for the assessment of preventive maintenance on a compressor drive system | Resilience assessment of smart critical infrastructures based on indicators | Professionalization in safety: a study of the professional context of a post master safety program's alumni | Research on kinematic reliability of flapping mechanism for flapping wing flight | |
| | Y. Zhang, A. Barros, A. Rauzy & E. Lunde | K. Øien, L. Bodsberg & A. Jovanović | W. van Wassenhove & C. Foussard | Z. Yang & J. Xuan | |
| COFFEE BREAK | | | | | |

# MONDAY 18th

| ROOM | R1 | R7 | R5 | |
|---|---|---|---|---|
| SESSION | Risk Assessment | System Reliability | Mathematical Methods in Reliability and Safety | |
| CHAIRMAN | Marko Cepin | Edoardo Patelli | Radim Bris | |
| 15:40-16:00 | Site risk analysis for nuclear installations — Nordic method developments and pilot studies | Availability modeling of a virtualized IP multimedia subsystem using non-Markovian stochastic reward nets | Bringing Formal Methods on the Rail: On Automatic Verifying RailRoad Interlockings from RailML Models | |
| | J.-E. Holmberg, O. Bäckström, E. Cederhorn, C. Sunde & T. Tyrväinen | M. Di Mauro, G. Galatro, M. Longo, F. Postiglione & M. Tambasco | T. Gonschorek, L. Bedau & F. Ortmeier | |
| 16:00-16:20 | Safety assessment: perspectives for next generation nuclear plants | AltaRica 3.0 Code Generation from SysML Models | Mathematical modelling of critical infrastructure reliability | |
| | A.Carpignano, S. Dulla & A.C. Uggenti | N. Nguyen, F. Mhenni & J. -Y. Choley | D. Vališ, K. Hasilová, Z. Vintr & M. Forbelská | |
| 16:20-16:40 | A general framework for integrated risk assessment of nuclear/non-nuclear combined installations on market-oriented nuclear industry | A PMS-MMDD model for Reliability assessment of multi-state phased-mission system | Self-healing networks : a theoretical approach to smart grids' resilience | |
| | K. Kowal, S. Potempski & Pawel M. Stano | X. -Y. Li, Y. -F. Li & H. -Z. Huang, J. Guo & E. Zio | A. Scala, F. Morone & H. Makse | |
| 16:40-17:00 | Risk significance assessment with operational events of Korea Nuclear power plants | Analyzing the reliability for connected vehicles using qualitative approaches and quantitative methods | A method of road network vulnerability identification taking into account travelers' heterogeneous risk attitudes | |
| | S. Kim, S. Yeong Choi, S. Hoon Han & J. Kim | A. Dabboussi, R. Kouta, J. Gaber, M. Wack, B. El Hassan & L. Nachabeh | B. Lv, J. Zhang, Y.L. Liu & Y. Huang | |
| ROOM | R1 | | | |
| 17:10-18:50 | ESRA General assembly meeting | | | |
| 18:50-20:00 | ESRA informal gathering | | | |

| | R9 | R6 | R4 | R90 | R3 |
|---|---|---|---|---|---|
| | Maintenance Modeling and Applications | Resilience Engineering | Organizational Factors and Safety Culture | Structural Reliability | Safety and risks in autonomy |
| | Cristiano Calvacante | Tor Olav Grøtan | Gudveig Gjøsund | Jana Markova | Stig Ole Johnsen |
| | Two imperfect repair models for a gamma deteriorating system: A comparison | Enhancing metro system resilience after signaling perturbations by bus bridging service: the case of Beijing | Validation of a gamified measure of safety behavior: The SBT | Reliability quantitative analysis method for mechanical system by using extended fault tree | Automated Driving on Steel and Rubber |
| | S. Mercier & I.T. Castro | Q. Wei, R. Niu, T. Tang, S. Su & L. Yue | C.B.D. Burt, L. Crowe & K. Thomas | T. Yu, Y. Liu, X. Zhuang & B. Shang | H. Schäbe |
| | Reliability-based maintenance optimization for the leased equipment with deterioration depending on age and usage | Lessons from the application of a resilience engineering based assessment method to evaluate the resilience of a train departure and arrival management system | Safety and risk management in oil & gas industry: Development of safety x-factor model. | Probabilistic analyses of existing power producing facilities | Safety analysis of autonomous driving using semi-Markov processes |
| | L. Shang, S. Si, Z. Cai & Xianzhi Wang | E. Rigaud, C. Neveu & S. D. Langa | D. Botheju | J. Markova, K. Jung & K. Stastna | M. Nyberg |
| | The real-time reliability evaluation and sequential inspection decision based on Wiener process | Simulating the world described with the Functional Resonance Analysis Method | Reliability and safety engineering: The principles innovation and optimisation of German and Japanese product constructions | Reliability of the aircraft in the Polish operational aviation | A simulation-based safety analysis framework for autonomous vehicles – assessing impacts on road transport system's safety and efficiency |
| | S. Bai, Z. Cheng, Y. Yang & B. Guo | P. Smoczyński, A. Kadziński & A. Gill | S. Bracke & M. Inoue | M. Zieja, M. Woch & J. Tomaszewska | L. F. Vismari, C. B. S. T. Molina, J. B. Camargo Jr, J. R. Almeida Jr, R. Inam, E. Fersman & M. V. Marquezini |
| | | Improving resilience management for critical infrastructures – Strategies and practices across air traffic management and healthcare | | Sealing life evaluation of soft-packed power batteries based on ADT and modified CZM | A scenario-based risk analysis oriented to manage safety critical situations in autonomous driving |
| | | V. Cedrini, M. Mancini, L. Rosi, G. Mandarino, S. Giorgi, I. Herrera, M. Branlat, J. Pettersson, C. -O. Jonson, L. Save & D. Ruscio | | W. Zhang, Y.M. Liu, Y.X. Chen & H. Sun | A. De Galizia, A. Bracquemond & E. Arbaretier |
| R1 | | | | | |
| ESRA General assembly meeting | | | | | |
| ESRA informal gathering | | | | | |

# TUESDAY 19th

| ROOM | R1 | | | |
|---|---|---|---|---|
| 09:00-09:50 | Ali Mosleh<br>«Ask the expert» | | | |
| 09:50-10:00 | TRANSITION | | | |
| ROOM | R1 | R7 | R5 | R2 |
| SESSION | Risk Assessment | System Reliability | Mathematical Methods in Reliability and Safety | Simulation for Safety and Reliability Analysis |
| CHAIRMAN | Genserik Reniers | Lesley Walls | Jørn Vatn | Nicolas Stromberg |
| 10:00-10:20 | PSA modeling method for a safety critical DI&C system | Reliability modeling for dependent competing failure processes between component degradation and system performance deterioration | A new hybrid Bayesian network approach for modeling reliability | Reliability-based design optimization by using support vector machines |
| | I. Animah & M. Shafiee | Y. Zhang, J. Liu, B. Song & T. Yu | F. Petiet, O. François & L. Bouillaut | N. Strömberg |
| 10:20-10:40 | Probabilistic analysis of faults affecting multiple trains of the electrical power supply system of nuclear power plants | Quantitative reliability analysis method for repairable systems with multiple correlations based on goal-oriented method | Statistical test planning using prior knowledge - advancing the approach of Beyer and Lauster | Selecting correct architecture for mission critical safe control systems |
| | B. Brück, G. Gänßmantel, A. Kreuser, C. Müller, E. Piljugin & J. C. Stiller | X. J. Yi, B. Xu, J. Shi, P. Hou & H. N. Mu | A. Grundler, M. Bartholdt & Prof. Dr.-Ing. B. Bertsche | E.H. Dogruguven & I. Ustoglu |
| 10:40-11:00 | A framework for modeling of multiple system failures - recoveries through multi-dimensional distributions in dynamic event trees | A mathematical model for preliminary reliability and maintainability allocation | MLE versus MCMC estimators of the mixture of failure rate model | Real-time work simulations of aircraft unit fuzzy reliability evaluator. |
| | C. Picoco, V. Rychkov & T. Aldemir | Z. Vintr, K. Hasilova & M. Vintr | T. T. Thach & R. Bris | N. Grzesik, R. Czapla, A. Krzyżak & M. Zieja |
| 11:00-11:20 | Risk-informed safety classification of components of auxiliary systems for emergency diesel generators in nuclear power plants | Approximation method for reliability of one-unit repairable system with time redundancy | Importance measure method for joint clearance of mechanism | Evaluation of a community pharmacy dispensing process using a Coloured Petri Net |
| | J. -E. Holmberg | X. Wu & H. Yu | Z. Sun, T. Yu, W. Cui & B. Song | M. Naybour, R. Remenyte-Prescott & M. Boyd |
| 11:20-11:40 | COFFEE BREAK | | | |

| R1 | | | | | |
|---|---|---|---|---|---|
| Ali Mosleh<br>«Ask the expert» | | | | | |
| TRANSITION | | | | | |
| R8 | R9 | R6 | R4 | R90 | R3 |
| Uncertainty Analysis | Maintenance Modeling and Applications | Resilience Engineering | Organizational Factors and Safety Culture | Structural Reliability | Exhibitor workshop |
| Rui Kang | Sophie Mercier | Eric Rigaud | Marja Ylönen | Jana Markova | |
| Modular global uncertainty analysis of event-driven indicators of system's availability | Maintenance resources allocation for the profit maximization of a park of identical systems | Working together towards critical infrastructure (CI) resilience | Applying elements of the STAMP method to the reorganization of the German nuclear waste management | Serviceability criteria for structural design in prescriptive documents | Exhibitor workshop by BQR Reliability Engineering Ltd. & AEGIS Engineering Systems Ltd<br><br>"Cross-domain safety standards overview with a practical RAMS lifecycle activities example" |
| P. M. Stano & M. Spirzewski | W. Zhu & B. Castanier | C. Lomba-Fernández, J.M. Sarriegi, P. Marana & L. Labaka | H. -P. Berg, S. Griebel & B. Milius | J. Markova, M. Holicky & L. Navarova | |
| A performance-margin-based belief reliability model considering parameter uncertainty | An optimal maintenance policy based on partial information | Technical safety and reliability methods for resilience engineering | Multicultural workplaces: A state of the art study of the Norwegian construction industry | Partial factors for fatigue loads in the Eurocode system for road bridge design | |
| Q. Zhang, M. Wen, R. Kang & T. Zu | R. Ahmadi & S. Wu | I. Häring & P. Gelhausen | K. Wasilkiewicz, S.S. Kilskar, A. Øren, R.K. Tinmannsvik & I. Kilanowska | S.B. Hashemi, J. Maljaars & H.H. Snijder | |
| Application of fuzzy finite element method in addressing the Presence of Uncertainties | A methodology for selecting and defining maintenance tasks for critical equipment | Best practices to improve Public Private People Partnerships in the city resilience-building process | On the level of safety knowledge in the general public | Technical service life prediction of deteriorating structures | |
| A. Y. N. Yusmye, A. K. Ariffin, S. Abdullah, S. S. K. Singh & M. Beer | M. Sousa & I. S. Lopes | P. Marana, L. Labaka & J.M. Sarriegi | G. Baldissone, M. Demichela, L. Comberti, E. Pilone, J. Geng & L. Maida | O. Lukoševičienė & R. Kliukas | |
| Advanced methodology for uncertainty propagation in computer experiments with large number of inputs: application to accidental scenario in a Pressurized Water Reactor | Optimal burn-in for repairable products sold with two-dimensional warranty considering preventive maintenance | Resilient performance in response to the 2015 refugee influx in the Øresund region | | | |
| A. Marrel & B. Iooss | X.P. Li & Z.X. Liu, Y.K. Wang & Y.L. Liu | H. Degerman, S. Bram & K. Eriksson | | | |
| COFFEE BREAK | | | | | |

# TUESDAY 19th

| ROOM | R1 | R7 | R5 | R2 |
|---|---|---|---|---|
| SESSION | Risk Assessment | System Reliability | Mathematical Methods in Reliability and Safety | Simulation for Safety and Reliability Analysis |
| CHAIRMAN | Enrico Zio | Mary Ann Lundteigen | Eduardo Patelli | Stefan Bracke |
| 11:40-12:00 | An experimental essessment of the MCS BDD algorithm in RiskSpectrum | Application of failure classification schemes to technology qualification | New resilience performance indices based on the k-terminal reliability of the complete graph | The use of reliability simulation techniques in data-driven facility simulation |
| | O. Bäckström, R. Gamble, P. Krcal & W. Wang | T. Myhrvold, A. Hafver, S. Eldevik, F.B. Pedersen, O.I. Haugen, K. Kvinnesland & D. McGeorge | C. Tanguy | F. Reinecke & S. Bracke |
| 12:00-12:20 | Branching rules and quantification based on human behavior in the ADS-IDAC dynamic PRA platform | Failure behavior analysis of hot standby system based on BDD method | Structure function in analysis of multi-state system availability | Integrated deterministic and probabilistic safety assessment of the cooling circuit of a superconducting magnet for nuclear fusion applications |
| | M.A. Diaconeasa & A. Mosleh | Z. Wang, Y. Chen, W. Men & R. Kang | M. Kvassay & V. Levashenko & J. Rabcan, P.Rusnak & E. Zaitseva | R. Bellaera, R. Bonifetto, N. Pedroni, L. Savoldi, R. Zanino, F. Di Maio & E. Zio |
| 12:20-12:40 | HYPRA: A hybrid static-dynamic PRA software platform | Dependability analysis of a product line using its model | Newly enhanced computing algorithm to quantify unavailability of maintained multi-component systems | Equal load-sharing models of cascades in interdependent network infrastructures |
| | M.A. Diaconeasa & A. Mosleh | B. Chieb, V. Idasiak & F. Kratz | R. Briš & N.T.T. Tran | A. Scala, P. G. De Sanctis Lucentini & G. D'Agostino |
| 12:40-13:00 | | Methodology for the preparation of accelerated reliability testing of electronic components in combat vehicles | A mathematical programming approach to railway network asset management | |
| | | X. P. Cu & H. A. Bui | C. Fecarotti & J. Andrews | |
| 13:00-14:00 | LUNCH | | | |

| - | R9 | R6 | R4 | R90 | R3 |
|---|---|---|---|---|---|
| | Maintenance Modeling and Applications | Resilience Engineering | Organizational Factors and Safety Culture | Structural Reliability | Exhibitor workshop |
| - | Christophe Bérenguer | Ivonne Herrera | Petter Almklov | Mauriusz Zieja | - |
| | A concept for a holistic risk-based operation and maintenance strategy for wind turbines | Contrasting critical infrastructure resilience from Swedish infrastructure failure data | Societal threat landscapes of petroleum industry activity in the high north | Thermal fatigue lifetime prediction of BGA solder joint via a novel fatigue crack propagation model | Exhibitor workshop by Aviation Academy<br><br>"How much is your system capable of avoiding safety risk events? The SAREAC indicator" |
| | C. T. Geiss & C. U. Grosse | J. Johansson, R. Jonason Bjärenstam & E. Axelsdóttir | E. Okstad & T.O. Grøtan & A. Øren | W. Men, Y. Chen, & R. Kang | |
| | Towards a Model based asset deterioration framework represented by probabilistic relational models | A simulation-game to explore collective critical infrastructure resilience | Harmonizing normative organizational structures and serification & validation concepts for safety critical generic projects | Two-dimensional approach towards a probabilistic model of fatigue cracking of an industrial pipeline | |
| | H. Zhang & D. W. R. Marsh | J. van Laere, Peter Berggren, O. Ibrahim, A. Larsson & S. Kallin | E.H. Dogruguven & I. Ustoglu | M. Zieja, M. Jasztal, S. Stępień & M. Ważny | |
| | Data-driven and risk-based decision support for maintenance planning on electrical power grid systems | The Kursk submarine disaster in view of resilience assessment | Contributors to successful safety level in the Norwegian railway sector | Integrity detection of mooring chains by the approach of thermography | |
| | N. J. Edwin, H. Mjølnerød & B. A. Gran | A. Leksin, U. Barth & R. Mock | D. W. Aarsland & J. Vatn | W. Yang, K. Wei & Z. Peng | |
| | A fuzzy evaluation method based on fuzzy consistency matrix for evaluating maintenance design program: case study on heavy vehicle systems | | | | |
| | X. J. Yi, Y. H. Lai, P. Hou & H. N. Mu | | | | |
| LUNCH | | | | | |

# TUESDAY 19th

| ROOM | R1 | R7 | R5 | R2 |
|---|---|---|---|---|
| SESSION | Risk Assessment | System Reliability | Mathematical Methods in Reliability and Safety | Simulation for Safety and Reliability Analysis |
| CHAIRMAN | Hyungju Kim | Mary Ann Lundteigen | Radim Bris | Roger Flage |
| 14:00-14:20 | Application of systems-theoretic process analysis to a subsea gas compression system | Reliability based topology optimization design of the network system: A case study on a sewage treatment system | Operation and Climate-Weather Change Impact on Maritime Ferry Safety | Evaluation of the reliability of composite materials used in aviation |
| | H. Kim, M. A. Lundteigen, A. Hafver, F. B. Pedersen, G. Skofteland, C. Holden & S. J. Ohrem | X. J. Yi, P. Hou, H. N. Mu & Y. H. Lai | K. Kołowrocki & E. Kuligowska | A. Krzyzak, G. Bemowski, R. Szczepaniak, N. Grzesik & L. Gil |
| 14:20-14:40 | Improvement of the risk-based approach for evaluation of permanently plugged and abandoned oil and gas wells | Simulation analysis of aerodrome CNS system reliability | Operating Environment Threats and Climate-Weather Hazards Impact on Maritime Ferry Safety | Research on failure mechanism and reliability of áircraft lock mechanism |
| | H. Langdalen, E.B. Abrahamsen, J.T. Selvik & H.P. Lohne | M. Kozłowski, J. Skorupski & A. Stelmach | K. Kołowrocki & E. Kuligowska | H. Pang, N. Wang & Tianxiang Yu |
| 14:40-15:00 | Risk assessment of worldwide refinery accidents using advanced classification methods: effects of refinery configuration and geographic location on outcome risk levels | LLVM-based Stochastic Error Propagation Analysis of Manually Developed Software Components | Comparison of machine learning algorithms on data from the nuclear industry | A metal-oxide-semiconductor devices reliability assessing method based on physics of failure |
| | P. Burgherr, M. Spada, M. Cinelli, J. Blaszczynski, Roman Słowiński & Y. Pannatier | A. Morozov, K. Janschek & Y. Zhou | E. Remy, E. Dautrême, C. Talon, Y. Dirat & C. Dinse Le Strat | H. Gu, M. Zhu, W. Zhang, L. Zhang, H. Zhu & M. Tang |
| 15:00-15:20 | | Probability-based reliability and availability assessments for a lane at a signalised intersection | Extensions of the I&AB method for the reliability assessment of the spent fuel pool of EPR | Case study of the effects of hurricanes on the coupled electricity and water systems of St Kitts |
| | | M. Maslak & K. Ostrowski | M. Bouissou | C.A. Johnson, R. Flage & S.D. Guikema |
| 15:20-15:40 | COFFEE BREAK | | | |

| R8 | R9 | R6 | R4 | | R3 |
|---|---|---|---|---|---|
| Prognostics and System Health Management | Maintenance Modeling and Applications | Human Factors and Human Reliability | Organizational Factors and Safety Culture | | Industry session |
| Jørn Vatn | Philip Scarf | Per Morten Schiefloe | Jan Hayes | | |
| Current status of the MFM suite for diagnostic and prognostic reasoning of industrial process plants | Bayesian update and aperiodic maintenance policy for deteriorating systems with unknown parameters | Teamwork Competence Required Across Operational States: Findings from Nuclear Power Plant Operation | False alarm? Effects of reducing unnecessary dispatches by fire and rescue services | | Industry challenges for railway safety and reliability<br>Bob Huisman, Dutch Railways (NS), NL,<br>Pierre Dersin, Alstom, F |
| Harald P.-J. Thunem | E. Mosayebi Omshi, A. Grall & S. Shemehsavar | A. B. Skjerve & L. Holmgren | G. Gjøsund, P. G. Almklov & C. Sesseng | | |
| Assessment method of the deterioration degree of asphalt concrete airport pavements | A predictive approach to jointly schedule missions and maintenances for a deteriorating vehicle | Human reliability analysis in NPP: a plant-specific sensitivity analysis considering dynamic operator actions versus accident management actions | Tough men cry- learning from sharp end military aviation II | | |
| M. Zieja, P. Barszc, K. Blacha & M. Wesołowski | E. Robert, C. Bérenguer, K. Bouvard, H. Tedie & R. Lesobre | D. Kancev, S. Heussen, J. U. Kluegel, P. Drinovac & T. Kozlik | T. J. Steiro & C. Moldjord | | |
| Adaptive meta-heuristic to predict dent depth damage in the fixed offshore structures | Modelling demand-caused failures. Estimation procedure. | Symptom-based approach for dynamic HRA and accident management | Tourism industry facing crises: setting the scene | | |
| W. Punurai, M.S. Azad, N. Pholdee & C. Sinsabvarodom | R. Mullor, A.I. Sánchez, P. Martorell & S. Martorell | G. I. Petkov | C. Martin, F. Guarnieri & F. Lamm | | |
| Anomaly indicators for Kaplan turbine components based on patterns of normal behavior | Time-dependent unavailability model integrating on demand-caused and standby-related failures addressing positive and negative effects of testing and maintenance | | | | |
| M.A. Sanz-Bobi, T. Welte & L. Eilertsen | P. Martorell, S. Martorell, I. Martón, S.Carlos & A.I. Sánchez | | | | |
| COFFEE BREAK | | | | | |

# TUESDAY 19th

| ROOM | R1 | R7 | R5 | R2 |
|---|---|---|---|---|
| SESSION | Risk Assessment | System Reliability | Mathematical Methods in Reliability and Safety | Simulation for Safety and Reliability Analysis |
| CHAIRMAN | Jan Erik Vinnem | Nicolae Brinzei | Jørn Vatn | Pierre-Ethienne Labeau |
| 15:40-16:00 | A probabilistic risk assessment method for the security of supply in gas networks supported by physical models | An evidential network-based method for common-cause failure analysis under uncertainty | Advances in Component Fault Trees | Availability simulation model of global navigation satellite system based on operation |
| | B. Gjorgiev, A. Antenucci, G. Sansavini & A. Volkanovski | S. Qiu & H. X. G. Ming & Y. Hou | B. Kaiser, D. Schneider, R. Adler, D. Domis, F. Möhrle, A. Berres, M. Zeller, K. Höfig & M. Rothfelder | A.G. Zhao, X. Sun, Y. Sun & B. D. Li |
| 16:00-16:20 | A risk-based approach for the analysis of LNG carriers port operations | Common cause failures and cascading failures in technical systems: similarities, differences and barriers | Advances in the simplification of Fault Trees automatically generated from AltaRica 3.0 models | A Safe Flow-Management Method for Air Traffic Considering the UAS Presence into the Non-Segregated Airspace |
| | F. Ovidi, G. Landucci, L. Picconi & T. Chiavistelli | L. Xie, M. A. Lundteigen, Y.L. Liu | M. Batteux, T. Prosvirnova & A. Rauzy | E. C. P. Neto, D. M. Baum & M. A. Brinati, J. R. Almeida Jr, P. S. Cugnasca & J. B. Camargo Jr. |
| 16:20-16:40 | Toward the integration of uncertainty and probabilities in spatial multi-criteria risk analysis: an application to tanker oil spills | Industry 4.0 and complexity: Markov and Petri net based calculation of PFH for designated architectures and beyond | Enhancement of the AltaRica 3.0 stepwise simulator by introducing an abstract notion of time | Active power dispatch strategy of wind farms under generator faults |
| | M. Spada & V. Ferretti | M. Albert & M. Dorra | M. Batteux, T. Prosvirnova & A. Rauzy | K. Ma, J. Zhu, M. Soltani, A. Hajizadeh, P. Hou & Z. Chen |
| 16:40-17:00 | | | Research on bayesian reliability growth evaluation method for mechanical products | Probabilistic assessment of the impact of connecting a new Distributed Generation unit to a potentially congested power system |
| | | | J. Yao & H. Wu, T. Jiang & Yiliu Liu | J. Sun, P.E. Labeau & A Vergnol |

| R8 | R9 | R6 | R90 | R3 | |
|---|---|---|---|---|---|
| Prognostics and System Health Management | Maintenance Modeling and Applications | Human Factors and Human Reliability | Risk Management | Occupational Safety | |
| Piero Baraldi | Mahmood Shafiee | Ann Britt Skjerve | Peter Hughes | Kristine Vedal Størk-ersen | |
| Join optimization of detectors' fleet settings to maximize global detection power | Industry 4.0 and real-time synchroni-zation of operation and maintenance | Usability and user ex-perience: Adaption and application for a railway related environment | A framework for as-sessment of techno-logical readiness level (TRL) and commercial readiness index (CRI) of asset end-of-life strategies | Norwegian police train-ing in the use of force: a preparation for facing the realities of street challenges? | |
| P. Beauseroy & E. Grall-Maës | J. Vatn | M. Burkhardt & B.Mil-ius | I. Animah & M. Shafiee | S. Vee Henriksen, A. Snortheimsmoen & B.I. Kruke | |
| Applying mahalano-bis-taguchi method to detect faults in rotating machinery | A maintenance time es-timated method based on Virtual Reality | Study on seafarers' emotion identification during watch-keeping using bridge simulation | Identifying hazards to include in risk analyses | Analysis of fatal fires in Norway over a decade, -a retrospective obser-vational study | |
| G.F.M. Souza & I.S. Melo & M.A.C. Michal-ski | J. Wu, D. Zhou & P. Liu | S. Fan, J. Zhang, X. Yan, E. Blanco-Davis, Z. Yang & J. Wang | M. Leonhardsen, O.E. Olsen & A.S. Nilsen | C. Sesseng, K. Storesund & A. Steen-Hansen | |
| A Diagnosis Method for Diesel Engine Wear Fault Based on Grey Rough Set and SOM Neural Network | Evaluation method of maintenance operation space based on virtual reality | Naturalistic decision making in process con-trol: The guidance-ex-pertise model and the model of resilience in situation | Engineering Safety Recommendations: Results from a Survey in Aviation | Personal protective equipment detection in industrial facilities using camera video streaming | |
| S. Qian, S. Zhou, W. Chang, Y. Xiao & F. Wei | P. Liu, D. Zhou, Z. Guo, J. Wu & Y. Li | S. Massaiu | N. Karanikas | C. B. S. Maior, J. M. Santana, L. M. Nasci-mento, J. B. Macedo, M. C. Moura, D. L. Isis & E. L. Droguett | |
| Statistical comparison of three different meas-urement technologies | | Ergonomic risk assess-ment of maintenance job in a gas power station | How systems engi-neering may be useful in preparing FMECA– Lesson learnt from a practical case | | |
| M. Hinz, A. Luecker, B. Bracke & C. Kloster-mann | | S. O. Ismaila | M. Bucelli, J. Zhang, A. Rauzy & S. Sultana | | |

# WEDNESDAY 20th

| ROOM | R1 | | | |
|---|---|---|---|---|
| 09:00-09:50 | Patrick Hudson<br>«Redefining risk and safety – a multidimensional approach» | | | |
| 09:50-10:00 | TRANSITION | | | |
| ROOM | R1 | R7 | R4 | R2 |
| SESSION | Risk Assessment | System Reliability | Digitalization and Big Data | Simulation for Safety and Reliability Analysis |
| CHAIRMAN | Genserik Reniers | Emmanuel Remy | Coen van Gulijk | Enrico Zio |
| 10:00-10:20 | A framework for aggregating risk information across organisational levels – the case of Swedish municipalities | Reliability Aspects of a Series Load–Sharing System | Safety Enterprise Architecture Approach for a Railway Safety Management System | Incremental fatigue damage simulation for reliability assessment of steel wire ropes under fretting fatigue conditions |
| | H. Hassel | V.V. Krivtsov, S.V. Amari & V.I. Gurevich | S. Khan & C. van Gulijk | S. Ahmad, S. Badshah, M. F. Abdulhamid, H. S. Kang, A. S. Kader & M. N. Tamin |
| 10:20-10:40 | Multi-risk and L.U.P.: a methodology to evaluate neglected risks and risk interactions. An Italian case study | Communication failure analysis for a fleet formation flight of drones based on absorbing markov chain | A computer leaning approach to obtain safety information from multilingual accident reports | A flow-based method for identifying critical pipelines in complex natural gas supply systems |
| | E. Pilone, M. Demichela & G. Camuncoli | R. Abdallah,C. Sarraf,R. Kouta, J. Gaber, M. Wack | P. Hughes, M. Figueres-Esteban, R.A.H. El Rashidy, C. van Gulijk & R. Slovak | H. Su, E. Zio, J. Zhang & X. Li |
| 10:40-11:00 | A new approach for social vulnerability in mainland Portugal area for risk mitigation | Masked data analysis for storage reliability model with initial failures | Reliability-based cyber plant | Bayesian information fusion for non-competing relationship degradation process |
| | A. O. Tavares, J. L. Barros, P. P. Santos & J. M. Mendes | M. Zhao, Y.J. Zhang & J.F. Yang | H. Rødseth, P. Schjølberg, R. Eleftheriadis & O. Myklebust | J. Guo, H. -Z. Huang, Y. -F. Li, J. Zhou & X. -Y. Li |
| 11:00-11:20 | | Verification of timing properties of a medical patient table case Study using probabilistic model checking | | An integrated bayesian network and cost-benefit analysis model for blowout preventer configuration selection in deepwater offshore fields |
| | | T. Mutzke, J. Braun, A. Morozov, K. Ding & K. Janschek | | E.M. Enjema, M. Shafiee & A. Kolios |
| 11:20-11:40 | COFFEE BREAK | | | |

| R1 | | | | | |
|---|---|---|---|---|---|
| Patrick Hudson<br>«Redefining risk and safety – a multidimensional approach» | | | | | |
| TRANSITION | | | | | |
| R8 | R9 | R5 | R90 | R3 | R6 |
| Prognostics and System Health Management | Security | Human Factors and Human Reliability | Risk Management | Accident and Incident Modeling | Safety and risks in autonomy |
| Bruno Castanier | Silke Holtmans | Karin Laumann | Rui Kang | Knut Øien | Ingrid Bouwer Utne |
| Structural damage detection by integrating Short Time Fourier Transform, Principal Component Analysis and Logistic Regression | Finding your aim – choosing your game | A computerized procedure system framework for U.S. utilities | Study on the flight landing quality evaluation model with analytical network process and matter element analysis method | An investigation identifying trends between the enforcement of offshore safety case regulations and the occurrence of vessel to platform collision incidents | Towards a framework for assurance of autonomous navigation systems in the maritime industry |
| A. K. Agrawal & G. Chakraborty | T. Grunnan & H. Fridheim | R. Lew, R. L. Boring & T. A. Ulrich | A. Jingsong Lei, B. Wenbing Chang, C. Lei Li, D. Shenghan Zhou & E. Yiyong Xiao | S. Loughney, J. Wang, B. Matellini & K. Pemberton | A. Brandsæter & K. E. Knutsen |
| Strategic view of an assets health index for making long-term decisions in different industries | Optimizing security patrolling scheduling in chemical industrial parks by using game theory | The weighting method's impact on the weighting process in decision making problems | Risk prediction method of aircraft hard landing based on flight data | Safety climate and work conditions related to acute spills and hydrocarbon leaks in the offshore oil and gas industry – a repeated cross-sectional study | Accounting for human failure in autonomous ship operations |
| A. De La Fuente, A. Guillén, A. Crespo, A. Sola, J. Gómez, P. Moreu & V. González-Prida | L. Zhang & G. Reniers | A. Tzioutziou & Y. Xenidis | L. Zheng & J. Xie & S. Qian | A. Aalberg, S. A. Kvalheim, I. B. Nilsen & R. J. Bye | M. A. Ramos, I. B. Utne, J.E. Vinnem & A. Mosleh |
| Reliability engineering based on operating data and monitoring systems within technical products: challenges, requirements and approaches | An overview on the obsolescence of physical assets for the defence facing the challenges of industry 4.0 and the new operating environments | Verification of HTC Vive deployment capabilities for ergonomic evaluations in virtual reality environments | Approach to a Bayesian decision model for cost-benefit analysis in security risk | Reliability of power system considering replacement of conventional power plants with renewables | Development of dynamic safety envelopes for autonomous remotely operated underwater vehicles |
| S. Bracke, M. Hinz, C. van Gulijk, F. Gronwald, M. Muenker, M. Inoue, S. Yamada, E. Patelli, B. Ulutas, M. Bonato & T. Yamada | V. Gonzalez-Prida, J. Zamora, A. Crespo Márquez, L. Villar-Fidalgo, A. De la Fuente, P. Martínez-Galán & A. Guillén | Z. Tůma, L. Kotek, J. Kroupa, P. Blecha & F. Bradáč | D. Lichte & K.-D. Wolf | M. Čepin | J. Hegde, E. H. Henriksen, I.B. Utne & I. Schjølberg |
| Cyber physical systems implementation for asset management improvement: a framework for the transition. | Security risk and vulnerability analysis in military operational planning: The why's and how's | A multi-discipline method to assess the human performance in manufacturing industry for safety and quality optimization. | Risk-based maintenance backlog | Losing containment at high temperature and pressure - An experimental study with water-steam circuit | Risk from cyberattacks on autonomous ships |
| L. Villar-Fidalgo, Dr. A. Crespo Márquez, Dr. V. González Prida, A. De la Fuente, P. Martínez-Galán & A. Guillén. | S. Malerud & H. Fridheim | L. Comberti, M. Demichela & M. C. Leva | H. Rødseth | F. Heymes, P. Lauret, C. Lopez & P. Hoorelbeke | J. E. Vinnem & I. B. Utne |
| COFFEE BREAK | | | | | |

# WEDNESDAY 20th

| ROOM | R1 | R7 | R4 | R2 |
|---|---|---|---|---|
| SESSION | Risk Assessment | System Reliability | Digitalization and Big Data | Simulation for Safety and Reliability Analysis |
| CHAIRMAN | Terje Aven | Laurent Bouillaut | Coen van Gulijk | Eduardo Patelli |
| 11:40-12:00 | Use case- based consideration of safety and security in cyber physical production systems applied to a collaborative robot system | Reliability Analysis in the Presence of Aleatory Uncertainty | Integrated analysis system for elevator optimization maintenance using ontology processing and text mining | Optimizing terminal logistics and dimensioning |
| | D. Lichte & K.-D. Wolf | L. G. Crespo, S. P. Kenny & D. P. Giesy | M. Nagasaka, M. Sato & E. Kinoshita | S.L. Isaksen & T. Lilleheier & N.J. Edwin |
| 12:00-12:20 | Emergency assessment in case of hazardous substance leakage at Czech Republic freight rail transport in 2008-2016 | Bayesian networks with imprecise datasets: application to oscillating water column | Building cyber resilience through a discursive approach to "big cyber" threat landscapes | An efficient computational strategy for robust maintenance scheduling: Application to corroded pipelines |
| | S. Hoskova-Mayerova | H. D. Estrada-Lugo, E. Patelli, M. de Angelis & D. D. Raj | T.O. Grøtan | E.Patelli & M. de Angelis |
| 12:20-12:40 | A study on the influence of uncertainties in physical security risk analysis | A reliability analysis method for complex mechanical systems containing probabilistic-interval information | Cyber physical systems implementation for asset management improvement: a framework for the transition. | A Monte Carlo method for evaluating dependability of mission repairable items |
| | D. Lichte & K.-D. Wolf | W. S. Peng, M. Xu, C. H. Zeng, Z. Bian & J. G. Zhang | L. Villar-Fidalgo, Dr. A. Crespo Márquez, Dr. V. González Prida, A. De la Fuente, P.Martín-ez-Galán & A. Guillén. | H. Cheng, J. Huang & Y. Zhang |
| 12:40-13:00 | | Reliability Forecasting of Components/ Systems in Automobile Applications by using two-dimensional Stress Functions | | Robust management of distributed energy resources for frequency control in microgrids with unreliable communication |
| | | A. Krini & J. Börcsök | | H.D. Mo & G. Sansavini |
| 13:00-14:00 | LUNCH | | | |

| R8 | R9 | R5 | R90 | R3 | R6 |
|---|---|---|---|---|---|
| Prognostics and System Health Management | Security | Human Factors and Human Reliability | Risk Management | Accident and Incident Modeling | Artic Safety |
| Pierre Beauseroy | Håvard Fridheim | Chiara Leva | Ingrid Utne | Thomas Porathe | Eirik Albrechtsen |
| Machine learning modeling for massive industrial data: Railroad peak kips prediction | Information power supporting the rail systems safety | Task level errors for human error prediction in GOMS-HRA | Analysis of 985 fire incidents related to oil- and gas production on the Norwegian continental shelf | Comparing HFACS and AcciMaps in a Health Informatics Case Study – The Analysis of a Medication Dosing Error | Urban avalanche search and rescue operations in Longyearbyen: A study of public-private cooperation. |
| C. Contreras, M. López-Campos, P. Escalona, R. Stegmaier & T. Grubessich | T. Kertis & D. Prochazkova | R. L. Boring, T. A. Ulrich & M. Rasmussen | C. Sesseng & K. Storesund & A. Steen-Hansen | O.O. Igene & C.W. Johnson | S.M. Tengesdal & B.I. Kruke |
| Optimal prognostic maintenance policy for railway track systems using rolling contact fatigue data | Constructing a method for classification of complex infrastructures for security threats: A case study of Norwegian ISPS port facilities | Challenges with data for human reliability analysis | Implications from major accident causation theories to activity-related risk analysis - An application to the Norwegian Atlantic salmon farming industry | Analysis on factors of subway incidents for signal system maintenance improving based on a hybrid model | Field operations in the high arctic – Experienced feedback and tacit knowledge as key tools for safety management |
| F. Dinmohammadi | K. Brattekås, J.A. Bruvoll, M. Maal, J.F. Aae & A. Breivik | K. Laumann & H. Blackman & M. Rasmussen | X. Yang & I. B. Utne & I. M. Holmen | S. Zhang, T. Tang, R. Niu, F. Yan, L. Yue & L. Wan | M. Indreiten, E. Albrechtsen & S. M. Cohen |
| Energy efficiency and predictive maintenance applications using smart energy measuring devices | Organizational information security culture in critical infrastructure: developing and testing a scale and its relationships to other measures of information security | Human reliability analysis – accounting for human actions and external factors through the project life cycle | Impact of human factors on threats in sewage treatment plants | Understanding and effectively managing conservatisms in safety analysis | Anti-icing expected heat loss as a risk indicator for arctic offshore logistics operations |
| S. Kotsilitis, E.C. Marcoulaki, E. Kalligeros, Y. Mousmoulas | T. Nævestad, S. F. Meyer & J. H. Honerud | C. Morais, R. Moura, M. Beer & E. Patelli | M. Łój-Pilch, A. Zakrzewska & E. Zielewicz | S. Krahn, M. Modarres & J. O'Brien | M. Naseri, E. M. Samuelsen |
| A particle filtering approach for temperature based prognostics | How can we explain improvements in organizational information security culture in an organization providing critical infrastructure? | Reviewing macro level factors as a foundation for understanding quality and patient safety improvement efforts across countries | Integrated monitoring of risks for Seveso plants | Strength of knowledge assessment for risk informed decision making | Hazard identification for a dynamic positioning and mooring system in Arctic condition: complementary use of hazard identification study (HAZID) and systems theoretic process analysis (STPA) |
| A. Bender & W. Sextro | T. Nævestad, J. H. Honerud, S. F Meyer | T. Johannessen, E. Ree, S. Wiig, H. van de Bovenkamp & R. Bal | G. Baldissone, L. Comberti, M. Demichela, T. Marcon, E. Plot & M.C. Leva | T. Bani-Mustafa & Z. Zeng, E. Zio & D. Vasseur | T. Joung, H. Kim, Y. Kim, S. Cho, K. Kang, Y. Liu & M. A. Lundteigen |
| LUNCH | | | | | |

# WEDNESDAY 20th

| ROOM | R1 | R7 | | R2 |
|---|---|---|---|---|
| SESSION | Risk Assessment | Natural Hazards | | Simulation for Safety and Reliability Analysis |
| CHAIRMAN | Enrico Zio | Nima Khakzad | | Jacek Malinowski |
| 14:00-14:20 | Air traffic safety in relation to visualization systems reliability | Impacts of climate change on rail systems: A new climate risk analysis model | | Crisis management in extreme situation: the model of resilience in situation (MRS) as a support to observe the organization with simulation |
| | J. Skorupski & P. Ferduła | T. Wang, Z. Qu, T. Nichol, Z. Yang, D. Dimitriu, G. Clarke & D. Bowden | | Q. Baudard & P. Le Bot & C. De La Garza |
| 14:20-14:40 | A method to evaluate an aircraft operational risk | Data management for the development of a flood vulnerability model | | Effectiveness investigation of the correlation algorithms applied in a Smart ID Card system to monitor the use of PPE |
| | Š. Hosková-Mayerovaá, M. Zieja, M. Woch, J. Tomaszewska & M. Matyjewski | J.-P. Pinelli, D. Rodriguez, D. Roueche, K. Gurley, M. Baradaranshoraka, S. Cocke, D.-W. Shin, L. Lapaiche & R. Gay | | M. Dźwiarek, T. Łempiński & M. Światowski |
| 14:40-15:00 | Analysis of domino scenarios in chemical and process facilities operating in harsh environmental conditions | Risk management for natural hazards based on reliability analysis: A case study of landslides | | Safety for automated warehouse exhibiting collaborative robots |
| | M. Bucelli, G. Landucci, S. Haugen, N. Paltrinieri & V. Cozzani | J, Lee & D. K. Lee | | R. Inam, E. Fersman, K. Raizer, R. Souza, A. Nascimento Junior & A. Hata |
| 15:00-15:20 | Assessment and management of ageing of critical equipment at seveso sites | A multidimensional risk evaluation framework for managing floods in urban areas | | |
| | M.F. Milazzo, G. Ancione, G. Scionti & P.A. Bragatto | L. B. L. da Silva, R. P. Palha, M. H. Alencar & A.T. de Almeida | | |
| 15:20-15:40 | COFFEE BREAK | | | |

| R8 | R9 | R5 | R90 | R3 | |
|---|---|---|---|---|---|
| Prognostics and System Health Management | Security | Human Factors and Human Reliability | Risk Management | Accident and Incident Modeling | |
| Anne Barros | Håvard Fridheim | Martin Rasmussen | Willy Røed | Rolf Bye | |
| Fault diagnosis and remaining useful life prediction of multiple deteriorating components in hybrid dynamical system | Customs - a vital contributor to safe societies? A study of the Norwegian Customs Service | Risk assessment in military transport - Human Factor in estimation of risk | Using microworlds to study critical infrastructure protection – the effect of incentives on risk management | Possibilities of using simulation software to estimate losses of industrial facilities and installations - critical analysis | |
| O. Prakash, A.K. Samantaray & R. Bhattacharyya | L.K. Stene & R. Folgerø | J. Ryczyński & M. Nowakowska | H. Tehler, J. Lindström & H. Lindbom | J. Ryczyński & P. Mastalerz & K. Ksiądzyna & T. Smal | |
| Enhanced hybrid prognostic approach applied to aircraft on-board electromechanical actuators affected by progressive faults | Perception of Security and Use of Public Travel Modes in an Urban Norwegian Public | Task complexity, and operators' capabilities as predictor of human error: modeling framework and an example of application | Rescue emergency drone (RED) network for assessment of traffic accidents in Denmark | Awareness and preparation of the population for emergencies | |
| P. C. Berri, M. D. L. Dalla Vedova & P. Maggiore | T. Rundmo, A.M. Kummeneje & T. Nordfjærn | M.C. Leva , A. Caimo, R. Duane, M. Demichela & L.Comberti | A. S. Kristensen, S. Mehmood, S. Ahmed, D. Ahsan & R. Zamora | M. Vašková, M. Náplavová & J. Barta | |
| A method for wind speed generation | A systematic classification scheme for cyber-attack taxonomy | Subjective assessment of risk among urban work travel cyclists | Swedish multi-level planning system for critical infrastructure protection: The regional core | A heterogeneous ensemble approach for the prediction of the remaining useful life of packaging industry machinery | |
| J. Ma, M. Fouladirad & A. Grall | S. Kim, J. Shin, G. Heo & J. G. Song | A.-M. Kummeneje & T. Rundmo | C. Groβ e & P.M. Olausson | F. Cannarile, P. Baraldi, M. Compare, D. Borghi, L. Capelli & E. Zio | |
| Optimization of periodic inspection time of sis subject to a regular proof testing | | Bayesian aggregation of expert judgment data for quantification of human failure probabilities for radiotherapy | Implementation guidance for resilience management of critical infrastructure | An investigation and statistical analysis into the incidents and failures associated with dynamic positioning systems | |
| H. Srivastav, A.V. Guilherme, A. Barros, M.A. Lundteigen, F.B. Pedersen, A. Hafver & F.L. Oliveira | | L. Podofillini, D. Pandya. F. Emert, A. J. Lomax, V. N. Dang & G. Sansavini | G. Cadete, B. Rød & M. M. da Silva | O. Olubitan, S. Loughney, J. Wang & R. Bell | |
| COFFEE BREAK | | | | | |

# WEDNESDAY 20th

| ROOM | R1 | R7 | R4 | R2 |
|---|---|---|---|---|
| SESSION | Risk Assessment | Natural Hazards | Digitalization and Big Data | Simulation for Safety and Reliability Analysis |
| CHAIRMAN | Tor Stålhane | Nima Khakzad | Coen van Gulijk | Jacek Malinowski |
| 15:40-16:00 | Risk assessment and the influence of new information | Optimizing warnings for slippery runways based on weather data | Pitfalls of machine learning for tail events in high risk environments | A flexible simulation model of the operation and maintenance process of a complex technical system |
| | T. Stålhane & S. O. Johnsen | A. B. Huseby & M. Rabbe | C. Agrell, S. Eldevik, A. Hafver, F.B. Pedersen, E. Stensrud & A. Huseby | J. Malinowski |
| 16:00-16:20 | Risk assessment in construction projects with the use of neural networks | Power Outage Forecasting: Methods, Results, and Uncertainty | Automated train driver competency performance indicators using real train driving data | Feasibility study of a simulation driven approach for estimating reliability of wind turbine fluid power pitch systems |
| | L. Giannakos & Y. Xenidis | S. D. Guikema | R.A.H. EL Rashidy, P. Hughes, M. Figueres-Esteban & C. van Gulijk. | J. Liniger, M. Soltani, H. C. Pedersen & N. Sepehri |
| 16:20-16:40 | Risk dimensions of fish farming operations and conflicting objectives | Probabilistic seismic hazard assessment for offshore structures in Andaman Sea | Fault Diagnosis of wind turbine structures using decision tree learning algorithms with big data | Simulator training in driver education – potential gains and challenges |
| | S.M. Holen, I.B. Utne & X. Yang | T. Ornthammarath | I. Abdallah, V. Dertimanis, H. Mylonas, K. Tatsis, E. Chatzi, N. Dervilis, K. Worden & E. Maguire | G.B. Sætren, P.A. Pedersen, R. Robertsen, P. Haukeberg, M. Rasmussen & C. Lindheim |
| 16:40-17:00 | | Time-dependent reliability in flood protection decision making in the Netherlands | A preliminary approach to subsea risk management using sensor network information | |
| | | W.J. Klerk, W. Kanning & M. Kok | M. Bucelli, I.B. Utne, N. Paltrinieri, P. Salvo Rossi & V. Cozzani | |
| 18:00-10:00 | GALA DINNER | | | |

| | R9 | R5 | R90 | | R3 |
|---|---|---|---|---|---|
| | Security | Human Factors and Human Reliability | Risk Management | | ESRA TC Maintenance annual meeting |
| | Yiliu Liu | Luca Podofillini | Willy Røed | | C. Bérenguer & M. Fouladirad |
| | Mobile data interception in 4G via diameter interconnection | A computational cognitive modeling approach to human performance assessment in nuclear power plants | Lessons learned from an unexpected uranium accumulation event | | INDUSTRIAL PANEL SESSION<br><br>Futur challenges for maintenance modeling and applications<br><br>Kim Alexander Jørgensen – Lundin<br>Erling Lunde – Statoil<br>Frank Børre Pedersen – DNV-GL |
| | Dr. S. Holtmanns, J. Ekman & C. McDaid | Y. Zhao & C. Smidts | D.G. Harrison & A. Smith | | |
| | Security and availability on embedded systems | Data learning and expert judgment in a bayesian belief network for offshore decommissioning risk assessment | Unforeseen events with a major accident potential – a study of some examples from the Norwegian oil and gas industry | | |
| | N. Burger, Y. Langeron, R. Cogranne & P. Lallement | M. L. Fam, X. H. He, P. Hilber, L. S. Ong, D. Konovessis & H. K. Tan | W. Røed | | |
| | Management of airport security screening system effectiveness | Applying an operational safety barrier framework in a major oil and gas field development project | Risk management for a particle therapy accelerator: The MedAustron experience | | |
| | J. Skorupski & P. Uchroński | J. T. Ludvigsen, K. van de Merwe, E. K. le-Borgne & T. Teigen | R. Filippini & P. Urschütz | | |
| | | | | | |
| | | | | | |
| GALA DINNER | | | | | |

# THURSDAY 21st

| ROOM | R1 | | | |
|---|---|---|---|---|
| 09:00-09:50 | M. Sam Mannan – «Perspectives on Ocean Energy Safety» | | | |
| 09:50-10:00 | TRANSITION | | | |
| ROOM | R1 | R7 | R9 | R4 |
| SESSION | Risk Assessment | Risk Assessment | Risk analysis and safety in standard | Economic Analysis in Risk Management |
| CHAIRMAN | Marko Cepin | Giovanni Sasavini | Luca Landi | Eric Rigaud |
| 10:00-10:20 | Risk of crack formation in power grid wooden poles and relationship with meteorological conditions: a Norwegian case study | Evaluating approaches for hazard identification for the inclusion in a safety assessment framework for efficient transport | Probabilities in safety of machinery - How fixed and movable guards bring about a significant risk reduction | Formalization of RAM contracts for advanced consistency and completeness checking |
| | M. Pacevicius, D. Roverso, P. S. Rossi & N. Paltrinieri | Ø. Skogvang, R. K. Opsahl, S. Solibakke, P. Karpati, A. A. Hauge, T. Sivertsen, B. A. Gran & M. A. Lundteigen | H. Moedden, E. Uhlmann, L. Prasol, S. Thom & B. Duchstein | A. Joanni & D. Ratiu |
| 10:20-10:40 | Understanding and including the dynamics of extreme natural hazard event uncertainty within the overall offshore wind farm project risk assessment using a causality-based graphical modelling approach | Evaluating models for the inclusion in a safety assessment framework for efficient transport | Safety of Machinery – Risk analysis and requirements for safety of gravity loaded axes | Cost-Benefit Analysis for non-structural flood risk mitigation measures: Insights and lessons learnt from a real case study |
| | R. Zamora, J. Qin, A.S. Kristensen, S. Mehmood, S. Ahmed & S. Cuthbert | P. Karpati, A. A. Hauge, T. Sivertsen & B. A. Gran | L. Landi, H. Mödden, I. Betti, M. Kohnle, R. Knorpp, A. Bornemann & P.Steger | G. Pesaro, M. T. Mendoza, G. Minucci & S. Menoni |
| 10:40-11:00 | Criticality analysis of wind turbine energy system using fuzzy digraph models and matrix method | A whole system approach to managing defective on-train equipment | Probabilities in safety of machinery - Markov model for the scaling of risk reduction effects due to limiting the hazard exposure | Behavioural modelling of attackers' choices |
| | M. K. Loganathan, I. Bezbaurah, O. P. Gandhi & R. C. Borah | A.J. Gilchrist | H. Moedden | S. Panda, I. Oliver & S. Holtmanns |
| 11:00-11:20 | The use of bond graph modelling in polymer electrolyte membrane fuel cell fault diagnosis | Scenario dependency of safety targets for platform doors | Probabilities in safety of machinery: sample space of yearly accident data | Asset replacement decisions: A Markowitz efficient frontier approach to evaluate the trade-off between total costs and system availability |
| | A. Vasilyev, J. Andrews, L. Mao & L. Jackson | B. Hulin | H. Moedden | A. M. Teodoro-Filho, G.A. da Costa-Lima, L.A.N. Costa, F.C. Marinho & A. Prestes |
| 11:20-11:40 | Risk analysis of high enthalpy fluid storage in geothermal power systems | The future of driver training and driver instructor education in Norway with increasing ADAS technology in cars. | Safe utilization of Additive Machines: a guide for end-users | Considerations related to insurance of cruise traffic in the arctic waters |
| | Z. Nivolianitou, E. Kondili & G. Piperidis | G.B. Sætren, J. P Wigum, R. Robertsen, P. Bogfjellmo & E. Suzen | E. Annacondia, L. Di Donato | K. Trantzas, O.T. Gudmestad & E.B Abrahamsen |
| 11:40-12:00 | COFFEE BREAK | | | |
| ROOM | R1 | | | |
| 12:00-13:00 | ESRA Plenary session | | | |
| 13:00-13:40 | Conference closing ceremony | | | |
| 13:40-14:40 | LUNCH | | | |

| R1 | | | | | |
|---|---|---|---|---|---|
| M. Sam Mannan – «Perspectives on Ocean Energy Safety» | | | | | |
| TRANSITION | | | | | |
| R8 | R90 | R3 | R6 | R2 | R5 |
| Prognostics and System Health Management | Dynamic Risk and Barrier Management | Uncertainty Analysis | Risk Management | Foundation of risk and reliability assessment and management | Safety and risks in autonomy |
| Antoine Grall | Stein Haugen | Christophe Berenguer | Bjornar Heide | Terje Aven | Ingrid Bouwer Utne |
| Prognostic and health management design for subsea applications | Towards an online risk model for dynamic positioning operations | Uncertainty sensitivity assessment on the optimization of the design and operation of complex energy systems: a comprehensive approach | Problems of mobile risks in territory | Safety Principles for autonomous driving | Automation of the Rail – Removing the Human Factor? |
| X. Gao & O. Niculita, D. McGlinchey & B. Alkali | A. Y. Dong, J. E. Vinnem & I. B. Utne | A. Nadal, A. Ruby, C. Bourasseau & D. Riu & C. Berenguer | J. Procházka & D. Procházková | H. Schäbe | T.M. Stene |
| Prognostic and health management for safety barriers in infrastructures: Opportunities and challenges | Dynamic risk assessment during eco-driving behaviors for conventionally fueled vehicles | Effect of load-generation variability on power grid cascading failures | EU risk governance of migrants and refugees' influxes: a realistic foundation for crisis governance? | Tool for risk reduction at specific component aircraft engine welding | Empirical studies of methods for safety and security co-analysis of autonomous boat |
| A. Zhang, Y. Liu, A. Barros & Y. Wang | G.L. Mauri, E. Bressan, F. C. Velardo & P.C. Cacciabue | R. Rocchetta, E. Patelli, L. Bing & G. Sansavini | B.I. Kruke & C. Morsut | D. Prochazkova & J. Prochazka | E. N. Torkildson & J. Li & S. O. Johnsen & J. A. Glomsrud |
| Return On Investment on PHM Systems | What could adaptive risk management look like in practice? | Application of evidential network to model uncertainty in quantitative risk assessment of Natech accidents | Risk and Social Interaction (Samhandling) to Meet the Unforeseen | Reliability of supplies in a manufacturing enterprise | At least as safe as manned shipping? Autonomous shipping, safety and ¨human error¨ |
| A. Segal & Y. Bot | J. M. Nisula | N. Khakzad & P.H.A. J.M. van Gelder | G. E. Torgersen, T. J. Steiro & L. I. Magnussen | J. Żurek & M. Zieja & J. Ziółkowski | T. Porathe, Å. Hoem, Ø. Rødseth, K. Fjørtoft & S. Johnsen |
| An evaluation method of methodology for integration of HALT, HASS and ADT | Risk indicators for safety performance assessment of crane-operations in the chemical industry | Application of PCE sensitivity analysis method to gas transmission network | Revitalization of risk management in the Norwegian petroleum sector | Swimming in a slurry of schemes: making sense of aquaculture standards and certification schemes | Sensemaking and resilience in safety-critical situations: a literature review |
| T. Zou, P. Li, W. Dang, K. Liu & G. Zhang | G. Ancione, M.F. Milazzo & N. Paltrinieri | V. Kopustinskas, P. Praks, T. Mara & R. Rossati | B. Heide & G. Ersdal | M. Nilsen, V.S. Amundsen & M.S. Olsen | S .S. Kilskar, B. -E. Danielsen & S. O. Johnsen |
| The class of life time distributions with a mean residual life linear in time: application to prognostics and health management | | Managing interdependencies in critical infrastructures – a cornerstone for system resilience | | An ontological and semantic foundation for safety science | Risk-based regulation and certification of autonomous transport systems |
| P. Dersin | | P. Ferreira & E. Bellini | | P. J. Blokland & G. L. L. Reniers | S.O. Johnsen, Å. Hoem, T. Stålhane, G. Jenssen & T. Moen |
| COFFEE BREAK | | | | | |
| R1 | | | | | |
| ESRA Plenary session | | | | | |
| Conference closing ceremony | | | | | |
| LUNCH | | | | | |

# INDUSTRY SESSIONS

## INDUSTRY SESSION

**Major accident collision risk management of DynPos (DP) marine operation**

*Olav Sæter, Bjørn Nygård and Kristian Gould, Statoil ASA, N*

Ship collision with offshore facilities may represent a potential major accident hazard, depending on several factors like the size and thrust force of the vessel, position keeping systems and the design of the facility. In the period 2001-2011, there have been 26 collisions between facilities and visiting vessels on the Norwegian shelf. Six of the incidents had a very large hazard potential.

The Petroleum Safety Authority Norway (PSA) is concerned that incidents involving collisions with vessels on assignment to the relevant facilities – so-called visiting vessels - will cause major accidents. Hence, there is a need for a significant improvement in how the vessels are operated and for assessing design loads for the facilities. Additionally, both human, organizational and technical risk factors must be considered in the assessment of all position loss scenarios. Improved quantification of the risk entailed by collisions is also necessary.

A risk management framework, including a risk model consisting of eight steps, has been developed to reflect the characteristics of collision risk picture for vessels operating on DynPos (DP). The model has been developed and used for visiting vessel operations, flotel operations and heavy lift operations utilizing DP.

From a risk management perspective, DP operations involve several technical, operational and risk analytical dilemmas. Statoil's risk model submits important elements to the decision-making process, but is likely not the only viable methodical approach. Principles for managing critical uncertainties and risk intensity levels during operation will be discussed, together with practical examples reflecting different risk reducing measures.

**Time & venue**
Monday 18. June, 1400–1520, S10 (Room R3)

## INDUSTRY SESSION

**Industry challenges for railway safety and reliability**

*Bob Huisman, Dutch Railways (NS), NL, Pierre Dersin, Alstom, F*

Railway transport long-standing track record in safe and reliable transport. With increasing demand on capacity, reliability and customer service and an ingress of digital techniques safety techniques are refined and tuned for the future. This railway-centric special session discusses the challenges and solutions for the railway industry and the research to refine it beyond the current state-of-the-art.

**Time & venue**
Tuesday 19. June, 1400–1520, S10 (Room R3)

# SPONSOR WORKSHOPS

## SPONSOR WORKSHOP

**Aviation Academy**

**How much is your system capable of avoiding safety risk events? The SAREAC indicator**

*Nektarios Karanikas, Aviation Academy, NL*

The use of severity-likelihood matrices to assess risks has been negatively criticised regarding validity and reliability due to effects of cognitive biases and a deterministic view of the possible consequences of risks. Even more, because of the lack of standardisation in risk matrices, a benchmarking across systems and organisations is not feasible. Taking into account these limitations, the Safety Risk Avoidance Capability (SAREAC) metric focus on the prevention of risk events and consists of two parts: the influence of hazards and the remaining effects of hazards after implementing or designing controls. Each of the SAREAC parts is calculated through specific steps which result in a normalized score that allows more reliable comparisons amongst systems or over time.

**Time & venue**
Tuesday 19. June, 1140–1300, (Room R3)

## SPONSOR WORKSHOP

**BQR Reliability Engineering Ltd & AEGIS Engineering Systems Ltd.**

**Cross domain safety standards overview with a practical RAMS lifecycle activities example**

*Yizhak Bot, BQR Reliability Engineering Ltd, IL,*
*Daniele Diana, AEGIS, UK,*

Part 1: Modern product safety and safety management. A cross-domain overview: common concepts, present and future challenges.

Part 2: A practical example using a computer aided tool to assist performing the required lifecycle activities. How to improve the early design and successfully achieve the RAMS requirements demonstration.

**Time & venue**
Tuesday 19. June, 1000–1120, (Room R3)

# PLENARY SPEAKERS

**ROAR THON**
SPECIALIST DIRECTOR
*NORWEGIAN NATIONAL SECURITY AUTHORITY (NSM)*

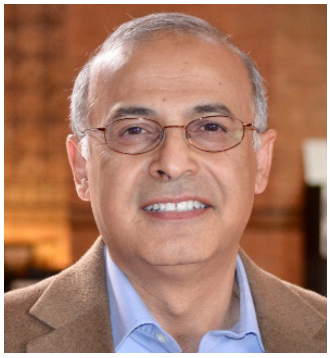
Roar Thon is a Specialist Director at the Norwegian National Security Authority (NSM) were he has served since 2003. He has a service background from the Norwegian armed forces and the national police.  He has delivered over 1000 presentations around the world, focusing on security culture, and human behavior related to security.

Roars focus the last years, has been how to communicate cybersecurity related issues on a national level towards politicians, CEO's and to the public. Not just in theory, but as a practitioner. Roar had the responsibility to increase the security awareness towards politicians and political parties before the Norwegian national parliament election in 2017.

## CYBERSECURITY – THE HUMAN FACTOR

Cyber! We all start thinking about technology. Combine it with Security! and we easily think about firewalls, antivirus, passwords etc. All of this is Cyber Security! But we tend to forget one important key factor – The human!

Our ability to be digital secure is not just a question about technology. It is the combination of tech, humans and good processes between the two factors. The presentation will address some of the challenges to get the human factor to be a positive factor when it comes to cyber security.



## ALI MOSLEH

DISTINGUISHED PROFESSOR

*EVELYN KNIGHT CHAIR IN ENGINEERING*

*INTERNATIONAL CHAIR IN RISK, NTNU*

Ali Mosleh is Distinguished University Professor and holder of the Evelyn Knight Endowed Chair in Engineering at the University of California in Los Angeles (UCLA), where he is also the Director of the B. John Garrick Institute for the Risk Sciences. He also holds honorary professorships at several universities worldwide. Prior to joining UCLA, Professor Mosleh was the Kim Chair Professor and Director of the Center for Risk and Reliability at the University of Maryland. He conducts research on methods for risk and reliability analysis of complex systems and has made many contributions in diverse fields of theory and application. He holds several patents, and has edited, authored, or co-authored over 500 publications including books, guidebooks, and technical papers. Dr. Mosleh 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. Prof. Mosleh if the recipient of many scientific achievement awards and has been a technical advisor to numerous international organizations.

### ASK THE EXPERT

It is hard to find a reliability or risk analysis that does not rely on some form expert opinion, a fact that is often cited as a weakness and source of doubts about the credibility of such analyses. This talk examines the technical challenges we often face in using expert judgment and provides an overview of theoretical studies and empirical findings that can help address some of these challenges.

# PLENARY SPEAKERS

**PATRICK HUDSON**
PROFESSOR EMERITUS IN THE HUMAN FACTOR IN SAFETY
*DELFT UNIVERSITY OF TECHNOLOGY*

Patrick Hudson is one of the world's leading authorities on the human factor in the management of safety, in the oil and gas industry, in commercial aviation, mining and in medicine. He was the Project Leader of Shell International's Tripod Research program, that led to the Organizational Accident model, known widely as the Swiss Cheese model. He was also one of the four-man team that developed Shell's approach to safety management systems after the Piper Alpha disaster, which has served as the template for most Safety Management Systems worldwide. He then led Shell Group's Hearts and Minds program on the development of safety culture in the Oil and Gas industry. He was a testifying expert witness on Safety Culture and Process Safety Management, representing Halliburton Energy Services, in the Federal Multi-District Litigation before the US 5th Federal Circuit in New Orleans – the BP Deepwater Horizon case, the world's largest civil process. In aviation he has worked across flight operations, maintenance and engineering with both Boeing and Airbus as well as many airlines. He is also the chairman of the International Expert Safety Team for the European Union's research nuclear reactor.

## REDEFINING RISK AND SAFETY – A MULTI-DIMENSIONAL APPROACH

Most approaches to risk management consider a fairly limited set of causes or causal influences. The majority of potential incidents, for example about 80%, can be seen to be due to linear and deterministic causes. Of the remaining 20%, 80% of the causes may be increasingly non-linear, but still deterministic, covering a total of 96%. The remaining potential accidents will have causes that are both non-linear and non-deterministic, a small set we have labeled weird –Wildly Erratic Incidents Resulting in Disaster. This approach concentrates on specified accidents and the probability of their occurrence. An alternative approach develops the notion of possibility space in which we can re-arrange the outcomes to correspond to the likelihood of occurrence. This has consequences for the level of analysis of incidents and the design of preventative programs.

**M. SAM MANNAN**
**PROFESSOR**
DIRECTOR, MARY KAY O'CONNOR PROCESS SAFETY CENTER
*HOLDER OF REGENTS PROFESSORSHIP*
*T. MICHAEL O'CONNOR CHAIR I*

Dr. M. Sam Mannan is Regents Professor in the Chemical Engineering Department at Texas A&M University and Executive Director of the Mary Kay O'Connor Process Safety Center at the Texas Engineering Experiment Station. The mission of the Center is to improve safety in the chemical process industry by conducting programs and research activities that promote safety as second nature for all plant personnel in their day-to-day activities. Before joining Texas A&M University, Dr. Mannan was Vice President at RMT, Inc., a nationwide engineering services company. Dr. Mannan also holds concurrent joint appointments as Professor of Mechanical Engineering, Professor of Petroleum Engineering, Professor of Industrial and Systems Engineering, Professor of Materials Science & Engineering at Texas A&M University.

Dr. Mannan is a registered professional engineer in the states of Texas and Louisiana, a Certified Safety Professional, and a Professional Process Safety Engineer. His experience is wide ranging, covering process design of chemical plants and refineries, computer simulation of engineering problems, mathematical modeling, process safety, risk assessment, inherently safer design, critical infrastructure vulnerability assessment, aerosol modeling, and reactive and energetic materials assessments.

He co-authored the *Guidelines for Safe Process Operations and Maintenance* published by the Center for Chemical Process Safety, American Institute of Chemical Engineers. He is the editor of the 3rd and 4th edition of the 3-volume authoritative reference for process safety and loss prevention, *Lees' Loss Prevention in the Process Industries*.

Dr. Mannan has published 313 peer-reviewed journal publications, 5 books, 8 book chapters, 223 proceedings papers, 14 major reports, and 283 technical meeting presentations.

## PERSPECTIVES ON OCEAN ENERGY SAFETY

Oil and gas are contributing enormously to the quality of our life into the 21st century, just as they were throughout the 20th century. With the economic growth, more and more energy sources are required by society, and in the last several decades, increasingly more attention is being directed to offshore deepwater hydrocarbon reservoirs. Current exploration and production are to some extent limited by technology needed to explore hard to get sources, which may lie in deeper wells, higher-pressure reservoirs, or crudes that are difficult to recover because of higher viscosity.

Innovative offshore technology needs to be developed to carry out deepwater production and operations. At the same time, these hazardous operations (i.e., deeper wells and higher-pressure reservoirs) are creating new and unique hazards. After the Transocean Deepwater Horizon Incident and Oil Spill in Gulf of Mexico, the U.S. Department of Interior's Bureau of Safety and Environmental Enforcement funded the Ocean Energy Safety Institute at Texas A&M University. At the same time, a number of other organizations have also redoubled efforts at addressing management systems and technologies for safer and environmentally benign ocean energy operations. This paper provides a perspective on the status of ocean energy safety and a projection for research and technology needs for the 21st century.

# SPECIAL SESSIONS

## SAFETY AND RISKS IN AUTONOMY I
Chair: Stig Ole Johnsen

*Room R3*
*Monday 15:40-17:00*

## SAFETY AND RISKS IN AUTONOMY II
Chair: Ingrid Bouwer Utne

*Room R6*
*Wednesday 10:00-11:20*

## ARCTIC SAFETY
Chair: Eirik Albrechtsen

*Room R6*
*Wednesday 11:40-13:00*

## SAFETY AND RISKS IN AUTONOMY III
Chair: Ingrid Bouwer Utne

*Room R5*
*Thursday 10:00-11:20*

## RISK ANALYSIS AND SAFETY IN STANDARD
Chair: Luca Landi

*Room R9*
*Thursday 10:00-11:20*

# ESRA EVENTS

## ESRA GENERAL ASSEMBLY
*Time & venue: Monday 18. June, 17:10–18:50 (Room R1)*

An informal gathering is organised just after, 18:50-20:00, in the same area.

## ESRA TC MAINTENANCE – INDUSTRIAL PANEL SESSION
*Time & venue: Wednesday 20. June, 15:40–17:00 (Room R3)*

The ESRA TC Maintenance is organizing every year a gathering at ESREL conference. This year, with the support of the RAMS group – NTNU, an industrial panel session will be held. People from the local industrial network will join to present their current main concerns in maintenance optimization. People from the academia will be challenged to answer.

Participants:

» Kim Alexander Jørgensen – Lundin
» Erling Lunde – Statoil
» Frank Børre Pedersen – DNV-GL
» Christophe Bérenguer and Mitra Fouladirad – ESRA TC maintenance
» Jørn Vatn and Anne Barros – RAMS group NTNU

# SOCIAL PROGRAM

Registration for social events and optional tours will be available in the conference registration.

## RECEPTION AT KAFÉ TO TÅRN ('CAFÉ TWO TOWERS')

*Sunday 17 June 6:00 PM*

**Description:**
Conference reception at Kafé To Tårn with finger food and mingling with fellow ESREL attendees.
View map

## CONCERT IN NIDAROSDOMEN CATHEDRAL

*Sunday 17 June 7:30 PM*

**Description:**
Following the reception, there will be a short concert played on the Steinmeyer organ in Nidarosdomen. Nidarosdomen is located next door to Kafé To Tårn.
View map

## CONFERENCE DINNER

*Tuesday 19 June 7:00 PM*

**Description:**
The conference dinner will be hosted at Clarion Hotel & Congress Trondheim.
View map

# GENERAL INFORMATION

## CONFERENCE APP
We recommend that you download our attendee app for ESREL2018. Here you will find information, your registration details, participant list and receive alerts.

Download "The event app by EventsAIR". Use the app code ESREL 2018. Log in with your email address and pin code sent on email/ on your name badge.

## CONFERENCE VENUE
The conference venue will be at the main campus of the Norwegian University of Science and Technology, NTNU.

## AIRPORT BUS TO/FROM TRONDHEIM:
Nettbuss/Flybussen (every 10-minutes) and Værnesekspressen (every 30-minutes) stops by, or close to the hotels in Trondheim.

Both buses stop at Studentersamfundet, 7 minutes walk from NTNU, Realfagbygget. The ticket price varies whether you prepay the tickets.

## BUSSES
AtB's bus from the City centre to Gløshaugen North: Buss 5 (Kongensgate K2) and 22 (Munkegata M1). The busride takes about 8 minutes. The prices varies from NOK 30 to 50 single tour, depending whether you download the AtB app and prepay the ticket.

## TAXI
Trøndertaxi tel: 07373
Norgestaxi tel: 08000

## LUNCHES
Lunch will be at Café Realfagsbygget and Café Hangaren ( another building). Please check your badge for your lunch area and the map for where to find it.

## EXIBITION
Our Exhibitiors will be located utside the plenary hall- R1

## GUIDELINES FOR PRESENTERS
All presenters are asked to come to the room where their session is taking place at least 15 minutes before the session starts. Contact the session chair.

Presentations must be brought on a USB memory stick for upload. Technical assistants will be available to help you with uploading if necessary. Personal devices (laptop, tablet, etc) are not allowed. All presentations must be in English and should be free of commercialism.

If you have specific requirements, such as sound or videos, we strongly recommend that you test this on the session room computer in advance of the session (during an earlier break) to avoid last minute technical problems.

The allocated time for each presentation, including questions, is 20 minutes. We expect all presenters to stick to this time limit.

The conference computers will all be running Powerpoint. All presentations must therefore be able to run on this software, alternatively you can also present in pdf-format.

## GUIDELINES FOR SESSION CHAIRS
All session chairs are asked to go to the room where their session is taking place at least 15 minutes before the session starts. When you get to the room, locate the speakers to make sure that everyone are present. Also make sure that all presentations have been uploaded.

If there are missing speakers, do not change the timings for the presentations, even if the missing speaker is in the beginning or the middle of the session. People move around between sessions and we therefore stick to the published schedule as far as possible. Instead, there should be a break in the session, even if this may feel awkward!

During the session, we expect you to do the following:

» Introduce each speaker with name and title of the paper.
» Keep the time strictly. Let the speakers know when they are beginning to run out of time and if necessary stop the presentation if the time is exceeded. This is out of courtesy to the other speakers in the session as well as the audience.
» Guide the discussion, again making sure that the schedule is adhered to. Lengthy discussions should be stopped with a suggestion that it can be continued in the following break.
» If there are speakers who do not show up, inform the secretariat after the session is completed.

## INTERNET ACCESS

Visitors can use either of the university's wireless networks, Eduroam or **ntnuguest**. The network ntnuguest allows web traffic, but nothing else. Eduroam assumes that your organization is in some way associated with the eduroam system, and that you have set up your computer according to the instructions from your local IT support.

## REGISTRATION DESK

The registration desk will be outside R1. You will find the conference secretariat in the room R92 and luggage room in R93

## SECURITY

Please wear your name badge at all times during the conference.

## EMERGENCY NUMBERS #

» **Fire department: 110**
» **Police department: 112**
» **Medical emergency: 113**
» **Conference secretariat: + 47 95801267**

# OPTIONAL TOURS

## CITY TOUR

Nidarosdomen photo: CH | visitnorway.com

Available Monday 18 June and Wednesday 20 June

**Price**
NOK 250,- (for one day)

**Meeting point**
Outside the tourist information. Look for green banner "Tourist information" spanning across street. Adress: Nordre gate 11.TBA

**Description**
Join a city guide for a walk through Trondheim City. A guided walk is a marvelous way to discover Trondheim's many hidden gems. Your city guide will share fascinating stories and surprising details that will submerge you into the city's diverse and more than 1000 year long history.

**Duration**
Approx. 2 hours

## HIKING IN THE WOODS: GRØNLIA CABIN AND OPTIONAL STORHEIA SUMMIT

Grønlia cabin. photo: Trondheim kommune

Monday 18 June

**Price**
NOK 625,-

**Meeting point**
TBA

**Description**
One of our greenest trips. Transportation by bus to Bymarka recreational area. We hike to the cabin, Grønlia, a popular excursion for locals. At Grønlia "Rømmegrøt" (sour cream porrigde) and cured meat will be served (traditional Norwegian dishes). You will also have the possibilty to hike up to Storheia, Trondheims highest peak, for spectacular views of the area (weather permitting). We hike back to the bus, which will bring us back to the meeting point.

**Capacity**
Minimum 20 pax, max 120

**Trip length (walking)**
8 km (dirt road), an additional 5km if you want to visit the peak of Storheia (light mountain terrain)

**Clothing**
Walking/hiking shoes suitable for outdoors and a bit muddy if rain. Outdoor jacket (waterproof if raining).

## HIKING IN THE WOODS: ST. OLAVS SPRANGET AND THE HOLST DAM.

Scenic viewpoint st. Olavs spranget photo: Trondheim kommune

Wednesday 20 June

Price
NOK 625,-

**Meeting point**
Thon Hotel Nidaros

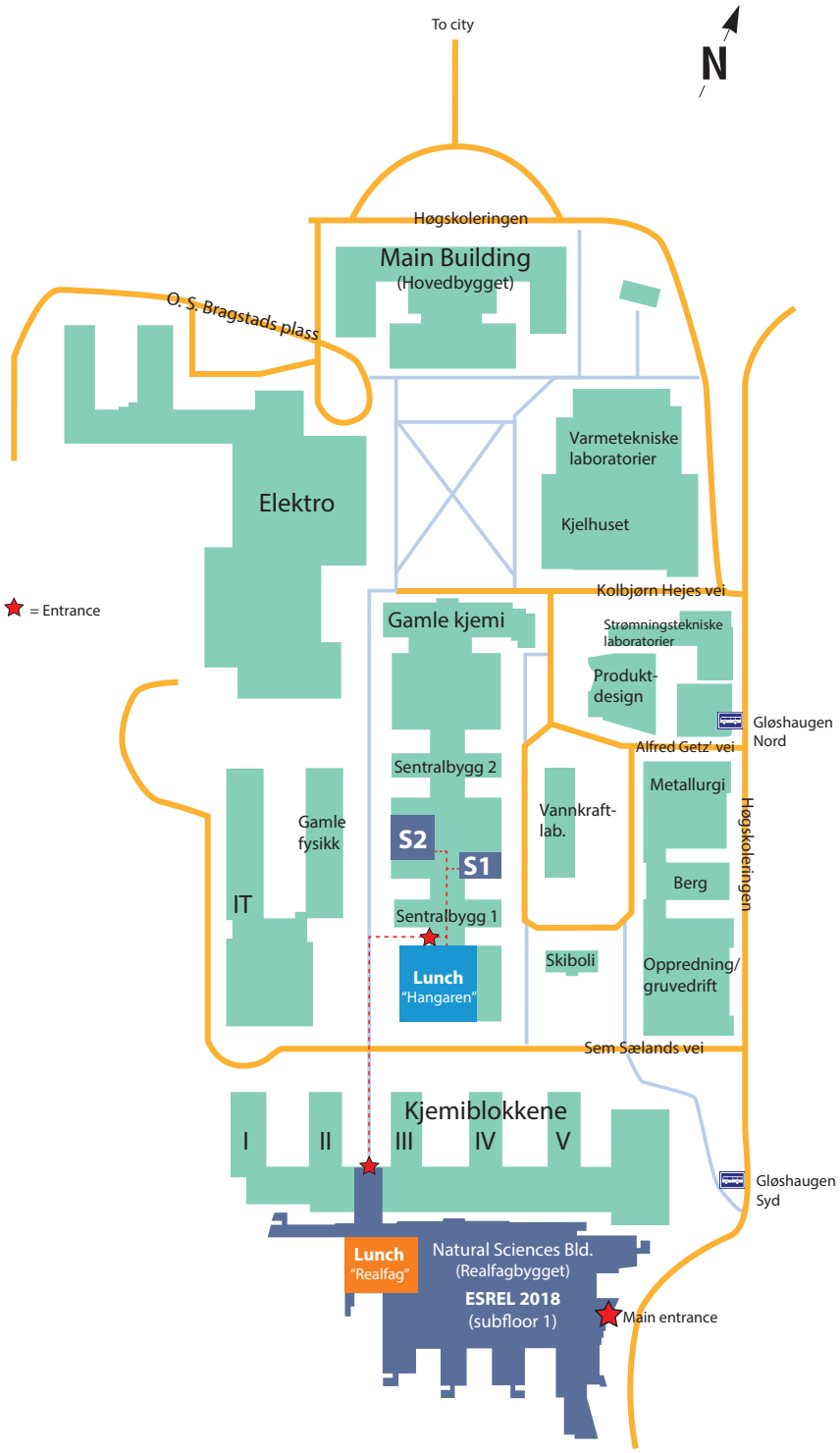
**Description**
Another green hiking tour. Transportation by bus to Bymarka recreational area. We will walk on nice tracks passing small lakes and old cabins. We will visit "St. Olavs spranget" which will give us a scenic view of Trondheim and the fjord. We will eat at the cabin Damhaugen before returning. The Bus will take us back from Bymarka to the meeting point.

**Capacity**
Minimum 20 pax

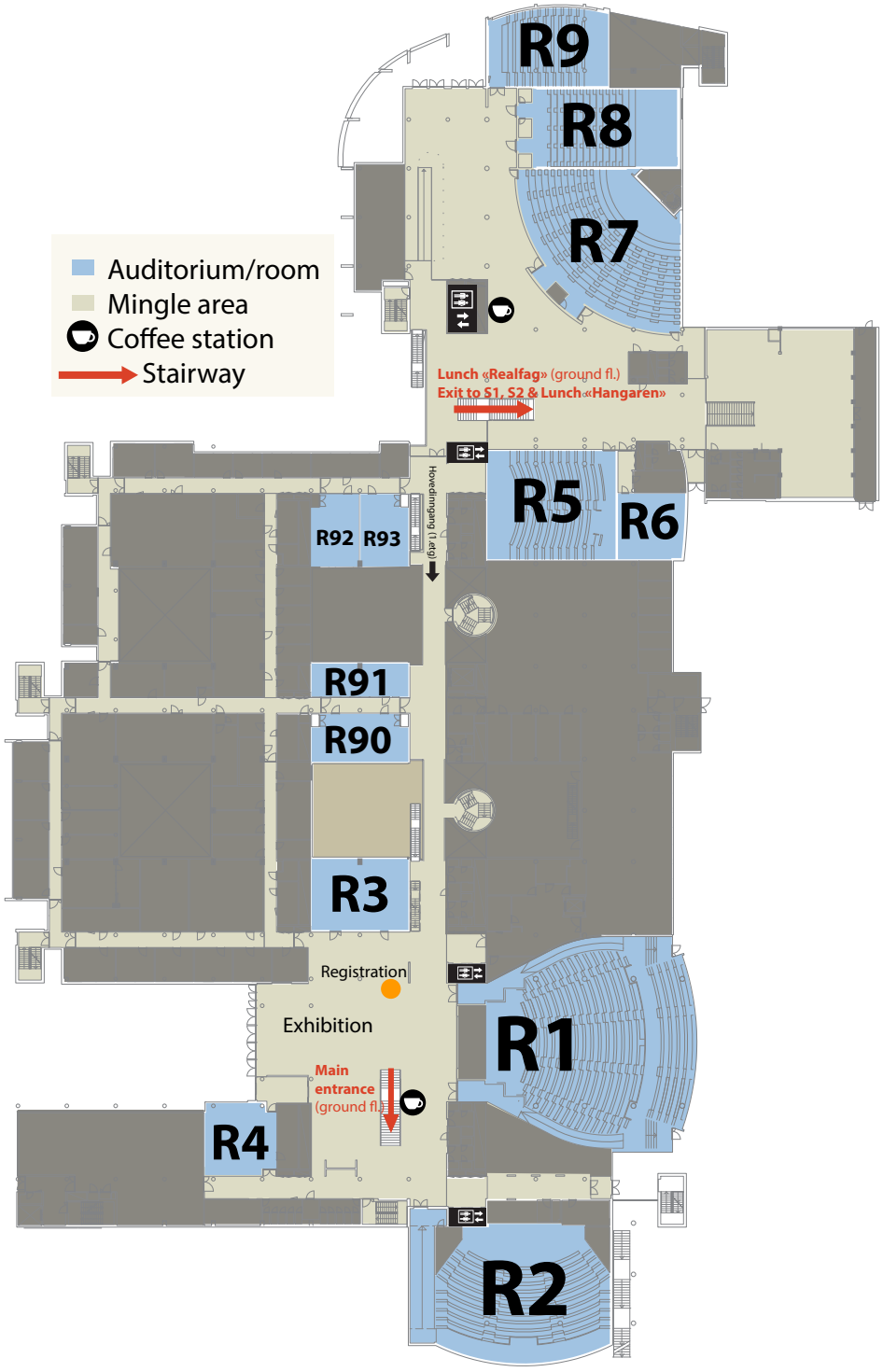
**Trip length (walking)**
6 km (mostly easy downhill, dirt roads and forest paths)

**Clothing**
Walking/hiking shoes suitable for outdoors and a bit muddy if rain. Outdoor jacket (waterproof if raining).

# MAP - NTNU CAMPUS GLØSHAUGEN



# MAP - REALFAGBYGGET (NATURAL SCIENCE BLD.) SUBFLOOR 1 (U1)



ESREL 2018