



European Safety and Reliability Association

Newsletter

<http://www.esrahomepage.eu>

March 2018

Editorial



*Terje Aven
ESRA Chairman
University of Stavanger, Norway*

Dear ESRA Colleagues,

I hope you are all enjoying the spring and are enthusiastically occupied with some interesting activities on safety, reliability and risk. June will soon be here and with it the ESREL 2018 conference in Trondheim. It will be some great days. Thanks to Stein Haugen, Anne Barros, Jan Erik Vinnem, Trond Kongsvik and Coen van Guljik, who are doing an excellent job in leading the planning of the conference.

For ESRA, ESREL is the main conference, but there are also many other interesting meetings (conferences, workshops, seminars), addressing different types of subjects and applications linked to safety, reliability and risk. Examples include the Society for Risk Analysis (SRA) Annual Meetings, the largest being in the USA in December with about 800 participants, but I would also like to mention the SRA European Meeting (this year in Sweden in June – and unfortunately coinciding with ESREL 2018 in Trondheim) and the SRA Nordic Meeting (this year in

Stavanger, Norway, in November); see <http://sra.org/events>. The SRA has a number of Specialty Groups (<http://sra.org/specialty-group/>), which overlap considerably with the Technical Committees of ESRA, for example on risk assessment, security, occupational safety and foundational issues (<http://esrahomepage.eu>). I encourage you all to study the SRA activities and the Speciality Groups in particular, to see whether there are areas for possible collaboration. In contrast to ESRA, SRA has only individual memberships.

This year, we have also provided financial support to some initiatives proposed by our members in response to our call for project proposals, including a Workshop at the “Structural Reliability 2018” Conference, organised by the VŠB-Technical University of Ostrava, Czech Republic; a training course on advanced methods for reliability, availability, maintenance, diagnostics and prognostics of industrial equipment at the Politecnico di Milano, Italy; and the international summer school in Poland (SSARS). Congratulations to all, and good luck with the activities.

As always, we look forward to reading about these events in coming issues of the ESRA newsletter.

Terje Aven
Chairman of ESRA

Feature Articles

Risk analysis and safety in standardization



*Heinrich Mödden
German Machine
Tool Builders' Association
Research and Technology
VDW
Frankfurt, Germany*

The issues “risk assessment” and “tolerable risk” are causing conflicting reactions not only among Health and Safety experts. Experienced designers are sometimes unsettled, too. The controversies are mainly about numerical probabilistic representations of tolerable risk levels. These were introduced, as an example, in the field of general machinery safety, when the revised European Machinery Directive 2006/42/EG extended the hazard analysis of former versions to a risk analysis by introducing the term “probability” in the expression:

“estimate the risks, taking into account the severity of the possible injury or damage to health and the probability of its occurrence”.

Since this alteration in a legal text, simplified probabilistic methods as in ISO 13849-1 are being developed. This standard encounters a well-proven practical state-of-the-art, which is merely based on qualitatively defined requirements. They were mainly focussing on hazards as such (and their countermeasures) rather than “risks and their probability of occurrence”. Nevertheless, on the background of customer demands for very high availabilities (which is equivalent to high inherent safety), it brought about a well-trying state-of-the-art following, for example, the three-step-reduction method of ISO12100. The state-of-the-art is defined on a non-quantitative descriptive background in harmonized safety standards in the Official Journal of the European Commission since more than 20 years.

However, the advantage of the quantitative probabilistic theory is clearly visible: the entire risk reduction process can be detailed in single quantitative factors showing the proportions to enable a more effective engineering. Surprisingly, the transition from “qualitative” to “quantitative” requirements was not so easy, since the key term „probability“ turned out to be ambiguous: subjective probabilities prevail the discussions, since many traditional experts claim that objective probabilities were missing. Is this really so?

Challenges:

Admittedly, theoretical risk assessment starts in the hypothetical “what if” domain, where theoretical risk can be logically scaled in cause and effect (at the

most), but it often cannot be calculated accurately as regards absolute values, since assumptions have to be made always for the situation at hand. Thus, in risk estimations, the necessarily theoretical model-based approach is sensible (probabilities), but it needs to be checked by empirical data (relative frequencies), too.

On the other side, verifiably founded probabilities, such as e.g. real findings in the operational field and logically deduced probability estimations are better than not scalable subjective good feeling, speculation and pure hypothetical assumption. Isn't it obvious that the real risk actually can be measured precisely, e.g. in terms of the yearly accident statistics, i.e. in terms of objective numbers? For the sake of operator safety of course, only the real risk reduction matters: it is a combination of a) reducing the magnitudes of consequences of possible failures and, b) simultaneously diminishing the frequencies of such consequences.

Therefore, the new special session tries to support plausible risk considerations connecting theory and reality. This is also a goal of the special session "Risk analysis and safety in standardization", because unfortunately, in the discussions of safety standardization experts, it seems to be the most important goal to establish a formal procedure, which could be suitable to defend against possible product liability suits. Furthermore, a majority of experts prefers simplistic “worst case possibility” models rather than probabilistically scaled realistic methods. Reasonable cause and effect relations do not seem to be important to the majority of experts, neither is a plausible scaling of effects. Corresponding safety designs may be “legally safe”, but their risks to the operators are presumably not at all “as low as reasonably practicable” (ALARP). Only if the decisions that form a safety design are plausibly justified (i.e. objectively), a risk in the ALARP-range can be achieved. Therefore, an understanding of the design requirements is all-important.

These and other observations out of the world of standardization shall be presented and reflected in Trondheim, where world of science and real applications comes together in June 2018. This happened already in former ESREL events since 2013 in different sessions, now it ought to be bundled. For this purpose, the steering committee has approved this new special session co-chaired by Luca Landi (UCIMU-UNIPG) and Heinrich Moedden (VDW) to promote discussion/ emerging problems on standardization and solutions especially in the field of Safety of Machinery Directive.

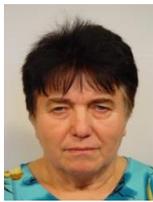
In a first important step, relative risk reduction effects of different designs should become scalable and comparable. Later on, an absolute scaling of risks could be attempted for comparison of similar risks. Hopefully, the special session at ESREL 2018 will provide useful contributions for this purpose. The prepared presentations are:

1. Separating guards and their benefit for risk reduction, as well for a) acute risks such as axes loaded due to gravity, as for b) chronic risks due to mist and vapour.

2. Gravity loaded axes and safety requirements
3. Mist and vapour risks of 3D Printing
4. Scaling of risk reduction by Markov Model
5. Probability space of accident data and further reduction

If you are occupied with safety standardization or otherwise interested, please visit ESREL 2018 for the application area: T18 "Risk analysis and safety in standardization", such that we are making better progress together, at first in the world of science, and then in the world of standardization.

Safety, resilience and risk of technological facilities



*Dana Prochazkova
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University in Prague
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At present the several terms are used in professional literature. For technical facilities management, it is necessary to know links among terms. On the basis of present level of knowledge that is e.g. represented by publications from the ESREL conferences [1], it holds: **Risk** je is understood as the probable size of losses, damages and harms on protected assets in real system that is calculated for unit of space and time. It is dependent on the disaster size and on the local assets vulnerabilities.

Safety is fundamental attribute of system. In advanced engineering disciplines, the safety is understood as the property that emerges on the system level. It is the measure of set of human measures and activities to protect system and its vicinity also at system critical conditions. At present in described in works [1, 2], the safety

Resilience is the measure of capability of real system (asset, object, facility) at disaster occurrence to reduce options of disturbance of operation and service for public, to absorb consequences of disturbance when they occur, and rapidly renew after disturbance and to ensure the service; is a capability of system to adsorb and to use the deviations and changes so that it lives through them without there might originate quality changes of its structure.

Criticality denotes the limit (boundary) from which the risk impacts are significant up to eliminative for followed system, which means that appurtenant risk needs to be always mastered.

Dependable (reliable) system is a system that performs required functions at a given place, a given time and in a given quality during the whole life cycle.

Secure system is the dependable system that is protected against to internal and external disasters of all kinds.

Safe system is the secure system that not at its critical conditions does not endanger itself and its vicinity.

Safety and risk are in certain relation but they are not complementary quantities. The risk reduction means the safety increase but it is not always valid inversely [2]. The complementary quantity to safety is the criticality; in some legislation, e.g. in the SEVESO directive, it is used the term recklessness instead of criticality.

The above definitions comparison shows that:

-for ensuring the system resilience we need correctly to work with risks, especially in technical and organizational domains (training and preparedness, situation awareness, staff engagement, networking, top management commitment, and flexibility),

-safety and resilience are quantities that direct to same aim. The purpose of safety is a little higher.

It means that the safe system is the resilient system. The safety of technological facilities is based on coping with risks [3]. With regard to world dynamic development it is necessary the priority risks to monitor and to cope with them during time, and also to measure the respective safety. The work [3] shows that for technological facility safety it is necessary to consider seven domains (Fig. 1) that influence the result of work with risks of technological facility, i.e. its safety, namely:

- 2.Context in which the risks inherently connected with technological facility are inserted.
 - 3.List of considered sources of risks.
 - 4.Type of risk form.
 - 5.Ways of mastering the risks.
 - 6.Process model of work with risks, application of the TQM and Coase theorem.
 - 7.Technique of management and coping with risks of technological facility.
- Way of management of risks in time.



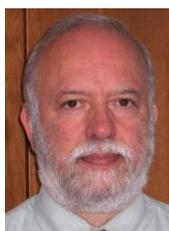
Fig. 1 Items that influence the result of work with risks of technological facility.

The results in [1-3] show that at present practice the alternatives of work with risks used at technological facilities safety management are often very simple. In all important domains they are still predominated the techniques of work with risks that do not respect the system nature of technological facilities and the dynamics of world development. From the study of followed technological facilities documentations [3] it is obvious that at creating their safety, the experts from different fields work separately, which of course does not guarantee optimal safety, or even the optimal cost.

REFERENCES

- [1] ESRA, Proceedings of ESREL conferences 2009-2017. Brussels: ESRA 2009-2017.
- [2] D.Procházková, Safety of Complex Technological Systems. ISBN: 978-80-01-05771-1. Praha: ČVUT 2015, 208p.
- [3] CVUT, Archives (Results of Research of Risks, Resilience and Safety in Real Technical Facilities Since 1980). Praha: ČVUT 2018.

RESS News



*Carlos Guedes Soares
Editor-in-Chief RESS
Instituto Superior Técnico,
Universidade de Lisboa*

A New Editor

The Journal has continued increasing the number of submissions, increasing thus the pressure on the Editorial Board and on the many faithful reviewers that provide the reviewing and quality control of the Journal. In order to meet this challenge one additional Editor has been nominated, from 1st January 2018, bringing the number of Associate Editors to three now.

I would like to welcome Dr Gregory Levitin to his new Editorial role in RESS. He has been publishing actively in various journals, including RESS and has had editorial experience in various journals, before taking over this task.

He is also Chair of one ESRA Technical Committee and thus he contributes to increase the link that RESS has with ESRA, which is simultaneously one important aspect.

The journal has also continued the policy of gradual rotation of Editorial Board members and thus this year we have welcomed several new members: R.L. Boring, B. Iooss, F.I. Khan, A.K. Parlikad, M. Sujan, L.P. Swiler, P. Weber. I hope they will bring a new impetus to some subject areas.

RESS is continuing an active policy towards having special sections or special issues on specific topics so as to present a more focused view on them.

The special issue of ESREL 2015 was announced under the topic of Foundations and Novel Domains for Human Reliability Analysis, with Guest Editors: Luca Podofillini and Ali Mosleh. The submissions to this issue will be closed very shortly.

Other special issues that have been initiated in the meanwhile are:

Advances on Computer Safety and Reliability, with Guest Editors: Stefano Tonetta and Erwin Schoitsch,

has started accepting submissions In December 2017 and will be open until May 2018.

The special issue on Quantitative Assessment and Risk Management of Natech Accidents has **Valerio Cozzani** and Nima Khakzad as Guest Editors. Submissions are open since March 2018 to September 2018.

ESRA News

Cross Disciplinary Project – RISK@Univ. Grenoble Alpes

Author: Christophe Berenguer



Univ. Grenoble Alpes – University of Innovation has launched a new Cross Disciplinary Program « RISK@Univ. Grenoble Alpes » at the beginning of 2018 with a 1.45 M€ budget over 3.5 years with the ambition to set up a Risk Institute in Grenoble. This project is led by GIPSA-lab, a member of ESRA and ESRA supports this project, with the participation of Prof Terje Aven to the Scientific Committee. One of the objectives of the project RISK@Univ. Grenoble Alpes is to develop international collaborations on risk research, and in particular with the ESRA community.

Managing Risk: Cross-Disciplinarity for a More Resilient World

The Risk project's goal is to develop cross-disciplinary research and scientific innovation in the field of disaster and risk management, specifically in areas that are made vulnerable due to a strong interdependency between human, natural or technological hazards. In addition to the Grenoble area, the project focuses on other specific vulnerable territories such as the Beirut area (Lebanon), Port-au-Prince (Haiti), and areas in Peru and in Nepal. The project also aims at proposing a risk institute within Univ. Grenoble Alpes.

Challenges

With 14 million people left homeless every year by natural disasters, and an estimated global cost of 330 billion Euros in 2017 alone, the main goal of the project is to contribute to the proactive mitigation of disaster risks and the development of the culture of risk. It is dedicated to a global and regional challenge, which is fundamental for the decades to come, due to the increase of the world population with often-anarchic densification of urbanized areas, the

increasing human impact on ecosystems, but also the emergence of new risks induced by climate change and technological development.

Interdisciplinarity

The project federates a hundred researchers belonging to 15 research labs from Human and Social Sciences, Information and System Sciences, Geosciences, and Engineering Sciences. The scientific challenges of collecting and processing heterogeneous data, modeling complex and cascaded phenomena, multi-objective decision making, and assessing or managing risk governance schemes require truly global and interdisciplinary approaches.

Project's Organization...

The project proposes an innovative scientific approach to address the following challenging issues: managing data heterogeneity through a participatory approach; integrating rare or emergent events and cascading events; moving from a static/reactive risk management approach to a proactive/dynamic approach; and designing appropriate strategies for, on the one hand, disaster risk reduction (apart from a relevant assessment of vulnerabilities and local cultures) and for communications on the other, in order to better manage risk and strengthen the culture of risk.

... And its International Visibility

The project is fully in line with Sendai's United Nations conference framework on disaster risk prevention in 2015, which encourages countries to better prevent and anticipate disaster risks. It aims at becoming a privileged interlocutor of the risk management stakeholders in France and abroad, in particular on the 5 selected study sites (economic sphere, public authorities, humanitarian organizations, academia or risk center networks).

The project will offer a strong contribution to both the structure and visibility of Univ. Grenoble Alpes in the field of risk assessment and management, by proposing in fine a risk management institute, unique in France. The Risk project will foster the development of new interdisciplinary methodologies by research teams to better work together, and will contribute to the transfer of research results to relevant stakeholders and decision-makers. It will also actively participate in reinforcing interdisciplinary curricula in risk management.

Partner laboratories

3SR • AE&CC • CEA-Leti • CERAG • EDYTEM • GIPSA-lab • G-SCOP • IGE • Irstea - Grenoble Alpes • ISTerre • LARHRA • LIG • LIP/PC2S • LJK • PACTE

Participating Research Departments

PAGE • PSS • MSTIC • PEM • SHS

Contacts

Project Head : Didier Georges
didier.georges@grenoble-inp.fr

Website : risk.univ-grenoble-alpes.fr

Past Safety and Reliability Events

3rd International “Computational Reliability Engineering (CRE)” Symposium

University of Liverpool

19 October – 20 December 2017

Author: Marcin Hinz



The “Computational Reliability Engineering in Product Development and Manufacturing (CRE)” Symposium was organized by the chair for reliability engineering and risk analytics of Univ.-Prof. Dr.-Ing. Stefan Bracke already for the third time. In order to extend the international character of the symposium, especially regarding the event location, for the first time it took place outside Germany. Due to the cooperation with the University of Liverpool, the event took place in the historical buildings of the London campus of the University of Liverpool in England. The CRE symposium was supported by Meiji University in Tokyo, the European Safety and Reliability Association (ESRA), the University of Wuppertal in Germany, the University of Liverpool as well as the Institute for Analytics and Prognostics of technical complex systems (IAP) from Cologne in Germany. The guests from the industry and academic world discussed, as usual, the current topics related to the product reliability and risk analysis. Academics were represented by attendees from Meiji University (Tokio, Japan), the University of Electro-Communications (Tokio, Japan), the University of Liverpool (GB), Technical University Delft (Netherlands), the University of Huddersfield (GB), University Paderborn (Germany), Leibniz University Hannover (Germany), University Siegen (Germany), the Technical University of Cologne (Germany), and the University of Wuppertal (Germany).

The industrial attendees came from Valeo S.S (France), Carl Zeiss SMT GmbH (Germany), Brockmann & Büchner GmbH (Germany), and diondo GmbH (Germany).

On the first day of the symposium (19th of October) all attendees were participating the meeting in the campus of the University of Liverpool in the London City. Topics of the discussions were focused on the product and process reliability, risk analytics, uncertainty analysis, testing of technical products,

sustainability engineering, and physics of failure. The Meiji University presented a new method for the calculations of uncertainties based on robust design. The University of Liverpool discussed the topic of uncertainties from the simulation perspective along the product development process whereas the University of Electro-Communications showed the challenges of reliability of sustainable products in the era of Trump and Brexit. University Paderborn presented the development of reliable and intelligent systems and the University of Wuppertal showed the development of new mathematical approaches for the optimization of product reliability. diondo GmbH was discussing new possibilities of reliability growth by means of the usage of computer tomography. Finally, Valeo S.A. concluded the presentation day with a talk about low-cycle fatigue of engine cooling radiators.

On the second day of the symposium (20th of October) the excursion to the Greenwich Royal Observatory museum took place. The observatory was set as a reference for the zero meridian (sometimes also called the Greenwich meridian) and used for the measurement of the longitudes. Primarily, clocks and astronomy as well navigation instruments were developed in the observatory, according to which the Greenwich Mean Time (GMT), a standardised time specification, was introduced. Many technical discussions regarding the technological development and practicability of the time measurement were conducted with the attendees of the symposium and the employees of the observatory. Hence, the excursion provided the chance to discuss about the history of the development of navigation tools as well as the theory and practice of high precision manufacturing of measurement systems.

The fourth CRE symposium with the University of Wuppertal as organiser will be held in September 2018 in Danzig, Poland in cooperation with the Gdynia Maritime University from Poland.

The organisers would like to thank the sponsors, the European Safety and Reliability Association (ESRA), Meiji University in Tokyo, the University of Wuppertal in Germany, the University of Liverpool as well as the Institute for Analytics and Prognostics of technical complex systems (IAP GmbH) from Cologne in Germany, which supported this annual symposium.

For further information please contact:

Prof. Dr.-Ing. Stefan Bracke
Chair of Reliability Engineering and Risk Analytics
Faculty of Mechanical and Safety Engineering
University of Wuppertal, Germany.

Workshop: "Computational Challenges in the Reliability Assessment of Engineering Structures"

24 January 2018

Delft, The Netherlands

Structural reliability and remaining service life assessment of engineering structures can be a daunting task. The main issue is that these assessments often involve computationally expensive physical models (e.g. NL-FE models) combined with a large number of random variables (e.g. due to random fields) and concern small failure probabilities ($1e-3$ to $1e-6$). Practical examples of such conditions can be found in many fields, e.g. civil engineering, aerospace, or automotive engineering.

To face this challenge and come up with workable solutions, the Department of Structural Reliability at TNO has organized a workshop on this topic. The aim of the workshop was to bring together researchers, practitioners, and software developers from all over the world to share experience, learn from each other, and to jointly find ways of solving these challenges.

The workshop day

The workshop was held on the 24 January in Delft, The Netherlands. With about 50 participants, the interest in the workshop has far exceeded our initial expectations. The participants were practitioners and researchers from various branches of engineering. They came from 10 different countries and affiliated with 22 different institutes/companies.

11 lectures were presented during the workshop, many of these by leading researchers in the field.

The first part of lectures dealt with state-of-the-art reliability methods (advanced subset simulations, hyper-spherical importance sampling, etc.). The second part focused on the latest developments and challenges in engineering practice.

Each of the lectures was recorded and along the lecture slides made publicly available on a designated website: www.reliabilitytno.com.

The outcomes

During the entire workshop there were lively discussions on the presented methods and future challenges. In the final discussion session this yielded to a clear agreement that a comparison of these methods is needed on the basis of carefully selected benchmark studies that are representative of realistic engineering problems. This can give insight to the performance and limitations of these methods.

Call

The methods are intended to be compared, measured against each other via a competition. TNO will take the lead in this by drafting the first proposal and facilitating the process. The proposal will include the guiding principles for the competition, as well as the practical and scientific requirements to the selected benchmark problems.

We invite all interested parties to assist TNO in the facilitation of the process.

For further information, please contact arpad.rozsas@tno.nl.

Website: www.reliabilitytno.com

Calendar of Safety and Reliability Events

10th IMA International Conference on Modelling in Industrial Maintenance and Reliability Manchester, UK 13 – 15 June 2018

The 10th International Conference on Modelling in Industrial Maintenance and Reliability (MIMAR) will take place in Manchester, UK from 13 – 15 June 2018. This event is the premier maintenance and reliability modelling conference in the UK and builds upon a very successful series of previous conferences. It is an excellent international forum for disseminating information on the state-of-the-art research, theories and practices in maintenance and reliability modelling and offers a platform for connecting researchers and practitioners from around the world. We hope you can attend and we will provide a warm welcome in Manchester in 2018.

Key Dates:

- Abstract deadline: April 3, 2018
- Paper submission for conference proceedings: May 15, 2018
- Final deadline for acceptance for conference proceedings: May 15, 2018

Organising Committee

Philip Scarf - Chair (University of Salford, UK)
Phuc Do - Co-Chair (University of Lorraine, France)
Shaomin Wu - Co-Chair (University of Kent, UK)

Further information

Details of publication and conference fees will be announced shortly.
Scientific enquiries to Prof. Philip Scarf (Salford Business School, University of Salford)
Email: p.a.scarf@salford.ac.uk

Conference Website:

<https://ima.org.uk/6619/mimar2018/>

Welcome to ESREL 2018

Trondheim, Norway
17-21 June 2018

The annual European Safety and Reliability Conference ESREL is an international conference under the auspices of the European Safety and Reliability Association (ESRA).

The topic for ESREL 2018 is “Safe Societies in a Changing World” and our ambition for the conference is to advance in the understanding, modeling, and management of the complexity of the risk, safety and reliability fields characterizing our world, now and in the future. We aim at setting up a multidisciplinary platform to address the technological, societal and financial aspects of these fields. With the support of

NTNU, we engage in broadening the scope of risk, safety and reliability from the technical to natural, financial and social aspects, focusing on Inter-dependencies of functions and cascade of failures in complex systems.

Conference General Chairman:

Prof. Stein Haugen – NTNU

Conference Co-Chairs:

Prof. Jan Erik Vinnem – NTNU

Prof. Trond Kongsvik – NTNU

Prof. Anne Barros – NTNU

Conference Website:

<https://www.ntnu.edu/web/esrel2018/home>

37th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2018) Symposium on Structures, Safety and Reliability Madrid, Spain 17-22 June 2018

The annual OMAE conference is an international assembly of engineers, researchers, and students in the fields of ocean, offshore and arctic engineering. The conference is organized by thematic area in 9 traditional Symposia, one of which deals with topics of Safety and Reliability as applied to this industrial domain. This Symposium typically has around 120 papers and thus is an interesting venue for reliability specialists that want to develop applications in this industrial sector.

Conference Chairs:

Dr. Antonio Souto-Iglesias – UPM (Spain)

Dr. Raúl Guancho García – UC (Spain)

Dr. Francisco Huera-Huarte – URV (Spain)

Technical Program Chair

Dr. Solomon C. Yim – OSU (USA)

Specific questions can be addressed to the

Symposium Coordinator at:

c.guedes.soares@centec.tecnico.ulisboa.pt

Conference Website: <http://www.omae2018.com>

Save the Date for ESREL 2019 – 29th European Safety and Reliability Conference

Leibniz Universität Hannover,
Hannover, Germany
22 - 26 September 2019



The 29th edition of the European Safety and Reliability Conference (ESREL) will be held on 22 - 26 September 2019 at the iconic Welfenschloss, the heart

xfsubmission system will open shortly after the ESREL 2018 conference in Trondheim. **The abstract deadline is fixed to October 31, 2018.**

We are looking forward to welcoming you in Hannover.

Sincerely,

Michael Beer (Conference General Chair)

Enrico Zio (Conference General Co-Chair)

Conference Website: <https://esrel2019.org/#/>



ESRA Information

1. ESRA Membership

1.1 National Chapters

- French Chapter
- German Chapter
- Italian Chapter
- Polish Chapter
- Portuguese Chapter
- Spanish Chapter
- UK Chapter

1.2 Professional Associations

- The Safety and Reliability Society, UK
- Danish Society of Risk Assessment, Denmark
- SRE Scandinavia Reliability Engineers, Denmark
- ESReDA, France
- French Institute for Mastering Risk (IMdR-SdF), France
- VDI-Verein Deutscher Ingenieure (ESRA Germany), Germany
- The Netherlands Society for Risk Analysis and Reliability (NVRB), The Netherlands
- Polish Safety & Reliability Association, Poland
- Asociación Española para la Calidad, Spain

1.3 Companies

- TAMROCK Voest Alpine, Austria
- IDA Kobenhavn, Denmark
- VTT Industrial Systems, Finland
- Bureau Veritas, France
- INRS, France
- Total, France
- Commissariat à l'Energie Atomique, France
- DNV, France
- Eurocopter Deutschland GmbH, Germany
- GRS, Germany
- SICURO, Greece
- VEIKI Inst. Electric Power Res. Co., Hungary
- Autostrade, S.p.A, Italy
- D'Appolonia, S.p.A, Italy
- IB Informatica, Italy
- RINA, Italy
- TECSA, SpA, Italy
- TNO Defence Research, The Netherlands
- Dovre Safetec Nordic AS, Norway

- PRIO, Norway
- SINTEF Industrial Management, Norway
- Central Mining Institute, Poland
- Adubos de Portugal, Portugal
- Transgás - Sociedade Portuguesa de Gás Natural, Portugal
- Cia. Portuguesa de Produção Electrica, Portugal
- Siemens SA Power, Portugal
- ESM Res. Inst. Safety & Human Factors, Spain
- IDEKO Technology Centre, Spain
- TECNUN, Spain
- TEKNIKER, Spain
- CSIC, Spain
- HSE - Health & Safety Executive, UK
- Atkins Rails, UK
- W.S. Atkins, UK
- Railway Safety, UK
- Vega Systems, UK

1.4 Educational and Research Institutions

- University of Innsbruck, Austria
- University of Natural Resources & Applied Life Sciences, Austria
- AIT Austrian Institute of Techn. GmbH, Austria
- Université Libre de Bruxelles, Belgium
- University of Mining and Geology, Bulgaria
- Czech Technical Univ. in Prague, Czech Republic
- Technical University of Ostrava, Czech Republic
- University of Defence, Czech Republic
- Tallin Technical University, Estonia
- Helsinki University of Technology, Finland
- École de Mines de Nantes, France
- Université Henri Poincaré (UHP), France
- Laboratoire d'Analyse et d'Architecture des Systèmes (LAAS), France
- Université de Bordeaux, France
- Université de Technologie de Troyes, France
- Université de Marne-la-Vallée, France
- INERIS, France
- Fern University, Germany
- Technische Universität Muenchen, Germany
- Technische Universität Wuppertal, Germany
- University of Kassel, Germany
- TU Braunschweig, Germany
- Institute of Nuclear Technology Radiation Protection, Greece
- University of the Aegean, Greece
- Università di Bologna (DICMA), Italy
- Politecnico di Milano, Italy
- Politecnico di Torino, Italy
- Università Degli Studi di Pavia, Italy
- Università Degli Studi di Pisa, Italy
- Technical University of Delft, The Netherlands
- Institute for Energy Technology, Norway
- Norwegian Univ. Science & Technology, Norway
- University of Stavanger, Norway
- Technical University of Gdansk, Poland
- Gdynia Maritime Academy, Poland
- Institute of Fundamental Techn. Research, Poland
- Technical University of Wroclaw, Poland
- Instituto Superior Técnico, Portugal
- Universidade de Coimbra, Portugal
- Universidade Nova de Lisboa - FCT, Portugal
- Universidade de Minho, Portugal
- Universidade do Porto, Portugal
- University Politechnica of Bucharest, Romania
- University of Iasi, Romania

- Slovak Academy of Sciences, Slovakia
- University of Trencin, Slovakia
- Institute “Jozef Stefan”, Slovenia
- Asociación Española para la Calidad, Spain
- PMM Institute for Learning, Spain
- Universidad D. Carlos III de Madrid, Spain
- Universidad de Extremadura, Spain
- Univ. de Las Palmas de Gran Canaria, Spain
- Universidad Politecnica de Madrid, Spain
- Universidad Politecnica de Valencia, Spain
- Institute de Matematica y Fisica Fundamental (IMAFF), Spain
- University of Castilla-La Mancha, Spain
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ESRA is a non-profit international organization for the advance and application of safety and reliability technology in all areas of human endeavour. It is an “umbrella” organization with a membership consisting of national societies, industrial organizations and higher education institutions. The common interest is safety and reliability.

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