

LIST OF AUTHORS AND CONTRIBUTIONS WITH ABSTRACTS (under completion)

Eirik Bjorheim Abrahamsen, Willy Røed

A semi-quantitative approach for verification of Safety Integrity Level requirements

Keywords

safety integrity level, probability of failure on demand, uncertainty

Abstract

A Safety Integrity Level (SIL) is a measure of performance required for a safety instrumented function. The IEC 61508/61511 standards define four safety integrity levels, SIL1 to SIL4, where SIL4 is the level with the most stringent requirements. For each safety integrity level there are many design requirements, including requirements for the probability of failure on demand (PFD). Verification of the required failure probability is usually based on a quantitative analysis. In this paper we argue that such an approach is better replaced by a semi-quantitative approach. The approach acknowledges that the PFD requirement for a safety function cannot be adequately verified only by reference to an assigned probability number. There is a need for seeing beyond the probability number. The key aspect to include is related to uncertainty. Such an aspect is often ignored in verification of a safety integrity level.

Terje Aven

A holistic framework for conceptualising and describing risk

Keywords

risk, probability, models, Bayesian approach

Abstract

A number of definitions and interpretations of the risk concept exist. Many of these are probability-based. In this paper we present and discuss a structure for characterising the definitions, which is founded on a clear distinction between (a) risk as a concept based on events, consequences and uncertainties; (b) risk as a modelled, quantitative concept; and (c) risk descriptions. The discussion leads to a holistic framework for conceptualising and assessing risk, which is based on risk defined by (a), and the probability-based definitions of risk can be viewed as related model parameters and/or risk descriptions. Two ways of detailing the framework are outlined: the relative frequency-based approach and the Bayesian approach. The framework provides clear guidance on how to think when conceptualising and assessing risk in practice. Such guidance is strongly needed for the risk analysis discipline which is young and characterised by many different risk perspectives and approaches.

Terje Aven

A conceptual framework for risk assessment and risk management

Keywords

risk, probability, risk assessments, uncertainties

Abstract

This paper presents and discusses a conceptual framework for risk assessment and risk management where risk is based on the triplet events, consequences and uncertainties. In addition to risk, the framework highlights the concepts of vulnerability and resilience. An example of the analysis of an LNG (Liquefied Natural Gas) plant is included to demonstrate the applicability of the framework. The proposed framework is more general than existing frameworks, for example the traditional Kaplan & Garrick approach, and provides also new perspectives on how to understand and describe uncertainties in a risk assessment and risk management context.

Berg Heinz-Peter

Aircraft crash onto a nuclear power plant - screening procedure and approach for a probabilistic analysis

Keywords

aircraft crash, crash frequency, probabilistic safety assessment, screening

Abstract

International experience has shown that external hazards (e.g. aircraft crash, flooding) can be safety significant contributors to the risk in case of nuclear power plants` operation. This is due to the fact that such hazards have the potential to reduce simultaneously the level of redundancy by damaging redundant systems or their supporting systems. In this paper, the procedure for the external hazard aircraft crash is described in more detail, starting with the screening procedure in order to determine scope and content of the assessment and the approach for those cases where a full scope analysis has to be performed. The consideration regarding this hazard does as not cover an intended aircraft crash.

Berg Heinz-Peter, Fritze Nicole

Power plant transformer explosion and fire

Keywords

transformer, power plants, explosion, fire, simulation, failure, reliability, risk management

Abstract

The transformer is the key equipment for electric power transmission. It has been found that main transformer failures require an in-depth assessment because of the high failure frequency and the resultant reliability and safety implications. Transformers are considered as a critical equipment because of the large quantity of oil in contact with high voltage elements. In particular, experience has shown an increasing number of transformer explosions and fires in all types of power plants worldwide. Therefore, these phenomena have been investigated and are discussed in more detail in this paper with regard to causes for these events, potential influence of the age of the transformers and possible diagnostic measure in order to avoid such events. For that purpose different types of databases have been evaluated.

Francesco Cadini, Diana Avram, Enrico Zio, Alfredo Luce, Alberto Taglioni

Monte Carlo simulation-based reliability model for the PSA of a radioactive waste repository

Keywords

radioactive waste repository, probabilistic safety assessment, reliability-based model, Monte Carlo simulation

Abstract

Disposal facilities for radioactive wastes comprise a series of engineered barriers whose purpose is to contain the radionuclides until their radiation hazard has decreased to acceptable levels. In this regard, it is required that the long-term functionality of the system of barriers be evaluated by a quantitative risk analysis procedure, also called performance assessment. In this paper, a Monte Carlo simulation-based reliability model is propounded for the preliminary analysis of the safety performance of a radioactive waste repository, accounting also for barrier degradation processes. The model strengths are: simplicity, which allows ease of computation, and flexibility, which allows modification to account for various physical aspects and inter-comparison of their effects. An application to a case study of literature is presented to validate the approach and demonstrate its flexibility.

Cui Yanhong, Guo Renkuan, Dunne Tim, Guo Danni

Decision theory under general uncertainty

Keywords

statistical decision, state space, action space, uncertain measure, loss function, risk, uncertainty decision

Abstract

The exposure of Toyota management's cover-up of its faulty car component problems raises a fundamental question: did Toyota management make a correct decision? Statistical decision theory is a framework with a probabilistic foundation, which admits the random uncertainty about the real world and human thinking. In general, the uncertainty of the real world is diversified and therefore the effort trying to deal with different forms of uncertainty with one special form of uncertainty – random uncertainty may be oversimplified. In this paper we introduce an axiomatic uncertain measure theoretical framework and reveal the unique and intrinsic characteristic of the uncertainty distribution and the uncertainty decision accordingly. We expect that a thorough understanding of the uncertainty distribution and uncertainty decision-making may help the intelligent communities to survive the extremely tough and diversifying reality.

Demichela Micaela, Murè Salvina, Cigna Caterina, Monai Laura, Patrucco Mario

Occupational accidents data collection and analysis

Keywords

occupational accidents, fuzzy logic, neural networks, expert systems, data collection

Abstract

Despite of the always growing attention to safety related topics, the enforcement of directives, regulations and technical standards and the improvement of technical solutions aimed to minimize the occupational risks, the number of people dying every day at workplaces is still excessively high. The overall number of injuries is recently decreasing, but both the frequency and the total yearly number of fatalities still remain fundamentally unchanged in the last years. The main problem with accidental data, as officially reported, is that very often, no evaluation is possible in terms of root causes, e.g. standard violations. Since the target of the analysis is the determination of the causal chain of events that lead to the accident to understand how it happened and how to avoid the occurrence of similar situations, the lack of detailed information lead to many difficulties in the definition of the suitable prevention measures. This paper shows three different, but integrated, methods able to collect, manage and analyze the information related to occurred accidents for preventive purposes.

Dziaduch Izabela

Unreliability costs in Life Cycle Cost Analysis (LCCA) – comparison of calculation methods

Keywords

Life Cycle Cost (LCC), operation and maintenance phase, unreliability costs, failure rate, discounting

Abstract

The paper describes aspects related to the reliability and its influence on life cycle cost analysis performance. The emphasis is on the unreliability costs, caused by failures, which are incurred over an entire object's useful life. Later, there are characterized three methods, i.e. exponentially distributed failure rate, the determined failures frequency, and Weibull distributed failure rate, which allow to quantify the economic impact of the costs associated with reliability in the Life Cycle Cost Analysis. Applications of these approach to predict the unreliability costs of railbus electrical system are presented as well.

Eid Mohamed

Modelling sequential events for risk, safety and maintenance assessments

Keywords

probability, sequential events, double Poisson stochastic process, modulated, spectral, polynomial.

Abstract

Assessing the Occurrence Probability of a given sequence of events in a determined order is necessary in many scientific fields. That is the case in the following fields: nucleation and microstructure growth in materials, Narrow-Band process, financial risk analysis, Sequential detection theory, rainfall modelling, in optics to model the sequences of photoelectrons under detection, population biology, software reliability, queuing in network traffic exhibiting long-range dependence behaviour, and DNA sequences and gene time expression modelling. However, the topic has a particular interest in the field of risk, safety and maintenance assessments.

The lecture will focus on sequences composed of Double Stochastic Poisson Processes.

Frenkel Iliia, Khvatskin Lev, Lisnianski Anatoly

Management decision making based on Markov reward models for refrigeration system

Keywords

Markov reward models, reliability measures, average availability, MTTF, refrigeration system

Abstract

This paper presents a method for calculation the reliability measures of multi-state supermarket refrigeration system for decision making of system structure, where the system and its components can have different performance levels ranging from perfect functioning to complete failure. The suggested approach presents the Markov reward models for computation of average availability, total number of system's elements failures and mean time to system failure for multi-state system. Corresponding procedures for reward matrix definition is suggested. A numerical example is presented in order to illustrate the approach.

Grabski Franciszek

Semi-Markov decision process as a safety and reliability model of a sea transport operation

Keywords

safety, reliability, semi-Markov decision process, transport operation

Abstract

A problem of optimization of a sea transport operation in safety and reliability aspect is discussed in the paper. To describe and solve this problem, a semi-Markov decision processes theory is applied. The semi-Markov decision process as a model of the sea transport operation is constructed. An algorithm which allows to compute the optimal strategy of the operation in safety and reliability aspect is presented.

Guo Renkuan, Cui Yanhong, Thiart Christrien, Guo Danni

Reliability concept under general uncertainty

Keywords

probabilistic reliability, uncertain reliability, uncertain measure, uncertainty lifetime, uncertain hazard function

Abstract

The Toyota crisis is tearing off the brand image of quality and reliability and therefore it is logical to question whether the dominating position of probability theory, on which Japanese quality and reliability engineering practices are established, should be examined. In general, reliability analysis is an exercise under uncertain environment. Foundationally speaking, uncertain modeling is a matter of choosing what kind of uncertain measure as its standing point. In this paper, we introduce the uncertainty reliability concept on the platform of the axiomatic uncertain measure theory and compare it to probabilistic reliability concept based on Kolmogorov's probability measure theory, on which the traditional quality and reliability engineering is established. It is expecting that a foundational work can be established for a more rigorous reliability engineering and risk analysis under general uncertainty environments.

Guo Renkuan, Cui Yanhong, Thiart Christrien, Guo Danni

Hybrid reliability modelling under general uncertainty

Keywords

uncertain measure, hybrid lifetime, uncertain parameter, average chance reliability

Abstract

The real world phenomena are often facing the co-existence reality of different formality of uncertainty and thus the probabilistic reliability modeling practices are very doubtful. Under complicated uncertainty environments, hybrid variable modeling is important in reliability and risk analysis, which includes Bayesian distributional theory, random fuzzy distributional theory, as well as fuzzy random distributional theory as special distribution families. In this paper, we define a new hybrid lifetime which is specified by a random lifetime distribution with an uncertain distributed parameter, which is called as random uncertain hybrid lifetime. We furthermore define the average chance distribution as a quality index for quantifying the hybrid lifetime and accordingly the average chance reliability is derived.

Kołowrocki Krzysztof, Soszyńska Joanna

Preliminary statistical identification and prediction of the container gantry crane operation process

Keywords

semi-markov process, system operation process, sojourn time, estimation

Abstract

In the paper a Semi-markov process is used to construct a general model of complex industrial systems' operation processes. Main parameters of this model are defined and its main characteristics are determined as well. In particular case, for a gantry crane, the operation states are defined, the relationships between them are fixed and particular model of its operation process is constructed and finally its main characteristics are determined.

Kołowrocki Krzysztof, Soszyńska Joanna

Testing uniformity of statistical data sets coming from complex systems operation processes

Keywords

complex system, operation process, sojourn times, uniformity testing

Abstract

The method of the statistical data sets uniformity analysis based on Kolmogorov-Smirnov test is presented. The procedure of statistical data sets uniformity testing is proposed to be applied to the empirical sojourn times in operation states coming from the operation processes of the complex technical systems. The proposed procedure is practically applied to the analysis and uniformity testing of the maritime ferry spring and winter sets of realizations of the sojourn times in particular operation states.

Kołowrocki Krzysztof, Soszyńska Joanna

Reliability, availability and safety of complex technical systems: modelling – identification – prediction – optimization

Keywords

reliability, safety, multistate system, operation process, complex system

Abstract

There is presented a practically well grounded approach concerned with the identification, evaluation, prediction and optimization of reliability, availability and safety of technical systems related to their operation processes. The main emphasis of this approach is on multi-state systems composed of ageing components and changing during the operation processes their structures and their components reliability and safety characteristics. There are proposed the convenient tools for analyzing these systems in the form of semi-markov modeling the systems' operation processes and multistate modeling the systems' reliability. There are described theoretical results of the proposed approach to reliability and safety analysis of multi-state systems with degrading components in their operation processes and the possibility of their practical applications to the reliability and safety analysis and optimization of the complex technical port and maritime transportation systems.

Kołowrocki Krzysztof, Soszyńska Joanna

Safety and risk optimization of a ferry technical system

Keywords

safety function, risk function, operation process, optimization

Abstract

The joint general model of safety of complex technical systems in variable operation conditions linking a semi-markov modeling of the system operation processes with a multi-state approach to system safety analysis and linear programming are applied in maritime transport to safety and risk optimization of a ferry technical system.

Nedbalek Jakub

New type of neural networks for rendering graph points

Keywords

description, gantt, graph, RBF 2 neural network

Abstract

The paper demonstrates new approach of rendering the graph point series called gantts. The gantts are placed in the two dimensional graph which contains the information about available production sources in the real manufacturing process. The gantt is defined as one dimensional coloured dash which has unique position. To have the interaction with a user, gantts are accompanied with the description text giving detailed information about each gantt. All gantt descriptions must be displayed without overlapping with each other. To optimize this task, the modified version of the RBF neural network with biases is applied. With respect to the similarity to the RBF structure, the new type of neural network is named RBF 2. We also give the picture of positive and negative attributes of the solution based on the neural network architecture.

Rahim Yousif, Kenett Ron S.

Patterns and characterization of accidents and incidents reported in oil and gas industry in Norway

Keywords

accident, incident, correspondence analysis, trend analysis, risk management, oil and gas

Abstract

Understanding the safety level of processes in any industry or any sector requires a situational analysis of current and future activities. This analysis includes identifying the hazards and sequence of events that can harm and lead to specific losses. Safety and risk levels are closely related to accident statistics. Accident/incident statistics and reporting systems enables enterprises and companies to identify risks, implement corrective measures' and comply with the national requirements and standards on health safety and environment.

The study describes how the accident statistics can be used as a basic tool for measuring the safety performance in oil and gas industry. The state of art in the literature in the field will be highlighted and analyzed with the summary of personal injury related statistics in Norwegian continental shelf is highlighted and analyzed.

Rakowsky Uwe Kay

On the prognosis of failure coincidences in multi-system scenarios

Keywords

coincidence probability, coincidence patterns, multi-system scenario, integral products, staple graphs

Abstract

The objective of the approach is to calculate the probability of failure coincidences or maintenance conflicts, respectively, in an n -system-single-maintenance-unit scenario. Beside the operation of conventional systems, reliability-adaptive systems can be considered as well in this scenario. The approach applies multiple integrals over probability density functions, which are arranged Matryoshka-like. The contribution discusses permutations of coincidence patterns explicitly and general coincidence probabilities. So-called staple graph and staple graph coincidence permutation diagrams are introduced as graphical representations.

Selvik Jon Tømmerås, Scarf Phil, Aven Terje

An extended risk based inspection methodology

Keywords

maintenance planning, risk based inspection, risk, uncertainty factors

Abstract

Risk based inspection (RBI) is a methodology commonly used in planning of inspections for static mechanical equipment, in particular piping networks. The inspections are prioritized based on risk, expressed as expected values, integrating the likelihood and consequences of failures. In this paper we suggest an extension of the RBI methodology which reflects risk and uncertainties beyond expected values. We argue that such an extension is essential for adequately supporting the inspection planning. A pipeline example from the Norwegian oil and gas industry is presented to illustrate and discuss the suggested approach.

Soszyńska Joanna, Kolowrocki Krzysztof, Blokus-Roszkowska Agnieszka, Guze Sambor

Identification of complex technical systems operation processes

Keywords

system operation, semi-markov process, statistical identification, transportation systems

Abstract

There is presented the contents of the training course addressed to industry. The curriculum of the course includes the methods, algorithms and procedures for identification of the unknown parameters of the operation processes of the complex technical systems and their application in practice. It is based on theoretical backgrounds concerned with the semi-markov modeling of the complex technical systems operation processes and the statistical methods of identification of the complex technical systems operation processes. The illustrations of the proposed methods and procedures practical application in port, shipyard and maritime transport sector are included.

Soszyńska Joanna, Kolowrocki Krzysztof, Blokus-Roszkowska Agnieszka, Guze Sambor

Testing uniformity of statistical data from complex technical systems operation processes

Keywords

system operation, statistical data, uniformity testing, maritime transport

Abstract

There is presented the contents of the training course addressed to industry. The curriculum of the course includes the methods and procedures for testing the uniformity of the statistical data collected from the operation process of the complex technical system in different experiments and their application in practice. It is based on theoretical backgrounds concerned with the semi-markov modeling of the complex technical systems operation processes and on the statistical methods of uniformity testing data of two samples coming from the complex technical system operation process. The illustration of the proposed methods and procedures practical application in maritime transport is included.

Soszyńska Joanna, Kołowrocki Krzysztof, Blokus-Roszkowska Agnieszka, Guze Sambor

Identification of complex technical system components reliability models

Keywords

system reliability, multistate system, statistical identification, port and shipyard transport

Abstract

There is presented the contents of the training course addressed to industry. The curriculum of the course includes the methods, algorithms and procedures for identification of the reliability models of components of the complex technical systems and their applications in practice. It is based on the theoretical backgrounds concerned with the semi-markov modeling of the complex technical systems operation processes, on the complex technical systems and their components multistate reliability models and on the statistical methods of identification of the complex technical system components reliability models. The illustrations of the proposed methods and procedures practical application in port and shipyard transportation are included.

Soszyńska Joanna, Kołowrocki Krzysztof, Blokus-Roszkowska Agnieszka, Guze Sambor

Identification of complex technical system components safety models

Keywords

system safety, multistate system, statistical identification, maritime transport

Abstract

There is presented the contents of the training course addressed to industry. The curriculum of the course includes the methods, algorithms and procedures for identification of the safety models of components of the complex technical systems and their applications in practice. It is based on the theoretical backgrounds concerned with the semi-markov modeling of the complex technical systems operation processes, on the complex technical systems and their components multistate safety models and on the statistical methods of identification of the complex technical system components safety models. The illustrations of the proposed methods and procedures practical application in maritime transportation is included.

Soszyńska Joanna, Kołowrocki Krzysztof, Blokus-Roszkowska Agnieszka, Guze Sambor

Prediction of complex technical systems operation processes

Keywords

system operation, semi-markov process, system operation prediction, transportation systems

Abstract

There is presented the contents of the training course addressed to industry. The curriculum of the course includes the methods, algorithms and procedures for prediction of the operation processes of the complex technical systems and their application in practice. It is based on the theoretical backgrounds concerned with the semi-markov modeling of the complex technical systems operation processes and on the methods of these processes prediction. The illustrations of the proposed methods and procedures practical application in port, shipyard and maritime transport sector and are included.

Szlapczyńska Joanna, Szlapczyński Rafał

Evolutionary sets of cooperating ship trajectories: COLREGS compliance

Keywords

evolutionary algorithms, multi-ship encounters, anti-collision, COLREGS

Abstract

The paper presents a newly designed improvement to the method of solving multi-ship encounter situations. In general, the method combines some of the assumptions of game theory with evolutionary programming and aims to find optimal set of cooperating trajectories of all ships involved in an encounter situation. The improvement presented here is a new way of modelling some of the COLREGS rules. Due to this change, the method is now able to find solutions, which are more compliant with COLREGS, more intuitive and consequently – safer from the navigator's point of view.

Tanguy Christian

On a few reliability issues in telecommunication networks

Keywords

network reliability, availability, failure frequency, uncertainty, large systems

Abstract

The paper proposes a short survey on a few issues currently addressed in telecommunication networks. We show on an example that the k -terminal reliability of recursive families of graphs can also be expressed in terms of products of matrices, leading to a simple asymptotic result. The uncertainty on equipment failure rates, which are not always easy to assess, and the possible occurrence of common-cause failures combine to possibly make the overall connection availability and failure frequency different from their expected values assuming independent failures. We finally discuss a source of impairment in long-haul optical networks, and other current issues where improvements would lead to a reduction of costs and to a better quality of service.

Tchórzewska-Cieślak Barbara

Failure risk analysis in the water distribution system

Keywords

risk analysis, failure, risk, water distribution system

Abstract

A water distribution system (WDS) ought to be high reliable continuous operating system. Failure factors in WDS should be identified and prioritised, for example, the causing factors in the most frequent failures in water-pipe network. In this paper, the failure risk analysis of the WDS is presented, and accordingly, a new method consisting the failures index (FI) and the evaluation of risk of failure within the relevant area, based on the assumed categories (tolerable, controlled and unacceptable risk). It is expecting that the methodology for the WDS performance risk analysis would provide the city leadership for decision making support.

Tchórzewska-Cieślak Barbara

Model of risk of water mains failure using fuzzy logic

Keywords

risk, safety, water supply, fuzzy logic

Abstract

Water supply network is an essential element of urban water supply systems. The basic task of the water supply network is to supply consumers with a required amount of water, with a specific pressure and a specific quality, and at an acceptable price. The operation of a water supply system is inseparably connected with a risk of failure. The main problem in the risk of failure analysis of water mains is the uncertainty of the information collected on the description of failure. The major objective of this research is to present a risk analysis model for water mains, including the probability of failure, the consequences of its occurrence and the possibilities of preventing failures and protecting water consumers. In order to consider the uncertainty of information the theory of fuzzy sets was used. The presented model is part of a complex model of risk management of failures in water mains and can be used in practice in system operator's decision-making process. An adaptation of the fuzzy set theory to analyze risk of failure of water mains is not a standard approach.

Valis David, Vintr Zdenek, Koucky Miroslav

Selected approaches on reliability assessment of complex system with one shot items

Keywords

reliability assessment, complex system, one shot item

Abstract

This paper deals with the modelling and analysis of the reliability of complex systems that use one-shot items during their operation. It includes an analysis of the impact of the reliability of used one-shot items on the resulting reliability of the system as a whole. Practical application of the theoretical knowledge is demonstrated using a model of reliability of an aircraft gun that was used for optimization of the gun's design during its development and design. Furthermore this paper demonstrates utilization of a proposed model to determine an optimum number of pyrotechnic cartridges that will achieve a required probability of fulfilment of the mission with the given reliability of individual subsystems of the gun, rounds and pyrotechnic cartridges. The proposed procedures of modelling and analysis of the reliability of complex systems with one-shot items were used in practice in designing and development of the PL-20 aircraft gun. Development of the gun was successfully finished in 2005, and the gun was fielded in the armament of the Czech Republic Air Force.

Zio Enrico, Piccinelli Roberta, Delfanti Maurizio, Olivieri Valeria, Pozzi Mauro

Performance analysis of a power transmission system under uncertain load conditions and network configurations

Keywords

vulnerability, electric power transmission network, load flow, power flow betweenness centrality, uncertainty

Abstract

In this paper, the load flow problem in a power transmission network is studied in presence of load and power generation uncertainties and transmission lines failures. Network performance indicators are computed and the importance of the different components is evaluated by a power flow betweenness centrality measure.

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