
2006

**Electronic Journal
Reliability: Theory & Applications
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Igor Ushakov
"Reliability: Past, Present, Future" (in English)

Игорь Ушаков
Надежность: прошлое, настоящее, будущее (in Russian).

Gregory Levitin
"The Universal Generating Function in Reliability Analysis and Optimization"

Mark Kaminskiy, Vasiliy Krivtsov
"A Monte Carlo Approach to Estimation of G-Renewal Process
in Warranty Data Analysis" (in English)

Марк Каминский, Василий Кривцов
"Применение метода Монте-Карло к оценке обобщенного процесса восстановления при анализе данных об отказах в период действия гарантийных обязательств" (in Russian)

Oleg Abramov
"Reliability-Directed Computer-Aided Design System" (in English)

Олег Абрамов
"Автоматизированная система надежностного проектирования" (in Russian)

Владимир Рыков
"Два подхода к декомпозиции сложных иерархически стохастических систем. Непрерывно взаимодействующие подсистемы" (in Russian)

Vladimir Rykov
"Generalized Birth & Death Processes as Degradation Models" (in English)

Igor Ushakov
"Reminiscence About B.V. Gnedenko" (in English)

Игорь Ушаков
"Воспоминания о Б.В.Гнеденко" (in Russian)

Ilya Gertsbakh
"Kh. B. Kordonsky: Recollections and Short Review of Scientific Results" (in English)

Nozer D. Singpurwalla, Richard L. Smith
"A Conversation with Boris Vladimirovich Gnedenko" (in English)

Нозер Д. Сигпурвалла, Ричард Л. Смит
"Беседа с Борисом Владимировичем Гнеденко" (in Russian)

Igor Ushakov

"D'OU VENONS-NOUS? QUI SOMMES-NOUS? OU ALLONS-NOUS?" (in English)

Игорь Ушаков

"Кто мы? Откуда мы? Куда мы идем?" (in Russian)

1th INTERNATIONAL WORKSHOP MODERN STATISTICAL METHODS AND MODELS within the Frame of INTERNATIONAL CONFERENCE. RELIABILITY AND STATISTICS IN TRANSPORTATION AND COMMUNICATION (RELSTAT'06) (Riga, Latvia 25 - 28 October, 2006)

Международный научный семинар им. Ю.Н.Руденко (г.Харьков 1 – 5 июля 2006 г.)

Gregory Levitin

"The Universal Generating Function in Reliability Analysis and Optimization"

Илья Герцбах

"Теория надежности с приложениями к профилактическому обслуживанию" (in Russian)

Ияа Gertsbakh

"Two-Level Factorial Life Testing With Type -II Censored Data" (in English)

Yakov Genis, Igor Ushakov

"Optimal Uniform-like Scheduling of Maintenance" (in English)

Яков Генис, Игорь Ушаков

"Оптимальное планирование ремонтных работ по критерию равномерности загрузки" (in Russian)

Oleg Abramov

"FAILURE PREVENTION BASED ON PARAMETERS ESTIMATION AND PREDICTION" (in English)

M. Kaminskiy, V. Krivtsov

"Bayesian Probability Papers" (in English)

Игорь Ушаков

"Контр-терроризм: распределение защитных ресурсов" (in Russian)

Igor Ushakov

"Counter-terrorism: Protection Resources Allocation" (in English)

Игорь Ушаков

"А для звезды, что сорвалась и падает... (воспоминания о Ю.Н.Руденко)" (in Russian)

FORUM PRESIDENTIAL ELECTIONS

ВЫБОРЫ ПРЕЗИДЕНТА ФОРУМА

Chin-Diew Lai, Min Xie

STOCHASTIC AGEING AND DEPENDENCE FOR RELIABILITY

Gregory Levitin

THE UNIVERSAL GENERATING FUNCTION IN RELIABILITY ANALYSIS AND OPTIMIZATION

Илья Герцбах

ТЕОРИЯ НАДЕЖНОСТИ С ПРИЛОЖЕНИЯМИ К ПРОФИЛАКТИЧЕСКОМУ ОБСЛУЖИВАНИЮ (in Russian)

The First International Conference On Maintenance Engineering (ICME '06) UESTC, Chengdu, Sichuan, P.R.China // October 15-18, 2006

Ernest V. Dzirkal, Victor A. Netes

OBSERVED STATISTICAL RISKS IN INSPECTION FOR QUALITY & RELIABILITY

Эрнест В.Дзиркал, Виктор Р.Нетес

ИСПОЛЬЗОВАНИЕ НАБЛЮДАЕМЫХ РИСКОВ ДЛЯ КОНТРОЛЯ ПОКАЗАТЕЛЕЙ КАЧЕСТВА И НАДЕЖНОСТИ

G. Sh. Tsitsiashvili, M.A. Osipova

RESERVATION WITH RENEWAL IN OPENED AND CLOSED QUEUEING NETWORKS

Г.Ш.Цициашвилли, М.А.Осипова

РЕЗЕРВИРОВАНИЕ С ВОССТАНОВЛЕНИЕМ В ОТКРЫТЫХ И ЗАМКНУТЫХ СЕТЯХ

Yakov Genis

ESTIMATION OF RELIABILITY OF SYSTEMS WITH FAST RESTORATION

Яков Генис

ОЦЕНКА НАДЕЖНОСТИ СИСТЕМ С БЫСТРЫМ ВОССТАНОВЛЕНИЕМ

Igor Ushakov

COUNTER-TERRORISM: PROTECTION RESOURCES ALLOCATION. PART II. BRANCHING SYSTEM

Игорь Ушаков

КОНТР-ТЕРРОРИЗМ: РАЗМЕЩЕНИЕ ЗАЩИТНЫХ РЕСУРСОВ. ЧАСТЬ 2. ВЕТВЯЩАЯСЯ СИСТЕМА

Владимир Шпер

Реферативный аналитический обзор наиболее значимых публикаций в отечественной и зарубежной периодике по вопросам оценки надежности продукции, в том числе об опыте предприятий" (часть 1)

John D. Kettelle, Igor A. Ushakov
WE ARE LIVING IN A YELLOW SUBMARINE... (scientific-romantic novella)

Джон Кеттель, Игорь Ушаков
МЫ ЖИВЕМ В ЖЕЛТОЙ СУБМАРИНЕ... (научно-романтическая новелла)

David Cox
MY BRIEF WITH GNEDENKO

Давид Кокс
МОИ ВСТРЕЧИ С ГНЕДЕНКО

Юлия Конокотина
КАК ЖЕ ЛЕГКО БЫЛО С НИМ РАБОТАТЬ ... (воспоминания о Б.В.Гнеденко)

Electronic Journal
Reliability: Theory & Applications
Vol.1 No.4, issue of December, 2006

Editor-in-chief: Dear friends!

Chronology of publications of Gnedenko's books

V.S. Koroliuk, I.N. Kovalenko, M.I. Yadrenko, D.B. Gnedenko
Brief note about life and scientific approaches by B.V. Gnedenko (in commemoration of the 95th anniversary of the birth)

Matteo Gaeta, Michael Konovalov, Sergey Shorgin
DEVELOPMENT OF MATHEMATICAL MODELS AND METHODS OF TASK
DISTRIBUTION IN DISTRIBUTED COMPUTING SYSTEM

Ciro d'Apice, Rosanna Manzo, Sergey Shorgin
SOME BAYESIAN QUEUEING AND RELIABILITY MODELS

Vitalii A. Gasanenko
Limit raring processes and rarefaction of two interacted renewal processes

Igor Ushakov
Thurst of life: two Gnedenko's visits to the United States

ОБРАЩЕНИЕ ГЛАВНОГО РЕДАКТОРА

Библиография работ Б.В.Гнеденко

В.Королук, И.Коваленко, М.Ядренко, Д.Гнеденко
КРАТКИЙ ОЧЕРК ЖИЗНИ И ТВОРЧЕСКОГО ПУТИ Б.В.ГНЕДЕНКО

Марио Гаета, Михаил Коновалов, Сергей Шоргин
РАЗРАБОТКА МАТЕМАТИЧЕСКИХ МОДЕЛЕЙ И МЕТОДОВ РАСПРЕДЕЛЕНИЯ
ЗАДАНИЙ В СИСТЕМЕ РАСПРЕДЕЛЕННЫХ ВЫЧИСЛЕНИЙ

Чиро д'Апиче, Росанна Манцо, Сергей Шоргин
НЕКОТОРЫЕ БАЙЕСОВСКИЕ МОДЕЛИ В ТЕОРИИ МАССОВОГО ОБСЛУЖИВАНИЯ И
ТЕОРИИ НАДЕЖНОСТИ

Виталий А Гасаненко
ПРЕДЕЛЬНЫЕ РЕДЕЮЩИЕ ПРОЦЕССЫ И РАЗРЕЖЕНИЕ ДВУХ
ВЗАИМОДЕЙСТВУЮЩИХ ПРОЦЕССОВ ВОССТАНОВЛЕНИЯ

Владимир Шпер
Реферативный аналитический обзор наиболее значимых публикаций в отечественной и
зарубежной периодике по вопросам оценки надежности продукции, в том числе об опыте
предприятий" (часть 2)

В.С.Королюк
Б.В.ГНЕДЕНКО И СОЗДАНИЕ ШКОЛЫ ТЕОРИИ ВЕРОЯТНОСТЕЙ НА УКРАИНЕ

Игорь Ушаков
ЖАЖАДА ЖИЗНИ. ДВА ВИЗИТА Б.В.ГНЕДЕНКО В АМЕРИКУ

2007

Electronic Journal
Reliability: Theory & Applications
Vol.2 No.1, issue of March, 2007

Igor Ushakov
IS RELIABILITY THEORY STILL ALIVE?

M. Nikulin, L. Gerville-Reache, V. Couallier
NEW BOOK! STATISTIQUE DES ESSAIS ACCELERES

Sumantra Chakravarty
ADAPTING BASS-NIU MODEL FOR PRODUCT DIFFUSION TO SOFTWARE RELIABILITY

G. Tsitsiashvili
ASYMPTOTIC ANALYSIS OF LOGICAL SYSTEMS WITH UNRELIABLE ELEMENTS

E. Aliguliyev
Optimization probability of the unfailing work of a network with use of statistical tests on a Monte-Carlo method

M. Kaminskiy
Risk Analysis of Military Operations

I. Ushakov
Counter-terrorism: Protection Resources Allocation. Part III. Fictional “Case Study”

Игорь Ушаков
ЖИВА ЛИ ЕЩЁ ТЕОРИЯ НАДЕЖНОСТИ?

Г.Цициашвили
АСИМПТОТИЧЕСКИЙ АНАЛИЗ ЛОГИЧЕСКИХ СИСТЕМ С НЕНАДЕЖНЫМИ РЕБРАМИ

Э.Алигулиев
ОПТИМИЗАЦИЯ ВЕРОЯТНОСТИ БЕЗОТКАЗНОЙ РАБОТЫ СЕТИ С ИСПОЛЬЗОВАНИЕМ СТАТИСТИЧЕСКИХ ИСПЫТАНИЙ ПО МЕТОДУ МОНТЕ-КАРЛО

И. Ушаков
АНТИ-ТЕРРОРИЗМ: РАСПРЕДЕЛЕНИЕ ЗАЩИТНЫХ РЕСУРСОВ. ЧАСТЬ 3. УСЛОВНЫЙ ПРИМЕР

Г.Цициашвили
ВОСПОМИНАНИЯ О ВЛАДИМИРЕ ВЯЧЕСЛАВОВИЧЕ КАЛАШНИКОВЕ

А.Андронов
ПРОФЕССОР КОРДОНСКИЙ - ИССЛЕДОВАТЕЛЬ И УЧИТЕЛЬ

Electronic Journal
Reliability: Theory & Applications
Vol.2 No.2, issue of June, 2007

WORKSHOP on Asymptotic Statistics and Its Applications to Survival Analysis and Reliability in Honor of Ildar Ibragimov

IEEE 2007 - INTERNATIONAL CONFERENCE ON INDUSTRIAL ENGINEERING AND ENGINEERING MANAGEMENT, SINGAPORE, DECEMBER 2-5, 2007

The 7th International Conference RELIABILITY and STATISTICS in TRANSPORTATION and COMMUNICATION (RelStat'07)
24-27 October 2007. Riga, Latvia

B. Dimitrov, G. Hayrapetyan, and P. Stanchev
Aging and Longevity Control of Biological Systems via Drugs – a Reliability Model

A. Krishnamorthy, Vishwanath C. Narayanan, T. G. Deepak
MAXIMIZATION OF RELIABILITY OF A k-OUT-OF-n SYSTEM WITH REPAIR BY A FACILITY ATTENDING EXTERNAL CUSTOMERS IN A RETRIAL QUEUE

V.M. Abramov
CONFIDENCE INTERVALS ASSOCIATED WITH PERFORMANCE ANALYSIS OF SYMMETRIC LARGE CLOSED CLIENT/SERVER COMPUTER NETWORKS

G.Sh. Tsitsiashvili
Narrow places in logical systems with unreliable elements

V.Gh. VODA
A NEW GENERALIZATION OF RAYLEIGH DISTRIBUTION

G.A. Fedotova, N.I. Voropai
OPTIMISATION OF RELIABILITY OF POWER SUPPLY TO CONSUMERS

A.V. Bochkov, I.A. Ushakov
Sensitivity analysis of optimal counter-terrorism resources allocation under subjective expert estimates

J. Kettelle
When Three's Not a Crowd

I.B. Gertsbakh
MORE ABOUT RIGA'S RELIABILITY SCHOOL

В.М. Абрамов
ДОВЕРИТЕЛЬНЫЕ ИНТЕРВАЛЫ, СВЯЗАННЫЕ С АНАЛИЗОМ
ПРОИЗВОДИТЕЛЬНОСТИ СИММЕТРИЧНЫХ БОЛЬШИХ ЗАМКНУТЫХ
КОМПЬЮТЕРНЫХ СЕТЕЙ ОБСЛУЖИВАНИЯ

Ю.К.Беляев
Воспоминания о Борисе Владимировиче Гнеденко

Г.Ш. Цициашвили
Узкие места в системе с ненадежными элементами

Г.А. Федотова, Н.И. Воропай
ОПТИМИЗАЦИЯ НАДЕЖНОСТИ ЭЛЕКТРОСНАБЖЕНИЯ ПОТРЕБИТЕЛЕЙ

Г.А. Федотова
ОТЗЫВ НА ПУБЛИКАЦИЮ В ЖУРНАЛЕ «RELIABILITY: THEORY & APPLICATIONS»
РЕФЕРАТИВНОГО АНАЛИТИЧЕСКОГО ОБЗОРА В. ШЕРА

Г. Ф. Ковалев
О Федеральном законе «О техническом регулировании» и проблеме надежности
электроэнергетических систем

Круизно-прогулочный катер «Мираж» (Boat "Mirage")

Electronic Journal
Reliability: Theory & Applications
Vol.2 No.3-4, issue of December, 2007

Issue 1
Section 1: System Safety, Reliability and Maintenance Modeling

Blokus-Roszkowska Agnieszka

Analysis of component failures dependency influence on system lifetime

Bris Radim

Stochastic ageing models – extensions of the classic renewal theory

Budny Tymoteusz

Two various approaches to VTS Zatoka radar system reliability analysis

Duarte Caldeira Jose, Soares Carlos Guedes

Optimisation of the preventive maintenance plan of a series components system with Weibull hazard function

Dziula Przemyslaw, Jurdzinski Misroslaw, Kolowrocki Krzysztof, Soszynska Joanna

On multi-state safety analysis in shipping

Elleuch Mounir, Ben Bacha Habib, Masmoudi Faouzi

Improvement of manufacturing cells with unreliable machines

Grabski Franciszek

Application of semi-Markov processes in reliability

Grabski Franciszek

The random failure rate

Grabski Franciszek, Zaleska-Fornal Agata

The model of non-renewal reliability systems with dependent time lengths of components

Guo Renkuan

An univariate DEMR modelling on repair effects

Guze Sambor

Numerical approach to reliability evaluation of two-state consecutive “k out of n: F” systems

Guze Sambor, Kolowrocki Krzysztof

Reliability analysis of multi-state ageing consecutive „k out of n: F” systems

Knopik Leszek

Some remarks on mean time between failures of repairable systems

Kolowrocki Krzysztof

Reliability modelling of complex systems - part 1

Kolowrocki Krzysztof

Reliability modelling of complex systems – part 2

Kudzys Antanas

Transformed conditional probabilities in the analysis of stochastic sequences

Kwiatuszewska-Sarnecka Bozena

On asymptotic approach to reliability improvement of multi-state systems with components quantitative and qualitative redundancy: series and parallel systems

Kwiatuszewska-Sarnecka Bozena

On asymptotic approach to reliability improvement of multi-state systems with components quantitative and qualitative redundancy: "m out of n" systems

Rakowsky Uwe Kay

Fundamentals of the Dempster-Shafer theory and its applications to system safety and reliability modelling

Soszynska Joanna

Systems reliability analysis in variable operation conditions

Valis David

Reliability of complex system with one shot items

Zio Enrico

Soft computing methods applied to condition monitoring and fault diagnosis for maintenance

Zio Enrico, Baraldi Piero, Popescu Irina Crenguta

Optimising a fuzzy fault classification tree by a single-objective genetic algorithm

2008

Electronic Journal
Reliability & Risk Analysis: Theory & Applications
Vol.1 No.1, issue of January, 2008

Thomas L. Saaty

CONFLICTS RESOLUTION AS A GAME WITH PRIORITIES: MULTIDIMENSIONAL CARDINAL PAYOFFS, PART 1

There are two ways to consider increasing the effectiveness of the theory of games in applications. The first is to derive priorities for the payoffs using a cardinal absolute relative scale instead of an ordinal or interval scale to do equilibrium analysis. Our approach using cardinal payoffs is illustrated with one example in an application to OPEC strategies that the author published in the International Journal of Game Theory.

Vyacheslav Abramov

FURTHER ANALYSIS OF CONFIDENCE INTERVALS FOR LARGE CLIENT/SERVER COMPUTER NETWORKS

In the recent paper [Abramov, RTA, 2 (2007), pp. 34-42], confidence intervals have been derived for symmetric large client/server computer networks with client servers, which are subject to breakdowns. The present paper mainly discusses the case of asymmetric network and provides another representation of confidence intervals.

Boyan Dimitrov, George Hayrapetyan, Peter Stanchev, Zohel Khalil
AGING AND LONGEVITY CONTROL OF BIOLOGICAL SYSTEMS VIA DRUGS - A
RELIABILITY MODEL

The treatments in bio-systems correspond to respective repairs known in reliability. Some treatments may make the biological objects younger; others may make them older, or not deteriorate their current age. Such kind of "maintenance" has some analogous failure/repair models in reliability. We use it to incorporate some results of reliability and bio modeling for the quantitative studies of the aging and resistance of bio-systems to environmental stress factors. We call "calendar age" the age of a bio-object which does not use treatments, or uses it without age improvement, or deterioration. All bio-objects, which are using treatments of same strength and direction of effect, have "virtual age". We explain here what the virtual age is, and how is it related to age correcting factors. We illustrate our common results about the virtual ages on the example of the Gompertz-Makenham law of mortality, and discuss the relations of the longevity, mechanism of aging and age affecting control. As a consequence, a concept of age determination is proposed. Numeric and graphical examples are provided.

Yakov Genis
RELIABILITY AND RISK ASSESSMENT OF SYSTEMS OF PROTECTION AND BLOCKING
WITH FAST RESTORATION

There is examined a system with fast restoration which should be operational beginning from some moments of time. If beginning from these moments of time the system is defective during the time more than the assigned random time interval it is considered failed. Such system includes the models of systems with the protection and blocking and systems with the discrete periodic functions. The estimations of indices of failure-free performance and maintainability of these systems and the estimation of indices of risk and losses, connected with the failure (accident) of the system with protection are obtained. This material was presented in the Mathematical Methods in Reliability 2007 Conference in Glasgow, UK.

Gurami Tsitsiashvili, A. Losev
AST ALGORITHMS OF ASYMPTOTIC ANALYSIS OF NETWORKS WITH UNRELIABLE
ARCS

A problem of a reliability in networks with unreliable elements naturally origin in technical applications. But a direct calculation of the reliability demands a number of operations which increases geometrically dependently on a number of arcs. So it is necessary to use approximate methods and particularly asymptotic one. In other work asymptotic reliability is calculated in analogous asymptotic suggestions on the network arcs. Main parameters in these asymptotic are a shortest way length and a maximal flow in a network. In this paper different partial classes of networks are considered and effective algorithms of their parameters calculations are suggested. These networks are networks originated by dynamic systems, networks with integer-valued lengths of arcs, superposition of networks and bridge schemes.

Gurami Tsitsiashvili
BOTTLENECKS IN GENERAL TYPE LOGICAL SYSTEMS WITH UNRELIABLE ELEMENTS

In this paper a model of general type logical system with unreliable elements is considered. An asymptotic analysis of its work (failure) probability is made in appropriate conditions on work (failure) probabilities of the system elements. A concept of bottlenecks of this system is constructed on a suggestion that an increase (a decrease) of elements reliabilities lead to an increase (a decrease) of the system reliability. A construction of general type logical system is founded on concepts of disjunctive and conjunctive normal forms (DNF and CNF) of a logical function.

Mark Kaminskiy, Vasili Krivtsov

AN INTEGRAL MEASURE OF AGING/REJUVENATION FOR REPAIRABLE AND NON-REPAIRABLE SYSTEMS

This paper introduces a simple index that helps to assess the degree of aging or rejuvenation of a non-repairable system. The index ranges from -1 to 1 and is negative for the class of decreasing failure rate distributions (or deteriorating point processes) and is positive for the increasing failure rate distributions (or improving point processes). The introduced index is distribution free.

Revaz Kakubava

ANALYSIS OF ALTERNATING RENEWAL PROCESSES WITH DEPENDENT COMPONENTS

In the terms of operational calculus the probability characteristics of direct and reverse residual renewal time of alternating renewal process, where renewal time depends on life-time, are found.

Edward Korczak

COMPUTATION OF FAILURE/REPAIR FREQUENCY OF MULTI-STATE MONOTONE SYSTEMS

The paper deals with calculation methods for failure and repair frequencies of multi-state monotone systems, both for the instantaneous and steady state cases. Being based on the binary representation of multi-state structure, new general formula for the failure/repair frequency is derived. This formula is used to obtain simple rules for the calculation of failure/repair frequency. In particular, the use of the algebra of dual numbers is presented.

Mark Bebbington, Chin-Diew Lai, Ricardas Zitikis

LIFETIME ANALYSIS OF INCANDESCENT LAMPS: THE MENON-AGRAWAL MODEL REVISITED

The use of the Weibull distribution to model lifetimes of incandescent lamps was originally suggested by Leff (1990). Following this suggestion, Agrawal and Menon have offered and investigated, in a series of papers, an improved model constructed from physical considerations and laws of mathematical statistics. In the present paper we offer supplementary thoughts concerning the Agrawal-Menon model and its several modifications. In addition, we discuss the use of Pinelis's l'Hospital-type calculus rules in the analysis of ageing properties of lifetime distributions.

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Igor Ushakov, Sergei Antonov, Sumantra Chakravarty, Asad Hamid, Thomas Keliinoini
SPARE SUPPLY SYSTEM FOR WORLDWIDE TELECOMMUNICATION SYSTEM
GLOBALSTAR

Berg Heinz-Peter, Gortz Rudolf, Kesten Jurgen
METHODS FOR THE TREATMENT OF COMMON CAUSE FAILURES IN REDUNDANT
SYSTEMS

Berg Heinz-Peter, Frohmel Thomas, Winter Christian
ANALYSIS OF THE IMPACT OF EXTERNAL FLOODING TO NUCLEAR INSTALLATIONS

Cadini Francesco, Zio Enrico, Pedroni Nicola
RECURRENT NEURAL NETWORKS FOR DYNAMIC RELIABILITY ANALYSIS

Dourmas N. Georgios, Nikitakos V. Ninitas, Lambrou A. Maria
A METHODOLOGY FOR RATING AND RANKING HAZARDS IN MARITIME FORMAL
SAFETY ASSESSMENT USING FUZZY LOGIC

Duffey Romney B., Saull John W.
RISK PREDICTION FOR MODERN TECHNOLOGICAL SYSTEMS

Galor Wieslaw
THE SHIPS IMPACT IN GROUND OF PORT WATER AREA

Van Gelder, P.H.A.J.M.
METHODS FOR RISK ANALYSIS IN DISASTER REDUCTION

Hryniewicz Olgierd
STATISTICAL ANALYSIS OF INTERVAL AND IMPRECISE DATA - APPLICATIONS IN
THE ANALYSIS OF RELIABILITY FIELD DATA

Jozwiak Ireneusz J., Laskowski Wojciech
A SHORT NOTE ON RELIABILITY OF SECURITY SYSTEMS

Kobylinski Lech
STABILITY AND SAFETY OF SHIPS: HOLISTIC AND RISK APPROACH

Kuo Way
RELIABILITY WAVE IN LIGHT OF THE NANO DEVELOPMENT

Rosicka Zdena
RISK ASSESSMENT RELATED TO INFORMATION UNCERTAINTY COMPONENTS

Sadovsky Zoltan, Fasko Pavol, Pecho Jozef, Bochnicek Oliver, Mikulova Katarina, St'astny Pavel
COLLECTION AND ANALYSIS OF CLIMATIC MEASUREMENTS FOR THE ASSESSMENT
OF SNOW LOADS ON STRUCTURES

Stodola Jiri
POSSIBILITIES OF TRAFFIC ACCIDENTS AND RISK CRASH EVALUATION

Szlapczynska Joanna, Smierzchalski Roman
ADOPTED ISOCHRONES METHOD IMPROVING SHIP SAFETY IN WEATHER ROUTING
WITH EVOLUTIONARY APPROACH

Witkowska Anna, Smierzchalski Roman
NON-LINEAR BACKSTEPPING SHIP COURSE CONTROLLER

Zio Enrico, Baraldi Piero, Librizzi Massimo, Podofillini Luca, Dang H. Vinh
SENSITIVITY ANALYSIS OF A FUZZY EXPERT SYSTEM FOR MODELLING
DEPENDENCIES IN HUMAN OPERATORS' EMERGENCY TASKS

Zio Enrico, Sansavini Giovanni, Maja Roberto, Marchionni Giovanna
ANALYSIS OF THE SAFETY EFFICIENCY OF A ROAD NETWORK: A REAL CASE STUDY

Electronic Journal
Reliability & Risk Analysis: Theory & Applications
Vol.1 No.3, issue of September, 2008

Yu. M. Paramonov

BAYES-FIDUCIAL APPROUCH FOR AIRCRAFT SPECIFIED LIFE NOMINATION

The problem of nomination of Retirement or Specified Life (SL) of aircraft on the base of full-scale fatigue test result processing is considered. SL can be defined (1) by requirement of fatigue failure probability limitation or (2) by economics reasons. For optimization problem the Bayes-fiducial (BF) approach is offered. BF decision is always a function of sufficient statistics and, by contrast with maximum likelihood method, it is based on the use of specific loss function. For the problem of failure probability limitation in case when sufficient statistics coincides with the sample itself (for example, for Weibull distribution) usually the Monte Carlo method is used but in this paper for the distributions with location and scale parameters an analytical solution is offered. Some numerical examples for lognormal, Weibull distributions are given.

O.V.Abramov, Y.V.Katueva and D.A.Nazarov

CONSTRUCTION OF ACCEPTABILITY REGIONS FOR PARAMETRIC RELIABILITY OPTIMIZATION

The problem of representation and analysis of analog technical devices and systems acceptable regions is introduced. This problem occurs during designing and controlling in view of parametric dithering. The algorithms of constructing circumscribed parallelepiped, representation of acceptable region as a set of non-overlapping parallelepipeds are offered. The algorithm of acceptable region centre of mass computation is offered as the example of utilizing the acceptable region representation.

Farhadzadeh E.M., Muradaliyev A.Z., Farzaliyev Y.Z.

MATCHING OF CRITERIA THE DISCERNMENT OF THE FUNCTIONAL CHARACTERISTICS OF INDEXES OF RELIABILITY OF PLANTS EES

References on variation of reliability on the curves received at analysis of statistical data can appear erratic if not to consider a random in character of assessments of indexes of reliability. The comparison method of criteria of a discernment of the functional characteristics indexes of reliability reduced at ordinal and nominal dials of variation of argument.

Maxim Finkelstein

ON ENGINEERING RELIABILITY CONCEPTS AND BIOLOGICAL AGING

In this study, various stochastic approaches to biological aging modeling are discussed. We assume that an organism acquires a random resource at birth. Death occurs when the accumulated damage (wear) exceeds this initial value. Another source of death of an organism is also taken into account, when it occurs as a consequence of a shock or of a demand for energy, which is a generalization of the Strehler-Mildvan's model. Biological age, based on the observed degradation, is also defined. Finally, aging properties of imperfectly repaired systems are discussed. We show that aging slows down with age in this case. This presents another possible explanation for human mortality rate plateaus.

G. F. Kovalev

"SAFETY" AS A CHARACTERISTIC OF ONE OF THE SINGLE RELIABILITY PROPERTIES

The paper deals with the problems of interrelation between two most important properties of technical (production) systems: safety and reliability that were considered historically separately. However, recently both properties have proven to be increasingly more interrelated, which makes their joint study topical. And the safety may be treated as the most important reliability property, determining to a great extent all the remaining single reliability properties. The relation between the notions of "technical safety" and "energy safety" is also studied.

B. A. Kulik

N-TUPLE ALGEBRA-BASED PROBABILISTIC LOGIC

The concept of "probabilistic logic" known in artificial intelligence needs a more thorough substantiation. A new approach to constructing probabilistic logic based on the N-tuple algebra developed by the author is proposed. A brief introduction is given to the N-tuple algebra and its properties that provide efficient paralleling of algorithms for solving problems of logical analysis of systems in computer implementation are generalized. Methods for solving direct and inverse problems of probabilistic simulation of logical systems are considered.

Nicholas A. NECHVAL, Konstantin N. NECHVAL

TECHNIQUE FOR FINDING SAMPLING DISTRIBUTIONS FOR TRUNCATED LAWS WITH SOME APPLICATIONS TO RELIABILITY ESTIMATION

In this paper, the problem of finding sampling distributions for truncated laws is considered. This problem concerns the very important area of information processing in Industrial Engineering. It remains today perhaps the most difficult and important of all the problems of mathematical statistics that require considerable efforts and great skill for investigation. The technique discussed here is based on use of the unbiasedness equivalence principle, the idea of which belongs to the authors, and often provides a neat method for finding sampling distributions. It avoids explicit integration over the sample space and the attendant Jacobian but at the expense of verifying completeness of the recognized family of densities. Fortunately, general results on completeness obviate the need for this verification in many problems involving exponential families. The proposed technique allows one to obtain results for truncated laws via the results obtained for non-truncated laws. It is much simpler than the known techniques. The examples are given to illustrate that in many situations this technique allows one to find the results for truncated laws and to estimate system reliability in a simple way.

G. Albeanu & H. Madsen, B. Burtschy, Fl. Popentiu-Vlădicescu, Manuela Ghica

BOOTSTRAPPING TIME SERIES WITH APPLICATION TO RISK MANAGEMENT

The bootstrap method is an extensive computational approach, based on Monte Carlo simulation, useful for understanding random samples and time series. It is a powerful tool, especially when only a small data set is used to predict the behaviour of systems or processes. This paper presents the results of an investigation on using bootstrap resampling (different types: uniform, importance based, block structured etc.) for time series appearing during software life cycle (mainly the software testing phase, and debugging), economics, and environment (air pollution generated by cement plants) in order to help the activity of staff working on risk management for software projects, risk management in finance, and those working on environment risk management.

G.Sh. Tsitsiashvili

DISCRETE TIME MODELS OF FORWARD CONTRACTS INSURANCE

In this paper financial management model of forward contracts insurance suggested in some works is considered by means of risk theory and heavy tailed technique. This model is based on a compensation principle. It attracted large interest and called active discussion among economists. So its mathematical analysis is initiated as economists so mathematicians.

G.Sh. Tsitsiashvili

ANALYSIS OF PORTS RELIABILITIES

This paper is devoted to algorithms of a calculation of ports reliabilities. A port is a no oriented graph with fixed initial and final nodes. As accuracy so asymptotic formulas are considered. Suggested algorithms have minimal numbers of arithmetical operations.

Igor Ushakov, Sumantra Chakravarty

OBJECT ORIENTED COMMONALITIES IN UNIVERSAL GENERATING FUNCTION FOR RELIABILITY AND IN C++

The main idea of Universal Generating Function is exposed in reliability applications. Some commonalities in this approach and the C++ language are discussed.

Igor Ushakov

METHOD OF OPTIMAL SPARE ALLOCATION FOR MOBILE REPAIR STATION

Method of finding optimal spare stock for Mobile Repair Station is suggested. Numerical calculations are performed with use of real field data. It showed significant improvement: probability of first fix for suggested variant is 0.967 in comparison with 0.534 for existing variant.

Andrey Kostogryzov

MATHEMATICAL MODELS AND SOFTWARE TOOLS FOR QUALITY AND RISK MANAGEMENT ACCORDING STANDARD REQUIREMENTS

The offered mathematical models and supporting them software tools complexes (M&STC) are purposed for a systems analysts from customers, designers, developers, users, experts of testing laboratories and certification bodies, as well as a staff of quality maintenance for any complex system etc. M&STC are focused on providing system standard requirements on the base of modeling random processes that exist for the life cycle of any complex system. Models implement original author's mathematical methodology based on probability theory, theory for regenerating processes and methods for system analysis. M&STC may be also used in training and education for specializations "System engineering", "Software engineering", "System safety and security", "Information systems".

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Solojentsev E.D., Karasev V.V.

SCIENTIFIC SCHOOL «MODELING AND ANALYSIS OF SAFETY AND RISK IN COMPLEX SYSTEMS» - ACTUAL APPROACH TO ACTUAL

Alexej Chovanec

PREDICTION OF NO – FAILURE SYSTEM OPERATION

Alexej Chovanec

PREDICTION OF THE SYSTEM AVAILABILITY USING SIMULATION MODELING

The article deals with the possibility of system availability prediction using the simulation modelling. The system availability determined with system faultlessness and system maintainability is expressed by various parameters of mean time between the failures and the mean time of single elements repair. The system simulations are carried out with more parameters MTBF and MTTR, the results of the simulation course gives a real idea about the system behaviour in time and about changes of the values of asymptotic system availability factor.

Anton Ambrozy, Alexej Chovanec

COST OPTIMIZATION FOR REALISATION OF MAINTENANCE COST

This paper deals with optimal control interval determination using minimization the financial costs. It clears conceptual, mathematical and simulation model of the problem solution. It enumerates and evaluates results of the simulation.

Jozef Bucha, Alexej Chovanec

SIMULATION OF FTA IN SIMULINK

This paper deals with possibility of simulation of reliability block diagrams, failure trees analysis as a time dependent analysis using Matlab/Simulnk

Himanshu Dutt Sharma, Bangale Shreyas Madhukarao

SIMULATED ELECTRICAL NETWORK APPROACH (SENA) TO HARD OPTIMIZATION PROBLEMS

A novel method is proposed for hard optimization type of problem wherein an exact optimal solution is increasingly difficult in terms of run time and memory requirements. Especially for the cases when search graph has higher number of nodes and more number of paths, which increase as factorial of node number. This is based on Simulated Electrical Network Approach (SENA) proposed here, in which the graph is modeled as an electrical network and current distribution is found which is used as a directive for search decisions. The proposed algorithm results in an approximate method that achieves average accuracy of 99.89% to reach close to the most optimal path that is found by ranking all possible paths. Conversely, it can eliminate on average 99.89% paths in polynomial time from consideration if one requires finding the most optimal one.

Milan Holicke

RISK ASSESSMENT AND OPTIMIZATION OF ROAD TUNNELS

Probabilistic methods of risk optimization are applied to specify the most effective arrangements of road tunnels. The total consequences of alternative arrangements are assessed using Bayesian networks supplemented by decision and utility nodes. It appears that the optimization may provide valuable information for a rational decision concerning number of escape routes. Discount rate seems to affect the total consequences and the optimum arrangements of the tunnels more significantly than number of escape routes.

Melnikov V.A.

MODEL OF A RELIABILITY FOR STRUCTURAL - COMPLICATED SYSTEMS, INCLUDING MULTYSTATE ELEMENTS

The problem of development of Boolean models of a reliability for systems, including elements with many states is considered on the basis of multivalued logic, algebra of trains, algebra of groups of incompatible events and classical logistic-probabilistic method (LPM). The inexpediency of

development of Boolean models of a reliability on the basis of multivalued logic is displayed. The numerical examples demonstrating serviceability of LPM and their new possibilities are demonstrated. The perspective of development of methods of an evaluation of effectiveness of operation at different levels of operation rate by formulation of a set of different tasks, solved by the same LPM is underlined

Solojentsev E.D.

SCENARIO MANAGEMENT OF RISKS OF ACCIDENTS AND CATASTROPHES IN BUSINESS AND ENGINEERING

The stages of development of Management and Risk are described. The scenario management of risks of accidents and catastrophes in complex systems on the stages of designing, debugging and exploitation test and exploitation itself are considered. In the scenario management of accidents and catastrophes risks the personnel and the General designer are taken into account. The uniform approach to the modelling of risks in technical, economic and organisational systems is presented on the basis of substantial description of a SCENARIO of an accident or a catastrophe, and then the construction of models of the risk for the purpose of analysis and management. As the intellectual core for the risk quantitative evaluation and analysis and the scenario management of accidents and catastrophes risk, LP-methods and risk LP-models with groups of incompatible events are used.

Romney B. Duffey, John W. Saull

MANAGING AND MEASURING RISK IN TECHNOLOGICAL SYSTEMS

Safety Management is intended to create order out of disorder, to reduce the “information entropy”, for the purpose of improved safety. Our purpose here and now is to try to introduce some predictability and insight into the risk or occurrence of apparently random events, where a general risk prediction we adopt a fundamental must be testable against the world’s existing data. The risk management issues are clear, given the classic features of major human involvement and contribution to accidents, errors and outcomes occurring with modern technological systems. Prior incidents and prior knowledge and experience must be fully incorporated or learned from. If we do not know where we are on the learning curve, we also do not know the probability of such an event, and we have no objective measure of the “safety culture”. Emphasis on defining and finding so-called “lack of safety culture” has resulted in an extensive and detailed study of the safety management and process safety of many global corporations. We utilize the concepts adopted in thermodynamics and Information Theory to establish the information entropy as a finite, physically based and useful measure of risk in technological systems. The results that we demonstrate show that the risk is dynamic, and can be utilized for management and predictive risk analysis purposes.

Jiri Stodola

TRAFFIC ACCIDENTS INFORMATION SYSTEM AND RISK CRASH EVALUATION

This article analyses the traffic accident rate on roads and highways and possibilities of risk evaluation related to traffic accident occurrence based on factors that were the causes of accidents. A new term – risk of traffic accident occurrence is a product of probability of accident occurrence and its impacts. The results are presented by way of example that uses selected statistical data of the Czech Republic traffic accident rate between 1993 - 2001. The article provides a brief methodological procedure of evaluation of the traffic accident rate using the risk of traffic accident occurrence.

I. Kozine, N.J. Duijm, H. Hagen

THE SEVESO II DIRECTIVE AND DANISH ACTIVITIES SUPPORTING ITS APPLICATION IN SOME EASTERN EUROPEAN COUNTRIES

K. Lauridsen, I. Kozine, A. Amendola, M. Fiori

EU ADVANCES IN IDENTIFYING SOURCES OF UNCERTAINTY IN RISK ANALYSES

This paper presents the scope and some main results of a European project on the ASSESSMENT of Uncertainties in Risk ANALYSIS of Chemical Establishments (ASSURANCE). The project aims at identifying the uncertainties associated with risk analysis of major industrial hazards and assessing the way these uncertainties can affect the final outcome of risk studies and of the relevant decisions based on that outcome. In order to achieve this goal, a number of benchmark exercises/case studies have been performed by the partners and the results were analysed in a modular and structured way. A reference plant served as the basis for a realistic description of these case studies. For this particular project an ammonia storage plant was selected, consisting of cryogenic and pressurised storage tanks, together with import loading/unloading facilities and the relevant piping. This installation was analysed independently by each partner, using common input data and boundary conditions, but different methods, tools and assumptions. The results were then compared and discrepancies identified, discussed and explained.

Henry K Moskatov

ADAPTATION, LEARNING AND INHERENT SAFETY OF 2ND GENERATION AIRSHIPS

Inherent safety of the new generation airships, based on some fundamental laws of Space, is discussed in some detail. An algorithm is proposed to analyze risks, resulting from hazards not compensated by “inherent safety”. Then a thoroughly verified statistical model of learning is used to evaluate results of airship flight testing—the probability of mission success and its confidence limit. The results can be used as a part of evidence for airship airworthiness certification.

Yu. Paramonov, A. Kuznetsov

PLANNING OF INSPECTION PROGRAM OF FATIGUE-PRONE AIRFRAME

To keep the fatigue ageing failure probability of an aircraft fleet on or below the certain level an inspection program is appointed to discover fatigue cracks before they decrease the residual strength of the airframe lower the level allowed by regulations. In this article the Minimax approach with the use one- and two-parametric Monte Carlo modelling for calculating failure probability in the interval between inspections is offered.

Finkelstein M.S.

STOCHASTIC APPROACH TO SAFETY AT SEA ASSESSMENT

A general approach for analysing spatial survival in the plane is suggested. Two types of harmful random events are considered: points with fixed coordinates and moving points. A small normally or tangentially oriented interval is moving along a fixed route in the plane, crossing points of initial Poisson random processes. Each crossing leads to termination of the process with a given probability. The probability of passing the route without termination is derived. A safety at sea application is discussed.

Novosyolov A.

MEASURING RISK

Problem of representation of human preferences among uncertain outcomes by functionals (risk measures) is being considered in the paper. Some known risk measures are presented: expected utility, distorted probability and value-at-risk. Properties of the measures are stated and interrelations between them are established. A number of methods for obtaining new risk measures from known ones are also proposed: calculating mixtures and extremal values over given families of risk measures.

Solojentsev E.D., Rybakov A.V.

RESEARCHES IN IDENTIFICATION OF LOGICAL AND PROBABILISTIC RISK MODELS WITH GROUPS OF INCOMPATIBLE EVENTS

In this paper the results of the researches in identification of the logical and probabilistic (LP) risk models with groups of incompatible events are presented. The dependence of the criterion function on several parameters has been investigated. The parameters include: the total number of optimisations, the amplitude of parameters increments, the initial value of the criterion function (CF), the choice of identical or different amplitudes of increments for different parameters, objects risks distribution. An effective technology of defining the global extreme in the identification of LP-risk model for the calculation time, appreciable to practice has been suggested.

Renzo Righini, Enrique Montiel

A NEW METHOD FOR THE APPLICATION OF RAMS TECHNIQUES TO QUALITY ASSURANCE (QA)

The application of RAMS techniques in all the phases of the lifecycle of each type of installation will surely guarantee its adequate exploitation in terms of production continuity and quality of the obtained products in the respect of prefixed constraints on the security of the working staff, safety and environment impact. In this frame, a particular importance must be attributed to the use of those techniques as support to quality assurance applied in the planning and building phases of the installation and of the products obtained by it. The present paper will include a short description of a method for the application of those techniques in this phase of the lifecycle and of the results that may be obtained by its application in shoes manufacturing, in particular those types where the technical requirements are higher, as it is the cases of certified products like “safety” footwear.

Igor Safonov

ASPECT-ORIENTED SOFTWARE RELIABILITY ENGINEERING

Aspect-Oriented Approach to Software Development allows us effectively to effectively extract, evaluate and solve the main problem of contemporary tendency in Information Technology (particularly, in an Application Software) – a unification is alternated by a personalization. Increasing customer concerns about Performance, Quality, Reliability and Security (PQRS concept) can be satisfied only by symbiosis synergy of adequate models, techniques and tools on all stages of the Software lifecycle. We propose original methodology, formal models and simple methods of Software Reliability Engineering based on our many years experience of concern separation and aspect orientation in Software Development for Specialized Computers, Business Application and Government Institutions.

Brian Bailey, Igor Safonov

TRUST ENGINEERING AND RISK MANAGEMENT FOR SAFETY OF METROPOLIS AND MEGALOPOLIS CITIZENS

The article describes the problems and solutions in the field of safety enhancement in emergency situations of the complex urban agglomerations and analyses of the most actual problem for all metropolises and megalopolises – terrorism, proposing the rational models and techniques of counterterrorism strategy, based on knowledge and experience.

Lev V. Utkin, Thomas Augustin

RISK ANALYSIS ON THE BASIS OF PARTIAL INFORMATION ABOUT QUANTILES

Risk analysis under partial information about probability distributions of states of nature is studied. An efficient method is proposed for a case when initial information is elicited from experts in the

form of interval quantiles of an unknown probability distribution. This method reduces a difficult to handle non-linear optimisation problem for computing the optimal action to a simple linear one. A numerical example illustrates the proposed approach.

Lev V. Utkin, Sergey P. Shaburov

RISK ANALYSIS ON THE BASIS OF JUDGMENTS SUPPLIED BY UNKNOWN EXPERTS

The development of a system requires fulfilling the available standards of reliability and safety. Due to possible complexity of the system, its parameters often are determined by experts whose judgements are usually imprecise and unreliable due to the limited precision of human assessments. Therefore, an approach for computing probabilities of expert judgments and for analysing the risk of decision about satisfying the parameters to standards of reliability and safety is proposed in the paper. A numerical example considering a microprocessor system of central train control illustrates the proposed approach.

David VALIS

CONTRIBUTION TO CONSEQUENCES ANALYSIS USING FUZZY PROBABILITY

This article deals both with dependability and risk analysis from a complex point of view. Both these fields seem to be similar in many aspects, but unfortunately no congruence in sources of basic characteristics has been reached, yet. Statistical files are often very vague in terms of monitoring dependability measures or risk factors. There is a great need to use another point of view to describe these factors. One of those measures and fragments of risk or dependability are consequences both in terms of an event occurrence and failure occurrence. By using a new approach, better interconnection between these both fields and deeper applicability would be provided. A theory of fuzzy probability could be one of these new methods that could facilitate modelling of quantitative factors.

David VALIS

CONTRIBUTION TO STOCHASTIC METHODS OF COMPLEX SYSTEMS RISK ANALYSIS

The paper deals with risk assessment of complex systems. As we investigate situations regarding military applications the fragments of risk management are very important for us. Risk and dependability characteristics of military battle equipment have the same importance for us as those measures which have to serve to perform battle missions itself. There is no time on the battle field to solve unpredicted and unexpected situations caused by high risk level or unreliability which might lead to loss of both equipment and crew. Due to high level of risk we face on the battlefield many systems have to be robust enough or have to be redundant to succeed.

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E.M. Farhadzadeh, A.Z. Muradaliyev, Y.Z. Farzaliyev

CRITERION OF THE SUPERVISION ACCURACY OF INDEXES RELIABILITY OF POWER-GENERATING UNITS A STATE DISTRICT POWER STATION

The atomized system is developed, allowing to determine and compare indexes of individual reliability of complex plants in view of a random in character of an initial conditions.

Mikhail Yastrebenetsky

HOW PROFESSOR B.V. GNEDENKO GOT CAUGHT ON A HOOK IN KHARKOV

G.Sh. Tsitsiashvili, M.A. Osipova

DIRECT CALCULATIONS OF A REACHING MOMENT DISTRIBUTION FOR AN AUTOREGRESSIVE RANDOM SEQUENCE BY RECURRENT INTEGRAL EQUALITIES

V. Raizer

RELIABILITY ASSESSMENT DUE TO WEAR

Evaluation of structural reliability under processes of deterioration presents very important problem in design. The structure's wear shows a reduction of bearing capacity in time that for one's turn leads to increasing the probability of failure. The reasons for long duration and irreversible change of structural features can be corrosion in steel structures, decomposition in wood structures, ageing in polymer structures, and processes of abrasion or erosion also. The problem of defects accumulation should be mentioned too, when reduction of the bearing capacity connects with load's value and its duration. The models and peculiarities of corrosion wear and its influence on bearing capacity are discussed in this paper.

G.Sh. Tsitsiashvili, M.A. Osipova

ACCURACY SOLUTION OF A.A. NOVIKOV PROBLEM

O.V. Abramov, Y.V. Katueva and D.A. Nazarov

DISTRIBUTED COMPUTING ENVIRONMENT FOR RELIABILITY-ORIENTED DESIGN

A theoretical approach and applied techniques for designing analogous electronic devices and systems with due account of random variations in system parameters and reliability specifications are considered. The paper discusses the problem of choosing nominal values of parameters of electronic devices and systems for which the system survival probability or the performance assurance probability for the predetermined time period is maximized. Several algorithms for region of acceptability location, modelling and discrete optimization using parallel and distributed processing are discussed. For seeking a numerical solution of the parametric design problem a distributed computer-aided reliability-oriented design system is proposed.

N.N. Radaev, A.V. Bochkov

DETERMINING A PRIORI DISTRIBUTION OF ERROR-FREE RUNNING TIME FOR HIGH-RELIABILITY COMPONENTS BY DELPHI METHOD

We have considered the approach to determining a priori distribution of error-free running time for high-reliability components by the method of paired comparisons useful for the increase of their reliability indicators. We have introduced the distinct variables, whose grades of membership are interpreted as subjective probabilities of finding the error-free running time and its characteristics at various time intervals. The method of recording the expert evaluation accuracy has been suggested.

T. Aven

RISK ANALYSIS AND MANAGEMENT. BASIC CONCEPTS AND PRINCIPLES

This paper reviews and discusses some key concept and principles of risk analysis and risk management, based on a set of statements, formulated as myths about risk. Examples of such myths are: risk is equal to the expected value, risk equals uncertainty, risk can be expressed by probabilities, risk is equal to an event, risk acceptance criteria contribute to obtaining a high safety standard, and ALARP can be verified by cost-benefit analyses. It is concluded that risk needs to address both the consequences and the uncertainties about the consequences, and that it is necessary to see beyond expected values and probabilities.

R. Guo, D. Guo

CREDIBILISTIC FUZZY REGRESSION

In reliability, quality control and risk analysis, fuzzy methodologies are more and more involved and inevitably introduced difficulties in seeking fuzzy functional relationship between factors. In this paper, we propose a scalar variable formation of fuzzy regression model based on the credibility measure theoretical foundation. It is expecting our scalar variable treatments on fuzzy regression models will greatly simplify the efforts to seeking fuzzy functional relationship between fuzzy factors. An M-estimator for the regression coefficients is obtained and accordingly the properties and the variance-covariance for the coefficient M-estimators are also investigated in terms of weighted least-squares arguments. Finally, we explore the asymptotic membership function for the coefficient M-estimators.

Krzysztof Kolowrocki

RELIABILITY AND RISK ANALYSIS OF MULTI-STATE SYSTEMS WITH DEGRADING COMPONENTS

Applications of multi-state approach to the reliability evaluation of systems composed of independent components are considered. The main emphasis is on multi-state systems with degrading components because of the importance of such an approach in safety analysis, assessment and prediction, and analysing the effectiveness of operation processes of real technical systems. The results concerned with multi-state series systems are applied to the reliability evaluation and risk function determination of a homogeneous bus transportation system. Results on homogeneous multi-state "m out of n" systems are applied to durability evaluation of a steel rope. A non-homogeneous series-parallel pipeline system composed of several lines of multi-state pipe segments is estimated as well. Moreover, the reliability evaluation of the model homogeneous multi-state parallel-series electrical energy distribution system is performed.

S. Guze

TRELIABILITY ANALYSIS OF TWO-STATE CONSECUTIVE "M OUT OF L: F"-SERIES SYSTEMS

A non-stationary approach to reliability analysis of two-state series and consecutive "m out of k: F" systems is presented. Further, the consecutive "m out of k: F"-series system is defined and the recurrent formulae for its reliability function evaluation are proposed.

Paramonov Yuri, Andersons Janis, Kleinhofs Martinsh

MINMAXDM DISTRIBUTION FAMILY FOR TENSILE STRENGTH OF COMPOSITE

Generalization of extended family of weakest-link distributions with application to the composite specimen strength analysis is presented. Composite (specifically, monolayer) specimen for tensile strength is modeled as series system but every "link" of this system is modeled as parallel system. Results of successful attempts of using some specific distribution from this family for fitting of experimental dataset of strength of some carbon fiber reinforced specimens are presented.

Viorel Gh. Voda

SOME COMMENTS ON STATISTICAL RISKS

In this work we make a detailed analysis of the concept of risk, the stress being focused then on various kinds of statistical risks: producer and consumer risks, technical risk, Taguchi's risk (making a connection with Cpm capability index) and a risk arising in SPC practice.

Roger Flage & Terje Aven

EXPRESSING AND COMMUNICATING UNCERTAINTY IN RELATION TO QUANTITATIVE RISK ANALYSIS

A quantitative risk analysis (QRA) should provide a broad, informative and balanced picture of risk, in order to support decisions. To achieve this, a proper treatment of uncertainty is a prerequisite. Most approaches to treatment of uncertainty in QRA seem to be based on the thinking that uncertainty relates to the calculated probabilities and expected values. This causes difficulties when it comes to communicating what the analysis results mean, and could easily lead to weakened conclusions if large uncertainties are involved. An alternative approach is to hold uncertainty, not probability, as a main component of risk, and regard probabilities purely as epistemic-based expressions of uncertainty. In the paper the latter view is taken, and we describe what should be the main components of a risk description when following this approach. We also indicate how this approach relates to decision-making. An important issue addressed is how to communicate the shortcomings and limitations of probabilities and expected values. Sensitivity analysis plays a key role in this regard. Examples are included to illustrate ideas and findings.

A. Blokus-Roszkowska, K. Kołowrocki

MODELLING ENVIRONMENT AND INFRASTRUCTURE OF SHIPYARD TRANSPORTATION SYSTEMS AND PROCESSES

In the paper an analytical model of port transportation systems environment and infrastructure influence on their operation processes is constructed and presented in an example of shipyard rope transportation systems in Naval Shipyard in Gdynia. A general semi-markov model of a system operation process is proposed and the methods of its parameters statistical identification are presented. Further, the shipyard rope transportation system and the ship rope elevator operation processes are analyzed and their operation states are defined. A preliminary collection of statistical data necessary to the ship transportation systems' operation processes identification is included.

P. Baraldi, E. Zio, M. Compare

IMPORTANCE MEASURES IN PRESENCE OF UNCERTAINTIES

This paper presents a work on the study of importance measures in presence of uncertainties originating from the lack of knowledge and information on the system (epistemic uncertainties). A criterion is proposed for ranking the risk contributors in presence of uncertainties described by probability density functions.

L. Gucma, M. Schoeneich

MONTE CARLO METHOD OF SHIP'S UNDERKEEL CLEARANCE EVALUATION FOR SAFETY OF FERRY APPROACHING TO YSTAD PORT DETERMINATION

The paper is concerned with the analysis of simulation research results of newly design Piast ferry entering to modernized Ystad Port. The ship simulation model is described. After execution of real time simulations the Monte Carlo method of underkeel clearance evaluation is applied to asses the probability of ferry touching the bottom. The results could be used in risk assessment of ships entering to the ports.

L. Gucma

METHODS OF SHIP-BRIDGE COLLISION SAFETY EVALUATION

The paper presents methods and models used nowadays for risk assessment of ship-bridge collisions.

R. Guo, D. Guo

DEAR THEORY IN SYSTEM DYNAMIC ANALYSIS

In this paper, we introduce our newly created DEAR (an abbreviation of Differential Equation Associated Regression) theory, which merges differential equation theory, regression theory and random fuzzy variable theory into a new rigorous small sample based inferential theoretical foundation. We first explain the underlying idea of DEAR modelling, its classification, and then the M-estimation of DEAR model. Furthermore, we explore the applicability of DEAR theory in the analysis in system dynamics, for example, repairable system analysis, quality dynamics analysis, stock market analysis, and ecosystem analysis, etc.

S. Guze

RELIABILITY ANALYSIS OF TWO-STATE SERIES-CONSECUTIVE “M OUT OF K: F” SYSTEMS

A non-stationary approach to reliability analysis of two-state series and consecutive “m out of k: F” systems is presented. Further, the series-consecutive “m out of k: F” system is defined and the recurrent formulae for its reliability function evaluation are proposed. Moreover, the application of the proposed formulae to reliability evaluation of the radar system composed of two-state components is illustrated.

B. Kwiatkowska-Sarnecka, K. Kołowrocki, J. Soszyńska

MODELLING OF OPERATIONAL PROCESSES OF BULK CARGO TRANSPORTATION SYSTEM

A general analytical model of industrial systems infrastructure influence on their operation processes is constructed. Next, as its particular case a detailed model of port infrastructure influence on port transportation systems operation processes is obtained to apply and test it to selected transportation systems used in Gdynia Port.

D. Montoro-Cazorla

SHOCK MODELS UNDER POLICY N

We present the life distribution of a device subject to shocks governed by phase-type distributions. The probability of failures after shocks follows discrete phase-type distribution. Lifetimes between shocks are affected by the number of cumulated shocks and they follow continuous phase-type distributions. The device can support a maximum of N shocks. We calculate the distribution of the lifetime of the device and illustrate the calculations by means of a numerical application. Computational aspects are introduced. This model extends other previously considered in the literature.

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Joanna Soszynska

ASYMPTOTIC APPROACH TO RELIABILITY EVALUATION OF LARGE “M OUT OF L”-SERIES SYSTEM IN VARIABLE OPERATION CONDITIONS

The semi-markov model of the system operation process is proposed and its selected parameters are defined. There are found reliability and risk characteristics of the multi-state “m out of l”-series system. Next, the joint model of the semi-markov system operation process and the considered

multi-state system reliability and risk is constructed. The asymptotic approach to reliability and risk evaluation of this system in its operation process is proposed as well.

C. Tanguy

ASYMPTOTIC DEPENDENCE OF AVERAGE FAILURE RATE AND MTTF FOR A RECURSIVE, MESHED NETWORK ARCHITECTURE

The paper is concerned with the exact and asymptotic calculations of the availability, average failure rate and MTTF (Mean Time To Failure) for a recursive, meshed architecture proposed by Beichelt and Spross. It shows that the asymptotic size dependences of average failure rate and MTTF are different, but not inverse of each other, as is unfortunately assumed too frequently. Besides, the asymptotic limit is reached for rather small networks.

D Valis

CONTRIBUTION TO FAILURE DESCRIPTION

In our lives we meet many events which have very diverse causes, mechanisms of development and consequences. We frequently work with the events' description besides other assessments in safety/risk assessment. In pure technical applications these events are related with the failure occurrence of equipment, a device, a system or an item. The theory speaks about failure itself, its mechanisms, circumstances of occurrence, etc. but at the same time we need appropriate terminology to describe these conditions. Our basic approaches into observing, dealing and handling failure may fall into two groups. We either talk about a probabilistic approach or about a deterministic (logic) approach. As we need to get some information about a failure we need to find it or transfer it from different sources. This contribution can be a complex problem for the term "failure" and its related characteristics. In the paper there are mentioned functions of an object and their description, classification of failures, main characteristics of failure, possible causes of failure, mechanisms of failure and consequences of failure and also other contributions related with failure very closely.

D. Valis

CONTRIBUTION TO AVAILABILITY ASSESSMENT OF COMPLEX SYSTEMS

As we use complex systems with one shot items in many technical applications we need to know basic characteristics of such system. Performance, safety and other are as much important as dependability measures. In real applications we have to take into account a related distribution of an observed variable. In terms of complex systems with one shot items it is a discrete random variable related to one shot item. The whole system and its failures (unexpected and inadvertent events) may have two typical types of distributions and their characteristics. We either consider a continuous variable (such as time, mileage, etc.) or a counting variable (such as number of cycles, sequences, etc.) regarding to a failure occurrence. As the one shot items is supposed to back up the main system function the total reliability of the system should be higher than. The main issue regarding the system using one shot items in their construction is to determine the probability of the task (mission) success. The paper presents both theoretical approach and practical example of the solution.

Mateusz Zajac, Tymoteusz Budny

ON DETERMINATION OF SOME CHARACTERISTICS OF SEMI-MARKOV PROCESS FOR DIFFERENT DISTRIBUTIONS OF TRANSIENT PROBABILITIES

There is a model of transport system presented in the paper. The possible semi - Markov process definitions are included. The system is defined by semi – Markov processes, while functions distributions are assumed. There are attempts to assess factors for other than exponential functions distributions. The paper consist discussion on Weibull and Gamma distribution in semi – Markov

calculations. It appears that some forms of distribution functions makes computations extremely difficult.

Xuejing Zhao, Mitra Fouladirad, Christophe Bérenguer, Laurent Bordes
MAINTENANCE POLICY FOR DETERIORATING SYSTEM WITH EXPLANATORY
VARIABLES

This paper discusses the problem of the optimization of maintenance threshold and inspection period for a continuously deteriorating system with the influence of covariates. The deterioration is modeled by an increasing stochastic process. The process of covariates is assumed to be a temporally homogeneous finite-state Markov chain. A model similar to the proportional hazards model is used to represent the influence of the covariates. Parametric estimators of the unknown parameters are obtained by using Least Square Method. The optimal maintenance threshold and the optimal inspection interval are derived to minimize the expected average cost. Comparisons of the expected average costs under different conditions of covariates and different maintenance policies are given by numerical results of Monte Carlo simulation.

J. Okulewicz, T. Salamonowicz
PREVENTIVE MAINTENANCE WITH IMPERFECT REPAIRS OF A SYSTEM WITH
REDUNDANT OBJECTS

An object ability to realise tasks may be restored by repairing only failed components. This is called imperfect repair as the object is not as good as new after such a repair. Preventive replacement is an example of imperfect repair as well. The advantage of such maintenance is that it enables controlling a reliability level of a system. Sets of objects' components which should be replaced are derived on a basis of statistical diagnosing with use of data about components failures. The acceptable level of a failure risk while executing transportation tasks has been taken as a criterion of choosing elements to be replaced. An algorithm of selecting components for preventive replacement has been developed. It was shown that a level of a system reliability can be controlled by changing an order of a quantile function in coordination and a number of redundant objects. A computer simulation model of the system was used to illustrate derived dependencies.

Jakub Nedbalek
RBF NETWORKS FOR FUNCTION APPROXIMATION IN DYNAMIC MODELLING

The paper demonstrates the comparison of Monte Carlo simulation algorithm with neural network enhancement in the reliability case study. With regard to process dynamics, we attempt to evaluate the tank system unreliability related to the initiative input parameters setting. The neural network is used in equation coefficients calculation, which is executed in each transient state. Due to the neural networks, for some of the initial component settings we can achieve the results of computation faster than in classical way of coefficients calculating and substituting into the equation.

M.F. Milazzo, G. Maschio, G. Uguccioni
FREQUENCY ASSESSMENT OF LOSS OF CONTAINMENT INCLUDING THE EFFECTS OF
MEASURES OF RISK PREVENTION

This paper presents a method for the quantification of the effects of measures of risk prevention of the frequency for rupture of pipework. Some methodologies, given in the literature for this purpose, assume that each plant under analysis is characterized by the same combinations of causes of failure and prevention mechanisms but this assumption is not always true. The approach suggested here is based on the methodology proposed in 1999 by Papazoglou for the quantification of the effects of organizational and managerial factors. Taking advantage of this methodology the objective of the assessment of the influence of measures of risk prevention in pipework has been achieved through the definition of the links between the causes of failure and the measures

adopted by the company in order to prevent and/or to mitigate them.

Krzysztof Kolowrocki, Joanna Soszynska

MODELLING ENVIRONMENT AND INFRASTRUCTURE INFLUENCE ON RELIABILITY AND OPERATION PROCESSES OF PORT OIL TRANSPORTATION SYSTEM

In the paper a probabilistic model of industrial systems environment and infrastructure influence on their operation processes is proposed. Semi-markov processes are used to construct a general model of complex industrial systems' operation processes. Main characteristics of this model are determined as well. In particular case, for a port oil transportation system, its operation states are defined, the relationships between them are fixed and particular model of its operation process is constructed and its main characteristics are determined. Further, the joint model of the system operation process and the system reliability is defined and applied to the reliability evaluation of the port oil transportation system.

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V. Raizer

NATURAL DISASTERS AND STRUCTURAL SURVIVABILITY

The term "disaster" is known to denote any environmental changes putting human lives under threat or materially deteriorating living conditions. A considerable part of disasters comprises natural calamities. These disasters can originate inside Earth (earthquakes, volcanic processes), near or on its surface (disturbance of slope stability, karsts, considerable changes in soil conditions and ground's settlements). The causes of disasters can as well be associated with a water, either at a liquid (flood, tsunami) or at a frozen state (complex or glacier avalanches), and, finally with atmospheric conditions. In many cases successions of interdependent disasters are possible, including these occurring in different media (earthquake-tsunami, earthquake-landslide, and lands-flood etc.).

Gasanenko V. A., Chelobitchenko O. O.

DYNAMIC MODEL OF AIR APPARATUS PARK

The article is devoted to construction and research of dynamic stochastic model of park of aircrafts. A stochastic is enclosed in all of natural characteristic exploitations of this set of apparatuses: times of flight and landing, possibility of receipt of damage on flight, including the past recovery air apparatus; times of repair. The estimations of total possible flights are got for the any fixed interval of time.

Tsitsiashvili G.Sh., Losev A.S.

AN ASYMPTOTIC ANALYSIS OF A RELIABILITY OF INTERNET TYPE NETWORKS

In this paper a problem of a construction of accuracy and asymptotic formulas for a reliability of internet type networks is solved. Analogously to [1] such network is defined as a tree where each node is connected directly with a circle scheme on a lower level with $n > 0$ nodes. A construction of accuracy and asymptotic formulas for probabilities of an existence of working ways between each pair of nodes of the internet type network is based on a recursive definition of these networks and on asymptotic formulas for a reliability of a random port. This asymptotic formula

represents the port reliability as a sum of probabilities of a work for all ways between initial and final nodes of this port. An estimate of a relative error and a complexity of these asymptotic calculations for a radial-circle scheme are shown.

Salem Bahri, Fethi Ghribi, Habib Ben Bacha

A STUDY OF ASYMPTOTIC AVAILABILITY MODELING FOR A FAILURE AND A REPAIR RATES FOLLOWING A WEIBULL DISTRIBUTION

The overall objective of the maintenance process is to increase the profitability of the operation and optimize the availability. However, the availability of a system is described according to lifetime and downtime. It is often assumed that these durations follow the exponential distribution. The work presented in this paper deals with the problem of availability modeling when the failure and repair rates are variable. The lifetime and downtime were both governed by models of Weibull (the exponential model is a particular case). The differential equation of the availability was formulated and solved to determine the availability function. An analytical model of the asymptotic availability was established as a theorem and proved. As results deduced from this study, a new approach of modeling of the asymptotic availability was presented. The developed model allowed an easy evaluation of the asymptotic availability. The existence of three states of availability for a system has been confirmed by this evaluation. Finally, these states can be estimated by comparing the shape parameters of the Weibull model for the failure and repair rates.

Igor Ushakov, Sumantra Chakravarty

OBJECT ORIENTED COMMONALITIES IN UNIVERSAL GENERATING FUNCTION FOR RELIABILITY AND IN C++

The main idea of Universal Generating Function is exposed in reliability applications. Some commonalities in this approach and the C++ language are discussed.

Alexandru ISAIC-MANIU, Viorel Gh. VODĂ

SOME INFERENCES ON THE RATIO AVERAGE LIFETIME/TESTING TIME IN ACCEPTANCE SAMPLING PLANS FOR RELIABILITY INSPECTION

In this paper we construct effective single sampling plans for reliability inspection, when the distribution of failure times of underlying objects obey a Weibull law. To this purpose we use the index average lifetime ($E(T)$)/testing time (T) for two values of $E(T)$ - acceptable and non acceptable ones - and known shape parameter (K) of the Weibull cdf. We derive also a relationship between this index and reliability function $R(t)$ of the assumed statistical law. A numerical illustrations is provided in the case of Rayleigh cdf - that is for a Weibull shape

$k = 2$.

Tsitsiashvili G.Sh., Losev A.S.

AN ACCURACY OF ASYMPTOTIC FORMULAS IN CALCULATIONS OF A RANDOM NETWORK RELIABILITY

In this paper a problem of asymptotic and numerical estimates of relative errors for different asymptotic formulas in the reliability theory are considered. These asymptotic formulas for random networks are similar to calculations of Feynman integrals. A special interest has analytic and numerical comparison of asymptotic formulas for the most spread Weibull and Gompertz distributions in life time models. In the last case it is shown that an accuracy of asymptotic formulas is much higher.

Armen. S. Stepanyants, Valentina S. Victorova

FAILURE FREQUENCY CALCULATION TECHNIQUE IN LOGICAL- PROBABILISTIC MODELS

The technique for calculation failure frequency measure of reliability in class of logical-probabilistic-models is proposed. The technique is applicable for models of redundant repairable systems which are not limited by serial-parallel structures. In conjunction with system decomposition the techniques makes it possible to analyze high dimensional systems very efficiently.

Tsitsiashvili G. Sh.

PHASE TRANSITION IN RENEWAL SYSTEMS WITH COMMON RESERVE

Mathematical models of renewal systems with a common reserve have been introduced and analyzed detailed in the monograph [1]. In [2] a phenomenon of a phase transition in the aggregated renewal system with the unload reserve is analyzed as analytically so numerically. But the mathematical method applied in this paper is too specific to analyze the phase transition phenomenon in general renewal systems with the common reserve. This phenomenon is connected with a reform of municipal engineering systems.

In this paper a method based on a definition of a state in which a birth and death process describing this system has a maximal limit probability is suggested. This method allows to construct convenient upper bounds of the limit probability for other states and to analyze phase transition phenomenon. The obtained bounds depend on transition intensities of the birth and death processes which describe aggregations of renewal systems with unload, under load and load reserves. The suggested method allows an analyzing of a renewal system with a competition between the repair places also.

Mr. Marc Antoni MEng

THE AGEING OF SIGNALLING EQUIPMENT AND THE IMPACT ON MAINTENANCE STRATEGIES

Research projects of SNCF (French railway) aim at reducing the costs of infrastructure possessions and improving the operational equipment availability and safety. This permanent search for a better regularity led the SNCF to analyse the maintenance approach of signalling equipment in detail. Until now, it was commonly acknowledged that signalling equipment, which consists of many electronic devices, is not subject to ageing. In this study, a Weibull lifetime model, able to describe an ageing phenomenon, is used and it can be shown that the deterioration is statistically significant. The validity of the model is tested. We also analyse the influence of environmental covariates. We simulate different scenarios in order to investigate the impact of several maintenance strategies as well as on future

maintenance costs, on the amount of components to replace based on the mean age of the network. It can be shown that in most cases a systematic replacement strategy offers the best solution.

E.B. Abrahamsen & T. Aven, W. Røed

COMMUNICATION OF COST-EFFECTIVENESS OF SAFETY MEASURES BY USE OF A NEW VISUALIZING TOOL

A cost-effectiveness analysis (CEA) is often used as basis for comparisons between competing safety measures. In a CEA indices such as the expected cost per expected number of lives saved are calculated. These indices are presented to the decision-makers, and seen in relation to reference values, they form the basis for assessment of the effectiveness of the safety measures.

The appropriateness of using cost-effectiveness indices based on expected values have been thoroughly discussed in the literature. It is argued that uncertainty is not properly taken into account by the CEA, and extended frameworks for CEA are required. This paper represents a contribution to this end, by presenting a diagram that visualizes uncertainty in addition to the expected values as in the traditional CEA. The diagram is meant to be a presentation tool for semi-quantitative cost-effectiveness analyses used as a part of a screening process to identify safety measures to be assessed in a more detailed analysis. In the paper we discuss the use of the diagram in communication between analysts and other stakeholders, in particular the decision-makers. An example is presented to illustrate the applicability of the tool.

G. Albeanu, A. Averian, I. Duda

WEB SOFTWARE RELIABILITY ENGINEERING

There is an increasing request for web software systems, some of them to be used very intensive. The customers ask not only for fast design and implementation, but also for a high quality product. Considering reliability as an important quality attribute, this paper describes the current state of the art in designing, implementing, and testing web software. An important attention is given to software vulnerabilities and how to deliver secure software.

H.-P. Berg

CORROSION MECHANISMS AND THEIR CONSEQUENCES FOR NUCLEAR POWER PLANTS WITH LIGHT WATER REACTORS

It is well known that operational conditions in light water reactors strongly influence the corrosion processes. This paper gives an overview which types of corrosion are identified in operating practice based on the evaluation of events which are reported to the authorities in line with the German reporting criteria. It has been found that the main contributor is the stress corrosion cracking. Several examples of different corrosion mechanisms and their consequences are provided for PWR although a high standard of quality of structures, systems and components has been achieved. Recommendations have been given to check the plant specifications concerning the use of auxiliary materials or fluids during maintenance as well as to examine visually the outer surfaces of austenitic piping with regard to residua of adhesive or adhesive tapes within the framework of in-service inspections. However, events in the last two years show that such problems cannot be totally avoided.

H.-P. Berg, R. Gersinska, J. Sievers

IMPROVED APPROACH FOR ESTIMATING LEAK AND BREAK FREQUENCIES OF PIPING SYSTEMS IN PROBABILISTIC SAFETY ASSESSMENT

The estimation of leak and break frequencies in piping systems is part of the probabilistic safety assessment of technical plants. In this paper, the statistical method based on the evaluation of the German operational experience for piping systems with different diameters is described because an earlier estimation has been updated and extended introducing new methodical aspects and data. Major point is the inclusion of structure reliability models based on fracture mechanics calculation procedures. As an example of application the statistical estimation method for leak and break frequencies of piping systems with a nominal diameter of 50 mm (the volume control system of a German pressurized water reactor) was updated. Moreover, the evaluation of the operational experience was extended to 341 years with respect to cracks, leaks and breaks in the volume control system of German pressurized water reactors (PWR). Using the actual data base, new calculations of leak and break frequencies have been performed and the results have been compared with the previous values.

A. Blokus-Roszkowska, K. Kołowrocki

RELIABILITY AND AVAILABILITY OF A GROUND SHIP-ROPE TRANSPORTER IN VARIABLE OPERATION CONDITIONS

In the paper the environment and infrastructure influence of the ground ship-rope transporter operating in Naval Shipyard in Gdynia on its operation processes is considered. The results are presented on the basis of a general model of technical systems operation processes related to their environment and infrastructure. The transporter operation process is described and its statistical identification is given. Next, the reliability, risk and availability evaluation of the transporter in variable operation conditions is presented. In addition, the reliability and availability basic characteristics of the system assuming its components' failure dependence are determined. Finally, the obtained results for the ground ship-rope transporter under the assumption that its components are dependent and independent are compared.

R. Briš

UNAVAILABILITY CALCULATIONS WITHIN THE LIMITS OF COMPUTER ACCURACY

The paper presents a new analytical algorithm which is able to carry out direct and exact reliability quantification of highly reliable systems with maintenance (both preventive and corrective). A directed acyclic graph is used as a system representation. The algorithm is based on a special new procedure which permits only summarization between two or more non-negative numbers that can be very different. If the summarization of very small positive numbers transformed into the machine code is performed effectively no error is committed at the operation. Reliability quantification is demonstrated on a real system from practice.

F. Cadini, E. Zio, L.R. Golea, C.A. Petrescu
ANALYSIS AND OPTIMIZATION OF POWER TRANSMISSION GRIDS BY
GENETIC ALGORITHMS

Two applications of multi-objective genetic algorithms (MOGAs) are reported with regards to the analysis and optimization of electrical transmission networks. In a first case study, an analysis of the topological structure of a network system is carried out to identify the most important groups of elements of different sizes in the network. In the second case study, an optimization method is devised to improve the reliability of power transmission by adding lines to an existing electrical network.

R. Guo, D. Guo, C. Thiart
POISSON PROCESSES WITH FUZZY RATE

Poisson processes, particularly the time-dependent extension, play important roles in reliability and risk analysis. It should be fully aware that the Poisson modeling in the current reliability engineering and risk analysis literature is merely an ideology under which the random uncertainty governs the phenomena. In other words, current Poisson Models generate meaningful results if randomness assumptions hold. However, the real world phenomena are often facing the co-existence reality and thus the probabilistic Poisson modeling practices may be very doubtful. In this paper, we define the random fuzzy Poisson process, explore the related average chance distributions, and propose a scheme for the parameter estimation and a simulation scheme as well. It is expecting that a foundational work can be established for Poisson random fuzzy reliability and risk analysis.

S. Guze, L. Smolarek
MODELLING THE SHIP SAFETY ON WATERWAY ACCORDING TO
NAVIGATIONAL SIGNS RELIABILITY

An approach to safety analysis connected with consecutive “m out of n” systems is presented. Further, the consecutive “m out of n: G” system is defined and the recurrent formulae for its reliability function evaluation are proposed. Next the IALA buoys and leading lights system are introduced. Moreover, the safety states model for ship navigation are defined. Further, analysis of safety during manoeuvre in restricted area with curved draws is illustrated.

K. Kolowrocki, J. Soszynska
RELIABILITY, RISK AND AVAILABILITY BASED OPTIMIZATION OF
COMPLEX TECHNICAL SYSTEMS OPERATION PROCESSES. PART 1.
THEORETICAL BACKGROUNDS

A convenient new tool for solving the problem of reliability and availability evaluation and optimization of complex technical systems is presented. Linking a semi-markov modeling of the system operation processes with a multi-state approach to system reliability and availability analysis is proposed to construct the joint general model of reliability and availability of complex technical systems in variable

operation conditions. This joint model and a linear programming is proposed to complex technical systems reliability and availability evaluation and optimization respectively.

K. Kolowrocki, J. Soszynska

RELIABILITY, RISK AND AVAILABILITY BASED OPTIMIZATION OF
COMPLEX TECHNICAL SYSTEMS OPERATION PROCESSES. PART 2.
APPLICATION IN PORT TRANSPORTATION

The joint general model of reliability and availability 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 reliability and availability analysis and linear programming considered in the paper Part 1 are applied in maritime industry to reliability, risk and availability optimization of a port piping oil transportation system.

Krzysztof Kolowrocki, Joanna Soszynska

SAFETY AND RISK EVALUATION OF STENA BALTICA FERRY IN
VARIABLE OPERATION CONDITIONS

Basic safety structures of multi-state systems of components with degrading safety states related to their variable operation conditions are defined. For these systems the conditional and unconditional multi-state safety functions are determined. A semi-markov process for the considered systems operation modelling is applied. Further, the paper offers an approach to the solution of a practically important problem of linking the multi-state systems safety models and the systems operation processes models.

Theoretical definitions and results are illustrated by the example of their application in the safety and risk evaluation of the Stena Baltica ferry operating at the Baltic Sea. The ferry transportation system has been considered in varying in time operation conditions. The system safety structure and its components safety functions were changing in variable operation conditions.

Mohamed Salahuddin Habibullah, Ernest Lumanpauw, Kołowrocki Krzysztof,
Joanna Soszyńska, Ng Kien Ming

A COMPUTATIONAL TOOL FOR A GENERAL MODEL OF OPERATION
PROCESSES IN INDUSTRIAL SYSTEMS

The complexities of real industrial systems operation processes require computational methods that can analyze the large data and evaluate the behaviours of these systems. The use of methods such as Bayesian Network, Formal Safety Assessment and Statistical-Model based method were discussed as possibilities. Of which, a computational tool, based on the Semi-Markov model, was developed. This tool was then applied to analyze the behaviour of the operation processes of the oil transportation system in Dębogórze, Poland. The analyses showed that the computational solutions generated compared favourably well with some well-established analytical formulae, enabling possible extensions of the tool to include reliability and optimization evaluations to be explored.

D. Valis, Z. Vintr, M. Koucky

SELECTED APPROACHES FOR RELIABILITY COMPARISON OF HIGHLY RELIABLE ITEMS

The application of electronic elements introduces a number of advantages as well as disadvantages. The paper deals with advanced method of dependability - reliability analysis procedure of a highly reliable item. The data on manufacturing and operating of a few hundred thousands pieces of the highly reliable devices are available and from the statistical point of view they are very important collection/set. However, concerning some pieces of the items the manufacturing procedure of them was not made, controlled and checked accurately. The procedure described in the paper is based on the thorough data analysis aiming at the operation and manufacturing of these electronic elements. As the data sets collected are statistically non-coherent the objective of the paper is to make a statistical assessment and evaluation of the results. Failure rates calculations and their relation comparability regarding the both sets are presented in the paper.

Christian Tanguy

MEAN TIME TO FAILURE FOR PERIODIC FAILURE RATE

The paper is concerned with the determination of the Mean Time To Failure (MTTF) in configurations where the failure rate is periodical. After solving two configurations exactly, we show that when the period of the failure rate oscillations is small with respect to the average failure rate, the MTTF is essentially given by the inverse of the average failure rate, give or take corrections that can be expressed analytically. This could be helpful in the description of systems the environment of which is subject to changes.

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Bożena Babiarz

RELIABILITY ASSESSMENT OF HEAT SUPPLY SYSTEMS IN THEIR OPERATIONAL PROCESS

This paper presents an analysis of the operational process of heat supply system, taking into consideration its reliability. The specific character of the operation of heat-supply systems has been considered in this work. In the process of exploitation of heat-supply systems five operational states have been distinguished, using as a criterion the level of indoor temperature decrease in residential rooms. The method of modelling the reliability of heat-supply systems is worked out. The methodology of determining the overall index of heat-supply system reliability has been presented. The measure of heat-supply system reliability has been taken to be as the scale/quantity of inadequate supply of heat power at a given state. Calculations have been carried out regarding the changeability of exterior conditions for one of the groups of customers – residential users. On

the basis of the operational data for the heat supply system with two heat sources, shortfalls of heat power and the probability of their occurrence have been calculated as an application of this methodology.

R. V. Kakubava

MULTI-LINE MARKOV CLOSED QUEUEING SYSTEM FOR TWO MAINTENANCE OPERATIONS

In the given paper multi-component standby system with renewable elements is considered. For it multi-line closed Markov queuing model for two maintenance operations – replacements and renewals, is constructed and investigated. In this model the numbers of main elements as well as standby ones, also the numbers of replacement units as well as renewal ones are arbitrary. An economic criterion for dependability planning (structural control) of considered system is introduced, the optimization problem is stated and partially investigated.

R. Lisi, M. F. Milazzo, G. Maschio

RISK ASSESSMENT OF EXPLOSIVE ATMOSPHERES IN WORKPLACES

The application of the Directive 99/92/EC deals with the safety and health protection of workers potentially exposed to explosive atmospheres and requires the assessment of explosion risks. These can arise by the release of inflammable substances typical of industries classified as major hazards, but they often may be generated in other industries where inflammable materials are handled. Risk assessment of explosive atmospheres is required in both cases, for this purpose, in this article a quantitative approach has been proposed. The paper describes the main aspects of the methodology, based on a probabilistic risk assessment, and finally its application to a case-study.

R. Dubčáková, P. Praks

STATISTICAL MODELLING OF INDOOR RADON CONCENTRATION USING METEOROLOGICAL PARAMETERS

The radon volume activity in buildings is generally time variable. Its variability is caused by many natural and man-made factors. An example of these factors includes meteorological parameters, soil properties, characteristics of the building construction, properties of water used in the building and also the behavior of inhabitants. These factors can influence each other and also they are related with the exposition of inhabitants.

This article reports a continual indoor radon monitoring and a statistical evaluation of a dataset obtained by the 18 days-long measuring in a house located in the Czech Republic.

The contributions of carefully selected meteorological parameters and human influences were also observed. Results of the observation were divided into two parts (inhabited, uninhabited) and analyzed in relation with the indoor radon concentration. The multiplied linear regression was applied to model obtained datasets.

Results of time series analyses of the continual indoor radon concentration and the meteorological monitoring are presented and discussed as well.

G. Tsitsiashvili, A. Losev

CALCULATION OF CONNECTIVITY PROBABILITY IN RECURSIVELY DEFINED RANDOM NETWORKS

In this paper a problem of a construction of new and practically interesting classes of recursively defined networks, including internet type networks, with sufficiently fast algorithms of calculation of connectivity probability is considered. For this aim recursive and asymptotic formulas of connectivity probability calculation are constructed. Asymptotic formulas are based on assumptions that all network arcs are low reliable or there are high reliable and low reliable arcs in considered network. For example in radial-circle scheme radial arcs may be high reliable and circle arcs – low reliable.

Yakov Genis

RELIABILITY ASSESSMENT OF SYSTEMS WITH PERIODIC MAINTENANCE UNDER RARE FAILURES OF ITS ELEMENTS

There is investigated a model of a system with the highly reliable elements, where the periods of functioning are changed by the periods of maintenance. The system must be operational only in the periods of functioning although the restoration in these periods is not provided. The system is completely restored in the nearest period of maintenance. Since the elements of system are highly reliable, the reserve of system is rarely exhausted during each period of functioning. Therefore it is possible to use the results, obtained for the systems with fast restoration, for the reliability assessment of system, which is not restorable in the periods of the functioning. The estimations of indices of failure-free performance and maintainability of such systems are obtained.

M. Zajac, D. Valis

FUNDAMENTAL RISK ASSESSMENT IN EXAMPLE OF TRANSSHIPMENT SYSTEM

The paper represents discussion about risk assessment for transshipment system in reduces data condition. As a particular example transshipment system is presented. Article can be treated as first estimation. Future work and objectives are characterized in the end.

G.Sh. Tsitsiashvili

ASYMPTOTIC ANALYSIS OF LATTICE RELIABILITY

Asymptotic formulas for connection probabilities in a rectangular lattice with identical and independent arcs are obtained. For a small number of columns these probabilities may be calculated by the transfer matrices method. But if the number of columns increases then a calculation complexity increases significantly. A suggested asymptotic method allows to make calculations using a sufficiently simple geometric approach in a general case.

Al. Isaic-Maniu, I. M. Dragan

THE RISK OF OPERATIONAL INCIDENTS IN BANKING INSTITUTIONS

Banking-financial institutions are organizations which might be included in the category of complex systems. Consequently, they can be applied after adaptation and particularization, in the general description and assessment methods of the technical or organizational systems. The banking-financial system faces constrains regarding the functioning continuity. Interruptions in continuity as well as operational incidents represent risks which can lead to the interruption of financial flows generation and obviously of profit. Banking incidents include from false banknote, cloned cards, informatics attacks, false identity cards to ATM attacks. The functioning of banking institutions in an incident-free environment generates concern from both risk assessment and forecasting points of view.

Z. Bluvband & S. Porotsky

PARAMETER ESTIMATIONS FOR AVAILABILITY GROWTH

The reliability growth process applied to a complex system undergoing development and field test involves surfacing failure modes, analyzing the modes, and, in addition to repair, in some cases implementing corrective actions to the surfaced modes. In such a manner, the system configuration is matured with respect to reliability. The conventional procedure of reliability growth implies evaluation of two principal parameters of the NHPP process only for failure rate. Since standard NHPP does not take into account parameters of repairs, it is necessary to develop expanded procedure as the basis for the Availability Growth. It implies evaluation of both: a) the parameters of failure rate and, b) the parameters of repair rate. Authors suggest a model and numerical method to search these parameters.

Farhadzadeh E.M., Muradaliyev A.Z., Farzaliyev Y.Z.

CONTROL THE IMPORTANCE OBSERVABLE LAWS OF CHANGE RELIABILITY OVER OPERATION

The problem of the control of the importance of observable laws of change of parameters of reliability (PR) at small statistical data of operating experience or experiment in conditions when the argument has a serial or nominal scale of measurement, concerns to number of the most difficult and insufficiently developed. In particular, at operation of electro installations the important role-played with data on reliability of units of the same equipment, on the reasons of occurrence and character of their damage, law of change PR of the equipment for various classes of a pressure and so forth

A. I. Pereguda, D. A. Timashov

A FUZZY RELIABILITY MODEL FOR “SAFETY SYSTEM-PROTECTED OBJECT” COMPLEX

The paper presents a new fuzzy reliability model for automated “safety system-protected object” complex. It is supposed that parameters of reliability model and reliability indices are fuzzy variables. Scheduled periodic inspections of safety system are also taken into account. Asymptotic estimates of mean time to accident membership function are proposed.

A. I. Pereguda, D. A. Timashov

AN ADVANCED RELIABILITY MODEL FOR AUTOMATED “SAFETY SYSTEM-PROTECTED OBJECT” COMPLEX WITH TIME REDUNDANCY

The paper presents a new reliability model for an automated “safety system-protected object” complex with time redundancy. It is supposed that the time redundancy is caused by a protected object inertia. Scheduled periodic inspections of the safety system are also taken into account. Two-sided estimates of the mean time to accident are proposed.

Armen S. Stepanyants, Valentina S. Victorova

RELIABILITY AND CAPABILITY MODELING OF TECHNOLOGICAL SYSTEMS WITH BUFFER STORAGE

The paper is devoted to reliability and capability investigation of technological systems, inclusive of development of dynamic reliability model for two-phase product line with buffer storages and multiphase line decomposition

G.Tsitsiashvili

COMPARISON ANALYSIS OF RELIABILITY OF NETWORKS WITH IDENTICAL EDGES

Efficient and fast algorithms of parameters calculation in Burtin-Pittel asymptotic formula for networks with identical and high reliable edges are constructed. These algorithms are applied to a procedure of a comparison of networks obtained from a radial-circle network by a cancelling of some edges or their collapsing into nodes or by a separate reservation of these edges.

G.Tsitsiashvili

ASYMPTOTIC FORMULAS IN DISCRETE TIME RISK MODEL WITH DEPENDENCE OF FINANCIAL AND INSURANCE RISKS

Asymptotic formulas for a ruin probability in discrete time risk model with a dependence of financial and insurance risks are obtained. These formulas are constructed in a suggestion which is adequate to economical crisis: the larger is a financial risk the larger is an insurance risk.

Heinz-Peter Berg

QUANTITATIVE SAFETY GOALS AND CRITERIA AS A BASIS FOR DECISION MAKING

Internationally, probabilistic safety analyses represent the state of the art in the licensing process for new industrial facilities, but increasingly also for evaluating the safety level of older industrial plants, e. g. as part of periodic safety reviews of nuclear power plants. Quantitative safety goals have not yet reached the same level of acceptance. However, this depends on the type of industry. Most of the countries consider those criteria as safety targets rather than as sharply defined boundary values. The Netherlands and the United Kingdom are exceptions, they require demonstration of compliance with legally binding safety goals in the licensing procedure.

Heinz-Peter Berg

RISK MANAGEMENT: PROCEDURES, METHODS AND EXPERIENCES

Risk management is an activity which integrates recognition of risk, risk assessment, developing strategies to manage it, and mitigation of risk using managerial resources. Some traditional risk managements are focused on risks stemming from physical or legal causes (e.g. natural disasters or fires, accidents, death). Financial risk management, on the other hand, focuses on risks that can be managed using traded financial instruments. Objective of risk management is to reduce different risks related to a pre-selected domain to an acceptable. It may refer to numerous types of threats caused by environment, technology, humans, organizations and politics. The paper describes the different steps in the risk management process which methods are used in the different steps, and

provides some examples for risk and safety management.

A. Blokus-Roszkowska, K. Kołowrocki
RELIABILITY AND AVAILABILITY OF A SHIPYARD SHIP-ROPE ELEVATOR IN
VARIABLE OPERATION CONDITIONS

In the paper the environment and infrastructure influence of the ship-rope elevator operating in Naval Shipyard in Gdynia on its operation processes is considered. The results are presented on the basis of a general model of technical systems operation processes related to their environment and infrastructure. The elevator operation process is described and its statistical identification is given. Next, the elevator is considered in varying in time operation conditions with different its components' reliability functions in different operation states. Finally, the reliability, risk and availability evaluation of the elevator in variable operation conditions is presented.

F. Cadini, D. Avram, E. Zio
A MONTE CARLO-BASED TECHNIQUE FOR ESTIMATING THE OPERATION MODES OF
HYBRID DYNAMIC SYSTEMS

Many real systems are characterized by a hybrid dynamics of transitions among discrete modes of operation, each one giving rise to a specific continuous dynamics of evolution. The estimation of the state of these hybrid dynamic systems is difficult because it requires keeping track of the transitions among the multiple modes of system dynamics corresponding to the different modes of operation. A Monte Carlo-based estimation method is here illustrated through an application to a case study of literature.

F. Grabski, A. Załęska-Fornal
BOOTSTRAP METHODS FOR THE CENSORED DATA IN EMPIRICAL BAYES
ESTIMATION OF THE RELIABILITY PARAMETERS

Bootstrap and resampling methods are the computer methods used in applied statistics. They are types of the Monte Carlo method based on the observed data. Bradley Efron described the bootstrap method in 1979 and he has written a lot about it and its generalizations since then. Here we apply these methods in an empirical Bayes estimation using bootstrap copies of the censored data to obtain an empirical prior distribution.

R. Guo, D. Guo, T. Dunne
RANDOM FUZZY CONTINUOUS-TIME MARKOV JUMP PROCESSES

Continuous-time Markov chains are an important subclass in stochastic processes, which have facilitated many applications in business decisions, investment risk analysis, insurance policy making and reliability modeling. One should be fully aware that the existing continuous-time Markov chains theory is merely a framework under which the random uncertainty governs the phenomena. However, the real world phenomena often reveal a reality in which randomness and vagueness co-exist, and thus probabilistic continuous-time Markov chains modeling practices may be not wholly adequate. In this paper, we define random fuzzy continuous-time Markov chains, explore the related average chance distributions, and propose both a scheme for parameter estimation and a simulation scheme. It is expected that a foundational base can be established for reliability modeling and risk analysis, particularly, repairable system modeling.

S. Guze, B. Kwiatkowska-Sarnecka, J. Soszyńska
THE COMPUTER PROGRAM TO VERIFY THE HYPOTHESES AND TO PREDICT OF
THE PARAMETERS FOR OPERATIONAL PROCESS

The theoretical background and technical information for the program are presented. Further, the components of the program are described and user manual is given.

O. Hryniewicz
CONFIDENCE BOUNDS FOR THE RELIABILITY OF A SYSTEM FROM SUBSYSTEM
DATA

The paper is concerned with the construction of lower bounds for the reliability of a system when statistical data come from independent tests of its elements. The overview of results known from literature and obtained under the assumption that elements in a system are independent is given. It has been demonstrated using a Monte Carlo experiment that in case when these elements are dependent and when their dependence is described by Clayton and Gumbel copulas these confidence bounds are not satisfactory. New simple bounds have been proposed which in some practical cases perform better than the classical ones.

M. Jurdziński, S. Guze, P. Kamiński
TIME DIFFERENCES IN PERATION STATES OF STENA BALTICA FERRY DURING THE
OPEN WATER AREAS PASSAGE

The paper deals with analysis of ships operation stages in open water areas effected by environmental constraints influencing on ship sea keeping parameters in application to ferry “Stena Baltica” operated in the Baltic Sea between Gdynia and Karlskrona harbors.

K. Kołowrocki, B. Kwiatkowska-Sarnecka, J. Soszyńska
PRELIMINARY RELIABILITY, RISK AND AVAILABILITY ANALYSIS AND
EVALUATION OF BULK CARGO TRANSPORTATION SYSTEM IN VARIABLE
OPERATION CONDITIONS

In the paper, definitions and theoretical results on system operations process, multi-state system reliability, risk and availability modelling are illustrated by the example of their application to a bulk cargo transportation system operating in Gdynia Port Bulk Cargo Terminal. The bulk cargo transportation system is considered in varying in time operation conditions. The system reliability structure and its components reliability functions are changing in variable operation conditions. The system reliability structures are fixed with a high accuracy. Whereas, the input reliability characteristics of the bulk cargo transportation system components and the system operation process characteristics are not sufficiently exact because of the lack of statistical data. Anyway, the obtained evaluation may be a very useful example in simple and quick systems reliability characteristics evaluation, especially during the design and improving the transportation systems operating in ports.

K. Kolowrocki, J. Soszynska

METHODS AND ALGORITHMS FOR EVALUATING UNKNOWN PARAMETERS OF OPERATION PROCESSES OF COMPLEX TECHNICAL SYSTEMS (part 1)

The paper objectives are to present the methods and tools useful in the statistical identifying unknown parameters of the operation models of complex technical systems and to apply them in the maritime industry. There are presented statistical methods of determining unknown parameters of the semi-markov model of the complex technical system operation processes. There is also presented the chi-square goodness-of-fit test applied to verifying the distributions of the system operation process conditional sojourn times in the particular operation states. Applications of these tools to identifying and predicting the operation characteristics of a ferry operating at the Baltic Sea waters are presented as well.

K. Kolowrocki, J. Soszynska

METHODS AND ALGORITHMS FOR EVALUATING UNKNOWN PARAMETERS OF COMPONENTS RELIABILITY OF COMPLEX TECHNICAL SYSTEMS (part 2)

The paper objectives are to present the methods and tools useful in the statistical identifying the unknown parameters of the components reliability and safety of complex industrial systems and to apply them in the maritime industry. There are presented statistical methods of estimating the unknown intensities of departure from the reliability state subsets of the exponential distribution of the component lifetimes of the multistate systems operating in various operation states. The goodness-of-fit method applied to testing the hypotheses concerned with the exponential form of the multistate reliability function of the particular components of the complex technical system in variable operations conditions is suggested. An application of these tools to reliability characteristics of a ferry operating at the Baltic Sea waters is presented as well.

B. Kwiatkowska-Sarnecka

MODELS OF RELIABILITY AND AVAILABILITY IMPROVEMENT OF SERIES AND PARALLEL SYSTEMS RELATED TO THEIR OPERATION PROCESSES

Integrated general models of approximate approaches of complex multi-state series and parallel systems, linking their reliability and availability improvement models and their operation processes models caused changing reliability and safety structures and components reliability characteristics in different operation states, are constructed. These joint models are applied to determining improved reliability and availability characteristics of the considered multi-state series and parallel systems related to their varying in time operation processes. The conditional reliability characteristics of the multi-state systems with hot, cold single reservation of component and the conditional reliability characteristics of the multi-state systems with reduced rate of departure by a factor of system components are defined.

M.S. Habibullah, Fu Xiuju, K. Kolowrocki, J. Soszynska

CORRELATION AND REGRESSION ANALYSIS OF SPRING STATISTICAL DATA OF MARITIME FERRY OPERATION PROCESS

These are presented statistical methods of correlation and regression analysis of the operation processes of complex technical systems. The collected statistical data from the Stena Baltica ferry

operation process are analysed and used for determining correlation coefficients and linear and multiple regression equations, expressing the influence of the operation process conditional sojourn times in particular operation states on the ferry operation process total conditional sojourn time.

D. Valis, Z. Vintr, M. Koucky

CONTRIBUTION TO RELIABILITY ANALYSIS OF HIGHLY RELIABLE ITEMS

In recent years the intensive efforts in developing and producing electronic devices have more and more critical inference in many areas of human activity. Engineering is one of the areas which have been also importantly affected. The paper deals with dependability namely reliability analysis procedure of a highly reliable item. The data on manufacturing and operating of a few hundred thousands pieces of electronic item are available and they are statistically a very important collection/set. However, concerning some items the manufacturing procedure was not checked and controlled accurately. The procedure described in the paper is based on the thorough data analysis aiming at the operating and manufacturing of these electronic elements. The results indicate some behaviour differences between correctly and incorrectly made elements. It was proved by the analysis that dependability and safety of these elements was affected to a certain degree. Although there is a quite big set of data the issue regarding the statistical comparability is very important.