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Testing the integrated package of tools supporting decision making on identification, prediction and optimization of complex technical systems operation, reliability and safety

Part 1

Integrated Safety and Reliability Decision Support System – IS&RDSS

Keywords

reliability, safety, operation processes, availability, optimization

Abstract

The paper is composed of six parts and presents the main practical tool created in the scope of the Poland-Singapore Joint Research Project, the Integrated Safety and Reliability Decision Support System - IS&RDSS. In the paper first part, there are presented the procedure of the IS&RDSS usage in the form of detailed and clear scheme-algorithm and the list of the project final reports and these reports supporting bibliography. In the remaining paper parts, there is presented the IS&RDSS application to the reliability analysis of an exemplary complex technical system.

1. Introduction

The final stage of the project results in the packages of practical tools in the form of guidebooks, computer programs, procedures and regulations [1]-[44]. At this stage, these tools are applied and tested in the maritime and coastal transportation industry to provide practically validated individual safety and reliability decision support systems for individual maritime transport sectors as well as an overall Integrated Safety and Reliability Decision Support System for Maritime and Coastal Transport. This created in the project the integrated support system is more general and may be applied not only in maritime industry sectors but in other industry sectors as well. Therefore, it is called more generally the Integrated Safety and Reliability Decision Support System and is marked shortly by IS&RDSS.

The IS&RDSS is the main results of the project prepared in the form of the guide-book [28] composed of Tasks 10.0-10.15 of WP10: Safety

and Reliability Decision Support Systems for Various Maritime and Coastal Transport Sectors, and it is based on the results of the following project tasks: Task 7.1 - Methods of complex technical systems operation processes modelling [1], Task 7.2 - Methods of complex technical systems reliability, availability and safety evaluation and prediction [2], Task 7.3 - Methods of unknown parameters of complex technical systems operation, reliability, availability, safety models evaluation [3], Task 7.4 - Methods of complex technical systems reliability, availability and safety improvement [4], Task 7.5 - Methods of complex technical systems operation, reliability, availability, safety and cost optimization [5] included in the Workpackage WP7: Integrated Package of Solutions for Complex Industrial Systems and Processes Safety and Reliability Optimization.

The IS&RDSS is supplemented by Tasks 8.1-8.16, [6]-[21] of the Workpackage WP8: Packages of

Tools for Complex Industrial Systems and Processes Safety and Reliability Optimization, including the computer programs supporting the calculations.

The IS&RDSS is testified in Tasks 9.1-9.6, [22]-[27] of the Workpackage WP9: Applications and Testing of Packages of Tools in Complex Maritime Transportation Systems and Processes Safety and Reliability Optimization, where it is applied to the operation, reliability, safety and operation cost modelling, identification, prediction and optimization of the port, shipyard and maritime technical transportation systems and the exemplary system.

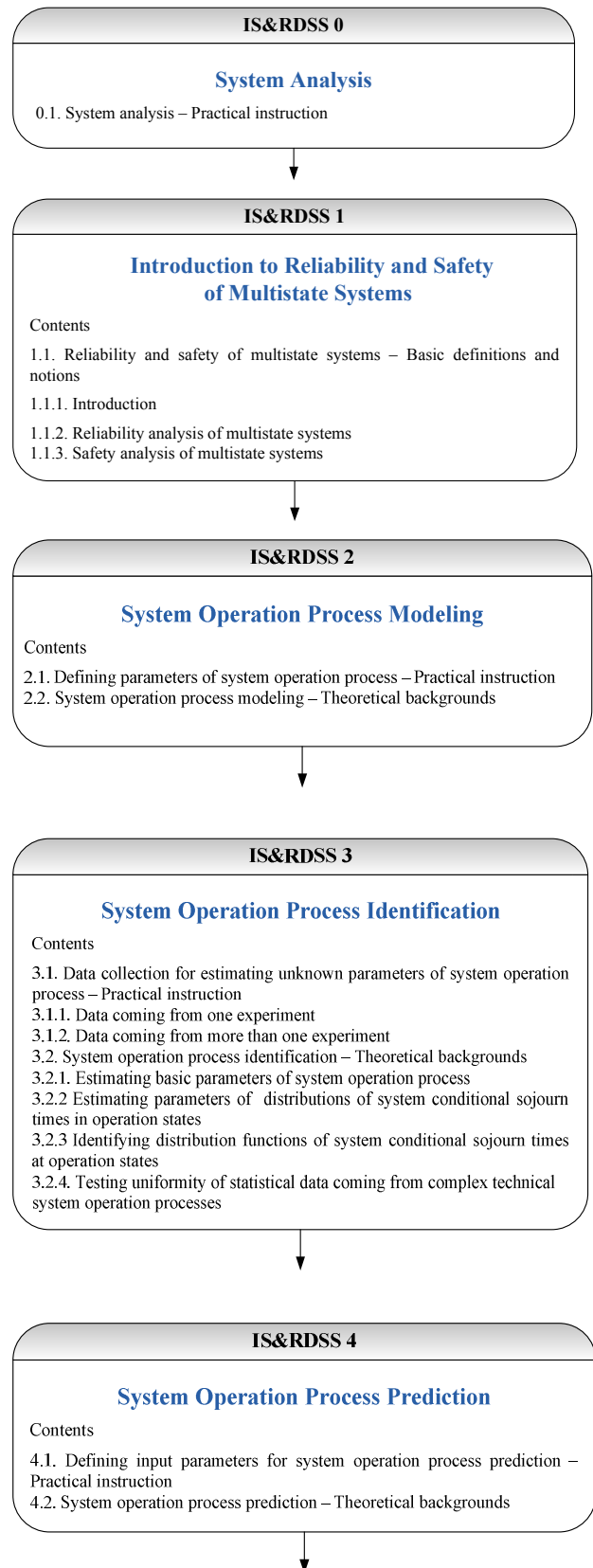
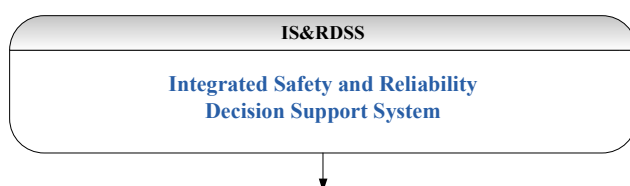
The IS&RDSS is supplemented by Tasks 11.1-11.16, [29]-[44] of the Workpackage WP11: Education, Training, Results Dissemination and Implementation, that are the training courses directed to the industry.

To make studying those all results included in the final project reports [1]-[44], additionally, at the end of the guide-book, the list of the supporting bibliography 1-87 is given.

The procedure of the IS&RDSS usage is presented in the paper in the form of detailed and clear scheme-algorithm that is placed at the beginning of the guide-book [28]. The procedure should start from the scheme-algorithm item IS&RDSS 0, and next either to study if it is necessary or to omit its introductory item IS&RDSS 1 and to continue with the items IS&RDSS 2-15. The user should follow the successive steps of the scheme using the support given in the forms of practical instructions and theoretical backgrounds placed at the further parts of the guide-book [28].

To make the use of the IS&RDSS easy and fluent, it is suggested to study its practical application to the reliability analysis of the exemplary complex technical system presented in the paper and its wide and detailed practical applications in maritime and coastal transport industry performed in Tasks 9.1-9.6, [22]-[27] of the Workpackage WP9.

2. Scheme of IS&RDSS



IS&RDSS 5**System Components Reliability and Safety Modeling**

Contents

- 5.1. Defining parameters of system components reliability and safety models – Practical instruction
 - 5.1.1. Parameters of system component reliability model
 - 5.1.2. Parameters of system component safety model
- 5.2. System reliability and safety modeling – Theoretical backgrounds
 - 5.2.1. Reliability of multistate system component in variable operation conditions
 - 5.2.2. Safety of multistate system component in variable operation conditions

**IS&RDSS 6****System Components Reliability and Safety Identification**

Contents

- 6.1. Data collection for estimating unknown parameters of system components reliability and safety – Practical instruction
 - 6.1.1. Collecting data coming from components reliability and safety states changing processes
 - 6.1.2. Collecting data coming from experts
- 6.2. System components reliability and safety identification – Theoretical backgrounds
 - 6.2.1. Estimating parameters of conditional multistate exponential reliability and safety functions of system components
 - 6.2.1.1 Estimating system components intensities of departure from reliability and safety state subsets on basis of data coming from components reliability and safety states changing processes
 - 6.2.1.2 Evaluating system components intensities of departure from reliability and safety state subsets on basis of data coming from experts
 - 6.2.2. Identification of conditional multistate exponential reliability and safety functions of system components
 - 6.2.2.1 Identifying system components conditional multistate exponential reliability and safety functions on basis of data coming from components reliability and safety states changing processes
 - 6.2.2.2 Identifying system components conditional multistate exponential reliability and safety functions on basis of data coming from experts

**IS&RDSS 7****System Reliability and Safety Prediction**

Contents

- 7.1. Defining input parameters for system reliability and safety prediction – Practical instruction
 - 7.1.1. Parameters of system reliability model
 - 7.1.2. Parameters of system safety model
- 7.2. System reliability and safety prediction – Theoretical backgrounds
 - 7.2.1. System reliability prediction
 - 7.2.2. System safety prediction

**IS&RDSS 8****System Renewal and Availability Prediction**

Contents

- 8.1. Defining input parameters for system renewal and availability prediction – Practical instruction
 - 8.1.1. Parameters of system reliability model
 - 8.1.2. Parameters of system renewal process
- 8.2. System renewal and availability prediction – Theoretical backgrounds
 - 8.2.1. System with ignored time of renovation
 - 8.2.2. System with non-ignored time of renovation

**IS&RDSS 9****System Operation Process Optimization**

Contents

- 9.1. Defining input parameters for system operation process optimization - Practical instruction
 - 9.1.1. Parameters of system operation process
 - 9.1.2. Parameters of system reliability
- 9.2. System operation process optimization – Theoretical backgrounds
 - 9.2.1. Optimal transient probabilities of system operation process at operation states
 - 9.2.2. Optimal sojourn times of system operation process at operation states

**IS&RDSS 10****System Reliability and Safety Optimization**

Contents

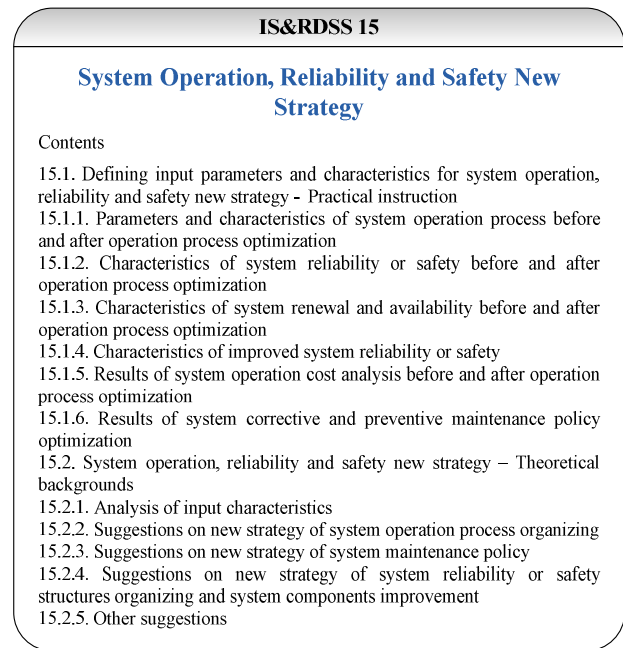
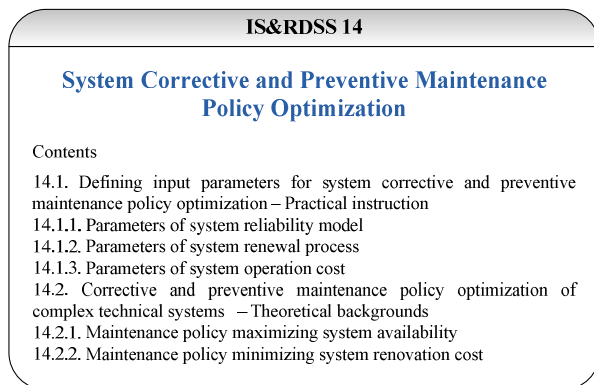
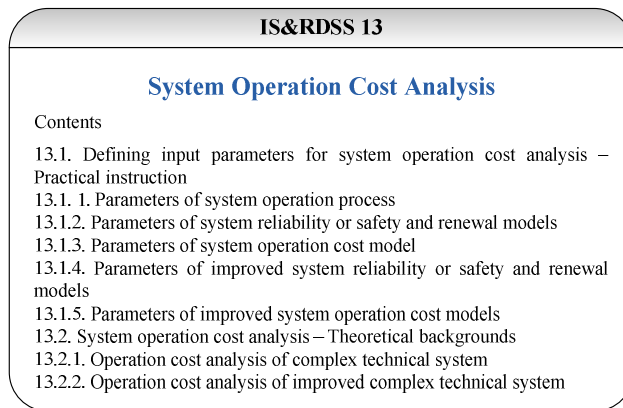
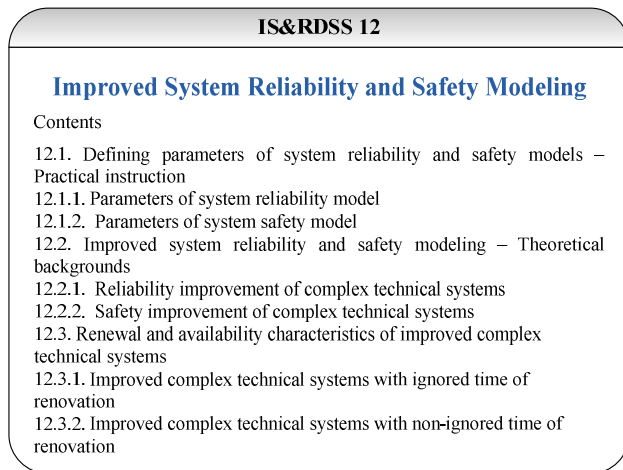
- 10.1. Defining input parameters for system reliability and safety optimization – Practical instruction
 - 10.1.1. Parameters of system operation process
 - 10.1.2. Parameters of system reliability and safety
- 10.2. System reliability and safety optimization – Theoretical backgrounds

**IS&RDSS 11****System Renewal and Availability Optimization**

Contents

- 11.1. Defining parameters of system reliability model – Practical instruction
 - 11.1.1. Parameters of system reliability and safety
 - 11.1.2. Parameters of system renewal process
- 11.2. System reliability modeling – Theoretical backgrounds
 - 11.2.1. System with ignored time of renovation
 - 11.2.2. System with non-ignored time of renovation





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