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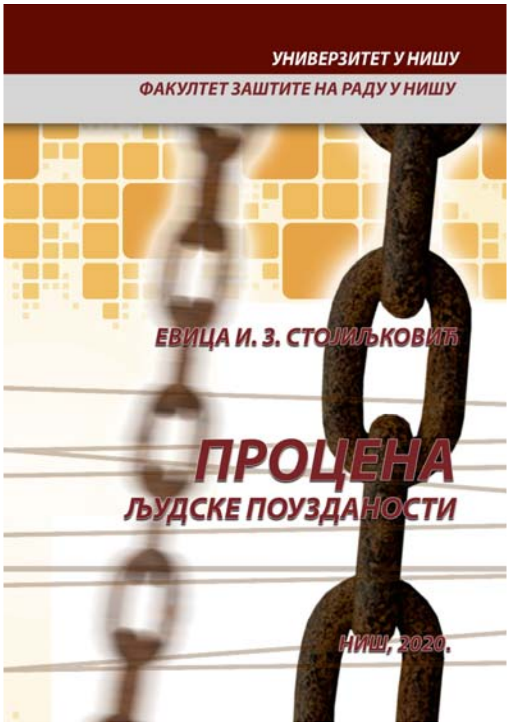

HUMAN RELIABILITY ASSESSMENT

(Procena ljudske pouzdanosti)

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In recent years, human errors have been intensively investigated as an important element of the quality and safety of technical systems functioning. These days, we are facing the development of new disciplines such as – Human Reliability Assessment/Analysis (HRA), Human Factors Engineering (HFE), and Human Error Analysis (HEA) – and each and every one of them provides basic methodologies for the study of human error.

In high-risk sectors, such as nuclear, aviation and petrochemical industries, up to individual SMEs, there was the need to analyze the methods for human error assessment, along with the risk assessment methods pertaining to entire systems. An analysis of the complex systems in diverse industrial and service industries has revealed that human error is the most frequent cause of all accidents in the workplace and environment (over 90% of accidents in the nuclear industry, over 80% in the chemical and petrochemical industries, over 75% in the maritime industry, over 70% in aviation accidents, 70 - 90% in road transport, over 70% in anesthesiology, over 65% in maintenance in various industries, etc.). For this reason, the role of humans in accident dynamics should be undoubtedly taken into account during the risk assessment process in order to ensure the prevention of hazardous events. Research into the causes and consequences of human errors in various industries, their quantification, as well as exploring the possibilities to mitigate or avoid them with the aim to ensure safe work, has a particular social and scientific justification and relevance.

A complete and universally accepted taxonomy of different types of human errors and their causes does not exist, because human error analysis is an interdisciplinary field of research not yet well defined. Human Errors (HE) are unintentional actions or activities that result in deviations from expected standards or norms, which place people, equipment, and the system at risk. However, it is very difficult to formulate a comprehensive definition of human errors, since they are often the result of a complicated series of events. According to the traditional approach, human error is the cause of failure in system functions and the cause of an accident, whereas the contemporary approach assumes that human error reflects the deeper trouble inside the system and is the result of complex relationships between people, tools, tasks and workplace environment. Therefore, the majority of researchers who investigate the HRA issues agree that the errors made by human beings are a specific outcome of their actions or character traits. The nature of the operator's activities depends on many factors, referred to as "Performance Shaping Factors" (PSFs). Performance Shaping Factors influence human behaviour and decision-making process. Since human error is one of the manifestations of human behaviour, it is believed that PSFs also incorporate the causes of error. Therefore, Performance Shaping Factors can both increase and decrease the likelihood of human error, depending on the personality traits, the environment, the organization at work, the complexity of the tasks, and similar.

Each assessment of human error conducted without a suitable classification and categorization is incomplete since there is a possibility that a certain level of risk might not have been considered. It is of utmost importance that the assessor understands the complicated nature of human error in complex systems and is aware of all the causes that lead to human errors, which again influence the level of risk inside the system. The purpose of an error classification system in an identification procedure is to help the assessor reliably identify the multitude of human errors and actions that may compromise the normal system functioning. If the classification system is unreliable or not sufficiently comprehensive, then the system risk assessment may be incorrect (e.g. the level of risk may be underestimated).

Human Error Analysis is the most significant part of Human Reliability Assessment because if an error is omitted at this stage it will not appear in the analysis, which may seriously underestimate the effect of human error on the observed system. For correct Human Error Analysis, it is necessary to supply adequate data, quality information processing and the relationship between different databases. Studies of industrial accidents are a valuable source of information about human errors; however, there are many obstacles to obtaining this kind of information. For that reason, the methods which rely on expert judgment are widely used for HRA.

Due to the emerging safety and risk issues in technological systems, the study of the work quality and the development of a unique methodology for the identification, quantification, and reduction of human errors has become imperative. In accident analysis, the HRA methods can be used retrospectively, or, more often, for prospective system analysis. Most methods are firmly rooted in a systems approach in which human contribution to the broader technical and organizational framework is visible. The purpose is to examine a task, a process, a system, or an organizational structure that may be defective or susceptible to error, rather than finding errors or identifying wrongdoers. Each system in which human error can happen could be analyzed using the HRA methods, which in practice means almost all processes that involve human participants. HRA methods have great potential for predicting errors with the aim to prevent accidents, as well as for analyzing accidents that have already happened and find out their causes. There is a variety of HEA methods which are classified into three generations following the chronological order. When it comes to their application, all these methods have advantages and disadvantages and it is rather difficult to single out the best one. The majority of methods have been developed for use in specific fields, most often in the case of nuclear plant design.

The content of this publication reflects the author's idea to illustrate the similarities, differences and conditionality between various HRA methods by analyzing them; to collect and systematize the most relevant HRA methods in one place; and, finally to compile the years of research in this area in Serbian education, especially in the scientific field of Environmental Engineering and Occupational Safety. Following this idea, the book covers seven chapters: Introductory Remarks, Theories of Accidents and Human Errors, Reliability of Operators and Man-Machine Systems, Basic Stages in Human Reliability Assessment, Human Reliability Assessment Methods, Case Studies, and Concluding Remarks.

In the first chapter, Introductory Remarks, the research interests are focused on defining basic terms used in human reliability assessment. Also, a bibliographic analysis of research on human errors worldwide and in our country was presented.

The second chapter, Theories of Accidents and Human Errors, highlights the significance of the so far developed theories used to analyze the human factor in the occurrence of accidents, and provides an overview of certain HE theories in order to analyze the causes and mechanisms of their occurrence. The chapter points to the distinction between the theories in order to set up a necessary theoretical framework that will be discussed in later chapters.

Since the reliability and safety of technical systems are often predominantly influenced by operators, the third chapter, Reliability of Operators and Man-Machine Systems, analyzes the basic indicators of operator reliability as well as the factors that affect human reliability in the Man-Machine System.

The fourth chapter in this publication, Basic Stages in Human Reliability Assessment, elaborates the basic theoretical and methodological assumptions in HEA and conceptually shapes the basic stages in HRA, such as Human Error Identification, Human Error Presentation, Human Error Quantification, and Human Error Mitigation.

An analysis of the relevant literature suggests that the human factor is the dominant cause of accidents in the workplace and the environment. However, even in cases where the human factor is not dominant, the roles and the significance of human errors in assessing hazards and risks in the systems commonly associated with these concepts have been observed (e.g. in high-tech industrial systems, including nuclear, chemical, power and similar plants). Starting from the facts and findings presented, chapter five, Human Reliability Assessment Methods, provides an overview of the relevant methods used to identify, quantify and reduce human errors. The following methods are of special interest to the researchers: Human Hazard and Operability Study; Systemic Human Error Reduction and Prediction Approach; Absolute Probability Judgement; Success Likelihood Index Method; Technique for Human Error Rate Prediction; Human Error Assessment and Reduction Technique; Paired Comparisons; Human Reliability Management System; Cognitive Reliability and Error Analysis Method; Nuclear Action Reliability Assessment, as well as some other methods for human error reduction.

Chapter six, Case Studies, describes the practical application of commonly used HRA methods. The intention of the author was not to favour certain methods, but to compile the years of research in the field of human reliability assessment and to offer useful subject matter for HEA in the Serbian region.

The methodological framework for human reliability assessment, which was created and practically validated by the Electric Power Industry of Serbia, can be applied in other industrial activities as well. This would certainly contribute to the cross-sectoral unification of the HEA methodology which is an integral part of the risk assessment methodology. The author believes that the results of the research presented may be beneficial to risk assessment teams, institutions and experts in the field of occupational safety and health, but also to company executives and employees, all with the aim to reduce the possibility of human errors. Besides, the research results can be a good starting point for further analysis of HEA in different industrial sectors, as well as a guideline for further study of this scientific issue.

The seventh, final chapter, entitled Concluding Remarks, highlights the significance of the synergy of methods, through various stages of the HRA process. After years of research, the author concluded that only Synergy Methods can facilitate the error identification in the investigated systems, human error probability assessment and the introduction of adequate measures for their reduction. This chapter also outlines future trends in the development of HRA methods.

At the end of the publication, there is a literature review, with the authors' key references in the field of human reliability assessment.

Annotation: Upon decision No. 03-299/10 of the Academic Coouncil of the Faculty of Occupational Safety, University of Nis, the publication titled Human Reliability Assessment has been categorized as a Monograph of national significance.