

# Quantitative Approach to Safety Assessment of the Railway Interlocking System

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## Abstract

The paper deals with a quantitative approach to safety assessment process applicable to the safety-related systems, specially the railway interlocking one. The authors present the methodology based on the Failure Mode and Effects Analysis (FMEA) and the Fault Tree Analysis (FTA) that is applicable to performing safety analysis of both electronic and computer based systems. The mathematical basis for the FTA is detailed, with a special attention paid to the mechanisms used to determine probability of hazardous events based on primary event occurrence. For the sake of better understanding examples of Markov's graphs for a different number of simultaneous hazardous faults are given. Relation between the presented approach and European Standards is indicated.

## 1. Introduction

The railway interlocking system is a special kind of control system that in addition to control functions must also

involve safety-related functions. Safety is considered to be a basic property inherent to such kind of systems. There is necessity to build a model describing transition of an interlocking system from failure-free (safe) mode to failure involved (potentially hazardous) mode as a consequence of random external influences in the process of system ageing. For the sake of introduction, let's give some ideas on such a model.

External influences can generally be characterised as the  $n$ -dimensional random process with time-dependent random quantities (temperature, voltage, electromagnetic interference etc.) of the  $n$ -dimensional random vector. Analysis of influences of this random process on operation of the interlocking system is possible only if its marginal, coupling and conditional characteristics are known. It is a complex task of mathematical statistics.

On the base of data analysis the process must be identified and its prognosis performed for the whole useful life of the interlocking system. In addition, external influences on the interlocking system depend on particular operation environment (i.e. on local conditions). It is unthinkable (for time and financial reasons) to perform the overall analysis of external influences on system safety individually for any operation environment. For the practical use it is acceptable if system requirements specification defines limit values for monitored random variables and in the interlocking system design there are used such technological and circuit solutions (barriers) that enable to omit (fully or partially) external influences. Operation environment of a system must be chosen in accordance with system requirements specification. This solution will also exclude possible

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Computer Science and Information Technologies  
CSIT'2000  
Ufa, Russia, 2000

# Safety Assessment A Quantitative Approach

**Terje Aven, Piero Baraldi, Roger  
Flage, Enrico Zio**



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environmental impacts and natural disasters security and financial risk management The main focus however is on engineering applications While requiring some fundamental background in risk assessment as well as a basic knowledge of probability theory and statistics *Uncertainty in Risk Assessment* can be read profitably by a broad audience of professionals in the field including researchers and graduate students on courses within risk analysis statistics engineering and the physical sciences *Uncertainty in Risk Assessment* Illustrates the need for seeing beyond probability to represent uncertainties in risk assessment contexts Provides simple explanations supported by straightforward numerical examples of the meaning of different types of probabilities including interval probabilities and the fundamentals of possibility theory and evidence theory Offers guidance on when to use probability and when to use an alternative representation of uncertainty Presents and discusses methods for the representation and characterization of uncertainty in risk assessment Uses examples to clearly illustrate ideas and concepts

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United States. Environmental Protection Agency. Office of Health and Environmental Assessment,1987 **Information Technology - New Generations** Shahram Latifi,2017-07-15 This volume presents a collection of peer reviewed scientific articles from the 14th International Conference on Information Technology New Generations held at the University of Nevada at Las Vegas on April 10 12 at Tuscan Suites Hotel in Las Vegas The Book of Chapters addresses critical areas of information technology including web technology communications computing architectures software engineering security and data mining [Fire Risk Management](#) Luca Fiorentini,Fabio Dattilo,2023-08-07 FIRE RISK MANAGEMENT Practical methodologies to develop holistic and comprehensive fire safety strategies for buildings and industrial assets In Fire Risk Management Principles and Strategies for Buildings and Industrial Assets a team of distinguished authors delivers an incisive combination of risk management principles and fire safety assessment methods that offers practical strategies and workflows to prevent and mitigate today s complex fire scenarios The book summarizes modern risk based approaches to fire safety discussing fire safety objectives in terms of functional statements performance requirements and detailed protection measures for buildings and industrial assets towards the development of a fire safety case to timely manage risk with a systematic and structured approach throughout the life cycle of the asset The authors introduce the fundamentals of fire safety and design principles before moving on to discuss topics like fire risk assessment methods risk profiles risk mitigation safety management and performance and protective layers and controls Fire Risk Management presents practical methods often borrowed from those successfully used in other domains that can be defined shared and communicated with multiple stakeholders from different backgrounds and with different needs and perspectives Readers will also find A code neutral

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