

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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The Risk Assessment Guidelines of 1986 United States. Environmental Protection Agency. Office of Health and Environmental Assessment,1987

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