



BSI Standards Publication

Railway applications — Guidance for the use of simulations — Guidance for the use of simulations to demonstrate compliance with technical and regulatory requirements and on the introduction and development of simulation requirements into standards

National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

**Railway applications - Guidance for the use of simulations
- Guidance for the use of simulations to demonstrate
compliance with technical and regulatory requirements
and on the introduction and development of simulation
requirements into standards**

Bahnanwendungen - Leitfaden für den Einsatz von
Simulationen - Leitfaden für den Einsatz von
Simulationen zum Nachweis der Einhaltung
technischer und regulatorischer Anforderungen sowie
zur Einführung und Entwicklung von
Simulationsanforderungen in Normen

This Technical Report was approved by CEN on 24 May 2022. It has been drawn up by the Technical Committee CEN/TC 256.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (CEN/TR 17833:2022) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

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1 Scope

The aim of this document is to help CEN/CENELEC Working Group convenors and experts to promote/develop simulation in their standards as an alternative to physical tests on the real system for proving conformity. It can also provide useful guidance to assessors in the railway sector in approving simulations where they are not yet specifically defined or where physical tests on the real system are not defined in standards. Consequently, this document is also relevant to companies developing and applying simulations with the intention to achieve their acceptance for the purpose of system validation. It is not intended to provide technical guidance on applying simulations in general.

Where simulations are already introduced in existing standards, this guide is not intended to modify the specified requirements. However, technical harmonisation between standards might benefit from this guide for the introduction of additional alternative methods for simulations.

This document principally covers:

- numerical simulation, using complex methods or using simple spreadsheets methods;
- hardware and software in the loop;
- mathematical models solved using numerical methods or iteration, including spreadsheets.

It does not cover the following, although the general principles outlined can be applied to these methods:

- laboratory tests of components;
- fatigue rig tests;
- model scale tests;
- mathematical models solved analytically.

NOTE Due to the limited experience in the railway sector in the application of data-based (as opposed to model-based) simulations, for example using artificial intelligence (AI), neural networks, big data, etc., this approach is not further developed at this stage in this document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

simulation (action and object)

(action) use of a similar or equivalent system to imitate a real system so that it behaves like or appears to be the real system; (object) similar or equivalent system used to imitate a real system

Note 1 to entry: Simulation can be mathematical, analogue or scale modelling. Mathematical simulation includes analytical and numerical calculation.

[SOURCE, ISO 16781:2013, 2.9, modified, Note 1 has been added.]

3.2**numerical simulation**

simulation based on numerical methods

3.3**test**

technical operation that consists of applying to the object a set of environmental and operating conditions under a specified procedure.

Note 1 to entry: A test can be carried out to determine one or more characteristics of a given object, process or service according to a specified procedure. It can be used for different purposes (verifying requirements, calibration, test cases and correct implementation of a model, etc.).

Note 2 to entry: A test can be conducted on the real system, or by entirely or partially using simulation (simulation testing)

[SOURCE: IEV modified, ISO/IEC Guide 2 (13.1), notes 1 and 2 have been added]

3.4**simulation tool**

in house, vendor or open source framework in which one may develop or embed models enabling the execution of tests. It can be software and/or hardware and parts of the real system can be installed in the tool.

3.5**model**

mathematical and/or physical representation of a system or a process

3.6**numerical model**

numerical representation of a mathematical model

3.7**verification (of simulation)**

process of determining that a simulation in its tool environment produces expected results according to the underlying model

3.8**validation (of simulation)**

process of determining the degree to which a model is an accurate representation of the real system in its environment

[ASME V&V 10 2006, modified] [ASME V&V 40 2018, modified]

3.9**system validation**

process of proving conformity to system requirements, ensuring that the system is fit for its intended use in its intended operational environment

3.10

regression testing

testing required to determine that a change to a system (e.g. a model or a tool) has not adversely affected functionality, reliability or performance and has not introduced additional defects

[SOURCE, ISO/IEC 27034-7:2018, 3.15, modified.]

3.11

environment

external aspects influencing the behaviour of a system

3.12

user

entity using the simulation

3.13

certification

third-party attestation related to components, sub-systems or systems

3.14

hardware in the loop simulation

type of simulation, in which some parts of the system or its environment are implemented or modelled by real equipment

Note 1 to entry: Hardware in the loop simulations are characterised by a two-way coupling between the simulated and the real components.

[SOURCE: IEC 16781:2013, 2.5, modified, note 1 added]

3.15

software in the loop simulation

type of simulation, in which a software that is executable on the real system is interfaced with simulation models

4 Introduction

4.1 Background

The rationale for producing this document is the perception that physical testing on the real system for train, infrastructure and command and control system certification leads to:

- excessive costs;
- delays bringing products to market.

The use of simulation is widespread in the automotive and the aerospace sectors, both for design and validation. The challenge is for the European railway sector to examine its certification processes and allow for the use of simulation methods as well as physical testing on the real system for system validation, where it is possible and safe. In the majority of instances, the demonstration methods are defined in CEN and CENELEC standards.