INTERNATIONAL STANDARD

ISO 23019

Railway applications — Driving simulator for drivers' training

Applications ferroviaires — Simulateur de conduite pour la formation des conducteurs

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 3, *Operations and services*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The construction of new railway lines is carried out all over the world. For the operation of new railway lines, advanced cultivation/education of a driver's skill is necessary. Even for existing railway lines, cultivation/education of a new driver's skill and his/her sustained re-skilling are also necessary. Intrinsically, cultivation/education of vehicle crew/staff (e.g. the driver, conductor) is important to ensure safety and stability of rail transport. This is because it can bring about accident prevention and reduce the effects of abnormal working conditions (e.g. an unexpected accident, breakdown of a train and its components). Since the driving simulator can easily reproduce these abnormal working conditions, it can lead to the improvement of driving techniques and effective crew/staff training. Therefore, the introduction of the driving simulator device becomes indispensable in the field of driver training, which has very high needs and demands.

For that reason, this document has been developed to:

— define the common terminologies;

— support the creation of specifications for international procurement (e.g. to avoid the possibility of applying too many specifications that can lead to a remarkable rise in price depending on the purpose of use of the simulator);

— define what is necessary for the performance of the driving simulator depending on the training purposes to ensure that appropriate and most efficient driver training is carried out.

This document covers these needs and, as a result, contributes to the further development of the railway industry.

This document will help customers by giving them a clear vision of the minimum functions and performances required for a simulator. Thus, it can help them to define their real needs.

Railway applications — Driving simulator for drivers' training

1   Scope

This document specifies requirements for railway driving simulators for drivers' training. It defines the minimum functions and performances for a driver training simulator.

This document is applicable to all guided transport systems, including for mainlines, metros, tramways and light rails, as part of public/private transport systems. These vehicles are intended for the operation of intercity, urban and suburban passenger or freight services with self-propelled systems and operated on either segregated or not segregated paths.

Annexes A to D provide additional information.

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 terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1   General

3.1.1
train
any guided transport vehicle that operates on tracks

Note 1 to entry: The term includes passenger trains and freight trains which vary in type (e.g. light rail, metro, mainline), speed (low speeds up to very high speeds) and distance. There can be overlapping types providing more than one function. There can exist many different compositions as appropriate (e.g. single train or multiple single trains connected together).

3.2   Actors

3.2.1
trainee
person to be trained with the driving simulator

3.2.2
instructor
trainer
person that trains *trainees* (3.2.1) with the driving simulator

3.2.3
administrator
person that manages the access, parameters and configuration of the simulator

3.2.4
maintainer
person or company that maintains the simulator (hardware and/or software) in operational condition

3.2.5
designer
person that has the ability and the approval to create or modify the *training scenario* (3.3.2) and/or the *simulated line and environment* (3.4.4) regardless of the organization he or she belongs to

3.3 Training functions and training states

3.3.1
training mode
use of a simulator for driver training purposes

Note 1 to entry: Two training modes can be defined:

— supervised mode for a training session executed with an *instructor* (3.2.2);

— self-training mode for a training session executed alone by a *trainee* (3.2.1).

3.3.2
training scenario
simulated situation including all relevant simulated items (e.g. simulated line and environment, *simulated train* (3.4.1), *controlled train* (3.4.2)), the initial conditions necessary (e.g. choice of the line, weather, time, signalling, *simulated train* (3.4.1) initial setup, *automatic managed train* (3.4.3) position, *controlled train* (3.4.2) initial setup) and *simulated events* (3.4.5) created to specific training objective(s)

3.3.3
pause
pause of a training scenario
suspension of the real-time simulation execution by the *instructor* (3.2.2) or automatically by the simulator during its execution

Note 1 to entry: The real-time simulation execution training scenario remains paused until restarted by an action of the instructor or the system (or a trainee action).

EXAMPLE   This function is to give an oral explanation by the instructor or to give a written explanation displayed to the *trainee* (3.2.1).

3.3.4
resume
resuming of a training scenario
continue the training scenario after it has been paused

Note 1 to entry: This function is available when a training scenario is paused. After an order of the *instructor* (3.2.2) or the system (or a trainee action, e.g. to close a pop up in self-training mode), the training scenario will resume at the exact location and the exact context it was at before being paused.

3.3.5
replay
playback
function that displays the *training scenario* (3.3.2) already completed by the *trainee* (3.2.1)

3.3.6
relocation
movement of the *simulated train* ([3.4.1](#)) into another time slot or location on track inside the *training scenario* ([3.3.2](#))

Note 1 to entry: This function is used when the *trainee* ([3.2.1](#)) has conducted a training scenario and the *instructor* ([3.2.2](#)) wishes the trainee to repeat only part of the real-time simulation (but not all the training scenario from the initial starting condition). For example, when the trainee has performed an incorrect action or had an accident, etc. and the instructor wants the trainee to quickly learn from the mistake without repeating the entire training scenario. The instructor sets the new state of the simulator from a defined condition (e.g. a recorded checkpoint position or other location or condition). Once set, the trainee is again in control of the real-time simulation and takes active control of the simulator. Data are recorded as usual.

3.3.7
training alarm
alarm or trigger that can be defined within the *training scenario* ([3.3.2](#))

Note 1 to entry: Typically to set the limits of a normal reaction and behaviour of the *trainee* ([3.2.1](#)) (for training), there may be several levels of alarms that can activate an action in the simulation.

3.3.8
training scenario log
log of the different variables available from the simulator

Note 1 to entry: Variables can include actions made by the *trainee* ([3.2.1](#)), alarms generated by the simulator, signalling state, simulated train and safety system states, automatic and controlled trains states, instructor actions, instructor notes if available and environmental conditions.

3.3.9
assessment report
report that describes the knowledge that has been validated or not during the *training scenario* ([3.3.2](#))

3.4 Simulated items

3.4.1
simulated train
train ([3.1.1](#)) controlled by the *trainee* ([3.2.1](#)) in the simulation

3.4.2
controlled train
train ([3.1.1](#)) that exists in the simulation but is not controlled by the *trainee* ([3.2.1](#)) (and can be controlled by the other trainees or the *instructor* ([3.2.2](#)) for a specific action or purpose)

3.4.3
automatic managed train
running *train* ([3.1.1](#)) that exists in the simulation for realism but is not controlled by the *trainee* ([3.2.1](#)), the other trainees or by orders from the *instructor* ([3.2.2](#))

3.4.4
simulated line and environment
all the necessary parts of the guided transport system that are needed to drive the *train* ([3.1.1](#)) correctly and all the objects that are outside the guided transport system

Note 1 to entry: The term includes all guided transport system infrastructure and the outside environment.

Note 2 to entry: The guided transport system infrastructure includes:

— tracks (with their geometrical characteristics, curves, slopes and straight sections);

— power distribution systems (e.g. catenary, third rail, charging stations);

— signalling systems used by drivers (e.g. signalling, switch and level-cross junctions (switch/point machines), passenger information equipment);

— passenger platform stations (areas visible to the driver);

— depot and stabling areas.

Note 3 to entry: The outside environment includes:

— static objects outside the guided transport system (e.g. buildings, roads, junctions, crossroads, station structures (architecture), the landscape (e.g. mountains, green areas, sea));

— dynamic objects (e.g. people (passengers and others), vehicles of all types (e.g. cars, trucks, bicycles));

— weather and time aspects.

3.4.5
simulated event
particular conditions (e.g. environmental, passenger or train behaviour, obstacles, *simulated anomaly* (3.4.6), emergencies) that are inserted into a *training scenario* (3.3.2) in order to test the reaction of a *trainee* (3.2.1)

Note 1 to entry: There are two kinds of simulated events:

— programmed simulated events that will automatically occur in a training scenario (under specific conditions defined in the software or in the training scenario script);

— free simulated events that can be inserted/deleted manually by the *instructor* (3.2.2) at any time during the running of the training scenario and activated immediately or under specific conditions (time, speed, weather or other conditions).

3.4.6
simulated anomaly
reproduction in the simulation of an abnormal item or behaviour on the transport system (e.g. a fault on a *train* (3.1.1), signal system, tracks)

3.5 Visual characteristics and functions

3.5.1
computer-generated imagery
CGI
graphical reproduction of still or animated visual contents with real-time image generating software

3.5.2
visibility
perception of the simulated items at a specified distance on the simulated line or environment typically from the driver (seated) position in the rolling stock

Note 1 to entry: The simulated items can be affected by the location of the driver (in the simulated train) on the line and can change based on the distance from the object (near or far), the perception of the driver can be affected by other simulated objects in the line of sight or due to simulated weather conditions and can change during day or night conditions.

3.5.3
clarity
clearness of the simulated items on the simulation graphical display device

3.5.4
anti-aliasing
technologies that are used to reduce the visual defects of stair-stepped on the image

3.5.5
field of view
FOV
extent (in horizontal and vertical axis angles) of the observable world that is seen from the viewer's position

3.5.6
train field of view
train FOV
extent (in horizontal and vertical axis angles) from the driver-seated position to observe the external environment

Note 1 to entry: The train FOV defined in the train specifications usually concerns the seated driver position (focal point) to the front window edges (which defines the angles).

3.5.7
simulator field of view
simulator FOV
result of the output images generated displayed on the visual display system as observed from the driver-seated position (typically representative of the same result in the real *train* (3.1.1))

3.6 Simulator items

3.6.1
simulator failure
fault on the simulator or its equipment

Note 1 to entry: It includes failure of the computer, power failure, etc.

3.6.2
simulator log
log of events of simulator usages

Note 1 to entry: Events can include *simulator failures* (3.6.1) and simulator states

4 Conceptual considerations for simulator

4.1 General

In this clause, the whole concept and the prerequisites for developing a driving simulator for drivers' training are described, including the purpose, classification, mode and simulated guided transport system.

A driving simulator is selected according to its target use. It is therefore important to clearly define the purpose and objectives to be achieved for driver training.

This can influence both the objectives and specifications of the simulator, e.g. choosing whether to use a generic train or a specific one circulating on a generic line or a specific line for the simulation.

The driving simulator equipment has the potential to affect the health and safety of people who use it. Therefore, consideration shall be taken of the relevant and safety local rules.

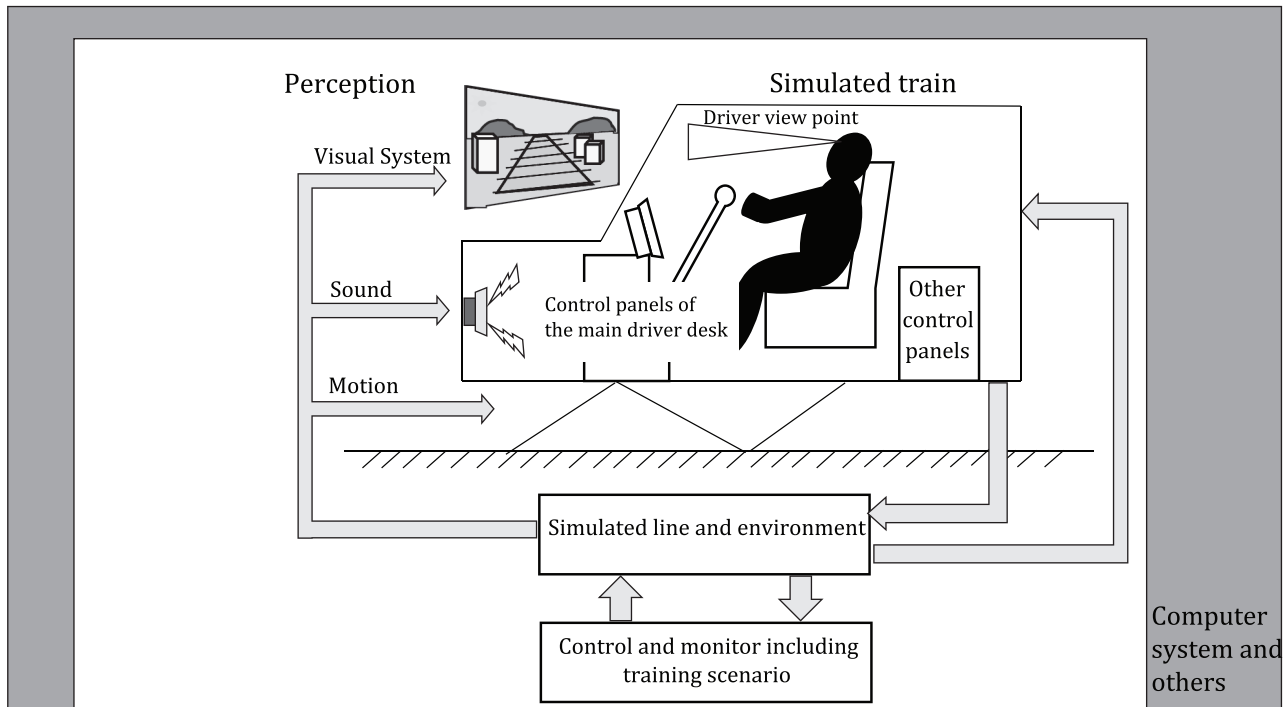Figure 1 shows a typically categorized conceptual diagram of a simulator (the type with a motion option).

Figure 1 — Typically categorized conceptual diagram of simulator

4.2 Purpose of simulator

The purpose(s) of the simulator for training influences the type of simulator needed. Therefore, it is important to clearly define the purpose before stipulating the specifications of the simulator.

EXAMPLE   The purpose of a driver training can be as follows.

— Basic training, including:

 — train equipment operation;

 — signalling (e.g. signals rules and signal displays);

 — railway and outside environment (e.g. line knowledge).

— Advanced training, including:

 — operational rules for normal or abnormal conditions;

 — special driving condition (e.g. weather, special timetable, passenger density, vehicle simulated anomaly handling and emergencies);

 — practice driver behaviour and reactivity skills.

The use of simulators can be implemented for one instructor for one or more trainee and/or self-training (without an instructor).

NOTE   The simulator also can be used for exam sessions in accordance with local regulations.

4.3 Classification of simulators

Classification of simulators is typically categorized as given in Table 1.

The types and scope of classification of simulators depend on the training purpose and budget.

Then, Table 1 shows the typical classification of simulators as a guidance to introduce simulators. Required functions and performances of simulators are described in the Clause 5, 6, 7, 8, 9 and 10.

Table 1 — Classification of simulators

	Type 1 Replica cabin	Type 2 Full scale desktop	Type 3 Customized desktop	Type 4 Light desktop
General description	Replica of the inside of the full driver cabin structure including interior functional components as in the real train (one to one ratio replica cabin).	Reproduction of the interior functional components of the driver cabin similar to the real train (full scale and function reproduction desktop).	Physical or virtualized main driver equipment with the possibility of different arrangements to the real train, including reduction of size for the desk, equipment, cabinets, front screen (main function customized desktop).	Virtualized main control equipment. Some can be physical if necessary (main function virtualization light desktop).
Control panels of the main driver desk	Physical reproduction of all the control equipment with same spatial arrangement and same shape and size as in the real train.	Physical or virtualized reproduction of all the control equipment with similar spatial arrangement as in the real train.	Physical or virtualized control equipment with a possible compact arrangement.	Virtualized control equipment. Some can be physical if necessary. Some equipment can be shared by the same device.
Other control Panels	Physical or virtualized reproduction of all the control equipment with same spatial arrangement as in the real train.	Physical or virtualized reproduction of necessary control equipment.	If necessary, physical or virtualized reproduction of the control equipment with possible compact arrangement.	If necessary, virtualized control equipment can be shared by the same device as for the main driver desk.
Control equipment behaviour	The behaviour of control equipment reproduced in the simulator is the same as the reaction and display of the real train.	The behaviour of control equipment reproduced in the simulator is similar to the reaction and display of the real train.		
Driver external environment viewpoint	Reproduction of the cabin views of the external environment from the driver position with similar train FOV. Front external environment view is mandatory. Other views can be required as necessary.		Reproduction of the cabin views of the external environment from the driver position. Front external environment view is mandatory. Possible reduced train FOV. Other views can be required as necessary.	
External environmental effects (audio, visual, motion effects)	All necessary audio elements and effects of the simulated train and simulated line and environment			
	All necessary visual objects and effects of the simulated line and environment			
	Motion effects are possible but not mandatory (mandatory for Type 1-A)	Motion effects are possible but not mandatory (mandatory for Type 2-A)	Motion effects are possible but not mandatory (mandatory for Type 3-A)	No motion effects required
NOTE 1: Various motion systems and degrees of freedom levels are possible based on training purposes and budget.				
NOTE 2: If motion system is provided, an A is added to the end of the type. For example, a Type 1 simulator with motion is a Type 1-A.				
NOTE 3: Type 1-A, Type 2-A and Type 3-A include the specification with motion system.				