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Railway applications — Concepts and basic requirements for the planning of railway operation in the event of earthquakes

Applications ferroviaires — Planification des concepts d'exploitation en cas de séisme

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Foreword

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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

Modern transportation systems, including the railway, are constructed with the prerequisite of maintaining the functions required for public service under the designed usage conditions and/or when faced with the expected external effects of natural phenomena that were taken into account at the time of their design. Such natural phenomena include earthquakes or extreme weather events. In case of events caused by natural phenomena, functional damage to transportation systems can occur, adversely affecting lives and societies.

There are no predictive signs for many natural phenomena events, especially earthquakes. Earthquakes tend to occur suddenly and without any prior warning which could enable the forecasting of the intensity of ground shaking and the size of the affected area using existing technology. Large earthquakes including aftershocks can affect society for an extended period of time where extensive damage to transportation systems occurs. Compared to other natural phenomena, earthquakes are infrequent. As such, it is difficult to obtain experience-based knowledge for improving information on construction countermeasures for resisting future events reliably.

Because of the nature of earthquakes, it is difficult to predict the scale and timing of damage to transportation systems. Therefore, due to potentially significant effects on society, the planning and implementation of countermeasures to restrict damage and to reduce the risk due to earthquakes is essential for transportation systems.

Railway operators aim to provide a safe and reliable transport service. In doing so, they need to take into account the reliability of the railway service for customers (passengers and consignors) and railway owners. This aim should be achieved as far as possible even under irregular railway operation conditions. One case in which irregular railway operation conditions are expected is that due to earthquake events. This is potentially the case not only for a specific area/country which has experienced a large earthquake event before, but also for other areas/countries without previous experience of significant earthquake events, but for which a risk of exposure to ground shaking exists. For these areas/countries, a significant seismic potential and a significant risk of exposure to ground shaking can be present. Therefore, in order to reduce a customer's risk in relation to earthquakes, the planning of any countermeasures for railway operation becomes an important issue for consideration.

Conversely, the solution to the above issue is hampered by the lack of standards, guidance, or other documentation available to the public. In order to help to reduce the potential risk due to earthquakes, and to thereby improve the reliability of a railway service and to protect the reputation of railway businesses, the establishment of an internationally accepted and publicly available document is essential.

Railway applications — Concepts and basic requirements for the planning of railway operation in the event of earthquakes

1 Scope

This document specifies the concepts and basic requirements for the planning of railway operation in order to reduce risk in the event of earthquakes. This excludes regions where the consequences of seismic hazard for railway operation are low or non-existent. The definition of such regions is out of the scope of this document.

NOTE The stages defined for consideration of the countermeasures necessary for the safe management of the seismic hazards can also be relevant for dealing with other natural phenomena.

This document includes only operational measures and excludes any infrastructure measures. Furthermore, this document does not include specific measures which ensure, without fail, passenger safety or which provide protection against railway-operational damage caused by earthquakes. Therefore, residual risk can remain.

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:

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

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

3.1
railway operation
control and management of the railway service

Note 1 to entry: In this context, railway operation includes responsibility for managing and maintaining railway infrastructure, traffic management and signalling, provision and maintenance of rolling stock, and services for the transport of goods and/or passengers by rail. In countries where these responsibilities are provided by different parties, the tasks defined in this document should be divided accordingly.

3.2
operator
party responsible for *railway operation* (3.1)

3.3
operational restriction
application of a speed restriction or an operation suspension to trains according to relevant operational procedures in order to improve the safety of the trains or to reduce the risk

3.4
operational condition
operational mode which depends on the permitted running velocity of a train on a particular section of the network

Note 1 to entry: Operational condition consists of two modes: regular and irregular conditions (3.5 and 3.6).

3.5
regular condition
condition in which trains can operate at the maximum permitted line speed

3.6
irregular condition
condition in which an *operational restriction* (3.3) is enforced due to an unusual situation

3.7
ground motion strength index
set of measures to represent ground motion strength utilized in decision-making

EXAMPLE Seismic peak ground acceleration.

3.8
threshold
pre-defined value for the strength of ground motion for deciding the *operational restriction* (3.3)

3.9
earthquake information
perception and/or physical information for earthquakes

EXAMPLE Perception of ground shaking, values of *ground motion strength indices* (3.7), earthquake source parameters such as origin time, hypocentre or epicentre location and magnitude.

4 Definition of stages for planning of railway operation

4.1 General

This clause defines the following five cyclic stages which are needed to consider the countermeasures necessary for railway operation during the time period of an earthquake (see Figure 1).

— Stage 1: Detection of earthquake

— Stage 2: Decision for operational restriction

— Stage 3: Implementation of operational restriction

— Stage 4: Inspection

— Stage 5: Resumption of regular condition

In Figure 1, the small black circles indicate “stages”, while the broken line arrows represent operational “conditions”. The stages here refer to a series of actions implemented by operators for railway operation during and after an earthquake event. The condition switches at Stage 3 or 5 as shown in Figure 1.

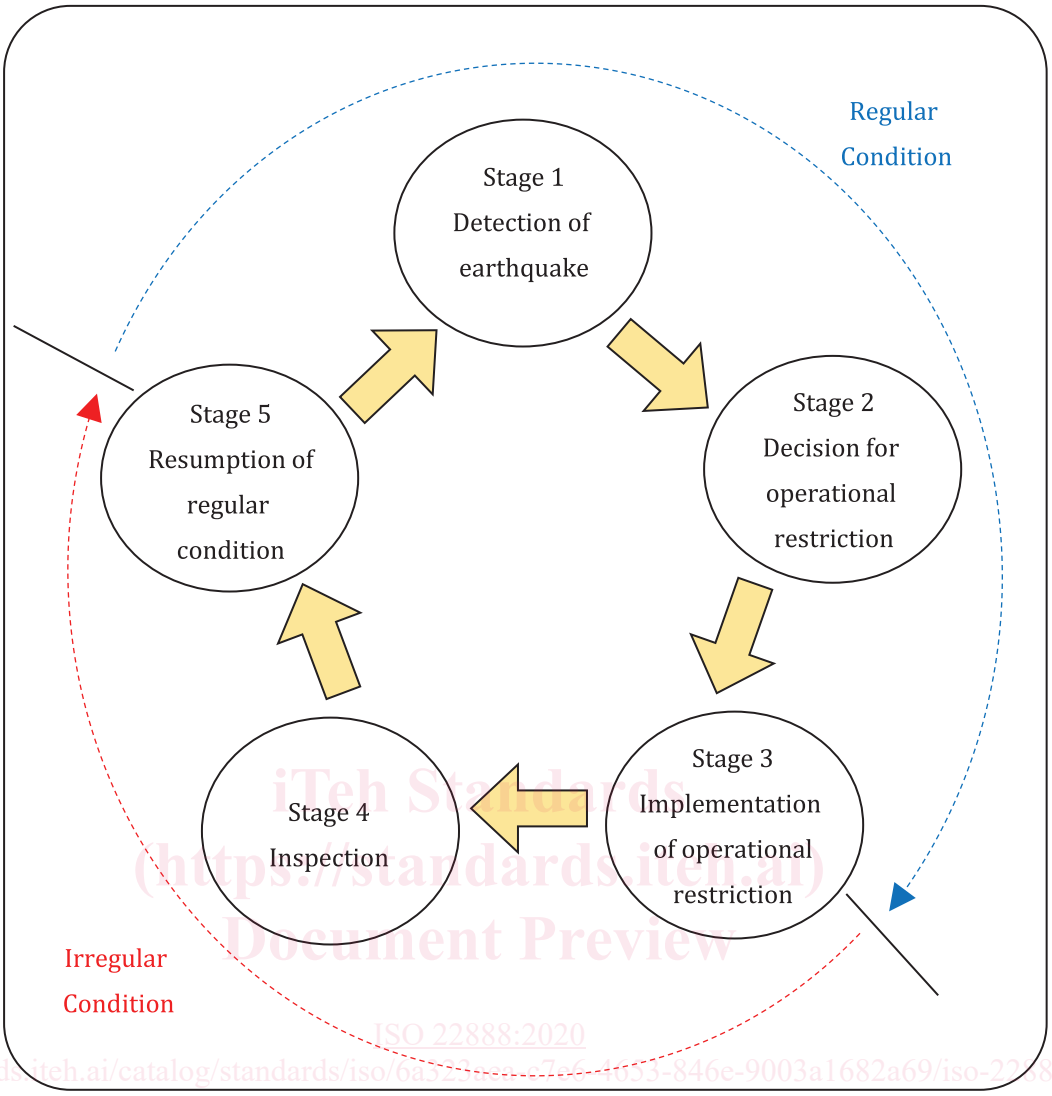

Figure 1 — Stages and conditions

4.2 Stage 1: Detection of earthquake

The purpose of Stage 1 is to detect an earthquake occurrence and to obtain event information.

4.3 Stage 2: Decision for operational restriction

The purpose of Stage 2 is to decide whether or not a safer operational condition is required and which mode of irregular condition shall be implemented (speed restriction or operation suspension) using the earthquake information obtained at Stage 1.

4.4 Stage 3: Implementation of operational restriction

The purpose of Stage 3 is to change to irregular condition (speed restriction or operation suspension) if it is decided as being necessary at Stage 2.

4.5 Stage 4: Inspection

The purpose of Stage 4 is to inspect the condition of railway facilities in order to provide information on whether railway operation can be resumed under regular or irregular conditions.

4.6 Stage 5: Resumption of regular condition

The purpose of Stage 5 is to return to regular condition based on the information gathered in the previous stages.

5 Concepts for planning of railway operation

5.1 General

Operators should change to a safer operational condition without delay. Operators should make efforts to minimize the risk to safety and economic loss to customers and operators, and should revert to regular operation immediately after it is considered safe to do so.

5.2 Basic plan

Operators can develop a basic plan which includes consideration of the factors that are necessary to develop the procedures for the railway operation during an earthquake event. The basic plan may be updated depending on the situation.

The basic plan may include consideration, for example, of:

— traffic frequency;

— passenger density;

— infrastructure vulnerability;

— economic and social impact;

— earthquake information for past/predicted events;

— damage due to past/predicted earthquakes;

— line speed;

— cost effectiveness.

The basic plan is not mandatory.

5.3 Development of procedures for railway operation

5.3.1 General

Operators should establish the procedures of railway operation for each stage in advance of earthquakes. Implementation of the specific stages, operational procedures and basic requirements for railway operation in a particular area/country can take account of the organizational and responsibility chain practices in that area/country. See Annex A for additional information of the procedures implemented in some countries.

It is common for a number of operators to be involved in railway operation during an earthquake event. The developed procedures should thus be shared among the concerned operators who are responsible for each task. Operators can promote dissemination and training for the developed procedures to efficiently apply them in case of earthquake events.