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Railway applications – Procedure to determine the performance requirements for radio systems applied to radio-based train control systems

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RAILWAY APPLICATIONS – PROCEDURE TO DETERMINE THE PERFORMANCE REQUIREMENTS FOR RADIO SYSTEMS APPLIED TO RADIO-BASED TRAIN CONTROL SYSTEMS

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62773, which is a technical specification, has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
9/1823/DTS	9/1899/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- reconfirmed,
- withdrawn,
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INTRODUCTION

The purpose of this Technical Specification is to provide a guideline for the rail transport authority and/or the supplier of the radio system to determine performance requirements of the radio system from the conditions of the railway systems using the radio-based train control systems.

This Technical Specification specifies the procedure to determine the performance requirements for radio system applied to the radio-based train control systems. The performance requirements are related to the radio parameters. Each radio parameter needs to be set to an appropriate value to enable data exchange with quality of service that will meet the requirements from the railway system as a whole and particularly the train control functions. Radio parameters are then decided based on the analysis of the conditions of the railway system using the train control system.

RAILWAY APPLICATIONS – PROCEDURE TO DETERMINE THE PERFORMANCE REQUIREMENTS FOR RADIO SYSTEMS APPLIED TO RADIO-BASED TRAIN CONTROL SYSTEMS

1 Scope

The objective of this Technical Specification is to establish a procedure to be used by rail transport authorities and/or radio suppliers to determine the appropriate performance requirements of radio system for a radio-based train control system, consistent with their specific business needs and existing conditions: the Technical Specification itself consists in defining a procedure linking preconditions to some radio parameters. Then, the appropriate performance requirements are deduced by the user of the Technical Specification from the radio parameters.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

None.

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

3.1.1
capacity
maximum amount of information transmitted and received per unit time on the radio link

3.1.2
data rate
amount of data transmitted over a given period of time (usually expressed in “bits per second” or “bytes per second”)

Note 1 to entry: The minimum data rate needs to take into account the maximum amount of transmitted data per unit time for the train control system.

3.1.3
encryption
method of transmitting information so that third parties cannot decode it

Note 1 to entry: It serves to enhance the secrecy of information transmitted and received within the system.

3.1.4
handover
shift of connection to an adjacent radio base station

3.1.5
measures against masquerading
measures involving the performance of electronic authentication or validity checks, providing network firewalls, or physically isolating systems to prevent tampering or spoofing of electronic messages

3.1.6
modulation method
method of varying one carrier signal to contain the information of a baseband signal

Note 1 to entry: It is determined in consideration of frequency, bandwidth, data rate and/or propagation characteristics such as antenna parameters.

3.1.7
number of connections
number of mobile radios that can simultaneously communicate with one wayside radio

3.1.8
period
time between the start of transmission of two consecutive packets at the physical radio interface

3.1.9
quality of service
quality of the communication service provided in terms of guaranteed throughput, jitter, latency and packet loss

3.1.10
type of transmission
open or closed transmission based on IEC 62280

3.2 Abbreviations

ATP Automatic Train Protection
GOA1 Grade Of Automation 1
GOA2 Grade Of Automation 2
GOA4 Grade Of Automation 4
GPS Global Positioning System
QoS Quality of Service
TC Train Control

4 Outline of the process for determining performance requirements

The determination of performance requirements of a radio system for radio-based train control systems requires specification of the conditions that may influence them, evaluation of these individual circumstances, and judgment of whether or not to reflect them in the performance requirements. An outline of the process is described in this clause, which helps specifying the various conditions that may influence these requirements.

The following factors need to be taken into consideration when determining the performance requirements of the radio system.

– Preconditions on available spectrum:
  Environmental conditions and regulatory constraints
– Preconditions on railway operation:

Railway line conditions, operating conditions, TC communication requirements and required type of transmission

– Radio parameters:

Security parameters and transmission parameters

These factors have to be in line with the expression of performance requirements defined at the level of the train control system as a whole.

Preconditions influence the radio parameters both directly and indirectly. Environmental conditions, regulatory constraints, railway line conditions, operational conditions, and train control communication requirements determine the transmission parameters. These preconditions determine the performance requirements of the radio system.

The relationships that exist among them are shown in Figure 1, and items related to the preconditions and radio parameters are listed in Table 1.

Individual preconditions are defined in Clause 5 and Clause 6, and radio parameters are defined in Clause 7. Clause 8 outlines the correlation between them.

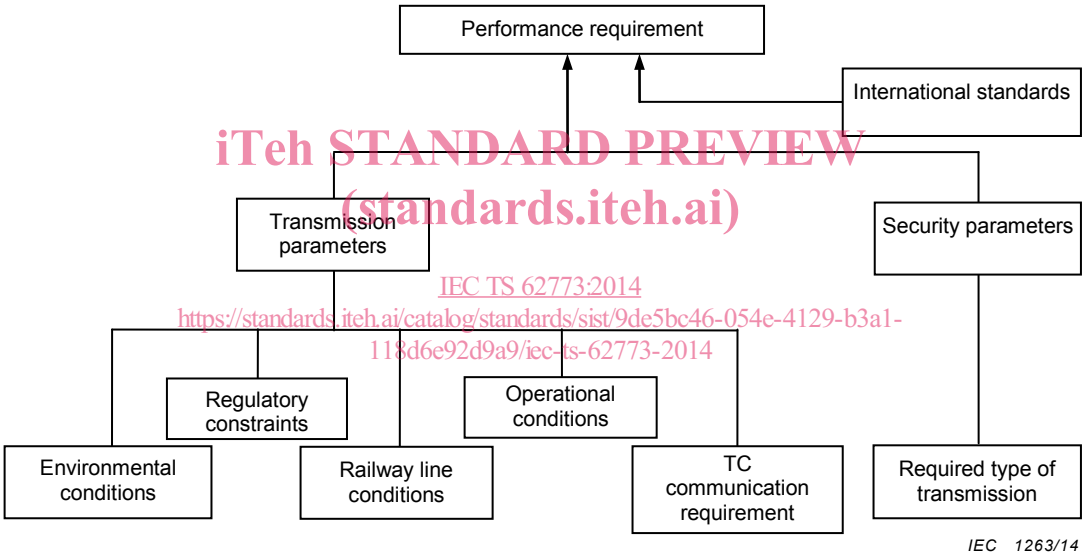

Figure 1 – Factors influencing performance requirements

Table 1 – List of preconditions and radio parameters

	Major division	Subclassification
Preconditions on available spectrum	Environmental conditions (5.1)	Obstacle, climate conditions, electromagnetic interference, etc.
	Regulatory constraints (5.2)	
Preconditions on railway operation	Railway line conditions (6.1)	Line maximum speed, track conditions (tunnels, etc.), line configurations, station configurations, etc.
	Operational conditions (6.2)	Minimum design headway, maximum number of trains in one control area (number of trains controlled at any one time).
	TC communication requirement (6.3)	Maximum tolerable loss of communication, network latency, TC transmission period, TC throughput, control area, maintenance conditions, etc.
	Required type of transmission (6.4)	
Radio parameters	Security parameters (7.2)	Encryption, measures against masquerading, etc.
	Transmission parameters (7.3)	Period, capacity (e.g. throughput), number of connections, handover, frequency, bandwidth, data rate, modulation method, type of propagation, etc.
NOTE Additional operational and system conditions for the train control systems can be found in Annex A and Annex B.		

5 Definition of preconditions on available spectrum

5.1 Environmental conditions

5.1.1 General

This subclause describes the environmental conditions which are the available spectrum constraints for a radio system applied to a radio-based train control system considered by a rail transport authority. Environment conditions are considered when transmission parameters such as frequency, modulation method and capacity of the radio system applied to the train control system are determined.

5.1.2 Obstacle

Obstacle described in this Technical Specification means structure (building, bridge, retaining wall and topography of the land, etc.) which may affect the performance of a radio system used for train control.

It is necessary for selecting the radio wave, the type of antenna and the placement of antennas, to consider the shape and the placement of obstacles along the line for securing the transmission and reception of radio waves. Multipath propagation from obstacles may cause a weak electric field area as a result of fading and shadowing.

Conditions of buildings along the line may change by environs development in the future.

Geographic characteristic such as the existence and shape of hills and rivers may affect range or absorption characteristic of radio waves.

A geometric profile may change unexpectedly due to a change of natural environments (e.g. growth of tree, natural disaster) over time.

These conditions affect the decision of characteristics, the placement and the number of antennas as well as their installation and maintenance.

5.1.3 Climate conditions

Climate conditions described in this Technical Specification means climate conditions that may affect the performance of a radio system used for train control.

In particular, rain (precipitation, squall or not), snowfall, lightning and fog may influence the propagation of radio waves and impact the quality of received radio signal depending on the frequency.

5.1.4 Electromagnetic interference

Electromagnetic interference from radio noise sources in neighbouring facilities (e.g. high voltage equipment, power lines, high-frequency equipment, electric switching devices, etc.) affects data transmission quality. Interference from radio equipment which is not used for train control or mobile radios such as a radio communication system for business use should also be considered.

This environment changes continually.

5.2 Regulatory constraints

This subclause describes legal conditions concerning radio systems which a rail transport authority should consider when a radio-based train control system is used.

For example, legal conditions concerning radio systems include the height of antenna installed on the ground, frequency, radiation power, type of antenna (gain and/or directivity), kind of polarized wave, etc.

The application (e.g. design and operation) of the radio system should be compliant with laws of the country or area that define the rules for radio transmission. Laws or regulations for obstacle or landscape may be considered.

6 Definition of preconditions on railway operation

6.1 Railway line conditions

6.1.1 General

This subclause describes the line conditions impacting radio parameters that a rail transport authority should ascertain when using a radio-based train control system.

6.1.2 Line maximum speed

The line maximum speed is the maximum speed in a particular section (referred to herein as the line) on a railway network defined by the rail transport authority. The factors that determine the line maximum speed include service limitations such as the type of service or considerations regarding the ambient environment, in addition to physical limitations such as track structure and vehicle performance.

6.1.3 Track conditions

Track conditions that affect radio communication include types of structures such as tunnels. Taking a tunnel as an example, the track conditions include its location on the track, its length, its structure (cross-sectional and three-dimensional shape considerations such as curve/inclination/vertical curve), the material of the tunnel wall surface, and the presence/absence of objects installed inside the tunnel. Other such structures include cut-slopes and obstacles on curved lines.

6.1.4 Line configurations

Line configuration described in this Technical Specification means configuration of tracks between stations such as single, double, or quadruple track. It is necessary to consider the line configuration for deciding control area or transmission system, etc.

6.1.5 Station configurations

Station configuration conditions described in this Technical Specification means the scale of the station and structure. Scale of the station described means conditions such as track layout, the number of platforms and size (related to the number of trains that can be present at the same time) of the station that may affect the capacity of system other than physical area of station affecting the coverage of radio. Structure of the station means conditions such as elevated structures, basement structures, multi-layer structures that may affect the electric field strength of radios.

6.2 Operational conditions

6.2.1 General

This subclause describes the operation conditions that a rail transport authority should ascertain when using a radio-based train control system. It should be noted that this Technical Specification does not preclude the implementation of suggestions from system suppliers or from a third party (e.g. consultant) for some conditions.

6.2.2 Minimum design headway

Minimum design headway is the minimum time interval between two successive trains achievable regarding track profile, braking performance, train length and performance of train control system.

6.2.3 Maximum number of trains in one control area

The maximum number of trains in one control area represents the number of trains in one area which can be controlled simultaneously by a radio-based train control system. In case that the area to be controlled is divided into more than one section for train control, it is defined in each of the divisions. (see Figure 2)

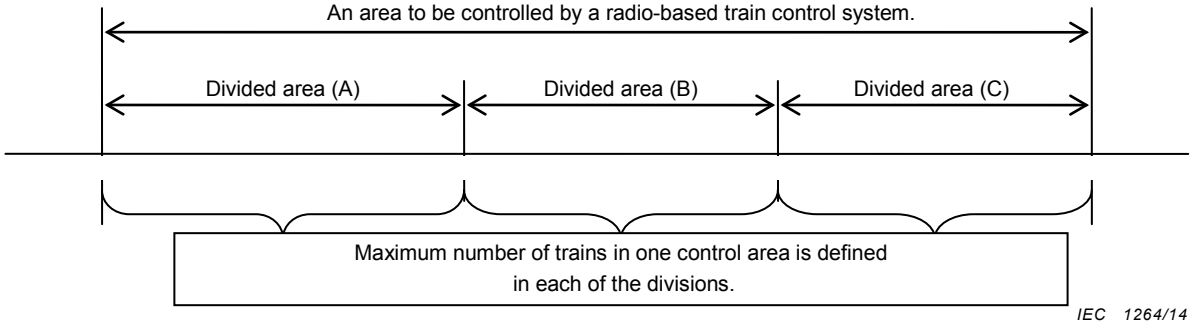

Figure 2 – Maximum number of trains in case of divided area