Guidelines of the Finnish Transport Agency

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Functional Requirement Specifications for the ERTMS/ETCS System in Finland (ETCS FI-FRS)

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Functional Requirement Specifications for the ERTMS/ETCS system in Finland (ETCS FI-FRS)

This is a national functional requirement specification of the European Rail Traffic Management System (ERTMS) and its European Train Control System (ETCS), ERTMS/ETCS. Guide presents the main operating principles of ERTMS/ETCS system. This requirement specification lays out top-level national requirements related to ERTMS/ETCS system.

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Guide is accepted by electronic signature.
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Preface

This specification (ETCS FI-FRS) has been ordered by Finnish Transport Agency (FTA) and written by railway experts from Proxion Plan Oy in close cooperation with the Finnish Transport Safety Agency Trafi, VR-Group Ltd. and rolling stock and equipment suppliers (Siemens, Ansaldo STS).

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Finnish Transport Agency
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1 Introduction

This document supports the implementation of the European Rail Traffic Management System (ERTMS) and European Train Control System (ETCS) in Finland.

Objective of this guide and the investigative work related to it is to define a general Functional Requirement Specifications (FRS) for the ERTMS/ETCS system in Finland. ERTMS/ETCS system consists of:

- On-board command, control and signalling subsystem and
- Trackside command, control, and signalling subsystem

Requirements are specified with separate and where necessary additional subsystem requirement specifications. This general specification is based on level 1 of the ETCS system.

National requirements defined in this work are presented with the notation FI-FRS. A summary of the requirements is presented as Appendix 1 of this document.

2 Terms and abbreviations

Abbreviation	Original term
ASP	Axle Load Speed Profile
Basic SSP	Basic Static Speed Profile
DMI	Driver Machine Interface
EBI	Emergency Brake Intervention
EoA	End of Authority
ERA	European Union Agency for Railways
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
FRS	Functional Requirements Spesification
FS	Full supervision
GSM-R	Global System for Mobile communications for railways
GUI curve	Guidance curve
IS	Isolation
JKV	ATP-VR/RHK, the Finnish National Train Control System in Finland
LEU	Lineside Electronic Unit
LS	Limited supervision
LX	Level crossing restriction
MA	Movement authority
MRSP	Most Restrictive Speed Profile

Abbreviation	Original term
NL	Non leading
NP	No power
OS	On sight
PS	Passive shunting
PT	Post trip
RAMS	Reliability, availability, maintainability and safety
RBC	Radio Block Center
RV	Reversing
SB	Stand by
SBI	Service Brake Intervention
SF	System failure
SH	Shunting
SL	Sleeping
SN	National System
SP	Speed Profile
SR	Staff Responsible
STM	Specific Transmission Module
TR	Trip
TSR	Temporary Speed Restriction
UN	Unfitted

3 General

3.1 Choice of baseline and level

FI-FRS01 ETCS system to be procured shall conform to the European Railway Agency's (hereinafter referred to as the ERA) definition and ETCS baseline 3 requirements (CCS TSI, *Set of specifications #2*, ETCS baseline 3).

FI-FRS02 Trackside and on-board equipment to be procured shall be updatable to meet ETCS level 2 requirements.

ETCS railway traffic is due to begin at ETCS level 1. The use of ETCS level 2 or 3 will be assessed later.

Requirements and transition period for the equipping of on-board and trackside functions with the ETCS system is presented in the Finnish Transport Safety Agency's (hereinafter referred to as Trafi) regulation *Command, control and signalling subsystem*.

3.2 National values

3.2.1 National ETCS parameters

National ETCS parameters define the
- use of the ETCS system,
- guidelines for functional use and
- train control operational rules.

These parameters define for example the maximum speed limits for different situations and forms of railway traffic, including time limits for related functions.

National parameters and chosen values are presented in *Finnish national ERTMS/ETCS parameters FTA guideline 20/2015* (*Suomen kansalliset ERTMS/ETCS-parametrit*).

Locations chosen for the commissioning of locomotives shall have ETCS balises that give the locomotive the chosen national values.

3.2.2 Country-specific identifiers

NID_C identifiers are used to specify a geographical area and NID_CTRACTION identifiers are used to specify the electrification system in use.

One country-specific identifier (NID_C) is not enough for the Finnish railway network because one area can contain only a limited amount of balise identification numbers, according to the terms of parameter NID_BG. Finnish Transport Agency has currently reserved 14 units of NID_C identifiers (numbers 322-335) for the Finnish railway network. The identifiers will be implemented in conjunction with the construction.

FI-FRS03 NID_C identifiers are used in accordance with maintenance areas.

NID_CTRACTION identifiers ensure that the locomotives specifications are compatible with the electrification system in use.

FI-FRS04 Identifier for the Finnish railway networks electrification system NID_CTRACTION = 27 shall be programmed as a default for the electric powered locomotives ETCS on-board equipment.

Country-specific identifiers (NID_C, NID_CTRACTION) have been approved by the ERA. A contemporary list of approved identifiers is presented in the ERA publication *Assignment of values to etcs variables*.

3.3 Modes

On-board equipment has different modes in the ETCS system. The mode in use defines what information and functions can be transmitted between the driver, the ETCS on-board equipment and trackside equipment.

Modes, related terms and the switching of modes are presented in further detail in the ERA publication" System Requirements Specification, Chapter 4, Modes and Transitions" Subset-026 (hereinafter referred to as SRS 026).

FI-FRS05 ETCS on-board equipment to be procured shall enable all possible modes presented in ETCS baseline 3.

3.3.1 Mode restrictions

FI-FRS06 Limited supervision mode (LS) shall only be used in an exceptional circumstance in a restricted area, and with the separate authorisation of the infrastructural manager of the railway network.

Use of the LS mode shall be justified case-specifically. The use may be considered for example in ETCS construction areas and in conjunction with commissioning.

FI-FRS07 Reverse mode (RV) shall only be used in a restricted area, and with the separate authorisation of the infrastructural manager of the railway network.

Use of the Reverse mode may be considered in locations where stock is moved to a platform by reversing. Following the use of the Reverse mode Standby mode (SB) is activated followed by the normal actions of Start of Mission.

3.4 Data communication

Data communication functions are used in ETCS system Level 2 and 3.

3.5 ETCS data recording

Data related to the functioning of a unit, and the information input by the driver, received by the on-board equipment and data presented to the driver is all recorded and bounded with time and location data. Detailed requirements regarding the functions of the recorder and the ETCS on-board equipment system is presented in the ERA publication *FIS Juridical recording* (Subset-027).

3.6 Reliability, availability, maintainability and safety (RAMS)

Requirements for the RAMS of the ETCS system shall be defined component specifically in the sub-requirement specifications (CCS).

4 ETCS train and axle load categories

4.1 ETCS train categories

ETCS specification defines two different train category types cant deficiency and other international train categories. Cant deficiency is associated with centrifugal force and how the stock behaves in curves. In the current specification other international train category is related to ETCS brake category.

The summarization of all ETCS train categories and their interdependence is presented in Table 1. The train data shall be entered from the first column, which determines values for cant deficiency and other international train category variables. For example, if category FG 1 is entered, it further defines cant deficiency variable value to *80 mm* profile and other international category to *freight train G* as ETCS brake type.

Currently there are only three (3) different values defined for other international train category. In theory, it is possible to set NC-TRAIN-value from 12 available options from the most right-hand side column. The use of available train categories is not possible at the moment, because current specifications do not define how to enter the data. According to specifications train can belong to one or more Other international train categories simultaneously. NC_TRAIN-values depends on brake types. In theory it is also possible to assign other properties and speed profiles to this variable.

FI-FRS08 ETCS on-board equipment to be used on Finnish railway network shall have all ETCS train categories available.

Table 1. ETCS train categories (ETCS Driver machine interface)

Category	Cant deficiency category (NC_CDTRAIN-value)		Other international train category (NC_TRAIN-value)	
FG 1	80 mm	(0)	freight train G	(xxx xxxx xxxx x010)
FG 2	100 mm	(1)	freight train G	(xxx xxxx xxxx x010)
FG 3	130 mm	(2)	freight train G	(xxx xxxx xxxx x010)
FG 4	150 mm	(3)	freight train G	(xxx xxxx xxxx x010)
FP 1	80 mm	(0)	freight train P	(xxx xxxx xxxx x001)
FP 2	100 mm	(1)	freight train P	(xxx xxxx xxxx x001)
FP 3	130 mm	(2)	freight train P	(xxx xxxx xxxx x001)
FP 4	150 mm	(3)	freight train P	(xxx xxxx xxxx x001)
PASS 1	80 mm	(0)	passenger train P	(xxx xxxx xxxx x100)
PASS 2	130 mm	(2)	passenger train P	(xxx xxxx xxxx x100)
PASS 3	150 mm	(3)	passenger train P	(xxx xxxx xxxx x100)
TILT 1	165 mm	(4)	passenger train P	(xxx xxxx xxxx x100)
TILT 2	180 mm	(5)	passenger train P	(xxx xxxx xxxx x100)
TILT 3	210 mm	(6)	passenger train P	(xxx xxxx xxxx x100)
TILT 4	225 mm	(7)	passenger train P	(xxx xxxx xxxx x100)
TILT 5	245 mm	(8)	passenger train P	(xxx xxxx xxxx x100)
TILT 6	275 mm	(9)	passenger train P	(xxx xxxx xxxx x100)
TILT 7	300 mm	(10)	passenger train P	(xxx xxxx xxxx x100)

4.1.1 Cant deficiency train category

NC_CDTRAIN variable is determined by the cant deficiency train category entered into the system. A unit can only belong to one cant deficiency train category (SRS 026).

Cant deficiency means the superelevation between theoretical and practical cant. Cant deficiency causes centrifugal force in the direction of the outer curve when the superelevation is lower than the theoretical cant.

Following figure presents cant deficiency and variables affecting it.

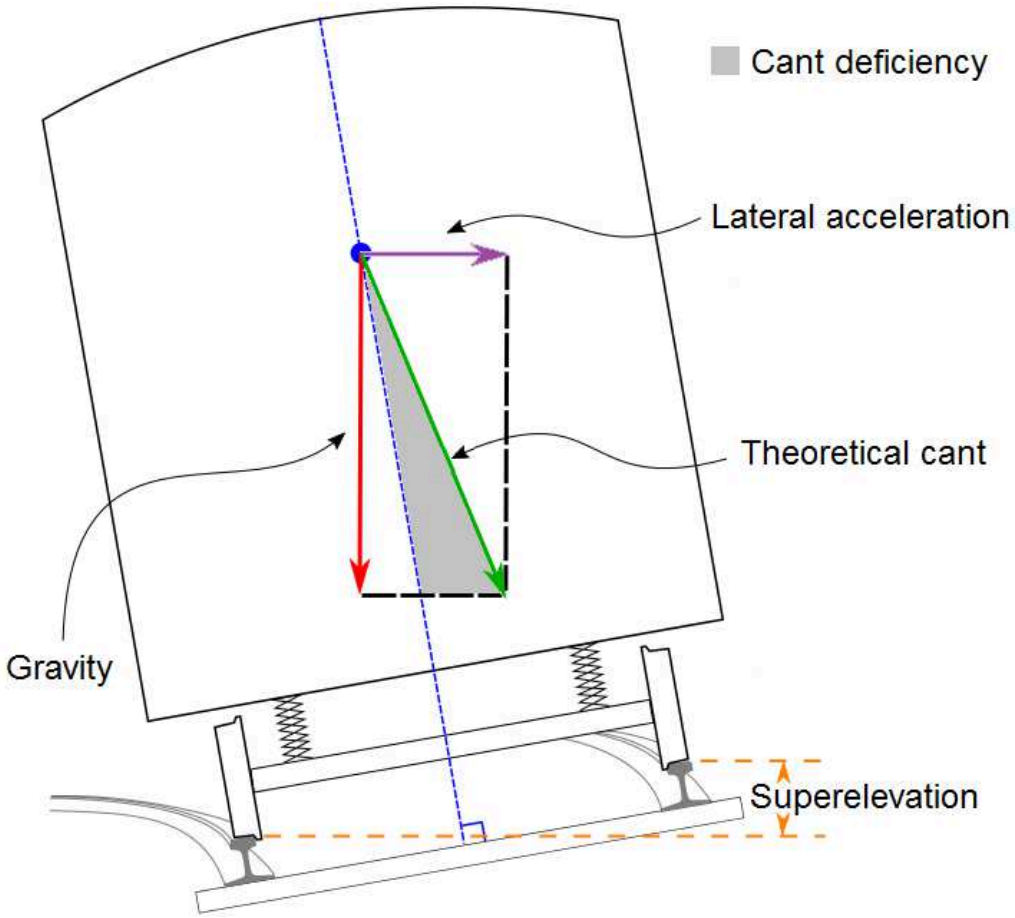


Figure 1. Cant deficiency

Different speed profiles can be established by applying cant deficiency values.

When the variable values increase, the speed profiles allow faster speed and, accordingly, bigger lateral acceleration. In the train categories TILT 1-7, the growing lateral acceleration is reduced for improved passenger comfort by means of a train tilting system.

4.1.2 Other international train categories

At the moment, cant deficiency train category selection also defines the other international train category variable (NC_TRAIN, Other International Train Category) as presented in table 1.

Other international train category indicates the train's ETCS brake type, which are

- freight train G,
- freight train P and
- passenger train P.

Brake type is a concept that expresses the operational speed and force of the braking system. The brake type P signifies rapid operating time and the brake type G a slow one.

Selection of the Other international train category and the brake type has an effect on the following things:

- Deceleration values for normal service braking can be separately defined for freight trains G and freight and passenger trains P. These deceleration values affect the functioning of the Guidance curve (GUI) which encourages better driving behaviour.

- Maximum deceleration values for bad weather conditions for Lambda trains can be given as three separate values. Value A_NVMAXREDADH1 concerns passenger trains P with eddy current brakes. Value A_NVMAXREDADH2 concerns passenger trains P without eddy current brakes. Value A_NVMAXREDADH3 concerns freight trains P and G.

- Maximum train length for passenger train P is 900 meters and 1500 meters for freight trains P and G.

- Lambda train speed dependent correction factor Kv_int for deceleration during emergency braking can be defined separately for freight trains and passenger trains.

- Lambda train emergency braking and service braking time delays are calculated separately for different brake types.

4.2 Axle load categories

Axle load category is a value to be entered as train data. A train always belongs to a single axle load category. Track categories and their authorised axle loads are presented in the commission decree (EU) No. 1299/2014 (TSI INF) and standard SFS-EN 15528.

Ascending order of axle loads (M_AXLELOADCAT) is as follows:
A, HS17, B1, B2, C2, C3, C4, D2, D3, D4, D4XL, E4 and E5.

FI-FRS09 ETCS on-board equipment to be used on Finnish railway network shall allow all the axle load categories required.

Table 2. ETCS axle load categories (SRS 026)

Axle load category	Axle load
A	≤ 16 t
HS17	≤ 17 t
B1, B2	≤ 18 t
C2, C3, C4	≤ 20 t
D2, D3, D4, D4XL	≤ 22,5 t
E4, E5	≤ 25 t

4.3 Speed profiles and speed restrictions

ETCS system contains the following main groups for speed profiles and speed restrictions

- static speed profile
- axle load speed profile
- temporary speed restrictions
- signalling related speed restrictions
- mode related speed restrictions
- train related speed restriction
- STM speed restrictions
- level crossing speed restriction
- override function speed restriction
- speed restriction to ensure a given permitted braking distance

The most restrictive speed profile is chosen.

4.3.1 Static Speed Profiles

Static Speed Profile (SSP) is a group of fixed speed restrictions given for a specific track section. It shall be possible for every element (distance between two discontinuities) of a static speed profile to define, if a transition to a higher speed limit than the speed limit specified for this element is permitted before the complete train has left the element.

There are three kinds of static speed profiles:

- Basic Speed Profile (Basic SSP)
- Cant Deficiency Speed Profiles (Cant Deficiency SSP)
- Other international train category speed profiles (Other Specific SSP)

ETCS trackside equipment shall always give the Basic SSP. The Basic SSP is given as continuous data and is based on the maximum permitted speed of the track section taking into account track geometry and other infrastructure.

The other speed profiles are given if the speed in the Basic SSP needs to be raised or lowered due to, for example, the characteristics of the stock. Cant Deficiency SSP and the Other Specific SSP are only given for the required sections of the track and to the extent required.

For each part of the Static Speed Profile, the ETCS on-board equipment shall select the SSP best suiting its Cant Deficiency train category, according to the following order of preference:

- Cant Deficiency SSP corresponding to the train category shall be selected
- if available, the Cant Deficiency SSP with the highest Cant Deficiency value below the value of its Cant Deficiency train category (NC_CDTRAIN) shall be selected
- Basic SSP shall be selected

Unique prioritisation is defined for each Other international train category speed profile (Other specific SSP) in relation to the Cant Deficiency SSP. The Cant Deficiency SSP can be replaced by an Other Specific SSP. The most restrictive speed profile shall be selected.

Speed profiles are given in the packet number 27:

- Basic SSP speed (V_STATIC)
- Cant Deficiency SSP and Other Specific SSP speed (V_DIFF)
- variable NC_CDDIFF explains which Cant Deficiency SSP the speed relates to
- variable NC_DIFF explains which Other Specific SSP the speed relates to

At the moment one Basic SSP, eleven Cant Deficiency SSPs and three Other Specific SSPs can be processed simultaneously.

ETCS on-board equipment shall not approve a Movement Authority (MA) if static speed and gradient profiles are not available for the corresponding distance. These profiles shall be given, at the latest, at the same time as the Movement Authority.

4.3.2 Axle load Speed Profiles

Axle load category, which corresponds train configuration, is always entered as train data.

Axle load Speed Profiles (ASP) can be given as a non-continuous profile for the required track sections.

ETCS on-board equipment supervises the most restrictive speed restriction that is associated with any axle load category lower than, or equal to that of the train.

Axle load restrictions are not considered if there is no axle load speed profile, or if they are only established for axle loads greater than the axle load category of the unit in question. At the end of each speed restriction zone, a decision is taken to determine if the maximum speed will be controlled considering the length of the train.

Axle load profiles are given in the packet 51. The variable M_AXLELOADCAT determines the axle load category and the variable V_AXLELOAD determines the equivalent speed.

4.4 ETCS categories of passenger trains

In Finnish Railway Network it is necessary to define at least three different speed profiles for passenger trains. These types are based on stock characteristics and are used to define curve and tunnel restrictions. Train categories of passenger trains and equivalent speed profiles are implemented based on the cant deficiency train categories.

For traditional Lamda trains, cant deficiency train category PASS 2 is selected.

For passenger trains with double-decker wagons, cant deficiency train category PASS 3 is selected.

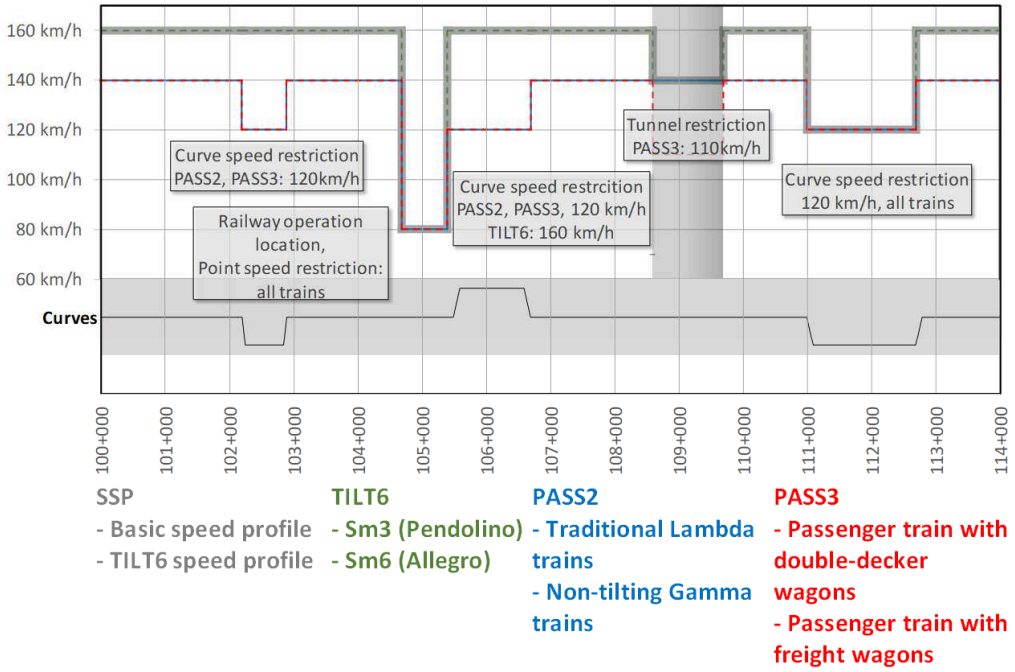
For gamma trains with non-tilting wagons, cant deficiency category PASS 2 is selected.

Train category for stock with tilting carriages is selected from TILT 1-7. The study presents that Sm3 and Sm6 trains would belong to the same TILT 6 category, altough there is differences between Pendolino and Allegro trains. The above-mentioned trains share a common limit value for uncompensated lateral acceleration (1.80 m/s^2). This value determines the maximum speed possible in curves regardless of the carriage tilting control. The passenger train categories to be introduced are highlighted in Table 3.

Table 3. ETCS categories of passenger trains

Train type	Train category	Cant deficiency train category (NC_CDTRAIN)	Other international train category (NC_TRAIN)
	PASS 1	80 mm	passenger train P
Traditional passenger Lambda trains, Non-tilting Gamma trains	**PASS 2**	**130 mm**	**passenger train P**
Passenger train with double-decker wagons, Passenger train with freight wagons (lateral acceleration 0.8 m/s^2)	**PASS 3**	**150 mm**	**passenger train P**
	TILT 1	165 mm	passenger train P
	TILT 2	180 mm	passenger train P
	TILT 3	210 mm	passenger train P
	TILT 4	225 mm	passenger train P
	TILT 5	245 mm	passenger train P
Sm3 (Pendolino), Sm6 (Allegro)	**TILT 6**	**275 mm**	**passeger train P**
	TILT 7	300 mm	passenger train P

Axle load category HS17 is used for Gamma operated passenger trains and category A for Lambda operated. Locomotives without wagons are categorized into axle load category B1.



Picture 2. Passenger trains' speed profiles on fictive track

The whole track section is provided with continuous Basic SSP. Category PASS 3 is assigned to curve sections as a discrete restriction. Then the restriction applies to all trains with a Cant deficiency category of 150 mm or lower. Categories which cant deficiency is higher than 150 mm do not follow the restriction.

Restrictions needed on double-docker passenger wagons and car carrier freight wagons in tunnels are given as restriction under the PASS 3 train category. Tunnel sections can have separate speed profiles for PASS 2 category trains. Thus, it is possible to drive single-decker Lambda passenger train and single-decker Gamma train faster in tunnels.

Passenger train can have wagons classified as passenger or freight wagons. If there are wagons with lateral acceleration of 0.8 m/s² in passenger trains' configuration, PASS 3 train category is selected. Passenger train is categorized to freight trains category FP 2, if passenger train has freight wagons with lateral acceleration of 0.65 m/s².

Passenger train brake type is otherwise always *passenger train P.*

4.5 ETCS categories of freight trains

In Finnish railway network it is necessary to define speed restrictions for freight trains which are related to axle load and stock properties. In addition, there is a need for vibration restrictions due to condition of the railway network and stock properties. Most of the needed speed restrictions and speed profiles are possible to implement with axle load categories.

Depending on the freight trains' brake type, the train category is FG 2 or FP 2.

Table 4. ETCS categories of freight trains

Train type	Train category	Cant deficiency train category (NC_CDTRAIN)	Other international train category (NC_TRAIN)
	FG 1	80 mm	freight train G
Freight traing with brake type G	**FG 2**	**100 mm**	**freight train G**
	FG 3	130 mm	freight train G
	FG 4	150 mm	freight train G
	FP 1	80 mm	freight train P
Freight train with brake type P, Passenger train with freight wagons (lateral acceleration 0.65 m/ s²)	**FP 2**	**100 mm**	**freight train P**
	FP 3	130 mm	freight train P
	FP 4	150 mm	freight train P

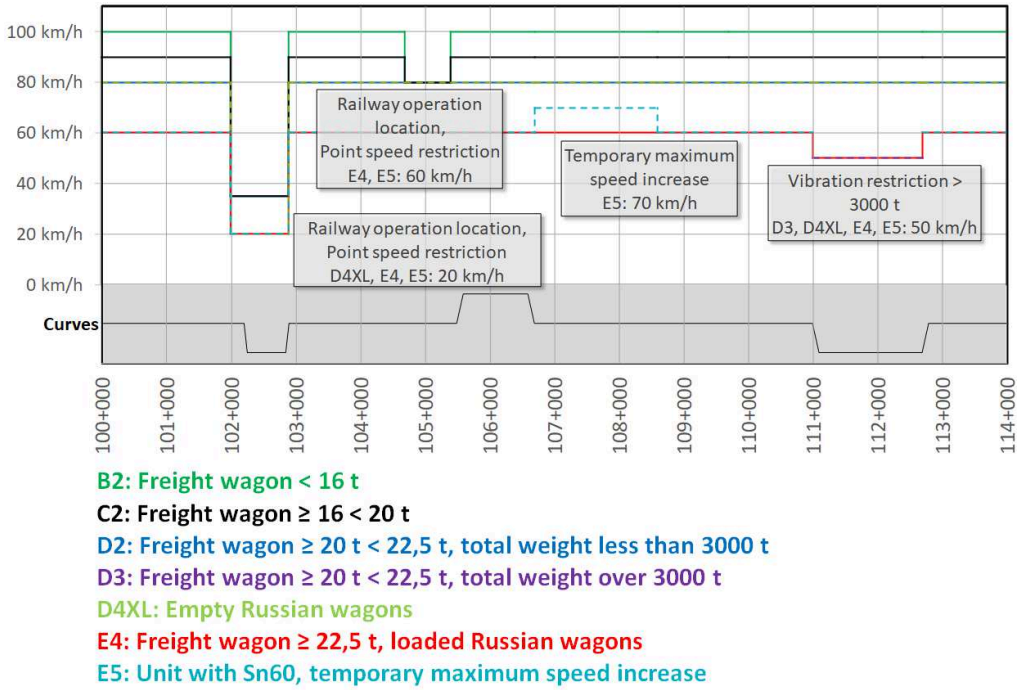
Freight train axle load categories shall be used as described in Table 5. In Finland, freight trains use speed restriction in accordance with the *Finnish railway network statement.* The network statement divides line sections to following axle load categories:

- < 16 t
- 16-20 t
- 20-22.5 t
- > 22.5 t

Because of the above breakdown, the axle load category B2 is not used in accordance with ETCS system in case of freight trains weighing under 16 t.

Table 5. Axle load Speed Profiles

Axle load category	Train type	Operational function
A	Lambda traind	-
HS17	Gamma trains	-
B1	Locomotives without wagons	-
B2	Freight trains with axle load ≤ 16 t	-
C2	Freight trains with axle load between 16 – 20 t	Axle load restrictions for different track sections
C3	Not defined	-
C4	Not defined	-
D2	Freight trains with axle load between 20 – 22.5 t, total weight under 3000 t	Axle load restrictions for different track sections
D3	Freight trains with axle load between 20 – 22.5 t, total weight over 3000 t	Vibration restrictions for trains weighing over 3000 t
D4	Not defined	-
D4XL	Freight trains with Russian wagons, axle load over 22.5 t	Speed restrictions for points 35 km/h -> 20 km/h
E4	Freight trains with axle load over 22.5 t, specialized wagons (e.g. transport wagon for points)	Speed restrictions for points 70/80 km/h -> 60 km/h Axle load restrictions for different track sections
E5	Unit which Sn is 60 km/h, need for temporary maximum speed increase	-



Picture 3. Freight train's speed profiles on fictive track

It is justified to use axle load categories in freight trains' speed profiles and other restriction, because most of network restriction needs are directly related to the axle load of the trains' configuration.

Russian freight wagons have special speed restriction needs on Finnish railway network. Russian wagons restriction by axle load leads to weakening of the current situation in some cases. E.g. empty Russian standard wagons (D4XL) also apply to axle load restrictions in categories D3 and D2, although empy wagons have real axle load of less than 20 t.

It is possible to achieve temporary maximum speed increase in axle load category E5 as inverted restriction. In particular axle load category speed is restricted to 60 km/h on the entire network and where temporary maximum speed increase is needed, restriction is not in use. The maximum speed allowed for the train shall be entered in accordance with the section of maximum speed increase. Speed increase is needed for heavy freight trains in specific ascent sections on the railway network.

4.6 Other speed restrictions

4.6.1 Temporary speed restrictions

Temporary speed restrictions (TSR) are used for controlling the temporary speed restrictions that are not included in other speed profiles. Several speed restrictions can be controlled simultaneously. The most restrictive among the restrictions is supervised.

At the end of each restriction it is possible to determine whether the restriction shall be delayed with train length.

Identification numbers from 0 to 126 are reserved for updatable temporary speed restrictions on ETCS Level 1. These can be used for example in order to relocate the end of the restriction according to updated route data. When the identification number of the restriction is 255, the restriction cannot be updated.

If the speed restriction that is monitored under the identification numbers 0 to 126 is modified, this change will be treated without supervising the length of the train. If more than one restriction is issued under the identification number 255, they will be treated as separate restrictions with unmodifiable data.

Temporary speed restrictions are given in the packet 65 where information on one single temporary restriction is given. Among multiple temporary restrictions, each one is given a unique starting and ending point.

4.6.2 Signalling related speed restrictions

A signalling related speed restriction can only be given on ETCS level 1. The speed restriction is prosessed by the ETCS on-board equipment immediately after it has been received. A signalling related speed restriction given by a repeater balise becomes valid when the next main signal is reached. A signalling related speed restriction remains valid until it is replaced by another signalling related speed restriction. If the value of the restriction is 0, it is prosessed as a Stop signal.

Signalling related speed restrictions are given in the packet 12 with the variable V_MAIN.

FI-FRS10 At the signal, signalling related speed restrictions shall be set to the same value as the basic speed profile.

4.6.3 Mode-specific speed restrictions

Mode specific speed restrictions are specific for the following modes

- Unfitted Area (UN)
- Limited Supervision (LS)
- Staff Responsible (SR)
- On Sight (OS)
- Shunting (SH)
- Reversing (RV)

Apart from RV, mode-specific speed restriction default values are set and presented in SRS 026. The default values can be replaced by national values and are given in the packet 3.

In SR mode, a speed restriction replacing the national value can also be given by the driver.

In RV mode, a speed restriction can only be given by trackside equipment, because RV mode can only be applied within an area defined by trackside equipment.

4.6.4 Maximum permitted speed

Maximum permitted speed is a speed restriction depending on the characteristics and the composition of the train. The driver shall enter the maximum permitted train speed as ETCS train data.

FI-FRS11 Unit with a temporary maximum speed increase shall set its maximum permitted speed according to the temporary maximum speed increase area.

4.6.5 STM speed restrictions

STM's maximum speed (V_STMMAX) is given by the STM equipment in HS mode (Hot Standby) when the equipment prepares transition to ETCS level NTC.

STM maximum speed becomes a speed restriction controlled by the ETCS, beginning at the level transition border. If the STM equipment is out of order, the ETCS sets 0 km/h as the STM maximum speed. The objective is to prevent a unit without functioning STM equipment from entering an area with level NTC.

STM system speed (V_STMSYS) and the corresponding system distance (D_STMSYS) are given by the STM equipment in HS mode (Hot Standby) when the equipment prepares transition to ETCS level NTC. STM system speed becomes a speed restriction supervised by ETCS at the system distance away from the level transition border. The objective is to restrict the speed of the train to the value required by the STM equipment when the equipment reads the first JKV balises preceeding the level transition border.

4.6.6 Level Crossing speed restrictions

Level crossing speed restriction (LX) used for supervising level crossings has a unique identification number. The level crossing supervising indicates if the crossing is secured. If the crossing is not secured, a speed restriction will be given together with the information if the unit is required to stop or not. If the unit is ordered to stop, a stopping point is also determined.

Level crossing speed restrictions are given in the packet 88. Packet 88 gives the speed restriction data for one level crossing. Unique starting and ending points are defined for the level crossing. The identification numbers from 0 to 126 have been reserved for the level crossing restrictions on Level 1. The identification number is indicated with the variable NID_LX and the speed restriction with the variable V_LX.

4.6.7 Override speed restrictions

When the traffic control gives an authorisation to pass a Stop signal, the speed limit default values defined in SRS 026 will be supervised. The default values can be replaced by the national values and are given in the packet 3 (V_NVALLOWOVTRP, V_NVSUPOVTRP, appendix 2).

4.6.8 Speed restriction for permitted braking distance

A speed restriction for permitted braking distance can be set for places where advance information about a Stop signal is received too late in comparison to the speed of the unit. For this reason, the speed of the unit is restricted in accordance with the available braking distance.

For braking, both emergency and service braking can be selected. ETCS on-board equipment calculates the maximum permitted speed that corresponds to the unit specific braking ability.

Data concerning a speed restriction for permitted braking distance is given in the packet 52.

5 Trackside equipments

5.1 Balise messages

5.1.1 Structure and length of balise messages

ETCS trackside equipment communicates with the on-board equipment by means of information packets. A message transmitted by the trackside equipment consists of an information part, a synchronisation part and a verification part.

Size of a single balise message is 341 or 1023 bytes. The message consists of the following:

- Information-part's short message (210 bytes) or normal message (830 bytes) and
- Encryption, synchronisation and verification bytes (131 or 193 bytes).

Contents of the ETCS balise message's structure, title and information packets are described in detail in parts 7-8 of the SRS 026 and the structure in SRS 036 (Subset 036, *FFFIS for Eurobalise*).

5.1.2 Message packets

The following chapter will describe the most important ETCS message packets and their usage. The contents and the variables of the message packets are described in detail in part 7 of the SRS 026.

5.1.2.1 Packet 3 National Values

FI-FRS12 National values shall be given in places where a unit can enter the Finnish national railway network.

Balises transmitting national values shall be located at least in the following areas:

- Maintenance depots where ETCS on-board equipment parts can be replaced.
- Border stations where units capable of operating on Finnish railway network can enter the country.
- Places where units to be used in Finland are commissioned for the first time.

5.1.2.2 Packet 5 Linking Information

Packet 5 gives information about linked balises.

5.1.2.3 Packet 12 Movement Authority

Packet 12 gives information about Movement Authority (MA). Movement authority is a main route secured by the signalling system and JKV control lines. Detailed requirements for control lines are presented in FTAs guideline *RATO 10*.

Movement authority can be given in one or more sections. With the MA distance given in packet 12, packets 21 (gradient data) and 27 (speed profiles) have to be given as well. If necessary, packet 12 also gives information about overlap length and the distance to the danger point.

At a signal the line speed (V_MAIN) is given with packet 12. Line speed is the maximum permitted speed at the current location when a Proceed signal is given. Line speed at a Stop signal is zero.

At a distant signal or a repeater balise, the given line speed marks the line speed for the next main signal.

Packet 12 cannot be used to issue point specific restrictions. Point specific restrictions are given in packet 27.

It is possible to set timers on MA's sections. These timers define for how long the secured route remains valid. If the train exceeds the time set by the timer, the signal ending the MA's section will function as a Stop signal.

There are two alternative ways of submitting a Movement Authority. The variants differ from each other in how the speed restriction at the end of the MA (V_LOA) and the ending point of the route is defined.

- In variant 1, it is assumed that V_LOA = 0 only if the location of the Stop signal is known
- In variant 2, it is assumed that V_LOA = 0 until the end of the data transmission distance where movement is known to be authorised.

Packet 12, Variant 1
As a priority, the length of the Movement Authority is the distance to a known Stop signal, when the location of the signal is known. In this variant the permitted speed at the End of Authority (EoA) is zero (V_LOA = 0). If the existence of a Stop signal is not known, the Movement Authority is issued until the next main signal where the permitted speed corresponds to the line speed for that signal (V_LOA = V_MAINnext).

For the main signal giving a Stop aspect, a danger point and, if necessary, overlap shall be defined.

Movement Authority can be divided in two sections (figure 4). When Movement Authority is divided in two sections, the first section lasts to the next main signal and the second section is the distance from the next main signal to the Stop signal.

In this variant, Movement Authority is given with packet 52 (speed restriction for permitted braking distance).

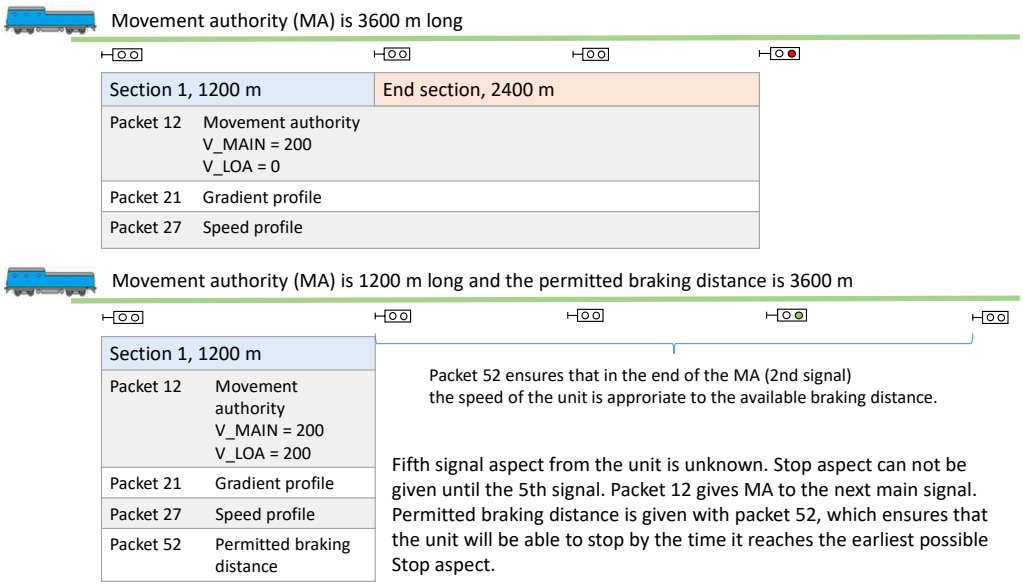


Figure 4. Movement authority, variant 1

Packet 12, Variant 2

Length of the Movement Authority is alternatively the distance

- to a known Stop signal in 3600 metres (Figure 5, top row)
- to a main signal with unknown aspect, but where movement is known to be authorised (Figure 5, bottom row).

At the end of the secured route the permitted speed is zero (V_LOA=0), even if the signal was Proceed.

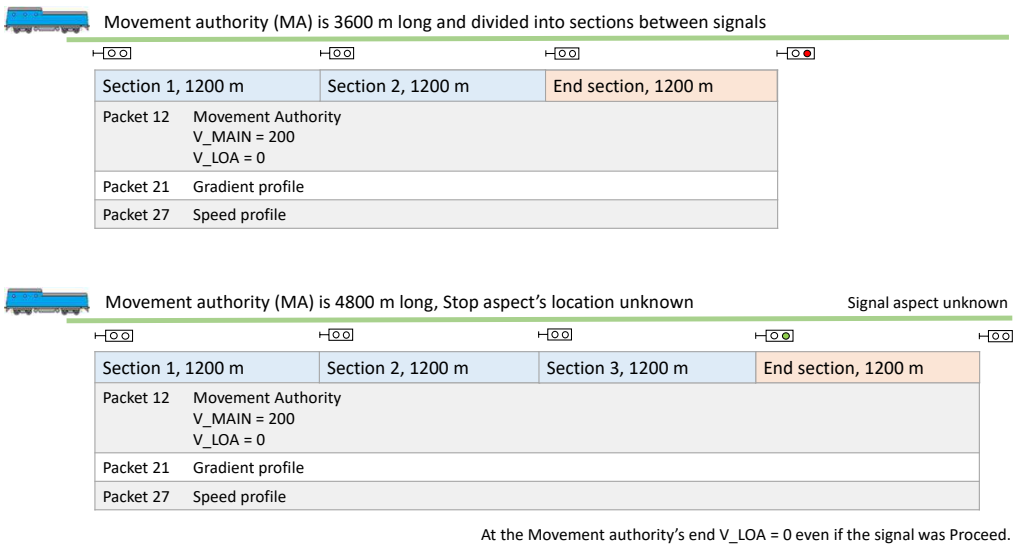


Figure 5. Movement authority, variant 2

5.1.2.4 Packet 21 Gradient Profile

Packet 21 gives a continuous track gradient profile. The information shall be given at least for the same distance as the one covered by the Movement Authority (MA) and the speed profiles (SSP).

Gradient data in the packet 21 is used, in addition to the control of Stop signals, to control speed restrictions and point specific restrictions. Gradient profiles are described in detail in chapter 6.

5.1.2.5 Packet 27 Static Speed Profile

Packet 27 gives a Static speed profile (SSP) for the track. The profile includes curve restrictions, point specific restrictions, temporary maximum speed increases and other permanent speed restrictions. The speed profile is given taking into account the data transmission distance.

Profile shall be given as continuous for the Basic SSP, but it can be discontinuous for cant deficiency and other international train categories. The selection of a speed profile is affected by the processing rules between different speed profiles (see chapter 4.3.1).

5.1.2.6 Packet 41 Level Transition

Packet 41 gives advance information about level transition and the distance to the level transition border. Packet 41 also gives the actual level transition order when the distance data is given with the value 0. Level transition is described in detail in chapter 4.9.

5.1.2.7 Packet 51 Axle load Speed Profile

Packet 51 gives the axle load profile for the track. The profile includes restrictions caused by track condition and track category and point specific restrictions. The axle load speed profile is given taking into account the data transmission distance.

5.1.2.8 Packet 52 Permitted Braking Distance

Speed restriction for service or emergency braking according to the available braking distance is given to the next distant signal or main signal or repeater balise where first information about a following Stop signal can be received. The length of the permitted braking distance is the distance from the location where the signal can be received to the first possible Stop signal. The length of the restriction zone before the signal shall be determined case-by-case.

Speed restriction for the permitted braking distance is only given when the Stop signal is not controlled as a target location. When the location of a Stop signal is known and the Movement Authority permits movement to that Stop signal, no speed restriction for the permitted braking distance is given.

Systematic use of speed restrictions ensure that each unit runs at a safe speed independent of the data transmission distance.

5.1.2.9 Packet 65 Temporary Speed Restriction

Packet 65 gives the temporary speed restrictions not included in the packets 27 and 51. A temporary speed restriction can be given a unique identification number with which the speed restriction can be revoked.

Restriction ID is presented with the variable NID_TSR and the speed variable V_TSR. Packet 66 may be used to revoke the temporary speed restriction based on it's ID (chapter 4.4.1).

5.1.2.10 Packet 136 Infill location reference

Packet 136 is issued with repeater balises and distant signals without a following main signal. The packet indicates which main signal the information is related to.

5.1.3 National definitions related with balise messages

Balise message data can be transmitted with several levels of accuracy. For each message, it is possible to select which distance unit (Q_SCALE) and which positioning accuracy (Q_LOCACC) are used.

Q_SCALE definition of distance unit (values: 0, 1 or 2): distance data can be given within an accuracy of 10 cm, 1 m or 10 m.

FI-FRS13 Default value shall be 1, within an accuracy of 1 meter and with the maximum data transmission distance of 32 767 metres.

Q_LOCACC positioning accuracy (values: 0-63 metres).

FI-FRS14 Default value used for linking balise groups is 12 m.

Effective gradient is given as the gradient value in balise messages. The gradient data is transmitted by trackside equipment within an accuracy of 1 ‰.

5.2 Data transmission distances

FI-FRS15 Principles for determining data transmission distances in the ETCS system shall be equivalent to the ones used in the current train control system JKV.

Advance information about a Stop signal, a point and a permanent speed restriction must be transmitted:

- at least 1000 m before the target point when the maximum permitted speed for the track is ≤ 40 km/h at the location where the advance information is transmitted for the first time,
- at least 2400 m before the target point when the maximum permitted speed for the track is ≤ 160 km/h at the location where the advance information is transmitted for the first time, or
- at least 3600 m before the target point when the maximum permitted speed for the track is over 160 km/h at the location where the advance information is transmitted for the first time.

5.3 Naming trackside equipment

A balise group may contain 1-8 balises. Each balise contains

- balises' number of order (1-8)
- total amount of balises in the group
- ID of the balise group

Number of order defines the balises' internal order and the balise groups nominal direction of operation in accordance to figure 6.

Location of a balise group shall be defined using the center point of the first balise of the group.

Naming of trackside equipment is presented in more detail in SRS 026 part 3.4.2.

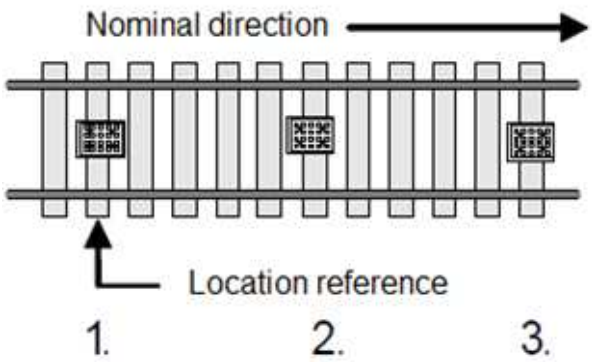


Figure 6. Balise group structure and location information

5.4 Trackside equipment placement

FI-FRS16 Distance between ETCS balise and JKV balise on a double equipped track shall be at least 10.5 m.

This distance ensures that the systems do not disturb each other.

On a double equipped track, ETCS balises shall be located at least 23.5 m in advance of a signal. Double equipment shortens the usable length of the track. This may become a problem for example on short platform tracks. Advantages and disadvantages of double equipment should be estimated case-by-case.

FI-FRS17 On ETCS track, the distance between the closest balise and a signal shall be at least 10 m.

5.5 Transition between train control systems

Next chapters describe the transition functions between JKV and ETCS tracks when ETCS and STM equipment are used.

FI-FRS18 Transition border between JKV and ETCS train control systems shall be located within a line section.

Placing the transition border in such a way that there is a point or another speed restrictive element after the transition balise group should be avoided. Because the braking curve calculation differ between the two train control systems, the permitted speed limit can change at the transition border and provoke braking.

Transition border shall be designed case-by-case. Transition border models that differ from the basic model should be designed and constructed by considering both risk assessment and braking curve calculations.

FI-FRS19 All level transitions that differ from recommendations shall be approved by the infrastructural manager of the railway network.

FI-FRS20 If it is necessary to set a temporary speed restriction at the transition border, the restriction shall be set on both sides of the transition border, so that both train control systems can supervise the restriction.

ETCS and STM modes related to level transition are presented in the following table:

Table 6. Modes related with level transition of the ETCS and STM equipment

Mode	Description
CS, Cold standby	Standby mode of the STM equipment
HS, Hot standby	Standby mode of the STM equipment: the equipment reads trackside equipment data, but the ETCS on-board equipment is still responsible for supervision
DA, Data available	Supervision mode of the STM equipment
FS, Full supervision	Supervision mode of the ETCS on-board equipment
SN, National supervision	Mode of the ETCS on-board equipment when the STM equipment is responsible for supervision
FA, Failure	Failure mode of the STM equipment

5.5.1 Transition from ETCS track to JKV track

Following figure presents the operational functions and distances of the trackside and the on-board equipment when moving from ETCS track to JKV track. Elements of the ETCS system are presented in blue and JKV system in green. Letters presented in the image refer to functions mentioned below.

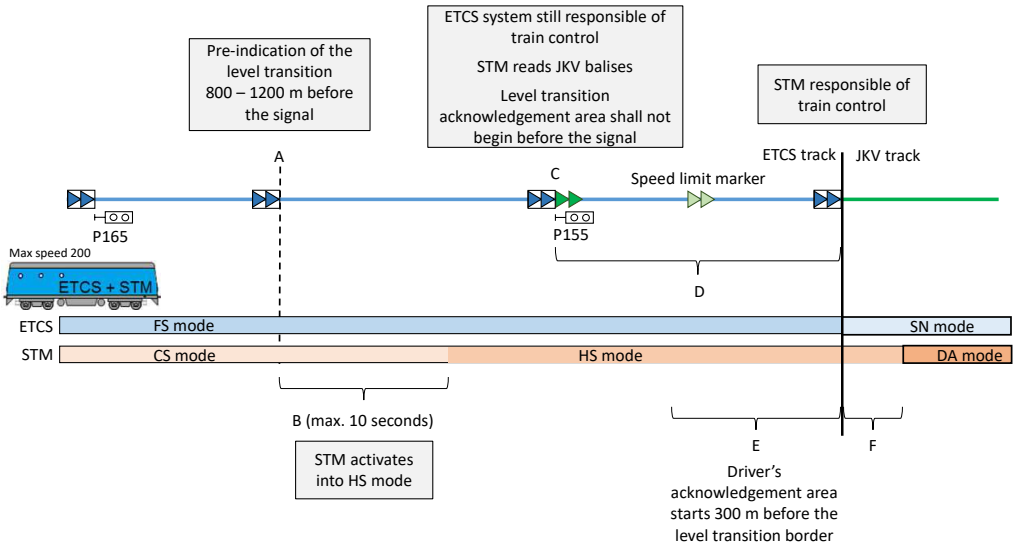


Figure 7. Transition from ETCS track to JKV track

A ETCS balise A gives advance information about the level transition (packet 41). It is recommended that advance information should be given by a fixed balise, so that the information is clearly distinguishable and will not disturb the detectability of the information received at signals and repeater balises.

FI-FRS21 Advance information of a level transition shall be given 800 to 1200 metres before the last signal on the ETCS track.

B Having received the advance information the ETCS on-board equipment gives an order that sets the STM equipment to HS mode. The activation of HS mode lasts maximum 10 seconds. After the activation time the STM equipment remains in HS mode and reads JKV balise messages.

C In this example the last signal before the transition border is double equipped. The objective of double equipment is to ensure that the on-board equipment has received all the necessary train control data, so that level transition can be performed without unnecessary restrictions.

FI-FRS22 JKV signal balise and if necessary also speed restriction with advance information balises shall be located in advance of the actual level transition border so that the route data received will be as complete as possible.

FI-FRS23 Advance information about the level transition shall be repeated at the signal (packet 41). The objective of the repetition is to ensure that the STM equipment has sufficient time to activate before the level transition border, and the level transition becomes effective even if one of the balises giving the advance information is out of order.

D It is recommended that the border balise should be located in advance of the repeater balise of the following signal. In this way the information is clearly distinguishable and will not disturb the detectability of the actual signal information.

FI-FRS24 Distance between signal balise C and the actual transition border shall be longer than the acknowledgment area resulting in the driver's acknowledgment function activating after the signal C.

E Driver shall acknowledge the level transition. The acknowledgment shall be done 300 m before the transition border or within 5 seconds after crossing the transition border. The acknowledgment area E is determined in the message in packet 41 with the variable L_ACKLEVELTR.

FI-FRS25 At the transition border from ETCS track to JKV track the default value for variable L_ACKLEVELTR shall be 300 m.

F If the driver has acknowledged the level transition and the train has passed the border balise, the ETCS on-board equipment orders the STM equipment to enter DA mode. ETCS on-board equipment supervises the level transition and transfers the responsibility of train control to the STM equipment after the transition.

Reacting to exceptional situations

- If STM equipment's mode transition CS -> HS does not become effective within 10 seconds, the ETCS on-board equipment orders the STM equipment to enter FA mode.
- If the driver does not acknowledge the level transition (300m + 5 s), the ETCS on-board equipment applies service brake and stops the unit.
- If STM equipment's mode transition HS -> DA does not become effective within 5 seconds, the ETCS on-board equipment applies service brake.
- If signal information is not available or if the STM equipment cannot receive sufficient advance information before the transition border the STM Start speed restriction 35 km/h shall be applied at the border.
- If a border balise is out of order and the information about the level transition is not received, the level transition becomes effective anyway, if the unit has received advance information about the level transition and if the distance given by advance information has been passed.

General requirements and functions concerning level transition are presented in detail in the document SUBSET 035 (*Specific Transmission Module, Annex A*) and in SRS 026, chapter 5.10.

5.5.2 Transition from JKV track to ETCS track

Following figure presents the operational functions and distances of the trackside and on-board equipment, when moving from JKV track to ETCS track.

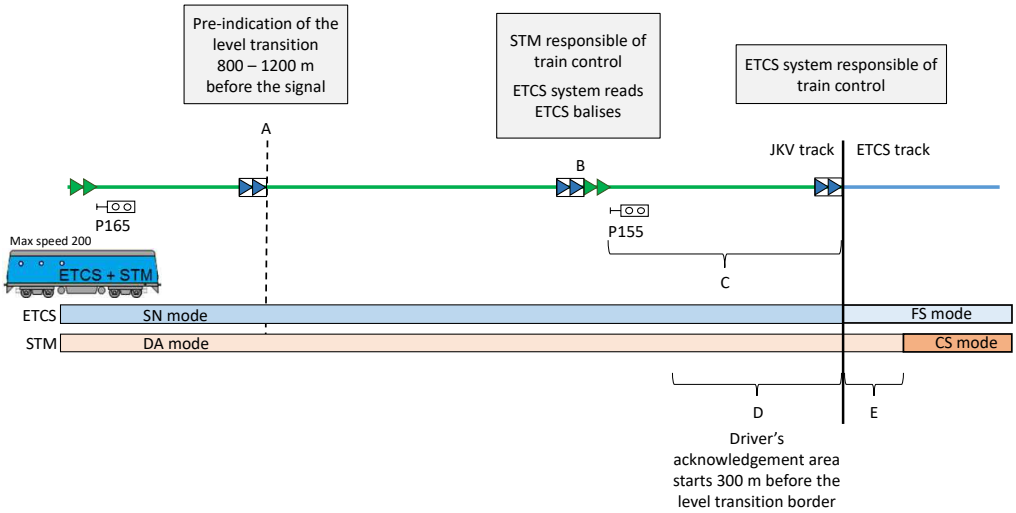


Figure 8. Transition from JKV track to ETCS track

A ETCS balise A gives advance information about the level transition (packet 41). It is recommended that advance information should be given by a fixed balise, so that the information is clearly distinguishable and will not disturb the detectability of the information received at signals and repeater signals.

FI-FRS26 Advance information of a level transition shall be given 800-1200 metres before the final JKV track signal.

B Sufficient distance between the signal B and and the level transition border helps avoid a situation where too much simultaneous information is transmitted to the driver at the signal balise.

C Distance between the signal and the actual level transition border must be longer than the acknowledgment distance.

FI-FRS27 Distance between signal point B and the actual transition border shall be longer than the acknowledgement distance resulting in the driver's acknowledgment function activating after the signal B.

D Driver shall acknowledge the level transition. The acknowledgment must be done 300 m before the transition border or within 5 seconds after crossing the transition border. The acknowledgment distance is defined in the message in the packet 41 with the variable L_ACKLEVELTR.

FI-FRS28 At the transition border from JKV track to ETCS track the default value for variable L_ACKLEVELTR shall be 300 m.

E If the driver has acknowledged the level transition and the unit has passed the transition border balise, ETCS on-board equipment takes control and orders the STM equipment to transfer from DA mode to CS mode.

Reacting to exceptional situations

- If STM equipment's mode transition DA -> CS does not become effective within 10 seconds, the ETCS on-board equipment orders the STM equipment to enter FA mode.
- If the driver does not acknowledge the level transition, the ETCS on-board equipment applies service brake and stops the unit.
- If a border balise is out of order and the information about the level transition is not received, the level transition becomes effective anyway, if the unit has received advance information about the level transition and if the distance given by advance information has been passed.

5.5.3 Transition border planning

Transition borders shall be planned and designed case-by-case considering the longevity of the interface. Permanent solutions shall be located in a way that additional speed restrictions are not needed.

Maximum permitted speed and distances between signals within the track section shall be considered when planning the transition border location. Locating the first advance information balise or the actual transition border near a signal or repeater balise shall be avoided.

5.6 ETCS track maintenance and inspection

Maintenance requirements for ETCS trackside equipment are described in detail in the ETCS trackside equipment maintenance manuals. Maintenance work of ETCS trackside equipment shall be documented.

6 ETCS on-board equipment

ETCS on-board equipment performs an automatic start test during the starting procedure. Driver machine interface indicates the test results.

When ETCS on-board equipment starts functioning, the driver has to enter his ID, the ETCS level to be applied and the train data required.

6.1 Configuring the on-board equipment

Acquiring new on-board equipment allows modifying some operational functions, such as the features of the driver machine interface and preconfigured train data.

The following describes national requirements that shall be taken into account during the acquisition process of an ETCS on-board system.

6.1.1 Operating on electrified track

ETCS system enables automatic controlling of pantographs or line interrupter through the on-board equipment. It is also possible to limit the power consumption through ETCS trackside equipment (M_CURRENT).

FI-FRS29 ETCS on-board equipment to be used on Finnish railway network shall have a function that ensures that pantograph or line interrupter control shall not be automated by trackside equipment.

JKV system does not transmit advance information about the electrified track. In order to avoid confusion, operating with pantographs or with a line interrupter will, for the moment, not be automatised in the ETCS system.

6.1.2 Loading gauge

ETCS system enables the control of restrictions for loading gauge through the on-board equipment.

FI-FRS30 ETCS on-board equipment to be used on Finnish railway network shall have a function that does not require loading gauge as train data.

At the moment, Finnish railway network does not impose restrictions for loading gauge that should be supervised by the train control system. The loading gauge used in Finland is not in the loading gauge profiles defined in INF TSI.

6.1.3 Air intake

ETCS system enables air intake control through the ETCS on-board equipment.

FI-FRS31 ETCS on-board equipment to be used on Finnish railway network shall have a function that does not require air intake data as train data.

Air intake control by trackside equipment will not be commissioned. At the moment there is no need to introduce air intake control through trackside equipment on the Finnish railway network.

6.1.4 Technical speed in SR mode

National maximum speed in Staff Responsible mode (SR) is 50 km/h. The national value is used as a default value in SR mode. However, in SR mode the driver is authorised to manually raise the speed.

FI-FRS32 Technical maximum speed limit of SR mode for the ETCS on-board equipment to be used on Finnish railway network shall be 80 km/h.

Definition of this technical maximum speed limit is based on the speed sign system used on Finnish railway network.

6.1.5 Standard composition of trains

It is possible to define a standard train composition for the ETCS on-board equipment. Train data input can be speeded up by pre-defining standard train compositions (for example one locomotive and four double-decker wagons).

Standard composition shall be defined by the procuring operator.

6.2 National specificities of the modes

6.2.1 No Power mode

In No Power (NP) mode it is possible to select the Cold Movement Detection function, when the ETCS on-board equipment saves the following recorded information at least for 72 hours after turning off the ETCS on-board equipment:

- ETCS level
- unit location data
- EoLM data (Euroloop)

Use of the Cold Movement Detection function shall be decided by the procuring operator. Cold Movement Detection function is applicable only on ETCS level 2.

7 Gradients in the ETCS system

7.1 Gradient profile

Gradient profile of the track is designed by dividing the track into segments. The length of the segments varies from a few hundred meters to several kilometres. The gradient profile of the track presented in speed charts form the basis of the ETCS gradient profile.

Gradient can be expressed within an accuracy of 1 ‰.

When there is no gradient profile available it is possible to define a default gradient (in packet 141) for a temporary speed restriction (TSR).

7.2 Gradient profile correction factor for normal service braking

Normal service braking deceleration controls the GUI curve which encourages good driving behaviour.

Correction factor Kn+(V) depending on the speed of Gamma trains is used for ascent and the correction factor Kn-(V) for descent. The values of the correction factors Kn+(V) and Kn-(V) are always positive. The value of the factors varies between 0-10 m/s^2. The value is given as a value depending on speed, with no more than five intermediary stages.

Values Kn+(V) and Kn-(V) are configured for the on-board equipment. The value of the variables shall be defined during the acquisition process by the procuring operator.

7.3 Compensation for train length

Gradient values used in deceleration calculations are defined by comparing the gradient between the actual location of the train and the target point, so that the used gradient value is the smallest of all the gradient values within the train's length.

The smallest gradient remains the determining gradient as long as a part of the unit is located within the area of that gradient.

7.4 Compensation for rotating masses

Rotating mass has an effect on the deceleration of the unit running ascent or descent. Because of rotating masses, the effect of the gradient on the unit's deceleration is compensated with correction factors. For a unit, in which rotating masses form an unknown part of the total weight, the equations are:

Deceleration change (increase) running ascent =
gradient * 9.81 m/s² / (1000 + 10 * 15)

Deceleration change (decrease) running descent =
gradient * 9.81 m/s² / (1000 + 10 * 2)

The equations above shall be used for Lambda trains and also for Gamma trains, if necessary. For a Gamma train with a fixed composition, the percentage of rotating masses can be defined, if it is known. In that case, the equations are:
Deceleration change (increase) running ascent =
gradient * 9.81 m/s² / (1000 + 10 * percentage of rotating masses in the total train weight)

Deceleration change (decrease) running descent =
gradient * 9.81 m/s² / (1000 + 10 * percentage of rotating masses in the total train weight)

Below, there is an example calculation presenting the effect of 10 ‰ and 5 ‰ ascent on deceleration. Without compensating for rotating masses, the deceleration of the train would increase by 0.1 m/s² and 0.05 m/s² because of ascent. By compensating for the rotating masses, the effect of ascent on deceleration shall be reduced 0.1 m/s² and 0.05 m/s² from the above values.

The same kind of effect can be observed in descent; without compensating for rotating masses, 10 ‰ and 5 ‰ descent would decrease the deceleration of the train by 0.1 m/s² and 0.05 m/s². By compensating for rotating masses, the effect of descent on deceleration shall be modified -0.1 m/s² and -0.05 m/s² from the above values.

Table 7. Compensation for rotating masses

Gradient [‰]	Uncompensated deceleration change [m/s²]	Compensated deceleration change [m/s²]	Degree of compensation [m/s²]
10	0.100	0.0850	-0.015
5	0.050	0.0430	-0.007
0	0.000	0.0000	0.000
-5	-0.050	-0.0480	0.002
-10	-0.100	-0.0960	0.004

7.5 Effect of gradient on deceleration

Change in deceleration caused by compensating for rotating masses influences the effectiveness of both emergency braking and service braking with full force.

Effectiveness of normal service braking is affected by, in addition to the compensating for rotating masses, the corrective factors Kn+(V) and Kn-(V) described before. Because of these correction factors, the increase in deceleration caused by ascent and the decrease in deceleration caused by descent can be reduced. In ascent, the correction factor Kn+(V) causes anticipation in the GUI curve, and in descent, the corrective factor Kn-(V) causes delay in the GUI curve.

If the value of the correction factor varies between 0-10 m/s^2, the gradient value is entered in the formula as a decimal figure.

7.6 Message packets with gradient values

Gradient values are G_A, G_PBDSR and G_TSR. The gradient value G_A is given in the Gradient Profile packet 21. The gradient value G_PBDSR is given in the Permitted Braking Distance Information packet 52. The gradient value G_TSR is given in the Default Gradient for Temporary Speed Restriction packet 141.

Bibliography

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Technical specification for interoperability relating to the 'operation and traffic management' subsystem of the rail system in the European Union (OPE TSI)

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ATP-VR/RHK STM-N FRS & GRS & RAMS (2011)
Suomen kansalliset ERTMS/ETCS-parametrit (2015)
Rautateiden verkkoselostus 2016

Others
FIS Juridical recording (Subset 027)
SFS-EN 15528
Assignment of values to etcs variables, ERA_ERTMS_040001
ETCS Driver Machine interface (DMI) ERA_ERTMS_015560
Subset-026 ETCS System Requirements Specification
Subset-035 Specific Transmission Module FFFIS

Requirement table

Identification	Chapter	Requirement	Additional notes	Reference
FI-FRS01	3.1	ETCS system to be procured shall conform to the European Railway Agency's (hereinafter referred to as the ERA) definition and ETCS baseline 3 requirements (CCS TSI, *Set of specifications #2*, ETCS baseline 3).		Set of specifications #2, ETCS baseline 3
FI-FRS02	3.1	Trackside and on-board equipment to be procured shall be updatable to meet ETCS level 2 requirements.	Primarily traffic operation will begin at ETCS level 1	Transition periods for the implementation of the ETCS system in procurements: TRAFI/14975/03.04.02.00/2016
FI-FRS03	3.2.2	NID_C identifiers are used in accordance with maintenance areas.	The Finnish national railway network has currently reserved 14 units of NID_C identifiers (numbers 322-335). The identifiers will be implemented in conjunction with construction.	
FI-FRS04	3.2.2	Identifier for the Finnish railway networks electrification system NID_CTRACTION = 27 shall be programmed as a default for the electric powered locomotives ETCS on-board equipment.		

Identification	Chapter	Requirement	Additional notes	Reference
FI-FRS05	3.3	ETCS on-board equipment to be procured shall have all possible modes presented in ETCS baseline 3 in use.		System Requirements Specification, Chapter 4, Modes and Transitions" Subset-026, Issue 3.3.0
FI-FRS06	3.3.1	Limited supervision mode (LS) shall only be used in an exceptional circumstance in a restricted area, and with the separate authorisation of the infrastructural manager of the railway network.		
FI-FRS07	3.3.1	Reverse mode (RV) shall only be used in a restricted area, and with the separate authorisation of the infrastructural manager of the railway network.		
FI-FRS08	4.1	ETCS on-board equipment to be used on Finnish railway network shall have all train categories available.		
FI-FRS09	4.2	ETCS on-board equipment to be used on Finnish railway network shall allow all the axle load categories required in the use of the equipment to be selectable.		

Identification	Chapter	Requirement	Additional notes	Reference
FI-FRS10	4.6.2	At the signal, signalling related speed restrictions shall be set to the same value as the basic speed profile.	In Finland, unique ID values are in use, using values between 0-126 or 255. The unique ID's in use for NID_C by areas is restricted. The ID 255 is to be used whenever possible, 0-126 is for updatables only.	
FI-FRS11	4.6.4	Unit with a temporary maximum speed increase shall set its maximum permitted speed according to the temporary maximum speed increase area.		
FI-FRS12	5.1.2.1	National values shall be given in places where a unit can enter the Finnish national railway network.		
FI-FRS13	5.1.3	Default value shall be 1, within an accuracy of 1 meter and with the maximum data transmission distance of 32 767 metres.	Q_SCALE = 1	
FI-FRS14	5.1.3	Default value used for linking balise groups is 12 m.	Q_LOCACC = 12 m	
FI-FRS15	5.2	Principles for determining data transmission distances in the ETCS system shall be equivalent to the ones used in the current train control system JKV.		RATO10 10.2.2

Identification	Chapter	Requirement	Additional notes	Reference
FI-FRS16	5.4	Distance between ETCS balise and JKV balise on a double equipped track shall be at least 10.5 m.		
FI-FRS17	5.4	On ETCS track, the distance between the closest balise and a signal shall be at least 10 m.		
FI-FRS18	5.5	Transition border between JKV and ETCS train control systems shall be located within a line section.		
FI-FRS19	5.5	All level transitions that differ from recommendations shall be approved by the infrastructural manager of the railway network.		
FI-FRS20	5.5	If it is necessary to set a temporary speed restriction at the transition border, the restriction shall be set on both sides of the transition border, so that both train control systems can supervise the restriction.		
FI-FRS21	5.5.1	Advance information of a level transition shall be given 800 to 1200 metres before the last signal on the ETCS track.		

Identification	Chapter	Requirement	Additional notes	Reference
FI-FRS22	5.5.1	JKV signal balise and if necessary also speed restriction with advance information balises shall be located in advance of the actual level transition border so that the route data received will be as complete as possible.		
FI-FRS23	5.5.1	Advance information about the level transition shall be repeated at the signal (packet 41). The objective of the repetition is to ensure that the STM equipment has sufficient time to activate before the level transition border, and the level transition becomes effective even if one of the balises giving the advance information is out of order.		
FI-FRS24	5.5.1	Distance between signal balise C and the actual transition border shall be longer than the acknowledgment area resulting in the drivers acknowledgment function activating after the signal C.		
FI-FRS25	5.5.1	At the transition border from ETCS track to JKV track the default value for variable L_ACKLEVELTR shall be 300 m.	L_ACKLEVELTR = 300m	
FI-FRS26	5.5.2	Advance information of a level transition shall be given 800-1200 metres before the final JKV track signal.		

Identification	Chapter	Requirement	Additional notes	Reference
FI-FRS27	5.5.2	Distance between signal point B and the actual transition border shall be longer than the acknowledgment distance resulting in the drivers acknowledgment function activating after the signal B.		
FI-FRS28	5.5.2	At the transition border from JKV track to ETCS track the default value for variable L_ACKLEVELTR shall be 300 m.		
FI-FRS29	6.1.1	ETCS on-board equipment to be used on Finnish railway network shall have a function that ensures that pantograph or line interrupter control shall not be automated by trackside equipment.		
FI-FRS30	6.1.2	ETCS on-board equipment to be used on Finnish railway network shall have a function that does not require loading gauge as train data.		
FI-FRS31	6.1.3	ETCS on-board equipment to be used on Finnish railway network shall have a function that does not require air intake data as train data.		
FI-FRS32	6.1.4	Technical maximum speed limit of SR mode for the ETCS on-board equipment to be used on Finnish railway network shall be 80 km/h.		

ERTMS/ETCS system's national parameters and chosen national values

Parameter abbreviation	Description	Default value	National value
V_NVONSIGHT	On Sight mode speed limit	30 km/h	35 km/h
V_NVSTFF	Staff Responsible mode speed limit	40 km/h	50 km/h
V_NVSHUNT	Shunting mode speed limit	30 km/h	35 km/h
V_NVUNFIT	Unfitted mode speed limit	100 km/h	80 km/h
V_NVLIMSUPERV	Limited supervision mode speed limit	100 km/h	80 km/h
V_NVREL	Release Speed	40 km/h	15 km/h
V_NVALLOWOVTRP	Speed limit for triggering the override function	0 km/h	50 km/h
V_NVSUPOVTRP	Override speed limit to be supervised when the override function is active	30 km/h	50 km/h
T_NVOVTRP	Maximum time for overriding the train trip	60 s	60 s
D_NVOVTRP	Maximum distance for overriding the train trip	200 m	200 m
D_NVROLL	Roll away distance limit	2 m	8 m
Q_NVGUIPERM	Permission to use the guidance curve	No	Yes
Q_NVSBTSMPERM	Permission to use service brake in target speed monitoring	Yes	
Q_NVSBFBPERM	Permission to use the service brake feedback	No	
Q_NVEMRRLS	Permission to release emergy brake	When stopped	When stopped
M_NVDERUN	Change of Driver ID permitted while running	Yes	Yes
Q_NVDRIVER_ADHES	Qualifier for the modification of trackside adhesion factor by driver	No	
M_NVCONTACT	T_NVCONTACT reaction	No action	
T_NVCONTACT	Maximal time without new 'safe' message	∞	
D_NVPOTRP	Maximum distance for reversing in Post Trip mode	200 m	200 m
D_NVSTFF	Maximum distance for running in Staff Responsible mode	∞	∞
Q_NVINHSMICPERM	Permission to inhibit the compensation of the speed measurement in accuracy	No	No
Q_NVLOCACC	Default accuracy of the balise location (absolute value)	12 m	12m

Open questions concerning on-board equipment

L3.1 Supervision of double pressure brakes

ETCS on-board equipment is not supervising the increase of brake pipe pressure during service braking. Even a small increase in brake pipe pressure during service braking can provoke the disconnecting of brakes in units equipped with double pressure brakes.

L3.2 Lowest permitted brake weight percentage

The lowest permitted brake weight percentage for the ETCS on-board equipment is 30 %. Currently on Finnish railway network there are units with a brake weight percentage lower than 30 %. These units will not be able to operate with ETCS on-board equipment on Finnish railway network.

L3.3 ETCS weather condition coefficient

Definition of the ETCS weather condition coefficient is based on the friction between the rail and the wheels of the unit. It does not sufficiently consider the decrease in friction caused by weather conditions.

In Finland, especially the brake weight percentages of freight trains vary on a large scale, and to ensure safe traffic, the fixed weather condition coefficient has to be defined to correspond to the lowest value. Because of this, the fluency of traffic is excessively reduced for units equipped with more effective brakes.

L3.4 Service braking

ETCS on-board equipment's braking curve calculation is based on the emergency braking curve. ETCS on-board equipment ables also service braking. ETCS service braking is always applied with full force.

According to the current train control system JKV, service braking is the primary braking method, and emergency braking a backup method. Depending on the type and the maximum permitted speed of the train, service braking in the JKV system can be applied lightly or with full force. This ensures that after service braking the air pressure brakes or the magnetic shoe brakes have braking power left, if the service braking has not been sufficient.

Applying service brake lightly can prevent unnecessary damage to the wheels, especially with freight trains.

L3.5 Brake types

ETCS system uses two brake types for freight trains (P and G) and one brake type for passenger trains (P).

The brake types differ substantially from the current options of G/P/R. The operator shall take these differences into account in their guidelines.

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