ERTMS/ETCS

System Requirements Specification
Chapter 3
Principles

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3.1 Modification History

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1.1.1 990521	All	Corrections after UNISIG review.	KL
1.1.2 990713	All	Additional functions for class 1 and changes related to these functions in other parts	KL
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	marked)	
2.2.2 020201	Refer to document: SUBSET–026 Corrected Paragraphs, Issue 2.2.2	KL
2.2.4 SG checked 040528	Including all CLRs agreed with the EEIG (see "List of CLRs agreed with EEIG for SRS v2.2.4" dated 28/05/04) Affected clauses see change marks	H. Kast
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2.2.7 220705	Including all CLRs extracted from "CR-Report_10.6.05-by number.rtf" and mentioned in column 2.2.7 in "CR status 13.6.05.xls" 22/07/05 Changes for CR 126 included (HK)	OG
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3.0.0 13/12/08	Release version	AH

3.0.1 22/12/09	Including the results of the editorial review of the SRS 3.0.0 and the other error CR's that are in state "Analysis completed" according to ERA CCM	AH
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3.3.0 07/03/12	Baseline 3 release version	AH
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3.3.2 23/04/14	Baseline 3 1st maintenance pre-release version	OG
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3.4.3 16/12/15	CR1283 plus update due to overall CR consolation phase	OG
3.5.0 18/12/15	Baseline 3 2nd release version as recommended to EC (see ERA-REC-123-2015/REC)	OG
3.5.1 28/04/16	CR 1249 reopening following RISC #75	OG
3.6.0 13/05/16	Baseline 3 2nd release version	AH

3.2 Table of Contents

3.3 Introduction

3.3.1 Scope and purpose

3.3.1.1 The chapter 3, Principles, specifies the system principles of ETCS/ERTMS. These principles apply to on-board and trackside subsystems.

3.3.1.2 The principles define the operational and technical behaviour of the system in general and functional terms.

3.3.1.3 The chapter is divided into subchapters. In each subchapter normally several requirements are defined. Each requirement is identified with a unique identification number.

3.3.1.4 Notes, Justifications and Examples are only informative and shall not be regarded as requirements.

3.4 Balise configuration and linking

3.4.1 Balise Configurations – Balise Group Definition

3.4.1.1 A balise group shall consist of between one and eight balises.

3.4.1.2 In every balise shall at least be stored:

a) The internal number (from 1 to 8) of the balise
b) The number of balises inside the group
c) The balise group identity.

3.4.1.3 The internal number of the balise describes the relative position of the balise in the group.

3.4.2 Balise Co-ordinate System

3.4.2.1.1 Every balise group has its own co-ordinate system.

3.4.2.1.2 The orientation of the co-ordinate system of a balise group (i.e., nominal or reverse direction) is identified as balise group orientation.

3.4.2.2 Balise groups composed of two or more balises

3.4.2.2.1 The origin of the co-ordinate system for each balise group is given by the balise number 1 (called location reference) in the balise group.

3.4.2.2.2 The nominal direction of each balise group is defined by increasing internal balise numbers.

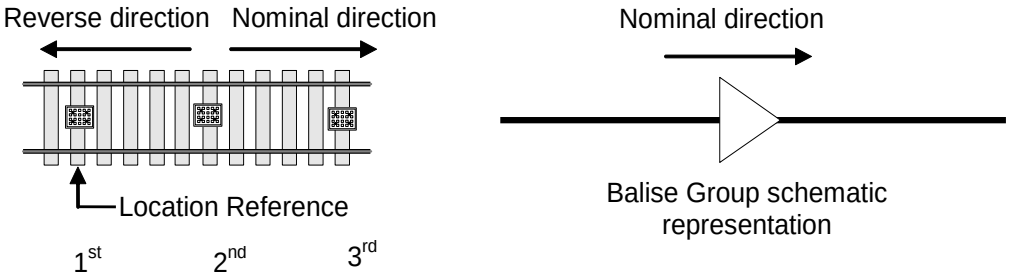


Figure 1: Orientation of the balise group

3.4.2.3 Balise groups composed of a single balise

3.4.2.3.1 Balise groups consisting of only one single balise are referred to as "single balise groups" in the following.

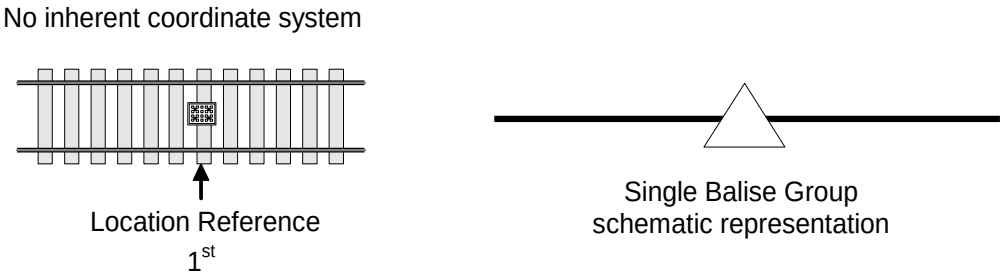


Figure 1a: Single balise group

3.4.2.3.2 Level 1:

3.4.2.3.2.1 The assignment of the co-ordinate system shall be by means of linking data.

3.4.2.3.2.2 For balise groups consisting of a single balise, the information "direction with which the linked balise group will be passed over" received from a previous balise group shall assign a co-ordinate system to the balise.

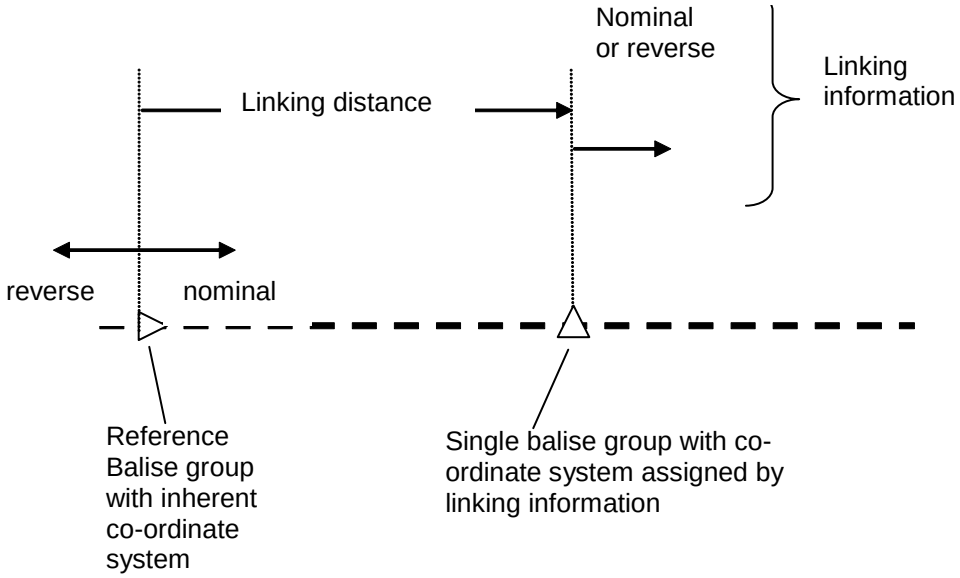


Figure 2: Assignment of a co-ordinate system to a single balise group by linking

3.4.2.3.2.3 The reference for the linking data shall be either a single balise group if a co-ordinate system has been assigned to it before, or a balise group consisting of two or more balises (with "inherent" co-ordinate system)

3.4.2.3.3 Level 2/3:

3.4.2.3.3.1 If the ERTMS/ETCS on-board equipment cannot evaluate the orientation of the last balise group detected, being a single balise group, i.e. no linking information is available to identify the orientation of the co-ordinate system of this single balise group, the ERTMS/ETCS on-board equipment shall report its position by means of a position report based on two balise groups reporting the train position in reference to the LRBG and the “previous LRBG”, if any.

3.4.2.3.3.1.1 Note: Receiving this type of position report advises the RBC of the need to assign a co-ordinate system to this single balise group.

3.4.2.3.3.2 When a single balise group is detected and the previous LRBG is known, the position report based on two balise groups shall use as direction reference a move from the “previous LRBG” towards this single balise group (being the new LRBG): directional information in the position report pointing in the same direction as the direction reference shall be reported as “nominal”, otherwise as “reverse”.

3.4.2.3.3.3 If the “previous LRBG “ is not known, the “previous LRBG” and all directional information of the position report based on two balise groups shall be reported as “unknown”.

3.4.2.3.3.4 If a new single balise group (BG2), different from the current LRBG (BG1), becomes LRBG while the running direction of the train is opposite to the running direction when this current LRBG (BG1) was last passed, the “previous LRBG” and all

directional information of the position report based on two balise groups shall be reported as “unknown” (see Figure 2a).

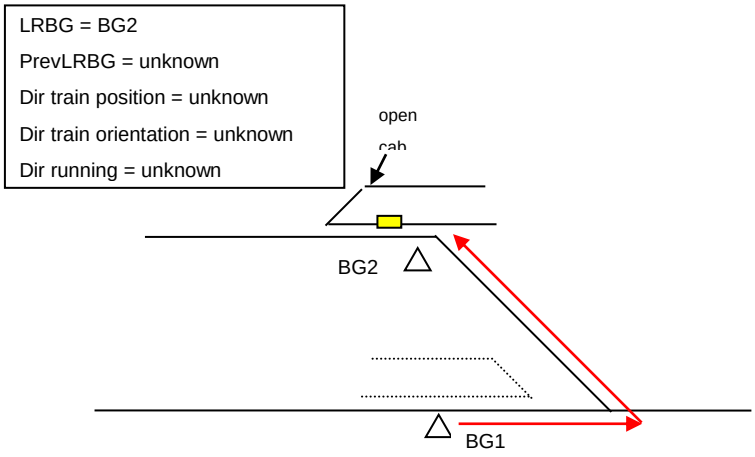


Figure 2a: Position report based on two balise groups versus train running direction

3.4.2.3.3.5 If a single balise group, being the LRBG, is detected again, the LRBG and the “previous LRBG” of the position report based on two balise groups shall remain unchanged.

3.4.2.3.3.6 The assignment of a co-ordinate system received from the RBC shall identify the balise group for which the assignment is given, and shall assign a balise group orientation “nominal” or “reverse” to this balise group relative to the on-board direction reference reported in the position report based on two balise groups (see 3.4.2.3.3.2).

3.4.2.3.3.6.1 Note: From the sequence of reported balise groups, the RBC can derive the balise group orientation with which the balise group was passed.

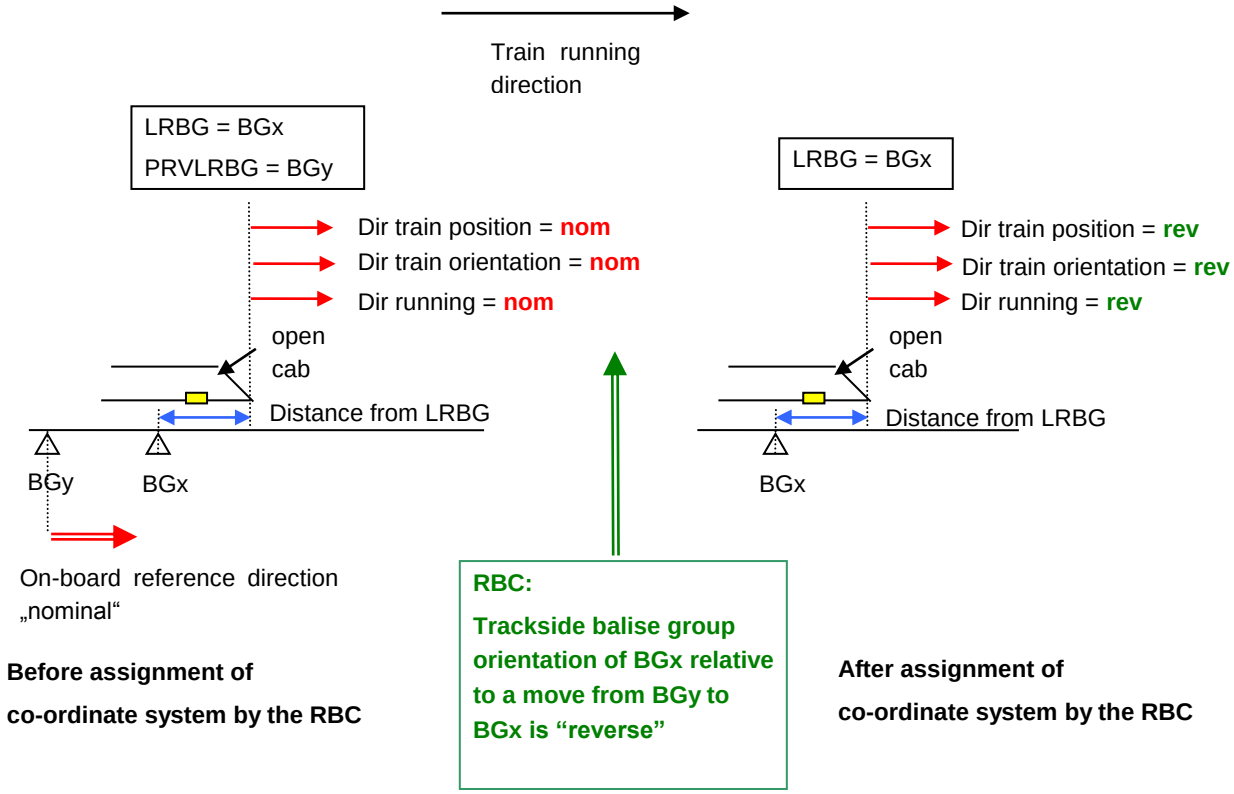


Figure 2b: Example for assigning a co-ordinate system

3.4.2.3.3.7 For single balise groups reported as LRBG and stored according to 3.6.2.2.2c, awaiting an assignment of a co-ordinate system, the ERTMS/ETCS on-board equipment shall be able to discriminate if a single balise has been reported more than once and with different “previous LRBGs” to the RBC.

3.4.2.3.3.7.1 Note: For a single balise group reported as LRBG awaiting the assignment of a co-ordinate system also the rules for LRBGs reported to the RBC (see 3.6.2.2.2) apply.

3.4.2.3.3.8 A co-ordinate system assignment received from trackside shall be rejected by the ERTMS/ETCS on-board equipment if the referred LRBG is memorised (see 3.6.2.2.2c) to have been reported more than once and with different “previous LRBGs”.

3.4.2.3.3.8.1 Note: If a single balise group is memorised, according to 3.6.2.2.2c, more than once, and with different “previous LRBGs”, the assignment of the co-ordinate system is ambiguous.

3.4.2.4 Balise groups composed of one pair of duplicated balises

3.4.2.4.1 A group of two balises duplicating each other shall be treated as a single balise group in case where only one balise is correctly read.

3.4.3 Balise Information Types and Usage

3.4.3.1 In level 1, all information to the on-board system is given from balise groups or additionally from EUROLOOPS or Radio Infill Units (see section 3.9). In level 2/3, balise groups are mostly used for location information.

3.4.3.2 A balise may contain directional information, i.e. valid either for nominal or for reverse direction, or may contain information valid for both directions. In level 1, this information can be of the following type (please refer to section 3.8.5):

a) Non-infill

b) Intentionally deleted

c) Infill.

3.4.3.2.1 Intentionally deleted.

3.4.3.2.2 Note: Infill information is referring to the location reference of an announced balise group.

3.4.3.3 Some information shall be read also in sleeping mode and when no linking information is available (see Chapter 4 Use of received information). If such information is transmitted by balises, and if the information is directional, balise groups consisting of at least two balises shall be used.

3.4.4 Linking

3.4.4.1 Introduction

3.4.4.1.1 Aim of linking:

- To determine whether a balise group has been missed or not found within the expectation window (see section 3.4.4.4) and take the appropriate action.
- To assign a co-ordinate system to balise groups consisting of a single balise.
- To correct the confidence interval due to odometer inaccuracy (see section 3.6.4).

3.4.4.1.2 A balise group is linked when its linking information (see section 3.4.4.2) is known in advance.

3.4.4.1.2.1 Note: In cases where a balise group contains repositioning information, the term linked also applies since the balise group is announced, marked as linked and contains repositioning information marked accordingly.

3.4.4.2 Content of linking information

3.4.4.2.1 Linking information shall be composed of:

a) The identity of the linked balise group.

b) Where the location reference of the group has to be found.

c) The accuracy of this location.
Note: If the reference balise is duplicated, it is the trackside responsibility to define the location accuracy to cover at least the location of the two duplicated balises.

d) The direction with which the linked balise group will be passed over (nominal or reverse).

e) The reaction required if a data consistency problem occurs with the expected balise group.

3.4.4.2.1.1 "Linking information is used" shall be interpreted as when balise group(s) are announced and the minimum safe antenna position has not yet passed the expectation window of the furthest announced balise group.

3.4.4.2.2 Instead of the identity of a linked balise group it shall be possible to identify a following linked balise group as unknown but containing repositioning information

3.4.4.2.2.1 Intentionally deleted.

3.4.4.2.2.2 Note 1: Regarding the repositioning information, see chapter 3.8.5.3.5 and 3.8.5.2.

3.4.4.2.2.3 Note 2: In case the identity of the next balise group is not unambiguously known because the route is not known by the trackside, this feature allows to link this balise group.

3.4.4.2.3 For each linked balise group, the trackside shall select one of the following reactions to be used in case of data inconsistencies:

a) Train trip (Trip mode, see Chapter 4)

b) Command service brake

c) No reaction

For further details see section 3.16.2.

3.4.4.3 Unlinked Balise Groups

3.4.4.3.1 A balise group, which contains information that must be considered even when the balise group is not announced by linking, is called an unlinked balise group.

3.4.4.3.2 Unlinked balise groups shall consist at minimum of two balises.

3.4.4.3.3 Unlinked balise groups shall always contain the unlinked balise group qualifier.

3.4.4.4 Rules related to linking

3.4.4.4.1 When no linking information is used on-board, all balise groups shall be taken into account.

3.4.4.4.2 When linking information is used on-board, only balise groups marked as linked and included in the linking information and balise groups marked as unlinked shall be taken into account.

3.4.4.4.2.1 When linking information is used on-board and the expected balise group is referred in the linking information with a balise group with ID “unknown”, a balise group marked as linked shall only be taken into account if:

a) the on-board equipment can determine the orientation of the linked balise group by information from the balise group itself (therefore excluding for example single balise groups), AND

b) the balise group contains repositioning information valid for the train orientation, AND

c) the balise group is crossed with the direction announced in the linking information.

3.4.4.4.3 The on-board equipment shall accept a balise group marked as linked and included in the linking information (i.e. the balise giving the location reference) from

- when the max safe front end of the train has passed the first possible location of the balise group

until

- the min safe front end of the train has passed the last possible location of the balise group

taking the offset between the front of the train and the balise antenna into account.

3.4.4.4.3.1 Note: The first possible location and the last possible location of the balise group are defined by the linking distance and the location accuracy.

3.4.4.4.3.2 Note: The interval between the outer limits to accept the balise group defines the expectation window.

3.4.4.4.4 In case of a balise group containing repositioning information, the first possible location shall start from the previously linked balise group.

3.4.4.4.5 The on-board equipment shall expect balise groups one by one (i.e., it shall supervise only one expectation window at a time) according to the order given by linking information.

3.4.4.4.6 The ERTMS/ETCS on-board equipment shall stop expecting a balise group and shall expect the next one announced in the linking information (if any) when:

a) the balise group is found inside its expectation window

b) a linking consistency error is found, see 3.16.2.3.1

3.4.4.4.6.1 Linking consistency error due to early reception of balise group expected later (see 3.16.2.3.1 c)): if the balise group found is the next one announced in the linking information, the ERTMS/ETCS on-board equipment shall check its linking consistency and apply again clause 3.4.4.4.6, i.e. it will immediately expect the further next balise group announced in the linking information.

3.5 Management of Radio Communication

3.5.1.1 Note: the following section refers to the behaviour of the user application interacting with Euroradio protocols. How the messages are actually transported from the sender to the receiver user application is not relevant for this description.

3.5.2 General

3.5.2.1 Each communication session managed by an entity allows the exchange of data with only one other entity.

3.5.2.2 Note: in the following sections reference is made to safe radio connections, whose definition and management is contained in Euroradio specification.

3.5.2.3 Note: The information Initiation of a Communication Session and Version not Compatible (see sections 3.5.2.4 and 3.17) are the same in every system version.

3.5.2.4 The ERTMS/ETCS on-board equipment shall be able to manage simultaneous communication sessions with at least two different entities.

3.5.3 Establishing a communication session

3.5.3.1 Only the ERTMS/ETCS on-board equipment can initiate a communication session.

3.5.3.2 Intentionally deleted.

3.5.3.3 Note: Only communication sessions between an ERTMS/ETCS on-board equipment and a trackside equipment (RBC or Radio Infill Unit) are considered here.

3.5.3.4 The on-board shall establish a communication session

a) At Start of Mission (only if level 2 or 3).

b) If ordered from trackside.

c) If a mode change, neither considered as an End of Mission nor triggered from condition g) below, has to be reported to the RBC (only if level 2 or 3)

d) If the driver has manually changed the level to 2 or 3

e) When the train front reaches the end of an announced radio hole

f) When the previous communication session is considered as terminated due to loss of safe radio connection (refer to 3.5.4.2.1)

g) When a Start of Mission procedure, during which no communication session could be established, is completed in level 2 or 3

h) When outside the Start of Mission procedure, the driver has manually selected the RBC contact information (only if level 2 or 3)

3.5.3.4.1 In respect of a), b), c), d), e) and h) of 3.5.3.4, the on-board shall not establish a new communication session with an RBC/RIU in case a communication session is currently being established or is already established with this RBC/RIU.

3.5.3.5 The order to contact an RBC shall include

a) The identity of the RBC.

b) The telephone number of the RBC.

c) The action to be performed (establish/terminate the session).

d) Whether this applies also to Sleeping units.

3.5.3.5.1 See table at the end of section 3.5.3.

3.5.3.5.2 If the ERTMS/ETCS on-board equipment has to establish a communication session with an RBC whilst in session with another RBC, the existing communication session shall be terminated (see 3.5.5.2 for details) and the new one shall be established. Exception: the order to contact an Accepting RBC shall not terminate the communication session with the Handing Over RBC.

3.5.3.5.3 The order to contact an Accepting RBC shall be part of the RBC transition order and shall include:

a) The identity of the Accepting RBC.

b) The telephone number of the Accepting RBC.

c) Whether this applies also to Sleeping unit.

3.5.3.6 The order to contact a Radio Infill Unit shall include

a) The identity of the Radio Infill Unit

b) The telephone number of the Radio Infill Unit

c) The action to be performed (establish/terminate the session).

3.5.3.7 The establishment of a communication session shall be performed according to the following steps:

a) The on-board shall request the set-up of a safe radio connection with the trackside. If this request is part of an ongoing Start of Mission procedure or is related to the establishment of a communication session due to condition 3.5.3.4 c), it shall be repeated until successful or a defined number of times (see Appendix A.3.1).

If this request is not part of an ongoing Start of Mission procedure and is not related to the establishment of a communication session due to condition 3.5.3.4 c), it shall be repeated until successful.

A request shall be repeated immediately after EURORADIO has indicated that setting up the safe radio connection has failed.

b) As soon as the safe radio connection is set-up, the on-board shall send the message Initiation of communication session to the trackside.

c) As soon as the trackside receives the information, it shall send the system version.

d) When the on-board receives the system version it shall consider the communication session established and:

- If one of its supported system versions is compatible with the one sent by trackside, it shall send a session established report, including its supported system versions, to the trackside.
- If none of its supported system versions is compatible with the one sent by trackside, it shall send a version independent message indicating “No compatible version supported”. It shall inform the driver and shall terminate the communication session.

e) When the trackside receives the session established report or the information that no compatible system version is supported by the on-board, it shall consider the communication session established.

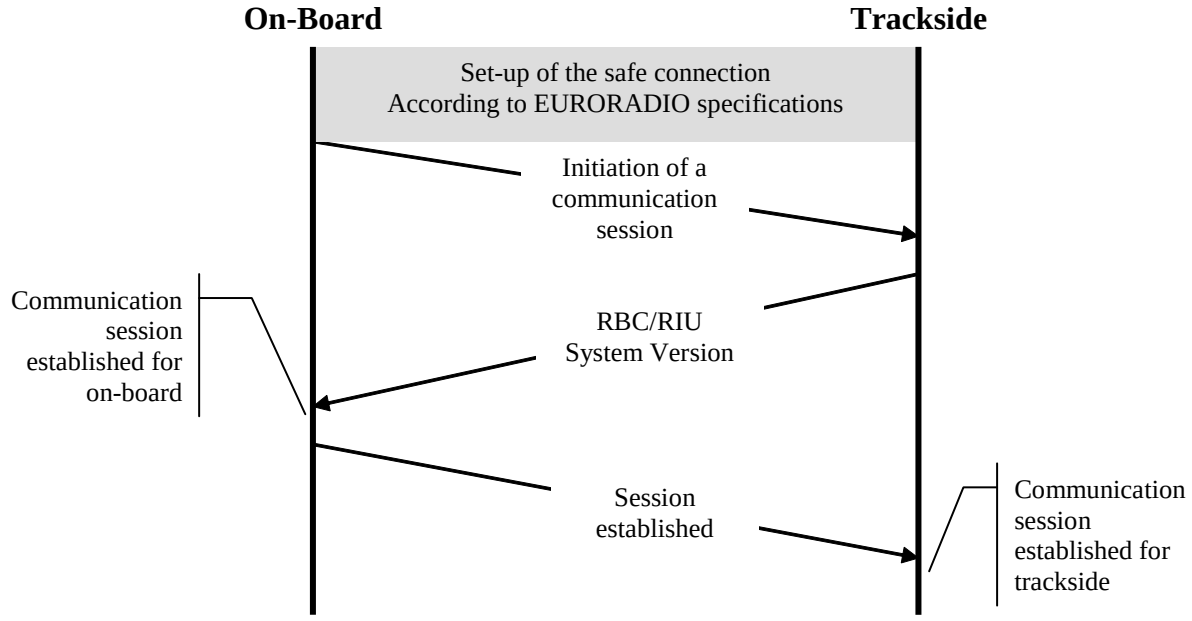


Figure 3: Establishment initiated by on-board

3.5.3.8 When a communication session is currently being established (i.e. at any time from the first request the set-up of a safe radio connection to the reception of the system version from trackside), the on-board shall no longer apply 3.5.3.7 a), 3.5.3.7 b) and 3.5.3.7 d) (i.e. it aborts the process of establishing it) and shall release the safe radio connection (if any) if at least one of the following conditions is met:

a) The driver closes the desk during Start of Mission

b) End of Mission is performed

c) An order to terminate the communication session is received from trackside

d) The train passes with its front end a level transition border from a level 2/3 area to an area where level 2/3 operation is not supported

e) An order to establish a communication session with a different RBC is received from trackside and the order does not request to contact an Accepting RBC

f) The train passes an RBC/RBC border with its front end

g) The train front passes the start of an announced radio hole

h) Regards RIUs only: Level 1 is left

3.5.3.9 Intentionally deleted.

3.5.3.9.1 Intentionally deleted.

3.5.3.10 Intentionally deleted.

Figure 4: Intentionally deleted

3.5.3.11 If the driver selects “Use of EIRENE short number” to contact the RBC, the on-board shall not use the stored RBC ID/phone number, if any.

3.5.3.11.1 Note: The on-board stored short number for calling the “most appropriate RBC” is defined by EIRENE.

3.5.3.11.2 Justification: In case of EIRENE short number selection by the driver, the termination of the connection if the “most appropriate RBC” does not match the one previously stored on-board (EURORADIO functionality) must not occur.

3.5.3.12 Intentionally deleted.

3.5.3.13 An order to contact the RBC may contain a special value for the RBC identity indicating that the on-board shall contact the last known RBC (i.e., using the stored RBC ID/phone number, if any); the phone number indicated in the order shall be ignored by the on-board equipment.

3.5.3.13.1 If there is no RBC ID/ phone number stored on-board, the order to contact the RBC shall be ignored.

3.5.3.14 Note: If a short number is used (considering trackside call routing), that number can be programmed into the balise instead of the normal phone number.

3.5.3.15 An order to contact the RBC may contain a special value for the RBC phone number indicating that the on-board shall use the on-board short number.

3.5.3.15.1 Intentionally deleted.

3.5.3.16

Option	Balise data content	Train reaction

Option	Balise data content	Train reaction
1	Order to contact RBC Special value for RBC ID: Contact last known RBC RBC Phone number irrelevant	Contact last known RBC (order is ignored in case no RBC ID/ phone number is stored on-board)
2	Order to contact RBC RBC ID Special value for RBC phone number: use on-board stored short number	Contact given RBC by using RBC ID and the on-board short number. Note: If the short number does not direct to the RBC with the given RBC ID, the connection will be terminated (EURORADIO functionality).
3	Order to contact RBC RBC ID + RBC phone number	Contact given RBC by using RBC ID and the RBC phone number

3.5.4 Maintaining a communication session

3.5.4.1 When a communication session is established, in case of a loss of the safe radio connection, i.e., if the disconnection has not been ordered (see 3.5.5.1), the involved entities shall consider the communication session still established for a defined time. The defined time shall start as soon as EURORADIO has indicated the loss of the safe radio connection.

3.5.4.2 When EURORADIO indicates the loss of the safe radio connection, the ERTMS/ETCS on-board equipment shall immediately try to set-up a new safe radio connection.

3.5.4.2.1 If the safe radio connection is not re-established after the defined time (as defined in A.3.1), both, on-board equipment and trackside, shall consider the session as terminated.

3.5.4.3 The attempts shall be repeated, until at least one of the following conditions is met:

- The safe radio connection is set-up.
- The session is considered as terminated.
- The train passes the location indicated in the RIU order “Terminate the communication session”

3.5.4.3.1 Note: if the session is considered as terminated due to 3.5.4.2.1, the attempts will be resumed immediately according to 3.5.3.4 f).

3.5.4.4 Exception to 3.5.4.2 and 3.5.4.3: the on-board equipment shall not try to set up a new safe radio connection and shall stop any ongoing attempts if the train front is inside an announced radio hole (see 3.12.1.3). The on-board equipment shall try to set it up again when the train front reaches the end of the radio hole.

3.5.4.5 In case a message has to be sent during the loss of the safe radio connection, this message shall be considered as sent.

3.5.5 Terminating a communication session

3.5.5.1 The termination of a communication session shall be initiated only by the on-board and in the following cases:

a) If an order is received from trackside (RBC, RIU or balise groups) (see sections 3.5.3.5 and 3.5.3.6 concerning the content of the order).

b) If a condition requiring the termination of the communication session is fulfilled without any explicit trackside order. The situations in which such condition is met are detailed in other sections of this specification.

c) Intentionally deleted.

d) Intentionally deleted.

e) Intentionally deleted.

f) Intentionally deleted.

3.5.5.2 In case a session is established, the on-board equipment shall terminate the communication session according to the following steps:

a) The on-board equipment shall send a Termination of communication session message.

b) As soon as this information is received, the trackside shall consider the communication session terminated and send an acknowledgement to the on-board.

c) When the acknowledgement is received the on-board shall consider the communication session terminated and request the release of the safe radio connection with trackside.

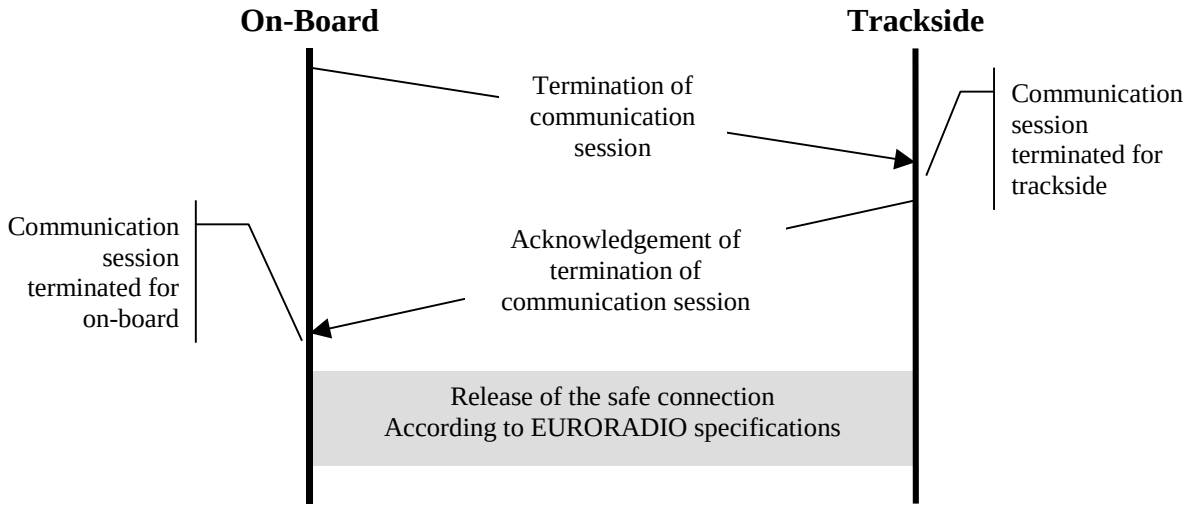


Figure 5: Termination of a communication session

3.5.5.3 No further message shall be sent by the on-board after the message Termination of communication session.

3.5.5.3.1 Exception: In case a communication session is established and no acknowledgement is received within a fixed waiting time (see Appendix A.3.1) after sending the "Termination of communication session" message, the message shall be repeated with the fixed waiting time after each repetition.

3.5.5.3.2 After a defined number of repetitions (see Appendix A.3.1), and if no acknowledgment is received within the fixed waiting time from the time of the last sending of "Termination of communication session", the ERTMS/ETCS onboard equipment shall consider the communication session terminated.

3.5.5.4 No further message shall be sent by the trackside after the message Acknowledgement of the termination of communication session.

3.5.5.5 Note: The information Termination of Communication Session and corresponding Acknowledgement are the same in every system version.

3.5.5.6 Messages from the RBC received onboard after the message "Termination of communication session" has been sent shall be ignored with the exception of the Acknowledgement of the termination of communication session.

3.5.5.7 Intentionally deleted.

3.5.6 Registering to the Radio Network

3.5.6.1 ERTMS/ETCS on-board equipment shall order the registration of its connected Mobile Terminal(s) to a Radio Network:

a) At power-up

b) Following driver entry of a new Radio Network identity

c) If ordered from the trackside

3.5.6.2 When powered-off, ERTMS/ETCS on-board equipment shall memorize the last received Radio Network identity (from trackside or from driver) and shall use it when powered-up again.

3.5.6.3 If no Radio Network identity received from trackside or from driver could have been memorized by ERTMS/ETCS on-board equipment (e.g. after a System Failure or at very first power-up), this latter shall nevertheless order the registration of its Mobile Terminal(s) to a default Radio Network.

3.5.6.3.1 Note 1: the source used to retrieve the default Radio Network identity (on-board equipment permanent storage, Mobile Terminal itself, or other external source) is implementation dependent.

3.5.6.3.2 Note 2: if ERTMS/ETCS on-board equipment is powered-up in an area not covered by the memorized or default Radio Network, attempts to register to this Radio Network will be repeated unconditionally by the Mobile Terminal(s) until either an attempt is successful or a new Radio Network identity is received from trackside or from driver, preventing Mobile Terminal(s) from registering to any unwanted Radio Network.

3.5.6.4 Intentionally deleted.

3.5.6.5 On reception of the trackside order, ERTMS/ETCS on-board equipment shall immediately order the Radio Network registration of each Mobile Terminal that fulfils the following conditions:

a) it is not yet registered to the ordered Radio Network, AND

b) it is not used for an established communication session, AND

c) no safe radio connection is being set-up

3.5.6.6 If a Mobile Terminal is not currently registered to the Radio Network ordered by trackside and if one of the conditions b) or c) is not fulfilled, ERTMS/ETCS on-board equipment shall initiate the Radio Network registration once communication session is terminated and safe radio connection is released.

3.5.6.7 If no Mobile Terminal is duly registered to a Radio Network, any order to contact an RBC or an RIU received from trackside shall be rejected by ERTMS/ETCS on-board equipment.

3.5.7 Safe Radio Connection Indication

3.5.7.1 The ERTMS/ETCS on-board equipment shall inform the driver about the status of the safe radio connection. To that purpose, the following indication statuses of the safe radio connection are defined: “No Connection”, “Connection Lost/Set-Up failed”, “Connection Up”.

3.5.7.2 In addition, the ERTMS/ETCS on-board equipment shall use a “connection status” timer (see Appendix A.3.1), in order to manage properly the transitions to the indication status “Connection Lost/Set-Up failed”.

3.5.7.2.1 Note: The purpose of the “connection status” timer is to avoid distracting the driver for any short disturbance of the safe radio connection.

3.5.7.3 The ERTMS/ETCS on-board equipment shall start the “connection status” timer as soon as the first request to set-up a safe radio connection with the relevant RBC/RIU is sent:

a) for what regards the session establishment, see items b), c), d), e) in 3.5.3.4.

b) for what regards maintaining a communication session, see 3.5.4.2 and 3.5.4.4

3.5.7.4 If the “connection status” timer is ongoing, it shall be stopped if the requests to set-up a safe radio connection are stopped with the relevant RBC/RIU.

3.5.7.5 The ERTMS/ETCS on-board equipment shall execute the transitions between the different indication statuses of the safe radio connection with the relevant RBC/RIU as described in Table 1 according to the conditions in Table 2 (see section 4.6.1 for details about the symbols).

No Connection	< 3 -p2-	< 5, 6, 7 -p1-
1, 2 > -p2-	**Connection Lost / Set-Up failed**	<2 -p2-
4 > -p1-	4 > -p1-	**Connection Up**

Table 1: Transitions between the indication statuses of the safe radio connection

Condition Id	Content of the conditions
[1]	(a Start of mission procedure is ongoing) AND (the final attempt to set-up the safe radio connection failed)
[2]	(the “connection status” timer expires)
[3]	(no Start of mission procedure is ongoing) AND (the requests to set-up a safe radio connection are stopped with the relevant RBC/RIU for reason other than the successful set-up)
[4]	(the safe radio connection is set-up)
[5]	(the safe radio connection is released)
[6]	(the safe radio connection is lost) AND (the requests to set-up a safe radio connection are stopped with the relevant RBC/RIU for reason other than the successful set-up)
[7]	(the safe radio connection is lost) AND (the train front is inside an announced radio hole)

Table 2: Transition conditions for the indication statuses of the safe radio connection

3.5.7.6 For the case of an RBC/RBC transition, the safe radio connection indicated to the driver shall switch from the indication status of the safe radio connection with the Handing over RBC to the one with the Accepting RBC as soon as one of the following conditions is met:

a) the ERTMS/ETCS on-board equipment sends a position report directly to the Accepting RBC with its maximum safe front end having passed the border, see 3.15.1.3.5 (i.e. the Accepting RBC becomes the supervising RBC),

b) the safe radio connection is released with the Handing over RBC and the minimum safe rear end of the train has crossed the border, see 3.15.1.2.7 and 3.15.1.3.9.

3.5.7.6.1 Note: During an RBC/RBC handover procedure, an indication status transition table and a connection status timer might have to be managed at the same time, for each RBC.

3.5.7.7 For the case of safe radio connection with RIU’s, the safe radio connection indicated to the driver shall be the one related to the current infill area.

3.6 Location Principles, Train Position and Train Orientation

3.6.1 General

3.6.1.1 Two types of location based data are defined:

a) Data that refers only to a given location, referred to as Location data (e.g. level transition orders, linking)

b) Data that remains valid for a certain distance, referred to as Profile data (e.g. SSP, gradient).

3.6.1.2 Note: Determination of the Train Position is always longitudinal along the route, even though the route might be set through a complex track layout.

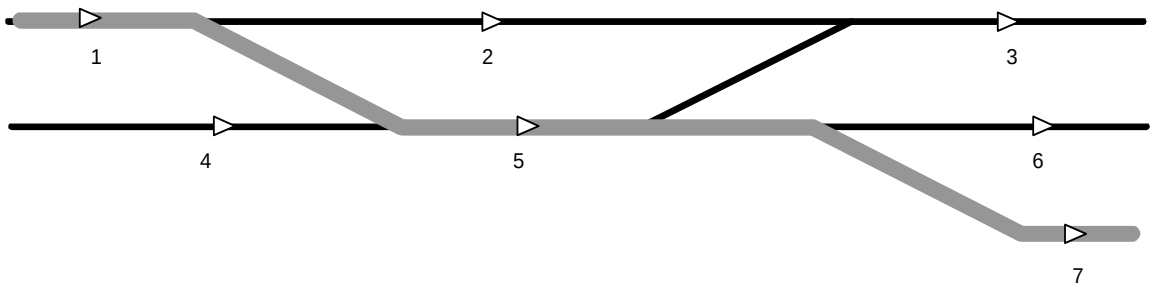


Figure 6: Actual route of the train

Figure 7: Route known by the train

3.6.1.3 The Train Position information defines the position of the train front in relation to a balise group, which is called LRBG (the Last Relevant Balise Group). It includes:

- The estimated train front end position, defined by the estimated distance between the LRBG and the front end of the train
- The train position confidence interval (see 3.6.4)
- Directional train position information in reference to the balise group orientation (see 3.4.2, also Figure 14) of the LRBG, regarding:
  - the position of the train front end (nominal or reverse side of the LRBG)
  - the train orientation
  - the train running direction

  In case of an LRBG being a single balise group with no co-ordinate system assigned, directional information is defined in reference to the pair of LRBG and "previous LRBG", see 3.4.2.3.3
- A list of LRBGs, which may alternatively be used by trackside for referencing location dependent information (see 3.6.2.2.2 c)).

3.6.1.4 Balise groups, which are marked as unlinked, shall never be used as LRBG.

3.6.1.4.1 Justification: The location of an unlinked balise group, or the balise group itself, may not be known to the RBC.

3.6.1.5 If there is an active cab, this one defines the orientation of the train, i.e. the side of the active cab shall be considered as the front of the train. If no cab is active, the train orientation shall be as when a cab was last active.

3.6.1.6 The “train orientation relative to LRBG” is defined as the train orientation related to the orientation of the LRBG, see Figure 14. It can be either “nominal” or “reverse”.

3.6.1.6.1 Note: The train orientation cannot be affected by the direction controller position.

3.6.2 Location of Data Transmitted to the On-Board Equipment

3.6.2.1 Data Transmitted by Balises

3.6.2.1.1 All location and profile data transmitted by a balise shall refer to the location reference and orientation of the balise group to which the balise belongs.

3.6.2.1.2 Exception: Regarding infill information the section 3.6.2.3.1 shall apply.

3.6.2.2 Data Transmitted by Radio from RBC

3.6.2.2.1 All location and profile data transmitted from the RBC shall refer to the location reference and orientation of the LRBG given in the same message.

3.6.2.2.2 For the LRBG the following requirements have to be met:

a) The on-board equipment shall use the last balise group passed as a reference when reporting its position to the RBC (in the following termed as $LRBG_{ONB}$). Only
   - balise groups marked as linked and contained in the previously received linking information, if linking information is used on-board

   or
   - the last balise group not marked as unlinked, if no linking was used when this balise group was passed

   shall be regarded.

b) The RBC shall use a balise group which was reported by the on-board equipment as a reference (in the following termed as $LRBG_{RBC}$). At a certain moment $LRBG_{RBC}$ and $LRBG_{ONB}$ can be different.

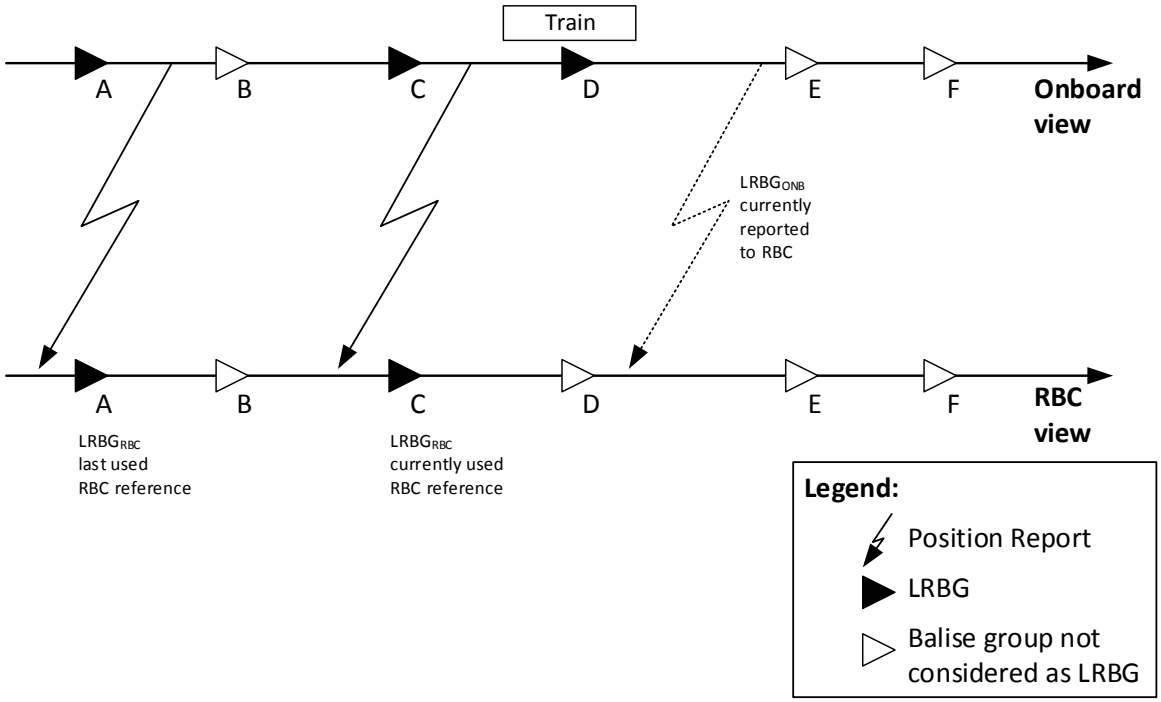
c) The on-board equipment shall be able to accept information referring to one of at least eight $LRBG_{ONB}$ last reported to the RBC.

3.6.2.2.2.1 Exception to a): When on-board position is unknown or when position data has been deleted during SoM procedure, the on-board equipment shall use an LRBG identifier set to "unknown" until the onboard has validated its position again by passing a balise group.

3.6.2.2.2.2 Exception to b): When the RBC has received from the onboard an unknown position (as per 3.6.2.2.2.1) or during SoM procedure an invalid position which it is not able to confirm, the RBC shall use an LRBG identifier set to "unknown" until it receives a position report from the onboard having validated its position by passing a balise group.

3.6.2.2.2.3 Regarding c): From the time it has reported an unknown position, or an invalid position during SoM procedure, to the time it has received from the RBC a message with an LRBG not set to “unknown”, the on-board equipment shall also be able to accept messages from the RBC containing LRBG “unknown”.

3.6.2.2.3 Example: The following figure illustrates the on-board and RBC views of LRBGs:



Balise groups A, C have been reported to the RBC and can be used by the RBC as LRBG

Balise groups D - F : are known thanks to previously received linking information and can be used in the future as onboard reference

Figure 8: On-board and RBC views of LRBG when train is reporting new LRBG$_{ONB}$ "D"

3.6.2.2.3.1 Note: Figure 8 illustrates the case where the RBC uses as reference the last received LRBG$_{ONB}$. The RBC could also use a previously received one (see 3.6.2.2.2 b)).

3.6.2.3 Data transmitted as Infill information

3.6.2.3.1 All location and profile data transmitted as infill information shall refer to the location reference of the balise group at the next main signal (identified by the infill information) and to the orientation given by the infill device. (See note after justification).

3.6.2.3.1.1 Justification:

- At locations where routes join: Infill information is the same for all routes, only linking information is different for different routes, see figure below (infill by means of balise group(s), loop or radio)

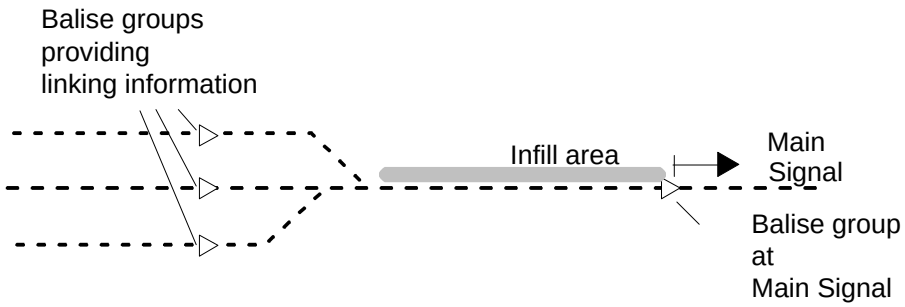


Figure 9: Routes Join in Rear of InFill Area

- In case of an infill area with multiple balise groups: all balise groups transmit identical information, as the information of all groups refers to the balise group at the main signal.

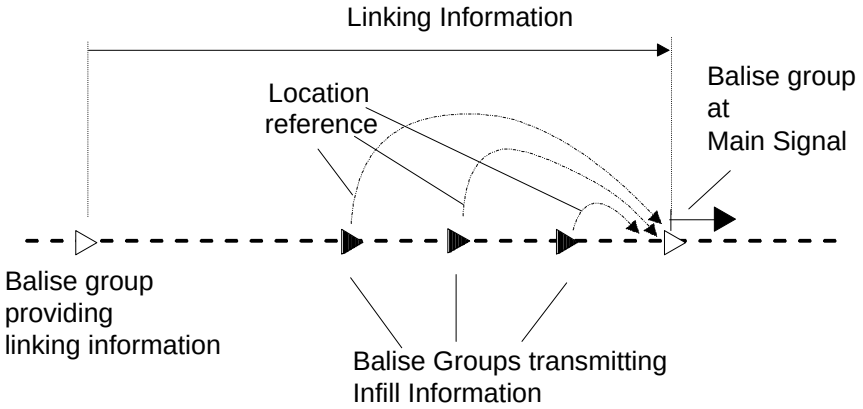


Figure 10: **Location referencing of infill information transmitted by balise groups**

3.6.2.3.1.2 Note: The orientation of infill information given by an infill device is defined in reference to (see also section 3.9):

- In case of a balise group, the orientation of the balise group sending the infill information
- In case of loop, the orientation indicated by the End Of Loop Marker
- In case of radio, the orientation of the LRBG indicated in the message

3.6.2.4 Data transmitted by Loop

3.6.2.4.1 It shall be possible to transmit non-infill location data by loop, which refers to a balise group as location reference.

3.6.2.4.1.1 Note: Regarding infill information see section 3.6.2.3.

3.6.2.4.2 The orientation of data transmitted by a loop is determined by the EOLM information which indicates how the directional information contained in loop messages is to be interpreted.

3.6.3 Validity direction of transmitted Information

3.6.3.1 General

3.6.3.1.1 The direction for which transmitted information is valid shall refer to:

a) the direction of the LRBG for information sent by radio

b) the direction of the balise group sending the information.

3.6.3.1.2 Data transmitted to the on-board equipment (by balise or radio) shall be identified as being valid for

a) both directions

b) the nominal direction

c) the reverse direction

of the referenced balise group.

3.6.3.1.2.1 Deleted.

3.6.3.1.3 When receiving information from any transmission medium, the ERTMS/ETCS on-board equipment shall only take into account information valid for its orientation. Other information shall be ignored. Exception: for SL, PS and SH engines, balise group crossing direction shall be considered.

3.6.3.1.3.1 If the train position is unknown, data received from any transmission medium valid for one direction only (nominal or reverse) shall be rejected by the onboard equipment. Data valid for both directions shall be evaluated (see section 4.8).

3.6.3.1.4 If no co-ordinate system has been assigned to a single balise group, data transmitted by trackside, which refers to that balise group requiring the co-ordinate system to be known (i.e. all data which are only valid for one direction (nominal or reverse)) shall be rejected by the ERTMS/ETCS on-board equipment. Data valid for both directions shall be evaluated (see section 4.8).

3.6.3.1.4.1 Exception: if not rejected due to balise group message consistency check (see 3.16.2.4.4.1 and 3.16.2.5.1.1), data to be forwarded to a National System (see section 3.15.6) shall be accepted. Justification: the co-ordinate system of the balise group might be known to the National System by other means inherent to the National System itself.

Figure 11: Intentionally deleted

3.6.3.2 Location, Continuous Profile Data and Non-continuous Profile Data

3.6.3.2.1 Location and profile data shall have the structure shown in Figure 12 below

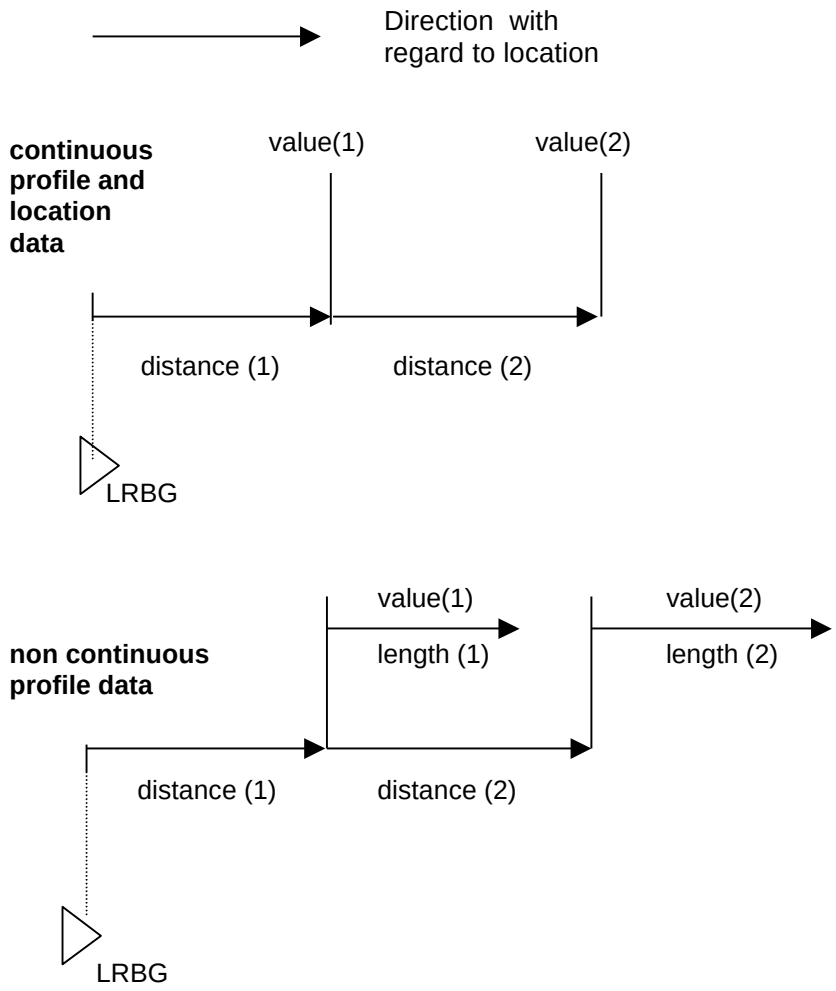


Figure 12: General Structure of location and profile data

3.6.3.2.2 With regard to Figure 12 the following applies to continuous profile data:

a) Value (n) shall be valid for distance (n+1)

b) For distance (1) the previously received data shall be used (in case of an SSP this includes train length delay, refer to 3.11.3.1.3).

c) Distances shall be given as unsigned incremental values representing the distance between value(n) and value(n-1).

d) The last value (n) transmitted shall be valid for an unlimited distance unless value(n) represents a special "end of profile" value.

e) If distance (n+1) = 0 then the corresponding profile value n shall still be taken into account.

3.6.3.2.3 With regard to Figure 12 the following shall apply to location data:

a) Distances shall be given as unsigned incremental values representing the distance between value(n) and value(n-1).

b) For distance (1) the previously received data shall be used.

c) Each value (n) may represent a single value or a set of data.

3.6.3.2.4 According to Figure 12 the structure for non-continuous profile data shall allow to contain multiple elements (value(n) for length(n)) inside the profile.

a) Distance to the start of each element (value(n) for length(n)) shall be given as unsigned incremental values, each increment representing the distance between starts of element (n) and element (n-1).

b) For distance (1) the previously received data (or initial data/default values, see section 3.7) shall be used.

c) Each value (n) may represent a single value or a set of data.

d) Note: There is no relationship between length of element (n-1) and distance (n), i.e., elements may overlap.

3.6.3.2.5 It shall be possible for the RBC to shift the location reference, e.g., after a change of train orientation or running direction.

3.6.3.2.5.1 Justification: Refer to Figure 13. To make it possible to shift the location reference if – due to the location of the LRBG and the start location – distance (1) would become a negative value.

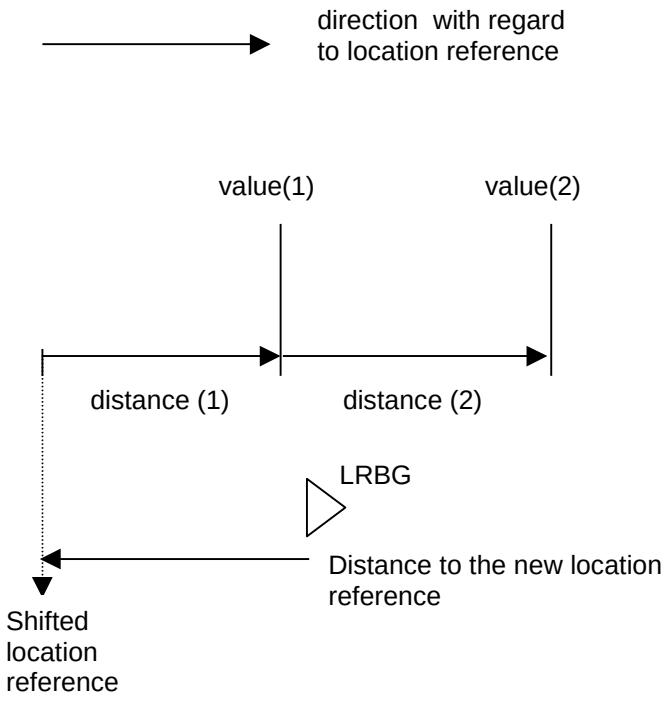


Figure 13: Shifted Location Reference (shown for continuous data /location profile, but also valid for non continuous data profile).

3.6.3.2.6 With regards to Figure 12 the following applies to linking information

a) The distance (1) shall be given to the first balise group included in the linking information

b) The distance (n) shall be given as the distance between two consecutive balise groups

c) Each value (n) shall represent the linking information related to that balise group.

3.6.4 Train Position Confidence Interval and Relocation

3.6.4.1 All location related information transmitted from trackside equipment shall be used by the on-board equipment taking into account the confidence interval to the train position, if required for safe operation.

3.6.4.2 The confidence interval to the train position shall refer to the distance to the LRBG and shall take into account

a) On-board over-reading amount and under-reading amount (odometer accuracy plus the error in detection of the balise group location reference)

b) The location accuracy of the LRBG.

3.6.4.2.1 Distance information received from trackside shall be evaluated on-board as nominal information (without taking into account any tolerances).

3.6.4.2.2 Note: The confidence interval increases in relation to the distance travelled from the LRBG depending on the accuracy of odometer equipment until it is reset when another balise group becomes the LRBG.

3.6.4.2.3 The value of the Location Accuracy shall be determined by Linking information if available, if not, by the corresponding National Value, or the corresponding Default Value if the National Value is not applicable.

3.6.4.3 When another balise group becomes the LRBG or when evaluating (see section 4.8) location related trackside information, which is referred to a previously received balise group different from the LRBG, all the location related information shall be relocated by subtracting from the distances that are counted from the reference balise group of the location related information:

a) the distance between the reference balise group of the location related information and the LRBG, retrieved from linking information if it is available and it includes both the reference balise group and the LRBG, OR

b) in all other cases, the estimated travelled distance between the reference balise group of the location related information and the LRBG.

3.6.4.3.1 Justification: it is always the trackside responsibility to provide linking in due course, knowing this rule; if the location related information is to be used in situations where linking is not provided (e.g. TSR transmitted by balise group marked as unlinked), the trackside can include provisions, if deemed necessary, when engineering the distance information.

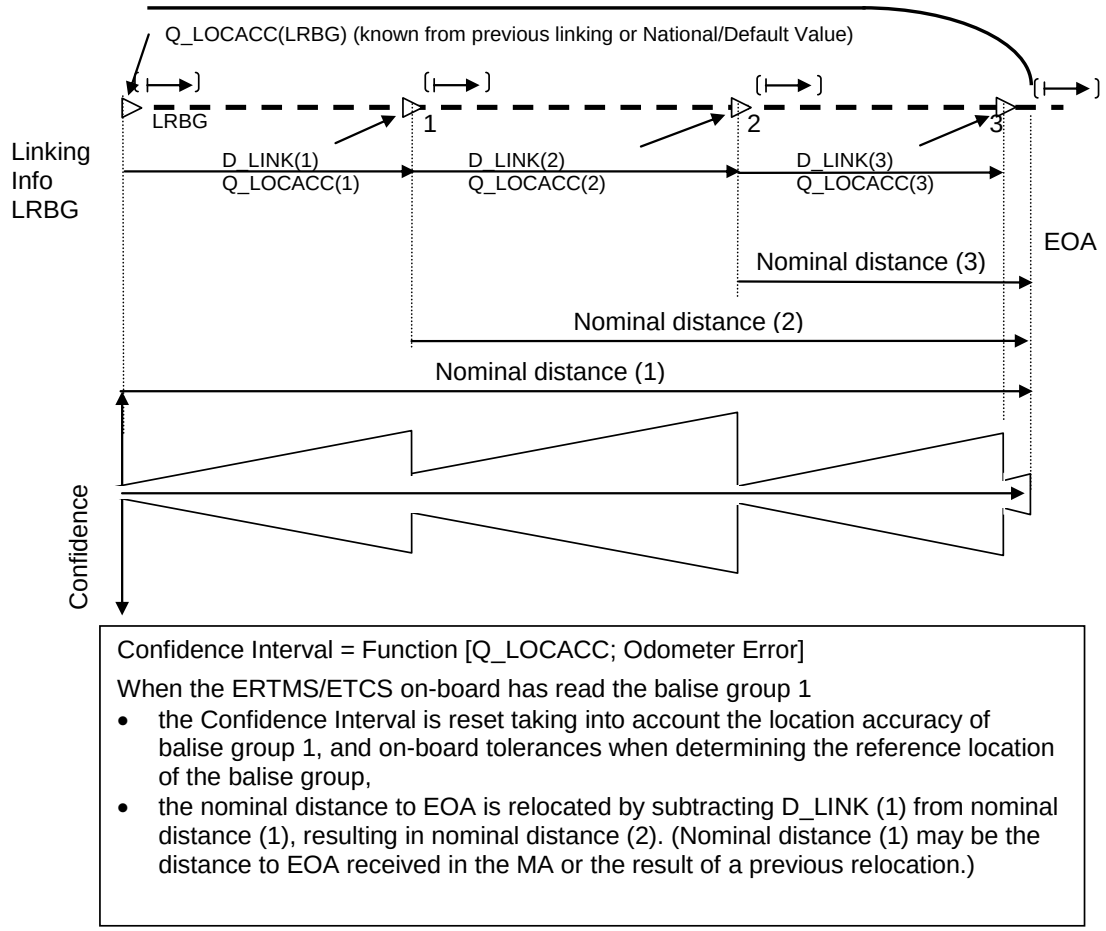
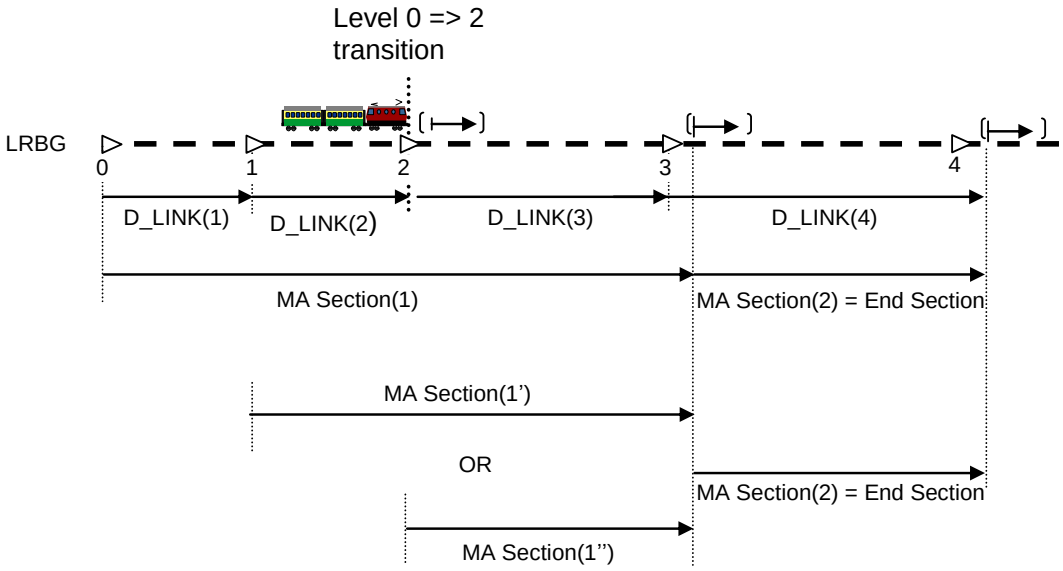


Figure 13a: Reset of confidence interval and relocation, on change of LRBG



When the on-board performs the transition to level 2, the MA stored on-board (referred to balise group 0) is relocated prior to its evaluation:

- If balise group 1 is still the LRBG, the first MA Section distance is relocated by subtracting D_LINK (1) from MA Section (1), resulting in MA section (1')
- If balise group 2 is already the LRBG, the first MA Section distance is relocated by subtracting (D_LINK (1) + D_LINK (2)) from MA Section (1), resulting in MA section (1")
- MA Section (2) distance remains unchanged

Figure 13b: Relocation of trackside information referred to previously passed balise group, different from the current LRBG

3.6.4.4 The train front end position shall be identified in the following way

a) The estimated front end position.

b) The max(imum) safe front end position, differing from the estimated position by the under-reading amount in the distance measured from the LRBG plus the location accuracy of the LRBG.
I.e. in relation to the orientation of the train this position is in advance of the estimated position.

c) The min(imum) safe front end position, differing from the estimated position by the over-reading amount in the distance measured from the LRBG plus the location accuracy of the LRBG.
I.e. in relation to the orientation of the train this position is in rear of the estimated position.

3.6.4.4.1 Note: The rear end position is referenced in the same way. However min safe rear end is only safe if sent together with train integrity information.

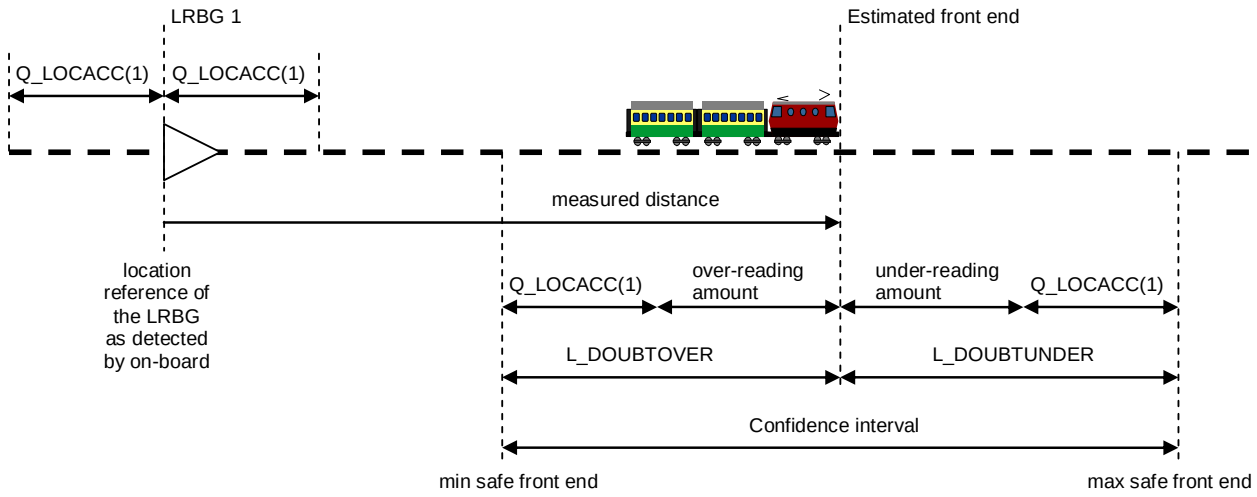


Figure 13c: Train confidence interval and train front end position

3.6.4.5 Intentionally deleted.

3.6.4.6 The estimated front end shall be used when supervising location information, unless stated otherwise.

3.6.4.7 Supervision of location related information transmitted by a balise group marked as unlinked and referred to this balise group:

3.6.4.7.1 By exception to clause 3.6.1.3, the train position is referred to this balise group marked as unlinked. The ERTMS/ETCS on-board equipment shall temporarily apply by analogy clauses 3.6.4.2, 3.6.4.2.1, 3.6.4.2.3 and 3.6.4.4 to determine an additional confidence interval, until a further received balise group becomes the LRBG or the location related information is deleted on-board.

3.6.4.7.2 If another balise group marked as unlinked is received before the additional confidence interval is deleted:

a) the additional confidence interval shall be reset in relation to this new balise group marked as unlinked

b) the location related information referred to the previous balise group marked as unlinked shall be relocated by subtracting the estimated travelled distance between both balise groups from the distances that are counted from this previous balise group marked as unlinked.

3.6.5 Position Reporting to the RBC

3.6.5.1 General

3.6.5.1.1 The position shall refer to the front end of the respective engine with regards to the train orientation.

3.6.5.1.1.1 Intentionally deleted.

3.6.5.1.2 The position report shall contain at least the following position and direction data

a) The distance between the LRBG and the estimated front end of the train.

b) The distance from the estimated front end position to the min safe front end position and the distance from the estimated front end position to the max safe front end position.

c) The identity of the location reference, the LRBG.

d) The orientation of the train in relation to the LRBG orientation.
Note: Driver selected running direction is only handled by the on-board system.

e) The position of the front end of the train in relation to the LRBG (nominal or reverse side of the LRBG).

f) The estimated speed

g) Train integrity information.

h) Direction of train movement in relation to the LRBG orientation

i) Optionally, the previous LRBG (see 3.4.2.3.3).

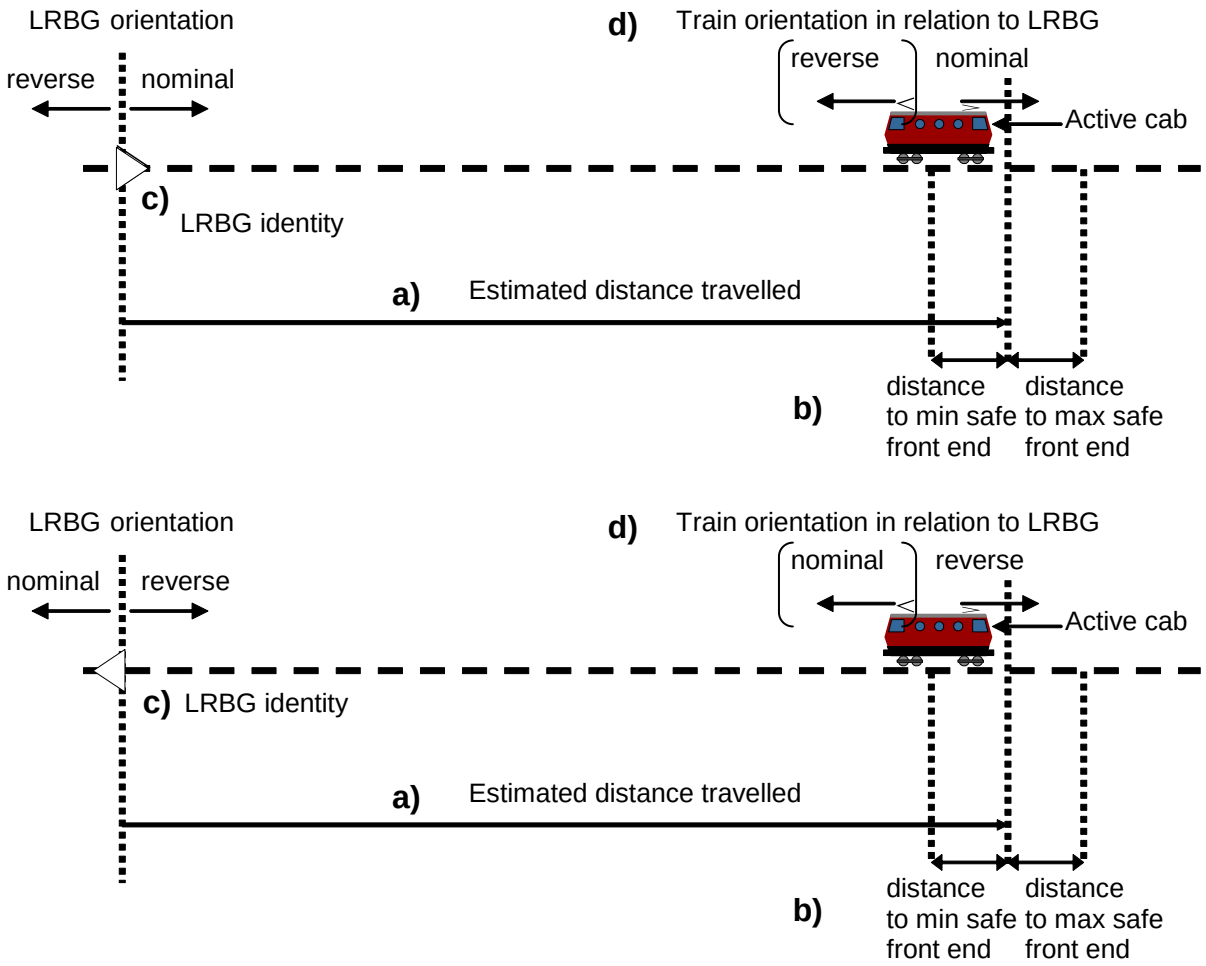


Figure 14: Information given in a position report (two examples to show the relation between LRBG and train orientation)

3.6.5.1.3 Intentionally deleted.

3.6.5.1.4 The on-board equipment shall send position reports as requested by the RBC in the position report parameters. In addition, it shall also send a position report if at least one of the events listed hereafter occurs:

a) The train reaches standstill, if applicable to the current mode.

b) The mode changes.

c) The driver confirms train integrity.

d) A loss of train integrity is detected.

e) The train passes a RBC/RBC border with its min safe rear end.

f) The train passes with its min safe rear end a level transition border which led to a transition from level 2/3 to level 0, NTC or 1.

g) The level changes.

h) A communication session is successfully established.

i) Intentionally moved.

j) The train passes an LRBG compliant balise group (see 3.6.2.2.2), if no position report parameters are stored on-board.

k) The train passes a RBC/RBC border with its max safe front end.

l) An error as defined in 3.16.4 is detected.

3.6.5.1.4.1 If the position report results from one or more events listed in 3.6.5.1.4, its content shall reflect the consequences of these events.

3.6.5.1.5 For the position report parameters requested by the RBC the following possibilities shall be available, individually or in combination

a) Periodically in time.

b) Periodically in space.

c) When the max safe front end or min safe rear end of the train has passed a specified location.

d) At every passage of an LRBG compliant balise group (see 3.6.2.2.2).

e) Immediately.

3.6.5.1.5.1 Note: d) and e) can not be combined.

3.6.5.1.6 Deleted.

3.6.5.1.7 The given position report parameters shall be valid until new parameters are given from the RBC.

3.6.5.1.8 The mode and level reported in a position report shall be consistent (e.g., no mode that relates to the previous level).

3.6.5.2 Report of Train Rear End Position for Level 3

3.6.5.2.1 Train integrity information shall be given by external device or by driver.

3.6.5.2.2 Driver input of train integrity shall only be permitted at standstill.

3.6.5.2.3 The train integrity information shall consist of

a) Train integrity status information

- No train integrity information
- Train integrity information confirmed by integrity monitoring device
- Train integrity information confirmed (entered) by driver
- Train integrity lost

b) Safe train length information (only valid if train integrity is confirmed at the same time).

3.6.5.2.4 The safe train length information shall represent the distance between the min safe rear end (by subtracting the train length from the min. safe front end position at the time when integrity was established last time) and the estimated position of the train front.

3.6.5.2.5 The safe train length information shall be re-calculated for every position report using the same last value of min safe rear end position until a new min safe rear end position is established on-board taking into account the time to detect train integrity.

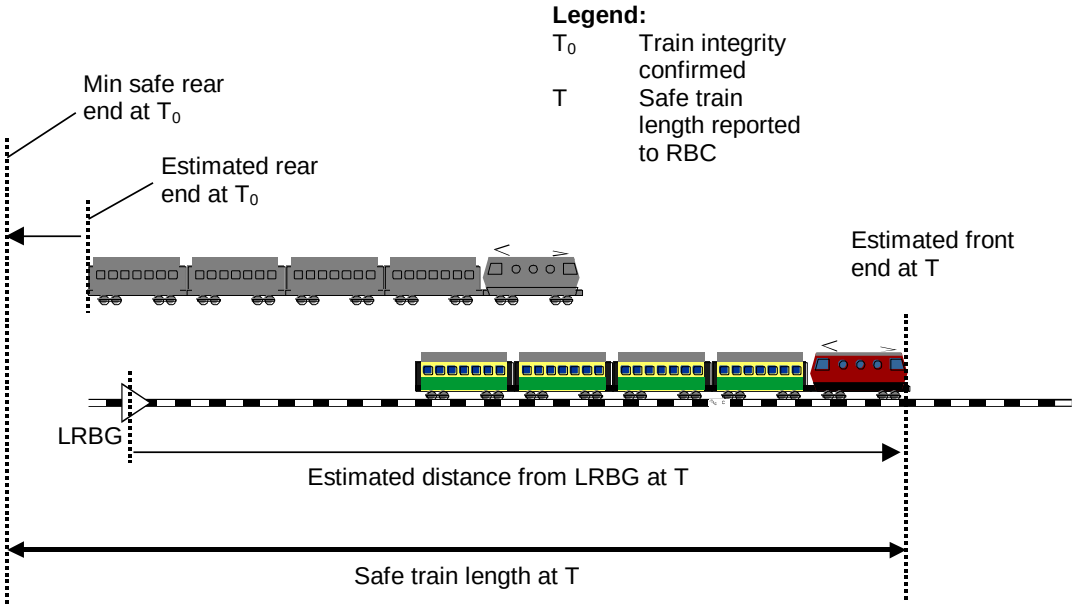


Figure 15: Calculation of Safe Train Length when train integrity was established

3.6.6 Geographical position reporting

3.6.6.1 The ERTMS/ETCS on-board equipment shall display, only on driver request, the geographical position of the estimated front end of the train in relation to the track kilometre. The display of the geographical position shall also be stopped on driver request.

3.6.6.2 The resolution of the position indication shall be 1 metre (sufficient to allow the driver to report the train position when communicating with the signalman).

3.6.6.3 When receiving new geographical position information (from radio or from balise group), the ERTMS/ETCS on-board equipment shall replace the currently stored

geographical position information (if any) by this new received one, continuing the ongoing geographical position calculation until at least one of the condition of 3.6.6.9 applies.

3.6.6.4 Geographical position information shall always use a balise group as geographical position reference balise group and if needed an offset from that balise group. A geographical position reference balise group shall be either:

a) part of the last reported balise groups memorised on-board, in case the information is transmitted by radio, OR

b) the balise group transmitting the information, in case the information is transmitted by balise group, OR

c) any balise group not yet passed at the time of reception of the information.

3.6.6.4.1 In case the information is received by radio and at least one of the announced geographical position reference balise group(s) is part of the last reported balise groups memorised on-board, the on-board equipment shall use the data related to the most recently reported balise group.

3.6.6.4.2 From the currently stored geographical position information, the track kilometre reference given for a geographical reference location shall become applicable if the train has detected the related geographical reference balise group and has travelled the offset distance from this reference balise group.

3.6.6.4.3 The announced and not applicable geographical references shall be deleted on-board if the train changes orientation.

3.6.6.5 The distance travelled from the geographical reference location shall be taken into account when calculating the geographical position.

3.6.6.6 In cases where the track kilometre is not incremental (jumps, changes in counting direction, scaling error) the reported position might be wrong between the point of irregularity and the next new reference.

3.6.6.7 In cases where single balise groups are used as a reference for geographical position information and where no linking information is available (and therefore no orientation can be assigned to the balise group), the on-board equipment shall ignore the geographical position information related to these single balise groups.

3.6.6.8 Intentionally deleted.

3.6.6.9 The on-board equipment shall continue calculating the position from a track kilometre reference (i.e. this track kilometre reference shall remain applicable) until:

a) a new track kilometre reference becomes applicable, OR

b) it is told not to do so, OR

c) the calculated geographical position becomes negative, OR

d) no more geographical position information is available (e.g., deleted according to conditions in SRS chapter 4)

3.6.6.9.1 Once a track kilometre reference is no longer applicable, it shall be deleted.

3.6.6.10 The following data shall be included in a message for geographical position (for every track kilometre reference):

- Identity of the geographical position reference balise group
- Distance from geographical position reference balise group to the track kilometre reference (offset)
- Value of the track kilometre reference
- Counting direction of the track kilometre in relation to the geographical position reference balise group orientation.

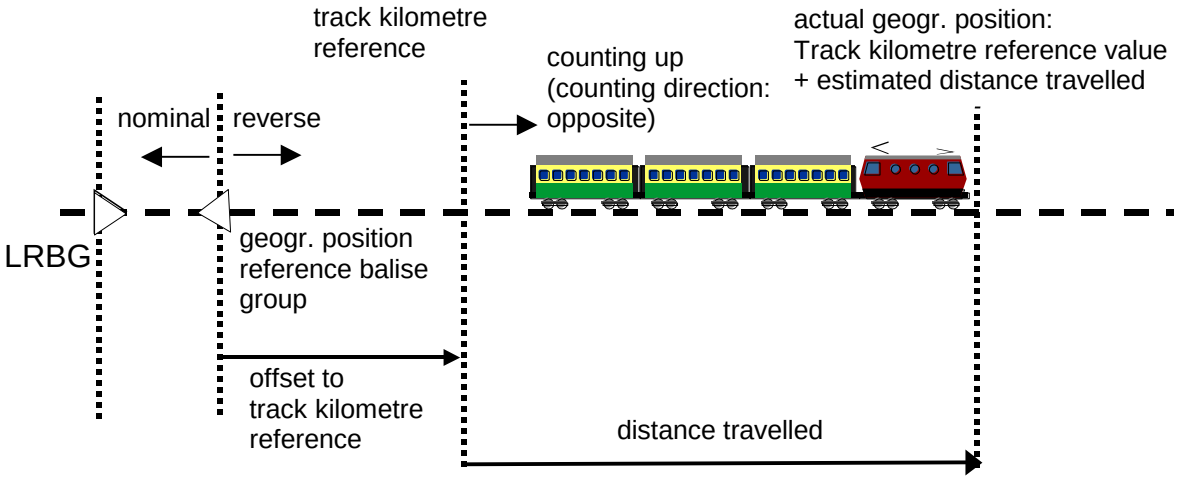


Figure 16: Geographical position example

3.7 Completeness of data for safe train movement

3.7.1 Completeness of data

3.7.1.1 To control the train movement in an ERTMS/ETCS based system the ERTMS/ETCS on-board equipment shall be given information from the trackside system both concerning the route set for the train and the track description for that route. The following information shall be given from the trackside

a) Permission and distance to run, the Movement Authority (MA) (see section 3.8)

b) When needed, limitations related to the movement authority, i.e. Mode profile for On Sight, Limited Supervision or Shunting and signalling related speed restriction (see

sections 3.12.4 and 3.11.6). Mode profile and Signalling related Speed restriction shall always be sent together with the MA to which the information belongs

c) Track description covering as a minimum the whole distance defined by the MA. Track description includes the following information
   - The Static Speed Profile (SSP) (see section 3.11.3).
   - The gradient profile (see section 3.11.12).
   - Optionally Axle load Speed Profile (ASP) (see section 3.11.4)
   - Optionally Speed restriction to ensure a given permitted braking distance (see section 3.11.11)
   - Optionally track conditions (see section 3.12.1).
   - Optionally route suitability data (see section 3.12.2).
   - Optionally areas where reversing is permitted (see section 3.15.4).
   - Optionally changed adhesion factor (see section 3.18.4.5.5).

d) Linking information when available.

3.7.2 Responsibility for completeness of information

3.7.2.1 The Movement Authority (MA) shall be given to the on-board equipment
- Together with the other information (as listed in section 3.7.1.1 c) and d))
  or
- Separately, if the other information has already been correctly received by the on-board equipment.

3.7.2.2 The trackside shall be responsible for that the on-board equipment has received the information valid for the distance covered by the Movement Authority.

3.7.2.2.1 In case of LOA, trackside shall be responsible for including any track description beyond the LOA relevant for calculating safe supervision limits.

3.7.2.3 The MA and the related mode profile, if any, shall not be accepted by the on-board equipment if the SSP and gradient already available on-board or given together with the MA do not cover the full length of the MA.

3.7.2.3.1 Full length means at least from the estimated front end of the train to the supervised location.

3.7.2.4 It shall be possible for the trackside to send additional information when needed. The information referred to is
- Emergency messages (from RBC only)
- Request to stop earlier (from RBC only)
- Temporary speed restrictions
- National values

- Level transition information
- LX speed restrictions
- Inhibition of revocable TSRs from balises in L2/3 (from RBC only)
- Virtual Balise Cover orders

3.7.3 Extension, replacement of track description and linking information

3.7.3.1 New track description and linking information shall replace (in the ERTMS/ETCS on-board equipment) stored information as detailed below:

a) New Static Speed Profile information shall replace all stored Static Speed Profile information from the start location of the new information.

b) New Gradient Profile information shall replace all stored Gradient Profile information from the start location of the new information.

c) New Axle Load Speed Profile information shall replace all stored Axle Load Speed Profile information from the start location of the first element of the new information.

d) New Speed Restriction to ensure Permitted Braking Distance information shall replace all stored Speed Restriction to ensure Permitted Braking Distance information from the start location of the first element of the new information.

e) New track condition Change of Traction System information shall replace all stored Change of Traction System information.

f) New track condition Big Metal Masses information shall replace all stored Big Metal Masses information from the start location of the first element of the new information.

g) New track condition information of at least one of the types listed here, i.e., sound horn, non stopping area, tunnel stopping area, powerless section - lower pantograph, powerless section - switch off the main power switch, radio hole, air tightness, switch off regenerative brake, switch off eddy current brake for service brake, switch off eddy current brake for emergency brake, switch off magnetic shoe brake, shall replace all stored track condition information of the listed types from the start location of the first element of the new information.

h) New route suitability loading gauge information shall replace all stored route suitability loading gauge information.

i) New route suitability traction system information shall replace all stored route suitability traction system information.

j) New route suitability axle load information shall replace all stored route suitability axle load information.

k) New reversing area information shall replace all stored reversing area information.

l) New adhesion factor information shall replace all stored adhesion factor information from the start location of the new information.

m) New linking information received as non-infill information shall replace all stored linking information from the LRBG.

n) New linking information received as infill information shall replace all stored linking information from the reference location of the infill information (i.e. the balise group at next main signal).

o) New track condition Station Platform information shall replace all stored Station Platform information from the start location of the first element of the new information.

p) New track condition Allowed Current Consumption information shall replace all stored Allowed Current Consumption information.

3.7.3.1.1 Intentionally deleted.

3.7.3.1.2 Intentionally deleted.

3.7.3.2 When requested by trackside, the ERTMS/ETCS on-board equipment shall resume initial states beyond a given location individually:

a) for stored Speed Restriction to ensure Permitted Braking Distance information (for initial state, refer to 3.11.11.11)

b) for stored axle load speed profile information (for initial state, refer to 3.11.4.5)

c) through a single request, for all stored track condition information of the following types: sound horn, non stopping area, tunnel stopping area, powerless section – lower pantograph, powerless section – switch off the main power switch, radio hole, air tightness, switch off regenerative brake, switch off eddy current brake for service brake, switch off eddy current brake for emergency brake and switch off magnetic shoe brake (for initial states, refer to 3.12.1.3)

d) through a single request, for all stored route suitability information (for initial state, refer to 3.12.2.10).

e) through a single request, for all stored track condition information of the type Station Platform (for initial state, refer to 3.12.1.3).

3.7.3.3 In some situations, the track description and linking information shall be deleted (or initial state shall be resumed) by the on-board equipment. These various cases where the data is affected (e.g. the MA is shortened) are described in detail in Appendix A.3.4.

3.7.3.4 Intentionally deleted.

3.7.3.5 Deleted.

3.7.3.6 Note: regarding the handling of Temporary Speed Restrictions and Level Crossings, see sections 3.11.5 and 3.12.5.

3.8 Movement authority

3.8.1 Characteristics of a MA

3.8.1.1 The following characteristics can be used in a Movement Authority (see Figure 17: Structure of an MA):

a) The End of Movement Authority is the location to which the train is authorised to move.

b) When the Target Speed at the End of Movement Authority is zero, the End of Movement Authority is called EOA (End of Authority); when the target speed is not zero, it is called the LOA (Limit of Authority). This non zero target speed can be time limited.

c) If no overlap exists, the Danger Point is a location beyond the End of Movement Authority that can be reached by the front end of the train without a risk for a hazardous situation.

d) The end of an overlap (if used in the existing interlocking system) is a location beyond the Danger Point that can be reached by the front end of the train without a risk for a hazardous situation. This additional distance is only valid for a defined time.

e) A release speed is a speed limit under which the train is allowed to run in the vicinity of the End of Movement Authority, when the target speed is zero. One release speed can be associated with the Danger Point, and another one with the overlap. Release speed can also be calculated on-board the train (see section 3.13.9.4).

f) The MA can be split into several sections, The last one is called End Section.

- A first time-out value can be attached to each section. This value will be used for the revocation of the associated route when the train has not entered into it yet. It is called the Section time-out.
- In addition, a second time-out value can be attached to the End Section of the MA. This second time-out will be used for the revocation of the last section when it is occupied by the train; it is called the End Section time-out.

3.8.1.2 The values of the time-outs possibly given in an MA shall take into account the time elapsed from the start of validity of information to the sending of the message.

3.8.1.3 Note: A Danger Point can be (not exhaustive list):

- the entry point of an occupied block section (if the line is operated according to fixed block principles)
- the position of the safe rear end of a train (if the line is operated according to moving block principles)

- the fouling point of a switch, positioned for a route, conflicting with the current direction of movement of the train (both for fixed and moving block mode of operation)

3.8.1.4 Note: Traditionally the overlap is a piece of track (beyond the danger point), that is put at disposal of a train, to guarantee a non hazardous situation, also in case the driver should misjudge the stopping distance for the train. In ERTMS/ETCS the overlap can be used to improve the efficiency of the braking supervision.

3.8.1.5 Note: Time-out values can be given in the MA to cope with the following situations depending on the interlocking operations, i.e. the timers on-board will only reflect the situation trackside and when expired (on-board) the actions taken are restrictive:

a) Section time-out or time-out for the speed at the LOA: When a signalman requests a route release of a part of a route not yet entered by the approaching train.

b) End Section time-out: When the train has entered the last part of a route, the automatic route release can be delayed to make sure that the train has come to a standstill before any switches inside the route can be moved.

c) Time-out for an overlap: When the train has entered the last part of a route, the overlap associated with the route remains valid for a certain time to make sure that the train has successfully stopped before its End of Movement Authority. If the overlap is still unoccupied when the timer expires the interlocking revokes the overlap.

3.8.1.6 Note: If the trackside equipment does not have enough information to give the distance to the End of Movement Authority with a target speed equal to zero, a target speed higher than zero can be given (LOA, Limit of Authority). It is the responsibility of the trackside to ensure that the safe distance beyond the LOA is long enough to brake the train from the target speed to a stand still without any hazardous situation. It is the responsibility of the on-board equipment to apply the brakes if no new information is received when the Limit of Authority is passed.

3.8.2 MA request to the RBC

3.8.2.1 It shall be possible for the on-board equipment to request a new Movement Authority from the RBC.

3.8.2.2 The parameters for requesting a new MA shall be given by the RBC.

3.8.2.3 In level 2/3, the following possibilities shall be available:

a) A defined time before the train reaches the perturbation location assuming it is running at the warning speed (see section 3.13.11 for details).

b) A defined time before the Section timer (not the End Section timer, not the Overlap timer) for any section of the MA expires, or before the LOA speed timer expires.

3.8.2.3.1 Regards to the above possibilities, the MA request shall be triggered when the train front has passed the resulting location (regards a)/ time (regards b)

3.8.2.4 The parameters given by the RBC also define whether the MA request shall be repeated until a new MA is received or not and if so, the time between each repetition.

3.8.2.5 The given data shall be valid until new MA request parameters are given from the RBC.

3.8.2.6 In case no MA request parameters are stored on-board and following an MA request no MA has been received, the request shall be repeated with a repetition cycle according to a fixed value (see appendix).

3.8.2.7 In level 2/3: an MA request shall be sent to the RBC when the driver selects start.

3.8.2.7.1 In level 0, 1, NTC: if a level 2/3 transition is announced and a communication session is already established, an MA request shall be sent to the RBC when the information "Track ahead free up to level 2/3 transition location" is received from balise group.

3.8.2.7.2 In level 0, 1, NTC: the ERTMS/ETCS on-board equipment shall also inform the RBC about the identity of the level 2/3 transition location balise group, as received through the information "Track ahead free up to level 2/3 transition location".

3.8.2.7.3 In level 2/3: An MA request shall be sent to the RBC when any part of the track description is deleted according to A.3.4, except for situations a, b, f, k.

3.8.2.8 Together with the MA request the on-board shall inform the RBC about the reason(s) why the MA request is sent:

a) Start selection by driver,

b) Time before reaching perturbation location reached,

c) Time before a section timer or the LOA speed timer expires reached,

d) The track description has been deleted,

e) Track ahead free up to level 2/3 transition location.

3.8.3 Structure of a Movement Authority (MA)

3.8.3.1 The distance to the End of Movement Authority can be composed of several sections.

3.8.3.2 For each section composing the MA the following information shall be given;

a) Length of the section

b) Optionally, Section time-out value and distance from beginning of section to Section timer stop location

3.8.3.3 In addition, it shall be possible to define for the End Section of the MA:

a) End Section time-out value and distance from the End Section timer start location to the end of the last section

b) Danger point information (distance from end of section to danger point, release speed related to danger point)

c) Overlap information (distance from end of section to end of overlap, time-out, distance from Overlap timer start location to end of section, release speed related to overlap)

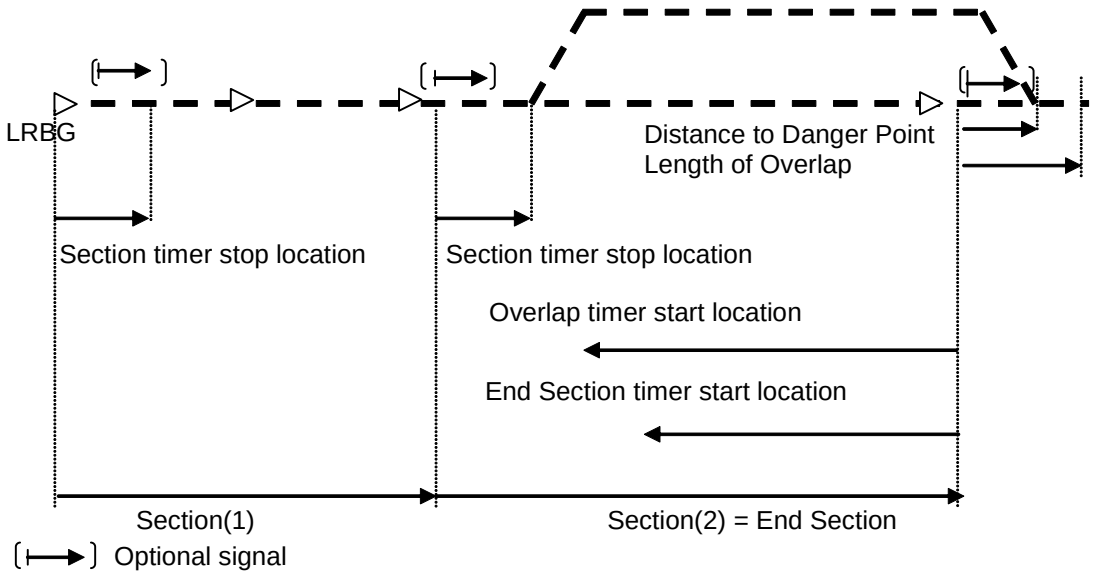


Figure 17: Structure of an MA

3.8.3.3.1 Note: If only one section is given in the MA it is regarded as the End Section.

3.8.3.4 The Section timer stop location shall be inside of the corresponding section.

3.8.3.4.1 Note: the End Section and Overlap timer start locations may be outside their corresponding section. One example can be seen referring to figure 22c: An infill MA towards a signal at stop will replace the previous End Section by a new short End Section starting at the infill location reference and ending at the next main signal, however the End Section and Overlap timer start locations still have to be consistent with the Interlocking timer start locations. Another example is when a timer start location is in rear of the LRBG.

3.8.3.5 In level 3, no time-outs shall be used.

3.8.3.5.1 Note: For level 3 functionality the split of responsibility between the RBC and the Interlocking has to be considered. Time-out of routes and related overlap can not be based on train position reports since the position report can be delayed compared to

the real position of the train. The route release and revocation of routes can not be carried out by the interlocking until permitted by the RBC.

3.8.3.6 When an MA is transmitted by a balise group, the length of the first section shall refer to the balise co-ordinate system of that balise group.

3.8.3.7 In case a main signal is at danger in level 1, the first section shall give the distance from the balise group at the main signal to the location of the main signal, i.e. the distance to EOA is given. Where available, information concerning danger point and overlap for this EOA may also be given.

3.8.3.7.1 Justification: The balise group is not necessarily placed at the same location as the signal and thus an infill message (which includes the same information as the balise group at the main signal) could change the location of the EOA to a position closer to the train.

3.8.3.8 Note: In case the main signal is at danger in level 1, the on-board will supervise the given distance (specified in section 3.8.3.7) as the distance to EOA.

3.8.3.9 When an MA is transmitted by radio from the RBC, the length of the first section shall refer to the balise co-ordinate system of the LRBG given in the same message.

3.8.3.10 It shall be possible to give the length of a section to any location in the track.

3.8.3.10.1 Note: A section can cover several blocks and is not restricted to block ends (see figures).

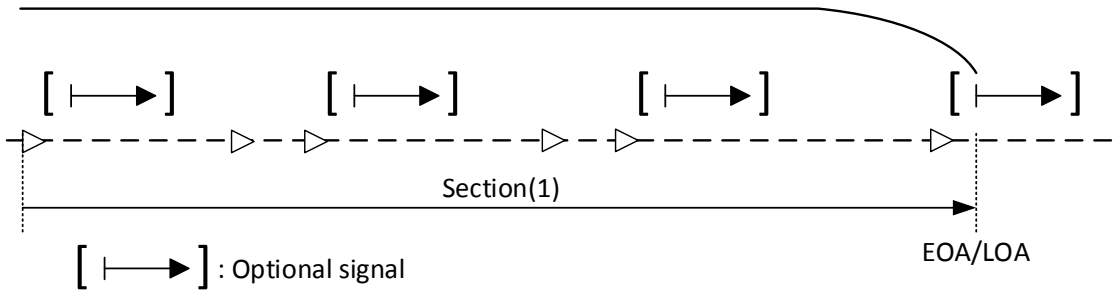


Figure 18: Distance to End of Movement Authority when no time-outs are needed

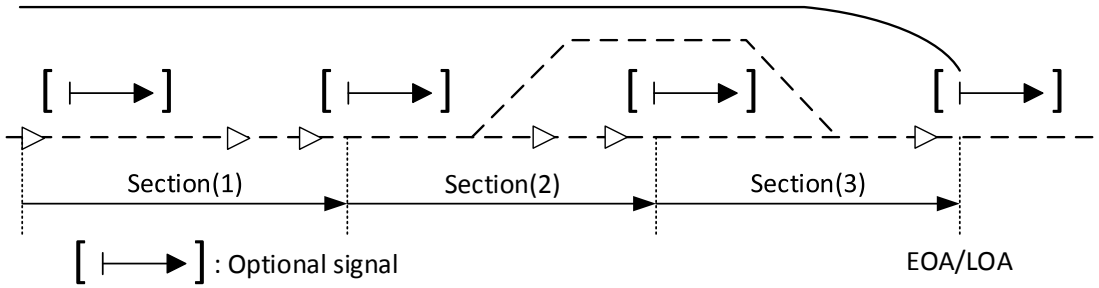


Figure 19 : Distance to End of Movement Authority when time-outs might be needed

3.8.3.11 In moving block operation the MA shall never exceed the min safe rear end of the preceding train.

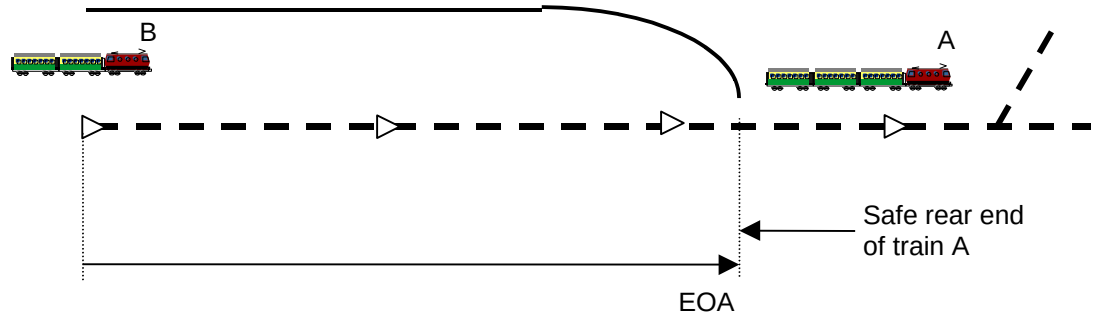


Figure 20: MA in moving block operation.

3.8.4 Use of the MA on board the train

3.8.4.1 End Section Time-Out

3.8.4.1.1 The End Section timer shall be started on-board when the train passes the End Section timer start location given by trackside with its max safe front end.

3.8.4.1.2 When the End Section timer value becomes greater than the time-out value given by trackside, the following shall apply:

a) The EOA/LOA shall be withdrawn to the current position of the train. Refer to appendix A.3.4 for the exhaustive list of location based information stored on-board, which shall be deleted accordingly;

b) if any, a non zero target speed value at the End of Movement Authority shall be set to zero (i.e. an LOA at the End of Movement Authority becomes an EOA withdrawn to the current position of the train).

3.8.4.1.3 In case no End Section timer is running when the on-board receives a new MA with an End Section timer start location in rear of the max safe front end of the train, the on-board shall consider that the End Section timer value became greater than its time-out value and apply 3.8.4.1.2.

3.8.4.1.3.1 Justification: in this case the train is already beyond the timer start location, therefore it is impossible to determine when that location was crossed and so what share of the time-out value has elapsed since the crossing event. The safe assumption is to consider that the time-out value has been exceeded and therefore that the End Section will soon be released by the Interlocking.

3.8.4.1.4 In case an End Section timer is already running when the on-board receives a new MA with an End Section timer start location in rear of the max safe front end of the train, the on-board shall keep the End Section timer running but replace the time-out value with the value received with the new MA.

3.8.4.1.4.1 Justification: this allows repetition of the MA via RBC (e.g. acknowledgment of current MA was lost) without unintentionally affecting the End Section timer.

3.8.4.2 Section Time-Outs

3.8.4.2.1 The on-board shall start a Section timer for each section:

a) For Level 2: at the value of the time stamp of the message including the MA.

b) For Level 1: at the time of passage over the first encountered balise of the balise group giving the MA.

3.8.4.2.1.1 Justification for b): This is to ensure that the timer is always started before or at the same time as the related variable information is received. Thus the timer start is independent of in which balise the variable information is given.

3.8.4.2.2 When a Section timer value becomes greater than the time-out value given by trackside, the following shall apply:

a) the EOA/LOA and the SvL shall be withdrawn to the entry point of the revoked section. Refer to appendix A.3.4 for the exhaustive list of location based information stored on-board, which shall be deleted accordingly;

b) the National/ Default Value of the Release Speed shall apply ;

c) if any, a non zero target speed value at the End of Movement Authority shall be set to zero (i.e. an LOA at the End of Movement Authority becomes an EOA withdrawn to the entry point of the revoked section).

3.8.4.2.2.1 Intentionally deleted.

3.8.4.2.3 The Section timer shall be stopped when the min safe front end of the train has passed the associated Section timer stop location.

3.8.4.3 Time-out of the speed associated with the End of Movement Authority (LOA speed time out)

3.8.4.3.1 The on-board shall start a timer for the LOA speed:

a) For Level 2: at the value of the time stamp of the message including the MA.

b) For Level 1: at the time of passage over the first encountered balise of the balise group giving the MA.

3.8.4.3.1.1 Justification for b): This is to ensure that the timer is always started before or at the same time as the related variable information is received. Thus the timer start is independent of in which balise the variable information is given.

3.8.4.3.2 When the LOA speed timer value becomes greater than the time-out value given by trackside, the speed associated with the LOA shall be set to zero (i.e. the Limit of Authority becomes an End of Authority and the SvL is defined on-board according to 3.8.4.5). Refer to appendix A.3.4 for the exhaustive list of location based information stored on-board, which shall be deleted accordingly.

3.8.4.4 Time-out of Overlap

3.8.4.4.1 The Overlap timer shall be started on-board when the train passes the Overlap timer start location given by trackside with its max safe front end. The timer shall be considered as started even if a time-out value “infinite” is given.

3.8.4.4.2 When the Overlap timer value becomes greater than the time-out value given by trackside, the following shall apply:

a) the overlap information shall be deleted and the Supervised Location shall be determined in accordance with 3.8.4.5. Refer to appendix A.3.4 for the exhaustive list of location based information stored on-board, which shall be deleted accordingly.

b) the release speed associated with the Overlap shall be deleted

c) if any, a non zero target speed value at the End of Movement Authority shall be set to zero (i.e. an LOA at the End of Movement Authority becomes an EOA).

3.8.4.4.3 If the train comes to a standstill after the Overlap timer has been started, the on-board shall consider that the Overlap timer value became greater than its time-out value and shall apply 3.8.4.4.2.

3.8.4.4.4 In case no Overlap timer is running when the on-board receives a new MA with an Overlap timer start location in rear of the max safe front end of the train, the on-board shall consider that the Overlap timer value became greater than its time-out value and shall apply 3.8.4.4.2.

3.8.4.4.4.1 Justification: in this case the train is already beyond the timer start location, therefore it is impossible to determine when that location was crossed and so what share of the time-out value has elapsed since the crossing event. The safe assumption is to consider that the time-out value has been exceeded and therefore that the Overlap will soon be released by the Interlocking.

3.8.4.4.5 In case an Overlap timer is already running when the on-board receives a new MA with an Overlap timer start location in rear of the max safe front end of the train, the on-

board shall keep the Overlap timer running but replace the Overlap time-out value with the value received with the new MA.

3.8.4.4.5.1 Justification: this allows repetition of the MA via RBC (e.g. acknowledgment of current MA was lost) without unintentionally affecting the Overlap timer.

3.8.4.5 Supervised Location

3.8.4.5.1 The Supervised Location (SvL) shall be defined on-board as:

a) the end of overlap (if any and before time-out).

b) if not, the Danger Point (if any).

c) if not, the End Of Authority.

3.8.4.5.2 As long as a Limit of Authority is supervised, no SvL shall be defined on-board.

3.8.4.6 Infill MA (level 1 only)

3.8.4.6.1 An MA given by an infill device is called an infill MA.

3.8.4.6.2 An infill MA shall be evaluated on-board only if the on-board equipment is in FS or LS mode.

3.8.4.6.3 The infill information shall include the identity of the balise group at the next main signal i.e. the identity of the balise group giving the information that is transmitted in advance by the infill device.

3.8.4.6.4 An infill MA shall be evaluated on-board only if the linking information, regarding the main signal balise group to which it refers, is available.

3.8.4.6.5 The on-board shall start a Section timer for each section beyond the next main signal:

a) When the infill information is received from a balise group at the time of passing the first encountered balise of the infill balise group.

b) When the infill information is received from a loop at the time of receiving the loop message.

c) When the infill information is received from a radio infill unit at the value of the time stamp of the radio infill message including the MA.

3.8.5 MA Update

3.8.5.1 A new MA shall replace a previously received MA in the following ways:

a) When the new MA is given from a balise group at a main signal (i.e. not infill information) or from the RBC all data included in the previous MA shall be replaced by the new data.

b) When the new MA is given as infill information all data beyond the announced balise group at the next main signal shall be replaced.

3.8.5.1.1 Note: This refers to all information included in the MA as listed in section 3.8.1.1 and the Signalling related speed restriction (see section 3.11.6).

3.8.5.1.2 When an infill MA is received, the on-board shall start a new MA section at the infill location reference, i.e. the balise group at the next main signal (see 3.6.2.3.1).

3.8.5.1.3 If the SvL defined from the new MA is closer than the one supervised with the former MA, this shall be considered by the on-board equipment as an MA shortening. Refer to appendix A.3.4 for the exhaustive list of location based information stored on-board, which shall be deleted accordingly.

3.8.5.1.4 If a new MA defines an SvL while the on-board was supervising an LOA, this shall always be considered by the on-board equipment as an MA shortening regardless of the SvL location. Refer to appendix A.3.4 for the exhaustive list of location based information stored on-board, which shall be deleted accordingly.

3.8.5.2 It shall be possible to update the length of an MA section by means of repositioning information contained in a balise group message (see section 3.8.5.3).

3.8.5.2.1 Note: The concerned MA section need not be the end section.

3.8.5.2.2 Upon reception of repositioning information and only if linking information has announced a following balise group as unknown but containing repositioning information, the on-board shall update the length of the current MA section in which the train front end is.

3.8.5.2.3 A balise group message containing a movement authority shall not contain repositioning information for the same direction.

3.8.5.2.3.1 Note: It is possible to combine repositioning with an infill MA.

3.8.5.2.4 The reception of repositioning information or of a new MA with an LOA shall not be considered as an MA shortening by the on-board equipment.

3.8.5.3 Examples of MA update

3.8.5.3.1 Note: In the following examples on how to update an MA are given. The examples are not exhaustive.

3.8.5.3.2 Example: Extension of MA via a main balise group in Level 1

- by giving a new longer section, see Figure 21a
- by giving a first section to the same location as in the previous MA and a second section, see Figure 21b

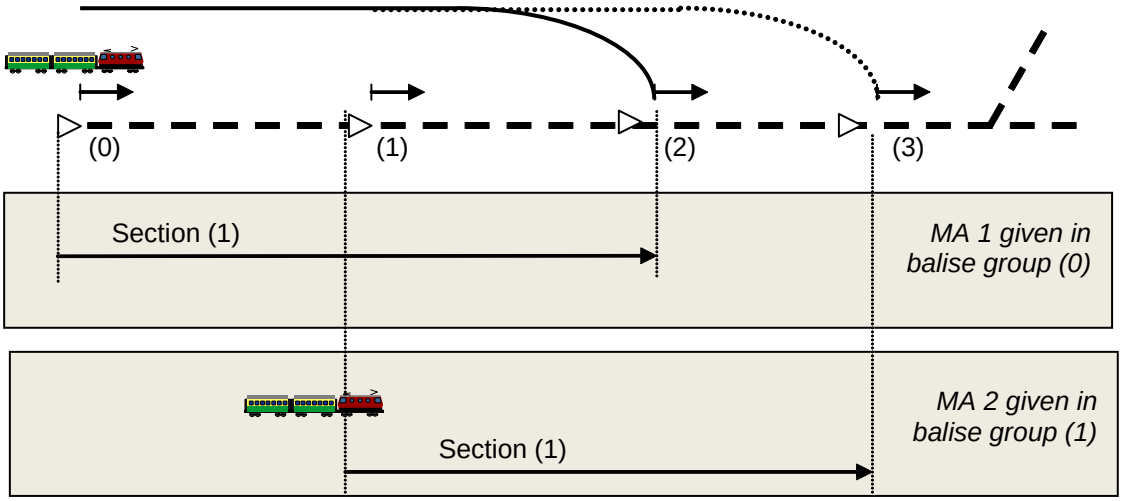


Figure 21a: Extension of an MA in Level 1, one section in the new MA

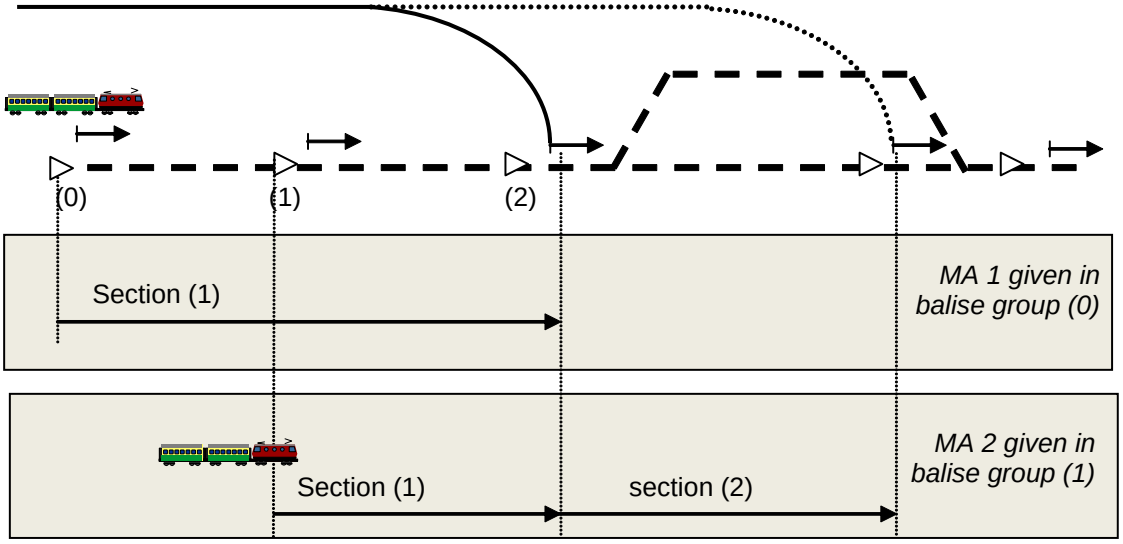


Figure 21b: Extension of an MA in level 1, two sections in the new MA

3.8.5.3.3 Example: MA update via infill information in Level 1. (Refer to section 3.6.2.3 for location reference of infill information)

- MA extension, by giving two new sections, see Figure 22a
- MA shortening, see Figure 22b
- MA repetition, see Figure 22c

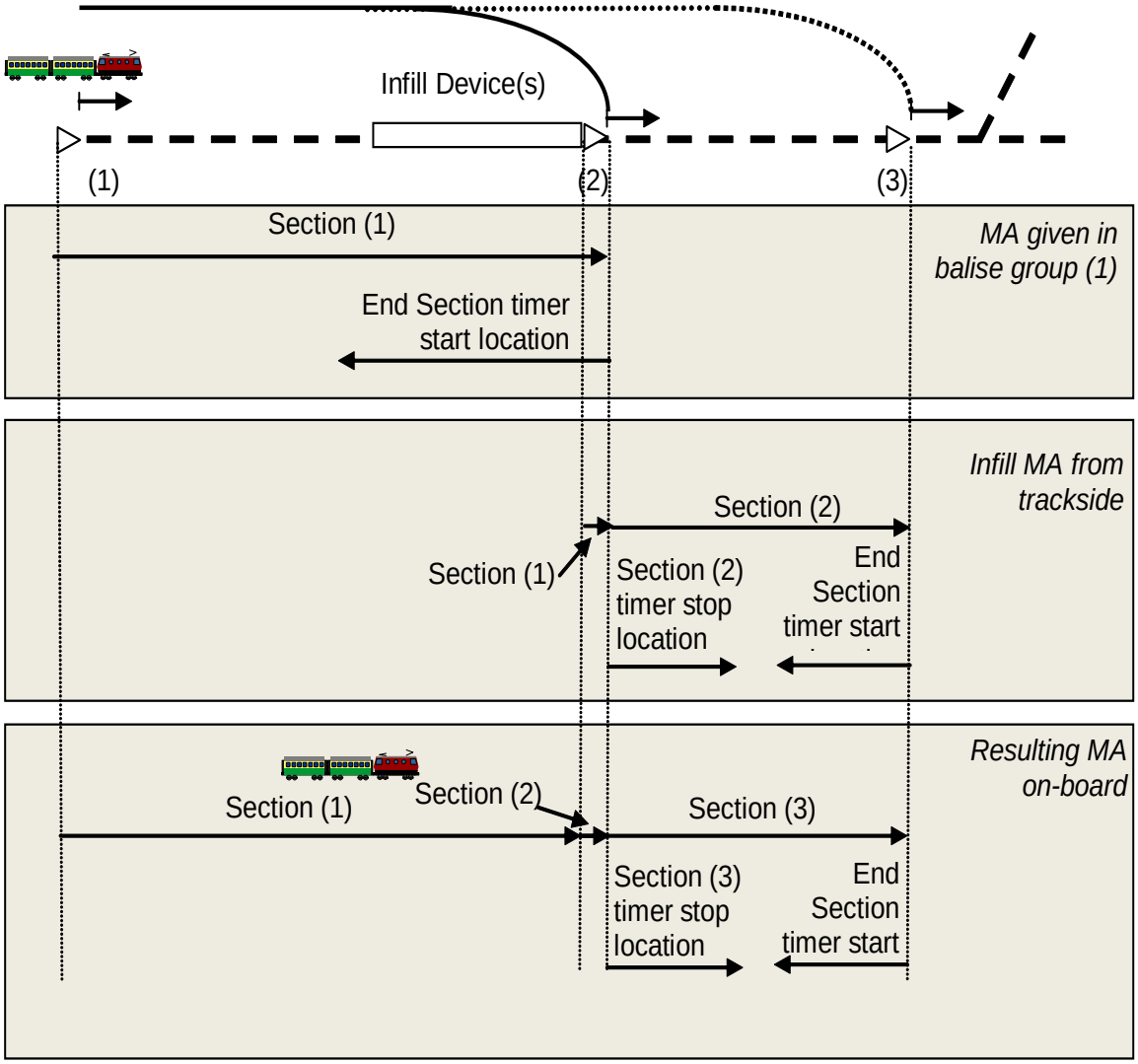


Figure 22a: Extension of an MA with Infill information

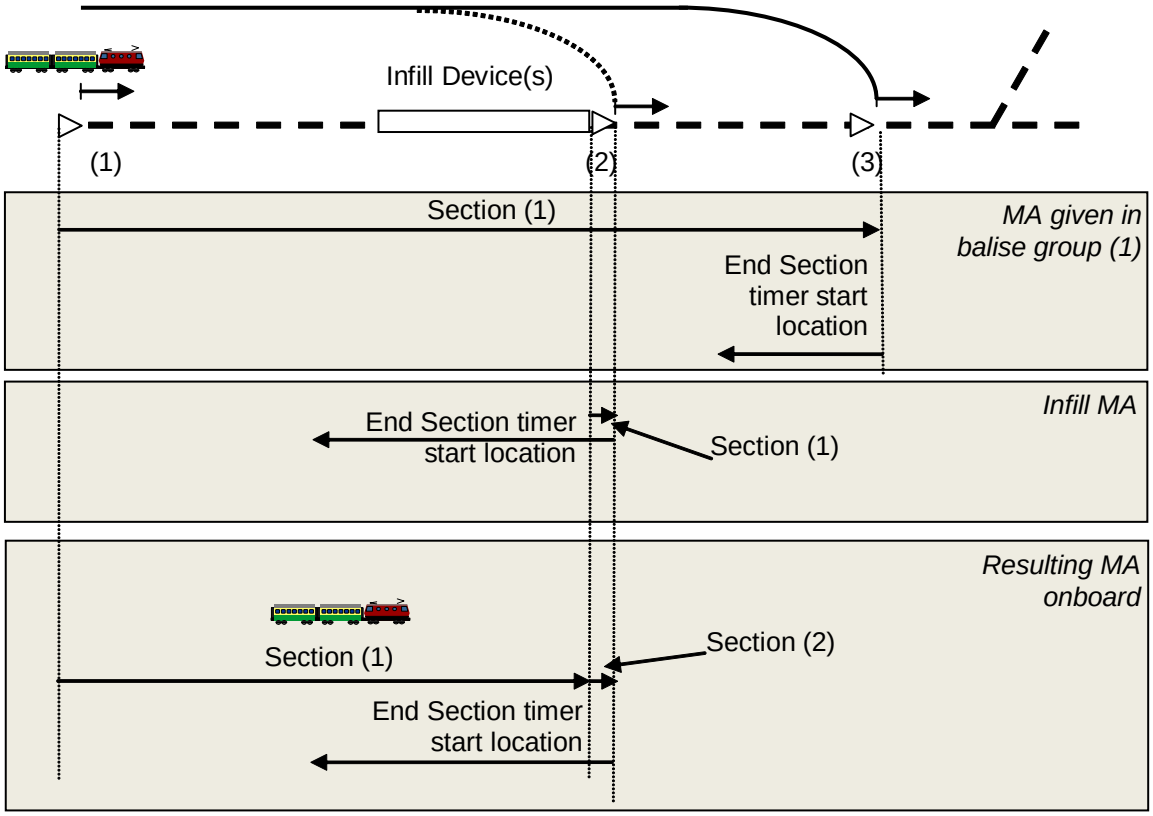


Figure 22b: Shortening of an MA with Infill information

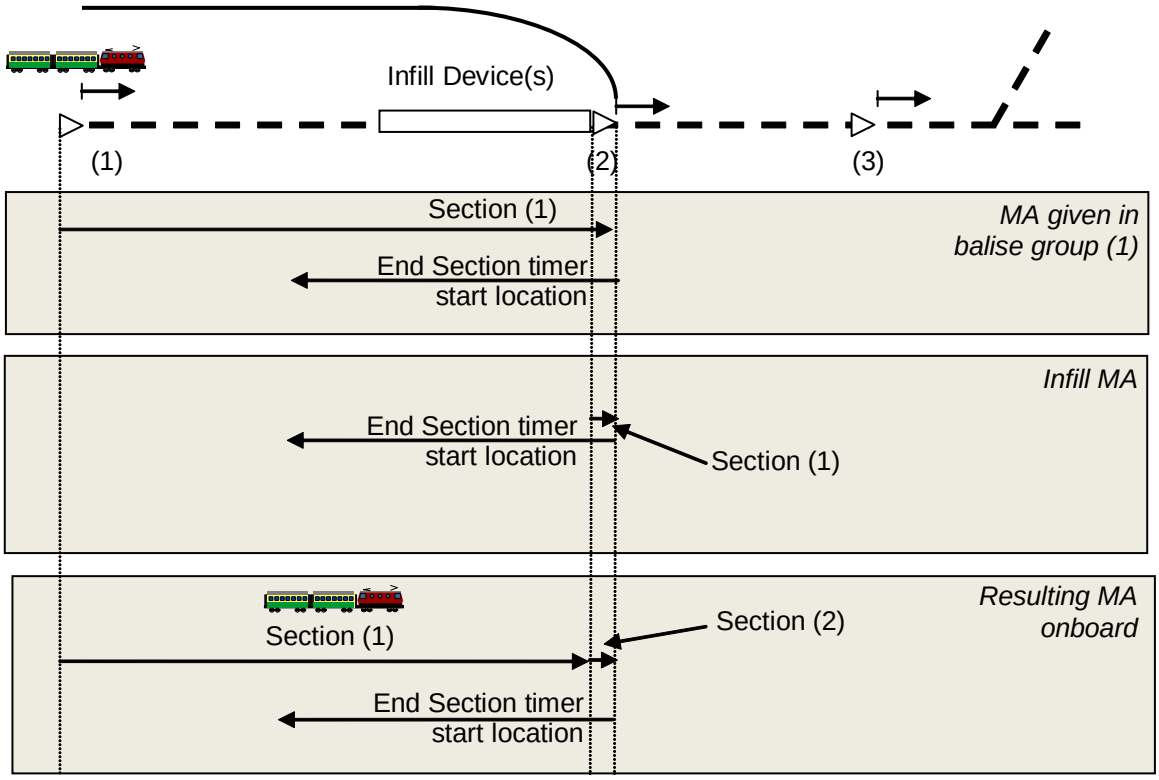


Figure 22c: Repetition of an MA with Infill information

3.8.5.3.4 Example: Extension of MA in Levels 2 and 3

- by using the same LRBG as in previous MA, see Figure 23a
- by using a new LRBG, see Figure 23b

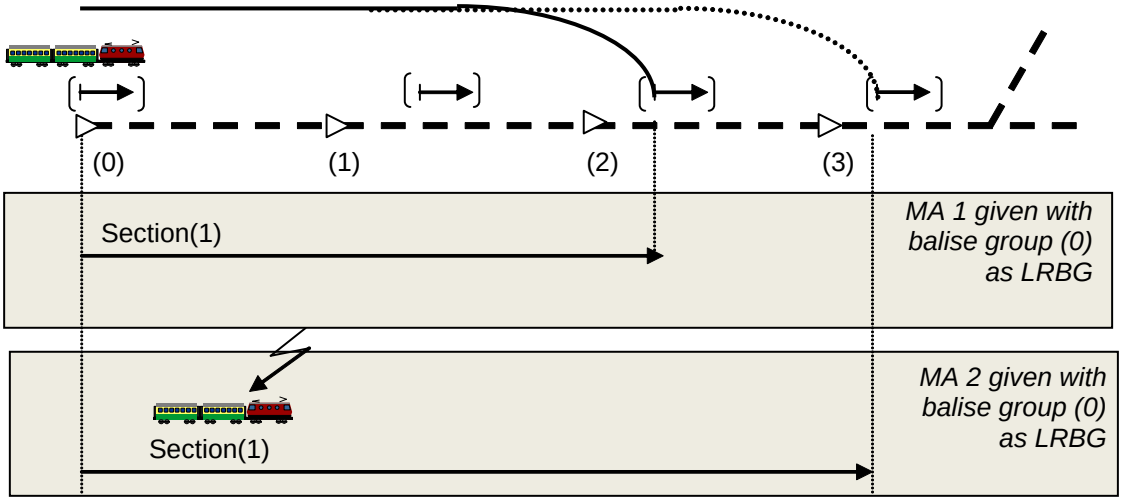


Figure 23a: Extension of an MA in level 2/3, using same LRBG

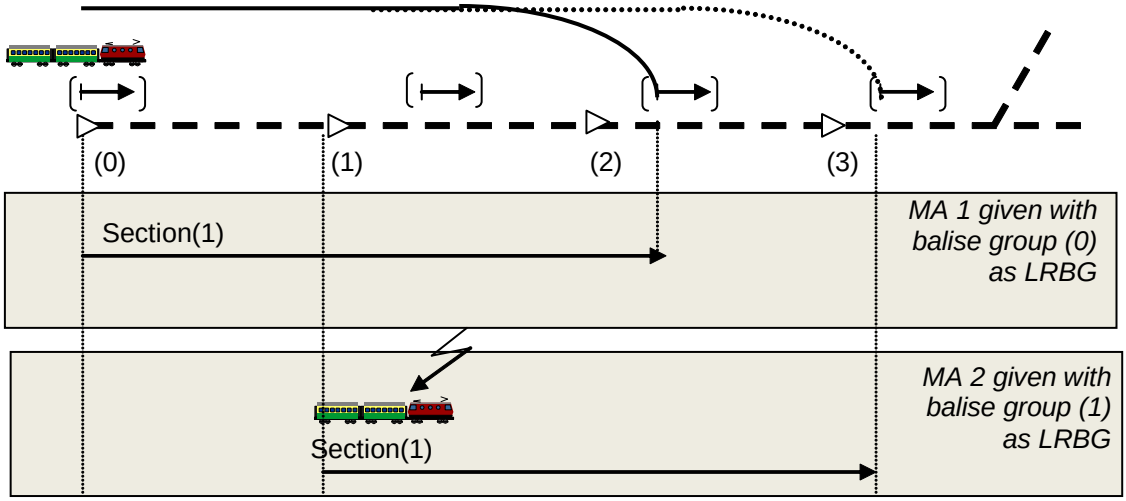


Figure 23b: Extension of an MA in Level 2/3, using a new LRBG

3.8.5.3.5 Example: Extension of MA in level 1 using a balise group containing repositioning information.

3.8.5.3.5.1 Note: In some existing systems, information about the locked route is not complete.

3.8.5.3.5.2 History of the situation (refer to the figure below):

a) Signal A gives an aspect to proceed up to signal Cx because it has received information about the locked route.

b) Signal A can determine whether track 3 or track 1 / 2 is locked but is unable to distinguish between track 1 and 2.

c) In the situation described the route is set to track 1 or 2.

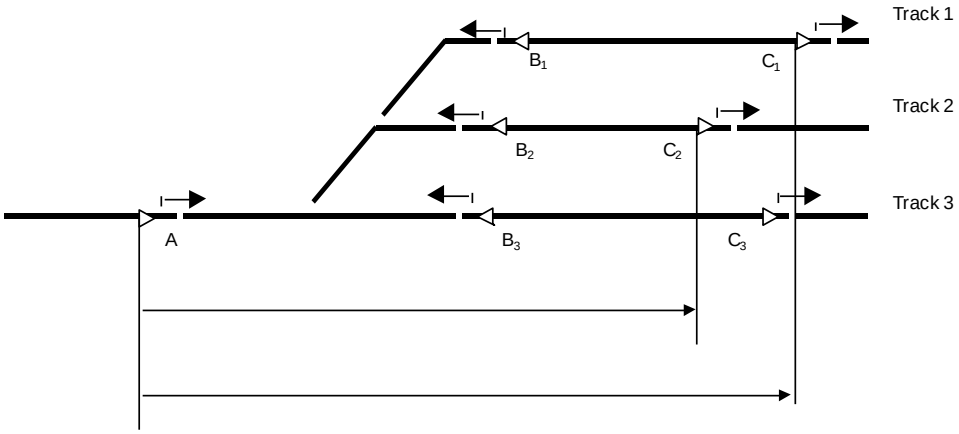


Figure 24: Information on set route not complete at signal A

3.8.5.3.5.3 In balise group A the following information is given:

a) The most restrictive track description from all routes (which could be a combination from the routes);

b) The linking distance given to the farthest balise group containing repositioning information, the identification of the repositioning balise group is not known;

c) For a given aspect of signal A, the most restrictive MA from all routes (the shortest sections from the routes and the lowest target speed at the End of Movement Authority);

d) If some sections are time limited, the most restrictive timer.

3.8.5.3.5.4 Balise groups B (B_1 or B_2) give the following static information:

a) This is repositioning information

b) Linking to the next balise group C

c) The distance to the end of the current section (i.e. the distance to the end of section B1 - C1, or the distance to the end of section B2 - C2)

d) The track description related to this track.

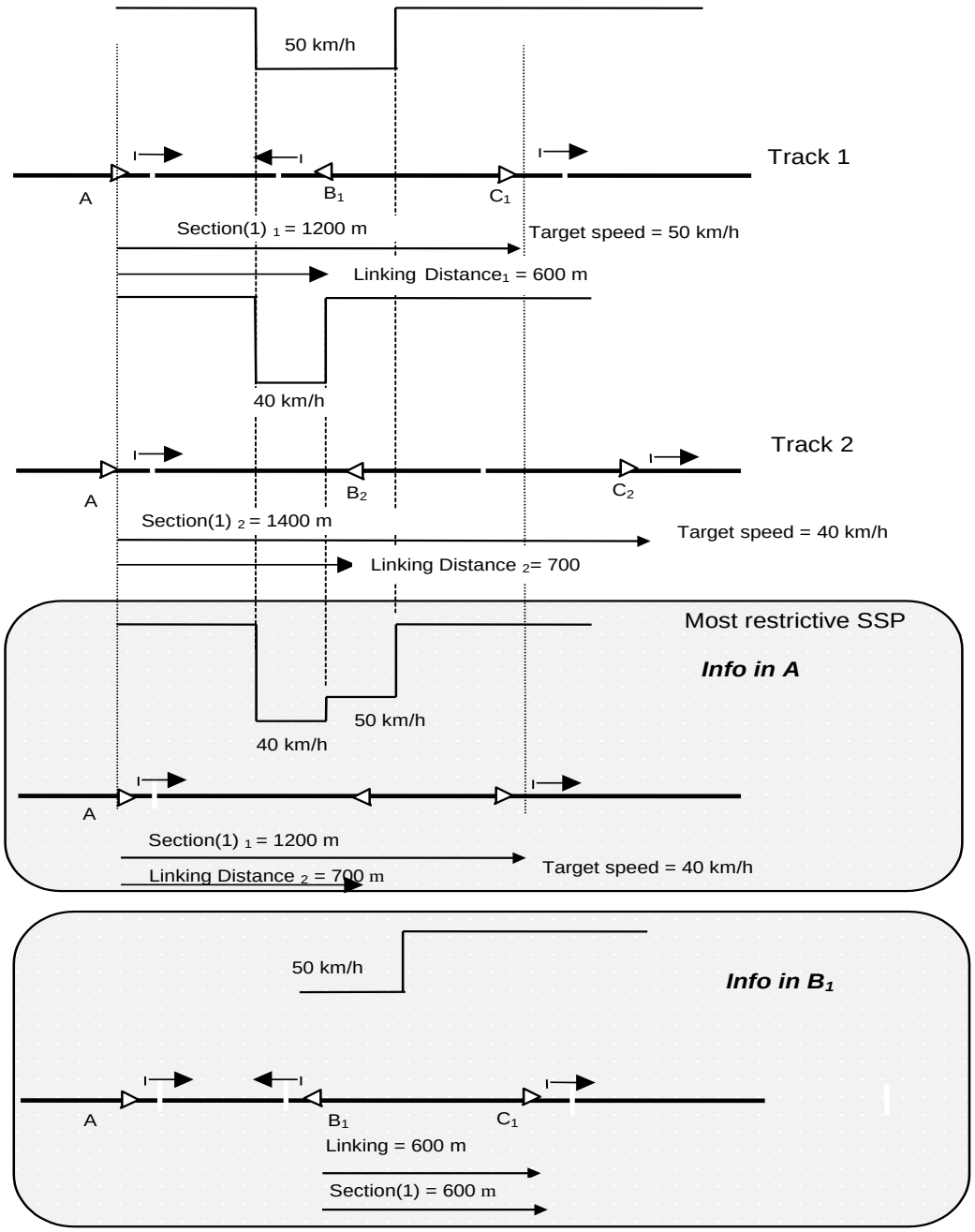


Figure 25: Information contained in A and B_1 (for clarity purposes, only SSPs are drawn but the procedure has to be applied for all track description)

3.8.6 Co-operative shortening of MA (Level 2 and 3 only)

3.8.6.1 It shall be possible to shorten a given MA using a special procedure between on-board equipment and RBC. The procedure is as follows:

a) The RBC proposes a new MA with an EOA closer to the train than the current EOA/LOA, optionally with a mode profile.

b) The ERTMS/ETCS on-board equipment shall check the train front end position versus the Indication supervision limit of the proposed shortened MA.
   - If it is in rear, the on-board equipment shall accept the new MA.
   - If it is in advance, the request shall be rejected and the previously received MA remains valid

c) The RBC shall be informed about the decision.

3.8.6.2 If the request from the RBC is granted by the on-board, refer to appendix A.3.4 for the exhaustive list of location based information, which shall be deleted accordingly.

3.9 Means to transmit Infill information (Level 1 only)

3.9.1 General

3.9.1.1 It shall be possible to transmit infill information to the on-board equipment using

a) Balise groups

b) Euroloops

c) Radio infill units.

3.9.1.1.1 If the information transmitted by Balise groups, Euroloops, and Radio includes infill information, those devices are also identified as infill devices.

3.9.1.2 The principle used for the infill information shall be the same independent of transmission media.

3.9.1.3 If the on-board system is not equipped with the infill transmission media as requested by the announcement balise group, the announcement information shall be ignored by the on-board equipment and the train shall proceed according to the previously received information.

3.9.1.4 Note: No additional description is needed for infill by balise group (other than already covered in previous chapters).

3.9.2 Infill by loop

3.9.2.1 An End Of Loop Marker (EOLM) is by definition a device to mark the beginning or the end of a loop. When receiving this information, the on-board equipment knows that it is entering/leaving a track equipped with a loop. In unidirectional applications it is possible to have an EOLM only at the entry side of a loop.

3.9.2.2 Balise groups shall be used as EOLMs. They act as an EOLM by sending the EOLM information to the passing train.

3.9.2.3 EOLMs have an orientation that is identical to the balise group orientation. The general rules for balise orientation therefore also apply to EOLMs.

3.9.2.4 EOLM information might be contained in a balise group that contains other information.

3.9.2.5 The EOLM shall send the identity of the announced loop.

3.9.2.6 The on-board shall only accept information coming from the loop with the announced identity.

3.9.2.7 Deleted.

3.9.2.8 Deleted.

3.9.2.9 The following information shall be sent in advance by the EOLM to prepare for reception of the loop information:

- Loop identity used to identify the loop.
- Key to select the spread spectrum key necessary to receive the loop telegrams.
- Distance to the loop giving the distance from the EOLM to the location from where on loop messages can be received.
- Length of the loop giving the length of the loop over which messages can be received.
- Indicator telling the on-board whether the orientation of the loop is identical or reverse to the orientation of the announcing EOLM.

3.9.2.10 The on-board shall be prepared to receive messages from the Euroloop after passing the EOLM.

3.9.2.11 When the on-board equipment reads the next main signal balise group or when it detects that the next main signal balise group was missed, new infill information possibly received from the loop shall be ignored.

3.9.2.12 The distances given in an EOLM (distance to loop, length of loop) are used for diagnostic purpose only. They shall therefore not be used to restrict reception of loop telegrams to specific locations.

3.9.3 Infill by radio

3.9.3.1 In level 1 areas it shall be possible to send to the on-board equipment orders to establish/terminate a communication session with a radio infill unit.

3.9.3.2 The orders shall be sent via balise groups or via Radio Infill units.

3.9.3.3 The order to establish a communication session shall be ignored:

a) Intentionally deleted.

b) If the on-board equipment does not include radio.

3.9.3.4 If the on-board equipment includes radio, the communication session shall be established using the same protocols and interfaces as for Level 2/3 operations.

3.9.3.5 If the order to establish a communication session with a radio infill unit sent via balise groups is received, the on-board equipment shall, once the location indicated in the order is reached:

a) terminate any existing communication session(s) with RIU(s) not indicated in the order

b) as soon as a new communication session can be handled, establish a communication session with the RIU indicated in the order

3.9.3.5.1 Intentionally deleted.

3.9.3.5.1.1 Intentionally deleted.

3.9.3.5.2 Intentionally deleted.

3.9.3.6 If the order to establish a communication session with a radio infill unit sent via Radio Infill unit is received, the on-board equipment shall:

a) If only one RIU communication session is ongoing, maintain the existing communication session and establish a new one with the RIU indicated in the order.

b) If two RIU communication sessions are ongoing, maintain the communication session related to the current infill area, terminate the other one and establish a new one with the RIU indicated in the order.

3.9.3.6.1 Exception (degraded situation): if the on-board can handle only one communication session, the order shall be ignored.

3.9.3.7 A Radio Infill Unit shall not initiate a communication session with an on-board equipment.

3.9.3.8 The order to establish/terminate a communication session sent via balise groups shall be sent together with the following radio infill area information:

a) Location where to perform the action (referred to the balise group containing the order).Note: if the action is to establish a communication session, this location marks the beginning of the Radio Infill Area.

b) Next main signal balise group identifier (ignored by the on-board if the action is Terminate communication session).Note: the reference location of this balise group marks the end of the Radio Infill Area.

3.9.3.8.1 The order to establish/terminate a communication session sent via Radio Infill units (see 3.5.3.6) shall not be sent together with any radio infill area information.

3.9.3.9 The establishment of a communication session for radio infill shall not change the operational level of the on-board i.e. the information in the balise group shall be taken into account as usual in level 1.

3.9.3.10 The on-board equipment shall inform the radio infill unit

a) As soon as the location indicated in the order sent via balise groups is passed (i.e. entry of the train in the infill area)

b) As soon as the next main signal balise group indicated in the order sent via balise groups is read or the on-board equipment detects that it was missed.

3.9.3.11 The information sent to the radio infill unit by the on-board equipment shall include

a) Train identity (ETCS-ID of the on-board equipment)

b) Position report

c) Identifier of the next main signal balise group

d) Time stamp

3.9.3.11.1 Justification:

a) The train identity is used for conformity with other train to track messages

b) The identifier of the next main signal balise group allows the radio infill unit to identify safely where the train is going, even in the case of a points area

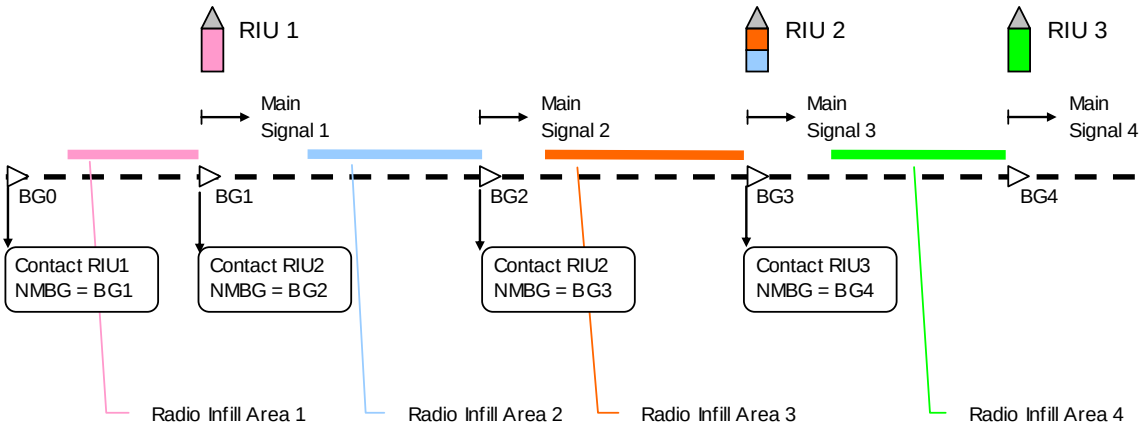
3.9.3.12 As soon as the radio infill unit is informed that a train has entered an infill area under its responsibility, it shall

a) Terminate a possible previous sending of infill information to the on-board equipment, AND

b) Send cyclically the infill information corresponding to the message currently sent by the next main signal balise group indicated in the information from the on-board equipment.

3.9.3.12.1 Justification: case a) refers to the possibility that a report from the on-board equipment, after having passed the previous main signal, was lost.

3.9.3.12.2 Note: A Radio infill unit may manage several signals, thus several Radio Infill Areas (see Figure 25a)



- NMBG = Next Main signal Balise Group
- RIU1 manages Radio Infill Area 1
- RIU2 manages Radio Infill Area 2 and 3
- RIU3 manages Radio Infill Area 4

Figure 25a: Line equipped with radio infill. Example of radio infill area information transmitted by balise.

3.9.3.13 The radio infill unit shall terminate the sending of infill information as soon as information is received, that the on-board equipment has read the next main signal balise group indicated in the order or that the on-board equipment has detected that it was missed.

3.9.3.14 The radio infill unit shall evaluate the time stamp according to the principles of section 3.16.3.2.
The on-board equipment shall check the consistency of radio infill data, according to the principles of section 3.16.3.1 and 3.16.3.3.

3.9.3.15 When the on-board equipment reads the next main signal balise group or when it detects that the next main signal balise group was missed, new infill information related to this balise group possibly received shall be ignored.

3.9.3.16 The ERTMS/ETCS on-board equipment shall terminate the communication session according to the orders received from the trackside (balise group or Radio Infill units) or when the level 1 is left.

3.9.3.17 Intentionally deleted.

3.10 Emergency Messages

3.10.1 General

3.10.1.1 Emergency messages shall be sent individually to each on-board equipment, either as high priority data or as normal priority data of the same radio connection, as described

in Euroradio specification. Only emergency messages can be sent as high priority data, not their acknowledgement or their revocation.

3.10.1.1.1 Justification: In case of hazardous events, it is possible to use high priority data in the radio connection between RBC and on-board equipment to get a quick reaction.

3.10.1.2 An emergency message shall contain an identifier decided by the trackside.

3.10.1.3 The same identifier shall be used in case the emergency message is repeated.

3.10.1.3.1 If the on-board receives a new message with the same identifier it shall replace the previous one.

3.10.1.4 Each emergency message to an on-board equipment shall be acknowledged, using the corresponding emergency message identification number.

3.10.1.4.1 Note: This acknowledgement informs the RBC about the use of the emergency message by on-board equipment and is independent from the general acknowledgement for track-to-train messages, as specified in section 3.16.3.5.

3.10.2 Emergency Stop

3.10.2.1 It shall be possible to stop a train with a conditional or an unconditional emergency stop message.

3.10.2.2 A conditional emergency stop message shall contain the information of a new stop location, referred to the LRBG. In case, when receiving this message

- the train has already passed with its min safe front end the new stop location, the emergency stop message shall be rejected and the RBC shall be informed.
- the train has not yet passed with its min safe front end the new stop location, the emergency stop message shall be accepted, however this location shall be used by the onboard to define a new EOA/SvL only if not beyond the current EOA/LOA. Refer to appendix A.3.4 for the exhaustive list of location based information stored on-board, which shall be deleted accordingly.

3.10.2.3 When receiving an unconditional emergency stop message the train shall be tripped immediately.

3.10.2.4 New movement authority received after any accepted emergency stop message and before the emergency message has been revoked, shall be rejected.

3.10.2.5 Intentionally deleted.

3.10.2.6 Intentionally deleted.

3.10.3 Revocation of an Emergency Message

3.10.3.1 The revocation message shall refer to the identity of the concerned emergency message.

3.10.3.2 The revocation messages shall be acknowledged by the on-board equipment, according to the general acknowledgement procedure (see section 3.16.3.5)

3.10.3.3 The revocation of an emergency message shall have no effect on the management of other emergency messages possibly received.

3.10.3.4 Intentionally deleted.

3.11 Static Speed Restrictions and Gradients

3.11.1 Introduction

3.11.1.1 The permitted speed at which the train is allowed to travel shall be limited to different kinds of Static Speed Restrictions.

3.11.1.2 A Static Speed Restriction shall be handled in the same way independent of ETCS level.

3.11.2 Definition of Static Speed Restriction

3.11.2.1 Static Speed Restrictions are imposed by the trackside infrastructure, the train characteristics, the signalling and the mode of the on-board equipment.

3.11.2.2 There are eleven categories of Static Speed Restrictions:

a) Static Speed Profile (SSP)

b) Axle load Speed Profile (ASP)

c) Temporary Speed Restrictions (TSR)

d) Maximum Train Speed

e) Signalling related speed restriction (only level 1)

f) Mode related Speed Restriction.

g) STM Max speed (for details refer to Subset-035)

h) STM System speed (for details refer to Subset-035)

i) Level Crossing speed restriction (LX SR)

j) Override function related Speed Restriction

k) Speed restriction to ensure a given permitted braking distance (PBD SR) (see 3.11.11)

3.11.2.3 The Static Speed Restriction categories are independent of each other. This means that one speed restriction category cannot affect, nor be affected by, any other category of Static Speed Restrictions.

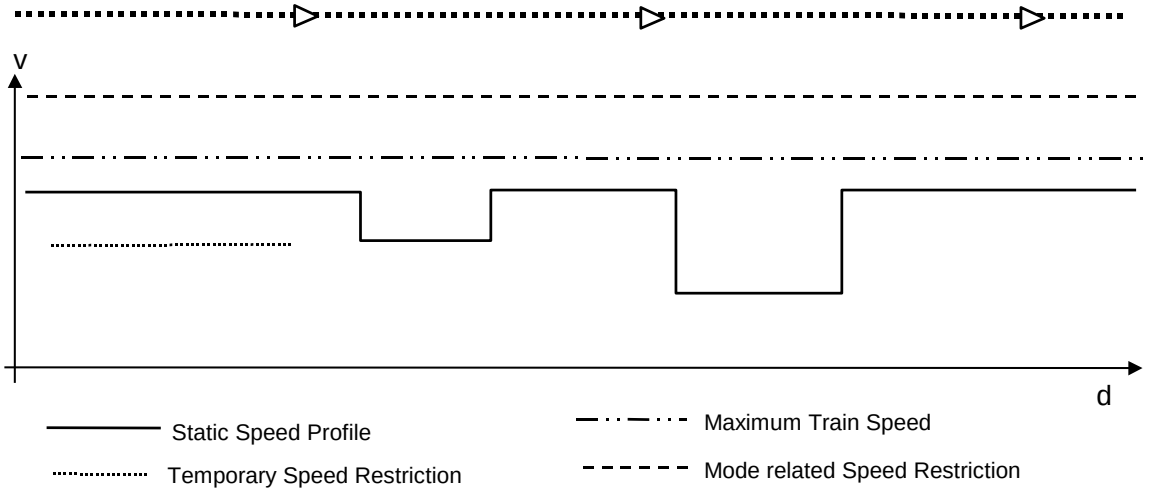


Figure 26: Example of Static Speed Restriction categories on a piece of track.

3.11.2.4 Depending on the type of Static Speed Restriction train length may have to be used to ensure that the full length of the train has passed a Static Speed Restriction discontinuity before a speed increase shall be taken into account.

3.11.2.5 Intentionally deleted.

3.11.2.6 Intentionally deleted.

3.11.3 Static Speed Profile (SSP)

3.11.3.1.1 The Static Speed Profile (SSP) is a description of the fixed speed restrictions of a given piece of track. The speed restrictions can be related to e.g. maximum line speed, curves, points, tunnel profiles, bridges.

3.11.3.1.2 The Static Speed Profile is based on factors, which are both track and train dependent. The relationship between track and train characteristics determines the individual Static Speed Profile for each train.

3.11.3.1.3 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.

3.11.3.2 Static Speed Profile Categories

3.11.3.2.1 It shall be possible to transmit several Static Speed Profile Categories; one Basic SSP category and specific SSP categories related to the international train categories.

3.11.3.2.1.1 The specific SSP categories are decomposed into two types:

a) The “Cant Deficiency” SSP categories: the cant deficiency value assigned to one category shall define the maximum speed, determined by suspension design, at which a particular train can traverse a curve and thus can be used to set a specific speed limit in a curve with regards to this category.

b) The “other specific” SSP categories: it groups all other specific SSP categories corresponding to the other international train categories

3.11.3.2.1.2 Whenever the type of specific SSP category is not explicitly specified in the following requirements, it shall be interpreted as being applicable for both types of specific SSP categories.

3.11.3.2.2 For each part of the Static Speed Profile, the ERTMS/ETCS trackside shall:

a) always give the Basic SSP, which shall be considered as the default “Cant Deficiency” SSP

b) optionally give one or more specific SSPs

c) specify, for each “other specific” SSP, whether it replaces or not the “Cant Deficiency” SSP as selected by the ERTMS/ETCS on-board equipment according to 3.11.3.2.3

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

a) if available, the “Cant Deficiency” SSP matching its “Cant Deficiency” train category, OR

b) if available, the “Cant Deficiency” SSP with the highest Cant Deficiency value below the value of its “Cant Deficiency” train category, OR

c) the Basic SSP

3.11.3.2.3.1 Intentionally deleted.

3.11.3.2.4 Intentionally deleted.

3.11.3.2.5 “Other Specific” SSP categories not relevant to the current train shall be ignored.

3.11.3.2.6 For each part of the Static Speed Profile, the ERTMS/ETCS on-board equipment in a train belonging to at least one or more “other international” train categories shall use the most restrictive speed amongst:

a) the ” Cant Deficiency” SSP as selected in 3.11.3.2.3, only if none of the “other specific” SSP categories matching the train categories replaces the ” Cant Deficiency” SSP, AND

b) all the “other specific” SSP categories matching the “other international” train categories.

3.11.3.3 Train categories

3.11.3.3.1 A maximum of 31 train categories is defined to match the SSP categories. 16 “Cant Deficiency” train categories and 15 “other international” train categories.

3.11.3.3.2 A train shall always belong to one and only one “Cant Deficiency” train category and may optionally belong to one or more “other international” train categories.

3.11.3.3.3 The train category(ies) to which a train belongs is a part of its Train Data.

3.11.4 Axle load Speed Profile

3.11.4.1 It shall be possible to define an Axle load Speed Profile as a non-continuous profile.

3.11.4.2 For each section with a speed restriction due to axle load, the different speed value(s) and for which minimum axle load category this speed value(s) applies shall be specified.

3.11.4.2.1 Note: Different speed restrictions depending on the axle load category can be applicable to the same distance.

3.11.4.3 The ERTMS/ETCS on-board equipment shall consider the most restrictive speed restriction that is associated with any axle load category lower than, or equal to that of the train.

3.11.4.4 For trains with an axle load category lower than the minimum axle load category given in the profile, the ERTMS/ETCS on-board equipment shall not consider any speed restriction due to axle load.

3.11.4.5 The initial state for Axle load Speed Profile shall be “no restriction due to axle load”.

3.11.4.6 Whether a speed increase after the axle load speed restriction shall be delayed with train length, shall be determined by the axle load speed profile information sent to the on-board equipment.

3.11.5 Temporary Speed Restrictions

3.11.5.1 The temporary speed restriction is defined in order to enable a separate category of track infrastructure speed restriction, which can be used for working areas etc.

3.11.5.2 All Temporary Speed Restrictions are independent of each other. This means that an individual Temporary Speed Restriction cannot affect, nor be affected by, any other individual Temporary Speed Restriction.

3.11.5.3 Whether a speed increase after the temporary speed restriction shall be delayed with train length, shall be determined by the temporary speed restriction information sent to the on-board equipment.

3.11.5.4 When two or more temporary speed restrictions overlap, the most restrictive speed of the overlapping temporary speed restrictions shall be used in the area of overlap.

3.11.5.5 Each Temporary Speed Restriction shall have an identity to make it possible to revoke the Temporary Speed Restriction using its identity. The speed restriction shall be revoked immediately when revocation is received from trackside, without delay for the train length.

3.11.5.6 It shall be possible to identify whether a Temporary Speed Restriction is possible to revoke or not.

3.11.5.7 A new Temporary Speed Restriction shall not replace a previously received Temporary Speed Restriction with another identity.

3.11.5.8 Temporary Speed Restrictions shall only be revoked on request from the trackside.

3.11.5.9 If the on-board equipment receives a new Temporary Speed Restriction (TSR) with the same identity as an already received TSR, the new Temporary Speed Restriction shall replace the previous one, except when the Temporary Speed Restriction is identified as non revocable in which case this shall be considered as an additional TSR.

3.11.5.10 In case the train has changed its orientation any Temporary Speed Restriction shall be deleted (operational requirement: will be executed due to the mode change).

3.11.5.11 Intentionally deleted.

3.11.5.12 It shall be possible for the RBC to order an ERTMS/ETCS on-board equipment in Level 2 or 3 to reject revocable TSRs from balises.

3.11.5.13 When ERTMS/ETCS on-board equipment has accepted an order to reject revocable TSRs from balises, this inhibition shall be stored and shall be effective immediately, but only for revocable TSRs received from balises thereafter.

3.11.5.14 The inhibition of revocable TSRs from balises shall be deleted if any of the following occurs:

- the communication session established with the RBC that ordered the inhibition is terminated, OR
- in case of RBC/RBC handover, the train front end crosses the RBC/RBC border.

3.11.5.15 Note: this inhibition may be useful in Level 1 / Level 2 mixed signalling applications when the RBC has more precise information about restrictions than can be given from balises. The RBC may then order inhibition of revocable TSRs from balises and instead send more precise TSRs to the train.

3.11.6 Signalling related speed restrictions

3.11.6.1 In level 1, it shall be possible to send to the on-board equipment a speed restriction with a value depending on the current state of signalling.

3.11.6.2 This speed value shall be taken into account by the on-board equipment as soon as it is received on-board, with the exception of a signalling related speed restriction from

an infill device. In case of infill information the speed restriction shall be taken into account from the location reference of the balise group at the next main signal.

3.11.6.3 The speed restriction shall be valid until a new signalling related speed restriction is received.

3.11.6.3.1 If the ERTMS/ETCS on-board equipment switches from level 1 to level 2/3, the signalling related speed restriction shall remain valid until a L2/3 MA is accepted by the ERTMS/ETCS on-board equipment

3.11.6.4 In case of a signal at danger the signalling related speed restriction shall have value zero, which shall be evaluated by the ERTMS/ETCS on-board equipment not as a speed limit but as a train trip order.

3.11.6.5 In case of infill information the signalling related speed restriction at zero shall be ignored.

3.11.6.5.1 Note: The infill information will also include an EOA at the next main signal that will be supervised according to the normal rules.

3.11.7 Mode related speed restrictions

3.11.7.1 The value of the mode related speed restriction shall be determined by the corresponding national value or the corresponding default values if the national values are not applicable.

3.11.7.1.1 Exception 1: For the modes On-sight, Limited Supervision and Shunting the speed limit can also be given from the trackside. The speed limit given from the trackside shall prevail over the National value and the default value.

3.11.7.1.2 Exception 2: For the mode Reversing there is no National/Default value. The speed limit is always given from trackside.

3.11.7.1.3 Exception 3: For the mode Staff Responsible the speed limit can also be entered by the driver. The speed limit given by the driver shall prevail over the National/Default value.

3.11.8 Train related speed restriction

3.11.8.1 It shall be possible to define the maximum train speed related to the actual performance and configuration of the train.

3.11.9 LX speed restriction

3.11.9.1 It shall be possible to define a LX speed restriction when the train has to pass a non protected Level Crossing.

3.11.10 Override function related Speed Restriction

3.11.10.1 While the “override” function is active, the override speed limit (national /default value) shall be taken into account.

3.11.11 Speed restriction to ensure permitted braking distance

3.11.11.1 It shall be possible for trackside to request the ERTMS/ETCS on-board equipment to calculate a speed restriction based on a permitted braking distance given by trackside.

3.11.11.2 The order shall be given by means of a non-continuous profile defining:

- The start and end location for the speed restriction
- The permitted braking distance (PBD) used to calculate the speed restriction value
- Whether the permitted braking distance is to be achieved with the Service Brake or Emergency Brake
- A single gradient value applicable for the calculation

3.11.11.3 The speed restriction shall be calculated when the ERTMS/ETCS on-board equipment receives the permitted braking distance information from trackside, and shall be re-calculated only if any of the inputs taken into account for the calculation of the speed restriction changes.

3.11.11.4 The calculation of the speed restriction by the ERTMS/ETCS on-board equipment shall take into account that:

- The single gradient value received from trackside shall be compensated in value according to the rotating mass as defined in 3.13.4.3.
- The safe deceleration shall be computed as in 3.13.6.2.1 but without considering the adhesion profiles, the track conditions related to brake inhibition and the track conditions related to powerless section given by trackside.
- The expected deceleration shall be computed as in 3.13.6.3.1 but without considering the track conditions related to brake inhibition and the track conditions related to powerless section given by trackside.
- The ERTMS/ETCS on-board equipment shall calculate an Emergency Brake Deceleration (EBD) curve based on the safe deceleration and that reaches zero speed at a distance equal to the permitted braking distance.
- If the permitted braking distance is to be achieved with the service brake, the ERTMS/ETCS on-board equipment shall also calculate a Service Brake Deceleration (SBD) curve based on the expected deceleration and that reaches zero speed at a distance equal to the permitted braking distance.
- The estimated acceleration shall be set to “zero”.
- If not inhibited by National Value, the compensation of the inaccuracy of the speed measurement shall be set to a value calculated from the PBD speed, as defined in SUBSET-041 § 5.3.1.2: V_delta0PBD = f_{41}(V_PBD + dV_EBI(V_PBD)) if the

permitted braking distance is to be achieved with the emergency brake; V_delta0PBD = f_{41}(V_PBD + dV_SBI(V_PBD)) if the permitted braking distance is to be achieved with the service brake.

- The train will travel a distance from the last encountered balise of a group that provides restrictive information until initiating the brake command. This travelled distance shall be set to a value calculated from the PBD speed considering a processing delay (T_{41}) equal to SUBSET-041 § 5.2.1.1.
- Regardless of how the service brake feedback is actually configured (see 3.13.2.2.7.2), T_bs1 and T_bs2 (see 3.13.9.3.3) shall be defined as if the service brake feedback was not implemented.
- Regardless of how the traction cut-off interface is actually configured (see 3.13.2.2.8), T_traction (see 3.13.9.3.2) shall be defined as if the traction cut-off was not implemented.

3.11.11.4.1 Note: Knowing how the PBD speed restriction is computed by the ERTMS/ETCS on-board equipment, it is the responsibility of the trackside to set the appropriate permitted braking distance with regard to the risk of not initiating the brake command in due time when encountering a further balise group providing restrictive information. In other words, if deemed necessary, the trackside can include provisions based on the characteristics of the balise group providing restrictive information e.g. distances between balises in that group with regards to validity direction of transmitted information and balise group orientation, accuracy of balise location.

3.11.11.4.2 Note: If the permitted braking distance is to be achieved with the service brake, it is the responsibility of the trackside to also consider an estimation of the on-board over-reading and under-reading amounts at the time the brake command is initiated in order to lower the likelihood of the max safe front end of the train reaching the EBI supervision limit.

3.11.11.5 Note: Throughout the following formulas, all the distances marked with “d” (lower case) are counted from a single arbitrary reference location.

3.11.11.6 If the permitted braking distance is to be achieved with the emergency brake, the ERTMS/ETCS on-board equipment shall seek the PBD speed restriction value (V_PBD) which satisfies the two following inequalities. The resulting value shall then be rounded down to the next lower multiple of 5km/h:

$$ABS\left\{\left(V_{PBD}+dV_{ebi}\right)-\left(V_{EBD}\left(d_{offset}+D_{bec}\right)-V_{delta0PBD}\right)\right\}\leq 1km/h$$

$$d_{offset}+D_{bec}\leq d_{PBD}$$

With dV_{ebi} as defined in 3.13.9.2.3 by substituting V_{MRSP} with V_{PBD}

With $V_{delta0PBD}=f_{41}\left(V_{PBD}+dV_{ebi}\right)$ or $V_{delta0PBD}=0$ (if compensation of speed inaccuracy is inhibited by National Value)

With $D_{bec} = \left(V_{PBD} + dV_{ebi} + V_{delta0PBD}\right) \cdot \left(T_{traction} + T_{berem}\right)$

With $T_{traction}$ and T_{berem} as defined in 3.13.9.3.2

With d_{PBD} being the permitted braking distance given by trackside

With $V_{EBD}\left(d\right)$ being the EBD curve that reaches zero speed at d_{PBD}

With $d_{offset} = L_{antenna-front} + T_{41} \cdot \left(V_{PBD} + dV_{ebi} + V_{delta0PBD}\right)$

If no speed value fulfils the above inequalities, then:

$$V_{PBD} = 0$$

3.11.11.7 If the permitted braking distance is to be achieved with the service brake, the PBD speed restriction (V_PBD) shall be equal to the most restrictive value amongst the one computed from the EBD (see 3.11.11.8) and the one computed from the SBD (see 3.11.11.9). The resulting value shall then be rounded down to the next lower multiple of 5km/h.

3.11.11.8 If the permitted braking distance is to be achieved with the service brake, the ERTMS/ETCS on-board equipment shall seek the PBD_{EBD} speed restriction value which satisfies the two following inequalities:

$$ABS\left\{\begin{array}{l}\left(V_{PBD} + dV_{sbi}\right) - \\ \left(V_{EBD}\left(d_{offset} + D_{bec} + \left(V_{PBD} + dV_{sbi}\right) \cdot T_{bs2}\right) - V_{delta0PBD}\right)\end{array}\right\} \leq 1km/h$$

$$d_{offset} + D_{bec} + \left(V_{PBD} + dV_{sbi}\right) \cdot T_{bs2} \leq d_{PBD}$$

With dV_{sbi} as defined in 3.13.9.2.5 by substituting V_{MRSP} with V_{PBD}

With $V_{delta0PBD} = f_{41}\left(V_{PBD} + dV_{sbi}\right)$ or $V_{delta0PBD} = 0$ (if compensation of speed inaccuracy is inhibited by National Value)

With $D_{bec} = \left(V_{PBD} + dV_{sbi} + V_{delta0PBD}\right) \cdot \left(T_{traction} + T_{berem}\right)$

With $T_{traction}$ and T_{berem} as defined in 3.13.9.3.2

With T_{bs2} as defined in 3.13.9.3.3

With d_{PBD} being the permitted braking distance given by trackside

With $V_{EBD}\left(d\right)$ being the EBD curve that reaches zero speed at d_{PBD}

With $d_{offset} = L_{antenna-front} + T_{41} \cdot \left(V_{PBD} + dV_{sbi} + V_{delta0PBD}\right)$

If no speed value fulfils the above inequalities, then:

$$V_{PBD} = 0$$

3.11.11.9 If the permitted braking distance is to be achieved with the service brake, the ERTMS/ETCS on-board equipment shall seek the PBD_{SBD} speed restriction value which satisfies the two following inequalities:

$$ABS\left\{\left(V_{PBD} + dV_{sbi}\right) - \left(V_{SBD}\left(d_{offset} + \left(V_{PBD} + dV_{sbi}\right)\cdot T_{bs1}\right)\right)\right\} \leq 1km/h$$

$$d_{offset} + \left(V_{PBD} + dV_{sbi}\right)\cdot T_{bs1} \leq d_{PBD}$$

With dV_{sbi} as defined in 3.13.9.2.5 by substituting V_{MRSP} with V_{PBD}

With T_{bs1} as defined in 3.13.9.3.3

With d_{PBD} being the permitted braking distance given by trackside

With $V_{SBD}(d)$ being the SBD curve that reaches zero speed at d_{PBD}

With $d_{offset} = L_{antenna-front} + T_{41}.\left(V_{PBD} + dV_{sbi}\right)$

If no speed value fulfils the above inequalities, then:

$$V_{PBD} = 0$$

3.11.11.10 Note: The method chosen (e.g. iterative algorithm) to compute the PBD speed restriction(s) is an implementation issue.

3.11.11.11 The initial state for Speed Restrictions to Ensure Permitted Braking Distance shall be “no speed restriction”.

3.11.12 Gradients

3.11.12.1 The gradient information for a given piece of track shall be transmitted to the on-board equipment in form of a gradient profile.

3.11.12.2 The gradient profile shall be continuous, i.e., give a gradient value for each location within the piece of track covered by the profile.

3.11.12.3 A gradient value shall be identified as a positive value for an uphill slope, and with a negative value for a downhill slope.

3.11.12.4 The gradient profile shall contain the gradient information as a sequence of gradient values, constant between two defined locations each, see Figure 27.

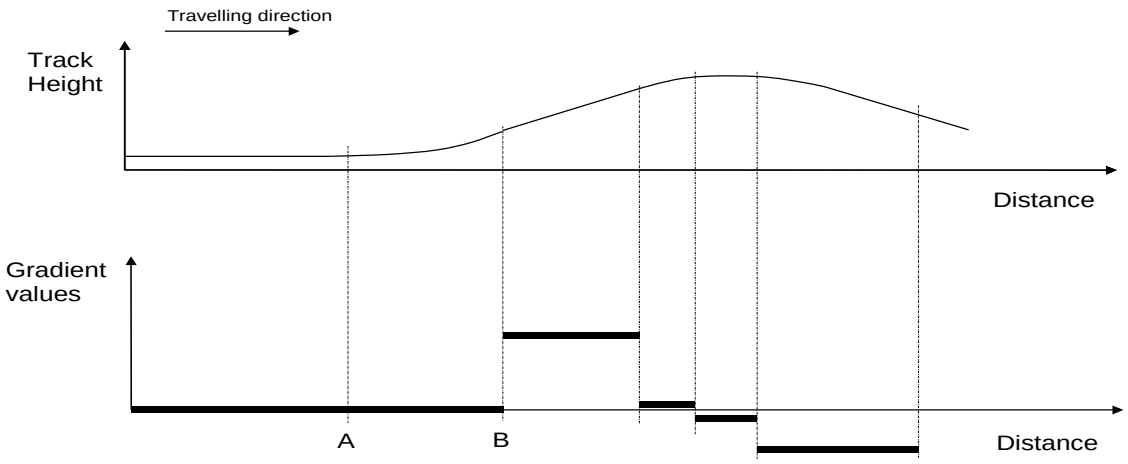


Figure 27: Gradient profile

3.11.12.4.1 Note: The figure above symbolises the engineering process to provide the values of gradients. Following the track height, the track must be split in segments giving for each segment a gradient value.

3.11.12.5 It shall be possible via balise groups to send to the on-board equipment a default gradient for TSR, to be used for the parts of the track not covered by the gradient profile.

3.11.12.6 The Default Gradient for TSR stored on-board shall be valid until a new Default Gradient for TSR is received.

3.12 Other Profiles

3.12.1 Track Conditions

3.12.1.1 The Track Condition function is used to inform the driver and/or the train of a condition in front of the train.

3.12.1.2 A Track Condition shall be given as profile data (e.g. non-stopping area), i.e. start and end of the data is given, or location data (e.g. change of traction system) i.e. start location given, depending on the type of track condition.

3.12.1.2.1 The starting point of a profile type track condition shall be evaluated taking into account the max safe front end of the train, the end of the profile taking into account the min safe rear end of the train. Location type data shall be evaluated taking into account the max safe front of the train.

3.12.1.2.1.1 Note: The timing of output data to control train equipment (e.g. pantograph) is application specific.

3.12.1.2.1.2 Exception 1: The starting point of a Big Metal Mass type track condition shall be evaluated taking into account the max safe antenna position, the end of the profile taking into account the min safe antenna position.

3.12.1.2.1.3 Exception 2: The end of the Powerless section and the end of the Station Platform shall be evaluated taking into account the min safe front end of the train.

3.12.1.2.1.4 Exception 3: The start and end of a tunnel stopping area and of a sound horn track condition shall be evaluated taking into account the estimated front end of the train.

3.12.1.3 The types of track conditions to be covered by this function are:

- Powerless section, lower pantograph (initial state: no powerless section, i.e. pantograph not to be lowered)
- Powerless section, switch off main power switch (initial state: no powerless section, i.e. main power switch not to be switched off)
- Air tightness (initial state: no request for air tightness)
- Sound horn (initial state: no request for sound horn)
- Non stopping area (initial state: stopping permitted)
- Tunnel stopping area (initial state: no tunnel stopping area)
- Change of traction system, switch traction system on-board, used for train capable of handling several traction systems (initial state: no initial state – keep the current setting)
- Change of allowed current consumption, limit current consumed by the train, used to adapt the maximum current consumption of the train to the maximum current allowed by the trackside (initial state: no initial state – keep the current setting)
- Big metal masses, ignore onboard integrity check alarms of balise transmission. (initial state: alarms not ignored)
- Radio hole, stop supervision of the loss of safe radio connection (initial state: loss of safe radio connection supervised)
- Switch off regenerative brake (initial state: regenerative brake on)
- Switch off eddy current brake for service brake (initial state: eddy current brake on for service brake)
- Switch off eddy current brake for emergency brake (initial state: eddy current brake on for emergency brake)
- Switch off magnetic shoe brake (initial state: magnetic shoe brake on).
- Station platform, enable passenger doors with or without steps according to platform location, side and height (initial state: no platform, i.e. passenger doors not enabled).

3.12.1.3.1 Note: In case of regenerative brake switch off or magnetic shoe brake switch off, the deceleration of the emergency brake might be affected if the effect of these brakes was included in the calculation of the deceleration value.

3.12.1.3.2 Note: In case of eddy current brake switch off the deceleration of the service brake or emergency brake might be affected if the effect of these brakes was included in the calculation of the deceleration value.

3.12.1.3.3 Note: in case of powerless section the deceleration of the service brake or emergency brake might be affected if the effect of a regenerative brake not independent from the presence of voltage in the catenary was included in the calculation of the deceleration value.

3.12.1.4 Intentionally deleted.

3.12.1.5 The following actions shall be performed once a track condition has been received:

a) Indicate on DMI (see chapter 5, procedure “Indication of track conditions”), except “Station platform”, “Change of allowed current consumption” and “Big metal masses”.

b) Send information with the remaining distance to an ERTMS/ETCS external function (see chapter 5, procedure “Generation of track conditions related information to an ERTMS/ETCS external function”), with the exception of big metal mass track condition, sound horn track condition, non stopping area, tunnel stopping area and supervision of radio transmission which are handled inside the ERTMS/ETCS on-board equipment.

3.12.1.5.1 Note: Whether some information shall be filtered (not shown to the driver or not sent to an ERTMS/ETCS external function) is outside the scope of ERTMS/ETCS.

3.12.1.5.2 Note: The ERTMS/ETCS external function must be able to handle new track condition of the same type as previously received and covering the same distance.

3.12.1.6 The train is permitted to run without any track condition information given from the trackside. The initial state shall then be used by the on-board equipment.

3.12.2 Route Suitability

3.12.2.1 Route suitability data defines which values concerning loading gauge, traction system and axle load category a train must meet to be allowed to enter the route.

3.12.2.2 It shall be possible for trackside to send route suitability data as location data when needed.

3.12.2.3 On reception of route suitability data, the ERTMS/ETCS on-board equipment shall compare it with the corresponding Train Data stored on-board. Unsuitability exists if:

a) The loading gauge profile of the train is not included in the list of loading gauges accepted by trackside

b) The list of traction systems accepted by the engine does not include the one received from trackside

c) The axle load category of the train is higher than the permitted one received from trackside

3.12.2.4 If at least one unsuitability exists, the closest location corresponding to the unsuitability(ies) shall be considered as both the EOA and SvL (instead of the EOA/LOA and the SvL (if any) derived from the MA), with no Release Speed. The driver shall be informed about all unsuitabilities.

3.12.2.5 Intentionally deleted.

3.12.2.5.1 Intentionally deleted.

3.12.2.6 Intentionally deleted.

3.12.2.7 Intentionally deleted.

3.12.2.8 If, for any reasons, the train overpasses the location of the first route suitability where incompatibility occurs, it shall be tripped.

3.12.2.9 The Train Data concerning route suitability is part of the Train Data sent to the RBC.

3.12.2.9.1 Note: This allows for route suitability supervision to be used in systems external to the ERTMS/ETCS system.

3.12.2.10 The train is permitted to run without any route suitability data given from the track. No default values shall be used or supervised by the on-board equipment, i.e. the initial state is that no restrictions related to route suitability exists.

3.12.3 Text Transmission

3.12.3.1 General Rules

3.12.3.1.1 It shall be possible to transmit information to be displayed to the driver from the trackside to the on-board equipment in the form of text messages.

3.12.3.1.2 Text messages shall always be supplemented by conditions on when and where they are to be displayed, and whether any acknowledgement is requested from the driver. These parameters shall be transmitted individually for each message.

3.12.3.1.3 Text messages and the supplementary information shall always be transmitted in one message.

3.12.3.1.4 It shall be possible to send the text to be displayed in plain text or to send a number selecting a fixed message.

3.12.3.1.4.1 Note: In case of plain text messages the trackside selects the language in which the message is displayed.

3.12.3.1.5 Intentionally deleted.

3.12.3.1.6 Intentionally deleted.

3.12.3.1.7 Intentionally deleted.

3.12.3.1.8 Intentionally deleted.

3.12.3.1.9 The following data shall be included in a text message:

- Class of message (auxiliary or important information)
- Plain text message or fixed message number
- Conditions for start of indication
- Conditions for end of indication
- If driver acknowledgement is requested or not

3.12.3.1.10 The appearance of a message shall depend on the class and on whether a driver acknowledgement is requested.

3.12.3.1.11 It shall be possible for trackside to send a text message with a request to report driver acknowledgement, if any, to an RBC.

3.12.3.2 Intentionally deleted

3.12.3.2.1 Intentionally deleted

3.12.3.3 Fixed text messages

3.12.3.3.1 Fixed text messages shall be stored on-board in all languages that can be selected by the driver.

3.12.3.3.2 Intentionally deleted.

3.12.3.3.3 Intentionally deleted.

3.12.3.3.4 Intentionally deleted.

3.12.3.3.5 Intentionally deleted.

3.12.3.4 Conditions for Start/End of Indication

3.12.3.4.1 It shall be possible to specify individual events for start/end condition of indication.

3.12.3.4.2 The following events can be used to define the start condition:

- Location
- Mode (start display as soon as in mode)
- Level (start display as soon as in level)

3.12.3.4.3 The following events can be used to define the end condition:

- Location
- Time
- Mode (stop display when leaving mode)

- Level (stop display when leaving level)

3.12.3.4.3.1 It shall be possible to define whether one or all of the events used from the list in 3.12.3.4.2/3.12.3.4.3 have to be fulfilled to define the start/end condition. This definition shall apply to both start and end conditions checked by the on-board.

3.12.3.4.3.2 In case a confirmation of the text message is requested, it shall be possible to define whether the driver acknowledgement is considered:

a) As always ending the text display, regardless of the end condition defined in 3.12.3.4.3.1

b) As a necessary condition to end the text display, in addition to the end condition defined in 3.12.3.4.3.1.

3.12.3.4.4 The end condition shall be evaluated as soon as the start condition is fulfilled. No display shall take place if the end condition is immediately fulfilled.

3.12.3.4.5 Once the text message is displayed and the end condition is fulfilled, the start condition shall not be re-evaluated.

3.12.3.4.6 When the end event "location" is used, the length on which the text is displayed shall refer to the location used for the start condition, independently from other start events.

3.12.3.4.7 In case a confirmation of the text message is requested, it shall be possible to define whether the service brake or emergency brake application shall be commanded if the driver does not acknowledge before the end condition is fulfilled.

3.12.3.4.7.1 If the driver does not acknowledge before the end condition is fulfilled, the text message shall remain displayed until acknowledged by driver.

3.12.3.4.7.2 If the driver acknowledges before the end condition is fulfilled, the on-board equipment shall consider the driver acknowledgement as requested by trackside (see 3.12.3.4.3.2).

3.12.3.4.8 Intentionally deleted.

3.12.3.5 Report of driver acknowledgement to RBC

3.12.3.5.1 If trackside requests a report of driver acknowledgement, then it shall include:

- a text message identifier
- the identity of the RBC to which the driver acknowledgement report is to be sent.

3.12.3.5.2 When the driver has acknowledged a text message with a request to report driver acknowledgement, the driver acknowledgement report, including the text message identifier, shall be sent to the RBC referenced in the request.

3.12.3.5.3 A new text message with request for report of driver acknowledgement shall be rejected by the ERTMS/ETCS on-board equipment if it has the same text message

identifier as a previously received text message, which the driver has not yet acknowledged.

3.12.4 Mode profile

3.12.4.1 It shall be possible for trackside to send a Mode Profile. The Mode Profile can request On Sight mode, Limited Supervision mode and Shunting mode.

3.12.4.2 For OS and LS mode the mode profile defines the entry and the length of the On Sight/Limited Supervision area. For SH mode the mode profile only defines the entry location to SH mode, any length given shall be ignored by the on-board.

3.12.4.3 On reception of a new MA (with or without Mode Profile) the on-board equipment shall delete the currently supervised Mode Profile.

3.12.4.3.1 Exception: When receiving a new MA by infill, any currently supervised Mode Profile shall be deleted only beyond the reference location of the infill information.

3.12.4.4 In case the mode profile information for shunting is overwritten by a new shunting profile, before the on-board equipment switches to SH mode, a previous list of balise groups for SH area shall be deleted or replaced by a new list of balise groups for SH area.

3.12.4.5 The beginning of the Mode Profile relates to the max safe front end of the train.

3.12.4.6 The end of the mode profile relates to the min safe front end of the train.

3.12.5 Level Crossings

3.12.5.1 It shall be possible for trackside to inform the ERTMS/ETCS on-board equipment about the conditions under which a Level Crossing (LX) must be passed.

3.12.5.2 Each Level Crossing shall have an identity, so that all LX information is independent of each other. This means that an individual LX information cannot affect, nor be affected by, any other individual LX information.

3.12.5.3 If the ERTMS/ETCS on-board equipment receives a new LX information with the same identity as an already received LX information, the new LX information shall replace the previous one.

3.12.5.4 Level Crossing information shall be given as profile data, corresponding to the LX start location and the length of the LX area.

3.12.5.5 Level Crossing information shall indicate whether the LX is protected or not.

3.12.5.6 In case the LX is not protected, ERTMS/ETCS on-board equipment shall be informed:

a) at which speed the LX is allowed to be passed

b) whether the stopping of the train in rear of the LX start location is required or not

3.12.5.7 In case stopping in rear of the non protected LX is required, a stopping area in rear of the LX start location shall be defined.

3.13 Speed and distance monitoring

3.13.1 Introduction

3.13.1.1 The speed and distance monitoring is the supervision of the speed of the train versus its position, in order to assure that the train remains within the given speed and distance limits.

3.13.1.1.1 Note: The speed and distance monitoring of the on-board can only assure this when the following necessary conditions are fulfilled:

- Brake system of the train functions as specified
- wheel/rail adhesion is sufficient for the required safe deceleration
- Brake characteristics (and other Train related inputs) are correctly entered into the on-board

3.13.1.2 Note: The ERTMS/ETCS on-board equipment triggers brake commands and revokes them, it may also receive status information if the brakes are applied or released. However, it cannot be made responsible if brake control circuits outside the equipment fail. Also the way the brakes are released by the driver after a revocation of a brake command is an implementation issue.

3.13.1.3 Figure 28 gives an overview of the main elements contributing to the speed and distance monitoring. These elements (inputs, functions and outputs) are detailed in the following chapters.

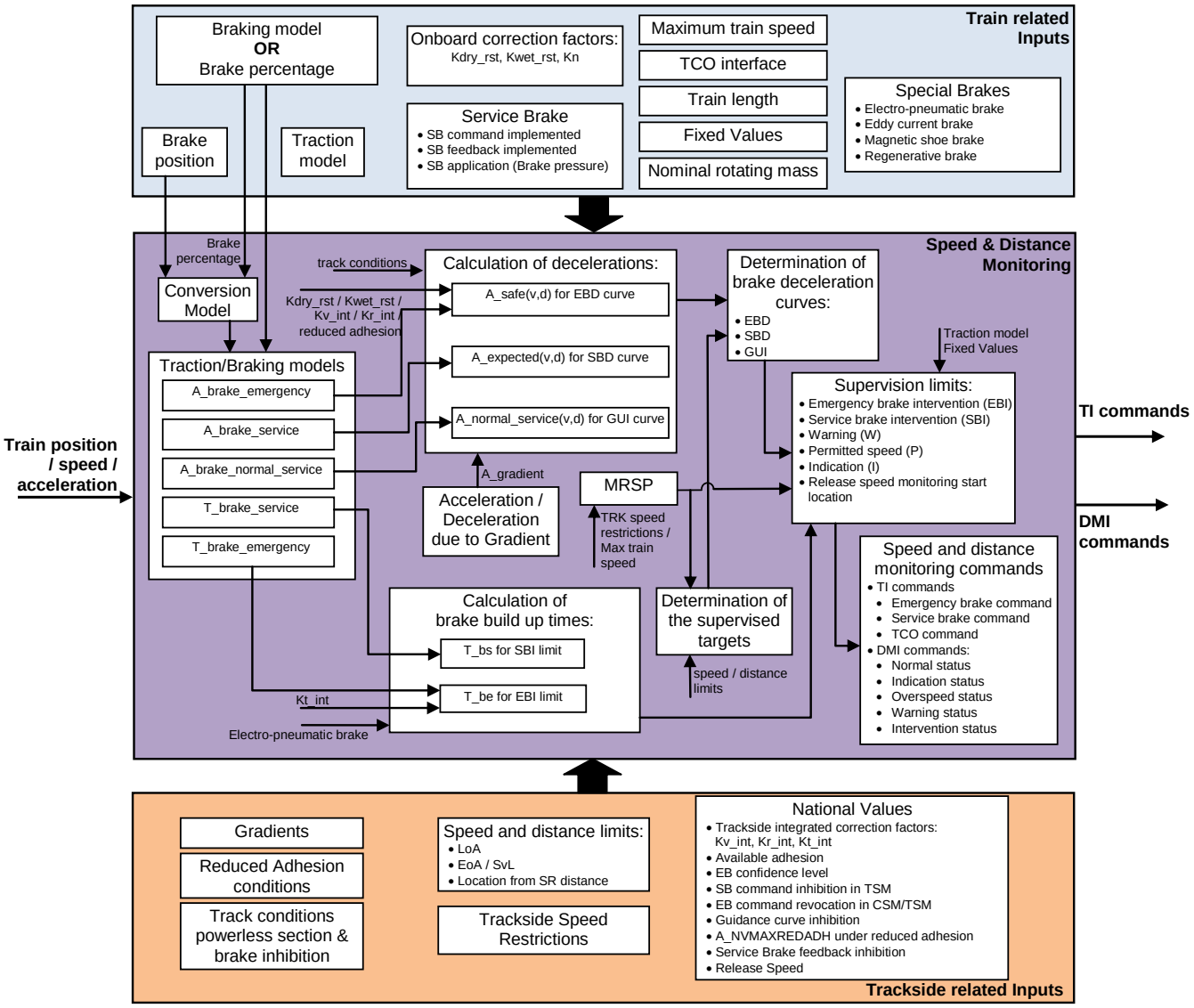


Figure 28: Speed and distance monitoring overview

3.13.1.4 Throughout the following sections, all the distances marked with “d” (lower case), which are referred in parameters, formulas and figures, are counted from the current reference location of the on-board equipment (e.g. the LRBG).

3.13.2 Inputs for speed and distance monitoring

3.13.2.1 Introduction

3.13.2.1.1 The traction / braking models, the brake position / brake percentage are used for the definition of the kinematic behaviour of the train after a service brake command or an emergency brake command has been initiated.

3.13.2.1.2 However, railway brakes have a statistical behaviour and braking distances vary within the typical distribution for a given condition. Correction factors are therefore incorporated for the speed and distance monitoring.

3.13.2.1.3 The correction factors will allow obtaining, from the nominal emergency braking performance of the train, the minimum emergency braking performances that are required for reference conditions set by trackside.

3.13.2.2 Train related inputs

3.13.2.2.1 Introduction

3.13.2.2.1.1 The train related inputs to be considered for the speed and distance monitoring are:

a) Traction model

b) Braking models (brake build up time and speed dependent deceleration) or brake percentage

c) Brake position

d) Special brakes (interface configuration and status)

e) Service brake (interface configuration and application)

f) Traction cut-off interface

g) On-board correction factors

h) Nominal rotating mass

i) Train length

j) Fixed values related to speed and distance monitoring

k) Train related speed restriction (i.e. the maximum train speed)

3.13.2.2.1.2 These train related inputs are acquired as Train Data (see 3.18.3.2 items b) c) and d)), except:

- the configuration of the special brakes, service brake and traction cut-off interfaces which are not affected by the Train Data acquisition,
- the service brake application and the special brakes statuses which are continuously acquired on the Train Interface,
- the fixed values.

3.13.2.2.1.3 The speed and distance monitoring shall use braking models acquired as Train Data, unless the brake percentage is acquired as Train Data and the conversion model is applicable (see 3.13.3.2 for its validity limits).

3.13.2.2.2 Traction model

3.13.2.2.2.1 The traction model shall be given as a step function as indicated in Figure 29. It shall describe the time delay T_traction_cut_off from the traction cut-off command by

the on-board (t0) to the moment the acceleration due to traction (A_traction) is guaranteed to be zero (t1). The estimated acceleration value of the train shall be considered during this time delay.

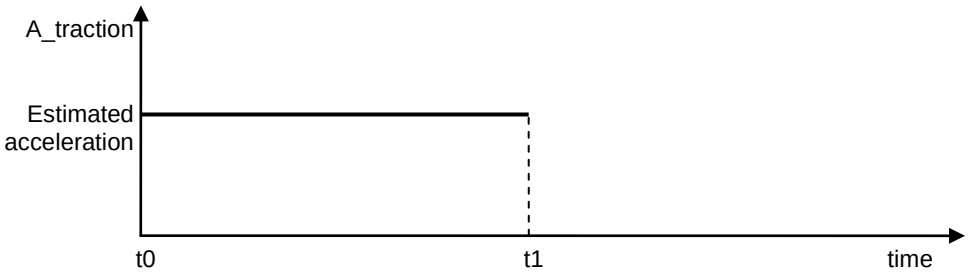


Figure 29: Traction Model

3.13.2.2.2.2 Note: The current value of A_traction is not known directly by the on-board. It is implicitly known as a contribution to the estimated acceleration, together with the acceleration due to gradient.

3.13.2.2.3 Braking Models

3.13.2.2.3.1 Speed Dependent Deceleration

3.13.2.2.3.1.1 The deceleration due to braking shall be given as a step function of the speed.

3.13.2.2.3.1.2 It shall be possible to define up to seven steps for each speed dependent deceleration model.

3.13.2.2.3.1.3 Note: An example with 4 steps is given in Figure 30. A_brake(V) is calculated as follows:

- A_brake = AD_0 when 0 ≤ speed ≤ V1
- A_brake = AD_1 when V1 < speed ≤ V2
- A_brake = AD_2 when V2 < speed ≤ V3
- A_brake = AD_3 when V3 < speed

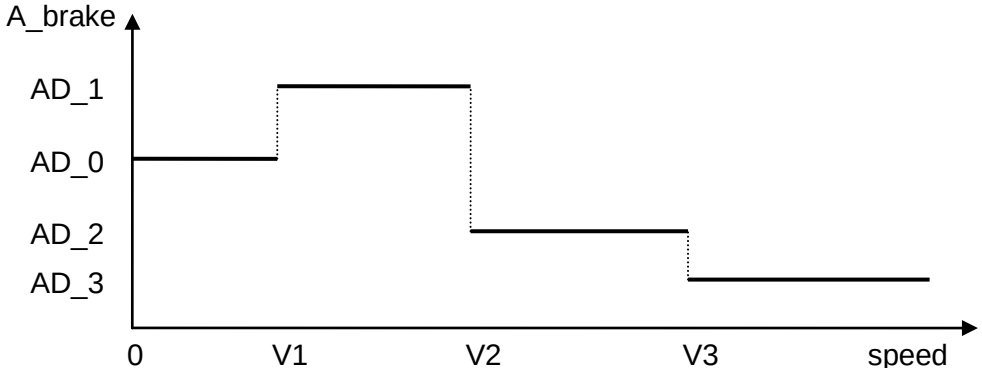


Figure 30: Speed Dependent Deceleration Model

3.13.2.2.3.1.4 The last step of A_brake(V) shall by definition be considered as open ended, i.e. it has no upper speed limit.

3.13.2.2.3.1.5 The model shall be applicable only after full build up of the braking effort (see a_full in Figure 31)

3.13.2.2.3.1.6 The model shall be used for the emergency brake nominal deceleration (A_brake_emergency(V)), for the full service brake deceleration (A_brake_service(V)) and for the normal service brake deceleration (A_brake_normal_service(V)).

3.13.2.2.3.1.7 It shall be possible to define individual speed dependent deceleration models of A_brake_emergency(V) and A_brake_service(V) for each combination of use of regenerative brake, eddy current brake and magnetic shoe brake.

3.13.2.2.3.1.8 Note: Individual deceleration models may be equal, thereby avoiding the influence of a specific brake on A_brake_emergency(V) or A_brake_service(V). However, the choice to take into account or not the contribution of a specific brake for A_brake_emergency(V) or A_brake_service(V) is only rolling stock dependent, not an ETCS implementation issue.

3.13.2.2.3.1.9 It shall be possible to define up to two sets of three models of A_brake_normal_service(V):

a) one set applicable when the brake position is in “Freight train in G”

b) one set applicable when the brake position is in “Passenger train in P” or “Freight train in P”

3.13.2.2.3.1.10 A set of A_brake_normal_service(V) shall be defined as a function of the full service brake deceleration at zero speed, A_brake_service(V=0):

If A_brake_service(V = 0) ≤ A_SB01

A_brake_normal_service(V) = A_brake_normal_service_0(V)

if A_SB01 < A_brake_service(V = 0) ≤ A_SB12

A_brake_normal_service(V) = A_brake_normal_service_1(V)

if A_SB12 < A_brake_service (V = 0)

A_brake_normal_service(V) = A_brake_normal_service_2(V)

3.13.2.2.3.1.11 Note: the two pivot values A_SB01 and A_SB12 are part of the A_brake_normal_service model, i.e. they are train related input data for the speed and distance monitoring function.

3.13.2.2.3.2 Brake build up time

3.13.2.2.3.2.1 The deceleration A_brake is not available immediately after the on-board commands the brake. There is a time lag between brake command and the start of the brake force build-up. There is also time needed to build up the full brake force.

3.13.2.2.3.2.2 The model for the brake build up time shall be given as a step function as explained in Figure 31.

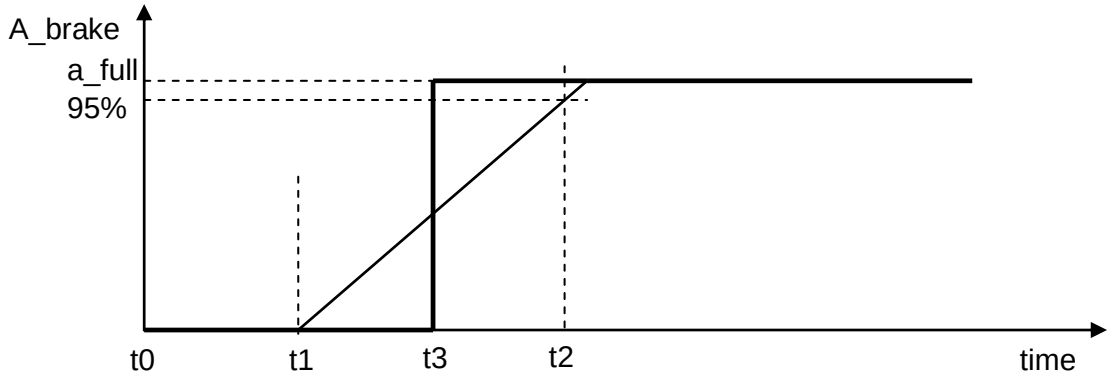


Figure 31: Brake Build Up Time Model

3.13.2.2.3.2.3 In Figure 31, the following time intervals are defined:

a) T_brake_react (t0…t1) is the interval between the command of the brake by the on-board and the moment the brake force starts to build up.

b) T_brake_increase (t1...t2) is the interval in which the brake force increases from the zero to the moment when 95% of full brake power is reached.

c) T_brake_build_up (t0...t3) is the equivalent brake build up time.

3.13.2.2.3.2.4 The equivalent brake build up time (T_brake_build_up) is defined as T_brake_build_up = T_brake_react + 0.5*T_brake_increase.

3.13.2.2.3.2.5 This model for T_brake_build_up shall be used for the emergency brake (T_brake_emergency) and for the full service brake (T_brake_service).

3.13.2.2.3.2.6 Note: The equivalent brake build up time is a safe approximation. In the beginning of the build-up time the model assumes a smaller deceleration, in the later part this is compensated by a higher deceleration.

3.13.2.2.3.2.7 Note: T_brake_react and T_brake_increase are indicated in Figure 31 for completeness reasons; only T_brake_build_up is to be considered as an input for the speed and distance monitoring function.

3.13.2.2.3.2.8 It shall be possible to define individual values of T_brake_emergency and T_brake_service for each combination of use of regenerative brake, eddy current brake, magnetic shoe brake and Ep brake.

3.13.2.2.3.2.9 Note: Individual values of T_brake_emergency and T_brake_service may be equal, thereby avoiding the influence of a specific brake. However, the choice to take into account or not the contribution of a specific brake for T_brake_emergency and T_brake_service is only rolling stock dependent, not an ETCS implementation issue.

3.13.2.2.3.2.10 Note: In general, T_brake_emergency and T_brake_service are determined by the pneumatic brake therefore avoiding to take into account of the influence of the regenerative brake, eddy current brake or magnetic shoe brake. However, if the Electro-pneumatic brake system is used, it is possible that T_brake_emergency and T_brake_service are determined by another special brake.

3.13.2.2.4 Brake Position

3.13.2.2.4.1 The brake position shall be set to one of the following three values:

a) Passenger train in P

b) Freight train in P

c) Freight train in G

3.13.2.2.4.2 Note: The brake position defines the behaviour of the brake for specific train types.

3.13.2.2.5 Brake Percentage

3.13.2.2.5.1 If the brake percentage is captured as Train Data and the conversion model is applicable (see 3.13.3.2), they are used to derive A_brake_emergency(V), A_brake_service(V), T_brake_emergency and T_brake_service.

3.13.2.2.5.2 Note: the conversion model has been designed assuming that all the provisions laid down in the UIC leaflet 544-1 6th edition, with the exception of sections 9.1.2, 9.2.2 and 9.3.3, apply for the acquired brake percentage.

3.13.2.2.6 Special Brakes

3.13.2.2.6.1 For each special brake (regenerative brake, eddy current brake, magnetic shoe brake and electro-pneumatic brake), the on-board shall be configured to define one of the following possibilities marked with an “X” in Table 3

		configuration possibilities			
		No interface exists	*Interface exists and status affects the emergency brake model only*	*Interface exists and status affects the service brake model only*	*Interface exists and status affects both emergency and service brake models*
Special brake	regenerative brake	x	x	x	x
	eddy current brake	x	x	x	x
	magnetic shoe brake	x	x		
	Ep brake	x		x	x

Table 3: On-board Configuration in relation to special brakes

3.13.2.2.6.2 When an interface exists with the regenerative brake, eddy current brake, magnetic shoe brake system and/or the Ep brake on-board system and depending whether their status affects the concerned brake parameter(s), the speed and distance monitoring shall take into account their status “active” or “not active” to select the appropriate brake parameter(s) captured as Train Data, according to Table 4:

		When interface exists and if status affects the brake parameter, selection of brake parameter according to status of:			
		regenerative brake	eddy current brake	magnetic shoe brake	Ep brake
Brake parameter	A_brake_emergency(V)	x	x	x	
	T_brake_emergency	x	x	x	x
	A_brake_service(V)	x	x		
	T_brake_service	x	x		x

Table 4: Selection of brake parameters according to status of special brakes

3.13.2.2.6.3 When the brake percentage is captured as Train Data and the conversion model is applicable, A_brake_emergency(V), T_brake_emergency and A_brake_service(V) shall not be influenced by the status of a special brake. However, the conversion model offers the possibility that T_brake_service can be affected by the status of the regenerative brake, eddy current brake or Ep brake (see A.3.9).

3.13.2.2.6.4 The on-board equipment shall be configured to define whether it is allowed to take into account the contribution of a special/additional brake, which is independent from wheel/rail adhesion, for the selection of the maximum emergency brake deceleration under reduced adhesion conditions (see 3.13.6.2.1.6).

3.13.2.2.6.5 Note: the choice to set to “allowed” the contribution of such special/additional brake in the selection of the maximum emergency braking effort, is rolling stock dependent.

3.13.2.2.6.6 If it is allowed to take into account the contribution of a special/additional brake, which is independent from wheel/rail adhesion, the speed and distance monitoring function shall take into account the status “active” or “not active” of the special/additional brake to select the appropriate National Value under reduced adhesion conditions (see 3.13.2.3.7.7).

3.13.2.2.7 Service brake

3.13.2.2.7.1 The on-board shall be configured to define whether the service brake command is implemented or not, i.e. whether a service brake interface is implemented to command a full service brake effort.

3.13.2.2.7.2 The on-board shall be configured to define whether the service brake feedback is implemented or not, i.e. whether it is able to acquire from the service brake interface the information that the service brake is currently applied.

3.13.2.2.7.3 If the service brake feedback is implemented and if not inhibited by National Value, the speed and distance monitoring function shall take into account either the main brake pipe pressure or the brake cylinder pressure to adjust in real time the expected brake build up time (see 3.13.9.3.3.4 and Appendix A.3.10).

3.13.2.2.8 Traction cut-off interface

3.13.2.2.8.1 The on-board shall be configured to define whether the traction cut-off command is implemented, i.e. whether the interface to the traction system is implemented or not.

3.13.2.2.9 On-board Correction Factors

3.13.2.2.9.1 Correction factors for the emergency deceleration

3.13.2.2.9.1.1 If the braking models are captured as Train Data, rolling stock correction factors shall be defined in the ETCS on-board equipment. If the brake percentage is captured as Train Data and the conversion model is used (see 3.13.3.2 for its validity limits), no rolling stock correction factor shall apply.

3.13.2.2.9.1.2 For each defined individual speed dependent deceleration model of A_brake_emergency(V) (i.e. corresponding to each combination of use of regenerative brake, eddy current brake and magnetic shoe brake), one set of rolling stock correction factors Kdry_rst(V, EBCL) and Kwet_rst(V) shall be defined in the on-board equipment.

3.13.2.2.9.1.3 For a given confidence level on emergency brake safe deceleration (EBCL), the rolling stock correction factor Kdry_rst(V) shall be given as a step function of speed, with the same steps as the ones of A_brake_emergency(V).

3.13.2.2.9.1.4 The confidence level on emergency brake safe deceleration represents the probability of the following individual event: the rolling stock emergency brake subsystem of the train does ensure a deceleration at least equal to A_brake_emergency(V) * Kdry_rst(V), when the emergency brake is commanded on dry rails.

3.13.2.2.9.1.5 The rolling stock correction factor Kwet_rst(V) shall be given as a step function of speed, with the same steps as the ones of A_brake_emergency(V). It represents the loss of deceleration with regards to emergency braking on dry rails, when the emergency brake is commanded on wet rails, according to wheel/rail adhesion reference conditions.

3.13.2.2.9.2 Correction factor for gradient on normal service deceleration

3.13.2.2.9.2.1 The speed dependent correction factors for gradient on the normal service brake, Kn+(V) and Kn-(V), shall be given as step functions in the range from 0 to 10 m/s2.

3.13.2.2.9.2.2 It shall be possible to define up to five steps for Kn+(V) and for Kn-(V), respectively.

3.13.2.2.9.2.3 Note: An example with 4 steps is given in Figure 32. Kn is calculated as follows:

- Kn = Kn_0 when 0 ≤ speed ≤ V1
- Kn = Kn_1 when V1 < speed ≤ V2
- Kn = Kn_2 when V2 < speed ≤ V3
- Kn = Kn_3 when V3 < speed

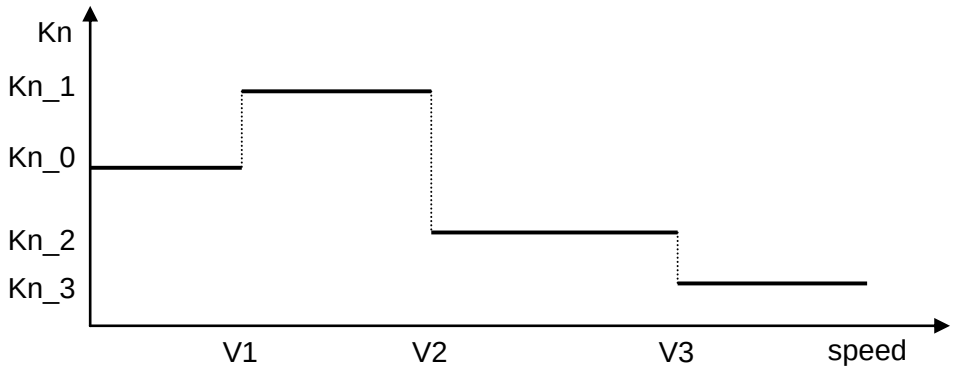


Figure 32 Speed dependent correction factor for normal service brake (Kn)

3.13.2.2.9.2.4 Kn+(V) shall be applicable for positive gradients.

3.13.2.2.9.2.5 Kn-(V) shall be applicable for negative gradients.

3.13.2.2.9.2.6 The last step of the Kn+(V) or Kn-(V) shall by definition be considered as open ended, i.e. it has no upper speed limit.

3.13.2.2.10 Nominal Rotating mass

3.13.2.2.10.1 It shall be possible to define the nominal rotating mass to be used for compensating the gradient, instead of the two related fixed values defined in A.3.1.

3.13.2.2.11 Train length

3.13.2.2.11.1 The speed and distance monitoring shall take into account the train length acquired as part of Train Data (see section 3.18.3).

3.13.2.2.12 Fixed values

3.13.2.2.12.1 The speed and distance monitoring shall take into account the fixed values defined in A.3.1 that are related to speed and distance monitoring.

3.13.2.2.13 Maximum train speed

3.13.2.2.13.1 The speed and distance monitoring shall take into account the maximum train speed defined as part of Train Data (see section 3.18.3).

3.13.2.3 Trackside related inputs

3.13.2.3.1 Introduction

3.13.2.3.1.1 The trackside related inputs to be considered for the speed and distance monitoring are:

a) Trackside related speed restrictions

b) Gradients

c) Track conditions related to brake inhibition

d) Track conditions related to powerless section

e) Reduced adhesion conditions

f) Specific speed and distance limits (e.g. EOA/SvL)

g) National Values

3.13.2.3.2 Trackside related speed restrictions

3.13.2.3.2.1 The speed and distance monitoring shall take into account the trackside related speed restrictions composed of all speed restrictions mentioned in 3.11.2 except the maximum train speed.

3.13.2.3.3 Gradients

3.13.2.3.3.1 The speed and distance monitoring shall take into account the gradient profile and the default gradient for TSR (see section 3.11.12).

3.13.2.3.4 Track conditions

3.13.2.3.4.1 The speed and distance monitoring shall take into account the following types of track condition received from trackside (see section 3.12.1): powerless section, inhibition of regenerative brake, eddy current brake and magnetic shoe brake.

3.13.2.3.5 Reduced adhesion conditions

3.13.2.3.5.1 The speed and distance monitoring shall take into account the track reduced adhesion received from trackside or selected by the driver (see section 3.18.4.6).

3.13.2.3.6 Specific speed / distance limits

3.13.2.3.6.1 The speed and distance monitoring shall take into account the following limits:

a) the Limit of Authority (LOA), the End of Authority (EOA), the Supervised Location (SvL) and its associated release speed, if any.

b) the maximum permitted distance to run in Staff Responsible

3.13.2.3.7 National Values for speed and distance monitoring

3.13.2.3.7.1 It shall be possible by means of a National Value to inhibit the use of the service brake command in target speed monitoring.

3.13.2.3.7.2 It shall be possible to state by means of a National Value whether an emergency brake command has to be revoked, both in ceiling speed and target speed monitoring, when:

a) the Permitted Speed supervision limit is no longer exceeded, or

b) the train is at standstill.

3.13.2.3.7.3 It shall be possible by means of a National Value to inhibit the guidance curve (GUI).

3.13.2.3.7.4 It shall be possible by means of a National Value to inhibit the service brake feedback function.

3.13.2.3.7.5 It shall be possible by means of National Values to indicate to the on-board equipment the required confidence level on the emergency brake safe deceleration, when the emergency brake is commanded on dry rails (see 3.13.2.2.9.1.4).

3.13.2.3.7.6 It shall be possible by means of a National Value to indicate to the on-board equipment the available wheel/rail adhesion, weighted between the wheel/rail adhesion for dry rails and the wheel/rail adhesion for wet rails according to reference conditions.

3.13.2.3.7.7 In order to adapt to the train behaviour under reduced adhesion conditions, it shall be possible by means of National Values either to limit to a maximum value the speed dependent deceleration for the emergency brake when the reduced adhesion conditions are known to ETCS (see 3.13.2.3.5) or to request supplementary DMI information assisting further the driver in ceiling speed monitoring. Three values shall be applicable for a given combination of the brake position and of the type of brakes:

a) the first value shall be used for “Passenger train in P” with special/additional brakes independent from wheel/rail adhesion;

b) the second value shall be used for “Passenger train in P” without special/additional brakes independent from wheel/rail adhesion;

c) the third value shall be used for “Freight train in P” or “Freight train in G”.

3.13.2.3.7.8 It shall be possible by means of a National Value to specify a release speed.

3.13.2.3.7.9 It shall be possible by means of a National Value to inhibit the compensation of the speed measurement inaccuracy.

3.13.2.3.7.10 It shall be possible by means of National Values to define integrated correction factors, namely Kv_int(V), Kr_int(l) and Kt_int. The integrated correction factors only apply to the on-board equipment when the conversion model is used.

3.13.2.3.7.11 The speed dependent correction factor, Kv_int(V), shall be given as a step function.

3.13.2.3.7.11.1 It shall be possible to define up to five steps for Kv_int(V).

3.13.2.3.7.11.2 Note: An example with 4 steps is given in Figure 33. Kv_int is calculated as follows:

- Kv_int = Kv_int_0 when 0 ≤ speed ≤ V1
- Kv_int = Kv_int_1 when V1 < speed ≤ V2
- Kv_int = Kv_int_2 when V2 < speed ≤ V3
- Kv_int = Kv_int_3 when V3 < speed

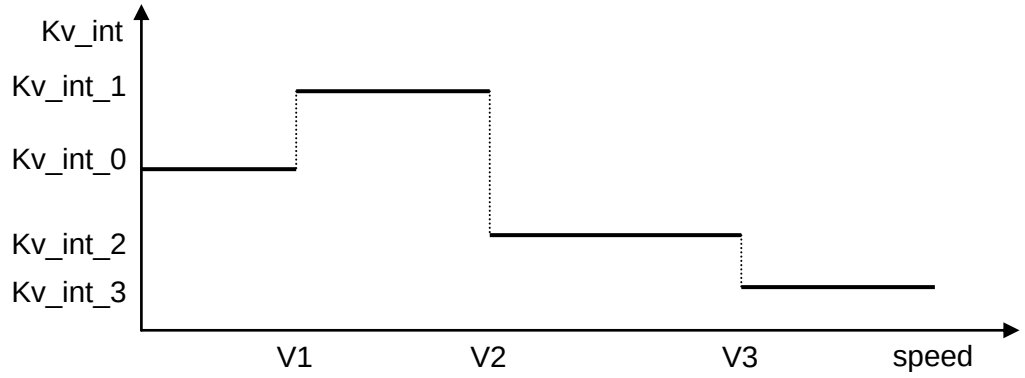


Figure 33 Speed dependent correction factor Kv_int

3.13.2.3.7.11.3 It shall be possible to define up to 2 sets of Kv_int with separate speed limits V1, V2, .. for each set. The sets of Kv_int relate to the following train types:

1) Freight trains
2) Conventional passenger trains

3.13.2.3.7.11.3.1 Note: Different sets of Kv_int are needed for different types of trains in order to compensate the absence of the rolling stock related correction factors when the conversion model is used.

3.13.2.3.7.11.4 The set of Kv_int for conventional passenger trains shall be divided into two sub sets Kv_int_x_a and Kv_int_x_b, with identical speed limits V1, V2, ...

3.13.2.3.7.11.5 Subset Kv_int_x_a shall be applicable for maximum emergency brake deceleration lower or equal to a deceleration limit, defined as a National Value.

3.13.2.3.7.11.6 Subset Kv_int_x_b shall be applicable for maximum emergency brake deceleration greater or equal to a deceleration limit, defined as a National Value.

3.13.2.3.7.12 The train length dependent correction factor, Kr_int(l), shall be given as a step function.

3.13.2.3.7.12.1 It shall be possible to define up to five steps for Kr_int(l).

3.13.2.3.7.12.2 Note: An example with 4 steps is given in Figure 34. Kr_int is calculated as follows:

- Kr_int = Kr_int_0 when 0 ≤ train length ≤ L1
- Kr_int = Kr_int_1 when L1 < train length ≤ L2
- Kr_int = Kr_int_2 when L2 < train length ≤ L3
- Kr_int = Kr_int_3 when L3 < train length

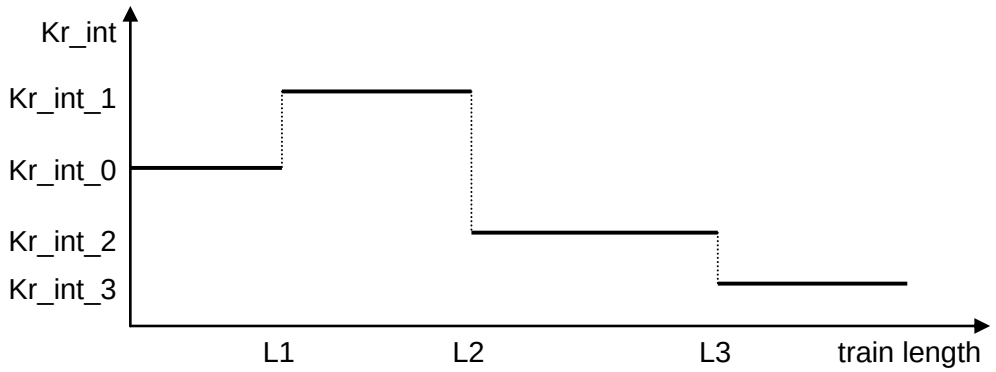


Figure 34 Train length dependent correction factor Kr_int

3.13.2.3.7.13 The last step of the Kv_int(V) and Kr_int(l) shall by definition be considered as open ended, i.e. it has no upper speed and train length limit, respectively.

3.13.2.3.7.14 The correction factor for brake build up time (Kt_int) shall be a single parameter.

3.13.3 Conversion Models

3.13.3.1 Introduction

3.13.3.1.1 For trains with variable composition (loco hauled trains), the brake characteristics can vary together with the composition of the train. In this case, it is not convenient to pre-program the brake parameters necessary to calculate the braking curves. The only practical way to obtain the correct values for the current train composition is to include them into the data entry process by the driver. However, it cannot be expected from the driver to know deceleration values and brake build up times. Conversion models are therefore defined to convert the parameters entered by the driver (brake percentage and brake position) into the parameters of the corresponding brake model.

3.13.3.1.2 Note: The process for defining the input parameters for the conversion model (brake percentage and brake position) is outside the scope of the ERTMS/ETCS specifications.

3.13.3.2 Applicability of the conversion models

3.13.3.2.1 The conversion models shall be used by the on-board equipment if the brake percentage is acquired as part of Train Data, and if the maximum train speed, the brake percentage and the train length are all within the following validity limits of the conversion models:

a) $0 \leq V \leq 200$, where V is the maximum train speed in km/h

b) $30 \leq \lambda \leq 250$, where λ is the brake percentage in %

c) $0 \leq L \leq Lmax$, where L is the train length in m and where Lmax = 900 m if the brake position is “Passenger train in P” or Lmax = 1500 m if the brake position is “Freight train in P” or “Freight train in G”

3.13.3.2.1.1 Note: The overspeed above the maximum train speed which may occur due to the ceiling speed margins is taken into account in the definition of the conversion model.

3.13.3.2.2 For trains not fitting into at least one of those validity limits, it is still possible to acquire the brake percentage as Train Data, but the conversion models are not applicable, which means that braking models (i.e. pre-programmed deceleration profiles and brake build up times) shall be used by the speed and distance monitoring function.

3.13.3.3 Brake percentage conversion model

3.13.3.3.1 Input parameters

3.13.3.3.1.1 The input for the model shall be the brake percentage of the train as defined in 3.13.2.2.5.

3.13.3.3.2 Calculation of the basic deceleration

3.13.3.3.2.1 The basic deceleration A_basic(V) shall be given as a step function of the speed using the algorithm defined in Appendix A.3.7.

3.13.3.3.3 Output parameters

3.13.3.3.3.1 The output of the brake percentage conversion model shall consist of two speed dependent deceleration brake models, A_brake_emergency(V) for the emergency brake and A_brake_service(V) for the service brake.

3.13.3.4 Brake position conversion model

3.13.3.4.1 Input parameters

3.13.3.4.1.1 The input for the model shall consist of the brake position of the train as defined in 3.13.2.2.4, the train length and the target speed.

3.13.3.4.2 Calculation of the emergency brake equivalent time

3.13.3.4.2.1 The equivalent brake build up time for the emergency brake shall be determined as specified in Appendix A.3.8.

3.13.3.4.3 Calculation of the full service brake equivalent time

3.13.3.4.3.1 The equivalent brake build up time for the full service brake shall be determined as specified in Appendix A.3.9.

3.13.3.4.4 Output parameters

3.13.3.4.4.1 The outputs of the brake position conversion model shall consist of:

a) two values of the equivalent brake build up time to be used when the target speed (V_target) is equal to zero, one value for the emergency brake and one for the full service brake:

T_brake_emergency_cm0 as defined for emergency brake in A.3.8

T_brake_service_cm0 as defined for service brake in A.3.9

b) two values of the equivalent brake build up time to be used when the target speed (V_target) is different from zero, one value for the emergency brake and one for the full service brake:

T_brake_emergency_cmt as defined for emergency brake in A.3.8

T_brake_service_cmt as defined for service brake in A.3.9

3.13.4 Acceleration / Deceleration due to gradient

3.13.4.1 Introduction

3.13.4.1.1 The elements of the gradient profile given from trackside shall be compensated:

a) in location according to the train length as defined in 3.13.4.2

b) in value according to the rotating mass as defined in 3.13.4.3 in order to derive the corresponding acceleration/deceleration.

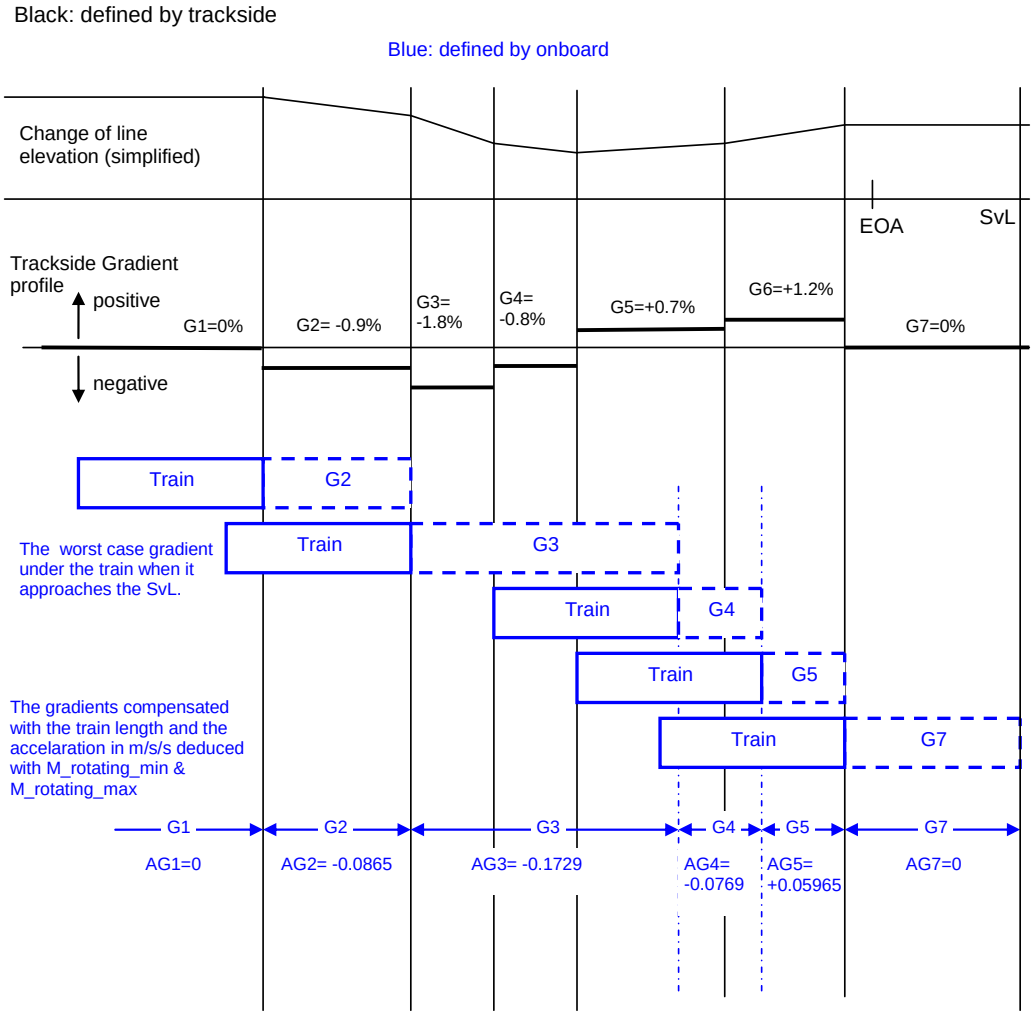


Figure 35: Compensation on the gradient profile

3.13.4.1.2 The default gradient for TSR shall be compensated in value according to the rotating mass as defined in 3.13.4.3.

3.13.4.1.3 For all locations not covered by the gradient profile, the on-board shall consider the gradient value as:

a) the default gradient for TSR, if available and if the concerned target is due to a TSR

b) zero, for other cases.

3.13.4.2 Train length compensation

3.13.4.2.1 Assuming that a fictive train front end would be at any location between the current (actual) train front end location and the SvL, the acceleration due to the gradient shall be determined using the lowest (taking the sign into account) gradient value given by the gradient profile between the location of the fictive train front end and the location of the fictive train rear end (see Figure 35).

3.13.4.3 Rotating mass

3.13.4.3.1 The influence of gradients shall be compensated for the rotating mass of the train (see Figure 35).

3.13.4.3.1.1 Note: Since the rotating mass works like a flywheel (rotating inertia), the effect of the gradient is reduced. Assume for instance a (theoretical) train without any rotating mass, not braking, on a downhill gradient from height 1 to height 2. All the energy added to the train when it goes from H1 to H2 is converted into linear forward motion. This can be observed as an acceleration due to the gradient. Now assume the same train with part of the weight rotating. If this train travels the same distance from H1 to H2, the same amount of energy is added to the train. But now a part of that energy is converted into rotational motion and only the remaining part is converted into linear forward motion. The latter can be observed as an acceleration which is less than for the train without rotating mass.

3.13.4.3.1.2 Note: For the influence of the rotating mass on the deceleration due to the brake, it is already taken into account in the values for the brake parameters.

3.13.4.3.2 The following formulas shall be used:

a) If M_rotating_nom is unknown:

- Uphill: A_gradient = g * grad / (1000+10*M_rotating_max)
- Downhill: A_gradient = g * grad / (1000+10*M_rotating_min)

b) If M_rotating_nom is known:

- Uphill: A_gradient = g * grad / (1000+10*M_rotating_nom)
- Downhill: A_gradient = g * grad / (1000+10*M_rotating_nom)

Legend:

A_gradient = acceleration/deceleration due to gradient

g = 9.81 m/s^2 - acceleration of gravity in m/s^2

grad = gradient values in ‰ (positive = uphill)

M_rotating_nom = nominal rotating mass (part of train data) as a percentage of the total train weight

M_rotating_max = maximum possible rotating mass (see A.3.1) as a percentage of the total train weight

M_rotating_min = minimum possible rotating mass (see A.3.1) as a percentage of the total train weight

3.13.5 Determination of locations without special brake contribution and with reduced adhesion conditions

3.13.5.1 As long as it uses a track condition profile given by trackside, the on-board shall consider locations without special brake contribution over a distance going from the start location of the profile to the foot of the deceleration curve (EBD, SBD or GUI, see sections 3.13.8.3, 3.13.8.4 and 3.13.8.5).

3.13.5.2 If the status of a special brake is “not active”, all locations shall be considered without the contribution of this special brake.

3.13.5.2.1 Note: in such case, a track condition profile implying the inhibition of this special brake will have no effect.

3.13.5.3 From the adhesion profile given by trackside, the on-board shall consider locations with reduced adhesion conditions over a distance going from the start location of the profile to the location derived by adding the train length to the end location of the profile.

3.13.5.4 When slippery rail is selected by the driver, all locations shall be considered with reduced adhesion conditions.

3.13.5.5 The speed and distance monitoring shall use, as resulting reduced adhesion conditions, the most restrictive value of the adhesion conditions selected by the driver and the adhesion conditions calculated from the trackside profile.

3.13.6 Calculation of the deceleration and brake build up time

3.13.6.1 Introduction

3.13.6.1.1 This chapter describes how the safe emergency brake, the expected and the normal service brake decelerations and the time intervals due to brake build up time are calculated.

3.13.6.2 Emergency brake

3.13.6.2.1 Safe deceleration

3.13.6.2.1.1 The safe deceleration, A_safe(V,d), is safety relevant. This means that for the calculation of the safe deceleration, all necessary track and train characteristics shall be taken into account.

3.13.6.2.1.2 The train and track related characteristics to be considered are:

a) The speed dependent deceleration model(s) for the emergency brake either acquired as part of Train Data (see 3.13.2.2.3.1) or derived from the brake percentage using the conversion model (see 3.13.3.3)

b) The acceleration/deceleration due to gradient i.e. A_gradient(d) (see 3.13.4)

c) The locations with reduced adhesion conditions (see 3.13.5)

d) The National Values for reduced adhesion condition (see 3.13.2.3.7.7)

e) The locations without special brake contribution (see 3.13.5), only if the speed dependent deceleration model(s) for the emergency brake are acquired as part of Train Data

f) The rolling stock correction factors Kdry_rst(V, EBCL) and Kwet_rst(V) (see 3.13.2.2.9.1), only if the speed dependent deceleration model(s) for the emergency brake are acquired as part of Train Data

g) The National Values for confidence level on emergency brake safe deceleration and for the available wheel/rail adhesion (see 3.13.2.3.7.5 & 3.13.2.3.7.6), only if the speed dependent deceleration model(s) for the emergency brake are acquired as part of Train Data

h) The integrated correction factors Kv_int(V) (with the two pivot deceleration values for passenger trains) and Kr_int(l) (see 3.13.2.3.7), only if the conversion model is used

i) The brake position (see 3.13.2.2.4)

j) The acquired train length L_TRAIN (see 3.13.2.2.11), only if the conversion model is used

3.13.6.2.1.3 A_safe(V,d) shall be equal to:

For locations with normal adhesion conditions and for locations with reduced adhesion conditions when A_MAXREDADH does not limit to a maximum value the speed dependent deceleration for the emergency brake:

A_safe(V,d) = A_brake_safe(V,d) + A_gradient(d)

For locations with reduced adhesion conditions when A_MAXREDADH limits to a maximum value the speed dependent deceleration for the emergency brake:

A_safe(V,d) = MIN(A_brake_safe(V,d) , A_MAXREDADH) + A_gradient(d)

3.13.6.2.1.4 A_brake_safe(V,d) shall be the safe emergency brake deceleration. A_brake_safe(V,d) shall be equal to:

If the speed dependent deceleration model(s) for the emergency brake are acquired as part of Train Data:

A_brake_safe(V,d) = Kdry_rst(V, M_NVEBCL) * (Kwet_rst(V) + M_NVAVADH *(1- Kwet_rst(V))) * A_brake_emergency(V,d)

If the conversion model is used:

A_brake_safe(V) = Kv_int(V) * Kr_int(L_TRAIN) * A_brake_emergency(V)

3.13.6.2.1.5 A_brake_emergency(V,d) shall be the emergency brake deceleration as a function of the speed, of the locations with change of special brake(s) contribution encountered between the train front and the foot of the EBD curve. A_brake_emergency(V,d) shall be equal to:

$A\_brake\_emergency_1(V)$ when $d_{estfront} \leq d \leq d_1$

$A\_brake\_emergency_2(V)$ when $d_1 < d \leq d_2$

$A\_brake\_emergency_3(V)$ when $d_2 < d \leq d_3$

....

Where

d_1, d_2, d_3,... are the locations with change of special brake(s) contribution

$A\_brake\_emergency_x(V)$ is equal to the emergency brake model, A_brake_emergency, applicable for the concerned combination of brake.

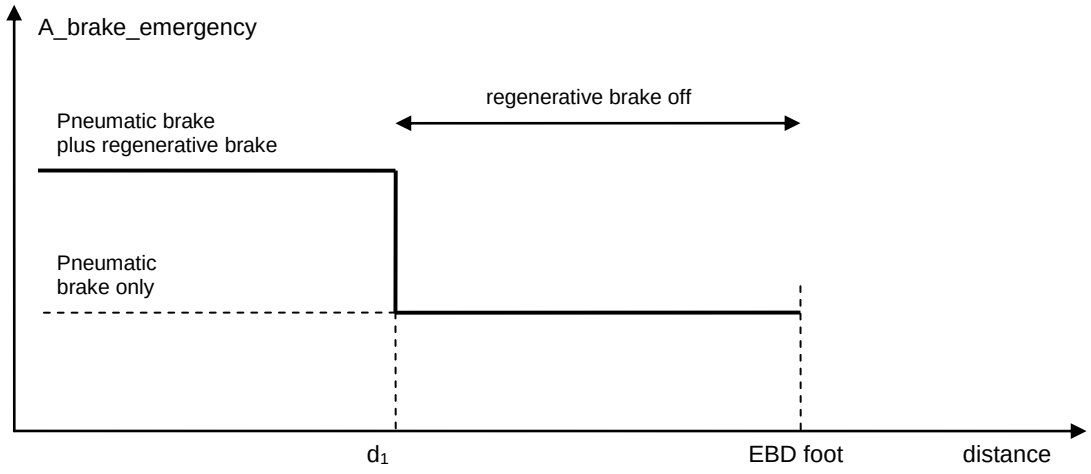


Figure 36: Influence of track conditions on A_brake_emergency(V,d)

3.13.6.2.1.6 A_MAXREDADH shall be the value, out of the three related National Values, applicable for this train according to:

a) its brake position

b) whether special/additional brakes independent from wheel/rail adhesion are active and it is allowed to take into account their contribution to the emergency braking effort.

3.13.6.2.1.7 Kdry_rst(V, M_NVEBCL) shall be the rolling stock correction factor, as a function of speed (with speed steps identical with the ones of A_brake_emergency(V)), corresponding to the confidence level on emergency brake safe deceleration required by trackside (National Value).

3.13.6.2.1.8 Kv_int(V) shall be the integrated correction factor applicable for the train, selected according to the brake position.

3.13.6.2.1.8.1 If the brake position is “Passenger train in P”, the set of Kv_int shall be calculated as a function of the maximum emergency brake deceleration (A_ebmax) in the following way (see also figure 10):

Kv_int_x = Kv_int_x_a when A_ebmax ≤ A_P12.

Kv_int_x = Kv_int_x_b when A_ebmax ≥ A_P23.

Kv_int_x = Kv_int_x_a + (A_ebmax - A_P12)/(A_P23 - A_P12) * (Kv_int_x_b - Kv_int_x_a) when A_P12 < A_ebmax < A_P23.”

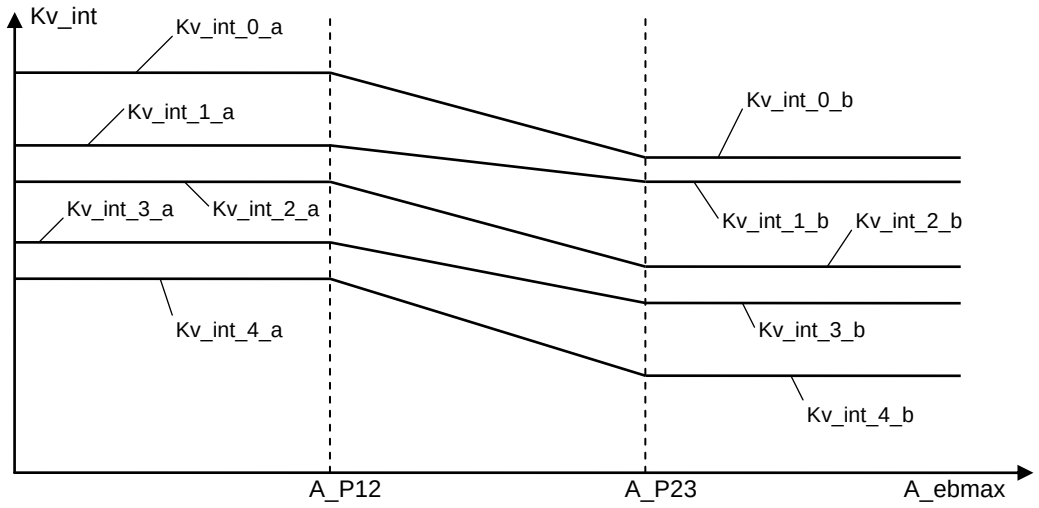


Figure 37: Kv_int structure for conventional passenger trains

3.13.6.2.1.8.2 The maximum EB deceleration A_ebmax shall be the maximum of A_brake_emergency between 0 km/h and the maximum speed of the train.

3.13.6.2.1.9 Note: Figure 38 gives an example of the influence of the various track/train characteristics on A_safe(V,d) and consequently on the EBD curve (see 3.13.8.3).

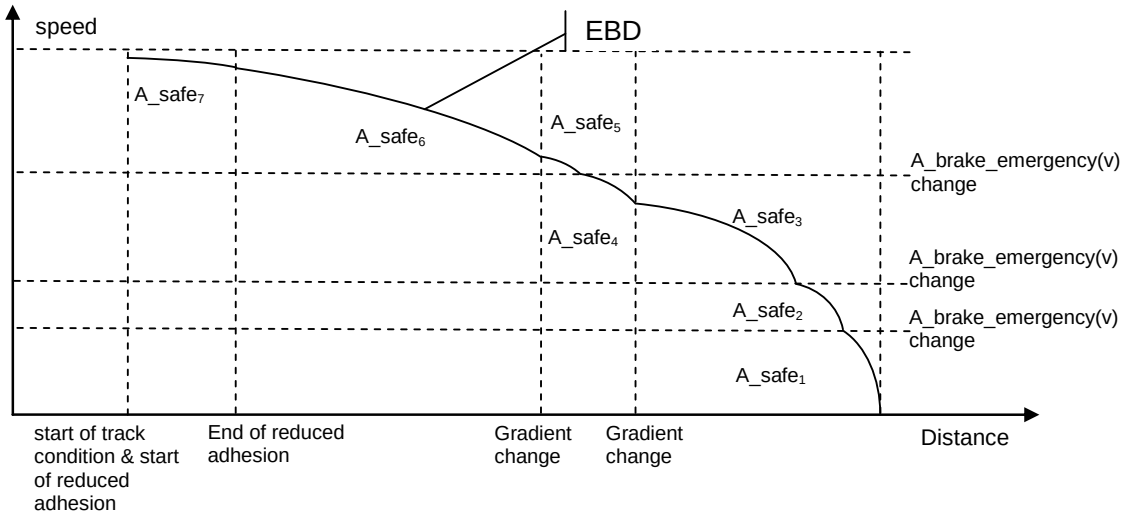


Figure 38: Influence of track/train characteristics on A_safe

3.13.6.2.2 Safe brake build up time

3.13.6.2.2.1 The safe brake build up time, T_be, is safety relevant. This means that for the calculation of the safe brake build up time, all necessary track and train characteristics shall be taken into account.

3.13.6.2.2.2 The train and track related characteristics to be considered are:

a) The values of T_brake_emergency acquired as part of Train Data (see 3.13.2.2.3.2.8) or the value of T_brake_emergency derived from the conversion model (see 3.13.3.4) using the brake position and train length acquired as Train Data.

b) The integrated correction factor Kt_int, only if the conversion model is used (see 3.13.2.3.7)

c) The status of the regenerative brake, eddy current brake, magnetic shoe brake and Ep brake system (see 3.13.2.2.6), only if the values of T_brake_emergency are acquired as part of Train Data

3.13.6.2.2.3 The safe brake build up time T_be shall be equal to:

If values of T_brake_emergency are acquired as part of Train Data:

T_be = T_brake_emergency, with T_brake_emergency corresponding to the combination of special brakes currently in use

If the conversion model is used:

T_be = Kt_int * T_brake_emergency

3.13.6.3 Service brake

3.13.6.3.1 Expected deceleration

3.13.6.3.1.1 Since the expected deceleration is not safety relevant, no worst case conditions (e.g. correction factors, adhesion conditions) need to be taken into account for its calculation.

3.13.6.3.1.2 The train and track related characteristics to be considered are:

a) The speed dependent deceleration model(s) for the full service brake either acquired as part of Train Data (see 3.13.2.2.3.1) or derived from the brake percentage using the conversion model (see 3.13.3.3)

b) The acceleration/deceleration due to gradient i.e. A_gradient(d) (see 3.13.4)

c) The locations without special brake contribution (see 3.13.5)

3.13.6.3.1.3 A_expected(V,d) shall be equal to:

$$A\_expected(V,d) = A\_brake\_service(V,d) + A\_gradient(d)$$

3.13.6.3.1.4 A_brake_service(V,d) shall be the full deceleration of the service brake as a function of the speed, of the locations with change of special brake(s) contribution encountered between the train front and the foot of the SBD curve. A_brake_service(V,d) shall be equal to:

$A\_brake\_service_1(V)$ when $d_{estfront} \leq d \leq d_1$

$A\_brake\_service_2(V)$ when $d_1 < d \leq d_2$

$A\_brake\_service_3(V)$ when $d_2 < d \leq d_3$

....

Where

$d_1, d_2, d_3, \ldots$ are the locations with change of special brake(s) contribution

$A\_brake\_service_x(V)$ is equal to the full service brake model, A_brake_service, applicable for the concerned combination of brake.

3.13.6.3.2 Expected brake build up time

3.13.6.3.2.1 Since the expected brake build up time is not safety relevant, no worst case conditions (e.g. correction factors, adhesion conditions) need to be taken into account for its calculation.

3.13.6.3.2.2 No track related characteristics are to be considered for the expected brake build up time.

3.13.6.3.2.3 The train related characteristics to be considered are:

a) The values of T_brake_service acquired as part of Train Data (see 3.13.2.2.3.2.8) or the value(s) of T_brake_service derived from the conversion model (see 3.13.3.4) using the brake position and train length acquired as Train Data)

b) The status of the regenerative brake, eddy current brake and Ep brake system (see 3.13.2.2.6)

3.13.6.3.2.4 The expected brake build up time T_bs shall be equal to the brake build up time of the full service brake:

T_bs = T_brake_service, with T_brake_service corresponding to the combination of special brakes currently in use

3.13.6.4 Normal service brake deceleration

3.13.6.4.1 Since the normal service brake deceleration is not safety relevant, no worst case conditions (e.g. correction factors, adhesion conditions) need to be taken into account for its calculation.

3.13.6.4.2 The train and track related characteristics to be considered are:

a) The speed dependent deceleration model(s) for the full service brake either acquired as part of Train Data (see 3.13.2.2.3.1) or derived from the brake percentage using the conversion model (see 3.13.3.3)

b) The speed dependent deceleration model(s) for the normal service brake acquired as part of Train Data (see 3.13.2.2.3.1)

c) The acceleration/deceleration due to gradient i.e. A_gradient(d) (see 3.13.4)

d) The brake position (see 3.13.2.2.4)

e) The on-board correction factors Kn+(V) and Kn-(V) (see 3.13.2.2.9.2)

f) The locations without special brake contribution (see 3.13.5)

3.13.6.4.3 The normal service brake deceleration shall be equal to:

For positive gradient values (uphill):

A_normal_service(V,d) = A_brake_normal_service(V,d) + A_gradient(d) – Kn+(V)*grad/1000

For negative gradient values (downhill):

A_normal_service(V,d) = A_brake_normal_service(V,d) + A_gradient(d) – Kn-(V)*grad/1000

Where

grad = gradient values in ‰ (positive = uphill)

3.13.6.4.4 A_brake_normal_service(V,d) shall be the normal deceleration of the service brake as a function of the speed, of the locations with change of special brake(s) contribution encountered between the train front and the foot of the GUI curve. A_brake_normal_service(V,d) shall be equal to:

$A\_brake\_normal\_service_1(V)$ when $d_{estfront} \leq d \leq d_1$

$A\_brake\_normal\_service_2(V)$ when $d_1 < d \leq d_2$

$A\_brake\_normal\_service_3(V)$ when $d_2 < d \leq d_3$

....

Where

$d_1, d_2, d_3,...$ are the locations with change of special brake(s) contribution

$A\_brake\_normal\_service_x(V)$ is equal to the normal service brake model applicable for the concerned combination of brake position and of the value of A_brake_service(V=0) between d_{x-1} and d_x (see 3.13.2.2.3.1.9 and 3.13.2.2.3.1.10).

3.13.7 Determination of Most Restrictive Speed Profile (MRSP)

3.13.7.1 The Most Restrictive Speed Profile (MRSP) is a description of the most restrictive speed restrictions the train shall obey on a given piece of track.

3.13.7.2 The Most Restrictive Speed Profile shall be computed from all speed restrictions (see 3.13.2.2.13 & 3.13.2.3.2) by selecting the most restrictive parts of each element, some elements being compensated by the train length if requested by trackside (see 3.11.3.1.3 for SSP, 3.11.4.6 for ASP and 3.11.5.3 for TSR).

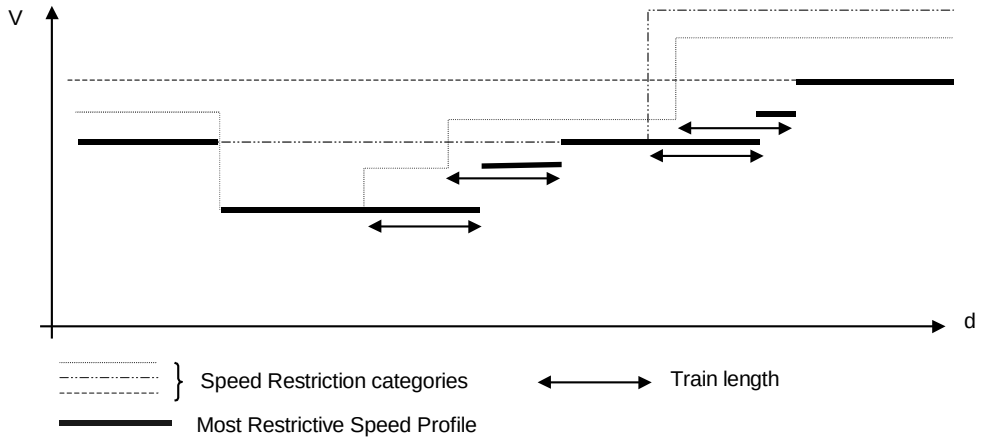


Figure 39: Most Restrictive Speed Profile selection

3.13.7.3 The Most Restrictive Speed Profile shall be recalculated when any of the elements it is built of is changed.

3.13.8 Determination of targets and brake deceleration curves

3.13.8.1 Introduction

3.13.8.1.1 A target is defined by a target location and a target speed, to which the train must decelerate before reaching the target location.

3.13.8.1.2 For that purpose, the on-board equipment shall use brake deceleration curves related to the supervised targets, from the deceleration values as specified in sections 3.13.6.2.1, 3.13.6.3.1and 3.13.6.4.

3.13.8.1.3 These deceleration values being speed and distance dependent, a brake deceleration curve shall be calculated piecewise, i.e. it shall be composed of interconnected arcs of

parabola, each one being based on one of the speed/distance dependent deceleration values (see Figure 38).

3.13.8.2 Determination of the supervised targets

3.13.8.2.1 The on-board shall continuously supervise a list of targets, which may include the following types of target:

a) the locations corresponding to a speed decrease of the MRSP (if any), which are in advance of the max safe front end of the train

b) the Limit of Authority (LOA)

c) the End of Authority (EOA) and the Supervised Location (SvL)

d) the location deduced from the maximum permitted distance to run in Staff Responsible, with a target speed zero

3.13.8.2.1.1 Note: depending on the information received from trackside and the position of the train, the list of supervised targets may be empty.

3.13.8.2.2 The list of supervised targets shall be re-evaluated when any of the elements it is built of is changed (e.g. new MA and/or track description accepted on-board, EOA and/or SvL temporarily supervised at the start location of a mode profile, update of stored information in specific situations (see sections A.3.4 and 4.10)).

3.13.8.2.3 A target corresponding to a speed decrease of the MRSP shall be removed from the list of supervised targets when the max safe front end of the train has passed the target location.

3.13.8.3 Emergency Brake Deceleration curves (EBD)

3.13.8.3.1 If a target belongs to the MRSP or is an LOA, the on-board shall calculate an EBD curve based on the safe deceleration A_safe(V,d), that crosses the ceiling speed EBI supervision limit (see 3.13.9.2) at the target location, and that extends up to the location where the target speed is reached (EBD foot).

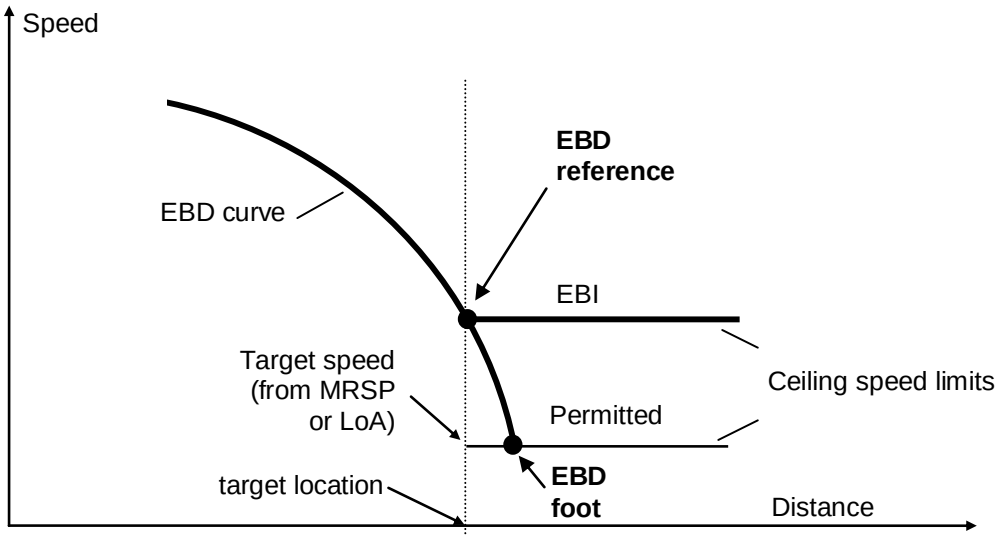


Figure 40: Calculation of the EBD curve with regards to MRSP or LOA target

3.13.8.3.2 If a target is an SvL, the on-board shall calculate an Emergency Brake Deceleration (EBD) curve based on the safe deceleration A_safe(V,d) and that reaches zero speed at the SvL.

3.13.8.3.3 If a target is the location at the end of the maximum permitted distance to run in Staff Responsible, the on-board shall calculate an Emergency Brake Deceleration (EBD) curve based on the safe deceleration A_safe(V,d) and that reaches zero speed at this staff responsible end location.

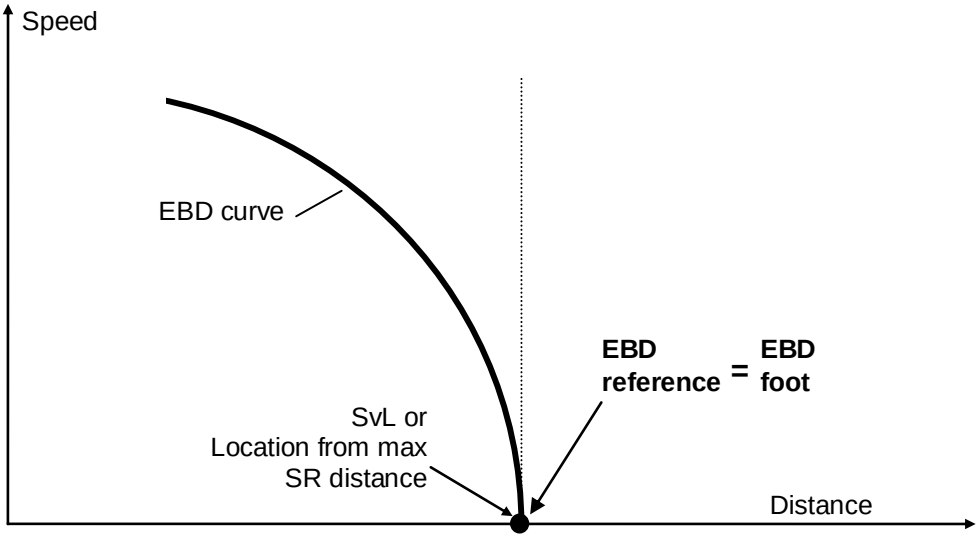


Figure 41: Calculation of the EBD curve with regards to SvL or SR distance

3.13.8.4 Service Brake Deceleration curves (SBD)

3.13.8.4.1 If a target is an EOA, the on-board shall calculate an Service Brake Deceleration (SBD) curve based on the expected deceleration A_expected(V,d) and that reaches zero speed at this EOA location.

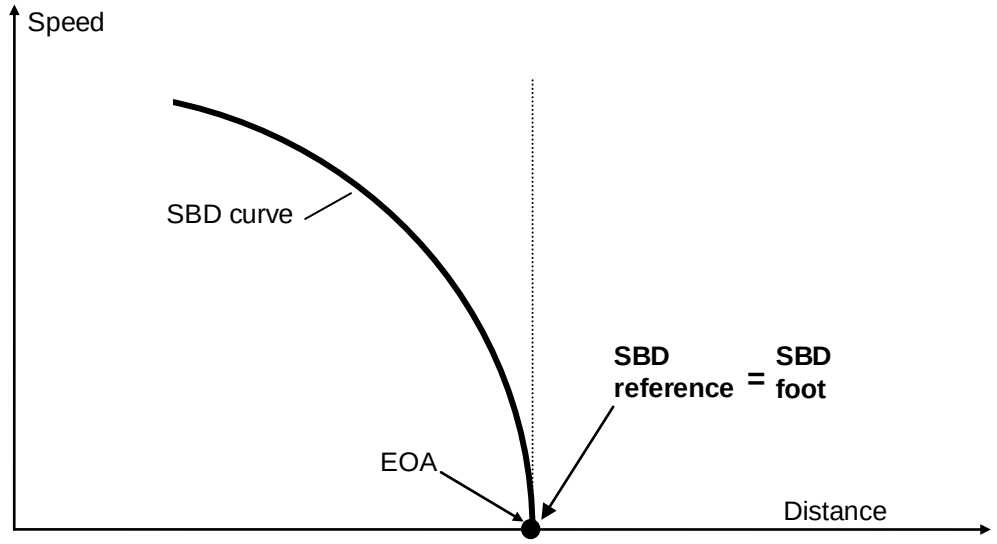


Figure 42: Calculation of the SBD curve with regards to EOA

3.13.8.5 Guidance curves (GUI)

3.13.8.5.1 The purpose of the guidance curve (GUI) is to provide a comfortable way of braking for the driver, to avoid excessive wear of the brakes and to save traction energy.

3.13.8.5.2 If the National Value does not inhibit them, the on-board shall calculate a guidance curve (GUI) for each supervised target, based on the normal service brake deceleration A_normal_service(V,d). The foot of a GUI curve (i.e. the location where the GUI speed is equal to the target speed) shall be:

a) the target location, in case of EOA/SvL

b) the location defined in 3.13.9.3.5.9, for others targets

3.13.9 Supervision limits

3.13.9.1 Overview

3.13.9.1.1 In this chapter the following supervision limits are defined:

- Emergency brake intervention (EBI)
- Service brake intervention (SBI)
- Warning (W)
- Permitted speed (P)
- Indication (I)

- Release speed monitoring start location

3.13.9.1.2 The purpose of the emergency brake intervention supervision limit is to assure that the train will remain within the various limits (in distance/speed) imposed by the trackside.

3.13.9.1.3 The purpose of all other supervision limits is to assist the driver in preventing an emergency brake intervention by maintaining the speed of the train within the appropriate limits.

3.13.9.2 Ceiling supervision limits

3.13.9.2.1 The ceiling supervision limits are derived from the MRSP elements, where the speed is constant (refer to 3.13.7) or from the LOA.

3.13.9.2.2 From an MRSP element or from the LOA, the Permitted speed, Warning, Service brake intervention and Emergency brake intervention supervision limits are defined (see Figure 43).

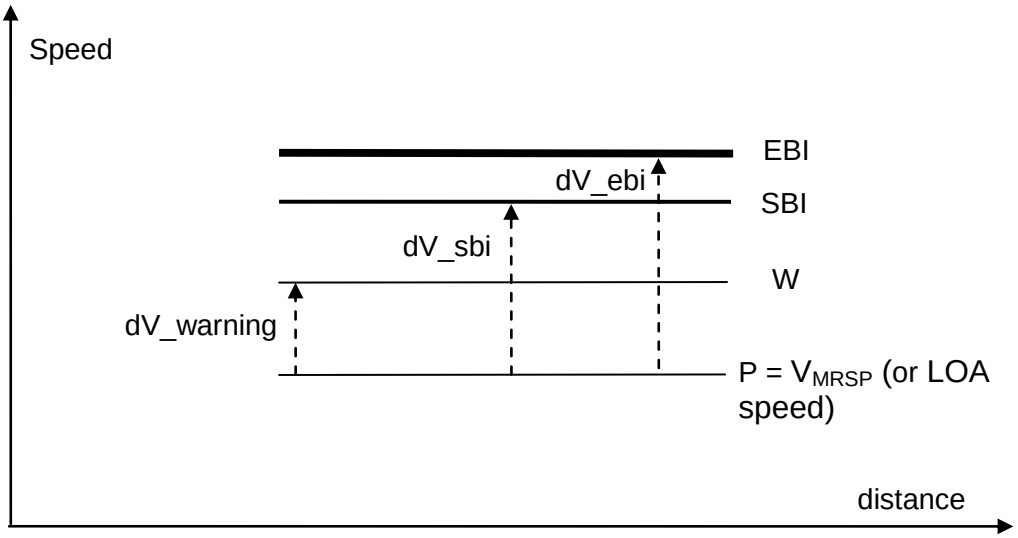


Figure 43: Ceiling supervision limits

3.13.9.2.3 For dv_ebi, the following formula shall be applied:

when $V_{MRSP} > V_{ebi\min}$:

$$dV_{ebi} = \min\left\{dV_{ebi\min} + C_{ebi} \cdot \left(V_{MRSP} - V_{ebi\min}\right), dV_{ebi\max}\right\}$$

with $C_{ebi} = \frac{\left(dV_{ebi\max} - dV_{ebi\min}\right)}{\left(V_{ebi\max} - V_{ebi\min}\right)}$

when $V_{MRSP} \leq V_{ebi\min}$: $dV_{ebi} = dV_{ebi\min}$

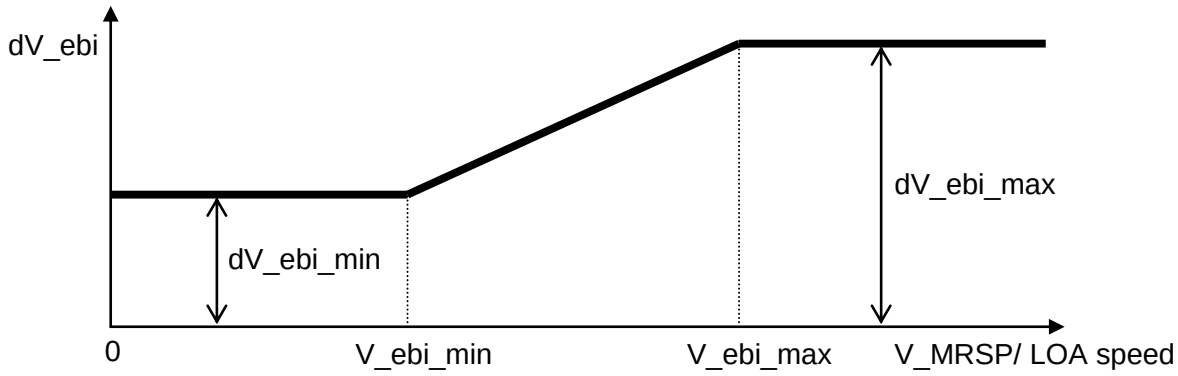


Figure 44: Definition of dV_ebi

3.13.9.2.4 dV_ebi_min, dV_ebi_max, V_ebi_min and V_ebi_max are defined as fixed values (See Appendix A.3.1)

3.13.9.2.5 For dV_sbi, the same formula as for dV_ebi shall apply, dV_sbi_min, dV_sbi_max, V_sbi_min and V_sbi_max being also defined as fixed values (See Appendix A.3.1)

3.13.9.2.6 For dV_warning, the same formula as for dV_ebi shall apply, dV_warning_min, dV_warning_max, V_warning_min and V_warning_max being also defined as fixed values (See Appendix A.3.1)

3.13.9.2.7 For LOA, the same formulas shall apply, by substituting V_MRSP with the LOA speed.

3.13.9.2.8 Intentionally deleted.

3.13.9.3 Braking to target supervision limits

3.13.9.3.1 Overview

3.13.9.3.1.1 The braking to target supervision limits are derived from the EBD, SBD and GUI curves.

3.13.9.3.1.2 From an EBD curve, the Emergency brake intervention (EBI), Service brake intervention (SBI2), Warning (W), Permitted speed (P) and Indication (I) supervision limits, valid for the estimated speed, are defined as follows(see Figure 45):

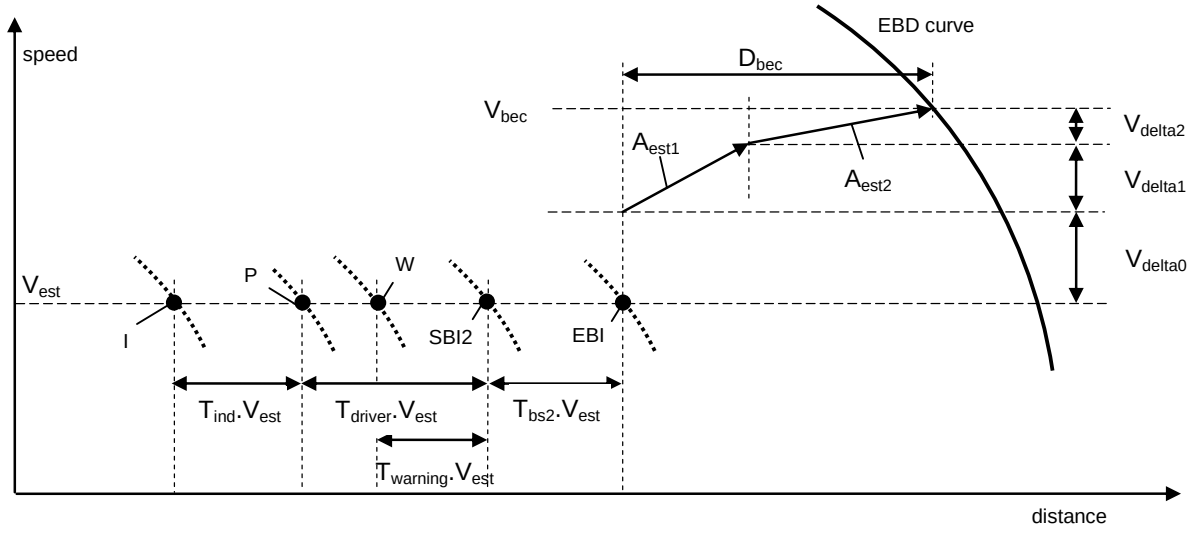


Figure 45: Braking to target supervision limits from EBD curve

3.13.9.3.1.3 From the SBD curve, Service brake intervention (SBI1), Warning (W), Permitted speed (P) and Indication (I) supervision limits, valid for the estimated speed, are defined as follows (see Figure 46):

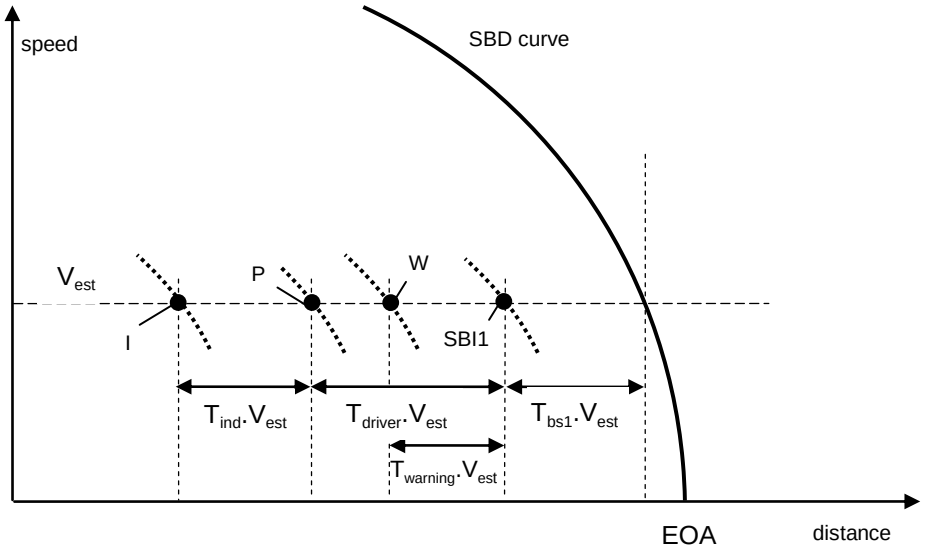


Figure 46: Braking to target supervision limits from SBD curve

3.13.9.3.1.4 No specific supervision limit is calculated from the GUI curve: it is only used to adjust the Permitted speed (P) supervision limit, which is obtained either from the EBD or the SBD curve.

3.13.9.3.2 EBI supervision limit

3.13.9.3.2.1 If not inhibited by National Value, the ERTMS/ETCS on-board equipment shall compensate the inaccuracy of the speed measurement by taking into account the

speed under reading amount (V_ura) at the moment when the calculation is made: V_delta0 = V_ura (see Figure 45).

3.13.9.3.2.2 The time elapsed between the Emergency brake intervention and the full application of the braking effort is reached (EBD) shall be split into two parts:

a) Time during which the traction effort is still present: T_traction

b) Remaining time during which the traction effort is not present: T_berem

3.13.9.3.2.3 The traction time (T_Traction) shall be defined as follows:

a) when the traction cut-off is implemented:

T_traction = MAX((T_traction_cut_off - (T_warning + T_bs2)) ; 0).

b) when the traction cut-off is not implemented: T_traction = T_traction_cut_off

3.13.9.3.2.4 Note: When the traction cut-off is implemented, the traction cut-off command is triggered when passing the warning limit. The term (T_warning + T_bs2) in the equation above takes this into account, assuming that the warning limit is derived from the EBD.

3.13.9.3.2.5 T_bs2 and T_warning are defined in sections 3.13.9.3.3 and 3.13.9.3.4.

3.13.9.3.2.6 The remaining time with no traction (T_berem) shall be equal to MAX(T_be - T_traction ; 0).

3.13.9.3.2.7 Note: T_Traction exceeding T_be is rather a theoretical case, but is nevertheless included to make the specifications complete.

3.13.9.3.2.8 During T_traction, the estimated acceleration (A_est1) shall be the one measured at the moment when the calculation is made, but limited to positive or null values.

3.13.9.3.2.9 If T_be > T_traction, the estimated acceleration during T_berem (A_est2) shall be the one measured at the moment when the calculation is made, but limited to values between 0 and +0.4m/s^2.

3.13.9.3.2.10 The compensated speed and the distance travelled during the time elapsed between the Emergency brake intervention and the full application of the braking effort is reached shall be derived as follows (see Figure 45):

$$V_{bec} = \max\left\{(V_{est} + V_{delta0} + V_{delta1}), V_{target}\right\} + V_{delta2}$$

$$D_{bec} = \max\left\{(V_{est} + V_{delta0} + \frac{V_{delta1}}{2}), V_{target}\right\} \cdot T_{traction}$$

$$+ \left(\max\left\{(V_{est} + V_{delta0} + V_{delta1}), V_{target}\right\} + \frac{V_{delta2}}{2} \right) \cdot T_{berem}$$

with $V_{delta0} = V_{ura}$ or $V_{delta0} = 0$ (if compensation of speed inaccuracy is inhibited by National Value)

with $V_{delta1} = A_{est1} \cdot T_{traction}$ and $V_{delta2} = A_{est2} \cdot T_{berem}$

3.13.9.3.2.11 Note: The formula avoids that V_bec is lower than V_target.

3.13.9.3.2.12 For the estimated speed V_est, the location of the EBI supervision limit shall be:

$$d_{EBI}(V_{est}) = d_{EBD}(V_{bec}) - D_{bec}$$

3.13.9.3.3 SBI supervision limit

3.13.9.3.3.1 For the EOA, the on-board shall calculate the location of the SBI supervision limit (SBI1) valid for the estimated speed, assuming that this latter remains constant during the interval T_bs1, until the SBD curve is reached.

$$d_{SBI1}(V_{est}) = d_{SBD}(V_{est}) - V_{est} \cdot T_{bs1}$$

3.13.9.3.3.2 For an EBD based target, the on-board shall calculate the location of the SBI supervision limit (SBI2) valid for the estimated speed, assuming that this latter remains constant during the interval T_bs2, until the location of the EBI supervision limit is reached.

$$d_{SBI2}(V_{est}) = d_{EBI}(V_{est}) - V_{est} \cdot T_{bs2}$$

3.13.9.3.3.3 If the service brake command is available for use and the service brake feedback is not available for use, T_bs1 and T_bs2 shall be equal to T_bs.

3.13.9.3.3.4 If both the service brake command and the service brake feedback are available for use, T_bs1 and T_bs2 shall by default be set to T_bs. When the service brake is used by the driver in target speed monitoring or release speed monitoring, they shall be reduced and possibly locked to the respective fixed values of 0s and T_bs2_locked, until the ceiling speed monitoring is entered; they are then reset to T_bs (refer to detailed algorithm in Appendix A.3.10).

3.13.9.3.3.4.1 In case T_bs < T_bs2_locked then T_bs2 shall be equal to T_bs2_locked.

3.13.9.3.3.5 If the service brake command is not available for use, T_bs1 and T_bs2 shall be set to zero.

3.13.9.3.3.6 Note: The values T_bs1 and T_bs2 = 0s are defined to achieve the maximum performance when service brake command is not used.

3.13.9.3.3.7 For display purpose only, the SBI1 speed for the estimated train front end, shall be calculated as follows (see Figure 47):

$$V_{SBI1}(d_{estfront}) = V_{SBD}\left(d_{estfront} + V_{est} \cdot T_{bs1}\right)$$

$$V_{SBI1}(d_{estfront}) = 0 \text{ if } d_{estfront} + V_{est} \cdot T_{bs1} \geq d_{EoA}$$

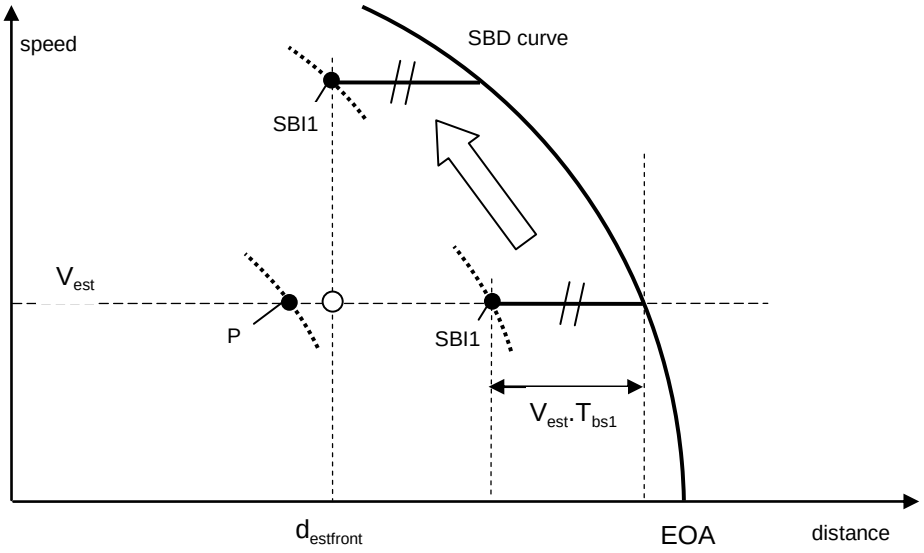


Figure 47: Calculation of SBI1 speed displayed to the driver

3.13.9.3.3.8 For display purpose only, the SBI2 speed for the max safe front end of the train shall be calculated as follows (see Figure 48):

$$V_{SBI2}(d_{\max safefront}) =$$
$$\max\left\{\left(V_{EBD}\left(d_{\max safefront} + V_{est} \cdot T_{bs2} + D_{be_{display}}\right) - \left(V_{delta0} + V_{delta1} + V_{delta2}\right)\right), \left(V_{target} + dV_{sbi}\left(V_{target}\right)\right)\right\}$$

$$V_{SBI2}(d_{\max safefront}) = V_{target} + dV_{sbi}\left(V_{target}\right) \text{ if}$$
$$d_{\max safefront} + V_{est} \cdot T_{bs2} + D_{be_{display}} \geq d_{EBD}(V_{target})$$

With V_delta0, V_delta1 and V_delta2 calculated according to 3.13.9.3.2.10

With $D_{be_{display}} = (V_{est} + V_{delta0} + \frac{V_{delta1}}{2}) \cdot T_{traction} + \left(V_{est} + V_{delta0} + V_{delta1} + \frac{V_{delta2}}{2}\right) \cdot T_{berem}$

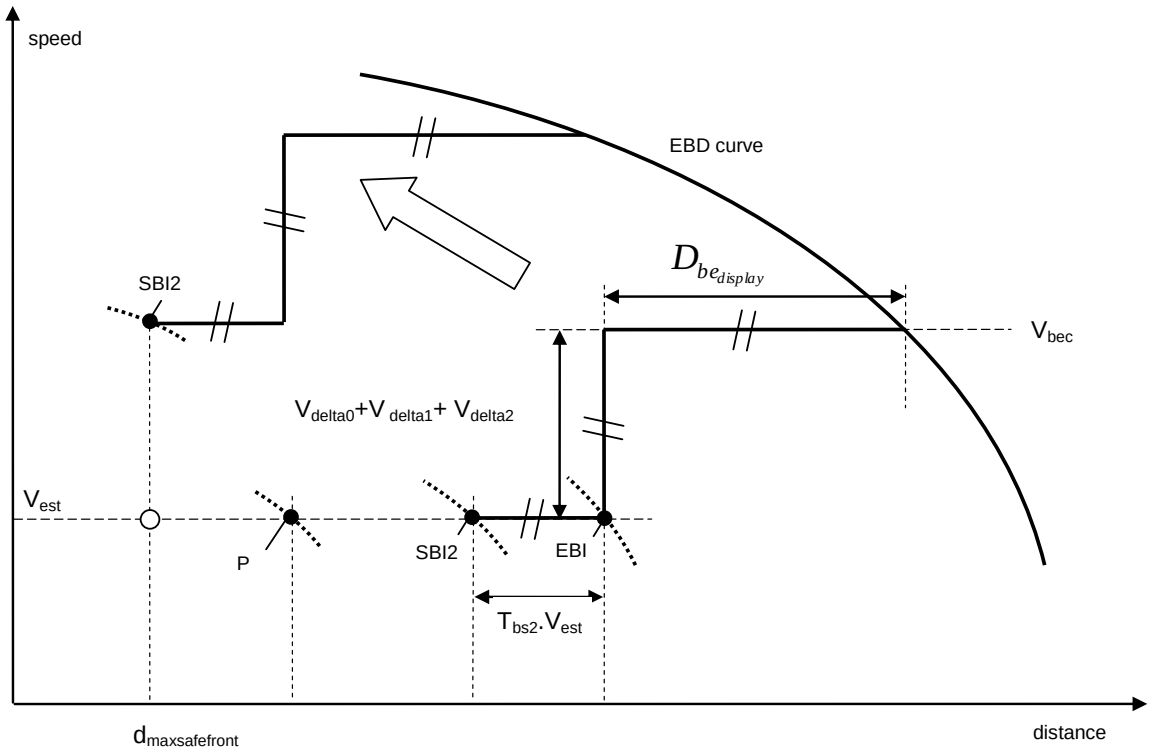


Figure 48: Calculation of SBI2 speed displayed to the driver

3.13.9.3.3.8.1 Note: the re-use of the same distance travelled and speed increase between the SBI2 supervision limit and the EBD, as for the estimated speed (see Figure 48), leads to an overestimation/underestimation of the SBI2 speed to be displayed to the driver. This simplification, which avoids the need of an iterated calculation, is however acceptable and necessary since the error made tends to zero when the train reaches the SBI2 supervision limit.

3.13.9.3.3.9 Intentionally deleted.

3.13.9.3.4 Warning supervision limit (W)

3.13.9.3.4.1 The on-board shall calculate the location of the Warning supervision limit valid for the estimated speed, assuming that this latter remains constant during the interval T_warning until the location of the SBI1 (for the EOA) or the SBI2 (for an EBD based target) supervision limit is reached.

$d_W(V_{est}) = d_{SBI1}(V_{est}) - V_{est} \cdot T_{warning}$ for the EOA

$d_W(V_{est}) = d_{SBI2}(V_{est}) - V_{est} \cdot T_{warning}$ for an EBD based target

3.13.9.3.4.2 T_warning is defined as a fixed value (refer to A.3.1).

3.13.9.3.5 Permitted speed supervision limit (P)

3.13.9.3.5.1 In case the calculation of the GUI curve is inhibited, the on-board shall calculate the location of the Permitted speed supervision limit valid for the estimated speed, assuming that this latter remains constant during the interval T_driver until the location of the SBI1 (for the EOA) or the SBI2 (for an EBD based target) supervision limit is reached.

$d_P(V_{est}) = d_{SBI1}(V_{est}) - V_{est} \cdot T_{driver}$ for the EOA

$d_P(V_{est}) = d_{SBI2}(V_{est}) - V_{est} \cdot T_{driver}$ for an EBD based target

3.13.9.3.5.2 T_driver is defined as a fixed value (refer to A.3.1).

3.13.9.3.5.3 Note: The reference for the Permitted speed supervision limit is the SBI supervision limit and not the Warning supervision limit. As a result the permitted and warning supervision limits are clearly separated and do not affect each other. In this way it is clear that the warning is not part of the critical performance interval.

3.13.9.3.5.4 In case the calculation of the Guidance curve is enabled, the on-board shall calculate the location of the Permitted speed supervision limit valid for the estimated speed, as follows:

$d_P(V_{est}) = \min\{(d_{SBI1}(V_{est}) - V_{est} \cdot T_{driver}), d_{GUI}(V_{est})\}$ for the EOA

$d_P(V_{est}) = \min\{(d_{SBI2}(V_{est}) - V_{est} \cdot T_{driver}), d_{GUI}(V_{est})\}$ for an EBD based target

3.13.9.3.5.5 In case the calculation of the GUI curve is inhibited, for display purpose only, the P speed related to SBD shall be calculated for the estimated train front end as follows:

$$V_{P\,EOA}(d_{estfront}) = V_{SBD}\left(d_{estfront} + V_{est} \cdot (T_{driver} + T_{bs1})\right)$$

$V_{P\,EOA}(d_{estfront}) = 0$ if $d_{estfront} + V_{est} \cdot (T_{driver} + T_{bs1}) \geq d_{EoA}$

3.13.9.3.5.6 In case the calculation of the GUI curve is enabled, for display purpose only, the P speed related to SBD shall be calculated for the estimated train front end as follows:

$$V_{P\,EOA}(d_{estfront}) = \min\left\{V_{SBD}\left(d_{estfront} + V_{est} \cdot (T_{driver} + T_{bs1})\right), V_{GUI\,EOA}\left(d_{estfront}\right)\right\}$$

$V_{P\,EOA}(d_{estfront}) = 0$ if $d_{estfront} + V_{est} \cdot (T_{driver} + T_{bs1}) \geq d_{EoA}$

3.13.9.3.5.7 In case the calculation of the GUI curve is inhibited, for display purpose only, the P speed related to EBD, shall be calculated for the max safe front end of the train as follows (see Figure 49):

$$V_{\substack{P \\ EBD\_Target}}(d_{\max safefront}) = \max\left\{\left(V_{EBD}\left(d_{\max safefront} + V_{est}\cdot(T_{driver}+T_{bs2}) + D_{be_{display}}\right) - \left(V_{delta0}+V_{delta1}+V_{delta2}\right)\right), V_{target}\right\}$$

$$V_{\substack{P \\ EBD\_Target}}(d_{\max safefront}) = V_{target} \text{ if } d_{\max safefront} + V_{est}\cdot(T_{driver}+T_{bs2}) + D_{be_{display}} \geq d_{EBD}(V_{target})$$

With V_delta0, V_delta1 and V_delta2 calculated according to 3.13.9.3.2.10

With $D_{be_{display}} = (V_{est} + V_{delta0} + \frac{V_{delta1}}{2})\cdot T_{traction} + \left(V_{est} + V_{delta0} + V_{delta1} + \frac{V_{delta2}}{2}\right)\cdot T_{berem}$

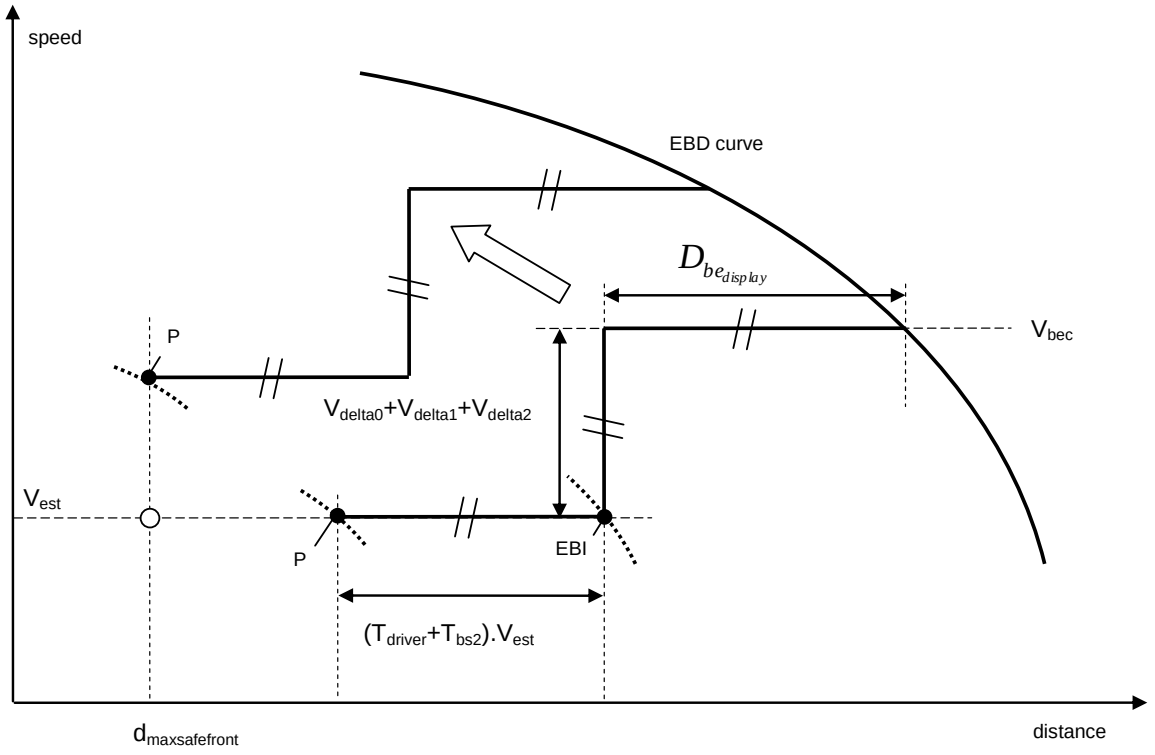


Figure 49: Calculation of Permitted speed displayed to the driver

3.13.9.3.5.7.1 Note: the re-use of the same distance travelled and speed increase between the Permitted speed supervision limit and the EBD, as for the estimated speed (see Figure 49), leads to an overestimation/underestimation of the Permitted speed to be displayed to the driver. This simplification, which avoids the need of an iterated calculation, is however acceptable and necessary since the error made tends to zero when the train reaches the Permitted speed supervision limit.

3.13.9.3.5.8 In case the calculation of the GUI curve is enabled, for display purpose only, the P speed related to EBD, shall be calculated for the max safe front end of the train as follows:

$$V_{P\ EBD\_T\arg et}(d_{\max safefront}) = \max\left\{\min\left\{\begin{matrix}\left(V_{EBD}\left(d_{\max safefront}+V_{est}\cdot(T_{driver}+T_{bs2})+D_{be_{display}}\right)-\left(V_{delta0}+V_{delta1}+V_{delta2}\right)\right),\\ V_{GUI\ EBD\_t\arg et}\left(d_{\max safefront}\right)\end{matrix}\right\}, V_{t\arg et}\right\}$$

$$V_{P\ EBD\_t\arg et}(d_{\max safefront}) = V_{t\arg et} \text{ if } d_{\max safefront}+V_{est}\cdot(T_{driver}+T_{bs2})+D_{be_{display}} \geq d_{EBD}(V_{t\arg et})$$

or if $d_{\max safefront} \geq d_{GUI}(V_{t\arg et})$

With V_delta0, V_delta1 and V_delta2 calculated according to 3.13.9.3.2.10

With $D_{be_{display}} = (V_{est}+V_{delta0}+\frac{V_{delta1}}{2})\cdot T_{traction}+\left(V_{est}+V_{delta0}+V_{delta1}+\frac{V_{delta2}}{2}\right)\cdot T_{berem}$

3.13.9.3.5.9 In order to determine the reference location of the target distance displayed to the driver, in order to check whether the target is masking another one, and in order to determine the foot of the GUI curve (only if it is enabled) in case of target different from EOA/SvL, the location of the Permitted speed supervision limit, valid for the target speed, shall be calculated from the EBD, taking into account the following assumptions:

a) the estimated acceleration shall be set to “zero”

b) if not inhibited by National Value, the compensation of the inaccuracy of the speed measurement shall be set to a value calculated from the target speed, as defined in SUBSET-041 § 5.3.1.2: V_delta0t = f_{41}(V_target)

3.13.9.3.5.10 To do so, the same formulas defined above with V_est and V_delta0 shall be applied, by substituting V_est with V_target and V_delta0 with V_delta0t.

$$d_{EBI}(V_{t\arg et}) = d_{EBD}(V_{t\arg et}+V_{delta0t})-(V_{t\arg et}+V_{delta0t})\cdot(T_{berem}+T_{traction})$$

$$d_{P}(V_{t\arg et}) = d_{EBI}(V_{t\arg et})-V_{t\arg et}\cdot(T_{driver}+T_{bs2})$$

3.13.9.3.5.10.1 Justification: these assumptions are intended to avoid fluctuations of the target distance displayed to the driver. Moreover the foot of the GUI curve may influence the perturbation location, which must be fully predictable for trackside engineering reasons.

3.13.9.3.5.11 In case a non protected LX start location is supervised as both the EOA and SvL and the stopping in rear of LX is not required, the location of the most restrictive

Permitted speed supervision limit, valid for the LX speed shall be used in order to determine the location where the supervision of the LX start location is substituted by the supervision of the LX speed (see section 5.16.3).

3.13.9.3.5.12 To calculate this location, the same formulas defined above with V_est shall be applied by substituting V_est with V_LX.

$$d_{SBI1}(V_{LX}) = d_{SBD}(V_{LX}) - V_{LX} \cdot T_{bs1}$$

$$d_{SBI2}(V_{LX}) = d_{EBI}(V_{LX}) - V_{LX} \cdot T_{bs2}$$

With

$$d_{EBI}(V_{LX}) = d_{EBD}(V_{LX} + V_{delta0} + V_{delta1} + V_{delta2}) - \left(V_{LX} + V_{delta0} + \frac{V_{delta1}}{2}\right) \cdot T_{traction}$$

$$- \left(V_{LX} + V_{delta0} + V_{delta1} + \frac{V_{delta2}}{2}\right) \cdot T_{berem}$$

And with V_delta0, V_delta1 and V_delta2 calculated according to 3.13.9.3.2.10

In case the GUI curve is inhibited:

$d_P(V_{LX}) = d_{SBI1}(V_{LX}) - V_{LX} \cdot T_{driver}$ if $d_{SBI2}(V_{LX}) - d_{SBI1}(V_{LX}) \geq d_{\max safefront} - d_{estfront}$

Or $d_P(V_{LX}) = d_{SBI2}(V_{LX}) - V_{LX} \cdot T_{driver}$ if $d_{SBI2}(V_{LX}) - d_{SBI1}(V_{LX}) < d_{\max safefront} - d_{estfront}$

In case the GUI curve is enabled:

$d_P(V_{LX}) = \min\{(d_{SBI1}(V_{LX}) - V_{LX} \cdot T_{driver}), d_{GUI}(V_{LX})\}$ if

$d_{SBI2}(V_{LX}) - d_{SBI1}(V_{LX}) \geq d_{\max safefront} - d_{estfront}$

Or $d_P(V_{LX}) = \min\{(d_{SBI2}(V_{LX}) - V_{LX} \cdot T_{driver}), d_{GUI}(V_{LX})\}$ if

$d_{SBI2}(V_{LX}) - d_{SBI1}(V_{LX}) < d_{\max safefront} - d_{estfront}$

3.13.9.3.5.12.1 Note: the use of the instantaneous speed under reading amount and acceleration in the calculation of this location avoids a jump of display when the substitution takes place.

3.13.9.3.6 Indication supervision limit (I)

3.13.9.3.6.1 The on-board shall calculate the location of the Indication supervision limit valid for the estimated speed, assuming that this latter remains constant during the interval T_indication until the location of the Permitted speed supervision limit is reached.

$$d_I(V_{est}) = d_P(V_{est}) - V_{est} \cdot T_{indication}$$

3.13.9.3.6.2 If the service brake feedback interface is not available for use, then T_indication shall be calculated as follows:

$$T_{indication} = \max\{(0.8 \cdot T_{bs}), 5s\} + T_{driver}$$

3.13.9.3.6.3 Note: The reduction of T_indication by a factor is intended to improve performance and the feasibility of this reduction is based on experience with real implementations. To avoid very low values when T_bs is small, a minimum is defined for T_indication, giving the driver always enough time to operate the brake.

3.13.9.3.6.4 If the service brake feedback interface is available for use then T_indication shall be equal to 5s + T_driver.

3.13.9.4 Release speed supervision limits

3.13.9.4.1 The release speed is a special ceiling speed limit, applicable in the vicinity of the EOA. The EBI supervision limit is equal to the release speed. There is no SBI, W, P, I supervision limit associated to the release speed.

3.13.9.4.2 Note: The release speed may be necessary for two reasons. One is that a train has to be able to approach the EOA where the permitted speed reaches zero and might be too restrictive to permit acceptable driving due to inaccuracy of the measured distance. The other reason is that in a level 1 application the train has to be able to overpass the balise when the signal clears. For these two reasons a (low) release speed may be given from trackside or may be calculated on board, based on the distance from the EOA to the Supervised Location.

3.13.9.4.3 With each MA, it shall be possible for the trackside to:

a) Give the value of the release speed directly to the on-board, OR

b) Instruct the on-board to calculate the release speed, OR

c) Instruct the on-board to use the national value.

3.13.9.4.4 In case the MA does not identify the variant to be used or in case of LOA, no release speed shall be supervised.

3.13.9.4.5 Note: When the release speed is given as a fixed value from trackside, the ERTMS/ETCS system cannot be responsible for stopping the train in rear of the Supervised Location. In this case, it is the full responsibility of the infrastructure manager to set the appropriate release speed with regard to the risk of passing the Supervised Location.

3.13.9.4.6 The start location of the release speed monitoring (i.e. where the EBI supervision limit related to EBD is replaced with an EBI supervision limit equal to the release speed value) shall be the location of the most restrictive SBI supervision limit among the SBI1 related to EOA, the SBI2 related to SvL and, when the Release Speed is calculated on-board, the SBI2 supervision limit(s) related to other target(s), if any, between the

Trip location related to the EOA and the SvL, calculated for the Release Speed value, taking into account the following assumptions:

a) the estimated acceleration shall be set to “zero”

b) if not inhibited by National Value, the compensation of the inaccuracy of the speed measurement shall be set to a value calculated from the release speed, as defined in SUBSET-041 § 5.3.1.2: V_delta0rs = f_{41}(V_release)

3.13.9.4.7 To do so, the same formulas defined above with V_est and V_delta0 shall be applied, by substituting V_est with V_release and V_delta0 with V_delta0rs.

$$d_{SBI1}(V_{release}) = d_{SBD}(V_{release}) - V_{release} \cdot T_{bs1}$$

$$d_{\substack{SBI2 \\ T\arg et\_n}}(V_{release}) = d_{\substack{EBI \\ T\arg et\_n}}(V_{release}) - V_{release} \cdot T_{bs2}$$

with $d_{\substack{EBI \\ T\arg et\_n}}(V_{release}) = d_{\substack{EBD \\ T\arg et\_n}}(V_{release} + V_{delta0rs}) - (V_{release} + V_{delta0rs}) \cdot (T_{berem} + T_{traction})$

with Target_n being any EBD based target between the Trip location related to the EOA and the SvL(included)

$$d_{\substack{SBI2 \\ MREBDT}}(V_{release}) = \min\left\{ d_{\substack{SBI2 \\ T\arg et\_1}}(V_{release}), \ldots, d_{\substack{SBI2 \\ T\arg et\_n}}(V_{release}) \right\}$$

with MREBDT = Most Restrictive Target amongst the EBD based targets between the Trip location related to the EOA and the SvL (included)

$$d_{\substack{start \\ RSM}} = d_{SBI1}(V_{release}) \text{ if } d_{\substack{SBI2 \\ MREBDT}}(V_{release}) - d_{SBI1}(V_{release}) \geq d_{\max safefront} - d_{estfront}$$

Or $d_{\substack{start \\ RSM}} = d_{\substack{SBI2 \\ MREBDT}}(V_{release})$ if $d_{\substack{SBI2 \\ MREBDT}}(V_{release}) - d_{SBI1}(V_{release}) < d_{\max safefront} - d_{estfront}$

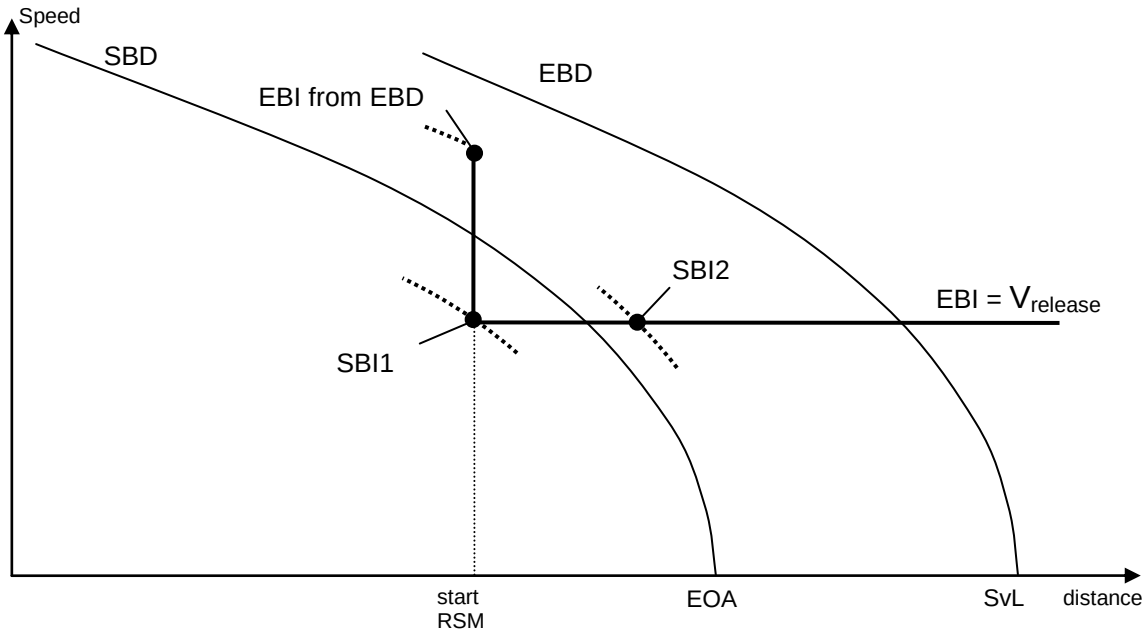


Figure 50: Start location of Release Speed Monitoring

3.13.9.4.8 When the Release Speed is calculated on-board (Figure 51 box 3), its value shall be equal to the most restrictive value, at the Trip location related to the EOA, amongst the EBI supervision limit related to the SvL (Figure 51 box 1) and, if any, the EBI supervision limits(s) related to other target(s) between the Trip location related to the EOA and the SvL (Figure 51 box 2).

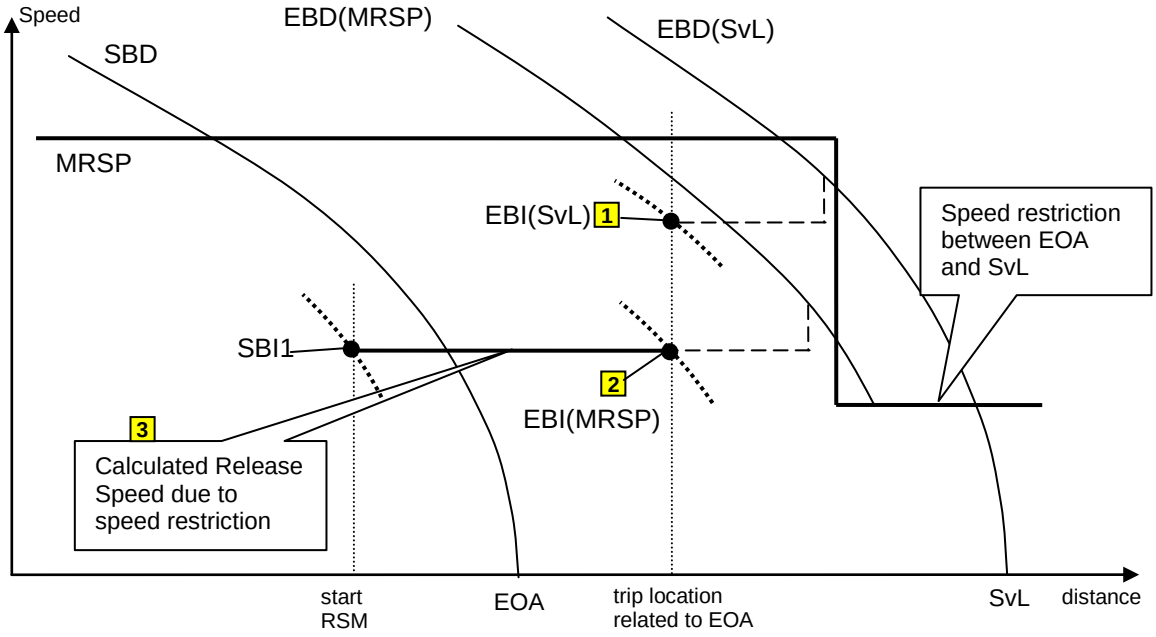


Figure 51: Calculated Release Speed based on speed restriction between EOA and SvL

3.13.9.4.8.1 In order to calculate in advance the EBI supervision limit at the Trip location related to the EOA, the on-board equipment shall take into account an estimated acceleration set to “zero”.

3.13.9.4.8.2 The on-board equipment shall seek for each target referred to in clause 3.13.9.4.8, a release speed value which satisfies the two following inequalities:

$$ABS\left\{V_{release} - \left(V_{EBD}\left(d_{tripEoA} + D_{bec}\right) - V_{delta0rsob}\right)\right\} \leq 1km/h$$

$$d_{tripEoA} + D_{bec} \leq d_{EBD}(V_{target})$$

With $V_{delta0rsob} = \max\left\{f_{41}\left(V_{release}\right), V_{ura}\right\}$ or $V_{delta0rsob} = 0$ (if compensation of speed inaccuracy is inhibited by National Value)

With $D_{bec} = \left(V_{release} + V_{delta0rsob}\right) \cdot \left(T_{traction} + T_{berem}\right)$

With

$$d_{tripEoA} = d_{EoA} + \alpha \cdot L_{antenna-front} + \max\left\{\left(2 \cdot Q_{locacc\_refBG} + 10m + 10\% \cdot d_{EoA}\right), \left(d_{\max safefront} - d_{\min safefront}\right)\right\}$$

And with $\alpha = 1$ if level = 1

$\alpha = 0$ if level = 2 or 3

If no speed value higher than V_target fulfils the above inequalities, then:

$$V_{release} = V_{target}$$

3.13.9.4.8.2.1 Note: The above formulas are intended to prevent the calculated release speed from fluctuating, according to the distance, speed and acceleration measurements. It allows calculating the release speed only once, for a given on-board reference location, unless

- the distance confidence interval exceeds a predicted one, which is based on the assumption that the whole distance between the current on-board reference location and the EOA would be travelled with SUBSET-041 odometer performance values and without any update of the on-board reference location, or
- the speed under reading amount (V_ura) exceeds the SUBSET-041 performance value

Whenever the on-board reference location is updated (e.g. new LRBG), the release speed will however be recalculated and will increase with a step. This behaviour is acceptable from an operational point of view.

3.13.9.4.8.2.2 Note: The method chosen (e.g. iterative algorithm) to compute the release speed is an implementation issue.

3.13.9.4.9 If the release speed (Figure 52 box 1 gives an example when it is calculated on-board) exceeds the MRSP anywhere in the area (Figure 52 box 2) delimited on one side by the presumed start location of the Release speed monitoring and on the other side by the trip location related to the EOA, the on-board shall use as a fixed release speed (Figure 52 box 4) the most restrictive value of the MRSP (Figure 52 box 3) within this area, and shall re-evaluate the start location of the Release speed monitoring accordingly.

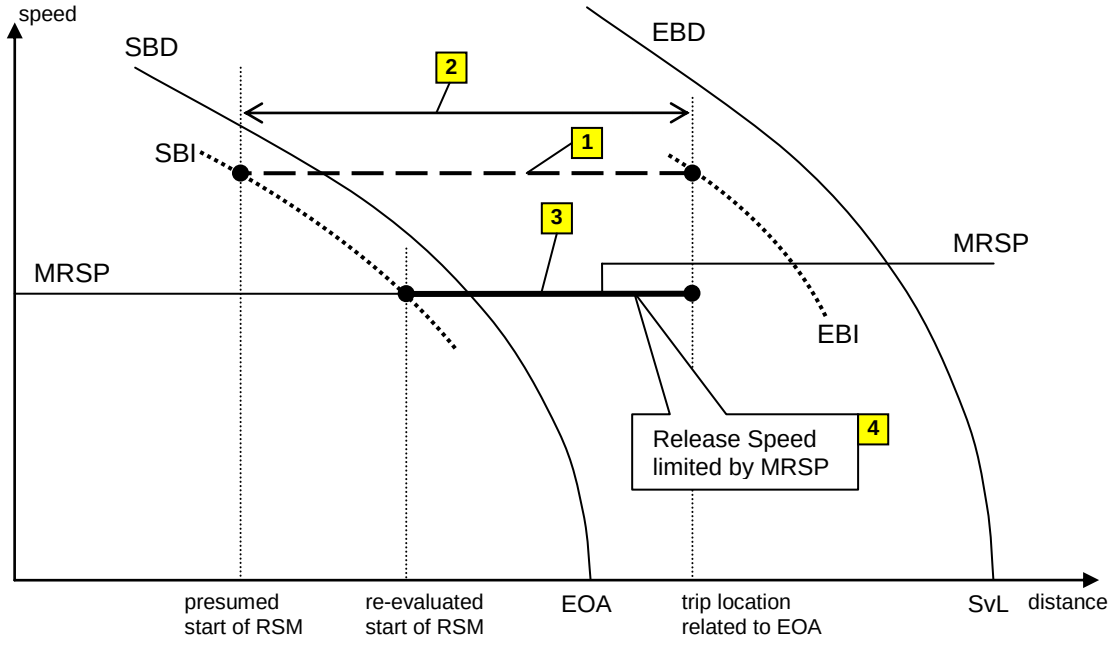


Figure 52: Release Speed limited by MRSP

3.13.9.5 Intentionally deleted

3.13.10 Speed and distance monitoring commands

3.13.10.1 Introduction

3.13.10.1.1 By comparing the train speed and position to the various supervision limits defined in the previous section, the on-board equipment generates braking commands, traction cut-off commands and relevant information to the driver. The information displayed to the driver is selected according to the following supervision statuses of the speed and distance monitoring function: Normal status, Indication status, Overspeed status, Warning status and Intervention status.

3.13.10.1.2 The following types of speed and distance monitoring are defined:

- Ceiling speed monitoring (CSM)
- Target speed monitoring (TSM)

- Release speed monitoring (RSM)

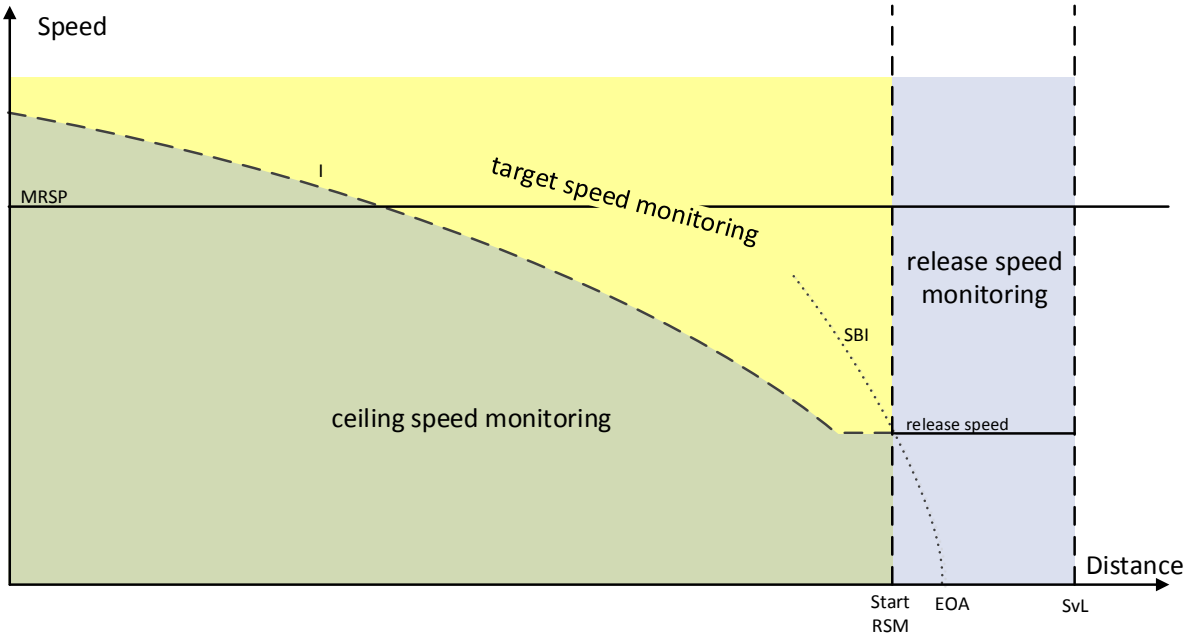


Figure 53: Different types of speed and distance monitoring

3.13.10.1.3 Ceiling speed monitoring is the speed supervision in the area where the train can run without the need to brake to a target.

3.13.10.1.4 Target speed monitoring is the speed and distance supervision in the area where the specific information related to a target is displayed to the driver and within which the train brakes to a target.

3.13.10.1.5 Release speed monitoring is the speed and distance supervision in the area close to the EOA where the train is allowed to run with release speed to approach the EOA.

3.13.10.2 General requirements

3.13.10.2.1 The train speed indicated to the driver shall be identical to the speed used for the speed monitoring. This shall be the estimated speed.

3.13.10.2.2 Once a Train Interface command (traction cut-off, service brake or emergency brake) is triggered, the on-board shall apply it until its corresponding revocation condition is met.

3.13.10.2.3 If there is no on-board interface with the service brake or if the use of the service brake command is not allowed by a National Value (only in Target speed monitoring), whenever a service brake command is specified, the emergency brake command shall be triggered instead.

3.13.10.2.4 The emergency brake command, which is triggered instead of the service brake command when an SBI supervision limit is exceeded, shall be revoked according to the requirements specified for the revocation of service brake command, unless the

emergency brake command has been also triggered due to an EBI supervision limit. In such case, the condition for revoking the emergency brake command due to EBI supervision limit shall prevail.

3.13.10.2.5 The on-board shall revoke the Intervention status only when no brake command is applied by the speed and distance monitoring function.

3.13.10.2.6 In level 2/3: Train trip shall be initiated if the on-board equipment detects that the minimum safe front end has passed the EOA/LOA location.

3.13.10.2.7 In Level 1: Train Trip shall be initiated if the on-board equipment detects that the minimum safe antenna position (calculated by subtracting distance between active Eurobalise antenna and the front end of the train from the min safe front end position) has passed the EOA/LOA location.

3.13.10.2.8 In the following sections, the term V_MRSP (together with the derived ceiling supervision limits) refers to the lowest MRSP element encountered between the min safe front end and the max safe front end of the train.

3.13.10.3 Requirements for Ceiling speed monitoring

3.13.10.3.1 The on-board equipment shall display the Permitted speed ceiling supervision limit.

3.13.10.3.2 When the supervision status is Overspeed, Warning or Intervention, the on-board equipment shall display the SBI speed ceiling supervision limit.

3.13.10.3.3 The on-board shall compare the estimated speed with the ceiling supervision limits defined in section 3.13.9.2 and shall trigger/revoke commands to the train interface (service brake if implemented or emergency brake) and supervision statuses as described in Table 5 and Table 6.

Triggering condition #	Estimated speed	Location	TI Command triggered	Supervision status triggered
t1	$V_{est} \leq V_{MRSP}$	Any	-	Normal Status
t2	$V_{est} > V_{MRSP}$	Any	-	Overspeed Status
t3	$V_{est} > V_{MRSP} + dV_{warning}(V_{MRSP})$	Any	-	Warning Status
t4	$V_{est} > V_{MRSP} + dV_{sbi}(V_{MRSP})$	Any	SB	Intervention Status
t5	$V_{est} > V_{MRSP} + dV_{ebi}(V_{MRSP})$	Any	EB	Intervention Status

Table 5: triggering of Train Interface commands and supervision statuses in ceiling speed monitoring

Revocation condition #	Estimated speed	Location	TI Command revoked	Supervision status revoked
r0	Standstill		EB	Intervention Status
r1	$V_{est} \leq V_{MRSP}$	Any	SB EB (only if allowed by National Value)	Indication Status Overspeed Status Warning Status Intervention Status (in case of EB command, only if allowed by National Value)

Table 6: Revocation of Train Interface commands and supervision statuses in ceiling speed monitoring

3.13.10.3.4 The on-board equipment shall execute the transitions between the different supervision statuses as described in Table 7 (see section 4.6.1 for details about the symbols). This table takes into account the order of precedence between the supervision statuses and the possible updates of the MRSP while in ceiling speed monitoring (e.g. when a TSR is revoked).

Normal status	< r1 -p1-	< r1 -p1-	< r1 -p1-	< r0, r1 -p1-
	Indication status			
t2 > -p3-	t2 > -p3-	**Overspeed status**		
t3 > -p2-	t3 > -p2-	t3 > -p2	**Warning status**	
t4, t5 > -p1-	t4, t5 > -p1-	t4, t5 > -p1-	t4, t5 > -p1-	**Intervention status**

Table 7: Transitions between supervision statuses in ceiling speed monitoring

3.13.10.3.5 When the speed and distance monitoring function becomes active and the ceiling speed monitoring is the first one entered, the triggering condition t1 defined in Table 5 shall be checked in order to determine whether the Normal status applies. If it is not

the case, the on-board shall immediately set the supervision status to the relevant value, applying a transition from the Normal status according to Table 7.

3.13.10.3.6 The Indication status is not used in ceiling speed monitoring. However, in case the ceiling speed monitoring is entered and the supervision status was previously set to Indication, the on-board equipment shall immediately execute one of the transitions from the Indication status, as described in Table 7.

3.13.10.3.7 In ceiling speed monitoring, only the ceiling supervision limits (described in section 3.13.9.2) are used to determine the commands to the Train Interface and the supervision statuses displayed to the driver. However the braking to target supervision limits and the release speed supervision limits (described in sections 3.13.9.3 and 3.13.9.4) are also used to determine the locations where the transition to target speed monitoring and to release speed monitoring occur respectively.

3.13.10.3.8 The on-board equipment shall display to the driver the first Indication location that will be reached by either the max safe or by the estimated train front end. To that effect, the on-board shall compute the remaining distance to the first Indication location as follows:

If $V_{est} < V_{release}$

Ind distance = $d_{\underset{RSM}{start}} - d_{estfront}$ in case $d_{\underset{RSM}{start}} = d_{SBI1}(V_{release})$

Ind distance = $d_{\underset{RSM}{start}} - d_{\max safefront}$ in case $d_{\underset{RSM}{start}} = d_{\underset{MREBDT}{SBI2}}(V_{release})$

With $d_{\underset{RSM}{start}}$ and $d_{\underset{MREBDT}{SBI2}}(V_{release})$ as defined in 3.13.9.4.7

If $V_{est} \geq V_{release}$

Ind distance =

$$\min\left\{\begin{array}{l}(d_{\underset{EOA}{I}}(V_{est}) - d_{estfront}), (d_{\underset{SvL}{I}}(V_{est}) - d_{\max safefront}), (d_{\underset{T\arg et\_1}{I}}(V_{est}) - d_{\max safefront}) \\ ,\ldots, (d_{\underset{T\arg et\_n}{I}}(V_{est}) - d_{\max safefront})\end{array}\right\}$$

With Target_1, ..., Target_n being EBD based targets whose speed value is below or equal to the estimated speed

3.13.10.3.8.1 In case no release speed is supervised, the same formulas shall be applied, by substituting V_release with the value 0.

3.13.10.3.8.2 Exception: In case the list of supervised targets is empty or in case of LOA with no EBD based target whose speed value is below or equal to the estimated speed, the

ERTMS/ETCS on-board equipment shall not display any first Indication location information.

3.13.10.3.9 If A_MAXREDADH (see 3.13.6.2.1.6) requests the target information as supplementary DMI information, the on-board equipment shall display to the driver the target information (target speed and distance to target) related to one target at a time: the Most Relevant Displayed Target (MRDT). The MRDT shall be selected amongst the supervised targets as the one whose remaining distance to its Indication supervision limit (as specified in 3.13.10.3.8 and 3.13.10.3.8.1) is the shortest. The indicated distance to the target shall be computed in the same way as for target speed monitoring, i.e. clauses 3.13.10.4.7, 3.13.10.4.8 and 3.13.10.4.8.1 shall apply.

3.13.10.3.9.1 Exception: In case the list of supervised targets is empty or in case of LOA with no EBD based target whose speed value is below or equal to the estimated speed, the ERTMS/ETCS on-board equipment shall not display any target information.

3.13.10.3.10 If A_MAXREDADH (see 3.13.6.2.1.6) requests a time to Indication as supplementary DMI information, the on-board equipment shall compute the Time to Indication (TTI) as the time to travel at the estimated speed the remaining distance to the first Indication location (as specified in 3.13.10.3.8 and 3.13.10.3.8.1). The on-board equipment shall inform the driver as long as this time is shorter than a fixed value (refer to A.3.1).

3.13.10.3.10.1 Exception: In case the list of supervised targets is empty or in case of LOA with no EBD based target whose speed value is below or equal to the estimated speed, the ERTMS/ETCS on-board equipment shall not compute any time to Indication.

3.13.10.4 Requirements for Target speed monitoring

3.13.10.4.1 In target speed monitoring, both the ceiling supervision limits and the braking to target supervision limits, described in sections 3.13.9.2 and 3.13.9.3, are used to determine the commands to the Train Interface and the supervision statuses displayed to the driver.

3.13.10.4.2 The on-board equipment shall display to the driver the target information (target speed and distance to target) related to one target at a time: the Most Relevant Displayed Target (MRDT). The MRDT shall be selected amongst the supervised targets whose Indication supervision limit is exceeded (i.e. a condition to trigger a supervision status with respect to these targets is met, see table 8 and table 9) and shall be determined according to the following steps:

- Step 0: $MRDT_0$ = the target of which the braking to target Permitted speed supervision limit (refer to section 3.13.9.3.5), calculated for the current position of the train, is the lowest one amongst the concerned targets:

$$\underset{MRDT_0}{V_P} = \min\left\{ \underset{EOA}{V_P(d_{estfront})}, \underset{SvL}{V_P(d_{\max safefront})}, \underset{Target\_1}{V_P(d_{\max safefront})}, \ldots, \underset{Target\_n}{V_P(d_{\max safefront})} \right\}$$

with $V_P(d_{\underset{EOA}{estfront}})$ taken into account only if $d_{estfront} > \underset{EOA}{d_I}(V_{est})$

with $V_P(d_{\underset{SvL}{\max safefront}})$ taken into account only if $d_{\max safefront} > \underset{SvL}{d_I}(V_{est})$

with $V_P(d_{\underset{T\arg et\_1}{\max safefront}})$ taken into account only if $d_{\max safefront} > \underset{T\arg et\_1}{d_I}(V_{est})$ and $V_{est} \geq V_{T\arg et\_1}$

...

with $V_P(d_{\underset{T\arg et\_n}{\max safefront}})$ taken into account only if $d_{\max safefront} > \underset{T\arg et\_n}{d_I}(V_{est})$ and $V_{est} \geq V_{T\arg et\_n}$

- Step 1: the on-board equipment shall check whether the MRDT obtained from the previous step ($MRDT_0$) masks any other target(s) remaining in the list of concerned targets, whose target speed is lower than $MRDT_0$. A target is masked by $MRDT_0$ if its Indication supervision limit is located in rear of the location of the $MRDT_0$ Permitted speed supervision limit, both at the target speed of $MRDT_0$. It shall be identified using one of the following formulas, where both the Indication supervision limit and the Permitted speed supervision limit are calculated using the same formulas defined above and by substituting V_est with V_target_$MRDT_0$:

$\underset{EOA}{d_I}(V_{\underset{MRDT_0}{t\arg et}}) < \underset{MRDT_0}{d_P}(V_{\underset{MRDT_0}{t\arg et}})$ or $\underset{SvL}{d_I}(V_{\underset{MRDT_0}{t\arg et}}) < \underset{MRDT_0}{d_P}(V_{\underset{MRDT_0}{t\arg et}})$ or

$\underset{T\arg et\_1}{d_I}(V_{\underset{MRDT_0}{t\arg et}}) < \underset{MRDT_0}{d_P}(V_{\underset{MRDT_0}{t\arg et}})$ or ... or $\underset{T\arg et\_n}{d_I}(V_{\underset{MRDT_0}{t\arg et}}) < \underset{MRDT_0}{d_P}(V_{\underset{MRDT_0}{t\arg et}})$

  If at least one target is masked by $MRDT_0$, then the MRDT obtained from this step ($MRDT_1$) shall be the masked target with its Indication supervision limit the furthest in rear of the location of the $MRDT_0$ Permitted speed supervision limit and the on-board equipment shall go to the next step.

  If none of the remaining targets from the list of concerned targets is masked by $MRDT_0$ or if there is no other remaining target to check in the list of concerned targets, then the MRDT shall be the target obtained from the previous step (i.e. $MRDT_0$).

  ...

- Step n: the on-board shall apply step n-1, substituting $MRDT_{n-2}$ with $MRDT_{n-1}$ and checking the list of concerned targets excluding the targets which have been preselected as MRDT in all the previous steps (i.e. from $MRDT_0$ to $MRDT_{n-1}$ inclusive).

3.13.10.4.2.1 Note 1: the above process for the determination of the MRDT ensures that in all circumstances (especially when several targets are close to each other) it is avoided that a target is displayed after its Indication supervision limit has been reached.

3.13.10.4.2.2 Note 2: when entering target speed monitoring, there is by definition at least one target that satisfies the conditions to be selected as MRDT. Afterwards (e.g. due to train braking) it is possible that no target satisfies any more the conditions to be selected as MRDT, which however only means that the target previously selected remains the MRDT (see clause 3.13.10.4.5).

3.13.10.4.2.3 Note 3: if $MRDT_{n-1}$ is a target at zero speed (e.g. EOA or SvL), then it is always selected as MRDT, i.e. no other target can be selected as MRDT as per step n.

3.13.10.4.3 The on-board equipment shall display the Permitted speed, according to following formula:

$$\underset{DMI}{V_P} = \min\left\{ V_P(\underset{EOA}{d_{estfront}}), V_P(\underset{SvL}{d_{\max safefront}}), V_P(\underset{Target\_1}{d_{\max safefront}}), ..., V_P(\underset{Target\_n}{d_{\max safefront}}), V_{MRSP} \right\}$$

With Target_1, ..., Target_n being all the targets from the list of supervised targets

3.13.10.4.4 When the supervision status is Overspeed, Warning or Intervention, the on-board equipment shall display the SBI speed, according to the following formula:

$$\underset{DMI}{V_{SBI}} = \min\left\{ \begin{array}{l} \max\left\{ \underset{EOA}{V_{SBI1}}\left(d_{estfront}\right), V_{release} \right\}, \max\left\{ \underset{SvL}{V_{SBI2}}\left(d_{maxsafefront}\right), V_{release} \right\}, \\ V_{SBI2}\left(\underset{Target\_1}{d_{maxsafefront}}\right), ..., V_{SBI2}\left(\underset{Target\_n}{d_{maxsafefront}}\right), V_{MRSP} + dV_{sbi}\left(V_{MRSP}\right) \end{array} \right\}$$

3.13.10.4.5 Once a target is the MRDT, it shall remain the MRDT until it is removed from the list of supervised targets or until it is replaced as MRDT with another target which is selected for the first time according to clause 3.13.10.4.2. The driver shall be informed upon any change of MRDT.

3.13.10.4.6 If the MRDT is either the EOA or the SvL, the on-board equipment shall display the release speed, if given by the trackside or calculated on-board.

3.13.10.4.7 If the MRDT is neither the EOA nor the SvL, the indicated distance to the target shall be the distance between the maximum safe front end and the location of the Permitted speed supervision limit calculated for the target speed (see section 3.13.9.3.5 for the calculation of this location), but limited to zero after this location is passed.

Target distance = $\max\left\{\left(d_P\left(V_{target}\right) - d_{\max safefront}\right), 0\right\}$

3.13.10.4.7.1 Intentionally deleted.

3.13.10.4.8 If the MRDT is either the EOA or the SvL, the indicated distance to the target shall be calculated as follows:

Target distance = $\max\left\{\min\left\{\left(d_{EOA} - d_{estfront}\right), \left(d_{SvL} - d_{\max safefront}\right)\right\}, 0\right\}$

3.13.10.4.8.1 As long as the displayed values are locked due to SB feedback (see Appendix A.3.10 for details), the on-board equipment shall ensure that the displayed Permitted speed, the displayed SBI speed (if any) and the distance to target never increase (e.g. due to the reduction of T_bs1 and T_bs2 or e.g. due to relocation). In other terms if a concerned displayed value (VP_DMI, VSBI_DMI or target distance) calculated as above has a higher value than the previously displayed value, then the previous value shall remain displayed until a further calculated value is lower than the displayed one.

3.13.10.4.9 The on-board shall consider the service brake command as available for use unless:

a) The service brake command is not implemented, OR

b) The national value inhibits its use.

3.13.10.4.10 The on-board equipment shall compare the estimated speed and train position with the ceiling and braking to target supervision limits and shall trigger/revoke commands to the train interface (traction cut-off if implemented, service brake if available for use or emergency brake) and supervision statuses, by evaluating and taking into account the conditions as specified in clause 3.13.10.4.10.1.

3.13.10.4.10.1 The conditions in Table 8 and Table 10 shall be evaluated for each target related to an MRSP speed decrease or LOA, the conditions in Table 9 and Table 11 shall be evaluated for the targets EOA and SvL and for the end of the maximum permitted distance to run in Staff Responsible.

Triggering condition #	Estimated speed	Train front end position (max safe)	TI Command triggered	Supervision status triggered
t3	$V_{target} < V_{est} \leq V_{MRSP}$	$d_I(V_{est}) < d_{\max safefront} \leq d_P(V_{est})$	-	Indication Status
t4		$d_{\max safefront} > d_P(V_{est})$	-	Overspeed Status
t6	$V_{MRSP} < V_{est} \leq V_{MRSP} + dV_{warning}(V_{MRSP})$	$d_I(V_{est}) < d_{\max safefront} \leq d_W(V_{est})$	-	Overspeed Status
t7	$V_{target} + dV_{warning}(V_{target}) < V_{est} \leq V_{MRSP} + dV_{warning}(V_{MRSP})$	$d_{\max safefront} > d_W(V_{est})$	TCO	Warning Status
t9	$V_{MRSP} + dV_{warning}(V_{MRSP}) < V_{est} \leq V_{MRSP} + dV_{sbi}(V_{MRSP})$	$d_I(V_{est}) < d_{\max safefront} \leq d_{SBI2}(V_{est})$	TCO	Warning Status
t10	$V_{target} + dV_{sbi}(V_{target}) < V_{est} \leq V_{MRSP} + dV_{sbi}(V_{MRSP})$	$d_{\max safefront} > d_{SBI2}(V_{est})$	SB	Intervention Status
t12	$V_{MRSP} + dV_{sbi}(V_{MRSP}) < V_{est} \leq V_{MRSP} + dV_{ebi}(V_{MRSP})$	$d_I(V_{est}) < d_{\max safefront} \leq d_{EBI}(V_{est})$	SB	Intervention Status
t13	$V_{target} + dV_{ebi}(V_{target}) < V_{est} \leq V_{MRSP} + dV_{ebi}(V_{MRSP})$	$d_{\max safefront} > d_{EBI}(V_{est})$	EB	Intervention Status
t15	$V_{est} > V_{MRSP} + dV_{ebi}(V_{MRSP})$	$d_{\max safefront} > d_I(V_{est})$	EB	Intervention Status

Table 8: Triggering of Train Interface commands and supervision statuses in target speed monitoring, MRSP target or LOA

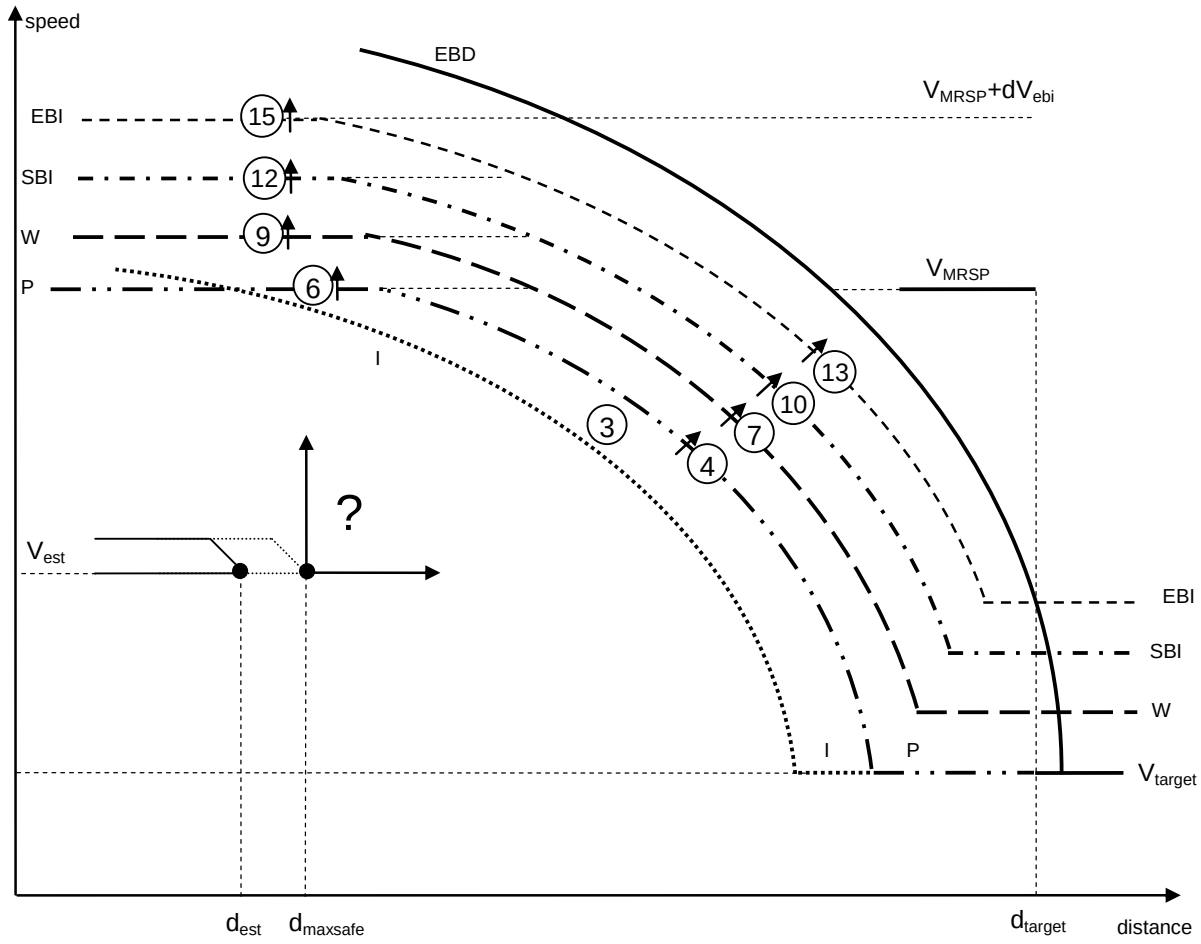


Figure 54: Triggering of Train Interface commands and supervision statuses in target speed monitoring, MRSP target or LOA (number in circle corresponds with the equivalent triggering condition in Table 8)

Triggering condition #	Estimated speed	Train front end position (estimated and max safe)	TI Command triggered	Supervision status triggered
t3	$V_{release} < V_{est} \leq V_{MRSP}$	($d_{\max safefront} > d_I(V_{est})$ for SvL OR $d_{estfront} > d_I(V_{est})$ for EOA) AND ($d_{\max safefront} \leq d_P(V_{est})$ for SvL AND $d_{estfront} \leq d_P(V_{est})$ for EOA)		Indication Status
t4		$d_{\max safefront} > d_P(V_{est})$ for SvL OR $d_{estfront} > d_P(V_{est})$ for EOA		Overspeed Status
t6	$V_{MRSP} < V_{est} \leq V_{MRSP} + dV_{warning}(V_{MRSP})$	($d_{\max safefront} > d_I(V_{est})$ for SvL OR $d_{estfront} > d_I(V_{est})$ for EOA) AND ($d_{\max safefront} \leq d_W(V_{est})$ for SvL AND $d_{estfront} \leq d_W(V_{est})$ for EOA)	-	Overspeed Status
t7	$V_{release} < V_{est} \leq V_{MRSP} + dV_{warning}(V_{MRSP})$	$d_{\max safefront} > d_W(V_{est})$ for SvL OR $d_{estfront} > d_W(V_{est})$ for EOA	TCO	Warning Status

Triggering condition #	Estimated speed	Train front end position (estimated and max safe)	TI Command triggered	Supervision status triggered
t9	$V_{MRSP} + dV_{warning}(V_{MRSP}) < V_{est} \leq V_{MRSP} + dV_{sbi}(V_{MRSP})$	$(d_{\max safefront} > d_I(V_{est})$ for SvL OR $d_{estfront} > d_I(V_{est})$ for EOA) AND $(d_{\max safefront} \leq d_{SBI2}(V_{est})$ for SvL AND $d_{estfront} \leq d_{SBI1}(V_{est})$ for EOA)	TCO	Warning Status
t10	$V_{release} < V_{est} \leq V_{MRSP} + dV_{sbi}(V_{MRSP})$	$d_{\max safefront} > d_{SBI2}(V_{est})$ for SvL OR $d_{estfront} > d_{SBI1}(V_{est})$ for EOA	SB	Intervention Status
t12	$V_{MRSP} + dV_{sbi}(V_{MRSP}) < V_{est} \leq V_{MRSP} + dV_{ebi}(V_{MRSP})$	$(d_{\max safefront} > d_I(V_{est})$ for SvL OR $d_{estfront} > d_I(V_{est})$ for EOA) AND $d_{\max safefront} \leq d_{EBI}(V_{est})$	SB	Intervention Status
t13	$V_{release} < V_{est} \leq V_{MRSP} + dV_{ebi}(V_{MRSP})$	$d_{\max safefront} > d_{EBI}(V_{est})$	EB	Intervention Status
t15	$V_{est} > V_{MRSP} + dV_{ebi}(V_{MRSP})$	$d_{\max safefront} > d_I(V_{est})$ for SvL OR $d_{estfront} > d_I(V_{est})$ for EOA	EB	Intervention Status

Table 9: Triggering of Train Interface commands and supervision statuses in target speed monitoring, EOA/SvL with release speed

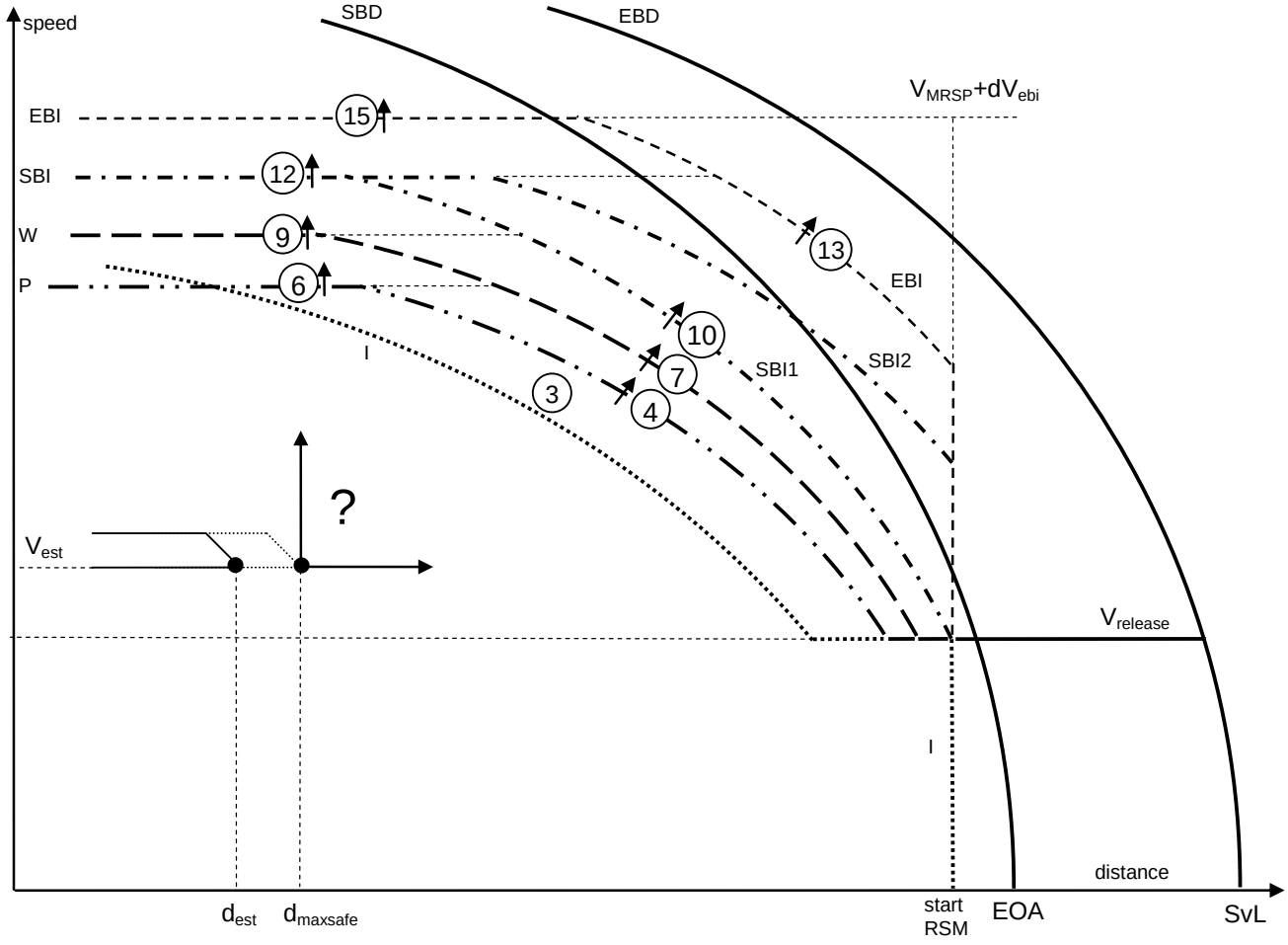


Figure 55: Triggering of Train Interface commands and supervision statuses in target speed monitoring, EOA/SvL with release speed (number in circle corresponds with equivalent triggering condition in Table 9)

Revocation condition #	Estimated speed	Train front end position (estimated and max safe)	TI Command revoked	Supervision status revoked
r0	Standstill		EB	Intervention status
r1	$V_{est} \leq V_{target}$	Not relevant	TCO SB EB (in case V_target ≠ 0, only if allowed by National Value)	Overspeed status Warning status Intervention status (in case of EB command and V_target ≠ 0, only if allowed by National Value)
r3	$V_{target} < V_{est} \leq V_{MRSP}$	$d_{\max safefront} \leq d_P(V_{est})$	TCO SB EB (only if allowed by National Value)	Overspeed status Warning status Intervention status (in case of EB command, only if allowed by National Value)

Table 10: Revocation of Train Interface commands and supervision statuses in target speed monitoring, MRSP target or LOA

Revocation condition #	Estimated speed	Train front end position (estimated and max safe)	TI Command revoked	Supervision status revoked
r0	Standstill		EB	Intervention status
r1	$V_{est} \leq V_{release}$	Not relevant	TCO SB EB (in case V_release ≠ 0, only if allowed by National Value)	Overspeed status Warning status Intervention status (in case of EB command and V_release ≠ 0, only if allowed by National Value)
r3	$V_{release} < V_{est} \leq V_{MRSP}$	$d_{\max safefront} \leq d_P(V_{est})$ for SvL AND $d_{estfront} \leq d_P(V_{est})$ for EOA	TCO SB EB (only if allowed by National Value)	Overspeed status Warning status Intervention status (in case of EB command, only if allowed by National Value)

Table 11: Revocation of Train Interface commands and supervision statuses in target speed monitoring, EOA/SvL with release speed

3.13.10.4.11 Note: For clarity reasons, the Figures 54 and 55 show the train speed/position in a region where the target speed monitoring may not have been entered yet, further to the crossing of an Indication supervision limit.

3.13.10.4.12 Note: Figure 55 shows the parts of the ceiling speed and braking to target supervision limits, which are used in target speed monitoring to trigger the brake commands and the transitions between supervision statuses. It does not show what is displayed to the driver: in particular, the braking to target Permitted supervision limit is displayed (even if not supervised) for values lower than the release speed.

3.13.10.4.13 In case of target EOA/SvL without any supervised release speed, the Table 9 and Table 11 shall be applied, by substituting V_release with the value 0.

3.13.10.4.13.1 In case the target is the location at the end of the maximum permitted distance to run in Staff Responsible, the Table 9 and Table 11 shall be applied, by substituting V_release with the value 0, SvL with staff responsible end location and by ignoring any formula related to EOA.

3.13.10.4.14 A TI command shall be triggered if a corresponding triggering condition is met for at least one target. On the other hand it shall be revoked only if a corresponding revocation condition is met for each supervised target.

3.13.10.4.15 The on-board equipment shall execute the transitions between the different supervision statuses as described in Table 12 (see section 4.6.1 for details about the symbols). A triggering condition shall be taken into account as soon as it is satisfied for any target. On the other hand a transition from Overspeed, Warning or Intervention status to the Indication status shall be made only if a revocation condition specified for the concerned transition is met for each supervised target.

Normal status				
t3 > -p4-	**Indication status**	< r1, r3 -p1-	< r1, r3 -p1-	< r0, r1, r3 -p1-
t4, t6 > -p3-	t4, t6 > -p3-	**Overspeed status**		
t7, t9 > -p2-	t7, t9 > -p2-	t7, t9 > -p2-	**Warning status**	
t10, t12, t13, t15 > -p1-	t10, t12, t13, t15 > -p1-	t10, t12, t13, t15 > -p1-	t10, t12, t13, t15 > -p1-	**Intervention status**

Table 12: Transitions between supervision statuses in target speed monitoring

3.13.10.4.16 When the speed and distance monitoring function becomes active and the target speed monitoring is the first one entered, the triggering condition t3 defined in Table 8 or Table 9 shall be checked for each target in order to determine whether the Indication status applies. If it is not the case, the on-board shall immediately set the supervision status to the relevant value, applying a transition from the Indication status according to clause 3.13.10.4.15.

3.13.10.4.17 The Normal status is not used in target speed monitoring. However, in case the target speed monitoring is entered and the supervision status was previously set to Normal, the on-board equipment shall immediately execute one of the transitions from the Normal status, as specified in clause 3.13.10.4.15.

3.13.10.4.18 Note: Depending upon train speed/position it is possible that for some target(s) none of the triggering conditions specified in table 8 and 9 is met. However the conditions to enter the target speed monitoring are such (see condition [1] in table 16) that the clauses 3.13.10.4.16 and 3.13.10.4.17 always allow determining a supervision status.

3.13.10.5 Requirements for release speed monitoring

3.13.10.5.1 The on-board equipment shall display the Release speed.

3.13.10.5.2 The on-board equipment shall display the target distance in the same way as for target speed monitoring, i.e. clauses 3.13.10.4.8 and 3.13.10.4.8.1 shall apply.

3.13.10.5.3 The braking to target Permitted speed supervision limit related to the MRDT (i.e. EOA or SvL), as calculated in target speed monitoring from the EBD or SBD, shall also be displayed in the same way as for target speed monitoring, i.e. clauses 3.13.10.4.3 and 3.13.10.4.8.1 shall apply.

3.13.10.5.4 The on-board equipment shall compare the estimated speed with the release speed and shall trigger/revoke commands to the train interface (emergency brake) and supervision statuses as described in Table 13 and Table 14.

Triggering condition #	Estimated speed	Location	TI Command triggered	Supervision status triggered
t1	$V_{est} \leq V_{release}$	Any	-	Indication Status
t2	$V_{est} > V_{release}$	Any	EB	Intervention Status

Table 13: Triggering of Train Interface commands and supervision statuses in release speed monitoring

Triggering condition #	Estimated speed	Location	TI Command revoked	Supervision status revoked
r0	Standstill		EB	Intervention Status
r1	$V_{est} \leq V_{release}$	Any	-	Overspeed Status Warning Status

Table 14: Revocation of Train Interface commands and supervision statuses in release speed monitoring

3.13.10.5.5 The on-board equipment shall execute the transitions between the different supervision statuses as described in Table 15 (see section 4.6.1 for details about the symbols). This table takes into account the order of precedence between the supervision statuses and the possible updates of the release speed while in release speed monitoring.

Normal status				
t1 > -p1-	**Indication status**	< r1 -p1-	< r1 -p1-	< r0 -p1-
		Overspeed status		
			Warning status	
t2 > -p1-	t2 > -p1-	t2 > -p1-	t2 > -p1-	**Intervention status**

Table 15: Transitions between supervision statuses in release speed monitoring

3.13.10.5.6 When the speed and distance monitoring function becomes active and the release speed monitoring is the first one entered, the triggering condition t1 defined in Table 13 shall be checked in order to determine whether the Indication status applies. If it is not the case, the on-board shall immediately set the supervision status to the Intervention status, applying a transition from the Indication status according to Table 15.

3.13.10.5.7 The Normal, Warning and Overspeed statuses are not used in release speed monitoring. However, in case the release speed monitoring is entered and the

supervision status was previously set to Normal, Warning or Overspeed, the on-board equipment shall immediately execute one of the transitions from respectively the Normal, Warning or Overspeed status, as described in Table 15.

3.13.10.6 Transitions between types of Speed and distance monitoring

3.13.10.6.1 The transitions between the Ceiling speed monitoring, the Target speed monitoring and the Release speed monitoring shall be achieved as described in the Table 16:

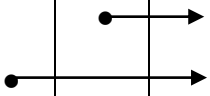
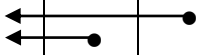
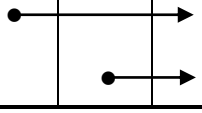
Condition id	Transition condition	CSM	TSM	RSM
[1]	((The train has passed with its max safe front end the Indication location calculated from an EBD whose target speed is below or equal to the train speed) OR (The train has passed with its estimated front end the Indication location calculated from the SBD)) AND (In case a release speed is supervised, the train speed is above or equal to the release speed)			
[2]	(The train has passed with its max safe front end the RSM start location if it is calculated from an EBD) OR (The train has passed with its estimated front end the RSM start location if it is calculated from the SBD)			
[3]	(The MRDT is removed from the list of supervised targets) AND (condition [1] is not fulfilled) AND (condition [2] is not fulfilled)			
[4]	(The list of supervised targets is updated) AND (condition [1] is fulfilled) AND (condition [2] is not fulfilled)			
[5]	(The list of supervised targets is updated) AND (condition [2] is fulfilled)			

Table 16: Transitions between types of Speed and distance monitoring

3.13.10.6.2 If a transition of speed and distance monitoring occurs while a brake command is already applied, the concerned command shall be maintained until the revocation condition, if specified for the newly entered speed and distance monitoring, is fulfilled.

3.13.10.6.2.1 Note: This means that when the service brake is commanded in ceiling speed monitoring while it is not available in target speed monitoring, the service brake remains commanded when the on-board switches to target speed monitoring and is only revoked when the Permitted speed supervision limit is no longer exceeded.

3.13.10.6.3 If a transition from target speed monitoring to ceiling speed or release speed monitoring occurs while a traction cut-off command is already applied, the traction cut-off command shall be immediately revoked.

3.13.10.6.4 If a transition from target speed monitoring to release speed monitoring occurs while a service brake command is already applied, the service brake command shall be immediately revoked.

3.13.10.6.5 On executing a transition between types of speed and distance monitoring, the supervision status shall be determined according to the requirements specified for the newly entered speed and distance monitoring.

3.13.11 Perturbation location

3.13.11.1 The purpose of the perturbation location is to trigger the MA request to the RBC in order to renew the Movement Authority in due time before the train would have to brake to an EOA/SvL or LOA target.

3.13.11.2 For the SvL or the LOA, the on-board shall calculate the perturbation location as follows.

3.13.11.3 Starting from the first element of the MRSP (i.e. from the start location of the on-board stored track description), the on-board shall calculate the location of the Indication supervision limit, valid for the speed of the MRSP element, taking into account the following assumptions:

a) the estimated acceleration shall be set to “zero”

b) if not inhibited by National Value, the compensation of the inaccuracy of the speed measurement shall be set to a value, calculated from the speed of the MRSP element, as defined in SUBSET-041 § 5.3.1.2: V_delta0ind = f_{41}(V_MRSP-n)

c) If available for use, the service brake feedback shall not have any effect: T_bs1ind and T_bs2ind shall be set to T_bs if the service brake command is available for use, otherwise they shall be set to “zero”. T_tractionind and T_beremind shall be defined as in 3.13.9.3.2 for T_traction and T_berem by substituting T_bs2 with T_bs2ind

3.13.11.4 To calculate the EBI supervision limit, the same formulas defined above with V_est, T_traction, T_berem and V_delta0 shall be applied, by substituting V_est with V_MRSP-n, T_traction with T_tractionind, T_berem with T_beremind and V_delta0 with V_delta0ind.

$$d_{EBI}\left(V_{MRSP-n}\right) = d_{EBD}\left(V_{MRSP-n} + V_{delta0ind}\right) - \left(V_{MRSP-n} + V_{delta0ind}\right) \cdot \left(T_{beremind} + T_{tractionind}\right)$$

$$d_{SBI2}\left(V_{MRSP-n}\right) = d_{EBI}\left(V_{MRSP-n}\right) - V_{MRSP-n} \cdot T_{bs2ind}$$

$$d_{I}\left(V_{MRSP-n}\right) = d_{P}\left(V_{MRSP-n}\right) - V_{MRSP-n} \cdot T_{indication}$$

With $d_{P}\left(V_{MRSP-n}\right) = d_{SBI2}\left(V_{MRSP-n}\right) - V_{MRSP-n} \cdot T_{driver}$ if the GUI curve is inhibited

Or $d_{P}\left(V_{MRSP-n}\right) = \min\left\{\left(d_{SBI2}\left(V_{MRSP-n}\right) - V_{MRSP-n} \cdot T_{driver}\right), d_{GUI}\left(V_{MRSP-n}\right)\right\}$ if the GUI curve is enabled

3.13.11.5 If the Indication supervision limit, obtained from the speed of the n^{th} element, is located between the start and end locations of this n^{th} element, the perturbation location shall be calculated as follows:

If $d^{a}_{MRSP-n} < d_I(V_{MRSP-n}) \leq d^{b}_{MRSP-n}$

Then $d_{perturbation} = d_I(V_{MRSP-n})$

3.13.11.6 If the Indication supervision limit, obtained from the speed of the nth element, is located in advance of the end location of this nth element, and if the Indication supervision limit, obtained from the speed of the n+1th element is located in rear of the end location of this nth element (see Figure 56), the perturbation location shall be calculated as follows:

If $d_I(V_{MRSP-n}) > d^{b}_{MRSP-n}$ and $d_I(V_{MRSP-n+1}) < d^{b}_{MRSP-n}$

Then $d_{perturbation} = d^{b}_{MRSP-n}$

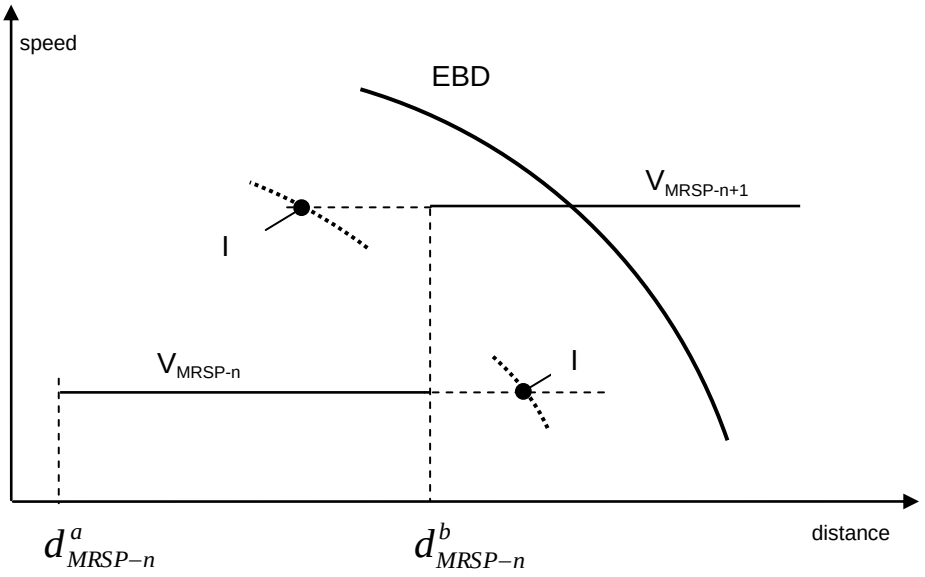


Figure 56: Perturbation location derived from MRSP speed increase

3.13.11.7 For the EOA, the on-board shall calculate its perturbation location in the same way as for an EBD based target, except that the formulas to calculate the distance between the location of the Indication supervision limit and the SBD shall be:

$$d_{SBI1}(V_{MRSP-n}) = d_{SBD}(V_{MRSP-n}) - V_{MRSP-n} \cdot T_{bs1ind}$$

$$d_I(V_{MRSP-n}) = d_P(V_{MRSP-n}) - V_{MRSP-n} \cdot T_{indication}$$

With $d_P(V_{MRSP-n}) = d_{SBI1}(V_{MRSP-n}) - V_{MRSP-n} \cdot T_{driver}$ if the GUI curve is inhibited

Or $d_P(V_{MRSP-n}) = \min\{(d_{SBI1}(V_{MRSP-n}) - V_{MRSP-n} \cdot T_{driver}), d_{GUI}(V_{MRSP-n})\}$ if the GUI curve is enabled

3.13.11.8 The on-board shall trigger the MA request to the RBC when the train has passed, either with its estimated front end for the perturbation location calculated from the EOA

or with its max safe front end for the perturbation location calculated from the SvL or the LOA, the following location:

$$d_{MAR} = d_{perturbation} - (V_{MRSP} + dV_{warning}(V_{MRSP})) \cdot T_{MAR} .$$

3.13.11.9 If, in exceptional situation (e.g. after a shortening of MA), the EBD, SBD or GUI speed at the start location of the MRSP is lower than the speed of the first element of the MRSP, the location to trigger the MA request to the RBC shall be considered as already passed.

3.13.11.10 Note: For trackside engineering reasons, the assumptions for the calculation of the EBI supervision limit are necessary to obtain a fully predictable perturbation location, i.e. independent from the measured acceleration and speed confidence interval.

3.14 Brake Command Handling and Protection against Undesirable Train Movement

3.14.1 Brake Command Handling

3.14.1.1 Note: Whenever the type of brake used is not specified explicitly in the text, it shall be interpreted as not being important for technical interoperability and being a property of the specific implementation.

3.14.1.2 In case only the application of (the non-vital) service brake has been commanded and the service brake fails to be applied, the emergency brake command shall be given.

3.14.1.3 If the emergency brake command was triggered due to a trip condition (see chapter 4) the emergency brake command shall be released at standstill and after driver acknowledgement of the trip condition.

3.14.1.4 For handling of brake commands resulting from the speed and distance monitoring, refer to section 3.13.10.

3.14.1.5 If the brake command was triggered due to roll away protection, reverse movement protection or standstill supervision the brake command shall be released at standstill and after driver acknowledgement.

3.14.1.6 If the brake command was triggered due to linking error, balise group message inconsistency or RAMS related supervision error, the brake command shall be released at standstill.

3.14.1.7 If the brake command was triggered due to supervision of the safe radio connection (T_NVCONTACT) the brake command shall be released at standstill or if a new consistent message has been received from the RBC.

3.14.1.7.1 If the brake command was triggered due to an overpassed reversing distance related to a reversing area or due to any further movement in the direction opposite to the train

orientation while the reversing distance is still overpassed, the brake command shall be released if the reversing distance becomes extended so that the reversing distance is no longer overpassed, or at standstill after driver acknowledgement.

3.14.1.7.2 If the brake command was triggered due to change of Train Data while running (see section 5.17 procedure "Changing Train Data from sources different from the driver"), the brake command shall be released at standstill and after driver acknowledgement.

3.14.1.7.3 If the brake command was triggered due to the detection of a train movement while modifying/revalidating train data or while entering SR speed/distance limits, the brake command shall be released at standstill and after driver acknowledgement..

3.14.1.7.4 If the brake command was triggered due to an overpassed distance allowed for moving backwards in Post Trip mode or due to any further movement in the direction opposite to the train orientation while the distance allowed for moving backwards in Post Trip mode is still overpassed, the brake command shall be released at standstill and after driver acknowledgement.

3.14.1.7.5 If the brake command was triggered due to the driver not having acknowledged a text message, the brake command shall be released after the driver has acknowledged the text message.

3.14.1.8 An indication shall be given to the driver to indicate when the brakes can be released and when an acknowledgement is requested.

3.14.2 Roll Away Protection

3.14.2.1 Note: This protection is only applicable if the required information can be obtained from the direction controller.

3.14.2.2 The Roll Away Protection (RAP) shall prevent the train from moving in a direction, which conflicts with the current position of the direction controller in the active desk.

3.14.2.3 If the controller is in neutral position, the RAP shall prevent forward and reverse movements of the train.

3.14.2.4 When the system recognises a movement exceeding the national value for the allowed roll away distance the brakes shall be triggered.

3.14.2.5 Refer to section 3.14.1.

3.14.2.6 An indication shall be given to the driver showing when the RAP is commanding the brakes.

3.14.2.7 After revocation of the brake command the RAP shall be re-initialised using the current position of the train as the new reference location.

3.14.3 Reverse Movement Protection

3.14.3.1 The Reverse Movement Protection (RMP) shall prevent the train from moving in the opposite direction to the permitted one. The permitted movement direction of a train shall be the one of the currently valid MA, if available on-board. See chapter 4 concerning permitted direction for special cases.

3.14.3.2 When a reverse movement is detected, the brake command shall be triggered after a distance specified by the national value.

3.14.3.3 Refer to section 3.14.1.

3.14.3.4 An indication shall be given to the driver showing when the RMP is commanding the brakes.

3.14.3.5 After revocation of the brake command the RMP shall be reinitialised using the current position of the train as the new reference location.

3.14.3.6 Information received from balises during reverse movement shall be ignored.

3.14.4 Standstill supervision

3.14.4.1 This function shall prevent the train from moving.

3.14.4.2 When a movement is detected, the brake command shall be triggered after a distance specified by the national value.

3.14.4.3 Refer to section 3.14.1.

3.14.4.4 After revocation of the brake command the standstill supervision shall be re-initialised.

3.14.4.5 If a cab is active, an indication shall be given to the driver showing when the Standstill Supervision is commanding the brakes.

3.15 Special functions

3.15.1 RBC/RBC Handover

3.15.1.1 Introduction

3.15.1.1.1 The RBC/RBC Handover principles are such that trains are able to pass from one RBC area to another automatically (without driver action).

3.15.1.1.2 This is also granted when, due to a failure in the on-board radio communication system, the on-board is no longer able to manage two communication sessions at once. Thereby, the behaviour of the RBCs is independent from such on-board degraded situation.

3.15.1.1.3 However, an RBC/RBC handover performed by a train with only one communication session available may result in performance penalties since it will not be able to "prepare" (session establishment, version determination, …) the expected supervision by the Accepting RBC until the on-board disconnects from the Handing Over RBC.

3.15.1.1.4 In level 3, trains following the one with only one communication session available will always suffer performance penalties since no more position reports will be issued from the disconnection from the Handing Over RBC until the connection to the Accepting RBC.

3.15.1.2 Handing Over RBC

3.15.1.2.1 When the Handing Over RBC detects that a route is set for a train to enter another RBC area, it shall send:

a) Intentionally deleted.

b) To the Accepting RBC the following information:

- The ETCS identity of the on-board equipment;
- The border location that will be passed by the train when entering the Accepting RBC area;
- Current mode of the on-board equipment;
- For a leading engine, Train Data and Train Running Number;
- The system versions supported by the on-board equipment;
- Optionally, for a non-leading engine, the ETCS identity of the leading engine.

3.15.1.2.2 The Handing Over RBC shall not send information to an on-board equipment concerning the route in advance of the border without receiving the corresponding information from the Accepting RBC.

3.15.1.2.3 It shall be possible for the Handing Over RBC to request route related information from the Accepting RBC, limited to a maximum amount of data.

3.15.1.2.3.1 Route related information is :

a) Movement authorities

b) Linking

c) International static speed profiles

d) Axle Load Speed profiles

e) Gradients

f) Temporary speed restrictions

g) Mode profiles

h) Intentionally deleted

i) Track Conditions

j) Level Transition orders

k) Intentionally deleted

l) Route Suitability Data

m) National Values

n) Adhesion Factor

o) Level Crossings

p) Permitted Braking Distance Information

3.15.1.2.3.2 Note: The amount of information to be sent between the RBCs is depending on the implementation trackside.

3.15.1.2.4 Note: Route related information received from the Accepting RBC will be processed by the Handing Over RBC if possible.

3.15.1.2.5 Deleted.

3.15.1.2.6 When the Handing Over RBC receives a position report and detects that the maximum safe front end of the train has passed the border location, it shall inform the Accepting RBC.

3.15.1.2.6.1 Note: This information might be needed to inform the signalman of the Accepting RBC that the train has entered the Accepting RBC area.

3.15.1.2.7 When the Handing Over RBC receives a position report and detects that the minimum safe rear end of the train has crossed the border, it shall send a disconnection order to the on-board equipment.

3.15.1.2.8 When the Accepting RBC informs the Handing Over RBC that it has taken over the responsibility, the latter shall stop sending route related information to the on-board equipment.

3.15.1.2.9 When the Handing Over RBC detects that the transition to the Accepting RBC has to be cancelled, it shall send this cancellation information to the Accepting RBC (including the train identification).

3.15.1.2.9.1 Note: For instance, the cancellation procedure can be triggered by:

- Change to a route which does no more include the border;
- The sending of an “end of mission” information from the on-board equipment.

3.15.1.3 On-board equipment

3.15.1.3.1 When receiving an order to switch to another RBC at a given location, the on-board equipment shall:

a) Establish the communication session with the Accepting RBC;

b) Send a position report to the Handing Over RBC when the maximum safe front end of the train passes the given location;

c) Send a position report to the Handing Over RBC when the minimum safe rear end of the train passes the given location;

3.15.1.3.2 Exception to 3.15.1.3.1 a) (degraded situation): If the on-board equipment is able to handle only one communication session at a given time, it shall wait until the session with the Handing over RBC is terminated due to crossing the border and then establish the session with the Accepting RBC.

3.15.1.3.3 As soon as the on-board equipment has established the session with the Accepting RBC, it shall send its Train Data unless it is in sleeping or non leading mode.

3.15.1.3.4 When the on-board equipment is connected to both RBCs, it shall send its position reports to both of them with the use of the position report parameters valid for the Handing Over RBC.

3.15.1.3.4.1 If the on-board equipment is connected to both RBCs, and it executes an End of Mission, it shall execute the End of Mission procedure with both RBCs

3.15.1.3.5 As soon as the on-board sends a position report directly to the Accepting RBC with its maximum safe front end having passed the border, it shall use information received from the Accepting RBC and only a disconnection order shall be accepted from the Handing Over RBC.

3.15.1.3.5.1 Intentionally deleted.

3.15.1.3.6 While both communication sessions are opened, if information is received from the Accepting RBC before a position report is sent to the Accepting RBC with the maximum safe front end having passed the border, this information shall be stored on-board.
Exception: The acknowledgement of Train Data shall be immediately accepted by the on-board equipment.

3.15.1.3.6.1 Note: for the exhaustive list of accepted/rejected information, please refer to Chapter 4 Use of received information.

3.15.1.3.7 When the train front end passes the announced border or when an order to execute the RBC transition immediately is received, the on-board shall substitute the current valid RBC ID/phone number with those of the Accepting RBC.

3.15.1.3.8 After this substitution, the on-board shall however retain the RBC ID/phone number of the Handing Over RBC until at least one of the following conditions is fulfilled:

a) Min safe rear end of the train has passed the border and the communication session with this Handing Over RBC has been terminated,

b) The RBC transition order is deleted according to A.3.4 or 4.10.

3.15.1.3.8.1 Note: Even after the train front end has passed the border, the on-board may have to maintain the communication session with the Handing Over RBC (see 3.5.4) or re-establish it (see 3.5.3.4 f)) and needs therefore to remember the RBC ID/phone number of this RBC.

3.15.1.3.9 In case the ERTMS/ETCS on-board equipment has reported that the train has passed with its min safe rear end the announced border and no order to terminate the session is received from the Handing Over RBC within a fixed waiting time (see Appendix A.3.1) from the time the position report was sent, it shall repeatedly send a position report with the fixed waiting time after each repetition, until the order to terminate the session is received, or the defined number of repetitions (see Appendix A.3.1) has been reached. If no reply is received within the fixed waiting time after the last repetition, the ERTMS/ETCS on-board equipment shall terminate the communication session with the Handing Over RBC.

3.15.1.4 Accepting RBC

3.15.1.4.1 The Accepting RBC shall keep route related information sent to the Handing Over RBC updated. In particular, this possibly includes temporary speed restrictions.

3.15.1.4.2 As soon as the Accepting RBC receives from the on-board equipment a position report and detects that the maximum safe front end of the train has passed the border, it shall inform the Handing Over RBC that it has taken over the responsibility.

3.15.1.4.3 When the Accepting RBC receives Train Data from both the on-board equipment and the Handing over RBC Train Data provided by the on-board equipment shall take precedence.

3.15.1.4.4 If the Accepting RBC receives a cancellation information from the Handing Over RBC, it shall send an order to terminate the communication session to the corresponding on-board equipment (if already established).

3.15.1.4.5 The Accepting RBC shall comply with the maximum amount of data contained in the last received route related information request from the Handing Over RBC.

3.15.1.5 RBC/RBC message acknowledgement

3.15.1.5.1 As soon as a consistent RBC/RBC message including the request for acknowledgement is received, the receiving RBC shall send an acknowledgement to the emitting RBC.

3.15.1.5.2 The RBC/RBC message is consistent when all checks have been completed successfully:

a) It has passed the checks performed by the RBC/RBC Safe Communication Interface protocol (see SUBSET-098);

b) Variables in the message do not have invalid values.

3.15.1.5.3 The acknowledgement message shall refer to the identity of the concerned message sent by the emitting RBC.

3.15.2 Handling of Trains with Non Leading Engines

3.15.2.1 It is possible to operate a train using more than one engine, each engine being under the control of a driver.

3.15.2.2 Only the leading engine is responsible for the train movement supervision functions.

3.15.3 Splitting/joining

3.15.3.1 ERTMS/ETCS allows Splitting and Joining using the normal supervision functions available (e.g. On-sight, Shunting).

3.15.3.2 Splitting only refers to the case that the two resulting trains contain at least one ERTMS/ETCS on-board equipment each.

3.15.3.2.1 Note: This must be ensured by operational procedures.

3.15.3.3 ERTMS/ETCS is not responsible for providing information that a Splitting/Joining operation has been correctly completed (technical aspect and/or operational aspect).

3.15.3.4 Justification: ERTMS/ETCS is not able to provide this information. Splitting and Joining requires the fulfilment of operating rules ensuring that a Splitting/Joining operation has been correctly completed (e.g. physical disconnection).

3.15.4 Reversing of movement direction

3.15.4.1 It shall be possible to send in advance to an on-board equipment information about areas, where initiation of reversing of movement direction is possible, i.e. change the direction of train movement without changing the train orientation.

3.15.4.1.1 A new reversing area given from the trackside shall replace the one already available on-board.

3.15.4.2 Together with start and end of reversing area, the following supervision information shall be sent:

a) Maximum distance to run in the direction opposite to the orientation of the reversing area, the fixed reference location being the end location of the area where reversing of movement is permitted with which the maximum distance information is sent.

b) Reversing mode speed limit allowed during reverse movement.

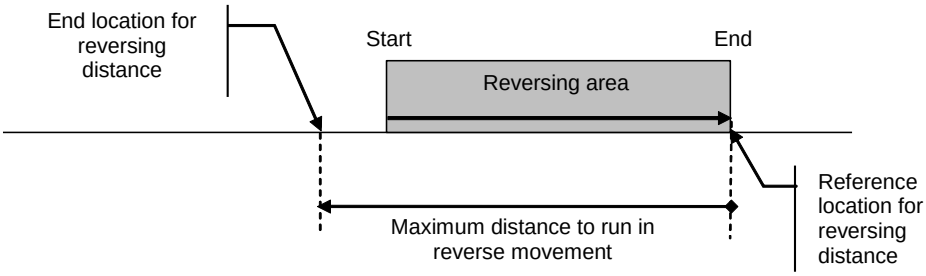


Figure 57: Reversing area and maximum distance to run

3.15.4.2.1 The ERTMS/ETCS on-board equipment shall use as fixed reference location for reversing distance the end location of the reversing area with which the maximum distance information is received. This fixed reference location shall remain unchanged until a new reversing area is received.

3.15.4.2.1.1 Example 1: If a closer SvL is defined, see Appendix A.3.4 for a complete list of situations, the reversing area is deleted beyond the new SvL. The reference location for the distance to run in the direction opposite to the reversing area remains fixed at its original position.

3.15.4.2.1.2 Example 2: the fixed reference location remains also unchanged in case of update of distance to run in reverse movement without receiving a new reversing area.

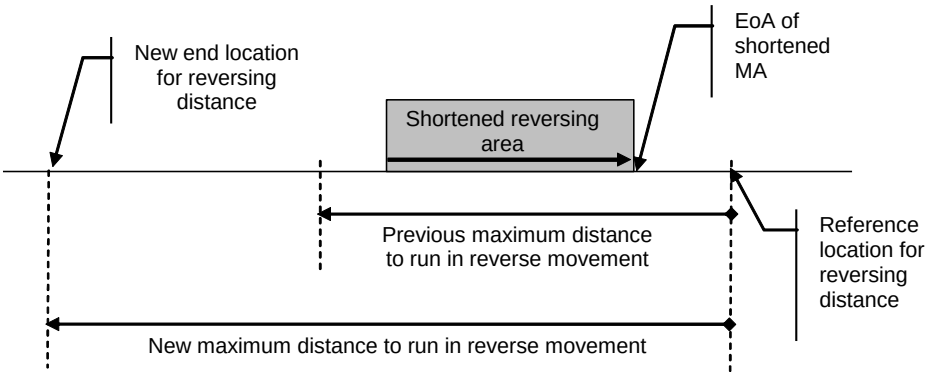


Figure 58: Influence of a shortened Movement Authority and of a renewal of the maximum distance to run

3.15.4.2.2 Note: All locations refer to the estimated front end of the train (refer to clause 3.6.4.6).

3.15.4.3 New distance to run and Reversing mode speed limit given from the trackside shall replace the one already available on-board.

3.15.4.3.1 Intentionally deleted.

Figure 59: Intentionally deleted

3.15.4.4 While at standstill with the front end of the train inside the indicated area, it shall be possible for the driver to reverse the direction of movement.

3.15.4.5 The on-board equipment shall allow movement in the direction opposite to the train orientation, supervising it according to distance and speed received.

3.15.4.6 Note: level transitions and RBC/RBC handovers are not handled by the ERTMS/ETCS on-board equipment when in Reversing mode.

3.15.4.7 When at standstill the on-board equipment shall inform the driver if the reversing of movement is permitted.

3.15.4.8 If the end location of the maximum distance to run in the opposite direction is passed by the train front end, the emergency brake command shall be triggered.

3.15.5 Track ahead free

3.15.5.1 In a level 2/3 area, the ERTMS/ETCS on-board equipment is able to handle a track ahead free request given by the RBC.

3.15.5.2 The track ahead free request from the RBC shall indicate to the on-board

a) at which location the ERTMS/ETCS on-board equipment shall begin to display the request to the driver.

b) at which location the ERTMS/ETCS on-board equipment shall stop to display the request to the driver (in case the driver did not acknowledge).

3.15.5.3 As long as it is displayed, the driver has the possibility to acknowledge the track ahead free request (meaning the driver confirms that the track between the head of the train and the next signal or board marking signal position is free).

3.15.5.4 When the driver acknowledges, the ERTMS/ETCS on-board equipment shall stop displaying the request, and shall inform the RBC that the track ahead is free.

3.15.5.5 There is no restrictive consequence by the on-board system if the driver does not acknowledge.

3.15.5.6 A new track ahead free request shall replace the one previously received and stored.

3.15.6 Handling of National Systems

3.15.6.1 The ERTMS/ETCS on-board supports driving on national infrastructure under the supervision of National Systems.

3.15.6.2 In case the ERTMS/ETCS on-board equipment is interfaced to a National System through an STM, refer to Subset 035 for detailed requirements.

3.15.6.2.1 Intentionally deleted.

3.15.6.3 Intentionally deleted.

3.15.6.4 Intentionally deleted.

3.15.6.5 Amongst the data to be used by applications outside ERTMS/ETCS that can be transmitted by trackside over the ERTMS/ETCS transmission channels, it shall be possible to send from balises or RBC data to be forwarded to a National System.

3.15.6.5.1 Note: Definition of what qualifies as “data to be forwarded to a National System” is national dependent and outside the scope of Subset 026.

3.15.7 Tolerance of Big Metal Mass

3.15.7.1 Big metal object in the track, exceeding the limits for big metal masses as defined in Subset-036, section 6.5.2 “Metal Masses in the Track” may trigger an alarm reporting a malfunction for the onboard balise transmission function.

3.15.7.2 In Levels 0/NTC, the alarms which may be triggered by metal masses shall be ignored for a defined distance (see A.3.1). If the alarm persists for a longer distance the ERTMS/ETCS on-board equipment shall trigger a safety reaction.

3.15.7.3 Justification: Ignoring the alarm for a defined distance eliminates the need to equip all excessive big metal masses with track condition “Big Metal Mass” outside ETCS fitted areas.

3.15.8 Cold Movement Detection

3.15.8.1 After being switched off (i.e. once in No Power mode), the ERTMS/ETCS on-board equipment shall be capable, if fitted with, to detect and record whether the engine has been moved or not, during a period of at least 72 hours.

3.15.8.2 When powered on again, the ERTMS/ETCS on-board equipment shall use, if available, the memorised information about cold movement in order to update the status of information stored by on-board equipment (see chapter 4 section 4.11 for details).

3.15.8.3 Note: information memorised by Cold Movement Detection function is considered as not available if:

a) no Cold Movement Detection function is implemented in the ERTMS/ETCS on-board equipment, OR

b) the Cold Movement Detection function has encountered a condition, during the No Power period, which prevents the use of the Cold Movement information (e.g. the battery ensuring the Cold Movement Detection function has run down during the No Power period).

3.15.9 Virtual Balise Cover

3.15.9.1 It shall be possible to set and remove from balise a Virtual Balise Cover (VBC). A VBC is defined by:

a) A marker corresponding to balises to be ignored by the on-board together with the area (country or region) in which the VBC is applicable. The VBC marker and the country/region identity form the unique VBC identity.

b) Its validity period.

3.15.9.2 During a start of mission, the driver shall have the opportunity to set a new VBC, or to remove an existing one.

3.15.9.3 As long as a VBC is stored on-board:

a) The ERTMS/ETCS on-board equipment shall ignore any balise telegram that includes a VBC marker and a country/region identity that both match the VBC identity.

b) No reaction shall be applied if errors in the reading of the rest of such balise telegram occur.

3.15.9.4 If the ERTMS/ETCS on-board equipment receives from balise or from driver a new VBC with the same VBC identity as an already stored VBC, the new VBC shall replace the previous one, including its validity period.

3.15.9.5 A VBC shall be retained on-board when the on-board equipment is switched off (i.e. enters No Power mode) and shall remain applicable when powered on again. It shall be deleted when:

a) it is ordered by trackside, or

b) its validity period has elapsed, or

c) it is removed by the driver (during Start of Mission), or

d) a mismatch is detected between the country/region identity read from a balise group and the country/region identity of the VBC. Note: this means that the reception of a consistent balise group message is a necessary condition for deleting a VBC due to mismatching country/region identities.

3.15.10 Advance display of route related information

3.15.10.1 The ERTMS/ETCS on-board equipment shall display an overview of the gradient profile (as received from trackside), of the MRSP, of the track conditions (except the tunnel stopping areas), of the first Indication location, if any (only in Ceiling Speed monitoring), and of the EOA/LOA, with the remaining distances referred to the train front end position.

3.15.10.2 With regards to the MRSP, the track conditions and the EOA/LOA, the remaining distances shall be computed taking into account the min safe, the estimated or the max safe train front end position depending on their respective supervision.

3.15.10.3 With regards to the gradient profile, the remaining distances shall be computed taking into account the estimated train front end position.

3.15.10.3.1 With regards to the first Indication location, the remaining distance shall be computed as specified in clauses 3.13.10.3.8 and 3.13.10.3.8.1.

3.15.10.4 The overview of route related information shall be restricted to the elements contained within the movement authority and up to the first target at zero speed, if any.

3.16 Data Consistency

3.16.1 Criteria of consistency

3.16.1.1 The on-board shall not consider a message transmitted from the trackside if any of the following criteria is not fulfilled.

a) Correctness of the received message: the whole message shall be complete and respect the ETCS language; variables shall not have invalid values

b) The message shall be received in due time.

c) The message shall be received at the right expected location.

3.16.1.1.1 Regarding a): a value of a variable is invalid when a spare value is used.

3.16.2 Balises

3.16.2.1 Definitions

3.16.2.1.1 The information that is sent from a balise is called a balise telegram.

3.16.2.1.2 The whole set of information (balise telegram or telegrams) coming from a balise group is called a balise group message.

3.16.2.1.2.1 Note: In case of a balise group containing a single balise, telegram and message coincide.

3.16.2.1.3 Intentionally deleted.

3.16.2.2 General

3.16.2.2.1 If the on-board is not able to recognise whether a balise group is linked or unlinked (if none of the balises in the balise group can be read correctly), it shall consider it as unlinked.

3.16.2.2.2 A balise within a balise group shall be regarded as missed if

a) No balise is found within the maximum distance between balises from the previous balise in the group.

or

b) A following balise within the group has been passed.

3.16.2.3 Linking Consistency

3.16.2.3.1 If linking information is used the on-board shall react according to the linking reaction information in the following cases:

a) If the location reference of the expected balise group is found in rear of the expectation window

b) If the location reference of the expected balise group is not found inside the expectation window (i.e. the end of the expectation window has been reached without having found the expected balise group)

c) If inside the expectation window of the expected balise group another announced balise group, expected later, is found.

3.16.2.3.1.1 The ERTMS/ETCS on-board equipment shall reject the message from a balise group found with its location reference outside its expectation window.

3.16.2.3.2 The on-board shall reject the message from the expected group and trip the train if the balise group is passed in the unexpected direction.

3.16.2.3.2.1 Exception: When the expected balise group is referred in the linking information with a balise group with ID “unknown”, 3.4.4.4.2.1 shall apply.

3.16.2.3.3 If the location reference balise of the group is duplicated and the on-board is only able to correctly evaluate the duplicating one, the duplicating one shall be used as location reference instead.

3.16.2.3.4 If the balise duplicating the location reference balise is used as location reference for the group, and is found within the expectation window, no linking reaction shall be applied.

3.16.2.4 Balise Group Message Consistency

3.16.2.4.1 If linking information is used, the on-board shall reject the message from a linked balise group found in the expected location and react according to the linking reaction in the following cases:

a) A balise is missed inside the group.

b) A balise is detected but no telegram is decoded (e.g. wrong CRC,...).

c) Variables in the balise group message have invalid values.

d) Message counters do not match (see 3.16.2.4.7)

3.16.2.4.2 Exception: Concerning a) and b) above, the ERTMS/ETCS on-board equipment shall not reject the message and shall not apply the linking reaction if the balise not found, or not decoded, is duplicated within the balise group and the duplicating one is correctly read.

3.16.2.4.3 If linking information is used, the on-board shall reject the message from a balise group marked as linked but not included in the linking information. No reaction shall be applied, even if errors in the reading of the balise group occur.

3.16.2.4.4 If no linking information is used, the on-board shall reject the message from a balise group marked as linked and command application of the service brake in the following cases:

a) A balise is missed inside the group.

b) A balise is detected, but no telegram is decoded (e.g. wrong CRC).

c) Variables in the balise group message have invalid values.

d) Message counters do not match (see 3.16.2.4.7)

3.16.2.4.4.1 Exceptions: Concerning a) and b) of clause 3.16.2.4.4, the ERTMS/ETCS on-board equipment:

a) shall not reject the message and shall not command application of the service brake if the balise not found, or not decoded, is duplicated within the balise group, the duplicating one is correctly read and contains:
   - directional information while the orientation of the balise group can still be evaluated, or
   - only information valid for both directions, or
   - neither directional information nor information valid for both directions, or
   - only data to be used by applications outside ERTMS/ETCS, or
   - only data to be used by applications outside ERTMS/ETCS together with other information valid for both directions.

b) shall not command application of the service brake if the telegram correctly read from another balise of the group contains the information “Inhibition of balise group message consistency reaction”.

3.16.2.4.4.2 Concerning clause 3.16.2.4.4, if the service brake is applied, the location based information stored on-board shall be shortened to the current position when the train has reached standstill. Refer to appendix A.3.4 for the exhaustive list of information, which shall be shortened.

3.16.2.4.4.3 Concerning clause 3.16.2.4.4, if the service brake is applied, the driver shall be informed that this is due to a balise group message consistency problem.

3.16.2.4.5 A message counter shall be attached to each balise telegram indicating which balise group message the telegram fits to.

3.16.2.4.6 Instead of a message counter corresponding to a given balise group message, it shall be possible to identify a telegram as always fitting all possible messages of the group.

3.16.2.4.6.1 It shall also be possible to identify a telegram as never fitting any message of the group.

3.16.2.4.7 Comparing message counters of the received telegrams of a balise group message, excluding the ones complying with 3.16.2.4.6 and the ones that are not used by the on-board to compose the message (see 3.16.2.4.8.2), if their values are not all identical, or at least one of them complies with 3.16.2.4.6.1, this shall be considered as a message consistency error.

3.16.2.4.7.1 In case of single balise group, if the message counter of the received telegram complies with 3.16.2.4.6.1, this shall also be considered as a message consistency error.

3.16.2.4.8 It shall be possible to indicate failures in the system underlying the balise/loop/RIU (e.g. the Lineside Electronic Unit, LEU) by sending a balise telegram, a loop message or a RIU message including the information "default balise/loop/RIU information".

3.16.2.4.8.1 If one (and only one) out of a pair of duplicated balise telegrams received by the on-board includes the information “default balise information”, the on-board shall ignore any other information included in this telegram and shall consider information from the telegram not containing “default balise information".

3.16.2.4.8.2 When duplicated balises are both found and decoded correctly, and both, or none of them, contain "default balise information", the ERTMS/ETCS on-board equipment shall compose the message using the telegram from the last received balise out of the pair.

3.16.2.4.9 If a message has been received containing the information "default balise information", the driver shall be informed.

3.16.2.5 Unlinked Balise Group Message Consistency

3.16.2.5.1 An on-board equipment shall reject the message received from a balise group marked as unlinked and command application of the service brake in the following cases:

a) A balise is missed inside the unlinked balise group.

b) A balise is detected, but no telegram is decoded (e.g. wrong CRC).

c) Variables in the balise group message have invalid values.

d) Message counters do not match (see 3.16.2.4.7)

3.16.2.5.1.1 Exceptions: Concerning a) and b) of clause 3.16.2.5.1, the ERTMS/ETCS on-board equipment:

a) shall not reject the message and shall not command application of the service brake if the balise not found, or not decoded, is duplicated within the balise group, the duplicating one is correctly read and contains:

- directional information while the orientation of the balise group can still be evaluated, or
- only information valid for both directions, or
- neither directional information nor information valid for both directions, or
- only data to be used by applications outside ERTMS/ETCS, or
- only data to be used by applications outside ERTMS/ETCS together with other information valid for both directions.

b) shall not command application of the service brake if the telegram correctly read from another balise of the group contains the information “Inhibition of balise group message consistency reaction”.

3.16.2.5.2 Concerning clause 3.16.2.5.1, if the service brake is applied, the location based information stored on-board shall be shortened to the current position when the train has reached standstill. Refer to appendix A.3.4 for the exhaustive list of information, which shall be shortened.

3.16.2.5.3 Concerning clause 3.16.2.5.1, if the service brake is applied, the driver shall be informed that this is due to a balise group message consistency problem.

3.16.2.6 Linking Reactions

3.16.2.6.1 When the linking reaction leads to train trip or a service brake application, the driver shall be informed that the intervention is due to data consistency problem with the expected balise group.

3.16.2.6.2 If the service brake is initiated due to the linking reaction, the location based information stored on-board shall be shortened to the current position when the train has reached standstill. Refer to appendix A.3.4 for the exhaustive list of information, which shall be shortened.

3.16.2.7 RAMS related supervision functions

3.16.2.7.1 Mitigation of balise reception degradation

3.16.2.7.1.1 If 2 consecutive linked balise groups announced by linking are not detected and the end of the expectation window of the second balise group has been passed, the ERTMS/ETCS on-board shall command the service brake and the driver shall be informed. At standstill, the location based information stored on-board shall be shortened to the current position. Refer to appendix A.3.4 for the exhaustive list of information, which shall be shortened.

3.16.2.7.2 Mitigation of balise cross-talk while expecting repositioning information

3.16.2.7.2.1 If repositioning is announced and the expected repositioning balise group has been found, the ERTMS/ETCS on-board equipment shall keep looking for a balise group that satisfies the same criteria as this previously expected and already found repositioning balise group, until one of the following events occurs:

a) the on-board antenna leaves the expectation window of the repositioning balise group that was announced and already found

b) a linked balise group that has been announced with known identity is found.

3.16.2.7.2.2 If a second balise group is found that satisfies the same criteria as the previously expected and already found repositioning balise group, the ERTMS/ETCS on-board equipment shall command the service brake and the driver shall be informed. At standstill, the location based information stored on-board shall be shortened to the current position. Refer to appendix A.3.4 for the exhaustive list of information, which shall be shortened.

3.16.2.7.2.3 Note: this function is independent from linking function, i.e. the rules related to linking always apply. This means that once a repositioning balise group has been found and if this latter contains new linking information, the ERTMS/ETCS on-board equipment will start expecting the first balise group announced in this new linking information in parallel with the monitoring specified in 3.16.2.7.2.1.

3.16.3 Radio

3.16.3.1 General issues

3.16.3.1.1 A radio message is consistent when all checks have been completed successfully:

a) Checks performed by Euroradio protocol have been passed (see Subset-037)

b) Time stamps checks have been passed (see 3.16.3.3.3)

c) Variables in the messages do not have in-valid values.

3.16.3.1.1.1 The on-board shall reject a message transmitted from the trackside if the message is not consistent.

3.16.3.1.1.2 The on-board shall inform the trackside if a not consistent message is received.

3.16.3.1.2 Emergency messages shall be transmitted either as high priority data or as normal priority data.

3.16.3.1.3 Other messages shall be sent as normal priority data.

3.16.3.1.3.1 Messages shall only be accepted when received with the data priority for which they are specified.

3.16.3.1.4 The chapters 3.16.3.2 to 3.16.3.5 define data consistency principles and corresponding checks for data transmitted as normal priority data. For high priority data, the checks shall not apply.

3.16.3.2 Time stamping

3.16.3.2.1 The trackside shall always transmit its information with reference to the train time.

3.16.3.2.2 To time-stamp its messages, the trackside shall make a safe estimation of the on-board time, based on the time-stamp of the received messages and the internal processing times. The estimation shall be made in such a way that the on-board time estimated by the trackside shall not be in advance of the real on-board time.

3.16.3.2.3 Wrap around of the onboard timer can occur during a communication session and shall have no impact on system behaviour.

3.16.3.3 Supervision of Sequence

3.16.3.3.1 The trackside shall time-stamp a message with a value corresponding to the time of sending.

3.16.3.3.2 There shall always be a time stamp increment between consecutive messages.

3.16.3.3.3 If the time stamp of the last received message is lower than or equal to the former one its content shall not be used.

3.16.3.3.3.1 Only time stamps of messages received as normal priority data shall be used.

3.16.3.3.3.2 Note: The supervision does not detect a lost message. This has to be assured by means of the “acknowledge” function.

3.16.3.3.4 Intentionally deleted.

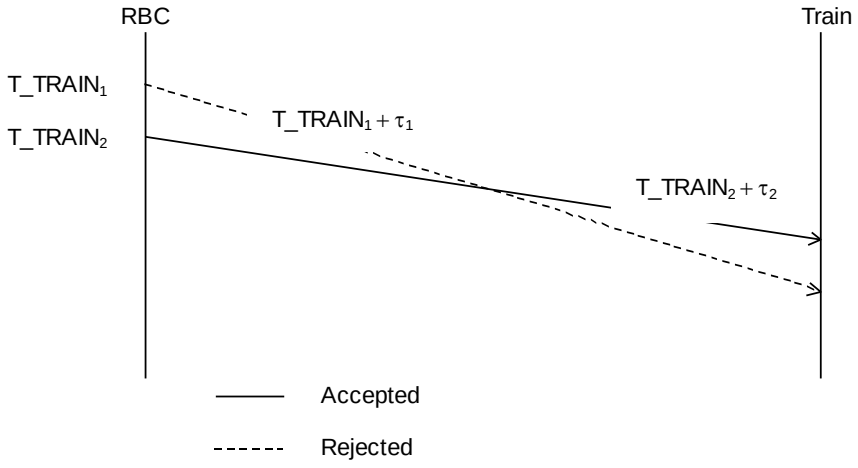


Figure 60: Supervision of sequence

3.16.3.4 Supervision of safe radio connection

3.16.3.4.1 When the difference between the time stamp of the latest consistent received message and the current on-board time is greater than the T_NVCONTACT parameter (national value), the on-board shall apply the reaction required by trackside (see 3.16.3.4.2).

3.16.3.4.1.1 After the on-board equipment has switched to L2 or 3 with no communication session established, the current onboard time shall be compared with the on-board time at the moment of the level transition (instead of the time stamp of the latest consistent received message) until a new consistent message has been received.

3.16.3.4.1.2 When an RBC/RBC handover has been announced, the current onboard time shall be compared with the time stamp of the latest consistent message from the Handing over RBC until the train considers the Accepting RBC as the supervising one (refer to 3.15.1.3.5). From then on the current onboard time shall be compared with the time stamp of the latest received consistent message from the Accepting RBC.

3.16.3.4.1.3 As long as the train front end is inside an announced radio hole, the ERTMS/ETCS on-board equipment shall stop the supervision of the safe radio connection. Afterwards, until a new consistent message has been received, the current onboard time shall be compared with the on-board time when the train front end left the radio hole (instead of the time stamp of the latest consistent received message).

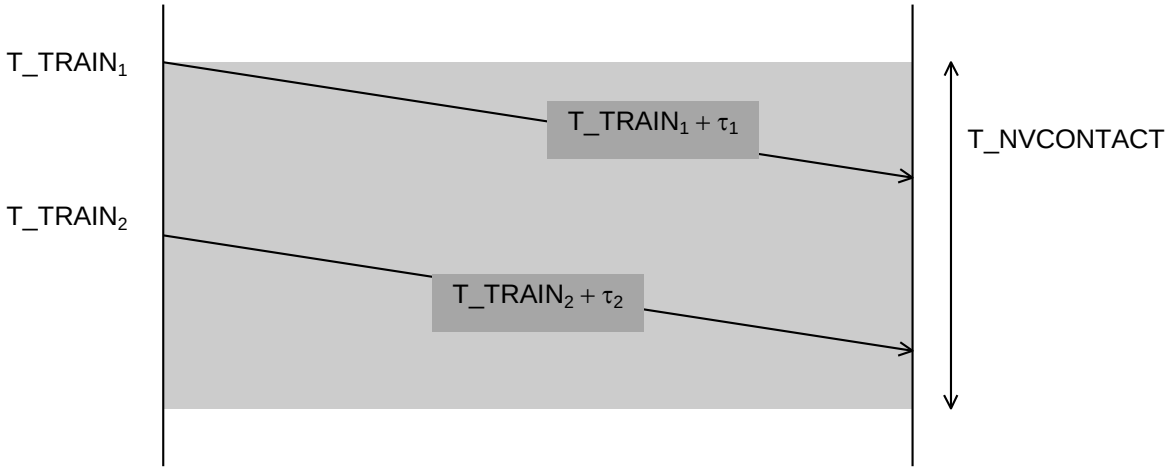


Figure 61: Supervision of the safe radio connection (Message received within the Window)

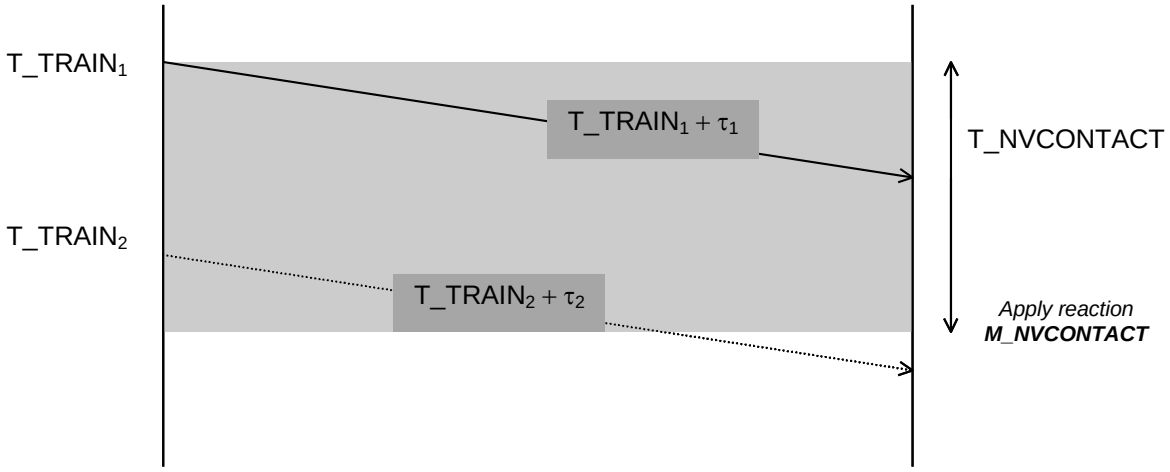


Figure 62: Supervision of the safe radio connection (No message received within the Window)

3.16.3.4.2 It shall be possible to select one of the following reactions (National value) :

a) Train trip

b) Apply service brake

c) No reaction

3.16.3.4.3 For all reactions, if no new consistent message has been received after an additional delay time (as defined in A.3.1), the on-board shall release the safe radio connection and then set-up it again (maintaining the communication session).

3.16.3.4.4 When the reaction leads to train trip or a service brake application, the driver shall be informed that no safe radio message has been received in due time.

3.16.3.4.5 If the service brake is initiated, the following reaction shall be taken;

a) For brake command release conditions refer to section 3.14.1.7.

b) If no new consistent message is received until the train reaches standstill, the location based information stored on-board shall be shortened to the current position. Refer to appendix A.3.4 for the exhaustive list of information, which shall be shortened.

3.16.3.4.6 Intentionally deleted.

3.16.3.4.7 To avoid the expiration of the on-board timer and if no new information is needed to be sent, the RBC shall send an empty message.

3.16.3.5 Message Acknowledgement

3.16.3.5.1 As soon as a consistent message (see 3.16.3.1.1) including the request for acknowledgement is received, the on-board shall send an acknowledgement to the trackside.

3.16.3.5.1.1 Note: In order to ensure trackside that the on-board has correctly received transmitted information, the RBC may ask the on-board to acknowledge.

3.16.3.5.2 Intentionally deleted

3.16.3.5.3 The acknowledgement message shall refer to the identity of the concerned message sent by the RBC.

3.16.3.5.4 Intentionally deleted.

3.16.4 Error reporting to RBC

3.16.4.1 In level 2/3, if a radio communication session is established, errors shall be reported as soon as the availability of a safe radio connection permits.

3.16.4.2 This refers to balise group errors and radio message errors regardless if there is an error reaction.

3.16.4.3 If linking information is used on-board, no error reporting shall be done for balise groups marked as linked but not included in the linking information.

3.17 System Version Management

3.17.1 Introduction

3.17.1.1 Definitions, high level principles and rules regarding the offline management of ERTMS/ETCS system version during the ERTMS/ETCS system life time are given in SUBSET-104.

3.17.1.2 The objective of this section is to define requirements applicable to ERTMS/ETCS on-board equipment and to trackside constituents, when different versions of the ERTMS/ETCS system have been defined.

3.17.1.3 Intentionally deleted.

3.17.2 Determination of the operated system version

3.17.2.1 The on-board equipment shall be able to operate with (i.e. shall support) any of the ERTMS/ETCS system version numbers X included in the envelope of legally operated system versions, as defined in chapter 6.

3.17.2.1.1 Within one of its supported system version numbers X, the on-board equipment shall always operate the highest system version number Y defined in this release of the SRS, regardless of the system version number Y transmitted by the trackside.

3.17.2.2 The on-board equipment shall operate with only one system version at a time, i.e. it shall behave according to the whole set of requirements applicable to a system version (refer to chapter 6 in case the operated system version is older than the last one introduced in this release of the SRS).

3.17.2.3 The on-board equipment shall determine the operated system version number X, in relation to non-RBC trackside constituents, as the system version number X transmitted by any balise, loop or RIU, if this system version number X is higher than the currently operated one.

3.17.2.4 It shall be possible from balise group to order the on-board equipment to operate a system version.

3.17.2.5 On receiving the order to operate system version from balise group, the on-board equipment shall immediately operate the system version number X given in the order. After the order is executed, the requirement 3.17.2.3 shall be again applied for any further received balise telegram/loop message or any further contacted RIU.

3.17.2.5.1 Note: the system version order is to be used wherever it is necessary to enforce an operated system version number X lower than the currently operated one.

3.17.2.6 If a mismatch has been detected between the country or region identifier read from a balise/loop and the corresponding identifier(s) for which a set of national values is used onboard, the on-board equipment shall consider the system version number X transmitted by this balise/loop as the operated one and shall comply again with requirement 3.17.2.3.

3.17.2.7 If the on-board equipment does not support the system version number X transmitted by a non-RBC trackside constituent or the one specified in the balise group order, it shall consider the operated system version as unchanged.

3.17.2.8 In case of communication session established with an RBC, the system version number X of the RBC shall take precedence on the operated system version in relation to non-RBC constituents and on system version ordered from balise group; the operated system version number X shall be determined according to the following principles:

a) if the on-board equipment is in level 0, NTC or 1 (e.g. entrance in level 2/3 area), the RBC system version number X shall be operated when the transition to level 2/3 is executed;

b) if the on-board equipment is in level 2/3 (SoM procedure or order received from trackside), the RBC system version number X shall be operated immediately;

c) in case of session established with an accepting RBC (RBC/RBC Handover), the accepting RBC system version number X shall be operated as soon as the engine has passed the RBC/RBC border location with its maximum safe front end;

d) in case the on-board equipment switches from level 2/3 to another level (e.g. exit from a level 2/3 area), the system version control in relation to non-RBC constituents shall be again applied and the balise group orders shall be again considered;

e) in case the engine passes the RBC/RBC border location with its maximum safe front end and no session is established with the accepting RBC, the system version control in relation to non-RBC constituents shall be again applied and the balise group orders shall be again considered.

3.17.2.9 The system version currently operated when the on-board equipment is switched off (i.e. enters No Power mode) shall be retained and re-used when powered on.

3.17.2.9.1 If the on-board equipment loses the information (failure situation), the highest supported system version shall be used.

3.17.3 Handling of trackside data in relation to system version

3.17.3.1 Every telegram transmitted by a balise, and every message transmitted by Euroloop and Radio Infill Unit shall contain only the data related to one system version. It is not

allowed for the balise, Euroloop and Radio Infill Unit to transmit data correspondent to several system versions.

3.17.3.2 All messages transmitted by an RBC shall contain data only related to one system version.

3.17.3.3 The on-board equipment shall check the system version prior to any further checks (data consistency, ..), as they depend on the system version.

3.17.3.4 Intentionally deleted.

3.17.3.4.1 Intentionally deleted.

3.17.3.4.2 Intentionally deleted.

3.17.3.5 The on-board equipment shall check the ERTMS/ETCS system version number X transmitted by any balise:

a) In all levels, if this system version number X equals to 0, the balise information shall be ignored.

b) In all levels, if this system version number X is different from 0 and lower than the lowest system version number X supported by the on-board equipment, it shall be able to interpret the balise information, to the extent defined for each type of information (see chapter 6 for detailed requirements). If the on-board is not able to interpret the information, this shall be considered as a message consistency error.

c) In all levels, if this system version number X is amongst its supported ones, the on-board equipment shall be able to interpret the balise information. See chapter 6 for detailed requirements.

d) In levels 1, 2 and 3, if this system version number X is greater than the highest version number X supported by the on-board equipment, the information from this balise shall be ignored, the train shall be tripped and an indication shall be given to the driver.

e) In levels 0 and NTC, if this system version number X is greater than the highest version number X supported by the on-board equipment, the information from this balise shall be ignored and no reaction shall be applied.

3.17.3.6 In level 1 the on-board equipment shall check the ERTMS/ETCS system version number X transmitted by any Euroloop found:

a) if this system version number X is lower than the lowest system version number X supported by the on-board equipment, it shall be able to interpret the loop information, to the extent defined for each type of information (see chapter 6 for detailed requirements). If the on-board is not able to interpret the information, this shall be considered as a message consistency error.

b) if this system version number X is amongst its supported ones, the on-board equipment shall be able to interpret the loop information. See chapter 6 for detailed requirements.

c) If this system version number X is greater than the highest version number X supported by the on-board equipment, no reaction shall be applied and the information from this loop shall be ignored.

3.17.3.7 The on-board equipment shall check the ERTMS/ETCS system version number X transmitted the first time any RBC is contacted (including RBC hand over) or any RIU is contacted. Refer to section 3.5.3.7 d) for details.

3.17.3.8 Intentionally deleted.

3.17.3.9 Intentionally deleted.

3.17.3.10 Intentionally deleted.

3.17.3.11 For trackside information only differing by Y with regards to the highest system version number X supported by on-board, the on-board equipment shall not consider the reception of unknown packet/message as a message data consistency error (i.e. use of spare value for NID_PACKET or NID_MESSAGE) and shall ignore the content of the unknown packet/message in the following cases:

a) unknown packet included in a balise telegram/loop message related to the higher system version;

b) unknown radio message from an RBC or RIU operating with the higher system version;

c) unknown packet from an RBC or RIU operating with the higher system version, included in a message in which one or more optional packet can be added according to the version operated by on-board.

3.17.3.12 Intentionally deleted.

3.17.3.12.1 Intentionally deleted.

3.17.3.13 Intentionally deleted.

3.18 System Data

3.18.1 Fixed Values

3.18.1.1 Note: Appendix to chapter 3 contains a list of Fixed values used as system parameters in the supervision. These parameters are system related and can easily be changed in later versions of the ERTMS/ETCS if required. These parameters are not defined as National data.

3.18.2 National / Default Values

3.18.2.1 Note: Appendix to chapter 3 contains list of National and Default Values.

3.18.2.2 Trains shall be supervised according to the National Values of the current infrastructure if they are available on-board.

3.18.2.3 National Values are transmitted with the area(s) (country or region) in which they are applicable. They shall become applicable at a defined location, or shall be applicable immediately.

3.18.2.4 Evaluating a balise group message, the balise identity information referring to the country or region shall be used to ensure that correct National Values are used.

3.18.2.5 For each National Value, the corresponding Default Value shall be used as fall back value if:

- the National Value is not available, or
- a mismatch has been detected between the country or region identifier read from a balise group and the corresponding identifier(s) of the applicable set with which the National Value was received and stored.

3.18.2.6 Note: even though the National Values are always transmitted as a single set for a given system version, the content of a set depends on the system version, so that when a set of National Values is received or becomes applicable, or when passing a balise group, the on-board equipment may apply clause 3.18.2.5 for a subset of National Values

3.18.2.7 The National Values currently applicable when the on-board equipment is switched off (i.e. enters No Power mode) shall be retained and shall remain applicable when powered on.

3.18.2.7.1 Justification: The aim of this requirement is to limit the number of balise groups containing National Value information. Once a set of National Values has been received on-board, there is no need to re-load the information unless National Values change, the on-board equipment loses the information (failure situation), or the train enters an area requiring different National Values.

3.18.2.8 The applicable set of National Values data shall be transmitted from the trackside on transition between areas requiring a different set of National Values.

3.18.2.8.1 When a new set of National Values becomes applicable its content shall always overwrite the corresponding National Values currently applicable regardless of the country or region identifier(s).

3.18.2.9 A previously received set of National Values which is not yet applicable shall be deleted if:

- a new set of National Values is received, or
- the ERTMS/ETCS on-board equipment is switched off (i.e., enters No Power mode).

3.18.2.10 If a National Value becomes invalid, i.e., a mismatch has been detected between the country or region identifier read from a balise group and the corresponding identifier(s)

of the applicable set with which the National Value was received and stored, then it shall be deleted.

3.18.2.11 When a new set of National Values becomes applicable, any ongoing supervision involving an overwritten National Value of type time or distance shall continue, but using the corresponding value from the new set. However, the starting location or starting time shall remain unchanged.

3.18.3 Train Data

3.18.3.1 Train Data can neither be provided nor modified by ERTMS/ETCS trackside equipment.

3.18.3.2 Before starting a mission, the Train Data shall be acquired by the ERTMS/ETCS on-board equipment of a leading engine

a) Train category(ies)

b) Train length

c) Traction / brake parameters:

- Traction model
- Braking models (brake build up time and speed dependent deceleration) or brake percentage
- Brake position
- On-board correction factors
- Nominal rotating mass

d) Maximum train speed

e) Loading gauge

f) Axle load category

g) Traction system(s) accepted by the engine

h) Train fitted with airtight system

i) List of National Systems available on-board

j) Intentionally deleted

k) Axle number

3.18.3.2.1 The Train Data may come from ERTMS/ETCS external sources (e.g. the Train Interface), from pre-configured values or from the driver.

3.18.3.2.2 Exception: The driver shall never be involved in the entry/ modification/validation of the Train Data “Traction system(s) accepted by the engine”, “List of National Systems available on-board” and “Axle number”.

3.18.3.2.3 The unit, range and resolution of the Train Data that can be directly entered by the driver shall be as specified in A.3.11.

3.18.3.3 At standstill, it shall be possible for the driver to enter, modify and revalidate the Train Data that requires driver validation according to the specific train implementation.

3.18.3.3.1 In normal operation after the start of mission, if a train movement is detected while the driver is modifying or revalidating the Train Data, the ERTMS/ETCS on-board equipment shall trigger the brake command.

3.18.3.4 Following any entry/modification of Train Data when a communication session is already established or following the successful establishment of a communication session when valid Train Data are already available (e.g. when approaching a level 2/3 area or an accepting RBC area), the ERTMS/ETCS on-board equipment of the leading engine shall send the following set of Train Data to the RBC:

a) Train category(ies).

b) Train length.

c) Maximum train speed.

d) Loading gauge.

e) Axle load category.

f) Traction system(s) accepted by the engine.

g) Train fitted with airtight system.

h) List of National Systems available on-board

i) Axle number

3.18.3.4.1 The RBC shall acknowledge the reception of this set of Train Data.

3.18.3.4.2 In case the safe radio connection is lost before the acknowledgement is received, the Train Data shall be sent again once the safe radio connection has been re-established within the ongoing communication session.

3.18.3.5 Intentionally deleted.

3.18.3.6 For modification of Train Data, which is/are affected by a change of input information from the ERTMS/ETCS on-board equipment external interface, refer to procedure "Changing Train Data from sources different from the driver" described in section 5.17.

3.18.3.7 In case the Train Data regarding train category, axle load category, loading gauge or traction system has been changed and the train is at standstill:

a) the location based information stored on-board shall be shortened to the current position of the train. Refer to appendix A.3.4 for the exhaustive list of information, which shall be shortened.

b) the stored MA, linking and track description, which have been received from the RBC after a level 2/3 transition or a RBC transition for a further location has been ordered, shall be deleted.

3.18.3.8 In case the Train Data regarding train length has been increased, the currently used track description, if any, shall be considered as unknown in rear of the former min safe rear end of the train.

3.18.4 Additional Data

3.18.4.1 Driver ID

3.18.4.1.1 The driver ID shall be used to identify the responsible person for operating an active desk.

3.18.4.1.1.1 Note: This data is used for recording purposes only.

3.18.4.1.2 If allowed by a National value, it shall be possible for the driver to change driver ID while the train is running.

3.18.4.1.3 It shall be possible to enter driver ID also in a non-leading engine.

3.18.4.1.4 The unit, range and resolution of the driver ID shall be as specified in A.3.11.

3.18.4.2 ERTMS/ETCS Level

3.18.4.2.1 The driver shall have the possibility to enter the ERTMS/ETCS level during a start of a mission.

3.18.4.2.2 The ERTMS/ETCS level information is required for train operation except sleeping mode.

3.18.4.2.3 In normal operation after the start of mission the driver shall not have to select the ERTMS/ETCS level (all other level transitions are executed automatically).

3.18.4.2.4 For operational fallback situations: at standstill, the onboard equipment shall allow the driver to change the ERTMS/ETCS level.

3.18.4.2.4.1 Intentionally deleted.

3.18.4.2.5 If the table of supported levels given by trackside is available, the selection of level by the driver shall be limited to those contained in this table. If the table of trackside supported levels is not available, the driver can select any level within a default list configured on-board.

3.18.4.3 Radio data: Network identification / RBC Identification / Telephone Number

3.18.4.3.1 The ERTMS/ETCS on-board equipment shall store one valid RBC identity and telephone number at a time, obtained from the last driver data entry, from the last received order to establish a session with an RBC (excluding RBC transition orders) or from the crossing of a RBC/RBC border (see clause 3.15.1.3.7).

3.18.4.3.1.1 Note: If a valid RBC identity and telephone number is available on-board, no driver data entry is needed to establish a connection to the RBC when performing a start of mission or after a manual level change to level 2/3.

3.18.4.3.2 In level 2/3 only, at standstill, the ERTMS/ETCS on-board equipment shall offer the driver different means to select the RBC contact information (RBC identity and telephone number to be used), for details see step S3, section 5.4, Start of Mission procedure.

3.18.4.3.3 Intentionally deleted.

3.18.4.3.4 If the driver selects “Use of EIRENE short number” to contact the RBC and the communication session is successfully established, the ERTMS/ETCS on-board equipment shall store as valid RBC identity and telephone number, the RBC identity reported by EURORADIO and the EIRENE short number, respectively.

3.18.4.3.4.1 Note: If the short number is re-used by the ERTMS/ETCS on-board equipment (e.g. following a loss of safe radio connection) and does not direct to a RBC with the stored RBC ID, the connection will be terminated (EURORADIO functionality).

3.18.4.3.5 The unit, range and resolution of the RBC identity and telephone number shall be as specified in A.3.11.

3.18.4.3.6 At standstill, the ERTMS/ETCS on-board equipment shall offer the possibility to the driver to modify the Radio Network ID.

3.18.4.4 ETCS Identity

3.18.4.4.1 The ETCS identity of an on-board equipment is made of a single identity number. The ETCS identity of an RBC, balise group, loop or RIU is composed of a country/region identity number and of an identity number within the country/region.

3.18.4.4.2 All on-board equipments in service, balise groups marked as linked, RBC’s, RIU’s, and loops shall be assigned a unique ETCS identity within their respective group.

3.18.4.4.3 The assignment of (unique or not) ETCS identities to balise groups marked as unlinked is the sole responsibility of the entity in charge of the assignment of values (see SUBSET-054), depending on the specific trackside implementation.

3.18.4.5 Train Running Number

3.18.4.5.1 During the Start of Mission, the ERTMS/ETCS on-board equipment of a leading engine shall acquire the train running number from driver input, from the RBC or from other ERTMS/ETCS external sources.

3.18.4.5.2 It shall be possible to enter train running number also in a non-leading engine.

3.18.4.5.3 It shall be possible to change the train running number while running, from driver input, from the RBC or from other ERTMS/ETCS external sources.

3.18.4.5.4 Following any entry/modification of the train running number when a communication session is already established or following the successful establishment of a communication session when valid train running number is already available, the ERTMS/ETCS on-board equipment shall send the train running number to the RBC.

3.18.4.5.4.1 Exception: if the train running number has been received from the RBC, it shall not be sent back to the RBC by the ERTMS/ETCS on-board equipment.

3.18.4.5.5 The unit, range and resolution of the train running number shall be as specified in A.3.11.

3.18.4.6 Adhesion Factor

3.18.4.6.1 The adhesion factor is used to adjust the emergency brake model of the train (see 3.13).

3.18.4.6.2 The adhesion factor may be changed while the train is running.

3.18.4.6.2.1 It shall be possible to update the adhesion factor from trackside and - if permitted by a National value - by the driver. If, following a change of National Values, the update of the adhesion factor is no more permitted to the driver, the adhesion factor previously modified by the driver to slippery rail shall immediately be reset to non slippery rail. Any trackside adhesion profile is not affected.

3.18.4.6.2.2 The adhesion factor shall be sent as profile data from trackside when needed.

3.18.4.6.2.3 The driver shall be informed whether the value of the adhesion factor is “slippery rail”.

3.18.4.6.3 The selection of the adhesion value from trackside or by driver entry shall be limited to the options slippery rail/ non slippery rail.

3.18.4.6.3.1 Intentionally deleted.

3.18.4.6.4 The default value for the adhesion factor shall be the highest value (i.e. not slippery rail).

3.18.4.6.5 Intentionally deleted.

3.18.5 Date and Time

3.18.5.1 Each ERTMS/ETCS on-board equipment shall be able to provide the date (day, month, year) and time (hour, minute, second) in Universal Time Co-ordinated (UTC) and Local Time.

3.18.5.2 The local time shall be presented to the driver, while the UTC shall be used for the juridical data.

3.18.5.3 Deleted.

3.18.6 Data view

3.18.6.1 Outside the context of data entry, the ERTMS/ETCS on-board equipment shall offer the possibility to the driver to view the driver ID, the train running number, the RBC contact information, the radio network ID, the Virtual Balise Cover(s) and the Train Data either modifiable by the driver or modifiable by other ERTMS/ETCS external sources.

3.18.6.2 Only valid data shall be presented to the driver.

3.19 Intentionally deleted

3.20 Juridical Data

3.20.1.1 The on-board recording device of the train is not part of the ERTMS/ETCS on-board equipment.

3.20.1.2 The ERTMS/ETCS on-board equipment shall transmit to the on-board recording device the information that may be used for legal purpose after hazardous situations.

3.20.1.2.1 For details about data messages that shall be transmitted to the on-board recording device and their related triggering events, refer to SUBSET-027.

3.20.1.3 Intentionally deleted.

3.20.1.4 Intentionally deleted.

3.20.1.5 Intentionally deleted.

3.20.1.6 Intentionally deleted.

3.20.1.7 Intentionally deleted.

3.20.1.8 Intentionally deleted.

3.20.1.9 Intentionally deleted.

APPENDIX TO CHAPTER 3

A.3.1 List of Fixed Value Data

Fixed Value Data	Value	Name
The number of times to try to establish a safe radio connection.	3 times	
Repetition of radio messages (i.e. excluding the first sending)	3 times	
Waiting time before radio message repetition	15 s	
Speed difference between Permitted speed and Emergency Brake Intervention supervision limits, minimum value	7.5 km/h	dV_ebi_min
Speed difference between Permitted speed and Emergency Brake Intervention supervision limits, maximum value	15 km/h	dV_ebi_max
Value of MRSP where dV_ebi starts to increase to dV_ebi_max	110 km/h	V_ebi_min
Value of MRSP where dV_ebi stops to increase to dV_ebi_max	210 km/h	V_ebi_max
Speed difference between Permitted speed and Service Brake Intervention supervision limits, minimum value	5.5 km/h	dV_sbi_min
Speed difference between Permitted speed and Service Brake Intervention supervision limits, maximum value	10 km/h	dV_sbi_max
Value of MRSP where dV_sbi starts to increase to dV_sbi_max	110 km/h	V_sbi_min
Value of MRSP where dV_sbi stops to increase to dV_sbi_max	210 km/h	V_sbi_max
Speed difference between Permitted speed and Warning supervision limits, minimum value	4 km/h	dV_warning_min
Speed difference between Permitted speed and Warning supervision limits, maximum value	5 km/h	dV_warning_max
Value of MRSP where dV_warning starts to increase to dV_warning_max	110 km/h	V_warning_min
Value of MRSP where dV_warning stops to increase	140 km/h	V_warning_max

to dV_warning_max		
Time before the first Indication to display the TTI	14 s	T_dispTTI
Time between Warning supervision limit and SBI	2 s	T_warning
Driver reaction time between Permitted speed supervision limit and SBI	4 s	T_driver
Maximum possible rotating mass as a percentage of the total weight of the train	15 %	M_rotating_max
Minimum possible rotating mass as a percentage of the total weight of the train	2 %	M_rotating_min
MA request repetition cycle, default value	60 s	$T_{CYCRQSTD}$
Level/Mode transitions: Driver acknowledgement time	5 s	T_{ACK}
Maximum time to maintain a communication session in case of failed re-connection attempts	5 minutes	
Distance of metal immunity in Levels 0/NTC	300 metres	D_Metal
Driver reaction time before sounding the horn	4 s	
Time between minimum safe rear end of the train leaving a track condition area and on-board deleting the applicable indication	5 s	
Distance to keep on-board information in rear of the min safe rear end of the train	300 metres	
Additional delay time to disconnection on supervision of safe radio connection	60 s	
“Connection status” timer for safe radio connection indication	45 s	
Time from the latest Radio Network registration order to a Mobile Terminal after which the registration is considered as failed.	40s	

A.3.2 List of National / Default Data

National / Default Data	**Default Value**	**SRS Name (Reference only)**
Modification of adhesion factor by driver	Not allowed	Q_NVDRIVER_ADHES
Shunting mode speed limit	30km/h	V_NVSHUNT
Staff Responsible mode speed limit	40km/h	V_NVSTFF
On Sight mode speed limit	30km/h	V_NVONSIGHT

Limited Supervision mode speed limit	100 km/h	V_NVLIMSUPERV
Unfitted mode speed limit	100km/h	V_NVUNFIT
Release Speed	40km/h	V_NVREL
Distance to be used in Roll Away protection, Reverse movement protection and Standstill supervision	2m	D_NVROLL
Permission to use service brake in target speed monitoring	Yes	Q_NVSBTSMPERM
Permission to release emergency brake	Only at standstill	Q_NVEMRRLS
Permission to use guidance curves	No	Q_NVGUIPERM
Permission to use the service brake feedback	No	Q_NVSBFBPERM
Permission to inhibit the compensation of the speed measurement inaccuracy	No	Q_NVINHSMICPERM
Speed limit for triggering the override function	0km/h	V_NVALLOWOVTRP
Override speed limit to be supervised when the “override” function is active	30 km/h	V_NVSUPOVTRP
Distance for train trip suppression when override function is triggered	200m	D_NVOVTRP
Max. time for train trip suppression when override function is triggered	60 s	T_NVOVTRP
Change of driver ID permitted while running	Yes	M_NVDERUN
System reaction if T_NVCONTACT elapses	No reaction	M_NVCONTACT
Maximum time since the time-stamp in the last received message	∞	T_NVCONTACT
Distance to be allowed for reversing in Post Trip mode.	200 m	D_NVPOTRP
Max permitted distance to run in Staff Responsible mode	∞	D_NVSTFF
Default location accuracy of a balise group	12 m	Q_NVLOCACC
Weighting factor for available wheel/rail adhesion	0	M_NVAVADH
Confidence level for emergency brake safe deceleration on dry rails	99.9999999 %	M_NVEBCL
Train length step used for the integrated correction factor Kr_int	N/A	L_NVKRINT
Train length dependent integrated correction factor Kr_int	0.9	M_NVKRINT*
Speed step used for the integrated correction factor Kv_int	N/A	V_NVKVINT
Speed dependent integrated correction factor Kv_int	0.7	M_NVKVINT*

Integrated correction factor for brake build up time	1.1	M_NVKTINT
Maximum deceleration value under reduced adhesion conditions (1)	1.0 m/s^2	A_NVMAXREDADH1
Maximum deceleration value under reduced adhesion conditions (2)	0.7 m/s^2	A_NVMAXREDADH2
Maximum deceleration value under reduced adhesion conditions (3)	0.7 m/s^2	A_NVMAXREDADH3
Lower deceleration limit to determine the set of Kv_int to be used	N/A	A_NVP12
Upper deceleration limit to determine the set of Kv_int to be used	N/A	A_NVP23

*The default value of the correction factor Kr_int shall be valid for any train length, and likewise the default value of the correction factor Kv_int shall be valid for any brake position, speed and maximum emergency brake deceleration. This means that the Kr_int model does not contain any train length step, and that the Kv_int model is valid for all train types and does neither contain any speed step nor any pivot deceleration limit.

A.3.3 Handling of information received from trackside

A.3.3.1 Before it can be accepted and used by the ERTMS/ETCS on-board equipment, raw information received from trackside is subject to various checks, which can lead to the individual rejection/ignoring of information (e.g. Movement Authority not valid for the train orientation), the ignoring of a whole balise telegram or the rejection of a whole message. The SRS clauses/sections corresponding to these checks are gathered in Table 17.

Type of check	**Type of data**		
	Individual information	**Telegram**	**Message**
System Version	3.17.3.11 a) & c)	3.17.3.5 a), d) & e)	3.17.3.5 b) 3.17.3.6 a) 3.17.3.6 c) 3.17.3.11 b)
Virtual Balise Cover		3.15.9.3 a)	
Reverse Movement Protection		3.14.3.6	
Duplicated balises	3.16.2.4.8.1	3.16.2.4.8.2	
Linking			3.4.4.4.2 and 3.16.2.4.3 3.4.4.4.2.1 3.16.2.3.1.1 together with 3.4.4.4.3 3.16.2.3.2 with exception 3.16.2.3.2.1

Type of check	Type of data		
	Individual information	Telegram	Message
Message consistency			3.16.2.4.1 together with 3.16.2.4.7, 3.16.2.4.7.1 and with exception 3.16.2.4.2 3.16.2.4.4 together with 3.16.2.4.7, 3.16.2.4.7.1 and with exception 3.16.2.4.4.1 a) 3.16.2.5.1 together with 3.16.2.4.7, 3.16.2.4.7.1 and with exception 3.16.2.5.1.1 a) 3.16.3.1.1.1 together with 3.16.3.1.1 a), 3.16.3.3.3 and 3.16.3.1.1 c) 3.16.3.1.3.1
Validity direction	3.6.3.1.3 3.6.3.1.3.1 3.6.3.1.4 with exception 3.6.3.1.4.1		
Level, mode, transmission medium, infill/not infill, other miscellaneous criteria	4.8		

Table 17: Check of raw data received from trackside

A.3.3.2 With the exception of the clauses/sections referred to in Table 17 and of the clause 3.16.3.5.1, all the clauses in this specification in which trackside information is referred to (through the terms “balise”, “telegram”, “balise group [message]”, “message”, “[name of] information”...), shall be applied assuming that the information has not been ignored/rejected by the ERTMS/ETCS on-board equipment due to all the checks listed in Table 17.

A.3.3.3 Example 1: clause 3.16.2.4.9 has to be understood as follows: “If a <*consistent*> message <*composed with telegrams that have passed the system version check, that have not been ignored because of a VBC, that have not been ignored because of duplication, and that have been received while no reverse movement was performed*> has been received <*with one of its telegrams composing it*> containing the information “default balise information” <*which is valid for the train orientation (or the balise group crossing direction for NL or SL engines) and which has passed the level and mode filters*>, the driver shall be informed.”

A.3.3.4 Example 2: as a result of the clause A.3.3.2, the ERTMS/ETCS on-board equipment will not apply requirements in relation to the content of the telegram or the message such as:

- clause 3.6.2.2.2 a), in case the balise group message is rejected because not consistent (e.g. according to 3.16.2.4.1), it does not become LRBG
- clause 3.16.3.3.3.1, in case the radio message is rejected because of its time stamp, this latter will not be used by the on-board to check the supervision of sequence of further messages
- clause 3.17.2.3, in case the balise telegram is ignored because of its system version number (e.g. according to 3.17.3.5 d)), this latter will not affect the system version operated by the on-board
- clause 3.18.2.5 2nd bullet, in case a message from a balise group marked as linked is rejected because the balise group was not announced by linking (see 3.16.2.4.3), the balise group country or region identifier will not be compared with the one(s) of the currently applicable set of National Values

A.3.4 Handling of Accepted and Stored Information in specific Situations

A.3.4.1 Introduction

A.3.4.1.1 All data that can be stored onboard after being accepted may be influenced in special situations.

A.3.4.1.2 The situations acting on the “status” of stored information are:

a) the execution of a conditional emergency stop (3.10.2.2);

b) the reception of a shortened MA (3.8.5.1.3, 3.8.5.1.4);

c) the stored MA is shortened due to a section time-out (3.8.4.2.2);

d) the SvL is shifted (to the DP if any or to the EOA) due to an overlap time-out (3.8.4.4.2) ;

e) the stored MA is shortened due to an end section time-out (3.8.4.1.2);

f) a cooperative MA revocation is granted by the onboard (3.8.6.2);

g) inconsistency in a balise group marked as unlinked and the train is at standstill (3.16.2.5.2);

h) a linking reaction led to a service brake and the train is at standstill (3.16.2.6.2) ;

i) the reaction due to the supervision of the safe radio connection led to a service brake and the train is at standstill (3.16.3.4.5 b) ;

j) the train category, axle load category, loading gauge or traction system is changed and the train is at standstill (3.18.3.7) ;

k) driver closes the desk during SoM ;

l) RAMS related supervision functions led to a service brake and the train is at standstill (3.16.2.7)

m) inconsistency in a balise group marked as linked and no linking is used onboard and the train is at standstill (3.16.2.4.4.2)

n) the Limit of Authority becomes an End of Authority and the on-board considers an SvL (3.8.4.3.2)

A.3.4.1.3 Depending on the situation, the action shall be one of the following:

a) data is deleted,

b) data is reset (set to initial states)

c) data status is unchanged,

d) data is to be revalidated

D = Deleted U = Unchanged R = Reset TBR = To Be Revalidated

Data Stored on-board	Situations listed above		
	a – d, f, n	**e, g – j, l, m**	**k**
National Values	U	U	U
Not yet applicable National Values	D[1]	D[10]	D
Linking	D[1]	D[10]	D
Movement Authority	D[1] [3]	D[10] [11]	D[5]
Gradient Profile	D[1]	D[10]	D
International SSP	D[1]	D[10]	D
Axle load speed profile	D[1]	D[10]	D
STM max speed	U	U	D
STM system speed/distance	U	U	D
Level Transition Order	U	U	D
Stop Shunting on desk opening	U	U	U
List of balises for SH area	D	D[9]	D[5]
MA Request Parameters	U	U	U
Position Report parameters	U	U	U
List of Balises in SR Authority + SR mode speed limit and distance	U[2]	U	D[5]
Temporary Speed Restrictions	U	U	D
Inhibition of revocable TSRs from balises in L2/3	U	U	D
Default Gradient for TSR	U[4]	U[4]	D

Data Stored on-board	Situations listed above		
	a – d, f, n	e, g – j, l, m	k
Signalling related Speed Restriction	D[1]	D[10]	D[5]
Route Suitability Data	D[1]	D[10]	D
Plain Text Information (location based)	D[8]	D[13]	D
Plain Text Information (not location based)	U	U	D
Fixed Text Information (location based)	D[8]	D[13]	D
Fixed Text Information (not location based)	U	U	D
Geographical Position	U	U	U
Mode Profile	D[1] [7] [14]	D[10] [12]	D[5]
RBC Transition Order	D[1]	D[10]	D
Radio Infill Area information	D[1]	D[10]	D
EOLM information	U	U	U
Track Conditions excluding big metal masses	R[1]	R[10]	R
Track condition big metal masses	R[1]	R[10]	R
Unconditional Emergency Stop	U	U	D
Conditional Emergency Stop	U	U	D
Train Position	U	U	U
Train Data	U	U	TBR
Adhesion factor	U	U	D
ERTMS/ETCS level	U	U	U
Table of priority of trackside supported levels	U	U	U
Driver ID	U	U	TBR
Radio Network ID	U	U	U
RBC ID/Phone Number	U	U	U
Train Running Number	U	U	TBR
Reversing Area Information	D[1]	D[10]	D
Reversing Supervision Information	U	U	D
Track Ahead Free Request	U[6]	U	D
Level Crossing information	U	U	D

Data Stored on-board	Situations listed above		
	a – d, f, n	e, g – j, l, m	k
Permitted Braking Distance Information	D[1]	D[10]	D
RBC/RIU System Version	U	U	U
Operated System Version	U	U	U
Language used to display information to the driver	U	U	U
Virtual Balise Covers	U	U	U
Generic LS function marker	U	U	U
LSSMA display toggle on order	U	U	D

[1]: beyond the new SvL or in case of situation a, beyond the stop location of the accepted CES

[2]: The considered situations cannot occur when a list of balises to be used in SR is available onboard. Indeed, the onboard is in SR mode and since no MA or track description are stored onboard, no new SvL may be defined.

[3]: In case of reception of a new non-infill MA (situation b or f), the stored MA is fully replaced with the new one. In case of reception of a new infill MA (situation b), the stored MA is replaced beyond the infill location reference, i.e. the balise group at the next main signal

[4]: The considered situations a-d, f, h, i cannot occur when the default gradient for a TSR is used on-board.

[5]: The considered situation cannot occur because acceptance of this information has led to exit from SoM procedure.

[6]: The considered situations b-d, f cannot occur when a TAF request is stored on-board

[7]: If the start location of the Mode Profile is beyond the new SvL, the acknowledgement window of the Mode Profile shall be deleted as well

[8]: only if the location where to start to display the text is beyond the new SvL; otherwise all the text information (i.e. including end location where to stop display, if any) shall remain unchanged

[9]: unchanged if the onboard is in SH mode

[10]: beyond the current max safe front end position of the train

[11]: the ERTMS/ETCS on-board equipment shall consider the current estimated front end and max safe front end positions of the train, as the EOA and SvL respectively, with no release speed

[12]: If the start location of the Mode Profile is beyond the current max safe front end, the acknowledgement window of the Mode Profile shall be deleted as well

[13]: only if the location where to start to display the text is beyond the current max safe front end; otherwise all the text information (i.e. including end location where to stop display, if any) shall remain unchanged

[14]: In case of reception of a new non-infill MA with or without Mode Profile (situation b or f), the stored Mode Profile is deleted. In case of reception of a new infill MA (situation b), the stored Mode Profile is deleted only beyond the infill location reference, i.e. the balise group at the next main signal

A.3.4.1.4 NOTES:

A.3.4.1.4.1 “Location” contains LRBG, distance travelled from LRBG, position of the front end in relation to the LRBG, the confidence interval and the orientation in relation to the LRBG.

A.3.4.1.4.2 The following information is not considered to be stored information:

a) Repositioning information

b) Session Management (exception: the RBC ID/phone number, which is given with an order to establish a communication session, is stored on-board)

c) Danger for SH information

d) Assignment of Co-ordinate system

e) Infill Location Reference

f) Location Identity (NID_C + NID_BG transmitted in the balise telegram)

g) Recognition of exit from TRIP mode

h) Acknowledgement of Train Data

i) SH refused

j) SH authorised

k) Balise/loop system version

l) Intentionally deleted

m) Intentionally deleted

n) Revocation of Emergency Stop (Conditional or Unconditional)

o) Temporary Speed Restriction Revocation

p) Intentionally deleted

q) Acknowledgement of session termination

r) Default Balise Information

s) Co-operative shortening of MA (if this message is used, it replaces the movement authority)

t) Train Rejected

u) Train Accepted

v) SoM position report confirmed by RBC

w) Track Ahead Free up to level 2/3 transition location

x) Signalling related speed restriction value zero (i.e., train trip order)

y) Stop if in SR mode

z) Data to be forwarded to a National System through the STM interface

aa) LSSMA display toggle off order

A.3.5 Handling of Actions in Specific Situations

A.3.5.1 Regards actions executed in reference to location information received from trackside, the on-board equipment shall ensure that the action related to a location is neither reverted, nor executed twice. Situations to be considered shall include reverse movement (initiated by driver or due to roll-away) and the sub-sequent forward movement, or adjustment of train position on passing a new LRBG. This rule shall apply to the following actions:

- Change of National Values (see 3.18.2)
- Request to acknowledge new level, level transition (see SRS chapter 5.10)
- Start and stop displaying plain or fixed text messages (see 3.12.3)
- Request to acknowledge a mode profile, mode transition due to mode profile (see 3.12.4)
- Start and stop accepting radio infill information (see 3.9.3)
- Actions related to RBC/RBC handover (see 3.15.1)
- Actions related to track condition information (see 3.12.1) with the exception of big metal masses and non stopping areas
- Permission to initiate Reversing mode, i.e., limits of Reversing Area (see 3.15.4)
- Start and stop Track Ahead free request to driver (see 3.15.5)
- Start and stop calculation of geographical position (see 3.6.6)
- Substitute the supervision of the LX start location as the EOA/SvL by the inclusion of the LX speed restriction in the MRSP (see 5.16.2 and 5.16.3)

A.3.5.2 Once the ERTMS/ETCS on-board equipment has received a balise group message (i.e. once it has received the last balise telegram of the balise group), the action(s) resulting from its content shall take into account the train position measured at the time of reception of this last telegram and shall take precedence on any other action related to a further location that is reached before the message has been fully processed.

A.3.5.2.1 Example 1: in level 1, the crossing of the EOA/LOA location with the min safe antenna, before a new extended MA (received when the min safe antenna was in rear of the EOA/LOA) has been processed, will not lead to train trip. In other terms the replacement of the EOA/LOA is considered by the on-board as happening before the min safe antenna crosses the EOA/LOA location (i.e. preventing that clause 3.13.10.2.7 applies).

A.3.5.2.2 Example 2: when the override function is active, the crossing of the former EOA/LOA location by the min safe antenna, before a “Stop if in SR” information (received when the min safe antenna was in rear of the former EOA/LOA) has been processed, will not

lead to the end of the override procedure followed by a train trip due to “Stop if in SR”. In other terms, both the deletion of the former EOA/LOA and the end of override procedure (see 5.8.3.1.3 and 5.8.4.1 c)) are considered by the on-board as simultaneously happening before the min safe antenna crosses the former EOA/LOA location.

A.3.6 Deletion of accepted and stored information when used

A.3.6.1 Standard case

A.3.6.1.1 When the train moves in the direction of its train orientation, storage capacity occupied by trackside information no longer used, i.e., the related on-board functionality has been completed, shall be made available immediately.

A.3.6.1.1.1 Note: The requirement is needed to allow trackside to predict the storage capacity available on-board in order to comply with dimensioning rules regards information stored on-board given in Subset 040.

A.3.6.2 Exception

A.3.6.2.1 Following information shall remain stored on-board for a distance defined by a fixed value in rear of the min safe rear end position of the train:

- location dependent static speed restrictions , i.e., SSP, ASP, TSR, LX SR, PBD SR (see 3.11.2.2)
- gradient information,
- reduced adhesion information received from trackside,
- Track condition “Big metal masses”.

A.3.6.2.1.1 Note: The above information remains stored for the case of a reverse movement:

- With the exception of the track condition “Big metal masses”, the stored information allows the ERTMS/ETCS on-board equipment to calculate speed supervision limits after a reverse movement (roll-away, or initiated by the driver)
- Track condition “Big metal masses” is needed also for a reverse movement itself to avoid any false alarms due to Big metal masses in the track.

A.3.6.2.1.2 Note: The distance to intervention of the roll away or reverse movement supervision is determined by a National/Default value. This is also true for a reverse movement in Post trip mode. However, following an intervention, the train will not stop immediately. In order to keep the on-board functionality simple, a fixed distance value was chosen to define an unambiguous location in rear of the train where the above information is no longer required and the related on-board storage capacity is made available again.

A.3.7 Calculation of the basic deceleration

A.3.7.1 The brake percentage (λ) shall be converted into two different input parameters:

$\lambda_o = \lambda$ for calculation of emergency brake deceleration (A_brake_emergency(V))

λ_o = MIN (λ, 135) for calculation of service brake deceleration (A_brake_service(V))

where λ is the brake percentage defined as part of Train Data.

A.3.7.2 The calculation of the basic deceleration (A_basic(V)) shall use a common algorithm that will be used twice, once for the service brake and once for the emergency brake.

A.3.7.3 The speed limit for the first step shall be calculated as $V\_lim = x * \lambda_o^y$.

V_lim is the speed limit for the first step in km/h

x = 16.85

y = 0.428

A.3.7.4 The first step of the basic deceleration shall be calculated as $AD\_0 = A * \lambda_o + B$

AD_0 is the basic deceleration in m/s^2 for 0 ≤ speed ≤ V_lim.

A = 0.0075

B = 0.076

A.3.7.5 The following steps of the basic deceleration shall be calculated by means of a set of polynomials of the third order with the following format:

$AD\_n = a3\_n * \lambda_o^3 + a2\_n * \lambda_o^2 + a1\_n * \lambda_o + a0\_n$

and with the following values for n (all speed limits in km/h):

n = 1	valid for V_lim < speed ≤ 100	if V_lim < 100
	to be ignored	if V_lim ≥ 100
n = 2	valid for V_lim < speed ≤ 120	if 100 < V_lim < 120
	valid for 100 < speed ≤ 120	if V_lim ≤ 100
	to be ignored	if V_lim ≥ 120
n = 3	valid for V_lim < speed ≤ 150	if 120 < V_lim < 150
	valid for 120 < speed ≤ 150	if V_lim ≤ 120
	to be ignored	if V_lim ≥ 150
n = 4	valid for V_lim < speed ≤ 180	if 150 < V_lim < 180
	valid for 150 < speed ≤ 180	if V_lim ≤ 150
	to be ignored	if V_lim ≥ 180
n = 5	valid for V_lim < speed	if V_lim > 180
	valid for 180 < speed	if V_lim ≤ 180

A.3.7.6 The coefficients for the polynomials shall be defined as follows:

am_n	m =			
	3	2	1	0

n =	1	-6.30E-07	6.10E-05	4.72E-03	0.0663
	2	2.73E-07	-4.54E-06	5.14E-03	0.1300
	3	5.58E-08	-6.76E-06	5.81E-03	0.0479
	4	3.00E-08	-3.85E-06	5.52E-03	0.0480
	5	3.23E-09	1.66E-06	5.06E-03	0.0559

A.3.8 Calculation of the emergency brake equivalent time

A.3.8.1 The basic brake build up time for the emergency brake with the brake position in passenger trains in P shall be calculated as:

$T\_brake\_basic\_eb = a + b * (L/100) + c * (L/100)^2$

where

L = MAX (400m; train length in m)

a = 2.30

b = 0.00

c = 0.17

A.3.8.2 The basic brake build up time for the emergency brake with the brake position in freight trains in P shall be calculated as:

$T\_brake\_basic\_eb = a + b * (L/100) + c * (L/100)^2$

where

L = MAX (400m; train length in m)

If train length ≤ 900m:

a = 2.30

b = 0.00

c = 0.17

If 900m < train length ≤ 1500m:

a = -0.40

b = 1.60

c = 0.03

A.3.8.3 The basic brake build up time for the emergency brake with the brake position in freight trains in G shall be calculated as:

$T\_brake\_basic\_eb = a + b * (L/100) + c * (L/100)^2$

where

L = train length in m

If train length ≤ 900m:

a = 12.00

b = 0.00

c = 0.05

If 900m < train length ≤ 1500m:

a = -0.40

b = 1.60

c = 0.03

A.3.8.4 The equivalent brake build up time for the emergency brake shall be computed as follows:

T_brake_emergency_cm0 = T_brake_basic_eb when V_target = 0

T_brake_emergency_cmt = kto * T_brake_basic_eb when V_target > 0

where

V_target is the target speed

A.3.8.5 The correction factor kto shall depend on the brake position as follows:

kto = 1 + Ct

where

Ct = 0.16 for freight trains in G

Ct = 0.20 for freight trains in P

Ct = 0.20 for passenger trains

A.3.9 Calculation of the full service brake equivalent time

A.3.9.1 The basic brake build up time for full service brake for passenger trains in P shall be calculated as:

$T\_brake\_basic\_sb = a + b * (L/100) + c * (L/100)^2$

where

L = train length in m

a = 3.00

b = 1.50

c = 0.10

A.3.9.2 The basic brake build up time for full service brake for freight trains in P shall be calculated as:

$T\_brake\_basic\_sb = a + b * (L/100) + c * (L/100)^2$

where

L = train length in m

If train length ≤ 900m:

a = 3.00

b = 2.77

c = 0.00

If 900m < train length ≤ 1500m:

a = 10.50

b = 0.32

c = 0.18

A.3.9.3 The basic brake build up time for full service brake for freight trains in G shall be calculated as:

$T\_brake\_basic\_sb = a + b * (L/100) + c * (L/100)^2$

where

L = MAX (400m; train length in m)

If train length ≤ 900m:

a = 3.00

b = 2.77

c = 0.00

If 900m < train length ≤ 1500m:

a = 10.50

b = 0.32

c = 0.18

A.3.9.4 The equivalent brake build up time for the service brake shall be computed as follows:

T_brake_service_cm0 = T_brake_basic_sb when V_target = 0

T_brake_service_cmt = kto * T_brake_basic_sb when V_target > 0

A.3.9.5 The correction factor kto shall be defined as in A.3.8.5

A.3.9.6 The values of a, b, c and kto used in A.3.9.1, A.3.9.2, A.3.9.3 and A.3.9.4 define reference values for the equivalent brake build up time for the service brake, which shall be considered as maximum ones. If justified by the specific brake system of the train other values of these coefficients, which lead to shorter values of the equivalent brake build up time for the service brake, may be used.

A.3.9.7 Note: Although certain trains may perform better, the reference values for the equivalent brake build up time for the service brake, as defined here, are the appropriate basis for infrastructure planning.

A.3.10 Service brake feedback

A.3.10.1 The purpose of service brake feedback is to reduce the distance between the SBI and EBI supervision limits and between the SBI and SBD curves.

A.3.10.2 The on-board shall consider the service brake feedback as available for use if:

a) The service brake feedback is implemented, AND

b) The national value does not inhibit its use.

A.3.10.3 Two different types of feedback from the service brake are specified, main brake pipe pressure and brake cylinder pressure. The algorithms below are made for main brake pipe pressure. When brake cylinder pressure is used instead this shall be converted into a fictive main brake pressure value in the following way:

p = fictive main brake pipe pressure (kPa)

p_cylinder = brake cylinder pressure (kPa)

k1 = vehicle dependent constant (set by engineering of ETCS on-board; k1 is normally between 2.0 and 2.7)

p = 500 - p_cylinder / k1

A.3.10.4 The value of T_bs1 and T_bs2 shall be calculated according to the following algorithm to take the service brake feedback into account:

p = current main brake pipe pressure (or fictive main brake pipe pressure calculated in A.3.10.3)

p0 = reference pressure when not braking

p1 = pressure at which the train starts to brake = p0 - 30

p2 = pressure limit, under which T_bs1 and T_bs2 are locked = p0 - 60

p3 = pressure at full service brake = p0 - 150

Q_feedback_active = a Boolean stating whether the feedback function is active, i.e. once it has started to reduce T_bs1 and T_bs2 until the ceiling speed monitoring is entered.

Q_Tbslocked = a boolean stating whether T_bs1 and T_bs2 have been locked to the following values due to enough main brake pipe pressure reduction:

T_bs1_locked = 0 s.

T_bs2_locked = 2 s.

Q_displaylocked_P = a boolean stating whether the displayed permitted speed is locked due to SB feedback.

Q_displaylocked_SBI = a boolean stating whether the displayed SBI speed (if any) is locked due to SB feedback.

Q_displaylocked_TD = a boolean stating whether the displayed target distance is locked due to SB feedback.

A displayed value is locked from the moment the SB feedback has started to reduce T_bs1 and T_bs2 until the calculated value becomes less than the displayed and locked value. Note: It is only SB feedback that can start the locking of the displayed values. Once started and still locked it remains locked also in case the calculated values are increased due to other reasons (e.g. due to relocation), which will prolong the locking period.

Initial values when the target speed monitoring is entered or when the release speed monitoring is entered not from target speed monitoring:

Tbs1_prev= Tbs

```
Q_feedback_active = false
Q_displaylocked_P = false
Q_displaylocked_SBI = false
Q_displaylocked_TD = false
Q_Tbslocked =false

If on-board is in target speed monitoring or release speed monitoring then
    If Q_Tbslocked then
        T_bs1 = T_bs1_locked
        T_bs2 = T_bs2_locked
    Else
        If p > p2 then
            If Q_feedback_active or p ≤ p1 then
                Q_feedback_active = true
                T_bs_feedback = T_bs * (p - p3) / (p0 - p3)
                T_bs1 = T_bs2 = T_bs_feedback
                If T_bs_feedback > T_bs then
                    T_bs1 = T_bs2 = T_bs
                Else if T_bs_feedback < T_bs2_locked then
                    T_bs2 = T_bs2_locked
                End If
            Else
                T_bs1 = T_bs
                T_bs2 = T_bs
            End If
        Else
            T_bs1 = T_bs1_locked
            T_bs2 = T_bs2_locked
            Q_feedback_active = true
            Q_Tbslocked = true
        End If
    End If
Else
    T_bs1 = T_bs
    T_bs2 = T_bs
End if
If Q_feedback_active and T_bs1 < T_bs1_prev then
```

Q_displaylocked_P = true

Q_displaylocked_SBI = true

Q_displaylocked_TD = true

End If

T_bs1_prev = T_bs1

If Q_displaylocked_P and the permitted speed computed for display purposes ($V_{P\text{-}DMI}$) as per clause 3.13.10.4.3 is less than the locked and displayed permitted speed, then

Q_displaylocked_P = false

End If

If Q_displaylocked_SBI and the SBI speed computed for display purposes ($V_{SBI\text{-}DMI}$) as per clause 3.13.10.4.4 is less than the locked and displayed SBI speed, then

Q_displaylocked_SBI = false

End If

If Q_displaylocked_TD and the target distance computed for display purposes as per clause 3.13.10.4.7 is less than the locked and displayed target distance, then

Q_displaylocked_TD = false

End If

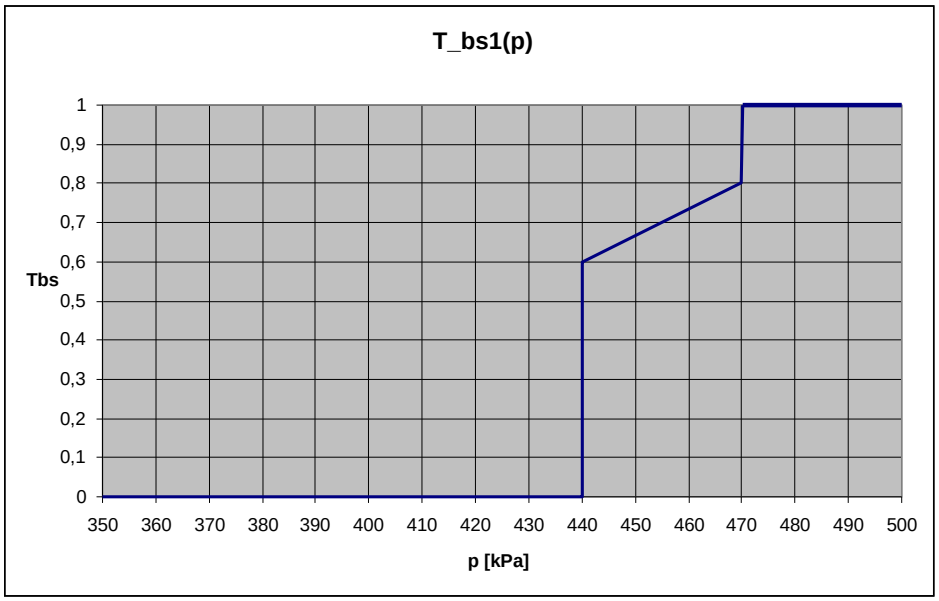
If the MRDT changes then

Q_displaylocked_P = false

Q_displaylocked_SBI = false

Q_displaylocked_TD = false

End If



The reference pressure p0 (nominal value 500 kPa) shall be set on starting the ETCS:

a) To the first stable p value between 400-550 kPa achieved.

b) Stable in this instance means that the pressure has not varied more than ± 20 kPa over 3 seconds.

The reference pressure p0 shall thereafter be adapted to the current pressure according to the following table (which applies if the calculation is performed once per second):

	CONDITIONS:	ACTION:	REMARKS
a)	p = p0	No change	Constant pressure
b)	p > p0	p0 = p0 + 1,5	Increasing pressure
c)	p < p0 - 30	No change	Braking
d)	p0 > p ≥ p0 - 30	p0 = p0 – 0,5	Decreasing pressure

Where:

- p is limited to max 550 kPa.
- Values given in kPa.

A.3.10.5 Note: If T_bs1 and T_bs2 have been locked to 0s and 2 s on approaching a non zero target, the locking will remain even if the train speed comes below the target speed. This avoids “jumping” indications related to the values of T_bs1 and T_bs2. It also makes it possible to release the brakes before a speed reduction, without having the curves moving back again. It might though result in emergency brake intervention if the driver releases the brakes too early. But since EBI is not moved, this is not a safety issue. To keep 2 s between the SBI and EBI enables the service brake to be activated first and thus may avoid emergency brake.

A.3.10.6 Note: If feedback is active but T_bs1 and T_bs2 are not locked, the feedback function will remain active until the ceiling speed monitoring is entered. This avoids “jumping” indications in some rare situations.

A.3.11 Data unit, range and resolution

Data	**Unit**	**Range**	**Resolution**
Train Data: Train length	m	0-4095	1 m
Train Data: Brake percentage	%	10-250	1 %
Train Data: Maximum train	km/h	0-600	5 km/h

speed			
Train Data: Loading gauge	n/a	G1, GA, GB, GC, does not fit any of the interoperable loading gauge profiles	n/a
Train Data: Axle load category	n/a	A, HS17, B1, B2, C2, C3, C4, D2, D3, D4, D4XL, E4, E5	n/a
Train Data: Train fitted with airtight system	n/a	Yes, No	n/a
Driver ID	n/a	1 to 16 alphanumeric characters (selected from 0 to 9 and a to z)	n/a
RBC ID	n/a	0-16777214	1
RBC phone number	n/a	no restriction	n/a
Train running number	n/a	no restriction	n/a
Distance to run in SR mode	m	0-100000	1 m
Maximum SR speed	km/h	0-600	5 km/h