ERTMS/ETCS

System Requirements Specification
Chapter 3
Principles

REF : SUBSET-026-3
ISSUE : 4.0.0
DATE : 05/07/2023

3.1 Modification History

Issue Number Date	Section Number	Modification / Description	Author/Editor
1.0.1 990307	All	Merge of Basic + Detailed Principles Removing redundant material, correcting text and adding proposals.	HE
1.1.0 990423	All	Class P Official Issue	HE
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
1.1.3 990722	All	Changes according to review of version 1.1.2	KL
1.1.4 990729	All	Editorial corrections, finalisation meeting Stuttgart 990729	HE
1.2.0 990730	Version number	Release version	HE
1.3.0 991201	All	Corrections and new functions according to ECSAG and UNISIG comments	KL
1.3.1 991217	All	Corrections after UNISIG review 15 December 99	KL
2.0.0 991222	Minor editing	Release Version	Ch. Frerichs (ed.)
2.0.1 000921	All	Corrections after UNISIG review 15 June 00	KL
2.1.0 001017	Most	Corrections after UNISIG review 11 October 00	KL
2.2.0 010108	Section 3.18.4.6.6 – 3.18.4.6.8 removed	Changes as decided on Steering Committee meeting 13 December 2000 (changes from 2.0.0 marked)	KL

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
2.2.5 210105	Incorporation of solution proposal for CLR 007 with EEIG users group comments Corrections according to erratum list agreed in SG meeting 170105	AH
2.2.6 050301	Including all CLRs being in state “EEIG pending” as per list of CLRs extracted on 28/01/05.	OG
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
2.2.8 211105	Change marks cleaned up and updated according to last CRs decisions (including split of CRs7&126)	OG
2.2.9 24/02/06	Including all CRs that are classified as “IN” as per SUBSET-108 version 1.0.0 Removal of all CRs that are not classified as “IN” as per SUBSET-108 version 1.0.0, with the exception of CRs 63,98,120,158,538	OG
2.3.0 24/02/06	Release version	HK
2.3.1 12/06/06		OG
2.3.2 17/03/08	Including all CRs that are classified as “IN” as per SUBSET-108 version 1.2.0 and all CRs that are in state “Analysis completed” according to ERA CCM	AH
2.9.1 06/10/08	Including all enhancement CR’s retained for baseline 3 and all other error CR’s For editorial reasons, the following CR’s are also included: CR656, CR804, CR821	AH
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

3.1.0 22/02/10	Release version	AH
3.1.1 08/11/10	Including all CR's that are in state "Analysis completed" according to ERA CCM, plus CR731, 972 and 1000.	AH
3.2.0 22/12/10	Release version	AH
3.2.1 13/12/11	Including all CR's that are in state "Analysis completed" according to ERA CCM, plus CR772	AH
3.3.0 07/03/12	Baseline 3 release version	AH
3.3.1 04/04/14	CR's 944, 1109,1124, 1127, 1149, 1150, 1183, 1185	OG
3.3.2 23/04/14	Baseline 3 1st maintenance pre-release version	OG
3.3.3 06/05/14	CR 1223 Baseline 3 1st maintenance 2nd pre-release version	OG
3.4.0 12/05/14	Baseline 3 1st maintenance release version	OG
3.4.1 23/06/15	CR's 239, 852, 1014, 1117, 1163, 1164, 1172, 1260	OG
3.4.2 17/11/15	CR's 299, 933, 1084, 1086, 1087, 1107, 1152, 1163 (update), 1184, 1190, 1197, 1249, 1254, 1262, 1265, 1266, 1273, 1277	OG
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
3.6.1 29/05/17	CR's 940, 994, 1120, 1170, 1251, 1252, 1259, 1263, 1264, 1288, 1293,1296, 1300	OG
3.6.2 31/05/18	CR's 887, 940, 994, 1120, 1293, 1300, 1306 Replacement of all equations due to the disabling of the former Microsoft equation editor	OG AH

3.6.3 21/02/20	CR's 940, 1130, 1267, 1282, 1311, 1312, 1313, 1318, 1320, 1327, 1328, 1329, 1330, 1332, 1333, 1334, 1338, 1341, 1345, 1347, 1348	OG AH
3.6.4 22/06/20	CR's 1282, 1306, 1313, 1334	OG AH
3.6.5 22/12/21	CR's 1021, 1162, 1238, 1354, 1358, 1370, 1372, 1376, 1377, 1382, 1384, 1386, 1396	OG AH
3.6.6 29/08/22	CR's 940 (updated), 968, 1288 (updated), 1302, 1342, 1363, 1367, 1389, 1410, 1411, 1414, 1418	OG AH
3.9.1 24/11/22	CR's 940 (updated), 988, 1307, 1344, 1367 (updated), 1397, 1423, 1424 Outcome of B4R1 1st consolidation phase	OG AH
3.9.2 21/02/23	CR's 1318, 1367, 1370 Outcome of B4R1 2nd consolidation phase	OG AH
3.9.3 31/05/23	CR's 1359, 1427 Outcome of B4R1 3rd consolidation phase	OG AH
3.9.4 30/06/23	CR's 1342 (updated), 1432 Outcome of B4R1 4th consolidation phase	OG AH
4.0.0 05/07/23	Baseline 4 1st release version	OG 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, linking and Euroloop

3.4.1 Balise Configurations – Balise Group Definition

3.4.1.1 A balise group consists of between one and eight balises sharing the same balise group identity.

3.4.1.2 In every balise, the following information is at least 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 is defined by the nominal direction (see 3.4.2.2.2) and 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.

3.4.2.2.1.1 Exception: If the balise number 1 of the group is duplicated, the balise number 2 shall be the location reference in case, out of this pair of duplicated balises, the ERTMS/ETCS on-board equipment has only received the telegram from the balise number 2.

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

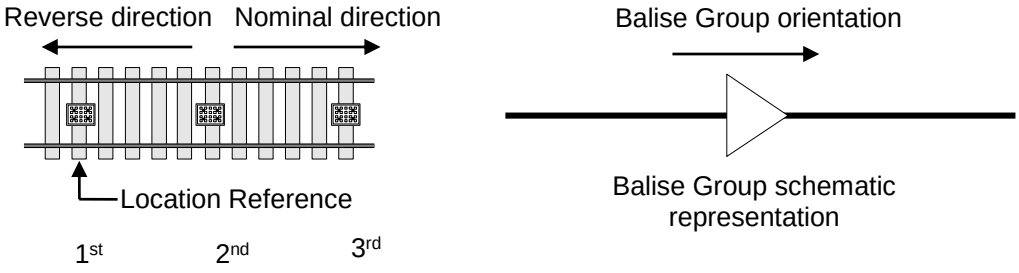


Figure 1: Orientation of the balise group

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.

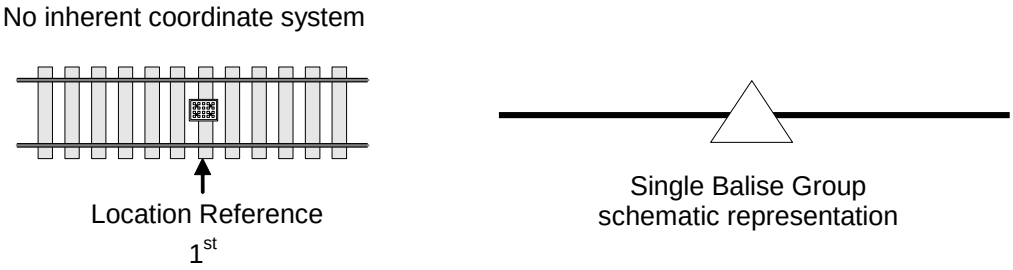


Figure 1a: Single balise group

3.4.2.3.2 Assignment of the co-ordinate system by means of linking information:

3.4.2.3.2.1 Intentionally deleted.

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" from a previously received linking information shall assign a co-ordinate system to the balise.

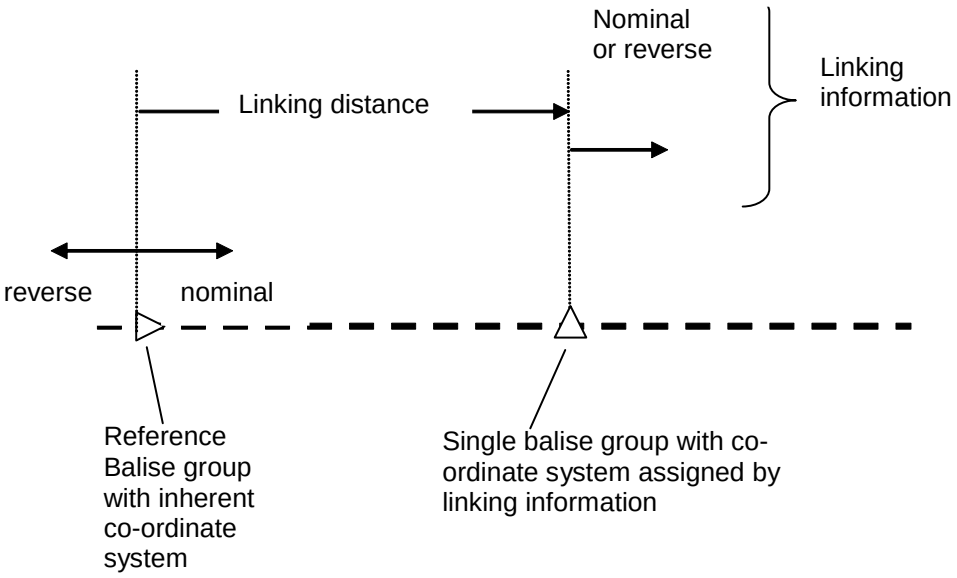


Figure 2: Assignment of a co-ordinate system to a single balise group by linking

3.4.2.3.2.3 The reference for the linking information can 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 Assignment of the co-ordinate system by means of a dialogue between the on-board and the RBC:

3.4.2.3.3.1 If the ERTMS/ETCS on-board equipment cannot evaluate the orientation of the last balise group received, 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 received 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).

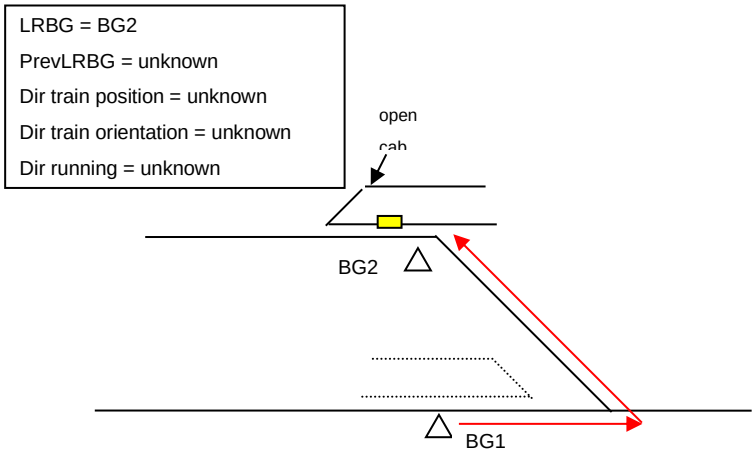


Figure 2a: Position report based on two balise groups versus train running direction

3.4.2.3.3.5 If a single balise group, being the LRBG, is received 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.

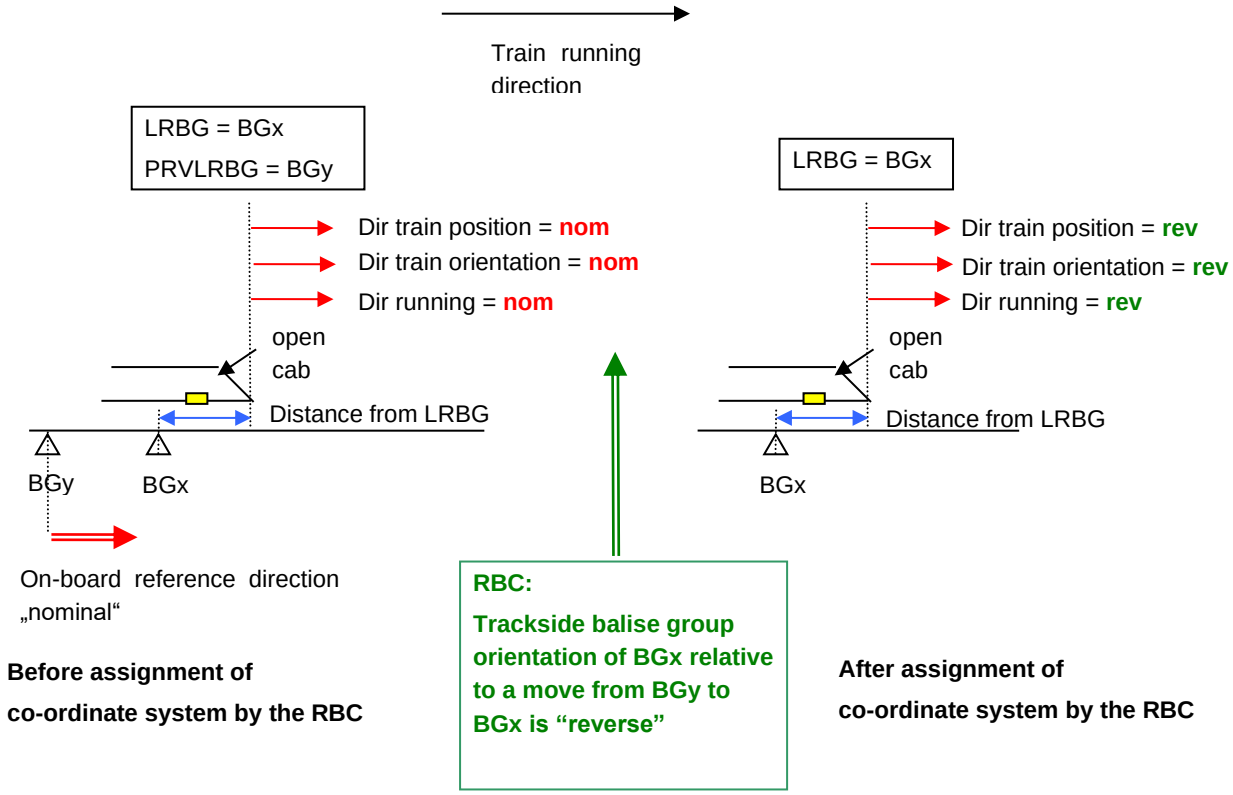


Figure 2b: Example for assigning a co-ordinate system

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, balise groups are mostly used for location information.

3.4.3.2 In level 1, the balise information can be of the following type (please refer to sections 3.6.2.3 and 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 received 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 perform the relocation of location based information without any consideration of the 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 is.

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 linked balise group.

3.4.4.2.1.1 "Linking consistency is checked" shall be interpreted as when:

a) linking information is stored on-board, AND

b) depending on the mode the linking consistency check is active, AND

c) the supervision of the expectation window of the furthest announced balise group has not yet been stopped (see 3.4.4.4.6).

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 applicable to balise groups when linking consistency is checked

3.4.4.4.1 "Expected balise group" shall be interpreted as an announced balise group whose expectation window is currently supervised by the on-board.

3.4.4.4.2 When the expected balise group is referred in the linking information with a balise group with ID not set to “unknown”, the ERTMS/ETCS on-board equipment shall reject the

message from any balise group marked as linked and not included in the linking information.

3.4.4.4.2.1 When the expected balise group is referred in the linking information with a balise group with ID “unknown”, the ERTMS/ETCS on-board equipment shall reject the message from any balise group marked as linked unless:

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.

3.4.4.4.2.2 Balise groups marked as unlinked shall be taken into account.

3.4.4.4.3 For each balise group marked as linked and included in the linking information, the ERTMS/ETCS on-board equipment shall check whether the balise giving the location reference of the group was detected (see SUBSET-036 sections 4.2.4.1 and 4.2.4.2) within its expectation window starting

- when the max safe antenna position has passed the first possible location of the balise group

and ending

- when the min safe antenna position has passed the last possible location of the balise group

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

3.4.4.4.3.2 The ERTMS/ETCS on-board equipment shall reject the message from a balise group whose location reference is detected outside its expectation window or whose location reference is received while its expectation window is no longer supervised.

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

3.4.4.4.5 The on-board equipment shall supervise only one expectation window at a time according to the order given by linking information and starting with the first announced balise group in advance of the train.

3.4.4.4.5.1 Upon reception of new linking information and after the replacement of previously stored linking information (if any), the first announced balise group in advance of the train shall be determined by the on-board equipment as the first one in the resulting linking information stored on-board, whose end of expectation window has not yet been reached.

3.4.4.4.6 The ERTMS/ETCS on-board equipment shall stop supervising the expectation window of a balise group and shall start supervising the expectation window of the next one announced in the linking information (if any) when one of the following events occurs:

a) the location reference of the group is detected (see SUBSET-036 sections 4.2.4.1 and 4.2.4.2) inside its expectation window

b) a linking consistency error is found, see 3.16.2.3.1

c) a balise group message consistency error is found, see 3.16.2.4.1

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 location reference received is the one of the next balise group 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.

3.4.4.4.6.2 Note: 3.4.4.4.6 a) implies that in case a balise group composed of more than one balise is crossed in nominal direction there will be other balise telegram(s) from this group still to be received once its expectation window is no longer supervised. Conversely, in case a balise group composed of more than one balise is crossed in reverse direction, the telegram(s) of the first balise(s) of this group might be received before its expectation window starts to be supervised.

3.4.4.4.7 In case the expected balise group is referred in the linking information with a balise group with ID not set to “unknown”, the ERTMS/ETCS on-board equipment shall reject the message from this group and trip the train if the balise group is passed in the unexpected direction.

3.4.4.5 Rules applicable to balise groups when linking consistency is not checked

3.4.4.5.1 All balise groups shall be taken into account.

3.4.5 Euroloop (level 1 only)

3.4.5.1 End Of Loop Marker (Euroloop announcement)

3.4.5.1.1 The End Of Loop Marker (EOLM) information is transmitted only by balise groups.

3.4.5.1.2 The balise group transmitting the EOLM information marks the beginning of a track area where loop messages can be received. In bidirectional applications, it is possible to have an EOLM at both sides of a loop.

3.4.5.1.3 The following information is included in the EOLM:

- Loop identity used to identify the loop.
- Key to select the spread spectrum key necessary to receive the loop messages.
- Distance to the loop giving the distance from the EOLM to the location from where the loop is installed.
- Length of the loop.
- Indicator telling the on-board whether the orientation of the loop (i.e. its nominal direction) is identical or opposite to the balise group orientation including the EOLM information.

3.4.5.1.4 The ERTMS/ETCS on-board equipment shall manage only one EOLM information at a time, therefore a new EOLM shall replace a previously stored one.

3.4.5.1.5 The loop area is defined as the track area from the reference location of the balise group from which the EOLM information has been received to the location determined by the distance to the loop plus the length of the loop.

3.4.5.1.6 After the min safe loop antenna position (calculated by subtracting the distance between the active Euroloop antenna and the front end of the train from the min safe front end position) has passed the start of the loop area, the ERTMS/ETCS on-board equipment shall delete the EOLM information as soon as the loop antenna position is outside the loop area, taking into account the min safe antenna position in case of movement in the direction of train orientation and the max safe antenna position in case of movement opposite to train orientation.

3.4.5.2 Rules related to Euroloop

3.4.5.2.1 The ERTMS/ETCS on-board equipment shall only accept information coming from a Euroloop if the loop identity referred in the loop message matches the loop identity referred in the EOLM information stored on-board.

3.4.5.2.2 The ERTMS/ETCS on-board equipment shall start accepting messages from the Euroloop as soon as its corresponding EOLM information is received.

3.4.5.2.3 The Euroloop information can be of the following type:

a) Non-infill.

b) Infill.

3.5 Management of Radio Communication

3.5.1 Introduction

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.

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

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 If the GSM-R radio system is installed on-board, the ERTMS/ETCS on-board equipment shall be able to manage simultaneous communication sessions established through GSM-R with at least two different entities.

3.5.2.5 Only the ERTMS/ETCS on-board equipment can initiate the establishment or the termination of a communication session.

3.5.2.6 The trackside has the following possibilities to order the initiation of establishment or termination of a communication session:

3.5.2.6.1 The session management order for RBC that includes:

a) The identity of the RBC.

b) The telephone number of the RBC (only if interfaced to GSM-R).

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

d) Whether the action applies also to Sleeping units.

3.5.2.6.2 The RBC transition order that embeds an order to establish a communication session with the Accepting RBC which includes:

a) The identity of the Accepting RBC.

b) The telephone number of the Accepting RBC (only if interfaced to GSM-R).

c) Whether the action to establish a communication session applies also to Sleeping units.

3.5.2.6.3 The Radio infill area information that embeds a session management order for RIU which includes:

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).

3.5.2.6.4 The session management order for neighbouring RIU that includes:

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 Establishing a communication session

3.5.3.1 Intentionally deleted.

3.5.3.2 Intentionally deleted.

3.5.3.3 Intentionally deleted.

3.5.3.4 The on-board shall establish a communication session

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

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)

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

e) When the engine rear end 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

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

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 with this RBC/RIU or
- is already established with this RBC/RIU and no Termination of Communication Session message has been sent to this RBC/RIU.

3.5.3.4.2 In respect of b), c), d), e) and h) of 3.5.3.4, in case a communication session is already established with this RBC/RIU and a Termination of Communication Session message has been sent to this RBC/RIU the on-board shall establish a new communication session with this RBC/RIU as soon as the already established communication session is terminated and the safe radio connection is released.

3.5.3.5 Intentionally deleted.

3.5.3.5.1 Intentionally deleted.

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 one or more other RBC(s), the existing communication session(s) shall be terminated (see 3.5.5.2 for details) and the new one shall be established.

3.5.3.5.2.1 Exception: an order to establish a communication session with an Accepting RBC, which is embedded in the RBC transition order, shall not terminate the communication session with the currently supervising RBC, unless the on-board equipment is only able to handle one communication session through GSM-R and the situation is such that a session must be established with another RBC (see 3.15.1.3.2.4 for details).

3.5.3.5.3 Intentionally deleted.

3.5.3.6 Intentionally deleted.

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. Upon reception of a session established report, the trackside shall acknowledge the establishment of the communication session to the on-board.

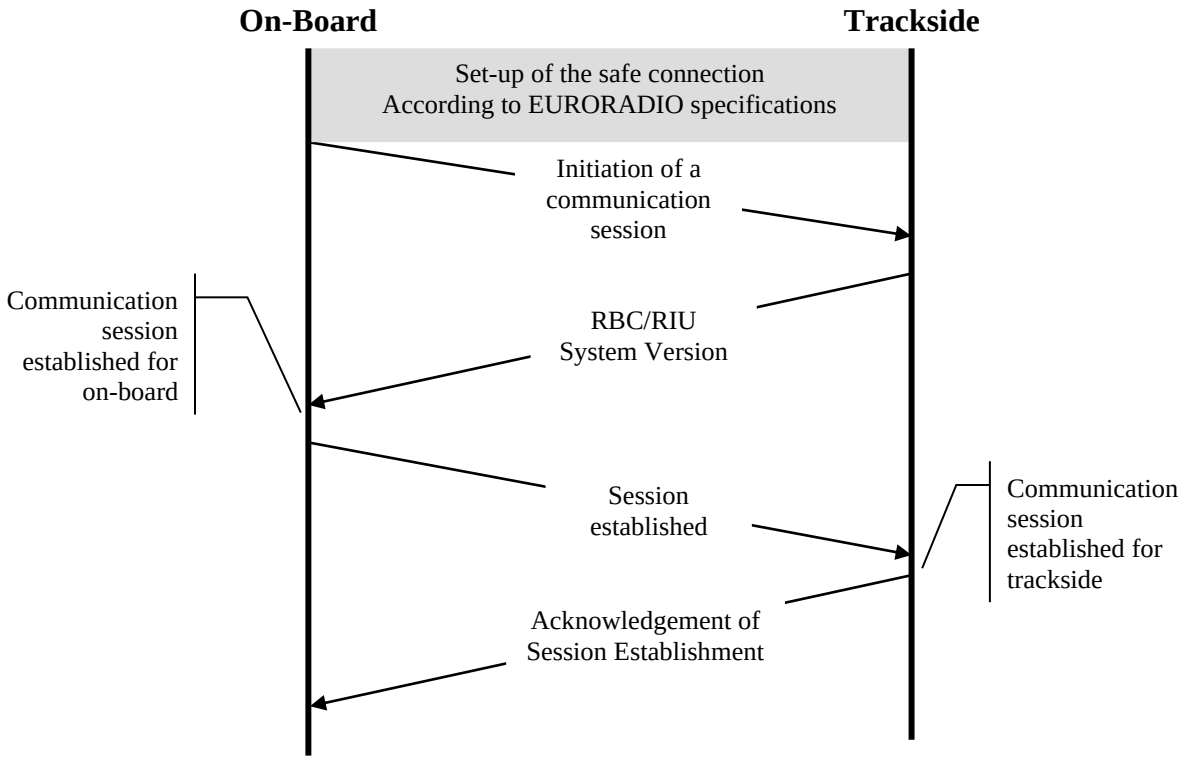


Figure 3: Establishment initiated by on-board

3.5.3.7.1 Regarding a), if both radio systems are installed on-board it shall request the set-up of a safe radio connection according to the following (by priority order):

1) In case of order received from trackside, depending on whether the order relates to an RBC interfaced with FRMCS only, OR

2) If the stored Radio Network type is FRMCS+GSM-R and if during the SoM the driver has elected to perform the mission with only one radio system, by using either the FRMCS on-board equipment or a GSM-R Mobile Terminal, depending on the radio system to which the registration was successful during the SoM, OR

3) According to the stored Radio Network information (Radio Network type and, if relevant, GSM-R Radio Network ID). If the Radio Network type is FRMCS+GSM-R, the ERTMS/ETCS on-board shall use, if available, the preferred radio system stored when establishing the previous communication session with the RBC (see SUBSET-037-1 for details)

3.5.3.7.2 Regarding b), if both radio systems are installed on-board it shall store the radio system through which the safe radio connection is successfully set up.

3.5.3.7.3 Exception to d): when the on-board does not receive the system version within a fixed waiting time (see A.3.1) it shall request the release of the safe radio connection with the trackside and shall restart the establishment of the communication session with step a).

3.5.3.7.4 Regarding e), in case the on-board has sent a session established report: when the on-board does not receive an acknowledgement of the establishment of the communication session within a fixed waiting time (see A.3.1), it shall again send a session established report to the trackside.

3.5.3.7.4.1 If, following the repetition of the session established report, the acknowledgement of session establishment is still not received within the fixed waiting time, the on-board shall terminate the communication session and re-establish a new one.

3.5.3.7.5 Exception to e): If the trackside receives a "Termination of communication session" message, instead of a session established report or the information that no compatible system version is supported by the on-board, it shall abort the process of session establishment and proceed with clause 3.5.5.2 b).

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 min safe rear end a level transition border from a level 2 area to an area where level 2 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 min safe rear end

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

h) Regards RIUs only: Level 1 is left

i) The driver elects to modify the Radio Network type or the GSM-R Radio Network ID

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 1: 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.

3.5.3.11.3 Note 2: the ‘EIRENE short number’ is a GSM-R only function. It is not used if the Radio Network type is FRMCS or is FRMCS+GSM-R while FRMCS is the only radio system installed on-board.

3.5.3.12 Intentionally deleted.

3.5.3.13 An order to establish a communication session with 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 contact information, 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 contact information stored on-board, the order to establish a communication session with the last known 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 establish a communication session with 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.

3.5.4 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 using the radio system through which the safe radio connection was successfully set up beforehand (see SUBSET-037-1 for details).

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 engine, taking into account its front and rear ends, overlaps an announced radio hole (see 3.12.1.3). The on-board equipment shall try to set it up again when the engine rear/front end reaches the end of the radio hole, depending on whether the train orientation is the same as/opposite to the active cab.

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.

3.5.4.6 When the trackside receives a session established report inside an existing communication session it shall acknowledge the establishment of the communication session to the on-board.

3.5.4.7 When the on-board receives a system version message inside an existing communication session it shall send a session established report.

3.5.4.7.1 Note: An RBC could repeat the system version message if it assumes that the message was not received by the on-board.

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 section 3.5.2 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.

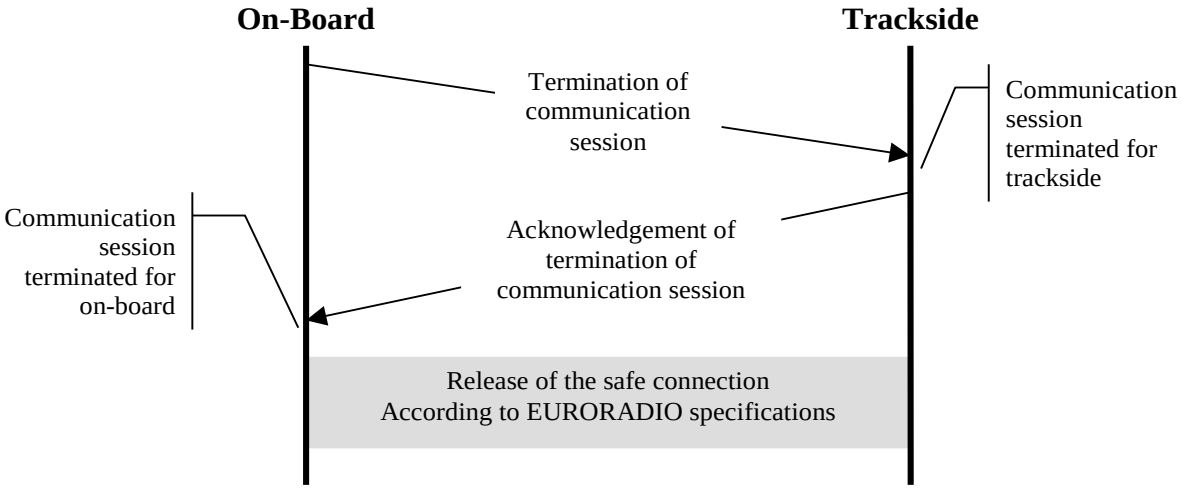


Figure 5: Termination of a communication session

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 Managing the Radio Networks

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

a) At power-up

b) Following driver entry of a new GSM-R Radio Network identity

c) If ordered from the trackside

3.5.6.1.1 In order to manage the transitions between different Radio Networks, the trackside can transmit Radio Network transition orders, which include:

a) The Radio Network type (FRMCS, FRMCS+GSM-R, or GSM-R)

b) Only if the Radio Network type is FRMCS+GSM-R or GSM-R, the GSM-R Radio Network identity

3.5.6.1.2 Note 1: Unlike the GSM-R Radio Networks, the FRMCS Radio Network can be seen by ETCS as one single entity without the need for ETCS to order the registration of its connected FRMCS on-board equipment to the FRMCS Radio Network or to manage the transitions between networks, which permits e.g. to not interrupt a radio connection on passing an international border where FRMCS is installed on both sides of the border.

3.5.6.1.3 Note 2: As soon as it is powered-up, the FRMCS on-board equipment reports continuously to the ETCS on-board equipment whether it is registered or not to the FRMCS radio network, i.e. that it is ready or not to establish a radio connection with an RBC.

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

3.5.6.3 If no GSM-R 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 GSM-R Radio Network.

3.5.6.3.1 Note 1: the source used to retrieve the default GSM-R 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 GSM-R 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 GSM-R Radio Network identity is received from trackside or from driver, preventing Mobile Terminal(s) from registering to any unwanted GSM-R Radio Network.

3.5.6.4 If no Radio Network type 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 use a default value configured on-board.

3.5.6.5 On reception of the Radio Network transition order, ERTMS/ETCS on-board equipment shall store the Radio Network type and, if the Radio Network type included in the order is FRMCS+GSM-R or GSM-R, it shall immediately order the Radio Network registration of each GSM-R Mobile Terminal that fulfils the following conditions:

a) it is not yet registered to the ordered GSM-R 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 GSM-R Mobile Terminal is not currently registered to the GSM-R 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 GSM-R Radio Network registration once communication session is terminated and safe radio connection is released.

3.5.6.7 Any order to establish a communication session with an RBC received from trackside shall not lead to any request to set-up a safe radio connection by ERTMS/ETCS on-board equipment if:

a) the stored Radio Network type is FRMCS or is FRMCS+GSM-R while FRMCS is the only radio system installed on-board and the FRMCS on-board is not registered to the FRMCS Radio Network, OR

b) the stored Radio Network type is FRMCS+GSM-R while both radio systems are installed on-board, and, unless the driver has elected to perform the mission with only one radio system, either the FRMCS on-board is not registered to the FRMCS Radio Network or no GSM-R Mobile Terminal is duly registered to a GSM-R Radio Network, OR

c) the stored Radio Network type is FRMCS+GSM-R while both radio systems are installed on-board, and, while the driver has elected to perform the mission with only one radio system, the concerned on-board radio system is no longer registered to the Radio Network, OR

d) the stored Radio Network type is GSM-R or is FRMCS+GSM-R while GSM-R is the only radio system installed on-board and no GSM-R Mobile Terminal is duly registered to a GSM-R Radio Network.

3.5.6.8 Any order to establish a communication session with an RIU received from trackside shall not lead to any request to set-up a safe radio connection by ERTMS/ETCS on-board equipment if no GSM-R Mobile Terminal is duly registered to a GSM-R Radio Network.

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) regarding the session establishment, see items b), c), d), e) in 3.5.3.4.

b) regarding 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 engine, taking into account its front and rear ends, overlaps 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 passed the border.

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 information are defined:

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

b) Information 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.

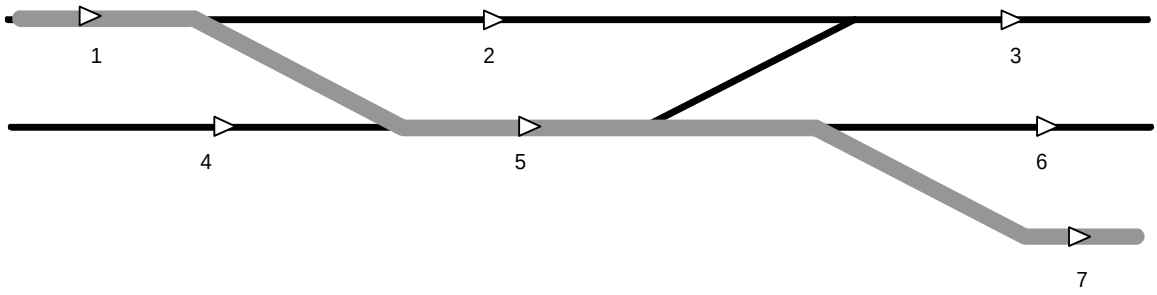


Figure 6: Actual route of the train

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 reference balise group, which is called LRBG (the Last Relevant Balise Group) in case the balise group is marked as linked and may be used for reporting the train position to the RBC (i.e. the balise group is LRBG compliant, see 3.6.2.2.2 a)), and/or in relation to other reference balise groups, which are called ORBGs (Other Reference Balise Groups).

It includes for each of the reference balise groups (LRBG/ORBGs):

- The estimated train front end position, defined by the estimated distance between the LRBG/ORBG and the front end of the train
- The train position confidence interval (see 3.6.4.1)
- Directional train position information in reference to the balise group orientation (see 3.4.2, also Figure 14) of the LRBG/ORBG, regarding:
  - the position of the train front end (nominal or reverse side of the LRBG/ORBG)
  - the train orientation
  - the train running direction

The ORBGs are at least the seven previous LRBGs last reported to the RBC, which may alternatively be used by trackside for referencing location dependent information (see 3.6.2.2.2 c)), the balise groups used as reference by information stored in any of the transition buffers (see section 4.8), and either the last passed balise group marked as unlinked or the last two passed balise groups marked as unlinked if there is no balise group marked as linked in between.

3.6.1.3.1 Note: the train position information in relation to an ORBG is necessary to relocate all location based information to the Single On-board Location Reference (SOLR), in case no linking distance can be used (see section 3.6.4.2).

3.6.1.3.2 The status of the Train Position information (see 3.6.1.3) is defined as unknown in case neither a train position in relation to an LRBG nor in relation to an ORBG is stored on-board.

3.6.1.3.3 Note: After the ERTMS/ETCS on-board equipment has been powered-off, a stored train position remains in status “invalid” until it is either revalidated (status becomes “valid”) or deleted (status becomes “unknown”).

3.6.1.3.4 The front end of the train refers to the front end of the engine with regards to the train orientation. Exception: In Stand-By mode while no valid Train Data is available but the safe consist length information is available, in Supervised Manoeuvre requests, and from the time the first Supervised Manoeuvre authorisation is received to the time the mission is either ended or continued in Non Leading mode, the estimated front end of the train takes into account the nominal consist length in front of/in rear of the engine depending on whether the train orientation is the same as/opposite to the active cab.

3.6.1.4 When the train position is unknown or invalid, the ERTMS/ETCS on-board equipment shall consider that a valid train position is stored on-board as soon as an LRBG or an ORBG has been passed and any previously stored invalid train position shall be deleted.

3.6.1.4.1 Intentionally deleted.

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 determining the front of the train. If no cab is active, the train orientation shall be defined by the last active cab.

3.6.1.5.1 Exception: from the time the first Supervised Manoeuvre authorisation is received to the time the mission is either ended or continued in Non Leading mode, the train orientation shall be determined by the direction of the Movement Authority in the last received Supervised Manoeuvre authorisation, regardless of the position of the engine in the shunting consist and of which of its cab(s) is active.

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

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

3.6.1.7 The min safe rear end position shall be calculated by subtracting from the min safe front end position, the train length stored as valid Train Data or if no valid Train Data is available but the safe consist length information is available:

- the min safe consist length in front of the engine and the max safe consist length in rear of the engine, if the train orientation is the same as the active cab, or
- the min safe consist length in rear of the engine and the max safe consist length in front of the engine, if the train orientation is opposite to the active cab.

3.6.2 Location reference 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 as a reference for reporting the train position to the RBC the last passed LRBG compliant balise group that fulfils the conditions of the clause 3.6.5.1.8.

This balise group is termed as $LRBG_{ONB}$ in the following.

Only

- balise groups marked as linked and contained in the previously received linking information, if linking consistency is checked on-board

or

- balise groups not marked as unlinked, if linking consistency was not checked when such a balise group was passed

shall be regarded as LRBG compliant balise groups.

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.

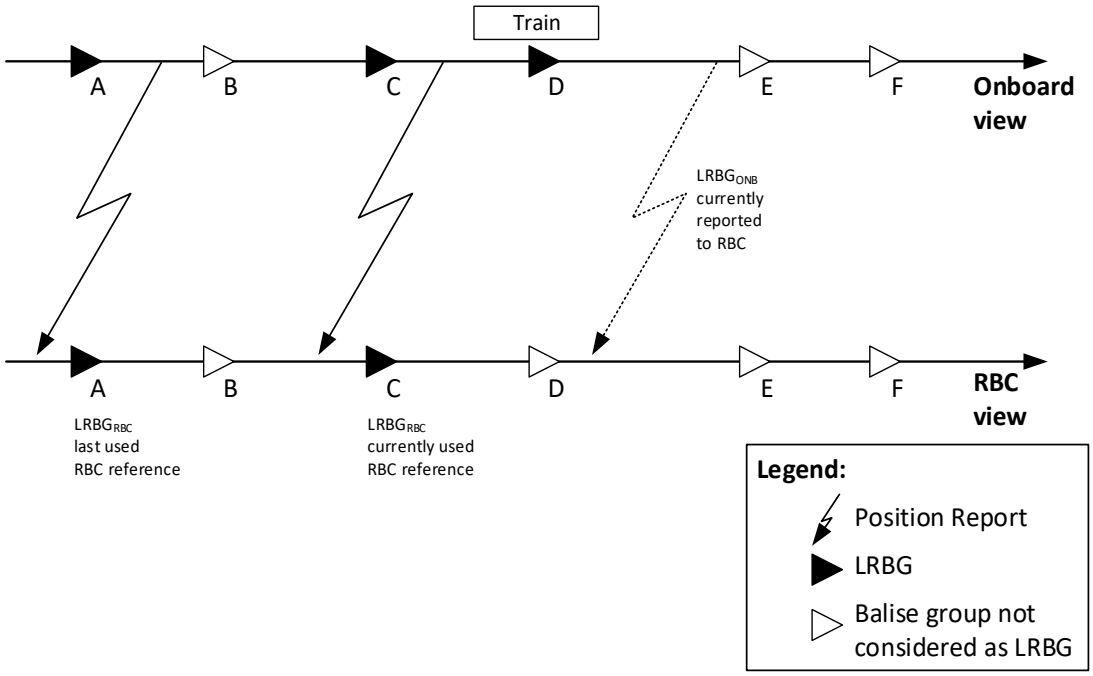
c) The on-board equipment shall be able to accept information referring to one of at least eight $LRBG_{ONB}$ last reported to the RBC.

3.6.2.2.2.1 Exception to a): When the train position is unknown, or when position data has been deleted during SoM procedure, or when the train position is valid or invalid but only referred to a balise group marked as unlinked, the on-board equipment shall use an LRBG identifier set to "unknown" until the onboard has passed an LRBG compliant balise group that fulfils the conditions of the clause 3.6.5.1.8.

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 passed an LRBG compliant balise group that fulfils the conditions of the clause 3.6.5.1.8.

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)

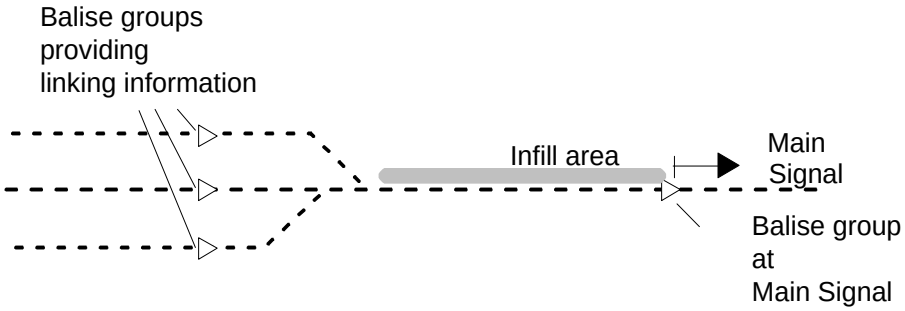


Figure 9: Routes Join in Rear of InFill Area

- 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.

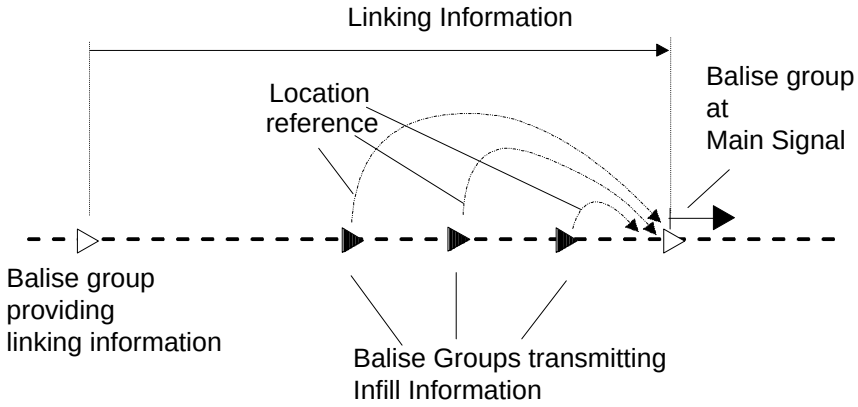


Figure 10: Location referencing of infill information transmitted by balise groups

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 Intentionally deleted

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 LRBG orientation for information sent by radio

b) the balise group orientation for information sent by this balise group

c) the loop orientation (which refers itself to the orientation of the balise group transmitting the EOLM information, see 3.4.5.1.3) for information sent by this loop

3.6.3.1.2 Data transmitted to the on-board equipment shall be identified as being valid for

a) both directions

b) the nominal direction

c) the reverse direction

of the referenced balise group (for information sent by balise or radio) or of the loop (for information sent by loop).

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 the train orientation. Other information shall be ignored.

3.6.3.1.3.1 Exception 1: for SL, PS and SH engines, balise group crossing direction shall be considered.

3.6.3.1.3.2 Exception 2: information in a Supervised Manoeuvre authorisation shall be taken into account also when its validity direction is opposite to that of the current train orientation

3.6.3.1.4 If the train orientation cannot be referred to a direction of the trackside device to which the transmitted information refers (or for SL, PS and SH engines if the balise group crossing direction 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).

3.6.3.1.4.1 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) valid for one direction only 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.

3.6.3.1.4.2 Note: the clause 3.6.3.1.4 applies for example if no co-ordinate system has been assigned to a single balise group.

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

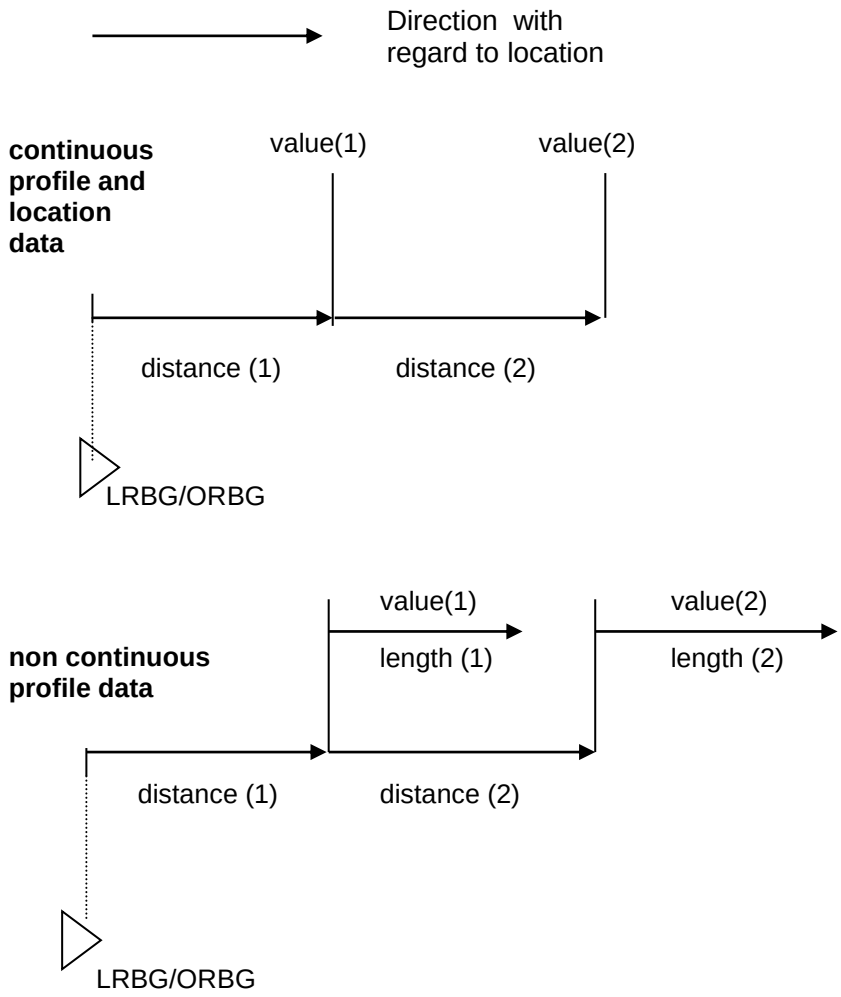


Figure 12: General Structure of location and profile data

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.

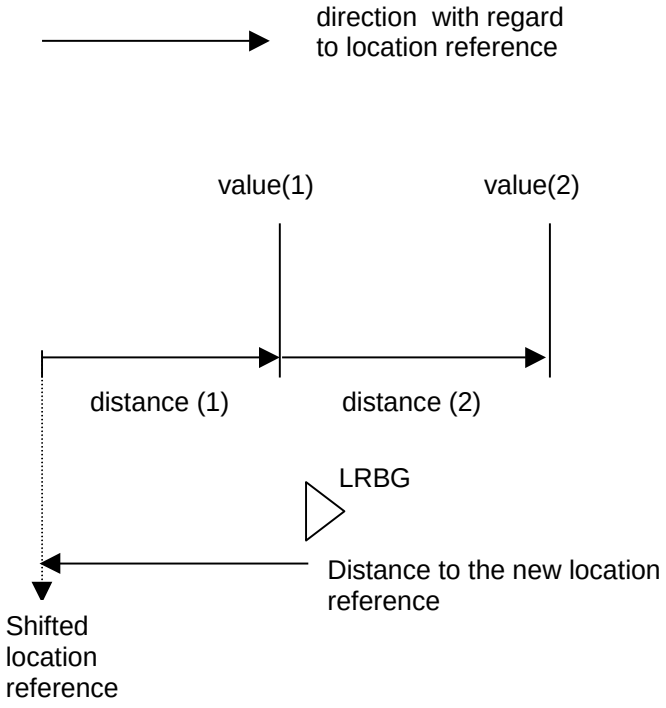


Figure 13: Shifted Location Reference (shown for continuous data /location profile, but also valid for non continuous data profile).

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 Train Position Confidence Interval

3.6.4.1.1 The confidence interval to the train position refers to the distance to the reference balise group and takes into account

a) On-board over-reading amount and under-reading amount, which include among other things the odometer accuracy and the error in detection of the balise group location reference.

b) The location accuracy of the reference balise group.

3.6.4.1.2 Note: The confidence interval increases in relation to the distance travelled from the reference balise group depending on the accuracy of odometer equipment.

3.6.4.1.3 The value of the Location Accuracy shall be determined by Linking information when it becomes available, or, if it has not been previously determined by Linking information when the balise group becomes LRBG or ORBG, by the corresponding National Value or the corresponding Default Value if the National Value is not applicable.

3.6.4.1.4 Once the location accuracy of a balise group has been determined according to the clause 3.6.4.1.3, it shall not be updated (e.g. neither upon reception of further Linking information, nor when linking is no longer checked, nor when new National Values becomes applicable).

3.6.4.1.5 The confidence interval to the train front end position shall be delimited by:

a) The min(imum) safe front end position, which is in rear (in relation to the orientation of the train) of the estimated train front end position at a distance calculated as follows:

$$L_{doubtover} = Q_{locacc-refBG} + \text{overreading amount} + \gamma \cdot L_{trainover}$$

b) The max(imum) safe front end position, which is in advance (in relation to the orientation of the train) of the estimated train front end position at a distance calculated as follows:

$$L_{doubtunder} = Q_{locacc-refBG} + \text{underreading amount} + \gamma \cdot L_{trainunder}$$

With $\gamma = 1$ only in Stand-By mode while no valid Train Data is available but the safe consist length information is available, in Supervised Manoeuvre requests, and from the time the first Supervised Manoeuvre authorisation is received to the time the mission is either ended or continued in Non Leading mode, and with $L_{trainover}$ & $L_{trainunder}$ determined as follows:

- $L_{trainunder}$ is the difference between the Train Data max safe consist length and nominal consist length in front of/in rear of the engine, depending on whether the train orientation is the same as/opposite to the active cab respectively.
- $L_{trainover}$ is the difference between the Train Data nominal consist length and min safe consist length in front of/in rear of the engine, depending on whether the train orientation is the same as/opposite to the active cab respectively.

Otherwise $\gamma = 0$

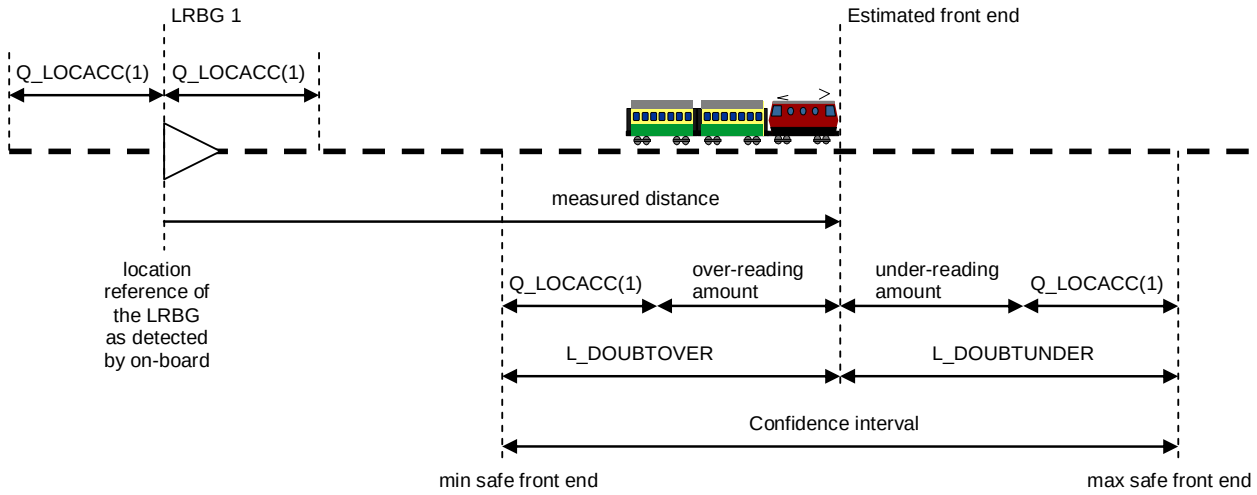


Figure 13a: Train confidence interval and train front end position in reference to LRBG

3.6.4.2 Relocation

3.6.4.2.1 The relocation consists in changing the reference location of all location based information handled by the ERTMS/ETCS on-board equipment, so that as soon it is used and at any further time it is referred to the Single On-board Location Reference (SOLR).

3.6.4.2.2 The Single On-board Location Reference (SOLR) shall be:

a) the last received balise group that is the reference of linking information or that is announced in linking information (including if it is announced with a balise group with ID “unknown” and it contains repositioning information), while the linking consistency is checked (see 3.4.4.2.1.1), or

b) the last received balise group, while no linking consistency is checked.

3.6.4.2.2.1 Exception to 3.6.4.2.2 b): when exiting No Power mode, the SOLR shall be set to the stored LRBG if any.

3.6.4.2.2.2 Whenever linking information is received (e.g. when it is released from the transition buffer), the clause 3.7.3.1 m) shall be applied before this clause 3.6.4.2.2. For all other information, any relocation to the SOLR resulting from this clause 3.6.4.2.2 shall take place before the corresponding item of the clause 3.7.3.1 is applied.

3.6.4.2.2.3 Note: the SOLR is generally equal to the $LRBG_{ONB}$. For some cases however, like the transition to level 1/2 area, it might be possible that the linking information released from the transition buffer provokes the change of SOLR to a former LRBG in case this information does not announce every balise group in rear of the border (see Figure 13e).

3.6.4.2.3 Before it can be relocated, all location based information received from trackside shall be first processed by the on-board equipment into a series of individual location items each of them being referred to an individual distance to the reference balise group of the location based information, this distance being counted positive/negative depending on whether the location item is in advance of/in rear of the reference balise group with regards to the train orientation.

3.6.4.2.4 For a given location based information (e.g. EOA), up to three individual location items can be defined, as stipulated in Table 2a. Whenever a (or a part of a) clause of the ETCS specifications is mentioned in this Table 2a, it shall be applied by the ERTMS/ETCS on-board equipment using the corresponding types of location item.

Information	Location	"min" location item	"estimated" location item	"max" location item
National Values	start of validity		3.18.2.3	
Linking	balise group(s) first possible location			3.4.4.4.3 1st bullet together with 3.4.4.4.3.1
	balise group(s) last possible location	3.4.4.4.3 2nd bullet together with 3.4.4.4.3.1		
Movement Authority	section ends	3.8.5.1 b) (MA partially replaced)	3.8.5.2.2 (determination of the current section)	3.8.4.2.2 a) (SvL withdrawal) Other clauses in row EBD based target
		3.8.4.2.2 a) & c) (EOA/LOA withdrawal) Other clauses in row EOA	3.8.4.2.2 a) & c) (EOA/LOA withdrawal) Other clauses in row EOA	
	section timer stop locations	3.8.4.2.3 3.8.4.2.4 3.8.4.2.5		
	End Section timer start			3.8.4.1.1 3.8.4.1.3 3.8.4.1.4
	Overlap timer start			3.8.4.4.1 3.8.4.4.4 3.8.4.4.5
	End of MA as EOA	3.8.4.3.2, 3.8.4.4.2 c) (LOA becomes EOA) Other clauses in row EOA	3.8.4.3.2, 3.8.4.4.2 c) (LOA becomes EOA) Other clauses in row EOA	
		3.10.2.2 b) 1st & 2nd bullets (comparison vs. CES stop loc.)		

Information	Location	"min" location item	"estimated" location item	"max" location item
	End of MA as LOA	3.10.2.2 b) 1st & 4th bullets (comparison vs. CES stop loc.) 3.12.4.7 b) & c) (comparison vs. Mode Profile area start)		See clauses in row EBD based target
		3.13.10.2.6 a) 3.13.10.2.7 4.4.19.1.4 a) 4.6.3 [12], [16] & [43]		
		SUBSET-041 § 5.2.1.9 SUBSET-041 § 5.2.1.13		
	End of MA as SvL			3.8.4.5.1 c) Other clauses in row EBD based target
				3.10.2.2 b) 2nd & 3rd bullet (comparison vs. CES stop loc.)
	Danger Point as SvL			3.8.4.5.1 b) Other clauses in row EBD based target
	End of overlap as SvL			3.8.4.5.1 a) Other clauses in row EBD based target
Signalling related speed restriction from an infill device	start	Not relevant Justification: The signalling speed restriction received by infill MA can only be accepted if the infill reference is known by linking with known ID. Moreover, SOLR at that time is also part of linking, because the existence of BG(s) announced by linking provokes a change of SOLR by 3.6.4.2.2a. As a consequence, the start location of this infill signalling speed restriction is always relocated through linking distance as per 3.6.4.2.5a, so that its classification as "min", "max" or "estimated" location item has no influence.		
Mode Profile	acknowledgement area start(s)		5.7.3.2 a) 5.9.3.2 a) 5.19.3.2 a)	
			4.6.3 [73], [74], [75] & [76], 4.8.4 [10] (sub-condition “The estimated front end of the train is not inside an OS/LS acknowledgement area”)	

Information	Location	"min" location item	"estimated" location item	"max" location item
	area start(s)	3.12.4.7 (Temporary EOA) Other clauses in row EOA	3.12.4.7 (Temporary EOA) Other clauses in row EOA	4.6.3 [10], [25], [31], [32], [34], [40], [71], [72], [73], [74], [75] & [76], 4.8.4 [9] & [10] (Check of train position confidence interval vs. MP area)
				4.6.3 [51], [61] 5.7.3.6 5.7.4.1 5.9.2.2 5.9.3.7 5.9.5.1 5.19.2.2 5.19.3.7 5.19.5.1
			4.6.3 [73], [74], [75] & [76] (sub-condition "The estimated front end of the train is not inside an OS/LS acknowledgement area")	3.12.4.3.1 b) & c)
				3.12.4.7 a) (temporary SvL) 3.12.4.7 b) (comparison with LOA location) 3.12.4.7 c) (temporary SvL and comparison with LOA location)
				3.13.7.2 together with 3.11.2.2 f) (start of speed element for MRSP) Other clauses in row EBD based target
				A.3.4.1.3 [7] A.3.4.1.3 [12]
	area end(s) (**)	4.6.3 [10], [25], [31], [32], [34], [40], [71], [72], [73], [74], [75] & [76], 4.8.4 [9] & [10] (Check of train position confidence interval vs. MP area)		
		5.9.2.2 5.9.5.1 5.9.6.1.1 5.19.2.2 5.19.5.1 5.19.6.1.1		

Information	Location	"min" location item	"estimated" location item	"max" location item
		3.13.7.2 together with 3.11.2.2 f) & 3.13.2.3.2.1 (end of speed element for MRSP) 3.15.10.2 A.3.4.1.3 [14]		
Gradient Profile	profile start (***)	3.7.3.1.2 together with 3.7.3.1 b) (replacing profile: end of the overlap distance between replaced profile and replacing profile)	3.7.2.3 together with 3.7.2.3.1 & 3.7.2.3.2 (comparison vs. train front to determine full coverage of the MA) 4.6.3 [69]	3.7.3.1.2 together with 3.7.3.1 b) (replacing profile: start of the overlap distance between replaced profile and replacing profile)
	Change(s) to lower value		3.13.4.2.1 (A_gradient(d) for 3.13.6.3.1.3 & 3.13.6.4.3) 3.13.6.4.3 (grad(d)) 3.15.10.3	3.13.4.2.1 (A_gradient(d) for 3.13.6.2.1.3)
	Change(s) to higher value	3.13.4.2.1 (A_gradient(d) for 3.13.6.2.1.3)	3.13.4.2.1 (A_gradient(d) for 3.13.6.3.1.3 & 3.13.6.4.3) 3.13.6.4.3 (grad(d)) 3.15.10.3	
	profile end (*)	3.7.3.1 b) (profile partially replaced)		3.7.2.3 together with 3.7.2.3.1 & 3.7.2.3.2 (comparison vs. SvL to determine full coverage of the MA)
International SSP	profile start (***)	3.7.3.1.1 together with 3.7.3.1 a) (replacing profile: end of the overlap distance between replaced profile and replacing profile)	3.7.2.3 together with 3.7.2.3.1 & 3.7.2.3.2 (comparison vs. train front to determine full coverage of the MA)	3.7.3.1.1 together with 3.7.3.1 a) (replacing profile: start of the overlap distance between replaced profile and replacing profile)
		3.13.7.2 together with 3.11.2.2 a) & 3.13.2.3.2.1 (replacing profile: start/end of SSP element for MRSP if, at this location, the speed of the element of the replacing profile, taking into account the possible relocation of change(s)	4.6.3 [69]	3.13.7.2 together with 3.11.2.2 a) & 3.13.2.3.2.1 (replacing profile: start/end of SSP element for MRSP, if the speed of the 1st element of the replacing profile is lower than the speed of the element of the replaced profile at this location)

Information	Location	"min" location item	"estimated" location item	"max" location item
		to lower value in rear of this location, is higher than the speed of the element of the replaced profile)		No profile previously stored on-board or replaced profile: 3.13.7.2 together with 3.11.2.2 a) & 3.13.2.3.2.1 (start of 1st SSP element for MRSP)
	Change(s) to lower value			3.13.7.2 together with 3.11.2.2 a) & 3.13.2.3.2.1 (start/end of SSP element for MRSP) Other clauses in row EBD based target
	Change(s) to higher value	3.13.7.2 together with 3.11.2.2 a) & 3.13.2.3.2.1 (start/end of SSP element for MRSP) 3.15.10.2		
	profile end (*)	3.7.3.1 a) (profile partially replaced)		3.7.2.3 together with 3.7.2.3.1 & 3.7.2.3.2 (comparison vs. SvL to determine full coverage of the MA)
		3.13.7.2 together with 3.11.2.2 a) & 3.13.2.3.2.1 (end of last SSP element for MRSP) 3.15.10.2		
Axle load speed profile	resume initial state	3.7.3.2 b)		
	1st area start	3.7.3.1.3 together with 3.7.3.1 c) (replacing profile: end of the overlap distance between replaced profile and replacing profile)		3.7.3.1.3 together with 3.7.3.1 c) (replacing profile: start of the overlap distance between replaced profile and replacing profile)
	area start(s) (***)			3.13.7.2 together with 3.11.2.2 b) & 3.13.2.3.2.1 (start of speed element for MRSP) Other clauses in row EBD based target
	area end(s) (*)	3.13.7.2 together with 3.11.2.2 b) & 3.13.2.3.2.1 (end of speed element for MRSP) 3.15.10.2		
Level Transition Order	acknowledgement area start			5.10.4.1 a)

Information	Location	"min" location item	"estimated" location item	"max" location item
	border	3.13.7.2 together with 3.11.2.2 h) & 3.13.2.3.2.1 (end of speed element for MRSP) 3.15.10.2 3.5.3.8 d) 3.6.5.1.4 f) 5.10.3.3.3 5.10.3.3.5 5.10.3.6.2 5.10.3.6.5 5.10.3.10.3 5.10.3.10.6	5.10.1.5 5.10.2.9 a) 5.10.3.7.5	3.13.7.2 together with 3.11.2.2 g) & h), 3.13.2.3.2.1 (start of speed element for MRSP) Other clauses in row EBD based target
Position Report parameters	location to report with min safe rear end	3.6.5.1.5 c)		
	location to report with max safe front end			3.6.5.1.5 c)
SR distance information from loop	distance in SR mode		4.6.3 [42] 5.8.4.1 h)	4.4.11.1.3.1 c) Other clauses in row EBD based target
Temporary Speed Restriction	area start (***)			3.13.7.2 together with 3.11.2.2 c), 3.13.2.3.2.1 (start of speed element for MRSP) Other clauses in row EBD based target
	area end (*)	3.13.7.2 together with 3.11.2.2 c) & 3.13.2.3.2.1 (end of speed element for MRSP) 3.15.10.2		
Route Suitability Data	resume initial state	3.7.3.2 d)		
	unsuitability location(s)		3.12.2.4 (Temporary EOA) Other clauses in row EOA	3.12.2.4 (Temporary SvL) Other clauses in row EBD based target
Adhesion Factor	slippery rail area start (***)			3.13.5.3 3.13.6.2.1.3
	slippery rail area end	3.13.5.3 3.13.6.2.1.3		
Plain/Fixed Text Information	start display		3.12.3.4.2 1st bullet A.3.4.1.3 [8] A.3.4.1.3 [13]	
	end display		3.12.3.4.3 1st bullet	
Geographical Position	offset from the location reference		3.6.6.1 together with 3.6.6.10 2nd bullet 3.6.6.4.2	

Information	Location	"min" location item	"estimated" location item	"max" location item
RBC Transition Order	border	3.5.3.8 f) 3.5.7.6 b) 3.6.5.1.4 e) 3.15.1.3.1 c) 3.15.1.3.9 4.6.3 [84]	3.15.1.3.7	3.5.7.6 a) 3.6.5.1.4 k) 3.11.5.14 2nd bullet 3.15.1.3.1 b) 3.15.1.3.2 3.15.1.3.5 3.15.1.3.6 3.17.2.8 c) & e) 4.6.3 [84] 5.15.1.4
Radio Infill Area information	location where to connect/disconnect		3.9.3.5 3.9.3.10 a)	
EOLM information	loop area start			3.4.5.1.6 together with 3.4.5.1.5
	loop area end	3.4.5.1.6 together with 3.4.5.1.5		
Track Condition…	resume initial state	3.7.3.2 c)		
…powerless section with pantograph to be lowered	area start	5.20.2.3 5.20.2.4		3.7.3.1 g) 3.12.1.2.1 3.15.10.2 5.18.2.2 5.18.2.3 5.20.2.2 5.20.2.3 1st bullet
	area end (*)	3.12.1.2.1.3 3.15.10.2 5.18.2.5 5.18.2.6 5.20.2.3 2nd bullet 5.20.2.4 5.20.2.5		
…powerless section with main power switch to be switched off	resume initial state	3.7.3.2 c)		
	area start	5.20.3.3 5.20.3.4		3.7.3.1 g) 3.12.1.2.1 3.15.10.2 5.18.3.2 5.18.3.3 5.20.3.2 5.20.3.3 1st bullet
	area end (*)	3.12.1.2.1.3 3.15.10.2 5.18.3.4 5.18.3.5 5.20.3.3 2nd bullet 5.20.3.4 5.20.3.5		
…non stopping area	resume initial state	3.7.3.2 c)		

Information	Location	"min" location item	"estimated" location item	"max" location item
	area start			3.7.3.1 g) 3.12.1.2.1 3.15.10.2 5.18.4.2 a) & b) 5.18.4.3 5.18.4.4
	area end (*)	3.12.1.2.1 3.15.10.2 5.18.4.2 b) & c)		
…radio hole	resume initial state	3.7.3.2 c)		
	area start		3.5.3.8 g) 3.5.4.4 3.7.3.1 g) 3.12.1.2.1.5 3.15.10.2 3.16.3.4.1.3 5.18.5.2	
	area end (*)		3.5.3.4 e) 3.5.4.4 3.5.7.5 (table 2 [7]) 3.15.10.2 3.16.3.4.1.3 5.18.5.3	
…air tightness	resume initial state	3.7.3.2 c)		
	area start			3.7.3.1 g) 3.12.1.2.1 3.15.10.2 5.18.6.2 5.18.6.3 5.20.4.2 5.20.4.3 5.20.4.4
	area end (*)	3.12.1.2.1 3.15.10.2 5.18.6.4 5.18.6.5 5.20.4.3 5.20.4.4 5.20.4.5		
…inhibition of special brake	resume initial state	3.7.3.2 c)		

Information	Location	"min" location item	"estimated" location item	"max" location item
	area start			3.7.3.1 g) 3.12.1.2.1 3.13.5.1 3.13.6.2.1.5 3.13.6.3.1.4 3.13.6.4.4 3.15.10.2 5.18.7.3 5.18.7.4 5.20.5.3 5.20.5.4 5.20.5.5
	area end (*)	3.12.1.2.1 3.15.10.2 5.18.7.5 5.20.5.4 5.20.5.5 5.20.5.6		
…tunnel stopping area	resume initial state	3.7.3.2 c)		
	area start		3.7.3.1 g) 3.12.1.2.1.4 5.18.8.4 5.18.8.5	
	area end (*)		3.12.1.2.1.4 5.18.8.3	
…sound horn	resume initial state	3.7.3.2 c)		
	area start		3.7.3.1 g) 3.12.1.2.1.4 3.15.10.2 5.18.9.2	
	area end (*)		3.12.1.2.1.4 3.15.10.2 5.18.9.3	
…change of traction system	change	5.18.10.6 5.20.6.3 5.20.6.4		3.12.1.2.1 3.15.10.2 5.18.10.2 5.18.10.5 5.20.6.2 5.20.6.3 1st bullet
…change of allowed current consumption	change	5.20.7.4 5.20.7.5		3.12.1.2.1 5.20.7.2 5.20.7.4 1st bullet
…station platform	resume initial state	3.7.3.2 e)		
	area start	5.20.8.4 5.20.8.5		3.7.3.1 o) 3.12.1.2.1 5.20.8.2 5.20.8.4 1st bullet

Information	Location	"min" location item	"estimated" location item	"max" location item
…Big Metal Mass	area end (*)	3.12.1.2.1.3 5.20.8.4 5.20.8.5 5.20.8.6		
	area start (***)			3.7.3.1 f) 3.12.1.2.1.2 5.22.3.1 5.22.5.2.1
	area end (*)	3.12.1.2.1.2 5.22.3.1		
Conditional Emergency Stop	stop location	3.10.2.2 a) 3.10.2.2 b) (comparison vs. train front) 4.8.5.7	3.10.2.2 b) 1st bullet (EOA withdrawal or LOA withdrawal to EOA) 3.10.2.2 b) 4th bullet (LOA withdrawal to EOA) Other clauses in row EOA	3.10.2.2 b) 1st bullet (comparison vs. EOA/LOA) 3.10.2.2 b) 2nd bullet (comparison vs. EOA & SvL) 3.10.2.2 b) 3rd bullet (comparison vs. SvL) 3.10.2.2 b) 4th bullet (comparison vs. LOA)
		3.10.2.2 b) 1st bullet (EOA withdrawal or LOA withdrawal to EOA) 3.10.2.2 b) 4th bullet (LOA withdrawal to EOA) Other clauses in row EOA		3.10.2.2 b) 1st, 2nd bullets (SvL withdrawal) 3.10.2.2 b) 4th bullet (LOA withdrawal to SvL) Other clauses in row EBD based target
				3.10.2.2 b) last sentence (A.3.4.1.3 [1])
Track Ahead Free Request	area start		3.15.5.2 a)	
	area end		3.15.5.2 b)	
Reversing Area Information	area start		3.15.4.4 5.13.1.3	
	area end (*)		3.15.4.4 5.13.1.3	
	Reference location for reversing distance		3.15.4.2.1	
	end of RV distance		3.15.4.8	
Permitted Braking Distance Information	resume initial state	3.7.3.2 a)		
	1st area start	3.7.3.1.4 together with 3.7.3.1 d) (replacing profile: end of the overlap distance between replaced profile and replacing profile)		3.7.3.1.4 together with 3.7.3.1 d) (replacing profile: start of the overlap distance between replaced profile and replacing profile)

Information	Location	"min" location item	"estimated" location item	"max" location item
	area start (***)			3.13.7.2 together with 3.11.2.2 k), 3.13.2.3.2.1 (start of speed element for MRSP) Other clauses in row EBD based target
	area end (*)	3.13.7.2 together with 3.11.2.2 k), 3.13.2.3.2.1 (end of speed element for MRSP) 3.15.10.2		
Level Crossing information	stopping area start		5.16.2.1	
	area start (***)	3.12.5.8 (temporary EOA) Other clauses in row EOA	3.12.5.8 (temporary EOA) Other clauses in row EOA 5.16.2.1	3.12.5.8 (temporary SvL) 3.13.7.2 together with 3.11.2.2 i), 3.13.2.3.2.1 (start of speed element for MRSP) Other clauses in row EBD based target
	area end	3.13.7.2 together with 3.11.2.2 i), 3.13.2.3.2.1 (end of speed element for MRSP) 3.15.10.2 5.16.1.5		
Confirmed train length *(computed on-board for train integrity reporting)*	min safe rear end at the time the train was last known to be integer			3.6.5.2.4 Table 2c [3] & [9]
EOA	*(corresponds to other location items as listed above or, for A.3.4.1.3 [11] to the estimated train front at the time of the MA shortening)*	3.13.9.4.8.2 (for d_EOA used without 10% coefficient in d_tripEOA formula) 3.13.10.2.6 a) 3.13.10.2.7 4.6.3 [12], [16] & [43] 4.4.19.1.4 a) 5.8.4.1 c)	3.8.6.1 b) 3.13.8.2.1 c) 3.13.9.4.8.2 (for d_EOA used with 10% coefficient in d_tripEOA formula) 3.15.10.2 3.15.10.4 A.3.4.1.3 [11] 5.16.3.2	3.13.10.2.6 b)
		SUBSET-040 § 4.2.4.5.3 SUBSET-040 § 6.2.1.1.2	SUBSET-125 §10.2.7.15	
		SUBSET-041 § 5.2.1.9 SUBSET-041 § 5.2.1.13		

Information	Location	"min" location item	"estimated" location item	"max" location item
EBD based target: SvL, LOA, start location of MRSP element, maximum permitted distance to run in SR	*(corresponds to other location items as listed above or, for A.3.4.1.3 [11] to the max safe train front at the time of the MA shortening)*			3.8.6.1 b) 3.13.8.2.1 a), b), c) & d) 3.13.9.4.8.2(for EBD) 3.13.11.7.1 3.13.11.7.1.1 3.13.11.7.1.2 3.15.10.2 3.15.10.4 A.3.4.1.3 [11] 5.16.3.2
				SUBSET-125 §10.2.7.3 a) & b) SUBSET-125 §10.2.7.9 a) & b) SUBSET-125 §10.2.7.15

(*): depending on whether A.3.4.1.3 [1] or [10] is applied, this may no longer be the area/profile end transmitted by the trackside

(**): depending on whether A.3.4.1.3 [1], [10] or [14] is applied, this may no longer be the area end transmitted by the trackside

(***): depending on whether A.3.6.2.1 is applied, this may no longer be the area/profile start transmitted by the trackside

Table 2a: Correspondence between location items and clauses in the ETCS specifications using them

3.6.4.2.4.1 Note 1: an individual location based information can be classified as several types of location items. For example, the EOA location is an "estimated" location item to define SBD foot, a "min" location item to provoke entry into Trip mode and a "max" location item if it defines the SvL. As a second example, a single TSR encompasses two location items, i.e. a "max" location item at its start location and a "min" location item at its end location. Classification of TSR location item, as true for any Speed Restriction, is indirectly deduced from the fact that V_MRSP is obtained with the min safe front end and the max safe front end of the train as per clause 3.13.10.2.8.

3.6.4.2.4.2 Note 2: in general (but not necessarily for all the functions), an “estimated”/”min”/”max” location item is used to apply a clause when this latter involves a comparison against the estimated front end position/min safe rear end position or the min safe antenna position/ max safe front end position or the max safe antenna position.

3.6.4.2.4.3 Note 3: as long as linking distance(s) can be used to perform the relocation, several items associated to a given location based information will be referred with the same distance to the SOLR by the on-board. Otherwise, these location items (e.g. “min”, “estimated” and “max” MA section ends) will be referred to the SOLR with different distances, after a relocation as per clause 3.6.4.2.5 b) or c) has taken place.

3.6.4.2.5 When a balise group becomes the SOLR or when evaluating (see section 4.8) location based trackside information, which is referred to a balise group different from the SOLR, every location item shall be relocated to the SOLR by subtracting from the distance to its former reference balise group (FRBG):

a) the distance between the FRBG and the SOLR, retrieved from linking information if it is available and known (i.e. no linking distance to a repositioning balise group being encountered between these balise groups) and, if any, the last relocation of this location item has not been performed as per clause 3.6.4.2.5 c), OR

b) if the last relocation of this location item has been performed as per clause 3.6.4.2.5 c) towards a BG not received earlier than the reference BG of this location item, the distance between the FRBG and the SOLR retrieved from linking information if it is available and known (i.e. no linking distance to a repositioning balise group being encountered between these balise groups):

- as such, for "estimated" location items,
- diminished by twice the location accuracy of the FRBG, for "min" location items,
- augmented by twice the location accuracy of the FRBG, for "max" location items, OR

c) in all other cases, the estimated, min or max travelled distance between the FRBG and the SOLR, computed as per clauses 3.6.1.3 and 3.6.4.1.5 from train front end positions in reference to FRBG and to SOLR, as follows:

- (estimated front end position against FRBG – estimated front end position against SOLR) for "estimated" location items,
- (min safe front end position against FRBG – min safe front end position against SOLR) for "min" location items,
- (max safe front end position against FRBG – max safe front end position against SOLR) for "max" location items.

3.6.4.2.5.1 Note 1: For infill information or when evaluating information from a balise group marked as unlinked while linking consistency is checked, the distances used for relocation will always be negative and will result in an increase of the supervised distances to the location items (because they are relocated back to the SOLR).

3.6.4.2.5.2 Note 2: The FRBG can be the former SOLR, a balise group that does not become the SOLR (e.g. an unlinked balise group while linking consistency is checked), a balise group that has transmitted information that has been stored in the transition buffer, the LRBG used in an RBC message or an infill location reference.

3.6.4.2.5.3 Note 3: All reference balise groups that are used in clause 3.6.4.2.5 are listed in Train Position defined in 3.6.1.3. Furthermore, the list of the location items that was relocated as per clause 3.6.4.2.5 c) needs also to be memorised to apply this clause 3.6.4.2.5.

3.6.4.2.5.4 Note 4: By principle, the relocation from former SOLR to new SOLR done by clause 3.6.4.2.5 c) has no effect on the supervision of the location items, because the same

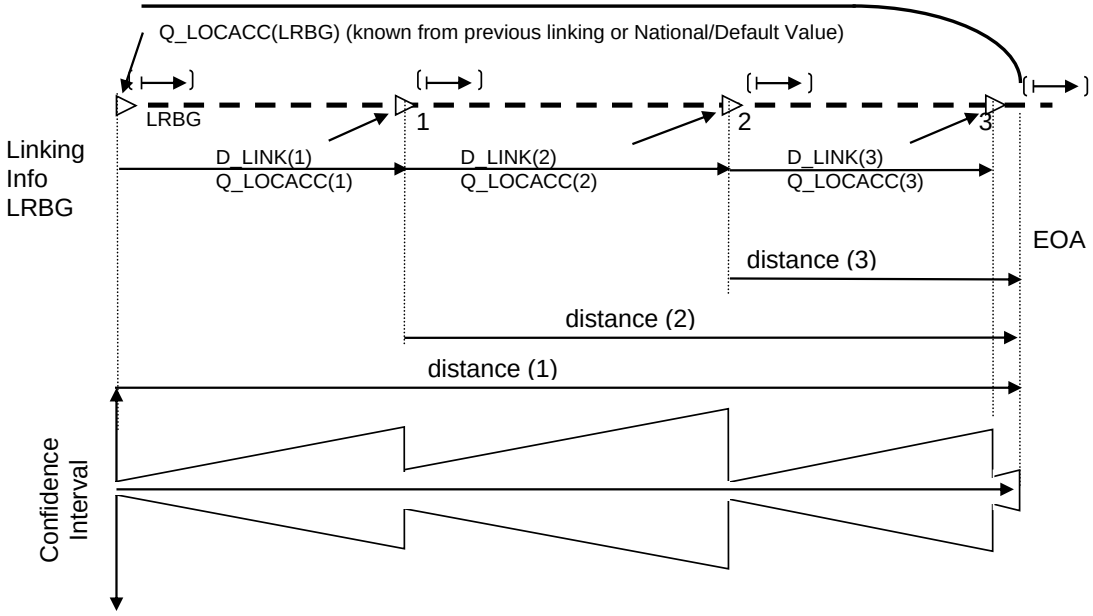
change of distances within the Train Position is applied inversely to the distances of the location items.

3.6.4.2.5.5 Note 5: The supervision of distances on-board will always be safe using these rules, together with the SUBSET-040 §4.6.1.1 rule as prerequisite. If the trackside wants to increase the performance, it is its responsibility to provide linking in due course or to repeat the location based information in reference to further balise groups.

3.6.4.2.6 Regarding the continuous profiles (i.e. SSP and gradient): if a relocation as per clause 3.6.4.2.5 b) or c) results in at least one change of value being relocated in rear of one or more preceding change(s) of value, the ERTMS/ETCS on-board equipment shall recompose the continuous profile according to the following steps:

- Step 1: For each concerned set of consecutive changes of value, the on-board shall consider the profile as if it would have been received from trackside with, by exception to 3.6.3.2.2 c), an incremental distance being negative from the furthest in advance concerned change of value to the furthest in rear concerned change of value;
- Step 2: From the end location to the start location of each “reverted” element(s) delimited by a negative incremental distance, the ERTMS/ETCS on-board equipment shall retain the lowest parts of the overlapping elements obtained from step 1;
- Step 3: The clause 3.6.4.2.3 shall be applied to the profile obtained from step 2, resulting in a continuous profile with all discontinuities ordered by increasing individual distances referred to the SOLR, as if this profile would have been received by trackside being compliant with 3.6.3.2.2 (i.e. with only unsigned incremental distances).

3.6.4.2.6.1 Note: the recomposed profile obtained from the clause 3.6.4.2.6 may include less elements than the profile before relocation, possibly with the original change(s) to higher value no longer present depending on the respective speed/gradient values of the concerned overlapping elements considered in steps 1 and 2.



Confidence Interval = Function [Q_LOCACC; Odometer Error]

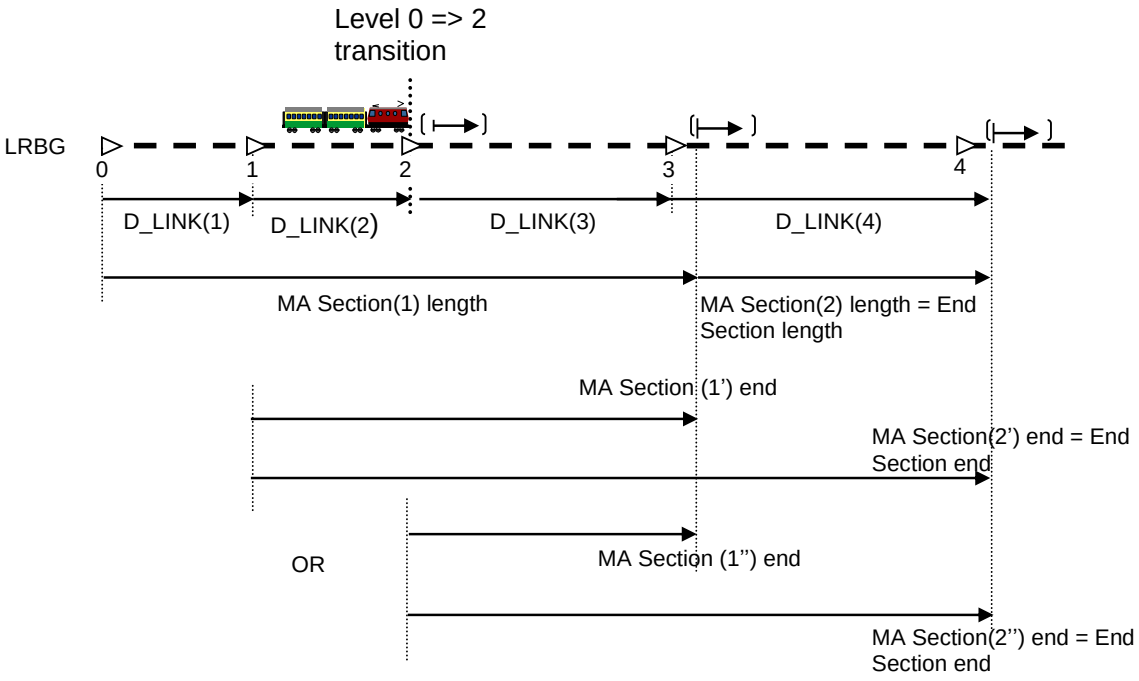
When the ERTMS/ETCS on-board has read the balise group 1

- the balise group 1 becomes the LRBG/SOLR
- the distance to EOA is relocated by subtracting D_LINK (1) from distance (1), resulting in distance (2). (distance (1) may be the distance to EOA derived from the MA or the result of a previous relocation.)
- the train position confidence interval vs. balise group 1 (taking into account the location accuracy of balise group 1 and on-board tolerances when determining the reference location of the balise group) replaces the one vs. the former LRBG, for the supervision of the on-board location based items

When the ERTMS/ETCS on-board has read the balise group 2

- the distance to EOA is relocated by subtracting D_LINK(2) from distance (2), resulting in distance (3).
- the train position confidence interval vs. balise group 2 replaces the one vs. balise group 1 for the supervision of the on-board location based items

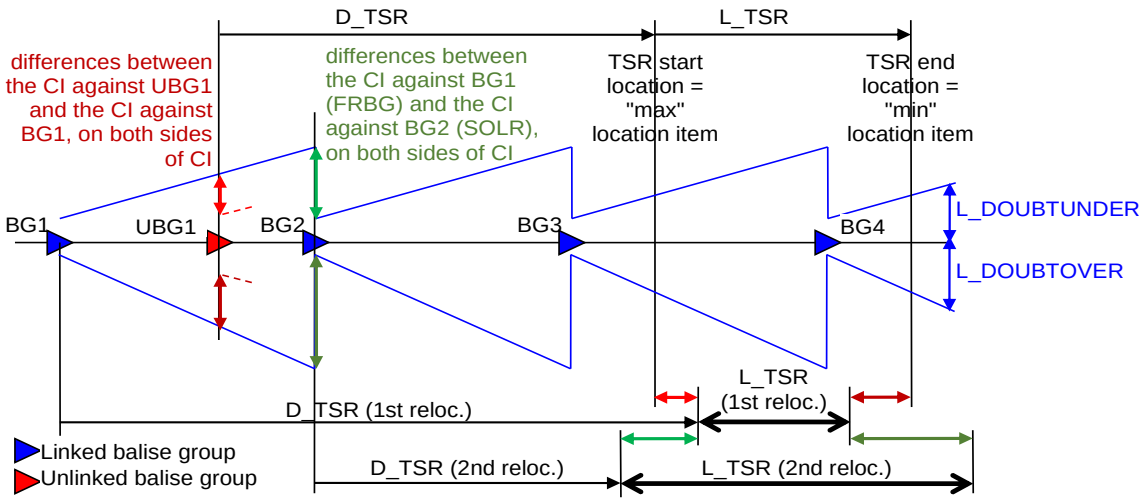
Figure 13b: Replacement of confidence interval and relocation with linking info, on change of LRBG/SOLR



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

- If balise group 1 is still the LRBG/SOLR, the first MA Section end is relocated by subtracting D_LINK (1) from MA Section (1) length, to obtain the distance from the SOLR to the MA section end (1')
- If balise group 2 is already the LRBG/SOLR, the first MA Section end is relocated by subtracting (D_LINK (1) + D_LINK (2)) from MA Section (1) length, to obtain the distance from the SOLR to the MA section end (1")
- The same goes for the second MA Section end, i.e. the distance from the SOLR to the MA section end (2') or (2'') are obtained by substracting D_LINK (1) or (D_LINK (1) + D_LINK (2)) from (MA Section (1) length + MA Section (2) length)

Figure 13c: Relocation with linking info of trackside information referred to previously passed balise group, different from the current LRBG/SOLR

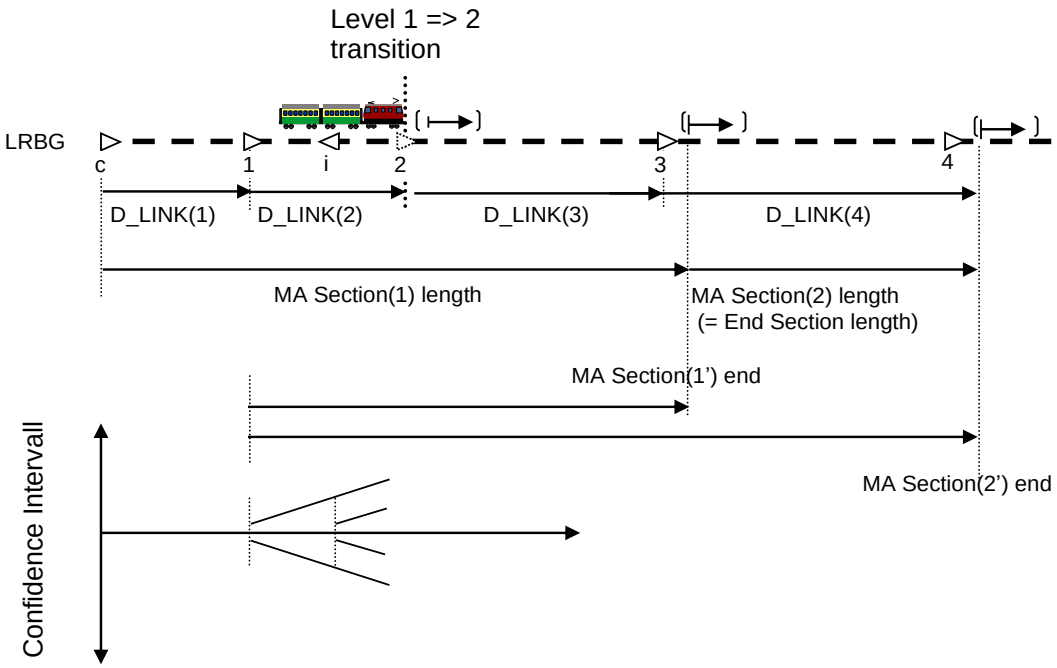


- 1st relocation: When the ERTMS/ETCS on-board reads UBG1, it does not become the SOLR, so that the location items of the TSR within the message it provides are relocated by clause 3.6.4.2.5c on BG1 (which was received earlier) which is the SOLR at that time:
  - the absolute value of the difference between the max safe front end positions against BG1 and against UBG1 is added (substraction of a negative difference) to D_TSR ("max" location item).
  - the absolute value of the difference between the min safe front end positions against BG1 and against UBG1 is added (substraction of a negative difference) to (D_TSR + L_TSR) ("min" location item).

  The start & end locations of the TSR are handled independently ; the original L_TSR is not used as a separate variable by the relocation process.
- 2nd relocation: When the ERTMS/ETCS on-board reads BG2, it becomes the new SOLR, so that the TSR location items are relocated on it: despite linking distance is available between BG1 and BG2, the relocation of the TSR location items is neither performed by clause 3.6.4.2.5a nor by clause 3.6.4.2.5b, as the last relocation of the TSR location items has been performed by clause 3.6.4.2.5c to a balise group, which was received earlier than the former reference balise group of the TSR location items, so:
  - the absolute value of the difference between the max safe front end positions against BG1 and against BG2 is subtracted from D_TSR ("max" location item).
  - the absolute value of the difference between the min safe front end positions against BG1 and against BG2 is subtracted from (D_TSR + L_TSR) ("min" location item).

  Each location item has to be handled independently. This example only covers the TSR location items.
- 3rd relocation: When the ERTMS/ETCS on-board reads BG3, it becomes the new SOLR, so that the TSR location items are relocated on it: linking distance is available between BG2 and BG3 and it is used for the relocation of the TSR location items, as the last relocation of the TSR location items has been performed by clause 3.6.4.2.5c but not towards a balise group received earlier than the former reference balise group of the TSR location items, so:
  - the linking distance between BG2 and BG3, retrieved from linking information and augmented by twice the location accuracy of BG2, is subtracted from D_TSR.
  - the linking distance between BG2 and BG3, retrieved from linking information and diminished by twice the location accuracy of BG2, is subtracted from (D_TSR + L_TSR).
- 4th relocation: When the ERTMS/ETCS on-board reads BG4, it becomes the new SOLR, so that the TSR location items are relocated on it: linking distance is available between BG3 and BG4 and it is used as such for the relocation of the TSR location items, as the last relocation of the TSR location items has not been performed by clause 3.6.4.2.5c, so:
  - the linking distance between BG3 and BG4, retrieved from linking information, is subtracted from D_TSR.
  - the linking distance between BG3 and BG4, retrieved from linking information, is subtracted from (D_TSR + L_TSR).

Figure 13d: Relocation with Train Position inaccuracy of trackside information transmitted by an unlinked balise group while linking consistency is checked



The balise group BG_i is still the LRBG and SOLR when the on-board performs the transition to level 2. The linking information which was stored in the transition buffer does not announce this BG_i but BG_1 that therefore becomes the new SOLR.
Then the location items of the MA also released from the transition buffer (referred to balise group BG_c) are relocated to BG_1 prior to its evaluation, through this linking information:

- The first MA Section end is relocated by subtracting D_LINK (1) from MA Section (1) length, to obtain the distance from the SOLR to the MA section (1') end
- The second MA Section end is relocated by subtracting D_LINK (1) from MA Section (1) length + MA Section (2) length, to obtain the distance from the SOLR to the MA section (2') end
- Although the balise group BG_i is the LRBG, the on-board uses the train position confidence interval vs. BG_1 to supervise the MA, as it is the SOLR.

Figure 13e: Relocation of buffered trackside information referred to previously passed balise group, with change of LRBG/SOLR

3.6.5 Position Reporting to the RBC

3.6.5.1 General

3.6.5.1.1 The position refers to the front end of the train , as per clause 3.6.1.3.4.

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 train position confidence interval in relation to the LRBG, given as 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) Whether the train is at standstill or, if it is not at standstill, its estimated speed

g) Train integrity information.

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

i) Optionally, the previous LRBG. In case of an LRBG being a single balise group with no co-ordinate system assigned, directional information referred to in items d), e) and h) is defined in reference to the pair of LRBG and previous LRBG (see 3.4.2.3.3).

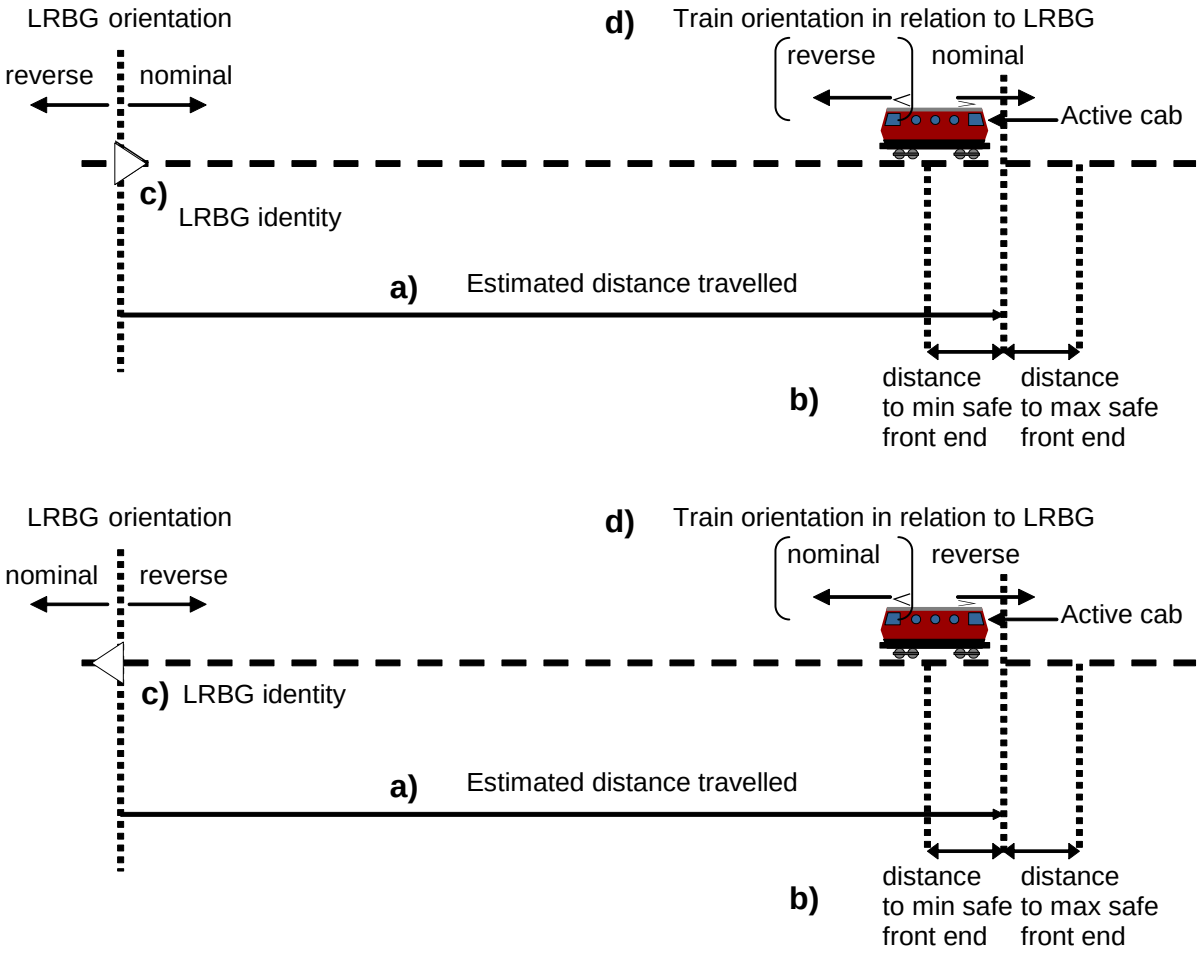


Figure 14: Information given in a position report (two examples to show the relation between LRBG and train orientation)

3.6.5.1.3 Note: A balise group marked as unlinked is never used for position reporting to the RBC, since its location, or the balise group itself, may not be known to the RBC.

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.

b) The mode changes.

c) The driver confirms train integrity.

d) A loss of train integrity is detected.

e) The train passes an 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 to level 0, NTC or 1.

g) The level changes.

h) A communication session is successfully established.

i) The train leaves standstill.

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

k) The train passes an 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 a)).

e) Immediately.

3.6.5.1.5.1 Exception: it shall not be possible to combine d) and e).

3.6.5.1.6 Regarding 3.6.5.1.4 j) and 3.6.5.1.5 d): the position report triggered by the passage of an LRBG compliant balise group shall be sent only once the content of the message from this balise group has been taken into account.

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 After an LRBG compliant balise group is passed, the ERTMS/ETCS on-board equipment shall be allowed to report the train position with this balise group as reference only once the content of the message from this balise group and the content of the messages from all the previous LRBG compliant balise groups (if any) have been taken into account.

3.6.5.1.8.1 Justification: The mode and level reported in a position report must be consistent with the content of the message of the LRBG used in this position report (e.g. if the reported train position is within an OS/SH/LS area provided by a Mode Profile given by the LRBG used in this position report, the reported mode will be the one requested by the Mode Profile).

3.6.5.2 Report of train integrity information

3.6.5.2.1 The confirmation of train integrity may be given by external source or by driver. For the ERTMS/ETCS on-board equipment, the confirmation of train integrity means that the train length stored as valid Train Data or the safe consist length at the time the train was last known to be integer can be used for reporting the train position to the RBC, which will allow the trackside to use the information about the confirmed train rear end position.

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

3.6.5.2.3 The train integrity information reported to the RBC shall consist of:

a) Train integrity status information
   - No train integrity information
   - Train integrity confirmed by external source
   - Train integrity confirmed by driver
   - Train integrity lost

b) Confirmed train length information (only available when train integrity confirmation is reported).

3.6.5.2.4 The confirmed train length information shall represent the distance between the min safe rear end at the time the train was last known to be integer and the estimated position of the train front at the time when the train integrity information is sent to the RBC (see Figure 15).

3.6.5.2.4.1 Note: when a confirmation of integrity is received from an external source, this does not necessarily mean that the train is complete at the moment that the confirmation is received, but rather that the train was known to be complete at some time before the confirmation of integrity was received. This time will depend on the properties of both the external source and the interface to this source.

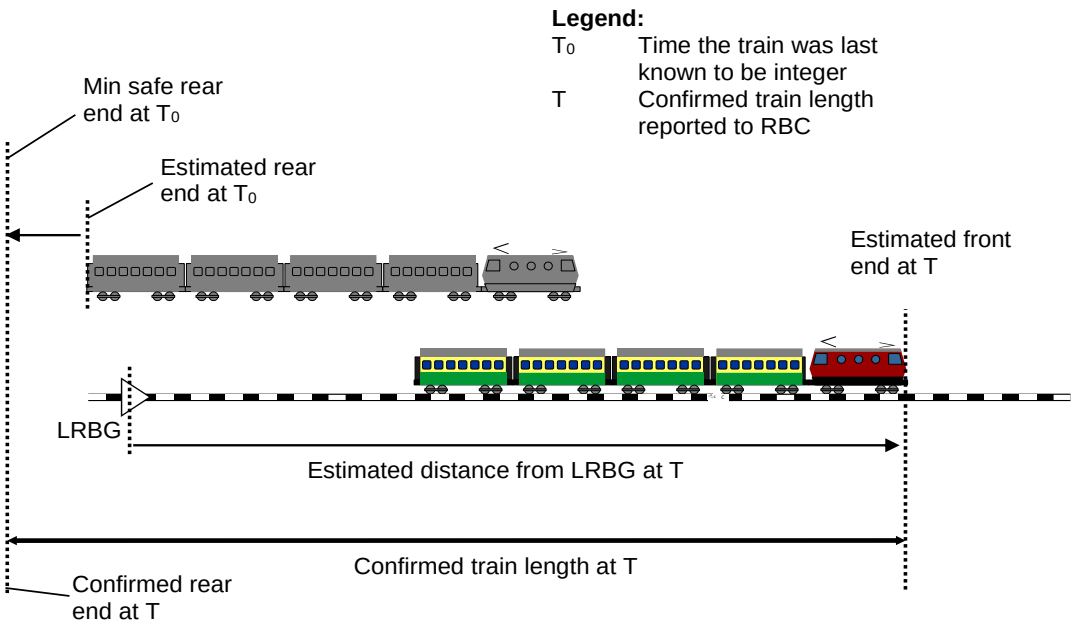


Figure 15: Calculation of Confirmed Train Length when train integrity is reported to the RBC

3.6.5.2.5 The transitions between the different values of the train integrity status information to be sent to the relevant RBC shall be executed as described in Table 2b according to the conditions in Table 2c (see section 4.6.1 for details about the symbols).

No Integrity information	< 5 -p1-	< 5,7,8,9,10 -p3-	< 1,6 -p3
2 > -p1-	**Integrity confirmed by driver**	< 2 -p2-	< 2 -p1-
3 > -p3-		**Integrity confirmed by external source**	< 3 -p2-
4 > -p2-		4 > -p1-	**Integrity lost**

Table 2b: Transitions between values of the train integrity status information to be reported to the RBC

Condition Id	Content of the conditions
[1]	The Train Data status is changed from valid to invalid
[2]	(Train is at standstill) AND {[(no Valid Train Data is available but the safe consist length is available) AND (if any, safe consist length information for Supervised Manoeuvre sent to the RBC has been acknowledged by this latter)] OR [(valid Train Data is available and has been acknowledged by the RBC) AND (no new Train Data regarding train length acquired from external source is pending driver's validation)]} AND (the train integrity is confirmed by the driver)
[3]	(The information "Train integrity confirmed" is received from an external source) AND {[(no Valid Train Data is available but the safe consist length is available and has not changed since the time the train was last known to be integer) AND (if any, safe consist length information for

	Supervised Manoeuvre sent to the RBC has been acknowledged by this latter)] OR [(valid Train Data is available and has been acknowledged by the RBC) AND (Train Data regarding train length has not changed since the time the train was last known to be integer) AND (no new Train Data regarding train length acquired from external source is pending driver's validation)]} AND (the train position is valid and is referred to an LRBG) AND (the train position was valid and was referred to an LRBG at the time the train was last known to be integer) AND (no reverse movement is currently performed nor has been performed since the time the train was last known to be integer) AND (no SM authorisation changing the train orientation has been received since the time the train was last known to be integer) AND (the distance between the min safe rear end at the time the train was last known to be integer and the current estimated train position does not exceed the range of the confirmed train length information)
[4]	(The information "Train integrity lost" is received from an external source) AND ((valid Train Data is available since the time the train integrity was last known to be lost) OR (the on-board is configured to capture the safe consist length from the Train Interface))
[5]	A position report indicating that the train integrity is confirmed is sent to the RBC
[6]	The information "Train integrity status unknown" is received from an external source
[7]	(Train Data regarding length is changed) OR (new Train Data regarding train length acquired from external source is pending driver's validation) OR (if no Valid Train Data is available, the safe consist length is changed or is no longer available)
[8]	A reverse movement is performed
[9]	The distance between the min safe rear end at the time the train was last known to be integer and the current estimated train position exceeds the range of the confirmed train length information

[10]	A Supervised Manoeuvre authorisation changing the train orientation is received

Table 2c: Transition conditions for the train integrity status information to be reported to the RBC

3.6.5.2.6 Following the successful establishment of a communication session with an RBC, the train integrity status information to be reported to this RBC shall initially be set to "No integrity information" and the conditions of the table 2c shall be evaluated before sending the first position report.

3.6.5.2.7 Note: As long as no train length is available (captured as valid Train Data or derived from the safe consist length information when no valid Train Data is available) or as long as the train position is not valid or not referred to an LRBG, the ERTMS/ETCS on-board equipment cannot report that the train integrity is confirmed, regardless of the train integrity information received from an external source. Justification: in order to calculate the confirmed train length when reporting a train integrity confirmation, the train position must be valid and referred to an LRBG and the train length must be available at the time of the train integrity confirmation.

3.6.5.2.8 Note: In order to keep the sending rate of position reports as requested by the RBC, the confirmation of train integrity by an external source does not trigger itself any position report. It is only in the first position report following the last confirmation of train integrity that such confirmation by external source can be reported. The difference between the confirmed train length and the train length will then grow to an extent depending on both the frequency of the train integrity confirmation and the position report sending rate.

3.6.5.2.9 Note: When the information "Train integrity lost" is received, the train integrity status information is reported in every position report following the detection of the loss of train integrity, until the train integrity is confirmed again, or until the information "Train integrity status unknown" is received from the external source, or until the Train Data is invalidated.

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.

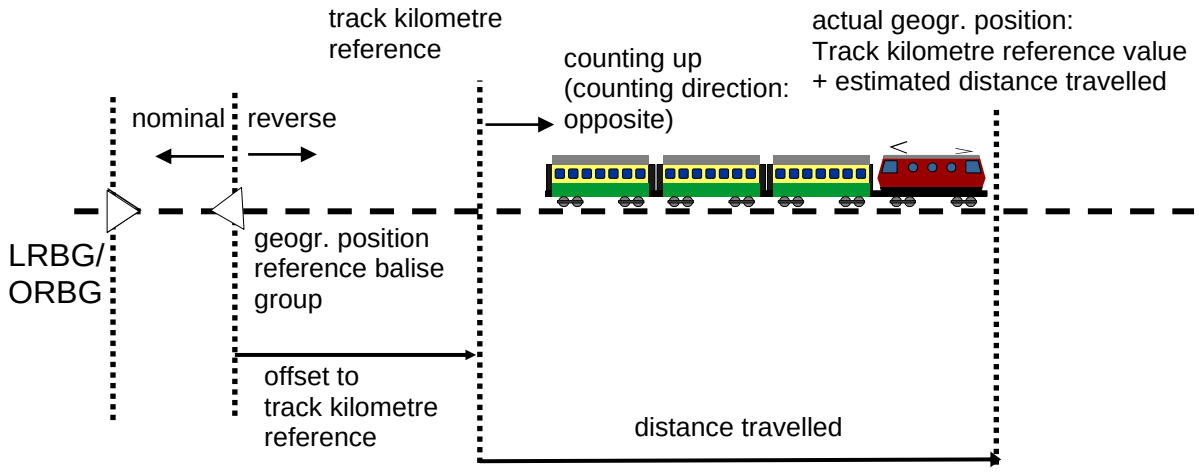


Figure 16: Geographical position example

3.6.7 Supervision of distances not referred to balise groups

3.6.7.1 Independently from the train position in relation to balise groups (see 3.6.1.3), the ERTMS/ETCS on-board equipment shall calculate the remaining distance to be travelled by the train in relation to the following distances as soon as their supervision is started or re-started:

a) the maximum distance the train can move (National/Default Value) in relation to the Roll Away Protection (see section 3.14.2), the Unauthorised Direction Movement Protection (see section 3.14.3) and the Standstill supervision (see section 4.4.7.1);

b) the maximum distance for reversing (National/Default Value) in Post Trip mode (see 4.4.14.1.3);

c) the distance for train trip suppression (National/Default Value) after the Override function has been triggered (see clause 5.8.4.1 b));

d) the fixed distance over which the on-board balise transmission alarms are ignored, before a safety reaction is triggered (see clauses 3.15.7.2 and 5.22.5.1 a));

e) the fixed distance for small movements in No Power mode (see clause 3.15.8.1.1), in relation to the Cold Movement Detection function;

f) a zero distance to the former EOA/LOA for the override de-activation or for the trip condition if the override is no longer active, after the Override function has been triggered in SB or PT mode while there was no valid train position stored on-board (see clauses 5.8.3.1.1 and 5.8.4.1 c));

g) the maximum permitted distance to run in Staff Responsible mode when it is determined by the National/Default Value, when it is transmitted by the RBC, or when it is entered by the driver (see clauses 4.4.11.1.3.1 a) & b)).

3.6.7.2 For the supervision of the distances referred in 3.6.7.1 a), b), c), d) & e) the ERTMS/ETCS on-board equipment shall take into account, for the concerned direction(s), the estimated distance travelled away from the location when their supervision was started/re-started.

3.6.7.3 For the supervision of the distances referred in 3.6.7.1 f) & g) the ERTMS/ETCS on-board equipment shall manage a virtual train front position in the following way:

a) The supervised distance minus the estimated distance travelled away from the location when the supervision was started determines the remaining distance from the estimated front end position to the end of the supervised distance.

b) The supervised distance minus the estimated distance travelled away from the location when the supervision was started and minus the odometer under-reading amount since the function was activated determines the remaining distance from the max(imum) safe front end position to the end of the supervised distance.

c) The supervised distance minus the estimated distance travelled away from the location when the supervision was started plus the odometer over-reading amount since the supervision was started determines the remaining distance from the min(imum) safe front end position to the end of the supervised distance.

3.6.7.3.1 Note 1: The location when the supervision is started/re-started is determined by the ERTMS/ETCS on-board (e.g. from a value of its raw position counter) regardless whether there is a stored train position in relation to balise group(s).

3.6.7.3.2 Note 2: This virtual train position is created at the time the supervision of the distance starts and overpassing a balise group does not impact its related estimated, min safe and max safe front end positions.

3.6.7.4 Any virtual train position in relation to such types of supervision of distance not referred to balise group locations shall be deleted when the related supervision ends (for the distance supervised as per 3.6.7.1 f), see 5.8.3.1.3).

3.6.7.5 For the maximum permitted distance to run in Staff Responsible mode, any update of this distance through the RBC, the driver or the triggering of the Override while already in SR mode shall be considered as a re-start of the supervision, i.e. any related previous virtual train position shall be deleted and replaced by a new one as per 3.6.7.3. Conversely, upon reception of new National Values, the related virtual train position shall be re-evaluated as per 3.6.7.3 only considering the new National Value.

3.6.8 Monitoring of odometer accuracy

3.6.8.1 The ERTMS/ETCS on-board equipment monitors the odometer accuracy based on the separate accumulation of underestimation and overestimation in measuring the movement of the train over a fixed distance.

3.6.8.1.1 Note: The accumulation of the underestimation/overestimation in measuring the movements considers that for both the forward and the backwards movements the absolute value contributes separately to the accumulation.

3.6.8.2 The ERTMS/ETCS on-board equipment shall store the accumulated underestimation/overestimation in measuring the movements over a defined total distance (as defined in A.3.1).

3.6.8.3 The check of the odometer accuracy shall be performed periodically at fixed distance intervals (see 3.6.8.5 and 3.6.8.7).

3.6.8.4 The distance of the intervals shall be less than or equal to a defined maximum distance interval (as defined in A.3.1).

3.6.8.5 When performing the check at fixed distance intervals, if any of the accumulated underestimation/overestimation in measuring the movements over the defined total distance travelled (see 3.6.8.2) exceeds the impairment threshold (as defined in A.3.1), the ERTMS/ETCS on-board equipment shall consider the odometer performance impaired, and the driver shall be informed.

3.6.8.5.1 Note: Exceeding the impairment threshold may indicate that the odometer accuracy exceeds the performance requirement as defined in SUBSET-041 §5.3.1.1.

3.6.8.6 Once the odometer performance is impaired, the ERTMS/ETCS on-board equipment shall continue to consider the odometer performance as impaired until the train has travelled the defined total distance (as defined in A.3.1 see 3.6.8.2) with both the accumulated underestimation and overestimation in measuring the movements being continuously below the "accuracy of distances measured on-board".

3.6.8.6.1 Note: This means that once the odometer performance is impaired, the odometer performance will continue to be displayed as being impaired until the train has travelled at least again the defined total distance (see 3.6.8.2).

3.6.8.6.2 As long as the odometer performance is considered as impaired the on-board shall inform the driver.

3.6.8.7 When performing the check at fixed distance intervals, if any of the accumulated underestimation/overestimation in measuring the movements over the defined total distance travelled (see 3.6.8.2) exceeds the safety threshold (as defined in A.3.1), the ERTMS/ETCS on-board equipment shall switch to mode System Failure.

3.6.8.7.1 Note: The train must not be stopped due to exceeding this safety threshold while operating in Level 0 or Level NTC. The ERTMS/ETCS on-board equipment should therefore handle this when entering Level 1 or 2.

3.6.8.8 If any of the accumulated underestimation/overestimation in measuring the movements exceeds the defined values (see 3.6.8.5 and 3.6.8.7) the ERTMS/ETCS on-board equipment shall apply the related reactions even if the on-board has not travelled the whole total distance (see 3.6.8.2).

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 For a non-infill MA full length means at least from the estimated front end of the train to the supervised location, while for an infill MA full length means at least from the infill location reference (refer to 3.6.2.3.1) to the supervised location.

3.7.2.3.2 For an MA that is part of a Supervised Manoeuvre authorisation and whose validity direction is opposite to the current train orientation, full length means at least from the estimated front end of the train derived from the new train orientation (see 4.4.21.1.7 a)) 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 shorten MA (from RBC only)
- Temporary speed restrictions
- National values
- Level transition information
- LX speed restrictions
- Inhibition of revocable TSRs from balises in level 2 (from RBC only)
- Virtual Balise Cover orders

3.7.3 Extension, replacement and deletion of location based 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 reference balise group of the new linking information.

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 Exception to 3.7.3.1 a): in case the start location of the new Static Speed Profile is relocated as per clause 3.6.4.2.5 b) or 3.6.4.2.5 c) towards a BG not received earlier than its former reference BG, the resulting Static Speed Profile information shall, over a distance starting from its start location as if it would be relocated as per 3.6.4.2.5 b) or c) 3rd bullet to its start location as if it would be relocated as per 3.6.4.2.5 b) or c) 2nd bullet, be composed of the lowest speed parts of each element of the stored Static Speed Profile and the new Static Speed Profile, taking into account the categories the train belongs to.

From the start location of the new Static Speed Profile as if it would be relocated as per 3.6.4.2.5 b) or c) 2nd bullet, 3.7.3.1 a) shall apply by analogy.

3.7.3.1.2 Exception to 3.7.3.1 b): in case the start location of the new Gradient Profile is relocated as per clause 3.6.4.2.5 b) or 3.6.4.2.5 c) towards a BG not received earlier than its former reference BG, the resulting Gradient Profile information shall, over a distance starting from its start location as if it would be relocated as per 3.6.4.2.5 b) or c) 3rd bullet to its start location as if it would be relocated as per 3.6.4.2.5 b) or c) 2nd bullet, be composed of the lowest gradient parts of each element of the stored Gradient Profile and the new Gradient Profile. From the start location of the new Gradient Profile as if it would be relocated as per 3.6.4.2.5 b) or c) 2nd bullet, 3.7.3.1 b) shall apply by analogy.

3.7.3.1.3 Exception to 3.7.3.1 c): in case the new Axle Load Speed Profile is relocated as per clause 3.6.4.2.5 b) or 3.6.4.2.5 c) towards a BG not received earlier than its former reference BG, the resulting Axle Load Speed Profile information shall, over a distance starting from the start location of its first element as if it would be relocated as per 3.6.4.2.5 b) or c) 3rd bullet to the start location of its first element as if it would be relocated as per 3.6.4.2.5 b) or c) 2nd bullet, take into account the lowest speed part in any overlap between the element(s) of the stored Axle Load Speed profile and the element(s) of the new Axle Load Speed Profile, taking into account the axle load category of the train. From the start location of the first element of the new Axle Load Speed Profile as if it would be relocated as per 3.6.4.2.5 b) or c) 2nd bullet, 3.7.3.1 c) shall apply by analogy.

3.7.3.1.4 Exception to 3.7.3.1 d): in case the new Speed Restriction to ensure Permitted Braking Distance information is relocated as per clause 3.6.4.2.5 b) or 3.6.4.2.5 c) towards a BG not received earlier than its former reference BG, the resulting Speed Restriction to ensure Permitted Braking Distance information shall, over a distance starting from the start location of its first element as if it would be relocated as per 3.6.4.2.5 b) or c) 3rd bullet to the start location of its first element as if it would be relocated as per 3.6.4.2.5 b) or c) 2nd bullet, take into account the lowest speed part in any overlap between the element(s) of the stored Speed Restriction to ensure Permitted Braking Distance information and the element(s) of the new Speed Restriction to ensure Permitted Braking Distance information. From the start location of the first element of the new Speed Restriction to ensure Permitted Braking Distance information as if it would be relocated as per 3.6.4.2.5 b) or c) 2nd bullet, 3.7.3.1 d) shall apply by analogy.

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 location based 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 Upon reception of a Supervised Manoeuvre authorisation:

a) If the validity direction of the new Movement Authority is the same as the current train orientation, the clause 3.7.3.1 shall apply.

b) If the validity direction of the new Movement Authority is opposite to the current train orientation, the clause 3.7.3.1 shall not apply and all previously stored location based information shall be deleted.

3.7.3.5 Deleted.

3.7.3.6 Note: regarding the handling of Temporary Speed Restrictions and Level Crossings, see also sections 3.11.5 and 3.12.4.7.

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 or at the End of Movement Authority that can be reached by the front end of the train without a risk for a hazardous situation. This additional distance beyond the End of Movement Authority 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 3.13.9.3.6.5).

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 last confirmed rear end of a train i.e. the position deduced from the confirmed train length information contained in a position report confirming the train integrity (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 General

3.8.2.1.1 The on-board equipment may request a new Movement Authority from the RBC for the following reasons:

a) “Start” selection by the driver (only level 2)

b) With respect to perturbation location (only level 2)

c) With respect to MA timer elapsing (only level 2)

d) Track description deletion (only level 2)

e) Reception of "track ahead free up to the level 2 transition location"

3.8.2.1.2 It shall be possible for the RBC to send MA request parameters defining:

a) whether MA requests shall be repeated and if so, the time between each repetition

b) the triggering time criterion for the reasons 3.8.2.1.1 b) & c) respectively

3.8.2.1.3 Note: the MA requests for reasons 3.8.2.1.1 b) & c) can be triggered only if the MA request parameters have been received from the RBC.

3.8.2.1.4 The parameters received from the RBC shall be valid until new MA request parameters are received from the RBC.

3.8.2.1.4.1 Note: This will lead to immediate sending of an MA request in case at the moment the new parameters are received, the time since the last sending of an MA request is equal to or higher than the new received repetition period.

3.8.2.1.5 As long as at least one reason for sending MA requests is applicable and unless it is requested by the RBC not to do so, the ERTMS/ETCS on-board equipment shall repeat the MA requests as indicated by the RBC or with a repetition cycle according to a fixed value (see appendix A.3.1) in case no MA request parameters are stored on-board.

3.8.2.1.6 If a reason for sending MA requests becomes applicable while an MA request repetition cycle is already ongoing for another reason, the MA request triggered for this new reason shall reset the repetition cycle.

3.8.2.1.7 Together with any MA request the on-board shall inform the RBC about the reason(s) that is (are) applicable at the time the MA request is sent.

3.8.2.2 MA request to the RBC with respect to the perturbation location or MA timer elapsing (only level 2)

3.8.2.2.1 The triggering criteria that can be used by the RBC are the following:

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.

3.8.2.2.2 With regard to the above possibilities, the MA request shall be triggered when the train front has passed the location defined by 3.8.2.2.1 a) / when the moment defined by 3.8.2.2.1 b) is reached.

3.8.2.2.3 Once the resulting location regarding 3.8.2.2.1 a) is passed by the train front, the reason "Time before reaching the perturbation location reached" shall remain applicable until the triggering criterion is not fulfilled anymore, e.g. due to the reception of a new MA or to a temporary EOA that is no longer supervised.

3.8.2.2.4 Once the defined time before the expiration of a Section timer or before the expiration of the LOA speed timer is reached, the reason "Time before a Section timer/LOA speed timer expires reached" shall remain applicable until no Section timer, for which the defined time before expiration is reached, is supervised and no LOA, for which the defined time before expiration is reached, is supervised.

3.8.2.3 MA request to the RBC on driver selecting “Start” (only level 2)

3.8.2.3.1 An MA request shall be sent to the RBC when the driver selects ”Start”.

3.8.2.3.2 The reason ""Start" selected by driver" shall remain applicable until:

a) an MA is received or

b) an SR authorisation is received or

c) the desk is closed.

3.8.2.4 MA request to the RBC on reception of "track ahead free up to the level 2 transition location"

3.8.2.4.1 If a level 2 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 transition location" is received from balise group.

3.8.2.4.2 The ERTMS/ETCS on-board equipment shall also inform the RBC about the identity of the level 2 transition location balise group, as received through the information "Track ahead free up to level 2 transition location".

3.8.2.4.3 By exception to the clause 3.8.2.1.5, only one MA request with the reason "Track ahead free up to the level 2 transition location" shall be sent upon reception of the corresponding information from balise group.

3.8.2.5 MA request to the RBC on track description deletion (only level 2)

3.8.2.5.1 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.

3.8.2.5.2 The reason "Track description deletion" for MA requests shall remain applicable until a new MA is received on-board.

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)

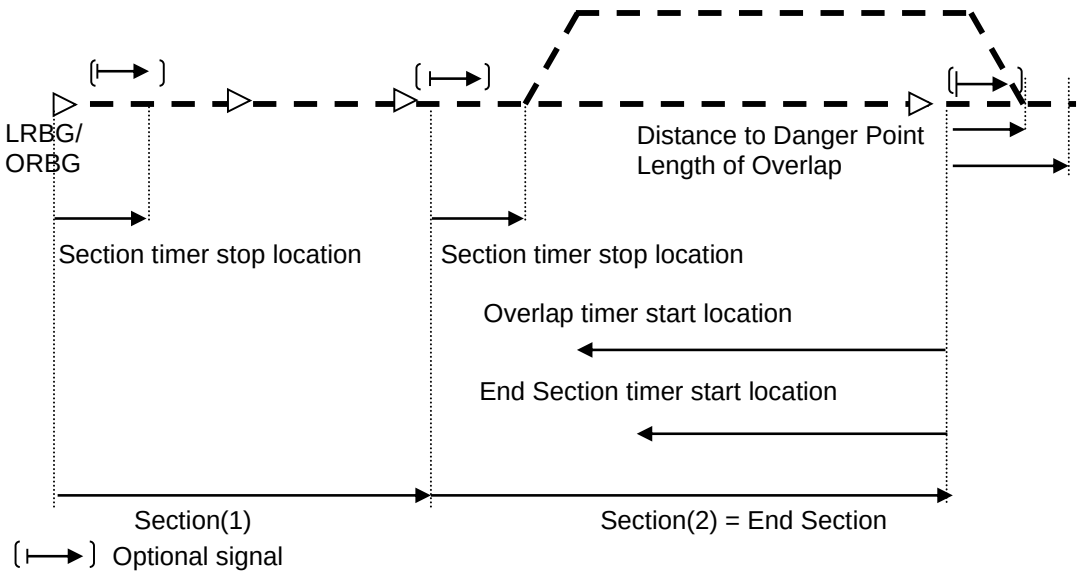


Figure 17: Structure of an MA

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 Intentionally deleted.

3.8.3.5.1 Intentionally deleted.

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).

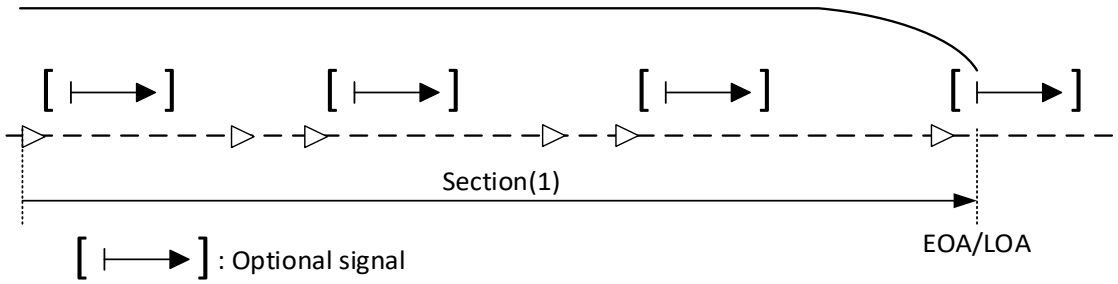


Figure 18: Distance to End of Movement Authority when no time-outs are needed

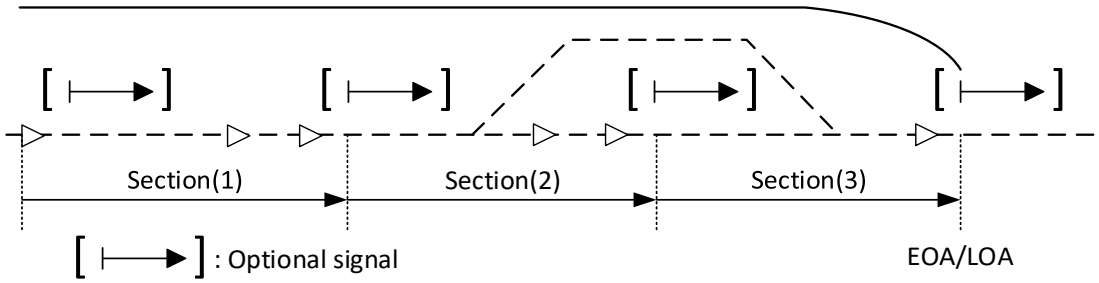


Figure 19 : Distance to End of Movement Authority when time-outs might be needed

3.8.3.11 Intentionally deleted.

Figure 20: Intentionally deleted

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 For each section, the on-board shall consider a Section timer that has started:

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 unless an MA shortening has occurred with A.3.4.1.3 condition [11] applied:

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 Justification: Applying 3.8.4.2.2 while the ERTMS/ETCS on-board equipment has considered the current estimated front end and max safe front end positions, as the EOA and SvL respectively, with no Release Speed, could lead to inappropriate system behaviour such as the EOA being moved in advance of the current one or in the sudden supervision of a Release Speed allowing the train to move forward.

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.

3.8.4.2.4 In case of reverse movement which brings back the min safe front end of the train in rear of a Section timer stop location after the Section timer has been stopped according to 3.8.4.2.3, the on-board shall consider that the Section timer value became greater than its time-out value and shall apply 3.8.4.2.2 once the train has reached standstill.

3.8.4.2.5 If, upon its evaluation, a new MA includes a section with its timer stop location already in rear of the min safe front end of the train, the on-board shall consider that the Section timer had been stopped before its value could become greater than its time-out value and shall not apply 3.8.4.2.2.

3.8.4.2.5.1 Justification: in this case the train is already beyond the timer stop location, therefore it is impossible to determine when that location was crossed and so what share of the time-out value has elapsed before the crossing event. Knowing the above on-board

behaviour, it is always the trackside responsibility to take the appropriate measures to ensure a safe release of the corresponding section.

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 For the LOA speed, the on-board shall consider a timer that has started:

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 Unless stated otherwise, 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 the End Section.

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, AD 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. non-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.

3.8.5.1.5 On reception of a shortened MA sent together with other location based information, the deletion of information referred to in the clauses 3.8.5.1.3 and 3.8.5.1.4 shall apply to the information stored on-board prior to the reception of this trackside information, before any clause dealing with the replacement of information (e.g. 3.7.3.1 or 3.18.2.9 first bullet) is applied.

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 non-infill 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

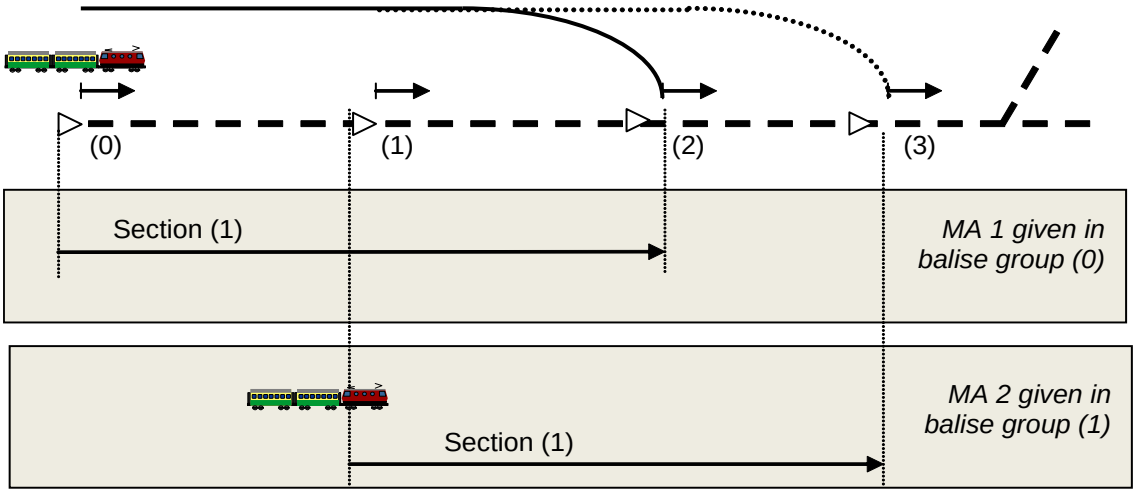


Figure 21a: Extension of an MA in Level 1, one section in the new MA

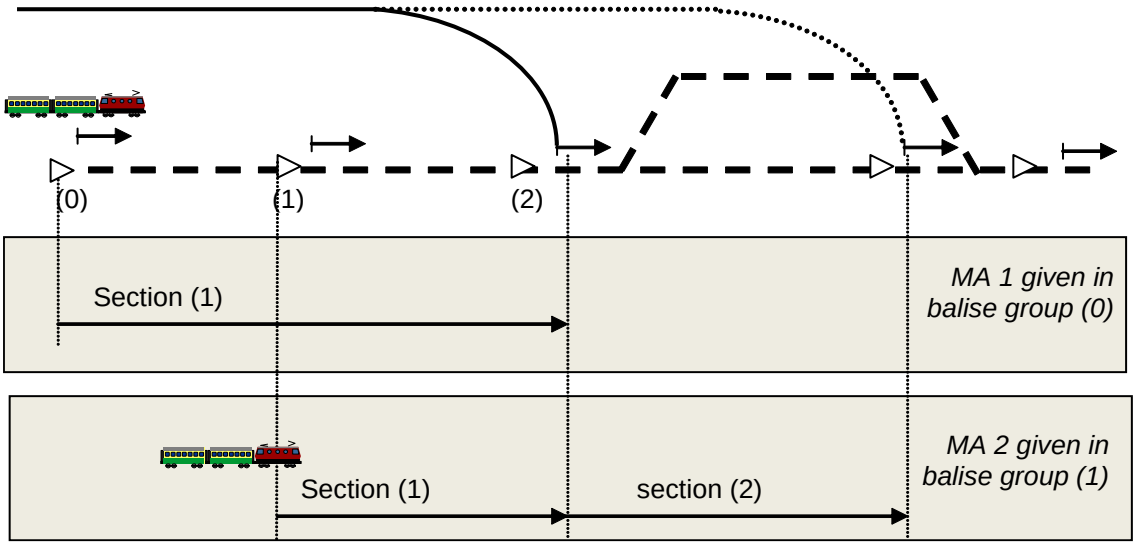


Figure 21b: Extension of an MA in level 1, two sections in the new MA

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

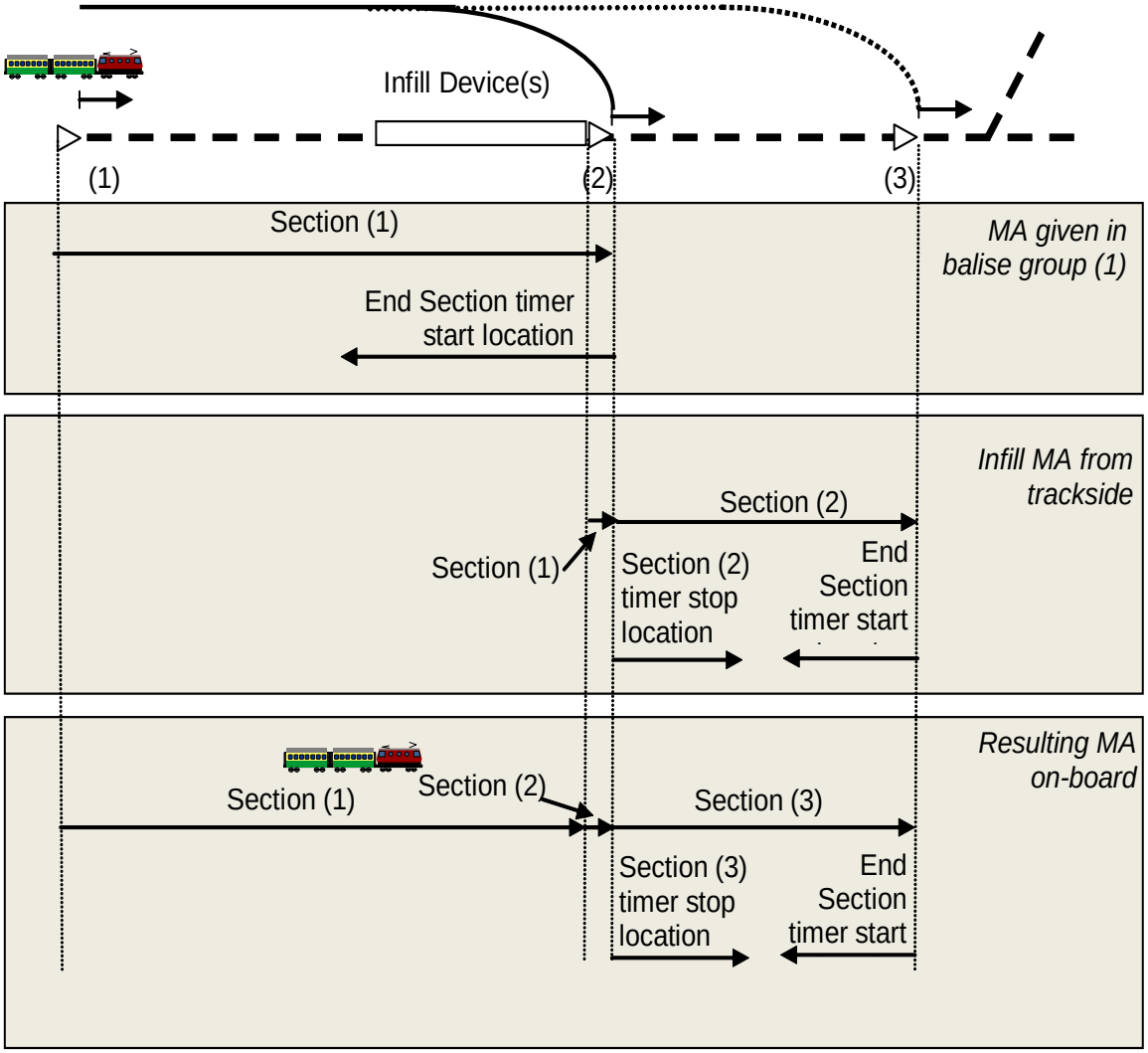


Figure 22a: Extension of an MA with Infill information

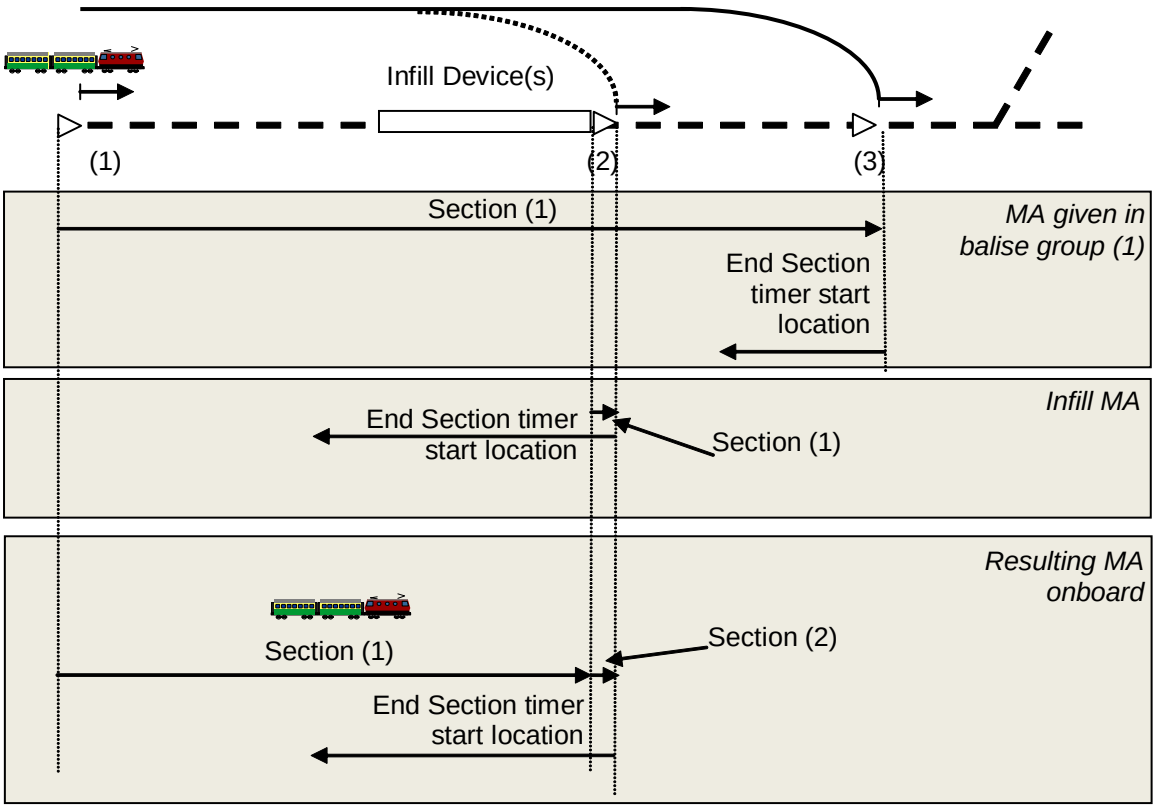


Figure 22b: Shortening of an MA with Infill information

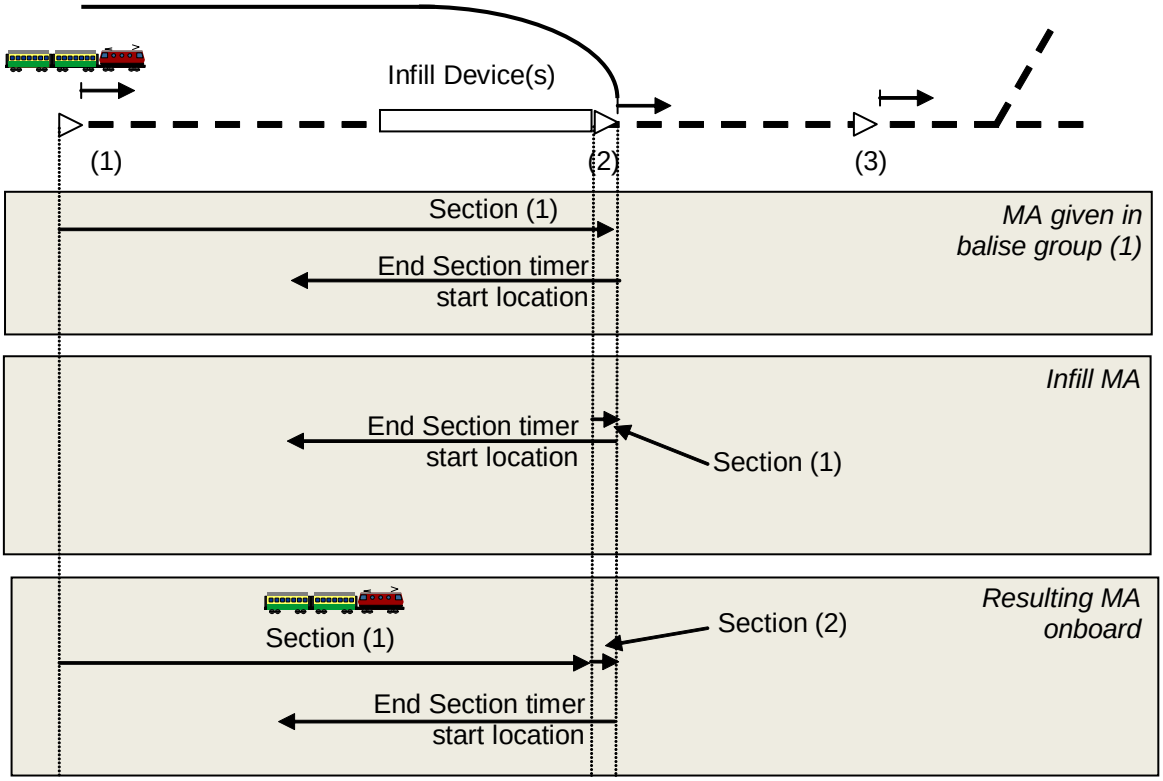


Figure 22c: Repetition of an MA with Infill information

3.8.5.3.4 Example: Extension of MA in Level 2

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

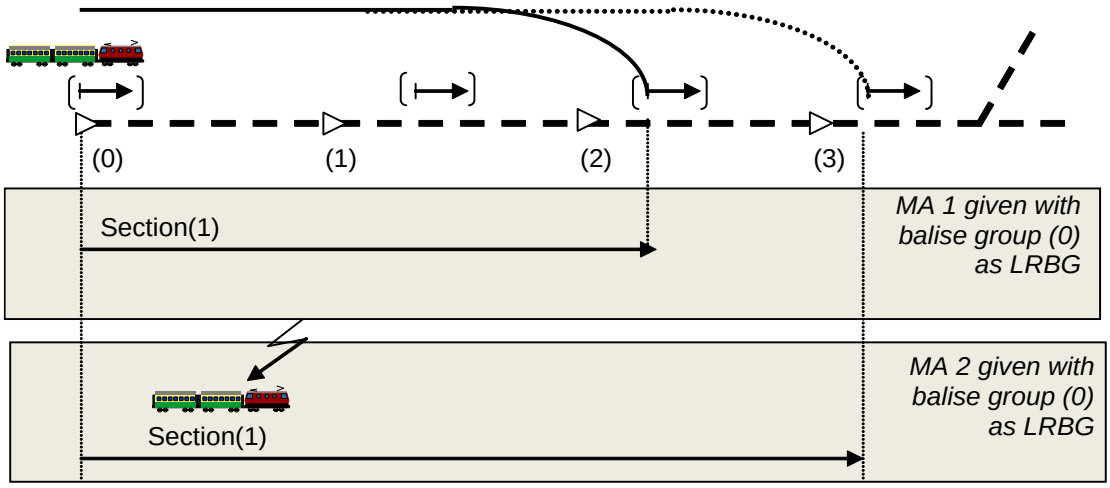


Figure 23a: Extension of an MA in level 2, using same LRBG

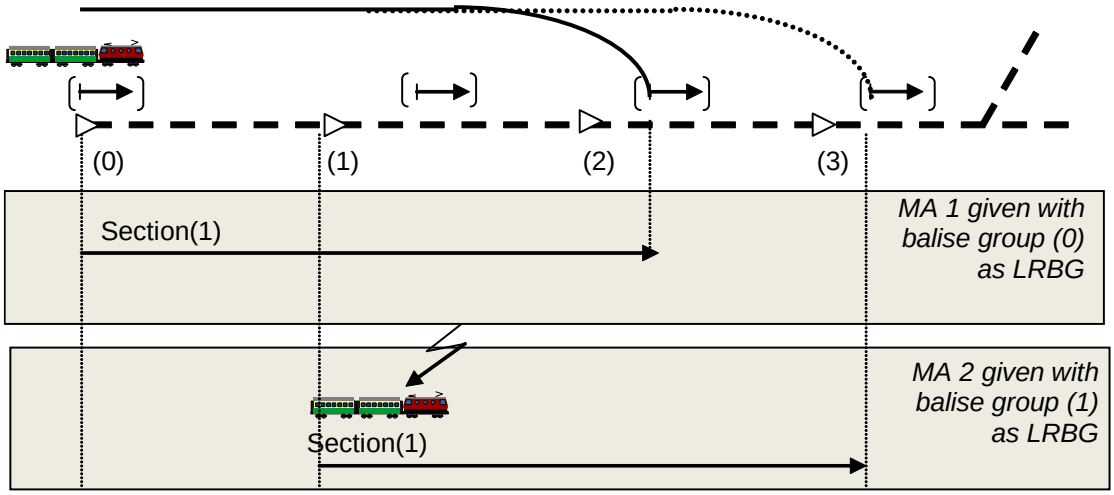


Figure 23b: Extension of an MA in Level 2, using a new LRBG

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.

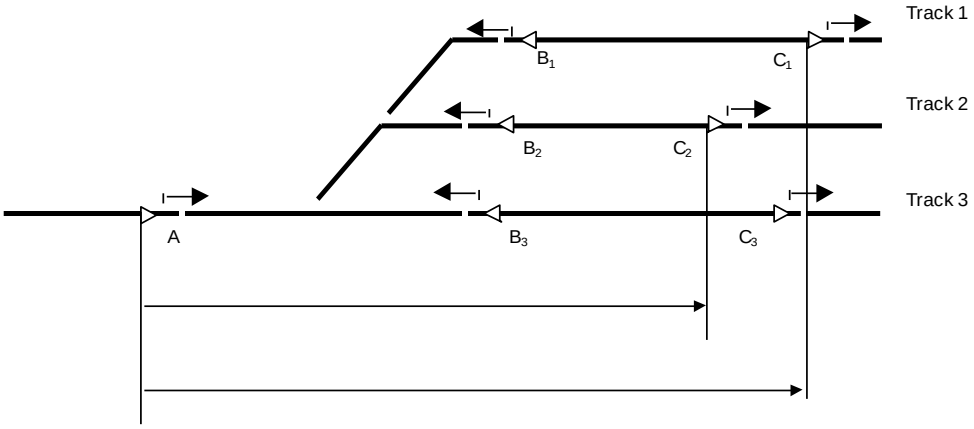


Figure 24: Information on set route not complete at signal A

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.

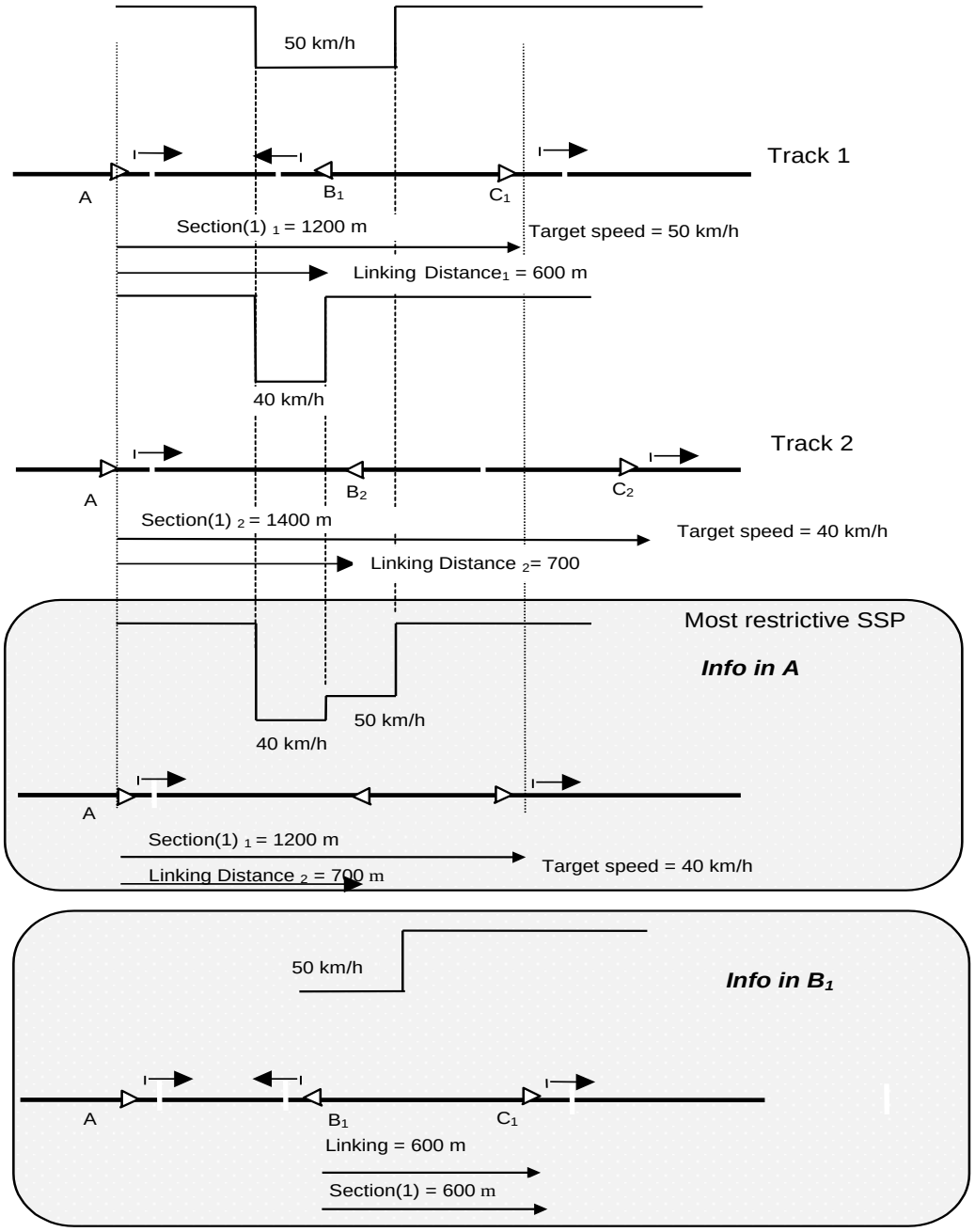


Figure 25: Information contained in A and B_1 (for clarity purposes, only SSPs are drawn but the procedure has to be applied for all track description)

3.8.6 Co-operative shortening of MA (Level 2 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 sends a request to shorten MA, which includes a proposed shortened MA with an EOA closer to the train than the current EOA/LOA, optionally with a mode profile and in case of SH mode profile optionally with a list of balise groups for SH area.

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 request shall be accepted and the on-board equipment shall consider the proposed shortened MA as the new MA, together with its accompanying mode profile (if any) and list of balise groups for SH area (if any).
- If it is in advance, the request shall be rejected and the previously received MA, mode profile (if any) and list of balise groups for SH area (if any) shall remain 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 is 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 Intentionally deleted.

3.9.2.2 Intentionally deleted.

3.9.2.3 Intentionally deleted.

3.9.2.4 Intentionally deleted.

3.9.2.5 Intentionally deleted.

3.9.2.6 Intentionally deleted.

3.9.2.7 Intentionally deleted.

3.9.2.8 Intentionally deleted.

3.9.2.9 Intentionally deleted.

3.9.2.10 Intentionally deleted.

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 Intentionally deleted.

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 GSM-R radio system is not installed on-board.

3.9.3.4 If the GSM-R radio system is installed on-board, the communication session shall be established using the same protocols and interfaces as for Level 2 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 established with the GSM-R radio system, 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

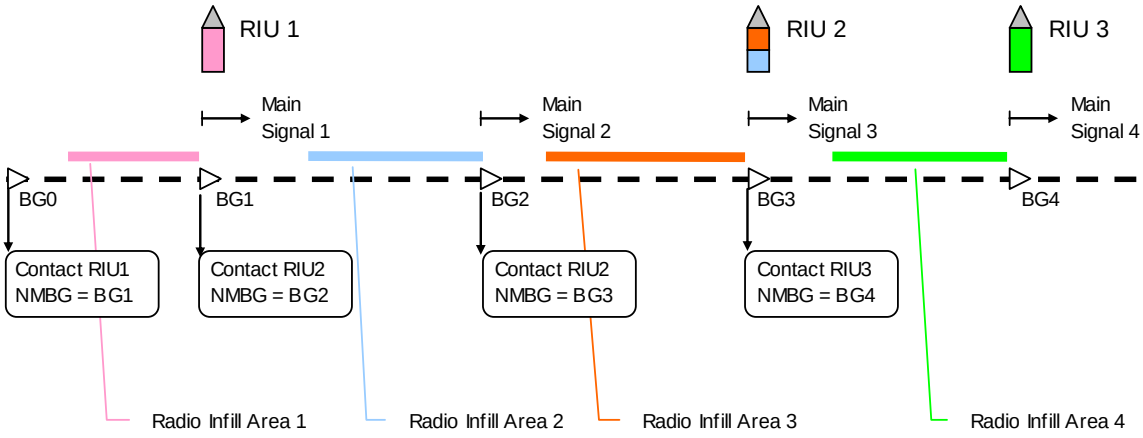
3.9.3.12 As soon as the radio infill unit is informed that a train has entered an infill area under its responsibility, it shall

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 are sent individually to each on-board equipment.

3.10.1.1.1 Intentionally deleted.

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 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

a) the train has already passed with its min safe front end the new stop location, the emergency stop message shall be rejected.

b) the train has not yet passed with its min safe front end the new stop location, the emergency stop message shall be accepted:

- If this new stop location is not beyond the current EOA/LOA, the on-board shall use it to define a new EOA/SvL with no release speed.
- If this new stop location is beyond the current EOA and not beyond the current SvL, the on-board shall use it to define a new SvL with no release speed, keeping the current EOA unchanged.
- If this new stop location is beyond the current SvL, the on-board shall keep the current EOA/SvL and release speed unchanged.
- If this new stop location is beyond the current LOA, the on-board shall replace the current LOA with a new EOA/SvL at the LOA location, with no release speed.

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.

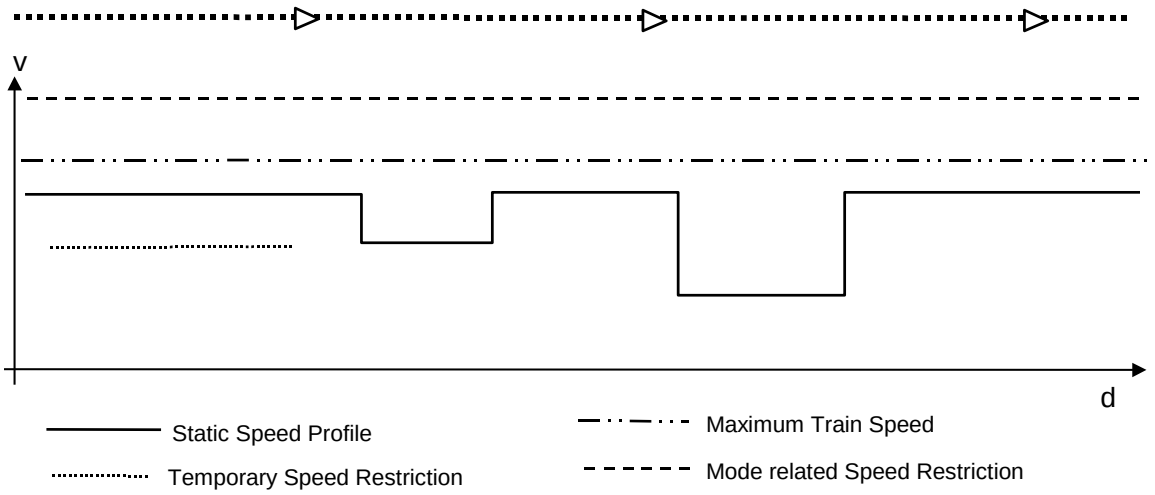


Figure 26: Example of Static Speed Restriction categories on a piece of track.

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, it shall be possible to transmit one or more axle load category speed restrictions.

3.11.4.2.1 Intentionally deleted.

3.11.4.3 The ERTMS/ETCS on-board equipment shall only consider the speed restriction that is associated with the axle load category matching that of the train.

3.11.4.3.1 Note: As a consequence, it is the trackside responsibility to provide the axle load category speed restrictions taking into account the different axle load categories of the trains suitable to operate on the line.

3.11.4.4 Intentionally deleted.

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 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 max safe front end of the train 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, the signalling related speed restriction shall remain valid until a level 2 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 modes Reversing and Supervised Manoeuvre 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:

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

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

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

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

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

With $T_{traction}$ and T_{berem} as defined in 3.13.9.3.2 but substituting T_be_reduced with T_be as defined in 3.13.6.2.2.3

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

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

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

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:

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

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

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

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

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

With $T_{traction}$ and T_{berem} as defined in 3.13.9.3.2 but substituting $T_{be\_reduced}$ with T_{be} as defined in 3.13.6.2.2.3

With T_{bs2} as defined in 3.13.9.3.3 but substituting $T_{bs\_reduced}$ with T_{bs} as defined in 3.13.6.3.2.4

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

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

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

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:

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

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

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

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.

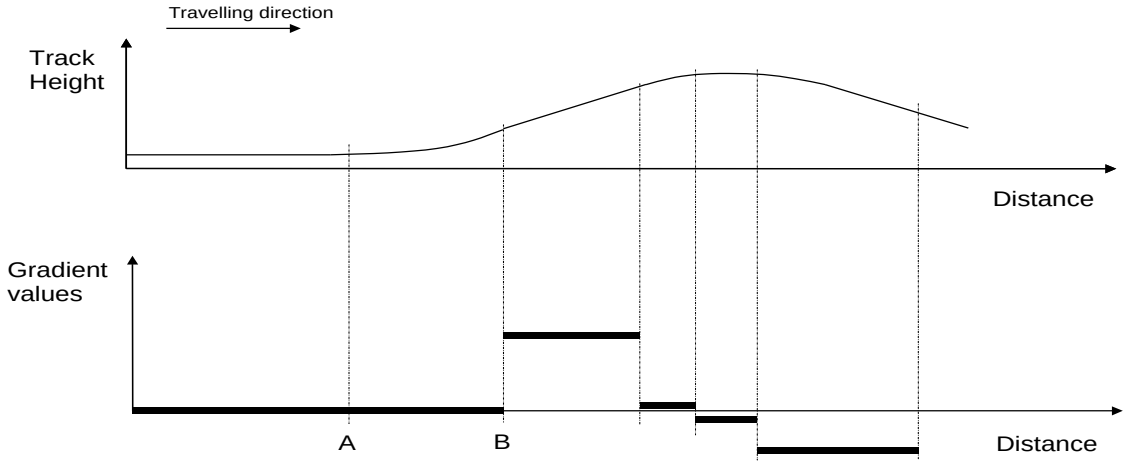


Figure 27: Gradient profile

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.

3.12.1.2.1.5 Exception 4: The start and end of a radio hole shall be evaluated taking into account the estimated position of the front/rear and rear/front ends of the engine respectively, depending on whether the train orientation is the same as/opposite to the active cab.

3.12.1.2.1.5.1 Note: it is assumed that all the radio antennas are installed on the engine.

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 not included in the list of permitted ones received from trackside

3.12.2.3.1 Exception to 3.12.2.3 b): If the engine is able to run on a line not fitted with any traction system, unsuitability never exists.

3.12.2.4 If at least one unsuitability exists, the closest location corresponding to the unsuitability(ies) shall be considered as both temporary EOA and SvL, with no Release Speed. The driver shall be informed about all unsuitabilities.

3.12.2.5 The temporary EOA and SvL are entities distinct from the EOA and SvL continuously supervised by the on-board. Unless specified otherwise, all the instances of the terms EOA or SvL used in this document do not refer to these temporary EOA/SvL.

3.12.2.5.1 Intentionally deleted.

3.12.2.6 Intentionally deleted.

3.12.2.7 Intentionally deleted.

3.12.2.8 Intentionally deleted.

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
- Condition for start of indication
- Condition 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 sub-conditions for start/end condition of indication.

3.12.3.4.2 The following sub-conditions can be used to define the start condition:

- Location (the train front end is in advance of this location)
- Mode (the on-board is in this mode)
- Level (the on-board is in this level)

3.12.3.4.3 The following sub-conditions can be used to define the end condition:

- Location (the train front end is in advance of this location)
- Time (the duration since the start condition is fulfilled elapses)
- Mode (a transition from this mode is executed)
- Level (a transition from this level is executed)

3.12.3.4.3.1 It shall be possible to define whether one or all of the sub-conditions 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 the start and the end conditions. It shall apply to the start condition checked by the on-board when at least two sub-conditions from the list in 3.12.3.4.2 are used by the trackside and it shall apply to the end condition checked by the on-board when at least two sub-conditions from the list in 3.12.3.4.3 are used by the trackside.

3.12.3.4.3.1.1 When at least two sub-conditions from the list in 3.12.3.4.2 are used and they all have to be fulfilled, they shall be continuously evaluated until they are all fulfilled at the same time.

3.12.3.4.3.1.2 When at least two sub-conditions from the list in 3.12.3.4.3 are used and they all have to be fulfilled, they shall be evaluated independently from each other and a sub-condition shall no longer be evaluated once it is fulfilled.

3.12.3.4.3.1.3 If none of the sub-conditions from the list in 3.12.3.4.2 is used, it shall be considered as a start condition immediately fulfilled.

3.12.3.4.3.1.4 If none of the sub-conditions from the list in 3.12.3.4.3 is used, it shall be considered as an end condition never fulfilled.

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, regardless if a confirmation of the text message is requested.

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 sub-condition "location" is used for the end condition, the length on which the text is displayed shall refer to the location used for the start condition, independently from other start sub-conditions.

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,

a) any currently supervised OS/LS Mode Profile shall be deleted only beyond the reference location of the infill information;

b) in case the infill location reference is in rear of or at the start location of a currently supervised SH Mode Profile, this currently supervised SH Mode Profile shall be deleted;

c) in case the infill location reference is in advance of the start location of a currently supervised SH Mode Profile, any Mode Profile and, if any, a list of balise groups for SH area included in this infill MA shall be ignored by the on-board equipment. No deletion of this currently supervised SH Mode Profile shall take place in this case.

3.12.4.4 In case the SH Mode Profile is deleted for another reason than entering SH mode, the corresponding list of balise groups for SH area shall be deleted.

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.

3.12.4.7 Until the ERTMS/ETCS on-board equipment has switched to the concerned mode, it shall consider the beginning of the Mode Profile as a temporary EOA. The ERTMS/ETCS on-board equipment shall only for the cases below consider a temporary SvL with no release speed that is at a location:

a) At the beginning of the Mode Profile if it is required by the Mode Profile.

b) That is determined in accordance with 3.8.4.5 as if no LOA had been given, if it is required that no temporary SvL is to be considered with respect to the Mode Profile and the MA defines an LOA located in advance of or at the start of the Mode Profile.

c) At the beginning of the Mode Profile, if it is required that no temporary SvL is to be considered with respect to the Mode Profile and the MA defines an LOA located in rear of the start of the Mode Profile.

3.12.4.7.1 Note: No temporary SvL results from the Mode Profile if it requires that no temporary SvL is to be considered with respect to it and the MA defines an EOA.

3.12.4.8 See clause 3.12.2.5.

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.

3.12.5.8 In case the LX is not protected, the ERTMS/ETCS on-board equipment shall consider the LX start location as both temporary EOA and SvL, with no release speed. See section 5.16 for other detailed requirements.

3.12.5.9 See clause 3.12.2.5.

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.

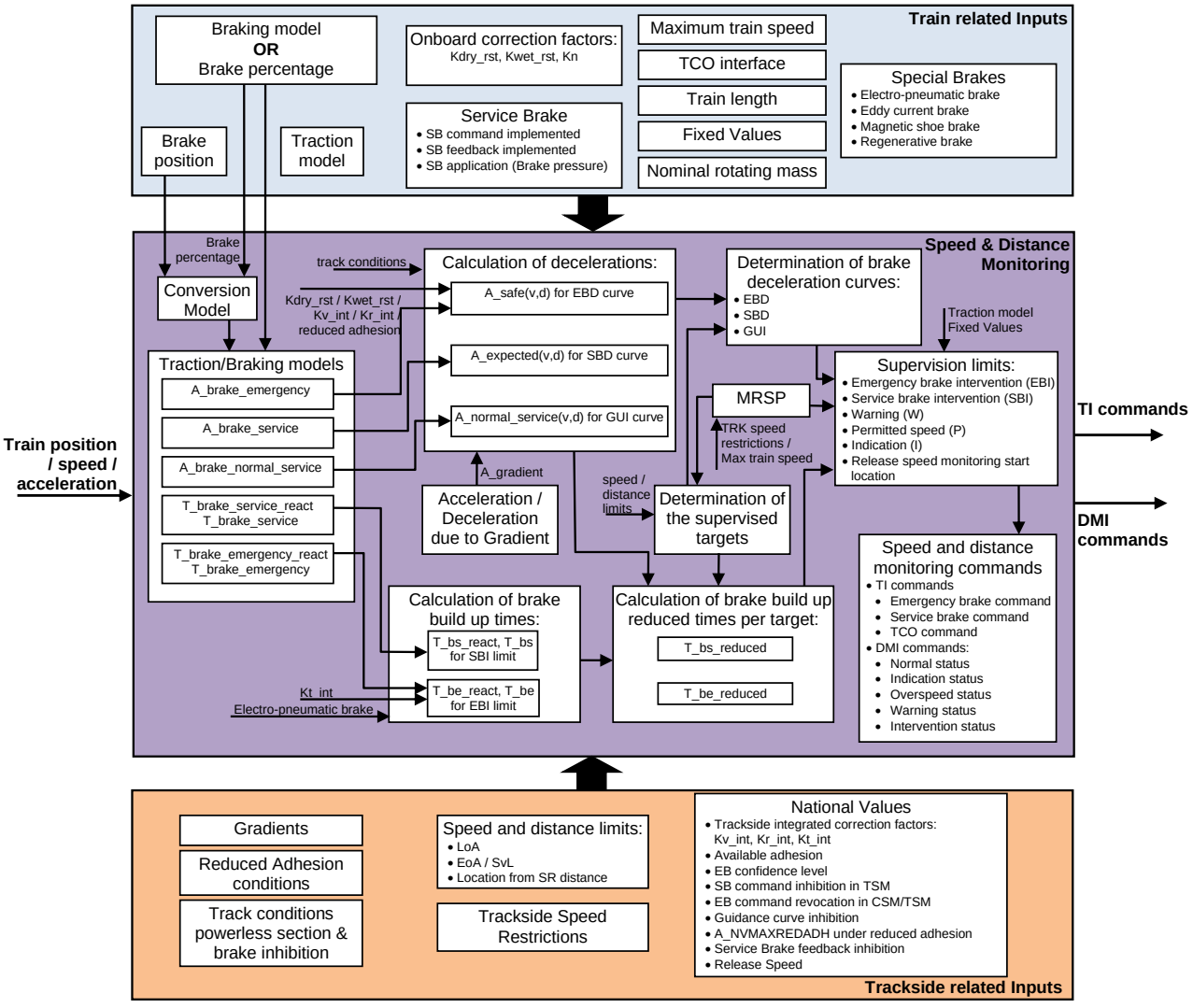


Figure 28: Speed and distance monitoring overview

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 single reference location of the on-board equipment for the supervision of distances (i.e. the SOLR).

3.13.1.5 When the ERTMS/ETCS on-board equipment applies at least one of the clauses 3.12.2.4, 3.12.4.7 and 3.12.5.8, all the instances of the terms EOA and SvL in this section 3.13 shall refer to the closest location amongst the temporary EOA(s) and the EOA and to the closest location amongst the temporary SvL(s) and the SvL, respectively.

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 reaction time, 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. Depending on whether the traction cut-off command is implemented or not (see 3.13.2.2.8.1), it shall describe the nominal traction cut-off time (T_traction_cut_off) counted from the moment when either the traction cut-off command or the emergency brake command is respectively triggered by the on-board (t0) to the moment the acceleration due to traction (A_traction) is zero (t1). The estimated acceleration value of the train shall be considered during this time.

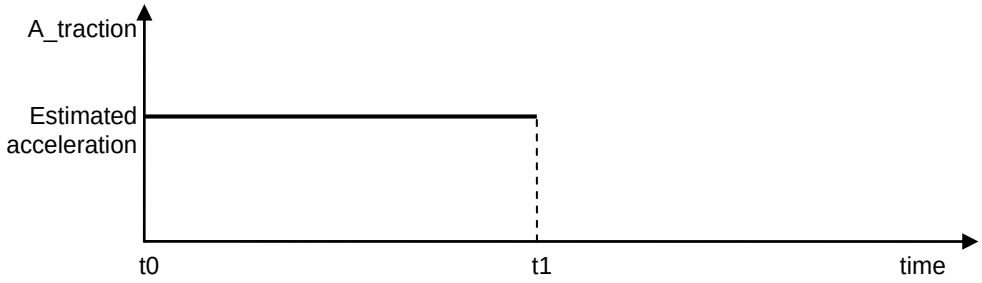


Figure 29: Traction Model

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

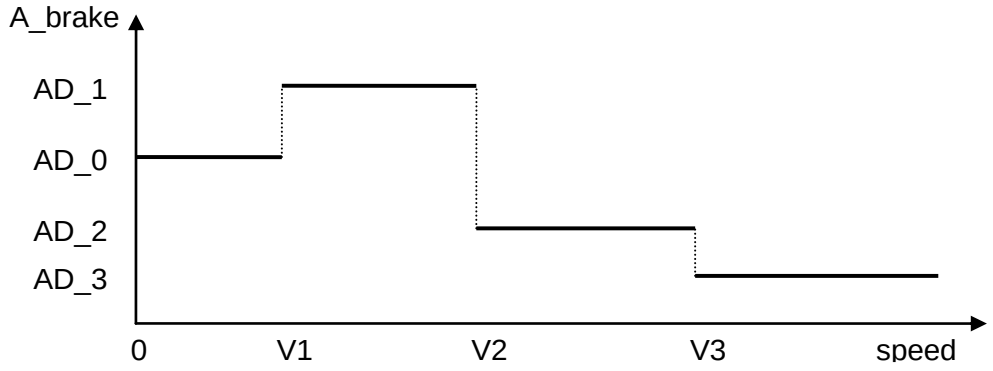


Figure 30: Speed Dependent Deceleration Model

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 reaction time and 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 models for the brake build up time shall be given both as a ramp function and as a step function as explained in Figure 31.

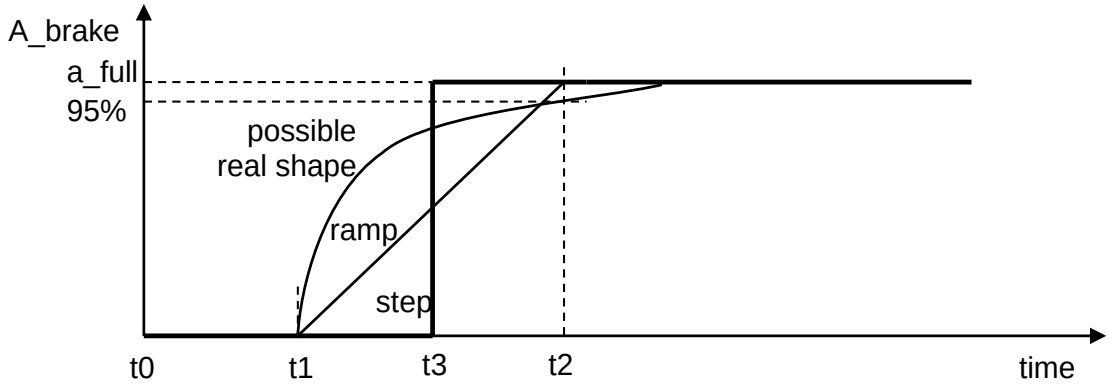


Figure 31: Brake Build Up Time Models

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 effort 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 ramp and step models assume a deceleration smaller than the real shape, in the later part this is compensated by a higher deceleration. The approximation done with the 95% factor is compensated by the margin between the models and the real shape existing in the beginning of the build-up time.

3.13.2.2.3.2.7 Intentionally deleted.

3.13.2.2.3.2.8 It shall be possible to define individual values of T_brake_emergency_react, T_brake_emergency, T_brake_service_react 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 EN 16834 : 2019, with the exception of sections 9.3.1, 9.4.1 and 9.5.2, 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_react T_brake_emergency	x	x	x	x
	A_brake_service(V)	x	x		
	T_brake_service_react 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

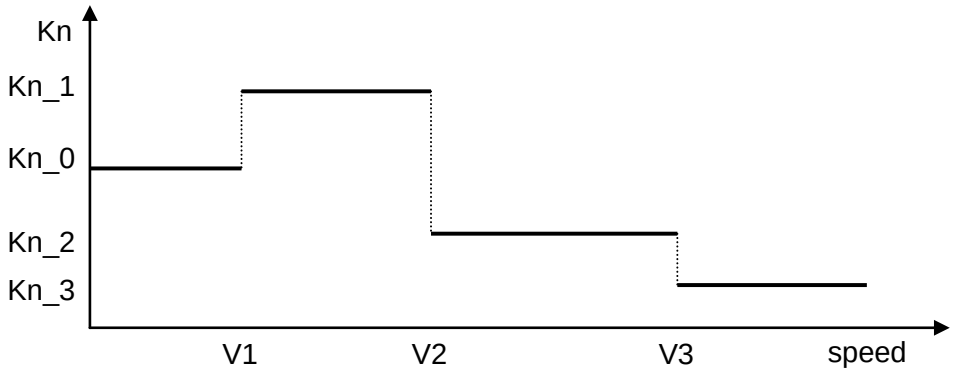


Figure 32 Speed dependent correction factor for normal service brake (Kn)

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

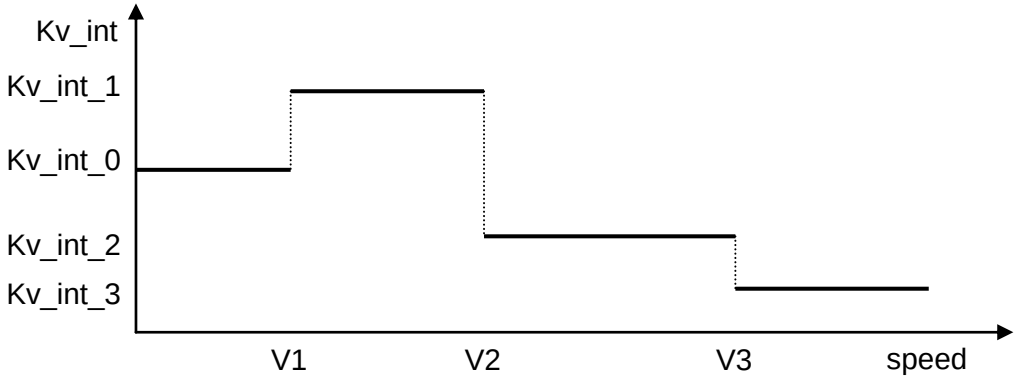


Figure 33 Speed dependent correction factor Kv_int

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

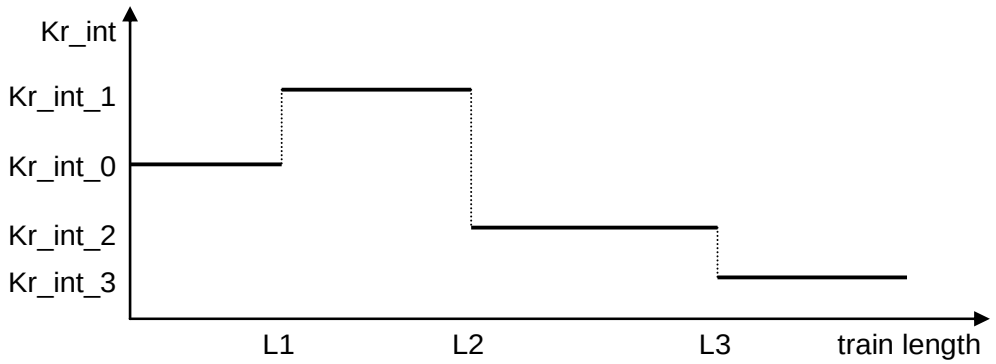


Figure 34 Train length dependent correction factor Kr_int

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 reaction time and equivalent build up time

3.13.3.4.2.1 The brake reaction time and 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 reaction time and equivalent build up time

3.13.3.4.3.1 The brake reaction time and 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

c) two values of the brake reaction time, one value for the emergency brake and one for the full service brake:

   T_brake_emergency_react value as defined for emergency brake in A.3.8

   T_brake_service_react value 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.

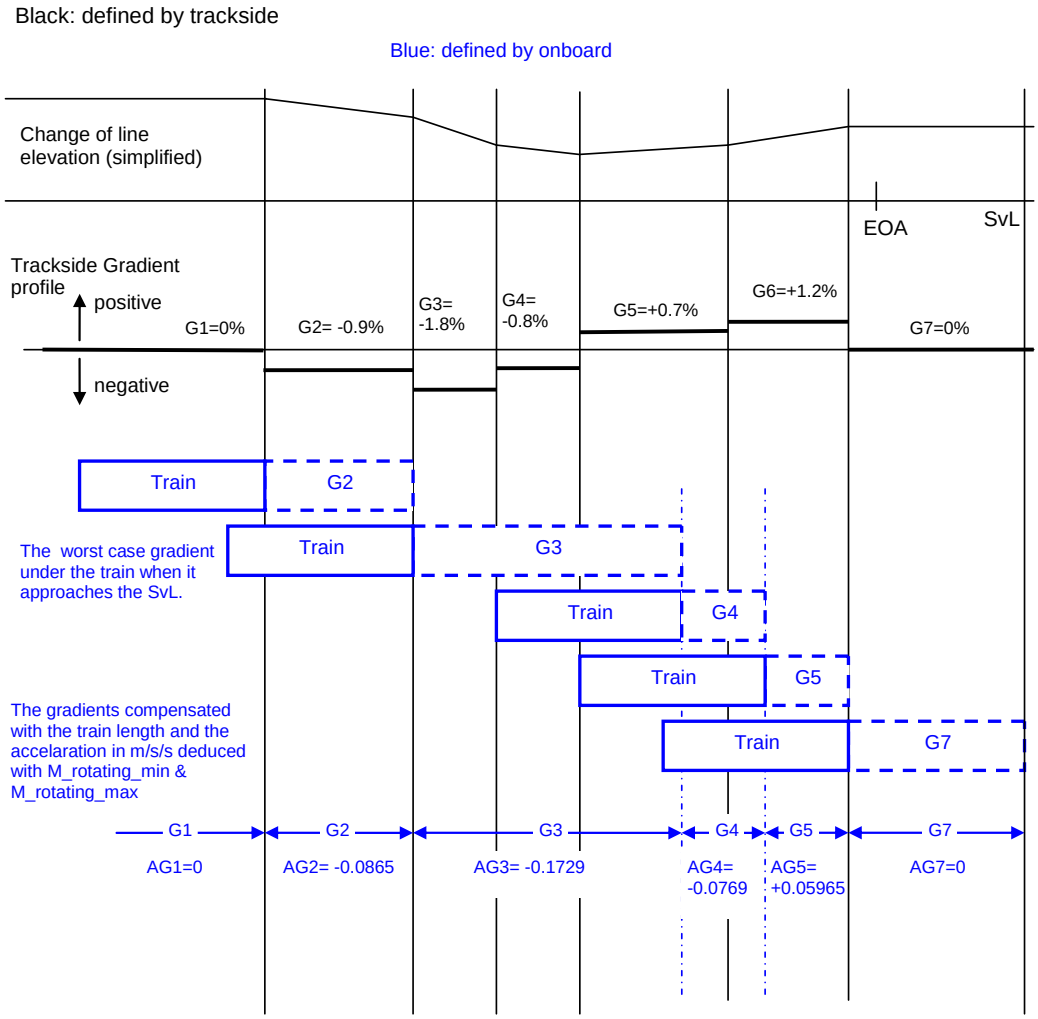


Figure 35: Compensation on the gradient profile

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 (downhill acceleration is given with a negative value)

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 c))

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.

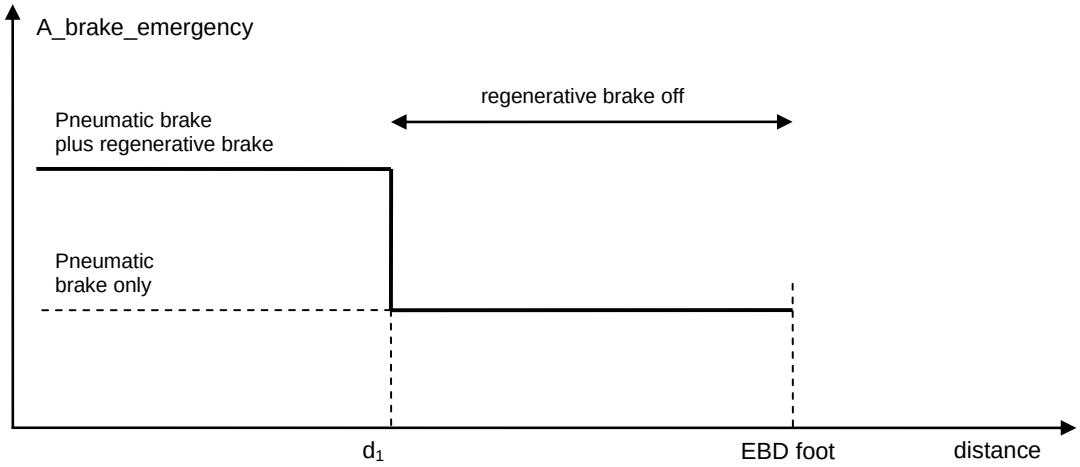


Figure 36: Influence of track conditions on A_brake_emergency(V,d)

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.”

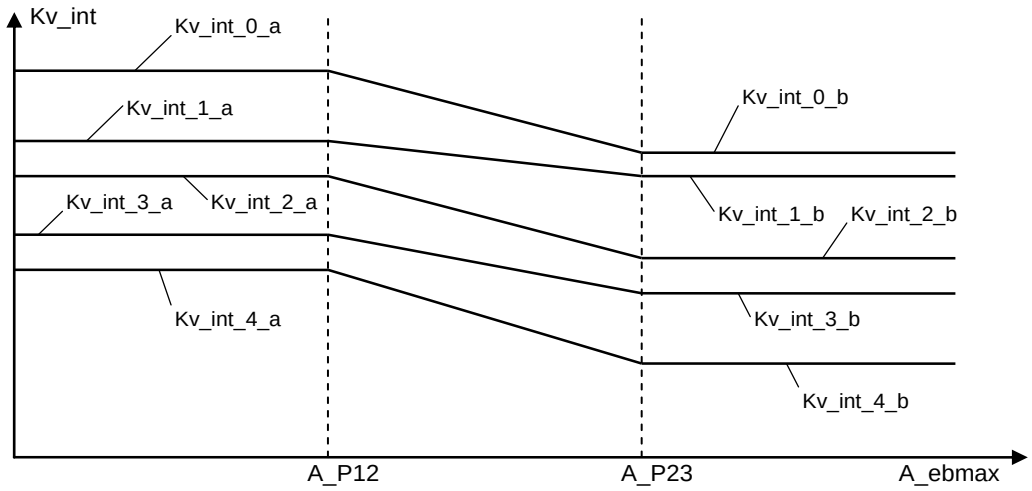


Figure 37: Kv_int structure for conventional passenger trains

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).

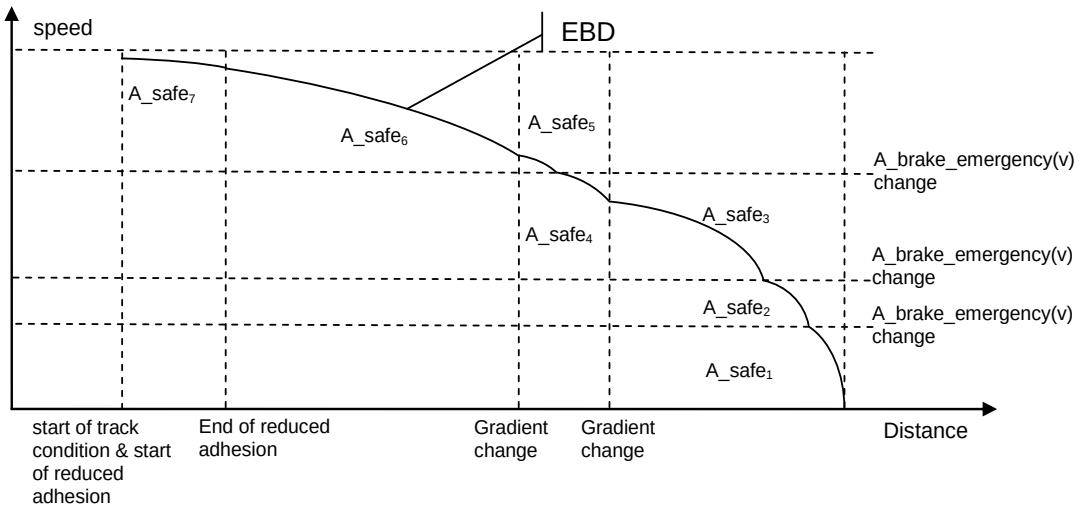


Figure 38: Influence of track/train characteristics on A_safe

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_react and T_brake_emergency acquired as part of Train Data (see 3.13.2.2.3.2.8) or the values of T_brake_emergency_react and

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 reaction time T_be_react and 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_react = T_brake_emergency_react, with T_brake_emergency_react corresponding to the combination of special brakes currently in use

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_react = Kt_int * T_brake_emergency_react

T_be = Kt_int * T_brake_emergency

3.13.6.2.2.4 The safe brake build up reduced time T_be_reduced shall be obtained for every target from T_be and T_be_react as defined in section A.3.12.

3.13.6.2.2.4.1 Note: Applying the Brake Build Up Time ramp model, it is possible that the predicted train speed reaches standstill or decelerates under the target speed before T_be time elapses.

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 c))

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

$d_1, d_2, d_3, ...$ 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_react and 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_react and 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 reaction time T_bs_react and the expected brake build up time T_bs shall be equal to the brake build up time of the full service brake:

T_bs_react = T_brake_service_react, with T_brake_service_react corresponding to the combination of special brakes currently in use

T_bs = T_brake_service, with T_brake_service corresponding to the combination of special brakes currently in use

3.13.6.3.2.5 If the service brake feedback is not available for use, the expected brake build up reduced time T_bs_reduced shall be obtained for every target from T_bs as defined in section A.3.12. Otherwise, T_bs_reduced shall be set to T_bs for every target.

3.13.6.3.2.5.1 Note: Applying the Brake Build Up Time ramp model, it is possible that the predicted train speed reaches standstill or decelerates under the target speed before T_bs time elapses.

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 c))

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)

g) The gradient profile compensated in location according to the train length (see 3.13.4.2)

3.13.6.4.3 The normal service brake deceleration shall be equal to:

For positive gradient values (uphill):

$$A\_normal\_service(V,d) = A\_brake\_normal\_service(V,d) + A\_gradient(d) - Kn+(V)*grad(d)/1000$$

For negative gradient values (downhill):

$$A\_normal\_service(V,d) = A\_brake\_normal\_service(V,d) + A\_gradient(d) - Kn-(V)*grad(d)/1000$$

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 must obey on a given piece of track.

3.13.7.2 The Most Restrictive Speed Profile shall be derived from elements corresponding to all speed restrictions (see 3.13.2.2.13 & 3.13.2.3.2), 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). To do so, the ERTMS/ETCS on-board shall continuously compute the MRSP current speed (V_MRSP), which is the lowest speed of the MRSP elements encountered between the min safe front end and the max safe front end of the train.

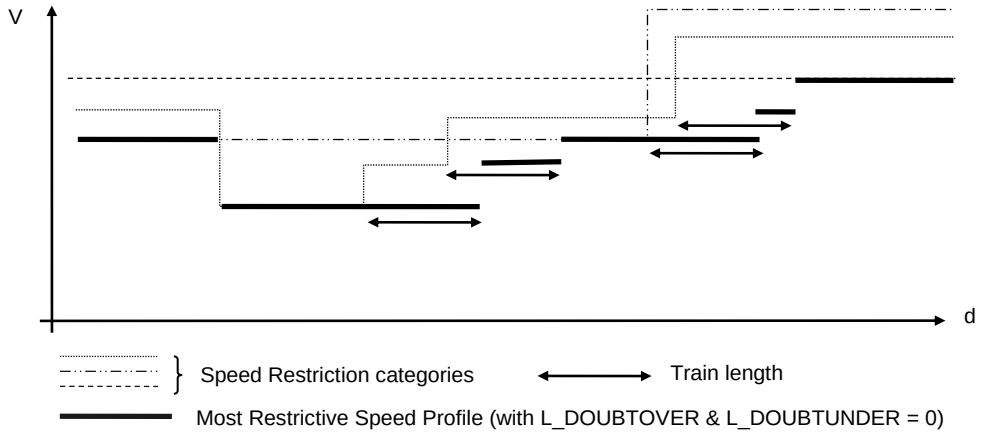


Figure 39: Most Restrictive Speed Profile selection

3.13.7.2.1 Note 1: The envelope of V_MRSP over a given piece of track travelled by the train forms the MRSP.

3.13.7.2.2 Note 2: The MRSP as a whole cannot be computed in advance by the on-board equipment, since the locations of its speed increases/decreases depend on the size of the train position confidence interval at a given time/location.

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 3.13.6.3.2.5.

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 start locations of the MRSP elements whose speed is lower than V_MRSP and 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, update of stored information in specific situations (see sections A.3.4 and 4.10)).

3.13.8.2.3 A target corresponding to an MRSP element 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).

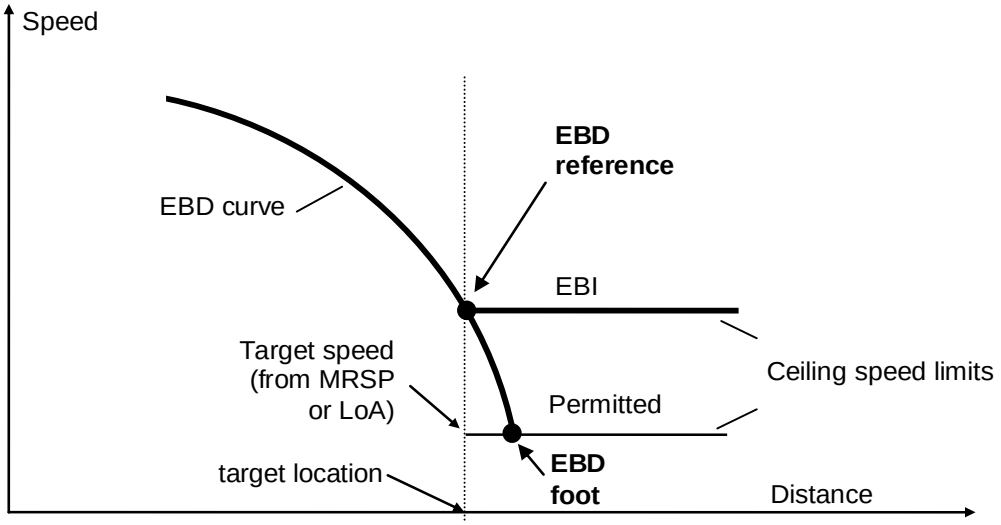


Figure 40: Calculation of the EBD curve with regards to MRSP or LOA target

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.

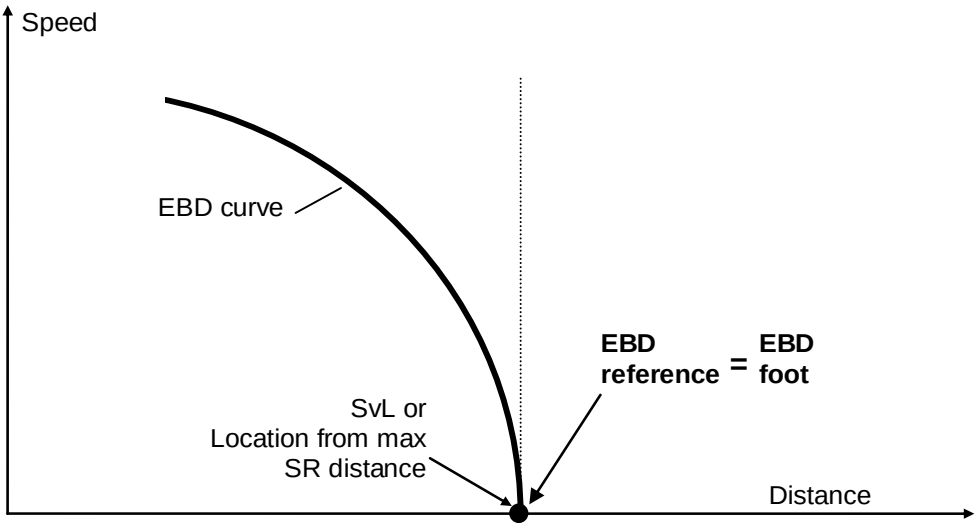


Figure 41: Calculation of the EBD curve with regards to SvL or SR distance

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.

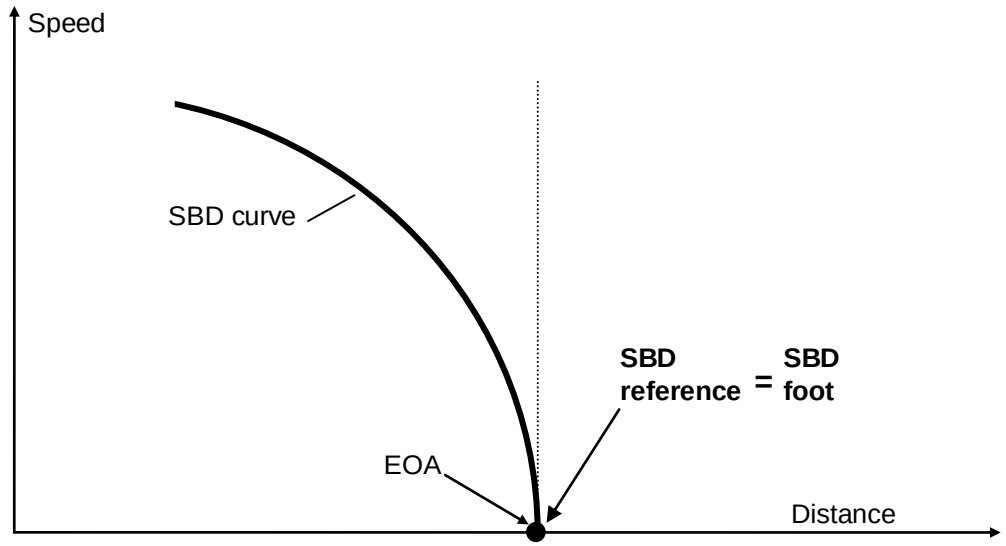


Figure 42: Calculation of the SBD curve with regards to EOA

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).

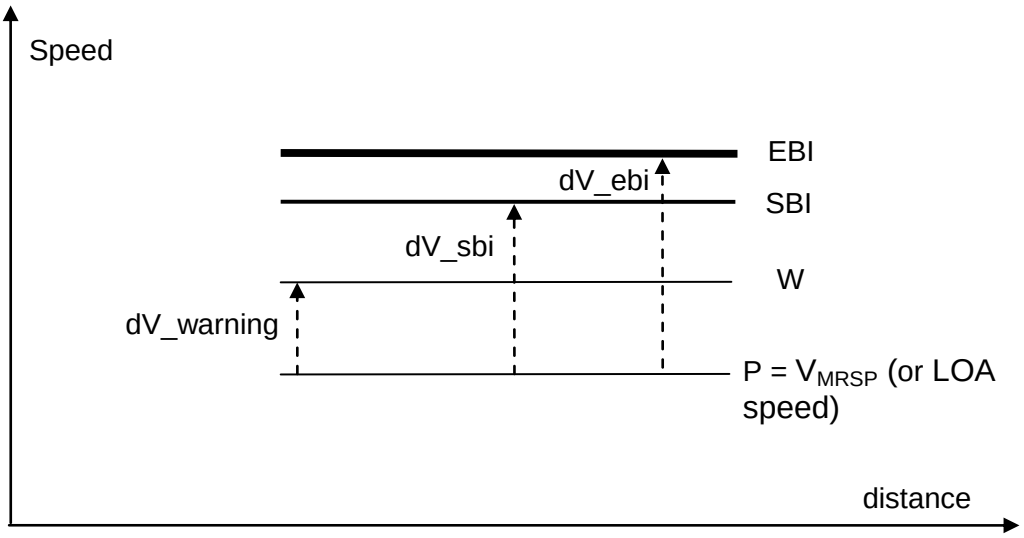


Figure 43: Ceiling supervision limits

3.13.9.2.3 For dv_ebi, the following formula shall be applied:

when $V_{MRSP} > V_{ebimin}$:

$$dV_{ebi} = min\{dV_{ebimin} + C_{ebi} \cdot (V_{MRSP} - V_{ebimin}), dV_{ebimax}\}$$

with $C_{ebi} = \frac{(dV_{ebimax} - dV_{ebimin})}{(V_{ebimax} - V_{ebimin})}$

when $V_{MRSP} \leq V_{ebimin}$: $dV_{ebi} = dV_{ebimin}$

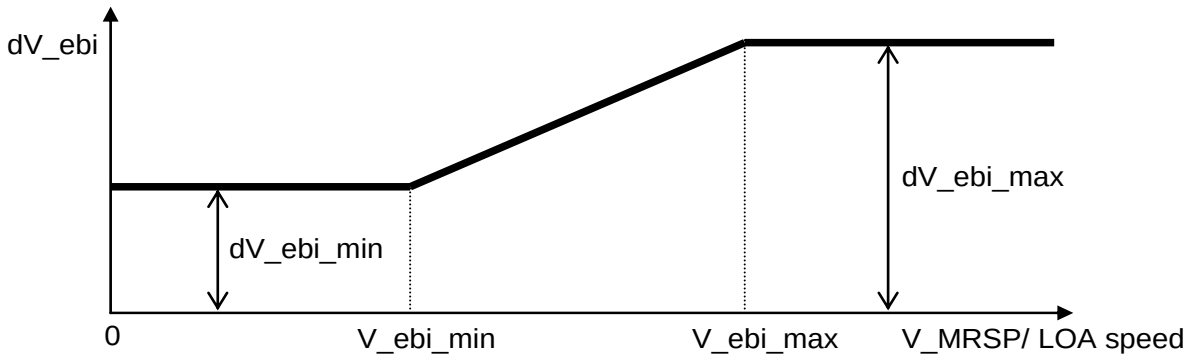


Figure 44: Definition of dV_ebi

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):

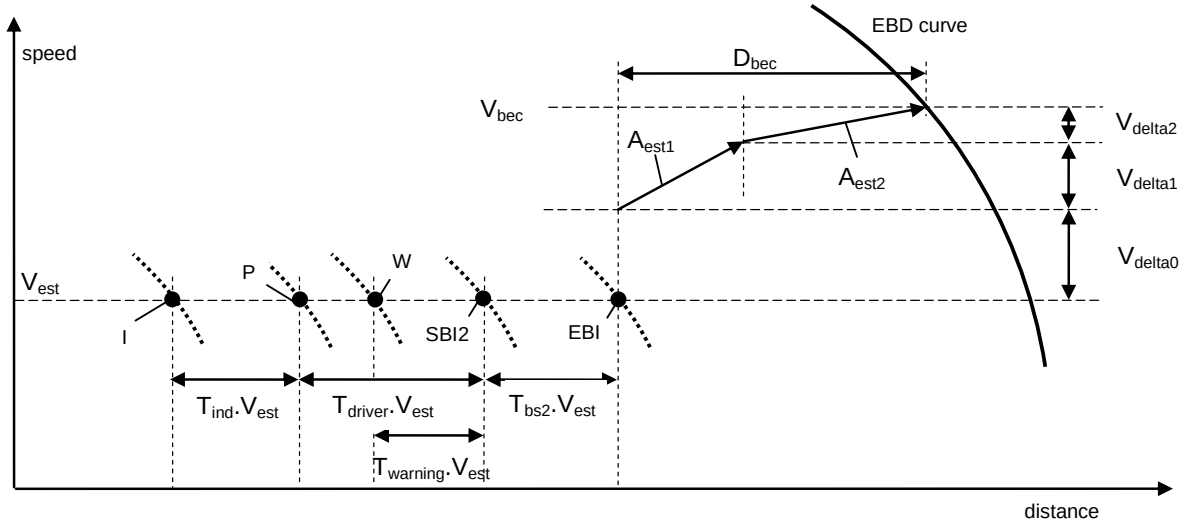


Figure 45: Braking to target supervision limits from EBD curve

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):

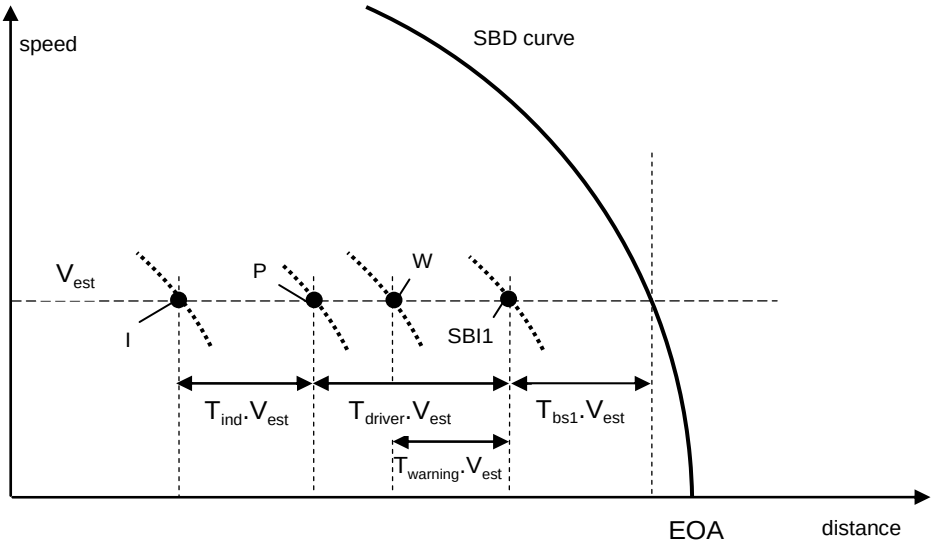


Figure 46: Braking to target supervision limits from SBD curve

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_reduced - T_traction ; 0).

3.13.9.3.2.7 Intentionally deleted.

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_reduced > 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):

$$V_{bec} = max\{(V_{est} + V_{delta0} + V_{delta1}), V_{target}\} + V_{delta2}$$

$$D_{bec} = max\left\{\left(V_{est} + V_{delta0} + \frac{V_{delta1}}{2}\right), V_{target}\right\} \cdot T_{traction}$$

$$+ \left(max\{(V_{est} + V_{delta0} + V_{delta1}), V_{target}\} + \frac{V_{delta2}}{2}\right) \cdot T_{berem}$$

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_reduced.

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):

$V_{SBI1}(d_{estfront}) = V_{SBD}(d_{estfront} + V_{est} \cdot T_{bs1})$

$V_{SBI1}(d_{estfront}) = 0$ if $d_{estfront} + V_{est} \cdot T_{bs1} \geq d_{EOA}$

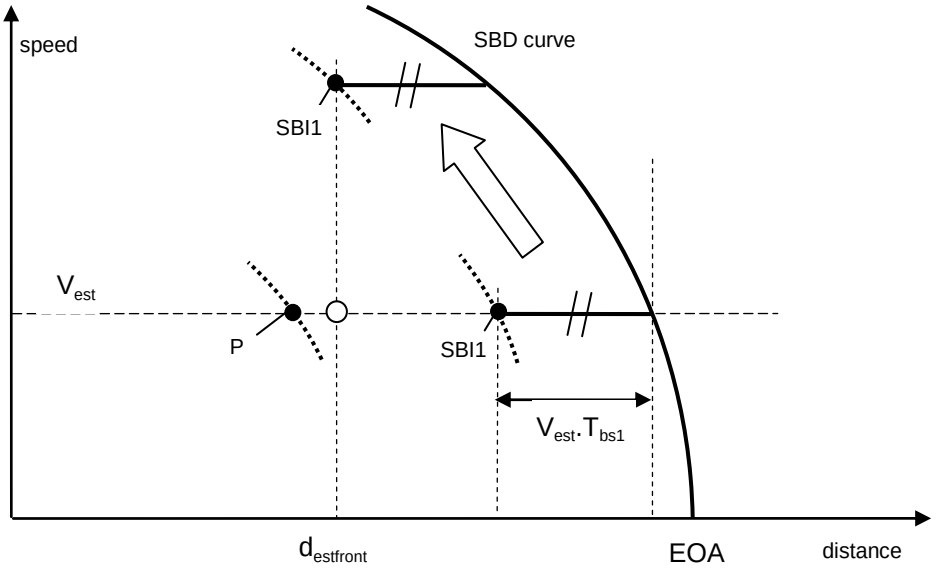


Figure 47: Calculation of SBI1 speed displayed to the driver

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):

$$V_{SBI2}(d_{maxsafefront}) = max\left\{\begin{matrix}\left(V_{EBD}\left(d_{maxsafefront} + V_{est} \cdot T_{bs2} + D_{be_{display}}\right) - (V_{delta0} + V_{delta1} + V_{delta2})\right), \\ \left(V_{target} + dV_{sbi}(V_{target})\right)\end{matrix}\right\}$$

$V_{SBI2}(d_{maxsafefront}) = V_{target} + dV_{sbi}(V_{target})$ if

$d_{maxsafefront} + V_{est} \cdot T_{bs2} + D_{be_{display}} \geq d_{EBD}(V_{target})$

With V_{delta0}, V_{delta1} and V_{delta2} calculated according to 3.13.9.3.2.10

With $D_{be_{display}} = \left(V_{est} + V_{delta0} + \frac{V_{delta1}}{2}\right) \cdot T_{traction} + \left(V_{est} + V_{delta0} + V_{delta1} + \frac{V_{delta2}}{2}\right) \cdot T_{berem}$

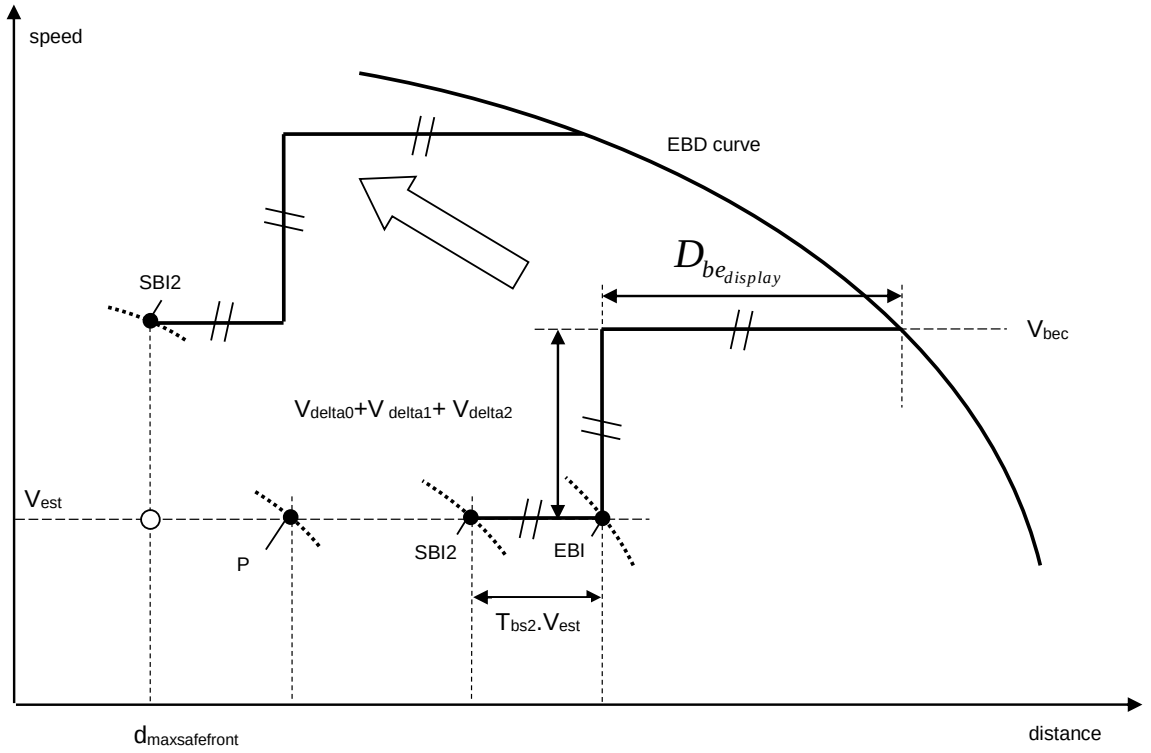


Figure 48: Calculation of SBI2 speed displayed to the driver

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

$d_P(V_{est}) = min\{(d_{SBI2}(V_{est}) - V_{est} \cdot T_{driver}), d_{target}\}$ 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:

$$\left[V_P\left(d_{estfront}\right)\right]_{EOA} = V_{SBD}\left(d_{estfront} + V_{est} \cdot (T_{driver} + T_{bs1})\right)$$

$\left[V_P\left(d_{estfront}\right)\right]_{EOA} = 0$ 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:

$$\left[V_P\left(d_{estfront}\right)\right]_{EOA} = min\left\{V_{SBD}\left(d_{estfront} + V_{est} \cdot (T_{driver} + T_{bs1})\right), \left[V_{GUI}\left(d_{estfront}\right)\right]_{EOA}\right\}$$

$\left[V_P\left(d_{estfront}\right)\right]_{EOA} = 0$ 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):

$$\left[V_P\left(d_{maxsafefront}\right)\right]_{EBD-Target} =$$

$$max\left\{\begin{pmatrix} V_{EBD}\left(d_{maxsafefront} + V_{est} \cdot (T_{driver} + T_{bs2}) + D_{be_{display}}\right) \\ -(V_{delta0} + V_{delta1} + V_{delta2}) \end{pmatrix}, V_{target}\right\}$$

$$\left[V_P\left(d_{maxsafefront}\right)\right]_{EBD-Target} = V_{target}$$

if $d_{maxsafefront} + V_{est} \cdot (T_{driver} + T_{bs2}) + D_{be_{display}} \geq d_{EBD}\left(V_{target}\right)$

With V_delta0, V_delta1 and V_delta2 calculated according to 3.13.9.3.2.10

With $D_{be_{display}} = \left(V_{est} + V_{delta0} + \frac{V_{delta1}}{2}\right) \cdot T_{traction} + \left(V_{est} + V_{delta0} + V_{delta1} + \frac{V_{delta2}}{2}\right) \cdot T_{berem}$

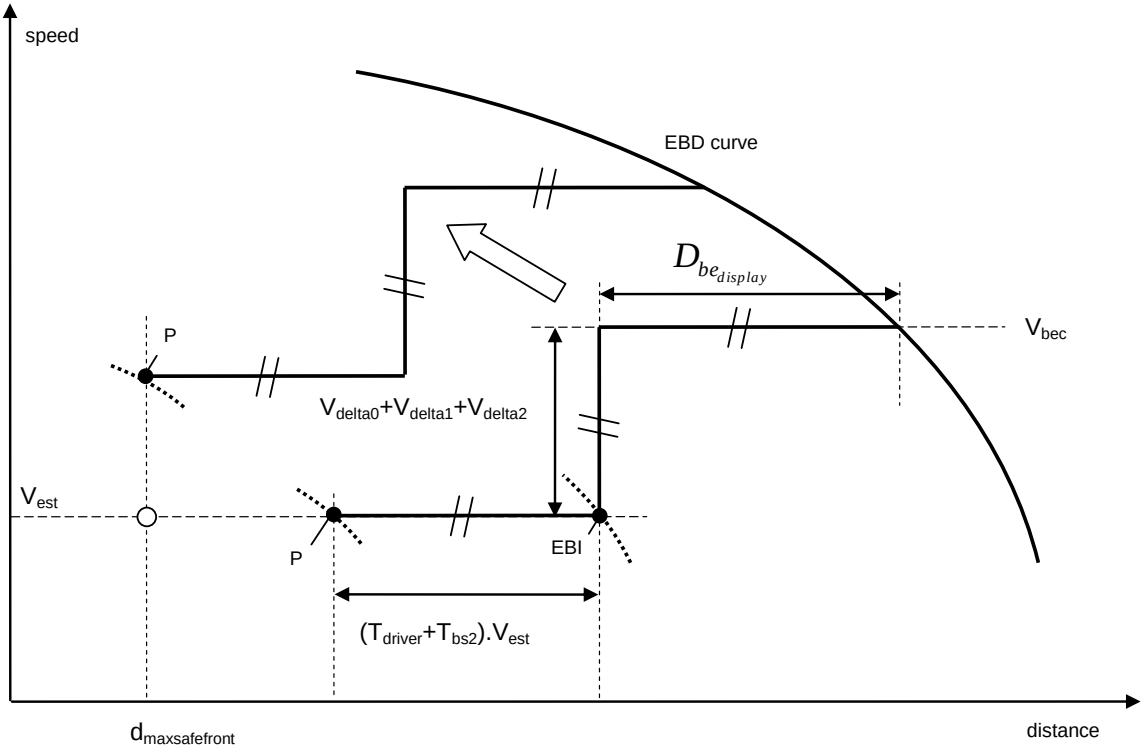


Figure 49: Calculation of Permitted speed displayed to the driver

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:

$$\left[V_P\left(d_{maxsafefront}\right)\right]_{EBD-Target} =$$

$$max\left\{min\left\{\begin{pmatrix} V_{EBD}\left(d_{maxsafefront} + V_{est} \cdot (T_{driver} + T_{bs2}) + D_{be_{display}}\right) \\ -(V_{delta0} + V_{delta1} + V_{delta2}) \end{pmatrix}, \left[V_{GUI}\left(d_{maxsafefront}\right)\right]_{EBD-Target}\right\}, V_{target}\right\}$$

$$\left[V_P\left(d_{maxsafefront}\right)\right]_{EBD-Target} = V_{target}$$

if $d_{maxsafefront} + V_{est} \cdot (T_{driver} + T_{bs2}) + D_{be_{display}} \geq d_{EBD}(V_{target})$

or if $d_{maxsafefront} \geq d_{GUI}(V_{target})$

With V_delta0, V_delta1 and V_delta2 calculated according to 3.13.9.3.2.10

With $D_{be_{display}} = \left(V_{est} + V_{deltao} + \frac{V_{delta1}}{2}\right) \cdot T_{traction} + \left(V_{est} + V_{deltao} + V_{delta1} + \frac{V_{delta2}}{2}\right) \cdot T_{berem}$

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)

c) the safe brake build up time shall be considered to be fully reduced as per A.3.12 algorithm, i.e. it shall be set to T_{be_react}

d) if the service brake command is available for use and the service brake feedback is not available for use, the expected brake build up time shall be considered to be fully reduced as per A.3.12 algorithm, i.e. it shall be set to T_{bs_react}

e) the above-mentioned location of the Permitted speed supervision limit shall not be beyond the target location

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.

$d_{EBI}(V_{target}) = d_{EBD}(V_{target} + V_{deltaot}) - (V_{target} + V_{deltaot}) \cdot (T_{berem\_min} + T_{traction\_max})$

$d_P(V_{target}) = MIN\{d_{EBI}(V_{target}) - V_{target} \cdot (T_{driver} + T_{bs\_foot}), d_{target}\}$

With $T_{berem\_min} = \mathrm{MAX}(T_{be\_react} - T_{traction\_max}, 0)$

With T_{be_react} as defined in clause 3.13.6.2.2.3

With $T_{traction\_max}$ as defined in A.3.12.2.7

With T_{bs_foot} set to T_{bs_react} as defined in clause 3.13.6.3.2.4 if the service brake command is available for use and the service brake feedback is not available for use; otherwise set to T_{bs2} as defined in section 3.13.9.3.3

3.13.9.3.5.10.1 Justification: the two first 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.

The third and fourth assumptions are intended to consider the nominal operation, in which the train speed follows the permitted speed, leading to the reduction of the needed brake build up times to the minimum before the target location is reached.

The fifth assumption is to ensure that the permitted speed displayed to the driver, considering the brake build up times reduction, is not higher than the target speed at the target location.

3.13.9.3.5.11 In case a non protected LX start location is supervised as both temporary 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

$$d_{EBI}(V_{LX}) = d_{EBD}(V_{LX} + V_{delta0} + V_{delta1} + V_{delta2}) - \left(V_{LX} + V_{deltao} + \frac{V_{delta1}}{2}\right) \cdot T_{traction}$$

$$- \left(V_{LX} + V_{deltao} + V_{delta1} + \frac{V_{delta2}}{2}\right) \cdot T_{berem}$$

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 $d_{SBI2}(V_{LX}) - d_{SBI1}(V_{LX}) \geq d_{maxsafefront} - d_{estfront}$

Or $d_P(V_{LX}) = d_{SBI2}(V_{LX}) - V_{LX} \cdot T_{driver}$ if $d_{SBI2}(V_{LX}) - d_{SBI1}(V_{LX}) < d_{maxsafefront} - d_{estfront}$

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
$d_{SBI2}(V_{LX}) - d_{SBI1}(V_{LX}) \geq d_{maxsafefront} - d_{estfront}$

Or $d_P(V_{LX}) = min\{(d_{SBI2}(V_{LX}) - V_{LX} \cdot T_{driver}), d_{GUI}(V_{LX})\}$ if
$d_{SBI2}(V_{LX}) - d_{SBI1}(V_{LX}) < d_{maxsafefront} - d_{estfront}$

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:

$$T_{indication} = max\{(0.8 \cdot T_{bs\_reduced}), 5s\} + T_{driver}$$

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_reduced 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.

3.13.9.3.6.5 If available for use, the service brake feedback shall not have any effect on T_bs1 and T_bs2 when calculating the Indication supervision limit: T_bs1 and T_bs2 shall be set to T_bs in the formulas in 3.13.9.3.2 and 3.13.9.3.3.

3.13.9.3.6.6 Note 1: This avoids that service brake feedback, while braking to one target which causes the full locking of T_bs1 and T_bs2 for all the targets, affects the Indication supervision limit for another target(s). Otherwise, the indication to the driver could come too late. It also avoids its influence on the acceptance criteria of request to shorten MA.

3.13.9.3.6.7 Note 2: If the service brake feedback is not available for use, T_bs1 and T_bs2 are set either to T_bs or to zero, depending on the availability of the service brake command (see 3.13.9.3.3.3 and 3.13.9.3.3.5).

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 (see d_tripEOA in 3.13.9.4.8.2) 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.

$d_{SBI1}(V_{release}) = d_{SBD}(V_{release}) - V_{release} \cdot T_{bs1}$

$[d_{SBI2}(V_{release})]_{Target-n} = [d_{EBI}(V_{release})]_{Target-n} - V_{release} \cdot T_{bs2}$

with $[d_{EBI}(V_{release})]_{Target-n} = [d_{EBD}(V_{release} + V_{delta0rs})]_{Target-n}$

$-(V_{release} + V_{delta0rs}) \cdot (T_{berem} + T_{traction})$

with Target_n (n=1) being the SvL and, when the Release Speed is calculated on-board, with Target_n (n>1) being any other EBD based target between the Trip location related to the EOA and the SvL

$[d_{SBI2}(V_{release})]_{MREBDT} = \min\{[d_{SBI2}(V_{release})]_{Target-1}, \dots, [d_{SBI2}(V_{release})]_{Target-n}\}$

with MREBDT = SvL or, when the Release Speed is calculated on-board, Most Restrictive Target amongst the EBD based targets between the Trip location related to the EOA and the SvL (included)

$d_{\underset{RSM}{start}} = d_{SBI1}(V_{release})$ if $[d_{SBI2}(V_{release})]_{MREBDT} - d_{SBI1}(V_{release}) \geq d_{maxsafefront} - d_{estfront}$

Or $d_{\underset{RSM}{start}} = [d_{SBI2}(V_{release})]_{MREBDT}$ if

$[d_{SBI2}(V_{release})]_{MREBDT} - d_{SBI1}(V_{release}) < d_{maxsafefront} - d_{estfront}$

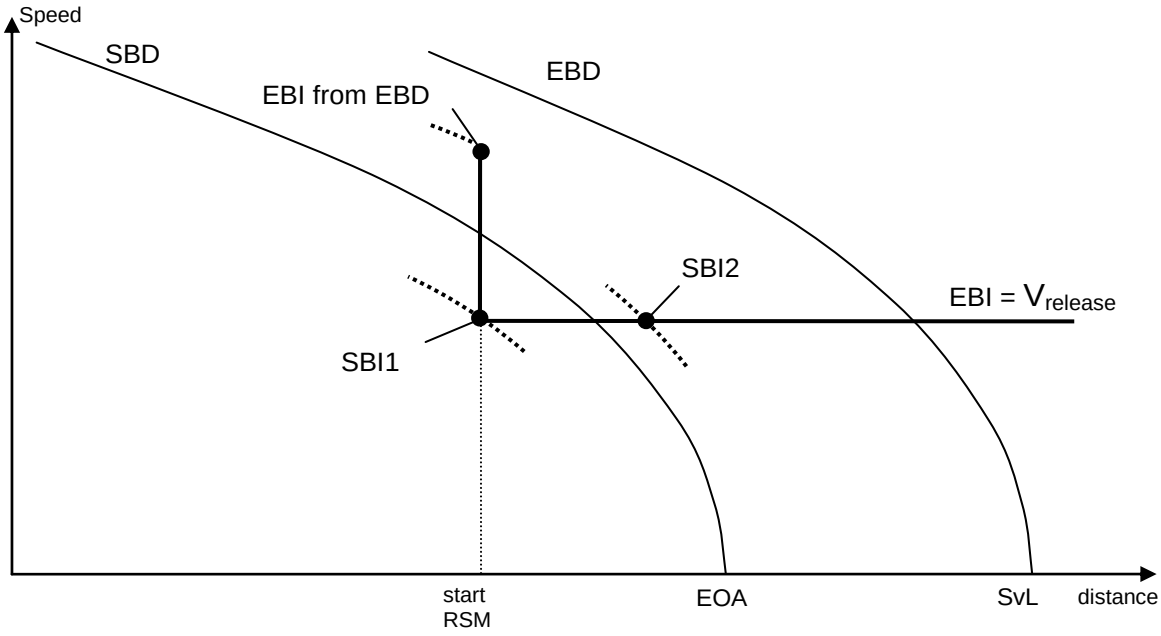


Figure 50: Start location of Release Speed Monitoring

3.13.9.4.8 When the Release Speed is calculated on-board (Figure 51/51a box 3), its value shall be equal to the most restrictive value, at the Trip location related to the EOA (see d_tripEOA in 3.13.9.4.8.2) plus (only in level 1) a distance in advance taking into account the maximum delay to apply the emergency brake when passing an EOA, amongst the EBI supervision limit related to the SvL (Figure 51/51a box 1) and, if any, the EBI supervision limits(s) related to other target(s) between the Trip location related to the EOA (see d_tripEOA in 3.13.9.4.8.2) and the SvL (Figure 51/51a box 2).

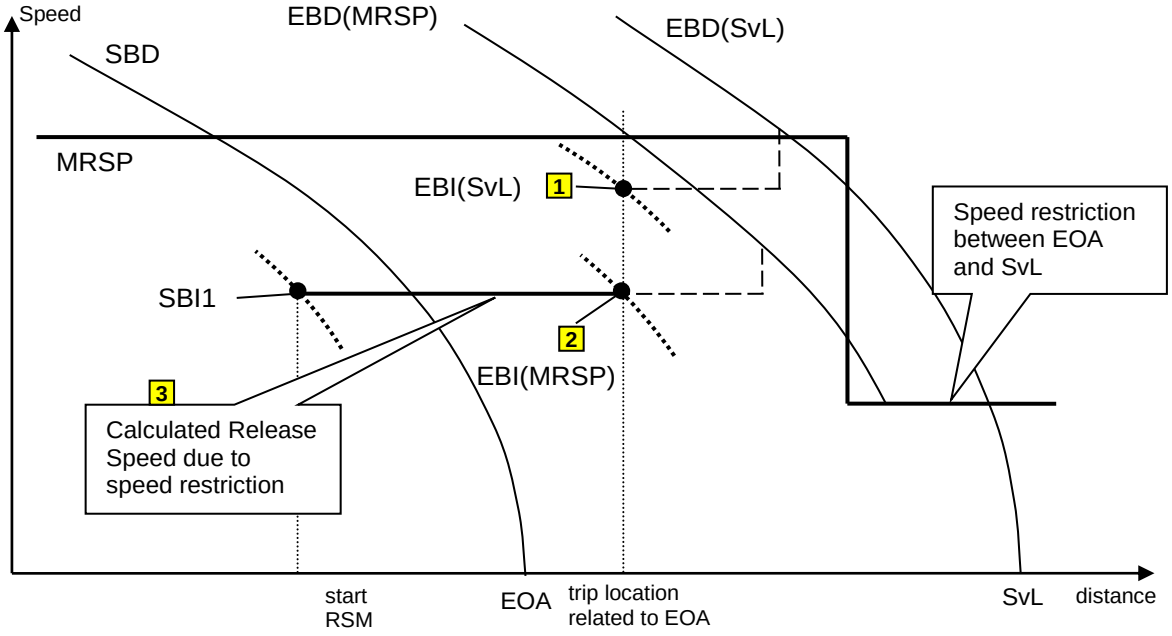


Figure 51: Calculated Release Speed based on speed restriction between EOA and SvL (level 2)

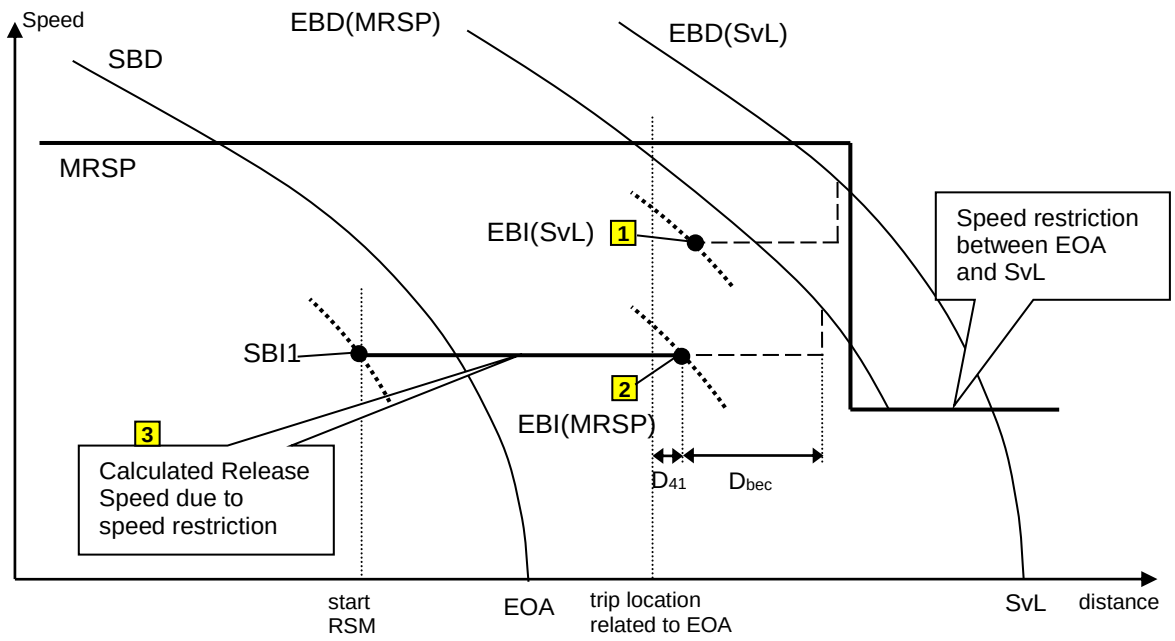


Figure 51a: Calculated Release Speed based on speed restriction between EOA and SvL (level 1)

3.13.9.4.8.1 In order to calculate in advance the EBI supervision limit(s) referred to in 3.13.9.4.8, 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:

$$ABS\{V_{release} - (V_{EBD}(d_{tripEOA} + \alpha \cdot D_{41} + D_{bec}) - V_{deltaorsob})\} \leq 1km/h$$

$$d_{tripEOA} + \alpha \cdot D_{41} + D_{bec} \leq d_{EBD}(V_{target})$$

With $V_{deltaorsob} = max\{f_{41}(V_{release}), V_{ura}\}$ or $V_{deltaorsob} = 0$ (if compensation of speed inaccuracy is inhibited by National Value)

With $D_{bec} = (V_{release} + V_{deltaorsob}) \cdot (T_{traction} + T_{berem})$

With $T_{traction}$ and T_{berem} as defined in 3.13.9.3.2 but considering the traction cut-off as if it was not implemented and substituting $T_{be\_reduced}$ with T_{be} as defined in 3.13.6.2.2.3

With $D_{41} = T_{41} \cdot (V_{release} + V_{deltaorsob})$

With

$$d_{tripEOA} = d_{EOA} + \alpha \cdot L_{antenna-front}$$
$$+max\left\{\begin{pmatrix} 2 \cdot Q_{locacc-refBG} + 10m + 10\% \cdot d_{EOA} \\ +\beta \cdot (L_{trainover} + L_{trainunder}) \end{pmatrix}, (d_{maxsafefront} - d_{minsafefront})\right\}$$

And with $\alpha = 1$ either if the current level is 1 and no order to switch to level 2 at a location in rear of the EOA is stored on-board or if an order to switch to level 1 at a location in rear of the EOA is stored on-board

$\alpha = 0$ either if the current level is 2 and no order to switch to level 1 at a location in rear of the EOA is stored on-board or if an order to switch to level 2 at a location in rear of the EOA is stored on-board

And with $\beta = 1$ only from the time a first Supervised Manoeuvre authorisation is received to the time the mission is either ended or continued in Non Leading mode (see clause 3.6.4.1.5 for $L_{trainover}$ and $L_{trainunder}$); otherwise $\beta = 0$

And with T_{41} as defined in SUBSET-041 § 5.2.1.13

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 train position 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 any MRSP element anywhere in the area (Figure 52 box 2) delimited on one side by the location situated at a distance equal to the train position confidence interval vs. the SOLR in rear of the presumed start location of the Release speed monitoring and on the other side by the trip location related to the EOA (see d_tripEOA in 3.13.9.4.8.2), the on-board shall use as a fixed release speed (Figure 52 box 4) the most restrictive MRSP element (Figure 52 box 3) within this (these) area(s), and shall re-evaluate the start location of the Release speed monitoring accordingly.

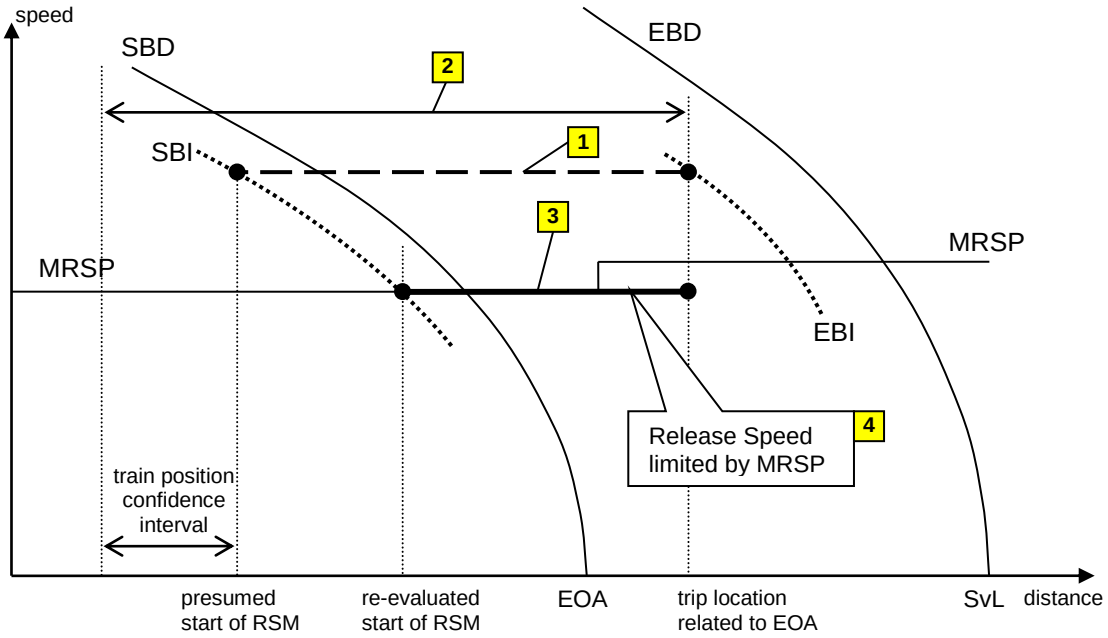


Figure 52: Release Speed limited by MRSP

3.13.9.4.9.1 Note: the train position confidence interval correction in rear of the presumed start location guarantees that an MRSP element, whose end would not be passed yet by the min safe front end of the train when the presumed start location of the Release speed monitoring is reached, is taken into account to adjust the release speed to the speed of this MRSP element.

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)

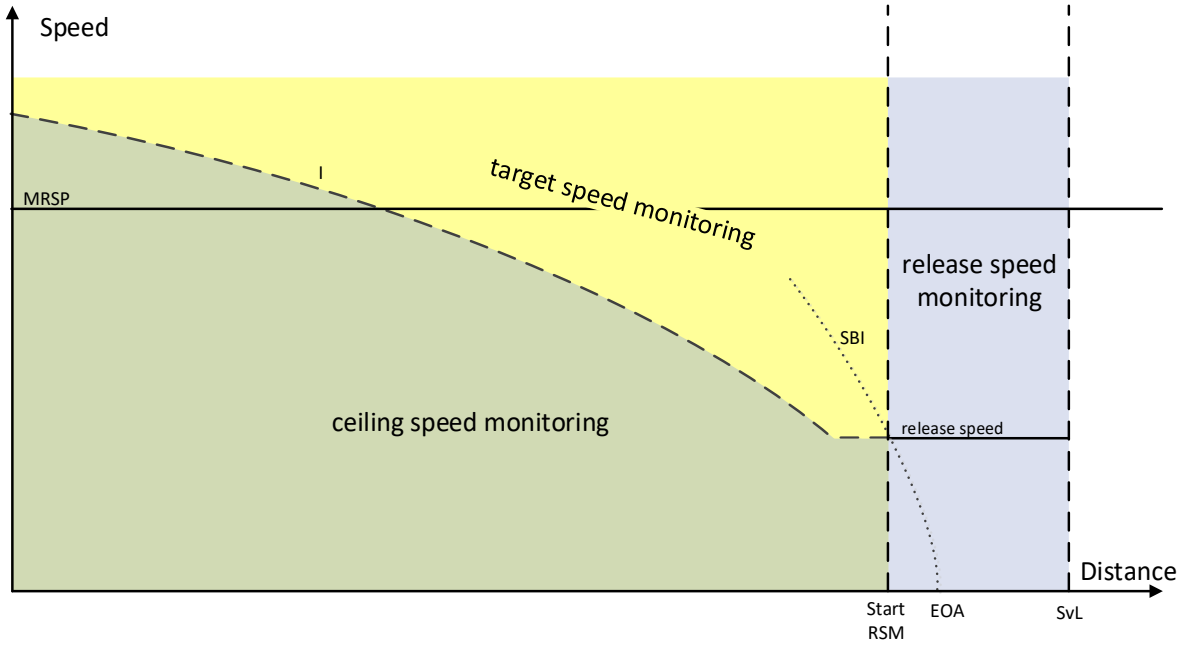


Figure 53: Different types of speed and distance monitoring

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: Train trip shall be initiated if:

a) the on-board equipment detects that the minimum safe front end has passed the EOA/LOA location, OR

b) while being in release speed monitoring, the on-board equipment receives a balise group whose first possible location (see 3.4.4.4.3.1) is known by linking information to be:

- in rear of the EOA by a distance shorter than the distance between the active Eurobalise antenna and the front end of the train, OR
- at the EOA, OR
- in advance of the EOA.

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 has passed the EOA/LOA location.

3.13.10.2.8 Intentionally deleted.

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 3.13.9.3.6.5) 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 either by 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 =

$$\min\left\{\begin{matrix}\left(d_{SBI1}(V_{release}) - d_{estfront}\right), \left([d_{SBI2}(V_{release})]_{MREBDT} - d_{maxsafefront}\right), \\ \left([d_I(V_{est})]_{Target-1} - d_{maxsafefront}\right), \ldots, \left([d_I(V_{est})]_{Target-m} - d_{maxsafefront}\right)\end{matrix}\right\}$$

With $[d_{SBI2}(V_{release})]_{MREBDT}$ as defined in 3.13.9.4.7

And with Target_1, ..., Target_m being EBD based targets whose speed value is below V_MRSP and is below the estimated speed, excluding the SvL and any other targets between the Trip location related to the EOA and the SvL

If $V_{est} \geq V_{release}$

Ind distance =

$$\min\left\{\begin{matrix}\left([d_I(V_{est})]_{EOA} - d_{estfront}\right), \left([d_I(V_{est})]_{SvL} - d_{maxsafefront}\right), \\ \left([d_I(V_{est})]_{Target-1} - d_{maxsafefront}\right), \ldots, \left([d_I(V_{est})]_{Target-n} - d_{maxsafefront}\right)\end{matrix}\right\}$$

With Target_1, ..., Target_n being EBD based targets whose speed value is below V_MRSP and is below the estimated speed, excluding the SvL

3.13.10.3.8.1 In case no release speed exists, 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 V_MRSP and with no EBD based target whose speed value is below 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 which determines the remaining distance to the first Indication location (as specified in 3.13.10.3.8 and 3.13.10.3.8.1). 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 V_MRSP and with no EBD based target whose speed value is below 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 V_MRSP and with no EBD based target whose speed value is below 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:

$$[V_P]_{MRDT_0} = \min\left\{\begin{matrix}\left[V_P\left(d_{estfront}\right)\right]_{EOA}, \left[V_P\left(d_{maxsafefront}\right)\right]_{SvL}, \\ \left[V_P\left(d_{maxsafefront}\right)\right]_{Target-1}, \dots, \left[V_P\left(d_{maxsafefront}\right)\right]_{Target-n}\end{matrix}\right\}$$

with $\left[V_P\left(d_{estfront}\right)\right]_{EOA}$ taken into account only if $d_{estfront} > [d_I(V_{est})]_{EOA}$

with $\left[V_P\left(d_{maxsafefront}\right)\right]_{SvL}$ taken into account only if $d_{maxsafefront} > [d_I(V_{est})]_{SvL}$

with $\left[V_P\left(d_{maxsafefront}\right)\right]_{Target-1}$ taken into account only if $d_{maxsafefront} > [d_I(V_{est})]_{Target-1}$, $V_{MRSP} > V_{target-1}$ and $V_{est} \geq V_{target-1}$

...

with $\left[V_P\left(d_{maxsafefront}\right)\right]_{Target-n}$ taken into account only if $d_{maxsafefront} > [d_I(V_{est})]_{Target-n}$, $V_{MRSP} > V_{target-n}$ and $V_{est} \geq V_{target-n}$

- 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_$MRDT_0$:

$$\left[d_I\left(V_{\substack{target\\MRDT_0}}\right)\right]_{EOA} < \left[d_P\left(V_{\substack{target\\MRDT_0}}\right)\right]_{MRDT_0} \text{ or } \left[d_I\left(V_{\substack{target\\MRDT_0}}\right)\right]_{SvL} < \left[d_P\left(V_{\substack{target\\MRDT_0}}\right)\right]_{MRDT_0} \text{ or}$$

$$\left[d_I\left(V_{\substack{target\\MRDT_0}}\right)\right]_{Target-1} < \left[d_P\left(V_{\substack{target\\MRDT_0}}\right)\right]_{MRDT_0} \text{ or ... or}$$

$$\left[d_I\left(V_{\substack{target\\MRDT_0}}\right)\right]_{Target-n} < \left[d_P\left(V_{\substack{target\\MRDT_0}}\right)\right]_{MRDT_0}$$

  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 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:

$$[V_P]_{DMI} = \min\left\{\begin{matrix}\left[V_P\left(d_{estfront}\right)\right]_{EOA}, \left[V_P\left(d_{maxsafefront}\right)\right]_{SvL}, \\ \left[V_P\left(d_{maxsafefront}\right)\right]_{Target-1}, \ldots, \left[V_P\left(d_{maxsafefront}\right)\right]_{Target-n}, V_{MRSP}\end{matrix}\right\}$$

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:

$$[V_{SBI}]_{DMI} = \min\left\{\begin{matrix}max\left\{\left[V_{SBI1}\left(d_{estfront}\right)\right]_{EOA}, V_{release}\right\}, max\left\{\left[V_{SBI2}\left(d_{maxsafefront}\right)\right]_{SvL}, V_{release}\right\}, \\ \left[V_{SBI2}\left(d_{maxsafefront}\right)\right]_{Target-1}, \ldots, \left[V_{SBI2}\left(d_{maxsafefront}\right)\right]_{Target-n}, V_{MRSP} + dV_{sbi}(V_{MRSP})\end{matrix}\right\}$$

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 that has a target speed lower than or equal to the current MRDT and which is selected 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.

$$[\text{target distance}]_{DMI} = max\left\{\left(d_P\left(V_{target}\right) - d_{maxsafefront}\right), 0\right\}$$

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:

$$[\text{target distance}]_{DMI} = max\left\{min\left\{\left(d_{EOA} - d_{estfront}\right), \left(d_{SvL} - d_{maxsafefront}\right)\right\}, 0\right\}$$

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) or are not allowed to increase (see Appendix A.3.13 for details), the on-board equipment shall ensure that the displayed Permitted speed, the displayed SBI speed (if any) and the distance to target (in case of service brake feedback) 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, if lower than V_MRSP, related to an MRSP element 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	$V_{target} < V_{est} \leq V_{MRSP}$	$d_I(V_{est}) < d_{maxsafefront} \leq d_P(V_{est})$	-	Indication Status
t4		$d_{maxsafefront} > d_P(V_{est})$	-	Overspeed Status
t6	$V_{MRSP} < V_{est} \leq V_{MRSP} + dV_{warning}(V_{MRSP})$	$d_{maxsafefront} \leq d_W(V_{est})$	-	Overspeed Status
t7	$V_{target} + dV_{warning}(V_{target}) < V_{est} \leq V_{MRSP} + dV_{warning}(V_{MRSP})$	$d_{maxsafefront} > d_W(V_{est})$	TCO	Warning Status
t9	$V_{MRSP} + dV_{warning}(V_{MRSP}) < V_{est} \leq V_{MRSP} + dV_{sbi}(V_{MRSP})$	$d_{maxsafefront} \leq d_{SBI2}(V_{est})$	TCO	Warning Status
t10	$V_{target} + dV_{sbi}(V_{target}) < V_{est} \leq V_{MRSP} + dV_{sbi}(V_{MRSP})$	$d_{maxsafefront} > d_{SBI2}(V_{est})$	SB	Intervention Status
t12	$V_{MRSP} + dV_{sbi}(V_{MRSP}) < V_{est} \leq V_{MRSP} + dV_{ebi}(V_{MRSP})$	$d_{maxsafefront} \leq d_{EBI}(V_{est})$	SB	Intervention Status
t13	$V_{target} + dV_{ebi}(V_{target}) < V_{est} \leq V_{MRSP} + dV_{ebi}(V_{MRSP})$	$d_{maxsafefront} > d_{EBI}(V_{est})$	EB	Intervention Status
t15	$V_{est} > V_{MRSP} + dV_{ebi}(V_{MRSP})$	Not relevant	EB	Intervention Status

Table 8: Triggering of Train Interface commands and supervision statuses in target speed monitoring, MRSP target or LOA

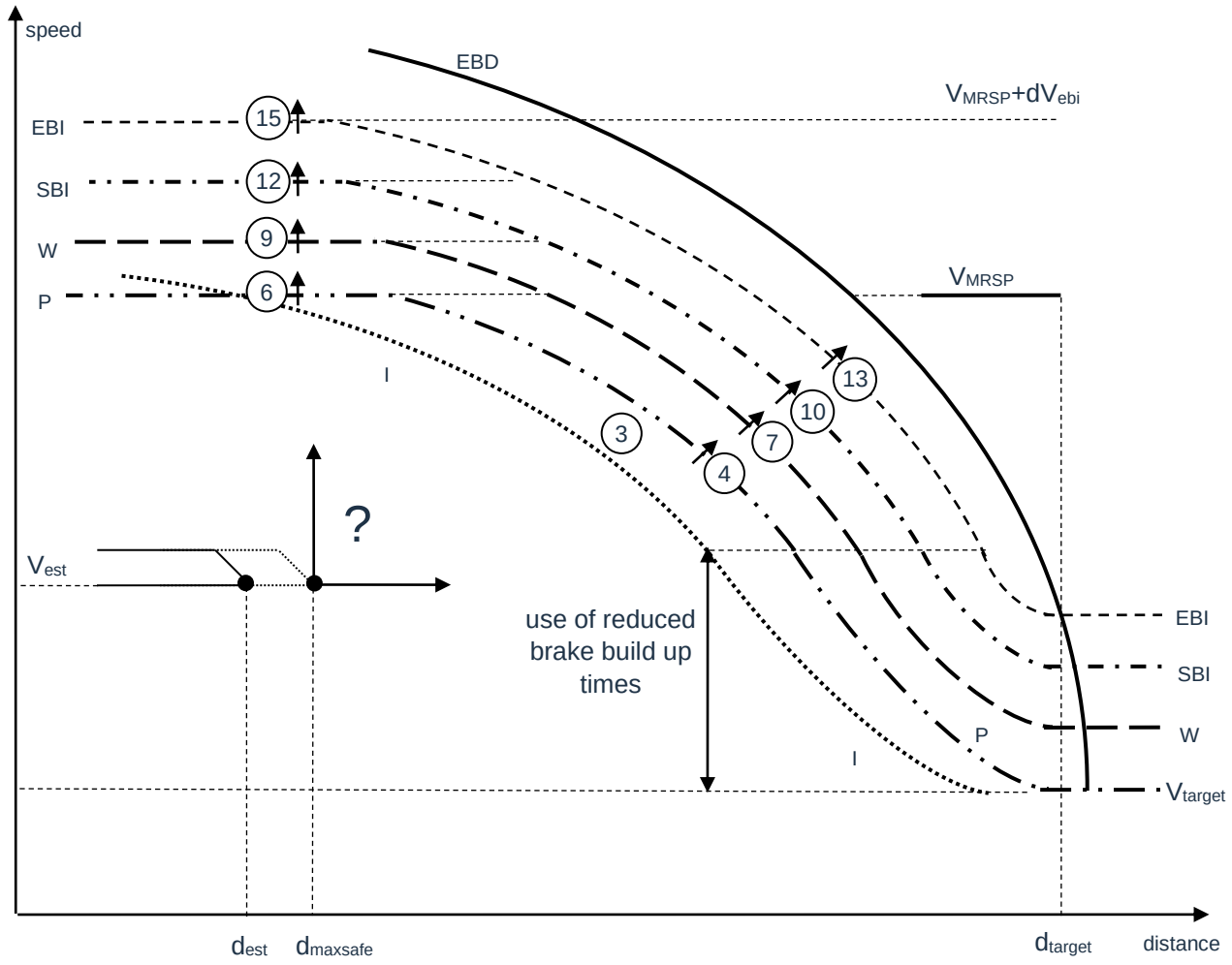


Figure 54: Triggering of Train Interface commands and supervision statuses in target speed monitoring, MRSP target or LOA (number in circle corresponds with the equivalent triggering condition in Table 8)

Triggering condition #	Estimated speed	Train front end position (estimated and max safe)	TI Command triggered	Supervision status triggered
t0	$V_{est} = V_{release}$	$(d_{maxsafefront} > d_I(V_{est})$ for SvL OR $d_{estfront} > d_I(V_{est})$ for EOA$)$	-	Indication Status
t1		$(d_{maxsafefront} > d_P(V_{est})$ for SvL OR $d_{estfront} > d_P(V_{est})$ for EOA$)$	-	Overspeed Status
t2		$(d_{maxsafefront} > d_W(V_{est})$ for SvL OR $d_{estfront} > d_W(V_{est})$ for EOA$)$	TCO	Warning Status
t3	$V_{release} < V_{est} \leq V_{MRSP}$	$(d_{maxsafefront} > d_I(V_{est})$ for SvL OR $d_{estfront} > d_I(V_{est})$ for EOA$)$ AND $(d_{maxsafefront} \leq d_P(V_{est})$ for SvL AND $d_{estfront} \leq d_P(V_{est})$ for EOA$)$	-	Indication Status
t4		$d_{maxsafefront} > d_P(V_{est})$ for SvL OR $d_{estfront} > d_P(V_{est})$ for EOA	-	Overspeed Status
t6	$V_{MRSP} < V_{est} \leq V_{MRSP} + dV_{warning}(V_{MRSP})$	$(d_{maxsafefront} \leq d_W(V_{est})$ for SvL AND $d_{estfront} \leq d_W(V_{est})$ for EOA$)$	-	Overspeed Status
t7	$V_{release} < V_{est} \leq V_{MRSP} + dV_{warning}(V_{MRSP})$	$d_{maxsafefront} > d_W(V_{est})$ for SvL OR $d_{estfront} > d_W(V_{est})$ for EOA	TCO	Warning Status
t9	$V_{MRSP} + dV_{warning}(V_{MRSP}) < V_{est} \leq V_{MRSP} + dV_{sbi}(V_{MRSP})$	$(d_{maxsafefront} \leq d_{SBI2}(V_{est})$ for SvL AND $d_{estfront} \leq d_{SBI1}(V_{est})$ for EOA$)$	TCO	Warning Status
t10	$V_{release} < V_{est} \leq V_{MRSP} + dV_{sbi}(V_{MRSP})$	$d_{maxsafefront} > d_{SBI2}(V_{est})$ for SvL OR $d_{estfront} > d_{SBI1}(V_{est})$ for EOA	SB	Intervention Status
t12	$V_{MRSP} + dV_{sbi}(V_{MRSP}) < V_{est} \leq V_{MRSP} + dV_{ebi}(V_{MRSP})$	$d_{maxsafefront} \leq d_{EBI}(V_{est})$	SB	Intervention Status
t13	$V_{release} < V_{est} \leq V_{MRSP} + dV_{ebi}(V_{MRSP})$	$d_{maxsafefront} > d_{EBI}(V_{est})$	EB	Intervention Status

Triggering condition #	Estimated speed	Train front end position (estimated and max safe)	TI Command triggered	Supervision status triggered
t15	$V_{est} > V_{MRSP} + dV_{ebi}(V_{MRSP})$	Not relevant	EB	Intervention Status

Table 9: Triggering of Train Interface commands and supervision statuses in target speed monitoring, EOA/SvL with release speed

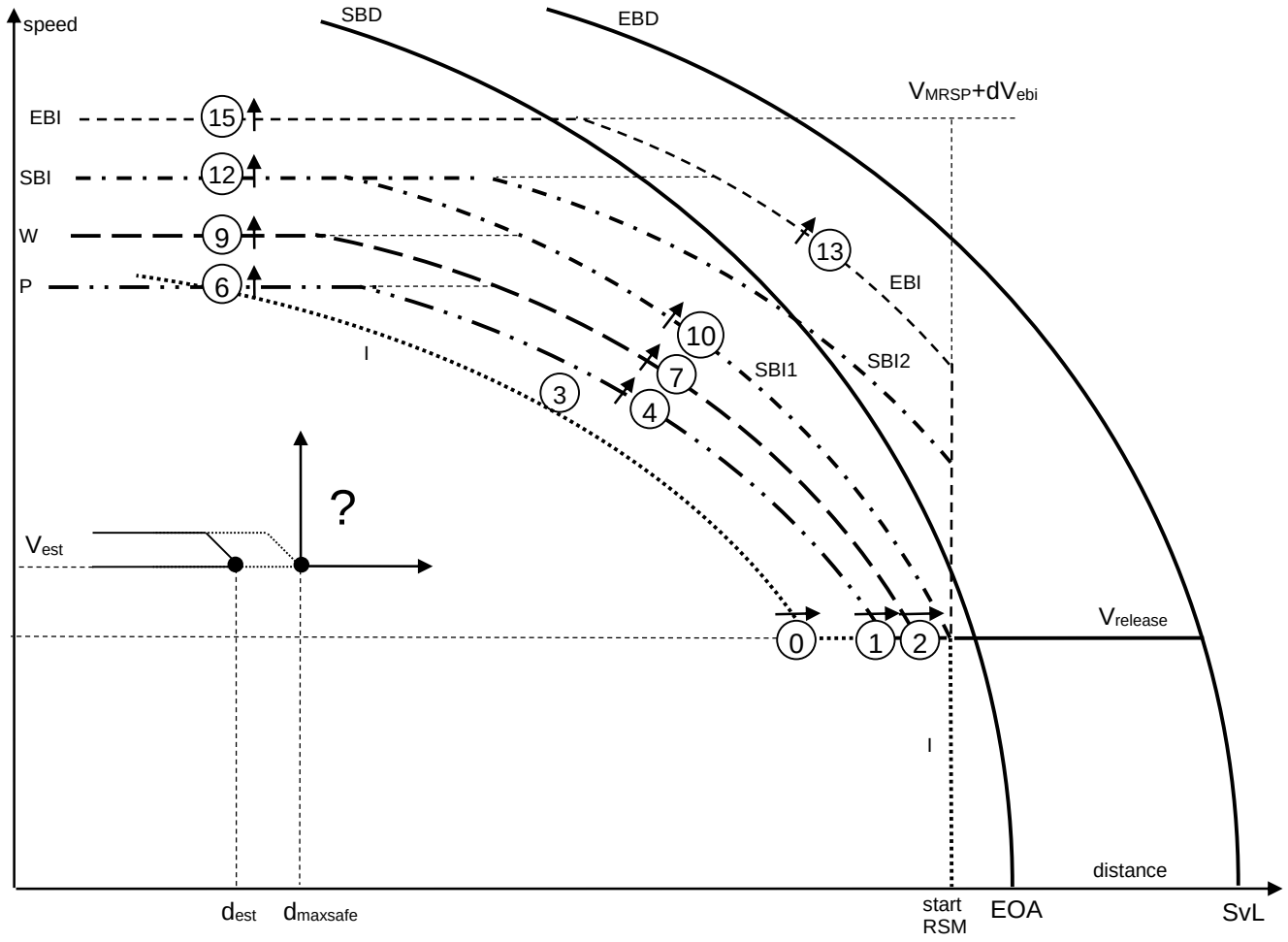


Figure 55: Triggering of Train Interface commands and supervision statuses in target speed monitoring, EOA/SvL with release speed (number in circle corresponds with equivalent triggering condition in Table 9)

Revocation condition #	Estimated speed	Train front end position (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	$V_{target} < V_{est} \leq V_{MRSP}$	$d_{maxsafefront} \leq d_P(V_{est})$	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	$V_{release} < V_{est} \leq V_{MRSP}$	$d_{maxsafefront} \leq d_P(V_{est})$ 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 with a release speed higher than or equal to V_MRSP or 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				
t0, t3 > -p4-	**Indication status**	< r1, r3 -p1-	< r1, r3 -p1-	< r0, r1, r3 -p1-
t1, t4, t6 > -p3-	t1, t4, t6 > -p3-	**Overspeed status**		
t2, t7, t9 > -p2-	t2, t7, t9 > -p2-	t2, 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 according to the following formula:

$$[\text{target distance}]_{DMI} = max\{min\{(d_{EOA} - d_{estfront}), (d_{SvL} - d_{maxsafefront})\}, 0\}$$

3.13.10.5.3 The braking to target Permitted speed supervision limit related to either the EOA or the SvL shall also be displayed according to the following formula:

$$[V_P]_{DMI} = \min\left\{\left[V_P\left(d_{estfront}\right)\right]_{EOA}, \left[V_P\left(d_{maxsafefront}\right)\right]_{SvL}\right\}$$

with $\left[V_P\left(d_{estfront}\right)\right]_{EOA}$ calculated as per 3.13.9.3.5.5 or 3.13.9.3.5.6

and with $\left[V_P\left(d_{maxsafefront}\right)\right]_{SvL}$ calculated as per 3.13.9.3.5.7 or 3.13.9.3.5.8

3.13.10.5.3.1 The clause 3.13.10.4.8.1 shall also apply by analogy for the display of the target distance and the braking to target Permitted speed supervision limit related to the EOA/SvL.

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 is not at standstill) AND ((The train has passed with its max safe front end the Indication location calculated from an EBD whose target speed is below V_MRSP and is below 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 exists, the train speed is above or equal to the release speed) OR (No release speed exists))} OR {(A release speed exists) AND (the train speed is below the release speed) AND (The train has passed with its max safe front end the Indication location calculated from an EBD whose target speed is below the train speed, excluding the EBD from the SvL and any other targets between the Trip location related to the EOA and the SvL)}			
[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)			
[6]	(V_MRSP is updated) AND (The MRDT speed is no longer below V_MRSP) AND (condition [1] is not fulfilled) AND (condition [2] is not 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, the on-board shall calculate the perturbation location applying the clauses 3.13.11.3, 3.13.11.4, 3.13.11.5 and 3.13.11.6.

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 and T_be_reduced with T_be as defined in 3.13.6.2.2.3

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.

$d_{EBI}(V_{MRSP-n}) = d_{EBD}(V_{MRSP-n} + V_{deltaoind}) - (V_{MRSP-n} + V_{deltaoind}) \cdot (T_{beremind} + T_{tractionind})$

$d_{SBI2}(V_{MRSP-n}) = d_{EBI}(V_{MRSP-n}) - V_{MRSP-n} \cdot T_{bs2ind}$

$d_I(V_{MRSP-n}) = d_P(V_{MRSP-n}) - V_{MRSP-n} \cdot T_{indication}$

With $d_P(V_{MRSP-n}) = d_{SBI2}(V_{MRSP-n}) - V_{MRSP-n} \cdot T_{driver}$ if the GUI curve is inhibited

Or $d_P(V_{MRSP-n}) = min\{(d_{SBI2}(V_{MRSP-n}) - V_{MRSP-n} \cdot T_{driver}), d_{GUI}(V_{MRSP-n})\}$ if the GUI curve is enabled

3.13.11.5 If the Indication supervision limit, obtained from the speed of the nth element, is located between the start and end locations of this nth 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 $d_{perturbation} = d^b_{MRSP-n}$

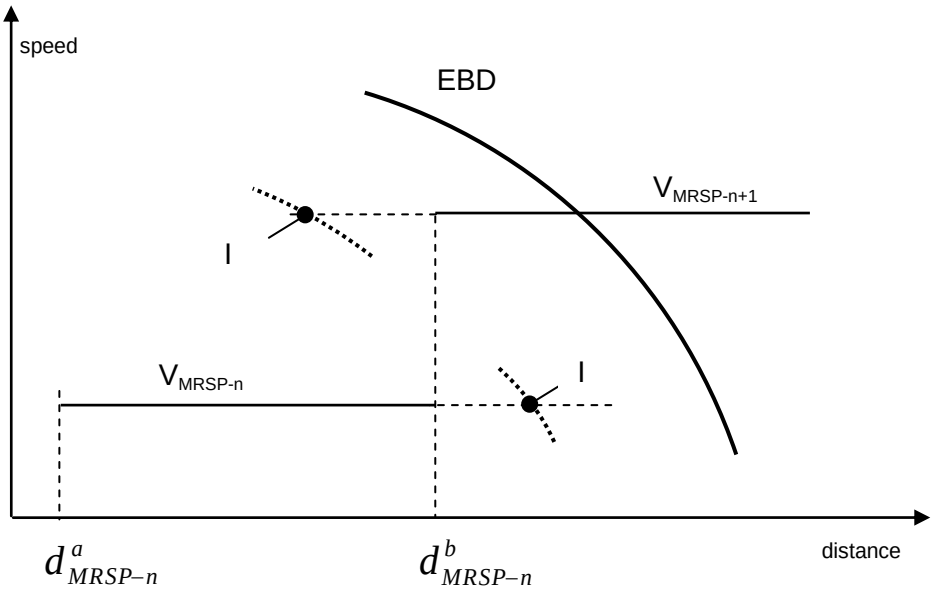


Figure 56: Perturbation location derived from MRSP speed increase

3.13.11.7 For the EOA, the on-board shall calculate its perturbation location in the same way as for the SvL, 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

3.13.11.7.1 For the LOA, the on-board shall calculate its perturbation location in the same way as for the SvL, except that:

a) the elements of the MRSP whose speed is lower than the LOA speed shall be skipped,

b) the clause 3.13.11.6 shall apply only if none of the two referred consecutive MRSP elements is skipped according to a)

3.13.11.7.1.1 In case no perturbation location can be found applying 3.13.11.7.1 (e.g. the LOA speed is higher than the speed of all elements of the MRSP), the perturbation location shall be set at the LOA location.

3.13.11.7.1.2 In case the perturbation location found applying 3.13.11.7.1 is in advance of the LOA, the perturbation location shall be set at the LOA location.

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:

$d_{MAR} = d_{perturbation} - \left(V_{MRSP} + dV_{warning}(V_{MRSP})\right) \cdot T_{MAR}$

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, unauthorised direction movement protection, standstill supervision, or 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.

3.14.1.6 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 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 driver not having acknowledged a mode or level change ordered from trackside (see sections 5.7, 5.9, 5.10 and 5.19), the brake command shall be released after the driver has acknowledged the mode or level transition.

3.14.1.7.4 If the brake command was triggered due to an overpassed distance allowed for reverse movement in Post Trip mode or due to any further movement in the direction opposite to the train orientation while the distance allowed for reverse movement 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.

3.14.1.7.6 If the brake command was triggered due to the safe consist length information having become unavailable, the brake command shall be released at standstill.

3.14.1.7.7 For handling of brake commands resulting from the STM control function, refer to SUBSET-035.

3.14.1.8 A brake command reason that pertains to one of the above clauses 3.14.1.3 to 3.14.1.7.7 shall be considered as applicable from the time the brake command is triggered to the time the release condition specified in the concerned above clause is fulfilled or to the time it is revoked due to a mode change.

3.14.1.9 Whenever an acknowledgement is requested together with standstill for the release condition of a brake command, it shall be requested to the driver only when the train reaches standstill.

3.14.1.10 In case more than one reason to command the brake is applicable at the same time, the brake command shall be released only when the release conditions specified for each of the above clauses 3.14.1.3 to 3.14.1.7.7 including the concerned reasons have been fulfilled. In particular, if several brake command reasons applicable at the same time are included in several clauses where a driver acknowledgement is required, there shall be as many individual driver acknowledgements required as concerned clauses.

3.14.1.10.1 In some of the above clauses 3.14.1.3 to 3.14.1.7.7, brake reasons are grouped: in case several brake command reasons are applicable at the same time and they are all pertaining to the same clause, only one driver acknowledgement shall be required in relation to these brake reasons.

3.14.1.11 In case a change of mode occurs while a brake command due to one or more reasons is still ongoing, see section 4.12 specifying for every individual brake command reason whether it shall be revoked or it shall remain applicable.

3.14.1.11.1 Upon a mode change, the ERTMS/ETCS on-board equipment shall maintain the brake command if at least one individual brake command reason remains applicable, until the corresponding release conditions have been all fulfilled.

3.14.1.11.2 If an individual brake command reason is revoked on a mode change, the release conditions specified in the clause including this brake reason shall not apply anymore, unless another brake reason included in the same clause remains applicable further to this mode change.

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 As soon as a movement conflicting with the position of the direction controller is detected, the ERTMS/ETCS on-board shall start supervising (see section 3.6.7) whether the train travels away, from the location when the conflicting movement was detected, over a distance longer than the national value for the allowed roll away distance. In case this roll away distance is exceeded, the brake command 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, i.e. the clause 3.14.2.4 shall be applied again.

3.14.3 Unauthorised Direction Movement Protection

3.14.3.1 The Unauthorised Direction Movement Protection (UDMP) 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 As soon as a movement opposite to the authorised direction is detected, the ERTMS/ETCS on-board shall start supervising (see section 3.6.7) whether the train travels away, from the location when the opposite movement was detected, over a distance longer than a distance specified by the national value. In case this distance is exceeded, the brake command shall be triggered.

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 UDMP is commanding the brakes.

3.14.3.5 After revocation of the brake command, the UDMP shall be reinitialised, i.e. the clause 3.14.3.2 shall be applied again.

3.14.3.6 Information received from balises during movement opposite to the authorised direction shall be ignored.

3.14.4 Intentionally deleted

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 GSM-R on-board radio communication system, the on-board is no longer able to manage two communication sessions established through GSM-R at once, while the communication session with the Handing Over RBC has been established through GSM-R and the communication session with the Accepting RBC can only be established through GSM-R. Thereby, the behaviour of the RBCs is independent from such on-board degraded situation.

3.15.1.1.3 However, such an RBC/RBC handover performed by a train with only one communication session established through GSM-R at once 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 Intentionally deleted.

3.15.1.1.5 For successive RBC/RBC handovers, it shall be possible for an RBC to act as the Accepting and as the Handing Over RBC for the same engine at different RBC/RBC border locations simultaneously.

3.15.1.1.5.1 Note: Successive RBC/RBC handover means that the trackside initiates another handover procedure while an ongoing handover has not finished. However, from the ERTMS/ETCS on-board point of view, there is only one handover at a time.

3.15.1.1.5.2 Note: An RBC acting as both Accepting and Handing Over RBC for the same engine may as Accepting RBC forward all or parts of route related information it receives as Handing Over RBC, but if and how this is done is intentionally not specified.

3.15.1.1.6 In an RBC/RBC handover, the Accepting RBC is defined by the RBC transition order, while the Handing Over RBC is the RBC which the ERTMS/ETCS on-board equipment considers as the supervising RBC when receiving an RBC transition order.

3.15.1.1.6.1 Exception: clause 3.15.1.3.2 describes a situation when the current Accepting RBC becomes the new Handing Over 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 performing a mission in a mode different from Supervised Manoeuvre, Train Data and Train Running Number;
- For an engine in Supervised Manoeuvre mode, safe consist length information and default Train Data;
- The system versions supported by the on-board equipment;
- Optionally, for a non-leading engine, the ETCS identity of the leading engine.

3.15.1.2.1.1 Exception: for successive handovers, an RBC already acting as Accepting RBC for the engine shall only send this information to the next Accepting RBC after the information about the train has been received from the ERTMS/ETCS on-board equipment.

3.15.1.2.2 Intentionally deleted.

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) Temporary speed restriction revocations

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 The Handing Over RBC shall send information to an on-board equipment concerning the route in advance of the border only if this information has been received from the Accepting RBC in the Route related information.

3.15.1.2.4.1 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 It is a trackside implementation issue to decide when it is appropriate to send the session termination order to the on-board equipment, e.g. when the Handing Over RBC receives a position report and detects that the minimum safe rear end of the train has passed the border, or after the RBC has received a train integrity confirmation indicating that the confirmed rear end of the train has passed the border.

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 need to initiate a Supervised Manoeuvre procedure, after the RBC-RBC handover has been engaged with an on-board equipment in a mode different from Supervised Manoeuvre;
- 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 Following the reception of an order to switch to another RBC at a given location, the on-board equipment shall:

a) Immediately 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), only if the following conditions are fulfilled:

a) the GSM-R radio system is installed on-board, AND

b) the on-board equipment is able to handle only one communication session established through GSM-R at a given time, AND

c) the communication session with the Handing Over RBC has been established through GSM-R, AND

d) the Radio Network type is GSM-R or is FRMCS+GSM-R while the RBC transition order does not relate to an RBC interfaced with FRMCS only,

the ERTMS/ETCS on-board equipment shall wait until the session with the Handing over RBC is terminated due to crossing the border, apply the clause 3.5.6.6 (if relevant), and then establish the session with the Accepting RBC after successful registration of the GSM-R Mobile Terminal to the new GSM-R Radio Network (if relevant).

3.15.1.3.2.1 Justification: in case of loss of safe radio connection with the Handing over RBC, the only GSM-R Mobile Terminal still available cannot be pre-empted to set-up a safe radio connection with the Accepting RBC as long as the Handing over RBC is the supervising one.

3.15.1.3.2.2 The ERTMS/ETCS on-board equipment shall manage only one RBC/RBC handover at a time, therefore a new RBC transition order shall replace a previously received order.

3.15.1.3.2.3 If, whilst in session with both the Handing Over RBC and the Accepting RBC, the ERTMS/ETCS on-board equipment receives a new RBC transition order with an Accepting RBC different than the current one from the RBC/RBC handover already engaged, the communication session with the RBC which is not the currently supervising RBC shall be terminated, while the currently supervising RBC remains or becomes the Handing Over RBC. Then after the clauses 3.15.1.3.1 and 3.15.1.3.2 (if relevant) shall be applied again for the new pair of Handing Over RBC/Accepting RBC.

3.15.1.3.2.4 Exception to 3.15.1.3.2: If, while waiting until the communication session with the Handing over RBC is terminated due to crossing the border, the on-board receives a new RBC transition order with an Accepting RBC different than the current one as per the RBC/RBC handover already engaged and if the maximum safe front end of the train has left the area of the current Handing Over RBC when this new RBC transition order is received, the communication session with the current Handing Over RBC shall be terminated, the registration of its GSM-R Mobile Terminal in working condition to the ordered GSM-R Radio Network (if any) shall be performed (see 3.5.6.6), and the communication session shall be established with the Accepting RBC from the previous RBC transition order, which becomes the new Handing Over RBC. Then after, the

clauses 3.15.1.3.1 and 3.15.1.3.2 (if relevant) shall be applied again for the new pair of Handing Over RBC/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 valid Train Data if available. If in Supervised Manoeuvre mode, it shall send its safe consist length information instead.

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, which is now considered to be the supervising 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 contact information with those of the Accepting RBC.

3.15.1.3.8 After this substitution, the on-board shall however retain the RBC contact information of the Handing Over RBC until at least one of the following conditions is fulfilled:

a) The communication session with this Handing Over RBC has been terminated,

b) The RBC transition order is deleted according to 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 contact information 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.

3.15.1.4.6 An Accepting RBC shall only give a transition order for a successive RBC/RBC handover after the on-board has reported as LRBG the balise group at the RBC/RBC border for the already ongoing RBC/RBC handover or a balise group in advance of that border.

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.

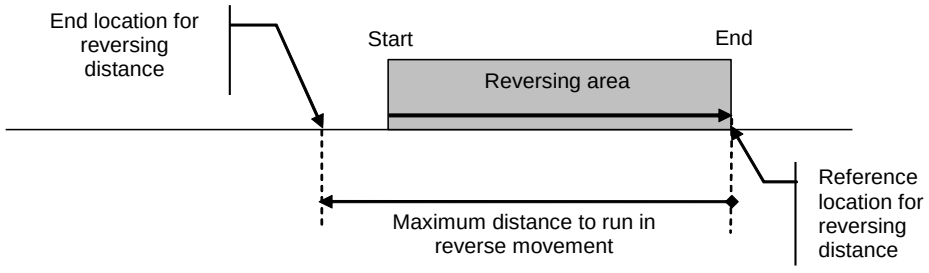


Figure 57: Reversing area and maximum distance to run

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.

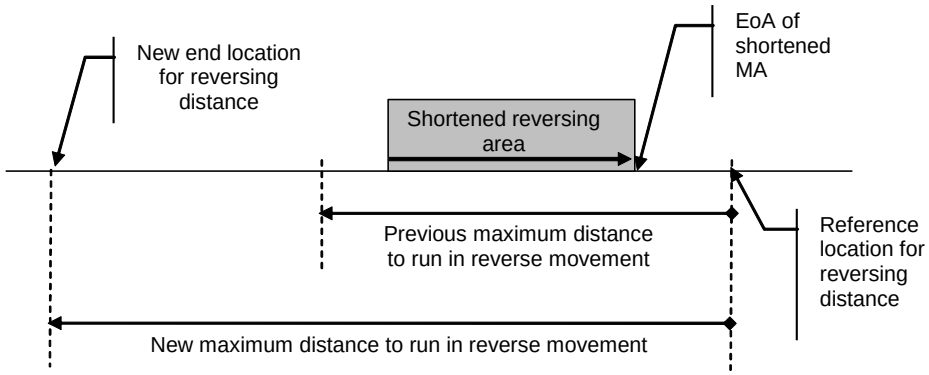


Figure 58: Influence of a shortened Movement Authority and of a renewal of the maximum distance to run

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 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, only from balise as non-infill information or from RBC, to identify a National System to which the data will be forwarded by the ERTMS/ETCS on-board equipment in case it is interfaced to this National System through an STM.

3.15.6.5.1 Note: In case the ERTMS/ETCS on-board equipment is not interfaced to the concerned National System through an STM, the way the data is forwarded to the National System is outside the scope of the ERTMS/ETCS specifications. However, the trackside has to take into account that any ERTMS/ETCS on-board equipment interfaced to the concerned National System through an STM will apply all the applicable ERTMS/ETCS rules to the balise group/RBC message that includes this data.

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 (called “Integrity check alarm of balise transmission”, and referred in the following as “BTM alarm” in short) 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.

3.15.7.4 In Levels 1/2, the BTM alarms which may be triggered by metal masses shall be ignored in any of the following cases:

a) if the “BTM alarm reaction inhibition” is active (see procedure in 5.22), or

b) if mode is Stand-By.

3.15.7.5 In all Levels, the BTM alarms which may be triggered by metal masses shall be ignored if the track condition “Big Metal Mass” is applicable for the given location (see 3.12.1.3, 9th bullet).

3.15.7.6 If the BTM alarm is triggered and not ignored according to 3.15.7.4 or 3.15.7.5, the ERTMS/ETCS on-board equipment shall trigger a safety reaction.

3.15.7.6.1 Note: the on-board reaction is left to specific implementation because it contributes to the attainment of the global on-board THR, whose apportionment is on-board-implementation specific.

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.

3.15.8.1.1 To allow small movements e.g. for coupling in No Power mode, the ERTMS/ETCS on-board equipment shall consider that no cold movement has occurred as long as the train does not move for more than 2m away from the train position stored when No Power mode was entered.

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) While applying any other clause (with the exception of the ones of section 3.20 "Juridical data") than this one, the ERTMS/ETCS on-board equipment shall consider any balise telegram that includes a VBC marker and a country/region identity that both match the VBC identity as not received (i.e. as if the balise was physically covered).

b) As a consequence, no reaction will be applied if errors in the reading of the rest of such balise telegram occur.

3.15.9.3.1 Since it relies on the system version number of the telegram itself (see chapter 6 for details), the check stipulated in 3.15.9.3 a) shall prevail on any system version number related check specified in the section 3.17, with the exception of 3.17.3.5 a).

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.

3.15.9.6 The validity period shall start at the time the balise group message is received or shall start at the time the VBC is entered by the driver.

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, big metal masses, changes of allowed current consumption and station platforms), 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.

3.15.10.5 When the ERTMS/ETCS on-board equipment applies at least one of the clauses 3.12.2.4, 3.12.4.7 and 3.12.5.8, the term EOA in this section 3.15.10 shall refer to the closest location amongst the temporary EOA(s) and the EOA.

3.15.11 Driving with Automatic Train Operation

3.15.11.1 In case it is interfaced to an ERTMS/ATO on-board, the ERTMS/ETCS on-board equipment supports automatic driving on lines fitted with an ERTMS/ATO trackside subsystem.

3.15.11.2 The driver shall have the possibility, through an ATO selector, to enable/disable the automatic driving and the display of the information related to the ERTMS/ATO subsystem, with the exception of the ATO data entry/view. The ATO selector position ("On" or "Stand-by") applicable when the ERTMS/ETCS on-board equipment is switched off (i.e. enters No Power mode) shall be retained and shall remain applicable when powered on.

3.15.11.3 For detailed requirements in case the ERTMS/ETCS on-board equipment is interfaced to an ERTMS/ATO on-board, refer to chapter 4 and SUBSET-125.

3.16 Data Consistency

3.16.1 General

3.16.1.1 The ERTMS/ETCS on-board equipment shall consider a message received from the trackside as inconsistent if it is not compliant with the ETCS specifications.

3.16.1.1.1 As a minimum, the ERTMS/ETCS on-board equipment shall consider the use of a spare value of a variable as not compliant with the ETCS specifications. Having in mind that the trackside messages are presumed to be compliant with the ETCS specifications, it is however not in the scope of this specification to list the other checks that the ERTMS/ETCS on-board equipment might consider to determine that a message is not compliant with them.

3.16.1.2 For the other inconsistency criteria, reactions and other functionality related to the consistency of the information from balises, see 3.16.2.

3.16.1.3 For the other inconsistency criteria, reactions and other functionality related to the consistency of the information from radio, see 3.16.3.

3.16.1.4 Unless stated otherwise, the ERTMS/ETCS on-board equipment shall reject a message that fulfils any inconsistency criteria.

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 detected (see SUBSET-036 sections 4.2.4.1 and 4.2.4.2) within the maximum distance between balises from the previous balise in the group, or

b) A following balise within the group is received, or

c) A balise from another group is received

3.16.2.3 Linking Consistency

3.16.2.3.1 If linking consistency is checked 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 detected (see SUBSET-036 sections 4.2.4.1 and 4.2.4.2) in rear of the expectation window

b) If the location reference of the expected balise group is not detected (see SUBSET-036 sections 4.2.4.1 and 4.2.4.2) inside the expectation window

c) If inside the expectation window of the expected balise group a balise from another announced balise group, expected later, is received.

3.16.2.3.1.1 For a balise group location reference not detected at all, the ERTMS/ETCS on-board equipment shall consider the criterion 3.16.2.3.1 b) as fulfilled only once the min safe antenna position has passed the last possible location of the balise group plus 1.3m, for a time equal to:

a) 100 ms for balise groups to be passed in nominal direction

b) Tn (see SUBSET-036 clause 4.2.9) for balise groups to be passed in reverse direction.

3.16.2.3.2 Intentionally deleted.

3.16.2.3.2.1 Intentionally deleted.

3.16.2.3.3 Intentionally deleted.

3.16.2.3.4 If the balise duplicating the location reference balise is used as location reference for the group, and is detected (see SUBSET-036 sections 4.2.4.1 and 4.2.4.2) within the expectation window, no linking reaction shall be applied.

3.16.2.4 Balise Group Message Consistency

3.16.2.4.1 The on-board shall react according to the linking reaction when the message from a balise group announced by linking, whose location reference was detected (see SUBSET-036 sections 4.2.4.1 and 4.2.4.2) inside its expectation window or whose expectation window is currently supervised, fulfils the general inconsistency criterion 3.16.1.1 or any of the following inconsistency criteria:

a) A balise is missed inside the group.

b) A balise is detected but no telegram is decoded (e.g. wrong CRC,...).

c) Intentionally deleted.

d) Message counters do not match (see 3.16.2.4.7)

3.16.2.4.2 Exception: Even if it considers the message as inconsistent due to either a) or b) above but the balise missed, or not decoded, is duplicated within the balise group and the duplicating one is correctly read, the ERTMS/ETCS on-board equipment shall not reject the message and shall not apply the linking reaction.

3.16.2.4.3 If linking consistency is checked, the expected balise group is referred in the linking information with a balise group with ID not set to “unknown”, and the on-board rejects the message from a balise group marked as linked as per 3.4.4.4.2, no reaction shall be applied, even if errors in the reading of the balise group occur.

3.16.2.4.3.1 If linking consistency is checked, the expected balise group is referred in the linking information with a balise group with ID “unknown”, and the on-board rejects the message from a balise group marked as linked because one of the conditions of 3.4.4.4.2.1 is not fulfilled:

a) in case the condition 3.4.4.4.2.1 a) is fulfilled but the condition 3.4.4.4.2.1 c) is not fulfilled, no reaction shall be applied, even if errors in the reading of the balise group occur. Rationale: the balise group can for sure not be the expected one (i.e. the one which contains repositioning information valid for the train orientation);

b) in all other cases and if an error in the reading of the balise group occurs, the linking reaction shall be applied. Rationale: it cannot be excluded that the balise group is the expected one (i.e. the one which contains repositioning information valid for the train orientation) because e.g. one of the missed or not decoded balise(s) does contain the repositioning information valid for the train orientation or e.g. although a balise containing repositioning information has been correctly received the balise group orientation cannot be determined from the balise group itself.

3.16.2.4.4 If linking consistency is not checked, the on-board shall command application of the service brake when the message from a balise group marked as linked fulfils the general inconsistency criterion 3.16.1.1 or any of the following inconsistency criteria:

a) A balise is missed inside the group.

b) A balise is detected, but no telegram is decoded (e.g. wrong CRC).

c) Intentionally deleted.

d) Message counters do not match (see 3.16.2.4.7)

3.16.2.4.4.1 Exceptions: Even if it considers the message as inconsistent due to either a) or 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 missed, 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.

3.16.2.4.4.4 Exception: Concerning clause 3.16.2.4.4, if the balise group was the last announced one by linking and the linking consistency is no longer checked as per 3.4.4.4.6 a), the on-board shall apply the clause 3.16.2.4.1 instead.

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, the message shall be considered as inconsistent.

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, the message shall also be considered as inconsistent.

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 received and decoded correctly, and both, or none of them, contain "default balise information", the ERTMS/ETCS on-board equipment shall compose the message using only the information from the last received balise telegram out of the pair.

3.16.2.4.8.2.1 Exception: The ERTMS/ETCS on-board equipment shall also include in the message all received data that is to be forwarded to a National System through the STM interface (see 3.15.6) which is contained in the first received balise telegram 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 The on-board equipment shall command application of the service brake when the message received from a balise group marked as unlinked fulfils the general inconsistency criterion 3.16.1.1 or any of the following inconsistency criteria:

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) Intentionally deleted.

d) Message counters do not match (see 3.16.2.4.7)

3.16.2.5.1.1 Exceptions: Even if it considers the message as inconsistent due to either a) or 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 missed, 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 detection degradation

3.16.2.7.1.1 If no balise is detected between the start of the expectation window of a balise group announced by linking and the end of the expectation window of the next balise group announced by linking, 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 received, the ERTMS/ETCS on-board equipment shall keep looking for a balise group that satisfies the same criteria as this previously expected and already received repositioning balise group, until one of the following events occurs:

a) the min safe antenna position leaves the expectation window of the repositioning balise group that was announced and already received

b) a linked balise group that has been announced with known identity is received.

3.16.2.7.2.2 If a second balise group is received that satisfies the same criteria as the previously expected and already received 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 consistency check function, i.e. the rules related to linking always apply. This means that once a repositioning balise group has been received 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 In addition to the check of the general inconsistency criteria 3.16.1.1, a radio message is inconsistent when any of the applicable checks among the following is not completed successfully:

a) Checks performed by Euroradio protocol (see Subset-037)

b) Time stamps check (see 3.16.3.3.3)

c) Message length check (see 8.4.4.2.1).

3.16.3.1.1.1 Intentionally deleted.

3.16.3.1.1.2 The on-board shall inform the trackside if an inconsistent message is received.

3.16.3.1.2 Intentionally deleted.

3.16.3.1.3 Intentionally deleted.

3.16.3.1.3.1 Intentionally deleted.

3.16.3.1.4 Intentionally deleted.

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 The on-board shall consider a message as inconsistent if its time stamp is lower than or equal to the time stamp of the preceding message.

3.16.3.3.3.1 Intentionally deleted.

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.

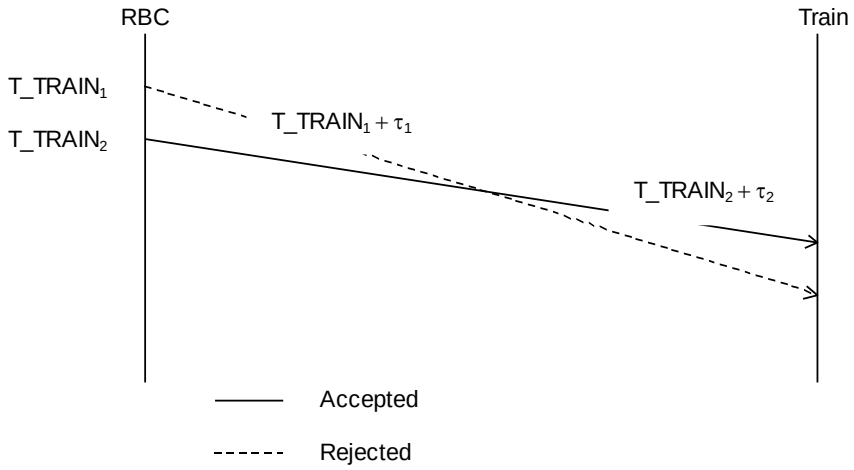


Figure 60: Supervision of sequence

3.16.3.4 Supervision of safe radio connection

3.16.3.4.1 When the difference between the time stamp of the latest 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 Level 2 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 received message) until a new 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 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 message from the Accepting RBC.

3.16.3.4.1.2.1 Exception: in case an RBC/RBC handover is announced when another RBC/RBC handover is already ongoing and this announcement changes the Handing Over RBC (refer to 3.15.1.3.2), then the current on-board time shall be compared with the time stamp of the latest received message.

3.16.3.4.1.3 As long as the engine, taking into account its front and rear ends, overlaps an announced radio hole, the ERTMS/ETCS on-board equipment shall stop the supervision of the safe radio connection. Afterwards, until a new message has been received, the current onboard time shall be compared with the on-board time when the engine rear/front end left the radio hole, depending on whether the train orientation is the same as/opposite to the active cab (instead of the time stamp of the latest received message).

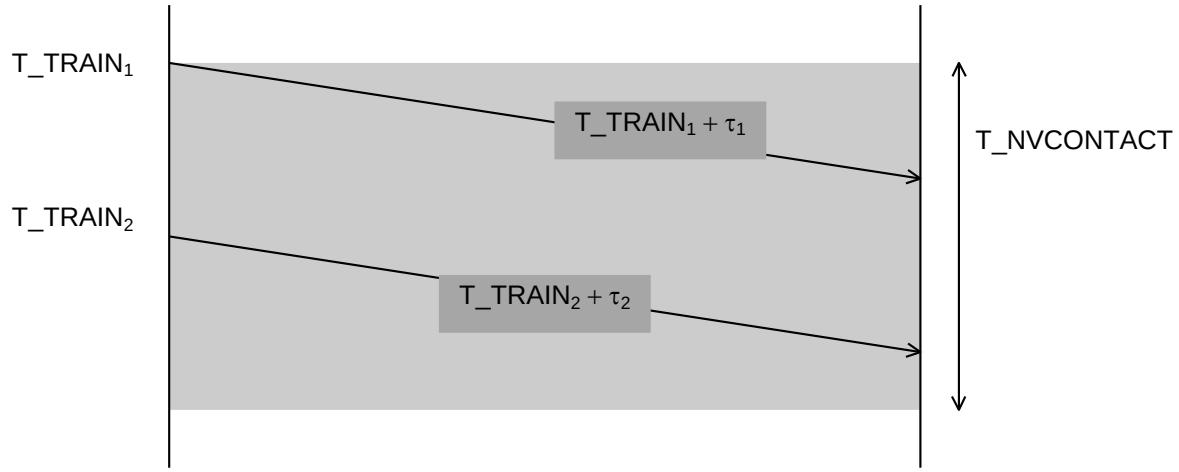


Figure 61: Supervision of the safe radio connection (Message received within the Window)

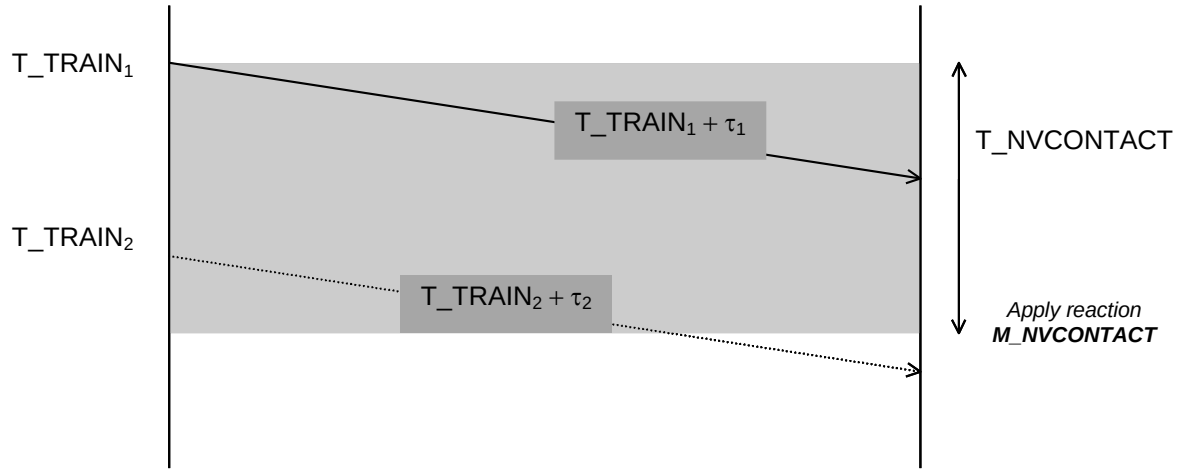


Figure 62: Supervision of the safe radio connection (No message received within the Window)

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 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 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 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 When a message including the request for acknowledgement is received and unless this message is considered as inconsistent, 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 trackside 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 time stamp of the concerned message sent by the trackside.

3.16.3.5.4 Intentionally deleted.

3.16.4 Error reporting to RBC

3.16.4.1 In level 2, 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, odometer accuracy related errors and radio message errors regardless if there is an error reaction.

3.16.4.3 If linking consistency is checked 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 its envelope of supported 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 its envelope of supported system versions, 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 highest system version number X transmitted in the telegrams forming a balise group message (i.e. the telegrams which are not ignored as per a clause referred to in the column "Telegram" of the Table 17), or as the system version number X transmitted by a loop whose message is not ignored as per a clause referred to in the column "Message" of the Table 17, or as the system version number X transmitted by an 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 Once a balise group message has been received, if one of the telegrams forming the message (i.e. a telegram which is not ignored as per a clause referred to in the column "Telegram" of the Table 17) includes an order to operate system version which would not be ignored as per a clause referred to in the column "Individual information" of the Table 17, the on-board equipment shall immediately operate the system version number X given in the order, regardless of the clauses 3.17.2.3 and 3.17.2.6. After the order is executed, the clauses 3.17.2.3 and 3.17.2.6 shall again apply for any further received balise group/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 group/loop and the corresponding identifier(s) of the applicable set of national values, the on-board equipment shall consider the highest system version number X transmitted in the telegrams forming the balise group message (i.e. telegrams which are not ignored as per a clause referred to in the column "Telegram" of the Table 17) or the system version number X transmitted by the loop whose message is not ignored as per a clause referred to in the column "Message" of the Table 17, as the operated one and shall comply again with requirement 3.17.2.3. For balise groups, the on-board equipment

shall take into account, if any, the country or region identifier(s) of a set of national values applicable immediately, which is included in a telegram forming the balise group message and which would not be ignored as per a clause referred to in the column "Individual information" of the Table 17.

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 area), the RBC system version number X shall be operated when the transition to level 2 is executed;

b) if the on-board equipment is in level 2 (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 train has passed the RBC/RBC border location with its maximum safe front end;

d) in case the on-board equipment switches from level 2 to another level (e.g. exit from a level 2 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.

3.17.2.8.1 For item a): if the switch from level 0, NTC or 1 to level 2 results from an immediate level transition order or a conditional level transition order received from balise group and if the RBC system version number X is different from the system version number X operated before the level transition, the checks of the raw balise group message and the evaluation of its whole content shall be performed taking into account the RBC system version and shall substitute the checks and evaluation performed beforehand with regards to the previously operated system version.

3.17.2.8.2 For item d): if the switch from level 2 to another level results from an immediate level transition order or a conditional level transition order received from balise group, the clauses 3.17.2.3, 3.17.2.5 and 3.17.2.6 shall be immediately checked to determine whether a change of operated system version occurs. If so, the checks of the raw balise group message and the evaluation of its whole content shall be performed taking into account the new operated system version and shall substitute the checks and evaluation performed beforehand with regards to the previously operated system version.

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 major system version X and, within one communication session, they shall contain only data for one minor system version Y.

3.17.3.3 Except for the balises whose telegram is ignored as per clause 3.14.3.6 or 3.15.9.3 a), the on-board equipment shall check the system version transmitted by the balises/loops and then shall determine the operated system version prior to any further checks (data consistency, ...) and evaluation of the other data included in a balise group/loop message, as they may depend on the system version.

3.17.3.4 If any of the further checks that are referred to in the column "Message" of the Table 17 leads to the rejection of the whole balise group/loop message, any change of operated system version due to the application of clause 3.17.2.3, 3.17.2.5 or 3.17.2.6 shall be revoked by the on-board equipment, i.e. the operated system version prior to the reception of the balise group/loop message remains unchanged.

3.17.3.4.1 Note: the clauses 3.17.3.3 and 3.17.3.4 imply that on reception of a balise group/loop message the on-board equipment checks first the information which may impact the determination of the operated system version as per clauses 3.17.2.3, 3.17.2.5 or 3.17.2.6 (i.e. the system version transmitted by the balises/loop/RIU, the country or region identifiers of a set of National Values applicable immediately and a system version order). Then, upon a change of operated system version, the other information included in the message received from the balise group or loop will be checked and evaluated considering the newly operated system version. However, should the whole balise group/loop message be rejected due to e.g. linking, no change of operated system version will take place.

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, the balise group message shall be considered as inconsistent in the sense of the clause 3.16.1.1.

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 and 2, 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:

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, the loop message shall be considered as inconsistent in the sense of the clause 3.16.1.1.

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 in a mode different from Supervised Manoeuvre, the Train Data shall be acquired by the ERTMS/ETCS on-board equipment of a leading engine

a) Train category(ies)

b) Train length:

- Either the safe consist length

- Or any value that is obtained by means of a process which involves the driver or by means of a process or an external source with a safety level that could be lower than the one for the safe consist length

c) Traction / brake parameters:
   - Traction model
   - Braking models (brake reaction time, 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 “safe consist length”, “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.

3.18.3.2.4 In the clauses where the term “safe consist length” is not explicitly used, the term “train length” shall be interpreted as referring to the overall length of the train from one extremity to the other one. When no valid Train Data is available but the safe consist length is available, the term “train length” shall refer to the sum of the max safe consist lengths in front of and in rear of the engine respectively. When the safe consist length is captured as part of valid Train Data, the term “train length” shall refer to the max safe consist length in rear of the engine.

3.18.3.2.5 If the safe consist length information is acquired from an external source and it becomes unavailable while performing a mission, the ERTMS/ETCS on-board equipment shall nevertheless consider the Train Data “safe consist length” as unchanged.

3.18.3.2.5.1 From the time the first Supervised Manoeuvre authorisation is received to the time the mission is either ended or continued in Non Leading mode, the train front end information shall still be derived from the safe consist length values in front or in rear of the engine, which are stored on-board as Train Data

3.18.3.2.5.2 Note: when no valid Train Data is stored on-board, the continuous availability of the safe consist length information is however necessary to send position reports with train integrity confirmed by external source or to start or continue a mission in Supervised Manoeuvre mode.

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 validation of Train data/modification of valid 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 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 If the safe consist length information is available and as long as the safe consist length in front of the engine, taking into account the side of the active cab which defines the front of the engine, is different from zero:

a) The ERTMS/ETCS on-board equipment shall consider that no valid Train Data is stored on-board

b) By exception to 3.18.3.3, the entry, modification and revalidation of Train Data that requires driver validation shall not be possible

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 transition or an RBC transition for a further location has been ordered, shall be deleted.

3.18.3.8 In case valid Train Data is available and the Train Data regarding train length has been increased or in case no valid Train Data is available but the Train Data “safe consist length” is available and has been increased in the direction opposite to the train orientation, the currently used track description, if any, shall be considered as unknown in rear of the former min safe rear end of the train.

3.18.3.9 In order to perform a mission in Supervised Manoeuvre mode with only the Train Data “safe consist length” available, the on-board shall be configured with default Train Data for all items of 3.18.3.2 except item b). From the time the first Supervised Manoeuvre authorisation is received to the time the mission is either ended or continued in Non Leading mode, the ERTMS/ETCS on-board equipment shall use these default Train Data and shall consider that no valid Train Data is stored on-board.

3.18.3.10 In Stand-By mode (only in level 2 when a communication session is already established) and from the time the first Supervised Manoeuvre request is sent to the time the mission is either ended or continued in Non Leading mode or to the time this Supervised Manoeuvre request is refused, the ERTMS/ETCS on-board equipment shall send the safe consist length information for Supervised Manoeuvre to the RBC following any modification of the Train Data “safe consist length” or when the safe consist length information acquired from an external source becomes available or becomes unavailable.

3.18.3.10.1 The RBC shall acknowledge the reception of the safe consist length information for Supervised Manoeuvre.

3.18.3.10.2 In case the safe radio connection is lost before the acknowledgement is received, the safe consist length information for Supervised Manoeuvre shall be sent again once the safe radio connection has been re-established within the ongoing communication session.

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 a table of supported levels given by trackside is stored on-board and is applicable, the selection of level by the driver shall be limited to those contained in this table. If no table of trackside supported levels is applicable, the driver can select any level within a default list configured on-board.

3.18.4.3 Radio data: Radio Network type and GSM-R Radio Network identification / RBC contact information

3.18.4.3.1 The ERTMS/ETCS on-board equipment shall store one valid RBC contact information (RBC identity and, if relevant, its 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 an RBC/RBC border (see clause 3.15.1.3.7).

3.18.4.3.1.1 Note: If a valid RBC contact information 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.

3.18.4.3.2 In level 2 only, at standstill, the ERTMS/ETCS on-board equipment shall offer the driver different means to select the RBC contact information, 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 an 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 type and/or, if the stored Radio Network type is FRMCS+GSM-R or GSM-R, the GSM-R Radio Network ID.

3.18.4.3.6.1 The ERTMS/ETCS on-board equipment shall terminate the ongoing communication session(s), if any, and shall abort any ongoing attempts to establish a communication session, in case:

a) The driver has selected a new Radio Network type different from the previously stored one

b) The driver elects to modify the GSM-R Radio Network ID

3.18.4.3.6.2 If the driver has elected to modify the GSM-R Radio Network ID: As soon as the related safe connection is released, if any, the on-board equipment shall acquire an alphanumeric list of available and allowed GSM-R networks, based on a request to the GSM-R Mobile Terminal(s).If the driver selects a new GSM-R Radio Network ID from the proposed list, the registration of the GSM-R Mobile Terminal(s) to this new GSM-R Radio Network shall be ordered.

3.18.4.3.6.3 If not “unknown” the status of the RBC contact information shall be immediately set to “invalid”, as soon as:

a) The driver has selected a new Radio Network type different from the previously stored one

b) The driver has selected a new GSM-R 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 type, the GSM-R 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 to dV_warning_max	140 km/h	V_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	
Distance of metal immunity set by procedure in level 1 or 2	300 metres	
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.	40 s	
Time from when the FRMCS on-board equipment has been detected to be connected to the ETCS on-board equipment after which the registration is considered as failed.	40 s	
Waiting time for system version message	15 s	
Waiting time for acknowledgement of session establishment	15 s	
Monitoring of odometer accuracy: Total distance of accumulated movements	5000 m	
Monitoring of odometer accuracy: Maximum distance interval	100 m	

Monitoring of odometer accuracy: Impairment threshold	250 m (derived from 5% of 5000m)	
Monitoring of odometer accuracy: Safety threshold	1500 m (derived from 30% of 5000m)	

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, Unauthorised Direction Movement Protection and Standstill supervision	2m	D_NVROLL
Permission to use service brake in target speed monitoring	Yes	Q_NVSBTSMPERM
Qualifier 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 of 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)	
Unauthorised Direction Movement Protection		3.14.3.6	
Duplicated balises	3.16.2.4.8.1 3.16.2.4.8.2 together with 3.16.2.4.8.2.1		
Linking			3.4.4.4.2 3.4.4.4.2.1 3.4.4.4.2.2 3.4.4.4.3.2 together with 3.4.4.4.3 and 3.4.4.4.6 3.4.4.4.7
Message consistency			3.16.1.4 together with 3.16.1.1 and 3.16.1.1.1 3.16.1.4 together with 3.16.2.4.1, 3.16.2.4.7, 3.16.2.4.7.1 and with exception 3.16.2.4.2 3.16.1.4 together with 3.16.2.4.4, 3.16.2.4.7, 3.16.2.4.7.1 and with exception 3.16.2.4.4.1 a) 3.16.1.4 together with 3.16.2.5.1, 3.16.2.4.7, 3.16.2.4.7.1 and with exception 3.16.2.5.1.1 a) 3.16.1.4 together with 3.16.3.1.1 a), 3.16.3.3.3 and 3.16.3.1.1 c)
EOLM vs loop identity			3.4.5.2.1
Validity direction	3.6.3.1.3 with exceptions 3.6.3.1.3.1 and 3.6.3.1.3.2 3.6.3.1.4 with exception 3.6.3.1.4.1		

Type of check	Type of data		
	Individual information	Telegram	Message
Level, mode, origin of information, infill/non-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 clauses 3.16.3.5.1, 3.17.2.3 , 3.17.2.5, 3.17.2.6 and 3.17.3.3, all the clauses in this specification and in the SUBSET-035, 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 movement opposite to the authorised direction 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 inconsistent (e.g. according to 3.16.2.4.1), it does not become LRBG
- 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.3.3.5 Example 3: as a result of the clause A.3.3.2, the clause 3.4.1.1 (definition of a balise group) has to be understood as follows: “A balise group consists of between one and eight balises sharing the same balise group identity <and which are not covered by a VBC (i.e. whose telegrams will not be ignored by the on-board) at a certain moment in time>”. Therefore when, for migration purposes, more than one instance of balises with the same internal number but with different VBC markers are used in a cluster of balises, the number of balises inside the group that is indicated in each balise telegram should

not take into account the balises which are covered by a VBC at a certain moment in time.

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 acceptance of a conditional emergency stop (3.10.2.2 b));

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 request to shorten MA 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 linking consistency is not checked 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)

o) the safe consist length information acquired from external source becomes unavailable (4.4.21.1.12)

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, o	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 balise groups for SH area	D	D[9]	D[5]
MA Request Parameters	U	U	U
Position Report parameters	U	U	U
List of Balise groups 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 level 2	U	U	D
Default Gradient for TSR	U[4]	U[4]	D
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

Data Stored on-board	Situations listed above		
	a – d, f, n	e, g – j, l, m, o	k
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
Accumulated underestimation / overestimation in measuring the movements over a defined total distance	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
Not yet applicable table of priority of trackside supported levels	U	U	D
Driver ID	U	U	TBR
Radio Network information (Radio Network type and GSM-R Radio Network ID, if any)	U	U	U
Radio system used for safe radio connection	U	U	U
RBC contact information	U	U	U
Mission performed with only one radio system	U	U	D
Train Running Number	U	U	TBR
Reversing Area Information	D[1]	D[10]	D

Data Stored on-board	Situations listed above		
	a – d, f, n	e, g – j, l, m, o	k
Reversing Supervision Information	U	U	D
Track Ahead Free Request	U[6]	U	D
Level Crossing information	U	U	D
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 balise groups 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 Intentionally deleted.

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 contact information, 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) Request to shorten MA (Note: if the request is accepted, the proposed shortened MA, the mode profile (if any) and the list of balise groups for SH area (if any) become(s) stored information)

t) Train Rejected

u) Train Accepted

v) SoM position report confirmed by RBC

w) Track Ahead Free up to level 2 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

bb) SM Authorisation

cc) SM Refused

dd) Acknowledgement of safe consist length for SM

A.3.5 Handling of Actions in Specific Situations

A.3.5.1 Regards the following actions executed in reference to location based information received from trackside, the on-board equipment shall, by exception to the other requirements in this document, ensure that the action related to passing a location is neither reverted, nor executed twice in case of reverse movement (initiated by driver or due to roll-away) and sub-sequent forward movement, or in case of adjustment of train position and relocation on passing a balise group that becomes SOLR, which result in a new train position situated in rear of the location which triggered the action:

- Applying new National Values (see 3.18.2.3)
- Request to acknowledge new level on entering the acknowledgement area (see 5.10.4.1 a)), actions related to passing the level transition border (see 3.5.3.8 d), 3.6.5.1.4 f), 5.10.1.5, 5.10.3.3.3, 5.10.3.6.2, 5.10.3.7.5, 5.10.3.10.3)
- Start and stop displaying plain or fixed text messages (see 3.12.3.4.3.1)
- Mode transition due to passing the beginning (see 3.12.4.5 together with 4.6.3 [34], [40], [71], [72], [73], [74]) or the end (see 3.12.4.6 together with 4.6.3 [75], [76]) of a LS/OS mode profile
- Actions related to radio infill areas (see 3.5.4.3 3rd bullet, 3.9.3.5, 3.9.3.10 a)&b), 3.9.3.15, 3.9.3.16)
- Actions related to RBC/RBC handover (see 3.5.3.8 f), 3.6.5.1.4 e)&k), 3.11.5.14 2nd bullet, 3.15.1.3.1 b)&c), 3.15.1.3.2, 3.15.1.3.7, 3.15.1.3.8 a), 3.17.2.8 c)&e), 5.15.1.4)
- Actions related to track condition information with the exception of big metal masses and non stopping areas (see 3.5.3.4 e), 3.5.3.8 g), 3.5.4.4, 3.16.3.4.1.3, 5.18.2.2,3,5&6, 5.18.3.2,3,4&5, 5.18.5.2&3, 5.18.6.2,3,4&5, 5.18.7.3,4&5, 5.18.8.3,4&5, 5.18.9.2&3, 5.18.10.2,5&6, 5.20.2.2,4&5, 5.20.3.2,4&5, 5.20.4.2,4&5, 5.20.5.3,5&6, 5.20.6.2&4, 5.20.7.2&5, 5.20.8.2,5&6)
- Intentionally deleted
- Start and stop Track Ahead free request to driver (see 3.15.5.2)
- Intentionally deleted
- Substitute the supervision of the LX start location as temporary EOA/SvL by the inclusion of the LX speed restriction in the MRSP (see 5.16.2.1, 5.16.3.2)
- Start the MA end section timer/overlap timer (see 3.8.4.1.1, 3.8.4.4.1)

A.3.5.1.1 Note: the fact that an action is not referred to in the above list does not mean that the action is automatically reverted, but that the other requirements in this document strictly apply. For instance:

- In case the reverse movement or the relocation brings back the max safe antenna position in rear of the start location of the big metal mass area, the on-board will stop ignoring the alarms which may be triggered by big metal masses (i.e. the clauses 3.12.1.2.1.2 and 3.12.1.3 apply)
- In case the reverse movement or the relocation brings back the min safe front end in rear of an unprotected LX end location, the on-board will take again into account the LX speed restriction (i.e. 3.13.10.2.8 applies) and display again the unprotected LX status (i.e. 5.16.1.5 applies)
- The transition to TR mode on passing the EOA/LOA will never be reverted, even if the train moves backwards in rear of the EOA/LOA location. Reason: on purpose, no such transition back to FS/OS/LS is specified in sections 4.6.2 and 4.6.3.
- The transition from CSM to TSM on passing the Indication supervision limit will not be reverted in case of relocation that brings back the train front end in rear of the Indication supervision limit. Reason: it has been specified in that way for obvious ergonomic reasons (see 3.13.10.6.1).

A.3.5.2 A maximum time Tn (see Subset-036 clause 4.2.9) after it has received a balise group message (i.e. a maximum time Tn after it has received the last balise telegram of the balise group), the ERTMS/ETCS on-board equipment shall not consider any action related to passing an EOA (only in level 1), an LOA, or a former EOA/LOA located in advance of the train position measured at the time of reception of this last telegram, until the content of the message has been taken into account.

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.3.5.2.3 Example 3: in level 2, the crossing of the LOA location with the min safe front end before an immediate level transition order to level NTC or level 0 (received when the min safe front end was in rear of the LOA) has been processed, will not lead to train trip. In other terms the deletion of the MA (and therefore the deletion of the LOA) due to the level change is considered by the on-board as happening before the min safe front end crosses the LOA location (i.e. preventing that clause 3.13.10.2.6 a) applies).

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”,
- MA Section entry points and their associated Section timer stop locations.

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,
- The MA Section information is needed to apply the clause 3.8.4.2.4 in case of reverse movement in rear of an MA Section timer stop location.

A.3.6.2.1.2 Note: The distance to intervention of the Roll Away Protection or the Unauthorised Direction Movement Protection 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 reaction time and 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.3.8.6 The brake reaction times for the emergency brake shall be defined as follows:

category	T_brake_emergency_react
brake position in passenger trains	1.42 s
brake position in freight trains in P	2.99 s
brake position in freight trains in G	9.30 s

A.3.9 Calculation of the full service brake reaction time and 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, kto and T_brake_service_react used in A.3.9.1, A.3.9.2, A.3.9.3, A.3.9.4 and A.3.9.8 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.3.9.8 The brake reaction times for the service brake shall be defined as follows:

category	T_brake_service_react
brake position in passenger trains	1.06 s
brake position in freight trains in P	2.07 s
brake position in freight trains in G	5.70 s

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

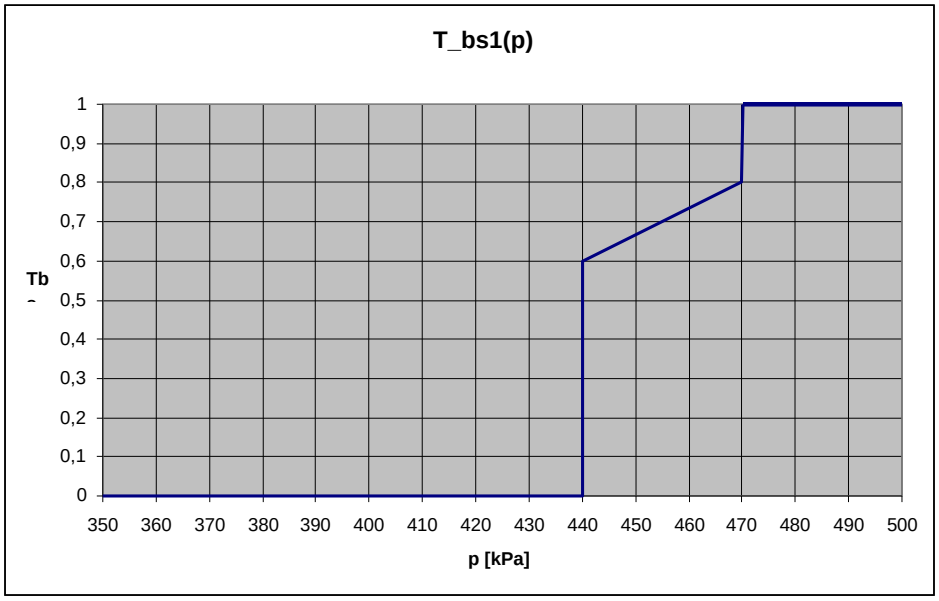
If the MRDT changes then

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 speed	km/h	0-600	5 km/h
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

A.3.12 Calculation of reduced values of safe brake build up time and expected brake build up time

A.3.12.1 Introduction

A.3.12.1.1 Modelling the brake build up effort using a ramp function rather than a step function allows to predict that a certain deceleration development may be enough to safely reach a target with only a portion of the equivalent brake build up time elapsed.

A.3.12.1.2 This section defines how the safe brake build up time and expected brake build up times can be reduced to take profit of such effect.

A.3.12.1.3 This computation is done for each target according to the following seven steps:

a) Determination of the inputs for the computation;

b) Extrapolation of the train speed development over the brake reaction time, to check whether this extrapolated speed is above the target speed at this time;

c) Extrapolation of the train speed development over the full brake build up time along the ramp model;

d) Computation of the time at which the target speed is reached along the ramp model, for the targets whose speed is higher than this train speed extrapolated as per bullet c);

e) Computation of the corresponding travelled distances;

f) Conversion of these travelled distances into reduced values of safe and expected (equivalent) brake build up times that are to be used in the formulas to derive the EBI/SBI supervision limits;

g) Selection of the highest reduced values of safe and expected (equivalent) brake build up times amongst the ones ensuring equivalent speed reduction and the ones ensuring equivalent travelled distance.

A.3.12.1.4 Exception: in case the conversion model is used and $K_{t\_int} = 0$, the rest of section A.3.12 does not apply for $T_{be\_reduced}$ determination and $T_{be\_reduced}$ shall be set to T_{be}.

A.3.12.1.5 Exception: if $T_{traction} \geq T_{be}$, the rest of section A.3.12 does not apply for $T_{be\_reduced}$ determination and $T_{be\_reduced}$ shall be set to T_{be}.

A.3.12.2 Inputs for the computation (brake build up times reduction)

A.3.12.2.1 The delays when full brake forces are reached, t_{2be} and t_{2bs}, shall be computed as follows:

$t_{2be} = 2 \cdot T_{be} - T_{be\_react}$

With T_{be_react} and T_{be} as defined in clause 3.13.6.2.2.3

$t_{2bs} = 2 \cdot T_{bs} - T_{bs\_react}$

With T_{bs_react} and T_{bs} as defined in clause 3.13.6.3.2.4

A.3.12.2.2 For every target except EOA, A_{EB} shall be set to:

- the minimum value of A_brake_safe(V,d) as defined in clause 3.13.6.2.1.4 if normal adhesion condition applies everywhere between the min safe front end train position and d_{target} taking into account 3.13.5.3, or if the applicable A_MAXREDADH value does not limit its value;
- MIN(the minimum value of A_brake_safe(V,d), A_MAXREDADH) otherwise

with the minimum value of A_brake_safe(V,d) applicable:

- at any location between the estimated train front position and d_{target}
- and at any speed value between V_{bec} and either null speed for SvL or V_{target} for other EBD based targets

with V_{bec} as defined in clause 3.13.9.3.2.10 but substituting T_be_reduced with T_be as defined in 3.13.6.2.2.3.

A.3.12.2.3 For every target except EOA, A_{safe_max} shall be set to the maximum value of A_safe(V,d) as defined in 3.13.6.2.1.3 and applicable:

- at any location between the estimated train front position and d_{target}
- and at any speed value between V_{bec} and either null speed for SvL or V_{target} for other EBD based targets

with V_{bec} as defined in clause 3.13.9.3.2.10 but substituting T_be_reduced with T_be as defined in 3.13.6.2.2.3.

A.3.12.2.4 For every target, A_{SB} shall be set to the minimum value of A_brake_service(V,d) as defined in clause 3.13.6.3.1.4 applicable:

- at any location between the estimated train front position and d_{target}
- and at any speed value between V_{est} and either null speed for EOA/SvL or V_{target} otherwise

A.3.12.2.5 For every target, $A_{expected\_max}$ shall be set to the maximum value of A_expected(V,d) as defined in clause 3.13.6.3.1.3 applicable:

- at any location between the estimated train front position and d_{target}
- and at any speed value between V_{est} and either null speed for EOA/SvL or V_{target} otherwise

A.3.12.2.6 If the service brake command is available for use, $T_{traction\_min}$ shall be the value of $T_{traction}$ as defined in clause 3.13.9.3.2.3 but substituting T_{bs2} with T_{bs}.

A.3.12.2.7 If the service brake command is available for use, $T_{traction\_max}$ shall be the value of $T_{traction}$ as defined in clause 3.13.9.3.2.3 but substituting T_{bs2} with T_{bs_react}

A.3.12.2.8 If the service brake command is not available for use, $T_{traction\_min}$ and $T_{traction\_max}$ shall be the value of $T_{traction}$ as defined in clause 3.13.9.3.2.3 (i.e. with $T_{bs2} = 0$).

A.3.12.3 Train speed after the brake reaction times (at the beginning of the ramp)

A.3.12.3.1 For every target except EOA, the estimated train speed V_{est} shall be extrapolated by the delay T_{be_react} as follows:

If $T_{traction\_max} < T_{be\_react}$:

$$V_{t1be} = V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_max} + A_{est2} \cdot \left(T_{be\_react} - T_{traction\_max}\right)$$

If $T_{traction\_max} \geq T_{be\_react}$:

$$V_{t1be} = V_{est} + V_{delta0} + A_{est1} \cdot T_{be\_react}$$

With V_{delta0} as defined in clause 3.13.9.3.2.1

With A_{est1} as defined in clause 3.13.9.3.2.8

With A_{est2} as defined in clause 3.13.9.3.2.9

With T_{be_react} as defined in clause 3.13.6.2.2.3

A.3.12.3.2 For every MRSP or LOA target, if $V_{t1be} \leq V_{target}$, the rest of section A.3.12 does not apply in $T_{be\_reduced}$ determination and $T_{be\_reduced}$ shall be set to T_{be_react}.

A.3.12.3.3 For SvL target or target at the end of the maximum permitted distance to run in SR, if $V_{t1be} = 0$, the rest of section A.3.12 does not apply in $T_{be\_reduced}$ determination and $T_{be\_reduced}$ shall be set to T_{be_react}.

A.3.12.3.4 For every MRSP or LOA target, if $V_{est} \leq V_{target}$, the rest of section A.3.12 does not apply in $T_{bs\_reduced}$ determination and $T_{bs\_reduced}$ shall be set to T_{bs_react}.

A.3.12.3.5 For EOA target, SvL target or target at the end of the maximum permitted distance to run in SR, if $V_{est} = 0$, the rest of section A.3.12does not apply in $T_{bs\_reduced}$ determination and $T_{bs\_reduced}$ shall be set to T_{bs_react}.

A.3.12.3.6 Note: For every target, the train speed is considered as remaining constant and equal to V_{est} during the delay T_{bs_react}.

A.3.12.4 Train speed after the full brake build up times (at the end of the ramp)

A.3.12.4.1 For every target except EOA, the estimated train speed V_{est} shall be extrapolated by the delay t_{2be} as follows:

$$V_{t2be} = \mathrm{MAX}\Big(0\,, V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_max} + A_{est2} \cdot \left(t_{2be} - T_{traction\_max}\right) - \frac{A_{EB} \cdot (t_{2be} - T_{be\_react})}{2}\Big)$$

With V_{delta0} as defined in clause 3.13.9.3.2.1

With A_{est1} as defined in clause 3.13.9.3.2.8

With A_{est2} as defined in clause 3.13.9.3.2.9

With T_{be_react} as defined in clause 3.13.6.2.2.3

A.3.12.4.2 For every MRSP or LOA target for which $V_{t2be} \geq V_{target}$, the rest of section A.3.12 does not apply for $T_{be\_reduced}$ determination and $T_{be\_reduced}$ shall be set to T_{be}.

A.3.12.4.3 For the SvL or the target at the end of the maximum permitted distance to run in SR, if $V_{t2be} > 0$, the rest of section A.3.12 does not apply for $T_{be\_reduced}$ determination and $T_{be\_reduced}$ shall be set to T_{be}.

A.3.12.4.4 For every target, the estimated train speed V_{est} shall be extrapolated by the delay t_{2bs} as follows:

$$V_{t2bs} = \mathrm{MAX}(0\ , V_{est} - \frac{A_{SB} \cdot (t_{2bs} - T_{bs\_react})}{2})$$

With T_{bs_react} as defined in clause 3.13.6.3.2.4

A.3.12.4.5 For every MRSP or LOA target for which $V_{t2bs} \geq V_{target}$, the rest of section A.3.12 does not apply for $T_{bs\_reduced}$ determination and $T_{bs\_reduced}$ shall be set to T_{bs}.

A.3.12.4.6 For the EOA, the SvL or the target at the end of the maximum permitted distance to run in SR, if $V_{t2bs} > 0$, the rest of section A.3.12 does not apply for $T_{bs\_reduced}$ determination and $T_{bs\_reduced}$ shall be set to T_{bs}.

A.3.12.5 Reduced brake build up times (as per the ramp model)

A.3.12.5.1 For every target except EOA, the time t_{2be_enough} shall be computed as follows:

$$t_{2be\_enough} = T_{be\_react} + \frac{A_{est2}}{A_{EB}} \cdot T_{be\_incr} + \sqrt{\left(\frac{A_{est2}}{A_{EB}} \cdot T_{be\_incr}\right)^2 + \frac{2 \cdot T_{be\_incr}}{A_{EB}} \cdot \left(\Delta V_{eb\_t} + (A_{est1} - A_{est2}) \cdot T_{traction\_max} + A_{est2} \cdot T_{be\_react}\right)}$$

With $\Delta V_{eb\_t} = \mathrm{MAX}\left(0\ , V_{est} + V_{delta0} - V_{target}\right)$

With $T_{be\_incr} = t_{2be} - T_{be\_react}$

A.3.12.5.2 For every target, the time t_{2bs_enough} shall be computed as follows:

$$t_{2bs\_enough} = T_{bs\_react} + \sqrt{\frac{2 \cdot T_{bs\_incr}}{A_{SB}} \cdot \Delta V_{sb\_t}}$$

With $\Delta V_{sb\_t} = \mathrm{MAX}\left(0\ , V_{est} - V_{target}\right)$

With $T_{bs\_incr} = t_{2bs} - T_{bs\_react}$

A.3.12.6 Travelled distances during reduced brake build up times (ramp model)

A.3.12.6.1 The distance travelled to reach the speed of any target for which t_{2be_enough} has been computed shall be computed as follows:

$$D_{t_{2be\_enough}} = \left[\frac{(A_{est2} - A_{est1}) \cdot {T_{traction\_max}}^2}{2} + \frac{A_{EB} \cdot {T_{be\_react}}^3}{6 \cdot T_{be\_incr}}\right] + \left[V_{est} + V_{delta0} + (A_{est1} - A_{est2}) \cdot T_{traction\_max} - \frac{A_{EB} \cdot {T_{be\_react}}^2}{2 \cdot T_{be\_incr}}\right] \cdot t_{2be\_enough} + \left[A_{est2} + \frac{A_{EB} \cdot T_{be\_react}}{T_{be\_incr}}\right] \cdot \frac{{t_{2be\_enough}}^2}{2} + \left[\frac{-A_{EB}}{T_{be\_incr}}\right] \cdot \frac{{t_{2be\_enough}}^3}{6}$$

A.3.12.6.2 The distance travelled to reach the speed of any target for which t_{2bs_enough} has been computed shall be computed as follows:

$$D_{t_{2bs\_enough}} = V_{est} \cdot t_{2bs\_enough} + \frac{-A_{SB}}{6 \cdot T_{bs\_incr}} \cdot \left(t_{2bs\_enough} - T_{bs\_react}\right)^3$$

A.3.12.7 Reduced values of safe brake build up time and expected brake build up time for distance equivalence

A.3.12.7.1 The distance computed along the ramp model shall be converted into the time $t_{be\_enough\_step\_dist}$ at which it is reached along the step model, as follows:

- if $A_{est1} = A_{est2} = 0$:

$$t_{be\_enough\_step\_dist} = \frac{D_{t_{2be\_enough}} + \frac{\left(V_{target}\right)^2}{2 \cdot A_{safe\_max}}}{(V_{est} + V_{delta0})} - \frac{V_{est} + V_{delta0}}{2 \cdot A_{safe\_max}}$$

- if A_{est1} & $A_{est2} > 0$:

$$t_{be\_enough\_step\_dist} = t_{be\_X} + t_{be\_Y}$$

With $t_{be\_X} = \frac{V_{est} + V_{delta0} + (A_{est1} - A_{est2}) \cdot T_{traction\_min}}{-A_{est2}}$

And with

$$t_{be\_Y} = \sqrt{\frac{A_{safe\_max}}{A_{safe\_max} + A_{est2}} \cdot \left({t_{be\_X}}^2 + \frac{(A_{est1} - A_{est2}) \cdot {T_{traction\_min}}^2 + 2 \cdot D_{t_{2be\_enough}}}{A_{est2}}\right) + \frac{\left(V_{target}\right)^2}{A_{est2} \cdot \left(A_{safe\_max} + A_{est2}\right)}}$$

A.3.12.7.2 The distance computed along the ramp model shall be converted into the time $t_{bs\_enough\_step}$ at which it is reached along the step model, as follows:

- if $V_{est} = 0$:

$$t_{bs\_enough\_step\_dist} = T_{bs\_react}$$

- if $V_{est} \neq 0$:

$$t_{bs\_enough\_step\_dist} = \frac{D_{t_{2bs\_enough}} + \frac{(V_{target})^2}{2 \cdot A_{expected\_max}}}{V_{est}} - \frac{V_{est}}{2 \cdot A_{expected\_max}}$$

A.3.12.8 Final reduced values of safe brake build up time and expected brake build up time

A.3.12.8.1 Finally, the reduced values of safe brake build up time and expected brake build up time shall be computed as follows:

$$T_{be\_reduced} = \mathrm{MAX}\left(T_{be\_react}, \mathrm{MIN}\left(t_{be\_enough\_step}, T_{be}\right)\right)$$

With $t_{be\_enough\_step} = MAX\left(t_{be\_enough\_step\_deltaV}, t_{be\_enough\_step\_dist}\right)$

and $t_{be\_enough\_step\_deltaV} = \frac{T_{be\_react} + t_{2be\_enough}}{2}$

$$T_{bs\_reduced} = \mathrm{MAX}\left(T_{bs\_react}, \mathrm{MIN}\left(t_{bs\_enough\_step}, T_{bs}\right)\right)$$

With $t_{bs\_enough\_step} = MAX\left(t_{bs\_enough\_step\_deltaV}, t_{bs\_enough\_step\_dist}\right)$

and $t_{bs\_enough\_step\_deltaV} = \frac{T_{bs\_react} + t_{2bs\_enough}}{2}$

A.3.12.8.2 Note: the limitation at T_{be} and T_{bs} values is needed because of the safe-side approximations done on the brake models in the computation defined in the present section.

A.3.12.9 Informative annex: derivation of the formulas

A.3.12.9.1 The purpose of this part is to explain how the formulas given in the rest of section A.3.12 have been obtained. The explanation is based on the emergency brake related formulas, A.3.12.7.17 explains how these can be modified to obtain service brake related formulas.

A.3.12.9.2 **About A.3.12.3&4:** For these calculations, it is assumed (refer to figure 45 and 3.13.9.3.2) that once the emergency brake command is triggered, the train speed (compensated for the speed measurement inaccuracy V_{delta0}) increases with A_{est1} acceleration up to $T_{traction\_max}$ time and then with A_{est2} acceleration. This speed increase is compensated by the A_{EB} deceleration coming from the brake force as per the ramp model from T_{be_react} to t_{2be} (refer to Figure 31). The average deceleration coming from the brake force is half of its final (full) value.

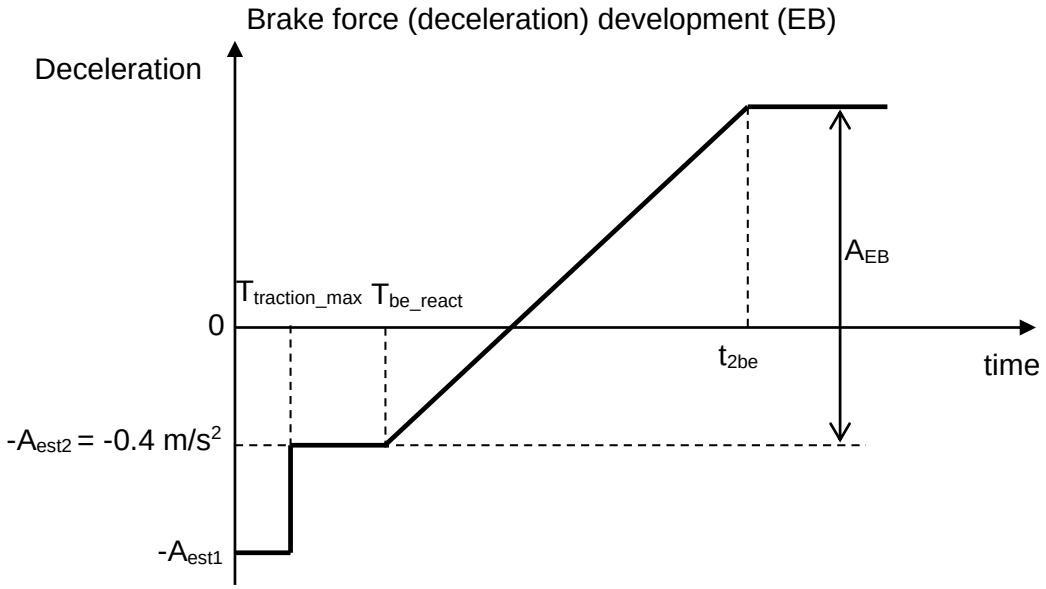


Figure 63: Example of the Brake Build Up Time Model

A.3.12.9.3 From the description above and from Figure 63, it is clear that solving the following definite integrals gives the final formula used in A.3.12.3.1:

$$V_{t2be} = v_0 + \int_0^{t_{2be}} a(t)dt = v_0 + \int_0^{T_{traction\_max}} a_1(t)dt + \int_{T_{traction\_max}}^{T_{be\_react}} a_2(t)dt + \int_{T_{be\_react}}^{t_{2be}} a_3(t)dt$$

$$= v_0 + \int_0^{T_{traction\_max}} A_{est1}dt + \int_{T_{traction\_max}}^{T_{be\_react}} A_{est2}dt$$

$$+ \int_{T_{be\_react}}^{t_{2be}} \left(A_{est2} + \frac{-A_{EB}}{(t_{2be} - T_{be\_react})} \cdot (t - T_{be\_react}) \right) dt$$

where $v_0 = V_{est} + V_{delta0}$

A.3.12.9.4 **About A.3.12.5:** The speed computed at t_{2be} in A.3.12.4 can be computed for any time t between MAX($T_{traction\_max}$, T_{be_react}) and t_{2be} by using the following substitution $t_{2be} = t$ in A.3.12.9.3 formulas, which give the following final formula:

$$v(t) = \text{MAX}\Big(0\,, V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_max} + A_{est2} \cdot (t - T_{traction\_max}) - \frac{A_{EB} \cdot (t - T_{be\_react})^2}{2 \cdot (t_{2be} - T_{be\_react})}\Big)$$

A.3.12.9.5 The above formula can be used to express an unknown time $(t - T_{be\_react})$ to get the final time $t = t_{2be\_enough}$ that corresponds to the wanted final speed $\left(V_{target} + dV_{ebi}(V_{target})\right)$. Doing so, this quadratic form from which $(t - T_{be\_react})$ or $t = t_{2be\_enough}$ finally, can be obtained by solving:

$$\frac{A_{EB}}{2.T_{be\_incr}} \cdot \left(t - T_{be\_react}\right)^2 - A_{est2} \cdot \left(t - T_{be\_react}\right)$$
$$+\left(-A_{est2} \cdot \left(T_{be\_react} - T_{traction\_max}\right) - A_{est1} \cdot T_{traction\_max} - \Delta V_{eb\_t}\right) = 0$$

With $\Delta V_{eb\_t} = \mathrm{MAX}\left(0\,, V_{est} + V_{delta0} - V_{target}\right)$

$$t_{2be\_enough} = T_{be\_react} + \frac{A_{est2}}{A_{EB}} \cdot T_{be\_incr}$$
$$\pm\sqrt{\left(\frac{A_{est2}}{A_{EB}} \cdot T_{be\_incr}\right)^2 + \frac{2 \cdot T_{be\_incr}}{A_{EB}} \cdot \left(\Delta V_{eb\_t} + \left(A_{est1} - A_{est2}\right) \cdot T_{traction\_max} + A_{est2} \cdot T_{be\_react}\right)}$$

A.3.12.9.5.1 Note: For solving the above quadratic equation, only the root with positive sign in front of the square root is used, in order to obtain $t_{2be\_enough} \geq T_{be\_react}$

A.3.12.9.6 **About A.3.12.6:** The distance travelled along the ramp model at any time t between MAX($T_{traction\_max}$, T_{be_react}) and t_{2be} can then be written as (with the assumption that $T_{be\_react} \geq T_{traction\_max}$, but the result is the same otherwise (i.e. for the case $T_{be\_react} < T_{traction\_max}$)):

$$d_{ramp}(t) = \left(distance\ from\ intervention\ to\ traction\ cut\text{-}off\left(T_{traction\_max}\right)\right)$$
$$+\left(distance\ between\ traction\ cut\text{-}off\left(T_{traction\_max}\right)\ and\ start\ of\ brake\ effort\ ramp\left(T_{be\_react}\right)\right)$$
$$+\left(variable\ distance\ over\ the\ brake\ effort\ ramp\ (t)\right)$$
$$= \int_0^t v(t)dt$$
$$= \int_0^{T_{traction\_max}} v_1(t)dt + \int_{T_{traction\_max}}^{T_{be\_react}} v_2(t)dt + \int_{T_{be\_react}}^{t} v_3(t)dt = \int_0^{T_{traction\_max}} \left(v_0 + A_{est1} \cdot t\right)dt$$
$$+ \int_{T_{traction\_max}}^{T_{be\_react}} \left(v_0 + A_{est1} \cdot T_{traction\_max} + A_{est2} \cdot \left(t - T_{traction\_max}\right)\right)dt$$
$$+ \int_{T_{be\_react}}^{t} \left(v_0 + A_{est1} \cdot T_{traction\_max} + A_{est2} \cdot \left(T_{be\_react} - T_{traction\_max}\right) + A_{est2} \cdot \left(t - T_{be\_react}\right) - \frac{A_{EB} \cdot \left(t - T_{be\_react}\right)^2}{2 \cdot T_{be\_incr}}\right)dt =$$

$$= \left(\left(V_{est} + V_{delta0} + \frac{A_{est1} \cdot T_{traction\_max}}{2} \right) \cdot T_{traction\_max} \right)$$
$$+ \left(\left(V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_max} + \frac{A_{est2} \cdot (T_{be\_react} - T_{traction\_max})}{2} \right) \cdot \left(T_{be\_react} - T_{traction\_max} \right) \right)$$
$$+ \left(\left(V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_max} + A_{est2} \cdot (T_{be\_react} - T_{traction\_max}) + \frac{A_{est2} \cdot (t - T_{be\_react})}{2} - \frac{A_{EB} \cdot (t - T_{be\_react})^2}{6 \cdot T_{be\_incr}} \right) \cdot \left(t - T_{be\_react} \right) \right)$$
$$= \left[\frac{-(A_{est1} - A_{est2}) \cdot {T_{traction\_max}}^2}{2} + \left(V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_max} + A_{est2} \cdot \left(\frac{T_{be\_react}}{2} - T_{traction\_max} \right) \right) \cdot T_{be\_react} \right]$$
$$+ \left[\left(V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_max} + A_{est2} \cdot (T_{be\_react} - T_{traction\_max}) \right) \cdot \left(t - T_{be\_react} \right) \right]$$
$$+ \left[\frac{A_{est2}}{2} \cdot \left(t - T_{be\_react} \right)^2 \right] + \left[\frac{-A_{EB}}{6 \cdot T_{be\_incr}} \cdot \left(t - T_{be\_react} \right)^3 \right]$$

A.3.12.9.7 The value of $D_{t_{2be\_enough}}$ is the value of $d\_ramp(t_{2be\_enough})$. It must be noticed that after having travelled this distance, the wanted final speed is reached, i.e. no distance is to be travelled over the EBD curve.

A.3.12.9.8 **About A.3.12.7:** Because the model that is used in section 3.13 is a step model, we need to find which (artificial) value of T_{be} ($t_{be\_enough\_step\_dist}$, here called t_{be_en}) would lead to obtaining the same travelled distance $D_{t_{2be\_enough}}$. In contrast to the use of the ramp model, a section of the EBD curve is needed here, between this sought time t_{be_en} and the time the wanted final speed V_{target}, here called V_T) is reached.

A.3.12.9.9 First, we need an expression of $d\_step(t_{be\_en})$:

$$d\_step(t_{be\_en}) = \left(distance\ from\ intervention\ to\ traction\ cut\text{-}off\left(T_{traction\_min}\right)\right) + \left(variable\ distance\ between\ traction\ cut\text{-}off\left(T_{traction\_min}\right)\ and\ brake\ step\ \left(t_{be\_en}\right)\right)$$

$$= \int_0^{t_{be\_en}} v(t)dt = \int_0^{T_{traction\_min}} v_1(t)dt + \int_{T_{traction\_min}}^{t_{be\_en}} v_2(t)dt$$

$$= \int_0^{T_{traction\_min}} (v_0 + A_{est1} \cdot t)dt + \int_{T_{traction\_min}}^{t_{be\_en}} \left(v_0 + A_{est1} \cdot T_{traction\_min} + A_{est2} \cdot \left(t - T_{traction\_min}\right)\right) dt$$

$$= \left(\left(V_{est} + V_{delta0} + \frac{A_{est1} \cdot T_{traction\_min}}{2}\right) \cdot T_{traction\_min}\right) + \left(\left(V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_min} + \frac{A_{est2} \cdot (t_{be\_en} - T_{traction\_min})}{2}\right) \cdot (t_{be\_en} - T_{traction\_min})\right)$$

where $v_0 = V_{est} + V_{delta0}$

A.3.12.9.10 The equation to solve is $d\_step(t_{be\_en}) + \frac{V_I^2 - V_T^2}{2 \cdot A} = D_{t_{2be\_enough}}$ with V_I and V_T being the Initial and Terminal speeds over the EBD, respectively

Where

$A = A_{safe\_max}$

$V_I = v_0 + \int_0^{t_{be\_en}} a(t)dt = v_0 + \int_0^{T_{traction\_min}} A_{est1}dt + \int_{T_{traction\_min}}^{t_{be\_en}} A_{est2}dt$

$V_T = V_{target}$

A.3.12.9.11 It can be re-written as:

$$\left(\frac{A_{est2}}{2} + \frac{{A_{est2}}^2}{2 \cdot A_{safe\_max}}\right) \cdot (t_{be\_en} - T_{traction\_min})^2 + \left(V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_min}\right) \cdot \left(1 + \frac{A_{est2}}{A_{safe\_max}}\right) \cdot (t_{be\_en} - T_{traction\_min}) + \left(\left(V_{est} + V_{delta0} + \frac{A_{est1} \cdot T_{traction\_min}}{2}\right) \cdot T_{traction\_min} + \frac{\left(V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_min}\right)^2 - {V_T}^2}{2 \cdot A_{safe\_max}}\right) = D_{t_{2be\_enough}}$$

A.3.12.9.12 Introducing $V_1 = V_{est} + V_{delta0} + A_{est1} \cdot T_{traction\_min}$:

$$\frac{A_{est2}}{2}\cdot\left(1+\frac{A_{est2}}{A_{safe\_max}}\right)\cdot(t_{be\_en}-T_{traction\_min})^2+V_1\cdot\left(1+\frac{A_{est2}}{A_{safe\_max}}\right)\cdot(t_{be\_en}-T_{traction\_min})+\left(\left(V_1-\frac{A_{est1}\cdot T_{traction\_min}}{2}\right)\cdot T_{traction\_min}+\frac{{V_1}^2-{V_T}^2}{2\cdot A_{safe\_max}}\right)=D_{t_{2be\_enough}}$$

A.3.12.9.13 If $A_{est1}=A_{est2}=0$ and $V_1\neq 0$, we then get:

$$t_{be\_en}=\frac{D_{t_{2be\_enough}}+\frac{{V_T}^2-{V_1}^2}{2\cdot A_{safe\_max}}}{V_1}$$

A.3.12.9.14 If A_{est1} & $A_{est2}>0$, we then get:

$$(t_{be\_en}-T_{traction\_min})^2+2\cdot\frac{V_1}{A_{est2}}\cdot(t_{be\_en}-T_{traction\_min})+\frac{A_{safe\_max}}{A_{est2}\cdot(A_{safe\_max}+A_{est2})}\cdot\left(-A_{est1}\cdot{T_{traction\_min}}^2+2\cdot V_1\cdot T_{traction\_min}-2\cdot D_{t_{2be\_enough}}+\frac{{V_1}^2-{V_T}^2}{A_{safe\_max}}\right)=0$$

$$t_{be\_en}=T_{traction\_min}-\frac{V_1}{A_{est2}}\pm\sqrt{\frac{{V_1}^2}{{A_{est2}}^2}+\frac{A_{safe\_max}}{A_{est2}\cdot(A_{safe\_max}+A_{est2})}\cdot\left(\begin{array}{c}A_{est1}\cdot{T_{traction\_min}}^2-\\2\cdot V_1\cdot T_{traction\_min}+2\cdot D_{t_{2be\_enough}}-\frac{{V_1}^2-{V_T}^2}{A_{safe\_max}}\end{array}\right)}$$

$$t_{be\_en}=\frac{V_1-A_{est2}\cdot T_{traction\_min}}{-A_{est2}}\pm\sqrt{\frac{A_{safe\_max}}{A_{safe\_max}+A_{est2}}\cdot\left(\frac{V_1^2}{{A_{est2}}^2}+\frac{A_{est1}\cdot{T_{traction\_min}}^2-2\cdot V_1\cdot T_{traction\_min}+2\cdot D_{t_{2be\_enough}}}{A_{est2}}\right)+\frac{{V_T}^2}{A_{est2}\cdot(A_{safe\_max}+A_{est2})}}$$

$$t_{be\_en}=\frac{V_1-A_{est2}\cdot T_{traction\_min}}{-A_{est2}}\pm\sqrt{\frac{A_{safe\_max}}{A_{safe\_max}+A_{est2}}\cdot\left(\left(\frac{V_1-A_{est2}\cdot T_{traction\_min}}{-A_{est2}}\right)^2+\frac{(A_{est1}-A_{est2})\cdot{T_{traction\_min}}^2+2\cdot D_{t_{2be\_enough}}}{A_{est2}}\right)+\frac{{V_T}^2}{A_{est2}\cdot(A_{safe\_max}+A_{est2})}}$$

A.3.12.9.15 Introducing $t_{be\_X}=\frac{V_1-A_{est2}\cdot T_{traction\_min}}{-A_{est2}}$:

$$t_{be\_en} = t_{be\_X} \pm \sqrt{\frac{A_{safe\_max}}{A_{safe\_max}+A_{est2}} \cdot \left({t_{be\_X}}^2 + \frac{(A_{est1}-A_{est2}) \cdot {T_{traction\_min}}^2 + 2 \cdot D_{t_{2be\_enough}}}{A_{est2}} \right) + \frac{{V_T}^2}{A_{est2} \cdot (A_{safe\_max}+A_{est2})}}$$

A.3.12.9.16 Since $t_{be\_X} = \frac{V_{est}+V_{delta0}+(A_{est1}-A_{est2}) \cdot T_{traction\_min}}{-A_{est2}}$ is always < 0, the valid solution of the quadratic equation is derived from the positive sign in front of the square root.

A.3.12.9.17 **About A.3.12.8:** This value t_{be_en}, i.e. $t_{be\_enough\_step\_dist}$, ensures that the distance travelled along the step model (supporting section 3.13 formulas) is equivalent to the one computed along the ramp model. However, it does not ensure that the speed reduction is equivalent along both models.

A.3.12.9.18 Therefore, an equivalent brake build up time $t_{be\_enough\_step\_deltaV}$ computed from t_{2be_enough} is used as a lower limit to the final $T_{be\_reduced}$ value. Its computation is similar to the one defined by clause 3.13.2.2.3.2.4:

$$t_{be\_enough\_step\_deltaV} = T_{be\_react} + \frac{t_{2be\_enough}-T_{be\_react}}{2} = \frac{T_{be\_react}+t_{2be\_enough}}{2}$$

A.3.12.9.19 **About service brake related formulas:** They can be obtained from the emergency brake ones by setting V_{delta0}, $T_{traction\_min}$, $T_{traction\_max}$, A_{est1} and A_{est2} to zero and making the following substitutions: $V_{t2be} = V_{t2bs}$; $T_{be\_react} = T_{bs\_react}$; $t_{2be} = t_{2bs}$; $A_{EB} = A_{SB}$; $A_{safe\_max} = A_{expected\_max}$; $D_{t_{2be\_enough}} = D_{t_{2bs\_enough}}$; $t_{2be\_enough} = t_{2bs\_enough}$.

A.3.13 Inhibition of increase of displayed permitted speed and SBI speed

A.3.13.1 This appendix specifies under which conditions the displayed permitted speed and SBI speed are locked in order to avoid their increase which could be caused by active reduction of brake build up times (see Appendix A.3.12).

A.3.13.2 The boolean stating whether the displayed permitted speed and SBI speed are not allowed to increase (Q_display_pawl) shall be calculated according to the following algorithm:

If on-board is in target speed monitoring or release speed monitoring then

If the MRDT changes then

Q_display_pawl = false

Else if T_be_reduced computed for any target is lower than T_be then

Q_display_pawl = true

Else if the service brake command is available for use, the service brake feedback is not available for use, and T_bs_reduced computed for any target is lower than T_bs then

Q_display_pawl = true

Else

```
            Q_display_pawl = false
        End if
    Else
        Q_display_pawl = false
    End if
```