EEIG ERTMS Users Group
123-133 Rue Froissart, 1040 Brussels, Belgium
Tel: +32 (0)2 673.99.33 - TVA BE0455.935.830
Website: www.ertms.be E-mail: info@ertms.be

ERTMS USERS GROUP – ENGINEERING GUIDELINE

84. Overall ETCS

Reference: 22E087
Version: 1-
Date: 2024-06-28

Modification history

Version	Date	Modification / Description	Editor
0a	02/06/2022	4.5.3, 4.3.3, 4.11	GR
	12/7/2022	Added 4.3.3.5, 4.6.1.5, modified 4.3.3.6, 4.5.4.2, 4.11.3.2	GR
	2/8/2022	Added 5.10.3 and 5.13	KvdV
	27/10/2022	Added 4.13	GR
	28/10/2022	Added 5.19	KvdV
	13/01/2023	Updated 3.3.10 CFC 23	AJM
	24/03/2023	Completion of chapter 1 and 2	ATJ
	10/05/2023	Review of chapter 1, 2 and 3 during ESG107	EUG ESG
	15/05/2023	Restructuring chapter 3.2 and 3.3	ATJ, ABA
0b	16/05/2023	Track changes of version 0a accepted	ATJ, GR
	23/05/2023	Added 5.1.4	LB
	17/07/2023	Yard leaving and ETCS & HABD text added	NVR
	01/08/2023	Resolving comments ESG108	ATJ
0c	01/08/2023	Track changes of version 0b accepted till section 4.4 inclusive	ATJ
	19/09/2023	Contribution from ESG members	EUG ESG
0d	2024-04-19	Upgrade following ESG115, all tracked changes and resolved comments removed	EUG
0e	2024-05-13	Upgrade following agreements in ESG ad-hoc meetings	EUG
0f	2024-05-31	Upgrade following comments from ERA and additional EUG comments.	EUG
1-	2024-06-28	Official version	EUG

Table of Contents

1. Introduction

1.1 Foreword

1.1.1.1 The Overall ETCS guideline aims to collect into one single document various ETCS engineering issues and challenges, based on today's experiences and best practices when designing an ETCS trackside.

1.1.1.2 This guideline allows the reader of the document to travel through a normal ETCS journey encountering operational scenarios using ETCS as train protection system.

1.2 Scope and Field of Application

1.2.1.1 The aim of this document is to describe purely ETCS engineering issues and topics and to provide a recommended solution for the engineering of ETCS tracksides.

1.2.1.2 The objective is to support a harmonized, efficient, and safe implementation of ERTMS from both a technical and operational point of view, simplifying and harmonising future system implementations by taking advantage of the experience obtained from projects already in operation or under development.

1.2.1.3 This document provides recommendations concerning both strategy and process and technical choices to design and implementation of ERTMS.

1.2.1.4 This document considers ETCS level 2 application as the default scenario. In case of specific recommendations applicable to other levels, it will be explicitly mentioned.

1.2.1.5 This guideline focuses on the functional engineering rules of an ETCS project, and these are classified into 2 categories: ETCS procedures and ETCS system design. One chapter is allocated to each category.

- Chapter 3 considers ETCS procedures during train operation which are directly linked to the presence of ETCS as train protection system. Examples are ETCS Start of Mission, ETCS level transitions, RBC/RBC handovers, splitting/joining operations, level crossings, etc.
- Engineering topics that come out of the specific ETCS functionalities are addressed in chapter 3.21.1.4. Examples are balise engineering, emergency messages, elements positioning, text messages, block section engineering, mode profiles, etc.
- Besides these 2 main categories, a separate category only related to lineside Marker Boards is handled in chapter 4.16.

1.2.1.6 For more complex scenarios, references throughout this guideline are made to the existing engineering guidelines produced by the EUG. Each of these EUG guideline covers one specific topic.

1.2.1.7 The following ERTMS domains are not considered in this guideline (non-exhaustive list):

- Installation/mounting rules of the ERTMS constituents, e.g. Eurobalises, LEU, RBC
- Processes of ETCS configuration (e.g. data preparation)
- ETCS engineering tools
- Maintenance rules of various ETCS subsystems/constituents
- Processes of telecom configuration rules

1.2.1.8 In case there are specific system version applicability constraints or specific limitations (e.g. legacy system present or not, level 1 or level 2…, Technical Opinion), these will be explicitly mentioned in the relevant chapters or in the referred guidelines.

1.2.1.9 This document is developed taking into consideration Baseline 3 Release 2 (i.e. SUBSET-026 v3.6.0 [3]). Unless explicitly indicated, references to SUBSET-026 or other TSI CCS documents will refer to the version included in Baseline 3 Release 2.

1.2.1.10 Unless explicitly indicated, ETCS Baseline 2 (i.e. SUBSET-026 v2.3.0d [4]) for trackside is not considered in this guideline.

1.2.1.11 Baseline 4 (i.e. SUBSET-026 v4.0.0 [2]) is not fully considered in this guideline, however some specific CRs related to B4R1 are considered.

1.2.1.12 For ETCS on-board subsystem, the terms B3MR1 and B3R2 are used with reference to Set of Specifications #2 and #3, resp. of Annex A of TSI CCS 2016 [22], while on-board system version 2.1, 2.2, and 3.0 are used when making reference to the single set of specification in Annex A of TSI CCS 2023 [23].

1.3 Document structure

1.3.1.1 The topics in this guideline are sorted according to the classification of the engineering rules (see section 1.2.1.5).

1.3.1.2 Chapter 1 introduces the document, defines the scope and the field of application.

1.3.1.3 Chapter 2 provides definitions, references, terms and abbreviations used in this document and the list of appendices (if any).

1.3.1.4 Chapter 3 addresses engineering rules related to ETCS procedures during train operation.

1.3.1.5 Chapter 3.21.1.4 addresses engineering rules related to ETCS system design.

1.3.1.6 Chapter 4.16 addresses engineering rules related to lineside Marker Boards.

2. References and Abbreviations

2.1 Definitions

2.1.1.1 For the ERTMS/ETCS terminology, SUBSET-023 [1] is used as reference.

2.1.1.2 Any specific terminology that is already defined in a guideline which addresses the specific topic will not be repeated here.

2.1.1.3 The following table includes terms and definitions which are used in the current document:

Terminology	Definition
Non-controlled	An area (e.g. a yard) or an object (e.g. a point), which is not controlled by an IXL

2.2 Abbreviations

2.2.1.1 The following table includes acronyms and abbreviations, which are used in the current document, and which are not listed in SUBSET-023 [1].

Abbreviation	Description
BG	Balise Group
BMM	Big Metal Masses
CES	Conditional Emergency Stop
EoM	End of Mission
EUG	ERTMS Users Group
HAB	Hot Axle Box
IM	Infrastructure Manager
IXL	Interlocking
LTO	Level Transition Order
MB	Marker Board
SM	Supervised Manoeuvre mode (only applicable starting from B4)
SMB	Stop Marker Board
SV	System Version
TMS	Traffic Management System
TRN	Train Running Number
TTD	Trackside Train Detection
UES	Unconditional Emergency Stop

2.2.1.2 Abbreviations used in referenced documents are not mentioned here and they can be found in the documents themselves.

2.3 References

2.3.1.1 The following documents and versions apply:

Ref. N°	Document Reference	Title	Version
[1]	SUBSET-023	ERTMS/ETCS Glossary of Terms and Abbreviations	3.3.0 2016-05-13
[2]	SUBSET-026	ERTMS/ETCS System Requirements Specifications	4.0.0 2023-07-05
[3]	SUBSET-026	ERTMS/ETCS System Requirements Specifications	3.6.0 2016-05-13
[4]	SUBSET-026	ERTMS/ETCS – Class 1 System Requirements Specification	2.3.0d 2008-04-23
[5]	18E120	Start of Mission in L2 and L3 (B3)	3- 2024-06-28
[6]	17E130	Level transition from SV1.Y to SV2.Y with NTC fallback	2- 2024-06-28
[7]	16E155	Level transition from LNTC to L1 (SV2.Y)	2- 2024-06-28
[8]	15E157	Level transition from L1 to LSTM	3- 2024-06-28
[9]	15E158	Level transition from L2 to LSTM	3- 2024-06-28
[10]	17E113	Level transition from LSTM to L1	3- 2024-06-28
[11]	19E190	Level transition from LNTC to L2	4- 2024-06-28
[12]	19E191	Level transition from L2 to LNTC	3- 2024-06-28
[13]	17E112	RBC/RBC Handover	2- 2024-06-28
[14]	SUBSET-041	ERTMS/ETCS Performance Requirements and Interoperability	3.2.0

Ref. N°	Document Reference	Title	Version
			2015-12-17
[15]	17E054	Handling of Level Crossings with Baseline 3	5- 2024-06-28
[16]	17E087	Border Crossings	4- 2024-06-28
[17]	18E020	Management of Shunting Activities utilising SH	2- 2024-06-28
[18]	ERA_ERTMS_015560	ETCS Driver Machine Interface	3.6.0 2016-05-13
[19]	EIRENE SRS	GSM-R System Requirements Specification	16.0.0 2015-12-21
[20]	SUBSET-093	GSM-R Interfaces – Class 1 requirements	4.0.0 2022-03-04
[21]	18E124	Balise Engineering for L2 and L3	2- 2024-06-28
[22]	TSI CCS 2016/919	Regulation (EU) 2016/919	2016-05-27
[23]	TSI CCS 2023/1695	Regulation (EU) 2023/1695 (TSI CCS)	2023-08-10
[24]	16E156	Automatic Track Ahead Free (B3)	4- 2024-06-28
[25]	ERA/OPI/2020-2	Opinion of the European Union Agency for Railways to the European Commission regarding error corrections of current ERTMS baselines	2020-05-05
[26]	SUBSET-125	ERTMS/ATO System Requirement Specification	1.0.0 2023-07-05
[27]	SUBSET-126	ATO-OB / ATO-TS FFFIS Application Layer	1.0.0 2023-07-05
[28]	SUBSET-040	Dimensioning and Engineering rules	3.4.0 2016-12-15

Ref. N°	Document Reference	Title	Version
[29]	18E056	Gradient segmentation	3- 2024-06-28
[30]	20E215	B2 trackside for B3 trains	3- 2024-06-28
[31]	SUBSET-113	ETCS Hazard Log	1.5.0 2022-05-10
[32]	21E087	Hybrid Train Detection engineering	4- 2024-06-28
[33]	21E089	Engineering rules for harmonised marker boards.	1- 2023-07-05
[34]	prEN 16494	Railway applications - Requirements for ERTMS Trackside Boards	2015
[35]	SUBSET-091	Safety Requirements for the Technical Interoperability of ETCS in Levels 1 & 2	3.6.0 2016-05-12
[36]	20E234	Extension Key Request Function	2- 2024-06-28

3. Engineering rules coming from ETCS procedures during train operation

3.1 Start of Mission

3.1.1.1 See guideline Start of Mission [5].

3.2 Track Conditions

3.2.1 Transmission of Track Conditions

3.2.1.1 It is recommended that the ETCS trackside should be engineered to transmit Track Conditions when these are applicable. This would lead to harmonised information to the driver in the DMI and possibility to perform some operations automatically when rolling stock is configured for this.

3.2.1.2 For track conditions not supposed to change, these should be sent with the corresponding MA. Therefore, if the route is changed, the track conditions will be updated together with the new MA. For track conditions which may change status, e.g. sound horn due to a level crossing not reaching protection, these can be sent in separate messages.

3.2.1.2.1 Note: In case shifted location is used, a general message cannot be used for track conditions (according to SUBSET-026 [3] chapter 8 and SUBSET-113 [31] Hazard ETCS-H0063).

3.2.1.2.2 Note: BMM is an exception (see SUBSET-026 [3] 3.7.3.1 f)) because it can be sent by BG only.

3.2.1.3 For additional considerations about the use of Track Conditions and the accompanying harmonised ERTMS Marker Boards, see section 5.1.

3.2.2 More than three track conditions

3.2.2.1 In the ETCS DMI planning area, only 3 track conditions and announcement of track conditions can be shown at the same time (see ETCS DMI specifications ERA_ERTMS_015560 [18] 8.2.3.5.3).

3.2.2.2 According to SUBSET-026 [3], a priority list for track conditions is not possible. The following track conditions can be used in principle at the same time (see SUBSET-026 [3] 3.12.1.3 and ETCS DMI specifications [18] section 8.2.3.5):

- Non stopping area
- Tunnel stopping area
- Switch off / on main circuit
- Lower / rise pantograph
- Eddy current or magnetic shoe or regenerative brake forbidden
- Change of traction system
- Air tightness
- Sound horn
- Radio hole

3.2.2.2.1 Note: For B3MR1 on-boards, the planning area is optional when in FS and not shown when in OS; for B3R2 on-boards, the planning area is shown in FS and can be toggled on/off by the driver in OS.

3.2.2.3 It is recommended to engineer the trackside so that the on-board does not need to supervise at the same time more than 3 track conditions which are shown in the DMI (see 3.2.2.2 above).

3.2.2.4 For those track conditions that have more spatial flexibility (e.g. sound horn), the location of the announcement and execution of those track conditions should be engineered taking into consideration this DMI limitation.

3.2.2.5 If data entry of a temporary track condition at the operator terminal of the RBC is possible, and if already 3 track conditions apply at the same time and location, then the RBC should warn the signaller and allow him/her to choose the priority of the track conditions.

3.3 Level transitions

3.3.1 Introduction

3.3.1.1 This chapter on ETCS level transitions discusses the frequency of level transitions to consider in the deployment of ERTMS (see section 3.3.2) and provides engineering details on level transition announcement applicable for ETCS levels through the correct use of D_LEVELTR (see section 3.3.3). For more details and recommended technical solutions on specific level transitions, see the following guidelines depicted hereunder:

- For level transitions from LSTM to L1 using SV1.Y, see EUG guideline [10] (this guideline is mainly based on B2 trackside, and cover only to a minor extent tracksides with B3 SV1.Y).
- For level transitions from L1 to LSTM using SV1.Y, see EUG guideline [8] (this guideline is only based on B2 trackside, and cover only to a minor extent tracksides with B3 SV1.Y).
- For level transitions from L2 to LSTM using SV1.Y, see EUG guideline [9] (this guideline is mainly based on B2 trackside, and cover only to a minor extent tracksides with B3 SV1.Y).
- For level transitions from LNTC to L1 using SV2.Y, see EUG guideline [7].
- For level transitions from LNTC to L2 using SV2.Y, see EUG guideline [11].
- For level transitions from L2 to LNTC using SV2.Y, see EUG guideline [12].
- For level transitions from SV1.Y to SV2.Y with NTC fallback, see EUG guideline [6].

3.3.2 Frequency of level transition

3.3.2.1 The deployment of ERTMS may expose the drivers to more or less frequent transitions between operations under ETCS and operations under a National

System. Each one of those transitions may require an adjustment period from the drivers during which the performance and/or safety can be impacted.

3.3.2.2 Level transitions could also impact the effectiveness of the driving if there are level specific functions that require a driver action (e.g. acknowledgement is required according to SUBSET-026 [3] 5.10.4.4).

3.3.2.3 As this degradation in effectiveness of the driving may be exacerbated by the frequency of the transitions, it is recommended that ERTMS deployment strategies limit the number of transitions especially for level transitions requiring acknowledgement (i.e. between ETCS and a National System) to a minimum (drivers should be consulted). See also SUBSET-091 [35] clause 10.2.1.18 for a general limitation of 2 level transitions per hour.

3.3.2.3.1 Note: CR1166 (error correction included in B4) removes the need for acknowledgement when performing a level transition from LNTC to L1 or L2.

3.3.2.4 During migration periods, additional temporary transitions can be foreseen for a short period of time.

3.3.2.5 ERTMS deployment strategies that lead to a transition back to the previous level (for instance see Figure 1) after a short distance/time should be avoided as it may have a negative impact on the driver ergonomics, the effectiveness of the driving, and the capacity of the line.

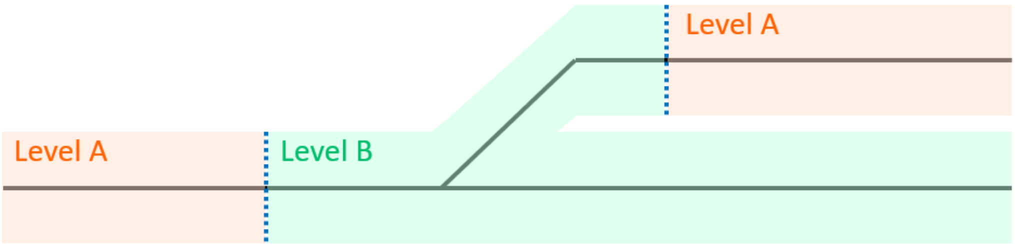

Figure 1: Example of two consecutive level transitions from level A to B and vice versa

3.3.2.6 In case of two close level transitions cannot be avoided, the announcement of the second transition, while being sent in due time, can only be sent after the first transition is completely executed, otherwise the first transition will never be executed.

3.3.2.7 Furthermore, the MA related to the second level transition should be sent together with the LTO related to the second level transition. This is to ensure that the MA will only be extended once the first level transition has been completely executed.

3.3.3 Level Transition Announcement and variable D_LEVELTR

3.3.3.1 It might occur that a Level Transition Announcement message sent by BG is ignored because the D_LEVELTR is so small that the level transition border location announced by packet 41 falls in rear of the estimated front end, considering the system decoding delays. In this case, the condition described in clause 5.10.1.5 of SUBSET-026 [3], does not apply and the level transition does not take place.

3.3.3.2 In a standard solution the level transition is ordered by a Level Transition Order message (D_LEVELTR = now), which forces the transition anyway at the level transition border location. For redundancy reasons, a Level Transition Order message could be added if the issue described in 3.3.3.1 might occur.

3.3.3.3 In case the Level Transition Announcement message should force the transition, it is recommended to use a sufficiently large D_LEVELTR value to guarantee that the level transition border location is in advance of the estimated front end. This is necessary to fulfil the level transition condition of clause 5.10.1.5 of SUBSET-026 [3].

3.3.3.4 Hazard ETCS-H0118 (see SUBSET-113 [31]) states that after receiving a Level Transition Announcement, it is not clear which levels should be part of the table of priority of trackside supported levels. Because of this, the driver may be able to select a level that is not supported by the trackside.

3.3.3.4.1 Note: CR1376 (error correction included in B4) clarifies the possibility to send a list of priority of available levels to the train. When included in a Level Transition Announcement, the list will not be taken into account before the estimated front end passes the level transition border location.

3.4 RBC/RBC Handover

3.4.1.1 For details and recommended technical solutions on RBC/RBC handovers, see guideline RBC/RBC handovers [13].

3.5 Reversing

3.5.1.1 There are different use cases where mode RV can be used. In a first use case mode RV is used to evacuate trains in a reverse movement from an incident or a failure (e.g. unintentionally entering the wrong tracks). Another use of mode RV is to adjust the train position at a platform for safe evacuation.

3.5.1.2 A train in mode RV receives no full MA but only a speed limit and a distance limit. The train is supervised to run within these limits. Thus, the train in mode RV is not supervised by any braking curve but by a maximum speed and maximum reversing distance.

3.5.1.3 In mode RV the safe radio connection is not supervised. Thus, it is possible to move a train in mode RV after the reversing distance is transmitted even if the safe radio communication fails (temporarily).

3.5.1.4 The ERTMS/ETCS on-board has no possibility to ask for an extension of the received reversing distance. The trackside system can be designed to send a new reversing distance that overwrites the already given reversing distance, based on the position of the train from the TTD section or the reported train position.

3.5.1.5 If the new permission to reverse includes a reduced speed limit, the driver has to be informed to avoid that the ERTMS/ETCS on-board unit immediately commands the Emergency or Service brake. The information about reduced speed can be transmitted in a separate text message a certain time or distance before the speed change.

3.5.1.6 As the reversing distance goes beyond the point where the driver latest is permitted to stop the train and the DMI will only show the reversing distance, the driver could be informed about the stopping point by mean of MBs (unless the reference to the stopping point is clear, e.g. end of a tunnel, or if it is indicated by national rules for reversing procedure, e.g. up to the location of an evacuation area).

3.5.1.7 The number of speed changes should be kept to a minimum to reduce the risk of braking a train by exceeding its new speed limit.

3.5.1.7.1 Note: The longitudinal forces during braking in a reverse movement are different than during a forward movement. There are higher risks that forces between wagons cause derailment or train separation.

3.5.1.8 To prevent a train from colliding with another obstacle when overrunning its reversing speed or distance limit, a safety distance should be reserved in rear of the limit of the reversing distance, see Figure 2. This safety distance should be based on:

- the max train length admitted on the line (considering that the ERTMS/ETCS on-board will command the brake as soon as the estimated front end overpasses the reversing distance, see SUBSET-026 [3] 3.15.4.8 and 3.15.4.2.2),
- an odometry factor (see chapter 5.3.1.1 of SUBSET-041 [14])
- the expected worst case braking distance

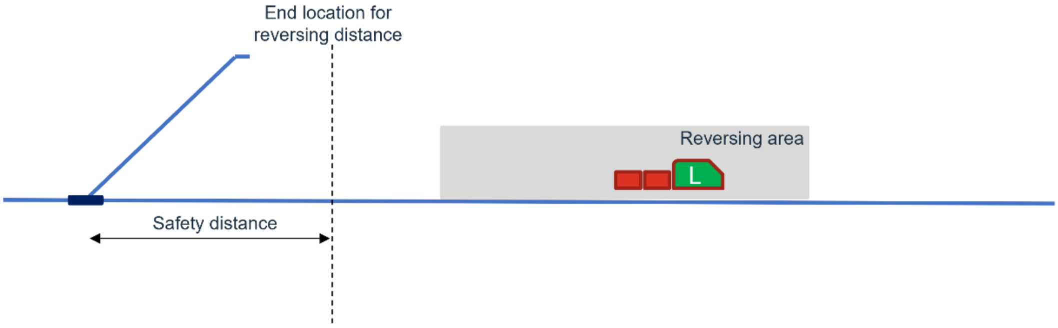

Figure 2: Example of end location for reversing distance considering the safety distance from a point

3.5.1.8.1 Note: The max train length and the expected braking distance are independently from the reversing distance but the odometry factor is proportional to the reversing distance. The longer the reversing distance is, the higher is the influence of the odometry factor and therefore the reserved distance should be larger.

3.5.1.9 The principle of ensuring the safety of the reversing train should be based on the overall safety philosophy of the reversing procedure, taking into account the operational rules for authorising reverse movements, the operational rules for the reverse movement itself, the purpose of reversing, and the worst-case scenario considered.

3.5.1.10 The ETCS trackside could be designed in such a way that the permission to reverse is dependent on the occupancy state of the track section until the end of the reversing distance (+ safety distance) and/or on the command by the dispatcher or the TMS to permit a reverse movement.

3.5.1.11 This design increases the safety of the reversing movements, however if the occupancy state is not known or if the communication is lost, this might make it impossible to permit a reverse movement, which could be a bigger risk in some situations (e.g. impossibility to prompt start of evacuation of the train in the case of a fire in a tunnel).

3.5.1.12 Another possibility for the ETCS trackside design could be that permission to reverse is always given by the trackside before the train enters the relevant area (e.g. a tunnel). This design ensures that the option to enter RV mode is shown to the driver if the train stops in the reversing area.

3.5.1.13 This design would ensure that reverse movements can always be performed, independent of track occupancy and/or communication state. However, the conditions for reverse movements should be defined by operational rules (e.g. verbal permission from the dispatcher, if communication is possible, or the driver's judgement, if communication is lost).

3.6 Level Crossing

3.6.1.1 For details and recommended technical solutions on level crossings, see guideline Handling of Level Crossings with Baseline 3 [15].

3.7 Border Crossing

3.7.1 Introduction

3.7.1.1 For more details and recommended technical solutions on how to deal with locations where operational rules and/or functionality and/or juridical aspects change and ETCS is in place on at least one side of the border, see guideline Border Crossing [16].

3.7.2 Times for radio network registration and session management

3.7.2.1 Prior to each regular entry to a new level 2 area, a balise group with Packet 45 Radio Network registration should be provided for dialling into the respective GSM-R network.

3.7.2.2 The distance of the Packet 45 Radio Network registration to the Packet 42 Session Management balise group to establish communication session with the RBC should be determined using the respective maximum line speed (v_{max}) in the relevant area before the point of entry. If the maximum line speed varies in the relevant area, this should be considered.

3.7.2.3 However, a larger distance is possible, e.g. in order to reduce the number of balise groups by smart positioning. In this case it should be ensured that a suitable GSM-R coverage is available. Between Packet 45 Radio Network registration and

Packet 42 Session Management the GSM-R coverage should be at least -98dBm. From the moment Packet 42 is passed, the GSM-R coverage should be at least -95dBm depending on the line speed, see GSM-R System Requirements Specification [19].

3.7.2.4 A Packet 45 Radio Network registration balise group should be planned for all routes leading to the Packet 42 Session Management balise group and for which an entry of ETCS vehicles is planned.

3.7.2.5 A Packet 42 Session Management balise group should be also planned to terminate communication session if the connection to the RBC is not needed, e.g. due to a route branch before entering the ETCS area.

3.7.2.5.1 Note: Additional information concerning Radio Network Registration and Session Management Establishment are available in Appendices A and B of guideline Level transition from LNTC to L2 [11].

3.8 Shunting

3.8.1 Introduction

3.8.1.1 This chapter on ETCS shunting activities discusses how to perform shunting activities in a mode different from SH mode (see section 3.8.4) and how to enter & leave a shunting yard (see sections 3.8.1.2 and 3.8.3). For more details and recommended technical solutions for shunting activities making use of SH mode, see guideline Management of Shunting Activities utilising SH [17].

3.8.1.2 Non-controlled yards should be managed as shunting areas.

3.8.2 Movement from a shunting yard to a L2 area through a controlled point

3.8.2.1 In case the consist leaves the yard with a propelling movement, SH mode should be used pending the implementation of SM mode.

3.8.2.2 In case the loco is in front of the consist when leaving the yard, the driver should exit SH mode and perform a SoM at standstill at latest in front of the Marker Board at the border of the controlled area.

3.8.2.3 A relocation BG should be installed before the Marker Board at the border of the controlled area in order to allow the consist to unambiguously provide its position before leaving the yard.

3.8.2.3.1 Note: Exit SH and the L2 SoM could also take place in rear of a Marker Board outside the shunting yard

3.8.2.4 Figure 3 below gives an example of track layout where the train stops at the Marker Board at the border of the controlled area, and where the driver performs the SoM.

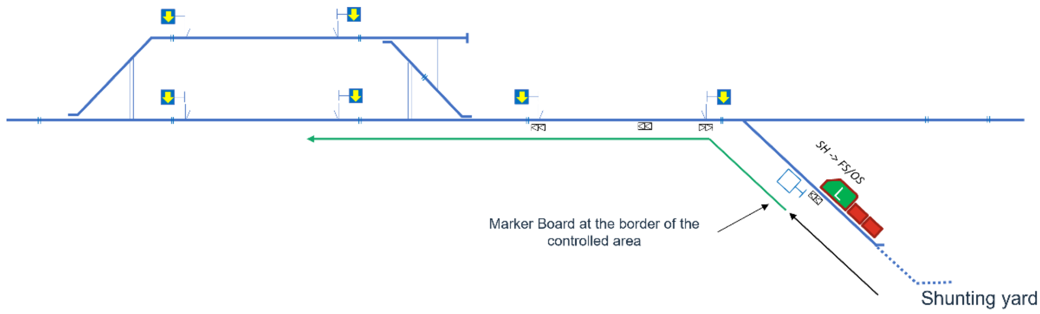

Figure 3: Movement from a shunting yard to a L2 area through a controlled point

3.8.2.5 The use of a BG with the information "danger in SH" in relation to the Marker Board at the border of the controlled area can be considered unless additional mitigations preventing from the undue exit of a consist from the non-controlled yard is already in place (e.g. physical flank protection is provided). However, the use of the "danger in SH" information implies the need for using switchable BGs or the "override" function in case of consist leaving the non-controlled yard with a propelling movement, and the need to consider the possible maximum length of the consist in front of the propelling loco.

3.8.2.5.1 Note: In case propelling movements are allowed when switchable BG are used, the occupancy of the track in advance of the switchable BG should not be the only trigger for sending the "danger in SH" information.

3.8.2.6 The provision of the track description for the entire length of the train should be provided by RBC when sending an MA in order to avoid displaying the message "Entering FS/OS" on the DMI and to avoid the driver taking responsibility to protect the entire length of the train while already having received an MA. In case of non-controlled points in the area, this can be done by defining the worst-case track description for all the tracks on which the train could be located.

3.8.2.6.1 Note: The conditions the RBC should consider in order to send an MA can vary according to the characteristics of the installation (e.g. position of the consist, status of the point leading to the controlled area).

3.8.3 Movement to/from a shunting yard through a non-controlled point

3.8.3.1 This section deals with the scenario of a train entering/exiting a non-controlled shunting yard through a non-controlled point. See Figure 4 for an example of entry into a shunting yard.

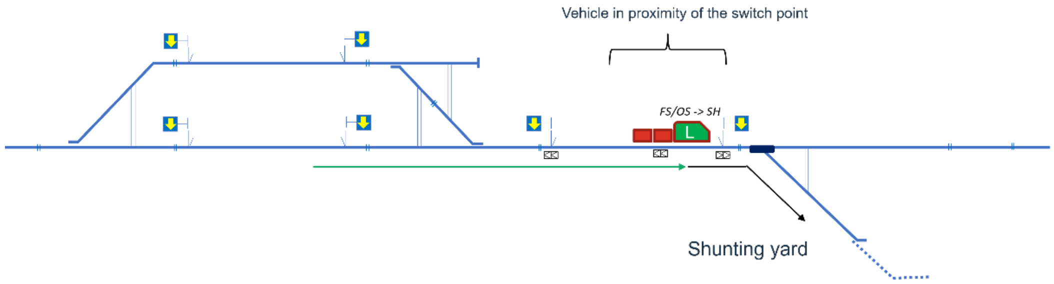

Figure 4: Movement into a shunting yard through a non-controlled point

3.8.3.2 The movement of the train from the station to the position as close as possible to the entry point of the shunting yard and from the exit point of the shunting yard back to the station, should be performed by using an MA in order to increase the level of protection (i.e. complete supervision of train movements).

3.8.3.3 The movement of the train to enter/exit the non-controlled shunting yard, after the point has been moved, should be performed in SH due to the fact that the point is not controlled, and a possible change of the running direction can be necessary.

3.8.3.4 For ETCS level 2 applications, the RBC should grant the SH mode only in case the train asking for SH is in an area close to the entry point of the shunting yard, additional conditions can also be used (e.g. the information from the interlocking that the consensus to move the point has been released).

3.8.3.5 When the entry into the shunting yard needs a change in the running direction, it is recommended to indicate to the driver the location on the track that the train should not overpass, to be sure that the RBC can grant the authorization to SH mode. An ETCS Stop or Location Marker can be used to indicate this location, see Figure 5.

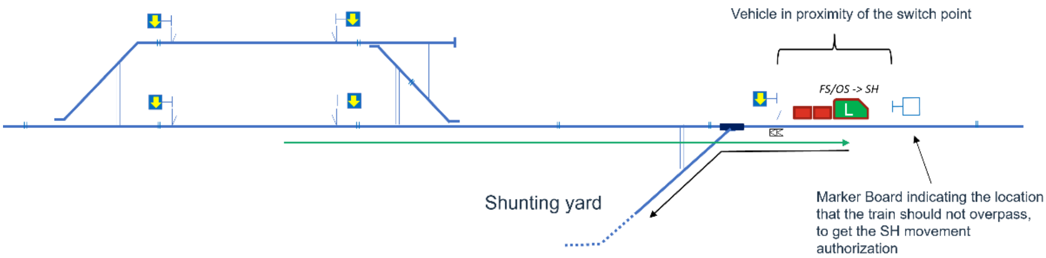

Figure 5: Movement into a shunting yard through a non-controlled point, where a change in the direction is needed

3.8.3.6 The risk a train could unduly exit from the non-controlled shunting area should be mitigated physically, e.g. by using derailer or independent track.

3.8.3.7 Note: ETCS can also provide partial mitigations depending on the mode used in the non-controlled area:

- in case UN or SN are used, a BG with the transition order to L2 can be placed in correspondence to the “exit” marker board indicating to the driver the location on the track that the train should not overpass without having the RBC granted the authorization to SH mode;
- in case SH (with level different from 2) is used, the only mitigation ETCS can provide is by the information “Danger if in SH” however this implies the use of the override function (unless switchable BGs are used) once RBC has granted the SH mode after the Level 2 SoM in rear of the “exit” marker board. Therefore, the use of “Danger if in SH” is not recommended.

The possible ETCS mitigation mentioned above is anyway only partial because it is not effective for propelling movements.

3.8.4 Shunting activities in OS

3.8.4.1 Pending the implementation of the SM mode, shunting movements in a controlled area can be protected by an OS MA.

3.8.4.2 OS provides a higher level of train protection compared to SH mode and could be used when:

- A route suitable for shunting movement is set;
- Train position and train data are valid;
- The opened cab desk is according to train movement direction;
- No coaches or wagons are in front of the active cab.

3.8.5 Joining and track sharing

3.8.5.1 Problem Description

3.8.5.1.1 For safety reasons, it needs to be ensured that the 1st approaching train is at standstill before the 2nd train is permitted to enter the same track.

3.8.5.1.2 For tracks used to join trains or to be shared by several trains, the intended way to enter the occupied track section needs to be considered.

3.8.5.1.3 For operational efficiency stopping of approaching trains before entering the occupied track should be avoided.

3.8.5.1.4 Starting point for an OS or SH mode profile needs to be considered.

3.8.5.1.5 The permitted speed for entering an occupied track section needs to be considered as a trade-off between safety and operational performance.

3.8.5.2 Solution

3.8.5.2.1 Possible solutions to ensure that the first approaching train is at standstill are:

- Shorten MA to the reported train position at standstill (and revoke the remaining route as well)
- Driver performs EoM and remaining route is revoked
- Permit a route to be set to approach the 1st train based on a position report confirming that this train is at standstill
- Change MA to OS after standstill, if a need to move the first arrived train to enable the coupling of the trains.

3.8.5.2.2 Possibilities to enter an occupied track without stopping:

- FS MA including an OS mode profile for the last part of the track
- FS MA including a SH mode profile for the last part of the track.

3.8.5.2.3 Possible starting points for an OS or SH mode profile:

- On the approach to the last ETCS Stop marker
- On the approach to the start of the occupied track section.

3.8.5.2.4 These further considerations should be included, when a choice is made:

- Starting point on the approach to the first occupied section provides the driver time to acknowledge and take control of the train – particularly for

trains with brakes which take time to release and apply this can be an issue
- Granting OS or SH too far from the occupied track / train waiting to be joined should be considered carefully, as the driver is expected to be more vigilant, if he is able to see the train he approaches
- Sub dividing tracks into several train detection sections, maybe each protected by an ETCS Stop marker, to shorten the distance run with low speed can be considered.

3.8.5.2.5 Regarding speed for entering an occupied track section, possible solutions are:

- Use the National Values for permitted speed in OS respectively SH
- Lower speed could be considered for safety, especially if trains with passengers are involved
- A lower speed to replace the national value can be included in a mode speed.

3.8.5.2.6 Approaching an announced OS or SH mode profile will always be monitored as an EOA with no Release Speed. Possible methods to support a smooth entry in mode SH/OS the following should be considered:

- An optimal acknowledgement window length
- Using SvL of the sent MA instead SvL at EOA
- Using mode change order on current location instead of further location

3.8.6 Splitting

3.8.6.1 Two (or more) trains performing SoM in the same track is a challenge using ETCS level 2:

- If two (or more) trains have to leave the same track section in the same direction, giving the first train the authorisation could be problematic.
- The basic supplier solutions for SoM with unambiguous position (see section 3.1.2) do not seem to provide a train location sufficiently specific to determine the row of several vehicles in the same section.

3.8.6.2 Procedure should ensure that SoM is performed according to schedule, e.g. train that will leave first should perform SoM first, then the second train can perform SoM.

3.9 Limiting traction power

3.9.1.1 Regular fluctuations in voltage are usually absorbed and rectified by onboard power systems, longer term power degradation however can require action whereby traction units are required to draw less current. During such degraded scenarios an intelligent control centre could automatically limit the current draw from each powered section.

3.9.1.2 Where no intelligent system exists, an operational rule can be used where the signaller informs the driver to limit the amount of traction current at a certain location.

3.9.1.3 In such scenarios, packet 40 (Track condition change of allowed current consumption), can be used to limit the allowed onboard traction current and define the distance the limited traction current should apply for.

3.9.1.3.1 Note: It is unclear what would be the on-board behaviour if the trackside sends packet 40 with a higher allowed current consumption than what was previously defined through NID_CTRACTION sent by packet 39.

3.9.1.3.2 Note: At the date of the current version of the document, there is no direct experience on the use of packet 40.

3.9.1.3.3 Note: The EVC only acts as a “postman” forwarding the possible received current consumption information to the consist; ETCS does not guarantee the consist will use this info. In addition, no ETCS DMI information is foreseen.

3.9.1.3.4 Note: In the case of operation with ERTMS/ATO (available in B4, SV2.2), the allowed current consumption will be specified in the Segment Profile (see SUBSET-126 [27] 7.3.9.2). In addition, it is also possible to specify temporary restrictions of current consumption in the Journey Profile (see SUBSET-126 [27] 7.3.6.2). This information will be used by the ATO-OB to predict the traction/brake capabilities of the train (see SUBSET-125 [26] 7.1.2.2 g)).

3.10 Change of traction to diesel

3.10.1.1 Some trains can switch from electric to diesel “on the fly”. However, the diesel engine needs to be started (warmed up) long before it is in charge of the traction (at least 15 min).

3.10.1.2 ETCS change of traction function only warns the driver of the change of traction, but not to heat the diesel engine. In addition, at the moment such an information should be transmitted to the train, the RBC (or the interlocking) does not know yet where the train will be routed.

3.10.1.3 A different way to remind the driver where to start heating the diesel should be found, also outside ETCS. Among the options:

- GPS triggered heating
- Boards along the track
- Direct connection between RBC and TMS triggering the sending of a text message to the appropriate trains at the right location, based on timetable or production schedule.

3.11 RBC limiting or preventing train movement based on received train data

3.11.1.1 The RBC can use train data received from the EVC to apply driving limitations on the train, or to prevent the train from entering an area. Hereafter some examples:

- Train category could be used to set specific limitation distinguishing the kind of brake (G or P)
- Traction system voltage could be used to prevent only electric train from entering a non-electrified line.

- Train length, axle load, Train Running Number etc. could be used to prevent trains entering L2 (these data is used as L2 entry-check to compare planned/expected data with real data from the train)

3.11.1.1.1 Note: For hybrid (diesel-electric) trains, M_VOLTAGE = 0 (meaning the train supports diesel/battery traction), should be transmitted to avoid undue reactions from an RBC operating on non-electrified lines.

3.11.1.2 The RBC can share train data received from the EVC with the TMS to optimize traffic management e.g. train length could be used by TMS to properly set a route (manage short platform) or to impede a LX/point to remain occupied with the train at standstill. The following solutions can be considered:

- The traffic management layer can be designed to prevent setting a train route for an unsuited train. A warning should be given to the signaller if a train route is set over a track that the train is not suited for.
- The RBC can be designed to inhibit the extension of the MA if the train is not suited for the train route, possibly stopping the train in a location which allows the train to be re-routed without the need to move backward. A warning should be given to the signaller if a train route is locked over the track that the train is not suited for and a text message informing the driver why the MA is not extended should be sent.
- The on-board function Route suitability can be used. In such a case a standardised text message is shown on driver DMI.

3.11.1.2.1 Note: With reference to solution 3.11.1.2 third bullet, it should be considered that B2 on-boards allow to override the Route suitability function while this is not possible for B3MR1 and B3R2 on-boards.

3.11.1.3 The preferred solution is the one described in 3.11.1.2 first bullet, however in case this solution cannot be implemented, the solution of the second bullet should be adopted.

3.11.1.3.1 Note: The above recommendation aims to avoid the demand of using on-board function when equivalent trackside function can be used instead in L2 applications, targeting the future goal of simplifying on-board specification.

3.11.1.4 When implementing solution 3.11.1.2 second bullet, the text message to inform the driver through the DMI should have the same text and characteristics of the standardised text message defined for the Route Suitability function.

3.12 Approach to a buffer

3.12.1.1 This section describes some general recommendations to use when designing the trackside to handle the operation of approaching a buffer.

3.12.1.2 When it can be guaranteed that no other train is occupying the buffer stop section, an FS MA can be issued to approach the buffer stop, else an OS MA should be issued.

3.12.1.3 The location of the buffer stop should be defined as the location for End of Authority with an associated Release Speed to enable full approach to the buffer stop.

3.12.1.3.1 Note: An additional margin in rear of the buffer stop could be considered (e.g. 5, 10 m) but this could bring to possible train trip

3.12.1.3.2 Note: The Release Speed can be dependent on the kind of buffer (e.g. energy absorbing buffer).

3.12.1.4 The buffer stop should be engineered as the danger point and with no overlap.

3.12.1.5 To handle odometric errors, a relocation balise group in approach to the buffer should be placed. Based on member experience a location of 25-100m in advance of the EOA is suitable.

3.12.1.6 Used variables and possible values based on input from EUG members

Variable	**Suggested value**
D_DP	0
Q_OVERLAP	0
V_RELEASEDP	5, 10, 15, 20 km/h

3.13 Speed restriction for specific trains

3.13.1.1 Railway operations may require reducing the speed of trains based on information or characteristics of the train which are not within ETCS data (i.e. two trains with the same ETCS data might still have different speed restrictions), mostly for operational reasons:

- according to specific services (e.g. extraordinary cargo trains, or whether a freight train is loaded or not)
- for the first train of the day
- depending on the active traction system of the train (e.g. the use of the pantograph might be problematic in higher speed in certain locations)
- in double track tunnels, according to the type of train running in the opposite direction (to handle the gap of air pressure, both for passenger comfort and for safety reasons).

3.13.1.2 The RBC should provide SSPs and TSRs based upon the TRN and/or the NID_ENGINE in addition to operational rules.

3.13.1.2.1 Note: It should be considered that the TRN is added by the driver and therefore there is a risk that the driver has entered the wrong TRN and therefore the EVC would never receive the appropriate restriction.

3.14 Pushing and banking movements in ETCS

3.14.1.1 In some countries uncoupled helper/pushing/banking locomotives are used to push a freight train up an incline. As they are not coupled, there is no need to stop the freight train when at the top of the incline. There is no recommended solution to support these movements by the ETCS system, because the chosen solution will strongly depend on national safety considerations and operational rules.

3.15 HAB and ETCS

3.15.1.1 This section only applies to infrastructures where HAB information is used by the ETCS system.

3.15.1.2 Whatever the level of responsibility of the ETCS system in the management of HAB information, it should always be up to the signaller or the TMS or the interlocking to decide whether (and where) a train that triggered an HAB alarm should be rerouted/stopped.

3.15.1.2.1 Note: In case of HAB alarm, a suitable rerouting location should be chosen taking into account the distance to travel, the maximum train speed, the braking capacity (to avoid the use of emergency brakes) and other constraints such as the presence of a bridge, a tunnel, a station, etc.

3.15.1.2.2 Note: If possible, trains that triggered an HAB alarm should not be stopped on the main line as it would make the examination of the train harder and as there is a chance the train will not be able to move anymore, hindering the traffic even more.

3.15.1.3 Depending on the information received from the TMS or the interlocking, and depending on the track topology and the type of alarm, the RBC should associate the HAB information to the train and should do one or more of the following:

- Impose a TSR until the following HAB detector.
- Impose an EOA to the selected HAB check point where the driver can perform the necessary train checks until a specific command is sent by the driver and/or signaller.
- Send a text message to warn the driver in case of HAB alarm.

3.16 Working areas

3.16.1 Applicability

3.16.1.1 During engineering works, maintenance trains need to be able to move in both directions. The ETCS trackside equipment may be unavailable or disarrayed (e.g. balises are missing) and it may not be possible to issue movement authorities.

3.16.1.2 The area of engineering work is generally under the control of site staff rather than the signaller.

3.16.1.2.1 Note: Preventing a train from unduly passing the protecting signal or ETCS Stop Marker and enter the working area, is out of scope. ETCS functions impeding the passing of a signal at danger should be used.

3.16.1.2.2 Note: Marker Boards to indicate the working area and the relevant engineering placement rules are not harmonized.

3.16.1.3 Maintenance trains fitted with ETCS need to be able to approach and enter the engineering area, undertake work and then depart the area to ETCS-fitted lines.

3.16.1.4 To tackle the different issues, 3 different sub-scenarios have been identified:

- Scenario 1: Movements to the working area
- Scenario 2: Movements inside working area
- Scenario 3: Departure from the working area

3.16.1.5 In the following paragraphs, the use of SM (available in onboard SV 3.0) is not considered because further operational investigation about the use of this mode for working area management is necessary.

3.16.2 Scenario 1: Movements to the working area

3.16.2.1 When moving to reach the working area, the use of an MA (OS or FS) rather than SR depends on the features of the RBC and its relationship with the IXL considering that the piece of line where working activities have to take place is in possession. This could prevent the IXL from setting a route and the RBC from providing an MA.

3.16.2.2 When moving to reach the working area, in case an MA cannot be issued by the RBC (route not available), the override procedure should be considered.

3.16.2.3 When moving to reach the working area in SR mode, clause 4.11.1.3 should be considered.

3.16.2.4 In case other coaches/vehicles need to be pushed when leaving the last station to reach the working area, SH can be used.

3.16.2.4.1 Note: The use of SH has the advantage that a European Instruction 1 from signaller is not necessary unless BG with info "danger if in SH" are used.

3.16.3 Scenario 2: Movements inside working area

3.16.3.1 In this paragraph, the case of a train awakening inside the working area with position different from valid is not considered because the maintenance train is supposed to reach the working area with the ETCS on-board system powered on.

3.16.3.2 During engineering works, SH mode should be used.

3.16.3.2.1 Note: Inside working area it could be difficult to provide an MA because not all devices could be under control. However, for some specific case (e.g. small maintenance task mainly in only one direction), when the movement to the working area was done with an MA, it may be possible to use FS or OS mode also inside the working area.

3.16.3.2.2 Note: The choice of SH mode allows movements in both directions and to cope with possible unavailability of ETCS trackside equipment (e.g. balises missing).

3.16.3.3 The entry in SH mode can be provided by the RBC through a mode profile when the movement to the working area is done with an MA or, alternatively by driver request once the maintenance train is in front the entry/inside the working area.

3.16.3.4 In case the entry in SH is required by the driver in level 2, the RBC should be properly instructed to authorize SH also when the train is located within the working area.

3.16.3.4.1 Note: The RBC could be configured to authorise SH required by specific NID_ENGINE belonging to maintenance trains, even in case a shunting route or a shunting area is not set for such a train.

3.16.3.5 The use of SH mode implies the need of override procedure in case of presence of a fixed BG with the information Danger for SH.

3.16.3.5.1 Note: Switchable BG are not recommended in L2 but they can prevent from the need to override

3.16.3.5.2 Note: The use of the VBC function is not recommended because it makes the procedure for setting and managing the working area more complex.

3.16.3.5.3 Note: The use of BG with the information Danger for SH to mitigate the risk of working vehicles in SH mode to unduly exit the working area, should be evaluated taking into account that such mitigation is valid only for pulled trains and it makes more complex the working activities due to the possible need of override.

3.16.4 Scenario 3: Departure from the working area

3.16.4.1 When leaving the working area, the use of an MA (OS or FS) rather than SR depends on the features of the RBC and its relationship with the IXL considering that the maintenance train performs a new SoM (after exit SH) in a piece of track which is occupied and in possession (this could prevent the IXL from setting a route and the RBC from providing an MA).

3.16.4.2 When leaving the working area, in case an MA cannot be issued by the RBC (route not available), the override procedure should be considered in case RBC is instructed not to provide an SR authorisation (or providing an SR authorisation with a 0 distance) when required by a train without any route being set.

3.16.4.3 When leaving the working area in SR mode, clause 4.11.1.3 should be considered.

3.17 Rescue of trains by an assisting train

3.17.1 Applicability

3.17.1.1 Recommendations provided in this chapter are valid for a train that is disabled on a line (between stations) equipped with ETCS only, and where the train cannot be moved by itself.

3.17.1.2 The purpose is to assist a disabled train by moving it with an assisting train equipped by ETCS.

3.17.1.3 To tackle the different issues, 2 different sub-scenarios have been identified once the driver has decided that the train needs to be disabled and cannot continue by its own:

1) Scenario 1: Movements of the assisting train to the disabled train
2) Scenario 2: Departure once the disabled train has been joined to the assisting train

3.17.1.4 In the following paragraphs, the use of SM (available in onboard SV 3.0) is not considered because further operational investigation about the use of this mode for an assisting train is necessary.

3.17.2 Scenario 1: Movements of the assisting train to the disabled train

3.17.2.1 The use of an MA (OS), rather than SR depends on the feature of the RBC and its relationship with the IXL, as well as operational rules. It needs to be taken into consideration that the train occupies the line, and may prevent the system from being able to make a route to reach the disabled train.

3.17.2.2 Before setting an on-sight route to the track section where the disabled train is located, the original route and the MA for the disabled train need to be removed. Furthermore, the signaller needs to ensure that the both drivers (of the assisting train and the disabled train) are informed that the assisting train is entering the occupied section.

3.17.2.3 Note: It may be necessary to instruct the driver of the disabled train to perform an EoM, in order to allow the assisting train to move with an MA.

3.17.2.4 In case the RBC cannot issue an MA due to route unavailability, override procedures should be considered.

3.17.2.5 In case SR mode is used, clause 4.11.1.3 should be considered.

3.17.2.6 When the assisting train has reached the disabled train, the driver will control the train according to Railway Undertaking procedures to ensure safe joining and coupling of trains.

3.17.3 Scenario 2: Departure once the disabled train has been joined to the assisting train

3.17.3.1 The use of an MA (OS), rather than SR depends on the feature of the RBC and its relationship with the IXL, considering that the train occupies the line, and may prevent the system from being able to make a route from the line block.

3.17.3.2 In case an MA cannot be issued by the RBC (route not available), the override procedure should be considered in case RBC is instructed not to provide an SR authorisation (or providing an SR authorisation with a 0 distance) when required by a train without any route being set. In case SR modce is used, clause 4.11.1.3 should be considered.

3.18 Management of a block section occupied due to a train detection system failure

3.18.1 Applicability

3.18.1.1 Recommendations provided in this chapter are affected by the functions the interlocking can provide to manage degraded scenarios and by the type of train detection system (track circuits and axles counter).

3.18.2 Track section occupied due to a failure

3.18.2.1 In case of track section occupied due to failure of a train detection system, OS mode should be used according to the information provided by the interlocking or the legacy signalling system.

3.18.2.2 FS mode could be used once the track is free and the relevant interlocking reset command, when present, succeeds to move the signal (luminous or ETCS MB) to a “proceed” aspect.

3.18.2.2.1 Note: For axle counting detection systems this is usually the case of the error in the counting of entering/exiting axles.

3.18.2.2.2 Note: It is out of scope of this guideline to provide the operational procedure that the signaller will follow to use the interlocking reset command.

3.18.2.3 In case the interlocking reset command fails or if it is not present, override should be used to pass the signal at danger and a furher transition to OS should be done, if possible, to cross the part of the track occupied because of the failure.

3.18.2.3.1 Note: For axle counting detection systems this is usually the case of an electric failure of the axle counter.

3.18.2.3.2 Note: The use of OS mode ensures a higher level of safety compared to SR mode following the override procedure (e.g. LX protection through packet 88).

3.18.2.4 In case the interlocking reset command has failed or if it is not present, but a train has already swept the piece of track which was occupied due to a failure, and in case the interlocking has an additional command or the trackside CCS implements a logic which considers the “sweep train”, FS mode should be used.

3.18.2.4.1 Note: It is out of scope of this guideline to provide the operational procedure the signaller will follow to use the possible additional interlocking command.

3.18.2.4.2 Note: For axle counting detection systems, in case the following axle counter can reset an erroneous counting of the previous counter, only the first train will be affected by the possible restrictions.

3.19 Running at caution

3.19.1.1 Many operational situations require the driver to operate a train at a lower speed than allowed by infrastructure because there are non-railway obstacles in or nearby the track:

- Animals
- Suspicion of broken rail
- Trees on the track
- Landslip

3.19.1.2 In these situations, even if the track is free of railway vehicles (the signalling system could transmit an FS MA), it is needed for the driver to drive cautiously at least to check if the track can be safely operated.

3.19.1.3 European Instruction 6 is the expected way of warning the driver of such a need.

3.19.1.4 Setting a speed restriction for the area to be inspected is a technical option.

3.19.1.5 Transmitting an OS mode profile can be an option to restrict the speed of the train and instruct the driver to look outside. The signaller could also close the signal, to force the driver to use override and switch to SR mode.

3.19.1.6 Independently of the retained solution, the need to inform the driver on what type of obstacle it is looking for, the start and end of movement under restriction etc remains.

3.20 Speed limits below degraded mode speeds

3.20.1.1 In degraded or unsupervised modes (e.g. SR or SH mode), the driver could not always be informed about applicable speed restrictions in the DMI. In case a speed restriction is above or equal to the allowed speed in degraded mode, there is no need to inform the driver additionally. But in case a speed restriction is below the allowed speed in degraded mode, the driver should be informed by European Instruction 5.

3.20.1.2 The use of TSR packet from balises is possible for mode SR, but it doesn't work for SH mode. If the function "inhibition of revocable TSRs from balises in L2/3" is used for other reasons, this could conflict.

3.20.1.2.1 Note: The guideline Balise Engineering for L2 and L3 [21] 4.13.4.2 does not recommend the use of Packet 64.

3.20.1.2.2 Note: For temporary speed restrictions a European Instruction 5 could be given to inform the driver. However, this is very time consuming when a speed restriction will be active for a long time.

3.20.1.2.3 Note: For permanent speed restrictions, the route book could give information to the driver. However, this is not seen as a good solution because it could lead to mistakes, e.g. wrong speed, wrong location, not aware of speed restriction.

3.20.1.3 Under class B, the driver would be informed by lineside speed panels. For ERTMS, there are no harmonised speed panels defined and only non-harmonised speed panels could be used.

3.20.1.4 As not all scenarios can be covered by ETCS, final decision remains to IM, taking into consideration the human factor.

3.21 Train standstill condition

3.21.1.1 In some situations, the trackside system may need some information from the on-board about being at standstill or about moving after standstill (i.e. departing). For example, for releasing routes with train on it, releasing overlaps, before setting an opposite route to join trains or for departure detection to close level crossings.

3.21.1.1.1 Note: For on-boards not implementing enhancement CR1363 "Standstill report to trackside" (introduced in SV 3.0) or not running on a X=3 trackside, standstill is not explicitly reported. However, the trackside system could derive the information from the position report.

3.21.1.2 Position reports are sent for several reasons, e.g. when passing BG, at standstill (based on SUBSET-026 [3] 3.6.5.1.4), cyclically and together with, for example, an MA request, so RBC receives reports with “random” intervals between subsequent reports.

3.21.1.3 Based on observed on-board behaviour, the RBC should consider the following additional conditions in order to detect when a position report indicates that a train is at standstill:

- V_TRAIN is rounded by the on-board to an accuracy of 5 km/h. Since there is no rounding rule defined in the specification, different on-board behaviour needs to be expected.
- On-boards report V_TRAIN = 0 km/h while positions change, mainly at stopping and departing. In this case the train is actually moving. By using 2 consecutive position reports this could be detected.
- On-boards report V_TRAIN = 0 km/h while positions (estimated front end and/or doubt-over/doubt-under values) are slightly changed. The train is assumed to be standing still. By using a small margin, e.g. 1 meter, availability problems could be avoided.
- On-boards report in 2 consecutive position reports V_TRAIN = 5 km/h while the positions are the same within 1 second, because onboard in a moving train sends the same position report twice (still fulfilling SUBSET-041 [14] 5.3.1.3). By using 2 position report only with a minimum time (some seconds at least) in between, this risk the train is still moving could be avoided.
- On-boards report in 2 consecutive position reports V_TRAIN = 5 km/h while the positions are the same with more than 1 second in between. The train is assumed to be standing still. This could be avoided by also accepting V_TRAIN = 5 km/h when the positions are the same.

3.21.1.4 Other checks can be implemented to detect if a train is at standstill, based on the specific line conditions.

3.22 European Instructions

3.22.1 Using text message to transmit European Instruction 7

3.22.1.1 If all the conditions listed below are fulfilled, a text message could be used to transmit a European Instruction 7, so that additional verbal communication is not necessary. Additional technical mitigations should be considered to mitigate the fact that there are no safety requirements for the plain text message.

3.22.1.2 The overall issuing and transmission process of an authorisation to start in SR via ETCS text message must be safeguarded by the underlying technical system. The following elements must as a minimum be respected:

- That the signalling conditions for issuing the authorisation are met (route set and secured, etc.)

- That the authorisation is addressed to the correct train, standing on the defined track and scheduled for a particular route.
- That the list of balises allowed to be passed in SR have been transmitted to the train.
- That the message is received at the right time

3.22.1.2.1 Note: In addition, Packet 72 could include an end condition for the display of the text message so that the message is removed when the ETCS mode is changed to SR. The Packet 72 could also require the text message to be acknowledged by the driver

3.22.1.2.2 The header of European Instruction 7 ("European Instruction 7 – Authorisation to start after preparing a movement") shall be also transmitted.

3.22.1.3 If the instruction to start in SR needs to be withdrawn (since it is not possible to delete a text message already sent),, this will be done by means of a European Instruction 3 "Obligation to remain at standstill"

3.22.1.4 A technical mitigation should be to remove the list of balise groups which could be passed in SR.

4. Engineering rules coming from ETCS system design

4.1 Balise Engineering

4.1.1.1 See guideline Balise Engineering for L2 and L3 [21].

4.2 EOA, Release Speed, SvL and overlap

4.2.1 Minimum distance between EOA and danger point

4.2.1.1 When designing a track layout, a minimum distance between EOA and the closest safety relevant device (point, LX, etc) has to be applied. IMs apply different minimum distances, among others, the following arguments are used to define the distance to danger point:

- Braking distance from Release Speed
- Possibility to have simultaneous train movements in a station
- National system constraints

4.2.1.1.1 Note: The distance to target shown in the DMI can differ between the target bar and the planning area as the distances are based on different criteria. The criteria are related to among others the odometer inaccuracy and distance to danger point/SvL. If the distance to danger point/SvL is short and/or the odometer inaccuracy is large there is an increased possibility that different distances are shown in the DMI.

4.2.2 Relation between EOA, SvL and Release Speed

4.2.2.1 There are two types of Release Speed, a fixed Release Speed, given by the trackside, that is applicable for a certain location, or the onboard can be instructed to calculate the Release Speed.

4.2.2.2 In case of fixed Release Speed, it is the responsibility of the IM to set the appropriate Release Speed with regard to the risk of passing the SvL, while in case of an onboard calculated Release Speed, the IM cannot be responsible for stopping the train in rear of the SvL.

4.2.2.3 Most IMs apply fixed Release Speeds, that depend on the distance between EOA and the location to be protected. Common practice is that the closer the EOA is to the location to be protected, the lower is the Release Speed.

4.2.2.3.1 Note: Common practice is that the fixed Release Speed is no higher than 40 km/h, and when the distance between the EOA and the location to be protected is less than 100 meters, the fixed Release Speed is no higher than 20 km/h.

4.2.2.4 The fixed Release Speed could also be adjusted by the RBC according to whether the train is a passenger or freight train, which is known by the RBC through the validated Train Data (NC_TRAIN), taking into account safety and driveability aspects.

4.2.2.5 Generally, the following engineering is usually applied by IMs: if no IXL overlap is applied, the SvL is at the same place as the EOA, but if IXL overlap is applied, the SvL is shifted from the EOA.

4.2.3 Overlap functionality

4.2.3.1 Overlap functionality is used to avoid an accident if a train would pass the EOA.

4.2.3.1.1 Note: There are two types of overlap functionality (IXL and ETCS).

4.2.3.2 IXL overlap can be used to prove that a section of the line remains unoccupied while a train approaches the EOA,

4.2.3.3 In some countries, the IXL overlap is released after expiration of a timer, which could depend on the track section length.

4.2.3.4 In other countries the IXL overlap is released after detection of train at standstill.

4.2.3.5 It is recommended to release the IXL overlap after the detection of train at standstill (see 3.21) and not to wait for the expiration of the IXL timer.

4.2.3.6 It is recommended to engineer the timers so that the timer for the IXL overlap does not elapse before the timer for the ETCS overlap.

4.2.3.7 ETCS overlap is used to adapt the SvL and Release Speed after expiration of the ETCS overlap timer/detection of standstill.

4.2.3.8 The ETCS overlap timer can also be used to lower or to revoke the Release Speed after standstill, even if the ETCS overlap and danger point distances are not used.

4.3 Accuracy of infrastructure data

4.3.1 Introduction

4.3.1.1 There is no defined requirement for the accuracy of ETCS infrastructure data. Generally accepted accuracies are within ±1m for longitudinal (x-axis) measurements.

4.3.1.1.1 Note: The use of ERTMS/ATO (available in B4, SV2.2) on a line can require greater accuracies to be used and needs to be considered based on user requirements.

4.3.1.2 Lateral (y-axis) measurements for balises placement, are often a factor of 10 better than that of the longitudinal accuracies however the accuracy needs to be considered based on its use case.

4.3.1.3 During data collection systematic cumulative errors should be reduced.

4.3.2 Gradients Segmentation

4.3.2.1 See guideline Gradients segmentation [29].

4.3.3 Position report accuracy

4.3.3.1 The on-board odometry system measures the distance since the last power-on. The EVC uses this measured distance to report the train position from the LRBG to the RBC using a certain Q_SCALE value, possibly leading to rounding the distance up or down. As long as the confidence window fulfil the performance requirements from SUBSET-041 [14], the Q_SCALE value used by the on-board can be chosen from 10 cm, 1m or 10m.

4.3.3.2 The reported position is used by the trackside in several functions. For example, functions that use the position to send information to the train. Some functions only use the LRBG as reference, other functions use the distance information including confidence interval information, e.g. shifted MA, link list, track description.

4.3.3.3 When sending location information to the onboard, the RBC has also a choice to use a certain Q_SCALE value. A mismatch between the Q_SCALE value used by on-board and by trackside could lead to issues. A known issue is described in the guideline Start of Mission in L2 and L3 (B3) [5], i.e. clauses 3.1.1.4/3.1.1.5 about missing track description by using another Q_SCALE value leading to non-acceptance of an MA.

4.3.3.4 It is recommended that the IMs agree on the use of Q_SCALE value with the RBC supplier to avoid issues.

4.4 System version management between B2 trackside and B3 on-board

4.4.1.1 See guideline B2 trackside for B3 trains [30].

4.5 ATAF

4.5.1.1 See guideline Automatic Track Ahead Free (B3) [24].

4.6 Allocation of train categories

4.6.1 Introduction

4.6.1.1 The performance of the railway can be maximised by using a variety of speed profiles depending on the different types of trains operating on the route.

4.6.1.2 The following variables are used to categorise the trains:

- NC_TRAIN: It indicates the brake setting of the train (Passenger, Freight train braked in “P” position, Freight train braked in “G” position)
- NC_CDTRAIN: It indicates the Cant Deficiency Train Category
- M_AXLELOADCAT: It indicates the Axle load category
- M_LOADINGGAUGE: It indicates loading gauge profile

4.6.1.2.1 Note: NC_CDTRAIN is independent of the type of train and is based on the trains physical and mechanical properties to negotiate a curve.

4.6.1.3 The rules for the categorisation of the infrastructure and the definition of static speed profiles are developed by each Infrastructure Manager in conjunction with the Railway Undertakings.

4.6.1.4 When ETCS is being implementing in an existing infrastructure, a mapping table should be established between the current legacy train categorisations and the

ETCS categories ensuring the best performances while not exceeding the infrastructure safety margin.

4.6.1.5 RBC should only send the SSP corresponding to the category of the train received from the on-board.

4.6.1.5.1 Note: The recommendation above aims to avoid the demand of using on-board function when equivalent trackside function can be used instead in L2 applications, targeting the future goal of simplifying on-board specification.

4.6.1.6 If it is necessary to allow circulation on the line of special trains that exceed the train category limits, e.g. loading gauge and axle load, RBC could send a minimum SSP that the driver will have to respect in addition to the procedural speed restrictions.

4.7 Stop a train or shorten MA

4.7.1 Introduction

4.7.1.1 There are different needs to shorten an MA or even to force the stopping of a train.

4.7.1.2 There may be reasons in the IXL e.g. there is a route violation, flank protection loss or a revocation of the route. Depending on the current position of the train there is an immediate stop or a stop ahead of a certain location needed.

4.7.1.3 There may be operational desires to re-route a train or change the schedule of trains where it is only needed to shorten the MA (if possible) to be able to apply the new schedules. To trip a train in this situation does not seem appropriate and should be avoided.

4.7.1.4 There may be reasons to immediately stop all trains inside an area. As well there might be a need to stop just a specific train.

4.7.1.5 There may be reasons to immediately stop a train which reports specific data (e.g. train with MA reporting unknown position or position outside L2, position in FS or OS outside the route, not expected mode in L2).

4.7.1.6 There may be reasons to immediately stop a train which has not accepted an MA shortenings or conditional emergency stops.

4.7.1.7 There may be reasons from peripheral systems to stop a train. Some of them request only a stop if the train is still able to stop ahead of this point. Examples of peripheral systems are:

- tunnel alarm
- rescue station
- landslide detection
- falling cars detection.

4.7.1.8 There may be reasons to do a check if the correct train has entered the next track section. In case it is the wrong train, the train should be stopped.

4.7.1.9 SUBSET-026 [3] offers different technical solutions to shorten an MA or stop a train. These solutions are described in the next subchapters. Depending on the reason to do the MA shortening or ordering a stop, there are preferred technical solutions.

4.7.2 Use of CES

4.7.2.1 The CES is sent to a train instructing it to stop or attempt to stop at a given location unless the train has already passed the location.

4.7.2.2 In case the train is already beyond the CES location, the train will not accept the CES and retain its old EOA/LOA. Means the CES function does not guarantee in any case that a train is immediately stopped or stopped at all.

4.7.2.3 The following use cases can preferably request the use of the CES function in order to stop the train only when necessarily:

- to check if the MA was assigned to the correct train (e.g. as part of guideline Automatic Track Ahead Free (B3) [24] in Chapter 4.5)
- to check if a section occupation is caused by the train itself (e.g. to detect flank protection).

4.7.3 Use of UES

4.7.3.1 The UES is sent to a train instructing it to stop immediately. The train will change to mode Trip. The train will not be able to move until the UES is revoked.

4.7.3.2 According to 3.6.2.2.2.3 of SUBSET-026 [3], an on-board implementing CR1086 (included into specification starting from B3R2) will accept a UES sent by the RBC with the NID_LRBG = "unknown" if the last position provided by the on-board was reported as unknown or invalid during SoM procedure.

4.7.3.3 An on-board, even if implementing CR1086 (included into specification starting from B3R2), will not accept a UES sent by the RBC with the NID_LRBG="unknown" if it had previously reported a valid position but referring to a NID_LRBG not known to the RBC because the time window from clause 3.6.2.2.2.3 of SUBSET-026 [3] does not apply. It is therefore recommended that the RBC should not send a UES with NID_LRBG = “unknown”.

4.7.3.3.1 Note: If CR1086 is not implemented, the onboard behaviour could be different from the expected one.

4.7.3.4 The following use cases can preferably request the use of the UES function:

- to stop a train in case the system detects an unsafe element inside the already occupied section of the train.
- to stop a train which has not accepted or answered to CES messages.
- to stop a train in Mode SR, if connected to the RBC.

4.7.4 Use of Co-operative shortening

4.7.4.1 The Co-operative MA shortening is a replacement MA which is offered to the train. It is only accepted if the train can comply with the new proposed EOA. It is therefore ensured that the MA shortening (and route revocation) is only triggered if the train is still able to stop ahead of the new proposed EOA.

4.7.4.2 A request to shorten the MA which is granted by the on-board allows the trackside to revoke the route without timer since the train has given the confirmation that this track section will not be used.

4.7.4.3 The request to shorten MA needs to include a proposed shortened MA with an EOA closer to the train than the current EOA/LOA (see SUBSET-026 [3] 3.8.6.1).

4.7.4.4 The following use cases can preferably request the use of the co-operative shortening function:

- to stop a train based on operational reasons (e.g. faster route releasing compared to interlocking in case of route revocation);
- to stop a train ahead of a tunnel or at an evacuation location but only in case the train is still able to stop there.

4.7.5 Use of MA shortening

4.7.5.1 The MA shortening is a replacement MA which is sent to the train. It may lead to a brake intervention if the train is already on the approach to the new EOA/LOA and may even lead to a trip in case the train overpasses its new EOA/LOA.

4.7.5.2 The following use cases can preferably request the use of the MA shortening:

- route revocation;
- to stop a train when an obstacle is detected in a subsequent route or its protection (see Figure 6);
- during a joining process, when the first train has come to a stop.

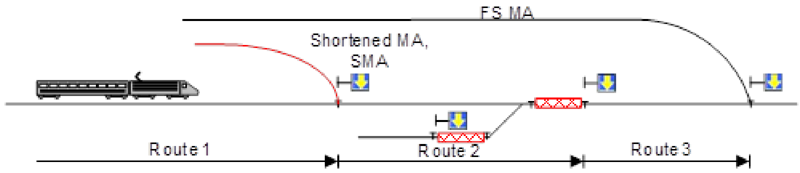

Figure 6: MA shortening when an obstacle is detected in a subsequent route or its protection

4.7.6 Use of TSR with 0 km/h

4.7.6.1 When a TSR with 0 km/h is used to stop a train, the on-board still keeps the existing MA. If the train is already inside or close to the TSR, the on-board will brake, but the train will not change to mode Trip (as long as the train does not overpass the EOA/LOA). In this case, the recovery after an emergency stop is easier compared to the use of CES or UES, as there is no change to mode Post Trip.

4.7.6.2 The TSR with 0 km/h configured in the RBC allows the signaller the immediate activation when required. A prerequisite for this is that the RBC will update the MA immediately after the activation of the TSR.

4.7.6.3 When using TSR with 0 km/h to stop a train, the length of the TSR should be long enough to avoid the risk that the train overpasses the end of the TSR, since then the train would be again free to move forward. Therefore, the length of the TSR needs to take into consideration the line speed.

4.7.6.4 If possible, the starting point of the TSR should be selected at a Marker Board in advance of the train in case there is a need for the driver to be able to specify the location of the train in the communication with the signaller.

4.7.6.4.1 Note: The only way to allow a train to start again after having stopped due to a TSR is to revoke the TSR itself.

4.7.6.5 The following use cases can preferably request the use of the TSR with 0 km/h to stop a train:

- based on specific temporary emergencies from the TMS or signaller (e.g. presence of people or animals along the track)
- when temporary moving signals in rear e.g. due to track maintenance
- in case of alarm provided by HAB detection (see also 3.15 above)

4.8 MA extension

4.8.1 Conditions to give MA

4.8.1.1 When the RBC is issuing a new FS/OS MA to a train for a certain track section, the RBC should check if already an FS/OS MA for the same track section was sent to another train in the same or opposite driving direction and if the other train has already left this track section.

4.8.1.2 When the RBC is issuing a new FS MA to a train for a certain distance, it should be ensured that the relevant distance is not occupied.

4.8.1.2.1 Note: For OS MA this check cannot be done, because the train detection information might not be available.

4.8.1.2.2 Note: For certain tracks with joining/splitting trains in stations the checks described in 4.8.1.1 and 4.8.1.2 may fail.

4.8.1.3 If one point belonging to an already set route, in advance of the train, is no more in control, then the RBC should try to stop the train before passing the point (e.g. using CES, UES, cooperative shortening of MA).

4.8.1.4 In degraded situation (e.g. interlocking or ETCS failure), the signaller is fully responsible to allow trains to enter a track section by operational rules (e.g. issue a European Instruction to the driver or set an auxiliary signal).

4.8.1.5 When setting auxiliary signals, the interlocking does not check all criteria for setting a locked route. (e.g. track section is free, points are in correct position and locked, flank protection is provided).

4.8.1.6 If the signaller ignores one of the operational rules for degraded situations, accidents could happen.

4.8.1.7 Additional technical checks in degraded situations done by the RBC could improve the safety level of overall railway system. These additional RBC checks should not replace operational rules or interlocking functions.

4.8.2 T_MAR settings

4.8.2.1 The engineering rules for a country/project should establish whether there is an operational need for the MA request from an ERTMS/ETCS on-board to be used to trigger an MA extension or an external function.

4.8.2.2 Where the MA request is to be solely used to trigger the issue of an extended MA then the engineering rules should detail whether a single value of T_MAR is to be used (and state the required value) or whether the value needs to vary according to the current MA issued to the train.

4.8.2.3 In establishing the value of T_MAR used for extension of the MA, consideration should be given to the likely transmission and processing time from the request being generated in the ERTMS/ETCS on-board to the updated MA being received and processed by the ERTMS/ETCS on-board. The value should also consider whether train drivers will begin to respond to the planning area showing that the train is approaching the indication point and increase the value of T_MAR to reduce the likely impact on train performance of driver anticipation.

4.8.2.4 The following elements should be considered in order to define T_MAR:

- The communication time between EVC and RBC (both ways), see SUBSET-041 [14] for related constraints
- The IXL route setting time
- The RBC processing time for building the MA
- The EVC elaboration time

4.8.2.5 Where the MA request is used to trigger an external function, the engineering rules should consider:

- the time to be allowed for that function to operate
- the system to undertake any proving of necessary conditions
- the MA to be updated

4.8.2.5.1 Note: An example of an external function that is triggered by an MA request is LX activation (see guideline Handling of Level Crossings with Baseline 3 [15]).

4.8.3 MA Request and Position Report parameters on a level 2 line

4.8.3.1 If the behaviour of the RBC relies on the reception of a specific position report or the reception of an MA Request, the non-reception of certain position reports or MA Request could lead to a deadlock of the system. As an ERTMS/ETCS on-board will consider a message to have been sent even if the safe communication is lost at the moment of transmission of the message (see clause 3.5.4.5 of SUBSET-026 [3]), there is no way for the trackside to determine whether the message was lost or not transmitted. To prevent the deadlock situation, ETCS provides two set of parameters which can be transmitted by the RBC:

- MA Request parameters
- Position report parameters

4.8.3.2 These two sets of parameters are stored by the ERTMS/ETCS on-board until it goes to NP mode (see section 4.10 of SUBSET-026 [3]) or level 1 (see section 4.9 of SUBSET-026 [3]), which means that

- if the train did not go to NP mode and did not enter level 1 before entering a new level 2 line, the train will use the previously received parameters, if they are not overwritten
- if the train went to NP mode or entered level 1 before entering a new level 2 line, the train will use the Fixed Value Data (see SUBSET-026 [3], appendix 3.1), if they are not overwritten

4.8.3.3 It is recommended that RBC transmits Position Report and MA Request parameters applicable on the level 2 line as soon as the session is established with an ERTMS/ETCS on-board, even if the needed parameters are the default ones (see appendix A.3.1 and clause 3.6.5.1.4 of SUBSET-026 [3]). This should be done in the following session establishment situations (at minimum):

- Start of mission
- Level transitions
- RBC/RBC Hand-overs
- Exit of a radio hole

4.8.4 MA request with no session established

4.8.4.1 If a train has saved MA Request Parameters that disables the repetition of MA Request (T_CYCRQST = 255), the train may reach a deadlock situation if there are issues with the communication session when the train needs to send the MA Request. This situation may occur, e.g. when entering a level 2 area, or when performing SoM, or during an RBC/RBC handover.

4.8.4.2 If there is an issue with the communication session at the time the train needs to send the MA Request, the RBC may not receive the MA Request and may therefore not send an MA to the train. However, since the train will follow the saved MA Request Parameters, if the repetition of MA Request is disabled in the saved MA Request Parameters, the train will not send a new MA Request even if the RBC does not send an MA to the train.

4.8.4.3 Therefore, if the RBC relies on the reception of an MA Request message before sending an MA to the train (e.g. in a degraded situation), the RBC should always make sure to send the appropriate MA Request Parameters as soon as the communication with the on-board has been established, to ensure that the train does not rely on saved MA Request Parameters that prohibits it from sending repeated MA Requests to the RBC.

4.9 T_NVCONTACT & T_SECTIONTIMER dimensioning

4.9.1.1 Monitoring of radio communication vitality is necessary for ensuring the safety in L2 and in L1 when radio in-fill is used. Expiration of T_NVCONTACT timer or T_SECTIONTIMER (due to safe radio connection lost) triggers safety reaction (service brake or train trip).

4.9.1.2 Chosen option (T_NVCONTACT / T_SECTIONTIMER) and timer settings (values of T_NVCONTACT, T_SECTIONTIMER, M_NVCONTACT and D_SECTIONTIMERSTOPLOC) should cover possible risks depending on possible operational scenarios. Relevant interlocking algorithms (e.g. revocation of operational unpassed train route, loss of route conditions, managing level crossing in advance of the train front end, etc.) should consider the timeout value and arising possible delay of safety reaction.

4.9.1.3 Some recommendations concerning T_NVCONTACT dimensioning are provided by SUBSET-093 [20]. CR1146 should also be considered as it is included in ERA/OPI/2020-2 [25].

4.9.1.4 If a lower timeout value than "Connection status" timer for safe radio connection indication value (see SUBSET-026 [3], Appendix A.3.1) is used, a safety reaction due to loss of connection may occur without indicating a loss of connection to the driver.

4.9.1.5 T_NVCONTACT timer is reset by reception of every message. Therefore, to ensure that safety related message is received by the train before T_NVCONTACT is reset (in case of malfunctioning radio modem/poor radio coverage), it is recommended that requirements on the RBC are added to ensure that no non-safety related message is sent to the train when an emergency message or shortened MA has been sent but not yet acknowledged.

4.9.1.6 GSM-R QoS parameters should be in accordance with used T_NVCONTACT / T_SECTIONTIMER timeout value. Otherwise, undesirable braking due to timer expiration may occur.

4.10 SSP engineering in specific situations

4.10.1.1 Track limitations, like curves, require defining speed restrictions. Based on the applicable speed restrictions in a route, the static speed profile (SSP) is defined and send to the onboard together with the authorisation to move. The onboard uses its train length (if train length delay is applicable) and maximum vehicle speed to create the dynamic speed profile to be supervised and shown to the driver.

4.10.1.2 A static speed profile can start at every location and the driver is informed continuously. So, it is possible to implement a speed profile change exactly at the location of a required speed restriction. To gain as much as possible capacity it is recommended to implement speed profile changes exactly at the start and end of a track limitations (e.g. the location of the point in case of diverted route).

4.10.1.3 When speed restrictions are close to each other, it could occur that due to braking curve distances an increase of speed is not really possible to be followed, i.e. there is no time for acceleration. It could also be that a speed increase is barely shown to the driver or even not allowed. For ergonomic reasons (e.g. to manage planning area information), a minimum length of section with higher speed in an SSP could be considered to smoothen the speed profile shown to the driver.

4.10.1.4 However, if train lengths differ on the line, smoothening could impact capacity unnecessarily (e.g. short trains may be able to follow a speed increase that only long trains could not). Therefore, it is recommended to be careful in the engineering when smoothening an SSP. In addition, as the onboard itself also "smoothens" the speed profile by considering the train length, it could be that there is no need to smoothen the SSP.

4.10.1.5 When engineering consecutive speed restrictions, one of them could be hidden for the driver by the other due to braking curves. The onboard correctly supervises all speed restrictions, thus from safety point there is no reason to prevent such situations.

4.10.1.6 A speed restriction should be applied for a train passing over 2 consecutive failed HAB detectors, with one of the failed HAB detector outside the ETCS area, but without impacting all the trains passing over the failed detector inside the ETCS area (see Figure 7).

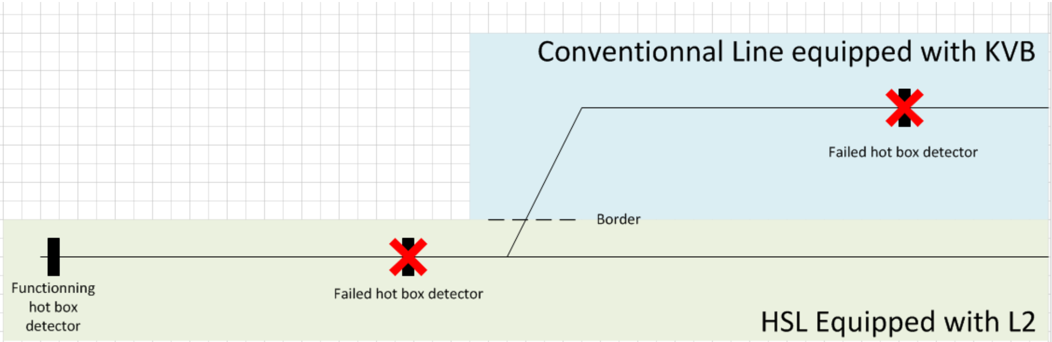

Figure 7: Two consecutive failed HAB detectors

4.11 Use of National Values

4.11.1.1 National Values are variables in the ERTMS/ETCS language that are defined per region or country (see SUBSET-026 [3] 3.18.2.2 and 3.18.2.3) to allow ETCS to be implemented according to national safety/performance rules (which depend on the legacy constraints, especially when overlaying/using legacy lineside signals) such as specific speeds in degraded modes or parameters linked to operational rules. The use of National Values makes the implementation of ERTMS/ETCS more flexible and the migration from class B train protection systems to ERTMS/ETCS is easier.

4.11.1.2 On specific tracks where different train behaviour is required, it is possible to change National Values to adapt the on-board behaviour. An example is the increase of the maximum shunting speeds in yards or the change of the speed in SR to cope with long distances to be run in degraded mode (other examples can be found in other chapters of this guideline).

4.11.1.3 When the driver is allowed to increase SR speed, the last value entered by the driver prevails over the National Values (4.4.11.1.6.3 of SUBSET-026 [3]) unless additional override procedure is required (e.g. to pass a Stop signal in SR), in which case the National Values prevails (4.4.11.1.6.5 of SUBSET-026 [3]).

4.12 Consecutive mode profiles

4.12.1.1 The usage of consecutive mode profiles for 2 different modes in one packet 80, where the mode profiles do not overlap (in compliance with SUBSET-040 [28] 4.2.4.6) but the acknowledgment areas do, could lead to unexpected behaviour if not engineered correctly. Such overlap between acknowledgment areas is compliant to SUBSET-026 [3].

4.12.1.1.1 Note: An example of unexpected behaviour that could occur when the acknowledgement area of a 2nd mode profile lies in rear of the start of the acknowledgement area of the 1st mode profile: the first acknowledgement by the driver will change the mode to the associated mode profile, i.e. the 2nd mode profile. In case the 2nd mode profile is SH mode profile an End of Mission is performed which deletes any other mode profile. In case of an OS/LS mode profile and in case that the 2nd mode profile is not yet acknowledged after passing the start of the acknowledgement area of the 1st mode profile, it is unknown which acknowledgement area will be displayed.

4.12.1.2 If using consecutive mode profiles for 2 different modes in one packet 80, the start of the two acknowledgement areas (as defined by the length of the acknowledgement area in rear of start of the respective required mode) should not be at the same location. The start of the acknowledgement areas should be in the order of the start of the related mode profiles.

4.12.1.3 A shunting mode profile should never be followed by another mode profile, because after switching to SH mode the EoM is performed and the MA and mode profiles are deleted.

4.12.1.3.1 Note: Because the behaviour of the DMI for B2 on-board is not defined, special attention due to unspecified behaviours should be paid in case more than one acknowledgment request could be activated at the same time/location. For B3 on-board, the FiFo principle is applicable and the behaviour of the DMI is therefore known.

4.12.1.3.2 Note: It is also possible that an acknowledgement area for a mode profile and an acknowledgement area for a level transition are engineered at the same location. CR1166, included in ERA/OPI/2020-2 [25], solves this issue by removing the need to acknowledge the level transition from level NTC to level 1 or 2.

4.13 Hybrid Train Detection

4.13.1.1 See guideline Hybrid Train Detection engineering [32].

4.14 Minimal block length in relation to start of Release speed monitoring

4.14.1.1 It is recommended to engineer a block length before the EOA that is longer than the distance between the EOA and the start of the RSM. The advantage is that, when ERTMS/ETCS on-board enters the RMS, the first MB the driver is going to meet will correspond to the EOA he/she needs to respect. If the recommendation above cannot be implemented, the driver should rely on the information on the DMI to identify the MB he/she needs to stop in front of.

4.14.1.2 The distance between the start of RSM and the EOA depends on multiple parameters, among others:

- The value of the release speed;
- The distance between the EOA and SvL;
- The slope in approach to the EOA;
- The braking parameters and length of the train
- The EBCL value or integrated correction factors;
- Whether speed inaccuracy compensation is active;
- The location of repositioning BG's.

4.14.1.3 With the inputs in 4.14.1.2, the ETCS braking model can be used to determine the distance between the start of RSM and the EOA. A worst-case train and/or location can be considered to determine a suitable block length.

4.14.1.4 In general, the following can be stated about the effects of the parameters in 4.14.1.2 on the start of RSM.

- The biggest effect on the start of RSM is the Release Speed value itself when Release Speed is sent from trackside.
- For low Release Speed values (15 km/h or lower), nearly all parameters have a negligible effect on the start of RSM. Except for BG engineering and speed inaccuracy compensation.
- Repositioning BG engineering has a significant effect on the start of RSM for all Release Speed values.
- The larger the distance is between the EOA and the SvL, the smaller the distance will be between the beginning of the RSM and the EOA.

4.14.1.4.1 Note: In case of Release Speed of 10 km/h, up to slopes of -5 ‰ and with a BG at a maximum of 300 m from the EOA, a minimal block length of 100 m allows to avoid having more than one MB before the location the driver needs to stop.

4.15 Short OS/LS/SH mode profiles

4.15.1.1 In B3MR1 and B3R2 it is not clearly defined if the onboard shall change to the requested mode in case a mode profile (OS, LS or SH) is received and the max safe front end of the train has already passed the end of this mode profile, see Figure 8. This could occur when using short mode profiles. See SUBSET-113 [31], hazard ETCS-H0074 for possible mitigations for trains not implementing CR1274 (error correction included in B4).

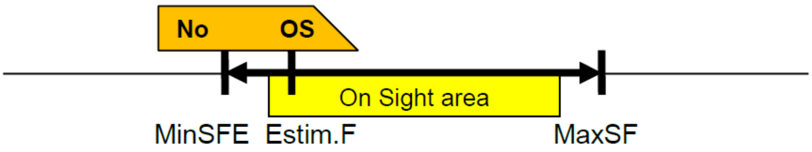

Figure 8: Short mode profile

4.15.1.1.1 Note: CR1274 defines that the mode will change even if one of the front ends (min, estimated, max) is still inside the given mode profile. This behaviour could have impact on trackside designs, i.e. for the location of the end/beginning of mode profile in relation to safety and/or operation and if CR1274 is implemented or not in the onboards. This is applicable for both cases, if it was assumed that the mode is not changed when the max safe front already passed the mode profile and if it was assumed that the mode is changed when the min safe front end is still in the mode profile.

4.16 Key Management

4.16.1 Extension Key Request Function

4.16.1.1 See guideline Extension Key Request Function [36].

5. Marker Boards

5.1 Introduction

5.1.1.1 Marker Boards are used to provide information to the driver related to specific operational needs in a dedicated area or location. Marker Boards are used in addition to ETCS trackside engineering rules.

5.1.1.2 See the Engineering rules for harmonised marker boards [33].

5.1.1.3 In addition, there might be non-harmonised Marker Boards used for specific situations not covered by the harmonised Marker Boards.

5.2 LX MB indication and location

5.2.1.1 At the moment there is no harmonized LX MB in TSI CCS 2023 [23].

5.2.1.1.1 Note: prEN 16494 [34], which is referred in TSI CCS 2023 [23], is in the process of being updated, and the intention is to introduce a harmonised LX Marker Board in this updated version. This MB should be used to indicate where a train should stop/reduce speed before the level crossing in case of LX failure or unprotected LX.

5.3 MB with reduced size

5.3.1.1 As far as prEN 16494 [34] is respected, there is a possibility to reduce the MB size in specific scenarios, e.g. in tunnels with limited space.

5.4 Location of MBs and BGs relative to operational stopping points

5.4.1.1 The Marker Board should always be located at the same location or at maximum 10-15 meters in advance of the operational stopping point to allow the driver to be able to read the signal id.

5.4.1.2 If a BG is associated to the Marker Board and provides the information Stop if in SR, the BG should always be located in advance of the operational stopping point.

5.4.1.2.1 Note: It may be necessary to use switchable balises when providing the information Stop if in SR. However, the use of switchable BG should not be recommended in L2 unless B2 on-boards are allowed to operate on the track (for more details see guideline Start of Mission in L2 and L3 (B3) [5]).