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
72. LEVEL TRANSITION FROM LEVEL STM TO LEVEL 1   Follow up of ERA Guideline ERA_ERTMS_040058 V1.0
Ref: EUG_17E113   Version: 2.0   Date: 10/11/2020

Modification history

Version	Date	Modification / Description	Editor
0.A	29/06/15	Guideline taken over by EUG Added System version matrix	A. Bossy
0.B	25/01/16	Added system version management	A. Bossy
0.C	12/12/16	Rework after review from ProRail, RSSB and Infrabel	A. Bossy
0.D	12/10/17	Reword after review from RFI and RSSB	A. Bossy
0.E	13/11/17	Update reference to SUB026 6.6.3.2.3 in requirement 4.2.19.2	G. Ridolfi
1.0	27/11/17	Finalization	D.Cuesta
1.1	10/08/2020	Added issue of odometric error for max/min safe front end-based supervisions	A. Bossy
2.0	10/11/2020	Second final version	A. Joos

Table of Contents

1 Introduction

1.1 Foreword

1.1.1.1 This document is the follow-up of ERA Guideline ERA_ERTMS_040058 V1.0. This ERA guideline is the base for this guideline, but some extra information was added by the ESG, following the publication of baseline 3 of ETCS. Some slight differences can also be found due do extra review by the ESG members.

1.1.1.2 The procedure for level transitions is defined technically in chapter 5 of the SRS (see [SS026] and [SS108]) and operationally the harmonized ETCS rules apply (see [OPE]) in addition to national rules. The procedures possible for transitions from level STM to level 1 are very flexible and currently there are many different ERTMS implementations dealing with this issue.

1.1.1.3 The aim of this document is to define a set of recommended trackside solutions for the engineering of transitions from level STM to an ETCS system version 1.Y area only equipped for level 1 for the benefit of future ERTMS projects. The objective is to support an efficient and safe implementation of ERTMS, both from a technical and operational point, simplifying and harmonising future system implementations taking advantage of the experience obtained from projects already in operation.

1.2 Scope and Field of Application

1.2.1.1 This document is based on ERTMS/ETCS Baseline 2 and applicable for transitions from an area only equipped with ETCS level STM to an area only equipped with ETCS Level 1.

1.2.1.2 Some ERTMS functions, controls or information are considered out of scope of this document because they are not directly related to the transition procedure:

- The route suitability check in rear of a level 1 area depends on many local issues such as national procedures, national rules, type of unsuitability, geographical location of the unsuitability and places to stop trains if not suitable. Thus, the route suitability function is considered out of scope for this document.

- Track conditions information is considered as general information to be sent to the train independent of the transition and thus out of scope for this document.

1.2.1.3 Preventing trains that are not fitted with ERTMS/ETCS onboard equipment from entering the ETCS Level 1 area is out of the scope for this document.

1.2.1.4 It is strongly recommended that any entity using ERTMS/ETCS follows the recommendations defined in this document.

1.3 Applicable system versions

1.1.1.1 Table 1 describes which trackside and onboard system versions are managed by this guideline. It also describes in which guidelines other system version combinations are managed.

	Trackside System Version	
Onboard System Version	1.Y	2.Y
1.Y	This guideline	To be defined
2.Y		To be defined

Table 1: System version management

1.1.1.2   This guideline is applicable for a trackside where system version is 1.Y.

1.1.1.3   However; this guideline takes into consideration the following onboard systems:

– Onboard system with pure system version 1.Y (i.e.: they are not fitted with any other system version)

– Onboard system supporting version 1.Y and 2.Y, with active system version 1.Y or 2.Y when approaching the level transition.

1.4   Definitions

1.4.1.1   ETCS approach area: The area in rear of the ETCS border where balise groups are located to realize the transition to ETCS Level 1

1.4.1.2   ETCS area: The area in between ETCS borders with infrastructure for trains running in ETCS levels 1, 2 or 3

1.4.1.3   ETCS border: The location where the ETCS level is changed

1.4.1.4   On-sight route: A locked route which is not unambiguously detected free

1.5   Document structure

1.5.1.1   Chapter 1 introduces the document and defines the scope.

1.5.1.2   Chapter 2 provides references, terms and abbreviations used in this document.

1.5.1.3   Chapter 3 provides the general functional steps for transition to level 1.

1.5.1.4   Chapter 4 provides the issues to be considered.

1.5.1.5   Chapter 5 provides the recommendations for each functional step and further details for some of the issues identified in chapter 4.

2   References and Abbreviations

2.1   Abbreviations

Abbreviation	Description
ATP	Automatic Train Protection (national systems)
BG	Balise Group
DMI	Driver Machine Interface
EoA	End of Authority
FS	Full Supervision (ETCS mode)
L1	ERTMS/ETCS Level 1
LRBG	Last Relevant Balise Group
LSTM	ERTMS/ETCS Level STM
LTC	Balise group for Level Transition Cancellation
LTO	Balise group for Level Transition Order
MA	Movement Authority
OS	On-sight (ETCS mode)
P	Packet, e.g. P41 is ETCS packet 41
SoM	Start-of-Mission; procedure for start-up of an ERTMS/ETCS train
STM	Specific Transmission Module (for national ATP systems)
SvL	Supervised Location
SVO-LTA	Balise group for System Version Order and Level Transition Announcement
TSR	Temporary Speed Restriction

2.2   References

2.2.1.1   The following documents and versions apply:

Ref. N°	Document Reference	Title	Version
[OPE]	TSI OPE Annex A	Annex A, TSI OPE, 2012/464/EC, ERTMS Rules and Principles	2
[SS026]	SUBSET-026	ERTMS/ETCS Class 1 System Requirements Specification	2.3.0

Ref. N°	Document Reference	Title	Version
[SS041]	SUBSET-041	Performance Requirements for Interoperability	2.1.0
[SS108]	SUBSET-108	Interoperability-related consolidation on TSI annex A documents	1.2.0
[SS026-B3]	SUBSET-026	ERTMS/ETCS Class 1 System Requirements Specification	3.4.0 or higher
[BCA]	EUG_UNISIG_BCA	Backward Compatibility Analysis	1.0.0 or higher (the one appropriate for [SS026-B3].
[ERA_GL1]	ERA_ERTMS_040058_V1.0	Guideline transition from LSTM to L1	1.0
[SS-113]	SUBSET-113	Report from UNISIG Hazard Log	1.3.0

3 Transition from level STM to level 1

3.1 Introduction

3.1.1.1 This chapter intends to give a general overview of how to perform a transition from level STM to level 1 and can be used as a reference for the issues discussed in chapter 4. The track layout and sequence diagram presented here are further detailed in chapter 5, e.g. with alternative solutions as applicable for each functional step.

3.2 Functional Steps

3.2.1.1 In order to facilitate the recommendations detailed in chapter 5, the transition to ETCS Level 1 is divided into the following functional steps:

0) Downgrade to system version 1.Y

1) Level 1 announcement

2) Level 1 transition

3.2.1.2 Note: although functional step 0 and 1 occur at the same time, they are explained separately to aid understanding.

3.3 General Track Layout

3.3.1.1 The following drawing shows the general and relevant track design and balise groups needed to perform the functional steps of the transition from level STM to level 1 listed in paragraph 3.2.1.1.
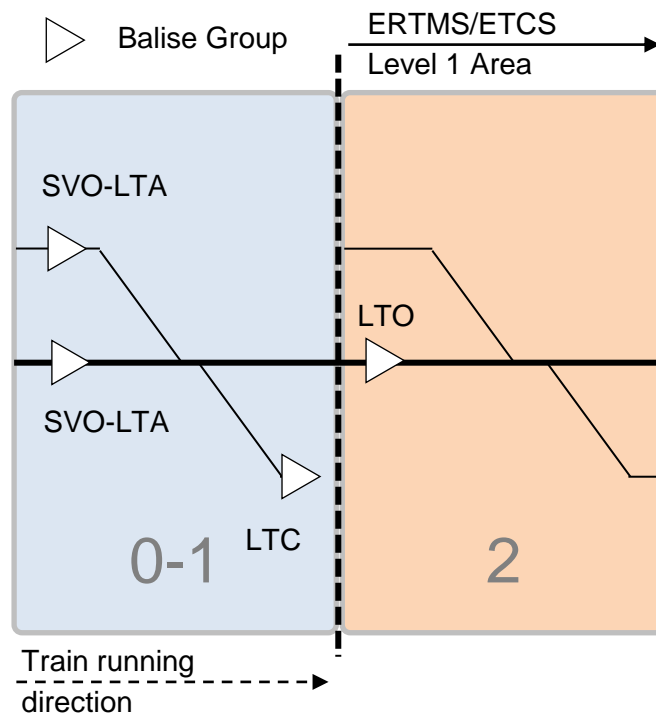

Figure 1: Generic track layout for transition from LSTM to L1

3.3.1.2   There are intentionally no optical signals or marker boards shown in the figures as they are not relevant for the transition procedure as such from a technical point of view. Optical signals and marker boards are useful for degraded situations related to level transition, as described in [OPE].

3.3.1.3   The train approaching the ETCS border needs to get a Movement Authority and track description before or at the border; otherwise it will be tripped when making the transition to level 1. This information can be given either together with the announcement or at the border or in a balise group in between. These options are detailed in sections 5.1 and 5.3.

3.3.1.4   The table below represents the balise groups and information (in ETCS packets) recommended for each functional step to succeed with a transition from level STM to level 1. Optional and alternative balise groups and packets will be suggested in chapter 5.

BG	BG DESCRIPTION	BG INFORMATION (ETCS PACKETS)
SVO-LTA	System version order Level Transition Announcement	Mandatory: Packet 41: Level Transition Order announcing the coming transition to level 1 at the ETCS border Optional: Packet 2: System Version order, to enforce the onboard to use a given system, version. Recommended : Packet 12: Level 1 Movement Authority (together with applicable packets)
LTC	Level Transition Cancellation	Mandatory: Packet 41: Level Transition Order with immediate transition to the level applicable in that area; this cancels the announced transition to level 1
LTO	Level Transition Order	Mandatory: Packet 41: Level Transition Order (with immediate transition to level 1) Packet 12: Level 1 Movement Authority (together with applicable packets) Optional : Packet 2: System Version order, to enforce the onboard to use a given system, version.

Table 2: Balise groups for transition from LSTM to L1

3.3.1.5   The information in the balise groups in the figures is only valid in the indicated train running direction, unless defined otherwise.

3.3.1.6   Balise group SVO-LTA has two goals:

- Enforcing the system version to be used if necessary
- Announce the level transition

3.3.1.7   Enforcing the system version is not always necessary and depends on project decision (see **Error! Reference source not found.** and CR757). The enforced system version has to be amongst the legal ones (1.0 or 1.1 depending on the one to be used on the line). No specific distance or time has to be taken into account except for the one necessary to read the balise group, as the system version change shall be immediate. It is then possible to transmit the packet 2 together with the packet 41.

3.3.1.8   Announcing the transition to level 1 is not required by the ERTMS/ETCS SRS [SS026] and using this is a project decision. However, there are advantages in informing the driver in advance and if specifying an acknowledgement window; see [SS026] 5.10.4 it allows for more time than 5 seconds to acknowledge the level transition by permitting the acknowledgement to be made prior to the transition occurring .

3.3.1.9   Balise group LTC is needed for cancelling a level transition order in case there are diverging tracks between the SVO-LTA and the ETCS border. Alternatively, the LTC can be left out if the SVO-LTA has a switchable balise with the transition announcement depending on route locking; this is elaborated in 5.2.2.8 and 5.2.2.9. In that case, the SVO-LTA balise group may also send Level 1 Movement Authority to the train.

3.3.1.10   Balise group LTO is located at the ETCS border; it orders the immediate transition to ETCS Level 1 and provides a Level 1 MA with linking (optional) and track description.

3.4 General Sequence Diagram

3.4.1.1 The following sequence diagram shows the relevant information that is exchanged between the main actors when performing the transition to ETCS Level 1 according to the functional steps listed in 3.2.1.1 above.

3.4.1.2 On Figure 2, functional steps 0 and 1 occur in parallel as the packet 2 and 41 are transmitted together by balise group SVO-LTA. As the two functions are not correlated to make the analysis clearer, they are explained separately.
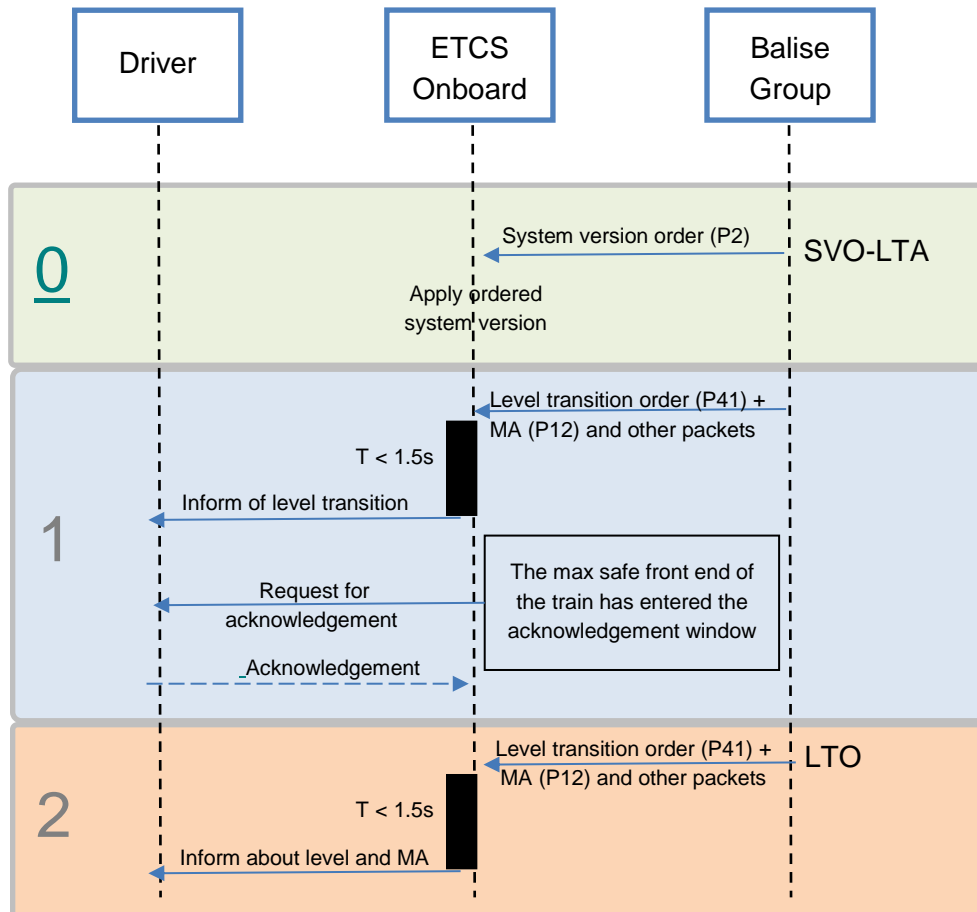
Figure 2: General sequence diagram for transition from LSTM to L1

3.4.1.3 T is the time needed by the ERTMS/ETCS onboard equipment to process the information received from a balise group before presenting it on the DMI according to [SS041] 5.2.1.3.

3.4.1.4 The arrow for driver acknowledgement is 'dashed' as it does not influence the level transition (it will take place also without the driver acknowledging it). The driver can acknowledge before the level transition is executed (from the location specified in the transition announcement) or at latest 5 seconds after the transition (see [SS026] 5.10.4.2); i.e. in step 1 or 2.

4 Issues to be addressed

4.1 Introduction

4.1.1.1 This chapter lists issues that need to be considered for the transition from level STM to level 1 and some of them are further detailed in the recommendations given in chapter 5. The issues that are not part of the recommendations are mentioned here because projects could still need to consider them.

4.2 Issues

4.2.1 Entry location determination

4.2.1.1 For a successful announcement of the transition to ETCS Level 1, it is essential that the trackside system is able to determine at which ETCS border location an approaching train will enter. It is also necessary to determine the entry location if providing the L1 Movement Authority already in rear the border. This issue depends on the track layout in the area in rear of the ETCS border and is considered in section 5.2.1.8.

4.2.2 First entering train determination

4.2.2.1 For a safe transition to ETCS Level 1, it is essential that there is no other train entering at that border location. This must cover multiple track occupations by vehicles on the approach to the ETCS border; e.g. when driving on-sight or splitting trains before the border.

4.2.2.2 This issue is in principle solved by the fact that a train should not receive an authorization from a balise group unless this is safe. This is an issue for the interlocking system and not further considered in chapter 5.

4.2.2.3 Note that in case the replacement of the authorization depends on track detection being located far from the balise group, measures have to be taken to avoid that a following train may receive the same authorization as a preceding train.

4.2.3 Loss of route protection in the route from the ETCS border

4.2.3.1 There must be a safe reaction in case one or more conditions supervised to protect the route in advance of the ETCS border fail; e.g. due to unexpected track occupations.

4.2.3.2 The system that detects the loss of route protection is responsible for taking action to resolve the hazardous situation for an affected train, e.g. by changing the authorization from balise groups as controlled by the interlocking. As this has an impact on the Movement Authority, this issue is considered in section 5.3.1.

4.2.4 Manual cancellation of the route from the ETCS border

4.2.4.1 In case the route from the ETCS border is cancelled manually for operational purposes (e.g. for preferred vehicle movements, change of departure sequence, etc.), an already given authorization must be revoked.

4.2.4.2 To cover for the case of a lost balise message in the balise group at the border, a Movement Authority given to a train outside the ETCS area with EoA inside the ETCS

area can be limited in time by specifying a section timeout for the MA. If the timeout expires the train will shorten the MA to the location of the border. The section timeout must be defined considering the operational needs.

4.2.4.3 This issue has no direct impact on the transition procedure and is not further considered in chapter 5.

4.2.5 Avoid contradiction between line side and cab signalling

4.2.5.1 Unclear or overlapping responsibilities of two signalling systems can give different and contradicting signalling information to the driver. This could be caused by different delays, different signalling principles (e.g. speed signalling / distance to go), different track information, different odometers, etc.

4.2.5.2 This issue is avoided by synchronization of the involved signalling systems or a clear split of responsibility at the ETCS border.

4.2.5.3 This issue has no impact on the transition procedure and is not further considered in chapter 5.

4.2.6 Authorisation across the ETCS border

4.2.6.1 The authorisation for the train to pass the ETCS border is the responsibility of the national system; this is a project issue and therefore not considered in chapter 5.

4.2.7 Allow level transition at line speed

4.2.7.1 Trains approaching the ETCS area should not face speed restrictions caused by the transition procedure to ETCS Level 1, e.g. limitations in length of movement authority.

4.2.7.2 When the conditions in the Level 1 area allows it, the underlying signalling system has to provide proceed information to the level 1 trackside system being long enough to avoid ETCS braking until reaching the next balise group with MA extension.

4.2.7.3 This is not further considered in chapter 5 as each project must decide for which situations the level transition should be possible at line speed and make the additional provisions for that.

4.2.7.4 Note that this is partly an engineering issue for the first blocks in the ETCS area as the speed monitoring in the ERTMS/ETCS onboard may be more restrictive than for the national system area. Thus, it might not be possible to approach the ETCS border at the line speed allowed in that area unless the first block section in the ETCS area is long enough to avoid an immediate brake intervention after making the transition to level 1.

4.2.8 Allow transition with On-sight route to and/or from the ETCS border

4.2.8.1 The possibility for a train to approach the ETCS border in an On-sight route on a track which is not detected clear may cause problems for determining if it is the correct train that enters the ETCS area.

4.2.8.2 Considerations for approaching the ETCS border in an On-sight route are further detailed in section 5.3.1.

4.2.8.3   For an On-sight route from the ETCS border, the driver could be requested to acknowledge both the OS mode and the level transition at the same time. This is avoided by announcing the level transition with a distance in rear of the border where the driver is requested to acknowledge the transition; i.e. by separating the requests in time as mentioned in 5.2.1.6.

4.2.8.4   For an On-sight route starting shortly in advance of the border, there is a risk that the train will be braked after the transition to level 1 due to the onboard supervising the start of the OS mode profile as EoA/SvL. As it may not be possible to move the start of the On-sight route/area further from the border, this can instead be solved by engineering the start of the OS profile at the ETCS border, but then the national system or national rules must consider this in the authorisation for passing the ETCS border. This issue is not further considered in chapter 5.

4.2.9   Avoid transition announcements for diverging trains

4.2.9.1   Vehicles moving in the ETCS approach area should not receive a level transition announcement (which has to be displayed to the driver) or be forced to make a level transition unless they are routed to the ETCS border. This issue is considered in section 5.2.1.

4.2.9.2   Note that the announcement is optional, but if the announcement is given in a fixed balise group then it must be cancelled for a diverging train before the level transition is performed onboard and preferably before the driver is requested to acknowledge the level transition.

4.2.9.3   This problem can be avoided if using a switchable balise to announce the level transition only if the train is routed towards the ETCS border.

4.2.10   Driver acknowledgement of level transition

4.2.10.1   The driver will be requested to acknowledge the transition to level 1, except if the onboard is in non-leading (NL) mode. This request to acknowledge can appear either at a certain distance in rear of the border (if specified in the level transition announcement) or when switching level at the border.

4.2.10.2   The distance in rear of the border can be seen as a certain time before making the transition considering the applicable line speed; the level transition announcement must be transmitted in rear of the required acknowledgement distance/time, considering the required processing time of the level transition announcement. If the driver is not required to acknowledge in rear of the border, the distance is set to zero.

4.2.10.3   When requested to acknowledge the driver should do so at latest 5 seconds after making the transition, as otherwise the train will be braked; see [SS026] 5.10.4.2.

4.2.10.4   This issue is considered in section 5.2.1 together with the announcement, i.e. in step 1, even if the driver acknowledgement may be done in step 2.

4.2.11   Start of mission in rear of the ETCS border

4.2.11.1   ERTMS/ETCS trains always have the possibility to perform start-of-mission in the area before the ETCS border, but the selection of ETCS level(s) and national systems is limited by a table of priority of trackside supported levels if available onboard the train. This table

is assumed to contain only the applicable level and hence the train is assumed to start in level STM in rear of the ETCS border.

4.2.11.2　As the start-up location may have impact on receiving a transition announcement, this issue is further considered in section 5.2.2.7.

4.2.12　Avoid displaying "Entry in FS/OS" to the drivers

4.2.12.1　This issue depends on the fact that the ETCS onboard does not have track description for the full length of the train. It can be solved by giving the track description from a location in rear of the border considering the longest train expected to enter at this border location.

4.2.12.2　This issue is further considered in chapter 5.2.1. But there is no general solution as it depends on the actual track layout. For the onboard to accept the track description, the transition to L1 must be announced before or together with the track description.

4.2.12.3　Note that the display of "Entry in FS/OS" is not limited to the level transition and in level 1 it will also appear after start-of-mission.

4.2.13　Minimize the use of switchable balises

4.2.13.1　The use of switchable balises should be minimized due to the extra costs, e.g. for cabling, compared with a fixed balise. But, for level 1 they cannot be completely avoided even if it is possible to engineer this level transition without switchable balises in rear of the ETCS border. Therefore, this is not further discussed in chapter 5.

4.2.14　Minimize the size of the ETCS approach area

4.2.14.1　For the transition to ETCS Level 1, the approach area is between the transition announcement and the level border.

4.2.14.2　There are only two relevant parameters for this issue; the time given for the driver to acknowledge the level transition at the applicable line speed and the maximum train length if requested to avoid displaying "Entry in FS/OS" to the driver. The optimal size of the approach area is project specific and therefore not further discussed in chapter 5.

4.2.15　Management of TSRs in the area in advance of the ETCS border

4.2.15.1　The systems on both sides of the ETCS border must be aware of speed restrictions having an impact on the train speeds. It is always possible to transmit TSRs to ETCS onboard from balise groups after announcing the level transition. Note that braking curves may differ between ETCS and the national ATP.

4.2.15.2　This has no impact on the transition procedure and is not further considered in chapter 5.

4.2.16　Management of National Values

4.2.16.1　The ERTMS/ETCS train that enters the ETCS area should have the correct National values stored onboard. This can be achieved by transmitting them from a balise group and is noted in section 5.4.1.3.

4.2.17 Avoid transition to Trip mode at the ETCS border

4.2.17.1 When announcing a level transition, the train will make the transition to level 1 after travelling the indicated distance to the ETCS border; then, if it has no Movement Authority it will change to Trip mode.

4.2.17.2 This can be avoided either by giving MA when announcing the level transition or by engineering the announced distance so that the train makes the transition when reading the border balise group which also gives the relevant MA.

4.2.17.3 This issue is further considered in section 5.2.1.

4.2.17.4 Note that harmonized operational rules for degraded situations related to level transitions are available in [OPE].

4.2.18 Manual level selection in rear of the ETCS border

4.2.18.1 The train driver may manually select level when the train is at standstill. In case the L1 MA is given in rear of the border and level 1 is available for manual selection (in the table of trackside supported levels or with no table onboard), the driver could change to level 1 already in rear of the border and use the MA in the transition buffer to move in the level STM area.

4.2.18.2 This is potentially unsafe, and it is advised to start in level STM close to the ETCS border for operational reasons because the train is in the national ATP area and should apply the operational rules for that area.

4.2.18.3 This issue is avoided either by not giving the L1 MA in rear of the border or by updating the table of trackside supported levels with a Packet 46 Conditional Level Transition Order not including level 1 in a balise group in rear of the SVO-LTA balise group (assuming that the SVO-LTA announces the transition and gives MA).

4.2.18.4 Note that Packet 46 should not be read from balises after a train has received an announcement by Packet 41, because this may cancel the announcement as the onboard behaviour is unclear on this in ERTMS/ETCS Baseline 2.

4.2.18.5 This issue is considered for the option when a L1 MA is provided together with the level transition announcement as described in 5.2.1.10.

4.2.19 Ensure the operating system version onboard the train is 1.Y

4.2.19.1 If the level 1 line could also accept train fitted with baseline 3 onboard, in addition to baseline 2 trains, it could be necessary to force the downgrade of the system version of the train to system version 1.Y.

4.2.19.2 The determination to downgrade the SV shall be made on the analysis of the behaviour of a baseline 3 train when on operating system version 1.Y described in chapters 6.6.2 and 6.6.3.2.3 (concerning national values) of [SS026-B3].

4.2.19.3 This issue is addressed in chapter 5.1.

4.2.20   Transmit extra information to only Baseline 3 trains

4.2.20.1   If the line fitted with ETCS L1 could accept trains fitted with baseline 3 onboard, it can be necessary or wanted to transmit extra information applicable only to train supporting system version 1.1 (specific track conditions...).

4.2.20.2   This information shall be transmitted with balise groups using system version 1.1.

4.2.20.3   This issue is project specific and will not be detailed in this document.

4.2.21   Ensure correct operation of baseline 3 trains

4.2.21.1   Some error correction or enhancement can introduce slight differences in the behaviours of baseline 3 trains compared to baseline 2 trains. Mitigation measures to avoid interoperability problems are described in [BCA].

4.2.21.2   As this depends on the functions implemented in the level 1 area, and this guideline only focuses on the transition, this topic is not managed in this guideline.

4.2.22   Ensure trains use the correct location reference for infill information

4.2.22.1   The change request 1120 was opened to raise an ambiguity in the subset-026 (from version 2.3.0d to 3.6.0). It explains that when a level transition to level 1 is announced to a train in level STM/NTC (or any other level), and the train encounters a balise group containing infill information (P136 and all the packets after this packet), the train could filter only the infill information packet (P136), and accept the other packets after it, using the infill balise group as the reference for all distances in these packets, instead of the one announced by the packet 136.

4.2.22.2   If this information is not overwritten before the transition, for example by passing over another balise group containing the same packets, this could result in:

- an MA shorter than expected;

- a speed decrease announced too soon to the driver

- a speed increase allowed too early

Or any other impact due to a shift in the reference location of infill information.

The hazard is fully described in hazard ETCS-H0081 (see [SS-113]).

4.2.22.3   This problem is addressed at section 5.2.2.3.

4.2.23   Supervision of location-based data in the L1 area when announced from NTC area

4.2.23.1   As no linking is used in NTC area, on a change of LRBG, the train will always subtract the estimated travelled distance between the reference balise group of the location-based data and the new LRBG to the supervised location-based data (see clause 3.6.4.3.b of [SS026]).

4.2.23.2   As a consequence, the supervision of location-based data with maximum safe front end (e.g. SvL, speed reduction) or minimum safe front end (EOA) could be overestimated or underestimated, leading to potential performance (early brake application) or safety impacts (late brake application).

4.2.23.3   This issue is addressed in paragraph 5.4.1.3 of this document.

5 Recommended solutions

5.1 Downgrade to system version 1.Y

5.1.1 Basic considerations

5.1.1.1 Functional step 0 is about the process to downgrade to the system version 1.Y before announcing the level transition to level 1.

5.1.1.2 The following issues from chapter 4 must be considered in this functional step:

- Ensure the operating system version onboard the train is 1.Y (§4.2.19);

5.1.1.3 The recommendation is to have at least one balise group downgrading to the system version 1.Y.

5.1.1.4 It is recommended to use fixed balise groups to downgrade to the system version 1.Y.

5.1.2 Track layout

5.1.2.1 The need for balise groups in this functional step highly depends on the track layout. The enforcement of the system version can be done independently of diverging routes.

5.1.2.2 If there is a diverging route between the balise group downgrading the system version to 1.Y and the level transition announcement, there is no impact on operations:

- If the diverging route leads to an area with system version 2.Y, system version 2.Y will automatically be activated on reading the first balise group with system version 2.Y or on connecting to the RBC (see [SSS026-B3] 3.17.2.3 and 3.17.2.8).
- If the diverging route leads to line equipped with system version 1.Y, the operated system version will already be 1.Y.
- If the diverging route leads to an NTC area, the system version is not relevant: the behaviour of the STM interface is not changed if the onboard changes its operated system version.

5.1.2.3 The downgrade of the system version to 1.Y is operated in advance of level transition announcement to ensure the correct interpretation of information.

5.1.2.4 The SVO-LTA balise group shall use system version 1.1 in the header as it is the only minor 1.Y system version allowing the use of packet 2 (packet 2 being introduced starting from [SS02-B3]). Using M_VERSION 2.Y in the header of the telegrams is to be avoided as the level 1 line can also be operated by baseline 2 trains. Even if the trains won't be tripped as they are in STM / NTC level at this location, it is highly recommended to keep the same system version in the header and the packet 2 (1.Y). Actually, even if the use of packet 2 should prevail over the system version inside the header of the balise telegram, [SS026-B3] does not clearly states that §3.17.2.5 prevails over §3.17.2.3. However, change request 1306 fixes this problem, and clearly specifies it :

*3.17.2.5: Once a balise group message has been received, if one of the telegrams forming the message (i.e. a telegram which is not ignored as per a clause referred to in the column "Telegram" of the Table 17) includes an order to operate system version which would not be ignored as per a clause referred to in the column "Individual information" of the Table 17, **the on-board equipment shall immediately operate the system version number X given in the order, regardless of the clauses 3.17.2.3 and 3.17.2.6**. After the order*

is executed, the clauses 3.17.2.3 and 3.17.2.6 shall again apply for any further received balise group/loop message or any further contacted RIU.
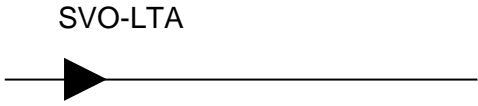
TRACK LAYOUT	BG	DESCRIPTION	BG INFORMATION
SVO-LTA	SVO-LTA	System Version Order – Level Transition Announcement	Packet 2: System Version order with appropriate M_VERSION (1.Y). *Reminder :* *Packet 41 is also included in the balise group. See functional step 1.*

Table 3 : Balise group used for functional step 0

5.1.3 Sequence diagram
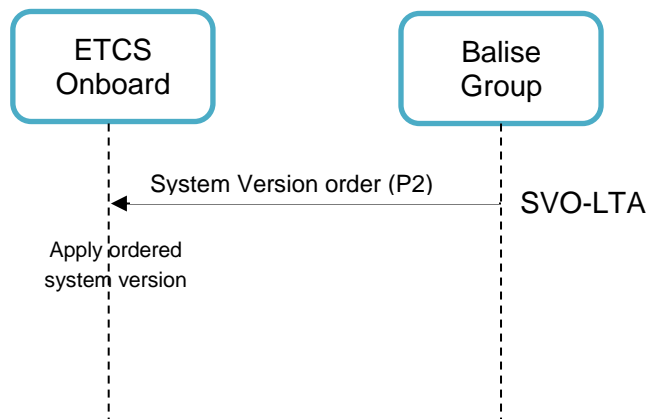
Figure 3: Sequence diagram for functional step 0

5.1.3.1 No system delays and no system distances were identified to have any implication on the system behaviour, as the change of system version has to be immediate (see § 3.17.2.5 of [SS026].

5.1.4 Alternative solution

5.1.4.1 No alternative situation was identified.

5.1.5 Degraded situation

5.1.5.1 This functional step has the following degraded situation:

1. Failure to read SVO-LTA.

5.1.5.2 This could result in a misinterpretation of the S.V = 1.Y information inside the level 1 area. If the packet 2 is added to the SVO-LTA balise group, it is highly recommended to also

add it in the LTO balise group, so that redundancy is also achieved for the functional step 0.

5.2 Level 1 Announcement

5.2.1 Basic considerations

5.2.1.1 Functional step 1 is about the process to announce the transition to level 1 before passing the ETCS border. It is recommended to announce this level transition even if it is not required in the ERTMS/ETCS SRS (see [SS026] 5.10.1.1).

5.2.1.2 The following issues from chapter 4 must be considered in this functional step:

- Entry location determination (§4.2.1)
- Allow transition with On-sight route to and/or from the ETCS border (§4.2.8)
- Avoid transition announcements for diverging trains (§4.2.9)
- Driver acknowledgement of level transition (§4.2.10)
- Start of mission in rear of the ETCS border (§4.2.11)
- Avoid displaying "Entry in FS/OS" to the driver (§4.2.12)
- Avoid transition to TRIP mode at the ETCS border (§4.2.17)
- Manual level selection in rear of the ETCS border (§4.2.18)

5.2.1.3 The recommendation is to have a balise group SVO-LTA announcing the transition to ETCS Level 1. This has the following benefits:

- The driver is alerted about the upcoming level transition
- Possibility to configure the driver acknowledgement of the level transition to be requested in rear of the ETCS border
- Redundancy for the level transition order at the ETCS border

5.2.1.4 Note that when performing start-of-mission in rear of the border, receiving an announcement depends on the location where the train starts.

5.2.1.5 When announcing the level transition, an additional benefit is that the onboard will accept MA, linking and track description in rear of the border. This gives the possibility to avoid displaying "Entry in FS/OS" to the driver by providing track description, if the distance to the ETCS border is enough for the longest train.

5.2.1.6 The announcement should specify the driver acknowledgement of the level transition to be requested in rear of the border. This has the added benefit that there will be no concurrent requests for driver acknowledgement in case of an On-sight route starting at the border.

5.2.1.7 When using fixed balises for SVO-LTA, depending on the track layout, it may require additional LTC balises for cancellation of the transition order for trains diverging from the ETCS border. Depending on the track layout, it may also be possible to give track description to avoid displaying "Entry in FS/OS" to the driver.

5.2.1.8   In case the SVO-LTA balise group can have a switchable balise, then there are the following independent options:

- The announcement can differ between routes towards the border, thus providing the entry location, avoiding announcements to diverging trains and minimizing the need for cancellation balise groups.
- The announcement can depend on having a route locked from the border.
- To avoid transition to Trip mode at the ETCS border, the SVO-LTA balise group can also provide a Movement Authority to pass this border.
- To avoid displaying "Entry in FS/OS" to the driver, the SVO-LTA balise group can provide route-dependent linking and track description, with or without MA.

5.2.1.9   If providing MA already in rear of the ETCS border, it is recommended to use section timers to limit the possibility to use this MA in case changes to the routes make it invalid, e.g. if new route setting leads the train to divert from the ETCS border. This MA may also need to consider restrictions in the route in rear of the border and the general recommendation on using linking in 5.4.1.2.

5.2.1.10   In case the SVO-LTA provides a L1 MA it could be necessary to have a balise group in rear of the SVO-LTA with a packet 46, Conditional Level Transition Order, to update the table of trackside supported level not listing level 1. This is to prevent the driver from selecting level 1 in rear of the border, but that can also be mitigated by giving the MA with a restrictive speed up to the border; the speed profile should then be given without train length delay to avoid unnecessary braking.

5.2.2   Track layout

5.2.2.1   The need for balises in this functional step depends on the track layout. The level transition can be announced independent of the presence of diverging routes, but then the transition must be cancelled for trains routed away from the border.

5.2.2.2   In case of diverging tracks near the ETCS border, it is recommended to avoid announcing a level transition to trains that will not pass the ETCS border as this may be confusing to the train driver when looking at the DMI. This is achieved by placing the SVO-LTA after the last diverging points; thus, there is no need for any cancellations.

5.2.2.3   It is highly recommended not to install and use infill information between SVO-LTA and LTO. This is to prevent trains impacted by the CR 1120 to use the transmitting BG as location reference for all the packets located after P136, instead of the BG announced by the P136. If it is not possible to do such, the appropriate functional test shall be realized before allowing a train to operate the L1 line.

| TRACK LAYOUT	BG	DESCRIPTION	BG INFORMATION
Option with fixed balises ▶ Fixed balise group ▷ Switchable balise group SVO-LTA D1 LTO SVO-LTA LTC 0-1	SVO-LTA	System Version Order – Level Transition Announcement	Packet 41: Level Transition Order announcing transition to level 1 at the location of the ETCS border Packet 12: Level 1 MA (optional) (together with applicable packets) *Reminder: Contains also Packet 2*
	LTC	Level Transition Cancellation (if needed)	Packet 41: Level Transition Order with immediate transition to the applicable level; this cancels the transition to level 1
Option with switchable balises ▶ Fixed balise group ▷ Switchable balise group SVO-LTA D1 LTO SVO-LTA LTC 0-1	LTO	Level Transition Order	See section 5.3 for details about the content of LTO balise group

Table 4: Balise groups used for functional step 1

5.2.2.4 Note that in the track layout above, the solutions consider the case when the SVO-LTA balise group cannot be placed after the last diverging points as this would be too close to the border for the required time for driver acknowledgement.

5.2.2.5 Balise group SVO-LTA announces the transition to ETCS Level 1. The announcement gives the distance to the level border and the distance in rear of the border where the driver is requested to acknowledge the transition. In case the transition should be performed when reading the LTO balise group, then the level transition order in the SVO-

LTA should announce the transition for a location in advance of the border at the LTO. This is because the ERTMS/ETCS onboard equipment will otherwise make the transition according to the travelled distance of the estimated front end of the train and this depends on the actual accumulated odometer inaccuracy. In that case the announced location must consider the possible accumulated odometer inaccuracy near the border. Optionally, the SVO-LTA balise group is switchable and gives a Movement Authority with linking information and track description; see 5.2.1.8.

5.2.2.6   The parameter for placing the SVO-LTA balise group announcing the level transition is the time given for the driver to acknowledge the level transition before the ETCS border. The minimum distance D1 should be calculated using this time together with the time T from section 5.2.3.1 below and the applicable line speed. In case there are multiple tracks leading to the ETCS border then the distance D1 may need to be calculated for each track based on its own specific speed profile. In case there is need to avoid displaying "Entry in FS/OS" to the driver, then the distance D1 must also consider the longest train operating on this line.

5.2.2.7   Note that if start-of-mission is common in rear of the ETCS border, then this may need to be considered for the location of the SVO-LTA as otherwise the train will not receive the level transition announcement; alternatively, a redundant SVO-LTA can be placed closer to the border at a location fulfilling a distance D1 for a lower speed.

5.2.2.8   Balise group LTC cancels the transition to ETCS Level 1. If needed, the LTC is put in tracks diverging from the route leading to the ETCS border and must be located so that the transition is cancelled before being executed after travelling the announced distance, preferably even before the driver is requested to acknowledge the level transition. Note that this location must also consider the accumulated odometer inaccuracy onboard the train.

5.2.2.9   Balise group LTC is needed when a route to the border can be cancelled after the transition announcement. This applies also if the SVO-LTA giving the announcement is switchable.

5.2.3   Sequence diagram
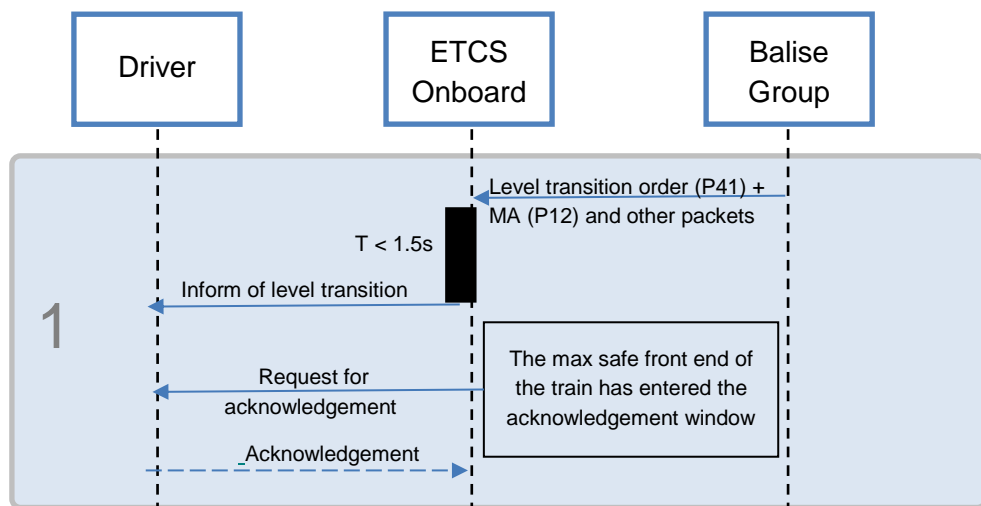
Figure 4: Sequence diagram for step 1

5.2.3.1   T is the time needed by the ERTMS/ETCS onboard equipment to process the information received from the SVO-LTA balise group before presenting it on the driver DMI according to [SS041] 5.2.1.3.

5.2.3.2   Intentionally deleted.

5.2.4   Alternative solution

5.2.4.1   The alternative solution is not having any announcement as it is anyway not required by the ERTMS/ETCS SRS [SS026]. The benefit from this is that:

- there is no announcement for trains diverging from the ETCS border;
- the behaviour is the same after performing start-of-mission at different locations in rear of the border (where announcements could be missed);
- depending on track layout, costs for one or more balise groups can be saved.

5.2.4.2   The disadvantages of not having the announcement are that:

- drivers only have 5 seconds for acknowledgement after the level transition;
- drivers will always see the "Entry in FS/OS" on the DMI;
- there is no redundancy for the level transition order;
- with an On-sight route from the border, the driver will be requested to acknowledge both the level transition and the OS mode at the same time.

5.2.5   Degraded situations

5.2.5.1   This functional step has the following degraded situations:

1. Failure to read the SVO-LTA balise group

2. Failure to read the LTC balise group

5.2.5.2   The consequence of degraded situation 1 is that the train driver will not be informed about the upcoming level transition. This can be mitigated by repeating the information in other balises, but as there is no requirement in the ERTMS/ETCS SRS [SS026] to announce transitions to level 1, the need for this mitigation has to be decided by each specific project.

5.2.5.3   The consequence of degraded situation 2 is that the train will make the level transition after travelling the announced distance and trip if it has no MA. This can be mitigated by repeating the LTC information in other balises or by having the announcement in a switchable balise.

5.3   Level 1 Transition

5.3.1   Basic considerations

5.3.1.1   The following recommendations are related to functional step 2; i.e. the transition to ETCS Level 1.

5.3.1.2   The following issues from chapter 4 must be considered in this functional step:

- Loss of route protection in the route from the ETCS border (§4.2.3)
- Allow transition with On-sight route to and/or from the ETCS border (§4.2.8)

5.3.1.3   It is recommended to use a switchable balise group providing the MA with linking (optional) and track description together with the immediate level transition order to level 1. This has the following advantages:

- The MA can be updated (reduced or extended) depending on changes in route statuses, thus solving the issues of loss of route protection.
- It is possible to approach the ETCS border in On-sight routes and still get a FS MA from the LTO depending on information of the replacement track.
- Trains can start-up at any location in rear of the ETCS border as the MA is given in the LTO balise group.

5.3.1.4   In case the Movement Authority is not available at the ETCS border, then it must be given from a balise group in rear of the border. The alternatives are to give this in the SVO-LTA balise group announcing the level transition or in another balise group in between the announcement and the border.

5.3.2 Track layout

TRACK LAYOUT	BG	DESCRIPTION	BG INFORMATION
ERTMS/ETCS Level 1 Area → LTO 2	LTO	Level Transition Order	Packet 41: Level Transition Order (immediate transition to Level 1) Packet 12: Level 1 MA (together with applicable packets)

Table 5: Balise group used for functional step 2

5.3.2.1   Balise group LTO is switchable and located at the ETCS border; it orders immediate transition to ETCS Level 1 and provides a Level 1 MA with track description and optionally linking and mode profile depending on the actual route status.

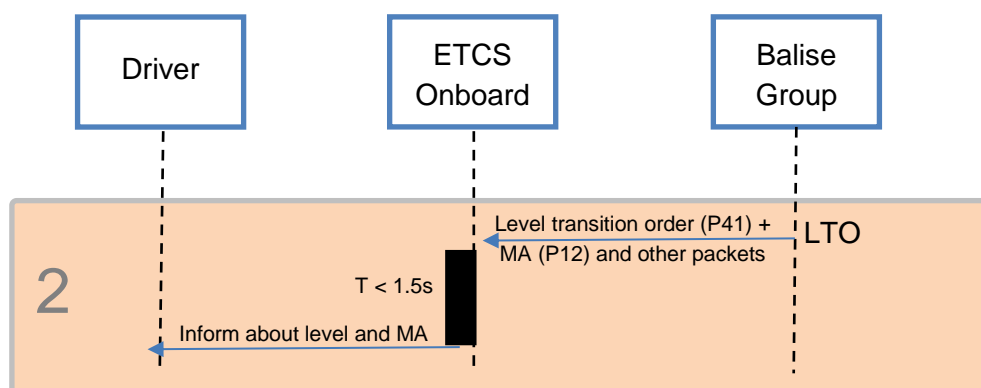### 5.3.3 Sequence diagram

Figure 5: Sequence diagram for step 2

5.3.3.1   T is the time needed by the ERTMS/ETCS onboard equipment to process the information received from the LTO before presenting it on the driver DMI according to [SS041] 5.2.1.3.

5.3.3.2   Note that after the transition to ETCS Level 1, the STM may still have access to the brake system for some time until it is in state Cold Standby and may therefore need access to

information from the national system. As the STM is not in the scope of this guideline, this is not further considered here.

5.3.4 Alternative solution

5.3.4.1 The alternative is to have the LTO as a fixed balise group with only a Level Transition Order. The benefit of this is that the border location can be more flexible as it does not need to be located at a signal.

5.3.4.2 The alternative solution has the following disadvantages:

- the SVO-LTA balise group or an additional balise group between the SVO-LTA and the LTO must be switchable (to be able to give the MA; see also 5.2.1.9);
- there is no possibility to give or update (reduce or extend) the MA in the LTO, thus it is not recommended to stop or perform start-of-mission between balise groups SVO-LTA and LTO as this may lead to using override to be able to enter the level 1 area;
- there is need for additional measures to determine the first entering train and to handle On-sight routes to the ETCS border as otherwise the train may need to continue in OS mode in the first route.

5.3.5 Degraded situations

5.3.5.1 This functional step has the following degraded situation:

1. Failure to read the LTO balise group

5.3.5.2 This may result in that a train can continue in LSTM for some (infinite) distance. An ERTMS/ETCS train shall be in level 1 in a level 1 area, so it is recommended to mitigate this failure by announcing the level transition in the SVO-LTA balise group or by repeating the transition order in another balise group in advance of the border, thus having a redundant solution. It could be partly mitigated by having the balises in the LTO duplicated.

5.3.5.3 Note that this degraded situation may also have impact on the Movement Authority. This is especially important if an MA has been given together with the transition announcement and there is a need to revoke it in the LTO; in this case the LTO should be linked with a restrictive linking reaction which will be applied after the train has executed the level transition. But this is a general engineering issue for balises in a level 1 area and it is not further detailed here.

5.4 General Recommendations for Transition to Level 1

5.4.1 Balises

5.4.1.1 The balise groups in the ETCS approach area must consist of at least two balises for the information in them to be valid in a defined direction.

5.4.1.2 In case there is problem with big metal masses near the ETCS border, this could have an impact on placing of the SVO-LTA balise group.

5.4.1.3 If providing MA in the SVO-LTA balise group, it is recommended to have the LTO balise group and any balise group located between SVO-LTA and LTO marked as linked and included in linking information given together with the MA. This is to have the relocation

of information taken from the transition buffer based on accurate reference locations as the linking is the first information to be used when extracting data from the buffer (see [SS026] 4.8.1.6). It will also reduce the odometric error when entering L1 area.

5.4.2 National Values

5.4.2.1   The ERTMS/ETCS train entering the ETCS area should have the correct National Values stored onboard. The National Values for the level 1 area must be given at the latest at the ETCS border. It may also be necessary to provide another set of National Values in rear of the border, e.g. the time and distance for the validity of using override to pass the ETCS border.

5.4.2.2   If the line could also host baseline 3 trains, national values shall also include the packet 203 (National Values for braking curves) together with the system version 1.0 national values. In this situation, the system version used for the transmitting BG shall be 1.1.

5.4.2.3   Note that if transmitting National Values for the ETCS area in a balise group in rear of the ETCS border, then the National Values may need to be changed if the train moves away from the ETCS area.