ERTMS/ETCS
Dimensioning and Engineering rules
REF : SUBSET-040 ISSUE : 3.4.0 DATE : 16/12/15

Company	Technical Approval	Management approval
ALSTOM		
ANSALDO		
AZD		
BOMBARDIER		
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SIEMENS		
THALES		

1. MODIFICATION HISTORY

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Issue Number Date	Section Number	Modification / Description	Author
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2.0.2 working draft	All	Updates up to and including SG 14.02.2006	Ado
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2.0.4 04/08/06	All	After comments from EEIG	Ado
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2.3.0 7/4/09		Release Version: Document updated to be in line with 2.3.0d plus “DC” CRs 302, 654, 690, 691, 692, 693	HK

Issue Number Date	Section Number	Modification / Description	Author
3.0.1		Updated to CRs 124, 535, 671, 676, 712, 731, 745, 767, 802, 919, 954, 967, 1019 (superseded by CR 767), 1020. Also: 4.2.4.5.1 updated for consistency with Subset-026 Chapter 7; 4.2.4.7.2 amended for consistency with CR 1015; 4.2.4.13, 4.3.2.1.1v) and 4.3.4.3 added in accordance with requirement in CR 413. Chapter 6 added for backward compatibility. 'In-fill' replaced with 'infill' in line with other documents. All versions of documents deleted as the latest version always applies. SUBSET-037 deleted in 3.1.1.1 - not referred to in this document.	APS
3.0.2 05/07/11	4.2.4.1.1 4.3.2.1 b), c), i), j), v) 6.1 and 6.2 6.3	As per SG meeting 16/6/11	LR
3.0.3 15/08/11	3.2.1.2 3.2.1.2.1 3.4 4.2.4.2 4.2.4.12	As for additional findings in SG meeting 19/7/11	LR
3.0.4 18/09/11	3.1.1.1 3.2.1.2.1 6.2.1.1.1	As for additional findings in SG meeting 23/8/11	LR

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3.0.5 29/09/11	4.2.4.4 4.2.4.5.1 6.2.1.2.1	As per decisions in SG meeting 22/9/11	LR
3.0.6 30/09/11	3.1.1.1 4.2.4.7.2 4.2.4.9.1	Following review comments by CK	LR
3.0.7 04/10/11	4.3.2.1.1n	Editorial leftover fixed Release version	LR
3.0.8 08/02/12	Header 3.1.1.1 3.2.1.1 4.1.1.4 4.1.1.8/9 4.2.4.5.1 4.3.2.1.1x 4.4 4.5 6.2.1.1.1 6.2.1.3	Second draft release for Baseline 3	LR
3.0.9 13/02/12	3.1.1.1 3.2.1.5 4.4.1.5.2.1 4.5.1.1 6.2.1.1.1	As for review in SG meeting 13/02/12	LR
3.1.0 28/02/12	3.1.1.1 4.2.4.14 4.2.4.7.1 4.3.2.1.1 4.4.2 6.2.1.4.1 6.3.1.1	As detailed in “cover” CR 1103	LR

Issue Number Date	Section Number	Modification / Description	Author
3.1.1 02/03/12	4.3.2.1.1w 4.3.2.1.1x (new) 4.5 4.5.1.2 (new)	As per CR 992 revised solution and additional reason detailed in “cover” CR 1103	LR
3.2.0 03/03/12	-	Baseline 3 release version	LR
3.2.1 04/04/14	4.2.4.4 4.4.3 (new) 6.2.1.3.1 (new) 6.2.1.4.2 (new) 6.2.1.5 (new)	First draft version for Baseline 3 first maintenance release (CRs 944, 1155 and 1176).	PP
3.2.2 25/04/14	4.4.3 6.2.1.4.2	Modifications as per agreed ERA review comments. Baseline 3 1st maintenance pre-release version.	PP
3.2.3 07/05/14	4.2.4.4	CR 1223 Baseline 3 1st maintenance 2nd pre-release version.	PP
3.3.0 09/05/14	-	Baseline 3 1st Maintenance release version	PP
3.3.1 18/11/15	3.1.1.1 4.3.2.1.1 bullet t) 4.3.2.1.1 bullet u)	CRs 1163, 1273	PP
3.3.2 16/12/15	4.1.1.4 4.1.1.12	CR 1283	PP
3.4.0 16/12/15	-	Baseline 3 2nd release version	PP

2. TABLE OF CONTENTS

3. INTRODUCTION

3.1 References

3.1.1.1 The following documents are referenced in this document:

- System Requirement Specification - SUBSET-026
- Safety Requirements for Technical Interoperability of ETCS in Levels 1 & 2 – SUBSET-091
- FFFIS for Eurobalise – SUBSET-036
- FFFIS for Euroloop – SUBSET-044
- Interface ´G´ Specification – SUBSET-100
- Interface 'K' Specification – SUBSET-101
- Technical Specification for the Interoperability of the Trans-European High Speed rail system, Rolling Stock subsystem, 2008/232/EC, dated 21/02/08
- Technical Specification for the Interoperability of the Trans-European Conventional rail system, Rolling Stock subsystem – locomotives and passenger rolling stock, 2011/291/EU, dated 26/04/11
- Brakes – Braking power, UIC Leaflet 544-1, 6th edition
- Railway Applications – Braking – Wheel Slide Protection, EN 15595, dated 2009
- Interfaces between Control-Command and Signalling trackside and other subsystems, ERA/ERTMS/033281

3.1.1.2 Intentionally deleted

3.1.1.3 Intentionally deleted

3.2 Aim and purpose for a subset of engineering rules

3.2.1 ERTMS/ETCS engineering rules

3.2.1.1 The engineering rules are system-related limitations for installation of equipment, exchange of information, on-board configuration data, etc. that characterise the implementation of ERTMS subsystems.

3.2.1.2 These engineering rules provide additional constraints to the requirements stated in the SRS and other sub-level documents in order to ensure interoperability.

3.2.1.2.1 The Engineering Rules stated here are therefore complementary to the requirements stated in the SRS and subdocuments. References herein to other documents are not exhaustive, in particular to the SRS.

3.2.1.3 Intentionally deleted

3.2.1.4 The aim of these engineering rules is not to define the whole set of rules necessary to realise a project with ERTMS/ETCS.

Additional rules, which are not defined in this document, may be needed, and may vary depending on the project constraints, Clients requirements or rules and Industry procedures. However, those rules must not preclude the use of any equipment meeting the engineering rules stated here.

3.2.1.5 The engineering rules defined stated herein or referenced are mandatory; Engineering advice is not in the scope of this document

3.2.2 Transmission systems other than ERTMS/ETCS

3.2.2.1 Some constraints related to KER-compatible systems are described in appendix to this document.

3.2.2.2 Possible additional constraints related to transmission systems different from ERTMS (e.g. KER) must be defined within the relevant project.

3.3 Referencing balises and antennas

3.3.1 Referencing balises and balise groups

3.3.1.1 The reference location of a balise is the Balise Reference Marks, which are visible signs on the surface of the balise.

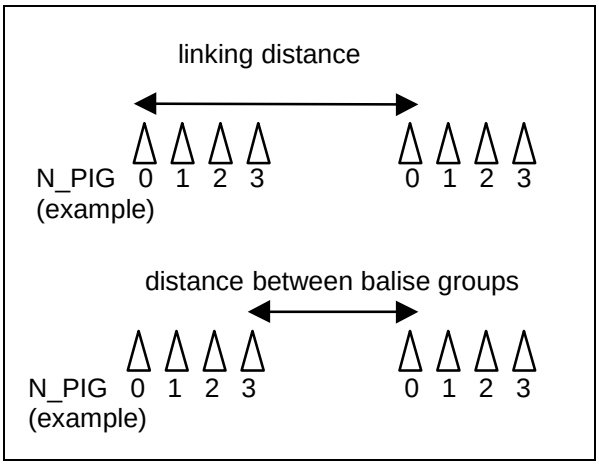
3.3.1.2 Balise groups will be considered as a complete device limited by the reference location of its outer balises.

3.3.1.3 The reference location of a balise group is the reference location of its outer balise with N_PIG variable = 0.

3.3.1.4 The «last switchable balise» of a balise group refers to the last encountered switchable balise with regards to the balise group crossing direction.

3.3.1.5 Distance between balise groups is by definition the distance between closest balises of the two groups (i.e. between the Balise Reference Mark of the last one of the first group and the Balise Reference Mark of the first one of the second group).

- Note: This convention should not be mixed up with the distance used in the linking information (i.e. between the Balise Reference Mark of the balise with N_PIG variable = 0 of the first group and the Balise Reference Mark of the balise with N_PIG variable = 0 of the second group); see following figure



3.3.2 Referencing antennas

3.3.2.1 The reference location of an antenna is the Antenna Reference Marks, which are visible signs on the surface of the antenna.

3.4 Intentionally deleted

4. RULES

4.1 Installation rules

4.1.1 Rules for balises

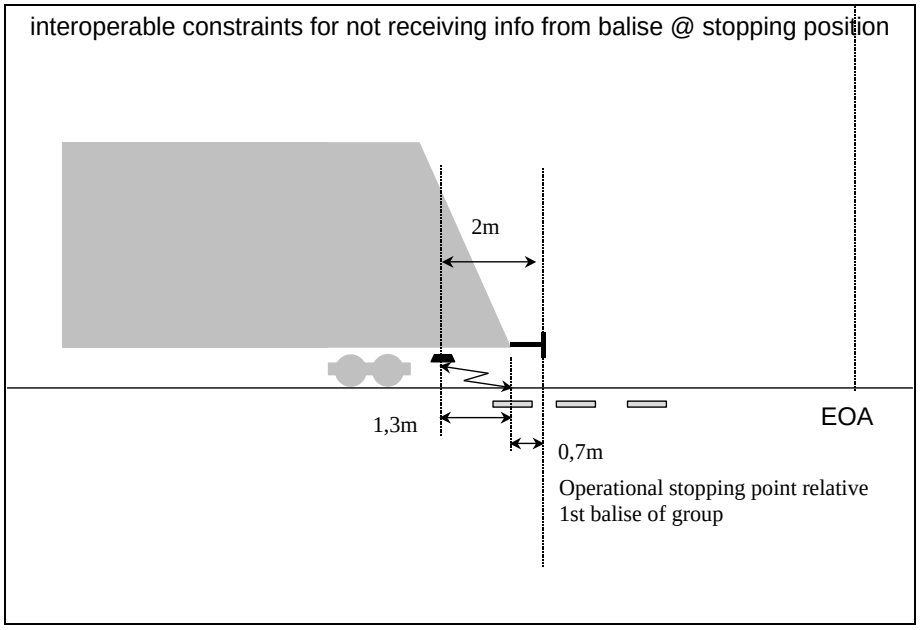
4.1.1.1 General installation rules for balises

Rule	Reminder: the rules of the references below must be respected.
Reference	SUBSET-036 ❑ Section 4.2.5: Cross-talk protection ❑ Section 5.2 : Balise air gap interface ❑ Section 5.6.2 : Installation requirements for balises ❑ Section 5.6.3: Distance between balises ❑ Section 5.7: Environmental Conditions
Justification	The rules of the reference above are required in order to guarantee interoperability from a transmission point of view.

4.1.1.2 Maximum distance between balises within a group – to determine that no further balise is expected within a group (potentially missing balise).

Rule	The maximum distance between two consecutive balises within the same group shall be 12 m from reference mark to reference mark.
Reference	
Justification	The distance must be as short as possible in order to determine potential loss of balises as soon as possible, but must respect the longest minimum distance according to rule referenced in 4.1.1.1 herein.

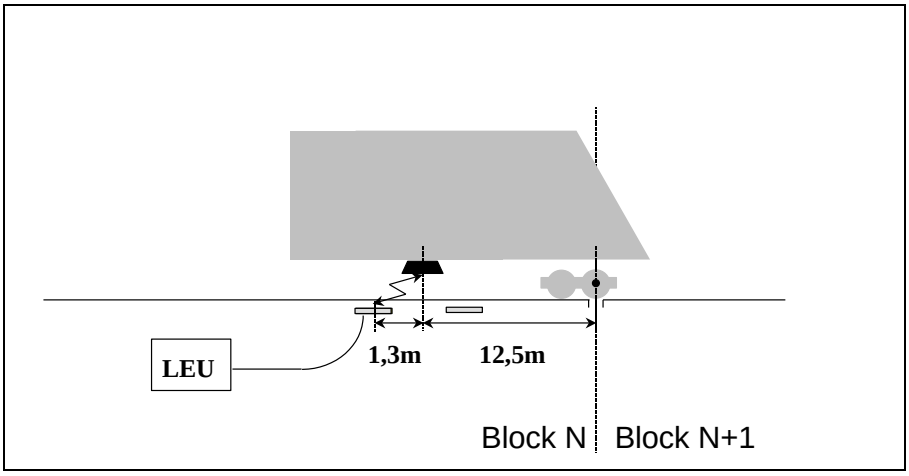
4.1.1.3 Maximum distance between any balise at a signal containing switched information and the stopping point – for level 1.

Rule	With regards to balises at a signal containing switched information any balise located in rear of the operational stopping location shall not be located further than 0.7m in rear of the operational stopping location.
Reference	SUBSET-036 section 5.2.2.5 (for the value 1.3 m)
Justification	- A train that stops at the operational stopping point in rear of the signal showing stop should not be able to receive information contained in the balise group between the stopping point and the EOA - The rule refers to the antenna being mounted closest to the extremity of the engine where the reference mark of the antenna is 2m in rear of the extremity of the engine - For the earliest reception of a balise signal the ”side lobe zone” of the balises (= 1.3 m) is taken into account 

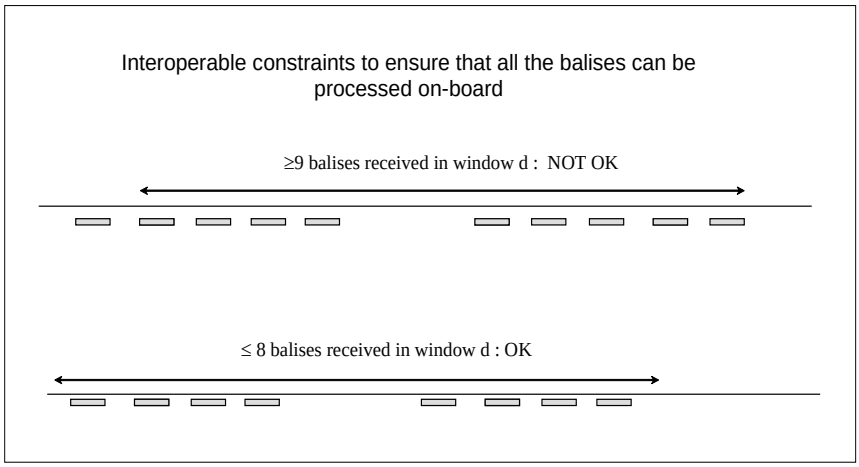
4.1.1.4 Minimum distance between the balise group and the EOA/LOA.

Rule	The last encountered balise of the balise group giving an MA, giving an immediate level transition order, or giving a “Stop if in SR”, that is placed close to the EOA/LOA shall be a minimum distance of 1.3m plus the distance the train may run during the time Tn, calculated from the formulas in Subset-036, clause 4.2.9, in rear of the EOA/LOA. Note: for train speeds lower than 80 km/h, the time Tn always equals to 100ms. In Level 2/3 for the immediate level transition order, the maximum distance between the on-board antenna and the train front end (12.5m + max. distance first axle to front end) shall be added to the above distances. Exception: for an immediate level transition order, this rule does not apply in case the level transition has been announced and the distance for the execution of the level transition has been engineered such that the level transition is performed before the EOA/LOA is passed.
Reference	SUBSET-036 section 5.2.2.5 (for the value 1.3 m); section 4.2.9 (for the time Tn); section 5.6.3 (for the value 80 km/h). ERA/ERTMS/033281 section 3.1.2 (for the max distance between the first axle and the train front end).
Justification	- The underlying approach is that all information related to the extension of an MA or the level transition order at a border or the “Stop if in SR” must have been received before the train is tripped, or override is ended, due to overpassing the EOA/LOA. - This rule is sufficient to ensure that the action resulting from the content of the balise group message will be considered by the on-board as preceding the overpassing of the EOA/LOA with the train “min safe antenna position”/”min safe front end”, i.e. it is sufficient to avoid that a train trip will occur regardless the time needed to process the balise group message (refer to SUBSET-026 section A.3.5.2). - According to the FFFIS Eurobalise no further information can be received from a balise if the (on-board) antenna has passed a balise by a distance of more than 1.3m

4.1.1.5 Minimum distance between the last switchable balise of a balise group and limit of train detection section – for level 1

Rule	If the transition from one train detection section to the following one affects the information transmitted by a switchable balise, this switchable balise shall be placed at least 13.8 m in rear of the location where the detection device of the next section may start detecting the train.
Reference	SUBSET-036 section 5.2.2.5 (for the values 1.3 m)
Justification	- The aim of this rule is to avoid that the antenna of the train is still able to read information coming from the balise group of block n, while the train is already detected in block n+1 (e.g. as its 1st axle short-circuits the track circuit of block n+1). - The rule takes into account the side lobe zone of the antennas and the balises, the last switchable balise of the group is therefore to be located at least 12.5 m (= the furthest location of the antenna in rear of the 1st axle) + 1.3 m (= side lobe zone) = 13.8 m in rear of the detection device limit (to be defined). 
Comment	In case of jointless track circuits the train detection area is overlapping both track circuits. The start of this area must be considered when defining the distances.

4.1.1.6 Number of balises that can be processed per unit of time

Rule	Let “d” be the distance run by a train at the maximum speed of the line during 0.8 s. In this distance “d”, the number of encountered balises shall not exceed 8. Note: The maximum speed of the line is the nominal line speed value (engineered SSP). Tolerances due to inaccuracy of speed measurements and speed margins before brake intervention are not to be taken into account for engineering.
Reference	Limitations of SUBSET-036 - section 4.2.9 must be considered
Justification	The rule is linked to processing of balise information on-board
Remark	Figure 

4.1.1.7 Intentionally deleted

4.1.1.8 Lateral and angular tolerances for balise installation

Rule	Reminder: the rules of the reference below must be respected.
Reference	Subset-036 section 5.6.2.3
Justification	-

4.1.1.9 Rules for balise installation in narrow curves

Rule	Reminder: the rules of the reference below must be respected regards the installation of Eurobalises in horizontal or vertical curves.
Reference	Subset-036 section 5.6.5
Justification	-

4.1.1.10 Intentionally deleted

4.1.1.11 Balise group configurations

Rule	Reminder: the rules of the reference below must be respected regards - Number of balises in each group/use of single balise groups - TSR Balise groups
Reference	SUBSET-091 – section 8.3.2.1
Justification	

4.1.1.12 Balise installation relative to track locations

Rule	The infill location reference given by the infill device must be in rear of the current EOA/LOA.
Reference	SUBSET-026 – section 3.4.3.1; 3.8.4.6.2-4; 4.8.1.5
Justification	An MA extension via an infill MA is only possible if there is no gap between the old MA and the MA extension.

4.1.1.13 Balise installation relative to mission profile

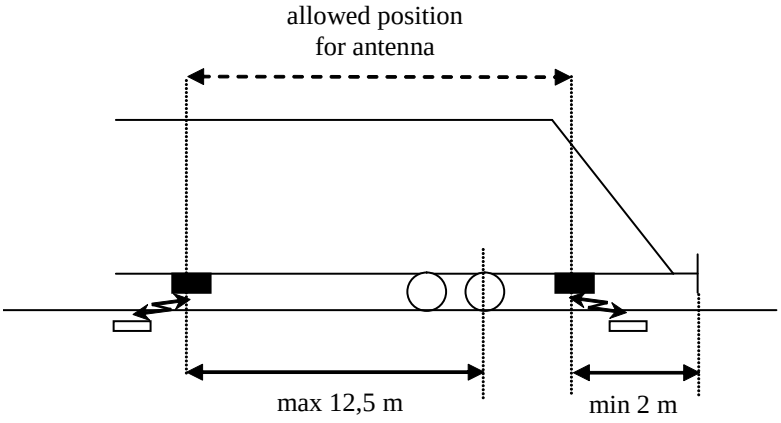
Rule	Reminder: the rules of the reference below must be respected e.g. - Number of Unlinked Balise groups (marked as unlinked) - Maximum distances between Balise groups
Reference	SUBSET-091 – chapter 10 Mission Profile
Justification	The safety analysis and safety requirements are based on this mission profile of the reference above.

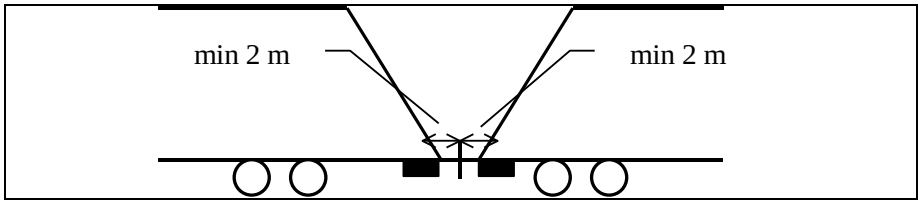
4.1.2 Rules for Eurobalise antenna

4.1.2.1 General installation rules for antennas (former 4.1.2.3)

Rule	Reminder: Installation rules presented in FFFIS for Eurobalise shall be respected.
Reference	SUBSET-036: ❑ Section 5.2 : Balise air gap interface ❑ Section 6.5 : Installation Requirements for Antennas ❑ Section 6.6: Specific Environmental Conditions for Antennas ❑ Section 6.7: Specific EMC Requirements for Antennas
Justification	

4.1.2.2 Minimum / maximum distance between the front of the engine / 1st axle of the engine and the Eurobalise antenna

Rule	The antenna shall be placed such that the Reference Mark of the balise antenna lies: • between 2m from the front of the engine and the 1st axle : The minimum value of 2m shall be ensured taking into account dynamic effects of the coupling • or, up to 12.5 m in the rear of the 1st axle. The front of an engine shall be defined by the extremity on the side of the active cab, the "1st axle" as the axle closest to the front of the engine. For an engine with a cab on each side, one antenna is sufficient if the areas of both sides where the antenna can be placed overlap, and the antenna, regards its reference mark, is placed in the overlapping part. 

Reference	
Justification	The maximum value of 12.5m has been specified to allow the use of the same antenna for both directions, on a locomotive, and to provide sufficient space to install the antenna on all different types of trains. Furthermore the aim of the minimum distance of 2m to train front is :  - to avoid an antenna receiving a telegram from a balise energised by another antenna - to avoid a balise energised by one antenna perturbing the transmission of an adjacent antenna.
Remark	Interference with antennas of other systems, especially KER based, has to be considered as well.

4.1.2.3 Intentionally deleted (former 4.1.2.2)

4.1.3 Rules for Euroloops

4.1.3.1 Intentionally deleted

4.1.3.2 General installation rules for Euroloops

Rule	Reminder: All installation rules given in FFFIS Euroloop have to be respected.
Reference	SUBSET-044 ❑ Section 6.1.3: Arrangements ❑ Section 6.10: Trackside Installation Rules ❑ Section 6.11: Specific Electrical Requirements ❑ Section 6.13: EMC Requirements ❑ Section 7.8: Installation constraints for the Antenna Unit Function
Justification	

4.1.4 Intentionally deleted

4.2 Telegrams and messages

4.2.1 Balise telegrams

4.2.1.1 Length of balise telegrams (300 km/h, 500 km/h)

Rule	Reminder: the rules of the references below must be respected.
Reference	SUBSET-036 section 5.2.2.3.
Justification	The rules are required in order to guarantee interoperability from a transmission point of view.

4.2.2 Radio messages

Note: Radio messages means RBC messages or radio infill messages (the same protocol is used in both cases).

4.2.2.1 Maximum length per message – to allow for the dimensioning of radio input buffers

Rule	Application data (excluding Euroradio protocol data) sent as normal priority data shall not exceed 500 bytes.
Reference	
Justification	- the length must be sufficient for MA - track description, according to 4.3.2.1 a) - transmission delay - more risk of perturbation - size of EVC buffers
Remark	A maximum number of bytes is not relevant for high priority data as only fixed size messages are used.

4.2.3 Intentionally deleted

4.2.4 Data engineering rules for individual data types

4.2.4.1 Packet 145 (Inhibition of balise group, message consistency reaction)

Rule	For all balise groups: it shall be forbidden to transmit the packet 145 if the balise group message contains, for the same validity direction as packet 145, safety related data that, if missed, could lead to the ETCS core hazard.
Reference	SUBSET-026, section 3.16.2.4.4.1 b), 3.16.2.5.1.1 b), 7.4.2.37.2
Justification	According to SUBSET-091 table 14.1.1.2 footer 14, the message consistency check is a protective feature, which has already been credited when deriving the safety targets for the hazards BTM-H1, BTM-H4, EUB-H1, EUB-H4.

4.2.4.2 Sharing of identifiers within different transmission systems

Rule	Reminder: the rules of the reference below must be respected
Reference	SUBSET-026, section 3.18.4.4
Justification	

4.2.4.3 List of balises for SH Area

Rule	It shall be forbidden to send the packet 49 (list of Balises for SH Area) in a message which does not contain the packet 80 (Mode Profile) with the variable M_MAMODE = “Shunting”. Exception: the rule does not apply for the radio message “SH authorised” since its list of optional packets includes the packets 3, 44 and 49 only.
Reference	SUBSET-026, section 4.4.8.1.1 b), 8.4.4.4.1
Justification	The on-board must always link a list of balises for SH area to either one given mode profile “Shunting” or to one SH authorisation from the RBC.

4.2.4.4 Transmission of non-infill information by loop or RIU

Rule	The following non-infill information can be transmitted from a loop: - Packet 13 (SR distance information from loop) - Packet 44 (Data used by applications outside the ERTMS/ETCS system) - Packet 180 (LSSMA display toggle order) - Packet 254 (Default Balise/Loop/RIU information) The following non-infill information can be transmitted from an RIU: - Message 32 (RBC/RIU System Version) - Message 39 (Acknowledgement of session termination) - Packet 44 (Data used by applications outside the ERTMS/ETCS system) - Packet 45 (Radio Network registration) - Packet 143 (Session Management with neighbouring RIU) - Packet 180 (LSSMA display toggle order) - Packet 254 (Default Balise/Loop/RIU information)
Reference	SUBSET-026 - 3.6.2.3, 4.8.1.5 SUBSET-040 - 4.2.4.5
Justification	To clarify which packets not included in the list of allowable infill packets defined in section 4.2.4.5 can nevertheless be transmitted by loop or RIU.

4.2.4.5 Infill Information

4.2.4.5.1

Rule	Infill information which is repeated from the balise group at the next main signal by any infill device shall be limited to infill MA, linking and route related track description information. All information which does not relate to Infill (e.g. information for opposite direction or EOLM etc.) shall not be given as infill information. Permitted infill information: - Packet 136 (infill location reference) - Packet 12, 80, 49 (MA, Mode Profile, List of Balises for SH area) - Packet 21 (Gradient Profile) - Packet 27, 51, 65/66, 70 (SSP, ASP, TSR, Route Suitability) - Packet 5 (Linking) - Packet 41 (Level transition) (see also next rule below) - Packet 44 (data used outside ERTMS) - Packet 39, 40 67, 68, 69 (Track condition) - Packet 71 (adhesion factor) - Packet 133 (Radio in-fill area information) - Packet 138, 139 (Reversing area information) - Packet 52 (Permitted Braking Distance Information) - Packet 88 (Level Crossing Information)
Reference	SUBSET-026 – section 3.8.4.6.3
Justification	This is to avoid any misinterpretation by on-board.

4.2.4.5.2

Rule	If infill information contains an announcement of an immediate level transition at the location of the location reference for the infill information, for the distance D_LEVELTR the value of “0m” shall be used.
Justification	For infill only distance based information can be interpreted on-board

4.2.4.6 Mode Profile

4.2.4.6.1

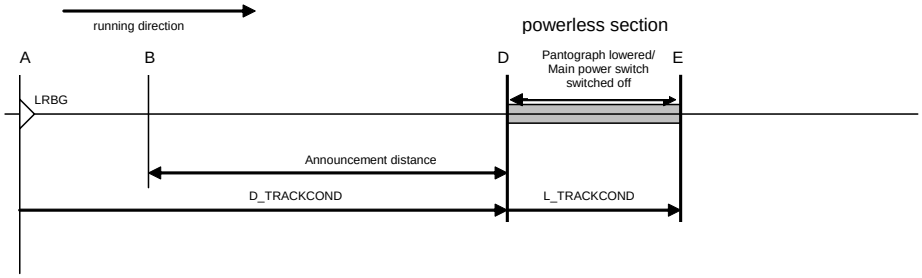
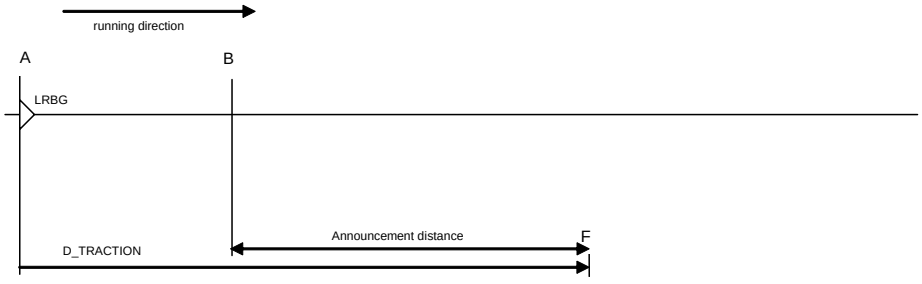
Rule	The overlapping of mode profile areas in the mode profile packet shall be forbidden.
Reference	
Justification	There is no possibility to handle two mode profiles at the same location.

4.2.4.6.2

Rule	In case a Level 1 MA contains V_MAIN = 0 and the MA is transmitted with a mode profile, the mode profile shall start at distance zero.
Reference	SUBSET-026 – 4.6.2 & 4.6.3 transition [32]
Justification	The procedures for mode transitions caused by mode profiles in Subset 026, chapter 5 do not cover “further location” transitions from SR mode to OS, SH, LS.

4.2.4.7 Track conditions

4.2.4.7.1

Rule	The minimum distance (latest transmission) between announcement of track condition Powerless Section with pantograph to be lowered and the start location of this track condition shall correspond to 17s when running at line speed (engineered SSP) in the approach area (B-D in the figure below). The minimum distance (latest transmission) between announcement of track condition Powerless Section with main power switch to be switched off and the start location of this track condition shall correspond to 11s when running at line speed (engineered SSP) in the approach area (B-D in the figure below).  The minimum distance (latest transmission) between announcement of track condition Change of Traction System and the location of this track condition shall correspond to 17s when running at line speed (engineered SSP) in the approach area (B-F in the figure below).  A: LRBG which is the location reference point for the distances given B: latest announcement location D: start location of track condition Powerless Section with pantograph to be lowered or with main power switch to be switched off E: end location of track condition Powerless Section with pantograph to be lowered or with main power switch to be switched off F: location for track condition Change of Traction System

Reference	SUBSET-026 –section 3.7.1.1 c)
Justification	This distance needs to be long enough to ensure that the driver (or an optional automatic system) is able to perform the necessary actions (e.g. reduce traction power, open the main switch, lower the pantograph, change the traction system) before reaching the beginning of the powerless section or the location of the change of traction system, respectively.

4.2.4.7.2

Rule	The minimum distance (latest transmission) between announcement of track condition - Air tightness - Switch off regenerative/eddy current (service/emergency)/magnetic shoe brake and the start location of this track condition shall correspond to 10s when running at line speed (engineered SSP) in the approach area.
Reference	SUBSET-026 –section 3.7.1.1 c)
Justification	This distance needs to be long enough to ensure that the driver (or an optional automatic system) is able perform the related action before reaching the beginning of the track condition.

4.2.4.8 Linking data handling

4.2.4.8.1

Rule	Balise groups with balise group qualifier “unlinked” shall never be announced via linking.
Reference	
Justification	This is to avoid any contradiction between the consistency reaction regarding “Unlinked” balise groups and the one regarding announced linking reaction.

4.2.4.8.2

Rule	Balise groups with balise group qualifier “unlinked” shall never be used to transmit linking information unless it is sent as infill information (see 4.2.4.5 herein).
Reference	SUBSET-026 – section 3.6.1.4
Justification	Balise groups with a balise group qualifier “unlinked” can never become an LRBG. This rule aims at reducing system complexity caused by the relocation of information received from a mixture of linked and unlinked balise groups which in addition only leads to a degradation of performance.

4.2.4.9 Intentionally deleted

4.2.4.9.1 Intentionally deleted

4.2.4.9.2 Intentionally deleted

4.2.4.10 Text transmission

Rule	The use of the end condition “location” shall be allowed only if the start condition 'location'' is used.
Reference	SUBSET-026 – section 3.12.3.4; 7.4.2.23/24
Justification	

4.2.4.11 Packet 131 (RBC Transition Order)

Rule	It shall be forbidden to use the special value “Contact the last known RBC” for the RBC ETCS identity number NID_RBC.
Reference	SUBSET-026 – section 7.5.1.96
Justification	Using the special value “Contact the last known RBC” would point to the Handing Over RBC which makes no sense in announcing an RBC Handover

4.2.4.12 Intentionally deleted

4.2.4.13 Packet 88 (Level Crossing information)

Rule	The location of a level crossing, as defined by the combination of D_LX and L_LX, shall not coincide with the location of another level crossing, i.e. the defined positions of crossings shall be independent.
Reference	SUBSET-026 - section 3.12.5.4
Justification	

4.2.4.14 Packets 72 and 76 (text messages)

Rule	It shall be forbidden to use the special value “Contact the last known RBC” for the RBC ETCS identity number NID_RBC.
Reference	SUBSET-026 – sections 7.4.2.23; 7.4.2.24
Justification	The driver acknowledgement report is to be sent to the RBC interested in such report, which cannot be ensured by the use of the special value.

4.3 Dimensioning rules for messages

4.3.1 Constraints

4.3.1.1 The maximum number of iterations of the same type of information:

Rule	In case the Engineering rules limit the number of iterations of a certain type of information, this shall take precedence over the 31 (= maximum of N_ITER) iterations stated in chapter 7 of the SRS.
Reference	SUBSET-026 – section 7.5.1.77
Justification	In chapter 7 of the SRS, a nominal value range for N_ITER was chosen in order to rationalise the ETCS language. Where specific limits for N_ITER are required, they are stated in the Engineering Rules document.
Remark	

4.3.2 Data

4.3.2.1 List of data that are related to dimensioning rules:

4.3.2.1.1 Note: The value for the “Maximum number of iterations in 1 packet” in the rules below refers to the value of N_ITER in the related packets.

a) Number of MA sections (excluding the End Section

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	5	6
Reference		
Justification		The use of infill information requires at least one additional section to be memorised.
Remark	In addition the MA includes an End Section which is not included in the above numbers	

b) Number of balise IDs in balise list for SR authority or for shunting mode

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	15 being transmitted using the same packet	
Reference		
Justification	This packet will never be combined with other packets requiring a big data volume.	A new incoming balise list replaces the previous one.

c) Number of mode profile sections

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	2	6
Reference	SUBSET-026 section–7.4.2.26 and section 4.2.4.6 herein	
Justification		A mode profile contained in an Infill MA replaces the one stored only beyond the reference location. Therefore onboard can currently have 3 sections of mode profiles, and receive 3 more sections in the Infill MA.

d) Number of locations with changes of SSP

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	31	50
Reference		
Justification		50 SSP sections memorised on-board with a change of SSP section every 500m would cover a distance of 25km.

e) Number of TSR

	Maximum number of packets in 1 message	Minimum memorised on board
Rule	10	30
Reference		
Justification		

f) Number of changes of gradient

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	31	50
Reference		
Justification		50 gradients memorised on-board with a change in gradient every 500m would cover a distance of 25 km.

g) Number of locations for position reports

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	15	
Reference		
Justification		
Remark		If a train gets a new packet 58 from the RBC, it replaces the old position report parameter.

h) Number of text messages

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	1 plain text + 1 fixed text	5 plain text + 5 fixed text
Reference		
Justification		

i) Number of linked balise groups

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	29	30
Reference		
Justification	29 iterations allow for a maximum of 30 linked balise groups to be transmitted in one packet. Because new linking information completely overwrites old information, the amount of linked balises to be stored is unchanged Exception: In case linking information is transmitted as infill information, Engineering must take care of any balises between the infill location and the infill reference location (i.e. the main signal balise group) which remain stored on-board	The on-board system should be able to manage an MA of 30 km with an average of 1 linked balise group per km.

j) Number of Track Conditions Change of traction system

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	No iteration in packet	1
Reference	SUBSET-026 – section 7.4.2.8	
Justification		The onboard system is able to manage one change of traction system at a time.

k) Number of Track Conditions Big Metal masses

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	4	5
Reference	SUBSET-026 – section 7.4.2.19	
Justification		

l) Number of Track Conditions

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	19	20
Reference	SUBSET-026 – section 7.4.2.20	
Justification		

m) Number of Route suitability data

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	2	1 list of loading gauges AND 1 value of axle load AND 1 value of traction system type.
Reference	SUBSET-026 – section 7.4.2.21	
Justification		

n) Intentionally deleted

o) Number of Axle load speed profile segments

	Maximum number of iterations of ASP segments in 1 packet	Minimum memorised on board
Rule	14	30
Reference	SUBSET-026 – section 7.4.2.13	
Justification		

p) Number of Axle load speed restriction values per ASP segment

	Maximum number of iterations per ASP segment	Minimum memorised on board
Rule	3	
Reference	SUBSET-026 – section 7.4.2.13	
Justification		

q) Number of adhesion profiles

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	No iteration in packet	10
Reference	SUBSET-026 – section 7.4.2.22	
Justification		

r) Number of reversing area

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	No iteration in packet	1
Reference	SUBSET-026 – section 7.4.2.34	
Justification		

s) Number of Permitted Braking Distance Speed Restrictions

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	2	5
Reference	SUBSET-026 – section 7.4.2.13.1	
Justification		

t) Number of Track Conditions Station Platforms

	Maximum number of iterations in 1 packet	Minimum memorised on-board
Rule	4	5
Reference	SUBSET-026 – section 7.4.2.20.1	
Justification		

u) Number of Track Conditions Allowed Current Consumption

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	No iteration in packet	1
Reference	SUBSET-026 – section 7.4.2.8.1	
Justification		

v) Number of Level Crossings

	Maximum number of packets in 1 message	Minimum memorised on board
Rule	10	10
Reference		
Justification		

w) Number of Virtual Balise Covers set by trackside

	Maximum number of packets in 1 message	Minimum memorised on board
Rule	10	10
Reference	SUBSET-026 – section 7.4.2.2.1	
Justification		
Remark		The minimum number stored on-board of this rule does not include the minimum number of VBCs set by driver that the on-board must be able to store (see rule 4.5.1.2)

x) Size of packet 44 with NID_XUSER = 102

	Maximum number of bytes in packet 44 if NID_XUSER = 102	Minimum memorised on board
Rule	222	
Reference	SUBSET-026 sections 3.15.6.5 and 7.4.2.11 SUBSET-058 section 7.2.22	
Justification	The total size of a packet 44 with NID_XUSER = 102, which will be forwarded in its entirety to an STM inside packet STM-45, must not exceed the maximum number of bytes which can be transmitted as user data in packet STM-45 (i.e. maximum value of variable N_LITER).	No memorisation applicable
Remark	The rule is only relevant for radio	

	messages. In a balise group message, the maximum allowed size can never be exceeded.	

4.3.3 Intentionally deleted

4.3.4 Multiple instances of Packets

4.3.4.1 Intentionally deleted

4.3.4.2 Multiple instances of packets in messages

Rule	Reminder: with regards to multiple instances of the same Packet inside a message, the rules of the references below must be respected.
Reference	SUBSET-026 – section 8.4.1.4
Justification	

4.3.5 Intentionally deleted

4.4 Rules for on-board configuration data

4.4.1 Braking curves

4.4.1.1 Introduction

4.4.1.1.1 In order to properly set the National Values for braking curves, it is necessary to define the conditions under which the nominal emergency brake deceleration and build up time are determined for the rolling stock.

4.4.1.1.2 If the braked weight percentage is acquired as Train Data by the ERTMS/ETCS on-board equipment and if the conversion model is applicable (i.e. the train is said to be a “Lambda” train), the speed dependent deceleration profile and the brake build up time, which are obtained from the Conversion Model, are to be considered as the nominal emergency brake deceleration and build up time.

4.4.1.1.3 Otherwise, the nominal emergency brake deceleration profile(s) and build up time(s) are preconfigured and acquired as ETCS Train Data by the ERTMS/ETCS on-board equipment (i.e. the train is said to be a “Gamma” train), and the rules specified in the section 4.4.1.2, 4.4.1.3, 4.4.1.4 and 4.4.1.5 shall apply.

4.4.1.1.3.1 Note: these rules are applicable for one set of emergency brake deceleration profile, brake build up time and rolling stock correction factors belonging to a given set of ETCS Train Data, regardless of whether this latter covers one or more train formations.

4.4.1.2 Nominal emergency brake deceleration profile

4.4.1.2.1 Environmental conditions

4.4.1.2.1.1 The nominal emergency brake deceleration shall be based on the following environmental conditions: for conventional trains according to appendix F1.1 of UIC Leaflet 544-1, for high speed trains according to case A of 2008/232/EC.

4.4.1.2.2 Humidity of friction elements

4.4.1.2.2.1 The emergency brake deceleration shall be based on dry friction elements.

4.4.1.2.3 Track profile

4.4.1.2.3.1 If field tests are carried out to define the nominal emergency brake deceleration, they shall be performed on straight and as level as possible track. The deceleration shall be corrected to level track.

4.4.1.2.4 Load

4.4.1.2.4.1 Passenger trains without automatic loading device

4.4.1.2.4.1.1 The nominal emergency brake deceleration shall be valid for normally loaded vehicles (see clause 4.2.3.2 of 2008/232/EC and clause 4.2.2.10 of 2011/291/EU).

4.4.1.2.4.2 Passenger trains with automatic loading device

4.4.1.2.4.2.1 For vehicles with automatic loading device the nominal emergency brake deceleration shall be defined as the lowest deceleration from the whole loading range (from empty to exceptional load) and if the lowest deceleration is obtained by several loads then the greatest load shall be taken into account as the nominal loaded condition

4.4.1.2.5 Use of special brake systems

4.4.1.2.5.1 Note: All installed brake systems can be considered in the nominal emergency brake deceleration, based on a reliability/availability study.

4.4.1.2.5.2 In case special brake system(s) (regenerative brake, magnetic shoe brake or eddy current brake) is/are considered in the nominal emergency brake deceleration and if the train is running on lines where a certain special brake system is not permitted or must be inhibited at certain locations (through the track condition “Inhibition of special brakes”), further nominal deceleration profiles without the contribution of the concerned special brake system shall be defined.

4.4.1.2.5.3 In case the dynamic brake not independent from the presence of voltage in the catenary (i.e. regenerative brake not backed up by a rheostatic brake) is included in the nominal emergency brake deceleration, further nominal deceleration profile(s) without the contribution of this brake shall be defined. Justification: the train will always encounter a powerless section (through the track condition “powerless section”) wherever it will operate.

4.4.1.2.6 Wheel diameter

4.4.1.2.6.1 The nominal deceleration shall be based on new wheel diameter.

4.4.1.3 Emergency brake build up time

4.4.1.3.1 The nominal brake build up time shall be the equivalent brake build-up time as specified in section 3.13.2.2.3.2 of SUBSET-026.

4.4.1.4 Rolling Stock Correction factor Kdry_rst

4.4.1.4.1 Kdry_rst(V,EBCL) shall be established for each confidence level that can be required by trackside (refer to sections 3.13.2.2.9.1.2, 3.13.2.2.9.1.3, 3.13.2.2.9.1.4 and variable M_NVEBCL in SUBSET-026). For the dry rail reference conditions, see section 4.4.1.2.1.

4.4.1.4.2 Note: The Monte Carlo methodology has shown to be suitable for the determination of the Kdry_rst values. However another methodology can be chosen, provided that it can be demonstrated that the required confidence levels are achieved.

4.4.1.5 Rolling Stock Correction factor Kwet_rst

4.4.1.5.1 Trains fitted with wheel slide protection system

4.4.1.5.1.1 In order to determine the correction factor Kwet_rst(V), field tests shall be made according to the provisions laid down in the following sections of EN15595:

- 6.1.2 (ambient temperature condition);
- 6.2.3 table 5 tests 1 & 3 and 2 & 4 (test programme for initial speed 120 km/h and maximum train speed, respectively);
- 6.4.2.1 (generation of reduced adhesion);
- 6.4.3.5 (spraying conditions for tests at speed higher than 200 km/h);
- 6.4.4.1 (correction of the measured stopping distance);
- 6.4.4.2 (number and validity of tests on dry rails);
- 6.4.4.3 (evaluation of validity of tests on wet rails).

4.4.1.5.1.2 For each pair of deceleration distances (on dry rail and with reduced adhesion) obtained from the tests 1 & 3 and 2 & 4, the increase of deceleration distance (in %)

obtained from the tests shall be used as follows to determine the correction factor: Kwet_rst = 100/(100+ increase of deceleration distance (in %)), with the deceleration distance resulting from tests 3 & 4 being the mean of the valid tests.

4.4.1.5.1.3 The deceleration distance is defined as the total distance travelled from the triggering of brake command to the train stop, minus the distance travelled from this triggering to the elapsing of the equivalent brake build up time.

4.4.1.5.1.4 In case a unique Kwet_rst (i.e. valid for all speeds) is defined, the maximum increase of deceleration distance between the tests 1 & 3 and 2 & 4 shall be retained.

4.4.1.5.1.5 Note: supplementary tests at other initial speeds (e.g. low speed) may be performed according to the same requirements, e.g. depending on a particular braking system configuration.

4.4.1.5.2 Trains not fitted with wheel slide protection system

4.4.1.5.2.1 For trains where the first four braked wheelsets are not fitted with a WSP system (without which the reference wheel/rail adhesion condition cannot be validated) the field tests specified in EN15595 cannot be used and the rules of §4.4.1.5.1 shall not be applied.

4.4.1.5.2.2 Note: For such trains, any value lower than or equal to 1 for the rolling stock correction factor Kwet_rst may be used.

4.4.2 On-board Supported Levels

Rule	The default list of levels configured on-board shall include all the levels fitting the trackside infrastructures where the train has been granted access (i.e. the levels listed in the Interoperability Registers on the concerned infrastructures).
Reference	SUBSET-026 section 3.18.4.2
Justification	The ERTMS/ETCS on-board equipment must always be able to switch to a level ordered by trackside (i.e. fitting the line where the train is), independently from the availability of the parts of the on-board equipment allowing to support this level. In case of degraded operation, it is always the responsibility of the Infrastructure Manager to order the level the on-board will switch to and, even though the train is not fitted with the National System corresponding to the ordered level, to instruct the driver to follow the ad-hoc operating rules applicable for a train with a failed National System. Therefore the so-called on-board default list of levels is not an unilateral choice made by the Railway Undertaking based on the

	devices the on-board is fitted with, but is rather a substitute of the list of trackside supported levels (packet 41) ordered by trackside when this list is not stored on-board.

4.4.3 Data Checks for Driver Input

Rule	The permitted range(s) for the technical and/or operational checks of a specific input field shall be within the limits defined in Subset-026, section A.3.11. The permitted resolution for a specific input field shall be equal to or lower than that defined in Subset-026, section A.3.11.
Reference	SUBSET-026 section A.3.11 ERA_ERTMS_015560 section 10.3.4
Justification	Data check rules for data entered by the driver must comply with the limits defined by the SRS for this data.

4.5 On-board dimensioning rules

4.5.1.1 STM related dimensioning rules

Rule	Reminder: the rules of the references below must be respected.
Reference	SUBSET-035 ❑ Section 15 Limitations
Justification	

4.5.1.2 Storage of Virtual Balise Covers set by driver

Rule	The ERTMS/ETCS on-board equipment shall be able to store at least 20 VBCs set by the driver
Reference	SUBSET-026 – section 3.15.9.2
Justification	In case of cross border cold movement from an LUC A to another LUC B, there should be sufficient storage capacity left for further VBC data entry by driver, assuming that the number of VBCs stored on-board from driver data entry in LUC A does not exceed the maximum allowed number of VBC that can be enforced by trackside at a time (see rule 4.3.2.1.1w)

5. APPENDIX: RULES FOR KER COMPATIBILITY

5.1.1.1 The following rules are not requested for ERTMS/ETCS interoperability. They are additional requirements to equipment offering KER compatibility.

Rule	Reminder: the rules regarding KER compatibility of the reference below have to be respected
Reference	SUBSET-100 ❑ Section 4: Physical Interaction and Environment ❑ Section 6 : RAMs ❑ Annexes : Balise Type Specific Parameters SUBSET-101 ❑ Section 4.1.5: Balise group separation
Justification	

5.1.1.2 Intentionally deleted

5.1.1.3 Intentionally deleted

6. APPENDIX: ENGINEERING RULES FOR OLDER SYSTEM VERSIONS

6.1 Installation Rules

6.1.1 Miscellaneous

6.1.1.1 Level transitions borders and RBC/RBC handover borders

6.1.1.1.1 For any trackside system operating with system version number X = 1, the following rule shall apply:

Rule	Level transition borders and RBC/RBC handover borders shall not be located where shunting or reversing could take place.
Reference	
Justification	Level transitions and RBC/RBC handovers are rejected by ERTMS/ETCS on-board equipment, supporting only system version number X = 1, when in Shunting mode or in Reversing mode.

6.2 Telegrams and Messages

6.2.1 Data engineering rules for individual data types

6.2.1.1 Infill Information

6.2.1.1.1 For any balise telegram, loop message and RIU message with M_VERSION where X = 1, rule 4.2.4.5.1 shall be replaced with:

Rule	Infill information which is repeated from the balise group at the next main signal by any infill device shall be limited to infill MA, linking and route related track description information. All information which does not relate to Infill (e.g. information for opposite direction or EOLM etc.) shall not be given as infill information. Permitted infill information: - Packet 136 (infill location reference) - Packet 12, 80; 49 (MA, Mode Profile, List of Balises for SH area) - Packet 21 (Gradient Profile) - Packet 27, 51, 65/66, 70 (SSP, ASP, TSR, Route Suitability) - Packet 5 (Linking) - Packet 41 (Level transition) (see also rule 4.2.4.5.2) - Packet 44 (data used outside ERTMS) - Packet 39, 67, 68, 206, 207, 239 (Track condition) - Packet 71 (adhesion factor) - Packet 138, 139 (Reversing area information)
Reference	
Justification	This for consistency with SRS Chapter 6, that defines which packets a Trackside operating with M_VERSION where X = 1 is allowed to transmit.

6.2.1.2 Mode Profile

6.2.1.2.1 For any balise telegram, loop message and RIU message with M_VERSION where X = 1, rule 4.2.4.6.2 shall be replaced with:

Rule	In case there is a Level 1 MA Packet with V_MAIN = 0, it is not allowed that the Message includes any mode profile packet.
Reference	
Justification	For an ERTMS/ETCS on-board equipment supporting only system version number X = 1, the reaction to a message containing a Level 1 MA Packet with V_MAIN = 0 and a mode profile is undefined.

6.2.1.3 Level transition order

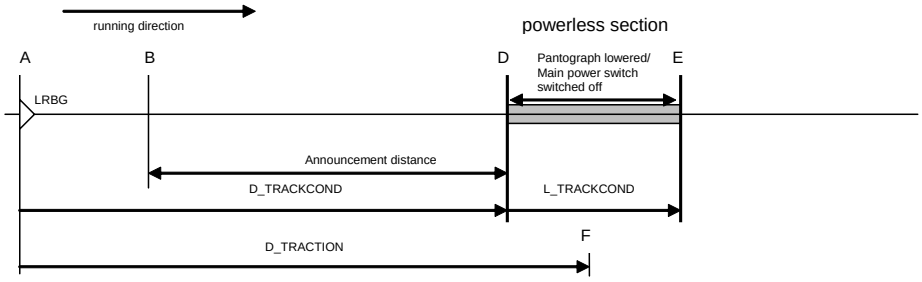
Rule	In a level transition order sent in a balise telegram or loop message with M_VERSION where X=1, or sent by an RBC/RIU with System Version where X=1, trackside shall include all applicable values of NID_STM containing the national system(s) installed in the infrastructure.
Reference	Subset-035 §7.4.1.1.17
Justification	When receiving such telegram or message, the on-board will not use any “level translation” look-up table.

6.2.1.3.1 Conditional Level Transition Order

Rule	Any trackside system operating with system version number X = 1 shall not send packet 46 (Conditional Level Transition Order) in a telegram or message which contains the packet 41 (Level Transition Order). In addition, it shall be forbidden to send packet 46 between a level transition announcement and the announced location of the level transition.
Reference	
Justification	In ERTMS/ETCS on-board equipment supporting only system version number X=1, a packet 46 (Conditional Level Transition Order) may replace a packet 41 (Level Transition Order) received at the same time or already stored on-board and consequently cancel an announced level transition.

6.2.1.4 Track conditions

6.2.1.4.1 For any trackside system operating with system version number X = 1, rule 4.2.4.7.1 shall be replaced with:

Rule	The minimum distance (latest transmission) between announcement of track condition Powerless Section with pantograph to be lowered and the start location of this track condition shall correspond to 17s when running at line speed (engineered SSP) in the approach area (B-D in the figure below). The minimum distance (latest transmission) between announcement of track condition Powerless Section with main power switch to be switched off and the start location of this track condition shall correspond to 11s when running at line speed (engineered SSP) in the approach area (B-D in the figure below). The “Distance to change of traction system” shall refer to the middle of a Powerless Section track condition (F in the figure below).  A: LRBG which is the location reference point for the distances given B: latest announcement location D: start location of track condition Powerless Section with pantograph to be lowered or with main power switch to be switched off E: end location of track condition Powerless Section with pantograph to be lowered or with main power switch to be switched off F: location for track condition Change of Traction System
Reference	SUBSET-026 –section 3.7.1.1 c)
Justification	No Change of Traction System announcement is computed by an ERTMS/ETCS on-board equipment supporting only system version number X = 1.

6.2.1.4.2 Updating track conditions

Rule	A trackside operating in system version number X=1 that wants to update one track condition must at the same time resend all track conditions that it wants the ERTMS/ETCS on-board to apply, including those already entered by the train. Note: information about Big Metal Mass cannot be repeated from an RBC.
Reference	Subset-026, section 3.7.3
Justification	How to update track conditions in ERTMS/ETCS on-boards supporting only system version number X=1 is open for different interpretations and there is a risk that when updating one track condition this may also replace (delete) others.

6.2.1.5 National Values

Rule	In National Values sent in a balise telegram with M_VERSION where X=1, or sent by an RBC with System Version where X=1, trackside shall include at least one country identifier for which the National Values are applicable.
Reference	Subset-026 §6.5.1.5.4
Justification	There is no on-board behaviour defined for handling National Values received without identifier of the area(s) (country or region) in which they are applicable

6.3 Dimensioning rules for messages

6.3.1 Data

6.3.1.1 For any Trackside operated with system version number X=1, rule 4.3.2.1.1 c) shall be replaced with:

Number of mode profile sections

	Maximum number of iterations in 1 packet	Minimum memorised on board
Rule	2	3
Reference	SUBSET-026 section–7.4.2.26 and section 4.2.4.6 herein	
Justification		Based on the maximum number of iterations in 1 packet and on

		the fact that no minimum number of mode profile sections memorised on-board is specified for ERTMS/ETCS on-board equipment supporting only system version number X=1, it cannot be assumed that it stores more than 3 mode profile sections.