

Signalling Design Principle – ETCS Level 1

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Document history

Revision	Effective date	Summary of changes
1.0	07 July 2017	First issue.
2.0	28 March 2018	<p>The changes from the previous version include clarification to the following key elements:</p> <ul style="list-style-type: none"> • balise naming • balise placement • confidence interval calculation • balise message consistency and linking • provision of repositioning • gradient simplification • requirements for providing redundancy and safety in design • requirements for LSSMA • application for virtual balise covers (VBCs) • application of level transition borders • speed information to be sent from the trackside • yard entry and exit • wrong running requirements • provision of ETCS trainstops
3.0	18 April 2019	<p>The changes from the previous version include the following:</p> <ul style="list-style-type: none"> • updated confidence interval calculation • updated buffer stop configuration • updated repositioning expectation window and the minimum distance formula for balise placement • updated ERA Braking tool parameters • clarification on the level transition announcement distance calculation • updated requirement on combining big metal mass with other functions • updated wrong running exit exception conditions • addition of the toroidal transformer requirement • updated high-risk turnout assessment criteria • error corrections and formatting updates • updated level transition border placement conditions

Revision	Effective date	Summary of changes
4.0	30 June 2020	The changes from the previous version include the following: <ul style="list-style-type: none">• alignment with the automatic train protection (ATP) project (formerly known as the advanced train control mitigation system (AMS) project)• provide clarification to design requirements throughout the document
1.0	25 November 2021	Renumbered as TS 05333.31:1.0. Version number recommenced in line with new designation.
2.0	09 December 2022	Updated to include requirements to cater for scenario where non-electric trains fitted with onboard ETCS system, traverse from Trackside ETCS fitted area and to non-fitted area and vice versa.

Preface

This is a second issue of TS 05333.31.

This standard forms a part of the TfNSW suite of railway signalling principles which detail the design requirements of the complete signalling system. To gain a complete overview of signalling design requirements, this standard should be read in conjunction with the suite of signalling design principle standards.

This standard specifically covers the implementation of the ETCS level 1. It specifies the requirements and design principles for ETCS level 1 trackside implementation to mitigate derailment and collision risks.

This standard has been developed by the AMB in consultation with other TfNSW agencies and industry representatives.

The changes from the previous content include the following:

- expansion of the scope to include the fitment of non-electrified territory on the TfNSW Metropolitan Heavy Rail Network
- boundaries between TfNSW Metropolitan Heavy Rail Network and other rail networks managed through a level transition.

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SUPERSEDED

1 Scope

This document specifies the design requirements for ETCS level 1 trackside implementation.

The trackside implementation complements the fitment of onboard ETCS equipment on TfNSW fleet, however, the onboard system is out of scope of this document.

Any requirements in this document that are an amendment from the ERA ETCS specifications are explicitly stated as such.

This standard does not cover the following:

- The determination of ETCS level 1 deployment type, whether ETCS is implemented by using combination of fixed and controlled balise groups or implemented by using fixed balise groups only. The ETCS deployment type is identified as part of business and system definition phase, supported by a risk assessment.
- The determination of turnout risk classification and the application of mitigations (other than ETCS) to manage such risk. The turnouts identified as high-risk turnouts and the mitigations to be applied are covered in the project scope, business and system requirements. If the mitigations specify the use of a turnout switched and fixed balise TSM arrangement to manage turnout speed, then Section 8.3 of this standard applies.
- The determination of overrun risk and the possible mitigations that can be applied. The classification of identified overruns and the mitigations to be applied are covered in the project scope, business and system requirements. If ETCS is required to be used for risk mitigation, then Section 8.4 of this standard applies.
- Interface to ETCS Level 2.
- Interface to train protection systems used on other rail networks (for example, Australian Rail Track Corporations' Advanced Train Management System (ATMS)).

2 Application

This standard applies to TAOs engaged to carry out the preliminary and detailed signal design for new and existing installations in the TfNSW MHRN, and all connection lines and sidings within these areas, but excluding private sidings. Further detail on the boundaries of the TfNSW MHRN are defined in TS TOC 1, TS TOC 2, and TS TOC 3.

Current projects which are in the planning phase of their asset life cycle as detailed in T MU AM 06006 ST and are no longer in compliance with this version of the standard, should consult with AMB in order to continue to use the previous version of this standard.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

ETCS B3 MR1 GSM-R B1 *CCS technical specification for interoperability (TSI) Set of specifications # 2*

Transport for NSW standards

EGG 1656 *Balise Placement and Metal Mass Assessment Guide*

SPG 0706 *Installation of Trackside Equipment*

SPG 0708 *Small Buildings and Location Cases*

T HR SC 00003 ST *Circuit Design Standard – ETCS Level 1 Interface Circuits*

T HR SC 01650 SP *ETCS Onboard Equipment*

T MU AM 01007 TI *Asset Reference Codes Register*

T MU AM 06006 ST *Systems Engineering*

TS 00003.1 *Concessions to Transport Standards Part 1 – Concessions Process*

TS TOC 1 *Train Operating Conditions (TOC) Manual – General Instructions*

TS TOC 2 *Train Operating Conditions (TOC) Manual – Division Pages*

TS TOC 3 *Train Operating Conditions (TOC) Manual – Track Diagrams*

Other referenced documents

Advanced train control Migration System (AMS) Specifications – Resolving Maximum Speed in Areas Where Speed Signs are Deficient

RailSafe NSY 514 *Special Proceed Authority*

The following documents are not publicly available. To obtain access, email standards@transport.nsw.gov.au

ASDO Trackside Design Guideline

Sydney Trains, 2019, GL S 45201 *Gradient Simplification Design Guideline*

Sydney Trains, 2019, PR S 45012 *Identification of High Risk Turnouts*

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document.

ARTC Australian Rail Track Corporation

ASDO automatic selective door operation, utilising ETCS packet #44

ATMS Advanced Train Management System

ATP automatic train protection

CBI computer-based interlocking

CRN Country Regional Network

DMI driver machine interface

DPU data pick-up unit

EBD emergency brake deceleration

EMU electric multiple unit

EOA end of authority

ERA European Union Agency for Railways (formerly European Railway Agency)

ETCS European train control system

ETCS level 0 a level of ERTMS/ETCS

ETCS level 1 a level of ERTMS/ETCS

ETCS level 2 a level of ERTMS/ETCS

EVC European vital computer

FS full supervision

IS isolation

JRU juridical recording unit

LEU lineside electronic unit

LOA/MRSP limit of authority or most restrictive speed profile

LS limited supervision

LSSMA lowest supervised speed within the movement authority

MA movement authority

MHRN Metropolitan Heavy Rail Network

N_BG balise group identity number

NL non-leading

N_PIG balise position in group number

outer signal a signal one or more blocks in the rear of:

- the home signal of a turnout, or

- the protecting signal of a high-risk overrun

OS on sight

protecting signal a stop signal immediately in the rear of a hazard point for a high-risk overrun

PS passive shunting

PT post trip

RIM rail infrastructure manager

In relation to rail infrastructure of a railway, means the person who has effective control and management of the rail infrastructure, whether or not the person–

(a) owns the rail infrastructure; or

(b) has a statutory or contractual right to use the rail infrastructure or to control, or provide, access to it;

(Source: *Rail Safety National Law (NSW) 2012*)

RIU radio interface unit

RSM release speed monitoring

RSO rolling stock operator

means a person who has effective control and management of the operation or movement of rolling stock on rail infrastructure for a railway, but does not include a person by reason only that the person drives the rolling stock or controls the network or the network signals (Source: *Rail Safety National Law (NSW) 2012*).

RV reversing

SB standby

SH shunting

SL sleeping

SN national system

SPA special proceed authority

SR staff responsible

SSP static speed profile

SvL supervised location

SF system failure

TR trip

TSM target speed monitoring

TSR temporary speed restriction (ETCS function)

TSW temporary speed warning

UN unfitted

VAD vertical alignment database

VBC virtual balise cover

TfNSW Transport for NSW

5 European train control system

The ETCS is a standardised ATP system that provides various options to permit flexible application across different railway jurisdictions.

ETCS onboard equipment receives information related to the track ahead from ETCS trackside equipment, and together with train parameters uses this information to determine speed and distance supervision parameters.

If a supervision limit is exceeded, then the onboard equipment triggers one or more of the following:

- audible and visual warnings to the driver
- traction cut-off
- service brake application
- emergency brake application.

6 Balises and balise groups

A balise group consists of one to eight balises, located within specified distance limits and identified as belonging to the same group within the ETCS data. Each balise within the group is identified individually by its position in the group.

Where a balise group consists of more than one balise, the order of reading the balises allows the onboard equipment to determine whether the train has passed the balise group in the 'nominal' direction or in the 'reverse' direction. Where the group consists of a single balise, the direction in which the balise group has passed is assigned using the information received from a prior balise group.

Each balise transmits a telegram to the train. The combination of telegrams from all balises in the group makes up the balise group message. Each telegram is made-up of a header and packets, with different packets defined for different functions. The packets can convey information applicable to trains travelling in the nominal direction, the reverse direction, or in

either direction. Separate information can be given for each direction by using a separate packet for each direction.

The nominal direction of the balise group shall be in accordance with its primary purpose, unless a repositioning requirement overrules. See Section 7.2.4 for more details on repositioning.

Where a balise group performs more than one function, the primary purpose may be unclear. In such situations, the following shall apply:

- for controlled balise groups, the primary purpose shall be in accordance with the controlling function
- for fixed balise groups, the primary purpose shall be in accordance with the following priority order:
 - buffer stop protection
 - speed sign
 - speed sign in the normal running direction (for back-to-back speed signs on a bidirectional line)
 - speed sign in the Down direction (for back-to-back speed signs on a single line)
 - speed update after a turnout
 - yard entry.

Balise groups shall consist of two balises, with the following exceptions:

- dedicated calibration balise groups shall consist of one balise
- buffer stop balise groups shall consist of one balise where the distance between the operational stopping location and the buffer stop is less than or equal to 10 m.

The use of an additional balise within a balise group is permitted where needed to cater for the amount of data to be transmitted. Additional balises may be assigned during data design activities.

For a balise group composed of controlled and fixed balises, the controlled balise shall be the first to be read in the nominal direction of travel (in accordance with the signalled direction).

6.1 Balise identification

Balises and balise groups shall have a name for asset management purposes and a number for ETCS functional purposes.

6.1.1 Balise identification numbers

Balise identification consists of three elements, namely the balise country/region code, the NID_BG and the N_PIG.

The balise group identity number shall be unique for each balise group. Subject to risk assessment, an exception may apply to the following:

- TSW balise groups
- VBC balise groups (in level 0 territory only).

Adjacent VBC balise groups shall not have the same NID_BG to avoid misinterpreting a message where one balise is missed.

Within a balise group, the balise with the N_PIG value of zero is termed the reference balise.

6.1.2 Balise naming

6.1.2.1 Naming

With the exception of TSW and VBC (in level 0 territory) balises, each balise shall be assigned a name that complies with the following naming structure:

WWWXXXXXXXXX_YYYY_Z_T

The underscores shown shall be included in the balise name.

6.1.2.2 WWW

WWW is the three-letter location code as listed in T MU AM 01007 Tl.

For balises in a fixed balise group, WWW shall be the location code of the nearest station to the reference balise of the balise group.

For balises in a controlled balise group, WWW shall be the location code according to the connecting LEU; that is, the location code of the nearest station to the interfaced signal.

The station kilometrages in TS TOC 3 shall be used in determining the nearest station.

6.1.2.3 XXXXXXXX

XXXXXXXX shall be a maximum of eight characters. These characters shall describe the signal name, point's number or balise group kilometrage.

6.1.2.3.1 Signal name

The signal name shall be used for balises in controlled balise groups, using the name of the signal interfaced to the LEU.

The signal name shall be used for balises in fixed balise groups where the primary purpose of the balise group requires it to be positioned at a relative distance to a signal. Examples include the following:

- dedicated balise groups that toggle-off the display of the LSSMA near the protecting signal of a high-risk overrun
- wrong running entry or exit balise groups on plain line
- dedicated balise groups near signals that perform an early mode change after a train turns back.

Where the signal name is used, XXXXXXXX shall be in accordance with the signal identification plate; however, the signal name shall not include spaces, decimal points or any suffix denoting the line name.

Where more than one balise group on the same line is required to be named after the same signal, a suffix shall be appended to the signal name to maintain uniqueness. Examples of suffixes include 'L' for toggling-off LSSMA, 'C' for an early mode change after turning back, 'A' for an approach balise group or 'A1', 'A2' and so forth for multiple approach balise groups, starting at 1 for the approach balise group farthest in advance.

6.1.2.4 Points number

The point's number (not including interlocking identifier) shall be used in the balise name where the primary purpose of the balise group is for repositioning.

The points-end identification (A, B, C) shall be included as a suffix to the point's number.

If the balise group is in rear of the points in the facing direction, then an additional 'A' shall be included as a prefix to the point's number, indicating that it is 'on approach'.

For a balise group in rear of independent switches in the facing direction then the choice of the point's number shall be as follows:

- where there are signalled moves through only one lay of the points in the facing direction, the balise group name shall include the number of points that are required in the reverse position for the facing move
- where there are signalled moves through both lays of the points in the facing direction, the balise group name shall include the lower points number.

6.1.2.5 Kilometrage

The approximate kilometrage of the reference balise shall be used for balises that are not required to include the signal name or points number in its name. The kilometrage shall be based upon kilometrages given by the GIS, rounded off to the nearest 10 m. The decimal point

shall be omitted. The kilometrage used in the balise name shall consist of five digits, padded with leading zeros where necessary.

6.1.2.6 YYYYY

YYYYY is the four-character track code as listed in T MU AM 01007 TI. Track codes are an abbreviation of the line name shown on the signalling plan.

6.1.2.7 Z

Z is the value allocated to the data variable N_PIG.

6.1.2.8 T

T is the balise type as follows:

- C for a controlled balise
- F for a fixed balise.

Table 1 provides examples of different balise names established using the convention described in Section 6.1.2.1 to Section 6.1.2.8.

Table 1 – Balise naming convention

Balise name	Explanation
BTN03575_UPSB_0_F BTN03575_UPSB_1_F	The two fixed balises in a speed sign balise group on the Up Suburban at 35.745 km, near Blacktown.
NMHY17_DNMN_0_C NMHYY17_DNMN_1_F	The two balises in a balise group for a high-risk turnout on the Down Main near Normanhurst. The controlled balise is interfaced to Hornsby signal HY17.
HBV502A_DNMN_0_F HBV502A_DNMN_1_F	The two fixed balises in a repositioning balise group on the Down Main that is passed after travelling through the 'A' end of Hornsby 502 facing points in the normal position. The nearest station is Hornsby.
VBC_GENERIC_A_0_F VBC_GENERIC_A_1_F	The two fixed balises for a VBC balise group.
TSW_GENERIC_0_F TSW_GENERIC_1_F	The two fixed balises for a TSW balise group.

The balise group name (used in the ETCS balise tables) shall be in accordance with the balise name without the 'position in group' or balise type suffix; that is, WWWXXXXXXXXX_YYYY.

6.2 Balise placement

All references for balise placement refer to the centre of the balise.

Balises shall have a minimum longitudinal separation of 2.3 m in accordance with installation requirements in ETCS B3 MR1 GSM-R B1. Balises within the same balise group shall have a

maximum longitudinal separation of 12 m in accordance with dimensioning and engineering rules in ETCS B3 MR1 GSM-R B1. Balises within the same balise group shall be installed at the minimum separation achievable for a given site.

Balises should not be installed in crossovers, except for balises for yard entry and exit so as to minimise the amount of infrastructure between the running lines.

A balise shall not be installed closer than 1.5 m from the running face of the nearest rail of an adjacent track, as a train on the adjacent track could otherwise receive the balise telegram. This distance prevents balises being installed in or adjacent to a turnout until the running faces are separated by at least 0.8 m and prevents installation of balises in a crossover where the main line track centres are less than 4.5 m. An exception to this requirement is when an adjacent line is not fitted with ETCS (lines not used by ETCS fitted trains or run offs for fitted lines).

Balises shall only be installed on track with a horizontal radius greater than 180 m.

To avoid any possible interaction, balises shall not be installed:

- less than 10 m of a train radio transponder or track magnet located in any of the possible paths of an ETCS fitted train
- within a 2 m radius of a train radio transponder or track magnet located on any adjacent track, which is not on any possible path of the ETCS fitted train
- less than 1.5 m of a track circuit DPU
- less than 1 m of an axle counter wheel sensor.

Balises shall not be installed where the body of the balise is within a 0.3 m longitudinal distance from a fishplate to ensure that the metal mass in fishplates or joints do not affect the onboard transmission equipment.

Balises should not be installed within 10 m after a rail grease pot/lubricator in the normal direction of travel.

A Balise shall not be installed in the same sleeper bay as a rail grease pot/lubricator.

Balises should not be placed in tunnels, bridges, viaducts or platforms.

The designer shall assure, through stakeholder consultation that the distance to the next balise group providing movement authority (in the direction of travel) would not introduce unacceptable operational delays in case a train is forced to run this distance in SR mode. This applies to the following locations:

- station platforms not provided with mode change BGs
- signals fitted with ETCS TS.

6.2.1 Controlled balises near replacement points

Controlled balises shall not be installed less than 5.0 m in rear of the replacement point of the connected signal, as the balise could otherwise be read after the signal is replaced.

Where a train is required to stop close to a signal, then one of the following special arrangements are required:

- relocating the replacement point (with or without relocating the signal)
- placing the controlled balise closer to the replacement point and providing additional controls to maintain the correct balise information as the train passes the replacement point without affecting the operation of the signal.

Refer to T HR SC 00003 ST for more information on interface circuits.

The replacement point of the signal shall be deemed to be one of the following:

- insulated rail joint or the one farther in advance where there is a stagger
- 3.5 m in advance of the first tuning unit connection (tuned loops >19 m)
- tuned bond connection (tuned loops 19 m or less)
- axle counter head
- centre of the DPU.

6.2.2 Balises near signals

Balises for ETCS trainstops shall not be installed greater than 8.9 m in rear of the signal, as the balise can otherwise be read before the train stops at the signal. This is based on a train stopping with its coupling face at a minimum of 5.0 m from the signal, in addition to the position and reading range of the onboard antenna.

Balises (controlled) at platform departure signals should be installed in advance of all operational stopping locations. Operational stopping locations are typically the car markers, if they exist, or the platform railing.

Balises at outer signals used for protecting high-risk turnouts and high-risk overruns should not be installed greater than 8.9 m in rear of the signal unless greater separation is required to achieve the correct braking distance. This allows for a less restrictive speed profile to be transmitted for a train waiting at the signal if the protecting signal in advance clears, or the home signal of the turnout clears for the straight route.

For future proofing of FS applications the fixed balise associated with balise groups that are interfaced to a signal shall be located in advance of the controlled balise; however, no closer than 1.3 m from the signal. The controlled balise shall be typically placed 2.3 m from the fixed balise.

6.2.3 Guard rails and derailment plinths

Balises shall not be placed within angle iron guard rails.

Balises should not be placed within the following:

- derailment plinths
- between guard rails
- containment catch point guard rail.

Balises between guard rails shall be provided with special purpose insulated joints to ensure both cross-talk protection and reliable transmission.

Balises between guard rails shall be installed longitudinally. This requirement prevents balises being installed between guard rails where the horizontal track radius is less than 300 m.

Refer to ETCS B3 MR1 GSM-R B1 and SPG 0706 for further information on installation requirements.

7 Data functions

The telegram transmitted by a balise consists of a balise header and a series of packets.

Each balise group function requires certain packets to be transmitted. The packets used are shown in Table 2.

Table 2 – Packets used

Packet number	Packet name
0	VBC cover marker
3	National values
5	Linking
6	VBC order
12	Level 1 MA
16	Repositioning information
21	Gradient information
27	International SSP
41	Level transition order
44	Data used by applications outside the ERTMS/ETCS system (used for ASDO)
65	TSR
67	Track condition: big metal masses
72	Plain text messages
80	Mode profile

Packet number	Packet name
132	Danger for shunting information
137	Stop if in SR
145	Inhibition of balise group message consistency reaction
180	LSSMA display toggle order
181	Generic LS function marker
254	Default balise, loop or RIU information
255	End of information

Refer to ETCS B3 MR1 GSM-R B1 for further information on ERTMS/ETCS language and messages.

Certain figures in this document show packet information for balise group messages. For completeness, all packets transmitted are shown, excluding packet #255, which is transmitted as a finishing flag for every telegram. Packet information that is pertinent to the particular balise group function is shown in boldface within the figures.

7.1 Confidence interval

The onboard computer's estimated train position from the reference balise group may not be at its actual position, mainly due to inaccuracies in the odometer. The actual train position can be up to one half of the confidence interval distance, either side of the estimated position.

For any ETCS trackside design calculation that requires an estimation of the confidence interval (CI), the CI shall be calculated as follows:

$$CI = 2 \times (5\% \times \text{distance travelled} + 5 \text{ m} + Q_LOCACC)$$

Distance travelled refers to the estimated position of the train front from the last balise group used for location reference.

Q_LOCACC refers to the location accuracy of the last balise group used for location reference. The value of Q_LOCACC shall comply with Section 7.2.2.

7.2 Linking

Linking is the announcement of balise groups in advance. The aim of linking is to:

- determine whether a balise group has been missed or not found within the expectation window and take the appropriate action
- assign a coordinate system to balise groups consisting of a single balise
- correct the confidence interval due to odometer inaccuracy.

Refer to ETCS B3 MR1 GSM-R B1 for further information on linking principles.

7.2.1 Q_LINK qualifier

The balise header contains the data variable Q_LINK, applicable to both directions, which marks the balise group as linked (Q_LINK=1) or unlinked (Q_LINK=0).

Balise groups marked as unlinked are always processed by the onboard computer.

When linking information is used onboard, the following balise groups shall be taken into account:

- balise groups that are marked as linked and included in the linking information
- balise groups marked as unlinked.

When no linking information is used onboard, all balise groups shall be taken into account.

All balises shall be marked as linked (Q_LINK=1) except for the following:

- TSW balise groups
- the yard balise group located on the running line side
- ASDO balise groups (Q_LINK=0).

7.2.2 Packet #5

Packet #5 is used for linking to balise groups in advance.

The requirements for linking differ depending on whether movements are supervised using the requirements for wrong running. See Section 8.9 for details on wrong running.

Where movements are not supervised with wrong running (typically the signalled direction), all balise groups shall be linked to (by the balise group(s) in the rear), with the following exceptions:

- the yard balise group located on the yard side
- VBC balise groups
- unlinked (Q_LINK=0) balise groups
- big metal mass announcement balise groups in level 0 territory
- level 0 to level 1 transition announcement balise groups
- at terminating roads where the balise group(s) in rear are not able to provide linking in the applicable direction (that is, buffer stop calibration balise groups and balise groups consisting of a single balise that are positioned directly in rear of the EOA to provide an immediate trip order).

For a balise group that transmits linking (packet #5), it shall link to two balise groups that are marked as linked. Exceptions to this requirement are as follows:

- Balise groups in rear of an ETCS trainstop balise group shall not link to a balise group in advance of this ETCS trainstop balise group. This is because the stored linking information is deleted from the onboard computer if a service brake linking reaction occurs as a result of the ETCS trainstop balise group being missed.
- When a linked balise group is announced as an unknown balise group, no further balise group can be linked, as the next balise group is not known from the balise group sending the linking (packet #5).

Where movements are supervised with wrong running (typically the unsignalled direction), only the following balise groups shall be linked to:

- both balise groups announcing a level crossing

Approaching a level crossing in the wrong running direction, the balise group in the rear of the balise groups protecting the crossing in the wrong running direction shall link to the first and second balise groups protecting the crossing. In the wrong running direction of travel, the first balise group protecting the crossing shall link to the second balise group. The first balise group shall not link to any balise group between the second balise group and the level crossing.

- the first (or only) wrong running entry balise group

The exception to this is where the approach to the wrong running entry balise group is after a trip order, such as from an ETCS trainstop at a fixed red signal.

Yard balise groups shall not perform linking even though the yard-side balise group is marked as linked (Q_LINK=1). VBC balise groups and big metal mass announcement balise groups in level 0 territory shall also not perform linking even though the balise groups are marked as linked (Q_LINK=1).

A value of 5 m shall be allocated to the data variable Q_LOCACC for all balise groups. The exception to this is for balise groups that link to a buffer stop calibration balise (that is, a balise placed 40 m from the EOA), which shall have a value of 3 m allocated to Q_LOCACC for the calibration balise.

7.2.3 Reaction

For a balise group that is linked from a balise group in rear, it is expected to be read within the expectation window. This distance is calculated by the onboard computer. The expectation window is based on the distance to the balise group (assigned to the data variable D_LINK) and the confidence interval. If a balise group that is linked to has an inconsistent balise group message or is not detected, then a linking reaction occurs. The type of reaction is defined by the data variable Q_LINKREACTION.

When linking to an ETCS trainstop, the linking reaction shall be to command the service brake.

When linking to all other balise groups, the linking reaction shall be 'no reaction' for the first balise group referred to in the linking information; however, the onboard equipment shall be configured to display a message on the DMI if the balise group has an inconsistent message or is not detected. The linking reaction shall be 'service brake reaction' for the second balise group referred to in the linking information.

Unnecessary linking inconsistency errors shall be avoided at diverging junctions to any lines that may be used by ETCS fitted trains.

7.2.4 Repositioning

A special value for an unknown identity is used in the linking information at facing points, when the link to the balise group is not known. A balise group that links to an unknown identity is termed 'repositioning announcement balise group'. The repositioning announcement function does not require a dedicated balise group. The function shall be combined with the balise group that is first in rear of the facing points.

The first balise group in advance of facing points (in each position) is termed 'repositioning balise group'. It contains packet #16.

The D_LINK distance in the repositioning announcement balise group shall be the distance to the farthest repositioning balise group.

The expectation window for repositioning extends from the last repositioning announcement balise group until the minimum safe front end of the train has passed the last possible location of the repositioning balise group, taking the antenna position into account. Refer to ETCS B3 MR1 GSM-R B1 for further information on repositioning.

For the purposes of balise placement (taking into account the repositioning expectation window), the minimum distance between the repositioning announcement balise group and the balise group in advance of the repositioning balise group, shall be calculated using the following formula:

$$\text{minimum distance} = \frac{1.05}{0.95} \times D_LINK + \frac{25.25}{0.95} + 6.3 \text{ (m)}$$

Only one linked balise group shall be passed in the minimum distance calculated.

In the signalled direction, repositioning shall be used for all facing turnouts regardless of whether there are signalled moves through both point positions and if the balise group that will be passed next is known. This solution minimises the signalling interface and provides a simple and consistent method.

Note: This application of repositioning differs in part from ETCS B3 MR1 GSM-R B1 intent, in so far as repositioning is not used to provide an extension to the MA.

Repositioning is not required where linking is not required. For example, there is no requirement to link to a yard balise group. Repositioning is not required where there is no balise group through one of the turnout positions.

In the unsignalled direction, repositioning shall only be provided where there is a requirement for linking.

The repositioning balise groups that are linked to, from a given repositioning announcement balise group shall all have the same orientation; however, the orientation may be different to the repositioning announcement balise groups, such as where the Up and Down directions change at a facing junction, for example at a triangle.

A dedicated repositioning balise group may be required on the fork that has the change of direction, such as where repositioning is combined with a balise group of the opposite nominal direction.

As a repositioning balise group cannot contain a MA for the same direction, a repositioning balise group cannot be combined with another function that requires an MA for the same direction. As a mode profile is always accompanied by an MA, a repositioning balise group cannot be combined with another function that requires a mode change for the same direction. In other words, packet #16 cannot be combined in a balise group that has packet #12 or packet #80 for the same direction.

A balise group used for initiating TSM shall not contain repositioning information for the same direction. This is to ensure that a train travelling in SR mode is transitioned to LS mode when approaching a hazard. This requirement does not apply to redundant TSM balise groups.

Thus a repositioning balise group cannot be combined with the following functions for the same direction:

- ETCS trainstops
- TSM-initiating balise groups (for buffer stops, high-risk speed signs, high-risk turnouts, high-risk overruns and wrong running level crossings)
- buffer stop balise groups
- buffer stop redundant TSM balise groups
- mode change balise groups providing an early change to LS mode after a train turns back.

See Section 8.9.1 where a repositioning balise group is required to be used as a wrong running entry balise group. See Section 8.9.2 where a repositioning balise group is required to be used as a wrong running exit balise group.

7.2.4.1 Repositioning for low-risk turnouts

For a low-risk turnout, the repositioning balise group on the diverging line typically transmits the new line speed. The preferred position is as close as possible (up to 10 m) in advance of the end of the (last) turnout or crossover. See Figure 1 for an example.

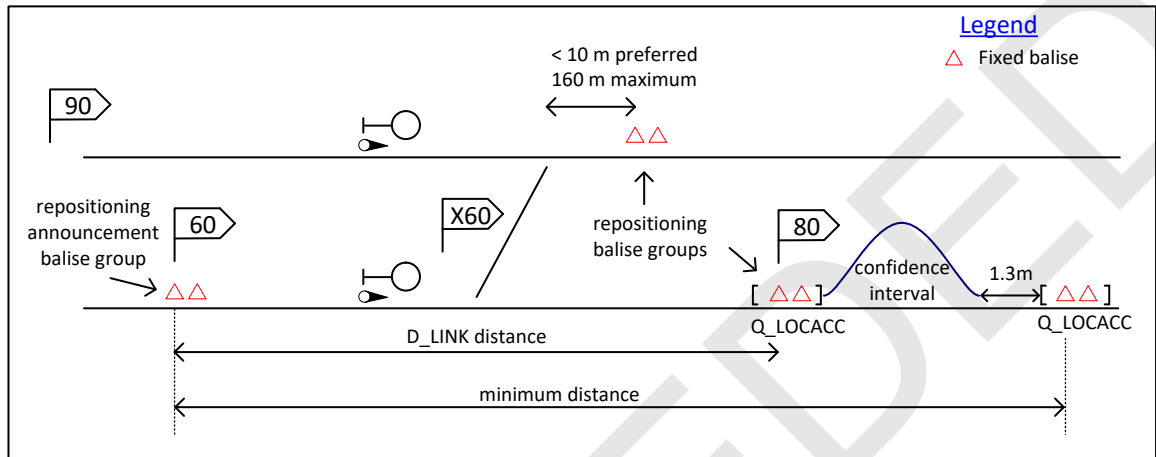


Figure 1 – Repositioning – low-risk turnout through a crossover

A position that is less than 160 m in advance of the end of the (last) turnout or crossover is permitted to allow the repositioning function to be combined in a balise group performing another function. See Figure 2 for an example.

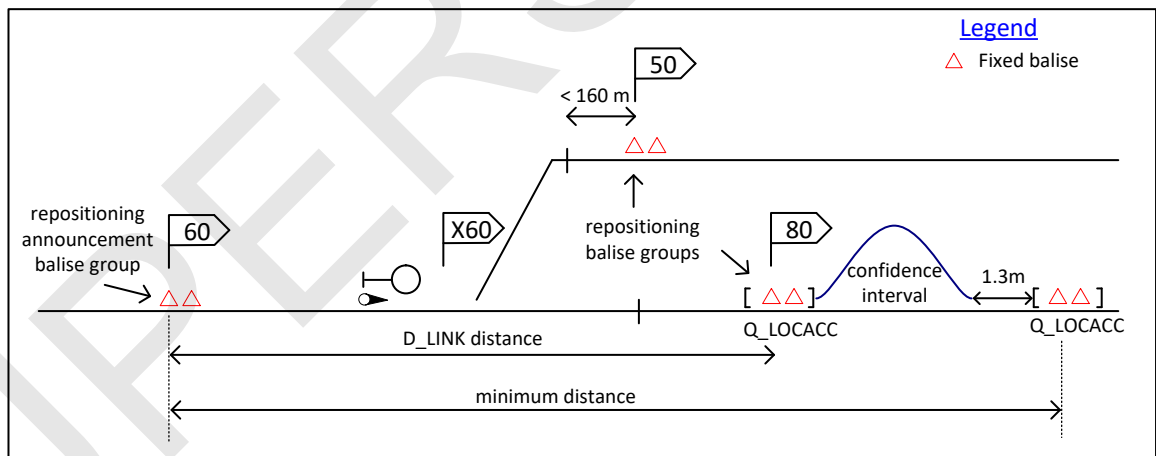


Figure 2 – Repositioning – low-risk turnout to a refuge line

The 160 m maximum distance avoids the operational restriction of providing a line speed update after the rear of a typical 8-car train has cleared the points. A position greater than 160 m is permitted if there is no speed difference on the diverging line.

The end of a crossover is assumed to be at the toe of the trailing end. The end of a turnout is assumed to be at the first insulated joint past the clearance point.

Apart from the expectation window requirements and those described in Section 6.2, the repositioning balise group on the non-diverging line has no specific positioning requirements.

The repositioning function will typically be combined in a balise group performing another function.

7.2.4.2 Repositioning for high-risk turnouts

For a high-risk turnout, the repositioning balise groups shall toggle-off the display of the LSSMA when required and typically transmit line speed.

The repositioning balise group on the diverging line shall be in advance of the end of the turnout or crossover. The preferred position is 160 m in advance of the end of the last turnout or crossover. The position may be up to 200 m in advance of the end of the last turnout or crossover. The position is not as critical as a low-risk turnout, as the diverging line speed is typically sent as an iteration by the repositioning announcement balise group. See Section 9.3.2 for more information on when the diverging line speed is sent.

The 160 m and 200 m distances aim to minimise the operational restriction for EMUs, consisting of 8-cars and 10-cars respectively. The line speed update minimises the operational restriction in the situation where the diverging line speed has not been sent by the repositioning announcement balise group and the repositioning balise group has been missed.

The repositioning balise group on the non-diverging line shall be in advance of the turnout and as close to the turnout as possible.

7.3 ETCS onboard equipment modes

Refer to T HR SC 01650 SP for details specific to the onboard subsystem.

7.3.1 Modes used

Where a mode transition is ordered from the trackside subsystem, the mode transition is achieved by transmitting packet #80, which contains the mode profile associated with an MA.

Refer to ETCS B3 MR1 GSM-R B1 for a full description of all mode transitions and the conditions required for each transition.

Section 7.3.1.1 to Section 7.3.1.5 describe the following:

- the modes used by the onboard equipment
- some of the common mode transitions
- details specific to the trackside subsystem.

7.3.1.1 Limited supervision

LS is the desired mode on running lines for both signalled and unsignalled moves. The LS mode cannot be selected by the driver. The order to change to LS mode shall be transmitted whenever an MA is transmitted for a given direction.

After a train has been tripped, re-entering LS mode cannot be achieved until a valid message is received from a balise group that transmits an MA and the order to change to LS mode for the applicable direction.

In LS mode, balise groups shall transmit the maximum network speed of 160 km/h for the V_MAMODE variable in packet #80, except for wrong running situations. See Section 8.9 for details.

7.3.1.2 Trip

TR mode commands the emergency brake.

7.3.1.3 Post trip

PT mode can be entered from TR mode if certain conditions are met, including the train being at a standstill. PT mode releases the emergency brake command.

7.3.1.4 Staff responsible

SR mode allows drivers to move trains under their own responsibility. SR mode is proposed by onboard equipment from PT mode when restarted unless driver selects shunting. SR mode is also used after the onboard equipment starts-up. A train is required to be in SR mode before it exits an ETCS-protected yard. Speed is limited by the SR mode speed limit (V_NVSTFF) of 40 km/h.

7.3.1.5 Shunting

SH is the desired mode for movements within yards where speed is limited by the SH mode speed limit (V_NVSHUNT) of 25 km/h. The order to change to SH mode shall be transmitted when entering an ETCS protected yard. Operational procedures specify that SH mode should be manually selected by the driver for amalgamating, dividing or setting back, if not already in SH mode.

Other modes used are as follows:

- SL
- NL
- IS
- SF
- SB
- UN.

7.3.2 Modes not used

The following modes are not used:

- FS
- OS
- SN
- RV
- PS.

7.3.3 Stop if in SH mode

Certain balise group functions transmit packet #132, which contains the 'Danger for Shunting' information. This packet transmits the 'Stop if in SH mode' order to trip the train if in shunting mode.

7.3.4 Stop if in SR mode

Certain balise group functions transmit packet #137, which contains the 'Stop if in Staff Responsible' information. This packet transmits the 'Stop if in SR mode' order to trip the train if in SR mode.

7.4 Movement authorities

Packet #12 contains the MA and MA shall be treated as a single section.

The section length of all MA shall be of the maximum value allowed in the data, with the following exceptions:

- ETCS trainstop balise groups when transmitting a trip order
- buffer stop balise groups
- buffer stop TSM-initiating balise groups
- buffer stop redundant TSM balise groups.

The order to change to level 1 (using packet #41) and the order to change to LS mode (using packet #80) shall be transmitted whenever a MA is transmitted for a given direction.

Balise groups in a level 0 area shall not transmit a MA, unless a transition to level 1 is announced. Balise groups transmitting an immediate transition order to level 0 shall not transmit a MA for the same direction.

7.5 Gradient

Packet #21 contains gradient information and is transmitted for the applicable direction from the following balise groups:

- those transmitting packet #12 for the same direction
- redundant TSM balise groups
- TSM-initiating balise groups.

Each gradient section shall be expressed as per mille (‰), safely rounded down to the nearest integer. For example, a 1.43% rising grade would be expressed as 14‰, and a -1.43% falling grade would be expressed as -15‰.

The gradient of the line shall be transmitted when the onboard computer is required to calculate a TSM braking curve. The default gradient of -35‰ shall be transmitted otherwise.

The VAD and SAD shall be the source of gradient information (where provided by the RIM). For a section containing a vertical curve (easement), the VAD shows the section split in two, with each half becoming part of the adjoining gradient section. This approach shall also be used for gradient information that cannot be sourced from the VAD.

Note: This requirement differs from ETCS B3 MR1 GSM-R B1.

Gradient information shall be provided to cover the permitted braking distance plus 20% of the permitted braking distance, ending at the farthest target point, to allow for the onboard equipment to accurately calculate the TSM braking curve.

Where the approach to a target point traverses a crossover, the gradient for the crossover shall be assumed to be the lower of the lines. The term 'lower gradient' implies a lower per mille value. For example, -3‰ is lower than -2‰.

The braking tool has a maximum of 10 gradient sections. If there are more than 10 sections of gradient over the required distance, then a gradient simplification process shall be followed to reduce the number to no more than 10. An iterative process may be required as the braking tool results and the gradient simplification results are dependent upon each other.

To limit the amount of data transmitted, a maximum of 10 gradient sections shall be used for the calculation of the braking curve.

7.5.1 Gradient simplification

The steps for gradient simplification shall be applied in the following order until there are 10 gradient sections. Within step b and step d, the simplification shall be applied in the order of travel:

- a. If two consecutive gradient entries have the same value, then the gradients shall be combined and treated as one entry.

- b. For a gradient section of less than 150 m adjoining a lower gradient section at one end, the section shall be assumed to be part of the lower gradient section. For a gradient section of less than 150 m adjoining lower gradient sections at both ends, the section shall be assumed to be part of the section with the higher gradient of the two.
- c. The initial sections shall be combined and assumed to have a gradient of the lowest of these sections, and assumed to end at a point where the EBD curve is 10 km/h above the line speed.
- d. Steps b and c shall be repeated, without the 150 m constraint.

For a detailed gradient simplification process, refer to GL S 45201.

7.6 Target speed monitoring

TSM is where train speed is supervised to an onboard calculated braking curve, braking to a target speed at a target point. The TSM target information is transmitted by balise groups in rear of the target.

TSM shall be used when approaching buffer stops, high-risk speed signs, high-risk turnouts, high-risk overruns and wrong running level crossings. All possible approaches to these hazards shall be taken into account.

7.6.1 Redundancy

The TSM target information shall be sent from two balise groups to provide redundancy.

The balise groups sending the TSM information shall be consecutive to provide a fail-safe solution and to avoid the TSM information associated with the target being omitted due to both balise groups being missed.

The first transmission is for redundancy purposes, providing a fail-safe solution for these high-risk locations if the second transmission is missed. This first transmission is typically transmitted from a balise group provided for another purpose. The balise group is termed the 'redundant TSM balise group'. A dedicated balise group may be necessary in certain layouts, for example where the target point is in advance of a facing turnout.

This redundant TSM shall be transmitted regardless of the signalling controls and can be transmitted from a fixed balise group. It shall be the most restrictive TSM associated with the hazard.

The redundant TSM balise group shall include any high-risk speed signs and any intermediate speed increases; however, the redundant TSM balise group shall not include any intermediate low-risk speed reductions. The inclusion of intermediate speed increases in the redundant TSM balise group is to ensure that the train can operate at line speed even if the TSM initiating balise group is missed.

The second transmission is from a balise group termed the 'TSM-initiating balise group'. One balise in this balise group shall be controlled by an LEU if the TSM is dependent upon signalling controls.

7.6.2 Lowest supervised speed within the movement authority

The display to the driver of the LSSMA is toggled on or off by the use of packet #180. Packet #181 shall always accompany packet #180, enabling this toggling.

The toggle-off order shall be transmitted by all balise groups, except in the following circumstances:

- LSSMA shall be toggled on at a controlled balise group (excluding the redundant balise group) protecting a high-risk overrun or turnout, if the signal aspect information provided to the LEU cannot positively identify whether the protecting/home signal is clear for either the straight or turnout routes
- where it is possible that a cascading function requires the display of the LSSMA to remain toggled on.

The LSSMA shall not be displayed for a high-risk converging junction, as TSM is always applied.

On an approach that includes a turnout or crossover, the design shall ensure that the LSSMA speed displayed to the driver is not higher than the turnout speed on the approach.

After traversing a high-risk turnout, the display of the LSSMA shall remain toggled on until passing the repositioning balise group.

For a high-risk overrun, the display of the LSSMA shall remain toggled on until passing the balise group associated with the protecting signal or has been toggled off by a balise group provided on the approach to revoke a TSM (once the signal aspect clears). The toggle off order shall be transmitted by a balise group up to 8.9 m in rear of, or up to 10 m in advance of the protecting signal. The balise group shall be fixed unless the toggle off function is combined with a function requiring a controlled balise group.

7.6.3 Braking tool

The braking tool is a customised version of the ERA braking curves tool. The ERA publishes an accompanying handbook for this tool.

The braking tool is customised by applying the following:

- service brake
 - deceleration rate of 0.55 ms^{-2} (based on the C set and K set)
 - brake delay of 3.6 seconds (based on the K set).

- emergency brake
 - deceleration rate of 0.6 ms^{-2} (derived from the GE52 braking curve)
 - brake delay of 3.85 seconds (based on the M set).

The 'permitted distance' results given by the braking tool shall be used as an input for all TSM design. The TSM-initiating balise group shall not be closer to the target point than this permitted distance.

Buffer stops shall use the EOA or SvL option with fixed release speed. All other TSM calculations shall use the 'LOA/MRSP' option.

The location accuracy of all 'relocation balises' shall be 5 m unless otherwise stated. Refer to ETCS B3 MR1 GSM-R B1 principles for the balises that are considered as relocation balises.

7.7 National values

National values are variables applicable to the whole network. Packet #3 contains the national values.

National values shall be transmitted for movements in both directions at all yard balise groups, VBC balise groups, and at all level transition announcement and border balise groups. The values shall be applicable immediately when received.

Table 3 specifies the applicable national values.

Table 3 – National values

Variable	Explanation	Value
NID_C	Identity number of the country or region	540
V_NVSHUNT	SH mode speed limit	25 km/h
V_NVSTFF	SR mode speed limit	40 km/h
V_NVONSIGHT	On sight mode speed limit	30 km/h
V_NVLIMSUPERV	LS mode speed limit	40 km/h
V_NVUNFIT	Unfitted mode speed limit	160 km/h
V_NVREL	Release speed	40 km/h
D_NVROLL	Roll away distance limit	2 m
Q_NVSBTSMPerm	Permission to use service brake in TSM	Yes
Q_NVEMRRLS	Permission to revoke the emergency brake command	Only at standstill
Q_NVGUIPERM	Permission to use the guidance curve	No
Q_NVSBFBPerm	Permission to use the service brake feedback	No
Q_NVINHSMICPerm	Permission to inhibit the compensation of the speed measurement inaccuracy	No

Variable	Explanation	Value
V_NVALLOWOVTRP	Speed limit allowing the driver to select the override function	0 km/h
V_NVSUPOVTRP	Override speed limit to be supervised when the override function is active	25 km/h
D_NVOVTRP	Maximum distance for overriding the train trip	100 m
T_NVOVTRP	Maximum time for overriding the train trip	45 s
D_NVPOTRP	Maximum distance for reversing in post trip mode	0 m
M_NVCONTACT	T_NVCONTACT reaction	No reaction
T_NVCONTACT	Maximum time without new safe message	∞ s
M_NVDERUN	Entry of driver ID permitted while running	Yes
D_NVSTFF	Maximum distance for running in SR mode	∞ m
Q_NVDRIVER_ADHES	Qualifier for the modification of trackside adhesion factor by driver	Not allowed
A_NVMAXREDADH1	Maximum deceleration under reduced adhesion conditions (1)	1.0 ms^{-2}
A_NVMAXREDADH2	Maximum deceleration under reduced adhesion conditions (2)	0.7 ms^{-2}
A_NVMAXREDADH3	Maximum deceleration under reduced adhesion conditions (3)	0.7 ms^{-2}
Q_NVLOCACC	Default accuracy of the balise location (absolute value)	5 m
M_NVAVADH	Weighting factor for available wheel or rail adhesion	0
M_NVEBCL	Confidence level for emergency brake safe deceleration on dry rails	9
Q_NVKINT	Qualifier for integrated correction factors	0

7.8 Data variables

The data variables shall be set as indicated in Table 4.

Table 4 – Data variables

Variable	Explanation	Value
Q_SCALE	Qualifier for the distance scale	1 m
Q_UPDOWN	Balise telegram transmission direction	Up link telegram
M_VERSION	Version of ETCS system	2.0
Q_MEDIA	Qualifier to indicate the type of media	Balise
M_DUP	Duplicate balise	No duplicates
V_MAIN	Signalling related speed restriction (where there is no trip)	160 km/h

Variable	Explanation	Value
V_LOA	Permitted speed at the limit of authority (where there is no trip or not approaching a buffer stop)	160 km/h
V_LOA	Permitted speed at the limit of authority (trip order or approaching a buffer stop)	0 km/h
T_LOA	Validity time for the target speed at the limit of authority (where there is no trip or not approaching a buffer stop)	∞ s
T_LOA	Validity time for the target speed at the limit of authority (trip order or approaching a buffer stop)	0 s
Q_DANGERPOINT	Qualifier for danger point description (not approaching a buffer stop)	0
Q_DANGERPOINT	Qualifier for danger point description (approaching a buffer stop)	1
Q_ENDTIMER	Qualifier to indicate whether end section timer information exists for the end section in the MA	0
Q_OVERLAP	Qualifier to tell whether there is an overlap	0
L_SECTION	Length of section in the MA (in a repositioning balise group not in advance of a buffer stop TSM-initiating balise group)	32767 m
L_SECTION	Length of section in the MA (in a repositioning balise group in advance of a buffer stop TSM-initiating balise group)	Distance to EOA
L_ACKMAMODE	Length of the acknowledgement area in rear of the start of the required mode	0 m
L_MAMODE	Length of the area of the required mode	Infinite length
Q_MAMODE	Qualifier to indicate the supervision of the beginning of the mode profile	0

The data variable for the message counter, M_MCOUNT shall have values assigned as indicated in Table 5.

Table 5 – M_MCOUNT values

Balise type	Function	M_MCOUNT
Fixed	All	255
Controlled	Default telegram	254
Controlled	Line speed	1
Controlled	ETCS trainstop trip	2
Controlled	High-risk overrun: protecting signal at stop. Values from 4 to 9 shall be used where the balise group protects more than one high-risk overrun (values allocated from the least to the most restrictive).	3 to 9

Balise type	Function	M_MCOUNT
Controlled	High-risk turnout: home signal at stop (unless this aspect has been assigned an M_MCOUNT for another function)	10
Controlled	High-risk turnout: home signal clear for its only turnout	11
Controlled	High-risk turnout: home signal clear for a turnout (values allocated from least to most restrictive) (values to be equal for equal speed profiles)	11 to 19

In a cascading function situation where a message covers more than one TSM, the M_MCOUNT value shall be assigned according to the most restrictive TSM.

7.9 Virtual balise cover

The VBC function allows a balise group or a set of balise groups to be ignored by the onboard equipment.

This function may be used to allow trains to ignore balise groups that have been installed and not yet commissioned. This shall be achieved by installing dedicated temporary balise groups on each approach to the yet-to-be commissioned area. Using packet #6, these VBC order balise groups shall either set or remove the VBC for the applicable direction.

The VBC order function shall be transmitted from two consecutive balise groups for redundancy. VBC orders shall have a validity period of seven days.

For a balise to be able to be ignored, the balise shall transmit a marker identification in packet #0. All balises shall transmit packet #0 except for big metal mass announcement balise groups in level 0 territory, yard balise groups and TSW balise groups. The marker identification shall be number 63 for balises in VBC balise groups, number 3 for ASDO balise groups, number 2 is for ETCS Level 2, and number 1 for all other balises that transmit packet #0.

When exiting a yard, yard balise groups shall transmit packet #6 set to remove any VBC with a marker identification number 1 that may be stored.

The use of other VBC marker identification numbers may be considered for use subject to a formal risk assessment (that is, for complex stage working requirements).

8 Fixed balise group functions

A fixed balise group is a balise group that always transmits the same message; that is, the message is not dependent upon any signalling controls and thus an LEU is not required. The functions described in this section, in addition to repositioning and LSSMA toggle off, shall be implemented using fixed balise groups, except where these functions can be combined with other functions requiring a controlled balise group.

8.1 Level transitions

Level transitions shall be provided between level 0 and level 1 territory.

Areas of track infrastructure not fitted with ETCS are defined as level 0 territory.

The only balise groups used in level 0 territory on the TfNSW MHRN are for big metal masses, TSW signs, VBC orders and announcement of level transitions.

All balise groups that transmit a MA shall also transmit an immediate level transition order.

Packet #41 contains the level transition information.

8.1.1 Level 0 territory

Level 0 territory exists on the network where trackside fitment has not been provided and shall be managed via a level transition border application.

Level 0 territory is typically (but not limited to) adjacent rail networks managed by third party RIMs, for example:

- ARTC Defined Interstate Rail Network
- ARTC Metropolitan Freight Network (both electrified and unelectrified)
- Country Regional Network
- Port Kembla Port Corporation
- BHP railway at Wollongong
- power station and mine loops/sidings
- Sydney Metro.

For management of levels and modes at sidings as part of the TfNSW MHRN, adjoining Level 1 territory, see Section 8.6.

8.1.2 Level transition borders

Level transition borders exist where level 0 territory meets level 1 territory.

A balise group shall be placed at the level transition border. The first balise in the direction of travel (N_PIG 0) shall be placed within 3 m of the level transition border. It shall transmit an immediate level transition, achieved by the data variable D_LEVELTR assigned the value of 32767. The order to change to level 1 shall additionally be transmitted by other balise groups whenever a MA is transmitted for a given direction.

On a unidirectional line, the level transition balise group shall transmit a level 1 transition for one direction and a level 0 transition for the other. Figure 3 shows an example of this arrangement.

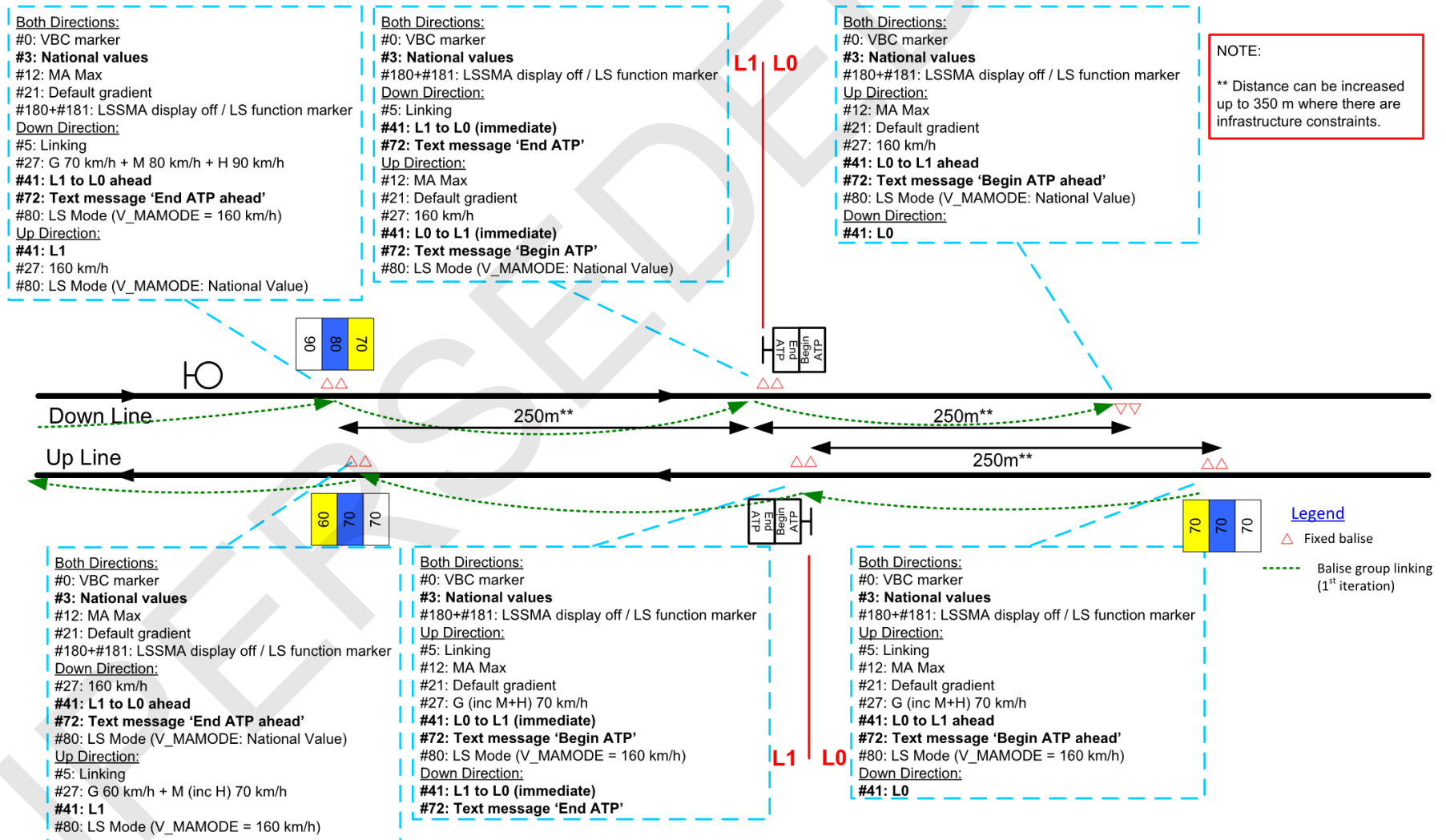


Figure 3 – Level transition

On a single line or bidirectional line, the Up and Down level transition borders should coincide or be placed in close proximity. If the borders coincide, then this reduces the number of balises required. If the borders are in close proximity, then this aids drivers' route knowledge.

In the case of multiple lines, the level transition borders for each line should be in close proximity to aid drivers' route knowledge.

Where the level 0 and level 1 border transitions do not coincide on a given line, the 'BEGIN ATP' and 'END ATP' signs shall be placed adjacent to their relevant reference balise. Where the transitions coincide, the back-to-back 'BEGIN ATP' and 'END ATP' signs shall be placed adjacent to the reference balise, with the primary purpose of the balise group deemed to be for the normal running direction.

The location of level transition borders should be chosen where the driver is less likely to be concentrating on other critical tasks. To achieve this and to minimise certain risks associated with the transition, the following apply for the location of level transition borders:

- level transition borders should be placed:
 - in automatic sections or outside of yard limits
 - in areas with adequate sighting
 - where the first signal in the level 0 area has a trip arm style trainstop.
- level transition borders should not be placed:
 - in proximity to stations, junctions, level crossings, or any other location that may be associated with route complexity or elevated attentional demand by the driver
 - in areas where signals are closely spaced.
- level transition borders shall not be placed:
 - in areas where a driver fails to acknowledge a transition that would result in the train stopping in a tunnel, on a bridge or on a viaduct
 - in areas of insufficient braking in rear of hazards requiring ETCS protection, when entering level 1 territory
 - less than 1 km in the rear of what would be deemed a high-risk speed sign, high-risk turnout or high-risk overrun, when entering level 0 territory.

Specific trackside constraints between the TfNSW MHRN and adjacent networks (managed by other RIMs), may not allow for level transition borders fully compliant with this section. In such cases, TAOs shall consult with RIMs, Rolling Stock Operators (RSO), and AMB as to the outcome. The proposed solution shall be captured as a concession in accordance with TS 00003.1.

For level transitions to Level 0 when entering adjacent networks (managed by other RIMs), the contents of packet #0, packet #3 and packet #6 shall be agreed upon with the RIMs of affected networks, and RSOs of affected train fleet(s).

To allow the driver to select either level 0 or level 1, packet #41 shall transmit the following in addition to the immediate transition:

- for a transition from level 0 to level 1, an iteration containing level 0 as a lower priority
- for a transition from level 1 to level 0, an iteration containing level 1 as a lower priority.

8.1.3 Level transition announcement

Announcement balise groups shall be provided on both approaches to level transition borders. The preferred position is 250 m in rear; however, it may be up to 350 m if infrastructure constraints do not permit. The exception to this is for the level 1 to level 0 transition announcement for the unsignalled direction. There is no positional requirement for this function. Therefore, this function does not need a dedicated balise group, and is typically combined in the balise group closest to the transition border.

Announcement balise groups should be placed at a speed sign, unless a speed sign is not present in the vicinity. This allows the driver, a sufficient distance to react to the speed sign before reaching the level transition. It can also allow the balise group to be reused for the speed sign in a subsequent stage.

The announcement balise group shall transmit a distance-delayed level transition order, providing redundancy for the level transition border balise group. The distance ($D_{LEVELTR}$) shall be the distance from the level transition announcement balise group ($N_{PIG 0}$) to the level transition border balise group ($N_{PIG 0}$) plus half the confidence interval. This variable aims to minimise the likelihood that the transition acknowledgement request does not occur before the level transition border.

8.1.4 Text messages

Level transition and announcement balise groups shall transmit important, plain text messages to be displayed to the driver. Packet #72 contains the text for the message. Driver acknowledgment shall not be requested.

The message transmitted from level 0 to level 1 transition announcement balise groups shall be 'Begin ATP ahead'.

The message transmitted from level 1 to level 0 transition announcement balise groups shall be 'End ATP ahead'.

These level transition announcement messages shall be displayed immediately upon passing the announcement balise groups.

The messages shall continue to be displayed until the level changes.

The message transmitted from level 0 to level 1 transition border balise groups shall be 'Begin ATP'.

The message transmitted from level 1 to level 0 transition border balise groups shall be 'End ATP'.

These level transition border messages shall be displayed immediately upon the level change.

The messages shall continue to be displayed for five seconds.

8.2 Speed signs

The scope for speed signs includes all permanent track speed signs, except for the following:

- intermediate trainstop advisory speed signs
- turnout speed signs
- yards speed signs
- freight speed signs.

A balise group shall be placed at each speed sign with the reference balise placed as follows:

- in line to the speed sign
- up to 20 m in rear or advance of the speed sign for a speed increase, or up to 20 m in advance for a speed decrease.

Exceptions to the above requirement are as follows:

- When meeting the above distance is not possible, an appropriate risk assessment for the given location shall be undertaken to establish an alternative position for the speed sign balise group (including recombination with existing balise group). The risk assessment has to be completed prior to the configuration management gate 4 and included as part of the minimum requirements for the gate submission, in accordance with T MU AM 04001 PL. The risk assessment shall contain each specific noncompliance and how the risk is controlled SFAIRP.
- Speed sign balise group shall not be installed where it could unintentionally revoke TSM. For such speed signs, the speeds shall be transmitted as a distance-delayed iteration by the TSM-initiating balise group in rear of the speed sign.
- Speed sign balise group should not be installed when a route is associated with a shunting signal only. This is permitted if there is no safety impact and it minimises the potential operational impact or unnecessary mode change commands.

The risk assessment process shall ensure that the additional requirements of ETCS level 1 are still adhered to, that all appropriate stakeholders are consulted and the requirements of the RIM are applied.

Figure 4 and Figure 5 show examples of balise groups at speed signs.

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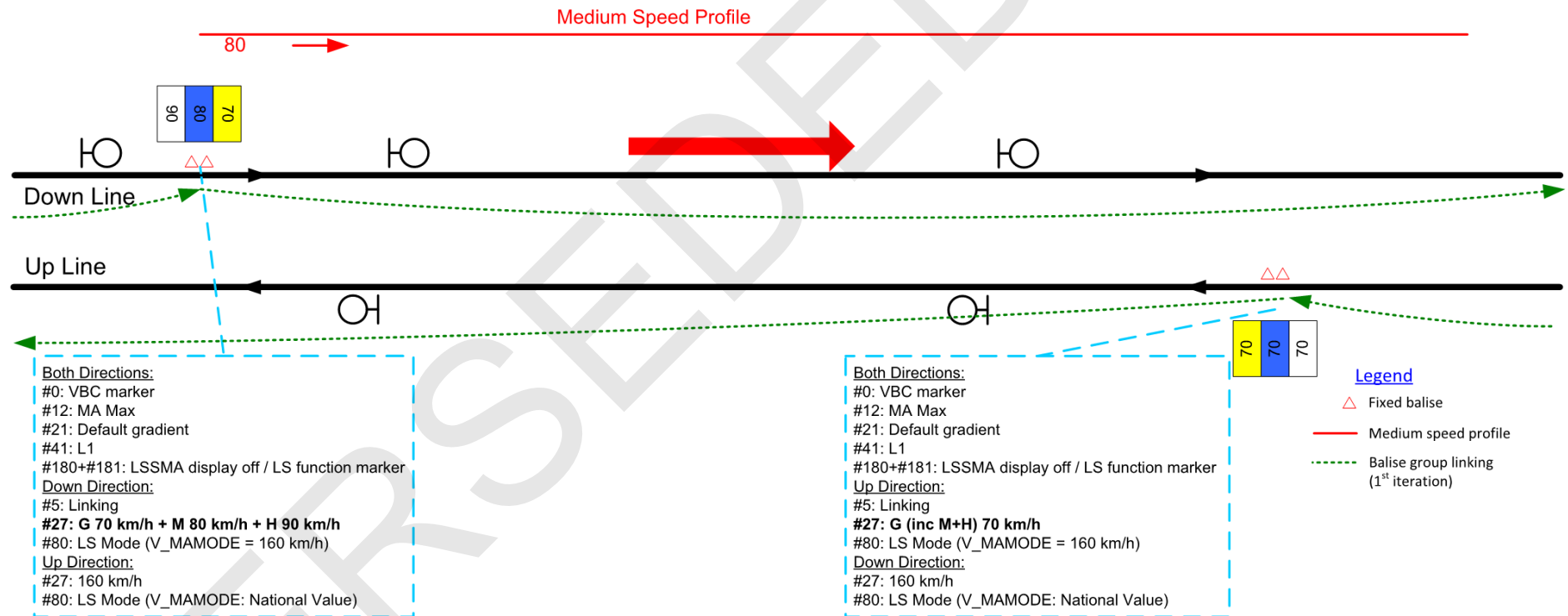


Figure 4 – Speed signs – unidirectional line

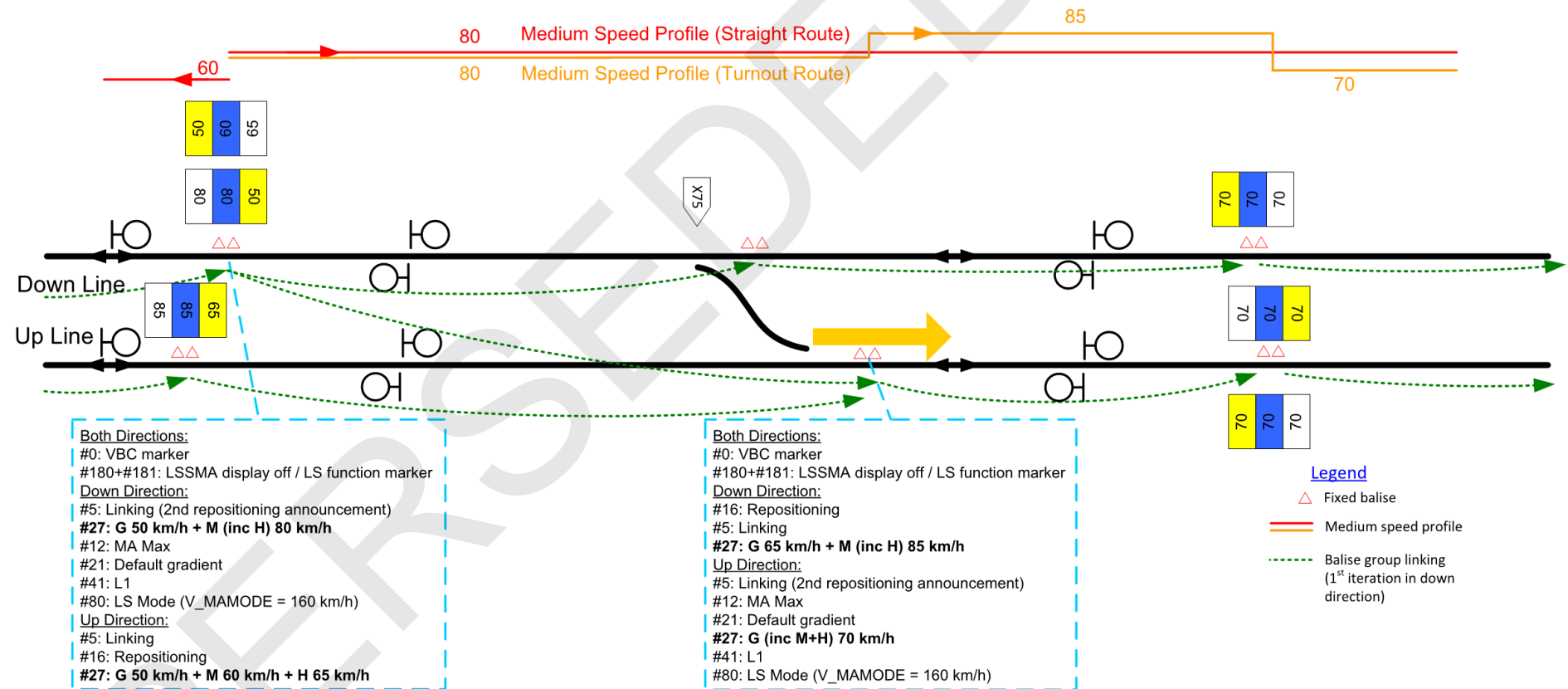


Figure 5 – Speed signs – bidirectional lines

Packet #27 transmits the SSPs. Three profiles shall be transmitted as general, medium and high. All speed sign information identified in TS TOC 1 and TS TOC 2 and subsequent weekly notices shall be correlated with actual onsite speed signage.

The speeds for normal, MU and XPT speed signs shall be transmitted as general, medium and high profiles, respectively.

The general profile shall be the 'basic' profile transmitted. The medium profile shall be transmitted utilising the variables Q_DIFF=0 and NC_CDDIFF=1. The high profile shall be transmitted utilising the variables Q_DIFF=0 and NC_CDDIFF=2. To reduce the amount of data transmitted, medium or high speed profiles, or both, shall not be sent if they are the same speed as a transmitted lower speed profile.

Train length delay shall not be enforced at a speed sign.

8.2.1 High-risk speed signs

Speeds signs in the scope as specified in Section 8.2 are classified as either low-risk or high-risk.

Balise groups at low-risk speed signs provide CSM, where speed is supervised without the need to brake to a target. Where a low-risk speed sign indicates a reduction in line speed, the train is not supervised to this new line speed until the speed sign is passed. Where there is a deemed risk of a train travelling faster than the new line speed at (or just in advance of) the speed sign, then the speed sign is deemed high-risk, and is protected by announcing it from a balise group in the rear, using TSM with the speed sign as the target. See Figure 6 for an example of this arrangement.

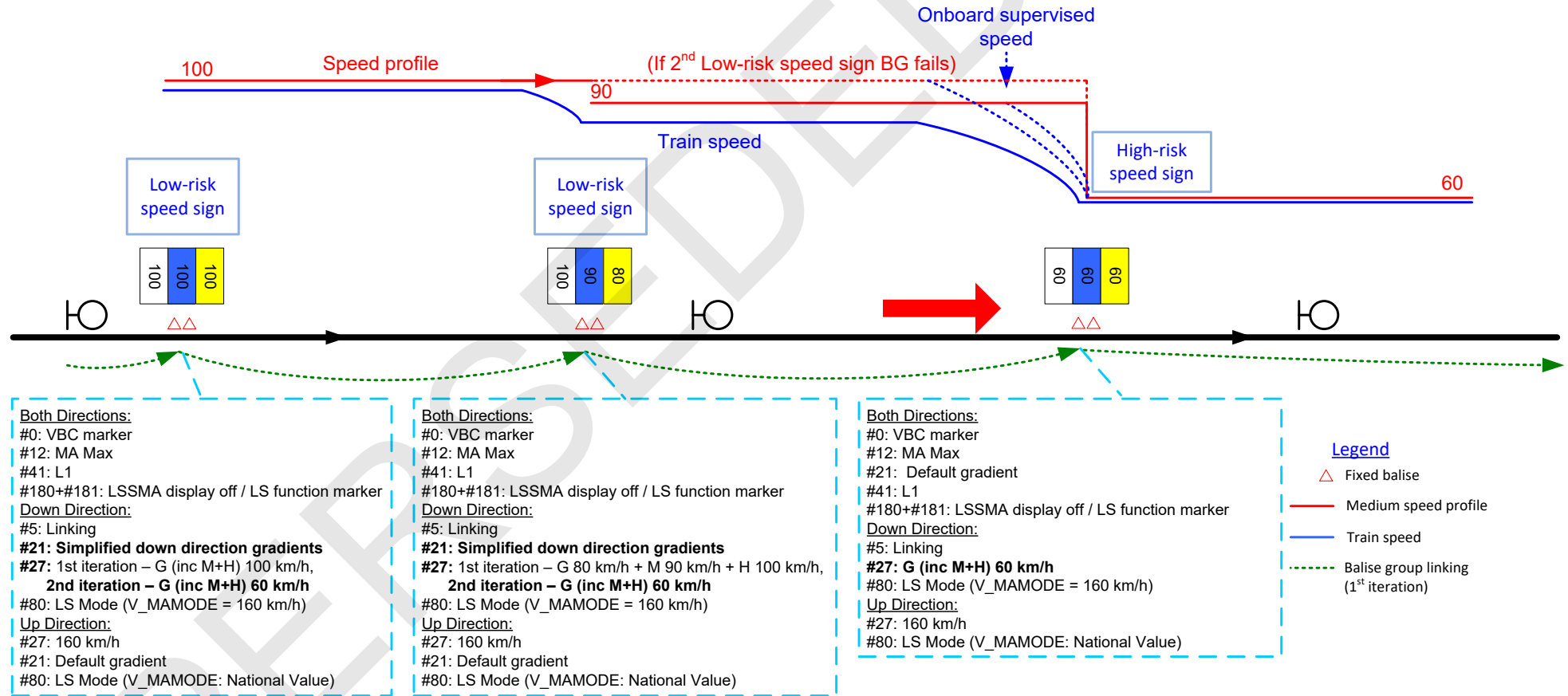


Figure 6 – High-risk speed sign

The braking tool shall be used to determine which balise group in rear of the high-risk speed sign becomes the TSM-initiating balise group.

Speed signs can only be deemed high-risk if they indicate a reduction in line speed for the medium or high profiles. The general profile does not need to be considered in determining high-risk speed signs.

A speed sign shall be deemed high-risk if there is a specified hazard within the deceleration distance in advance of the speed sign, assuming deceleration does not start until the train is at the speed sign. This deceleration distance shall be calculated as the distance travelled in 2 seconds at the approach line speed, plus the distance travelled to decelerate to the posted line speed at a deceleration rate of 0.6 ms⁻².

The specified hazards are as follows:

- a timed level crossing approach where over-speeding would result in a warning time less than the minimum required
- a deemed high-risk level crossing protected by controlled signals
- a manually controlled level crossing
- a platform.

If the above specified hazards do not exist in the deceleration distance, then the following shall apply:

- The speed sign shall be deemed low-risk if the speed reduction is 17% or less.
- If the speed reduction is greater than 17% and less than 25%, then the speed sign shall be deemed as high-risk if the track in the deceleration distance is curved horizontally. In this context, being curved is defined as having any curve tighter than 500 m radius, or having any curve tighter than 950 m radius if the approach line speed is greater than 115 km/h.
- If the speed reduction is greater than or equal to 25%, then the speed sign shall be deemed high-risk.

Speed reductions shall be calculated as a percentage of the posted line speed. For example, a reduction from an approach line speed of 100 km/h to a posted line speed of 80 km/h shall be considered a 25% speed reduction.

The determination of turnouts and overruns as being high-risk is generally based on the approach speed to the first warning signal protecting the hazard. For situations where a speed sign exists between the first warning signal and the hazard, it may be possible to sufficiently mitigate the hazard by treating the speed sign as high-risk. This solution should be implemented if possible, as it can be achieved by the use of fixed balise groups.

8.2.2 Level crossing speed signs

Balise groups at level crossing speed signs shall send a speed profile that includes speed iterations for the following:

- indicated level crossing speed on approach
- line speed prior to the level crossing speed sign (applied at the departure edge of the crossing), to ensure a train can return to line speed as soon as possible after passing the crossing.

If the level crossing speed sign is a high-risk speed sign, then the line speed at the departure edge of the crossing shall also be sent from the redundant balise group and balise group initiating the TSM.

8.2.3 Temporary speed signs

Temporary speed signs include the warning, caution and clearance signs for speed-restricted areas. Where there is a requirement to protect a speed-restricted area with ETCS equipment, a TSW balise group shall be installed at the warning sign, with the reference balise preferably placed adjacent to the sign. See Figure 7 for an example of this arrangement.

Where physical constraints exist on site and to provide a fitment tolerance to aid in the installation, the TSW balise group may be placed as close as practicable up to 30 m in advance of the warning sign in the direction of travel. The 30 m distance provides an adequate margin for a train having passed the warning sign and the system alerting the driver of TSR.

TSW balise groups shall transmit an important, plain text message to be displayed to the driver. Packet #72 contains the text for the message. The message transmitted shall be 'Warning: Temporary Speed Restriction'. The message shall be displayed immediately upon passing the balise group. The message shall continue to be displayed until acknowledged by the driver. The service brake shall be commanded if the message is not acknowledged within five seconds.

The TSW balise group shall not be placed in rear of the TSW sign to reduce the risk of a driver being distracted when approaching the TSR.

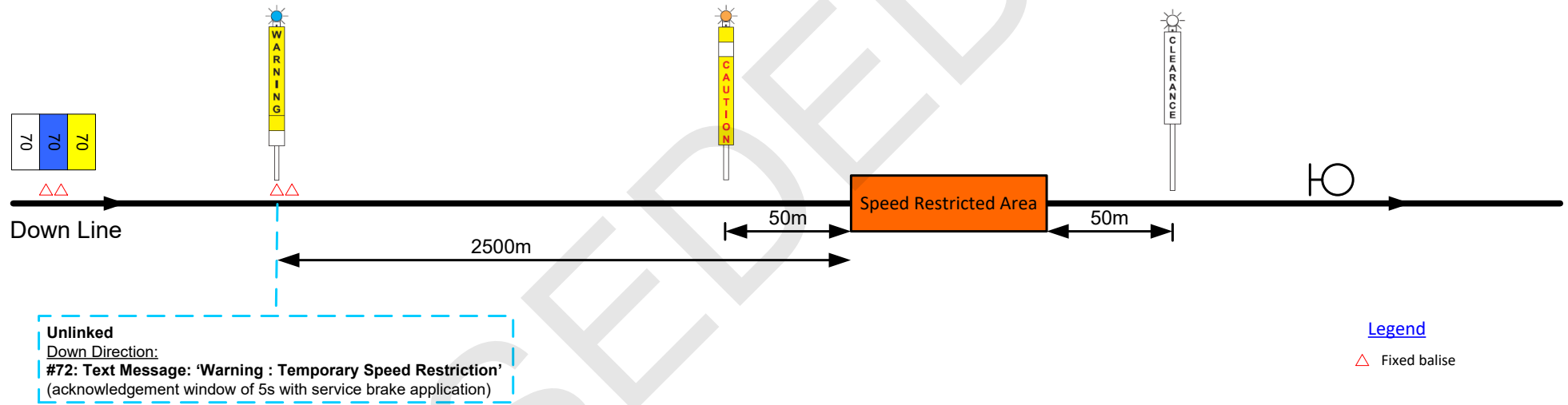


Figure 7 – Temporary speed signs with TSW balise group

8.2.4 Speed sign deficiencies

Certain portions of track on the network do not have track design speeds indicated by speed signs. These deficiencies typically occur on loop lines and where trains turn back or turnout onto the track in the opposite direction of normal running.

If speeds are indicated in the opposite direction, then the track design speeds shall be assumed to be the lower of either the opposite direction speeds or those on the next speed sign in advance. This may be a turnout speed sign or an implied X25 km/h speed sign at a converging junction. A risk-based approach shall be followed, if this assumption results in speeds lower than the turnout speed entering this portion.

If speeds are not indicated in the opposite direction, then the track design speeds shall be assumed to be the lower of either of the following:

- the speeds on the speed sign in rear (typically a turnout speed sign, posted or implied)
- the speeds on the speed sign in advance (which may be a turnout speed sign, posted or implied, at a converging junction).

Refer to *AMS Project Specifications – Resolving Maximum Speed In Areas Where Speed Signs Are Deficient* for more information.

An assumed track design speed shall never be higher than that is suitable for the existing signalling system.

8.3 Converging junctions

Converging junctions include situations where two running lines converge, or at a facing crossover where the only main class signalled moves are through the turning out lay. See Section 8.6.1 for details on converging when exiting a yard.

A balise group may not be required to be installed at or in advance of a converging junction; however the balise groups in rear of the convergence may require extra SSP iterations, in accordance with Section 8.3.1.

The turnout (facing or trailing) of a converging junction may be deemed high-risk. See Section 9.3.1 for details on assessing high-risk turnouts.

At a facing crossover where the only main class signalled moves are through the turning out lay, the target point for a high-risk converging junction shall be the facing turnout.

Where two running lines converge, the target point for a high-risk converging junction shall be one of the following, in order of preference:

- the turnout speed sign
- the toe of the catch points (where the converging turnout has an associated catch point)

- the geometric beginning of the turnout.

A high-risk converging junction requires a balise group in rear to become the high-risk turnout balise group, as detailed in Section 9.3.2, however this balise group may be fixed, as the SSP iterations are not dependent upon signalling aspects. The display of the LSSMA shall not be toggled on.

8.3.1 Converging junctions static speed profiles

The high-risk turnout balise group for a high-risk converging junction shall send an SSP containing the following iterations:

- line speed at the balise group
- converging turnout speed
- line speed in advance of the convergence, starting at the toe of the trailing points (this iteration is only required where there is no balise group that can provide an SSP update within 160 m in advance of the toe of the trailing points)
- any additional iterations necessary for TSMs in advance of the convergence.

See Figure 8 for an example of this arrangement.

For a low-risk converging junction, the balise group in rear of the convergence shall send an SSP containing the following iterations:

- line speed at the balise group
- line speed in advance of the convergence, starting at the toe of the trailing points (this iteration is only required where there is no balise group that can provide an SSP update within 160 m in advance of the toe of the trailing points)
- any additional iterations necessary for TSMs in advance of the convergence.

See Figure 9 for an example of this arrangement.

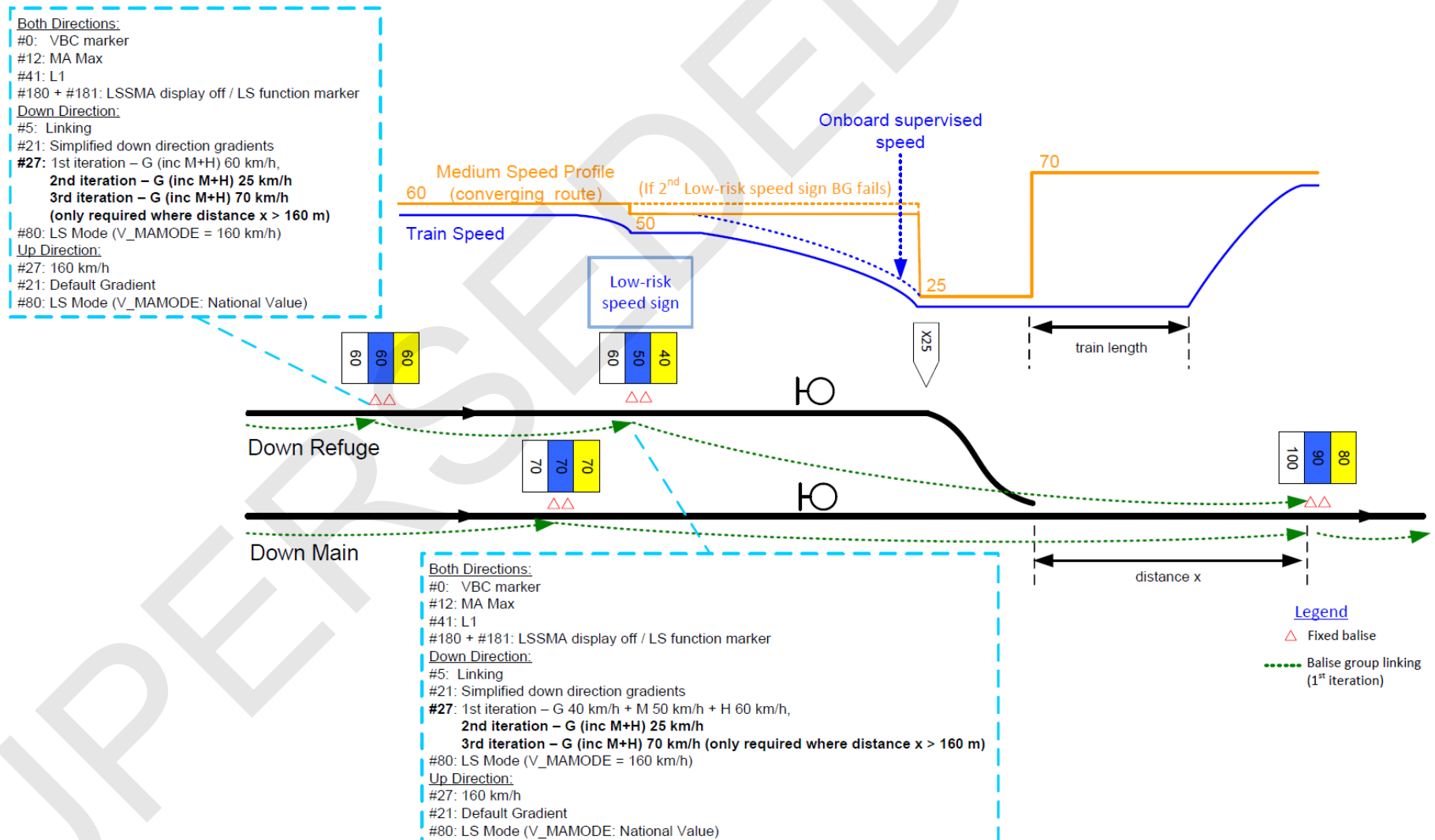


Figure 8 – High-risk converging junction

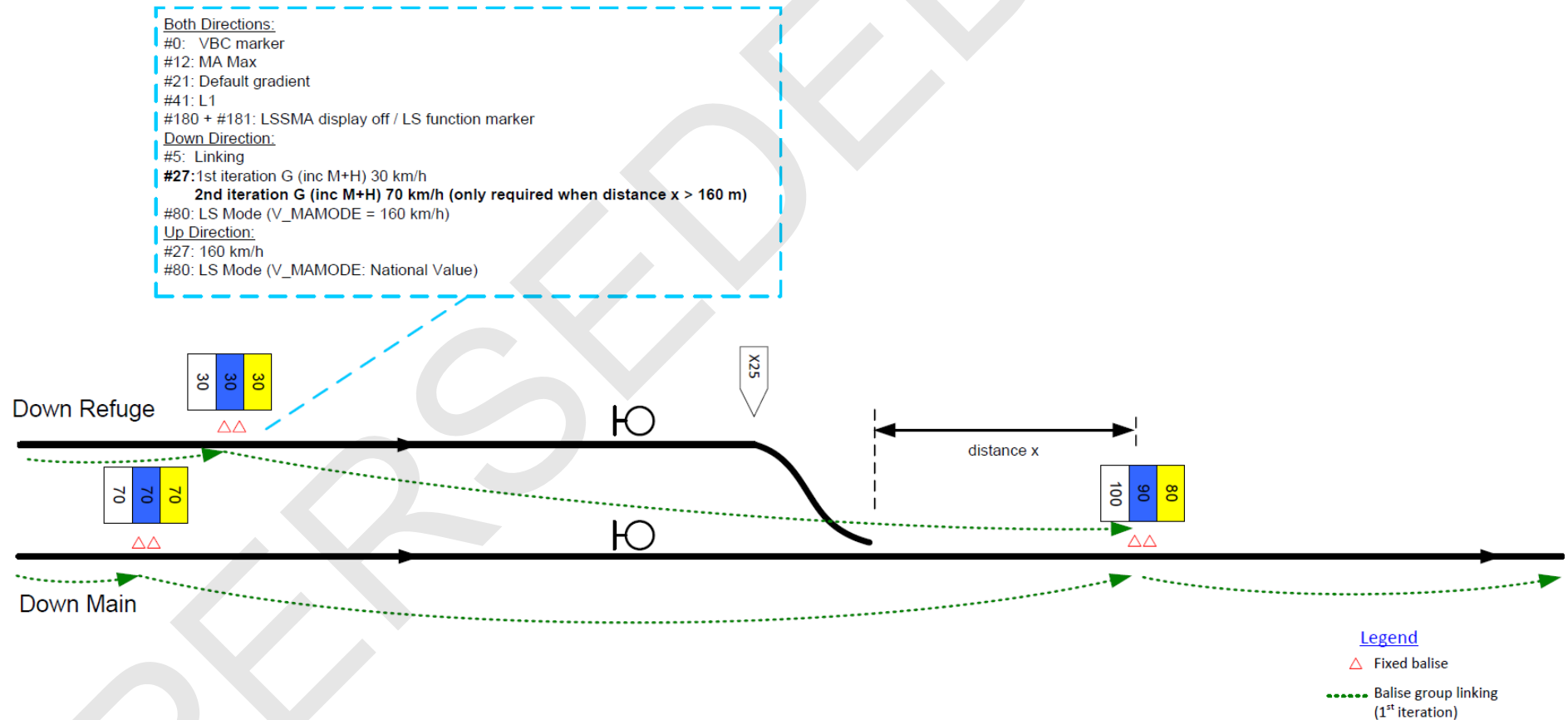


Figure 9 – Low-risk converging junction

8.4 Calibration

Calibration balises are used for the purpose of resetting the confidence interval and improving the odometer accuracy.

Where the TSM-initiating balise group for a high-risk speed sign is required that is greater than 2 km in rear of the high-risk speed sign and there is no balise group that can provide calibration within that distance, then a calibration balise shall be installed if either of the following can be demonstrated:

- the braking tool permitted braking distance can be reduced by more than 150 m
- reduce the travel time by more than 4 seconds.

Figure 10 shows an example of the calibration balise arrangement where the position improvement distance is greater than 150 m.

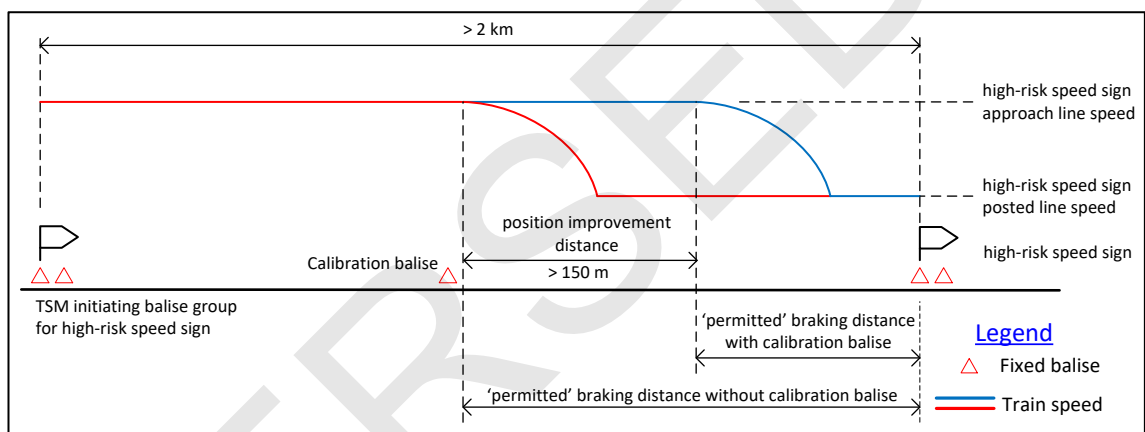


Figure 10 – Calibration balise

The travel time reduction shall be calculated by subtracting the time taken to travel the position improvement distance at the approach line speed, from the time taken to travel the position improvement distance at the posted line speed.

The preferred location for the calibration balise is at the 'permitted' braking distance in rear of the speed sign, calculated without the calibration balise present.

8.5 Buffer stops

TSM shall be used when approaching a buffer stop on a running line, with RSM used in the vicinity of the EOA. An end-of-line without a buffer stop shall be treated as a buffer stop at the end of the line.

Balise group configuration differs depending on the distance between the operational stopping location and the buffer stop.

The operational stopping location at a platform leading to a buffer stop shall typically be the 8-car (or last) marker, if one exists, or the platform railing.

The SvL shall be defined at a point that is 40 m in advance of the EOA. This distance is sufficient to maintain a manageable speed on the approach to the buffer stop and to avoid supervision of the SvL interfering with the approach to the EOA.

8.5.1 Short overrun distance available

The buffer stop balise group (immediately in rear of the EOA) shall consist of one balise where the distance between the operational stopping location and the friction or combination of hydraulic and friction buffer stop is less than or equal to 10 m.

The configuration shall be as follows:

- The EOA shall be the buffer stop.
- A TSM-initiating balise group shall be placed no closer than the braking tool 'permitted' distance in rear of the EOA.
- A single balise shall be placed 40 m in rear of the EOA, used for calibration purposes.
- A single balise shall be placed 3.3 m in rear of the EOA. For movements in both directions, this balise shall transmit a trip order that immediately commands the emergency brake. It shall also transmit 'Stop if in SH mode' and 'Stop if in SR mode'.
- The release speed shall be 10 km/h.

For an example of this arrangement, see Figure 11.

The location specific assessment shall be carried out to determine if any safety benefit can be achieved by installing a fixed balise at 3.3 m from the buffer stop. This installation is done in consideration of the actual capability of the fitted train to read the balise before hitting the buffer stop.

Additional method of protection, such as intermediate trainstops, shall be provided if the assessment determines that a desired safety benefit is not achievable unless stakeholders advise that residual risks can be managed differently; for example, tolerated or transferred to different programs.

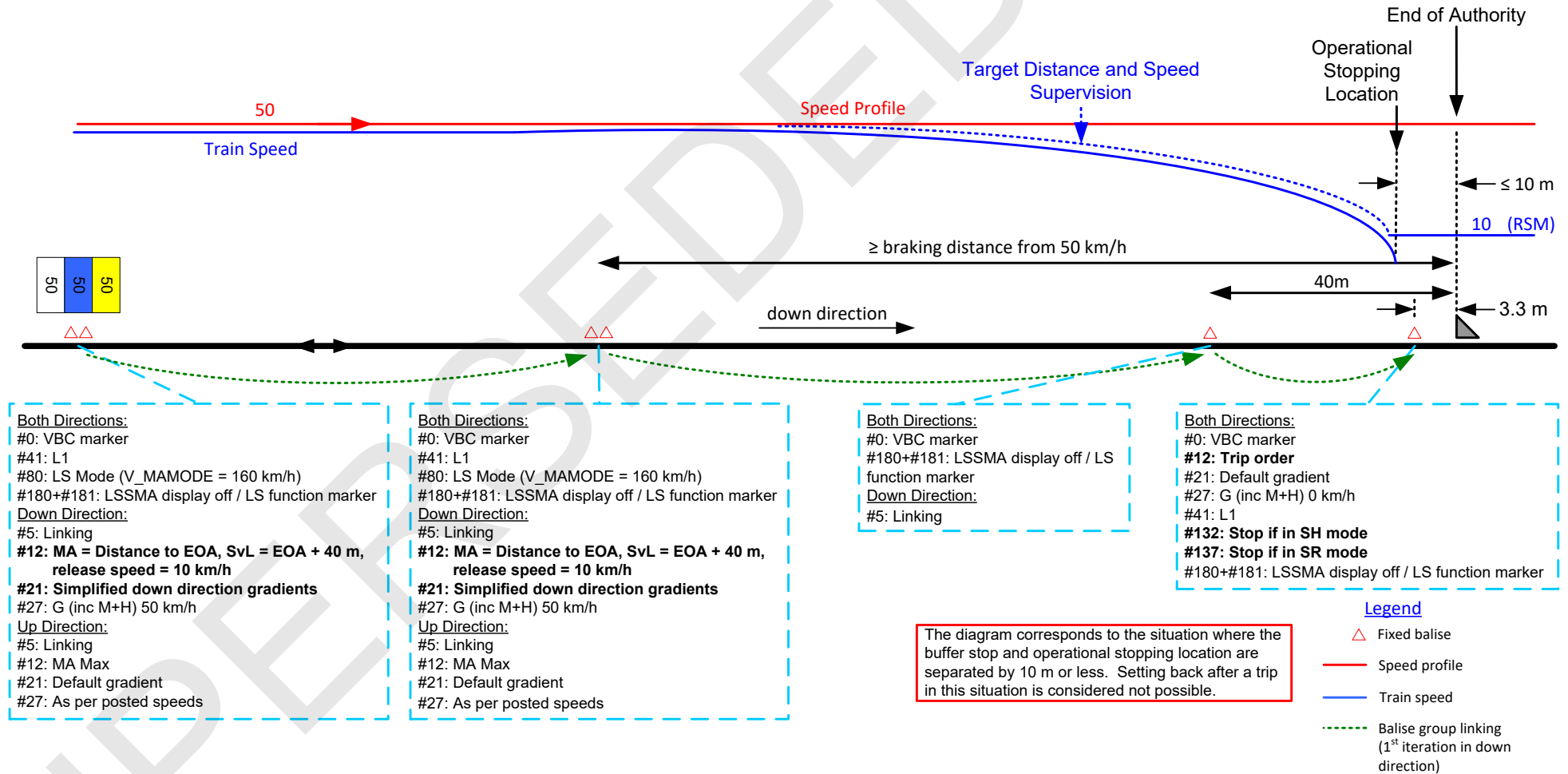


Figure 11 – Buffer stop – short overrun distance available

8.5.2 Longer overrun distance available

Where the distance between the operational stopping location and the buffer stop is greater than 10 m, the buffer stop balise group (immediately in rear of the EOA) shall consist of two balises. This allows a train that has overrun to set back without a further brake intervention. The configuration shall be as follows:

- The EOA shall be 5 m in advance of the operational stopping location.
- A TSM-initiating balise group shall be placed no closer than the braking tool 'permitted' distance in rear of the EOA.
- A single balise shall be placed 40 m from the EOA used for calibration purposes.
- A balise group shall be placed with the reference balise at the EOA. For movements towards the buffer stop, this balise group shall transmit a trip order that immediately commands the emergency brake. It shall also transmit 'Danger for shunting information' and 'Stop if in SR mode'.
- The release speed depends on the length of the confidence interval at a position just before reaching the EOA and the distance between the EOA and the buffer stop. Where this distance is at least 30 m greater than the confidence interval, the release speed shall be 15 km/h; otherwise it shall be 10 km/h.

For an example of this arrangement, see Figure 12.

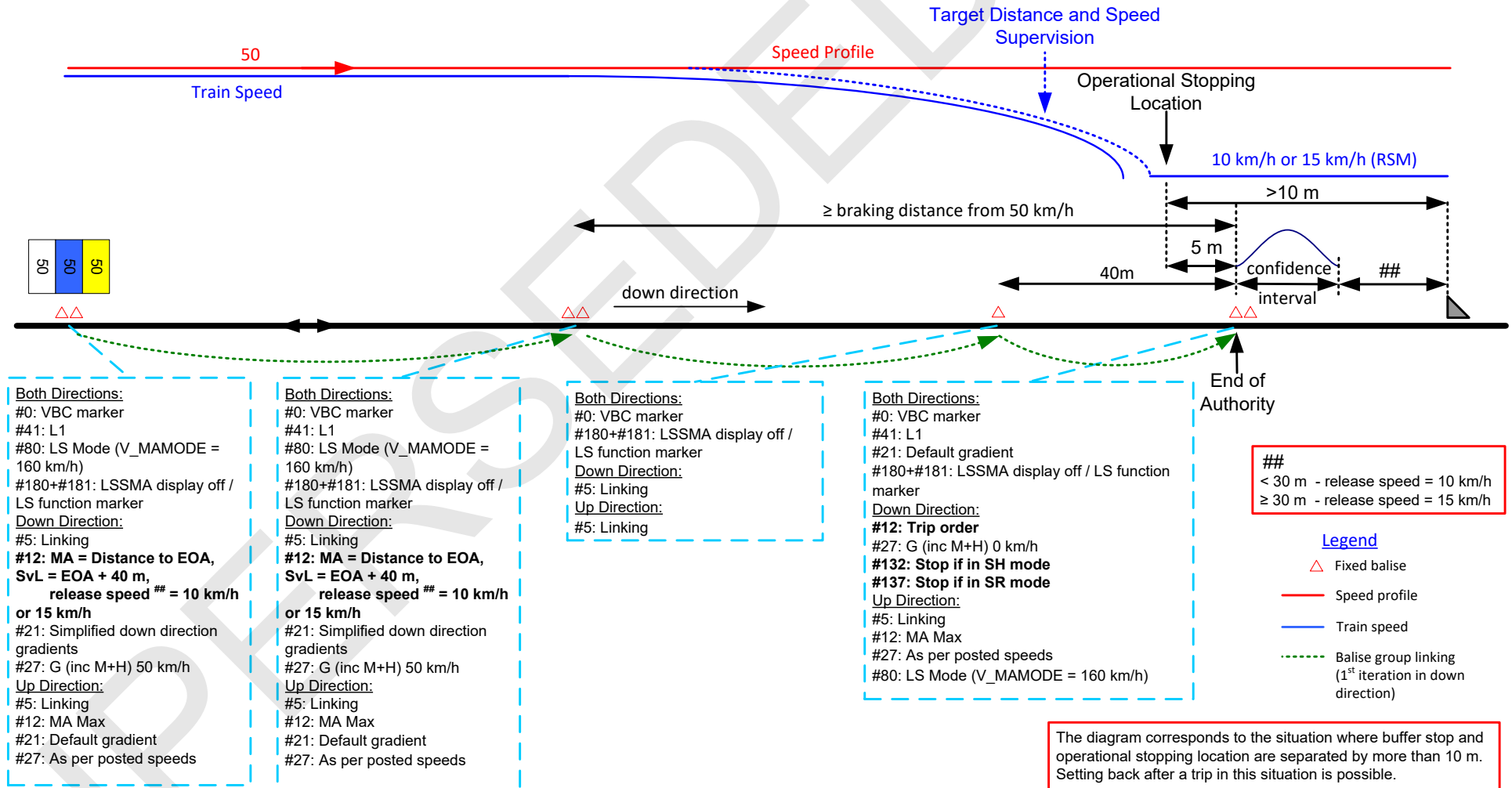


Figure 12 – Buffer stop – long overrun distance available

8.6 Yards

In the context of this document, a yard refers to any unsignalled line(s) or any line(s) that are signalled with shunt class routes only. Running lines adjacent to yards shall not be treated as part of the yard.

A yard shall be provided with two balise groups (transmitting duplicated mode profile information for redundancy), under any of the following circumstances:

- where there is a deemed risk of collision of trains in the yard; this risk shall be deemed to exist where both of the following conditions are true:

- a particular road or siding exists that fits more than one train

Note: The term 'train' here refers to rail traffic routinely timetabled to enter that particular road or siding.

- entrance to the yard is through a signalled move, not involving ground frame points in the reverse position.

- yards where trains regularly enter service from including:

- maintenance centres
- stabling facilities
- particular sidings used during routine trackwork configurations.

- yards where trains regularly amalgamate or divide.

For minor sidings on the TfNSW MHRN not covered by the above definition of a yard, a risk assessment shall be conducted. The risk assessment shall at least assess hazards including overspeed, buffer stop collisions, balise fault messages, and operational impacts. Mitigations against the risks identified in the risk assessment shall be identified and implemented. The proposed solution shall be captured as a concession in accordance with TS 00003.1.

Yard balise groups are provided to mitigate the following:

- the risk of a train travelling on a running line in SH mode or SR mode, without the protection provided by LS mode
- operational restrictions by a train's speed being limited to the 40 km/h SR mode speed limit until the train passes the next balise group (that transmits an MA for the applicable direction) on the running line, and a train's speed being limited to 25 km/h SH mode speed limit where the driver fails to complete the procedure that changes the mode to SR
- the risk of a train travelling in a yard faster than 25 km/h SH mode speed limit.

Yard balise groups shall be placed such that they are not passed by a movement wholly within the yard, as this would cause an emergency brake intervention for this type of movement with a train in SH mode.

Yard balise groups shall send information applicable to both signalled and unsignalled (wrong running) train moves.

Specific trackside constraints between running lines and sidings may not allow for yard entry and yard exit balise groups fully compliant with this section. In such cases, TAOs shall consult with RIMs, RSOs, and AMB as to the outcome. The proposed solution shall be captured as a concession in accordance with TS 00003.1

8.6.1 Yard exit

A 'Stop if in SH mode' order, level transition order and national values shall be transmitted from the yard balise groups when exiting a yard onto a running line. For the yard balise group located on the running line side, the 'Stop if in SH mode' order shall be made valid for both the directions.

Yard balise groups shall be placed such that any running move is supervised in LS mode as soon as possible after passing the running signal. See Figure 13 for an example of this arrangement.

When exiting an ETCS protected yard, the yard balise group shall send an SSP containing the following iterations:

- line speed at the balise group
- converging turnout speed (this iteration is only required where the turnout is deemed high-risk)
- line speed in advance of the convergence, starting at the toe of the trailing points
- any additional iterations necessary for TSMs in advance of the convergence.

In cases of complex layouts or as a consequence of installation constraints (that is, no suitable location for the balise group within the turnout) the TAO may consider placing any of the yard balise groups in the rear of the departure signal for the yard. In general, this type of balise group placement introduces a risk of message consistency error. That is, if the train is not able to correctly receive the telegram from both balises of each of the two yard balise groups as it starts running, the related linking error will trigger a service brake reaction by the onboard system. This risk is dependent on the onboard antenna location with respect to the balise, for any of the expected operational movements within the yard for which a new Start of Mission is required.

Balise groups shall be placed such that message consistency errors are mitigated. Where this is not possible, refer to Section 8.6 for consultation and concession requirements.

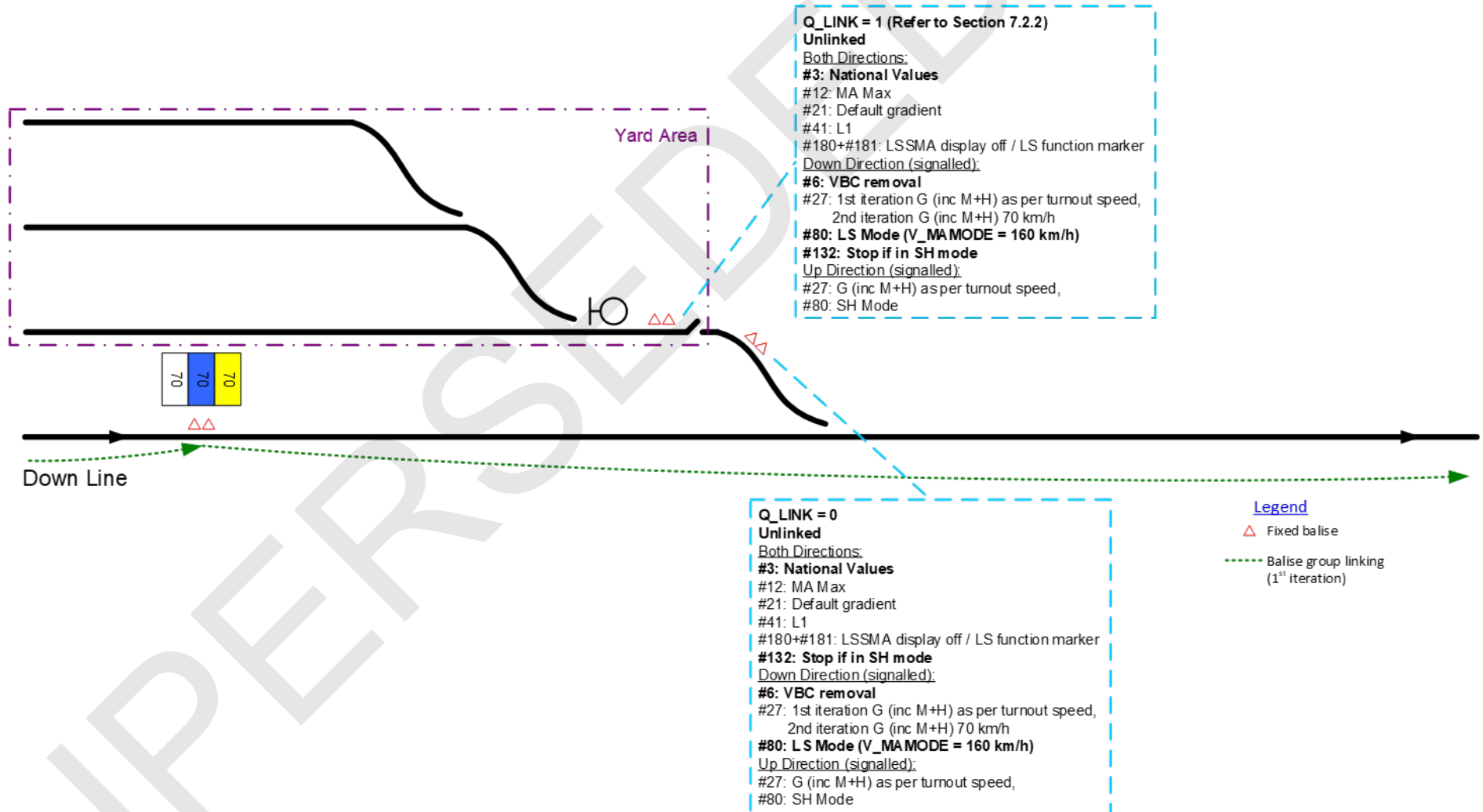


Figure 13 – Yard exit

8.6.2 Yard entry

For yard entry, the balise groups shall both transmit an immediate order to change to SH mode.

Yard balise groups should be placed as close as possible in advance of the point where only shunting or signalled shunt class movements are allowed. Yard balise group shall be placed within D_Link distance from the last relevant balise group on the running line. See Figure 14 for an example of this arrangement.

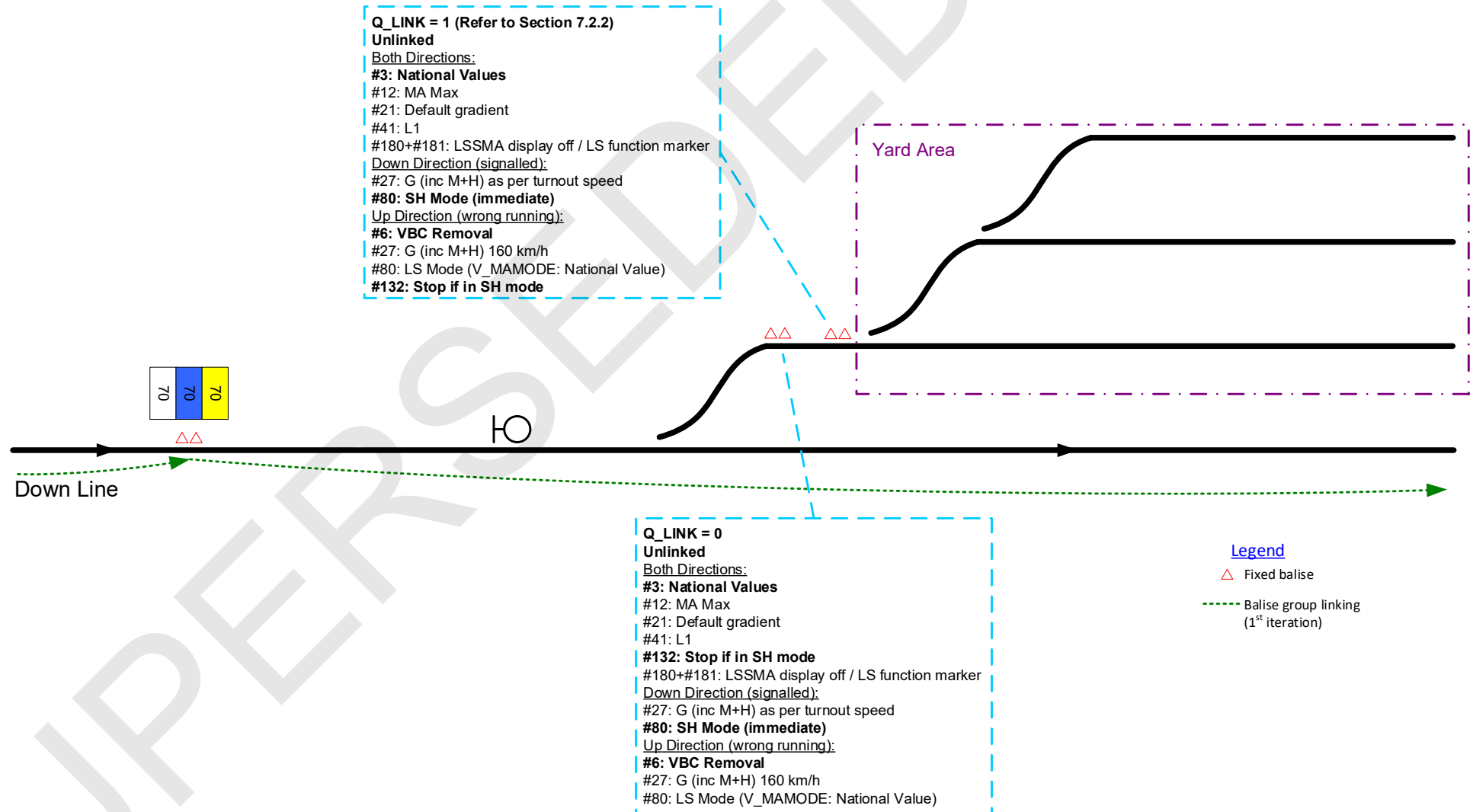


Figure 14 – Yard entry

The yard balise groups shall not be placed on running lines, as this would cause trains to change to SH mode when remaining on a running line.

Where the yard has a specific speed limit lower than 25 km/h, it remains the driver's responsibility to avoid exceeding the specified speed limit.

8.6.3 Yard exit and entry in level 0 territory

Upon maintenance of the European vital computer (EVC), some onboard systems may revert to the default ERA national values. Such areas where this may take place include sidings and maintenance facilities in level 0 areas on the TfNSW MHRN, and sidings and maintenance facilities in level 0 areas not on the TfNSW MHRN.

This may present operational risks whereby trains are limited to an undesired ceiling speed (for example, unfitted mode speed limit (V_NVUNFIT) of 100 km/h, instead of 160 km/h).

The following content is informative to assist RIMs and RSOs in management of risks related to trains operating with default ERA national values.

Balise groups specifically for updating national values (packet #3) may be required.

Prior to implementing any trackside-based solution for updating national values on yards under the control of other RIMs, the following ETCS variables shall be considered by the TAO:

- national values per Section 7.7
- data variables in the balise message header (see Section 7.8)
- any specific requirements for packet #0 and packet #6.

The above ETCS variables shall be agreed upon with the RIMs of affected networks, and RSOs of affected train fleet(s).

Intended function of the proposed solution shall be demonstrated with all affected ETCS onboard systems.

8.7 Turning back

When a train terminates and is required to turn back, the driver changes end and starts a new mission, typically in SR mode. The maximum speed in SR mode is 40 km/h. The next balise group that is passed (that transmits an MA for the applicable direction) changes the mode to LS, thus allowing the train to run at line speed.

An additional balise group providing an earlier change to LS mode should be provided where there is a significant operational benefit in doing so.

In cases of complex layouts or as a consequence of installation constraints (for example, presence of cables, tuning units or equivalent) the TAO may consider placing a balise group for an early change to LS in rear of the departure signal for the platform, in some cases even within

the platform limits. In general, this type of balise group placement introduces a risk of message consistency error. That is, if the train is not able to correctly receive the telegram from both balises of the balise group as it starts running, the related error will trigger a service brake reaction by the system. This risk is dependent on the onboard antenna location with respect to the balise for any of the expected operational movements at the platform for which a new Start of Mission is required.

Balise groups shall be placed such that message consistency errors are mitigated. Where this is not possible, TAOs shall consult with RIMs, RSOs, and AMB as to the outcome. The proposed solution shall be captured as a concession in accordance with TS 00003.1.

8.8 Big metal masses

Metal masses on or beneath the track structure can obstruct the ability of the onboard transmission equipment to function correctly, which in turn can cause alarms on the DMI. These alarms are suppressed when the metal mass is announced.

A metal mass larger than the dimensions specified in ETCS B3 MR1 GSM-R B1 shall be classified as a big metal mass. Refer to EGG 1656 for identification of big metal masses.

Packet #67 contains the big metal mass information. The distance to and length of the big metal mass shall be transmitted by a big metal mass announcement balise group.

In level 1 territory, big metal masses longer than 10 m shall be announced. In level 0 territory, big metal masses longer than 300 m shall be announced.

A big metal mass shall be announced on all possible approaches to it.

A big metal mass announcement balise group shall not be placed less than 75 m from the big metal mass. This distance is based on the network maximum speed of 160 km/h and a 1.5 second onboard delay. Where infrastructure constraints prevent standard placement, the maximum allowable speed for the section of line may be used in calculating the minimum distance.

A big metal mass announcement balise group shall not be placed more than 500 m from the big metal mass. This is to limit the confidence interval on either side of the big metal mass. See Figure 15, Figure 16 and Figure 17 for examples of announcing big metal masses.

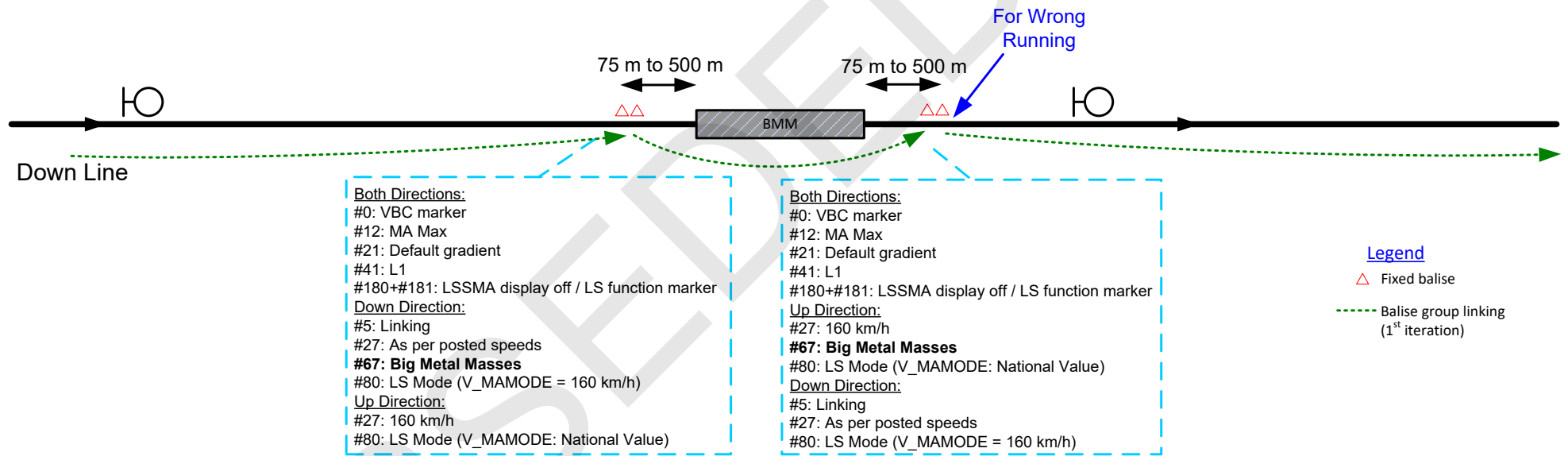


Figure 15 – Big metal masses – unidirectional line

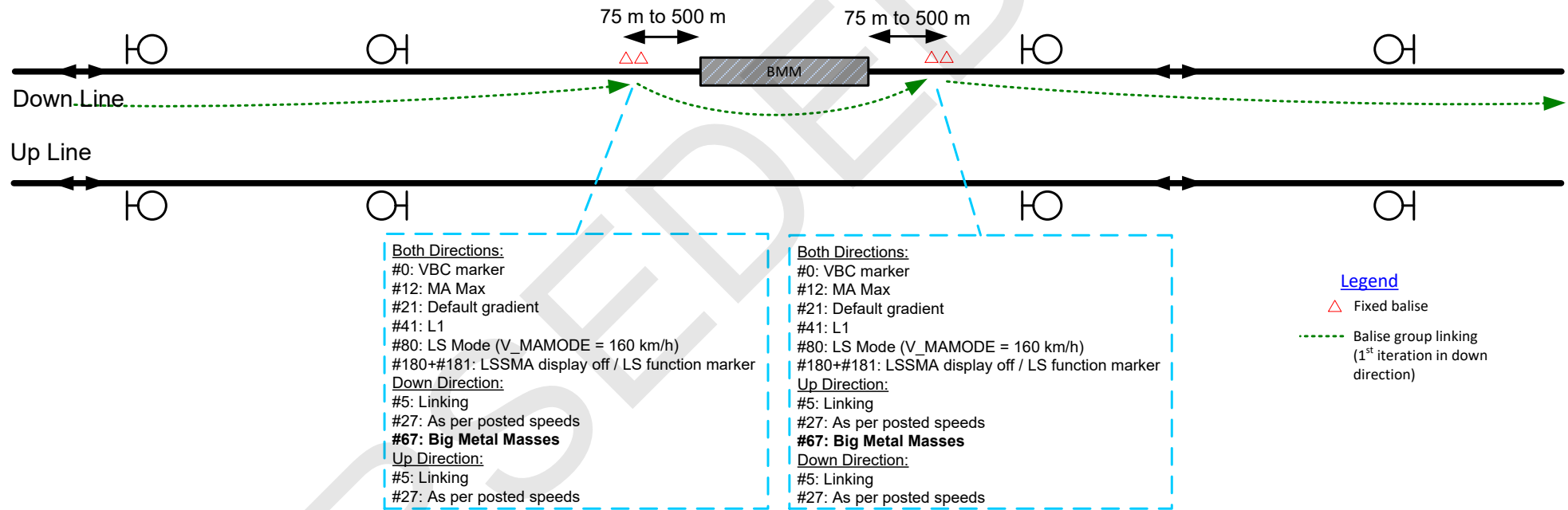


Figure 16 – Big metal masses – bidirectional line

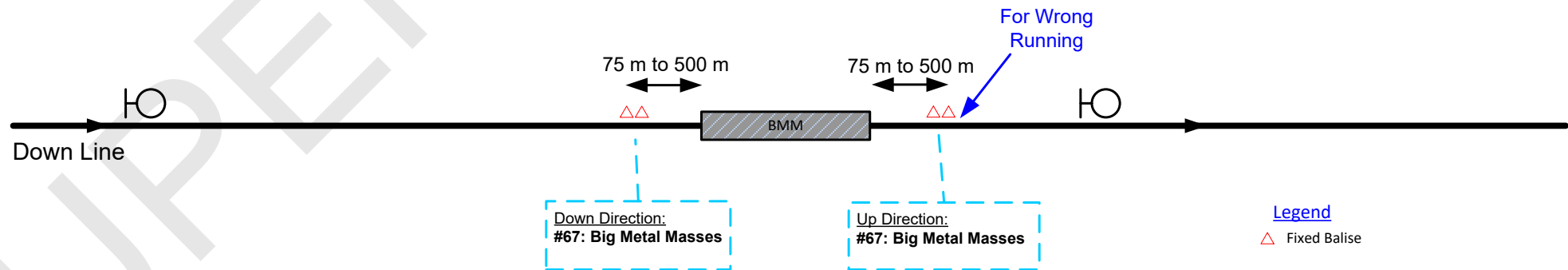


Figure 17 – Big metal masses – level 0 territory

Balise groups shall not be placed in a big metal mass area or within the confidence interval on either side of it.

Where the separation of two or more big metal masses is small enough to prevent individual announcement due to confidence interval constraints, then the big metal mass announcement balise group shall announce all the big metal masses.

A big metal mass announcement shall not be transmitted to a train that diverges away from a big metal mass, unless it avoids the use of an LEU and there are no balises on the diverging line within the bounds of the resulting confidence interval.

8.9 Wrong running

Wrong running refers to train movements on running lines in the unsignalled direction. All wrong running movements shall be supervised to a maximum speed of 40 km/h, in accordance with NSY 514. In general, the speed supervision of wrong running movements (including all balise groups in the wrong running section) shall utilise packet #80 (mode profile). The speed is configured (with the use of the V_MAMODE variable) to use the national value V_NVLIMSUPERV of 40 km/h, rather than limiting the speed through packet #27 SSP set to match the network speed of 160 km/h. This approach allows a possible future alteration to the maximum SPA speed while minimising the number of balises requiring a data alteration.

Exceptions to using the mode profile to supervise the wrong running speed are as follows:

- The balise group contains repositioning information. In such case, the SSP shall be used to enforce the wrong running speed. No mode profile shall be sent.
- The first balise group at the exit from the wrong running movement (that is, the first balise group in the signalled movement) contains repositioning information. In such a case, the last balise group in the wrong running section shall use SSP to enforce the wrong running speed. The mode profile shall be configured to use the maximum network speed of 160 km/h.

8.9.1 Wrong running entry

In order for the train to be updated with the appropriate speed supervision for a wrong running movement, a wrong running entry point shall be defined to permit the onboard equipment to be updated as early as possible to avoid a train maintaining line speed.

Where no crossovers or turnouts are provided, the wrong running entry point shall be assumed to be at the point where there is no signalled move in the applicable direction over that portion of track.

Where crossovers or turnouts are provided, the wrong running entry point is typically defined as the toe of the trailing points.

A wrong running entry balise group shall be placed at a nominal 10 m in advance of the wrong running entry point; however, a distance of up to 160 m is permitted (based on typical 8-car EMU). The wrong running entry function is permitted to be in a balise group in rear of the wrong running entry point to allow the function to be combined in a balise group performing another function, provided there is no additional operational restriction or safety risk, see Figure 18 for an example.

SUPERSEDED

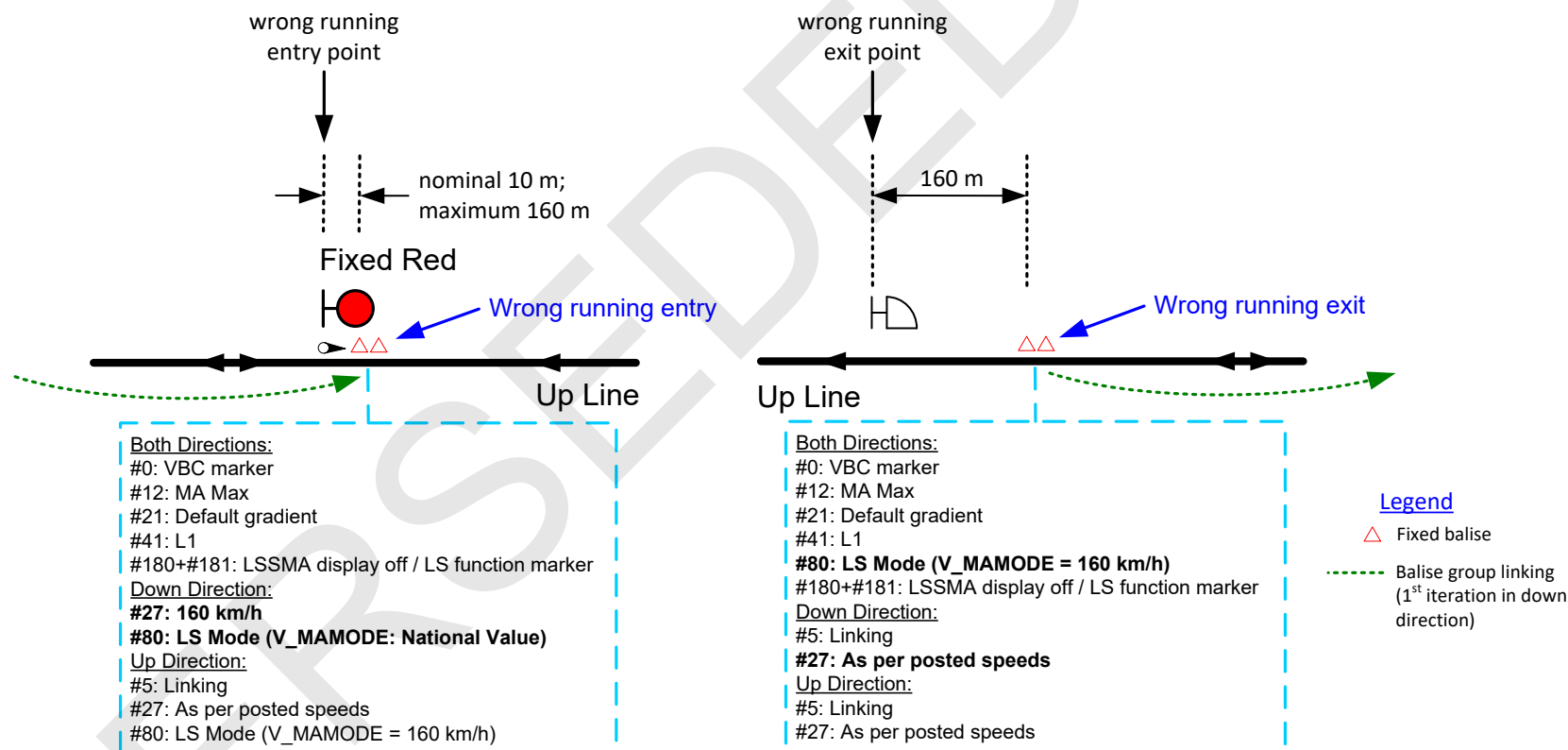


Figure 18 – Wrong running entry and exit – without combination with repositioning

Two situations exist for a wrong running entry balise group, depending on whether the balise group also transmits packet #16 in the applicable direction as a repositioning balise group.

Where the balise group does not transmit packet #16, the balise group shall transmit packet #80, indicating through the V_MAMODE variable that speed is monitored to the national value. Packet #27 shall transmit the network maximum speed of 160 km/h, see Figure 18 for an example.

Where the balise group transmits packet #16, it cannot also transmit packet #80. The balise group shall utilise packet #27 to transmit a speed of 40 km/h. The next balise group in advance shall transmit packet #80, indicating through the V_MAMODE variable that speed is monitored to the national value. Packet #27 at this next balise group shall transmit the network maximum speed of 160 km/h, see Figure 19 for an example.

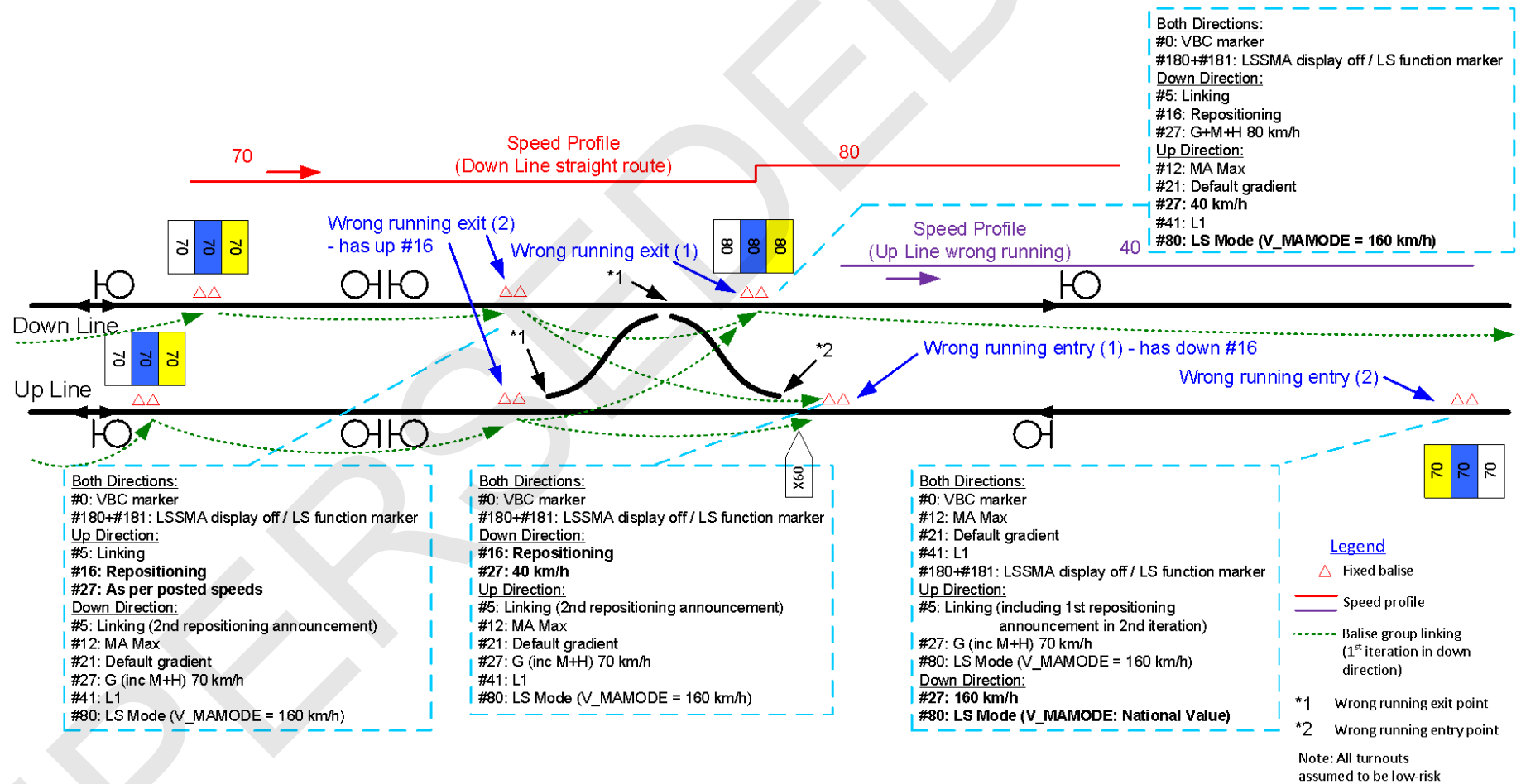


Figure 19 – Wrong running entry and exit – with combination with repositioning

An ETCS trainstop balise group cannot be combined with a wrong running entry function in the same direction, as the trip order issued by the ETCS trainstop changes the onboard mode to trip mode. When trip mode is entered, certain information that is stored onboard is deleted. Refer to ETCS B3 MR1 GSM-R B1 for further details on mode transitions and the conditions required for each transition.

A preferred separation of 100 m, up to a maximum of 160 m, shall be provided between an ETCS trainstop balise group and a wrong running entry balise group to allow a tripped train to come to a stand. Figure 25 shows a wrong running entry balise group in advance of a fixed red signal fitted with an ETCS trainstop balise group.

8.9.2 Wrong running exit

In order for the train to be updated with the appropriate speed supervision for the signalled direction, a wrong running exit point shall be defined to permit the onboard equipment to be updated as early as possible to avoid the train's speed being restricted by the wrong running speed supervision.

The wrong running exit point is typically defined as the point where there is a signalled move in the applicable direction over the portion of track.

Where the wrong running move is through a crossover or turnout, the wrong running exit point is typically defined as the toe of the trailing points.

A wrong running exit balise group shall be placed at 160 m (based on typical 8-car EMU) in advance of the wrong running exit point.

Exceptions to the 160 m placement requirement are as follows:

- A distance less than 160 m is permitted to allow the wrong running exit function to be combined in a balise group performing another function.
- A distance greater than 160 m is permitted to avoid unintentionally revoking TSM. See Section 11.2 for details.
- A distance greater than 160 m is permitted to minimise the potential operational impact or unnecessary mode change commands.

Two situations exist for a wrong running exit balise group, depending on whether the balise group also transmits packet #16 in the applicable direction as a repositioning balise group.

Where the balise group does not transmit packet #16, the balise group shall transmit packet #80, reverting the V_MAMODE variable back to the network maximum speed of 160 km/h. Packet #27 shall transmit the line speed. See Figure 18 for an example of this arrangement.

Where the balise group transmits packet #16, it cannot also transmit packet #80. Packet #27 shall transmit the line speed. The balise group first in rear shall transmit packet #80, reverting

the V_MAMODE variable back to the network maximum speed of 160 km/h. This balise group in rear shall utilise packet #27 to transmit a speed of 40 km/h. See Figure 19 for an example of this arrangement.

8.9.3 Wrong running level crossings

Speed supervision in the unsignalled direction shall apply to actively protected level crossings and pedestrian level crossings that have no active protection for movements in the unsignalled direction.

An ETCS TSR shall be used for this protection. Packet #65 contains the TSR. A target speed of 15 km/h shall apply at a target point of 50 m in rear of the level crossing approach edge. The length of the TSR shall be 1 m.

The TSR shall be transmitted from two consecutive balise groups. The first transmission is for redundancy purposes, transmitted from a balise group at a minimum distance of 300 m from the level crossing approach edge. The second balise group shall be at least the permitted distance from the TSR target point as shown in Figure 20. The permitted distance shall be obtained from the braking tool, using 40 km/h as the initial speed.

The redundant balise group shall transmit an important, plain text message to be displayed to the driver. Packet #72 contains the text for the message. Driver acknowledgement shall not be requested. The message shall be 'Warning: level crossing'. The message shall be displayed from 300 m until 49 m in rear of the level crossing approach edge.

The TSR shall also be transmitted from any balise group between the second balise group and the TSR target point.

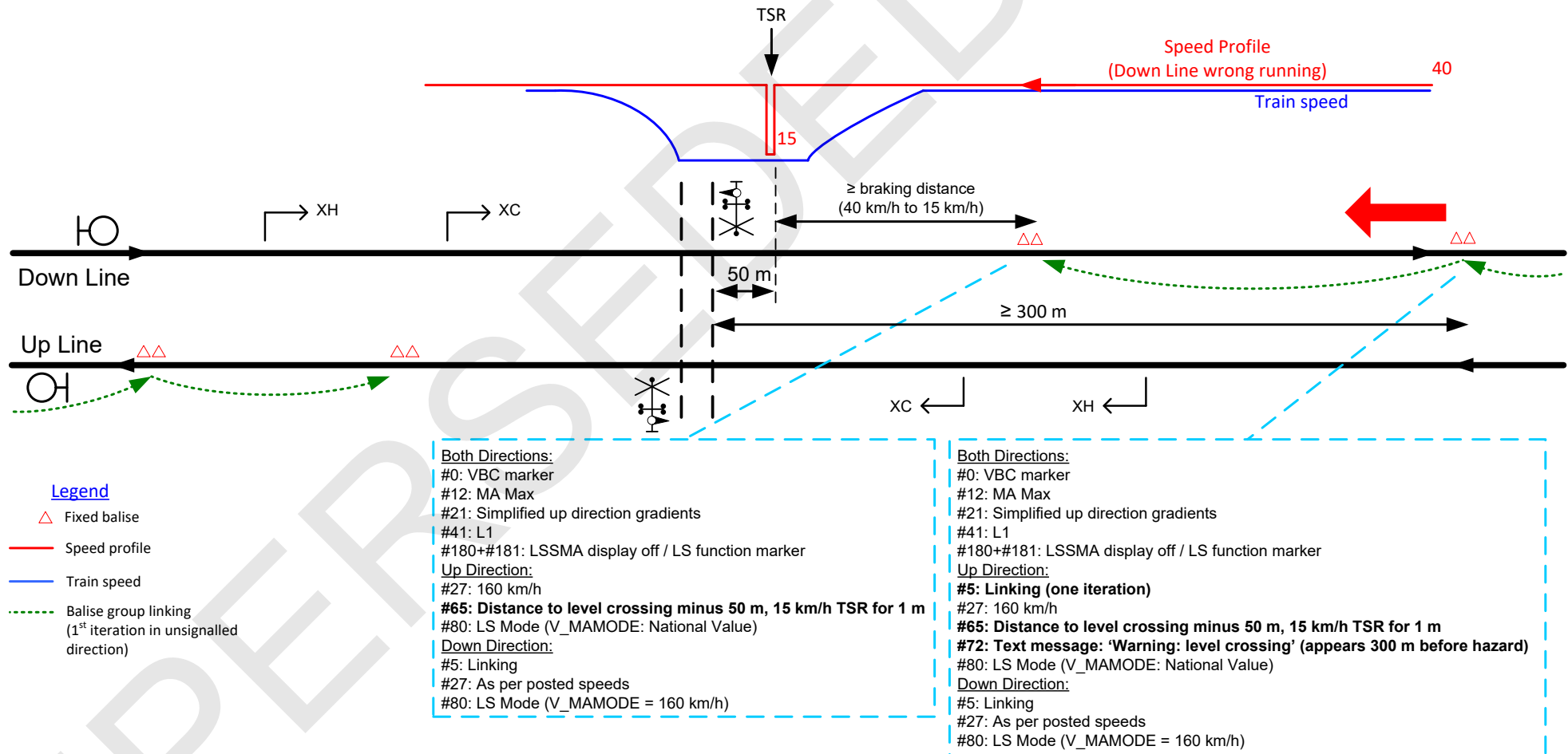


Figure 20 – Wrong running level crossing

8.10 ASDO

The ASDO system utilises ETCS to ensure automatic and safe enabling of train passenger doors. Refer to *ASDO Trackside Design Guideline* for more information.

Platform information is transmitted for each station platform by a dedicated ASDO balise group which contains the following:

- Packet #44 that provides platform information for use by the train's door control system and gives the following details:
 - the location of the start and end of the usable platform, that is, the area accessible to passengers which, in most cases, is defined by the platform fences
 - the side of doors (left or right)
 - the height of station platforms
 - the accuracy of the balise location.

Note: All distance measurements for ASDO are required to be of tighter tolerances than is necessary for other balise groups.

- Packet #145 in each balise of the ASDO balise group, valid for both directions, in order to avoid the service brake application when a balise group message consistency error is detected by a train.
- Packet #0 with a VBC marker set to 3.

8.10.1 ASDO balise group

ASDO balise groups are unlinked and consist of two balises.

For each direction of travel, the reference balise (N_PIG = 0) of the ASDO balise group is as follows:

- the balise closer to the car marker
- placed, in the four-foot, at 9.4 m (with tolerance to the next sleeper) longitudinally in rear of the car marker for the longest stopping train for each direction of travel.

Note: The nominal separation is 9.4 m and the minimum separation between the balise group and its corresponding car marker is 7 m.

Additional ASDO balise groups may be necessary and, for most applications, not more than two ASDO balise groups shall be provided on a platform.

The different configurations of the ASDO reference design are as follows:

- For unidirectional platforms, whenever all the car markers are located at the same position (all within 2.4 m), the ASDO reference balise is designed at the defined location from the car marker as shown in Figure 21.
- Alternatively, depending on the layout:
 - If all the car markers are not at the same location (more than 2.4 m of each other), for unidirectional platforms, an extra ASDO balise group shall be provided at the beginning of the platform, to ensure nominally positioned short trains have adequately controlled confidence intervals as shown in Figure 22.
 - An extra ASDO balise group may be provided for divide and amalgamation scenarios or in case there is an ETCS balise group within the platform.
- For bidirectional platforms, two ASDO balise groups shall be installed that transmit two platform information, one for the nominal direction and one for the reverse direction as shown in Figure 23.

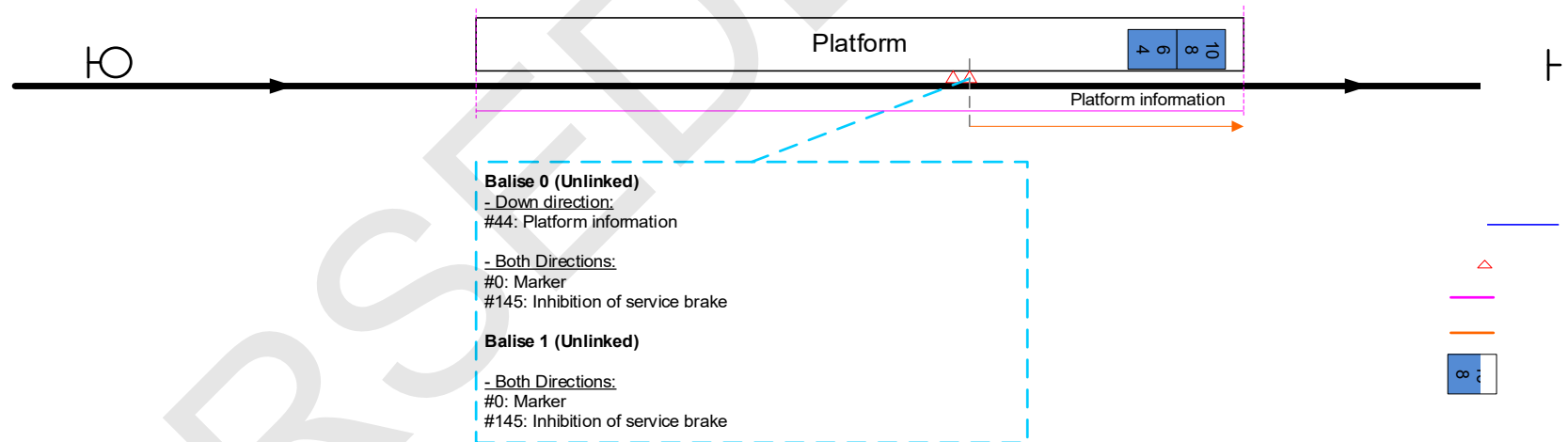


Figure 21 – ASDO – Unidirectional platform – car markers at the same location

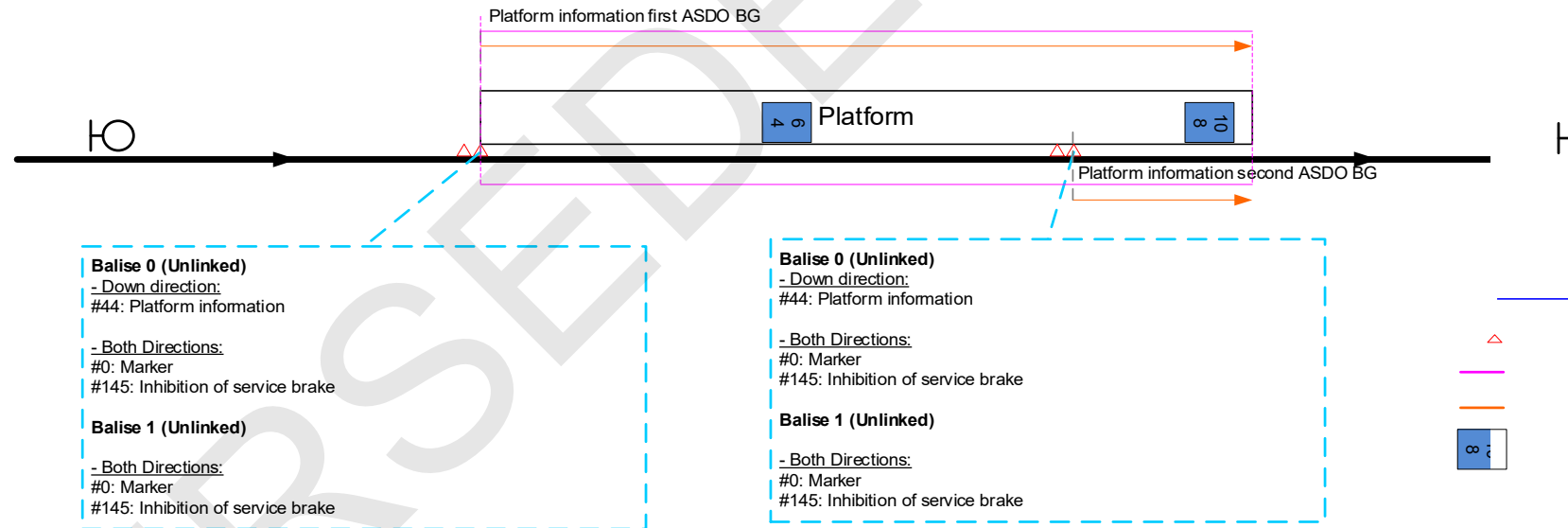


Figure 22 – ASDO – Unidirectional platform – car markers at different locations

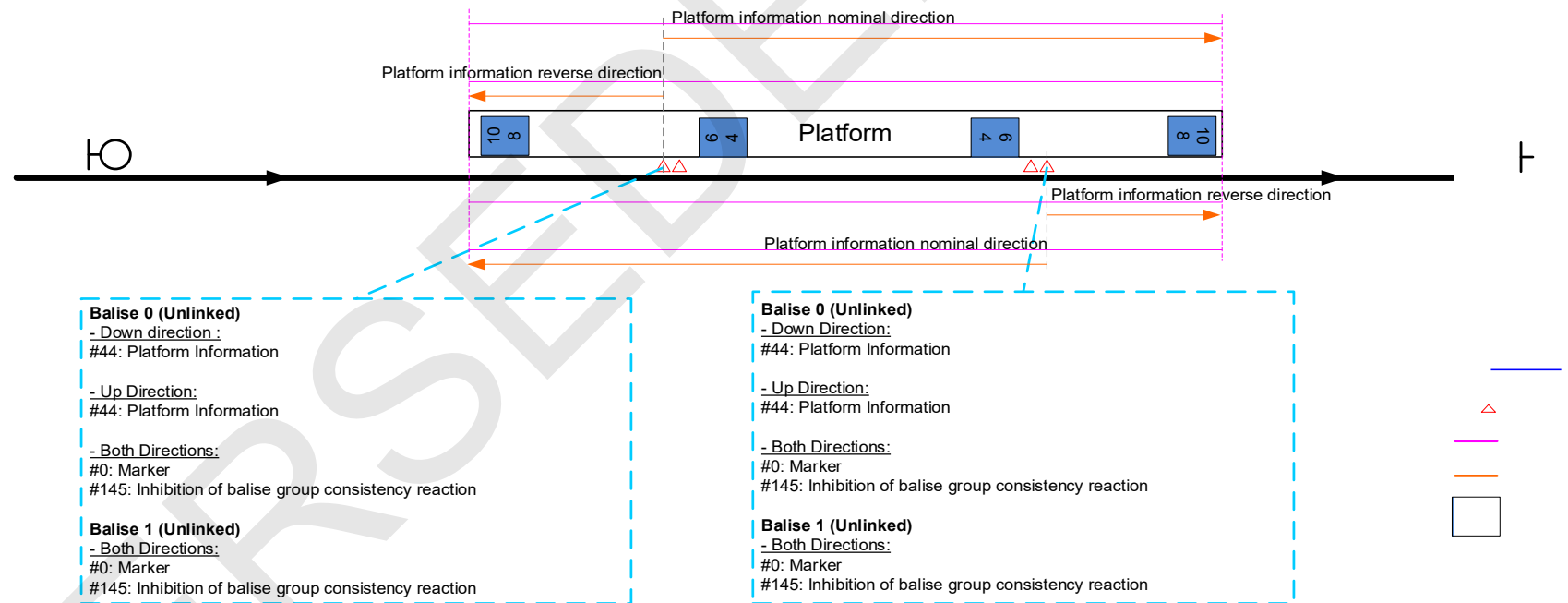


Figure 23 – ASDO – Bidirectional platform

8.10.2 Platform information

Platform information shall be provided by Packet #44 with variable NID_XUSER value set to 103. Packet #44 shall be sent for each direction of travel, that is, for bidirectional platforms, ASDO balise groups contain two Packet #44.

Platform information provided by Packet #44 enables passenger doors in FS, OS, LS, SH, UN, SR, SB, SL, NL, TR and PT ETCS modes.

ASDO Packet #44 contains the following special variables that are specific to ASDO:

- **NID_PACK**

With NID_XUSER = 103, packet #44 may be used for future functions by selecting a different value for variable NID_PACK. For ASDO purposes variable NID_PACK shall be set to 1.

- **D_TRACKCONDEND**

D_TRACKCONDEND is the distance from the reference balise to the end of the platform location.

- **Q_NVLOCACC_ASDO**

In order to reduce the confidence interval, Packet #44 provides the accuracy of the ASDO balise location with an ASDO specific variable Q_NVLOCACC_ASDO that is different from the default accuracy of the balise location Q_NVLOCACC of the national values.

The location related platform information provided by Packet #44 shall be modified in order to cater for uncompensated error as follows:

- The platform length (variable L_TRACKCOND) shall be artificially shortened by 90 cm (45 cm for each side of the platform).
- The distance from the ASDO balise group to the platform end (variable D_TRACKCONDEND) shall be artificially shortened by 45 cm.

All other variables of packet #44 are listed in Table 6.

Table 6 – P#44 variables for ASDO

Variable	Explanation	Value
NID_PACKET	Packet identifier	44
Q_DIR	Direction of the information	0 (Reverse) 1 (Nominal)
L_PACKET	Length of Packet	85
NID_XUSER	Identity of user system: TfNSW	103
Q_SCALE	Qualifier for the distance scale	10 cm

Variable	Explanation	Value
NID_PACK	Identifier of applications outside the ERTMS/ETCS system: ASDO	1
Q_TRACKINIT	Qualifier for resuming the initial states of the related track description of the packet	0
D_TRACKCONDEND	Distance from the reference balise to the end of the platform location	
L_TRACKCOND	Length of the platform	
M_PLATFORM	Nominal height of platform above rail level	1100 mm
Q_PLATFORM	Platform position	Left or Right
Q_NVLOCACC_ASDO	Accuracy of the ASDO balise location	0 m

8.11 Generic VBC

For Generic VBC sequencing, the following applies:

Generic VBC balise groups shall always be placed as a pair for redundancy.

- The generic VBC balise group pair shall never be made up of two balise groups with same balise identification.
- The same generic VBC balise group shall not be placed in multiple locations on the network where there is a possibility of an ATP fitted train traversing it twice (irrespective of signalled/timetabled moves), unless one of the following is satisfied:
 - at least one other balise group (containing a different NID_BG) within the path between the matching generic VBC balise groups (that is, an ASDO balise group or another ATP balise within the VBC active area)
 - the train would have to come to a standstill and turn back prior to traversing the matching generic VBC balise group.
- for all generic balise groups, coordinate system sequences are as follows:
 - nominal direction – VBC(ON)
 - reverse direction – VBC(OFF).

9 Controlled balise group functions

A controlled balise group is a balise group that can vary the message that it transmits depending on the state of the signalling controls. Controlled balise groups shall be provided for ETCS trainstops, high-risk turnouts and high-risk overruns. Controlled balise groups are required for approach balise groups.

A controlled balise group typically consists of one controlled balise and one fixed balise. The fixed balise always transmits the same telegram, whereas the controlled balise transmits a telegram selected by a connected LEU.

ERA documents also use the term 'switchable balise' for a controlled balise.

9.1 Lineside electronic units

An LEU receives vital inputs from the conventional signalling system and sends outputs to one or more controlled balises.

The Alstom Micro-coder type 1 module is the only type-approved LEU.

Note: This document is currently written to support the Alstom Micro-coder type 1 module; however this document will be updated in the future to support other type approved LEUs.

An LEU shall not control balises on more than one line. An LEU shall not interface to both Up and Down signals.

9.1.1 Lineside electronic unit naming

Each LEU shall be assigned a unique name, complying with the following naming structure:

WWWXXXXXXXXX LEU A

Note: The spaces separate certain parts.

Underscores shall replace spaces in filenames.

9.1.1.1 WWW

WWW shall be the three-letter location code as listed in T MU AM 01007 TI.

It shall be the location code of the nearest station to the interfaced signal.

The station kilometrages in TS TOC 3 shall be used in determining the nearest station.

The location code shall be omitted from the name of LEU sub-assets, such as terminals, power supply units and Ethernet switches.

9.1.1.2 XXXXXXXX

XXXXXXXX is a maximum of eight characters that describe the signal name of the interfaced signal.

XXXXXXXX shall be in accordance with the signal identification plate; however, it shall not include spaces, decimal points or any suffix denoting line name.

9.1.1.3 LEU

The text 'LEU' shall form part of the LEU name.

9.1.1.4 Naming suffix

Each LEU name shall have a sequential alphabetical suffix, with the first or only LEU using 'A'. Subsequent locally networked LEUs shall use 'B' and 'C'.

The following are examples of LEU names established using this convention:

- CWDCD29 LEU A
- CWDCD29 LEU B
- WRE643 LEU A
- CTND342 LEU A
- ARNSM810 LEU A.

9.1.2 Signalling inputs

Two forms of input arrangement are possible – relay contact sensing and lamp current sensing. When the Alstom Micro-coder type 1 module is used as the LEU, contact sensing is achieved using current sensing inputs with a series load resistor.

Contact sensing shall be used where signals are operated by relays. Current sensing shall be used where signals are not operated by relays, that is, where CBI equipment directly drives the signal lamps. The exception to this is that turnout repeaters operated by relays shall use current sensing where CBI equipment directly drives the running aspect signal lamps, such that standard LEU data can be utilised. Contact sensing shall be used for route indicators, when required, where they are operated by relays.

In a contact sensing arrangement, inputs shall disregard the lamp proving status.

A vital relay interface to facilitate contact sensing shall be provided where controls of mechanically operated signals are required as LEU inputs.

A bypass terminal shall be provided for each current sensing input to retain the displayed aspect of a signal when it is necessary to disconnect the LEU.

Alstom Micro-coder type 1 modules have a maximum of six physical inputs (from the signalling system) and a maximum of two physical outputs (to controlled balises). These LEUs may be networked to accommodate a higher number of inputs or outputs. The balise message selection table can consider a maximum of 16 inputs. The controlled balise(s) should be connected to the first LEU.

The standard input allocation shown in T HR SC 00003 ST applies to the Alstom Micro-coder type 1 module and allows standard LEU data to be utilised. Spare inputs of an LEU shall be used to avoid the provision of an additional LEU.

9.1.3 Location of LEUs

LEUs shall be installed in the signal control output location.

A cabinet compliant to SPG 0708 shall be provided.

Single cutting of contacts may be provided where an annexe cabinet is used.

9.1.4 Default telegrams

If a controlled balise loses communication with the LEU, for example due to an LEU failure, then the balise transmits its default telegram. If the inputs of an LEU are not a valid combination, for example, due to a relay failure, then the LEU selects its default telegram. The default telegram header shall allocate a message counter value of 254 to the M_MCOUNT variable. This value deems the message inconsistent for both directions, triggering a linking reaction. The failure is reported to the driver by a system text message displayed on the DMI.

Additional important, plain text messages shall also be sent to the train to be logged in the JRU; however, these messages are not reported to the driver. The text messages shall be valid for both directions. The message shall be 'DEF_BAL' for the default balise telegram and 'DEF_LEU' for the default LEU telegram.

The messages shall:

- start immediately
- not require driver acknowledgement
- have no ending conditions.

Controlled balises shall always transmit packet #254 under a failure situation, indicating that the telegram contains default information. Packet #254 shall be valid for both directions. A valid combination of signal inputs in a LEU shall not trigger a default telegram. All valid input combinations shall be taken into account in the design of LEU tables.

9.1.5 Power arrangements

The power for the LEU shall be derived from the same power source as the signalling system.

Each LEU shall have its own power supply unit. A power supply unit can additionally supply power to an Ethernet switch where the LEU has no outputs to balises. Each power supply unit shall be separately fused.

Where contact sensing is used, multiple rail lines shall not be affected by the failure of a single transformer supplying power to LEU inputs. A separate transformer should be provided for the

signal controls and LEU interface per signal. Where site constraints exist, a single transformer may be provided for the interface of more than one signal up to a maximum of three LEU modules.

A fuse shall be provided for each signal for the inputs in a contact sensing arrangement. The fuse shall be located in the same location enclosure as the LEU.

Surge protection shall be provided at the 120 V ac bus supplying the LEU equipment if no inbuilt surge protection is provided on this bus.

9.2 ETCS trainstops

An ETCS trainstop is an alternative to the mechanical trip arm style trainstop.

Where an ETCS trainstop balise group is provided for a signal that is required to provide 'no trip' for one or more aspects, it shall consist of one controlled balise and one fixed balise. See Figure 24 for an example.

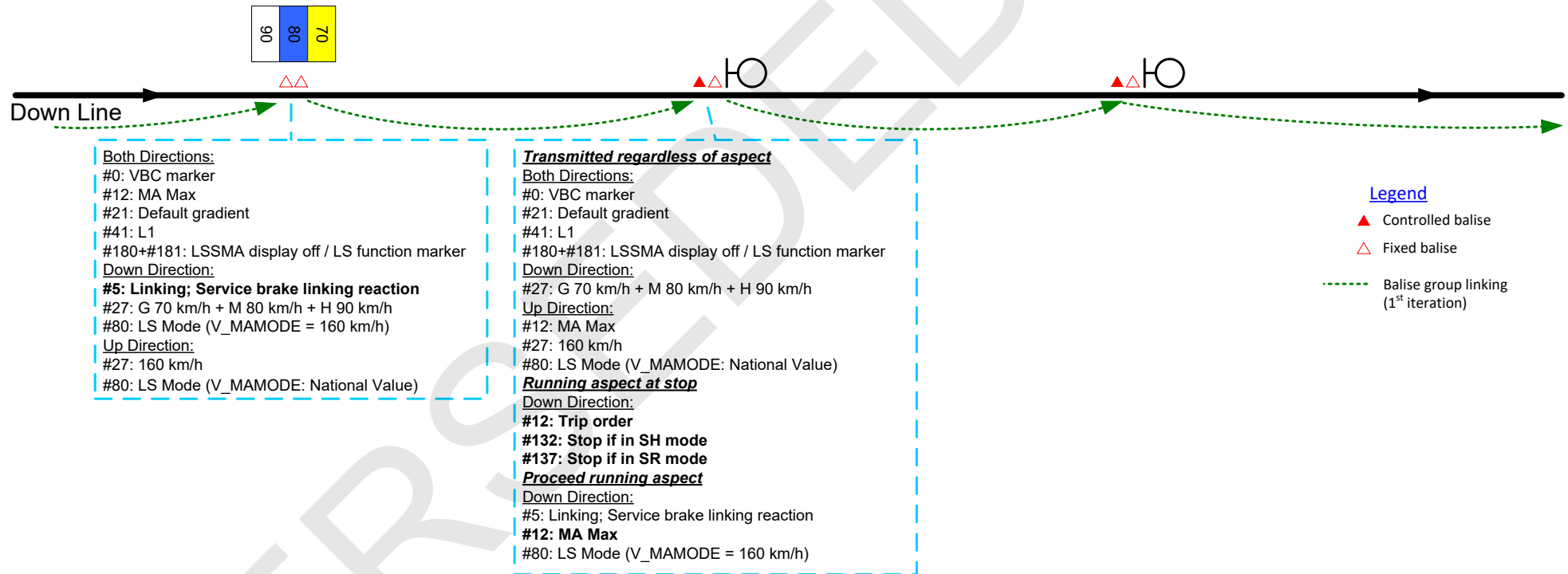


Figure 24 – ETCS trainstop

For a fixed red signal, or for a signal that is always required to provide a trip for the main class route in the applicable direction, the ETCS trainstop balise group shall consist of two fixed balises as shown in Figure 25.

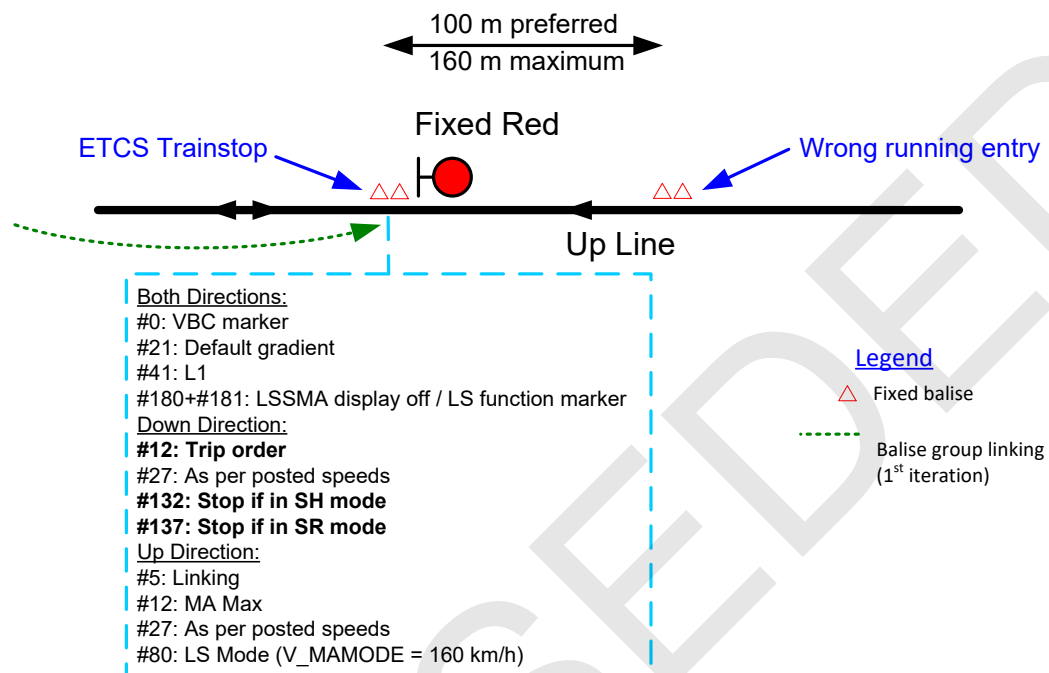


Figure 25 – ETCS trainstop – fixed red signal

When an ETCS trainstop balise group is required to trip a train, for example, when a signal is displaying a stop aspect, the balise group shall transmit a trip order to command the emergency brake. 'Stop if in SH mode' and 'Stop if in SR mode' shall also be transmitted.

When an ETCS trainstop balise group is required to provide no trip, for example, when a signal is displaying a proceed running aspect, the balise group shall not transmit a trip order. 'Stop if in SH mode' and 'Stop if in SR mode' shall not be transmitted. The balise group shall transmit the standard maximum length MA.

A shunt route may allow the balise group to provide no trip where there is an operational need, subject to a risk assessment.

The risk assessment shall determine the need to prove:

- the speed of the approaching train has suitably reduced
- the section is clear.

9.2.1 Contact sensing arrangement

In a contact sensing arrangement, the LEU requires only one input, indicating when no trip is required. This is typically the caution 'HR' relay or the low speed 'LSp' relay, or both. The replacement track shall be added in series to gain the protection provided by the track stick function.

9.2.2 Current sensing arrangement

In a current sensing arrangement, the LEU requires inputs from the following lamps:

- running aspects, including low speed aspects
- marker lights
- close-up aspects.

The LEU does not require inputs from the following lamps:

- co-acting signals
- turnout repeaters
- route indicators
- other subsidiary aspects.

In the event of lamp failure, the ETCS trainstop shall transmit a message to reflect the degraded state of the signalling system consistent with the most restrictive combination of the remaining illuminated lamps.

In the event of an invalid signal indication, the LEU inputs shall be deemed an invalid combination, resulting in the LEU selecting its default telegram, triggering the linking reaction and commanding the service brake.

9.3 High-risk turnouts

Where identified as a high-risk turnout, a balise group using TSM shall be provided on approach to the turnout that is deemed high-risk. This minimises the risk of a derailment resulting from excessive speed.

Refer to PR S 45012 for supporting information and guidance.

9.3.1 Turnout assessment

A risk-based approach shall be followed in determining high-risk turnouts.

The following factors should be considered in this determination:

- line speed or speeds on approach
- signalling controls on approach
- attainable speed, considering factors such as signalling controls
- likelihood of acceleration after receiving a restrictive aspect
- turnout design speed
- any overspeed allowance afforded by the turnout geometry

- frequency of timetabled train movements
- the likelihood of an overrun past the turnout protecting signal at stop, considering the distance from the signal to the turnout
- consequences of a derailment, including:
 - injury and loss of life to passengers, staff and the public
 - damage to infrastructure and rolling stock
 - disruption to train operations
 - public relations.
- likelihood and consequences of an overrun or misrouting into an unwired section of track
- risks associated with monitoring the speed of the plain line track in advance of the turnout using simple ceiling speed monitoring.

Where any of these factors change for a given turnout, a new risk assessment shall be required to reassess the risk classification of the turnout.

9.3.2 High-risk turnout balise group

A high-risk turnout balise group shall consist of one controlled balise and one fixed balise. The preferred position of the balise group is at the 'permitted distance' obtained from the braking tool, using the turnout as the target point and the published turnout speed as the target speed.

The balise group may be positioned farther than the 'permitted distance', including at an outer signal that is one or more blocks in rear of the home signal of the turnout as shown in Figure 26.

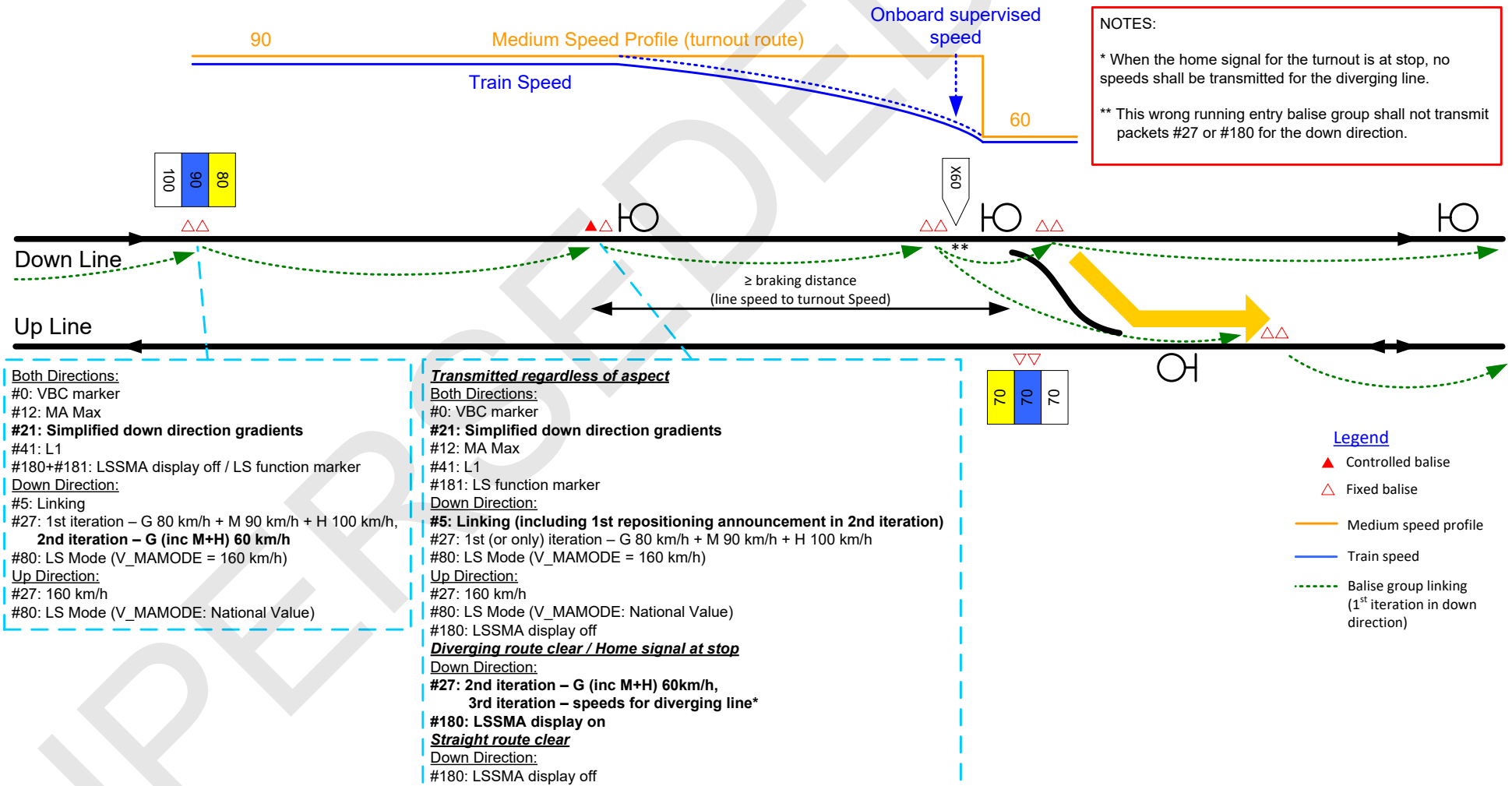


Figure 26 – High-risk turnout

When determining the position of the balise group, the following factors shall be taken into account:

- braking distance
- cable routing costs
- the need for look-ahead
- the need for additional LEUs
- the need for approach balise groups.

The balise group shall transmit an SSP for the straight route with the home signal of the turnout clear for the straight main class route and all other intermediate signals clear between the balise group and the home signal. This SSP revokes the redundant target speed information sent from the balise group in rear.

The balise group shall transmit an SSP for the turnout route with the home signal of the turnout clear for the main class turnout route and all intermediate signals clear. The SSP shall include iterations for the turnout speed and the line speed of the diverging line, starting at the toe of the trailing points or the first insulated rail joint in advance of the clearance point. Train length delay shall not be enforced.

Where neither of these conditions is satisfied, for example, when the home signal of the turnout is at stop, the balise group shall transmit an SSP that is consistent with the most restrictive turnout route; however, it shall not transmit an iteration for the line speed of any diverging line.

Where the home signal protects multiple turnouts, the distance between the TSM initiating balise group and each high-risk turnout should be considered in determining the most restrictive speed profile. In some situations, the speed profile may include more than one turnout speed.

Where the home signal also protects low-risk turnouts, they should not be considered for the purpose of calculating the most restrictive speed profile.

The LEU controlling the controlled balise typically interfaces with an outer signal. There are situations where it interfaces with the home signal of the turnout, either due to a relatively short braking distance, or where an additional balise group is required for approach purposes. See Section 9.5 for the requirements of approach balise groups.

Sufficient inputs shall be provided to the LEU to positively identify each main class route (requiring a different TSM response) cleared at the home signal of the turnout, regardless of which signal the LEU is interfaced to. Multiple routes may be combined in one LEU input, where each combined route has the same TSM response regarding turnout speeds, associated target points and line speeds of the diverging line in advance of the turnouts. Further combination of inputs is possible where the line speeds of the diverging lines do not need to be identified at the TSM initiating balise group due to these speeds being transmitted from an approach balise

group. See Section 9.5 for details. Where the required input functions are not available in the same location as the LEU, look ahead is required. See Section 9.6 for details.

Refer to T HR SC 00003 ST for examples of inputs to LEUs.

Where a shunt route is clear at the home signal of a turnout, the TSM shall be revoked or relaxed if both of the following conditions are true:

- the LEU interfaces with the home signal of the turnout
- there is an identified operational restriction in applying the most restrictive TSM.

The TSM shall be revoked or relaxed by applying the SSP applicable to the main class route of the same destination.

9.3.3 Contact sensing arrangement

In a contact sensing arrangement, each LEU input shall apply to one route from the home signal of the turnout, unless routes can be combined. The input shall consist of control relays for the first or higher proceed aspect clear for the applicable main class route and all intermediate signals clear. Multiple routes from the home signal shall be combined into one input where the routes have the same TSM response regarding turnout speeds, target points and line speeds of the diverging line in advance of the turnouts.

Input 1 of the LEU shall be allocated to the straight route at the turnout. TSM shall be revoked when this input is made. Additional controls shall be added to this input if TSM is required to be revoked for other reasons, such as where there would be an operational impact in applying TSM to a train that will be routed away before reaching the turnout.

Input 2 of the LEU shall be allocated to the turnout route, or to the least restrictive turnout route where there are multiple high-risk turnouts from the same signal.

Further inputs shall be allocated in increasing restriction order where there are multiple high-risk turnouts from the same signal.

The replacement track shall be added in series to all inputs to gain the protection provided by the track stick function. The exception to this is where a shunt route revokes or relaxes TSM, and it is possible for the route to clear with the replacement track occupied. In this situation, the shunt control portion of the input shall bypass the replacement track.

9.3.4 Current sensing arrangement

In the event of lamp failure in a current sensing arrangement, the balise group shall transmit a message consistent with the most restrictive combination of the remaining illuminated lamps.

In the event of an invalid signal indication, the LEU inputs shall be deemed an invalid combination, resulting in the LEU selecting its default telegram. Speed will be supervised to the profile transmitted by the redundant TSM balise group.

9.3.4.1 Outer signals

Where the LEU interfaces to an outer signal, the LEU requires inputs from the following lamps:

- running aspects in the main heads
- marker lights
- turnout repeaters (preferably using current sensing, even if relay-driven, where the running aspects use current sensing)
- bands of lights and any necessary main line route indicators in the following situations:
 - the route leads to the home signal of the turnout
 - there is a requirement to revoke TSM for a train routed away before reaching the turnout.

The LEU does not require inputs from the following lamps:

- low-speed aspect
- close-up aspects
- co-acting signals
- miniature route indicators
- shunt aspects
- other subsidiary aspects.

9.3.4.2 Home signals

Where the LEU interfaces to the home signal of the turnout, the LEU requires inputs from the following lamps:

- yellow and green aspects of single light signals
- marker lights
- all aspects in the top head of double light signals
- lower green aspect of double light signals
- low-speed aspects
- close-up aspects
- bands of lights
- main line route indicators (using contact sensing if relay-driven)
- shunt aspects and any applicable route indicators necessary to positively identify any shunt routes that revoke or relax TSM.

The LEU does not require inputs from the following lamps:

- red aspects of single light signals
- red and yellow aspects in the lower head of double light signals
- co-acting signals
- turnout repeaters
- other subsidiary aspects.

9.4 High-risk overruns

An overrun is deemed high-risk, due to one or more of the three types of identified hazards, namely deficient overlaps, high-risk catch points and high-risk level crossings. The signal that is overrun is termed the 'protecting' signal.

In determining a high-risk overrun, the trip speed would generally have been assumed to be the line speed on approach to the first warning signal. Where there is a decrease in line speed between the first warning signal and the protecting signal, it may be possible to sufficiently mitigate the hazard from the high-risk overrun by treating the speed sign as high-risk. See Section 8.2.1. Where this solution is not possible, a balise group using TSM shall be provided on approach to the protecting signal.

9.4.1 High-risk overrun balise group

A high-risk overrun balise group shall consist of one controlled balise and one fixed balise. The preferred position of the balise group is at the 'permitted distance' obtained from the braking tool, using the protecting signal as the target point. See Figure 27 for an example of this arrangement.

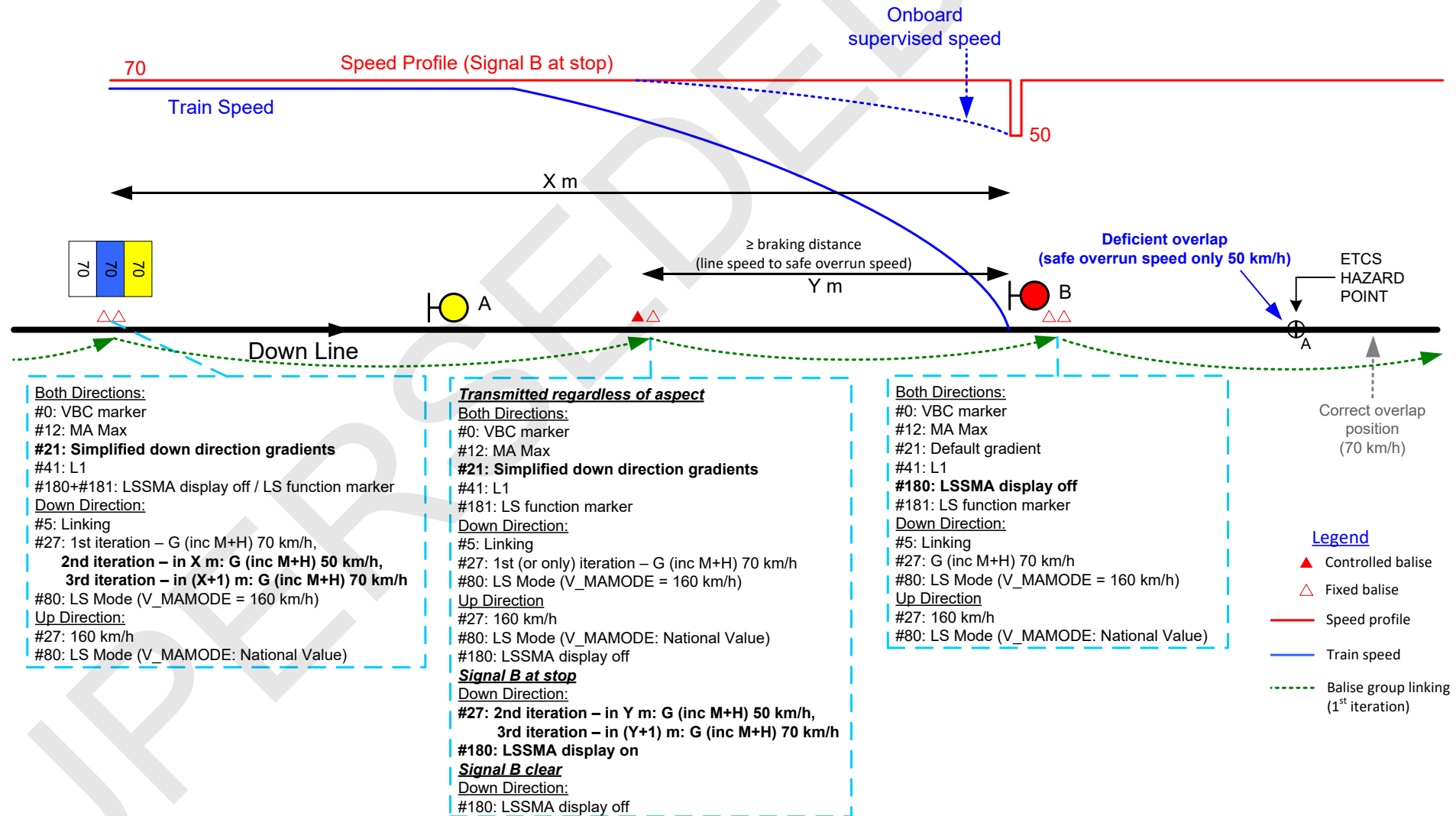


Figure 27 – High-risk overrun – deficient overlap

The target speed shall be the safe overrun speed, that is, the maximum speed that allows a train that has tripped at the protecting signal to stop before the hazard point. For the medium speed profile, the applicable GE52 or GE52A braking curve shall be used in determining the safe overrun speed. For the high-speed profile, the GX2M braking curve shall be used in determining the safe overrun speed.

The hazard point for a deficient overlap shall be at the end of the signalling overlap.

The hazard point for catchpoints shall be the nearest end of the throw-off rail.

The hazard point for containment catch points shall be the toe of the catch points.

The hazard point for a level crossing shall be the nearest edge of the crossing.

The balise group may be positioned farther than the 'permitted distance', including at an outer signal, one or more blocks in rear of the protecting signal.

When determining the position of the balise group, the following factors shall be taken into account:

- braking distance
- cable trenching costs
- the need for look-ahead
- the need for additional LEUs
- the need for approach balise groups.

The balise group shall transmit line speed for the SSP with any main class route clear at the protecting signal and all other intermediate signals clear. This SSP revokes the redundant target speed information sent from the balise group in rear. Where these conditions are not satisfied, for example, when the protecting signal is at stop, the SSP transmitted by the balise group shall be the greater of the safe overrun speed or 10 km/h.

The 10 km/h minimum is for operational reasons. The medium safe overrun speed shall apply to both medium and general speed profiles. The safe overrun speed transmitted for each speed profile shall not exceed the line speed for that profile.

Where the safe overrun speed (or the 10 km/h minimum) is transmitted, the SSP shall additionally include an iteration for the line speed at a position of 1 m in advance of the target point. Train length delay shall not be enforced.

The LEU controlling the controlled balise will either interface with the protecting signal or with an outer signal, one or more blocks in rear. Where the required input functions are not available in the same location as the LEU, look-ahead is required. See Section 9.6 for details. Refer to T HR SC 00003 ST for examples of inputs to LEUs. There are situations where an additional balise group is required for approach purposes. See Section 9.5 for the requirements of approach balise groups.

Where the LEU interfaces with the protecting signal and the safe overrun speed is less than 25 km/h, TSM shall be revoked with a shunt class route clear at the protecting signal where an operational restriction would exist if the safe overrun speed was transmitted instead. This operational restriction will typically exist only in one of the following situations:

- where the shunt route lowers the trainstop (or the ETCS trainstop transmits no trip order) with no approach control of the trainstop
- where the timing speed for the approach control of the trainstop is greater than the safe overrun speed.

9.4.2 Contact sensing arrangement

In a contact sensing arrangement, only one LEU input is required. This shall be Input 1 of the LEU. TSM shall be revoked when this input is made. The input shall consist of the control relays for the first or higher proceed aspect clear at the protecting signal for any main class route and all intermediate signals clear. Additional controls shall be added to this input if TSM is required to be revoked for other reasons; for example, where a train will be routed away before reaching the protecting signal, or where necessary to avoid an operational restriction when subsidiary aspects are clear at the protecting signal.

The replacement track shall be added in series to the input to gain the protection provided by the track stick function. The exception to this is where a shunt route revokes TSM, and it is possible for the route to clear with the replacement track occupied. In this situation, the shunt control portion of the input shall bypass the replacement track.

9.4.3 Current sensing arrangement

In the event of a lamp failure in a current sensing arrangement, the balise group shall transmit a message consistent with the most restrictive combination of the remaining illuminated lamps.

In the event of an invalid signal indication, the LEU inputs shall be deemed an invalid combination, resulting in the LEU selecting its default telegram. Speed will be supervised to the profile transmitted by the redundant TSM balise group.

9.4.3.1 Outer signals

Where the LEU interfaces to an outer signal, the LEU requires inputs from the following lamps:

- running aspects in the main heads
- marker lights
- bands of lights and any necessary main line route indicators where the route leads to the protecting signal or there is a requirement to revoke TSM for a train routed away before reaching the protecting signal.

The LEU does not require inputs from the following lamps:

- low-speed aspects
- close-up aspects
- co-acting signals
- miniature route indicators
- turnout repeaters
- shunt aspects
- other subsidiary aspects.

9.4.3.2 Protecting signals

Where the LEU interfaces to the protecting signal, the LEU requires inputs from the following lamps:

- running aspects, including bands of lights
- marker lights
- shunt aspects and any applicable route indicators necessary to positively identify any shunt routes that revoke TSM.

The LEU does not require inputs from the following lamps:

- co-acting signals
- route indicators
- turnout repeaters
- other subsidiary aspects.

Due to the inconsistent application of low-speed and close-up aspects, each occurrence shall be assessed to determine whether it is necessary to revoke TSM to avoid an operational restriction with one of these aspects displayed.

9.5 Approach balise groups

A driver should ideally be able to accelerate to an appropriate speed when they see a signal clear to a less restrictive aspect. However, where a target speed has been transmitted by a TSM-initiating balise group to a train approaching a high-risk turnout (or a high-risk overrun), and the home signal of the turnout subsequently clears for the straight route (or the protecting signal subsequently clears), the driver is forced to continue braking to the target speed until after the turnout (or the protecting signal) is passed. The addition of an approach balise group provides an update of the speed profile, allowing a train to take early advantage of a signal clearing to a less restrictive aspect, thereby reducing the operational restriction caused.

One or more approach balise groups can be provided to achieve a time gain for the travel time of a train. Time gain calculations shall assume the worst-case scenario, that is, when the home signal of the turnout clears for the straight route (or the protecting signal clears) immediately after the train has passed the TSM-initiating balise group. The time gain is calculated by subtracting the travel time with the approach balise group or groups provided, from the travel time without the approach balise groups provided.

The LEU controlling the controlled balise of the approach balise group shall interface with the signal at the approach balise group, or with the next signal in advance of the approach balise group.

Where the home signal of the turnout has not cleared for the straight route (or the protecting signal has not cleared), the approach balise group shall resend the TSM speed profile according to the TSM-initiating balise group. Where the home signal of the turnout has cleared for a turnout route, the approach balise group shall send an updated TSM speed profile, including an iteration for the line speed of the diverging line. The iteration for the line speed of the diverging line of a high-risk turnout may be omitted from the TSM-initiating balise group where it is sent from an approach balise group, potentially reducing or avoiding look-ahead requirements.

9.5.1 Approach balise group types

The following are two types of approach balise group to consider:

- The first type is a balise group placed at, or in the last block approaching the home or protecting signal. The LEU in this case interfaces with the home or protecting signal. See Figure 28 for an example of this arrangement.
- The second type occurs where the TSM-initiating balise group is more than one block in rear of the home or protecting signal. The approach balise group is placed at or in rear of an intermediate signal between the TSM-initiating balise group and the home or protecting signal. The LEU in this case interfaces with this intermediate signal. See Figure 29 for an example of this arrangement.

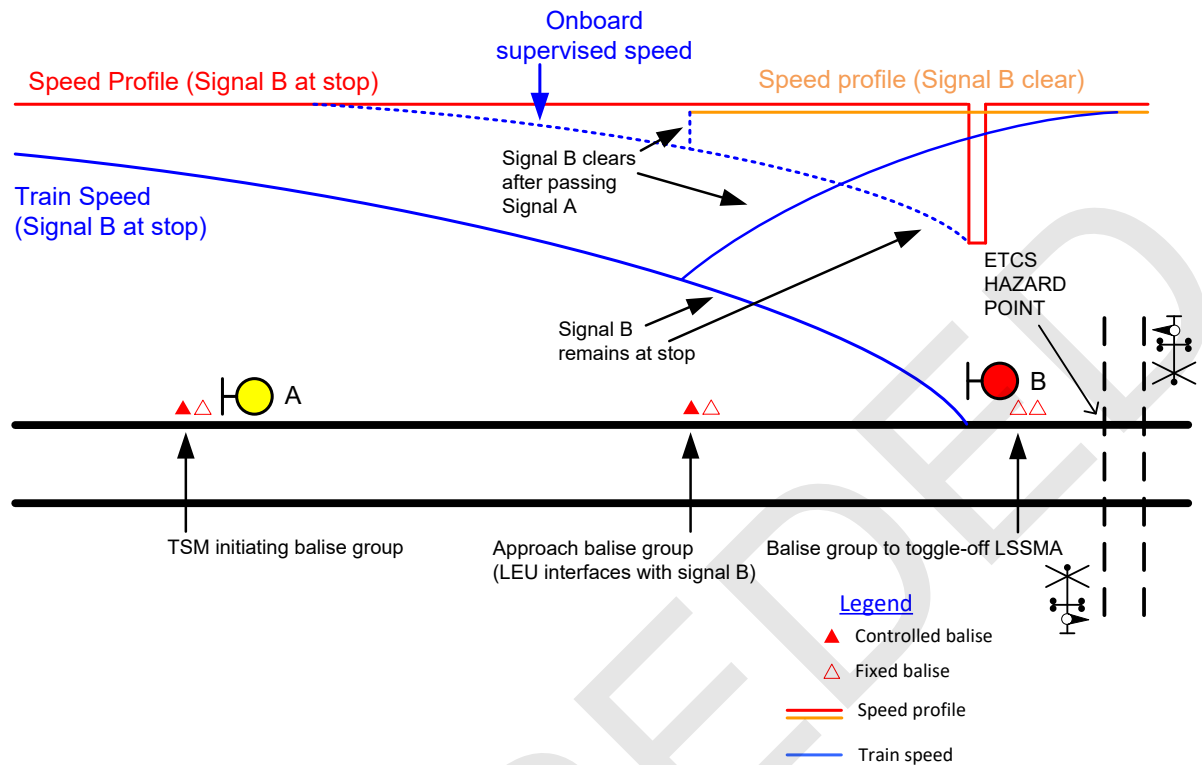


Figure 28 – Approach balise group in the last block

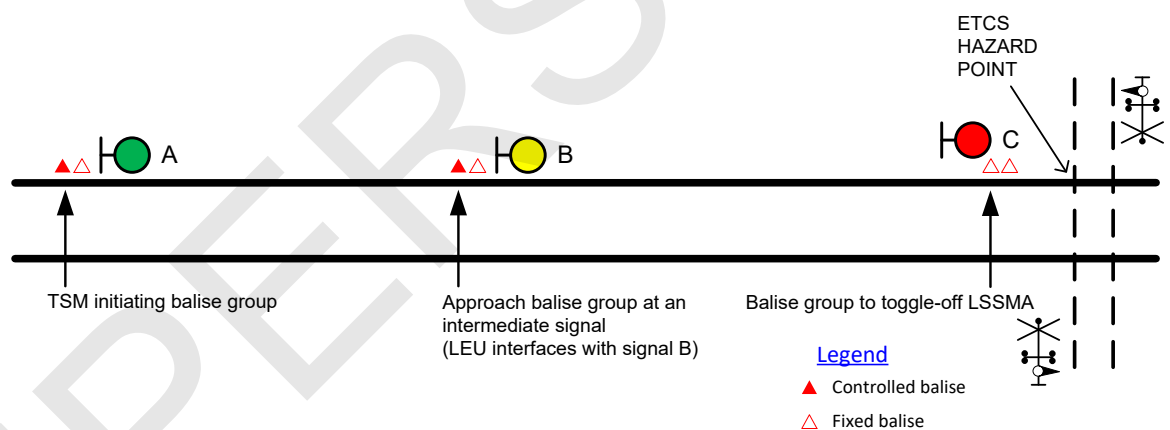


Figure 29 – Approach balise group at an intermediate signal

Approach balise groups can potentially be provided as follows:

- at one or more intermediate signals
- one or more in the last block approaching the home or protecting signal
- at the home signal.

9.5.2 Selection of approach balise groups

Not every approach to a high-risk turnout and high-risk overrun requires an approach balise group. The selection of approach balise groups requires qualitative judgement on any significant, regular operational benefit in providing them.

The greater the time gain, the more significant the operational benefit can be.

The greater the distance (or travel time) between the TSM-initiating balise group and the home or protecting signal, the more likely a significant operational benefit is gained by the approach balise group.

A regular operational benefit is likely to exist, only where timetabled trains are running closer than the headway allows or where the signaller regularly clears a signal after a train has passed the TSM-initiating balise group. This includes the scenario of a train turning out with a closely following train taking the straight route from the same signal.

An operational benefit is unlikely to exist in the following circumstances:

- where all trains stop at a platform in the vicinity of either side of the TSM target point
- in the last block approaching an automatic signal protecting a deficient overlap.

This is because when the signal clears, it will only clear to first aspect, thereby preventing the following train from accelerating fully.

A significant operational benefit is unlikely to exist where the difference between line speed and the target speed is relatively small.

9.5.3 Position of approach balise groups

The positioning of an approach balise group also requires qualitative judgement, as there is an engineering trade-off involved. The closer the approach balise group is to the TSM-initiating balise group, the more time gain can be achieved. However the closer the approach balise group is to the home or protecting signal, the greater the number of trains would benefit from it.

The operational benefit is insignificant in positioning an approach balise group farther from its interfaced signal than the sighting point of this signal. This is because a driver is unlikely to accelerate, based purely on the absence of the display of the LSSMA.

For an approach balise group interfaced to an intermediate signal, there can be a benefit in positioning the balise group at the signal (as opposed to farther in rear of the signal), if the signal regularly clears at the same time or after the home or protecting signals clear.

Where a regular, significant operational benefit has been identified, consultation with network operators shall be made in determining the need and positioning of an approach balise group.

9.6 Look-ahead

Where a controlled balise interfaces to an outer or intermediate signal for a high-risk turnout or a high-risk overrun, in some situations the locally available signal control relays and aspects are insufficient to provide the LEU with the required input information. In these situations, additional information is required to be brought back from a signal in advance. The arrangement for providing this additional information is termed as 'look-ahead'.

The following are three methods of implementing look-ahead:

- splitting signal aspect control relays
- additional CBI outputs
- networking LEUs.

Examples of each method are shown in T HR SC 00003 ST.

Where LEUs are networked, the local LEU shall be provided with one or more additional local inputs where these inputs can revoke TSM independently of the inputs at the remote LEU. This is to minimise the operational restriction caused by a failure in the LEU networking arrangement.

Where a new relay function is created to provide look-ahead, the design shall ensure that a failure of the relay to energise does not go undetected. This shall be achieved by restricting the aspect of the signal that the LEU is interfaced with.

Where a new relay function is created to provide look-ahead, the design shall ensure that a failure of the relay to de-energise does not present an unsafe situation for a subsequent train. This shall be achieved by back proving the relay in the track stick function.

9.6.1 Splitting signal aspect control relays

This method requires multi-core signalling cables between locations to provide extra relay functions to be input to the LEU.

This method would typically be used in areas with existing multi core signalling cables between locations, such as in relay based interlockings or in automatic sections.

9.6.2 Additional CBI outputs

This method requires new output relay functions from a CBI to be input to the LEU.

This method would typically be used in areas where a computer-based interlocking outputs to lamps or relays in a lineside signalling location.

9.6.3 Networking LEUs

This method requires connecting LEUs in different locations using Ethernet switches and optical fibre cable. The logic in the LEU connected to the controlled balise can then use inputs from the LEU interfaced to a signal in advance.

This method would typically be used in CBI areas where the process and cost of altering the data in the CBI precludes providing additional CBI outputs.

10 Combining functions

Where practicable the number of balises installed shall be minimised for optimisation.

Certain combinations are not possible or prohibited, as described elsewhere in this document.

Judgement is required when determining the benefit of combining functions. For example, where additional trenching is required to combine a high-risk turnout balise group with a speed sign balise group in rear, the potential extra cost of trenching together with the greater potential operational restriction may influence the decision whether to combine the functions.

11 Cascading functions

When more than one function requires ETCS protection in the same vicinity, one function can affect the others. This cascading effect can affect the number, positioning and data of the required balise groups.

Some layouts have cascading functions, for example a high-risk speed sign followed by a high-risk turnout. Individual assessment of each hazard shall be made to determine if protecting one hazard removes the need to protect the other, or whether both hazards need protection.

11.1 Low-risk turnouts in rear of high-risk speed signs

When turning out through a low-risk turnout results in a speed reduction from the original line to the diverging line, the speed of the diverging line shall require assessment in accordance with Section 8.2.1. See Figure 30 for an example.

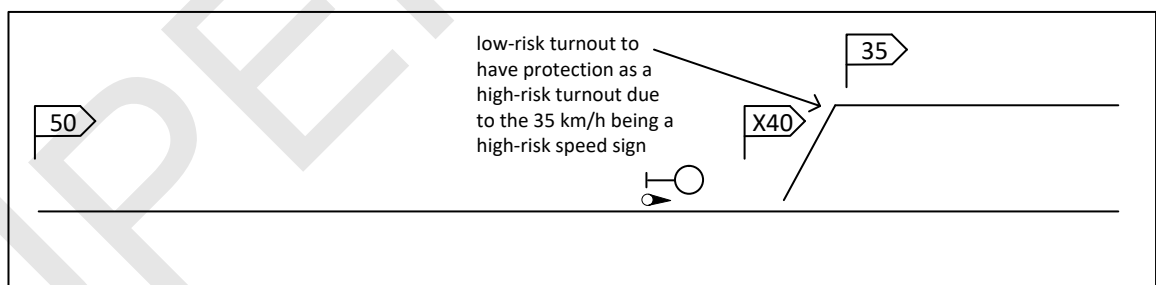


Figure 30 – Low-risk turnout in rear of high-risk speed sign

If the assessment deems it as a high-risk speed sign, then the turnout shall have protection according to a high-risk turnout.

When ETCS level 1 protection is provided by fixed balises and the assessment of speed sign after the low-risk turnout deems it as high-risk speed sign, protection shall be provided SFAIRP without creating operational restrictions on the non-diverging line.

11.2 Speed signs and speed updates inside TSM areas

In a given direction, a balise group transmitting a fixed SSP packet shall not be placed between a TSM-initiating balise group (where the TSM is conditional on signalling inputs) and the TSM target point, as this can unintentionally revoke the TSM.

For example, where a speed sign is located between the TSM-initiating balise group and a high-risk turnout, a balise group shall not be installed at the speed sign. Instead, the relevant speeds shall be transmitted as iterations from the TSM-initiating balise group. See Figure 31 for an example.

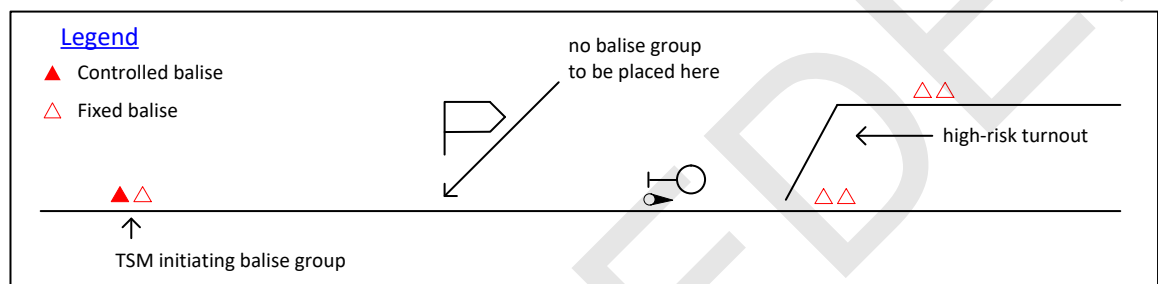


Figure 31 – Speed sign inside TSM area

Another example is where a train can enter the TSM area through a trailing turnout from a wrong running direction move. This is shown in Figure 32.

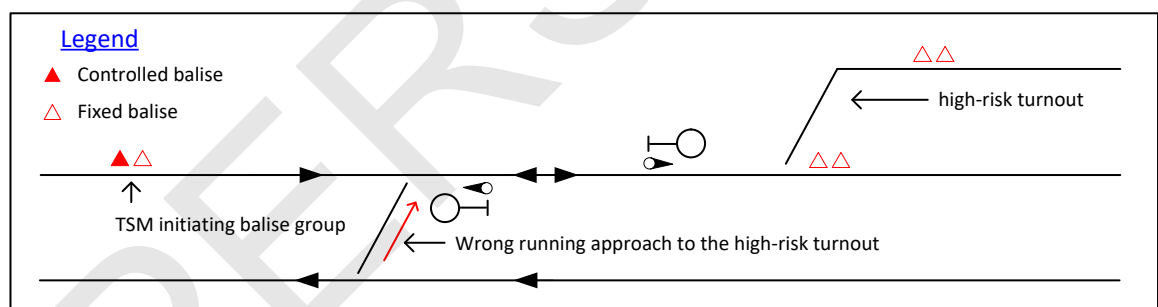


Figure 32 – Wrong running exit into TSM area

There would be no significant operational restriction in preventing the train accelerating to line speed until the end of the TSM area, as it would not be a regular move. If an approach speed of 40 km/h to the TSM target point is deemed high-risk, then this approach shall also be taken into account for protection.

For a balise group that is not transmitting an SSP packet #27 in a given direction, it cannot be used as a mode change balise group for that direction, as packet #80 can only be sent with packet #12, and packet #12 requires packet #21 and packet #27 to accompany it as shown in Figure 33.

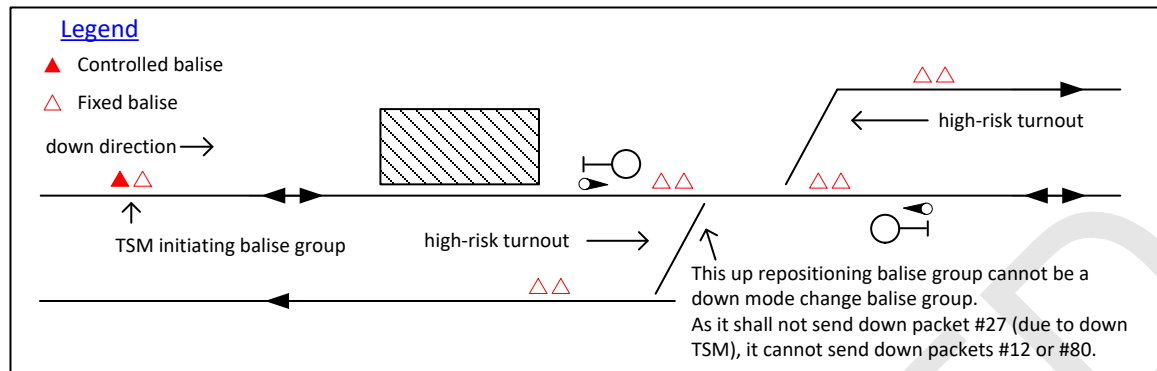


Figure 33 – Mode change not possible inside TSM area

11.3 LSSMA value considerations

The display of the LSSMA on the DMI can cause operational restrictions where there are cascading functions. If a restriction is considered significant, then an extra balise group can be provided to reduce the restriction.

For example, consider a TSM-initiating balise group transmitting an SSP packet containing the iterations 90/60/90/25 km/h, where 90 km/h is the line speed, 60 km/h is for a high-risk overrun with the protecting signal at stop, and 25 km/h is transmitted as a redundant TSM for a high-risk turnout farther in advance. This is shown in Figure 34.

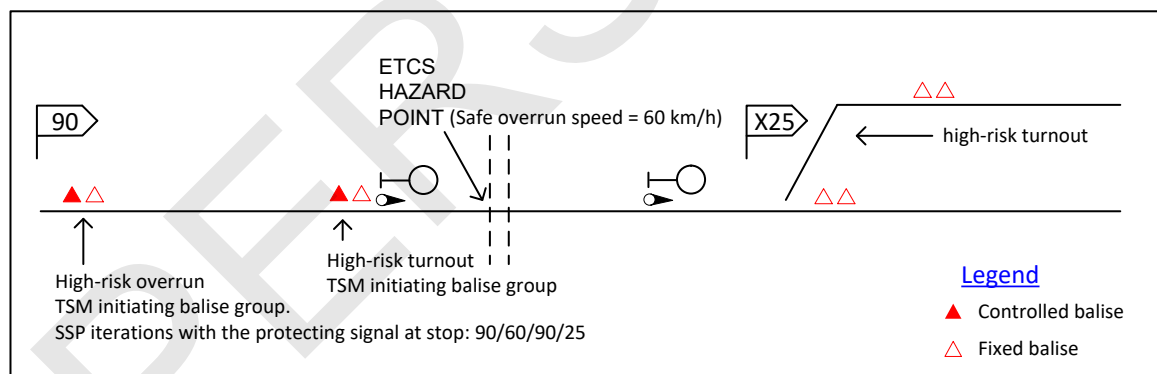


Figure 34 – High-risk overrun followed by high-risk turnout

The DMI displays an LSSMA of 25 km/h, as it is the lowest of the speed iterations. This can cause an operational restriction approaching the high-risk overrun protecting signal if it clears after passing the TSM-initiating balise group. This is because the driver may notice the display of 25 km/h on the DMI, and can be misled into believing that accelerating faster than 25 km/h would cause warnings or brake interventions.

11.4 LSSMA display considerations

The display of the LSSMA shall not be toggled-off where it is required to remain toggled-on. An example of a cascading function where this needs consideration is a high-risk overrun followed by a high-risk turnout.

The standard arrangement for a high-risk overrun includes a balise group at (or up to 10 m in advance of) the protecting signal whose purpose is to toggle-off the display of the LSSMA. See Figure 34 for an example of this arrangement. Where the display of the LSSMA is toggled-on for another reason when passing this protecting signal, for example, approaching a high-risk turnout, the display of the LSSMA shall remain toggled-on, potentially removing the need for a balise group at the protecting signal.

Where a controlled balise group is required at the protecting signal, it shall conditionally toggle off the display of the LSSMA.