

Information for printer users

The attached document:

NR/SP/SIG/02023
Issue 2

contains colour on the following
electronic pages:

16, 31, 35, 37, 42 & 43

Proceed to document ►

Colour pages can be purchased separately from:

The Network Rail Document Centre @ Rapidoc

Tel: 01344 404446

Fax: 01344 714440

Email: rapidoc@ihsti.com

Please have the following details to hand when purchasing:
Contact and delivery details, Standard No., Title, Quantity.
Please also have your credit card/payment details to hand

Ref	NR/SP/SIG/02023
Issue	2
Date	December 2005

Business Process Document

Requirements for TASS Infrastructure - System Design

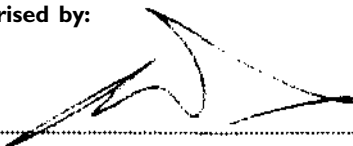
Endorsement & Authorisation

Endorsed by:


.....

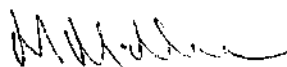
Andrew Simmons, Professional Head of Signal Engineering

Authorised by:


.....

Andrew McNaughton, Chief Engineer

Accepted for issue by:


.....

Mick McManus, National Standards Manager

This document is the property of Network Rail. It shall not be reproduced in whole or part nor disclosed to a third party without the written permission of the Standard Owner.

©Copyright 2005 Network Rail

Uncontrolled copy once printed from its electronic source.

Published & Issued by: Network Rail 40 Melton Street, London NW1 2EE



Ref:	NR/SP/SIG/02023
Issue:	2
Date:	December 2005

Issue record

Issue	Date	Comments
1	December 2003	New Specification
2	December 2005	Updated to align with TASS Design Authority application rules and to remove the overlap with NR/SP/SIG/02026 Requirements for the Provision and Management of TASS Infrastructure Data. Document reference changed to new lettering system. Previous reference RT/E/S/02023. Changes have not been sidelined.

Implementation

The requirements of this specification shall apply to all Tilt Authorisation and Speed Supervision (TASS) track-based sub-system equipment used on Network Rail controlled infrastructure.

Compliance

The requirements of this specification are mandatory and shall apply to Network Rail, their contractors and any other parties involved with the provision of TASS track-based sub-system equipment on Network Rail controlled infrastructure on or after 3 December 2005.

Disclaimer

In issuing this document for its stated purpose, Network Rail makes no warranties, express or implied, that compliance with all or any documents it issues is sufficient on its own to ensure safe systems of work or operation. Users are reminded of their own duties under health and safety legislation.

Supply

Copies of documents are available electronically, within Network Rail's organisation. Hard copies of this document will be available to Network Rail employees on request to the Document Controller and to other organisations from Technical Indexes Ltd (01344 404409).

Contents

1	Purpose	5
2	Scope	5
3	Reference Documentation	5
4	Definitions	6
5	Design Process Overview	8
5.1	TASS Track-Based Infrastructure Design	8
5.2	TASS Balise Data Preparation and Validation	9
6	TASS Balise Position Design	11
6.1	Defining The Position of TASS Balises	11
6.2	TASS Balise Positioning Rules	16
6.3	Positioning Factors To Be Considered	38
6.4	TASS Balise Position Finalisation & Acceptance Requirements	47
7	TASS Balise & Telegram Identity	48
7.1	TASS Balise Identification Requirements	48
8	TASS Balise Telegram Design	52
8.1	Overview	52
8.2	Defining The Data To Be Programmed Into Each Identified Balise	57
8.3	Identity Data Within TASS Balise Telegrams	57
8.4	Position & Odometry Tolerances Within TASS Balise Telegrams	58
8.5	Format of TASS Balise Telegrams	70
8.6	TASS Variables	81
8.7	TASS Sub-packets	82
8.8	Directionality	82
8.9	Configuration Control	84
9	TASS Balise Telegram Data Issue And Records	85
9.1	TASS Balise Telegram Acceptance Requirements	85
9.2	TASS Balise Programming	85
9.3	TASS Balise Issue Documentation	86
9.4	Infrastructure Data Retention, Requests And Returns	86
10	Appendices	87

Ref:	NR/SP/SIG/02023
Issue:	2
Date:	December 2005

Appendix A	NR/GN/SIG/11110 'Outline Project Specifications (OPS) For Signalling Schemes'	88
Appendix B	NR/GN/SIG/11600 'Signalling and Operational Telecommunications Design: Technical Guidance'	89
Appendix C	NR/GN/SIG/11701 'Signalling Design: Production Guidance'	90
Appendix D	NR/GN/SIG/11710 'Signalling Design Handbook'	91



I Purpose

This specification defines the design requirements for the Tilt Authorisation and Speed Supervision (TASS) system developed to deliver the principal requirements of Railway Group Standards [GE/RT8012](#) 'Controlling The Speed Of Tilting Trains Through Curves' and [GE/RT8019](#) 'Tilting Trains: Controlling Tilt Systems To Maintain Clearances'. This specification covers the following aspects of the system:-

- TASS track-based equipment configuration design.
- TASS balise data requirements and preparation.
- TASS balise telegram structure.
- TASS balise programming.
- Associated design documentation.

2 Scope

This document describes the design requirements and processes necessary to establish a TASS system on Network Rail infrastructure. It defines the ruleset used to calculate balise positions together with the data requirements and the structure of the balise telegrams for use with the TASS system as developed by ALSTOM for use on Network Rail infrastructure.

3 Reference Documentation

C80056-SPEC-SYS-00166	BEPT User Manual
GK/RT0038	Signing of Permissible Speeds and Speed Restrictions
GE/RT8012	Controlling The Speed Of Tilting Trains Through Curves
GE/RT8019	Tilting Trains: Controlling Tilt Systems To Maintain Clearances
NR/GN/SIG/02022	Requirements For TASS Infrastructure – System Description
NR/GN/SIG/11110	Outline Project Specifications (OPS) For Signalling Schemes
NR/GN/SIG/11600	Signalling and Operational Telecommunications Design: Technical Guidance
NR/GN/SIG/11701	Signalling Design: Production Guidance
NR/GN/SIG/02025	Guidance for Consideration of TASS Balises During Railway Engineering Activities
NR/GN/SIG/11710	Signalling Design Handbook
NR/SP/SIG/02024	Requirements For TASS Infrastructure – Installation, Test and Maintenance
NR/SP/SIG/02026	Requirements for the Provision and Management of TASS Infrastructure Data

4 Definitions

NOTE: Calculation variable abbreviations are defined in Section 6.1.7, Table 1.

Accuracy

The degree of variance from an exact value that can be tolerated.

Automatic Warning System (AWS)

A track inductor based system in use on the Network Rail network, linked to the aspects of fixed lineside signals and capable of providing driver alerts and braking intervention.

Balise

A track mounted spot transmission unit that uses magnetic transponder technology. Its function is to transmit/receive messages to/from the train passing overhead. A TASS balise is passive with no interface to a Lineside Electronic Unit (LEU) and will therefore only transmit the fixed telegram stored in its memory. This data can only be changed by reconfiguration.

Balise Encoder Programming and Test (BEPT) Tool

The ALSTOM test and programming tool for use with the TASS track equipment.

Cant Deficiency (CD)

Cant is the cross level angle of track on a curve, used to compensate for lateral forces generated by a train passing through the curve. Cant deficiency is the difference between the applied cant on the track and the equilibrium cant for the vehicle at the particular stated speed.

Engineers Line Reference (ELR)

A unique Network Rail reference for a particular section of track.

Enhanced Permissible Speed (EPS)

The permitted speed (higher than the Permissible Speed) over a section of line which applies to a specific type of tilting train. However, in the speed supervised section, the single speed profile transmitted to the train at any one time will be the higher of either the PS or the EPS for the appropriate train.

Gradient

The actual gradient of the track or, for gradient changes of less than 200 yards, the average over the distance. Gradients are signed (+ve or -ve) when standing with back to zero or lowest absolute mileage irrespective of direction of travel.

High Cant Deficiency

A Cant Deficiency greater than 150mm (see Cant Deficiency above).

Immediate Tilt Stop (ITS) balise

Balise sited just before a tilt prohibit zone or end of TASS route to mitigate against out of tolerance odometry error resulting in tilt being authorised in a non-tilt area.

Mileage

The distance along the track from a defined datum.

Permissible Speed (PS)

The maximum permitted speed over a section of line which applies to all trains when not operating at an Enhanced Permissible Speed.

TASS

Tilt Authorisation and Speed Supervision system (ALSTOM's tilt management solution).

Tilt Authorised

The tilt supervision system provided to fulfil requirements defined in Railway Group Standards *authorises* the train to tilt when it is within a tilt permitted area. A Tilt Authority (TA) output is generated by TASS. As trains leave tilt permitted areas, this authorisation is removed.

Tilt Control System

The trainborne system controlling the tilting of the train.

Tilt Enabled

The tilt control system on the train *enables* tilting, when authorised by the tilt supervision system, and when related drivers controls and tilt self-monitoring indicate that it is desirable to do so.

Tilt Permitted

The Network Rail defined areas of the network where tilting by particular train types is *permitted*.

Tilt Prohibit Zone

An area in a TASS fitted route where tilting is not permitted.

Train Protection Warning System (TPWS)

A system in use on Network Rail lines to provide protection against signals being passed at danger and overspeed protection at certain speed restrictions.

Track ID

The identity of the track that is equivalent to the Geogis Track Code.

TASS Vital Computer (TVC)

ALSTOM's trainborne computer used for TASS.

UNISIG

The group of signalling suppliers who produced ERTMS specifications.

Zone

Comprises of a start and end mileage with a single value describing an entity within these limits. A change in value of the entity requires a new zone to be defined.

5 Design Process Overview

5.1 TASS Track-Based Infrastructure Design

5.1.1

The design of the track-based infrastructure for TASS has two primary interlinked tasks, together with a process of data gathering and processing that feeds into these tasks. The two tasks are:-

- Defining the position and identity of TASS balises.
- Defining the data to be programmed into each identified balise.

5.1.2

The track-based infrastructure design is summarised in Figure 1:-

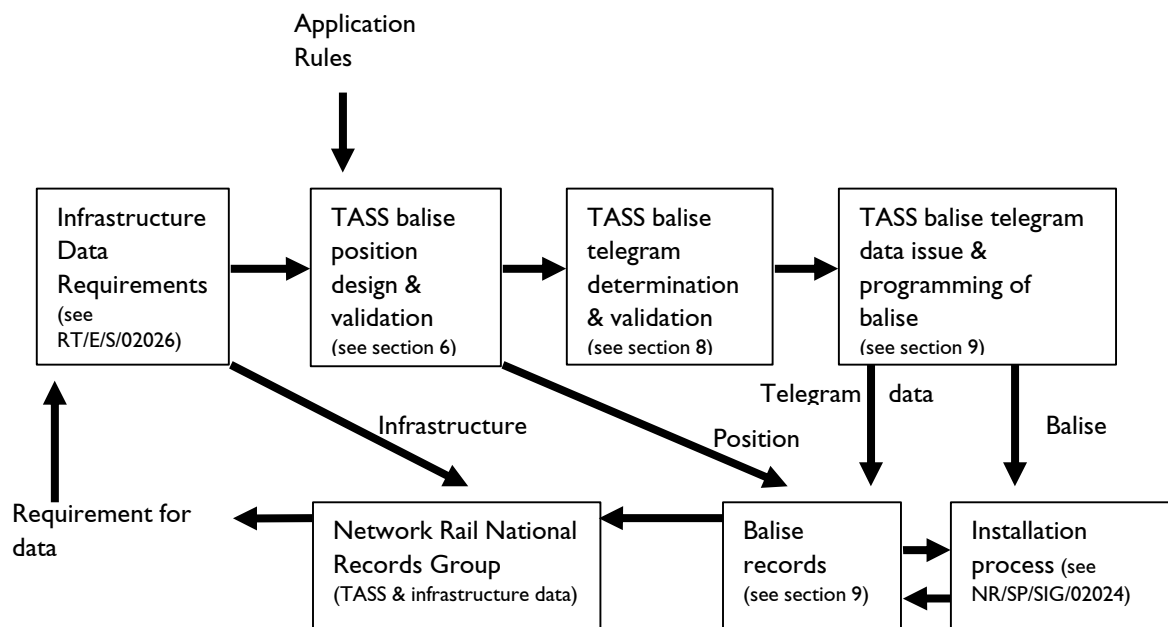


Figure 1

5.1.3

The Network Rail infrastructure data for the layout, or change to existing layout, and the specified TASS routes form the primary inputs. A speed profile needs to be identified. The infrastructure data needs to be recorded in a particular format to enable a consistent design process as defined in [NR/SP/SIG/02026](#). Balise positions are calculated based on the application rules described in this document and [NR/GN/SIG/02022](#) 'Requirements for TASS Infrastructure – System Description'.

5.1.4

Provisional TASS balise positions need to be verified with Network Rail to establish suitable confirmed positions. This process needs to include checks against identified track features (from Network Rail's data records or site surveys) to identify any physical constraints. These confirmed positions need to have associated absolute references such as Overhead Line Equipment (OLE) masts or other track features and confirmation of the sleeper / balise mounting types required. Balise position records need to be established, capable of supporting the installation process and forming the as-built record of the route, and unique balise identities created.

5.1.5

TASS balise telegrams need to be established to a defined format and the data verified before inclusion in the balise flash memory and as a separate electronic record. The infrastructure data, TASS balise positions and telegram data need to be validated together and considered in terms of whole sections of route to ensure they are correct, fit for purpose and acceptable to Network Rail and the train operators using the TASS system.

5.1.6

The master as-built records from the design process need to reside with Network Rail National Records Group (NRG).

5.2 TASS Balise Data Preparation and Validation

5.2.1

The design and production progression from source data to accepted installation shall include the following steps:-

- Design the balise position from the infrastructure data and the balise positioning rules.
- Obtain Network Rail acceptance of the proposed balise position.
- Prepare the telegram message in Excel format.
- Verify the Excel telegram message against the source data.
- Compile the Excel telegram message into a balise data telegram in hexadecimal format.
- Encode the hexadecimal balise data telegram into binary format.
- Verify the binary balise telegram against the source data.
- Obtain formal design acceptance by Network Rail.

Ref:	NR/SP/SIG/02023
Issue:	2
Date:	December 2005

- Program the balise with the binary telegram.
- Verify the telegram in the balise against the telegram used for programming.
- Validate the balise telegram and sequence of programmed balises against the source data.
- Supply Network Rail National Records Group with a CD-ROM containing Excel and binary telegram messages, balise telegram functionality record and installation documentation.

6 TASS Balise Position Design

6.1 Defining The Position of TASS Balises

6.1.1

Balise positions shall be designed based on the infrastructure data provided and the TASS application rules. There are two guiding principles of TASS balise position:-

- The distances to supervised locations defined in TASS balise data shall be short enough to ensure sufficient accuracy of on-board distance measurement.
- The number of trackside TASS balises should be minimised, consistent with the safe operation of the system.

6.1.2

In order to establish the optimum arrangement TASS balises positions shall be defined relative to critical locations on the track and, between these locations, additional TASS balises shall be placed, ensuring the spacing does not exceed 5km. The absolute minimum spacing permitted between TASS balises shall be 200 metres (except for balise pairs – section 6.2.3 I defines balise pair spacing). The process steps are as follows:-

- Acquire all source data.
- Identify mandatory TASS balise locations, and define the permissible range for balise fitment for each, to keep supervised distances sufficiently short.
- Check for non-preferred TASS balise locations.
- Combine overlapping mandatory TASS balise locations, to reduce the total number of balises.
- In-fill on plain track between these locations with the minimum number of additional TASS balises, subject to constraints of non-preferred balise locations.

6.1.3

The following general principles shall apply:-

- Tilting starts as soon as possible on regularly used entry to tilting routes. Priming balises or closer balise spacing is used to achieve this.
- Continuous speed supervision is provided throughout the TASS fitted route, including areas between EPS sections that are traversed at PS.

- Speed reductions from EPSs to lower PSs approaching the regularly used ends of tilting routes are supervised by TASS.
- For simplicity of TASS application, TASS may be arranged to supervise a blanket single speed profile for all routes through some large, complex station areas and, in some of these cases, tilt may not be authorised. The defined blanket speed is the highest of all possible speeds through multiple speed profiled area.
- Tilting operation expires shortly after trains have left tilting routes.
- Speeds appropriate to diverging junctions are NOT supervised by TASS.
- TASS is NOT used to supervise speeds approaching buffer stops.
- TASS balises are located on the tilting route(s) following diverging and converging junctions used by tilting trains, and on the approach to critical locations on the track.
- TASS balises are not to be fitted within S&C.
- TASS balises are not to be fitted in tunnels unless absolutely necessary.
- Balise pairs are required on bi-directionally signalled lines excluding those for shunt and set-back moves.
- Switchable balises are not used by the TASS system.
- No redundancy need be provided within the layout of balises.
- TASS trainborne equipment detects the absence of an expected balise.

6.1.4

Deceleration distances are required when extending the tilt authority defined in a balise preceding a balise that is in close proximity to the start of a high cant deficiency zone. These distances shall be determined by following the methods described in section 8.4.7.

6.1.5

Emergency braking distances shall be applied to balise positioning and tilt authority approaching tilt prohibit zones. The distances shall be calculated for each train class as follows:-

$$BrakingDistance = \frac{U^2 - V^2}{2 * Deceleration} + \left(\frac{U * Brake_Application_Delay}{2} \right)$$

Where :

V = End velocity in m/s (zero for stopping distance)

U = Start velocity in m/s

$$\text{Deceleration} = (g/\text{Grad}) + (\text{Braking Rate} * g)$$

Grad = +x if gradient = 1/x uphill or -x if gradient = 1/x downhill
(determined in accordance with GK/RT0038 Appendix B)

Brake Application Delay and Braking Rate (see section 6.1.7)

$$g = 9.81 \text{ m/s}^2$$

6.1.6

For example, braking distance for a class 221 from 140mph to 0mph on a falling gradient of 1 in 200 is calculated (using values in section 6.1.7) as follows:-

$$V = 0 \text{ mph} = 0 \text{ m/s}$$

$$U = 140 \text{ mph} = 62.57 \text{ m/s}$$

$$\text{Deceleration} = (9.81/-200) + (10.8/100 * 9.81) = 1.01043 \text{ m/s}^2$$

$$\text{Braking Distance} = \frac{(62.57)^2 - (0)^2}{2 * 1.01043} + \left(\frac{62.57 * 4}{2} \right)$$

$$\text{Braking Distance} = 2062.4 \text{ m}$$

6.1.7

The various tolerance variables that shall be assumed in determining TASS track-based equipment requirements are as shown in Table I. The variable names and abbreviations are used throughout the standard.

Tolerance Variable	Abbreviation	Definition	Values
Balise Installation Tolerance	BT	Tolerance allowed for balise location during trackside installation.	5m
Supervised Location Tolerance	FT	Track feature location accuracy	20m
Odometry Distance Tolerance	ODO	A fixed value based on the total odometry tolerance of ODOm + ODO% for the track-based application.	10m
Odometry Percentage Tolerance	ODO%	The odometry percentage tolerance is calculated as a percentage of the total distance from the balise transmitting the data to the next (continuation) balise for the track-based application.	3%
Trainborne Odometry Distance Tolerance	TODO	Values used for trainborne calculations associated with train position maximum and minimum.	3m
Trainborne Odometry Percentage Tolerance	TODO%	Values used for trainborne calculations associated with train position maximum and minimum.	2%

Table I (continued overleaf)

Tolerance Variable	Abbreviation	Definition	Values
Supervised Reversion Tolerance	SUP	A fixed value based on the total supervised reversion tolerance of SUPm + SUP%.	220m
Supervised Reversion Percentage Tolerance	SUP%	The supervised reversion percentage tolerance is calculated as a percentage of the total distance from the balise transmitting the data to the next (continuation) balise.	5%
Response Distance	RD	Distance used in trainborne application calculations to allow delays in functionality due to TVC cycle times	20m
Active Tilt Centering Time	ATCT	Active Tilt Centring time.	5s
Passive Tilt Centering Time	PTCT	Time taken by Class 390 and 221 to centre passively from maximum tilt angle.	10s
Hard Tilt Feedback Time	HTFT	Time for hard tilt disable feedback to be provided and checked.	1s
Ceiling Speed	CS	Ceiling Speed is a train type dependant maximum defined in trainborne TASS data but for the purposes of the trackside design the higher value is taken.	140mph
Braking Distance	BD	Dependant on scenario: BD = Emergency braking distance from Ceiling Speed to stop if approaching a tilt prohibit location BD = Braking distance from EPS to lower supervised speed if next balise in close proximity to start of high cant deficiency area.	(see 6.1.4 and 6.1.5)
Gradient Value Tolerance	(no abbreviation)	Tolerance applied to gradient value converted from a ratio of 1:x to a ratio of y:1000.	-1 per mil
Maximum Train Length	TL	The maximum TASS train length is that of a class 221 train consisting of 16 cars in a tilting configuration. 221 car length = 23.25m.	372m
Brake Application Delay Class 221	BAD221	The delay between brake request and achievement of derated brake rate.	4s
Brake Application Delay Class 390	BAD390	The delay between brake request and achievement of derated brake rate.	4s
Braking rate Class 221	BR221	The safe deceleration rate for 221 emergency brakes is 1063mm/s/s.	10.8%g
Braking rate Class 390	BR390	The safe deceleration rate for 390 emergency brakes is 750mm/s/s.	7.6%g

Table I (continued)

6.1.8

Each TASS balise transmits TASS active distance information (see Figure 2). The D_TASS_ACTIVE variable defines the exact distance between the designed position of the balise for which the telegram is to be calculated and the designed position of the next balise in mileage (applicable to the same direction) except if the next balise is an Immediate Tilt Stop (ITS) balise. In this case the D_TASS_ACTIVE value defined in the telegram shall be the nominal distance to the balise immediately beyond the ITS balise. This value is used by the trainborne system to calculate a distance window in which the next balise should be encountered. No tolerances are applied for the calculation of D_TASS_ACTIVE. The TASS system will only act on speed and tilt data from a balise telegram if it has already received valid TASS active distance information from a previous balise, and if the location of the current balise relative to the previous balise falls within the defined TASS active window. If no continuation balise data is received before the end of the calculated active window is reached, a supervised reversion is initiated. To prevent this happening at the end of supervision from the last balise installed on a route, the D_TASS_ACTIVE distance shall be set to a value greater than or equal to the longest defined supervision extent in the telegram. The TASS active window extends from 94%-20m to 103%+20m of the TASS active distance provided by D_TASS_ACTIVE at the previous balise.

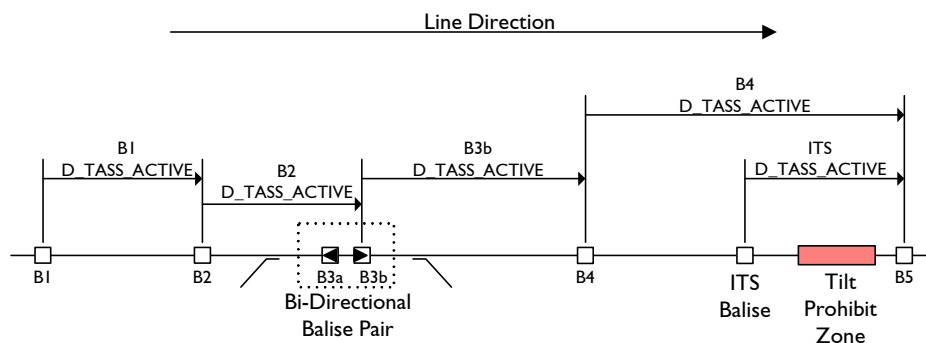


Figure 2

6.1.9

The TASS system supervises a reversion to non-tilting operation if any of the following occur:-

- The tilt system becomes unhealthy or isolated at any time.
- A balise is not read by the end of the TASS active window.

- Wheelslide is detected for more than a predetermined value between balises.

6.1.10

Supervised reversion to non-tilting operation involves:-

- A delay of four seconds following one of the events described in 6.1.9.
- Calculation of the distance required to decelerate from current train speed to 40mph, and a check within this distance for the lowest defined supervised speed value. If no supervised speed value is available after the four second delay no supervised deceleration takes place, therefore the speed supervised profile within the telegram needs to be designed to extend to a point at least 4 seconds beyond the end of the TASS active window.
- Supervised reduction in speed from current train speed to greater of (lowest supervised speed value - 25mph) or 40mph.
- Removal of all tilt enables, if they have not already been removed as part of normal TASS operation, when speed drops below supervised reduction value.

6.1.11

TASS balise positioning rules are given in section 6.2. Where a scenario is encountered that is not covered by these rules the design authority shall be consulted for guidance.

6.2 TASS Balise Positioning Rules

Entry to Tilting Routes

6.2.1

On the approach to the start of a tilting route, for example from a terminal station, two balises are required to initiate tilting and speed supervision. The first balise is the priming balise (containing only data defining the TASS active window), and the second a balise (described as the initiator balise) containing Tilt Authority (TA), speed supervision and, if necessary, TPWS temporary isolate data. The positioning of the initiator balise could result in a non-zero value for D_START_TILTING within the initiator balise telegram if the TA starts beyond the initiator balise position. Gross odometry error could then result in tilt being authorised early. To minimise this possibility the distance between the initiator balise and the defined start of the TA shall not exceed 1 km. If this is unavoidable, the proposed configuration shall be subject to a documented risk assessment. If the configuration cannot be justified, the

initiator balise telegram shall not define a TA and an additional balise shall be required at train length beyond the start of the TA to define the TA and speed supervision requirements. The initiator balise shall be installed at a distance on approach to the entry point between the earliest and latest defined below and illustrated in Figure 3:-

Earliest position	Latest position	Preferred position
5km before the start of TASS speed supervision as defined in Network Rail infrastructure data.	250m before the start of TASS speed supervision as defined in Network Rail infrastructure data. This ensures that the 'speed supervised' indicator illuminates in time for the driver to observe the first speed sign in the speed supervision area.	As near as possible to the latest position within this range (to minimise odometry error).

6.2.2

The priming balise shall be installed at a distance before the initiator balise between the earliest and latest defined below and illustrated in Figure 3:-

Earliest position	Latest position	Preferred position
5km before the initiator balise	Dependent on the distance between the initiator balise and the start of tilt authority. If this distance is greater than 250m, the latest position of the priming balise shall be moved further away from the initiator balise to ensure that the TASS active distance specified by the priming balise is within 80% and 100% of the distance between the initiator balise and the start of the tilt authority. This is to ensure that the odometry system has been checked against a similar distance to that defined for the start of tilt authority in the initiator balise. If the distance between the initiator balise and the start of tilt authority is less than 250m, the latest position of the priming balise shall be 200m before the initiator balise.	As near as possible to the latest position within this range (to assist balise access).

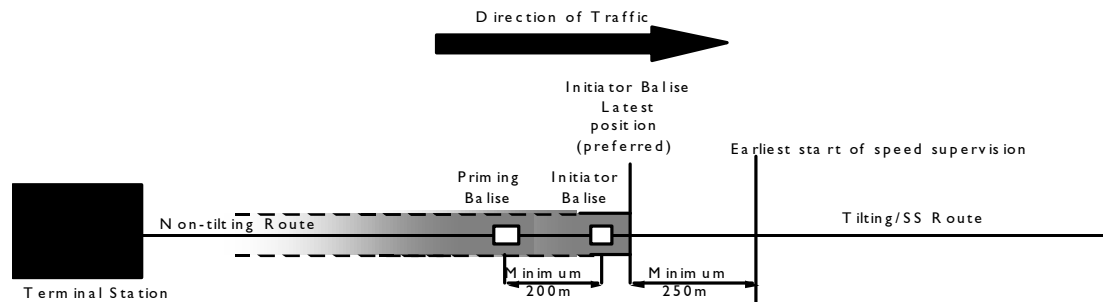


Figure 3

6.2.3

A balise is required both on the approach to and beyond regularly used normal direction entry points for tilting trains converging onto the tilting route from non-tilting routes, i.e. not slow to fast crossovers, passenger loops, etc. The balise on approach to the entry point is the priming balise that ensures valid TASS active data is received prior to the initiator balise. A priming balise may be excluded at the entry to a TASS fitted route from a converging non-TASS fitted route, if this entry route is infrequently used, e.g. entry from a stabling yard or siding, entry from a station platform where trains stable, entry from a goods loop. In this case the initiator balise, positioned as shown in Figure 4, will be the first encountered and function as the priming balise for these trains. Where required, the priming balise shall be installed at a distance on approach to the entry point between the earliest and latest defined below and illustrated in Figure 4:-

Earliest position	Latest position	Preferred position
No more than 5km before the earliest position of the initiator balise.	50m before the start of the converging route S&C on the convergent track.	As near as possible to the latest position within this range.

6.2.4

The initiator balise associated with the arrangement described in section 6.2.3 shall be installed at a distance beyond the entry point between the earliest and latest defined below and illustrated in Figure 4:-

Earliest position	Latest position	Preferred position
Maximum Train Length + balise installation tolerance (BT) + supervised location tolerance (FT) beyond the end of the non-tilting entry track section.	As soon as possible after the earliest position distance while ensuring that the distance from the priming balise is less than 5km.	As near as possible to the earliest position within this range (to minimise journey time and improve passenger comfort).

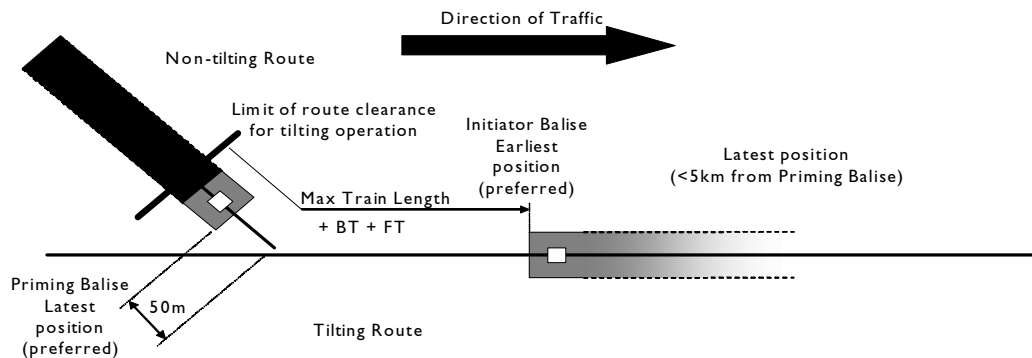


Figure 4

6.2.5

Alternatively, the first two balises beyond the converging junction may be positioned to facilitate earliest activation of TASS supervision for a train joining the route.

6.2.6

Every valid tilt authority received by the trainborne equipment is submitted to a tilt length check depending on the tilt status of the train. The tolerances applied to continuous tilt authority sections ensure that the extent of a defined tilt authority always allows for the proper removal of tilt authority. The distance required to properly enable tilt is dependant on the distance between consecutive balises. As tilt authority is enabled beyond the defined start of tilt authority, defining a minimum distance between balises equal to this amount ensures that the non-tilting length check is always passed. The balise following the initiator balise shall therefore be installed at a distance beyond the first balise authorising tilt between the earliest and latest defined below:-

Earliest position	Latest position	Preferred position
Distance to start of tilting plus maximum train length plus trainborne odometry distance tolerance divided by 1 minus trainborne odometry percentage tolerance: $(D_START_TILTING + TL + TODO) / (1 - TODO\%)$ beyond the initiator balise.	Beyond the earliest position while ensuring that the distance from the initiator balise is less than 5km.	As required.

6.2.7

Although the non-tilting length check is normally applied at the start of tilting routes, a balise failure along the route would result in the train reverting to non-tilting operation. A subsequently received tilt authority would be submitted to a non-tilting tilt length check. To minimise increases in journey time due to the possible rejection of tilt authority due to failed tilt length checks following balise failures, it is recommended that, where possible, balises providing continuing tilt authority are positioned a minimum of 343 metres apart.

Approaching a Lower Supervised Speed

6.2.8

A balise is required on the normal direction approach to a lower supervised speed at a distance from its start determined as shown below, and illustrated in Figure 5, according to the approach speed, and designed to be sufficiently far in advance of the start of the lower speed to be before the start of the supervised braking curve calculated by the trainborne system:-

Earliest position	Latest position	Preferred position
Twice the lineside warning board distance (see below regarding locations where no lineside warning board is provided) from the start of the lower supervised speed.	438m (7 seconds at ceiling speed) before the lineside warning board for the lower supervised speed. The warning board is a minimum distance varying with gradient (see below regarding locations where no lineside warning board is provided) before the start of the lower supervised speed.	As near as possible to the latest position in this range (to minimise odometry error, intrusiveness of supervision and journey time).

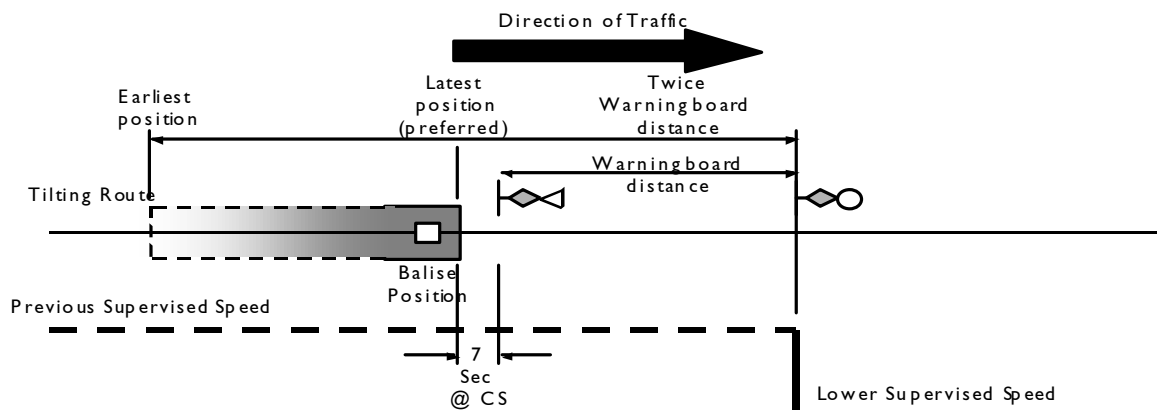


Figure 5

6.2.9

As lineside warning boards are not positioned for every single speed reduction, it may be necessary to determine the position of a 'virtual' warning board for the speed decrease. The deceleration distance used in the positioning of the virtual warning board is determined both from Appendix B of GK/RT 0038 for 'Previous PSR' to the 'lower PSR' and from braking distance calculations from the 'Previous EPS' to the 'lower PSR' at 7%g. The greater of the two distances is used. The balise is positioned from the calculated virtual warning board position as described above.

At an Increase in Supervised Speed

6.2.10

A balise is required on the normal direction approach to an increase in supervised speed, at a distance from the start of the increase determined as shown below and illustrated in Figure 6:-

Earliest position	Latest position	Preferred position
5km from the start of the higher supervised speed.	250m before the increase in supervised speed to allow sufficient time for the driver to see the relevant speed board.	Not critical

Note: An increase in supervised speed may often be conveniently defined in a balise which is required for other TASS purposes, avoiding the need for an extra balise.

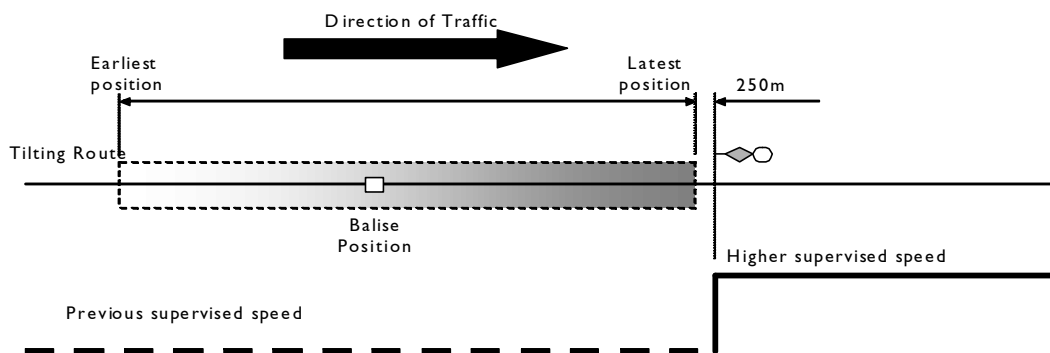


Figure 6

Approaching Tilt Prohibited Zones

6.2.1.1

A balise is required on the normal direction approach to tilt prohibited zones, at a distance from the start of the tilt prohibited zone determined as shown below and illustrated in Figure 7. To avoid the possibility of a balise telegram being received due to crosstalk and leading to authorisation of an extended tilt on the approach to a tilt prohibit zone, the TASS active window defined by the balise immediately on approach to the balise removing tilt shall be a mandatory balise free zone on any adjacent TASS fitted lines (see Figure 8):-

Earliest position	Latest position	Preferred position
1.5 times emergency braking distance from ceiling speed, adjusted for gradient (*) + tolerances on balise position and start of tilt prohibited zone.	Active tilt centring time (ATCT) plus hard tilt feedback time (HTFT) plus 7 seconds at ceiling speed plus emergency braking distance from ceiling speed, adjusted for gradient (*), + tolerances on balise position and start of tilt prohibited zone. Use higher value of applicable train types in use.	As near as possible to the latest position in this range (to minimise odometry error and risk of tilting in a prohibited zone)

(*) Note: All distances shall be calculated assuming a ceiling speed of 140mph.

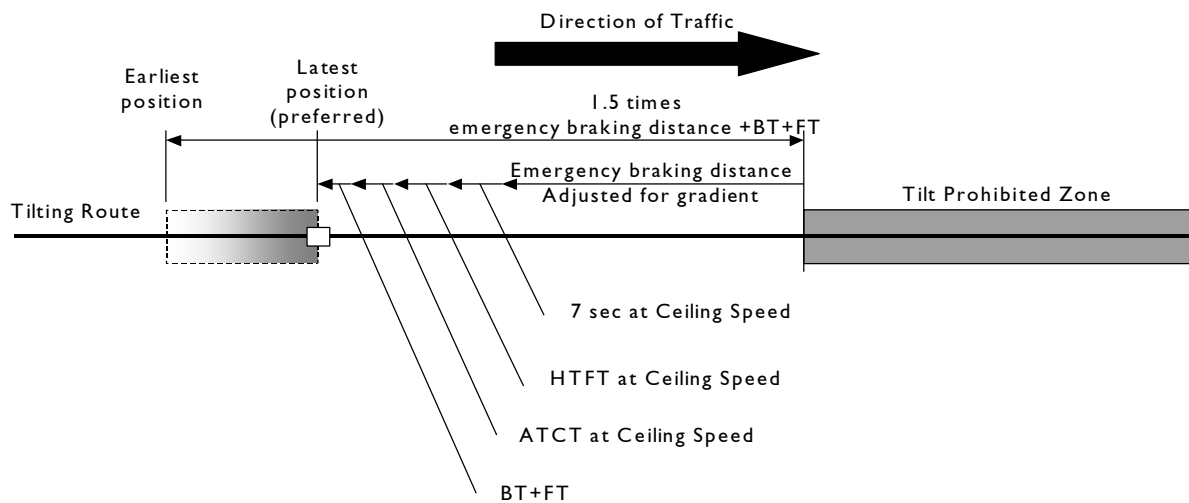


Figure 7

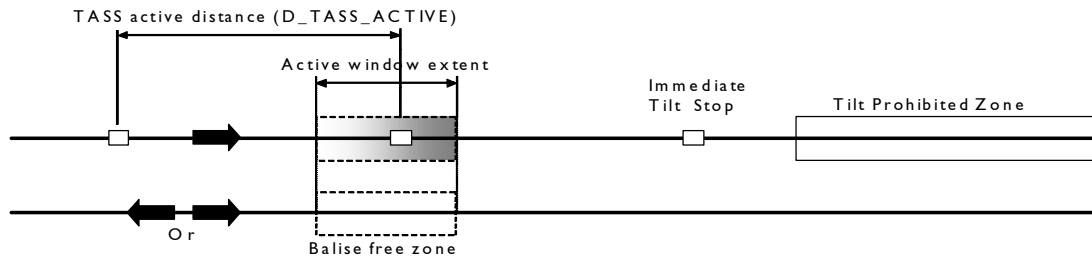


Figure 8

6.2.12

To mitigate against an out of tolerance odometry error resulting in tilt being authorised within a tilt prohibit zone, 'Immediate Tilt Stop' balises shall be fitted on the approach to all defined tilt prohibit zones, including the approach to terminal stations where a tilt prohibit zone is not explicitly specified, but tilt authorised data expires. These balises shall be positioned on the normal direction approach to tilt prohibited zones, at a distance from the start of the tilt prohibited zone determined according to the ceiling speed as shown below and illustrated in Figure 9:-

Earliest position	Latest position	Preferred position
1.5 times latest position distance from start of tilt prohibit zone.	Maximum passive tilt centring time (PTCT) plus hard tilt feedback time (HTFT) at ceiling speed (*) plus tolerances on balise position and start of tilt prohibited zone. Use the higher value of the train types in use.	As near as possible to the latest position in this range (to minimise risk of a misplaced balise occurring between the balise and the tilt prohibit zone).

(*) Note: All distances shall be calculated assuming a ceiling speed of 140mph.

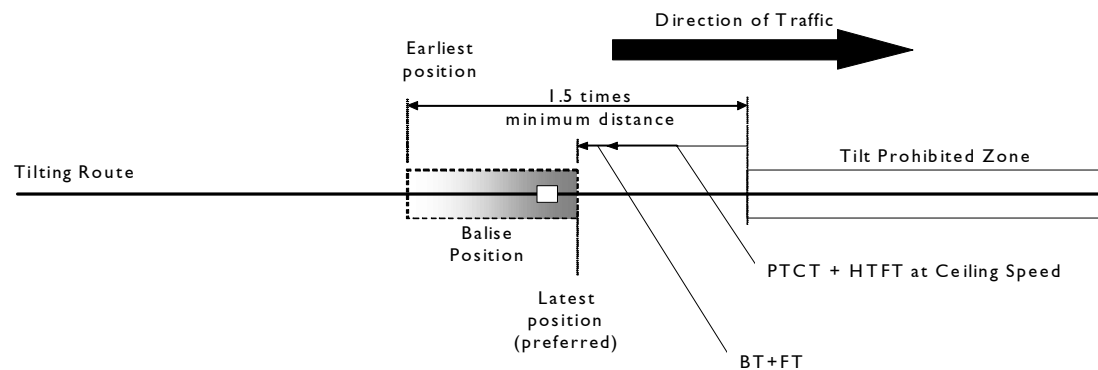


Figure 9

Leaving Tilt Prohibited Zones

6.2.13

A balise is required near the end of each tilt prohibited zone on a tilting route, at a distance from the end of the tilt prohibited zone defined below and illustrated in Figure 10:-

Earliest position	Latest position	Preferred position
Maximum Train Length + balise installation tolerance (BT) + supervised location tolerance (FT) beyond the end of the non-tilting section.	As soon as possible after the earliest position while ensuring that continuous TASS supervision is maintained.	As near as possible to the earliest position (to minimise journey time, and improve passenger comfort).

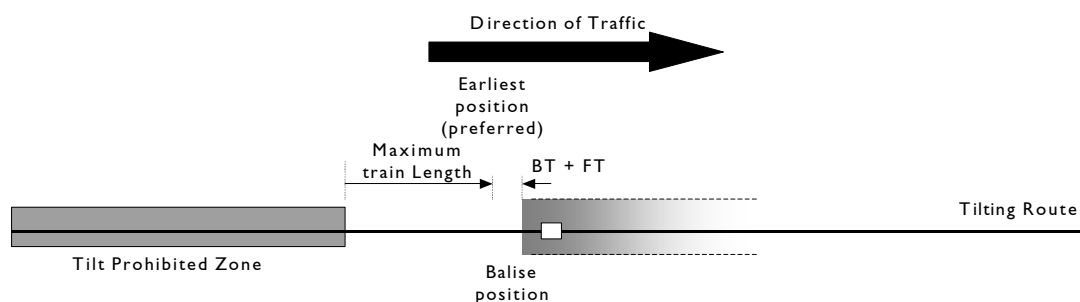


Figure 10

TPWS at Speed Restrictions

6.2.14

A balise is required on the normal direction approach to TPWS overspeed sensor systems protecting speed restrictions where there is also an EPS, at a distance from the TPWS overspeed sensor system arming loop determined according to the approach speed as shown below and illustrated in Figure 11.

A balise shall always be located between the preceding TPWS installation and the trigger loop over which TPWS is to be isolated.

The TPWS isolate zone shall end at least 180 metres before the arming loop of the next TPWS track installation. This is to ensure that the trainborne equipment has checked and confirmed that the TPWS has de-isolated, before the next TPWS loops are encountered.

TPWS Isolation is not permitted if there is insufficient spacing from any signal overspeed or train stop loop. This may affect the achievable signed speed profile.

Earliest position	Latest position	Preferred position
800m before the start of the TPWS isolate zone as defined in Network Rail infrastructure data (arming loop). More than 50m from any previous TPWS loop.	300m before the start of the TPWS isolate zone as defined in Network Rail infrastructure data (arming loop).	As near as possible to the latest position (to minimise odometry error)

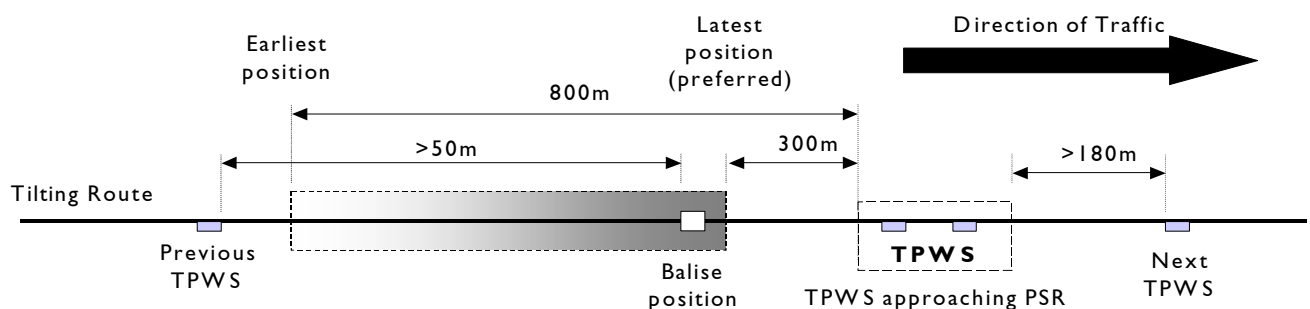


Figure 11

End of TASS Fitted Route

6.2.15

Approaching the end of a TASS fitted route tilt authority shall be removed and speed supervision terminated at PS. Tilt authorisation shall be dealt with in the same way as approaching a tilt prohibited zone. This shall apply when approaching a terminal station where a tilt prohibit zone is not explicitly specified, but tilt authorised data expires. It shall be assumed that the tilt prohibit zone starts at the end of the section cleared for tilting operation.

TASS Balise Positions at Diverging Junctions

6.2.16

Individual TASS balises can only define a tilting profile for a single route. In the situation where a diverging non-tilting route is taken, the continuous tilt authority defined in the balise on approach to the entrance to the diverging route shall expire, i.e. the balise continuing tilt is not seen. The balise layout to achieve this is described below and illustrated in Figure 12.

The balise immediately beyond the junction shall be positioned according to the following:-

Earliest position	Latest position	Preferred position
15m beyond the end of the diverging route S&C zone as defined in Network Rail Infrastructure data.	As soon as possible after the earliest position while ensuring that the distance from the previous balise is less than 750m.	As near as possible to the earliest position (to minimise the extent of authorised tilt on the diverging route thereby minimising gauge clearance requirements).

The balise immediately before the diverging route S&C zone shall be positioned according to the following table:

Earliest Location	Latest location	Preferred location
750 m from the balise immediately beyond the diverging route S&C zone	200m from the balise immediately beyond the diverging route S&C zone.	343m from the balise immediately beyond the diverging route S&C zone to ensure tilt length checks are passed if the through route is taken.

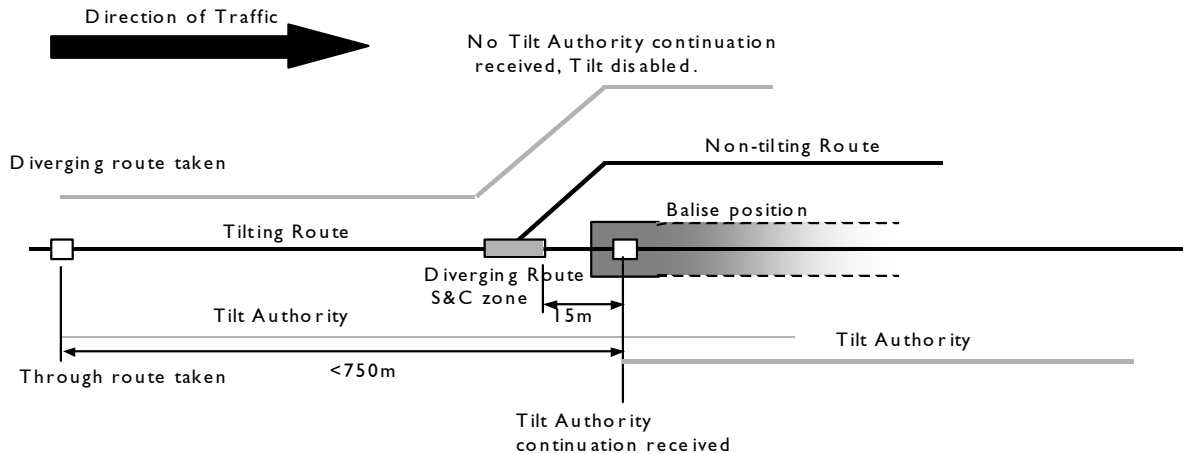


Figure 12

6.2.17

Tilting clearances (gauge clearance) shall be maintained for a distance beyond the end of the tilt authority on the diverging route to allow the train to centre itself and be brought safely to a halt, and to allow detection of unauthorised tilting after removal of tilt authorisation (see Figure 13). If tilting of certain types of train is not permitted when entering diverging routes, balises shall be arranged to ensure that tilting is safely inhibited on those trains before the junction is reached. The non-preferred zones on the adjacent track mitigate against cross talk from any balise which might have been positioned in this area, causing a train approaching the diverging route to receive a tilt authority extending beyond the end of gauge clearance on the diverging route.

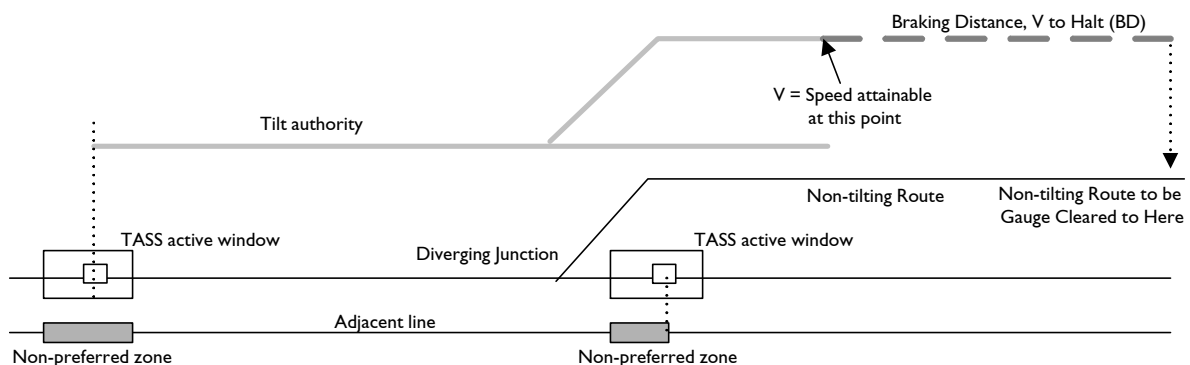


Figure 13