



GN

This document contains one or more pages which contain colour.

Published by:

RSSB
Block 2
Angel Square
1 Torrens Street
London
EC1V 1NY

© Copyright 2015
Rail Safety and Standards Board Limited

GE/GN8675
Guidance on AWS and TPWS Interface Requirements
Issue Two March 2015
Rail Industry Guidance Note for GE/RT8075



Documents
Document Sharing Hub

Guidance on AWS and TPWS Interface Requirements

Issue record

Issue	Date	Comments
One	September 2013	Original document Gives guidance on interpreting the requirements of GE/RT8075 issue one
Two	March 2015	The requirements associated with assuring the operational status and sensitivity of Automatic Warning System (AWS) receivers on trains entering service by means of depot test magnets (DTMs) have been withdrawn as they are out of scope of Railway Group Standards. Guidance on AWS receiver sensitivity testing has been added in G 3.5. Additional guidance has been included in G 3.2.4 to support the amended requirements in GE/RT8075 2.2.4.7 specifying the AWS caution acknowledgement delay period for trains authorised to operate at speeds above 160 km/h (100 mph) which have a braking capability of 9% <i>g</i> or greater. Relevant guidance from withdrawn guidance note GM/GN2169 has been incorporated at G 5.4.1.3, G 5.4.1.4, and Appendices J, K and L.

Amended or additional parts of revised pages have been marked by a vertical black line in the adjacent margin.

Superseded documents

The following Rail Industry Guidance Notes are superseded, either in whole or in part as indicated:

Superseded document	Sections superseded	Date when sections are superseded
GM/GN2169 issue one Combined Manual for AWS and TPWS Trainborne Equipment	All	06 June 2015
GE/GN8675 issue one Guidance on AWS and TPWS Interface Requirements	All	06 June 2015

GM/GN2169 issue one Combined Manual for AWS and TPWS Trainborne Equipment, ceases to be in force and is withdrawn as of 06 June 2015.

GE/GN8675 issue one Guidance on AWS and TPWS Interface Requirements, ceases to be in force and is withdrawn as of 06 June 2015.

Supply

The authoritative version of this document is available at www.rgsonline.co.uk. Uncontrolled copies of this document can be obtained from Communications, RSSB, Block 2, Angel Square, 1 Torrens Street, London EC1V 1NY, telephone 020 3142 5400 or e-mail enquirydesk@rssb.co.uk. Other Standards and associated documents can also be viewed at www.rgsonline.co.uk.

Guidance on AWS and TPWS Interface Requirements

Contents

Section	Description	Page
Part 1	Introduction	5
G 1.1	Purpose of this document	5
G 1.2	The structure of this document	5
G 1.3	Copyright	5
G 1.4	Approval and authorisation of this document	5
Part 2	System Description	6
G 2.1	General introduction	6
G 2.2	AWS	7
G 2.3	TPWS	8
Part 3	Guidance on Track / Train Interface for AWS	10
G 3.1	AWS track sub-system	10
G 3.2	AWS train sub-system	31
G 3.3	AWS route compatibility assessment requirements	47
G 3.4	Guidance on AWS design principles	47
G 3.5	Guidance on AWS Receiver Sensitivity Testing	48
Part 4	Guidance on Track / Train Interface for TPWS	50
G 4.1	TPWS track sub-system	50
G 4.2	TPWS train sub-system	59
Part 5	Guidance on Driver / Machine Interface (DMI) for AWS and TPWS	68
G 5.1	Layout of Driver / Machine Interface (DMI)	68
G 5.2	Operation of Driver / Machine Interface (DMI)	72
G 5.3	Fault detection	80
G 5.4	Output requirements	84
Part 6	Guidance on System Availability and Integrity	86
G 6.1	AWS and TPWS equipment	86
Part 7	Application of this document	87
Appendices		
Appendix A	AWS Visual Indicator	89
Appendix B	TPWS Visual Indicator State Transition Diagram	91
Appendix C	Field Strength Diagram for TPWS Track Sub-System Standard Loop Installations	93
Appendix D	Field Strength Diagram for TPWS Track Sub-System Miniature Loop Installations	95
Appendix E	Field Strength for TPWS Track Sub-System Installations through Section B-B of Appendices C and D	97
Appendix F	Guidance on Driver / Machine Interface for AWS and TPWS – Design Requirements for Non-integrated DMI	98
Appendix G	Guidance on Driver / Machine Interface for AWS and TPWS – Design Requirements for DMI Integrated with ETCS	105
Appendix H	Guidance on TPWS Audible Alert Sound Files	107
Appendix I	AWS Train Sub-System – Operational States and Sequences	108
Appendix J	Description of AWS and TPWS Trainborne Equipment	109
Appendix K	AWS and TPWS Trainborne Equipment – Fault and Failure Management	114
Appendix L	AWS Testing Using a Hand-Held Permanent Magnet	126
Definitions and Abbreviations		128
References		

Guidance on AWS and TPWS Interface Requirements

Tables		
Table 1	Dimensions of magnetic field planes above AWS track magnet	11
Table 2	Magnetic flux densities for standard strength track equipment	12
Table 3	Magnetic flux densities for standard strength depot test magnets	13
Table 4	Magnetic flux densities for extra strength track equipment	14
Table 5	Magnetic flux densities for extra strength depot test magnets	15
Table 6	Provision of AWS at signals (extract)	16
Table 6	Provision of AWS at signals (extract)	17
Table 6	Provision of AWS at signals (extract)	17
Table 6	Provision of AWS at signals (extract)	17
Table 7	Configurations of AWS track magnets (extract)	18
Table 7	Configurations of AWS track magnets (extract)	19
Table 7	Configurations of AWS track magnets (extract)	19
Table 7	Configurations of AWS track magnets (extract)	19
Table 8	Magnetic flux densities for standard strength AWS receivers	32
Table 9	Magnetic flux densities for extra strength AWS receivers	32
Table 10	Operational ready state	38
Table 11	Primed state	38
Table 12	Clear signal response state	39
Table 13	Restrictive response state	40
Table 14	Restrictive acknowledgement state	41
Table 15	Brake demand non-acknowledgement state	42
Table 16	Brake demand acknowledgement state	43
Table 17	AWS suppressed state	44
Table 18	System isolation state	45
Table 19	Track transmitter frequencies for overspeed protection functionality	50
Table 20	Track transmitter frequencies for train stop functionality	50
Table 21	Trigger delay timer settings	63
Table G K.5	Common AWS/TPWS faults	125
Table G L.1	Test after a 'right side failure' reported	127
Table G L.2	Test after a 'wrong side failure' reported	127
Figures		
Figure G 1	TPWS typical layout	8
Figure 1	Defined magnetic field planes above AWS track magnet	11
Figure 2	Position of TSS transmitters	56
Figure A.1	AWS visual indicator	89
Figure E.1	Field strength for TPWS track sub-system installations through section B-B of Appendices C and D	97
Figure F.1	General arrangement of TPWS DMI	98
Figure F.2	Dimensioned diagram of TPWS DMI	98
Figure G J.1	Typical AWS/TPWS trainborne sub-system	109
Figure G K.1	AWS/TPWS right side failure investigation process	115
Figure G K.2	AWS wrong side failure investigation process	117
Figure G K.3	Combined AWS/TPWS fault finding guide	121
Figure G K.4	Combined AWS/TPWS system fault-finding flowchart	122

Guidance on AWS and TPWS Interface Requirements

Part 1 Introduction

G 1.1 Purpose of this document

- G 1.1.1 This document gives guidance on interpreting the requirements of Railway Group Standard GE/RT8075 issue two 'AWS and TPWS Interface Requirements'. It does not constitute a recommended method of meeting any set of mandatory requirements.

G 1.2 The structure of this document

- G 1.2.1 All requirements from Railway Group Standard GE/RT8075 are reproduced with a grey background in this document. The numbering of these clauses is the same as in the Railway Group Standard.
- G 1.2.2 Guidance is provided as a series of sequentially numbered clauses prefixed 'G' immediately below the greyed text to which it relates.
- G 1.2.3 Specific responsibilities and compliance requirements are laid down in the Railway Group Standard itself.
- G 1.2.4 This document incorporates relevant material from sections 2.5, 2.10.1.1, 2.10.1.2, 3.5.7 to 3.5.9 and 3.5.11 to 3.5.13 of the withdrawn guidance note GM/GN2169 issue one 'Combined Manual for AWS and TPWS Trainborne Equipment'. The original version of GM/GN2169 can still be accessed in the 'withdrawn documents' section of the Railway Group Standards website.

G 1.3 Copyright

- G 1.3.1 Copyright in the Railway Group documents is owned by Rail Safety and Standards Board Limited. All rights are hereby reserved. No Railway Group document (in whole or in part) may be reproduced, stored in a retrieval system, or transmitted, in any form or means, without the prior written permission of Rail Safety and Standards Board Limited, or as expressly permitted by law.
- G 1.3.2 RSSB members are granted copyright licence in accordance with the Constitution Agreement relating to Rail Safety and Standards Board Limited.
- G 1.3.3 In circumstances where Rail Safety and Standards Board Limited has granted a particular person or organisation permission to copy extracts from Railway Group documents, Rail Safety and Standards Board Limited accepts no responsibility for, nor any liability in connection with, the use of such extracts, or any claims arising therefrom. This disclaimer applies to all forms of media in which extracts from Railway Group Standards may be reproduced.

G 1.4 Approval and authorisation of this document

- G 1.4.1 The content of this document was approved by Control Command and Signalling (CCS) Standards Committee on 18 September 2014.
- G 1.4.2 This document was authorised by RSSB on 13 November 2014.

Guidance on AWS and TPWS Interface Requirements

Part 2 System Description

G 2.1 General introduction

- G 2.1.1 This document covers interface requirements for the Automatic Warning System (AWS) and the Train Protection and Warning System (TPWS). Other methods of train protection are in use on some sections of Network Rail routes, including mechanical train stops, non-mechanical (magnetic) train stops and Automatic Train Protection (ATP) systems (which include trial systems introduced by BR on the Great Western and Chiltern lines and the European Train Control System (ETCS)). These systems are not covered in this document.
- G 2.1.2 AWS and TPWS supplement the indications given by lineside signalling systems. While lineside signals and signs give drivers the information they need on movement authority and permissible speed, AWS and TPWS are provided to mitigate risk from overrun or overspeed due to any failure to observe or obey lineside signals or signs.
- G 2.1.3 AWS is provided to give train drivers in-cab warnings on the approach to signals, reductions in permissible speed, temporary / emergency speed restrictions and other locations where the attention of the driver needs to be attracted, such as level crossings. AWS applies the brakes in the event that a driver does not acknowledge the cautionary warnings given by the system.
- G 2.1.4 Although the Great Western Railway introduced a form of Automatic Train Control (ATC) from 1906, AWS was developed from the Hudd system installed by the London Midland and Scottish Railway on the London, Tilbury & Southend line (where fog was a problem) in 1937. AWS track equipment was gradually installed on most routes over a period from the late 1950s through to the 1980s, and AWS trainborne equipment has been provided on most trains operating on the network since the 1960s.
- G 2.1.5 Following the Southall accident in 1997, the government decided that a more effective train protection system was required. However, it was considered that provision of a full ATP system could not be justified, partly due to the forthcoming development of the European Train Control System (ETCS), and TPWS was developed as a cost-effective alternative. Following the Ladbroke Grove accident in October 1999 the completion date was brought forward by one year to December 2002.
- G 2.1.6 TPWS is designed to intervene and apply the train brakes if the train passes a signal displaying a stop aspect or approaches a stop aspect or a speed restriction at too high a speed. Unlike AWS, TPWS does not provide any warnings to the driver, but activates only when it is necessary to make a brake application. Generally the driver will previously have received a warning from the AWS for the same hazard.
- G 2.1.7 The original intention was that the name 'TPWS' would cover the combination of additional Train Protection (TP) functionality with the existing warning functions given by AWS. Thus 'TPWS' should be applied to the whole system, including AWS. This is how the terms were used in Annex B of the CCS TSI, where the combined system is named 'TPWS' and it is stated that this 'includes the functionality of AWS'.
- G 2.1.8 However, in common usage the term 'TPWS' has come to be applied solely to the train protection element of the combined system, with the warning functions still referred to as a separate system called 'AWS'. Due to the established use of these terms, including in the Rule Book, this usage is retained in GE/RT8075 and this guidance note, though in certain areas such as the Driver-Machine Interface (DMI) and self-testing procedures, requirements for the two parts of the system are closely linked.

Guidance on AWS and TPWS Interface Requirements

G 2.2 AWS

G 2.2.1 This section provides an overview of how the AWS system operates.

G 2.2.2 So far as its application to signals is concerned, the basic AWS system operates as follows:

- a) As a train approaches a signal, it passes over AWS track equipment (one or more magnets) which is fixed between the running rails. This comprises a permanent magnet producing a south pole, which may be followed (in the direction of travel) by an electromagnet which produces a north pole when it is energised.
- b) The magnets are sensed by a receiver mounted under the leading end of the train, and the information derived is passed to a logic unit which interfaces with the AWS equipment in the cab and with the train brake system. The equipment in the cab comprises audible and visual indicators, an 'acknowledgement' push button, and a switch or similar device for isolating the AWS equipment if it is defective.
- c) If the signal is displaying a clear aspect, the electromagnet is energised and the train therefore detects a south pole followed by a north pole. This causes a bell (or an electronic equivalent) to sound in the driver's cab, and the visual indicator displays an 'all black' state (that is, the appearance is a black circle – described in the Rule Book as the 'normal' indication). No action in respect of the AWS is required of the driver.
- d) If the signal is displaying a cautionary or stop aspect, the electromagnet is not energised and the train therefore detects only the south pole of the permanent magnet. This causes a horn (or an electronic equivalent) to sound in the driver's cab and the display shows 'all black'. The driver has to acknowledge the warning by operating the 'acknowledgement' push button.
- e) When the driver operates the push button, the horn is silenced and the visual indicator changes to a segmented black and yellow circular display (described in the Rule Book as the 'warning' indication), as a reminder to the driver that he / she has acknowledged the cautionary or stop aspect being displayed by the signal.
- f) If the driver fails to acknowledge the warning horn within a set time period, the brakes are applied automatically. The visual indicator remains 'all black' and the horn continues to sound.
- g) If the driver acknowledges the warning after the brakes have been applied, the horn is silenced and the indicator changes to the black and yellow display, but the train brakes are not released until a minimum time period has elapsed and the driver has operated a separate brake release device.

G 2.2.3 Facilities are provided within the cab for isolating the on-board AWS equipment alone and for full isolation of AWS and TPWS together. This is necessary in order to cope with equipment failure while the train is in service (failures could result in the train being immobilised, or the horn / bell sounding continuously in the cab, for instance), and to deal with a train brought to a stand with its AWS receiver directly over AWS track equipment.

G 2.2.4 Track-mounted test magnets may be provided at certain locations, for example on the exit lines from maintenance depots, to give assurance before a train enters service that the trainborne AWS equipment is capable of functioning correctly.

G 2.2.5 Where AWS track equipment is provided on the approach to a reduction in permissible speed, a temporary / emergency speed restriction or a signal that cannot display a clear (green) aspect, only a permanent magnet is provided and the cab equipment always operates as on the approach to a signal displaying a caution or stop aspect. The driver receives a warning (as set out in G 2.2.2 d), and has to respond to it accordingly, otherwise the brakes are applied automatically as set out in G 2.2.2 f) and (g).

Guidance on AWS and TPWS Interface Requirements

- G 2.2.6 Where AWS track equipment is passed over by trains travelling in both directions, but is only applicable to movements in one direction, a suppressor magnet may be provided. This incorporates a suppressor coil which can be energised to counteract the magnetic flux from the permanent magnet, so that the receiver on the track will not detect the presence of the AWS track equipment.

G 2.3 TPWS

- G 2.3.1 TPWS (see Figure G.1 for typical layout) is designed to initiate a brake application independently of AWS:

- At selected signals, if a train passes a stop aspect.
- On the approach to selected signals, if a train approaches a stop aspect at excessive speed.
- At other locations (for example, on the approach to a permanent speed restriction or buffer stop) if a train approaches the location at excessive speed.

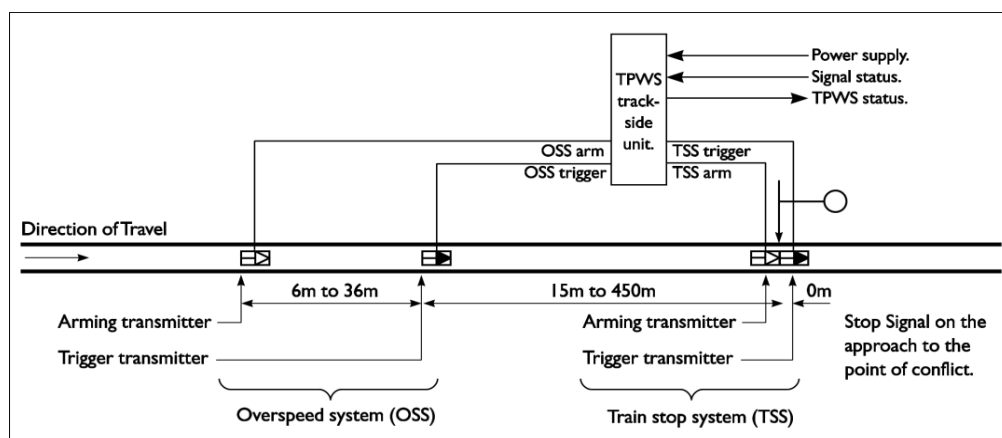


Figure G 1 TPWS typical layout

- G 2.3.2 The TPWS track sub-system comprises pairs of transmitter loops forming either a train stop system (TSS) or an overspeed system (OSS). These have sometimes been referred to as train stop sensor and overspeed sensor, but these terms are not really accurate because it is the trainborne equipment which detects the frequencies transmitted by the track sub-system loops.
- G 2.3.3 A TSS consists of two loops mounted adjacent to each other in the four foot on the track centre line, such that the magnetic fields transmitted by the two loops overlap and are detected together by the trainborne receiver.
- G 2.3.4 A TSS brake application is made if, firstly, a valid arming frequency is detected and then, while still detecting the arming frequency, the appropriate trigger frequency is detected, irrespective of train speed.
- G 2.3.5 The OSS operates on the principle of measuring the time taken for a train to pass two points on the track. If this time is less than a pre-set time an automatic brake application is initiated. On the track, two transmitters, each emitting a different frequency, define the points at which the timing starts and stops. The distance between the two transmitters and the trigger delay timing which is set on the train, together determine the set speed.
- G 2.3.6 More than one set of OSS loops may be provided on the approach to a signal to provide more effective control of trains over a wider range of approach speeds. An additional set of OSS loops further from the signal than the primary OSS is sometimes referred to as 'OSS+', and an installation incorporating such an additional set of loops may be referred to as 'TPWS+'.

Guidance on AWS and TPWS Interface Requirements

- G 2.3.7 To avoid interference problems experienced with closely spaced OSS loops, smaller loops are used on the approach to buffer stops where the required set speed is low.
- G 2.3.8 In the case of TPWS loops that are associated with a signal (the TSS at the signal and OSS on the approach to the signal), the two transmitters are energised when the signal is required to display a stop aspect.
- G 2.3.9 When associated with any other location, such as the approach to a speed restriction or buffer stop, only an OSS is provided. The two transmitters are either permanently energised or energised to coincide with the passing of a train on the line concerned.
- G 2.3.10 There are two sets of frequencies that can be used for transmitter loops. Each frequency set contains three separate frequencies; one is for use as the OSS arming frequency, one for the TSS arming frequency, and one for use as the trigger frequency for both OSS and TSS.
- G 2.3.11 Either frequency set can be used for either direction of operation, and there is no specific allocation of different frequency sets for up and down directions.
- G 2.3.12 Any pair of transmitters which constitute either a TSS or an OSS only initiate an automatic brake application if the train receives both the correct frequencies in the correct order. This allows trains to operate in both directions along the same line and avoids unwanted interventions when trains operate in the opposite direction along the same line.
- G 2.3.13 It is possible to use the other pair of frequencies, at the same location, for the opposite direction of travel, and the track transmitters for the two directions may be interleaved if necessary. Any valid pair of frequencies, detected in the correct order, should be correctly interpreted in this situation.

Guidance on AWS and TPWS Interface Requirements

Part 3 Guidance on Track / Train Interface for AWS

G 3.1 AWS track sub-system

G 3.1.1 General requirements for AWS track equipment

GE/RT8075 issue two

2.1.1 General requirements for AWS track equipment

2.1.1.1 AWS permanent magnets, including suppressor magnets, shall be mounted on the track with their south pole uppermost.

G 3.1.1.1 Rationale: Correct operation of the trainborne AWS sub-system requires a south pole magnetic field to be provided as the initial input at each location. In the normal state of the trainborne sub-system, the AWS receiver is set to respond to a south pole.

GE/RT8075 issue two

2.1.1 General requirements for AWS track equipment

2.1.1.2 AWS electromagnets shall be mounted on the track with their north pole uppermost.

G 3.1.1.2 Rationale: Where the AWS is required to give a clear indication as well as a warning, correct operation of the trainborne AWS sub-system requires provision of a switchable north pole magnetic field in addition to the permanent south pole. The trainborne sub-system is designed to respond to a north pole after detecting a south pole.

GE/RT8075 issue two

2.1.1 General requirements for AWS track equipment

2.1.1.3 The magnetic centres of AWS magnets shall be positioned between the running rails, within 10 mm of the track centre line.

G 3.1.1.3 Rationale: This is to ensure that the magnetic field will be reliably detected by an AWS receiver mounted centrally under the train. A variation of 10 mm allows for practical installation tolerances without significantly affecting the position of the magnetic field in relation to the trainborne receiver.

GE/RT8075 issue two

2.1.1 General requirements for AWS track equipment

2.1.1.4 Where AWS magnets are used in combinations, as set out in Table 7, the distance between the magnetic centres of adjacent magnets, measured longitudinally along the track centre line, shall be not less than 0.70 m and not more than 0.75 m.

G 3.1.1.4 Rationale: The two magnets need to be far enough apart to produce distinct magnetic fields of opposite polarity that can be reliably detected by the AWS receiver at train speeds up to 125 mph. They should be as close together as practicable to ensure that, after passing over the permanent magnet, the receiver detects the adjacent electromagnet (if it is energised) within the initial delay period, even at slow speed. The specified distance is compatible with the specified initial delay period (one second) for train speeds down to 5 mph or below (see G 3.2.4.9).

GE/RT8075 issue two

2.1.1 General requirements for AWS track equipment

2.1.1.5 The uppermost surfaces of AWS magnets shall be not more than 12 mm above rail level.

G 3.1.1.5 Rationale: The maximum height above rail level is specified to provide physical clearance between the AWS track equipment and rolling stock in line with lower sector structure gauge requirements set out in GC/RT5212.

Guidance on AWS and TPWS Interface Requirements

- G 3.1.1.6 Maximum and minimum heights of AWS magnets with respect to rail level should be specified by manufacturers so that the magnetic field produced by the magnet meets the required values of flux density at the specified heights (defined in relation to rail level) set out in GE/RT8075 sections 2.1.2 and 2.1.4.
- G 3.1.1.7 Typically AWS magnets are designed to be mounted with their upper surface between 12 mm above and 12 mm below rail level.

GE/RT8075 issue two

2.1.1 General requirements for AWS track equipment

- 2.1.1.6 The magnetic flux densities of AWS track magnets specified in 2.1.2 and 2.1.3 for standard strength magnets and in 2.1.4 and 2.1.5 for extra strength magnets shall apply throughout the planes above the magnet defined in Figure 1 and Table 1.

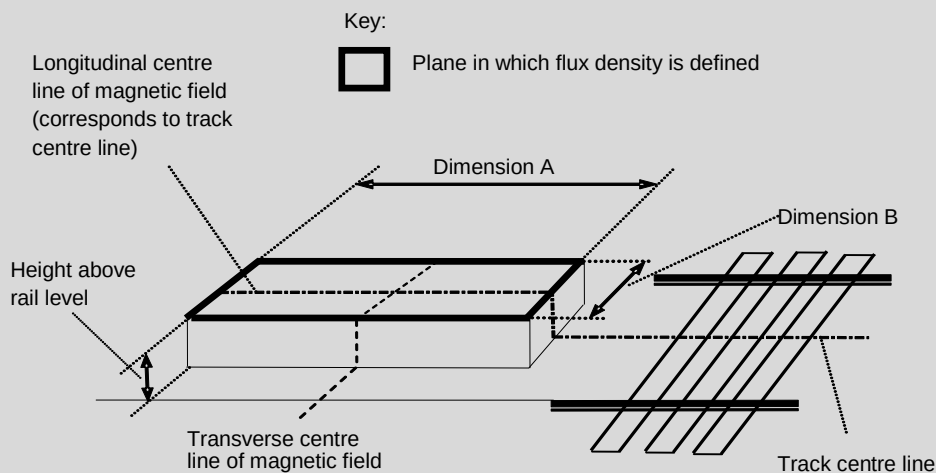


Figure 1 Defined magnetic field planes above AWS track magnet

Type of AWS magnet	Dimension A in Figure 1 (mm)	Dimension B in Figure 1 (mm)
Standard strength (except depot test magnets)	150	100
Extra strength (except depot test magnets)	70	100
Depot test magnets	50	50

Table 1 Dimensions of magnetic field planes above AWS track magnet

- G 3.1.1.8 Rationale: These planes are specified so that the magnetic fields of the AWS magnets produce the required levels of magnetic flux over a sufficient area to ensure that they are reliably detected by the AWS receivers.
- G 3.1.1.9 Dimension A (along the track in the direction of travel) is specified so that, on a train travelling at 200 km/h (125 mph), which is the maximum speed at which AWS is designed to operate, the receiver should be within the magnetic field of defined minimum strength for long enough to respond reliably.
- G 3.1.1.10 Older electro-mechanical types of AWS receiver could take a significant time to respond to a magnetic field, and dimension A was critical in determining the maximum speed at which the receiver would reliably detect the AWS magnets. With modern electronic receivers this dimension may be less significant.

Guidance on AWS and TPWS Interface Requirements

- G 3.1.1.11 Dimension B (perpendicular to the direction of travel) is specified so that a receiver that is displaced from the centre-line of the track, for example when the vehicle is travelling around a curve, should still pass through an area of magnetic field with the defined minimum flux density.
- G 3.1.1.12 For extra strength track equipment, the defined rectangle has a smaller value for dimension A (70 mm rather than 150 mm), because it was difficult to manufacture magnets capable of producing high levels of flux over as large an area as for standard magnets. This reduced dimension along the track limits the speed for extra strength receivers to a maximum of 160 km/h (100 mph), whereas the standard strength magnet should be detectable at 125 mph.
- G 3.1.1.13 For extra strength magnets, previous standard GE/RT8035 issue one also defined an 'outer' flux area of 200 mm x 100 mm; however, the flux levels specified within the outer area were lower than those which an extra strength receiver was required to detect, so the rationale for specifying this outer flux area was not clear. The flux in this outer area is no longer specified in this document.

G 3.1.2 Magnetic field requirements for standard strength track equipment

GE/RT8075 issue two

2.1.2 Magnetic field requirements for standard strength track equipment

- 2.1.2.1 The minimum magnetic flux density of the magnetic field of a standard strength AWS magnet in free air shall conform to the limits set out in Table 2 throughout the plane above the magnet shown in Figure 1.

Height above rail level (mm)	Minimum flux density (mT) for standard strength magnets
100	5.0
120	4.1
140	3.4
160	2.8
180	2.3
200	2.0

Table 2 Magnetic flux densities for standard strength track equipment

- G 3.1.2.1 Rationale: The minimum magnetic flux density produced by AWS magnets at specified heights is defined so that the AWS receiver can be specified to detect these magnetic fields and thus respond correctly to any AWS magnets it passes over.
- G 3.1.2.2 The magnetic flux density values in GE/RT8075 Table 2 have been derived from the lowest values produced by any type of standard strength AWS magnet, as determined by measurements from RSSB research project T804.

GE/RT8075 issue two

2.1.2 Magnetic field requirements for standard strength track equipment

- 2.1.2.2 The minimum flux densities set out in Table 2 shall apply to:
- Permanent magnets, including portable magnets for temporary and emergency speed restrictions.
 - Electromagnets when energised.
 - Suppressor magnets when not suppressed.

- G 3.1.2.3 Rationale: All types of AWS magnets should be detected by the AWS receiver.

Guidance on AWS and TPWS Interface Requirements

- G 3.1.2.4 In practice, AWS electromagnets and suppressor magnets typically produce lower levels of magnetic flux than AWS permanent magnets. The specification of minimum flux levels takes these types of magnet into account.

GE/RT8075 issue two

2.1.2 Magnetic field requirements for standard strength track equipment

- 2.1.2.3 For all types of standard strength magnets, except depot test magnets, the maximum flux density at 115 mm above rail level shall be 18 mT.

- G 3.1.2.5 Rationale: The maximum flux density produced by AWS magnets is specified to inform manufacturers of trainborne equipment of the levels of flux that AWS receivers need to withstand without incorrect operation or damage, and to limit the potential effects of excessive magnetic fields on other trainborne equipment.

- G 3.1.2.6 Historically, values of flux density were specified at only one height. This was 115 mm for standard strength magnets. While minimum flux densities are now specified over a range of heights in GE/RT8075 Table 2, maximum flux density limits are still defined at this specific height.

GE/RT8075 issue two

2.1.2 Magnetic field requirements for standard strength track equipment

- 2.1.2.4 The maximum flux density produced by a de-energised standard strength electromagnet at 115 mm above rail level shall be 0.7 mT.

- 2.1.2.5 The maximum flux density produced by a suppressed standard strength magnet at 115 mm above rail level shall be 0.7 mT.

- G 3.1.2.7 Rationale: When an electromagnet is not energised, or when a permanent magnet is suppressed, any remnant magnetic field should be below the level that would be detected by a trainborne receiver. The maximum flux density is specified to be well below the minimum detection level for standard strength receivers specified in GE/RT8075 section 2.2.

G 3.1.3 Magnetic field requirements for standard strength depot test magnets

GE/RT8075 issue two

2.1.3 Magnetic field requirements for standard strength depot test magnets

- 2.1.3.1 For standard strength depot test magnets (where provided) the minimum and maximum magnetic flux density of the magnetic field in free air shall conform to the limits set out in Table 3 throughout the plane above the magnet shown in Figure 1.

Height above rail level (mm)	Minimum flux density (mT) for standard strength depot test magnets	Maximum flux density (mT) for standard strength depot test magnets
100	4.8	5.0
120	3.9	4.1
140	3.2	3.4
160	2.6	2.8
180	2.1	2.3
200	1.8	2.0

Table 3 Magnetic flux densities for standard strength depot test magnets

- G 3.1.3.1 Rationale: Depot test magnets may be provided to confirm that the AWS receiver will detect the minimum flux density of AWS magnets encountered in service. To achieve this, the maximum flux density levels specified for a standard strength depot test magnet are equal to the minimum flux density levels for other standard strength magnets specified in GE/RT8075 Table 2.

Guidance on AWS and TPWS Interface Requirements

G 3.1.3.2 Rationale: The minimum flux density specified for standard strength depot test magnets is equal to the minimum sensitivity level for a standard strength AWS receiver as set out in GE/RT8075 Table 8. The minimum flux density levels are 5% below the maximum levels, subject to a minimum differential of 0.2 mT between maximum and minimum values, to allow for manufacturing tolerances and other variations which may occur in application.

G 3.1.3.3 Further guidance on provision of depot test magnets is set out in section G 3.5.

G 3.1.4 Magnetic field requirements for extra strength track equipment

GE/RT8075 issue two

2.1.4 Magnetic field requirements for extra strength track equipment

2.1.4.1 The minimum magnetic flux density of the magnetic field of an extra strength AWS magnet in free air shall conform to the limits set out in Table 4 throughout the plane above the magnet shown in Figure 1.

Height above rail level (mm)	Minimum flux density (mT) for extra strength magnets
120	6.5
140	6.1
160	5.7
180	5.3
200	5.0
220	4.6

Table 4 Magnetic flux densities for extra strength track equipment

G 3.1.4.1 Rationale: The minimum magnetic flux density produced by AWS magnets at specified heights is defined so that the receiver can be specified to detect these magnetic fields and thus respond correctly to any AWS magnets it passes over.

G 3.1.4.2 The magnetic flux density values in GE/RT8075 Table 4 have been derived from the lowest values produced by any type of extra strength AWS magnet as determined by measurements from RSSB research project T804.

GE/RT8075 issue two

2.1.4 Magnetic field requirements for extra strength track equipment

2.1.4.2 The minimum flux densities set out in Table 4 apply to:

- Permanent magnets, including portable magnets for temporary and emergency speed restrictions.
- Electromagnets when energised.
- Suppressor magnets when not suppressed.

G 3.1.4.3 Rationale: All types of extra strength AWS magnets should be detected by the AWS receiver.

GE/RT8075 issue two

2.1.4 Magnetic field requirements for extra strength track equipment

2.1.4.3 For all types of extra strength magnets, except depot test magnets, the maximum flux density at 193 mm above rail level shall be 20 mT.

Guidance on AWS and TPWS Interface Requirements

- G 3.1.4.4 Rationale: The maximum flux density produced by AWS magnets is specified to inform manufacturers of trainborne equipment of the levels of flux that AWS receivers need to withstand without incorrect operation or damage, and to limit the potential effects of excessive magnetic fields on other trainborne equipment.
- G 3.1.4.5 Historically, values of flux density were specified at only one height. This was 115 mm for standard strength magnets and 193 mm for extra strength magnets. While minimum flux densities are now specified over a range of heights in GE/RT8075 Table 4, maximum flux density limits are still defined at these specific heights.

GE/RT8075 issue two

2.1.4 Magnetic field requirements for extra strength track equipment

- 2.1.4.4 The maximum flux density produced by a de-energised extra strength electromagnet at 193 mm above rail level shall be 1.2 mT.
- 2.1.4.5 The maximum flux density produced by a suppressed extra strength magnet at 115 mm above rail level shall be 1.2 mT.

- G 3.1.4.6 Rationale: When an electromagnet is not energised, or when a permanent magnet is suppressed, any remnant magnetic field should be too low to be detected by a trainborne receiver. The maximum flux density is specified to be well below the minimum detection level for extra strength receivers specified in GE/RT8075 section 2.2.

G 3.1.5 Magnetic field requirements for extra strength depot test magnets

GE/RT8075 issue two

2.1.5 Magnetic field requirements for extra strength depot test magnets

- 2.1.5.1 For extra strength depot test magnets (where provided) the minimum and maximum magnetic flux density of the magnetic field in free air shall conform to the limits set out in Table 5 throughout the plane above the magnet shown in Figure 1.

Height above rail level (mm)	Minimum flux density (mT) for extra strength depot test magnets	Maximum flux density (mT) for extra strength depot test magnets
120	6.2	6.5
140	5.8	6.1
160	5.4	5.7
180	5.0	5.3
200	4.8	5.0
220	4.4	4.6

Table 5 Magnetic flux densities for extra strength depot test magnets

- G 3.1.5.1 Rationale: Depot test magnets may be provided to confirm that the AWS receiver will detect the minimum flux density of AWS magnets encountered in service. To achieve this, the maximum flux density levels specified for an extra strength depot test magnet are equal to the minimum flux density levels for other extra strength magnets specified in GE/RT8075 Table 4.
- G 3.1.5.2 Rationale: The minimum flux density specified for extra strength depot test magnets is equal to the minimum sensitivity level for an extra strength AWS receiver as set out in GE/RT8075 Table 9. The minimum flux density levels are 5% below the maximum levels to allow for manufacturing tolerances and other variations which may occur in application.
- G 3.1.5.3 Further guidance on provision of depot test magnets is set out in section G 3.5.

Guidance on AWS and TPWS Interface Requirements

G 3.1.6 Provision of AWS track equipment – lines to be fitted

GE/RT8075 issue two

2.1.6 Provision of AWS track equipment – lines to be fitted

2.1.6.1 AWS shall be fitted on all signalled lines, except those where an alternative train protection system providing a level of protection equivalent to or better than that provided by AWS and TPWS is fitted and operational on the infrastructure and on all trains operating on the route.

- G 3.1.6.1 Rationale: AWS is a warning system used to mitigate the risk from signals passed at danger (SPAD) and from overspeed, where an alternative system is not used.
- G 3.1.6.2 AWS (together with TPWS) is the standard system which is installed throughout the national network, except where there is an alternative system which provides an equivalent level of protection. Such alternative systems include Automatic Train Protection (ATP), the European Train Control System (ETCS) and mechanical trainstops.
- G 3.1.6.3 There have been some exceptions to the fitment of AWS, which are covered by derogations. See www.rgsonline.co.uk for further details of derogations which were made against GE/RT8035 issue one.

G 3.1.7 Provision of AWS track equipment – equipment to be provided

GE/RT8075 issue two

2.1.7 Provision of AWS track equipment – equipment to be provided

2.1.7.1 On fitted lines, AWS equipment shall be provided at signals in accordance with Table 6, except where AWS gaps are permitted by the provisions of 2.1.9.1.

- G 3.1.7.1 Rationale: AWS is normally provided at all colour light signals, whether or not they can display a cautionary aspect.
- G 3.1.7.2 The green aspect at a two aspect (red / green) colour light signal is identical to that given by a two aspect distant (yellow / green) signal or by a three or four aspect signal, and it is less confusing to drivers to give the same AWS indication in all cases.

Type of signal at which AWS shall be fitted	Exemptions from fitment
All colour light signals	a) Signals that have no main signalled route leading up to them (including the platform starting signal nearest to the buffer stops on bay and terminal platform lines and signals provided solely for turnback moves).

Table 6 Provision of AWS at signals (extract)

- G 3.1.7.3 Rationale: Platform starting signals on bay and terminal platform lines are not provided with AWS because in many cases trains will be standing close to the signal before departure and would not pass over an AWS magnet if one was provided.
- G 3.1.7.4 Rationale: Signals provided for turnback moves are applicable only to moves in the opposite direction to the normal direction of operation on the line. Such signals can be approached by unsignalled movements, but there is no requirement to provide AWS for unsignalled movements.
- G 3.1.7.5 If AWS were provided at turnback signals, it would need to be suppressed for normal direction movements. As the movements approaching the signal are not signalled routes, there is no practicable way to control the removal of suppression for these movements.

Guidance on AWS and TPWS Interface Requirements

Type of signal at which AWS shall be fitted	Exemptions from fitment
All colour light signals	b) Signals that give access to running lines from non-running lines where: i) Trains usually come to a stand. And ii) Trap points are provided to protect the running line(s).

Table 6 Provision of AWS at signals (extract)

- G 3.1.7.6 Rationale: At the exit from a non-running line (such as a siding) onto a running line, there may often be trap points to prevent trains entering the main line when the route is not set. The trap points provide alternative protection for the main line, and fitment of AWS approaching the exit signal is not necessary.

Type of signal at which AWS shall be fitted	Exemptions from fitment
All colour light signals	c) A colour light stop signal in a block signalling area where: i) The stop signals controlled by adjacent signal boxes are not fitted with AWS track equipment. And either: ii) This signal cannot display a cautionary aspect. Or iii) If the signal displays a cautionary aspect when the signal ahead is at danger, this aspect is approach released and preceded by a distant signal displaying an ON aspect. This exemption from fitment does not apply, however, where a colour light signal controls entry to a single line. In these circumstances AWS track equipment shall be provided unless the signal is exempt under (a) above.

Table 6 Provision of AWS at signals (extract)

- G 3.1.7.7 Rationale: Where a 'semaphore equivalent' aspect sequence applies on a non-track circuit block line, a train should always receive a cautionary aspect at the distant signal if it is not possible to clear all the stop signals controlled from a signal box. AWS at the distant signal should provide the necessary warning to the driver if the train does not have a clear movement authority through all the associated stop signals, and in these circumstances it is not necessary to provide AWS at the stop signals.

Type of signal at which AWS shall be fitted	Exemptions from fitment
All semaphore distant signals and distant boards	None

Table 6 Provision of AWS at signals (extract)

- G 3.1.7.8 Rationale: For semaphore signals, AWS is normally provided only at distant signals, as it is apparent that a semaphore stop signal or stop board cannot display a cautionary aspect and the driver will not expect an AWS indication at such signals.

GE/RT8075 issue two

2.1.7 Provision of AWS track equipment – equipment to be provided

2.1.7.2 AWS equipment shall be provided only at the locations and for the purposes set out in this document and in GK/RT0075 and GK/RT0192.

- G 3.1.7.9 Rationale: Provision of AWS is limited to specified applications to avoid proliferation of additional AWS indications which could confuse the driver and reduce the impact of the AWS indications given at the required locations.
- G 3.1.7.10 GK/RT0075 sets out requirements for the provision of AWS equipment for reductions in permissible speed, and for temporary / emergency speed restrictions.
- G 3.1.7.11 GK/RT0192 sets out requirements for the provision of AWS equipment at warning boards on the approach to level crossings.

GE/RT8075 issue two

2.1.7 Provision of AWS track equipment – equipment to be provided

2.1.7.3 On bi-directionally signalled lines, AWS track equipment shall be provided for signalled train movements in both directions.

- G 3.1.7.12 Rationale: AWS is provided for all signalled movements authorised by main signals. On a section of track where main signalled movements apply in both directions, AWS track equipment is provided to give appropriate AWS indications to drivers for movements in each direction.

GE/RT8075 issue two

2.1.7 Provision of AWS track equipment – equipment to be provided

2.1.7.4 Magnets, or combinations of magnets, shall be provided and configured as set out in Table 7.

- G 3.1.7.13 Rationale: The configuration of AWS track equipment should provide the appropriate indications to drivers for all train movements.
- G 3.1.7.14 AWS track equipment is not inherently directional, and where lines are used in both directions, equipment provided for movements in one direction is also detected by movements in the opposite direction. A south pole initiates a response from the trainborne sub-system on a train passing in either direction, although a clear indication will only be generated if the north pole follows the south pole. The effects of this should be considered in the application of the track equipment.

Application	Magnets to be provided
a) Colour light signal not capable of displaying a green aspect.	Permanent magnet (south pole).
b) Semaphore distant signal fixed at caution.	
c) Fixed distant board.	

Table 7 Configurations of AWS track magnets (extract)

- G 3.1.7.15 Rationale: The permanent south pole is required so that the driver should always receive an AWS warning indication on the approach to a signal which can only display cautionary or danger aspects.

Guidance on AWS and TPWS Interface Requirements

Application	Magnets to be provided
d) Colour light signal capable of displaying a green aspect.	Permanent magnet (south pole) followed, in the direction of travel, by an electromagnet (north pole).
e) Semaphore distant signal (except those fixed at caution).	

Table 7 Configurations of AWS track magnets (extract)

- G 3.1.7.16 Rationale: Where a signal can display cautionary or clear aspects, the AWS is required to give a warning or a clear indication depending on the aspect displayed by the signal. A permanent south pole is provided to initiate a response from the trainborne equipment, together with a switchable north pole which can be energised when required to give a clear indication.

Application	Magnets to be provided
f) Two colour light signals or semaphore distant signals for movements in opposite directions, sharing a common set of AWS track equipment.	Permanent magnet (south pole), with electromagnets (north pole) both before and after the permanent magnet. (Where either of the signals is not capable of displaying a green (or distant signal 'off') aspect, the electromagnet for that signal is not required.)

Table 7 Configurations of AWS track magnets (extract)

- G 3.1.7.17 Rationale: This arrangement provides bi-directional functionality using one shared permanent magnet.
- G 3.1.7.18 This permits the use of a single set of magnets, for both directions of traffic, for instance in a bi-directional platform or in other locations where opposing signals are appropriately spaced.
- G 3.1.7.19 The track equipment is located between the signals applying to movements in either direction, and comprises one permanent magnet with two electromagnets, one each side of the permanent magnet: this is referred to as an 'E-P-E' arrangement. The appropriate electromagnet (the one nearer to the signal) is energised when the associated signal is showing a green aspect.
- G 3.1.7.20 A train heading towards the cleared signal detects the appropriate sequence of magnetic fields – a south pole followed by a north pole – to give a 'clear' indication. If a train moves over the AWS magnets in the opposite direction (heading towards a signal which has not been cleared), it detects a north pole first, before detecting the south pole. The north pole will have no effect, as the AWS receiver in its normal state is set to detect a south pole.
- G 3.1.7.21 A single permanent magnet, without associated electromagnets, can be shared by a signal or sign in each direction where an AWS warning is always required to be given.

Application	Magnets to be provided
g) Warning of an approach to a reduction in permissible speed.	Permanent magnet (south pole).
h) Warning of an approach to a level crossing.	
i) Warning of an approach to a temporary or emergency speed restriction (where required by GK/RT0075).	Permanent magnet (south pole).

Table 7 Configurations of AWS track magnets (extract)

Guidance on AWS and TPWS Interface Requirements

- G 3.1.7.22 Rationale: Where AWS is provided in association with a warning sign, AWS is required to give a warning. The permanent south pole is provided so that the driver receives the required warning indication.

GE/RT8075 issue two

2.1.7 Provision of AWS track equipment – equipment to be provided

- 2.1.7.5 Where AWS is required to be suppressed, a suppressor magnet shall be provided instead of the permanent magnet.

- G 3.1.7.23 Rationale: A suppressor magnet is capable of generating a magnetic field that cancels out the magnetic field of the permanent magnet and therefore inhibits the AWS warning (or any other indication) being given to the driver.

- G 3.1.7.24 A suppressor magnet includes a permanent south pole and a suppressor coil. When the suppressor coil is energised, the magnetic field resulting from the combined effect of the permanent magnet and the suppressor coil is reduced to a level below the minimum level that can be detected by an AWS receiver.

- G 3.1.7.25 A suppressor magnet is used in preference to an electromagnet generating a south pole only when it is needed because, in failure conditions, an electromagnetic south pole could fail to generate a magnetic field and therefore fail to provide the required warning. With a suppressor magnet, if the power supply or the suppression coil fails, it should default to an effective permanent south pole.

GE/RT8075 issue two

2.1.7 Provision of AWS track equipment – equipment to be provided

- 2.1.7.6 Standard strength AWS magnets shall be used on lines that are not DC electrified.

- 2.1.7.7 Extra strength AWS magnets shall be used on DC third rail electrified lines.

- G 3.1.7.26 Rationale: The AWS receivers fitted to DC electric trains are less sensitive than standard strength receivers so that they are less prone to interference from stray magnetic fields associated with cross-track cables etc. Extra strength AWS magnets are required on DC electrified lines to maintain compatibility with trains that are fitted with less sensitive receivers.

- G 3.1.7.27 Trains fitted with standard strength AWS receivers are also capable of detecting the magnetic fields generated by extra strength magnets.

G 3.1.8 Provision of AWS track equipment – position of equipment

GE/RT8075 issue two

2.1.8 Provision of AWS track equipment – position of equipment

- 2.1.8.1 AWS track equipment shall be positioned not less than three seconds running time at the permissible speed before the associated signal or sign.

- G 3.1.8.1 Rationale: The driver needs at least two seconds to read the applicable signal or sign after receiving the AWS audible indication.

- G 3.1.8.2 Rationale: If the driver does not acknowledge an AWS warning, the system should apply the brakes before the train passes the associated signal or sign so that the full signalling braking distance is available to the train.

- G 3.1.8.3 Rationale: There is a one second initial delay period between detecting the south pole of the permanent magnet and giving a warning indication to the driver. This is to give time for the equipment to detect whether or not a north pole (energised electromagnet) is present after passing the south pole. The running time at permissible speed between the AWS magnet and the associated signal or sign is not less than three seconds, thus giving a minimum period of two seconds between receiving the warning and passing the signal or sign.

Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two

2.1.8 Provision of AWS track equipment – position of equipment

2.1.8.2 AWS track equipment shall be positioned 180 m (+ 18 m, – 9 m) before the associated signal or sign, except where any of the following apply:

- G 3.1.8.4 Rationale: A consistent distance between the AWS magnet and the applicable signal or sign helps drivers to reliably identify which signal or sign the warning applies to, and, in the case of approaching a signal at danger, to judge their stopping position.
- G 3.1.8.5 Rationale: A distance of 180 m (originally specified as 200 yards) gives the driver at least two seconds to read the applicable signal or sign at speeds up to 200 km/h (125 mph).
- G 3.1.8.6 Rationale: The permitted tolerance (which is +10%, –5% of the nominal distance of 180 m) allows the position of the AWS magnet to be adjusted to meet site specific constraints without significantly altering the relationship between the magnet and the signal or sign as perceived by the driver.
- G 3.1.8.7 The position of AWS magnets potentially influences signal overrun risk and driveability. The signal overrun risk assessment process is set out in RIS-0386-CCS. Further guidance on driveability assessment is given in GE/GN8612.

- a) On a section of line where existing AWS track equipment at successive signals is positioned 230 m (+ 23 m, – 11.5 m) before signals, it is permissible for new AWS track equipment also to be positioned at this distance, provided that this does not create additional risk.

- G 3.1.8.8 Rationale: A consistent distance between the AWS magnet and the applicable signal or sign helps drivers to reliably identify which signal or sign the warning applies to, and, in the case of approaching a signal at danger, to judge their stopping position.
- G 3.1.8.9 GE/RT8035 issue one required AWS magnets to be positioned 230 m from the signal on higher speed lines (where the permissible speed was more than 100 mph) to provide additional time for the driver to observe the signal after receiving the AWS indication. This requirement was withdrawn because it led to other inconsistencies, for example where there were parallel fast and slow lines with a speed exceeding 100 mph on the fast line and 100 mph or less on the slow line, requiring the magnets to be positioned at different distances from parallel signals.
- G 3.1.8.10 In terms of equipment response, the increased distance was not necessary provided the caution acknowledgement delay period was limited to two seconds, as a distance of 180 m allows sufficient time for the initial delay period and the caution acknowledgement delay period to elapse before the train passes the signal at a speed of 125 mph.
- G 3.1.8.11 Where a series of AWS magnets are installed at a distance of 230 m from consecutive signals, it might be preferable to maintain this distance for consistency within the localised area when additions or modifications are made to the existing signalling arrangements.

- b) On bi-directionally signalled platform lines, it is permissible to position AWS track equipment at distances other than those specified above where common AWS track equipment is provided for signals applying in opposite directions, in order to achieve correct operation of the equipment for train movements.

- G 3.1.8.12 Rationale: The use of a single set of magnets, for both directions of traffic, applying to the signals at either end of the platform, as set out in item f) of GE/RT8075 Table 7, is a practicable method of providing correct operation of AWS for all trains without needing complex suppression controls, particularly in platforms when permissive working and joining and splitting of trains takes place.
- G 3.1.8.13 Rationale: Most platforms are less than 360 m in length, so this arrangement will require the AWS track equipment to be less than 180 m from one or both of the signals.

Guidance on AWS and TPWS Interface Requirements

G 3.1.8.14 The minimum distance from the AWS magnet to the signal is limited by the specified minimum running time of three seconds set out in GE/RT8075 section 2.1.8.1. This equates to 40 m at 30 mph or 80 m at 60 mph.

G 3.1.8.15 Where speeds in both directions are low, and most trains stop in the station, it will often be appropriate to position the AWS magnets in the middle of the platform, the same distance from both signals.

G 3.1.8.16 Where:

- a) There is a designated normal direction of operation on the line through the platform,
- b) Speeds in the normal direction are high or a significant number of trains run through the station without stopping,

And

- c) The speed for movements in the opposite direction is lower and most trains using the platform line in that direction will stop at the station,

it may be appropriate to position the AWS magnets at a greater distance from the signal applying to normal direction movements (at or nearer to the standard distance of 180 m) and at a reduced distance from the opposite direction signal.

- | | |
|----|--|
| c) | Where the AWS magnet is positioned less than 180 m from the signal or sign so that the driver is able to read the associated signal aspect or sign when the audible warning is received. |
|----|--|

G 3.1.8.17 Rationale: It is desirable to position AWS magnets so that the driver can see and interpret the applicable signal aspect or sign at the time that the AWS warning is received.

G 3.1.8.18 In most cases this will be achieved by placing the magnet at the standard distance of 180 m, but this may not be the case if visibility of the signal is restricted. In these circumstances there are two alternatives:

- a) Position the AWS magnet at the standard distance (180 m) from the signal, accepting that the signal will not be visible to the driver when the warning is received.

Or

- b) Position the magnet closer to the signal (subject to the minimum of three seconds running time set out in GE/RT8075 section 2.1.8.1), so that the signal is visible when the warning is received.

G 3.1.8.19 The preferred arrangement is for the associated signal or sign to be visible to the driver when the AWS audible indication is received, so that the AWS indication can be readily associated with the appropriate item of lineside equipment which the driver is required to observe.

- | | |
|----|--|
| d) | On a non-passenger line on which permissive working is authorised, the AWS track equipment may be positioned beyond, but as close as practicable to, the signal. |
|----|--|

G 3.1.8.20 Rationale: This avoids the possibility that the driver of a train which has entered an occupied section under a permissive movement authority will receive a clear AWS indication when the exit signal is displaying a green aspect for a preceding train which is between the AWS magnet and the signal.

G 3.1.8.21 If this alternative position is not adopted, complex controls may be required to prevent the AWS giving a clear indication in these circumstances.

- | | |
|----|--|
| e) | Where infrastructure constraints prevent the installation of AWS equipment at the standard position. |
|----|--|

Guidance on AWS and TPWS Interface Requirements

- G 3.1.8.22 Rationale: At some locations, features of the infrastructure, such as bridge decks, pointwork or other obstructions, may make it impossible to install AWS track equipment at the preferred position. In such cases an alternative position should be used.

f) Where an alternative position is required to meet the constraints set out in 2.1.8.3.

- G 3.1.8.23 Rationale: A number of situations which might prevent AWS track equipment from being placed in the preferred position are set out in GE/RT8075 section 2.1.8.3.

- G 3.1.8.24 If the AWS track equipment cannot be placed at its preferred location, generally 180 m (+ 18 m, – 9 m) from the signal, due to one of these constraints, and it is not possible to relocate the item of equipment which gives rise to this constraint, the AWS equipment should be moved to an alternative position.

- G 3.1.8.25 It is generally better to place the signal in its optimum position and locate the AWS equipment at a non-standard distance from the signal, rather than moving the signal to a less advantageous position so that the AWS can be placed at the standard distance from it.

g) Where the AWS magnet is positioned beyond the signal in the circumstances set out in 2.1.8.7a).

- G 3.1.8.26 Rationale: Where AWS is fitted at a signal controlling train movements from a through running line not fitted with AWS track equipment to a running line that is fitted, GE/RT8075 section 2.1.8.7a) requires the AWS track equipment to be positioned beyond the signal so that it can be suppressed for a train routed along the unfitted line, but it will be effective for a train routed to the fitted line.

h) Where a signal sighting committee (SSC) recommends an alternative position and this achieves a reduction in risk.

- G 3.1.8.27 Rationale: The signal sighting committee (SSC) may identify specific local factors which mean that driveability could be improved by positioning the AWS magnet at a distance other than the standard distance from the signal or sign.

- G 3.1.8.28 In recommending an alternative position for the AWS magnet, the SSC should consider the factors set out in GE/RT8075 section 2.1.8.5.

- G 3.1.8.29 The reasons for recommending an alternative position of an AWS magnet should be recorded on the signal sighting form.

GE/RT8075 issue two

2.1.8 Provision of AWS track equipment – position of equipment

2.1.8.3 AWS equipment shall not be positioned:

a) Where a train is likely to come to a stand with the receiver for the active driving position over the AWS track equipment.

- G 3.1.8.30 Rationale: If a train comes to a stand with the active AWS receiver over AWS track equipment, it might not be possible to acknowledge the AWS warning or release the brakes except by isolating the trainborne equipment.

b) Within four seconds travelling time of any other AWS track equipment (calculated at the permissible speed), except where one or other of the sets of equipment is always suppressed for any movement over them.

- G 3.1.8.31 Rationale: Placing two sets of AWS track equipment within four seconds travelling time of each other could result in the response of the trainborne AWS equipment to the first set of track equipment, including the time to reset the receiver following acknowledgement of a warning, masking its response to the second set.

Guidance on AWS and TPWS Interface Requirements

- c) Where AWS equipment could interfere with the correct operation of Automatic Power Control (APC) equipment, or vice versa.

G 3.1.8.32 Rationale: APC equipment uses magnets similar to AWS magnets but positioned each side of the track, with receivers mounted on the side of the vehicle.

G 3.1.8.33 In junction areas, care should be taken in positioning AWS and APC track equipment so that the receiver of one system does not inadvertently detect the field from the magnets provided for the other system, leading to unwanted responses.

- d) Where the correct operation of the AWS track equipment could be jeopardised by the proximity of DC traction cables or impedance bonds. Specifically, on DC electrified lines, AWS track equipment shall not be positioned:

- i) Less than 3.5 m from cross-track traction feeder cables, traction return bonds or impedance bonds.

G 3.1.8.34 Rationale: AWS track equipment should be positioned far enough from DC electric traction supply equipment to avoid the magnetic field of the AWS magnet being distorted or suppressed by magnetic fields emitted by the other equipment.

- ii) Less than 1.5 seconds travelling time (measured at the permissible speed) before cross-track traction feeder cables, traction return bonds or impedance bonds.

G 3.1.8.35 Rationale: This is to reduce the potential for incorrect AWS indications caused by stray magnetic fields.

G 3.1.8.36 Rationale: The magnetic field from DC electric traction supply equipment could generate a north pole which could be detected by the AWS receiver on the train. If AWS track equipment is positioned less than 1.5 seconds running time from DC traction equipment, a north pole from the traction equipment could be received after the train has correctly detected a south pole from the AWS magnet and cause a false 'clear' AWS indication when a warning should be given.

GE/RT8075 issue two

2.1.8 Provision of AWS track equipment – position of equipment

2.1.8.4 An SSC shall agree the position of the AWS track equipment where either:

- a) The distance of the track equipment from the signal or sign is other than 180 m (+ 18 m, – 9 m).

Or

- b) The AWS audible indication is received by the driver before the signal or sign becomes visible.

2.1.8.5 In considering the position of AWS track equipment, the SSC shall assess whether the positioning of the equipment will:

- a) Help the driver to read the associated signal or sign safely.

And

- b) Not create a risk that the driver fails to associate the audible warning with the signal or sign.

G 3.1.8.37 Rationale: The signal sighting process is used to confirm that lineside signals and signs are adequately visible and readable. This process should take account of the contribution of the AWS to readability and the effectiveness of the warning which it provides.

Guidance on AWS and TPWS Interface Requirements

- G 3.1.8.38 AWS track equipment should preferably be positioned to meet two conditions – a standard distance of 180 m from the associated signal or sign, and visibility of the signal or sign when the warning is received.
- G 3.1.8.39 Both these conditions are intended to provide a consistent and effective warning to drivers. Where it is not possible to achieve one or both of these conditions, the effectiveness of the AWS warning to the driver could be reduced.
- G 3.1.8.40 There are also circumstances where the AWS track equipment may be positioned so that the audible indication is received before the signal is visible to the driver, provided that the time interval between receiving the AWS indication and seeing the signal is not excessive.
- G 3.1.8.41 Where AWS track equipment cannot be positioned to meet the preferred parameters, an SSC should assess the position to confirm that it will still provide an effective warning to drivers. Further guidance on the signal sighting process is given in GE/GN8537.

GE/RT8075 issue two

2.1.8 Provision of AWS track equipment – position of equipment

- 2.1.8.6 The following infrastructure features shall not be positioned between a signal or sign and its associated AWS track equipment:
- a) Another main signal applicable to movements in the same direction.
 - b) A warning indicator for a reduction in permissible speed.
 - c) A warning board for a temporary or emergency speed restriction.
 - d) Other AWS equipment applicable to movements in the same direction.

- G 3.1.8.42 Rationale: When a driver receives an AWS indication, there should be no potential for confusion as to which item of signalling equipment the AWS indication relates.
- G 3.1.8.43 In order to avoid confusion in relating an AWS indication to the equipment for which it is intended to give a warning, the signal or sign to which the AWS indication applies should be clearly identifiable by the driver. Therefore, no other items of equipment which could be associated with an AWS indication should be positioned between an AWS magnet and the signal or sign to which it applies.

GE/RT8075 issue two

2.1.8 Provision of AWS track equipment – position of equipment

- 2.1.8.7 Where a signal controls train movements from a running line not fitted with AWS track equipment to a running line that is fitted, one of the following arrangements shall apply:
- a) Where there is a turnout from a through running line not fitted with AWS onto an AWS fitted line, AWS track equipment shall be provided for the stop signal controlling the movement onto the fitted line. The track equipment shall incorporate provision for suppression, and shall be positioned beyond, but as close as practicable to, the signal.

The signals that display cautionary aspects associated with the stop signal shall not be fitted with AWS.

- G 3.1.8.44 Rationale: Trains running onto a line fitted with AWS should receive an AWS indication at the signal that controls the movement onto the fitted line. Trains continuing along the unfitted line should not be given an AWS indication, as it would be inconsistent to present a single AWS indication to the driver travelling along an otherwise unfitted line.

Guidance on AWS and TPWS Interface Requirements

G 3.1.8.45 Rationale: So that the AWS magnet can be appropriately controlled (that is, suppressed for a train routed along the unfitted line but active for a train routed to the fitted line), it is located beyond the signal so that the routing of the train is known at the time it passes over the magnet. If the magnet was located before the signal, and a train approached the signal when no route had been set, it would not be possible to determine the route that the train was to take.

G 3.1.8.46 This situation should not arise if all lines are fitted with AWS, but there may still be some locations where a through goods line running parallel to a passenger line has not been fitted.

Or

- b) Where a running line not fitted with AWS converges with an AWS fitted line, the stop signal controlling movements from the unfitted line to the fitted line and any associated signals displaying cautionary aspects shall be fitted with AWS track equipment in accordance with the requirements set out in 2.1.6.

G 3.1.8.47 Rationale: Where an unfitted line leads only onto an AWS fitted line, normal AWS indications should be provided at the signals approaching the convergence as it will always be appropriate for the train to receive them.

G 3.1.9 AWS gap areas

G 3.1.9.1 In some cases AWS has not been provided in major stations where speeds are low and where bi-directional working applies, often with permissive working for platform sharing and / or joining and splitting of trains, so that excessively complex controls would be required to give reliable and consistent AWS indications.

GE/RT8075 issue two

2.1.9 AWS gap areas

2.1.9.1 When an existing signalling layout incorporating an AWS gap area (a station area not fitted with AWS track equipment) is resignalled, AWS track equipment shall be provided, unless both of the following apply:

- a) Permissible speeds in the unfitted area do not exceed 50 km/h (30 mph).

And

- b) A risk assessment shows that absence of AWS track equipment within the gap area does not introduce an unacceptable risk.

G 3.1.9.2 Rationale: Non-provision of AWS in a gap area represents a reduction in the level of train protection generally provided, and AWS gaps should only be retained where the absence of this provision can be justified.

G 3.1.9.3 Rationale: Low permissible speeds reduce the level of collision risk.

GE/RT8075 issue two

2.1.9 AWS gap areas

2.1.9.2 The geographical limits of an AWS gap shall be clearly identifiable.

G 3.1.9.4 Rationale: A driver should be able to easily identify the area where AWS is not provided.

G 3.1.9.5 The Sectional Appendix sets out information on the location of AWS gap areas.

GE/RT8075 issue two

2.1.9 AWS gap areas

2.1.9.3 Lineside signs shall be provided to indicate the commencement and termination of the AWS gap on all running lines that provide entry to or exit from the gap area as follows:

- a) A 'commencement of AWS gap' lineside sign shall be provided at or beyond the last fitted signal and before the position where the AWS track equipment for the next signal would have been, had it been provided.

Guidance on AWS and TPWS Interface Requirements

And

- b) A 'termination of AWS gap' sign shall be provided beyond the last signal not fitted with AWS and not less than four seconds travelling time at the permissible speed before the AWS track equipment for the first fitted signal.

- G 3.1.9.6 Rationale: These signs are provided to remind the driver of the extent of the AWS gap and to avoid any confusion over where AWS indications should be received and where they are not provided.
- G 3.1.9.7 The design of lineside signs is specified in GI/RT7033.
- G 3.1.9.8 The 'commencement of AWS gap' and 'termination of AWS gap' signs are provided where there is a short gap in AWS fitment on a line that is otherwise fitted, and are distinct from the signs for 'commencement of AWS' and 'termination of AWS' used at the transition to and from areas with other types of train protection.

G 3.1.10 Control of AWS track equipment

GE/RT8075 issue two

2.1.10 Control of AWS track equipment

2.1.10.1 The AWS electromagnet shall be energised only when the associated colour light signal is displaying a green aspect, or when the associated semaphore distant signal is intentionally displaying the OFF aspect.

2.1.10.2 In the case of a splitting distant signal, the AWS electromagnet shall be energised if either signal colour light head is displaying a green aspect.

- G 3.1.10.1 Rationale: AWS gives a clear indication (bell) to the driver when the energised electromagnet (north pole) is detected by the AWS receiver. A clear indication is given only when a signal is displaying a clear aspect (colour light signal showing green or semaphore distant OFF). Giving an AWS clear indication in combination with any other signal aspect would be misleading to the driver.
- G 3.1.10.2 Rationale: At a splitting distant signal, a clear AWS indication is given when the signal is cleared for either route so that the AWS indication is consistent with the green aspect displayed by the signal.

GE/RT8075 issue two

2.1.10 Control of AWS track equipment

2.1.10.3 Where an AWS magnet is positioned beyond the signal, as set out in 2.1.8.2d), the AWS track equipment shall be controlled to provide an indication that is consistent with the aspect seen by the driver at the time of passing the signal.

- G 3.1.10.3 Rationale: Where the AWS magnet is located beyond the signal, the AWS indication presented to the driver should correspond to the state of the signal seen by the driver before the train passes the signal.

GE/RT8075 issue two

2.1.10 Control of AWS track equipment

2.1.10.4 Where a suppressed AWS magnet is situated beyond the signal protecting a turnout from a through unfitted line, as set out in 2.1.8.7, the magnet shall be suppressed for movements along the unfitted line.

- G 3.1.10.4 Rationale: The magnet is suppressed so that the driver of a train running along the unfitted line does not receive an AWS indication, which would give an inconsistent presentation to the driver travelling along an otherwise unfitted line.

Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two

2.1.10 Control of AWS track equipment

2.1.10.5 For movements through the turnout onto the fitted line, the AWS track equipment shall be controlled to provide an indication that is consistent with the aspect seen by the driver at the time of passing the signal controlling the movement onto the fitted line.

- G 3.1.10.5 Rationale: This provides an appropriate AWS indication to the driver of a train running onto the fitted line.
- G 3.1.10.6 Where the AWS magnet is located beyond the signal, the AWS indication presented to the driver should reflect the state of the signal seen by the driver before the train passes the signal.
- G 3.1.10.7 This may be achieved by delaying the replacement of the signal to danger until after the train has passed over the AWS magnet, where this can be done without introducing other risks.
- G 3.1.10.8 Where it is not reasonably practicable or desirable to delay the replacement of the signal, the control of the AWS magnet should correspond to the aspect displayed by the signal before it was replaced to danger.

G 3.1.11 Suppression of AWS track equipment

GE/RT8075 issue two

2.1.11 Suppression of AWS track equipment

2.1.11.1 On bi-directionally signalled lines, except where AWS track equipment is effective for movements in both directions, as set out in Table 7 item f), the magnetic field of the AWS track equipment shall be suppressed for signalled movements in the direction to which the equipment does not apply, except as permitted by 2.1.11.4 and 2.1.11.5.

- G 3.1.11.1 Rationale: This prevents the driver receiving an inappropriate AWS indication.
- G 3.1.11.2 On a single / bi-directional line, the driver of a train passing over the equipment in the opposite direction to that for which the AWS indication is provided should not receive an AWS indication, and the status of the trainborne AWS equipment should not change.

GE/RT8075 issue two

2.1.11 Suppression of AWS track equipment

2.1.11.2 Suppression shall be effective from before the vehicle on which the receiver for the active driving position is mounted has reached the AWS track equipment until that vehicle has passed over the AWS track equipment.

- G 3.1.11.3 Rationale: The magnet should be suppressed when the AWS receiver passes over it.
- G 3.1.11.4 In order to economise on power consumption of the trackside equipment, it is permissible for suppression to be removed as soon as the vehicle on which the receiver (for the active driving position) is mounted has passed over the AWS track equipment, rather than waiting for the whole train to pass clear. This may be particularly desirable for extra strength suppressor magnets because of their high power consumption.

GE/RT8075 issue two

2.1.11 Suppression of AWS track equipment

2.1.11.3 Where a semaphore junction signal has both stop and distant arms but the distant arm(s) are not applicable to all routes, the AWS equipment shall be suppressed when the signal is cleared for a route to which the distant arm(s) is / are not applicable.

- G 3.1.11.5 Rationale: This prevents the driver receiving an inappropriate AWS indication.

Guidance on AWS and TPWS Interface Requirements

- G 3.1.11.6 This situation will arise when a semaphore junction signal has distant arms for some of the routes from the signal but not for all of them. A driver should not receive an AWS indication when the signal is cleared for a route that is not associated with a distant signal arm.
- G 3.1.11.7 If no route from the signal has been cleared when a train passes over the AWS magnet, the magnet should not be suppressed and the driver of a train approaching the signal at danger should receive an AWS warning indication.

GE/RT8075 issue two

2.1.11 Suppression of AWS track equipment

2.1.11.4 It is permissible for AWS track equipment not to be suppressed for:

- a) Shunting movements on unidirectionally signalled lines.
- b) Unsignalled movements.
- c) Movements over AWS magnets associated with warning boards for temporary / emergency restrictions that are not applicable to the direction of movement.

- G 3.1.11.8 Rationale: It is not generally practicable to provide suppression for movements over the AWS equipment in the opposite direction in these cases. In these circumstances drivers will expect to receive AWS warnings that may not be applicable to the movement being made.

GE/RT8075 issue two

2.1.11 Suppression of AWS track equipment

2.1.11.5 On lightly used single lines it is permissible for AWS track equipment not to be suppressed for movements in the direction to which the AWS indication does not apply where this is justified by a risk assessment.

- G 3.1.11.9 Rationale: At some locations on single lines it may not be cost effective to provide appropriate controls to suppress AWS magnets.
- G 3.1.11.10 On track circuit block lines, it should normally be practicable to provide and control suppression for AWS associated with signals at passing loops. In this case, non-provision of suppression should be limited to intermediate locations within a signalling section, such as permissible speed warning indicators where provision and control of suppression may not be practicable.
- G 3.1.11.11 On lines worked by other block and token systems, it may not be practicable to provide and control suppression for AWS associated with signals.
- G 3.1.11.12 Factors to be taken into account in the risk assessment include:
- a) Whether indications from unsuppressed AWS equipment could cause confusion to drivers in the vicinity of signals or signs that are applicable to the direction of movement.
 - b) The level of overrun risk at a stop signal, particularly at a signal controlling the entrance to a section of single line where the driver might subconsciously ignore a valid AWS warning as a consequence of repetitively cancelling previous unsuppressed AWS warnings.
 - c) The regular use of the line for special purposes such as driver training, where receipt of inapplicable indications from unsuppressed AWS equipment could have a particular impact on driver behaviour.
- G 3.1.11.13 For the purposes of this risk assessment, a line which has no more than two train movements per hour may generally be considered a 'lightly used line'.

Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two

2.1.11 Suppression of AWS track equipment

2.1.11.6 Provision or non-provision of suppression of AWS track equipment shall be applied consistently on all single line sections on an operating route.

- G 3.1.11.14 Rationale: Consistency in the application of AWS suppression helps drivers to identify the locations where they expect to receive inapplicable warnings, and thus reduces the risk that they will ignore applicable warnings.
- G 3.1.11.15 Receiving inapplicable warnings from unsuppressed AWS equipment could create a risk that drivers become accustomed to ignoring AWS warnings and could also ignore warnings that do apply to them.
- G 3.1.11.16 The risk assessment should form part of the overall layout assessment process set out in GK/RT7006. Note that GK/RT7006 is planned to be withdrawn and replaced by RIS-0386-CCS.

G 3.1.12 AWS cancelling indicators

- G 3.1.12.1 Where trains pass over unsuppressed AWS magnets provided for trains travelling in the opposite direction, the driver receives an unwanted AWS warning which does not apply to that train. AWS cancelling indicators, in the form shown in GI/RT7033, indicate to the driver that the AWS warning which has been received is not applicable to that train and may be cancelled – that is, it should be acknowledged and no further action need be taken.

GE/RT8075 issue two

2.1.12 AWS cancelling indicators

2.1.12.1 Where AWS track equipment is not suppressed for signalled movements in the opposite direction, as permitted by 2.1.11.4c) and 2.1.11.5, an AWS cancelling indicator shall be provided for each set of track equipment.

- G 3.1.12.2 Rationale: The AWS cancelling indicator is provided to remind the driver that the AWS warning which has been received is not applicable. Providing a sign to confirm that an AWS warning does not apply reduces the risk that a driver will mistakenly ignore an AWS warning that does apply thinking that it is not applicable.
- G 3.1.12.3 Requirements for the provision and positioning of cancelling indicators for temporary and emergency speed restriction AWS equipment are set out in GK/RT0075.

GE/RT8075 issue two

2.1.12 AWS cancelling indicators

2.1.12.2 The AWS cancelling indicator shall be positioned:

- a) 180 m (+ 18 m, – 9 m) beyond the AWS track equipment in the direction of movement to which the equipment does not apply.

And

- b) Facing trains travelling in the direction to which the AWS track equipment does not apply.

2.1.12.3 The AWS cancelling indicator shall be positioned so that it is readable from the normal driving position when the train passes over the unsuppressed track equipment.

- G 3.1.12.4 Rationale: The cancelling indicator should be visible to the driver when the AWS warning is received, so that the driver can clearly identify that the AWS warning is not applicable.

Guidance on AWS and TPWS Interface Requirements

G 3.2 AWS train sub-system

G 3.2.1 Provision of trainborne AWS equipment

GE/RT8075 issue two

2.2.1 Provision of trainborne AWS equipment

2.2.1.1 AWS trainborne equipment shall be fitted to all vehicles that have a driving cab, with the exception of the following types of vehicles:

- a) Locomotives used exclusively for shunting purposes.
- b) Vehicles that operate solely within T3 possessions.
- c) Vehicles that are authorised to operate only on lines where an alternative train protection system providing a level of protection equivalent to or better than that provided by AWS and TPWS is fitted and operational on both the trains and the infrastructure.

2.2.1.2 It is permissible to suppress the operation of the AWS train sub-system when an alternative train protection system providing a level of protection equivalent to or better than that provided by AWS and TPWS is fitted and operational on the train and on the track over which the train is operating.

G 3.2.1.1 Rationale: AWS is the default SPAD risk and overspeed risk mitigation measure on running lines where an alternative system is not used.

G 3.2.1.2 AWS is the standard system that is installed on most vehicles with driving cabs operating on the national network.

G 3.2.1.3 AWS does not have to be fitted on vehicles which always operate using an alternative train protection system which provides an equivalent level of protection. Such alternative systems include Automatic Train Protection (ATP), the European Train Control System (ETCS) and mechanical trainstops / tripcocks. This will only apply if the vehicles are fitted with the alternative system and they operate only over lines on which this alternative system is fitted and operational.

G 3.2.2 Receiver sensitivity requirements for AWS train sub-system

GE/RT8075 issue two

2.2.2 Receiver sensitivity requirements for AWS train sub-system

2.2.2.1 AWS receivers shall be capable of detecting the sequences and polarities of magnetic fields emitted by the configurations of AWS track magnets set out in Table 7.

G 3.2.2.1 Rationale: AWS receivers are required to respond correctly and reliably to the magnetic fields generated by all specified combinations of track-mounted AWS magnets.

G 3.2.2.2 Railway undertakings should establish procedures to assure that AWS receivers on trains entering service are compliant with the relevant sensitivity parameters set out in GE/RT8075 table 8 and table 9.

G 3.2.2.3 Further guidance on AWS receiver sensitivity testing is given in G 3.5.

Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two

2.2.2 Receiver sensitivity requirements for AWS train sub-system

2.2.2.2 On lines fitted with standard strength magnets, the trainborne equipment shall be capable of detecting the minimum field strengths set out in Table 8, measured in free air at the heights above rail level set out in the table and directly above the track centre line.

Height above rail level (mm)	Flux density (mT) which trainborne AWS equipment shall detect
100	4.8
120	3.9
140	3.2
160	2.6
180	2.1
200	1.8

Table 8 Magnetic flux densities for standard strength AWS receivers

- G 3.2.2.4 Rationale: On all lines other than DC electrified lines, AWS receivers should be capable of reliably detecting any AWS magnets producing the levels of flux density specified to be produced by standard strength magnets (including standard strength depot test magnets as defined in Table 3).
- G 3.2.2.5 Rationale: A range of heights and associated flux density levels has been set out in Table 8, as receivers are mounted at different heights and, in addition, dynamic movement of the receiver should be considered. The range of heights reflects the variation found in practice.
- G 3.2.2.6 The flux density levels set out in Table 8 are those which can be expected to be found in free air, and correspond to the minimum flux density levels for standard strength depot test magnets set out in Table 3.

GE/RT8075 issue two

2.2.2 Receiver sensitivity requirements for AWS train sub-system

2.2.2.3 On lines fitted with extra strength magnets, the trainborne equipment shall be capable of detecting the minimum field strengths set out in Table 9, measured in free air at the heights above rail level set out in the table and directly above the track centre line.

Height above rail level (mm)	Flux density (mT) which trainborne AWS equipment shall detect
120	6.2
140	5.8
160	5.4
180	5.0
200	4.8
220	4.4

Table 9 Magnetic flux densities for extra strength AWS receivers

- G 3.2.2.7 Rationale: On DC electrified lines, extra strength AWS magnets are fitted, and AWS receivers should be capable of reliably detecting the levels of flux density specified to be produced by extra strength magnets (including extra strength depot test magnets, as defined in Table 5).

Guidance on AWS and TPWS Interface Requirements

- G 3.2.2.8 Rationale: A range of heights and associated flux density levels has been set out in Table 9, as receivers are mounted at different heights and, in addition, dynamic movement of the receiver should be considered. The range of heights reflects the variation found in practice.
- G 3.2.2.9 The flux density levels set out in Table 9 are those which can be expected to be found in free air and correspond to the minimum flux density levels for extra strength depot test magnets set out in Table 5.
- G 3.2.2.10 The sensitivity parameters set out in Table 8 and Table 9 are specified in free air. When a vehicle passes over an AWS magnet, the vehicle bogie / bodywork and the AWS receiver flux plate will have the effect of focusing the magnetic flux of the magnet on the sensing element of the AWS receiver. This will increase the magnetic flux level at the sensing element of the AWS receiver to above that of the magnetic flux measured in free air.

GE/RT8075 issue two

2.2.2 Receiver sensitivity requirements for AWS train sub-system

- 2.2.2.4 Trainborne AWS equipment shall not detect magnetic fields producing a flux density less than 1.5 mT at a height of 115 mm above rail level and directly above the track centre line.

- G 3.2.2.11 Rationale: The 1.5 mT detection limit is set so that AWS receivers should not detect magnetic fields from suppressed AWS magnets or de-energised electromagnets, and to reduce the likelihood that they will respond to any stray magnetic fields present in the vicinity of the receiver.

GE/RT8075 issue two

2.2.2 Receiver sensitivity requirements for AWS train sub-system

- 2.2.2.5 AWS receivers shall be positioned so that:

- a) They are within 18 m of all the driving positions in the cabs that they provide with indications.

- G 3.2.2.12 Rationale: The AWS receiver should be close enough to the driving position that the driver does not experience a significant delay between passing over the AWS magnet and receiving the audible indication.

- G 3.2.2.13 A distance of 18 m allows one AWS receiver to be used for both ends of a twin-cab single vehicle.

- b) The time delay experienced by the driver between passing over a track magnet and receiving the audible warning, for a given speed, is consistent for all rolling stock of the same class.

- G 3.2.2.14 Rationale: This is to minimise the variation in AWS response time experienced by drivers for each type of vehicle.

- c) The trainborne AWS equipment will not respond to the magnetic fields of APC magnets.

- G 3.2.2.15 Rationale: This is to minimise the potential for spurious AWS indications resulting from interference from APC magnets.

- G 3.2.2.16 APC magnets are located at the side of the track. APC magnets should not be located in pointwork in a position where an AWS receiver could pass over them when the train takes a diverging route.

- d) So far as is practicable, the trainborne AWS equipment will not respond to extraneous magnetic fields from DC traction supply infrastructure or impedance bonds.

Guidance on AWS and TPWS Interface Requirements

- G 3.2.2.17 Rationale: This is to minimise the potential for spurious AWS indications resulting from interference from DC traction infrastructure.

GE/RT8075 issue two

2.2.2 Receiver sensitivity requirements for AWS train sub-system

- 2.2.2.6 Each AWS equipped vehicle of an electric train that operates over both AC and DC electrified lines shall be fitted with two separate receivers, or one receiver with switchable sensitivity, with appropriate sensitivities for use on DC electrified lines, as set out in Table 9, and on other lines, as set out in Table 8.

- G 3.2.2.18 Rationale: AWS receivers should respond correctly to any AWS magnets or combination of magnets fitted on the track.
- G 3.2.2.19 It was formerly a requirement that all trains operating over DC electrified lines should have less sensitive receivers, in order to avoid incorrect operation from DC traction cables and other associated equipment. This requirement has been withdrawn following extensive experience of trains with a single-sensitivity standard strength receiver operating over DC electrified lines without reported incidents.
- G 3.2.2.20 DC electric trains can only travel over DC electrified lines, and can therefore use a less sensitive receiver in accordance with Table 9. Non-electric trains may travel over DC electrified, AC electrified or non-electrified routes, and if fitted with a single-sensitivity receiver this should be a standard strength receiver in accordance with Table 8.
- G 3.2.2.21 However, electric trains operating on the DC traction system, including dual system electric trains when operating on DC traction, should still be fitted with a less sensitive receiver, as there may be a possibility of interference from DC traction currents supplied to the train itself.

GE/RT8075 issue two

2.2.2 Receiver sensitivity requirements for AWS train sub-system

- 2.2.2.7 Where switchable receiver sensitivities are provided in accordance with 2.2.2.6, the appropriate receiver or receiver sensitivity for the line over which the train is passing shall be selected automatically.

- G 3.2.2.22 Rationale: Automatic selection of receiver sensitivity avoids the risk from selecting the lower sensitivity receiver setting when operating over standard strength magnets, leading to a potential failure to detect these magnets.
- G 3.2.2.23 On dual system electric trains, the receiver sensitivity is normally selected by the traction system selection; the standard receiver setting (compatible with standard strength magnets) is selected when operating on AC, and the less sensitive setting (compatible only with extra strength magnets) when operating on DC.
- G 3.2.2.24 The former requirement for switching receiver sensitivity on non-electric trains was difficult to implement as no practicable method of automatic switching was available.

GE/RT8075 issue two

2.2.2 Receiver sensitivity requirements for AWS train sub-system

- 2.2.2.8 So far as is reasonably practicable, on trains that are fitted with AWS receivers with switchable sensitivity for operation on DC electrified lines and on other lines (in accordance with 2.2.2.6), a failure of the automatic selection sub-system shall cause the receiver(s) to default to the 'other lines' configuration.

- G 3.2.2.25 Rationale: AWS receivers should respond correctly to any AWS magnets or combination of magnets fitted on the track.

Guidance on AWS and TPWS Interface Requirements

G 3.2.3 Operation of trainborne AWS equipment

GE/RT8075 issue two

2.2.3 Operation of trainborne AWS equipment

2.2.3.1 The interface between the AWS and the train brake system shall enable an emergency brake application, or where available an enhanced emergency brake application, to be initiated and cancelled.

G 3.2.3.1 Rationale: If the driver fails to acknowledge an AWS warning, the brakes should be automatically applied to bring the train to a stand as quickly as possible.

G 3.2.3.2 Rationale: An emergency brake application is presumed to provide a high integrity method of stopping the train within the shortest possible distance.

G 3.2.3.3 Requirements for multiple unit train braking systems, including enhanced emergency braking, are set out in GM/RT2044. Further interface requirements for the emergency brake control are set out in GM/RT2045 section 7.4.

G 3.2.3.4 Rationale: The system should allow the brake demand to be cancelled so that the driver can resume control and restart the train.

GE/RT8075 issue two

2.2.3 Operation of trainborne AWS equipment

2.2.3.2 Each vehicle shall be fitted with an isolation device to enable the trainborne AWS equipment to be isolated. Requirements for the controlling device and associated indications are set out in Part 4.

G 3.2.3.5 Rationale: It should be possible to isolate the AWS equipment so that the train can be moved (under appropriate operating conditions) if the system has failed.

GE/RT8075 issue two

2.2.3 Operation of trainborne AWS equipment

2.2.3.3 The trainborne AWS equipment shall be capable of operating at train speeds up to at least the lower of:

a) The maximum permissible speed of the vehicle in which it is installed.

And

b) The maximum speed at which the AWS is required to be operational.

G 3.2.3.6 Rationale: The AWS equipment should operate correctly at all speeds at which it needs to be used.

G 3.2.3.7 Generally, AWS should operate up to the maximum speed of the vehicle.

G 3.2.3.8 Where trains have an alternative train protection system which is used for high-speed operations, AWS is only required to operate at the maximum speed at which the train will run when using AWS.

GE/RT8075 issue two

2.2.3 Operation of trainborne AWS equipment

2.2.3.4 The trainborne AWS equipment shall be capable of operating down to a minimum speed of 5 km/h.

Guidance on AWS and TPWS Interface Requirements

- G 3.2.3.9 Rationale: At very low speeds the AWS equipment may give a warning instead of a clear indication when the electromagnet is energised, as the receiver may not detect the north pole from the electromagnet within the one second delay period after detecting a south pole from the permanent magnet.
- G 3.2.3.10 5 km/h is equivalent to 1.4 m/s, so the receiver should be able to detect two adjacent magnets at the specified spacing of 0.75 m at this speed.
- G 3.2.3.11 There is no reason why a caution indication should not be given correctly, however low the speed. If the train actually stops with the receiver over the AWS magnet, however, it may not be possible to acknowledge the warning or to release the brakes without isolating AWS.

GE/RT8075 issue two

2.2.3 Operation of trainborne AWS equipment

2.2.3.5 The trainborne AWS equipment shall respond within 100 ms to:

- a) Detection of the presence of magnetic fields of the relevant flux densities set out in 2.1.2 and 2.1.4.

And

- b) Operation of the caution acknowledgement device.

- G 3.2.3.12 Rationale: Delay in responding to detected magnetic fields should be minimised to ensure that a warning is given to the driver as soon as possible, without any significant delay beyond the one second initial delay period.
- G 3.2.3.13 Rationale: The system should respond without delay to the driver's acknowledgement so that the brakes will not be applied if the driver acknowledges the warning towards the end of the permitted acknowledgement delay period.

G 3.2.4 AWS functional requirements and states

- G 3.2.4.1 The functional requirements of the AWS trainborne sub-system are specified in terms of defined functional states, the outputs delivered in each state, and the conditions which initiate a transition from one state to another.

GE/RT8075 issue two

2.2.4 AWS functional requirements and states

2.2.4.1 The trainborne AWS equipment shall comply with the functional requirements set out in Table 10 to Table 18. The functional requirements are expressed in the form of functional states and the transitions between them.

- G 3.2.4.2 Rationale: The functional states of the system are defined to ensure consistency in operation between different classes of train and consistent presentation of indications to the driver.
- G 3.2.4.3 The functional states of the AWS train sub-system are shown in the form of a flowchart in Appendix I.

Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two

2.2.4 AWS functional requirements and states

2.2.4.2 The rows in each table have the following meanings:

State	Indicates the state that the table is describing
Valid preceding state(s)	Indicates which state(s) (functional or non-functional) it is permissible for the equipment to have been in prior to entering this state.
Entry conditions	Indicates the conditions that shall be satisfied before this state is entered. The equipment shall also be in one of the defined valid previous states in order to enter this state.
Events on entry	Indicates the events that shall take place immediately upon entry into this state.
Status during state	Indicates the status of the equipment that shall be maintained while it is in this state.
Exit conditions	Indicates the conditions that shall be fulfilled before the equipment can move from this state to another one.
Next valid state(s)	Indicates which functional states it is permissible for the equipment to move to on leaving this state.

2.2.4.3 The operational ready state shall be the normal operational state of the trainborne AWS equipment on initialisation. The equipment shall return to the operational ready state after having passed over a set of AWS track magnets and, where appropriate, the driver has responded to the audible warning given in response to the track magnets.

- G 3.2.4.4 Rationale: This is the quiescent state of the AWS trainborne sub-system, in which the receiver is receptive to detection of a south pole.
- G 3.2.4.5 Earlier types of AWS receiver used either a pivoted electro-mechanical armature or a reed relay to detect a magnetic field. These were inherently bistable devices which were switched from one state to another by a magnetic pole of the appropriate polarity, and thus in any given state they were only responsive to one polarity of magnetic field.
- G 3.2.4.6 Newer AWS receivers using Hall effect sensors could be capable of detecting a magnetic field of either polarity at any time, but in order to retain the existing logic of the AWS control unit they are configured to respond only to the expected polarity of field, that is, a field of the opposite polarity to which it is currently set. This is normally the polarity of the last magnet detected, or south for a receiver that has been reset to the operational ready state. The receiver takes no action on detecting a magnetic field of the same polarity as the one to which it is currently set.

State	Operational ready state
Valid preceding state(s)	Clear signal response state, or Restrictive acknowledgement state, or Brake demand acknowledgement state, or System isolation state. The equipment also enters this state on initialisation after a self-test routine has been satisfactorily completed, as set out in 2.2.5
Entry conditions	See exit conditions of valid preceding states
Events on entry	None

Guidance on AWS and TPWS Interface Requirements

State	Operational ready state
Status during state	Equipment is capable of detecting south pole magnetic fields of AWS track equipment, and Audible indicator is silent, and Visual indicator is maintained in its last set indication ('all black' or 'black and yellow'), and No AWS brake demand is applied
Exit conditions	South pole of an AWS track magnet is detected
Next valid state(s)	Primed state

Table 10 Operational ready state

- G 3.2.4.7 Rationale: The receiver remains in this state until it detects a south pole magnetic field, which is assumed to be generated by a permanent AWS track magnet. The receiver is then 'primed' to look for a north pole generated by an adjacent electromagnet.
- G 3.2.4.8 The receiver enters this state on initialisation and returns to it after giving a clear indication. When a warning indication is given, the receiver only returns to the operational ready state following acknowledgement of the warning.

GE/RT8075 issue two

2.2.4 AWS functional requirements and states

- 2.2.4.4 The trainborne AWS equipment shall enter the primed state when it has passed over the south pole of an AWS track magnet and is waiting to determine whether there is an energised electromagnet (north pole) immediately after it.

- G 3.2.4.9 After detecting a south pole, the receiver waits for one second to allow time to detect a north pole from an adjacent electromagnet. If it does not detect a north pole within the initial delay period of one second after detecting the south pole, it assumes that the south pole has been produced by an AWS permanent magnet, with the associated electromagnet (if one is present) not energised, which is intended to generate a warning indication.

State	Primed state
Valid preceding state(s)	Operational ready state
Entry conditions	South pole of an AWS track magnet is detected
Events on entry	Visual indicator changes to 'all black' (if it was previously at 'black and yellow')
Status during state	Equipment capable of detecting the north pole of an AWS track magnet, and Audible warning indicator is silent, and Visual indicator is at 'all black', and No AWS brake demand is applied
Exit conditions	North pole of an AWS track magnet is detected within one second (+0.0, -0.1 seconds) of having entered the primed state (in which case the trainborne equipment moves to the clear signal response state), or Automatic exit occurs one second (+0.0, -0.1 seconds) after the primed state was entered, if a north pole is not detected (in which case the trainborne equipment moves to the restrictive response state). The one second period is known as the Initial Delay Period
Next valid state(s)	Clear signal response state, or Restrictive response state

Table 11 Primed state

Guidance on AWS and TPWS Interface Requirements

- G 3.2.4.10 Rationale: The one second initial delay period allows the receiver to correctly interpret a pair of magnetic fields (south pole followed by north pole) as a clear indication, assuming the magnets are 0.75 m apart, at speeds down to 0.75 m/s (2.7 km/h or 1.7 mph). This ensures that the system meets the 5 mph or below requirement set out in G 3.1.1.4.
- G 3.2.4.11 In practice, a train may respond correctly to the pair of magnets at a lower speed than this, as the magnetic field should be detected before and after the point when the receiver is over the centre of the magnet. However, a warning may be given in place of a clear indication at a higher speed if the magnetic field from the permanent magnet (south pole) is stronger than that from the electro-magnet (north pole) and is therefore detected at a greater distance from the centre of the magnet.
- G 3.2.4.12 Rationale: The visual indication is reset to an 'all black' state and any reminder of a previous signal aspect or speed warning indicator is superseded by a new AWS indication. The 'black and yellow' indication is provided as a discrete event for each AWS warning in response to the driver's acknowledgement.

GE/RT8075 issue two

2.2.4 AWS functional requirements and states

- 2.2.4.5 The trainborne AWS equipment shall enter the clear signal response state when it has passed over AWS track equipment associated with a signal that is displaying a green aspect or a semaphore distant signal showing 'off'.

- G 3.2.4.13 When the receiver detects a north pole within one second after detecting the south pole, it assumes this has been produced by an AWS track installation with an energised electromagnet which is intended to generate a clear indication.

State	Clear signal response state
Valid preceding state(s)	Primed state
Entry conditions	North pole of an AWS track magnet detected
Events on entry	Audible 'clear' indication given, as set out in 4.2.2.3
Status during state	Visual indicator maintained at 'all black', and No AWS brake demand is applied
Exit conditions	Automatic exit occurs when the audible 'clear' indication has finished
Next valid state(s)	Operational ready state

Table 12 Clear signal response state

- G 3.2.4.14 Rationale: An audible indication of a clear state is given by sounding a bell (or a bell-like tone) which lasts for one second.
- G 3.2.4.15 Rationale: The visual indicator remains at black as no reminder is given to the driver for a clear signal.

GE/RT8075 issue two

2.2.4 AWS functional requirements and states

- 2.2.4.6 The trainborne AWS equipment shall enter the restrictive response state when it has passed over AWS track equipment associated with a signal that is displaying an aspect other than green (or other than 'off' in the case of a semaphore distant signal), or that is associated with a warning for a reduction in permissible speed, a temporary / emergency speed restriction or the approach to a level crossing.

- G 3.2.4.16 If the receiver does not detect a north pole within one second after detecting the south pole, it assumes this has been produced by an AWS permanent magnet not followed by an energised electromagnet, which is intended to generate a warning indication.