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

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Superseded in part by GERT8075 Iss 3 and in part by RIS0775-CCS Iss 1
with effect from 03/03/2018
Guidance on AWS and TPWS Interface Requirements

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<td>One</td>
<td>September 2013</td>
<td>Original document&lt;br&gt;Gives guidance on interpreting the requirements of GE/RT8075 issue one</td>
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<td>March 2015</td>
<td>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of Automatic Warning System (AWS) receivers on trains entering service by means of depot test magnets (DTMs) have been withdrawn as they are out of scope of Railway Group Standards.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.&lt;br&gt;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at speeds above 160 km/h (100 mph) which have a braking capability of 9% g or greater.&lt;br&gt;Relevant guidance from withdrawn guidance note GM/GN2169 has been incorporated at G 5.4.1.3, G 5.4.1.4, and Appendices J, K and L.</td>
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Amended or additional parts of revised pages have been marked by a vertical black line in the adjacent margin.

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The following Rail Industry Guidance Notes are superseded, either in whole or in part as indicated:

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<td>GM/GN2169 issue one Combined Manual for AWS and TPWS Trainborne Equipment</td>
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<td>GE/GN8675 issue one Guidance on AWS and TPWS Interface Requirements</td>
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GM/GN2169 issue one Combined Manual for AWS and TPWS Trainborne Equipment, ceases to be in force and is withdrawn as of 06 June 2015.

GE/GN8675 issue one Guidance on AWS and TPWS Interface Requirements, ceases to be in force and is withdrawn as of 06 June 2015.

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### Guidance on AWS and TPWS Interface Requirements

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with effect from 03/03/2018
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.

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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.
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.
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).
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 train 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:

a) At selected signals, if a train passes a stop aspect.

b) On the approach to selected signals, if a train approaches a stop aspect at excessive speed.

c) 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.
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.
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](image)

**Table 1** Dimensions of magnetic field planes above AWS track magnet

<table>
<thead>
<tr>
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<th>Dimension A in Figure 1 (mm)</th>
<th>Dimension B in Figure 1 (mm)</th>
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<tr>
<td>Standard strength (except depot test magnets)</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>Extra strength (except depot test magnets)</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>Depot test magnets</td>
<td>50</td>
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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.
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.

<table>
<thead>
<tr>
<th>Height above rail level (mm)</th>
<th>Minimum flux density (mT) for standard strength magnets</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>5.0</td>
</tr>
<tr>
<td>120</td>
<td>4.1</td>
</tr>
<tr>
<td>140</td>
<td>3.4</td>
</tr>
<tr>
<td>160</td>
<td>2.8</td>
</tr>
<tr>
<td>180</td>
<td>2.3</td>
</tr>
<tr>
<td>200</td>
<td>2.0</td>
</tr>
</tbody>
</table>

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:
   a) Permanent magnets, including portable magnets for temporary and emergency speed restrictions.
   b) Electromagnets when energised.
   c)Suppressor magnets when not suppressed.

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

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

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.

<table>
<thead>
<tr>
<th>Height above rail level (mm)</th>
<th>Minimum flux density (mT) for extra strength magnets</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>6.5</td>
</tr>
<tr>
<td>140</td>
<td>6.1</td>
</tr>
<tr>
<td>160</td>
<td>5.7</td>
</tr>
<tr>
<td>180</td>
<td>5.3</td>
</tr>
<tr>
<td>200</td>
<td>5.0</td>
</tr>
<tr>
<td>220</td>
<td>4.6</td>
</tr>
</tbody>
</table>

**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**

_2.1.4.2_ The minimum flux densities set out in Table 4 apply to:

a) Permanent magnets, including portable magnets for temporary and emergency speed restrictions.

b) Electromagnets when energised.

c) 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.
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.

<table>
<thead>
<tr>
<th>Height above rail level (mm)</th>
<th>Minimum flux density (mT) for extra strength depot test magnets</th>
<th>Maximum flux density (mT) for extra strength depot test magnets</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>6.2</td>
<td>6.5</td>
</tr>
<tr>
<td>140</td>
<td>5.8</td>
<td>6.1</td>
</tr>
<tr>
<td>160</td>
<td>5.4</td>
<td>5.7</td>
</tr>
<tr>
<td>180</td>
<td>5.0</td>
<td>5.3</td>
</tr>
<tr>
<td>200</td>
<td>4.8</td>
<td>5.0</td>
</tr>
<tr>
<td>220</td>
<td>4.4</td>
<td>4.6</td>
</tr>
</tbody>
</table>

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.
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.

<table>
<thead>
<tr>
<th>Type of signal at which AWS shall be fitted</th>
<th>Exemptions from fitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>All colour light signals</td>
<td>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).</td>
</tr>
</tbody>
</table>

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

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

**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.

<table>
<thead>
<tr>
<th>Type of signal at which AWS shall be fitted</th>
<th>Exemptions from fitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>All colour light signals</td>
<td>c) A colour light stop signal in a block signalling area where:</td>
</tr>
<tr>
<td></td>
<td>i) The stop signals controlled by adjacent signal boxes are not fitted with AWS track equipment.</td>
</tr>
<tr>
<td></td>
<td>And either:</td>
</tr>
<tr>
<td></td>
<td>ii) This signal cannot display a cautionary aspect.</td>
</tr>
<tr>
<td></td>
<td>Or</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Type of signal at which AWS shall be fitted</th>
<th>Exemptions from fitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>All semaphore distant signals and distant boards</td>
<td>None</td>
</tr>
</tbody>
</table>

**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.
Guidance on AWS and TPWS Interface Requirements

**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.

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.

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.

<table>
<thead>
<tr>
<th>Application</th>
<th>Magnets to be provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Colour light signal not capable of displaying a green aspect.</td>
<td>Permanent magnet (south pole).</td>
</tr>
<tr>
<td>b) Semaphore distant signal fixed at caution.</td>
<td></td>
</tr>
<tr>
<td>c) Fixed distant board.</td>
<td></td>
</tr>
</tbody>
</table>

**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

### Table 7 Configurations of AWS track magnets (extract)

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

**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.

<table>
<thead>
<tr>
<th>Application</th>
<th>Magnets to be provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>f) Two colour light signals or semaphore distant signals for movements in opposite directions, sharing a common set of AWS track equipment.</td>
<td>Permanent magnet (south pole), with electromagnets (north pole) both before and after the permanent magnet.</td>
</tr>
</tbody>
</table>

(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.)

**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.

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

**Table 7 Configurations of AWS track magnets (extract)**
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.

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.

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

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.
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.
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.

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.
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.
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.

<table>
<thead>
<tr>
<th>Or</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

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.
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.

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 reached the AWS track equipment until that vehicle has passed over the AWS track equipment.

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

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’.
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.

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

2.1.12.1 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**

#### Provision of trainborne AWS equipment

<table>
<thead>
<tr>
<th><strong>GE/RT8075 issue two</strong></th>
<th>** Provision of trainborne AWS equipment**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2.2.1</strong></td>
<td>** Provision of trainborne AWS equipment**</td>
</tr>
<tr>
<td><strong>2.2.1.1</strong></td>
<td>AWS trainborne equipment shall be fitted to all vehicles that have a driving cab, with the exception of the following types of vehicles:</td>
</tr>
<tr>
<td></td>
<td>a) Locomotives used exclusively for shunting purposes.</td>
</tr>
<tr>
<td></td>
<td>b) Vehicles that operate solely within T3 possessions.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td><strong>2.2.1.2</strong></td>
<td>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.</td>
</tr>
</tbody>
</table>

**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.

### Receiver sensitivity requirements for AWS train sub-system

<table>
<thead>
<tr>
<th><strong>GE/RT8075 issue two</strong></th>
<th>** Receiver sensitivity requirements for AWS train sub-system**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2.2.2</strong></td>
<td>** Receiver sensitivity requirements for AWS train sub-system**</td>
</tr>
<tr>
<td><strong>2.2.2.1</strong></td>
<td>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.</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Height above rail level (mm)</th>
<th>Flux density (mT) which trainborne AWS equipment shall detect</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>4.8</td>
</tr>
<tr>
<td>120</td>
<td>3.9</td>
</tr>
<tr>
<td>140</td>
<td>3.2</td>
</tr>
<tr>
<td>160</td>
<td>2.6</td>
</tr>
<tr>
<td>180</td>
<td>2.1</td>
</tr>
<tr>
<td>200</td>
<td>1.8</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Height above rail level (mm)</th>
<th>Flux density (mT) which trainborne AWS equipment shall detect</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>6.2</td>
</tr>
<tr>
<td>140</td>
<td>5.8</td>
</tr>
<tr>
<td>160</td>
<td>5.4</td>
</tr>
<tr>
<td>180</td>
<td>5.0</td>
</tr>
<tr>
<td>200</td>
<td>4.8</td>
</tr>
<tr>
<td>220</td>
<td>4.4</td>
</tr>
</tbody>
</table>

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.

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.

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

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.

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.

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

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.
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 Rationale:** 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.
- 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 Rationale:** Generally, AWS should operate up to the maximum speed of the vehicle.

**G 3.2.3.8 Rationale:** 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.
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:

<table>
<thead>
<tr>
<th>State</th>
<th>Indicates the state that the table is describing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid preceding state(s)</td>
<td>Indicates which state(s) (functional or non-functional) it is permissible for the equipment to have been in prior to entering this state.</td>
</tr>
<tr>
<td>Entry conditions</td>
<td>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.</td>
</tr>
<tr>
<td>Events on entry</td>
<td>Indicates the events that shall take place immediately upon entry into this state.</td>
</tr>
<tr>
<td>Status during state</td>
<td>Indicates the status of the equipment that shall be maintained while it is in this state.</td>
</tr>
<tr>
<td>Exit conditions</td>
<td>Indicates the conditions that shall be fulfilled before the equipment can move from this state to another one.</td>
</tr>
<tr>
<td>Next valid state(s)</td>
<td>Indicates which functional states it is permissible for the equipment to move to on leaving this state.</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>State</th>
<th>Operational ready state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid preceding state(s)</td>
<td>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</td>
</tr>
<tr>
<td>Entry conditions</td>
<td>See exit conditions of valid preceding states</td>
</tr>
<tr>
<td>Events on entry</td>
<td>None</td>
</tr>
</tbody>
</table>
Guidance on AWS and TPWS Interface Requirements

### Table 10 Operational ready state

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

#### 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.

### Table 11 Primed state

<table>
<thead>
<tr>
<th>State</th>
<th>Primed state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid preceding state(s)</td>
<td>Operational ready state</td>
</tr>
<tr>
<td>Entry conditions</td>
<td>South pole of an AWS track magnet is detected</td>
</tr>
<tr>
<td>Events on entry</td>
<td>Visual indicator changes to ‘all black’ (if it was previously at ‘black and yellow’)</td>
</tr>
<tr>
<td>Status during state</td>
<td>Equipment capable of detecting the north pole of an AWS track magnet, and</td>
</tr>
<tr>
<td></td>
<td>Audible warning indicator is silent, and</td>
</tr>
<tr>
<td></td>
<td>Visual indicator is at ‘all black’, and</td>
</tr>
<tr>
<td></td>
<td>No AWS brake demand is applied</td>
</tr>
<tr>
<td>Exit conditions</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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).</td>
</tr>
<tr>
<td></td>
<td>The one second period is known as the Initial Delay Period</td>
</tr>
<tr>
<td>Next valid state(s)</td>
<td>Clear signal response state, or</td>
</tr>
<tr>
<td></td>
<td>Restrictive response state</td>
</tr>
</tbody>
</table>
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.

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

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.
State | Restrictive response state
--- | ---
Valid preceding state(s) | Primed state
Entry conditions | Initial delay period expires without detecting a north pole magnet during that period
Events on entry | Audible warning indication given, as set out in 4.2.2.2, which continues until the equipment exits from this state
Status during state | Equipment capable of accepting a caution acknowledgement (by operation of the caution acknowledgement device), and Visual indicator maintained at ‘all black’, and No AWS brake demand is applied
Exit conditions | Caution acknowledgement device is operated within the caution acknowledgement delay period, in which case the restrictive acknowledgement state is entered, or Automatic exit occurs if the caution acknowledgement device is not operated within the caution acknowledgement delay period, in which case the brake demand non-acknowledgement state is entered*
Next valid state(s) | Restrictive acknowledgement state, or Brake demand non-acknowledgement state

**Table 13** Restrictive response state

G 3.2.4.17 Rationale: The warning state is indicated by the sounding of a horn (or a horn-like tone), which continues until the driver acknowledges it.

G 3.2.4.18 Rationale: The visual indicator remains at black at this stage, as the ‘black and yellow’ indication is not intended to supplement the audible warning but is given as a reminder after the warning has been acknowledged.

**GE/RT8075 issue two**

2.2.4 AWS functional requirements and states

2.2.4.7 The caution acknowledgement delay period shall be as follows:

a) For trains authorised to operate at speeds above 160 km/h (100 mph) and which have a braking capability less than 9% g, the caution acknowledgement delay period shall be 2.0 seconds (+/- 0.25 seconds) after entering the restrictive response state.

G 3.2.4.19 Rationale: If the driver has not acknowledged the warning, AWS should automatically apply the brakes by the time the train passes the signal or sign, to ensure that adequate braking distance is available (in normal conditions) to bring the train to a stand before the end of its movement authority, or to reduce the speed sufficiently before the train enters the section of line where a lower permissible speed applies.

G 3.2.4.20 A train travelling at 125 mph will take a minimum of three seconds to travel from the magnet to the associated signal (see 2.1.8.1). Therefore, following the one second initial delay, there will be a minimum of two seconds from the time when the warning is given until the train passes the associated signal or sign.

**GE/RT8075 issue two**

2.2.4 AWS functional requirements and states

b) For trains authorised to operate at speeds up to and including 160 km/h (100 mph) the caution acknowledgement delay period shall be no less than 2.0 seconds (+/- 0.25 seconds) and no greater than 2.7 seconds (+/- 0.25 seconds) after entering the restrictive response state.
G 3.2.4.21 Rationale: A train travelling at a speed not exceeding 100 mph will take a minimum of four seconds to travel from the magnet to the associated signal. Therefore, following the one second initial delay, there will be a minimum of three seconds from the time when the warning is given until the train passes the associated signal or sign.

G 3.2.4.22 AWS was originally designed for a maximum speed of 100 mph, and the caution acknowledgement delay was specified as 2.7 seconds. On a train with a maximum speed not exceeding 100 mph, a value up to 2.7 seconds may be used to provide the driver with a longer period to respond to the AWS warning without receiving a brake application, and to maintain operational compatibility with existing trains using this timing.

GE/RT8075 issue two
2.2.4 AWS functional requirements and states
c) For trains authorised to operate at speeds above 160km/h (100 mph) which have a braking capability of 9% g or greater, the caution acknowledgement delay period shall be no less than 2.0 seconds (+/− 0.25 seconds) and no greater than 2.7 seconds (+/− 0.25 seconds) after entering the restrictive response state.

G 3.2.4.23 Rationale: A train travelling at 125 mph will cover 220 m in 3.95 seconds (one second initial delay followed by acknowledgement delay of 2.7 seconds with tolerance of +0.25 seconds). If the AWS magnet is at the standard distance of 180 m from the signal, the train may therefore have travelled approximately 40 m beyond the signal before AWS initiates a brake application.

G 3.2.4.24 Rationale: If a train with a maximum speed exceeding 100 mph has adequate braking capability to ensure that it will stop before the end of its movement authority even though the brake application may not be initiated until shortly after passing the cautionary signal, an acknowledgement delay of up to 2.7 seconds may be used to provide the driver with a longer period to respond to the AWS warning before receiving a brake application.

GE/RT8075 issue two
2.2.4 AWS functional requirements and states
2.2.4.8 The trainborne AWS equipment shall enter the restrictive acknowledgement state when a driver has acknowledged receipt of an AWS warning by operation of the caution acknowledgement device.

<table>
<thead>
<tr>
<th>State</th>
<th>Restrictive acknowledgement state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid preceding state(s)</td>
<td>Restrictive response state</td>
</tr>
<tr>
<td>Entry conditions</td>
<td>Driver operates the caution acknowledgement device</td>
</tr>
<tr>
<td>Events on entry</td>
<td>Visual indicator changes to ‘black and yellow’, and</td>
</tr>
<tr>
<td></td>
<td>Audible warning indication is silenced</td>
</tr>
<tr>
<td>Status during state</td>
<td>No AWS brake demand is applied and</td>
</tr>
<tr>
<td></td>
<td>Visual indicator maintained at ‘black and yellow’, and</td>
</tr>
<tr>
<td></td>
<td>Audible indicator is silent</td>
</tr>
<tr>
<td>Exit conditions</td>
<td>Automatic exit occurs when the entry events have been completed</td>
</tr>
<tr>
<td>Next valid state(s)</td>
<td>Operational ready state</td>
</tr>
</tbody>
</table>

Table 14 Restrictive acknowledgement state

G 3.2.4.25 Rationale: The visual indicator changes to a distinctive black and yellow ‘sunflower’ display to remind the driver that a warning has been received and acknowledged, and the driver is now responsible for controlling the train in accordance with the movement authority or permissible speed indicated by the lineside signals or signs.
G 3.2.4.26 Rationale: Although the driver is required to continue to control the train in accordance with the movement authority or permissible speed information which the AWS warning drew attention to, the equipment returns to the operational ready state as it may be required to detect and respond to another set of AWS track equipment.

GE/RT8075 issue two

2.2.4 AWS functional requirements and states

2.2.4.9 The trainborne AWS equipment shall enter the brake demand non-acknowledgement state when a driver has failed to acknowledge receipt of an AWS warning by operation of the caution acknowledgement device within the caution acknowledgement period.

G 3.2.4.27 If the warning is not acknowledged within the caution acknowledgement delay period (see 2.2.4.7), it is assumed that the driver may be distracted or incapacitated. At the expiry of the caution acknowledgement delay period, therefore, if the warning has not been acknowledged, the system applies the brakes to bring the train to a stand.

<table>
<thead>
<tr>
<th>State</th>
<th>Brake demand non-acknowledgement state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid preceding state(s)</td>
<td>Restrictive response state</td>
</tr>
<tr>
<td>Entry conditions</td>
<td>Driver fails to operate caution acknowledgement device within the caution acknowledgement period</td>
</tr>
<tr>
<td>Events on entry</td>
<td>AWS brake demand is initiated and maintained</td>
</tr>
<tr>
<td>Status during state</td>
<td>Equipment capable of accepting a caution acknowledgement (by operation of the caution acknowledgement device), and Audible warning indication continues, as set out in 4.2.2.2, and Visual indicator maintained at ‘all black’</td>
</tr>
<tr>
<td>Exit conditions</td>
<td>Driver operates caution acknowledgement device</td>
</tr>
<tr>
<td>Next valid state(s)</td>
<td>Brake demand acknowledgement state</td>
</tr>
</tbody>
</table>

Table 15 Brake demand non-acknowledgement state

G 3.2.4.28 Rationale: Although the system has applied the brakes, the audible warning continues until it is acknowledged.

G 3.2.4.29 Rationale: The visual indicator remains at black, as the black and yellow indication is only given as a reminder after the warning has been acknowledged.

GE/RT8075 issue two

2.2.4 AWS functional requirements and states

2.2.4.10 The trainborne AWS equipment shall enter the brake demand acknowledgement state when a driver has acknowledged receipt of an AWS warning by operation of the caution acknowledgement device following the expiration of the caution acknowledgement period.

G 3.2.4.30 If the driver acknowledges the warning after a brake demand has been initiated, the audible warning is silenced but the brakes remain applied until a separate brake release procedure has been carried out.
Guidance on AWS and TPWS Interface Requirements

State | Brake demand acknowledgement state
---|---
Valid preceding state(s) | Brake demand non-acknowledgement state
Entry conditions | Driver operates the caution acknowledgement device
Events on entry | Visual indicator changes to ‘black and yellow’, and Audible warning indication is silenced
Status during state | After satisfying the conditions in 2.2.4.11, the AWS brake demand is cancelled
Exit conditions | Automatic exit occurs when the brake demand has been cancelled
Next valid state(s) | Operational ready state

Table 16  Brake demand acknowledgement state

G 3.2.4.31 Rationale: As in the restrictive acknowledgement state, the visual indicator changes to a distinctive black and yellow ‘sunflower’ display to remind the driver that a warning has been received and acknowledged.

G 3.2.4.32 In earlier implementations of AWS, acknowledging the warning would also release the brakes if they had been applied. As the brake release procedure is harmonised for AWS and TPWS brake applications, a further specific action is now required to release the brakes.

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2.2.4  AWS functional requirements and states

2.2.4.11 The AWS brake demand shall be cancelled not less than 59 seconds after the brake demand has been initiated, and following operation of the caution acknowledgement device and the brake release action set out in Part 4.

G 3.2.4.33 Rationale: Once AWS has initiated a brake demand, the brakes should not be released until the train has come to a stand and the driver has carried out the appropriate procedures.

G 3.2.4.34 A time of 59 seconds is considered to be sufficient for the emergency brake application to bring the train to a stand, or nearly so. The driver is then required to contact the signaller before releasing the brakes and moving the train.
### GE/RT8075 issue two

#### 2.2.4 AWS functional requirements and states

**2.2.4.12** In the suppressed state the trainborne AWS equipment shall remain operational but shall not provide any indications to the driver or initiate any brake demands.

<table>
<thead>
<tr>
<th>State</th>
<th>AWS suppressed state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid preceding state(s)</td>
<td>Any state</td>
</tr>
<tr>
<td>Entry conditions</td>
<td>AWS suppression requested by another train control system or by manual input</td>
</tr>
<tr>
<td>Events on entry</td>
<td>AWS brake demand (if it has been initiated) is maintained unless the alternative train control system has the facility to apply appropriate controls, and Audible indicator is silenced (if it was previously operative), and Visual indicator changes to default indication (if this is defined for the type of indicator), or does not change (if no default indication is defined), and System status indicator indicates that trainborne AWS equipment is suppressed</td>
</tr>
<tr>
<td>Status during state</td>
<td>No AWS brake demand is applied, and Visual indicator does not change, and Audible warning indicator is silent</td>
</tr>
<tr>
<td>Exit conditions</td>
<td>Request for AWS suppression removed</td>
</tr>
<tr>
<td>Next valid state(s)</td>
<td>Operational ready state (unless entry to an alternative state is controlled by suppressing system)</td>
</tr>
</tbody>
</table>

### Table 17 AWS suppressed state

**G 3.2.4.35** Rationale: Provision is made for an alternative train control system (such as ETCS) to switch AWS into a suppressed state. In this state AWS does not provide any audible indications to the driver or initiate a brake application.
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2.2.4 AWS functional requirements and states

2.2.4.13 In the system isolation state the trainborne AWS equipment shall be inoperative.

<table>
<thead>
<tr>
<th>State</th>
<th>System isolation state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid preceding state(s)</td>
<td>Any state</td>
</tr>
<tr>
<td>Entry conditions</td>
<td>System isolation device operated so as to isolate the trainborne AWS equipment</td>
</tr>
<tr>
<td>Events on entry</td>
<td>AWS brake demand is cancelled (if it has been initiated), and Audible indicator is silenced (if it was previously operative), and Visual indicator changes to default indication (if this is defined for the type of indicator), or does not change (if no default indication is defined), and Isolation indicator indicates that trainborne AWS equipment is isolated</td>
</tr>
<tr>
<td>Status during state</td>
<td>No AWS brake demand is applied, and Visual indicator does not change, and Audible warning indicator is silent</td>
</tr>
<tr>
<td>Exit conditions</td>
<td>System isolation device is operated so as to restore the AWS to its functional condition</td>
</tr>
<tr>
<td>Next valid state(s)</td>
<td>Operational ready state</td>
</tr>
</tbody>
</table>

Table 18 System isolation state

G 3.2.4.36 Rationale: Provision is made for isolation of the trainborne AWS equipment to allow the train to be moved if the brakes cannot be released with the system operational.

G 3.2.5 Trainborne AWS equipment self-test capability

GE/RT8075 issue two

2.2.5 Trainborne AWS equipment self-test capability

2.2.5.1 The trainborne AWS equipment shall have a built-in self-test routine which, as a minimum, tests the following features:

a) That the audible and visual indications operate correctly when required to do so.

And

b) That an AWS brake demand is requested when required.

G 3.2.5.1 Rationale: Because AWS is considered to be a primary safety system, the principal features of the trainborne system should be tested for correct operation before the start of each journey to give assurance that the system is capable of providing effective protection for the train.

G 3.2.5.2 The self-test requirements set out in GE/RT8075 only test the functionality of the system and the driver interface, and do not on their own confirm that the AWS receiver will actually detect track magnets.

G 3.2.5.3 Further guidance on AWS receiver sensitivity testing is given in G 3.5.
## Guidance on AWS and TPWS Interface Requirements

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Trainborne AWS equipment self-test capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.5</td>
<td>The AWS power-up test routine, as set out in 4.3.1, shall be initiated whenever the train is powered up or, in the case of dual cab trains, when the driver changes cab.</td>
</tr>
</tbody>
</table>

G 3.2.5.4 Rationale: The test should be carried out when a cab is brought into use. In the case of a dual-cab locomotive, although a single AWS receiver provides input to both cabs, the audible and visual indications are separate for each cab and should be tested separately when the driver changes ends.

G 3.2.5.5 Detailed requirements for the power-up test and the layout and functionality of the DMI are given in GE/RT8075 Part 4.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Trainborne AWS equipment self-test capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.5</td>
<td>An AWS self-test routine shall also be conducted automatically when a train enters a portion of line where the trainborne AWS equipment is required to be active, having previously been suppressed.</td>
</tr>
</tbody>
</table>

G 3.2.5.6 Rationale: When an alternative system is providing train protection functionality for part of a journey, the AWS equipment should be proved operational before it is required to take over the role of train protection from the other system.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Trainborne AWS equipment self-test capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.5</td>
<td>When carrying out an AWS self-test in the circumstances of 2.2.5.3, it is not necessary to test that a brake demand is requested if this has been done when the train or cab was powered up.</td>
</tr>
</tbody>
</table>

G 3.2.5.7 Rationale: It is sometimes required to carry out the AWS self-test at the point of transition from an alternative system to AWS without stopping the train. In these circumstances it would be impracticable to require a brake demand to be initiated as part of the self-test routine.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Trainborne AWS equipment self-test capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.5</td>
<td>On successful completion of the test routine the trainborne AWS equipment shall move to the operational ready state.</td>
</tr>
</tbody>
</table>

G 3.2.5.8 Rationale: When the self-test has confirmed that the AWS sub-system is in a healthy state, the equipment should be ready to detect and respond to magnets on the track.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Trainborne AWS equipment self-test capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.5</td>
<td>Failure to complete the self-test successfully shall result in an appropriate and distinct warning being given to the driver.</td>
</tr>
</tbody>
</table>

G 3.2.5.9 Rationale: If the self-test routine fails to complete, the driver should be made aware that AWS is not operational and should then take the appropriate action to deal with faulty equipment.

G 3.2.5.10 When the self-test includes initiation of a brake demand, failure to complete the test will usually result in the brakes remaining applied. It may then be necessary to isolate the system to release the brakes in order to allow the train to be moved.
G 3.2.5.11 When the self-test does not include a brake demand, failure to complete the test will not usually result in a brake application, but may prevent the system switching to AWS mode. The driver should be given a clear warning of the failure and may need to apply the appropriate operating rules if the train is to enter AWS-fitted lines with the system not fully operational.

G 3.3 **AWS route compatibility assessment requirements**

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AWS route compatibility assessment requirements</strong></td>
</tr>
</tbody>
</table>

2.3 If on a route it is proposed to replace AWS track equipment of one type (standard or extra strength) by equipment of the other type, the infrastructure manager shall assess the risks of so doing, taking into account the types of AWS receivers fitted to trains that operate on the route.

G 3.3.1.1 Rationale: Trainborne AWS receivers are required to be compatible with the AWS track equipment on the routes on which they operate. Changing the type of magnet may introduce incompatibility with existing receivers.

G 3.3.1.2 In some cases non-standard arrangements of AWS equipment have been introduced to deal with particular situations. In such cases, changing the type of magnet (even if this change is from an existing non-compliant arrangement to a compliant arrangement) may introduce incompatibility with trainborne receivers which work satisfactorily with the existing track equipment.

G 3.3.1.3 Rationale: Trainborne AWS receivers are required to be compatible with the AWS track equipment on the routes on which they operate. There is a specific requirement to assess the compatibility of the AWS receiver with the AWS track equipment on the route, particularly where a single sensitivity receiver is to be operated over both standard strength and extra strength track equipment.

G 3.3.1.4 Rationale: Agreed operational procedures are required to manage the risks arising from operation of trains not fitted with AWS on a line where AWS is provided as a primary safety system.

G 3.4 **Guidance on AWS design principles**

G 3.4.1 **Failure modes**

G 3.4.1.1 AWS equipment (both track and train sub-systems) should be designed and interfaced with other equipment and systems (including power supplies) so that, so far as is reasonably practicable, there is no credible failure mode, as experienced by the driver, which results in any of the following events:

a) A ‘clear’ audible indication being given to the driver when a ‘warning’ indication should have been given.
b) No indication being given when a ‘warning’ indication should have been given.

c) A caution acknowledgement being effected – that is, the equipment entering the restrictive acknowledgement state (Table 14) or the brake demand acknowledgement state (Table 16) – that was not initiated by the driver operating the caution acknowledgement device.

d) Failure to initiate an AWS brake demand when such a brake demand is required.

e) Release of an AWS brake demand when not initiated by the driver.

G 3.4.1.2 Where it is not reasonably practicable to achieve this for any of the events set out in G 3.4.1.1, then the event should, so far as is reasonably practicable, be made self-protecting or self-revealing.

G 3.4.1.3 An AWS brake demand should be initiated automatically if the power supply to the trainborne AWS equipment fails. Such an event should not, however, prevent the trainborne equipment subsequently being isolated by the driver so that the train can be moved.

G 3.4.2 Compatibility

G 3.4.2.1 Requirements for electromagnetic compatibility of railway equipment are set out in BS EN 50121.

G 3.4.2.2 AWS track equipment should not jeopardise the safe operation of neighbouring equipment as a result of the electromagnetic fields that it generates.

G 3.4.2.3 AWS track and trainborne equipment should be designed to withstand electromagnetic fields emitted by other equipment that might otherwise jeopardise the correct operation of the equipment.

G 3.4.2.4 AWS track and trainborne equipment should be sufficiently robust to withstand, and continue to operate correctly under, all reasonably foreseeable levels of mechanical shock that might be experienced during normal railway operations.

G 3.4.2.5 The interfaces between the AWS track equipment and the signalling system should be designed so as not to jeopardise the correct operation of either the AWS track equipment or the signalling system.

G 3.4.2.6 The interfaces between the trainborne AWS equipment and other equipment and systems on board the train should be designed so as not to jeopardise the correct operation of either the trainborne AWS equipment or other equipment and systems.

G 3.5 Guidance on AWS Receiver Sensitivity Testing

G 3.5.1.1 Trains entering service are required to have fully functional AWS equipment, in accordance with GE/RT8075 section 2.2, in any cab that is intended to be used. In particular, AWS receivers are required to meet the relevant sensitivity parameters set out in GE/RT8075 Table 8 and Table 9.

G 3.5.1.2 Operation of AWS is monitored by the driver, who is required to report an AWS failure in accordance with the Rule Book, module TW5 part B. If an incorrect indication is received, or no indication is received where one is expected, the driver should report it. However, many AWS magnets have an actual flux density higher than the minimum specified level, and therefore correct operation of AWS may not confirm that the receiver is sufficiently sensitive to detect magnets at the lower end of the specified flux range.

G 3.5.1.3 The AWS trainborne sub-system self-test routine, set out in GE/RT8075 section 2.2.5, only tests the functionality and driver interface of the AWS train sub-system. It does not test the AWS receiver sensitivity.

G 3.5.1.4 Railway undertakings should establish procedures within their safety management systems to confirm that AWS receivers meet the sensitivity values set out in GE/RT8075 Table 8 and Table 9.
G 3.5.1.5 The aim of the procedure is to provide assurance that trains will not operate with a non-compliant AWS receiver.

G 3.5.1.6 Where vehicles are fitted with both standard strength and extra strength AWS receivers, the procedures should cover each type of AWS receiver.

G 3.5.1.7 Historically, a depot test magnet was the established method of testing AWS receiver sensitivity, but it is permissible to use alternative methods to provide the required assurance.

G 3.5.1.8 Where provided, the test magnet should be positioned so that trains that need to be tested pass over it before entering the main line network infrastructure.

G 3.5.1.9 A depot test magnet simulates an AWS track magnet using a south pole in order to initiate an AWS warning indication in the cab.

G 3.5.1.10 Depot test magnets are required to produce lower flux density levels than other AWS magnets in order to test the sensitivity of the AWS receiver and provide assurance that the receiver is sufficiently sensitive to detect magnets at the lower end of the specified flux range.

G 3.5.1.11 GE/RT8075 Table 3 and Table 5 set out the required flux density levels for depot test magnets for standard strength and extra strength receivers respectively.

G 3.5.1.12 An extra strength AWS receiver (which is less sensitive than a standard receiver) may not detect a standard strength depot test magnet, so an extra strength depot test magnet is required to confirm its operation. However, detection of an extra strength depot test magnet does not adequately test the required sensitivity of a standard strength AWS receiver.

G 3.5.1.13 Depot test magnets only test the AWS receiver that is active when the train passes over the magnet. The AWS testing procedures should take account of circumstances where there is potential for operation of trains in service using a different receiver that has not been tested using the depot test magnet.

G 3.5.1.14 Examples of such circumstances include cases when:

   a) A train reverses direction and a different receiver becomes active;
   b) A multiple unit train divides and another receiver becomes active;
   c) A switchable receiver is operated to an alternative sensitivity setting.

G 3.5.1.15 The process of AWS receiver testing should take account of:

   a) The effectiveness of using depot test magnets and / or alternative methods to detect AWS receivers that do not comply with sensitivity requirements
   b) The effectiveness of procedures in detecting AWS receivers that have been damaged or displaced

And

   c) The level of assurance of AWS receiver stability.
Part 4  Guidance on Track / Train Interface for TPWS

G 4.1  TPWS track sub-system

G 4.1.1  Positioning of TPWS track equipment

GE/RT8075 issue two

3.1.1  Positioning of TPWS track equipment

3.1.1.1  TPWS track transmitters shall be positioned between the running rails on the longitudinal centre line of the track.

G 4.1.1.1  Rationale: This is to ensure that the magnetic field will be reliably detected by a TPWS receiver mounted centrally under the train.

G 4.1.2  Magnetic field requirements of TPWS track equipment

GE/RT8075 issue two

3.1.2  Magnetic field requirements of TPWS track equipment

3.1.2.1  When the track transmitters are energised, the TPWS track sub-system shall transmit the appropriate pair of frequencies set out in Tables 19 and 20 as unmodulated sinusoidal carriers, with a tolerance of ± 10 Hz.

<table>
<thead>
<tr>
<th>Frequency set</th>
<th>Arming frequency</th>
<th>Trigger frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSS frequency set A</td>
<td>64.25 kHz (f1)</td>
<td>65.25 kHz (f2)</td>
</tr>
<tr>
<td>OSS frequency set B</td>
<td>64.75 kHz (f4)</td>
<td>65.75 kHz (f5)</td>
</tr>
</tbody>
</table>

Table 19  Track transmitter frequencies for overspeed protection functionality

<table>
<thead>
<tr>
<th>Frequency set</th>
<th>Arming frequency</th>
<th>Trigger frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS frequency set A</td>
<td>66.25 kHz (f3)</td>
<td>65.25 kHz (f2)</td>
</tr>
<tr>
<td>TSS frequency set B</td>
<td>66.75 kHz (f6)</td>
<td>65.75 kHz (f5)</td>
</tr>
</tbody>
</table>

Table 20  Track transmitter frequencies for train stop functionality

G 4.1.2.1  Rationale: The frequencies of the magnetic fields emitted by the TPWS track transmitter loops have been specified to be detectable and distinguishable by TPWS receivers, and to avoid frequencies used by other equipment expected to be present in the area of the track/train interface which could potentially interfere with the transmitted signal or lead to detection of spurious signals from other sources.

G 4.1.2.2  Rationale: A tolerance of ± 10 Hz allows for minor variations in the transmitter characteristics while retaining a clear distinction between adjacent frequencies which have a nominal separation of 500 Hz.

G 4.1.2.3  Rationale: The dimensions of the magnetic fields emitted by the TPWS track transmitters and the required flux density levels within specified areas are defined to provide for reliable detection by TPWS receivers.

G 4.1.2.4  The standard parameters defined in Appendix C are applicable to all TPWS TSS transmitters and to OSS transmitters, except those on the approach to buffer stops and other places where miniature loops are used.
3.1.2 Magnetic field requirements of TPWS track equipment

3.1.2.3 The magnetic fields emitted from miniature OSS track transmitters shall comply with the magnetic field strength parameters set out in Appendices D and E.

G 4.1.2.5 Rationale: The dimensions of the magnetic fields emitted by the TPWS track transmitters and the required flux density levels within specified areas are defined to provide for reliable detection by TPWS receivers.

G 4.1.2.6 Rationale: OSS track transmitters installed on the approach to buffer stops and in certain other low speed applications use miniature loops of smaller dimensions than the standard type of transmitter. This enables them to be spaced more closely to provide lower set speeds, without problems from mutual interference which were experienced with closely spaced standard size loops.

G 4.1.2.7 Problems were experienced with the use of standard TPWS transmitter loops at the close spacings necessary to give the lower set speeds (down to 10 mph) required for OSS on the approach to buffer stops. The close proximity of the two loops gave rise to interference between the fields from the two loops, which resulted in unwarranted tripping of the TPWS train sub-system even though the speed of the train was lower than the set speed.

G 4.1.2.8 To avoid this problem, a smaller loop was developed for lower speed applications.

G 4.1.2.9 Rationale: The defined parameters of the magnetic field are designed to produce an overlapping field so that TPWS receivers can reliably detect the field from both loops and in such a way that they can identify this as an active TSS.

G 4.1.2.10 Rationale: The use of alternative frequency sets and the ability to interleave and nest track transmitters gives the flexibility necessary to allow configurations of TPWS transmitters, which should provide appropriate information to control the speed of trains in the variety of circumstances that may arise in application of TPWS to track and signalling layouts.

G 4.1.2.11 The second set of frequencies was originally intended for use in the opposite direction on bi-directionally signalled track. However, it was realised that both sets of frequencies could be utilised in the same direction to enable multiple OSS and TSS installations to be more closely spaced than if restricted to a single set of frequencies.
Guidance on AWS and TPWS Interface Requirements

G 4.1.2.12 The use of alternative frequency sets and the possibility of interleaving and nesting track transmitters means that TPWS receivers should be capable of correctly interpreting the various permitted arrangements.

G 4.1.3 Provision of TPWS track equipment

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>3.1.3</th>
<th><strong>Provision of TPWS track equipment</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.3.1</td>
<td>TPWS track sub-system equipment shall be provided on all passenger lines at the locations specified in 3.1.3.2 to 3.1.3.8, except where exemptions are permitted by 3.1.4.</td>
</tr>
</tbody>
</table>

G 4.1.3.1 Rationale: TPWS is the default system provided to control the residual risk from SPAD and overspeeding that is not addressed by provision of AWS.

G 4.1.3.2 TPWS (together with AWS) is the standard train protection system which is installed throughout the national network, except where there is an alternative system which provides an equivalent level of protection.

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<table>
<thead>
<tr>
<th>3.1.3</th>
<th><strong>Provision of TPWS track equipment</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.3.2</td>
<td>TPWS shall be provided on passenger lines at all main stop signals and stop boards that protect crossing or converging movements with any running line or siding.</td>
</tr>
</tbody>
</table>

G 4.1.3.3 Rationale: TPWS is provided to mitigate the risk from a SPAD at locations where the risk is greatest, which applies primarily at locations where a signal at danger protects a conflicting movement.

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<table>
<thead>
<tr>
<th>3.1.3</th>
<th><strong>Provision of TPWS track equipment</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.3.3</td>
<td>TPWS shall be provided at any main stop signal on a non-passenger line that protects a crossing of, or convergence with, a passenger line.</td>
</tr>
</tbody>
</table>

G 4.1.3.4 Rationale: A non-passenger movement that could enter a passenger line without authority presents a risk to authorised movements of passenger trains.

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>3.1.3</th>
<th><strong>Provision of TPWS track equipment</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.3.4</td>
<td>TPWS shall be provided at a stop signal where conflicting movements could take place in the overlap of the next stop signal ahead.</td>
</tr>
</tbody>
</table>

G 4.1.3.5 Rationale: If it is not possible for TPWS at the following signal to stop a movement before it reaches a potential point of conflict beyond that signal, TPWS protection is required at the previous signal.

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<table>
<thead>
<tr>
<th>3.1.3</th>
<th><strong>Provision of TPWS track equipment</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.3.5</td>
<td>On non-track circuit block lines with a semaphore equivalent aspect sequence, TPWS shall be provided at the first home signal at the end of a block section where conflicting movements could take place within station limits ahead.</td>
</tr>
</tbody>
</table>

G 4.1.3.6 Rationale: On lines where a semaphore-type aspect sequence applies, a train should be stopped, or brought nearly to a stand, at the first home signal if there is any conflicting movement preventing the signals ahead from being cleared. TPWS at the first stop signal therefore protects any conflicting movement within station limits.
Guidance on AWS and TPWS Interface Requirements

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Provision of TPWS track equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.3</td>
<td>It is permissible to provide TPWS at other signals where required for mitigation of SPAD risk, as set out in GK/RT0045.</td>
</tr>
</tbody>
</table>

**G 4.1.3.7** Rationale: GK/RT0045 requires train protection to be configured to reduce SPAD risk in a transition from 3-aspect to 4-aspect signalling. Where TPWS is in use as the train protection system, this will require provision of additional TPWS loops at the signal concerned (the signal that displays a red aspect at the end of the last 3-aspect sequence).

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Provision of TPWS track equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.3.7</td>
<td>TPWS shall be provided on the approach to the buffer stop at the end of a passenger platform.</td>
</tr>
</tbody>
</table>

**G 4.1.3.8** Rationale: Buffer stop collisions are an additional area of risk that TPWS has been designed to mitigate.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Provision of TPWS track equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.3.8</td>
<td>TPWS shall be provided on the approach to speed restrictions where the permitted speed on the approach is 60 mph or more and the speed restriction reduces the speed by at least one-third, except for:</td>
</tr>
<tr>
<td></td>
<td>a) Temporary speed restrictions in place for three months or less.</td>
</tr>
<tr>
<td></td>
<td>b) Temporary speed restrictions in place for between three months and twelve months, subject to risk assessment, as set out in 3.1.4.2.</td>
</tr>
</tbody>
</table>

**G 4.1.3.9** Rationale: Derailment due to overspeed at speed restrictions was identified as an additional risk that TPWS was designed to protect.

**G 4.1.3.10** Rationale: The criteria previously established for determining whether a speed reduction should be protected by AWS are also applied to determine the requirement for TPWS protection.

**G 4.1.3.11** Rationale: While temporary speed restrictions are protected by AWS, there are practical difficulties in applying TPWS protection on a temporary basis. The Railway Safety Regulations 1999 stated that temporary speed restrictions would not require TPWS protection; however, these regulations define a temporary speed restriction as one that is in place for three months or less.

**G 4.1.3.12** In practice, temporary speed restrictions are often in place for more than three months. The requirements for provision of TPWS at temporary speed restrictions which are in place for between three months and twelve months are set out in 3.1.4.2.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
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</thead>
<tbody>
<tr>
<td>3.1.3.9</td>
<td>TPWS miniature loops shall be used as OSS transmitters only where the speed of trains does not exceed 40 mph.</td>
</tr>
</tbody>
</table>

**G 4.1.3.13** Rationale: TPWS miniature loops were initially designed for use on the approach to buffer stops (see G 4.1.2.6), but may be used in other low-speed applications. GE/RT8270 3.2.3.9 requires the TPWS train sub-system to respond correctly to TPWS miniature loops at speeds up to 40 mph.
G 4.1.4  Exemptions to provision of TPWS track equipment

GE/RT8075 issue two

3.1.4  Exemptions to provision of TPWS track equipment

3.1.4.1  The TPWS track sub-system is not required to be provided in the circumstances set out below:

a)  Where an alternative train protection system providing a level of protection equivalent to or better than AWS and TPWS is fitted and operational on the infrastructure and on all trains operating on the route.

b)  At a signal used solely for shunting purposes.

c)  At a stop signal that protects only a convergence of a passenger running line with a locally operated emergency crossover.

d)  At a stop signal that protects a crossing or convergence with a passenger running line, where the track layout and interlocking controls would prevent a collision at the crossing or convergence in the event of a SPAD.

e)  At a stop signal that protects only a convergence with a siding that is secured out of use in accordance with GE/RT8000.

f)  Where a permissible speed indicator is provided to indicate a permissible speed that has been imposed solely to reduce the dynamic loading on track systems from rail traffic.

g)  Where the attainable speed on entry to the commencement of a speed restriction is less than 60 mph, or less than the excessive speed defined for the section of track.

h)  Where a permissible speed indicator is provided on the approach to a diverging junction where the risk from overspeeding on the diverging route is mitigated by approach control of the signalling.

G 4.1.4.1  Rationale: TPWS does not need to be provided where an alternative train protection system provides an equivalent or higher level of protection for all trains using the route.

G 4.1.4.2  Rationale: Provision of TPWS for shunting movements is not justified, as the slow speed of the movement reduces the level of risk.

G 4.1.4.3  Rationale: Provision of TPWS is not justified for protection of an emergency crossover which is infrequently used and where the local control arrangements will limit the impact of irregular operation.

G 4.1.4.4  Rationale: Provision of TPWS is not necessary where a train which passes a signal at danger will be diverted by trap points or similar layout configurations and will not reach a point of conflict with a train passing on the protected line.

G 4.1.4.5  Rationale: Provision of TPWS is not justified for protection of a siding which is secured out of use and may only be used infrequently under local control arrangements.

G 4.1.4.6  Rationale: A speed restriction may be imposed to reduce the loading on the track, but where this is the only reason for the speed restriction there should be no risk from derailment due to overspeeding.

G 4.1.4.7  Rationale: The risk from overspeeding at a speed restriction is related to the maximum attainable speed of trains, which may be less than the permissible speed.

G 4.1.4.8  Rationale: Approach release of a junction signal for a diverging route enforces a speed reduction on approaching trains, and so provides an alternative method of controlling the risk from overspeeding.
3.1.4 Exemptions to provision of TPWS track equipment

3.1.4.2 In the circumstances set out below, the TPWS track sub-system need be fitted only where the results of a risk assessment show that the fitment of TPWS is justified in order to reduce risk so far as reasonably practicable:

a) On the approach to a permissible speed indicator where, in order to prevent unwarranted emergency brake applications on freight trains passing over the TPWS OSS, the position of the OSS would have to be adjusted such that it would provide no protection to any trains.

b) On the approach to a permissible speed indicator solely associated with a plain line curve where there is a potential risk from derailment or overturning.

c) Where a permissible speed indicator is provided to indicate a permissible speed that has been imposed solely to protect trains from the infrastructure or other passing trains due to limited clearance.

d) Where a permissible speed indicator is provided on the approach to a footpath or bridleway level crossing for the sole purpose of increasing the warning time for crossing users.

e) For temporary speed restrictions that are planned to be in place for between three and twelve months.

G 4.1.4.9 Rationale: In some locations it is not possible to provide OSS protection for a speed restriction that will be effective in preventing overspeed risk for one category of train without the likelihood that it will cause unwarranted interventions for other types of train.

G 4.1.4.10 These circumstances arise because the different trigger delay timer settings for passenger and freight trains, which lead to different interpretations of the set speed of an OSS loop, are optimised for the speed profiles of trains braking to a stand. Therefore they may not correctly reflect the difference in the speed profiles of passenger and freight trains on the approach to a speed restriction, which may also be influenced by a lower approach speed for freight trains or different permissible speeds at the speed restriction for different types of train.

G 4.1.4.11 Rationale: At some locations on the approach to a curve, even though the reduction in permissible speed meets the criteria requiring provision of TPWS, the potential for a train derailing or overturning on the curve is very low.

G 4.1.4.12 Rationale: Speed restrictions are imposed as a mitigating measure where clearances between trains and infrastructure or between passing trains are limited, but the risk from actual contact is small.

G 4.1.4.13 Rationale: A speed restriction may be imposed to ensure the required minimum warning time for crossing users, but, while the risk to individual crossing users may be significant, the overall risk to the train from excessive speed is small.

G 4.1.4.14 Rationale: Derailment due to overspeed at speed restrictions was identified as an additional residual risk that TPWS was designed to protect, but it may not be practicable to provide TPWS at temporary speed restrictions.

G 4.1.4.15 Although the Railway Safety Regulations 1999 exempted temporary speed restrictions from the requirement for TPWS protection, these regulations define a temporary speed restriction as one that is in place for three months or less.

G 4.1.4.16 In practice, temporary speed restrictions are often in place for more than three months. Any speed restriction that comes within the TPWS fitment criteria and is in place for more than three months would therefore have required TPWS to be provided. An exemption was granted to the Railway Safety Regulations permitting TPWS not to be provided at a temporary speed restriction in place for up to twelve months if this does not create excessive risk.
Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two
3.1.4 Exemptions to provision of TPWS track equipment

3.1.4.3 The TPWS track sub-system is not required to be operational in the circumstances set out below:

a) When the track sub-system is to be disconnected, removed, replaced or repositioned in accordance with engineering protection or possession arrangements, as set out in GE/RT8000.

And

b) When the track sub-system is to be disconnected to facilitate other work, provided that permission to disconnect has been obtained in accordance with GE/RT8000.

G 4.1.4.17 Rationale: The Railway Safety Regulations did not allow for disconnection or temporary removal of TPWS track equipment during possessions or other work; an exemption was granted to allow this.

G 4.1.5 Positioning of TPWS track equipment – TSS

GE/RT8075 issue two
3.1.5 Positioning of TPWS track equipment – TSS

3.1.5.1 Except where this is not practicable, TSS transmitters shall be positioned at or near the longitudinal position of the signal, as shown in Figure 2.

Rationale: The TPWS TSS should stop a train as soon as possible after it passes a TPWS fitted signal without authority.

G 4.1.5.2 Rationale: The TSS should preferably be positioned so that the trigger transmitter loop is beyond the signal, as a trigger transmitter loop on the approach side of the signal could cause an unwarranted trip for a train which is still on the approach to a red signal and will correctly stop before passing the signal.

G 4.1.5.3 Where physical constraints require the TSS transmitter to be positioned on the approach to the signal (for example, at a gantry carrying signals for both directions), the centre of the TSS should be no further than 2 m on the approach to the signal. The layout should be assessed to confirm that the TSS is not likely to cause unwarranted trips of any train which is correctly stopping at the signal.

GE/RT8075 issue two
3.1.5 Positioning of TPWS track equipment – TSS

3.1.5.2 The distance from the centre of the TSS to the position on the track where the leading wheelset will cause the signal to be replaced to danger shall not be less than 3.5 m.
Guidance on AWS and TPWS Interface Requirements

G 4.1.5.4 Rationale: A train which has passed a signal displaying a proceed aspect should not receive a TPWS brake demand as a result of the signal returning to danger when the train has passed it.

G 4.1.5.5 Rationale: TPWS transmitters should therefore be positioned such that the signal will not be replaced to danger before the active TPWS receiver on the train passes over the track subsystem. This prevents the train receiving a TPWS brake demand as a result of the signal returning to danger, and the TSS consequently being re-energised, before the TPWS receiver passes over it.

G 4.1.5.6 Rationale: This distance is consistent with the requirement to locate the TPWS receiver not more than 2.3 m behind the leading wheelset of the train. An allowance of 1.2 m is included as a TPWS receiver could detect a TSS transmitter that becomes energised after it has passed over it but while it is still within this range.

G 4.1.6 Positioning of TPWS track equipment – OSS

G 4.1.6.1 Positioning of OSS transmitters is characterised by two factors: the spacing between the arming and trigger loops, which determines the set speed of the OSS, and the position of the trigger loop relative to the target stopping point.

G 4.1.6.2 Network Rail have developed rules for the provision and positioning of OSS loops which relate the loop position and spacing to approach speed, gradient, and safe overrun distance.

GE/RT8075 issue two

3.1.6 Positioning of TPWS track equipment – OSS

3.1.6.1 OSS transmitters shall be positioned to optimise their safety benefits, taking account of:

a) The braking performance of trains, as set out in GM/RT2045.

b) The attainable speeds of trains on the approach to the signal or other location.

c) The distance from the stop signal to the point of conflict at the crossing or convergence ahead.

d) The gradient of the line on the approach to the signal or other location.

e) The interleaving of other location OSS functions where signal OSS and TSS functions are, or will be, installed.

f) The potential for inhibition of the vehicle TPWS self-test on power-up.

g) The potential for unwarranted intervention during movements in the opposite direction on bi-directional or reversible lines.

G 4.1.6.3 Rationale: TPWS is not always able to provide fully effective protection for all trains approaching at speeds up to the maximum permissible speed of the line. Initial development of TPWS was based on an assumed braking rate of 12%g for passenger trains, but not all trains can achieve this.

G 4.1.6.4 To improve the effectiveness over a wider range of speeds, additional loops can be provided, but the provision of more than two OSS loops (‘standard’ and ‘TPWS+’) on the approach to any signal is rarely justifiable.
G 4.1.6.5 The policy developed by the TPWS Strategy Group and approved by the RSSB Board in 2011 is:

‘1. For new scheme designs, taking due account of future ERTMS fitment:
   a) Network Rail to continue to apply the design principle that calculates the number of loops necessary to protect 12%g trains, and then optimise the design on a site by site basis to maximise the protection provided by that number of loops, so that it provides better protection for lower braking rate trains that will continue to use the routes into the future.
   b) Network Rail to use the development of the TPWS effectiveness calculator within the Signal Overrun Risk Assessment Tool (SORAT) process and apply it on a signal by signal basis to new scheme designs to determine if it would be reasonably practicable to implement an extra OSS loop based on the improvement in the effectiveness (and hence the potential safety benefit) it delivers.

   Network Rail will demonstrate to the TOCs that they have applied these principles when undertaking the joint review of signalling scheme plans prior to their final approval.’

‘2. For existing signals, as part of Network Rail’s five year review programme for each junction signal (prioritised based on the RSSB risk ranked list) and taking due account of future ERTMS fitment:

   Use the development of the TPWS effectiveness calculator within the SORAT process and apply it to determine if it would be reasonably practicable to implement an extra OSS loop based on the improvement in the effectiveness (and hence the potential safety benefit) it delivers.’

G 4.1.6.6 Rationale: Item f) in GE/RT8075 section 3.1.6.1 is included because a vehicle fitted with older designs of TPWS equipment that is powered up while standing over a TPWS transmitter may be unable to complete the TPWS self-test due to the presence of the frequency transmitted by the loop. Positioning of transmitters should therefore as far as practicable avoid placing loops where trains may stand with their receiver over the loop, shut down and start up again (including locations where drivers may need to change cabs or where trains may be split).

GE/RT8075 issue two

3.1.6 Positioning of TPWS track equipment – OSS

3.1.6.2 The provision and positioning of the TPWS track sub-system shall be reviewed if a change to the infrastructure or the operational use of the railway is proposed which may affect the track layout, signal location, the attainable speed of trains, or the SPAD risk.

G 4.1.6.7 Rationale: Changes to any parameter can reduce the effectiveness of TPWS and may mean that previously determined positioning of track transmitters is no longer optimal.

G 4.1.6.8 This should also take account of changes to the characteristics of trains using the line, for example the replacement of trains which can achieve 12%g braking by trains with lower braking capability.

G 4.1.7 Control of TPWS track equipment

GE/RT8075 issue two

3.1.7 Control of TPWS track equipment

3.1.7.1 The track transmitters associated with signals shall be energised when the signal is controlled to danger.
G 4.1.7.1 Rationale: When a signal is at danger, all the associated TPWS loops (TSS and one or more OSS, if provided) are energised, so that the TPWS receiver on a train passing over them detects the transmitted signals and initiates an intervention if the train passes any of the OSS loops at excessive speed or passes the signal at danger and passes over the TSS.

G 4.1.7.2 When the signal is displaying any proceed aspect (main or subsidiary), the TPWS loops should be de-energised and therefore a passing train should not receive any intervention from the TPWS.

G 4.1.7.3 In some earlier installations, it was the practice to de-energise the TSS when a subsidiary aspect was cleared but keep the OSS energised. This was based on the assumption that a train approaching a cleared subsidiary aspect should not exceed the set speed at the OSS loops. However, in some cases it was found that trains proceeding towards the cleared subsidiary aspect were tripped at the OSS loops, although their speed was not considered excessive. Therefore the practice is now to de-energise all loops, including the OSS, when a subsidiary aspect is displayed. In many cases the approach release applied to a subsidiary aspect will not allow the aspect to clear anyway until after the train has passed over the OSS.

G 4.1.7.4 The infrastructure manager should have arrangements in place to identify the failure of the TPWS track sub-system to transmit a magnetic field when it is required, so that an alternative safe system of working of trains can be implemented without undue delay.

G 4.1.7.5 For TPWS fitted to signals, failures will normally be indicated to the signaller, and the means of notification of failure should generally be immediate and automatic. Where this is not practicable, for example at stop boards on RETB lines, the notification may be by means of a TPWS failure indication to the driver.

GE/RT8075 issue two

3.1.7 Control of TPWS track equipment

3.1.7.2 The track transmitters provided at other locations shall always be energised when a train is passing over the transmitter on the line concerned.

G 4.1.7.6 Rationale: Intervention will always be required if a train exceeds the set speed at the OSS loops on the approach to an ‘other location’ (a speed restriction or buffer stops).

G 4.1.7.7 The loops at other locations may be permanently energised, or, to economise on power supplies, may be energised only when a train is passing over them.

G 4.1.7.8 In the case of TPWS transmitters at other locations, the infrastructure manager should determine the most appropriate method of failure notification.

G 4.2 TPWS train sub-system

G 4.2.1 Provision of trainborne TPWS equipment

GE/RT8075 issue two

3.2.1 Provision of trainborne TPWS equipment

3.2.1.1 The TPWS train sub-system shall be provided on all trains that operate over lines fitted with the TPWS track sub-system, except for:

G 4.2.1.1 Rationale: TPWS (with AWS) is the default SPAD risk and overspeed risk mitigation measure which is installed on most rolling stock operating on the national network and is used whenever an alternative system is not used.

a) Vehicles that operate solely in T3 possessions.

G 4.2.1.2 Rationale: Vehicles operating within a possession are protected by alternative operating rules which do not depend on the observance of fixed signals.

b) Shunting locomotives that are not fitted with AWS and that operate over a route which has been risk assessed to demonstrate that there is little or no risk from collision with trains on running lines.
G 4.2.1.3 Rationale: For shunting locomotives which only infrequently approach a signal where TPWS would provide effective protection, fitting TPWS would provide limited benefit which would be insufficient to justify the costs of fitment.

G 4.2.1.4 Shunting locomotives which spend most of their operating time within sidings may rarely encounter a signal fitted with AWS or TPWS. In many cases the only signal such a locomotive would regularly approach will be the signal protecting the exit from the sidings or depot, and the connection to the main line would generally be protected by trap points. These locomotives have generally been exempt from the fitting of AWS, and fitting of TPWS is not justified.

c) Vehicles fitted with alternative train protection system(s) providing a level of protection equivalent to or better than that provided by AWS and TPWS that operate only over tracks fitted with the appropriate system(s).

G 4.2.1.5 Rationale: TPWS need not be fitted on vehicles which always operate with an alternative train protection system which provides an equivalent or higher level of protection.

G 4.2.1.6 This will only apply if the vehicles are fitted with the alternative system and they operate only on lines on which this alternative system is fitted and operational.

GE/RT8075 issue two

3.2.1 Provision of trainborne TPWS equipment

3.2.1.2 The TPWS train sub-system is not required to be operational in the circumstances set out below:

a) The TPWS train sub-system may be temporarily isolated:

i) When vehicles fitted with TPWS are working in a T3 possession

G 4.2.1.7 Rationale: Vehicles operating within a possession are protected by alternative operating rules which do not depend on the observance of fixed signals; in some cases they may be required to disregard the aspects displayed by signals.

ii) When temporary block working is implemented and a train is required to pass signals at danger, with authority, in accordance with GE/RT8000.

G 4.2.1.8 Rationale: Temporary block working is introduced as a form of degraded working when parts of the signalling system have failed or are unavailable. Trains are authorised to disregard the aspects displayed by a number of signals and to pass them if they are at danger. In such circumstances it would be inappropriate for the train to be tripped by TPWS on passing these signals, and TPWS is therefore temporarily isolated. Alternative protection is provided by the special operating rules which are applied.

iii) On driving units with an active cab that is not at the front of the train, in accordance with GE/RT8000.

G 4.2.1.9 Rationale: When a train has to be driven from a cab which is not at the front of the train, TPWS should be isolated to avoid unwanted interventions. Otherwise the train would be tripped by TPWS at signals which would be replaced to danger when the first vehicle passes the signal, thus energising the TPWS TSS loops before the active TPWS receiver passes over them.

b) It is permissible to suppress the operation of the TPWS train sub-system when an alternative train protection system is fitted and operational on both the train and the track over which the train is to operate.

G 4.2.1.10 Rationale: When a train is operating with an alternative train protection system, the TPWS trainborne equipment should be suppressed if it could otherwise produce unwanted TPWS interventions when the train is operating in accordance with its movement authority under the constraints provided by the alternative system.
Guidance on AWS and TPWS Interface Requirements

G 4.2.1.11 It is not necessary to suppress TPWS if either:

a) No TPWS track equipment is provided on the section of track where the alternative system is used.

Or

b) TPWS interventions will only occur when the train is operating outside the parameters of its movement authority, and any duplication of warnings or interventions that could arise between TPWS and the other system will not create conflicting or confusing indications to the driver.

GE/RT8075 issue two
3.2.1 Provision of trainborne TPWS equipment
3.2.1.3 The TPWS receiver shall be positioned:

a) Behind the leading wheelset of the vehicle.

And

b) Within 2.3 m of the leading wheelset of the vehicle.

G 4.2.1.12 Rationale: The receiver is required to be behind the leading wheelset to limit interference from track circuit currents in the rails.

G 4.2.1.13 Specific problems were identified due to harmonics of TI21 track circuit frequencies, which produced signals in the same frequency band as TPWS transmitted frequencies. These spurious signals could be detected by the TPWS receiver and interpreted as an active TPWS loop. In some circumstances this interference could cause a TPWS brake demand. Placing the receiver behind the leading wheelset means that the current in the rails seen by the receiver is sufficiently reduced by the shunting effect of the wheelset to avoid a problem.

G 4.2.1.14 Rationale: The receiver is required to be no further than 2.3 m behind the leading wheelset so that the signal will not be replaced to danger and the TPWS TSS loops re-energised before the receiver passes over them.

G 4.2.1.15 This dimension is related to the requirement set out in 3.1.5.2 that the signal replacement point is to be at least 3.5 m beyond the mid-point of the TSS loops; this should ensure that the signal will not be replaced before the receiver has passed clear of the loops.

G 4.2.2 Receiver sensitivity requirements for TPWS train sub-system

GE/RT8075 issue two
3.2.2 Receiver sensitivity requirements for TPWS train sub-system
3.2.2.1 The train sub-system shall be capable of detecting the magnetic fields emitted by the track sub-system, as set out in 3.1.2, when the active part of the receiver passes through the 90 nT region of the magnetic field shown in Appendix E.

G 4.2.2.1 Rationale: The train is required to detect the magnetic fields transmitted by any energised TPWS track loops it passes over so that it can identify situations when an intervention is required.

G 4.2.2.2 Appendix E defines the areas where the track sub-system is required to produce a field of 90 nT.

GE/RT8075 issue two
3.2.2 Receiver sensitivity requirements for TPWS train sub-system
3.2.2.2 The train sub-system shall respond to field strengths of 60 nT or more.
G 4.2.2.3 Rationale: The requirement for the receiver to respond to a field strength of 60 nT should allow sufficient tolerance that it will still detect the field transmitted by the track sub-system if the transmitters are transmitting a field below the specified level of 90 nT, or if the receiver is not correctly aligned with the centre of the track transmitter, or the flux density at the TPWS receiver is reduced by metalwork surrounding the receiver.

GE/RT8075 issue two
3.2.2 Receiver sensitivity requirements for TPWS train sub-system
3.2.2.3 Once a magnetic field of 60 nT or more has been detected, detection shall be retained as long as the field strength remains above 30 nT, and shall be lost if the field strength falls below 10 nT.

G 4.2.2.4 Rationale: On passing a TSS, the receiver is required to detect the presence of the fields from both loops simultaneously. Clause 3.1.2.4 requires the transmitters at an OSS to produce a field strength greater than 45 nT throughout the area between the 90 nT zones, and thus, even in the absence of a hold-on feature (as set out below), the receiver should detect the fields from both loops.

GE/RT8075 issue two
3.2.2 Receiver sensitivity requirements for TPWS train sub-system
3.2.2.4 To avoid spurious tripping during bi-directional operation, the train sub-system shall not hold detection of an arming frequency for a period greater than 150 milliseconds.

G 4.2.2.5 Rationale: Some types of TPWS receiver incorporate a hold-on feature that remembers the detection of an arming frequency for a period after the field has been lost. This was introduced to compensate for insufficient overlap of the two frequencies, which might lead to failure to recognise an active TSS. Where this feature is provided, it should be limited in duration to prevent the possibility of an arming frequency for the opposite direction being detected and held for long enough for the train to reach the trigger frequency loop for an unrelated OSS transmitter, thus causing a false intervention.

G 4.2.3 Operation of trainborne TPWS equipment at OSS

GE/RT8075 issue two
3.2.3 Operation of trainborne TPWS equipment at OSS
3.2.3.1 On detecting the presence of an OSS arming frequency as defined in Table 19, the train sub-system shall start the trigger delay timer.

G 4.2.3.1 Rationale: The OSS arming loop is placed at the appropriate distance from the trigger loop so that a train travelling at excessive speed reaches the trigger loop before the trigger delay timer has expired and thus initiate an intervention.

GE/RT8075 issue two
3.2.3 Operation of trainborne TPWS equipment at OSS
3.2.3.2 The trigger delay timer shall be set to one of two timings, with an appropriate value for either:
   a) Trains with a braking performance characteristic of a passenger train.
   Or
   b) Trains with a braking performance characteristic of a freight train.

3.2.3.3 The trigger delay timer shall be set to the appropriate value set out in Table 21.
**Table 21** Trigger delay timer settings

<table>
<thead>
<tr>
<th>Set speed adjustment</th>
<th>Trigger delay timer settings (+/- 2 ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight train braking performance</td>
<td>1218 ms</td>
</tr>
<tr>
<td>Passenger train braking performance</td>
<td>974 ms</td>
</tr>
</tbody>
</table>

**G 4.2.3.2** Rationale: The trigger delay timer setting determines how the trainborne equipment responds to the OSS loops to determine whether or not the train is travelling at excessive speed.

**G 4.2.3.3** Rationale: Because of their lower braking rate, freight trains will generally approach a signal at danger at a lower speed than a passenger train, and need to be tripped at lower speeds if they are to be effectively stopped by TPWS before the point of conflict. The trigger delay timer setting for freight trains is 1.25 times the setting for passenger trains, which means that freight trains are tripped if they pass over OSS loops at a speed exceeding 80% of the set speed for passenger trains.

**G 4.2.3.4** Initial proposals for TPWS included a potential range of trigger delay timer settings for different categories of train with differing braking performances. The agreed specification for the system implemented just two timer settings, one for passenger trains and one for freight trains.

**G 4.2.3.5** Where a locomotive has a mechanism for selecting the braking performance appropriate to the operation of the train (for example, by the use of a passenger / freight selection switch), then the selection of the braking rate should automatically select the correct TPWS trigger delay timer setting. Where there is no mechanism for selecting braking performance, the trigger delay timer should be permanently set to the timing appropriate to the braking performance of the train.

**GE/RT8075 issue two**

**3.2.3 Operation of trainborne TPWS equipment at OSS**

**3.2.3.4** If the trigger delay timer reaches the trigger delay timer setting before detecting the appropriate trigger frequency, as set out in Table 19, the train sub-system shall reset and no brake application shall be made.

**G 4.2.3.6** Rationale: If the train takes longer than the trigger delay timer setting to travel between the two OSS loops, it is travelling at a speed below the set speed. This is identified as an acceptable speed and TPWS is not required to intervene.

**GE/RT8075 issue two**

**3.2.3 Operation of trainborne TPWS equipment at OSS**

**3.2.3.5** If the appropriate trigger frequency is detected before the trigger delay timer reaches the trigger delay timer setting, an emergency brake application, or where available an enhanced emergency brake application, shall immediately be initiated.

**G 4.2.3.7** Rationale: If the train travels between the two OSS loops in a time shorter than the trigger delay timer setting, it is travelling at a speed greater than the set speed determined by the loop spacing. This is considered to be an excessive speed and TPWS is required to intervene.

**GE/RT8075 issue two**

**3.2.3 Operation of trainborne TPWS equipment at OSS**

**3.2.3.6** The train sub-system shall respond to valid OSS frequency sequences even when OSS transmitters are interleaved, as set out in 3.1.2.6. The train sub-system shall not make an OSS brake application in any other circumstance.
G 4.2.3.8 Rationale: The two transmitters comprising an OSS frequency sequence in one of the frequency sets may be interleaved with other transmitters from the other frequency set. The train sub-system should respond correctly to the OSS frequency sequences in such cases.

G 4.2.3.9 Rationale: No inputs other than a valid OSS frequency sequence should give rise to a brake application that is indicated to the driver as an OSS brake demand.

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<td>3.2.3 Operation of trainborne TPWS equipment at OSS</td>
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<td>3.2.3.7 The brake application and the visual indication shall be maintained until:</td>
</tr>
<tr>
<td>a) At least 59 seconds have elapsed since the initiation of the brake application.</td>
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<td>And</td>
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<td>b) The train sub-system has received an acknowledgement from the driver.</td>
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G 4.2.3.10 Rationale: Once TPWS has intervened and initiated a brake demand, the brakes should not be released until the train has come to a stand and the driver has carried out the appropriate procedures.

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</tr>
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G 4.2.3.11 Rationale: TPWS is required to operate correctly at the maximum speed at which it is used as the train protection system.

G 4.2.3.12 The maximum speed currently permitted with lineside signalling systems is 125 mph. A tolerance of 10% allows for correct TPWS operation if trains exceed the maximum permitted speed.

G 4.2.3.13 Standard OSS loops are not used for set speeds below 15 mph because, at the separation required for lower speeds, the fields from the two loops would interact and this was found to cause false interventions.

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G 4.2.3.14 Rationale: For set speeds below 15 mph, as required on the approach to buffer stops, smaller OSS loops are used to avoid problems arising from interference when standard size loops are closely spaced. The smaller loops should be detected correctly at speeds down to 10 mph.

G 4.2.4 Operation of trainborne TPWS equipment at TSS

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<td>3.2.4.1 The train sub-system shall detect the presence of a TSS arming frequency as defined in Table 19.</td>
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G 4.2.4.1 Rationale: The TSS arming loop primes the train sub-system such that it responds to the corresponding trigger frequency.
3.2.4 Operation of trainborne TPWS equipment at TSS

3.2.4.2 If, before detecting the loss of the arming frequency, the train sub-system detects the presence of the appropriate trigger frequency, an emergency brake application, or where available an enhanced emergency brake application, shall immediately be initiated.

Rationale: The parameters specified in 3.1.2.4 for the magnetic fields produced by TSS loops require that the frequencies from the two loops overlap. A TSS is only effective if the frequencies from the two loops are detected together. This avoids the need to enforce a maximum time limit between dropping the TSS arming loop and picking the TSS trigger loop, thus ensuring that the TSS operates down to zero speed, as required by GE/RT8075 section 3.2.4.5.

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

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.

Rationale: No inputs other than a valid TSS frequency sequence (with both frequencies detected together) should give rise to a brake application that is indicated to the driver as a TSS brake demand.

Rationale: Once TPWS has intervened and initiated a brake demand, the brakes should not be released until the train has come to a stand and the driver has carried out the appropriate procedures.

Rationale: TPWS is required to operate correctly at the maximum speed at which it is used as the train protection system.

The maximum speed currently permitted with lineside signalling systems is 125 mph. A tolerance of 10% allows for correct TPWS operation if trains exceed the maximum permitted speed.

Rationale: A train passing a signal at danger at any speed, however low, should be tripped by the TSS.
### G 4.2.5 Trainborne TPWS equipment self-test

**GE/RT8075 issue two**

#### 3.2.5 Trainborne TPWS equipment self-test

| 3.2.5.1 | The TPWS shall perform a power-up test, as set out in 4.3.1, when the system is started, subject to awaiting initialisation of ETCS when the TPWS indications are presented by the ETCS DMI. |

**Rationale:** As TPWS is a critical safety system, its correct operation is tested before a train enters service.

**G 4.2.5.2** The power-up test should normally be started as soon as the TPWS is powered up, but where the TPWS indications are integrated into the ETCS DMI it may be necessary to delay the start of the test until the DMI indications are available.

### G 4.2.6 Trainborne TPWS equipment in-service monitoring

**GE/RT8075 issue two**

#### 3.2.6 Trainborne TPWS equipment in-service monitoring

| 3.2.6.1 | The TPWS shall undertake system monitoring while in service. System monitoring shall continue to be undertaken while the train is operating with TPWS suppressed, as set out in 3.2.1.2. |

**Rationale:** As TPWS is a critical safety system, and, unlike AWS, cannot be monitored by the driver observing its regular operation during a journey, the system is required to monitor its correct operation while in service.

**G 4.2.6.2** A TPWS fault that results in loss of the protection normally provided by TPWS shall be indicated as a fault, as set out in 4.3.2, but shall not apply the brakes solely due to the detection of the fault.

**Rationale:** Drivers are required to take a train out of service if TPWS is not operational. Only faults which require action to be taken by the driver should be indicated during a journey.

**G 4.2.6.3** The brakes should not be applied automatically when a fault is detected, as bringing the train immediately to a stand in an uncontrolled manner may introduce more risk than allowing the driver to stop the train in a controlled manner.

| 3.2.6.4 | The in-service monitoring and fault display functions shall not disable or compromise the train stop or overspeed functionality of the TPWS, or the functionality of the AWS. Detection of a fault shall not suppress an existing brake demand. |

**Rationale:** Even when a fault has been detected, TPWS may still be able to intervene when required, and AWS may still be operational. The ability of the system to provide protection should still be available, if possible.

#### 3.2.6.4 Faults to be detected while the train is in service shall include:

- **a)** Electrical continuity failure between the aerial and the control unit.
- **b)** Degradation in signal transfer between the aerial and the control unit.
- **c)** A control unit fault that could result in loss of TPWS protection.
G 4.2.6.5 Rationale: Where possible, faults that mean that the train is no longer being protected by TPWS should be indicated to the driver, as these may require the train to be taken out of service.

GE/RT8075 issue two
3.2.6 Trainborne TPWS equipment in-service monitoring
3.2.6.5 A TPWS fault shall not be indicated solely as a result of powering up the system while the train is standing over an active TPWS loop.

G 4.2.6.6 Rationale: Powering up over a TPWS loop can interfere with the system self-test, as the frequency transmitted by the loop may interfere with a test frequency. The self-test routine should be able to accommodate this situation without indicating a TPWS fault; otherwise, TPWS would need to be isolated to enable the brakes to be released so that the train could be moved clear of the loop and re-tested.
Part 5 Guidance on Driver / Machine Interface (DMI) for AWS and TPWS

G 5.1 Layout of Driver / Machine Interface (DMI)

G 5.1.1 AWS visual indications

GE/RT8075 issue two
4.1.1 AWS visual indications

**4.1.1.1** An AWS visual indicator shall be provided in each driving cab, either as a separate indicator unit or incorporated into an integrated DMI (see Appendix G).

G 5.1.1.1 Rationale: The AWS indication provides an important reminder to the driver and should be clearly and prominently displayed.

G 5.1.1.2 Where an integrated DMI is used (see Appendix H), the AWS indication can be incorporated into the integrated display.

GE/RT8075 issue two
4.1.1 AWS visual indications

**4.1.1.2** The AWS visual indicator shall be capable of providing two indications, ‘all black’ and ‘black and yellow’ (described in the Rule Book as the ‘normal’ and ‘warning’ indications respectively), in the form shown in Appendix A.

G 5.1.1.3 Rationale: The ‘black and yellow’ indication is intended to be a prominent reminder to the driver that he / she has acknowledged an AWS warning and is responsible for controlling the train in accordance with the signal aspect or sign which the AWS warning drew attention to (except where the AWS warning was not applicable as indicated by a lineside cancelling indicator).

G 5.1.1.4 The ‘normal’ black indication is the default display which is shown when the black and yellow indication is not required. The black indication is shown when the last AWS indication received was a clear signal. The black indication is also shown when a warning has been received but has not yet been acknowledged by the driver.

GE/RT8075 issue two
4.1.1 AWS visual indications

**4.1.1.3** The AWS indications shall meet all the following requirements:

a) The indicator shall be circular, and shall have between eight and 10 narrow segments, with colours and size as depicted in Appendix A.

b) The indicator shall be in the field of vision of the driver when looking at the track ahead from the driving position(s) to which it applies.

c) The indications provided by the indicator shall be clearly visible from the driving position(s) to which the indicator applies, in all conditions of cab illumination.

d) Where duplicate indicators are provided in the same driving cab, they shall be synchronised in their operation.

G 5.1.1.5 Rationale: The size and form of the indicator are specified to provide a clear and distinctive indication to the driver.

G 5.1.1.6 Rationale: The indicator should be large enough to provide a prominent reminder to the driver that he / she has acknowledged an AWS warning.

G 5.1.2 AWS controls

GE/RT8075 issue two
4.1.2 AWS controls

**4.1.2.1** An AWS caution acknowledgement device shall be provided in each driving cab.
G 5.1.2.1 Rationale: The AWS caution acknowledgement device provides the means by which the driver is required to positively acknowledge an AWS warning.

G 5.1.2.2 If the driver fails to acknowledge the AWS warning within the specified time (see 2.2.4.7), the brakes are applied automatically.

GE/RT8075 issue two
4.1.2 AWS controls
4.1.2.2 The AWS caution acknowledgement device shall be in the form of a physical button, located where the driver can easily operate it when seated at the active driving position, but so that it is not operable from any other driving position.

G 5.1.2.3 Rationale: The driver is required to operate the caution acknowledgement device quickly and (where signals are closely spaced) frequently, and it should therefore be convenient and ergonomically suitable for regular and easy operation.

G 5.1.2.4 The AWS caution acknowledgement device should have a reliability that is appropriate for the duty.

G 5.1.2.5 It is not considered suitable to provide the acknowledgement control as part of an integrated VDU-based DMI, as this is not suitable for the quick and easy response required.

GE/RT8075 issue two
4.1.2 AWS controls
4.1.2.3 It shall not be possible for a driver to give a caution acknowledgement to the trainborne AWS equipment by either:
   a) Permanently operating the caution acknowledgement device.
   Or
   b) Operating the caution acknowledgement device before the restrictive response state is entered.

G 5.1.2.6 Rationale: To ensure that the driver positively responds to a specific AWS warning at a time when the associated signal or sign is visible, the acknowledgement is only effective if the device is pressed and released after the audible warning has sounded.

G 5.1.3 TPWS indications and controls

GE/RT8075 issue two
4.1.3 TPWS indications and controls
4.1.3.1 The TPWS Driver Machine Interface (DMI) shall be designed in accordance with the requirements set out in Appendix F when the TPWS DMI is provided as a separate group of physical control devices and indications which is not integrated into an ETCS DMI, and in Appendix G when TPWS indications and controls are integrated into the ETCS DMI.

G 5.1.3.1 Rationale: The TPWS controls and indications should be presented to the driver in a logical and clear arrangement. Appendix F defines a standard DMI layout which was developed following analysis and trials to provide a common design for this safety-critical interface. Appendix G outlines the principles which should be followed when these controls and indications are implemented in the form of an integrated VDU-based ETCS DMI.

GE/RT8075 issue two
4.1.3 TPWS indications and controls
4.1.3.2 A visual indication that the train sub-system has initiated a TPWS brake application shall be presented to the driver.

G 5.1.3.2 Rationale: The driver is made aware that a TPWS intervention (resulting from a SPAD or an overspeed) has caused the brakes to be applied.
Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two
4.1.3 TPWS indications and controls
4.1.3.3 The visual indication shall distinguish between brake demands caused by TPWS TSS, TPWS OSS, and failure to acknowledge an AWS warning.

G 5.1.3.3 Rationale: The driver is made aware of the cause of the brake demand so that he / she can take appropriate action in response.

G 5.1.3.4 Rationale: Initial designs of TPWS had a single visual indication for a brake demand, which did not distinguish between the various causes. This indicator was also illuminated for a brake application due to a failure to acknowledge an AWS warning, which had previously not had a visual indication (the AWS visual indicator only shows a black and yellow display after acknowledgement of the warning). Following a number of 'reset and continue' incidents, when the train received a TSS brake application but the driver did not recognise that a SPAD had occurred, and reset the brake demand without carrying out the required procedures, it was decided that the brake demand indication should identify the specific cause of the intervention.

GE/RT8075 issue two
4.1.3 TPWS indications and controls
4.1.3.4 The visual indication shall be a primary instrument, the design and positioning of which shall be in accordance with the requirements set out in GM/RT2161.

G 5.1.3.5 Rationale: The indication is a primary safety control which should be clearly visible from the driving position.

GE/RT8075 issue two
4.1.3 TPWS indications and controls
4.1.3.5 The train sub-system shall not permit the driver to use the train stop override or TPWS temporary isolation facilities to cancel a TPWS brake application.

G 5.1.3.6 Rationale: A brake demand should be acknowledged and subsequently released using the appropriate controls so that the driver has to positively respond to the specific brake demand indicator which is illuminated. Other controls (other than full system isolation) should not allow release of the brakes without positive correlation with the cause of the brake demand.

GE/RT8075 issue two
4.1.3 TPWS indications and controls
4.1.3.6 A facility to override the train stop function shall be provided to allow the driver to pass a signal at danger without TPWS initiating a brake application. The override facility shall be positioned in the primary control area of the active driving cab.

G 5.1.3.7 Rationale: This facility is provided for use when the driver is authorised to pass a signal at danger, so that he / she can do so under controlled conditions without being tripped by TPWS.

GE/RT8075 issue two
4.1.3 TPWS indications and controls
4.1.3.7 When the train stop override facility has been operated, it shall remain active until either:
   a) One active TSS has been passed.
   Or
   b) Up to 60 seconds have elapsed.
Guidance on AWS and TPWS Interface Requirements

G 5.1.3.8  Rationale: The use of the train stop override is limited in time, and is cancelled immediately the train has passed the TSS, to prevent it being ‘stored’ for future use. The override facility is therefore effective only if it is operated immediately before passing the signal at danger, so that the use of this facility is clearly associated with the signal concerned.

G 5.1.3.9  The time limit for the train stop override facility is generally set to 20 seconds for passenger trains; this is sufficient for a passenger train starting from rest to pass the signal and the associated TSS.

G 5.1.3.10 Due to the longer time that may be necessary to start a freight train from rest, the time limit for the train stop override facility on freight locomotives is generally set to the maximum permitted time of 60 seconds.

G 5.1.3.11 Rationale: The application of the train stop override cannot be extended by continuing to operate the control device, so that the driver is required to operate it immediately before passing the signal.

G 5.1.4  Isolation of AWS and TPWS

G 5.1.4.1 Rationale: Full isolation is required in the case of a failure of the system which may apply the brakes and prevent the train from being moved.

G 5.1.4.2 Rationale: When AWS needs to be isolated because of a fault which affects only the AWS element of the equipment, it should be possible to keep TPWS operational and retain the protection given by TPWS.

G 5.1.4.3 Rationale: Temporary isolation may be used to pass a number of signals at danger without needing to stop and use the train stop override at each signal. It may be used in such conditions as temporary block working when the driver has been authorised to pass a number of intermediate signals at danger.

GE/RT8075 issue two
4.1.3  TPWS indications and controls
4.1.3.8 Continuous operation of the train stop override facility shall not extend the active time of the override facility.
Guidance on AWS and TPWS Interface Requirements

G 5.1.4.4 Rationale: Temporary isolation is not intended to be used during normal operation, and requires the driver to leave his / her seat and undertake a deliberate action to isolate the system.

GE/RT8075 issue two
4.1.4 Isolation of AWS and TPWS
4.1.4.5 The driver shall be provided with a prominent visual indication that a temporary isolation has been effected. The visual indication shall be visible to the driver from the normal driving position.

G 5.1.4.5 Rationale: A conspicuous indication is required to remind the driver that TPWS has been isolated, and that TPWS should be restored to use when the train reaches the end of the section where the temporary isolation was authorised.

G 5.2 Operation of Driver / Machine Interface (DMI)

G 5.2.1 Brake demand visual indications

GE/RT8075 issue two
4.2.1 Brake demand visual indications
4.2.1.1 When a cab is made operational, any override or temporary isolations previously applied to the train sub-system shall be removed automatically and any TPWS train sub-system faults shall be indicated to the driver.

G 5.2.1.1 Rationale: When a driving cab is opened up for driving, TPWS initialises in an operational condition, in order to provide the required protection for the train, unless it is specifically isolated by the driver following initialisation. If a train stop override or temporary isolation was previously applied, this should not be retained, as this would place the system in a non-operational state without this being requested by the driver.

GE/RT8075 issue two
4.2.1 Brake demand visual indications
4.2.1.2 Following the successful completion of the power-up test (see 4.3.1), all brake demand indicators shall be extinguished until AWS or TPWS initiates a brake demand.

G 5.2.1.2 Rationale: The brake demand indicators are illuminated as part of the power-up test, but otherwise are illuminated only when required to indicate that a brake demand has occurred, and should not be illuminated for any other purpose than to display this important message.

GE/RT8075 issue two
4.2.1 Brake demand visual indications
4.2.1.3 The visual indicator for a SPAD brake demand shall flash when the TPWS aerial at the front of the train passes over an active TSS and a brake demand is initiated.

G 5.2.1.3 Rationale: The brake demand indicator should flash as soon as a brake demand occurs to draw attention to the incident and to advise the driver that the brake demand has been caused by a SPAD.

GE/RT8075 issue two
4.2.1 Brake demand visual indications
4.2.1.4 The visual indicator for an overspeed brake demand shall flash when the TPWS aerial at the front of the train passes over an active OSS and a brake demand is initiated.

G 5.2.1.4 Rationale: The brake demand indicator should flash as soon as a brake demand occurs, to draw attention to the incident and to advise the driver that the brake demand has been caused by an overspeed.
GE/RT8075 issue two
4.2.1 Brake demand visual indications

4.2.1.5 The visual indicator for an AWS brake demand shall flash when a brake demand is initiated following an AWS caution warning that has not been acknowledged within the caution acknowledgement period.

G 5.2.1.5 Rationale: The brake demand indicator should flash as soon as a brake demand occurs, to draw attention to the incident and to advise the driver that the brake demand has been caused by failure to acknowledge an AWS warning.

GE/RT8075 issue two
4.2.1 Brake demand visual indications

4.2.1.6 The flashing brake demand visual indication shall change to steady when the driver has acknowledged the appropriate alert.

G 5.2.1.6 Rationale: On acknowledgement, the brake demand indication becomes steady as it is no longer necessary to attract the driver’s attention to it, but it should remain illuminated to remind the driver of the nature of the incident.

GE/RT8075 issue two
4.2.1 Brake demand visual indications

4.2.1.7 The brake demand indicators shall display the indications as shown in the state transition diagram in Appendix B. Transitions between indication states shall occur in accordance with the conditions shown in Appendix B.

G 5.2.1.7 Rationale: Appendix B shows the various states and transitions that need to be indicated in a consistent manner.

GE/RT8075 issue two
4.2.1 Brake demand visual indications

4.2.1.8 When the TPWS train sub-system is suppressed, the TPWS DMI indicators (other than the fault indicator) shall be extinguished.

G 5.2.1.8 Rationale: When TPWS is not in use and the train is being controlled by an alternative system, no TPWS indications (other than a fault) should be shown as they are not relevant and could be confusing to the driver.

GE/RT8075 issue two
4.2.1 Brake demand visual indications

4.2.1.9 When the TPWS train sub-system is suppressed, the system shall continue to undertake in-service monitoring, as set out in 4.3.2, and any TPWS train sub-system faults shall be indicated to the driver.

G 5.2.1.9 Rationale: A fault indication should still be shown if a fault is detected when TPWS is suppressed, as it is useful for the driver to know in advance that there may be a problem with TPWS before the train reaches the point where TPWS is required to be in use.

G 5.2.2 AWS audible indications

GE/RT8075 issue two
4.2.2 AWS audible indications

4.2.2.1 Each driving cab shall be fitted with an AWS audible indicator that is capable of providing a ‘warning’ indication and a ‘clear’ indication. These two indications shall:

a) Be distinguishable from all other audible indications in the cab.
b) Have a sound level at least 10 dB above the expected ambient noise level, subject to a minimum of 65 dBA and a maximum of 95 dBA, at a distance of 1 m from the front of the equipment, measured as installed in the driving cab.

c) Be audible from all applicable driving positions and in all driving conditions.

G 5.2.2.1 Rationale: The AWS audible indication is the primary indication given by this system and should be clearly audible and distinctive so that the driver is alerted to a cautionary aspect.

G 5.2.2.2 Rationale: Previous standards specified a sound level of 90-95 dBA, but this was found to be too loud in quieter cabs and the requirement was amended to specify a differential above the ambient noise level.

GE/RT8075 issue two

4.2.2 AWS audible indications

4.2.2.2 The ‘warning’ indication shall be a steady alarm / horn with a frequency of 800 Hz (with a tolerance of +/- 20 Hz). The duration of the ‘warning’ indication is determined by the driver’s response to the indication, as set out in Table 13.

G 5.2.2.3 Rationale: The audible indications should be distinctive and readily recognisable. The warning indication was originally given by an air-operated horn; alternative sound generators are required to produce a sound that is broadly comparable.

GE/RT8075 issue two

4.2.2 AWS audible indications

4.2.2.3 The ‘clear’ indication shall be a bell or simulated chime tone with a frequency of 1200 Hz (with a tolerance of +/- 30 Hz) and a duration of 0.5 to 1.5 seconds.

G 5.2.2.4 Rationale: The audible indications should be distinctive and readily recognisable. The clear indication was originally given by a bell; alternative sound generators are required to produce a sound that is broadly comparable.

G 5.2.3 TPWS audible indications

GE/RT8075 issue two

4.3 TPWS audible indications

4.3.1 There shall be separate and distinct audible alerts to inform the driver of brake demands due to:

a) Operation of the TSS (SPAD audible alert).

And

b) Operation of the OSS (overspeed audible alert).

G 5.2.3.1 Rationale: Audible indications are provided to supplement the flashing brake demand indications and identify the cause of the brake application to the driver.

GE/RT8075 issue two

4.3 TPWS audible indications

4.3.2 The audible alerts for SPAD and overspeed events shall be speech messages, which shall be preceded by a short priming sound.

G 5.2.3.2 Rationale: Speech messages were chosen to provide a clear indication of the cause of the brake application.

G 5.2.3.3 Rationale: A priming tone alerts the driver to listen to the speech message.
The speech messages should be audible relative to ambient noise, but should not be so loud as to cause alarm to the driver. The volume of the speech warnings should be within the range 65-90 dBA and should be at least 6 dB above the ambient or expected ambient noise level, at a distance of 1 m from the front of the equipment.

The speech message for a SPAD audible alert shall be:

‘SPAD alert, contact the signaller’.

Rationale: The wording ‘SPAD alert’ was chosen to identify this situation as it was felt that just ‘SPAD’ would be too abrupt. The message emphasises the requirement for the driver to contact the signaller.

The speech message for an overspeed audible alert shall be:

‘Overspeed, contact the signaller’.

Rationale: The word ‘Overspeed’ identifies the situation. The message emphasises the requirement for the driver to contact the signaller.

The TPWS audible alerts shall be implemented using the sound files included in Appendix H.

Rationale: Use of standard sound files (set out in Appendix H) provides a consistent presentation of the spoken messages which assists driver recognition.

Once activated, the speech message shall be repeated, without the priming tone, with an interval of three seconds between the end of one announcement and the beginning of the next announcement, until acknowledged (see 4.2.4).

Rationale: Repetition of the speech message continues to draw attention to the incident until the driver acknowledges the brake demand indication.

When the TPWS train sub-system initiates a TSS brake demand after it has initiated an OSS brake demand, the overspeed speech message shall be immediately terminated and replaced by the SPAD speech message.

Rationale: A SPAD is potentially more serious than an overspeed and the SPAD alert message is therefore presented to the driver without delay.

Except in the circumstances set out in 4.2.3.7, at least one complete cycle of the speech message shall be played.

Rationale: Even if the driver acknowledges the brake demand before a complete message has been played, it is preferable to give the complete message to the driver.
Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two
4.2.3 TPWS audible indications
4.2.3.9 It shall not be possible for two or more TPWS speech messages to sound simultaneously.

G 5.2.3.11 Rationale: Two messages presented at the same time would be unintelligible.

GE/RT8075 issue two
4.2.3 TPWS audible indications
4.2.3.10 It shall not be possible for any TPWS speech message and pre-announcement priming tone to sound simultaneously.

G 5.2.3.12 Rationale: A priming tone sounded at the same time as a speech message would impair the intelligibility of the message.

GE/RT8075 issue two
4.2.3 TPWS audible indications
4.2.3.11 TPWS audible alerts shall not affect the operation of AWS audible indications.

G 5.2.3.13 Rationale: AWS audible indications are related to the signal or sign which the train is approaching, and it is therefore important that they are sounded without delay when the AWS receiver detects the appropriate magnetic fields so that the signal or sign is in the driver’s view.

GE/RT8075 issue two
4.2.3 TPWS audible indications
4.2.3.12 If the alert has not been acknowledged 60 seconds after the brakes have been applied, the volume of the speech message shall be reduced by 6 dB.

G 5.2.3.14 Rationale: When the train has come to a stand, the driver is required to contact the signaller. If for some reason the driver has not acknowledged the alert, or is unable to, the speech message continues but should not be loud enough to interfere with communication between the driver and the signaller.

G 5.2.4 Acknowledgment of visual and audible alerts

GE/RT8075 issue two
4.2.4 Acknowledgment of visual and audible alerts
4.2.4.1 A SPAD alert shall be acknowledged by pressing and releasing the SPAD acknowledgement device on the TPWS DMI.

G 5.2.4.1 Rationale: The alert has to be acknowledged by the appropriate acknowledgement device to ensure that the driver knows what has caused the brake demand.

GE/RT8075 issue two
4.2.4 Acknowledgment of visual and audible alerts
4.2.4.2 An overspeed alert shall be acknowledged by pressing and releasing the overspeed acknowledgement device on the TPWS DMI.

G 5.2.4.2 Rationale: The alert has to be acknowledged by the appropriate acknowledgement device to ensure that the driver knows what has caused the brake demand.

GE/RT8075 issue two
4.2.4 Acknowledgment of visual and audible alerts
4.2.4.3 The visual alert shall change from flashing to steady immediately on detection of acknowledgement.
### Guidance on AWS and TPWS Interface Requirements

#### 5.2.4.3 Rationale
On acknowledgement, the brake demand indication becomes steady as it is no longer necessary to attract the driver’s attention to it, but it should remain illuminated to remind the driver of the nature of the incident.

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>4.2.4 Acknowledgment of visual and audible alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.4.3 The audible alert shall continue, if necessary, to complete the first cycle of the speech message, as set out in 4.2.3.8, and shall then be silenced.</td>
</tr>
</tbody>
</table>

#### 5.2.4.4 Rationale
On acknowledgement, the brake demand indication remains illuminated to remind the driver of the nature of the incident, and an audible alert is no longer necessary.

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>4.2.4 Acknowledgment of visual and audible alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.4.5 An AWS caution shall be acknowledged using the AWS caution acknowledgement device.</td>
</tr>
</tbody>
</table>

#### 5.2.4.5 Rationale
The separate AWS caution acknowledgement device is ergonomically designed for frequent and rapid use, and is more suitable for the immediate response required to an AWS warning than a control incorporated in a multi-function DMI.

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>4.2.4 Acknowledgment of visual and audible alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.4.6 Acknowledgement of the AWS caution shall silence the AWS caution audible indication (horn) and change the AWS visual indicator to black and yellow.</td>
</tr>
</tbody>
</table>

#### 5.2.4.6 Rationale
The horn sounds until it is acknowledged, as it is the only form of warning given by the AWS. The indicator changes to black and yellow as a prominent reminder to the driver that he / she has acknowledged the AWS warning.

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>4.2.4 Acknowledgment of visual and audible alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.4.7 Acknowledgement of the AWS caution shall, if an AWS brake demand has been initiated, change the AWS brake demand visual indication from flashing to steady.</td>
</tr>
</tbody>
</table>

#### 5.2.4.7 Rationale
If acknowledgement of the AWS caution has been delayed so that a brake demand has been made, the AWS caution acknowledgement serves as an acknowledgement both of the warning itself and the brake demand indicator.

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>4.2.4 Acknowledgment of visual and audible alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.4.8 It shall not be possible to acknowledge an AWS caution (whether or not a brake demand has been initiated) using the acknowledgement device associated with the AWS brake demand indicator on the TPWS DMI.</td>
</tr>
</tbody>
</table>

#### 5.2.4.8 Rationale
An AWS warning can be acknowledged only by operating the AWS caution acknowledgement device, so that the method of acknowledgement is the same either before or after a brake demand has been initiated.

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>4.2.4 Acknowledgment of visual and audible alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.4.9 Operation of the AWS caution acknowledgement device following a TSS or OSS brake application shall not acknowledge the SPAD or overspeed alert.</td>
</tr>
</tbody>
</table>
Guidance on AWS and TPWS Interface Requirements

G 5.2.4.9 Rationale: The AWS caution acknowledgement device can perform only its designated function. SPAD and overspeed alerts should be acknowledged by the appropriate action specific to each to ensure that the driver has correctly identified the cause of the brake demand.

G 5.2.5 Brake release

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.5    Brake release</td>
</tr>
<tr>
<td>4.2.5.1 Following a brake application due to a TSS, OSS or AWS brake demand, the brakes shall not be released until the train has received the correct brake release action from the driver.</td>
</tr>
</tbody>
</table>

G 5.2.5.1 Rationale: The release of the brakes should be only as a result of the appropriate action by the driver which confirms that he / she has correctly identified the cause of the brake demand.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.5    Brake release</td>
</tr>
<tr>
<td>4.2.5.2 Following a brake application due to a TSS, OSS or AWS brake demand, the brakes shall not be released if the driver powers the cab down and back up again.</td>
</tr>
</tbody>
</table>

G 5.2.5.2 Rationale: Powering down the cab should not be used as a short cut to release the brakes without waiting for the specified time interval and going through the appropriate procedures, which would allow the driver to reset without identifying the cause of the brake demand.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.5    Brake release</td>
</tr>
<tr>
<td>4.2.5.3 A brake release action shall only be effective if:</td>
</tr>
<tr>
<td>a) It is initiated at least 59 seconds after the initiation of the brake application.</td>
</tr>
<tr>
<td>b) All brake demand alerts have been acknowledged.</td>
</tr>
</tbody>
</table>

G 5.2.5.3 Rationale: The train should be brought to a stand following the intervention before the driver carries out the procedure to release the brakes.

G 5.2.5.4 The driver is required to have carried out two separate actions of acknowledging the alert and requesting a brake release before the brakes can be released.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.5    Brake release</td>
</tr>
<tr>
<td>4.2.5.4 Following a brake application due to a TSS brake demand, the release of the brakes shall require both the SPAD acknowledgement device and the brake release control to be operated.</td>
</tr>
</tbody>
</table>

G 5.2.5.5 Rationale: The brake release also requires operation of the appropriate acknowledgement device to remind the driver of the cause of the brake demand with the intention that this will confirm that the appropriate procedures have been carried out.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.5    Brake release</td>
</tr>
<tr>
<td>4.2.5.5 Following a brake application due to an OSS brake demand, the release of the brakes shall require both the overspeed acknowledgement device and the brake release control to be operated.</td>
</tr>
</tbody>
</table>
### Guidance on AWS and TPWS Interface Requirements

**G 5.2.5.6** Rationale: The brake release also requires operation of the appropriate acknowledgement device to remind the driver of the cause of the brake demand with the intention that this will confirm that the appropriate procedures have been carried out.

GE/RT8075 issue two

<table>
<thead>
<tr>
<th>4.2.5</th>
<th>Brake release</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.5.6</td>
<td>Following a brake application due to a failure to acknowledge an AWS caution warning within the caution acknowledgement period, the release of the brakes shall require both the AWS brake demand acknowledgement device and the brake release control to be operated.</td>
</tr>
</tbody>
</table>

**G 5.2.5.7** Rationale: The brake release also requires operation of the appropriate acknowledgement device to remind the driver of the cause of the brake demand with the intention that this will confirm that the appropriate procedures have been carried out.

**G 5.2.5.8** Where the design of the DMI allows simultaneous operation of two control devices, the two controls required to implement a brake release, as set out in 4.2.5.4, 4.2.5.5 or 4.2.5.6, should be operated simultaneously. However, the two controls may need to be operated sequentially if the DMI does not permit simultaneous operation of two controls. Further requirements are set out in Appendix F, F.1.7 and Appendix G, G.6.

GE/RT8075 issue two

<table>
<thead>
<tr>
<th>4.2.5</th>
<th>Brake release</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.5.7</td>
<td>When both an overspeed and an AWS brake demand have occurred, and the overspeed and AWS brake demand indicators are both illuminated, the brakes shall be released by operating the overspeed acknowledgement device together with the brake release control. Release of the brakes in this way shall clear all brake demand indications on the DMI panel.</td>
</tr>
</tbody>
</table>

**G 5.2.5.9** Rationale: A brake release using the overspeed acknowledgement device is allowed to release an AWS brake demand, as the overspeed brake demand is a more important incident which the driver is required to acknowledge when releasing the brakes. Separate acknowledgement of the AWS warning is still required, and this gives a 'black and yellow' indication on the AWS indicator to remind the driver that he / she has received an AWS warning.

**G 5.2.6** Temporary isolation, train stop override and fault indicator

GE/RT8075 issue two

<table>
<thead>
<tr>
<th>4.2.5</th>
<th>Brake release</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.5.8</td>
<td>When both an overspeed and an AWS brake demand have occurred, and the overspeed and AWS brake demand indicators are both illuminated, pressing and releasing the AWS brake demand acknowledgement device, together with the brake release control, shall extinguish the AWS brake demand indicator but shall not release the brakes. The OSS brake demand indicator shall remain lit.</td>
</tr>
</tbody>
</table>

**G 5.2.5.10** Rationale: A brake release using the AWS brake demand acknowledgement device is not allowed to release an overspeed brake demand, as the overspeed brake demand is a more important incident which the driver is required to acknowledge when releasing the brakes.

**G 5.2.6.1** Rationale: The driver is to be given a clear reminder that the train is being driven without the protection provided by TPWS.

**G 5.2.6.2** The temporary isolation indicator may be combined with the fault indicator.
4.2.6 Temporary isolation, train stop override and fault indicator

4.2.6.2 Following a power-up test, the fault indicator shall not be illuminated unless a TPWS or AWS fault has been detected.

G 5.2.6.3 Rationale: The indicator is extinguished except when it is required to indicate that a fault has been detected.

G 5.2.6.4 As temporary isolation is switched off by default at power-up, a combined temporary isolation / fault indicator is extinguished immediately after the power-up test unless a fault has been detected.

4.2.6.3 The fault indicator shall flash when a fault has been detected with the TPWS or AWS system, either during the power-up test or while the train is in service.

G 5.2.6.5 Rationale: The indicator flashes to draw the driver’s attention to a fault condition which may mean that TPWS or AWS is not providing effective protection to the train.

G 5.2.6.6 The fault indicator may be combined with the temporary isolation indicator.

4.2.6.4 The train stop override indicator shall indicate to the driver when the TPWS train stop override has been activated.

G 5.2.6.7 Rationale: The driver is to be given a clear indication that the train stop functionality has been temporarily overridden.

4.2.6.5 Following a power-up test, the train stop override indicator shall not be illuminated until the train stop override function is activated.

G 5.2.6.8 Rationale: The indicator displays the important message that the train stop override is effective and should not be illuminated for any other purpose.

4.2.6.6 The train stop override indicator shall illuminate to steady (‘on’) when the TPWS train stop override is active.

G 5.2.6.9 Rationale: The indicator is illuminated to confirm that the train stop override is effective and that the driver may therefore pass a signal at danger without being tripped.

G 5.3 Fault detection

G 5.3.1 Power-up test

4.3.1 The AWS and TPWS power-up test shall incorporate the following operations:

a) Within 0.5 seconds of the power-up test commencing, all the TPWS DMI indicators shall illuminate simultaneously and the AWS visual indicator shall display black and yellow if not already doing so, and then change to display ‘all black’.
G 5.3.1.1 Rationale: The power-up test operates all the visual indicators – the TPWS DMI indications and the AWS visual indicator – to confirm that they are operating correctly.

b) The AWS horn shall sound.

G 5.3.1.2 Rationale: The AWS warning horn is an important safety function and its operation is therefore tested by requiring it to sound as part of the power-up test.

c) Upon acknowledgement of the AWS horn by pressing and releasing the AWS caution acknowledgement device, the AWS visual indicator shall change to black and yellow, the AWS horn shall cease to sound and the AWS bell shall sound for 0.5 second + 0.5/-0 second.

G 5.3.1.3 Rationale: This confirms that the AWS horn is operative and that the AWS acknowledgement device is effective. It also confirms that the AWS bell sounds and that the visual indicator correctly changes to the ‘sunflower’ display.

GE/RT8075 issue two
4.3.1 Power-up test
4.3.1.2 If the AWS horn is not effectively acknowledged within 30 seconds by pressing and releasing the AWS caution acknowledgement device, the AWS horn shall cease to sound after 30 seconds. This shall be indicated as a system fault as set out in 4.3.1.8.

G 5.3.1.4 Rationale: If the AWS acknowledgement device is not operating correctly, this allows the test to continue without receiving an acknowledgement of the AWS warning, but silences the horn to reduce unnecessary disturbance to the driver while the test continues.

G 5.3.1.5 This situation is indicated as a fault. If the driver attempted to operate the AWS acknowledgement device and it was not effective, this should be indicated by the visual indicator not changing to black and yellow – the driver may also have noticed that there was a delay in silencing the horn.

GE/RT8075 issue two
4.3.1 Power-up test
4.3.1.3 During the power-up test, the TPWS system shall initiate a brake demand.

G 5.3.1.6 Rationale: This tests that the system can effectively initiate a brake application so that it will be able to stop the train when required.

GE/RT8075 issue two
4.3.1 Power-up test
4.3.1.4 A TPWS or AWS fault detected during the power-up test shall cause the system to maintain the brake demand.

G 5.3.1.7 Rationale: A fault detected in the system holds on the brakes so that the train cannot proceed in service with a faulty protection system.

G 5.3.1.8 If it is necessary to move the train with a failed system, the system should be isolated.

GE/RT8075 issue two
4.3.1 Power-up test
4.3.1.5 On successful completion of the power-up test, all the TPWS DMI indicators will be extinguished (except in the circumstances set out in 4.3.1.10) and an audible announcement shall be sounded in the cab.

G 5.3.1.9 Rationale: The extinguishing of all indicators and the audible announcement advise the driver that the power-up test has been completed and no faults were detected.
4.3.1 Power-up test

4.3.1.6 The audible announcement shall comprise the speech message: ‘TPWS and AWS operational’, which shall be implemented using the sound file included in Appendix H.

G 5.3.1.10 Rationale: The audible announcement also confirms the operation of the audible announcement system to give confidence that the system will be capable of sounding the ‘SPAD alert’ or ‘Overspeed’ messages, if necessary.

4.3.1.7 The ‘TPWS and AWS operational’ speech message shall not be preceded by a priming sound.

G 5.3.1.11 Rationale: No specific priming sound is necessary to attract the driver’s attention in this case, as the driver should already be aware that the power-up test is taking place.

4.3.1.8 Any TPWS or AWS fault detected by the system shall be indicated to the driver by flashing the fault indicator and all other indicators shall be extinguished.

G 5.3.1.12 Rationale: The fault indication overrides any other indications to attract the driver’s attention to the fault.

4.3.1.9 The system shall maintain the brake demand until:

a) Any fault detected by the system has been cleared.
   And

b) There has been a successful power-up test following powering down and powering up.

G 5.3.1.13 Rationale: Any fault present should be rectified before the system can be re-initiated.

G 5.3.1.14 Rationale: A power-up test should be successfully completed with no fault present before the system can enter service.

G 5.3.1.15 If there is no actual fault present – for example, if the system recorded a failure because the driver did not operate the AWS acknowledgement button at the appropriate point in the test – it will be necessary to re-start the test by powering the cab down and back up again.

G 5.3.1.16 If it is necessary to move the train with a failed system, the system should be isolated.
GE/RT8075 issue two
4.3.1 Power-up test

4.3.1.10 If the cab was previously powered down with a TSS, OSS or AWS brake demand displayed:
   a) The brakes shall remain applied following completion of the power-up test.
   b) Any brake demand indications on the TPWS DMI that were illuminated before the cab was powered down shall be illuminated steadily following completion of the power-up test.
   c) The audible alerts associated with the brake demand indications shall not be sounded again following completion of the power-up test.

G 5.3.1.17 Rationale: This ensures that a brake demand cannot be overridden by powering the cab down and powering it up again, so avoiding the requirement for the driver to acknowledge the specific cause of the brake demand in order to release the brakes.

G 5.3.1.18 Rationale: The illumination of the brake demand indication, in association with the maintained brake application, provides an adequate indication to the driver in these circumstances, and it is not necessary to provide a further audible alert.

G 5.3.2 In-service monitoring

GE/RT8075 issue two
4.3.2 In-service monitoring

4.3.2.1 Detection of a fault that results in loss of the protection normally provided by TPWS shall cause the fault indicator to flash.

G 5.3.2.1 Rationale: In-service monitoring draws the driver’s attention to a fault in the system, which means that the train is no longer adequately protected.

G 5.3.2.2 Rationale: The brakes should not be applied automatically when a fault is detected, as bringing the train immediately to a stand in an uncontrolled manner may introduce more risk than allowing the driver to continue with TPWS failed to a location where the train can be conveniently and safely stopped.

G 5.3.2.3 Rationale: Except in the circumstances set out below, the fault indicator is extinguished when the fault is no longer present.

G 5.3.2.4 The fault may be a temporary fault which subsequently rectifies itself, or may require repair to the system to rectify it.

G 5.3.2.5 Rationale: If the train, despite the indicated fault, is still able to recognise and act on a request from the track sub-system to initiate a train stop or overspeed brake demand, this is indicated to the driver in the normal way by a flashing brake demand indication, without the potential distraction of a fault indication also flashing.
GE/RT8075 issue two

4.3.2 In-service monitoring

4.3.2.4 Where the temporary isolation indicator is combined with the fault indicator on the DMI, the visual indication of a detected fault through the flashing of the fault indicator shall be suppressed when the system is isolated by operation of the temporary isolation switch. When the temporary isolation is removed, the fault indicator shall again flash.

G 5.3.2.6 Rationale: Where a combined indicator is used, temporary isolation of the system is required to override the (flashing) fault indication, as it uses the same indicator, illuminated steadily. Indicating a temporary isolation is more important than indicating a fault, as the isolation removes all protection provided by TPWS, while in the case of a fault some protection may still be provided.

G 5.4 Output requirements

G 5.4.1 Outputs for on-train data recording

GE/RT8075 issue two

4.4.1 Outputs for on-train data recording

4.4.1.1 In addition to the on-train data recording requirements set out in GM/RT2472, AWS and TPWS shall supply suitable and sufficient outputs to facilitate connection to the on-train data recorder, to enable the status of each of the TPWS DMI functions to be recorded.

G 5.4.1.1 Rationale: The specific cause of a brake demand (SPAD, Overspeed or AWS) is a safety-related function and should be recorded individually. Additionally, acknowledgement, cancellation and isolation inputs should be recorded in order to facilitate incident investigation.

G 5.4.1.2 A serial data link may be necessary to accommodate the number of outputs to the data recorder which are required – this may raise compatibility issues when replacing earlier versions of TPWS equipment which had parallel data outputs.

G 5.4.1.3 The following AWS and TPWS related functions should be recorded:

a) Train brake demand by AWS or TPWS.

b) Operation of AWS and the driver’s response.

c) Isolation of AWS.

d) Operation of TPWS and the driver’s response.

e) Isolation and override of TPWS.

G 5.4.1.4 The precise application is vehicle specific but specific activities to be recorded are likely to include the following:

a) Operation of the AWS visual indicator.

b) Operation by the driver of the AWS reset pushbutton.

c) Sounding of the audible AWS caution indication (horn or electronic tone).

d) Sounding of the audible AWS clear indication (bell or electronic chime).

e) Brake demand requested by AWS or TPWS.

f) Isolation of the AWS/TPWS control unit.

g) Operation by the driver of the TPWS acknowledge pushbutton(s).

h) Normal direction TPWS transmitter loop detected.
Guidance on AWS and TPWS Interface Requirements

i) Opposite direction TPWS transmitter loop detected.

j) Train stop override (TSO) pushbutton operated.

k) Fault and / or temporary isolation of the TPWS control unit.

l) Full isolation of the TPWS control unit.

### G 5.4.2 Output to vigilance system

#### GE/RT8075 issue two

| 4.4.2.1 | An output shall be provided from the AWS acknowledgement device to reset the driver vigilance system when an AWS warning has been acknowledged. |

### G 5.4.2.1 Rationale: This enables an AWS acknowledgement to be recognised as a relevant driver activity that resets the vigilance system and reduces the need for the driver to make a separate action to reset the vigilance system.
Guidance on AWS and TPWS Interface Requirements

Part 6  Guidance on System Availability and Integrity

G 6.1  AWS and TPWS equipment

GE/RT8075 issue two

5.1  AWS and TPWS equipment

5.1.1  AWS and TPWS equipment shall be designed, operated and maintained to have a level of availability that is as high as reasonably practicable, and shall, as a minimum, meet the following:

a)  The train sub-system shall have an availability, measured on a ‘per fleet, per year’ basis, of not less than 99.9%.

b)  The AWS track sub-system shall have an availability, measured on an ‘AWS population, per year’ basis, of not less than 99.9%.

c)  The TPWS track sub-system shall have an availability, measured on a ‘TPWS population, per year’ basis, of not less than 99.9%.

G 6.1.1  Rationale: To meet the shared responsibility for safe operation, both elements of the system – the train sub-system and the track sub-system – for both AWS and TPWS should meet specified availability levels so that, in assessing the safety requirements of their sub-system, each party can have appropriate reliance on the availability of the complementary contribution of the other sub-system.

G 6.1.2  Suitable and sufficient test equipment and procedures should be provided and used for the maintenance and testing of AWS and TPWS equipment to facilitate continuing compliance with the requirements of GE/RT8075.
### Part 7  Application of this document

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
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</thead>
<tbody>
<tr>
<td><strong>6.1 Application - infrastructure managers</strong></td>
</tr>
<tr>
<td><strong>6.1.1 Scope</strong></td>
</tr>
<tr>
<td>6.1.1.1 The requirements of 2.1, 2.3, 3.1 and Part 5 of this document apply to all new infrastructure equipment used for the provision of AWS and TPWS.</td>
</tr>
<tr>
<td>6.1.1.2 Compliance with the requirements of this document relating to inspection, maintenance and in-service condition of infrastructure is mandatory, whether or not the infrastructure concerned is the subject of a designation, as set out above.</td>
</tr>
<tr>
<td>6.1.1.3 Action to bring existing AWS and TPWS infrastructure equipment into compliance with the requirements of this document is not required.</td>
</tr>
<tr>
<td>6.1.1.4 When lineside signalling on a line that is not currently fitted with AWS is modified, AWS shall be provided unless either:</td>
</tr>
<tr>
<td>a) The line is exempt from the requirement for AWS fitment, as set out in 2.1.6.1.</td>
</tr>
<tr>
<td>Or</td>
</tr>
<tr>
<td>b) A cost benefit analysis shows that provision of AWS is not justified.</td>
</tr>
<tr>
<td><strong>6.1.2 Exclusions from scope</strong></td>
</tr>
<tr>
<td>6.1.2.1 There are no exclusions from the scope specified in 6.1.1 for infrastructure managers.</td>
</tr>
<tr>
<td><strong>6.1.3 General compliance date for infrastructure managers</strong></td>
</tr>
<tr>
<td>6.1.3.1 This Railway Group Standard comes into force and is to be complied with from 06 June 2015.</td>
</tr>
<tr>
<td>6.1.3.2 After the compliance date, or the date by which compliance is achieved, if earlier, infrastructure managers are to maintain compliance with the requirements set out in this Railway Group Standard. Where it is considered not reasonably practicable to comply with the requirements, permission to comply with a specified alternative should be sought in accordance with the Railway Group Standards Code.</td>
</tr>
<tr>
<td><strong>6.1.4 Exceptions to general compliance date</strong></td>
</tr>
<tr>
<td>6.1.4.1 There are no exceptions to the general compliance date specified in 6.1.3 for infrastructure managers.</td>
</tr>
<tr>
<td><strong>6.2 Application - railway undertakings</strong></td>
</tr>
<tr>
<td><strong>6.2.1 Scope</strong></td>
</tr>
<tr>
<td>6.2.1.1 The requirements of 2.2, 2.3, 3.2 and Parts 4 and 5 of this document apply to all new and upgraded AWS and TPWS equipment fitted to vehicles.</td>
</tr>
<tr>
<td>6.2.1.2 Action to bring AWS and TPWS equipment on existing vehicles into compliance with the requirements of this document is not required.</td>
</tr>
<tr>
<td>6.2.1.3 Where AWS or TPWS equipment fitted to a vehicle is subject to alteration and the nature of the alteration provides a reasonable opportunity to bring the vehicle into conformity, then the requirements of this document applicable to the alteration shall apply.</td>
</tr>
<tr>
<td><strong>6.2.2 Exclusions from scope</strong></td>
</tr>
<tr>
<td>6.2.2.1 There are no exclusions from the scope specified in 6.2.1 for railway undertakings.</td>
</tr>
</tbody>
</table>
## 6.2.3 General compliance date for railway undertakings

6.2.3.1 This Railway Group Standard comes into force and is to be complied with from 06 June 2015.

6.2.3.2 After the compliance date, or the date by which compliance is achieved, if earlier, railway undertakings are to maintain compliance with the requirements set out in this Railway Group Standard. Where it is considered not reasonably practicable to comply with the requirements, permission to comply with a specified alternative should be sought in accordance with the Railway Group Standards Code.

## 6.2.4 Exceptions to general compliance date

6.2.4.1 There are no exceptions to the general compliance date specified in 6.2.3 for railway undertakings.

## 6.3 Health and safety responsibilities

6.3.1 Users of documents published by RSSB are reminded of the need to consider their own responsibilities to ensure health and safety at work and their own duties under health and safety legislation. RSSB does not warrant that compliance with all or any documents published by RSSB is sufficient in itself to ensure safe systems of work or operation or to satisfy such responsibilities or duties.

### G 7.1

No guidance is associated with Part 6 of GE/RT8075.
Appendix A  AWS Visual Indicator

The content of this appendix is mandatory.

### General Layout

- Minimum number of segments: 8
- Maximum number of segments: 10

<table>
<thead>
<tr>
<th>Status</th>
<th>Background colour</th>
<th>Segment colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>All black</td>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>Black and yellow</td>
<td>Black</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

#### Rationale

**G A.1**

Rationale: The ‘black and yellow’ display (often referred to as a ‘sunflower’) was designed to attract the driver’s attention and to serve as a reminder that the driver has acknowledged an AWS warning and thereby has taken responsibility for the control of the train.

**G A.2**

The form of the indicator was determined by the original design, which was an electro-mechanical indicator incorporating a fixed plate perforated with segmental slots and a rotating disc with black and yellow segments which showed through the slots in the fixed disc.

**G A.3**

When presented in the form of an image within an integrated DMI display, it is not essential for the AWS visual indicator in the ‘all black’ state to be visible when AWS is not in use.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background diameter</td>
<td>42 mm</td>
<td>90 mm</td>
</tr>
<tr>
<td>Segment circle – outer diameter</td>
<td>38 mm</td>
<td>85 mm</td>
</tr>
<tr>
<td>Segment circle – inner diameter</td>
<td>15 mm</td>
<td>20 mm</td>
</tr>
<tr>
<td>Arc of segments</td>
<td>11 °</td>
<td>18 °</td>
</tr>
</tbody>
</table>

**Figure A.1** AWS visual indicator
Guidance on AWS and TPWS Interface Requirements

G A.4  Rationale: The AWS visual indicator should be large enough to be clearly visible to the driver in all driving conditions.

G A.5  The AWS visual display should be bright enough to be clearly visible to the driver in all conditions, including in bright sunshine.

G A.6  The AWS display should not be so bright that it distracts the driver from other indications in the cab or from observing the railway outside the cab, particularly during hours of darkness.

G A.7  In the original design of AWS indicator, the yellow segments were sectors of a circle (that is, the boundary lines of the segments aligned with the centre of the circle), and thus the angle of arc was constant. If the yellow segments of the indicator display are not sectors of a circle, the angle of the arc from the centre to the outer corners of the segment should fall within the specified range.
Appendix B  TPWS Visual Indicator State Transition Diagram

The content of this appendix is mandatory.

Notes:
- OSS brake demand following TSS brake demand has no effect
- AWS brake demand following TSS brake demand has no effect on visual indications
- Brake release requires brake release action, as set out in 4.2.5
- Test sequences, isolation, override and fault conditions are not included in this diagram
Guidance on AWS and TPWS Interface Requirements

G B.1 Rationale: A TSS, OSS or AWS brake demand causes the appropriate brake demand indicator – SPAD, overspeed or AWS respectively – to flash.

G B.2 Rationale: Acknowledgement of the brake demand (using the appropriate acknowledgement device for the specific cause of the brake demand) causes the brake demand indicator to become steady.

G B.3 Rationale: A brake release action (operation of the brake release device, together with the appropriate brake demand acknowledgement device) extinguishes the brake demand indicator.

G B.4 As a SPAD is a more critical condition than an overspeed or an AWS brake demand, indication of a SPAD brake demand should override an overspeed or AWS indication. Thus:

a) If a TSS brake demand is indicated (either as a flashing indication prior to being acknowledged or a steady indication following acknowledgement), a subsequent OSS or AWS brake demand will not be indicated. (The AWS audible warning will sound and will require to be acknowledged by the AWS caution acknowledgement device in the normal way.)

b) If a TSS brake demand occurs after an OSS and/or AWS brake demand has been indicated (either flashing or steady), the OSS and AWS brake demand indications will be extinguished, leaving only the TSS brake demand to be acknowledged.

c) The full sequence of events should be recorded on the OTMR interface to facilitate post-incident investigation.

G B.5 If both an OSS brake demand and an AWS brake demand both occur, they should both be indicated, and each requires to be separately acknowledged. As stated in Part 4 of GE/RT8075, an overspeed brake release also cancels an AWS brake demand, provided the AWS audible alert has been acknowledged, but an AWS brake release does not cancel the OSS brake demand.
Appendix C  Field Strength Diagram for TPWS Track Sub-System
Standard Loop Installations

The content of this appendix is mandatory.

For dimension ‘d’ and detail of the >90 nT section, see Appendix E

For dimension ‘h’ and detail of the >90 nT section see Appendix E

Volume where the magnetic field strength is >90 nT

For dimension ‘d’ and detail of the >90 nT section, see Appendix E

Indicates the volume where the magnetic field strength is undefined

Indicates the volume where the magnetic field strength is undefined

Section A-A through track centre line

All dimensions in mm
Field strength is measured in free space and shown as rms values

Indicates the volume where the magnetic field strength is undefined

Uncontrolled When Printed
Supersedes GEGN8675 Iss 1 and parts of GMGN2169 Iss 1 as of 06/06/2015
Superseded in part by GERT8075 Iss 3 and in part by RIS0775-CCS Iss 1
with effect from 03/03/2018
Guidance on AWS and TPWS Interface Requirements

G C.1  Rationale: A TPWS trainborne receiver is required to detect a magnetic field of 60 nT or greater. To allow for the factors set out in G 4.2.2.3, a standard transmitter loop is required to produce a flux level of 90 mT in the unshaded area in the centre of the diagrams. This extends for 900 mm along the centre line of the track in the direction of travel. The width (d) and height (h) of the 90 mT area vary across the transmitter, as detailed in Appendix E.

G C.2  Rationale: The TPWS receiver will not detect magnetic fields below 30 nT, and will therefore not detect the presence of the transmitter in the outer unshaded areas in the diagrams – that is, at a distance of 700 mm or more from the defined 90 mT region at heights greater than 130 mm above rail level, and at a distance of 750 mm from the 90 mT region at below this height.

G C.3  Rationale: In the shaded area, where the magnetic field strength is undefined, a receiver may or may not detect the transmitter.
Appendix D  Field Strength Diagram for TPWS Track Sub-System
Miniature Loop Installations

The content of this appendix is mandatory.

Volume where the magnetic field strength is >90 nT

Indicates the volume where the magnetic field strength is undefined

Plan View

Section A-A through track centre line

For dimension ‘d’ and detail of the >90 nT section, see Appendix E

For dimension ‘h’ and detail of the >90 nT section see Appendix E

Volume where the magnetic field strength is >90 nT

Indicates the volume where the magnetic field strength is undefined

All dimensions in mm

Field strength is measured in free space and shown as rms values

Uncontrolled When Printed
Supersedes GEGN8675 Iss 1 and parts of GMGN2169 Iss 1 as of 06/06/2015
Superseded in part by GERT8075 Iss 3 and in part by RIS0775-CCS Iss 1
with effect from 03/03/2018
 Guidance on AWS and TPWS Interface Requirements 

G D.1 Rationale: A TPWS trainborne receiver is required to detect a magnetic field of 60 nT or greater. To allow for the factors set out in G 4.2.2.3, a miniature transmitter loop (as used on the approach to buffer stops) is required to produce a flux level of 90 mT in the unshaded area in the centre of the diagrams. This extends for 300 mm along the centre line of the track in the direction of travel. The width (d) and height (h) of the 90 mT area vary across the transmitter, as detailed in Appendix E.

G D.2 Rationale: The TPWS receiver will not detect magnetic fields below 30 nT, and will therefore not detect the presence of the transmitter in the outer unshaded areas in the diagrams – that is, at a distance of 550 mm or more from the defined 90 mT region at heights greater than 130 mm above rail level, and at a distance of 700 mm from the 90 mT region at below this height.

G D.3 Rationale: In the shaded area, where the magnetic field strength is undefined, a receiver may or may not detect the transmitter.
Appendix E  Field Strength for TPWS Track Sub-System
Installations through Section B-B of Appendices C and D

The content of this appendix is mandatory.

E.1 Figure E.1 shows the height (h) above rail level at different distances (d) either side of the track centre line, showing where the minimum field strength requirements should be met. Other detail is omitted.

---

**Figure E.1**  Field strength for TPWS track sub-system installations through section B-B of Appendices C and D

G E.1 Rationale: The diagram in Appendix E defines the cross-section of the region of the 90 nT magnetic field from TPWS transmitter loops specified in Appendices C and D. The width (d) and height (h) of the defined area are the same for standard and miniature loops.

G E.2 The defined area extends from 140 mm to 310 mm above rail level, which is sufficient to cater for static and dynamic variations in the height of TPWS receivers.
Appendix F  Guidance on Driver / Machine Interface for AWS and TPWS – Design Requirements for Non-integrated DMI

The content of this appendix is mandatory.

GE/RT8075 issue two

F.1 Introduction
F.1.1 This appendix sets out detailed requirements for the TPWS Driver Machine Interface (DMI) when this is provided as a separate group of physical control devices (pushbuttons) and indications which is not integrated into an ETCS DMI.
F.1.2 Where a vehicle is fitted with TPWS but not AWS, the DMI shall incorporate only the controls and indications required for TPWS.

G F.1 General layout

GE/RT8075 issue two

F.2 TPWS DMI appearance
F.2.1.1 The TPWS DMI is a primary control.
F.2.1.2 Figure F.1 shows the general arrangement of the TPWS DMI. A dimensioned diagram is shown at Figure F.2.

Figure F.1  General arrangement of TPWS DMI

Figure F.2  Dimensioned diagram of TPWS DMI
GE/RT8075 issue two
F.2 TPWS DMI appearance

F.2.1.3 Each brake demand indication shall be combined with the associated acknowledgement device in the form of an indicator / pushbutton.

G F.1.1 Rationale: This enables the driver readily to associate the device that has to be operated to acknowledge a brake demand indication, and subsequently to release the brakes, with the brake demand indicator.

F.2.1.4 From top to bottom the SPA D, overspeed and AWS indicator / pushbuttons shall be aligned in that order about a common vertical axis on the left side of the panel. The three indicator / pushbuttons shall be equally spaced vertically with a tolerance of ± 1 mm.

G F.1.2 Rationale: A standard DMI layout is specified so that all train operators adopt a common design for this safety-critical interface, to avoid confusion when drivers move to a different class of train and to facilitate a common understanding between drivers and signallers when they need to communicate following an AWS or TPWS intervention.

F.2.1.5 From left to right the overspeed indicator / pushbutton, temporary isolation / fault indicator, train stop override indicator / pushbutton and brake release pushbutton shall be aligned in that order about a common horizontal axis in the centre of the panel. The overspeed indicator / pushbutton, temporary isolation / fault indicator, train stop override indicator / pushbutton and brake release pushbutton shall be equally spaced to within a tolerance of ± 1 mm.

G F.1.3 Rationale: A standard DMI layout is specified so that all train operators adopt a common design for this safety-critical interface.

F.2.1.6 The TPWS DMI panel shall be delineated as a separate group of controls.

G F.1.4 Rationale: The TPWS controls need to be identifiable as a group that is associated with the functionality of TPWS.

F.2.1.7 The distance between the centres of the brake release pushbutton and the overspeed indicator shall not exceed 200 mm. The distance between the centres of the SPAD indicator and the AWS indicator shall not exceed 120 mm. The visual indicators / pushbuttons shall be spaced to avoid inadvertent operation of a pushbutton while operating the indicator / pushbutton next to it.

G F.1.5 Rationale: The controls need to be close enough to retain their identity as an associated group of functions, but far enough apart that the driver can easily operate each control while minimising the chance of pressing an adjacent button by mistake.

G F.1.6 The size of the buttons should be commensurate with the environment in which the unit is to be located and used. For example, consideration should be given to the ability to operate the buttons with a gloved hand when the unit is installed in an environment where such protective equipment is likely to be worn, such as on a steam locomotive.
Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two
F.2 TPWS DMI appearance
F.2.1.8 When illuminated, the indicators shall be detectable in all lighting conditions.

G F.1.7 Rationale: It is essential that the indications are clearly discernible by the driver under all ambient conditions.

G F.2 Brake demand indicators

GE/RT8075 issue two
F.2 TPWS DMI appearance
F.2.2.1 The three visual brake demand indicators (SPAD, overspeed and AWS) shall be circular and the minimum diameter of each shall be 10 mm.

G F.2.1 Rationale: A diameter of 10 mm is adequate to provide a clearly discernible display when illuminated and gives a suitable size for operation as a pushbutton.

GE/RT8075 issue two
F.2 TPWS DMI appearance
F.2.2.2 The three brake demand indicators shall also function as pushbuttons and shall depress by at least 2 mm when pressed.

G F.2.2 Rationale: This amount of movement provides suitable feedback to give the driver confidence that the button has been properly pressed.

GE/RT8075 issue two
F.2 TPWS DMI appearance
F.2.2.3 If the brake demand indicators / pushbuttons are less than 20 mm in diameter they shall protrude above the surface of the panel by a distance which is greater than the operational stroke.

G F.2.3 Rationale: This allows ease of operation of smaller buttons, allowing for users with larger fingers.

GE/RT8075 issue two
F.2 TPWS DMI appearance
F.2.2.4 The visual indicator for a SPAD shall be red (nominally Pantone 186C).

G F.2.4 Rationale: The SPAD indicator is red to emphasise to the driver the critical nature of a SPAD incident.

GE/RT8075 issue two
F.2 TPWS DMI appearance
F.2.2.5 The visual indicators for an overspeed and for an AWS brake demand shall be yellow (nominally Pantone Yellow C).

G F.2.5 Rationale: Overspeed and AWS brake demand indicators are yellow to give a warning to the driver but to indicate an incident that does not have the critical nature of a SPAD.

GE/RT8075 issue two
F.2 TPWS DMI appearance
F.2.2.6 When required to display a flashing indication, the brake demand indicator shall flash at a frequency of 2 Hz ± 0.25 Hz with a 50% ± 5% duty cycle.

G F.2.6 Rationale: This flashing rate has been determined to provide an easily recognised indication that attracts the driver’s attention more effectively than a steady indication.
### Temporary isolation / fault indicator

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>F.2</th>
<th>TPWS DMI appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.2.3.1</td>
<td>The temporary isolation / fault indicator shall be circular, coloured yellow (nominally Pantone Yellow C), shall have a minimum lens diameter of 18 mm, and shall not protrude above the surrounding bezel.</td>
</tr>
</tbody>
</table>

**Rationale:** The temporary isolation / fault indicator is yellow to draw the driver’s attention to the warning it gives that TPWS is not providing the protection which it normally does.

### Train stop override indicator / pushbutton

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>F.2</th>
<th>TPWS DMI appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.2.4.1</td>
<td>The train stop override indicator / pushbutton shall be square and coloured yellow (nominally Pantone Yellow C) and shall have a minimum lens width of 17 mm.</td>
</tr>
<tr>
<td>F.2.4.2</td>
<td>The train stop override indicator / pushbutton shall not protrude above the surrounding bezel.</td>
</tr>
</tbody>
</table>

**Rationale:** The train stop override indicator is yellow to draw the driver’s attention to the warning it gives that TPWS is not providing the protection which it normally does.

**Rationale:** The square shape of the train stop override indicator enables it to be distinguished more readily from the other indicators which are round, emphasising the special nature of this control and the particular circumstances in which it is used.

**Rationale:** This reduces the likelihood that the train stop override indicator / pushbutton will be operated inadvertently. Inadvertent operation could remove train stop protection when it has not been deliberately overridden after complying with the relevant rules.

**Rationale:** This amount of movement provides suitable feedback to give the driver confidence that the button has been properly pressed.

### Brake release button

**GE/RT8075 issue two**

<table>
<thead>
<tr>
<th>F.2</th>
<th>TPWS DMI appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.2.5.1</td>
<td>The brake release button shall be circular with a minimum diameter of 18 mm excluding any bezel, and shall be coloured black.</td>
</tr>
</tbody>
</table>

**Rationale:** The brake release button does not serve also as an illuminated indicator, and its black colour distinguishes it from the other TPWS indications and controls (which are either red or yellow).
### Guidance on AWS and TPWS Interface Requirements

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>TPWS DMI appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F.2</strong></td>
<td></td>
</tr>
<tr>
<td><strong>F.2.5.2</strong></td>
<td>The brake release button shall depress by at least 2 mm when pressed.</td>
</tr>
</tbody>
</table>

**G F.5.2** Rationale: This amount of movement provides suitable feedback to give the driver confidence that the button has been properly pressed.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>TPWS DMI appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F.2</strong></td>
<td></td>
</tr>
<tr>
<td><strong>F.2.5.3</strong></td>
<td>There shall be a cover which protects the brake release button. The cover shall be sprung so that it automatically returns to its covering position when resistance is removed. The spring tension shall not be so great that the cover is difficult to operate using one hand. The cover shall not create a nipping hazard. The cover shall not be easily removed by the driver.</td>
</tr>
</tbody>
</table>

**G F.5.3** Rationale: The brake release button is fitted with a cover which has to be deliberately moved aside in a separate action to allow the button to be pressed. This is intended to make the driver consciously consider the action being taken before releasing the brakes, and to carry out the appropriate procedures before doing so.

### Labelling of TPWS DMI

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Labelling of TPWS DMI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F.3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>F.3.1</strong></td>
<td>The visual indicators shall be labelled 'SPAD', 'OVERSPEED' and 'AWS' to identify the cause of the brake demand. It is permissible for the 'OVERSPEED' label to be shown over two rows.</td>
</tr>
</tbody>
</table>

**G F.6.1** Rationale: The brake demand indicators are to be clearly labelled so that the driver is aware of the cause of the brake demand, both before and after acknowledgement.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Labelling of TPWS DMI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F.3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>F.3.2</strong></td>
<td>The labelling of the SPAD, overspeed and AWS indicators shall be centred about a common vertical axis set to the left of the indicators to which they refer and shall be centred vertically with the applicable indicator centre.</td>
</tr>
</tbody>
</table>

**G F.6.2** Rationale: A standard layout is defined for consistency of presentation.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Labelling of TPWS DMI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F.3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>F.3.3</strong></td>
<td>The brake release button shall be labelled as shown below over two rows:</td>
</tr>
<tr>
<td></td>
<td>'BRAKE RELEASE'</td>
</tr>
</tbody>
</table>

**G F.6.3** Rationale: A standard layout is defined for consistency of presentation.

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
<th>Labelling of TPWS DMI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F.3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>F.3.4</strong></td>
<td>The temporary isolation / fault indicator shall be labelled as shown below over three rows:</td>
</tr>
<tr>
<td></td>
<td>'TEMPORARY ISOLATION/FAULT'</td>
</tr>
</tbody>
</table>

**G F.6.4** Rationale: A standard layout is defined for consistency of presentation.
Guidance on AWS and TPWS Interface Requirements

GE/RT8075 issue two
F.3 Labelling of TPWS DMI
F.3.5 The train stop override indicator / pushbutton shall be labelled as shown below over two rows:

‘TRAIN STOP OVERRIDE’

G F.6.5 Rationale: A standard layout is defined for consistency of presentation.

GE/RT8075 issue two
F.3 Labelling of TPWS DMI
F.3.6 The labelling of the temporary isolation / fault indicator, train stop override indicator / pushbutton and brake release button shall be centred above the centre of the corresponding indicator / pushbutton, and the rows of each label shall be vertically aligned.

G F.6.6 Rationale: The labelling should be clearly aligned with the associated indicator.

GE/RT8075 issue two
F.3 Labelling of TPWS DMI
F.3.7 The character height of the labelling shall be a minimum of 5 mm and, when viewed from the driving position, shall subtend as a minimum a visual angle of 15 minutes.

G F.6.7 Rationale: The labelling should be large enough to be easily readable from the driving position.

GE/RT8075 issue two
F.3 Labelling of TPWS DMI
F.3.8 Labelling shall be:

a) Permanent and durable.
b) Selected for maximum contrast against the panel background.
c) In capitals and in a sans serif font.

G F.6.8 Rationale: The labelling should be and remain clearly legible.

G F.7 Operation of pushbuttons

GE/RT8075 issue two
F.4 Operation of pushbuttons
F.4.1 Where 4.2.5 requires operation of two control devices together, this shall require both the pushbuttons concerned to be pressed simultaneously and then both released.

G F.7.1 Rationale: A brake release requires operation of the appropriate brake demand acknowledgement device, as well as the brake release push button to remind the driver of the cause of the brake demand. On a DMI using separate physical pushbuttons this should be achieved by requiring the two relevant push buttons to be operated at the same time.

G F.8 Pushbutton resistance

GE/RT8075 issue two
F.5 Pushbutton resistance
F.5.1 Pushbutton resistance on all buttons on a TPWS DMI panel shall be consistent and shall be within the range 2.8 to 15 newtons.

G F.8.1 Rationale: Resistance of pushbuttons should be sufficient to minimise unintentional operation but not so great that a significant effort is needed to operate them.
Guidance on AWS and TPWS Interface Requirements

G F.9  Pushbutton / switch confirmatory action

<table>
<thead>
<tr>
<th>GE/RT8075 issue two</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.6  Pushbutton / switch confirmatory action</td>
</tr>
<tr>
<td>F.6.1  Pushbuttons / switches shall provide audible and tactile feedback to the driver.</td>
</tr>
</tbody>
</table>

G F.9.1  Rationale: It is desirable from a human factors perspective to provide the driver with feedback to confirm that the control device has been operated effectively.
Appendix G  Guidance on Driver / Machine Interface for AWS and TPWS – Design Requirements for DMI Integrated with ETCS

The content of this appendix is mandatory.

GE/RT8075 issue two  
Driver / Machine Interface for AWS and TPWS - Design Requirements for DMI Integrated with ETCS  
G.1 This appendix sets out requirements for the design of the TPWS Driver Machine Interface (DMI) when it is integrated with the ERTMS/ETCS DMI.

G G.1 Where a train is to be fitted with ERTMS/ETCS, there may be advantages in incorporating many of the AWS and TPWS controls and indications into an integrated DMI. The benefits, potential disadvantages and constraints of this were reviewed by RSSB research project T906 and the reports produced by this project contain guidance on the arrangements that might be adopted. The specification for the ETCS DMI (ERA_ERTMS_015560) permits information from other train control systems to be displayed. However, no specific layout has been agreed for AWS and TPWS controls and indications within an integrated DMI.

G G.2 The detailed requirements for integrated AWS and TPWS controls and indications should be developed with the involvement of end users, which should include user trials of proposed options in the cab environment. Feedback obtained from the user trials should be used to finalise the design.

GE/RT8075 issue two  
Driver / Machine Interface for AWS and TPWS - Design Requirements for DMI Integrated with ETCS  
G.2 The AWS caution acknowledgement device, as set out in 4.1.2.2, shall not be incorporated into the ETCS DMI.

G G.3 Rationale: The AWS acknowledgement device requires to be sufficiently robust to withstand frequent operation, and is liable to be operated with some force as a rapid response to an AWS warning is required by the driver. It should therefore be provided in the form of a separate physical control device.

GE/RT8075 issue two  
Driver / Machine Interface for AWS and TPWS - Design Requirements for DMI Integrated with ETCS  
G.3 Where AWS and TPWS controls and indications are incorporated into the ETCS DMI, the layout of the control devices and indications shall provide the same facilities as set out in Appendix F, adapted as necessary to meet the constraints of the ETCS DMI specification.

G G.4 Rationale: The layout of the TPWS DMI set out in Appendix F was agreed following a substantial programme of research and trials to address issues identified with earlier versions of the interface, in particular the possibility of the driver resetting following a train stop intervention without going through the required reporting processes. The principles incorporated in this agreed layout, which include the provision of separate and clearly identifiable indications for brake demands initiated by train stop activations, overspeed activations or late acknowledgement of the AWS caution warning, should as far as possible be carried through to an integrated version of the DMI.
Particular attention should be given to the provision of equivalent safeguards against incorrect operation of functions such as resetting and brake release. For example, the brake release function as defined in Appendix F is protected against inadvertent operation by provision of a cover over the brake release button, and the requirement to operate the brake release button together with the appropriate brake demand acknowledgement button. If these functionalities are not achievable on a VDU-based DMI, alternative layouts of controls and associated operational procedures providing equivalent levels of security should be implemented.

The location and size of the indications and controls may be limited by the ETCS DMI specification. The controls and indications should be designed to support effective detection, decision making and operation of the indications and controls by the driver. When considering detection, factors associated with size, colour, illumination, contrast, flash rates of the indications and controls and sound levels of alerts need to be taken into account. When considering decision making, separate indications of brake demands supported by labelling is required. Text messages may also be used to reinforce the information provided by the indications and controls. When considering operation, adequate feedback is needed when interacting with the controls.

The AWS and TPWS indications and control devices shall be logically grouped and clearly identified.

The AWS and TPWS indications shall be clearly visible to the driver in all lighting conditions.

Where 4.2.5 requires operation of two control devices together but the design of the DMI does not permit recognition of two simultaneous control inputs, it is permissible to achieve the function by operating the two controls sequentially.

A brake release requires operation of the appropriate brake demand acknowledgement device, as well as the brake release control device to remind the driver of the cause of the brake demand. If the DMI does not allow for simultaneous operation of two controls, the layout of the controls and associated operating procedures should be designed to provide equivalent levels of security.
# Appendix H  Guidance on TPWS Audible Alert Sound Files

The content of this appendix is mandatory.

## GE/RT8075 issue two
TPWS Audible Alert Sound Files

### H.1  SPAD alert

**H.1.1** The SPAD audible alert (see 4.2.3.3) shall be:

![Tone plus SPAD.wav](Tone plus SPAD.wav)

### H.2  Overspeed alert

**H.2.1** The overspeed audible alert (see 4.2.3.4) shall be:

![Tone plus Overspeed.wav](Tone plus Overspeed.wav)

### H.3  Self-test announcement

**H.3.1** The audible announcement on successful completion of the power-up test (see 4.3.1.6) shall be:

![TPWS AWS.wav](TPWS AWS.wav)

---

G H.1 No guidance is associated with Appendix H.
Appendix I  AWS Train Sub-System – Operational States and Sequences

The content of this appendix is for information only.

This flowchart does not include the system isolation or suppressed states or the self-test routine.

OPERATIONAL READY STATE

South pole of track magnet detected

PRIMED STATE

North pole of electromagnet detected within initial delay period?

Yes

CLEAR SIGNAL RESPONSE STATE

No

RESTRICTIVE RESPONSE STATE

Driver operates caution acknowledgement device within caution acknowledgement period?

Yes

RESTRICTIVE ACKNOWLEDGEMENT STATE

No

BRAKE DEMAND NON-ACKNOWLEDGEMENT STATE

Driver carries out brake release procedure

AWS brake demand cancelled

AWS warning silenced AWS brake demand continues

BRAKE DEMAND ACKNOWLEDGEMENT STATE

AWS brake demand initiated

Driver operates caution acknowledgement device
Appendix J  Description of AWS and TPWS Trainborne Equipment

The content of this appendix is for information only.

G J.1  Introduction
G J.1.1  This section sets out an outline description of the components of the AWS and TPWS trainborne sub-system.

G J.1.2  As the functionality of AWS and TPWS is most often provided in a combined control unit, both AWS and TPWS equipment are described together to enable an understanding of the most commonly installed configurations. However, either system (AWS or TPWS) can be applied on its own, and, in some cases, for example certain shunting locomotives, only TPWS has been implemented.

G J.2  Trainborne sub-system components
G J.2.1  Figure G J.1 shows a typical trainborne sub-system, including both AWS and TPWS using a combined AWS and TPWS electronic control unit.

![Diagram of AWS and TPWS trainborne sub-system](image_url)

Figure G J.1  Typical AWS/TPWS trainborne sub-system
Guidance on AWS and TPWS Interface Requirements

G J.2.2 The boxes shown dotted in Figure G J.1 are only necessary for a dual-cab single control unit configuration, such as on a locomotive.

G J.3 Combined electronic control unit
G J.3.1 The combined AWS and TPWS control unit performs the logical functions, receiving various inputs and driving the external control and indication equipment. Most control units now in use are electronic, replacing the earlier relay logic types.

G J.3.2 The control unit may also provide specific outputs to reset the vigilance system (where a multi-resettable vigilance device is used) and outputs to train data recorders to enable recording of the detection of track magnets, together with the response of the trainborne sub-systems.

G J.4 AWS receiver
G J.4.1 The AWS receiver detects the presence of the south and north poles from the track-mounted magnets and provides a signal to the control unit that one or both of the magnets have been detected. Several different types of receiver exist (although not all types may still be in use), including pivoted permanent magnet, standard and high strength bi-stable reed relay type, twin lightweight bi-stable reed relay, and electronic / solid state.

G J.4.2 Some traction units may be fitted with two AWS receivers: one to detect standard strength track magnets and one to detect extra strength track magnets (the twin lightweight reed receiver and electronic versions are designed to detect either magnet type within a single housing). Where both receiver types are fitted on a dual system electric traction unit, the vehicle control circuitry is arranged to select the correct receiver depending on the traction current collection system in use. Diesel traction units generally use only a standard strength receiver, even if they also operate over lines fitted with extra strength track magnets.

G J.4.3 Locomotives and other dual-cab vehicles are normally only fitted with one receiver and control unit which feeds indications in either cab, as shown in Figure G J.1.

G J.4.4 The receiver is mounted underneath the driving vehicle, either on the bogie or suspended from the vehicle underside, nominally on the centre line of the vehicle, and within a height range that keeps the equipment both within kinematic gauge and able to respond to the minimum track magnet field strength specified in GE/RT8075 under all dynamic conditions. The receiver cable is connected to a junction box which forms a coupling and test point.

G J.5 AWS alarm and indicator unit
G J.5.1 The AWS alarm and indicator unit provides the main interface with the driver for AWS indications. The unit contains an electronic tone generator for the ‘caution’ (approximately 800 Hz continuous tone) and ‘clear’ (approximately 1200 Hz chime tones), and contains the yellow / black visual indicator (also known as the sunflower indicator) to remind the driver of the previous signal aspect and actions taken. The unit is mounted in a position where the driver may readily see it from the normal driving position. Several versions of this equipment exist, including those with a mechanical sunflower and those with LED arrays to provide the yellow element of the sunflower.

G J.5.2 Older installations may have separate audible (bell and horn) and visual (sunflower) indicators. These generally have conventional electric trembler bells, which ring for 0.5 seconds for a clear signal, and pneumatic horns, although the horn may be of the ‘Yodalarm’ electric type.

G J.5.3 Where provided separately, the visual ‘sunflower’ indicator is normally of a mechanical type and is larger than the combined alarm and indicator unit type. It contains a bi-stable electromechanical device with a magnetic circuit incorporating two coils, and is magnetically latched in either of its two positions. Luminous paint is applied to the yellow segments, so that the ‘black and yellow’ indication can be seen in the dark.
G J.6 TPWS aerial

G J.6.1 The TPWS aerial receives the six TPWS frequencies transmitted from the track-mounted transmitter loops (as set out in Table 19 and Table 20). The aerial, in conjunction with the control unit, may be capable of undertaking an integrity test as part of its inbuilt self-testing routines.

G J.6.2 The aerial is mounted underneath the leading vehicle (either on the bogie or suspended from the vehicle underside) nominally on the centre line of the vehicle, and within a height range that keeps the aerial both within kinematic gauge and able to respond to the minimum track transmitter loop field strength specified in GE/RT8075 under all dynamic conditions.

G J.6.3 For dual-cab vehicles, for example locomotives, two TPWS aerials are required, one at each end, to prevent an unwarranted TPWS brake application due to detection of signal ‘self-reversion’. Self-reversion is the result of the signal returning to danger (red aspect) due to the passage of the train, which will cause the transmitter loop to become active. If the TPWS aerial has not passed clear of the transmitter loops at the signal when they become active, then the brakes would be applied by TPWS as an unwarranted application. Self-reversion could also occur on a single-cab vehicle if the aerial is mounted more than 2.3 m behind the leading wheelset.

G J.7 Driver’s control panel or driver / machine interface

G J.7.1 The driver’s TPWS control panel (also known as the driver’s display unit or driver’s display panel) or driver / machine interface (DMI) consists of TPWS status indicators and a Train Stop Override (TSO) pushbutton.

G J.7.2 Older equipment incorporates a single brake demand indicator which indicates one of three TPWS brake demand states:

a) Unlit – no demand requested.
b) Flashing – brake demand requested by TPWS but not acknowledged by driver.
c) Steady – brake demand requested by TPWS and acknowledged by driver.

G J.7.3 Newer types of display equipment incorporate three separate brake demand indicators, as set out in GE/RT8075 section 4 and Appendix F: one for brake applications initiated by TPWS TSS (coloured red), one for brake applications initiated by TPWS OSS (coloured yellow) and one for an AWS brake application (also coloured yellow). Each of these indicators will show one of the three brake demand states, as set out in G J.7.2 above.

G J.7.4 The driver’s control panel / DMI also contains indications of TPWS temporary isolation and faults, which are usually combined in a single indicator. A combined temporary isolation / fault indicator indicates three states:

a) Unlit – TPWS operational.
b) Flashing – TPWS fault detected.
c) Steady – TPWS temporarily isolated.

G J.7.5 The train stop override (TSO) control is operated by the driver when it is necessary to pass a signal at danger with the authority of the signaller. In this case, the TSS on the track will still be transmitting and hence the train would be tripped on a legitimate movement past the stop signal. However, the driver can operate the TSO, which will prevent a brake demand from the first TSS the system encounters within a time period. The time period is preset to 20 seconds for a passenger train or 60 seconds for a freight train. After the time period, or on detecting the first TSS, the TSO will be reset to normal. When the TSO function is in operation, the TSO pushbutton (or associated indication) illuminates steady yellow.
G J.8  AWS reset pushbutton / TPWS acknowledgement

G J.8.1 The AWS reset pushbutton (sometimes referred to as the AWS acknowledgement pushbutton) is also part of the driver’s interface and is mounted on, or built into, the driver’s desk such that it can be readily operated from the driving position. The pushbutton contains a changeover contact which allows the AWS receiver to reset, the audible indication to be silenced and the visual indication to be set to ‘yellow / black’.

G J.8.2 On older systems, the AWS reset pushbutton is also used to acknowledge a TPWS brake demand. When pressed after a TPWS brake demand, the control unit receives an acknowledge input which will enable the release of the TPWS brake demand in combination with a preset timer.

G J.8.3 On newer systems equipped with three brake demand indicators (compliant with GE/RT8030 issue 3 or later standards), a brake demand is acknowledged by pressing the appropriate push button associated with the brake demand indication which has been activated.

G J.11 Full isolation switch and indicator

G J.11.1 A full isolation switch is provided for the driver to isolate the AWS and TPWS trainborne sub-system in the case of faults where:

   a) The brakes will not release.

   Or

   b) The AWS audible indications will not silence.

   Or

   c) A succession of incorrect or spurious responses are given by the AWS or TPWS systems.

G J.11.2 Various types of isolation switch exist: older types may be retained in the normal position with a seal or locking wire to deter abuse, while more modern installations are arranged such that the switch once operated cannot be reset by the driver. On older locomotives the full isolation switch may be incorporated with the change end switch.

G J.11.3 Full isolation of AWS will also render the TPWS system isolated (and vice versa) as the control unit also includes TPWS functionality. A TPWS temporary isolation switch is provided to overcome this limitation when only TPWS may be at fault.

G J.11.4 Full isolation is required to be indicated to the driver by a discrete indication or as part of a general safety system isolation indication. This is achieved on older vehicles by the visible position of the isolation switch and on modern vehicles by an illuminated indicator. The full isolation switch is required to:

   a) Ensure that the power supply is isolated from the AWS trainborne sub-system.

   b) Ensure that no AWS or TPWS brake demand is or can be actioned.

   c) Ensure that all indications except the isolation status indicator are inoperative.

   d) Provide a clearly visible indication that enables a trainborne sub-system isolation to be detected in all relevant driving positions.

   e) Provide an output to the train’s data recorder, where fitted, to indicate that the complete system is isolated.

G J.12 TPWS temporary isolation switch

G J.12.1 A TPWS temporary isolation switch is provided to allow the TPWS to overcome a fault in the sub-system which does not affect the AWS functions, for example a faulty TPWS antenna.

G J.12.2 The switch is centre-biased to the ‘off’ position so that when the equipment is powered down and on again, any existing temporary isolation will be removed.
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G J.12.3 The switch is mounted out of reach from the normal driving position.

G J.12.4 On some dual-cab vehicles only one temporary isolation switch is provided.

G J.13 AWS isolation switch
G J.13.1 On newer vehicles a separate AWS isolation switch may be provided to allow isolation of the AWS functions in case of a failure, for example one which prevents release of an AWS brake application, while allowing the TPWS to continue in operation.

G J.13.2 On older vehicles there is no facility to isolate the AWS separately from the TPWS.
Appendix K  AWS and TPWS Trainborne Equipment – Fault and Failure Management

The content of this appendix is for information only.

**Note**  
AWS Fault Codes are defined in GE/RT8106 Table A1.

**G K.1 Process for investigating reported right side failures**

G K.1.1 The process shown in Figure G K.1 is recommended to reduce the incidence of trainborne equipment being identified as faulty following a failure report when the failure was actually due to external influences. This will help to reduce cases where the equipment is sent for investigation but no fault is found. This process makes use of new technologies that have been produced for fault diagnosis.

G K.1.2 Various equipment exists to conduct a full AWS and / or TPWS test. A simple AWS functional test can be carried out using a hand-held magnet, as set out in Appendix L. Other test equipment should be used in accordance with the manufacturer’s instructions.

G K.1.3 Depot test procedures, as laid down in vehicle maintenance instructions, should be followed. If any item is identified as the cause of the fault, then it should be removed, sent for repair and a new item refitted. If the reported fault can be repeated, but changing the suspected faulty item does not cure the fault, then the fault is likely to be caused either by another faulty item of equipment, or the vehicle wiring. If the vehicle wiring is suspected to be faulty, it may need to be continuity and insulation tested if no obvious faults can be identified.

G K.1.4 After removing and / or changing any equipment, a full AWS and / or TPWS test should be conducted before releasing vehicles back into service.
Figure G K.1  AWS/TPWS right side failure investigation process
G K.2 Process for investigating reported wrong side failures

G K.2.1. The process shown in Figure G K.2 is recommended to reduce the incidence of wrongly diagnosed faulty equipment due to external influences, and in light of the new technologies that have been produced for fault diagnosis. This process relies on the use of approved test equipment such as the STS / Mors Smitt TY287 AWS tester.

G K.2.2 The AWS control unit and receivers are often sent to an approved technical investigation centre following a reported AWS code 5 or 7 failure, as the equipment is often assumed to have suffered a wrong side failure. However, in many cases the technical investigation centres are unable to find any faults with the equipment under investigation. In some cases, reported AWS code 5 or 7 failures have been caused by the trackside AWS equipment or by traincrew errors.

G K.2.3 Similarly for TPWS, alleged wrong side failures may be due to track-mounted equipment faults, driver error or operational circumstances, as identified in the common causes sections.

G K.2.4 Train data recorder (TDR) data should be downloaded at the earliest opportunity by maintenance depot staff, to avoid it being overwritten or otherwise lost. Train data recorder data should be supplied to the technical investigation centre to aid its investigation. This evidence may assist experts to pinpoint the cause of the failure, which may lie in the train wiring or ancillary components such as the AWS acknowledgement pushbutton. Technical investigation centres may in turn seek advice from the relevant AWS/TPWS supplier(s).
Figure G K.2  AWS wrong side failure investigation process
Guidance on AWS and TPWS Interface Requirements

G K.3 Managing defective components

G K.3.1 Defective AWS and TPWS components should be managed in accordance with the railway undertaking’s quality procedures, in order that defective components are segregated, labelled, and despatched for repair or scrap, as appropriate.

G K.3.2 For example, faulty items of AWS and TPWS equipment which have been involved in a right side failure should be treated as follows:

a) The equipment should be adequately packed, using special packaging, where available, and be clearly labelled as ‘AWS/TPWS equipment for repair’.

b) Equipment changed as a result of a ‘right side failure’ should be sent to the appropriate repair agent for repair.

G K.3.3 Faulty items of AWS and TPWS equipment which have been involved in a wrong side failure should be treated as follows:

a) The equipment should be adequately packed, using special packaging, where available, and have an appropriate label, generally coloured red, identifying the urgent nature of the package attached prior to dispatch. A wrong side failure report form should also be enclosed in the package.

b) Equipment changed as a result of a wrong side failure should be sent for technical investigation to an approved, competent technical investigation body. It is expected that a competent technical investigation body will provide detailed feedback to the railway undertaking on the nature of the defects found, as this may require further action on behalf of the railway undertaking on its fleet and, in certain cases, ‘urgent’ advice being given to other operators.

c) Equipment sent for technical investigation and / or repair should be properly labelled and accompanied by sufficient information to enable the investigators or repairers to properly diagnose and rectify faults. This information should include relevant TDR data, which may be sent electronically. A copy of the TDR data should be retained by the depot for possible future analysis that may be required following investigation by the technical investigation body.

G K.4 Fault finding techniques

G K.4.1 A traditional method of diagnosing AWS faults has been to use an AWS hand-held test magnet waved under the receiver to simulate the train passing over the AWS track magnets and hence functionally test the system (see Appendix L). Functioning the AWS system with a hand-held test magnet has the advantage of easily and quickly testing the AWS trainborne sub-system. Replacement of key components can be undertaken to remedy the fault, having tracked down the likely faulty component using a systematic process, in part using test equipment. More sophisticated test equipment is now available to supplement the basic functional test, thus allowing faults to be detected and healthy equipment to be identified more reliably.

G K.4.2 For all fault finding techniques, some basic checks should be undertaken first, as follows:

a) Check the vehicle records and component tracker system, to determine whether the vehicle has been involved in any AWS related incident within the last 12 months.

b) Measure and record the height of the bottom of the AWS receiver above rail level. This should be within the limits applicable to the vehicle concerned (as specified in the vehicle maintenance instruction). Standard electromechanical AWS receivers are commonly mounted within the range 133 mm to 171 mm above rail level, and the recommended height range for Thales electronic AWS receivers is between 165 mm and 185 mm above rail level. Receiver height should be adjusted, as necessary, on vehicles where adjustment is provided.
Standard strength AWS receivers running over high strength track magnets are commonly set towards the upper end of the permitted height range to avoid spurious right side failures by detecting high magnetic fields generated by cross-track traction cables, but if they are set too high this can result in failure to detect normal strength magnets and hence wrong side failures.

Further, the TY309 AWS characterisation tester may be used to adjust the generic receiver height tolerance for particular vehicles.

c) Examine items of equipment for possible causes of intermittent fault, for example external damage, loose connectors or water ingress to connectors.

G K.4.3 The fault diagnosis procedures should enable faulty equipment to be reliably diagnosed. If a fault persists, for example two repeat failures in three months, but cannot be traced by functional testing or the use of the various test equipment, and a fault to the vehicle frame (earth fault) is suspected, then wiring checks should be carried out to trace any possible wiring faults, as follows:

a) Visually examine, as far as is possible, all items of the AWS/TPWS trainborne sub-system carefully for possible causes of an intermittent fault, for example external damage, loose connectors, water ingress or defective wiring.

b) Disconnect wiring connectors from components likely to be affected by insulation testing, for example:

i) The AWS receiver.

ii) The TPWS aerial.

iii) The AWS alarm and indicator units (if fitted) and bells(s) / Yodalarm / horn (if fitted).

iv) The AWS/TPWS control unit.

v) The TPWS driver’s control panel / DMI.

vi) The EP repeat relay (if fitted).

vii) The EP valves (if fitted) and voltage converter (refer to relevant vehicle instructions).

viii) Train Data Recorder or similar equipment.

ix) All electronic equipment on the vehicle (or interconnected vehicles) not capable of withstanding the insulation test voltages likely to be applied.

c) Using an insulation tester (500 V or 1000 V), check that the cable insulation resistance between AWS/TPWS cables and all other cables running with them (refer to vehicle wiring diagrams) is not less than 10 MΩ (wire to wire and wire to earth).

d) Using an insulation tester, check that the cable insulation resistance between each AWS/TPWS cable and the vehicle chassis is not less than 10 MΩ.

G K.4.4 Further guidance on possible fault causes is given in G K.5.

G K.4.5 In addition, data from train data recorders and train management systems may include data related to the operation and performance of both the AWS system and the train control systems at the time of the fault. When fault finding, consideration should be given to downloading and analysing the data to assist in fault finding. These systems may also directly log the nature of the fault depending on the complexity of the installation.

G K.4.6 Data from a train data recorder may also enable determination of any driver errors that may have led to an unintended (spurious) automatic brake application by the AWS. For example, a reported spurious brake demand could be due to late operation of the AWS reset pushbutton, or holding down the AWS reset pushbutton before the system detects the track
magnet south pole. The sequence and timing of these actions could be identified from the train data recorder.

G K.4.7 A reported AWS or TPWS trainborne fault could be the symptom of an infrastructure fault, although this may not always be apparent. For example, an AWS fault code 8 (horn when no indication expected) could be due to the AWS receiver on the train detecting a magnetic flux from a cross-track cable, possibly as a result of a cable fault.

G K.4.8 Data from train management systems may also provide a precise location (for example, Ordnance Survey Grid Reference) which can be forwarded to the infrastructure manager to investigate.

G K.5 Guide to possible fault causes

G K.5.1 A guide to possible causes and remedies for AWS/TPWS failures associated with a combined electronic AWS/TPWS control unit is given in Figures G K.3 and G K.4 below. The flowchart in Figure G K.4 is based on the power up and self-test routine, following a sequence from power up of the system through the equipment automatic self-test routine. These flowcharts have been published for information purposes only and do not take precedence over approved vehicle maintenance and fault-finding procedures.

G K.5.2 Some TPWS systems have improved fault reporting that may be used to trace a fault. This can be used in conjunction with the TDR data to assist in finding the cause of any fault.
AWS Code 1
HORN & BELL
POSSIBLE CAUSE
SPURIOUS SWITCHING OF AWS RECEIVER
SOLUTION
CHANGE: AWS RECEIVER & CABLE

AWS Code 2
HORN NOTICED ON BELL
POSSIBLE CAUSE
RANDOM FAULT: INDICATE AWS Rx FAILURE MULTIPLE FAILURES AT SAME LOCATION: INDICATES WEAK AWS MAGNETS
SOLUTION
CHECK: AWS RECEIVER HEIGHT IS CORRECT, TX/CHANGE AWS RECEIVER & CABLE (Power Up Test would show if it is a PSU fault)

Potential Wrong Side Failure
AWS Code 3
NO INDICATION INSTEAD OF BELL
POSSIBLE CAUSE
POTENTIAL FAILURE OF AWS RECEIVER TO DETECT PERMANENT MAGNET (see Code 7) IF NO CODE 7 OBSERVED, POSSIBLY BELL FAULT
SOLUTION
IF POWER UP TEST OK THEN CHANGE AWS AUDIBLE ALARM UNIT

AWS Code 4
BELL & HORN
POSSIBLE CAUSE
POSSIBLY CAUSED BY AN OLD TYPE AWS RECEIVER USED IN AREAS WITH STRONG AWS TRACK MAGNETS
SOLUTION
CHECK AWS RECEIVER HEIGHT IS CORRECT, IF CORRECT CHANGE RECEIVER

AWS Code 5
BELL INSTEAD OF HORN
POSSIBLE CAUSE
PERMANENT RESET VOLTAGE ON AWS Rx
SOLUTION
CHECK: ACK BUTTON FOR SHORT CIRCUIT. IF OK, CHANGE CONTROL UNIT

AWS Code 6
BRAIN WITHOUT HORN
POSSIBLE CAUSE
HORN FAILURE (should be noticed during PUT)
SOLUTION
CHANGE AWS AUDIBLE ALARM, IF NOT FIXED THEN CHANGE CONTROL UNIT

Wrong Side Failure
AWS Code 7
NO HORN OR BRAKE
POSSIBLE CAUSE
AWS RECEIVER HAS FAILED TO DETECT PERMANENT MAGNET
SOLUTION
CHECK: AWS Rx HEIGHT, IF CORRECT THEN CHANGE AWS RECEIVER (AWS cable fault would cause a Code 2)

Wrong Side Failure
AWS Code 7a
SUNFLOWER NOT YELLOW/BLACK
POSSIBLE CAUSE
AWS INDICATOR FAILURE (should be noticed during Power Up Test)
SOLUTION
CHANGE: AWS INDICATOR, IF PROBLEM NOT FIXED THEN CHANGE CONTROL UNIT

AWS Code 8
HORN INSTEAD OF NO-INDICATION
POSSIBLE CAUSE
AWS RECEIVER FAILURE
SOLUTION
CHANGE: AWS RECEIVER & CABLE

AWS Code 9
BELL INSTEAD OF NO-INDICATION
POSSIBLE CAUSE
SPURIOUS AWS RECEIVER OPERATION – eg. Response to a trackside traction cable
SOLUTION
TRAINBORNE EQUIPMENT NOT AT FAULT

AWS Code 10
UNABLE TO CANCEL
POSSIBLE CAUSE
MANY POSSIBLE CAUSES POSSIBLE DRIVER ERROR WHEN ACK - CHECK TDP?
SOLUTION
CHANGE: AWS RECEIVER & CABLE, test CONTROL UNIT, test ACK BUTTON, TEST AWS INDICATOR

AWS Code 11
SUNFLOWER NOT ALL BLACK
POSSIBLE CAUSE
AWS INDICATOR FAILURE (should show up during Power Up Test)
SOLUTION
CHANGE: AWS INDICATOR, IF NOT FIXED THEN CHANGE CONTROL UNIT

Wrong Side Failure
AWS Code 16
TPWS FAILED TO ACTIVATE
POSSIBLE CAUSE
AERIAL POSITION COULD BE INCORRECT, OR TRACKSIDE FAULT
SOLUTION
CHECK: AERIAL LOCATION, PERFORM TTU TEST, IF OK, CHECK TRACKSIDE LOCATION

Unrequired TPWS Operation
AWS Code 17
POSSIBLE CAUSE
CAUSED BY ACK BUTTON PRESSED LATE, OR TRACK INTERFERENCE IN TRIP LOCATION
SOLUTION
CHECK: BRAKE WIRING, CHANGE CONTROL UNIT IF BRAKES DO NOT RELEASE

Note: Fault codes 12-15 are not relevant to this document

Figure G K.3 Combined AWS/TPWS fault finding guide
Figure G K.4  Combined AWS/TPWS system fault-finding flowchart
### G K.6 Common AWS and TPWS failure mechanisms

Some common AWS and TPWS failure mechanisms are set out below. These are categorised into human error, system faults and trainborne sub-system equipment faults.

<table>
<thead>
<tr>
<th>Type of fault</th>
<th>Category of Fault</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWS failed system power up test</td>
<td>System fault</td>
<td>A cab is opened up with the AWS receiver directly over an AWS magnet</td>
</tr>
<tr>
<td>Unwarranted AWS brake application</td>
<td>Human error</td>
<td>Driver not resetting AWS within the specified caution acknowledgement period</td>
</tr>
<tr>
<td>AWS fault code 1 (horn and bell when clear indication expected)</td>
<td>Trainborne equipment</td>
<td>Spurious switching of AWS receiver – fault in AWS receiver or cable</td>
</tr>
<tr>
<td>AWS fault code 2 (horn instead of bell when clear indication expected)</td>
<td>System fault</td>
<td>Faulty track magnet (for example electromagnet fault or field strength out of specification)</td>
</tr>
<tr>
<td>AWS receiver on the train marginal sensitivity or mounted too high or passing over magnet at extreme of suspension movement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AWS fault code 2 (horn instead of bell when clear indication expected)</td>
<td>Trainborne equipment</td>
<td>AWS receiver faults – check AWS receiver height and sensitivity</td>
</tr>
<tr>
<td>AWS fault code 3 (no indication instead of bell)</td>
<td>Trainborne equipment</td>
<td>AWS alarm and indicator unit or bell fault</td>
</tr>
<tr>
<td>AWS fault code 4 (bell and horn when warning indication expected)</td>
<td>Trainborne equipment</td>
<td>Reed AWS receivers operating over extra strength magnets, particularly at slow speed, may give rise to AWS code 4 failures as a result of incorrect operation of internal relays within the receiver. This fault could be masked in older relay based logic units by the timing of relay operation, but was revealed following the fitting of electronic control units. A possible solution would be to replace the reed AWS receiver with an electronic solid state AWS receiver</td>
</tr>
<tr>
<td>AWS fault code 5 (bell instead of horn)</td>
<td>Trainborne equipment</td>
<td>Permanent reset voltage on AWS receiver due to short circuit on AWS reset pushbutton or faulty control unit</td>
</tr>
<tr>
<td>AWS fault code 5 (bell instead of horn)</td>
<td>System fault</td>
<td>False energisation of an AWS receiver by unintentional magnetic flux – may be a particular issue for standard strength receivers operating over extra strength magnets</td>
</tr>
<tr>
<td>AWS fault code 6 (brake without horn)</td>
<td>Trainborne equipment</td>
<td>AWS alarm and indicator unit or horn fault</td>
</tr>
<tr>
<td>AWS fault code 7 (no indication or brake when warning indication expected)</td>
<td>System fault</td>
<td>Faulty track magnet (for example permanent magnet field strength out of specification)</td>
</tr>
<tr>
<td>Type of fault</td>
<td>Category of Fault</td>
<td>Possible cause</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-----------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>AWS fault code 7 (no indication or brake when warning indication expected)</td>
<td>Trainborne equipment</td>
<td>AWS receiver failed to detect track magnet – check AWS receiver height and sensitivity</td>
</tr>
<tr>
<td><strong>WRONG SIDE FAILURE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AWS fault code 8 (horn when no indication expected)</td>
<td>System fault</td>
<td>Trainborne equipment detecting a strong magnetic field from non-AWS trackside infrastructure, for example high currents passing through cross-track traction cables</td>
</tr>
<tr>
<td><strong>AWS fault code 8 (horn when no indication expected)</strong></td>
<td>Trainborne equipment</td>
<td>AWS receiver failure</td>
</tr>
<tr>
<td><strong>AWS Fault Code 9 (bell when no indication expected)</strong></td>
<td>System fault</td>
<td>Trainborne equipment detecting a strong magnetic field from non-AWS trackside infrastructure, for example high currents passing through cross-track traction cables</td>
</tr>
<tr>
<td><strong>AWS fault code 10 (unable to cancel)</strong></td>
<td>Human error</td>
<td>Driver holding down the AWS reset pushbutton before the AWS caution audible tone is sounded</td>
</tr>
<tr>
<td><strong>AWS fault code 10 (unable to cancel)</strong></td>
<td>System fault</td>
<td>A cab is opened up with the AWS receiver directly over an AWS magnet</td>
</tr>
<tr>
<td><strong>AWS fault code 10 (unable to cancel)</strong></td>
<td>Trainborne equipment</td>
<td>Identified issue with Thales Mark I control units prior to modification status strike 4</td>
</tr>
<tr>
<td><strong>AWS fault code 11 (indicator not changing to ‘all black’)</strong></td>
<td>Trainborne equipment</td>
<td>AWS alarm and indicator unit or sunflower fault</td>
</tr>
<tr>
<td>TPWS failed system power up test</td>
<td>System fault</td>
<td>A cab is opened up with the TPWS aerial directly over an active TPWS transmitter loop (affects older systems; newer systems may be able to cope with this situation)</td>
</tr>
<tr>
<td><strong>TPWS fault code 16 (TPWS failed to activate)</strong></td>
<td>Trainborne equipment</td>
<td>TPWS aerial not correctly located (possibly due to movement of the aerial within the assembly) but electrically still connected to control unit – possible solution is to install a composite aerial harness which has a mechanical location</td>
</tr>
<tr>
<td><strong>TPWS TSO not operated or timed out before passing signal at danger with authority</strong></td>
<td>System fault</td>
<td>Faulty TPWS transmitter loop</td>
</tr>
<tr>
<td><strong>TPWS fault code 17 (TPWS operated when not required)</strong></td>
<td>Human error</td>
<td>Over-speeding on OSS for signal or PSR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TPWS not temporarily isolated when required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TPWS TSO not operated or timed out before passing signal at danger with authority</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Type of fault</th>
<th>Category of Fault</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPWS fault code 17 (TPWS activated when not required)</td>
<td>System fault</td>
<td>Thales Mark I modification 0 control units could generate a brake demand due to trainborne equipment detecting a valid sequence of signals when travelling reverse direction over TSS. Trainborne equipment detecting TPWS frequencies from trackside infrastructure, specifically the harmonics of certain TI 21 track circuit transmitters (higher risk if TPWS aerial is ahead of the leading axle). TPWS OSS still active for movement controlled by subsidiary signal (standard arrangement is now to suppress OSS when subsidiary signal off). TPWS ‘self-reversion’ due to TPWS TSS reactivated before TPWS aerial clear of transmitter loops. Trainborne equipment wrongly interpreting OSS transmitter loop lobes as main field at low speed (experienced as a widespread problem at terminal stations where full size OSS loops were fitted on approach to buffer stops – generally avoided by changing to miniature loops).</td>
</tr>
<tr>
<td>Failure of TDR to record AWS/TPWS outputs</td>
<td>Trainborne equipment</td>
<td>Failure of control unit TDR output relay volt-free contacts soft-sticking due to inrush current damage.</td>
</tr>
<tr>
<td>AWS/TPWS brake application delay</td>
<td>Trainborne equipment</td>
<td>Thales control units prior to modification strike 2 subject to internal brake demand relay failure (sticking armature) – replace and return to Thales.</td>
</tr>
<tr>
<td>Flashing fault light on driver’s control panel</td>
<td>Trainborne equipment</td>
<td>Intermittent connection problem between TPWS aerial and connecting cable (solutions are to replace the aerial / cable connector arrangement with a hard wired aerial or improve the securing mechanism for the aerial / cable interface). Check the aerial for continuity.</td>
</tr>
</tbody>
</table>

Note: Fault codes 12-15 are not relevant to this document.

**Table G K.5**  Common AWS/TPWS faults
Appendix L  AWS Testing using a Hand-Held Permanent Magnet

The content of this appendix is for information only

G L.1.1 An AWS hand-held test magnet can be used, as set out in Table G L.1 below, to check the functioning of the AWS trainborne sub-system to detect where, within the basic sequence of events, a fault occurs. Testing the AWS trainborne sub-system with a hand-held test magnet has the advantage of rapidly repeating the failure. Dual-cab vehicles should be tested from both ends, as failure at one end only will indicate that the control unit, PSU and AWS receiver are healthy.

| A1 | Before any equipment or connections are disturbed, perform the tests set out in items A2 to A8. |
| A2 | With the air system fully charged, energise the AWS in the cab in which the failure is reported to have occurred. |
| A3 | Check that the horn sounds. Press and release the 'AWS acknowledge' pushbutton to silence the horn. |
| A4 | Carry out a caution signal test cancelling the AWS as follows: |
| | • Simulate a caution indication by passing the south pole (blue) end of the magnet under the AWS receiver. |
| | • The indicator should change to or remain 'all black', and after one second the horn should sound. |
| | • Within two seconds, press and release the 'AWS acknowledge' pushbutton to silence the horn – the indicator should change to 'yellow and black' and there should be no brake application. |
| A5 | Carry out a caution signal test allowing a full brake application and then cancel the AWS, as follows: |
| | • Simulate a caution indication by passing the south pole (blue) end of the magnet under the AWS receiver. |
| | • The indicator should change to or remain 'all black', the horn should sound after one second and, after a further time delay (2.0 seconds or 2.7 seconds) appropriate to the vehicle concerned, a full brake application should occur. |
| | • Press and release the 'AWS acknowledge' pushbutton – the horn should be silenced and the indicator should change to 'yellow and black' and, after a time delay appropriate to the vehicle concerned, the brake should release at least 59 seconds after the brake application. |
| A6 | Carry out a caution signal test allowing a partial brake application and then cancel the AWS, as follows: |
| | • Simulate a caution indication by passing the south pole (blue) end of the magnet under the AWS receiver. |
| | • The horn should sound after one second. As soon as the brake starts to apply, press and release the 'AWS acknowledge' pushbutton to silence the horn – the brake should continue to apply and should not release until after a time delay appropriate to the vehicle concerned. |
| A7 | Carry out a clear signal test as follows: |
| | • Simulate a clear indication by passing the south pole (blue) end of the magnet under the AWS receiver and then passing the north pole (red) end of the magnet under the AWS receiver, taking less than one second between the two operations. |
| | • The indicator should change to 'all black' and the bell ring for approximately 0.5 seconds (or a single chime is emitted on vehicles fitted with an alarm and indicator unit). |
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| A8 | Carry out a test with the AWS equipment isolated, as follows:  
|    | • Isolate the AWS in the cab concerned.  
|    | • Operate the AWS receiver with the south pole (blue) end and then the north pole (red) end of the magnet, taking less than one second between the two operations. Follow this by operating the AWS receiver with the south pole (blue) end only — there should be no effect on the AWS equipment.  
|    | • De-isolate the AWS in the cab concerned. |

| A9 | If any item of AWS equipment is suspected of being faulty it should be changed. After the replacement has been fitted repeat items A4 to A8 three times, if either:  
|    | • The reported fault can be reproduced, but changing the item indicated during the above tests does not cure it, or  
|    | • The fault cannot be reproduced but the vehicle has a history of related faults.  
|    | Check the system using an AWS test unit, if available, then visually examine the wiring and connectors as far as reasonably practicable. If the fault is still not revealed, then detailed wiring tests should be carried out. |

| A10 | After any equipment change, wiring repair or renewal has been carried out, items A4 to A8 should be repeated. |

Table G L.1  Test after a 'right side failure' reported

G L.1.2 An AWS hand-held test magnet can be used, as set out in Table G L.2 below, to check the functioning of the AWS trainborne sub-system as part of a wrong side failure investigation before any equipment / connections are disturbed. This should be as part of an overall inspection and test procedure using more sophisticated AWS test equipment.

| B1 | Carry out items A2 to A8, repeating items A4 to A8 a total of three times. |

| B2 | If any item of AWS equipment is suspected of being faulty it should be changed. If the AWS operates correctly or does not reproduce the reported fault, then follow procedures for a full system test. After replacements have been fitted, items A2 to A8 should be repeated, if either:  
|    | • The reported fault can be reproduced, but changing the item indicated during the above tests does not cure it, or  
|    | • The fault cannot be reproduced but the vehicle has a history of related faults  
|    | Check the system using an AWS test unit, then visually examine the wiring and connectors as far as reasonably practicable. If the fault is still not revealed, then detailed wiring tests should be carried out. |

| B3 | After any equipment change, wiring repair or renewal has been carried out, items A4 to A8 should be repeated. |

Table G L.2  Test after a 'wrong side failure' reported
Definitions and Abbreviations

Arming frequency
A frequency generated by the TPWS track sub-system which, when detected by the vehicle, arms the train sub-system.

AWS
Automatic Warning System.

Availability
The ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are present. (Source BS EN 50129:2003.)

DC electrified lines
Lines equipped with DC electrification, whether or not the line is also equipped with AC electrification.

Driver machine interface (DMI)
The driver machine interface provides indications to the driver of the system status, as well as allowing the driver to control selected system functions.

Driving position
The normal position from which the driver controls the train, by operating the primary controls, as set out in GM/RT2161. The active driving position is the position being used by the driver to drive the train.

Excessive speed
With reference to provision of TPWS on the approach to speed restrictions, a speed exceeding the overspeed margin above which derailment risk is considered to require mitigation.

Interleaving
Interleaving is the term used where the arming or trigger transmitter of one pair of TPWS track transmitters is positioned between a different pair of TPWS track transmitters.

Nesting
Nesting is the term used where one pair of TPWS track transmitters is positioned in between a different pair of TPWS track transmitters.

Overspeed system (OSS)
The overspeed system (OSS) (also referred to as the overspeed sensor system) is a TPWS facility whose function is to initiate a brake application on a train that approaches a signal showing a danger aspect, or other location, at excessive speed.

Running line
A line as shown in Table A of the Sectional Appendix as a passenger line or as a non-passenger line.

Set speed
Set speed is the minimum speed at which a brake application is initiated when a train passes over the track elements of an active OSS.

SPAD
Signal passed at danger.
Suppression (AWS and TPWS trainborne sub-systems)
A state of the trainborne sub-system where it is does not provide operational outputs to the driver or initiate brake demands, for example when an alternative train control system is in use and AWS indications and TPWS interventions are not required. The system is still active in monitoring its status and may indicate fault conditions.

Suppression (AWS magnets)
The application of an opposing magnetic field to an AWS permanent magnet to prevent the detection of the permanent magnet when a train is not required to receive an AWS indication.

TPWS
Train Protection and Warning System.

TPWS Miniature Loop
A TPWS transmitter loop smaller than the standard loop, which is used at OSS installations on the approach to buffer stops and certain other locations where speeds are low.

TPWS Standard Loop
A TPWS transmitter loop of standard dimensions, which is used at all TSS installations and at most OSS installations, except on the approach to buffer stops.

TPWS temporary isolation switch
A switch provided in the cab whereby the TPWS can be temporarily isolated.

Track sub-system
The TPWS track sub-system comprises the components mounted on the track or at the trackside that are used to provide the train stop system (TSS) and OSS functionality.

Train Data Recorder (TDR)
A device to record data concerned with the performance of on-board systems. Also known as ‘On Train Monitor and Recorder’ (OMTR).

Train stop override
The facility that allows a train to pass a signal at danger without invoking a brake demand caused by the train stop system (TSS).

Train stop system (TSS)
The train stop system (TSS) is a TPWS facility whose function is to initiate a brake application on a train that passes a signal at danger without authority.

Train sub-system
The TPWS train sub-system comprises the components mounted on vehicles that are used to provide TSS and OSS functionality.

Trigger delay
The pre-set period timed by the train sub-system and initiated by detection of an OSS arming frequency.

Trigger frequency
A frequency generated by the TPWS track sub-system which, when detected by the vehicle, triggers the train sub-system.

Vehicle
For the purposes of this document the term vehicle is used to define that part of a train which is fitted with the AWS and TPWS equipment, where ‘train’ has the same meaning as in section 83(1) of the Railways Act 1993.
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References

The Catalogue of Railway Group Standards gives the current issue number and status of documents published by RSSB. This information is also available from www.rgsonline.co.uk.

RGSC 01 Railway Group Standards Code
RGSC 02 Standards Manual

Documents referenced in the text

Railway Group Standards
GC/RT5212 Requirements for Defining and Maintaining Clearances
GE/RT8000 Rule Book
GE/RT8035 Automatic Warning System (AWS)
GE/RT8075 AWS and TPWS Interface Requirements
GE/RT8106 Management of Safety Related Control, Command and Signalling (CCS) System Failures
GE/RT8270 Assessment of Compatibility of Rolling Stock and Infrastructure
GI/RT7006 Prevention and Mitigation of Overruns – Risk Management
GI/RT7033 Lineside Operational Safety Signs
GK/RT0045 Lineside Signals, Indicators and Layout of Signals
GK/RT0075 Lineside Signal Spacing and Speed Signage
GK/RT0192 Level Crossing Interface Requirements
GM/RT2044 Braking System Requirements and Performance for Multiple Units
GM/RT2045 Braking Principles for Rail Vehicles
GM/RT2161 Requirements for Driving Cabs of Railway Vehicles
GM/RT2185 Train Safety Systems
GM/RT2472 Requirements for Data Recorders on Trains

RSSB documents
GE/GN8537 Guidance on Signal Positioning and Visibility
GE/GN8612 Guidance on Signalling Layout Driveability Assessment Requirements [in preparation]
RIS-0386-CCS Rail Industry Standard on Signal Overrun Risk Evaluation and Assessment

Other references
BS EN 50129:2003 Railway applications. Communication, signalling and processing systems. Safety related electronic systems for signalling
ERA_ERTMS_015560 ETCS Driver Machine Interface
SI 1999/2244 Railway Safety Regulations: 1999
T804 Automatic Warning System infrastructure characterisation
T906 ERTMS/ETCS driver machine interface options for future train cab design