Automatic Warning System (AWS)

Synopsis
This document defines the functional, performance and application requirements for the Automatic Warning System.

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Superseded documents

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GE/RT8035, Issue One, Automatic Warning System (AWS), ceases to be in force and is withdrawn as of 02 June 2012.

Supply

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Automotive Warning System (AWS)

Part 1  Purpose and Introduction

1.1  Purpose

1.1.1  This document mandates requirements for the functional operation, performance and application of the Automatic Warning System (AWS).

1.2  System description

1.2.1  Introduction

1.2.1.1  This section provides an overview of how the AWS system operates. Its purpose is informative, and it does not contain any mandatory requirements.

1.2.2  Purpose of AWS

1.2.2.1  AWS is provided to give train drivers in-cab warnings of the approach to signals, reductions in permissible speed and temporary / emergency speed restrictions, and to apply the brakes in the event that a driver does not acknowledge cautionary warnings given by the system.

1.2.3  Basic system operation

1.2.3.1  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 (magnets) which are fixed to the sleepers between the running rails.

   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, a brake demand indicator and brake release push button (as set out in GE/RT8030), and a switch or similar device for isolating the AWS equipment if it is defective.

   c) If the signal is displaying a clear aspect, a bell (or an electronic equivalent) sounds in the driver’s cab, and the visual indicator displays an ‘all black’ state (that is, the appearance is a black circle – described in GE/RT8000 – 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 caution or stop aspect, a horn (or an electronic equivalent) sounds 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 yellow and black 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 and the brake demand indicator on the TPWS control panel starts to flash. The visual indicator remains ‘all black’ and the horn continues to sound.
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GE/RT8035
Issue Two
Date March 2012

1.2.4 System operation for permissible speeds and speed restrictions
1.2.4.1 Where AWS equipment is provided on the approach to reductions in permissible speed and temporary / emergency speed restrictions, the cab equipment always operates in a manner equivalent to the approach to a signal displaying a caution or stop aspect. The driver receives a warning, as set out in 1.2.3.1d, and has to respond to it accordingly, otherwise the brakes are applied automatically, as set out in 1.2.3.1f) to 1.2.3.1g).

1.3 Related documents
1.3.1 Related requirements in other documents
1.3.1.1 The following Railway Group Standards contain requirements that are relevant to the scope of this document:

- GE/RT8030 Requirements for the Train Protection and Warning System (TPWS)
- GE/RT8106 Management of Safety Related Control, Command and Signalling (CCS) System Failures
- GI/RT7033 Lineside Operational Safety Signs
- GK/RT0075 Lineside Signal Spacing and Speed Signage
- GK/RT0192 Level Crossing Interface Requirements
- GM/RT2169 Combined Manual for AWS and TPWS Trainborne Equipment

1.4 Approval and authorisation of this document
1.4.1 The content of this document was approved by Control Command and Signalling Standards Committee on 26 January 2012.

1.4.2 This document was authorised by RSSB on 26 January 2012.
Part 2 Requirements for the Automatic Warning System (AWS)

2.1 Compatibility requirements for AWS

2.1.1 Route compatibility assessment

2.1.1.1 Where route compatibility is being assessed, as set out in GE/RT8270, the AWS receiver arrangements on a train shall be assessed to determine whether they are compatible with the type of AWS track equipment on the route over which the train is to operate (see also 2.6.2).

2.1.1.2 Where, under exceptional circumstances, it is necessary for a train not fitted with AWS equipment to operate over an AWS fitted line, the infrastructure manager and railway undertaking shall agree, document and implement appropriate operating procedures to ensure the safe movement of trains.

2.1.1.3 The requirement set out in 2.1.1.2 is not applicable where a train protection system is in use and the Railway Group Standard which specifies the application rules for that system provides an exemption from the requirement to fit AWS.

2.2 Provision of AWS track equipment

2.2.1 AWS for lineside signals

2.2.1.1 AWS equipment shall be provided at all signals as set out in Table 1, except as permitted by the ‘exemptions’ column or by the provisions of 2.2.5.

2.2.1.2 On single and bi-directional lines, AWS track equipment shall be provided for both directions of movement.

2.2.1.3 There is no requirement to provide AWS track equipment on the approach to buffer stops.

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<thead>
<tr>
<th>Type of signal at which AWS shall be fitted</th>
<th>Exemptions from fitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>All main colour light signals</td>
<td>a) On bay and terminal platform lines, the platform signal nearest the buffer stops does not have to be fitted (this is normally the signal at the end of the platform, but where mid-platform signals are provided, it is the mid-platform signal nearest the buffer stops).</td>
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<tr>
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<td>b) Signals which have no main signalled route leading up to them (for example, signals provided solely for turnback moves) do not have to be fitted.</td>
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<td></td>
<td>c) Where semaphore stop signals are replaced by colour light signals, it is permissible to perpetuate the provision of AWS track equipment at just the distant signals (that is, not providing AWS at the stop signals), but only if:</td>
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<tr>
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<td>i) A semaphore aspect sequence has been retained in accordance with the requirements set out in GK/RT0045 (this means that the distant signal will be held at caution when any of the associated stop signals is at danger), and</td>
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<tr>
<td></td>
<td>ii) The stop signals controlled by adjacent signal boxes are not fitted with AWS track equipment.</td>
</tr>
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</table>
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<table>
<thead>
<tr>
<th>Type of signal at which AWS shall be fitted</th>
<th>Exemptions from fitment</th>
</tr>
</thead>
</table>
| All main colour light signals which give access to running lines from non-running lines | Signals at which both:  
  a) Trains usually come to a stand, and  
  b) Trap points are provided to protect the running line(s). |
| All semaphore distant signals and signs that perform the function of a distant signal | None |

Table 1  Provision of AWS at signals

2.2.1.4 The positioning of the AWS track equipment shall give the driver sufficient time between receiving the audible warning and passing the associated signal so that he / she can relate the signal aspect and any associated indication to the AWS warning. This time shall be not less than 2 seconds. Allowing for the initial delay period of 1 second (see Table 9), this requires that the distance from the magnet to the signal shall be not less than the distance travelled in 3 seconds at the permissible speed.

2.2.1.5 AWS track equipment shall usually be positioned so that the driver is able to see the associated signal under conditions of normal visibility at the time that the audible warning is received.

2.2.1.6 In exceptional circumstances, it is permissible to place the AWS track equipment such that the audible warning is received by the driver before the signal becomes visible, where this will:

  a) Help the driver to obey the signal in a safe manner, and  
  b) Not create a risk that the driver fails to associate the audible warning with the signal, either because it could be erroneously associated with another signal or a speed restriction, or because the time interval between receiving the AWS warning and seeing the signal is excessive (it should typically be no more than 3 seconds at the permissible speed).

2.2.1.7 Subject to compliance with the requirements of 2.2.1.4, 2.2.1.5, 2.2.1.6 and 2.2.4, AWS track equipment for signals shall be positioned 180 m (tolerance +10%, -5%) before a signal, except as set out in 2.2.1.8, 2.2.1.9 and 2.2.1.10.

2.2.1.8 On a section of route where existing AWS track equipment is positioned 230 m (tolerance +10%, -5%) before signals, it is permissible for new AWS track equipment also to be positioned at a distance of 230 m (tolerance +10%, -5%) before signals to maintain consistency of AWS positioning on the line of route, provided that this does not create additional risk.
2.2.1.9 In the case of bi-directionally signalled platform lines, it is permissible to position AWS track equipment at distances other than those specified above, in order to achieve correct operation of the equipment for train movements (for example, where platform sharing is permitted).

2.2.1.10 Where there is a conflict between the position of a signal and the position of the AWS track equipment such that it is not possible to position both optimally, then the positioning of the signal shall take precedence.

2.2.1.11 The position of the AWS track equipment in relation to the signal shall be subject to endorsement by a signal sighting committee, as set out in GE/RT8037.

2.2.2 AWS for movements from unfitted lines to fitted lines

2.2.2.1 In the special case of signals controlling movements from running lines that are not fitted with AWS track equipment to a running line that is fitted, the following arrangements apply (see Figure 5 and Figure 6 in Appendix C):

a) Where there is a turnout from a through running line that is 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 be positioned beyond, but as close as practicable to, the signal.

For movements along the through unfitted line (that is, not through the turnout onto the fitted line) no AWS indication shall be given to the driver. This shall be achieved by suppressing the magnetic fields of the track equipment. Details of suppression arrangements are set out in 2.3.1, 2.3.2, and 2.4.3.

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.

The distant signal associated with the stop signal shall not be fitted with AWS.

b) Where the running line not fitted with AWS leads only to an AWS fitted line (that is, the two lines converge), the stop signal controlling movements from the unfitted line to the fitted line and the associated distant signal shall both be fitted with AWS track equipment in accordance with the requirements set out in 2.2.1.

2.2.3 Provision of AWS at other locations

2.2.3.1 The requirements for the provision of AWS equipment for reductions in permissible speed, and for temporary / emergency speed restrictions, are set out in GK/RT0075.

2.2.3.2 The requirements for the provision of AWS equipment at warning boards on the approach to level crossings are set out in GK/RT0192.

2.2.3.3 AWS equipment shall not be provided at any locations or for any purpose other than as permitted by this document and by the documents referenced in 2.2.3.1, 2.2.3.2 and 2.11.5.

2.2.4 General constraints on the positioning of AWS track equipment

2.2.4.1 The following constraints are applicable to the positioning of all AWS track equipment, whether provided for signals or for other purposes.
2.2.4.2 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, since this could cause the trainborne AWS equipment to malfunction, necessitating isolation of the equipment.

b) Within 4 seconds travelling time of any other AWS track equipment (calculated at the permissible speed), unless one or other of the sets of the equipment is always suppressed for movements over them (details of suppression are set out in 2.4.3). This is necessary to prevent the response of the trainborne AWS equipment to the first set of track equipment masking its response to the second set.

c) Where it could interfere with the correct operation of Automatic Power Control (APC) equipment, or vice versa (for example, in switches and crossings).

d) Where the correct operation of the AWS track equipment could be jeopardised by the proximity of DC traction cables or impedance bonds. Specifically, AWS track equipment shall not be positioned in either of the following locations:

i) Less than 3.5 m from cross-track traction feeder cables, traction return bonds or impedance bonds on DC electrified lines, in order to avoid the AWS magnetic field being 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 on DC electrified lines, in order to avoid a false ‘clear’ indication being given to a driver by a combination of the AWS track equipment and other equipment.

2.2.4.3 In order to avoid confusion about which signal or sign the AWS track equipment applies to, the following items of equipment shall not be positioned between a signal 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.

2.2.5 AWS gap areas

2.2.5.1 Where an existing station area is not fitted with AWS track equipment, AWS shall be fitted when the area is resignalled, unless both of the following apply:

a) All permissible speeds in the unfitted area are less than 50 km/h (31 mph), and

b) It is shown by a risk assessment that it is not reasonably practicable to fit AWS.
2.2.5.2 The risk assessment will usually be undertaken as part of the overrun risk assessment process required by GI/RT7006. Factors to be taken into account in the risk assessment include:

a) Positioning of the boundaries between AWS fitted and unfitted signals, in terms of being logical and consistent so far as drivers are concerned.

b) Time for which a driver is able to observe unfitted signals on the approach to them.

c) Other competing demands on the driver's attention at the time that he / she is observing the signals.

2.2.5.3 Any non-fitment shall be applied to well-defined areas or lines, not to selected signals within an area.

2.2.5.4 Where AWS is not provided, as permitted by 2.2.5.1, lineside signs shall be provided to indicate the commencement and termination of the gap on all running lines that provide entry to and / or exit from the gap area. The types of signs are set out in GI/RT7033, and shall be located as follows:

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

b) The 'termination of gap' sign shall be not less than 4 seconds' travelling time before the AWS track equipment for the first fitted signal. The travelling time shall be calculated using the permissible speed.

2.3 Design and configuration of AWS track equipment

2.3.1 Equipment required

2.3.1.1 The track equipment required for the various applications of AWS shall be as follows:

a) A permanent magnet, with its south pole uppermost (conventionally indicated as negative flux density) when fixed to the track.

b) An electromagnet, with its north pole uppermost (conventionally indicated as positive flux density) when fixed to the track and energised.

c) A permanent magnet, with its south pole uppermost (conventionally indicated as negative flux density) when fixed to the track, but whose magnetic field is capable of being suppressed when required (hereafter referred to as a suppressor magnet). Suppression is achieved by energising an electromagnet associated with the permanent magnet (see 2.4.3.2).

d) A permanent magnet for use as a depot test magnet, with its south pole uppermost (conventionally indicated as negative flux density) when fixed to the track.

2.3.1.2 DC electrified lines require magnets of higher field strength than those provided on lines that are not DC electrified. The field strength requirements for all magnets are set out in 2.5.

2.3.1.3 The functional and performance requirements for portable permanent magnets (provided for temporary / emergency speed restrictions) shall be the same as for permanent magnets provided for signals and for reductions in permissible speeds.
2.3.2 Permitted combinations of AWS magnets

2.3.2.1 The combinations of magnets that are permitted for the designated applications are set out in Table 2. Diagrams of typical configurations are shown in Appendix C.

<table>
<thead>
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<th>Application</th>
<th>Magnets to be provided</th>
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<tr>
<td>a) Main colour light signal not capable of displaying a green aspect</td>
<td>Permanent magnet, or where bi-directional running is permitted and AWS suppression is required, a suppressor magnet</td>
</tr>
<tr>
<td>b) Semaphore distant signals fixed at caution</td>
<td>Permanent magnet, or where bi-directional running is permitted and AWS suppression is required, a suppressor magnet</td>
</tr>
<tr>
<td>c) Signs that perform the function of a distant signal</td>
<td>Permanent magnet followed, in the direction of travel, by an electromagnet; or where bi-directional running is permitted and AWS suppression is required, a suppressor magnet followed in the direction of travel by an electromagnet.*</td>
</tr>
<tr>
<td>d) Main colour light signal capable of displaying a green aspect</td>
<td>Permanent magnet followed, in the direction of travel, by an electromagnet; or where bi-directional running is permitted and AWS suppression is required, a suppressor magnet followed in the direction of travel by an electromagnet.*</td>
</tr>
<tr>
<td>e) Semaphore distant signal (except those fixed at caution)</td>
<td>Permanent magnet, with electromagnets both before and after the permanent magnet (but where either of the signals is not capable of displaying a green aspect, the electromagnet for that signal is not required)</td>
</tr>
<tr>
<td>f) Main colour light signals for movements in opposite directions, sharing a common set of AWS track equipment</td>
<td>Permanent magnet, or where bi-directional running is permitted and AWS suppression is required, a suppressor magnet</td>
</tr>
<tr>
<td>g) Warning of an approach to a reduction in permissible speed (where required by GK/RT0075)</td>
<td>Permanent magnet, or where bi-directional running is permitted and AWS suppression is required, a suppressor magnet</td>
</tr>
<tr>
<td>h) Warning of an approach to a level crossing (where required by GK/RT0192)</td>
<td>Permanent magnet (usually a portable type)</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 (usually a portable type)</td>
</tr>
<tr>
<td>j) Maintenance depot exit lines</td>
<td>Depot test magnet, as set out in 2.11.5</td>
</tr>
</tbody>
</table>

* A suppressor combination of magnets is also required for the special circumstances set out in 2.4.3.6 and 2.4.3.7.
2.3.3 Mounting of magnets on the track

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

2.3.3.2 Where magnets are used in combinations, as set out in 2.3.2, the magnetic centres of adjacent magnets shall be not less than 0.70 m and not more than 0.75 m apart.

2.3.3.3 The uppermost surfaces of the magnets shall be not more than 12 mm above rail level. General requirements for maintaining clearances between trains and infrastructure, with which AWS track equipment has to comply, are set out in GC/RT5212.

2.3.3.4 The physical arrangements for the securing of the AWS track equipment to the track shall not adversely affect either of the following:

a) The mechanical integrity of the track.

b) The electrical integrity of the train detection systems.

2.4 Control of AWS track equipment by the signalling system

2.4.1 Colour light signals

2.4.1.1 The AWS electromagnet shall be energised only when the associated main signal is displaying a green aspect.

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

2.4.1.3 A train approaching a signal at green therefore senses a south pole field followed by a north pole field, and the driver receives a ‘clear’ AWS indication in the cab. A train approaching a signal that is displaying any other aspect, or that is not alight, senses only a south pole field, and receives a ‘warning’ AWS indication.

2.4.2 Semaphore signals

2.4.2.1 The AWS electromagnet shall be energised only when the associated distant semaphore signal is intentionally displaying ‘off’.

2.4.2.2 In the case of a semaphore splitting distant signal, the AWS electromagnet shall be energised if either arm is displaying ‘off’.

2.4.2.3 A train approaching a semaphore distant signal displaying ‘off’ therefore senses a south pole field followed by a north pole field, and the driver receives a ‘clear’ AWS indication in the cab. A train approaching a semaphore distant signal that is displaying ‘on’ senses only a south pole field, and receives a ‘warning’ AWS indication.

2.4.3 Suppression of AWS track equipment

2.4.3.1 In some circumstances it is necessary to suppress the operation of the AWS track equipment so that a train passing over it does not receive any indication (the circumstances are set out in 2.4.3.4 to 2.4.3.7).
2.4.3.2 To achieve this, a suppressor magnet shall be provided, comprising a permanent magnetic element and an electromagnetic element. The electromagnetic element shall be energised for a train movement over it in the direction for which the equipment does not apply, thereby suppressing the magnetic field above the suppressor magnet to a low residual level of flux density, as set out in 2.5.2.6 and 2.5.3.6.

2.4.3.3 For the purposes of economising on trackside equipment power consumption, it is permissible for suppression to be removed as soon as the vehicle on which the receiver (for the active driving position) is mounted has passed over the AWS track equipment, rather than waiting for the whole train to pass clear.

2.4.3.4 On single lines and bi-directionally signalled lines, AWS track equipment shall be suppressed for signalled movements in the direction to which the equipment does not apply, except as permitted by bullet point f) in Table 2, 2.4.3.8 and 2.4.3.9.

This applies to:

a) Running movements, shunting movements and movements on occupied lines.

b) AWS for both signals and for reductions in permissible speed.

2.4.3.5 On a single / bi-directional line, a train passing over the AWS equipment in the direction for which the equipment is provided therefore receives normal AWS indications, as set out in 2.4.1. A train passing over the equipment in the opposite direction receives no AWS indications at all, and the status of the trainborne AWS equipment is unaltered.

2.4.3.6 Where a semaphore junction signal has both stop and distant arms (and is therefore provided with AWS) the AWS equipment shall be suppressed when the signal is cleared for a route to which the distant arm(s) is / are not applicable. A train therefore receives no AWS indications at all for such a route, and the status of the trainborne AWS equipment is unaltered.

2.4.3.7 AWS track equipment associated with stop signals that control movements from through unfitted lines to fitted lines shall be suppressed for movements along the unfitted line, as set out in 2.2.2.

2.4.3.8 There is no requirement for AWS track equipment to be suppressed for:

a) Shunting movements on unidirectional lines.

b) Wrong direction movements during temporary single line working and the working of single / bi-directional lines by pilotman, as set out in the Rule Book.

c) Movements over AWS magnets associated with warning boards for temporary / emergency restrictions that are not applicable to the direction of movement.

2.4.3.9 On lightly used single lines operated by a method other than track circuit block, it is permissible not to suppress AWS track equipment (for movements in the direction to which the equipment does not apply), if it can be demonstrated that it is not reasonably practicable to provide suppression.
2.4.3.10 Any proposal not to provide AWS suppression shall be subject to risk assessment, usually undertaken as a part of the overrun risk assessment process required by GI/RT7006. Factors to be taken into account in the risk assessment include:

a) Whether the indications from unsuppressed equipment could cause confusion to drivers in the vicinity of signals or signs that are applicable to the direction of movement.

b) Risk of an overrun at a stop signal, particularly one 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).

2.4.3.11 A consistent approach shall be adopted for the suppression and non-suppression of AWS track equipment at all passing loops and on all sections of the single line, to avoid causing confusion to drivers.

2.4.4 Use of cancelling indicators

2.4.4.1 Where AWS track equipment associated with signals and reductions in permissible speed is not suppressed for movements in the direction to which the equipment does not apply, as permitted by 2.4.3.9, an AWS cancelling indicator shall be provided for each set of track equipment. The form of the cancelling indicator is set out in GI/RT7033.

2.4.4.2 Requirements for the provision and positioning of cancelling indicators for temporary and emergency speed restriction AWS equipment are set out in GK/RT0075.

2.4.4.3 Where provided for signals and reductions in permissible speed, cancelling indicators shall be positioned as follows:

a) 180 m beyond the AWS track equipment in the direction of movement to which the equipment does not apply.

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

c) Usually positioned on the left-hand side of the track as seen by a driver travelling in the direction to which the AWS track equipment does not apply.

2.4.4.4 Exceptionally, it is permissible to position the sign on the right-hand side where this is necessary to ensure that it is sufficiently visible.

2.4.5 Movements onto occupied lines

2.4.5.1 GK/RT0044 specifies additional signalling controls for AWS track equipment associated with movements onto occupied lines.
2.5 Train interface requirements for AWS track equipment

2.5.1 Dimensions of magnetic fields

2.5.1.1 Figure 1 shows the dimensions of the planes above the AWS track magnet in which the flux densities of the magnetic fields are defined in section 2.5.2 for standard strength magnets and in 2.5.3 for extra strength magnets.

![Diagram of AWS track magnet dimensions]

Key:
- Plane in which flux density is defined
- Longitudinal centre line of magnetic field (corresponds to track centre line)
- Transverse centre line of magnetic field
- Track centre line

Figure 1 Dimensions of magnetic field planes above AWS track magnet

<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 3 Magnetic flux densities for standard strength track equipment
2.5.2.3 The minimum flux densities set out in Table 3 apply to:

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

b) Electromagnets when energised.

c) Suppressor magnets when not suppressed.

2.5.2.4 For all types of magnets other than depot test magnets the maximum flux density at 115 mm above rail level shall be 18 mT.

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

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

2.5.2.7 For standard strength depot test magnets, the minimum and maximum magnetic flux density of the magnetic field in free air shall conform to the limits shown 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 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 4 Magnetic flux densities for standard strength depot test magnets

2.5.3 Extra strength track equipment

2.5.3.1 On lines that are DC electrified, the minimum magnetic flux density of the magnetic field in free air shall conform to the limits shown in Table 5 throughout the plane above the magnet shown in Figure 1.

2.5.3.2 The polarities of the magnetic fields are set out in 2.3.1.

<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 5 Magnetic flux densities for extra strength track equipment
2.5.3.3 The minimum flux densities set out in Table 5 apply to:

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

b) Electromagnets when energised.

c) Suppressor magnets when not suppressed.

2.5.3.4 For all types of magnets other than depot test magnets the maximum flux density at 193 mm above rail level shall be 20 mT.

2.5.3.5 The maximum flux density produced by a de-energised electromagnet at 193 mm above rail level shall be 1.2 mT.

2.5.3.6 The maximum flux density produced by a suppressed magnet at 115 mm above rail level shall be 1.2 mT.

2.5.3.7 For extra strength depot test magnets, the minimum and maximum magnetic flux density of the magnetic field in free air shall conform to the limits shown in Table 6 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 6 Magnetic flux densities for extra strength depot test magnets

2.5.3.8 The reason for providing extra strength track equipment is that on DC electrified lines, traction cables / bonds and impedance bonds generate magnetic fields which the trainborne AWS equipment could misinterpret as coming from AWS track equipment. To reduce the possibility of the equipment reacting to these magnetic fields, the AWS equipment on trains which regularly operate over such lines is, where practicable, designed and positioned so as to be less sensitive compared with trains operating on other lines, as set out in 2.6.2. However, to ensure that the trainborne AWS equipment still senses the magnetic fields of the AWS track equipment, magnets of extra strength are used on DC electrified lines.

2.5.4 Compatibility of infrastructure with trains

2.5.4.1 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 are authorised to operate on the route.

2.6 Provision of trainborne AWS equipment

2.6.1 Trains to be fitted with AWS equipment

2.6.1.1 Trains required to be equipped with AWS shall be fitted with the trainborne AWS equipment listed below, as set out in 2.6.2 to 2.6.8:

a) One or more receivers.
b) A logic unit.

c) Audible indicator.

d) Visual indicator.

e) Caution acknowledgement device.

f) Where enhanced TPWS functional requirements have been implemented, a brake release device (as set out in GE/RT8030).

g) Interface with the train brake system.

h) Isolation device and indicator.

2.6.1.2 General requirements for the positioning of control devices and indicators (including AWS) in driving cabs are set out in GM/RT2161. Additional requirements, specific to AWS, are set out in 2.6.4, 2.6.5, 2.6.6 and 2.6.8 of this document.

2.6.1.3 Requirements for train data recorders to record AWS operation are set out in GM/RT2472.

2.6.2 AWS receivers

2.6.2.1 AWS receivers shall be designed and positioned so as to be capable of detecting the sequences and polarities of magnetic fields emitted by the configurations of AWS track magnets set out in 2.3 of this document.

2.6.2.2 The trainborne equipment shall be capable of detecting the field strengths set out in Table 7.

<table>
<thead>
<tr>
<th>Type of line</th>
<th>Trainborne AWS equipment shall detect</th>
<th>Trainborne AWS equipment shall not detect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lines fitted with standard strength track equipment</td>
<td>Magnetic fields of the minimum flux density set out in Table 4, presented at the corresponding height above rail level set out in Table 4 and directly above the track centre line (measured in free air)</td>
<td>Magnetic fields of flux density &lt; 1.5 mT presented 115 mm above rail level and directly above the track centre line (measured in free air)</td>
</tr>
<tr>
<td>Lines fitted with extra strength track equipment</td>
<td>Magnetic fields of the minimum flux density set out in Table 6, presented at the corresponding height above rail level set out in Table 6 and directly above the track centre line (measured in free air)</td>
<td>Magnetic fields of flux density &lt; 3.5 mT presented 193 mm above rail level and directly above the track centre line (measured in free air) (except in the circumstances set out in 2.6.2.8)</td>
</tr>
</tbody>
</table>

Table 7 Field strength detection requirements for AWS receivers
2.6.2.3 The heights quoted in Table 7 are included to define the field strengths which the receivers are required to detect. The receivers are not necessarily mounted at these heights.

2.6.2.4 Special arrangements to be applied where a train is authorised to operate over both DC electrified lines and other lines are set out in 2.6.2.6 and 2.6.2.7.

2.6.2.5 In addition to being positioned so as to detect the magnetic fields of the specified strength, receivers shall be positioned on trains in accordance with the following requirements:

a) So as to meet clearance requirements, as set out in GM/RT2149 and GC/RT5212.

b) Such that the trainborne AWS equipment will not respond to the magnetic fields of APC magnets.

c) So far as is practicable, such that the trainborne AWS equipment will not respond to extraneous magnetic fields from DC traction supply cables, traction bonds or impedance bonds.

d) Within 18 m of all the driving positions in the cabs that they provide with indications, in order to avoid any significant reduction in the time available to the driver for correlating the AWS indication with the aspect of the signal ahead (in some cases this will necessitate providing more than one receiver on a train).

e) Such that, for all rolling stock of the same type / class, the driver experiences a reasonably consistent time delay between passing over a track magnet and receiving the audible warning, for a given speed (this includes taking account of trains equipped with two cabs and trains equipped with more than one receiver).

2.6.2.6 Where a train is authorised to operate over both DC electrified lines and other lines, one of the following arrangements shall be applied (except as permitted by 2.6.2.8):

a) Two receivers shall be provided, one for use on DC electrified lines and one for use on other lines, with sensitivities as set out in Table 7. The appropriate receiver is selected for the portion of line over which the train is passing, or

b) One receiver shall be provided, the sensitivity of which is adjusted for the portion of line over which the train is passing, in accordance with the sensitivities shown in Table 7.

2.6.2.7 The appropriate receiver (or receiver sensitivity) shall be selected automatically, for example, by linking it to the traction supply changeover equipment on the train. A manual arrangement, whereby the driver selects the appropriate receiver or receiver sensitivity, is not permitted.

2.6.2.8 Where a vehicle is fitted with AWS equipment that is not of the correct sensitivity for the route over which operation is proposed, it is permissible for the vehicle to operate over the route if it can be demonstrated that the associated risks are acceptably low (see also 2.1.1.1.).

2.6.2.9 It is permissible for the risk assessment to be conducted on a ‘per class’ of train basis, rather than for individual vehicles, provided that the AWS receiver arrangements are the same on all vehicles in the class.
2.6.2.10 In assessing the risks, the following factors shall be taken into account (the list is not necessarily exhaustive):

a) Any available performance data regarding the reliability of AWS operation that is relevant to the proposal.

b) Whether or not the infrastructure is compliant with the requirements of this document.

c) The mileage to be run on the route for which the AWS trainborne equipment is not of the correct sensitivity.

2.6.3 **AWS logic unit**

2.6.3.1 The AWS logic unit shall perform the following functions:

a) Process signals from the receiver(s).

b) Control the functional states, timings and transitions between states, as set out in 2.8.

c) Provide outputs to operate the audible and visual indications.

d) Accept inputs from the caution acknowledgement and isolation devices.

e) Interface with the train brake system in order to initiate brake demands when required.

2.6.3.2 It is also permissible for the AWS logic unit to control the changeover of receivers or receiver sensitivities, where required, as set out in 2.6.2.6.

2.6.4 **AWS audible indicator**

2.6.4.1 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 meet all the following requirements:

a) Be distinguishable from all other audible indications in the cab.

b) Have a sound level at least 10 dBA 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.

2.6.4.2 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 indication is determined by the driver’s response to the indication, as set out in 2.8.5.1.

2.6.4.3 The ‘clear’ indication shall be a bell or simulated chime tone with a frequency of 1200 Hz (with a tolerance of +/- 30 Hz). The duration of the indication is specified in Table 10.
2.6.5 AWS visual indicator
2.6.5.1 Each driving cab shall be fitted with an AWS visual indicator that is capable of providing two indications, known as ‘all black’ and ‘black and yellow’ (described in the Rule Book as the ‘normal’ and ‘warning’ indications respectively). The indications shall meet all the following requirements:

a) The indicator shall be circular, and shall have between eight and ten 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 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.

2.6.5.2 The minimum dimensions quoted in Appendix A shall be used only where it is not practicable to use a visual indicator with larger dimensions.

2.6.6 AWS caution acknowledgement device
2.6.6.1 Each driving cab shall be fitted with a caution acknowledgement device in the form of a push 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.

2.6.7 AWS brake system interface
2.6.7.1 The interface between the AWS logic unit and the train brake system shall enable the maximum available brake demand to be initiated and cancelled. The AWS brake demand shall also, either directly or indirectly, cause the traction power to be shut off.

2.6.8 AWS Isolation device and indication
2.6.8.1 Each vehicle shall be fitted with an AWS isolation device to enable the trainborne AWS equipment to be isolated. This shall not be located where the driver can operate it from a driving position, as set out in GM/RT2161.

2.6.8.2 It shall be possible to isolate the trainborne AWS equipment independently of the isolation of TPWS equipment.

2.6.8.3 Each vehicle shall be fitted with a visual indicator to indicate to the driver whether or not the trainborne AWS equipment is isolated. It is permissible for this indication to take either of the following forms:

a) Dedicated to the AWS system, and positioned so that it is visible from all driving positions, or

b) A general indicator which tells the driver whether or not one of a number of train safety systems is isolated (positioned so that it is visible from all driving positions), with another AWS-specific isolation indicator elsewhere on the vehicle.

2.6.8.4 Additional requirements relating to the isolation of train safety systems (which includes AWS) are set out in GM/RT2185.
2.7 General functional requirements of the trainborne AWS equipment

2.7.1 Train speeds at which equipment is required to operate

2.7.1.1 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 (for example, because at higher speeds cab signalling is in use, without dependency on AWS).

2.7.1.2 The lowest speed at which the trainborne AWS equipment is required to operate is 5 km/h. This limit is set by the magnet spacing, as set out in 2.3.3.2, and the 1 second initial delay period, as set out in 2.8.3.

2.7.1.3 Trainborne AWS equipment with sensitivities appropriate for DC electrified lines does not reliably detect the magnetic fields of the extra strength AWS track equipment at speeds in excess of 160 km/h (100 mph).

2.7.2 Equipment response times

2.7.2.1 The trainborne AWS equipment response times to valid changes of magnetic field strength and to operation of the caution acknowledgement device by the driver shall be a negligible proportion (typically <0.5 %) of the minimum time interval between the receiver passing over an AWS track magnet and the driver passing the signal or sign to which the track equipment applies (measured at the permissible speed). This minimum time interval is typically around 4 seconds.

2.8 Functional states of the trainborne AWS equipment

2.8.1 Functional requirements, states and transitions

2.8.1.1 The trainborne AWS equipment shall comply with the functional requirements set out in Table 8 to Table 14 (2.8.2 to 2.8.7). The functional requirements are expressed in the form of functional states and the transitions between them (see also Appendix B).

2.8.1.2 The rows in each table have the following meanings:

State: Indicates the state that the table is describing.

Valid previous state(s): Indicates which state(s) (functional or non-functional) it is permissible for the equipment to have been in prior to entering this state.

Entry conditions: Indicates the conditions that shall be satisfied before this state is entered. The equipment shall also be in one of the defined valid previous states in order to enter this state.

Events on entry: Indicates the events that shall take place immediately upon entry into this state.

Status during state: Indicates the status of the equipment that shall be maintained while it is in this state.

Exit conditions: Indicates the conditions that shall be fulfilled before the equipment can move from this state to another one.

Next valid state(s): Indicates which functional states it is permissible for the equipment to move to on leaving this state.
2.8.2 Operational ready state

2.8.2.1 This is the normal operational state of the trainborne AWS equipment 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.

<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</td>
</tr>
<tr>
<td></td>
<td>Restrictive acknowledgement state, or</td>
</tr>
<tr>
<td></td>
<td>System isolation state</td>
</tr>
<tr>
<td></td>
<td>The equipment also enters this state on initialisation after a self-test routine has been satisfactorily completed, as set out in 2.10.1</td>
</tr>
</tbody>
</table>

Entry conditions: See exit conditions of valid preceding states

Events on entry: None

Status during state:
- Equipment is capable of detecting AWS track equipment magnetic fields, and
- Audible indicator is silent, and
- Visual indicator is maintained in its last set indication (‘all-black’ or ‘black and yellow’) and
- No AWS brake demand is applied

Exit conditions: South pole of an AWS track magnet is detected

Next valid state(s): Primed state

Table 8 Operational ready state

2.8.3 Primed state

2.8.3.1 This is the state that the trainborne AWS equipment enters when it has passed over the south pole of an AWS track magnet and is checking to see whether there is an energised electromagnet (north pole) immediately after it.

<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>
</tbody>
</table>

Uncontrolled When Printed
Document to be superseded as of 07/12/2013
To be superseded by GERT8075 Iss 1 published on 07/09/2013
### Automatic Warning System (AWS)

<table>
<thead>
<tr>
<th>State</th>
<th>Primed state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit conditions</td>
<td>North pole of an AWS track magnet is detected within 1 second (+0.0, -0.1 seconds) of having entered the primed state (in which case the trainborne equipment moves to the clear signal response state), or Automatic exit occurs 1 second (+0.0, -0.1 seconds) after the primed state was entered, if a north pole is not detected (in which case the trainborne equipment moves to the restrictive response state). The 1 second period is known as the Initial Delay Period</td>
</tr>
<tr>
<td>Next valid state(s)</td>
<td>Clear signal response state, or Restrictive response state</td>
</tr>
</tbody>
</table>

#### Table 9  Primed state

**2.8.4 Clear signal response state**

2.8.4.1 This is the state that the trainborne AWS equipment enters when it has passed over AWS track equipment associated with a signal that is displaying a green aspect (or ‘off’ in the case of a semaphore distant signal).

<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 magnet detected</td>
</tr>
<tr>
<td>Events on entry</td>
<td>Audible ‘clear’ indication given, as set out in 2.6.4.3, of duration 0.5 to 1.5 seconds</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 10  Clear signal response state

**2.8.5 Restrictive response state**

2.8.5.1 This is the state that the trainborne AWS equipment enters 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 or a temporary / emergency speed restriction.

<table>
<thead>
<tr>
<th>State</th>
<th>Restrictive response state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid preceding state(s)</td>
<td>Primed state</td>
</tr>
<tr>
<td>Entry conditions</td>
<td>Initial delay period expires without detecting a north pole magnet during that period</td>
</tr>
</tbody>
</table>
Automatic Warning System
(AWS)

<table>
<thead>
<tr>
<th>State</th>
<th>Restrictive response state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Events on entry</td>
<td>Audible warning indication given, as set out in 2.6.4.2, which continues until the equipment exits from this state</td>
</tr>
<tr>
<td>Status during state</td>
<td>Equipment capable of accepting a caution acknowledgement (by operation of the caution acknowledgement device), and&lt;br&gt;Visual indicator maintained at ‘all black’, and&lt;br&gt;No AWS brake demand is applied</td>
</tr>
<tr>
<td>Exit conditions</td>
<td>Caution acknowledgement device is operated within 2 seconds (±0.25 seconds) of having entered the restrictive response state (in which case the restrictive acknowledgement state is entered), or&lt;br&gt;Automatic exit occurs if the caution acknowledgement device is not operated within 2 seconds (±0.25 seconds) of having entered the restrictive response state (in which case the restrictive non-acknowledgement state is entered).)*&lt;br&gt;The 2 second period is known as the caution acknowledgement period.</td>
</tr>
<tr>
<td>Next valid state(s)</td>
<td>Restrictive acknowledgement state, or&lt;br&gt;Restrictive non-acknowledgement state</td>
</tr>
</tbody>
</table>

Table 11  Restrictive response state

* Where the maximum speed that the train is capable of is not greater than 160 km/h (100 mph), it is permissible for the caution acknowledgement period to be up to 2.7 seconds (±0.25 seconds).

2.8.5.2  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.

2.8.5.3  If the driver attempts to give a caution acknowledgement by either of the above means, the trainborne AWS equipment shall function as though the caution acknowledgement device had not been operated.

2.8.6  Restrictive acknowledgement state

2.8.6.1  The restrictive acknowledgement state is the state that the trainborne AWS equipment enters when a driver has acknowledged receipt of an AWS warning by operation of the caution acknowledgement device.
Automatic Warning System (AWS)

### State

<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, or Restrictive non-acknowledgement 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 Audible warning indication is silenced</td>
</tr>
<tr>
<td>Status during state</td>
<td>No AWS brake demand is applied (applicable only if preceding state was the restrictive response state), or After satisfying the conditions in 2.8.6.2, the AWS brake demand is cancelled (applicable only if preceding state was the restrictive non-acknowledgement state), and Visual indicator maintained at ‘black and yellow’, and 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 12**  
Restrictive acknowledgement state

2.8.6.2 The AWS brake demand shall be cancelled by the AWS trainborne equipment following operation of the caution acknowledgement device and, where enhanced TPWS functional requirements have been implemented, the brake release action set out in GE/RT8030, but not less than 59 seconds after the brake demand has been initiated.

### 2.8.7 Restrictive non-acknowledgement state

2.8.7.1 The restrictive non-acknowledgement state is the state that the trainborne AWS equipment enters when a driver has failed to acknowledge receipt of an AWS warning by operation of the caution acknowledgement device within the caution acknowledgement period.

<table>
<thead>
<tr>
<th>State</th>
<th>Restrictive 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 2.6.4.2, 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>Restrictive acknowledgement state</td>
</tr>
</tbody>
</table>

**Table 13**  
Restrictive non-acknowledgement state
2.9 Non-functional states of the trainborne AWS equipment

2.9.1 System isolation state

2.9.1.1 In the system isolation state the trainborne AWS equipment is 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</td>
</tr>
<tr>
<td></td>
<td>Audible indicator is silenced (if it was previously operative), and</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>Visual indicator does not change, and</td>
</tr>
<tr>
<td></td>
<td>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 14 System isolation state

2.10 Trainborne AWS equipment self-test capability

2.10.1 Self-test requirements

2.10.1.1 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.

2.10.1.2 It is not mandatory that the test routine proves that the receiver is capable of detecting the magnetic fields of AWS track equipment, nor that the brakes are actually applied in response to the brake demand.

2.10.2 Self-test on initialisation of cab

2.10.2.1 The test routine shall be initiated (preferably automatically, but alternatively by the driver) whenever the train is powered up or, in the case of dual cab trains, when the driver changes cab. On successful completion of the test routine the trainborne AWS equipment shall move to the operational ready state.
2.10.3  Self-test when entering an AWS fitted area from a cab signalled area

2.10.3.1 The self-test routine shall also be conducted automatically when a train enters a portion of line where the trainborne AWS equipment has to be active, having previously been disabled to avoid unnecessary cab indications (because the train was using cab signalling even though the track was fitted with AWS equipment, as set out in GE/RT8026).

2.10.3.2 Failure to complete the self-test successfully in these circumstances shall result in an appropriate and distinct warning being given to the driver.

2.11  System integrity

2.11.1  Dependability

2.11.1.1 AWS track and trainborne equipment, and its interfaces with other equipment and systems, shall be designed and maintained so that the probability of failure is as low as reasonably practicable.

2.11.1.2 AWS 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 requirements:

a) Trainborne AWS equipment shall have an availability of not less than 99.9%. This target shall be met on a ‘per fleet, per year’ basis, not on a ‘per train, per failure’ basis (that is, the total time or mileage that trains are in service when diagnosed as having faulty AWS equipment, but before being taken out of service in accordance with GO/RT3437, shall amount to not more than 0.1% of the total in-service time or mileage).

A fleet, for the purposes of this document, constitutes all the AWS-fitted trains that a train operator owns or leases.

The term ‘in service’ has the same meaning as in GO/RT3437.

b) Track equipment shall have an availability of not less than 99.9%. This target shall be met on a ‘whole AWS population, per year’ basis, not on a ‘per AWS equipment, per failure’ basis (that is, the total time that AWS track equipment is in service when diagnosed as being faulty, while trains are still permitted to operate over the line, shall amount to not more than 0.1% of the total time that the equipment is in service).

2.11.2  Failure modes

2.11.2.1 So far as is reasonably practicable, AWS equipment (both track and trainborne) shall be designed and interfaced with other equipment and systems (including power supplies) so that 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 at all when a ‘warning’ indication should have been given.

c) A caution acknowledgement being given that was not initiated by the driver.

d) Failure to initiate an AWS brake demand when such a brake demand was required.
Automatic Warning System (AWS)

e) Release of an AWS brake demand when not initiated by the driver (only applicable if enhanced TPWS functional requirements have been implemented).

2.11.2.2 Where it is not reasonably practicable to achieve this for any of the events listed above, then the event shall, so far as is reasonably practicable, be made self-protecting or self-revealing.

2.11.2.3 An AWS brake demand shall be initiated automatically if the power supply to the trainborne AWS equipment fails. Such an event shall not, however, prevent the trainborne equipment subsequently being isolated by the driver in order that the train can be moved, as set out in 2.6.8 and 2.9.1.

2.11.2.4 So far as is reasonably practicable, on trains that are fitted with trainborne AWS equipment for operation on DC electrified lines (in accordance with 2.6.2.6), a failure of the automatic selection sub-system shall cause the receiver(s) to default to the ‘other lines’ configuration, so as to detect the magnetic field strengths of standard strength AWS track equipment, rather than resulting in a complete failure of the trainborne AWS equipment.

2.11.3 Compatibility

2.11.3.1 So far as is reasonably practicable, AWS track equipment shall not jeopardise the safe operation of neighbouring equipment as a result of the electromagnetic fields that it generates.

2.11.3.2 So far as is reasonably practicable, AWS track and trainborne equipment shall be capable of withstanding electromagnetic fields emitted by other equipment that might otherwise jeopardise the correct operation of the equipment.

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

2.11.3.4 So far as is reasonably practicable, AWS track and trainborne equipment shall 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.

2.11.3.5 BS EN 50125 specifies environmental conditions for equipment used for railway applications. In relation to clause 10.7 of BS EN 61373 (referenced by BS EN 50125), it is a requirement that AWS equipment shall operate and retain its integrity during the vibration and shock test sequences.

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

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

2.11.4 Maintenance

2.11.4.1 Asset management plans and maintenance specifications shall detail the arrangements for the maintenance and testing of AWS track equipment, including both permanently installed equipment and equipment provided for temporary and emergency speed restrictions.
2.11.4.2 Provided acceptance testing has been carried out to verify performance in accordance with section 2.5 of this document, and given the known performance stability of the AWS track equipment, it is permissible to confirm the magnetic performance of AWS track equipment using a single test measurement for a field strength consistent with the appropriate table (Tables 3 to 6).

2.11.4.3 In addition to the requirements of 2.11.4.2, it is necessary to confirm the height of the AWS track equipment with respect to rail level.

2.11.4.4 Maintenance plans and specifications (as required by GM/RT2004) shall detail the arrangements for the maintenance and testing of trainborne AWS equipment.

2.11.4.5 Train operators shall also ensure that depot test magnets are subject to maintenance and testing.

2.11.5 Depot test magnets

2.11.5.1 AWS test magnets shall be provided (in accordance with the requirements set out in 2.3 and 2.5) on the exit lines from maintenance depots, except as permitted by 2.11.5.4, so that trains pass over a test magnet before entering Network Rail managed infrastructure. The purpose of this is to verify on a regular basis that the trainborne AWS equipment is functioning correctly, and in particular that it meets the appropriate field strength sensitivity requirements set out in 2.6.2.2.

2.11.5.2 The field strength requirements for AWS test magnets are set out in 2.5.

2.11.5.3 Requirements that trains enter service with fully functional trainborne AWS equipment are set out in GM/RT2185 and GO/RT3437.

2.11.5.4 A depot test magnet is not required if all trains that leave the maintenance depot have trainborne AWS equipment that includes a self-test routine which is:

a) Conducted before the train enters Network Rail managed infrastructure, and

b) Adequate for the purposes of verifying that the trainborne AWS equipment is fully functional, and in particular that it meets the appropriate field strength sensitivity requirements set out in 2.6.2.2.

2.11.5.5 A self-test routine as required by 2.10.1 which meets only the minimum requirements set out in that section is not sufficient for compliance with 2.11.5.4.

2.11.5.6 In addition to the requirements set out in 2.11.5.1, it is permissible to provide other AWS magnets within maintenance depots, and at other locations that are not part of Network Rail managed infrastructure, where required by the train operator for the purposes of testing trainborne AWS equipment.

2.11.5.7 Where a maintenance depot services trains that are fitted with AWS receivers for operation on DC electrified lines, as well as trains fitted with receivers for operation on other lines, additional arrangements shall be made to ensure that all types of receivers are regularly tested for compliance with the sensitivity requirements set out in Table 7. Possible means of achieving this include (but are not restricted to):

a) Providing both standard and extra strength test magnets in the maintenance depot, and

b) Use of self-test routines, as set out in 2.11.5.4.
2.11.5.8 In the special case of trains that are fitted with dual sensitivity AWS receivers, as set out in 2.6.2.6, the following options for testing are also available:

a) Diagramming trains so that the trains regularly pass over depot test magnets at more than one depot, so that both receivers (or receiver sensitivities) are tested,

b) Applying special maintenance procedures on a regular basis, which include tests of both receivers (or receiver sensitivities). The procedures shall specifically include a check that the receivers comply with the sensitivity requirements.
Part 3  Application of this document

3.1  Application - infrastructure managers

3.1.1  Scope

3.1.1.1  The requirements of 2.1, 2.2, 2.3, 2.4, 2.5 and 2.11 of this document apply to all new infrastructure equipment used for the Automatic Warning System (AWS) and to all work that affects the provision of AWS.

3.1.1.2  It is permissible for the infrastructure manager to designate specific infrastructure projects, ongoing when this document comes into force, for which compliance with the requirements of this document applicable to the design, construction and commissioning of new or altered infrastructure is not mandatory. When designating such projects, the infrastructure manager shall consider:

a)  Its responsibilities under its current safety authorisation.

b)  The stage reached by the project at the time this document comes into force (for example, approval in principle).

c)  Whether compliance is necessary to ensure compatibility with other parts of the infrastructure.

d)  Whether compliance is necessary to facilitate safe interworking having regard to changes to related requirements mandated on another infrastructure manager or a railway undertaking.

e)  The economic impact of compliance, but subject to its current safety authorisation in relation to the infrastructure in question.

3.1.1.3  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.

3.1.1.4  Where an investigation into a signal passed at danger identifies that the risk of recurrence could be mitigated by alterations to the AWS track equipment arrangements, the revised arrangements shall be in accordance with the requirements of this document.

3.1.1.5  Other than in the circumstances set out in 3.1.1.4, action to bring existing AWS infrastructure equipment into compliance with the requirements of this document is not required.

3.1.1.6  It is permissible for existing AWS magnets in service prior to 02 June 2012 to remain in service, subject to meeting the test levels in accordance with GE/RT8035 issue one, provided there are no reported AWS system failures associated with these magnets.

3.1.2  Exclusions from scope

3.1.2.1  There is no requirement to fit AWS on lines where a train protection system is fitted and in use on both the trains and the infrastructure, and the Railway Group Standard which specifies the application rules for that system provides an exemption from the requirement to fit AWS.

3.1.3  General compliance date for infrastructure managers

3.1.3.1  This Railway Group Standard comes into force and is to be complied with from 02 June 2012.
3.1.3.2 After the compliance dates 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, authorisation not to comply should be sought in accordance with the Railway Group Standards Code.

3.1.4 Exceptions to general compliance date
3.1.4.1 There are no exceptions to the general compliance date specified in 3.1.3 for infrastructure managers.

3.2 Application - railway undertakings
3.2.1 Scope
3.2.1.1 The requirements of 2.1, 2.6, 2.7, 2.8, 2.9, 2.10 and 2.11 of this document apply to all work that affects the provision or modification of AWS equipment on vehicles.

3.2.1.2 Action to bring existing AWS equipment into compliance with the requirements of this document is not required.

3.2.2 Exclusions from scope
3.2.2.1 The requirements in the document are not applicable to the following types of vehicles:

   a) Locomotives used exclusively for shunting purposes.

   b) Vehicles that operate solely within possessions.

   c) Vehicles operating solely on lines where a train protection system is fitted and in use on both the trains and the infrastructure, and the Railway Group Standard which specifies the application rules for that system provides an exemption from the requirement to fit AWS.

3.2.3 General compliance date for railway undertakings
3.2.3.1 This Railway Group Standard comes into force and is to be complied with from 02 June 2012.

3.2.3.2 After the compliance dates 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, authorisation not to comply should be sought in accordance with the Railway Group Standards Code.

3.2.4 Exceptions to general compliance date
3.2.4.1 There are no exceptions to the general compliance date specified in 3.2.3 for railway undertakings.

3.3 Health and safety responsibilities
3.3.1 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.
Appendix A Visual Indicator

The content of this appendix is mandatory

Segments yellow   Background black

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>

<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>39 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>
Appendix B  Vehicle Sub-System Sequence Flowchart

The content of this appendix is for information only
(This flowchart does not indicate the system isolation state or self-test)
Appendix C  Typical Configurations for AWS Track Equipment

The content of this appendix is for information only

![Diagram 1](image1.png)  
**Figure 2**  Equipment for a unidirectional line

![Diagram 2](image2.png)  
**Figure 3**  Equipment for a bi-directional line

![Diagram 3](image3.png)  
**Figure 4**  Equipment for a bi-directional line that is shared by two signals
Automatic Warning System (AWS)

Figure 5  Positioning of AWS for converging unfitted and fitted lines, as set out in 2.2.2

Figure 6  Positioning of AWS for transitions from through unfitted lines to fitted lines, as set out in 2.2.2

Note: Unfitted lines should be interpreted as a line not fitted with AWS. Such a line may or may not be fitted with another system (for example, cab signalling or trainstops).
Definitions

**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, as set out in 2.11.1.2. (Source BS EN 50129.)

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

**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.

**Enhanced TPWS functional requirements**
The requirements for enhanced functionality of TPWS set out in GE/RT8030 Appendix F, which include additional requirements affecting the operation of AWS.

**Maintenance depot (as used in this document)**
A location identified within the train operator’s contingency plan with the facilities to maintain, repair or replace items of trainborne AWS equipment, as set out in GO/RT3437.

**Shunting (as used in this document)**
The local movement of trains or vehicles, other than the normal passage of trains along running lines, which could affect the safe operation of trains on Network Rail managed infrastructure.

**Signal (as used in this document)**
All main lineside signals (colour light and semaphore) and signs that perform the function of a signal.
Automatic Warning System (AWS)

References

The Catalogue of Railway Group Standards and the Railway Group Standards DVD give the current issue number and status of documents published by RSSB. This information is also available from www.rgsonline.co.uk.

RGSC 01 Issue Three Railway Group Standards Code

Documents referenced in the text

Railway Group Standards

GC/RT5212 Requirements for Defining and Maintaining Clearances
GE/RT8000 Rule Book
GE/RT8026 Safety Requirements for Cab Signalling Systems
GE/RT8030 Requirements for the Train Protection and Warning System (TPWS)
GE/RT8037 Signal Positioning and Visibility
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 Assessment
GI/RT7033 Lineside Operational Safety Signs
GK/RT0044 Controls for Signalling a Train onto an Occupied Line
GK/RT0045 Lineside Signals, Indicators and Layout of Signals
GK/RT0075 Lineside Signal Spacing and Speed Signage
GK/RT0192 Level Crossing Interface Requirements
GM/RT2004 Rail Vehicle Maintenance
GM/RT2149 Requirements for Defining and Maintaining the Size of Railway Vehicles
GM/RT2161 Requirements for Driving Cabs of Railway Vehicles
GM/RT2169 Combined Manual for AWS and TPWS Trainborne Equipment
GM/RT2185 Train Safety Systems
GM/RT2472 Data Recorders on Trains – Design Requirements
GO/RT3437 Defective On-Train Equipment

Other references

BS EN 50121 Railway Applications – Electromagnetic compatibility
BS EN 50125 Railway Applications – Environmental conditions for equipment
BS EN 50129 Railway Applications – Safety Related Electronic Systems for Signalling
BS EN 61373 Railway Applications – Rolling Stock Equipment – Shock and Vibration Tests