Railway Group Standard
GL/RT1210
Issue One
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AC Energy Subsystem and Interfaces to Rolling Stock Subsystem

Synopsis

This document defines the requirements for the AC energy system and the interfaces to rolling stock operating over the AC electrified railway.

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AC Energy Subsystem and Interfaces to Rolling Stock Subsystem

Issue record

Issue	Date	Comments
One	December 2014	Original document This document has been developed under project 09/013a to identify existing in-scope requirements and reduce costs associated with establishing compatibility between energy and rolling stock subsystems. The document retains in scope requirements from GE/RT8025 issue three and GL/RT1254 issue three and specifies new requirements needed to establish electrical compatibility between the two subsystems.

Superseded documents

The following Railway Group documents are superseded, either in whole or in part as indicated:

Superseded documents	Sections superseded	Date when sections are superseded
GE/RT8025 issue one Electrical Protective Provisions for Electrified Lines	B 4.1, parts of B 4.2, B 4.3, part of B 4.5.1, B 4.5.2, B 4.5.3, parts of B 4.6.	07 March 2015
GL/RT1254 issue one Electrified Lines Traction Bonding	Part of 4.1.3	07 March 2015

Other parts of GE/RT8025 issue one are superseded by GM/RT2111, issue one, Rolling Stock Subsystem and Interfaces to AC Energy Subsystem.

GE/RT8025 issue one Electrical Protective Provisions for Electrified Lines, ceases to be in force as of 07 March 2015 for AC subsystems.

GL/RT1254 issue one Electrified Lines Traction Bonding, ceases to be in force as of 07 March 2015 for AC subsystems.

Supply

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Part 1 Purpose and Introduction

1.1 Purpose

1.1.1 This document mandates requirements for the AC energy subsystem, in order to manage interfaces with rolling stock. This document also mandates requirements for the safety of the AC energy subsystem, where this aligns with the Energy (ENE) TSI.

1.1.2 This document contains an 'open point', as set out in Appendix A, to address requirements that have not yet been specified but which are within the scope of the document.

1.2 Introduction

1.2.1 Background

1.2.1.1 This document consolidates existing practice for 25 kV AC electrification, and mandates requirements in line with EU requirements for interoperability and a migration towards a uniform system for the Great Britain (GB) mainline 25 kV AC electrified railway, while continuing to give compatibility with existing rolling stock.

1.2.2 Supporting documents

1.2.2.1 The following Rail Industry Guidance Note supports this Railway Group Standard:

GL/GN1610	Guidance on AC Energy Subsystem and Interfaces to Rolling Stock Subsystem

1.3 Approval and authorisation of this document

1.3.1 The content of this document was approved by Energy (ENE) Standards Committee on 04 September 2014.

1.3.2 This document was authorised by RSSB on 03 November 2014.

Part 2 Electrical Requirements

2.1 Technical requirements

2.1.1 System voltage

2.1.1.1 The system voltage shall comply with the requirements of EN 50163:2004+ A1:2007 clause 4.1, applicable to the 25 kV AC 50 Hz system, excluding the UK special national condition set out in Annex B of EN 50163:2004+A1:2007.

2.1.1.2 The minimum value of 'mean useful voltage at the pantograph' shall be 22 kV for lines speeds of less than or equal to 200 km/h, and 22.5 kV for lines speeds greater than 200 km/h calculated using the method set out in EN 50388:2012 clauses 8.2 and 8.4.

2.1.2 Frequency

2.1.2.1 The nominal system frequency shall be 50 Hz. The frequency range shall remain within the limits specified in EN 50163:2004+A1:2007 clause 4.2, for systems with 'synchronous connections'.

2.1.3 Short circuit fault levels

2.1.3.1 Where all rail vehicles using the route are compatible with the parameters set out in Table 1, the maximum values for short circuit faults between the energy subsystem overhead contact line (OCL) (including other 25 kV conductors) and infrastructure or vehicles connected to the traction return rail, and falling within the contact line zone, as set out in 3.2.1, shall comply with Table 1.

Maximum rms fault current [EN50388:2012, clause 11.2]	Maximum fault duration with back-up protection	Maximum fault duration with main protection operating	Maximum number of reclosures permitted	Maximum cumulative fault duration with main protection operating and maximum number of reclosures
15 kA	1 s	200 ms	2	600 ms

Table 1 Fault current characteristics – target system

2.1.3.2 Where all rail vehicles using the route are not yet compatible with the parameters set out in Table 1, the maximum values for short circuit faults between the energy subsystem OCL (including other 25 kV conductors) and infrastructure or vehicles connected to the traction return rail, and falling within the contact line zone, as set out in 3.2.1, shall comply with Table 2.

Maximum rms fault current	Maximum fault duration with back-up protection	Maximum fault duration with main protection operating	Maximum number of reclosures permitted (see Note 1)	Maximum cumulative fault duration with main protection operating and maximum number of reclosures
6 kA	1 s	250 ms	2	750 ms
12 kA	1 s	250 ms	1	500 ms
15 kA	0.65 s	150 ms	1	300 ms
Note 1: Where vehicles are not yet compatible, the allowable number of reclosures is limited. See 2.1.5.3.				

Table 2 Fault current characteristics for compatibility with existing rail vehicles

2.1.3.3 The magnitude of the maximum peak current associated with the maximum short circuit fault levels set out in 2.1.3.1 and 2.1.3.2 shall not exceed 2.5 times the values of the maximum root mean squared (rms) fault current set out in Tables 1 and 2.

2.1.3.4 The maximum circuit time constant (relating to the X/R ratio) at the contact line is an open point.

2.1.4 Electrical protection co-ordination

2.1.4.1 Substation and sectioning location protection systems shall meet the requirements of EN 50388:2012 clause 11.2.

2.1.4.2 The disconnection times for the energy subsystem equipment under short circuit fault conditions shall be within the maximum values set out in 2.1.3.1 and 2.1.3.2, with the electrical protection system operating normally or where back-up protection operates.

2.1.5 Loss of line voltage and reclosure procedure

2.1.5.1 When the power supply to the OCL is switched off (for example, by a protection system) and is to be restored, the switching process and timing shall be as set out in EN 50388:2012 clause 11.3. Reclosure shall not be attempted within three seconds.

2.1.5.2 The reclosure sequence shall be one reclosure of the track feeder circuit breakers after at least a three second delay following the initial trip.

2.1.5.3 When the track feeder breaker trips on closure and reclosure is permitted, as set out in 2.1.3.1 and 2.1.3.2, there shall be a delay of at least one minute before any subsequent reclosure of the track feeder circuit breaker.

2.1.5.4 When main protection is not available, or if back-up protection operates, reclosure shall not take place without further investigation or testing to ensure the fault condition is no longer present.

2.1.6 Train current and power factor

2.1.6.1 The energy subsystem shall be designed to operate with a maximum allowable train current for each train of not less than 300 A (Imax), at any voltage in the range, as set out in EN 50388:2012 clause 7.2, Figure 1.

2.1.6.2 The energy subsystem design shall be compatible with traction units having a power factor as set out in EN 50388:2012 clauses 6.2 and 6.3. Where the energy subsystem is required to support the operation of non-TSI compliant rolling stock, the design shall take account of their power factors.

2.1.7 Regeneration compatibility

2.1.7.1 The AC energy subsystem shall permit the use of regenerative braking.

2.1.8 Electrical insulation co-ordination

2.1.8.1 Insulation which separates 25 kV exposed live parts of the OCL from earth shall have the following dielectric withstand rating values, except where 3.1.7.3 results in a reduced value. These values are co-ordinated with the values set out in EN 50124-1:2001+A2:2005:

a) Basic insulation:

- Rated impulse voltage (U_{Ni}) = 200 kV peak. Corresponding to an air clearance of 370 mm assuming the worst case dielectric condition of the electrodes.

b) Functional insulation:

- Rated impulse voltage (U_{Ni}) ≥ 145 kV peak. Corresponding to an air clearance 270 mm assuming the worst case dielectric condition of the electrodes.

c) Reinforced insulation:

- Rated impulse voltage (U_{Ni}) ≥ 320 kV peak. Corresponding to an air clearance of 600 mm.

2.1.9 Harmonic overvoltages on the overhead line

2.1.9.1 In order to achieve electrical compatibility between the energy subsystem and electric rail vehicles, harmonic overvoltages shall be limited below critical values, as set out in EN 50388:2012 clause 10.4.

2.2 Safety requirements

2.2.1 Protective provisions against direct contact – general

2.2.1.1 Protective provisions against direct contact with exposed live parts of the energy subsystem shall comply with the requirements set out in EN 50122-1:2011+A1:2011 clause 5.1. The protective provisions shall be by safety clearances or, where the safety clearances are not achievable, by obstacles.

2.2.1.2 Return conductors shall be treated as high voltage equipment in relation to protective provisions against direct contact.

2.2.2 Protective provisions against direct contact – protection by clearance

2.2.2.1 Exposed live parts of the energy subsystem, including a pantograph head (complying with 3.1.6.1 and in contact with the contact line), shall comply, at all locations, except where 2.2.2.2 applies, with the clearance requirements set out in EN 50122-1:2011+A1:2011 clause 5.2.1, using the public area dimensions in Figure 4. The United Kingdom special national condition relating to clause 5.2.1, as set out in EN 50122-1:2011+A1:2011 Annex G, shall not be used.

2.2.2.2 It is permissible, where existing physical features of a particular site constrain the gauge (for example, overline bridges and tunnels) and it is not reasonably practicable to modify them or the public platform area, for a pantograph head, conforming to 3.1.6.1, which is in contact with the contact line, to encroach into the area defined in EN 50122-1:2011+A1:2011 clause 5.2, Figure 4 (public area), provided that reinforced insulation in accordance with 2.1.8.1 c) is maintained between persons, including any foreseeable objects they may be carrying, and the nearest part of the pantograph head, where justified by a risk assessment complying with the Common Safety Method for Risk Evaluation and Assessment (CSM RA) and the application of appropriate safety measures. Requirements for other live parts of the train-mounted equipment are set out in GL/RT2111 clause 3.16.1.

2.2.2.3 With the exception of routes electrified using the auto-transformer system, exposed live parts shall be positioned no lower than 5.2 m above any standing surface, under the worst conditions of temperature and loading, at those locations where the lateral distance from the live parts to the closest running rail is greater than 3 m.

2.2.2.4 For routes electrified using the auto-transformer system, exposed live parts shall be positioned no lower than 5.2 m above any standing surface, under the worst conditions of temperature and loading, at those locations where the lateral distance from the live parts to the closest running rail is greater than 5 m.

2.2.2.5 In the case of return conductors, where the safety clearances set out in 2.2.2.1 cannot be achieved, the return conductor shall be protected by an obstacle, as set out in 2.2.3, or insulated to achieve a rated insulation voltage of 3 kV (rms).

2.2.3 Protective provisions against direct contact – protection by obstacles (screens)

2.2.3.1 If the clearances set out in 2.2.2 cannot be achieved, protection by an obstacle shall be provided in accordance with EN 50122-1:2011+A1:2011 clauses 5.3.1 to 5.3.3.

2.2.3.2 Using an electrical clearance in accordance with Table 5, the nearest proximity in air, between an exposed live part and an obstacle, shall be determined in accordance with EN 50122-1:2011+A1:2011 clause 5.3.1.

2.2.3.3 For routes electrified using the auto-transformer system, where protection by clearance or protection by obstacles cannot be achieved, the feeder conductor shall be an insulated and screened cable, meeting the requirement for basic insulation set out in 2.1.8.1a).

2.2.4 Indirect contact, exposed conductive parts, touch voltages and rail potential

2.2.4.1 Protection against electric shock shall be achieved by compliance with the touch voltage requirements set out in EN 50122-1:2011+A1:2011 clauses 6.1, 6.2.1, 9.1 and 9.2.

2.3 Safety warning signs

2.3.1 Warning to crews on trains approaching a neutral section forming a phase separation section

2.3.1.1 At phase separation sections, signs AJ01z and AJ02z, as set out in GI/RT7033, shall be provided (see Appendix B). Signs shall be placed at the trackside and readable for a minimum of two seconds at the highest permissible (including enhanced permissible) speed approaching the location concerned.

2.3.2 Warning to crews on trains of a traction system changeover

2.3.2.1 On the approach to an electrical changeover from 750 V DC to 25 kV AC, signs AJ04z and AJ05z, as set out in GI/RT7033, shall be provided. Signs shall be placed at the trackside and readable for a minimum of two seconds at the highest permissible (including enhanced permissible) speed approaching the location concerned.

2.3.3 Overhead contact line structure identification plate

2.3.3.1 Every OCL structure shall be provided with an identification plate giving the structure reference code (unique within the area). The size and location shall be such that the text shall be readable from the cab of a train at rest.

Part 3 Mechanical Requirements

3.1 Overhead contact line geometry and gauging

3.1.1 Nominal contact wire height

3.1.1.1 On lines with speeds of less than 250 km/h (155 mph) the nominal contact wire height shall be 4700 mm.

3.1.1.2 On lines with speeds of 250 km/h (155 mph) and above, the nominal contact wire height shall be in the range between 5080 mm and 5300 mm.

3.1.2 Maximum contact wire height

3.1.2.1 The maximum contact wire height, including OCL and track tolerances, shall be 5940 mm in static conditions and 6200 mm with uplift.

3.1.3 Minimum contact wire height and design contact wire height

3.1.3.1 The minimum design contact wire height shall be calculated in accordance with EN 50119:2009+A1:2013 clause 5.10.5 and Figure 1, taking into account:

a) The maximum swept envelope height defined by the maximum co-ordinates of the upper gauge(s), as set out in GE/RT8073, for standard vehicle gauges of rail vehicles permitted or intended to be used on the route.

b) The value of Electrical Clearance (EC) shown in EN 50119:2009+A1:2013 Figure 1, between the swept envelope height defined by the co-ordinates in a) and the contact wire determined according to the requirements set out in 3.1.7 of this document.

3.1.3.2 On lines with speeds of less than 250 km/h (155 mph) the minimum contact wire height shall be not less than the standard vehicle gauge static height of 3965 mm, as set out in GE/RT8073, plus the static electrical clearance determined in accordance with 3.1.7 of this document, subject to a minimum of 4165 mm.

3.1.3.3 On lines with speeds of 250 km/h (155 mph) and above, the minimum contact wire height shall be not less than 5080 mm.

3.1.4 Minimum contact wire height – earthed wire

3.1.4.1 The minimum earthed contact wire height shall be calculated in accordance with EN 50119:2009+A1:2013 clauses 5.10.4, 5.10.5 and Figure 1, taking into account:

a) The maximum swept envelope height defined by the maximum co-ordinates of the upper gauge(s), as set out in GE/RT8073, for standard vehicle gauges of rail vehicles permitted or intended to be used on the route.

b) A clearance of 80 mm between the swept envelope height of the rail vehicle and the contact wire, as the value designated as EC in EN 50119:2009+A1:2013 Figure 1.

3.1.5 Contact line height at level crossings

3.1.5.1 The minimum height of exposed live parts of the contact line and its associated feeders and clearance to road vehicles at road level crossings and private level crossings shall be as set out in Table 3.

System voltage	Minimum height	Minimum clearance to road vehicle	Provisions
25 kV AC	5800 mm	600 mm	Crossing user warning signs

Table 3 Minimum height of exposed live parts at road level crossings and private level crossings

3.1.5.2 It is permissible to reduce the height of exposed live parts at road level crossings and private level crossings to 5.6 m where justified by a risk assessment complying with the CSM RA and the application of appropriate safety measures.

3.1.5.3 The minimum height of live parts of the contact line and its associated feeders at footpath and bridle path level crossings shall be as set out in Table 4.

System voltage	Minimum height	Provisions
25 kV AC	5200 mm	Crossing user warning signs, including those advising horse riders to dismount before crossing, if necessary

Table 4 Minimum height of exposed live parts at footpath and bridle path level crossings

3.1.6 Contact wire lateral deviation

3.1.6.1 The OCL geometry shall be designed to be compatible with the pantograph profiles set out in EN 50367:2012 Figures A.6 and B.6.

3.1.6.2 For upgrade or renewal of existing lines, the contact wire shall not approach within 200 mm of the outer end of each pantograph horn, taking into account the sway of the pantograph.

3.1.7 Electrical and mechanical clearances

3.1.7.1 Electrical clearances to exposed live parts of the OCL, including raised pantograph heads in contact with the contact wire, are dimensioned as set out in Table 5.

3.1.7.2 The maximum reasonably practicable value of electrical clearance shall be provided.

3.1.7.3 Where it is not reasonably practicable to provide clearances in the ‘normal’ category, it is permissible for smaller clearances to be used where justified by a risk assessment complying with the CSM RA and the application of appropriate safety measures.

3.1.7.4 For all rail vehicles permitted to use the route, electrical clearances shall take into account the gauge and pantograph sway envelope, as set out in in GM/RT2149.

	Electrical clearance (EC) **Normal**
Static electrical clearance	EC ≥ 270 mm (see note 1)
Passing electrical clearance	EC ≥ 200 mm
Note 1: Static electrical clearances of less than 370 mm do not give basic insulation, as set out in 2.1.8.1a).	

Table 5 Electrical clearance (EC) for overhead line electrification

3.1.7.5 A minimum mechanical clearance applicable to the pantographs of rail vehicles permitted to use the line complying with the gauge and pantograph sway envelope, as set out in in GM/RT2149, shall be provided, as set out in Table 6.

	Minimum mechanical clearance
Static and passing mechanical clearance between the pantograph and contact line equipment at the same electrical potential	80 mm
Static and passing mechanical clearance between the pantograph and the steady arm (when approximately parallel to the pantograph profile)	15 mm (under all conditions, including wear of the contact wire and pantograph)

Table 6 Mechanical clearance for overhead line electrification

3.2 Contact line and current collector zones

3.2.1 Overhead contact line and current collector zones

3.2.1.1 The method for determining the zones in which structures may accidentally be made live by coming into contact with a live broken OCL or an energised de-wired or broken current collector and its fragments shall be as set out in EN 50122-1:2011+A1:2011 clause 4.1 and Figure 1, where:

a) Dimension ‘X’ is:

i) 5200 mm from the centre line of each electrified track, or the distance to the overhead line structures from the track centre line (TCL) where this is less.

ii) Increased, where necessary, such that the OCL zone extends a minimum of 2000 mm beyond the horizontal position of any 25 kV out-of-running or terminating contact lines.

b) Dimension ‘Y’ is 1400 mm either side of the TCL.

c) Dimension 'Z' is equal to 'SH' – 'HP', where the maximum height of the current collector zone 'SH' is 6800 mm and 'HP' is the highest point of the OCL.

3.3 Contact wire

3.3.1 Contact wire material

3.3.1.1 The contact wire shall be copper or copper alloy (but excluding cadmium copper), as set out in EN 50149:2012 clause 4.2.

3.4 Current collection

3.4.1 Quality of current collection

3.4.1.1 The quality of current collection to meet the criteria set out in 3.4.2.3 at the interface between OCL and the pantographs and spacings intended for use on the route shall be established by a compatibility assessment, as set out in 3.4.2.

3.4.1.2 Where acceptable quality of current collection has been previously established for the same types of pantograph and OCL, no further compatibility testing is required.

3.4.1.3 For all other situations a compatibility test is required, which shall be undertaken using a train with pantographs complying with:

a) The pantograph profile intended to use the line.

b) Pantograph spacing intended to use the line.

c) Producing a Mean Contact Force in Newtons, of $0.00047*v^2+60 \leq Fm \leq 0.00047*v^2+90$, where v = speed in km/h.

3.4.2 Dynamic behaviour and quality of current collection assessment criteria

3.4.2.1 Compatibility of the OCL shall be assessed in accordance with EN 50367:2012 clause 7.3.

3.4.2.2 The assessment shall include Contact wire uplift (S), Mean contact force (F_m) and standard deviation of contact force (σ). During dynamic assessment a representative section of the OCL on the route shall be used, containing examples of OCL features over which current collection requires to be verified.

3.4.2.3 For all operating pantographs, the following criteria selected from EN 50367:2012 shall be met for each pantograph:

a) Mean contact force in Newtons, F_m shall be:

$0.00047*v^2+60 \leq F_m \leq 0.00047*v^2+90$.

b) $\sigma < 0.3\ F_m$ where σ is the standard deviation of the contact force.

c) Maximum contact force (F_{max}) at discrete locations ≤ 350 Newtons (filtered at 20 Hz).

d) The uplift of the contact wire (S) shall not exceed $2 \times S_0$ or, in areas of restrictions included in the design, uplift of the contact wire shall not exceed $1.5 \times S_0$.

Where:

v is the speed in km/h.

F_m is the Mean contact force (Newtons).

F_{max} is the Maximum contact force (Newtons).

σ is the standard deviation of contact force (Newtons).

S_0 is the design uplift of the contact wire (mm).

3.4.3 Vertical movement of the contact point

3.4.3.1 The space for free and unrestricted uplift at the support shall be a minimum of 2 x S_0. If restrictions to uplift of the contact wire are included in the design, a figure of not less than 1.5 x S_0 shall be used (where S_0 is the design uplift of the contact wire).

3.5 Pantograph spacing

3.5.1 Pantograph spacing used for the design of OCL

3.5.1.1 As set out in Table 4.2.13 of the ENE TSI, the OCL shall be designed to allow operation of electric trains with minimum pantograph spacing compatible with the ENE TSI, selected from one column, as set out in Table 7.

Operating speed (v) km/h	Number of pantographs per train	A	B	C
v>250	2	200 m	200 m	200 m
200 < v ≤ 250	2	200 m	85 m	35 m
180 < v ≤ 200	2	200 m	85 m	35 m
160 < v ≤ 180	2	200 m	85 m	35 m
120 < v ≤ 160	2	85 m	85 m	35 m
80 < v ≤ 120	2	20 m	15 m	15 m
v ≤ 80	2	8 m	8 m	8 m

Note 1: A table of speed conversions is set out in Appendix E.

Note 2: Compliance with the values set out in this table may not provide compatibility with certain configurations of existing passenger rolling stock or future rolling stock intended to operate on the route. See 3.5.1.2.

Note 3: See 3.5.1.3 for operation of double-headed freight trains at speeds up to 120 km/h.

Table 7 Pantograph minimum spacing related to speed for lines where the ENE TSI is applicable

3.5.1.2 Where it is designated that the route is to be designed to enable the operation of electric multiple units with pantograph spacing less than those selected from in Table 7, the OCL shall additionally be designed to allow the operation of electric trains with:

a) Two and three pantographs with a pantograph spacing of 45 m at speeds of up to 180 km/h.

And / or

b) Two pantographs with a pantograph spacing of 100 m at speeds of up to 200 km/h.

3.5.1.3 Where it is designated that the route is to be designed to enable the operation of double-headed freight trains in excess of the speed in Table 7, the OCL shall additionally be designed to allow the operation of electric trains with two pantographs with a pantograph spacing of 8 m at speeds of up to 120 km/h.

3.5.2 Compatibility with position of signals

3.5.2.1 In relation to the location of stop signals or movement stop marker boards, neutral sections shall be positioned such that the pantograph is not required to come to rest in an OCL neutral section forming a phase or system separation.

3.5.2.2 At an OCL neutral section forming a phase or system separation, it is permissible in the case of trains using more than one pantograph for only a single pantograph to remain in contact with the exposed live part of the OCL.

3.5.2.3 In relation to the location of stop signals or movement stop marker boards, neutral sections forming a phase or system separation shall be positioned such that the acceleration of the train from rest allows the train to gain sufficient speed to pass through the neutral section.

3.5.2.4 The OCL shall be designed so that trains do not come to a stand at stop signals or movement stop marker boards with any raised pantograph where damage may be caused, associated with:

a) An OCL section insulator.

Or

b) An OCL switched booster overlap.

Or

c) An OCL booster overlap.

3.6 Separation sections and section insulators

3.6.1 Short neutral sections for phase and system separation operated with pantograph raised

3.6.1.1 The in-line insulation shall provide electrical clearance sufficient to prevent flashover when pantographs with a maximum along-track width of 650 mm operate over it.

3.6.1.2 The distance from neutral section centre line to in-running live equipment, shall not exceed 4167 mm. This dimension replaces the requirement for length D set out in 4.2.15.1 (1) of the ENE TSI.

3.6.1.3 Signage, as set out in 2.3, shall be positioned either side of the neutral section, as shown in Appendix B.

3.6.1.4 Automatic power control magnets shall be provided on each side of the track, with the across track position and height in accordance with the dimensions shown in Appendix C and performance in accordance with the requirements set out below.

3.6.1.5 The magnetic field strength for the APC magnet is set out in Table 8 and shown in Appendix C Figure C.2 and shall extend over a rectangular plane extending 100 mm laterally and 100 mm longitudinally from the magnet centre. The magnet shall be a 'south pole'.

Height above rail level	Minimum magnetic field strength	Guidance
178 mm	3.8 mT	Minimum receiver height, train with worn wheels
200 mm	3.3 mT	Nominal receiver height
222 mm	2.9 mT	Maximum receiver height, train with new wheels

Table 8 Magnetic field strength for the APC magnet

3.6.1.6 The along-track location of the APC magnet on approach to the neutral section, shown as 'A' in Appendix B Figure B.1, is determined by the formula:

Distance (APC to Neutral Section centre line) = Distance from neutral section centre line to in-running live equipment (4167 mm) + Pantograph - Receiver offset (7.75 m) + (v x t), where:

v is the line speed for electric trains in m/s plus 10%, and

t = 150 ms, where this is the maximum time taken for the on-train equipment to react to the magnet, and comprises the receiver detection time, together with the vehicle main circuit breaker operation time.

3.6.1.7 The location of the APC magnet on the retreat from the neutral section, shown as 'B' in Figure B.1, on a uni-directional line shall be no closer than 7.75 m plus half the length of the neutral section, in metres, from the centre line of the neutral section.

3.6.1.8 Automatic power control magnets shall not be located between any running rails, or in any other location that could interfere with the correct operation of the automatic warning system (AWS) equipment.

3.6.2 Section insulator limiting dimensions

3.6.2.1 A section insulator shall be dimensioned to permit pantograph heads with individual contact strips of a minimum width of 25 mm, and pantograph heads with single strips of not less than 80 mm to pass smoothly and without losing electrical contact.

3.6.3 Split neutral sections for phase and system separation operated with pantograph raised

3.6.3.1 This is an open point.

3.7 Compatibility with train exhaust gas emissions

3.7.1 Compatibility of contact systems with train exhaust emissions

3.7.1.1 This is an open point.

3.8 Trackside pantograph monitoring sites

3.8.1 Trackside pantograph monitoring sites – train identification

3.8.1.1 Each trackside pantograph monitoring site shall be capable of reading the automatic vehicle identification (AVI) radio frequency identification (RFID) tag on electric rail vehicles passing the system.

3.9 Assessment of the OCL

3.9.1 Assessment of the OCL where a UK specific case is required

3.9.1.1 As an alternative to the assessment of the OCL as an interoperable constituent, it is permissible to assess the interoperability constituent OCL, as defined in section 5 of the ENE TSI, as a component of the energy subsystem. In this case only, an intermediate statement of verification is required. This assessment shall include the particular features on the UK mainline network for GB, as set out in section 7.4.2.9 of the ENE TSI for the following:

a) Contact wire height (clause 3.1 of GL/RT1210).

b) Maximum lateral deviation (clause 3.1.6 of GL/RT1210, and GM/RT2149).

c) Pantograph gauge (GM/RT2149).

3.9.1.2 The assessment process set out in section 6 of the ENE TSI for simulation of dynamic behaviour and quality of current collection shall use:

a) In ENE TSI 6.1.4.1 (2) (b) two TSI compliant pantographs that can include those which comply with UK Specific Cases contained within the LOC&PAS TSI and as set out in clauses 4.2, 4.3, 4.4, 4.5, and 4.7 of GM/RT2111.

b) In ENE TSI 6.1.4.1 (2) (b), in addition, all pantographs intended to operate on the route.

c) In ENE TSI 6.1.4.1 (2) (c) including those complying with 3.9.1.2 a).

d) In ENE TSI 6.1.4.1 (2) (d) pantograph configurations as set out in 3.5.1.

3.9.1.3 The assessment process set out in section 6 of the ENE TSI for measurement of dynamic behaviour and quality of current collection shall use:

a) In ENE TSI 6.1.4.1 (3) (c) one of the pantographs chosen for the simulation in ENE TSI 6.1.4.1 (2), as amended by 3.9.1.2, installed on rolling stock that allows the appropriate speed to be achieved on the representative section of route.

b) In ENE TSI 6.1.4.1 (3) (d) the measurements shall be performed at least for the worst case arrangement regarding the interaction performance derived from the simulations. If it is not possible to test using the worst case arrangement, then it is permissible to select a representative pantograph configuration from those simulated under 3.1.9.2.

3.9.1.4 The assessment process set out in section 6 of the ENE TSI for assessment of dynamic behaviour and quality of current collection (integration into a subsystem) shall use:

a) In ENE TSI 6.2.4.5 (3) a pantograph that is TSI compliant or that complies with UK Specific Cases contained within the LOC&PAS TSI and as set out in clauses 4.2, 4.3, 4.4, 4.5, and 4.7 of GM/RT2111 and that meets the uplift required by point 4.2.11 of the ENE TSI.

Part 4 Application of this Document

4.1 Application - infrastructure managers

4.1.1 Scope

4.1.1.1 The requirements of this document apply to all new infrastructure equipment used in the AC energy subsystem.

4.1.1.2 Action to bring the existing AC energy subsystem into compliance with the requirements of this document is not required.

4.1.1.3 Where the existing AC energy subsystem does not comply with the requirements of this document, action to bring them into compliance is required when:

a) The AC energy subsystem is modified.

b) The AC energy subsystem is renewed as a whole.

c) Any major component of the AC energy subsystem is replaced.

4.1.2 Exclusions from scope

4.1.2.1 There are no exclusions from the scope specified in 4.1.1 for infrastructure managers.

4.1.3 General compliance date for infrastructure managers

4.1.3.1 This Railway Group Standard comes into force and is to be complied with from 07 March 2015.

4.1.3.2 After the compliance date, or the date by which compliance is achieved, if earlier, infrastructure managers shall 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.

4.1.4 Exceptions to general compliance date

4.1.4.1 There are no exceptions to the general compliance date specified in 4.1.3 for infrastructure managers.

4.2 Application - railway undertakings

4.2.1 There are no requirements applicable to railway undertakings.

4.3 Health and safety responsibilities

4.3.1 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 Open Points

The content of this appendix is not mandatory and is provided for guidance only

A.1 List of open points in GL/RT1210.

A.2 The open points in GL/RT1210 are set out in Table A.1, which also indicates where information on industry practice relating to each open point is given.

Open point	Section of GL/RT1210	Additional information
The maximum circuit time constant (relating to the X/R ratio) at the contact line is an open point	2.1.3.4	See GL/GN1610 clauses G 2.1.13 and G 2.1.14
Split neutral sections for phase and system separation operated with pantograph raised	3.6.3	Requirements for split neutral sections for phase and system separation operated with pantograph raised are an open point currently under development
Compatibility of contact systems with train exhaust emissions	3.7.1.1	Components which are vulnerable to higher temperatures and contamination shall not be placed within the zone affected by exhaust gases from internal combustion engines. The gas emission pattern is set out in GM/RT2130 clause 3.1

Table A.1 List of open points

Appendix B Short Neutral Section Signage

The content of this appendix is mandatory

B.1 Typical arrangement of track signs and track magnets (see 3.6.1.3).

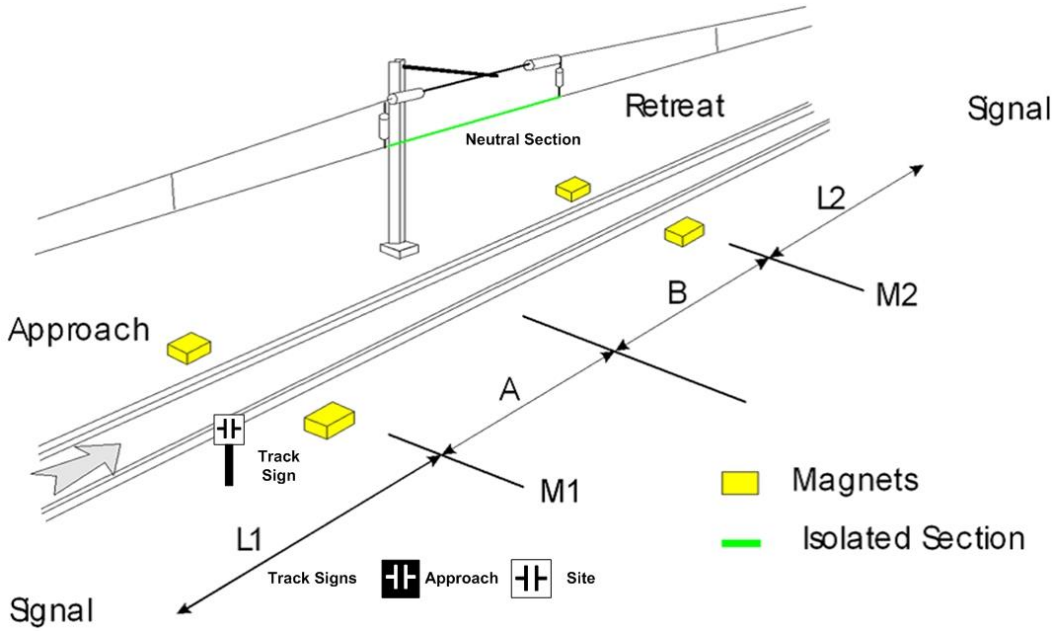


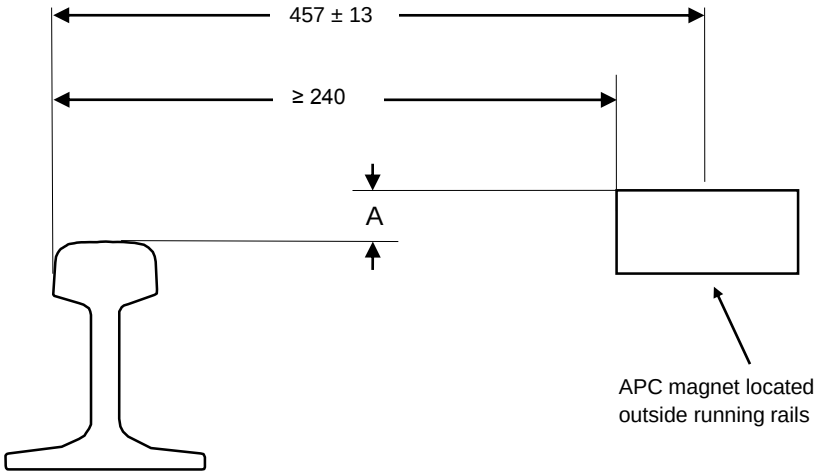
Figure B.1 Typical arrangement of track signs and track magnets

A	Distance between the magnet and the centre line (see 3.6.1.6)
B	Distance between the signal and the centre line (see 3.6.1.6 and 3.6.1.7)
A and B	Form the 'Dead Section'
M1	Approach magnet
M2	Retreat magnet
L1	Distance between the signal on approach and the magnet [guidance on the determination of L1 is given in GL/GN1610]
L2	Distance between the magnet and signal beyond [guidance on the determination of L2 is given in GL/GN1610]

Appendix C Location of the Automatic Power Control (APC) Track Magnet

The content of this section of the appendix is mandatory

C.1 Position of the APC magnets.



Notes
1. Magnets located outside running rails both sides of the track.
2. All dimensions in millimetres referenced from gauge face of running rails.
3. Height of top of APC magnet enclosure above top of rail: A = 45 mm ± 6 mm.

Figure C.1 Position of the APC magnets

C.2 Relationship between the APC receiver and the APC track magnet.

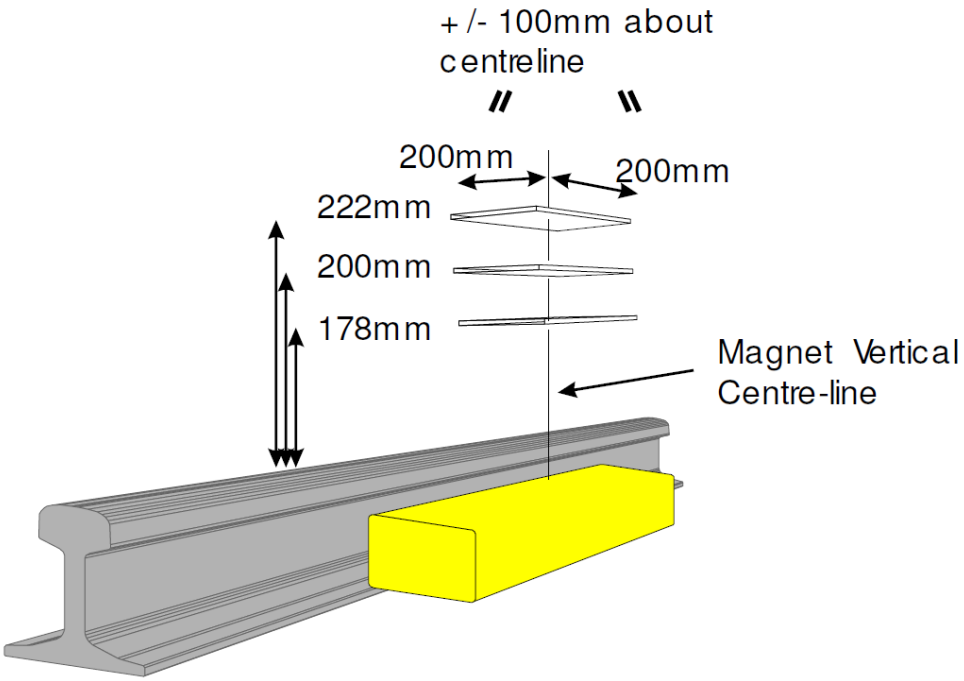
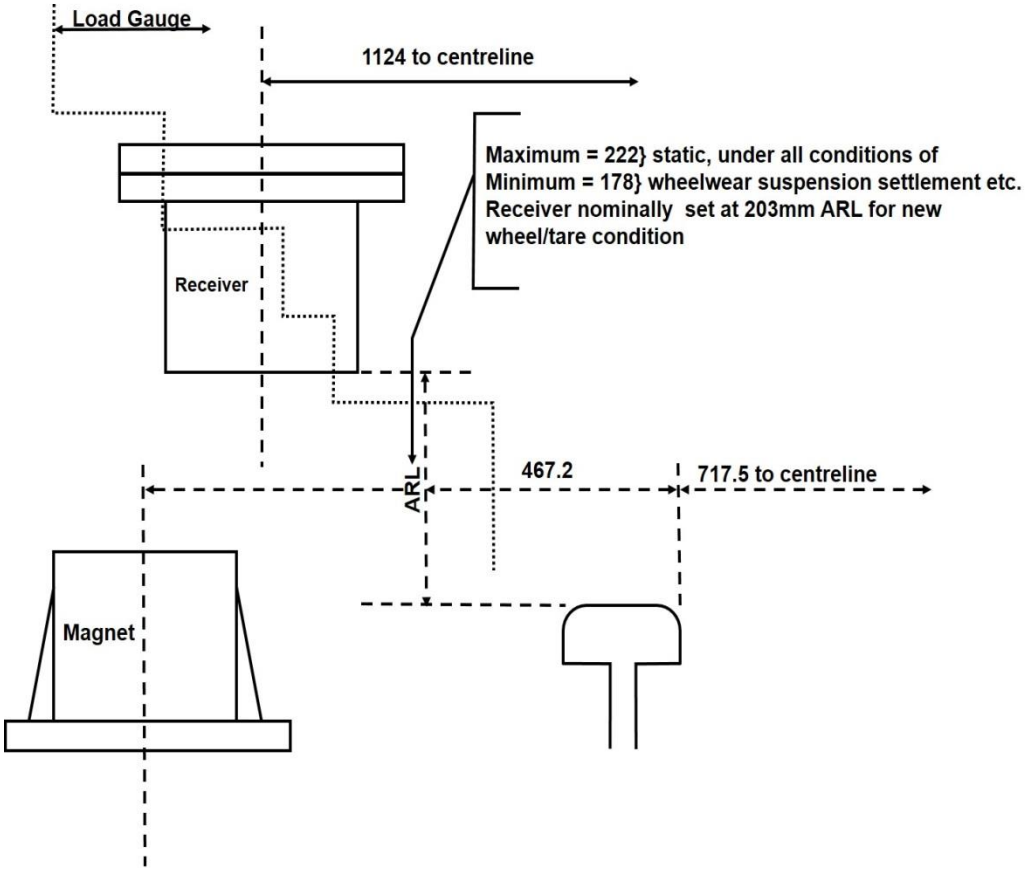


Figure C.2 Representation of flux planes

The content of this section of the appendix is not mandatory and is provided for information only

C.3 Relationship between the APC receiver and the APC track magnet.



Note: Magnets are provided on both sides of the track.

Note: Receiver across track dimension based on fitment to rail vehicle bogie.

Figure C.3 Relationship between the APC receiver and the APC track magnet

Appendix D AC System Characteristic for Rolling Stock Compatibility

The content of this appendix is not mandatory and is provided for information only

D.1 This appendix summarises the values set out in 2.1.1.1, 2.1.1.2, 2.1.2, 2.1.3, 2.1.3.1, 2.1.3.2, 2.1.3.3, 2.1.3.4 and 2.1.8.1.

1 Contact line voltage					
Ref	**System characteristic**	**Symbol**	**Value**	**EN source**	**GL/RT1210**
1.1	Nominal voltage.	U_n	25,000 V AC	EN 50163:2004+ A1:2007, clause 4.1 and Table 1.	2.1.1.1
1.2	Highest permanent voltage.	U_{max1}	27,500 V AC	EN 50163:2004+ A1:2007, clause 4.1 and Table 1.	2.1.1.1
1.3	Highest non-permanent voltage. (Maximum duration five minutes.)	U_{max2}	29,000 V AC	EN 50163:2004+ A1:2007, clause 4.1 and Table 1.	2.1.1.1
1.4	Lowest permanent voltage.	U_{min1}	19,000 V AC	EN 50163:2004+ A1:2007, clause 4.1, Table 1.	2.1.1.1
1.5	Lowest non-permanent voltage. (Maximum duration two minutes.)	U_{min2}	17,500 V AC	EN50163:2004 +A1:2007, clause 4.1, Table 1.	2.1.1.1
1.6	Lowest non-permanent voltage (existing lines only). (Maximum duration 10 minutes.)	U_{min2} a	14,000 V AC	EN 50163:2004+ A1:2007, clause 4.1, Table 1, and Annex B.	2.1.1.1
1.7	Lowest non-permanent voltage (existing lines only). (Maximum duration two minutes.)	U_{min2} b	12,500 V AC	EN 50163:2004+ A1:2007, clause 4.1, Table 1, and Annex B.	2.1.1.1
1.8	Mean useful voltage (at the pantograph) (v < = 200 km/h).	$U_{mean\ useful}$	22,000 V AC	EN 50388:2012, clause 8.3.	2.1.1.2

1 Contact line voltage					
Ref	**System characteristic**	**Symbol**	**Value**	**EN source**	**GL/RT1210**
1.9	Mean useful voltage (at the pantograph) (v > 200 km/h).	$U_{mean\ useful}$	22,500 V AC	EN 50388:2012, clause 8.3.	2.1.1.2
1.10	Rated impulse voltage (basic insulation).	U_{Ni}	200 kV peak,	EN 50124-1:2001+A2:2005, Table A.2, 2.1.8.1b).	2.1.8.1
1.11	Rated impulse voltage (functional insulation).	U_{Ni}	≥ 145 kV peak	EN 50124-1:2001+A2:2005, Table A.2, 2.1.8.1a).	2.1.8.1
2 Contact line frequency					
2.1	Nominal frequency.	F_n	50 Hz	EN50163:2004+ A1:2007, clause 4.2.	2.1.2
2.2	Maximum frequency for 99.5% of the year.	F_{max1}	50,5 Hz	EN50163:2004+ A1:2007, clause 4.2.	2.1.2
2.3	Minimum frequency for 99.5% of the year.	F_{min1}	49,5 Hz	EN50163:2004+ A1:2007, clause 4.2.	2.1.2
2.4	Maximum frequency for 100% of the time.	F_{max2}	52 Hz	EN50163:2004+ A1:2007, clause 4.2.	2.1.2
2.5	Minimum frequency for 100% of the time.	F_{min2}	47 Hz	EN50163:2004+ A1:2007, clause 4.2.	2.1.2
3 Contact line fault current					
3.1	Maximum rms fault current. (Maximum duration one second.)	I_{sc} rms	15 kA (target)	EN 50388:2012, clause 11.2 and Table 6.	2.1.3.1
			6 kA, 12 kA, 15 kA (existing)		2.1.3.2
3.2	Maximum peak fault current in the first half cycle.	I_{sc} peak	2.5 times maximum rms fault current	EN 60077-4:2003, clause 5.3.6.1.	2.1.3.3
3.3	Maximum circuit time constant at the contact line.		Open point	EN 62271-100: 2009+A1:2012 clause 4.101.2.	2.1.3.4

Table D.1 AC system characteristic for rolling stock compatibility

Appendix E Speed Conversions

The content of this appendix is mandatory

E.1 Where there is a reference in any EN or TSI to a speed in km/h, the following conversion to mph shall be used.

Infrastructure subsystem (INF), Rolling Stock subsystem (RST) and Energy subsystem (ENE) speed conversions	
km/h	**mph**
2	1
3	1
5	3
10	5
15	10
20	10
30	20
40	25
50	30
60	40
80	50
100	60
120	75
140	90
150	95
160	100
170	105
180	110
190	120
200	125
220	135
225	140
230	145
250	155
280	175
300	190
320	200
350	220
360	225

Table E.1 INF, RST and ENE speed conversions

Definitions

AC energy subsystem

The Energy TSI (ENE TSI) states that the AC energy subsystem consists of:

Substations: connected on the primary side to the high-voltage grid, with transformation of the high-voltage to a voltage and / or conversion to a power supply system suitable for the trains. On the secondary side, substations are connected to the railway contact line system.

Sectioning locations: electrical equipment located at intermediate locations between substations to supply and parallel contact lines, and to provide protection, isolation and auxiliary supplies.

Separation sections: equipment required to provide the transition between electrically different systems or between different phases of the same electrical system.

Contact line system: a system that distributes the electrical energy to the trains running on the route and transmits it to the trains by means of current collectors. The contact line system is also equipped with manually or remotely controlled disconnectors which are required to isolate sections or groups of the contact line system according to operational necessity. Feeder lines are also part of the contact line system.

Return circuit: all conductors which form the intended path for the traction return current and which are additionally used under fault conditions. Therefore, so far as this aspect is concerned, the return circuit is part of the energy subsystem and has an interface with the infrastructure subsystem.

Back-up protection

Protection which is intended to operate when a system fault is not cleared or abnormal condition not detected in the required time, because of failure or inability of other protection to operate or failure of the appropriate circuit-breaker(s) to trip. [IEV ref 448-11-14]

Basic insulation

Insulation of hazardous-live-parts, which provides basic protection. Note: this concept does not apply to insulation used exclusively for functional purposes. [IEV ref 195-06-06]

Basic protection

Protection against electric shock under fault-free conditions. [IEV ref 195-06-01]

Contact force

Vertical force applied by the pantograph to the overhead contact line (OCL).
[EN 50367:2012 and EN 50317:2012]

Contact line system

A system that distributes the electrical energy to the trains running on the route and transmits it to the trains by means of current collectors.

Contact wire uplift

Vertical upward movement of the contact wire due to the force produced from the pantograph. [EN 50119:2009+A1:2013]

Current collector

Equipment fitted to the rail vehicle and intended to collect current from a contact wire or conductor rail. [IEV ref 811-32-01]

Direct contact

Electric contact of persons or animals with live parts [IEV ref 195-06-03-modified] or sufficiently close that danger may arise.

Double insulation

Insulation comprising both basic insulation and supplementary insulation. [IEV ref 195-06-07]

Electric shock

A dangerous physiological effect resulting from the passing of an electric current through the human body or livestock. [IEV ref 195-01-04]

Exposed conductive part

A conductive part of equipment which can be touched and which is not a live part but which may become live under fault conditions. [IEV ref 441-11-10]

Failure

The termination of the ability of an item to perform a required function. [IEV ref 191-04-01]

Functional insulation

Insulation between conductive parts, necessary for the proper functioning of the equipment. [IEV ref 195-02-41]

Gauge

Set of rules including a reference contour and its associated calculation rules allowing defining the outer dimensions of the rail vehicle and the space to be cleared by the infrastructure.

Note: According to the calculation method implemented, the gauge is a static, kinematic or dynamic.

Lateral deviation

Deviation of the contact wire from the track centre line under action of a crosswind. [EN 50367:2012]

Level crossing

Crossing of a railway and a road at the same level. [IEV ref 821-07-01 − modified]

NOTE: Level crossings can be prefixed with ‘public’ (where the relevant authority for the road is a public entity) and ‘private’ (where the relevant authority for the road is a private entity).

Line speed

Maximum speed measured in km/h for which a line has been designed.

Live part

Any conductor and any conductive part of electrical equipment intended to be energised in normal use. [IEV ref 195-02-19-modified]. Insulators are considered to be live parts.

Maximum contact wire height

Maximum possible contact wire height which the pantograph is required to reach, in all conditions. [EN 50119:2009+A1:2013]

Mean contact force

Statistical mean value of the contact force. [EN 50367:2012]

Mean useful voltage train

Voltage identifying the dimensioning train and enables the effect on its performance to be quantified. [EN 50388:2012]

Mean useful voltage zone

Voltage giving an indication of the quality of the power supply in a geographic zone during the peak traffic period in the timetable. [EN 50388:2012]

Minimum contact wire height

A minimum value of the contact wire height in the span, in order to avoid the arcing between one or more contact wires and rail vehicles in all conditions. [EN 50119:2009+A1:2013]

Nominal contact wire height

A nominal value of the contact wire height at a support in the normal conditions. [EN 50119:2009+A1:2013]

Minimum design contact wire height

Theoretical contact wire height, including tolerances, designed to ensure that the minimum contact wire height is always achieved. [EN 50119:2009+A1:2013]

Nominal voltage

Voltage by which an installation or part of an installation is designated. [EN 50163:2004+A1:2007]

Normal service

Planned timetable service.

On-track machine

A rail-mounted machine that meets the requirements of GM/RT2400.

Open points

Requirements formally identified in a TSI or Railway Group Standard for which no common requirement has been agreed.

Overhead contact line (OCL)

Contact line placed above (or beside) the upper limit of the rail vehicle gauge and supplying vehicles with electric energy through roof-mounted current collection equipment. [IEV ref 811-33-02]

Note: where this includes, in addition to all current-collecting conductors, the following elements: reinforcing feeders; cross-track feeders; disconnectors; section insulators; over-voltage protection devices; supports that are not insulated from the conductors; insulators connected to live parts; along-track feeders; conductors connected permanently to the contact line for supply of other electrical equipment; earth wires and return conductors.

Pantograph exclusion zone

The length of track relative to a defined OCL feature (for example, an overlap) within which the pantograph of an electric train does not touch the contact wire when the train is stationary or moving at a slow speed, in order to prevent electrical arcing.

Passing electrical clearance

The distance, being created by a momentary reduction of the static electrical clearance, caused by the dynamic interaction of the pantograph and the OCL during the passage of electric trains, or a train in motion at a specific location.

Rail vehicle

Any vehicle, moving either under its own power (locomotives fixed formation units and multiple units) or hauled by another vehicle (coaches, railcar trailers, vans and wagons), on-track machine, road-rail vehicle or rail-mounted maintenance machine.

Rated impulse voltage (U_{Ni})

Impulse voltage value assigned to the system or part of it, characterising the specified withstand capability of its insulation against transient overvoltages. [EN50124-1:2001+A2:2005, 1.3.2.7 – modified]

Register of Infrastructure (RINF)

A register that shall be maintained for each TSI-certified line that describes the main features and requirements of each subsystem and their correlation with the relevant TSI.

Reinforced insulation

Insulation of hazardous-live-parts, which provides a degree of protection against electric shock equivalent to double insulation.

Note – Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation. [IEV ref 195-06-09]

Return circuit

All conductors which form the intended path for the traction return current and the current under fault conditions. [EN 50122-1:2011+A1:2011]

Return conductor

Conductor paralleling the track return system and connected to the running rails at periodic intervals. [EN 50122-1:2011+A1:2011]

Safety Measure

A set of actions either reducing the frequency of occurrence of a hazard or mitigating its consequences, in order to achieve and / or maintain an acceptable level of risk. [Commission Regulation (EU) No 402/2013 on the Common Safety Method for Risk Evaluation and Assessment (CSM RA)]

Static contact force

Mean vertical force exerted upwards by the pantograph head on the OCL, and caused by the pantograph-raising device, while the pantograph is raised and the rail vehicle is at a standstill. [EN 50367:2012]

Static electrical clearance

The distance forming insulation in air between:

a) Exposed live parts of the OCL system and the parts of rail vehicles that are earthed via the fixed installation.

b) Exposed live parts of the OCL system and fixed assets under the control of different infrastructure managers.

c) Exposed live parts of electric rail vehicles and earthed parts of the OCL system.

d) Exposed live parts of electric rail vehicles and fixed assets.

Subsystem

One of the subsystems (of the European railway system) identified by the Interoperability Directive. Subsystems can be structural or functional.

Supplementary insulation

Independent insulation applied in addition to basic insulation, for fault protection. [IEV ref 195-06-08]

Train

An operational train which may consist of locomotives, wagons, coaches, multiple units or a single fixed formation unit.

Abbreviations

AC
Alternating current.

APC
Automatic power control.

ARL
Above rail level

AVI
Automatic vehicle identification.

AWS
Automatic warning system.

CSM RA
Common Safety Method for Risk Evaluation and Assessment. As set out in Commission Regulation (EU) No 402/2013.

DC
Direct current.

EC
Electrical clearance.

ENE
Energy subsystem.

IEV
International Electrotechnical Vocabulary IEC 60050 series available on line as ‘Electropedia’.

IM
Infrastructure manager.

INF
Infrastructure subsystem.

LOC&PAS
Locomotives & Passenger Carriages TSI. Part of the RST.

OCL
Overhead contact line.

RFID
Radio frequency identification.

RINF
Register of Infrastructure.

rms
Root mean squared.

RST
Rolling stock subsystem.

SI

Section insulator.

TCL

Track centre line.

TSI

Technical Specifications for Interoperability.

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/RT8073	Requirements for the Application of Standard Vehicle Gauges
GI/RT7033	Lineside Operational Safety Signs
GM/RT2111	Rolling Stock Subsystem and Interfaces to AC Energy Subsystem
GM/RT2130	Vehicle Fire, Safety and Evacuation
GM/RT2149	Requirements for Defining and Maintaining the Size of Railway Vehicles
GM/RT2400	Engineering Design of On-Track Machines in Running Mode

RSSB documents

GL/GN1610	Guidance on AC Energy Subsystem and Interfaces to Rolling Stock Subsystem

Other references

EN 50119:2009+A1:2013	Railway applications. Fixed installations. Electric traction overhead contact lines
EN 50122-1:2011+A1:2011	Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part 1: Protective provisions against electric shock
EN 50124-1:2001+A2:2005	Railway applications. Insulation coordination. Part 1: Basic requirements. Clearances and creepage distances for all electrical and electronic equipment
EN 50149:2012	Railway applications. Fixed installations. Electric traction. Copper and copper alloy grooved contact wires
EN 50163:2004+A1:2007	Railway applications. Supply voltages of traction systems
EN 50317:2012	Railway applications. Current collection systems. Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line
EN 50367:2012	Railway applications. Current collection systems. Technical criteria for the interaction between pantograph and overhead line (to achieve free access)

EN 50388:2012	Railway applications. Power supply and rolling stock. Technical criteria for the coordination between power supply (substation) and rolling stock to achieve interoperability
EN 60077-4:2003	Railway applications. Electric equipment for rolling stock - Part 4: Electrotechnical components. Rules for AC circuit-breakers
EN 62271-100:2009+A1:2012	High-voltage switchgear and controlgear. Alternating current circuit-breakers
IEV 60050 series	International Electrotechnical Vocabulary (IEV) available on line as 'Electropedia'

Details of the current TSIs and links to the documents are available at: http://www.rssb.co.uk/SiteCollectionDocuments/rgs/TSI_status_summary.pdf

The Health and Safety (Safety Signs and Signals) Regulations 1996 − Statutory Instruments, 1996 No. 341

Commission Implementing Regulation (EU) No 402/2013 of 30 April 2013 on the Common Safety Method for Risk Evaluation and Assessment.

Other relevant documents

Railway Group Standards

GE/RT8015	Electromagnetic Compatibility between Railway Infrastructure and Trains
GK/RT0045	Lineside Signals, Indicators and Layout of Signals
GK/RT0058	Lineside Signal Aspect and Indication Requirements [to be published]
GL/RT1212	DC Energy Subsystem and Interfaces to Rolling Stock Subsystem [to be published]
GM/RT2113	Rolling Stock Subsystem and Interfaces to DC Energy Subsystem [to be published]
GO/RT3215	Requirements for the Weekly Operating Notice, Periodical Operating Notice and Sectional Appendix

RSSB documents

GM/GN2611	Guidance on Rolling Stock Subsystem and Interfaces to AC Energy Subsystem
GM/GN2613	Guidance on Rolling Stock Subsystem and Interfaces to DC Energy Subsystem

Other references

BR 12034/17	Railway Electrification 25 kV AC Design Acceptance Measures
BS 2754 (IEC 536)	Construction of Electrical Equipment for Protection Against Electric Shock [withdrawn]
BS 7671:2008+A1:2011	Requirements for electrical installations. IET Wiring Regulations
EN 50122-2:2010	Railway applications. Fixed installations. Electrical safety, earthing and the return circuit. Part 2: Provisions against the effects of stray currents caused by DC traction systems

EN 50153:2002	Railway applications. Rolling stock. Protective provisions relating to electrical hazards
EN 50318:2002	Railway applications. Current collection systems. Validation of simulation of the dynamic interaction between pantograph and overhead contact line

European Railway Agency 'Guide for the application of CR ENE TSI (According to Framework Mandate C (2007)3371 final of 13/07/2007)'

IEC 60479 Guide to effects of current on human beings and livestock. The Grid Code published by the National Grid (Issue 5 Revision 1 06 November 2012) available at http://www.nationalgrid.com/uk/Electricity/Codes/gridcode/

The Electricity Safety, Quality and Continuity Regulations 2002 (S.I. No. 2665)