Electromagnetic Compatibility between Railway Infrastructure and Trains

Synopsis
This document mandates requirements for the management of electromagnetic compatibility between railway infrastructure and trains. It also mandates the processes to enable compatibility between infrastructure and trains to be demonstrated in order to meet the requirements of route acceptance.

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This document is a NOTIFIED STANDARD in the context of the European directives for interoperability of railway systems.

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Issue One
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# Electromagnetic Compatibility Between Railway Infrastructure and Trains

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Part A

A1 Issue record

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This document will be updated when necessary by distribution of a complete replacement.

A2 Implementation of this document

The publication date of this document is 5 October 2002.

This document comes into force on 7 December 2002.

The dates by which compliance with the requirements of this document is to be achieved are set out in Part B2. Where those dates are later than the date on which this document comes into force, this is to give Railway Group members additional time to plan and commence implementation so as to achieve full compliance by the dates set out in Part B2.

This document supersedes the following Railway Group Standards, either in whole or in part as indicated:

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A3 Scope of Railway Group Standards

The overall scope of Railway Group Standards is set out in Appendix A of GA/RT6001. The specific scope of this document is set out in Part B2.

A4 Responsibilities

Railway Group Standards are mandatory on all members of the Railway Group* and apply to all relevant activities that fall into the scope of each individual’s Railway Safety Case. If any of those activities are performed by a contractor, the contractor’s obligation in respect of Railway Group Standards is determined by the terms of the contract between the respective parties. Where a contractor is a duty holder of a Railway Safety Case then Railway Group Standards apply directly to the activities described in the Safety Case.

* The Railway Group comprises Railtrack PLC, Railway Safety, and the train and station operators who hold railway safety cases for operation on or related to infrastructure controlled by Railtrack PLC.

Railtrack PLC is known as Railtrack.
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A5 Health and safety responsibilities

In issuing this document, Railway Safety makes no warranties, express or implied, that compliance with all or any documents published by Railway Safety is sufficient on its own to ensure safe systems of work or operation. Each user is reminded of its own responsibilities to ensure health and safety at work and its individual duties under health and safety legislation.

A6 Technical content

The technical content of this document has been approved by:

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A7 Supply

Controlled and uncontrolled copies of this document may be obtained from the Industry Safety Liaison Dept, Railway Safety, Evergreen House, 160 Euston Road, London NW1 2DX.
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Part B

B1 Purpose

This document (issue one of GE/RT8015) mandates requirements for the management of electromagnetic compatibility (EMC) between railway infrastructure and trains to enable safe operation to be assured. In particular, it defines responsibilities and sets out requirements for:

a) the infrastructure controller to characterise the susceptibility of the infrastructure, and to determine maximum allowable train emission levels

b) the provision of that infrastructure information when required

c) processes to enable compatibility between infrastructure and trains to be demonstrated in order to meet the requirements of the route acceptance process set out in Railway Group Standard GO/RT3270 (to be superseded by GE/RT8270).

See also section B4.8.

B2 Application of this document

B2.1 To whom the requirements apply

This document contains requirements that are applicable to duty holders of the following categories of Railway Safety Case:

a) infrastructure controller

b) train operator.

B2.2 Compliance requirements for infrastructure

B2.2.1 Provision of susceptibility and emissions data

The infrastructure controller shall identify the information that is already available which will contribute to meeting the requirements of section B6, and publish it no later than 7 December 2002.

Also by 7 December 2002, the infrastructure controller shall publish a staged plan setting out the dates when the remaining data will be made available. Priority shall be given to data required for routes affected by proposals for:

a) introduction of new or modified trains

b) introduction of trains which are new to the route

c) changes to the infrastructure.

The plan shall define staged targets for the progressive publication of the required data, and the infrastructure controller shall regularly report progress to Railway Safety against these defined targets.

All of the data required to meet the requirements of section B6 shall be made available by the infrastructure controller no later than 6 December 2003.

B2.2.2 Infrastructure systems

The infrastructure design requirements in this document are mandatory for new Railtrack controlled infrastructure and for alterations to existing Railtrack controlled infrastructure for which Approval in Principle is given on or after 6 December 2003.

When Approval in Principle is given before 6 December 2003, but the infrastructure has not yet been brought into service, the design shall be reviewed and, where reasonably practicable, brought into line with the requirements of this document. Where it is not reasonably practicable to do so, the situation shall be regularised by means of a non-compliance or derogation (see section B2.2.3).
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Action to bring existing infrastructure systems into compliance with the design requirements set out in sections B5.3.2, B5.3.3, B5.3.4 and B5.4.2 of this document is not required.

B2.3  Compliance requirements for trains

B2.3.1  General
The requirements of this document are applicable to all rail vehicles intended to operate on Railtrack controlled infrastructure, except for vehicles which are permitted to be on Railtrack controlled infrastructure only within possessions.

B2.3.2  Design
The vehicle design requirements mandated in this document are to be complied with by all vehicles of previously uncertificated designs with a Certificate of Conformance for Vehicle Design signed on or after 6 December 2003. In addition to this the design requirements shall be complied with by any future vehicles, built to the same design as a vehicle already having Engineering Acceptance, which enter service on Railtrack controlled infrastructure on or after 2 December 2007.

Action to bring existing trains and train systems into compliance with these requirements is not required.

B2.3.3  Assessment
All assessments of electromagnetic compatibility (EMC) forming part of a Route Acceptance Safety Case (RASC) shall make use of all relevant EMC susceptibility and emissions data which has been published by the infrastructure controller. As far as practicable the latest data shall be used.

Where it is required prior to 6 December 2003 to demonstrate compatibility, in accordance with section B7.2, with infrastructure systems for which all the information required by section B6 has not yet been made available, the train operator shall submit his proposals and assumptions to the infrastructure controller in respect of susceptibility parameters and the methodology to be used.

If accepted by the infrastructure controller these can be used to demonstrate compatibility. For this purpose it is permissible for the train operator to make use of any information relating to susceptibility parameters and acceptable methodologies which has been provided by the infrastructure controller even though the form in which this information has been developed and provided is not fully compliant with section B6. If the infrastructure controller does not accept the train operator’s proposals for susceptibility parameters and methodology, the infrastructure controller shall specify the basis on which compatibility is to be demonstrated.

All assessments for an RASC submitted for route acceptance on or after 3 December 2005 shall be based fully on the data published by the infrastructure controller in accordance with this document.

B2.3.4  General
All other requirements mandated in this document, including the responsibility to manage immunity and emission levels of existing trains set out in sections B5.1 and B5.2.1, shall be complied with from 7 December 2002.

The requirements of section B5.1 a) and B5.2.2 are within the scope of Vehicle Acceptance Body approval.

B2.4  General compliance requirements
Until the compliance dates, or the date by which compliance is achieved (if earlier), the applicable requirements of the predecessor documents shall continue to be met (see Part A for details).

After the compliance dates, or after the date by which compliance is achieved (if earlier), Railway Group members shall not deviate from the requirements set out in this document.
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Where it is considered not reasonably practicable to comply with the requirements set out in this document, authorisation not to comply shall be sought in accordance with GA/RT6001, GA/RT6004 or GA/RT6006.

B3 Definitions

**Electromagnetic compatibility**
Compatibility of electrical and electronic systems, in respect of emission and immunity levels, to ensure that operation of one system is not adversely affected by emissions from any other system or equipment. For the purposes of this document, EMC assessment shall include consideration of conductive, inductive, capacitive and radiated effects at all frequencies from DC to 2 GHz.

**Electromagnetic interference**
Emissions of electromagnetic energy which have the potential to threaten electromagnetic compatibility.

**Emission**
A disturbance to the environment caused by the release of energy in the electromagnetic spectrum from equipment or apparatus. For the purposes of this document, this shall be considered to include all frequencies from DC to 2 GHz.

**Immunity**
The ability of equipment or apparatus to operate without failure or malfunction in the presence of electromagnetic interference.

**Infrastructure emission**
An emission of electromagnetic energy from any part of the railway infrastructure, for example feed currents from track circuit transmitters, or power supply harmonics or distortion from DC sub-stations.

**Infrastructure systems**
Fixed and portable systems and equipment forming part of the railway infrastructure provided or operated by the infrastructure controller. For the purposes of this document, infrastructure systems do not include:

a) train-borne equipment (including train-borne components of signalling, control or communication systems, even where such systems are mandated or specified by the infrastructure controller)
b) systems outside the boundary of the railway.

**Normal condition of infrastructure**
The normal (‘as designed’) condition of the infrastructure, in terms of its susceptibility to electromagnetic interference (EMI) from trains, includes the following:

a) operation under normal traction feeding conditions
b) the effects of the range of weather conditions appropriate for the location, including icing
c) the effects of anticipated environmental factors
d) for track circuits, a defined minimum ballast resistance (normally 2 Ω km from DC to 20 kHz)
e) a defined rail impedance
f) all bonding intact.

**Route Acceptance Safety Case**
The document(s) which demonstrate the conditions under which vehicles can be operated safely on the defined route(s) and which forms the basis of an application for a Certificate of Authority to Operate. (See GO/RT3270, to be superseded by GE/RT8270). This may also be referred to as the Rolling Stock System Safety Case.
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RASC author
The person producing a Route Acceptance Safety Case (RASC), or part of an RASC, as required by Railway Group Standard GO/RT3270 (to be superseded by GE/RT8270). As permitted by GO/RT3270 and GE/RT8270, this can be the train operator or a third party.

Susceptibility
Sensitivity of equipment or apparatus to electromagnetic emissions.

Train
For the purposes of this document, a train is any permitted combination of rail vehicles.

B4 Introduction
Section B4 summarises the principal requirements of the following sections of the document and is included for guidance.

B4.1
This document sets out requirements, both for the design of systems and equipment and for the control of operations, to enable the infrastructure controller and train operators to ensure that, under normal operating conditions and credible failure modes, their operations and equipment do not compromise safety due to electromagnetic interference. This includes assurance of electromagnetic compatibility, both between train emissions and infrastructure susceptibility (sections B5.2 and B5.3), and between infrastructure emissions and train susceptibility (sections B5.1 and B5.4).

B4.2
In addition, this document defines the process for determining allowable train emission levels and allowable infrastructure susceptibility to ensure safe operation, in order to demonstrate electromagnetic compatibility as part of the route acceptance process set out in Railway Group Standard GO/RT3270 (to be superseded by GE/RT8270). This process, which comprises the steps described in section B4.3, ensures a safety margin between train emissions and infrastructure susceptibility as shown in Figure 1.

B4.3
Sections B6.1 to B6.4 of this document set out the responsibility of the infrastructure controller to analyse the infrastructure, determine the maximum allowable per train emission levels and determine safety margins and safety targets. It is the responsibility of train operators, as set out in section B5.2, to maintain train emissions at all frequencies to no more than the maximum allowable per train emission levels for section of track that the train travels over. It is the responsibility of the infrastructure controller, as set out in section B6.5, to maintain the infrastructure such that train emissions equal to or below the maximum allowable per train emission level plus the safety margin will not result in a safety related or safety critical failure of the infrastructure. Section 7 describes the process for assessing and demonstrating EMC as part of the route acceptance process for new or modified vehicles and for infrastructure changes.
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Level of per train emissions

100%

Minimum per train infrastructure susceptibility (normal conditions)

Allowance for infrastructure degradation/faults

>=50%

Safety margin

Minimum allowable per train infrastructure susceptibility (fault/degraded conditions)

Maximum allowable per train emission

Figure 1: Basis of train emissions and infrastructure susceptibility determination

B4.4
The maximum allowable per train emission level is determined (as illustrated in Figure 1) by initially considering susceptibility of the infrastructure under normal conditions, taking into account the effect of transmitter interference from the infrastructure itself, external interference and interference from other trains, then considering failures and degradation of the infrastructure which could affect susceptibility, and then applying a safety margin. This document requires that the maximum allowable per train emission level set by the infrastructure controller is not less than 50% of the train emission which the infrastructure can be expected to tolerate under normal conditions, unless a lower level is agreed by all train operators using that section of track.

B4.5
It is recognised that the train may convert certain types of infrastructure emission into a form of train emission. This document requires that this is taken into account, and allowance is made for increases in these infrastructure emissions above normal levels (up to a maximum of 200% of the normal value unless a higher level is agreed by all train operators using that section of track).

B4.6
The control of electromagnetic compatibility requires the infrastructure controller and the train operators to co-operate in the specification and assessment of levels of emission and immunity of their systems and the application of suitable controls to maintain the integrity of the systems throughout their life-cycle. A network-wide system authority constituted in accordance with Railway Group Standard GE/RT8049 is appropriate for this purpose.
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B4.7
The requirements of this document are concerned with safety and are, therefore, additional to the requirements for electromagnetic compatibility set out in EN50121 and EMC Directive 89/336/EEC.

B4.8
This issue (issue one) of GE/RT8015 defines controls to ensure system safety and safe interworking in the context of EMC between railway infrastructure and trains. A further issue (issue two) of GE/RT8015 is planned, which is intended to replace other Railway Group Standards and Codes of Practice on the subject of EMC, including GM/RC1501 and BR13422, and to include more detailed consideration of the following:

a) fitment of train-borne control and communications systems, such as ERTMS and GSM-R, to existing rolling stock
b) supply of information on susceptibility of train-borne systems by train operators
c) review of the definition of normal infrastructure
d) alignment with emerging European standards.

B5 General system requirements

B5.1 Requirements for train operators: immunity of trains
Train operators shall ensure that trains are designed, built, operated and maintained so as to ensure that the safety performance of train systems is not compromised by exposure to:

a) emissions at the levels specified in the immunity requirements of EN50121 part 3
b) emissions from the train itself, including train-borne equipment
c) any emissions from the railway infrastructure which have been specified by the infrastructure controller, as required by section B6.6, where these are in excess of the immunity levels specified in EN50121 part 3 or outside the scope of that standard.

B5.2 Requirements for train operators: emissions from trains

B5.2.1
Train operators shall ensure that electromagnetic emissions from trains are limited to levels which will not create a hazard to the safe operation of infrastructure systems and equipment. These levels shall be defined by the infrastructure controller in accordance with the requirements of section B6. This shall take into account normal, degraded and fault conditions on the train, and shall consider abnormal situations such as recovery of a failed train.

B5.2.2
Train operators shall ensure that emissions from new trains, or from new or modified equipment on existing trains, do not exceed the levels specified in EN50121 part 3.

B5.3 Requirements for infrastructure controller: immunity of infrastructure

B5.3.1
The infrastructure controller shall ensure that infrastructure systems, including the power supply, signalling and telecommunications systems, are designed, installed and maintained so as to ensure that they are immune to reasonable levels of electromagnetic emission from trains, in accordance with the requirements of sections B5.3.2, B5.3.3, B5.3.4 and B6.4.9. In addition, infrastructure systems shall be designed, installed and maintained so as to ensure that their safety performance is not compromised by EMI from other elements of the infrastructure, or from any portable equipment that is permitted to be used within the railway boundary.
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B5.3.2
When changes are made to existing infrastructure, the infrastructure controller shall not make alterations to systems or configurations of equipment which reduce the overall level of immunity of the infrastructure to EMI compared to existing susceptibility levels. This shall apply in respect of any change which will reduce the level of immunity of any system below that applying to other systems on the same section of track. It is permissible to introduce changes which reduce the level of immunity of individual items of equipment if the reduced immunity is still higher than that of other similar systems on the same section of track. For example, it is permissible to combine two short track circuits into a single track circuit if the combined track circuit is still shorter than other track circuits of the same type on the same section of track (provided that other factors affecting its immunity to interference and applicable safety targets are comparable). In all cases, however, any changes shall comply with all current standards set by the infrastructure controller for the equipment or system concerned, in so far as they affect the susceptibility levels of that equipment or system.

B5.3.3
When new or significantly altered infrastructure is introduced (such as where new systems or new configurations of equipment are introduced), the infrastructure controller shall ensure that these are designed to increase the level of immunity of the infrastructure to EMI compared to existing susceptibility levels, where this can reasonably be achieved within the context of whole system costs. The infrastructure controller shall document details of an assessment justifying the decision on the level of immunity achieved.

B5.3.4
The infrastructure controller shall ensure that new safety-critical and safety-related systems are designed such that the consequences of EMI on safety performance are minimised or eliminated. Acceptable methods of achieving this requirement include:

a) use of multiple data sources and logic to avoid a reduction in safety performance due to wrong-side failure of a single component (such as a track circuit)

b) design of system such that simple energisation within an operating frequency band will not result in a reduction in safety performance.

B5.4 Requirements for infrastructure controller: infrastructure emissions
B5.4.1
The infrastructure controller shall ensure that electromagnetic emissions from the infrastructure are limited to levels which will not create a hazard to the safe operation of train-borne systems or other elements of the infrastructure. In particular, the infrastructure controller shall ensure that electromagnetic emissions from the infrastructure do not exceed the levels for which trains accepted to operate on the section of track are designed to be immune. This shall take into account normal, degraded and fault conditions of the infrastructure.

B5.4.2
The infrastructure controller shall ensure that emissions from new or modified infrastructure do not exceed the levels specified in EN50121 parts 4 and 5.

B6 Identification of EMC data for infrastructure systems
B6.1 General requirements
B6.1.1
The infrastructure controller shall establish and maintain information on infrastructure systems, in relation to their susceptibility to EMI, as set out in sections B6.2 to B6.4, in order to facilitate safe management of EMC.
B6.1.2
The infrastructure controller shall ensure that the information on the susceptibility of infrastructure systems is kept up to date and documented. In particular, where a change to the infrastructure affects any EMC susceptibility data previously issued, the infrastructure controller shall ensure that the EMC susceptibility data for the systems affected is re-evaluated and updated as necessary.

B6.1.3
The infrastructure controller shall, on request, provide the information on the susceptibility of infrastructure systems in a controlled manner to train operators and train builders. The infrastructure controller shall also make this information available on request to ROSCOs, RASC authors and other interested parties.

B6.2 Identification of susceptible infrastructure systems
B6.2.1
The infrastructure controller shall identify and document all safety-critical and safety-related infrastructure systems which could have their safety performance reduced as a consequence of EMI. Examples of the types of system to be considered are given in Appendix 2.

B6.3 Requirements for information on infrastructure susceptibility
B6.3.1
For each susceptible infrastructure system identified in section B6.2, the infrastructure controller shall analyse the susceptibility of the system to interference, as detailed in section B6.4. Information on the susceptibility of each system shall be documented in line with the requirements of sections B6.3.2 to B6.3.10, and the infrastructure controller shall provide this information to train operators and other stakeholders in accordance with the process set out in section B6.1.

B6.3.2
Where a generic analysis can be carried out, valid for all applications of a particular system, this information shall be provided.

B6.3.3
Where it is not possible to carry out a generic analysis, either:
   a) a series of analyses shall be carried out covering all the different scenarios of application which could be encountered (for example, different configurations of the equipment or differences in physical parameters such as circuit length) or
   b) a generic methodology shall be defined which can be applied to each scenario which could be encountered.

B6.3.4
The analysis for each system shall consider steady state and transient interference.

B6.3.5
The infrastructure controller shall provide sufficient information on the location and configuration of all susceptible infrastructure systems to enable train operators to determine the relevant data, as detailed in section B6.4, for any route a train formation may take. The infrastructure controller shall identify any specific locations, or particular items of equipment, which have a susceptibility lower than any standard susceptibility levels which have been defined by the infrastructure controller for that type of equipment.

B6.3.6
Allowable emission levels shall be stated per train.

B6.3.7
All analyses shall take into account the maximum number of trains which could be on the section of track. It is permissible for the maximum number to allow for...
a future increase in the number of trains operating on the route where agreement has been reached with all train operators using the section of track. The system authority referred to in section B4.6 is appropriate for this purpose.

**B6.3.8**
All analyses shall take into account any interference generated within the railway infrastructure (including transmitter breakthrough) and known sources of interference external to the railway.

**B6.3.9**
All assumptions shall be documented.

**B6.3.10**
The analysis of each system shall be independently validated, and a record of this validation shall be made available as part of the documentation referred to in section B6.1.2.

**B6.4 Information on susceptibility of infrastructure systems to interference**

**B6.4.1**
The infrastructure controller shall carry out and document an analysis of each system identified in section B6.2 (for example a particular type of track circuit) to determine the nature and levels of train emissions which would cause a reduction in safety performance for the normal ('as designed') condition of the infrastructure.

**B6.4.2**
The infrastructure controller shall determine the faults and degraded conditions which could occur on the infrastructure that would cause the sensitivity of each system to be reduced. The fault and degraded conditions information shall be documented on a fault tree or equivalent.

**B6.4.3**
The infrastructure controller shall carry out and document an analysis of each system identified in section B6.2 (for example a particular type of track circuit) to determine the nature and levels of train emissions which would cause a reduction in safety performance under the fault and degraded conditions of the infrastructure identified in section B6.4.2. Based on these levels and on consideration of the maximum number of trains which could affect the system at any time, the infrastructure controller shall define the minimum allowable per train infrastructure susceptibility.

**B6.4.4**
The infrastructure controller shall determine a safety margin which shall be adequate to allow for any uncertainties in the emission and susceptibility levels. This safety margin shall be subtracted from the minimum allowable per train infrastructure susceptibility in order to determine the maximum allowable per train emission level.

**B6.4.5**
Where the maximum allowable per train emission level for any infrastructure system (as determined in accordance with sections B6.4.3 and B6.4.4) is less than 50% of the level which would apply under normal infrastructure conditions (as determined in accordance with section B6.4.1), the infrastructure controller shall:

a) consider potential improvements to the infrastructure configuration or maintenance regime  
b) re-evaluate the fault and degraded conditions identified in section B6.4.2, taking account of these improvements  
c) repeat the analysis described in sections B6.4.3 and B6.4.4 for these revised fault and degraded conditions, in order to raise the maximum allowable per
train emission to a level which is not less than 50% of the level which would apply under normal infrastructure conditions

d) ensure that the identified changes to the infrastructure configuration or maintenance regime are implemented.

Alternatively, it is permissible for the infrastructure controller to reach agreement with all train operators using that section of track on acceptability of a lower value of maximum allowable per train emission; the system authority referred to in section B4.6 is appropriate for this purpose.

**B6.4.6**

Where the safety performance of an infrastructure system can be reduced through conduction or other coupling of an infrastructure emission by the train (for example 50 Hz voltage from a DC sub-station conducted through train impedance), the level of the infrastructure emission under the normal (‘as designed’) conditions of the infrastructure shall be determined and documented by the infrastructure controller.

**B6.4.7**

The infrastructure controller shall determine the faults and degraded conditions which could occur on the infrastructure that would cause an increase in the level of infrastructure emissions identified in section B6.4.6, and shall determine the increased level of infrastructure emissions which could occur under these conditions. The fault and degraded conditions information shall be documented on a fault tree or equivalent.

**B6.4.8**

Where the maximum level of infrastructure emissions under fault and degraded conditions (as determined in accordance with section B6.4.7) is greater than 200% of the level which would apply under normal infrastructure conditions (as determined in accordance with section B6.4.6), the infrastructure controller shall:

a) consider potential improvements to the infrastructure configuration or maintenance regime

b) re-evaluate the fault and degraded conditions identified in section B6.4.7, taking account of these improvements

c) determine the emission level for these revised fault and degraded conditions, in order to reduce the maximum level of infrastructure emissions under these conditions to a level which is not more than 200% of the level which would apply under normal infrastructure conditions

d) ensure that the identified changes to the infrastructure configuration or maintenance regime are implemented.

Alternatively, it is permissible for the infrastructure controller to reach agreement with all train operators using that section of track on acceptability of a higher value of maximum infrastructure emissions; the system authority referred to in section B4.6 is appropriate for this purpose.

**B6.4.9**

The infrastructure controller shall set a safety target for the acceptable failure rate of each safety-critical or safety-related infrastructure system due to emissions from trains. An acceptable way of expressing this safety target is as mean time between failures per system. This safety target shall be apportioned equally between:

a) failures caused by train emissions exceeding the maximum allowable per train emission level

b) failures due to the infrastructure susceptibility falling below the minimum allowable per train infrastructure susceptibility specified in sections B6.4.3 or B6.4.5

c) failures due to the infrastructure emissions identified in section B6.4.6 rising above the maximum value defined in sections B6.4.7 or B6.4.8.
These safety targets shall be documented.

**B6.4.10**
The infrastructure controller shall provide information which will enable the train operator to demonstrate compatibility with the infrastructure system under normal conditions and under the fault and degraded conditions of the infrastructure identified in sections B6.4.3 (or B6.4.5) and B6.4.7 (or B6.4.8). In particular, this information will enable the train operator to demonstrate compliance with the maximum allowable per train emission levels and with the associated safety targets specified in section B6.4.9. The infrastructure controller shall provide this information in one of the following forms, selecting the most appropriate form of information for each infrastructure system:

a) a model of the system that will relate the reduction in its safety performance to interference from trains or

b) sufficient data to enable the train operator to construct such a model or

c) details of the transfer function from train emissions to the system, applicable to interference under normal conditions and under the specified fault and degraded conditions of the infrastructure, together with guidance on a suitable methodology for demonstrating compatibility (for example by carrying out tests with samples of the actual equipment used in the system).

**B6.5 Infrastructure maintenance requirements**

**B6.5.1**
The infrastructure controller shall specify and implement a maintenance and testing regime for the infrastructure that will ensure that the sensitivity of the system is not reduced below the minimum allowable per train infrastructure susceptibility identified in section B6.4.3 (or B6.4.5), in accordance with the safety targets specified in section B6.4.9.

**B6.5.2**
Where safety performance of the system can be reduced through conduction of an infrastructure emission (for example 50 Hz voltage from a DC sub-station conducted through train impedance), the infrastructure controller shall specify and implement a maintenance and testing regime for the infrastructure that will ensure that the infrastructure emission shall not exceed the defined increase in level identified in section B6.4.7 (or B6.4.8), in accordance with the safety targets specified in section B6.4.9.

**B6.6 Information on infrastructure emissions**
The infrastructure controller shall identify any infrastructure emissions which could affect the correct operation of train-borne systems, and which are not defined in EN50121 parts 4 and 5, or exceed the levels specified therein. The infrastructure controller shall ensure that information on such emissions is made available to train operators. The information shall also include interference from other known sources which could be propagated by the infrastructure.

There are specific compliance requirements for the whole of section B6. See section B2.2 for details.

**B7 Process for assessing electromagnetic compatibility between infrastructure and trains**

**B7.1**
Railway Group Standard GO/RT3270 requires the production of an RASC as part of the route acceptance process for rail vehicles. The RASC shall include an assessment of the risks arising from electromagnetic interference between the train and the infrastructure.
Appendix 1 gives the requirements for assessment of electromagnetic compatibility as part of the route acceptance process mandated by Railway Group Standard GO/RT3270. It addresses the specific requirements for EMC assessment and supplements the more general requirements in GO/RT3270. It is intended to include these requirements in Railway Group Standard GE/RT8270 which will supersede GO/RT3270.

B7.2
The process for assessing the electromagnetic compatibility of new or modified vehicles set out in Appendix 1, section 1.1, is applicable to the introduction of new trains on any route, and to the introduction of existing trains on additional routes. It is also applicable to any modification to trains or any change in operations which could have a material effect on electromagnetic compatibility, for example operation of trains in a different formation, significant timetable changes or changes in maintenance regime.

B7.3
The process for assessing the electromagnetic compatibility of new or modified infrastructure set out in Appendix 1, section 1.2, is applicable when any change is made to the infrastructure which would result in a change to the susceptibility of infrastructure systems to EMI from trains, or in an increase in potential electromagnetic emissions which could affect trains operating over the route.

B8 Resolution of disputes
Railway Group Standard GO/RT3270 (to be superseded by GE/RT8270) includes provision for resolution of disagreements between the infrastructure controller and train operators or third parties in respect of the appropriateness of methodology or data used in assessments or the acceptability of the results of assessments as part of the route acceptance process.
Appendix 1

Route acceptance – process for assessing electromagnetic compatibility between infrastructure and trains
(The content of this appendix is mandatory).

This appendix contains the requirements for assessment of electromagnetic compatibility as part of the route acceptance process mandated by Railway Group Standard GO/RT3270. It addresses the specific requirements for EMC assessment and supplements the more general requirements in GO/RT3270. It is intended to include these requirements in Railway Group Standard GE/RT8270 which will supersede GO/RT3270.

1.1 Process for assessing electromagnetic compatibility of new or modified vehicles

1.1.1 Assessment of compatibility between infrastructure systems and emissions from trains

1.1.1.1 Railway Group Standard GO/RT3270 requires the production of a Route Acceptance Safety Case (RASC) as part of the route acceptance process for rail vehicles. The RASC is required to include an assessment of the risks arising from electromagnetic interference between the train and the infrastructure.

1.1.1.2 The infrastructure controller shall have in place a process which will provide sufficient information, as defined in section B6 of this document, about the configuration of the infrastructure and the characteristics of equipment to enable the RASC author to carry out an adequate assessment of these risks.

1.1.1.3 Where any information which is required to demonstrate compatibility is not already available, the infrastructure controller shall, following a request for such information from a train operator, supply the required information to a mutually agreed timescale.

1.1.1.4 The train operator shall, in the RASC, demonstrate compatibility of new or modified vehicles with the infrastructure systems, using the information provided by the infrastructure controller, as specified in section B6, and the methodology set out in section 1.1.3 of this appendix.

1.1.2 Assessment of compatibility of train-borne systems with infrastructure emissions

1.1.2.1 The train operator shall identify all safety-critical and safety-related systems on board the train which could have their safety performance reduced as a consequence of EMI, and shall carry out and document an analysis of each susceptible system to identify the mechanisms by which EMI could reduce the safety performance of the system and to determine its susceptibility. Examples of the types of system to be considered are given in Appendix 3.

1.1.2.2 The infrastructure controller shall provide sufficient information on the level and characteristics of EMI which could be emitted or propagated by the infrastructure on the route, as specified in section B6.6, to enable the train operator to assess the compatibility of train-borne systems with this interference.
1.1.2.3 The train operator shall demonstrate in the RASC that the safety performance of train-borne systems will not be compromised by EMI from the infrastructure at the levels declared by the infrastructure controller.

1.1.3 Application of the information on infrastructure susceptibility

1.1.3.1 Train operators shall use the information specified in section B6.4 in the RASC to demonstrate the safety of the system, under normal and defined degraded conditions of the infrastructure, throughout the period that the train formation will operate on the route. This shall take into account normal, degraded and fault conditions on the train, and shall consider abnormal situations such as recovery of a failed train.

1.1.3.2 The train operator shall specify in the RASC, and shall incorporate in the certificated maintenance plans, a maintenance and testing regime for the train that will ensure that the probability of excessive train emissions is limited to the level which is stated in the RASC.

1.2 Process for assessing electromagnetic compatibility of infrastructure changes

1.2.1 Assessment of compatibility of new and modified infrastructure systems with emissions from trains

1.2.1.1 Whenever any planned change to the infrastructure would result in an identified change to the susceptibility of infrastructure systems to EMI from trains, the infrastructure controller shall review the effects of this change on the validity of the route acceptance for all trains authorised to operate over the route (including those trains authorised to operate by processes which preceded the issue of Railway Group Standard GO/RT3270).

1.2.1.2 Train operators shall provide, to a mutually agreed timescale, any additional train data requested by the infrastructure controller (in accordance with the procedures set out in GO/RT3270) which is needed to permit the effects of the change to be assessed.

1.2.2 Assessment of compatibility of train-borne systems with emissions from new and modified infrastructure

Whenever any planned change to the infrastructure could result in an identified increase in potential electromagnetic emissions (of any type or at any frequency), the infrastructure controller shall advise all train operators of trains authorised to operate over the section of track of the revised emission levels. The train operator shall assess the effects of the revised emission levels on the safety performance of train-borne systems and inform the infrastructure controller whether the safety performance of these systems would be compromised.

1.2.3 Resolution of identified incompatibility

If the assessment of the effect of the planned infrastructure change identifies an increased risk due to EMI, either as a result of the susceptibility of the new infrastructure to EMI from trains (section 1.2.1) or as a result of the effect of emissions from the new infrastructure on the safety performance of existing train-borne systems (section 1.2.2), the infrastructure controller shall either:

a) revise the planned changes to the infrastructure to ensure that compatibility with existing trains authorised to operate over the section of track will be maintained or
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b) reach agreement with the train operator(s) concerned on the necessary changes to the trains in order to achieve compatibility with the planned changes to the infrastructure. The system authority referred to in section B4.6 is appropriate for this purpose.
Appendix 2

Infrastructure systems whose safety performance could be affected by electromagnetic interference

(The content of this appendix is not mandatory and is given for guidance).

The list below gives examples of safety-critical and safety-related infrastructure systems and equipment which could have their safety performance reduced as a consequence of EMI. This list (which is not exhaustive) provides an indication of the types of systems and equipment which the infrastructure controller needs to include in the assessment in accordance with section B6:

a) train detection systems (including track circuits and axle counters)
b) interlocking systems
c) signals and point operating equipment and their controlling circuits
d) train warning and protection systems
e) telecommunications systems (including voice and data transmission, and supervisory control and data acquisition (SCADA) systems)
f) radio systems (including voice and data transmission, fixed and mobile systems).
Appendix 3

Train-borne systems whose safety performance could be affected by electromagnetic interference

(The content of this appendix is not mandatory and is given for guidance).

The list below gives examples of safety-critical and safety-related train-borne systems and equipment which could have their safety performance reduced as a consequence of EMI. This list (which is not exhaustive) provides an indication of the types of systems and equipment which the train operator needs to include in the EMC assessment:

a) braking systems
b) traction control systems
c) tilt control systems
d) door control systems
e) coupling systems
f) communications systems
g) lighting systems (internal and external)
h) train-borne elements of command and control systems.
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References

Railway Group Standards and other Railway Group Documents
- **GA/RT6001**: Railway Group Standards Change Procedures
- **GA/RT6004**: Temporary Non-Compliance with Railway Group Standards
- **GA/RT6006**: Derogations from Railway Group Standards
- **GE/RT8049**: The Creation and Management of System Authorities
- **GE/RT8270**: Route Acceptance of Rail Vehicles [to be issued – will supersede GO/RT3270]
- **GO/RT3270**: Route Acceptance of Rail Vehicles [to be superseded by GE/RT8270]

Other related Railway Group Documents
- **GM/RC1500**: Code of Practice for EMC between the Railway and its Neighbourhood


Other References
- **EN50121**: Railway applications: Electromagnetic compatibility
- **89/336/EEC**: Electromagnetic Compatibility Directive