

Ref:	NR/L2/RSE/30041
Issue:	2
Date:	2 June 2012
Compliance date:	1 September 2012

Level 2

Electromagnetic compatibility (EMC) assurance process

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Published and Issued by Network Rail, Kings Place, 90 York Way, London. N1 9AG.



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User information

This Network Rail standard contains colour-coding according to the following Red–Amber–Green classification.

Red requirements – *No deviations, could stop the railway*

- **Red requirements shall** always be complied with and achieved.
- Red requirements shall be presented in a red box **with the word “shall” or expressed as a direct instruction**.
- Accountability for the efficacy of red requirements lies with the Professional Head/Standard Owner.
- Red requirements are monitored for compliance.
- Corrective actions shall be enforced if deviations are discovered through functional checks (e.g. engineering verification visits, audit or Operations Self-Assurance).

Amber requirements – *Controlled deviations, approved risk analysis and mitigation*

- **Amber requirements shall** be complied with unless deviation has been approved in advance.
- Amber requirements shall be presented with an amber sidebar **and with the word “shall” or expressed as a direct instruction**.
- Accountability for the efficacy of these requirements lies with the Professional Head/Standard Owner, or their nominated Delegated Authority.
- Amber requirements are monitored for compliance.
- Deviations **may** be permitted. Deviations are approved by the Standard Owner or through existing Delegated Authority arrangements.
- Corrective actions shall be enforced if **non-approved** deviations are discovered through functional checks (e.g. engineering verification visits, audit or Operations Self-Assurance).

Green – *Guidance*

- Guidance is based on good practice. Guidance represents supporting information to help achieve **Red** and **Amber** requirements.
- Guidance shall be presented with a dotted green sidebar **and with the word “should” (usually in notes) or as a direct instruction**.
- Guidance is **not mandatory** and is not monitored for compliance.
- Alternative solutions may be used. Alternative solutions do not need to be formally approved.
- Decisions made by a competent person to use alternative solutions should be backed up by appropriate evidence or documentation.

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Issue record

Issue	Date	Comments
1	August 2008	First issue
2	June 2012	Engineering standards update

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors if applicable from 1 September 2012.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 3 (Option Selection) to continue to comply with the issue of any relevant Network Rail standards current when GRIP Stage 3 was completed and not to comply with requirements contained herein, unless stipulated otherwise in the scope of this standard.

Reference documentation

1999/95/EC. The Radio Equipment & Telecommunications Terminal Equipment Directive (R&TTE).

2004/108/EC. The Electromagnetic (EMC) Compatibility Directive.

BS EN 50121:2006, Parts 1 – 5. *Railway Applications – Electromagnetic Compatibility. Parts 1 – 5.*

BS EN 50122-1:2011 +A1:2011, *Railway Applications – Fixed Installations – Electrical Safety, earthing and the return circuit – Protective provisions against electric shock.*

BS EN 50388:2005, *Railway Applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock to achieve interoperability.*

NR/GN/ELP/27010, *Compatibility between Electric trains and electrification systems.*

NR/L1/RSE/30040, *EMC Strategy for Network Rail.*

NR/L1/TEL/30029, *Telecoms Installation.*

NR/L2/ELP/27311, *Engineering Assurance Requirements for Design and Implementation of Electrical Power Engineering Infrastructure Projects.*

NR/L2/INI/02009, *Engineering Management for Projects.*

NR/L2/INI/GRIP/101, *GRIP Project Management.*

NR/L2/RSE/100/02, *Safety Verification.*

NR/L2/RSE/100/03, *Compliance with Interoperability Regulations for Infrastructure Projects.*

NR/L2/RSE/100/04, *New or changed vehicles on Network Rail Infrastructure.*

NR/L2/RSE/100/05, *Product Introduction & Change.*

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NR/L2/RSE/100/06, *How to decide what needs Product Acceptance.*

NR/L2/RSE/100/07, *System Review Panels.*

NR/L2/RSK/00001, *Integrated Risk Management.*

NR/L2/SIG/30014, *Signalling Works Testing Handbook.*

NR/L2/SIG/D110A, *Master Test Certificate MTC (TC1).*

NR/L2/TEL/30003, *Immunity Test Requirements for Lineside Communications Systems.*

NR/L2/TEL/30094, *Installation of Telecommunications Equipment & Systems.*

NR/L2/TEL/31106, *Overview of Electromagnetic Coupling Between Traction Systems and telecommunications Cables.*

NR/L2/TEL/31107, *Limits and Test Methods of Induced Voltages on Telecommunications Cables due to Electrification Systems.*

NR/L3/ELP/27406/MOD A, *Engineering Deliverable Requirements for Electrical Power Design – Module A Generic Requirements.*

NR/L3/ELP/27406/MOD L, *Engineering Deliverable Requirements for Electrical Power Design – Module L AC/DC Traction Power Supply Interfaces.*

NR/SP/TEL/50016, *Methodology for the Demonstration of Compatibility with Telecommunications Systems.*

GE/RT8015, *Electromagnetic Compatibility between Railway Infrastructure and Trains.*

Statutory Instrument 2000 No. 730. The Radio Equipment & Telecommunications Terminal Equipment Regulations 2000 (as amended).

Statutory Instrument 2006 No. 599. The Railways & Other Guided Transport (Safety) Regulations (2006) (as amended).

Statutory Instrument 2006 No. 3418. The Electromagnetic Compatibility (EMC) Regulations (2006) (as amended).

Statutory Instrument 2011 No. 3066. The Railways (Interoperability) Regulations (2011).

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1 Purpose

This standard specifies how Network Rail manages the risks of asset failure associated with known uncontrolled electromagnetic phenomena.

It supports the Network Rail policy requirements as specified in NR/L1/RSE/30040, *Electromagnetic Compatibility (EMC) Strategy for Network Rail*, and its legal obligations under the EMC Regulations (2006).

2 Scope

This Network Rail standard:

- a) specifies the assurance process for the management and control of EMC to meet the requirements of the EMC Regulations (2006);
- b) specifies the standards for the acceptance of equipment for integration onto the railway system;
- c) specifies best practice based on current European and Network Rail EMC engineering standards;
- d) applies to all new or modified infrastructure, including apparatus, fixed and mobile installations, all types of rail vehicles and rolling stock on the operational railway.

This standard does not specify requirements for equipment that is classified as “inherently benign”. A list of examples of “inherently benign” equipment is in Appendix A.

3 Roles and responsibilities

EMC Responsible Person

The person within a company or organisation who has been identified as the Responsible Person as defined in Interpretation 3(h) of the EMC Regulations (2006).

- In relation to “apparatus”, this means the manufacturer established in the European Community or its authorised representative, or the person who places the apparatus on the market or puts it into service.
- In relation to a fixed installation, the person who, by virtue of their control of the fixed installation, is able to determine that the configuration of the installation is such that when used it complies with the essential requirements of the EMC Regulations.

Within Network Rail, this is the Network Rail Board. The management of these responsibilities are then delegated to the appropriate appointments as specified in this standard. In-service responsibility is discharged via the Route Asset Management Organisation. Any requests from enforcement authorities in respect of EMC are required to be referred to the Head of EMC Engineering, as deemed appropriate. See Table 1 for the responsibility of EMC management.

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Designated Body

DeBo

A Designated Body is a person appointed under the provisions of Regulation 31 of the Railways (Interoperability) Regulations (2011).

Designated Project Engineer

DPE

For the purposes of this standard, the Designated Project Engineer acts as the EMC Responsible Person under delegated authority during time of alterations to the infrastructure unless an alternative appointment is made and recorded.

Director, Route Asset Management

DRAM

For the purposes of this standard and for compliance with the EMC Regulations (2006), the DRAM or their delegated representative is responsible for maintaining the equipment and/or installation as identified in the relevant Operations & Maintenance Manual (O&MM).

Within Network Rail, the Asset Manager is the individual with the formally delegated responsibility for the management of an asset in a geographical area or at a specific location.

Network Rail Board

Executive and non-executive Directors, responsible for the day-to-day running of the company.

Notified Body

NoBo

Notification is an act whereby a Member State informs the Commission and the other Member States that a body, which fulfils the relevant requirements, has been designated to carry out conformity assessment according to a directive. Notification of Notified Bodies and their withdrawal are the responsibility of the notifying Member State.

The Member States, EFTA countries (EEA members) and other countries with which the EC has concluded Mutual Recognition Agreements (MRAs) and Protocols to the Europe Agreements on Conformity Assessment and Acceptance of Industrial Products (PECAs) have designated Notified Bodies, established per directive.

A Notified Body is defined in Regulation 30 of the Railways (Interoperability) Regulations (2011). It is a body appointed by an EC member government to review Declarations of Conformity submissions, etc. The involvement of a Notified Body is not a requirement of the new EMC Directive but is an option for manufacturers and suppliers who wish to seek third party endorsements of their Declarations of Conformity.

NOTE There are different NoBos dealing with different Directives.

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Project Manager

Within Network Rail, the Project Manager is the person appointed by Network Rail with overall responsibility for the management of a Project to deliver the Remit.

The Project Manager is responsible for checking that the completed Project is acceptable to the Sponsor and Maintenance Engineer responsible for managing the asset.

The EMC National Specialist Team

EMC-NST

The EMC-NST is the centre of technical expertise within Network Rail. It advises on matters concerning EMC and to assist Projects and Routes to meet Network Rail's legal obligations under the EMC Regulations (2006).

It is also able to help Network Rail, routes, functions, projects or departments, to minimise operational difficulties caused by potential EMC phenomena and to close out EMC mitigation issues.

The mission statement of the EMC-NST is specified in NR/L1/RSE/30040.

The EMC-NST may be used to act as a mentor to the nominated EMC Responsible Person, where there is more limited EMC experience.

4 Definitions

For the purposes of this standard, the following terms and definitions apply.

apparatus

finished appliance or combination of appliances made commercially available as a single functional unit, intended for the end user and liable to generate electromagnetic disturbance, or the performance of which is liable to be affected by such disturbances

NOTE This includes components or sub-assemblies intended for incorporation into an apparatus that are liable to generate electromagnetic disturbance, or the performance of which is liable to be affected by such disturbance.

NOTE Trains are regarded as mobile installations, with respect to the EMC Regulations (2006).

Boundary Safety Case

part of the overall system safety case, which considers exported risk to third party/outside parties and neighbouring railways

component

item that is intended for incorporation into an apparatus that is liable to generate electromagnetic disturbance, or whose performance is liable to be affected by such disturbance

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electromagnetic compatibility

ability of equipment to function satisfactorily in its electromagnetic environment, without introducing intolerable electromagnetic disturbances into that environment.

Electromagnetism is associated with alternating currents and voltages which can reach the victim device by:

- conduction;
- electromagnetic field radiation;
- inductive and capacitive coupling

electromagnetic disturbance or interference

electromagnetic phenomenon that can degrade the performance of equipment

An electromagnetic disturbance can include:

- electromagnetic noise;
- an unwanted signal;
- a change in the propagation medium itself;

i.e. undesirable voltages or currents are present, to adversely influence the performance of a device.

NOTE These voltages or currents can reach the victim device by conduction or by electromagnetic field radiation, inductive and capacitive coupling.

electromagnetic environment

electromagnetic phenomena observable at a given location

emission(s)

electrical, magnetic and/or electromagnetic fields, voltages or current generated by an apparatus, or installation (fixed or mobile)

fixed installation

particular combination of one or more types of apparatus and, where applicable, other devices, which are assembled, installed and intended to be used permanently at a pre-defined location

immunity

ability of equipment to perform as intended without degradation in the presence of an electromagnetic disturbance

inherently benign equipment

equipment that:

- a) has inherent physical characteristics such that it is incapable of generating or contributing to electromagnetic emissions that exceed a level allowing radio and telecommunications equipment and other equipment to operate as intended; and

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- b) will operate without unacceptable degradation in the presence of the electromagnetic disturbance normally present in its intended environment

NOTE Equipment that is inherently benign in terms of electromagnetic compatibility is excluded from the scope of the EMC Directive. Appendix A gives examples of the types of equipment that comes within the scope of this category.

mobile installation

combination of apparatus and, where applicable, other devices, intended to be moved and operated in a range of locations

NOTE Within Network Rail, this applies to trains and road–rail vehicles. Mobile installations are treated as apparatus in the context of the EMC Regulations (2006).

so far as is reasonably practicable

SFAIRP

Railway duty holders are required to go through a process of risk assessment which results in them making a decision about whether they consider that their safety measures are adequate to reduce risks SFAIRP. To demonstrate that an employer has complied with Health & Safety Law to ensure “so far as is reasonably practicable” that the duties to ensure the health, safety and welfare at work of their employees and those affected by their undertakings are met.

Network Rail’s policy in this regard is detailed in the Health & Safety Management System.

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5 Abbreviations

AC	Alternating Current
APA	Asset Protection Agreement
CE	Mandatory conformity mark on products placed on the single market in the European Economic Area, denoting compliance to relevant standards
CENELEC	European Committee for Electro-technical Standardisation
DC	Direct Current
DeBo	Designated Body
DEL	A series of Delivery Manuals contained within the GRIP Process
DoC	Declaration of Conformity
DPE	Designated Project Engineer
DRAM	Director, Route Asset Management
E&P	Electrification & Plant
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	European Normalised (Norm) Standard
ESC	Electrical Systems Compatibility
EU	European Union
GRIP	Governance of Railway Investment Projects
HAZID	Hazard Identification
HMRI	Her Majesty's Railway Inspectorate
H&SMS	Health and Safety Management System
NNTR	National Notified Technical Rules
NANDO	New Approach Notified & Designated Organisations Information Systems
NoBo	Notified Body
NR	Network Rail
NRAP	Network Rail Acceptance Panel
NST	National Specialist Team
OMM	Operations Maintenance Manual
ORR	Office of Rail Regulation
PADS	Parts & Drawing System
PM	Project Manager
PMF	Project Management Framework
RGS	Railway Group Standard
RIR	The Railways (Interoperability) Regulations (2006)
ROEP	Rise of Earth Potential
ROGS	The Rail and Other Guided Transport Systems (Safety) Regulations (2006)
ROTS	The Railway and Other Transport Systems (Approval of Works, Plant & Equipment) Regulations 1994
RST	Rolling Stock
R&TTE	Radio & Telecommunications Terminal Equipment
SFAIRP	So far as is reasonably practicable
SRP	System Review Panel
TSI	Technical Specifications for Interoperability
VAB	Vehicle Acceptance Body
WSF	Wrong Side Failure

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6 Requirements of the EMC Regulations (2006)

The EMC Regulations (2006) cover both apparatus and fixed installations.

The important change concerning the railways was that fixed installations (which cover most railway assets) were brought within the scope of the EMC Regulations.

A “fixed installation” shall be installed with regard to the information on the intended use of its constituent parts and by applying good engineering practices, with a view to meeting the essential protection requirements of the EMC Regulations.

Engineering practices shall be documented. The documentation shall be held by the person responsible for the installation for as long as it is in operation.

The EMC Directive introduces a requirement that all products must be delivered with EMC “instructions for use”. The instructions for use define the intended operational environment that the certification (CE marking) applies to, including any maintenance and operating instructions to be applied, in order to maintain the qualification level of the EMC performance throughout the operational life of the product.

Radio and telecommunications terminal equipment (e.g. radios and modems) are subject to the Radio & Telecommunications Terminal Equipment (R&TTE) Regulations implementing the R&TTE Directive 1999/5/EC. These regulations specify requirements for radio and the telecommunications aspects of equipment in addition to the essential requirements of the EMC Regulations. Their effect upon an established installation is considered as a source of EMI.

Products intended for a specific application, i.e. not CE-marked, are subject to the same requirements.

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7 EMC and safety

Whilst the EMC Regulations (2006) do not lay down the requirements for safety, there will be some convergence between EMC management and safety because some EMC phenomena can, if not controlled, lead to unsafe situations arising.

Duties under the Railway Interoperability Regulations (RIR) and the Rail and Other Guided Transport (System) Safety Regulations (ROGS) require formal authorisation for certain infrastructure schemes before they can be brought into service.

The strategies and processes that need to be considered and adopted to comply with the safety requirements can be found in the Network Rail Health & Safety Management System (H&SMS).

Infrastructure projects that are likely to at least trigger the requirements for independent safety assessment (safety verification or common safety method) as specified in NR/L2/RSE/100/02 should be considered in meeting the categorisation application to NRAP under that standard.

These projects involve:

- a) changing the network such that a significant new EMC risk is created;
- b) an existing EMC risk being significantly altered;
- c) the network, in EMC terms, being significantly different from that previously in operation.

Where NRAP has determined that a project requires authorisation under the RIR, the EMC aspects will be considered by the NoBo (for RIR) and Designated Body (for RIR) as specified in NR/L2/RSE/100/03.

Safety verification shall assess EMC risks as a result of those changes.

Authorisation under the Railways (Interoperability) Regulations (2011) normally includes verification of the rolling stock for infrastructure compatibility in compliance with the relevant TSI and the associated Interface Specification.

Infrastructure projects on interoperable lines shall refer to NR/L2/RSE/100/03 for certification.

Authorisation of interoperable RST includes assessment for compatibility with any NNTRs. For EMC, the UK has notified the Railway Group Standard (RGS) GE/RT8015.

Compliance with this RGS shall be achieved by following the requirements of Network Rail's EMC standards (listed in Appendix B), as applicable to the route to which the train is authorised to run.

Projects on interoperable lines shall check the RST compatibility status by referring to the NRAP Certificate for the RST.

When introducing new products into service as part of Network Rail's infrastructure or considering the compatibility of railway vehicles and plant with Network Rail's

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infrastructure, assess the electromagnetic characteristics of that product, vehicle and infrastructure.

NOTE NR/L2/RSE/100/05 and NR/L2/L2/RSE/100/06 contain requirements and guidance on Product Acceptance. Engineering vehicles are required to conform to NR/L2/RSE/100/04.

Where a new system safety case or safety argument is being developed (e.g. when there is a change involving the risk of reduced availability, due to anticipated EMI), evaluate this in relation to the overall safety and performance risk to the railway.

This evaluation shall encompass failures under both normal, fault and earth fault conditions as follows.

- a) Evaluate compatibility of the new system under normal conditions against the limits from the appropriate EN standards.
- b) The new system shall not be affected by EMI from a train in normal or degraded conditions or by power supply disturbances.
- c) Any residual risk from interference to the new system, shall be quantified with respect to the availability of the whole railway system, without compromising established performance.

The safety case or safety argument shall demonstrate that the safety risk associated with the installation(s) is tolerable so far as is reasonably practicable (SFAIRP).

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8 Standard installation subject to significant alterations

Some existing products (apparatus or systems in the context of the EMC Regulations) that are already accepted and that appear on the PADS Database might still require additional EMC Assurance if their EMC environment is changed, e.g. non-electrified route to AC traction.

Where there is an identified EMC risk, if the EMC environment is changed, close it out via the safety verification process.

9 Integrated Risk Approach

Define and manage the risk score as specified in NR/L2/RSK/00001, *Integrated Risk Management*.

Base the impact score upon unmitigated consequences.

The EMC verification activities (clause **18**) shall deliver satisfactory confirmation of the following assumptions:

- a) installed to standards applicable at time of installation including any retrospective action required by standards; and
- b) currently operates to an acceptable level of safety when used with existing traction and rolling-stock; and
- c) correctly maintained in accordance with the appropriate company and manufacturers' standards, where applicable; and
- d) operating within the limits specified by the manufacturer, the design authority or Network Rail as the infrastructure controller.

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10 EMC management

New product(s) introduced onto the operational railway shall:

- be addressed by the Designer (or Designated Project Engineer) prior to commencing the single option detailed development; or
- have a product specification of any apparatus that forms part of a novel installation that considers all aspects of EMC before detailed design commences.

Projects altering or building new infrastructure shall be as specified in this standard under the principles specified in NR/L1/RSE/30040.

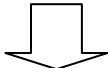
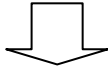
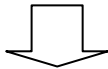
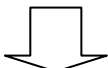
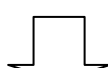
Documentation	Development	Responsibility
Documentation/Guidance Notes part of Maintenance Process	Existing Installation	Network Rail Board
1. Product Acceptance		1. Head of Technology Introduction
2. Project Requirements Specification.	Instigator of Change (Sponsor)	2. Route Asset Manager
EMC Strategy		Designated Project Engineer (DPE)
Entry into service	Design (including EMC)	Designated Project Engineer (DPE)
Certificate of Compliance/ Completion with ORR (HMRI) Requirements and other relevant standards		Designated Project Engineer (DPE)
ROGS/VAB	Implementation	Nominated representatives with delegated authority
Relevant sections in O&MM		Route Asset Manager
Product Acceptance Certificate	Acceptance / Handover	NRAP
		
	Maintenance	

Table 1 – The transfer of responsibilities for EMC management within Network Rail

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11 Evidence to demonstrate compliance with the EMC Regulations (2006)

The Project should proceed with their activities (Figure 1) in the normal course of delivering their objectives in accordance with NR/L2/INI/02009, *Engineering Management for Projects*.

Operate the EMC Strategy within the Project Management Framework so that most EMC effort is paralleled with those requirements.

For novel installations, where the EMC Strategy requires additional technical effort and resources that are beyond the scope of a project team, contact the EMC National Specialist Team first.

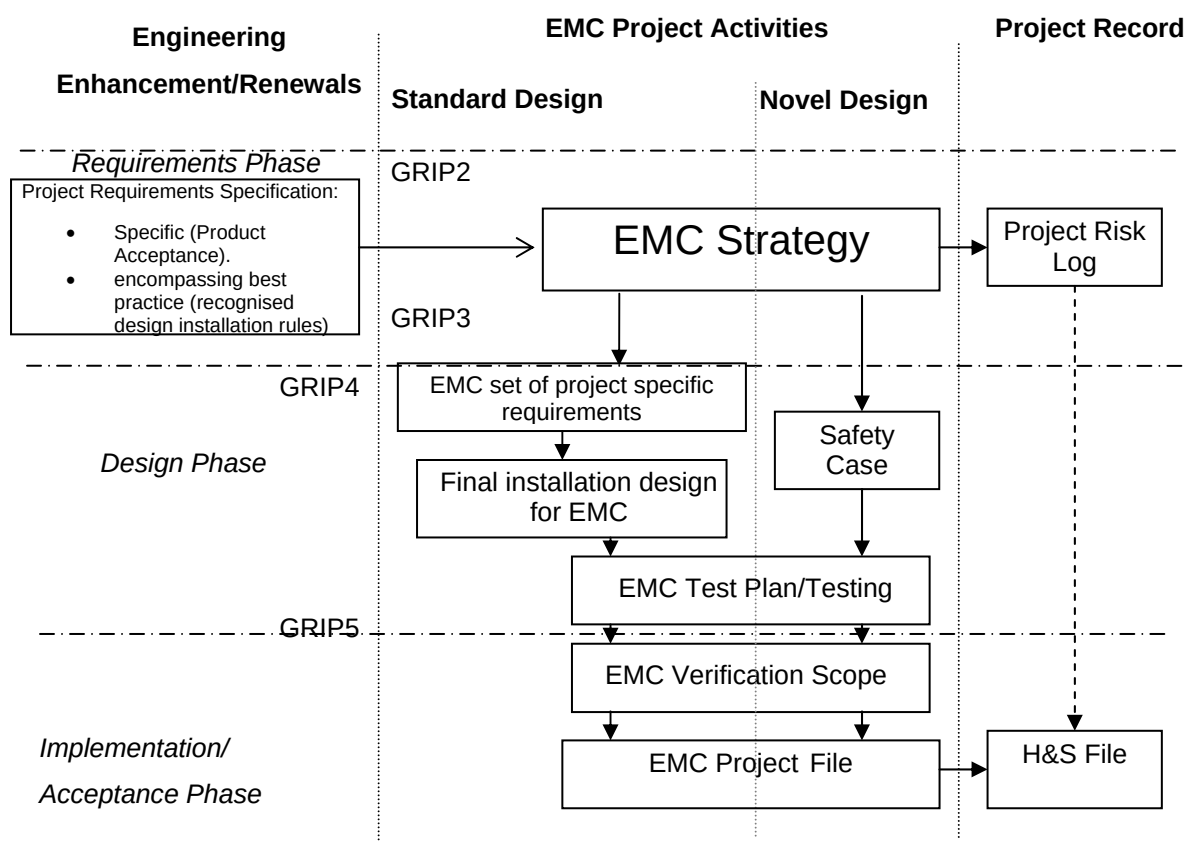


Figure 1 – Project EMC activities

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Where there are cross-functional issues, implement a robust Strategy as follows.

- The DPE shall commence the development of the Project EMC Strategy at GRIP Stage 2 to explain the approach and shall complete it by the end of GRIP Stage 3, aligning the approach to the chosen option.
- The EMC Strategy shall be updated, where necessary, to reflect the type of fixed/mobile installation(s) being deployed by the Project and the major hazards present.
- Conduct the EMC Hazard Identification and management as specified in clause **15** and Appendix C.
- The DPE shall review the hazards arising from the management of EMC and identify suitable methods of mitigation to the SFAIRP principle.
- Record and monitor the EMC risks in the Project Risk Log and close them out in accordance with the procedure for GRIP Project Management, to enable robust control throughout the project lifecycle.

NOTE See NR/L2/INI/GRIP/101, GRIP Project Management.

NOTE The EMC-NST is available to assist the DPE in identifying EMC risks.

Identify individual risks. Considering the transfer characteristics between different systems as specified in Figure 2.

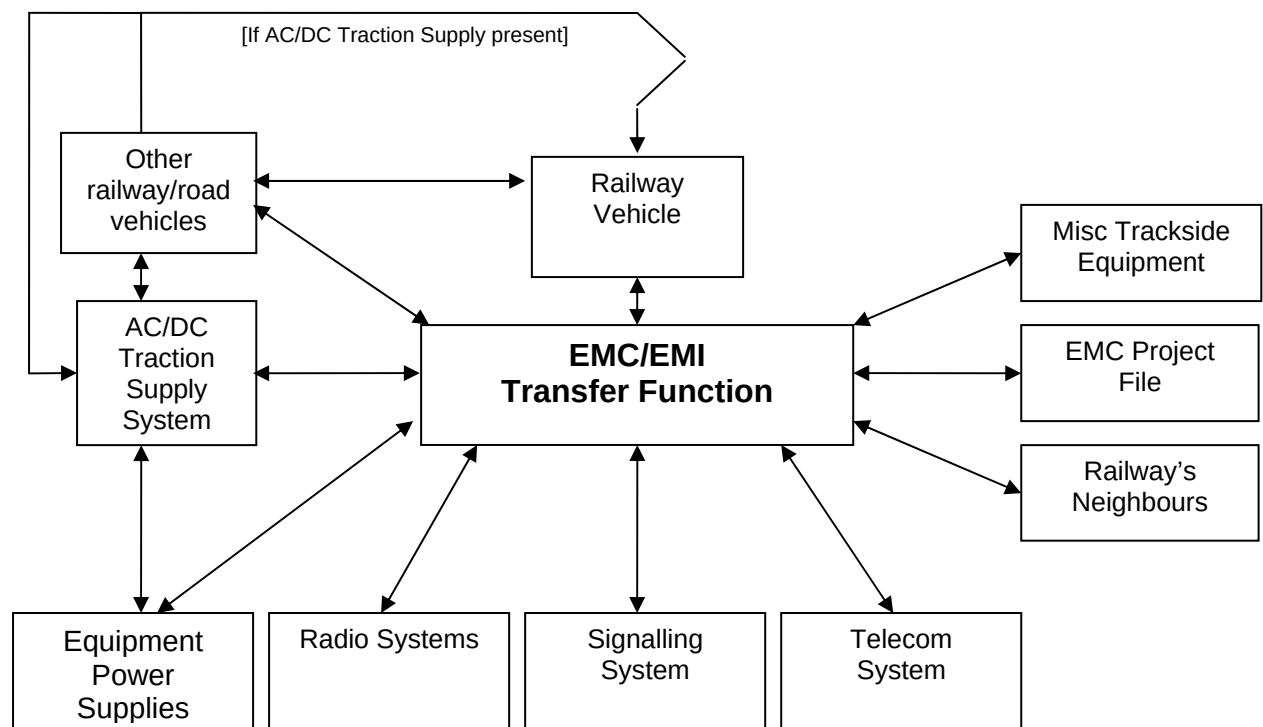


Figure 2 – Interdisciplinary EMC transfer schematic

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For installations, analyse electromagnetic coupling that is identified as posing a potential threat to safety and/or performance.

Determine the level of that threat by mapping the immunity (susceptibility) characteristics of the device under threat (e.g. a track circuit) against known emitters (e.g. traction power, radiated interference sources). Apply appropriate factors of safety.

NOTE See NR/GN/TEL/31106 for an Overview of Electromagnetic Coupling between Traction Systems and telecommunications cables.

The Project EMC Strategy shall consist of at least the following:

- a) definition of the installation, taken from the project requirements specification;
- b) applicable EN Standards on EMC, used for certification of individual products;
- c) Special Requirements over and above the EN standard content (including Notified Standards) and Network Rail-specific standards;
- d) any risks identified as part of the HAZID process (Appendix C). This shall include the contractor(s) scope of work;
- e) proposed methods to close out or mitigate hazards during the life of the installation, including an EMC Test Plan, if required;
- f) EMC Project File;
- g) all hazards closed and/or mitigated to SFAIRP.

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12 Types of installations in the context of EMC

12.1 Standard installations

A project might be classified as a standard fixed/mobile installation by the DPE where:

- a) reference can be made to a similar installation, with a practical completion certificate, according to existing established Network Rail practice.

The sectional appendix shall be checked for the type of RST authorised to operate on the reference installation.

If the project remit differs from the established, standard installation, then the project shall consider the associated risks in accordance with the methodology for non-standard (novel) installations as detailed in this standard.

- b) the design is approved by a relevant safety authority (e.g. NoBo or DeBo) as a standalone installation.

Where no such reference can be established, follow the process for a non-standard (novel) fixed/mobile installation.

12.2 Non-standard (novel) installations – EMC documentation

The DPE shall produce an EMC Project File in accordance with NR/L2/RSE/100/02, *Safety Verification*. The EMC Project File shall contain:

- *EMC Strategy*;
- *EMC HAZID*;
- *EMC Control Plan*, detailing proposed management of EMC risk(s) as captured in the individual sub-contractors' remits (if required);
- *EMC Test Plan* (if required)
- *EMC Verification Scope*.

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13 EMC non-standard (novel) installations

13.1 Conform to harmonised EMC standards

Individual apparatus shall conform to established harmonised EMC standards where possible to close out or mitigate hazards.

The CENELEC framework of harmonised EMC standards (listed in Appendix D) is expected to provide satisfactory closure of EMC risks in about 90% of novel installations.

13.2 Electrical safety (AC electrified lines) – Induced Voltage Controls

Existing electrification systems operate at 6 kA and 12 kA fault levels. Some 6 kA systems operate without any form of suppression, i.e. rail return, but most incorporate suppression of induced voltages provided by the one of the following methods:

- a) earth wire;
- b) return conductor;
- c) return conductor and earth wires;
- d) return conductor and booster transformers;
- e) return conductor, earth wires and return screening conductor;
- f) autotransformers and return screening conductor;
- g) autotransformers, earth wires and return screening conductor.

These provide differing levels of suppression. Specific guidance on general arrangements and maximum circuit lengths for a particular arrangement may be obtained from the EMC-NST. All of these systems may be further enhanced in practice by the presence of a mutual screening conductor (MSC).

In general, for new systems, only the following systems should be used:

- a) return conductor, earth wires and return screening conductor;
- b) autotransformers, earth wires and return screening conductor.

The requirements for assessment and testing of induced voltages, and the applicable standards of acceptable induced voltage, are independent of the system type, system load level and system fault level. The applicable limits are in BS EN 50122-1:2011 and the test in NR/L2/TEL/31107.

The applicable fault duration shall be taken as 200 ms to give a permissible induced voltage of 645 V under fault conditions. Under continuous conditions, the maximum induced voltage shall be the accessible voltage limit of 60 V.

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Fault conditions are not necessarily the worse case of the two. Load induction can present higher values as a percentage of the acceptable limit.

Wherever possible, standard arrangements of line side circuits should be employed to minimise detailed modelling and analysis. Guidance on this is available from the EMC-NST for all types of system.

13.3 Other systems

In general, signalling and telecommunications systems that are compatible with 750V DC and 25 kV a.c. electrification, which are not dependent upon appreciable lengths of line side cabling, are suitable for use with all types of electrification system, fault level and suppression system. Notable exceptions to this at present are axle counters.

Any emerging interoperability requirements shall be complied with.

13.4 Rise of earth potential (ROEP) controls

The design of any electrification system, at its nominal fault level and nominal system load level, shall control the rise of earth potential of any exposed metal work, including rails, to the limits in BS EN 50122-1:2011.

The limits for fault and load conditions shall be those given for induced voltages as in clause **13.2**. Compliance of the ROEP to these limits shall be demonstrated by design and testing for all new and modified systems.

In rare cases where ROEP control is considered impracticable, the Network Rail Professional Head (Electrical Power) may consider a derogation for use of touch potential control methods. Further guidance on this is available through Network Rail electrification standards.

NOTE Mitigation measures available to control safe permissible and accessible voltages are systematically described in NR/GN/TEL/31106.

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14 EMC standards framework

14.1 The Zoning Principle

Apply the EMC standards framework in Appendix D to all equipment deployed on Network Rail's operational infrastructure. Use it to close out or mitigate any identified hazards before placing it in service on or near the railway.

The CENELEC framework of harmonised EMC standards contained in Appendix D will provide satisfactory closure of EMC risks in about 90% of novel installations.

It corresponds to the following "Zoning Principle" illustrated in Figure 2.

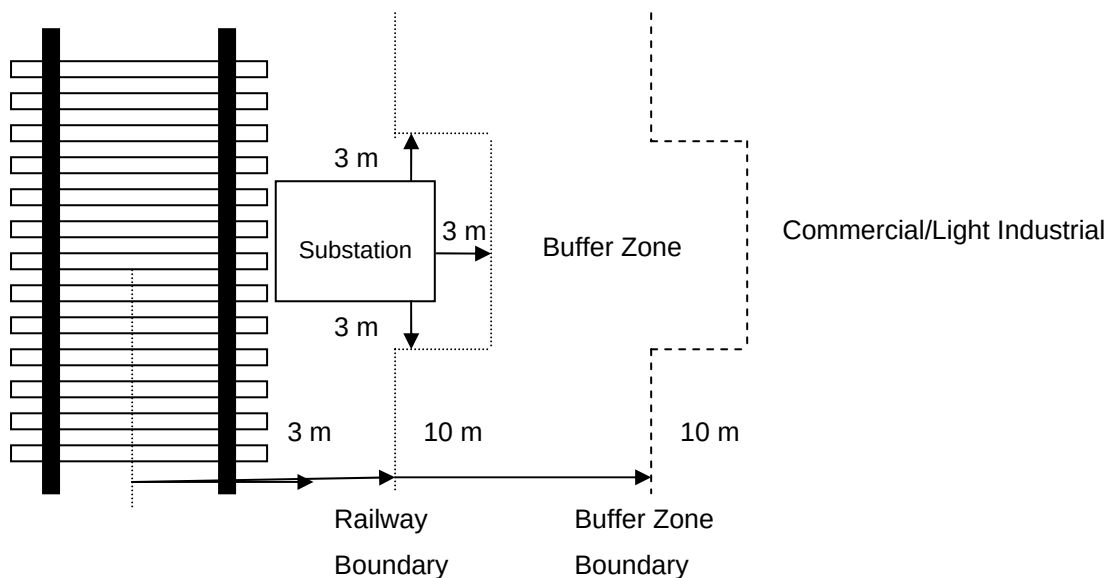


Figure 3 – EMC Zoning Principle

The BS EN 50121 series of railway-specific standards defines test limits for equipment placed within the railway boundary. This is defined as an area up to 10 m from the centre of the nearest running line and extends beyond 3 m of a sub-station boundary. Limits contained within the standards applicable to the railway boundary are generally equivalent to the limits defined for standards relevant to the "heavy industrial" environment.

There are some specific limits for equipment placed within 3 m of the nearest running line.

Beyond the 10 m railway boundary, "light industrial" environment EMC standards apply. In practice, it is more likely that there is a gradual transition from "heavy industrial" limits to "light industrial" limits and associated EM environments at 20 m.

It is therefore recommended that equipment supplied for the "Buffer Zone" that extends beyond the 10 m railway boundary is also certified to EMC standards

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applicable to the “heavy industrial” environment, or to the requirements in BS EN 50121, to achieve immunity and resilience to known sources of EMI.

To mitigate a known deficiency in BS EN 50121 at frequencies below 9 kHz, additional testing might be needed at frequencies between 0 – 9 kHz to establish immunity to traction interference, dependant upon the nature of the system.

For telecommunications equipment and systems, this is achieved by compliance with NR/L2/TEL/30003 and NR/L2/TEL/31107.

The EMC Assurance Process is an attempt to capture all EMC eventualities and is not necessarily exclusive to any one particular discipline within Network Rail. For example, Railway Project Engineers will generally deal within the 3 m zone. Asset Protection Project Managers may deal from the centre-line up to the boundary of the Buffer Zone. Signalling Control Centres may be positioned within the Buffer Zone and so the EMC requirements will differ, depending upon the scope of the installation being considered.

14.2 EMC standards and PADS certification

Where the product is accepted but the PADS Database refers to a different product standard than that which is applicable according to Appendix C, Table C.1, conduct a EMC Gap Analysis using the standards and limits listed in Appendix D, Table D.1. Identify any additional tests that might be required before finalising the installation design.

Record any additional testing identified as a result of that EMC Gap Analysis or individual site surveys in an EMC Hazard Identification Table. Use it to identify the scope for verification activities under GRIP Stages 5 to 8.

NOTE See Appendix C, Table C.2, Example of EMC Hazard Identification Table.

14.3 EMC at the Railway Boundary

Conduct assessments associated with the EMC footprint of any proposed installation and its possible impact upon our neighbours according to the “Zoning Principle”.

If no evidence exists to show compliance to the individual parts of BS EN 50121 series of standards then testing to the latest published version of BS EN 50121-2 for “new builds” shall be conducted.

Record the outcome of that assessment to discharge Network Rail’s duty of due diligence and to aid our neighbours with their conformity requirements with the EMC Regulations.

Where there is a shared interface with a neighbouring railway(s), these studies shall form part of a Boundary Safety Case.

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15 EMC Hazard Identification (EMC HAZID) and the EMC Strategy

As part of the EMC process, perform a hazard identification (HAZID). Consider:

- a) all systems and apparatus within the scope of the project remit that might interact electromagnetically with each other;
- b) if established limits as per existing EMC Certification is sufficient for the environment in which the product is intended to operate.

Address any deficiencies following a gap analysis against the normative references contained in Appendix D;

Assess the risks as specified in NR/L1/RSK/00001.

Consider applicable mitigation measures, depending on the interference coupling mechanism.

The identified risks and associated mitigation measures shall form the EMC Strategy for the project.

NOTE To reduce the risk to SFAIRP, additional testing may be required.

16 Project risk log co-ordination

Capture the mitigation activities recorded in the Project Risk Log contained in the H&S file in the contracts for GRIP Stages 5 to 8 identified during the detailed design and in the corresponding Project Programme activities.

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17 EMC Test Plan requirements

Where additional testing has been identified in the Project EMC Strategy, the project shall produce an EMC Test Plan that depends upon the type of installation (Table 2).

Installation	Test Plan requirements
Category 2 and 3 project installations or apparatus	Individual hazards identified for closure by additional testing.
New E&P installations	a) Compliance with the requirements in BS EN 50121-5:2006 b) Test for safe touch potential limits on telecoms copper cables, as defined in NR/L2/TEL/31107 <i>NOTE Any installation declared as conforming to NR/L2/TEL/31107 is considered safe with respect to induced voltages on copper circuits, which indirectly provides a presumption of conformity with the EMC Regulations (2006).</i> c) Test to demonstrate compliance with the ROEP profile in BS EN 50122. Demonstrate that the revised installation does not introduce a touch potential hazard that would exceed the limits defined in BS EN 50122, irrespective of changes in local ground conditions.
Signalling installations	Functional testing under normal operating conditions at a typical site.

Table 2 – EMC Test Plan requirements by installation

Where new sites have “significant” differences in the EMC environment, e.g. AC instead of DC electrification, carry out further functional testing. This additional testing shall be carried out by a specialist organisation in consultation with the EMC-NST.

NOTE This will be in addition to any standard EMC testing required to show compliance with the EMC Regulations.

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18 EMC verification

Determine the EMC verification activities by the type of project. EMC verification shall form part of the project safety verification associated with the detailed design at GRIP Stage 5.

Records of Conformance to Design (GRIP Stage 6) shall be in accordance with NR/L2/INI/GRIP/101, *GRIP Project Management*.

Before the Project completion certificate is issued, use the activities in Table 3 to record that EMC “best practice” has been used.

Standard Electrification & Plant Projects	Engineering Assurance activities shall include a review for any planned EMC activities, as described in NR/L3/ELP/27406/MOD A and MOD L and as specified in clause 17
New and extended electrification schemes	Accessible voltages and touch potentials on lineside cables are within the limits defined in NR/L2/TEL/31107, <i>Limits and Test Method of Induced Voltages on Telecommunications Cables due to Electrification Systems</i> . ROEP testing, if applicable, shall be applied to demonstrate compatibility with signalling equipment. <i>NOTE Form A/B/E approval procedure is in accordance with NR/L2/ELP/27311 and NR/L3/ELP/27406/MOD A and MOD L.</i>
Standard Signalling Projects	The Master Test Certificate (TC1) shall be used as a record of evidence that the installation meets the “essential requirements” of the EMC Regulations (2006). The minimum requirements shall be as defined in NR/L2/SIG/30014 Signalling Works Testing Handbook. <i>NOTE The Master Test Certificate TC1 is found in NR/L2/SIG/D110A.</i>
Standard Telecommunications Projects	Records of Interface Testing in accordance with NR/L1/TEL/30029 and Verification and Validation carried out in accordance with NR/L2/TEL/30094 and V_L V_T testing in accordance with NR/L2/TEL/31107 and the limits contained within NR/L2/TEL/30003, where applicable, shall be used as a record of evidence that the installation meets the “essential requirements” of the EMC Regulations (2006).
Novel Installations	In addition to standard testing, any additional testing identified for EMC mitigation shall be conducted as required by the safety case or safety argument, or the product approval requirements.

Table 3 – EMC verification activities

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19 EMC Project File

19.1 General project EMC considerations

Compile the EMC Project File on the basis of the EMC Strategy.

Reference it via an established archiving and auditing process as specified in NR/L2/INI/02009, *Engineering Management for Projects*.

The EMC Project File, depending upon the scope of the project, shall contain the following evidence, which shall be recorded in the Health & Safety File:

- a) EMC Risks as identified from the HAZID;
- b) EMC Requirements for mitigation(s), to close out or reduce the risks;
- c) EMC Test reports and corresponding results;
- d) Standards used to mitigate or close out EMC hazards.

19.2 Maintenance considerations

Where any modifications to the installation are proposed that could change the EMC characteristics during its operational lifetime (e.g. rerouting of cables), the Asset Manager shall liaise with the Head of EMC Engineering, before requesting any amendments to any configured fixed installation on the ground.

20 Commercial considerations

In all instances, where following a manufacturer's good EMC practice would introduce an unacceptable safety hazard (e.g. in earthing and bonding practice), document this with a rationale explaining the "best practice" adopted.

Fully document engineering decisions made, e.g. as a result of an EMC gap analysis in accordance with this standard, within the EMC Project File.

■ *NOTE The EMC Regulations (2006) do not require the demonstration of compatibility at all costs but they do require that due diligence can be demonstrated. This means that occasionally an engineering judgement will have to be made that further efforts to achieve compliance are unlikely to produce sufficient benefits without incurring disproportionate financial costs. See Network Rail's policy on SFAIRP as detailed in the Health & Safety Management System.*

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Appendix A

Examples of inherently benign equipment

Examples of inherently-benign equipment from the EMC Directive, provided that they do not include any active electronic part(s), are:

- a) cables and cabling, cable accessories, considered separately. The characteristics and installation of cables and cable systems can have a significant effect upon the overall EMC performance of equipment, apparatus or an installation;
- b) equipment containing only resistive loads without any automatic switching device, e.g. simple domestic heaters with no controls, thermostat or fan;
- c) batteries and accumulators (without active electronic circuitry);
- d) headphones, loudspeakers without amplification;
- e) pocket lamps without active electronic circuits;
- f) protection equipment that only produces transitory disturbances of short duration during the clearing of a short circuit failure or an abnormal condition in a circuit and which do not include active electronic components, such as fuses and circuit breakers without active electronic parts or active components;
- g) high voltage types of equipment in which possible sources of disturbances are due only to localised insulation stresses which may be the result of the ageing process and are under the control of other technical measures included in non-EMC product standards, and which do not include active electronic components.

Other examples of inherently benign equipment are:

- a) capacitors (e.g. power factor correction capacitors);
- b) induction motors;
- c) quartz watches (without additional functions such as radio receivers);
- d) filament lamps (bulbs);
- e) home and building switches that do not contain any active electronic components;
- f) passive antennas used for TV and radio broadcast reception.
- g) plugs, sockets, terminal blocks, etc.

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Appendix B

Network Rail EMC standards

NR/SP/SIG/50002, *Methodology for the demonstration of compatibility with single rail Reed Track Circuits on the AC railway*

NR/SP/SIG/50003, *Methodology for the demonstration of compatibility with Reed Track Circuits on the DC railway*

NR/SP/SIG/50004, *Methodology for the demonstration of electrical compatibility with DC (AC-immune) Track Circuits*

NR/GN/SIG/50005, *Methodology for the demonstration of compatibility with 50 Hz Single Rail Track Circuits*

NR/SP/SIG/50006, *Methodology for the demonstration of compatibility with 50 Hz Double Rail Track Circuits*

NR/GN/SIG/50007, *Methodology for the demonstration of compatibility with HVI Track Circuits*

NR/GN/SIG/50008, *Methodology for the demonstration of compatibility with TI21 Track Circuits*

NR/GN/SIG/50009, *Methodology for the demonstration of compatibility with FS2600 Track Circuits*

NR/L2/SIG/50010, *Methodology for the demonstration of compatibility with train detection systems in use on non-electrified lines*

NR/SP/SIG/50011, *Methodology for the demonstration of compatibility with Axle Counters*

NR/SP/SIG/50012, *Methodology for the demonstration of compatibility with TPWS trackside equipment*

NR/GN/SIG/50013, *Methodology for the demonstration of compatibility with Interlockings*

NR/GN/SIG/50014, *Methodology for the demonstration of compatibility with Lineside Equipment on AC and DC Railways*

NR/SP/SIG/50015, *Methodology for the demonstration of compatibility with Reed FDM Systems*

NR/SP/TEL/50016, *Methodology for the demonstration of compatibility with Telecomms Systems*

NR/GN/SIG/50018, *Methodology for the determination of interaction with Neighbouring Railways*

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Appendix C

Hazard identification and risk assessment process

C.1 Introduction

The hazard identification and management process includes the following activities:

- a) definition of existing infrastructure;
- b) definition of change;
- c) completion of interaction matrix;
- d) identification of potential hazards;
- e) risk assessment & ranking.

The identification of potential sources of EM interference and the potential victims of EM interference shall be listed in an EMC Hazard Matrix.

C.2 Operating conditions

Consider the various operating modes of major electrical systems, including:

- a) normal running conditions (including peak timetable traffic, and future growth);
- b) degraded mode conditions (e.g. d.c. sub-station failure, train degraded modes);
- c) fault conditions (e.g. electrical short circuits on the track or in the train).

C.3 Hazard identification activities

Take into account hazards associated with all relevant coupling mechanisms and all possible operating conditions.

First define the severity and likelihood for each hazard and each cause. Assuming that no mitigation measures are adopted, calculate the risk factor by summing the severity and likelihood for each hazard, in accordance with NR/L2/RSK/00001. The table of hazards is then ranked in order of risk.

The Project shall enter all hazards with an initial rating greater than 5 in the project risk register and all priority risks in the project H&S File. Priority risks should include all risks greater than or equal to 5, or the 10-15 highest scoring risks.

It is not necessary to record all risks in the H&S File.

Make the hazard logs available to all Contractors. Contractors shall check that all hazards have been captured and that all relevant hazards will be closed by their designs and installations. Record any new hazards identified and immediately provided them to the Project, together with any proposed mitigations.

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C.4 EMC measures

Where possible, adopt appropriate measures to reduce the risk of each hazard. Repeat the risk calculation assuming the mitigation is implemented, preserving the original risk calculation without mitigation.

For hazards that score 5 or less, no further mitigation is essential. If measures can be implemented that reduce the risk without significantly increasing the cost, included them.

When the hazard logs include some proposed mitigations, it is the responsibility of the Project to review these proposed mitigations and check they are complete and adequate to reduce the risks to SFAIRP.

This can include extensions to the specified frequency range of immunity testing for high levels of traction current harmonics below 9 kHz or frequencies at which radio communications and radars can produce a threat. This might be a problem close to Radio Transmitting Stations, Airport Radar Systems and Defence Installations.

The Project should review the Hazard Matrix and periodically check its completeness and adequacy, e.g. to include temporary work requirements that prevents risk during construction.

Recalculate the risk associated with each hazard as before.

C.5 Ongoing risk management and transfer of risks

The Project introducing each change is responsible for the on-going management of all risks they are introducing. Capture any new hazards identified during the life of the project and add them to the hazard log and included in the EMC Strategy, with any proposed mitigations. Identify any mitigating measures that are not currently within the project scope for immediate change of that scope to avoid expensive rework at a later stage.

The New Directive requires that on “putting into service” fixed installations can be demonstrated to be installed in accordance with good engineering practices. The Guide to 2004/108/EC states that only the “changed elements” of an established fixed installation need to comply with the essential requirements of the EMC Directive. It is not required to show that non-certified infrastructure prior to changes which is unaffected by the changes has been brought to a compliant status.

Assign each risk an owner. The DPE is responsible for closing all the risks associated with the changes they are introducing. Before the project is completed, close risks by implementing appropriate mitigations, or by demonstrating through relevant studies that the risk is SFAIRP.

The presence of such apparatus forms an EMC risk: address it in the Project Risk Register.

In all cases, mitigation shall be to the SFAIRP principle.

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Any infrastructure outside the scope of a project that has been introduced after June 1998 and has been found to be non-compliant shall be the responsibility of Network Rail and shall be addressed under separate arrangements.

The basic EMC specification for apparatus to be installed on Network Rail infrastructure is that the requirements of the relevant part of BS EN 50121 shall be met, whilst also taking the installation environment into account.

The nature of most infrastructure upgrades and renewals projects is limited, and the entire infrastructure at a given location is rarely modified under the remit of a single project. This means that elements of a location will be a composite of apparatus that has been modified or renewed, and other apparatus that has been unchanged.

Unchanged apparatus might often include infrastructure that predates June 1998, which has “grandfather rights” and for which the EMC performance is unknown. The fact that it is operational within the environment it is used in, can give some credibility that it meets the essential requirements of the EMC Directive and a general presumption of conformity with the EMC Regulations (2006).

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	Victim	A				B					C		D	E					F		
Source	Sheffield Tram-Train Pilot Scheme [un-mitigated EMC Hazards]	750v DC Electrification	...Intro of 750V DC [OLE & DC Sub-station]	...Power Distribution System [11kV Distribution]	...DC Stray Current	NR Signalling & Train Detection Systems	...Train Detection System (TDS) [DC, HVI]	Signalling Control Equipment/	... AWS	... TPWS	Tram Rolling Stock	...Introduction of new Tram Rolling Stock	Fixed Telecoms Network (FTN)	Network Rail Structures / Interfaces	...Steel Sleepers	...Brinsworth St (Holmes Chord) Level Crossing	...Bridges [Ickles Viaduct CHR passes over WME.]	...Signals & gantries	3 rd Party Structures [Utilities]	... BOC O ₂ Pipeline [incl. Cathodic Protection System]	... Other Utilities [Gas, Water, Tele, UTX]
A	750v DC Electrification																				
	...Intro of 750V DC [OLE & DC Sub-station]			X	X		10.1	X	10.2	10.3		X	X		X	10.4	10.5	X		X	X
	...Power Distribution System [11kV Distribution]		X		X		10.6	X	X	10.7		X	10.8		X	X	X	X		X	X
	...DC Stray Current		X	10.9			10.10	10.25	X	X		X	10.11		10.12	X	10.13	10.14		10.15	10.16
B	NR Signalling & Train Detection Systems (TDS)																				
	...Train Detection System (TDS) [DC, HVI]		X	X	X			X	X	X		X	X		X	X	X	X		X	X
	...Signalling Control Equipment		X	X	X		X		X	X		X	X		X	X	X	X		X	X
	... AWS		X	X	X		X	X		X		10.17	X		X	X	X	X		X	X
	... TPWS		X	X	X		X	X	X			10.18	X		X	X	X	X		X	X
C	Tram Rolling Stock																				
	...Introduction of new Tram		X	X	X		10.19	X	10.20	10.21			10.22		X	X	X	X		X	X

Table C.1 –Example of unmitigated Hazard Matrix

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Hazard Serial	Hazard category	Description of Identified Hazard	Description of Consequence	Assessed Risk			Potential Controls	Identified Potential Risk Reduction Measures	Target Risk			Result of HAZID
				Impact	Likelihood	Risk Score			Impact	Likelihood	Combined	
10.1	750V DC Electrification Introduction of 750V DC [EMC-0011]	Potential conducted interference onto NR Train Detection System.	False operation of Train Detection System causing Wrong Side or Right Side Failure affecting Safety & reliability	4	5	9	NR/SP/SIG/11752 Train Detection	Use of EBI200 (TI21 Digital) Dual Immune TDS* Use of EBI200 (TI21 Digital) Single Rail through S&C* *See NR/L3/SIG/11761 (Issue 2) Handbook for EBI Track 200 Style TI21 Audio Frequency Track Circuit re use of these TDS through steel sleeper area. (Section 9.5.3) HVI TDS can remain in S&C Consider use of Axle Counters (Dual Immune TDS)	4	1	5	
10.2	750V DC Electrification Introduction of 750V DC [SIG-0047]	Introduction of 750v DC OLE Traction Power System. DC Traction cables/bonds and impedance bonds generate magnetic fields.	Trainborne AWS equipment could misinterpret as coming from AWS track equipment.	3	3	6	RGS GE/RT8035 Automatic Warning System (AWS)	Replace existing AWS "Standard" magnets with "Extra Strength" Magnets, but any non-tram train vehicles would be configured for normal AWS and may pick up magnetic fields generated by traction cables/bonds & impedance bonds. Carry out modelling to establish levels of magnetic fields generated within this proposed scenario?	3	1	4	

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Hazard Serial	Hazard category	Description of Identified Hazard	Description of Consequence	Assessed Risk			Potential Controls	Identified Potential Risk Reduction Measures	Target Risk			Result of HAZID
				Impact	Likelihood	Risk Score			Impact	Likelihood	Combined	
10.21	Introduction of new Tram Rolling Stock onto NR Infrastructure TPWS	EM noise generated by new tram-train.	EM Interference with TPWS System affecting Safety & Availability	4	3	7	Tram Train TIIS states EMC requirements on Tram. BS EN 50121-3-1 BS EN 50121-3-2 Additional Compatibility with 5xxxx series of appropriate NR Compatibility Standards, dependant upon, choice of TDS.	Compliance with NR/SP/SIG/50012	4	1	5	
10.22	Introduction of new Tram Rolling Stock onto NR Infrastructure FTN	Potential induced voltages in lineside cables from traction power package.	Electrical noise in voice and data circuits, affecting availability.	2	2	4	Tram Train TIIS states EMC requirements on Tram. BS EN 50121-3-1 BS EN 50121-3-2 Additional Compatibility with 5xxxx series of appropriate NR Compatibility Standards, dependant upon, choice of TDS and Rolling Stock.		2	1	3	
10.23	Network Rail Structures Steel Sleepers	Potential interference to selected TDS	Potential EM effect upon selected TDS	3	3	6	Identify type of Train detection System.	See 10.1 above.	3	1	4	
10.24	3 rd Party Structures BOC O ₂ Pipeline	Potential interference from Cathodic Protection system.	Potential DC Interference dependant upon the nature of Cathodic Protection System in use.	1	1	2	Identify type of CP system(s) in use, if applicable.	Sacrificial anode CP System believed to be in place. No impressed current CP system known to be in use. No DC Track Circuits to be installed or continuing in operation with proposed 750VDC OLE				CLOSED

Table C.2 – Example of EMC Hazard Identification Table (referenced back to the HAZID Matrix)

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Appendix D

EMC standards framework

System	Standards that apply		
	Outside boundary [20m >]	Buffer Zone (Heavy or Light industrial depending on criticality) [20m – 10m]	Within railway boundary [<10m]
Power apparatus	No power apparatus >415V 3-phase	BS EN 50121-5 ^a	BS EN 50121-5
Signalling	BS EN 61000-6-3 (commercial emissions) BS EN 61000-6-1 (commercial immunity)	BS EN 50121-4 ^a	BS EN 50121-4
Telecommuni- cations	ETSI EN 300 339 ETSI 300 386-2	BS EN 50121-4 ^a Advisory only ^b	BS EN 50121-4 Advisory only ^b
Transceivers 9 kHz – 25GHz [Short Range Radio Devices]	ETSI ETS 300 683	Specialist considerations	Specialist considerations
Alarm systems	EN 55130-4 (immunity)	BS EN 50121-4 ^a Advisory only ^b	BS EN 50121-4 Advisory only ^b
Lifts and escalators	BS EN 12015 (emissions) BS EN 12016 (immunity)	BS EN 12015 (emissions) Apply safety limits from BS EN 12016 (immunity)	BS EN 12015 (emissions) Apply safety limits from BS EN 12016 (immunity)
Public Address Systems	Apply light industrial environment BS EN 55103-1 (emissions) BS EN 55103-2 (immunity)	Apply light industrial environment BS EN 55103-1 (emissions) BS EN 55103-2 (immunity)	BS EN 50121-4
Passenger information displays	Apply light industrial environment BS EN 55103-1 (emissions) BS EN 55103-2 (immunity)	Apply light industrial environment BS EN 55103-1 (emissions) BS EN 55103-2 (immunity)	BS EN 50121-4
CCTV	BS EN 50132	BS EN 61000-6-4 (emissions) BS EN 61000-6-2 (immunity)	BS EN 61000-6-4 (emissions) BS EN 61000-6-2 (immunity)
IT administrative	BS EN 55022 (emissions) BS EN 55024 (immunity)	BS EN 61000-6-4 (emissions) BS EN 55024 (immunity)	Special restrictions apply
General commercial apparatus	Product family standard, or BS EN 61000-6-3 (emissions) BS EN 61000-6-1 (immunity)	BS EN 61000-6-4 (emissions) BS EN 61000-6-2 (immunity)	N/A
^a The limits are applicable to the 10 m zone only			
^b A cost–benefit analysis shall be conducted according to the risk involved.			

Table D.1 – EMC Standards Framework

Ref:	NR/L2/RSE/30041
Issue:	2
Date:	2 June 2012
Compliance date:	1 September 2012

Appendix E

EMC CENELEC standards – Comparative chart for signalling and telecommunications equipment

EMC Test ^a	Test Method ^b	PC ^c	Condition ^d	50121-4:2006	50121-4:2000	61000-6-4:2001 61000-6-2:2001	61000-6-4:2001 61000-6-2:2005	50082-1:1997 50082-2:1995	61000-6-3:2001 61000-6-1:2001
				Rail S&T ^e	Rail S&T ^e	Industrial Gen ^e	Industrial Gen ^e	Industrial Gen ^e	Residential Gen ^e
Conducted Emissions	EN 55022 CISPR 11		0.15 - 0.5 MHz	79 qp, 66 av	79 qp, 66 av	79 qp, 66 av	79 qp, 66 av	79 qp, 66 av	66-56 qp, 56-46 av
			0.5 – 5 MHz	73 qp, 60 av	73 qp, 60 av	73 qp, 60 av	73 qp, 60 av	73 qp, 60 av	56 qp, 46 av
			5 – 30 MHz	73 qp, 60 av	73 qp, 60 av	73 qp, 60 av	73 qp, 60 av	73 qp, 60 av	60 qp, 50 av
Radiated Emissions	EN 55022 CISPR 11		30 – 230 MHz	40 dBµV @ 10 m	40 dBµV @ 10 m	40 dBµV @ 10 m	40 dBµV @ 10 m	40 dBµV @ 10 m	30 dBµV @ 10 m
			230 – 1000 MHz	47 dBµV @ 10 m	47 dBµV @ 10 m	47 dBµV @ 10 m	47 dBµV @ 10 m	47 dBµV @ 10 m	37 dBµV @ 10 m
Harmonics	IEC 61000-3-2		0 – 2 kHz	NR	NR	NR	NR	NR	See standard
Flicker	IEC 61000-3-3		0 – 2 kHz	NR	NR	NR	NR	NR	See standard
Electrostatic Discharge	EN 61000-4-2 not if outdoors	B	Contact	±6 kV	±6 kV	±4 kV	±4 kV	±4 kV	±4 kV
			Air	±8 kV	±8 kV	±8 kV	±8 kV	±8 kV	±8 kV
Radiated Immunity	EN 61000-4-3	A	80 – 1000 MHz 80 % AM	10 V/m	10 V/m	10 V/m except ITU freq.	10 V/m except ITU freq. – or IEC 61000-4-20 for small EUT	10 V/m	3 V/m
			800 – 1000 MHz 80 % AM	20 V/m					
			1.4 – 2.1 GHz 80 % AM	10 V/m			3 V/m – or IEC 61000-4-20 for small EUT		
			2.1 – 2.5 GHz 80 % AM	5 V/m			1 V/m – or IEC 61000-4-20 for small EUT		

^a The EMC test to be carried out under the appropriate standard in columns.

^b Test Method to be used. If no reference is made then the method within the same standard is used.

^c “Protection Criteria”, normally referenced to a table of letters within the associated standard to indicate to what level a piece of apparatus has to reach the classification, e.g. “PC = A” would ordinarily require a piece of equipment not to malfunction in any way when subjected to RF Immunity Levels specified in the associated standard being tested to.

^d The appropriate conditions, e.g. frequency span or type of test that will be needed to meet the appropriate standard.

^e These are the values extracted from the standards for comparison purposes. Note that the standards can have the same number in the top row and column, e.g. EN 50121-4 but a different year indicating the change in the standard. This is so current equipment that has been tested to a previous standard can be compared with the levels contained within the more recent standard. All new equipment should be assessed against the latest standard.

NOTE 1 “qp”: quasi-peak measurement; “av”: average measurement; “dBuV”: decibels relative to a microvolt; “A/m”, “V/m”: radiated field strength values.

NOTE 2 Where there is no entry in a particular box, this might be because the standard does not require it or it has not yet been established.

Table E.1a) – EMC CENELEC standards – comparative chart

Ref:	NR/L2/RSE/30041
Issue:	2
Date:	2 June 2012
Compliance date:	1 September 2012

EMC Test	Test Method	PC	Condition	50121-4:2006	50121-4:2000	61000-6-4:2001	61000-6-4:2001	50082-1:1997	61000-6-3:2001
						61000-6-2:2001	61000-6-2:2005	50082-2:1995	61000-6-1:2001
				Rail S&T	Rail S&T	Industrial Gen	Industrial Gen	Industrial Gen	Residential Gen
Radiated Immunity EM Field [Digital Phones] Pulse Modulated	ENV 50204	A	900±5 MHz 50 % duty, 200Hz		20 V/m if in 3 m zone or →			10 V/m	
Power - Frequency Magnetic Field Immunity Test	EN 61000-4-8	A	50 Hz If mag susceptible	100 A/m if in 3 m zone or →	100 A/m if in 3 m zone or →	50 Hz, 30 A/m	50 Hz, 30 A/m	50 Hz, 30 A/m	50 Hz, 3 A/m
			DC If mag susceptible	300 A/m if in 3 m zone or →	100 A/m if in 3 m zone or →				
Pulsed Magnetic Field	EN 61000-4-9	B	50 Hz	300 A/m if in 3 m zone or →	300 A/m if in 3 m zone or →				
Fast Transients	EN 61000-4-4	A or B	AC Power	±2 kV PC A	±2 kV PC A	±2 kV PC B	±2 kV PC B	±2 kV PC B	±1 kV PC B
			DC Power	±2 kV PC A	±2 kV PC A	±2 kV PC B	±2 kV PC B >3 m	±2 kV PC B	±0.5 kV PC B
			I/O	±2 kV PC A	±2 kV* PC A	±1 kV PC B	±1 kV PC B >3 m	±1 kV PC B	±0.5 kV PC B
			PE	±1 kV PC A	±1 kV PC A	±1 kV PC B	±1 kV PC B	±1 kV PC B	±0.5 kV PC B
Surge Immunity	EN 61000-4-5	B	AC Power 12 Ω, 9 μF	±2 kV LE ±1 kV LL	±2 kV LE ±1 kV LL ±2 kV LL unbalanced	±2 kV LE ±1 kV LL	±2 kV LE ±1 kV LL	NR	±2 kV LE ±1 kV LL
			DC Power 12 Ω, 9 μF 42 Ω, 0.5 μF	±2 kV LE ±1 kV LL	±2 kV LE ±1 kV LL ±2 kV LL unbalanced	±0.5 kV LE ±0.5 kV LL >10 m cables	±0.5 kV LE ±0.5 kV LL not if adaptor and no DC distribution		±0.5 kV LE ±0.5 kV LL >10 m cables
			I/O 42 Ω, 0.5 μF	±2 kV LE ±1 kV LL unbalanced	±2 kV LE ±1 kV LL ±2 kV LL unbalanced	±1 kV LE >30 m cables	±1 kV LE >30 m cables		
Conducted Immunity	EN 61000-4-6	A	0.15 – 80 MHz 80 % AM All ports inc PE	10 V	10 V	10 V except ITU freq.	10 V 3V @ ITU freq.	10 V	3 V cables > 3m
Voltage Dip	EN 61000-4-11	B				30 % 10 ms	100 % 20 ms	100 % 20 ms	30 % 10 ms
		C				60 % 100 ms	60 % 200 ms	60 % 200 ms	60 % 100 ms
		C				60 % 1 s	30 % 500 ms	30 % 500 ms	
		C				100 % 5 s	100 % 5 s	100 % 5 s	100 % 5 s
Traction Freq Informative		A	50 Hz		150 V, ≥ 60 s				
		B	50 Hz		650 V, ≥ 60 s				

Table E.2b) – EMC CENELEC standards – comparative chart

Standards Briefing Note

Ref: NR/L2/RSE/30041		Issue: 2					
Title: Electromagnetic Compatibility (EMC) Assurance Process							
Publication Date: 02/06/2012		Compliance Date: 01/09/2012					
Standard Owner: Head of Systems Engineering							
Non-Compliance rep (NRNC): Head of EMC Engineering							
Further information contact: Clive Armstrong		Tel:					
Purpose: This standard specifies how Network Rail manages the risks of asset failure associated with known uncontrolled electromagnetic phenomena. It supports the Network Rail policy requirements as specified in NR/L1/RSE/30040, <i>Electromagnetic Compatibility (EMC) Strategy for Network Rail</i> , and its legal obligations under the EMC Regulations (2006).		Scope: This Network Rail standard: a) specifies the assurance process for the management and control of EMC to meet the requirements of the EMC Regulations (2006); b) specifies the standards for the acceptance of equipment for integration onto the railway system; c) specifies best practice based on current European and Network Rail EMC engineering standards; d) applies to all new or modified infrastructure, including apparatus, fixed and mobile installations, all types of rail vehicles and rolling stock on the operational railway. This standard does not specify requirements for equipment that is classified as “inherently benign”. A list of examples of “inherently benign” equipment is in Appendix A.					
What’s New/ What’s Changed and Why: The EMC Assurance process will capture immunity problems associated with the introduction of new technologies onto the railway infrastructure. Inadequate EMC assurance prior to the existence of an assurance process has led to cases of Network Rail paying delay compensation to TOCs/FOCs as a result of the delay minutes accrued. The opportunity has been taken to update the standard in line with the Engineering Standards rewrite project and to put it into the new standards writing format. This is to make the standard simpler for projects and others who are required to use it, to follow and comply in the normal course of their business.							
Affected documents: <table><tr><td>Reference</td><td>Impact</td></tr><tr><td>NR/L2/RSE/30041 ISSUE 1</td><td>Superseded</td></tr></table>				Reference	Impact	NR/L2/RSE/30041 ISSUE 1	Superseded
Reference	Impact						
NR/L2/RSE/30041 ISSUE 1	Superseded						
Briefing requirements: Where Technical briefing (T) is required, the specific Post title is indicated. These posts have specific responsibilities within this standard and receive briefing as part of the Implementation Programme. For Awareness briefing (A) the Post title is not mandatory. Please see http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b804504da for guidance.							
Briefing (A-Awareness/ T-Technical)	Post	Team	Function				
T	Director, Route Asset Management		Network Operations				
T	Head of Asset Management [Electrical Power]	Asset Management [S&P]	Asset Management				
A		Major Programmes & Projects	Investment Projects				
A	Asset Protection Project Manager	Building and Civils	Asset Management				
A	Senior Commercial Manager [Route]		Strategic Sourcing				

S*NOTE: Contractors are responsible for arranging and undertaking their own Technical and Awareness Briefings in accordance with their own processes and procedure