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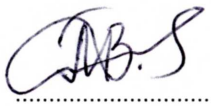
Level 2

EMC assurance process for Network Rail

Endorsement and Authorisation

Endorsed by:



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Issue record

Issue	Date	Comments
1	26 August 2008	First issue.

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors if applicable from 1 December 2008.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 4 to continue to comply with the Issue of any relevant Network Rail Standards current when GRIP Stage 4 was reached and not to comply with requirements contained herein, unless the designated Standard Owner has stipulated otherwise in the accompanying Briefing Note.

Reference documentation

NR/CS/ACC/029, *Product and plant acceptance.*

NR/GN/SIG/11722, *Good Practice Test Certificates and related forms.*

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

NR/SP/BUS/02009, *Engineering management for projects.*

NR/SP/ELP/27311, *Technical approval of Electrification & Plant asset design.*

NR/SP/OHS/00109, *Project Safety and Assurance requirements* (formerly NR/HSSM/09.01).

NR/SP/SIG/500XX. Series of Network Rail standards for EMC Compatibility.

NR/SP/TEL/30066, *Signalling & Telecommunications Telecomms Clearance for fixed transmitters.*

NR/WI/ACC/0001, *Safety verification.*

NR/SP/ACC/013, *System Review Panel and Technical Review Groups.*

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

NR/L2/TEL/31107, *Limits and Test Method of Induced Voltages on Telecommunications Cables due to Electrification Systems (to be issued)*

NR/L2/SIG/30014, *Signalling works testing handbook*

NR/SP/TEL/30003, *The Performance of Telecommunications Equipment Under Conditions of Electrical Interference*

BR 13422, *50 Hz Single Phase Electrification – Immunisation of signalling and telecommunication systems against electrical interference.*

GRIP Manual. The Delivery Manual. DEL02. *Project Engineering Delivery.*

GRIP Manual. The Delivery Manual. DEL03. *Safety.*

Construction (Design & Management) Regulations 1994. “CDM Regulations”.

The Electromagnetic Compatibility Regulations 2006. “EMC Regs (2006)”: SI 2006 No 3418.

Radio Equipment and Telecommunications terminal Equipment Directive 1995/5/EC: SI 2000 No 730.

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Contents

1 Purpose

This standard supports NR/L1//SIG/30040, *EMC Strategy for Network Rail* and specifies the process for Project Management of EMC.

This standard also specifies EMC best practice based on “state-of-the-art” European and Network Rail EMC engineering standards that can be used where they do not compromise Electrical Safety considerations for the integration of all apparatus and systems on Network Rail Infrastructure.

2 Scope

This Network Rail standard includes:

a) requirements for the acceptance of EMC apparatus for integration onto the railway infrastructure;

b) process for EMC Management and Control to meet the requirements of the EMC Regulations 2006.

This standard applies to all infrastructure on the operational railway and all types of rail vehicles operating on Network Rail infrastructure.

Legal requirements as a result of the European EMC Directive 2004/108/EC and as specified in NR/L1/SIG/30040 are considered. This European Directive was written into UK Legislation under Statutory Instrument 2006 No. 3418: The Electromagnetic Compatibility Regulations 2006.

NOTE Throughout this standard this legislation is referred to as the EMC Regs (2006).

This standard is applicable to the preparation of the Infrastructure EMC Project File, when required, or for the verification of EMC for fixed installations as discussed in section 9.6.

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 Regs (2006).

NOTE Within Network Rail, this is the Chief Engineer. The management of these responsibilities are then delegated to the appropriate appointments as specified in this standard. In service responsibility is discharged via the maintenance Support Group (MSG). Any requests from enforcement authorities shall be referred by the Chief Engineer as deemed appropriate.

Designated Project Engineer

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

Maintenance Engineer

For the purposes of this standard and for compliance with the EMC Regs (2006), the Maintenance Engineer, or his 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 Maintenance Engineer is the individual with the formally delegated responsibility for the management of an asset in a geographical area or at a specific location.

Notified Body
NoBo
A Notified Body is a body appointed by an EEC 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 DoCs.

NOTE There are different NoBos dealing with different Directives.

Project Manager
The Project Manager is responsible and accountable for the completed Project, and will check that the completed Project is acceptable to the Sponsor and Maintenance Engineer responsible for managing the asset.

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 EMC National Specialist Team
EMC NST
The EMC NST is the centre of technical expertise within Network Rail. It exists to advise on matters concerning EMC and to assist Projects and Area Delivery Units, to meet Network Rail's legal obligations under the EMC Regs (2006) and to help 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/SIG/30040.

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. 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 Regs (2006).

As Low As is Reasonably Practicable (ALARP)
ALARP is a principle method to demonstrate risk mitigation. Determining that risks have been reduced ALARP involves an assessment of the risk to be avoided, against the sacrifice (in money, time and trouble) involved in taking measures to avoid that risk.

Note: See definition of "so far as is reasonably practicable" ("SFARP") below for a Health & Safety Executive comparison of the terms "ALARP" and "SFARP" and network Rail's policy on the application of this concept in Section 3.5 of Network Rail's Health and safety management System (H & SMS)..

Boundary Safety Case

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

Component
Any 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

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

Electromagnetic interference
Undesirable voltages or currents are present to influence adversely 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

Fixed installation
A 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
The 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 which exceed a level allowing radio and telecommunications equipment and other equipment to operate as intended; and

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
A 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 rail-road vehicles. Mobile installations are treated as apparatus in the context of the EMC Regs 2006.

Responsible Person
- In relation to apparatus means the manufacturer established in the Community or the authorised representative of; otherwise the person who places the apparatus on the market or puts it into service.

- In relation to 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.

So far as is reasonably practicable (SFARP)
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 SFARP. To demonstrate that an employer has complied with Health & Safety Law by ensuring "so far as is reasonably practicable" that the duties to ensure the health, safety and welfare at work of their employers and those affected by their undertakings are met.

NOTE "SFARP and "ALARP" In terms of what they require of duty holders, is that the Health & Safety Executive considers that duties to ensure health and safety so far as is reasonably practicable SFARP and duties to reduce risks as low as is reasonably practicable ALARP call for the same set of tests to be applied. However, SFARP and ALARP are not always interchangeable because legal proceedings will have to employ the particular term cited in the relevant legislation. Network Rail's policy in this regard is detailed in section 3.5 of the H & SMS.

5 Abbreviations

Abbreviations considered helpful to the understanding of this standard are provided in Table 1.

AC	Alternating current
ALARP	As low as is reasonably practicable
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
DEL	A series of Delivery Manuals contained within the GRIP Process
DoC	Declaration of Conformity
DPE	Designated Project Engineer
E&P	Electrification & Plant
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	European Norm standard
ESC	Electrical Systems Compatibility
EU	European Union
GRIP	Guide to Railway Investment Projects
HAZID	Hazard Identification
HMRI	Her Majesty's Railway Inspectorate
H&SMS	Health and Safety Management System
MSG	Maintenance Support Group
NoBo	Notified Body
NST	National Specialist Team
OMM	Operations Maintenance Manual
PADS	Parts & Drawing System
PM	Project Manager
PMF	Project Management Framework
RGS	Railway Group Standards
RIR	The Railways (Interoperability) Regulations 2006
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
R&TTE	Radio & Telecommunications Terminal Equipment
SFARP	So far as is reasonably practicable
SRP	System Review Panel
VAB	Vehicle Acceptance Body
WSF	Wrong Side Failure

Table 1 – Abbreviations

6 Introduction to the requirements of the EMC Directive

The New EMC Directive came into force across the EU from 20th July 2007. The current Directive remains in force until 2009, and so the Directives overlap by two years. The EMC Directive is not retrospective upon existing installations.

The UK Statutory Instrument SI 2006 No. 3418: The EMC Regulations 2006, implementing Directive 2004/108 has been published and subsequently amended by Correction Slip in November 2007. Directive 2004/108 divides equipment into two categories: 'Apparatus' and 'Fixed Installations'.

The EMC Regulations 2006 cover both apparatus and fixed installations. 'Inherently benign equipment' is excluded from the scope, whether it is an apparatus, system or fixed installation. According to Statutory Instrument 2006 No. 3418 inherently benign equipment cannot contain semiconductors (such as rectifiers and transistors).

The important change concerning the railways is that fixed installations (which cover most railway assets) have been brought within the scope of the New Directive. A fixed installation is required to 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 Directive. Engineering practices have to be documented, and the documentation held by the person responsible for the installation for as long as it is in operation. Apparatus intended specifically for a pre-defined installation is not required to undergo conformity assessment unless it is also commercially available on the market.

The New Directive aims to reduce the regulatory burden placed on manufacturers by the previous EMC Directive and makes the involvement of a Notified Body voluntary. Consequently greater care may be required by Network Rail when assessing relevant documentation submitted by manufacturers.

The implementation of the EMC Regulations does not alter the application of UK legislation regulating the safety of equipment or the safety of railway transportation systems. Therefore, Network Rail's compliance with the EMC Regs 2006 is addressed under our existing Health and Safety Management System (H & SMS).

*NOTE Commercial and responsibility issues are specified in section **9.9**.*

The new Directive introduces a requirement that all products must be delivered with EMC "instructions for use"' that define the intended operational environment that the certification (CE marking) applies to. These instructions include any maintenance and operating instructions to be applied in order to maintain the qualification level of EMC performance throughout the operational life of the apparatus. Products intended for a specific application, i.e. not CE-marked, are subject to the same requirements.

The legal obligation of complying with the EMC Directive does not necessarily deliver the safety of the railway and a complete compatibility case shall also be produced for any new system that requires a safety authorisation.

NOTE Radio and telecommunications terminal equipment (such as radios, modems, etc.) are subject to the Radio & Telecommunications Terminal Equipment (R&TTE)Regulations for the implementation of R&TTE Directive 1999/5/EC. These regulations specify requirements for radio and

telecommunications aspects of equipment in addition to the essential requirements of the EMC Directive. However, their effect upon an established installation is considered as a source of EMI.

7 EMC and the safety process

Whilst the new EMC Regs (2006) do not lay down the requirements for safety, there will be some convergence in relation to EMC Management and Safety in the future because some EMC phenomena can impact on safety. The Network Rail Health & Safety Management System (H&SMS) details the strategies and processes that need to be considered and adopted in order to comply with the appropriate safety requirements.

Products and plant might also be subject to a process as detailed in the H&SMS for the acceptance of new or modified products and change of application of, materials, equipment, systems, etc. It includes almost any product or plant and equipment that might affect or interact with the railway infrastructure.

Duties under the Railway Interoperability Regulations (RIR) and Rail and Other Guided Transport System (Safety) Regulations (ROGS) related to the need to obtain formal authorisation to bring into service certain infrastructure schemes and are generally discharged through the acceptance arrangements. The requirements of the EMC Regs (2006) will need to be integrated into these processes, where appropriate.

Infrastructure projects that involve changing the network such that a significant new risk is created, or an existing risk is significantly altered, or that the network is significantly different from that previously in operation may be required to be authorised into service under the Safety Verification process described in ROGS, or alternatively under RIR. This will normally include verification of the rolling stock and infrastructure compatibility.

7.1 Integrated risk approach

The risk score shall be defined and managed following the principles laid down in NR/L2/RSK/00001.

The impact score shall be based on unmitigated consequences.

7.2 Assumptions for EMC

The complete argument for electromagnetic compatibility over the life of the installation and the target risk score are based on some assumptions, for example:

- the line side signalling equipment has been installed to the standards applicable at the time of installation, and has been upgraded where changes in standards require that retrospective action be taken;
- the line side signalling equipment as it currently exists operates to an acceptable level of safety when used with the existing traction and rolling stock;
- the line side signalling equipment is correctly maintained in accordance with Company Standards and the manufacturer’s recommendations where applicable;

- the line side signalling equipment is operating within the limits specified by the manufacturer, the design authority or by Network Rail as the infrastructure controller.

The verification activities (section 9.6) shall deliver satisfactory confirmation of these assumptions.

8 Responsibilities for the management of EMC

8.1 EMC management for product introduced on the operational railway

The product specification of any apparatus that is part of a novel installation shall consider all the EMC aspects before detailed design commences.

The EMC shall be addressed by the Designer (or the Designated Project Engineer), prior to commencing the single-option detailed development. The Standards framework and the zoning principle shall be as specified in section 8.2.

NOTE 1 The EMC NST is available to Designers (or DPE) for further advice.

NOTE 2 EMC issues can influence the fundamental system design and the selection of apparatus options. A failure to properly consider the EMC input into apparatus specifications could have serious ramifications to the later stages of a project.

8.2 EMC management for projects

The responsibilities for EMC management for projects altering or building new infrastructure shall be as specified in NR/L1/SIG/30040, *EMC Strategy for Network Rail.* To assist understanding the chart that illustrates the transfer of responsibilities for EMC management is shown here, too in Figure 1.

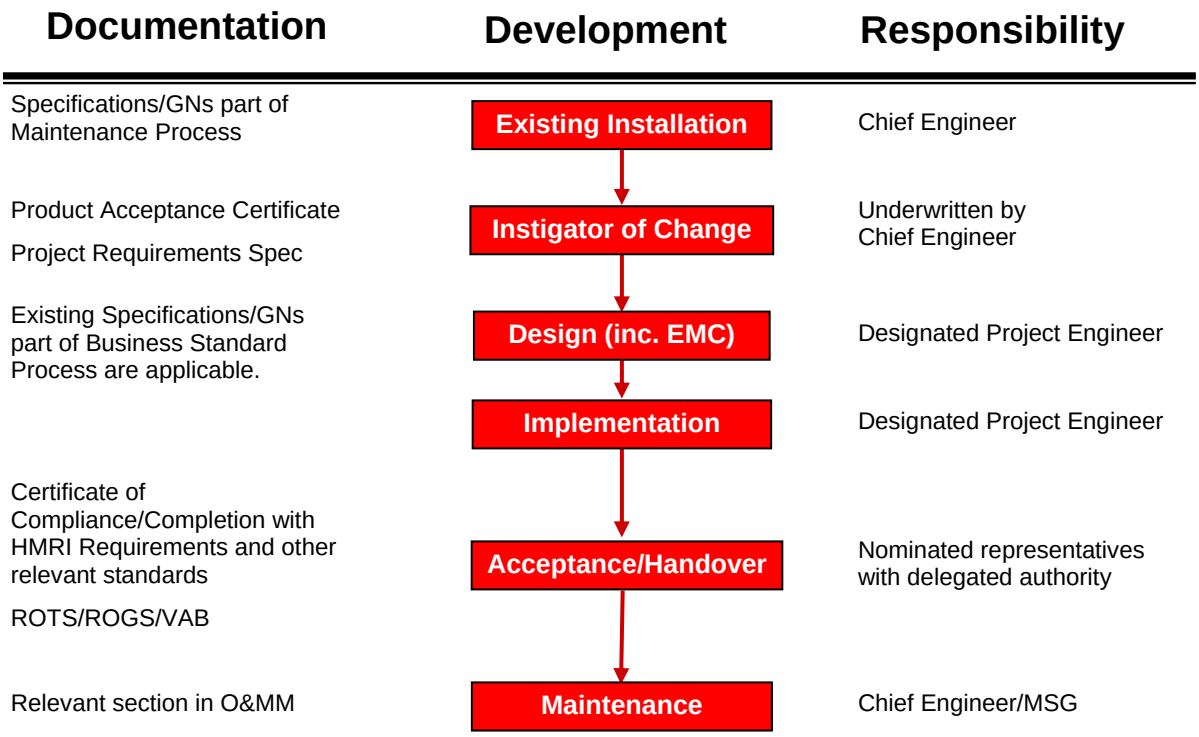

Figure 1 – Responsibility for EMC Management

9 Evidence to demonstrate compliance with the essential requirements of the EMC Directive

9.1 Project EMC Strategy

The DPE (or other appointed person) shall commence the development of the Project EMC Strategy at GRIP stage 2 and complete it by the end of GRIP stage 4.

The EMC Strategy shall consider the type of fixed/mobile installation being deployed by the project and the major hazards present.

The DPE shall review the hazards arising from the management of EMC, and identify suitable mitigation to the SFARP principle.

NOTE 1 The EMC NST is available to assist the DPE in identifying any safety and commercial EMC risks.

The Project Risk Log, owned by the PM, shall be used to record and close EMC risks, as specified in **9.4**. A section dedicated to EMC shall be included.

NOTE 2 See also NR/SP/OHS/00109 and DEL03.

The projects shall proceed with their activities and supporting PMF submissions in the normal course of delivering their objectives in accordance with DEL02, *GRIP Manual – Project Engineering Delivery* and NR/SP/BUS/02009, *Engineering management for projects.* The DPE shall review the overall testing/analysis programme for the project with respect to its completeness and coverage of EMC tests. The EMC activities for populating the Health & Safety file (H&S file) required by GRIP Manual DEL02 shall be as shown in Figure 2.

The individual hazards shall be identified considering Figure 3 and managed according to NR/L2/RSK/00001, *Integrated Risk Management Process*.

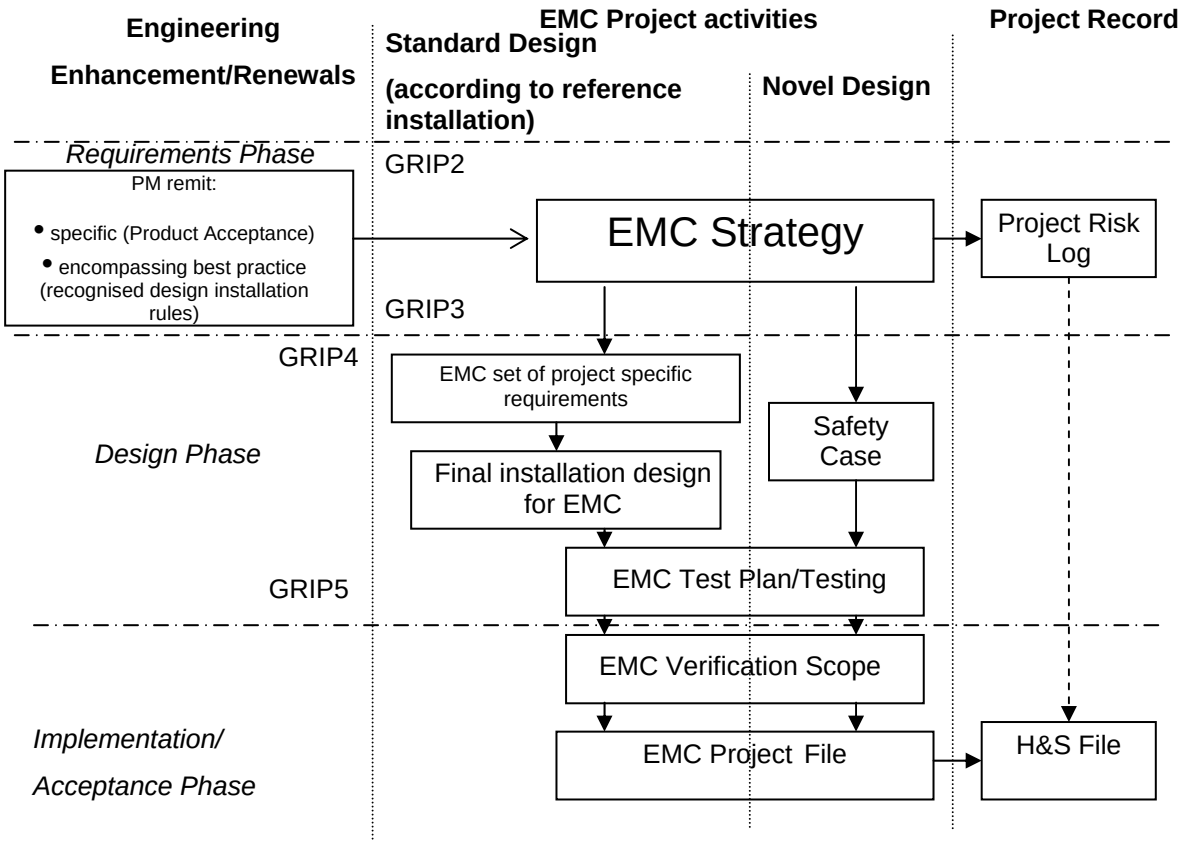

Figure 2 – EMC project activities

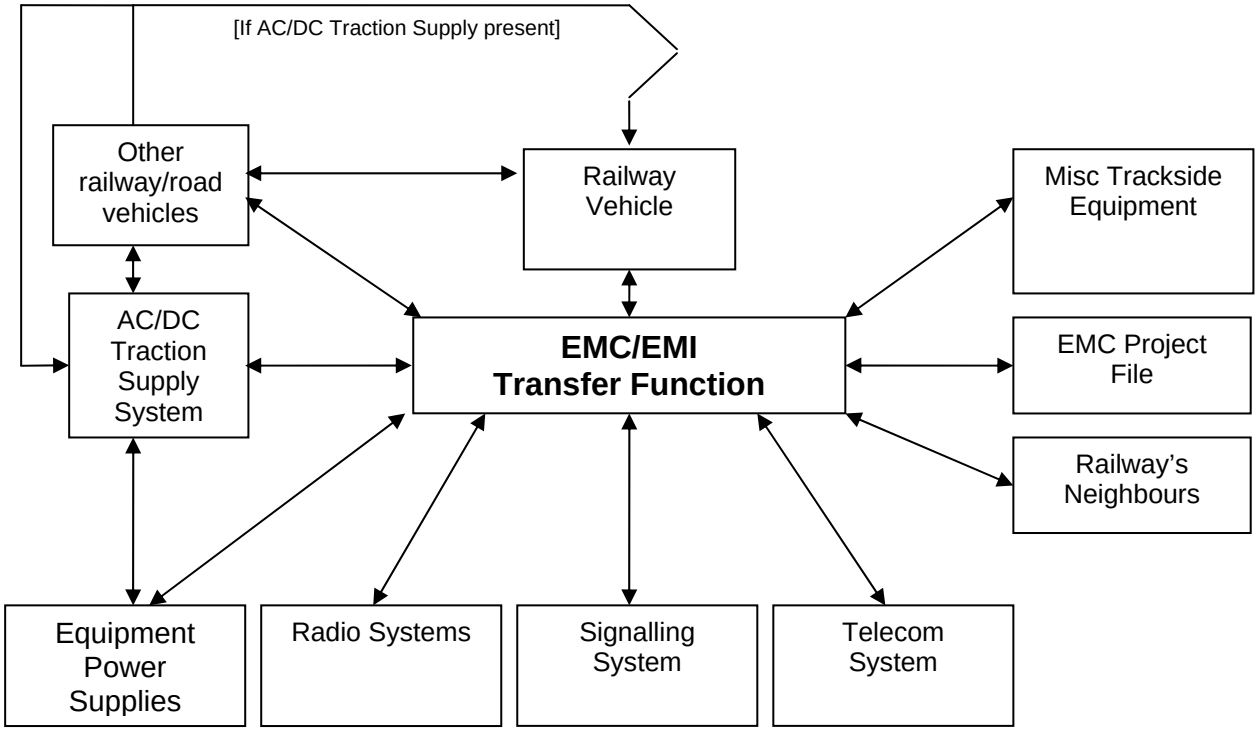

Figure 3 – Interdisciplinary EMC transfer schematic

The EMC hazard identification and management shall be conducted as specified in Appendix B.

The EMC strategy shall be operated within the PMF so that most project EMC effort is paralleled with the PMF requirements. For novel installations, where the EMC Strategy requires technical effort and resources that are beyond the scope of most Project Teams, the EMC National Specialist Team shall be contacted in the first instance. With any cross-functional issues, a robust strategy shall be implemented.

The EMC Strategy shall consider pragmatic factors such as the scale of the changes and the size of the project and resources available. The Project EMC strategy shall be a framework that can be scaled according to those resources and the level of risk involved.

The EMC Strategy shall consist of the following parts:

- Definition of installation (from project remit);
- Hazards identified through a HAZID process;
- Proposed methods to close or mitigate hazards during the life of the installation, including EMC Test Plan if identified as required.

For standard installations, the EMC Strategy shall comprise a Summary table. An example of a summary table is shown in Appendix E.

For novel installations (see **9.3**) an EMC control plan shall be produced if deemed required because of the complexity of the installation. The EMC control plan shall capture the relevant sub-contractor's EMC scope, as part of project development beyond GRIP stage 4.

NOTE Example documents are available from EMC NST.

9.2 Standard Fixed/Mobile Installations

A project may be classified as a Standard Fixed/Mobile Installation where reference can be made to a similar Installation that has a Practical Completion Certificate (DEL02) with HMRI Requirements and other relevant standards (ROTS/ROGS/VAB).

All Fixed/Mobile Installations become Standard Installations if a reference installation exists or the design is approved by the relevant safety authority (HMRI/ORR).

The DPE shall be able to justify that the project scope is a “Standard Fixed Installation”, if a Practical Completion Certificate (DEL02) of the reference infrastructure exists. If no such model can be established, the process for a Novel Fixed Installation shall be followed.

9.3 Novel Fixed Installations

9.3.1 EMC Project Requirements for non-standard (novel) projects

For Novel Fixed Installations, the DPE (or other appointed person) shall produce the EMC Project File. It shall form part of the safety case submissions. The principles of the Yellow Book shall preferably be followed or an equivalent guidance.

For novel projects, an EMC Control Plan shall be produced as part of the EMC Project File in the Project Safety Case and the Project H &S File. The EMC Control Plan shall detail the proposed management of EMC risk as captured in the individual subcontractors’ remits.

Compliance of individual apparatus with established harmonised EMC standards shall be used where possible to close or mitigate hazards. The framework of EMC standards provided in Appendix C is part of the CENELEC framework of harmonised EMC standards for demonstration of compatibility with the EMC Regs (2006), and as such it provides typically about 90% satisfactory closure of the EMC risks for a fixed installation.

When a new system safety case is being developed, the risk of reduced availability of the system due to anticipated EMI shall be evaluated with relation to the overall safety and performance risk to the railway. Such analyses must encompass failures under both normal and fault conditions, including that under earth faults as follows:

- Compatibility under normal conditions shall be evaluated as a pass or fail against the limits from appropriate EN standards and NR EMC specifications.
- The established availability/reliability of the signalling system shall not be compromised due to EMI from a train in degraded conditions.
- The rate of failures leading to train interference emissions in excess of declared signalling compatibility limits shall be demonstrated to be commensurate with the applicable safety / availability targets for the victim equipment.

The safety case shall demonstrate that the safety risk associated with the installed installations is tolerable and ALARP.

9.3.2 EMC Project requirements for significant alterations to existing standard installations

Some current products (understand apparatus or systems in the context of the EMC Directive), which are already accepted and which appear in the PADS database, might still require additional assurance of their EMC if the electromagnetic environment is found to be different, e.g. a change from an AC to a DC traction environment. In these cases, the identified EMC risk shall be closed out via the safety case process.

Appendix C provides guidance on the EMC standards framework that can be applied to all equipment deployed on Network Rail's operational infrastructure before placing it in service on or near the electrified railway. It corresponds to the following zoning principles as illustrated in Figure 4:

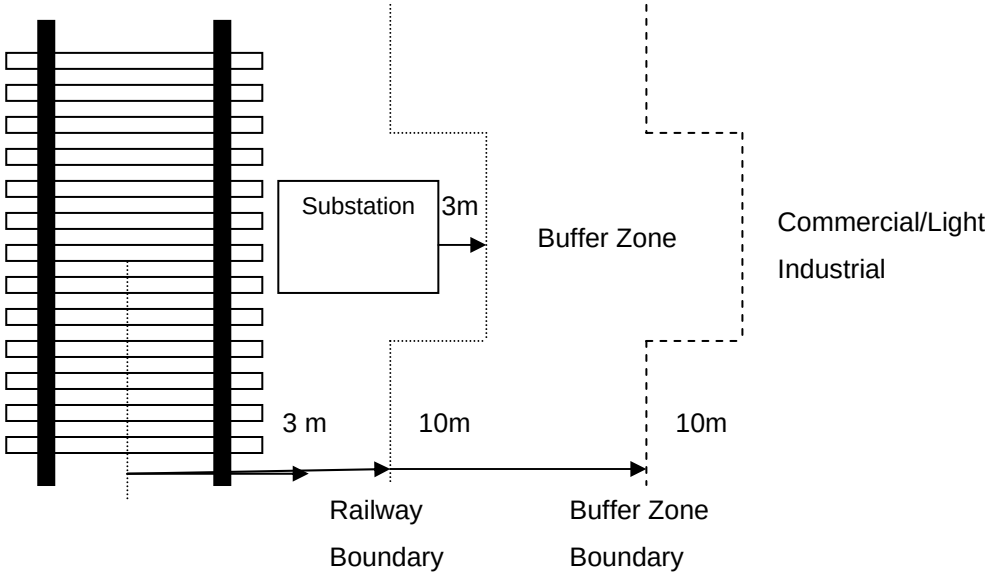

Figure 4 - Zoning Principles

BS EN 50121 defines test limits for equipment placed within a railway boundary. The railway boundary is defined as an area up to 10 m from the centre of the nearest running line, and extends 3m beyond substation boundary. The limits in the standard applicable to the railway boundary are generally equivalent to limits defined in heavy industrial environment. Some specific limits are provide for equipment placed within 3m from the centre of the nearest running line. Beyond this 10m railway zone, light industrial standards for EMC apply. In practice, it is more likely that the transition from heavy industrial to light industrial environment occurs gradually. It is therefore recommended that equipment supplied for the Buffer Zone which extends 10m beyond the railway boundary covered in BS EN 50121 is also certified to EMC standards applicable to heavy industrial environment or BS EN 50121 to achieve resilience to known EMI.

To mitigate a known deficiency in BS EN 50121 at frequencies below 9 kHz, additional testing will be required at frequencies 0 – 9 kHz to establish immunity to traction interference. Known problem frequencies are 50Hz and its harmonic for telecommunications equipment. Such extra tests for new communication equipment are provided in NR/SP/TEL/30003.

Further advice on the applicability of standards is available from the EMC NST.

In cases when the EMC certification recorded in PADS is to a different product standard from Appendix C, Table C.1 then Appendix D, Table D.1 shall be used to conduct gap analyses and identify any necessary tests, before finalising the installation design.

NOTE The PADS Database lists approved items subject to confirmation of the extent of any acceptance certificate.

The installation guidance for products approved in accordance with NR/CS/ACC/029 and within the project scope shall form the scope of EMC requirements for standard installations, plus any additional requirements identified as a result of conducting the gap analyses.

Any additional testing identified as a result of conducting the gap analyses and individual site surveys shall be recorded in a Strategy summary table and shall be used to identify the scope for verification activities under GRIP Stages 5 to 8.

NOTE See Appendix E, North London Line EMC (Electrical System Compatibility) summary for an example.

The risks as identified through HAZID shall be controlled as part of the relevant sub-contractors scope of work, in accordance with NR/SP/OHS/00109.

Depending on the exposure and criticality, the installation rules can vary from site to site, and from one system to another.

9.3.3 EMC at the railway boundary line

Assessments associated with the EMC footprint of the proposed installation and possible impact on our neighbours shall be conducted according to the zoning principles specified in Figure 4. The outcome shall be used to discharge Network Rail duty of due diligence and to aid neighbours with their Certificate of Conformity with the EMC Directive. In cases of shared interface with neighbouring railways, these studies shall form part of a Boundary Safety case.

9.4 Co-ordination of the Project Risk Logs

The risks identified as a result of the HAZID exercise shall be incorporated in the Project Risk Log to enable robust control through the project lifecycle.

For Installations, any electromagnetic coupling that is identified as potentially posing a threat to safety and/or performance shall be analysed to determine if there is a real threat. This shall be done by mapping the immunity (susceptibility) characteristics of the device under threat (e.g. a track circuit) with known emitters (traction, radiated interference sources) and applying appropriate factors of safety.

NOTE These are often based on the knowledge and experience of the engineers preparing and auditing the Safety Case for the system. A combination of computer modelling coupled with site specific and laboratory measurements are useful techniques for demonstrating whether or not a design is safe.

In developing the EMC aspects of a Safety Case reference shall be made to appropriate Network Rail standards and European Norms.

The mitigation activities for risks recorded in the Project Risk log shall be captured in the contracts for GRIP Stages 5 to 8 identified for the detailed design and in the corresponding project programme activities.

Any studies initiated on the subject of EMC shall confirm that the EMC risk for the installation is within acceptable limits.

9.5 EMC test plan requirements

For any testing identified in the EMC Strategy (**9.1**), a test plan shall be produced by the project.

a) *Novel installation*. For novel projects, the test plan shall cover the individual hazards.

b) *Standard installation.* For a new standard E&P installation, this shall cover sub-station design type test if applicable and a test for safe touch potential limits, as specified in BR 13422 and NR/L2/TEL/31107.

For signalling installations, functional testing in normal operational conditions at a typical site shall be used as verification that the installation is fit for purpose from the EMC point of view for sites of that type on the premise that it is “functioning as intended and the performance is not affected by any EMI”.

Where new sites have significant differences, such as AC instead of DC electrification, further functional testing will be required. This is in addition to any standard EMC testing for compliance with the EMC Directive. This additional testing shall be carried out by a specialised test house, in consultation with EMC NST.

9.6 EMC Verification

NOTE 1 EMC Verification forms part of the project safety verification associated with detailed design GRIP Stages 5 to 8.

Records of conformance to Design (GRIP6) shall be in accordance with DEL02, *GRIP Manual – Project Engineering Delivery*. Before the Project Completion Certificate is issued, the following activities shall be used as a record that EMC best practice has been used:

a) *Standard Electrification & Plant Projects*. Form E/B approval by DPE Sign Off shall include a check for any planned EMC activities. Upon completion, the accessible voltages and touch potentials on lineside cables shall be checked in accordance with NR/L2/TEL/31107, *Limits and Test Method of Induced Voltages on Telecommunications Cables due to Electrification Systems.* The tests shall include verification that the transfer voltages at the terminal communication equipment are within specified limits.

b) *Standard Signalling Projects*. The Master Test Cetrificate (TC1) shall be used as a record and evidence that the installation meets the “essential requirements” of the EMC Regs (2006). The minimum requirements shall be as defined in DEL02.

NOTE 2 Form E/B is provided in NR/SP/ELP/27311.An example TC1 Certificate is provided in NR/GN/SIG/11722. The complete documentation list for signalling projects is in accordance with NR/L2/SIG/30014 Signalling works testing handbook.

c) *Novel Installations*. In addition to standard testing listed under a) and b) tests shall be conducted as required by the Safety Case.

9.7 EMC Project File

The EMC Project File shall be the record of any EMC test reports and corresponding results, or standards used to close or mitigate hazards. A log of drawing numbers, analyses, and special EMC requirements/risks shall be included where applicable, depending on the scope of the project.

The Project EMC documentation shall be compiled through the activities specified to safe deliver core activities in accordance with the H & SMS. Reference shall be kept via an established archiving and auditing process as specified in NR/SP/BUS/02009. Any EMC evidence for new products or plant identified in the PM’s Remit shall be recorded as specified in NR/CS/ACC/029.

For Novel Installations, the EMC Project File shall form part of the Project Safety Case documentation, and shall be recorded and submitted via the appropriate SRP route specified in NR/SP/ACC/013, *System Review Panel and Technical Review Groups.*

Any considerations for EMC resulting in management of spares or defining maintenance frequency shall be included in the Operations & Maintenance Manual (O&MM) and provided to Maintenance on handover. The O&MM shall also list any special measures required to maintain continued EMC over time, e.g. cable screening, terminations, spare earthing rods, couplers and EMC gaskets. Part identification and ordering information are essential.

9.8 Maintenance of the EMC Project File

If any modifications are introduced to the installation that are likely to change the EMC characteristics of that installation during its life, for example re-routing cables, then the Maintenance Engineer should liaise with the owner of this standard before requesting any necessary amendments to the EMC Project File.

9.9 Resolution of commercial and responsibility issues

NOTE The EMC Regs (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 benefits without incurring disproportionate financial costs (see NR policy on SFARPas detailed in section 3.5 of the H & SMS).

Engineering decisions, e.g. as a result of conducting gap analyses in accordance with **9.3.2** shall be fully documented within the EMC Project File. In addition, all instances where following a manufacturer's "good EMC practice" would introduce an unacceptable safety hazard (e.g. in earthing and bonding practice), shall be documented together with the rationale for the "best practice" used.

Where there is limited EMC experience, the EMC NST may be used to act as mentor to the nominated EMC Responsible Person.

Appendix A
Examples of inherently benign equipment

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

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.

Appendix B
EMC hazard identification (EMC HAZID)

As part of the EMC process, a hazard identification (HAZID) shall be performed. The HAZID shall consider all systems and apparatus which might interact electromagnetically with each other and shall identify whether further or additional testing will be required over and above that specified in the relevant part of BS EN 50121.

NOTE 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 microwave communications and radars may produce a threat. This might be a problem close to Airport Radar Systems and Defence Installations.

The EMC Regs (2006) require installers of fixed installations to follow a regime that demonstrates compliance with the essential protection requirements of the EMC Directive by:

a) following the installation and user instructions required to be provided with apparatus;

b) respecting the information on the intended use of its components if instructions required to be provided with apparatus are not provided because, for example, the apparatus is not placed on the market and is supplied only to specified fixed installations;

c) the application of good EMC engineering practices to the fixed installation, having regard to the state of the art.

NOTE 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.

NOTE 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 general presumption of conformity with the EMC Regs 2006.

The presence of such apparatus forms an EMC risk and it shall be addressed in the Project Risk Register.

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

NOTE The New Directive requires that on "putting into service" fixed installations can be demonstrated to be installed in accordance with good engineering practices, and 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 compliance status.

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 in 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.

Appendix C
Standards framework for EMC

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 50121-4 [a]	BS EN 50121-4
Telecommunications	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 EN55024 (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 C.1 – Standards framework for EMC

Appendix D
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**	**61000-6-4:2001**	**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 [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 D.1a) – EMC CENELEC standards - comparative chart

EMC Test	Test Method	PC	Condition	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	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 D.1b) – EMC CENELEC standards comparative chart *(concluded)*

Appendix E
Example of EMC (Electrical System Compatibility) summary table - North London Line Railway Infrastructure project

EMC Summary						
Description	**Specific Design Requirement**	**Qualitative Assessment .**	**Quantitative Assessment.**	**Comm. Tests**	**Criteria**	**Comments**
3rd Parties	No	Yes	No	No	EN50121-2	Model of standard configuration only
Other railways (DC lines)	Yes	No	Yes	Yes	Track circuit criteria	Location specific design to take account of immunisation requirements
T&RS Safety case	No	No	No	No	Comparison	Representative tests on selected representative modern stock
Existing train detection	Yes	No	Yes	Yes		Standard design rules with regard to earthing and bonding
AWS	Yes	No	Yes	No	.	Standard design rules with regard to earthing and bonding
Lineside systems - operation	Yes	No	Yes	Yes	BR 13422, mainly comparison	Installation to conform to set rules. Asset survey to ensure that systems installed to standards
Lineside systems Access and touch potentials	Yes	No	Yes	Yes	GT/TDINT/100 and GK/ES/683	Installation to conform to set rules. Asset survey to ensure that systems installed to standards
Telecomms. Operation	Yes	Yes	No	Yes	BR 13422	Installation to conform to set rules. Asset survey to ensure that systems installed to standards
Telecomms. -Access and Touch potentials	Yes	No	Yes	Yes	NR/SP/ELP/21085 + EN 50122	Installation to conform to set rules. Asset survey to ensure that systems installed to standards
Stray DC	Yes	No	Yes	Yes	EN 50122 - 2	Installation to conform to set rules. Asset survey to ensure that systems installed to standards

Table E.1 – North London Line Project EMC (Electrical System Compatibility) summary table

Standards Briefing Note

Ref: NR/L2/SIG/30041	Issue: 1	Publication Date: 26/08/2008	Compliance Date: 01/12/2008
Title: EMC Assurance Process For Network Rail			
Standard Owner: Signal Engineering			
Non-Compliance rep (NRNC): Head Of Signal Engineering			

Purpose: The purpose of this standard is to support NR/L1/SIG/30040, EMC Strategy for Network Rail.

Scope: The purpose of this standard is to enable compliance with NR/L1/SIG/30040, EMC Strategy for Network Rail by providing a set of requirements for managing EMC for fixed and mobile installations identified in project remits, or modifications to existing installations due to maintenance activities.

What's New/Changed: New Standard

Affected documents:

Reference	*Impact*
DEL03	EMC Regs (2006) added
DEL02	NR/L2/SIG/30041 added

Implementation requirements:

The following posts have specific responsibilities within this standard and shall receive technical briefing as part of the Implementation Programme:

Designated Project Engineers, Maintenance Engineers

For further information contact:
Name: Maya Petkova
Contact number: 085 78051
Email: Maya.petkova@networkrail.co.uk

The following teams require awareness briefing:

- Executive Management Group ☐
- Commercial Property ☒
- Contracts and Procurement ☒
- Strategic Change ☐
- CTRL ☐

Engineering

- Asset Management ☐
- Civil Engineering ☐
- E&P Engineering ☒
- Enhancements Engineering ☒
- Ergonomics ☐
- Future Railway Programme ☒
- Ops Principles & Standards ☐
- Rail Vehicle Engineering ☒
- Railway Systems ☒
- Telecoms Engineering ☐
- Track Engineering ☐
- Signal Engineering ☒

- Finance ☐
- Funding ☐
- Govt & Corp Affairs ☐
- Human Resources ☐
- Information Management ☐

Infrastructure Investment

- Crossrail ☐
- Track ☒
- Programme Management ☐
- Contracts & Procurement ☐
- HSEA ☐
- Sig. Power & Comms ☒
- WCRM ☒
- Construction ☐
- FTN/GSM-R ☒
- Thameslink ☒
- Enhancements ☒

Infrastructure Maintenance

- Maintenance Areas ☒
- Operational Property ☐
- Overhead Condition Renewals ☐

- Legal Services ☒
- National Delivery Service ☐
- Network Development ☒
- Operations & Customer Services ☒
- Planning & Regulation ☐
- Safety and Compliance ☒
- Westwood ☐