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Business Process Document

Methodology for the Demonstration of Compatibility with Telecommunications Systems

Endorsement & Authorisation

Endorsed by:



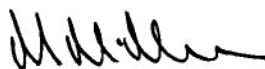
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Issue record

Issue	Date	Comments
3	April 2006	To supersede NR/GN/TEL/50016 Issue 2

Implementation

(Please include implementation date, if applicable.)

Compliance

This Network Rail Company Standard is mandatory and must be complied with by [Network Rail/Contractors] from 1st April 2006.

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

Where the Standard Owner has specified that all projects will comply with the requirements, specific authority not to comply can be sought in the usual manner using the appropriate non-compliance authority processes described in Network Rail Standard, [NR/SP/STP/045](#) Managing the Process for Non-compliance Authority (formerly RT/LS/P/045).

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1 Purpose

This document provides a methodology to ensure electromagnetic compatibility with operational telecommunications equipment and systems adjacent to the AC and DC electrified railway on Network Rail controlled infrastructure. This is achieved by:

- identifying generic types of safety-related, operational telecommunications equipment and systems present on Network Rail controlled infrastructure
- determining maximum tolerable levels of interference at the terminal equipment
- defining limits of interference at the terminal equipment due to rolling stock
- compatibility argument

This methodology will facilitate the demonstration of compatibility of rolling stock with operational telecommunications equipment and systems, as part of a Route Acceptance Safety Case.

2 Scope

This document covers interference with cabled fixed operational telecommunications systems only and does not include

- analysis of interference to signalling, electrification and other equipment which may result from connections carried through lineside telecommunications systems
- the effects of resonance, which must be addressed separately
- retail telecommunications systems
- third party systems (either side of the railway boundary)
- train-borne systems

Other generic types of lineside system not covered by this document are included within the scope of [RT/E/C/50014](#) and other specific documents (see, for example, [RT/E/C/50011](#) Axle Counters, which includes interference effects within the transmission line).

As the methodology involves defining limits for the transverse voltage at terminal equipment, the limits are applicable to all routes.

3 Reference Documents

3.1 RSSB Group Standards

- [GM/RC/1500](#) Code of Practice for EMC between the Railway and its Neighbourhood.
- [BR 13422](#) Immunisation of Signalling and Telecommunications Equipment against Interference

3.2 Network Rail Company Standards

- [RT/E/PS/00015](#) Unit twin copper telecommunications cable.
- [RT/E/S/30003](#) The Performance of Telecommunications Equipment under Conditions of Interference
- [RT/E/C/50011](#) Methodology for the Demonstration of Compatibility with Axle Counters
- [RT/E/C/50014](#) Methodology for the Demonstration of Compatibility with Lineside Equipment

3.3 Other Standards

- O.9 Measuring arrangements to assess the degree of unbalance about Earth. ITU-T
- O.41 Psophometer for use on telephone-type circuits. ITU-T
- G.151 General Characteristics of International Telephone Circuits and National Extension Circuits. ITU-T
- V.34 A modem operating at data signalling rates of up to 33 600 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits. ITU-T
- BS EN 50121 Parts 1-5. Railway Applications: Electromagnetic Compatibility. BSI
- BS EN 50238 Railway applications: Compatibility between rolling stock and train detection systems
- BR 886 Unit twin copper telecommunications cable.
- BR 887 Star Quad Carrier Type Polyethylene Insulated & Sheathed Cable for Railway Telecommunications
- BR 892 Brass Tape Armouring & PVC Oversheath for Plastic Sheathed Cables
- BR 894 Aluminium Sheathed & PVC Oversheath for Cables Subject to Electromagnetic Induction
- BR 895 Magnetic Screening Tapes Aluminium Sheath & PVC Oversheath for Cables Subject to High Electromagnetic Induction
- BR 1818 Installation and Jointing of Separate Screening Conductors for Telecoms Cables (archived for reference only)
- BR 1820 Earthing and Bonding of Separate Screening Conductors and Associated Lineside Telecoms Equipment in DC Electrified and Non-Electrified Areas (Withdrawn)
- BR1822 Steel/ Polymer Laminate tape & Oversheath for Plastic Sheathed Cables
- BR 1845 Cab Secure Radio. British Railways Board, Apr 1991
- BR 1609 VHF 3-Band Radio for the National Radio Network. British Railways Board, Aug 1987

3.4 Project Documents

ENG/R/434	EMC Standards Project: Test Report. Thales Telecoms Services. Apr 2005
ENG/R/459	Industry Data Initiative: Cable types, parameters and locations, Thales Telecoms Services, Apr 2004
ENG/R/551	Industry Data Initiative: Generic Telecommunications Equipment List, Thales Telecoms Services, Apr 2004
ENG/R/587	EMC Standards Project: Test Specification Thales Telecoms Services, Jul 2004

4 Definitions & Abbreviations

AC	Alternating Current
BR	British Rail
BSI	British Standards Institute
CSR	Cab Secure Radio
CSV	Comma Separated Variable
DC	Direct Current
DTMF	Dual Tone Multi-Frequency
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FFT	Fast Fourier Transform
IGBT	Insulated Gate Bipolar Transistor
ITU	International Telecommunications Union
LCL	Line Conversion Loss
NRN	National Radio Network
PCM	Pulse Code Modulation
PETS	Public Emergency Telephone System
PVC	Polyvinylchloride
RF	Radio Frequency
RMS	Root Mean Square
RSS	Root Sum Square
RSSB	Rail Safety and Standards Board
SDH	Synchronous Digital Hierarchy
TSC	Trunk Switching Centre
UIC	Union Internationale de Chemin de Fer (International Railway Union)

Where the term 'train' is used, this is defined as an influencing unit which comprises all coupled/ connected vehicles and their traction and auxiliary supplies (as defined in [BS EN 50238](#)).

5 Methodology for Demonstration of Compatibility

5.1 General Acceptance

The compatibility of new rolling stock with operational telecommunications transmission systems connected to trackside cables shall be assured by demonstrating that, under the test conditions specified in §5.3, the following requirements are met:

1. the psophometric transverse voltage induced on trackside cables does not exceed 1 mV measured in accordance with §6.1;
2. the transverse voltage with the susceptibility weighting calculated in accordance with §6.2 does not exceed 1 mV.

The tests are performed with a single train present in the electrical section and telecommunications cable section under test. Compliance with these limits for a single train will ensure compatibility of multiple train scenarios.

5.2 Route Acceptance

In addition to the requirements for general acceptance, route acceptance shall require a demonstration that frequency division multiplex (FDM) systems, if present on the route, continue to function without disturbance.

5.3 Test Conditions

The following test conditions shall apply when measuring the performance of the rolling stock in accordance with §5.1.

Where it is not possible to meet all the conditions specified, the applicant shall propose a test plan with suitably adjusted acceptance limits for approval by the Head of Telecommunications Engineering.

5.3.1 Track

The test site requirements are:

1. 25 kV AC electrified line with single rail return and with booster transformers positioned at a nominal spacing of 3.2 km.
2. The track may be either 2-track or 4-track. For 2-track, the testing shall be carried out with the train running on the track next to the telecommunications cables. For 4-track, the train shall run on the track adjacent to the track nearest the telecommunications cable.
3. The tests shall be carried out on a telecommunications cable with a mutual screening conductor (and no integral screen). The cable shall be no less than 12 km long and entirely within the electrical section.

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5.3.2 Rolling Stock

The rolling stock shall be tested under the following conditions:

1. A single train inducing interference into the telecommunications cable under test.
2. Where multiple units are used, testing shall be carried out in the maximum length configuration.
3. Normal and worst case degraded operation (e.g. not all converters working).

6 Test Methods

6.1 Psophometric Transverse Voltage

Psophometric measurements are designed to provide an indication of the audible disturbance caused by noise on speech circuits. ITU-T O.41 defines a set of weighting coefficients over the frequency range 16.66 Hz to 6,000 Hz that matches the response of the human ear, which are reproduced and interpolated in Table 1 and shown graphically in Figure 3.

Psophometric measurements may be made either with the use of a psophometric filter, or through digital processing of digitally recorded data.

6.1.1 Using Psophometric Filter

For measurement of psophometric transverse voltage, a cable pair shall be selected in a representative cable. One end of the cable pair shall be terminated with a 600 Ω resistor and the other end shall be terminated with 600 Ω , passed through a psophometric filter and measured using a voltmeter with an analogue bandwidth of no less than 10 kHz, as shown in Figure 1. Voltmeters with built-in psophometric filters and or 600 Ω terminating resistors may be used.

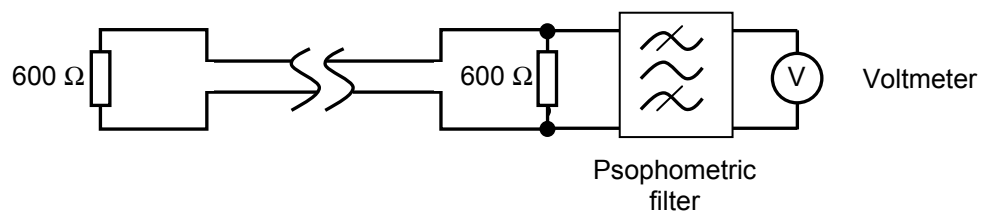


Figure 1 Test set-up for psophometric measurements