European Infrastructure

Compatibility Standards

Maya Petkova
28 January 2014
National priorities up to 2019

- Safety – improve passenger and worker safety
- Reliability – Achieve an overall ‘public performance measure’ of at least 92.5%
- Capacity – significantly increase passenger and freight carrying capacity
- Financial sustainability – improve efficiency and value for money for customers
- Customer satisfaction – improve passenger satisfaction (NPS)
- Environmental Performance – become more sustainable

- Why do we need compatibility? How do we define it and how do we measure it, so that we can control it?
EMC Regulations 2006

- EMC is the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to other equipment in that environment.

- Electromagnetic disturbance – any electromagnetic phenomenon which may degrade the performance of equipment.
Answer to the Big Question

EMC Risk

• Failure to ensure EMC can result in:
  - Safety risks due to dangerous failures
  - Commercial risks due to unavailability

• Level of risk depends on:
  - Whether risk is safety critical
  - Whether risk is safety related

• Effort to address EMC risk is proportionate to the level of risk identified
Safety Risk Model

- Quantified model of safety risk on the mainline railway – Risk Profile Bulletin
- Produced by RSSB – last issue August 2006
- Uses fault & event trees to assess risk
- Risk measured in Fatalities & Weighted Injuries (FWI) index
- Total risk on the railway = 202 FWI/year
- Trackside and other exposed party - < 13%
- **Safety Risk to passengers and workforce safety – reduce by 3% over Control Period 2009-2014**
- Measured by reference to the Rail Safety and Standards Board’s (RSSB) Safety Risk Model (SRM)
- Interoperability challenges – risk measured by Common Safety Methods
BS EN 50121 standards series

Emissions to Neighbourhood BS EN 50121-2

- Infrastructure Electrical
- Infrastructure S & T
- Whole Train Emissions
- On-board systems Em & Im
  - EN 50121-3-2
- Buffer Zone

- EN 50121-3-1
- EN 50121-5
- EN 50121-4

Office Environment standards
- Residential, commercial and light industrial + Information Tech. Equip.
  - EN 61000-6-3 (Em) & EN 61000-6-1 (Im) + EN 55022 (Em) & EN 55024 (Im)
EN50121 – should we extend the scope?

• Decision 48/6 of TC9X of CENELEC: Justification of the need for additional requirements regarding Intra-EMC (…)

- Protection of railway internal radio services
- Protection of railway systems/ signalling systems / short range devices
- Protection against resonances in the railway power supply

• Request for feedback within WG 18 and WGA4-2 (EN 50238-series)
Open Item Number 1

• A general test procedure for ATC systems other than:
  • - track circuits, axle counters (both covered in EN 50238-series) and
  • - ERTMS equipment (covered in UNIFE / UNISIG JWG related to subsets 36 and 116)

• communicating between trackside (e.g. track beacons) and RST (e.g. antennae) is required.

• Therefore it is suggested to create another part of EN 50238-series to cover this item.

• Open Item Number 1 goes to SC9XA and WGA4-2

• This topic is not restricted to mainline but is also relevant especially in metro and light rail lines.
Open Item Number 2

- Transient effects close (within a distance of 1 – 3 km) to neutral sections (e.g. of 25 kV systems) are known to influence trackside devices with high frequency and high power.

- It is suggested to investigate these effects and define additional immunity requirements to be included in EN 50121-4 and -5.

- Onboard rolling stock - this effect can be handled by an improved cabling in most cases. Therefore no additional requirements need to be defined for EN 50121-3-2.

- Open Item Number 2 stays with TC9X and WG18

- It is not suggested to include this topic already in 3rd edition of this set of standards.
• Both “open item” are not related to the fact that emission values in the frequency range between 9 kHz and 150 kHz have been taken out of the mandatory part of EN 50121-2 and -3-1.

• It is not feasible to standardize EMC requirements for short range devices (SRD) due to the fact that their limits may be specific to their locations and their application is not restricted to the railway environment.

• Different activities within Europe are related to resonances in the railway power supply system:
  • EN 50388 (developed by SC9XC), EUREMCO Research projects, supported by the European Railway Agency
Technical Specifications for Interoperability

**Subsystem**
1. Infrastructure
2. Energy
3. Control-Command and Signalling (onboard and trackside)
4. Rolling Stock. Locomotives and passenger rolling stock
5. Rolling Stock. Freight Wagons
6. Rolling Stock. Noise (transverse TSI, including locomotives, passenger rolling stock and freight wagons)
7. Operation and Traffic Management
8. Telematic Applications for Freight Services
9. Telematic Applications for Passenger Services
10. Safety in Railway Tunnels (transverse TSI, including infrastructure, energy, CCS and rolling stock) Accessibility for PRM (transverse TSI, including infrastructure and rolling stock)

**New**
Interfaces Between Control-Command and Signalling trackside and other subsystems
ref. ERA/ERTMS/033281
Compatibility between individual systems

- Combining rolling stock and detection systems requires robust EMC management to achieve a safe and reliable interface between the individual subsystems (RST, CCS and Energy supply ENE).

- Frequency Management as proposed in the new standard EN50617: Technical parameters of Train Detection Systems, will be used to develop the Frequency management for RST, which ERA requires to close one of the open points in ERA/ERTMS/033281, for the purposes of interoperability.

- Approach to validation of FrM for compatibility of RST with Track circuits
  - Rolling stock emissions are defined for each power supply system, based on existing technologies, without any additional measures to achieve compatibility for a specific country or infrastructure segment like costly filters;
  - Track circuit limits are taken into account as defined in TS50238-2;
  - Economic evaluation will be conducted in stages by ERA, to determine the final definition of the Frequency Management, for the target system in the context of Interoperability.
Compatibility between individual systems in UK

- Delivering infrastructure susceptibility limits – NR’s responsibility
- Based on Industry Data Initiative for trainborne emissions
  - Susceptibility limits translated into line current values via transfer function suite as required by GE/RT8015 and validated by testing
  - Suite of EMC standards published as NR’s methodology documents/standards in the 500XX series
  - Overall risk to the railway from excessive EMI managed by compliance to our Asset Policies (incl. EMC Policy)
- Limits for compatibility with radio emissions from fixed transmitters published in standard NR/L2/TEL/30066
Is Frequency Management possible?

Overall Gabarit for all train detection

Harmonic Current (Amps RMS) vs Frequency (Hz)

- Frequency: 1 Hz to 100,000 Hz
- Harmonic Current: 0.001 to 1000 Amps RMS
Frequency Management development

DC networks (evaluation by bandpass filter)

A

„Substation“

„Panto bounce“

„Motor converter“
Frequency Management for DC systems

Interference current limits TSI for DC systems (proposal)

Free for future highly efficient DC traction drives (filter resonance 60 ... 80 Hz)

Steady-state limits may be lower; clear definition on how to handle transients needed

Grey lines: center frequencies $f_0$ as a result of technical criteria [1]
Frequency Management for AC systems

Proposed limits for odd harmonics of RST emissions

Steady-state limits may be lower; clear definition on how to handle transients needed

Low limits possible only if 10 times higher odd harmonics allowed

free for co-ordination with preferred line converter switching frequencies and network resonances:

- 4-kHz band
- 8-kHz band
- 16-kHz band
Interference effects in the Audio Frequency Band B

- Motor converter:
  - Frequency $f = \text{fully variable}$

- Line converter:
  - Frequency $f = N \times f_{\text{nom}}$
  - $N = \text{odd natural}$
UK Challenges

Interference current limits for 50–Hz systems

- DC TCs
- EBI 400 TCs – station F, single rail
EMC Risk Assessment

- Identify railway subsystem components in the project scope
- Assess compliance of each subsystem with appropriate ENs
  - Note: Compliance with BS EN 50121 is not sufficient in terms of frequency coverage and doesn’t cover safety
- Assess compatibility between systems via compliance to NR EMC Specifications to achieve the basis for compliance with the Safety Directive/ROGS
  - Note: GE/RT8015 is being revised by RSSB. The new version will be shaped such that it will contain only joint requirements on RU and IM in conformity with the principles of ROGS and will become a NSR (or series). Specific requirements for compatibility in UK will be captured by a series of NTRs.
- Assess compliance with relevant earthing and bonding standards to achieve occupational safety (ROGS)
- Risk ranking
- Provide mitigations and amend installation requirements if necessary
Risk ranking for EMC

- Integrated risk approach to EMC
  - Demonstration of compatibility under EMC Directive is pass/fail—
    all normal modes, specified environment
  - Numerical targets used in risk ranking relate not to EMI itself but
    to the system faults that can cause normal/established emission
    levels to be exceeded, i.e. degraded operation like broken rail
  - Frequency of occurrence of excessive interference levels known
    to potentially cause mal-operation of other equipment is
    established
  - Frequency of occurrence can be linked to the figures in
    TSIs/current NNTRs for compliance with Safety Regulations
**Broken Rails – 1998 to 2012 Major Changes**

- **Focus on RCF, large volumes of rerailing, reduction in existing defect populations**

- **New Sperry pedestrian UT equipment introduced along with revised standards for inspection frequencies and minimum actions for the management of rail defects**

- **New Sperry equipped train based UT equipment introduced and rolled out with increasing coverage of Track Categories 1A to 3**

- **New standards introduced to set limits and actions for dip angles. Revised inspection frequencies and minimum actions for rail defects**

- **New standards with revised minimum actions for rail defects**

---

**Financial Year End**

- 1998-1999: 952
- 1999-2000: 919
- 2000-2001: 706
- 2001-2002: 534
- 2002-2003: 445
- 2004-2005: 322
- 2005-2006: 317
- 2006-2007: 192
- 2007-2008: 181
- 2008-2009: 164
- 2009-2010: 152
- 2010-2011: 171
- 2011-2012: 127
- 2012-2013: 178

---

**Number of Breaks**

- 0
- 100
- 200
- 300
- 400
- 500
- 600
- 700
- 800
- 900
- 1000

**Yearly Breaks**

- 1998-1999: 952
- 1999-2000: 919
- 2000-2001: 706
- 2001-2002: 534
- 2002-2003: 445
- 2004-2005: 322
- 2005-2006: 317
- 2006-2007: 192
- 2007-2008: 181
- 2008-2009: 164
- 2009-2010: 152
- 2010-2011: 171
- 2011-2012: 127
- 2012-2013: 178
Conclusion

Quote (ORR):

I found the workshop (on EMC values as NTRs – for AC lines) yesterday quite encouraging having gone with an expectation of it making no progress

What is your opinion?

• Thank you for your attention