Introducing a New Track Circuit on British Infrastructure

IET Railway Safety Assurance Seminar
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Case study of the application of a generic safety case to the UK railway
EBI Track 400 – New equipment, new frequencies (to UK), new modulation / coding techniques, new application rules

Cubicle equipment unique to EBI Track 400

Wayside equipment with UK approval for EBI Track 200 (TI21) application

Wayside equipment new to UK
Safety Baseline – Metro de Madrid

First installation of *EBI* Track 400:

- Summer 2010: Desktop / lab safety case.
- Winter 2010: Attended over and back trials in depot installation of existing *EBI* Track equipment.
- Minor updates to condition monitoring and manual.
- Autumn 2011: unattended depot trials.
- Spring 2013: unrestricted approval received.
Project Organisation for NR Acceptance – Lots of holes in the dotted line for information to pass through!

**Bombardier**
- **ET400 NR Acceptance Project Manager**
  - A. Morgan
- **Trials Coordination**
  - L. Chapman
- **Project Engineer**
  - A. Millar
- **Safety Engineer**
  - C. Mackie
- **EMC Engineer**
  - Y. Bocharnikov
- **ISA**
  - R. Brewer

**Network Rail**
- **NR Product Sponsor**
  - D. Weedon
- **Trials Coordination**
  - D. Bardwell
  - S. Walker
- **Acceptance Coordination**
  - D. Bardwell
NR Acceptance Plan (1) – NR specific case required for system EMC and evidence of site trials

Acceptance Plan (This diagram)

Plan for Assessment of Immunity Limits for Rolling Stock Compatibility

Submit to SRP by correspondence

Test Plan for AC and DC Areas – Operational Scope

Rx RSF Immunity Limits

Calculation of Transfer Function

Analysis of Traction Current Spectrum

Review of Compatibility with NR Infrastructure

Site Trial Evidence Operational Scope

Site Trial Critical Review (Operational Scope)

EMC Acceptance Case

Safety Case

Safety Case

Manuals etc.
NR Acceptance Plan (2) - Evidence adds UK application into safety case and develops manuals & training
Managing electrical infrastructure compatibility when introducing a new frequency spectrum
The Problem

The first approval of a new track circuit by Network Rail.

- Must demonstrate that it will not be interfered with by NR infrastructure or existing rolling stock.
- Must demonstrate that it will not interfere with NR infrastructure or existing rolling stock.

NR aim was to produce a generic acceptance to allow installation across the network (including AC, DC and unelectrified lines).

Accepted at start of process that proof existed that, due to the coding design, the probability of wrong side failure of EBI Track 400 due to traction interference is Incredible.

Remaining compatibility proving through desktop assessment, simulation and practical testing.
Traction Interference Immunity

Allowable traction interference = Transfer function through track interface (simulation, multiple cases) × Receiver sensitivity (measured)

4 of 16 track circuit frequencies (E to H) found to have sub-optimal sensitivity in some applications. Coded nature of EBI Track 400 allows these frequencies to be made non-preferred.

Results made freely available to allow train compatibility to be assessed.

Methodology allows future track configurations to be easily assessed.
Rolling Stock Compatibility

Network Rail have responsibility for demonstrating compatibility of new infrastructure with existing rolling stock.

Susceptibility figures from previous slide provide basis for assessment of compatibility. Compatibility demonstration eased by acceptance that wrong side failures of track circuit through traction interference is Incredible. Bombardier are currently defining simplified models of track circuit performance for use in NTR and forthcoming CENELEC standard.

NR and Bombardier worked jointly to address specific concerns from rolling stock operators.
**Wayside Equipment Compatibility**

*EBI* Track 400 must be compatible with equipment in NR/GN/SIG/50014, plus further equipment identified by NR, approximately 125 types in total:


Desktop assessment covered approximately 95% of applications, based on expert knowledge of *EBI* Track 400 EMC case.

Remaining cases required specific testing based on manufacturers’ specifications, carried out by EMC consultant on Bombardier test track.

Some installation restrictions applied regarding co-location of equipment.
Planning and executing field trials of a new track circuit system
## Trial Criteria

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<thead>
<tr>
<th>Component Under Test</th>
<th>Objectives</th>
<th>Success Criteria</th>
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| EBI Track 400 Track Circuit | • Stable track circuit | • The operation of ET400 equipment is not effected by being installed in DC/AC traction territory.  
• No track circuit fails to detect a train.  
• No Receivers or Transmitters fail within the test period.  
• Track circuit current shall be within 5%.  
• Receiver threshold shall be within 1%.  
• Receivers shall achieve output voltage stability within 5%.  
• Transmitter output voltage shall be within 5%.  
• PSU voltage within ±5%. |
Non-electrified Trial – Bere Alston, Devon, installed Feb 2012

Token block with no existing train detection system so straightforward trial certificate. Single train shuttles on line.

Local to Bombardier with easy access.

Good, close, open communications with NR product acceptance and local maintainer.

Shared ownership of trials between NR & BT. BT provided location case and monitored data. NR funded track works and provided possessions.

Logging via MPEC SA380. Helped MPEC develop logger for EBI Track 200 & 400.

Ballast was challenging, but seen as a realistic worst case.

Once track was set up system fully met trial criteria.

Basis for electrified trials.

Still “live” as a local test and demonstration site with minimal impact on rail network.
Site chosen for range of (passenger) rolling stock, including known problem stock.

Axle counter territory.

Required proof that it would not interfere with axle counter, installation ensured no overlap between test wayside equipment and axle counter heads.

Used “track circuit cases” for ease of temporary installation.

Compared with axle counter repeat relays in logger to confirm trains detected.

Used MPEC logger with GSM link for remote condition monitoring.

Monitored over 4176 hours, system fully met trial criteria.
AC Trial – Rugby, installed Feb 2013

Site chosen for wide range of passenger and freight stock.

Axle counter territory.

Minor updates had been made to receiver SIL0 (monitoring) functionality, so trial was also used to functionally prove these updates.

Compared with axle counter repeat relays in logger to confirm trains detected.

Intention was to measure interference currents. Complex bonding made this unfeasible.

Monitored over 1968 hours, system fully met trial criteria.
Summit Tunnel – Trial installed Feb 2012

Non-electrified installation.
Wet tunnel with reed track circuits.
Long feed length of EBI Track 400 gave external access for ease of maintenance.
12 hour over and back proving trial (c.f. 7 week axle counter overlay trials), followed by full installation on line by line basis.
Failure rate reduced from c. 1 per week for reed track circuits to none for EBI Track 400.
Final thoughts
Final Thoughts

Trial certificate for operational use in Summit Tunnel and South Bermondsey (Thameslink) received August 2013.

Unrestricted NR certificate received 1st February 2014.

Achieved through:

- Realistic trials without impacting rail network: “The railway is NOT a test bed”
- Close, open relationship between Network Rail and Bombardier Transportation.
- Clear acceptance strategy formulated by all parties, kept under continuous review.
- Use of all available expertise, e.g. rolling stock knowledge within Bombardier Transportation, maintainers’ experience for track trials.

- Pragmatic, flexible approach:
  - End goals must be set, clear, understood and agreed by all.
  - The route to get to these goals can be adapted as circumstances arise.

Thank you for listening!

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