Mega Watts – Milli Amps

The contrasting worlds of Traction and Signal engineers
Why the need for testing?

• Prove compliance to standards
• Vehicle will not generate a wrong side failure of the signalling system
• Vehicle will not generate a right side failure of the signalling system
• Vehicle will not ‘lock up’ a particular type of digital track circuit
What Tests are conducted?

- **Static tests**
  - Static testing such as vehicle outline, signal sighting, wheel profile
  - Axle resistance measurements etc

- **Dynamic tests**
  - Vehicle detection tests - known as shunt testing
  - Signal Interference
    - Testing for conducted currents & Close up (near) effects
• EN50238 provides a good outline of the test process
  – Requires the train detection system to be characterised
  – Requires the traction power system to be characterised
  – Outcome of testing is to characterise the rolling stock
• Nominates interested parties, roles and responsibilities
• Details an acceptance methodology
Characterisation of the Train Detection system

• For each track circuit class, detail
  – Maximum permitted levels of interference currents
  – Maximum permitted residual voltage (under train occupancy)
### Characterisation of the Train Detection system (continued)

<table>
<thead>
<tr>
<th>Track circuit type</th>
<th>Test point</th>
<th>Unit of measure</th>
<th>Maximum train shunt or zero feed value (see note 1)</th>
<th>Advise responsible signal engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC with shelf relay</td>
<td>relay coil</td>
<td>V dc</td>
<td>&lt;30% of drop away test value</td>
<td>&gt;10% of drop away test value</td>
</tr>
<tr>
<td>DC with plug-in relay</td>
<td>R1/R2</td>
<td>V dc</td>
<td>&lt;30% of drop away test value</td>
<td>&gt;10% of drop away test value</td>
</tr>
<tr>
<td>50 Hz ac</td>
<td>control terminals</td>
<td>V ac</td>
<td>&lt;30% of drop away test value</td>
<td>&gt;10% of drop away test value</td>
</tr>
<tr>
<td>UM 71 CSEE</td>
<td>receiver R1 R2</td>
<td>mV ac (with filter)</td>
<td>&lt;90</td>
<td>&gt;30</td>
</tr>
<tr>
<td>ML Ti 21</td>
<td>input resistor (1 ohm) terminals</td>
<td>mV ac (with filter)</td>
<td>(mV x gain) &lt;100</td>
<td>(mV x gain) &gt;35</td>
</tr>
<tr>
<td>WB&amp;S FS2500</td>
<td>receiver monitor</td>
<td>mV ac</td>
<td>&lt;400</td>
<td>&gt;135</td>
</tr>
<tr>
<td>HVI Jeumont Schneider</td>
<td>receiver terminals</td>
<td>V dc (with integrator)</td>
<td>&lt;100</td>
<td>&gt;35</td>
</tr>
<tr>
<td>HVI Jeumont Schneider</td>
<td>C+/C1 (RVT-600) 3/C1 (BRT-CA2)</td>
<td>V dc (with integrator)</td>
<td>&lt;100</td>
<td>&gt;35</td>
</tr>
<tr>
<td>USS Microtrax coded track circuit</td>
<td>slave end - track interface panel terminals</td>
<td>mV dc</td>
<td>&lt;80mV (pulse)</td>
<td>&gt;50mV (pulse)</td>
</tr>
<tr>
<td>WB&amp;S FS2600</td>
<td>receiver monitor</td>
<td>mV ac</td>
<td>&lt;500</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Safetran PSO 4000 audio frequency overlay</td>
<td>signal display</td>
<td>receiver signal level</td>
<td>&lt;40 (train shunt) &lt;20 (zero feed)</td>
<td>&gt;20</td>
</tr>
</tbody>
</table>
Interested parties, roles and responsibilities

Railway infrastructure authority No.1

Compatibility case

Railway infrastructure authority No.2

Rolling stock operator

Acceptance certificate

Accepting body

Industry (signalling)

Laboratory

Industry (rolling stock)

Laboratory

Rolling stock operator
Acceptance process breakdown

- Planning
  - Cross acceptance analysis
- Execution
- Evaluation
- Approval
Planning pathway

• Consider the value / potential for cross acceptance from a previous test program
  – Shortens the local test program
  – Testing only type and configurations not included in the original compatibility case

• Comprehensive test plan
Analysis for Cross Acceptance

- Identical vehicle
- Comparable railway
- Common specification requirement
- Auditable results
- Reputable performance
- Potential conflict due to philosophical differences in train testing versus signals’ testing
Planning

• Establish the aims of testing
• Types of tests to be conducted
  – Degraded modes of operation
• What track circuits are to be tested
  – Selection of a test site
• Possession planning
• Network access
• Test equipment to be used → test schematics
Test Schematics

<table>
<thead>
<tr>
<th>TEST</th>
<th>LOCATION</th>
<th>TRACK</th>
<th>FREQ</th>
<th>TIP</th>
<th>CIRCUITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>UP EAST HILLS</td>
<td>CSEE T1</td>
<td>EH16.56BT - 2600Hz</td>
<td>850</td>
<td>Q50 T01 T02</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>EH14AT - 2000Hz</td>
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<tr>
<td>A0</td>
<td>ALSTOM A In Rail</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>ALSTOM B Up Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>EH16.56BT R1-R2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>EH16.56BT Rail - Rail</td>
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<tr>
<td>A4</td>
<td>ALSTOM C In Rail</td>
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</tr>
<tr>
<td>A5</td>
<td>ALSTOM D Up Rail</td>
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<tr>
<td>A6</td>
<td>EH14AT R1-R2</td>
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<tr>
<td>A7</td>
<td>EH14AT Rail - Rail</td>
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</tr>
<tr>
<td>D0</td>
<td>EH16.56BT Relay</td>
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</tr>
<tr>
<td>D1</td>
<td>LASER 1 (EH16.56BT)</td>
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<td></td>
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</tr>
<tr>
<td>D2</td>
<td>EH14AT Relay</td>
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<td></td>
</tr>
<tr>
<td>D3</td>
<td>LASER 2 (EH14AT)</td>
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<tr>
<td>D4</td>
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<td>D6</td>
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<tr>
<td>D7</td>
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</tr>
</tbody>
</table>
Test Schematics (continued)
Execution

• Work site protection arrangements in place
• Connection of test equipment
• Booking out of order signal equipment
  – Trainstop suppression
  – Clipping of points
• Conduct the necessary tests
• Disconnect test equipment
• Restore and certify signalling equipment
• Determine results against the pass / fail criteria
• Ensure the results are valid
• Look for any non conformances
• Manage the non conformance
• Peer Review → Gateway to approval
Results
Managing Non Conformances

• Identify the cause
• Identify the boundaries of the event
  – Magnitude – worst case needs to be considered
  – What frequencies are being produced
  – What is the duration of the event
  – How often does it occur
• Consider the impacts to the safe operation of the track circuit
  – Demonstrate by both theoretical analysis and bench tests
• Develop the compatibility case
Approval

• Test results submitted, peer reviewed with recommendation / approval
  – Interim approvals / briefing notes
    • Per track circuit class / route
  – Route clearance – restricted approval
  – Must detail versions of traction control and related software

• Accepting body reviews test reports and if in agreement signs off on the compatibility case and approves the vehicle to run
• Untested Vehicles must be assessed for the potential to interfere with the signalling system
• Approval to run on a network is dependent on the vehicles ability to be protected by the signalling system
  – Hauled dead attached to test sites
  – Block worked – self powered
  – Restricted operation / route clearance
  – Unrestricted operation → trial period → revenue service
Test Equipment

- Gauges & simple measurement tools
- Low Ohms meter
  - Alternative is a 4 – wire test method
- Multimeter (with recording function)
- Chart recorder (accurate at frequencies of interest)
- Transducers – coils, transformers, current shunts
- Multi channel Analogue to Digital recorder
  - User interface
  - Validated processing system