Improving track circuit actuation performance at the wheel/rail interface

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Overview

Track circuit actuator interference devices (TCAID) have been effective in preventing wrong side track circuit failures caused by railhead contamination. However, TCAIDs have a variety of reliability issues that can give rise to track circuit right side failures.

Approximately 20 options for alternative methods of train detection using a track circuit overlay have also been identified and considered, by taking input from relevant technical and domain experts, and a number of technology providers. The research discusses the results of applying an evaluation of these and identifies five options that are considered to be worthy of further study.

Recommendations are made to improve the reliability of TCAIDs and to assist the maintainers in the application of good practice throughout the network.

Aims

On behalf of the Train Control Technical Sub-Group, which reports to the Vehicle/Train Control and Communications System Interface Committee, the key aim of this research was to identify potential ways of maintaining reliable train detection where there is heavy rail contamination, such as leaf mulch, sand or other contaminants. Ideally, it was suggested that any additional or alternative train detection method should not rely on the train being fitted with a track circuit assister (TCA), which is currently needed to support the operation of a TCAID, and that this should be reliable and cost-effective to develop, install, and maintain.

The implementation of European Train Control System (ETCS) Levels 2/3 is likely to obviate the need for an additional or alternative train detection method for vulnerable areas, so any proposed solution might only be required for a limited time.
It was suggested that an alternative train detection method could be:

- A replacement for the TCAID, or maybe a TCAID variant
- A new type of train detection overlay in addition to the track circuits
- An alternative train detection approach to track circuits (such as replacing the track circuit)

In addition to technology for train detection, it was suggested that options associated with maintaining a clean railhead should be considered, including enhanced vegetation management, and rail head cleaning.

Method

The TCAID asset performance review was based on information extracted from Network Rail's ELLIPSE and Failure Management System (FMS) together with interviews with selected Network Rail maintenance staff. The results are defined in the TCAID Asset Performance Review report.

Train detection options identification was performed by holding a workshop that brought together relevant stakeholders, industry experts and representatives from suppliers outside the rail industry to facilitate a 'blue skies' discussion and agree possible alternative train detection options. This was supplemented by technical searches and direct contact with technology suppliers.

To facilitate the evaluation and ranking process, a bespoke ranking spreadsheet was designed and applied in combination with an assessment of likely costs for each option. In addition, the output from the TCAID asset performance work was used to inform the process.

Another key element of the methodology applied was the use of a second workshop, with a subset of stakeholders representing the areas of railway signalling, train operator, signalling maintenance, and system design and development. The workshop output was used to enhance the spreadsheet tool and led to the development of a shortlist of options to be taken forward for further work. The full analysis and evaluation is detailed in the second deliverable, the Options Review and Evaluation Report.

Findings

Findings are grouped and discussed in three sub-sections:

- TCAID asset performance review
- Train detection options identification, evaluation, and ranking
- Maintaining a clean railhead
TCAID asset performance review

The first stage of this research was to assess the current TCAID asset condition and quantify, as far as practicable, TCAID performance. The conclusions are:

- The estimated current GB TCAID population is between 2700 and 3300 units.
- The cost of TCAIDs, including routine maintenance costs (estimated at £650,000 per year), faulting costs (estimated at £10,000 per year) and costs due to associated delay minutes (estimated at £85,000 per year), is about £745,000 per year.
- Based on formal records and feedback from maintainers, it is recognised that TCAIDs are effective in preventing track circuit wrong side failures. However, the reliability of the TCAID product and the maintenance costs remain a major concern to the maintainers.

The following proposals resulted from this first stage of the research:

1. Network Rail and the relevant TOCs further investigate the issue of TCAID crosstalk (where a train activates a TCAID on an adjacent line).
2. Network Rail survey the TCAID sites and advise the maintainers on the compliance or otherwise of the installations with the TCAID standard.
3. An upgrade from the Mk1 and 2 TCAID testers to the Mk3 version, and provision of a TCAID relay monitor.
4. That sites with significant numbers of wrong side failures (WSF) should be re-evaluated for additional TCAIDs or other leaf fall mitigation measures.
5. To ensure that required information, such as train head codes, train class, and operating status of the TCAs, is consistently recorded in the Network Rail FMS for all TCAID failures.

Train detection options, identification, evaluation, and ranking

Around 20 alternative train detection overlay options were initially identified, using input from stakeholders, sensor suppliers and other industry experts. A shortlist of five options was produced:
• TCAID redesign for continued use as a distributed train detection overlay system.

• Electronic treadles at the beginning and end of a section (this includes axle counters as essentially the same technology).

• A smart track circuit based on the existing level crossing predictor design (resonant/inductance).

• A form of alternative point train detection system other than a treadle - sub-options include a piezo electric pad and magnetic detection device.

• A long cable detection device where magnetic loop technology is the favoured option, although further development of the Train Actuator Detector (TAD) (dependent on the train being fitted with TCA) and consideration of the piezo electric cable (even as a lower ranked option) should not be entirely discounted.

The following proposals resulted from this concept analysis for improving train detection:

1. For a short-term solution, make the minimum modifications necessary to the TCAID to enhance current performance and reduce maintenance. Ensure compatibility with the existing TCAID such that the new device can be used as a direct replacement.

2. Investigate the practicalities associated with the use of timers or sequencers with point detection devices such as treadles. The focus should be on reducing line side cabling as far as practicable, and assessing whether a simple timer solution could in fact provide sufficient mitigation in the majority of applications, or whether a sequencer is the only option. If the results of this investigation are positive, continue to investigate which point detection technology offers lowest cost with low risk development.

3. Investigate, with input from maintenance staff, how cabling in the four foot could be made robust to minimise vandalism and reduce susceptibility to damage during track maintenance works. If the results of this investigation are positive, continue to investigate which detection technology offers lowest cost with low risk development.

4. Carry out a more detailed analysis on the viability of a smart track circuit.
5 Compare results from recommendations 2, 3 and 4. Determine the best option as a replacement for TCAID and develop product requirements for single option development.

**Maintaining a clean railhead**

Vegetation management and use of rail cleaning vehicles remains part of Network Rail's approach to managing the leaf fall problems, both for vehicle traction and vehicle detection. However, no new practical ideas to enhance the approaches currently taken have been identified by this research.

**Deliverables**

The following deliverables have been provided by this research:

1. **TCAID Asset Performance Review** - This report focuses on recording an investigation concerning the current performance of the TCAID. The investigation addressed the following issues regarding the current status of TCAIDs on Network Rail:
   - Establishing the current TCAID population and condition
   - An analysis of route-specific failures associated with TCAIDs
   - An analysis of the failure modes of TCAIDs
   - A statistical analysis of failure rate
   - Delay minutes and costs
   - Maintenance costs and concerns
   - Success in preventing wrong side train detection failures

2. **Options Review and Evaluation Report** - This report investigated and evaluates new methods and techniques of improving train detection when the wheel/rail interface is contaminated, and considered:
   - Train detection technologies other than TCAIDs that could be used as secondary systems to overlay and improve the performance of existing track circuits
   - The potential replacement of track circuits by another high integrity train detection system which is less susceptible to rail contamination
   - Alternative solutions for maintaining the railhead in good condition and free of contamination

Copies of the deliverables from this project have already been provided to Network Rail and are available to RSSB members on request.
Next Steps

The outputs of this research have been considered by Network Rail, and members of the TCTSG and V/T C&C SIC. In view of the business case summary which was found to be strongly in favour of adopting a minimal TCAID Mk1 to Mk2 replacement approach, Network Rail has now identified that this is the course of action that they intend to pursue; all other options being considerably more expensive. This leaves unanswered questions relating to the potential need to continue to fit TCAs onto trains solely to operate TCAIDs (following favourable analysis on related research project T579 allowing trains to operate with a failed TCA), as an issue for the railway industry to address in the medium-term. The Train Control Technical Sub-Group has agreed to prepare a Project Closure report on this basis.

The benefit of this research is that it has provided the railway industry with visibility of a number of viable alternatives to support TCAID replacement in the short-, medium- and potentially longer-term, if an industry-wide business case or future strategic initiative is found to be able to justify this. The research has also identified areas for improvement in the existing TCAID design and maintenance processes, which if implemented could result in significant cost saving to Network Rail. Network Rail has agreed to look into these.

Contact

For more information please contact:

Head of Engineering Research
R&D Programme
RSSB
enquirydesk@rssb.co.uk