

# Special Investigation



## **RAIB review of the railway industry's investigation of an irregular signal sequence at Milton Keynes, 29 December 2008**

### **Summary**

On 28 December 2008 a serious signalling irregularity occurred at Milton Keynes Central station on the West Coast Main Line. The driver of a passenger train observed a signal change from red to green, although the track beyond the signal was occupied by another train. There were no injuries or damage in this incident.

The incident was investigated by the railway companies which were involved, in accordance with railway industry standards and procedures. The Rail Accident Investigation Branch (RAIB) was subsequently asked (by one of the railway companies) to review the results of the industry investigation.

This report describes the original incident, the industry investigation, and the RAIB's review of that investigation. The RAIB concluded that although the industry investigation report provided a good account of the events and made some useful recommendations, it did not address in detail many of the underlying factors which had led to a potentially very serious situation.

The RAIB has identified eleven significant findings. These, together with Network Rail's subsequent response, are described in this report. The RAIB believes that the actions already taken and committed to by Network Rail and the Office of Rail Regulation address the issues identified in the RAIB's review.

There are a number of lessons to be learned from these events, and this report is published to highlight these to the railway industry as a whole.

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 2005.

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## The incident

- 1 As part of the West Coast Route Modernisation (WCRM) project, new signalling was commissioned in the Milton Keynes area on 28 December 2008. At 23:01 hrs on the following day, the driver of train 1A74, the 20:48 hrs Virgin Trains service from Liverpool to London Euston, reported that he had observed an irregular signal sequence while his train was standing at signal TK9740 on the Reversible Fast line at Milton Keynes Central station.
- 2 When train 1A74 arrived at Milton Keynes, signal TK9740 was displaying a red aspect. A train, 1A75 21:15 hrs Manchester to London Euston, then passed on the Up Fast line. The points leading from the Reversible line to the Up Fast changed, routing 1A74 onto the Up Fast, and signal TK9740 then changed to a green aspect while 1A75 was still visible on the line ahead (figure 1). Shortly afterwards signal TK9740 changed to a single yellow aspect.
- 3 The driver of 1A74 reported this irregular sequence to the signaller on the Bletchley workstation at Rugby Signalling Control Centre. After recording the details, the signaller allowed 1A74 to proceed, and then took the Reversible Fast line out of use in the up direction pending investigation of this apparent wrong side failure of the signalling system.

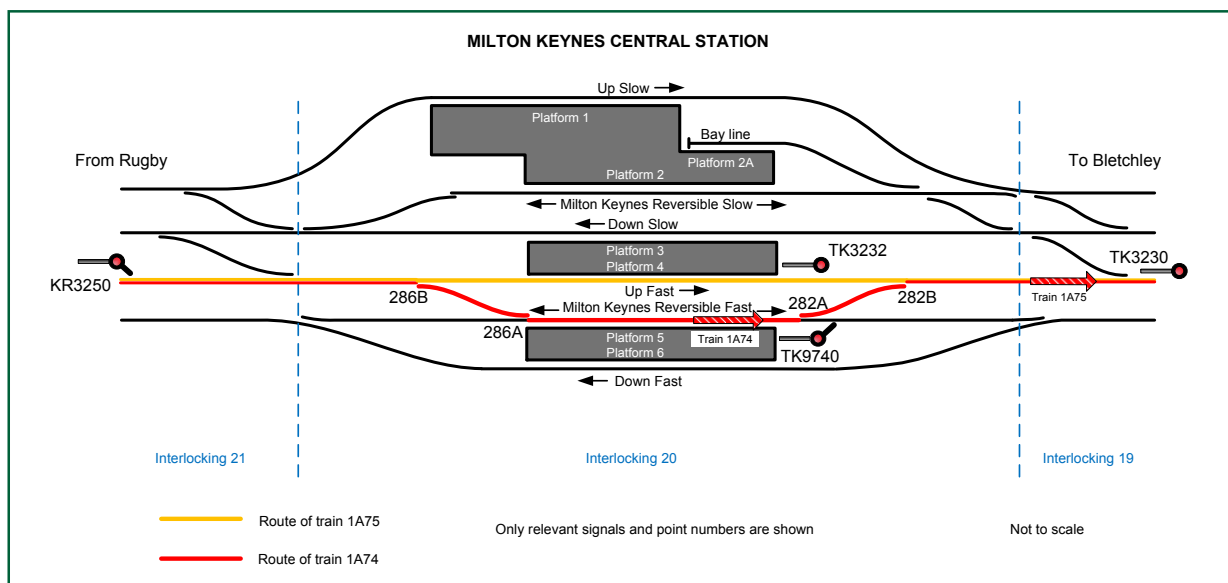


Figure 1: diagram of incident

- 4 WCRM project staff investigated the reported incident during the night of 29/30 December 2008, and discovered that there was missing data in the cross-boundary interface between two interlockings covering the Milton Keynes station area. The Solid State Interlocking (SSI) data was rectified and tested and the route was brought back into use on 4 January 2009.
- 5 The incident was not reported to the RAIB at the time, as it was not immediately reportable under regulation 4(1) of the Railways (Accident Investigation and Reporting) Regulations 2005 (the RAIR Regulations). The incident was later recorded in a monthly Network Rail document entitled "Safety and Environment Assurance Report". This document is routinely sent to the RAIB for information on safety events and trends, and is used by Network Rail to notify RAIB of events that are reportable under Regulation 4(3) of the RAIR Regulations.

- 6 Such incidents are subject to investigation by railway industry parties under the requirements of Railway Group Standard GO/RT3119 'Accident and Incident Investigation'. Consequently, a 'Formal Investigation' was established by the involved industry parties. This was led by the infrastructure manager, Network Rail, and involved part-time observers from two train operating companies, Virgin Trains and London Midland.

### **The Formal Investigation report**

- 7 The Formal Investigation reported on 13 March 2009. It identified that the immediate cause of the incident was that the occupation status of the relevant axle counter sections was not included in the SSI data associated with the aspect controls for signal TK9740 for the route from TK9740 to signal TK3230 on the Up Fast line. The design, checking and testing work had been carried out by a main contractor (Signalling Solutions Limited) and two sub-contractors working within the structure of the WCRM project.
- 8 This signal and route had been commissioned a short time before the incident. The Formal Investigation report identified that the underlying causes of the incident were:
  - An error in the data design due to the omission of data in the data construct for the control of the aspect of TK9740 signal, caused by a change to the cross boundary telegram information (made by the designer for interlocking 19), the consequences of which were not thoroughly understood by the designer for interlocking 20.
  - Failure of the data design checking process to identify the omission of data resulting from a late change in the data construct for the control of the aspect of TK9740 signal, due to a lapse by the design checker.
  - Failure of the data testing process to identify the omission of data in the data construct for the control of the aspect of TK9740, due to a lapse by the principles tester.
  - Issues of professional competence, resource planning and management.

### **The RAIB review of the Formal Investigation**

- 9 Following the issue of the Formal Investigation report Virgin Trains made a request to RAIB to investigate the incident. Following its preliminary review of the report, and after discussion with the parties involved, the RAIB decided that it would carry out an in-depth review of the Formal Investigation. As part of this review, the RAIB carried out further investigations of the incident and the railway industry investigation process. In doing this, the RAIB attempted to establish whether the industry investigation had identified all relevant risk areas and actions that should be taken as a result.

- 10 The RAIB reviewed the report, and carried out further examination of documents and interviews with staff of Network Rail and its contractors to clarify aspects of the incident and the investigation. During the review, the RAIB maintained contact with the relevant industry parties and the Office of Rail Regulation (ORR) regarding the emerging findings.
- 11 Network Rail and Signalling Solutions Ltd freely co-operated with the RAIB's review.

## Conclusions of RAIB's review and actions proposed by Network Rail

- 12 The Formal Investigation report provided a reasonable account of the events leading to the wrong side failure, a good description of the way the original error occurred and how it was that the correction of this error resulted in the introduction of further incorrect data. The report had also made a number of useful recommendations (and 'local actions') that addressed a number of the issues identified. These recommendations were generally focused on avoiding one or more of the direct causes of the various errors and omissions. The areas covered included:
  - improvements to process and documentation;
  - re-briefing areas of non-compliance;
  - measures to clarify roles and responsibilities; and
  - measures to address competence and supervision issues.
- 13 However, the Formal Investigation did not address in any detail many of the following underlying management factors which had led to a method of working that was not commensurate with the preparation of safety critical application data<sup>1</sup>. It neither examined in any depth Network Rail's overarching risk control measures for SSI data preparation nor attempted any comparison with established good industry practice. This omission was significant because the rigorous application of established principles of engineering safety management would have had the potential to have prevented, and/or detected, the problems that occurred.
- 14 The RAIB wrote to Network Rail on 23 April 2010 to outline the above conclusions and report a number of detailed findings relating to the adequacy and effectiveness of the industry's investigation process and the resulting report. Each of these findings is set out in the following pages (marked in red).
- 15 Following detailed technical discussions and correspondence with the RAIB, Network Rail committed itself to a number of actions in response to the RAIB findings. These are also set out in the following pages (marked in blue).

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<sup>1</sup> Data input by the designer of a new application of SSI (eg a new signalling scheme). This data will be specific to each new application.

## **RAIB findings following its review of the Formal Investigation and Network Rail's response**

### Finding 1 of the RAIB's review

The report did not consider whether Network Rail's instructions provided sufficient guidance on when changes to the design of data should necessitate a repeat of previously completed checking or testing (ie what is the policy for regression checking?).

#### Network Rail's action in response to finding 1

Network Rail will provide further guidance/instruction on when re-checking/re-testing is required and when there is a need to completely re-check/re-test the data. Both the scope and scale of the changes will be considered. Consideration will also be given to the degree of reliance on individual judgement to assess the scope and adequacy of the testing process (taking into consideration industry best practice provided within the Yellow Book and EN50128) and guidance/instruction will be provided where necessary.

### Finding 2 of the RAIB's review

The report made no recommendations related to the lack of a clear specification/definition of interfaces between different interlockings within a single scheme.

#### Network Rail's action in response to finding 2

Network Rail will amend the Data Preparation Guide to include a requirement to produce an 'interface document(s)' during design (and that this document is independently checked and approved) to specify cross-boundary functions (including between Route Relay Interlockings (RRI) and SSI (or equivalent)) or internal boundaries between SSIs.

### Finding 3 of the RAIB's review

The report did not consider why the newly commissioned signalling was allowed to be used post incident and before the extent of the wrong side failure was fully understood.

#### Network Rail's action in response to finding 3

Network Rail will conduct a review to determine if its post-commissioning incident and escalation processes are sufficiently robust. In particular what actions could be taken if a similar problem were to be identified with a new interlocking, and the route of escalation to the project team.

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#### Finding 4 of the RAIB's review

The report did not examine whether the means of entering SSI application data generated an unacceptable risk of designer error.

#### Network Rail's action in response to finding 4

Network Rail will consider whether greater onus at the tender evaluation stage should be placed on:

- what design, data entry and checking tools the suppliers are using;
- the supplier's assurance regime; and
- the competence of staff involved.

#### Finding 5 of the RAIB's review

The report contained no comparison of Network Rail SSI data preparation and testing standards with recognised good industry practice (eg the Yellow Book and BS EN 50128) for signalling software which is required to be designed to a high level of safety integrity.

#### Network Rail's action in response to finding 5

Network Rail states it will undertake a comparison of the processes required for SSI data preparation and testing with the guidance provided within the Yellow Book and EN50128. This review will look at both the processes and people involved. The comparison will also include consideration of opportunities to be gained through increased automation in the verification of SSI data, including full regression testing where appropriate, from both an efficiency and reliability perspective.

#### Finding 6 of the RAIB's review

Existing railway standards governing the safety assurance of safety critical appliance data place a high degree of reliance on individual judgement to assess the scope and adequacy of checking and testing. This was not addressed.

#### Network Rail's action in response to finding 6

Network Rail responded that its processes require the designer or tester in charge to be consulted on the impact of modifications, and that the investigation noted that the checkers had data search tools available to them which they did not use. Further guidance on the use of data search tools by checkers has already been provided.

*continued*



### Finding 7 of the RAIB's review

Matters related to safety approvals were not addressed. In particular:

- the depth and quality of the evaluation that was carried out by Network Rail's safety review panel (known as the Competent Independent Panel (CIP)); and
- the quality and appropriateness of submissions to the panel.

### Network Rail's action in response to finding 7

Network Rail will undertake a review of the CIP<sup>2</sup> process in respect of the quality/timeliness of submissions made to the CIP and depth/quality of the review the CIP undertakes. In particular this will specifically consider:

- The completeness and quality of risk assessments that were carried out in support of the design and testing process (client, project, delivery team and contractors);
- The adequacy of the risk management systems established by the client, project, delivery team and contractors; and
- The adequacy of documentation/records and how the end configuration is recorded.

### Finding 8 of the RAIB's review

There was no examination of matters related to the completeness and quality of risk assessments that were carried out in support of the design and testing process.

### Network Rail's action in response to finding 8

Network Rail will undertake a review of the completeness and quality of risk assessments that were carried out in support of the design and testing process (client, project, delivery team and contractors).

### Finding 9 of the RAIB's review

The report did not examine the adequacy of the risk management systems established by the client, project, delivery teams and contractors (including the associated contractual arrangements).

### Network Rail's action in response to finding 9

Network Rail will undertake a review of the adequacy of the risk management systems established by the client, project, delivery team and contractors.

Network Rail will also consider providing guidance on when an investigation remit should include a specific objective to examine proactive assurance activities, such as the role of the independent safety review panel/person.

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<sup>2</sup> The function of competent independent safety review can be undertaken by either a suitably qualified person or a panel of experts.



### Finding 10 of the RAIB's review

The report did not address why the quality management process did not detect a serious breakdown of the prescribed management system (in particular, the poor quality of data submitted to checkers and direct submission of data to testers).

### Network Rail's action in response to finding 10

Network Rail will undertake a review of its assurance processes applied to such processes. In particular:

- In the case of Milton Keynes were the assurance processes adequate?
- What levels of assurance do Network Rail's contracts typically require for such schemes/projects?
- What level of assurance is required and applied by contractors?
- Whether the level of assurance that is applied is proportional to the potential risk involved?

### Finding 11 of the RAIB's review

The potential role for automatic tools as a means of verifying that SSI data entered does not breach a signalling principle, thereby improving the reliability of data preparation and easing the reliance on manual processes during checking/testing, was not considered.

### Network Rail's action in response to finding 11

Consideration will be given to the opportunities to be gained through increased automation in the verification of SSI data, including full regression testing where appropriate, from both an efficiency and reliability perspective.

## **Other incidents**

- 16 During its review of the Formal Investigation, the RAIB became aware of other incidents that occurred between 2005 and 2009 in which SSI data errors had not been detected before interlockings were commissioned, both in the WCRM project and elsewhere on the national rail network.
- 17 These other incidents that have come to the RAIB's notice occurred at Rugby during the WCRM project, and at Glasgow Central, Peterborough and Shenfield following other signalling work. These other incidents reinforce the need for Network Rail to address the issues identified by the RAIB.

## Future actions

- 18 The ORR has indicated that it is already engaging with Network Rail to address some of the issues with safety verification arrangements arising from the incidents at Milton Keynes and Glasgow and is auditing the effectiveness of Network Rail's change control process, including that of the safety verification of changes to signalling.
- 19 Each of the actions that Network Rail has proposed to take in response to the RAIB review (listed at paragraph 15) has been submitted to Network Rail's National Recommendations Review Panel. All were accepted for implementation. In each case a lead manager has been nominated and a target date for implementation established. Network Rail has indicated that it will table this report at its Tactical Safety Group (a senior level safety meeting) to review where the learning from Milton Keynes could be applicable to other engineering disciplines.
- 20 In discussions with the RAIB, the ORR has indicated that it recognised the significance of the issues that had been identified by the RAIB's review, and proposed to monitor Network Rail's implementation of the actions that the company has committed itself to take.

## The Formal Investigation

- 21 The relevant Railway Group Standard (ref: GO/RT3119), and the associated Network Rail processes, mandate that all involved railway undertakings should be invited to participate in Formal Investigations. The process also permits (but does not mandate) the appointment of an independent person to advise the investigation panel on technical matters or to lead the investigation.
- 22 The Formal Investigation into the incident at Milton Keynes was led by a Network Rail Senior Programme Manager. The team members included technical specialists from within Network Rail and observers representing the two Train Operating Companies (TOCs) most closely involved. Neither of the observers had detailed technical knowledge of railway signal engineering, and associated software issues (although they were familiar with signalling systems from the perspective of a train driver), because the TOCs do not have staff who are qualified in this discipline.
- 23 The remit for the Formal Investigation was the subject of consultation with all the parties involved and was subsequently approved on 13 January 2009. This remit included the requirement to investigate the 'immediate and underlying causes' of the incident. However, the listing of specific objectives for the investigation did not include any consideration of the wider engineering management issues such as the processes for safety verification and quality assurance.
- 24 Although compliant with the requirements of the relevant standards, the scope of the remit and the constitution of the investigation team appear to have led to an apparent lack of independent challenge and insufficient focus on the wider engineering management issues. It is notable that the option of appointing an independent person with sufficient authority to lead the investigation was not adopted.

- 25 At no point during the investigation was there a request by any party that the remit be reviewed or extended (this is allowed for in GO/RT3119).
- 26 Given the above factors, the report neither fully addressed the underlying factors nor made substantial recommendations in these areas.
- 27 The RAIB has previously raised its concerns relating to the railway industry's investigation process with the ORR. The ORR has undertaken to review the issues raised by the RAIB.

## Lessons learned

- 28 The RAIB has kept Network Rail informed of its findings throughout the review process. This summary of the key findings of the RAIB's review and the actions that Network Rail is proposing to take is now issued to highlight the general lessons for the rest of the railway industry, in particular:
  - the need for investigations to provide for challenge by a person(s) with sufficient independent and technical expertise (**paragraph 24**);
  - the need for railway industry investigations to consider the underlying factors that may have influenced the causes of an event or permitted an unsafe condition to arise (**paragraph 25**);
  - the importance of establishing investigation teams with the necessary technical expertise, independence and authority to press for consideration of underlying management issues and the suitability of existing standards (**paragraph 24**);
  - the need for investigations to consider the way in which the railway recovers from serious signalling irregularities involving newly installed interlockings (**finding 3**);
  - the need to correctly apply safety verification processes to the preparation of safety critical application data (**findings 1 and 5**);
  - the need for the clear specification of interfaces between computer based systems (**finding 2**);
  - the need for signalling projects to give careful consideration to the way in which design modifications to software and safety critical application data will be executed, checked and tested (**findings 4 and 6**);
  - the need for assurance processes (including audit and approvals) that address the particular risks associated with software and safety critical application data (**findings 7, 8, 9 and 10**); and
  - the potential role of automated data entry and/or checking systems as a means of reducing the risk of human error leading to an unsafe outcome (**finding 11**).

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