

## **Summary of position in respect of the 29 recommendations made by RAIB in association with the derailment at Grayrigg on 23 February 2007 (as at 8 April 2011)**

### **Introduction**

1. One person was fatally injured and 28 people including the train driver were seriously hurt when a passenger train derailed at Grayrigg in Cumbria on 23 February 2007. The Rail Accident Investigation Branch (RAIB) investigated the accident and published its report on 23 October 2008.<sup>1</sup>
2. The report made twenty-nine recommendations. In accordance with the Railways (Accident Investigation and Reporting) Regulations 2005 (the Regulations), twenty-six recommendations were addressed to the Office of Rail Regulation (ORR), the remaining three (numbered 26, 27 and 28) were addressed to another public body or authority.
3. The Regulations require ORR to ensure that recommendations addressed to it, are duly taken into consideration and where appropriate acted upon and a report made to RAIB within 12 months of the publication of its report. To facilitate this, the Regulations enable ORR to direct a recommendation to any person who is in a position to implement it, and this person is under the same obligation; to consider and where appropriate act on the recommendations and report to ORR in a defined or agreed timescale.
4. We have reported to RAIB a number of times since October 2008. This report summarises our most recent report dated 8 April 2011. For completeness it addresses all twenty-nine recommendations.
5. ORR wishes to stress that it has reported to RAIB on the consideration given and action taken only in respect of the RAIB recommendations addressed to it. ORR continues to investigate whether any person or organisation committed any health and safety offences in connection with the derailment. This report should not be read as providing an indication of the conclusions that may be reached by that investigation or of any future enforcement action that may be brought by ORR. Similarly, this report should not be taken as providing an indication of the findings that may be reached at the inquest into the death of the passenger who was travelling in the leading carriage of the train.

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<sup>1</sup> A full copy of the report can be found at:  
[http://www.raib.gov.uk/publications/investigation\\_reports/reports\\_2008/report202008.cfm](http://www.raib.gov.uk/publications/investigation_reports/reports_2008/report202008.cfm)

## **Initial consideration by ORR**

6. Following an internal review of the twenty nine recommendations on 9 December 2008, we directed:
  - (a) Recommendations 1 to 20 inclusive to Network Rail;
  - (b) Recommendation 21 required ORR to consider and act and was managed within ORR;
  - (c) Recommendations 22, 23 and 25 to the Rail Safety and Standards Board (RSSB);
  - (d) Recommendation 24 to Virgin Trains and Angel Trains,
  - (e) Recommendations 26, 27 and 28 were directed to another public body or authority; and
  - (f) Recommendation 29 was addressed to Network Rail but was not directed to them by ORR. The reasoning for this is given in this report.

## **Summary position on status of recommendations**

7. The following recommendations are reported as having been implemented: recommendations 1(a), 1(b), 1(c), 1(d), 7; 8; 9; recommendation 10(b), 12; 14; 15; 16; 17; 18; 19; 20; 21; 22; 23; 24; 25; 26; 27; and 29 (by alternative means). Of these ORR is still undertaking assurance work in respect of recommendations 9 and 14 to ensure that they have been fully implemented.
8. Recommendations 1(e), 1(f) 1(g), 2; 3; 4; 5, 6, 10 (a), 10(c) to 10(i) inclusive; 11; and 13 are still in the process of being implemented. These recommendations are all directed to Network Rail and ORR continues to monitor their progress. ORR will make a further report to RAIB by 28 October 2011 and publish a summary of this.
9. The information contained in this report is up to date at the time of publication. In accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, ORR is required to report to RAIB if it becomes aware that the information previously reported is or becomes inaccurate.

## **Recommendations directed to Network Rail**

10. ORR directed twenty recommendations to Network Rail in December 2008. ORR received Network Rail's initial written submission outlining their actions to meet the requirements of all 20 recommendations on 15 May 2009. The submission lacked sufficient detail and ORR requested further information. This introduced a delay in ORR receiving sufficient information to decide whether the recommendations had been implemented, or were in the process of implementation
11. A high level ORR / Network Rail review group was established to ensure the recommendations received appropriate attention and Network Rail

appointed a National Engineering Recommendations Manager, to manage the process and act as a central point of contact for ORR.

12. Network Rail has created a new post of Switches and Crossings Manager, to coordinate the track and signalling activities at switches and crossings. This post and small team have been instrumental in managing Network Rail's actions to implement recommendation 1 and have provided technical engineering input (both track and signalling) to other recommendations.
13. ORR has challenged Network Rail on all 20 recommendations and by various activities including inspection has verified those recommendations reported as implemented.
14. Recommendations 1, 2, 3, 5, 6, 7 and 8 all refer to switches and crossings (S&C) systems. The RAIB report does not define this term. Network Rail provided a definition of 'S&C system' to ORR on 13 January 2010 as *"the switch panel including the point operating equipment and supplementary drive. The switch panel is the element of S&C that has the highest risks associated with it, the risks associated with the remainder of the S&C, i.e. the crossing and closure rails are very much lower"*.
15. ORR accepted the definition for recommendations 1, 3, 5, 6 7 and 8, but not for recommendation 2. ORR expects the actions to meet recommendation 2 to apply to all types of S&C and to all components because if implemented properly, recommendation 2 should provide information on precursor faults and the frequency of different failure modes and allow suitable design, inspection and maintenance regimes. Outputs from recommendation 2 inform recommendations 1, 4 and 19, making it a particularly significant recommendation.

## Summary of position for Grayrigg recommendations

### Recommendation 1

*The intention of this recommendation is that Network Rail should modify the design of the non-adjustable stretcher bar assembly, including its joints, so that it can withstand normal operational loads (and credible faults) with a safety margin and without excessive reliance on human intervention.*

Network Rail should review its S&C non-adjustable stretcher bar<sup>2</sup> assembly design, so as to understand the relationships between the design, loading, usage, and the inspection and maintenance regimes, and implement any appropriate modifications to the design or the regimes.

The following elements (a) to (f) should be considered to achieve this:

- (a) Define the system level functional and safety requirements for S&C with non-adjustable stretcher bars;
- (b) Determine all of the functions that the non-adjustable stretcher bar assembly is required to deliver for the functional and safety performance of the S&C system, including from traffic, fastenings and operating/motor forces;
- (c) Determine a set of load cases for the non-adjustable stretcher bar assembly, including its rail fastening arrangement. This should include forces which it experiences during both normal and reasonably foreseeable fault conditions. All foreseeable combinations of normal and fault conditions that could exist within the stretcher bar assembly itself, other components and the S&C system, should be considered. This should include, but not be limited to:
  - (i) configurations of S&C on which it is fitted;
  - (ii) traffic usage patterns and track geometries;
  - (iii) manufacturing and installation variations.

The load cases should be established and validated by field measurements, supported by appropriate other testing, modelling and/or calculation.

- (d) Assess the performance of the current non-adjustable stretcher bar assembly against the forces that arise from the load cases.
- (e) If justified by the outcomes of the previous work, modify the current design of the non-adjustable stretcher bar assembly to include an appropriate factor of safety. The revised design should be risk assessed; taking into account the quality and reliability of human intervention in inspection and maintenance (refer also to Recommendation 13).

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<sup>2</sup> A bar that links the two switch rails in a set of switches (set of points) and maintains their correct relationship, e.g. one is open when the other is closed.

- (f) Should measures such as component redundancy or other defence barriers be necessary to achieve the required integrity, the reliability of each redundant element and defence barrier should itself be assessed using the above process.
- (g) Modify the current installation, inspection and maintenance regimes against the requirements determined in element 1(e) so that they are appropriately risk based for the new design (refer also to recommendation 13).

Introduce processes to implement the modified design and modified inspection and maintenance regimes and any associated mitigation measures where justified.

### **Action taken**

Network Rail and ORR agreed that recommendation 1 sets out sequential steps to consider the current design of non-adjustable stretcher bars and as necessary make improvements to that design. To implement this recommendation, Network Rail has made incremental improvements to the design of the current non-adjustable stretcher bar and at the same time is developing a new design.

Elements 1(a) and 1(b)

Network Rail has implemented recommendation 1(a) and 1(b) and has provided evidence to ORR to support this.

Element 1(c)

In the summer of 2008, Network Rail commissioned work to establish a set of load cases<sup>3</sup> for the existing non-adjustable stretcher bar. The results were unreliable, probably because of the number of variable forces found at stretcher bars. Network Rail commissioned further work using a different measuring technique, but this also proved unsuccessful in establishing load case information as envisaged by this recommendation. The work did determine a load above which the stretcher bar fails by buckling rather than by nuts unwinding from the bolts. This information has been used in the specification for the new stretcher bar design.

ORR has accepted it is not reasonably practicable to do further work to identify the load case, but Network Rail should through recommendation 2, ensure an accurate picture of the failure modes and rates at non-adjustable stretcher bars and use this to inform design changes or changes to the inspection and maintenance regimes.

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<sup>3</sup> The specification of the duty under which a product must perform. Can be derived from calculation, analysis and or testing. Commonly the product is validated against the load case to ensure that it is fit for its intended purpose.

#### Element 1(d)

It has been difficult for Network Rail to meet this recommendation as written because of the difficulty in arriving at a meaningful load case from measured data against which to assess the performance of the previous non-adjustable design of black stretcher bar to Network Rail's drawing (ref: RE/PW/55/113A) and the inability of the available test rigs to replicate the loads seen in service. Instead, Network Rail used likely load case data to carry out simplified theoretical and practical analysis of the current non-adjustable stretcher bar and its brackets and fastenings

Network Rail has concluded that the non-adjustable design of black stretcher bar to Network Rail's drawing had:

- an infinite fatigue life when installed into switches that have been set up correctly, with no flange back contact, and correct residual switch opening. However, proper inspection and maintenance is required to ensure that the stretcher bar does not degrade, and fastenings do not become loose.
- increased probability of fatigue failure as dynamic loading increases. This increased dynamic loading can come from flange back contact, or by overdriving the point operating equipment.
- dramatically shortened fatigue life when flange back contact<sup>4</sup> is present.
- fastening design that has an increased risk of coming loose when compared with other types of fastening. The characteristics of the stretcher bar / rail web material increases the possibility of the fastening becoming loose and it will become undone once it is loose.

Network Rail has undertaken to test the existing stretcher bar designs in any test process developed for the new design, this will give comparative information.

ORR accepts that Network Rail has done what is reasonably practicable to meet the requirements of this recommendation, but expects Network Rail to fulfil its commitment to testing the current designs with the test methods developed for the new design.

#### Element 1(e)

Using information from work done prior to the RAIB recommendations and the results of their testing and assessment, required by recommendations 1(c) and (d), Network Rail has made incremental changes to the existing design of the non adjustable stretcher bar. For example, improvements have been made to the fastening arrangements and the metallurgical finish and to the installation, inspection and maintenance regimes.

Comparative testing and outcomes from monitoring faults and failures in service, as required by recommendation 2, may result in further

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<sup>4</sup> Contact between the flange back of a train wheel and a rail.

enhancements to the current design and the supporting inspection and maintenance regimes.

ORR has accepted the qualitative improvements to the current design as being satisfactory in the interim and while a new design is under development.

Network Rail prepared a specification for a new design of stretcher bar and tenders were awarded in December 2009. Subject to successful acceptance trials, Network Rail has reported the new design will be ready for installation in July 2012,

Elements 1(f) and 1(g)

Installation, inspection and maintenance requirements were inputs to the design specification and will be outputs from the design process. These outputs are not available at present. Network Rail has reported they will be available before the new design is at the installation stage.

## **Recommendation 2**

*The intention of this recommendation is that Network Rail should implement processes to gather and analyse data, both in the short term and thereafter, that will enable it to identify and monitor accident precursor events in its S&C. This information can then be used to identify potential problems before they can lead to catastrophic failure, and also to inform the development of process safety indicators (see Recommendation 14).*

Network Rail should implement processes to:

- (a) capture, and record on a single national database, data about component failures, and interventions made during maintenance and inspection activities, for each set of S&C;
- (b) use the data from a) above to monitor failure and intervention rates locally and nationally in the behaviour of S&C components;
- (c) identify precursor faults that might lead to more serious failures; and
- (d) identify those precursor faults where the failure and intervention rates indicate a need to reduce the risk of catastrophic failure.

### **Action taken**

The four elements (a), (b), (c), and (d) of recommendation 2 are interlinked and have been considered together by Network Rail and ORR.

ORR is encouraged by the appointment of an Asset Information Director, but has concerns about the slow progress with this recommendation and is pressing Network Rail to improve the rate of implementation.

Network Rail has improved the capture of data in relation to the components identified as accident precursors in the Grayrigg derailment and this data is now being analysed and is providing useful information about failure modes and failure rates. But this recommendation is wider in scope than the components identified as failing at Grayrigg and Network Rail has further work

to do to develop ways of capturing the full range of data required by this recommendation.

Network Rail has advised December 2011 as the end delivery date. ORR intends to verify the implementation of this recommendation because the outputs are required to show full implementation of recommendations 1, 3, 4, and 19.

### **Recommendation 3**

*The intention of this recommendation is that Network Rail should implement the measures it identifies from Recommendation 2.*

Network Rail should introduce processes to implement any design modifications arising from Recommendation 2 using the principles outlined in Recommendation 1.

#### **Action taken**

Network Rail has provided evidence of effective mechanisms to ensure the results of work arising from recommendations 1 and 2 inform one another. The data so far captured on component failures described in recommendation 2 shows a higher incidence of failures at the front non-adjustable stretcher bar compared to other stretcher bars and this has informed the design specification of the new stretcher bar being developed under recommendation 1.

This recommendation is in progress, ORR is not tracking it separately because of the close links to recommendation 2. Network Rail is due to report on recommendation 2 in December 2011.

### **Recommendation 4**

*The intention of this recommendation is that Network Rail should move to a risk-based regime for the maintenance and inspection of S&C.*

Network Rail should introduce processes that require the adoption of a structured risk based approach when reviewing and enhancing its standards for the inspection and maintenance of all existing types of S&C.

#### **Action taken**

At the time of the derailment, Network Rail was using a Reliability-Centred Maintenance (ROSE) methodology for a limited number of signal assets. ROSE is a structured means of applying an appropriate cyclic inspection and maintenance regime taking into account usage, environment, asset condition, and failure history.

ORR has concerns about the slow progress with extending the ROSE principles within signal assets. ORR has recently engaged an independent reporter to examine the ROSE methodology and the extent of its use in Network Rail. ORR expects the independent report to be available on its website in May 2011.



Network Rail is unable to demonstrate a reliability centred approach to its track asset comparable to ROSE. Network Rail has acknowledged this is because of lack of suitable quantitative data; there is no track equivalent to the Signalling Incident System (SINCS) database. ORR has agreed with Network Rail that this data should become available through outcomes from recommendation 2: the development of tools to record and analyse data about precursors to risk at S&C for both track and signals assets and the outcomes of failure modes, effects and criticality analysis for S&C.

This recommendation is still in progress. Network Rail is due to report to ORR in September 2011 and ORR will provide an update to RAIB by 28 October 2011.

## **Recommendation 5**

*The intention of this recommendation is that Network Rail should, as soon as possible, provide its front line staff with clear guidance on when a defect, fault or failure requires investigating, and the scope of investigation required.*

Network Rail should include in maintenance standards and instructions:

- (a) the circumstances under which an investigation of a defect, fault or failure to S&C systems as a whole or its sub-components is required; and
- (b) definition of the scope of the investigation and other immediate actions to be taken (e.g. temporary speed restrictions, special monitoring) for each situation.

### **Action taken**

Network Rail uses detailed written standards and procedures to provide staff with guidance on how to inspect and maintain switches and crossings. The relevant standards for track staff responsible for inspecting S&C and for signalling staff responsible for maintaining S&C have been up dated and re-issued and these now mandate the circumstances in which faults and defects must be recorded and investigated and what immediate actions should be taken on discovering defined defects.

ORR is currently carrying out inspection work to verify that Network Rail has implemented this recommendation. Our findings will be reported to Network Rail in May 2011 and reported to RAIB by 28 October 2011.

## **Recommendation 6**

The intention of this recommendation is that Network Rail should be able to systematically identify, and rectify, any potential or actual incidence of flange-back contact.

Network Rail should review its processes for S&C examination so that the following are included:

- (a) examination for, and reporting of, signs of flange-back contact; and
- (b) measuring, recording and reporting gauge, free wheel clearance and residual switch opening dimensions at frequencies commensurate with adequate risk control.

### **Action taken**

Following the Grayrigg derailment, Network Rail carried out a series of special inspections to determine how switches and crossings were set up. This work, combined with the requirements of this recommendation, led Network Rail to develop comprehensive instructions for the examination and reporting of flange-back contact, freewheel clearance<sup>5</sup>, track gauge and residual switch opening.

Network Rail uses detailed written standards to provide track and signalling staff with guidance on how to inspect and maintain switches and crossings. In December 2008, a new standard was issued and other relevant standards have been up dated to implement this recommendation.

In 2010, ORR inspection activity found that staff carrying out inspection and maintenance work did not always follow the instructions. ORR made recommendations to Network Rail to secure improvement in staff compliance.

ORR is currently carrying out further inspection work and will report to Network Rail in May 2011 and reported to RAIB by 28 October 2011.

## **Recommendation 7**

*The intention of this recommendation is that Network Rail should provide its front line staff with adequate information on the correct installation, inspection and maintenance of fasteners associated with non-adjustable stretcher bars.*

Network Rail should modify its maintenance instructions to define:

- (a) how staff should initially fit and tighten non-adjustable stretcher bar fasteners;
- (b) how staff should inspect and maintain the fasteners if necessary during subsequent visits, including practical instructions to achieve any required torque;
- (c) when a fastener is considered to be loose taking into account the nut rotation required to achieve the required preload;
- (d) how staff should act in the event of a fastener being identified as loose;

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<sup>5</sup> The dimension between the stock rail and the switch rail on the open switch side. This must be sufficient to allow the wheel on the open switch rail side to pass without contact.

- (e) how staff should record actions taken; and
- (f) how staff should carry out any other actions identified from Recommendation 4.

#### **Action taken**

Network Rail's new standard implemented in January 2009, and referred to under recommendation 6 above has explicit practical instructions to implement parts (a) to (e) inclusive. The briefing material provided to staff required to use the standard reinforced the instructions and requirements.

On this basis, ORR has reported to RAIB that this recommendation has been implemented.

### **Recommendation 8**

*The intention of this recommendation is that Network Rail should provide its front line staff with clear information on permitted residual switch opening dimensions.*

Network Rail should revise its maintenance instructions to clearly specify the value (or range of values) required for residual switch openings, particularly with reference to the maximum permissible value (or range of values) and the frequency at which it must be checked.

#### **Action taken**

This recommendation links closely with recommendation 6. Network Rail has reviewed and revised a number of standards to address this recommendation.

ORR has reviewed the relevant standards and concluded that Network Rail has:

- (a) specified a range of values required for residual switch openings; and
- (b) specified a frequency at which residual switch openings must be checked.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

### **Recommendation 9**

*The intention of this recommendation is that Network Rail should provide its front line signalling maintenance staff with all the information that they need to carry out their work, including secondary documents referred from principal documents, and that its systems provide for checking and recording the actions taken. The information from this system should be readily accessible and usable on or off site.*

Network Rail should review management systems and associated documentation covering the maintenance of S&C systems so that signalling maintenance staff:

- (a) have ready access to all relevant documentation on and off site;
- (b) are reminded on site of all the required maintenance actions;
- (c) positively record that each required maintenance action has been carried out; and
- (d) are subject to regular supervisory checks to verify that actions that are required to be taken have been carried out to the required quality.

### **Action taken**

#### **Element (a)**

Network Rail responded by putting the standards and procedures used by signalling maintenance staff (the signalling maintenance specifications) on to the hand-held data devices used by staff to record maintenance work. This had the benefit of the standards and procedures being more portable than the paper equivalents. It also ensured that staff had access to the latest version of any instruction as documents are up dated automatically.

ORR inspection found staff resistance to the use of the hand-held devices, mostly because of difficulties with consulting documents on small screens and with transferring between documents. Network Rail has made some changes to improve the usability of the devices and has promoted the good practice in using the device by an instructional DVD.

#### **Elements (b) and (c)**

Network Rail argued that their current work scheduling tool Ellipse is sufficient to demonstrate implementation with the requirement for staff to be reminded on site of all maintenance actions and to positively record actions. ORR questioned if Ellipse was sufficiently detailed to meet the intent of the recommendation. Network Rail argued it was and said to go further would create records in too much detail that could take longer to report than to carry out the action. Any tasks not completed by maintenance staff are highlighted by creation of a Works Arising Input Form (WAIF); these matters are subject to verification by a Network Rail, National Core Audit Programme audit.

There was discussion about the possibility of combining elements (b) and (c); by ensuring that each signalling maintenance specifications had identified key steps which had to be recorded as complete before a technician could continue in the maintenance task. Network Rail argue that this is not reasonably practicable, partly because of the functionality of the current handheld devices and partly because of the volume of information in the process.

ORR agreed that Network Rail had demonstrated the requirement to positively record; but wanted consideration given to recording details of key, critical elements in future if technological advances make it simpler. This

would also satisfy the aspiration to have positive prompts about selected significant steps.

#### Element (d)

Better compliance with Assessment in The Line (AiTL) since Grayrigg has improved the level of supervision of staff by local managers and this is supported by recent revisions to the standard for surveillance of staff NR/L2/SIG/10027 'Surveillance of Signal Engineering Activities'. Network Rail has also introduced new management self assurance checks.

ORR accepted that the enhanced surveillance requirements for AiTL and the new self assurance checks meet the needs of element (d). ORR intends to verify by inspection that the arrangements are adequate.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

### **Recommendation 10**

*The intention of this recommendation is that Network Rail should improve the quality of the existing basic visual inspections. Longer term issues concerning track inspection are dealt with under Recommendation 19.*

Network Rail should review and amend its processes for basic visual track inspection so that the issues identified in this report are addressed.

To achieve this Network Rail should consider issuing modified instructions to define:

- (a) the contents of task instructions issued to staff undertaking basic visual inspections;
- (b) the nature of defects that can occur and how to detect those that are difficult to readily observe;
- (c) job cards to advise the start and finish locations and the direction of the inspection for every occasion;
- (d) the information supplied to a patroller before an inspection in terms of clearly-presented intelligence on previously-reported defects;
- (e) the scope of information that is to be recorded during an inspection (including definition of the need to record or comment on previously-reported defects);
- (f) the requirement to make positive statements about areas of the inspection where no defects have been found;
- (g) the checks for completeness that should be made within the track section manager's office, including verification that every inspection has been carried out;
- (h) the analysis and supervision that should be undertaken to confirm that inspections are being conscientiously completed; and

- (i) a suitable level of continuity that can be achieved by identifying individual patrollers with individual sections.

### **Action Taken**

#### **Element (a)**

Network Rail has revised its working instructions and Track Inspection Handbook which together contain sufficient information for a competent track patroller to carry out a basic visual inspection.

#### **Element (b)**

A Network Rail standard gives information on types of track defect to be considered and reported at basic visual inspection. This information and the minimum actions to take on finding certain types of defect are repeated in the Track Inspection Handbook – Patroller. This Handbook has been issued to all track patrollers holding a certificate of track patrolling competency. The Handbook includes specific actions required at switches and crossings.

Network Rail manages “difficult to readily observe” defects, through trained and competent track patrollers and a system of monitoring and surveillance. ORR has verified examples of the training and competence documentation. ORR considers this element to be implemented.

#### **Element (c)**

Track patrol diagrams to indicate the start and finish of a track patrol were a requirement at the time of the Grayrigg derailment. Network Rail has revised the standard and reinforced the requirement for track patrol diagrams by issuing a new work instruction for track patrollers. The standard requires that track patrol diagrams state the start and finish points; the line to be walked; and the route or direction. This information is provided in a table and diagrammatically. In addition, the track patrol report form must record the start and finish locations.

#### **Element (d)**

Network Rail has revised a work instruction which now requires track patrollers to mark the infrastructure with defects recorded on the track patrol report form. Standards have also been revised to ensure that track patrollers are allocated to specific patrols, to give the opportunity to become familiar with the patrol section and any defects.

#### **Element (e)**

Network Rail has revised one of its standards which now defines information to be recorded by a patroller during inspection duties, namely new or repeat defects that require action within 4 weeks and defects that are repaired during the inspection. The associated work instruction also requires the patroller to note if no actionable defects were identified.

#### **Element (f)**

Network Rail has revised a Work Instruction which now requires the patroller to record ‘no actionable defects’, if none are found during the track patrol. The track patrol record has been amended to remind the patroller.

#### Element (g)

Network Rail has its processes set out to ensure that basic visual inspections are completed within the required compliance intervals. Network Rail's process has five elements:

- (a) Ellipse planning;
- (b) patroller checks and implementation of defined actions if a track patrol is not completed (for example, notify the Incident Control Centre and obtain a fault number);
- (c) in the majority of situations the track section manager is required to check basic visual inspections are completed within the compliance period
- (d) The track section manager is required to review track patrol records; and
- (e) the section planner's review process.

Network Rail's primary control to ensure track patrols are completed as required is for the track patroller to inform the control centre if, for any reason, he can not complete the patrol. Additionally the track patrol report form reminds the patroller of actions, if he cannot complete the patrol and requires various statements to be recorded as completed.

#### Element (h)

Network Rail inspections are carried out conscientiously. Standards require track section managers to:

- (a) review patrol records;
- (b) hold regular face to face discussions with track patrollers;
- (c) accompany track patrollers on patrols;
- (d) verify the effectiveness of the basic visual inspection; and
- (e) track and monitor these activities.

#### Element (i)

Network Rail's standards now require patrols to be carried out by a regular patroller for a period of six months. This is monitored by the track section manager.

ORR believe that the principles are sound, but are waiting further information from Network Rail's human factors work before reaching a final conclusion on the implementation of element (i).

ORR has reported to RAIB that element (b) of this recommendation has been implemented, and that we will provide an update to RAIB in respect of the other elements by 28 October 2011.

## **Recommendation 11**

*The intention of this recommendation is to ensure that when a supervisory and a basic visual inspection are combined, both are fully and correctly delivered, and recorded.*

Network Rail should modify its processes to specify the following safeguards when a supervisor's visual track inspection is combined with a basic visual inspection:

- (a) all the paperwork relevant to the basic visual inspection (see Recommendation 10, is supplied to the supervisor; and
- (b) an assurance check is carried out by a person other than the relevant supervisor to confirm that both inspections have been completed and recorded appropriately.

### **Action taken**

A Network Rail standard specifies how a basic visual inspection is checked for completeness when it is carried out by a patroller. This includes a requirement in the majority of situations for the track section manager to check the basic visual inspection is carried out within the compliance period. It is impossible to apply the same process when the track section manager for whatever reason, does the basic visual inspection.

Network Rail has argued that to implement element 11(b) as written requires additional process, whereby someone other than the supervisor carries out an assurance check.

Network Rail has not added a further check but has provided details of alternative arrangements. Network Rail relies on its routine monitoring systems for assurance of complete basic visual inspections by supervisors; principally by outputs from Ellipse.

ORR accepts that the procedures for making and monitoring basic visual inspections are more robust than at the time of the Grayrigg derailment; that basic visual inspections by supervisors should be by exception; and that supervisors have responsibility for either completing the task or reporting it as not complete. In this situation, ORR does not think it is reasonably practicable to introduce further checks involving more people.

ORR has committed to provide RAIB with an update by 28 October 2011.

## **Recommendation 12**

*The intention of this recommendation is that Network Rail should address the competence and management issues relating to the inspection and maintenance of S&C that have been demonstrated in this report.*

Network Rail should review its processes for practical training, assessment competence assurance for those undertaking S&C inspection and maintenance against current UK rail industry best practice (e.g. ORR's



publication 'Developing and Maintaining Staff Competence'), and make relevant changes so that the requirements arising from Recommendations 6, 7, 8, 9, 10 and 11, as appropriate, and those from the more general observation about competence in this report, can be delivered.

### **Action taken**

Whilst Network Rail has not separately reviewed all aspects of practical training and competence across all inspection and maintenance activities of S&C it has, as part of on-going business, improved the assessment in the line processes and audited the outcomes. As part of recommendations, 10 and 11 Network Rail has made changes to the basic visual inspection and supervisor's inspection regimes. Network Rail is using various company standards and specifications, put in place just before Grayrigg and has asserted that these are now delivering the required outcomes.

ORR has seen some key outputs since Grayrigg:

- (a) details of Network Rail's assessment in the line process;
- (b) audits on the effectiveness of assessment in the line;
- (c) a review of standards in respect of track and signalling and telecommunications.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 13**

*The intention of this recommendation is that Network Rail should establish whether it is practicable, in human factors terms, for the inspection and maintenance processes to identify and rectify all defects to an adequate and consistent standard, and revise the design of S&C to allow for any identified impracticability or variability in those activities.*

Network Rail should conduct a review, focused on human factors, to develop an accurate understanding of the practicability of, and variability in, the performance and outcome of inspection and maintenance so that any issues identified can be taken into account in the design of S&C systems and the associated inspection and maintenance specification. This activity is integral to Recommendations 1 and 10, and a precursor to Recommendation 19.

### **Action taken**

There have been a number of Network Rail / ORR discussions culminating in Network Rail providing ORR with a summary of human factors work in support of recommendation 13 on 23 July 2010. This summary, taken together with information previously received and work with ORR lead inspectors for related recommendations, has provided some confidence that Network Rail is progressing a wide range of human factors issues arising from the investigation.

ORR was not satisfied that the information provided was enough to demonstrate a 'review' i.e. what was considered and why, what actions were taken / or why no action was taken.

ORR has therefore asked Network Rail to demonstrate more fully how the wide range of human performance influencing factors affecting relevant inspection and maintenance tasks have been reviewed in a structured way, and how consideration of each factor has improved risk controls and mitigations, and how Network Rail are progressing further improvements in controls. Network Rail is to include how consideration of human performance influencing factors has fed into the related recommendations 1, 10 and 19.

ORR has committed to provide RAIB with an update by 28 October 2011.

## **Recommendation 14**

*The intention of this recommendation is that Network Rail should have adequate monitoring of S&C failure precursors.*

Network Rail should review and improve its management arrangements for monitoring performance in relation to the inspection and maintenance of S&C assets, taking account of the guidance contained in HS(G)254, 'Developing process safety indicators' by introducing an suitable 'leading' and 'lagging' performance indicators. The indicators should encompass measures of the reliability of both maintenance and inspection activities and the performance and condition of key components.

### **Action taken**

Network Rail has undertaken a structured review of its management arrangements for monitoring performance in relation to the inspection and maintenance of S&C assets taking account of relevant guidance.

Network Rail has provided information on how it utilises an HS(G)254 type approach to its asset management, from frontline, tactical control through to strategic, board level review. It also detailed where it was going to strengthen its arrangements. Most notably this is related to the assurance of the accuracy of data within Network Rail's maintenance recording system. Other indicators were also put forward for implementation.

ORR sees the improvements as:

- (a) Better quality data in Network Rail's systems, making the outputs more reliable. The outputs are used in monitoring performance. ORR believes that further improvements could be made in this area and is continuing to monitor Network Rail.
- (b) Assurance through peer review of the quality of the maintenance undertaken. Again, ORR believes that further improvement is possible and will continue to keep this under review;
- (c) Improvement to activity indicators; and

- (d) Improved checks on outcomes, for example the repeat failure escalation process.

On this basis ORR has concluded that this recommendation has been implemented, though it will still be the subject of ongoing monitoring by ORR.

## **Recommendation 15**

*The intention of this recommendation is that Network Rail's compliance and assurance systems should mandate site checks of its S&C asset so that it is independently aware of the actual state of its assets on the ground, any developing trends in its asset performance (see Recommendation 2), and their relationship to its records from inspections.*

Network Rail should extend its compliance and assurance processes to include independent end product checks on a sample of its S&C asset to:

- (a) confirm that its inspections and work database reflect the physical state of its assets;
- (b) confirm that the asset is compliant with appropriate standards;
- (c) confirm that the actions identified in Recommendations 1 to 3 are, in fact, delivering an improvement in the performance of S&C assets;
- (d) observe for defects or problems that, although the asset and systems may comply with the appropriate standards, may effect the safety of the line.

### **Action taken**

Network Rail has introduced an engineering verification process to address elements (a) and (b) and provided ORR with supporting details to demonstrate that its routine processes and assurance regime addresses these elements. This process is not confined to S&C.

Elements (c) and (d) are about demonstrating that the outputs from recommendations 1, 2 and 3 are delivering improvements to the S&C asset and capturing any defects or conditions that may be occurring, even though appropriate standards are complied with.

ORR will continue to monitor the outputs from recommendations 1, 2 and 3, but accept that Network Rail has done enough to demonstrate the process is in place and is beginning to produce useful results. Outputs from these recommendations, if they become part of routine business, will be subject to engineering verification checks.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 16**

*The intention of this recommendation is that Network Rail should specify adequate opportunities for inspection (and also for maintenance, although recognising that lack of maintenance opportunities was not an issue in the Grayrigg derailment) activities when developing infrastructure enhancement projects.*

Network Rail should include within its infrastructure enhancement project processes an assessment of the impact of any project on the inspection and maintenance of the assets at a stage of the project which allows identification and implementation of suitable measures before commissioning.

### **Action taken**

Network Rail has amended its standards to address all the issues required by this recommendation.

ORR has obtained assurance that Network Rail's actions address this recommendation in three ways:

- (a) that there is 'adequate access for inspection' and that Delivery Units are resourced, equipped and organised to ensure safety of the line;
- (b) that there is a mechanism in the timetabling process to identify changes that may affect inspection and maintenance opportunities 40 weeks ahead of revised timetables; and
- (c) through inspection during 2008/9 and analysis of the revised standard.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 17**

*The intention of this recommendation is that Network Rail should review whether there is currently adequate access for inspection on its main-line routes.*

Network Rail should review and, if necessary, revise its access arrangements and plans (including Rules of the Route) for its main-line routes. This should be done to provide for the needs of maintenance and inspection of existing infrastructure, given current and planned traffic levels.

### **Action taken**

Network Rail has revised one of its standards to include the requirement for a detailed review and assessment of timetable changes including "the effects of past changes... and look ahead to the implications of change aspirations proposed to take place beyond the next timetable." The standard requires the review process to be initiated at Route level (not by HQ) and is driven on a route by route basis. Each route review group looks back 3 years and forward 3 years. Any risks identified are required to be documented and mitigation put

in place before the timetable change is implemented. This demonstrates an ongoing commitment to "review and revise access arrangements and plans to provide for the needs of maintenance and inspection of existing infrastructure."

In addition, Network Rail separately asked each Infrastructure Maintenance Delivery Unit Manager (IMDM) to confirm sufficient track access exists for routine inspection and maintenance of existing infrastructure. Network Rail has provided ORR with documentation from every IMDM confirming this.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 18**

*The intention of this recommendation is that Network Rail should review the interfaces in its headquarters' engineering department concerning S&C, with particular reference to track and signalling engineering.*

Network Rail should review and, if necessary, revise its management organisation to provide effective stewardship of S&C assets. The review should include consideration of the creation of a single professional department (design authority) responsible to the chief engineer for all aspects of S&C, including specifying design, procurement, installation, set-up, commissioning, inspection, maintenance and performance.

### **Action taken**

Network Rail has revised the organisational structure which now includes a 'Switch & Crossings Manager' who heads a team that acts as the company and industry experts on all aspects of switch and crossing design. The Switch & Crossings Manager is responsible for development of a cross functional S&C strategy, including the development of standards and technology and the provision of expert technical advice to industry.

ORR has seen the positive outputs from the creation of an S&C manager and team, not least in the work to implement recommendations 1, 2, 6 and 8.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 19**

*The intention of this recommendation is that Network Rail should review its track inspection requirements so that best use is made of new technology for plain line and S&C inspections.*

Network Rail should re-assess the differing requirements of plain line and S&C track inspections with regard to:

- the amount that is appropriate to be done by human intervention, and the amount by automated data capture, for both types of track;
- the different relative frequencies that may be appropriate for both types of track; and
- what protection arrangements should be provided.

Consideration should be given to separate processes for plain line and S&C inspections to recognise the different requirements of each.

### **Action taken**

Network Rail has delivered this recommendation by implementing:

- (a) a formal methodology for assessing signalling maintenance requirements;
- (b) reliability centred maintenance techniques to track; and
- (c) rolling out condition monitoring to around 2,000 points across the network.

In addition Network Rail is actively seeking to automate the track basic visual inspection process.

Network Rail has formally assessed the differing requirements of plain line and S&C track inspections and the use of automated data capture as opposed to human intervention.

ORR accepts that Network Rail has in place a limited risk based approach to track inspection which it is developing and has changed track inspection frequencies where the evidence and analysis support this. To further develop this risk based approach requires a greater degree of evidence based numerate risk analysis. Network Rail acknowledges this and remote condition monitoring is evidence of this. Grayrigg recommendations 2 and 4 require Network Rail to gather and analyse data and move to a risk based regime for the inspection and maintenance of S&C.

ORR's inspection of Network Rail's New Technology Project relating to S&C, found it was well managed. Relevant staff have been involved at all stages of the development and emerging issues have been addressed in a timely and robust way. ORR will continue to monitor Network Rail's progress in Control Period 4 (CP4).

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 20**

*The intention of this recommendation is that Network Rail should carry out its S&C engineering safety management in line with UK railway industry documented best practice.*

Network Rail should review its S&C engineering safety management arrangements with reference to current UK rail industry best practice (e.g. the 'Yellow Book' [Engineering Safety Management]) and address any deficiencies identified.

### **Action taken**

Analysis shows that recommendation 20 is an all encompassing recommendation and captures the more specific requirements of recommendations 1 to 19. There has been good progress since Grayrigg in Network Rail's safe engineering management of its S&C systems and initiatives continue to make further improvements. ORR has not assessed Network Rail's actions against each of the very detailed principles set out in the Yellow Book, but has taken a holistic view, informed by outcomes to meet other Grayrigg RAIB recommendations and proposals to improve monitoring of implementation of standards. ORR accepts Network Rail is adopting best practise principles in its current S&C engineering safety management and ORR is closely monitoring actions to meet the remaining Grayrigg recommendations.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 21**

*The intention of this recommendation is to ensure that, in the short term, ORR explicitly includes S&C in its delivery plan assignments for as long as it remains an identified high risk in the ORR's assessment. In the longer term the intention is to ensure that the ORR includes assignments for all the higher risk items within its delivery plan, irrespective of the topic in which it is grouped.*

The ORR should amend its process for planning and briefing the annual delivery plan to make explicit when an area of high risk is to be included within an individual assignment.

### **Action taken**

ORR has reviewed its planning arrangements and the structure of ORR inspection assignments. ORR prioritised S&C inspection as one of three major areas of work for inspectors dealing with Network Rail in 2009/10. This involved sampling the effectiveness of Network Rail's revised track management arrangements and focus on key areas.

The way ORR prioritises its planned inspection activity has been aided by the complete reorganisation of our operational inspection teams. This has achieved the following:

- (a) Simplified the structure so that there is a clear focus on duty holders for each inspector, and a specific division focused on Network Rail;
- (b) The number of levels of management has been reduced to enable simpler lines of communication between the Deputy Chief Inspectors responsible for railway networks or railway operators, to the individual inspectors;
- (c) The planning process has been simplified and a central team established to help ensure the correct priorities for the inspection teams are risk based and take into account total system safety. The team leaders of inspectors are involved directly with the planning process.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 22**

*The intention of this recommendation is to minimise the risk of injury from detachment of seats in the event of an accident, by enhancing the requirement in the current design standard, for seats to deform in a ductile manner when overloaded, particularly in the lateral direction.*

RSSB should make a proposal in accordance with the Railway Group Standards code to introduce a specific requirement in the relevant interiors design standard, that future seats designs, including those that may be fitted at refurbishment, should demonstrate a ductile deformation characteristic, when overloaded in the vertical, lateral or longitudinal directions, in order to minimise the risk of complete detachment in accidents.

### **Action taken**

This recommendation has been implemented by inclusion of a specific requirement in the relevant group standard that future seats designs, including those that may be fitted at refurbishment, should demonstrate a ductile deformation characteristic, when overloaded in the vertical, lateral or longitudinal directions, in order to minimise the risk of complete detachment in accidents.

On this basis ORR has reported to RAIB that this recommendation has been implemented.



## **Recommendation 23**

*The intention of this recommendation is to minimise the risk of injury arising from the detachment of heavy internal panels in the event of an accident.*

RSSB should consider, and where appropriate, make a proposal in accordance with the Railway Group Standards code to implement a requirement in the relevant design standard to provide sufficient means of retention for internal panels assessed as capable of causing serious injury in the event of complete detachment.

### **Action taken**

This recommendation has been implemented by inclusion of a specific requirement in the relevant group standard requirement to provide sufficient means of retention for internal panels assessed as capable of causing serious injury in the event of complete detachment.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 24**

*The intention of this recommendation is to minimise the risk of the reading light panels in a Pendolino train becoming detached in the event of an accident.*

Virgin Trains and Angel Trains should review the mounting of the reading light panels on the Class 390 Pendolinos and take steps to minimise occupant injury from failure of the panel retention system.

### **Action taken**

- (a) Virgin Trains and Angel Trains have reviewed the mounting of the reading light panels on the Class 390 Pendolinos and identified that the mechanical lock failure was due to failure of the riveting technique used to assemble to reading light panel locks.
- (b) In undertaking a risk assessment the current design can be considered to be as low as reasonably practicable as the failure of the lock was due to the design load being exceeded.
- (c) The UK supplier of the lock has however improved the quality control by amending the manufacturing process of the locks. In order to accommodate this improved manufacturing process some minor design detailed changes have been implemented.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## Recommendation 25

*The intention of this recommendation is that general safety lessons regarding rail vehicle crashworthiness emerging from the Grayrigg accident are considered and, where appropriate, research is undertaken to assess the practicability of making improvements. If suitable improvements are found, proposals should be made for changes to crashworthiness standards.*

RSSB should:

- (a) Identify any gaps in industry knowledge about vehicle dynamic behaviour in derailments (for example the forces acting on inter-vehicle couplers and bogie retention systems) and where appropriate, undertake research to investigate improvements in vehicle performance. Where appropriate, RSSB should make a proposal in accordance with Railway Group Standards code to change relevant design standards.
- (b) Investigate and, where practicable, make a proposal in accordance with Railway Group Standards code to introduce specifications for roll-over strength and penetration resistance of rail vehicle bodysells in design standards to ensure consistency of performance in accidents across all future fleets;
- (c) Undertake research into the injury mechanisms at Grayrigg to identify means of improving occupant survivability in future rail vehicle designs. Where appropriate, RSSB should make a proposal in accordance with Railway Group Standards code to change relevant design standards;
- (d) Review and revise, if necessary, its past research into seat belts in rail vehicles in the light of the findings from the Grayrigg derailment, taking into account foreseeable changes to vehicle behaviour in future accidents, in order to check whether the conclusions reached therein remain valid; and
- (e) Confirm and publish the results of its cost benefit analysis as to the reasonable practicability of fitting seat belts to passenger trains. If the analysis shows that fitting seat belts is other than grossly disproportionate to the risks involved, further investigate how to take the issue forward.

### Action taken

RSSB has now completed the outstanding research projects on 'Whole Train Dynamic Behaviour in Collisions and Improving Crashworthiness' and 'Literature review of rail vehicle structural crashworthiness'. RSSB has made some recommendations for feeding into Technical Specification for Interoperability drafting and also the review of the guidance note on Guidance on Traction and Rolling Stock Mechanical Coupling Systems and related standard. This work completes the outstanding elements of recommendation 25 with the exception of element (e), where RSSB have provided full reasoning as to why the fitting of seat belts would not be reasonably practicable.

On this basis ORR has reported to RAIB that this recommendation has been implemented.

## **Recommendation 26**

*The intention of this recommendation is to assist the emergency services to optimise their response to an accident.*

Cumbria Police should carry out a review of, and change as appropriate, its management, procedures and training relating to the rapid and accurate location of an accident from information received in emergency calls in the control room so that received information is filtered effectively and without loss of significant data.

### **Action taken**

ORR has received information from RAIB that Cumbria police has reviewed its management, procedures and training relating to the rapid and accurate location of an incident from information received in emergency calls and strengthened these.

This recommendation is therefore viewed by both ORR and RAIB as being implemented.

## **Recommendation 27**

*The intention of this recommendation is to promote the safety of Ambulance Service personnel who are called upon to carry out rescue work after a railway accident.*

The Department of Health's eleven mainland Ambulance Service NHS Trusts, the Welsh Ambulance Services NHS Trust and the Scottish Ambulance Service should:

- (a) agree and implement suitable processes so that their staff are suitably trained for work on the railway; and
- (b) agree a protocol with Network Rail to cover the necessary steps for the ambulance services to enter Network Rail property safely in an emergency.

### **Action taken**

ORR has received information from RAIB that Emergency Medical Dispatch Centres are responsible for the receipt of emergency calls and deployment of emergency ambulances and supporting resources. They will coordinate communications and inter agency liaison. Protocols are in place in respect of railway incidents based on documents produced in consultation with Network Rail.

This recommendation is therefore viewed by both ORR and RAIB as being implemented.

## **Recommendation 28**

*The intention of this recommendation is to improve communications between rescue organisations after an accident.*

The Ministry of Defence should equip the Royal Air Force and Royal Navy search and rescue fleet of helicopters with radio communication equipment that allows direct contact with civil emergency services.

### **Action taken**

ORR has received information from RAIB that it is still waiting a response to this recommendation.

## **Recommendation 29**

*The intention of this recommendation is to identify possible links between working hours and performance, and to implement steps that can be taken to reduce any resultant risk.*

- (a) Network Rail should carry out research to establish if there is a link between working long hours over extended periods, including the number and distribution of rest days, and the propensity for human errors during safety critical tasks. The study should include, but not be limited to, those staff who have ordinary office-based duties interspersed with safety critical tasks, such as inspections. The output of the research should be a set of threshold levels of hours for differing roles.
- (b) Using the output of the research, Network Rail should establish procedures to deliver compliance with the thresholds identified.

### **Action taken**

Network Rail advised that it had already:

- studied the effects of extended periods of overtime and has procedures to understand and control the risks associated with shift patterns; and
- describe the requirements for the monitoring and controlling of excessive working hours by Network Rail employees, or those employed under contract by Network Rail, who undertake work of a safety critical nature.

So that employees do not work such hours as would be likely to cause fatigue. Compliance is monitored via the company's assurance arrangements. Also, as with all Network Rail's standards, they are subject to review, incorporating lessons learned, and emergent research.

Network Rail has undertaken further work to improve its management of fatigue, and this is continuing. This has particularly come to light in

connection with recommendations associated with the incident at East Somerset Junction on 10 November 2009.

On this basis ORR has reported to RAIB that this recommendation has been implemented by alternative means.