Network Rail

West Coast Trains Ltd (Virgin Trains)

Summary report of the investigation into the train derailment of 1S83, the 17.15hrs Virgin Pendolino train from London Euston to Glasgow

Date:	23 February 2007
Location:	Lambrigg, nr Grayrigg, Cumbria

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A. Investigation process

A1.1. Network Rail has finalised the investigation into the circumstances that led to the train derailment of the 17.15hrs Virgin Pendolino service from London Euston to Glasgow, at the Lambrigg Ground Frame (2A/B) crossover in Cumbria, on 23 February 2007.

A1.2. The formal investigation was conducted in accordance with Railway Group Standard GO/RT3473 (Issue 3) that sets out industry protocols for the investigation of accidents. The investigation was led by Network Rail, who were supported by representatives from Virgin Trains.

A1.3. As with all such industry led investigations, the investigation team's task was to establish the immediate and underlying causes of the accident and make recommendations to prevent or reduce the risk of recurrence.

A1.4. The investigation has been conducted in close co-operation with the Rail Accident Investigation Branch (RAIB), who are continuing with their own enquiries.

A1.5. RAIB investigations will continue as they have a wider scope that includes issues such as the crashworthiness of the rolling stock and post-event activity. However, the outcomes and recommendations detailed in this report have been informed by working closely with RAIB during its investigations.

A1.6. The objectives of this investigation, as confirmed by Railway Group Standard GO/RT3473 (Issue 3), are not the allocation of blame or liability and thus the information contained should not be construed as creating any presumption of these. The purpose of this report is to explain to the railway industry and the wider public the events that led up to the accident, the causes and what actions will be taken as a result

A1.7. In order to be worthwhile and identify immediate and underlying causes, industry led investigations depend on the full cooperation of railway staff. Such cooperation has been forthcoming. It is very important to understand the importance of such cooperation and the blame/liability free approach on which it depends.

B. Context

B1. The Incident

B1.1. At approximately 20.12hrs, all vehicles of 1S83, the 17.15hrs London Euston to Glasgow Central service, travelling at 94mph, derailed at the Lambrigg GF (2A/B) crossover.

B1.2. The train travelled out of a cutting and onto an embankment. The leading vehicle went down the embankment to the north of the track, turning through 180 degrees from its previous direction of travel.

B1.3. The second vehicle came to rest lying nearly perpendicular to the track on the side of the embankment; foul of the up and down main lines. It had travelled approximately 472m from the initial point of derailment at 2B points.

B1.4. The following vehicles came to rest at various positions along the northwest side of the embankment. Vehicles three to five ended up on their sides at the base of the embankment and the remaining vehicles were at various positions either sloping or vertical on the side of the embankment.

B1.5. There were 108 passengers and 4 staff on the train. One passenger suffered fatal injuries. Twenty two other people were detained in hospital.

B2. Post-Incident

B2.1. Following the derailment, and with the arrival of daylight hours, Network Rail – working with RAIB and others' – began an assessment of the crash site and the points at Lambrigg, so as to understand what might have caused this terrible accident.

B2.2. An early finding was that the condition of the set of points at Lambrigg were the cause of the accident.

B2.3. Network Rail then carried out extensive checks of similar points across the rail network. Over the weekend, in the aftermath of the accident, more than 700 special inspections took place, and nothing out of the ordinary was found.

B2.4. The investigation, as detailed in this report, has since sought to understand the underlying issues at Lambrigg to determine if these were systemic across the network.

B2.5. The report provides an open and honest account of events leading up to the accident and the investigation team's subsequent findings. The objective of the report is not the allocation of blame or liability and thus the information contained should not be construed as creating any presumption of these.

C. Conclusions

C1. Immediate cause

C1.1. Deterioration of components in the stretcher bar system of 2B facing points at Lambrigg GF led to the left hand switch rail becoming disconnected from the right hand switch rail, leading to an uncommanded movement towards the left hand stock rail, enabling at least two wheel sets of 1S83, the 17.15 hrs Euston to Glasgow service, to make contact with the left hand switch rail and run into derailment, whilst the right hand switch and stock rails remained correctly located and locked.

C2. Underlying causes

C2.1. Deficiencies in the asset inspection and maintenance regime employed on Lancs & Cumbria maintenance area resulted in the deterioration of 2B points not being identified. These deficiencies included:

- A breakdown in the local management/supervisory structure that leads, monitors and regulates asset inspection and maintenance activities;
- A systematic failure in the track patrolling regime employed on the local area;
- The issue and subsequent briefing of mandated standards not being carried out in a robust and auditable manner;
- A lack of sample verification to test the quality and arrangements for inspections undertaken.

C2.2. The routine basic visual patrol was not undertaken at Lambrigg 2B points on the 18th February 2007.

C2.3. The self assurance and audit regime failed to identify system failures in the application of safe systems of work and reliability of inspection regimes.

C3. Contributory Factors

C3.1. With the introduction of EPS running in December 2005 and the interim arrangements for access to the WCML, no structured assessment was undertaken to establish if sufficient resources existed. Management systems employed on the Lancs & Cumbria area were not sufficiently robust and embedded so as to ensure that any risk arising from the change in maintenance practices was controlled.

C3.2. Following the introduction of EPS passenger services, Lambrigg 2B points were exposed to increased cant deficiency. The consequence of this situation, meant small changes in the alignment of the S&C, as produced by S&C tamping in Dec 2006, could result in increased dynamic loadings on components in the points system. The presence of a 5-7mm residual opening on the right-hand switch blade may have been critical to enabling dynamic loadings to influence the stretcher bar system.

C3.3. Current standards for S&C maintenance do not specify a tolerance for residual switch opening where supplementary detection is not provided.

D. Details

D1. Description of the location

D1.1. Lambrigg Ground Frame (GF) is located on the West Coast Main Line (WCML) – between Oxenholme and Tebay. Two crossovers, one facing (2A/B) and one trailing (3A/B) between the Up Main Line (UML) and Down Main Line (DML) are provided. The line is electrified with a 25kV overhead wire system.

General view of Lambrigg GF, 2B points in the foreground, looking eastwards (July 2004)

D1.2. Looking eastwards through the GF at Lambrigg, the line curves, with a design radius of 1457m, to the left, with the DML (from London/Oxenholme towards Tebay and Glasgow) on the left and the line to the right, the UML (from Glasgow/Tebay towards Oxenholme/London Euston).

D1.3. Lambrigg GF is located in an east to west cutting, with Docker Harper's Viaduct to the West (24mls 00yds) and an embankment to the East across rural land (24mls 440yds to 24mls 650yds).

D1.4. Vehicular and pedestrian gated access to the track at the Lambrigg GF is available on the Down side at 24mls 440yds.

D1.5. The line speed, on both lines, through the GF is 95mph for Enhanced Permissible Speed (EPS) operation. The route is fitted with Tilt Authorisation Speed Supervision (TASS) which enables speed supervision of tilting trains to operate. The line speed for non EPS trains at Lambrigg GF is 85mph.

D1.6. The tracks rise towards Tebay at a gradient of 1 in 106.

D1.7. The Lambrigg GF can only be operated by a person on site, to whom local control has been given by the signaller at Carlisle Power Signal Box (PSB).

D2. Train involved

D2.1. The train involved was 1S83, the 17.15hrs London Euston to Glasgow Central service, a Class 390, Pendolino train which consisted of 9 vehicles, operated by West Coast Trains Ltd.

D3. Description of the signalling

D3.1. Signalling at Lambrigg is controlled from Carlisle Power Signal Box (PSB) in accordance with the track circuit block regulations. The four aspect signals protecting normal movements over the crossovers are CE72 on the DML and CE75 on the UML. The signals normally work in automatic mode but the signaller can operate a replacement switch on both signals in order for him to protect the crossovers if the GF is to be used.

D3.2. The crossovers are locally operated by Lambrigg GF. The GF is situated on the down side of the line near 3A points at 24mls 440yds. It consists of a switch panel with point detection indications provided for the GF operator. Movement of the switches is achieved using Westinghouse style 63 point machines employing a back drive on the third stretcher bar.

D3.3. A TASS balise is provided on the DML at approximately the 23 mile post.

D4. Description of the Track – 2B points

D4.1. On the western approach to 2B points, in the DML, at Lambrigg GF, the track comprises of 1965 concrete sleepered continuous welded rail (CWR) with Spring Hoop Clip (SHC) fastenings and 1991 113A rail (24mls 000yds to 24mls 262yds), leading into a 9yd length (24mls 262yds to 24mls 271yds) of 1987 F27BS concrete sleepered CWR with Pandrol fastenings and 1987 113A rail immediately to the south of 2B points.

D4.2. 2B points at Lambrigg GF form the DM portion of a facing ‘CV 10’ crossover – 2A points forming the UM portion (note relating to CV 10: C relates to the length of the switch, V means vertical rails, 10 indicates the angle of the crossing – a 1 in 10 angle equivalent to 5.72 degrees).

D4.3. 2B points comprise of full depth stressed CV vertical 113A rail section Switch and Crossing (S&C), on hardwood bearers originally installed in 1987. The heel stress transfer blocks are standard design – for installation in CWR. The left-hand half-set of switches is original, with standard ‘PV’ baseplates, requiring standard lubrication. The right-hand half-set of the switch was manufactured in 2001 and installed soon afterwards, with PV baseplates incorporating nylon slippers, requiring no lubrication.

D4.4. There is no point heating provided to the installation.

D4.5. The 1 in 10 crossing was manufactured in 2002 and comprises of a cast Austenitic Manganese Steel centre block, with weldable leg ends.

D4.6. The design cant through 2B points is 100mm on a design curve of 1457m radius. This results in an equilibrium speed of 69 mph and a maximum cant deficiency of 89mm when traversed at the maximum design speed of 95 mph.

D4.7. The Equivalent Million Gross Tonnage Per Annum traversing 2B points is recorded as 22, resulting in a Track Category of 1 for the location; although the dominant Track Category for the route between Preston and Carlisle is 1A (driven by linespeeds up to 125mph elsewhere).

E. Factors for consideration

E1. Design

E1.1. The investigation team noted that 2B points at Lambrigg GF was a vertical CV 10 full depth layout, laid in CWR, operated by a style 63 point machine. The layout was 34 yards long and had a 1 in 10 cast centre block crossing with weldable legs. The points were installed in 1987. The rail section was 113A FB secured to hardwood bearers with pandrol clips. The ballast was granite.

E1.2. The CV10 design had been in use for some years prior to 1987 and the design at Lambrigg GF was consistent with the British Railways Board diagram BRS-SM 350 approved in 1967 and updated in 1970 and 1976.

E1.3. A schematic diagram in the appendices illustrates the details of the standard stretcher bar systems. At the toe of the points there is a lock stretcher bar which affords detection and FPL through the point machine. This is followed by the first stretcher bar which is connected to the style 63 point machine and acts as the front drive. The second stretcher bar is connected to the switch rails. The third stretcher is linked to the first drive stretcher bar via a back drive to enable the points to operate uniformly.

E1.4. The average radius through 2B points at the time of the derailment was 1429m on a left hand curve with 93mm of applied cant. This equates to an equilibrium speed of 66mph and a cant deficiency of 100mm for a linespeed of 95mph (EPS).

E1.5. Graphical output from the NMT on 21st February 2007 shows the dynamic track gauge through the 2B points to be in the range of 1435mm to 1443mm. Track gauge specification within the length of the moving switch rail is 1430mm to 1438mm, whereas the track gauge specification elsewhere in the S&C is 1430mm to 1450mm. It is not possible to establish the track gauge in the moving switch rail location definitively from the NMT trace. However, it is apparent the track gauge along part of the moveable switch rail was in excess of 1438mm.

E1.6. After the derailment, reconstruction of the 3rd stretcher bar and all associated fastenings within 2B points at the Health and Safety Laboratories (HSL), Buxton, demonstrated a FWC of 53mm with a RSO of 7mm leading to an approximate clearance of 8mm before flange back contact between passing wheelsets and the LH switch rail in the vicinity of the 3rd stretcher bar.

E1.7. Thus the track gauge through 2B points was not creating flange back contact whilst all the stretcher bar system was in place and secure with the points in their normal position.

E1.8. Assuming the layout was installed in 1987 to similar geometry (alignment and level) to that existing in February 2007 a review of historic design requirements indicated the layout was within the safety limits of 110mm of cant deficiency allowed for S&C, but in excess of the passenger comfort limit of 80mm of negative cant permitted for the crossover route and therefore, not material to the incident.

E1.9. The current design specification NR/SP/TRK/049 Issue 10, February 2007 (Track Design Handbook), specifies hardwood bearer layouts should not be introduced where either the cant (E) or cant deficiency (D) is greater than 90mm on a linespeed greater than 90mph, or where the cant deficiency is greater than 110mm (irrespective of speed). This new non retrospective clause was introduced to NR/SP/TRK/049, Issue 9 in June 2006 to capture layouts in primary routes and the faster secondary routes at the top of the distribution of canted S&C, and intended to improve the whole life economic performance of S&C in such locations.

E1.10. Although there were no reported relevant component failures before the S&C tamping event on 2nd/3rd December 2006, a subtle change in traversing wheel paths and a variation in the loading pattern on the S&C components could have induced cyclic loading tending toward fatigue failures.

E1.11. The fault observed on the 3rd stretcher bar on 7th January 2007 may have been indicative of such a change in loading.

E2. Assessment of condition of Lambrigg 2B points post derailment.

E2.1. Examinations in conjunction with RAIB took place at Lambrigg on the 24th February 2007 and on the 26th February 2007. When the S&C was removed from site, further examinations have taken place at HSL, Buxton. These investigations have enabled the following to be established:

E2.2. **Lock Stretcher Bar**

- Both bolts securing the lock stretcher and the left-hand switch rail extension bar to the left-hand switch rail were detached. One of these bolts was found lying between the switch rail and the stock rail on the slide plate. The markings on the slide plate showed the bolt head limited the extent to which the left-hand switch rail could close against the left-hand stock rail at the switch toe to 30mm. The second bolt could not be found at the time of the inspection and has not been found subsequently.
- Nuts, large plain washers and steel collars for both bolts securing the lock stretcher bar to the left-hand switch rail were found loose on the left-hand end of the soleplate and on the ballast between the first and second bearers under the left-hand switch rail. The nuts were of Aerotight design. These nuts appear to be the original nuts from installation and have damage to the torque prevailing mechanism that indicates several occurrences of re-use in situ. This will reduce the effectiveness of the Aerotight nuts to prevent loosening under vibration.
- No evidence was found of any significant damage to the threads on the inside of either nut. Both nuts showed evidence of grease contamination on the outer three turns of thread. The remainder of the threads in the nuts showed dry threads with light corrosion. This is indicative of the nuts vibrating off over a period of time.

- From inspection of the inside face of the lock stretcher bar and the outer face of the left-hand switch rail it appears that the second bolt furthest from the tip of the switch may have been loose or missing longer than the first bolt nearest the switch tip. This is shown by the slight discoloration on the web of the left-hand switch rail where the left-hand switch extension bar would have been in contact with the switch rail web.
- The bolt recovered from the front lock stretcher bar showed evidence of some fretting damage and truncation of the peaks of the threads where it passed through the lock stretcher bar indicating that the lock stretcher bar had been loose and moving against the bolt for a period of time before it came undone and fell out completely.
- This bolt showed very little evidence of corrosion on the final 15mm and in particular the last 6mm of thread. This would indicate that the nut had come off very recently and that the threads had not been exposed to the atmosphere for long.
- The left-hand switch detection extension piece had dropped down under gravity and sat against the edge of the switch rail foot. The left-hand end of the lock stretcher bar had dropped less as it was still firmly secured to the right-hand switch rail.
- The left-hand switch rail sat naturally with a toe opening of approximately 52mm. With the left-hand switch rail correctly positioned in its original location against the left-hand extension bar and lock stretcher the switch toe opening was measured at 114mm.
- The right hand end of the lock stretcher bar was found securely fastened to the right hand switch rail. The lock stretcher was correctly positioned with the insulation placed between the lock stretcher and the right hand switch extension bar. The Aerotight nuts and washers were all found to be in position and showed no evidence of any movement with a general build up of dirt and corrosion product on the exposed surfaces.

E2.3. **1st Stretcher Bar**

- The 1st stretcher bar was found to be securely bolted to the right hand switch rail with no evidence of any significant movement. Both bolts between the stretcher bar bracket and the switch rail were found to be in place and did not appear to have moved recently.
- The broken left hand stretcher bar bracket was loose on the switch rail with the first bolt nearest the switch tip missing from the bracket. The second bolt was in position but loose allowing the bracket to rotate resting on the switch rail foot. The other bolt nut and spring washer were found on the ballast between the 1st and 2nd bearers back from the switch toes. This bolt had no evidence of any significant damage to the threads and appears to have vibrated loose. This would indicate that there has been relatively little movement of the left hand 1st stretcher bar bracket prior to the bracket fracturing.

- The failed stretcher bar bracket had cracked through both cheeks at the change of radius and 90 degree twist in the bracket. The left hand ear nearest the switch tip appears to have failed by tensile overload with a granular fracture face and only light build up of corrosion products.
- The right hand side of the bracket furthest from the switch tip appears to have failed through the whole section by fatigue and had been broken for some time prior to the left hand side of the bracket finally breaking.
- The goose neck towards the right hand end of the 1st stretcher showed no visible cracking around the first bolt hole.
- The 1st stretcher bar was driven from the point motor at its left hand end with the drive to the back drive at its right hand end. The fatigue cracking in the left hand bracket occurred in the side of the bracket furthest from the switch toe and on the same side as the point motor drive. The front drive was set with approximately 10mm of lost motion. This may induce some over driving as the lost motion would normally be expected to be set at 15mm as this type of point motor drives through 127mm and the switch toe opening is only 114mm. This over driving may have induced additional stresses in the left hand 1st stretcher bar bracket.

E2.4. **2nd Stretcher Bar**

- The second stretcher bar was not present at the time of the inspection and appeared to have been missing from the S&C for a period of time prior to the derailment.
- On the left hand switch rail the "shadow" left by the 2nd stretcher bar bracket was still clearly visible on both the web and foot where the rail showed light corrosion product with no significant build up of grease or debris. Similar but less apparent shadows were also visible on the left hand switch rail web both before and after the normal position of the bracket. In addition to this, marks were also visible on the surface of the web and foot of the left hand switch rail where it appears that the bracket had become loose and moved backwards and forwards along the switch rail. This was most evident where the extended end of the 2nd stretcher bar has repeatedly impacted against the underside of the left hand switch rail.
- The bolts and nuts from the left hand end of the 2nd stretcher bar were found in the ballast beneath the bar.
- One bolt showed little damage to the threads with a light build up of corrosion product over the whole length of the bolt which would indicate that the bracket had not been moving before this bolt came undone and fell out of the left hand switch.
- The second bolt showed similar levels of corrosion but significantly more damage to the threads where it passed through the stretcher bar bracket indicating that the bracket had been loose and moving with the bolt in position before the bolt had completely come undone and fallen out.

- This bolt also showed an area where foreign material had dropped onto the damaged portion of the thread after it had fallen onto the ballast. Neither bolt showed any damage to the ends of the thread that would be expected if the nuts had been stripped from the bolts rather than vibrating loose.
- Both nuts from the left hand end showed extensive build up of grease and debris on their outer faces and flats.
- On the right hand switch rail there was a clear shadow left where the stretcher bracket had been seated against the web. Unlike the left hand end there was no marking to the side of the normal bracket position towards the switch toe.
- More marks were visible on the web outside of the normal bracket position furthest away from the switch toes. This marking on both the web and foot of the rail would indicate that the right hand end of the stretcher bar may have become displaced in the direction of traffic.
- Damage was also evident on the toe side of the nylon slide plate supporting the right hand switch rail and on the top of the nearest chair screw immediately ahead of the right hand end of stretcher bar. This damage appears recent as the nylon is still bright in colour and has not been covered by any build up of debris.
- The bolts which originally secured the right hand end of the 2nd stretcher bar were still captive in the right hand switch rail as there was insufficient clearance between the right hand switch and stock rail with it in the closed position for the bolts to fall out.
- The first bolt nearest the switch toe showed a general build up of corrosion product with only slight damage to the threads on the end of the bolt. The bolt point “flat part of the threaded end” showed evidence of repeated light hammering possibly where it had been in contact with the back face of the right hand stretcher bar bracket after the nut had come off.
- The second bolt nearest the heel of the switch showed similar levels of corrosion but with more damage to the last threads and end of the bolt where it appears to have been in repeated contact with the hole in the switch rail and bracket and back face of the stretcher bar bracket after the nut had come off.
- This bolt also showed more damage to the point where it has started to bur over where it appears to have been in repeated contact with the back of the stretcher bar bracket. No evidence was visible to indicate that the threads had been stripped indicating that the nuts had vibrated undone.
- The nuts and spring washers from the right hand of the stretcher bar were found spread in the ballast under the normal position of the bar. One of the nuts was found a distance from the bracket lying almost centrally in the middle of the four foot.
- Both nuts from the right hand end also showed extensive build up of grease and debris on their outer faces and flats.

E2.5. **3rd Stretcher Bar**

- The left hand end of the 3rd stretcher bar was bolted to the left hand switch rail. Both bolts were loose with some evidence of movement of the bracket against the web of the switch rail.
- The left hand bolt nearest the switch toes was loose but still located with the standard spring washer and square nut.
- The right hand bolt furthest from the switch toes was also loose but still located in position with a square nut but no spring washer.
- This bolt showed evidence of movement where the nut and or bolt has rotated against the bracket leaving a clear circle in the grease and deposits that have built up on the bracket.
- The 3rd stretcher bar had fractured at the insulation located towards the right hand end of the bar.
- The fractured insulation lug from this bar was found in the four foot on the left hand side of the sleeper (no. 3) just forward of the normal position of the second stretcher bar. Examination of the fracture faces on the lug and on the two ends of the 3rd stretcher bar showed them to be from the same original component.
- The opposing fracture faces on the lug and the stretcher bar showed a combination of fatigue and tensile or bending overload failure.
- The fracture faces on the right hand, short end of the stretcher bar showed it to have failed almost entirely by fatigue. The fatigue was divided into two distinct areas with a small area of much older fatigue damage adjacent to the first bolthole nearest the stretcher bar. The second area of fatigue appeared more recent and had propagated through the entire section of the short end of the bar.
- This fatigue fracture through the short end of the bar at the first bolthole had allowed the two halves of the bar to separate.
- The subsequent failure of the left hand, long end of the 3rd stretcher bar has occurred due primarily to bending overload. This bending overload appears to have resulted from the broken ends of the stretcher bar jamming together and being subjected to a large compressive load as passing vehicles strike the back face of the left hand switch rail. This compressive force in the 3rd stretcher bar appears to have caused the secondary break and lead to the complete fracture of the insulation piece from both the left hand and right hand ends of the stretcher bar.
- The right hand end of the 3rd stretcher bar was found to be detached from the right hand switch rail where both bolts had come undone.
- The foot of the right hand switch rail showed evidence of damage where the stretcher bar bracket has repeatedly fretted against the rail foot.
- 4 bolts, washers and nuts from this bracket were found in the ballast underneath the bracket and the S&C when lifted out.

- The nuts that appeared to have been in the ballast for the least period of time were hexagonal nuts unlike the remaining brackets on the layout which all utilised the older design square nuts.
- The hexagonal nuts did not have a build up of grease and other deposits when compared with other components. This would indicate that these nuts had been in service for a relatively short period of time.
- The bolts found in the ballast beneath the right hand stretcher bar bracket showed severe damage with wasting of the shanks where they would normally pass through the stretcher bar bracket and flattening around the end of the bolt points possibly where they have been in contact with the inside of the stretcher bar bracket or holes in the right hand switch rail. This damage appears to be a result of the bolts progressively jamming between the right hand switch and stock rail leading to crushing damage as the switch rail is closed hard against the stock rail under the passage of traffic.
- Two of the bolts appeared to be older and also showed very severe flattening of the shanks where they have been repeatedly crushed after becoming trapped between the feet of the right hand switch and stock rails.
- The back drive at the right hand end of the 3rd stretcher bar showed evidence of polishing on the sleeve nut where the stretcher bar appears to have been moving repeatedly against the supplementary drive. This would indicate that the left hand free wheel clearance may have been controlled solely by the back drive when the nuts on the 3rd stretcher bar bracket to switch rail had come undone.

E3. Mechanism of derailment

E3.1. From the initial evidence examined both on site immediately preceding the derailment and at the Health and Safety Laboratories (HSL) in Buxton a likely sequence of events has emerged. This is set out below:

- Measurements were made on site after the derailment and these showed a residual closed switch opening of approximately 7mm at the 3rd stretcher bar between the right hand switch and stock rail. A significant residual opening would have increased the load in the 3rd stretcher bar as the right hand switch rail would have been forced closed by the passage of each wheel set.
- Measurements taken at HSL, Buxton showed that the 3rd stretcher bar was set up to achieve a nominal flangeway opening of approximately 52mm. This would have allowed for little tolerance from flange back contact.
- Minor changes in alignment as a result of the S&C tamping activity on the 2/3rd December 2006 and an increased cant deficiency may have increased the dynamic loading on the 3rd stretcher bar and fastenings. This change in dynamic loading may have caused the nuts to work loose on the 3rd stretcher right hand switch rail and the nuts and bolts were observed to have been missing by the patroller on the 7th January 2007.

- The nuts and bolts were changed on 7th January 2007 as per the fault team's evidence. A torque wrench wasn't used to secure the nuts, but instead the fault team members used an adjustable spanner. The dynamic loadings induced by the residual opening on the closed right hand switch rail may have led to the replacement fastenings coming undone relatively quickly after installation on the 7th January 2007.
- The nuts fell into the ballast and the bolts became progressively trapped between the right hand switch and stock rail and resulted in a reduction in the free wheel clearance of approximately 3mm.
- The reduced free wheel clearance then resulted in flange back contact on the back of the left hand switch rail and led to increased dynamic loading and more rapid fatigue crack growth in the short end of the 3rd stretcher bar at the insulated connection.
- The bolts showed damage where they had fallen out of the right hand switch rail and had become trapped between the feet of the switch and stock rails.
- The trapped bolts would have prevented the residual opening on the right hand switch rail from closing up freely under the passage of traffic. This may have also tended to induce additional stresses in the 3rd stretcher bar as the switch rail would not simply close under traffic and would have tended to rotate about its foot where the bolts had become jammed.
- The 3rd stretcher bar remained largely in position even after the fastenings had become undone from the right hand bracket as the load in this stretcher bar would have been largely taken by the backdrive assembly. The transfer of load from the bracket onto the back drive would have caused a small reduction in free wheel clearance and resulted in flange back contact which may have affected the stress in the stretcher bar and in turn the insulated connection.
- Increased dynamic loading and vibration led to the nuts and bolts securing the 2nd stretcher bar to begin to come loose.
- The absence of any reported defects on the patrol of 11th February 2007 was difficult to reconcile with the available technical evidence. The investigation team noted however that this patrol was split between 2 patrollers without authorisation and the patrol sheet did not record any defects for the entire patrol mileage.
- The investigation team concluded that the bolts remained captive between the feet of the switch and stock rail until the S&C was "tested" ahead of planned Single Line Working operations undertaken on the night of the 14th/15th February 2007.
- Concerning the nuts and bolts securing the bracket on the left hand end of the 3rd stretcher bar, one of which was missing, the standard spring washer had also worked loose.
- The fatigue crack in the insulated connection in the 3rd stretcher bar had propagated through the whole cross section of the bar and failed. The short end of the 3rd stretcher bar became detached from the long end leaving the insulated connection attached to the left hand end of the stretcher bar. This allowed the left hand switch rail to partially close resulting in a free wheel clearance of approximately 31mm.

- This reduced free wheel clearance around the 3rd stretcher bar resulted in back of flange contact with passing wheelsets and was approximately 22mm foul.
- This reduction in free wheel clearance would have led to an increase in the dynamic load experienced by the switch under the passage of traffic.
- The remaining ends of the 3rd stretcher bar then came back together with the short end jammed against the outer face of the gooseneck insulation. A passing wheelset forced the stretcher bar into compression and caused distortion of the outer plate on the connection and broke off the insulation piece from the long end of the stretcher bar due to bending overload. This piece then came to rest in the four foot adjacent to the 2nd stretcher bar location.
- The 2nd stretcher bar became detached from the left hand switch rail because the bolts holding the bracket came undone from the left hand switch rail. This reduced the free wheel clearance to approximately 20mm and further increased the dynamic load experienced by the switch under the passage of traffic.
- The bolts at the right hand end of the 2nd stretcher bar also worked loose and allowed the kicking strap on the left hand end of the 2nd stretcher bar to bounce up and down. The kicking strap made contact and marked the underside of the left hand switch rail over a length of approximately 600mm.
- On the 21st February 2007 the enhanced footage from the NMT train showed significant deterioration in the stretcher bar system; the 3rd stretcher bar had broken, and the 2nd stretcher bar was not fixed in its designed position.
- The right hand end of the 2nd stretcher bar became detached from the switch rail and allowed the stretcher bar to move freely.
- The 2nd stretcher bar had then dropped down at the right hand end into the increased gap between the switch rails and fouled the slide chair and switch rail foot. The stretcher bar became trapped and was subjected to large compressive loads under traffic.
- The long end of the 2nd stretcher bar had broken off through the first bolt hole in the gooseneck insulation due to tensile or bending overload and allowed both halves to separate and fall to the four foot where they were picked up either by an earlier passing vehicle or the derailed train and thrown down the track.
- The remaining half of the bracket at the left hand end of the 1st stretcher bar broke and allowed the switch rail to close.
- The Aerotight nuts securing the front lock stretcher bar had worked loose. One bolt became trapped between the toe of the left hand switch and the stock rail. The other bolt was never found. The nuts showed signs of distortion from re-use which may have reduced the torque prevailing properties and made them more susceptible to loosening from vibration.

- The left hand switch rail then closed up against the head of the lock stretcher bar bolt which left a toe opening on the left hand switch rail of approximately 32mm. At the time of the derailment the right hand switch was correctly locked to the right hand stock, but the left hand switch was free and able to move 'downhill' *(the S&C is located on 100mm of cant)* and closed the gap between the left hand switch and stock rails. This was limited by the presence of one of the lock-stretcher bolts which were lodged between the two rails.
- The lock stretcher bar, FPL detector rod, left hand switch detector rod and left hand switch extension piece all remained connected to the right hand closed switch rail or point machine as appropriate and thus detection was maintained. Only the left hand switch rail was free to move due to the total failure of the stretcher bar system.
- One or two wheel flanges then struck the tip of the left hand switch rail. At least 4 flanges made contact with the left-hand switch rail and climbed into derailment. It is likely these were the wheels associated with the rear bogie of the leading vehicle and the lead bogie of the second vehicle. All the remaining wheels of the train derailed north of 2B points, dragged into derailment by the derailment of preceding wheelsets, i.e. most of the derailed vehicle went through on the normal route with one or two vehicles appearing to take the turnout route.

E4. Access Issues

E4.1. In December 2005, in order to facilitate the new winter timetable, EPS running was introduced north of Preston, through to Carlisle. The straighter sections of the route experienced a linespeed increase from 110mph to 125mph (14% increase); curved locations (with pre-existing local permanent speed restrictions (PSRs)) experienced similar percentage increases; Lambrigg GF stepped up from 85mph to 95mph (12% increase).

E4.2. Consequently, following a full pre-EPS review, resourced by the West Coast Route Modernisation Project (WCRM), many infrastructure activities – including track inspection and routine track maintenance tasks – previously carried out with lookout protection under red zone conditions – became prohibited as large areas became either red zone prohibited or red zone restricted.

E4.3. Various options to undertake patrolling and track maintenance activities were considered – including applying new technology, improved logistics, application of 'Design Patrolling' and TSRs imposed for the duration of mandated inspections.

E4.4. The 'Proof of Maintainability' documentation was signed in October 2005 with a caveat concerning patrolling / inspection / maintenance; specifically for medium and long term solutions to be developed with WCRM input and resources assisting the maintenance manager.

E4.5. The investigation team reviewed the Proof of Maintainability document and was unable to establish if any risk assessment activity was undertaken to determine if resources currently available were sufficient to inspect and maintain the track infrastructure after the introduction of EPS, within the more restricted access available.

E4.6. The immediate (short-term) solution was to carry out patrolling and essential maintenance in Sunday morning access, available every week. This enabled inspections and work to be carried out to mandated timescales, but created an intensive period of activity each Sunday morning, which stretched the available in-house resources. This placed reliance on volunteers and therefore use of overtime.

E4.7. The investigation team observed that no risk assessment activity was undertaken and the maintenance manager's statement that he didn't have the means to do so. Although he accepted that he was quite capable of conducting a risk assessment but felt it was not relevant to the short term patrolling and inspection regime that evolved post- the introduction of EPS running. Both the maintenance manager and his safety advisor were competent in the principles of risk assessment, and the maintenance manager was familiar with the mandated frequencies in respect of patrolling and inspection and the resources he had available to discharge those activities. Therefore not only did the right skills exist within his team to undertake this assessment, he had readily at his disposal the management data.

E4.8. In discharging his action contained in the Proof of Maintainability document regarding confirming the ability to deliver the patrolling and inspection regime following changes to the Hazard Directory, the investigation team considers that due management attention appears not to have been given to this issue.

E4.9. Joint plans were produced between the maintenance manager and WCRM to enable this arrangement to take place. The investigation team noted that the implementation of those plans has been compromised by the unauthorised practice of splitting patrols.

E4.10. The investigation team noted that as patrolling and inspections activities were constrained to Sunday mornings for 40 miles of the WCML Route. Patrolling was allocated randomly to available experienced staff, rather than regular staff being assigned to a specific section of track. The ability to inspect the track under load (although not mandated by Group and Company Standards) was also compromised.

E4.11. The investigation team noted that the intended short term solution to inspection and patrolling has migrated into an extended period. The resolution to this arrangement is all the more important with the implementation of the 2008 timetable which further constrains access.

E5. Patrolling

E5.1. The investigation team identified a systematic failure in the track patrolling regime and its management on the local area. This manifested itself in the following ways:

- direction of patrolling not managed;
- specific track (i.e. Up or Down) to be patrolled not managed;
- no patrolling diagrams;
- random allocation of patrollers to patrol lengths;
- competency certification lapsed;
- no post-patrol reviews between patroller and local manager;

- no surveillance or verification of patrolling activity;
- no mentoring of new patrollers;
- unauthorised re-allocation of patrolling workload by patrolling staff;
- use of pre-existing defect lists by patrollers not consistent;
- variable patrollers' reports – i.e. one signature covering several unauthorised patrollers inputs;
- no policy for marking of defects on site;
- no review of COSS patrolling paperwork to check working arrangements.

E5.2. All patrollers confirmed they would visually inspect the stretcher bars in the switch panel – and enhance the visual inspection by 'kicking' the stretcher bars to listen and watch for any loose components.

E5.3. The investigation team identified that patrol reports were signed off by the local management team without any clarification of supplied data or details reported. The patrollers also consistently stated they were very rarely accompanied by supervisory/management staff. Thus the work and patrol outputs were not checked. It was noted that a check on the quality and content of the patrol reports was dependent on the thoroughness of the local management, comparing reports with his own separate visual inspections (2 monthly for S&C, 3 monthly for plain line).

E5.4. A general theme presented by patrollers interviewed by the investigation team was that patrollers were under pressure, from the PICOP, to clear the track up to one hour before the possession was due to be terminated, although issues concerning access are dealt with separately, the investigation team could find no evidence to support this theme.

E5.5. The investigation team examined several examples of COSS paperwork and cross checked with the patroller and confirmed that the COSS procedure had not been applied compliantly; there were examples of one patroller logging in on behalf of several patrollers.

E5.6. Patrollers were rarely allocated to the same patrol in successive weeks; so the pattern of patrollers being matched to specific patrols tended to be random. In one ten week period between November 2006 and February 2007, the patrol between 19mls 00yds to 24mls 440yds was undertaken by 10 different patrollers. This meant that ownership and understanding of deterioration rates for specific sections of track and discrete defects was compromised.

E5.7. The investigation team reviewed competency of the patrollers interviewed. It was alleged by a number of witnesses that a dispensation was authorised in respect of lapsed competency. The investigation team found no evidence to suggest that any dispensation existed.

E5.8. During interview the investigation team exposed a local unauthorised practice that had been used for at least two winters concerning the 'splitting' of designated patrols into two or three 'sub-patrols'. The strategy enabled, for example, a 6 mile designated patrol, allocated to 1 patroller, to be carried out by 2 or 3 'sub-patrollers', each doing 3 or 2 miles – the end result being complete coverage of the designated patrol, in significantly less time.

E5.9. The track patrol sheet would then be completed and signed by the designated patroller, using defect notes provided by the 'sub-patrollers', along with his own. The sub-patrollers' utilised in this practice were regular patrollers, with patrolling experience, but not necessarily in-date certification.

E5.10. The patrolling staff involved with this practice claimed they had not agreed or discussed the practice with local management. In the opinion of the investigation team this practice evolved, because of time constraints particularly in the winter months and was the least effort to achieve the task.

E5.11. The practice compromised the quality of defect reporting, in that patrollers were on occasions reporting defects that they had not observed for themselves. It was also noted by the investigation team that when reviewing the spread of defect reporting there was little consistency and on certain occasions – the 11th February 2007 being an example – the number of defects reported on patrols are minimal and it is difficult to reconcile these patrols with other patrols of the same mileage which appear to be of a greater quality in respect of defect reporting.

E6. Points Maintenance

E6.1. The investigation team noted from photographic evidence of 2B points dated April 2004, a residual switch opening of 5 to 7mm in the vicinity of the 3rd stretcher bar. This could have been caused by a combination of the following: a short stretcher bar, incorrectly adjusted back-drive or a widening of track gauge over time or the result of an historic run-through. Due to high cant deficiency at 2B points, passing wheelsets forced the residual switch opening to close creating cyclic loads in the 3rd stretcher bar assembly.

E6.2. Maintenance of the points in the Carlisle area including Lambrigg 2B points is carried out by the JPT at Carlisle. Evidence gathered by the investigation team gives rise to the following concerns:

- there is no requirement in the current Signal Maintenance Specification (SMS) to check, measure or adjust the residual switch opening;
- current instructions are functionally written and do not fully align with the joint working approach adopted in the Lancs & Cumbria area;
- lack of clarity by line-management of elements of the team leading to
    - inadequate surveillance of the team activities;
    - inadequate briefing of standards;
    - the use of out-of-date documentation.
- lack of functional ownership of stretcher bars within the Lancs & Cumbria area reducing the quality and integrity of stretcher bar checks;
- the falsification of NR/SP/TRK/053 records;
- in respect of Lambrigg 2B points, the failure to detect long standing fatigue cracks;
- the practice of updating photocopied records of the previous inspections;
- the overall workload of the unit which requires some 2400 maintenance and inspection activities per annum on 273 point ends;
- the short time taken to carry out FPL testing on 9th January 2007;
- the inconsistent equipment used for measuring free wheel clearance;

- the variable use of spanners and torque-wrenches for checking bolt/nut assemblies.

E6.3. The former maintenance contractor (prior to maintenance being taken in-house by Network Rail) introduced JPTs whilst they were contracted by Railtrack to maintain railway infrastructure in the area. This method of working has been continued by the Lancs & Cumbria staff following their transfer into Network Rail.

E6.4. The use of the joint point inspection (PA11) form dates from its early introduction by the maintenance contractor and continued use was allowed by local management. Failure to take into account changes to standards and responsibilities rendered the form out of date. The JPT practice of photocopying previously used forms including the tick boxes compromised the intention of the check list acting as an aide-memoir to staff so tasks would not be overlooked.

E6.5. The local signal engineering management team did not brief signal technicians in detail about changes to the point SMS's in April 2006. Had they done so this might have provoked questions about the continued use of the form. There is no doubt both signalling and track local management knew the form remained in use because the JPT sent completed forms to them. However, local management did not update the PA11 Joint Point Inspection form to reflect new organisational responsibilities and standards.

E6.6. On 17th December 2006 the signalling members of the JPT carried out quarterly maintenance of 2B points. The signalling side of the PA11 joint inspection form was completed but the track side was struck through with a line as track team members were not present. The signalling team claimed the points were in "perfect condition" on this date although the investigation team believe fatigue cracks were already developing in the 3rd stretcher bar goose neck and first stretcher bar left hand bracket. The investigation team believe that the integrity of this maintenance was compromised by the absence of the track team members and deficiencies in the processing of paperwork.

E6.7. FPL testing was carried out by the JPT on 9th January 2007 and 31st January 2007 with nothing untoward found. The JPT claim they checked the stretcher bars during these tests although they are not required to by the standard.

E6.8. However, given the time taken by the JPT team to undertake the FPL tests on the 9th January 2007 and a review of timings available from phone calls at the start and end of the work the investigation team do not believe they would be able to spend any time robustly checking the stretcher bars during this visit.

E7. Supervision

E7.1. The investigation team identified a systematic failure in the supervision and management regime employed in the maintenance delivery organisation. This manifested itself in the following ways :

- poor surveillance and verification of physical activities, e.g. patrolling , FPL testing, competency, signing off of records, hours worked;
- prevalence of a 'them and us' culture;
- high number of key staff acting higher-grade-duty for a period of time;
- supervisors employing unsafe inspection arrangements;
- non-compliant inspections e.g. mandated gauging not being carried out;

- sparse safety tour activities, leading to low interaction with out-based staff;
- Local management team covered responsibilities by activity rather than location or alignment to specific staff groups;
- no review of patrolling activity output with patrollers;
- absence of a simple training records and competency management system for use by supervisors and managers.

E7.2. The investigation team further considered that local management planned a supervisory inspection on Sunday 18th February 2007, which is a visual inspection. On this date the mileage of the routine track patrol between 19mls 00yds and 24mls 440yds (Lambrigg) was scheduled to be completed. However, a local manager forgot the scheduled walk limits and only completed the section from 19mls 00yds to 23mls 650yds, omitting the planned inspection of Lambrigg S&C. The investigation team were further concerned that the situation was not recovered when the patrolling inspection was countersigned for the adjacent section of line patrolled on Sunday 18th February 2007 when the plan-do-review meeting was held on 19th February 2007 and did not realise there was a gap in the patrolling undertaken.

E7.3. In the opinion of the investigation team, an adequate basic visual patrol of 2B points on 18th February 2007 would have detected evidence of deterioration in the components of the 2nd and 3rd stretcher bars – prompting remedial action. Therefore the failure to undertake the basic visual patrol on the 18th February 2007 is causational.

E7.4. The investigation team does not believe the mandated frequency of basic patrolling inspections specified within NR/SP/TRK/001 is a causal factor to this incident.

E7.5. The investigation team also noted that numerous supervisory inspections, including NR/SP/TRK/053 and NR/SP/TRK/054, and plain line and S&C inspections, were undertaken by local management, with no safe system of work in place with the individuals inspecting under IWA conditions. This meant that mandated gauges were not used, the line was inspected from the cess, and therefore these inspections were not compliant.

E8. Condition monitoring of the track including faulting history for 2B points from January 2006 to 23 February 2007

E8.1. On 13th June 2006, a loose PW bolt was reported between stock and switch rail on a slide baseplate at Lambrigg although the records do not show at which point end. The fact that the report refers to the bolt being on a baseplate discounts the likelihood of it being associated with the stretcher bar system. The investigation team considered this defect was not material to the investigation and did not investigate further.

E8.2. Overnight on the 6/7th January 2007 overnight maintenance work took place at Lambrigg 2B points. The planned work involved track work to address a Critical Rail Temperature (CRT). The local manager who lead that work claimed that work on Lambrigg 2B points was severely disrupted because a passage of the Long Welded Rail (LWR) train prevented ballasting work being carried out on 2B points. During detailed questioning the local manager conceded that the planned LWR train movement had been on his worksite for 17 minutes and had not been sitting on the S&C for any considerable time and therefore had not severely disrupted the work.

E8.3. At 09.10hrs on 7th January 2007 after the overnight maintenance work on Lambrigg GF IFC at Birmingham were contacted by a patroller, who reported that nuts were missing from the third stretcher bar hanger bracket on the six foot side of 2B points at Lambrigg. The track patrol sheet record states that "2 bolts were missing". At interview when challenged about the discrepancy between his conversation with IFC and the written record, he stated the written record was an error it was the nuts that were missing, the bolts were still there and were greasy in appearance.

E8.4. The investigation team considered how it could be, that after overnight maintenance at Lambrigg GF, within 2 hours of the maintenance team leaving site, fastenings on the 3rd stretcher were found disconnected. It was established that no evidence existed that would indicate any work overnight on the 6th/7th January that would have compromised the integrity of the fastenings of the 3rd stretcher. It is therefore concluded that upon completion of the weather disrupted work the local manager in charge did not establish that the site was in a safe condition in particular the stretcher bars and fastenings.

E8.5. Given the conflicting evidence offered to the investigation team, by the local manager in particular in connection with the time the LWR occupied his work site, there is some doubt in the investigation team's considerations as to the extent of work that took place at Lambrigg overnight on the 6th/7th January 2007.

E8.6. The patroller did not invoke a speed restriction in accordance with the Track Inspection Handbook (TIH) on the basis that the line was within a possession and there were no trains to run over the affected portion of the line before the fault team could remedy the situation. Nevertheless, the patroller did advise the PICOP of the circumstances.

E8.7. The investigation team noted that the patroller correctly described the fault on his patrolling record as a fault based on the level of risk and requiring immediate attention and the IFC recorded this incident as lower level of risk.

E8.8. Discrepancies exist between the fault team and the patroller as to the actual condition of the bolts on the 3rd stretcher bar right hand end. The technical evidence partially supports the fault team version that both nuts and bolts were off the 3rd stretcher. The patroller's written record also indicates bolts missing although the voice recording of the conversation between the patroller and fault controller indicates nuts run off. The investigation team have considered this sequence of events in some detail and have concluded that it is difficult to explain the discrepancy between the patroller's verbal and written evidence but on considering the technical evidence it is probable that neither nuts and bolts were in situ.

E8.9. It was offered as evidence that an FPL test was conducted afterwards, but this action was not recorded on the site record card by the FTL. It was also noted that appropriate arrangements/COSS documentation was not completed.

E8.10. The investigation team could not reconcile the team leader's assertion that 'brand new' square headed bolts and nuts and washers had been fitted as subsequent technical examination has established that the hexagonal nuts and square headed bolts found in the vicinity of the 3rd stretcher bar right hand switch rail are the "newest " components found.

E8.11. The investigation team concluded that prior to 7th January 2007; Lambrigg 2B points had no significant failure history.

E9. Management and Leadership

E9.1. The investigation team was concerned about supervisory practices and sought to determine to what extent, if at all, the local management team was aware of the issues and of any actions being taken to address them.

E9.2. It was clear to the investigation team that the relationship between management and the supervisory tier was poor and had been so for some time prior to the incident. This was evidenced, in part, by numerous e-mail exchanges, often very direct in nature, made available to the investigation team between the local track unit and maintenance delivery unit about difficulties being experienced by supervisors in gaining access to the track, reducing critical backlog, implementing training and conducting supervisory inspections.

E9.3. The response of the management unit to these issues was inconsistent, for example while there were projects ongoing to examine new access arrangements and there was evidence of attempts to resolve other difficulties reported by the supervisors, these had long lead times and there was no evidence of any short term resolutions.

E9.4. To the contrary, pressure was brought to bear upon the track maintenance unit to reduce critical backlog inspections within current access arrangements. No evidence was forthcoming that indicated that any individual within the management team sought to challenge the integrity of the reduction of critical backlog inspections given the obvious access and resource constraints that existed north of Preston following the introduction of EPS.

E9.5. While attempts to bring about such reductions in itself would be laudable, it is unlikely to have positive effect without an understanding of how it would be delivered in practice. Indeed in this case, while a marked reduction in the backlog was observed this was in part achieved through non-compliant supervisory inspections, i.e. without use of correct gauges, which were conducted outside of the required personal safety rules.

E9.6. The investigation team were surprised that more attention had not been given by the management unit to the continued robustness of the short term solution to inspection (namely access during weekend possessions) given that the same unit had raised such concerns about access with the WCRM (to the point that caveats were placed within the "Proof of Maintainability" document) prior to EPS introduction. Although the maintenance manager stated that he had attended a weekend winter possession shortly after EPS commenced, for the purpose of satisfying himself that patrolling arrangements were adequate (and concluded that they were, though inefficient), there was little evidence after that of any other forms of surveillance of patrolling and inspection practices. Instead the focus was upon the promise, and development, of longer term solutions while the current practices were largely left unchecked while poor practices and habitual rule violations continued.

E9.7. Outside of direct surveillance activities, other opportunities for the management unit to understand the daily inspection and maintenance practices being employed were missed.

- the visibility of local management to front line teams was limited and the investigation team could not establish a management plan of visits to locations such as Oxenholme, Lancaster or Tebay. All parties interviewed confirmed that such visits were infrequent and staff based at such locations could not recall any visits at all;
- the excessive workloads of local engineers reduced their involvement in front line activities and their ability to fully execute their safety assurance roles;
- the local signal engineer has been diverted from key responsibilities to resolve general management issues such as materials supply with only 5% of working time spent on checking compliance with maintenance and inspection standards and wrong side failure management.

E9.8. Although it is difficult to accurately characterise the cultural characteristics of an organisation the investigation team is in no doubt that a "them and us" culture had developed between the track supervisory tiers and maintenance management tiers.

E9.9. This was reinforced by a management team that appeared to be striving for attainment of 'green' KPIs and targets whilst neglecting the interaction within the delivery unit, incorrect focus of efforts of key personnel with the maintenance manager's direct report team.

E9.10. For the local management team this arose from a number of sources including

- the perceived slow progress being made on matters they had been raised coupled with continued and direct pressure to deliver maintenance targets;
- discontent about new arrangements since NR brought maintenance back into the organisation, and particularly about new arrangements for training and assessment;
- a lengthy period of time where posts are covered on higher grade duty;
- a lack of visibility of management at depot level.

This collectively gave them the impression that their management cared little for them or what they did, providing that key performance indicators were met.

E9.11. Ironically the Management Unit in many ways had similar concerns as the supervisory tier – a belief that the move to EPS had been forced upon them without their concerns regarding access being addressed in a timely fashion and continued pressure to deliver maintenance and inspection targets. Taking this as the reality they faced, they attempted to try and manage the delivery of maintenance and inspection with a supervisory structure which was becoming distant from them.

E9.12. From this situation arose a position where it appeared from the reporting and recording systems that all patrolling and inspections were being achieved, however the reality was, in many instances, they were not being conducted to the appropriate standard and the local management and supervisory regime failed to detect this.

E10. Organisation

E10.1. The investigation team had some difficulty in identifying where responsibilities lay**.** The local engineers in their view provided technical advice to the maintenance teams. But there was a lack of clarity on checking competence, and job descriptions of area engineers were open ended, and it was unclear whether area engineers were responsible for the competency of their direct reports only or whether they were to take a greater overview of competency or asset condition as part of assurance and compliance.

E10.2. The investigation team had concerns that the JPT dealing with 2B points were direct reports to the local track and signal engineers whilst the track safety-of-line responsibility for the site at Lambrigg was the responsibility of the local management team. This creates more lines of communication with local management losing direct control over some of the resources that inspect and carry out maintenance on the points.

E10.3. Numerous employees, i.e. patrollers, a track chargeman, assistant section managers and one senior manager, were unclear who the track members of the JPT (who were responsible for NR/SP/TRK/053 inspections) responded to. The track members of the JPT clearly felt isolated and this was demonstrated in that both members still used 1997 documentation for guidance on NR/SP/TRK/053 inspections despite revision of the specification as Issue 3 in October 2002.

E10.4. The investigation team noted that there was a Network Rail organisation chart and a Carillion organisation chart still in circulation to support the Carillion job descriptions that are currently in place because certain employees have chosen not to sign new job descriptions.

E10.5. The charts gave conflicting information on accountability for the track members of the point inspection team.

E11. Human factors

E11.1. The investigation team noted that the Lambrigg GF was at the southern extremity of the Carlisle JPT area of responsibility, whereas the track asset responsibility for the location rested with the local management.

E11.2. The S&C might have been perceived as low risk infrastructure by the JPT due its infrequent usage as a single line working facility. Evidence presented to the investigation team indicated that, its ownership was undoubtedly compromised in the eyes of the local management team.

E11.3. The investigation team noted that supervisory inspections were carried out without adequate protection arrangements in place which were conscious violations and deviations from the prescribed processes.

E11.4. There was some discord between the local management team and area line management particularly around issues such as track access and training. This created a disrespectful environment and reinforced the "them and us" mentality.

E11.5. Numerous patrols were carried out by staff with lapsed certification; albeit the employees with lapsed certification had experience spanning up to 34 years. This situation was identified to the local management, but not corrected, potentially leading to a lowering of importance associated with the patrolling activity for the staff involved.

E11.6. This local environment created a culture of learned helplessness which affected their decisions and actions resulting in a management style where breaches were left unchecked and observance was unrewarded.

E11.7. The group cohesion also had a negative effect in that failure to follow rules and standards was not reported or acted upon. This behaviour was reinforced by the supervisors as they themselves failed to adhere to rules and standards. This culture is evidenced by the lack of any anonymous safety reports or evidence of individuals invoking the work safe procedure.

E11.8. Patrolling without lookouts formed part of the behavioural culture. The unauthorised splitting of the patrolling by using the lookout to patrol part of the section of line was a routine violation and required the minimum time to achieve the task.

E11.9. This practice evolved at Tebay because there was no effective surveillance regime for patrollers in place and no verification of paperwork was being undertaken. The investigation team noted that failings by individuals or organisations remote from outside the local area were regularly picked up after each weekend and followed through. This reinforced the investigation team's view of a "them and us" culture. The fact that the missed basic patrol mileage at Lambrigg on the 18th February 2007 was not picked up by the local team is a further illustration of this fact.

E11.10. The investigation team also noted that the geographical challenges of the Lancs & Cumbria also contributed to the culture as the opportunity for regular face to face dialogue was diminished.

E12. Assurance

E12.1. The investigation team identified a systematic failure in the assurance regime, on the Lancs and Cumbria area. This manifested itself in several ways:

- the systematic failings of basic visual patrolling and supervisory inspections;
- surveillance plans not implemented in some disciplines, and where implemented no tracking or adherence to;
- the absence of basic management verification activities;

- failure to provide adequate cascade briefing arrangements for the introduction of new/amended standards;
- competency management in particular patrollers not monitored and managed;
- senior personnel whose responsibilities include assurance diverted to general management tasks, therefore basic responsibilities remained incomplete;
- current, i.e. Network Rail Organisation charts and JDs not authorised or being adhered to;
- basic visual patrol mileages not completed remained undetected and therefore not acted upon;
- self certification process not adequately understood by team leaders.

E12.2. The investigation team had concerns that the local engineer had volunteered or been volunteered for various initiatives one of which was the ordering of equipment for the entire area not exclusive to signalling equipment, even though there were those within the maintenance delivery organisation charged with this responsibility. It was noted that the local engineer had received the surveillance plan two years ago and not approved it through pressure of work – citing that "it is not uncommon to work up to a 60 hour week and they had not got to it, though it was the same as the previous plan". The investigation team also had concerns with the local engineer stating there was rarely time to deal with wrong side failure management as evidenced by the large backlog in SINCS files on the area.

E12.3. The investigation team noted the surveillance regime had been subject to a minor non-conformance report raised by the National Core Audit Programme (NCAP) audit team in January 2007 where the surveillance of signal engineering fault teams had been based on surveillance of the team rather than the individual. The local engineer gave an assurance to the investigation team that based on regular meetings with the local signal engineers it was clear that remedial action had been taken but the local engineer had not undertaken a verification check.

E12.4. The investigation team noted that the local track engineer could not recall completing an annual self certification assurance certificate which was an important way of alerting senior managers regarding lapsed certification and the consequential risks.

E12.5. The investigation team noted that, with the withdrawal of the previous training organisation, the local track team had no records to identify when certificates were to expire but had latterly created a training needs analysis spread sheet to identify what competencies were needed and when they were to expire.

F. Recommendations and Action Plans

F1.1. Network Rail to review the maintenance organisation with the objective of strengthening reporting lines for the maintenance delivery unit and alignment with their counterparts within the area engineering function.

Intention to: clarify roles and responsibilities of area engineering and delivery units.

F1.2. Network Rail to review the design of points and components including fixed stretcher bars and associated fastenings, with particular reference to points on curves.

Intention to: confirm the provision of adequate safety margins and tolerances

F1.3. Network Rail to review work instructions, procedures and specifications used by installation and maintenance teams in respect of points systems.

Intention to: Confirm specifications and work instructions, including defect management, are adequately precise in their requirements.

F1.4. Network Rail to consider the practicability of implementing a procedure which provides that when any component (excluding fastenings) of a fixed or lock stretcher bar requires replacement, then the complete stretcher bar assembly should be replaced with new components including nuts bolts and washers.

Intention to: Improve the mechanical integrity of the stretcher bar system.

F1.5. Network Rail to consider the practicability of implementing a procedure where any fixings or lock nuts for items fixed to the stock or switch rail are found to be loose then both nuts, bolts and washers are replaced with new components.

Intention to: Improve the mechanical integrity of the stretcher bar system.

F1.6. Network Rail to review the arrangements and responsibilities for managing and providing instruction, technical briefing, supervision and adequate surveillance where joint point teams exist.

Intention to: Provide clear lines of responsibility and understanding for management of the JPT including briefing on technical standards and that appropriate surveillance regimes are in place.

F1.7. Network Rail to standardise documentation used for inspections to provide positive confirmation of asset condition. In association, consideration is to be given to the practicability of the use of tamper proof date stamped photographs being submitted to support annual, quarterly NR/SP/SIG/10660 and NR/SP/TRK/053 point inspections.

Intention to: Enhance inspection records by recording actual condition measured or observed.

F1.8. Network Rail to review the training programme and pre-existing competencies relating to point systems.

Intention to: establish whether an enhancement to training is necessary.

F1.9. Network Rail to consider implementing a patrolling procedure which specifies the following minimum requirements: patrol details to be on diagrams, start and finish, direction, line to walk, use of walkout report, tools to be carried, marking of defects on site, incomplete patrol process, signatures required and use of Track Inspection Handbook, and actions for defects encountered.

Intention to: Provide a consistent procedure for the management of track patrolling capable of verification and audit.

F1.10. Network Rail to consider putting in place arrangements for all relevant senior line managers to receive process safety management training.

Intention to: Support the management of system safety

F1.11. Network Rail to consider inclusion within its risk assessment methodology the impact of train timetable changes on the maintenance system.

Intention to: To ensure maintenance and inspection activities can be safely carried out to the required specifications, when traffic patterns and track access change.

F1.12. Network Rail to review the effectiveness of the line supervisory/management surveillance regime for track patrolling, and all aspects of switch inspection with focus on how physical work is carried out.

Intention to: Develop a sustainable surveillance regime and provide good practice on-site guidance and direction.

F1.13. Network Rail to review the effectiveness and impartiality of the present audit and self assessment assurance regime relating to asset condition and safety critical activity, to include a level of physical inspection of both.

Intention to: Provide impartial audit processes capable of reviewing the full scope of work activity and associated documentation.

F1.14. Network Rail to review whether there are technical standards which require delivery of an in depth briefing and consider ways in which this will engage relevant employees at all levels.

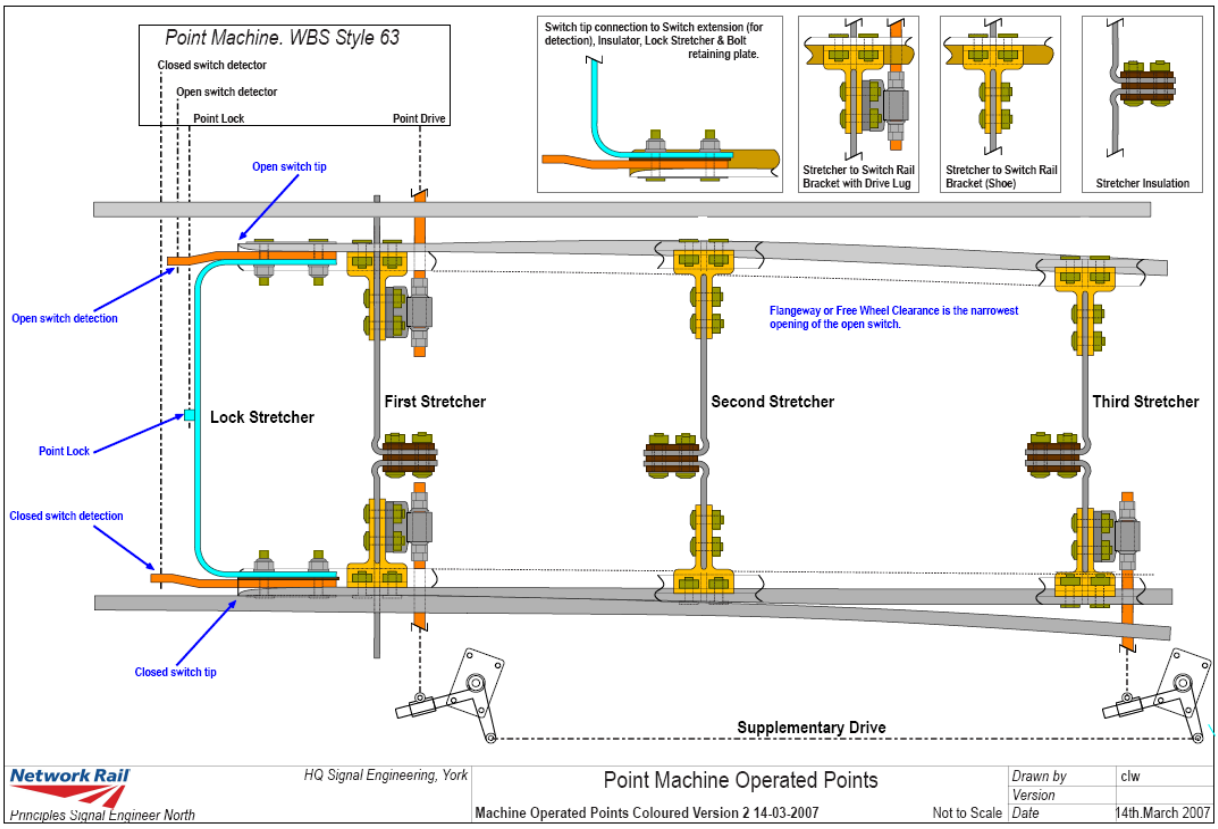
Intention to: Improve the understanding of briefed standards and increase retention of delivered material.

F2. Action Plans

As well as the 14 recommendations contained in paragraph F1 above, the investigation panel also put forward 19 action plans. The action plans relate to individuals and will not be published in this summary report in order to maintain confidentiality.

G. Appendices

G1. A schematic diagram of CV points



G2. Glossary of abbreviations, acronyms and terms

AiTL	Assessment in the Line
BTP	British Transport Police (a Police Force which operates on the national rail network)
COSS	Controller of Site Safety (a person responsible for establishing and maintaining the arrangements for the safety of personnel working on or near the line, in relation to the movement of trains)
CRT	Critical Rail Temperature (the rail temperature at which a specific action is required to preserve the safety of the track)
CWR	Continuous Welded Rail (produced by welding several rails into one continuous length)
DML	Down Main Line (generally the line taking trains away from London)
EPS	Enhanced Permissible Speed (a speed limit on certain stretches of line which applies to passenger trains which have tilting equipment in operation)
ES	Engineering Supervisor (responsible for the provision of Rule T3 which relates to worksites)
FPL	Facing Point Lock (the device which locks points (switches) in position)
FTL	Fault Team Leader
FWC	Free wheel clearance
GF	Ground Frame (a set of points controlled from the trackside, not by the signaller, but able to be locked and unlocked only on the signaller's authority and action)
Green Zone	An area of track where train movements have been stopped to enable work to be carried out
HMRI	Her Majesty's Railway Inspectorate
HSL	Health & Safety Laboratory, Buxton
IBJ	Insulated Block Joint (a joint between two rails)
IFC	Infrastructure Fault Control (an organisation within Network Rail that controls the real-time reporting and rectifying of infrastructure faults)
IRSE	Institution of Railway Signal Engineers

IWA	Individual Working Alone (a specific personal safety competence relating to a person who has been trained and assessed as competent to work alone on the track)
JPT	Joint Point Team – A team made up of different disciplines within the maintenance function tasked with the care and upkeep of points in a local area
KPI	Key Performance Indicator
LOWS	Lookout Operated Warning System (equipment for warning personnel working on the track of approaching trains during Red Zone working)
LWR	Long Welded Rail (rails which are up to 180ft in length)
NCAP	National Core Audit Programme
NCR	Non-conformance Report
NMT	New Measurement Train (a high speed train with equipment for measuring track geometry)
OLE	Overhead Line Equipment (provides electric power to trains on 25kV AC electrified routes)
OTM	On-track Machine (an engineer's train used for track work)
PICOP	Person in Charge of Possession (responsible for providing the 'protection' at each end of the possession, taking possession of the line from the signaller etc.)
PPE	Personal Protective Equipment
PSB	Power Signal Box
PSR	Permanent Speed Restriction (applied to a portion of track where it is not permissible for trains to travel at line speed)
PTS	Personal Track Safety (a competency certificate issued to a person who has satisfactorily completed a course and is therefore competent to walk on the track or be under the control of a COSS)
PW	Permanent Way (generic term used to describe the various components which constitute the structure on which trains run, often referred to as the track)
Red Zone	An area of track where personnel are working and train movements have not been stopped

RIMINI	Risk Minimisation (track access planning designed to minimise the risk to the safety of the personnel involved)
RRV	Road Rail Vehicle (a vehicle which is capable of working on both roadways and railways)
RSO	Residual switch opening
SGT	Structure Gauging Train (a train equipped with specialised equipment for measuring and recording structural clearances)
S&C	Switch and Crossing (the arrangement of rails which enables a train to move from one line to another)
SINCS	Signalling Incident Management System
SLW	Single Line Working (a form of operation which enables to trains to run in both directions when only one line is available)
SMP	Standard Maintenance Procedure
SMS	Signal Maintenance Specification
SMTH	Signal Maintenance Testing Handbook
SOP	Standard Operating Procedure
T2	The protection of engineering work or hand trolley on a line not under a possession
T3	Possession of the line for engineering work
T12	The protection of personnel carrying out activities on the line that does not affect the safety of the line
TASS	Tilt Authorisation Speed Supervision (pieces of equipment on the track which send messages to tilting trains in connection with the operation of on-board tilting equipment)
TIH	Track Inspection Handbook
TPWS	Train Protection Warning System (an automatic train braking system that will automatically apply the brakes of a train if it passes a red light or approaches a red light too quickly)
TRV	Track Recording Vehicle (sensitive equipment which can measure and record track geometry imperfections/faults)
TSR	Temporary Speed Restriction (applied when it is necessary for the speed of trains to be reduced below the actual line speed)

UML	Up Main Line (generally the line taking trains towards London)
WAIF	Work Arising Input Form
WCML	West Coast Main Line
WCRM	West Coast Route Modernisation Project