Rail Accident Investigation Branch

Rail Accident Report

Derailments at London Waterloo
11 September and 24 October 2006

Department for Transport

Report 44/2007
December 2007

This investigation was carried out in accordance with:

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

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Introduction

1 The sole purpose of a Rail Accident Investigation Branch (RAIB) investigation is to prevent future accidents and incidents and improve railway safety.

2 The RAIB does not establish blame, liability or carry out prosecutions.

3 Access was freely given by Network Rail to their staff, data and records in connection with the investigation.

4 Appendices at the rear of this report contain the following glossaries:

- acronyms and abbreviations are explained in Appendix A; and
- technical terms (shown in *italics* the first time they appear in the report) are explained in Appendix B.

5 The descriptors left and right are used in the direction of travel of the appropriate trains for a *facing movement* over the points concerned. Hence for the first incident (1565 points), direction of travel is southwards away from Waterloo station, whereas for the second incident (1507 points), direction of travel is towards the station.

6 The references in this report to Waterloo station only refer to platforms 1 to 19 of the station and not to Waterloo International or Waterloo East stations. All distances *(chainages)* are measured from a zero point at the *buffer stop* line in Waterloo station.

Summary of the report

Key facts about the derailments

7 At 22:48 hrs on 11 September 2006, a train formed of two class 455 electric multiple units derailed on 1565 points, which were traversed in the *facing direction* as the train made an *empty coaching stock* move into Waterloo south sidings. The points had recently been subject to unplanned maintenance.

8 At 18:27 hrs on 24 October 2006, a loaded passenger train, also formed of two class 455 units derailed on 1507 points, which were traversed in the facing direction as the train approached Waterloo station from Dorking. These points had also been subject to recent unplanned maintenance.

Immediate cause, causal and contributory factors, underlying causes

9 The immediate cause of both derailments was the condition of *switch blades* within each set of points. These exhibited known derailment risks which had not been identified by the routine inspection process or by detailed inspections following maintenance activity.

10 Causal factors were:

a. a visual inspection practice which failed to properly identify defects;

b. a reporting practice which resulted in essential information on the condition of the points being routinely unavailable to the Track Section Manager (TSM) and others with responsibility for track maintenance;

c. at 1565 points, a grinding repair that failed to correct an existing rail profile defect and increased the surface roughness of the switch blade without applying lubrication; and

d. at 1507 points, the repair of the defective switch blade which introduced a sharp edge along its upper surface, and exacerbated the derailment risk presented by an already defective and unlubricated switch blade profile.

11 Contributory factors were:

a. the Facing Point Inspection form (FPI form) used for recording three-monthly inspections,which was not effective in supporting the defined inspection process;

b. the lack of guidance within the applicable standard on the scope of both visual and increased-frequency inspections;

c. track access time during dayshift working, which was limited and compromised the effectiveness of the *switch* inspection regime;

d. the provision of insufficient special inspection resources, which led to the Asset Inspectors having a significant and unremitting workload;

e. lack of planning support, which placed an additional burden on the asset inspectors and did not result in track protection arrangements appropriate to their needs being arranged;

f. the Track Section Manager not being trained or certified competent to undertake the necessary switch inspections, which led to over-reliance on the asset inspection regime;

g. the lack of transfer of records or plan to install the replacement half set at 1565 points, which allowed the defective rail to remain in the track for an extended period;

h. not observing the switch blade closed against the *stock rail*, or correctly recording the developing *sidewear*, which resulted in the effectiveness of the standard 053 inspections being seriously compromised;

i. the Waterloo Grinding Supervisory Manager (GSM) whose authority was undermined when grinding went ahead at 1565 points. This resulted in an inappropriate grinding repair being attempted;

j. the post-grinding inspection which did not identify the presence of a significant rail profile defect at 1565 points, or a sidewear value on the adjacent stock rail which required facing movements to be immediately prohibited;

k. the lack of site checks by Network Rail which meant that they had no detailed knowledge of the activities of their sub-contractor;

l. the lack of recognition of an existing standard 053 derailment hazard by both the welder and welding manager at 1507 points; and

m. the welder's lack of practical experience in undertaking standard 053 inspections which allowed a non-compliant switch profile to remain in the track at 1507 points.

12 Underlying causes were:

a. loss of information on legacy renewal plans;

b. an inadequate understanding of the requirements of the Network Rail standard for detailed switch inspections by Network Rail staff and contractors working within the Wessex area;

c. inadequate understanding or involvement by depot management staff in the facing point inspection process and a lack of checks on inspection and maintenance activity;

d. a lack of an appreciation of the need to lubricate newly ground running surfaces;

e. a general inadequacy of the various inspection forms and reports produced; and

f. inadequate track access.

Severity of consequences

13 Both derailments occurred at low speed. Damage to the trains was minor and there were no injuries.

14 Signalling and electrification equipment was damaged after coming into contact with derailed wheels.

15 Services into and out of Waterloo station were affected for several days while repairs were undertaken to the affected points and others exhibiting similar defects.

Recommendations

16 Recommendations can be found in Paragraph 276. They relate to the following areas:

- clarification of Network Rail's standards and guidance relating to switch inspections;
- training of inspection staff;
- communication of information arising from inspections;
- track access; and
- the management of sub-contractors.

The accident

Summary of the derailments

17 This report encompasses derailments which occurred at London Waterloo station on 11 September and 24 October 2006. The incidents were similar in that both derailments resulted from incorrectly profiled rails within sets of points. The defective rail profiles each presented a ramp which enabled wheel flanges to climb onto the rail head. The affected wheels then failed to take the diverging route set for the train and became derailed due to a loss of lateral guidance.

18 Both derailments involved trains formed of pairs of four-car Class 455 electrical multiple unit trains. The first incident involved an empty coaching stock movement from Waterloo station into Waterloo south sidings, and the second involved an incoming service from Dorking. In both instances, the trains remained upright and there were no injuries caused.

19 In both instances, recent maintenance activity had exacerbated latent defects which had not been identified by previous routine inspection.

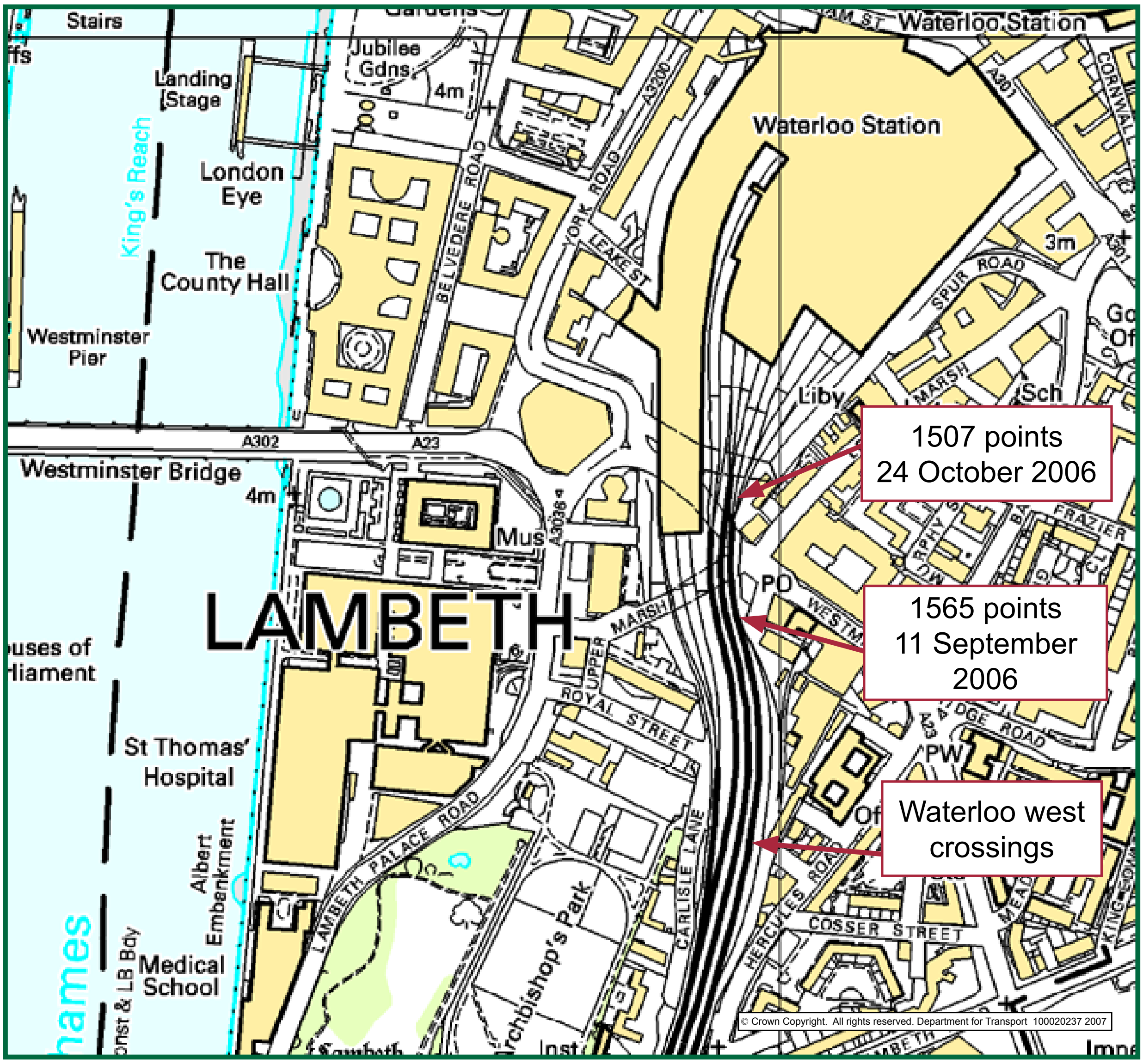


Figure 1: Map of Waterloo station showing approximate location of derailments

The parties involved

20 The infrastructure involved is owned by Network Rail Infrastructure Ltd (Network Rail), who are responsible for its maintenance and renewal. Waterloo station falls within Network Rail's South-Eastern territory and Wessex route.

21 KCI Rail Engineering Ltd (KCI Rail) were employed by Network Rail as rail grinding subcontractors within the Wessex area.

22 Trains 5G05 on 11 September 2006 and 1D54 on 24 October 2006 were operated by South West Trains Ltd.

Location

23 Both derailments occurred in the immediate vicinity of Waterloo station on track with a speed limit of 15 mph. All lines are electrified using the third rail system.

External circumstances

24 Both derailments occurred in dry and mild conditions. The weather conditions did not contribute to either incident.

Trains/rail equipment

25 The derailment on 11 September 2006 occurred at low speed and involved an empty train formed of two four-car Class 455 units, of which the leading *bogie* of the last carriage became derailed. The trailing unit was 455741 and the affected vehicle number 77807.

26 The derailment occurred at 1565 points, a left-hand turnout from the down main slow line into Waterloo south sidings as the train performed an empty-coaching stock movement.

27 The derailment on 24 October 2006 also involved a train formed of two four-car Class 455 units travelling at low speed. The last four bogies of trailing unit 455918 were derailed. The affected vehicles were numbers 71732 and 77848.

28 The derailment occurred at 1507 points giving access from the up main slow line into platforms 1-4 and involved a train loaded with an unknown number of passengers.

Events preceding the derailments

29 Rail grinding had been undertaken at 1565 points on 7 September 2006, four days prior to the first derailment, and the points had passed a post-repair inspection. This work had been undertaken by staff provided by KCI Rail.

30 Rail grinding had similarly been undertaken at 1507 points on 22 October 2006, two days prior to the second derailment to repair a damaged rail. This work had been undertaken by a welder employed by Network Rail. A post-repair inspection was due to be undertaken after the derailment.

Events during the derailments

11 September 2006

31 On 11 September 2006, train 5G05 made a low speed empty-coaching stock move into the Waterloo down sidings from platform 5 (Figure 2). The train, with only the driver on board, derailed at 22:48 hrs when the leading wheelset of the rear coach climbed the switch blade of 1565 points. This allowed the flange to drop into the gap between the stock rail and switch blade 1.2 m from the *switch toes*, and run into derailment. The leading bogie was fully derailed, until its leading wheelset subsequently re-railed itself on 1566A points, within the sidings. The train came to a halt clear of the main lines, and the driver was unaware of the incident until the power supply was lost. There were no injuries.

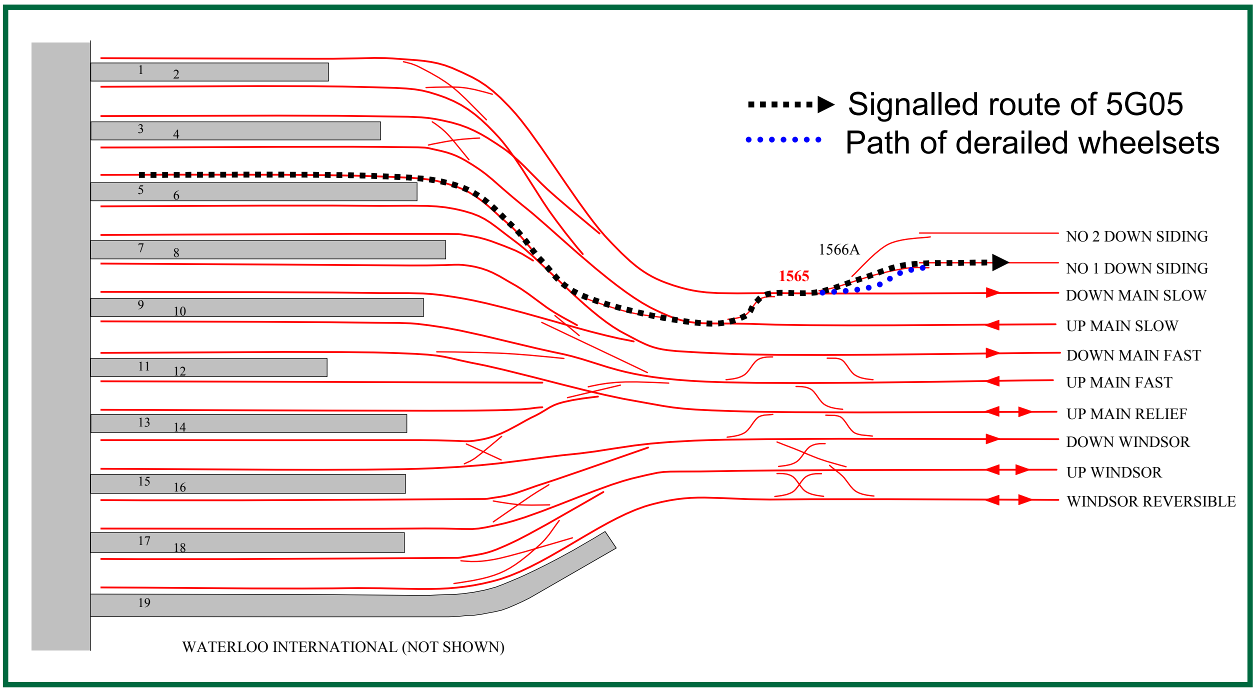


Figure 2: Schematic diagram of derailment at 1565 points

24 October 2006

32 On 24 October 2006, train 1D54 forming the 1735 Dorking – London Waterloo service was routed from the up main slow line towards platform 2 of Waterloo station via 1512B and 1507 points (Figure 3). The derailment occurred at 18:27 hrs as the 7th and 8th carriages crossed 1507 points at low speed on the final approach to London Waterloo.

33 The train came to a halt with the 7th and 8th vehicles upright and still attached to the remainder of the train, but straddling the lines between platforms 2 and 3 (Figures 14 and 15). Stationary trains occupying platforms 1, 3 and 4 became 'trapped' by the obstruction caused by the derailed vehicles and consequential loss of the power supply.

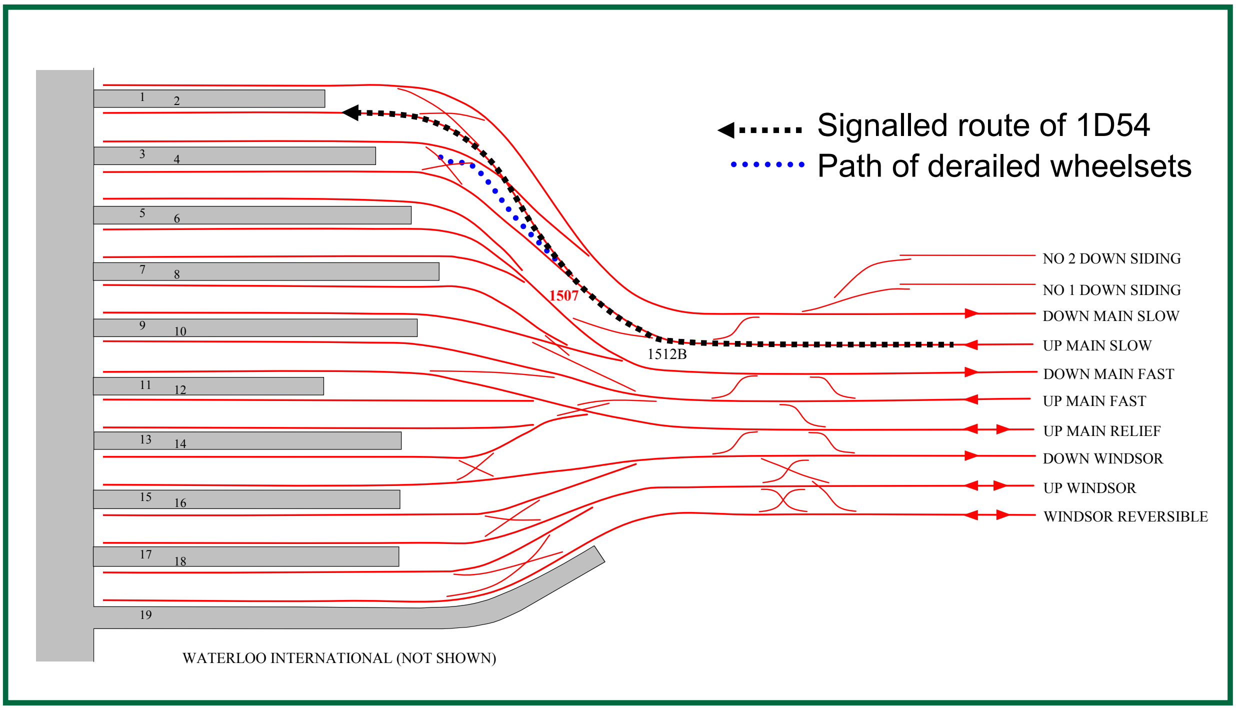


Figure 3: Schematic diagram of derailment at 1507 points

34 The driver was already braking slightly on approach to the station, and applied the *full service brake* after receiving a motor alternator warning light on his console and feeling a series of sudden jerks. The train came to a stand with the front four carriages in the platform after travelling derailed for approximately 100 m. When the driver looked back from his window, he saw a train behind him and assumed this was from a different service, not recognising it initially as being the derailed rear section of his own train.

35 The derailment was reported to signalling staff at Wimbledon Area Signalling Centre. Passengers within the front seven carriages were able to leave the train via the platform, but damage to the gangway connection between the 7th and 8th carriages meant that six passengers in the rear carriage could not pass through the train. Network Rail staff gave assistance in de-training passengers from the rear of the train via the rear driver's cab and along the track using a route which did not require any conductor rails to be crossed. There were no reported injuries to staff or passengers.

Consequences of the derailments

36 In both instances, damage was caused to the track, signalling equipment, and power supplies requiring repair before train services could recommence. The trains sustained underframe and bogie damage, and in the case of the 24 October derailment, there was also body-end damage to the rear two vehicles.

37 Both trains were subsequently removed to South West Train's maintenance depot at Wimbledon for detailed inspection and repair.

Events following the derailments

38 After the derailment on 11 September 2006, the south sidings remained out of use until the affected unit was recovered two days later. Public train services were unaffected, but facing movements over 1565 points into the south sidings were prohibited for six weeks until the damaged rails were replaced. This prevented any train movement being made directly from the station into the sidings during this period.

39 Following the derailment on 24 October 2006, Waterloo station remained partially closed until 06:26 hrs on 26 October, to allow for recovery of the train and repairs to the track and conductor rail. Train services were affected for several more days as a result of other defects found following the derailment which led to the prohibition of facing movements over five other sets of points in the vicinity of the station. These defects were discovered during an emergency inspection programme instigated by Network Rail as a direct reaction to this derailment.

40 Nationally, Network Rail also inspected a sample of the *switches and crossings* (S&C) at other major stations including London Victoria, London Liverpool Street and London Charing Cross. One similar defect was found, but this was on a set of points which were not used for facing moves.

The Investigation

Investigation process and sources of evidence

41 Evidence was obtained from the following sources:

a. interviews with staff;

b. examination and measurement of the wheels of both trains;

c. examination and survey of the derailment sites;

d. Network Rail track inspection and maintenance records; and

e. Network Rail staff training records.

Factual Information

London Waterloo

42 The track layout at London Waterloo station was renewed during the 1970s and is subject to a blanket speed restriction of 15 mph in the *station throat* area because of its complexity. Trains serving the 19 domestic platforms are operated by South West Trains. The track is examined and maintained by Network Rail staff and their appointed contractors who have reported an apparent increase in workload following the introduction of new-generation electrical multiple unit trains since 2004. However, the south side of Waterloo station is predominantly used by older Class 455 trains which were introduced in 1984.

<u>Infrastructure Inspections</u>

<u>*Basic Visual Track inspections*</u>

43 All track is subject to basic visual inspections at frequencies established in Network Rail standard NR/SP/TRK/001 'Inspection and Maintenance of Permanent Way' (standard 001). Much of the S&C in the station area is of a *vertical design*, with *unstrengthened switches* and constructed using BS 113A FB (flat-bottomed) rail. The *BS 113A FB* vertical design of S&C has been the standard design for British Rail since approximately 1970. Standard 001 requires a twice-weekly basic visual inspection for unstrengthened S&C and this is undertaken by local track maintenance staff. The purpose of this inspection (or patrol) is to identify defects which could affect the safe or reliable operation of the railway and determine any immediate or short term actions required. When inspecting S&C, a patroller is required to walk through each route and observe the condition of the track including broken, cracked, distorted or worn rails and other track components.

<u>*Supervisor's Inspections*</u>

44 Standard 001 also requires an eight-weekly supervisor's inspection which supplements the basic visual track inspection, and is undertaken by the local Track Section Manager or his nominated deputy. The purpose of this inspection is to assess the requirements arising from patrol reports, and includes the measurement of critical dimensions such as *track gauge*. The supervisor's inspection is also required to determine the need to initiate detailed switch inspection regimes in accordance with Network Rail standard NR/SP/TRK/053 (Issue 3) 'Inspection and repair procedures to reduce the risk of derailment at switches' (standard 053). This may be necessary if wear is observed when assessing rail condition, but there is no requirement on the supervisor to arrange for the points to be operated when making this assessment.

<u>*Inspection and repair procedures to reduce the risk of derailment at switches*</u>

45 S&C is provided to allow trains to move from one track or route to another. This is achieved using a pair of rails that move from one side of the track to the other and allow the route to be selected, normally by the signaller. These rails are known as switch blades and are designed to abut against static rails known as stock rails, a switch blade and stock rail pair being known as a switch half-set. A set of points incorporates a left and a right-hand *switch half* set.

46 *Facing points* occur where two routes diverge in the direction of travel, and are dependent on profiled switch rails to provide directional guidance to wheels. Facing points present a greater risk of derailment when compared with plain line if rail profiles are excessively worn, damaged, or if the rails forming a switch half set are poorly matched. These risks mean that facing points are subject to special inspections at intervals not exceeding three-months, and standard 053 provides a detailed specification for this activity. Standard 053 gives information on five recognised derailment hazards, numbered 1 to 5, which are each subject to specific checks, and specifies the requirement for increased levels of inspection as sidewear develops (paragraph 50). Further information on the five derailment hazards is given in Appendix D.

47 Standard 053 Issue 3, which is now superseded, required a visual inspection to be undertaken initially, and for this to be the basis for determining whether a detailed inspection was required. The person carrying out this inspection was required to be trained and certified as competent to determine whether a detailed inspection was necessary. The standard did not specify any criteria for the visual inspection, except to state that 'the inspections shall require switch blades to be inspected in both the *normal* and *reversed* positions' and that 'the inspections shall be carried out totally before any remedial treatment is considered'. The visual inspection does not require sidewear to be measured, and as a consequence, the decision whether to progress to a detailed inspection was a subjective one. There was no standard form in use for recording visual inspections.

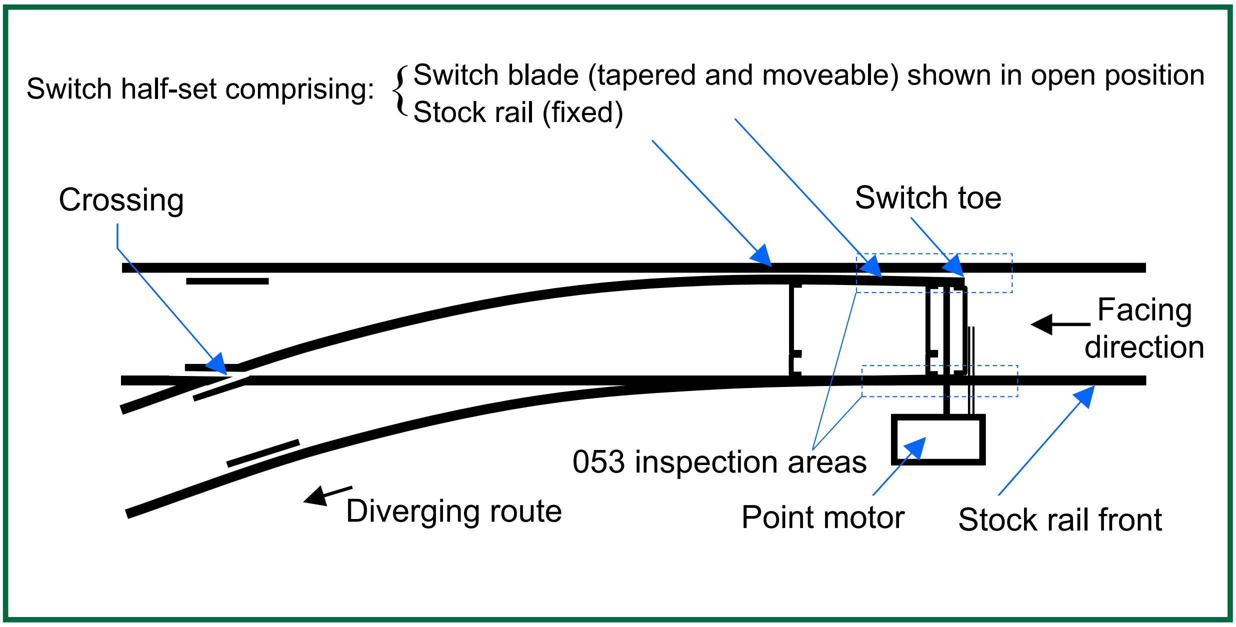


Figure 4: Simplified diagram of S&C (left-hand turn-out shown eg 1565 points)

48 A standard 053 detailed inspection involves a close examination of rail profiles for one metre in front of the switch toe (refer to Figure 4) and for two metres beyond using gauges provided for this purpose. A replacement sidewear gauge and a new track gauge incorporating a new *P8 wheel profile* (TGP8) were introduced by Network Rail during 2005. The P8 wheel profile is found on most passenger trains.

49 The purpose of the inspection is to ensure that the wheels of a vehicle passing over the switch blades follow the intended path, and that there are no defects which could lead to derailment.

50 The standard 053 detailed inspection requires sidewear on the stock rail front to be checked for a distance of one metre from the switch toe. This measurement is taken using a two-piece gauge, and gives a dimensionless value referred to as a ‘step’. New rail typically has a sidewear reading of step 18 and this value gradually reduces as the rail becomes more worn (Figure 5). Standard 053 (Issue 3) requires the frequency of inspections to be increased to two monthly when the sidewear on the switch fronts falls below step 12 and monthly at step 9 or below, but does not specify the type of inspection required. In addition, at step 9, a replacement switch half set is to be ordered with arrangements made to replace the half set as soon as possible, and ‘the condition of the *switches* is to be closely monitored’. At step 6, train movements in the facing direction are prohibited. Therefore, under normal maintenance conditions, the affected half set is replaced before sidewear reaches step 6 to avoid service disruption. An order can typically take three months to complete.

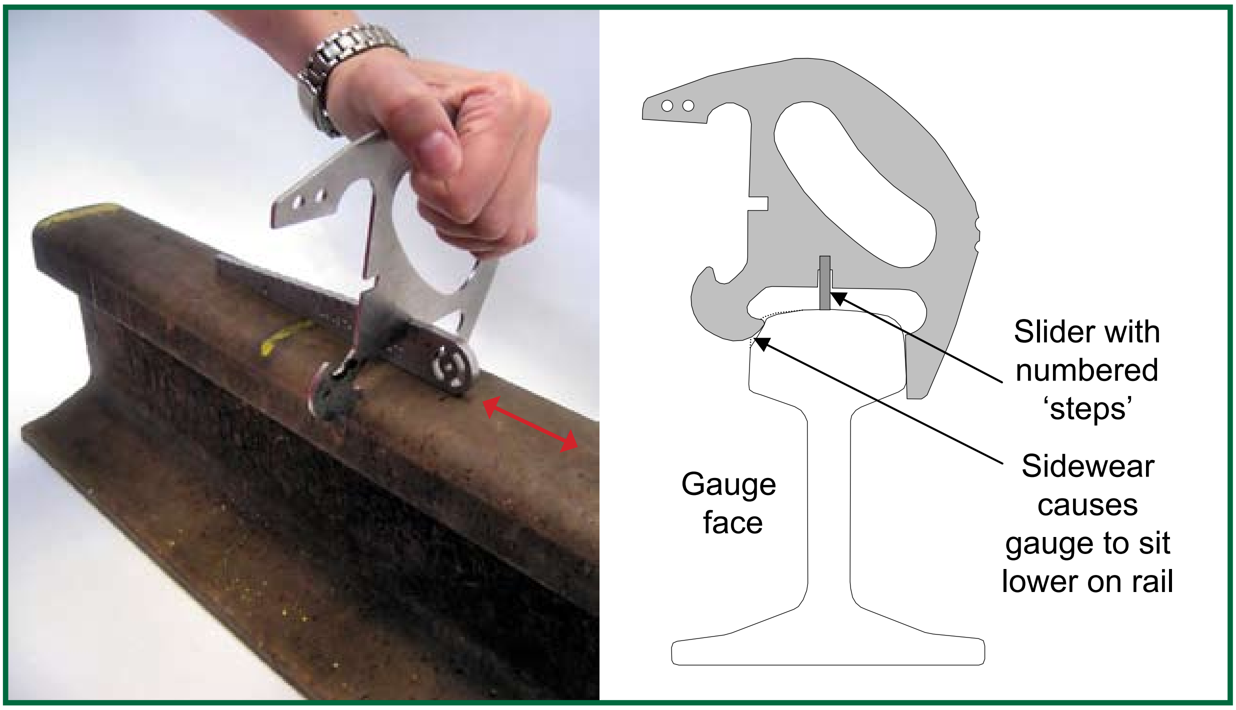


Figure 5: Illustrations of NR4 sidewear gauge on new and sideworn rail

51 The assessment of derailment hazards 1 and 2 is undertaken by visually comparing the height and profile of a switch blade relative to its stock rail; hazard 1 exists if the top of the switch blade is above the base of any sidewear visible on the stock rail, and hazard 2 exists if the angle of the switch blade face is shallower than the sidewear on the adjacent stock rail and less than 60° to the horizontal following reprofiling (Figure 6). A derailment hazard is avoided if the *flange contact zone* occurs at a position that does not present a ramp for a wheel flange to climb.

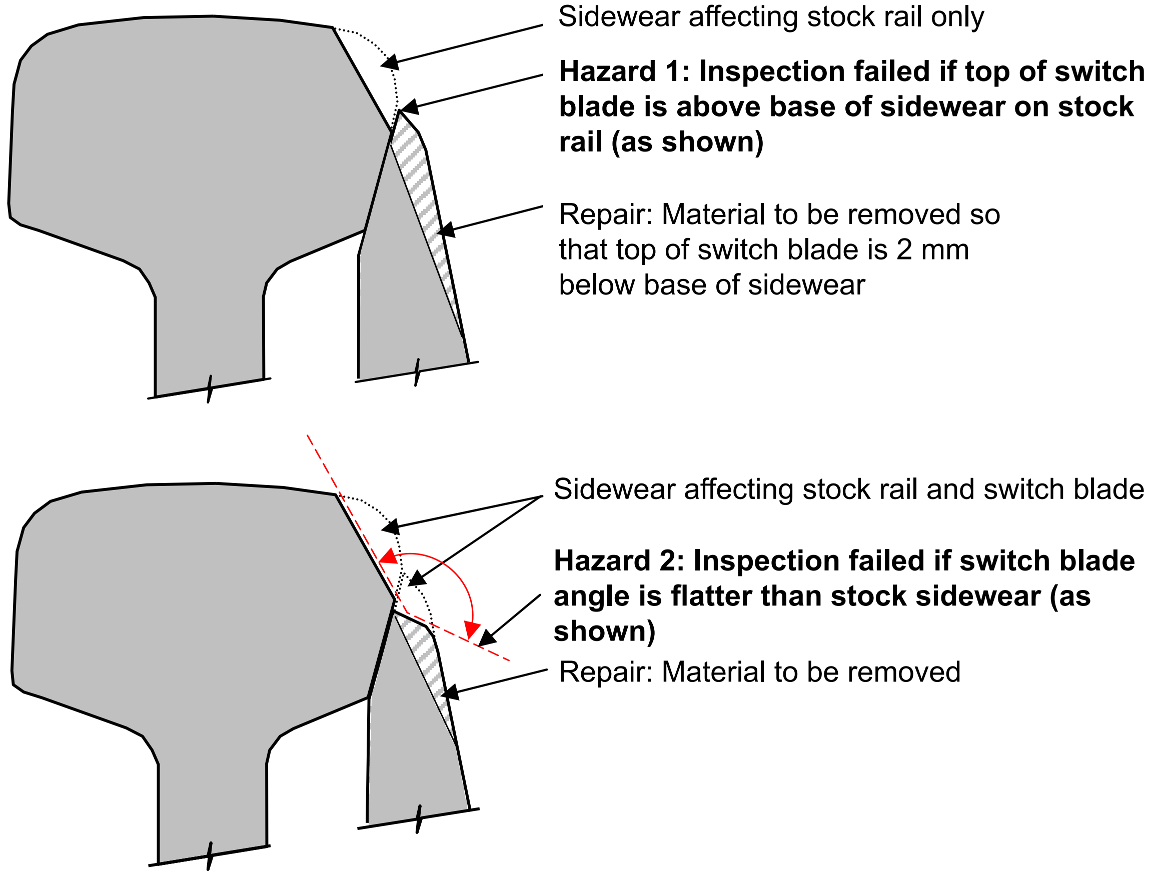


Figure 6: Illustration of derailment hazards 1 and 2 as defined by standard 053

52 The introduction of the TGP8 gauge since 2005 has allowed a more accurate assessment of a derailment hazard 2 risk to be made. The gauge allows the contact point of a wheel flange on the switch blade to be visualised and an indicator line drawn normal to the 60° flange contact angle (Figure 13) allows a defective switch blade profile to be positively identified. To be acceptable, the flange contact angle must be at least 60° to minimise the risk of a derailment occurring should a high coefficient of friction develop between the wheel and the rail.

53 The identification of a derailment hazard requires follow-up action to be taken within a prescribed timescale. Repairs may involve rail grinding (paragraph 58), welding (paragraph 64) or the complete replacement of the affected switch half set.

Asset management systems

54 Network Rail has operated an asset condition database, the Minicom Iinformation Management System (MIMS), since 2003. In October 2006, the system was upgraded and renamed Ellipse. MIMS replaced the Railway Asset Register (RAR) and was originally populated with information from this and other legacy systems, including IMPART; a database operated by the Infrastructure Maintenance Contractor (IMC) responsible for track maintenance in this area until 2004.

55 MIMS is an asset management and scheduling tool and contained the asset inspection programme. Recurring inspection or maintenance requirements, known as maintenance scheduled tasks (MSTs), were set up manually within the system. Once an MST entry has been committed, the system generated task lists or work orders in accordance with the details input for the MST. Work orders were issued to relevant staff when inspections became due. On completion, the entry was signed-off and closed, giving the TSM a facility for monitoring the progress of inspections. Any inspection more than two weeks overdue was flagged up in reports generated by the database and brought to the attention of the Infrastructure Maintenance Manager (IMM).

56 MIMS also served as a repository for issues identified during track inspections which required remedial action to be taken. The defect, or action, was recorded on a Work Arising Identification Form (WAIF) by inspection staff before being prioritised and signed off by the local track section manager. The record was then entered into MIMS by a scheduler who checked that the work had not been entered previously. The scheduler could also refer an item back to the track section manager for re-prioritisation if a subsequent report showed that its condition had deteriorated.

57 A separate system called NEONS was used for the ordering of replacement components required for maintenance. This tracked the order and delivery of components which were then prioritised for installation using MIMS, although there was no direct link between the two systems.

Specialist track maintenance

Rail grinding

58 Rail grinding teams work under the control of a Grinding Supervisory Manager (GSM) who may also act as the grinding team leader. The GSM is required to establish the scope of work and enter details onto a Network Rail hand grinding form (HG1 form), for the guidance of the grinding team leader (Appendix H).

59 The purpose of rail grinding is to optimise the rail profile in order to arrest rail head defects occurring as a result of *rolling contact fatigue* (RCF), and to remove local areas of damage, such as *wheel burns*. Special engineering trains fitted with grinding equipment are used to maintain both plain line and S&C, the latter being supplemented by hand grinding teams who also work on sections of track which cannot be accessed by the train. Hand grinding is addressed by standard 001 and aims to produce the same rail profile as the grinding train. This may include the removal of *lipping* from switch blades which can avoid damage leading to a hazard 4 failure developing.

60 Standard 001 requires that at least one member of the team undertaking grinding of S&C is trained in the inspection and repair of S&C to standard 053. This is normally the GSM. A grinding repair may be unsuitable in cases where a standard 053 failure has been detected if the stock rail has a sidewear value below step 12, as the correction of one derailment hazard can lead directly to development of another. In these instances, a weld repair (paragraph 64) or the complete replacement of the switch half set may be required.

61 The reprofiling of a switch blade needs to be run-out over a sufficient distance to achieve a smooth transition between newly ground and existing rail surfaces. Grinding is required to achieve a longitudinal taper of 1 in 600, meaning that removal of 5 mm of material at the switch toe requires a minimum 3 m length of rail to be ground.

62 Trolley mounted equipment, set to a predetermined angle, can assist in achieving the correct rail profile, although hand-held grinders are normally used to achieve the final profile and remove any remaining sharp edges. Grinding of switch blades will temporarily increase the surface roughness and can result in a slightly increased risk of derailment if the roughness or a sharp edge interacts with a wheel flange and aids it to climb onto the rail head. Lubrication will reduce this risk.

63 Any maintenance activity affecting the switch blades within S&C has to pass a standard 053 detailed inspection before the track is reopened to traffic. Following grinding, this is normally undertaken by the GSM.

Repair of S&C by welding

64 The welding of S&C was addressed by Network Rail standard NR/SP/TRK/132 'Weld repair of rails' (standard 132) which has now been superseded. The purpose of a weld repair is to increase the amount of material available for reprofiling following wear or damage.

65 Standard 132 required a repair to be scoped in advance, normally by reference to the standard 053 inspection report identifying the original failure. Appropriately qualified welders are trained in the assessment of switch blades for repair, and are therefore able to determine whether a repair can achieve the desired result. A switch blade that is already low when compared with the adjacent stock rail may require replacement or the addition of weld material to restore its depth before reprofiling is commenced.

66 Standard 132 mandated a follow-up inspection, 48 hours after switch welding has taken place, to allow its behaviour under traffic to be assessed. This requirement was aligned to metallurgical issues associated with the welding process, and did not include a detailed check of the switch geometry or rail profiles.

Signal maintenance department inspections

67 Maintenance of S&C is shared between track maintenance staff, with responsibility for the rails, rail fastenings, baseplates and associated track support systems, and signal maintenance staff. The signal maintenance department maintains the control systems which operate the points, and all moving components with the exception of the rails themselves. Their inspections assess the condition of the points and drive mechanisms in accordance with Network Rail standard NR/SP/SIG/10660 'Implementation of Signalling Maintenance Specifications' (ISMS).

68 The ISMS includes the requirement that a *Facing Point Lock* (FPL) test is undertaken every three months and after any activity which could affect the signalling system's ability to detect the position of the points. The FPL test requires the points to be set normal and reversed in order to check the locking and position detection systems for both switch blade positions.

Infrastructure Maintenance Manager's organisation

69 London Waterloo forms part of Network Rail's Wessex maintenance area which extends from London to Portsmouth, Weymouth and Exeter. The maintenance organisation is led by an IMM, who is given technical support by an Area Track Engineer (ATE) and an Area Signal Engineer (see Figure 7). Area-wide functions are managed by an Area Services Manager.

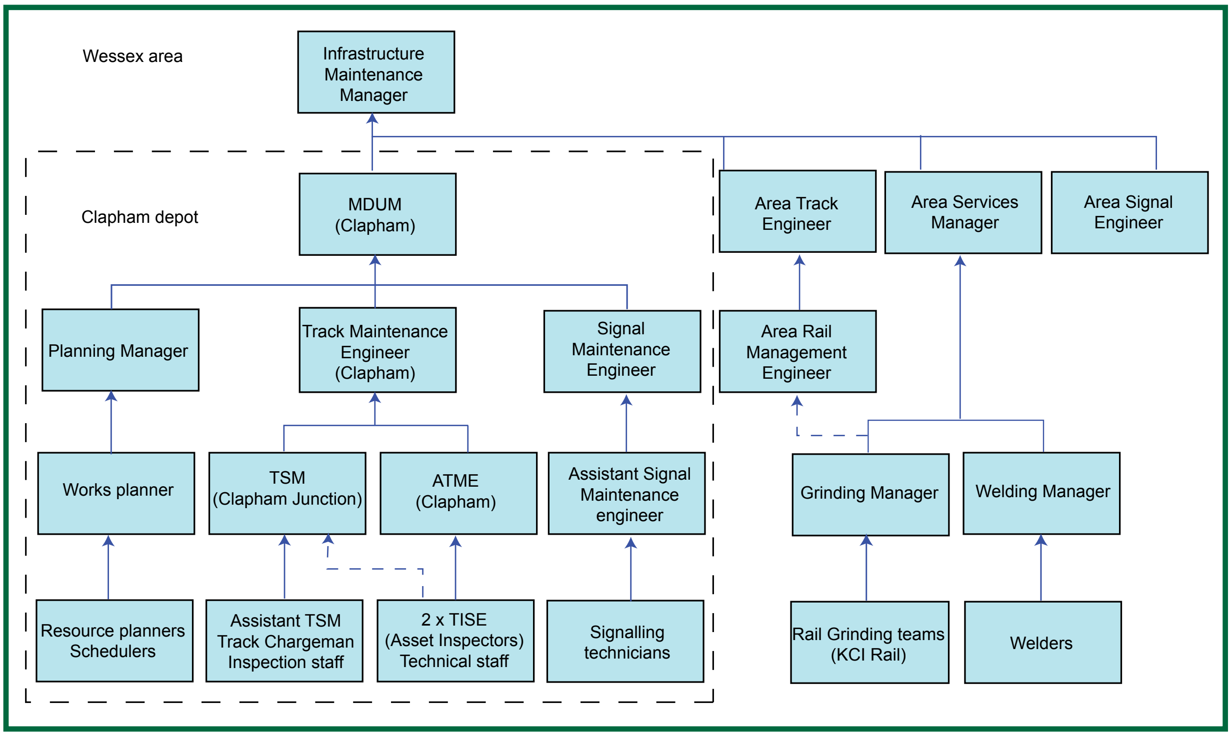


Figure 7: Simplified diagram of local Network Rail maintenance organisation

70 Within the Wessex area, Maintenance Delivery Units (depots) are located at Clapham, Woking and Eastleigh, with sub-depots at Feltham, Guildford, Wimbledon and Salisbury. Each depot is managed by a Maintenance Delivery Unit Manager (MDUM) who reports to the IMM.

Clapham Maintenance Delivery Unit

71 The Clapham Maintenance Delivery Unit (Clapham depot) had responsibility for the inner-Wessex area, including the lines between Clapham Junction and Waterloo station. Track maintenance activity was led by a Track Maintenance Engineer (TME).

Track Maintenance Engineer

72 The Clapham TME had 14 technical and managerial staff, including the Clapham Junction Track Section Manager (TSM), within his section. He was supported by an Assistant Track Maintenance Engineer (ATME). Clapham depot has recently experienced a relatively high turnover of staff and the TME, TSM and ATME had each been in position for less than 12 months, although all had previous experience in similar roles.

Track Section Manager

73 The TSM was responsible for all track between Clapham Junction and Waterloo station, and had approximately 50 staff within his section. Staff worked day shifts for patrolling and night shifts for maintenance under a duty shift manager.

74 Visual track inspections within the Waterloo to Clapham corridor were undertaken by a seven man patrol gang, led by a Track Chargeman. They patrolled the lines within an established pattern of line blockages using a combination of *T2 protection* and *T3 possessions*. This gave daylight access to different sections of the track on Wednesdays, Thursdays and Sundays.

75 The patrolling team undertook minor work as it was found, and recorded defects on a WAIF for attention by maintenance gangs working at night. On some occasions, the TSM and patrollers worked together as they were required to use the same protection arrangements.

76 The TSM undertook supervisor's inspections for the 265 *point-ends* in his area. Within this population, standard 053 failures occurred at a typical rate of about 25 per annum, although this historical figure has reportedly started to rise since 2004. Despite the requirement for him to identify the need for detailed 053 inspections (paragraph 44), he was not required to be standard 053 trained and nor were any of his staff. The TSM had attended a standard 053 briefing, but was not trained or certified as competent to undertake inspections (paragraph 47).

77 A TSM needs to be aware of all maintenance activities which affect the condition of the track within his area in order to discharge his responsibilities effectively. While he was normally informed of progress for remedial works which he had requested, but he not always made aware of activities undertaken by other parts of the organisation such as the rail grinders and welders. The duty shift manager maintained a record of overnight work but this did not always include detailed information concerning the work undertaken. The TSM found it was frequently necessary to chase up the related paperwork to maintain his records.

78 The position of TSM for Clapham Junction was acknowledged as having a significant workload due to the volume of S&C, worn condition of the track and severe access constraints. Undertaking the mandatory eight-weekly inspections had to be planned into the access available, but this made inefficient use of his time.

Assistant Track Maintenance Engineer

79 The ATME worked as a member of the TME's team and had responsibility for planning and technical functions. He also managed the Track Inspector Special Examinations (TISE) staff.

80 The ATME had been standard 053 trained more than two years prior to the first derailment and his certificate had since lapsed. There was no requirement for him to hold this certification despite being the AI's line manager and the person from whom the AIs would be expected to seek guidance or a second opinion when necessary. The previous holder of this post had not received standard 053 training and had relied on the AIs to identify compliance issues.

Track Inspector Special Examinations staff (Asset Inspectors)

81 TISE staff, often known as Asset Inspectors (AIs), undertook standard 053 inspections within the Clapham Depot area, together with specialist inspections of *check rails, tie bars, wheel-timbers*, track in tunnels and buffer stops. Clapham depot had two AI positions for this purpose.

82 The Clapham AIs had responsibility for inspecting a total of 340 points on routes extending for 124 *track miles* between London, Dorking and Effingham Junction in Surrey, with each point-end requiring an inspection at least once every three months. This resulted in a significant workload and records examined for the six month period preceding September 2006 showed that the AIs each worked an average of 46 hours spread over six days each week, excluding travelling time.

83 The AIs had been trained and were certified as competent to undertake switch inspections to standard 053. However, their training had not specifically addressed the scope of a standard 053 visual inspection as distinct from a detailed inspection using gauges. Their certification was valid for five years and remained in-date, although they had not been subject to intermediate refresher training or competence assessment as there was no requirement for this.

84 Clapham depot had no written procedure requiring work undertaken by the AIs to be formally checked, and there had been no on-site assessments made during the 3 years prior to the derailments. However, an element of random checking occurred between the AIs as they worked separately but covered the same geographical area and shared responsibility for inspecting each set of points.

85 Each standard 053 inspection was entered into MIMS as an MST (paragraph 55). MIMS was then able to generate a work order when an inspection became due.

86 The AIs used a locally-developed FPI form when undertaking a standard 053 visual inspection, which had been developed, in the absence of a standard form, by the former IMC. Within the Wessex area, its recent use had been limited to Clapham and Woking as other depots had found alternative formats which were more suitable to their requirements, but there had been no sharing of best practice.

87 The FPI form, known locally and rather confusingly as the 'FPL' form, comprised a list of checks, together with a space for making general notes (Appendix E). The five derailment hazards defined in standard 053 were contained within three of the 24 checks on the form; hazards 1, 2 and 3 were listed within a footnote to a question about switch blade to stock rail fit, and as a consequence, the standard 053 part of the question was routinely left unanswered. Hazards 4 and 5 were individually listed, and the questions included a prompt to undertake a standard 053 detailed inspection if signs of wear were observed. However, there was no cell to prompt the recording of sidewear values, and the AIs had received no formal training in the use of the form.

88 The FPI form required certain measurements to be recorded, such as track gauge and *toe opening* dimensions. The form also recommended that some items should be observed under traffic whenever possible, as this allowed deflection and the behaviour of the components to be assessed. However, many items related to the general condition of the S&C, and did not form part of a standard 053 inspection. Undertaking a standard 053 inspection under traffic is rarely practical in extremely busy areas as it may be difficult to arrange with the signaller for the switch blades to be moved to the reversed position.

89 On occasion, the AIs were able to arrange for a signalman to reverse the points, but sometimes this was done on the condition that the AI remained on the phone throughout the inspection. In practice, an estimated 90 per cent of points were not reversed during these inspections, and toe opening dimensions for the closed side were obtained from the previous form or from signal maintenance department records following their FPL test.

90 Following an FPI, the AIs signed the relevant work order to allow it to be closed within MIMS. Any action requiring attention required a WAIF to be raised for entry into MIMS and subsequent maintenance planning.

91 There is evidence that the AIs reacted quickly when a standard 053 detailed inspection identified a derailment hazard. The AIs contacted the relevant parties (eg the TSM and grinding manager) by telephone or in person and forwarded the detailed inspection report and WAIF (refer to examples included as Appendices I and J). The AIs also photographed some defects for their records and to assist in planning the remedial work.

92 Where no specific action was identified, the FPI form was completed on a computer and printed off. The hard copy was then filed in the AI's office at Clapham. There was no provision for sign off by either the ATME or the respective TSM and the depot had no procedure in place by which the AIs automatically provided copies of their reports to either party. Neither did the TSM routinely review FPI reports, instead relying on the AIs to bring any actions to his attention either directly or by means of a WAIF.

93 The AIs used a local form entitled 'Point Examination' for recording increased frequency inspections, such as at 1565 points. This form also originated from the former IMC, and was used to undertake standard 053 visual inspections by AIs at Eastleigh depot. The form contains ambiguous notes such as the letter 'P' standing for both Pass and Poor depending on the context. Although standard 053 gave no information on the scope of a monthly inspection, Network Rail has since confirmed that it was their intention that a standard 053 detailed inspection should be undertaken in these instances.

Signal maintenance department inspections

94 The signal maintenance department's three-monthly inspections included a FPL test on each point-end, and this was undertaken at night when access to the track could be gained and arrangements could be made to reverse the points. Prior to approximately 2003 there was an additional AI position at Clapham depot which allowed standard 053 inspections to be undertaken at the same time that signalling staff did their FPL tests. Network Rail discontinued the post, and thereafter standard 053 tests reverted to a predominantly daytime activity.

Area Services

95 The Area Services Manager's organisation provided specialist resources which supported the individual maintenance delivery units throughout Wessex. This included track welding and rail grinding activities.

Grinding Manager

96 Rail grinding was managed by a Network Rail grinding manager (grinding manager) who had 30 years experience in this field. He was responsible for rail grinding across the whole Wessex area comprising a total of 1258 track miles with 1229 point-ends. The grinding manager had recently started reporting to the Area Services Manager, having previously been part of the ATE's organisation, and provided the Area Rail Management Engineer (ARME) with technical information on rail condition for entry onto a database. The grinding manager had no recognised deputy and had worked regular night shifts to support the grinding teams for several years.

97 Since October 2003, rail grinding within the Wessex area has been subcontracted to KCI Rail Engineering. Grinding was undertaken during overnight possessions by self-contained teams of three staff, each headed by a KCI Rail GSM. From a single team during 2003, the requirement for grinding had grown, such that three teams were deployed in the Wessex area during 2006, together with equipment and gauges needed to undertake this activity. A fourth team was assigned to work with the rail grinding train when this operated.

98 By 2006, KCI Rail employed 12 staff and the Wessex area grinding contract represented a significant amount of the company's workload.

99 The KCI Rail GSMs had been trained and certificated by Network Rail approved training providers. An individual holding this position was required to be qualified as a GSM, as a *Controller of Site Safety* (COSS), and to hold a facing switch inspection certificate to standard 053. While a GSM's training enabled him to undertake standard 053 detailed inspections, it was focused on grinding to arrest RCF and did not develop the necessary competence to scope a repair following a standard 053 failure. Switch repair techniques are instead covered by the MMA 5 (metal manual arc welding level 5) welding qualification which is not normally held by a GSM.

100 Switch blade grinding details were recorded on site using a form developed by the grinding manager and titled 'Pre Grind Inspection' (PGI form). The single-page PGI form (Appendix G) was divided into sections to allow details of the pre-grinding inspection, the grinding and the post-grinding inspection to be recorded, the latter section being closely based on a standard 053 detailed inspection form (Appendix I) and including yes/no boxes to be ticked to questions concerning specific standard 053 hazards; 'yes' answers indicating potential failures. However, the pre-grinding section did not include prompts to record details of switch blade damage or sidewear readings.

101 Completed PGI forms were handed to the grinding manager, who then transferred the details onto a HG1 form (Appendix H), before forwarding this to the ARME for entry into an area RCF database. The local depot was also informed of sections of track where grinding had taken place.

102 The PGI form had been developed because the HG1 form did not provide sufficient prompts for grinding and checking switch blades, and combining this with a standard 053 form had led to problems with the GSM having too many sheets of paper on site. The PGI form was intended to address both requirements.

Management of KCI Rail

103 The Network Rail grinding manager worked without assistance due to recruitment difficulties, and had to manage the KCI Rail teams remotely. With a large geographical area to cover, he was unable to undertake sufficient pre-grinding inspections or perform sample checks of completed work. To address this situation, the ATE agreed a temporary arrangement whereby the grinding manager provided KCI Rail with a list of locations for plain line RCF grinding in lieu of a full scope of work. This arrangement was to continue until the grinding manager's team could be reinforced, and required the KCI Rail GSMs to self-certify their activities. The grinding programme was based on the ARME's RCF database, and supplemented by occasional requests received from AIs and TSMs to remedy identified defects such as standard 053 failures and wheel burns.

104 The KCI Rail GSMs were required to scope the work themselves following arrival on site, but this led to a reduction in the time available during a possession and meant that the GSM lacked access to any records relevant to that location. The GSM was responsible for progressing the work he had identified without seeking independent approval of the scope, and self-certifying the completed activity before submitting records to the grinding manager on completion of work.

105 The grinding manager undertook occasional site audits, but these were restricted to checking safety documentation and machine data and did not include a check of the work undertaken or technical competency as he did not understand this to be part of his duties. Nevertheless, Network Rail staff believed KCI Rail to be competent and the grinding teams often found additional work based on an assessment of rail head conditions if all the requested activities were completed.

106 KCI Rail's grinding activities within the Wessex area were almost exclusively concerned with the treatment of RCF, much of this through S&C. The grinding manager had ceased issuing HG1 forms in advance of work as the process was disrupted by changes and cancellations, and instead issued KCI Rail staff with lists of point numbers requiring attention. RCF grinding required a standard 053 inspection to be undertaken on each occasion to check that the existing switch blade profile had not been adversely affected. Switch blade repair work following a standard 053 failure was normally undertaken by Network Rail's welding staff, although KCI Rail had occasionally undertaken standard 053 repairs in the Guildford area when requests were received. This was scoped and checked by local AIs.

Welding Manager

107 The Network Rail area services assistant for welding (welding manager) was responsible for managing track welding for the inner-Wessex area, and reported to the area services manager. He had a team of 12 track welders, two of whom were qualified to MMA 5 level, allowing them to scope and undertake switch blade repairs involving welding and grinding. They were also qualified to undertake standard 053 inspections. However, most of the section's activity concerned *Thermit welding* of rails or repairs to crossings, and the welders rarely undertook the repair of switch blades.

Track access

108 To minimise the risk to staff working on the track, Network Rail has a policy that work activities should take place in a *green zone* whenever reasonably practicable. This can be achieved by blocking the line to train movements in accordance with Section T of the railway Rule Book (GE/RT8000). A site of work that is not protected from train movements is referred to as a *red zone*, and this method of working is only permitted where there is adequate visibility, a place of safety for staff to occupy while trains pass and where safer alternatives are not practicable. Some sections of track are unsuitable for red zone working at any time and these areas are identified as being *red zone prohibited* in Network Rail's local hazard directory.

109 Between Waterloo station and the west crossings (0 miles 638 yards from Waterloo station – see Figure 1), red zone working is prohibited on all lines. Furthermore, access to the track for the two mile section between Waterloo station and Nine Elms Junction west of Vauxhall station, is restricted due to a series of curves which limit visibility of approaching trains, and the absence of a place of safety between the eight parallel tracks. Similar issues occur in the Clapham Junction area and in addition, some lines are bi-directional, meaning that trains can approach from either direction.

110 Red zone restrictions affect an estimated 40 per cent of the S&C inspected and maintained by Clapham Depot, where the track can only be inspected at night or with lines closed to traffic. In the first half-mile from Waterloo station, there are more than 160 point-ends within this category.

111 Track protection arrangements were made by the depot's planning department. However, the emphasis was on supporting the basic visual and supervisor's inspection regimes, leaving the AIs to make most of their own access arrangements. The lack of planned access for the standard 053 inspections led to the AIs experiencing difficulty in completing this task. There were limited opportunities to request points to be reversed as this inevitably affected more than one route into and out of the station.

112 Track access constraints similarly affected the supervisor's eight-weekly S&C inspections and the bi-annual TME inspections, as very little daylight access was possible outside of the routine patrolling blocks. Any additional inspections required to address specific problems had to be arranged at night or under special protection arrangements, which could take up to four hours to organise. The difficulty in gaining track access, in the event of any unplanned inspections being required, was disruptive to the management of the area.

1565 Points

113 Waterloo 1565 points are located at a chainage of 0 miles 594 yards, and provide a low speed connection from the down main slow line into Waterloo south sidings, used for stabling empty trains. The points are normally set for the down main slow line (ie the through route), but the right-hand stock rail is subject to sidewear despite being located on straight track, as the points are situated immediately beyond a 200 m radius left-hand bend on leaving the station. The simultaneous occurrence of a sideworn stock rail and a relatively unworn switch blade is a known derailment risk and is identified as derailment hazard 1 in standard 053.

114 The points are fitted with *shallow-depth switches* mounted on rollers which assist the movement of the switch blade. When compared with other types of switch blade, this design provides a shallower, but thicker asymmetrical profile which fits inside the web of the stock rail and avoids the need to remove part of the stock rail's foot during manufacture. The points are mounted on timber bearers. Although a relatively modern design, there are several other examples in the area covered by Clapham depot.

115 The points are situated within a red zone prohibited area (paragraph 108).

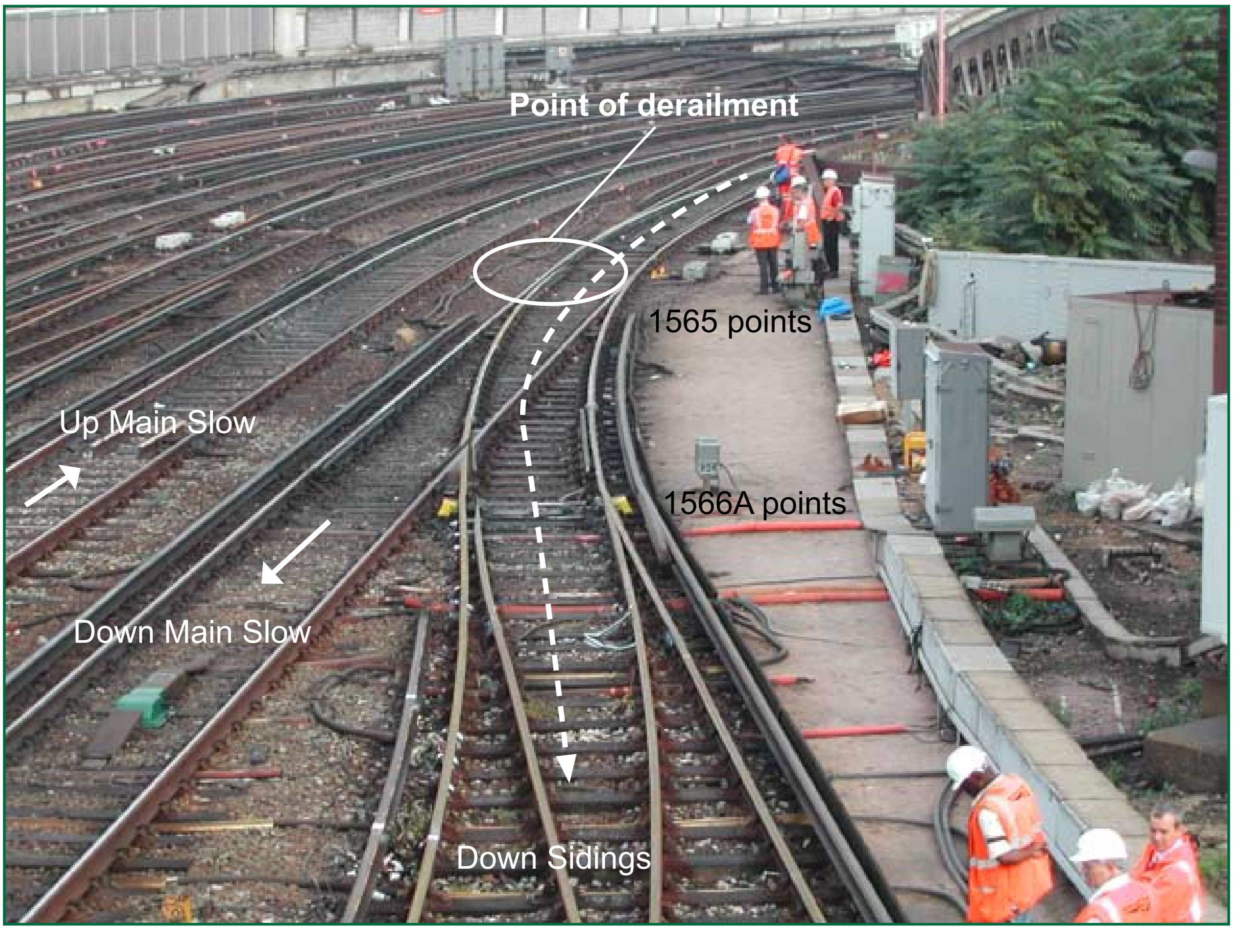


Figure 8: View of 1565 points looking towards London Waterloo, showing route of train 5G05

Maintenance history

116 Waterloo 1565 points were installed in 1996. Records examined from September 2004 show that the sidewear on the right-hand stock rail had already developed to an extent that required action to be taken under standard 053. This was reflected in the AI's reports (paragraphs 122 to 130).

117 MIMS records indicate that the need to change the right-hand half set was identified in both August 2003 and May 2005. On both occasions, the entry was closed with the code MI indicating 'cancelled mistake' by a member of the Clapham depot planning department although it is not known how this action was authorised. In the first instance, the work is believed to have been cancelled due to a lack of information. In the second, the entry was treated as a duplicate of the first and cancelled for that reason. MIMS contains no other record of welding or grinding on these switches and the requirement to renew the switch half set was not raised again.

118 The TSM requested details of *permanent way* materials held in store at Woking and Eastleigh depots following his appointment to the post, and requested that items destined for his section be delivered for storage at Clapham. This information revealed that a replacement right-hand switch half set for 1565 points had been delivered to a storage yard at Woking on 12 April 2002 (reference BB1461), but had not been installed. In 2002, the yard was operated by the IMC as this pre-dated Network Rail bringing maintenance activities under direct control. The order also pre-dated the introduction of NEONS (paragraph 57) and MIMS. The TSM took no immediate action following receipt of this information as he was unaware of any significant problems with the points and had greater priorities elsewhere.

Basic visual, TSM and TME inspections

119 The TSM's inspection reports did not identify any defect with the points, although he did not see the right-hand switch blade closed against the stock rail during his inspections. He considered the gauge and fastenings to be in reasonable condition and had not observed any significant sidewear. He was confident in the ability of the AIs to identify and prioritise defects, and was reliant on them to bring any issues to his attention.

120 The down and up main slow lines were patrolled on Sunday mornings when they were blocked to traffic. However, the Track Chargeman who was the most senior member of the patrolling team, rarely undertook this duty himself as he did not normally work this shift. The points were also examined under traffic during patrols of the south sidings which were undertaken during a blockage of the siding each Thursday.

121 TME inspections occur on a 2-yearly cycle and the most recent inspection occurred during February 2006. The points were observed in the normal position on this occasion as the points were set for traffic using the down main slow line and as a consequence, it was not possible to assess the relationship between the right-hand switch and stock rails.

Asset Inspector's Reports

122 The points were subject to a monthly inspection (paragraph 128) in addition to the three-monthly FPI as sidewear on the right-hand stock rail was below step 9. The FPI was normally undertaken during a Sunday morning possession arranged for patrolling, but to make effective use of the limited access opportunities, the AIs routinely inspected up to 15 point-ends on each occasion. This meant that the available time at each location was restricted, and points were not routinely reversed in order to avoid delay while arrangements were made with the signaller. As a consequence, the right-hand switch blade of 1565 points was not observed closed against the right-hand stock rail during an inspection for at least a year. With the switch blade open, it was not possible to assess how the switch blade was bearing on the *slide chairs*, or observe its height and profile relative to the stock rail sidewear so the appropriate checks could not be completed.

123 The most recent FPI report was dated 16 July 2006 (Sunday) and is included as Appendix E. This report recorded that:

a. track gauge 100 mm in front of the switches was 1452 mm (item 6);

b. both switch rails rested evenly on the first 2 slide baseplates (item 13);

c. there was sidewear to the right-hand switch rail, and chipping requiring a switch blade weld repair (items 15 and 16); and

d. the right-hand stock rail had a sidewear reading of 8 (item 25).

124 The defects noted were identical to those recorded in the previous five FPI reports dating back to May 2005, with the exception of small changes in track gauge and switch toe opening dimensions. In all five reports, the track gauge at a position 100 mm in front of the switch toes was reported at between 1448 and 1452 mm. Standard 001 states that the maintenance limit for track gauge throughout the movable length of the switches including the 100 mm in front of the switch toes is between 1430 and 1438 mm for vertical S&C (Table 5). Despite this discrepancy, there is no record of a WAIF being raised in respect of this issue.

125 Standard 053 requires that any gap beneath the switch blade, due to vertical curvature or *hogging*, is measured and taken into account when inspecting a switch half set. This is to ensure that an accurate comparison between rail profiles can be made. On each recent FPI report, the switch rail is confirmed as bearing evenly on the first two slide chairs, but a 4 mm gap was recorded by KCI Rail on 7 September, despite no other maintenance having occurred, and this gap remained apparent following the derailment.

126 The AIs did not consider the switch blade profile to be a potential standard 053 failure during their three-monthly visual inspections, despite repeatedly recording sidewear and chipping damage. The relationship between the stock rail and the switch blade could not be accurately assessed with the switch blade in the open position and it was not recorded or photographed. The supervisor's inspections also overlooked these defects and as a consequence, a standard 053 detailed inspection was not instigated by either party.

127 Standard 132 (Issue 3) does not cover the weld repair of shallow-depth switches, although this omission has since been addressed in Issue 4 of the standard published in February 2007. A shallow-depth switch blade is an asymmetric shape with a relatively thick section, and this creates a risk of distortion when heat is applied, making a weld repair difficult to achieve. This subject had been raised in email correspondence between the AIs and ATE dating from September 2005, and in the absence of a written procedure, the ATE had obtained agreement at corporate level for repairs to be undertaken with a welding supervisor, manager or engineer present. The ATE briefed this information to all the Wessex TMEs, but at the time of the derailment a year later, the Clapham AIs remained unaware of this arrangement. The AIs had received no training in weld repair techniques.

128 The AIs used the Point Examination form (paragraph 93) for recording their monthly inspections. In the absence of instructions to the contrary, measurements were restricted to the sidewear of the right-hand stock rail and the remainder of the form was left blank. The AIs considered that the purpose of this inspection was to check that sidewear did not drop below step 6. Reports for the two year period preceding the derailment consistently report the sidewear at step 8 or 9, but the switch/stock condition was coded 2 ('wear serious') rather than 1 ('requires replacement'). Appendix F refers.

129 The AIs had been provided with the NR4 sidewear gauge (Appendix D) during 2005.

130 The AIs had not been provided with the new TGP8 gauge (Appendix D), or trained in its use, despite it being mandated since early 2006.

Rail grinding: 07 September 2006

131 The RCF grinding programme for the week commencing 4 September 2006 (Monday) required KCI Rail teams to undertake work at three different locations during overnight possessions, including Waterloo. Each GSM was provided with a list of point numbers, and work progressed normally during the early part of the week with the teams working separately. The KCI Rail GSM appointed to Waterloo (Waterloo GSM) had four point numbers on his list, but this did not include 1565 points.

132 On the morning of Thursday 7 September, the Waterloo GSM moved his team to 1565 points, which he (wrongly) believed to be the last item on his list. On this occasion, the Waterloo team was joined by a second KCI Rail team, headed by the Waterloo GSM's manager within KCI Rail, following cancellation of work at Wimbledon due to access problems. As a consequence, the Waterloo GSM now had two teams, a total of six staff, on site. His manager (senior GSM) took control of grinding, leaving the Waterloo GSM in overall charge of the site.

133 The possession was booked to commence at 00:30 hrs, but access to the track was delayed until 02:20 hrs due to difficulties in taking the possession and isolating the third rail power supply. This was over an hour later than the previous night. However, the requirement to be clear of the track by 04:15 hrs remained unchanged, resulting in a working period of slightly less than two hours on site. This included the time required to scope the work and get men and equipment onto and off the track.

GSM's qualifications and experience

134 The Waterloo GSM was appropriately qualified (paragraph 99) having completed his training during May 2005. He had worked for KCI Rail on the Wessex contract since October 2003, initially as a grinder, before progressing to GSM. He had been trained as a grinding operator in December 2003 by a recognised training organisation.

135 The Waterloo GSM was considered to be competent and conscientious by the Network Rail grinding manager, based on experience of working with him over a four year period. Shortfalls later identified in the inspection undertaken on 7 September 2006 (paragraph 147) were considered to be unusual and out of character. However, this assessment was not based on any workplace assessments as none had been undertaken in the 16 months since the GSM had become qualified.

Grinder's qualifications and experience

136 The grinding was undertaken by the senior GSM, assisted by a junior member of the team who was working under his supervision. The senior GSM had attended a grinding operator's course in November 2003 and a rail grinding powered plant proficiency course in December 2004. He was qualified both as a GSM, and to undertake facing switch inspections in accordance with standard 053, having undertaken training in both disciplines during July 2005.

137 The senior GSM had undertaken rail grinding within the Wessex area since KCI Rail were awarded the sub-contract in October 2003. This work was predominantly involved with the control of RCF.

Pre-Grinding Inspection

138 The Waterloo GSM inspected 1565 points and observed heavy sidewear on the stock rail leading up to the switch and damage to the right-hand switch blade at the toe, extending for a length of 170 mm. There was no paperwork to reflect this damage as it had not been identified by track inspection staff and grinding had not been requested at this location.

139 The Waterloo GSM undertook a pre-grinding inspection, and this confirmed that damage to the right-hand switch blade failed the gauge 2 test when allowance was made for 4 mm of hogging. Gauge 2 is used to assess switch blade damage (derailment hazard 4) and to pass the test, the upper and lower faces gauge of the gauge are required to make contact with the top of the stock rail and switch blade at the same time.

140 The Waterloo GSM was inclined to report that the switch had failed gauge 2 and that a welder's attention was required. However, the senior GSM believed that the rail could be repaired and, following a discussion in front of the group, this view prevailed.

Rail Grinding

141 Once the site had been established and grinding had commenced, the Waterloo GSM and another member of the team left 1565 points and undertook a follow-up inspection of the previous night's work on a set of points a short distance away to check the position of the *running bands*.

142 The Waterloo GSM's normal practice was to grind, then inspect each switch blade in turn. This minimised the risk of overrunning a possession or leaving work incomplete and also allowed the grinding operators an opportunity to rest briefly during mid-shift. This practice was not adopted at 1565 points.

143 On his return to 1565 points some 50 minutes later, grinding had been completed to the left-hand blade and the team were working on the right-hand blade using a hand grinder. The Waterloo GSM's next task was to make alternative arrangements for signal maintenance staff to undertake an FPL test following completion of the grinding, due to a problem with the original arrangements. Once this was achieved, the Waterloo GSM returned to 1565 points, and assisted the clear-up operation by sweeping out grinding debris and lubricating the slide chairs.

144 The Waterloo GSM was unaware of the need to apply lubrication to the newly ground areas where a wheel flange would be in contact with the rail, known as the flange contact zone, and it is not addressed by the Network Rail standards applicable to grinding (001 and 053) and was not highlighted during his GSM training. As a consequence, he did not apply lubrication to this area.

Post-grinding inspection

145 The Waterloo GSM undertook the post-grinding standard 053 detailed inspection concurrently with the FPL test while his team cleared heavy equipment from the site prior to the end of the possession, including the portable lighting. He used a piece of scrap paper to record the results before transferring the information onto the PGI form.

146 Derailment hazards 1 and 2 can be assessed visually (or for hazard 2, by using the TGP8 gauge) with the switch blade closed against the stock rail. The TGP8 gauge was provided by Network Rail for use by their staff during early 2006, and should also have been in use by KCI Rail staff. Instead, the Waterloo GSM had an older track grinding profile gauge which included a wheel profile element. He had received no training on the use or interpretation of measurements taken with this gauge, so did not use it. The Waterloo GSM also used an obsolete type of sidewear gauge for measuring the sidewear, this type having been replaced by the NR4 gauge earlier in 2006. The specific sidewear gauge used has not been identified, although all Network Rail approved gauges are purchased through Network Rail approved suppliers and are subject to annual calibration.

147 The Waterloo GSM recorded a sidewear value of step 10 at the switch fronts on the PGI form (Appendix G) and ticked "No" boxes, indicating that the switch blade was not above the bottom of the sidewear (hazard 1), and was not at an angle flatter than that of the stock rail (hazard 2). He also indicated that there was no switch blade damage, recording that the right-hand half set was compliant with standard 053 after reference to the senior GSM.

148 The related HG1 form (Appendix H) confirms that grinding was undertaken to a depth of 1 mm to profile the rail, and includes the remark that the sidewear value at the toe of the switch was at step 9. The form was completed by the Network Rail grinding manager, using information from the Waterloo GSM's PGI form, and confirms that the points were considered to be standard 053 compliant. It had not been signed by the Waterloo GSM. The supervisory manager's confirmation box is only signed if a follow-up inspection has been completed.

149 The TSM had not requested work on 1565 points and remained unaware that they had been ground until after the derailment.

Examination of 1565 points following derailment

150 Following the derailment, the switches were examined and rail head profiles were taken at intervals along the right-hand switch and stock rails. A sidewear reading of step seven was obtained at the right-hand switch tips, reducing to a value of step five on the right-hand stock rail at a position 760 mm from the switch toes. Had this been recorded prior to the derailment, standard 053 would have required the prohibition of train movements in the facing direction involving the affected switch blade (ie into the south sidings).

151 Grease was observed on the switch toes, suggesting that grinding had not extended to the tip of the switch blade. However, other areas were effectively unlubricated.

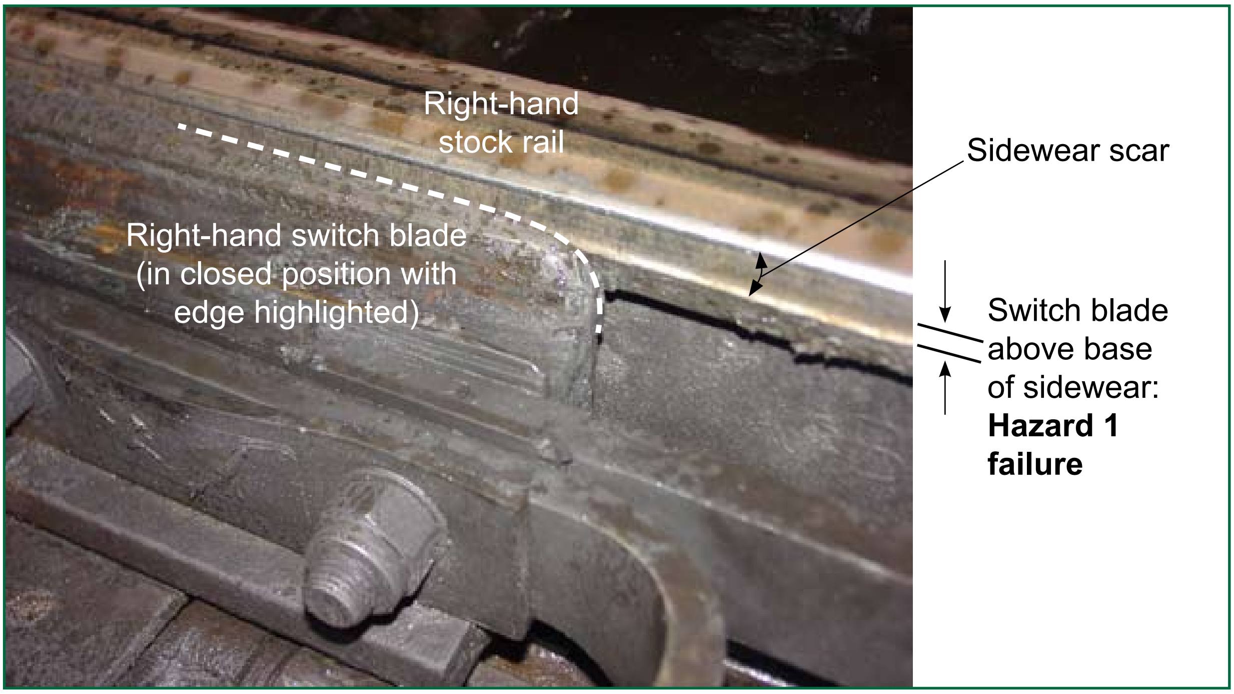


Figure 9: 1565 points: View of right-hand switch rail in reverse (closed) position

152 The right-hand switch blade of 1565 points was to be found non-compliant with standard 053 (Figure 10) in terms of the height of the switch blade when compared with the sidewear on the stock rail (hazard 1). In addition, the angle of the switch blade face was measured as being less than 40° to the horizontal at a position 100 mm from the switch tips, which was significantly shallower than the stock rail and less than the 60° requirement following reprofiling (hazard 2). This did not reflect the Waterloo GSM's findings.

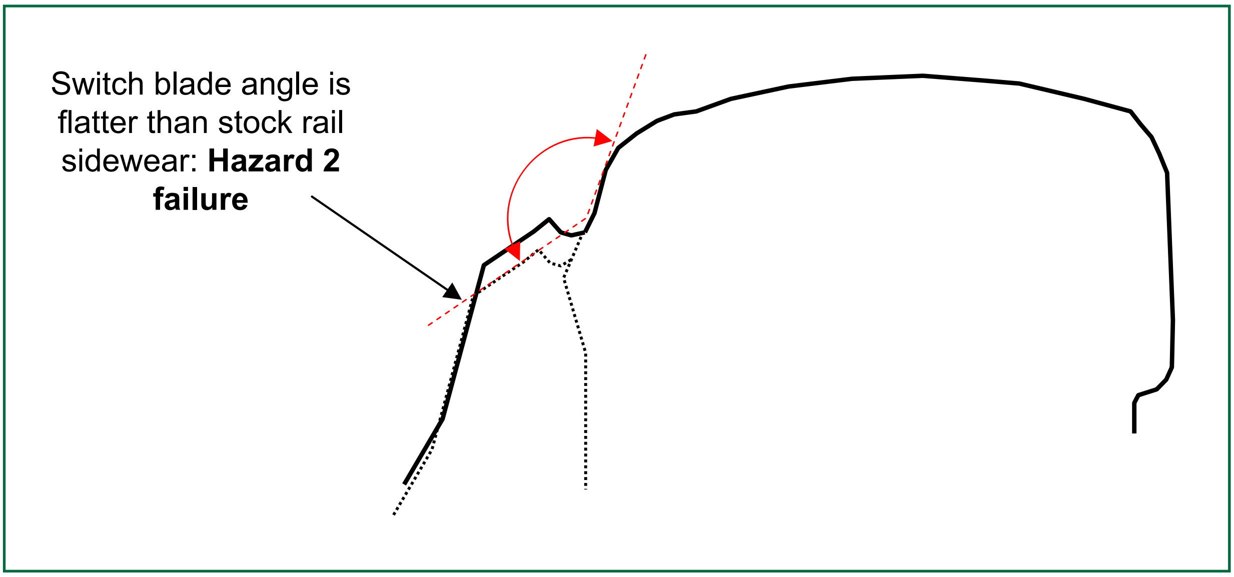


Figure 10: 1565 points: Profile of switch and stock rail, 40mm from switch tip, after correction for hogging (corrected profile is shown by dotted line)

153 As a consequence of the switch and stock rail profiles, the right-hand wheel flanges of each train entering the south sidings, already in contact with the stock rail due to the track geometry, were presented with a ramp. Marks on the switches showed that several wheelsets had attempted to climb this ramp without leading to derailment.

154 Following the derailment, an experienced grinding team were unable to correct the switch blade's profile, which demonstrated that the grinding repair attempted was not possible with this degree of sidewear. The replacement switch half set at Woking was measured but was no longer found to be suitable for installation, possibly due to track movement, and new components had to be ordered to return the points to service. The points were consequently barred to facing moves until repairs were completed on 5 November 2006, restricting access to the down sidings for six weeks.

<u>Examination of train 5G05</u>

155 On train monitoring recorder (OTMR) data for the train indicates that it was not exceeding the 15 mph (24 km/h) speed limit and show no other significant features during the short journey, indicating that the way in which the train had been driven was not a factor. The train was subject to detailed examination at Wimbledon depot following the derailment and despite consequential damage to the wheels, bogies and suspension, no fault was found with the suspension or running gear.

156 The train had been subject to recent refurbishment, and this included the turning and reprofiling of all wheels on a wheel lathe at Wimbledon depot in July 2006. The wheel profiles were found to be within tolerance with no ridges present. Maintenance records indicated no pre-existing faults which could have contributed to the derailment.

1507 Points

157 Waterloo 1507 points are located at a chainage of 0 miles 440 yards, and control access for trains into platforms 1 to 4 from the up main slow line. The track is bi-directional, but the points are mainly used in the facing direction. Both the through and diverging lines curve to the right when approaching the station; the diverging line on a curve of 170 m radius, and the through line on a curve of 230 m radius. The switches are fitted with a *clamplock* drive mechanism and *full-depth* switch blades mounted on rollers and installed on timber bearers. The points were set in the reversed position (ie set towards Platform 2) at the time of the derailment.

158 The points are located within a red zone prohibited area (see paragraph 108).

Maintenance history

159 The left-hand switch half set was replaced in November 2005, but there is no record within MIMS of this event despite a requirement for all such work to be entered, retrospectively if necessary. The new rails were manufactured from hardened *mill heat treated* (MHT) steel, and as such, required the implementation of a special inspection regime (paragraph 165 and Appendix D).

160 There are no records of any grinding or welding at this location contained within MIMS.

161 The rate of sidewear was a recognised problem in the station throat area, this being compounded by the poor provision of working *rail lubricators* over several years due to manpower shortages within the TME's organisation. This issue had been identified by the TME following his appointment in 2005, and he had put arrangements in place to improve the maintenance of existing equipment and provide additional lubricator units in the area. The lubricator installation programme was ongoing at the time of the derailment.

Basic visual and supervisor's inspections

162 The basic visual and supervisor's inspections did not identify any defects affecting 1507 points in the period leading up to the derailment.

Asset Inspector's Reports

163 FPI inspections were undertaken in November 2005, and in February, May and July 2006. The next inspection was required by 30 October, five days after the derailment.

164 FPI records for November 2005 show that the left-hand switch blade exhibited minor damage and required grinding. The February 2006 report confirms that the left switch half set had been renewed.

165 Standard 053 mandates the use of the switch blade radius gauge to check for derailment hazard 5 when undertaking standard 053 inspections on switches formed of MHT steel. In addition, standard 053 requires additional inspections each week for the first month, and then monthly for the next six months following installation or reprofiling. This is due to the derailment risk presented by a hard edge particular to switches of this type.

166 There is no evidence that the AIs had been alerted to the replacement of the switch half set and no record of the additional inspections having taken place.

167 The most recent report was dated 30 July 2006 (Sunday) and recorded that:

a. gauge at the switch tips was 1438 mm;

b. there was no switch blade damage or sidewear; and

c. there was a fracture in the left-hand stock rail front (following discovery, immediate action was taken to replace the stock rail front).

<u>Switch Blade Repairs: 22 October 2006</u>

168 The repair of 1507 points on 22 October was directly linked to planned work to 1512B points which lie immediately before 1507 points when approaching Waterloo station. Both activities were undertaken by an experienced track welder employed by Network Rail.

<u>Welder's training, qualifications and experience</u>

169 The welder who undertook repairs to 1512B and 1507 points normally worked as a plain rail welder using the Thermit welding technique. He had completed manual metal arc welding and switch blade grinding courses in December 2005 and had received certificates, valid for two years in each case. He was qualified to MMA 5 level (paragraph 99), and this training included instruction in the repair of switch blades.

170 The welder had repaired one set of switch blades since completing his training. On that occasion he was supervised by the welding manager as the switch blades were shallow-depth and required special arrangements to be made (paragraph 127).

171 The welder subsequently attended a standard 053 course (prevention of derailments at switches) in May 2006, run by Network Rail. This course had lasted for one day, and included instruction in visual inspection, the use of gauges and the relevant timescales for the completion of remedial work. The training was followed by a practical assessment session which the welder passed. He was issued with a certificate valid for five years.

172 The welder had not undertaken any standard 053 inspections since being trained, and did not have any practical experience in scoping a switch blade repair to be complaint with standard 053.

<u>Repairs to 1512B points</u>

173 Switch blade damage had been identified by the AIs at 1512B points during an FPI inspection on 8 October. A standard 053 detailed inspection was requested, which was subsequently failed. The TSM was notified and he requested a weld repair via the welding manager during the week commencing 16 October. A suitable possession opportunity was identified on Sunday 22 October when part of Waterloo station was closed in connection with an ongoing track upgrade (Waterloo Improvement Project, paragraph 196) and the necessary lines were under possession.

174 The welding manager identified an appropriately qualified welder from his team for the task, and requested paperwork detailing the necessary work from the AIs on Friday 20 October. This was to provide the welder with the information he required in accordance with standard 132. The welding manager spoke to the AIs and was subsequently informed that the paperwork was not available. In his experience, welders often had to work without the necessary paperwork, despite the fact that he was aware that a report had been produced. He also experienced difficulties with legibility as incoming forms were often received by fax.

175 The welding manager was standard 053 trained and had welding experience. He attended site with the welder at the start of his shift on Sunday 22 October to assess the remedial work required. The repair to 1512B points involved attending to a 125 mm length of the switch blade, and was assessed as being within the limits of specification for weld repairs. The welder had some standard 053 gauges with him, but this did not include a sidewear gauge or a TGP8 gauge, and neither had he received instruction in the TGP8 gauge's use.

176 Whilst accessing 1512B points, the welder and welding manager both observed a shard of metal breaking out from the top of the left-hand switch blade of 1507 points resulting in a dangerous condition. It was agreed that the welder would attend to this damage once work was completed on 1512B points. The welding manager attempted to contact the AIs to alert them to the damage and for advice or assistance, but it was the weekend and neither was on duty, one having already completed a shift earlier that day.

177 The welder commenced work on 1512B points and understood that the welding manager was going to undertake checks on 1507 points before leaving to allow the repair to be scoped. The welding manager provided the welder with hogging readings and arranged for signal maintenance staff to attend 1507 points and make an adjustment to the *kicking strap* before any work was undertaken.

178 After the welding manager left, the welder worked alone completing a weld repair to 1512B points before undertaking a partial standard 053 inspection using gauges 1, 2 and a switch blade radius gauge.

Repairs to 1507 points

179 The welder subsequently moved his equipment back to 1507 points and examined the damaged switch blade. He used a hand grinder to remove a shard of metal and tested the blade for cracks using a non-destructive penetrative dye technique. As no cracks were visible, he determined that grinding was the most suitable repair technique, and reprofiled the first 600 mm of the left-hand switch blade, removing a small amount of metal by using a hand grinder. He did not lubricate the newly-ground surface on completion and was unaware of the requirement to do so.

Post grinding inspection

180 On completion of the repair, the welder undertook a partial standard 053 inspection using the gauges he had available. He was unable to measure the sidewear.

181 The welder deemed the profile to be compliant and recorded details of the repair on form SMF/TK/0184 Welders Work Return – Switch Repairs TEF/3008 (Appendix K), but made no reference to the standard 053 inspection. This form had no cell in which to enter the information and he did not have a separate standard 053 form. Having notified the possession staff that his work was complete, the welder returned to his depot, arriving before the end of his shift.

182 A 48 hour follow-up inspection of the welding at 1512B points, as prescribed by standard 132, was planned for the night of 24 October. This was to be undertaken by the welding manager but did not occur due to the intervening derailment.

Examination of 1507 points following derailment

183 An examination of the left-hand stock rail and switch blade of 1507 points showed that sidewear was affecting both rails. The resulted from the right-hand curve at this location, which caused wheels to make continuous contact with the left-hand rails, and was exacerbated by a general lack of lubrication (paragraph 161).

184 A standard 053 detailed inspection indicated that (Figures 11 and 12):

a. the switch blade height was above the base of the sidewear on the stock rail, resulting in a derailment hazard 1 failure;

b. the switch blade profile was flatter than the stock rail's sidewear resulting in a derailment hazard 2 failure;

c. a sharp edge was apparent along the upper edge of the switch blade resulting in a derailment hazard 5 failure; and

d. sidewear on the left-hand stock rail was at step 9 (there is no record of sidewear in the July FPI and an increased-frequency inspection regime had not been instigated).

185 Following the derailment, facing moves were prohibited until the switch blade was reground to comply with the requirements of a standard 053 detailed inspection.

Figure 11: 1507 points viewed towards Waterloo station in the direction of travel. Train 1D54 is visible in the right background, with carriages 7 and 8 behind a Class 73 locomotive being used for recovery

186 Inspection of the site confirmed that the leading wheelset on the 7th vehicle had been first to derail close to the toes of 1507 points, with the following bogies being derailed as a result of the diverging movement. The first bogie to be derailed continued towards platform 2, while the remaining three bogies took a separate route towards platform 3/4.

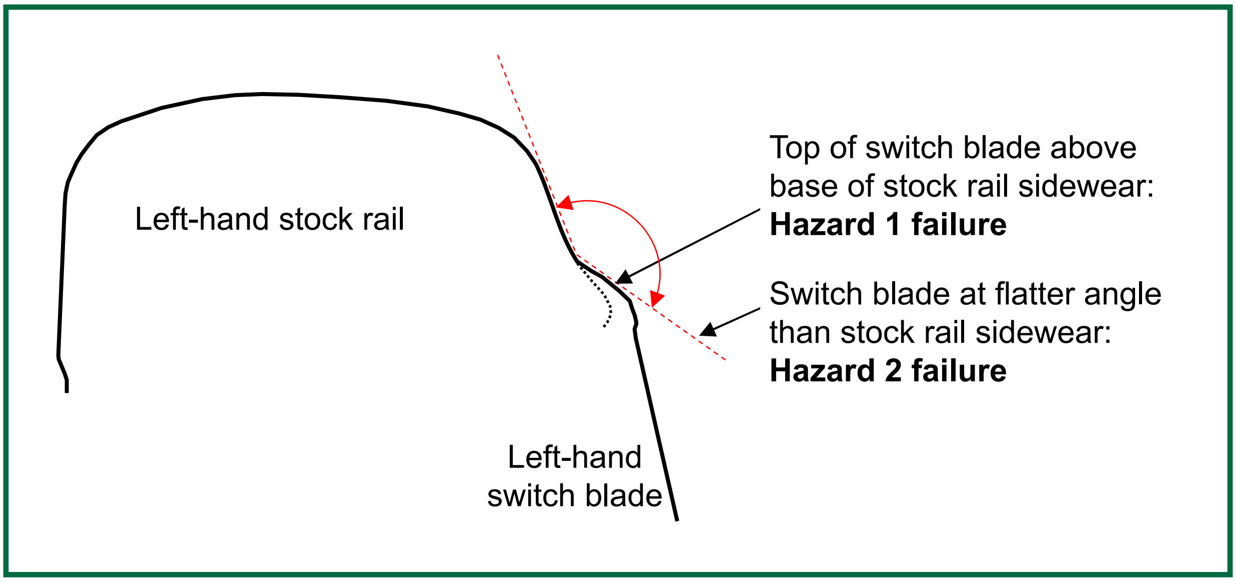


Figure 12: Profile of left-hand switch half set of 1507 points, 100 mm beyond switch toe (from data recorded by Delta Rail)

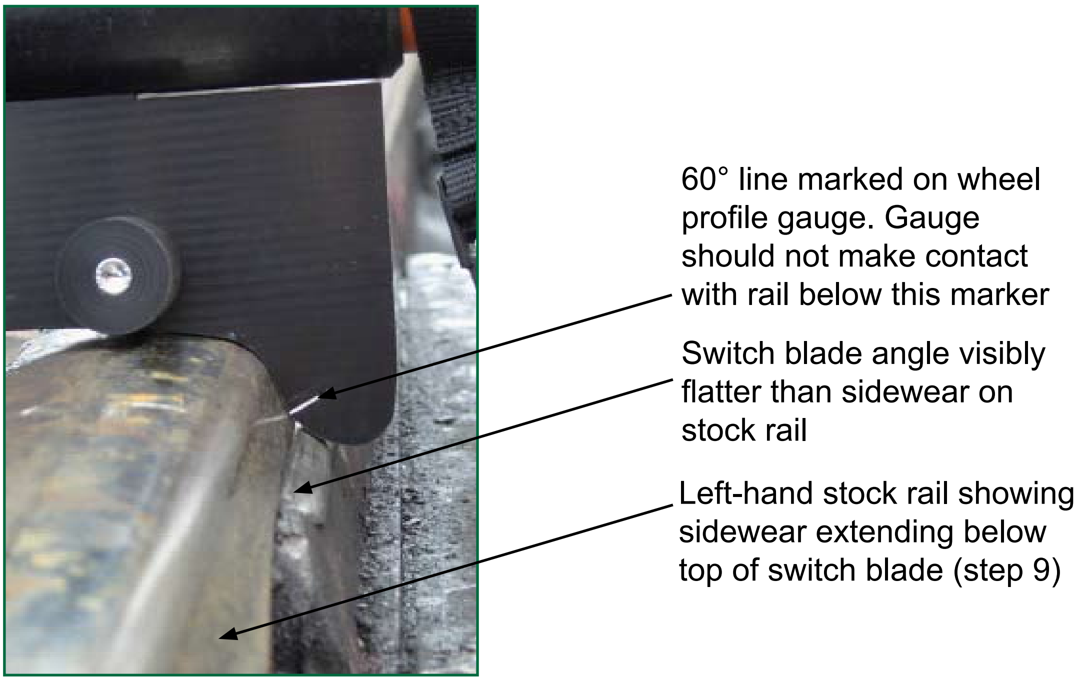


Figure 13: Image of wheel profile gauge on 1507 points (left-hand switch half-set). Photograph courtesy of Network Rail

187 The derailment was caused by the flange of the left-hand wheel on the leading axle of coach 7 climbing the left-hand switch blade, before progressing to the stock rail/switch blade interface, splitting the points and running into derailment. The following wheelsets were all derailed. There was also evidence, from marks on the rails, that several other wheelsets had attempted to climb the left switch blade but had corrected themselves without proceeding into full derailment.

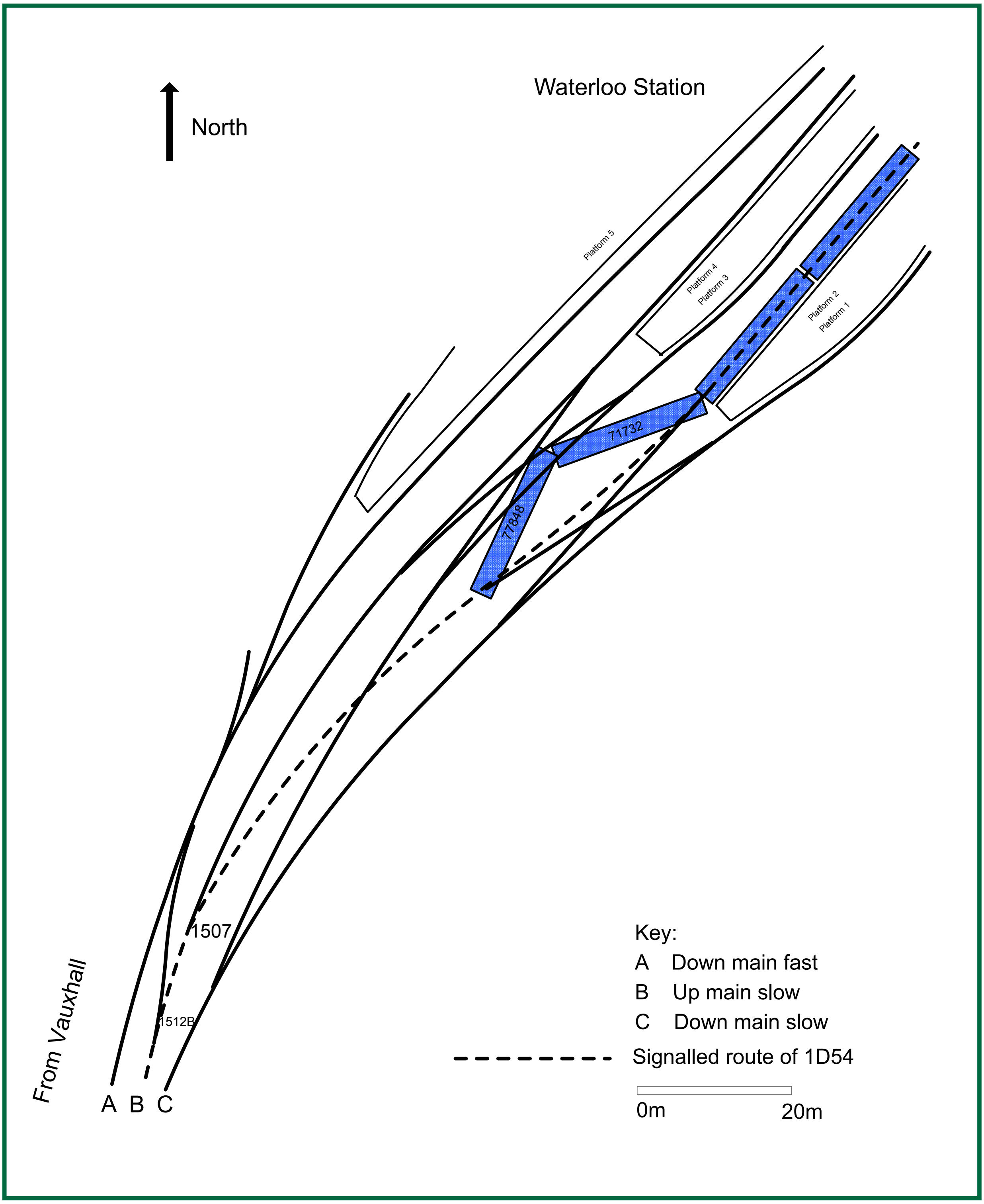


Figure 14: Diagram showing position of train 1D54 following derailment

Figure 15: View of rear two carriages of train 1D54 in direction of travel following derailment

Examination of 1512B points

188 Waterloo 1512B points were examined following the derailment. A standard 053 detailed inspection was undertaken and these points also failed, resulting in an immediate ban on facing moves. The failed switch blade required remedial work before the re-railed coaches could be recovered by a locomotive due to the high risk of a further derailment occurring.

189 Network Rail confirmed that the welder had not carried out repairs to any other switches.

Examination of train 1D54

190 The OTMR for train 1D54 indicated that the train approached 1507 points at 14 mph (22.5 km/h), and did not exceed the line speed of 15 mph (24 km/h)during its final approach to Waterloo station. The information shows no other significant features during the final part of its journey from Dorking.

191 The train was recovered to South-West Train's Wimbledon depot for detailed examination. No pre-existing faults with the primary suspension or running gear were found that could have contributed to the derailment. Examination of the wheel profiles confirmed that they were within acceptable wear tolerances. There was extensive consequential damage as a result of the derailment, included the crushing of coach body ends, and dislocation or breakage of bogie and braking equipment.

192 Maintenance records for the train indicate no items of relevance to the derailment mechanism. The leading unit was not derailed, but had, by coincidence, been involved in a derailment at Epsom on 12 September 2006. This derailment was caused by defective track and is the subject of RAIB report 34/2007.

193 There is no evidence to suggest that the condition of the train or the way in which it had been driven made any contribution to the mechanism of derailment.

Emergency post-derailment inspections

194 Following the second similar derailment in the same area, Network Rail instigated an emergency standard 053 inspection programme covering 117 point-ends in the Waterloo area, commencing on 25 October. At five locations, defects were sufficiently serious to require the prohibition of facing moves until repairs were completed. The most recent FPI reports for the affected switches list various maintenance requirements including the need for switch blade welding at one location and grinding at a second. The only request for a standard 053 detailed inspection related to 1512B points (paragraph 173).

195 The low number of failures detected during inspection of a sample of switches at other major stations (paragraph 40) initially suggested that the problem was specific to the Waterloo area, but more recent derailments at Snow Hill, Birmingham on the Midland Metro system (RAIB report 38/2007) and Exhibition sidings in Glasgow suggest that there may be national issues with switch inspections and the interpretation of standard 053. The latter derailment is subject to an ongoing RAIB investigation.

Waterloo Improvement Project

196 The Waterloo Improvement project was a heavy maintenance programme affecting much of the track in the immediate vicinity of the station and involving the renewal of some S&C units. The project was driven by the need to improve the reliability of the Waterloo layout, much of which is up to 30 years old.

197 The project was valued at £1.6M and commenced in October 2006 with an 11 week programme, the start date having been delayed from the Spring. The project was not driven by specific safety concerns, although speed restrictions had been imposed in the west crossings area, outside the station, due to the condition of the track. That part of the layout was intended as a five year temporary project when installed in 1977 and is still in use, albeit with speed restrictions imposed.

198 The project's scope did not include work to the switch or stock rails of either 1565 or 1507 points.

Previous occurrences of a similar character

199 Derailments occurred in similar circumstances at Birkenhead (May 2004) and Walsall (October 2004). The subsequent industry investigations led to a guidance briefing to clarify the requirements of standard 053 being developed and briefed to territory and area staff and training suppliers. These briefings should have been cascaded to front-line staff, but those involved in these incidents had little or no knowledge of this matter.

200 The previous derailments led to the development of the new track gauge with wheel profile attachments as an aid in assessing the presence of derailment hazards associated with worn switch blades. This gauge was not in use at Waterloo at the time of the derailments.

Analysis

Identification of the immediate cause

201 The immediate cause of both derailments was the unsatisfactory condition of the switch blade controlling the diverging movement. This presented a ramp to wheelsets, leading directly to derailment.

Identification of causal and contributory factors

Effectiveness of the visual inspection process

202 The AIs undertook inspections of facing points in accordance with their understanding of standard 053. Following these inspections, reports were produced and work orders generated by the MIMS system were closed-out by the AIs, giving confidence that the issues were under control.

203 The visual inspection forms a vital part of the standard 053 inspection regime and is the basis for deciding if a detailed inspection is required. Any failure to correctly apply the criteria for visual inspections affects the safety of the whole system if detailed inspections are not triggered when needed. Completing a visual inspection without reversing the switches significantly compromised this process, and by not recording the fact on the FPI reports, no-one other than the AIs could be aware of it. Shortfalls in the inspection process led to derailment hazards developing, unknown even to the AIs, and ultimately led to the derailment at 1565 points and the ban on train movements in the facing direction across five other sets of points at Waterloo.

204 A visual inspection practice which failed to properly identify defects was a causal factor in the derailment at 1565 points.

Asset condition reporting

205 The AIs routinely undertook their inspections within the required timescales and habitually worked without guidance or oversight from the ATME. Where standard 053 failures were identified, there is evidence that the necessary paperwork was raised using a standard 053 detailed inspection form and a WAIF. Both formal and informal means were used to ensure that remedial work was instigated within the required timescales. In these instances, the response was effective.

206 In other instances where the defects were considered to be minor or benign, the routine FPI reports were completed and filed within the AIs' office and no further action was taken. The ATME did not sign-off these reports and there was no process or depot procedure whereby either he, or the TSM, routinely reviewed them. However, the TSM had a good working relationship with the AIs and was confident that they would alert him to issues requiring his attention.

207 The MIMS database exists to manage the workbank of defects requiring remedial action. Despite the long-standing defects at 1565 points (paragraph 124) and maintenance work at 1507 points there is no record within the MIMS system of any work being required or occurring at either 1565 or 1507 points in the four years preceding the derailments with the exception of the cancelled switch half set replacement (paragraph 117).

208 The reporting practice which developed at Clapham depot resulted in essential information on the condition of the points being routinely unavailable to the TSM and others with responsibility for track maintenance. The system depended on the AIs alerting other staff to the presence of defects on a case-by-case basis, and in the absence of such an alert, no action was taken. This was a causal factor.

1565 points: Effectiveness of grinding repair

209 KCI Rail were not programmed to undertake repair work to 1565 points during the week commencing 4 September and the work was included in error. However, as their instructions rarely extended to more than simple details of the location where work was required, the KCI Rail GSMs were familiar with the process of scoping the activity before grinding commenced.

210 KCI Rail's workload included a significant amount of RCF grinding within switches. They therefore had experience of grinding switch blades to improve the rail profile, and undertaking post-grinding standard 053 inspections. However, this is substantially different to reprofiling of switch blades to remove a specific derailment hazard. Scoping of a standard 053 repair requires a detailed knowledge of the derailment hazard to be addressed and the repair techniques available, many of which require welding to rebuild the switch profile. A GSM is not specifically trained to assess the repair requirements for a switch blade damaged in this way.

211 The Waterloo GSM observed damage to the right-hand switch blade, but he did not identify that the rail's profile represented a derailment hazard. He believed that routine grinding had been requested and recorded some elements of his pre-grinding assessment on a PGI form (Appendix G). He did not make a record of the damage to the switch front or the outcome of checks made using Gauge 2 (paragraph 139).

212 The PGI form was not suitable for recording the standard 053 detailed inspection required before remedial treatment was considered, and was not intended for this purpose. It did not allow proper consideration of the condition of the points to be made or the repair to be scoped to ensure compliance with standard 053.

213 In the event, the grinding team attempted to reprofile a rail which was worn beyond the point where a grinding repair could be effective, and without seeking advice from the grinding manager. The repair led to the introduction of slight roughness on the switch blade and when combined with a lack of lubrication, made it more likely that the existing rail profile defect would lead to a *flange-climb* derailment occurring.

214 The grinding repair failed to correct an existing rail profile defect and increased the surface roughness of the switch blade. This was a causal factor in the derailment at 1565 points.

1507 points: Effectiveness of grinding repair

215 At 1507 points, the welder was working without assistance and his experience of undertaking switch blade repairs was limited to a single set of switches undertaken some months previously. The welder had been trained in switch blade repair techniques, but this did not include switch rebuilding. He was an infrequent user of the necessary skills and had little practical experience of scoping or undertaking standard 053-compliant repairs. He therefore lacked the competence to undertake work of this nature.

216 The welder did not identify or attempt to correct the already-defective switch blade profile. Instead, the repair removed the visible damage, but introduced a sharp edge along the upper part of the blade (derailment hazard 5). This, together with the lack of lubrication, exacerbated the existing derailment risk. The combined presence of these defects created an opportunity for flange-climb and was the causal factor in the derailment at 1507 points.

Use of the Facing Point Inspection (FPI) Form

217 The AIs used a locally-developed FPI form to record a wide range of information on the points being inspected. Most information concerns features which change slowly over time, so there was a high degree of repeatability between subsequent inspection reports. Some dimensions could not be measured without reversing the switches and as this was rarely achieved in practice, the necessary information was obtained from signal maintenance department records which may have been out of date at the time of the FPI.

218 Attributes such as sidewear were not prompted on the FPI form or required as part of the visual inspection process. As a consequence, this information was not routinely recorded, and data which could have been used to monitor asset condition was unavailable.

219 The FPI form used by the AIs for recording three-monthly inspections was not fit for purpose and was not effective in supporting the standard 053 inspection process. This was a contributory factor in both derailments.

Guidance on visual and increased frequency inspections within Standard 053

220 Standard 053 provides limited information on the scope of the three-monthly visual inspection or the increased-frequency inspections triggered by sidewear readings below step 12. The training received by the AIs was also lacking in this respect, and although they were recommended to undertake detailed inspections whenever there was doubt as to the condition of the rail profile, this was not always practicable.

221 It is Network Rail's intention that points which are known to be worn and subject to increased-frequency inspections are subject to a standard 053 detailed inspection on each occasion. This requirement was not made explicit within standard 053 Issue 3, and local interpretation of the increased-frequency inspection was simply a requirement to measure and monitor sidewear. The trigger for undertaking standard 053 detailed inspections at 1565 points was repeatedly missed as a consequence, and this resulted in significant rail profile defects remaining unidentified in the track.

222 The lack of guidance within standard 053 Issue 3 on the scope of both visual and increased-frequency inspections was a contributory factor.

Track access during daylight

223 Access to the track while trains are running depends on good visibility of approaching traffic and the availability of places of safety to allow staff to step clear when trains approach (paragraph 108). Continuous track curvature and an absence of places of safety between tracks in the Waterloo area mean that access is restricted. These restrictions made the facilitation of track inspections more difficult than in other areas and required the shared use of T2 protection and T3 possessions arranged for track patrolling (paragraph 74).

224 The AIs worked predominantly day-shifts, which allowed them to observe the behaviour of the track under load. However, this reduced the opportunities to safely access the track or to arrange for points to be reversed. To maintain their inspection programme (paragraph 82), the AIs needed to maximise the use of available possessions, resulting in a large number of FPIs being undertaken on some occasions (paragraph 122). Use of these access opportunities resulted in intense working periods which were not well suited for undertaking safety-critical standard 053 inspections.

225 Track access time during dayshift working was limited and compromised the effectiveness of the inspection regime. This was a contributory factor.

Asset inspection resources

226 The AIs were required to undertake a range of specialist inspections (paragraph 81) in addition to the FPIs over a wide geographical area. At the time of the incident, two positions were allocated for these duties, leading to both AIs working extended hours on a near-permanent basis (paragraph 82).

227 The provision of insufficient special inspection resources led to the AIs having a significant and unremitting workload which may have led to fatigue and affected the quality of the inspections. This was compounded by access restrictions covering 40 per cent of the points within their care, and is a contributory factor.

Planning support for standard 053 inspections:

228 The AIs were required to negotiate and arrange their own access into existing track possessions, a task which was undertaken by the Clapham planning department for patrollers. This added unnecessarily to their already considerable workload and required them to develop and submit their own access paperwork to possession management staff to allow entry to possessions. Had this been done on their behalf, they would have had more time and potentially more opportunities for inspection work.

229 The possessions available were intended for patrolling and were not planned with the AIs requirements in mind. The lack of this provision reduced the opportunity to have points reversed during FPIs, as signalling staff did not regard the AIs as prime users of the possession or necessarily understand their particular requirements (paragraph 89).

230 Lack of planning support resulted in an additional burden on the AIs and did not result in track protection arrangements appropriate to their needs being arranged. This is a contributory factor.

Track Section Manager's inspections

231 The Network Rail TSM was unaware of the deterioration of 1565 points as he had not been alerted to their true condition by the AIs. The TSM was not standard 053 trained and had only received a briefing on the subject. This conflicted with the requirement imposed by standard 001 for the supervisor's inspection to identify points requiring a standard 053 detailed inspection (paragraph 44) and led to an over-reliance on the asset inspection regime.

232 The TSM was not qualified to recognise standard 053 derailment hazards and was unaware of a long-standing defect at 1565 points. This led to over-reliance on the asset inspection regime and was a contributory factor.

1565 points: Deferred replacement of right-hand switch half set

233 The need to replace part of 1565 points had been recognised over four years prior to the derailment. A replacement right-hand switch half set was ordered and delivered to a yard at Woking, operated by the then IMC in April 2002 (paragraph 118). Details of this activity did not transfer into MIMS (paragraph 54), so no plans were developed to undertake the work.

234 A combination of staff turnover, the transfer of maintenance responsibility from the IMC to Network Rail in 2004, and lack of visibility of the FPI reports (paragraph 92) meant that the maintenance organisation became collectively unaware of the need for this work to take place and the existence of the replacement components. The defect remained in the track until the derailment occurred on 11 September 2006.

235 The lack of transfer of records or plan to install the replacement half set allowed the defective rail to remain in the track for an extended period and was a contributory factor to the derailment at 1565 points.

1565 points: effectiveness of inspections with switch open

236 The AIs experienced difficulty in arranging for points to be reversed when undertaking three-monthly standard 053 visual inspections (paragraph 122), despite the requirement within standard 053. Having failed to get the matter resolved or recognised, a situation developed where inspections were routinely undertaken without the normally open right-hand switch blade being observed in a closed position. The defective condition of the right-hand switch blade could not be identified in these circumstances.

237 Not observing the switch blade closed against the stock rail resulted in the effectiveness of the standard 053 visual inspections being seriously compromised. This is a contributory factor.

1565 points: Authority of the Waterloo GSM

238 During the possession of 7 September, the Waterloo GSM was responsible for KCI Rail's activities at Waterloo. This authority was affected by the arrival of the senior GSM (paragraph 132) and his views did not prevail during a discussion over whether a grinding repair should be attempted following the discovery of unrecorded damage at 1565 points.

239 The Waterloo GSM was in charge of his manager for a safety-critical activity, but his authority was undermined when grinding went ahead despite the discovery of damage to the switch blade. The situation was compounded by the number of staff in attendance and the Waterloo GSM having to leave site to make alternative arrangements for signalling staff to attend and undertake the FPL test. This resulted in an inappropriate grinding repair being attempted, and was a contributory factor in the derailment.

1565 points: Effectiveness of the post-grinding inspection

240 Following completion of the grinding, the Waterloo GSM had a short period of time in which to undertake the post-grinding standard 053 inspection. Due to the impending end of the possession, this was undertaken concurrently with checks by signal maintenance staff which meant that both activities were competing for access to the same part of the track. For reasons which may be linked to dismantling of the site lighting, the Waterloo GSM failed to record the sidewear correctly or observe the presence of longstanding derailment hazards affecting the right-hand switch blade.

241 The Waterloo GSM used a piece of rough paper on which to record the standard 053 detailed inspection results, before later transferring this information onto the PGI form (paragraph 147).

242 The PGI form for the right-hand switch half set contains incorrect sidewear values and other errors relating to the presence or otherwise of standard 053 derailment hazards. The Waterloo GSM had not been provided with the correct sidewear gauge or a TGP8 gauge. The TGP8 gauge may have highlighted the fact that the switch blade was much flatter than the stock rail, presenting a derailment hazard 2 risk.

243 The post-grinding inspection did not identify the presence of standard 053 derailment hazards affecting the switch blade. Neither did it identify a stock rail sidewear value of step 5 within one metre of the switch toe, which required an immediate prohibition to be placed on facing movements involving the associated switch blade (ie into the south sidings). By declaring the switches compliant with standard 053, the Waterloo GSM permitted facing movements into the south sidings. The situation was compounded by the lack of a mandated follow-up inspection (paragraph 148), and allowed the defective switch rail to remain unidentified in the track. This was a contributory factor in the derailment.

Site checks on KCI Rail by Network Rail

244 The grinding manager worked without a deputy or other formal assistance during the period preceding the derailment. Due to the size of the area covered, and the need to manage three dispersed grinding teams, it was not possible for him to scope or check more than a small proportion of the grinding activity, due to planning and reporting duties taking precedence. Standard 001 requires a detailed inspection of RCF sites to be carried out by a GSM so that the scope of work and all necessary planning could be assessed. The details should then be entered onto an HG1 form for use by the grinding team leader. In practice, works were scoped by the KCI Rail GSMs following arrival at site, and this did not allow for detailed planning should unusual rail defects be encountered.

245 The grinding manager's site checks were restricted to the examination of safety documentation. Network Rail had no programme for undertaking technical assessments of KCI Rail's activities and there was a lack of clarity within Area Services over who should have assumed this responsibility (paragraph 105).

246 The opportunity for an experienced person to assess the work undertaken by KCI Rail at 1565 points was not taken, and the non-compliant switch blade, presenting a latent defect, remained in the track.

247 The lack of site checks by Network Rail meant that they had no detailed knowledge of the activities of their sub-contractor. This is a possible contributory factor.

1507 points: Recognition of existing defect

248 Neither the welding manager nor the welder recognised the underlying derailment hazard 2 defect affecting the left-hand switch rail of 1507 points, despite both having been standard 053 trained. This may have been due to lack of use of the associated skills rather than a deficiency in the training itself as neither had used these skills since training or had the opportunity to develop competence.

249 The welder did not have access to the relevant FPI report or standard 053 detailed inspection report.

250 The lack of recognition of an existing standard 053 derailment hazard by both the welder and welding manager was a contributory factor.

1507 points: Effectiveness of the post-grinding inspection

251 The post-repair standard 053 inspection was compromised by the welder's lack of practical experience in this task, and the non-availability of sidewear and TGP8 gauges. Both 1512B points and 1507 points were deemed to be compliant with the requirements of standard 053, but both failed a subsequent inspection undertaken by more experienced staff following the derailment.

252 The weld return form TEF/3008 contained no reference to, and contained no prompts or guidance in the undertaking of standard 053 inspections.

253 The welder's lack of practical experience in undertaking standard 053 inspections was contributory in allowing a non-compliant switch profile to remain in the track. This was a contributory factor.

Identification of underlying causes

254 There was a systematic lack of understanding of the requirements for applying standard 053 requirements across the various teams responsible for inspection and maintenance activities. Either individuals had not been trained, or they had received training but had not developed skills sufficient to allow known defect types to be detected and were therefore not competent. This allowed derailment hazards to remain undetected in the track, and in the case of 1565 points, over a period of several years.

255 The asset inspection regime was not subject to sufficient management supervision and understanding. The AIs were required to undertake a large number of inspections, but attention was only given to the subsequent reports in the event that the AIs themselves identified a problem. There was no history of on-site checks being undertaken or means by which the competency of the AIs was checked. The method by which the AIs worked had developed over a period of time out of expediency, and no one was aware that points were not being routinely reversed, rendering the process defective.

Severity of consequences

256 The immediate consequences of both derailments were minor in that both had occurred at low speed and all vehicles had remained in an upright position.

257 The implications of an ineffective standard 053 inspection and reporting process across the inner-Wessex area are serious and had presented an ongoing risk to the safety of rail movements over a period of several years. Some procedures had been inherited from the former IMC and remained in use pending replacement by Network Rail's standard maintenance procedures.

Other factors for consideration

258 Some providers of training in standard 053 inspections issued certificates with a validity of five years, with no provision made for re-testing within this period, whereas others issued certificates valid for two years. The lack of refresher training and issue of long-duration certificates meant that some staff had limited recent experience in undertaking standard 053 inspections. This compromised the effectiveness of the control of the derailment risk.

259 The frequency of the standard 053 visual inspection was set at three months for all facing points, or points that could be used in a facing direction. This took no account of the differing risk or wear profiles or susceptibility for different derailment hazards. At 1507 points, accelerated sidewear affecting the left-hand switch rail had not been identified by the FPI regime. The derailment occurred 12 weeks after the last inspection and the absence of a sidewear reading on that occasion meant that increased frequency inspections had not been triggered. The inspection frequency was therefore insufficiently frequent to allow adequate monitoring of track condition. This may justify a bespoke standard 053 inspection regime at high-risk locations which may include more frequent visual inspections and periodic detailed inspections (**Recommendation 12**).

260 The effectiveness of MIMS has been variable, with very few entries referring to either 1565 or 1507 points during the 3-4 years that the system has been operational. This is despite maintenance actions either being required or taken at each location. Network Rail do not currently operate a single database containing comprehensive data about asset condition and details of all defects found including those remedied during inspections (**Recommendation 13**).

261 The paperwork to accompany the planned repair to 1512B points was requested but not provided in advance of the works despite the fact that a detailed inspection had been undertaken. This resulted in the work being scoped by staff who were inexperienced in the application of standard 053 (**Recommendation 14**).

Conclusions

Immediate cause

262 The immediate cause of both derailments was the condition of switch blades within each set of points. These exhibited known derailment risks which had not been identified by the routine inspection process or by detailed inspections following recent maintenance activity.

Causal factors

263 Causal factors were:

a. a visual inspection practice which failed to properly identify defects (Paragraphs 204 and 232, **Recommendations 1 and 2**);

b. a reporting practice which resulted in essential information on the condition of the points being routinely unavailable to the TSM and others with responsibility for track maintenance (Paragraph 208, **Recommendation 4**);

c. at 1565 points, a grinding repair that failed to correct an existing rail profile defect and increased the surface roughness of the switch blade without applying lubrication (Paragraph 214, **Recommendation 1 and 2**); and

d. at 1507 points, the repair of the defective switch blade which introduced a sharp edge along its upper surface, and exacerbated the derailment risk presented by an already defective and unlubricated switch blade profile (Paragraph 216, **Recommendations 1 and 2**).

Contributory factors

264 The following factors were considered to be contributory:

a. the FPI form used by the AIs for recording three-monthly inspections which was not effective in supporting the standard 053 visual inspection process (Paragraph 219, **Recommendation 1**);

b. the lack of guidance within standard 053 on the scope of both visual and increased-frequency inspections (Paragraph 222, **Recommendation 1**);

c. track access time during dayshift working which was limited and compromised the effectiveness of the standard 053 visual inspection regime (Paragraph 225, **Recommendation 8**);

d. the provision of insufficient special inspection resources, which led to the AIs having a significant and unremitting workload (Paragraph 227, **Recommendation 9**);

e. lack of planning support, which placed an additional burden on the AIs and did not result in track protection arrangements appropriate to their needs being arranged (Paragraph 230, **Recommendation 9**);

f. the TSM not being trained or certified competent to undertake standard 053 inspections, which led to over-reliance on the asset inspection regime (Paragraph 232, **Recommendations 3 and 5**);

1565 points

g. The lack of transfer of records or plan to install the replacement half set at 1565 points, which allowed the defective rail to remain in the track for an extended period (Paragraph 235, **Recommendation 7**);

h. not observing the switch blade closed against the stock rail, or correctly recording the developing sidewear, which resulted in the effectiveness of the standard 053 visual inspections being seriously compromised (Paragraph 237, **Recommendation 1**);

i. the Waterloo GSM whose authority was undermined when grinding went ahead. This resulted in an inappropriate grinding repair being attempted (Paragraph 239, **Recommendation 10**);

j. the post-grinding inspection which did not identify the presence of a significant rail profile defect, or a sidewear value on the adjacent stock rail which required facing movements to be immediately prohibited (Paragraph 243, **Recommendation 6**);

k. the lack of site checks by Network Rail which meant that they had no detailed knowledge of the activities of their sub-contractor (Paragraph 247, **Recommendation 11**);

1507 points

l. The lack of recognition of an existing standard 053 derailment hazard by both the welder and welding manager (Paragraph 250, **Recommendations 1 and 2**); and

m. The welder's lack of practical experience in undertaking standard 053 inspections which allowed a non-compliant switch profile to remain in the track (Paragraph 253, **Recommendations 1 and 2**).

Underlying causes

265 The underlying causes were:

a. loss of information on legacy renewal plans (paragraph 118);

b. an inadequate understanding of the requirements of standard 053 by Network Rail staff and contractors working within the Wessex area (Paragraph 254, **Recommendations 2 and 3**);

c. inadequate understanding or involvement by depot management staff in the facing point inspection process and a lack of checks on inspection and maintenance activity (paragraph 84);

d. a lack of an appreciation of the need to lubricate newly ground running surfaces (paragraphs 144 and 179);

e. a general inadequacy of the various inspection forms and reports produced (paragraphs 87 and 181); and

f. inadequate track access (paragraph 110).

Actions reported as already taken or in progress relevant to this report

266 For several months following the derailments, the Wessex ATE instructed that all standard 053 inspections should be detailed rather than visual to identify any latent defects. This led to a short-term increase in the AI's workload and a requirement for standard 053 grinding at a number of sites to correct developing, but previously unidentified, defects.

267 Standard 053 training has been extended to staff within the depot including TSMs and some track patrol staff. As a consequence, the rail profiles are now examined by a wider range of staff and this has resulted in requests for additional standard 053 detailed inspections.

268 A limited number of inspections are now undertaken jointly with the signal maintenance department, following the creating of an additional AI position to cover night-shifts. This has enabled some standard 053 inspections to be undertaken at the same time as the Facing Point Inspections. Inspections not completed at night are undertaken during the day.

269 A spreadsheet is now in use which operates in parallel to MIMS/Ellipse and indicates to the AIs which switches are due for inspection. Use of the spreadsheet gives greater visibility and ensures that information is in front of the AIs at all times. Grinding staff also have access to the spreadsheet.

270 The grinders now complete paperwork to show the repair and post-repair testing and have access to records compiled by welding and grinding teams. This allows defects to be closed-out. The AIs are also requested to do follow-up checks following weld repairs.

271 The Clapham TSM now reviews and signs off all facing point inspection reports which are undertaken using a new, but locally-developed form in the absence of a standardised format. In accordance with the standard 053 revision 4 (paragraph 275), these inspections are now undertaken by the TSM or by the AIs on his behalf.

272 Network Rail have commissioned a study of track access in the Waterloo area, identifying positions of safety and areas where current Red Zone Prohibitions could potentially be removed. It has also identified inaccessible areas including those where lookout sighting distances are inadequate. The study has made a case for:

a. Weekday T2(H) line blockages on the up main relief line (which becomes the down Windsor slow line) between Waterloo and Nine Elms Junction which is not required to operate the off-peak timetable.

b. Additional T3 possessions or T2(H) blockages for currently inaccessible areas.

c. The reduction of the permanent line speed in the down direction between 0 miles 29 chains and 1 mile 0 chains as the current 60 mph (99.6 km/h) limit cannot be achieved by any train accelerating away from Waterloo within this distance as this would allow shorter lookout sighting distances.

273 Network Rail have issued guidance note NR/BS/LI/063 (December 2006) to clarify actions following rail grinding. This amplifies the requirements for flange lubrication and use of the TGP8 gauge. These requirements have since been incorporated into Revision 4 of standard 053 (paragraph 275).

274 Network Rail have appointed two assistant grinding managers within the Wessex area to work with the grinding manager. This allows closer control of grinding activity, including the pre-planning of work and some post-work inspections.

275 Network Rail have published revision 4 of standard 053 (October 2007) which incorporates guidance note NR/BS/LI/063 (paragraph 273) and other lessons from the Waterloo derailments. While the fundamental principles are unchanged, the revision provides clarification for the following:

a. responsibilities, which are now centred on the TSM;

b. competency requirements for staff undertaking each type of inspection;

c. visual inspections, which are now termed 'supervisor's visual inspections' and are undertaken by the TSM or other nominated person on his behalf;

d. the identification of higher risk switch configurations;

e. the requirement for lubrication following grinding;

f. the use of TGP8 gauge;

g. the requirement for TSM to review records prior to planning switch repairs;

h. the frequency of detailed inspections, which can now be based on wear rates;

i. the validity of certificates which is now set at two years; and

j. the requirement for a follow-up inspection for newly ground switches after a period under traffic.

Recommendations

276 The following safety recommendations are made[1] :

Recommendations to address causal and contributory factors

1 Network Rail should review and revise the guidance provided for staff undertaking or supervising standard 053 inspections to make clear the following:

a. the detailed requirements for visual and increased-frequency inspections, including the use of photographs, and the development of standard forms with suitable prompts for this purpose (Paragraphs 204, 219, 222 and 237);

b. the conditions where a switch blade repair cannot be safely achieved such that staff understand the alternative courses of action available (Paragraphs 214, 216, 250 and 253); and

c. that work should be suitably planned and organised so that there is time for it to be carried out and with sufficient lighting for individuals to complete necessary inspections (paragraph 240).

2 Network Rail should review the frequency and content of training to (Paragraphs 204, 214, 216, 250 and 253):

a. improve skills retention amongst occasional standard 053 inspection practitioners;

b. introduce a mentoring programme with individual staff log books;

c. introduce refresher training; and

d. introduce a programme of periodic monitoring of AIs and TSMs by a supervising manager.

3 Network Rail should provide a handbook for use by front-line and supervisory staff which summarises the requirements of standard 053 inspections, post-inspection actions, and pre and post-grinding inspections. This should contain the necessary inspection forms. The handbook should be written in plain English and certified as such (Paragraphs 232 and 254).

4 Network Rail should establish a formal communication channel between Asset Inspection staff and TSMs such that the relevant TSM reviews and signs-off all standard 053 inspection reports (Paragraphs 208 and 271).

Continued

[1] Responsibilities in respect of these recommendations are set out in the Railways (Accident Investigation and Reporting) Regulations 2005 and the accompanying guidance notes, which can be found on RAIB's web site at www.raib.gov.uk

5 Network Rail should update the training of TSMs to enable them to obtain the standard 053 derailment hazard recognition training and experience necessary to properly fulfil their functions when undertaking supervisor's inspections and signing-off standard 053 inspection reports (Paragraphs 232 and 267).

6 Network Rail should introduce the requirement for a follow-up inspection after a standard 053 repair is carried out involving welding or grinding. This should be undertaken by an independent and competent person within a timescale commensurate with minimising the risk of derailment (Paragraph 243).

7 Network Rail should undertake a check of all S&C components held in stock within the Wessex area to check whether information on any remaining legacy renewal plans is identified and captured within the current planning system as appropriate (Paragraph 235).

8 Network Rail and South West Trains should jointly review and amend track access arrangements to ensure that sufficient and appropriate track access is provided to enable the safe inspection of switches and crossings between Waterloo and Clapham Junction. This should include consideration of Network Rail's daily T2(H) line blockage initiative and an extension of the existing Sunday possesssion arrangements if appropriate (paragraphs 225 and 272).

9 Network Rail should review resource requirements for the undertaking of special inspections in complex track areas to ensure that the problems identified at Waterloo do not exist elsewhere. Sufficient AI positions should be provided to allow the mandated inspections to be completed, and planning resources should be aligned to support TISE requirements for track access (Paragraphs 225, 227, 230 and 268).

10 KCI Rail should ensure that any appointed GSM retains full authority and responsibility for site activities. Any transfer of responsibility between staff should be undertaken with the agreement of both parties and by reference to the grinding manager or duty shift manager (Paragraph 239).

11 Network Rail should provide sufficient technical resources to select and manage sub-contractors engaged in rail grinding activity effectively. This should include the pre-scoping of any non-routine work and the undertaking of on-site checks including periodic technical audits. Standard 053 repairs should not be attempted unless the work has been scoped in advance by an appropriately experienced and qualified person (Paragraph 247 and 274).

Continued

Recommendations to address other matters observed during the investigation

12 Network Rail should review inspection regimes at recognised high-risk sites (ie sites with little used turnouts, a history of sidewear, or a turnout of similar flexure) to ensure these are effective. This should consider the introduction of bespoke inspection regimes such as more frequent visual inspections or periodic detailed inspections regardless of the degree of wear apparent (Paragraph 259).

13 Network Rail should develop a handbook for use by staff who operate or otherwise use the Ellipse system. This document should provide guidance on the nature of information to be presented, and interpretation of the resulting reports (Paragraph 260).

14 Network Rail should mandate the provision of a standard 053 detailed inspection report or equivalent paperwork prior to all switch repair activity. The report should describe the defect and proposed repair and identify who will undertake the post-repair inspection and any subsequent inspections (Paragraph 261).

Appendices

Glossary of abbreviations and acronyms — Appendix A

AI	Asset Inspector
ARME	Area rail management engineer
ATE	Area track engineer
ATME	Assistant track maintenance engineer
COSS	Controller of site safety
FPI	Facing point inspection
FPL	Facing point lock
GSM	Grinding supervisory manager
IMC	Infrastructure maintenance contractor
IMM	Infrastructure maintenance manager
ISMS	Implementation of signalling maintenance specifications
MDUM	Maintenance delivery unit manager
MIMS	Minicom Information Management System
MMA	Manual metal arc
MHT	Mill heat treated (hardened) rail
MST	Maintenance scheduled task
NR4	NR4 sidewear gauge
OTMR	On Train Monitoring Recorder
PGI	Pre Grind Inspection
PTS	Personal track safety
RAR	Railway Asset Register
RCF	Rolling contact fatigue
S&C	Switch and crossing
TISE	Track Inspector (Special Examinations)
TME	Track maintenance engineer
TSM	Track section manager
WAIF	Work Arising Identification Form

Glossary of terms **Appendix B**

All definitions marked with an asterisk, thus (*), have been taken from Ellis's British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com.

BS 113A FB	A flat bottom (FB) pattern rail section weighing 113 pounds per yard but having a thicker rail web than its predecessor BS 110A rail. It has been re-titled CEN54E1.*
Bogie	A metal frame equipped with two or three wheelsets and able to rotate freely in plan, used in pairs under rail vehicles to improve ride quality and better distribute forces to the track.*
Buffer stops	A device used to stop the progress of rail vehicles at the end of sidings and other dead-end lines.*
Chainage	The absolute position along the line of a route measured from some designated reference point in a standard measurement unit, not necessarily chains.*
Check rail	A rail or other special section provided alongside a running rail to give guidance to flanged wheels by restricting lateral movement of the wheels. Check rails are mandatory on curves with a radius of 200m (220 yards, 10 chains) or less.*
Clamplock	A hydraulic ram arrangement that operates and positively clamps the closed switch to the stock rail. It is actuated by a small electrically operated hydraulic pump located adjacent to the switch toe.*
Controller of site safety	A safety critical qualification demonstrating the holder's competency to arrange a safe system of work, ie Protecting staff working on the line from approaching trains.*
Empty coaching stock	The term for a train consisting of empty passenger coaches being moved from one place to another (rather than a passenger train with no passengers).*
Facing direction	Aligned towards the direction from which trains approach in the normal direction. The opposite is trailing.*
Facing movement	A train movement made through a crossover or turnout in the facing direction, ie, moving from switch toe to crossing. The opposite is trailing movement.*
Facing points	A set of points or set of switches installed so that traffic travels from switch toe to switch heel in the normal direction of traffic.*
Facing Point Lock	A device fitted to a set of facing switches at the front stretcher bar position which positively locks the switches in one setting or the other, totally independently of any other switch operating mechanism. Such an arrangement is often incorporated into a point machine.*
Flange-climb	A fault condition in which the lateral force exerted by a rail wheel is sufficient to force the wheel up the running face of the rail. One the flange tip clears the rail head a derailment normally occurs. Flange climb can be caused by a twist, excessive speed or severe sidewear.*

Flange contact zone	The rail head section where a wheel flange can potentially make contact.
Full depth switch	A switch assembly in which the switch rail and stock rail are manufactured from the same initial rail section. *
Full service brake	A full (non-emergency) brake application.
Green zone	A site of work on or near the line within which there are no train movements. The opposite is a red zone.
Hogging	The vertical upward curvature of an unfastened rail due to stresses built into the rail during manufacture. The effect is observed most clearly in switch rails.*
Kicking strap	The extended section of a stretcher bar that is located under the stock rail and thus prevents excessive upward movement (kicking) of the switch rail under passing trains. *
Lipping	A description of the effect on a running edge being subjected to the rolling action by passing wheelsets, causing plastic deformation of the rail head. The symptom of this is thin strips of metal developing laterally from the running edge. Eventually these strips break away. *
Mill heat treated	Steel subject to controlled cooling during manufacture to produce additional rail head hardness.
Normal	For a set of points or set of switches, this is the default position, decided generally as being the position which permits the passage of trains on the most used route. The opposite is reversed. *
P8 wheel profile	A wheel profile based on a worn p1 profile, found on most passenger vehicles built since 1970 and class 91 locomotives. *
Permanent way	The track, complete with ancillary installations such as rails, sleepers, ballast, formation and track drains, as well as lineside fencing and lineside signs.*
Personal Track Safety	The minimum training required before being allowed on or near the line. The course introduces basic concepts of safety and emergency action.*
Point-end	A term describing a pair of switch half sets assembled to make a set of points or set of switches.
Rail lubricator	A device for delivering a measured quantity of lubricant (generally grease) onto the running edge (re) of a running rail in order to reduce the friction between the rail and wheel flange on curved track. Rail lubricators are used to reduce noise and increase rail life on such curves. The general principle relies on passing trains operating a small piston pump to move lubricant from a reservoir to an applicator mounted on the rail web.*
Red zone	A site of work on or near the line which is not protected from train movements.

Red Zone Prohibition	A length of track on which work cannot be carried out safely if trains are running. This is normally due to a place of safety not being available in the area. A typical example is the track located between two station platforms.*
Reversed	For a set of points this is the "wrong" position, permitting the passage of trains on the least used route. The opposite is normal. *
Rolling contact fatigue	Collective term for all rail defects directly attributable to the rolling action of a rail wheel on the rail.*
Running band	That part of the running surface upon which the majority of vehicle wheels make contact. *
Shallow depth switches	A switch assembly in which the switch rail is produced from a rail section of shallower depth than that used for the stock rail, allowing the switch rail to pass over the un-machined foot of the stock rail when the switch is in the closed position. *
Sidewear	A progressive removal of rail metal generally afflicting the high rail on curves, due to the high lateral forces produced when a train negotiates a curve. Eventually the rail head assumes a profilecomplimentary to the passing wheelsets, increasing the likelihood that wheelsets will climb the rail. Sidewear is measured using a sidewear gauge.*
Slide chair	A rail chair having a horizontal flat surface upon which the switch rail can be moved laterally.*
Station throat	Describing the division of running lines into the platform lines at one or both ends of a station. These sites are usually constricted, producing complex junction arrangements. *
Stock rail	The fixed rail in a switch half set. The other rail is the switch rail.*
Switch	An assembly of two movable rails (the switch rails) and two fixed rails (the stock rails) and other components (baseplates, bolts, distance blocks, soleplates, stress transfer blocks and stretcher bars) used to divert vehicles from one track to another. Generally referred to as a set of switches. One switch rail and one stock rail together make a switch half set. *
Switch blade	The thinner movable machined rail section that registers with the stock rail and forms part of a switch assembly.*
Switch half set	The assembly for one side of a switch comprising a stock rail, a switch rail, chairs or baseplates, slide chairs or baseplates, heel blocks or switch anchors, plus all appropriate bolts, nuts, washers and rail clips or keys.*
Switch toe	The end of a switch rail that is first traversed by a rail vehicle negotiating a switch in a facing direction.*
Switches and crossings	Track provided to allow trains to move from one line to another, also known as points.

T3 possession	The rules applying to possessions of running lines, also known as absolute possession. Under these arrangements the times and extents are agreed in advance, but the engineer decides when the possession is given up, not the signaller.*
T12 protection	A method of blocking the line for periods of less than 30 minutes where the safety of trains will not be affected.
Tie bar	An adjustable metal bar normally constructed with an insulated section in the middle, fixed between gauge rails to restore and maintain track gauge.*
Thermit welding	(Tradename) A proprietary type of alumino-thermic Welding process produced by Thermit Welding (GB) Ltd. Thermit is a registered trademark of Th. Goldschmidt AG. Also the adopted colloquial term for any such weld. *
Toe opening	A specified distance, between the gauge face of a stock rail and the back edge of an open switch rail, measured at the switch tip.*
Track gauge	The distance between the running edges (RE) of related running rails, measured between two points each 14 mm below the crown of the rail.*
Track miles	The total length of all running lines between two geographical points.
Unstrengthened switches	Switches which have not been designed to transfer thermal stresses between switch blades and stock rails arising from continuously welded rail.
Vertical design S&C	A standard suite of switch and crossing (S&C) designs in which the vertical axes of all the rails are at right angles to the longitudinal axis of the bearers or timbers. The other arrangement is inclined switch and crossing. Standard vertical S&C is normally called 113A vertical, and the inclined types are bullhead inclined (BHI), flat bottom inclined (FBI), RT60 and NR60. *
Wheel burn	A rail defect found on the running surface of the rail. They are caused by the excess rotation of a driving wheel that has ceased to grip the rail properly. Wheelburns are a potential source of more severe cracking and broken rails. *
Wheel-timber (longitudinal timber)	An alternative term for a longitudinal timber. A bearer which runs parallel to the rails, instead of at right angles to them, and supports the baseplates or chairs. Such timbers are often found on bridges.*

Key standards current at the time — Appendix C

GE/RT8000	Railway rule book
NR/SP/SIG/10660	Implementation of Signalling Maintenance Specifications
NR/SP/TRK/001 Issue 2	Inspection and maintenance of permanent way
NR/SP/TRK/132 Issue 3	Weld repair of rails.
NR/SP/TRK/053 Issue 3 (formally RT/CE/S/053 Issue 3)	Inspection and repair procedures to reduce the risk of derailment at switches

Summary of derailment hazards as defined in standard NR/SP/TRK/053 (issue 3) — Appendix D

Derailment hazard	Abbreviated inspection criteria	Inspection gauges required
Hazard 1 Sideworn stock rail	Check that top of switch rail is below base of sidewear on stock rail.	Plain rail NR4 sidewear gauge (note b) Metric stepped gauge
Hazard 2 Sideworn stock rail and switch blade	If sidewear is below step 13, check that sidewear angle on switch blade is no flatter than sidewear angle on stock rail.	Plain rail NR4 sidewear gauge Metric stepped gauge TGP8 gauge (note c)
Hazard 3 Stock rail headwear with less worn switch blade	Check the relative height of the switch rail compared with the stock rail.	Switch wear gauge 1 Metric stepped gauge
Hazard 4 Switch blade damage	Check extent and position of any damage to switch blade.	Switch wear gauge 2 Metric stepped gauge
Hazard 5 Sharp blade profile (restricted to hardened rails formed from MHT and Austenite manganese steel (AMS)	Check that square lip has not been formed on switch blade. To be inspected weekly for first month, and monthly for first six months	Switch blade radius gauge

Notes:

a. Sidewear and switch blade hogging values are also required.

b. The type NR4 sidewear gauge was introduced in early 2005 and its use was mandated in early 2006);

c. A track gauge incorporating a wheel profile gauge (TGP8) was introduced in spring 2005 and its use mandated from mid-2006. This allows the inspector to assess the degree of wear and the contact position of a wheel flange. An indicator line drawn normal to the 60° flange contact angle indicates the lowest point of the flange which should be in contact with the switch blade and a profile which makes contact below this point is deemed to present a derailment risk (see Figure 13).

Network Rail

CHECKLIST/REPORT FORM
FACING POINT INSPECTIONS

FORM No FPIFORM.02
ISSUE 02 MAY 1999
TI/009

FPIFORM1.DOC

REGIONAL DIRECTOR........WESSEX.. DETAIL REPORT

LOCATION .WATERLOO......................... POINT No 1565.........................

LINE.DN MAIN SLOW..................................MILEAGE.. .0m 594yds..........................

	CHECK		LEFT SIDE	RIGHT SIDE
1.	**Switch Bay Ballast Level** - is at least 30mm below signalling equipment.		LOWER	LOWER
2. *	**Voids Under Switch Bearers** - (max. permitted void is 7mm).	Special attention required for timbers carrying point machines	OK	OK
3. *	Condition of Timbers - for splits, rot & elongated chair/baseplate holes.		GOOD	GOOD
4.	**Chair/Baseplate/Rail Condition** - for damaged & badly worn slide and heel chairs or baseplates slide table under stock rail (with mirror) for baseplate/rail wear (gall) - baseplate gall max. 3mm, rail side gall max. 2mm		NO YES NONE	NO YES NONE
5.*	**Chair/Baseplate Screws and Fastenings** - to ensure they are tight. (ensure first baseplate/chair screw does not impede switch travel)		OK	OK
6.	**Track Gauge** - measure 100mm in front of switch & at every 4th bearer. Vertical design tolerance 1430 - 1435mm inclined design tolerance 1433 - 1438mm		1452 1445	1442 1437
7.	**Twist Faults** - for any faults present (in switches or on the approaches)		NONE	NONE
8.	**Alignment** - for any faults present (specially at the stock rail front joint)		GOOD	GOOD
9.	**Components** - for correctly matched components (e.g. no mix of vertical & inclined components)		B.VERTICAL	B.VERTICAL
10.	**Soleplate Gauge Stop** - for wear (not to exceed 2mm) & cracked welds.		GOOD	GOOD
11.	**Insulated Rail Joints** - for lipping at the end post (distance between rail ends must not be less than 6mm) & damage to insulation material.		OK	N/A
12.	**Rail Joint Dip** - (measure 10mm from joint with 1 metre straightedge) Linespeed 80mph or over: dip not to exceed 3mm Linespeed less than 80mph: dip not to exceed 6mm		OK	OK
13.	**Switch Rail** - to ensure: Bearing evenly on at least first 2 slide chairs or baseplates. back edge lipping does not exceed 1mm. they are not twisted.		YES NO NO	YES NO NO
14.	**Switch Rail / Stock Rail Fit and Wear** - For good fit without excessive force along the whole length of the rail. Supplementary drives and detectors (do visual examination). Is clearance between feet of stock rail or wing rail & switch rail: Inclined FB switches, vertical FB switches, curved chamfered BH switches: between 1mm & 5mm other BH switches: zero For tell-tale signs of wear (hazards 1, 2 & 3) If signs of wear do detailed examination (see RT/CE/S/053)		PASSED	PASSED

* items marked thus should be observed under traffic wherever possible

PAGE 1 OF 3

REGIONAL DIRECTOR...........WESSEX...DETAIL REPORT

Section of form dealing with standard 053 hazards 1, 2 and 3

Network Rail

CHECKLIST/REPORT FORM
FACING POINT INSPECTIONS

FORM No FPIFORM1.DOC
ISSUE 02 MAY 1999
TI/009

FPIFORM1.DOC

LOCATION .WATERLOO..................... POINT No. ..1565.........................

LINE.......DN MAIN SLOW...................................MILEAGE...0m 572yds..

	CHECK	LEFT SIDE	RIGHT SIDE
15.	**Switch Sidewear** - for tell tale signs (hazard 5) If signs of wear do detailed examination (see RT/CE/S/053)	NONE	SIDEWEAR
16.	**Switch Blade Damage** - for tell tale signs (hazard 4) If signs of wear do detailed examination (see RT/CE/S/053)	NONE	CHIPPING S.B.W.R
17.	**Stock Rail** - to ensure: lipping does not exceed 1mm. all bolts are tight & none are broken. rail is seating correctly on chairs or baseplates.	OK YES NONE	OK YES NONE
18.	**Stretcher Bars** - to ensure: brackets are secure on switch rail. insulations and bolts are secure and in good condition. kicking strap to stock rail clearance is between 3 & 9 mm.	YES YES OK	YES YES OK
19.	**Switch Toe Opening** - measure movment between switch & stock rails: Clamplock fitted switches (other than switch diamonds); 105-110mm Clamplock fitted switch diamonds; 82-87mm. } measured directly above the lock arm Motor switches (other than switch diamonds) Motor switch diamonds Lever switches (other than switch diamonds) Lever switch diamonds } 102 to120mm measured at switch toe	115mm	113mm
20	**Flangeway Clearance** - to ensure narrowest opening is at least 50mm	60mm	60mm
21.	**Switchglides/Slipper Baseplates** - for wear & to ensure: switch rail seated correctly switchglides are not in contact with foot of stock rail	OK	OK
22.	**Slide Chair Lubrication** - Low Friction Devices: for scoring & to ensure NOT greased. Switch Slide Tables: to ensure film of lubricant over the whole table.	N/A	N/A
23.	**Point Identification** - to ensure each point end is correctly identified. That numbers & letters are undamaged, legible and correctly oriented.	OK	
24.	**Facing Point Lock Test** - carry out at end of inspection.		

ANY ITEMS EXAMINED AND FOUND TO OUTSIDE STATED TOLERANCES MUST BE RECTIFIED IN ACCORDANCE WITH THE APPROPRIATE CODES OF PRACTICE AND HANDBOOKS.

25.	**Remedial Work** - carried out on the inspection? If yes, page 3 of this checklist must be completed.	NO

INSPECTION CARRIED OUT BY: Signalling representative #

Civil Engineering representative #

DATE: 16/07/2006

Report must be signed by both Signals and Civils representatives for **joint** inspection

PAGE 2 OF 3

Section of form dealing with standard 053 hazards 4 and 5

FPI form 1565 points, dated 16/07/2006, page 2 of 3

Network Rail

CHECKLIST/REPORT FORM
FACING POINT INSPECTIONS

FORM No FPIFORM.01
ISSUE 02 MAY 1998
7I/009

FPIFORM1.DOC

REGIONAL DIRECTOR........WESSEX...DETAIL REPORT

1565 POINTS DN MAIN SLOW

IF ANY ITEMS ARE EXAMINED AND FOUND TO OUTSIDE STATED TOLERANCES, AND RECTIFICATION IS UNDERTAKEN BY THE INSPECTION TEAM, THE RELEVANT TEST MUST BE UNDERTAKEN.

COMMENTS (To include details of ALL remedial action taken and any further action required)

1) REGAUGE TIPS 1452

2 RH STOCK SIDEWEAR READING 8

3 GAUGE CORNER CRACKING L/H STOCK HEAVY + SWITCH

4 LH STOCK HEAD WEAR HEAVY

5 R/H SWITCH BLADE SIDEWEAR S.B.W.R

Items identified by AI

26.	**Detection Test** - carry out following any repairs.		
27.	**Facing Point Lock Test** - carry out following any repairs.		
28.	**Full Test of Relevant Track Circuit** - carry out if insulations are tightened or renewed		

INSPECTION CARRIED OUT BY: Signalling representative #

Civil Engineering representative #

DATE: 16/07/2006

Report must be signed by both Signals and Civils representatives for **joint** inspection PAGE 3 OF 3

FPI form 1565 points, dated 16/07/2006, page 3 of 3 (names removed)

Network Rail

POINT EXAMINATION

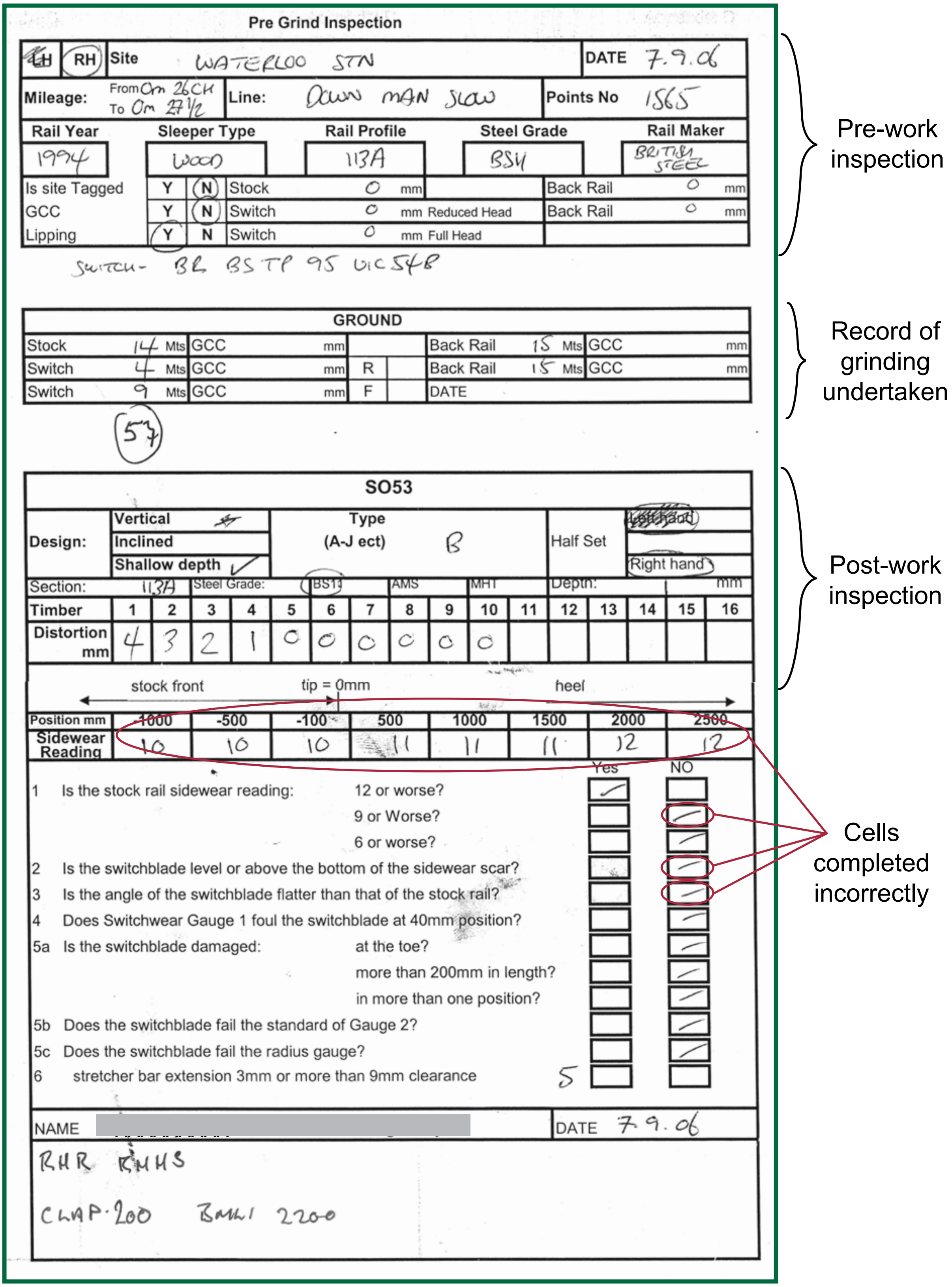
LOCATION WATERLOO LINE DMS MILEAGE OM.26CH POINT NO. 1565

Date of Inspection	LH Stock			LH Switch					RH Stock			RH Switch					Gauge at Tips	Timber Cond	Fixing Cond	Repair Job No		Signed	
	S/W	Lip	Cond	G1	G2	Pac	Lip	Cond	S/W	Lip	Cond	G1	G2	Pac	Lip	Cond				Job	Pty	Civils	Signals
05/03/2006									8	P	2												
Comments	MONITOR OF SIDE WEAR ON STOCK FRONTS																						
30/03/2006									8	P	2												
Comments																							
07/05/2006									8	P	2												
Comments																							
04/06/2006									9	P	2												
28/06/2006									9	P	2												
Comments																							
02/09/2006									8	P	2												
08/10/2006									6	P	2												
Comments	BAR FACING MOMENTS NOW IN PLACE																						

S/W = plain rail sidewear reading
G1 = gauge 1:P (Pass) or F (Fail)
G2 = gauge 2:P (Pass) or F (Fail)
Pac = 'Pacman' switch blade radius gauge: P (Pass) or F (Fail)
Lip = lipping present: P (Pass) or F (Fail)

Stock/Switch Cond = condition:
5 = no sign of wear (appearance as new)
4 = no sign of wear (but new appearance now gone)
3 = wear showing
2 = wear serious
1 = requires replacement

Timber/Fixing Cond = condition:
G = Good
F = Fair
P = Poor



Pre Grind Inspection

LH	RH	Site	WATERLOO STN	DATE	7.9.06
Mileage:	From Om 26CH To Om 27½	Line:	DOWN MAIN SLOW	Points No	1565

Rail Year	Sleeper Type	Rail Profile	Steel Grade	Rail Maker
1994	WOOD	113A	BSII	BRITISH STEEL

Is site Tagged	Y	N	Stock 0 mm		Back Rail 0 mm
GCC	Y	N	Switch 0 mm Reduced Head		Back Rail 0 mm
Lipping	Y	N	Switch 0 mm Full Head		

SWITCH - BR BSTP 95 UIC 54B

GROUND

Stock	14 Mts	GCC mm			Back Rail 15 Mts	GCC mm
Switch	4 Mts	GCC mm	R		Back Rail 15 Mts	GCC mm
Switch	9 Mts	GCC mm	F		DATE	

57

SO53

Design:	Vertical	Type (A-J ect) B	Half Set	Left hand
	Inclined			
	Shallow depth ✓			Right hand

Section: 113A Steel Grade: BS11 AMS MHT Depth: mm

Timber	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Distortion mm	4	3	2	1	0	0	0	0	0	0						

stock front tip = 0mm heel

Position mm	-1000	-500	-100	500	1000	1500	2000	2500
Sidewear Reading	10	10	10	11	11	11	12	12

			Yes	NO
1	Is the stock rail sidewear reading:	12 or worse?	✓	
		9 or Worse?		✓
		6 or worse?		✓
2	Is the switchblade level or above the bottom of the sidewear scar?			✓
3	Is the angle of the switchblade flatter than that of the stock rail?			✓
4	Does Switchwear Gauge 1 foul the switchblade at 40mm position?			✓
5a	Is the switchblade damaged:	at the toe?		✓
		more than 200mm in length?		✓
		in more than one position?		✓
5b	Does the switchblade fail the standard of Gauge 2?			✓
5c	Does the switchblade fail the radius gauge?			✓
6	stretcher bar extension 3mm or more than 9mm clearance	5		

NAME [redacted] DATE 7.9.06

RHR RMHS

CLAP. 200 BALL 2200

Image of PGI Form completed by the Waterloo GSM following grinding at 1565 points (names removed). Note that a 'Yes' response to questions 2 or 3 would have indicated the presence of derailment hazards 1 or 2 and resulted in the switch blade failing standard 053.

Appendix D

RAILTRACK PLC HAND GRINDING RECORD - FORM HG1

Track Inspection Report

	Visual	UT	EMA		
Inspection Type				RDT Def Id (Taken from Rail Defect Database)	Clap 200

Location	Waterloo

			Start		Finish	
ELR	BML1		Mls	Chs	Mls	Chs
Track ID	2200		0	26		

Rail	Left/Right: Right	Curve Radius	metres	S&C	Points No: 1565
Track Inspector		Signed		Date	

Grinding Supervisory Manager's Report

Inspection Date	
Access to Site	
Prepartory Work Required	
Special Requirements	Frog, MLC and MP12 Grinders
Protection and Access Requirements	T3
Grinding Specification	RHHS Remove lipping profile and test.
Number of Gangs	1
Estimated Possession Time Required	
Grinding Supervisory Manager	[redacted]
Signed	
Date	

Grinding Team Leader's Record

Work Complete	Yes	✓	If yes	Depth of Grinding: 1 mm	Total Length Ground: 57 Metres
	No			Length of Blending: mm	Man hrs

Remarks	RHHS: Removed lipping and profiled, All RCF clear. Side wear on stock rail 9 at tip of switch area.

			Method		
NDT Test Acceptable	Yes	✓	UT	MPI	EMA
	No			✓	

Inspection S/053 Compliant	Yes	✓	Switch and Crossing Confirmed Operational	Yes	✓
	No			No	

Team Leader GSM	[redacted]	Signed		Date	7-Sep-06

Supervisory Manager's Confirmation

Supervisory Manager		Signed		Date	
	Original Retained	Copy	Track Inspector		Railtrack

HG1 form for 1565 points, completed by grinding manager based on information received from the PGI form (Appendix G) (names removed).

ATTENTION RICHARD GRINDING MANAGER

Switches: Full Inspection Form SQ53 *example*

Network Rail

Location	**Division:** WESSEX	**Site:** WATERLOO		Mileage: OM 23CH
		Line: UP MAIN RELIEF		Points No 1570B

Switch	**Design:**	Vertical ✓	Type CHAMFERED	Half Set	Left hand ✓
		Inclined			
		Shallow depth			Right hand

Rail	Section:	Steel Grade:	BS11 ✓	AMS	MHT	Depth: FULL mm

Vertical Distortion Of Switch Rail																
Timber No	1 Toe	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Distortion mm	1	1	1	1	2	3										

Stockrail sidewear

stock front ← tip = 0mm → heel

Position mm	-1000	-500	-100	500	1000	1500	2000	2500
Sidewear Reading	10	9	9					

Limiting Conditions

KICKING STRAP READING 8

			Yes	NO
1	Is the stock rail sidewear reading:	12 or worse?	✓	
		9 or Worse?		
		6 or worse?		
2	Is the switchblade level or above the bottom of the sidewear scar?			
3	Is the angle of the switchblade flatter than that of the stock rail?		✓	
4	Does Switchwear Gauge 1 foul the switchblade at 40mm position?			
5a	Is the switchblade damaged:	at the toe?		
		more than 200mm in length?		
		in more than one position?		
5b	Does the switchblade fail the standard of Gauge 2?			
5c	Does the switchblade fail the radius gauge?		✓	
6	**Is there less than 3mm or more than 9mm clearance between the stretcher bar extension and underside of the stock rail foot?**			✓

If any of these are answered "YES" apply RT/CE/S/053 required action.

Action	Action HAZARD 2 AND 5 ON LEFT HAND SWITCH BLADE ALSO REMOVE LIPPING
	Required:

Example of full inspection report form in use by Clapham depot at time of derailment (names removed). This was completed by the AIs following a detailed inspection and identifies standard 053 derailment hazards at 1570B points which were subsequently repaired. The associated WAIF is included as Appendix J.

Work Arising Identification Form — Network Rail

Work Identified ✓ / W Completed	Actioned / Found By: [redacted]	Date Found: 05/10/2006	Related Work Order No:

Fault Work	Date	Time Reported:	Time Attended:	Time Completed:
Work Group:		Fault Number:		

ELR: BML1	Track ID: 1211	Mileage From: OM.23ch	To:	Job Cost Number:
Rail – Left, right or both	Location: WATERLOO			Miles/Yards Miles/Chains ✓

Work / Defect Identified	Quantity	Unit of Work	Std Job No
HAZARD 2 AND 5 FOUND ON 1570B POINTS LEFT HAND HALF SET 3 DAY REPAIR	5	YDS	9084
	Originator's Priority: MO		

Action Taken:	Quantity Remaining

Work Group: **4ECLPC5**	Crew Size:	Date Job Completed:

Team Leader Comments:	Time on Tools		h	m
	1 Travel Time	TVL	h	m
	2 Train Interruption	TRN	h	m
	3 Weather Delays	WEA	h	m
	4 Set Up Time	SET	h	m
Team Leader Signature:..	5 Equipment & Mat Delays	EQP	h	m

On Near The Line (Detail protection below)		Lineside Only (Protection not required)	

Green Zone	T1	T2-A	T2-D	T2-H	T2-T	T2-X	Protection Controller	Patrolman's Lockout	T3 Worksite	T4	Not on Track
Safeguarded											
Fenced											
Separated											

	ATWS	TOWS	LOWS	Lookout		B1 Unplanned Isolation	B2 Planned Isolation	Not Required
Red Zone					**Isolation**			

Supervisor Comments: Date: **05/10/06**	W.G. Assigned To:	
	Required by Date:	
	Planned Start Date:	
Supervisor Initials: Signature: [redacted]	Supervisor's Priority:	

MIMS Equipment Number: 45290	MIMS Equipment Number For Non Prod Time:
Input into MIMS By: [redacted]	Date: 5/10/2006

Work Order No	WAIF No										
1338683		C	0	6	2	7	6	A	B	0	1

Version 3 08.05.03

Example of a WAIF raised by AIs in connection with standard 053 derailment hazards identified at 1570B points (names removed). The associated inspection report is included as Appendix I.

Network Rail

SMF/TK/0184 Welders Work Return - Switch Repairs TEF/3008

SHEET	2 of 2	WELDER'S NAME	[redacted]	WEEK NO	30
FROM	CLAPHAM	SIGNATURE	[redacted]	DATE	22-10-06
GRADE		This return must highlight any changes from initial request		JCN	
TO				MIMS NO	

SITE DETAILS

LOCATION	GPS CO-ORDINATES		MILEAGE	TO MILEAGE	POINTS NO	ELR	TRACK ID	SWITCH LH/RH	FACING / TRAILING	
W/LOO			0.2144		1507	BML1	UP/DN SLOW	RH + LH	BOTH	

053 ASSESSMENT DETAILS

Extent of damage repair required				LENGTH	mm
Extent of sidewear repair to stock rail front required	STEP NO	ANGLE	deg	LENGTH	mm
Extent of sidewear repair to stock rail behind switchblade required		ANGLE	deg	LENGTH	mm
Extent of sidewear repair to switchblade required		ANGLE	deg	LENGTH	mm

VERTICAL DISTORTION	Toe	2	3	4	5	6	7	8	9	10	11	12	13	14	INSPECTED BY
Initial Inspection	0	1	1	0	1	1	1	0							[redacted]
Pre-welding Inspection	0	1	1	0	1	1	1	0							
Post-welding Inspection															
Follow Up Inspection															

SIDEWEAR ANGLE	Toe	2	3	4	5	6	7	8	9	10	11	12	13	14	INSPECTED BY
Initial Inspection															
Pre-welding Inspection															
Post-welding Inspection															
Follow Up Inspection															

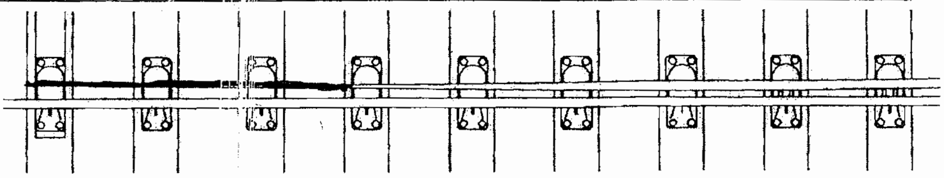
SWITCH DETAILS / WELDING DETAILS

REPAIR NO	TYPE	DESIGN	ANGLE	COMPONENT	DEFECT NO	REPAIR TYPE	RAIL SECTION	RAIL GRADE	EXCAVATION LENGTH	EXCAVATION DEPTH	WELDER STAMP NO
1		VERTICAL		Switch / Stock / Fronts		Damage / Wear	113A	HT	—	—	[redacted]
2				Switch / Stock / Fronts		Damage / Wear					
3				Switch / Stock / Fronts		Damage / Wear					

Welder's Comments 6MM TRACKING STRAP, RE-PROFILE SWITCH BLADE

PREHEATER	GENERATOR	WIRE FEEDER	CONSUMABLE TYPE AND SIZE

Indicate location and extent of repairs



INSPECTION

	DATE INSPECTED	INSPECTED BY	RESULT	COMMENTS	DATABASE NO
REPAIR 1					
REPAIR 2					
REPAIR 3					
POST WELD DIMENSION					

TEF/3008 form completed by welder following repair to 1507 points (names removed). There is no reference to a standard 053 inspection or inspection from.

This report is published by the Rail Accident Investigation Branch,
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