RAIB
Rail Accident Investigation Branch

Rail Accident Report

Collision near Burton on Trent
1 August 2007

Department for Transport

Report 01/2008
January 2008

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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Collision near Burton on Trent 1 August 2007

Contents

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 Central Trains and English, Welsh and Scottish Railway (EWS) 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.

The Incident

Summary of the incident

5 At 16:16 hrs on Wednesday 1 August 2007, a *stanchion* on EWS freight train 6E79 struck and damaged Central Trains passenger train 1G46 as they passed in opposite directions at a location north of Burton on Trent station (Figure 1). There were no injuries but there was some damage to the passenger train as a consequence of this incident.

6 The 14:17 hrs freight train service from EWS Wolverhampton Steel Terminal to Scunthorpe Anchor Sidings comprised a locomotive and ten empty wagons. The 15:34 hrs passenger train service from Nottingham to Birmingham New Street comprised a two vehicle *diesel multiple unit* (DMU).

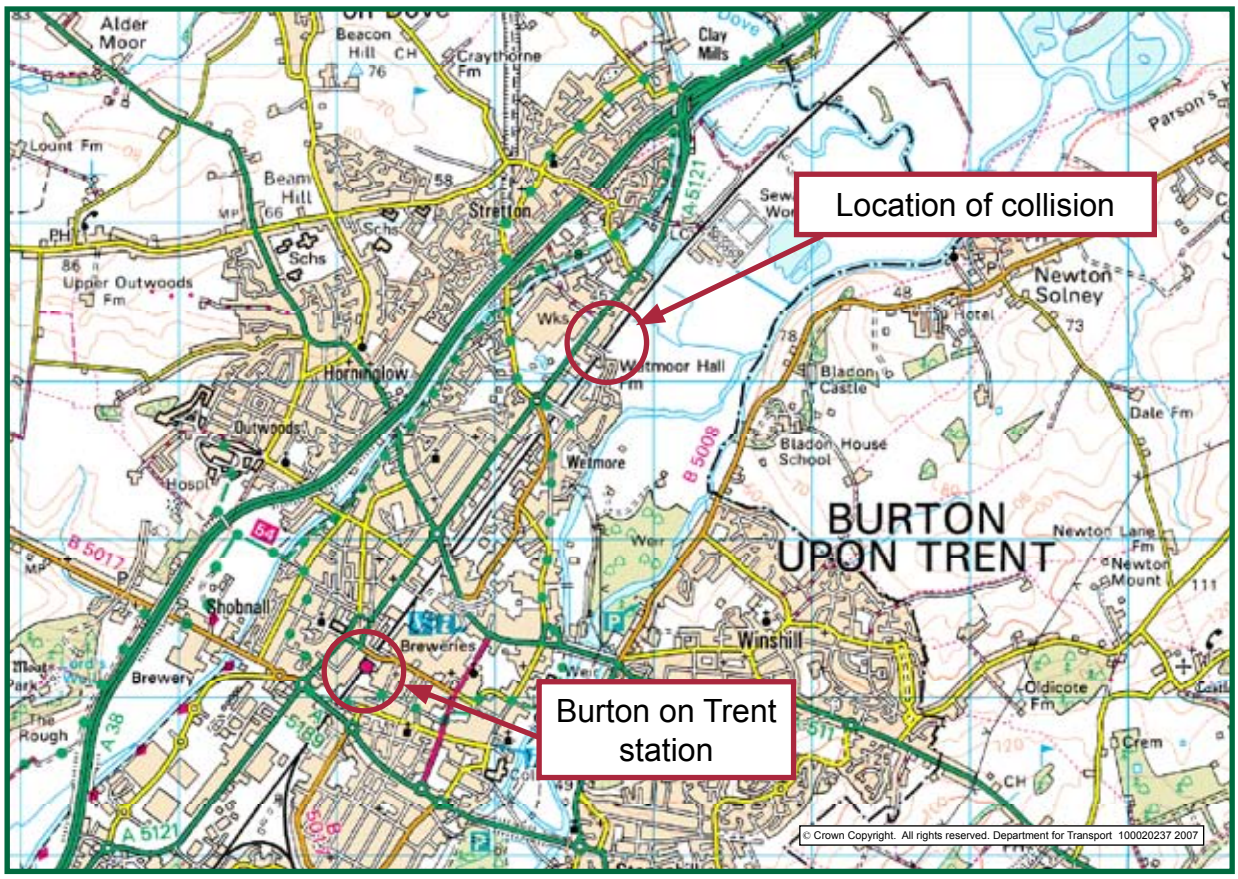

Figure 1: Extract from Ordnance Survey map showing the location of the collision

The parties involved

7 EWS was the operator of the freight train, and the maintainer of the locomotive and wagons it comprised. EWS was also the employer of the freight train driver, the *load examiner*s and the *train preparer*s.

8 Central Trains was the operator of the DMU and the employer of its driver and senior conductor.

9 Network Rail is the owner and infrastructure controller of the tracks on which the collision occurred.

Location

10 The collision occurred at a location 1.5 miles (2.4 km) north of Burton on Trent station (Figures 1 and 2). The maximum permitted speed at this location was 100 mph (161 km/h) for the DMU and 60 mph (97 km/h) for the freight train.

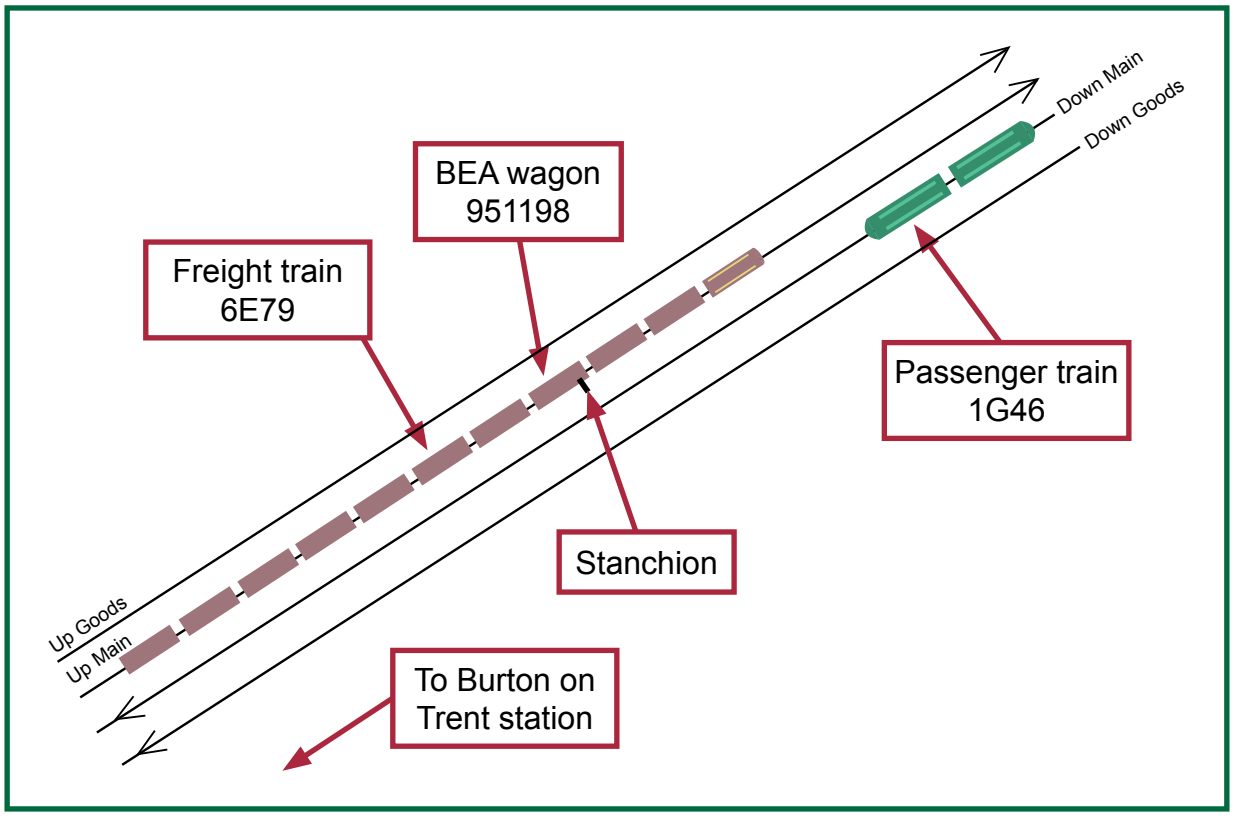

Figure 2: Trains 1G46 & 6E79 before the collision

The trains

11 DMU number 170508 comprised vehicles numbered 79508 and 50508. Vehicle number 79508 was leading in the direction of travel at the time of the collision and was the only vehicle to sustain damage (Figure 3).

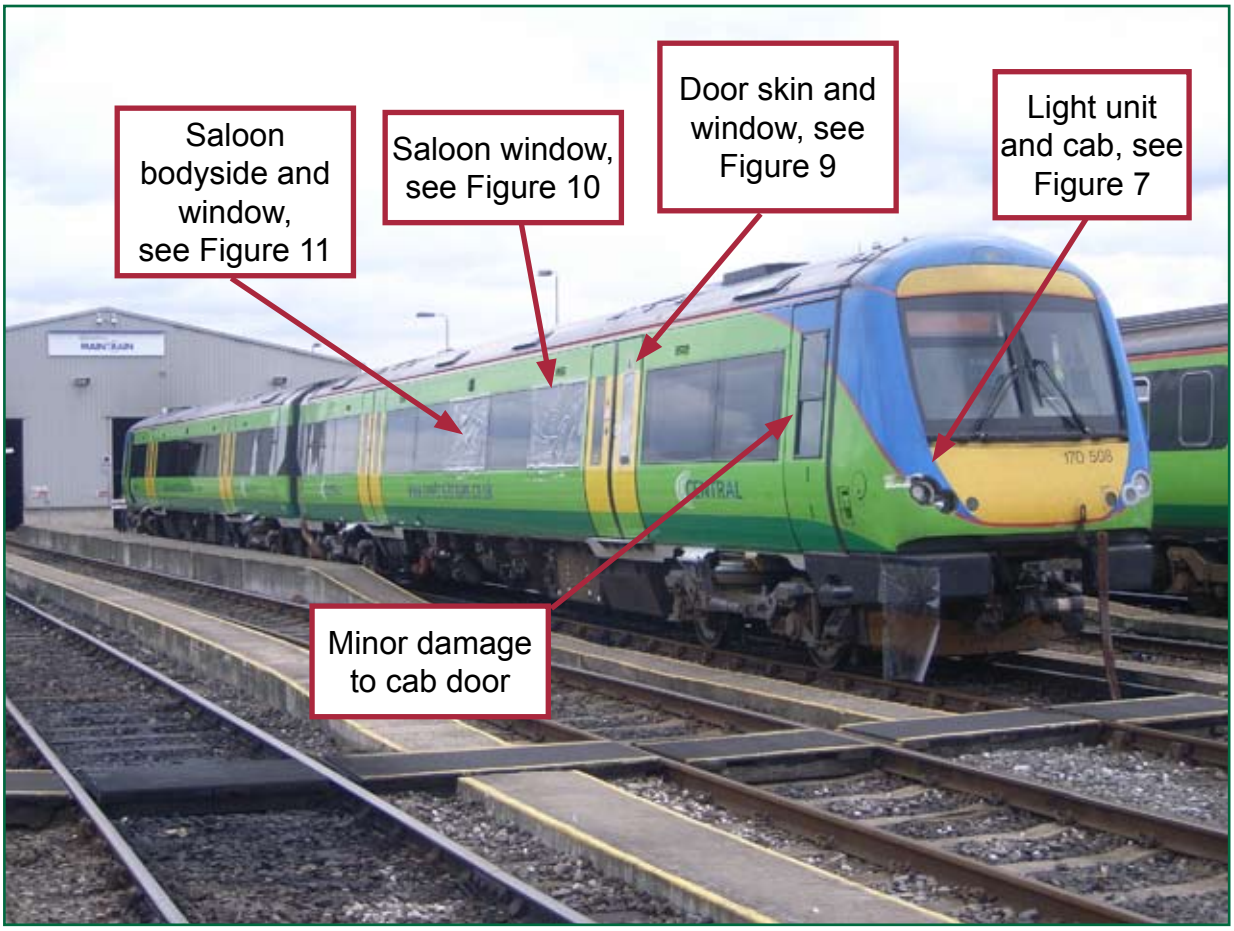

Figure 3: Collision damage to 170508 (broken windows covered with protective sheeting)

12 The freight train was hauled by locomotive number 66231 and comprised ten empty wagons; five BEA wagons and five BDA wagons.

13 BEA wagons were originally manufactured as BDA wagons and were reclassified when their *bolster* arrangement was redesigned. They have a flat bed and six bolsters with stanchion pockets. Each BEA wagon is mounted on two *bogie*s. The wagons had carried long metal products from Scunthorpe to Wolverhampton and were returning empty to Scunthorpe at the time of the incident.

14 BEA wagon number 951198 was the third wagon back from the locomotive. It carried the stanchion involved in the incident in an outer pocket on the third bolster (Figures 2 and 4).

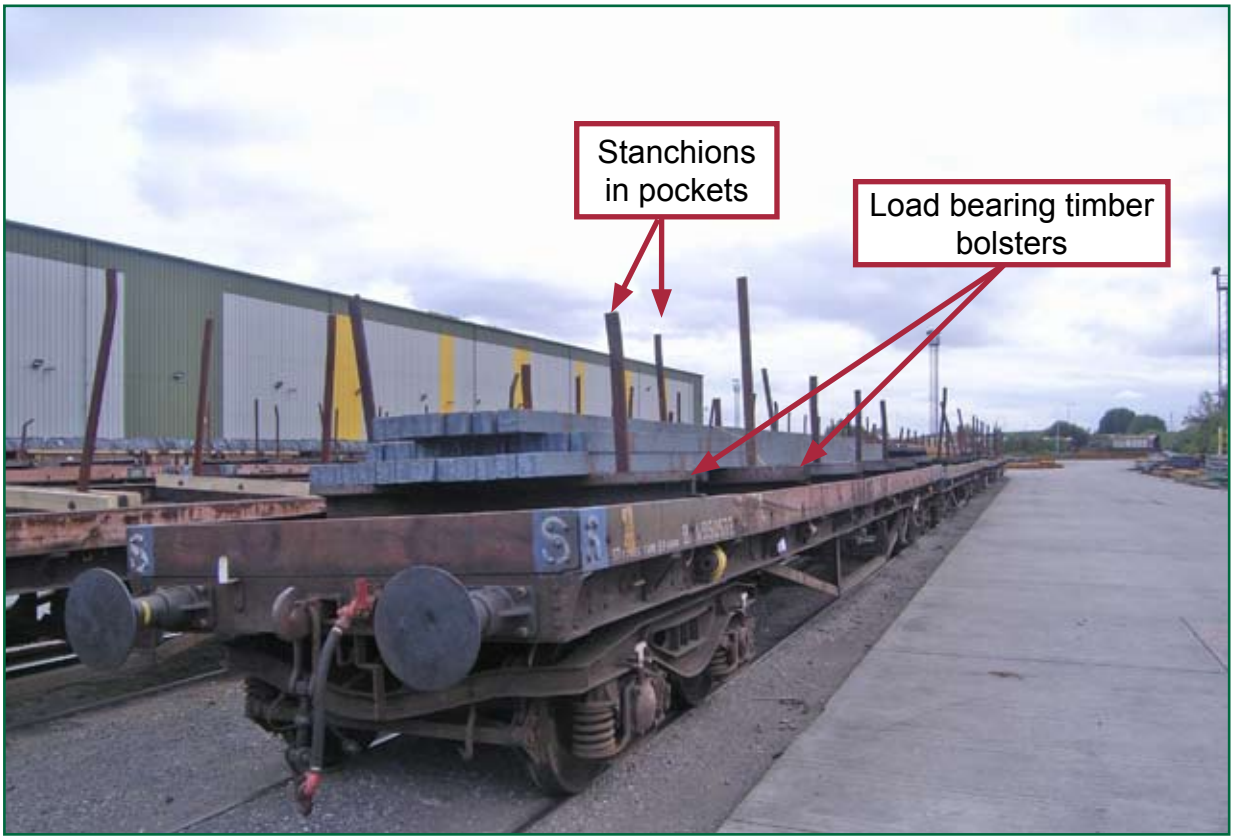

Figure 4: A BEA type wagon

Events preceding the incident

15 Freight train 6M47 arrived at Wolverhampton from Scunthorpe on the morning of 1 August 2007. It contained wagon 951198 loaded with steel *billet*s. The load was confined by stanchions and secured by webbing straps in accordance with the EWS loading and securing manual OM 003D (issue 4 January 2004).

16 During the morning two EWS employees began unloading the wagons. At 13:20 hrs train preparer 'A' came to examine and prepare ten wagons for the empty return journey to Scunthorpe and completed the task while aware that three of the ten wagons, including 951198, had not yet been unloaded.

17 At 13:58 hrs train preparer 'A' used the *Total Operations Processing System* (TOPS) to produce the *train document,* signed it and handed it to train preparer 'B' who had just started the afternoon shift. Train preparer 'A' then left site. Neither train preparer 'A' nor 'B' re-examined the three wagons after they were unloaded.

18 Train preparer 'B' coupled locomotive 66231 to the ten wagons that were now all empty, walked to the rear of the train and helped the driver to carry out a satisfactory *brake continuity test*. Train preparer 'B' then walked back to the locomotive and handed the train document to the driver. At 14:17 hrs the train departed for Scunthorpe.

19 The DMU departed Nottingham for Birmingham New Street at 15:34 hrs. It made scheduled stops at Beeston, Long Eaton and Derby, leaving Derby on time at 16:08 hrs for its next scheduled stop at Burton on Trent.

20 A stanchion carried on wagon 951198 moved out towards a horizontal position shortly before the freight train and the DMU passed while travelling north east on the *up* main line and south west on the *down* main line respectively (Figure 5).

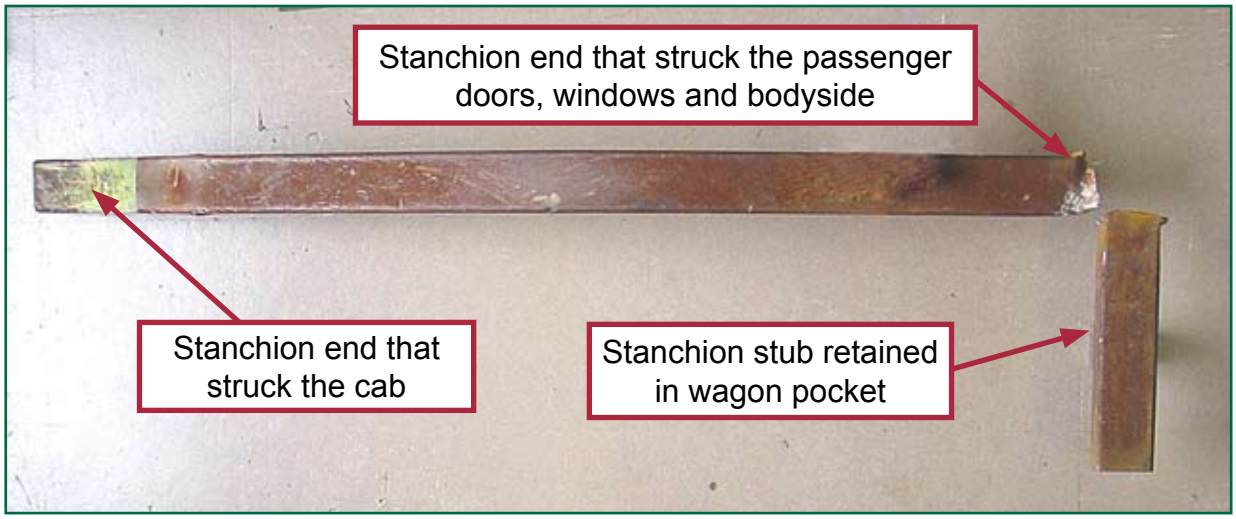

Figure 5: Stanchion position as it struck the cab of the DMU

Events during the incident

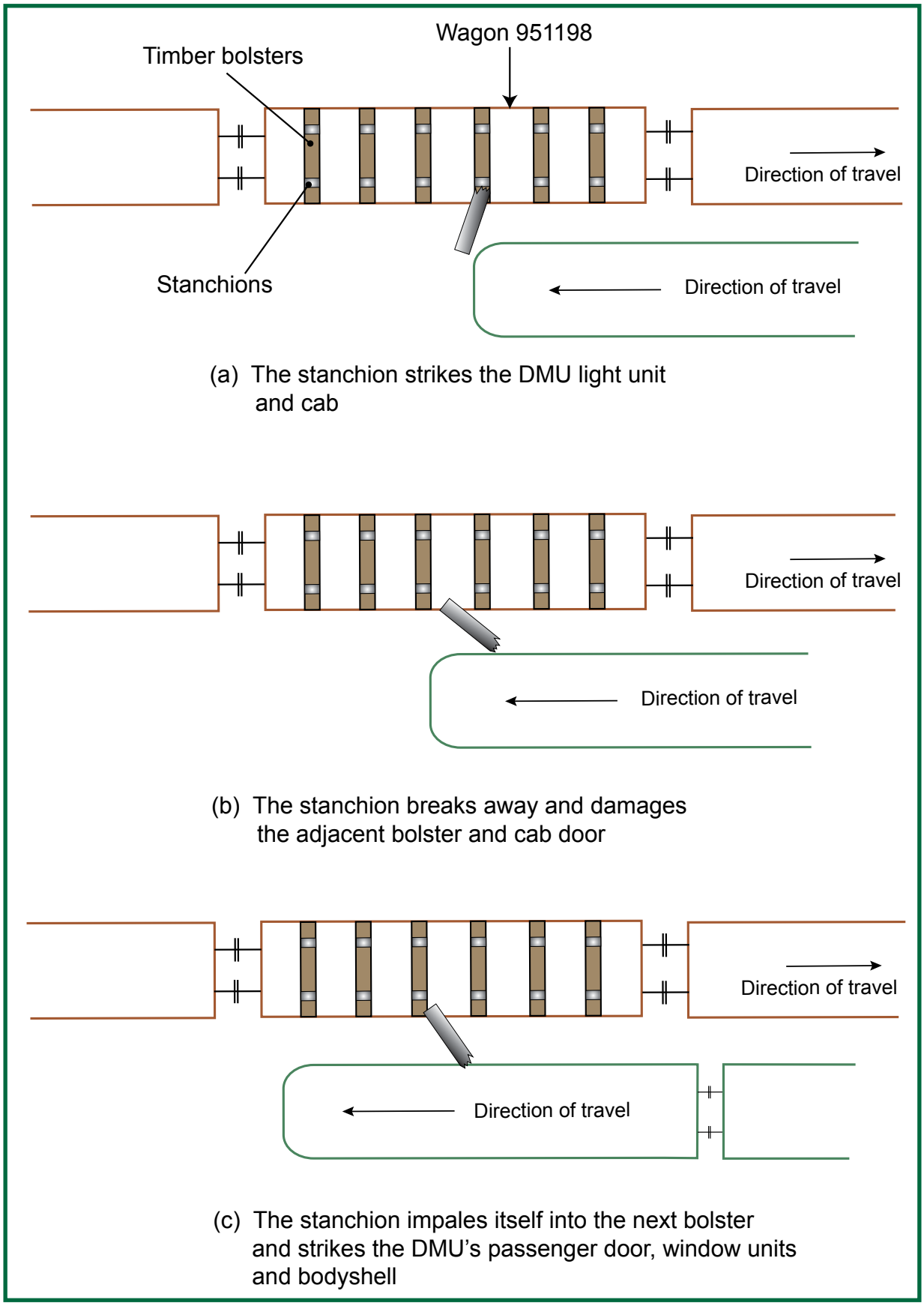

Figure 6: Sequence of events

21 The stanchion struck the DMU cab as the freight train was travelling at 55 mph (89 km/h) and the DMU was travelling at 90 mph (145 km/h) (Figures 6 and 7).

Figure 7: Damage to the cab and light unit

22 The collision caused the stanchion to break away, leaving the stub in the wagon pocket. The detached stanchion then struck the adjacent timber bolster (Figure 8) and the DMU cab door, causing minor damage to the wagon bolster and the frame of the cab door window unit.

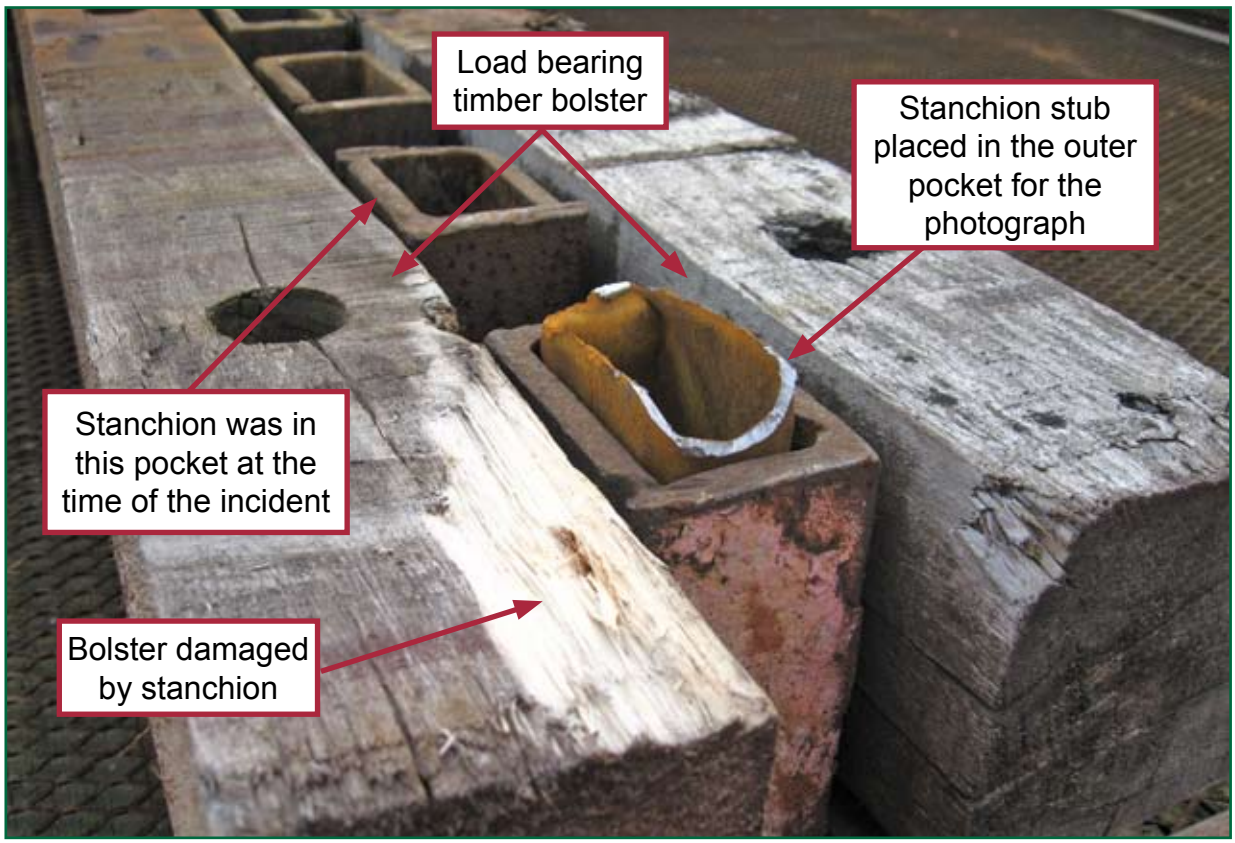

Figure 8: BEA Wagon 951198

23 As the freight train and the DMU continued to pass one another, the detached stanchion impaled itself into the vertical face of the next timber bolster back from the wagon's direction of travel. Timber from the bolster was later found compacted into the end of the stanchion.

24 The stanchion then struck the first set of passenger doors, breaking the outer pane of a double glazed window unit, tearing the door skin and deforming the door leaf (Figure 9).

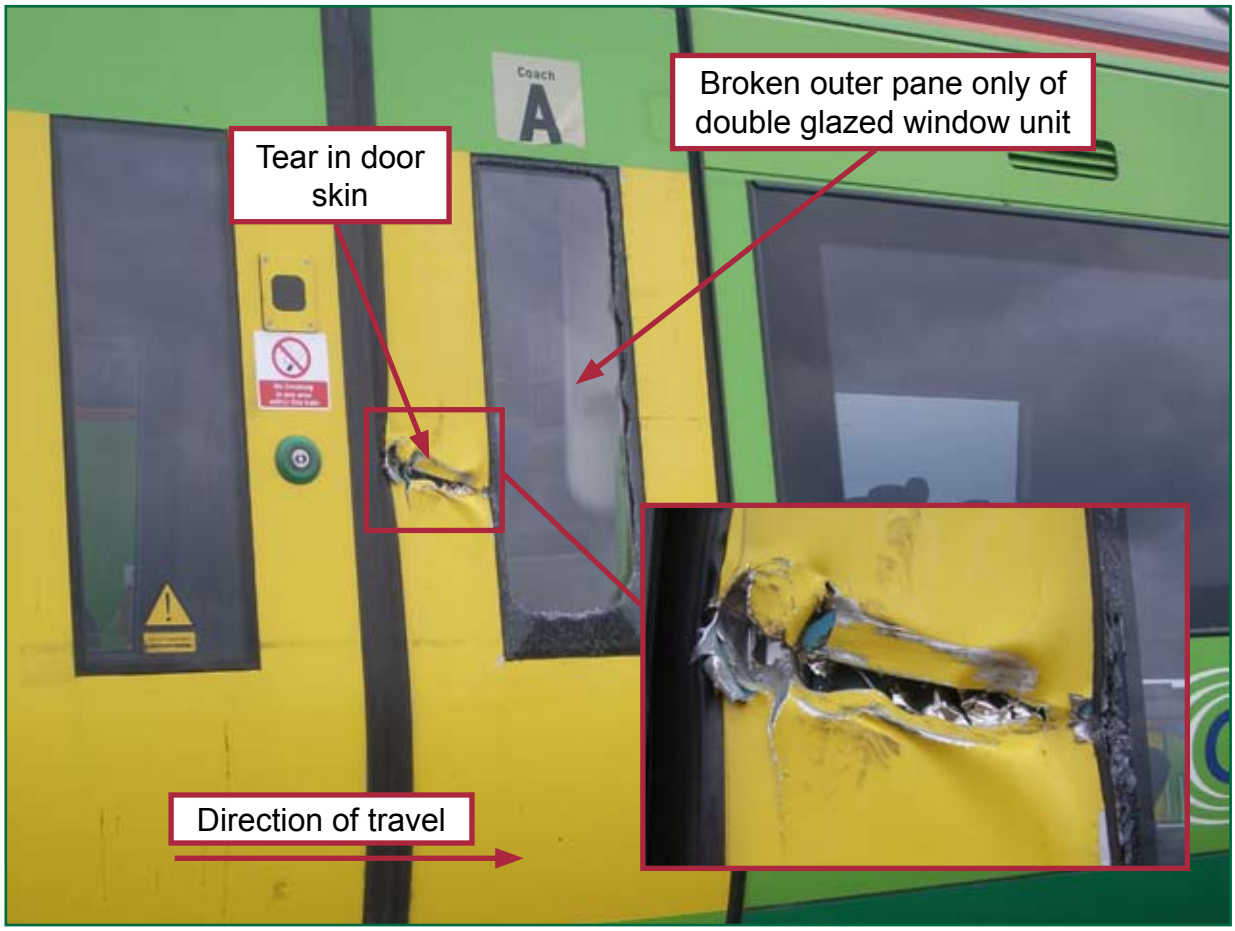

Figure 9: Damage to door skin and window

25 The stanchion next struck the bottom left corner of the adjacent double glazed and laminated window unit, breaking the outer pane (Figure 10).

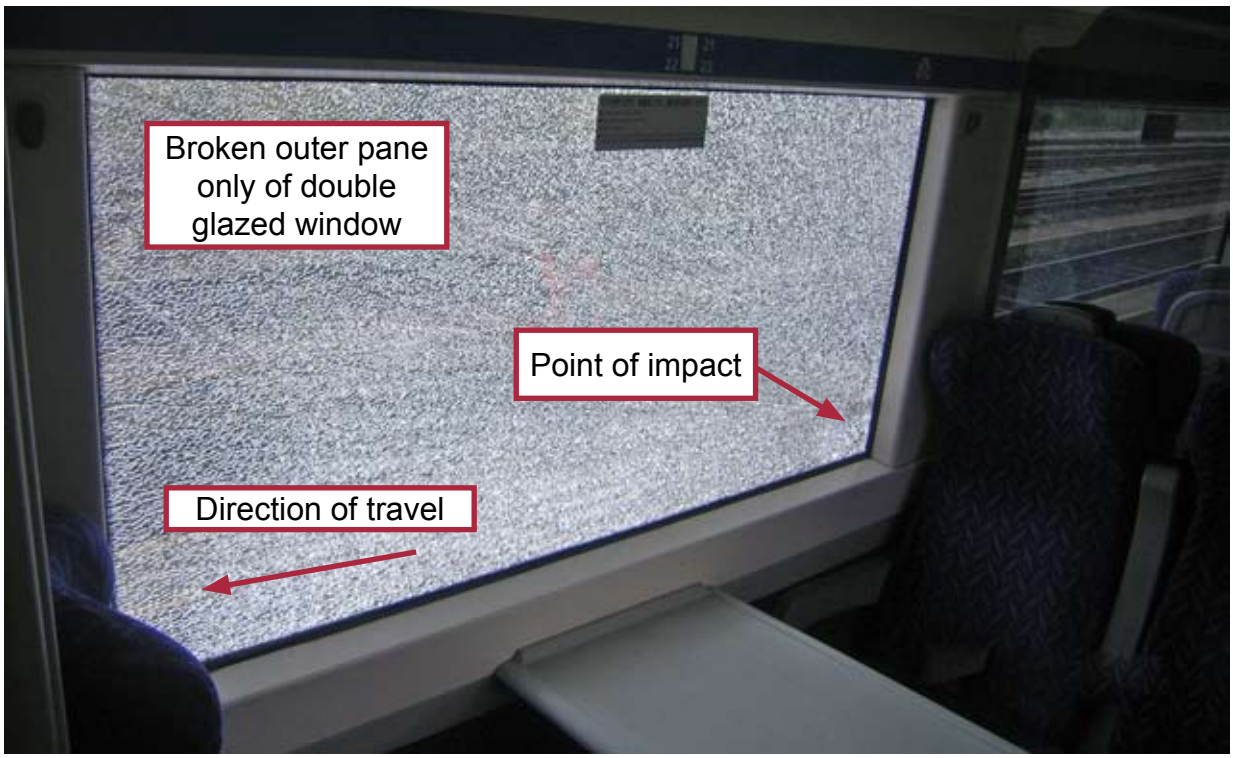

Figure 10: Saloon window viewed from inside

26 Finally the stanchion struck the vehicle, denting and tearing the bodyside outer skin; the tear in the skin corresponded with the stanchion end in size and shape. The stanchion deflected the vehicle bodyside as it struck, breaking the inner pane of a double glazed and laminated window unit and the adjacent table (Figure 11).

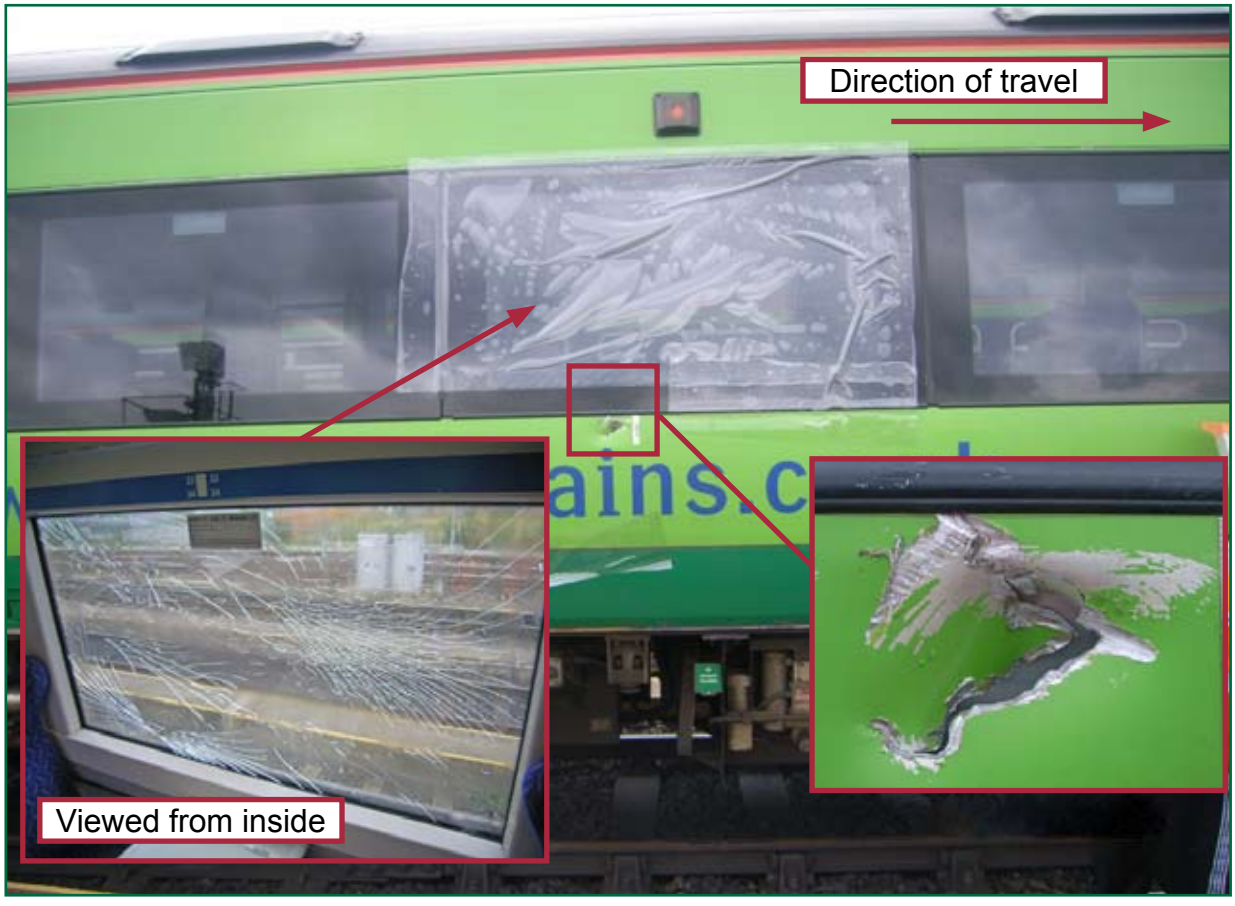

Figure 11: Damage to saloon bodyside and window (broken window covered by protective sheeting)

Consequences of the incident

27 There were no injuries to either passengers or train crew, although a passenger later contacted Central Trains to claim to have suffered shock when the window at which they were sitting was broken in the collision.

28 The DMU sustained damage to its leading vehicle cab, light unit, bodyside, doors and window units while the wagon sustained minor damage to two timber bolsters.

Events following the incident

29 The Central Trains driver and senior conductor detrained their passengers at Burton on Trent station and examined the DMU. Later that afternoon the DMU was driven at reduced speed to Nottingham Eastcroft depot for further examination and attention.

30 The Network Rail signaller stopped the freight train on the up *goods line* at Derby West, immediately south of Derby station. The driver examined the train at this location and reported finding the stanchion stub in an outer pocket of the third bolster of wagon 951198. No other damaged stanchions or hazardous projections were found.

31 The freight train proceeded to Rotherham Steel Terminal where it was met and inspected by the EWS Safety and Compliance Manager and the on call EWS Production Manager, after which it resumed its journey to Scunthorpe.

32 Network Rail had the collision location examined for the detached stanchion. The drivers of the 13:45 hrs Cardiff to Nottingham and 12:05 hrs Edinburgh to Plymouth services examined the up and down main lines respectively; both were found to be clear. A Network Rail employee sent to examine the site of the collision found the stanchion in the *four foot* of the down goods line, near to the collision location and 1.5 miles (2.4 km) north of Burton on Trent station.

Analysis

Identification of the immediate cause

33 The stanchion found in the four foot and the stub that remained on wagon 951198 had matching fracture faces. The stanchion was marked with green paint that matched the DMU cab while the DMU damage corresponded with the stanchion in size and shape.

34 There were no reports of previous collisions between the wagon stanchion and other trains or the infrastructure.

35 The immediate cause of the collision was that a fractured stanchion moved out towards a horizontal position as the freight train passed the DMU travelling in the opposite direction on the adjacent track.

Identification of causal factors

The stanchion box section

36 Stanchions used on BEA and BDA wagons are manufactured from 4 mm thick steel box section measuring 76.5 mm wide by 38.5 mm deep by 1800 mm long. They are often bent unintentionally, either by the loads they are confining or through contact during loading and unloading.

37 EWS staff take bent stanchions that project beyond the wagon side and turn them so that they project inward. This is in accordance with the EWS manual.

38 On examination of the stanchion and stub it was found that the stanchion had fractured at a position that corresponded with the height of the bolster pockets that locate the stanchions on the wagons (Figure 8).

39 When the stub and stanchion fracture faces were realigned it was found that this end of the stanchion had previously been bent in the opposite direction to that in which it failed. This confirmed that the stanchion had previously been turned inward after being bent.

40 The other end of the stanchion was also bent at a position corresponding to the height of a bolster pocket. This confirmed that the stanchion had previously been turned on its end after being bent. The box section material on the inside of the bend had distorted and created ‘folds’ (Figure 12).

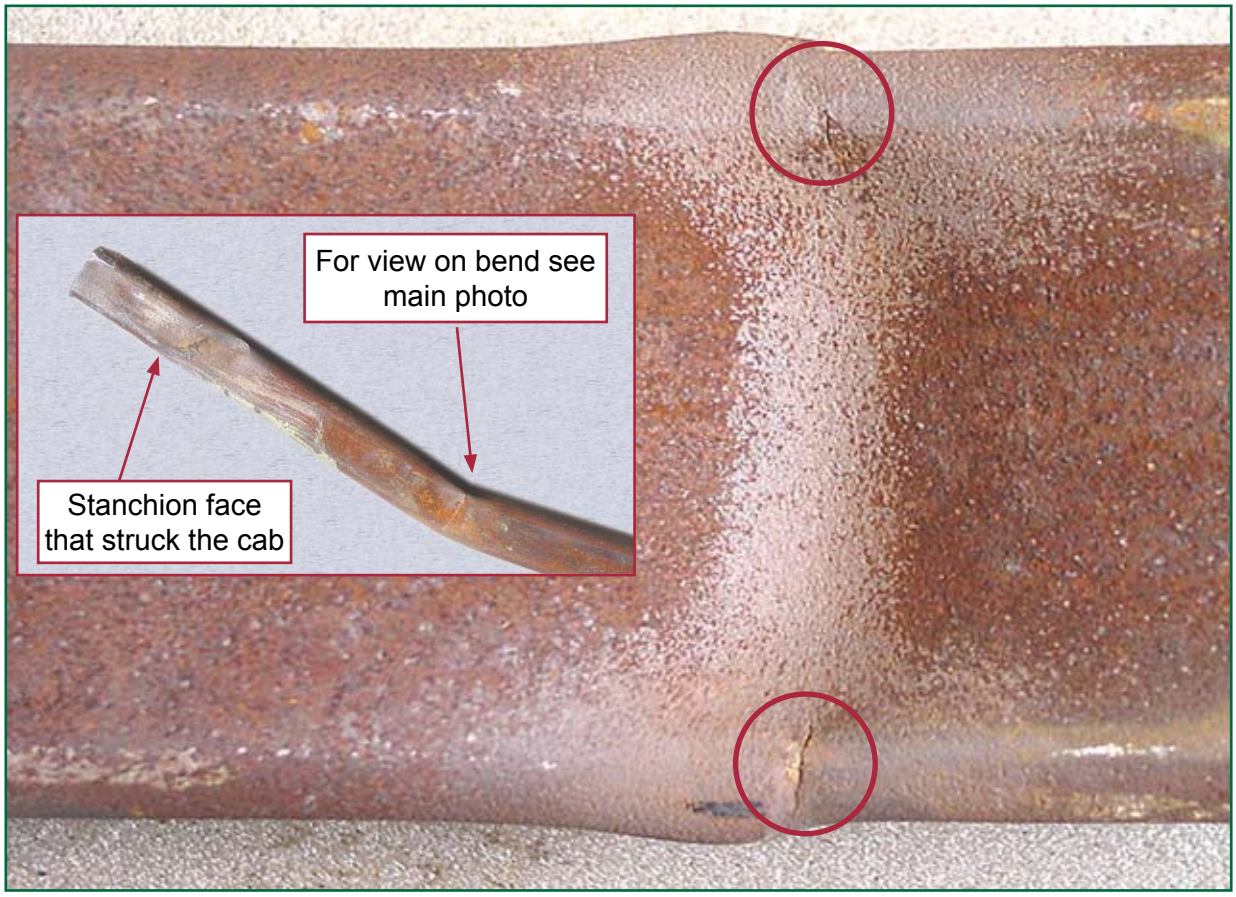

Figure 12: The inside of the bend. The material at the corners had distorted and created folds (circled) (photograph courtesy of Serco Technical & Assurance Services, Derby)

41 The stub fracture face was corroded continuously across one end and both sides, confirming that three sides of the box section had been fractured prior to the incident. The remainder of the fracture face was not corroded and was where the final fracture had occurred (Figure 13).

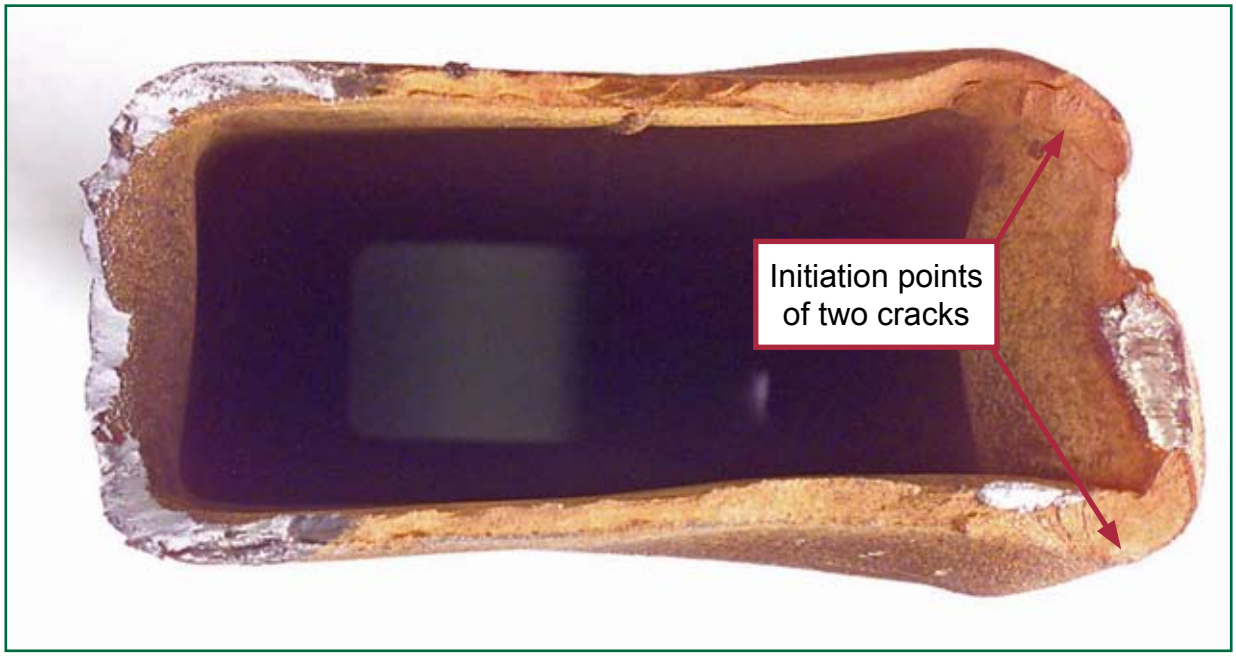

Figure 13: The stanchion stub end fracture face (photograph courtesy of Serco Technical & Assurance Services, Derby)

42 The stub fracture face was chemically cleaned to show two cracks that began from the material 'folds'. Three sides of the box section fractured rapidly from these cracks when the stanchion was bent back to near straight. There was no evidence of material *fatigue* (Figures 14 and 15). The fracture of the remaining material was due to the collision with the DMU.

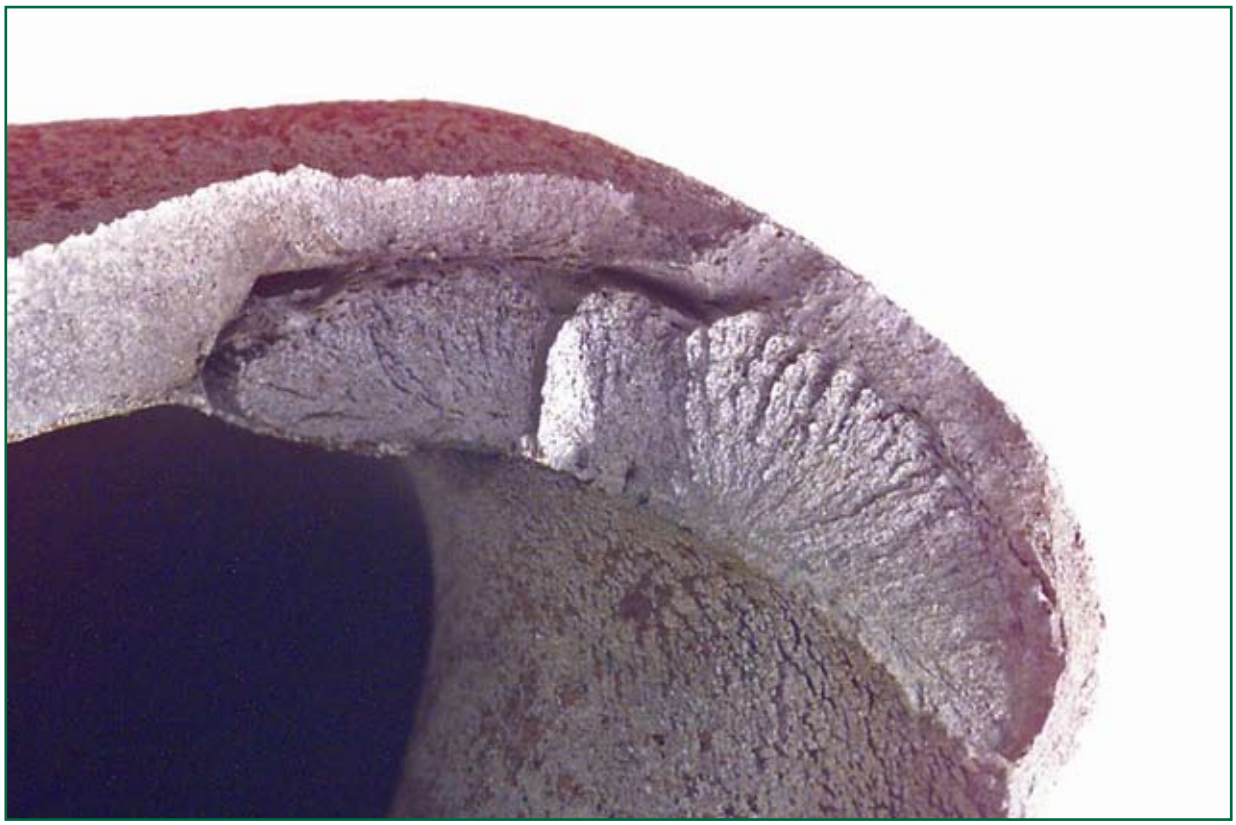

Figure 14: Cracking from the inside of one corner after corrosion removal (photograph courtesy of Serco Technical & Assurance Services, Derby)

Figure 15: Cracking from the outside of one corner after corrosion removal (photograph courtesy of Serco Technical & Assurance Services, Derby)

43 A causal factor was that the stanchion box section, previously fractured along three of its four sides, yielded on its remaining side and moved out towards a horizontal position.

Inspection of stanchions

44 A load examiner is responsible for confirming that a loaded train complies with the requirements of the EWS manual. The manual requires a load examiner to ensure that stanchions:

a. are a minimum of 100 mm higher than their load;

b. are firmly located into the bottom of their pockets;

c. have no wear marks showing at their ends;

d. are the same height - unless they are obviously of different sizes;

e. are positioned in the closest pockets to the load;

f. that are cracked are not used;

g. that protrude beyond the wagon sides are taken out and turned inwards or in extreme cases replaced.

45 The corroded stub fracture face indicated that the stanchion had made earlier load examined journeys. During this time the fracture, along three sides of the box section and visible from trackside, went undetected and the stanchion remained in service.

46 A causal factor was that the fractured stanchion was not detected and replaced prior to despatch.

Identification of contributory factors

Train unloading and preparation

47 During the morning of 1 August 2007, two EWS employees began unloading wagons stabled on outdoor track at Wolverhampton Steel Terminal. The wagons had not been ordered as expected before leaving Scunthorpe so they had to make more fork lift truck movements than usual to place the loads in their correct locations for onward despatch. By the afternoon they were behind schedule and not all wagons had been unloaded.

48 At 13:20 hrs train preparer 'A' came to examine and prepare ten wagons for the empty return journey to Scunthorpe, and completed the task while aware that three of the ten wagons, including 951198, had not yet been unloaded.

49 At 13:58 hrs train preparer 'A' produced the train document, signed it to confirm that the wagons were fit to run and handed it to train preparer 'B' who had just started the afternoon shift. Train preparer 'A' then left site. Neither train preparer 'A' nor 'B' re-examined the three wagons after they were unloaded.

50 The EWS manual states that the load examiner is responsible for confirming that wagon stanchions are fit for purpose (paragraph 44). A load examiner is not routinely required to assess a train before a return journey from Wolverhampton to Scunthorpe as the train almost always returns empty. In this event the EWS staff members that unload the trains and prepare them for despatch may detect and replace damaged stanchions, although the requirement for them to inspect stanchions is not specified in the EWS manual.

51 Throughout the unloading of wagon 951198 and its preparation to form part of the train, the fracture along three sides of the box section went undetected, and the stanchion remained in service.

52 A contributory factor was that the EWS manual did not require stanchion inspection by those responsible for loading and unloading wagons and by train preparers.

Stanchions in service

53 The steel billets on wagon 951198 were confined by stanchions placed as close to the load as possible and secured by webbing straps in accordance with the EWS manual.

54 Billets and other heavy loads may move into contact with adjacent stanchions due to load settlement or to load shifting forces generated during transit. This may cause the stanchions to bend and, in more severe cases, may also damage the pockets in which the stanchions are contained.

55 The EWS manual states that '…stanchions protruding beyond the wagon sides… must be taken out and turned inwards or in extreme cases replaced'. The manual does not consider stanchions that are bent longitudinally as they would not protrude beyond the wagon side.

56 As the manual does not define 'extreme cases' of stanchion damage, EWS staff members must make a subjective judgement when deciding to re-use or replace stanchions; this means that badly damaged stanchions may remain in service.

57 A contributory factor was that the EWS manual did not define the type of damage that would require a stanchion to be replaced.

Stanchion length

58 The EWS manual requires stanchions that are a minimum of 100 mm higher than their load (paragraph 44a). The stanchion described in this report and typical of stanchions in service, was over one metre higher than its earlier load of steel billets and was more susceptible to damage during loading and unloading than a shorter stanchion (Figure 4).

59 Had the stanchion been nearer to 100 mm higher than its associated load it would not have protruded a sufficient distance to strike the DMU cab when it moved out towards a horizontal position, although it would still have subsequently yielded and broken away, possibly resulting in other undesirable consequences.

60 A contributory factor was that the stanchion was significantly higher than its associated load.

Additional observations

Wagon maintenance

61 Wagon 951198 underwent its most recent annual Vehicle Inspection and Brake Test (VIBT) on 26 July 2006 and was due its next VIBT around the time of the collision. If a VIBT is not carried out within 28 days of its anniversary then the wagon is *'H' carded* in TOPS and may not be loaded.

62 VIBT assesses the operating condition of the wagon including its structural integrity, its braking performance and its suspension. It does not consider the condition of its stanchions. See also paragraphs 68b and 68c.

Conclusions

Immediate cause

63 The immediate cause of the collision was a fractured stanchion that moved out towards a horizontal position as the freight train passed the DMU travelling in the opposite direction on the adjacent track (paragraph 35).

Causal factors

64 The causal factors were that:

a. the stanchion box section, previously fractured along three of its four sides, yielded on its remaining side and moved out towards a horizontal position (paragraph 43);

b. the fractured stanchion was not detected and replaced prior to despatch (paragraph 46 and **Recommendation 1**).

Contributory factors

65 The contributory factors were that:

a. EWS did not require stanchion inspection by those responsible for loading and unloading wagons and by train preparers (paragraph 52 and **Recommendation 2**);

b. EWS did not define the type of damage that would require a stanchion to be replaced (paragraph 57 and **Recommendation 3**);

c. the stanchion was significantly higher than its associated load (paragraph 60 and **Recommendation 4**).

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

66 EWS issued a stanchion pre-departure checklist[1] to staff members responsible for train preparation in August 2007. This identified three conditions to be checked for and the actions to be taken if any of the conditions were found. The three conditions to be checked for were:

a. deformed stanchions protruding beyond the wagon side;

b. cracked or fractured stanchions; and

c. cracked or fractured stanchion pockets.

67 EWS issued a stanchion check sheet[2] to all operational, engineering and train crew locations in September 2007. The check sheet used photographs to raise awareness of a type of defect that should result in a stanchion being replaced.

68 EWS carried out an investigation into the collision and recommended that:

a. train preparer 'A' be re-assessed immediately and over a period of time to ensure the correct execution of train preparation duties;

b. wagons must not fall out of compliance with annual VIBT;

c. stanchions must be regularly examined for damage and that this task be added to VIBT;

d. the use of stanchions far higher than their loads should be reviewed.

[1] EWS operating digest advice number 141 issued on 17 August 2007.
[2] EWS notice to all staff – stanchion pin checks – issued on 12 September 2007.

Recommendations

69 The following safety recommendations are made[3]:

Recommendations to address causal factors

1 EWS should put in place a system to assure itself that damaged stanchions are detected and replaced by its load examiners (paragraph 64b).

Recommendations to address contributory factors

2 EWS should revise its manual and procedures to require the detection and replacement of damaged stanchions, where possible by those responsible for loading and unloading wagons, and by train preparers before every despatch (paragraph 65a).

3 EWS should revise its manual and procedures so they define the type of damage that would require a stanchion to be replaced using pass/fail criteria, diagrams or photographs (paragraph 65b).

4 EWS should evaluate the practicability of using stanchions similar in height to their associated loads and, if practicable, revise its manual, procedures and stanchion specifications accordingly so that the relevant members of staff are able to select stanchions appropriate in height to their loads (paragraph 65c).

[3] Duty holders, identified in the recommendations, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to The Office of Rail Regulation (Her Majesty's Railway Inspectorate) to enable them to carry out their duties under regulation 12(2) to:

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to the RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 167 to 171) can be found on RAIB's web site at www.RAIB.gov.uk.

Appendices

Glossary of abbreviations and acronyms — Appendix A

DMU	Diesel Multiple Unit
EWS	English, Welsh and Scottish Railway
TOPS	Total Operations Processing System
VIBT	Vehicle Inspection and Brake Test

Glossary of terms — Appendix B

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

Billet	Steel manufactured into a long, large bar.
Bogie	A frame equipped with wheels that is able to rotate freely, used to improve ride quality and distribute forces to the track.*
Bolster	A heavy timber section bolted laterally to the floor of a flat wagon to simplify the loading and unloading of the wagon by crane or fork lift truck.*
Brake continuity test	A test to confirm the application and release of brakes on the locomotive and wagons in the train when demanded by the driver.
Diesel multiple unit	A train consisting of two or more vehicles, semi-permanently coupled together, with a driving cab at each end. Some or all vehicles may be equipped with axles powered by one or more diesel engines.
Down	Track on which the normal direction of trains is away from Derby (in this instance).
Four foot	The area between the two running rails of the track.
Fatigue	Progressive, localised damage that occurs when a material is subjected to frequent, repeated loading.
Goods line	Track used predominantly for carrying freight trains.*
'H' carded	A card physically attached to a wagon exhibiting the code 'H' indicating overdue VIBT.
Load examiner	Defined by EWS as a member of staff who has been passed competent to sign Load Examination labels and assess traffic as fit to travel.
Stanchion	A removable vertical bar used along the sides of a flat wagon to assist in preventing the load sliding off.*
Train document	A series of sheets printed from TOPS giving information including the train's identification number; departure time; origin; destination points; maximum load; brake force type and tonnage; route availability; length limit and maximum speed. TOPS automatically checks whether the train formation conforms to prescribed criteria and standards when it produces the train document.
Total Operations Processing System	A computer system used to track rail vehicles. It deals with destination, load, location and maintenance information for all vehicles on the network. Vehicle data is entered for every movement, allowing virtually real time updates.*

Train preparer	The railway term for a person appointed by a train operator and passed competent to carry out train preparation before departure. Duties include checking the train for compliance with the train document and physically checking all vehicles to ensure that they are properly coupled (including brake-pipe and electrical connections); the necessary lamps are provided on the train; all vehicles appear safe to travel; all handbrakes are released.
Up	Track on which the normal direction of trains is toward Derby (in this instance).

This report is published by the Rail Accident Investigation Branch,
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