Accident
Investigation Board
Norway

Issued May 2008

REPORT JB 2008/04

REPORT ON ACCIDENT AT LILLESTRØM STATION 02.10.2006, TRAIN NO. 1606.

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REPORT

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Date issued: 08.05.2008
JB Report: 2008/04

This report is translated from Norwegian. The Norwegian text remains the official version of the report. Should ambiguity arise between the two the Norwegian text takes precedence.

This investigation has been limited in scope. Consequently, AIBN has elected to use a simplified report format. A full report is used only when the scope of the investigation makes this necessary. The simplified report highlights the findings made and puts forward potential safety-related recommendations.

Date and time:	Monday 2 October 2006 at time 0702
Accident site:	Lillestrøm station
Form of operation:	Centralised control
Type of incident:	Derailment
Train type and number:	Passenger train no. 1606
Registration:	NSB 72015
Operator:	NSB AS
Transportation type:	Passenger transport
Gross train weight:	61 tonnes
Train length:	44 m
Brake group and percentage:	EPZ 151%
Weather conditions:	Overcast
Light conditions:	Daybreak
Track operating conditions:	Slightly damp
Number onboard:	Not known
Injuries to persons:	None
Material damage:	Moderate damage to train unit and track. Break in a point blade in a double slip switch.
Other damage:	
Locomotive driver:	
- Gender and age:	Male, aged 40
- Training:	Train driver
- Experience:	4 years as train driver
Information sources:	NSB AS, the Norwegian National Rail Administration and the AIBN's own investigations

FACTUAL INFORMATION

On Monday 2 October at time 0702, train 1606 was passing through the points while entering Lillestrøm station. The train was en route from Eidsvoll to Oslo S and the driver was preparing to stop at the platform at Lillestrøm when he heard a loud bang under the train. The front part of the train then veered to the left onto the gravel. The train came to a halt quite gently after approx. 40 metres. The distance from the train to the end of the platform was approx. 10 metres and the passengers were evacuated from the train to the platform without any problems.

Figure 1: The derailed train - view from platform.

Figure 2: The derailed train - view towards platform.

Derailment site
The derailment happened in the switch area for the tracks at the north end of station, approx. 50 metres north of the end of the platform between tracks 6 and 7. As shown in figures 1 and 2, the derailment area is flat and a relatively good distance from slopes and buildings on both sides. There are platform edges, small apparatus cabinets and catenary poles in the area.

Damage
No-one was injured during the derailment and evacuation. The train unit suffered relatively moderate damage, as did the track. However, a break was discovered in a point blade in a points intersection underneath the derailed train. The derailment did not result in a full traffic standstill, as the derailed train was only blocking two of the tracks. This reduced capacity and caused some delays to other trains.

The train
The train comprised a class 72 single multiple-unit set, number 72015. Nothing was found in/on the train or in the operation of the train which could have had an influence on the incident. The train was on time before the derailment occurred and was making a scheduled stop at Lillestrøm. The train driver estimates that the speed on entering the points was approx. 35 km/h, which was confirmed by the train's data recorder.

Other trains

To AIBN's knowledge, there were no messages from earlier trains about points irregularities on the derailment date. As this is a simplified investigation, AIBN has not examined in more detail which trains had passed through the points prior to the derailment, but would nevertheless point out that as it was a Monday morning, the number of freight trains passing through Lillestrøm was minimal. However, the Norwegian National Rail Administration has provided information that a freight train taking jet fuel to Gardermoen had passed through on that morning.

Figure 3: Break in the point blade under the train.

Figure 4: Close-up of the break in the point blade.

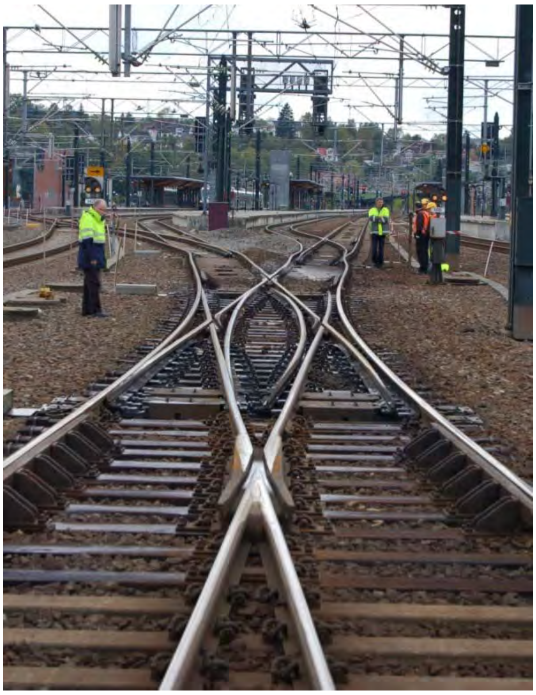

Figure 5: The points intersection where the derailment occurred (after removal of the train).

Figure 6: Close-up of the break (after removal of the train).

The track

The points system at Lillestrøm station was renewed and rebuilt in conjunction with the extension of the Gardermoen line and the double slip switch where the derailment occurred was laid in 1996. This double slip switch connects Hovedbanen and Kongsvingerbanen with tracks 5 to 11 at Lillestrøm station. The points are built on S54 rails, have a gradient of 1:9 R=190 and have timber sleepers with a 630 mm sleeper interval in the central part. The steel grade in the blade is specified as R260. The maximum permitted speed through the points is 40 kmh. The permitted axle load on this stretch is normally 22.5 tonnes.

Observations at the accident site
A break was found at the heel of a point blade in switch no. 47/20. A horizontal distance of 4-5 cm was observed and a difference in height of approx. 2 cm between the broken sections after the derailment (see figures 3 and 4). The running and side surfaces on the Oslo side of the break were deformed. The break had occurred in the interval between the last fixed sleeper and the first sleeper with a slide chair. In this area, the height of the blade web changes. The break surfaces appeared slightly corroded approx. 2 hours after the derailment, unlike the rail's running surfaces which were still shiny (see figure 4). The rails were damp at this time as a result of light drizzle. Marks left by the derailed wheel were found on the rails and sleepers after the break site.

Examination of the break
The Norwegian National Rail Administration sent the broken point blade to the National Institute of Technology, Norway for examination. The examinations and results were published in the Teknologisk Institutt's report no. 3420-06-0611, dated 11.12.06. The Norwegian National Rail Administration made the report available to AIBN. The report makes the following conclusion:

> *"The result of a chemical analysis shows the steel to be grade 260. The measured values are a little above the permitted maximum value for grade 260, but this could be due to work hardening in the surface.*
>
> *The probable cause of the damage is development of a fatigue break from cracks or corrosion pitting. The rough striation lines and the large resulting break indicate major tensile stress in the underside of the rail. The fatigue break in turn triggered the resulting clean break as the train passed."*

The report contains the following photograph which illustrates the break:

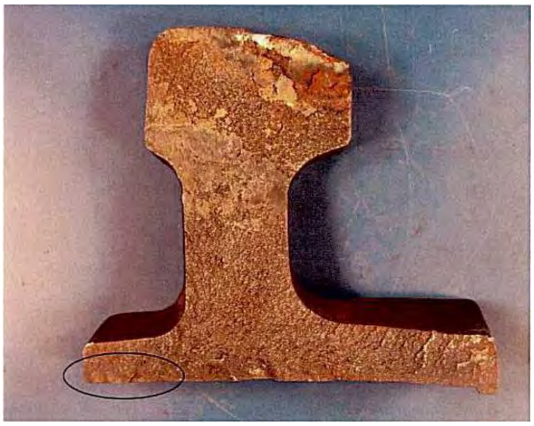

Figure 7: macro picture of the break surface. The ellipse marks the area of the fatigue break. Photo: National Institute of Technology, Norway.

Figure 8: Fatigue break in bottom left part of cross section. Photo: National Institute of Technology, Norway.

The points
The blades in this switch construction are spring blades, i.e. the blades move position in the event of elastic stretching under the influence of forces from the switch motor. The blades in this double slip switch are short compared with blades in normal single switches. This means that the necessary

stretching must be distributed over a shorter blade length. The Norwegian National Rail Administration has provided information that the blade in this point is tension-neutral when it is approx. 7 cm from the stock rail (normally approx. 10 cm). However, the blade’s neutral position may have been adjusted by cold pressing, based on experience during use, without this having been documented.

Checks and maintenance
An ultrasound check was run on the stretch of track on 20 July 2005. However, the ultrasound train cannot check the foot flanges in the point blades. Ultrasound checking of foot flanges must be done manually. This is not part of the routine tasks of the ultrasound train.

The last routine annual check of the points before the derailment was conducted on 11 June 2006. Nothing emerged from the check that could have had any bearing on the incident. This check included checking the blade for wear and shelling, but no checking for cracks using ultrasound equipment.

The last routine (monthly) visit to the points before the derailment took place on 5 September 2006. In addition, the signalman was called out to the points twice in the weeks prior to the derailment (25 September and 27 September). In both cases, the problem was resolved by greasing the slide chairs. No other faults were reported during these call-outs.

Other factors
It was discovered that the second point blade (of the pair) was replaced in September 2006 due to a break. This break occurred further back in the blade where it was securely fixed; consequently, there was no immediate danger of derailment here.

The Norwegian National Rail Administration reports that it does not have any statistical or experience materials that would indicate any frequency of breaks in point blades. Nor can it produce a list of reported faults for the points in question.

The Norwegian National Rail Administration describes the traffic load over the points as high, although this has not been quantified. All trains to and from Hovedbanen and Kongsvingerbanen passes through these points. AIBN has not gone any further into quantifying the traffic load in this limited investigation.

Regulations
The Norwegian Railways Act and associated regulations require the Norwegian National Rail Administration (JBV) to establish a safety control system. To fulfil this requirement, the JBV has established a control system based on The Safety Manual (STY-0345), The Maintenance Manual (1B-Ve, STY-0524) and Technical Regulations(JD 500-series). Technical Regulations JD 530 and 531 contain rules on designing and building track systems. Technical Regulations JD 532 specifies “generic working procedures” for preventive maintenance and associated control intervals.

The following extract from Technical Regulations is relevant to this event:

JD 530, Chapter 7 section 2 deals with the selection of points types. Section 2.1 reads:

> *“When designing a new system, single points should be chosen in the main track. Asymmetrical double points and slip switches should only be chosen if for considerations of space single points cannot be used for the track system.”*

JD 530, Chapter 7 section 4 deals with rail steel grades. This states that point blades should be of steel grade R350HT in accordance with NS-EN 13674-2. Table 1 shows a selection of properties for steel grades R260, R260Mn and R350HT compared with the data measured for the broken blade.

Table 1: Properties for steel grades R260, R260Mn and R350HT compared with the broken blade. Source NS-EN 13674-2:2006 (E) and report from the National Institute of Technology, Norway.

Steel grade	Carbon content C %	Manganese content Mn %	Fracture toughness R_m [MPa] Min.	Fracture elongation A_5 [%] Min.	Hardness in running surface [HBV]
R260	0.60/0,82	0.65/1,25	880	10	260/300
R260Mn	0.53/0,77	1.25/1,75	880	10	260/300
R350HT	0.70/0,80	0.65/1,25	1175	9	350/390
Blade (measured)	0.67	0.98	..	..	313

The Norwegian National Rail Administration (JBV) has provided information that previous regulations also accepted R260 in the point blades. The R350HT requirement was implemented in the regulations at the time when these points were laid. However, dispensations from this requirement were granted, which meant that the stocks of blades with R260 grade steel could be used up. JBV has provided information that the transition to steel grade R350HT was primarily based on the steel’s capacity to withstand wear and tear.

The standard requires testing of fracture toughness and hardness for steel from the rail-head. JBV has stated that steel grade R350HT was obtained by heat treatment (hardening) of the rail-head and believes that grades R260Mn and R350HT have exactly the same properties in the rail bottom where the break started.

JD 532, Chapter 11 specifies rules for maintenance of points. It also gives intervention limits (IL) and safety limits (SL) for important parameters. However, the chapter does not explicitly deal with checks for breaks in the blade. The defined (generic) control frequency is specified in JD 532 Chapter 4, appendix 4b “Generic working procedures”, which states that points on tracks of quality classes 3 and 4 must be supervised for clearing of stones, gravel and other clutter, and slide chairs must be checked and greased each month. Measurement of important parameters and checking of limit measurements must be conducted at a frequency of every 12 months.

The regulations for ultrasound checking of rails are listed in JD 532 Chapter 7, section 5.1. The regulations state that registrations from the automatic fault measurement car must be followed up with a manual after-check. Appendix 7b of the same chapter gives additional procedures for this type of manual check. Neither Chapter 7 section 5.1 nor appendix 7b deals explicitly with points or point blades.

The Maintenance Manual (1B-Ve, STY-0524) states that the generic working procedures must be adapted by means of controlled processes based on local conditions and systemised experience data. AIBN has not received any information from JBV about whether any such local adaptations were carried out for the track system at Lillestrøm.

Implemented measures
The Norwegian National Rail Administration has provided information that after the derailment, extra ultrasound checking of blade bottoms in double slip switches was implemented in Region East.

AIBN'S ASSESSMENTS

Based on measurements at the accident site and subsequent information it has received, AIBN believes that the derailment of train 1606 occurred as a result of the train driving over a point blade which had a break, with each part of the break being sufficiently displaced to result in the flange on the leading wheel being lifted off the rail. As it has not been possible to subsequently ascertain when the break in the point blade occurred, AIBN cannot rule out the possibility that other trains passed over the point blade with a partial or complete break without derailing.

In this case, the derailment did not result in any personal injuries and only caused moderate material damage. This is largely due to the fact that the derailment happened at a low speed as the train was making a scheduled stop at Lillestrøm and was braking to stop. Evacuation of the passengers proceeded without any problems, as a result of the lay-out of the derailment site and proximity of the platform.

The reasons why the point blade broke are not clear, The report from the National Institute of Technology did not reveal any material fault, but indicated a (small) fatigue break area and assumes major tensile stress in the underside of the rail. The following condition may have contributed towards major tensile stress/overloading of the material in the underside of the rail:

- Traffic load over the points is high, as the points are used by all trains to and from Hovedbanen and Kongsvingerbanen. This includes log trains and trains carrying jet fuel, which normally have high axle loads.
- Points with shorter blades than normal can give higher tension at the heel of the blade in the case of maximum deviation from a tension-neutral position. Adjustment of the blade's tension-neutral position may have compounded this effect. These tensions will be additional to those which normally occur in the foot flange when trains pass.

The Norwegian National Rail Administration has decided that steel grade R350HT must be used in the point blades. The measured values of the blade determined that the grade was R260. The steel has insufficient carbon content to fulfil the requirement for R350HT and insufficient manganese content to fulfil the requirement for R260Mn. JBV acknowledged that the remaining stock of R260 was used. Whether the deviating steel grade had a significant impact on the break is difficult to determine.

JBV's established control and maintenance system did not catch the development of this fault before a derailment occurred. Unlike the rest of the main track where regular checks for cracks are conducted using ultrasound, the foot flange in the point blade was not normally examined with this equipment, either by running an ultrasound train on the stretch of line or by scheduled periodical checking. In view of the combined load to which the foot flange in the point blade was exposed, the system for checking for cracks appears be weaker for the points than for the rest of the track.

AIBN has noted that when the track system at Lillestrøm was rebuilt in 1996, it was decided to use double slip switches in some positions and use of point blades with a steel grade that did not fulfil the requirements in the technical regulations was allowed. As this investigation is of limited scope, it does not examine the reasons for the deviation from the standards which was allowed in 1996.

AIBN would point out that the traffic load over the points is likely to have increased during the ensuing period, particularly with regard to high axle loads. Deviations from the regulations and development of traffic load are not considered to have been taken into account sufficiently with regard to local adaptations in the generic working procedures as defined in the Maintenance Manual and other relevant publications. AIBN's perception of the guidelines in the Maintenance Manual is that local adaptations may cover maintenance intervals and qualitative changes in the form of omission or addition of tasks. In principal, there may have been talk of both cutting the intervals between inspections and adding/concretising tasks in the process of checking for cracks.

Because the concretisation level in checking for cracks in points is relatively low in the technical regulations, AIBN is of the opinion that the central regulations and generic procedures should also be reviewed in order to better support this problem area.

SAFETY RECOMMENDATIONS

The investigation of this railway accident has revealed two areas in which AIBN considers it necessary to propose safety recommendations for the purpose of improving railway safety.[1]

Safety recommendation JB no. 2008/08T

A point blade on a main track with a high traffic volume broke and caused a derailment. The established checking procedure for discovering crack development is considered to be weaker for the point blades than for the rest of the main track. The National Railway Inspectorate is recommended to order the Norwegian National Rail Administration to assess whether its regulations for points checking should include explicit provisions for checking for cracks and also specify checking methods, checking areas, checking frequency and documentation requirements.

Safety recommendation JB no. 2008/09T

The investigation work revealed circumstances indicating that the required processes of local adaptation of generic working procedures for checking and maintenance of points at did not function as required. The National Railway Inspectorate is recommended to order the Norwegian National Rail Administration to assess whether the guidelines for local adaptation of generic working procedures for checking and maintenance of points are adequate and are put into practice as intended.

[1] The investigation report has been sent to the Norwegian Ministry of Transport and Communications which is taking the necessary action to ensure that due consideration is given to the safety recommendations, cf. Regulation 31 March 2006 no. 378 regarding public investigations of railway accidents and serious railway incidents etc (Railway Investigation Regulations) § 16.