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Accident
Investigation Board
Norway

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REPORT JB 2008/08

REPORT ON SERIOUS INCIDENT HOVEDBANEN STRØMMEN 07.03.2008 TRAIN 41941

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This report has been translated into English and published by the AIBN to facilitate access by international readers.
As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

The Accident Investigation Board has compiled this report for the sole purpose of improving railway safety. The object of any investigation is to identify faults or discrepancies which may endanger railway safety, whether or not these are causal factors in the accident, and to make safety recommendations. It is not the Board's task to apportion blame or liability. Use of this report for any other purpose than for railway safety should be avoided.

Photos: AIBN and Ruter As

Statens Havarikommisjon for Transport

REPORT

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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:	Saturday 8 March 2008 at approx. 0050	
Incident site:	Hovedbanen, Strømmen station	
Form of operation:	Remote control, DATC	
Safety system:	NSI 63, automatic line block	
Type of incident:	Brake failure	
Train type and number:	Freight train no. 41941	
Registration:	German-registered wagon no. 33684955117-9	
Operator:	CargoNet AS	
Transportation type:	Freight transport	
Gross train weight:	993 tonnes	
Train length:	495	
Brake group and percentage:	P 84%	
Weather conditions:	Rain	
Light conditions:	Dark	
Track operating conditions:	Wet	
Number onboard:	1	
Injuries to persons:	0	
Material damage:	None	
Other damage:	None	
Locomotive driver:		
- Gender and age:	Male, aged 57	
- Training:	Train driver	
- Experience:	30 years	
Other personnel:		
- Position:	Brake tester 1	Brake tester 2
- Gender and age:	Male, aged 56	Male, aged 39
- Training:	Shunter	Shunter
- Experience:	Over 14 years brake testing	19 years brake testing
Information sources:	CargoNet AS and AIBN's own investigations	

FACTUAL INFORMATION

Notification

On Monday 10 March at approx. 1000, AIBN received a message from the engine drivers' safety representative at CargoNet AS about a serious rail incident involving train no. 41941 on Friday 7 March. After receiving the message, AIBN decided to impound two of the wagons from the train, which was at Alnabru at that time.

The sequence of events

When the train wagons were being shunted to train 41941 on Friday 7 March 2008, some problems with the brakes were noted. In the subsequent brake testing, problems emerged in the tightness test. After a long fault localisation session involving a total of eight different people and resulting in the replacement of one wagon and the disengagement of the brakes on another, an approved result was finally obtained.

The train left Alnabru on Saturday 8 March at 0040 after a delay of 4 hours and 20 minutes. While decelerating the train to 40 km/h in order to pass through a temporarily speed reduction area at Strømmen station, the train driver noticed that the train's braking effect was poorer than expected. As an attempt to increase the braking effect by a further reduction in brake pressure did not produce any greater effect, the driver applied emergency braking to obtain control of the train. This produced an effect and the train braked to below 40 km/h, and the driver performed a brake release manoeuvre and continued through Strømmen station. In the descent to Lillestrøm, the driver kept the speed down at 40 km/h. He believes that this gave him control of the train and he would have been able to stop before the entry signal to Lillestrøm station had this been necessary.

On the level stretch after Lillestrøm, the driver accelerated the train to 90 km/h and carried out a deceleration test which gave the value 23 as opposed to the expected value of 63. He contacted the traffic controller to report the brake problems and request a stop at Roven to have the train checked. The Roven check revealed that the brakes were only set on the first four wagons and the first bogie of wagon no. five. The driver went to the end of the train and opened the brake pipe valve on the end wagon. This switched on the brakes on the train's remaining wagons. On closing the valve again, the brakes gradually switched off on the end part of the train.

It was decided to take the train back to Alnabru with a new locomotive attached to the back of it. When the brakes were tested from this locomotive, the back part of (the original) train now had brakes, while the first four wagons and the first bogie on wagon five did not have brakes.

Damage

This serious railway incident did not result in any injuries to persons or material damage.

The train

On 7 March 2008, train 41941 comprised El 16 2210 and 14 loaded and empty goods wagons of type Sdggmrs (495 5 and 495 6). The total train weight was 993 tonnes. The braking group was P and the specified braking percentage was 84%. An overview of the train is provided in appendix A: R207, "Train information for Drivers".

Summary of examination of the trainset and wagon 33684955117-9.

The trainset (the train's wagons) was examined by representatives of AIBN and CargoNet AS at Alnabru on 11 March 2008. The wagons were then unloaded and placed on one of the departure tracks. Based on the knowledge of the incident, the investigation was only initially focused on two of the train's wagons. However, the first inspection did not reveal any irregularities. A Di8

locomotive was attached and brake testing was initiated. The first tightness test gave a pressure drop of 0.8 bar over one minute, i.e. not approved. When the wagons were checked, a whistling noise could be heard from the brake hose above the middle bogie on wagon no. 33684955117-9. On closer inspection of the hose, it was discovered that it had twisted during fitting.

When the brake pipe on the end wagon was opened, there was found to be air in the pipe along the length of the train. By successively opening the brake pipe in front of and behind the fifth wagon and listening to the airflow, the pressure behind the fifth wagon was considered to be lower than in front. Wagon no. 33684955117-9 was therefore moved to the wagon workshop at Alnabru for closer examination. The remainder of the trainset was assembled and brake testing was conducted without any problems.

Figure 1: Brake hose above the middle bogie fitted without twisting.

Figure 2: The brake hose on wagon 33684955117-9 was fitted with twisting.

The brake hose above the middle bogie on this wagon type consists of a standard brake hose encircled by a steel coil, cf. figs. 1 and 2. The connection part at one end has fixed nuts, while the other end has freely rotating nuts. On wagon 33684955117-9 it appeared that the brake hose had twisted during fitting. On moving the steel spring to the side, it was discovered that the brake hose had been damaged causing it to become partly compressed, cf. figures 3 and 4. The hose was dismantled and replaced with a new one. The wagon's brakes were then found to be functioning normally.

Figure 3: The twist in the brake hose resulted in a narrowing of the hose.

Figure 4: The cut brake hose could easily be squeezed together.

Wagon 33684955117-9

Wagon 33684955117-9 is a 6-axle articulated wagon for the transportation of semi-trailers, containers and swap bodies. The wagon is owned by Ahaus-Alstätter Eisenbahn AG (AAE), registered in Germany, and is one of a series of 177 corresponding wagons leased by CargoNet AS. The wagon type has been in use in Norway since 2000.

Information from CargoNet AS was used to track the wagon's movements in the days prior to the incident. The wagon underwent maintenance (an overhaul) at SweMaint AB in Gothenburg which was completed on 22 February 2008. The wagon was then transported to Alnabru where it remained as a stand-by wagon until 7 March when it joined the trainset comprising train 41941.

During the maintenance operation at SweMaint AB, the brake hose above the middle bogie was dismantled and the wagon's two halves were separated in order to carry out the prescribed maintenance work. On completion of the work, the brake hose was refitted and the wagon's brakes were tested using brake testing equipment. The records of this testing do not indicate any irregularities.

CargoNet AS has brought up this incident with SweMaint AB as a matter for complaint. In its complaint investigation, SweMaint AB assumes that the twisting in the hose which occurred during refitting was caused by the freely rotating nut turning the hose with it at the end of the tightening torque, and this was not discovered by the fitter or during the final check out from the workshop.

Brake testing of train 41941 at Alnabru on 7 March 2008

Brake testing of trains at Alnabru is normally carried out by terminal staff approved for this operation in accordance with CargoNet AS's internal regulations. In the case of technical problems, specialist wagon maintenance staff (wagon inspectors) can be enlisted for help with fault localisation and any necessary repairs. AIBN has been informed that the staffing situation at the terminal was normal on the Friday evening in question.

There was a little delay in bringing the trainset comprising train 41941 to a departure track at Alnabru S on that evening. Testing of the train's brake system was started at around the train's normal departure time. The first tightness test indicated too high a level of leakage in the train. After repeated tests, all with non-approved results, the locomotive driver asked the brake testing personnel to test the trainset for leakage. The braking tester asked for and was given assistance from the wagon maintenance specialist. However, the trainset check did not reveal any leakage. The brake testing personnel suggested changing the locomotive. This was rejected by the driver on the grounds that the locomotive's compressor capacity would not be capable of affecting the results of the tightness test.

At 2200, there was a shift change for the brake testing and fault localisation staff. Although the fault localisation work on train 41941 continued, this was now conducted as an additional task to the night shift's normal duties. An attempt was made to locate the fault by sectioning the train, but this was not carried out in such a way as to locate the fault. On the basis of the results, wagon no. 7 in the trainset was removed from the train. This shunting operation was carried out with the train's locomotive and the first seven wagons in the trainset. The air-tightness was subsequently a little better, but still "not entirely good".

After a while, a suggestion was made to carry out a "self-release test" on the train. This was done and the brakes on part of one wagon were found to have self-released (wagon no. 11 of the train). The brakes on this part of the wagon were disengaged. After that, the air-tightness in the train was satisfactory and normal brake testing was carried out with approved results.

Meteorological information
Observations from the Meteorological Institute's measurement stations at Alna (temperature), Hovin and Haugenstua (precipitation) show that the temperature in the Alnabru area on the evening of 7 March 2008 was between +0.7^{o} C at 2000 and +2.4^{o} C at 2400. Precipitation measurements show approx. 2.3 mm of rainfall between 2200 and 2330. Before and after this period, rainfall was minimal.

Organisation
In addition to CargoNet AS, AAE is also involved in the incident as owner of the wagon in question. SweMaint AB is involved as AAE's maintenance supplier.

CargoNet AS has indicated that AAE decides when these wagons are due for an overhaul and monitors the maintenance supplier in this connection. Staff from CargoNet AS carry out periodic maintenance of these wagons and ensure they are not used beyond the overhaul intervals specified for the wagons.

Regulatory rules
Rules relating to railway operations are regulated under the Norwegian Railways Act (11 June 1993, no. 100) and its associated regulations. Below are references to, or quotations from, certain paragraphs which are relevant to this incident.

FOR-2005-12-19-1621: Section 4 of the Regulations concerning requirements for railway enterprises on the national (Norwegian) rail network (the safety regulation) states that railway enterprises shall manage the safety of their railway operations and shall have a safety management system. § 4-3 states *"The safety management system must be adapted to the enterprise and the enterprise's activities and must cover all aspects of its operations, including the use of contractors…(etc.)."*

Regulations no. 240 of 29 February 2008 nr. 240 concerning traffic control and rail traffic on the national railway network and connecting private tracks (the rail traffic regulation) chapter V deals with the train's composition and brakes etc. Section 3, which deals with brake testing, states that "*The operator shall have its own procedures for testing brakes on all rolling stock types and stock combinations which it uses*". Section 3.1 also specifies the minimum requirement for the procedures for testing and control of air brakes etc. Section 4, which deals with checking air brakes while the train is in motion, states that *"After the train has moved out of the departure station or stations where considerable changes to the train's composition have been made, test braking shall be carried out at the first opportunity to ascertain the train's braking effect."*

FOR 2002-12-18-1679: Regulations concerning the training of staff in tasks that are crucial to traffic safety on railways, including trams, underground lines and suburban lines (the training regulation) require railway operators to have competence requirements, training plans and systems for testing and review for personnel carrying out tasks that are crucial to traffic safety.

CargoNet AS's regulations and procedures
CargoNet AS has indicated that the following regulating documents are relevant to this incident:

- C-600 Terminalaktiviteter og fremføring av godstog; Chapter 8: Togs utstyr med bremser og bremseprøve; Rev. 0 dated 1 April 2003
- C-201 Kompetansekrav og opplæring i trafikksikkerhet; Rev. 0, dated 20 March 2006
- C-201-V31 Opplæringsplan for terminalpersonale kombitog; Rev. 3, dated 9 January 2008

- C-201-V18 Reparasjon og vedlikehold av godsvogner; Rev. 1, dated 1 April 2003
- C-710 Vedlikehold og kontroll av godsvogner; Rev. 2,

Implemented measures
CargoNet AS has informed affected personnel of this incident by means of C Circular 08/2008, which gives instructions on how to identify this type of fault and what to do if such a fault is discovered. In addition, CargoNet AS has checked the brake hose above the middle bogie on all 6-axle wagons operated by CargoNet.

SweMaint AB has reported that all affected personnel have been informed and that the final control has been extended to include visual checking of the hoses with particular emphasis on deformation.

AIBN'S ASSESSMENTS

The physical cause
It is AIBN's opinion that the physical cause of the problems during brake testing of train 41941 at Alnabru and the brake failure in the same train on the approach to Strømmen station was the twisted brake hose above the middle bogie on wagon no. 33684955117-9. AIBN considers it likely that the brake hose was twisted while being refitted after maintenance work at SweMaint AB in Gothenburg.

The reason why this fault was not discovered during brake testing with brake testing equipment after maintenance at SweMaint AB in Gothenburg could be that the wagon's brake system may happen to have been filled from the "favourable end", and/or only a small volume was pumped through the narrowed cross section during this test. Another explanation may be that the twisting of the hose with the wagon's movements in the train resulted in a gradual reduction in the cross section so that problems did not emerge until a later point in time. This would also explain why it was possible for the wagon to be transported from Gothenburg to Alnabru without the problem being discovered.

The "leakage problems" which were thought to exist during brake testing of train 41941 at Alnabru were probably in fact air which was being squeezed past the narrowed brake hose and trying to fill up the brake system on the wagons behind the narrowed area. The narrowing must have been so tight by now that it appeared to the locomotive driver as if the brake system was filled up and pressure stabilised.

Why was the cause of the problems not found during brake testing at Alnabru?
Brake testing of the train at Alnabru was carried out by personnel who had been trained under CargoNet AS's internal regulations and had extensive experience. In addition, the brake testers were given assistance from wagon maintenance specialists (wagon inspectors), both before and after the shift change. It is AIBN's opinion that the following circumstances had a bearing on why the cause of the problems was not discovered at Alnabru:

- The fault type was "new", i.e. not identified and discussed in the regulating documents, including training plans and required reading.
- CargoNet AS's internal documents and training plans for brake testers give very little guidance on effective fault localisation in terms of identifying the wagon with the fault.
- The problems arose at the end of a normal working session – a Friday evening – and had to be transferred to the night shift as an additional task.

Although the possibility of a full or partial blockage in the brake pipe is not a new problem in principle, this type of blockage due to a twisted “permanently mounted” brake hose is a new experience for CargoNet AS and its staff. There was no documentation from the wagon owner or the wagon’s approval process to identify this danger. Nor was there any knowledge of similar incidents in other countries.

CargoNet AS’s procedures for brake testing described in C-600 give instructions on how brake testing is to be conducted and specify the criteria to be met in order to achieve a god result. As far as AIBN can see from documents received from CargoNet AS, there are no descriptions of fault localisation methods aimed at quickly identifying the wagon(s) with the fault (e.g. sectioning the train using the “process of elimination” or similar). CargoNet AS’s procedures do not give any “ceiling” with regard to how long to spend on brake testing and fault localisation in a train before the decision is made to cancel it. When a train does not achieve an approved brake testing result within the prescribed testing period, this will be an additional task to the normal jobs later in the shift. The staffing-workload relationship may have a bearing on safety and quality when clearing trains. CargoNet AS should consider issuing guidelines to support terminal personnel in the fault localisation process as well as prioritisation of resources and decisions to cancel trains.

The suggestion to resolve the problem with the tightness test by changing the locomotive, and also to some extent the attempt to perform a self-release test, may indicate that not everyone had full understanding of the purpose of the individual components of brake testing.

How was an approved brake testing result finally achieved at Alnabru?
Even with a partial blockage in the brake pipe, the wagons’ brake system will gradually be replenished with compressed air so that the airflow past the narrow part will decrease. This could then be interpreted as the train being air-tight. The shunting which was carried out with the front part of the train, when wagon no. 7 was removed, may have affected the hose in such a way as to reduce the blockage. In addition, the self-release test may have produced reactive forces in the hoses which may also have affected the blockage in a favourable direction. Similar reactive forces may have affected the brake hose when the locomotive driver applied emergency braking at Strømmen station.

Investigations carried out in connection with the gas fire at Lillestrøm on 5 April 2000 (cf. NOU 2001:09) showed that even with only 1% residual opening in the brake pipe, brake setting was achieved, albeit with a delay of 5 seconds in the end wagon, provided the train's brake system was loaded at normal pressure. Such a delay would hardly be noticed during brake testing. AIBN assumes that when the last brake testing was carried out, the train’s brake system was sufficiently replenished as to allow the tightness test to be passed, and the brake pipe gave sufficient through flow so that the time delay in setting and releasing the brakes was not observed by the brake tester.

Checks after train departure
According to statements received, the problems with the braking capacity on train 41941 were discovered when the train was about to decelerate to 40 km/h in order to pass through Strømmen station slowly. Section 4 of the **rail traffic regulation** requires test braking to be conducted at the “first opportunity” after the train’s departure, and before making long descents, so that any such problems are discovered before the situation becomes critical.

Underlying factors
The selected solution of brake hoses with fixed and rotating nuts in their connections should not cause competent staff any problems in fitting them correctly. However, the fact that the hose is encircled by a steel coil may contribute to failure on the part of staff to notice any twisting.

Nevertheless, this problem is not considered to be beyond the abilities of competent staff if relevant information is in place – a set of job instructions, for example.

As this investigation is limited in scope, AIBN has not checked whether similar incidents have occurred in other locations in Europe, but cannot see that this type of fault has been identified in international damage catalogues.

The wagon in which the fault was located is owned by AAE, registered in Germany, and leased by CargoNet AS. The wagon type is RIV-marked, i.e. covered by an agreement for exchanging carriages and wagons employed for international rail services. Similar wagons are used relatively widely in Europe. As the wagon type is RIV-marked and registered in Germany, it was not subjected to a full approval process in Norway. The safety documentation which CargoNet AS (NSB Gods) received from the wagon owner on inception of the lease is considered inadequate. According to information received by AIBN, CargoNet AS does not possess any documented risk analysis for the wagon type where the possibility of a blocked brake pipe resulting from the hose above the middle bogie is identified.

In this case, the absence of identification and exchange of information about the possibility of this fault arising resulted in inadequate guidance for maintenance personnel on fitting the brake hose above the middle bogie and the lack of a final check to ensure that this was correctly fitted. In addition, brake testers were not aware of this potential fault, which resulted in it not being found during brake testing.

AIBN has noted that it is the wagon owner (AAE) which has a contract with the maintenance supplier for such maintenance jobs. AIBN believes that CargoNet AS must therefore inform the wagon owner of the circumstances, ensure that the necessary instructions are given to maintenance suppliers and that CargoNet is also party to all necessary safety information concerning use and maintenance of the wagon type.

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. 2008/17T

A wagon with a partially blocked brake pipe was not identified during brake testing despite the fact that several persons and service groups were involved. CargoNet AS's internal procedures do not provide adequate instructions for supporting fault localisation and responses to problems which arise during brake testing. It is recommended that the National Railway Inspectorate order CargoNet AS to assess whether current internal rules on brake testing, including expertise requirements, are adequate and are carried out as prescribed, and to supplement rules and training plans with instructions on fault localisation and responses to fault situations.

[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.

Safety recommendation JB no. 2008/18T
The possibility of incorrect fitting of the brake hose above the middle bogie on articulated wagons was either not identified in connection with the design and approval process for the wagon type, or not communicated by the wagon owner to the maintenance supplier and user. Safety management in the system which covers foreign registration, wagon ownership and maintenance work is not considered to have functioned satisfactorily. It is recommended that the National Railway Inspectorate check that railway enterprises leasing rolling stock obtain access to all necessary documentation on its safe use and maintenance and send feedback on experiences to the owner of the stock and the registering authority.

APPENDIX

Appendix A Train information for drivers

Vedlegg A

R207-11-174021-1 CargoNet-GTS DATUM: 08.03.2008

R207, TÅGUPPGIFT TILL FÖRARE KL: 00:25

Tågnr.: 41942 Datum: 07.03.2008 Från station: CHARLO Telefonnr: 87913298

Type	Nummer	Innsettst	Utsettst	Trekkraft
Forspannlok. El16	162210	CHARLOTTENBERG	ÅRSTA-ÄLVSJÖ	100

Ln	Vagnsnr	S	Avst	Beststt	Brutto	Brems	Aksler	Sth	Antekn	Utsettst	Ö-nummer
1	336849551682	T	ALNABRU	ÅRSTA-ÄLVSJÖ	35	35	6	120		ÅRSTA-ÄLVSJÖ	
2	336849566268	T	ALNABRU	ÅRSTA-ÄLVSJÖ	35	35	6	120		ÅRSTA-ÄLVSJÖ	
3	336849551500	T	ALNABRU	ÅRSTA-ÄLVSJÖ	35	35	6	120		ÅRSTA-ÄLVSJÖ	
4	336849551898	T	ALNABRU	ÅRSTA-ÄLVSJÖ	35	35	6	120		ÅRSTA-ÄLVSJÖ	
5	336849551179	T	CHARLOTTENBERG	ÅRSTA-ÄLVSJÖ	35	35	6	120		ÅRSTA-ÄLVSJÖ	
6	336849563091	L	ALNABRU	ÅRSTA-ÄLVSJÖ	83	83	6	120		ÅRSTA-ÄLVSJÖ	
7	336849551187	T	ALNABRU	ÅRSTA-ÄLVSJÖ	35	35	6	120		ÅRSTA-ÄLVSJÖ	
8	336849554108	T	ALNABRU	ÅRSTA-ÄLVSJÖ	35	35	6	120		ÅRSTA-ÄLVSJÖ	
9	337649550833	T	ALNABRU	ÅRSTA-ÄLVSJÖ	35	35	6	120		ÅRSTA-ÄLVSJÖ	
10	336849554454	L	ALNABRU	ÅRSTA-ÄLVSJÖ	108	92	6	100	gcö 2143	ÅRSTA-ÄLVSJÖ	
11	336849554678	L	ALNABRU	ÅRSTA-ÄLVSJÖ	108	30	6	100	gcö 2143	ÅRSTA-ÄLVSJÖ	
12	336849552326	L	ALNABRU	ÅRSTA-ÄLVSJÖ	109	92	6	100	gcö 2143	ÅRSTA-ÄLVSJÖ	
13	336849551732	L	ALNABRU	ÅRSTA-ÄLVSJÖ	107	92	6	100	gcö 2143	ÅRSTA-ÄLVSJÖ	
14	337649551088	L	ALNABRU	ÅRSTA-ÄLVSJÖ	108	108	6	100	gcö 2143	ÅRSTA-ÄLVSJÖ	

Ln	Vagn/contnr	Farenr	UNNr	Varenavn och beskrivning	NOS info	Fareseddel	Emb. gr.	Mengde	Nettomängd	Märknad	Tom lastbärar ej rengjort

Stax D **Medförs inte:** X

Medförs: **från:** **til:**

Långsammaste vagn km/h: 100

INFO FÖR TÅGET **Uppgiftslemnare:** tr

Sum längd inkl. lok (Meter) : 495
Sum antal axlar exkl.lok : 84
Sum Tågvikt inkl.lok (Ton) : 993
Sum Vognvikt exkl.lok (Ton) : 903
Sum Bromsvikt exkl.lok (Ton) : 777

Sum Bromsprocent inkl.lok : 84%