aibn Accident Investigation Board Norway

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REPORT Road 2015/05

REPORT ON HEAD-ON COLLISION BETWEEN TWO HEAVY GOODS VEHICLES ON THE E39 ROAD BY THE LAVOLL TUNNEL IN FLEKKEFJORD ON WEDNESDAY 22 OCTOBER 2014

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As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

Photos: AIBN

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REPORT ON ROAD TRAFFIC ACCIDENT

Date and time:	Approximately 21:05 on Wednesday 22 October 2014	
Scene of the accident:	Flikka by the Lavoll tunnel in Flekkefjord municipality	
Road no, main section (hp), km:	EV 39, HP 17, m 680	
Type of accident:	Head-on collision	
Vehicle type and combination:	**Eastbound vehicle:** Tractor: Volvo FH13 62T, 2012 Semi-trailer: AMT S340, 2013	**Westbound vehicle:** Tractor: Volvo FH, 2007 Centre-axle trailer: DAPA, 2007
Type of transport:	Empty heavy goods vehicle in commercial operation	Heavy goods vehicle in commercial operation
Country of registration:	Sweden	Denmark
Transport company:	Tornado Transport, Sweden	Alex Andersen Ølund A/S, Denmark
Transport agent:	Nortransport	

NOTIFICATION OF THE ACCIDENT

At 22:11 on 22 October 2014, the AIBN was notified of a head-on collision between two heavy goods vehicles on the E39 road west of Flikka in Vest Agder county. The AIBN inspected the accident site on 23 October.

SUMMARY

The accident happened in wet conditions, in a right-hand bend with a gradient, when the empty semi-trailer of an eastbound heavy goods vehicle skidded because the anti-lock brakes (ABS) were not working. The semi-trailer hit the front of an oncoming heavy goods vehicle, seriously injuring the driver of that vehicle.

The AIBN considers it a significant safety issue that semi-trailers skid into the opposite lane causing serious head-on collisions such as in this accident. The anti-lock brakes on the semi-trailer did not work because the ABS/EBS had been disabled. Contact and sensor faults in the braking system were found on the semi-trailer, and the only indication of these serious faults was a yellow warning light on the dashboard in the tractor. This indication does not differentiate between a minor fault and a serious fault in the vehicle's braking system. Nor is this type of fault identified in road-side inspections. The AIBN believes that there is a need for better follow-up of driving with electronic faults in the braking system.

The AIBN issues one safety recommendation in this area.

1. FACTUAL INFORMATION

1.1 Sequence of events

On Wednesday 22 October 2014 in the evening, a heavy goods vehicle belonging to the Swedish transport company Tornado Transport was heading east along the E39 road drawing an empty semi-trailer after having completed an assignment. After passing through the Lavoll tunnel on a straight downhill section with a speed limit of 80 km/h on the way to Flikka, the heavy goods vehicle entered a right-hand bend.

Figure 1: The accident location between the Lavoll tunnel and Flikka. Source: © The Norwegian Mapping Authority/AIBN

While going downhill and heading into the bend, the speed of the heavy goods vehicle varied between 84 and 92 km/h[1]. The recorded speed on entering the bend was approximately 84 km/h, as the vehicle initiated normal braking procedure. The semi-trailer, which was empty, skidded into the opposite lane and hit the crash barrier.

At the same time, a westbound heavy goods vehicle, belonging to Alex Andersen Ølund AS and consisting of a tractor and centre-axle trailer, was approaching in the opposite lane. This vehicle entered what, from its perspective, was a left-hand bend below the Lavoll tunnel, and ran into the skidding semi-trailer. The point of impact with the westbound heavy goods vehicle was the left part of the driver's cab. The westbound vehicle was pushed into the crash barrier on the right-hand side of the westbound lane. Under the impact of the collision, the eastbound vehicle's semi-trailer was pushed back into the eastbound lane, hit the crash barrier in that lane and stopped as illustrated in Figure 2.

[1] According to the tachograph manufacturer, the recorded speed may be subject to an error margin of +/- 6 km/h.

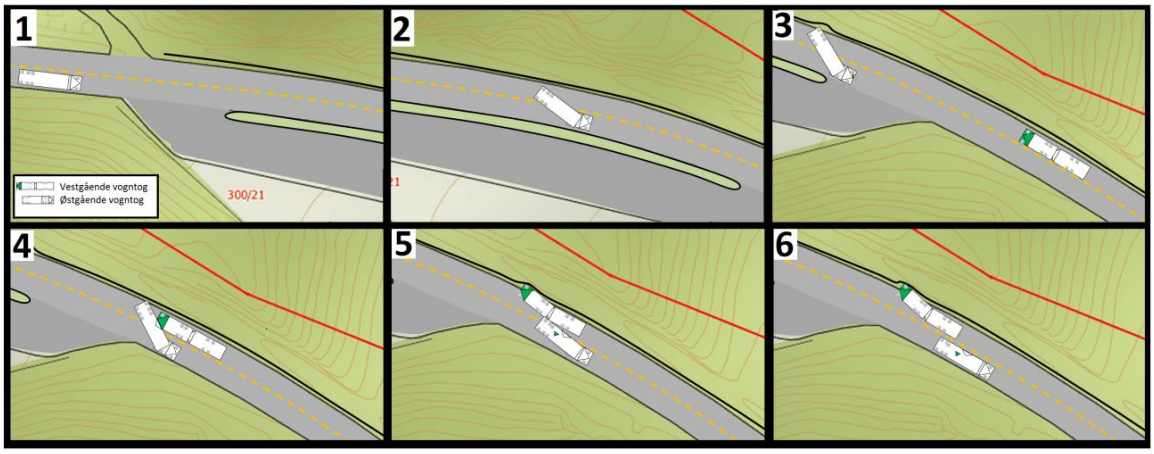

Figure 2: The sequence of events. Source: © The Norwegian Mapping Authority/AIBN

1.2 Injuries to persons

The driver of the westbound heavy goods vehicle was seriously injured in the accident, while the driver of the eastbound heavy goods vehicle sustained no physical injuries.

1.3 Survival aspects

1.3.1 Life-saving first aid

One of the first road users to arrive at the accident scene administered life-saving first aid to the driver of the westbound heavy goods vehicle, who was unconscious and suffered from severe bleeding. First aid was administered and the airways were kept free until ambulance service personnel arrived and took over.

1.3.2 The emergency services' notification and call-outs

The Emergency Medical Communication Centre (AMK) was notified at 21:02, and issued a triple alert notification to the ambulance, police and fire services in the course of two minutes.

The two ambulances that were deployed to the accident site both arrived at around 21:15, approximately 13 minutes after being alerted.

The ambulance that saw to the driver of the westbound vehicle was ready to depart from the scene at 21:29. It had taken 10 minutes to free the driver. The ambulance arrived at Sørlandet Hospital in Flekkefjord at approximately 21:35. A trauma team had meanwhile been requested from the hospital's emergency department.

Two police patrol units were notified by the police district's operations centre at approximately 21:05. The police patrol units, located in Lyngdal and Mandal, respectively, deployed personnel to the scene of the accident. Before they arrived, information was provided that a police officer in civilian clothes had already arrived, and that a forensic expert was on the way. The first patrol unit (from Lyngdal) arrived at the scene of the accident at approximately 21:35. Technical examinations were carried out that evening and into the night.

1.3.3 Safety equipment and survival space

1.3.3.1 *Westbound heavy goods vehicle*

The driver was wearing a seat belt at the time of the collision. The tractor was not equipped with an air bag. The physical survival space[2] was relatively small, as the left side of the driver's cab was extensively crushed in the collision.

1.3.3.2 *Eastbound heavy goods vehicle*

The tractor of the eastbound heavy goods vehicle was undamaged after the accident, and the driver's survival space was not reduced as a result of the collision.

1.4 Damage to vehicles

1.4.1 Westbound heavy goods vehicle

The left wall of the driver's cab took most of the damage and was completely crushed. Traces were found that showed that the flatbed of the semi-trailer had hit both the driver's cab and the left part of the tractor cabinet. The bumper bore traces of the collision with the eastbound semi-trailer's forward wheel suspension; see Figure 6.

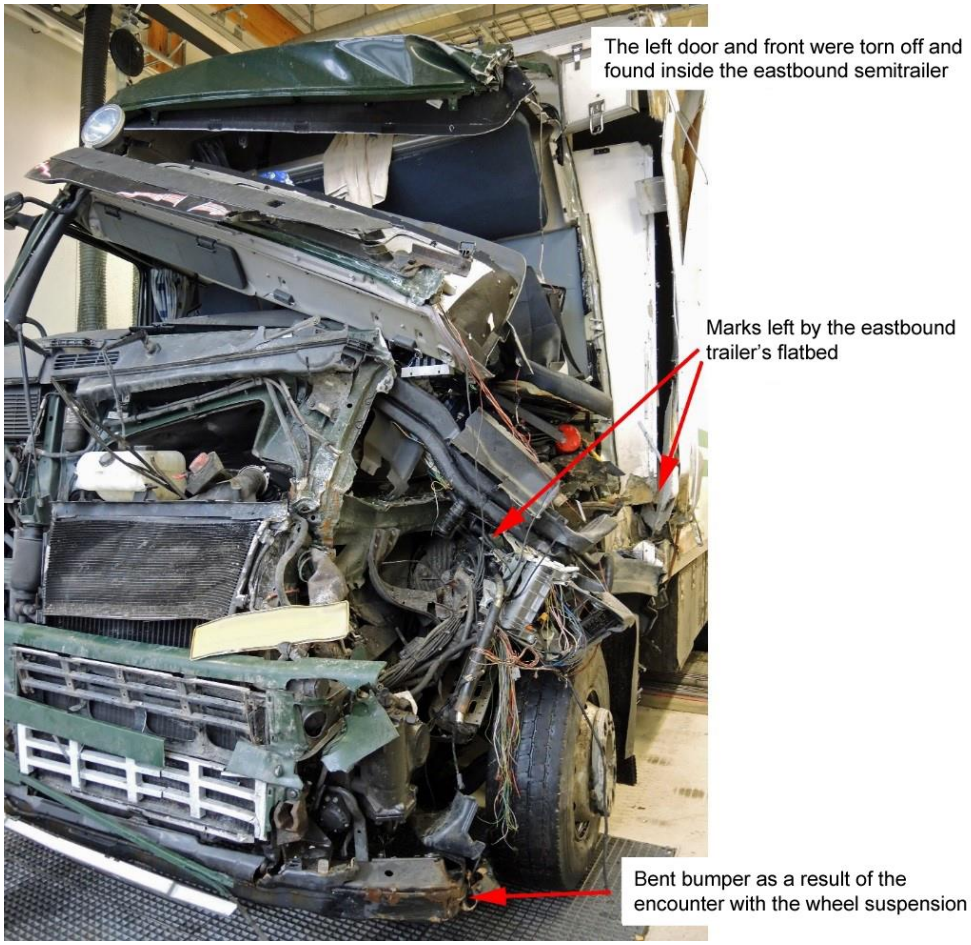

Figure 3: Damage to the driver's cab of the westbound heavy goods vehicle. Photo: AIBN

[2] The survival space available to the driver and passengers in the compartment after deformation and crushing of the vehicle body in a collision.

1.4.2 Eastbound heavy goods vehicle

The heavy goods vehicle's tractor was not damaged in the collision. The semi-trailer's side wall was damaged in the collision with the westbound heavy goods vehicle and the rear side panel on the left side was marked by the encounter with the crash barrier on the right-hand side of the opposite lane. See Figure 4 and Figure 5.

Figure 4: Damage to the left side of the semi-trailer. Photo: AIBN

Figure 5: The left side panel is marked by the encounter with the crash barrier on the right-hand side of the opposite lane. Photo: AIBN

The suspension rod for the left wheel on the semi-trailer's forward axle came off in the collision and showed traces of having been hit by the westbound vehicle's bumper; see Figure 6. The door of the westbound vehicle was found inside the semi-trailer after the collision; see Figure 7

Figure 6: The torn-off left suspension rod on the forward axle. Photo: AIBN

Figure 7: The door of the westbound vehicle inside the semi-trailer (photo taken after salvaging). Photo: AIBN

1.5 The scene of the accident

The crash barrier on the right-hand side of the westbound lane was damaged when the accident occurred. The barrier posts in Figure 8 mark the westbound heavy goods vehicle's final position, while the barrier posts seen in the distance (approximately 30 m behind) mark the point of impact with the eastbound vehicle's semi-trailer. Tyre marks were also found on the edge line, indicating that the westbound vehicle may have been pushed back towards the right. Figure 9 and Figure 10 show the heavy good vehicles' final positions after the collision.

Figure 8: Damages to the crash barrier looking westwards. The closest barrier posts mark the final position of the westbound heavy goods vehicle. Approximately 30 m behind them in the photo, we find marks from the eastbound semi-trailer. The photo was taken the day after the accident. Photo: AIBN

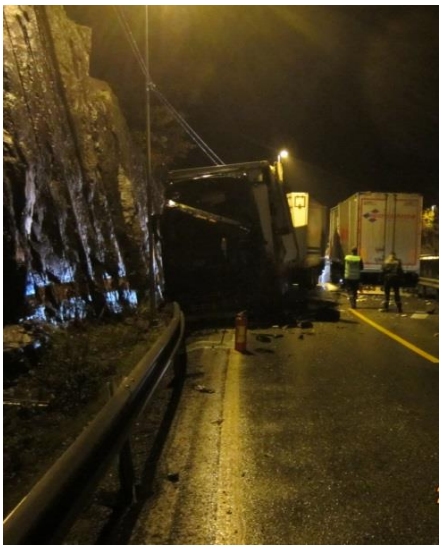

Figure 9: Final positions looking eastwards. Photo: NPRA

Figure 10: Final positions looking westwards. Photo: NPRA

1.6 Road users

1.6.1 The driver of the westbound heavy goods vehicle

The vehicle driver was 39 years old at the time of the accident and a Danish national. He had driven heavy goods vehicles for almost 20 years and had taken driving assignments in Norway for the past three years.

1.6.2 The driver of the eastbound heavy goods vehicle

The vehicle driver was 32 years old at the time of the accident and a Polish national. He had a driving licence covering categories B, C, BE and CE. He had taken the category C and CE licence in Poland in 2013. He had been employed by the Swedish company Tornado Transport since July 2014.

1.7 Medical conditions

Blood samples were taken of the driver of the eastbound vehicle immediately after the accident. The driver of the westbound vehicle was treated at Sørlandet Hospital and transferred to Denmark after a few days.

No traces were found of drugs, medication or illness in either of the drivers that could have contributed to the accident.

1.8 Vehicle and load

1.8.1 Westbound heavy goods vehicle

1.8.1.1 *Driving route*

The vehicle started out from Grønn Logistikk/Alex Andersen Norge AS in Larvik at approximately 12:00. It carried flowers that were delivered to various destinations in the course of the day. The vehicle left Mandal at approximately 20:00, and was on its way to make a delivery in Sandnes when the accident occurred.

1.8.1.2 *Model and technical condition*

The heavy goods vehicle's tyres were measured and the tread depth was found to meet the requirements. Because of the collision damage, no comprehensive technical inspection was carried out of the vehicle. A visual inspection did not uncover any defects.

Both the tractor and centre-axle trailer were registered in Denmark. The tractor was a Volvo FH 2007 model. The vehicle had passed its most recent periodic roadworthiness test on 23 December 2013.

The centre-axle trailer was a DAPA 2007 model, most recently approved on 23 November 2013.

1.8.2 Eastbound heavy goods vehicle

1.8.2.1 *The eastbound heavy goods vehicle's driving route*

The vehicle had started out from Lier and delivered various parcels to agreed locations in Porsgrunn, Brevik, Kristiansand and Ualand in the course of the day. After making a final delivery in Ualand, the vehicle was bound for Flekkefjord with an empty semi-trailer.

1.8.2.2 *Model and technical condition*

The heavy goods vehicle's tyres were inspected and all tyres were found to meet the requirements for tread depth. The semi-trailer had marked winter tyres (M+S). Both the tractor and semi-trailer were registered in Sweden. The tractor was a Volvo FH13 62T, 2012 model. The tractor underwent regular checks at a Volvo garage in Sweden and had most recently passed a periodic roadworthiness test on 10 August 2014.

The semi-trailer was an AMT 2657, S340, 2013 model, manufactured by MTDK A/S. It was equipped with an electronic braking system (EBS) comprising both an anti-lock braking system (ABS) and automatic load-dependent brake pressure regulation (anti-lock brake – ALB). The semi-trailer had an automatic front lift axle and a friction-controlled third axle. The semi-trailer had passed its most recent periodic roadworthiness test on 30 December 2013.

1.8.2.3 *The NPRA's roadside inspections of the eastbound heavy goods vehicle in Norway*

The NPRA had carried out nine roadside inspections of the tractor since the end of 2012, and a post-inspection had been ordered twice as a result of defects. In both cases, it was the condition of the tyres that was defective. Since the end of 2012, the semi-trailer had been subject to four roadside inspections.

The most recent roadside inspection of 9 May 2014 included brake tests, and led to the issuance of an inspection sheet with a prohibition on use, in which the vehicle was requested to proceed to the nearest garage for further inspection. At the time of the roadside inspection, the semi-trailer was connected to another tractor. The prohibition on use was issued because the yellow warning light on the dashboard in the tractor indicated that the trailer's anti-lock braking system (ABS) was defective. During the same roadside inspection, brake tests were carried out in which the semi-trailer was found to have a retardation of 4.43 m/s^2. The prohibition on use meant that the heavy goods vehicle could proceed to the nearest garage or undergo a post-inspection after seven days or when next crossing the border to Norway. The inspection report from the roadside inspection was not sent to the Swedish authorities.

1.8.2.4 *Technical inspection of the eastbound heavy goods vehicle*

Brake tests of the tractor were carried out after the accident. The tractor had only been transferred from the accident site to the Driver and Vehicle Licensing Office at the time of these tests. The brake test showed a calculated retardation of 4.4 m/s^2. The tractor was not damaged in the accident, and when the tractor was inspected, the key had not been in the ignition switch since the accident. The ABS plug for the semi-trailer had suffered corrosion in several places, including on the pin for transmitting fault signals to the dashboard. On closer inspection, it was also discovered that the fuse for the semi-trailer's ABS had been removed. During the investigation, it has not been possible to ascertain when or by whom this fuse was removed.

A yellow ABS-1 fault (fault signal for semi-trailer) was observed on the dashboard when the ignition was turned on. An EBS fault was also indicated on the dashboard when the fuse was installed.

Figure 11: 7-pin ABS plug for semi-trailer. Photo: AIBN

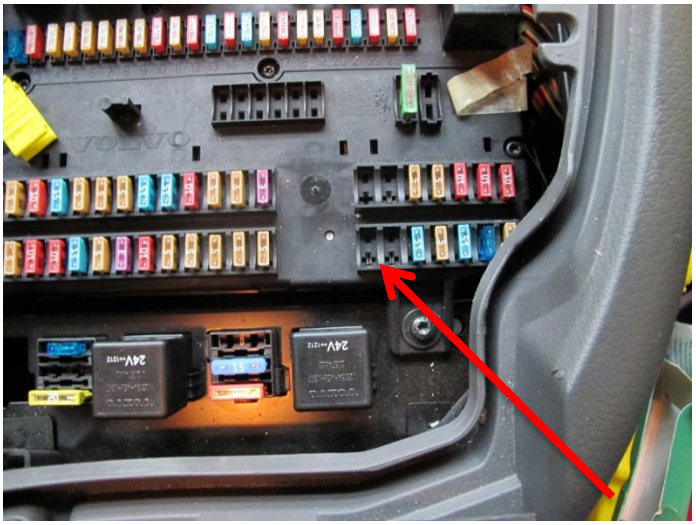

Figure 12: The 'Supply ABS/EBS trailer' fuse is missing (fuse no 70). Photo: AIBN

Figure 13: Dashboard display, without ABS power supply fuse for trailer. The yellow warning light means that it is connected to a trailer with ABS fault. (The arrow indicates which lamp was lit when driving.) Photo: AIBN

Figure 14: Dashboard display with ABS fuse for trailer installed. The EBS fault was now indicated on the dashboard. (The arrows show the lamps that would have been lit with the fuse installed.) Photo: AIBN

1.8.2.5 *The semi-trailer's braking system*

The semi-trailer was equipped with a Knorr TEBS G2 ES2060 brake modulator. This is an electronic braking system (EBS) comprising ABS control, automatic load-dependent brake pressure regulation (ALB), opening/locking of controllable axle, automatic front lift axle and a roll-over stability programme (RSP). Active and passive fault codes were downloaded from the braking system immediately after the accident. No dated fault messages were found from before 16 May 2014. This does not mean that no active faults had occurred before that date, but that no further time-stamped faults were recorded. The following active fault codes had been recorded for the braking system:

- Open circuit or phase short-circuiting in two wheel rotation sensors (22 and 29 September 2014).
- Electrical fault in locking of controllable axle.
- Faults in the power supply to the braking system on 15 occasions.
- The emergency power supply had only been activated five times (through the power supply to the brake lights).
- Fault in the power cable's auxiliary function, intended to activate the yellow warning light (persistent, undated fault).

The investigation showed that the left ABS sensor on the middle axle was disconnected, while there was no damage to the cable or mountings. Measurements on the right ABS sensor on the middle axle showed that it was defective.

The front axle has no wheel rotation sensors, so if neither of the ABS sensors on the middle axle are working, both the front and middle axles will be without an anti-lock braking system.

Figure 15: Right wheel on the second axle, ABS connected but with contact failure. Photo: AIBN

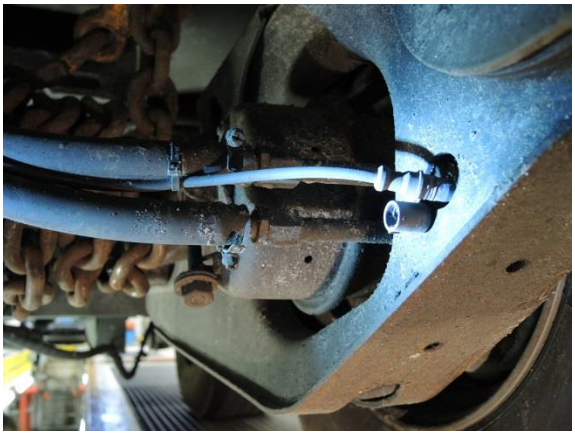

Figure 16: Left wheel on second axle. ABS sensor not connected. Photo: AIBN

Information obtained by the AIBN shows that, before the accident, there had been challenges involved in locking the rear axle and lowering the front axle of the semi-trailer, which is also confirmed by the fault codes that were recorded for the semi-trailer.

In the modulator, the controllable axle of the semi-trailer was programmed to lock at a speed of 50 km/h or higher. The speed signals for this function are transmitted by the ABS sensor on the second axle, which was not working.

The modulator is programmed in such a way that when the braking system is running on emergency power, the module is activated every time the driver steps on the brake pedal, and power is supplied to the ABS and ALB functions only. When the 'Supply ABS/EBS trailer' fuse is missing, the semi-trailer modulator will run on emergency power.

Lifting and lowering of the semi-trailer's front axle was controlled by the semi-trailer's modulator and could not be manoeuvred from the tractor.

The semi-trailer's automatic load-dependent brake pressure regulation (ALB) was controlled electronically by the bellow pressure in the trailer's air spring assembly. The load sensing plate shown in Figure 17 is a simplified representation of the modulator's programmed brake pressure regulation settings shown in Figure 18. The AIBN's technical examination did not include an examination of the ALB function.

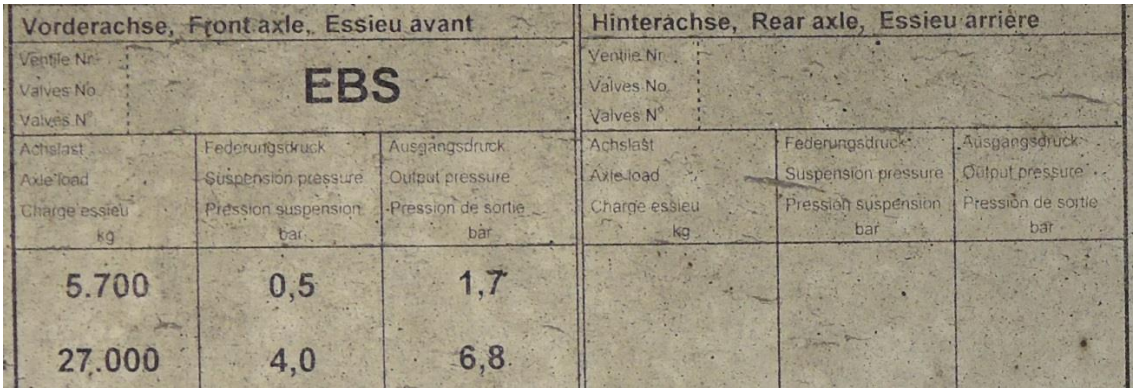

Figure 17: The semi-trailer's load sensing plate. The ALB settings are indicated on the lower left. Photo: AIBN

	Front pressure parameters Parametrar för bälgtryck fram				Rear pressure parameters Parametrar för bälgtryck bak			
Demand Styrtryck	Pneumatic (CAN) [bar] Pneumatiskt (CAN) [bar]				Pneumatic (CAN) [bar] Pneumatiskt (CAN) [bar]			
Control pressure [bar] Styrtryck [bar]	-	-	-	-	0,70	1,6	4,5	6,5
Brake press. unladen [bar] Bromstryck olastad [bar]	-	-	-	-	0,44	0,7	1,7	2,3
Brake press. laden [bar] Bromstryck lastad [bar]		-	-	-		1,4	4,5	6,7

Figure 18: Programmed settings for the ALB function in the TEBS modulator. Source: Knorr-Bremse

1.8.3 General information about electronically controlled air brakes (EBS) and anti-lock brakes (ABS/ALB)

In most heavy goods vehicles, the primary braking system is operated by compressed air. In order to set a heavy goods vehicle in motion, the air pressure must be sufficient to be capable of pushing back the springs in the parking brake's brake cylinders to free the wheels.

Several braking systems are used during ordinary driving. The main braking system distributes the braking force between the wheels and is activated by the brake pedal, electrical signals and the compressed air system. Auxiliary braking systems, such as the retarder and engine brake, only transmit braking power to the driving axle.

The main braking system that is controlled via the foot pedal also includes an anti-lock braking system (ABS). Its primary purpose is to prevent loss of control of the vehicle during braking. The ABS 'senses' wheel rotation. The ABS works on the principle that friction with the underlying surface is greatest just before the tyre ceases to maintain tractive contact with that surface. One desired effect is that the braking system prevents wheel-lock by 'pumping', so that the tyres keep hugging the surface without skidding while the system maintains the highest possible braking force.

Automatic load-dependent brake pressure regulation (ALB) is another system intended to prevent unnecessary brake wear and which adapts the braking force to the gross vehicle weight. The weight on air-sprung semi-trailers is calculated by determining the air pressure needed to keep the trailer at a constant height above the axle. This calculation is done by the ABS brake modulator on the trailer. If no power is supplied to the trailer's ALB function, the braking pressure will not be regulated according to the load, and full air pressure will be supplied to the brake cylinders when the trailer is empty.

The ALB function is not an anti-lock braking system, but because less brake pressure is supplied when there is little weight on the trailer, there is less risk of wheel-lock in connection with normal braking. As from 1 October 1992, ALB is no longer mandatory in vehicles equipped with ABS.

1.8.3.1 *Indication of faults in trailer brakes*

This Volvo model enables several ABS faults to be displayed on the dashboard. A brake pressure fault will be indicated by a red signal. A fault in the ABS function on the tractor or semi-trailer will be indicated by a yellow light signal in combination with a simple explanation on the dashboard. These signals are explained in Volvo's user manual as shown in Figure 19 and are also shown on the display in Figure 14:

	ABS fault on trailer
	Fault in trailer EBS function

Figure 19: ABS and EBS fault signals with description from the Volvo FH user manual. Source: Volvo

The semi-trailer was equipped with a braking system delivered by the brake manufacturer Knorr-Bremse. The system is programmed to give differently coloured signals for different faults as shown in Figure 20:

Yellow warning:
Continuous illumination of the yellow warning lamp indicates to the driver that there is a braking related fault on the trailer. A flashing yellow warning lamp indicates that there is a fault relating to an auxiliary function of the TEBS or no EOL test has been completed.
Red warning:
Continuous illumination of the red warning lamp indicates that there is a critical fault condition within the trailer braking system (this includes a warning when the reservoir pressure is below 4.5 bar).

Figure 20: The intended warning signals to be issued by the Knorr-Bremse braking system to indicate different faults. Source: Knorr-Bremse

1.9 Weather/driving conditions

At the time of the accident, the roadway was wet and it rained. The air temperature was 8.5 °C and the road temperature was around 9.5 °C. It was dark and the road was lit by road lights.

1.9.1 Surface friction

The NPRA's vehicle for measuring friction measured surface friction along the relevant road section at 00:13 on 23 October, approximately three hours after the accident. Friction measurements were taken both to the east and to the west of the accident site. From the accident site towards the Lavoll tunnel, friction measurements showed an average friction ('μ') value of 0.59, with a lowest value of 0.41 approximately 500 m west of the accident site. Friction values of between 0.5 and 0.61 were measured east of the accident site.

1.10 Road conditions

The road where the accident occurred forms part of the main road between Kristiansand and Stavanger. East of the accident site, the road is in the form of a straight, approximately 830 m long downhill section, with an even gradient of approximately 4.7%, as shown in Figure 21. The accident site is identified as EV39 HP 17m 680, with road characteristics as shown in Table 1.

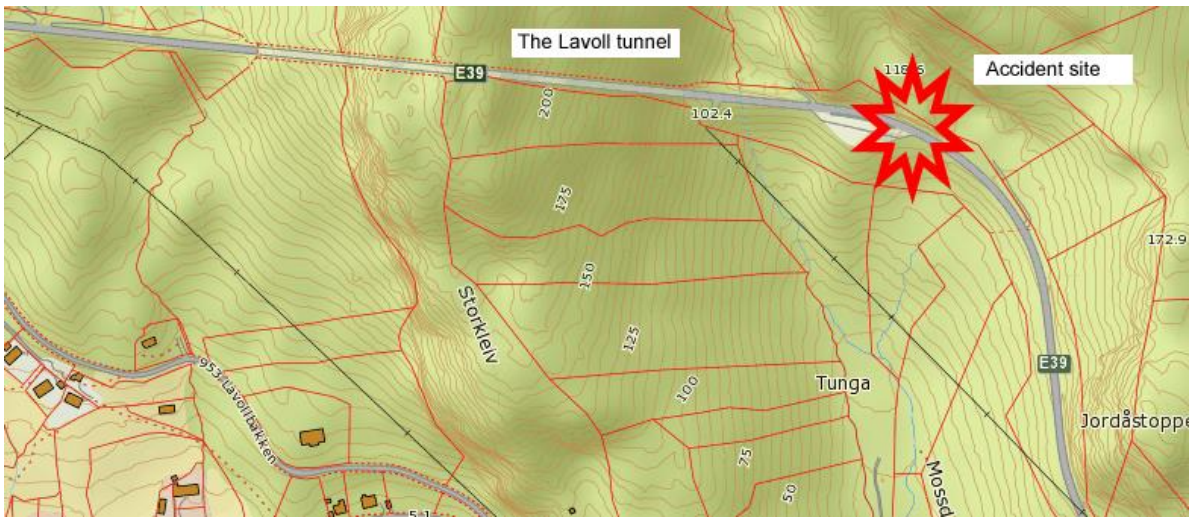

Figure 21: Map of the road at the accident site. Source: © The Norwegian Mapping Authority

Table 1: Road characteristics at the accident site. Source: The Norwegian National Road Database (NVDB)/AIBN

EV39 HP 17m 680			
Use class:	BK 10	**Gradient:**	4.7%
Mean surface width:	7.1 m	**Superelevation:**	10%
Mean roadway width:	6.4 m	**Radius:**	219 m (HP17 m626 – 767) 160 m (HP17 m567 – 626)
Mean road width:	7.4 m	**Crash barrier:**	Steel railing on wooden posts on either side of the road.

1.11 Technical registration systems

1.11.1 Tachograph data for the westbound heavy goods vehicle

Tachograph data were also downloaded for the westbound heavy goods vehicle. The vehicle was passing through a left turn with a gradient and had a recorded speed of between 63 and 66 km/h up until the final two seconds before the collision. During the last two seconds before colliding, the recorded speed of the vehicle was 54 km/h, and the final speed that was registered was 24 km/h.

1.11.2 Tachograph data for the eastbound heavy goods vehicle

Tachograph data were downloaded for the eastbound heavy goods vehicle after the accident. Among other things, the tachograph records speed data[3]. The vehicle's retardation can be calculated on the basis of these data. From 500 to 100 m before the place where the vehicle came to a halt, the vehicle speed was recorded as between 84 and 92 km/h. A short distance before the bend, approximately 100 m before coming to a halt in its final position, the driver applied the brakes to slow down in the normal manner from a speed of 84 km/h. Figure 22 and Figure 23 show the calculated retardation and speed of the heavy goods vehicle.

[3] Speed data from a tachograph may be subject to an error margin of ± 6 km/h.

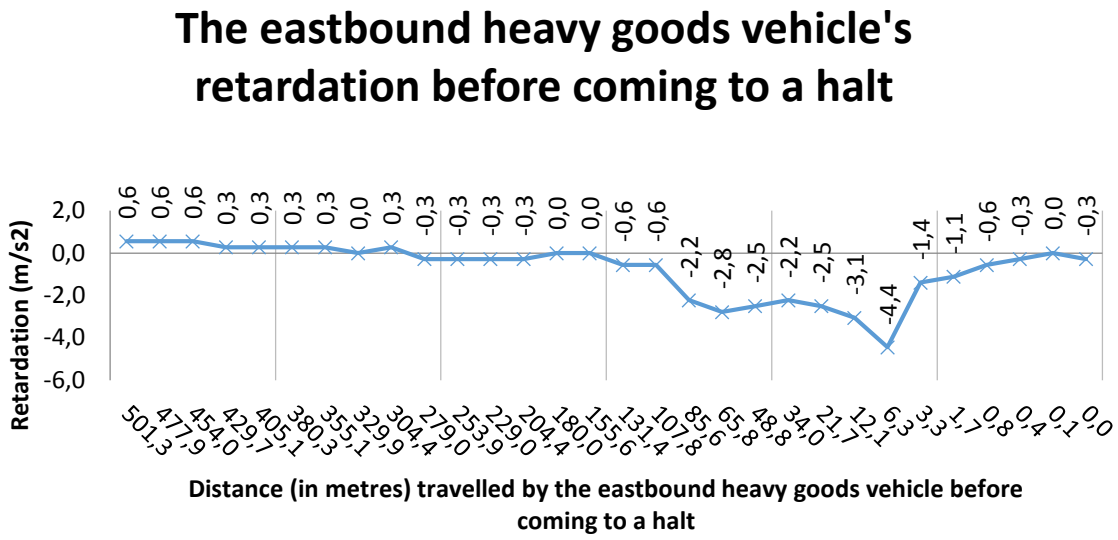

Figure 22: The eastbound heavy goods vehicle's retardation over the final 500 metres or so before coming to a halt. Source: AIBN

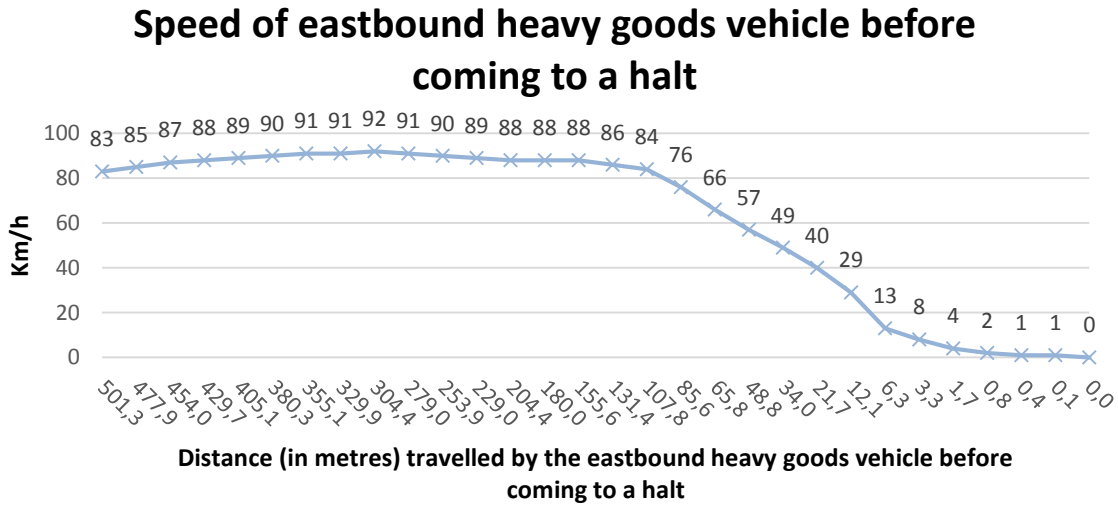

Figure 23: Speed of the eastbound heavy goods vehicle over the final 500 metres or so before coming to a halt. Source: AIBN

1.12 Critical skid speed in a bend depending of friction and braking force

Figure 24 shows the theoretical maximum speed before skidding at different speeds in a bend, under the application of braking forces and subject to different friction values. The figure has been conservatively adapted to the bend where the accident occurred, in that it describes a bend with a radius of 200 m, a superelevation of 6% and different friction curves that can be measured in the roadway.

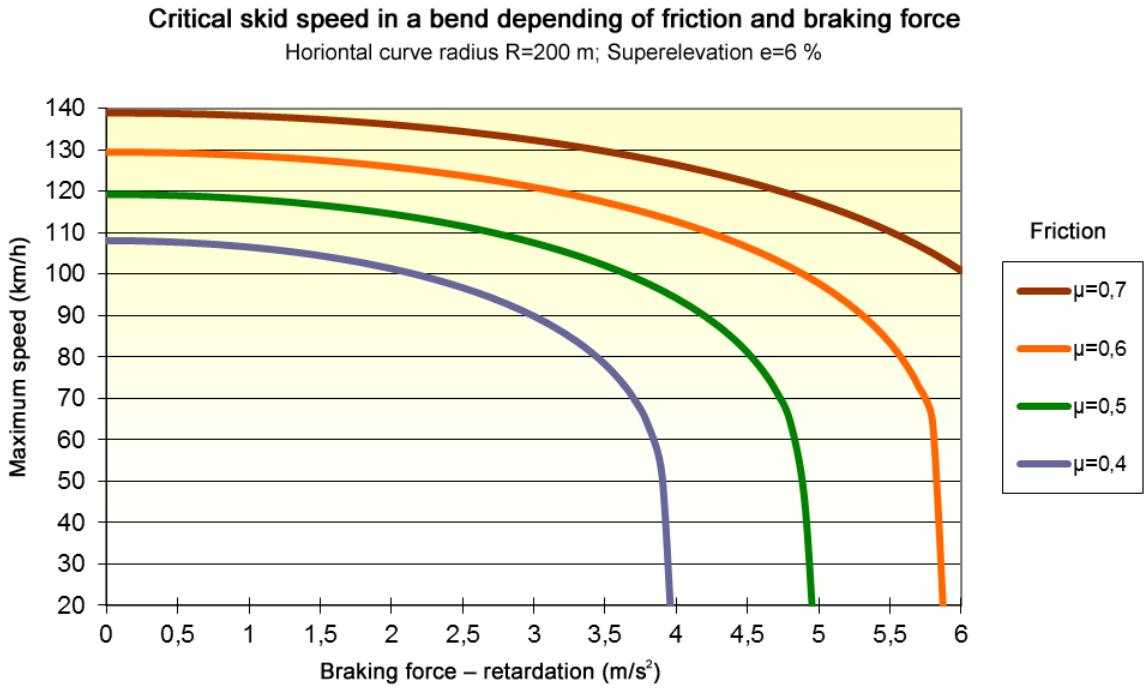

Figure 24: Critical skid speed in a bend depending of friction and braking force. Source: AIBN

In principle, a vehicle could theoretically pass through this bend at a speed of approximately 110 km/h without skidding on a wet road surface (μ=0.4). When braking ($3m/s^2$), the vehicle could reach a critical skid speed at 90 km/h, given the same friction value of μ=0.4. This is based on the assumption that the vehicle's brakes have a correct braking force distribution.

1.13 Laws and regulations

Use, operation, inspection and control in the road sector are largely regulated by the Act of 18 June 1965 No 4 relating to road traffic (the Road Traffic Act) and its regulations, and by the Act of 21 June 1963 No 23 relating to roads (the Road Act).

Requirements relating to the technical condition of the heavy goods vehicles are mainly regulated by the respective countries' national regulations. Swedish regulations apply to the eastbound heavy goods vehicle, while Danish regulations apply to the westbound heavy goods vehicle.

Requirements relating to the technical condition of vehicles, addressed to the vehicle manufacturer, among others, are described in EU directives. The provisions and requirements are implemented in the regulations of the European states in accordance with the directives.

1.13.1 Requirements of the driver and owner

The Act of 18 June 1965 No 4 relating to road traffic (the Road Traffic Act) and the Regulations of 21 March 1986 No 747 relating to vehicular and pedestrian traffic (the Traffic Rules) contain guidelines for all motor vehicle traffic on Norwegian roads. Both the owner and the person who is in charge of the vehicle on the road are required to make sure that the vehicle is in a safe technical condition (Section 23 of the Road Traffic Act).

1.13.2 Requirements for use of vehicles in Norway

The Regulations of 25 January 1990 No 92 relating to the use of vehicles (Vehicle Use Regulations) regulate the use of Norwegian and foreign vehicles in Norway. Section 4-2(5) states:

A trailer with an air brake system and a maximum total weight of more than 3,500 kg must be equipped with and use ABS brakes (anti-lock brakes) when drawn by a vehicle with ABS brakes. This shall apply even if the vehicle has a switch for disconnection of or the ABS braking function has been modified or removed.

1.13.3 Requirements for inspection

1.13.3.1 *Directive on roadside inspection of commercial vehicles circulating in the Community*

Directive 2000/30/EC of the European Parliament and of the Council of 6 June 2000 on the technical roadside inspection of the roadworthiness of commercial vehicles circulating in the Community has been implemented in the Norwegian Regulations of 13 May 2009 No 590 relating to roadside inspection of vehicles (the Roadside Inspection Regulations). A set of instructions for roadside inspections has been prepared on that basis.

Article 5 of the Directive states that:

> *... If the authority of the inspector considers that deficiencies in the maintenance of a commercial vehicle may represent a safety risk such that, as regards the brakes in particular, further examination is justified, the commercial vehicle may be subjected to a more elaborate test at a testing centre in the vicinity, designated by the Member State, in accordance with Article 2 of Directive 96/96/EC.*

Article 7 of the Directive states that:

> *Serious deficiencies in a commercial vehicle belonging to a non-resident, in particular those resulting in a ban on using the vehicle, shall be reported to the competent authorities of the Member State in which the vehicle is registered or has been put into service by means of the specimen report in Annex I, without prejudice to the prosecution in accordance with the legislation in force in the Member States in which the deficiency was recorded.*

Annex II to the Directive sets out rules for testing and/or checking braking systems and exhaust emissions. For braking systems, it is a requirement that every part of the braking system and its means of operation is maintained in good working order and is properly adjusted.

Directive 2014/47/EU of the European Parliament and of the Council of 3 April 2014 on the technical roadside inspection of the roadworthiness of commercial vehicles circulating in the Union and repealing Directive 2000/30/EC was incorporated into the EEA Agreement on 30 April 2015. The new Directive describes new competence requirements for roadside inspectors and places greater emphasis on cargo securing, among other things. The Directive will be implemented in the EEA by 20 May 2018.

The proposed new Directive (EU) 2015/413 of the European Parliament and of the Council of 11 March 2015 facilitating cross-border exchange of information on road-safety-related traffic offences provides for the exchange of information related to traffic offences, but not of information about technical vehicle faults detected by the inspection authorities without police involvement.

1.13.3.2 *Instructions for roadside inspections by the NPRA, 2013*

An inspection policy has been prepared for roadside inspections by the NPRA. It provides clear guidelines for the organisation and implementation of roadside inspections. All planning and implementation of roadside inspections shall be based on this inspection policy. The instructions include guidance on what sanctions to impose in response to any warning lights in vehicles.

Table 2: Sanctions imposed pursuant to Section 36 of the Road Traffic Act (national adaptations). Source: 'Instructions for roadside inspections by the NPRA, 2013'

Description	Sanction	Reference
No power supply to EBS/ABS for trailer. The warning light for ABS/EBS is activated, and ABS for the trailer is defective.	Prohibition on use Inspection sheet and prohibition on use	Road Traffic Act Section 13 Motor Vehicle Regulations Chapter 1 Sections 1–5 Motor Vehicle Regulations Chapter 26

When an inspection of an EEA-registered vehicle results in the imposition of a prohibition on use, or if other serious defects are found to exist, a copy of the inspection report shall be sent to the Directorate of Public Roads as required under Directive 2000/30/EC.

A new version of the VaDIS roadside inspection system was introduced on 22 January 2015, which enables automatic transmission of inspection forms for foreign vehicles to the Directorate of Public Roads. The Directorate of Public Road forwards the inspection form to the heavy goods vehicle's country of registration.

1.13.4 Requirements for international carriage operations

Section 10 of the Act of 21 June 2002 No 45 on professional transport by motor vehicle and vessel (the Professional Transport Act) provides guidelines for foreign enterprises that wish to engage in the carriage of goods in Norway.

1.13.5 Requirements for vehicles in Denmark, Norway and Sweden

Denmark, Norway and Sweden have all implemented the EU directives on the technical condition of vehicles in their regulations. The ECE Regulations on the technical condition of vehicles that are of relevance to this investigation are No 13 and No 121. They concern braking systems and requirements for tell-tales and indicators to be displayed on the dashboard during normal operation and in the event of faults and defects.

1.13.5.1 *Standard for vehicle dashboards*

ISO 2575:2004 is the international standard for the symbols and colours to be used on vehicle dashboards. This standard explains how the driver should interpret the colour code used for the different symbols. The difference between the colours red, yellow and green should be understood as follows:

Red:	*Danger to persons or very serious damage to equipment, immediate or imminent*
Yellow or amber	*Caution, outside normal operating limits, vehicle system malfunction, damage to vehicle likely, or other condition which may produce hazard in the longer term*
Green	*Safe, normal operating condition (where blue or yellow is not required).*

1.13.5.2 *The Volvo driving manual*

In addition to the regulations, Volvo has prepared a handbook in which it is stated that, if the warning signal 'Check' appears and a fault is found to exist, the vehicle should be brought to a garage for repair. It is not always the case that the vehicle breaks down or is damaged, and it is sometimes possible to complete the assignment. 'Check' signals also indicate conditions that the driver may be able to remedy on his/her own by driving more carefully or stopping for a while.

1.13.6 The Swedish Motor Vehicle Act (*Fordonslag (2002:574)*)

Type approval of vehicles in Sweden must take place in accordance with the Swedish Motor Vehicle Act (*Fordonslag (2002:574)*) in accordance with EU legislation for type approval (EG and ECE).

Chapter 18 of the Swedish Transport Agency's Regulations TSFS 2013:63 sets out requirements for underrun protection and lateral protection (*18 kap. Uderkörningsskydd och sidoskydd')*. Vehicles must meet the requirements for lateral protection devices set out in ECE Regulation No 73. In Norway and Sweden, as well as under the ECE Regulation, the lateral protection is required to be capable of withstanding the same force, namely 1 kN or 100 kg.

In Sweden, type approval is also required of the bumper in accordance with the requirements for front underrun protection devices (FUPD) set out in ECE Regulation No 93, which describes testing and acceptance criteria for bumpers on tractors. Among other things, the FUPD shall have a maximum ground clearance of 400 mm, so as to ensure good energy absorption in the event of a head-on collision and protect the tractor's steering worm. The force applied when testing the FUDP must not exceed 80 kN at either end of the front bumper or 160 kN when divided between two points. Such bumpers have been mandatory since 2001.

1.13.7 Road requirements

Legal authority for road standards is found in Section 3.2 of the Regulations of 29 March 2007 No 363 on the construction of public roads. The NPRA's handbook V120 (2014)

specifies the premises for geometrical minimum and maximum requirements (for example horizontal curve radii) based on physical formulae.

1.14 Authorities, organisations and leadership

1.14.1 The NPRA

The NPRA has several roles in connection with this investigation, in its capacity as both road owner and supervisory and inspection authority.

1.14.2 Nortransport

Nortransport was the agency responsible for the transport assignments undertaken by Tornado Transport. Nortransport is a logistics company whose business is to plan and administer transport assignments, and it has no vehicles of its own. Nortransport coordinates transport assignments for around 200 vehicles, between 30 and 40 of which are foreign vehicles on assignment in Norway.

1.14.3 Tornado Transport

Tornado Transport is a Swedish transport company that undertakes transport assignments in Norway. The AIBN has made a number of unsuccessful attempts to get into contact with the company's management or those who are in charge of the company.

Tornado Transport had not asked the driver of the eastbound heavy goods vehicle to present proof of his driving competence on signing the contract. Nor had the driver been given any form of training in the company.

The driver told the AIBN that, according to the guidelines from the company's management, any faults in the vehicle were to be repaired at a garage in Sweden.

1.14.4 Alex Andersen

Alex Andersen is a family-owned Danish transport company specialising in the transport of flowers.

1.15 Additional information

1.15.1 Defects/faults found in ABS during vehicle inspections in Norway (periodic vehicle inspections and roadside inspections)

The AIBN has requested and been provided with an overview of inspections of vehicles (trailers) with an authorised total weight of more than 7,500 kg where defects/remarks relating to ABS have been registered under item 1.1.12 on the inspection sheet for periodic vehicle inspections.

Table 3: Vehicles for which defects/remarks relating to ABS on trailer have been registered, 2011-2015. Source: the NPRA

Year	Number of inspected vehicles	Defect/remark	Percentage with registered defect/remark
2011	19,998	2,629	13.1%
2012	19,870	2,528	12.7%
2013	20,825	2,633	12.6%
2014	21,655	2,679	12.4%
2015 (7 June)	10,494	1,260	12.0%

As from 8 June 2015, a new system was taken into use for periodic vehicle inspections. New inspection items have been included for remarks about ABS and EBS. Of the 2,001 vehicles (trailers) that were inspected between 8 June and 9 July 2015, 213 (10.6%) were found to have defective ABS and 60 were found to have defective EBS.

A new version of the VaDIS roadside inspection system was introduced on 22 January 2015. The system includes an option for retrieving a limited amount of statistics. Between 22 January and 21 May 2015, 11,780 vehicles were inspected, of which 2,690 were found to be defective and 349 were found to have defective brakes. In the course of these four months, approximately 27% (94) of the 349 vehicles with defective brakes were registered as having faulty ABS/EBS.

1.16 Implemented measures

As a consequence of the accident, Nortransport has drawn up a new general contract for all carriers and a code of ethics to be enclosed with the general contract.

1.17 Previous AIBN investigations of a related nature

1.17.1 Head-on collision between heavy goods vehicle and passenger car on the FV115 road at Hjellebøl on 19 October 2012 (Report Road 2013/06)

In its investigation of the accident, the AIBN found, among other things, several contact faults in the EBS control unit as a result of corrosion. This entailed that the semi-trailer's brakes became too powerful and was a contributory cause when it skidded into the opposite lane. The only information displayed to the driver on the dashboard was that the trailer's ABS brakes were inoperative.

The AIBN submitted the following safety recommendation:

> *The AIBN recommends that the National Public Roads Administration follow up the issues of inadequate warning and loss of ABS and ALB functions in connection with contact faults/loss of power supply to the trailer.*

The recommendation was closed with the following statement:

> *The Norwegian Public Roads Administration believes that it has good focus and procedures in the form of instructions for roadside inspections concerning the inspection of brakes and ABS/EBS.*

Inspection of brakes is also extensively focused on in our training of inspectors through the Road User and Vehicle course ('Trafikant og Kjøretøystudiet'), which is used in the training of all inspectors. The NPRA conducts regular audits of the instructions to identify points for improvement and to close nonconformities that we become aware of. The NPRA will review the procedures for the inspection of brakes, including the issues of inadequate warning and contact faults/loss of power supply to the trailer during its next audit.

Concerning periodic vehicle inspections, based on feedback from the AIBN, among others, the Directorate of Public Roads will revise the inspection instructions for periodic vehicle inspections that enter into force on 1 January 2015, so that the above-mentioned inspection method for ABS is upheld in section 1.6 of the inspection instructions.

As this was an expression of an intention to implement measures, the AIBN submitted a new query to the NPRA following this most recent accident, asking whether any specific changes had been made relating to 1) inspection procedures, 2) the training curriculum or 3) inspection guidelines, and received the following reply:

1) At meetings with roadside inspectors, the importance of inspecting the ABS/EBS function and the importance of warning lights are reiterated and emphasised. We have not found it necessary to make any further changes to our procedures.

2) Inspection of brakes is an important part of the training that the inspectors receive through the Road User and Vehicles course. The training curriculum has not been changed as regards the inspection of brakes as the curriculum is at a more general level. The curriculum contains references to our procedures, to which reference is made in our reply to question 1.

3) Section 1.6 of the inspection instructions for periodic vehicle inspections has been revised so that a 'listening test' has been reintroduced; see the Regulations relating to periodic vehicle inspections, Annex 1 Inspection guidelines – Periodic vehicle inspections.

1.17.2 Head-on collision on the E39 road at Vinjeøra in Hemne 12 December 2011 (Report Road 2013/04)

In this investigation, the AIBN found, among other things, inadequate braking effect on the trailer as a result of faults in both the brake cylinders and the anti-lock braking system (ABS). These faults were not indicated by warning lights on the dashboard in the driver's cab.

1.17.3 Head-on collision between two heavy goods vehicles on the E39 road at Lenefjord 29 September 2006 (Report Road 2009/04)

The AIBN's investigation of this accident, found, among other things, that the brake effect was uneven, so that the lorry tended to veer to the right when braking. The ABS warning lights on the dashboard were also found to be defective, and the ABS sensor on the left drive wheel had short-circuited or broken.

2. ANALYSIS

2.1 Introduction

In the present accident, the sequence of events is relatively clear: When the eastbound heavy goods vehicle braked in the bend, the empty semi-trailer skidded into the opposite lane and collided with the westbound heavy goods vehicle. The technical examination found serious faults in the semi-trailer's electronic braking system.

The AIBN considers that the incident was a very serious one. Loss of control of a heavy goods vehicle has a high injury/damage potential depending on the oncoming vehicle type. In this case, the semi-trailer hit the front of an oncoming heavy goods vehicle so that the driver was seriously injured.

The AIBN's investigation has focused on explaining and understanding the extent to which the skidding was a result of the defective ABS/EBS, how the fault arose and why it was not detected and repaired or compensated for. The investigation has also focused on the inspection and testing of heavy goods vehicles and on how any fault in the brakes over time can be overlooked in the inspection regime. The AIBN has had limited access to information about why the technical fault in the vehicle was not repaired. The AIBN has interviewed and received information from the driver and the transport agent, but has not succeeded in obtaining information about the transport company. As a consequence, certain organisational aspects can only be discussed to a limited degree.

2.2 Sequence of events

The accident occurred in a bend, after a straight downhill section. When entering the bend, the eastbound heavy goods vehicle applied the brakes in the normal way. Because the ABS/EBS had been disabled on the semi-trailer, the trailer's anti-lock brakes did not work.

When the driver stepped on the brake pedal, it is highly probable that the wheels locked on account of the fault in the trailer's ABS/EBS. At the same time, the heavy goods vehicle was gradually making a right turn. The semi-trailer skidded into the opposite lane. This caused the driver to lose control of his own vehicle and collide with the oncoming Danish heavy goods vehicle.

Friction was measured through the bend and found to be uneven. However, the AIBN considers that it would have been possible for the eastbound vehicle to pass through the bend at the speed it held without skidding, if the brakes had not been applied. The need to brake was a result of the speed of the eastbound heavy goods vehicle as it approached the bend. The AIBN concludes that the accident was largely due to technical faults in combination with the low axle load of the empty trailer and the wet roadway in the bend.

The westbound heavy goods vehicle had no real possibility of avoiding the collision due to the crash barrier along the side of the road and the fact that it was passing a rock cutting.

2.3 Speed adjustment

The eastbound heavy goods vehicle had been driven along the same section and passed the accident location in the opposite direction on the same day, and the driver was

familiar with the road alignment. The prevailing friction conditions were difficult to ascertain, however, and, in the AIBN's opinion, this had to do with the fact that the roadway was wet when the accident occurred. At the time of the accident, when entering the bend, the eastbound heavy goods vehicle had a speed of just over 90 km/h going downhill from the Lavoll tunnel. Had the heavy goods vehicle kept a lower speed, there would have been less need to brake through the bend.

As part of its investigation after the accident, the AIBN observed a random selection of heavy goods vehicles' driving behaviour when passing the accident location. The observations showed that the normal driving pattern appeared to be to break before and while driving through the right bend east of the tunnel. Based on these observations, the AIBN concludes that the driving behaviour of the eastbound vehicle's driver did not deviate from the general driving behaviour of other heavy goods vehicle drivers passing the accident location, even though no speed measurements were carried out.

The AIBN is nonetheless of the opinion that, even if it is normal driving behaviour to brake along the relevant section, the risk associated with not slowing down was not sufficiently considered by the driver, having regard to the fact that the roadway was wet and that there was indication on the dashboard of an ABS fault on the trailer. However, the fact that the speed was not adjusted is also related to the driver's knowledge and understanding of what the yellow warning light meant.

The road conditions were generally predictable along the section where the accident occurred, even if friction was slightly reduced due to the roadway being wet. Due to the slope of the downhill section through the Lavoll tunnel, it is natural for an eastbound vehicle to build up speed as it approaches the right-hand bend. The slope creates a need to brake when entering the bend and some of the available friction may be utilised for this purpose. Measures should be considered where friction is reduced due to the road conditions and where the speed limit is not observed due to the slope of a road section.

2.4 Electronic brake fault on semi-trailer

There were records of many active brake faults on the eastbound semi-trailer, of which the fault in the anti-lock braking system (ABS) was the most serious. The information displayed on the dashboard is very limited and in the present case consisted of nothing more than a yellow warning signal. In the AIBN's opinion, the loss of the ABS brake function on the semi-trailer had a major impact on the sequence of events in this accident.

2.4.1 Lack of knowledge

The driver of the heavy goods vehicle has informed the AIBN in an interview that he was aware of the yellow ABS signal from the semi-trailer. The driver had asked his employer and been told that he could continue to drive the vehicle with a yellow warning light until he returned to the garage in Sweden on completion of the assignment. Some of his driver colleagues also told him that the brakes improved, or became 'sharper', without the ABS.

As mentioned above, the AIBN has not been able to get the transport company to verify this information. The AIBN is under the impression that the driver sought information to tackle a challenge, but the investigation has shown that he did not succeed in getting in touch with anybody who was sufficiently informed to explain the severity of this type of fault to him.

A driver is responsible for changing his/her driving pattern based on the indications given on the dashboard that the ABS is no longer working. In practice, it is probable that the heavy goods vehicle's braking characteristics were suddenly very different from those that the driver had been trained to use and were familiar with. The driver of the eastbound heavy goods vehicle told the AIBN that he lacked knowledge about this. Had the driver been instructed in how to drive a heavy goods vehicle without anti-lock brakes, he might have handled speed adjustment and braking differently.

The AIBN sees this investigation as an indication that there is a lack of knowledge about anti-lock brakes and what warning signals entail.

2.4.2 Insufficient barriers against serious faults

The AIBN is also of the opinion that the yellow warning light did not constitute a sufficient barrier in relation to the fault in question. The yellow warning light was simply an indication of a fault in the braking system and did not provide any information about the type of fault or what impact it would have on the heavy goods vehicle's driving characteristics.

In the AIBN opinion, the severity of the faults in the eastbound heavy goods vehicle's braking system was not sufficiently indicated on the dashboard, and the colour yellow is too weak an indication of such serious faults. Nor were the warning lights in accordance with the information, actions and colour codes provided for in ISO 2575:2004 (see section 1.13.5).

The NPRA's statistics for the period 2011–2015 show that just over 12% of all heavy goods vehicles on Norwegian roads had defects or remarks related to the ABS on the trailer before they arrived for the annual periodic vehicle inspection. Records from the NPRA's roadside inspections also show that there were a considerable number of ABS faults in the vehicles that were inspected. Regardless of the degree of severity of these defects, the AIBN takes a very serious view of the fact that one in eight Norwegian-registered heavy goods vehicles arrive for the annual periodic vehicle inspection with ABS faults on the trailer.

In Report ROAD No 2013/06 concerning a collision between a passenger car and a semi-trailer at Hjellebøl on 12 October 2012, the AIBN described this type of fault as critical to safety and recommended that consideration be given to introducing other types of barriers over and above the yellow warning light. Examples of such barriers are limitation of speed or reduction in engine power in the case of defective anti-lock brakes. The AIBN is still of the opinion that these are measures that should be considered.

2.5 Inspection of heavy goods vehicles

2.5.1 Follow-up of electronic faults

The eastbound semi-trailer underwent a roadside inspection and was issued a prohibition on use five months before the accident occurred, based on the yellow warning light for brake fault. The yellow warning light was an indication of a fault that needed to be repaired, and the heavy goods vehicle was in this case permitted to drive to the nearest garage. Whether this was done is unknown, as the AIBN has no information as to whether this was followed up.

The NPRA's inspectors have limited possibility of identifying any active serious faults in the technical condition of a vehicle in such cases, as they do not have access to equipment for downloading fault codes.

The AIBN notes that nor do the Roadside Inspection Regulations contain any requirement for having equipment available for testing brakes in accordance with the brake manufacturers' instructions, as is the case, for example, for equipment for testing exhaust emissions from vehicles.

The AIBN observes that the availability of equipment for downloading and identifying active fault codes relating to the braking system would have made it possible for road side inspectors to detect serious faults in the technical condition of vehicles.

In the AIBN's opinion, trailers that skid into the opposite lane and serious head-on collisions like in the present case constitute a serious safety problem. Electronic faults in the braking system continue to be an important causal factor in many accidents. Statistics from both periodic and roadside inspections of vehicles of more than 7,500 kg show that 12% of the inspected vehicles also have electronic faults on the trailer.

This has been focused on in previous investigations and a safety recommendation has previously been submitted concerning the need to follow up inadequate warning signals and loss of ABS/ALB functions. This has resulted in a change of procedure during periodic inspections and a 'listening test' has been reintroduced. The possibility of detecting such faults during inspections is still limited, even though there is much focus on this in the inspection authorities' training of inspectors.

In the AIBN's opinion, there is a need to further improve the follow-up of vehicles with electronic faults in the braking system. This can be seen in conjunction with the increasing number of foreign vehicles that are subject to different inspection regimes, the special driving conditions on Norwegian roads, particularly during winter, and, not least, the higher weights and sizes that are increasingly being permitted for heavy goods vehicles.

Electronic braking and stability systems are intended to perform important safety functions, and any undesired loss of such functions has a direct impact on safety, sometimes without the driver being adequately warned of the actual risk. The situation is not improved by widely varying roadway conditions and, in some cases, extensive use of hired/borrowed trailers.

In the report ROAD 2013/06 (Hjellebøl), a safety recommendation was submitted that had to do with this problem (section 1.17.1). The AIBN is unsure about the effect of that recommendation and, based on the present investigation, which shows that electronic brake faults continue to contribute to serious accidents, a new safety recommendation is therefore submitted on this subject.

2.5.2 Follow-up of foreign vehicles

The NPRA does not have any procedures for after-inspection for the purpose of ascertaining whether the basis for issuing a prohibition on use of a foreign heavy goods vehicle has been remedied, as in the case of Norwegian-registered vehicles. As the prohibition on use that was issued in May was not forwarded to the Swedish authorities,

they were also unable to follow-up the prohibition on use issued in Norway based on Swedish regulations.

In the AIBN's opinion, inspections of foreign vehicles in Norway that result in a prohibition on use could potentially be more effectively communicated to other countries' inspection authorities (in this case Sweden), so that follow-up can be continued after a vehicle has crossed the border.

2.6 Follow-up of safety by the transport company and the client

The AIBN has made numerous unsuccessful attempts to contact the transport company's management or management representatives. Hence, it has been unable to obtain any information about or documentation of the company's safety management. Nonetheless, based on technical findings and available information, the AIBN takes a critical view of Tornado Transport's follow-up of its own vehicle and driver.

In the AIBN's opinion, Tornado Transport should have seen to the repair of such an ABS fault as soon as it became aware of it, and facilitated safe driving to a place where such repairs could be carried out. However, we lack a sufficient basis for explaining or understanding why this was not done, or for making general observations based on this one case.

After the accident, Nortransport, the transport agent for this assignment, has reviewed its general agreement with Tornado Transport and introduced more stringent requirements for ethical standards. The AIBN takes a positive view of the fact that a transport agent wishes to improve its contracts to increase safety.

2.7 Survival aspects – side barriers on semi-trailer

Lateral protection is meant to protect vulnerable road users from getting under a semi-trailer, and it is not designed in accordance with or seen in conjunction with the requirements for underrun protection at the front and rear of light and heavy vehicles. This becomes evident in accidents involving semi-trailers that end up in the opposite lane and collide with oncoming vehicles. Evidence of this was also found in the accident at Hjellebøl on 19 October 2012 (Report ROAD No 2013/06).

In the present incident, the semi-trailer's flatbed went through the wall of the Danish-registered tractor's driver's cab. The investigation showed that it was not until the bumper in front of the Danish lorry's left front wheel hit the axle mountings on the skidding trailer that the vehicles were separated so that further damage inside the driver's cab of the westbound heavy goods vehicle was prevented.

The AIBN is of the opinion that, had the lateral protection also been designed to prevent underrunning, not just by vulnerable road users but also by oncoming vehicles, it could have had a positive effect on safety in connection with this accident and reduced the scope of the injuries inflicted on the driver of the oncoming heavy goods vehicle.

3. CONCLUSION

The accident occurred in a right-hand bend on a wet roadway when the empty semi-trailer of an eastbound heavy goods vehicle skidded because the anti-lock braking system (ABS) was not working. In this case, the semi-trailer hit the front of an oncoming heavy goods vehicle so that the driver was seriously injured.

3.1 Material safety findings

a) In the AIBN's opinion, the yellow warning light is too weak a barrier in relation to the serious faults that were found in the braking system of the eastbound vehicle.

b) The AIBN considers the inspection regime to have certain weaknesses as regards the detection of serious brake fault in roadside inspections and as regards communication of information about prohibition on use to other countries' inspection authorities.

3.2 Investigation results

3.2.1 Factors relating to the technical condition of the vehicles

a) The anti-lock brakes on the semi-trailer did not work because the ABS/EBS had been disabled.

b) Contact and sensor faults were found in the braking system on the semi-trailer, the fuse for the semi-trailer's ABS had been removed from the tractor's fuse box, and there was possibly a fault in the emergency power supply.

c) These serious faults were indicated by a yellow warning light on the dashboard in the tractor. This indication does not differentiate between a minor and a serious fault.

3.2.2 Operational factors

d) The AIBN's overall assessment is that the driver's choice of speed was not sufficiently adjusted to take account of an empty semi-trailer with a defective ABS/EBS as indicated by the yellow warning light.

e) The driver lacked knowledge about what the ABS warning light meant. He therefore asked both the transport company and his colleagues, but nobody explained to him the degree of severity of this type of fault.

3.2.3 Road conditions

f) The road conditions were generally predictable along the section where the accident occurred, even if friction was slightly reduced due to the roadway being wet.

g) The slope creates a need to brake when entering the bend and some of the available friction may be utilised for this purpose.

3.2.4 The transport company

h) The transport company instructed the driver to drive to Sweden for repairs in the company's garage, and no compensatory measures were implemented.

i) The AIBN takes a critical view of the transport company's follow-up of its own vehicle and the driver in its employment.

3.2.5 Inspection of heavy goods vehicles

j) The NPRA's inspectors lack downloading equipment for viewing the applicable braking system structure and identifying active fault codes.

k) Inspections of foreign vehicles in Norway that result in a prohibition on use could potentially be more effectively forwarded to other countries' inspection authorities (in this case Sweden), so that follow-up can be continued after a vehicle has crossed the border.

3.2.6 Survival aspects

l) The lateral protection on the eastbound semi-trailer was not designed to reduce the impact of a collision with the westbound heavy goods vehicle.

4. SAFETY RECOMMENDATIONS

The investigation of this accident has identified several areas in which the AIBN deems it necessary to submit one safety recommendation for the purpose of improving road safety[4].

Safety recommendation ROAD No 2015/08T

The investigation of a head-on collision between two heavy goods vehicles on the E39 road on 22 October 2014 shows that the anti-lock braking system (ABS/EBS) on the eastbound vehicle's empty semi-trailer was disabled, and that there were contact and sensor faults in the braking system. The AIBN is of the view that a yellow warning light on the dashboard is too weak a barrier against such serious faults, and that there are also weaknesses in the inspection regime when it comes to identifying and preventing vehicles with such faults from being driven.

The Accident Investigation Board Norway recommends that the Norwegian Public Roads Administration, in cooperation with the automotive and transport sectors, review and improve the barriers that can prevent electronic faults in the braking system from contributing to accidents.

Accident Investigation Board Norway
Lillestrøm, 15 December 2015

[4] The investigation report is submitted to the Ministry of Transport and Communications, which will take necessary measures to ensure that due consideration is given to the safety recommendations, cf. the Regulations of 30 June 2005 on Public Investigation and Notification of Traffic Accidents etc. Section 14.