aibn Accident Investigation Board Norway

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REPORT Road 2017/02

REPORT ON THE COACH ACCIDENT ON COUNTY ROAD 63 AT VALLDAL IN MØRE OG ROMSDAL COUNTY ON 30 JULY 2016

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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 THE ROAD TRAFFIC ACCIDENT

Date and time:	30 July, 2016, 16:23	
Location of the accident:	Valldal, Norddal municipality	
Road, main section (ms), km.:	County road (CR) 63, MS 10 km 7,975	
Type of accident:	Meeting accident/Run off-road accident	
Vehicle:	Neoplan, 2003 model	BMW X3 Xdrive 20D, 2012 model
Type of transport:	Tourist coach and private personal transport	

NOTIFICATION OF THE TRAFFIC ACCIDENT

The Accident Investigation Board of Norway (AIBN) received a notificaton of the traffic accident from the Police Operational Centre at 17:01 hours on 30 July. The accident inspector on watch initiated a preliminary investigation with the assistance of the Norwegian Public Roads Administration (StatensVegvesen) and the police. Representatives of the AIBN travelled to Valldal on 2-4 October 2016, where they carried out interviews with the rescue services and an inspection of the accident site.

SUMMARY

On Saturday, 30 July 2016, a Ukrainian tourist coach carrying 38 Ukrainian passengers, one tour guide and two drivers was heading westward towards Valldal on the Fv. 63 county road. At the same time, a passenger car was headed in the opposite direction, towards Åndalsnes. Some sections of the road were not marked with a centre line: the general speed limit was 80 km/h.

The passenger car and the coach met just outside Grønning on a straight section of the road. The driver told the AIBN that he observed that the passenger car was veering slightly onto his side of the road, and he therefore chose to edge the coach further out to the right. The driver reduced the speed slightly and considered it possible to pass the passenger car in this situation. He had not realized that there was a change in the width of the road from 5.4 metres to 4.75 metres, and that there was no sign to indicate this either.

The first point of contact between the two vehicles was on the coach's left front wheel and the left rear wheel of the passenger car. The rear wheel suspension on the left side of the passenger car was deformed during the impact, and the coach's steering worm sustained significant damage. The coach continued uncontrolled, veered towards the left-hand side of the road and drove through the crash barrier and onto the verge where it rolled over and came to rest on its roof.

The AIBN's technical examinations showed that the coach was in good technical condition prior to the accident and that the steering worm only broke as a result of the collision with the passenger car. The investigation has also shown that the available road width, which was marginal to start with, was further reduced along a 200-metre road section, without the road users being warned of this. The AIBN is of the opinion that this was a contributory cause of the collision. Furthermore, the AIBN's investigation showed that neither before nor after the road was designated a National Tourist Route, were any risk assessments or safety inspections of this road section carried out.

The AIBN has investigated several run-off-the-road accidents involving buses. In this particular investigation it was found, once again, that several of the passengers were not wearing seat belts. Among other things, a reconstruction demonstrated that the passenger who died would most probably have survived had he been wearing a seat belt. Two other passengers were seriously injured in the accident.

The AIBN has chosen not to submit any safety recommendations on the basis of this investigation, but makes reference to other reports concerning run-off-the-road accidents involving buses and the consequences of not wearing seat belts.

1. FACTUAL INFORMATION

1.1 Sequence of events

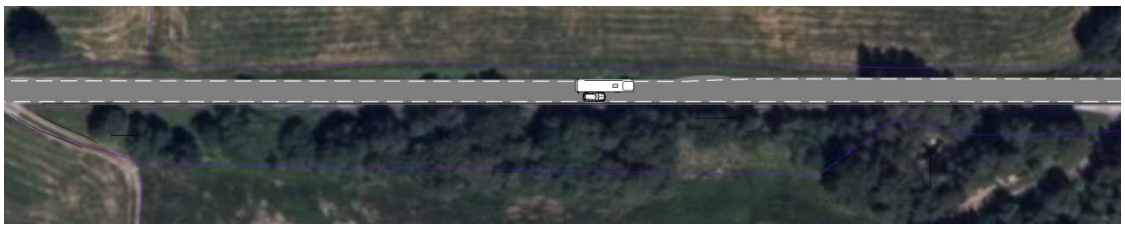
Figure 1: The accident took place close to Grønning between Valldal and Trollstigen. Map: Road map, Norwegian Public Roads Administration

A Ukrainian coach, with 38 Ukrainian passengers, a tour guide and two drivers, was , on Saturday 30 July, 2016 , being driven westwards on county road (Fv.) 63 towards Valldal. A passenger car was, at the same time, being driven eastwards from Valldal towards Åndalsnes.

The passenger car and the coach met on a straight stretch of the road, close to Grønning. The road was marked with white dashed edge lines on this stretch but the width of the road was insufficient for it to have a marked central line. The road was narrowed, on the side to the right of the coach, in connection with access to a farmed area. There were, on the side of the road to the right of the passenger car, a regular edge and a low, metal crash barrier. The actual width of the road at the point of collision was 4.75 metres, following a reduction from 5.4 m approx. 40 metres from the point of collision in the direction from which the coach came (see Chapter 1.6).

The driver has told AIBN that he had not registered the narrowing of the road, of which no particular warning was given. The driver has told AIBN that he observed that the passenger car was a little over in his driving lane. He explained further, that he had placed the coach so far out to the right as possible, so that passing should be possible. Tracks at the site show that half of the right front wheel of the coach was, at a given point in time, outside the edge of the asphalt. The perception of the driver of the passenger car was that the bus approached at high speed, and she, when they were quite close, chose to place the passenger car to the right.

Figure 2: The vehicles driving towards one another: the location of the access road to the farmed area is shown in red. Sketch: AIBN



Figur 3: The location of the collision on the stretch of road. Sketch: AIBN

The speed of both vehicles was reduced just before they should have passed. The coach braked from approx. 64 km/h to 57 km/h[1]. The speed of the passenger car is estimated to have been 10 km/h. The permitted speed on this stretch of road is 80 km/h, which is the general speed limit outside built-up areas.

The first point of contact between the two vehicles was between the nuts on the left-front wheel of the coach and the wheel housing of the left-rear wheel of the passenger car. The left-front wheel of the passenger then hit the left-back wheel of the passenger car. This impact deformed the rear-wheel suspension on the left side of the passenger car. The steering worm (pinion) on the coach was badly damaged, causing oil to run out onto the road surface after the collision, see Figure 12.

The driver has explained that he, at this point in time, lost the possibility to steer the coach. He had the feeling that the coach was sliding, and was unable to steer the coach even when turning the steering wheel. He, due to his experience of the coach as sliding, took his foot off the brake. The coach continued, uncontrolled towards the left side of the road, drove through the low crash barrier, tumbled down the slope and turned over onto its roof before stopping. The roof of the coach was pushed inwards and displaced to the

[1] Registered speed on the tachograph in the coach.

right, and several windows were smashed. When the coach tipped over the crash barrier its speed was reduced after the collisions with the passenger car and the crash barrier.

Figure 4: The final position of the vehicles. Sketch: AIBN

Many of the passengers got out through their own efforts, and those who were caught in the wreckage were liberated by the rescue team.

1.2 Personal injuries

A total of 41 persons were on the coach, 38 passengers, two drivers and a guide. One of the 38 passengers died and two suffered serious injuries. 14 people were sent to a hospital or medical centre with lesser injuries. The driver of the coach did not suffer physical injuries in the accident.

The forensic-medical obduction report concluded that the victim died due to compressive injuries experienced during the accident.

1.3 Survival aspects, rescue work and use of seat belts

1.3.1 Survival space[2]

The height of its roof was reduced in the part of the coach in which the roof was deformed downwards and to the right side of the coach: there was minimal clearance between the top of the seat backs and the depressed roof of the coach. Several of the window frames on the left side were pushed over to the right, into the interior of the coach. There was survival space in all of the seats in the coach.

The passenger car did not incur damage to, or within its passenger compartment which affected its survival space.

1.3.2 Rescue work

The Emergency Medical Communications Center (AMK) in Møre og Romsdal county was alerted at 16:23 hours, and a triple alert was immediately implemented. The police were alerted at 16:24, and the fire brigade at 16:25. The first ambulance arrived at the scene of the accident at 16:37. The fire brigade arrived just after the ambulance and the police arrived at approx. 17:05. In total there were 6 ambulances, 2 air ambulances and one rescue helicopter (Sea King) at the site together with the police and the fire brigade.

Ambulance personnel who were not on watch also came to the accident site to assist in the rescue work. The drivers involved and other travellers also assisted. Triage (prioritisation) was implemented: each of the persons involved was given a notice classifying their degree of injury and need for treatment. This contributed to a better overview of the accident location.

[2] The space which is available in the interior of the vehicle, after deformation or compression of parts of the coachwork during a collision, for the drivers and passengers to survive the accident.

1.3.3 Seat-belt use

The driver and passenger in the passenger car were not physically injured. Both used seat belts.

The coach was equipped with three-point belts in the first row and in the row in front of the back door. The other seats were equipped with two-point belts.

Figure 5 shows where the passengers sat. AIBN has confirmed information on the seat placing of 28 passengers, both drivers and the guide, on the basis of statements taken by the police. The remaining 10 seat placings are probable, on the basis of findings made at these seats during AIBN's reconstruction.

The passenger who died was sitting at a window seat. He was thrown obliquely forward against the back of the seat on the aisle (marked with an arrow in Figure 5), and was caught tightly between the back of the seat and the roof, which was pushed inwards when the bus tumbled down the slope.

Figure 5: Overview of the location of the persons in the coach, the use of seat belts and their degree of injury. The seat of the passenger who died is shown with the letter L and of those who were seriously injured with the letter A. Drawing: MAN, illustration: AIBN

One passenger who was seriously injured did not use a seat belt either. This person was thrown forwards and ended up hanging over the back of a seat by the hips. It is unclear whether the other passenger who was seriously injured used a seat belt. She was caught with her hand outside the window and under a tree root outside the coach, and had to be released by the fire brigade.

Several passengers told the police that the drivers and the guide had, several times on the journey, encouraged them to use the seat belts, stating that this was required in Norway.

1.4 Damage to the vehicles

1.4.1 Damage to the coach

Figure 6: Damage to the coach as a result of the collision and subsequent rolling down over, during which the roof was displaced to the right. Photo: AIBN.

There was serious damage to the coachwork of the coach as a result of it driving off the road and turning over following the collision with the passenger car. Most of the window frames, from the B-frame and backwards, were torn from their fixture to the coachwork at the bottom edge of the windows. The roof was pushed downwards and displaced to the right. All the windows were crushed when the bus tumbled down the slope.

The left side of the coach shows marks in the paintwork resulting from the forward motion of the coach as it tumbled down the slope. There are corresponding marks on the roof which was more deformed inwards in the middle than at the front and rear. Within the coach, seats were loosened and displaced. Internal hatches in the floor had also loosened during the tumble down the slope, as they were not locked.

1.4.2 Damage to the passenger car

Figure 7: The red circle marks the damage to the passenger car resulting from the collision with the bus, including the rubber track caused by the left front wheel of the coach. Photo: Police.

The suspension of the passenger car was damaged: it was ripped loose from the bodywork of the car. The left wing, - rear wheel and rear bumper were also damaged. The left wing showed clear rubber tracks caused by the left front wheel of the coach.

1.5 Other damage

The crash barrier on the road was badly damaged when the coach drove through it and turned over.

1.6 The scene of the accident

Tracks and damage at the site of the accident were documented by the police and the Norwegian Public Roads Administration on the day of the accident (NPRA). In addition, representatives from AIBN examined the stretch of road on which the accident took place on 4th October, 2016.

The accident occurred on a straight stretch of road with clear sight and with an asphalt surface on which the permitted speed was 80 km/h. It was a single–lane road with white dashed edge lines but no marked central line, and the width of the road was less than 5.4 metres. There was, on the passenger car's side of the road, a low metal crash barrier, class N1 (see Figure 10), which is described in more detail in Chapter 1.6.1. There were no physical hindrances along the road to the clear lines of sight of either driver (see the figures below).

Figure 8: South-directed driving lane seen from the position of the coach. The road is 0.7 metres narrower at this place. Photo: Norwegian Public Roads Administration

The standard of the road shows a degree of "wear and tear". The asphalt was partly cracked and the white edge lines were also worn so that it was difficult to see the edge of the road at a distance. There was, on the side of the coach, an access to a farmed area approx. 40 metres before the point of collision. The road, immediately after this access, was approx. 0.70 metres narrower than before the access. This narrowing of the road was not marked or warned of in advance: the width of the road on a stretch of approx. 200 metres before and after the point of collision, varied from 5.4 metres to 4.75 metres (see Figures 8 and 9).

Figure 9: The road becomes narrower after the access to the farmed area. Photo: Norwegian Public Roads Administration.

Figure 10: Northerly-directed lane facing the point of collision, seen from the position of the driver of the private car. Photo: AIBN

The width of the road between the edges of the asphalt was 4.75 metres at the point of collision (see Figure 11). The combined width of the vehicles, without their wing mirrors, was approx. 4.40 metres. This gives a difference of 0.35 metres, which is available to the drivers in the context of their vehicles meeting.

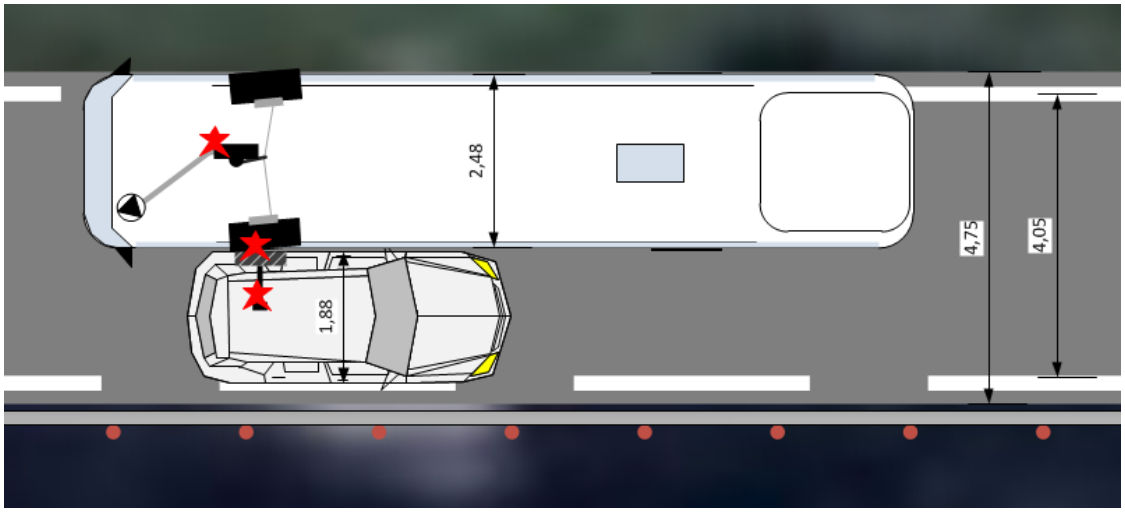


Figure 11: Assumed positions at the moment of collision. The point of contact and the breaks in the steering worm and rear axle are marked in red. The figures are given in metres. Sketch: AIBN

The road had no shoulder beyond the edge of the asphalt. The trench, which extended up to the edge of the asphalt on the coach's side of the road, had, as shown in Figure 12, a significant inclination and was covered in grass. There was, before the access to the farmed area, a shallow ditch beside the road in the direction in which the coach was being driven.

Figure 12: The road viewed forwards from the point of collision in the direction in which the coach was being driven: there is a minimal road shoulder and a steeply sloping ditch. Traces of oil leaks can be clearly seen in the photograph. Source: Norwegian Public Roads Administration

1.6.1 Crash barrier system N1 and N2

The roadside crash barrier which was in place at the site of the accident was dimensioned for passenger cars, strength class N1. The crash barrier along the road in the direction taken by the driver of the passenger car was approx. 210 metres long, and was manufactured in galvanised steel and mounted on wooden posts.

The crash barrier posts which were mounted at the top of the slope were, according to the Norwegian Public Roads Administration (NPRA), without adequate anchoring in the ground beneath. The NPRA has stated that they have, following the accident, mounted a new side crash barrier in strength class N2, which meets the requirements in Handbook N101.

Figure 13:The crash barrier was bent down and the wooden posts loosened from their foundation when the coach rolled over. Photo: Norwegian Public Roads Administration

1.7 The road users

AIBN has carried out interviews of the drivers of the coach and of the passenger car, and have also collected information from the police. The following text is based on this information.

A medical examination was, according to the police, carried out on the driver: this included sampling urine, blood and exhaled breath and investigation of the oral cavity. A blood sample only was taken from the driver of the passenger car. The results were negative for all the samples taken from both drivers.

1.7.1 The coach driver

The coach driver was 49 years old at the time of the accident and came from Ukraine. He had a driving licence in class BCD.

He had worked as a professional driver for approx. 20 years, and was also the owner of the coach.

Information acquired by AIBN confirms that driving- and resting-times were maintained according to the applicable regulations. The passengers in the coach and the drivers have stated that they drove for a maximum of 3.5 hours each, before changing. The driver confirmed this in an interview with AIBN.

The second driver was hired for this tour, and sat in front on the right side of the coach when the accident happened. Several of the passengers have stated that the driving behaviour of both drivers was good, and that they felt safe.

There was, according to the driver, no fixed arrangement for the tour, but a discussion between the passengers, the guide and the drivers as to where they should drive and where they should stop. Hotel reservations had, however, been made at various destinations in Norway.

1.7.2 The driver of the passenger car

The driver of the passenger car was a woman, aged 40 at the time of the accident, and holding a driving permit in class B. She was additionally approved as an emergency driver in the police. She was the owner of the vehicle and was on private business.

1.8 The vehicles and their loads

1.8.1 BMW X3

The passenger car was a 2012 model BMW X3 XDRIVE 20D. The length of the car was 4.65 metres, its width 1.88 metres and it had a weight of 1725 kg. The car was equipped with summer tyres with dimensions 225/60R17 on the front and rear-wheels. All the tyres had a depth of tread exceeding the minimum requirements. The car had been driven a total of 39797 km. The last periodic driving control (PKK) was carried out in January, 2016. Representatives from the NPRA investigated the car at the accident site, but did not find any fault which could have contributed to the accident.

1.8.2 Neoplan

The coach was a 2003 model from Neoplan. Its length was 11.90 metres and the width of the bodywork was 2.45 metres. The wheel bolts add a further approx. 2 cm to the width, on the outside of the main bodywork. The total weight of the coach was 18 000 kg.

The coach had been driven a total of 982 663 km. It was equipped with summer tyres on both the front axle (dimension 245/45-19) and the rear axle (med dimension 275/40-19). The depth of tread was within the minimum requirements.

The coach was registered for 46 passengers in addition to the driver- and guide seats, and was equipped with three-point belts in the first row and in the row in front of the back door. The other seats were equipped with two-point belts. NPRA carried out an investigation of the steering worm before it was dismantled and found it possible to turn the wheel approx. one complete rotation before there was any movement out to the wheels.

Representatives from AIBN carried out an additional more technical investigation of the coach. This did not reveal further faults or deficiencies in addition to the defect steering worm, which was damaged in the collision. A separate investigation of the steering worm was made (see Chapter 1.9).

1.9 Technical investigation of the steering system of the bus

AIBN and the NPRA carried out technical investigations of the steering worm with assistance from the bus importer, MAN Truck & Bus Norge AS. KGK Norge AS, who are, i. a., distributer and workshop for ZF steering worms, also participated in the investigations. AIBN has also been in contact with the steering-worm factory in Germany, Robert Bosch Automotive Steering GmbH. AIBN has had assistance from the Forsvarets laboratorietjeneste (FOLAT) (Armed Forces Laboratory Service) in connection with metallurgical investigations.

1.9.1 Investigation of the steering worm

Investigation of the steering system showed that there was a fracture in the steering worm (worm housing) where the axle from the steering wheel goes into the steering worm.

Forces have, during the collision, been transmitted from the wheel rim, via the steering arms and into the steering house, see Figure 14. This load was transmitted further via the steering worm. Pressure marks were left, i.a. in the worm screw. The forces caused the support point for the inward axle in the steering house to be knocked loose, displacing it by approx. 5 cm, see Figures 15 and 16.

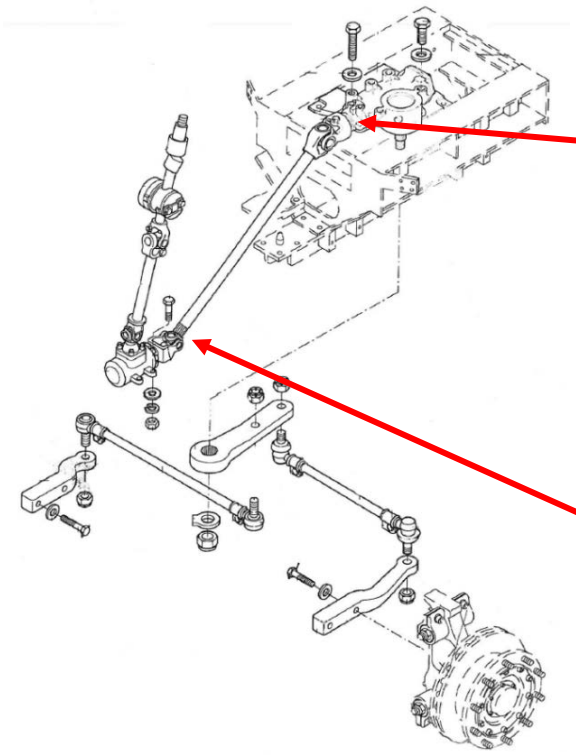


Figure 14: The steering system from the wheel axle, via the steering worm, to the fixture of the wheel rim. Source: Neoplan

Figure 15: The fracture in the steering worm and the oil leak. The outward displacement of the axle in the steering worm was measurable. Photo: Norwegian Public Roads Administration

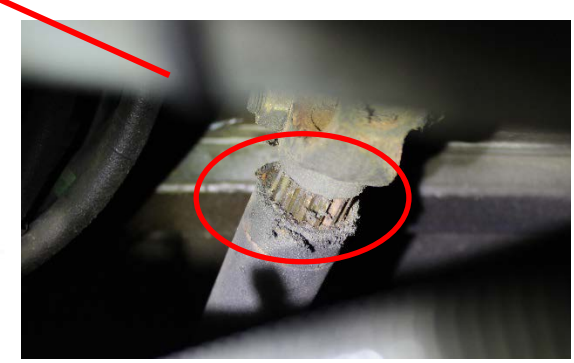


Figure 16: The axle which connects the steering worm to the steering-wheel axle has been bent and pulled a short distance in reverse. Photo: Norwegian Public Roads Administration

The steering worm was dismantled and the internal components checked with assistance from KGK Norge AS. The worm screw, with the recirculating ball, was locked which meant that a greater effort than normal was needed to turn it round. The worm screw and the pressure rotor had load marks which are compatible with the collision forces. There were, in addition, internal marks and a thrust bearing was destroyed as a result of the accident. The other thrust bearing, which was exposed to stresses in the collision was in the area of the break surface (red ring, Figure 17), was not found again at the accident site.

It was not possible to say if the there had been a loosening in the “rotational direction” (free play), due to the missing pressure bearing. The investigation showed that there was some wear, but this has probably not influenced the sequence of events.

Figure 17 shows the combination of the components in the steering worm which were exposed to the forces of the collision and the components (red ring) which were studied further by FOLAT (Armed Forces Laboratory Service) at the request of the AIBN. The

conclusion of FOLAT's metallurgical investigations was that there was an overload breakage.

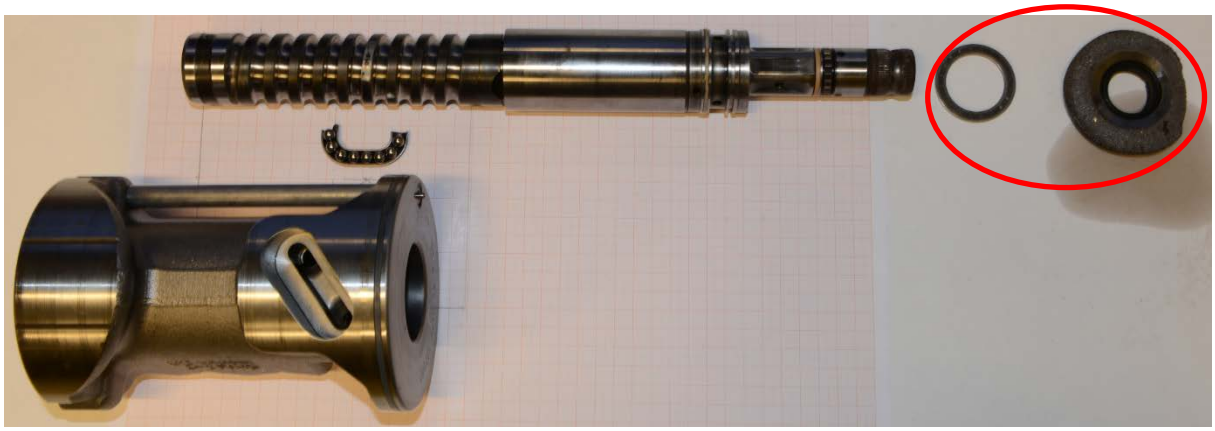


Figure 17: Internal components exposed to the collision forces piston, worm screw, pressure bearing and "break part". Illustration: AIBN

Neither AIBN nor the worm screw manufacturer are familiar with breakages resembling this case, but have informed that some maintenance must be expected after a high number of kilometres driven is reached. This type of steering worm is not now used in new busses, but is still used in the after-sales market. There are currently no legal requirements regarding the tolerance of steering worms, only the producer's internal requirements. The last test carried out by the producer on this type of steering worm showed a tolerance of 4 times the hydraulic torque.

AIBN has not, during the course of the investigations, become aware of any similar breakages in the worm housing.

1.10 Weather and driving conditions

The temperature was 18°C according to the police report, the weather was fine and the road surface dry at the time of the accident.

1.11 Road conditions

1.11.1 General

County road 63 (Fv. 63) connects Åndalsnes municipality in Møre og Romsdal county and Skjåk municipality in Oppland county. Fv. 63 was originally a state road, but was, after the management reform in 2010, converted to country road status, and is now owned by Møre og Romsdal county. The Norwegian Public Roads Administration manages the road on behalf of the county through "collective road administration". Fv. 63 includes the mountain pass roads Trollstigen, Ørnevegen and Geirangervegen and the whole stretch of road has status as a "National tourist road"

Parts of the road are closed in the winter: this applies to Trollstigen and the road from Geiranger to Langvatn in Sjåk municipality.

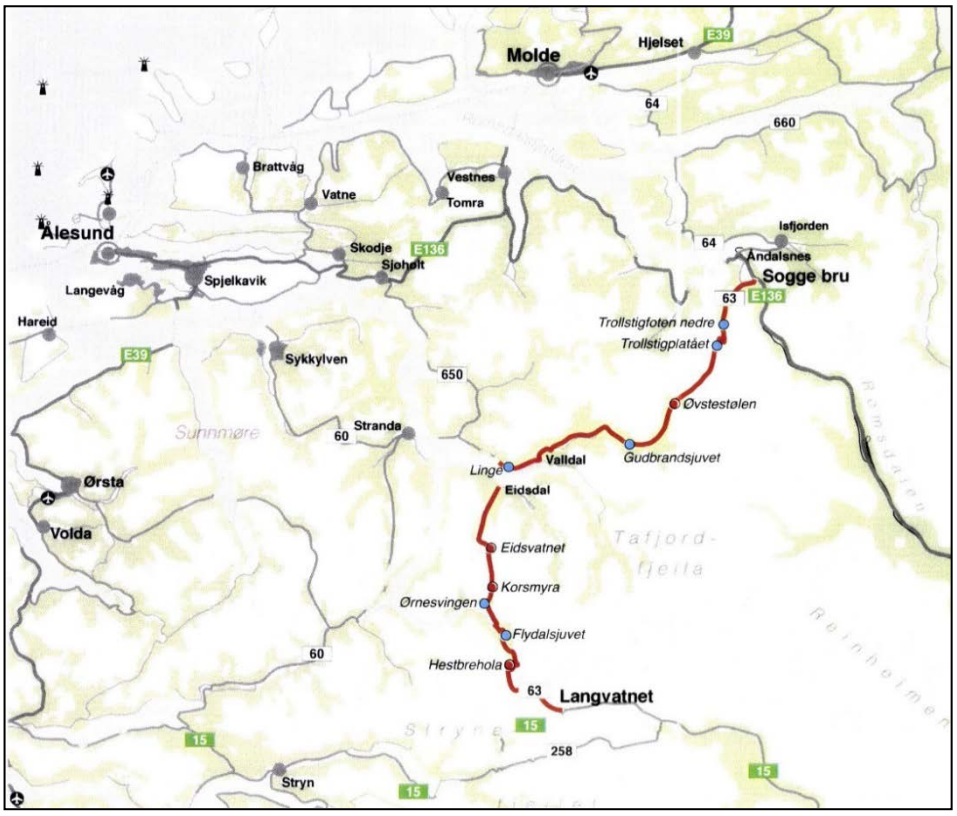


Figure 18: The map shows the route of the National Tourrist Road from Langvatnet to Sogge bridge. Source: Norwegian Public Roads Administration

Statistics acquired by the Norwegian Public Roads Administration show that the annual-day-traffic (ÅDT)[3] on Fv. 63 at the accident location was about 550 vehicles/day in 2016, increasing in the tourist season to approx. 1400 vehicles/day. The traffic on the road is however, very variable in the course of a year, as shown by the graph below which has been compiled on the basis of monthly traffic counts.

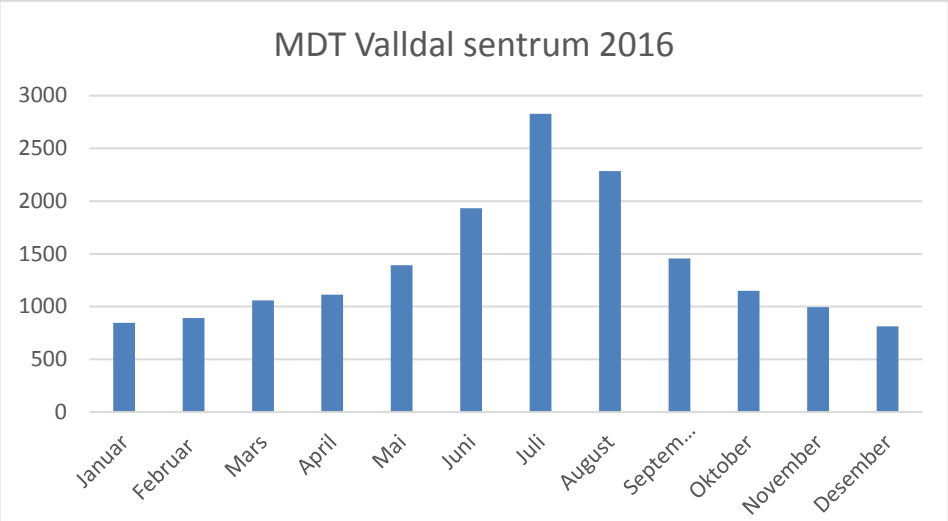


Figure 19. Traffic volume/month for Fv. 63, at Valldal sentrum. MDT = month-day traffic. Source: Norwegian Public Roads Administration/Nortraf

[3] The total number of vehicles which passes this stretch of road within a year, divided by 365.

As shown in Figure 19 there is a marked increase in traffic volume in the summer months, with July as the month with the heaviest traffic, close to triple the background volume.

No police-reported traffic accidents have been registered on the stretch of road on which the accident described here occurred, within the last 10 years. There have not been traffic-security inspections on the stretch of road either in the last 10 years.

1.11.2 The standard and design of the road

Fv. 63 is classified as a primary county road, but has both an important local function and a regional function as a national tourist road. The stretch of road on which the accident took place was insufficiently wide for central marking, and the road, seen in this context has one driving lane with two-way traffic. Fv. 63 has this standard for much of the stretch from Trollstigen to the accident site, a stretch which the bus had driven prior to the accident. From the accident site to Valldal the road, on which the private car had driven, is somewhat broader and includes stretches with central marking.

The road passes through demanding terrain: this is reflected in the course of the road and in the adjacent terrain, with relatively tight curves and steep slopes. The road narrows at several places in connection with bridges and culverts: in most cases these restrictions are warned by danger signs in combination with information on the actual free road width. In other places, as at the accident site, the road narrows without this being warned by a road sign or in any other form.

1.12 Technical registration systems

The tachograph's record disc shows that the bus braked from approx. 64 km/h. to approx. 57 km/h[4] immediately before the collision.

1.13 Laws and regulations

Use, operation, supervision and control of the road sector are mainly regulated in the law of 18th June, 1965 no. 4 on road traffic (the Road Traffic Act) with associated regulations and the law of 21st June, 1963 no. 23 on roads (the Road Act).

1.13.1 Requirements for the driver

The Road Traffic Act and related traffic rules include requirements relating to the driver's responsibility in use of vehicles.

1.13.2 Technical requirements relating to the vehicle

The regulation of 4th October, 1994 no. 918 on technical requirements and approval of vehicles, parts and equipment (the vehicle regulation) defines technical requirements for motor vehicles and tank trailers registered for the first time after 1st January, 1995. There are, in addition to the technical requirements, specific requirements relating to use of the vehicle, both on a general basis and in relation to special conditions and types of transport.

The coach is subject to Ukrainian vehicle regulations.

[4] The margin of error for the registered speed is +\- 6 km\hr.

1.13.3 Laws, regulations, norms and guidelines for building, operation and maintenance of roads

The following regulations, norms and guidelines are relevant in connection with this investigation:

- The Norwegian Public Roads Administration Handbook V721 – Risk assessment in road traffic (previously Handbook 271)

- The Norwegian Public Roads Administration Handbook V133 – Roads and tourism (previously Handbook 2015). Handbook V133 Roads and tourism considers, i. a., the National Tourist Routes.
  Møre og Romsdal county is the owner of the road and has responsibility for all operation, maintenance and improvement of the road metwork. At Tourist Route points (picnic areas and viewing points) the Norwegian Public Roads Administration is the owner of the Tourist Route installations and has responsibility for maintenance, but the road owner has responsibility for operation of toilets, parking areas, green areas, etc. under the terms of management contracts.

1.14 Authorities, organisations and leadership

1.14.1 The Norwegian Public Roads Administration

The Norwegian Public Roads Administration is a management agency within the Ministry of Transport and Communications. The agency is organised in two management levels – the Norwegian Public Roads Administration and five regions. The Public Roads Administration has responsibility for planning, building operation and maintenance of state roads, and for approval of and monitoring of vehicles and traffic. They also prepare rulings and directions for the design of roads, operation and maintenance, road traffic, road-user training and vehicles.

The Norwegian Public Roads Administration (NPRA) has also been given the task of providing collective road administration for the county roads at the regional level, in this case NPRA Central Region, which is led by a Regional Road Manager. The Regional Road Manager reports to the county on matters relating to county roads, but to the Road Directorate (part of NPRA) on matters relating to state roads and other national-level responsibilities, including National Tourist Routes – see the Public Roads Act § 10. The NPRA has responsibility for operation and maintenance of the national tourist route Geiranger – Trollstigen Fv. 63 on behalf of the road owner, Møre og Romsdal county. Veidekke Industri AS is the operational subcontractor.

1.14.2 Møre og Romsdal county

Møre og Romsdal county (MRFK) is the owner of the county road network and has responsibility for the overall planning of communications in Møre og Romsdal. Ownership of part of the road network was transfererd from NPRA to MRFK in connection with the management reform in 2010. MRFK, has also, in addition to responsibility for safety and overall planning, responsibility for prioritising investment and major maintenance projects related to the county road network.

The Infrastructure Section in the Transport Division of Møre og Romsdal county which has responsibility as road owner. A road plan for Fv. 63 Korsmyra-Indreeide was approved in June 2016, but it did not include the part of the road on which the accident took place.

NPRA handbooks form the basis for planning, building, operation and maintenance of the county road network in Møre og Romsdal.

1.15 Measures implemented

The speed limit was reduced from 80 km/h to 50 km/h a short time after the accident, because of repairs to the crash barrier and clearing of the drivers' view at Grønning. This sped limit has now been restored to the general speed limit of 80 km/h. NPRA has, in the course of the summer of 2017, marked the narrowing of the road in the direction of Valldal, with a warning of the hindrance in the form of a sign.

Work on improvement of the road at the site of the accident, including an increase in its width, will be carried out in the course of the autumn of 2017.

2. ANALYSIS

2.1 Introduction

The Accident Investigation Board Norway initiated investigations of the accident on the basis of the sequence of events, together with the seriousness including the death of one of the passengers. In addition to examining the reasons for the collision, it was considered that there was a learning potential in investigating the factors which led to the coach driving off the road, and in the connection between the outcome of the accident and the presumed low energy in the collision.

The analysis is introduced with an assessment of the sequence of events. This is based on tracks and documentation at the location of the accident, as well as the design and condition of the road. The driving behaviour and comprehension of the situation of both drivers will be analysed, including the interaction between them in the context of their approach, one to the other. The importance of the oil leak from the steering worm, which led to the coach losing steerability will be assessed.

The road conditions at both the site of the accident and a nearby stretch of road will, in addition, be assessed. Follow-up of the safety on the road by Møre og Romsdal county and by the NPRA is described.

The Accident Investigation Board Norway has previously investigated several bus accidents in which neglect o fuse of seat belts has influenced the level of injuries, and this will also be mentioned briefly in the report.

2.2 Analysis of the sequence of events

The investigation has proved that the collision between the vehicles occurred at a point which was significantly narrower than the adjacent stretch in the driving direction of the bus. There was very little clearance for meeting vehicles where the collision occurred, only approx. 0.35 metres, if the vehicles kept within the asphalt.

The first points of contact between the vehicles were the front wheel of the coach and the rear wing of the passenger car. This shows that they avoided a frontal collision by a margin of a few centimetres. It also shows that there was a minimal overlap in the collision (see Figure 11) and that the vehicles did not have an exactly direction, but were at an angle, one to the other. A closer examination of the drivers' behaviour in this situation is given in the following chapter.

AIBN's assessment is that the break in the steering worm could not have been foreseen, and that the driver had no possibility to hinder driving off the road in this situation. The investigation has not permitted definite clarification of how the speed developed after the collision, but the tracks left on the coachwork of the bus suggest that its speed was very low when it left the road.

The potential for injury of the persons in the coach was large, because the coach turned over and lay then on its roof. One passenger died as a result of compressive injuries and two were seriously injured. An assessment of this will be made later in the analysis.

2.3 The drivers' driving behaviour and comprehension of the situation

2.3.1 The coach driver

The driver, who was also the owner of the coach, had not driven on this stretch of road before. He had, on the stretch from Trollstigen to the accident site, met several small and large vehicles without problems. When he came round the last curve before the accident site he saw the private vehicle at the end of the flat area, and did not envisage it to be problematic to meet it.

The driver adjusted his course out to the right, but observed at the same time that the passenger car was a little over on his side of the road. The driver expected, at this point that the driver of the passenger car would move the vehicle further out so that they could pass each other. Further, he has explained that he did not see the narrowing further along the road. AIBN considers this to be understandable as the narrowing was not marked and was not easily visible from the driver's position (see Figure 8).

The driver, when the vehicles passed each other, heard a thud in the coach and sensed that it had begun to slide to the left. The second driver, who sat on his right side, shouted that he should turn the wheel to the right. The driver has described to AIBN that he, when he felt that the coach was sliding, chose to release the brake in order to gain control of the bus. This, as assessed by AIBN, is a sensible action in a situation in which the wheels loose traction on the road. It could not be expected that the driver, even one with long experience, could understand that the steering work had been destroyed in the collision.

AIBN, even though the driver did not have information on the narrowing of the road, considered that the driver misjudged the situation and maintained too high a speed in relation to the small safety margins given by the road. The driver himself believed that the speed chosen could be defended in that it was below the permitted speed limit.

2.3.2 The driver of the passenger car

The driver of the passenger car observed the coach and considered that it maintained a speed that was a little too high. She reacted to the fact that the bus, when the vehicles approached each other, did not reduce its speed, and she chose therefore to reduce the speed of her vehicle considerably, and to adjust its course to the right. When the vehicles approached each other she felt that her car had almost stopped. She thereafter noticed a thud in the car and saw, in her wing mirror, that the coach veered to the left.

AIBN, based on her explanation and final position, considered that she could have driven closer to the crash barrier, which could have contributed to the collision being avoided .

2.4 The road users' interaction in the meeting situation

AIBN considers that the design of the road and the road users' understanding of the situation contributed to the collision. The driver of the passenger car had driven the stretch of road once previously, but the coach driver was not familiar with the area and drove on this road for the first time.

The drivers had differing understanding of the situation and differing expectations as to each others' actions as they met. The driver of the passenger car reduced its speed dramatically, such that the car stood almost still when the vehicles passed each other, but the coach driver did not perceive the situation as differing from meeting other vehicles previously on the stretch of road and maintained the speed of the bus as the vehicles approached one another.

The road rapidly became much narrower in the direction in which the coach was driving without adequate warning: this narrowing was not easy to observe. This specific situation is considered to be demanding for all, especially for road users who are not familiar with the situation, as was the case in this context. Reference can, however, be made to AIBN's assessment of the coach driver's chosen speed (see Chapter 2.3.1).

2.5 Use of seat belts and the scope of injuries

AIBN has investigated several coach accidents within the last decade and has pointed to a clear link between neglected or incorrect use of seat belts and the scope of injuries (see the references to the reports in Appendix A). Both drivers and the tour guide had, in the context of this accident, encouraged the use of seat belts. Nevertheless there were ten passengers who did not use seat belts, including the passenger who died.

It is highly probable that the passenger who died would have survived if a seat belt had been used, because it would not have been possible to reach the position in which the passenger died with correct use of a seat belt. One of the passengers who was seriously injured was also thrown forwards, over the back of the seat in front. She, according to AIBN, would not have suffered such serious injuries if she had used a seat belt.

AIBN considers that it is still important to maintain focus on use of seat belts in coaches. This is one of the few, simple steps a passenger can take to secure themselves and others. Use of a seat belt can be decisive in surviving off-road and overturning accidents in coaches.

2.6 The steering worm on the coach – contributory reason for the coach driving off the road

The technical investigation of the steering worm led to the conclusion that the break occurred during the collision, and AIBN considers that the driver had, thereafter, limited possibilities for controlling the direction of the wheels.

AIBN has, via the factory in Germany, been informed that this type of steering worm is used only in the after-sales market. They do not know of similar breakages, nor have AIBN discovered more cases of this type of fault in the course of the investigation. AIBN has, on the basis of these findings and a total assessment, chosen not to investigate further aspects related to the break in the steering worm.

2.7 Monitoring of safety on national tourist roads

Fv. 63 is classified as a primary county road, and has an important local function in addition to a regional function as a national tourist road. This is particularly the case in the summer half-year. Traffic counts from Valldal show that the volume of traffic is modest for much of the year and almost triples in the summer months. It would be reasonable to assume that there is a corresponding growth in heavy vehicle traffic.

The road passes through a demanding landscape, and this is reflected in the design and standard of the road and in the adjacent terrain. For much of this stretch of road, especially between Valldal and Trollstigen, there is insufficient road width for central marking. This places great demands on the drivers of heavy vehicles in relation to adaption of speed and placing of the vehicle on the road, especially when meeting other traffic.

AIBN believes that the narrowing of the road at the site of the accident was a contributory factor in causing the accident. The narrowing was neither warned nor marked in a way visible to the road users and it was, in AIBN's opinion, difficult to identify.

No form of risk analysis or traffic safety inspection had been carried out on this stretch of road prior to the accident. Viewed in the light of the road's status as a national tourist road, the increase in traffic in the summer half-year and the number of road-users who are not familiar with the road, it is AIBN's view that a critical assessment of the stretch of road should have been initiated by the owner in connection with the road's definition as a national tourist road.

There is every reason to anticipate that tourist traffic along the national tourist roads will increase further. Increased focus on landmarks and development and upgrading of picnic areas will contribute to this. AIBN believes that it is important, in this context, to carry out an assessment of the road's traffic security standard using risk assessment and traffic-safety inspections, with special focus on the challenges implicit in tourist traffic.

The speed limit was reduced to 50 km/h a short time after the accident, with signs were set up, due to repair work on the crash barrier. The general speed limit was reintroduced after the repairs were completed. AIBN is critical to the removal of the reduced speed limit without any other form of adjustment. AIBN is, however, positive to the fact that a sign is now being set up to show the narrowing clearly for road users.

Following the accident the lines of sight have been cleared and plans are being made for improvement of the road at the site of the accident. Plans have also been made for road improvement, with a larger crash barrier area, in the direction of Trollstigen, improvements which will be implemented in the course of the autumn of 2017. AIBN considers these measures to be appropriate and that they will raise the safety level on this stretch of road.

3. CONCLUSION

AIBN distinguishes between operative and technical factors which are events and interactions in the sequence of events which individually or in combination contributed to the accident, underlying factors which explain why the operative and technical factors were present or arose in the sequence of events, and other results from the investigation which are considered to be important safety-related information or findings (but which are not considered to have contributed to this accident).

3.1 The sequence of events and survival aspects

a) The driver placed the coach as far to the right as possible so that passing should be possible, but with only a small reduction in its speed.

b) The collision occurred approx. 40 metres after the road became narrower in the driving direction of the coach: the driver was not aware of this narrowing.

c) The driver of the passenger car was not aware of the fact that the coach approached at high speed, and that the speed was not being reduced. She chose to place her vehicle out to the right as the vehicles approached one another

d) The first point of contact between the two vehicles was between the nuts on the left front wheel of the bus and the housing of the left rear wheel of the passenger car.

e) The collision deformed the rear-wheel suspension on the left side of the passenger car, and led to considerable damage of the steering worm on the coach.

f) The driver lost the possibility to steer the coach, and the coach continued uncontrolled towards the left side of the road, drove through the crash barrier and out into the adjacent terrain where it turned over and came to a rest on its roof.

g) There was space for survival at all the seat places, and it is probable that the person who died would have survived if a seat belt had been used.

h) The drivers and the guide had, several times on the journey, encouraged the passengers to use the seat belts, stating that this was required in Norway.

3.2 Underlying factors

a) The accident took place on a straight, clearly visible stretch of road with an asphalt surface and the generally permitted speed of 80 km/h.

b) There was, on the side of the road occupied by the coach, a narrowing of the road immediately after an access to a farmed area, and approx. 40 metres before the point of collision.

c) The narrowing of the road was not marked by a sign, nor by any easily visible deviation in the road markings.

d) The road has a variable traffic volume through the year, but with a marked increase in traffic volume in the summer months, with July as the month with most traffic, close to triple the background volume.

e) There had been no traffic safety inspections on the stretch of road in the previous 10 years.

f) Investigation of the steering system showed that there had been a break in the steering worm (worm house) where the axle from the wheel goes into the steering worm.

3.3 Other results from the investigation

a) The crash barrier posts mounted at the top of the slope, did not have adequate anchorage.

4. SAFETY RECOMMENDATIONS

The investigation of this road traffic accident has documented lessons to be learned for several of those involved (the authorities, the drivers and the passengers). AIBN believes that safety on national tourist roads should be given particular attention, because the traffic volume increases considerably on road stretches which are not dimensioned for increased numbers of large vehicles such as, e.g. tourist coaches.

AIBN has chosen not to propose safety recommendations, but refers to the results of the investigation and wishes to point out that all those involved can take up the lessons to be learned in this investigation as a contribution to better traffic safety.

Accident Investigation Board Norway

Lillestrøm, 12 July, 2017

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Appendix A: Overview of the AIBN's investigations of seat-belt use and the extent of injuries in buses

The AIBN has, in the period 2005 – 2015, investigated several bus accidents in which lack of use or misuse of seat belts has been a contributory reason for the extent of injuries.

Report Vei 2015/03 (AIBN 2015) describes the most serious off-road driving accident investigated by SHT. Four passengers died and 11 had lesser injuries. The bus was equipped with two-point seat belts. The driver and the 12 passengers who survived used their seat belts. Only one of the four passengers who died used their seat belt.

Report Vei 2015/01 (AIBN 2015) describes a meeting accident in which the driver and two passengers died when the bus collided with a semi-trailer on a very icy road. There was no survival space for those who died. Two passengers were seriously injured: only one of them used a seat belt. The three who had lighter injuries did not use their seat belts.

Report Vei 2014/03 (AIBN 2014) describes a collision between two buses in which 2 passengers died, 2 were seriously injured and 4 including one of the drivers had lighter injuries. Only 4 of 23 passengers in the one bus used their seat belts. 4 of 7 passengers in the other bus, in addition to the driver, used their seat belts.

Report Vei 2014/05 (AIBN 2014) describes an off-road driving accident in which the driver and five passengers were thrown out of the bus because they had not used their seat belts. Neither the driver nor the passenger who were killed had used their seat belts. The passenger who was seriously injured had not either used a seat belt.

Report Vei 2014/01 (AIBN 2014) describes an off-road driving accident involving a bus with 20 passengers and a driver, in which only 5 passengers used their seat belts. One passenger was seriously injured. Several of the passengers incurred lighter injuries as a result of not using their seat belts.

Report Vei 2013/03 (AIBN 2013) documented that only 5 of 26 passengers used their seat belts. The bus had been delivered with shorter seat belts than normal, so that many of the passengers, could not, for practical reasons, use them. Two of those who did not use seat belts were thrown out of the bus and died as a result. Many of those who had lighter injuries had not used seat belts either.

Report Vei 2012/02 (AIBN 2012) documented that neither the driver nor the 42 passengers, all of them minors, in the bus involved used their seat belts. The driver and one passenger were thrown out of the bus. 29 passengers suffered light injuries

Report Vei 2010/01 (AIBN 2010) describes an off-road driving accident and following turning over of a bus. The driver and 44 passengers were on board the bus. The bus was equipped with seat belts in 6 of the 46 seats in the bus, but only the driver used a seat belt. It was registered at the accident site that 3 of the passengers had died, 2 were seriously injured and 23 had lighter injures. AIBN believes that lack of the availability of – and use of seat belts increased the scope of injuries in relation to the number injured in this accident.

Report Vei 2009/01 (AIBN 2009) describes an off-road driving accident with a bus from Unibuss Ekspress AS in which 16 of 53 passengers informed the AIBN that they had used the seat belts in the bus. 4 persons were seriously injured and several had lighter injuries. None of those who were seriously injured had used their seat belts, and some of those who had used their seat belts incurred lighter injuries because other passengers had been thrown over them.