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REPORT ON LEVEL CROSSINGS

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

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

Photos: AIBN and Ruter As

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SUMMARY

This report on level crossings discusses problems related to the design, safety and maintenance of level crossings. The report is based on reviews of all Synergi reports on serious incidents in the years 2005 and 2006. Based on the review, AIBN has conducted inspections of the relevant level crossings in order to gain a better understanding of the problems. Challenges that experience has shown to be relevant to level crossings but which are not explicitly mentioned in the Synergi reports are discussed in a separate chapter. The work forms the basis for safety recommendations addressed to both the Norwegian National Rail Administration and the Norwegian Public Roads Administration. The purpose of these recommendations is to improve the safety at level crossings on the Norwegian rail network.

1. INTRODUCTION

1.1 Background and purpose

The purpose of this report is to shed light on the issue of incidents and near-misses involving level crossings (LCs). The Accident Investigation Board Norway (AIBN) has prepared this report in order to be able to make safety recommendations on a general basis. The report is the result of cooperation between the board's railway and public roads departments. The object of the report and safety recommendations is to improve railway and road safety.

The consequences of an accident at a level crossing are potentially very serious for the passengers, the train and other road users. There have been several major accidents in the UK and elsewhere in Europe with major consequences[1][2][3]. Compared with other countries, Norway has had few accidents, but the potential of such accidents is so great that it was decided to initiate a general investigation of the issue that would also include near-misses.

Figure 1: Serious accident on a level crossing in France on 2 June 2008 that resulted in many fatalities.

1.2 About this report

This report is based on reports in the Norwegian National Rail Administration's (JBV) Synergi database. This is where Norwegian National Rail Administration, train operators, and others register actual incidents and near-misses involving level crossings. The Accident Investigation Board Norway (AIBN) held several work meetings during which Synergi reports from 2005 and 2006 were systemised according to cause and location in order to form an overall picture of the situation. This provided an overview of hazardous level crossings and the types of causes that most frequently form the basis for incidents. In order to get a more nuanced impression of the level crossings than that which emerges from the statistics, a selection of level crossings were inspected and local people were interviewed.

[1] Accident Investigation Board Finland, 'Safety study on Level Crossing Accidents - A shortened version', 2008.
[2] Accident Investigation Board Denmark, Civil Aviation and Railway
[3] Accident Investigation Board Sweden

Based on experience, level crossings are associated with certain general problems that do not emerge from the Synergi reports, and a separate chapter has therefore been devoted to these problems.

Scandpower AS has contributed with expertise in the field of man-technology-organisation (MTO), prepared statistics on the basis of Synergi reports and contributed to drawing up the report.

Overview of the contents of the report: This chapter provides a brief introduction and describes the object and limitations of the report, while chapter 2 contains factual information about the level crossings. Section 2.1 provides a general overview of the level crossings. Section 2.2 contains statistics from the reviews of all the Synergi reports relating to level crossings in 2005 and 2006 and on-site inspections of a selection of these crossings. Section 2.3 describes some general problems that are not explicitly mentioned in the Synergi reports. Chapter 3 contains an analysis of the above-mentioned problems. Chapter 4 draws a conclusion and chapter 5 presents safety recommendations put forward on the basis of this work.

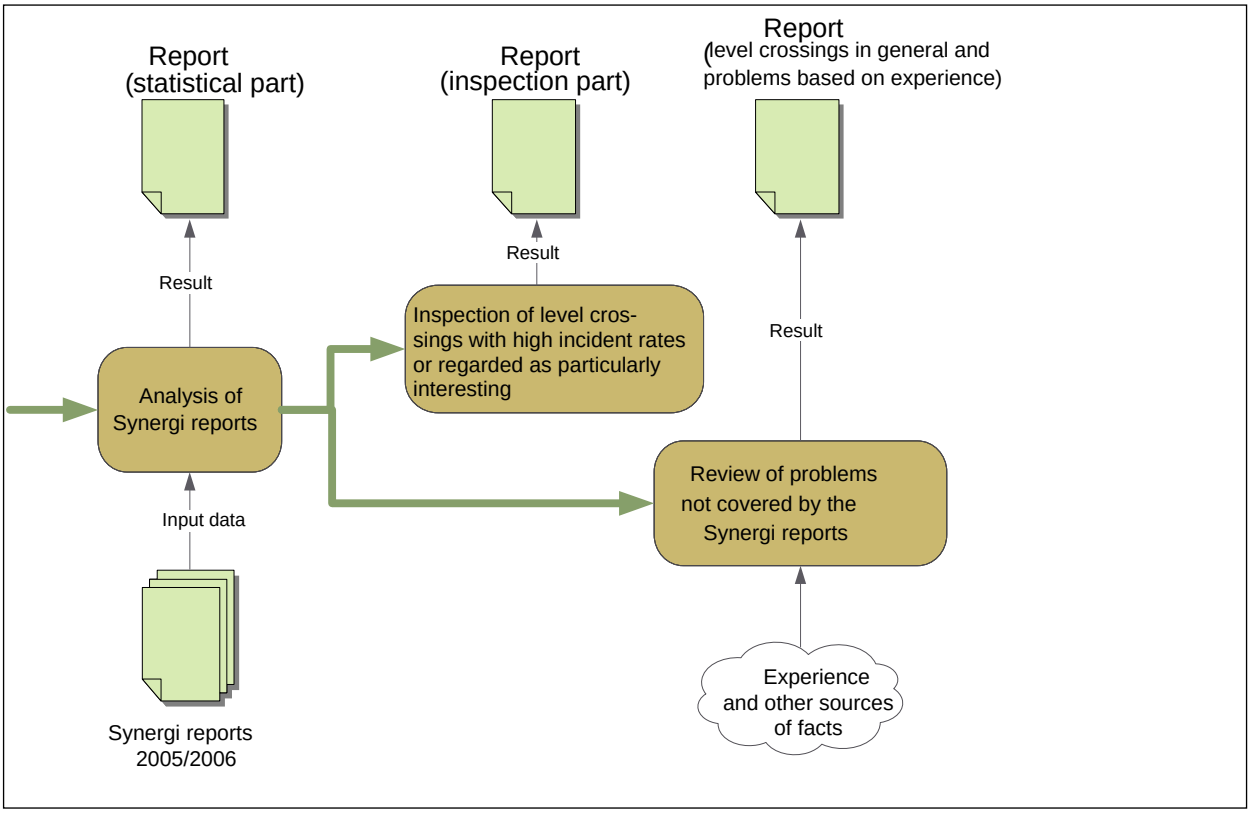

Figure 2: Work process for this report.

1.3 Limitations

This report is based on Synergi reports relating to level crossings made by railway operators, JBV itself or others in 2005 and 2006. These reports often provide a brief and not very detailed description of the incident or near-miss, and do not describe the underlying conditions that may have led to the incidents. It is therefore emphasised that one or more incidents may have been incorrectly classified as a result. However, such incorrect classification is of no consequence to the *number* of incidents, which was decisive when preparing statistics and overviews. Furthermore, for the results to be affected, incidents at one and the same level crossing would have to be repeatedly misclassified, which is considered unlikely.

Furthermore, all near-misses have probably not been reported. In order for this to affect the statistics, several near-misses at one and the same level crossing would need to have gone unreported. If the lack of reporting is evenly distributed between the level crossings, the statistics will remain unaffected since they present crossings with the greatest number of incidents, regardless of the number of crossings.

Not all, but only a selection of the level crossings with high statistics were inspected in connection with this report. Some of the level crossings have been inspected before and experience from such inspections have been utilised where expedient.

2. FACTUAL INFORMATION

2.1 About level crossings

2.1.1 General information about level crossings

According to the Norwegian National Rail Administration (JBV)[4], there are approx. 3,900 level crossings in the Norwegian railway network, of which approx. 3,500 are located on private roads. In 2005 and 2006, approximately 640[5] incidents and near-misses (accidents and potentially serious near-accidents) involving level crossings were registered in the Synergi reporting system used by JBV and the Norwegian State Railways (NSB), among others. Operator reports involving level crossings are sent to JBV in order to collect them all in one place. A collision between a vehicle and a train can have serious consequences, both for the people in the vehicle and for the people on board the train. In the worst case, a collision between a heavy vehicle and a train on a level crossing can cause the train to derail.

Figure 3: A car wreck following a collision with a train in Sweden.

2.1.2 Overview of level crossing incidents in Norway in 2005 and 2006

Of the approx. 640 incidents (and near-misses), Figure 4 below shows the ten level crossings (abbreviated 'LC') that were most frequently registered in Synergi in 2005 and 2006. This includes both near-misses and actual incidents; the number of near-misses being much higher than the number of actual incidents (approx. 85% are near-misses). 'Incidents' include both injuries and material damage. The relationship between near-misses and actual incidents at the most exposed level crossings is shown later in this report.

[4] www.jbv.no

[5] This is an approximate figure since it does not include incidents at pedestrian crossings at stations. There are also instances of incorrect and double registration of reports, and there are different ways in which to search in Synergi.

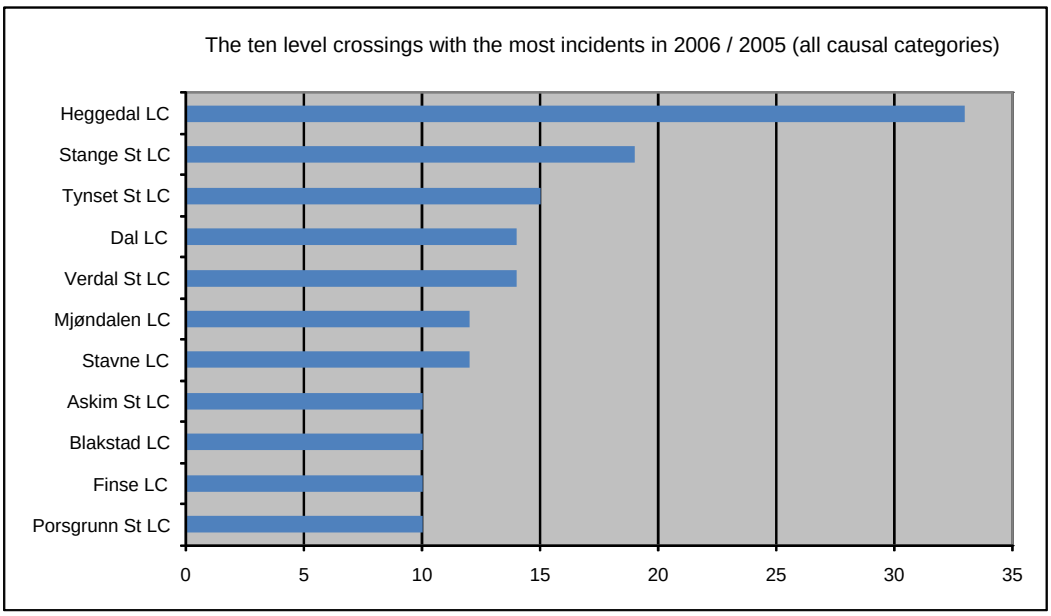

Figure 4: The ten level crossings with the most incidents (2005/2006 figures).

Of the ten level crossings with the most incidents, five have full barriers, four have half barriers and one has a warning light system (LS) (Table 1).

Table 1: Type of systems at the top ten level crossings

Number of cases		
Location/track/system (project)	System type	Total
Heggedal LC	full barrier	33
Stange St LC	half barrier	19
Tynset St LC	full barrier	15
Dal LC	full barrier	14
Verdal St LC	full barrier	14
Mjøndalen LC	half barrier	12
Stavne LC	half barrier	12
Askim St LC.	full barrier	10
Blakstad LC	half barrier	10
Finse LC	LS	10
Porsgrunn St LC	full barrier	10

2.1.3 Safety of level crossings barriers

There are various barriers that can be used to secure level crossings, including full barriers or half barriers, sound or light signals, or simply gates. Figure 5 below contains an illustration of different barriers that can be utilised to prevent collisions between trains and vehicles.

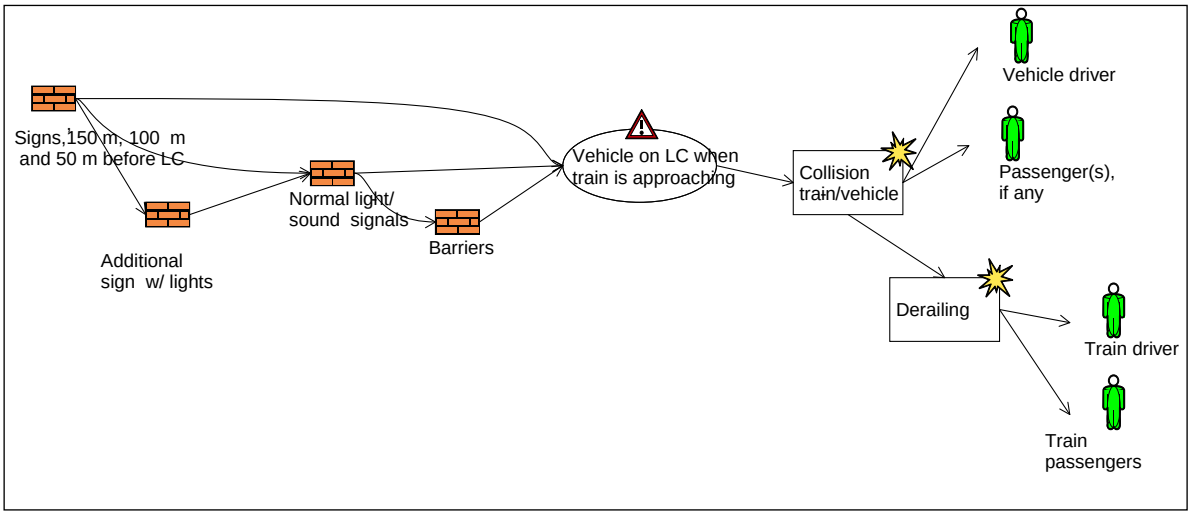

Figure 5: Flowchart showing barriers at level crossings that can contribute to preventing hazardous situations and undesirable incidents involving personal injury.

The following section provides an overview of different types of safety measures, based on information from the Norwegian National Rail Administration.

2.1.3.1 *Full barriers*

Level crossings with full barrier systems are used in particular where roads with heavy traffic cross the railway track. Full barriers cover the entire width of the road. All barrier and light systems include signals for the train indicating whether the barrier system is in proper working order or not. If the barrier system is not in working order, the train must stop, if possible, before reaching the level crossing and then pass the crossing slowly, at maximum 10 km per hour. Just before the barriers are lowered, red lights start flashing to signal to road traffic that they are being lowered. Level crossings are required to have full barrier systems on track sections where train speeds of more than 130 km/h are permitted. Barriers on these sections must block the entire road on both sides of the track. For double tracks and in places where trains can pass at speeds of more than 160 km per hour, the Norwegian National Rail Administration requires crossings to be on a different level from the track, i.e. that level crossings be replaced with an underpass or bridge.

Figure 6: Example of a full barrier and well-marked road safety system (Spydeberg).

2.1.3.2 *Half barriers*

Half barriers are used on most public roads. The time from the red lights start flashing until the barrier is lowered is relatively short, since the white signal light for the train is lit when the barrier has been lowered two degrees from its upright position. Half barriers block the approach lane so that motorists can leave the crossing unobstructed if they have driven onto the level crossing against a red light.

Figure 7: A half barrier.

2.1.3.3 *Sound and light signals*

Some level crossings have sound and light signals to indicate that a train is approaching. The same rules apply to these crossings as to barrier crossings. A red flashing light means that a train is approaching and that it is hazardous and prohibited to cross the track. The number of such systems has been reduced in recent years since half barriers have been added for better safety.

Figure 8: Example of sound and light signal (Embretsfoss LC before a full barrier system was installed).

2.1.3.4 *Gates*

Most private level crossings are equipped with gates only. These crossings require great caution on the part of road users wishing to cross the track. Although such level crossings are usually found in places where the track is seldom crossed by more than a small

number of road users, they nevertheless make up the vast majority of level crossings. In recent years, several hundred such level crossings have been replaced with underpasses or overpasses. This is usually done by eliminating several such old level crossings and leading the traffic to an underpass or bridge. JD 532 Maintenance, Superstructures, contains the following rules for the use of gates:

'Level crossings are normally fitted out with gates. Previously, the main purpose of the gates was to prevent livestock from entering the track.

a) Those who have right of use are obliged to keep the gate closed and locked, and everyone who uses the level crossing has a duty to shut the gate behind them (the Railways Act section 9).

If the gate no longer serves a purpose (e.g. there is no longer grazing livestock in the area), the gate can be removed by agreement with the person who has right of use. When it becomes relevant to remove the gate, it must be assessed whether the gate has a safety function with respect to the following:

The gate prevents children from entering the track

The gate can limit vehicle traffic, e.g. by being locked

The gate marks the level crossing and ensures that traffic stops before crossing.

b) When the gate is removed, the need to implement other measures must be assessed, e.g. the posting of road signs.'

Figure 9: Example of gates (the eastern track on the Østfold line).

Figure 10: Example of gates and signs (a private level crossing on the Rauma line).

Unless otherwise agreed, it is the Norwegian National Rail Administration's responsibility to maintain level crossings and barriers and to ensure that they are in good working order at all times. With respect to private level crossings, persons with right of use are responsible for both safety and traffic at the level crossing. The warning lights at private level crossings serve as a warning to users only, and must not be compared with light signals at crossings. Some private level crossings have warning lights with a single white light that lights up when a train is approaching. This warning light does not depend on the direction of approach. At public level crossings, road users will see flashing red lights when a train is expected.

2.1.4 Regulations and responsibility

Road and rail traffic are regulated by different rules. The safety of road traffic approaching the track depends on signposts and the layout of the road leading up to the level crossing. Level crossings are crossing points requiring interaction between road and railway, and the respective rules that apply to road and rail traffic must therefore be harmonised in order to provide good safety.

2.1.4.1 *Laws regulating the road sector*

The Norwegian Road Act is the basis for the pertaining Regulations relating to the construction of public roads, and the latter is supplemented by the Norwegian Public Roads Administration's (NPRA) Road and Street Design Manual (Manual 017) which relates to road design and construction.

Manual 0917 contains practical guidelines intended to ensure the safety of new systems. Chapter A provides system guidelines and gives priority to requirements for safety and follow-up of the zero harm vision in connection with the planning and design of new systems. The manual is further divided into chapter B 'Streets' and chapter C 'Roads', which describe the standards for the design of streets and roads, respectively, on the basis of the guidelines outlined in chapter A. In addition, chapter D describes how the manual's requirements should be used in connection with the improvement of existing roads.

There is no specific mention of the design of rail/road intersections or level crossings anywhere in the manual.

The Road Traffic Act is the basis for the general regulations that regulate road use and road traffic behaviour. The Regulations relating to public signs and signals are important in connection with the regulation of traffic at level crossings, and the Regulations relating to vehicular and pedestrian traffic (the Traffic Rules) also regulate the behaviour of and set out requirements that apply to road users.

Through a joint working group in 2003, the NPRA and JBV have also drawn up proposals for joint guidelines for signage of level crossings. However, the report that contains these proposals has no formal status.

Regulations and guidelines pertaining to the Road Traffic Act contain some requirements that apply specifically to road users.

The Regulations relating to vehicular and pedestrian traffic (the Traffic Rules) section 10 'Right of way' second paragraph states:

'Road users shall make way for trams and trains, and stop if necessary. Before traversing a level crossing, a road user shall make sure that there is no train or tram approaching.

This applies even if the crossing is specially safeguarded. Drivers shall maintain a speed that allows them to stop, if necessary, at a safe distance from the crossing.'

The Signage Standard (Manual 050)[6] contains technical provisions and guidelines for the use and location of public signs and prescribes requirements and recommendations quite clearly. The Manual is provisional and the latest version is from 2007. The following is stated in the introduction:

'The Signage Standard contains technical provisions and guidelines for the use and design of public road signs. The Signage Standard is adopted by the Directorate of Public Roads on the basis of the Regulations relating to public signs and signals, and is published as Manual 050 in the Norwegian Public Roads Administration's series of manuals. The provisions of the Signage Standard apply to all use of public traffic signs, regardless of road type. All signage authorities must comply with these provisions, including municipalities and the police.

The table below describes the difference between requirements and recommendations and lists bodies that have the authority to deviate from them. The consequences must be assessed before the competent authority grants exemption from the requirements.'

Table 2 - Overview of authority to grant exemption from the Regulations relating to signs and signals

Verb	Meaning	Deviation
Shall (or wording to that effect)	Requirement	Only the Public Roads Administration may grant exemptions from requirements. Applications must be sent to the NPRA, and the NPRA must provide grounds for its decision. No exemption will be granted from the following requirements/conditions Provisions that follow directly from acts and regulations Conditions of such a nature that they are obviously not a subject for discussion.
Should (or wording to that effect)	Recommen-dation	The regional Director of Public Roads or a person authorised by him/her may grant exemption. This also applies where exemption is requested by the police or the municipality. Grounds must be stated for granting the exemption, and the NPRA must be notified and have the opportunity to annul the decision within three weeks of having received such notification (six weeks during the period 1 June-31 August).

[6] Norwegian Public Roads Administration – Manual 050 Traffic signs

Can/may	Guideline	Exemption may be granted by whoever is authorised to approve sign plans or sign applications. There is no requirement that the NPRA should be informed.

Level crossings are divided into the following three safety categories in the Regulations relating to signs and signals:

Public signs and signals must be used on level crossings on public roads.
As a rule, the use of public signs on level crossings on private roads is only permitted where these roads are open to public traffic.
The use of public signs is not desirable on minor private exit roads or agricultural crossings; private signs are mandatory at such crossings.
Public and private signs must not be used together.
The type of sign that must be used is determined by the function and use of the road.

In accordance with NPRA Manual 050, level crossings are divided into the following safety levels:

1: Level crossing equipped with road barrier or road safety system.
   Level crossing with road barriers.
   Level crossing with road safety system.
   Level crossing with road safety system (limited signage).
2: Level crossing without road safety system, but with public signs.
3: Level crossing on private road with private signs.

Type of road	Safety level				
	1a	1b	1c	2	3
National Road	X				
County Road	X				
Municipal road	X	X			
Municipal road with tram/light rail system	X	X	X		
Private road to more than 10 housing units	X	X	X	X	
Private road with through traffic	X	X	X	X	
Private road to outdoor leisure area, community centre or similar		X	X	X	X
Private road to sales area/premises			X	X	X
Private road to 5-10 housing units			X	X	X
Private road to 2-5 housing units				X	X
Private road to 1 housing unit					X
Closed industrial area				X	X
Forest road or similar, closed for general traffic					X
Agricultural crossings					X

Level crossings with barrier systems
Level crossings with road safety systems
Level crossing with road safety system (limited signage)
Level crossings without road safety systems on private roads with public signs
Level crossings on private roads with private signs

Figure 11: Alternatives for securing level crossings (from NPRA Manual 050 relating to traffic signs, part 2).

If a road and a level crossing fall into more than one safety category, the most 'stringent' level must be used as a basis for the solution chosen.

The Regulations relating to signs and signals section 23 states the following about traffic lights:

Three-aspect signal (Figure 12): *Motorists and cyclists must not pass the signal or stop line when the light is red. Pedestrians must not begin to cross the carriageway if this would constitute a hindrance to motorists or cyclists or involve a hazard.*

Flashing light signals before the railway track (Figure 13): *A red flashing light signal instructs the road user to stop at the stop line or at a safe distance before the light signal. A white flashing light signal means that the road user can cross the level crossing in accordance with the provisions of the Traffic Rules. A white flashing light shows that the signal system is in operation.*

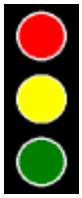

Figure 12: Signal 1080 – Three-aspect signal.

Figure 13: Signal 1096 - Flashing light signal before railway track

If the term ‘road users’ as used above is taken to mean pedestrians, cyclists and motorists, this means that pedestrians can cross at crossroads when the lights are red but not at level crossings.

The Signage Standard [7] describes the use and design of flashing light signals for railway tracks as follows: *Flashing light signals before railway tracks must be installed on both sides of the road where the traffic is to be stopped. The signals should have a black back plate with a white outline.* However, it is local conditions that determine the number of light signals.

The Markings Standard chapter 10.5 Matters relating to signs and markings states that the stop line should be located 5 metres before the signals. Manual 050 relating to traffic signs states that if the road has a centreline, it must be marked as a barrier before the level crossing at a minimum sight distance corresponding to the brake distance. The stop line markings must be located at least five metres before the signal pole.

[7] NPRA Manual 048 Traffic Signals Systems (the Signals Standard)
[8] NPRA Manual 049 Road Markings (the Markings Standard)

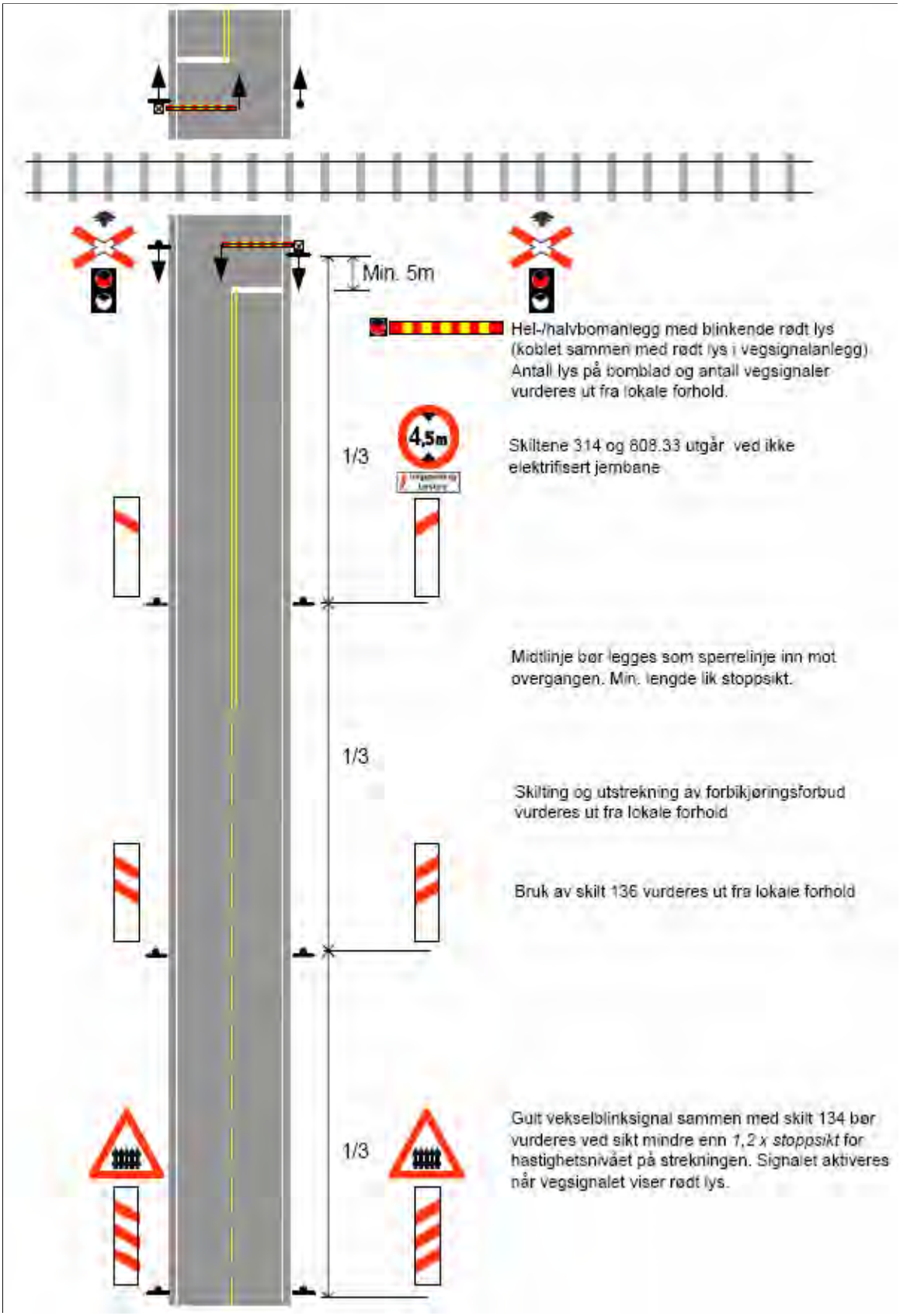

Figure 14: Rules for signage at level crossings with barrier systems (NPRA Manual 050 part 2).

2.1.4.2 *Railway*

Regulation no 1621 of December 2005 relating to requirements for railway enterprises on the national rail network (the Safety Regulation) section 12-5 Level crossings.

Level crossings must be adapted for safe crossing by road users. Level crossings on public roads…

The following technical rules are relevant in this context:

The Norwegian National Rail Administrations' technical rules (1 April 2008), Signals /x JD 55x: Competence requirements for personnel.

The Norwegian National Rail Administrations' technical rules (1 January 2004), JD530, chapter 12, Superstructures/ Level crossings/ Rules for engineering.

The Norwegian National Rail Administrations' technical rules (1 January 2004), JD532, chapter 10, Superstructures/ Rules for maintenance/ level crossings.

The Norwegian National Railway Administrations' technical rules (1 January 2004), JD532, chapter 10, appendix C, Superstructures/Annex relating to Maintenance/ Guidelines for road geometry.

The Norwegian National Railway Administrations' technical rules (1 April 2008), Signals /Rules for engineering JD550: Standards for engineering and structural design.

The Norwegian National Railway Administrations' technical rules (1 April 2008), Signals / Rules for construction JD551: Rules for construction - general technical requirements.

The Norwegian National Railway Administrations' technical rules (1 April 2008), Signals / Rules for maintenance JD552: Rules for maintenance of infrastructure.

The Norwegian National Railway Administrations' technical rules (1 April 2008), Signals /Rules for inspection JD553: Procedures for internal control and follow-up.

T5309a00 Protocol for inspection of road safety systems for level crossings on railway tracks.

T5309a00 Protocol for the inspection of road barrier systems for level crossings at stations.

Figure 15 provides an overview of the location of equipment at a level crossing.

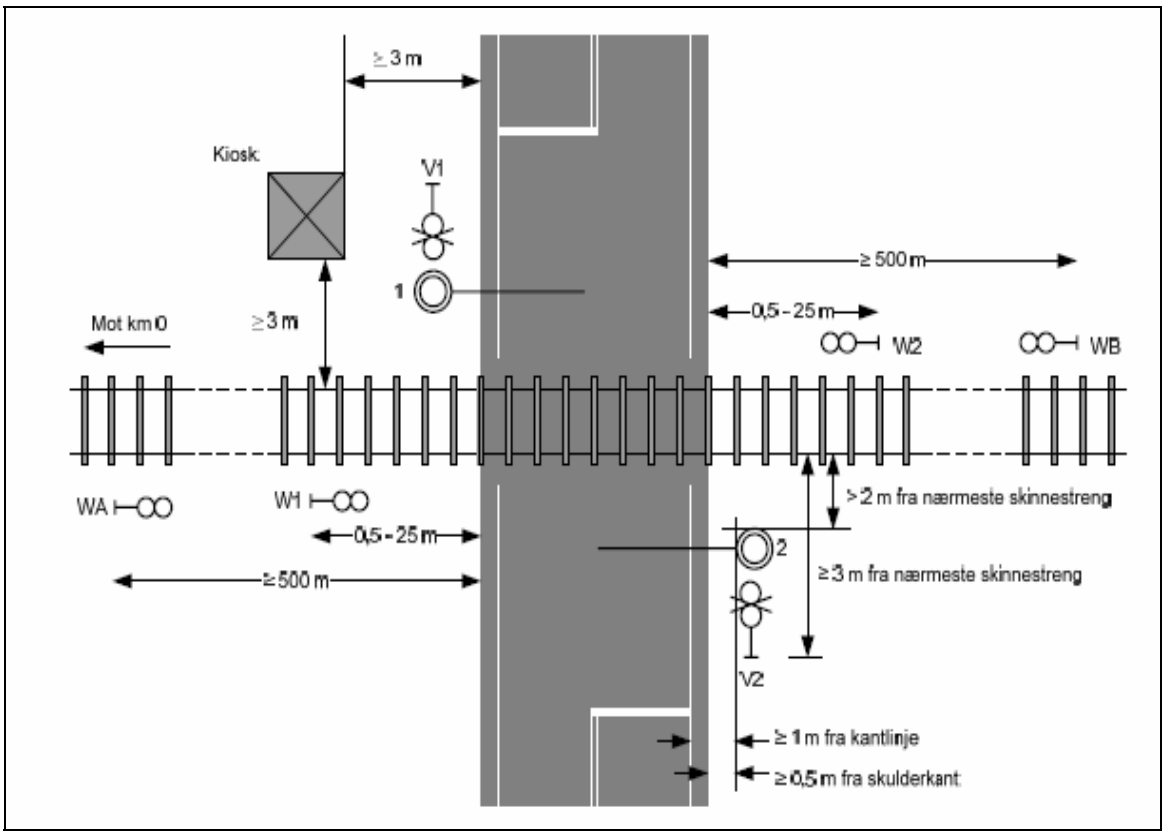

Figure 15: Location of equipment for road traffic signalling system (from JD550).

The following operative rules are relevant in this context:

The Signage Regulations. Regulations No. 1336 of 4 December 2001 relating to signals and signs on the national railway network and connected private tracks (the Signage Regulation):

Chapter III: Light signals (JD 321) – section 17. Level crossing signals with distant signals. Level crossing signals are normally preceded by distant signals. If a faulty level crossing signal means that the distant signal or main signal cannot give the all clear for passing the level crossing when the train reaches the level crossing mark, the train must stop before reaching the level crossing, if possible. The train driver must repeatedly sound the 'train approaching' signal as the train approaches the level crossing. If the train is able to stop before reaching the level crossing, it can then proceed to pass the crossing at a maximum speed of 10 km/h if road traffic does not prevent safe passage. If there is a lot of traffic, the level crossing must be cordoned off using equipment located in the relay cabin. Where the level crossing is located at a manned station, it must be passed in accordance with the station master's instructions. If the train stops at a terminal ahead of a level crossing, the 'train approaching' signal shall not be given.

Chapter IV: Signal signs etc. (JD 332) – section 12. Level crossing sign - black 'V' against a yellow background. The sign must be located minimum 500 metres before the level crossing. It indicates that there is a level crossing with an automatic barrier or traffic signal system ahead.

The Train Operation Regulations: Regulations No. 1335 of 4 December 2001 relating to traffic control and the operation of trains on the state-owned rail network and connected private tracks (the Train Operation Regulation):

Chapter III: Traffic control (JD 341) – section 18.9. If there is little traffic at a level crossing, the traffic controller is not required to monitor the level crossing when the road traffic signal system is not in operation.

2.2 Review of relevant Synergi reports from 2005 and 2006

2.2.1 Information about Synergi

This section contains a review of Synergi reports from 2005 and 2006 related to level crossings. The purpose of the review is to classify incidents by cause and to prepare statistics to identify particular problem areas. Synergi is a reporting system for, among other things, railway incidents and near-misses on the infrastructure used by JBV, NSB AS, CargoNet AS and others. Reports from train operators concerning the infrastructure are sent to JBV and stored in its Synergi database. The Norwegian Railway Inspectorate has access to all Synergi reports. Train drivers can submit observations and report incidents, and these are then available for reporting, statistics, follow-up and trend analysis.

For this survey, AIBN was given access to all Synergi reports involving level crossings in 2005 and 2006, and these reports form the basis for the categorisation of causes in the following section.

2.2.2 Categorisation of incidents by cause

AIBN has reviewed all the incidents on the basis of their brief description in Synergi and has attempted to classify them in one or more causal categories (see Table 3 below). In most cases the incident falls into a single category, but in some cases it falls into several categories. The classification is based on sound judgement and experience, since AIBN does not have access to all the facts about the incidents as the Synergi reports contain limited information. There is consequently a risk that the incidents have been incorrectly classified, even though the classification is based on a conservative approach so that incorrect actions are labelled 'accidental' in cases of doubt in order to prevent unfairly accusing the person(s) involved in the incidents of willingly breaching the law.

The data on which the review is based consist of Synergi reports involving level crossings registered in JBV's Synergi database, and includes both near-misses and incidents.

When all the incidents had been categorised, pivot tables were used to generate statistics showing the frequency of different combinations of causes.

Table 3 - Causal categories used

Causal categories	
'Pedestrian – intentional wrongdoing'	When it is described in the Synergi report that a person has crawled under a barrier or walked/cycled around or zigzagged between barriers, the act is considered intentional wrongdoing. This category includes incidents where the person was observed by the train driver to cross intentionally, despite being aware that the train was approaching.
'Motorist – intentional wrongdoing'	The most obvious intentional wrongdoing is zigzagging between half barriers. Other examples include drivers who first slow down as if to stop, and then change their minds and cross in front of the train. In

	many cases, scheduled vehicular traffic, i.e. buses, waste collection vehicles etc. can also be said to act intentionally since we must assume that they are familiar with what happens at level crossings when a train is approaching.
'Motorist – unintentional wrongdoing'	It is assumed that cases in which motorists are caught between the barriers or are hit by barriers can be ascribed to unintentional wrongdoing, since it is unlikely that anyone would intentionally expose themselves or their vehicle to danger and injury/ damage.
'Technical fault at the level crossing'	This category covers situations in which the barrier rises or descends at the wrong time. The category also includes faulty road traffic signals. Some faults in the category 'technical fault at the level crossing' are safety-critical with potentially serious consequences. However, the brief Synergi reports do not provide a sufficient basis to decide whether a fault is safety-critical or not.
'Pedestrian– unintentional wrongdoing'	This category is used for pedestrians and cyclists who, based on the description in Synergi, were not aware that they were in a dangerous situation. Incidents involving children are always classified in this category since it is assumed that they do not understand the danger associated with occupying or crossing a level crossing.
'Physical design of level crossing/ road'	In some cases, the physical design of a road, vegetation that blocks sight lines or inadequate signage can contribute to incidents at level crossings.
'Weather/ driving conditions'	Although winter conditions such as snow, ice and salt on the road can affect the functionality of a road barrier system, the most common incidents involve vehicles having problems stopping before or getting stuck on level crossings.

2.2.3 Results of the categorisation of causes

The figure below shows the distribution of incidents by causal category. The vast majority of incidents are caused by unintentional wrongdoing on the part of motorists. The second biggest category is intentional wrongdoing by pedestrians/cyclists. As mentioned earlier in this report, the classification of unintentional acts is based on a conservative approach, i.e. there is a factor of uncertainty attached to the classification and it is likely that incidents have occurred that should have been categorised as intentional wrongdoing. It is also possible that unintentional wrongdoing occurs as a result of the physical design of level crossings and roads being inexpedient, and that this is not clear from the categorisation of causes.

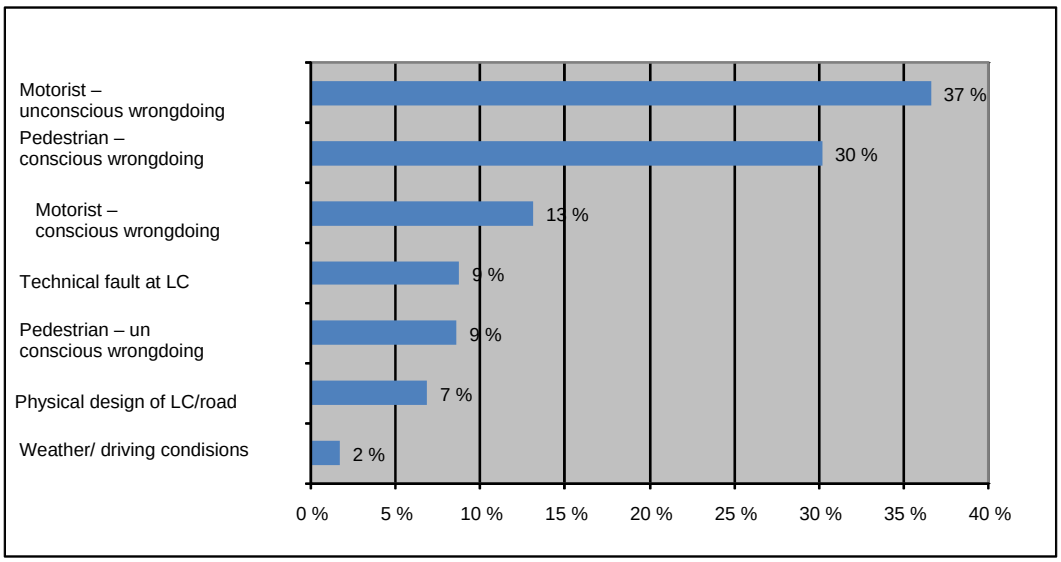

Figure 16: Overview of number of incidents by category (Figures for 2005 and 2006).

2.2.3.1 *Factors pertaining to the level crossing itself*

The figures below (Figures 17 and 21) show level crossings at which there have been more than two incidents in each category. The low number of level crossings for which this cause has been cited reflects either that only a small number of incidents can be ascribed to factors pertaining to the level crossing itself or that these factors are not described in the Synergi reports. Incomplete or brief descriptions are a disadvantage of the Synergi reports that make it difficult to identify clear trends and follow them up.

Based on the descriptions, only a small number of incidents have occurred in which weather and driving conditions seem to have played a part. It is not likely that this result is correct since experience has shown that slippery roads have often played a role in whether or not motorists have managed to stop in time. It is probable that this information is not adequately described in the Synergi reports since these reports do not contain the motorist's version of the incident.

Porsgrunn LC is the level crossing with the most reports that indicate that its physical design contributes to undesirable incidents. An inspection of this crossing is described in section 2.2.7.2. Porsgrunn LC is followed by Ranheim LC, while Øyo LC will probably be removed in 2009 and is therefore of limited interest.

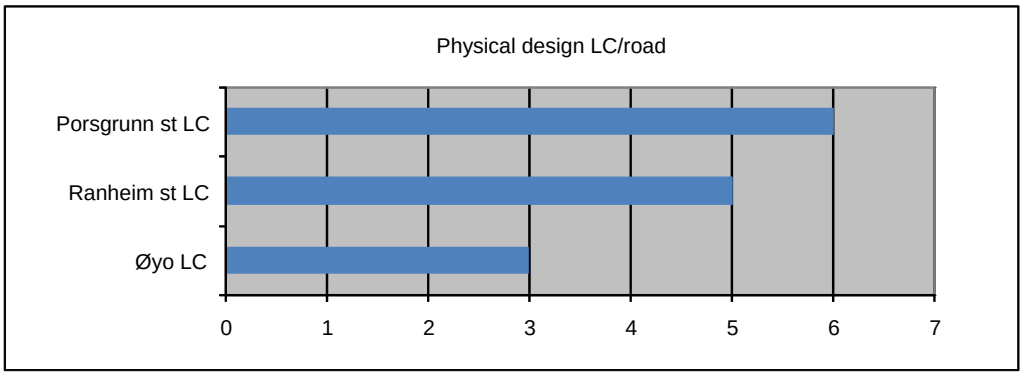

Figure 17: Physical design of level crossings/roads (2005 and 2006 figures).

At Ranheim station (Figure 18), four tracks cross the road along a short road section. The two tracks nearest the station are safeguarded by barrier systems. It is often the case that the barriers are open and motorists have the all clear signal while a stationary train is waiting at the station.

If a motorist focuses on the stationary train (Figure 19) while the barriers begin to descend, there is a risk that the motorist will think that it is the stationary train at the station that is about to depart rather than a train approaching from the left. In the worst case, the motorist may reverse in order to clear the track nearest the station (Figure 20) and thus end up on the approaching train's track.

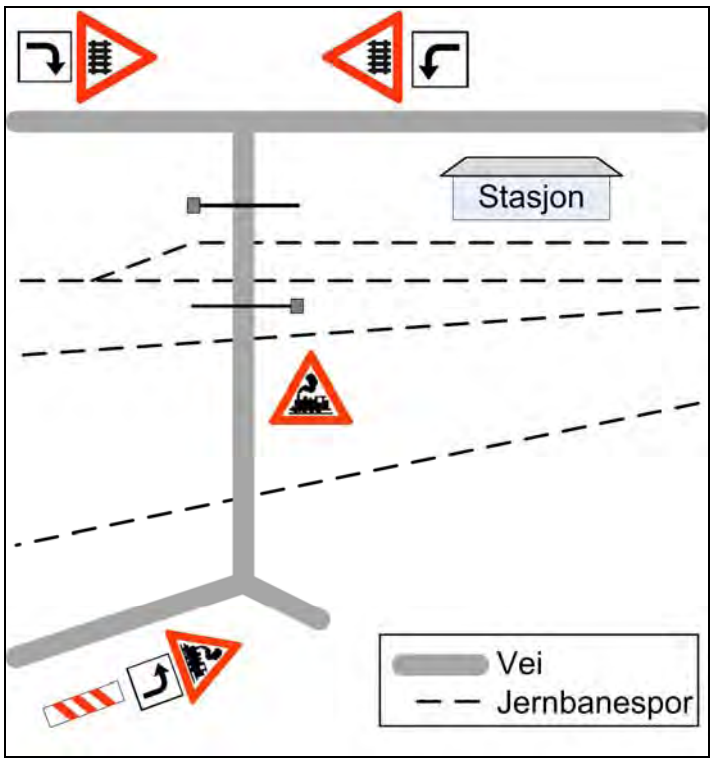

Figure 18: Overview of roads and railway lines at Ranheim.

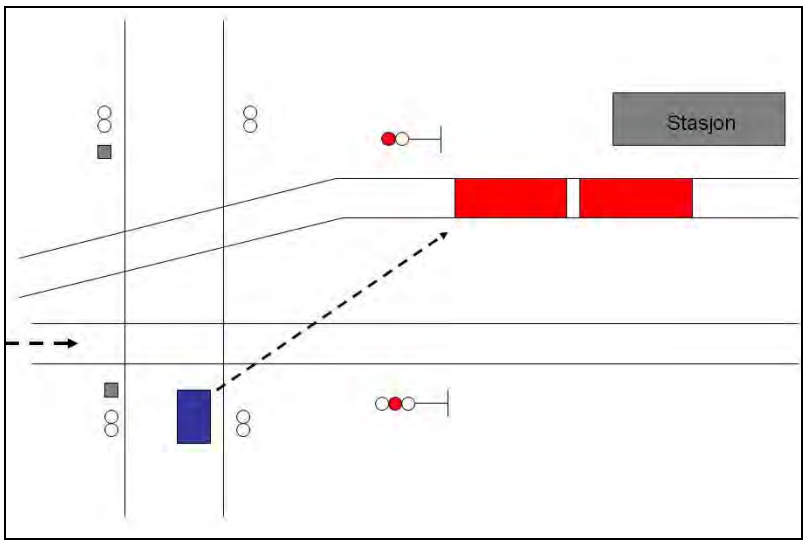

Figure 19: The problem at Ranheim, part 1.

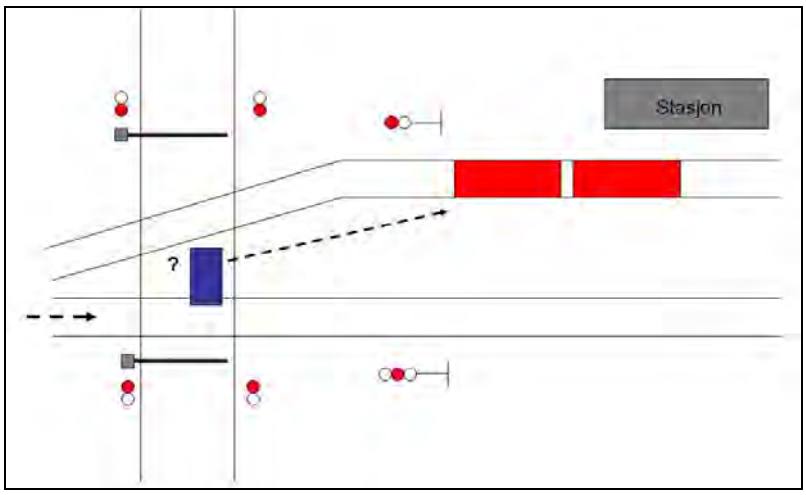

Figure 20 – The problem at Ranheim, part 2

There are few reports of technical faults at the level crossings; only at Blakstad LC have more than three cases been reported. This does not give us reason to believe that technical faults are a frequent contributing factor to incidents at level crossings, and such faults will therefore not be discussed further in this report.

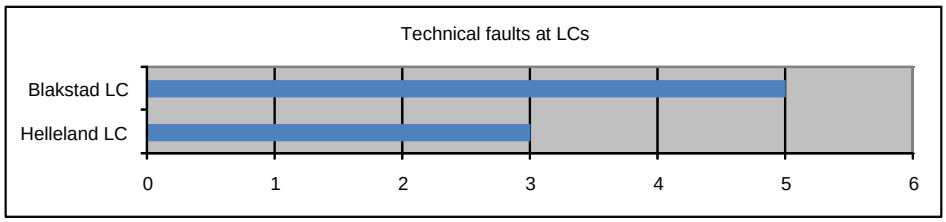

Figure 21: Technical faults at level crossings (figures from 2005 and 2006).

2.2.3.2 *Pedestrians/cyclists*

The Figure below shows level crossings with two or more incidents in the categories ‘Pedestrian- intentional wrongdoing’ and ‘Pedestrian - unintentional wrongdoing’. As used here, the term ‘pedestrian’ also covers cyclists.

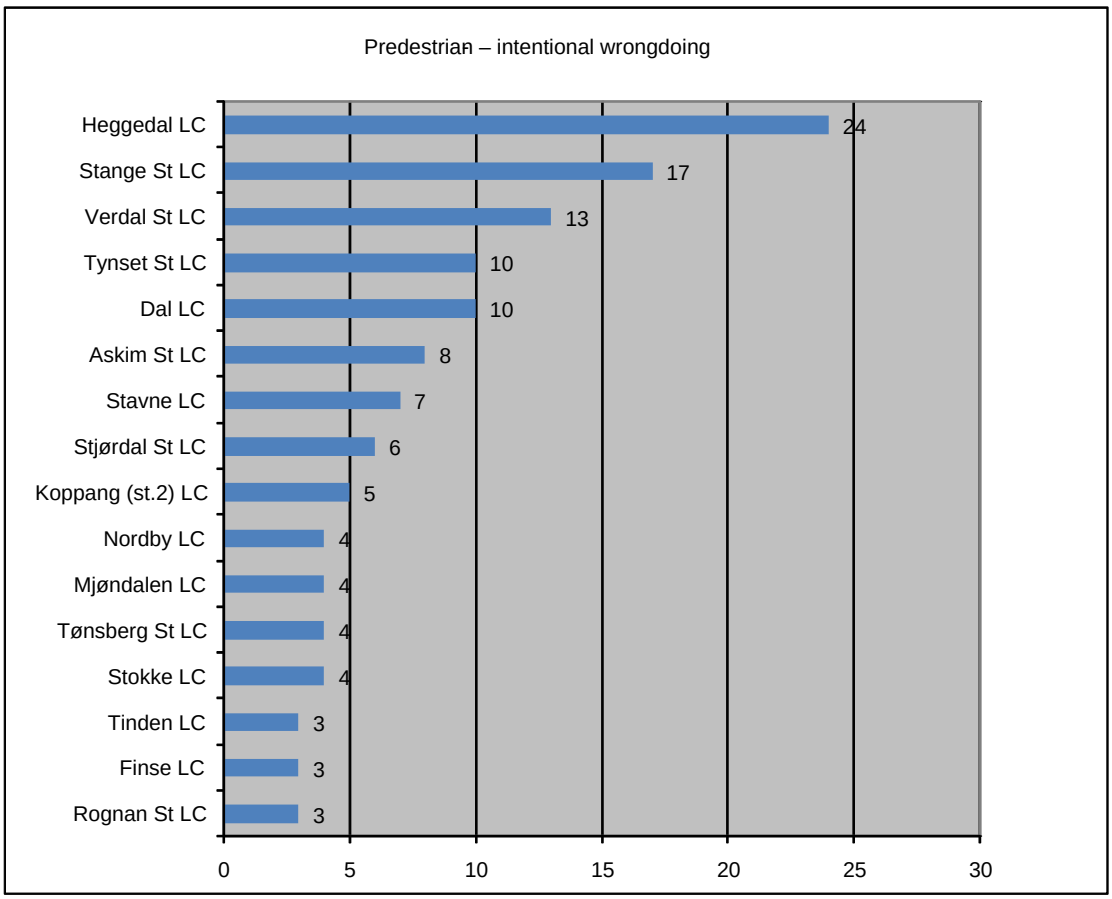

Figure 22: Pedestrian – intentional wrongdoings.

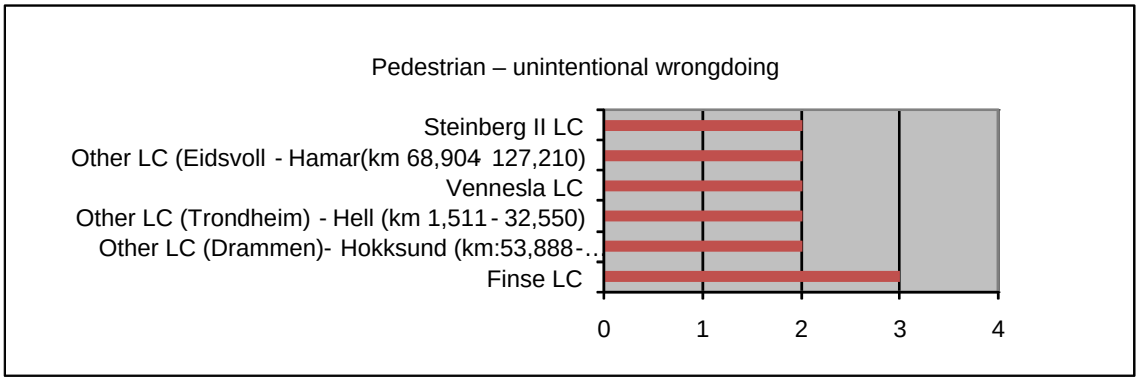

Figure 23: Pedestrian - unintentional wrongdoing.

2.2.3.3 *Motorists*

The figure below shows incidents in the categories Motorist – intentional and unintentional wrongdoing. Only level crossings with two or more incidents are included in the figure. It is not clear why Mjøndalen LC has so many more incidents than the rest. The train driver on the section in question was unable to provide a good explanation, except that it has sometimes been a problem that school children cross the track against a red light at the level crossing. This is a problem that becomes more or less pressing according to when it was last raised with the school.

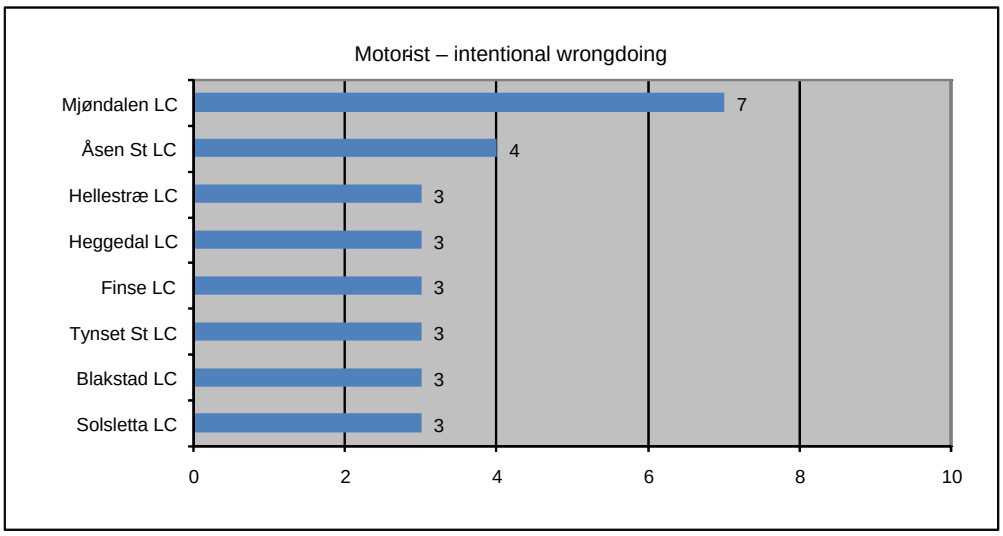

Figure 24: Motorist - intentional wrongdoings.

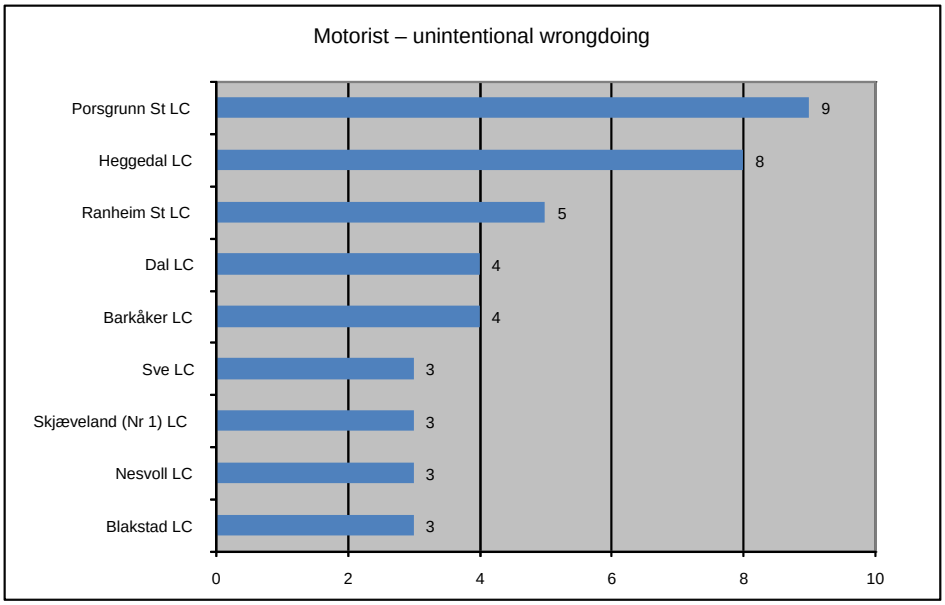

Figure 25: Motorist - unintentional wrongdoings.

2.2.4 Level crossings at stations that have problems associated with crossing and overtaking

Problems associated with crossing and overtaking exist at level crossings at stations where trains either cross each other's tracks or overtake each other. Pedestrians and motorists frequently tend to focus on the stationary train that is waiting at the station for the approaching train to pass. There is a risk that pedestrians do not respect the barriers because they assume that these have been lowered for the stationary train, and hence take the risk of crossing the level crossing without sufficient attention to the crossing/overtaking train that might be moving at a relatively high speed.

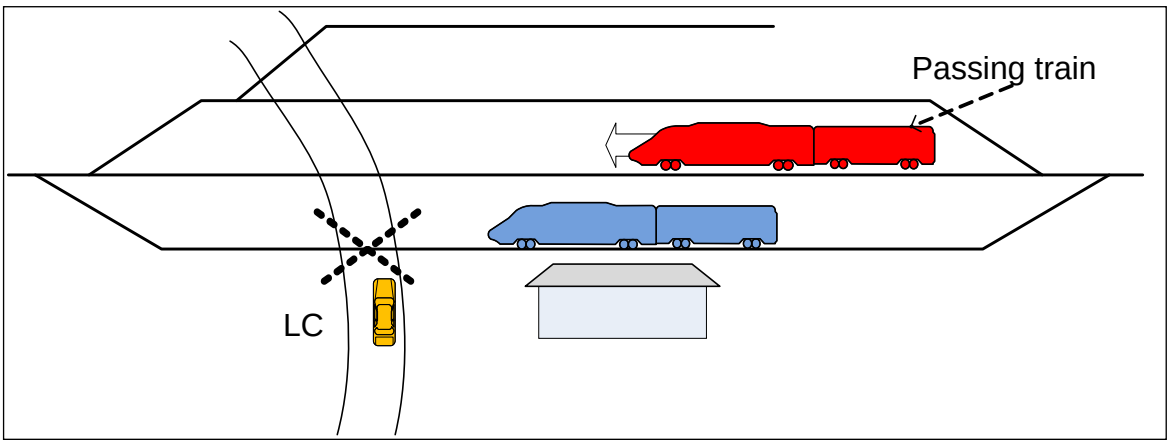

Figure 26: Diagram showing the problems associated with crossing and overtaking (like at Dal station).

Stations that experience problems associated with crossing and overtaking, and that are among the ten level crossings with the most incidents, are marked in orange in the table below (Table 4).

Table 4: Type of system at the ten level crossings with the most incidents

Number of incidents		
Location/track/system (project)	Type of system	Total
Heggedal LC	full barrier	33
Stange St. LC	half barrier	19
Tynset St. LC	full barrier	15
In Verdal St. LC	full barrier	14
Dal LC	full barrier	14
Stavne LC	half barrier	12
Mjøndalen LC	half barrier	12
Porsgrunn St. LC	full barrier	10
Finse LC	Light signal system	10
Blakstad LC	half barrier	10
Askim St. LC	full barrier	10

Figure 27: An overtaking freight train at Dal station.

2.2.5 Variation by month of the year

The table below shows a relatively even distribution of incidents between the months of the year (Table 4). The differences are too small to be significant.

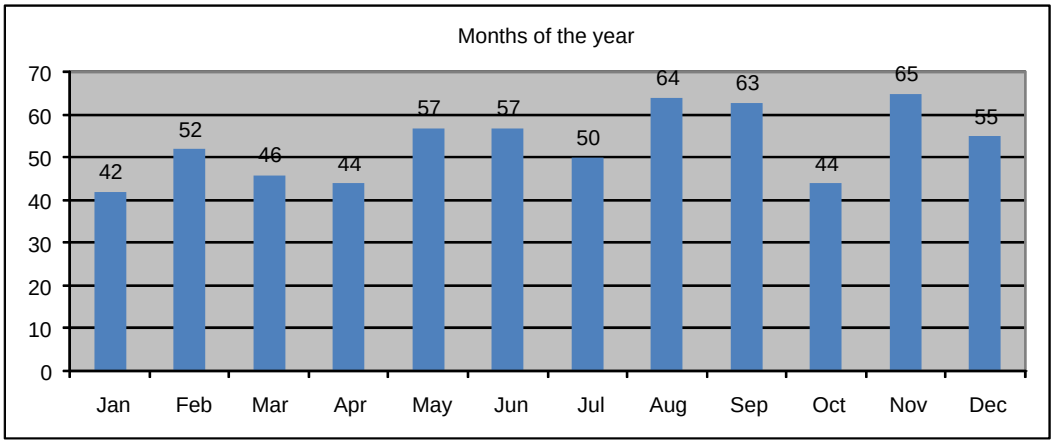

Figure 28: Total number of incidents per month (figures from 2005 and 2006).

The statistics show that most incidents occur at full barrier or half barrier systems. Although the majority of incidents at barrier systems occur in the darkest months of the year (November and December), the tendency is not the same for the months during which snowfall can be expected (January to March).

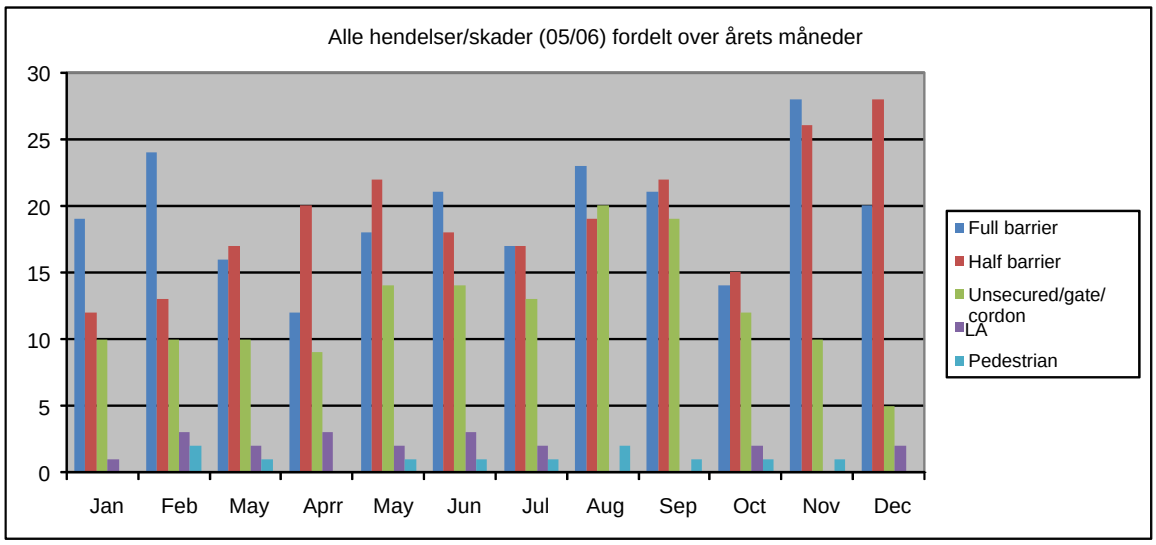

Figure 29 - Incidents per month distributed according to the type of level crossing (figures from 2005 and 2006)

Table 5: Incidents by month and type of level crossing

Month	Full barrier	Half barrier	Unsecured/ gate/chain	LSS	Pedestrian	Total
Jan.	19	12	10	1		42
Feb.	24	13	10	3	2	52
March	16	17	10	2	1	46
April	12	20	9	3		44
May	18	22	14	2	1	57
June	21	18	14	3	1	57
July	17	17	13	2	1	50
Aug.	23	19	20		2	64
Sept.	21	22	19		1	63
Oct.	14	15	12	2	1	44
Nov.	28	26	10		1	65
Dec.	20	28	5	2		55
Total	233	229	146	20	11	639

2.2.6 Relationship between near-misses and accidents

The relationship between the number of near-misses and the number of accidents is not necessarily proportional. The figure below shows that the level crossings with the highest number of registered incidents do not have the highest number of accidents. Although Heggedal LC has a high number of reports, they are primarily of near-misses. The situation is different for Porsgrunn LC, where there are significantly fewer reports, but as many as half of them are classified as accidents.

This means that when considering where to implement measures, it should be considered where they have the greatest risk-reducing potential.

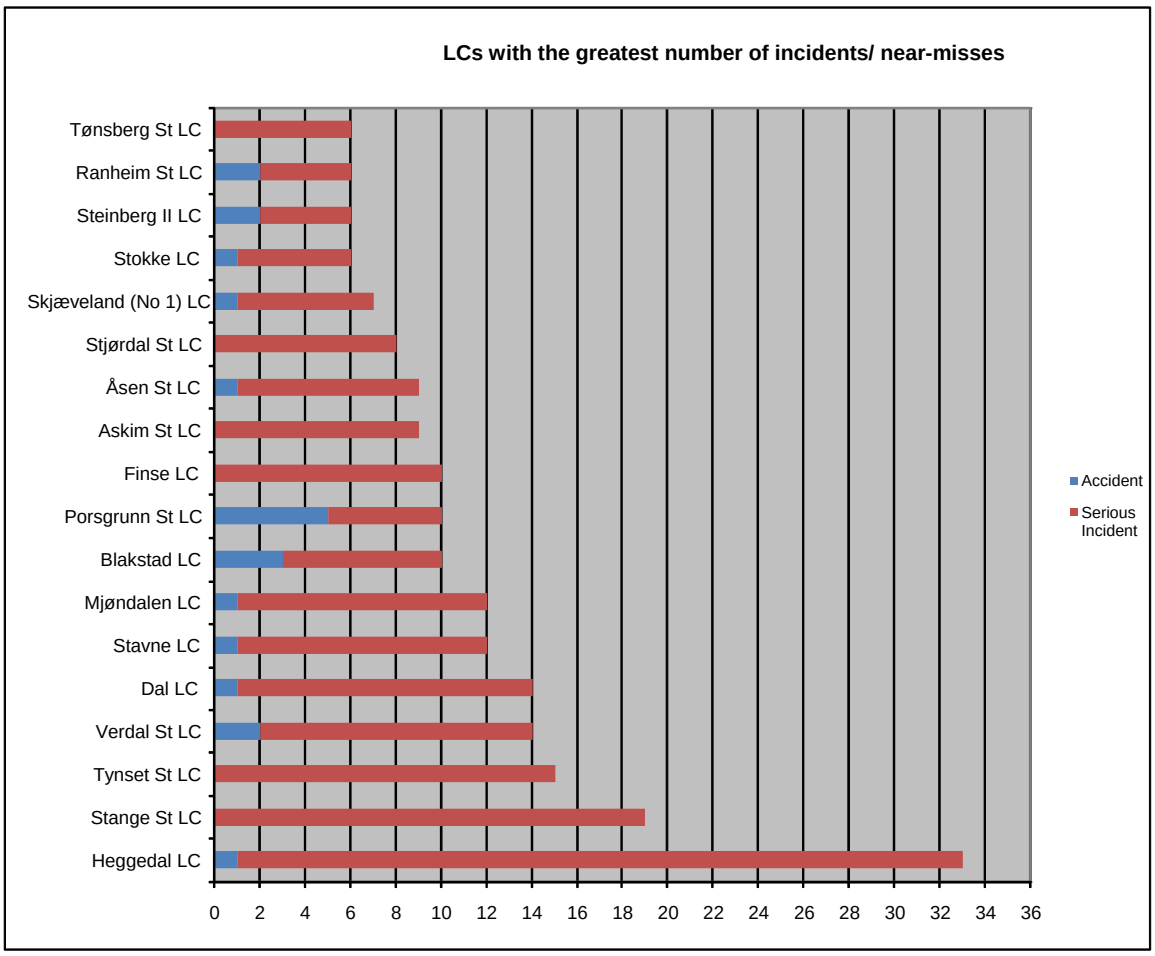

Figure 30: Total number of incidents divided between accidents and near-misses.

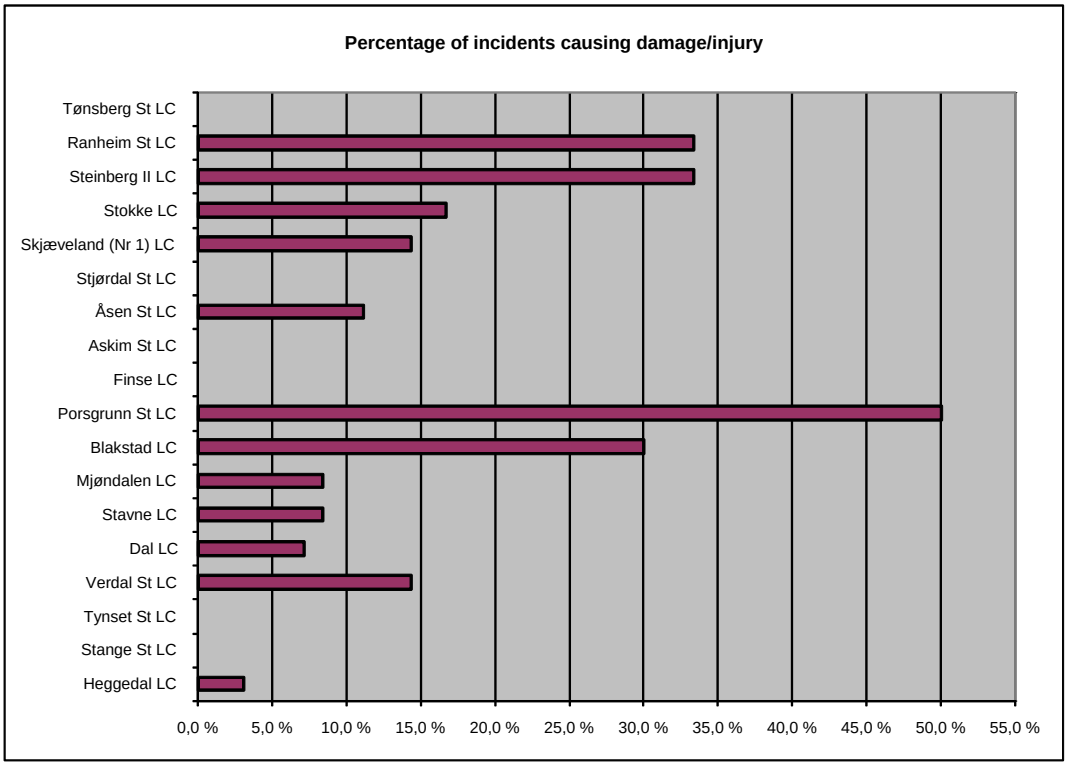

Figure 31: Percentage of total number of incidents at level crossings causing damage/injury.

2.2.7 Inspection of selected level crossings mentioned in Synergi reports

The statistics that AIBN has been able to prepare on the basis of the Synergi reports provide a basic description of the situation surrounding level crossings in Norway. As mentioned earlier, these reports contain only brief descriptions of the incidents. Inspections have therefore been made of a selection of level crossings that have many Synergi reports in order to gain a more nuanced picture. For practical reasons, AIBN has chosen to study a selection that is representative of several other level crossings.

Visits have been made to the following level crossings:

Heggedal LC - although the traffic pattern is simple, there are nevertheless many near-misses involving both vehicles and pedestrians (see section 2.2.7.1).

Porsgrunn LC - has a complex traffic pattern with many incidents involving vehicles (see section 2.2.7.2).

Dal LC - although the traffic pattern is simple, it is a crossing station (see section 2.2.7.3).

Harborg LC and Nesvoll LC: Although this is an open line with an uncomplicated traffic pattern, there are nevertheless quite a few incidents (see section 2.2.7.4).

Section 4.2 contains a summary and general conclusions based on the above inspections.

2.2.7.1 *Heggedal LC*

Heggedal LC is a level crossing near Heggedal station that has an uncomplicated traffic pattern and relatively little train traffic - approx. 52 train movements per 24 hours. Heggedal station has some crossing issues (the current timetable includes eight train crossings per 24 hours). The level crossing is equipped with a full barrier, LED matrices in the road traffic signals and sound signals. The barriers have flashing red LED matrices.

Figure 32 shows an areal view of the level crossing at Heggedal station which was inspected on 21 May 2008.

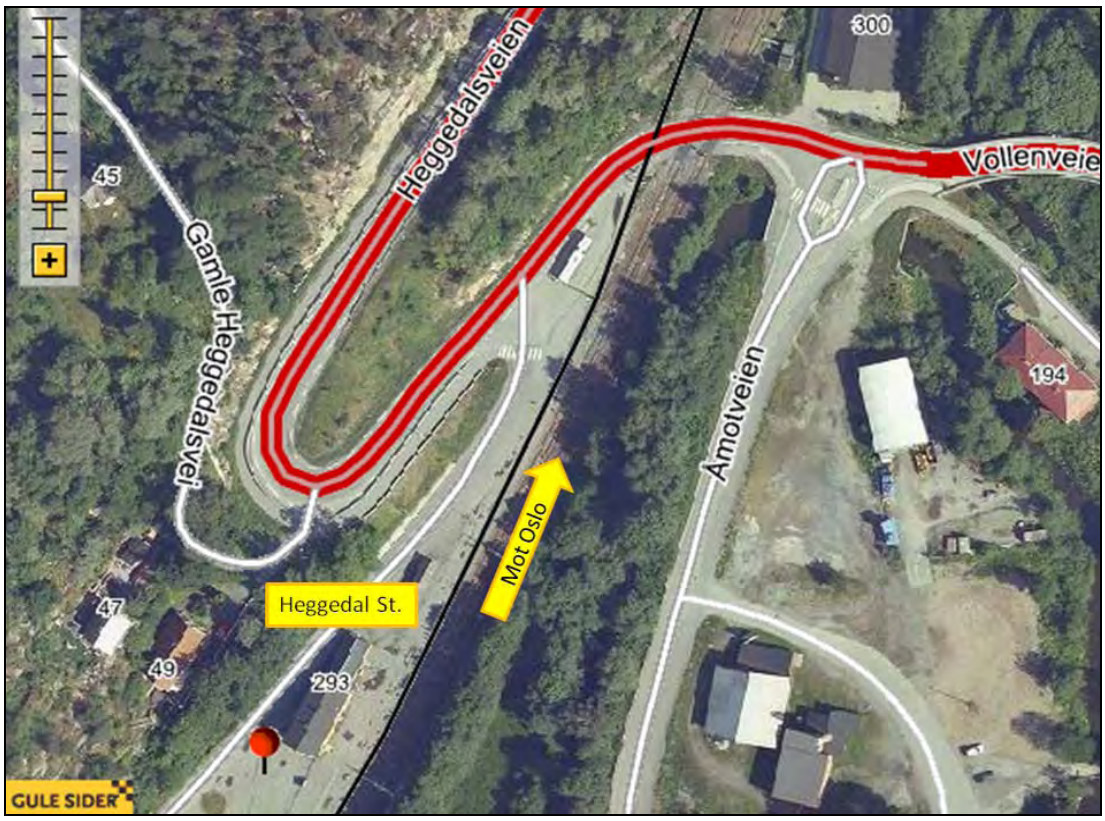

Figure 32: Heggedal LC.

When the train bound for Oslo passes, the barrier is down for approx. 4 min 20 sec. Approx. 1 min 30 sec passes from the barrier begins to descend until the approaching train can be spotted, and, on average, approx. one train per hour passes in each direction.

During the inspection, three persons who were going to catch the train to Oslo were observed bypassing the barriers. When asked directly why they broke the rules, one of them answered as follows: 'The barriers are always down for approx. two and a half minutes before the train leaves. I often run across the track after the barrier has descended. A train has never approached unexpectedly from the other side. Everyone in the area does this.' (Woman, approx. 20-25 years old)

In Norway, it is not illegal for pedestrians to cross the road on a red light if the traffic permits (see 2.1.3). This may be one reason why red lights at level crossings are also not respected.

When the cars that had stopped for the barrier started up again, several of them drove against a red light while the barrier was still in motion. Although this is not a big problem in itself, there is a risk that this behaviour is deemed acceptable and that other, potentially more serious transgressions become more 'legitimate'.

A motorist, a learner driver true enough, had to reverse in order to prevent the barrier from hitting the car (on the Heggedalsvei side) The road was recently asphalted and it is therefore unknown whether it is normally marked with a stop line in accordance with the recommendations in the NPRA Manuals.[9,10]. Furthermore, since the barrier is not correctly installed (i.e. perpendicular to the road), an inattentive driver can be caught on the crossing or the car could be hit by the descending barrier.

[9] NPRA Manual 048 Traffic Signal Systems (the Signals Standard)
[10] NPRA Manual 049 Road Markings (the Markings Standard)

Figure 33: Three people crossed the level crossing while the barriers were down. A motorist had to reverse in order to avoid collision with the barrier.

Figure 34: Several cars drove through the level crossing before the barrier was fully raised.

The Synergi reports clearly indicate that there is a lack of respect for the barriers, since 24 of the 33 incidents are classified as 'Pedestrian - intentional wrongdoing'.

There are also some cases of cars being caught between the barriers and of cars being hit by a barrier. Eight of these cases are in the category 'Motorist - unintentional wrongdoing' and three are in the category 'Motorist - unintentional wrongdoing'. Most of these incidents take place on the Heggedalsvei side of the level crossing (the same side as the station building) where it can be difficult for a motorist unfamiliar with the crossing to see where the barrier will descend. During the inspection, it was also observed that the barrier on the Heggedalsvei side of the crossing is not installed in accordance with the regulations in that it is not perpendicular to the road.

Many train passengers travel to Heggedal station by bus. When the bus is delayed so that the barrier has already descended, the passengers disembark on the Vollenvei side of the crossing and, according to the Synergi reports, many of them choose to run across the tracks as they feel that they have no choice if they are to catch the train.

2.2.7.2 *Porsgrunn LC*

Porsgrunn LC is a level crossing near Porsgrunn station with a complex traffic pattern in the form of a junction with heavy traffic regulated by lights. The level crossing is equipped with full barriers, and light and sound signals. Both the light signals towards the road and the actual barriers have LED matrices. There are also ordinary traffic lights since this is a road junction (see the figure below). There are approximately 38 train movements per 24 hours at Porsgrunn LC. An inspection was carried out on 21 May 2008.

The level crossing at Porsgrunn station seen from above:

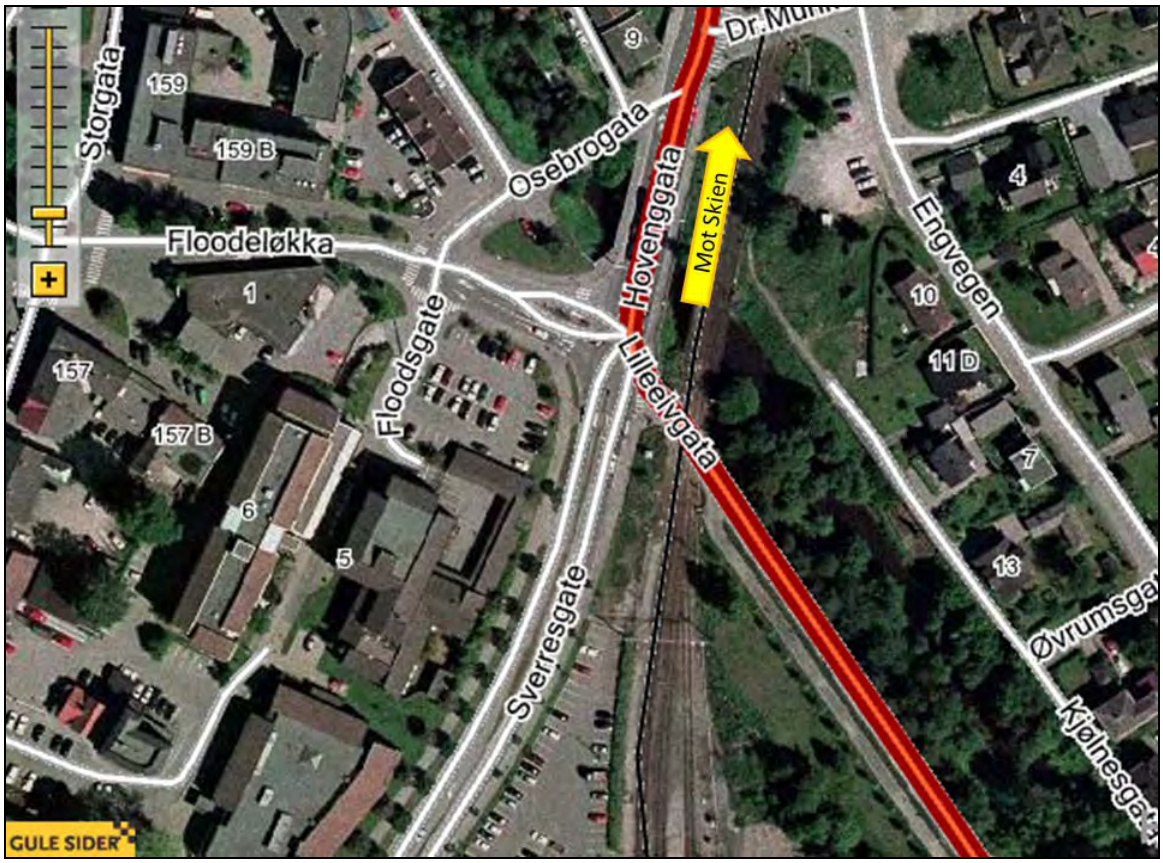

Figure 35: Porsgrunn LC (Lilleelvgata).

The actual level crossing is only a small part of the overall chaos that includes several junctions regulated by traffic lights, both with and without level crossings. There is a great deal of traffic and heavy vehicle traffic crossing the level crossing, since the road is the main road between the E18 motorway and Skien. Because of the heavy traffic combined with a 'jungle' of signs this junction has been a problem for several decades.

The design of the junction invites incorrect behaviour. Very many instances were observed in which motorists were forced to take unnecessary chances in order to make it across the junction from Hovengata to Lilleelvgata during the brief interval when the light was green.

It was noted that the road signals and railway signals are not synchronised with each other. When trains are approaching, the traffic lights start flashing yellow. In a road traffic context that means that the junction is out of operation but motorists may proceed through the junction with particular caution.

When indication of a passing train (a maintenance train from Skien) was initiated and the traffic lights started flashing yellow, the motorist at the front of the queue approaching

the junction from Lilleelvgata became hesitant and started to roll forward. The motorist stopped when he or she discovered that the barriers were descending or that the red railway signal was flashing.

According to a local taxi driver, seniors are a group that have a particularly difficult time in keeping up with the quick decisions that must be made in order to cross the complicated junction and level crossing. According to several people this junction deserves the title ‘Europe’s worst junction’ because of the combination of heavy traffic and road and rail crossings.

Those who live and work in Porsgrunn are very familiar with the problems surrounding this junction and largely adapt their driving style to the actual situation. However, random visitors to the area have a very small chance of understanding the situation, which frequently leads to unfortunate behaviour in the junction. This often applies to heavy vehicle drivers whose vehicles naturally need more time to cross the junction and therefore occasionally get stuck in the middle so that they block the roadway.

Several local taxi drivers said that one of the factors that complicate the traffic junction is the fact that although the main road leading up to and continuing on the other side of the junction (Sverresgate) is a priority road, drivers have a duty to give way in the actual junction itself. This can confuse motorists who are unfamiliar with the junction and cause them to behave incorrectly.

It seems that the level crossing in the junction may be an additional complicating factor. As an experienced local taxi driver put it: ‘The barriers are going up and down all the time! I try to avoid the junction all together’.

It was also stated that there are often technical problems with the barriers during winter due to salting of the roads. The fact that the level crossing itself is not salted has little impact in this instance, since the traffic is so heavy at the junction that salt from vehicle tires is deposited on the level crossing in any case. This creates operational problems for the road safety system, since the salt short-circuits the trip function section of the level crossing. This causes the barriers to remain down even when there is no train approaching, which can contribute to motorists losing respect for the road safety systems, even though this function is fail safe.

Figure 36 below shows a combination of road traffic lights and railway signals. The combination of the two types of signal creates confusion and it can be difficult to decide which signal applies in different situations. The complicated and dense signage makes it challenging to drive correctly in the junction for a person who is not familiar with the area.

Figure 36: A combination of different types of signs and light signals is very demanding for motorists.

The photograph below shows the distance between the road junction and the level crossing. At the level crossing, one has a stronger sense of being in a road junction than on a level crossing.

Figure 37: The junction with the level crossing in the background.

The photograph below shows the level crossing when the barriers are down. In this instance, the traffic lights are flashing yellow. Long queues build up in every direction when the barriers are down.

Figure 38: The barriers are down and the traffic lights are flashing yellow.

The categorisation of causes on the basis of the Synergi reports classifies the majority of incidents at Porsgrunn LC as ‘Motorist - unintentional wrongdoing’ (9) with ‘Physical design of level crossing/road’ as a secondary cause (applies to 6 of 9 incidents). Many of the reports involve either a car being hit by a barrier or a car being caught between the barriers.

2.2.7.3 *Dal LC*

Dal LC is a level crossing at Dal station with an uncomplicated traffic pattern. Dal station is the end terminal for several local trains and is frequently used as a crossing and takeover station for freight trains with 66 train movements per 24 hours. The local trains terminate here and stop in track 1 before returning.

The categorisation of causes on the basis of the Synergi reports shows that out of the 14 incidents that have been registered for Dal LC, ten are classified as ‘Pedestrian - intentional wrongdoing’ and four are classified as ‘Motorist - unintentional wrongdoing’.

The level crossing is equipped with full barriers, and light and sound signals. The light signals have LED matrices towards the road, but not on the barriers. An inspection was conducted on 21 May 2008.

The level crossing at Dal station viewed from above:

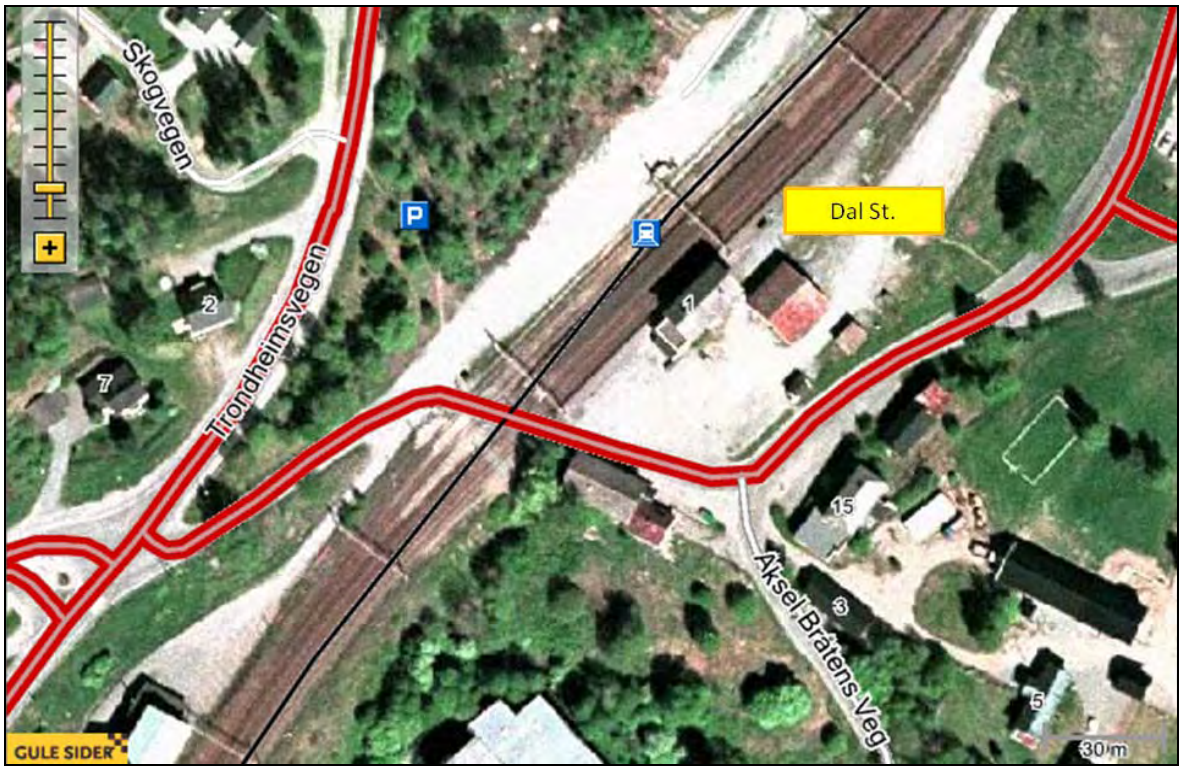

Figure 39: Dal LC.

During the inspection, AIBN observed the crossing of a freight train and a local train that stops and changes direction at Dal station. While the train was crossing, the barriers were down for approximately 7 min and 15 sec. During this time, the local train for Oslo was waiting at the station.

One of the big risks at this level crossing is probably the attention that is paid to the stationary train at the station while another train passes behind it. If anyone were to take the chance of crossing the track despite the barriers being down, there is a risk of being hit by another train that is partly hidden by the stationary train and approaching at high speed.

Another problem is that both pedestrians and motorists have a very short sight distance when waiting on the station side of the level crossing to cross to Trondheimsvegen. The photo on the following page (Figure 40) shows how the stationary train, platform and buildings block the sight lines from the barriers at the level crossing.

Figure 40: Level crossing at Dal station.

Figure 41: Dal station, the level crossing and a stationary local train.

2.2.7.4 *Harborg LC and Nesvoll LC*

Both Harborg LC and Nesvoll LC on the Røros line lie on an open line with an uncomplicated traffic pattern. The level crossings have approximately six train movements per 24 hours. The inspection at Røros was carried out in response to an enquiry from the Røros police in connection with an accident that occurred in December 2007. There had also been several other serious incidents at these two level crossings. The inspection was a result of the police's wish to gather representatives from different bodies. The inspection was carried out on 27 May 2008 and included participants from the police, NPRA, JBV and AIBN.

AIBN has been given access to the reports from Harborg LC and Nesvoll LC from 2007, in addition to the Synergi reports from 2005 and 2006. In total, three incidents were registered for Harborg LC and seven incidents were registered for Nesvoll LC. The

majority of reports concern damage to the barriers or light poles following a collision with a vehicle. In most cases these incidents were classified as ‘Motorist - unintentional wrongdoing’. So the problem at these level crossings is not that vehicles cross in front of trains, but rather those motorists lose control of their vehicles and damage the system. In the worst case, vehicles may skid onto the track.

Figure 42: Inspection of Harborg LC on the Røros line.

Harborg LC is equipped with a half barrier and sound and light signals. The light signals and barriers have LED matrices. There is a cattle grid on the northern approach to the level crossing (see Figure 43) that might contribute to reducing speed.

Barriers and light signals at Harborg LC and Nesvoll LC are often damaged in collisions with vehicles. The two level crossings have largely the same design. The incidents occur on the side of the level crossing where the road goes from being a relatively long, straight stretch and curves before the level crossing.

Figure 43: Harborg LC.

Like Harborg, Nesvoll LC has half barriers, light signals with LED matrices and sound signals. There are also LED matrices on the actual barriers.

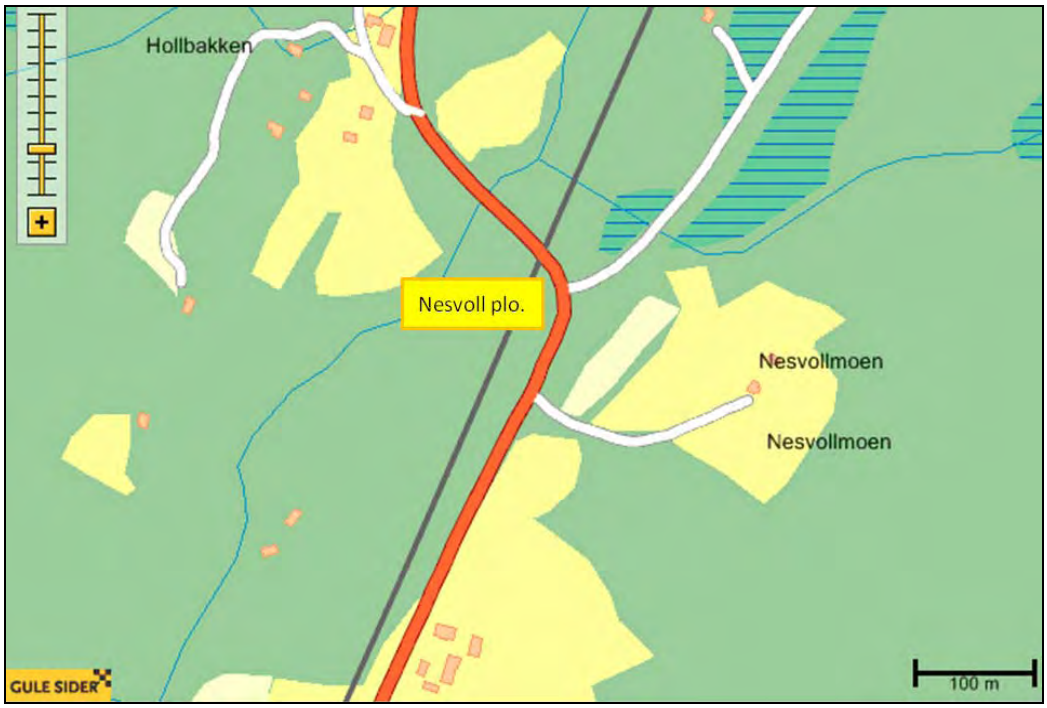

Figure 44: Nesvoll LC.

The signs at both level crossings are in accordance with the regulations and in good condition. Incidents almost invariably happen on the same side of the road, i.e. southbound traffic at Harborg and northbound traffic at Nesvoll. In both cases a long stretch of straight road is followed by a sharp turn just before the level crossing (see Figures 43 and 44). Both level crossings have signs showing the recommended speed limit of 40 km per hour.

Figure 45: Good sight lines at Nesvoll LC on the Røros line

As a result of a meeting between the Norwegian National Rail Administration, the Norwegian Public Roads Administration and the police, it has been decided that Harborg LC and Nesvoll LC will be equipped with warning signs with flashing yellow lights similar to those at Jømna LC on the Solør line and at Tomsbakken LC on the Vestfold line (see the figures below).

Figure 46: Warning sign at Tomsbakken LC on the Vestfold line.

The warning system consists of two signs with alternating yellow lights on either side of the road. These are connected to JBV's signal system. Motorists will pass a warning sign with flashing lights (one on each side of the LC) before reaching the red light by the barrier. The lights on the signs will start flashing when the traffic lights at the level crossing switch to red and the barriers descend.

At Tomsbakken the signals towards the road are also fitted with surrounding black shades that help to highlight the signal, since they provide more contrast than signals without shades. The barriers are equipped with alternating red LED matrices, one of which is always visible when the barrier is down. The rumble strips on either side of the level crossing help to make motorists aware that the speed must be reduced. In order to ensure that the rumble strips are effective, it is necessary to carry out regular maintenance since the surface is exposed to wear.

Figure 47: Shades highlighting the signal and alternating warning lights on the barrier.

2.3 Problems that do not emerge from the Synergi reports

2.3.1 Introduction

The Synergi reports do not provide a complete picture of all incidents involving level crossings. This section therefore addresses more general problems that exist at many level crossings without the number of incidents at the individual level crossings being sufficient for the problems to be clearly illustrated by the statistics. These problems are often more relevant to motorists and will therefore not emerge from the Synergi reports submitted by railway personnel. The problems primarily relate to an unfortunate design of the level crossing itself or to inadequate signage at the level crossing, which in turn may contribute to potentially hazardous situations.

2.3.2 Signage, road markings and sight lines

Both the Norwegian National Rail Administration and the Norwegian Public Roads Administration have clear regulations for signage at level crossings. Nevertheless, the Norwegian Public Roads Administration permits local adaptation both with respect to distant signs, the number of light signals, the number of barrier lights and the need to reduce the speed limit. This means that signage and signals to indicate level crossings vary from one place to another.

In some cases, local conditions have required additional signs/warning signals to those required under the rules; examples of this include the warning sign at Tomsbakken LC (Figure 46) and the extra light on top of the St Andrew’s cross at Hjellum LC near Hamar (Figure 48). These are examples of positive measures where the general signage regulations have been perceived as insufficient and special solutions have been designed as a consequence. In order for such solutions to be effective, it is important that they are unequivocal and impossible to misinterpret.

Figure 48: Extra red light signal at the top of a St Andrew's cross.

The fact that signs at level crossings are in accordance with the regulations is to no avail if the signs are so worn that they are difficult to interpret. There are numerous examples of such signs, and these signs should be replaced (Figure 49). If it is no longer possible to see what a sign indicates, it can hardly be said to have any function. The traffic load and pattern of traffic in the area may also have changed during the time that has passed since the signs were first put up. It may therefore be necessary to carry out a safety assessment of the traffic pattern in the vicinity of the level crossing in order to determine whether the signage is adequate.

Figure 49: Worn-out signs.

If a vehicle approaches a level crossing at too high a speed, the driver may have problems stopping in time. At Tomsbakken LC rumble strips have been installed on the road surface in order to reduce speed. The noise and vibration help make the driver aware that he or she is approaching a level crossing. If maintained, this can be an effective measure that could be utilised at other level crossings. It should be taken into consideration that rumble strips produce a certain amount of noise in the surrounding area and may, in some cases, make the road more slippery. The solution is therefore not suitable in all locations and for all speeds.

Figure 50: Example of poorly maintained rumble strips (Tomsbakken LC).

During the inspection of Heggedal LC, a car was observed that was forced to reverse when the barrier descended because it had stopped too close to the level crossing (Figures 33 and 51). At Heggedal LC, the barrier is not quite perpendicular to the direction of traffic and it is not obvious to motorists who are unfamiliar with the area how far they can proceed before stopping. One possible measure would be to mark the road in the same way as at traffic light junctions. NPRA manual 048 Traffic signal systems, section 10.5 states that the 'Stop line should be located five metres before the signals', This refers to the stop lines *before* the signals, which are in turn located before the barriers. Unfortunately, such stop lines are not very common.

Figure 51: Would a stop line here have helped motorists to ascertain where the barrier comes down?

If some form of road marking is used to indicate how far forward vehicles can drive, such markings must not 'invite' transgression. The 'give way' line in the road at Skjeberg LC (Figure 52) is an example of how motorists can be misled into driving right up to it, as one does at an ordinary junction. This may cause vehicles to stop in the middle of the track, on a stretch where the trains reach speeds of up to 130 km per hour.

Figure 52: The give way line can mislead motorists into stopping too close to the track.

Even if a level crossing is designed to have clear sight lines, surrounding vegetation can give rise to a maintenance problem. In accordance with the Norwegian National Rail Administration's regulations[11], trees, bushes, branches, tall grass etc must be removed so that drivers who have stopped before a level crossing have a clear view of a large enough section of the railway track to be able to cross without danger. Vegetation on the railway's own land can simply be removed. For removal of vegetation on land not belonging to the railway, see JD522[12] , which states that: 'In cities and densely populated areas, the neighbour's trees often grow into the track area and block the sight lines to signals or constitute a risk or a nuisance to railway operations.' Pursuant to the Norwegian Neighbour Act section 12[13], the Norwegian National Rail Administration is entitled to cut down trees or remove branches along property borders if they constitute a risk or a nuisance. The neighbour must be notified in advance and be given a reasonable time to remove that which constitutes a risk or a nuisance.'

In addition to this, the Railways Act section 10[14] , entitles the Norwegian National Rail Administration to carry out control of vegetation on land belonging to other parties. This right applies within 30 metres of the nearest track when warranted by considerations relating to rail traffic or the safety of the surroundings. Although the right to carry out vegetation control is not in doubt, there are nevertheless many examples of inadequate control (Figure 53).

[11] The Norwegian National Rail Administration's technical rules, JD532 Superstructure, rules for maintenance of level crossings.
[12] The Norwegian National Rail Administration's technical rules, JD532 Substructure, maintenance rules, chapter 9
[13] Act no 15 of 16 June 1961 relating to the legal relationship between neighbours (the Neighbour Act]
[14] Act no 100 of June 1993 on the establishment and operation of railways, including tramways, underground railways, suburban railways etc.

Figure 53 - Vegetation blocking sight lines to the level crossing (Stavne LC).

The location of cabins, including so-called relay cabins, can also obstruct sight lines. Pursuant to technical regulations[15], cabins must be located next to level crossings equipped with light/sound signals or a barrier system (see also Figure 15). The cabin contains interlocking equipment, power supply (batteries etc), an exterior control cabinet and equipment for manual control of the system. Although the cabin must be placed so as not to block the sight line from the road to the track, there are examples of cabins that do just that (Figure 54). This is very unfortunate since it can cause hazardous situations in which the driver of a vehicle is unaware of an approaching train. There are examples of a lower type of cabin being used to solve this problem, e.g. in Sweden (Figure 55).

Figure 54: A cabin blocking sight lines at Grytbakkstranda.

[15] The Norwegian National Railway Administrations' technical rules, JD550 Signals, Rules for Engineering, Road safety systems.

Figure 55: Example of a cabin that does not block any sight lines (Sweden).

2.3.3 Design of level crossings

There are quite a number of examples were the design of a road and level crossing is sub-optimal, and this can confuse motorists and thereby create hazardous situations. Driving instruction includes learning about behaviour at level crossings. However, since level crossings are not found everywhere such instruction is of a more theoretical than practical nature. The fact that hardly any two level crossings are the same also contributes to uncertainty about how to behave as a motorist or a pedestrian.

The combination of limited sight distance and complex design of crossings is a typical problem. Skjeberg (Figure 56) is one example of this. There, motorists are almost 'forced' to stop on the track in order to have adequate sight distance. Motorists who are turning left may have to wait a long time on the track since they have a duty to give way. The speed limit for trains here is 130 km per hour.

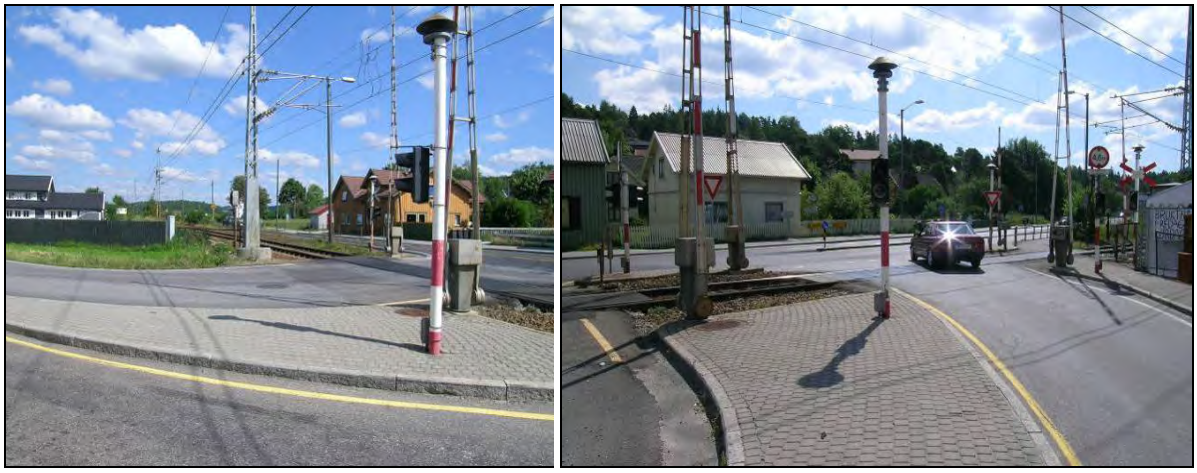

Figure 56: Poor sight lines to road traffic on the priority road (Skjeberg LC).

Where level crossings are close to road junctions, there are examples of inconsistencies in the manner in which motorists are warned that a train is approaching. In Tønsberg, for example, all the traffic lights turn red when the barrier descends, whereas they flash

yellow in Porsgrunn. We know that flashing yellow traffic lights in an ordinary road junction do not signify that motorists must stop, but rather that the traffic lights are out of operation.

In areas with heavy traffic and queues, vehicles getting caught between barriers is a relevant problem. In these areas, both the design of level crossings and the signage play a role in preventing hazardous situations. Before extra measures were implemented Tomsbakken LC (see section 2.2.7.4) was one such level crossing where there were problems in connection with queues. Better signalling has probably contributed to lowering the number of incidents.

Figure 57: Example of poor traffic behaviour - two cars have managed to cross the level crossing before the light changes to white and the barriers have been fully raised

If the road slopes down towards a level crossing, vehicles may have difficulty braking when the road surface is slippery. In the opposite case, when there is a slope leading up to the level crossing, a hazardous situation may arise as a result of the vehicle being unable to start quickly enough to get across the level crossing when the road is slippery. One example of such a level crossing is Ranheim, where the road has quite a steep gradient at the level crossing (Figures 58 and 18). Another example is Gubberud LC, where a collision between a vehicle and a train was also assumed to have been caused by a slippery road surface (Figure 59).

Figure 58: Slope leading up to a level crossing (Ranheim LC).

Figure 59: Slope leading down to a level crossing (Gubberud LC).

Slopes by level crossings are very demanding in terms of winter road maintenance. It is normal to salt the roads in Norway during the winter. However, this could lead to operational problems for level crossings since the salt short-circuits the trip function sections. It is therefore a requirement that salting must stop at a certain distance from level crossings. Even if salt is replaced by sand, salt will still be deposited on level crossings if there is a certain amount of traffic.

Figure 60: Good signage.

Pursuant to the rules, barriers must be located on either side of the road. Despite that, there are still examples of level crossings where both barriers are located on the same side of the road, e.g. Ranheim (Figure 58), Os (Figure 61) and Moss South (Figure 62). In some cases, this has been done to take account of other infrastructure, such as sewage pipes etc. The argument against having both barriers on the same side is that vehicles that are trapped between the barriers have a smaller chance of escaping short of smashing through the barrier.

There are several examples of motorists who were reluctant to drive through the barrier when trapped. This is not a rational way to behave, but it is impossible to predict how a person will behave in a stressful situation. In some cases, motorists have manoeuvred the vehicle away from the track where there was room for this; and this should be taken into account when designing level crossings. The Norwegian National Rail Administration requires barriers to be located at a distance of at least two meters from the nearest rail (Figure 15). If it is possible to have enough space for a vehicle behind the barrier, this could help motorists trapped between barriers to stay off the track.

Figure 61: Barriers on the same side of the level crossing (Os LC).

Figure 62: Barriers on the same side of the level crossing (Moss South LC).

3. ANALYSIS

3.1 Review of Synergi reports

The review of the Synergi reports on level crossing incidents from 2005 and 2006 shows that:

By far the greatest number of incidents (37%) can be classified as 'Motorist - unintentional wrongdoing' – a category in which Porsgrunn LC is most frequently represented.

This is followed by 'Pedestrian – intentional wrongdoing' (30%) – a category in which Heggedal LC is most frequently registered.

Four of the five level crossings with the most reports on incidents or near-misses also have road traffic junction problems.

The exact location of a large number of incidents at level crossings has not been registered. This makes it difficult to determine whether there is any particular level crossing in the category 'Other LCs' (section)' that stands out. Synergi reports should be as unambiguous as practically possible.

A disadvantage of basing oneself on the information in the Synergi reports is that they describe the incidents exclusively from the point of view of the railway. They rarely include the motorist's or pedestrian's explanation and understanding of the situation. Although it is unrealistic to believe that this information can be captured in every report, it would be helpful if the person reporting also made an attempt to arrive at some hypothesis about why the motorist or pedestrian behaved as he or she did. Writing 'two people crawled under the barriers at station x' provides significantly less information about the incident than if information of the type '… probably because the barriers here remain down for several minutes prior to train departure' or '… because the school bus was delayed and the pupils were to take the train' etc. were included Although this would to some extent be a subjective explanation, since it is not possible to get an objective statement from those involved, it must still be considered the second best option and would be of great help to those reviewing the reports.

Many reports are coloured by the fact that although the matter has been reported before nothing has happened. The belief that reporting does not help may contribute to reducing the number of reports, which is very unfortunate.

3.2 Results from inspections following the review of Synergi reports

The inspections showed that even if the cause of incidents at a certain level crossing could generally be classified as unintentional wrongdoing on the part of motorists, motorists are often influenced by a combination of factors to act the way they do. The impression from the Synergi reports corresponds to the actual situation, but the reports rarely describe the whole picture. It is therefore very important to also have experience of the level crossings.

In areas near town and city centres, the problem is not necessarily the level crossing itself, but rather that the combination of road junction and level crossing is inexpedient. In other cases, the amount of time that the barriers are down can be a problem. The barriers can be down for a disproportionately long period or for varying lengths of time, so that

the users are uncertain of whether a train will approach at any moment or in a while, or, in the worst case, they assume that the system has a technical fault (e.g. at Dal LC, where the barriers were down for more than seven minutes).

At Heggedal LC, the Synergi reports clearly show a lack of respect for the barriers. This is possibly because many people feel that the barriers are down for an unnecessarily long time before the train passes. Twenty-four of the 33 incidents are classified as 'Pedestrian – intentional wrongdoing'. The inspection and the Synergi reports give grounds for assuming that the barriers being down for such a long time before a train actually approaches has resulted in poor passenger behaviour in that they have lost respect for the barriers. In addition, motorists have a problem in that it is not clearly indicated where they must stop in order to be clear of the barrier. Independently of this report, it has been decided to modify the activating section of Heggedal LC for the direction Spikkestad-Asker so that the system is not activated until stopping trains have passed main approach signal B (from 4 June 2008). The fact that the Norwegian National Rail Administration has modified the activation time for trains heading towards Oslo indicates that they are aware of the problem.

For Dal station, two main problems emerge from the Synergi reports: One problem is that the barriers at the station are seemingly lowered too soon, so that people lose respect for them and cross the track anyway. The other problem follows from the first one in that people cross the track right before the crossing train passes. In some cases, this is assumed to happen because people wrongly believe that the barriers have been lowered for the train that is awaiting departure from the station, while they have actually been lowered for a passing freight train. If it were always the case that a train arrived shortly after the barriers had been lowered, people would have more respect for the barriers and very few of them would risk crossing the track illegally. In those cases where the freight train passed just after a person ran across the track, it must be assumed that the person was not aware of how close he or she was to being run over. On the other hand, the situation indicates that there is a lack of knowledge and information about the situation combined with a sub-optimal technical solution, since the barriers descend too soon in some cases.

After having observed the driving patterns at Porsgrunn LC, one gains an understanding of how the incidents occur. There is also a possibility that these transgressions are the result of intentional wrongdoings that went wrong - a risk that was taken as a result of a build-up of frustration at having to wait in the queue.

Barriers and light signals at Harborg LC and Nesvoll LC are often damaged in collisions with vehicles. This happens most frequently during the winter months and suggests that drivers may be unable to reduce the speed adequately before reaching the level crossing. The two level crossings have largely the same design. Since the incidents happened on the side of the level crossing on which a relatively long straight stretch of road is followed by a curve before the level crossing, the most likely cause seems to be that motorists are unaware that they are approaching a level crossing and therefore need to reduce their speed.

At such intersections between roads and railways, it is important that there is cooperation between the various public services and bodies. Both the Norwegian Public Roads Administration, the Norwegian National Rail Administration and the police took part in the inspections of Harborg LC and Nesvoll LC. This made it possible to exchange experience and points of view, and ended with representatives from the Norwegian Public Roads Administration and the Norwegian National Rail Administration agreeing there

and then to try a new type of signage. This is a good example of how it is possible to find solutions in a simple and direct manner.

3.3 Problems relating to diverse legislation

Although general rules exist for the design of level crossings, signage and maintenance, very many level crossings are affected by local conditions. In some places, problems at level crossings are due to road design, while in other places the problems may be due to the traffic load, signage or buildings.

It would be unfortunate if adaptation to local conditions were to result in fewer signs or markings than the rules prescribe. Where necessary, adaptation to local conditions should involve the implementation of additional rather than fewer safety measures. There are several examples of distant signs being omitted and of existing signs being combined with level crossing signs. Relevant requirements pursuant to the Road Traffic Act are described in the Regulations relating to signs and signals, and in manuals. These requirements permit the road sector to deviate from the rules at different levels.

The Accident Investigation Board Norway has found no overriding legislation or guidelines that require coordination of the different authorities' legislation and procedures. The road sector has no regulatory guidelines for how level crossings should be designed or reconciled with the guidelines provided for in railway legislation. The Norwegian National Rail Administration's technical rules describe engineering, construction and maintenance of level crossings.

Railway regulations and road traffic regulations do not correspond completely in terms of what they permit. For example, pedestrians can cross the road when the traffic lights are red as long as they do not obstruct other traffic. In the context of railways, it is illegal to cross a level crossing when the lights are red. Motorists are primarily familiar with road traffic rules and it is therefore important that these do not deviate from the railway rules. There are several examples of motorists not stopping at red lights before crossing a level crossing given that the barrier has risen far enough to allow them to pass (see Figure 34). It is particularly important that signals be used together in a uniform manner at level crossings with both railway and road traffic signals. The majority of motorists have a better understanding of road traffic signals than they have of railway signals, and it is likely that they will pay more attention to the former. If traffic lights or other markings provide ambiguous signals (e.g. the yellow flashing lights at Porsgrunn or the lack of a stop line at Heggedal), this may cause drivers to act incorrectly. In other words, it is very important that road traffic authorities and railway authorities collaborate on signage in order to ensure that there is no confusion (examples of combined signage/signalling are shown in Figures 63 and 64 below).

Figure 63: Road traffic and railway signs (Porsgrunn).

Figure 64: Traffic light in front of a railway sign (Tønsberg).

Although the design of a level crossing and its surroundings plays an important role in relation to safety at the level crossing, maintenance is also important. Vegetation can grow and block sight lines and signs can fade; the traffic pattern around the level crossing can change over time so that the original signage is no longer satisfactory. In winter, when vegetation is not such a big problem, maintenance work must instead focus on preventing a slippery road surface leading up to the level crossing and on preventing motorists from getting stuck on the level crossing itself. Poorly maintained road surface panels in combination with snow that makes it difficult to see where to stop can cause the wheels of vehicles to end up outside the level crossing so that they get stuck and the motorist is unable to proceed without assistance. Such incidents can largely be prevented if the level crossing is well maintained.

3.4 Level crossings in a man-technology-organisation perspective

3.4.1 Methodology

The dangers associated with complex level crossings are seldom due to one single factor, but must be seen in the context of the interaction between man, technology and organisation (MTO). A British survey (Dixon, Baker, Dickinson 2007) carried out by HM

Railway Inspectorate resulted in a set of factors that are assumed to affect people's behaviour at level crossings. The main conclusion from the survey is that human understanding of risk and the surroundings and design of the level crossing itself are important causes of behaviour in connection with the crossing of level crossings. HM Railway Inspectorate's report lists a total of eight factors:

competence, distraction, inadequate design, individually experienced control, risk compensation, familiarity, complacency and mental models. In the following these factors are explained and discussed in relation to the specific level crossings described in this report.

The extent to which a person crosses a level crossing illegally depends on the person's *competence*, i.e. whether he or she is familiar with and completely understands current laws and regulations that apply to the crossing of level crossings.

Noisy surroundings are an example of a factor that can have a *distracting* effect on motorists and pedestrians, and can contribute to making them forget which laws and regulations apply. Another example of a distracting factor is group behaviour, i.e. if many other people are crossing the level crossing, it is easy to do the same.

Many level crossings have existed for a long time, during which both the surroundings and the density of traffic may have changed, and the various level crossings are designed differently. An increase in built-up areas may have increased traffic across the level crossing, without the level crossing having been adapted to take account of the increase. One example of *inadequate design* is Porsgrunn LC, which today has a greater traffic load than when it was first built.

Individually experienced control is a factor that is dependent on people's perception of risk. If a person feels that he or she has good control of the situation, there is a greater likelihood that the person will take chances if there is an advantage to be gained by doing so.

Risk compensation means that people accept a varying degree of risk according to what they stand to gain or lose. The possibility of saving time can be considered a positive gain, while the possibility of injury/damage is a negative loss. If the positive gain is very high and the negative loss is low, it is likely that the person will cross the track. Hence, a level crossing with limited sight distance makes people more alert and cautious about crossing the track, while a level crossing with good sight lines is associated with a higher risk of people crossing.

A person who regularly crosses a level crossing will experience a certain degree of *familiarity*, which might cause them to fail to comprehend signals dictating how they should behave at the level crossing. In the worst case, this can cause users who repeatedly see no sign of danger at the level crossing (e.g. because trains pass very seldom) to perceive the crossing as less dangerous and thereby to behave with less caution than users who are less familiar with the crossing. This may be a contributing factor to the behavioural pattern, for example, at Heggedal LC.

Complacency means that people act on the basis of their belief that nothing bad will happen to them since everything has gone well so far. People who consider themselves to be very experienced and to have good control may therefore behave less cautiously than others.

The final factor that affects people's behaviour at level crossings is the *mental model* that all people create in order to interpret reality. If such a model contains incorrect facts, e.g. that it is always possible for a train to stop for a person on the level crossing, it may cause the person to take greater risks when judging the situation.

3.4.2 Examples

Considering Heggedal LC in the context of the results of this research, the reason that individuals and vehicles either pass illegally or before the all clear signal is given may be a combination of several factors:

Failure to take responsibility: When a group does something illegal it is not perceived as very negative since ‘everybody is doing it’.

Inadequate design: The barriers are down for an unnecessarily long period before a train passes.

Individually experienced control and familiarity: Persons who behave in this way are probably very familiar with the level crossing and feel in control when trains are approaching.

Risk compensation: The risk of missing the train is given more consideration than the risk of being hit by the train. There is normally a one-hour wait for the next train.

Changing these factors, e.g. having more frequent departures, having the barriers down for shorter periods and launching information campaigns aimed at users, may contribute to reducing the number of illegal crossings.

The most important factor that affects behaviour at the Porsgrunn station level crossing may be:

Distraction: There is a ‘jungle’ of signs and lights, heavy traffic and queues, and it is common behaviour for ‘everyone’ to drive against a red light; the combination of these factors may contribute to the intentional or unintentional misbehaviour of motorists at the level crossing.

Inadequate design: The signals at the level crossing come into conflict with the signals at the traffic junction, thus creating uncertainty. The volume of traffic is also much greater than that for which the level crossing was originally designed.

Risk compensation: Motorists have often waited a long time in a queue before reaching the crossing and are therefore willing to take chances in order to cross during the brief period that the lights are green.

Familiarity: The problems associated with the junction and the level crossing are well-known and many motorists have adapted their driving style accordingly.

If there were a lesser degree of distraction and better design of the road junction and level crossing (better signs and light signals, less queues), this might reduce the risk compensation factor (queuing times would be shorter). A high degree of familiarity would no longer have a negative impact since the junction would no longer ‘encourage’ illegal behaviour.

At Dal LC, the following factors can be said to influence people to behave illegally:

Inadequate design: The barriers are down for a very long time before a train arrives.

Individually experienced control and familiarity: Many people commute from the station on a daily basis and assume that they know the traffic pattern.

Incorrect facts in the mental model: It is easy to be misled into believing that the barriers are lowered for the train standing at the platform, while they are actually lowered for a passing train.

Increasing respect for the barriers by ensuring that they are lowered when a train is about to pass rather than a long time in advance, together with an improvement in the users' mental model of the level crossing (including the danger associated with crossing it) could lower the number of illegal crossings.

Despite clear signage, the main problem at Nesvoll LC and Harborg LC seems to be that motorists are unaware that they are approaching a level crossing. It is therefore difficult to relate these crossings to the above factors (Dixon, Baker, Dickinson 2007). Distraction insofar as the motorists are unaware of the level crossing can nevertheless be perceived as a contributory cause of the motorists' inability to adjust their speed. There may also be a certain degree of familiarity with the traffic pattern at the level crossing, which has so little traffic that raised barriers is the rule rather than the exception. The majority of the incidents did not involve trains, but rather vehicles veering off the road and damaging the system, with some risk that they could end up on the track. Increasing people's focus on the fact that they are approaching a level crossing may contribute to reducing the number of incidents.

4. CONCLUSION

In this report, AIBN has reviewed and systemised Synergi reports involving level crossings from 2005 and 2006. Based on this systemisation, AIBN has carried out inspections of a selection of the level crossings in order to gain first-hand experience of the specific problems. This report has also discussed a number of general problems relating to level crossings that do not emerge from the Synergi reports.

Although many incidents involving level crossings are reported in Synergi each year, the quality and level of detail in the reports vary. It is uncertain whether all incidents are reported, particularly in the case of problems that have been reported repeatedly without any measures being implemented. Where this is the case, there is a risk that reporting will be experienced as a waste of time. AIBN has divided these reports into overriding causal categories. The review of the reports shows that the cause of most incidents is unintentional wrongdoing by vehicle drivers. The second biggest cause of incidents is intentional wrongdoing by pedestrians. Some level crossings are over-represented in the statistics. In order to investigate whether their causal categorisation is correct, AIBN has observed how people behave at these level crossings.

The inspections showed that although the cause of incidents at a given level crossing can generally be classified as unintentional wrongdoing by motorists, there is often a combination of factors that influences motorists to act as they do. Although the impression from the Synergi reports corresponds to the actual situation, the reports rarely describe the whole picture. It is therefore very important to also have experience of the level crossings.

In areas near town and city centres, the problem is not necessarily the level crossing itself, but rather that the combination of road junction and level crossing is inexpedient. In other cases, the amount of time that barriers are down can be a problem, either because they are down for an unnecessarily long time or because they are down for a varying length of time, causing users to become uncertain.

Based on experience of level crossings, a number of general problems are known that do not immediately emerge from the Synergi reports. These often relate to the design of the level crossing, particularly its interface with road traffic. Today, level crossings are signposted in many different ways, and there are also differences in how traffic lights are used at level crossings in conjunction with road junctions. A number of combined level crossing/ road junctions were not originally intended for the traffic load they have today. Together, the above factors may require that the combination of level crossing and road junction be considered as a single whole and that safety measures be considered for the two together.

The Norwegian National Rail Administration has an updated list of priority areas that affect the traffic safety aspect of rail transport. As of October 2008, landslides have the highest priority. Level crossings are the second priority and ignoring stop signals is the third priority. This report has been drawn up on the basis of statistics from 2005 and 2006, and inspections of selected level crossings. The Accident Investigation Board Norway is aware that the Norwegian National Rail Administration has level crossings as its highest safety priority in 2005-2006. Furthermore, the Accident Investigation Board Norway's list of the most heavily trafficked level crossings corresponds well with the Norwegian National Rail Administration's ongoing planning to phase out level crossings.

Continual efforts are being made to reduce the number of level crossings, either through redevelopment or by building underpasses or bridges. This work is demanding in terms of time and costs, and level crossings will therefore exist for many years to come. It is important that laws, regulations and rules are harmonised in order to provide the best possible traffic safety on both roads and railways. In order to find measures that can reduce the number of incidents at level crossings, it is important that there is cooperation between the various public services and bodies. Many level crossings vary from each other and appear to have an intricate and complex design. Despite this, there may be characteristics of the different types of level crossings that are worth noting. In this report, AIBN has studied level crossings at four different locations, and these can be characterised as follows:

1) Level crossings near stations with an uncomplicated traffic pattern. The design of the system may cause the barriers to stay down for an ‘unnecessarily’ long time. This may reduce users’ respect for the barriers, and can cause people to intentionally break the rules.

2) Level crossings near stations with a complex traffic pattern: The level crossing and pertaining signs and light signals can be ‘drowned out’ by other traffic signs, markings and light signals. There is often heavy traffic at these level crossings, which causes stress and uncertainty and thereby leads to negative behaviour.

3) Level crossings at stations with crossing trains: The combination of barriers that are down for a seemingly long period (from the perspective of pedestrians and motorists) can create uncertainty since it is not apparent why they are down for such a long time. This can cause people to take chances crossing the track since they are not aware of the crossing train.

4) Level crossings on open lines with an uncomplicated traffic pattern: A lack of awareness by motorists combined with excessive speeds on approaching the level crossing can create hazardous situations.

5. SAFETY RECOMMENDATIONS

The Accident Investigation Board Norway proposes the following safety recommendations.[16]

Safety recommendations JB no 2009/04 T

Road traffic and rail traffic are regulated by different rules. This is not only a challenge for those who build, own and regulate infrastructure, but also for road and railway network users. Level crossings are crossing points that require coordination between road and railway and it is therefore important that the rules that apply to road traffic and railway traffic are harmonised and provide good safety. The Accident Investigation Board Norway recommends that the Norwegian Railway Inspectorate, the Norwegian National Rail Administration and the Norwegian Public Roads Administration jointly review and coordinate their rules with a view to improving safety at level crossings.

Safety recommendations JB no 2009/05 T

The design of level crossings and their surroundings greatly influences road users' behaviour when they cross level crossings. The individual road user's possibility of understanding the risk in such places is greatly affected by the design and condition of the level crossing. It is therefore important that level crossings are designed in such a way that they provide the best possible opportunity for road users to behave safely. The Accident Investigation Board Norway recommends that the Norwegian National Rail Administration and the Norwegian Public Roads Administration jointly review and coordinate their plans for the design and operation of level crossings with a view to improving safety at existing and future crossings.

Safety recommendations JB no 2009/06 T

Currently, the information that is used in Synergi reports is exclusively gathered from people connected with the railway. The experience of users who are involved in near-misses are only recorded in the accident database to a small extent. Today, information from road users is taken from the police's road accident reports. Where possible, reporting by road users can be a valuable contribution to increasing the quality of the accident database as a source of safety improvement measures. The Accident Investigation Board Norway recommends that the Norwegian Railway Inspectorate request the Norwegian National Rail Administration and railway undertakings to endeavour to ensure that an assessment of road users' behaviour is included when reporting undesirable incidents involving level crossings.

The Accident Investigation Board Norway

Lillestrøm, April 02 2009

[16] The investigation report is submitted to the Ministry of Transport and Communications, which takes necessary action to ensure that due consideration is given to the safety recommendations, cf. Regulations no 378 of 31 March 2006 relating to public investigations into railway accidents and serious railway incidents etc. (the Railway Investigation Regulations) section 16.

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