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Longer and heavier vehicles

Monitoring Traffic Safety Longer and Heavier Vehicles

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Summary

Introduction

Since 2001 articulated vehicles commonly referred to as LHVs (Longer and Heavier Vehicles) have been permitted on public roads in the Netherlands. Because there had been no prior experience to build on, a pilot scheme was introduced first. LHV authorisations were subsequently extended gradually. An evaluation phase for LHVs has been in effect since 1 November 2007. This means that this is the first time that LHVs are being driven around on such a large scale. On 1 July 2010, 153 companies had been given a dispensation and 397 towing vehicles had been issued an exemption to drive with an LHV combination. Both the number of LHVs and the number of routes covered by LHVs are expected to steadily increase over the coming period. The Dutch Minister of Infrastructure and the Environment wants to keep tabs on this, particularly in relation to road traffic safety. Although previous research has given no cause for concern over the traffic safety of these types of vehicles, it is important to eliminate any possible risks accompanying the increase in the number of LHVs. The first monitoring study was conducted in 2009. And another monitoring study was conducted in 2010, the results of which are presented in this report.

Outlines for research

On the basis of a few research questions it was investigated whether the current deployment of LHVs on the Dutch road network causes any issues in terms of road traffic safety, traffic flows and road design. Police accident reports and accident statements from transport companies and insurers served as a basis for answering the research questions. Analyses of recorded accidents involving LHVs alone, however, provide insufficient basis to substantiate reliable conclusions in relation to the traffic safety of LHVs nationwide; since the number of LHVs involved in accidents is too limited to allow statistical analysis. Therefore accident reports have been used to design a number of case studies, which, in turn, were examined on the basis of accident statements submitted by companies and insurers, and the case studies were subsequently tested against the experiences of LHV drivers, some of whom having had one or more accidents with an LHV and others having had no such accidents. Finally, in order to create an exhaustive image of possible risks attached to the use of LHVs, the case studies were tested against the judgement of other important experts by experience, such as road managers, examiners and enforcement bodies.

The second part of the study consists of an analysis of the core areas. These consist of roads that have been designated for use by LHVs, such as industrial sites for example. Various stakeholders have been contacted to assess which bottlenecks occurred and to what extent the various types of core areas differ from each other. In addition to road traffic safety issues other issues such as regarding traffic flows and road design were also examined.

Outcomes

Between 2007 and mid-2010 the police recorded 19 accidents involving an LHV. In only one case a person was slightly injured. All other cases involved material damage only. Additionally, companies reported 35 accidents. In one of these cases the victim had to be admitted to hospital. Both cases involving a victim concerned rear-end collisions whereby the specific characteristics of the LHV (length and swerving behaviour) did not play a role in the accident.
None of these cases involved vulnerable road users.

Not all accidents that occur are recorded by the police. However, considering the high degree to which accidents involving hospitalisations and fatal casualties are recorded, it is highly unlikely that other accidents involving LHVs and resulting in hospitalisations or fatal casualties took place in the period between 2007 and mid-2010.

Looking back on the research questions, two conclusions can be drawn:
- No direct issues or bottlenecks can be observed with regard to traffic safety, flows and road design;
- The type of accidents whereby an LHV was involved are typically characterised as a 'truck accident'. Owing to the fact that only a limited number of LHVs drive on Dutch roads it is not yet possible to establish whether certain types of accidents that typically occur with trucks occur more or less frequently with LHVs.

Although no direct issues were observed, there are several points of interest:
- Traffic safety:
  - Other road users possibly insufficiently recognise LHVs whilst overtaking or merging;
  - LHVs that have a limited axle pressure due to a light or little cargo could be more prone to poor weather conditions (slippery surface and wind) than regular trucks.
- Traffic flows:
  - Some breakdown bays are unsuited to accommodate LHVs;
  - It is not known whether the Incident Management protocol takes LHVs into account;
- Road design:
  - It may be harder for LHVs to take tight corners;
  - There are insufficient parking spaces that can accommodate LHVs;
  - It is harder for LHVs to reverse than it is for regular vehicles;
  - LHVs are insufficiently taken into account during roadworks and diversions.

The limited number issues that exist with regard to traffic safety, road design and traffic flows is in part due to vehicle requirements set for LHVs in the Netherlands, and the designation of core areas regarding their admission on the Dutch road network. The experts have, however, pointed out areas for improvement. Some of these refer to better facilitation of LHVs should their number increase. These recommendations are included in chapter 8.

1 Introduction

1.1 Outset

1Since 2001 articulated vehicles, commonly referred to as LHVs (Longer and Heavier Vehicles) have been permitted on public roads in the Netherlands. Vehicle combinations have a maximum train weight of 60 tonnes (as opposed to 50 tonnes for regular trucks) and a maximum length of 25.25 metres (as opposed to 18.75 metres).

The LHV was initially an entirely new concept for the Netherlands. As it was not possible to build on previous experience, an intensely monitored pilot scheme was introduced first. LHV authorisations were subsequently extended gradually. An evaluation phase for LHVs has been in effect since 1 November 2007. During this phase, every haulage business in the Netherlands can claim dispensation to operate LHVs. This means that, for the first time, LHVs are being driven around on a large scale. On 1 July 2010, 153 companies had a dispensation and 397 towing vehicles had been issued an exemption to drive with an LHV combination.

Both the number of LHVs and the number of routes covered by LHVs are expected to steadily increase over the coming period. Exactly how this will turn out is difficult to say beforehand. The Dutch Minister for Infrastructure and the Environment therefore wants to keep tabs on this, particularly in relation to road traffic safety. Although previous research has given no cause for concern over the traffic safety of these types of vehicles, it is important to eliminate any possible risks accompanying the increase of the number of LHVs. The Directorate-General for Mobility (DGMo) of the Ministry of Infrastructure and the Environment has requested the Directorate-General's Traffic and Shipping Department (DVS) to monitor the evaluation phase, among other things in relation to road traffic safety. Additionally, clarity is sought on which, if any, consequences the presence of LHVs brings about for road design and traffic flow. The first monitoring study was conducted in 2009. In 2010 the DVS commissioned ARCADIS and NEA to conduct a new monitoring study, the results of which are given in this report.

1.2 Objectives and research questions

Objectives

The research aims to provide insight in whether the current deployment of LHVs is causing issues in relation to road traffic safety, traffic flows and road design. The study consists of an analysis of LHVs, interviews with experts and an analysis of core areas.

Research questions

This study answers the following research questions:

1 Did an analysis of the accidents involving LHVs bring to light any possible issues following the authorisation of LHVs on the Dutch road network? If so, what are these issues?
   a. How do these differ from accidents involving regular trucks?
   b. Is there a difference between driving on the motorway and the underlying road network?
2 Can differences between the different LHV configurations be observed?
   a, Which other aspects particularly attract attention in analysis of the accidents that occurred whereby LHVs were involved?

b. What are the general observations of the experts experienced with LHVs in core areas, specifically in terms of road safety in relation to vulnerable road users, traffic flows and road design?
c. How do these experiences differ from regular road traffic?
d. Can differences be observed between the different core areas or forms of local road management that offer points of application for policy?

1.3 Approach

Rarefactive issue

On 1 July 2010 some 397 towing vehicles had a valid exemption to drive an LHV combination. In proportion to the entire Dutch fleet of vehicles, these are too few LHVs for statistical analysis to substantiate reliable conclusions in terms of potential risks attached to further deployment of such vehicle combinations, pre-eminently in relation to their road traffic safety. Given the total number of vehicles in use in the Netherlands, chances of an LHV getting involved in an accident are relatively slim. Mere analysis of recorded accidents involving LHVs therefore provides insufficient basis to substantiate any statements on a nationwide level. This could be referred to as a *rarefactive issue*: there are simply not enough LHVs and (because of that) not enough LHV accident records to allow for quantitative statistical analysis. In some way the experts face a *rarefactive issue* as well: there are currently so few LHV combinations on the roads that most people working in highways management and road maintenance have as yet had little hands-on experience with LHVs.

To reduce the rarefactive issue, for the purpose of the 2010 survey, the decision was made to, in addition to information on police registered accidents, also compile data on accident statements that were only registered by companies and insurers. This means an increase in the total number of incidents which were to subjected analyses, and helps to create better insight in the effects on traffic safety through the deployment of LHVs.

Focus on interviews with LHV drivers and examiners

LHV drivers are currently the only true experts by experience. They know the vehicle, its behaviour on the road, circumstantial influences and are able to draw comparisons between LHVs and regular large goods vehicles, since they operate or have operated both. Examiners from the Central Office for Motor Vehicle Testing also have experience driving LHVs. Based on the exams with prospective drivers of longer and heavier vehicles, they know which matters of interest to focus on. For example, difficult situations that are encountered with LHVs. Drivers and examiners are therefore a good source of obtaining information on potential road traffic safety issues regarding LHVs. This study has cantered around interviews with LHV drivers and their examiners. They have the most extensive practical experience both with LHVs and regular trucks, and are best suited to indicate the differences between driving LHVs and regular trucks.

Simulated case study analysis

The driver and examiner interviews alone, however, are insufficient. In order to gain a complete overview of any possible risks involved with deployment of LHVs, additional sources are required. It was therefore decided to apply simulated case study analysis. In this methodology, derived from criminal investigation, it is attempted through analysis of available facts – by way of statements from witnesses and witness experts – to 'fill in the blanks'. Based on the bare facts, hypotheses are formulated, which are then tested against experts' insights and, if necessary, refined and amended. This significantly increases the reliability and usability of the results, even if there have only been few cases available for analysis.

The recorded accidents involving LHVs served as a basis for this study. These were subsequently further elaborated with the experiences of LHV drivers who had been in one or more accidents with an LHV and LHV drivers who had not had any accidents. Their judgements were then tested against the expert opinions of people such as those working in road management and road maintenance, and employees of companies that use LHVs.

The deliberate starting point of the analysis was that an increase in the number of LHVs is accompanied by risks in terms of road traffic safety and issues in relation to traffic flow and road design. Rather than *prove* that an increase in the number of LHVs *will not* bring about any additional risks, the aim has been to *disprove* that an increase in the number of LHVs *will* bring about additional risks. Firstly, this approach ensured that as many issues and risks as possible were systematically investigated and examined. Secondly, it enabled the researchers to pass firmer judgements in respect of the probability of any issues to occur.

1.4 Guidance notes

Chapter 2 details the research methodology. Chapter 3 describes the accident analysis, and chapter 4 provides an analysis of the accident statements. Chapters 5 and 6 respectively show the results of the interviews with the drivers and examiners, and the expert session. Chapter 7 examines the core areas. Chapter 8 provides the conclusions and recommendations.

2 Research methodology

2.1 Introduction

The figure below shows a visualisation of the research methodology. The left column shows the different forms of consultation. The central and right column respectively show the activities and results per step.

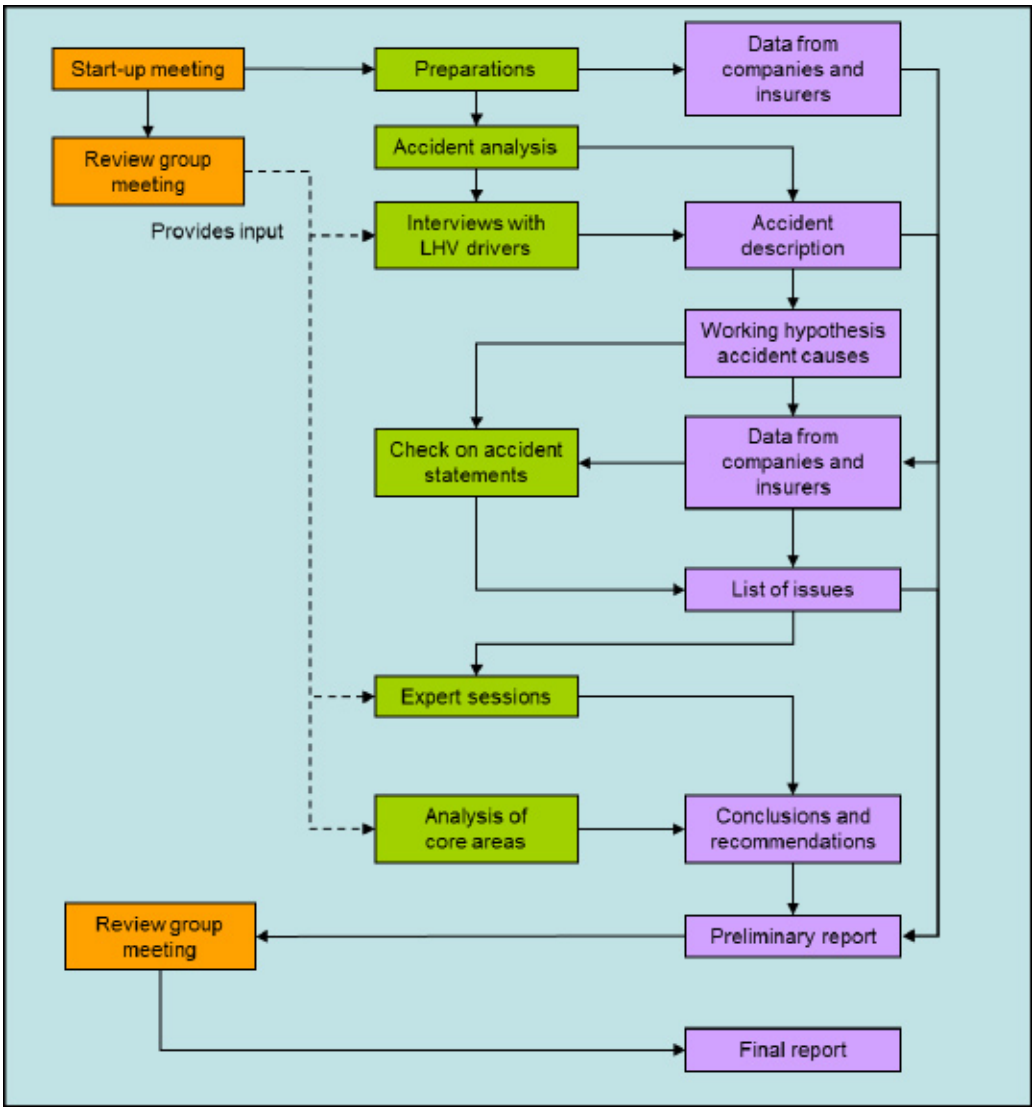


Figure 2.1 Research methodology diagram

As explained, the methodology applied was that of simulated case study analysis. The accident analysis is not dissimilar to crime scene investigation. The information captured in police accident records is pretty much the only hard data available in relation to actual traffic safety of LHVs. Based on exhaustive technical analysis of this data, working hypotheses were formulated regarding the causes of accidents involving LHVs. This produced initial insight into potential and, particularly, LHV-related issues in respect of traffic safety that may occur in consequence of an increase in the number of LHVs on the Dutch road network.

The subsequent step was to hear witnesses: the working hypotheses were tested and refined by putting them to the leading experts by experience: LHV drivers. Both LHV drivers with and without past involvement in registered LHV accidents were interviewed. This generated a list of potential, LHV-specific traffic safety issues, as well as matters of road design and traffic flow that merited further attention.

The third and final step was for expert witnesses to assess this list. Expert witnesses consulted included representatives of the Dutch vehicle licensing agency (RDW), the Transport and Water Management Inspectorate (IVW) and the national police authority (KLPD). They assessed and complemented the findings and, where possible, translated them into national recommendations.

The accidents registered by the police were subsequently compared with information on claims that were submitted to the insurers. In spite of the fact that these accident statements are less detailed than the police registration forms, they do provide a good basis to assess whether the potential causes that were mentioned based on the accident analysis also played a role with regard to these accident statements. If this is the case, then it is possible to ascertain that the cause concerned is also causing road traffic safety issues.

The second part of the study consists of an analysis of the core areas. The core areas are made up of roads that have been designated for use by LHVs. A core area generally consists of an industrial park. Various stakeholders were consulted to assess the specific issues that occur within the core areas and to what extent the different types of core areas differ from each other. In addition to road traffic safety issues, other issues regarding traffic flows and road design were also examined.

The following paragraphs will provide further elaboration on each stage of the methodology.

Review group
For all research as part of monitoring the evaluation phase a review group was put together. This review group was made up of specialists from a variety of backgrounds and organisations concerned with the implementation of LHVs. An initial meeting with the review group was convened to discuss and agree on research methodology. The preliminary report will be discussed in a second meeting. As soon as the report gains unanimous approval from the review group, its status will be changed to final. Appendix A lists the review group members.

2.2 Accident analysis

2.21 *Purpose*

The purpose of factual accident analysis is to gain preliminary insight into possible issues concerning LHVs in relation to traffic safety, road design and traffic flow. This insight is obtained through technical analysis of LHV accident records.

2.2.2 *Working method*

Considering the relatively small number of LHV combinations in the Netherlands, the number of accidents will be limited. In the 2009 study the decision was made to analyse each accident separately and use the outcome of the analysis to formulate working hypotheses pertaining to possible causal factors. The analysis focused on five aspects: infrastructure, weather conditions, driver behaviour, vehicle characteristics and traffic. The same working method was applied for the study conducted in 2010 and was supplemented with two questions: how was the accident

caused and what action could have help to prevent the accident. The present report also includes all accidents that were analysed in the previous study. This increase in the total number of analysed accidents makes it possible to draw firm conclusions.

Various steps of the accident analysis are explained in brief below. The analysis itself is described in full in chapter 3.

Step 1: ascertaining accidents involving LHVs
Accidents involving trucks are recorded by registration number of the towing vehicle. However, police accident records do not contain details of the actual vehicle combination driven at the time of an incident. Because of this, the groundwork for research consisted of all accidents involving towing vehicles registered as having been issued with dispensation to be driven as LHV combinations. In order to establish how many of these vehicle combinations were in fact being operated as LHV, inquiries were made with the owners of the towing vehicles, most of which were haulage firms.

Since not all owners were able to trace whether the towing vehicle was hauling an LHV combination, an accident breakdown schedule was drawn up to try and determine with the highest possible degree of certainty whether the accidents involved LHVs.

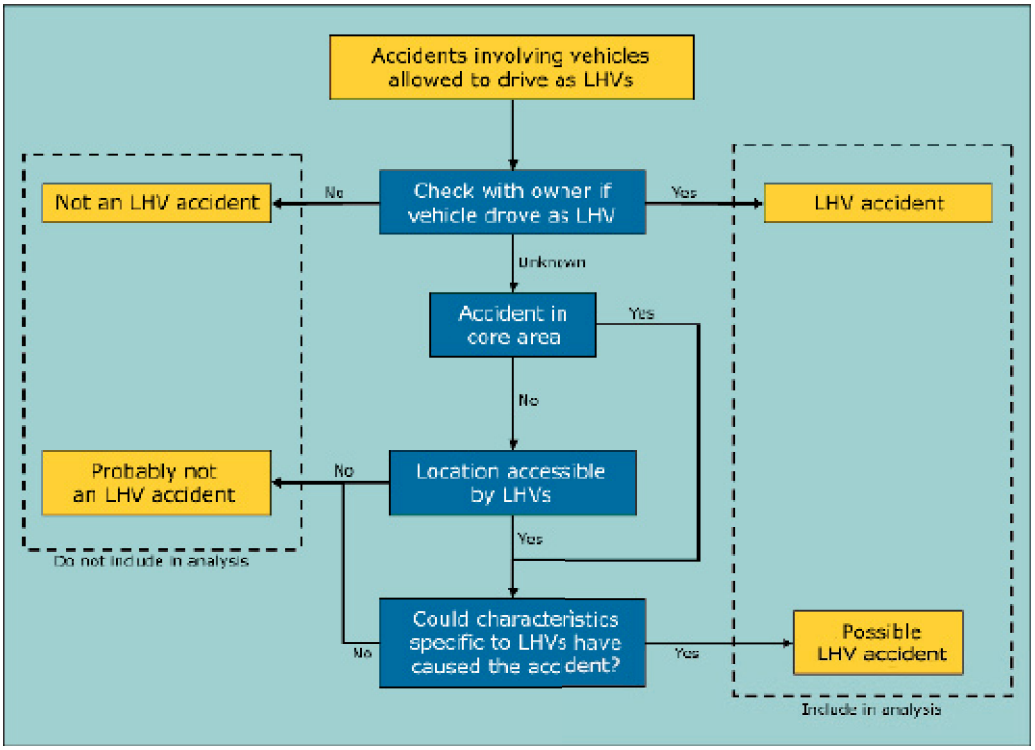


Figure 2.2 Analysis diagram of LHV accidents

If the owner was unable to trace whether the vehicle was being driven in an LHV combination, it was first determined whether the accident had taken place within or outside of the routes and core areas designated as permitted for use by LHVs. If the accident happened outside these designated zones, it would have meant the LHV was in breach of regulations. For accidents that had happened outside of permitted

routes and areas, aerial photographs were used to examine whether the infrastructure surrounding the accident scene would have been accessible by LHV. If the location proved inaccessible by LHV – for instance in a 30 kph zone with traffic calming measures – any involvement of an LHV in the accident could be ruled out. Finally, based on the police accident records, attempts were made to determine whether the cause of the accident bore any relation to vehicle characteristics specific to LHVs (length, swerving behaviour).

All relevant data on the accidents with LHVs were subsequently recorded in a database.

Step 2: analysis of the individual cases
All accident records of accidents involving LHV combinations were analysed. In order to trace back to which extent LHV characteristics contributed to each accident, the accidents were assessed against a number of criteria. Using aerial photographs, the location of the accident was checked for any particular infrastructural characteristics. The Netherlands' national accident database (BRON) was also consulted to find out whether any of the accident locations concerned could be considered accident hotspots. (ViaStat-Online was the application that was used to access *BRON*.) LHV accidents were also compared to typical truck accidents. Moreover, weather conditions were taken into consideration, as well as whether the accident could have been caused by driver error on the part of the other party involved. Lastly, the cause of the accident and what should have been done to prevent the accident were examined. The last-mentioned point is especially interesting as input for measures that will lead to a safer use of LHVs.

Step 3: comparison of accident characteristics
To determine what, if any, common denominators there were between the accidents, the various characteristics of all accidents were compared to each other to gain an understanding of possible influences from elements such as infrastructure, special conditions (weather, light/brightness, traffic congestion), driver behaviour and vehicle characteristics. The point of this comparison was to establish which particular cause-circumstance combinations occurred more often than others. This would provide a first outset towards formulating the working hypotheses concerning possible traffic safety risks in relation to the use of LHVs.

2.3 Comparison with insurers' claims information

2.3.1 *Purpose*

This step was aimed at evaluating and supplementing the analysis of the accidents registered by the police.

2.3.2 *Working method*

For this step all companies that had a dispensation to operate one or more LHVs between 1 November 2007 and 1 September 2010 were contacted. The companies were asked to provide data on accident statements involving LHVs. The companies were also asked to give their permission so that additional information from their insurers could be obtained.

The Dutch Association of Insurers was subsequently contacted to assess whether there more incidents involving towing vehicles that were permitted to drive as an LHV. This was only done for companies that had given their permission to obtain this information.

The available data on the accident statements was subsequently entered into the same database that contains information on the police-registered accidents. This helped to create a complete overview of all known incidents involving LHVs.

Based on the available data on accident statements, the working hypotheses were assessed on the basis the accident analysis. It was examined to what extent potential traffic safety risks, resulting from the accident analysis, were also the cause of damage reported by the companies and the Dutch Association of Insurers. This comparison resulted in a list of risk factors that play a role in road traffic safety issues involving LHVs.

This step is further elaborated in chapter 4.

2.4 Interviews LHV drivers and examiners

2.44.1 *Purpose*

The purpose of the third step was to fine-tune and test the working hypotheses.

2.4.2 *Working method*

To put to test whether the accident analysis would hold up in real life, in-depth-interviews were conducted with LHV drivers and examiners of the Central Office for Motor Vehicle Driver Testing (CBR).

The first series of interviews scheduled concerned those with LHV drivers who had been involved in the accidents we had studied. After all, they were the prime persons to elaborate on and supplement the bare data from the accident records with their first-hand experience: "Could the accident indeed be attributed to the turning radius of the vehicle being too tight?", "To what extent did the length of the vehicle combination complicate matters?" and so on and so forth

The second series of interviews to take place was with LHV drivers and examiners who had not been involved in an accident. They were asked to review the very same data and questions as the aforementioned group. In addition, their near-accident experiences were focused on, asking under what circumstances these had taken place and to what extent vehicle-specific characteristics had contributed to each experience.

There was no standard questionnaire for these interviews, but rather a listing of matters of interest which was based on the working hypotheses from step 1, for every accident is different. Aside from that, experience has shown that interviews run more smoothly and are more productive if the questioning allows for some flexibility. This leaves space to improvise at points in the conversations that weren't anticipated in advance, which in turn benefits the depth of conversation and allows it to flow more pleasantly for the interviewee.

In this study it is of paramount importance to be able to distinguish traffic safety risks specific to LHVs from traffic safety risks that generally apply to all goods transport vehicles. Since LHV drivers are experienced at handling both LHVs and non-LHVs, they are pre-eminently suited to provide decisive answers on this subject.

This step is further examined in chapter 5.

2.5 Expert session

2.5.1 *Purpose*

The purpose of this step is, firstly, to establish which issues in relation to road traffic safety, traffic flow and road design would arise from allowing (large numbers of) LHVs onto the Dutch road network. Secondly, where possible, the aim is to draw up recommendations to deal with such issues.

2.5.2 *Working method*

In order to make sensible statements about the use of LHVs in relation to matters such as traffic safety and road design, sufficient insights are required into the Dutch road network and traffic situation, but, of course, more importantly their bearing on LHVs and vice versa.

To gain a better understanding of this a session was set up with professionals working in highways management, enforcers (RDW and the National Police Services Agency (KLPD) and representatives of LHV companies. In this session, the findings from the preceding accident analysis and interviews were put forward to the experts for them to assess and extend on. Together they discussed what issues could arise in which particular locations, how serious this would be and what measures could possibly be taken in anticipation of this.

This step is further elaborated in chapter 6.

2.6 Analysis of core areas

2.6.1 *Purpose*

The purpose here was to gain insight in how LHVs function in the core areas.

2.6.2 *Working method*

The analysis of core areas is a new component as part of the 'Monitoring Traffic Safety of LHVs' study. To assess the diversity of core areas the effects of LHVs on traffic safety, traffic flows and the road design were examined.

To gain insight in the diversity of the core areas, the core areas were first categorised by type. The following aspects were assessed among others - their location in relation to domestic areas, the spatial layout and the dominant industrial sector.

Ten core areas that accurately reflect the diversity of core areas were subsequently chosen. These core areas were visited and discussions were held with stakeholders such as companies that drive the LHVs to the core areas in question, the road administrator and the regional police. On top of that an assessment of the accidents occurring in these areas was made.

This step is further elaborated in chapter 7.

3 Accident analysis

3.1 Introduction

The purpose of the factual accident analysis is to gain preliminary insights into possible issues concerning LHVs in relation to road traffic safety, road design and traffic flow. These insights are obtained through an in-depth analysis of registered accidents involving such vehicle combinations. The process involved three steps. The first step was to ascertain how many accidents involving LHVs had taken place. Secondly, each accident was subjected to individual analysis and the third step was a combined analysis to compare accident characteristics between incidents.

In order to make statements based on the registered accidents, it is important to gain an understanding of the specific vehicle characteristics that distinguish an LHV combination from a regular truck combination. Further insight required concerns the types of accidents that are relatively common among large goods vehicles and could therefore be considered 'typical truck accidents'. Finally, it is important to know whether the scene of each LHV accident is a known accident hotspot. These aspects are further explained in paragraph 3.2. The subsequent paragraphs detail the accident analysis. Finally, paragraph 3.7 lists the outcomes from these accidents.

3.2 Distinctive features of LHV combinations

Vehicle characteristics specific to LHVs
The aim of this study is to establish whether the presence of LHVs on Dutch roads creates issues in relation to road traffic safety, traffic flow and road design. Any autonomous growth aside, deployment of LHVs will result in a decrease in the number of regular truck combinations.

The accident analysis should help establish whether this shift could give rise to any traffic safety issues. To do so, what needs to be determined is whether any accidents involving LHV combinations were (partly) caused by vehicle characteristics specific to LHVs, i.e. specific features that distinguish an LHV from a regular truck. If such LHV-specific characteristics did indeed play a part in any accidents, this could be an indication of possible traffic safety issues.

Specific characteristics of LHV combinations:
- Their extended length (25.25 metres instead of 18.75 metres);
- More likely to swerve when negotiating bends and corners.

Previous research shows that the vehicles' extended length and swerving behaviour are the only characteristics that truly distinguish LHVs from regular truck combinations. Vehicle licence dispensation notices clearly state that the blind spot as well as the vehicle acceleration and deceleration performance of an LHV combination are not allowed to differ from a regular truck combination. As such, LHVs cannot be distinguished from regular trucks on those particular points. Appendix D contains the Policy Statement Testing and Dispensation LHV Evaluation Phase 2009 as published in the Dutch Government Gazette no. 13876 on 17 September 2009.
Typical truck accidents
Aside from the characteristics that distinguish LHVs from regular trucks, it is also important to know which types of accidents are relatively more common among

large goods vehicles than among passenger or light commercial vehicles. Not only are both LHVs and regular trucks longer and heavier than passenger and light commercial vehicles, these differences in size and weight also result in different acceleration and deceleration patterns as well as blind spots that are sizeably different. These differences between LHVs and regular trucks on one side and passenger and light commercial vehicles on the other side are conceivably greater than the differences among LHVs and regular trucks. One may therefore assume that accident types relatively more prevalent among regular trucks are likely to occur among LHVs to a similar extent. In light of this, in assessing accidents involving LHVs, knowledge of accident characteristics relatively common among regular trucks is essential.

To this end, truck accidents recorded in the Netherlands between 2005 and 2009 were compared to accidents which did not involve trucks. The survey focused on accident type, critical manoeuvre and root cause. The below tables list the ten most common occurrences within each angle, both for accidents that did and did not involve trucks. Truck accidents listed are all accidents which involved a truck; this by no means implies that the truck was always to blame for the accident.

Accident type	**Number**	**Percentage**
Side collision	150137	29.9
Rear-end collision	126765	25.2
Fixed object	97992	19.5
Head-on collision	62323	12.4
Single-vehicle accident	36574	7.3
Animal	11179	2.2
Pedestrian	9606	1.9
Parked vehicle	5340	1.1
Unknown	1474	0.3
Inanimate (loose) object	988	0.2

Table 3.1 Non-truck accidents in the Netherlands 2005-2009 by accident type

Type of accident	**Number**	**Percentage**
Side collision	22155	41.0
Rear-end collision	13731	25.4
Fixed object	9392	17.4
Head-on collision	4284	7.9
Single-vehicle accident	3264	6.0
Pedestrian	438	0.8
Parked vehicle	327	0.6
Inanimate (loose) object	197	0.4
Unknown	163	0.3
Animal	97	0.2

Table 3.2 Truck accidents in the Netherlands 2005-2009 by accident type

When looking at the type of accident, it becomes clear that the Top 5 most common accident types are the same for both truck and non-truck accidents in the Netherlands. Figures do show that the number of side collisions is about a third higher among truck accidents than among non-truck accidents (41.0% as opposed to 29.9%).

Critical manoeuvre	**Number**	**Percentage**
Rear-end collision without involving turning vehicle	76686	15.3
Other side collisions	57366	11.4
Other	42565	8.5
Side collision at intersection	40468	8.1
Collisions with tree and other fixed objects	34751	6.9
Collisions with other road furniture	32787	6.5
Collisions with lamppost	30454	6.1
No vehicle off the road	27288	5.4
Head-on collision without lane change	26854	5.3
Head-on collision with parked vehicle	19876	4.0

Table 3.3 Non-truck accidents in the Netherlands 2005-2009 by critical manoeuvre

Critical manoeuvre	**Number**	**Percentage**
Other side collisions	11142	20.6
Rear-end collision without involving turning vehicle	6199	11.5
Grazing	4363	8.1
Collisions with tree and other fixed objects	3786	7.0
Other	3234	6.0
Collisions with other road furniture	2905	5.4
No vehicle off the road	2735	5.1
Collisions with lamppost	2701	5.0
Side collision at intersection	2540	4.7
Head-on collision without lane change	1655	3.1

Table 3.4 Truck accidents in the Netherlands 2005-2009 by critical manoeuvre

When analysing accidents by critical manoeuvre there are some distinctions between truck and non-truck accidents. Truck accidents show a significantly greater share of other side-collisions (for instance while overtaking incorrectly) than non-truck accidents, whereas there were relatively fewer rear-end collisions that did not involve a turning vehicle among truck accidents.

Root cause	Number	Percentage
Failure to give right of way	105227	20.9
Tailgating	95717	19.1
No cause given	74962	14.9
Loss of control of the vehicle	39995	8.0
Failure to make way	39594	7.9
Error negotiating turn/bend	24983	5.0
Carelessly overtaking/cutting off	22798	4.5
Skidding	22521	4.5
Outside (middle) lane hogging	19949	4.0
Error in crossing	16663	3.3

Table 3.5 Non-truck accidents in the Netherlands by root cause 2005-2009

Root cause	Number	Percentage
Tailgating	7776	14.4
Carelessly overtaking/cutting off	7583	14.0
Failure to give right of way	7071	13.1
Error negotiating turn/bend	6879	12.7
No cause given	6735	12.5
Outside (middle) lane hogging	2955	5.5
Failure to make way	2866	5.3
Inside (right) lane hogging	2588	4.8
Error merging into other lane	2574	4.8
Loss of control of the vehicle	1787	3.3

Table 3.6 Truck accidents in the Netherlands by root cause 2005-2009

Looking at root causes of accidents, one striking difference is that truck accidents relatively less often result from one road user failing to give right of way to another. Accident root causes more common among truck accidents are careless overtaking/ cutting off and errors negotiating turns or bends. The former tends to result in side collisions or rear-end collisions, while the latter often culminates in side collisions (grazing) or collisions between trucks and fixed objects.

One conclusion from the above comparison is that side collisions are more common among truck accidents than non-truck accidents. This is either through trucks or passenger traffic driving next to the truck failing to accurately negotiate bends or because of careless overtaking/cutting off. Both culminate in side collisions concerning sideswipe impact (with both vehicles involved headed in the same direction) rather than front-to-side impact (as would be the case with side collisions at intersections). This type of incident can therefore be regarded as ‘typical truck accidents’.

Assessment at accident hotspots
In order to determine to what extent LHV characteristics played a part in a particular

accident, it is also important to know whether there have been more and/or similar accidents at the location concerned. If so, then it may be assumed that not only LHV characteristics but also local conditions at the scene may have played a part in the accident. A particular location is defined as accident hotspot if over a period of three years twelve or more accidents had taken place there. This definition is in keeping with the one generally used in traffic safety studies. The analysis of LHV accidents in the 2009 study was based on accidents that occurred between 2006 and 2008. The analysis of LHV accidents that were firstly analysed in the 2010 study was based on the period 2007 to 2009; whereby the objective was to determine whether the location of the accident was subject to a high accident density (hereinafter referred to as 'accident hotspot').

3.3 Step 1: ascertaining accidents involving LHVs

Accidents involving large goods vehicles are recorded by registration number of the towing vehicle. However, police accident records do not contain details of the actual vehicle combination driven at the time of an incident. Because of this, the groundwork for research consisted of all accidents involving towing vehicles registered as having been issued a dispensation to be driven as LHV combination. Between January 2007 and mid-2010 the total number of accidents as such was 71.

In order to establish how many of the towing vehicles had in fact been hauling LHV combinations at the time of their accidents, the owners of the towing vehicles – mostly haulage firms – were contacted by telephone. Trusting that the information they provided was truthful, details of vehicle combinations could be traced for 67 incidents; it turned out that 18 had involved LHVs and 49 had involved regular truck combinations.

In comparison to the total number of accidents that involved towing vehicles which had been issued a dispensation to drive as LHVs, the number of accidents that actually involved LHVs was rather limited. This may have been due to the following reasons:

- The towing vehicle had not (yet) been issued a vehicle licence dispensation notice and was therefore driving regular truck combinations only;
- Towing vehicles that had been issued a dispensation to drive an LHV, can still be deployed as regular truck combinations, and will be used as such if, for instance, the route to be driven includes roads where LHVs are not permitted;
- Between 2007 and 2010 the maximum weight allowance for LHV combinations was, for almost one year, reduced from 60 to 50 tonnes; as a result of this some haulage firms could not use the towing vehicles for LHVs, and deployed them in regular truck combinations only.

In the four instances where the owner of the towing vehicle was unable to trace whether it had been driving as LHV combination at the time of its accident, the accident breakdown schedule pictured in paragraph 2.1.2 was applied to try and determine, with the highest possible degree of certainty, whether the accidents concerned had involved LHVs.

Firstly, it was investigated whether the accident had taken place on a road designated as permitted for use by LHVs. Of the four accidents where it was unknown if the large goods vehicle involved had been an LHV, two had taken place on roads where LHVs were permitted and two on roads where they were not allowed. With regard to the latter two locations, it was investigated whether they

would have been accessible at all by LHV. Both scenes were in the province of Overijssel in the East of the Netherlands; one in a residential area in Hengelo and the other at an industrial park near the A35 motorway. The possibility of an LHV having been involved in the accident in the residential area was dismissed after location analysis proved it to be poorly accessible to a vehicle of that size. There is, however, a chance that the vehicle involved in the accident at the industrial park to was an LHV, particularly considering its location near the A35 motorway.

Subsequently, through analysis of the police accident records, it was investigated whether characteristics specific to LHVs could have played a part in the two accidents on roads designated for use by LHVs as well as the one at the industrial park in Borne. The following paragraphs contain rundowns of each of these three accidents, based on the information from their accident records. Such records usually contain only brief descriptions of the actual circumstances at the time of the incident and often do not include any drawing or diagram of the accident scene. The information from police accident records may therefore not answer every possible question about the incident.

Possible LHV accident A
At an industrial park within the built-up area of Hoogvliet – speed limit 50 kph – the driver of a large goods vehicle failed to give right of way to a passenger vehicle at an intersection. This resulted in a side collision with material damage only. At the time of the incident, which occurred at 15.40, the weather was dry.

Considering the fact that the root cause of the accident was a driver's failure to give right of way, it may be concluded that it is unlikely for any specific LHV characteristics to have played a part, as the incident could have happened to any regular goods or passenger vehicle.

Possible LHV accident B
On the A15 motorway, near Rotterdam – speed limit 100 kph – a passenger vehicle in the middle lane overtook a large goods vehicle in the inside lane. Police have indicated that the driver of the passenger vehicle had presumably fallen asleep behind the wheel, causing his vehicle to drift sideways towards the truck. The consequence was a side collision with material damage only. At the time of the incident, which happened at 14.15 hours, it was raining. With regard to the truck involved, the accident record mentions a towing vehicle and a trailer.

Considering the root cause of the accident, it may be concluded that LHV characteristics played no part in the accident and that the critical overtaking manoeuvre could have involved either an LHV or a regular truck. Given that police indicated that the driver of the passenger vehicle had presumably fallen asleep, one may infer that there was no misjudgement of vehicle length upon overtaking.

Possible LHV accident C
At an industrial park within the built-up area of Borne – speed limit 50 kph – a large goods vehicle turns left at an intersection and, as a result of its swerving trailer, hits a lamp post. This was a single-vehicle collision with material damage only. At the time of the incident, which happened at 11.49, the weather was dry. The accident report refers to a towing vehicle with double trailer. From this, one may derive that this presumably concerned an LHV combination. The swerving of the trailer is a further indication of this incident having been an LHV accident.

Possible LHV accidents A and B are both incidents in which specific LHV characteristics played no part in the lead-up. The accidents were therefore not included in further analysis, even though it could not be ascertained whether they had actually involved LHVs.

Accident C presumably did involve an LHV and was therefore included in further analysis. Swerving may be an LHV characteristic and the accident record explicitly made mention of a double trailer combination.

The figure below shows the same breakdown schedule as displayed in paragraph 2.1.2, only this time the numbers applicable to each category have been inserted.

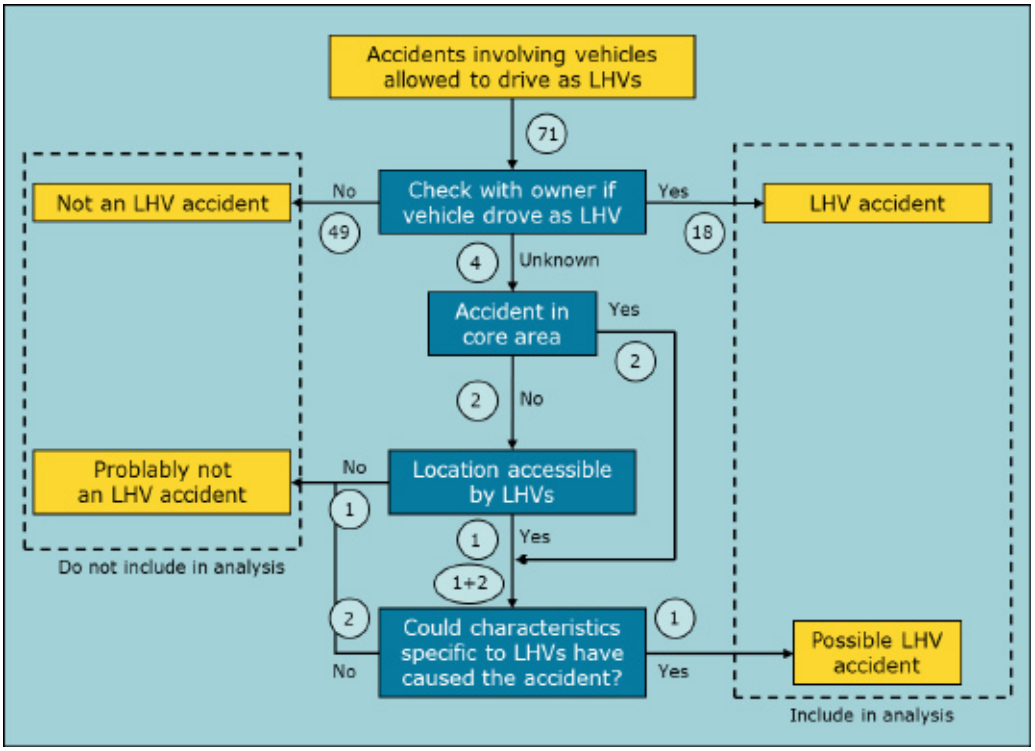


Figure 3.1 Accidents divided into LHV accidents and non-LHV accidents

From this breakdown it may be concluded that out of the 71 accidents involving a towing vehicle that has been issued a dispensation to drive as LHV combination, 18 accidents have been confirmed to have actually involved an LHV and one may be presumed to have involved an LHV. These 19 accidents in total were further analysed in the subsequent step; eleven of which were analysed in the study conducted in 2009.

3.4 Step 2: analysis of the individual accidents

This step further elaborates on the 19 accidents remaining after step 1. Appendix C provides a case-by-case account of each incident based on the data from the accident report.

As already mentioned in paragraph 3.3, these accident reports tend to contain only very brief descriptions of the actual circumstances surrounding each case, leaving

questions about particular conditions that may have been at the root cause of the accident unanswered. Drawings or diagrams of the accident scene are often not included in the accident report either. It will therefore not be possible to answer every question about the accident with the information available from the accident report.

The 19 accidents are each chronicled by the following points:
- Description of location
- Description of circumstances (weather and traffic conditions)
- Description of accident (type of accident and manoeuvres of vehicles involved)
- Significance of LHV characteristics
- Accident proneness of location
- Why did the accident occur?
- Which factors could have prevented the accident from occurring?

The first three points provide the factual description of the accident. The appendix shows a diagram of the accident scene to create a clearer picture of the accident and its location. The accident scene diagram is a *reconstruction* based on the information from the accident record and may as such deviate from the actual accident scene. The LHV depicted in all accident scene diagrams is a Type D LHV, but this may not necessarily have been the LHV type actually involved in the accident.

The last four points represent the accident analysis. Besides the information from the police accident records, sources used included aerial photographs, national accident database (BRON) and the website maximumsnelheden.nl which contains a database of all applicable speed limits for every road in the Netherlands. The latter source was used because accident records often only mention the speed limit applicable to goods traffic rather than the speed limit at the particular road concerned.

Additional information from the interviews
Ten of the 19 accidents were discussed with the driver involved. The information he provided in the interview about his own accident has been added to the accident description in a separate text box. This box will also include details of the type of LHV driven by the driver concerned. Appendix B contains an overview of possible LHV configurations. Please note that the interviews were held *after* the accident analyses had taken place. The information provided by the driver was added later and had therefore not been taken into account in determining whether the accident had been a typical LHV accident, or in the further analysis made in paragraph 3.5.

For 11 of these accidents the above-mentioned analysis was already conducted in the previous study (2009). The data from these accidents has been copied from the 2009 study. The data was supplemented with the questions ‘Why did the accident occur?’ and ‘Which factors could have prevented the accident from occurring?’.

Appendix C includes an extensive analysis of the 19 accidents involving LHVs. The main conclusions from the analysis are described in this paragraph. Based on the accident descriptions it was determined to what extent this specifically involved an LHV accident. The following criteria were assessed:
- Did the LHV characteristics play a role here?
- Did weather play a role?
- Is this a location an accident hotspot?
- Was this a typical truck accident?
- Did the other party involved cause the accident?

Conclusion analysis of individual accidents

The analysis of these 19 accidents showed that nearly all LHV accidents resulted in material damage only and did not involve vulnerable traffic participants like cyclists and pedestrians. There was only one recorded LHV accident involving a person who was slightly injured. It is common knowledge, however, that not all accidents that occur are registered by the police. Research has shown that accident registration levels[1] rise in line with accident severity levels. Registration levels of accidents involving fatal casualties and casualties requiring hospital treatment are relatively high, whereas registration levels of less severe accidents are considerably lower. It is also known that registration levels for accidents on main roads are higher than for secondary roads. Based on this information, it is assumed that it is highly unlikely that there were any accidents involving casualties that were not registered. To gain better insight in incidents involving LHVs that were not registered by the police, in 2010 companies and insurers were contacted to provide information on incidents registered by them. Chapter 4 describes this in further detail.

Observing the circumstances of the accidents, it may be concluded that the consequences of some accidents could have been more severe. The reason for this is that several accidents (numbers 3, 4, 6, 9, 10, 12, 13, 15 and 19)[2] that occurred on a trunk road or a motorway involved relatively high speeds. The other accidents occurred on secondary roads, in most cases on or nearby a roundabout or an intersection where the average speeds tend to be lower and as such the risk of a severe outcome is lower.

In most cases human error played an important factor in causing the accident. In the majority of cases the driver of the other vehicle involved was the one that who made the error, whether or not this was done deliberately. In some cases, the driving behaviour, for example trying to merge in front of the LHV at the last moment, proved to be the underlying cause of the error. These type of accidents also occur with regular trucks. This is due to the fact that compared to a passenger vehicle the truck has a lower acceleration and top speed. Road users experience longer travel times and a limited view of the road ahead when forced to drive behind a truck. To limit these negative effects, the driver will often attempt to overtake the truck if the opportunity presents itself. Although LHVs are even longer than regular trucks, it is mainly the difference between passenger traffic and truck traffic that causes this type of driving behaviour.

1 The accident registration level refers to the number of accidents that is recorded by the police relative to the total number of accidents that actually occurred.

2 Accidents 7, 16 and 17 also occurred on a motorway, but at a time when a lower local speed applied as a result of traffic jams or roadworks.

Table 3.7 provides an overview of the 19 LHV accidents indicating the characteristics and circumstances that played a role in the accident. The following points were specifically examined:
LHV characteristics: did the LHV's length or swerving behaviour play a part?
Weather conditions: were the weather conditions bad?
Accident hotspot: is the location considered an accident hotspot?
Typical truck accident: does this type of accident happen to trucks relatively often?
Critical third-party manoeuvre: did a critical manoeuvre by the other driver involved contribute to the accident with the LHV?

Accident	LHV characteristics	Weather conditions	Accident hotspot	Typical truck accident	Critical third-party manoeuvre
1	X		X	X	X
2		X	X		X
3	X	X		X	
4	X	X		X	X
5			X	X	X
6					X
7	X	X	X	X	
8					X
9	X			X	
10	X	X		X	
11	X			X	
12	X			X	
13	X			X	X
14					X
15	X			X	X
16	X			X	X
17			X		X
18				X	
19					X

Table 3.7 Overview of contributing factors in LHV accidents

From the table above it may be concluded that, based on the available information, eight of the 19 LHV accidents - accidents 2, 5, 6, 8, 14, 17, 18 and 19 – did not show to have involved any possible influence from LHV-specific characteristics such as length or swerving behaviour. These accidents have therefore been left out of the next step (step 3).

In four of the remaining 11 accidents the LHV's sideways motion contributed to the cause of the accident. Three of these accidents happened under poor weather conditions. LHVs may be more prone to sideways motion than regular trucks because of their two pivot points, though this was not proven in previous research.

All accidents in which either LHV characteristics (length or swerving) or sideways motion may have played a part were typical truck accidents, i.e. accidents that are relatively common to trucks. This implies that not just characteristics that distinguish an LHV from a regular truck were of influence, but also characteristics that distinguish trucks from passenger vehicles. Based on the accident records, however, it is not possible to trace which of those two distinctions were at the heart of each accident. Aside from that, three (out of 11) LHV accidents happened in accident hotspots, and four out of 11 accidents were predominantly caused by driver error on the part of someone other than the LHV driver involved.

The following paragraph will further deal with those aspects of the seven accidents where LHV characteristics played a part and what, if anything, connects them.

3.5 Step 3: comparison of accident characteristics

To determine whether there are any similarities between the seven LHV accidents, and to gauge how factors like infrastructure, special conditions (weather, light, traffic, etc.), driver behaviour and vehicle features may have been of influence, the various particularities of each LHV accident were compared to each other. Table 3.8 juxtaposes all data relevant to this comparison. The table is followed by a point-by-point description.

LHV accident	Month	Time	Light/ darkness	Weather	Road surface from weather	Maximum speed	Manoeuvre	Infrastructure
1	January	18:00	darkness	dry	wet/damp	50	merging	intersection
3	March	1:04	darkness	dry	snow/ black ice	120	overtaking	straight road
4	April	5:33	daylight	rain	dry	120	overtaking	straight road
7	November	17:58	darkness	snow or hail	wet/damp	100	changing lanes	straight road
9	March	6:30	dusk	dry	dry	120	skidding	straight road
10	February	19:00	darkness	strong gusts of wind, rain	wet/damp	120	overtaking	straight road
11	March	11:49	daylight	dry	dry	50	left turn	intersection
12	May	15:52	daylight	dry	dry	120	changing lanes	straight road
13	May	7:11	daylight	dry	wet/damp	100	merging	straight road
15	October	12:35	daylight	dry	dry	100	merging	straight road
16	November	7:30	daylight	dry	wet/damp	90	overtaking	bend/turn

Table 3.8 Information from LHV accident records of accidents whereby LHV characteristics may have played a part.

Infrastructure
The majority of the 11 accidents occurred on straight roads, mostly on trunk roads or motorways. Apart from that, two accidents occurred on or near an intersection. The infrastructure was directly of influence in accidents 11 and 16. In the case of accident 11 the LHV hit a lamppost after understeering around a bend, which also happened on a road where LHVs are not allowed to drive. Accident 16 involved

roadworks whereby the lanes were made narrower and barriers were positioned along the road. A passenger vehicle subsequently collided with the LHV and the barrier on the left side of the road.

In several other cases the infrastructure had an indirect impact on the accident. In the case of accident 1 the passenger vehicle was forced to change lanes as a result of a lane reduction. In accident 7 the LHV had to change lanes in order to exit the motorway. Accidents 12, 13 and 15 involved merging traffic on a road without a hard shoulder after the acceleration lane. The changing of lanes may have affected these accidents, whereby the drivers involved had insufficient space for their vehicles or attempted to merge in front of the LHV at the last minute. In these cases the infrastructure was able to accommodate the LHVs. These accidents could have also taken place with regular truck combinations.

Nine accidents took place outside and two within the built-up area. LHVs mainly drive on roads outside the built-up area, but industrial parks where LHVs are permitted are usually located within the built-up area. The division between accidents within and outside the built-up area does not show any abnormalities.

It may be concluded that with regard to the infrastructure no particularities were found that specifically relate to LHVs. However, in five out of 11 accidents the infrastructure at that time required drivers to change lanes, for example when driving onto an acceleration lane. This had an effect on all traffic at that location.

Special conditions
Four of the 11 accidents occurred on either wet road surfaces (3) or a road surface covered in snow or black ice (1). In three of the accidents there was actual precipitation. Therefore it may be possible that LHVs, because of their length and weight (load), are more affected by poor weather conditions, particularly with regard to swerving. Five of the 11 accidents happened in darkness or at dusk; a possible explanation for this could be that other road users have more difficulty recognising an LHV as such in the dark.

Because of the relatively small number of LHV accidents, it is impossible to draw firm conclusions based on the data presented. Further research will be required to prove whether poor weather conditions and darkness actually are at the heart of LHV accident causes. It should be noted that a difference was observed between accidents in the period until early 2009 and accidents that occurred in the period thereafter. In the last-mentioned period no accidents occurred during poor weather conditions, and only one accident (number 17) occurred during darkness.

Based on the accident records there are no indications that any of the 11 accidents occurred during traffic jams. Most of the 11 LHV accidents occurred during spring and autumn. Neither is it possible to say that a peak in accidents occurred during a specific part of the day.

Driver behaviour
Two out of 11 accidents were single-vehicle accidents. The other nine accidents involved a second or third vehicle besides the LHV. Critical manoeuvres at the root cause of all nine of these accidents involved lane changes, such as overtaking and merging. In accidents 7, 11 and 12 the critical manoeuvre of the LHV was the root cause of the accident. In all other accidents, the driver of the other vehicle involved caused the critical manoeuvre.

Other road users, and to a lesser extent LHV drivers themselves, may possibly be misjudging the length of LHVs when changing lanes, but to put this in perspective: paragraph 3.2 explains that accidents involving overtaking or lane-changing manoeuvres are relatively common to large goods vehicles, as are the two single-vehicle accidents. Paragraph 3.4 already showed that the differences in acceleration and speed limit between passenger vehicles and trucks leads to a situation whereby many drivers of passenger vehicles or delivery vehicles try to overtake the truck or merge in front of it. This mainly occurs on trunk roads and motorways. This driving behaviour results in dangerous situations that, in some instances where there was insufficient space to overtake or merge, this led to accidents.

Vehicle characteristics
Based on the accident records no direct link can be proven between characteristics specific to LHVs and any of the accidents. In some cases there is an indirect link: the paragraphs on *infrastructure* makes mention of bend and turns, those on *special conditions* mention the influence of poor weather conditions and those on *driver behaviour* make mention of possible misjudgements of vehicle length when changing lanes. The LHV's swerving behaviour is only mentioned under *special conditions* in a context of poor weather conditions. As it was not known in every accident what the type of LHV configuration was, it is not possible to state differences between vehicle configurations. This was also due to the limited number of accidents.

In all accidents, those features that distinguish any large goods vehicle from a passenger vehicle played a part as well, thus all cases could be earmarked as being typical truck accidents. None of the accidents can therefore be attributed specifically to LHV characteristics; at best it may be presumed that specific LHV characteristics contributed to the cause of an accident. Nevertheless, those features that distinguish trucks from passenger vehicles are far more likely to have contributed towards an accident than specific LHV characteristics; this particularly applies to the matter of vehicle length.

3.6 Comparison of LHV accidents to national overview of accidents

To achieve a clear understanding as to whether LHV accidents were relatively common or uncommon it would be interesting to make a comparison to the number of truck accidents occurring nationally. However, between January 2007 and mid-2010 only 19 accidents involving LHVs were recorded. This is a tiny number in comparison to the 100,000 to 120,000 road traffic accidents recorded each year, about 10% of which involved trucks. As LHVs make up less than 0.1% of this, it is impossible to make any statistically reliable comparison between LHV accidents and truck accidents in general. However, based on various available data, it is possible to make a qualitative pronouncement on the road traffic safety of LHVs.

Based on the study 'LHVs in practice' it is known how many kilometres the average LHVs drives annually, and how many kilometres regular trucks travel annually. LHVs travel an average distance of 104,000 kilometres per year, this is slightly more than the 80,000 to 90,000 kilometres that regular trucks drive annually. According to information from the organisation, Statistics Netherlands, on 1 January 2010 around 145,000 trucks and towing vehicles were noted as being registered in the Netherlands. On 1 July 2010 397 towing vehicles were permitted to drive as LHVs; amounting to under 0.3% of the total number of trucks.

To make a comparison between LHV accidents and accidents with other trucks, the accident registration level should also be taken into account. Research has shown that the less severe the accidents are, the fewer number of accident reports that are submitted. Registration levels of accidents involving fatal casualties and casualties requiring hospitalisation are relatively high, but as severity drops, so does the registration level. Aside from that it is known that the registration level of accidents occurring on main roads is relatively higher than the registration level of accidents happening on secondary roads. Since LHVs tend to drive mainly on main roads, it may be assumed that the registration level of LHV accidents deviates from that of regular truck accidents; however, the extent to which it deviates is unknown.

Based on the above it can be concluded that, on average, LHVs travel more kilometres per year than regular trucks, and the percentage of LHV accidents as part of total truck accidents is lower than the percentage of towing vehicles that are permitted to drive as LHV as part of the total number of trucks in the Netherlands. Based on the aforementioned information there is no reason to assume that LHVs are less safe than regular trucks. However, one should be careful to draw conclusions on the basis of just 19 accidents involving LHVs. In view of the limited number of LHV accidents, the chance factor may have played a significant role in the accidents that occurred. In other words, an increase in the number of LHV combinations does not necessarily have to lead to a similar increase in the number of accidents that took place during the past three-and-a-half years.

3.7 Outcome

It was noticed that out 19 LHV accidents, there was only one incident that involved a person who was slightly injured. However, not all accidents that occurred were registered by the police. Registration levels of accidents involving fatal casualties or casualties requiring hospital treatment are relatively high, particularly of those occurring on main routes. Based on this information it seems highly unlikely that any other LHV accidents involving casualties occurred without being registered by the police. It is also worth noting that due to the high speeds involved, some accidents could have had more severe consequences.

There is no direct connection between characteristics specific to LHVs and the causes of the examined accidents; that is to say, none of the accident records explicitly stated that an LHV's length or swerving provided the root cause of the accident concerned. There do appear to be indirect links with an LHV's length in relation to *special conditions* (rain, slippery road surfaces) and *driver behaviour* (misjudgement of vehicle length when changing lanes), as well as – in some of the accidents – a link between poor weather conditions and sideways motion; there is a possibility that LHVs, because of their two pivot points, are more prone to sideways motion than regular trucks, but research to date has not yet provided any proof of this.

It should also be noted that all accidents involving LHVs whereby their specific characteristics may have played a part were like any so-called typical truck accident. This raises the suspicion that the accidents did not particularly relate to characteristics specific to LHVs, but could have just as easily happened to a regular truck. Due to the limited number of LHVs on the Dutch roads, it is, as yet, impossible to determine whether a specific type of accident that is typical of trucks occurs more or less frequently with LHVs.

In part because of the limited number of accidents involving LHVs it is not possible to draw firm conclusions based on the accident analyses. This is not made easier by the lack of detail in the accident records and any circumstances surrounding them. Questions about conditions leading up to each accident are usually left unanswered by the accident records. It can, however, be said that none of the 19 accidents give reason to believe that LHVs, compared to regular trucks, pose higher traffic safety risks; that isn't to say that such risks are non-existent.

In order to further research potential increased traffic safety risks of LHVs, a number of working hypotheses were formulated. These working hypotheses were tested against interviews with LHV drivers and through the expert session. Based on the accident illustration, barely any specific risks in relation to LHVs can be identified, but to elicit rapport from the experts in interview, the working hypothesis put forward to them were made to be rather evocative. They were as follows:

1. The infrastructure is not always able to accommodate LHVs. This mainly applies to turns and bends.

2. LHVs have a harder time dealing with poor weather conditions than regular trucks. This concerns conditions like rain, strong gusts of wind, snow and black ice, leading to skidding and swerving.

3. Overtaking and changing lanes lead to treacherous situations. Road users often misjudge an LHV's length.

4. LHVs are not properly identifiable as such at night.

4 Analysis of accident statements from companies and insurers

4.1 Introduction

To assess whether more accidents involving LHVs occurred than just those registered by the police, the companies themselves and the Dutch Association of Insurers were also requested to provide information on accidents. As previously mentioned, it is a well-known fact that the police does not register every accident that occurs. This is certainly true for accidents that only involve damage to bodywork and accidents involving only slightly-injured persons. By gathering this information it is possible to create a more comprehensive picture of incidents involving LHVs. This additional information can also be used to assess whether the points that were mentioned on the basis of the accident analysis in chapter 3 also apply to incidents as reported by the companies and the Dutch Association of Insurers.

4.2 Accident statements from companies

Firstly, all companies that possessed a dispensation for one or more LHVs in the period between 1 November 2007 and 1 September 2010, were contacted. These companies were asked to provide information on accident statements with LHVs. Out of a total of 201 LHV companies, 155 responded to this request. These companies reported a total number of 35 accident statements involving LHVs.

Although the gathered information on accident statements differed per case, it was still possible to conduct several analyses on the basis of the accident statements. The accident statements are divided into four categories:

- Accidents whereby the LHV driver made a driver error;
- Side collisions while another vehicle attempted to overtake or change lanes;
- Rear-end collisions;
- Technical defects and lost cargo.

The first two categories constitute the majority of the accident statements that the companies provided. In many cases where the accident involved driver error, the LHV was reversing. It may be more difficult for LHV drivers to perform this manoeuvre than it is for drivers of regular trucks. It is not known how the number of accidents involving an LHV that is reversing relates to the total number of accidents with regular trucks that were reversing. A remarkable accident that occurred involved an LHV that was making a detour and crashed into a parked vehicle on the alternative route. Most of the side collisions involved another party that judged the situation wrongly and tried to overtake or merge at a location where this was not possible.

The police-registered accidents also involved several incidents with side collisions. Within the category of accidents that the police registered, ‘driver error’ was hardly ever mentioned as the cause of the accident. This is likely because of the fact that in these cases the damage is often limited and there are no discussions as to which party is to blame. These type of accidents are directly handled by the insurer. Or, if this only involved a limited amount damage, the damage was often paid by the party that caused the damage because this falls under their own liability limits. This amount is usually higher for trucks than for passenger vehicles.

The accident statements also include several rear-end collisions. In one case the

LHV was driving at night on the A16 motorway near Dordrecht and subsequently crashed into another truck. The driver of the LHV was injured and taken to hospital. In the case of rear-end collisions there is no reason to assume that the vehicle's length or swerving behaviour played a part in the accident. However, the extra mass of the LHV may have been a contributing factor. LHVs have a maximum allowable weight of 60 tonnes; whereas a maximum of 50 tonnes applies to regular trucks. It is unknown whether these rear-end collisions involved an LHV that weighed over 50 tonnes.

A number of accident statements were the result of a technical defect or lost cargo. Examples of technical defects include a burst tyre and a dislodged door. In the case of lost cargo there was one incident whereby an LHV lost a part and passenger vehicle subsequently drove over it. Two other accidents involved an LHV that collided with an object on the carriageway. These accidents are not related to specific LHV characteristics such as the vehicle's length and swerving behaviour.

The working hypotheses in paragraph 3.7 were subsequently tested on the basis of the aforementioned analysis. The findings per working hypothesis are given below:

1. The infrastructure is not always able to accommodate the LHVs. This mainly applies to bends and turns.

Accident statements that were reported by the companies also include accidents in bends and turns. In some cases the vehicle hit an object after the trailer had swerved in the turn.

2. LHVs have a harder time dealing with poor weather conditions than regular trucks. This concerns conditions like rain, strong gusts of wind, snow and black ice, leading to skidding and swerving.

The accident statements did not involve any accidents that explicitly referred to poor weather conditions. This hypothesis cannot be confirmed on the basis of the accident statements. However, the hypothesis cannot be rejected either because in many cases the weather conditions are not explicitly mentioned in the accident records.

3. Overtaking and changing lanes lead to dangerous situations. Road users often misjudge an LHV's length.

A large part of the accident statements consist of this type of accident. In most cases a third party attempted to overtake or change lanes and subsequently caused the accident. This was often due to the driver wrongly assessing the amount of space available to overtake or change lanes. The LHV's length may also have played a part in these accidents. The information from the accident statements was too limited to draw any firm conclusions.

4. LHVs are not properly identifiable as such at night.

The accident statements included two accidents (of the 35) that occurred in the dark. One accident involved a burst tyre on the A15 motorway, the other a rear-end collision on the A16 near Dordrecht. The fact whether or not the LHV was clearly recognisable as such, played no role in these accidents. This hypothesis cannot be confirmed on the basis of the accident statements by the companies.

One hypothesis was formulated on the basis of the accident statements by the companies:

5. It is more difficult to reverse an LHV than a regular truck.

4.3 Accident statements from Dutch Association of Insurers

In addition to information provided by the companies, the Dutch Association of Insurers was also requested to provide information. The Association subsequently gave the Centre for Insurance Statistics (or CVS in Dutch) permission to make this information available on behalf of this study. The purpose was to assess whether they possessed information on accident statements that was not put forward by the haulage firms. Prior to this step, the companies concerned were approach to seek their permission. Of the 155 businesses that responded to the request to provide information, 109 companies gave their permission to seek additional information from the CVS.

The Centre for Insurance Statistics provided 72 accident statements from 32 companies concerning the period between 1 September 2008 and 1 July 2010. In view of the fact that this organisation does not possess information from all insurance companies, this could mean that some accident statements from these 109 companies are not available for assessment. The Centre for Insurance Statistics possesses data on around 70 to 80% of insured vehicles. It is therefore safe to conclude that a large number of these companies did not have accident statements.

One recorded incident concerned an accident with a casualty. Upon further inquiry the company confirmed that this did not concern an LHV accident. At the time of the accident the towing vehicle was riding without a trailer. Three accident statements were already known based on information gathered from the police (1) and the companies themselves (2). Information from the police-registered accident showed that no LHV was involved in the accident. The two accidents that were reported by the companies did involve an LHV. According to information on 14 of these accidents, including the police-registered accident, it is known that at the time of the accident the towing vehicle did not have a dispensation. It is therefore highly unlikely that these accidents involved an LHV. In the majority of the other 56 accidents the companies indicated whether or not this involved an LHV accident. Considering that the companies did not report these 56 accidents, it is highly unlikely that they involved LHV accidents.

It is impossible to test the hypotheses elaborated in paragraph 4.2 for the accident statements that the companies reported, on the basis of the information from the Centre for Insurance Statistics. This is due to the fact that this organisation does not possess concrete data on accidents. Of the reported accident statements, it is not known where they occurred, who the other party concerned was and what the cause of the accident was. The Centre for Insurance Statistics did provide information on the amounts of the claim. This showed that the amounts claimed did not exceed €5,000. It can be deduced from this that the nature of the accidents was not very severe. In view of this conclusion and the fact that accident statements made available by the Centre for Insurance Statistics did not include accidents involving casualties with LHVs, the decision was made not to further examine these accident statements. It is highly unlikely that further investigation will lead to new insights. Furthermore, retrieving files containing substantive accident data from the different insurers is very labour intensive.

4.4 Conclusions

Based on the police-registered accidents, the following four working hypotheses were formulated:

1. The infrastructure is not always able to accommodate LHVs. This mainly applies to bends and turns.
2. LHVs have a harder time dealing with poor weather conditions than regular trucks. This concerns conditions like rain, strong gusts of wind, snow and black ice, leading to skidding and swerving.
3. Overtaking and changing lanes lead to dangerous situations. Road users often misjudge an LHV's length.
4. LHVs are not properly identifiable as such at night.

Hypothesis 1 and 3 are also applicable to the accident statements made by the companies. This is not the case for hypothesis 2 and 4. An additional hypothesis can also be formulated based on the accident statements from the companies:

5. It is more difficult to reverse an LHV than a regular truck.

5 Interviews with drivers

5.1 Introduction

To test and further refine the results from the accident analysis, interviews were convened with LHV drivers and examiners. Ten drivers and three examiners were interviewed. Four of the drivers had been involved in an accident with an LHV. Persons from the group of participating companies were randomly selected for the interviews.

The interviews were deliberately conducted in a general fashion. Drivers were asked to indicate which real-life situation they found challenging, and by listing points of interest, matters that possibly merited further attention were discussed. A similar approach had been applied in analysing the truck accidents: no pointing of fingers, but rather analysis of actual accident scenes to – together with the driver – point out the possibilities and impossibilities of the vehicle.

This flexible approach in questioning proved very beneficial. Generally speaking, willingness to cooperate proved great, even among the 'accident drivers'. Because interviewees were given the opportunity to contribute points themselves and interviewers were able to go along with such unanticipated leads, the interviews gained in depth and conversations flowed easily and casually.

A particularly leading topic of conversation was, naturally, the difference between an LHV and a regular truck. Because LHV drivers have experience of driving both LHVs and regular truck combinations, they are the ultimate experts on the subject.

Examiners from the Liaison Committee for Professional Competence (CCV) were also contacted. The CCV is part of the Central Office for Motor Vehicle Driving Testing (CBR). Through their specific expertise and extensive experience, the examiners have clear insight in the potential traffic safety risks that the haulage sector faces. The interviewed examiners were involved in the LHV pilot from the onset, and they are the ones who conduct the tests with potential LHV drivers. As a result, they know all there is to know about driving an LHV, and can make accurate comparisons to regular transport vehicles. The following paragraphs describe the results of the interviews.

5.2 Infrastructure

Based on the interviews, it can be concluded that the normal road infrastructure hardly presents any problems for LHVs. According to the drivers this is, among others, due to the additional requirements that the vehicles were subjected to: ' … the manoeuvrability of the LHV is impressive!" Other relevant points include the training and – as a result – the drivers' abilities: '…compared to other drivers, LHV drivers are the elite," The 'infrastructural problems' that LHV drivers experience, primarily concern how specific road and traffic situations relate to each other. These are elaborated in the next paragraph.

The lack of sufficient, suitable parking facilities is an infrastructural problem that specifically concerns LHVs. Currently, there are only a limited number parking spaces for LHVs. Other road users regularly occupy the LHV car park along the A4 motorway. During the day this does not lead to any significant problems. Drivers make arrangements with the managers of truck cafés or drive to the next car park.

If necessary they will park their vehicle in two parking spaces, or somewhere along the side of the road. At night the situation is more difficult because of an even greater lack of parking space.

The biggest problems seem to occur on secondary roads during city distribution. To maximise the use of LHVs for city distribution it is important to have sufficient decoupling and parking facilities at a reasonable distance from the city centre. According to the drivers, in reality the available facilities are scarce. Another frequent problem is other equipment and/or vehicles that obstruct the loading and unloading locations, and therefore make it hard for the LHV to make a proper turn.

Sharp bends remain a problem: when making a sharp bend to the right, if possible, the LHV driver sometimes occupies two lanes to properly negotiate the turn. This has the added benefit that this prevents other road users from passing by, and therefore reduces the likelihood of side collisions and grazing. To prevent problems, drivers of regular truck combinations often also take this precautionary measure.

Drivers also indicated that they deliberately lock the steering axle in bends and on roundabouts to ensure that the trailer follows smoothly. Although at the start of the pilot this system seemed to falter (‘so-called teething troubles’), roundabouts no longer pose any problems. According to the drivers, because of their radius of curvature, so-called ‘turbo roundabouts’ enable traffic to be processed more smoothly.

However, drivers did point out that problems with visibility did occur at some roundabouts because the centre of the roundabout was filled with plants or other objects. Cyclists and moped riders are unable to see the LHV until the last moment. It should be noted, however, that on so-called LHV routes there is much less interaction with slow traffic. Drivers did feel that the proposed division between slow-moving traffic and LHVs had been carried through very strictly. The same applied to avoiding viaducts and railway crossings. This not only leads to illogical routes, but drivers also consider this to be unfair, because these restrictions do not apply to ‘low riders’ and exceptional transport. Drivers do adhere to the obligatory routes for LHVs. They will follow the routes as scheduled by their company’s planning department.

According to the drivers, diversions along the route only occurred during roadworks and after an accident. Roadworks are an everyday occurrence, and according to the drivers, the diversions are not always suitable for LHVs. Formally, these routes are not covered by the dispensation, and drivers wonder how the police would act in such a case (force majeure or offence?).

Traffic measures form an additional practical problem where roadworks are concerned. Lanes and radius of curvature are sometimes too limited for LHVs. It is worth noting that regular transport vehicles also complain about this, and lately where reconstruction work is carried out on lanes, efforts have been made to ensure that the radius of curvature is adjusted to accommodate LHVs.

During their training, LHV drivers are advised to contact the police in the event of an incident. This appears to work in practice: “… a quick call helps to create goodwill and they will be more likely to help to find a practical diversion.”

5.3 Traffic

All road users are familiar with difficult traffic situations. Daily annoyances or spectacular incidents that 'were lucky to have ended without disaster'. This also applies to LHV drivers. Drivers named the following points as particularly relevant to driving LHVs: overtaking, changing lanes and reversing.

Overtaking

- Drivers remarked that it can take other trucks a while to overtake an LHV. This leads to annoyed road users and some drivers even opt to overtake via the hard shoulder;
- A restriction on overtaking applies to LHVs. Drivers are well aware of this, however they do not always understand why this is useful and necessary. Drivers mentioned the example of 'being stuck' behind a van with a trailer, or a passenger vehicle with a caravan. They do not understand why they cannot overtake vehicles on roads that have three lanes in each direction.

Changing lanes

- Changing lanes can be difficult, especially when there is a lot of traffic. It takes precision to find a sufficient space to safely change lanes. Drivers indicated that they anticipated this situation by adjusting their speed on time. During their training, specific attention was paid to this manoeuvre;
- Allowing other road users to safely change lanes also requires skills. Other drivers often simply assume that the truck will change lanes to make sufficient space. LHVs are not permitted to this, which sometimes leads to irritation among other drivers. However, according to the drivers, this did not lead to any real problems. Some drivers indicated that they do 'change lanes' if the traffic situation demands this;
- Drivers mentioned that bigger problems arose at short slip roads. If the slip road is short the vehicles sometimes come to a halt on the slip road or continue driving on the hard shoulder, because of the LHV there is insufficient space to merge. According to the drivers, dangerous situations sometimes occur if the slip road is not long enough or if there is no hard shoulder to continue on at the end of them;
- Lastly, the drivers are hindered by vehicles that merge at the very last moment; this mainly occurs on motorways with many exits and entry lanes. Just like in the previous study that was conducted in 2009, the drivers blame this on the longer distance that they are required to keep. Some drivers indicated that they reduce their distance to the vehicle in front of them, so they do not have to repeatedly apply the brakes for merging traffic.

Reversing

- According to the interviewed drivers, 'special skills are required' to reverse an LHV. This mainly applies to drivers who are accustomed to driving simpler and much smaller vehicles: '... a city trailer drives very differently than a truck'. It should be remarked that this also applies to drivers who switch from a truck to a truck-trailer combination;
- Extra attention is paid to this manoeuvre during training and the exam. Examiners indicated that they also take into account the different features of the different types of LHVs. For example, in the case of the city trailer it is important for the steering axle to be positioned correctly, to ensure that the trailer follows correctly when reversing;
- This also applies to the truck-trailer-trailer combination (type B). One of the drivers indicated that the steering rear axle of his truck-trailer-trailer combination was not facing forward, causing it to jam. While reversing the driver also lost

control of the rear trailer, causing it to hit a tree. This incident could have just as easily occurred with a regular truck-trailer combination. All the interviewed drivers stated that it pays to practise: drivers should first practise reversing the LHV during a 'dry run' and will then quickly manage this skill in practice. They also pointed out that, due to limited space at some distribution centres, it can be difficult to reverse the LHV. Drivers welcomed the special LHV docks at some centres;

Just like in 2009, it is safe to conclude that the majority of the aforementioned situations occur on the main road network. This is where the longest distances are travelled, however previous studies have suggested that interaction between slow traffic and LHVs can lead to dangerous situations. According to the drivers, as previously mentioned, there is not much interaction between LHVs and slow-moving traffic. Designating core areas seems to have been successful.
Traffic flows
The drivers hardly complained about congestion. It is not difficult for LHVs to drive in traffic jams. The combinations are not permitted to overtake other vehicles, this prevents unnecessary manoeuvres and results in calmer traffic situations.

5.4 Special conditions

According to the dispensation LHVs are not permitted to drive during extreme weather conditions. Drivers consider this a difficult rule, because the dispensation does not specify what 'extreme' weather conditions are. If fog occurs – and visibility is less than 200 metres –the LHV is prohibited from driving; however, the term 'slippery' is a very vague criterion, especially because this situation could occur suddenly and locally. Because this rule is open to interpretation, it sometimes causes tension between planners and drivers. Generally speaking, drivers are often influenced by the opinions of their colleagues: "…last week a storm was raging, and I had my doubts. But if your colleagues take to the road, you do the same."

Wind is mainly disruptive when driving a lightly-loaded or unloaded LHV. However, drivers are generally aware of so-called 'smart' weight distribution. For example, in the case of three 20ft-containers, if the wind is strong, the empty container is deliberately not placed in front but at the rear. According to the drivers, rain does not cause much disruption. They consider the splash guards against splashing water to be very effective. Darkness does not lead to any problems either. The many lights and reflectors make sure that the LHV are clearly visible to other road users.

5.5 Driver behaviour

According to examiners from the CCV the LHV drivers themselves are responsible for traffic safety. This does not involve specific skills, but mainly revolves around mentality. Good drivers will drive defensively and will proactively rule out risks in as far as this is possible.

Over the past years the CCV noticed that many potential LHV drivers showed good driving skills. These professionals were specially selected by their boss to take part in the training. Motivated drivers do not just simply learn the rules, they also understand what they are meant for and how they can best be applied. This group had very high success rates.

However, over the past year the percentage dropped from 95% to 75%. This is still a high success rate, but it does mark a significant drop. According to the examiners, this was due to the fact that the LHV market has become a broader market. In the

past only the best drivers operated LHVs, whereas nowadays almost anyone can work with these vehicles. In some cases unmotivated drivers and drivers who are inexperienced at handling 'heavy' vehicles are sent to the training ("… a few years on a truck is incomparable to driving an LHV".) The CCV has also observed an increase in the number of foreign drivers. This not only leads to language problems, but the examiners have also experienced a different mentality among these drivers, and which is often not compatible with the required defensive driving style.

As a result the CCV feels that the current training and certification requirements should be upheld. Strict exam requirements help to maintain the level of the training: "… if they (the trainers) see what aspects we test, they will have to incorporate this into their training".

Examiners have observed a potential risk in the current, broader LHV market. This concerns drivers who operate LHVs without a valid certificate. In their opinion the National Police Services Agency and the regional police should play an active role here.

The interviewed LHV drivers endorse the importance of a good driving mentality: "… this may be a vehicle with all the trimmings, but in the end it's about the person behind the wheel". Each and every driver is committed to his profession. They are proud of their vehicle combination and their handling of the vehicle. Drivers subscribe to the importance of training and, in particular, understand the need for experience requirements.

However, it is important for drivers to be able to enjoy operating the LHV: due to restrictions that are in place, drivers are limited in the number of routes that they can drive. And because LHV drivers and regular truck drivers are paid the same salary, the only real challenge lies in the ability to control the vehicle.

Drivers feel that other road users do not consider LHVs to be different from regular transport vehicles. Passenger vehicles overtake LHVs or merge next to them without considering the fact that this vehicle is longer than regular trucks. This sometimes leads to panic reactions and unexpected manoeuvres. It can be concluded that this traffic safety risk is specific of LHVs.

Drivers also mentioned that they encounter bizarre situations when operating regular vehicles. So the question remains whether the extra length actually leads to extra dangerous situations. The potential extra danger does not lie in the shock reactions regarding the vehicle's length. Drivers were of the opinion that Dutch road users are becoming ever more accustomed to seeing LHVs on the road. They further mentioned that it is hard to distinguish modern LHVs (city trailers) from regular combinations. It should be ascertained whether the fact that the vehicle is 'longer than expected' poses extra risks to other road users.

The drivers themselves think that people exaggerate: "… because the vehicle is several metres longer, this doesn't mean that it takes other drivers several minutes longer to overtake the LHV". They also mentioned that they feel the responsibility partly lies with the other road users themselves: "… if you keep your eyes open, you will see that this is a long vehicle".

In view of the last-mentioned point, drivers feel that driving schools should pay more attention to the presence of trucks on the road. They feel that the use of

markings (side markings or a larger sign) to indicate the extra length of the vehicle will not solve any problems. This will only have a limited effect: "… if you do not expect the sign, you will not pay any attention to it, and it doesn't make any difference even if you do see it!".

5.6 Vehicle characteristics

The primary question in this study is actually whether vehicle characteristics specific to LHVs bring about additional risks or matters that require attention. One hypothesis from the accident analysis stated that LHVs had greater difficulty negotiating bends. Drivers did admit to finding sharp and tight turns challenging, but said this is no different than with regular trucks. The fact that a regular truck-trailer with rigid rear axles is less manoeuvrable than an LHV with steering rear axles was mentioned as an example.

The swerving behaviour of LHVs is another potential matter of interest. Drivers indicated that because city trailers, for example, have an extra steering axle the rear end of the first trailer can swerve across the lane of oncoming traffic when negotiating a turn. As previously mentioned, it is important for the steering axle to be positioned correctly before a vehicle wants to reverse. At the start of the LHV pilot scheme vehicles occasionally experienced 'power failures', this made it impossible to steer the axles as a result of which the trailer was unable to properly follow the vehicle.

5.7 Conclusions

The following five working hypotheses were formulated on the basis of the police-recorded accidents and the accident statements that the companies provided:

6. The infrastructure is not always able to accommodate LHVs. This mainly applies to turns and bends.
7. LHVs have a harder time dealing with poor weather conditions than regular trucks. This concerns conditions like rain, strong gusts of wind, snow and black ice, leading to skidding and swerving.
8. Overtaking and changing lanes lead to dangerous situations. Road users often misjudge an LHV's length.
9. LHVs are not properly identifiable as such at night.
10. It is more difficult to reverse an LHV than a regular truck.

The drivers did not corroborate the first hypothesis (6): generally, the infrastructure does not cause any special problems for LHVs. Negotiating sharp bends may be difficult, but this just as easily applies to regular transport vehicles. It was pointed out that regular truck-trailers with rigid rear axles are less manoeuvrable than LHVs with steering rear axles.

The lack of sufficient, suitable parking facilities, mainly for urban distribution, remains a point of attention. Breakdown bays are not (yet) able to handle LHVs either.

The second hypothesis was (partially) corroborated by the interviews: drivers indicated that lightly-loaded LHVs suffer more from strong winds.

The third hypothesis – overtaking and changing lanes are a risk because road users misjudge the length of the vehicle – cannot be corroborated on the basis of the interviews. Drivers do consider manoeuvres such as overtaking and changing lanes

to be risky, however, in their opinion, the fact that other drivers possibly wrongly estimate the length of the LHV does not play any significant role. Drivers also encounter similar risky manoeuvres from other road users, when driving with regular trucks.

Based on the interviews, the fourth hypothesis was dismissed. Because of the many lights and reflectors (both at the rear and on the sides), drivers considered LHVs to be properly visible even in lower light.

The drivers corroborated the fifth hypothesis: they consider reversing an LHV to be a special skill. It should be noted that the complexity is partly dependent on the type of LHV that is being driven. The saying 'practice makes perfect' also applies here. The LHV training pays extra attention to reversing, as a result of which drivers have little difficulty executing this manoeuvre in practice.

Further to the above-mentioned hypotheses, the driver interviews brought about the following matters of interest:

Infrastructure
11. Limited (suitable) parking facilities
12. Length of breakdown bays
13. Short slip roads and slip roads that do not go over in a hard shoulder;
14. Motorways with many high-density entry and exit lanes;
15. Limited space at distribution centres;
16. Roadworks: cordons and diversions
17. Incident management (towing away abandoned vehicles);
18. Parking facilities (allowing for coupling and uncoupling of vehicles);

Special conditions
19. Poor weather conditions (wind, slippery road surfaces) combined with limited axle pressure because of a small or light vehicle load;
20. Changing the current rules governing 'bad weather' because these are unclear and therefore difficult to apply;

Driver behaviour
21. Overtaking and changing lanes by other road users;
22. Information and education on the existence of LHVs;
23. Driving illegally – without valid LHV certification;
24. Drop in the pass rates for LHV certification;
25. Language problems in relation to foreign drivers;

Vehicle characteristics
26. Swerving/overturning (due to strong winds);

6 Expert session

As a third and final step in this study, the findings from the interviews were put forward to experts. To this end, an expert session was arranged with representatives of the National Police Services Agency (KLPD), Regional Police and representatives from three companies. Appendix A includes a list of participants.

In the session the conclusions from the interviews were presented to the participants. In addition to looking at possible traffic safety risks of LHVs, specific attention was paid to traffic flows and road design. The results of the expert session are elaborated in the following paragraphs.

6.1 Vehicle

According to the experts, from a technical point of view, LHVs are generally in great condition. These vehicles must already comply with stricter requirements than those that apply to regular transport vehicles. On top of that, for the time being, the concept seems to appeal to the 'higher segment' of the transport market; companies that can and want to invest in good equipment. This is not only apparent from the prescribed vehicle inspections, but also from police inspections. LHVs stand out in a positive way: as yet, there have been no incidents whereby standards have been exceeded.

6.2 Infrastructure

It was purposely decided in the Netherlands to adapt vehicles – in this case LHVs – to infrastructure, rather than the other way around. Where necessary, additional vehicle requirements were set. This means that in practice the 'normal' infrastructure should not pose any problems for LHVs. As with every rule, there will always be exceptions. To rule out some specific traffic safety risks, but also in consideration of management and maintenance, LHVs are prohibited from accessing certain roads. Recommendations were formulated in a publication by the centre for policy and research in civil and traffic engineering (CROW). LHVs are permitted to drive on trunk roads, within the core areas and on connecting routes in-between.

The lack of sufficient parking and coupling space is an issue that should be mentioned. Even though industrial parks are equipped to accommodate LHVs, the available space is often limited. According to the companies, the biggest problem involves city distribution. To obtain maximum benefit from the concept, the city trailer must park as near as possible to the city centre. However, these locations often lack the proper facilities to accommodate LHVs, forcing them to deviate to other peripheral areas. According to the companies, the road administrators should pay more attention to this problem.

Companies do not have many complaints regarding the designation of the core areas. It sometimes takes a long time for applications to be processed, and certain routes are rejected without proper reasons being provided[3], but generally speaking the procedure is smooth. According to the surveyed companies, the road administrators are becoming more accustomed to the concept of LHVs. The RDW's professional approach to matters was also mentioned. Companies also responded positively to the 'Full dispensation for LHVs' (if a company has applied for a dispensation for a route, the dispensation directly applies to all companies).

3 In one case, the road administrator concerned had been mistaken about the applicable speed limit on their road.

This reduces the administrative burden and, at the same time, increases the range of the companies and their drivers. A point of interest here is the fact that drivers are still obliged to travel with the 'road documents' of all routes/core areas in their truck. Because of the large number of core areas, drivers are required to keep enormous amounts of paperwork in their vehicle. If a digital map of all core areas would be made available, this would mean a significant improvement. On top of that, a map is much clearer and easier to understand than a simply having a list of street names on the 'road documents'.

According to the experts, the current restrictions that apply with regard to railway crossings are also in need of a revision. The following rule applies to railway crossings: in principle, LHVs are prohibited from using intersections where trains travel faster than 40 kph. In actual practice, LHVs are forced to take illogical routes and some industrial parks are even completely inaccessible.

Since 1993 longer waiting times at traffic lights have applied at over 40 crossings. Since 2007 LHVs have been permitted to use these crossings on the condition that there is sufficient amount of space after the railway crossing (31m). This is to prevent LHVs from coming to a standstill on the railway track. Companies, but also the National Police Services Agency, fail to understand why the rules on 'extended waiting times at traffic lights' are not extended to other areas, and wonder whether these extended waiting times should even be implemented at all "… if 'low riders' are permitted to cross every railway crossing in the Netherlands, then you could ask yourself why this does not apply to LHVs?"

Experts also argued that the CROW publication should distinguish more clearly between urban and industrial areas. The experts agreed that current regulations that apply to urban areas should remain in place: no LHVs are allowed in urban areas. However, the rules that apply to industrial areas could be relaxed, for example regarding the requirement with regard to a separated infrastructure. In industrial areas the interaction with slow traffic is limited, therefore in this case the regulation surpasses its goal[4].

Roadworks
As already mentioned, experts think that LHVs are insufficiently taken into account where roadworks are in place. Cordons do not accommodate LHVs, and some lanes and curves are too tight. On top of that, some diversion routes may lead off designated LHV routes onto roads that are unsuitable and formally even prohibited for LHVs.

The consulted companies and police recognise and acknowledge these problems. In the event of diversions, the police advises drivers to contact them.

6.3 Traffic

According to the drivers, it is hard for LHVs to reverse, overtake and change lanes. The consulted experts also agree to this fact, however they noted that these situations also cause problems for regular transport vehicles.

Opinions on the extent to which LHVs are clearly recognisable varied. According to the companies, LHVs are a common sight on Dutch roads. According to the police, this is not the case on the secondary roads, and could lead to shock reactions from

4 Not all experts were aware of the fact that roads lying within five kilometres of an LHV core area do not necessarily have to comply with the recommendations in CROW publication 260, LHVs on secondary roads. In this case it is the road administrator who decides whether or not it is safe for LHVs to use these roads.

other road users. However, all the experts did agree on the solution to this problem: more effort should be invested in information and education. Many problems could be prevented if people would have a better comprehension of the types of combinations that can be encountered on the road.
Incidents and traffic flows
According to the National Police Services Agency, incidents involving with LHVs are a rare occurrence. In their opinion salvage companies are sufficiently capable of handling large vehicle combinations. Given the fact that LHVs also use congestion-prone routes on the main road network, it is recommended that this should be checked with the road inspectors. If it would take a lot more time to salvage LHVs than it would to salvage regular combinations, then according to the experts, it would be wise to create a special LHV incident management protocol.

The National Police Services Agency also observed that the media pay a disproportionate amount of attention to truck accidents. This leads to a negative perception among the general public: "… people are of the opinion that trucks are far more dangerous than passenger vehicles." To avoid such situations the police propose that every accident involving an LHV should be subject to an in-depth analysis: "… this enables people to debate the situation on the basis of facts, instead of on the basis of 'horror stories'. People are easily scared."

According to the consulted experts, it is not difficult for LHVs to drive in traffic jams. They expect that an increase in the number of LHVs will have a positive effect on congestion; on the one hand because of the expected reduction in the number of vehicle movements, on the other hand because an increase in the number of LHVs is expected to even out overall traffic: "… more LHVs on the road means fewer drivers and less overtaking manoeuvres".

6.4 Driver behaviour

Experts felt that, over the past years, the general traffic situation has coarsened. Road users do not or hardly take other road users into consideration, and occasionally behave in an anti-social manner. According to the experts, LHV drivers formed an exception to the rule. The police praise the manner in which LHV drivers handle their vehicles, but also the manner in which they anticipate other traffic.

During the initial stage of the evaluation phase, they did encounter drivers who did not have valid certification. The National Police Services Agency wondered whether, as a result of the increased use of LHVs, sufficient numbers of drivers have been and are being trained to drive LHVs. The companies indicated that enough drivers undergo training, so that in the event of illness or other unexpected circumstances, the company can still rely on sufficient capacity.

All experts felt that the current requirements regarding training should be maintained. This in spite of the fact that there were some doubts regarding the added value of the training "… you are either able or not able to operate an LHV, it doesn't require any training'. The LHV certification is still considered to be an important indicator of quality. The same applies to requirements on the vehicle (including inspections): "… this helps you to separate the wheat from the chaff, and prevents every cowboy from driving an LHV."

6.5 Special weather conditions

LHVs are - in principle – prohibited from taking to the road when road surfaces are slippery or if fog limits visibility to under 200 metres. From the interviews it became

apparent that drivers do not think this offers a practical solution. The experts shared this opinion. In view of the fact that extreme weather conditions pose extra risks to any vehicle on the road, it was argued that the restriction should be dropped, and that it was best to leave it to the industry's self-regulatory capacity.

6.6 Conclusions

In relation to the working hypotheses formulated based on the accident analysis, the following conclusions can be drawn:

Ad hypothesis 1
The infrastructure does not always accommodate LHVs. This especially applies to bends.

The experts are of the opinion that the normal infrastructure accommodates LHVs just fine. No problems that are specific to LHVs occur with regard to bends. As the number of LHVs increases, further thought will need to go into introducing changes regarding aspects such as breakdown bays that are too short, the limited number of sufficient parking spaces, and filter lanes that are too short. The experts also argued for an adjustment of the current guidelines. According to them the following points should be adjusted/relaxed: the need for a separate infrastructure for slow traffic on industrial parks, and the ban on using LHVs at railway crossings.

Ad hypothesis 2
LHVs have more difficulty in poor weather conditions than regular combinations. This includes rain, strong gusts of wind, snow and black ice, which lead to skidding and swerving.

The consulted experts are of the opinion that extreme weather conditions always lead to more dangerous situations for any vehicle on the road. And therefore extra regulations regarding this point are not necessary. The experts also argued that the rules applicable to 'bad weather' should be dropped.

Ad hypothesis 3
Overtaking and changing lanes lead to dangerous situations. Road users do not correctly judge the length of the LHV.

Overtaking and changing lanes is not a risk that specifically applies to just LHVs, it is a general risk that concerns all trucks. Efforts should be made to increase road users' knowledge and awareness of truck traffic via public information (publicity campaign).

Ad hypothesis 4
LHVs are not properly identifiable as such at night.

According to the experts this is not a problem that is specifically related to LHVs, and therefore does not deserve any specific attention.

Ad hypothesis 5
It is more difficult to reverse an LHV than a regular truck

Experts agree that reversing is a skill that requires practice. An LHV handles differently than a truck-trailer, and the driver must therefore learn how to reverse again. It was also noted that this also applies to drivers who are making the switch

from a truck to truck-trailer, and is therefore not a problem that is specifically related to LHVs.

The following conclusions can be drawn with regard to matters raised during the driver interviews:

Infrastructure
6. Limited (suitable) parking facilities
7. Length van breakdown bays
8. Short slip roads and slip roads that do not go over in a hard shoulder;
9. Motorways with many high-density entry and exit lanes;
10. Limited space at distribution centres;
11. Roadworks: cordons and diversions
12. Incident management (towing away abandoned vehicles);
13. Parking facilities (where vehicles can couple and uncouple);

The experts are of the opinion that, especially considering the fact that the number of LHVs is increasing, the road design should focus more explicitly on the aforementioned points.

They still consider interaction with slow-moving traffic to be the greatest risk. However, the guidelines are very stringent with regard to this point, and therefore, in practice, the risk remains extremely limited.

Special conditions
14. Poor weather conditions (wind, slippery road surfaces) combined with limited axle pressure because of a small or light vehicle load;
15. Changing the current rules governing 'bad weather' because these are unclear and therefore difficult to apply;

See under hypothesis 2.

Driver behaviour
16. Other road users overtaking and - especially - joining the stream of traffic;
17. Information and education on the existence of LHVs;
18. Driving illegally – without valid LHV certification;
19. A drop in the pass rates for LHV certification;
20. Language problems in relation to foreign drivers;

According to the experts, faulty overtaking and merging manoeuvres by other road users are part and parcel of interaction between passenger and goods vehicles. They feel further effort should be made to raise awareness (education/information) regarding the specific risks of goods vehicles. To maintain the current quality level, all experts feel that the current LHV training should remain in place. The KLPD has observed an increase illegal driving. In the future, this may require extra efforts in terms of enforcement.

Vehicle characteristics
21. Swerving/overturning (due to strong winds);

According to the experts, the risks of swerving and overturning differ per type of LHV. It would need to be examined what measures could be taken to prevent vehicles from overturning.

In addition to the issues already mentioned, the following additional conclusions can be drawn:

- Based on the outcome of regular checks, it is concluded that companies generally comply with the requirements;
- LHV equipment is generally in good order;
- Generally speaking, vehicles seem to be staying on the prescribed routes;
- It should be examined whether Incident Management (IM) procedures take sufficient account of LHVs;
- The additional requirements which LHV drivers have to meet, prove satisfactory in practice and contribute to an enrichment of the profession;
- The experts believe that an increase in the number of LHVs will positively affect traffic easing; on the one hand because of the expected decline in the number of vehicle movements, on the other because an increase in the number of LHVs is expected to even out overall traffic.

Variance analysis

On what points did experts' opinions differ from drivers' opinions? It may be concluded that the opinions of the consulted experts barely differed from those of the drivers.

This outcome was not surprising. Mainly companies were consulted during the expert session. It is remarkable that experts from the National Police Services Agency and the regional police largely shared the same conclusions as the industry.

7 Analysis of core areas

7.1 Introduction

The Dutch network of roads where LHVs are permitted to drive consists of three parts: the trunk roads, the core areas and the connecting roads from the trunk roads to the core areas.

The main road network comprises the network of motorways, trunk roads and other roads that are managed by the Directorate-General for Public Works and Water Management (the national road administrator). LHVs have access to the entire system of motorways and trunk roads. However, some road sections are only accessible to trucks with a maximum weight of 50 tonnes, such as the A12 motorway near Zeist; this is measure applies because of the condition of a structure at this location. The other roads that fall under the Directorate-General's management are accessible if local conditions permit this. A speed limit of 80kph applies to nearly all these roads. The primary condition subject to which dispensations are given is that a complete ban on overtaking applies on these roads.

A core area is defined as an area that is not designated for agricultural or residential purposes, where one or multiple of companies are established and which form the point of departure or destination of an LHV's journey. Examples include industrial parks, ports and auctions. Connecting roads refer to routes that connect a core area to the trunk roads. In most cases this concerns through roads that are managed by the province, like the N201 to the Aalsmeer flower auction. The Netherlands currently has over 450 core areas where regional road administrators have given their permission for LHVs to be used. Most of the submitted dispensation applications concern core areas around the Port of Rotterdam.

If a company that operates LHVs wants to drive to a destination that is not yet accessible to LHVs, the company must submit a request to the Dutch Road Transport Directorate (RDW). The RDW subsequently submits the request to the road administrators concerned. They will assess whether the industrial park and route from the main road network are suitable for LHVs. Since early 2009 road administrators can use CROW publication 260 'LHVs on secondary roads' to make their evaluation. This publication contains advice to support the evaluation. If the road administrators decide to provide access to these roads, the RDW will designate this a core area and the company will be given a dispensation to drive to the core area in question.

Until 1 November 2010, companies were also required to apply for a dispensation if they wanted to drive their LHVs to an existing core area. This meant that companies required one or more dispensations for specific core areas, and were only permitted to drive to these core areas. On 1 November 2010 a so-called 'full dispensation for LHVs' was introduced. This means that all companies that had a dispensation on 1 November 2010 are permitted to drive to all core areas. Companies are no longer required to apply for another dispensation if they want to drive an existing core area that they have not travelled to before. Companies can only access new core areas after receiving a dispensation from the RDW.

For the analysis of core areas, the study specifically focussed on industrial parks. The reason for this is that insight is desired in possible issues regarding traffic safety, road design and traffic flows in these industrial parks. The aspect of traffic

safety primarily concerns the safety of moped riders, cyclists and pedestrians. The analysis consisted of two parts. Firstly, the industrial parks were categorised on the basis of various criteria. This provided insight in the different types of core areas. Paragraph 7.2 describes this analysis. Paragraph 7.3 subsequently further examines the traffic safety of moped riders, cyclists and pedestrians in relation to LHVs. The second part consisted of a close look at ten industrial parks. The results are explained in paragraph 7.4.

7.2 Categorising the core areas

To offer clear insight in the different types of core areas, the core areas were categorised on the basis of different criteria. The analysis did not focus on all core areas. For example some provincial roads that connect different motorways are designated a core area. Because the focus lies on industrial parks, these connecting roads are not interesting for the purpose of this analysis. So-called training and exam routes also exist. These core areas consist of various separate core areas and connecting roads between them. In fact, the training and exam routes overlap different core areas. In total, 447 core areas were categorised.

The core areas were categorised on the basis of the following characteristics:
- The size of the industrial park;
- The location of the industrial park in relation to residential areas;
- The location of the route to the main road network in relation to residential areas;
- The distance from the industrial park to the main road network;
- The spatial layout/design of the industrial park;
- The infrastructural facilities for moped riders, cyclists;
- The dominant sector in the industrial park.

Below several tables have been added to illustrate the results of categorising the data; this is followed by an explanation of the information in the tables.

Size of industrial park	In residential area	Edge of residential area	Outside	Total
Small	14	28	51	93
Medium-sized	3	80	21	104
Large	4	183	54	241
Very large	-	1	8	9
Total	**21**	**292**	**134**	**447**

Table 7.1 Size of industrial parks in relation to their situation with regard to residential areas

The table above shows that the majority of industrial parks fall under the category ‘large’. These parks vary between 100 and 500 hectares. Small and medium-sized industrial parks each make up over 20% of the total number of industrial parks. In this case, small industrial parks are usually individual addresses or just a single street which LHVs have access to. This includes agricultural organisations and waste-processing companies. In over 50% of the cases, these businesses are situated outside residential areas. A relatively large percentage of the small industrial parks are located in a residential area. Compared to the total number of industrial parks, only a limited number lie in residential areas.

Dominant sector	Small	Medium-sized	Large	Very large	Total
Waste processing	7	-	-	-	7
Exam location	3	-	-	-	3
Mixed industrial park	33	83	183	-	299
Port	4	3	37	6	50
Industry	7	4	5	-	16
Aviation	-	1	2	3	6
Ornamental horticulture/ agriculture	27	4	3	-	34
Transport	12	9	11	-	32
Total	**93**	**104**	**241**	**9**	**447**

Table 7.2 Dominant sector in relation to size of the industrial park

According to table 7.2 very large industrial parks primarily include the dominant sectors: port and aviation. This concerns the ports of Rotterdam and Amsterdam, and Amsterdam Schiphol Airport. Two-thirds of the industrial parks are categorised by a mix of companies, thus making it impossible to indicate a dominant sector. These companies include of a mix of production companies, car dealers, wholesalers, DIY stores, distribution centres and office properties. The other industrial parks primarily include companies that are active in the port, ornamental horticulture/agriculture and transport sectors.

Location	Moped riders, cyclists on the roadway	Moped riders, cyclists partly on the cycle path	Moped riders, cyclists on the cycle path	Total
In a residential area	9	6	6	21
Edge of residential area	173	115	4	292
Outside	89	35	10	134
Total	**271**	**156**	**20**	**447**

Table 7.3 Industrial park's location in relation to infrastructure for moped riders and cyclists

The table above shows that there are only a limited number of industrial parks where moped riders and cyclists and can rely on a separate infrastructure. The reason for this is that industrial parks are often located inside the built-up area, and mainly consist of 'property access roads'. Just like in residential areas, moped riders and cyclists drive on the road. Cycle paths or lanes are often situated along the access roads to industrial parks. These access roads are busier than the 'property access roads'. Moped riders and cyclists are more likely to encounter LHVs in areas where they are required to drive on the road. It should be noted that, when travelling in the built-up area, moped riders are normally required to drive on the road. Not many moped riders and cyclists drive on the industrial parks that are situated in the outlying area, as a result of which the parks do not have a separate infrastructure for these users.

Route to main road network	< 1 km	< 5 km	< 10 km	> 10 km	Total
Through a residential area	4	28	15	5	52
Along a residential area	11	43	14	22	90
Not along a residential area	192	81	18	14	305
Total	**207**	**152**	**47**	**41**	**447**

Table 7.4 Length of the route to the main road

Table 7.4 shows that the majority of industrial parks that offer access to LHVs are situated within five kilometres of the main road network. For two-thirds of the industrial parks, the route to the main road network does not go through or along a residential area. This is positive, because this reduces the likelihood of LHVs encountering slow traffic like moped riders and cyclists on the route from and to the main road network. Just over 10% of the industrial parks do have a route that runs through a residential area. This is the case for 21 industrial parks that are situated in a residential area. These are often through roads that run through residential centres and do not have a ring road.

Size	Limited	Average layout	Spacious layout	Final total
Small	23	53	17	93
Medium-sized	28	39	37	104
Large	49	79	113	241
Very large	-	-	9	9
Total	**100**	**171**	**176**	**447**

Table 7.5 Spatial layout of the industrial parks in relation to their size

Over three-quarters of industrial parks that accommodate LHVs, range in size between average and large. Parks with 'spacious layouts' have wide roads and bends to ensure that trucks have sufficient room to manoeuvre. Parks that include a relatively high percentage of companies that rely on heavy truck traffic often have spacious layouts. According to the table above these are usually large industrial parks. Around 80% of industrial parks that have a 'limited spatial layout' accommodate a mixed range of companies, and therefore do not just focus on heavy vehicles.

Conclusions of categorising core areas

Based on the previous analysis of the core areas it can be concluded that the majority of industrial parks that have an exemption for LHVs are located on the edge of residential areas or in the outlying area. The route to the main road network is usually less than five kilometres, and in just over 10% of the industrial parks the route runs through a residential area. In most industrial parks, moped riders and cyclists must primarily drive on the road. This often concerns roads with a low intensity and a small amount of truck traffic. Busy roads often have cycle paths running alongside them.

7.3 Traffic safety of moped riders, cyclists and pedestrians

A 2008 study that was conducted by the SWOV led to the conclusion that traffic safety risks of moped riders, cyclists and pedestrians in relation to LHVs are largely the same as those that regular trucks face. This is due to the fact that accidents

between trucks and moped riders or cyclists are often right-of-way accidents. These are mostly side collisions that are related to the truck's blind spot, for example a cyclist who is hit by a truck that was turning right. One year ago, the use of blind spot mirrors was made compulsory. This has resulted in a decline in the number of accidents with moped riders, cyclists and pedestrians. Both LHVs and regular trucks must comply with the same requirements regarding blind spots. This means the risks of blind spot accidents are the same for LHVs as they are for regular truck combinations. However, the LHV's length in combination with the swerving behaviour in bends could pose a higher risk for moped riders and cyclists travelling next to an LHV. It is worth noting that an LHV combination with trailers that have steering axles has a smaller turning circle than a regular truck combination without steering axles. It is unlikely that risks arising from the length and the swerving behaviour of LHVs are higher than those of regular truck combinations.

Industrial parks that accommodate LHVs are also accessible to regular truck combinations. Slow traffic at industrial parks will generally be used to the presence of trucks.

A close look at the accident analysis (chapter 3) reveals that between 2007 and mid-2010 no accidents between slow traffic and LHVs were registered. Only two out of 19 accidents that involved an LHV occurred at an industrial park. The other accidents occurred on the main road network or the route between an industrial park and the main road network. Paragraph 7.2 showed that moped riders and cyclists must, for the most part, travel on the road when riding in an industrial park. In spite of this fact, as yet, there have been no registered accidents involving LHVs and moped riders, cyclists or pedestrians. However, it is impossible to state with absolute certainty that such accidents did not place. Considering that accident statements that were made available by the companies and the Dutch Association of Insurers did not contain any information on accidents between LHVs and moped riders, cyclists or pedestrians, it is highly unlikely that such an accident occurred.

7.4 Further analysis of ten core areas

To gain better insight in the core areas, some ten industrial parks were subjected to a further examination. The aim was to survey the greatest possible diversity of industrial parks. The following table shows which core areas were examined.

Name	City	Size	Location	Route to main road network	Spatial layout	Dominant sector	Distance to main road network	Facilities for moped riders/ cyclists
ABC Westland	Poeldijk	Medium-sized	Edge of residential area	Through a residential area	Spacious	Ornamental horticulture/ agriculture	< 10 km	Moped riders, cyclists on the road
Europoort	Rotterdam	Very large	Outside residential area	Not along a residential area	Spacious	Port	< 1 km	Moped riders, cyclists partly on a cycle path
Het Hoogveld	Asten	Medium-sized	Edge of residential area	Along a residential area	Average	Mixed industrial park	< 5 km	Moped riders, cyclists on the road
Loven	Tilburg	Large	Edge of residential area	Along a residential area	Limited	Mixed industrial park	< 1 km	Moped riders, cyclists partly on a cycle path
Majoppeveld-North/South	Roosendaal	Large	Edge of residential area	Not along a residential area	Limited	Mixed industrial park	< 1 km	Moped riders, cyclists on the road
Marslanden	Zwolle	Large	Edge of residential area	Along a residential area	Average	Mixed industrial park	< 5 km	Moped riders, cyclists partly on a cycle path
Oosterseveldweg	Wijster	Small	Outside residential area	Not along a residential area	Average	Waste processing	< 5 km	Moped riders, cyclists on a cycle path
Ruyven	Delfgauw	Medium-sized	Edge of residential area	Not along a residential area	Average	Mixed industrial park	< 1 km	Moped riders, cyclists partly on a cycle path
Trade Port East	Venlo	Medium-sized	Outside residential area	Not along a residential area	Spacious	Transport	< 1 km	Moped riders, cyclists on the road
Weststad	Oosterhout	Large	Edge of residential area	Not along a residential area	Average	Industry	< 5 km	Moped riders, cyclists on the road

Table 7.6 Further examined core areas

To gain a clear picture of the layout of industrial parks, the above-mentioned parks were visited. The road administrator, police and various companies were also contacted to enquire about their experiences regarding the deployment of LHVs at the industrial parks in question. Furthermore, accidents occurring at industrial parks between 2007 and 2009 were also reviewed. The specific focus of this review was on accidents with trucks and accidents with moped riders/cyclists.

7.4.1 Accidents

Between 2007 and 2009, exactly 429 accidents occurred at the ten industrial parks. Eighty accidents resulted in casualties. A further 54 accidents involved slow traffic, whereby 35 cases involving casualties were reported. Compared to the total number of accidents, the percentage of accidents with causalities was relatively high. This is due to the fact that moped riders, cyclists and pedestrians lack proper protection against injuries. Eight-four accidents involved trucks, 17 of which resulted in casualties. There were seven accidents involving trucks and slow traffic, which resulted in four casualties.

The accidents primarily occurred at intersections on the access roads to the industrial parks. These were primarily due to high traffic intensities on these roads. A general conclusion that can be drawn from looking at the different industrial parks is the fact that the number of accidents is proportionate to the size of the industrial park. The Europoort at Rotterdam and Marslanden in Zwolle are two exceptions to the rule. In spite of the fact that Europoort is a large site, only relatively few accidents occur here. This is due to the fact that the length of public roads at this industrial park is fairly limited. Most of the areas at the Europoort are private property. Accidents that occur here are not registered by the police. At Marslanden, part of the ring road from Zwolle runs across this industrial park. A relatively large number of accidents occur on these relatively busy roads, in particular at intersections. Less accidents occur on the other roads of this industrial park.

The seven accidents between trucks and slow traffic occurred at Loven in Tilburg (4), Oosterseveldweg in Wijster (1), Weststad in Oosterhout (1) and Marslanden in Zwolle (1). The last-mentioned case involved an accident between a truck and a microcar. In this case no one was injured. Of the four accidents that occurred at Loven industrial park, three involved cyclists and one involved a moped rider. All three cyclists were injured, whereby two of them were admitted to hospital. On two occasions the accident involved a towing vehicle (without a trailer) one involved a truck. The moped rider had an accident with a truck, but was not injured. At Weststad an accident occurred between a moped rider and a towing vehicle (without a trailer). In this case the moped rider was not injured either. The accident at Oosterseveldweg occurred between a towing vehicle (without a trailer) and a cyclist. The cyclist was slightly injured.

7.5 Analysis per core area

7.5.1 ABC Westland industrial park, Poeldijk

'Agri Business Centrum Westland' (abbreviated to: ABC Westland) is a large industrial park with around 60 companies that are directly or indirectly involved with the agricultural sector. This industrial park has existed for over ten years and has undergone a renovation; all work on the infrastructure has been completed. This is a spacious park with plenty of parking facilities for large and heavy vehicles. This year a new office complex will be opened, this will result in an increase in passenger traffic. This lively park sees a constant flow of trucks. The site is accessible on two sides. If there is heavy traffic at Paul Capetijnlaan this can lead to delays at the exit points.

According to the Government Road Transport Agency's official 'road documents', LHVs can only travel to the main road network via Paul Capetijnlaan, the N211 provincial road and the N213 provincial road to the Westerlee junction from where the vehicles can drive further via the A20. This industrial park is also accessible from the 'The Hague south' on the A4 motorway via the N211 or via the auction route (Veilingroute), and then further via the N213 and N211 to ABC Westland.

Seven companies currently have a dispensation for this industrial park; one of which is established on this site. The other companies are vegetable and fruit transporters that load and unload products at the site. Neither the municipality nor the companies know of any special incidents regarding traffic flows and traffic safety.

7.5.2 *Europoort industrial park, Rotterdam*

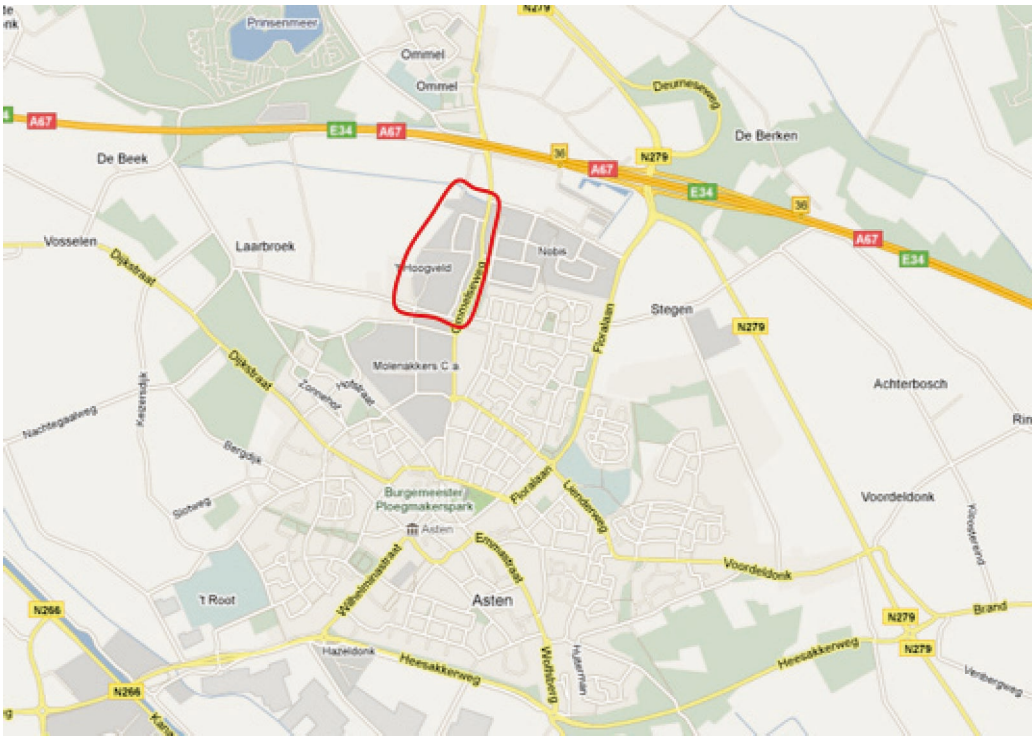
Europoort is an industrial and port area that belongs to the municipality of Rotterdam, and is part of Mainport Rotterdam. This area includes a lot companies that process bulk products such as: petro chemicals, ore, cars, steel and wood. The Moezelweg is the main road on the industrial park, this provides access to the industrial sites via roadway junctions. This is industrial park has a spacious layout. At the time of the survey no LHVs were observed. It was observed that vehicles, passenger vehicles in particular, drive relatively fast here. This is probably because these are wide and relatively quiet roads. Truck traffic and slow traffic use different roads and paths. It should be noted that slow traffic hardly makes use of this industrial area.

A total of 23 companies have a dispensation for this core area. These are predominantly companies that operate in the container transport sector. These companies are not established at this site. The municipality is unaware of any negative experiences with LHVs at this industrial park.

7.5.3 *'t Hoogveld industrial park, Asten*

't Hoogveld is a rather small and relatively old industrial park (10 hectares) that is situated on the north side of Asten. Mainly small companies are established in this park. A transporter and Vriescentrale Asten, a company that stores and processes fish products, are the biggest companies at this site. The access route runs from the A67 motorway along Nobis industrial park to 't Hoogveld.

Three companies have a dispensation to access 't Hoogveld. In addition to the transporter, two companies visit Vriescentrale. No LHVs were observed during the survey. It was established that vehicles do park at various places on the road. Some of the streets are narrow, and this can lead to obstructions. According to the municipality, parking problems are a common problem at this park and are not directly related to the use of LHVs. The municipality recently introduced a night-time parking ban that is applicable to various industrial parks, including 't Hoogveld. The municipality is unaware of any specific negative experiences involving the use of LHVs.



7.5.4 *Loven industrial park, Tilburg*

Loven is a large industrial park of nearly 150 hectares on the northeast side of Tilburg. It is situated around the Wilhelmina canal, and various companies that are located here focus on transport via ships. The southern part of the industrial park (Loven II), to the south of Gelrebaan, consists of a mix of small companies and homes. This is also the oldest section of the industrial park. A lot of trucks travel to and from several large companies that are situated at the subarea, Loven I. These companies include – the Barge Container Terminal, an Albert Heijn distribution centre and SCA Packaging (packaging material). Some containers are shipped via shunting vehicles from the container terminal to the railway on the eastside of Loven, where they are subsequently transferred to trains.

A total of 23 companies have a dispensation for Loven. The access roads run from the A65 or from the A261 via the N261 to Zuiderkruisweg. Most LHVs drive to and from Loven I, whereby the Barge Container Terminal and the Albert Heijn distribution centre form the primary destinations. Hardly any LHVs drive to Loven II. The municipality of Tilburg has deliberately refused LHVs from accessing the Loven III subarea. The reason is that this subarea runs along a 'no through road' which means LHVs are unable to turn around here. The municipality also indicted that no applications for a dispensation for Loven III were submitted. As yet, the municipality has not received any complaints regarding the use of LHVs at Loven.

7.5.5 *Majoppeveld north/south industrial park, Roosendaal*

The Majoppeveld industrial park is located on the east side of the municipality of Roosendaal and includes two areas: Majoppeveld north and Majoppeveld south. Majoppeveld north lies north of the A58 motorway (Eindhoven-Breda-Roosendaal-Vlissingen) and on its northern end it is bordered by the Breda-Roosendaal railway line. The site covers a gross area of around 100 hectares. Various garage businesses and large offices of the Philips Lighting company and Jan the Rijk Transport are located along the trunk road. The industrial park is part of a revitalisation project, 'Refurbishing Majoppeveld', whereby the focus lies on improving the paving, signposts and security. Majoppeveld south is located to the south of the A58 and borders on Rucphense Baan. The entire site covers a gross area of around 80 hectares. A furniture boulevard is located at Majoppeveld south. An industrial park of around 40 hectares is being built adjacent to Majoppeveld south. This new industrial park, extending from the A58 to Rucphense Baan, provides access to Majoppeveld south industrial park. This new site is called Majoppeveld east.

In total 12 companies have a dispensation for Majoppeveld north, and ten companies for Majoppeveld south. Seven companies have a dispensation for both Majoppeveld north and south. Majoppeveld south is accessed via exit 23 on the A58 motorway, and Majoppeveld north via exit 22. Neither the municipality nor the companies are aware of any special incidents involving LHVs at these industrial parks. The only complaints concerned the fact that many road users drive too fast on Leemstraat in Majoppeveld north. However, this unrelated to the use of LHVs.

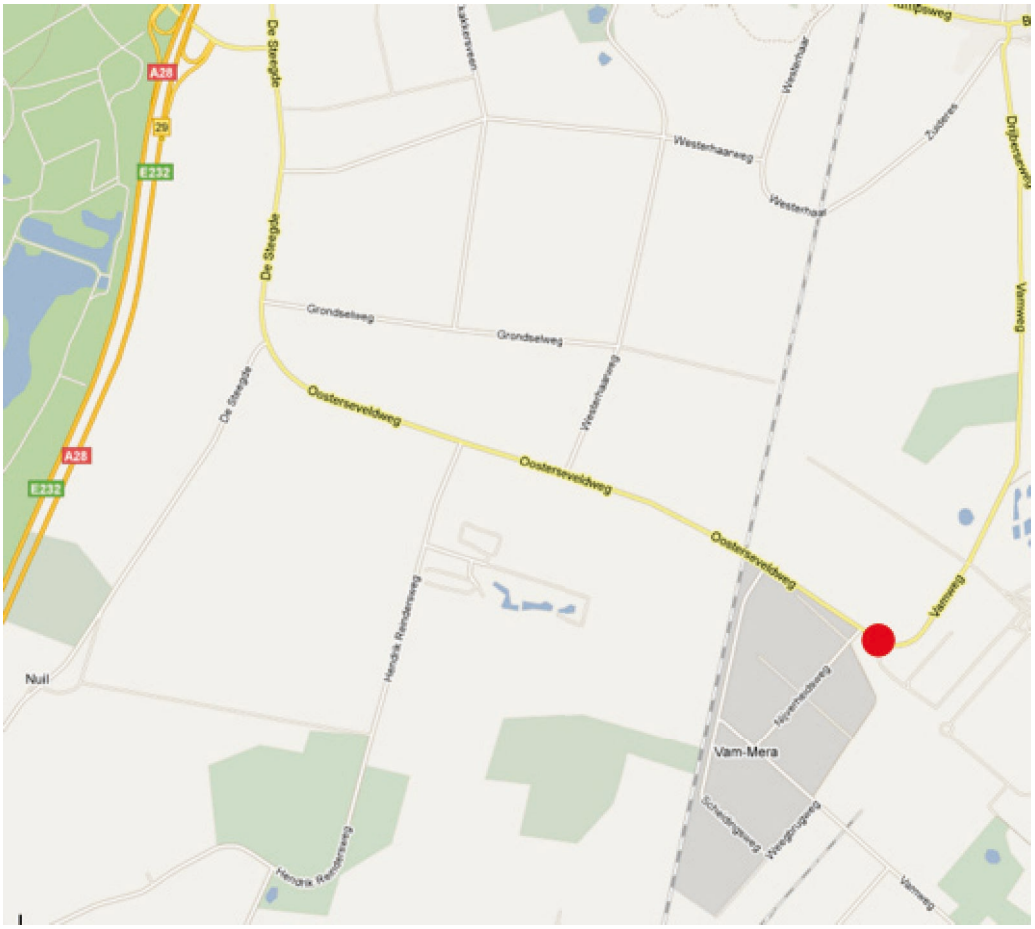
7.5.6 *Marslanden industrial park, Zwolle*

Marslanden industrial park is located on the southeast side of Zwolle. The site nearly covers 200 hectares and consists of seven subareas, A through G, whereby A is the oldest section and G the newest. This site is marked by a huge diversity of companies: from DIY markets to an Albert Heijn distribution centre, and from small office properties to a breaker's yard. the IJsselallee, Oldeneelallee and Ceintuurbaan constitute the southern part of the ring road from Zwolle. As a result, these are fairly busy roads. Separate cycle paths are located along all main roads, and several other roads have cycle lanes.

Twenty-four companies have a dispensation for Marslanden. To access the A28 motorway vehicles must travel via the N337 (IJsselallee) to the connecting road at Zwolle south or via the N35 (Ceintuurbaan) to the connecting road at Zwolle north. The Albert Heijn distribution centre at Marslanden D is an important destination for many LHV companies. The transport company, Pack2Pack, that operates multiple LHVs, is established at Marslanden A. Upon commencement of the evaluation phase the Municipality of Zwolle, in consultation with the cyclists' union, determined which roads would be accessible to LHVs. The municipality decided that several roads that are unsuitable for longer and heavier vehicles will remain inaccessible to these vehicles. According to the municipality there have been no experiences relating to the use of LHVs at Marslanden.

7.5.7 Oosterseveldweg industrial park, Wijster

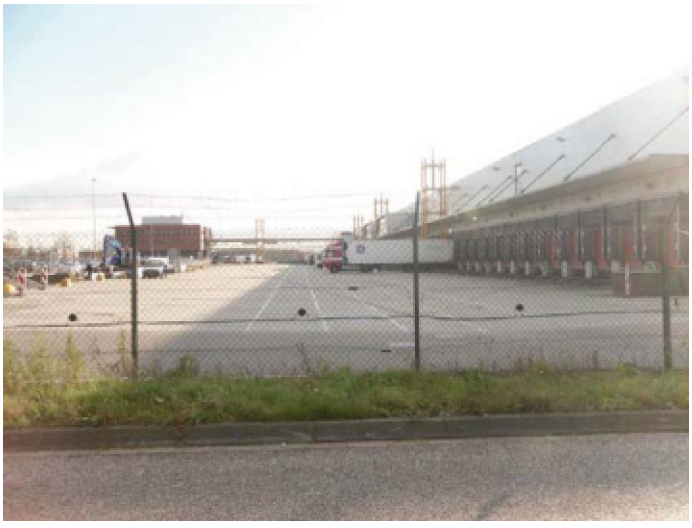
Only one business is established at the Oosterseveldweg core area in Wijster. Attero, a waste processing company (formerly known as VAM), is based at this location. The company is situated in the outlying area. Only one container transporter has a dispensation for this core area. From the A28 motorway the route runs via the Steegde and Oosterseveldweg to Attero. LHVs are permitted to use the railway crossing which lies along the route. The percentage of trucks that drive on these roads is relatively high. This is due to the fact that besides trucks travelling to and from Attero, hardly any other vehicles use these roads. The municipality is unaware of any specific matters of interest regarding this core area.



7.5.8 *Ruyven industrial park, Delfgauw*

Thirty companies – mainly consisting of distributors, trading companies and offices - are established at Ruyven industrial park. The biggest company at this location, an Albert Heijn distribution centre, generates a constant flow of goods traffic.

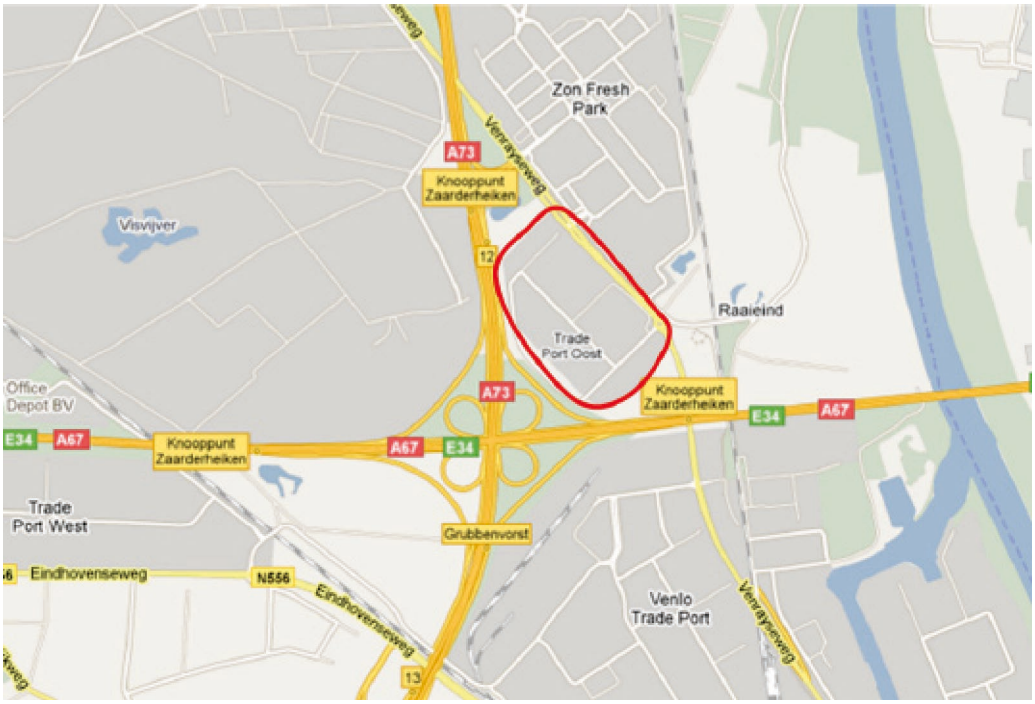
Seventeen companies have a dispensation to access Ruyven industrial park with LHVs; none of which are established at this site. These are primarily companies that load and unload their products - mainly fresh produce – at the Albert Heijn distribution centre.



Both the municipality and companies generally have positive experiences with LHVs; the vehicles simply constitute part of everyday traffic. From the start of the pilot scheme there has been strict supervision of parking in the public areas; as a result this hardly occurs at this site. The companies have sufficient parking facilities to accommodate heavy vehicles. The only problem at this park is the heavy traffic flow that occurs at the roundabout in the direction of the N470 during rush hour. This is because the industrial park is only accessible via this roundabout. During rush hour it takes trucks (that mainly want to turn left in the direction of the A13) more time to access the roundabout, which makes it difficult for them to exit the industrial park. This applies to all truck traffic, and not just to LHVs. The industrial park includes a petrol station, which generates extra traffic to and from the industrial park but this does not lead to significant problems. In general, slow traffic and trucks are able to travel without problems on this industrial park.

7.5.9 *Trade Port East industrial park, Venlo*

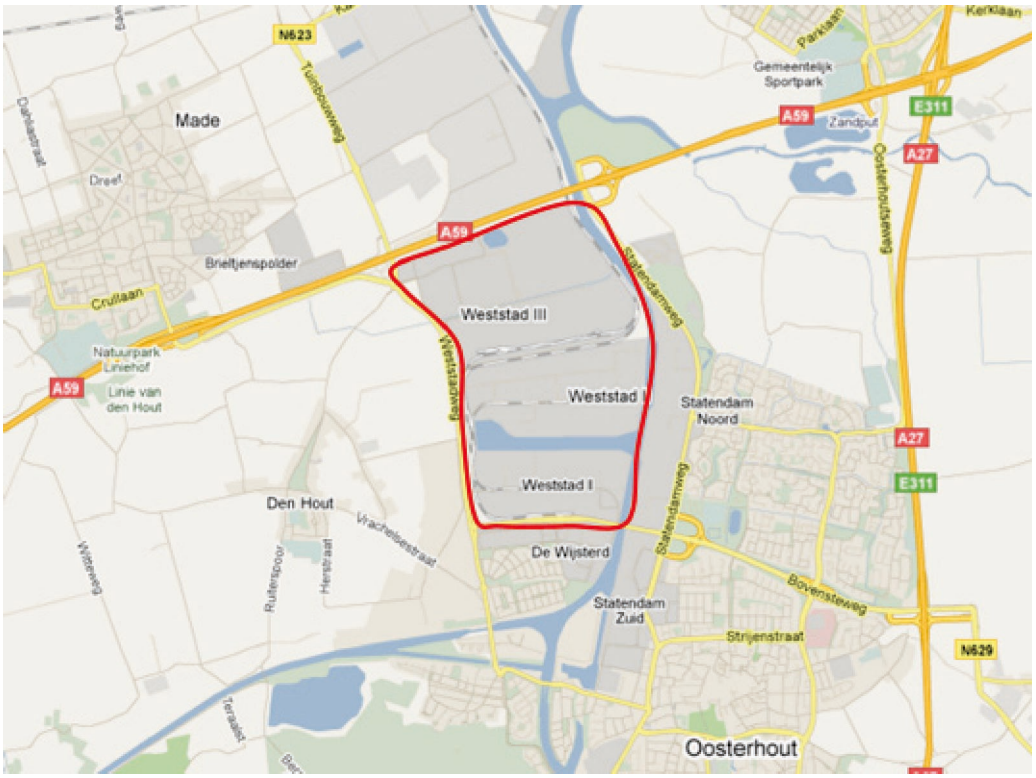
The Trade Port East industrial park is a relatively new site on the north side of Venlo. A small section of the plots have not yet been developed. The 20-hectare industrial park houses several wholesale businesses that are active in the home furnishing sector, and haulage firms. The site has a spacious layout and is located outside a residential area, and therefore has hardly any slow traffic.



Eight companies have a dispensation for Trade Port East. One of their destinations at this site is Flora Holland. No LHVs were observed during the survey. Several trailers were parked on the road. This did not cause any obstructions because this is a dead-end road with hardly any traffic. It is unknown whether these trailers were uncoupled units belonging to LHVs. The municipality is unaware of any negative experiences with LHVs at this industrial park.

7.5.10 *Weststad industrial park, Oosterhout*

Weststad industrial park in Oosterhout is easily accessible from the A59 motorway. This large industrial park actually consists of three parks. Weststad I, II and III. Coming from the A59 motorway, Weststad III is the first park. It is also the most modern of the three. Several small companies are established at this location, these mainly cater to consumers, however it also includes large companies like an IKEA distribution centre and GEFCO, a major distributor of French cars. The cycle paths are separated from the roads. During the survey it was observed that trailers were parked at different spots on one of the lanes. However, this did not cause any hindrances to other traffic.



Weststad I and II are slightly older than most other industrial parks. They are situated on the water and accommodate a wide range of transport vehicles, including trucks, tipping trucks, containers and tilt carts. A factory siding runs on both sites. These industrial parks do not have separate roads or paths for moped riders and cyclists. The quality of infrastructure at these sites is inferior to that of Weststad III. There were large puddles of water at different places on the site. Over half a lane was covered by water. This may be caused by the fact that various bulk companies are established on this part of Weststad, and the heavy vehicles that drive on these roads. Numerous trailers and cars were parked on the lanes. This caused traffic hindrances. The Municipality of Oosterhout is currently investigating how to deal with the parking problems at these sites.

Seven companies have a dispensation for the Weststad core area. No LHVs were observed during the survey; and no uncoupled units belonging to LHVs were encountered. The parked trailers either belonged to companies based on the industrial park or foreign drivers awaiting their return journey. Shunting vehicles were used to transport trailers from one location to another on the industrial park.

On the southside of Weststad I the area transitions into a residential area. The trucks drive in the opposite direction to the A59 motorway, so no trucks drive through the residential area. Although the industrial park offers good accessibility, it is difficult to exit the area during rush hour. This problem is mainly prevalent during the evening rush-hour. The industrial park does have any problems that are specifically related to use of LHVs.

7.6 Conclusions

The main conclusion, based on the analysis of the ten core areas, is that the use of LHVs at these industrial parks does not lead to undesired effects with regard to traffic safety, traffic flows and infrastructure.

The above conclusion was drawn primarily because the analysis showed that LHVs are more or less 'absorbed' by other (truck) traffic, and do not really differ from regular traffic. A survey was conducted among employees of the municipalities, police, park management, companies and road users. This showed that part of these people are unaware of the use of LHVs and therefore did not notice any issues involving the use of LHVs. The municipalities in question did not receive any complaints on LHVs either.

Various matters of concern were mentioned with regard to the surveyed industrial parks; however these issues apply to many industrial parks in the Netherlands and are not directly related to the use LHVs. These matters include: traffic flow issues during rush hours, speeding and illegal parking. The last-mentioned aspect is related to the use of LHVs. This situation mainly occurs when transporters want to uncouple part of the LHV combination and subsequently drive to another address outside the core area. This means sufficient space is required to accommodate the LHV combination. This point was also mentioned during the interviews and the group session. It is worth remarking that, in none of the ten surveyed areas, it could be established that vehicle components belonged to LHVs. Further points include incidental situations where a sharp bend hinders the traffic flow of trucks and LHVs.

The mixed composition of many industrial parks also leads to mixed traffic flows. On the one hand trucks deliver or collect goods from the companies, and on the other car drivers, moped riders and cyclists visit companies that cater to consumers, and workers also access the industrial park. Furniture boulevards, petrol stations and eating establishments generate relatively large traffic flows. According to a review of the accidents, the number accidents between passenger vehicles and slow traffic was relatively higher than accidents between trucks and slow traffic. Between 2007 and 2009 a total of 429 accidents took place at the ten examined industrial parks. In 54 cases the accident involved a moped rider or cyclist, and in 84 cases a truck was involved. Seven of these accidents involved a truck and a moped rider or cyclist, four of which resulted in injuries. It is striking that in four of these seven accidents this involved a towing vehicle without a trailer.

Lastly, paragraph 7.2 showed that the total 447 core areas give a very mixed picture. The core areas vary in terms of size, location and layout. The analysis of the ten core areas also showed that a core area's size is not always proportionate to the number of dispensations that are applied for. This makes it difficult to apply the conclusions that were drawn on the basis of the ten core areas to other core areas. Core areas with a limited spatial layout and with a large percentage of consumer businesses form two matters of interest. It is also worth mentioning here that these matters do not specifically concern the use of LHVs, but generally apply to all trucks.

8 Conclusions and recommendations

8.1 Conclusions

Traffic safety

Between 2007 and mid-2010 the police registered 19 accidents involving an LHV. In only one case a person was slightly injured. The other accidents involved material damage only (MDO). The companies reported a further 35 accidents; one of which involved a hospital casualty. Both accidents with casualties concerned rear-end collisions whereby specific LHV characteristics (length and swerving behaviour) played no role. None of the accidents involved vulnerable road users. It is not possible to state differences between LHV configurations, because the vehicle configuration was only known in a limited number of cases.

The police does not register every accident that occurs. Considering the relatively high registration level of accidents involving hospital casualties and fatalities, it is highly unlikely that – between 2007 and mid-2010 – more accidents with LHVs involving casualties and fatalities occurred.

Looking back on the research questions there are two conclusions:

- No direct issues were observed with regard to traffic safety, traffic flows and road design;
- The type of accidents that involved LHVs are usually typical truck accidents. In view of the fact that the number of LHVs is still limited, it cannot be established whether a certain type of accident that typically involves trucks occur more or less frequently during accidents with LHVs.

Although no direct issues were observed, there are several points of interest that should be mentioned:

- If an LHV is not clearly identifiable on its rear or side, there is a risk that, when overtaking or changing lanes, road users do not know that they are driving alongside an LHV until it is too late;
- If an LHV has a limited axle pressure due to a light or little cargo it could be more prone to poor weather conditions (slippery surface and wind) than regular trucks.

The points of interest regarding road design and traffic flows are examined below.

Road design

Partly because of vehicle requirements that apply to LHVs in the Netherlands, the current road design raises few issues for LHVs. The following points merit further attention:

- Sharp bends remain an issue. At tight turns to the right, LHV drivers will, if possible, take up two lanes on approach in order to negotiate it well;
- There are currently (too) few LHV parking spaces;
- Reversing LHVs is more difficult than reversing regular trucks; this poses a problem particularly at distribution centres which sometimes offer too little space to manoeuvre; drivers welcome the special LHV docks at some centres;
- At roadworks, LHVs are currently not taken sufficiently into account when creating cordons and diversion routes.

Drivers would also welcome the installation of special facilities to couple and uncouple LHVs. This would allow transporters to maximise on the flexibility of the

concept. Extra parking facilities near cities would enable LHVs to effect city distribution.

Traffic flow
Driving LHVs in traffic jams does not pose any problems at the moment. The overtaking prohibition for LHVs results in fewer traffic manoeuvres, calming overall traffic.

Currently, some breakdown bays are too short to fit LHVs. This could cause obstructions to traffic flows in the event of vehicle breakdowns.

It is unknown whether Incident Management (towing away abandoned vehicles) focuses sufficiently on the presence of LHVs on Dutch roads. If the towing service lack the capacity to tow an LHV, it could take longer to clear the road if an LHV breaks down, or is involved in an accident.

8.2 Recommendations

Although the accident analyses and interviews with experts currently give no reason to suspect there to be any issues as a result of LHVs having been introduced on the Dutch road network, there are some recommendations and points for improvement.

Recommendations with regard to vehicle requirements
It is recommended that current vehicle requirements be maintained. Further research is advised in relation to the remarks made by drivers about acceleration performance, to investigate whether requirements set in respect of engine capacity are sufficient.

Additionally, further research is advised into the sideways movements (swerving) of LHV combinations. On the one hand, closer insight is needed in how LHVs handle during poor weather conditions in combination with a limited cargo. On the other, it is important to understand exactly how space an LHV requires in relation to road design, especially during roadworks.

Recommendations for the road administrator
In accordance with the publication 'LHVs on secondary roads' by the centre for policy and research in civil and traffic engineering (CROW), it is recommended that the current restrictions on LHVs in urban areas be maintained. This also applies to avoiding interaction with slow traffic.

It is recommended to assess whether the Incident Management protocol is sufficiently geared towards LHVs. If this is not the case, it is advised that the protocol be adjusted.

When constructing new infrastructure and restructuring existing infrastructure during regular management and maintenance, more specific attention should be paid to the presence of LHVs; for example to determine the length of breakdown bays and the length and number of parking spaces. Furthermore, short slip roads should be avoided as much as possible.

At roadworks on LHV routes, LHVs need to be taken into consideration when creating cordons and setting out diversion routes. Transport firms should receive timely notification of planned road maintenance. It is further recommended to assess whether diversions (so-called U-routes) that are used during incidents on the

main road network are suitable for LHVs.

Recommendations for the Ministry of Infrastructure and the Environment
One relevant point following a further increase in the number of LHVs is the possibility for the LHV to uncouple so that it can continue its journey outside the core areas. This parking problem mainly applies in relation to city distribution. It is recommended that the current studies into city distribution also explicitly focus on the use LHVs. it should be noted that it not just the ministry's responsibility to create the necessary facilities, like a more spacious layout of industrial parks and distribution centres. This is the joint responsibility of road administrators, companies and managers of industrial parks. However, the ministry could create a foundation on which parties are able to build.

It is further recommended to continue monitoring accidents with LHVs. This will allow for timely action to be taken if problems occur. A point of interest with regard to monitoring is the influence of the extra permitted weight of LHVs in relation to the cause of the accidents. Although there are currently no indications that the permitted weight causes safety risks, it is desired to assess whether this could be the case. It is advised that LHV companies should be pointed to the fact, in accordance with the dispensation, they are required to report incidents with LHVs.

A third recommendation concerns providing information to road users, particularly drivers of passenger vehicles and delivery vans. Both the accident analysis and the interviews showed that these road users do not always display appropriate behaviour when overtaking or merging in front of a truck. It is recommended that the campaign should not specifically focus on LHVs but on truck traffic in general.

Recommendations for the dispensation issuer
Firstly, it is recommended that training and certification of LHV drivers be maintained. The human factor is, to a large extent, the determining factor with regard to vehicle safety. The training will help to guarantee that only skilled drivers are permitted to drive an LHV.

Secondly, it is recommended to assess whether industrial parks could be connected to the main road network via more logical routes. In some cases, the ban on using a railway crossing leads to LHVs driving an alternative route that poses more potentially unsafe situations than the route via the railway crossing.

Appendix A Experts and review group members

Members of the review group
Loes Aarts (Rijkswaterstaat Dienst Verkeer and Scheepvaart, DVS)
Directorate-General for Public Works and Water Management
Wim Busser (Binnenlandse Container Terminal Nederland, BCTN)
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Gerben Feddes (Rijksdienst voor het Wegverkeer, RDW)
Dutch Road Transport Directorate
Bart Haneveld (Korps Landelijke Politiediensten, KLPD)
National Police Services Agency
Rona Helder (Vereniging van Nederlandse Gemeenten, VNG)
Association of Netherlands Municipalities
Geert Hendriks (Veilig Verkeer Nederland, VVN)
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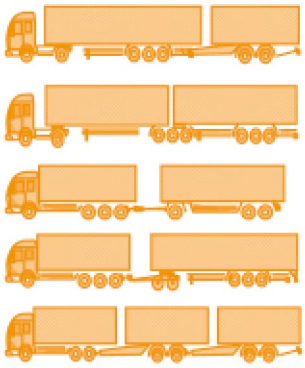
Centre for Policy and Research in Civil and Traffic Engineering (CROW)
Martin Salet (Ministerie van Infrastructure and Milieu, DG Mobiliteit)
Ministry of Infrastructure and the Environment, DG for Mobility
Chris Schoon (Stichting Wetenschappelijk Onderzoek Verkeersveiligheid, SWOV)
Institute for Road Safety Research
Liesbeth Slagter (Inspectie Verkeer and Waterstaat, IVW)
Transport, Public Works and Road Safety Inspectorate
Ambro Smit (Transport and Logistiek Nederland, TLN)
Dutch Association for Transport and Logistics
Peter Stehouwer (Stadsregionale Coördinatie Verkeer and Vervoer, SKVV)
Intra-metropolitan Partnership for Traffic and Transport
Willem Vermeulen (Rijkswaterstaat Dienst Verkeer and Scheepvaart, DVS)
Directorate-General for Public Works and Water Management
Ruben Willems (Eigen Vervoerders Organisatie, EVO)
Dutch Association of Transport users and Transporters on own account

Participants in the expert session
Dick van Elburg (Korps Landelijke Politiediensten, KLPD)
National Police Services Agency
Onno Franken (Van Rooijen Logistiek)
Van Rooijen Logistics
Iwan of the Geer (Van Rooijen Logistiek)
Van Rooijen Logistics
Hans Peeman (Simon Loos)
Haulage firm
Hans Tornij (Regiopolitie Noord- and Oost-Gelderland)
North and East Gelderland Regional Police
Bert van der Waaij (Blokker)
Retail company

Appendix B Overview of LHV configurations



Type A

Type B

Type C

Type D

Type E

Appendix C Analysis of LHV accidents

Accident 1

Description of location

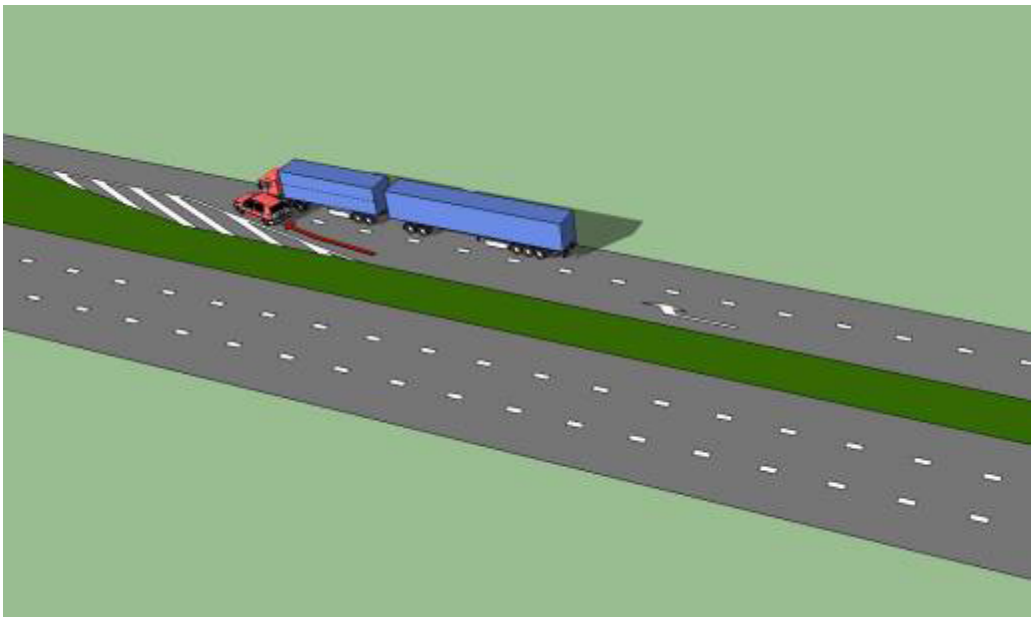
The accident occurred at the traffic-light controlled intersection of the roads called Marsweg and Ittersumallee in Zwolle, in the northbound lanes of the Marsweg, north of the crossroads. From Ittersumallee there are two designated traffic lanes for traffic turning left into the Marsweg. The accident occurred on the section of the Marsweg where two lanes merge into one. A speed limit of 50 kph applies there. The intersection is located at Marslanden industrial park.

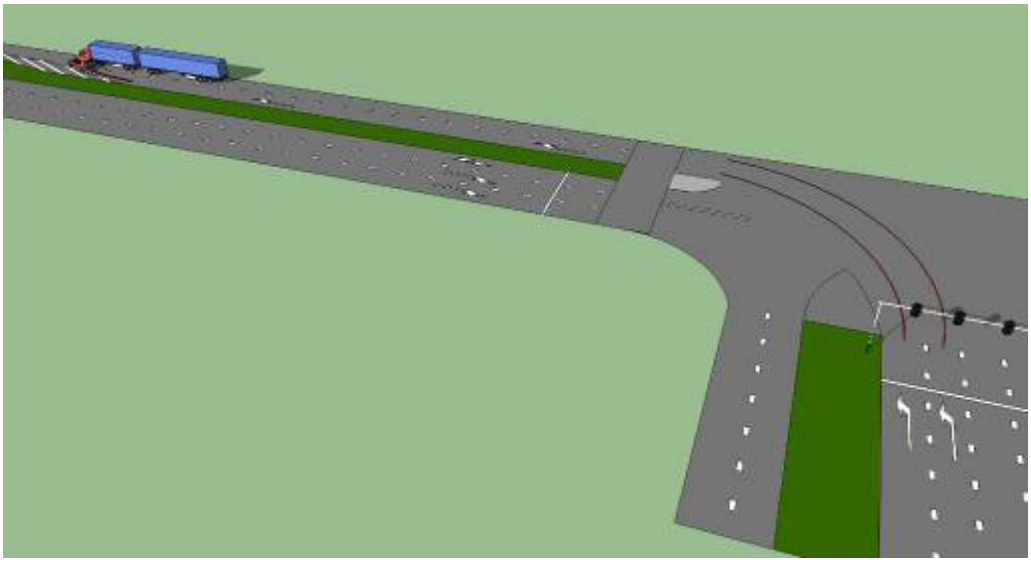
Description of circumstances

The accident occurred on 14 January 2008 at 18:00 hours. It was dark at the time of the accident; the road lights on site were on. Although there was no precipitation, the road surface was still wet. Traffic was not congested.

Description of accident

A passenger vehicle was driving in the outside lane with the intention to overtake the LHV driving in the inside lane. When the car changed lanes to merge across into the through lane in front of the LHV, the vehicles collided sideways, resulting in material damage only. The LHV was hit at the front left side. The passenger car failed to stop at the scene of the accident.





Why did the accident occur?
The driver of the passenger vehicle may have misjudged the length of the LHV and, as a result, steered to the right too soon. The accident could also have been caused because the driver of the passenger vehicle tried to overtake the LHV, because further on down the road there is only one lane in each direction, as a result of which there are less opportunities to overtake the LHV.

How could the accident have been prevented?
The accident could have been prevented if the driver of the passenger vehicle would have looked far enough ahead and signalled on time that they were about to change lanes. The driver of the passenger vehicle could have slowed down and changed lanes behind the LHV. The accident could also have been prevented if the LHV would have braked.

Significance of characteristics
The LHV's length may have played a part in the accident. It should be noted that accidents due to overtaking/cutting off are relatively more common with trucks.

Accident proneness of location
Between 2004 and 2008 a total of 35 accidents occurred at this intersection. No serious accidents occurred, however there were four accidents with casualties. The type of accidents vary (head-on, side collision and rear-end) and so do the root causes (jumping a red light, insufficient distance, losing control of the vehicle, skidding, failure to give right of way). Based on the number of accidents occurring here, it can be concluded that this intersection is an accident hotspot.

Additional information from the interview with the LHV driver
According to the driver, the recognisability of his LHV (Type D) is somewhat lacking, particularly on the side of the vehicle. He stated that it happens regularly that other road users donít realise they are driving next to a longer vehicle and fail to merge into through traffic because of that. Nevertheless he would not put the accident down to (misjudgement of) vehicle characteristics specific to LHVs; he believes the driver of the passenger vehicle was not paying attention and made a sudden right turn. The car driver failed to stop at the scene of the accident.

Accident 2

Description of location

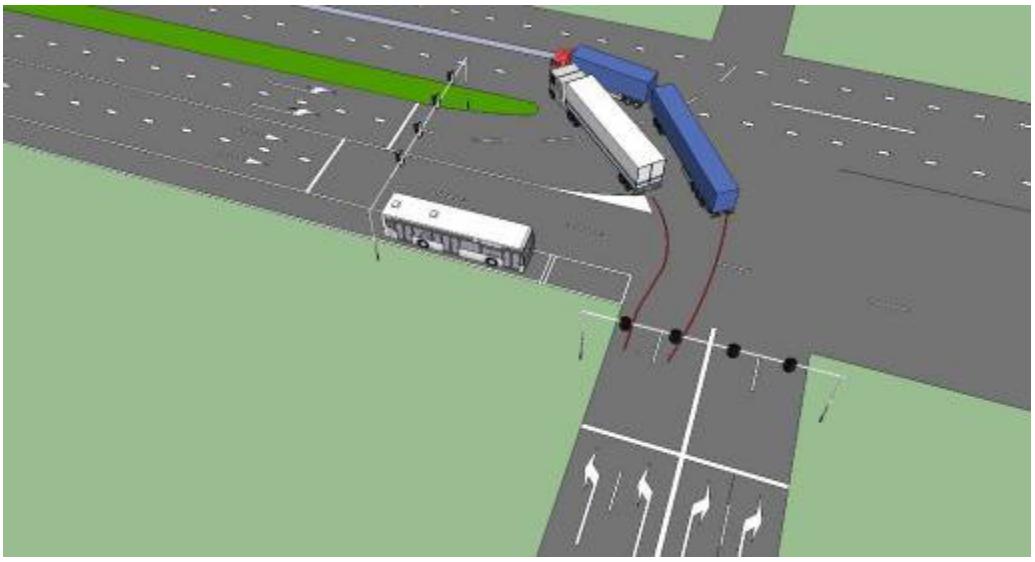
The accident occurred at the traffic light-controlled intersection at the top of the southbound junction for the Volendam link-up to the A10 motorway. The intersection features two designated left-turn lanes for traffic towards Volendam (road no. N247).

Description of circumstances

The accident happened on 26 February 2008 at 10.00 hours. It was light at the time of the accident, and raining. Traffic was not congested.

Description of accident

Adjacent to each other in the two left-turn lanes there was a regular truck on the outside lane and an LHV in the inside lane. As both approached the intersection, the regular truck negotiated the turn too widely, causing a side collision resulting in material damage only.



Why did the accident occur?

This accident occurred because the truck on the left lane negotiated the left turn too widely and partially ended up in the right lane.

How could the accident have been prevented?

The accident could have been prevented if the driver of the truck would have steered his combination more carefully through the bend and had kept to the desired lane. The accident could also have been prevented if the driver would have positioned the truck in the lane designated for traffic turning right. The infrastructure at a lot of the intersections was not designed to allow two trucks to drive next to each other and simultaneously negotiate a left or right turn.

Significance of characteristics

Length and swerving behaviour of the LHV played no part in this accident. In fact, this accident could have happened to any vehicle driving next to the truck understeering around the bend.

Accident proneness of location

Between 2004 and 2008 a total of 23 accidents occurred on the intersection. These included accidents with casualties, whereby in one case the victim was admitted to hospital. Most accidents were side and rear-end collisions. The root causes primarily included maintaining insufficient distance, jumping a red light and failure to make way. This location is regarded as an accident hotspot. In this five-year period the type of accidents involving LHVs did not occur more frequently.

Accident 3

Description of location

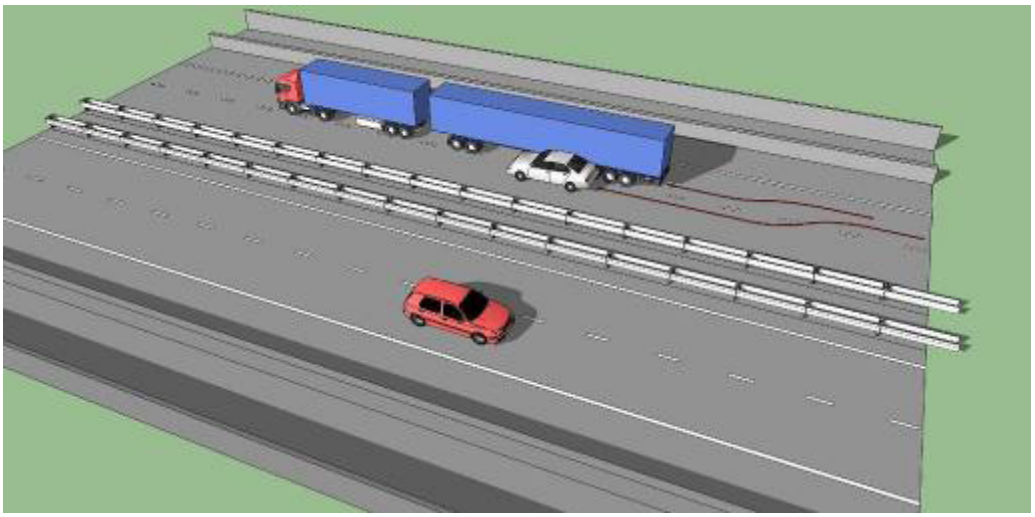
The accident happened on the A50 between junctions Ewijk and Valburg (km 151,2) on the road towards Arnhem. The road here has two lanes in each direction and a speed limit of 120 kph applies here.

Description of circumstances

The accident occurred on 5 March 2008 at 1:04 hours. The road lights on site were on. It was dry at the time of the accident, but there was snow or black ice on the road. Traffic was not congested.

Description of accident

A passenger vehicle was in the process of overtaking an LHV combination when the LHV swerved. This led to a side collision resulting in material damage only.



Why did the accident occur?

The accident occurred because the LHV was driving too far on the left side of the lane, or the passenger vehicle was driving too far on the right. This was probably caused because of wintery weather conditions.

How could the accident have been prevented?

The accident could have been prevented if the driver of the LHV had managed to keep his combination on the right side. The accident could also have been prevented if the driver of the passenger vehicle had overtaken the LHV from a greater distance.

Significance of characteristics

The root cause of the accident is a sideways swerve by the LHV. Because of its two pivot points, an LHV is possibly more prone to sideways swerving than a regular truck. Weather conditions may have added to the situation. Although previous research did not prove higher proneness to sideways motion due to the vehicle's two pivot points to be a typical LHV characteristic, it may have contributed to this accident.

Accident proneness of location

Between 2004 and 2008 a total of eight accidents occurred near the accident

location. There were no accidents with casualties. The type of accidents vary (rear-end, collision with a fixed object and side collision). The root causes are mainly skidding, loss of control of the vehicle and maintaining insufficient distance. This location is not regarded as an accident hotspot.

Additional information from the interview with the LHV driver
The driver confirmed that local frost patches had caused road surfaces to be slippery in places; the bridge had been unexpectedly covered in black ice. However, when the passenger vehicle attempted to overtake the LHV (Type E), it had not been the LHV suddenly swerving sideways and hitting the car, but the car driver skidding with his car and then bouncing off the guard rail into the LHV.
According to the driver, the cause of the accident is therefore not connected to a possibly increased risk of sideways motion of LHVs. If the accident was somehow related to LHV characteristics, at best it would be a misjudgement of the LHVís length by the car driver (poor sideways recognisability).

The LHV driverís version of events is not represented in the police accident record, though. He confirmed that he and the driver of the passenger vehicle had clashed over how the accident came to happen. The car driverís version of event was recorded in the accident report.

Accident 4

Description of location

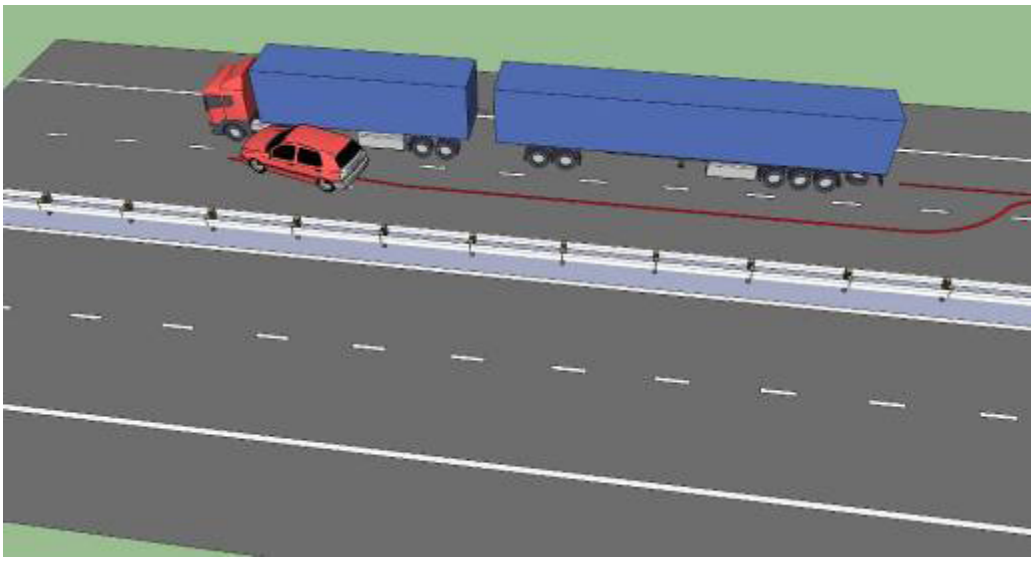
The accident happened on the A15 between the exits for Echteld and Tiel (km 132.0) on the road towards Gorinchem. The road here has two lanes in each direction and a speed limit of 120 kph applies here.

Description of circumstances

The accident occurred on 24 April 2008 at 05:33 hours. At the time of the accident it was dusky and raining. Traffic was not congested.

Description of accident

A passenger vehicle was in the process of overtaking the LHV, when the driver steered sideways too early, causing a side collision and resulting in material damage only. The LHV was hit on its left side. The driver of the passenger vehicle failed to stop at the scene of the accident.



Why did the accident occur?

This accident occurred because the driver of the passenger vehicle steered too early to the right to continue on the inside lane after overtaking. Because of the rain and the fact that it was dusky the driver of the passenger vehicle may not have noticed that he was overtaking an LHV.

How could the accident have been prevented?

The accident could have been prevented if the driver of the passenger vehicle had looked far enough ahead while overtaking the LHV, and had observed the LHV's extra length on time. This accident may have been prevented if the LHV would have had extra signs to show that this was an extra long vehicle.

Significance of characteristics

The LHV's length may have played a part in the accident.

Accident proneness of location

Between 2004 and 2008 a total of four accidents occurred near the accident location, none of which involved any casualties. This location is not regarded as an accident hotspot.

Accident 5

Description of location

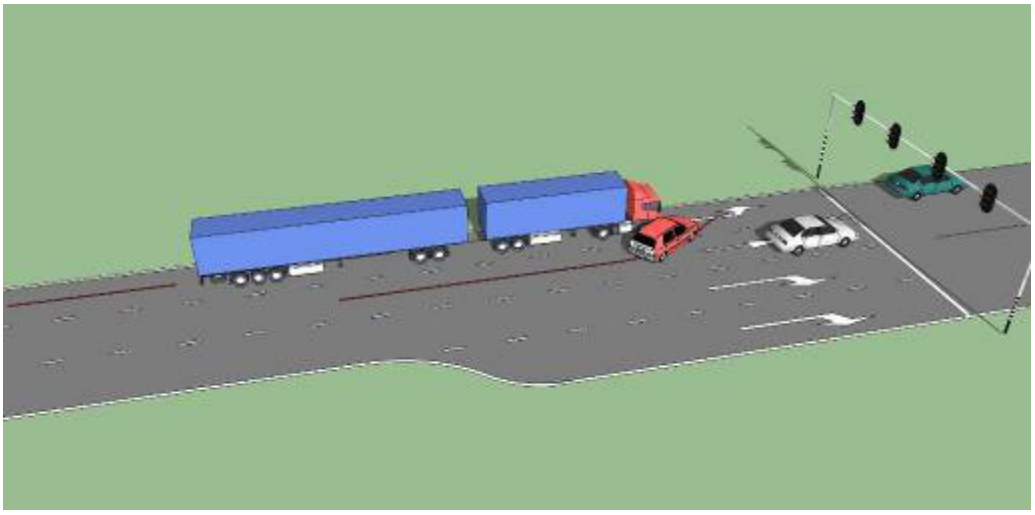
The accident occurred on the Basisweg road in the Western Docks area (Westelijk Havengebied) of Amsterdam, at the traffic light-controlled western intersection connecting to the A10 motorway. The Basisweg features four lanes here: one lane for traffic turning left towards the A10 northbound, one through lane towards Amsterdam and two lanes for traffic turning right towards the A10 westbound. A speed limit of 50 kph applies there.

Description of circumstances

The accident happened on 10 July 2008 at 15.58 hours. At the time of the accident it was light and, although there was no precipitation, the road surface was still wet. Traffic was not congested.

Description of accident

The LHV involved had pulled up in the lane designated for traffic turning left for the A10 northbound. The passenger vehicle involved had pulled up in the through lane. The traffic lights for both these lanes changed to green simultaneously. As traffic started moving, both the LHV and the passenger vehicle accelerated. At that point the driver of the passenger vehicle decided he wanted to turn left for the A10 northbound and changed lanes right in front of the LHV. The space to do so had become available as the car in front of the LHV had accelerated more swiftly than the LHV. Although the driver of the passenger vehicle presumed that the driver of the LHV had noticed him, he was in fact positioned in the LHV's blind spot. This led to a side collision resulting in material damage only.



Why did the accident occur?

This accident occurred because the driver of the passenger vehicle was standing in the wrong lane before the intersection. In an attempt to recover the mistake, the driver switched lanes in front of the LHV and failed to consider that the driver of the LHV was unable to see the passenger vehicle because it was in the LHV's blind spot.

How could the accident have been prevented?

The accident could have been prevented if the driver of the passenger vehicle had looked sufficiently far ahead and when getting in lane had selected the correct lane. The accident could also have been prevented if the driver of the passenger vehicle

had waited until there was sufficient space on the lane for traffic turning left so that he could have safely corrected his mistake.

Significance of characteristics
In view of the fact that the LHV's blind spot does not differ to that of a regular truck, the typical LHV characteristics played no part in this accident. This was considered to be a typical truck accident. It should be noted that the passenger vehicle made an unexpected manoeuvre.

Accident proneness of location
Between 2004 and 2008 a total of 12 accidents occurred on the intersection; including three accidents with casualties whereby two hospital casualties and two slightly-injured people were involved. Most accidents were side and rear-end collisions. The main root causes were - maintaining insufficient distance, jumping a red light and carelessly overtaking/cutting off. This location is regarded as an accident hotspot. The type of accidents that involved an LHV - an accident due to carelessly overtaking/cutting off – occurred several times over the past five years.

Additional information from the interview with the LHV driver
The information from the police accident record matches up perfectly with the version of events given by the driver of the LHV (Type D with container trailer). The passenger vehicle changed lanes unexpectedly upon accelerating at the traffic lights, cutting off the LHV. The car was positioned in the LHVís blind spot, but the driver stated this to be no different than that of a regular truck combination. According to the driver this incident was a typical truck accident rather than an LHV accident.

Accident 6

Description of location

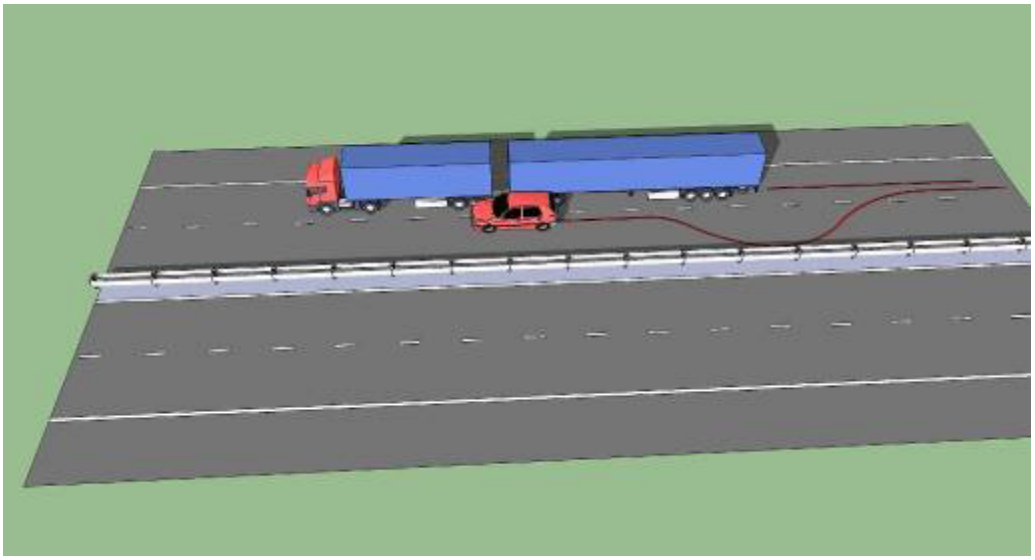
The accident occurred on the A58 between the exits for Gilze and Bavel (48.8 km marker) on the road towards Breda. The road here has two lanes in each direction and a speed limit of 120 kph applies here.

Description of circumstances

The accident occurred on 30 October 2008 at 19:51 hours. It was dark at the time of the accident. The road lights on site were on. There was no precipitation at the time of the accident. Traffic was not congested.

Description of accident

A passenger vehicle was driving in the outside lane, adjacent to an LHV driving in the inside lane. According to the police accident record, the car presumably drifted into the grassed central reserve, upon which the driver of the vehicle oversteered in the opposite direction, leading to a rear-end collision resulting in material damage only. The passenger vehicle thereby hit the LHV between its trailer and dolly.



Why did the accident occur?

This accident occurred because the driver of the passenger vehicle steered too sharply to the left as a result of which the vehicle collided with the central reserve. The passenger vehicle subsequently attempted to correct the manoeuvre whereupon he collided with the LHV.

How could the accident have been prevented?

The accident could have been prevented if the driver of the passenger vehicle had looked sufficiently far ahead and had maintained the correct line on the road and the left wheels had not hit the central reserve.

Significance of characteristics

Considering the nature of the accident, it seems safe to conclude that specific LHV characteristics played no part in the accident. This accident could have occurred with any vehicle that was driving on the right of the passenger vehicle.

Accident proneness of location
Between 2004 and 2008 a total of five accidents occurred near the accident location, none of which involved any casualties. All five accidents concerned rear-end collision whereby the root causes varied (insufficient distance, outside (middle) lane hogging and cutting off). This location is not regarded as an accident hotspot.

Additional information from the interview with the LHV driver
The driver of the LHV (type D) remembers the accident clearly because of the bizarre circumstances: he recounted that a passenger vehicle with four young people was driving alongside him. The passenger vehicle suddenly steered into the central reserve. When the driver of the passenger vehicle attempted to steer his car back onto the road, he steered too far to the right and ended up between the truck and the trailer on the dolly. According to the LHV driver, this was not a typical LHV accident.

Accident 7

Description of location

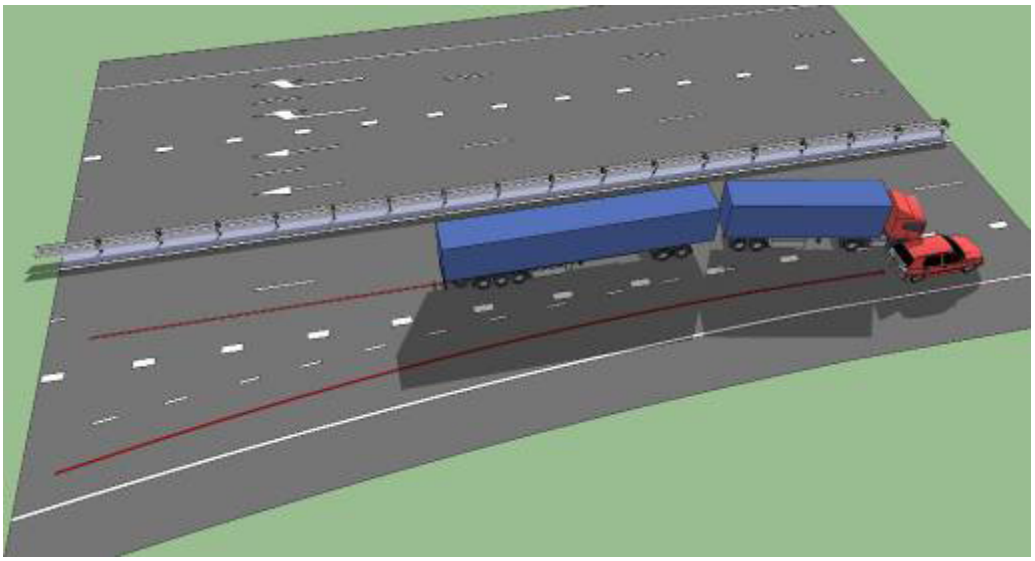
The accident occurred on the A28 between junction Hattemerbroek and the exit for Zwolle south (km 86.4) on the road towards Zwolle. Here the connecting road from the A50 from the direction of Apeldoorn merges with the main carriageway of the A28 via a so-called 'tapered section'. Here the A28 has three lanes of which the inside lane is a weaving lane between junction Hattemerbroek and the exit for Zwolle south. At this location a top speed of 100 kph normally applies, but at the time of the accident the matrix signs indicated that a top speed of 50 kph applied.

Description of circumstances

The accident occurred on 27 November 2008 at 17:58 hours. It was dark at the time of the accident. The road lights on site were on. At the time of the accident there was wintry precipitation. The accident report does not show whether the top speed of 50 kph applied because of congestion or due to weather conditions.

Description of accident

The passenger vehicle was coming from the A50 and driving on the inside lane. The LHV came from the A28 from the direction of Amersfoort and switched to the right lane to continue on the weaving lane towards the exit, Zwolle south. The LHV driver failed to see the passenger vehicle driving on his right because it was driving in the LHV's blind spot. This caused a collision with material damage only.



Why did the accident occur?

This accident occurred because the driver of the LHV had failed to properly check whether the weaving section was free of traffic and that no vehicles were in its blind spot. As a result the driver steered the LHV too early to the right and subsequently hit the passenger vehicle. The poor weather conditions and congestion may have contributed towards the accident.

How could the accident have been prevented?

The accident could have been prevented if the driver of the LHV had looked sufficiently far ahead before changing lanes and had checked to see that there was no traffic in the vehicle's blind spot. The accident could also have been prevented if

the driver of the passenger vehicle had anticipated the LHV's lane change and reduced its speed to give the LHV room, in spite of the fact that in this situation the passenger vehicle had priority.

Significance of characteristics
Accidents resulting from a sideways lane change by a truck are typical truck accidents, this is partly due to the fact that, compared to a passenger vehicle, a truck has a relatively large blind spot. It should be noted that an LHV's blind spot does not differ from that of a regular truck. This did involved a typical truck accident, and was not specific to an accident with LHVs.

Accident proneness of location
Between 2004 and 2008 a total of 25 accidents occurred at this section of the A28 motorway, three of which involved a total of five casualties, all of whom suffered only minor injuries. These accidents were mainly rear-end and side collisions caused by careless lane changes, cutting off and tailgating. This location is regarded as an accident hotspot. Accidents like this particular one involving the LHV – a collision caused by careless overtaking/cutting off – have happened more often during this five-year period.

Additional information from the interview with the LHV driver
According to the driver of the LHV (type A) the road layout at the accident location is poorly arranged because of the ëclutter of connections and auxiliary lanesí. At the time of the accident it was dark, the weather was bad (hail) and the road was busy; therefore the speed limit imposed via the matrix signs had been reduced to 50†kph. Although the LHV driver claims to have been particularly alert because of these conditions, he completely failed to notice the passenger vehicle driving next to him as he changed lanes. As stated by the driver it was a typical blind spot accident, exacerbated by bad weather and traffic congestion.

Accident 8

Description of location

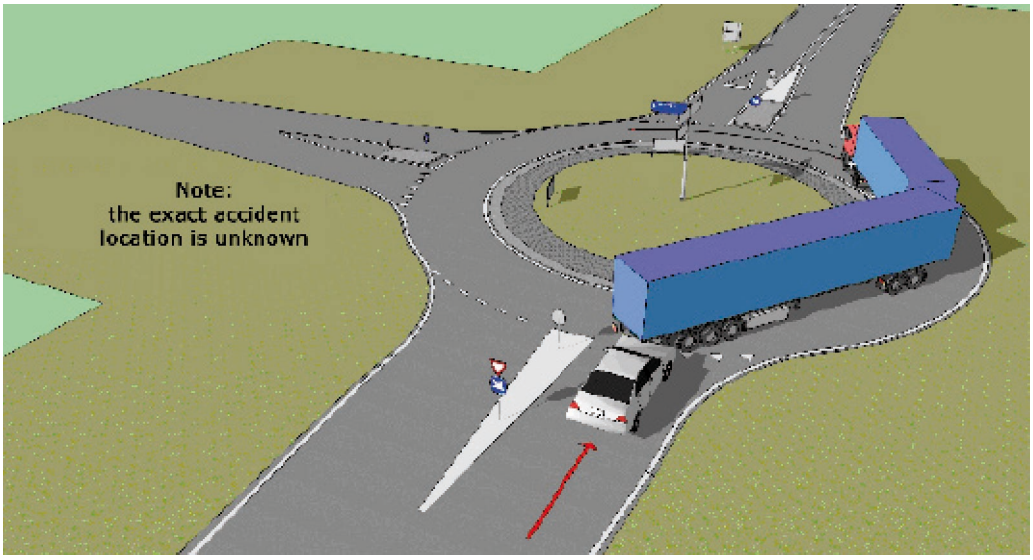
The accident occurred on the roundabout between the Zuiderzeestraatweg and Rondweg roads in Wezep, near the slip road onto the A28 motorway. This is a single-lane roundabout in the built-up area of the village. A speed limit of 50 kph applies. The accident record provides insufficient information to determine the exact scene of the accident, so the accident scene diagram merely provides a possible reconstruction of the accident.

Description of circumstances

The accident occurred on 20 December 2008 at 03:11 hours. It was dark at the time of the accident. The road lights on site were on. At the time of the accident there was no precipitation. Traffic was not congested.

Description of accident

The LHV approached the roundabout and as it did, felt a knock. The driver declared to the police that he wasn't aware he had been hit, and had continued on his way. He later noticed damage to his trailer which had clearly been caused by another vehicle. According to the accident record, there was material damage only; the damage corresponded with a side collision with another – passenger – vehicle.



Why did the accident occur?

This accident occurred because the driver of the passenger vehicle had kept insufficient distance to the LHV and did not brake on time upon approaching the roundabout.

How could the accident have been prevented?

The accident could have been prevented if the driver of the passenger vehicle had maintained sufficient distance to the LHV and had braked on time upon approaching the roundabout.

Significance of LHV characteristics

Considering the nature of the accident, it seems safe to conclude that specific LHV characteristics played no part in the accident. This accident could also have happened to a regular truck.

Accident proneness of location
Between 2004 and 2008 a total of three accidents occurred on the roundabout. There were no accidents with casualties. This location is not regarded as an accident hotspot.

Accident 9

Description of location

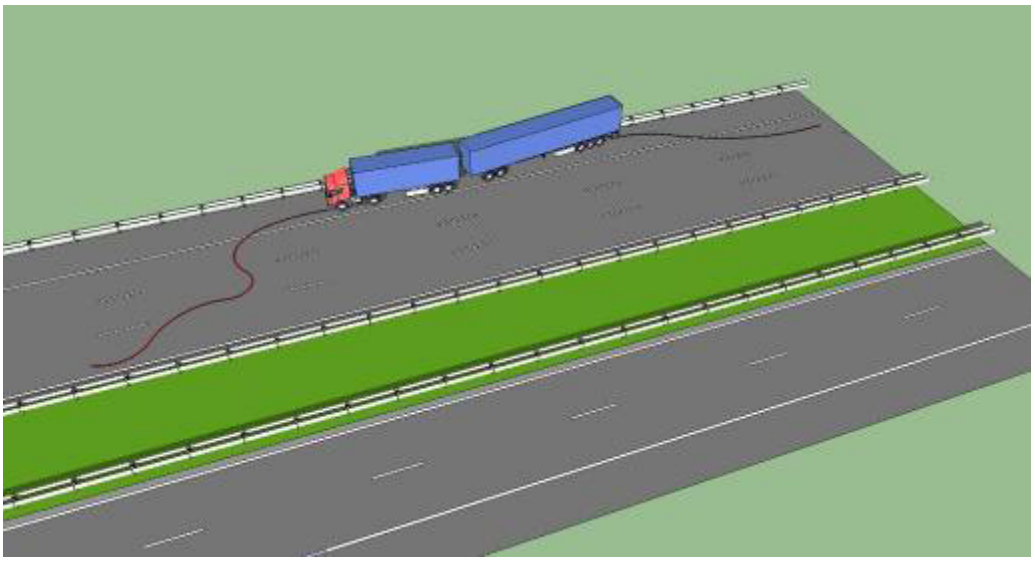
The accident occurred on the A27 between junction Everdingen and the exit for Lexmond (km 53.1) on the road towards Gorinchem. The road here bends to the right. The road has three lanes in each direction and a speed limit of 120 kph applies here.

Description of circumstances

The accident occurred on 28 March 2007 at 06:30 hours. At the time of the accident it was dusky. The road lights on site were on. At the time of the accident there was no precipitation. Traffic was not congested.

Description of accident

The driver of the LHV lost control of his vehicle. This led to the trailer hitting the guard rail, causing the LHV to skid and the trailer to overturn. This single-vehicle accident resulted in material damage only.



Why did the accident occur?

This accident occurred because the driver of the LHV lost control of the vehicle as a result of a being hit another vehicle. The combination started swerving and the trailer tipped over. As the police had no record of this accident, and it was only mentioned by the driver, it is impossible to assess why the LHV was hit.

How could the accident have been prevented?

The accident could have been prevented if the LHV had not been hit by another vehicle.

Significance of characteristics

As a consequence of its two pivot points, an LHV may encounter more sideways motion than a regular LHV. This would increase the risk of an LHV driver losing control of his vehicle.

Accident proneness of location

Between 2004 and 2008 a total of five accidents occurred near the accident location, whereby one casualty was involved. These were rear-end collisions and accidents

with a fixed object. This location is not regarded as an accident hotspot.

Additional information from the interview with the LHV driver
The driver of the LHV (Type A) corroborated that he had lost control of the vehicle, but claims this happened because his trailer had been hit by another vehicle. There is, however, no mention of this at all in the accident record. This would imply the LHV did not encounter spontaneous sideways motion but the trailer ëwas nudgedí. This caused the trailer to hit the crash barrier, resulting in the LHV skidding and overturning. The driver did state that he was unable to regain control of the vehicle. Although he does not doubt the general stability of his vehicle combination, he does think that once an LHV gets into a situation where it is in danger of overturning, it will more likely ëkeel overí than a regular truck combination.

Accident 10

Description of location

The accident occurred on the A16 between junction Galder and the exit for Breda (km 65.2) on the road towards Rotterdam. The road here has three lanes and a speed limit of 100 kph applies here.

Description of circumstances

The accident occurred on 27 February 2007 at 19:00 hours. It was dark at the time of the accident. The road lights on site were on. It was raining and there were strong gusts of wind. Traffic was not congested.

Description of accident

A passenger vehicle proceeded to overtake the LHV. During this manoeuvre the LHV swerved causing a side collision with material damage only. Both vehicles were damaged on the right side.

No accident scene diagram

The information in the accident report does not clearly state what positions the LHV and passenger vehicles were in when the collision occurred. For this reason, no accident scene diagram was included.

Why did the accident occur?

This accident occurred because the LHV made a sideways motion. This was possibly caused by weather conditions (strong gusts of wind).

How could the accident have been prevented?

The accident could have been prevented if the driver of the LHV had managed to keep driving his combination in a straight direction. The accident could also have been prevented if the driver of the passenger vehicle had overtaken the LHV from a longer distance.

Significance of characteristics

Because an LHV has two pivot points, the vehicle may be more prone to sideways movements than regular trucks. Although this type of accident can be considered a typical truck accident, LHVs may possibly have a higher risk of encountering this type of accident.

Accident proneness of location

Between 2004 and 2008 a total of three accidents occurred near the accident location; however, there were no casualties. These were rear-end collisions and accidents with a fixed object. This location is not regarded as an accident hotspot.

Accident 11

Description of location

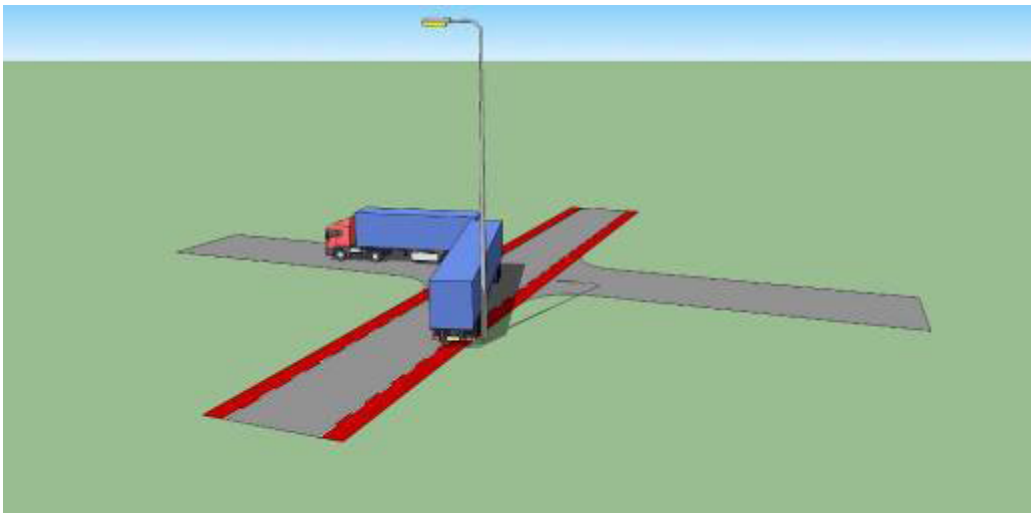
The accident occurred at the intersection of the roads named *Oonksweg* and Hanzeweg, at the Molenkamp industrial park within the built-up area of the town of Borne. A speed limit of 50 kph applies there. This industrial park is not among the areas designated to allow LHVs.

Description of circumstances

The accident occurred on 10 March 2008 at 11:49 hours. At the time of the accident it was dry. Traffic was not congested.

Description of accident

As the LHV made a left turn at the intersection, the far corner of its trailer swerved out into a lamp post. This collision resulted in material damage only.



Why did the accident occur?

This accident occurred because the LHV negotiated the turn too widely, whereby the driver misjudged the length of the LHV.

How could the accident have been prevented?

The accident could have been prevented if the LHV's driver had paid attention while turning and had observed the lamppost on time. The accident could also have been prevented if the driver of the LHV had not ventured outside of the designated core area. It should be noted that in this case it is uncertain whether the accident involved an LHV because the owner was unable to provide any details on this.

Significance of characteristics

The driver may have misjudged the length and swerving behaviour of the LHV while taking the turn. This type of accident is also referred to as a typical truck accident. However, because of the length and swerving behaviour of LHVs, this type of accident is more likely to occur to LHVs.

Accident proneness of location

Between 2004 and 2008 a total of seven accidents occurred near the accident location, whereby there were no casualties. In addition to the accident with the LHV, this concerned side and rear-end collisions. In most cases the accident was caused

by a failure to give priority or to maintain sufficient distance. This location is not regarded as an accident hotspot.

Accident 12

Description of location

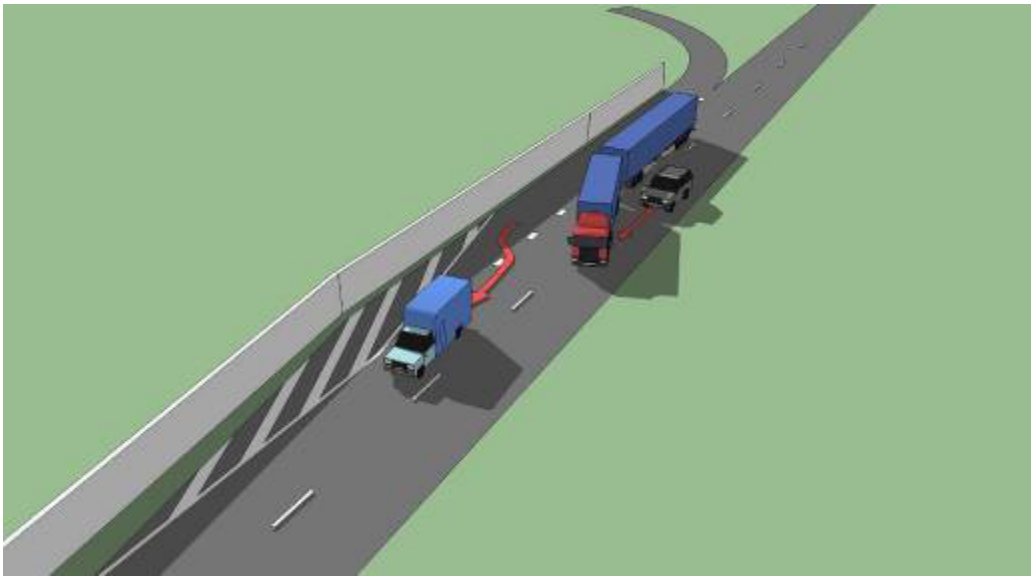
The accident occurred on the A17 at the filter lane of the exit to Stampersgat (km 14.7) on the road towards Moerdijk. The road here has two lanes in each direction and a speed limit of 120 kph applies here. Passed the filter lane, the A17 does not have a hard shoulder. This is because of the bridge across the river Mark. Merging traffic is unable to evade oncoming traffic if it is unable to merge on the filter lane.

Description of circumstances

The accident occurred on 4 May 2009 at 15:52 hours. At the time of the accident it was dry. Traffic was not congested.

Description of accident

To give merging traffic sufficient space the LHV, which was travelling on the inside lane on the A17, changed to the outside lane. The driver of the LHV failed to notice a delivery van on the outside lane. This resulted in a side collision whereby the delivery van was badly damaged. The accident resulted in material damage only.



Why did the accident occur?

This accident occurred because the LHV wanted to give room to the merging truck. This may have been because the LHV driver knew that the merging truck did not have any other options to merge because of the lack of a hard shoulder. Upon changing lanes the driver of the LHV failed to see the delivery van on the outside lane, this was possibly due to the fact that the delivery van was in its blind spot.

How could the accident have been prevented?

The accident could have been prevented if the driver of the LHV had properly checked to see if there was a vehicle on the outside lane prior to switching lanes. The accident could also have been prevented if the LHV had remained on the inside lane. It should be noted that the driver of the LHV may have had to brake to avoid an accident with the merging vehicle. The driver of the merging truck could have also prevented the accident by changing lanes behind the LHV.

Significance of characteristics

The driver may have misjudged the length of the LHV whilst changing lanes. The delivery van could also have been located in the blind spot, which meant the driver of the LHV would have been unable to see the delivery van. This type of accident is a typical truck accident because trucks have a larger blind spot than passenger cars and delivery vans. Because of their length, this type of accident is more likely to occur to LHVs.

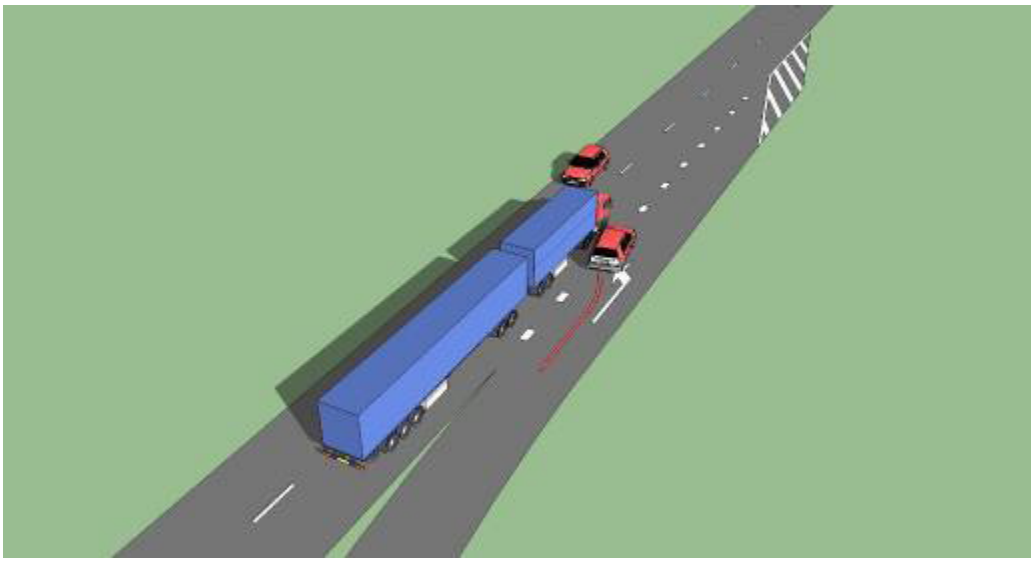
Accident proneness of location
Between 2005 and 2009 a total of four accidents occurred near the accident location, one of which involved a casualty. In addition to the accident with the LHV, two single-vehicle accidents occurred and one accident with a fixed object. This location is not regarded as an accident hotspot.

Accident 13

Description of location
The accident occurred on the N36 towards Ommen where the lane filters towards the exit for Beerzerveld/Kloosterdijk. The N36 is a trunk road with one lane in each direction and no separator. A speed limit of 100 kph applies here. There is no hard shoulder along this road. Merging traffic is unable to conduct evasive manoeuvres if it is unable to merge on the filter lane.

Description of circumstances
The accident occurred on 28 May 2009 at 7:11 hours. There was no precipitation at the time of the accident. Traffic was not congested.

Description of accident
While merging on the N36, a passenger vehicle collides with the right side of an LHV. The accident resulted in material damage only. The accident report does not contain any further details on the circumstances.



Why did the accident occur?
This accident probably occurred because the driver of the merging passenger vehicle wanted to merge in front of the LHV. The driver of the passenger vehicle possibly misjudged the LHV's length, which caused the driver to merge at the wrong time. This type of accident is a typical truck accident. On the one hand, this is due to the length of the truck, which was misjudged by the other road user, but also because of the difference in speed between the trucks and passenger vehicles. The N36 only has one lane in each direction, this makes it difficult to overtake other vehicles. This means that the passenger vehicle should probably have remained behind the truck.

How could the accident have been prevented?
The accident could have been prevented if the driver of the merging passenger vehicle had merged behind the LHV. The accident could possibly also have been prevented if the LHV had slowed down, thereby creating sufficient room for the passenger vehicle to change lanes. It

should be noted that the passenger vehicle may have been situated in the LHV's blind spot, thus preventing the driver of the LHV from anticipating the passenger vehicle's attempt to overtake it.

Significance of characteristics
Although this accident is considered to be a typical truck accident, because of an LHV's extra length, this type of accident is more likely to occur to LHVs.

Accident proneness of location
Between 2005 and 2009 a total of five accidents occurred near the accident location, one of which involved a casualty. Besides the accident with the LHV, there were three rear-end collisions and one accident involving an animal. In most cases the accident was caused by a failure to maintain sufficient distance. This location is not regarded as an accident hotspot.

Accident 14

Description of location

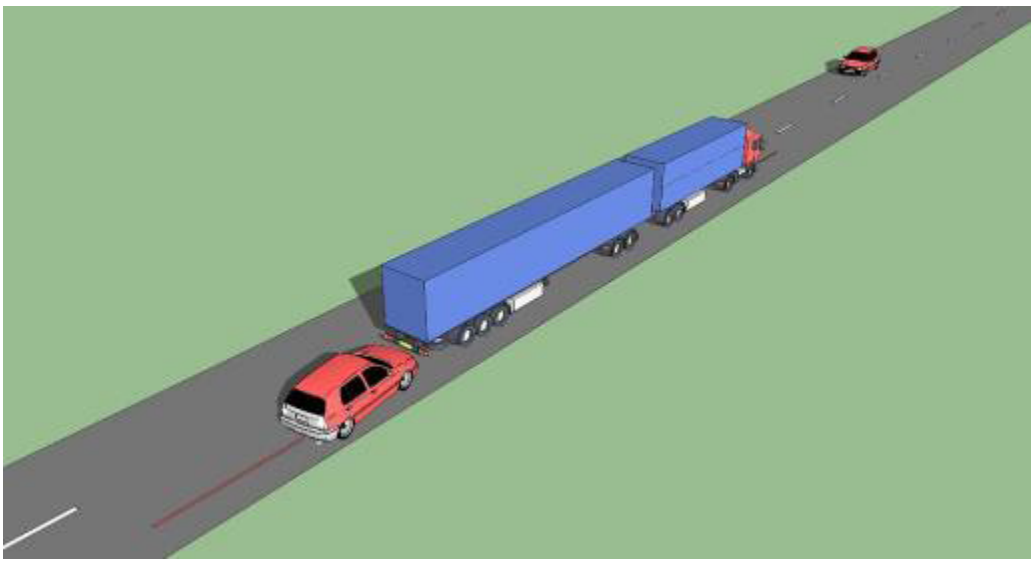
The accident occurred on the N369 at Kootstertille (the road here is called 'De Koaten') north of Drachten. The N369 is an access road with one lane in each direction and without a separator. A speed limit of 80 kph applies here.

Description of circumstances

The accident occurred on 3 October 2009 at 17:54 hours. At the time of the accident it was dry. Traffic was not congested.

Description of accident

While the LHV was travelling on the N369, two children of eight and nine years of age threw chestnuts at the side of the cabin. This shocked the LHV driver and caused him to slam on the brakes, because of seeing children playing on the roadside. The passenger vehicle travelling behind the LHV subsequently collided with the LHV; this in spite of the fact that the passenger vehicle was travelling at a safe distance from the LHV. Both vehicles were driving around 70 kph, and there was no reason why the passenger vehicle would have expected the LHV to suddenly brake. After the collision the driver of the passenger vehicle suffered injuries to her neck and shoulder. After being checked by ambulance staff on site, she was allowed to go home.



Why did the accident occur?

This accident was caused because two children were throwing chestnuts at the LHV; this subsequently caused a shock reaction from the driver of the LHV. Because of the nature of the location where they were travelling, the driver of the passenger vehicle never expected that she would have to suddenly brake. This resulted in a rear-end collision.

How could the accident have been prevented?

The accident could have been prevented if the children had not thrown chestnuts at the LHV. It should be noted that this was an external factor which the road users had no influence on. The accident could also have been prevented if the driver of the passenger vehicle had maintained sufficient distance to the LHV so that she would have also been able to stop on time in event of suddenly having to bring the vehicle to a stop.

Significance of characteristics
Considering the nature of the accident, it seems safe to conclude that specific LHV characteristics played no part in the accident. This accident could also have happened to a regular truck or passenger vehicle.

Accident proneness of location
Between 2005 and 2009 a total of eight accidents occurred near the accident location, two of which with casualties. Besides the accident with the LHV, this involved side and rear-end collisions. In most cases the accident was caused by a failure to give priority or to maintain sufficient distance. This location is not regarded as an accident hotspot.

Accident 15

Description of location

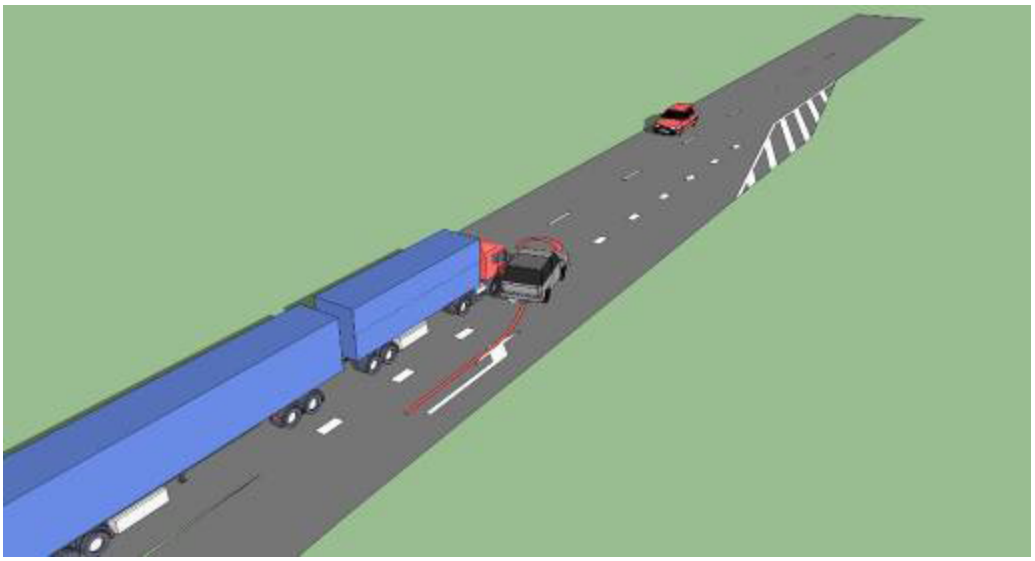
The accident occurred on the N50 towards Zwolle at the filter lane of the Kampen south exit. The N50 is a trunk road which has one lane in each direction and no separator at the exit. A speed limit of 100 kph applies here. There is no hard shoulder along the road. Merging traffic cannot take evasive manoeuvres if it is unable to merge on time.

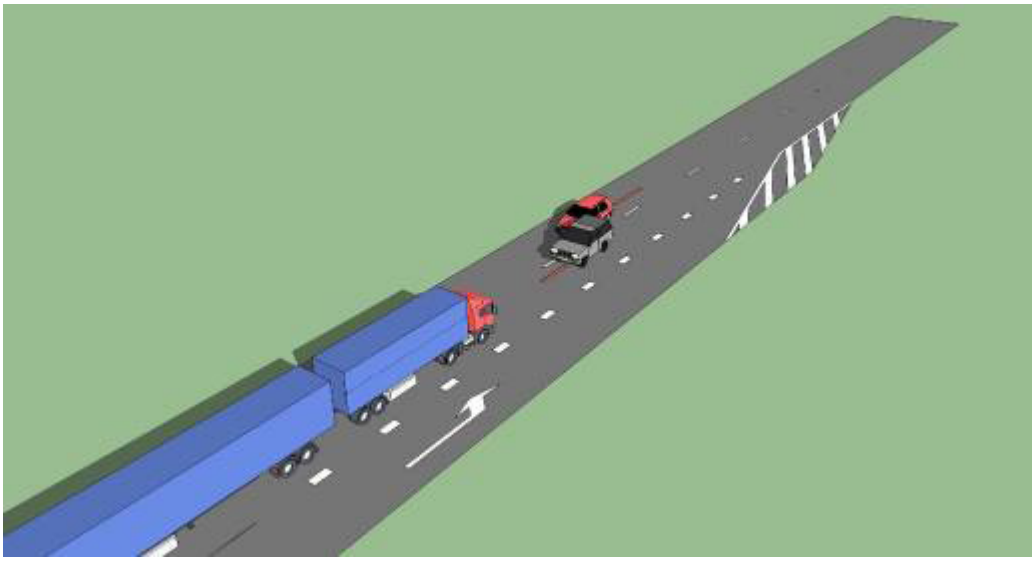
Description of circumstances

The accident occurred on 23 October 2009 at 12:35 hours. At the time of the accident it was dry. Traffic was not congested.

Description of accident

While attempting to merge on the N50 a delivery hit an LHV, already travelling on the N50, on its right front side. The delivery van turned on its axis and collided with the LHV once again; this time both vehicles hit each other's front. The delivery van, which was now facing in the opposite direction on the N50, reversed and hit an oncoming passenger vehicle from the other direction. The accident resulted in material damage only.





Why did the accident occur?
This accident probably occurred because the driver of the merging passenger vehicle wanted to merge in front of the LHV. The driver of the passenger vehicle possibly misjudged the LHV's length and chose the wrong time to merge. This type of accident is a typical truck accident. On the one hand, the incident occurred because the other road user misjudged the length of the truck, but the difference in speed between both vehicles also played a part in the accident. At this location the N50 only has one lane in each direction, this makes it difficult to overtake vehicles. The passenger vehicle should probably have remained behind the truck. The N50 does have acceleration lanes further on towards Zwolle.

How could the accident have been prevented?
The accident could have been prevented if the driver of the merging passenger vehicle had merged behind the LHV. The accident may also have been prevented if the LHV had slowed down, this would have given the passenger vehicle sufficient space to merge. It should be noted that the passenger vehicle may have been situated in the LHV's blind spot, as a result of which the driver of the LHV was unable to anticipate the passenger vehicle's attempt to overtake it.

Significance of characteristics
Although this is characterised as a typical truck accident, the extra length of the LHVs did increase the likelihood of this type of accident with an LHV.

Accident proneness of location
Between 2005 and 2009 a total of nine accidents occurred near the accident location, one of which involved a casualty. The nature and cause of the accidents were diverse. In this period, in addition to the accident with the LHV, one side collision occurred. This location is not regarded as an accident hotspot.

Accident 16

Description of location

The accident occurred on the A2 between the Beesd and Geldermalsen exit (km 84.2) on the road towards Den Bosch. Because of roadworks the two lanes on the A2 were narrower and were guided via another lane. The accident occurred at the location where the lanes were directed to another lane. A top speed of 90 kph applied at the time of the accident.

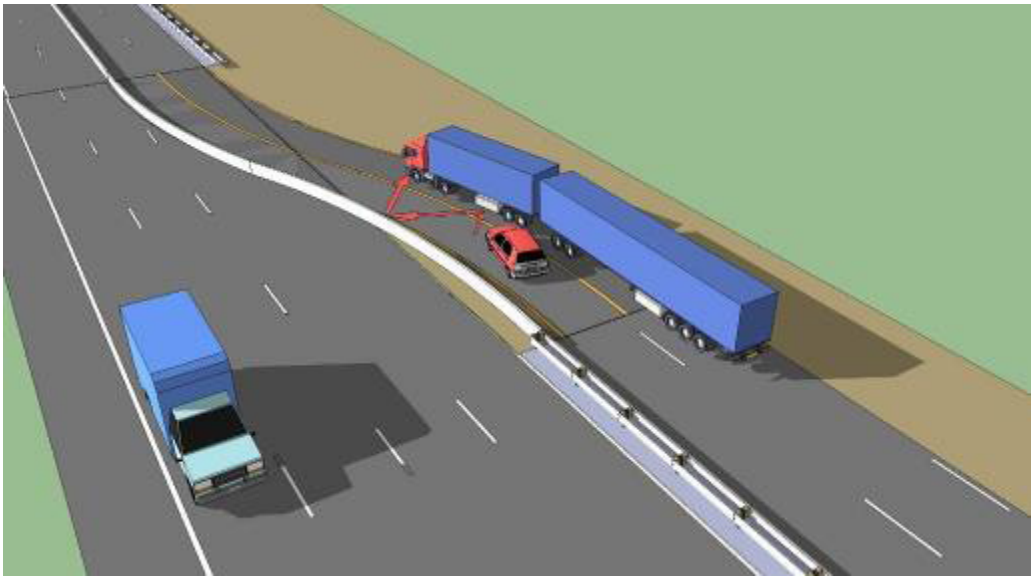
Description of circumstances

The accident occurred on 6 November 2009 at 7:30 hours. At the time of the accident it was dry. Traffic was not congested. Because of roadworks, the lanes were narrowed and there was no hard shoulder.

Description of accident

At this section of the road a passenger vehicle travelling on the outside lane collided with the left side of the LHV. The passenger vehicle attempted to correct the manoeuvre whereupon it collided with the barrier on the left side of the road, and subsequently hit the LHV again. The extent of damage to the passenger vehicle was so severe that it had to be towed.

Comment: there were roadworks at the time of the accident. A top speed of 90 kph applied at the time. In view of the fact that this road section is normally a straight road, it is highly likely that the narrow lanes and curve in the road meant there was less room for both vehicles to make sideways movements. The accident resulted in material damage only.



Why did the accident occur?

This accident probably occurred because the driver of the passenger vehicle did not stay in their own lane. As a result, the passenger vehicle hit the LHV and after attempting to correct their actions, hit the barrier and LHV once more. Due to roadworks with narrow lanes and the curve in the road, road users had to be extra concentrated on maintaining a correct course on the road. In this case one can speak of circumstances that added to the complexity of driving safely. A limited sideways movement by one of the vehicles could easily cause the vehicles to graze each other. This type of accident is a typical truck accident. Because a truck is wider

than a passenger car or delivery vehicle it was more likely for the vehicles to graze each other, than would be the case with two twee passengers driving next to each other.

How could the accident have been prevented?

The accident could have been prevented if the driver of the passenger vehicle had kept their vehicle in their own lane. This meant that the driver of the passenger vehicle should concentrated more on driving the vehicle.

Significance of characteristics

Although this involved a typical truck accident, there is a higher chance of an accident with an LHV because of the vehicle's swerving behaviour. It was not possible to conclude from the accident report whether the LHV had made a sideways movement at the time of the accident.

Accident proneness of location

Between 2005 and 2009 the accident with the LHV was the only accident that occurred at this location. This location is not regarded as an accident hotspot.

Accident 17

Description of location

The accident occurred on the A15 between junction Benelux and the Heijplaat exit (km 52.0) towards Ridderkerk. The road here features three ongoing lanes and a weaving section with two lanes. A speed limit of 100 kph applied here.

Description of circumstances

The accident occurred on 10 December 2009 at 16:30 hours. It was dark at the time of the accident. The road lights on site were on. At the time of the accident there was no precipitation. Although it was not explicitly stated in the accident report, based on the location, time and circumstances around the accident, there was probably congestion at the time of the accident.

Description of accident

Upon merging onto the A15, a passenger vehicle from the A4 hit the front right side of the LHV, which was standing still on the A15. This caused a side collision with material damage only.

Why did the accident occur?

This accident possibly occurred because the driver of the passenger vehicle wrongly judged the length of the LHV upon merging on the A15. In view of the fact that the LHV was standing still, it is more likely that driver of the passenger vehicle failed to observe that traffic on the A15 was standing still, and subsequently merged at a point in the road where there was no room for this manoeuvre.

How could the accident have been prevented?

The accident could have been prevented if the driver of the passenger vehicle would have observed the fact that traffic on the A15 was standing still, and subsequently adjusted their speed to the situation. The accident could also have been prevented if the driver of the passenger vehicle had properly assessed whether there was sufficient space to merge.

Significance of characteristics
In view of the circumstances surrounding this accident, the incident could have just as likely occurred with another vehicle. It is unlikely that specific characteristics of the LHV played a part in this accident.

Accident proneness of location
Between 2005 and 2009 a total of 14 accidents occurred near the accident location, one accident involved a casualty. Besides the accident with the LHV, this mainly concerned side and rear-end collisions, and accidents with a fixed object. In most cases the accident was caused by a driver error, failure to give right of way or to maintain sufficient distance. This location is regarded as an accident hotspot.

Accident 18

Description of location

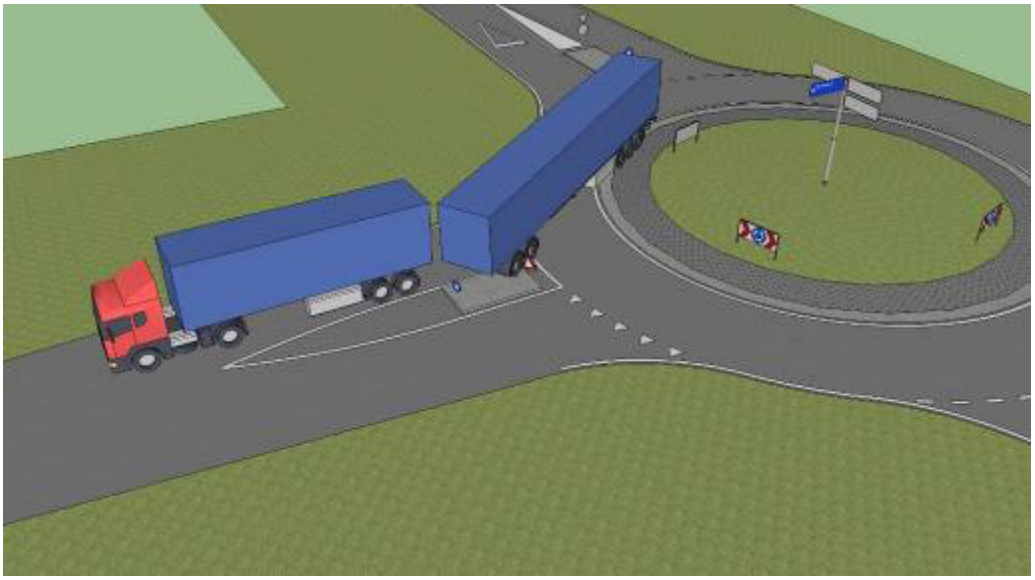
The accident occurred on the roundabout between the Steenwijkseweg and the Ruxveenseweg (N334) to the northeast of Steenwijk. This concerned a single-lane roundabout outside the built-up area where a top speed of 80 kph applied.

Description of circumstances

The accident occurred on 17 March 2010 between 22:00 and 23:00 hours. It was dark at the time of the accident. The road lights on site were on. At the time of the accident there was no precipitation. Traffic was not congested.

Description of accident

Upon negotiating three-quarters of the roundabout, the trailer separated from the rest of the combination upon exiting the roundabout. This caused the trailer to partially fall onto the road and onto the guide island on the roundabout. The trailer and the guide island with the traffic sign were damaged. No other vehicles were involved in this accident, which resulted in material damage only.



Why did the accident occur?

This accident occurred because the trailer was incorrectly connected, or because the attachment point was damaged while taking the roundabout. It is impossible to establish the exact cause on the basis of the police accident report. It should be noted that the LHV concerned had already travelled a great distance prior to the accident. This means it is highly likely that the sudden defect was the underlying cause of the accident.

How could the accident have been prevented?

The accident could have been prevented prior to the journey if a proper check had been conducted to confirm that the trailer was securely attached, and that the LHV combination did not display have any technical defects.

Significance of characteristics

Considering the nature of the accident, it seems safe to conclude that specific LHV characteristics played no part in the accident. This accident could also have happened to a regular truck combination.

Accident proneness of location

Between 2005 and 2009 a total of three accidents occurred near the accident location, however, there were no casualties. This concerned two side collisions and an accident with a fixed object. The accident was caused by a failure to give right of way or driver error. This location is not regarded as an accident hotspot.

Accident 19

Description of location

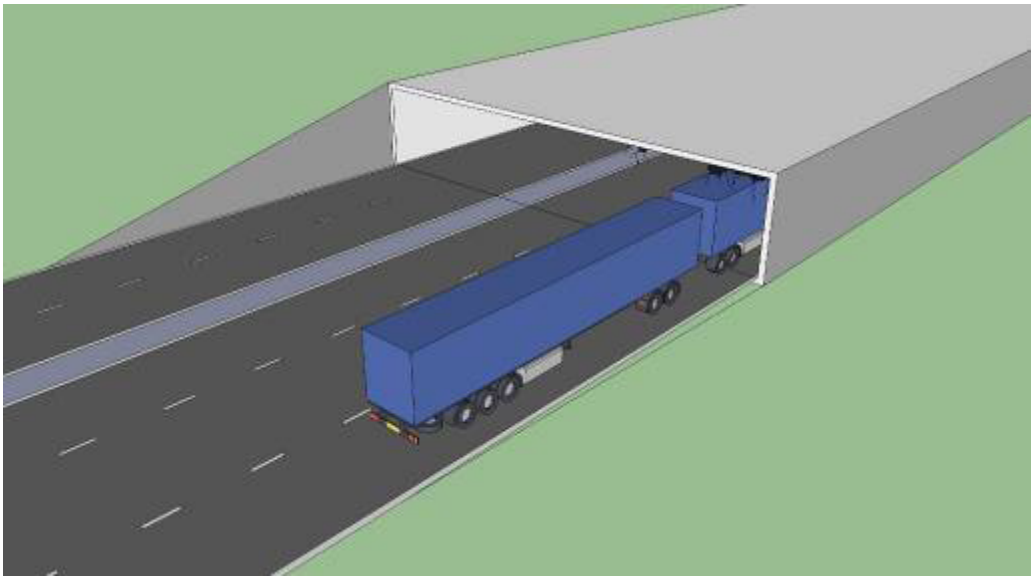
The accident occurred on the N15 in the Thomassen tunnel towards Ridderkerk. The N15 is a trunk road with separated lanes, and at this section has three lanes going in the direction of Ridderkerk. A speed limit of 100 kph applies here.

Description of circumstances

The accident occurred on 14 July 2010 at 19:30 hours. At the time of the accident it was dry. Traffic was not congested.

Description of accident

Upon entering the Thomassen tunnel, an exceptional transport vehicle, consisting of a trailer with a mobile caterpillar crane, crashed into the installations positioned on the tunnel's ceiling. The mobile caterpillar crane supposedly collided with the installations because a plate on top of the crane was not properly attached, causing it to stick upwards. The tunnel installations were separated from the ceiling and, 23 vehicles, among which the LHV, were subsequently damaged by the loose installations. This resulted in material damage only. The LHV was damaged on the front, right side and top.



Why did the accident occur?

This accident occurred because part of the metal plate on top of the mobile crane came loose. This caused the plate to protrude and damage the installations on the ceiling in the tunnel. Various other vehicles subsequently collided with the installations that were hanging loose, and were unable to brake in time to prevent a collision with these objects.

How could the accident have been prevented?

The accident could have been prevented, if prior to the journey, the mobile caterpillar crane had been checked properly so the loose component on the metal plate would have been discovered on time.

Significance of characteristics
Considering the nature of the accident, it seems safe to conclude that specific LHV characteristics played no part in the accident. In addition to the LHV a large number of other vehicles were also damaged.

Accident proneness of location
Between 2005 and 2009 a total of nine accidents occurred near the accident location, however, there were no casualties. These accidents involved a fixed object, side- and rear-end collisions. In most cases the accident was caused by driver error, failure to give right of way or to maintain sufficient distance. This location is not regarded as an accident hotspot.

Appendix D Policy statement testing and dispensation LHV evaluation phase 2009

This is an edition of

Rijkswaterstaat

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