List of Figures and Tables

Figure 1: Number of registered vehicles involved in accidents per 1,000 registered vehicles for Light Commercial Vehicles and Heavy Duty Vehicles (3.5 to 7.5 tons) in Germany 7
Figure 2: New registration of Light Commercial Vehicles up to 3.5 tons in the EU-15 8
Figure 3: New registration of Light Commercial Vehicles up to 3.5 tons in the EU 16-27 9
Figure 4: Distribution of the stock of Light Commercial Vehicles up to 3.5 tons in the year 2007 in the EU-15 9
Figure 5: Number of persons fatally injured in the EU-25 in the year 2002 in accidents involving light utility vehicles 10
Figure 6: Number of persons fatally injured in accidents involving light utility vehicles taking the kilometres driven into account 10
Figure 7: Absolute development of the figures for Heavy Duty Vehicles of the various weight classes in Germany 11
Figure 8: Relative development of the figures for Heavy Duty Vehicles of the various weight classes in Germany 11
Figure 9: Absolute development of the figures for Heavy Duty Vehicles in the various weight classes up to 3.5 tons in Germany 12
Figure 10: Relative development of the figures for Heavy Duty Vehicles in the various weight classes up to 3.5 tons in Germany 12
Figure 11: Time series for accidents resulting in injuries to persons involving Light Commercial Vehicles 17
Table 1: Absolute values for Light Commercial Vehicles involved in accidents leading to injuries to persons 18
Table 2: Absolute values for those fatally injured in accidents involving Light Commercial Vehicles to persons in Germany 18
Figure 12: Time series for those killed in accidents involving Light Commercial Vehicles and Heavy Duty Vehicles (2.8 t to 3.5 tons) according to the local situation 19
Figure 13: Causes of accidents involving Light Commercial Vehicles that are dependent on the age of the driver in Germany (2008) 19
Figure 14: Development of the accident involvement per 1,000 vehicles (numbers involved per 1,000 registered vehicles) for Light Commercial Vehicles 21
Figure 15: Impact regions of Light Commercial Vehicles involved in accidents 21
Table 4: Annual number of kilometres driven by passenger cars and Light Commercial Vehicles 21
Figure 17: Collision counterparts of Light Commercial Vehicles 22
Figure 18: Collision velocities and Delta-v in the event of frontal collisions between Light Commercial Vehicles and passenger cars or other Light Commercial Vehicles 22
Figure 19: Delta-v in the event of rear-end collisions with passenger cars or other Light Commercial Vehicles 22
Figure 20: List of equipment of Light Commercial Vehicles with selected safety feature 23
Figure 21: Quota of seat belt wearing and non-seat belt wearing front seat passengers of passenger cars and Light Commercial Vehicles 23
Figure 22: Severity of injuries depending on seat belt usage 24
Figure 23: Comparison of the severity of injuries to seat-belt wearing front seat passengers of passenger cars and Light Commercial Vehicles in the event of collisions with passenger cars and Light Commercial Vehicles 25
Figure 24: Severity of injuries suffered by pedestrians in the event of collisions with passenger cars or Light Commercial Vehicles 26
Figure 25: Number of accidents mainly caused by Light Commercial Vehicles (n=11,694) and types of accidents caused by Light Commercial Vehicles (n=956) 27
Figure 26: Maximum threshold velocity in the double VDA-lane departure test depending on the load position 29
Figure 27: Type of user and purpose of the use of Light Commercial Vehicles causing accidents 33
Figure 28: Annual number of kilometres driven of passenger car, Light Commercial Vehicle and heavy duty vehicle drivers 33
Figure 29: Time between the last break and the accident 33
Figure 30: A comparison of the causes of accidents on motorways for accidents caused by Light Commercial Vehicles and by passenger cars 35
Figure 31: A comparison of the causes of accidents on rural roads for accidents caused by Light Commercial Vehicles and by passenger cars 35
Light Commercial Vehicles are an important part of the fleet of vehicles and for a number of years now have been taking over a constantly increasing share of the transport services both in Germany and in Europe. Hand in hand with this there has been an intensified debate about road traffic safety in connection with the increase in transports with this kind of vehicle. With the aim of analysing objectively accidents involving Light Commercial Vehicles, the Federal Highway Research Institute (BASt), the DEKRA Accident Research Department, the German Insurers Accident Research (UDV) and the Association of the Automotive Industry (VDA) have initiated a research project into the question of the safety of Light Commercial Vehicles.

The analyses of this project are based upon data drawn from the official German road traffic accident statistics, the accident database of the German insurers (UDB) and the DEKRA as well as those of the German In-Depth Accident Study (GIDAS). Both the mitigation of the consequences of accidents with regard to the protection of both oneself and one’s partners and the topic of how accidents occur or rather how to avoid them were analysed. On one hand the results provide answers to questions based upon the various regulations and, on the other hand, recommendations are made for activities that may be taken, especially in the context of consumer protection and consumer information.

It has been revealed that accidents involving Light Commercial Vehicles show a similar pattern to those involving passenger cars; noteworthy differences can be established in connection with accidents involving pedestrians, vehicle reversing and the causes of accidents. The level of passenger protection in the Light Commercial Vehicle is currently not being exploited to the full, however, as the number of those making use of the safety belt is significantly lower than it is with passengers in passenger cars. In connection with partner protection it is to be stated that, in the event of a collision with a passenger car, the energy absorbing vehicle structures are not compatible. Higher demands upon passive security in the Light Commercial Vehicle are not the answer, however; on the contrary, more rigid structures for the vans would in this case be counter-productive.

Summary
The analysis of accidents involving Light Commercial Vehicles and pedestrians reveals significant differences in the accident kinematics compared to accidents between pedestrians and passenger cars. The available test procedures for the pedestrian protection features of motor vehicles have been developed for passenger cars and still have to be adapted for application in Light Commercial Vehicles.

Regarding the origins of accidents, some focal points may be recognised in connection with accidents involving Light Commercial Vehicles. Here it is revealed that rear-end accidents caused by Light Commercial Vehicles are predominant and represent the most frequent accident scenario. From these analyses, possible areas of application for emergency braking or forward alert systems could be won. The accidents caused by Light Commercial Vehicles when turning into a road or crossing it, occupy second spot in the ranking list of the main accident scenarios, these, however, cannot be influenced in their entirety by technical measures based upon technologies available today. The third most frequent accident scenarios were identified as driving accidents, i.e. those accidents that have their origin in the loss of control over the vehicle. These accidents could be influenced positively by vehicle dynamics control (such as ESP). Lane departure warning systems could possibly make a further contribution here. The analyses moreover revealed that vehicle reversing is a further noteworthy type of accident involving Light Commercial Vehicles, as collisions with pedestrians frequently occur thereby. Here, rear view monitoring cameras or acoustic warning systems could help relieve the situation. It remains to be noted that driver assistance systems such as rear view cameras, lane departure warnings and emergency braking or forward alert warning systems do indeed reveal possible avoidance potential in the retrospective analysis of accident data, this cannot as yet, however, be quantified on the basis of prospective accident data.

In addition to the technical, in-built measures the behaviour and attitude of the vehicles' drivers were also examined by means of the analysis of accident data, which are admittedly limited in their informational value in this context. The analyses revealed that the drivers of Light Commercial Vehicles in comparison to those of passenger cars, have a striking tendency to cause accidents on country roads. Alongside the second most frequent cause of accidents, right of way and turning off, the most striking factors when compared to passenger cars are to be found in inappropriate driving speeds and lack of attention and distraction. These deficits cannot be adequately addressed with the technical measures or controls existing today. The road to improvement here can only lie in suitable measures designed to increase the awareness of the driver and his working environment.

In order to be able to develop suitable measures in the field of driver training it is necessary to identify a suitable target group. Here it is revealed that carefully targeted measures may take effect, in particular with regard to craft enterprises and small companies.

Note
There is a variety of different terms commonly used to describe Light Commercial Vehicles, e.g. Vans, Light Goods Vehicles (LGV), Light Utility Vehicles (LUV) etc. In this report all these are used synonymously.

Introduction

Light Commercial Vehicles of up to 3.5 tons have established themselves in the supply chain throughout the EU as a link between logistics centres and the retail trade/final consumer. But Light Commercial Vehicles are also a cornerstone in the rapid and flexible long-distance transportation of goods and commodities as well as in courier and supply services. With their increasing relevance in road traffic, other road users' perception of these vehicles increased automatically. Over the course of the past few years this led to a debate on the safety of Light Commercial Vehicles in the media, politics and the general public, and one that was not always conducted objectively. Statistically, also, the increasing relevance was reflected in higher accident figures, particularly in that group of vehicles with a maximum permitted total weight of 2.8 to 3.5 tons.

In the meantime, the accident risk for Light Commercial Vehicles no longer reveals any great peculiarities when compared to passenger cars or Heavy Duty Vehicles. In road traffic they manoeuvre almost as safely as passenger cars and offer passengers protection comparable to that offered by cars. A comparison of the data for accident involvement per 1,000 vehicles in Germany for the year 2008 reveals similar dimension for passenger cars and Light Commercial Vehicles (Figure 1). The category of Light Commercial Vehicles of up to 2.8 tons, measured by their numbers, is involved in accidents to a similar degree as passenger cars. The numbers-based risk for Light Commercial Vehicles between 2.8 and 3.5t maximum permitted weight is higher than that of the passenger cars. It is to be taken into account hereby that this category of vehicle has an almost 80 per cent higher number of kilometres driven than a passenger car. Nevertheless, every endeavour should be made in this area also, in order to reduce the risk of accidents further and increase the safety of both passengers and other road users.

In order to derive appropriate improvement measures it is essential that the accidents involving Light Commercial Vehicles should be analysed thoroughly. To this purpose, the Federal Highway Research Institute (BASf), the German Insurers Accident Research (UDV), the DEKRA Accident Research Department and the Association of the Automotive Industry (VDA) have initiated a common research project into the question of the safety of Light Commercial Vehicles. The aim of this is to elaborate, based on accident analyses, suitable improvement measures designed to increase the safety in connection with accidents involving Light Commercial Vehicles. The aim was not to levy, by way of the database evaluation, behavioural data or suchlike. The results are inasmuch to be regarded or qualified against this background and do not reflect the full picture of a countermeasure identification. The findings of this project are described in detail in the following study.

Figure 1: Number of registered vehicles involved in accidents per 1,000 registered vehicles for Light Commercial Vehicles and Heavy Duty Vehicles (3.5 to 75 tons) in Germany

![Figure 1: Number of registered vehicles involved in accidents per 1,000 registered vehicles for Light Commercial Vehicles and Heavy Duty Vehicles (3.5 to 75 tons) in Germany](image-url)
High growth of the number of Light Commercial Vehicles in the EU

The status of Light Commercial Vehicles in the transportation of goods by road is underlined by their numbers, which have increased rapidly over the course of the past few years. Regarding the number of registrations, according to the European Branch Association ACEA (European Automobile Manufacturers’ Association) France, Germany, Italy, Spain and the United Kingdom dominate within the EU (Figure 2). In each of these countries at least 200,000 Light Commercial Vehicles per year were newly admitted onto the roads in the years 2007 and 2008. The only exception to this is Spain, where ca. 166,000 Light Commercial Vehicles were newly admitted in the year 2008. In Belgium, Denmark, Ireland, The Netherlands, Portugal, Sweden, the Czech Republic and Poland, between 40,000 and 100,000 vehicles were admitted onto the roads annually (Figures 2 and 3). The front-runners in terms of new registrations also have, among the EU-15, the largest total of vehicles with regard to Light Commercial Vehicles (Figure 4). Almost 80 per cent of the EU15’s 24,627,963 Light Commercial Vehicles are registered in the five countries named. When regarding this figure it should, however, be taken in account that the definition of a Light Commercial Vehicle is not identical in the individual states.

Figure 2: New registration of Light Commercial Vehicles
up to 3.5 tons in the EU-15

Figure 3: New registration of Light Commercial Vehicles
up to 3.5 tons in the EU 16-27

Figure 4: Distribution of the stock of Light Commercial Vehicles
up to 3.5 tons in the year 2007 in the EU-15

Source: European Automobile Manufacturers’ Association (ACEA)
International statistics

The figures published in the IMPROVER-Project (Impact Assessment of Road Safety Measures for Vehicles and Road Equipment) for the numbers fatally injured in accidents with light utility vehicles involved show the European significance and the differences in the magnitude of the problem in the individual countries. The project was handled by the BASt together with 14 partner institutes from November 2001 until May 2006 on behalf of the European Commission (Directorate-General Energy and Traffic).

The statistics for 2002 reveal more than 400 fatally injured respectively for Greece, Italy, Spain and Poland. These are followed by Germany, France and Great Britain, with between 200 and 400 victims each (Figure 5). If the absolute numbers of deaths are set in relation to the number of kilometres driven, the picture changes significantly (Figure 6). Spain, a country with more than 440 deaths resulting from accidents involving light utility vehicles, has a top rating of less than one fatally injured person for every 100 million vehicle kilometres if the number of kilometres driven is taken into account. Lithuania, on the other hand, may indeed have less than 50 deaths to mourn, but lags clearly behind Spain with more than six deaths for every 100 million vehicle kilometres if the number of kilometres driven is taken into account.

How the figures have developed in Germany

For Germany, the figures for the various weight classes of Heavy Duty Vehicles are published in the annual publications of the Federal Motor Transport Authority (KBA). A striking fact thereby is the high percentage of the absolute numbers of vehicles up to 3.5 tons. In this weight class, the number of registered vehicles has almost doubled, from 1,026,706 in the year 1992 to 1,847,187 by the year 2007 (Figure 7).

Attention should be paid to the fact that, since 2008, the KBA no longer includes temporarily deregistered vehicles in its figures. This explains the decline in numbers in the year 2008. Following the change in the statistics, there were 1,802,557 vehicles in this class in Germany on January 1st 2009. The relative development of the figures for Light Commercial Vehicles shows an increase of 81 per cent from 1992 till 2002. Until the year 2007 the numbers grew, compared with the initial year, by a further 9 per cent to 190 per cent (Figure 8).

Figure 5: Number of persons fatally injured in the EU-25 in the year 2002 in accidents involving Light Utility Vehicles

Source: IMPROVER-Project

Figure 6: Number of persons fatally injured in accidents involving Light Utility Vehicles taking the kilometres driven into account

Source: IMPROVER-Project

Figure 7: Absolute development of the figures for Heavy Duty Vehicles of the various weight classes in Germany
(from 2008 onwards not including temporarily deregistered vehicles)

Source: Federal Motor Transport Authority

Figure 8: Relative development of the figures for Heavy Duty Vehicles of the various weight classes in Germany
(from 2008 onwards not including temporarily deregistered vehicles)

Source: Federal Motor Transport Authority
In the context of this project, meaningful data pertaining to accidents involving Light Commercial Vehicles, especially in Germany, were extracted and analysed. The basis for the analyses are real-life accident data from the GIDAS-database, the database of the German Insurers Accident Research (UDV), the DEKRA database and official national and international statistics. An overview of the databases:

1. Official accident statistics

According to § 1 of the Act pertaining to the Statistics on Road Traffic Accidents (StVUnfStatG), country-wide statistics relating to accidents in which, as a consequence of the traffic on public roads and squares, persons are killed or injured or damage to property is incurred are being collected on a regular basis. This serves the purpose of compiling an up-to-date, comprehensive and reliable pool of data about the structure and development of road traffic accidents. Light Commercial Vehicles may not be an individual class of vehicle in their own right and are not recorded as such in the context of the police accident reports. On the basis of registration-related information provided by the Federal Motor Transport Authority (KBA) regarding the type of vehicle and permitted total weight, it is nonetheless possible to identify Light Commercial Vehicles in the data material of the official statistics. The basis of data pertaining to accidents involving Light Commercial Vehicles are thus individual data extracted for the official road traffic accidents statistics that are complemented by information gathered from the central vehicles’ register of the Federal Motor Transport Authority. For this reason the data material refers exclusively to Light Commercial Vehicles registered in Germany, the registration numbers of which were clearly identifiable.

2. GIDAS database

GIDAS (German In-Depth Accident Study) is a joint project of the BASt and the Research Association of Automotive Technology (FAT) of the Association of the Automotive Industry (VDA). The project collects detailed and statistically representative data on real-life road traffic accidents in Germany. The GIDAS-project originated from the accident research team of the Hanover Medical School (MHH) that had been investigating and documenting road traffic accidents on behalf of the BASt since 1973. In the year 1999 the statistical area was expanded to include the Metropolitan area of Dresden.

The collection of data in that area is implemented by the Road Traffic Research Department of the TU Dresden (VUFO GmbH). Since July 1999, the GIDAS project has been recording annually approx. 2,000 accidents, each with circa 3,000 individual data. The database currently comprises 18,980 accidents involving 33,661 vehicles and a total of 47,315 persons, some of whom have been injured.
In every shift a team comprised of two technicians, one physician and one coordinator stands by to record the accident data. The criteria for the recording of the accident are:

- Road traffic accident,
- Accident took place in the Metropolitan Areas of either Hanover or Dresden,
- Accident during a recording shift (a defined random sampling pattern) and at least one injured person.

The following data are recorded at the place of accident and subsequently:

- Environmental conditions,
- Road design, traffic regulations, constructional particularities
- Vehicle deformation,
- Impact points of passengers or other road users,
- Key technical data such as vehicle type and technical equipment,
- Crash information and parameters (collision and driving speed, Delta v and EES, depths of deformation),
- How the accident happened and the causes thereof
- Personal data such as weight, height or Age, as well as injury patterns, pre-clinical and clinical care

The data levied and the accidents reconstructed are rendered anonymous before being stored in a database for use by the participants in the project. In addition there is extensive pictorial material pertaining to the vehicles involved, the scene of the accident and the injuries. Due to the defined random sampling procedure and the deployment of weighting factors the GIDAS-Database is representative of national statistics for accidents in which persons are injured. The number of cases is so high that the analysis of the data material leads to meaningful results. The high level of detail of the cases also enables in-depth investigations. From this database, accidents involving a total of 910 Light Commercial Vehicles and 1,411 passengers were analysed.

3. Database of the German insurers accident research (UDV)

The analysed case material from the UDV is primarily gathered from the German insurers’ claims files that are routinely retrieved by random samples from the total number of all third party motor insurance claims in Germany for the purpose of accident research. In the case of the 459 accidents involving Light Commercial Vehicles, in which 477 Light Commercial Vehicles with a total of 670 passengers were involved, these were accidents results in injuries to persons and total claim value of at least 15,000 Euros. They happened in the period between 2001 and 2006.

A few of the cases (circa five per cent) originate from a total of all serious Heavy Duty Vehicle accidents resulting in at least one fatally or seriously injured person that occurred in 1997 in Bavaria, as well as from a collection of accidents involving vehicles equipped with an accident data recorder (UDS) that occurred in Berlin between 1998 and 2006.

As of October 2009 the UDV’s database contains a total of 4,496 accidents with 8,161 casualties. The contents of the claims files varies from case to case, but is essentially drawn from the following sources of information:

- Accident report
- Statements by those involved and witnesses,
- Accident reconstruction expertise,
- Assessment of damages
- Pictures of the scene of the accident and the vehicles
- Medical reports of doctors and hospitals containing descriptions of injuries and details of in-patient treatments,
- Correspondence between the lawyers and
- Court ruling.

4. DEKRA accident database

DEKRA maintains a country-wide network of experts for road traffic accident analysis. Primarily at the behest of courts, public prosecutors, the police and insurance companies, accident reconstruction expertises are compiled. DEKRA Accident Research has access to these expertises. The data sentences contain most comprehensive technical information; regarding the injuries suffered by the casualties mostly only basic data are available. The database currently contains ca. 3,000 accidents. The following details are, as a general rule, included:

- Accident report
- Statements by those involved and witnesses,
- Accident reconstruction expertise,
- Assessment of damages
- Pictures of the scene of the accident and the vehicles
- Special reports (lighting engineering, tachograph evaluation, report on the condition of the tyres, determination of the cause of fire).

The particularity of DEKRA’s accident data lies in the extremely detailed reconstructions, which cover the events leading up to the accident (pre-crash phase including driving and collision speed), collision analysis (with the aid of, inter alia, Delta-v and EES), the events following the accident (post-crash phase) and an assessment as to whether or not the accident could have been avoided. The DEKRA database contains 270 involved Light Commercial Vehicles with 371 passengers.
Accident Occurrence

The longer-term development of accident occurrences in Germany reveals significant differences within the class of Light Commercial Vehicles. In the context of the harmonisation of the legal provisions within the EU there were decisive changes made in the motor vehicles sector in the year 1997. One of the consequences of the EU-directives 70/156/EEG and 86/633/EEG was the speed limit waiver for vehicles with a maximum permitted total weight between 2.8 and 3.5 tons. Thereupon there was a strong increase in both the numbers of this class of vehicles as well as their involvement in accidents. For this reason - based on the registration-based information from the Federal Motor Transport Authority pertaining to the type of vehicle and the maximum permitted total weight – a sub-division in the following sub-groups was undertaken:

- Extremely light-weight Light Commercial Vehicles of up to 2 tons (maximum permitted total weight up to 2,000 kg).
- Light Commercial Vehicles of more than 2 and up to 2.8 tons (maximum permitted total weight between 2,001 and 2,800 kg) and
- Light Commercial Vehicles of more than 2.8 and up to 3.5 tons (maximum permitted total weight between 2,801 and 3,500 kg).
- In addition, Heavy Duty Vehicles weighing between 3.5 and 75 tons were included in the investigation as a comparison group.

For information only: Light Commercial Vehicles are not an independent group of vehicles in their own right and are not registered as such in the context of police accident reports. From the registration-based information from the Federal Motor Transport Authority (KBA) pertaining to the type of vehicle and the maximum permitted total weight, however, Light Commercial Vehicles up to 3.5 tons can be identified from the data material of the official statistics. The basis of data pertaining to accidents involving Light Commercial Vehicles are thus individual data extracted for the official road traffic accidents statistics that are complemented by information gathered from the central vehicles’ register of the Federal Motor Transport Authority. For this reason the data material refers exclusively to Light Commercial Vehicles registered in Germany, the registration numbers of which were clearly identifiable.

The focus of the analyses was on the topics of active and passive safety, whereby particular attention was paid to advanced driver assistance systems, drivers’ behaviour and passenger and partner safety. The results provide answers to questions within the area of tension between future statutory regulations and consumer protection activities. At the same time the measures derived from active safety were analysed for their safety potential. A differentiation between sub-groups (inter alia 2.8 to 3.5 tons) was not possible due to the limited number of cases and the fact that the maximum permitted total weight could not always be clearly deduced from the data material.

Accident trends, accident location and causes

The data analyses of the Federal Highway Research Institute BASt (Figure 11) reveal that, with a total of 7250 Light Commercial Vehicles with a maximum permitted overall mass between 2.8 and 3.5 tons involved in accidents resulting in injuries to persons (of these 65.9 per cent were the main causes of the accident), the figure for 2008 has more than quadrupled that for 1996 (1,733 vehicles involved). With a share of 19.3 per cent among the drivers of Light Commercial Vehicles, in the context of total accident occurrences, is comparatively low.

In total, 4,477 persons (1996: 8,758; 2001: 6,977) died on the roads in Germany in the year 2008. The number of those killed in accidents involving Light Commercial Vehicles between 2.8 and 3.5 tons went up from 50 in the year 1996 to 132 in the year 2008. Compared to that, the number of people killed in accidents involving Light Commercial Vehicles between 2 and 2.8 tons decreased significantly in the period referred to (Figure 12). A sub-division of accidents involving Light Commercial Vehicles between 2.8 and 3.5 tons according to the local situation reveals that, up to 2001 the increase on the motorways had been stronger than in built-up areas or on rural roads. A change in this trend can be noted from the year 2001 onwards (Figure 13).

The cause of accident “turning off, u-turns, reversing, turning into a road and starting up,” is the most significant one, having a share of 19.3 per cent among the drivers of Light Commercial Vehicles between 2.8 and 3.5 tons. There follows the cause “insufficient safety distance” with 17.9 per cent. In a direct comparison the accident cause “turning off, u-turns, reversing, turning into a road and starting up,” also tops the list with regard to passenger cars. The analyses that have been undertaken thereby take as their basis all the causes of accidents named in connection with Light Commercial Vehicles.

As the analysis of the accident data of the Federal Statistics Office reveals, the distribution of the causes of accidents varies depending on the age of the drivers (Figure 14). As a general rule, those causes that may be assigned to more complex traffic situations such as right of way or turning into a road or crossing it are more frequently to be observed among older drivers. Among the younger drivers, the problems are more likely to be found in connection with insufficient safety distance or speed. The influence of age, for both older and younger Light Commercial Vehicle drivers, is not as strong as is the case with the drivers of passenger cars.

According to the investigations carried out by DEKRA after accidents involving Light Commercial Vehicles, technical defects of the vehicle may also be responsible for an accident.1 In the period from 2002 to 2008, DEKRA inspected at total of 152 Light Commercial Vehicles after accidents. Of these, 86 vehicles (= 56.6 per cent) revealed technical defects, 35 of them defects relevant to the accident. The number of defects added up to a total of 227 of which 58 were relevant to the official statistics. Among the component groups causing accidents it was the brakes component that topped the negative ranking list with 55.6 per cent followed by the chassis (22.2 per cent) and tyres (11.1 per cent).

Figure 11: Time series for accidents resulting in injuries to persons involving Light Commercial Vehicles

Source: BASi-report on accidents involving Light Commercial Vehicles (2010)
**Figure 12:** Time series for those killed in accidents involving Light Commercial Vehicles and Heavy Duty Vehicles

![Time series chart](image)

**Source:** BASt-report on accidents involving Light Commercial Vehicles (2010)

**Absolute values for Light Commercial Vehicles involved in accidents leading to injuries to persons**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Van</td>
<td>up to 2.0 t</td>
<td>3,033</td>
<td>3,366</td>
<td>3,645</td>
<td>4,088</td>
<td>4,644</td>
<td>4,205</td>
<td>3,916</td>
<td>3,703</td>
<td>3,552</td>
<td>3,261</td>
<td>3,286</td>
<td>3,045</td>
<td>3,085 1.7%</td>
</tr>
<tr>
<td>Van</td>
<td>2.01 – 2.8 t</td>
<td>9,366</td>
<td>10,217</td>
<td>10,285</td>
<td>11,275</td>
<td>10,967</td>
<td>10,420</td>
<td>9,049</td>
<td>8,537</td>
<td>8,080</td>
<td>7,080</td>
<td>7,033</td>
<td>7,119</td>
<td>7,609 -22.3%</td>
</tr>
<tr>
<td>Van</td>
<td>2.81 – 3.5 t</td>
<td>1,733</td>
<td>1,662</td>
<td>2,490</td>
<td>3,577</td>
<td>4,644</td>
<td>5,273</td>
<td>5,223</td>
<td>5,429</td>
<td>5,674</td>
<td>5,874</td>
<td>6,223</td>
<td>6,901</td>
<td>7,260 316.3%</td>
</tr>
<tr>
<td>Van</td>
<td>2.01 – 3.5 t</td>
<td>11,269</td>
<td>12,106</td>
<td>12,875</td>
<td>14,852</td>
<td>15,177</td>
<td>15,683</td>
<td>14,271</td>
<td>13,365</td>
<td>13,754</td>
<td>14,023</td>
<td>14,156</td>
<td>14,910</td>
<td>14,874 20.9%</td>
</tr>
<tr>
<td>Van</td>
<td>3.51 – 7.40 t</td>
<td>5,263</td>
<td>5,205</td>
<td>5,272</td>
<td>5,633</td>
<td>5,421</td>
<td>4,849</td>
<td>4,991</td>
<td>5,085</td>
<td>5,350</td>
<td>5,438</td>
<td>5,650</td>
<td>5,003</td>
<td>5,003 -45.4%</td>
</tr>
</tbody>
</table>

Source: BASt-report on accidents involving Light Commercial Vehicles (2010)

**Absolute values for fatally injured persons in accidents involving Light Commercial Vehicles**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Van</td>
<td>up to 2.0 t</td>
<td>24</td>
<td>41</td>
<td>50</td>
<td>49</td>
<td>54</td>
<td>46</td>
<td>54</td>
<td>50</td>
<td>57</td>
<td>42</td>
<td>36</td>
<td>35</td>
<td>57 8.8%</td>
</tr>
<tr>
<td>Van</td>
<td>2.01 – 2.8 t</td>
<td>213</td>
<td>245</td>
<td>218</td>
<td>219</td>
<td>226</td>
<td>222</td>
<td>182</td>
<td>163</td>
<td>160</td>
<td>135</td>
<td>142</td>
<td>124</td>
<td>80 -537.7%</td>
</tr>
<tr>
<td>Van</td>
<td>2.81 – 3.5 t</td>
<td>50</td>
<td>46</td>
<td>80</td>
<td>76</td>
<td>119</td>
<td>132</td>
<td>120</td>
<td>134</td>
<td>133</td>
<td>101</td>
<td>111</td>
<td>135</td>
<td>126 152.1%</td>
</tr>
<tr>
<td>Van</td>
<td>2.01 – 3.5 t</td>
<td>263</td>
<td>291</td>
<td>262</td>
<td>295</td>
<td>345</td>
<td>354</td>
<td>302</td>
<td>297</td>
<td>290</td>
<td>236</td>
<td>253</td>
<td>259</td>
<td>216 -17.9%</td>
</tr>
<tr>
<td>Van</td>
<td>3.51 – 7.40 t</td>
<td>198</td>
<td>193</td>
<td>130</td>
<td>164</td>
<td>177</td>
<td>137</td>
<td>146</td>
<td>143</td>
<td>115</td>
<td>99</td>
<td>126</td>
<td>91</td>
<td>78 -40.6%</td>
</tr>
</tbody>
</table>

Source: BASt-report on accidents involving Light Commercial Vehicles (2010)

**Absolute values for the Light Commercial Vehicles involved in accidents resulting in damages to persons in Germany**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>urban area</td>
<td>1,080</td>
<td>1,158</td>
<td>1,304</td>
<td>1,985</td>
<td>2,405</td>
<td>2,631</td>
<td>2,678</td>
<td>3,049</td>
<td>3,183</td>
<td>3,183</td>
<td>3,079</td>
<td>4,114</td>
<td>4,476 322.3%</td>
</tr>
<tr>
<td>rural area*</td>
<td>462</td>
<td>556</td>
<td>765</td>
<td>1,074</td>
<td>1,349</td>
<td>1,622</td>
<td>1,627</td>
<td>1,742</td>
<td>1,689</td>
<td>1,730</td>
<td>1,935</td>
<td>1,993</td>
<td>2,686.2%</td>
</tr>
<tr>
<td>motorway</td>
<td>181</td>
<td>178</td>
<td>310</td>
<td>508</td>
<td>676</td>
<td>820</td>
<td>738</td>
<td>759</td>
<td>760</td>
<td>687</td>
<td>914</td>
<td>942</td>
<td>874 382.9%</td>
</tr>
<tr>
<td>total</td>
<td>1,723</td>
<td>1,832</td>
<td>2,486</td>
<td>3,577</td>
<td>4,460</td>
<td>5,075</td>
<td>5,223</td>
<td>5,429</td>
<td>5,674</td>
<td>5,974</td>
<td>6,023</td>
<td>6,901</td>
<td>7,250 318.3%</td>
</tr>
</tbody>
</table>

* excluding motorway

Source: BASt-report on accidents involving Light Commercial Vehicles (2010)

**Figure 13:** Time series for accidents resulting in injuries to persons involving Light Commercial Vehicles (2.8 t to 3.5 tons) according to the accident location

![Time series chart](image)

**Source:** BASt-report on accidents involving Light Commercial Vehicles (2010)

**Figure 14:** Causes of accidents involving Light Commercial Vehicles that are dependent on the age of the driver in Germany (2008)

![Causes of accidents chart](image)

**Source:** BASt, own calculations
Development of numbers, accident involvement per 1,000 registered vehicles and in-depth-analysis

The continuous increase in the number of Light Commercial Vehicles between 2.8 and 3.5 tons differs considerably from the development in the comparison groups (cf. also Chapter “Introduction”, Figure 10). In the period from 1996 to 2007 (since January 1st 2008 the KBA’s figures no longer include temporarily deregistered vehicles, so that the figures for 2008 are no longer comparable with those of previous years) the numbers increased by 268 per cent from 166,017 vehicles to 605,943. In contrast, the figures for the comparison groups reveal only slight fluctuations.

The numbers represent a decisive parameter for the accident frequency (accident involvement per 1,000 registered vehicles). The accident involvement per 1,000 vehicles for Light Commercial Vehicles between 2.8 and 3.5 tons differs from that of the comparison groups. From 1997 (11 accidents per 1,000 vehicles) it increases significantly to 16 in the year 2001. After that, the accident involvement per 1,000 vehicles decreases continuously and reaches a more favourable level of 12 incidents in the year 2007, only slightly above the 1997 level (Figure 15). In comparison to that, the rate for passenger cars in the year 2007 was 9 cases of accident involvement.

In addition to their numbers, the vehicles’ kilometre performance is also a decisive parameter when determining accident involvement per 1,000 vehicles. The Light Commercial Vehicles of a total weight of up to 2.8 t have already been revealed to have a ca. 40 per cent higher annual kilometre performance compared to passenger cars (Table 1). For Light Commercial Vehicles of the category 2.8 to 3.5 t the figures are almost 80 per cent higher than those for passenger cars. The accident risk for Light Commercial Vehicles is therefore, when based purely on their numbers and number of kilometres driven, rather lower than that of the passenger cars. Overall it is to be established that the significant increase up until 2001 did not continue after 2001 even though the number of Light Commercial Vehicles between 2.8 and 3.5 tons continues to increase significantly. Based purely on the numbers of Light Commercial Vehicles, their accident risk is a little greater than that of passenger cars. If both numbers and number of kilometres driven are taken into account, their risk is lower than that of passenger cars.

The databases of GIDAS, UDV and DEKRA were used for the in-depth analysis. The numbers of passenger cars in the GIDAS database were taken as a comparison group in each case. Only Light Commercial Vehicles with a maximum permitted weight of between 2 and 3.5 tons, where the distance between the front axle and the hip-point is less than 1,100 mm were included in the analysis (values determined by comparing data with manufacturers).

When examining the impact areas one is struck by the fact that there are no noteworthy differences between passenger cars and Light Commercial Vehicles. Neither were any relevant deviations discovered in the analyses of the different databases. In circa 80 per cent of the cases there is just one single impact, whereby collisions with the front of the vehicle occur most frequently (Figure 16).

In accordance with their road usage, passenger cars are the most frequent counterparty in the event of an accident, both with other passenger cars and Light Commercial Vehicles. Their frequency is approximately 50 per cent. In ca. 30 per cent of the cases the vehicles collide with unprotected road users such as pedestrians or cyclists (Figure 17).

An analysis of the GIDAS-data reveals that the speed with which passenger car and Light Commercial Vehicle collide frontally with passenger cars and with Light Commercial Vehicles is almost identical. Significant deviations are found, on the other hand in the collision-induced velocity changes Delta-v. The greater mass of the Light Commercial Vehicles means that the Delta-v is lower in these instances (Figure 18).

In the event of a rear-end collision, the cumulated frequency distribution of the Delta-v values does not reveal any significant differences (Figure 19).

Figure 17: Impact regions of Light Commercial Vehicles and cars involved in accidents

Source: GIDAS + UDV
Passive and Active Safety

Generally speaking, the level of protection in vans, with regard to self-protection, is already at a high level. For example the risk of injury for the passengers of vans is to be assessed as significantly lower than for those in passenger cars. The manufacturers have been investing a good deal of development work in this field for many years now. One also sees that the level of equipment for certain selected safety elements has significantly increased in the past years (Figures 20 and 22). It is striking, however, that the rate of seat-belt use is significantly lower in the case of van passengers when compared to passenger cars. Here it would be quite easy for numerous van passengers to increase their own safety merely by putting on their seat belts for every journey as a matter of principle, thus taking advantage of an instrument of passive safety.
Since 1999, the DEKRA Accident Research Department has been establishing the rate of seat belt use in utility vehicles depending on vehicle type and local situation. Since 2004, the figures for N1-vehicles have been declared separately. In the years of the survey, the quotas were subject to fluctuations, whereby two factors may be clearly read off. The quota of seat belt usage established in the surveys for N1-vehicles is significantly lower than for passenger cars and increases along with the class of road. Whereas, in built-up areas, 63 to 71 per cent put on their seat belts, the figure increases on roads outside built-up areas to 67 to 79 per cent and to 76 to 84 per cent on motorways. Depending on the local situation, these values are between 15 and 20 per cent less than those for passenger cars.

These results can quite easily be brought into line with those of the GIDAS-database. Here, the figure for front-seat passengers wearing seat belts is ca. 80 per cent (ca.16 per cent are unknown). The number of cases classified as unknown in the UDV-data pool is very high. The analysis leads one to expect a somewhat lower quota of seat belt usage (Figure 21). When regarding the severity of the injuries depending on the seat belt usage, the effectiveness of the seat belt as a passive protection element becomes clear. The severity of injuries suffered is influenced significantly. It may also be established that the risk of injury for Light Commercial Vehicle passengers is lower than those of passenger cars (Figures 22).

The differences regarding the risk of suffering distortion of the cervical spine (whiplash injury) in the event of a rear-end collision are also heavy. Whereas this type of injury is suffered by 42.4 per cent of front-seat passenger car passengers wearing seat belts, the figure for Light Commercial Vehicle passengers wearing seat belts is 25 per cent (GIDAS-data). If all (both seat belt wearers and non-seat belt wearers) Light Commercial Vehicle passengers are included in the analysis, the figure is lower again than that.

Possible measures by which the seat belt usage quota may be improved are:

- The training of drivers,
- Increased surveillance and
- Seat-Belt reminders.

**Figure 22: Severity of injuries depending on seat belt usage (inasmuch as this is known)**

<table>
<thead>
<tr>
<th>Injury Level</th>
<th>Car FSO belted</th>
<th>Car FSO unbelted</th>
<th>LDV FSO belted</th>
<th>LDV FSO unbelted</th>
<th>UDV FSO belted</th>
<th>UDV FSO unbelted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninjured</td>
<td>87%</td>
<td>63%</td>
<td>61.1%</td>
<td>50%</td>
<td>63.6%</td>
<td>25%</td>
</tr>
<tr>
<td>Slightly injured</td>
<td>9.4%</td>
<td>25.9%</td>
<td>25.9%</td>
<td>48.5%</td>
<td>63.7%</td>
<td>42.3%</td>
</tr>
<tr>
<td>Severely injured</td>
<td>5.9%</td>
<td>16.7%</td>
<td>25.9%</td>
<td>19.7%</td>
<td>22.3%</td>
<td>25.6%</td>
</tr>
<tr>
<td>Fatally injured</td>
<td>0.8%</td>
<td>0.6%</td>
<td>0.6%</td>
<td>0.6%</td>
<td>0.6%</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

Source: GIDAS + UDV

**Compatibility and pedestrian protection**

In addition to that of one’s own passengers, partner projection also has an important role to play. For example, the safety systems must also be capable of working efficiently in the event of a collision with a Light Commercial Vehicle. If, on the one hand, height differences should lead to either over- or under-running, then not all safety reserves can be exploited. Also, too rigid structures may also increase the risk of injury for the other person involved in the accident, as the latter would have to convert higher energy values. Hereby it is the difference in mass in particular that play an important role.

If it should come to a collision between a passenger car and a Light Commercial Vehicle the risk of injury for the car passengers wearing a seat belt is considerably higher than is the case with Light Commercial Vehicle passengers who are wearing a seat belt (Figure 23). The UDV-figures also bear witness to this circumstance. The number of front seat passengers of passenger cars wearing seat belts is 25 per cent (GIDAS-data). If all (both seat belt wearers and non-seat belt wearers) Light Commercial Vehicle passengers are included in the analysis, the figure is lower again than that.

One of the results is that a common interaction zone in the event of frontal impact is of considerably greater advantage than the extension of ECE-R94/95 (current crash stipulations for frontal or lateral impacts of passenger cars) to include Light Commercial Vehicles. A higher test velocity such as with consumer protection tests would, on the other hand, lead to interventions in the vehicle structure of the Light Commercial Vehicles which would in turn lead to a considerable increase in the risk of injury for more vulnerable accident counterparties – and thus to the majority of accident counterparties.

**Figure 23: Comparison of the severity of injuries to seat-belt wearing front seat passengers of passenger cars and Light Commercial Vehicles in the event of collisions with passenger cars and Light Commercial Vehicles**

<table>
<thead>
<tr>
<th>Injury Level</th>
<th>Car occupants Collision with car (n = 1481)</th>
<th>Car occupants Collision with LDV (n = 174)</th>
<th>LDV occupants Collision with car (n = 288)</th>
<th>LDV occupants Collision with LDV (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIS 0</td>
<td>53.8%</td>
<td>61.1%</td>
<td>5.9%</td>
<td>5.9%</td>
</tr>
<tr>
<td>MAIS 1</td>
<td>34.2%</td>
<td>5.9%</td>
<td>14.3%</td>
<td>80.6%</td>
</tr>
<tr>
<td>MAIS 2</td>
<td>16.3%</td>
<td>2.0%</td>
<td>14.3%</td>
<td>14.3%</td>
</tr>
<tr>
<td>MAIS 3</td>
<td>1.8%</td>
<td>0.9%</td>
<td>24%</td>
<td>24%</td>
</tr>
</tbody>
</table>

Source: GIDAS
In about 30 per cent of the cases examined both in GIDAS and in the UDV-database the counterparty in the collision involving a Light Commercial Vehicle was a pedestrian or cyclist (cf. Figure 17 in Chapter 3). As regards passive pedestrian protection, the form of the front of the vehicle should be taken into account in addition to the rigidity of the structure at the front end. Owing to the different designs of the front of passenger cars and Light Commercial Vehicles the accident kinematics changes enormously. Whereas 56 per cent of the pedestrians who collide with the front of a passenger car land on top of the vehicle, ca. 75 per cent are flung away upon impact with a Light Commercial Vehicle.

As a result of this the relevance of those parts causing injury also differs, which is why the impact with the ground assumes particular importance. According to a study carried out by the Road Traffic Research in Dresden (VUFO) entitled “Scope Extension on Pedestrian Legislation”, 50 per cent of head injuries are to be attributed to the front bumper and to the pedal haunch. The other hand, according to this GIDAS-based study, contact with the front bumper leads to less than six per cent of all injuries.

The different distribution of these injuries in accidents involving passenger cars and Light Commercial Vehicles is illustrated in Figure 24. It is hereby made clear that collisions with a Light Commercial Vehicle have more serious consequences than collisions with a passenger car. Leg injuries are suffered considerably more frequently as a result of collisions between pedestrians and passenger cars.

The findings show that a transfer of the test procedures used for passenger cars to Light Commercial Vehicles cannot lead to any improvements regarding collisions with pedestrians. Suitable test procedures have not been compiled as yet.

**Active safety**

In order to avoid accidents and determine optimisation potential in Light Commercial Vehicles, the circumstances of the accident must be known. In order to arrive at a clear delimitation of the main focal points of accidents involving Light Commercial Vehicles, only those accidents were looked into that had been caused by the Light Commercial Vehicles. In a second step, safety potentials were derived on this basis.

This results in a conservative assessment of said potentials as different systems may, in certain cases, unfold their potential also in Light Commercial Vehicles that are merely involved in accidents but are not the cause thereof.

The safety potentials quoted in the context of the conservative assessment are theoretical maximum values that cannot be achieved in practice. This is indicated already by the methodological assumption of a 100-per cent rate of equipment with the systems in the case of Light Commercial Vehicles. As many years of experience demonstrate, influential factors such as the interaction between human and machine, system deactivation or failure to adapt the driving speed appropriately may also reduce the potential quoted as well as the set function limitations of the systems.

The analysis of all accidents recorded in GIDAS revealed that 4.7 per cent were caused by Light Commercial Vehicles. Four main accident scenarios may be identified within these. Rear-end collisions are the largest group at 30 per cent, followed by accidents when turning into a road or crossing junctions (21 per cent) and driving accidents (17 per cent). Accidents involving reversing are the fourth main accident scenario at six per cent (Figure 25). This sequence could be derived from the accident data of the UDV, as well.
Rear-end collision accidents caused by Light Commercial Vehicles are characterised by driving into a vehicle moving ahead, driving into the end of a tail-back or into a vehicle that has stopped or is stationary due to traffic regulations – at a traffic light, for example. These three types of crashing into the backs of vehicles cover between 85 per cent (GIDAS) and 95 per cent (UDV) of all accidents of this type caused by Light Commercial Vehicles. Technologies that could address these scenarios are not available as yet for Light Commercial Vehicles.

If one assumes the deployment of an assistance systems that supports the driver by the braking process by, for example, identifying two-track vehicles (moving and standing still), warning a driver who responds in an ideal fashion and initiating a partial braking procedure, the analyses of the UDV reveal that ca. 37 per cent of the accidents caused by Light Commercial Vehicles could be avoided. This figure corresponds to nine per cent of all accidents caused by Light Commercial Vehicles in the UDV-data base, i.e. 0.7 per cent of all accidents in the UDV-database.

If one, when regarding this potential, widens the data basis to include those Light Commercial Vehicles which were merely involved in accidents but were not the cause thereof, 43 per cent of the rear-end collisions involving Light Commercial Vehicles could be avoided in the analyses of the UDV. In comparison to the figures quoted above this underlines the conservative character of the method used here of only regarding accidents in which the Light Commercial Vehicle was the major cause thereof. An assistance system in a Light Commercial Vehicle may, occasionally address situations that were not brought about by this vehicle.

A prerequisite for an effective braking procedure as a decisive basis for the avoidance of accidents is the performance of the braking system. Comprehensive comparative tests performed by DEKRA with Light Commercial Vehicles and passenger cars have revealed that the braking deceleration of modern Light Commercial Vehicles are on a similar level.

The turning into a road / junction crossing accidents caused by Light Commercial Vehicles may indeed occupy second place among the main accident scenarios but they are not to be influenced in their entirety by technical measures based upon technologies available today. Here it is rather the awareness of the drivers for these critical situations that should be at the centre of attention.

Vehicle dynamics

17 per cent of the accidents caused by Light Commercial Vehicles are driving accidents. In accordance with the definition the cause of this type of accidents lies in the loss of control over the vehicle. These are mainly cases in which the vehicle leaves its lane either to the left or the right and cases of an unstable driving condition before the initial impact. These could be positively influenced by vehicle dynamics control (ESP) and/or lane change warners. That this does indeed occur in the course of accidents has been revealed by the results of a study carried out by Mercedes. The introduction of ESP as a standard in the Mercedes-Benz sprinter made meaningful before-and-after inspections on the basis of the official statistics possible (Source: Daimler ESP-inspection). It was revealed thereby that it had proven possible to reduce driving accidents with the sprinter by one third with the aid of ESP.

The result of the GIDAS-analysis was that in ca. 50 per cent of all driving accidents caused by Light Commercial Vehicles, the vehicle had been in an unstable condition before the collision. In the data of the UDV, this figure is around 70 per cent. These accidents could be positively influenced by ESP. This represents 7 per cent (UDV) or 8 per cent (GIDAS) of all accidents caused by Light Commercial Vehicles recorded in the databases. This would, according to the analyses of the UDV affected circa 20 per cent of the seriously and fatally injured persons in accidents caused by Light Commercial Vehicles.

An investigation carried out by the University of the Federal Armed Forces Hamburg at the behest of the BASf into the influence of a dynamic handling control system upon the safety of N1-vehicles under various loading conditions confirms in particular the positive effect of a load-dependent ESP handling control. The results reveal, both for loaded and unloaded vehicles equipped with ESP, considerable advantages compared with vehicles without ESP, particularly in driving situations in which obstacles suddenly appear and involving inexperienced drivers. Vehicles not equipped with ESP become, during the most varied of driving manoeuvres, unstable at a significantly earlier point in time and overturn. In addition it was also revealed that dynamic handling controls that react to the mass of the vehicle and its centre of gravity in x-direction make a further contribution to an improvement in driving stability.

Experiments performed by DEKRA with a vehicle not equipped with ESP make it clear how great the influence of the positioning of the load is. The positioning of the load has a greater influence upon the threshold velocity in the VDA-lane departure test than that of the mass of the load itself (Figure 26). The other position of the load results in a lower threshold velocity for the VDA-lane departure test at the same overall load. This knowledge could, particularly with respect to the drivers of older vehicles (not equipped with ESP), help reduce the number of critical driving conditions.

Figure 26: Maximum threshold velocity in the double VDA-lane departure test depending on the load position

<table>
<thead>
<tr>
<th>Load Position</th>
<th>Maximum Threshold Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 km/h</td>
<td>56 km/h</td>
</tr>
<tr>
<td>54 km/h</td>
<td>53 km/h</td>
</tr>
<tr>
<td>51 km/h</td>
<td>49 km/h</td>
</tr>
</tbody>
</table>

Source: DEKRA
Influential factors such as the interaction between human and machine remain high

The driving accident is not only characterised by a pre-collision unstable driving condition, but also by the unintentional departure from the lane. This could be remedied with the aid of lane departure warning system (LDW). In the analysis of the potential of such a system a generic, i.e. perfectly functioning lane departure warning system was considered that would warn the driver if, for example, he or she should unintentionally cross over lane markings at a minimum driving speed of 60 km/h.

The analysis was based upon the following assumptions:

- The initial speed of the van involved is greater than 60 km/h.
- There is at least one visible road marking (when leaving the lane to the side).
- The system is able to recognise all types of white lane markings.
- A perfect driver reacts to the system’s warnings.
- No system function in case of
  - Non-white lane markings,
  - Within roadwork areas,
  - Curves with a radius \(<200\) metres,
  - Evasive manoeuvres
  - Snow-covered road.

The generic lane departure warning system would, according to the analyses, be able to address a maximum of 37 per cent (GIDAS) or 30 per cent (UDV) of all driving accidents caused by Light Commercial Vehicles assuming an ideal reaction on the part of the driver. This represents three per cent (UDV) or six per cent (GIDAS) of all accidents caused by Light Commercial Vehicles registered in the data bases. If one, in the analyses of the UDV-database, broadens the relevant accident types of the data basis, this reveals that, in comparison to the conservative estimate, six per cent of all accidents of which Light Commercial Vehicles were the cause could have been avoided. In some accidents, both LDW and ESP had been activated, the potentials calculated for ESP and LDW may therefore not be added together. From this fact, the application of both systems to the relevant accident data results in an avoidance potential of 76 per cent (GIDAS) or 88 per cent (UDV) for all driving accidents caused by Light Commercial Vehicles. This figure represents in its turn nine per cent (UDV) or 13 per cent (GIDAS) of all accidents caused by Light Commercial Vehicles.

The fourth main accident scenario is reversing. The comparison of other types of vehicle such as passenger cars or Heavy Duty Vehicles reveals, in both GIDAS and the UDV-data, a significant accident rate when reversing for Light Commercial Vehicles. After all, six per cent of the accidents caused by Light Commercial Vehicles can be attributed to reversing. For both Light Commercial Vehicles with rear windows and vehicles without such windows it is the type of accident in which the pedestrian crosses behind the vehicle that occurs most frequently. It is primarily elderly persons (60 plus) who are the victims of such accidents. Rear view camera systems or acoustic warning systems would be helpful here.

It has already been demonstrated that collisions with more vulnerable road users (pedestrians, cyclists) are the second most frequent type of accident after accidents involving Light Commercial Vehicles and passenger cars. The analyses of the UDV reveal that in 22 per cent of the accidents of which the Light Commercial Vehicle is the cause, the counterparty is either a pedestrian (11 per cent) or cyclist (11 per cent). If one examines all accidents between Light Commercial Vehicles and cyclists/pedestrians, this figure rises to 30 per cent. 29 per cent of the accidents thereby occur when the LGV is turning off the road and collides with a cyclist/pedestrian, 28 per cent of the collisions when the pedestrian is crossing the road and 16 per cent of the accidents whilst the LGV is turning into a road or is crossing it and collides with a cyclist/pedestrian. Systems that will, in the future, be able to influence such collisions in a positive manner or indeed avoid them, would have considerable potential and should be discussed in the context of passive measures for the protection of pedestrians and cyclists.
The Human Factor

The analysis of the accident data of the partners involved in this current project did not permit the identification of a dominance of technical topics for increasing further the safety of Light Commercial Vehicles. On the one hand there are deficits in matters of passive safety - in particular regarding partner protection. On the other hand an increase in the safety of Light Commercial Vehicles could be derived from their being equipped with certain driver assistance systems.

It is a fact, however, that in matters of the road safety of Light Commercial Vehicles, it is above all their users and/or drivers that represent a decisive element. However, the aspect of the drivers is something that may only be observed to a limited extent using the tool of accident data analysis. The partners involved are thus subject to certain restrictions within this project. First of all it is striking that the group of Light Commercial Vehicle drivers is a very heterogeneous one and their behaviour is very much determined by their working environment.

The description of this group was the aim of a parallel research project commissioned by BASi concerning measures designed to increase the road traffic safety of Light Commercial Vehicles. Here it is clearly revealed that the figures derived from the accident analyses must always be regarded against the background of the heterogeneous group of users and their working environment in order to be able to conduct a coherent analysis of the causes and in particular to be able to derive expedient measures.

At this point attention is once again explicitly drawn to the fact that, in the following analyses of the behaviour of the driver it was not possible to make any differentiation between the sub-groups (e.g. maximum permitted weight of between 2.8 and 3.5 of the Light Commercial Vehicles. In this respect it cannot be ruled out that the problem group of Light Commercial Vehicles with a maximum permitted weight of between 2.8 and 3.5 tons could reveal other patterns regarding the driver analysis.

General behaviour of the driver

The analysis of the accidents involving Light Commercial Vehicles in the UDV-data base reveals that a clear pattern emerges regarding the type of user and purpose of use of the Light Commercial Vehicle (Figure 27). Only four per cent of the Light Commercial Vehicles causing accidents are to be assigned to the courier-express services. The overwhelming majority of the Light Commercial Vehicles causing accidents (66 per cent) are underway on behalf of crafts businesses, companies and other tradespersons. Within this group, professional journeys of the classic handicraft enterprise dominate with 32 per cent. This partial aspect roughly agrees with the results of a study of the German Insurers’ Institute for Traffic Engineering (VTIV) carried out in the year 2004. At 30 per cent the group of private persons with their own vehicle dominate with 32 per cent. This partial aspect roughly agrees with the results of a study of the German Insurers’ Institute for Traffic Engineering (VTIV) carried out in the year 2004. At 30 per cent the group of private persons with their own vehicle account for a not insignificant share, however.

If the age of the drivers of Light Commercial Vehicles with a maximum permitted weight of between 2 and 3.5 tons is looked into, this reveals that drivers aged between 18 and 24 years have a share of 17 per cent in the data of the German insurers’ accident research. 76 per cent of this age group were thereby responsible for the accidents. The analysis of the BASi from the year 2010 reveals that 77 per cent of the drivers aged between 18 and 24 of Light Commercial Vehicles between 2.8 and 3.5 tons could reveal other patterns regarding the driver analysis.

For the purpose of analysing the aspect of the driver, various characteristics and behavioural patterns of the drivers were examined with the aid of the GiDAS-database. The main focus of attention was thereby placed upon drivers who had been responsible for an accident involving injuries to persons. For example, information pertaining to age, medical history, medication being taken, amount of time spent behind the wheel and driving experience with the respective type of vehicle were looked into. In the assessments, the group of the Light Commercial Vehicle drivers were compared to the drivers of passenger cars and lorries.

Overall, no striking differences could be determined that could not be explained by the fundamental differences in the ways in which the individual groups use their vehicles. One example for this is the annual number of kilometres driven of the vehicle used on the day of the accident (Figure 28). Due to the fact that lorries are mainly used in long-distance traffic, the number of kilometres they drive is correspondingly higher compared to that of passenger cars and Light Commercial Vehicles. Another object of the analysis was the question of the time between the last break and the accident. These analyses, like the other aspects examined in the study, are based upon the questioning of the drivers at the scene of the accident. This revealed that, for both passenger cars and Light Commercial Vehicles, more than half of the accidents occurred less than 30 minutes after the last break or the beginning of the journey (Figure 29). This does not exclude the possibility that tiredness could play its part.

As was to be expected, the time spent by heavy duty vehicle drivers behind the wheel before an accident tends to be a longer period. For all three groups it may be seen that only a small number of accidents resulting in injuries to persons occur after a driving time (without a break) of more than 4.5 hours.

Figure 27: Type of user and purpose of the use of Light Commercial Vehicles causing accidents from 2.0 to 3.5 tons

Figure 28: Annual number of kilometres driven by passenger car, Light Commercial Vehicle and Heavy Duty Vehicle drivers

Figure 29: Time between the last break and the accident
Analysis of the causes of accidents

Using the methods of accident analysis it was possible to reveal that there are main focal points in the misconduct of Light Commercial Vehicle drivers causing accidents. According to an analysis carried out by the BASt in the year 2010 of the involvement of Light Commercial Vehicles in accidents, the most frequent cause of accidents in the case of vehicles between 2.8 and 3.5 tons (19 per cent) is the group "turning off, u-turns, reversing, turning into a road or crossing it and starting off". This is almost equalled by "insufficient safety distance" (18 per cent); after this come the causes "right of way, priority" (14 per cent) and "speed" (13 per cent). On motorways, however, the group "speed" attains a significantly higher value, namely 28 per cent. With the aid of the UDV-data the causes of the accident were determined from the aspect of the causer thereof in each case for the two categories Light Commercial Vehicles (2 to 3.5 t) and passenger cars – not taking into account the type and purpose of the deployment of the vehicle. This was done by analysis of the individual case and in line with the accident causes noted in the accident reports for both accidents on motorways and on country roads. Attention should thereby be paid to the fact that, for each person-involved, several accident causes may be drawn upon simultaneously – for example distraction and insufficient safety distance. Thus it is that, depending on the individual case, the number of causes established may exceed the number of causes registered by the policy. In the case of accidents on motorways (Figure 30), both groups recorded the same order regarding the three most frequent causes of accidents:

<table>
<thead>
<tr>
<th>Accident Cause</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inappropriate speed</td>
<td>31%</td>
</tr>
<tr>
<td>Lack of attention, distraction</td>
<td>27%</td>
</tr>
<tr>
<td>Insufficient safety distance</td>
<td>17%</td>
</tr>
</tbody>
</table>

It can be seen that the accident cause “insufficient safety distance” is 1.7 times as frequent for passenger cars, and yet results, in the case of Light Commercial Vehicles, more frequently to serious accidents by the same factor. The feature “inappropriate speed” is more frequent for Light Commercial Vehicles by a factor of 1.5 and also leads more frequently to serious accidents. On the other hand the feature “lack of attention, distraction” is more than twice as frequent in the case of the passenger car; but results less often in serious accidents. "Alcohol" and “fatigue” are underrepresented in both groups but mostly result in serious accidents. The generally ascertained attention, distraction is more than twice as frequent in the case of the passenger car, more than twice as frequently the accident cause. The cause “lack of attention, distraction” is also twice as frequent on rural roads in the case of the Light Commercial Vehicle. As regards serious accidents the relative number of this type of accident caused by the passenger car is slightly higher. "Insufficient safety distance" is, in the case of the Light Commercial Vehicle, twice as often cited as the cause of accident compared with the passenger car.

According to an analysis carried out by the BASt in the year 2010 of the involvement of Light Commercial Vehicles in accidents, the most frequent cause of accidents in the case of vehicles between 2.8 and 3.5 tons (19 per cent) is the group "turning off, u-turns, reversing, turning into a road or crossing it and starting off". This is almost equalled by "insufficient safety distance" (18 per cent); after this come the causes "right of way, priority" (14 per cent) and "speed" (13 per cent). On motorways, however, the group "speed" attains a significantly higher value, namely 28 per cent. With the aid of the UDV-data the causes of the accident were determined from the aspect of the causer thereof in each case for the two categories Light Commercial Vehicles (2 to 3.5 t) and passenger cars – not taking into account the type and purpose of the deployment of the vehicle. This was done by analysis of the individual case and in line with the accident causes noted in the accident reports for both accidents on motorways and on country roads. Attention should thereby be paid to the fact that, for each person-involved, several accident causes may be drawn upon simultaneously – for example distraction and insufficient safety distance. Thus it is that, depending on the individual case, the number of causes established may exceed the number of causes registered by the policy. In the case of accidents on motorways (Figure 30), both groups recorded the same order regarding the three most frequent causes of accidents:

<table>
<thead>
<tr>
<th>Accident Cause</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right of way/turning</td>
<td>36%</td>
</tr>
<tr>
<td>Inappropriate speed</td>
<td>32%</td>
</tr>
<tr>
<td>Lack of attention, distraction</td>
<td>24%</td>
</tr>
</tbody>
</table>

It can be seen that the accident cause “insufficient safety distance” is 1.7 times as frequent for passenger cars, and yet results, in the case of Light Commercial Vehicles, more frequently to serious accidents by the same factor. The feature “inappropriate speed” is more frequent for Light Commercial Vehicles by a factor of 1.5 and also leads more frequently to serious accidents. On the other hand the feature “lack of attention, distraction” is more than twice as frequent in the case of the passenger car; but results less often in serious accidents. "Alcohol" and “fatigue” are underrepresented in both groups but mostly result in serious accidents. The generally ascertained attention, distraction is more than twice as frequent in the case of the passenger car, more than twice as frequently the accident cause. The cause “lack of attention, distraction” is also twice as frequent on rural roads in the case of the Light Commercial Vehicle. As regards serious accidents the relative number of this type of accident caused by the passenger car is slightly higher. "Insufficient safety distance" is, in the case of the Light Commercial Vehicle, twice as often cited as the cause of accident compared with the passenger car.

<table>
<thead>
<tr>
<th>Accident Cause</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inappropriate speed</td>
<td>31%</td>
</tr>
<tr>
<td>Lack of attention, distraction</td>
<td>27%</td>
</tr>
<tr>
<td>Insufficient safety distance</td>
<td>17%</td>
</tr>
</tbody>
</table>

It can be seen that the accident cause “insufficient safety distance” is 1.7 times as frequent for passenger cars, and yet results, in the case of Light Commercial Vehicles, more frequently to serious accidents by the same factor. The feature “inappropriate speed” is more frequent for Light Commercial Vehicles by a factor of 1.5 and also leads more frequently to serious accidents. On the other hand the feature “lack of attention, distraction” is more than twice as frequent in the case of the passenger car; but results less often in serious accidents. "Alcohol" and “fatigue” are underrepresented in both groups but mostly result in serious accidents. The generally ascertained attention, distraction is more than twice as frequent in the case of the passenger car, more than twice as frequently the accident cause. The cause “lack of attention, distraction” is also twice as frequent on rural roads in the case of the Light Commercial Vehicle. As regards serious accidents the relative number of this type of accident caused by the passenger car is slightly higher. "Insufficient safety distance" is, in the case of the Light Commercial Vehicle, twice as often cited as the cause of accident compared with the passenger car.

According to these figures, on rural roads it is the accident cause “right of way/turning”, for example non-observance of traffic signs governing the right of way, line-of-sight obstruction at junctions by obstacles, other vehicles, trees, etc.) that is dominant in the case of the passenger car (35 per cent). In the case of the Light Commercial Vehicle, this accident cause slips to second place (28 per cent). The further evaluation of the causes of accidents on rural road (not including Federal Motorway) led to the findings summarised in Figure 31.

“inappropriate speed” is, in connection with Light Commercial Vehicles compared to the passenger car, more than twice as frequently the accident cause. The cause “lack of attention, distraction” is also twice as frequent on rural roads in the case of the Light Commercial Vehicle. As regards serious accidents the relative number of this type of accident caused by the passenger car is slightly higher. "Insufficient safety distance" is, in the case of the Light Commercial Vehicle, twice as often cited as the cause of accident compared with the passenger car.

<table>
<thead>
<tr>
<th>Accident Cause</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right of way/turning</td>
<td>36%</td>
</tr>
<tr>
<td>Inappropriate speed</td>
<td>32%</td>
</tr>
<tr>
<td>Lack of attention, distraction</td>
<td>24%</td>
</tr>
</tbody>
</table>

It can be seen that the accident cause “insufficient safety distance” is 1.7 times as frequent for passenger cars, and yet results, in the case of Light Commercial Vehicles, more frequently to serious accidents by the same factor. The feature “inappropriate speed” is more frequent for Light Commercial Vehicles by a factor of 1.5 and also leads more frequently to serious accidents. On the other hand the feature “lack of attention, distraction” is more than twice as frequent in the case of the passenger car; but results less often in serious accidents. "Alcohol" and “fatigue” are underrepresented in both groups but mostly result in serious accidents. The generally ascertained attention, distraction is more than twice as frequent in the case of the passenger car, more than twice as frequently the accident cause. The cause “lack of attention, distraction” is also twice as frequent on rural roads in the case of the Light Commercial Vehicle. As regards serious accidents the relative number of this type of accident caused by the passenger car is slightly higher. "Insufficient safety distance" is, in the case of the Light Commercial Vehicle, twice as often cited as the cause of accident compared with the passenger car.
Increasing awareness and training of the drivers of Light Commercial Vehicles

The analyses of the accident data of the UDV thus clearly reveal that there is a striking tendency on the part of Light Commercial Vehicle drivers to cause accidents on rural roads compared to the drivers of passenger cars. Here, the Light Commercial Vehicles contrast with passenger cars. A main focal point in this respect is the accident cause “speed”. Both the exceeding of the maximum permitted speed on rural roads as well as failure to adapt one’s speed appropriately occur remarkably frequent when compared to the passenger car. Whereby it is only the failure to adapt one’s speed appropriately that is of any great relevance when regarded in the context of all causes.

This problem can only be addressed partially with technical means regarding infrastructure and vehicle technology. Exceeding the speed limit can only be countered by more controls on the part of the police. It is conceivable that ISA-systems (intelligent speed adaptation) built into the vehicle could offer a solution here. However, the more relevant area of inappropriate speed cannot be addressed by vehicle technology infrastructure or by controls. Here, the main focus of activities remains with the awareness and training of the driver of the Light Commercial Vehicle and/or the responsible working environment and company. The driver must be aware that his vehicle, when loaded accordingly, is not comparable to a passenger car, not in its general handling, and in particular not in critical situations.

A further focal point among the causes is “right-of-way/turning” for both the passenger car and the Light Commercial Vehicle. However, infrastructure aspects (such as line of sight obstruction) also play their part in accidents of this type. This should also be taken into account in the context of measures taken to increase the drivers’ awareness. Thus the bundle of measures aimed at the driver comes to the centre of attention and joins the ranks of the bundles of measures described in the other chapters.

It is essential that the environment in which it is intended that a particular measure should take effect should be taken into account. In this respect the crafts business and small companies have revealed themselves to be the dominating problem areas regarding accident occurrence. In view of a lack of quantification of the effects of possible measures in the drivers’ environment in the context of this project it is necessary to continue to establish this aspect in the research landscape. The question remains open as to whether this picture is exactly the same for the sub-group of Light Commercial Vehicles of a total permitted weight of between 2.8 and 3.5 tons.

Driver training

A significant component for increasing traffic safety, in particular with regard to the Light Commercial Vehicle has always been outstanding training and further training programmes of the drivers. The Professional Drivers’ Qualification Act (BKrFQG), valid throughout the EU, does indeed prescribe regular further training programmes “only” for drivers of Heavy Duty Vehicles from a weight of 3.5 tons upwards and buses with room for at least eight passengers. It remains to be discussed, however, whether it would not make sense to extend the BKrFQG to include the drivers of Light Commercial Vehicles. Notwithstanding this it is well worth the while of those operating fleets of Light Commercial Vehicles or for the owners of Light Commercial Vehicles to regularly invest in the training of drivers.

In Germany alone there is a multitude of those offering such training, which are often subsidised by the professional associations, whether in the companies’ operating yards, on training grounds, under real traffic conditions or simulator-supported. The training courses contribute towards recognising dangers in good time, towards avoiding them beforehand as far as possible and, if the worst comes to the worst, towards overcoming them and thus reduce accident frequencies.

Securing of loads

The cause of accidents “inadequately secured loads or vehicle accessories” is indeed contained in the official reporting of the Federal Statistics Office for Road Traffic Accidents in Germany, but plays only a very minor role. In the year 2009, this type of wrongful behaviour on the part of the drivers of goods transport vehicles (all weight classes) was established in connection with 452 serious accidents resulting exclusively in damages to property and with 248 accidents resulting in injuries to persons (of these, five accidents resulting in deaths). By way of illustration: wrongful behaviour on the part of drivers of goods transport vehicles was, all in all, established in connection with 8,870 serious accidents resulting in injuries to persons (of these, 540 accidents resulting in deaths).

As regards the inadequate securing loads as a cause of accidents, however, experts presume a number of unreported cases, as the influence of a load inadequately secured or even not secured at all upon the coming about of an accident is - if at all - very difficult to recognise after the event.

In the case of Light Commercial Vehicles with a superstructure in the form of a closed box or case, the load does not, as a general rule, fall onto the road – at least not if the doors are kept properly closed during the journey. If non- or inadequately secured loads should move about over the loadbearing area, this can be dangerous for those within the vehicle. Other road users are endangered, should accidents be triggered by influences of the cargo upon the driver or the behaviour of the vehicle.
Summary

From the analysis of the accident data of the partners involved in this project no single dominating topic could be pinpointed for increasing further the safety of Light Commercial Vehicles. On the one hand there are possibilities for the further development of passive safety and in particular compatibility. On the other hand an increase in the safety of Light Commercial Vehicles could be derived from the equipping thereof with certain driver assistance systems. Among these are ESP, the emergency braking assistant and the lane departure warning system. These technical aspects are in a position to increase the safety of Light Commercial Vehicles in traffic. A cost-benefit analysis would have to follow in order to be able to make specific recommendations in this matter.

Where it is a question of the traffic safety of Light Commercial Vehicles, it is in particular their driver that represent a defining element. However, an examination of the aspect of the driver and his environment are only possible to a limited extent with the tools of accident data analysis in the context of this project. The class of the Light Commercial Vehicle driver is a very heterogeneous one. According to the accident data of the UDV it was crafts businesses, companies and other professional persons who were the major causes of accidents in connection with Light Commercial Vehicles. The analyses revealed among other things that Light Commercial Vehicle drivers, when compared to passenger car drivers, have a striking tendency to cause accidents on rural roads. In addition to the second most frequent cause of accident, right of way turning, the striking features compared to the private are to be found in inappropriate driving speed as well as lack of attention and distraction. These deficits can only be addressed inadequately with today’s technical measures or controls. Here, the way forward can only be via appropriate measures to increase the awareness of the drivers and their working environment.

It is inasmuch not possible to come to a concluding evaluation and recommenda-
tion covering all possible fields of activity. It should be noted, however, that a further increase in the safety of Light Commercial Vehicles can only succeed in the form of a combination of technical and behavioural adjusting measures.

Attention is drawn at this point to the fact that in all in-depth analyses of accidents in the context of this project, it was not possible to differentiate between sub-groups, in particular the category of Light Commercial Vehicles between 2.8 and 3.5 t. It is therefore not possible to exclude the possibility that this striking group of Light Commercial Vehicles with a maximum permitted weight of between 2.8 and 3.5 t would reveal special patterns of its own regard the statements made in the above.

For this reason among others it is necessary in further studies to analyse this group more closely. A further main focal point of attention should, in future, be placed upon the analysis of the driver’s behaviour and that of his environment. This is because, in contrast to the present detailed analyses of accident data regarding technical aspects the effectiveness of possible measures relating to the driver and his working environment have not as yet been analyzed sufficiently.

In all analyses, however, it should be clear that this group of vehicles is used because of economic considerations. The Light Commercial Vehicle is a utility vehicle, to which it is not possible to apply the same standards as to a passenger car in all respects.

Recommendations: ESP should be built into the vehicles as a standard: optional equipping with an emergency braking assistant and lane departure warning system. These technical aspects are in a position to increase the safety of Light Commercial Vehicles in traffic. A cost-benefit analysis would have to follow in order to be able to make specific recommendations in this matter.

Bibliography


DEKRA Erhebung zur Ausstattung von Kleintransportern nach Herstellerangaben (Internet + Prospektmaterial).


unfallforschung Dresden.

ECE R 94 Reg. 94 – Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a frontal collision.

ECE R 95 Reg. 95 – Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a lateral collision.

ESP-Studie Mercedes (unveröffentlicht).

EU-Projekt IMPROVER (Impact Assessment of Road Safety Measures for Vehicles and Road Equipment), Abschlussbericht Teilprojekt SP2 (final report subproject 2), April 2008.


KBA, Statistische Mitteilungen, Bestand an Kraftfahrzeugen und Kraftfahrzeuganhängern nach zulässigem Gesamtgewicht und Fahrzeugarten, jährlich erscheinend, Flensburg.

statt für Straßenverkehr, Bergisch Gladbach.


Statistisches Bundesamt (StB). Unfallentwicklung im Straßenverkehr, jährlich erscheinend, Wiesbaden.


VDI 2700-16 Ladungssicherung auf Straßenfahrzeugen. Ladungssicherung auf Straßenfahrzeugen bei Transportern bis 7,5 t zGm, Berlin, Beuth Verlag, April 2008.
Imprint

Publisher
VDA
Verband der Automobilindustrie e.V.
(German Association of the Automotive Industry)
Behrenstr. 35
10117 Berlin
Phone +49 30 897842 - 0
Fax +49 30 897842 - 600
info@vda.de
www.vda.de

Design
DANGEROUS. Berlin

Copyright
Verband der Automobilindustrie e.V. (VDA) 2013