1 Status and Trends

1.1 Road accidents in Germany

The number of road accidents decreased for the last 10 years until 2009 – by nearly 2% to 2,313,453 road accidents in 2009. Although there were light increases in single years such as 2004 or 2007, on the long run, accident figures have still decreased. However, the forecast for 2010 once again indicates a further increase in accident figures (2010: 2.34 million road accidents).

The number of road accidents with personal injury has decreased by more than 18% since 2000, resulting in 310,806 road accidents with personal injury in 2009. For 2010 a further decrease of almost 7% to approximately 290,000 injury accidents is expected.

Casualty figures have also decreased, with lower reductions for slight injuries and higher reductions for severe injuries and fatalities. The total number of casualties has decreased by more than 21% from 511,577 in 2000 to 401,823 in 2009. For 2010 a reduction of approximately 5% compared to 2009 has been predicted – to about 380,000 casualties in 2010.

Since 2000, the number of severe injuries has been reduced by 33% to 68,567 seriously injured road users in 2009 and the number of slight injuries has been reduced by 18% to 329,104 slightly injured road users. Fatalities have decreased by 45% from 7,503 fatalities in 2000 to 4,152 fatalities in 2009 – which is the lowest number of fatalities ever recorded by the national road accident statistics. And this positive development will go on. A reduction to approximately 3,750 fatalities has been predicted for 2010.

1.2 Socio-economic costs due to road traffic accidents in Germany

The Federal Highway Research Institute (BASt) calculates the costs of road accidents on an annual basis. The cost of road traffic accidents to Germany’s national economy includes personal injuries and damage to goods.

Due to changes in central parameters of the German accident cost calculation, the costs of personal injuries and damage to goods were redetermined by a research project, in which new calculation models have been developed for all cost components to gain knowledge about the economic losses caused by traffic accidents.

The calculated costs include direct costs (e.g. for medical treatment, vehicle repair/replacement), indirect costs (for police services, the legal system, insurance administration, replacement of employees), lost potential growth (including the shadow economy), lost value added of housework and voluntary work, humanitarian costs, costs of monetised travel time losses due to accidents on motorways. Using the developed calculation model an analysis of very severe injuries and the effect of underreporting on total accident costs could be accomplished.

The calculated total accident costs for 2009 amounted to approximately 30.52 billion Euros.

Furthermore, personal injuries amounted to 13.29 billion Euros. Costs of about 17.23 billion Euros were caused by damage to goods.

1.3 Vehicle population and road performance

Germany, with its 82.3 million inhabitants, is the most populated country in Europe and plays an important role for transit traffic. The number of passenger cars in Germany on 01/01/2008 was 41.2 million. Caused by a change in registration method (without temporary stopped cars), a comparison to the year before is not possible. Traffic intensities on the approximate 12,700 km of federal motorways in 2009 were about 48,800 vehicles per 24 hours on average (ADT).
The ADT of vehicles with a permissible total weight of above 3.5 t was on federal motorways in 2009 about 6,780 heavy vehicles. Figure 2 and 3 show the situation in the year 2005.

The total driving performance of all vehicles in 2009 was preliminary about 699 billion vehicle-km, out of which over 30% took place on the federal motorways alone.

1.4 Automotive IT

Information and communication technologies (ICT) are becoming more and more prevalent in modern life. In the world of transport and traffic, these systems are of greater importance than in earlier times. These systems lead to an upgrade in comfort, environmental protection and road safety.

Moreover, even portable devices are finding their way into cars. This finding is underlined by the fact that today more portable navigation systems are sold than systems provided by original equipment manufacturers.

Smart phones (e.g. iPhones) are offering a constantly growing number of applications in the field of transport and traffic, e.g. navigation services. Some advantages of these systems are – apart from their lower price – that they are not permanently installed, thus easily replaceable, easily upgradeable and updateable, have a greater functionality and can be also used outside the vehicle. Apart from all of these advantages for the user, however, other challenges exist which should be taken in account:

In order to deploy the benefits of portable devices it has to be ensured that they can be safely used by the driver while the vehicle is in motion. In particular portable or nomadic devices are often not specifically...
The “National Platform” is organized by the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) and Economics (BMWi) by a joint office (“Common office on electric mobility”). It is formed by seven working groups, addressing the topics Propulsion Technology (Group 1), Battery Technology (Group 2), Charging Infrastructure and Grid Integration (Group 3), Normative Standards and Certification (Group 4), this group also addresses vehicle safety regulations, materials and recycling (Group 5), Education and Qualification (Group 6), Socio-economic Constraints (Group 7). Each working group involves high-level members from industry (including several CTOs and CEOs from OEMs and suppliers), academia and government.

The “National Platform” published a first mid-term report in November 2010 that further refines the strategy for the “National Development Plan” and defines road maps. It will also be the National Platform’s responsibility to monitor the road maps’ implementation.

2 Research

2.1 Safety of electric vehicles

Electric vehicles do offer advantages over conventional vehicles. They can help to cut local pollutant and greenhouse gas emissions, and they can lower Germany’s dependence on crude oil. This being said, these vehicles also incorporate new technologies that could pose new risks on traffic safety. These aspects need to be adequately addressed parallel to the growing share of electric vehicles. Severe accidents in an early phase would very likely give electric vehicles an image of being unsafe - although this might not be the case and unjustified – and as a consequence the public demand would decrease, in the worst case the breakthrough of electric vehicles into the mass-market would not happen.

One of the issues that is being addressed by the UN ECE and other regulatory bodies and that is also a research topic all over the world is the quietness of electrically-propelled vehicles. This could be a risk for blind pedestrians, but also for other groups of vulnerable road users. On the other hand, even conventional passenger cars have become relatively quiet over the last decade – which was a common wish of all relevant stakeholders in order to cut environmental noise.

German national and regional research as well as European research projects aim at quantifying the risk of those silent vehicles and developing methods beyond sound. The UNECE will very likely propose a first step guideline for approaching vehicle audible systems. These systems are already recommended in Japan and will probably become mandatory in the US as well.

Electric vehicles use relatively high voltages in their power-train and batteries. These voltages could be harmful to occupants (and to a lesser extend or in case of an accident to external persons) if there is no adequate protection. Again, the regulatory bodies develop amendments to today’s safety requirements. For in-use safety and protection against electric shock the corresponding regulation is already updated. For crash and post crash safety the work is in progress. However, various research questions with regard to driving dynamics, compatibility, safe rescue and maintenance still need to be answered.

Specific research questions are for example: how do battery systems behave in the case of an accident, will...
there still be a risk coming from the batteries in the phase of towing after the accident, how could first aiders and rescue workers be efficiently protected from electric and chemical hazards.

The current amendments to regulations for in-use safety and post-crash safety of electric vehicles will be reviewed after research projects have answered these questions.

For now, at least from today’s perspective the first steps have been made for a safe introduction of electric vehicles. And of course the test organizations (like Euro NCAP) and crash test facilities prepare to test electric vehicles with at least the same requirements that today’s vehicles have to fulfill and by taking into account the specific properties of the propulsion system.

2.2 Forward looking safety systems

The positive development in road traffic safety which we could observe in the past decades, is based to a great extent on measures of vehicle safety, especially on those of passive safety. Seat belts, stiff passenger compartments, improved vehicle structures and airbags are the basis of good occupant protection. During the last years further systems were implemented like active or adaptive restraint systems as seat belt pre-tensioners and load limiters. At present it becomes obvious that also forward looking and integrated systems of vehicle safety respectively will play an increasing role in reducing the number of accidents and casualties.

While in the area of vehicle crashworthiness test procedures have been established and refined for years, the technology of accident avoidance is at the beginning of its development. E. g. from the application of forward looking emergency braking systems to passenger cars a high benefit for road traffic safety is expected. Approx. 35 % of the killed vehicle occupants can be assigned to longitudinal traffic accidents. The systems which are under discussion in principle work using three stages. First, in case of an imminent accident the driver should be warned and herewith requested to act in a way such that he can master the situation himself. If he brakes too weakly, the system should automatically increase the braking force just as much as necessary for avoiding the collision. If the driver does not react at all, the system should automatically and maximally brake just before an inevitable impact and thus significantly reduce the impact energy.

Up to now objective and generally recognised test procedures for the described systems do not exist. However, research activities on this item have been initiated and established world-wide between vehicle manufacturers, suppliers and research institutions. Here at the first place, the US the project "Crash Avoidance Metrics Partnership" (CAMP) promoted by the US-American National Highway Traffic Safety Administration (NHTSA) is to be mentioned.

In Europe the research project ASSESS (Assessment of Integrated Vehicle Safety Systems for improved vehicle safety), which is funded in the 7th R&D framework programme by the European Commission aims at developing harmonised and standardised assessment procedures and related tools for frontal pre crash sensing systems. Procedures are developed for driver behaviour evaluation, pre crash system performance evaluation, crash performance evaluation and socio economic assessment. As result a relevant set of test and assessment methods applicable to a wide range of integrated vehicle safety systems is expected.

Figure 5: Test of the crashability of the ASSESS target with propulsion system carried out by BASf

It is planned to carry out a following project called AsPeCSS (Assessment methodologies for forward looking integrated pedestrian and further extension to cyclists safety systems), which focuses on forward looking safety systems that are designed to address pedestrian and cyclist accidents. It is the aim to deliver harmonised test procedures as input for further regulatory and consumer rating activities.

For the development of harmonised test procedures for integrated safety systems all German car manufacturers, the Federal Highway Research Institute (BASI) and the German Insurance Association have got together under chairmanship of DEKRA in the consortium "vehicle frontal safety systems" (vFSS). Based on real accident data test and assessment procedures for pedestrian protection systems and systems for the avoidance and mitigation of rear-end collisions are developed.

The above mentioned projects show that at a lot of national and world wide activities are around the specification of active and integrated safety systems. Now it is a matter of bundling these activities and of using the chance of an early world-wide exchange about the potential benefit of advanced forward looking and in case of an imminent crash braking safety systems, no matter if it is an accident between two cars or between a car and a vulnerable road user.
This includes an agreement of the definition of test procedures for these systems. Therefore, BASt and NHTSA have concluded on April 26th, 2010 in Washington D.C. a memorandum of cooperation. The aim of this cooperation is the exchange of research results and the execution of common analyses between CAMP and vFSS on the named subject.

2.3 Cooperative systems – integration of existing systems

In the past, substantial progress was made in the reduction of road accidents and journey times through the installation of road infrastructure. Various systems both in the fields of traffic safety and efficiency have been installed by the road operators, e.g. traffic control systems or variable message signs.

With the development of Cooperative Systems a new promising technical advancement is disposable. By combining advanced driver assistance systems (ADAS) and established road infrastructure telematics with mobile communication (e.g. WLAN, cellular) new potential is generated to improve the driver’s provision with information regarding traffic safety and efficiency related affairs. This includes higher information density, faster information distribution and improved up-to-dateness.

But the potential rollout of cooperative systems raises various questions from the viewpoint of a road operator. Those concern especially the integration of existing systems as the established implementation of conventional systems was often subject to long term strategy which does not incorporate the complete replacement in short periods.

For this reason an approach is required that accounts for the possible integration of existing systems when deploying Cooperative systems. Since an architecture is supposed to provide the framework for the successful operation of Cooperative Systems it is an obvious choice to add the issues regarding the integration of established systems. With the different viewpoints of an architecture describing the various layers of a system a powerful tool is provided to pioneer the incorporation both technical and organizational.

The entire architecture topic will be addressed in the context of Mandate M/453 towards the European Standardisation Bodies published by the European Commission in 2010. The Federal Highway Research Institute both introduced this issue and will actively contribute to architecture standardization. CEN will consolidate the necessary activities.

2.4 Safety related traffic information

The “ITS Directive”¹ of the European Commission has defined Priority Actions for the development and use of specifications and standards in the upcoming years. One of these priorities is the definition of “data and procedures for the provision, where possible, of road safety related minimum universal traffic information free of charge to users”.

Within the next years, the European Commission will define functional, technical, organizational and service provisions that describe the roles of the various stakeholders and the information flow between them in so-called specifications. A specification for Priority Action “Safety Related Traffic Information” is expected at the end of 2012 and shall include the following:

- the identification and use of a standardized list of safety related traffic events (‘universal traffic messages’) which should be communicated to ITS users free of charge,
- the compatibility and the integration of ‘universal traffic messages’ into ITS services for real-time traffic and multimodal travel

Since 2007, when Germany has held the Presidency of the EU Council, German experts are working on a proposal of the list of safety related traffic events. The challenge is to organize the provision of such an interoperable minimum service amongst all parties involved. There are technical questions to be solved but even more challenging are the business issues. To provide safety-related information free of charge to the end user doesn’t mean that the generation of this information won’t raise cost. This is especially an issue with commercial partners that fulfill a role in the value chain of providing this information, e.g. in the phase of detecting safety related events, or in the phase of sending safety related messages to the end user.

A group of German stakeholders – public and commercial representatives – has made a proposal on a first list of categories of safety related information:

- Category: Information on ghost driver (driving on the wrong lane)
- Category: Information on dangerous road surface
- Category: Information on reduced visibility
- Category: Information on animals / people / debris on the road
- Category: Information on unmanaged road closure

By analyzing the value chains – each step from event detection to message provision – for each of the categories all partners involved were identified. The challenging discussion on sustainable models of cooperation between all parties is still ongoing – also on an European level – and will give a major input on this issue to the legislative process of the European Commission with the framework of the ITS directive.

Implementation of eCall in Germany

The European Commission (EC) attaches great importance to the implementation of eCall, which has been identified as an efficient ITS service that can be deployed in the short term. eCall is a standardized automatic crash notification service for road safety based on the European emergency call number 112. The eCall initiative of the EC is supported by the German Federal Ministry of Transport, Building and Urban Development (BMVBS). Germany has signed the Memorandum of Understanding on eCall during the German Presidency of the EU-Council in 2007.

The member states of the EU are responsible for the implementation on a national level, i.e. to ensure that emergency calls under eCall can be received and followed up by national Public Service Answering Points or rescue coordination centres. In 2009 the German regulation on emergency calls has been updated in order to include eCall.

In 2009 the EC has initiated the European eCall Implementation Platform (EeIP) which aims to push the deployment of eCall on European level. A national German implementation platform has been launched by the German ministry of transport. The national implementation platform brings together all relevant stakeholders and coordinates the implementation activities of the federal states which are responsible for the implementation of eCall in the existing emergency services in Germany. Some of the federal states will be involved in the project HeERO, a pre-deployment pilot study funded by the EC. The pilot study will run from 2011 to 2013 and test the communication infrastructure needed for eCall in the PSAPs.

Currently, the EC is checking whether to deploy eCall on a voluntary basis or a mandatory basis. A decision of the EC is expected by mid of 2011. The further procedure of the eCall deployment in Germany depends on the decision of the EC.

2.5 Freight transport

2.5.1 Action plan freight transport and trial with longer trucks

In the context of the predicted increase in freight transport, the Ministry of Transport Building and Urban Affairs published in 2010 an action plan for freight transport and logistics. For road freight transport the aim is to increase the productivity and decrease the environmental impact. New technologies and an increased use of combined transport are main topics. One proposed measure is the introduction of longer but not heavier articulated trucks in a trial in Germany in 2011. The truck combination length may be increased up to 25.25 m (to load 3 instead of 2 swap bodies or containers) while the gross vehicle weight stays at 40 t or 44 t in combined transport respectively. These trucks should be equipped with the latest generation of driver assistance systems and should fulfill the standard turning circle requirements to avoid any conflict with the road infrastructure. Only specially trained drivers will be allowed to drive these larger trucks and a “street map” where these longer trucks may be operated will be made available by the Federal States. BASt is assigned to conduct in the technical and scientific monitoring of this project.

2.5.2 Lane Departure Warning Systems and Advanced Emergency Braking Systems (AEBS) for heavy duty vehicles

With the regulation (EC) No. 661/2009 of the European Parliament and of the Council concerning type-approval requirements for the general safety of motor vehicles AEBS will become mandatory for heavy duty vehicles and busses. It is expected that the systems contribute to reduce accident figures and accident severity with regard to rear end collisions and departure accidents. These accidents often show a high severity due to the high masses of the vehicles involved. Beginning 1st November of 2013 new types of vehicles and beginning 1st November of 2015 all new vehicles must be equipped. Performance criteria which have to be fulfilled by the systems, however do not exist yet. They are elaborated by an informal group of experts on UNECE-level. Here it is taken into account that the requirements on the one hand could be
fulfilled with existing technology and reasonable costs but on the other hand are thus demanding that traffic safety will of course benefit from the fitment of the systems.

2.6 „BioRID TEG, dummy harmonization“

For several years, work is in progress with regard to develop an improved regulatory dynamic test procedure for head restraints with the aim of mitigation of neck injuries. The dynamic test option in the current GTR No. 7 on head restraints foresees the use of a Hybrid III dummy using the test pulse as described in FMVSS 202a. According to several studies like those from EEVC, the Hybrid III is lacking biofidelity under rear impact conditions and is not humanlike enough for seat or head restraint testing. In consumer test programs like Euro NCAP or IIHS, the BioRID is used for many years for the dynamic assessment of seat performance under rear impact conditions. However, several concerns have been raised about the repeatability and reproducibility of the BioRID. As the anthropometric test device (ATD) is the crucial factor in a dynamic test a suitable dummy needs to be defined for use in regulation. Several studies have shown that out of the available dummies (Hybrid III, THOR, RID3D, BioRID) the BioRID seems to be the potentially best suitable dummy for low speed rear impact seat testing.

Within the framework of the Informal Working Group on a GTR No. 7 on head restraints phase 2 a BioRID Technical Evaluation Group (TEG) has been given the task to improve the BioRID and to develop the necessary specifications and documentation for regulatory purposes. The BioRID TEG started its work in January 2010 and most of the meetings are held as WebEx meetings with some joint face to face meetings with the GTR No. 7 group. The BioRID TEG is chaired by BASt. The TEG has made significant progress and quite a lot of issues have been discussed, investigated further and addressed in the meantime e.g. by technical bulletins released by the dummy manufacturer (now Humanetics after the merging of Denton and FTSS). A drawing package is now available on the UNECE website as well as a new draft certification procedure; a built level check list has been published as well as a PADI (Procedures for Assembly, Disassembly and Inspection). Work is ongoing with the aim of reducing the response corridors during certification and refining the certification procedure. The improvements developed and proposed by the TEG and the new certification procedure are used by Euro NCAP and IIHS, too. The aim is a worldwide harmonized BioRID for testing under rear impact conditions for regulatory purposes as well as consumer testing. A really challenging task of the GTR No. 7 group and the BioRID TEG will be the development of validated injury or seat performance criteria addressing the risk of cervical spine distortions.

A similar work is done by the UNECE Informal Group on Side Impact Dummy Harmonization. The aim of this group is to introduce the WorldSID 5% and 50% percentile as a worldwide harmonized side impact dummy into regulation (and as far as possible into consumer test programs, too). In contradiction to the BioRID, the WorldSID itself has only been used in research up to now and not for consumer testing before. On the other hand, different side impact dummies are used by the contracting parties of the 1998 agreement in their domestic regulations or standards (e.g. ES2, ES2RE, US-SID).

There are also activities around the world with regard to the improvement or further development of frontal impact test procedures under regulatory aspects as well as in consumer test programs. The currently used Hybrid III family which was basically developed in the 70th has several limitations. Having in mind the demographic impact and the findings by European projects like THORAX and COVER, an improved test tool seems to be needed e.g. for a better prediction of the thoracic injury risk. The THOR dummy has a good potential for worldwide harmonization on a frontal impact dummy. However, at this point only two prototypes with the latest upgrade kit are available. If changes in regulations or in consumer programs are planned in a short or midterm range the THOR seems to be some years away for this purpose. Therefore some organizations like BASt are working on other solutions that might be available earlier and which could serve as interim solutions until the THOR will be ready.

Technical solutions like RibEye or THUMPR are now available which can already be used in the Hybrid III. These systems can be mounted on each rib of the Hybrid III rib cage and are able to measure the deflection of the ribs in 2 or 3 dimensions. BASt is currently investigating whether and how these systems can be used for an improvement of injury risk assessment in the thoracic region.

**Advanced dummy technology for assessment of thoracic injury risk**

Analyses of recent accident data show that thoracic injuries are forming the largest portion of severe injuries in motor vehicle collisions. The evaluation of the injury risk to the thorax in frontal motor vehicle accidents is based in current test procedures on the chest deflection measurements in the dummy hybrid III. Several studies have shown the limited biofidelity of this dummy. Furthermore the chest deflection is only measured in one single point of the chest.

BASt is involved in various research activities to address this problem.

A multi-point chest deflection measurement device called RibEye available for the dummy hybrid III is
currently been investigated. With this measurement device it is possible to measure the chest deflection at multiple points of the chest. BASt is investigating if an improved assessment of vehicle safety can be achieved with this kind of advanced measurement system.

The RibEye is also available for the side impact WorldSID dummy (Figure 7), which might also have potential for improved assessment of thoracic injury risk in side impact. This will also be evaluated by BASt in future studies.

![Figure 7: Advanced Chest Deflection Measurement System RibEye integrated in the Dummy WorldSID50%](image)

BASt is also involved in the project THORAX (Thoracic injury assessment for improved vehicle safety) funded by the European commission. The aim of the project is to better understand the mechanism of thoracic injury in frontal impact. For this purpose accident data was analyzed to find the most relevant types of thoracic injury. The two injuries of highest importance were found to be rib fractures and lung injuries. Shoulder injuries and sternum fracture were identified to be of secondary importance.

The research findings of the project will be implemented in an updated design of a dummy thorax, which will be integrated in the advanced dummy for frontal impact assessment THOR (Figure 8).

![Figure 8: An improved dummy chest will be developed in the European research project THORAX and integrated in the THOR dummy](image)

Within the project injury risk curves taking into account user diversity will also be developed. Especially elderly and small female occupants, which have been found to be at high risk for thoracic injury in motor vehicle accident, will be considered.

2.7 Compatibility

Vehicle safety has been improved in Europe with the introduction of legislative and consumer testing. Stronger occupant compartments and improved occupant restraint systems are evident in the higher assessments awarded in the Euro NCAP testing programme. However, in current passive safety tests the role of the collision partner is not considered explicitly.

Previous research supports the conclusion that vehicle-to-vehicle crash performance is worse than single vehicle-to-barrier test performance, even when the collision partner is an identical vehicle model. This unfortunate fact means that new safety features do not perform as well as expected in real world conditions. This behaviour is a function of the incompatibility encountered in the vehicle fleet today.

Based on the work in VC-Compat², 14-31% of fatally injured individuals and 29-52% of seriously injured individuals would be affected by improvements in vehicle compatibility – these are significant figures, particularly when being extended to the EU27. Some early estimates indicate that improved compatibility can reduce the annual cost of traffic injuries for society by € 2 billion per annum.

Although compatibility has been analysed worldwide for years, no final assessment approach was defined which motivates a need to further pursue compatibility research to improve the outcome of a significant proportion of EU road casualties.

France made in 2007 a proposal to amend ECE Regulation No. 94³ and to introduce the PDB (Progressive Deformable Barrier) but the GRSP Informal Working Group of Frontal Impacts (IWG FI)
could not find an agreement between the parties. The IWG FI is still working and trying to set up a new proposal. Germany has made a proposal at the UNECE on the steps forward and the requirements that shall be covered by the frontal impact regulation including the geometric alignment of vehicles’ front structures. At this time the group is waiting for results from projects like FIMCAR and THORAX.

Work package 5 supports the other work packages by numerical simulation. Different kinds of simplified and generic models are developed to use for further studies.

Work package 6 combines the results of the other work packages to establish an assessment approach. Car to car testing as well as the development of a data base which includes previous crash tests is also part of WP 6.

The project includes six research and development work packages.

Work package 1 includes accident analyses and cost benefit analyses. Output is to identify and verify compatibility issues and to perform a methodology which predicts future fleet characteristics.

Work package 2 develops an off-set assessment procedure and is focusing on the PDB. The metric will assess the deformation as well as the homogeneity.

Work package 3 develops a full overlap test together with a metric using load cell wall measurement to address vertical alignment. Currently the FWRB (Full Width Rigid Barrier) and the FWDB (Full Width Deformable Barrier) are considered.

Work package 4 develops a moving deformable barrier assessment procedure. As barrier the PDB will be taken, test speed and trolley mass needs to be defined.

Figure 9: Car-to-car test

In the seventh framework programme the compatibility project, called FIMCAR (Frontal Impact and Compatibility Assessment Research), is establishing an assessment approach for frontal impact, integrating self and partner protection.

The FIMCAR consortium consists of 12 partners which include the important research organizations from Europe as well as seven different car manufactures. Japanese institutes are not an official partner; however an extensive collaboration is ongoing. Harmonization activities include also interaction with GRSP IWG FI and EEVC WG 15. Therefore it is expected that the proposal will be widely accepted.

The project includes six research and development work packages.

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Figure 10: Small family car in full-width deformable barrier test

Based on accident analyses performed different areas of compatibility issues were identified and rated.

Structural Interaction:
FIMCAR has high priority on establishing structural interaction assessments using both a full width and offset test to support alignment and load spreading.

Front End Force / Deformation:
Vehicles must have minimum energy absorption requirements which are likely to be resolved with the combination of a full width and an offset test. Force level issues were rated as lower priority and are unlikely to be resolved.

Compartment Integrity:
FIMCAR will maintain an offset test with sufficient test severity as current levels. Extended accident studies are ongoing to investigate if special actions for small vehicles are necessary. This was also rated as lower priority.

Restraint system
A full width test is proposed to assess restraint system capacity and to address acceleration injuries which were identified as important in accident analysis. A combination of tests is advised for sensor and restraint performance evaluation.

The current status is that a combination of a full width test and an off-set test will be proposed. The different test procedures are under development and needs to be finalized.
The **full width test** will be proposed in order to create a high deceleration pulse. It needs to be decided if the test will be with the full width barrier face or without. Metrics were developed based on the proposal from Japan\(^5\). With these metrics in particular the structural alignment will be addressed to provide a basis for further compatibility issues.

The **offset test** procedure will be proposed in order to test compartment integrity. The PDB barrier face was selected. With the proposed criteria the homogeneity as well as the deformation will be assessed based on barrier deformation plots. Existing ODB will be maintained if PDB cannot meet necessary performance requirements.

The **movable deformable barrier** (MDB) will be developed with a PDB barrier face. The MPDB test can address mass ratio compatibility issues which are probably not fully addressed in the fixed barrier tests. The MPDB is envisaged as a replacement for an offset barrier test.

![Figure 11: A car in a movable deformable barrier test](image)

Within the next months (until September 2012) further steps have to be performed to finalize the assessment procedure.

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\(^2\) Improvement of Vehicle Crash Compatibility through the Development of Crash Test Procedures (VC-COMPAT) - Final Report, GRD2/2001/50083, 15/02/2007

\(^3\) Proposal for draft amendments to Regulation No. 94 - (Frontal collision) http://www.unece.org/trans/main/wp29/wp29wgs/wp29grsp/grsp2007.html

\(^4\) Official website of the FIMCAR Project: http://www.fimcar.eu/project/

\(^5\) Yonezawa, et al., ESV Conference 2009, Summary of Activities of the Compatibility Working Group in Japan


### 2.8 Child safety

#### 2.8.1 Euro NCAP Child Restraint Systems (CRS)

BASt is chairing the Euro NCAP Child Safety Working Group. The group is dealing with a new child protection protocol with the aim to clearly improve consumer information. It shall motivate the CRS industry to develop well performing CRS for smaller children and the vehicle manufacturer to develop robust interfaces with more than one seat in mind. New aspects shall be included such as e.g. misuse. It will be a clear challenge to the vehicle manufacturer to work on the protection of larger children respectively small adults on rear seats. The new protocol should be based on the separation of the CRS assessment from car assessment for smaller children and use existing CRS consumer ratings to identify “best performing child seats”, available on the European market. Within the dynamic Euro NCAP car tests, the young children should be replaced by older children. The Euro NCAP assessment should re-focus on CRS-car interface compatibility, vehicle based assessment and front/side impact dynamic results of older children. Within the scope of the group a protocol was drafted with regard to the interface and vehicle based assessment. The aim is to reflect the ability of a vehicle to transport children in CRS safely. A list of 9 seats, good/ best performing in consumer tests, has been identified for the use in the vehicle assessment. The chosen CRS cover all age groups and all installation methods.

#### 2.8.2 CASPER

BASt is participating in the European project CASPER (Child Advanced Safety Project for European Roads). CASPER wants to develop a full understanding of the circumstances of the transport of children in vehicles and the requirements for the protection of children in the cars. The project takes into account passive and, if possible, active safety as well as sociological aspects. CASPER wants to develop test procedures (including virtual) for different accident-configurations. Proposals will be made for both, child restraint systems and their applications, as well as for devices in the vehicles with regard to their effectiveness for the safety of children in cars. A virtual environment for children (numerical models for child dummies and human models, child protection systems and vehicle restraint systems) will be developed. CASPER is supporting the work of the UNECE/GRSP Informal Group “Child Safety”.

#### 2.8.3 UNECE/GRSP Informal Group “Child Safety”

BASt is also involved in the work of the UNECE/GRSP Informal Group “Child Safety”. The
Group deals with a new regulation for CRS. A step by step approach is implemented. The actual Phase 1 is dealing with ISOFix Integral “Universal” CRS. The new regulation shall include side impact testing, change the actual weight group system to an easier understandable solution, update the test bench, implement Q-Dummies in regulation and give the possibility to have universal rearward facing CRS with ISOFix anchorages. The aim is to enlarge scope of the group, after finalisation of Phase 1, in a second and third phase to other CRS types.

2.9 Research project IMVITER – virtual testing

The acronym ‘IMVITER’ stands for an EU project called “IMplementation of VIrtual TEsting in Safety Regulations”. The main objective of this project is to work out recommendations for the implementation of virtual testing (VT) procedures in existing homologation procedures and the consolidation of advanced VT technologies for this purpose.

The EU project brings together 15 partners from 6 European countries: Automobile manufacturers, regulatory bodies and software developers as well as research institutions. Industry and regulatory bodies work together in order to build up a common vision and common understanding regarding VT in homologation/ regulation. The three-year cooperation started in 2009 and will continue through 2012.

This project is part of a long term process which might lead step by step to a complete “electronic certification”, including full scale vehicles as well as human models instead of crash test dummies under certain safety directives. It is important to address today the technical feasibility, institutional acceptability and economic benefits and cost of enforcing these VT by working on simple cases. Technology development in this field will progressively provide industry and technical centers with more and more realistic and reliable models. This process is illustrated by Figure 12.

The achievement of this objective implies among others, that the accuracy and reliability of the simulation models and related procedures can be assured and rated independently. Thus, one of the obstacles of the use of VT in homologation/ regulation will be addressed: the lack of confidence in simulation tools for homologation/ regulation. The project will support to prove the reliability of these systems under certain safety directives.

The research project IMVITER consists of six technical work packages:

WP1: Identification of potential pilot cases
In WP1 detailed work plans of WP2 and WP3 were defined. Four pilot cases that will be further investigated in the project were selected related to three different safety directives/regulations:
- Towing devices acc. to Directive 77/389/EEC
- Safety-belt anchorages acc. to ECE Regulation 14
- Pedestrian lower leg protection acc. to Regulation (EC) Nº 78/2009
- Pedestrian head protection acc. to Regulation (EC) Nº 78/2009, see Figure 13

WP2: Potential evaluation criteria of VT methods
The focus of this WP is on the definition of evaluation criteria of VT. The required accuracy of the simulation models and procedures must be ensured independently of the modeling process, software tools, computing platform and the performing organization. New correlation criteria will be proposed. Activities to improve predictability of numerical models according to the evaluation criteria requirements will be performed and guidelines for quality and reliability of simulation will be defined.

WP3: Proposals for VT homologation procedure
Based on the flowchart in Commission Regulation (EU) No. 371/2010 (see Figure 14) procedures to implement VT in the selected regulations will be defined in WP3. Hardware tests based regulations will be transferred to virtual test based or combined VT/RT regulations for each pilot case. Questions of liability and accountability are of major significance.
WP4: Implementation of VT on pilot cases
In WP4 the developed VT procedures for homologation/regulation will be applied in order to investigate feasibility and reliability of these procedures”.

Figure 14: Flowchart in Commission Regulation (EU) No. 371/2010

The process used for validations of homologation procedures by public authorities will be analysed. Recommendations will be drafted how VT procedures can be implemented in specific homologation/regulation procedures.

WP5: Cost-benefit analysis
A cost-benefit analysis and assessment will be performed in WP5.

WP6: Potential of VT in safety technologies
In this work package new biofidelic virtual test devices and active and pre-crash systems will be investigated. Currently these systems are tested via physical tests with activated mechanisms, but the activation mechanism and the sensing and actuation are not evaluated. The use of VT can allow evaluating these systems taking also into account a range of possible sensing techniques as well as the actuation mechanics and investigate their behaviour in real world scenarios. Requirements and obstacles to implement this kind of VT in current homologation/regulation procedures and proposals for future procedures will be analysed.

In general IMVITER is investigating the future potential of VT for homologation procedures by analysing how VT could result in cost reductions and increased competitiveness for European car manufacturers by substituting a range of real tests by VT.

2.10 Druid – Driving under the influence of drugs, alcohol and medicines
The use of psychoactive substances such as alcohol, drugs and medicines is a major cause of many traffic accidents in Europe.

The European Commission decided to combat DUI (driving under influence) on the basis of solid research results, launching the integrated project DRUID (Driving under the influence of Drugs, Alcohol and medicines). In this project BASF took the part of coordinator, leading a consortium of 37 partner-institutes from 17 member states and Norway and administrating a total budget of more than 24 Mio €.

Figure 15: DRUID – Driving under the influence of drugs alcohol and medicines

DRUID aims at understanding the role of psychoactive substances as a main factor for traffic accidents. It was decided to conduct epidemiological surveys aiming to overview the actual situation with drug consumption in traffic in Europe; to implement experimental studies on how psychoactive substances impair fitness to drive; to analyze enforcement options; to collect and assess information on the impact of medicines and dispensing guidelines; to evaluate effectiveness of driver rehabilitation and licence withdrawal policies existing in the Member States.

The project is divided in seven Work-Packages (WPs) to cover the whole area of research. Working Groups for special issues were established, crossing WPs such as a toxicology group to establish a uniform and harmonized approach to sampling and analyzing or a conversion factors group, which tries to overcome the problem of using different sample substances (saliva, blood and plasma) in different studies and countries. All DRUID-participants collaborate very closely on a bilateral basis as well as within Work Packages. The range of disciplines within the project is widespread - physicians, pharmacologists, psychologists, toxicologists, methodologists, police officers. An important part of the collaboration is knowledge transfer. E.g. it has to be ensured, that all involved partners can work in compliance with unified standards for toxicological laboratories. In some countries, the appropriate equipment had to be installed and the staff had to be trained accordingly.

7 IMVITER, Description of work, 2009
8 IMVITER, Deliverable D1.4, Detailed description and planning of WP2&3, 2010
Some of the key aspects of the DRUID activities are:

**Experimental and epidemiological studies**

In order to analyze the impact of psychoactive substances on the ability to drive, DRUID employs different methodologies, well established and recognized by the international scientific community. All experimental studies conducted in DRUID have to follow a methodological framework, which assures the comparability of results.

Three main sources of information on the impairment caused by psychoactive substances are used within DRUID. These are epidemiological studies, experimental studies and meta-analyses. Each of these scientific approaches is linked to a specific measurement which reflects the amount of impairment. Epidemiological studies are conducted to obtain information on the prevalence of driving under influence of certain psychoactive substances. Epidemiological data compiled within DRUID contains samples collected from 50,000 drivers and 3,000 injured drivers. Accident rates are calculated for different psychoactive substances.

In experimental studies on several psychoactive substances a standardized driving test is conducted. For this test drivers have to drive on a highway while the lateral position of the car is continuously assessed. Here, amongst others, the amount of weaving is used as a measure for the amount of impairment caused by different substances.

**Enforcement**

Police bodies mainly use oral fluid screening devices for drug enforcement. Such devices have to meet the demands of the everyday police enforcement as well as to be reliable from a scientific/legal point of view. Within the project 13 oral fluid devices were evaluated by police teams; 8 devices have been qualified as promising. From an analytical perspective (sensitivity, specificity, accuracy, negative predictive value and positive predictive value) and in combination with blood tests only three devices were evaluated positively. This means that after completion of ROSITA (2000) and ROSITA II (2005) quality and capacities of devices with regard to specificity and sensitivity were not substantially improved.

Cost-benefit analysis showed that increased drug driving enforcement based on roadside saliva screening is potentially beneficial – especially for countries with lower baseline enforcement level. Yet, if the drink driving enforcement will be decreased for the sake of increasing the drugged driving enforcement, the net benefit for road safety will decrease.

**Classification of medicaments**

DRUID will propose guidelines on prescribing and dispensing medicines that may have an impact on fitness to drive. These guidelines will address health care professionals like physicians and pharmacists. Furthermore, a categorization and labeling system has been developed. This four-step warning system will help health-care professionals to consult patients and patients to make a decision, whether to drive or not under the influence of a certain medicine. Dosage related issues are included into the system as well as the time of intake or the duration of the therapy. All relevant substances on the European market were examined and codified according to the specifications of the new system.

The practicability of the guidelines and the classification system is presently evaluated in a multi-centered study in three European countries.

**Withdrawal and rehabilitation**

The results of the questionnaire implemented in the respective work package confirm that the withdrawal legislation and practices in the EU are very heterogeneous. On the other hand, the set of policies is limited, the differences concern rather the hardness of the deterring approach. A consolidation of legislation would be helpful because the mobility in Europe is a cross-border mobility and requires cross-border approaches to combat traffic offences, including DUI. In DRUID a comprehensive set of data on European rehabilitation schemes has been analyzed and evaluated in order to give recommendations for best practice. The general conclusion is that rehabilitation measures and education might be useful and effective. A longer period of withdrawal of driving license does not necessarily lead to the desired results. It would be reasonable, to take the driver rehabilitation into account, when defining the duration of withdrawal, because rehabilitation may affect driving aptitude positively.

**Dissemination**

Dissemination of the DRUID results is an integral part of the project. One WP deals exclusively with this task. Dissemination takes place on many different levels. Within the consortium the website and meetings are main platforms for knowledge transfer. All deliverables are available for public, as far as they are approved by the Commission. The website offers an opportunity for documents sharing and joint activities during the working process.

The broader public will be separated into five target groups: patients, young drivers, physicians/pharmacists, politicians and the general public. For all these groups the results of DRUID are put to the test and appropriate key-messages will be filtered out. These key-messages will build the base for adequate information materials. For instance, clear
information about thresholds and the compulsory consequences of driving under the influence need to be communicated by public campaigns. Especially young people should be better informed about the risks of driving under the influence and legal regulations should be better communicated.

Relevant institutions and bodies have been involved early in the process (like EMA in the development of a classification system for medicines).

DRUID consortium was deliberately established as an alliance of as much key players in the domain of road safety research, as possible. Besides, as a result of our dissemination activities, all relevant agencies in the world are informed concerning DRUID activities. DRUID consistently informs international partners, e.g. from USA, Australia, Canada bilaterally as well as using platforms like ICADTS/ TIAFT, TRA, Fit-to-Drive Congresses, etc.

Europe could benefit from broad DRUID coverage and from the fact that all DRUID partners have an access to policy makers in their states. DRUID partners inform their national governments on DRUID achievements, and some countries (e.g. Belgium and Norway) have already taken into account the DRUID results while reconsidering their national regulations.

2.11 Fire safety of buses

Although the bus belongs to the safest traffic means, separate accidents can be particularly severe and concern many passengers. Particularly in case of fires a high number of injured and killed persons can be the outcome. Fire safety of buses therefore is of high importance. With the increase of synthetic or plastic materials as a material for the interior equipment of buses and coaches because of their good mechanical properties combined with low weight, the question arises whether the safety level has decreased in case of a fire during the last years - also compared to other means of transport. Because of the combustible and often easy ignitable plastics the main fire load in buses is no longer the fuel but the plastic materials. Besides the flammability of the equipments, the production of smoke, the smoke development and propagation and its toxicity for the people as well as the testing methods and limit values are of interest.

For those reasons a research project is carried out by BAM (Federal Institute for Materials Research and Testing) on behalf of BASt to examine and to develop effective and economically reasonable fire safety requirements for interiors of buses and for fire alarm systems which would improve the current situation and which would lead to amendments of current requirements. In particular, it is taken into consideration whether reasonable fire safety standards from other transport sectors could be transferred to buses. Also the assessment of the toxic potential of combustion products of interior materials in various representative fire scenarios including the derivation of limit values and the development of a proposal for the use of fire and smoke detection systems in buses are part of the project.

Figure 16: Fire of a doubledecker bus

2.12 Milled shoulder rumble strips

In Germany, there are almost 20,000 crashes each year with personal injuries on motorways. At about 20% of these crashes the vehicle was running of the road to the right. Irrespectively the loss of control over the vehicle, due to an inappropriate speed or a conflict situation with another vehicle; a major part of these crashes is caused by inattentiveness or fatigue.

There are several active safety measures to prevent such crashes. One measure, which is running within the whole road network, is the lane departure warning system. So far, not every vehicle is equipped with this system, but the system is foreseen to be mandatory for at least some new HGVs to be registered after November 2015.

Despite the use of lane departure warning systems, the use of milled shoulder rumble strip is discussed. The advantage of milled shoulder rumble strips is, that their effect is independent of the vehicle type. In the framework of a pilot trial along a 35.9 km motorway section it could be shown, that the number of run-off road crashes by leaving the carriageway to the right, was reduced by 43%. Due to this figure, the application of milled rumble strips on motorway shoulders is recommended, especially on route sections, which show a disproportionally high density of the crash type mentioned before.

The effect of rumble strips on rural roads for single-track vehicles is also analysed in the context of an investigation. The handling of bicycles and powered-two-wheelers from the perspective of traffic safety is of particular interest as there is currently only little data present on the behavior when cornering (tilted two-wheeler) and on the general stability riding for long...
straight distances on rumble strips (issues concerning guidance and excitation of self-oscillations).

Figure 17: Rumble strip pilot trial

2.13 Vehicle lighting

Good lighting and visibility are basic prerequisites for traffic safety. It is therefore not astonishing that a lot of stringent regulations cover this field. However accident figures show that the share of motorcycle riders among the casualties does not decrease and that visibility is one contributing factor since the riders are sometimes overlooked by other road users. Another important aspect in the context of lighting is to avoid unnecessary glare which sometimes is a counterproductive side effect of higher luminous intensities.

2.13.1 Conspicuity of Powered-Two-Wheelers

The problem of conspicuity of motorcycles during the day is well known since many years and there are different international proposals to further enhance conspicuity by improvement of the frontal signal pattern of motorcycles – for night- and daytime driving. Conspicuity is one part of the 2BeSafe project (2-Wheeler Behaviour and Safety), which officially started on January 15th 2009. It is a collaborative Project (co financed by EC-FP7/Transport) that basically aims to study the naturalistic driving behaviour of Powered Two Wheeler (PTW) riders in normal and critical riding situations. That includes the interaction between PTW riders and other road users. Its main objective is to target behavioural and ergonomics research, including research on crash causes and human errors, to develop countermeasures for enhancing PTW riders’ safety. It is the world’s first naturalistic riding study involving instrumented PTWs. It comprises 29 partners in 14 different countries in Europe, Israel and Australia, divided among research and academic institutes, end-users associations and industrial partners.

BAST is responsible for improvements in conspicuity and the development and evaluation of recommendations. After the development of design and manufacturing solutions for improving PTW conspicuity, taking into account characteristic driver behaviour in conflict situations, an abstract recognizing pattern for PTWs is defined, enabling other road users (e.g. car drivers) to clearly identify riders. At the end, a proposal for a uniform signal pattern or lamp configuration at the front of all motorcycles and riders will be outlined. Particularly using the findings of the studies on conflict situations, contrived possible lighting arrangements/positions to enhance conspicuity of PTWs during the day and at night are tested in a laboratory setting. For those tasks, experimental motorcycles with different lighting configurations of different colours as well as helmet lights, are used. Figure 18 shows one of the configurations.

Figure 18: T-Design for nighttime, daytime running lights are used as position lamps in this case

2.13.2 Bend (or curve) lighting for motorcycles

The usual lighting arrangement for motorcycles at the present time - the one (or two) driving-beam and passing-beam headlamp(s) - leads to an inadequate illumination of the road while cornering because of the tilt angle of the motorcycle. The improvement of road illumination has been neither investigated for a modified arrangement of the headlamps nor for possible future headlight systems with a compensation of the inclination angle of the motorcycle, and was therefore the subject of the study.
In the research project, done by BASt, two novel bend lighting systems for motorcycles were examined in real traffic situations with the help of volunteers in order to work out the advantages and disadvantages of the systems. Both, a retrofit bend lighting system for motorcycles with two additional headlamps (with driving- and passing-beam) and also a prototype bend lighting system – with some modifications currently available as BMW K1600 GT/GTL - with tilt compensation showed clear advantages in terms of an improved road illumination at night. The range of the spotlight, the illuminated roadway, the direction of the spot following the curve and the compensation of the inclination angle offer many advantages compared to conventional motorcycle headlights. Both systems, in particular the prototype system under examination, produce much less glare for the oncoming traffic and are therefore a contribution to the improvement of road safety. The questioning of the test persons on the basis of the experiments (test rides) showed a clear reduction of the stress perceived by the subjects during the test.

2.13.3 Automatically dipped high beam and rear view mirrors (high-beam assistant)

A project, carried out by Technical University of Darmstadt on behalf of BASt, focused on the reduction of glare by automatically dipping high beam and rear view mirrors. To analyse glare through opposing vehicles a free field test setup had been developed which allowed measuring in a dynamic driving situation. To determine the influence of glare the contrast sensitivity of a driver was used as dependent variable: The higher the glare illuminance, the higher is the absolute threshold of viewing an object. This classical practice was realised with a head-up-display in a car to guarantee the rating of glare in realistic or virtually realistic driving situations. A speech recognition system allowed the driver to evaluate any situation verbally, so he was not hindered too much in his driving and viewing task.

The viewing task was e.g. the estimation of the position of a square relative to a bar repeatedly shown in different positions in the Head-Up-Display (HUD) (see figure 19).

The viewing task was performed while the test person converged to an opposing car with powered high beam. When the test person failed to solve the viewing task, the physical impairment of glare was considered to be intolerably high. A tolerable amount of glare is the impact on the visual system by dipped beams in 50 m distance which is inevitable in normal traffic situations. The same amount of glare with high beam is reached in a distance of approx. 450 m, therefore this is the distance where high beam assistant systems should dip.

Also the psychological glare has been evaluated and most of the test persons wished the other car to dip the high beam at 500 m to 550 m distance.

The HUD viewing task has also been performed to determine the glare of subsequent cars, which is perceived through the driving mirrors (Figure 20). Since this part took place in the laboratory in a static and stylised environment, smaller threshold luminances could be detected by the probands. Obviously the driving task is missing, so a precise transfer into realistic driving situations is not possible. But by this way also small declines in the luminance threshold evoked by little glare illuminances have been measureable. As a result, a realistic specification for any automatically dipping mirror system is to keep the glare illuminance on the driver’s eye under 2 lx. The project results will be partially introduced as amendments to ECE-Regulations in Geneva by Germany.

Figure 19: Visual task with a square to be detected in different positions relative to a bar

Figure 20: Experimental set-up for determining rear glare
2.14 Winter tyre obligation

Since December 2010 -just before the winter period in Germany- the Ministry of Transport Building and Urban Affairs concretised the existing mandatory tyre law (introduced in 2006) of using of winter tyres while driving on roads covered with snow, ice and/or snow mud. Only M+S labeled tyres and snow flake marked tyres may be used under these weather conditions, passenger cars on all 4 tyre positions and trucks only on the drive axles. In the last winter period 85% of the passenger cars were already equipped with winter tyres and nearly all trucks. This measure will increase road safety and will avoid blocked roads in winter time.