Submitted by the expert from Germany

Informal document **GRSG-105-23**
(105th GRSG, 8–11 October 2013
agenda item 7.)

PROPOSAL FOR DRAFT AMENDMENTS TO REGULATION No. 58
Justification for amendments proposed in document GRSG/2013/27

Note: The text reproduced below was prepared by the expert from Germany to inform GRSG about the data and justification to change the requirements for read underrun protection devices on heavy goods vehicles.

I. History of discussions

In 2011 at the 100th session of GRSG Germany presented the official document GRSG/2011/19 to propose a significant improvement of the situation of rear underrun accidents by introducing more demanding requirements for rear underrun protection devices (RUP) on heavy goods vehicles (HGV). The target is to ensure a sufficient level of safety for passenger car occupants, who have a high risk to get severely or fatally injured in case of hitting the rear of a truck or trailer.

At the 101st session of GRSG experts raised some concerns and it was agreed to organise an expert meeting for an exchange of views and for a detailed discussion of the document GRSG/2011/19.

Following the discussions during the GRSG sessions and the expert meeting, Germany has proposed a revised proposal (document GRSG-102-26) taking most of the comments that were made into account. During the 102nd session of GRSG and a follow-up expert meeting, the discussion showed that some Contracting Parties would like to see further clarifications for the German proposal.

As a consequence Germany has announced at the 103rd session of GRSG the objective to perform a cost benefit study analysing the current accident situation and considering the proposals to improve rear underrun protection devices.

At the 104th session the experts of GRSG received a short introduction of the results of the cost benefit study. The study was distributed to the experts after the 104th session.

For the 105th session of GRSG Germany has submitted a revised proposal (GRSG/2013/27) to amend regulation no. 58.

II. Cost benefit study

a) Summary

The UNECE Regulation no. 58 governs the design and installation of rear underrun protection devices on vehicles of categories N2, N3, O3 and O4. Nevertheless, rear-end collisions – especially those involving vehicles of category M1 – with the aforementioned categories of commercial vehicles are characterized by a high level of accident severity. Germany thus submitted a proposal to GRSG suggesting that the regulation be amended. This would include, inter alia, increasing test forces and reducing ground clearance.

Using an injury risk model based on German national accident statistics, it is estimated that these measures could reduce the number of fatalities by 53 to 78 % and the number of seriously injured casualties by 27 to 49 % in such accident constellations, which is equivalent to 20 fatalities and 95 seriously injured casualties per year for Germany. In monetary terms, the benefit would be 35.7 million euros. The costs for the goods vehicles and trailers affected each year would be between 5

and 20 million euros, depending on how the costs are estimated. Thus, the benefit-cost ratio for the proposed measures is between 1.78 and 7.

Related to relevant accidents at EU 27 level based on a CARE database analysis, the benefit is estimated to be higher than in Germany by at least a factor of 7, whereas fleet-dependent costs would only exhibit a factor of 4. Thus, for the European commercial vehicle fleet and the accidents in which they are involved, it can be estimated that the effectiveness at EU 27 level would be at least as high as in Germany.

Against the background of the problems associated with HGV rear underrunning, the question arises as to whether passenger car emergency braking systems can, in the near future, represent an effective and efficient alternative for improving the situation of rear underrun accidents.

For Germany the benefit from introducing an ideal emergency braking system for all passenger cars would be around 842 million euros per year, while the costs for 3 million newly registered vehicles per year in Germany would be between 489 and 917 million euros. This produces a benefit-cost ratio of 0.9 to 1.7. By comparison, improving the Rear Underrun Protection Regulation would prevent 38 % (20 of 53) of the fatalities theoretically addressed by an emergency braking system but would only cause 2 % of the costs of passenger car emergency braking systems.

b) Details

The study undertaken was based on the amendments proposed in document GRSG-102-26. In the analysis mainly the force levels for the test procedure, the ground clearance of the RUP and the distance of the RUP from the rear of the truck or trailer were taken into account.

For the analysis accident data from the years 2002 to 2010 was used. In Germany per year 35 car occupants are killed and 250 seriously injured per average in rear-end collisions with HGV.

Statistics show, that rear-end collisions – especially those involving vehicles of category M1 – with HGV are characterized by a high level of accident severity. The risk for car occupants to be fatally or seriously injured during an impact against the rear of a HGV accounts for more than 60% (in 2011). For comparison: in car-to-car rear-end collisions the risk accounts for 6% (in 2011) and is therefore 10 times lower.

If the impacting vehicle hits the rear of an HGV at a high initial or collision speed, underrunning often results in the unimpeded penetration of vehicle structures at head level, which frequently involves critical injuries to occupants.

With the help of a statistical model, the potential of changed underrun protection to reduce the severity of injuries in the impacting passenger car was estimated. In this case, an ordinal probit model was used. The model establishes a link between the severity of injuries in the impacting passenger car and explanatory variables. For the type of accident under consideration – a passenger car running into the rear of an HGV on a federal motorway – it was assumed that the severity of injuries is essentially dependent on:

- the kinetic energy of the underrunning passenger car;
- the structural interaction between the rear of the HGV and the front of the passenger car.

Arithmetically the effectiveness of the proposed changes in geometry and/or enhanced stability were assumed as reduction in the relevant accident populations. Using this injury risk model, it is estimated that the measures could reduce the number of fatalities by 53 to 78 % and the number of seriously injured casualties by 27 to 49 % depending of the measurements to be taken (only changes in geometry or only changes in test force or changes in geometry and test force).

For the benefit calculation the accident cost unit rates for Germany and the European Union were used. For the costs to update the HGV with an improved RUP the estimated costs from the European research project VC-Compat was used. It has to be mentioned, that the latter costs in VC-Compat are based on estimations made by industry and can therefore be seen as conservative assumptions[1].

Based on the effectiveness calculation, in Germany, the number of fatalities could be reduced by up to 20 and the number of seriously injured casualties by up to 95 per year, with 15 of these being accounted for by potentially improved semi-trailers. In monetary terms, the benefit would be 35.7 million euros. The costs for the goods vehicles and trailers affected each year would be between 5 and 20 million euros, depending on how the costs are estimated.

Thus, the benefit-cost ratio (BCR)for the proposed measures is between 1.78 and 7. The BCR is highest in in the category of heavy semi-trailers and trailers (O4) that are involved in the critical rear-end collisions.

Based on further analysis for the European commercial vehicle fleet and the accidents in which they are involved, it can be estimated – even without a new detailed BCA – that the effectiveness at EU 27 level would be at least as high as in Germany.

In recent years, numerous vehicle manufacturers have rolled out active safety technology in the form of optional driver assistance systems. In premium-price segments, in particular, these radar- and camera-based sensor systems are likely to enjoy a high take-up rate and wider distribution in the future. In the context of HGV rear underrunning, the question arises as to whether emergency braking systems can, in the near future, represent an efficient alternative for improving HGV underrun protection, since they also address rear-end collisions.

The benefit from introducing this system to prevent rear-end collisions would be around 842 million euros per year, while the costs for 3 million newly registered vehicles per year would be between 489 and 917 million euros. This produces a benefit-cost ratio of 0.9 to 1.7. Accordingly, the impact on the national economy would not be totally positive in every case.

Compared with rear underrun protection, the ideal benefit of a passenger car emergency braking system would be up to 23 times higher, because significantly more people are injured (e.g. whiplash) in car-on-car collisions, which are much more frequent. However, improving the Rear Underrun Protection Regulation would, by comparison, prevent 38 % (20 of 53) of the theoretically addressed fatalities, whereas the costs for passenger car emergency braking systems would be up to

[1] The Insurance Institute for Highway Safety (IIHS) performed rear underrun tests at a speed of 56 kph and different overlaps (30% to 100%). One trailer manufacturer re-designed a RUP on a trailer to prevent a medium sized car at 56 kph with 30% from underriding a trailer, while the former design failed this test configuration. The increase in costs and mass estimated by the trailer manufacturer were at most 20 USD and 20 pounds.

50 times higher. In addition, given the likely ratio between the two measures, the “investment risk" of the much larger measure would have to be factored in by an appropriate discounting of the benefit.

III. Document ECE/TRANS/WP.29/GRSG/2013/27

In preparing a new document, Germany has taken comments on board which have been introduced by Contracting Parties and OICA addressing the former proposal in document GRSG/2011/19.

However, the general force requirements have been kept unchanged for most of the vehicles except for vehicle types listed in the proposed Annex 6 of document GRSG/2013/27.

The geometric requirements and here especially the distance of the RUP from the rear of a vehicle have been modified to take the concerns raised by OICA on board.

In general document GRSG/2013/27 includes:

- higher force requirements,
- reduced ground clearance,
- increased section height of the cross-member of the RUP.

Most of the accidents of a car hitting the rear of a HGV resulting in fatally and severely injured occupants occur on motorways, involving mainly HGV with a mass of more than 12 tons and especially articulated trucks.

The problem is the effect that the car is under-riding the rear of the HGV which leads to massive deformation of the passenger car. Very often the frontal crash structures in a car are not activated leading to structural deformation up to the A-pillar which results in injuries to the car occupants.

The proposed amendments derive from analyzing various research activities in the European Community, standardization activities in Canada (GRSP-39-22e), accident data analysis, research tests and the cost benefit study.

For the reduced ground clearance and the increased section height of the cross-member the findings of the European research project VC-Compat (http://vc-compat.rtdproject.net/) on rear underrun protection devices were the basis for the proposal. The project made an investigation on the height of the main frontal crash structures of cars and the height of structures of the underrun protection devices on the rear of trucks and trailers. One of the project recommendations was to reduce the ground clearance of the RUP to 400 mm and to increase the section height of the cross-member to 200 mm.

Document GRSG/2013/27 proposes a ground clearance of 450 mm for automatic leveling suspension systems (pneumatic, hydraulic, hydropneumatic) and 500 mm for suspension systems without automatic leveling. Both measurements are taken when the vehicle is unladen. Under fully loaded condition, the ground clearance will be reduced to approximately 400 to 420 mm for both suspension types. This will perfectly match the frontal crash structures of cars that are in most cases located in an area of 406 to 508 mm ground clearance, also named “Part 581 zone” (FMVSS standard in the US). For this investigation of the geometry of frontal car structures, 55 vehicles representing 61 % of the European sales numbers in 2003 have been measured.

It is also proposed to increase the section height of the cross-member of a RUP up to 120 mm replacing the current height of 100 mm. This leads to advantages for the geometric match of the car front structures and the RUP in case of braking maneuvers of the impacting vehicle. The old requirement would still remain for vehicles with a platform lift due to constraints in the design of such systems.

As most of the relevant accidents of this rear underrun scenario occur on motorways, in 2011 an analyses of the German In-Depth Accident Study (GIDAS) was conducted looking at different parameters but especially the impact speed which is important to get information about the force levels during the impact. Four main scenarios were found (see Fig. 1):

- Scenario 1
  Truck velocity before collision: 0 km/h
  Car velocity before collision: 20 km/h
  No under-ride situation

- Scenario 2
  Truck velocity before collision: 0 km/h
  Car velocity before collision: 50 to 70 km/h
  Under-ride situation

- Scenario 3
  Truck velocity before collision: 40 to 60 km/h
  Car velocity before collision: 80 to 100 km/h
  Under-ride situation

- Scenario 4
  Truck velocity before collision: 80 km/h
  Car velocity before collision: 120 km/h
  Under-ride situation

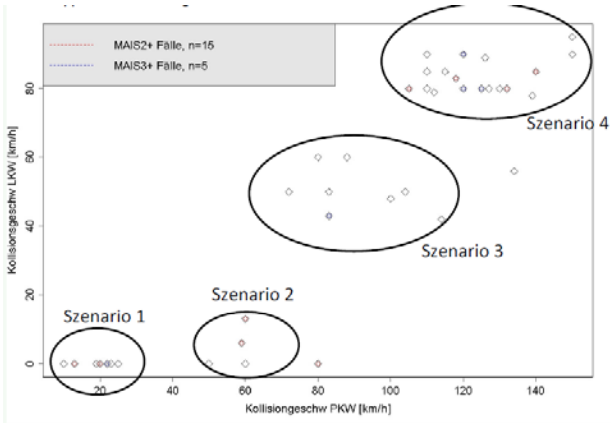

Figure 1: Collision velocities of car (x-axis) and HGV (y-axis) in km/h

The investigation of each case ended with the conclusion that most of the relevant accidents (scenario 2, 3 and 4) show a difference in velocity between the impacting car and the HGV of 40 to 45 km/h.

To have an indication of the force levels during the impact dynamic four tests with 100 % overlap were performed with two vehicle types of the categories small and medium family cars at a test speed of 35 km/h and 56 km/h with each vehicle. For the low speed test the maximum impact force reached 200 kN for the small vehicle and 490 kN for the medium size vehicle. At a speed of 56 km/h the force level went up to 370 kN for the small and 715 kN for the medium size vehicle.

The assumption for the test loads to be applied at the test points P1, P2 and P3 comes from the observation of the accident data showing that a vast majority of accidents happen with an overlap of less than 100 % of the car width. Looking at the geometry of a truck or trailer, the maximum width allowed in the European Union is 2.55 m (see Fig. 2).

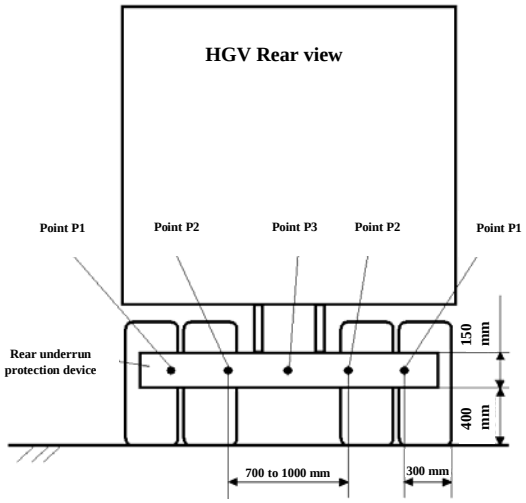

Figure 2: Rear underrun protection device with test points

Taking the width of 1.8 m for an average passenger car shows that for the case of an overlap of less than 100 % only three test points or less on the cross-member of a RUP will be hit. To cover and withstand the forces applied by a car at a speed of approximately 40 to 45 km/h a total maximum force level of 380 kN is proposed for the three test points P1, P2 and P3. The force levels to be applied at the three test points are as follows (GVW: Gross Vehicle Weight):

– P1: 50% GVW (max. 100 kN)

– P2: 85% GVW (max. 180 kN)

– P3: 50% GVW (max. 100 kN)

These force levels in combination with the reduced ground clearance of the RUP can ensure to hold cars back from under-riding the rear of a HGV and will therefore contribute to reduce the numbers of road victims significantly.

To cover current specific technical solutions the proposal made in document GRSG/2013/27 includes a minimum departure angle of 8° for vehicles having a large rear overhang. This ensures that these vehicle types still have access to ferries or loading ramps.

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