

DEVELOPING A CONSUMER SAFETY RATING FOR HEAVY GOODS VEHICLES (HGVS)

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ABSTRACT

In Europe, Heavy Goods Vehicles (GVW>3,500kg, aka trucks), represent around 1.5% of registered vehicles, and about 6% of traffic (vehicle km) but are involved in collisions resulting in nearly 15% of road fatalities. Goods transport is an essential fact of modern life, delivering most of our food and luxuries. This link to standard of living will tend to drive increasing truck use and Vision Zero clearly will not be achieved, unless action is taken to improve HGV safety. Size and mass bring significant difficulty but the challenges are not only technical. Freight transport runs on slim margins. Payload capacity, vehicle uptime, fuel and maintenance bills can all outweigh the latest safety innovation when it comes to vehicle specifications. How can we ensure a rating has influence when the relationship between Euro NCAP and the vehicle buyer will be business to business and not business to consumer? How can we create the market for safety that manufacturers need to allow innovation? One make and model can cover variants from an 18 tonne rigid for urban distribution, through off-road construction vehicles and on to 60 tonne multi-trailer combinations for long haul. How can the rating be applied in a meaningful yet economic way?

This paper summarises several years of work to find the answer to these questions, that has involved analysing collision data, investigating the availability, effectiveness and operational constraints of different technical safety measures that could be promoted, and engaging extensively with road owners, safety organisations, the freight operations industry and the vehicle industry. New and quite stringent regulation of HGV safety is imminent in Europe and this has also been a major consideration. Does this already solve the problems? Is there a need to go further? These questions are considered via a case study of measures intended to protect vulnerable road users

The end result is what we believe to be a globally unique application of the consumer rating approach to solve a complex and multi-faceted problem.

INTRODUCTION

In its roadmap to 2025 [1] Euro NCAP announced its intention to support the development of a truck city safety label. In 2020 the Commercial Vehicle working group was created and began by developing assessments of the ADAS offered on light commercial vehicles <3,500kg. This work has resulted in the world's first Commercial Van Safety Rating. The organisation is now building on that concept to develop a rating scheme for Heavy Goods Vehicles (HGVs) with a maximum permitted mass >3,500kg.

In Europe, Heavy Goods Vehicles (GVW>3,500kg, aka trucks), represent around 1.5% of registered vehicles, and about 6% of traffic (vehicle km) [2] but are involved in collisions resulting in nearly 15% of road fatalities [3]. Goods transport is an essential fact of modern life, delivering most of our food and luxuries. This link to standard of living will tend to drive increasing truck use and Vision Zero clearly cannot be achieved, unless action is taken to improve HGV safety. The issues involved in safe operation of HGVs vary substantially between city and highway environments.

While vans and HGVs have a similar function, to move goods around, they are quite different vehicles, subject to different regulations, and operated quite differently. The size, weight and the ways they are operated present significant technical challenges. Most of the casualties from collisions involving HGVs are those outside the vehicle and not the drivers. Their economic necessity, an extremely competitive freight market with low profit margins, and the structure of the total cost of ownership of an HGV all present significant economic challenges. In light of this, one of the biggest challenges is the method by which Euro NCAP can influence the market. The traditional consumer model, publishing the data, letting mainstream and trade media communicate the results to consumers and relying on them to make the right choices, may not be enough to substantially influence truck purchasing decisions.

This backdrop has meant that in the past vehicle manufacturers have seen a limited commercial market for safety. Innovating and developing new safety systems is a significant risk because if the initial costs are high, or worse, it increases the through life costs in some way, then it can be very hard for cost conscious fleet buyers to justify the investment, at least until such time as there is very strong evidence that the new technology is genuinely effective. As such, Regulation has played a key role in the development of truck safety and the recent Revision of the European Union's General Safety Regulation has imposed significant new safety obligations on HGVs. When the cost is applied to all, it can be more easily passed on to the client and ultimately the consumer because there is no fear that the competition will be cheaper. However, Regulation also has its challenges. It can be slow, prefers a one size fits all approach and this can be problematic in a dynamic and highly varied freight market.

This paper gives an overview of the development of a scheme intended to overcome these challenges and provides a more detailed case study based on one part of the rating to show how the approach varies from Regulation.

CASUALTY PRIORITIES

Euro NCAP Members have produced an analysis of the number and type of road users killed in collisions involving two vehicles or less that occurred between 2017 and 2019, involving a range of different types of vehicles. Five countries are represented (France, Great Britain, Germany, Italy and Sweden). In total over the combined three-year period, this data provided information on 28,452 fatalities from all types of collisions and 3,340 fatalities from collisions involving at least one HGV. Although the relative importance of HGVs in this sample is slightly lower than the EU average (12% compared to EU wide 14%), the patterns within the HGV group are closely representative of the EU as a whole. Casualty groups were identified separately when the collision occurred in an urban area (excluding motorways) and outside an urban area (referred to as extra urban and including all motorways regardless of whether classed as urban or rural). A high level summary of data from collisions where at least one HGV was involved¹ is reproduced below.

¹ Data included all fatalities, regardless of number per collision or road user type, from collisions where at least one HGV was involved, including single vehicle collisions involving just one HGV and no other road user, HGV to pedestrian collisions and collisions with other vehicles. Note that in order to allow precise attribution of impact partners, collisions where 3 or more vehicles were involved were excluded.

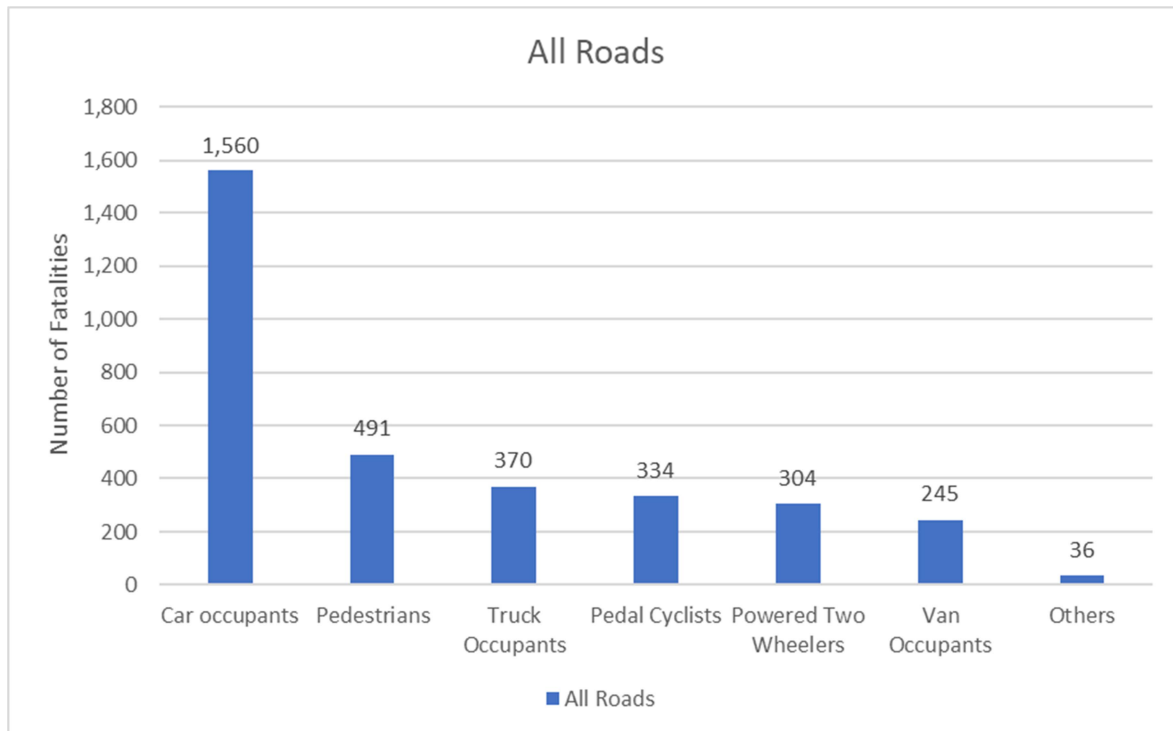


Figure 1: Number of fatalities from collisions involving at least one HGV by road user type killed

When all roads are considered, car occupants are clearly the dominant fatality group, and it can clearly be seen that fatalities from collisions involving trucks are dominated by road users outside of the truck (89%) with truck drivers and passengers representing just 11%. However, the pattern varies strongly when the roads are divided into categories of Urban Roads (City) and rural roads and motorways (Highways).

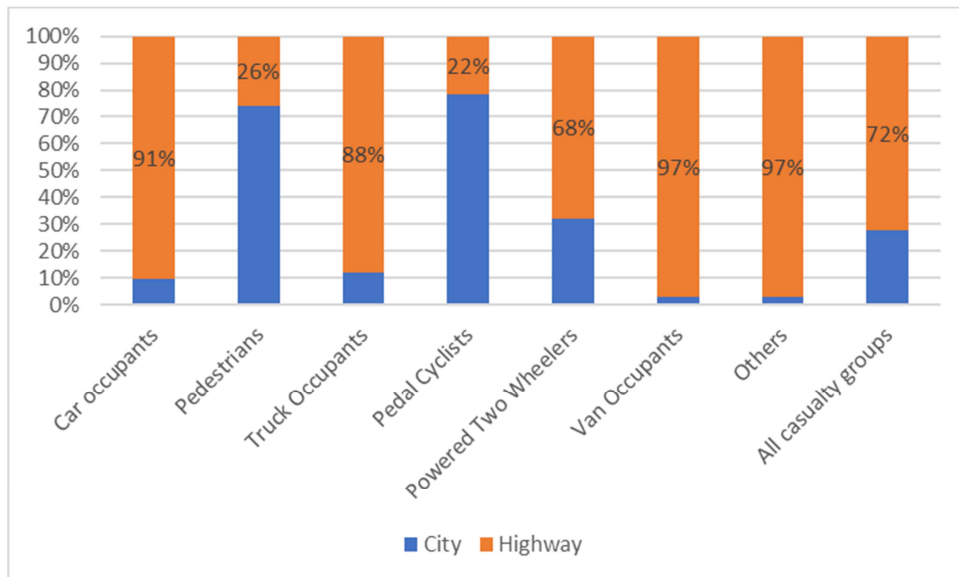


Figure 2: Distribution of fatalities by road user type killed and road environment

Truck collisions resulting in car occupant, truck occupant, and van occupant fatalities are predominantly a highway collision type. Those resulting in pedestrian and cyclist deaths are mainly a city collision type, with powered two wheelers a significant factor in both but mainly highway.

The data underlying these graphs also show that across all areas and casualty types 56% of fatalities involve rigid trucks and 44% tractor semi-trailer combinations.

KEY SAFETY TECHNOLOGIES

Euro NCAP has studied the available evidence about safety features for HGVs and assessed their potential in light of:

- The type of casualties they are intended to prevent (target population);
- System effectiveness (where evidence is available);
- Current and future availability in the commercial vehicle market;
- Opportunity to accelerate or exceed existing and forthcoming regulatory standards.

A brief summary of systems and the planned approach for each is presented below:

- **AEB for vulnerable road users** crossing or moving in the same direction: A large subset of pedestrian fatalities plus a significant number of cyclists are addressed, the crossing collisions mainly in urban areas, the longitudinal ones more often outside of towns. The effectiveness is proven in cars and currently only one HGV manufacturer offers the system.
- **Lane Support Systems:** Address a range of fatalities from different road user groups that occur when an HGV unintentionally leaves its lane, including the HGV occupants in run off road, pedestrians and other vehicle occupants when the HGV drifts onto a hard shoulder on motorways, or other vehicle occupants when they collide with overtaking or oncoming vehicles when drifting out of lane. Effectiveness is proven in passenger cars, there is only a regulatory requirement for simple warning systems in HGVs, and several manufacturers offer more advanced systems as options.
- **Vision:** This targets a sub-set of pedestrian and cyclist fatalities that occur during low speed manoeuvres such as nearside turns (right in EU, left in UK) and aims to decrease blind spots and improve driver reactions compared with seeing hazards in standard mirrors.
- **AEB Nearside Turn Across Cyclist Path:** Addresses part of the same casualty population as vision, but aims to do so even when the cyclist is in places that cannot be seen directly and/or where the driver response still is not the correct one, even if the hazard is available to be seen. One manufacturer offers a system but there is no regulatory requirement.
- **Motion Inhibit:** This addresses the part of those low speed manoeuvring crashes considered by direct vision that involve an HGV moving off from rest. The aim is to prevent forward motion if a VRU is detected ahead of the vehicle. Currently no manufacturers offer a system, though it is understood to be technically feasible.
- **AEB for vehicle front to rear:** Despite forthcoming improvements in the regulation, it is considered higher performance is possible in respect of the higher speeds, partial overlap collisions and driver over-ride.
- **Occupant Status Monitoring:** Inattentive driving is a major contributory factor to serious collisions of all types and HGVs are no exception. Evidence suggests that professional truck drivers experience inattention differently to car drivers, less frequently impaired by alcohol, more frequently by fatigue. However, Euro NCAP has shown with passenger cars that direct driver monitoring can be effective in both mechanisms and similar systems will be mandatory in the EU from 2026. We think there may be scope to encourage earlier fitment and exceed the regulatory standard, particularly in a professional driving context where trials suggest strong benefits from linking to fleet management systems to allow drivers struggling with fatigue to be identified and helped with softer interventions, not just in-cab warning.
- **Crash Compatibility:** The single biggest group of fatalities from collisions involving HGVs is car occupants. There are differences between countries but in many the largest group are killed in head on collisions. A large mass ratio, height differences and stiff structures create incompatibility. Front underrun protection regulations have been in place since 2003 to mitigate but is imperfect and more can be done, particularly where manufacturers offer 'elongated' cabins under new EU weights and dimensions regulations for improving safety and environmental performance. Similar issues occur at the rear of vehicles and less frequently the side.
- **Passive Pedestrian Protection:** This will address the same group of crashes as AEB VRU but in a different way. AEB will not avoid all frontal collisions with VRUs and HGVs are not subject to regulation on their passive pedestrian protection in the ways that cars are. Applying the principles from cars is possible but not straightforward. The near vertical front that many HGVs are designed significantly changes the distribution of injuries, the probability of damaging secondary impacts with the ground and being runover by the wheels and the same test procedures may no longer be appropriate. However, there is scope for encouraging improved shapes and kinematics, as well as energy absorption, particularly near the edges of the vehicle where AEB is less likely to be effective.

- **HGV occupant protection.** HGV drivers represent a substantial minority of fatalities and most frequently occur in a frontal collision with another heavy vehicle, or a single vehicle collision often involving rollover. Regulation demands a minimum standard of cab strength to ensure a basic survival space in simple pendulum tests and seat belts are mandatory. Manufacturers are thought to go beyond this and undertake internal programmes of full-scale crash tests and to some degree the kind of measures seen in cars, like a frontal airbag, are seen in HGVs. But, overall, they appear to remain well behind the best passenger vehicle occupant protection technologies.
- **ISA:** Although ISA will be mandatory in 2024, Euro NCAP protocols will go further, for example, in recognition of implicit speed limits and truck specific limits.
- **ISO 17840 compliant Rescue Sheets** for post-crash safety.

Some of these technologies are ready to go, with test procedures easily transferred from our car scheme, others will take time either for the technologies to develop among the industry and/or for Euro NCAP to develop the assessments.

WHAT ARE THE CHALLENGES

Euro NCAP’s usual audience is the European consumer, a mix of individual personal buyers, lease companies and fleets. Their motivations for choosing a safe vehicle are driven by personal needs and choices. Providing the consumer with clear and simple metrics has proven to be an effective way of stimulating customer demand that, in turn, encourages car makers to introduce innovative safety technology. This strategy is less likely to work for HGV safety, where drivers have little influence, and commercial pressures inevitable mean fuel and maintenance costs are high priority.

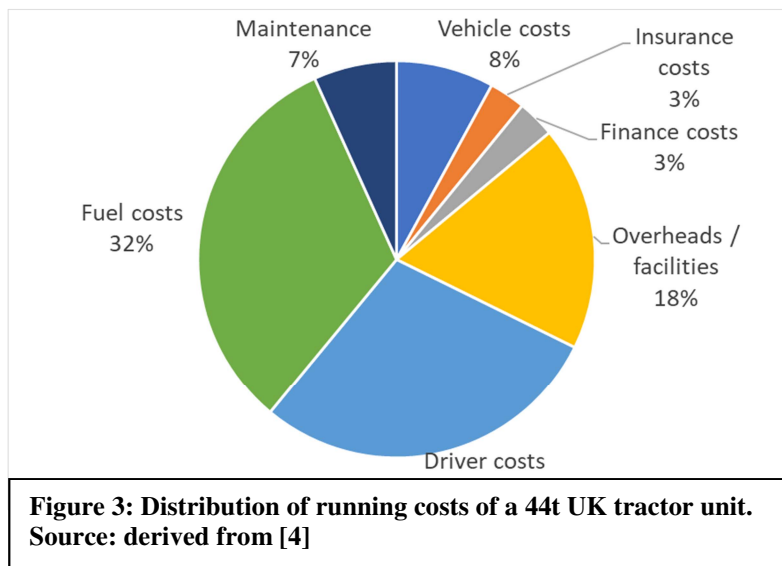
Whilst a fleet manager has a duty-of-care for their drivers, uncertainty over through life costs and reliability of innovative safety or environmental features can encourage a conservative approach to vehicle specifications. Stimulating customer demand for safer vehicles within the freight industry will therefore require a different approach from the simple publication of safety ratings. So how can this be achieved?

Road authorities, particularly those responsible for large cities, have started to take their own action. Low

emissions zones have proliferated and in some cases the approach has been extended to safety. For example, since 2020 London has banned HGVs from entering the city² unless they have a minimum standard of direct vision, or a collection of safety equipment intended to mitigate blind spot collisions. Vienna has also considered but rejected (due to legal concerns) banning trucks from turning right in the city³ unless they are equipped with a “turn assist” system. Austria as a whole, and Germany offer a financial incentive to operators to fit turn assist systems. Barcelona is supporting the fitment of forward collision warning and blind spot information systems on buses. These local schemes clearly influence the vehicle operators in those regions very directly. However, the focus is often on aftermarket technology and the standards applied in different areas vary considerably. This limits the influence such schemes can have on the truck OEMs and major tier 1 suppliers and makes life complicated for international operators shipping goods to different places.

How can we deal with the diversity of vehicles and companies?

HGVs are considerably more expensive than passenger cars, with an average tractor unit costing more than €100k. Their specifications are also extremely customisable so that they can cope with a wide range of applications and most manufacturers take a modular approach to at least some degree. At the most flexible end



² <https://tfl.gov.uk/info-for/deliveries-in-london/delivering-safely/direct-vision-in-heavy-goods-vehicles>

³ <https://ec.europa.eu/growth/tools-databases/tris/nl/index.cfm/search/?trisaction=search.detail&year=2020&num=10&iLang=EN>

of the scale, there are a selection of cab variants, engine variants, gearbox chassis, axle suspension etc. and these can be assembled in almost any permutation the customer wants, leading to many thousands of possible truck specifications. Although vehicles are sold under “model” names, these are not like the models of car as Euro NCAP knows, in some cases they are mainly marketing mechanisms with relatively little engineering meaning.

Autonomous Emergency Braking (AEB) performance can vary slightly for different variants of the same model of passenger car. However, this variation may be much greater for HGV's. The range of basic physical characteristics such as mass, number of axles and brake performance is much larger than for cars and lower sales volumes reduce the ability to economically tune systems to any specific application. For example, a 2 axle 18-tonne rigid with a low chassis height and a 3-axle tractor unit with highline twin bed cab for 44 tonne, 6 axle, long haul operation may both be available under the same “model” name. The extent of the effect of this variation on the performance of each safety feature incorporated in the rating needs careful consideration.

HGVs are often built in multiple stages with the OEM responsible for the chassis cab and another company responsible for constructing the body (e.g. box, curtainsider, tipper etc). While the OEM is responsible for most relevant safety features, the body builder may be responsible for crash compatibility measures (underrun protection) at the side and the rear, elements of lighting etc. These tend to be much smaller companies, often serving a very local market. Similarly, the situation with trailers complicates things. The design and performance of the trailer will influence the performance of some safety systems on the tractor (e.g. combination brake performance) but they also come with their own important safety systems, such as roll stability control, rear and side crash compatibility measures etc. In most countries it would be typical for there to be significantly more trailers in existence than tractor units and they are often seen as low-tech, lower cost assets and may be kept in service for much longer than the HGV.

THE PROPOSED SOLUTION

A new business model

Euro NCAP consider that creating a market where the safest choice of vehicle is also the most profitable choice of vehicle will be critical to success. Euro NCAP cannot achieve this in isolation. Many other stakeholders already have a large safety and economic influence on freight operations. The freight carriers themselves have the key stakes but in a competitive industry they will be strongly focussed on their customer needs, those shipping the goods. Both carriers and shippers will have corporate and social responsibility objectives and providing them with the means to easily embed strong safety improvements in their contracting processes or in-house procedures is an important path to influence. Other than national and international regulations around the use of vehicles, another main factor driving freight industry behaviour is the ability and cost of accessing the road network with their vehicles. Road owners, often but not always local or national public sector bodies, can dictate of at least guide industry behaviours on their specific networks. The aim of the new business model is to target this broad range of professional stakeholders with the safety information that Euro NCAP provides so that they can use it in their local contracting, road pricing, or road access policies as well as freight best practice programmes that already exist in many countries. Direct links with national and local initiatives that have a strong influence on freight operations, combined with a robust, harmonised framework of technical standards, these can create the buying power necessary to generate the demand for safe vehicles that manufacturers need if they are to combine innovation and commercial success.

Euro NCAP's membership is mainly national governments, consumer, and motoring organisations. This new model changes the dynamic and our customers for this information become city authorities, highway authorities, fleet insurers and freight shippers and operators. The aim is that the existence of the Euro NCAP standard can make it easier for authorities to create local schemes comparable to, London's HGV safety permit, or Germany's financial incentives. There is no longer a need to create a bespoke technical measure for each area. In addition to this, it is hoped that authorities will join Euro NCAP as members to identify the safety problems in their jurisdiction that new safety measures could solve. In this way, the rating scheme and the technology roadmap should continuously evolve to meet the needs of the communities affected by HGV operations.

The rating concept

Euro NCAP has identified several aims for its rating concept. It should:

- Create clear and simple ratings applicable to the operating area of each vehicle
- Offer clear indication to fleet managers as to the safest vehicles for their application
- Be relevant to the collision types and environmental problems commonly occurring in each different usage area.

- Appeal directly to the organisations that can promote vehicle safety and sustainability through the use of the Euro NCAP Rating
- Create a pan-European market for safe freight vehicles through an international technical standard and a cooperative model of local and national actions that can help deliver Vision Zero
- Encourage the adoption of zero emission vehicles to address environmental concerns

Euro NCAP already has a safety rating scheme for Commercial Vans in the N1/N2 category that is designed to be relevant to fleet managers and business owners and offers a safety rating in 4 graded areas from Bronze to Platinum. Consistency with this approach is seen as a clear benefit. However, it is also clear to us that our key customers have quite different needs. For cities, it's all about vulnerable road users. Outside of those areas, vehicle occupants are more important. Similarly, with HGVs there is much more dedication of vehicles to specific missions. Yes, some will be general purpose vehicles engaged in many different tasks. However, many will be used depot to depot and never go near a built-up area. Others will spend their whole life distributing goods in cities, and others such as 4 axle rigid tippers might be built for very specific construction or waste purposes and require diverse usage capability covering, off-road sites, rural lanes, motorways and city centres.

One size does not fit all when it comes to trucks, and sustainability should include consideration of economic sustainability too. There is no point encouraging an urban specific safety solution on a truck that never enters an urban area, that would just be a cost without a benefit. But if vehicles without urban safety systems are permitted it is only right to allow cities to try and keep them out of areas where those urban risks are high. This has led to our concept of a dual rating for City and Highway environments. All vehicles will be rated against both sets of criteria. City authorities will link their access restrictions or incentive schemes only to the City rating, motorway authorities to the Highway rating. Freight shippers can choose what is important to them on a contract-by-contract basis. If vehicle operators buy a vehicle for a specific use, they also only need consider the appropriate rating. Only general-purpose vehicles may require good performance in both ratings.

Application of the rating

Creating the scheme is a very significant departure from business as usual, both for Euro NCAP and for the wider freight and vehicle industries. We see “win-win” partnerships as the ideal approach and the plan is to start simple:



- OEM chassis cab evaluation only – no body builder or trailer features
- Include ability to rate vehicles down to VIN level – important enabler of local incentive schemes
- Euro NCAP Membership aim to test each safety feature for at least one high sales volume variant from each manufacturer, in each of 4 freight applications:
 - Long Haul
 - Distribution
 - Construction/waste
 - Utility
- Maximum rating validity of 3 years.

The extent to which industry will be willing to pay to extend their rating to more individual variants of vehicle will depend strongly on the actions of our partners in city and highway authorities around Europe, and how they use the standard to drive vehicle procurement based on the Euro NCAP rating. Expanding this usage rapidly will be a key focus for Euro NCAP.

The Roadmap

The same roadmap process is proposed as has been successfully used in the passenger car rating, to let manufacturers know what is coming in time to design solutions for it. The roadmap targets technologies that are both cost effective and realistic in their implementation over the next few years. The passenger car model started with just three assessment areas and grew over time. A similar evolution is expected. The proposal for certified safe trucks are presented for Cities (top) and Highways (bottom) below.

Table 1: Matrix of roadmap technologies and the casualty groups they affect for City Safety (top) and Highway Safety (bottom)

Casualty Scenario		Weighting*	2024										2027			2030			
			Speed Assistance	AEB Vehicle Front-to-Rear	Lane Support	AEB Vulnerable Road User	Vision	AEB Turn Across Bicyclist Path	Rescue Info, eCall, ...	Occupant Status Monitoring	Motion Inhibit	AEB Reverse	AEB Turn Across Vehicle Path	AEB Head-On	Passive Ped. Protection	Crash Compatibility Front/Side	Occupant Protection		
	Partner protection	Crossing Pedestrian/Bicyclist	50%	●			●	●					●	●					
		In-Lane Pedestrian/Bicyclist	5%	●		●	●									●			
		Turning Across Pedestrian/Bicyclist	10%					●	●					●					
		Reversing Over Pedestrian/Bicyclist	5%					●						●	●				
		Powered Two Wheeler Rider	10%	●	●									●					
		Car/Van Occupant	15%	●	●	●								●	●		●		
		Self	HGV Occupant	5%	●	●	●					●	●						●
	Partner protection	Crossing Pedestrian/Bicyclist	5%	●			●						●						
		In-Lane Pedestrian/Bicyclist	5%	●		●	●									●			
		Powered Two Wheeler Rider	10%	●	●									●					
		Car/Van Occupant	65%	●	●	●								●	●		●		
		Self	HGV Occupant	15%	●	●	●					●	●						●

*Provisional weighting based on EU accident data.

WILL REGULATION DO THE JOB ANYWAY: A CASE STUDY OF VRU SAFETY

Summary of the Regulatory & Market Developments

According to analysis of the collision data for 5 Euro NCAP Member Countries, approximately 34% of all those killed in collisions involving at least one heavy goods vehicles are either pedestrians, pedal cyclists or powered two wheeler riders. The General Safety Regulation has recognised the safety of vulnerable road users in collision with an HGV as a particular problem and three of the 17 new technical measures implemented, specifically target heavy duty vehicles (trucks and buses):

- **UN Regulation 151:** Blind spot information systems, intended to inform the driver of the presence of a cyclist to the nearside of a vehicle in order to prevent a collision if the driver were to turn the vehicle to the nearside across the path of the cyclist. The driver must get a more urgent collision warning if a collision becomes imminent. Compliance will be mandatory for all new registrations in the EU from the summer of 2024
- **UN Regulation 159:** Moving -off information system, intended to inform the driver of the presence of a pedestrian or cyclist immediately in front of the vehicle in order to prevent collisions where the driver may have pulled away from a rest position because they were unable to see the person in a blind spot in front of the vehicle. Compliance will be mandatory for all new registrations in the EU from the summer of 2024
- **UN Regulation XXX⁴:** Direct vision, intended to significantly improve the view through the cab windows so that more vulnerable road users can be seen through the windows, which research suggests results in faster reaction times, compared to seeing the same hazard in mirrors. Compliance will be mandatory for all new registrations in the EU from 2029.

These three regulations represent strong action on specific crash types involving low speed manoeuvres where the truck turns across the path of a cyclist travelling to the nearside of an HGV and where the HGV pulls away from rest when a pedestrian or cyclist is present. Considering the collision data across the EU, the Volvo Truck Safety report [5] shows that these mechanisms are responsible for 20% and 5% respectively of killed and seriously injured (KSI) casualties resulting from collisions between trucks and VRU. The same report shows that a further 30% arise in situations where a VRU, mainly pedestrians, suddenly cross the path of an HGV approaching at moderate to high speed. Similar results have been found in other studies in the UK and Germany [6,7].

Pedestrian AEB is a well-documented mitigation for this more classic ‘crossing pedestrian’ scenario. Thanks to Euro NCAP it is almost ubiquitous on new passenger cars in Europe but only Daimler currently offer a production version on trucks. A comprehensive revision of UN ECE Regulation 131 on AEBS for heavy duty

⁴ At the time of writing this had been adopted by WP.29 but not yet published with an official number

vehicles has been adopted, and at the request of Japan, that included rules for a pedestrian AEB function. These will come into force very soon. However, the General Safety Regulation is primary legislation, the latest revision does not require pedestrian AEB and the next revision is likely to be some years away, so it is not thought likely to be mandatory in Europe for some years yet. This is a very clear gap, where Euro NCAP can continue its leading role in driving the fitment of active safety systems and extend and adapt its requirements to HGVs.

The low speed manoeuvring crashes are a very local phenomenon. Data from London [8] shows a clear difference to the Europe wide figures [5], with some 58% of pedal cyclist and pedestrian casualties involving this mechanism, compared with 30% where the HGV was going ahead at normal traffic speeds.

When GB as a whole was considered [9] 57% of GB pedestrian and cyclist fatalities from collisions involving HGVs turning to the nearside or moving off from rest occurred in just 5 major cities, representing 25% of the population. Thirty seven percent of those fatalities occurred in London alone (15% of GB population).

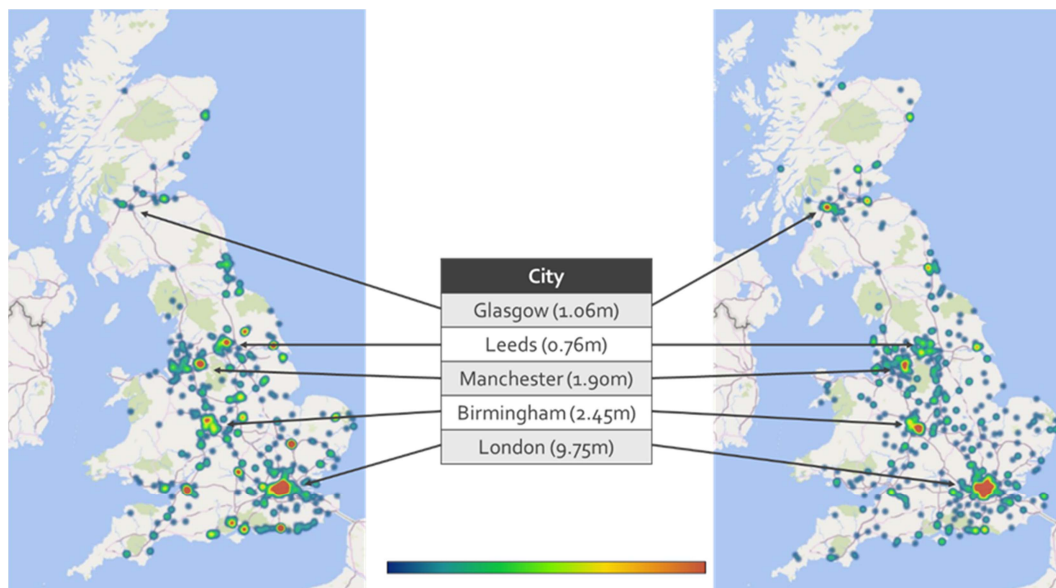


Figure 4: Location of GB collisions between HGVs moving off or turning to nearside and pedal cyclists (left) and pedestrians (right)

This localisation of the problem presented a severe technical challenge to the development of a direct vision regulation. Comparison of the direct vision performance of existing HGVs [10] has shown strong correlation with the height from the ground at which the seat is positioned and, in turn, this is very strongly dependent on operational requirements for ground clearance, engine power, and interior space in the cabin in different circumstances, such as long haul, quarrying, or forestry. A Regulation will affect ALL vehicles regardless of where they end up being used. As such a minimum standard of direct vision that was sufficiently demanding to make a meaningful improvement in the performance of the type of vehicles most commonly used in cities, could potentially impose severe limitations on some important operating characteristics of those that are rarely used in cities.

As a consequence, it took the working group 5 years to develop the regulation and the development was controversial throughout. Reaching a defined limit value involved a new approach, unique to type approval, to try to identify likely vehicle use from design proxies such as GVW, axle configuration, sleeping facilities, engine power etc. This categorised vehicles into three categories by their probability of use in an urban area. It is highly complex and will inevitably be imperfect. The presence of the imperfections also drove additional safeguards that made the technical method of measuring the direct vision more complex, with some unintended design constraints that will only be solved with a subsequent regulatory amendment. That amendment is still work in progress at the time of writing. The agreed limit values, although very demanding for industry to meet with vehicles servicing the most difficult parts of the freight market, still fall a long way short of the best available for urban operations that already exist in the market. Some low-entry cabs have near perfect close proximity views through the windows but are limited in ground clearance and engine power so cannot do all freight tasks.

Other developments have also occurred in parallel with the development of the direct vision regulation

- Regulations 151 and 159 for information systems to alert drivers to the presence of VRUs in close proximity to the vehicles and are subject to relatively high minimum standards of effectiveness, expected to work well in practice. In the case of R151 for nearside turns, the warnings are active in situations where the cyclist is positioned significantly to the rear of the cab at the critical moments the driver needs to see them. They are already visible in mirrors at this time and cannot possibly be seen in direct vision at that time.
- Camera Monitor Systems to replace physical mirrors have become more common and the evidence around their use [5] suggests that with good design they mitigate for initial human factors concerns about distracting glances away from the road and can offer a better view than mirrors in terms of both size and quality.
- Mercedes have brought to market a form of AEB that they call Active Sideguard Assist. The stated function of this system is to act like the Regulation 151 warning systems but to automatically brake the vehicle to a stop to increase the range of collisions it is effective in, by guaranteeing the correct response and requiring less response time than the average driver. A similar approach is technically feasible for moving off from rest collisions, and is perhaps technically simpler, but no manufacturer has yet brought this to market.

It is clear that the benefits of these systems are partially overlapping and partially additive, and even individually, can go further than the Regulations require. None are a silver bullet alone and achieving vision zero may well require all of them.

What will Euro NCAP do differently and how will it help?

Euro NCAPs approach is always led by the analysis of collisions and other relevant data to define the problems, working with technology and the industries producing it to find the solutions, and helping to create the market that makes those solutions financially viable.

The example provided by the Direct Vision is an unusual one, but the 'one size fits all' approach of most Regulation is of at least some issue in many areas of HGV safety and the way in which vehicles are used in some areas of the freight industry, constrain the safety features fitted. This typically results in exemptions, which can be quite wide ranging at in some cases. Electronic Stability Control, AEB, underrun protection are all subject to at least some exemptions, sometimes because of problems that will occur in only small proportions of the total use of those vehicle categories.

Solving this problem is the primary driver in the decision to have a separate City and Highway rating, linkable to the schemes of local authorities such as the London HGV Safety Permit. It is considered far simpler and more effective to consider the constraints or advantages of the different use of vehicles at the point where they are in use, rather than at the point of design. At a crude level, an off-road vehicle operating within and around quarries in remote parts of Sweden will never enter a major city and will have no need for a City Safe rating. However, it is not necessary for either the manufacturer or the authority to identify some feature of the vehicle that accurately identifies its end use in this industry. It is simply up to the buyer of the vehicle to assess whether or not they need a rating and up to the city authorities to decide whether they wish to try to discourage or even prohibit unrated vehicles from entering their territory.

This means that demanding high standards of performance for an urban vehicle will not excessively constrain another area of performance in a long haul or specialist vehicle, providing much more freedom to promote higher levels of performance where it is needed.

The freedom to incentivise higher standards, means that the concerns about improvements to only one side largely disappear, all performance is improved. As such, the technical method used can revert to the simpler part of the regulatory procedure and removes the need for a complex alternative method to avoid unintentional barriers to innovative vehicles. As such, while still being entirely consistent with the regulation, the method can be substantially simpler and start with the floor level set by regulation at 7m³.

The effectiveness of different approaches to vulnerable road user safety will be measured in relation to their ability to reach Vision Zero. Where the same fatalities could be prevented by alternative different measures, appropriate degrees of substitution will be allowed in the rating. As such, the ability of advanced, mirror replacement, camera monitor systems to complement direct vision and the current new technology for AEB turn across cyclist path and future technology for motion inhibit will be packaged in the rating with Direct Vision and will be balanced in a way that allows some degree of flexibility to manufacturers in how they move along the path towards elimination of close proximity manoeuvring collisions. The incentive must be that the

casualties are prevented, not that vehicles must be designed in a certain way. Manufacturers should have freedom to innovate to achieve the goal.

Current gaps in the GSR approach to VRU safety in collisions with HGV will be filled.

- The inclusion of AEB VRU in 2024 and the future development of passive pedestrian protection for 2030 will more than double the total number of VRU casualties that are in scope, and the inclusion of two approaches will improve the effectiveness over time.
- Additionally, powered two wheelers are rarely involved in either the low speed manoeuvring or the crossing collisions mainly targeted by the measures. Analysis of more detailed collision data from France has suggested that one of the most frequent causes of moped/motorcycle casualties in collisions involving HGVs is when the HGV turns across the path of a motorcyclist coming in the opposite direction. AEB technologies to address this situation are roadmapped for 2030. These technologies are only just beginning with passenger cars and the HGV market is lagging substantially behind passenger cars, so it is not expected to be commercially available for some time.

So, in summary, compared with Regulation, the Euro NCAP rating approach will much better reflect the wide variety of different jobs that the freight industry use vehicles for and the local differences in both vehicle usage and crash patterns. This better matching, and acceptance of small niche functions allows the Euro NCAP approach to be implemented much faster than regulation, in some cases with considerably less complexity, responding more quickly to technical changes and being much more flexible about how industry achieve the goals. The same setup allows a common international standard to much better link with proliferating local safety schemes in order to create the demand from the customers buying HGVs that will create a more profitable market for vehicle manufacturers selling safety features, and encourage innovation.

CONCLUSIONS

HGVs are disproportionately represented in the fatality statistics compared with their use. However, their use is, and will continue to be, essential to economic development and well-being.

The paper describes the use of a novel interpretation of the Euro NCAP consumer rating approach that aims to translate the safety transformation that NCAPs around the world have had in the passenger car market, to the commercial vehicle market.

To do this, requires the scheme to go much further than regulation, while simultaneously imposing no more, or ideally less, constraint on vehicle operations and ensuring industry can be both safe and economically sustainable.

The key innovation is to link to a range of local initiatives, such as Transport for London's HGV Safety Permit or financial incentives in Germany or Austria. These can provide the levers that make it profitable for the freight industry to invest in additional safety features. The harmonised technical standard helps create the volume demand that is, in turn, what enables to vehicle industry to innovate and produce the safer vehicles that progress in the car market has proven to be possible.

Making a dual rating based on the type of in-service use (City or Highway) supports the link with authorities that can implement local safety schemes, but also allows the resolution of complex trade-offs that Regulations can find hard to deal with.

Reduced complexity in the application will help Euro NCAP develop and evolve much faster than regulation and allow the standards to be pushed much closer to best practice than is generally possible in an international regulation.

REFERENCES

[1] Euro NCAP, 2017. "2025 Roadmap: In pursuit of vision zero" Brussels: Euro NCAP

[2] Extracted from Eurostat Data <https://ec.europa.eu/eurostat/data/database>

[3] ERSO, 2017. Traffic Safety Basic Facts 2017: Heavy Goods Vehicles and Buses, Brussels: The European Road Safety Observatory supported by the European Commission.

[4] Motor Transport, 2020. Cost Tables, s.l.: <https://motortransport.co.uk/wp-content/uploads/2021/01/Cost-Tables-2020.pdf>.

- [5] Kockum, Ortlund, Ekfjorden, & Wells, 2017. "Volvo Trucks Safety Report 2017". Volvo Trucks Accident Research Team.
- [6] Schindler, R., Jansch, M., Johannsen, H. & Balint, A., 2020. An Analysis of European crash data and scenario specification for heavy truck safety system development within the Aeroflex project, Helsinki, Finland: Proceedings of the 8th Transport Research Arena TRA
- [7] Knight, I. et al., 2017. A Direct Vision Standard for HGVs: Casualty impact analysis for proposed implementation in London, London: Transport for London
- [8] Knight, I., Dodd, M., Robinson, B. & Ainge, M., 2018. HGV Safety Permit for London: Evidence of effectiveness and candidate technical requirements for the safe system, London: Transport for London
- [9] Direct Vision Task Force, 2018. "Summary of justification and proposal for differentiated requirements for N3 vehicles". UNECE working Group GRSG, informal Group VRU-Proxi, Document VRU-Proxi-18-02-Rev1
- [10] Summerskill et al., 2015. Understanding direct and indirect driver vision in heavy goods vehicles: Final report prepared on behalf of Transport for London . Loughborough: Loughborough University, pp. 1-432
- [11] Robinson, Knight, Martin, Seidl, Manning & Eyers, 2016. "Assessing the direct vision performance of Heavy Goods Vehicles (HGVs)". TRL Project report CPR 2277 published by Transport for London.