Direct Vision: Summary of justification and proposal for differentiated requirements for N3 vehicles

1 Introduction

At the 14th VRU-Proxi on May 24th 2020, OICA presented a proposal for a division of the direct vision requirement between vehicles that are more likely to run in cities and vehicles that very seldomly or never enter a city.

- Different direct vision thresholds to apply for the different vehicle groups
- Proposal based on a few basic vehicle characteristics and leveraging a similar division done in the EU CO2 Regulations

The proposal was discussed and refined at various VRU-Proxi and Direct Vision Taskforce meeting during the remainder of 2020. This document is intended to summarise the evidence presented, explain the decision process and to make a final proposal in relation to differentiation.

2 Justification

There can be different reasons for allowing different safety standards on different vehicle types. These can include the technical feasibility or cost of implementing a measure on different vehicle types as well as any differences in the associated benefits when applied to different vehicle types.

2.1 Technical Feasibility

Through the progress of the VRU Proxi working group, OICA has highlighted technical difficulties with achieving high standards of direct vision on some (but by no means all) vehicles, particularly some that undertake defined roles. These are summarised as:

- Long Haul and High Capacity: Vehicles intended for use in long haul transport will carry very high loads, particularly in countries that permit high capacity goods vehicles at more than the standard 40 tonnes. This requires very powerful engines with associated needs for very high cooling capacity. Drivers may need to stay in cabs overnight and may live in the cab for days at a time. Comfort and well being are important in their own right but also become a safety issue if the driver is not well rested or focussed on the driving task. Raising the cab above the engine such that the floor is flat increases the volume of space in the cab for comfort features and eases movement around the cab. Weights and dimensions limits and the economic and environmental need for high productivity means that engines cooling and driver accommodation are all located in the same section of length. Relative mass of components and considerations of vehicle stability and crashworthiness mean that engine and cooling components are always positioned beneath driver accommodation, which can also be maximised in this configuration. This means that long haul or high capacity trucks need considerable height between the chassis and the drivers seating position. One of the main mechanisms for improving direct vision is lowering the height of the driver and cab creating a challenging conflict between operational objectives and direct vision objectives.
- Off road vehicles: Some N2 and N3 vehicles must be capable of operating off-road. There are a very diverse range of applications, including for example, certain fire appliances, mountain rescue vehicles, those used in the military, or quarrying, forestry and construction industries. Many but not all of these will also involve carriage of very dense and heavy loads. However, manoeuvrability constraints will limit the use of high capacity vehicles to certain sectors (e.g. Forestry) and drivers will much more rarely live in the cab for long periods. Productivity considerations remain relevant, though those carrying the most dense loads will not be so

concerned about reserving the maximum permitted proportion of length for load space. As such, the height between chassis and cab can be less than for long haul vehicles. However, vehicles must be able to negotiate very uneven and potentially slippery ground. This requires additional height between the ground and the chassis and requires additional driven axles for improved traction. Thus, the drivers seat position remains high, creating challenges for the provision of high standards of direct vision.

In both of the above cases, if the height of the driving position has to be reduced by more than can be accommodated by clever design, one or more of the parameters driving this choice of configuration must be compromised. Depending on the exact nature of compromises, this may have knock on implications for the wider freight industry and economy that were not considered in the Commission's Impact Assessment.

2.2 Variation in Benefits

Collision analyses in GB and DE showed that the casualties that this safety measure targeted occurred predominantly in dense urban areas. This is illustrated in Figure 1, below.

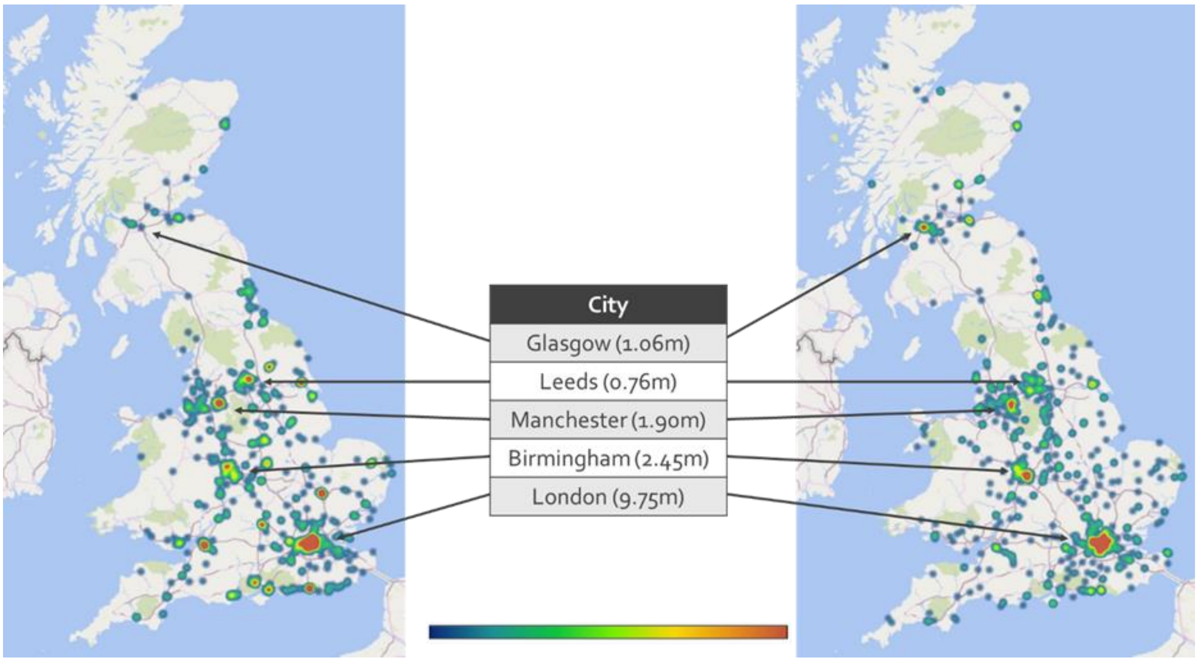

Figure 1: Location of GB collisions between HGVs moving off or turning to nearside and pedal cyclists (left) and pedestrians (right)

The quantitative data behind this presentation showed that 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).

When considering collision data by road type, only 1% of relevant fatalities occurred on high speed major roads typically used for inter-urban travel. 97% occurred on roads classified as urban. It is, therefore, very clear that the vast majority of the benefits of direct vision only occur on a localised basis. Vehicles that never travel in those locations will not benefit vulnerable road user safety as a consequence of the proposed changes to direct vision. However, these data cannot confirm whether there are any vehicles that truly never use urban roads and no regulatory restrictions exist to completely exclude any class of vehicle from all urban roads.

2.3 Analysis

It is clear that there are design challenges with very large improvements to direct vision for some specific types of vehicle and that these have the potential for compromising operational characteristics if the magnitude of improvement required for certain types of vehicles exceeds the improvement that clever design solutions can deliver. It is also clear that the benefits of improved direct vision are not generalised across the whole road network. There are road types where the target collision types very rarely occur. Nominally the vehicles that are challenged by direct vision would not be expected to be commonly used in dense urban areas where the collisions occur. This suggests strong potential for a differential approach.

However, the factors that affect both the vehicle limitations and the potential benefits are effectively operational characteristics. Type approval regulation can only directly control parameters related to vehicle design and construction. This creates challenges in accurately identifying in vehicle approval, the most appropriate performance level for each vehicle.

Although freight vehicles are much more segmented in their use than passenger cars, there are relatively few legal access restrictions limiting the use of any type of vehicle in urban areas. Weight limits are applied on specific roads but this is most commonly related to structural strength of infrastructure rather than risk of collisions with VRUs. London's access restrictions in relation to vehicle safety performance is thought to be currently unique. As such, there is a risk that some vehicles identified as benefiting less from direct vision, may in fact enter high risk urban areas and get involved in collisions.

In theory, analysis of collision data should quantify this risk. Consideration of GB data was able to show that 26% of potentially relevant pedestrian fatalities and 13% of pedal cyclist fatalities involved an articulated HGV of 40t or more GVW. Articulated HGVs at that weight can often all be thought of as "long haul" vehicles. In fact, they will be used in a wide range of applications and many will have a driving position much lower than those vehicles specifically intended for the longest haul operations. Similarly, the GB collision data can identify that 23% of potentially relevant pedestrian fatalities and 39% of potentially relevant cyclist fatalities involve a 4 axle rigid vehicle. These are often found to be tippers or concrete mixers commonly used in the construction industry. However, this does not automatically mean that these are off road vehicles likely to find improvements to direct vision more technically challenging.

What this data cannot tell us is the relevant risk for sub-categories of these vehicles. So, it remains unknown whether the number of collisions occur because of a moderately high exposure (frequent urban use) to the risk from, for example, regional distribution articulated vehicles, or on-road construction vehicles, or whether it is from low exposure to (infrequent urban use of) higher risk long haul or off-road vehicles.

Case studies from DE and GB confirm that relevant collisions involving N3G vehicles do occur in urban areas but were insufficient to quantify the relative risk.

As a proxy for the collision risk, analysis of the amount of time spent on urban roads by different classes of vehicle was undertaken based on fleet telematics data fitted to Scania vehicles. This broadly supported the theory that the roads vehicle were used on were biased by type, with those identified as long haul vehicles spending much more time on motorways and other high speed roads and much less time in urban areas. Where they were identified in urban areas they were more likely to be on major roads than minor roads compared with smaller vehicles. However, it was also clear that the usage of long haul or N3G vehicles was far from zero on relevant urban roads and there was also many specific localised patterns that were difficult to interpret with confidence.

2.4 Conclusion

It was clear that there was a case for differentiation in the application of direct vision standards but also that there was practical difficulties in implementing it because the key differentiators were operational characteristics and vehicle design characteristics were only approximations of the relative risk. It was concluded that the benefits of differentiation outweighed the risks because it would allow a higher standard to be applied to urban vehicles than would otherwise be possible if all vehicles were considered as one homogenous group.

3 Definition of Levels

A differentiation was initially proposed between vehicles that are more likely to run in cities and those that very seldomly or never will enter into a city.

- Vehicles that are more likely to run in cities will be required to meet Direct Vision Level A
- Vehicles that very seldomly or never enter a city will be required to meet Direct Vision Level B

It was found that some vehicles within category N3G, off-road vehicles, did not fit in well in either category for design and operational reasons. Therefore, a third category Level B+, with an intended stricter limit value than for Level B, but less strict than for Level A, was introduced. This was named B+ because it was considered that the same design changes would naturally result in this category achieving a direct vision 1 m^3 better than category B.

- Non-AWD vehicles of category N3G that do not qualify into Level B group will be required to meet Direct Vision Level B+

However, this definition has caused some confusion among stakeholders. For the purpose of clarity, from hereon we rename those groups to better correlate to the expected limit values

- Level A will be renamed to Level 1 (higher performance requirement for vehicles regularly used in urban areas)
- Level B+ will be renamed to Level 2 (intermediate performance requirement for vehicles sometimes used in urban areas with specific operational limitations)
- Level B will be renamed to Level 3 (lower performance requirement for vehicles that are rarely used in urban areas)

4 Mechanism for identifying vehicles according to their use.

Although the benefits of direct vision correlate with the usage of the vehicle and the regulation directly controls only the design, trucks built for different operations do differ from a design perspective. Some correlation between a few basic vehicle characteristics and the usage of the vehicle does, therefore, exist. A division based on such parameters can be introduced in order to design a differentiation between vehicle groups. Such a division, for another purpose, was introduced in the EU CO2 Regulations.

4.1 Vehicle Groups in CO2 Regulation

Regulation (EU) 2017/2400 determines the CO2 emissions and fuel consumption of heavy-duty vehicles. Annex I, table 1 defines *vehicle groups* for vehicles of category N, based on:

- Axle configuration
- Chassis configuration
- Technically permissible maximum laden mass (tons)

Axle config	Chassis config	Mass (tons)	Vehicle group
4x2	Rigid	>3,5 – <7,5	(0)
	Rigid/Tractor	7,5 – 10	1
	Rigid/Tractor	>10 – 12	2
	Rigid/Tractor	>12 - 16	3
	Rigid	>16	4
	Tractor	>16	5
4x4	Rigid	7,5 – 16	(6)
	Rigid	>16	(7)
	Tractor	>16	(8)

Axle config	Chassis config	Mass (tons)	Vehicle group
6x2	Rigid	all weights	9
	Tractor	all weights	10
6x4	Rigid	all weights	11
	Tractor	all weights	12
6x6	Rigid	all weights	(13)
	Tractor	all weights	(14)
8x2	Rigid	all weights	(15)
8x4	Rigid	all weights	16
8x6, 8x8	Rigid	all weights	(17)

4.2 Vehicle Sub-groups in CO2 Regulation

Regulation (EU) 2019/1242 sets the CO2 emission performance standards for heavy-duty vehicles. Annex I, table 1 defines vehicle sub-groups, based on:

- Vehicle group
- Cab type
- Engine power

Vehicle group	Cab type	Engine power	Vehicle sub group
4 (Rigid 4×2 >16 t)	All	< 170 kW	4-UD (Urban Delivery)
	Day cab	≥ 170 kW	4-RD (Regional Delivery)
	Sleeper cab	≥ 170 kW and < 265 kW	
	Sleeper cab	≥ 265 kW	4-LH (Long Haulage)
9 (Rigid 6×2)	Day cab	All	9-RD
	Sleeper cab	All	9-LH
5 (Tractor 4×2 >16 t)	Day cab	All	5-RD
	Sleeper cab	< 265 kW	
	Sleeper cab	≥ 265 kW	5-LH
10 (Tractor 6×2)	Day cab	All	10-RD
	Sleeper cab	All	10-LH

Vehicle groups 4, 5, 9 and 10, but not yet the other vehicle groups, are divided into vehicle sub-groups in the CO2 Regulation. For the purpose of a direct vision division between urban and rural vehicles however, the same principle (cab type and engine power) can be applied for other vehicle groups.
A vehicle sub-group, yet to be defined, is the EMS sub-group for the heaviest transports – proposed to be used for vehicles with the following performance:

- Cab type: Sleeper cab
- Engine power: ≥ [350] kW

One immediate concern that the TF had was the definition of a sleeper cab. It was understood that there was little incentive to misclassify vehicles in the CO2 regulation but there could be a strong incentive to do so for direct vision, such that a robust definition was required. However, the group reviewed the definition used in the CO2 regulation, reproduced below, and considered it acceptable. The key phrasing was considered to be the requirement that the sleeping space was positioned behind the driver, which would mean a larger cab was essential to qualify which has cost and loadspace implications that would offset or reverse any perceived benefit of misclassification.

'Sleeper cab' means a type of cab that has a compartment behind the driver's seat intended to be used for sleeping as reported in accordance with Regulation (EU) 2018/956.
'Day cab' means a type of cab that is not a sleeper cab.

5 Assigning vehicle groups to vision levels

5.1 Tractors >16 tons

The ACEA report[1] on the CO2 baseline estimations for Q3 and Q4 2019, production figures of sub-groups 5 and 10 (tractors 4x2, 6x2) show:

- 5-RD 0,8% share of production
- 5-LH 62,8% share of production
- 10-RD 0,1% share of production
- 10-LH 9,7% share of production

Tractors of category Regional Delivery (5-RD and 10-RD) and those below 16 tonnes GVW are proposed in Level 1 group since those may sometimes enter cities, while tractors of category Long Haulage (5-LH and 10-LH) are proposed in Level 3 group since those are less likely to run in cities.
The production numbers showing RD tractor units are very low combined with traffic data from cities suggesting the vehicle km by articulated vehicles is a higher proportion of gooods vehicle traffic, suggests a risk that some vehicles categorised as Long Haul are in fact used in regional distribution. However, this does not mean the extremely tall long haul vehicles that cannot have the highest standard of direct vision will be entering cities. Apollo and LDS presented a direct vision measurement of an articulated vehicle expected to qualify as long haul (sleeper cab and above threshold power, subject to exact spec) that had a relatively low mounting height and very good vision performance. This is because the power remained a long way from the highest levels for long haul and operational characteristics already drove a low cab height because frequent cab access and rare needs for multiple overnight stays means that the driver comfort advantages of a low cab outweigh those of a high cab. No perverse incentive could be identified that would cause misclassifying such a vehicle as long haul in the regulation to result in a reduction in its already high standard of direct vision.

5.2 Rigids 4x2, 6x2 >16 tons

Two or three axle rigid vehicles are the most common goods vehicle type found in urban areas. However, a rigid truck, most often 4x2 or 6x2, towing a full trailer is also a very common configuration for Long Haulage. The 265 kW division for LH, indicates higher cooling needs and combined with a sleeper cab it strengthen the indication of the truck being designed for Long Haulage purposes. This indicates that sub-groups 4-LH and 9-LH are placed in Level 3 group.

- 4-LH (1,9% share of production)
- 9-LH (9,2% share of production)

Sub-groups to be placed in the Level 1 group.

- 4-UD (0,4% share of production)
- 4-RD (7,9% share of production)
- 9-RD (7,2% share of production)

Rigids below 16 tonnes are proposed in the Level 1 group.

[1] https://www.acea.be/uploads/publications/ACEA_preliminary_CO2_baseline_heavy-duty_vehicles.pdf

5.3 6x4, 8x2, 8x4 >16 tons

Some construction vehicles, often 6x4, 8x2 and 8x4 tippers and mixers, may enter into cities and should therefore be included in the Level 1 group. Where construction sites are well maintained and trucks are, for example, delivering materials from a regional depot, then the off-road capability required is not particularly demanding. However, vehicles of the same configuration may also be used for specialist heavy road transports, such as forestry and timber transport. These transports may often use high capacity vehicles and are usually well away from urban areas. For instance timber trucks and heavy transports in many parts of the world often use 6x4 rigid plus trailer(s) at weights in excess of 40 tonnes and will need the high cabs to have enough engine power.

In order to separate between construction vehicles and heavy transport vehicles, the [350] kW division combined with sleeper cab for sub-group EMS is proposed, since it indicates cooling and long distance needs.

The following sub-groups should therefore be included in the Level 3 group:

- 11-EMS, 12, 15-EMS, 16-EMS

While the remaining (non-EMS) 6x4, 8x2, 8x4 rigids to be included in the Level 1 group:

- 11-RD, 11-LH, 15-RD, 15-LH, 16-RD, 16-LH

[Proposal from SE – amend definition of EMS. Replace [350]kW AND sleeper cab with [350]kW AND/OR sleeper cab. intended to allow certain types of 70+tonne vehicle combinations in short/med haul specialist operations such as logging. To be evaluated for potential for misclassification/perverse incentive to increase power for equivalent urban vehicles with a day cab of to fit sleeper cabs on lower powered construction vehicles].

5.4 Off-road vehicles (N3G)

Regulation (EU) 2018/858 defines category N3G vehicles as off-road capable. However, even within that definition there is significant variation in usage and factors constraining improvements in direct vision. Traditionally, the provision of all wheel drive capability on multi-axle N3 vehicles has only ever been done on relatively small numbers of vehicles for niche applications where severe off-road use is central to their function. This is because this capability adds significant cost, weight and complexity to the vehicle. This is reflected in Regulation (EU) 2018/858 by the fact that N3 vehicles equipped with all wheel drive automatically qualify for sub-category G “off-road” status. Such vehicles are low in number and will almost never enter urban areas. As such, it is proposed that AWD vehicles of any other category definition are considered to be in the Level 3 group.

Concern had been expressed that the AWD criteria may not remain robust for future vehicles, particularly those with electrified power train. For example, the development of in-wheel motors may cause some manufacturers to offer AWD on vehicles not intended for off road use. They may then be able to have a lesser standard of direct vision than their use dictated. The TF considered this to be relatively unlikely in the HGV sector in the short term but acknowledged it was possible. However, if it occurs this will be a problem across several regulations and it was considered that any change would be better addressed to the definition of N3G with the direct vision regulation following that solution.

Other vehicles can be considered to be off-road capable without all wheel drive provided at least half of the wheels are driven and at least 4 of 6 other criteria relevant to ground clearance and traction are satisfied. The use of such vehicles is more mixed. Some may operate within and to and/from remote quarries and not enter urban areas. Others may, for example take waste materials from city centre construction sites to out of town landfill sites where the landfill sites are of a standard requiring off-road capability. These clearly enter urban areas regularly but do still have a specialist operational need for high ground clearance that limits the direct vision potential. It is therefore, proposed that these are considered in Level 2 regardless of which other category they may fall in based on their weight, chassis, engine power and cab execution.

5.5 Axle configuration other than above

Axle configurations are expressed in basic configurations. Extended axle configurations are included in the basics and should fall in that group respectively. Trucks with five axles and more should be in Level 3 group.

6 Overall summary of vehicle differentiation proposal

Overall, a system is proposed based on the Vecto categories from EU CO2 regulation with adaption to define an “EMS” sub-category for high capacity vehicles. However, it is proposed that the definitions are written directly into the Direct Vision regulation to avoid reliance on legislation defined outside of the UNECE context. A summary table shows the proposed definitions as it is proposed that they are used in the UNECE Regulation. A second table adds the Vecto group definitions for reference purposes.

Differentiation table Direct Vision for vehicles of categories N3 and N3G

	Gross Weight	Chassis Execution	Axle Configuration	Engine Power	Cab Execution	Vehicle Category
Level 1	<16 tons	All	4*2 6*2 6*4 8*2 8*4	All	All	N3
	>16 tons	Articulated	4x2	All	Day	N3
				<265 kW	Sleeper	N3
			6x2	All	Day	N3
		Rigid	4x2	All	Day	N3
				<265 kW	Sleeper	N3
			6x2	All	Day	N3
			6x4 8x2 8x4	All	Day	N3
				<[350] kW	Sleeper	N3
Level 2	<16 tons	All	4x2 6x4 8x4	All	All	N3G
	>16 tons	Articulated	4x2	All	Day	N3G
				<265 kW	Sleeper	N3G
		Rigid	4x2	All	Day	N3G
				<265 kW	Sleeper	N3G
			6x4 8x4	All	Day	N3G
				<[350] kW	Sleeper	N3G
Level 3	>16 tons	Articulated	4x2	≥265 kW	Sleeper	N3, N3G
			6x2	All	Sleeper	N3
			6x4 8x2 8x4	All	All	N3, N3G
		Rigid	4x2	≥265 kW	Sleeper	N3, N3G
			6x2	All	Sleeper	N3
			6x4 8x2 8x4	≥[350] kW	Sleeper	N3, N3G
	All	All	4x4 6x6 8x6 8x8 10xX	All	All	N3, N3G

N.B. Axle configurations are expressed in basic configurations. Extended axle configurations are included in the basics, e.g. 6x2/4 and 6x2*4 are both included under 6x2.
N.B. 10xX include any axle configuration with five or more axles.

Differentiation table Direct Vision for vehicles of categories N3 and N3G including VECTO categorisation

	Gross Weight	Chassis Execution	Axle Configuration	Engine Power	Cab Execution	Vehicle Category	VECTO group(s)
Level 1	<16 tons	All	4*2 6*2 6*4 8*2 8*4	All	All	N3	--
	>16 tons	Articulated	4x2	All	Day	N3	5-RD
				<265 kW	Sleeper	N3	
			6x2	All	Day	N3	10-RD
		Rigid	4x2	All	Day	N3	4-UD, 4-RD
				<265 kW	Sleeper	N3	
			6x2	All	Day	N3	9-RD
			6x4 8x2 8x4	All	Day	N3	11-/15-/16-non-EMS
				<[350] kW	Sleeper	N3	
Level 2	<16 tons	All	4x2 6x4 8x4	All	All	N3G	--/--
	>16 tons	Articulated	4x2	All	Day	N3G	--
				<265 kW	Sleeper	N3G	
		Rigid	4x2	All	Day	N3G	--
				<265 kW	Sleeper	N3G	
			6x4 8x4	All	Day	N3G	--/--
				<[350] kW	Sleeper	N3G	
Level 3	>16 tons	Articulated	4x2	≥265 kW	Sleeper	N3, N3G	5-LH
			6x2	All	Sleeper	N3	10-LH
			6x4 8x2 8x4	All	All	N3, N3G	12/--/--
		Rigid	4x2	≥265 kW	Sleeper	N3, N3G	4-LH
			6x2	All	Sleeper	N3	9-LH
			6x4 8x2 8x4	≥[350] kW	Sleeper	N3, N3G	11-/15-/16-EMS
	All	All	4x4 6x6 8x6 8x8 10xX	All	All	N3, N3G	8/14/6/7/13/17/--

N.B. Axle configurations are expressed in basic configurations. Extended axle configurations are included in the basics, e.g. 6x2/4 and 6x2*4 are both included under 6x2.
N.B. 10xX include any axle configuration with five or more axles.

[Amendments proposed by SE are shown in the table below]

	Gross Weight	Chassis Execution	Axle Configuration	Engine Power	Cab Execution	Vehicle Category
Level 1	>16 tonnes	Rigid	6x4 8x2 8x4	<[350] kW	Day	N3
Level 2	> 16 tonnes	Rigid	6x4 8x4	<[350] kW	Day	N3G
Level 3	> 16 tonnes	Rigid	6x4 8x2 8x4	≥[350] kW	Day	N3, N3G
				All	Sleeper	N3, N3G