

FUTURE EUROPEAN MASSES AND DIMENSIONS REGULATIONS – A STUDY INTO THE TECHNICAL AND POLITICAL DEVELOPMENTS



Erik Dahlberg
Senior Manager
Vehicle Regulations
Scania, Sweden
erik.dahlberg@scania.com



Jorge Soria Galvarro
Senior Technical Advisor
Vehicle Regulations
Scania, Sweden
Jorge.soria_galvarro@scania.com

Erik holds a PhD in Vehicle Dynamics from Royal Institute of Technology in Stockholm and has worked 16 years at Scania. Since four years head of the Vehicle Regulations department dealing with Regulations, Certification, Homologation and Technical lobbying. Author of six HVTT papers and participant of every symposium since 2002.

Jorge holds a MSc in Vehicle Engineering from the Royal Institute of Technology in Stockholm and has worked six years at Scania and ten years at The Swedish Motor Vehicle Inspection Company, dealing with Regulations, Certification and Technical lobbying. Chairman of ISO expert group on Brake systems and author of several studies on Heavy Vehicles roller brake testing.

Abstract

This paper describes the recent developments of the revision of the European masses and dimensions directive 96/53/EC, its political as well as technical aspects. The paper focuses on the proposal regarding the possibility of exceeding the maximum lengths requirements for vehicles or vehicle combinations in the existing legislation. An analysis of the content and scope of the proposals from the European Commission, the European Parliament and the Council of the European Union is complemented with an analysis of the technical implications related to type approval requirements. The paper presents an envelope criterion for the vehicle combination based on the existing infrastructure requirements and boundary condition set by the existing safety requirements in the type approval legislation. The envelope is based on a deemed to comply-principle, showing a pragmatic and simple approach to a complex problem. The paper also analyses the consequences and the possible outcomes from the different proposals and suggests the way to proceed.

Keywords

Heavy vehicles, Dimensions, European policy making, Truck front, Turning circle, Envelope, Regulations, 96/53/EC

1. Background

Fuel consumption of European long haul operation constitute roundabout one third of the total operating costs for the haulier. It is therefore, and has for long been, an extremely important vehicle property on which vehicle manufacturers compete. Today, also the society focuses on reduced fuel consumption to reduce CO₂ emissions from transports. To further strengthen the forces acting to reduce fuel consumption, legislators started working with this issue.

There is an ongoing development of CO₂ legislation for heavy duty vehicles in Europe. This may result in legislation for a certified declaration of the fuel consumption of vehicles at different operations. Thereby it would strengthen the market forces by making this vehicle property more transparent to the vehicle buyer. Further, in 2011, the European Commission (COM) published the White Paper on Transport Policy, indicating the societal goal of reduced CO₂ emissions from the road transport sector. The legislators proposed a number of means to achieve the goals, one of which was to encourage reduced fuel consumption and CO₂ emissions through enhanced aerodynamic performance of vehicles.

For trucks cruising at 80 to 90 km/h, fuel consumption is largely influenced by aerodynamics. Approximately half of the resistance at cruising consists of aerodynamic drag and typically one third of the total fuel consumed is used to overcome air resistance. Despite these losses, aerodynamics has historically not been addressed in any regulation. Competition, together with high fuel taxes, have driven development towards aerodynamically well performing vehicles, within the boundaries permitted by the weights and dimensions directives. These directives have resulted in cab over engine design of European tractors, to maximize the semitrailer cargo area. In order to minimize aerodynamic drag, tractors have been designed with rounded corners, air deflectors, side skirts and other trim that enhances the aerodynamic performance but keep the dimensions within the box defined by the directive. Further aerodynamic treatments such as boat tailing of the rear trailer end, and protruding tractor front, either infringes on the space dedicated for cargo or exceeds maximum authorized dimensions. There is hence a need for a revised “aerodynamic friendly” legislation.

A revision of the Weights and Dimensions Directive 96/53/EC was therefore initiated by COM in April 2013. The base for the revision was to introduce flexibility for innovation to enhance fuel efficiency including aerodynamics performance. No increase in loading capacity or axle weights were considered and the vehicle interaction with infrastructure should remain constant, i.e. the swept area while turning should not increase.

From an engineering viewpoint, several other possibilities to enhance fuel efficiency come with more flexible weights and dimensions. The layout in the front of the truck is very dense and there is limited room for new technology. Increased payload also increases fuel efficiency per goods transported. This subject is however politically sensitive in Europe, where Northern countries strive more actively for higher goods capacity. Therefore, the directive is being developed into a compromise where payload remains more or less constant, the length may increase but the current turning circle requirement will be kept. At the same time there is a wish for better aerodynamics performance. Flexibility for protruding rounded vehicle fronts may facilitate both enhanced aerodynamics and room for innovation.

2. Existing Legal Framework

In Europe, vehicles masses and dimensions are regulated both with respect to the type approval and to the circulation on European roads, in two different legislations. Directive

96/53 states the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic for certain road vehicles. It is in this legislation that the cab length is indirectly limited, via the total length of a tractor-semitrailer combination and the loading area limits. Regulation 1230/2012 states the type-approval requirements for masses and dimensions of motor vehicles and their trailers. This legislation was recently revised in order to open up for some aerodynamic devices, which however cannot be used on the roads until Directive 96/53 is being adjusted. Both regulations include the Turning Circle Requirement, described in detail further on.

Additionally, vehicle safety requirements for type approval are gathered in the European General Safety Regulation 661/2009 (GSR) that refers to UNECE (United Nations Economic Commission for Europe) Regulations for motor vehicles. European vehicle safety legislations are hence handled by UNECE WP 29, the World Forum for Harmonization of Vehicle Regulations. This framework is constituted by a large number of requirements, including the following ones that set the boundary conditions for the vehicle front: Front underrun protection, Lighting installation and Mirrors and Indirect Vision.

Table 1 - UNECE Regulations Setting the Boundary Condition for the Vehicle Front

Regulation	ECE	Illustration
<p>Front Underrun Protection</p> <p>Sets the requirements for the front underrun device (bumper) to be fitted in heavy vehicles regulating its strength and its maximum position from the ground. The design of the lower front part of the cab and chassis and the ground clearance is designed to meet this requirements.</p>	<p>93IR 93IIR 93IIIR</p>	
<p>Lighting Installation</p> <p>The front of the truck must be designed to fulfil the lighting installation requirements regarding the position and angles of the light emitted from the vehicle.</p>	<p>48R</p>	
<p>Mirrors and Indirect Vision</p> <p>Sets the requirements for the indirect vision through mirrors around the vehicle. Regardless the cab design, this requirements must be fulfilled, thereby affecting the design of the cab and its mirrors.</p>	<p>46R</p>	

Additionally, Directive 2007/46/EC, establishes a framework for the type approval of motor vehicles and trailers. It includes all requirements in the GSR, some additional Commission Regulations that are yet not adopted in GSR and European emission and noise requirements. It is referred to as the Framework Directive for Whole Vehicle Type Approval and has the advantage that a vehicle with such approval can be registered in any EU Member State.

3. Assessment of New Legislative Proposal

In April 2013, the European Commission's DG MOVE (Directorate-General for Mobility and Transport) released a rather unbalanced proposal for a revision of Directive 96/53. In summary, it included:

- Possibility to elongate the truck front by up to two metres (tractor semitrailer) in order to improve the aerodynamics. Must not improve the loading capacity.
- Possibility to elongate the rear of the combination (semitrailer boat tail) in order to improve the aerodynamics. Must not improve the loading capacity and shall be foldable.
- The elongations must be certified for improved aerodynamics performance, a number of new or enhanced safety features demands (passenger car/pedestrian/bicyclist crash performance, direct field of vision, driver's safety) and driver's comfort.
- Hybrid/electrical vehicles and two-axle buses/coaches get one ton extra GVW allowance.
- 45 foot containers are allowed, maximum loading length thereby increased by 15 cm.
- Weight sensors communicating axle weights and total weight to road side inspectors via short range communication is demanded. Alternatively, member states should increase the number of weigh-in-motion stations and checks drastically.
- EMS vehicles (longer and/or heavier than the baseline in 96/53) are allowed to cross borders if both member states have granted the model in national law. Multiple borders are not to be crossed during one transport mission.
- The provisions would enter into force after transposition of the new rules into national law 18 months after publication of the Directive.

The proposal was then submitted to the European Council and the European Parliament for approval under the ordinary legislative procedure. During the political negotiations, much focus has been on the elongation of the vehicle front and the possibilities that may come from that, enhanced fuel efficiency from aerodynamics and other innovation, new safety features and even comfort for the driver (although not well suited for legislation).

After the European Parliaments (EP) first reading of the COM proposal, they voted in April 2014 for a compromise. Regarding the vehicle front the EP amendments say that an elongation shall be made possible if improvements in aerodynamics are proven. However EP text also demands improvements in road safety, primarily for vulnerable road users. The following criteria apply:

- Improved aerodynamics of the vehicle
- Improved direct vision
- Improved energy absorbing crash management system
- Improved pedestrian protection to minimize the risk of overruns in case of collision
- Improved comfort and safety for the drivers
- The vehicles shall be tested within the framework of Directive 2007/46/EC
- The safety requirements should apply to new N2 and N3 vehicles seven years from entry into force of the Directive

EP also proposed delegated acts to develop the technical requirements in line with UNECE legislation, to be adopted no later than two years after the publication of the directive which is unrealistic due to the fact that UNECE legislations takes longer time to be developed.

Having worked with the file during this spring, the European Council reached a first political compromise in June, enabling the start of negotiations with the EP in autumn. It is proposed that the elongation of the vehicles is possible if it complies with 2007/46 and with the existing infrastructure constraints defined by the turning circle requirement. The COM shall assess the necessity to develop technical requirements for type approval of such vehicles considering:

- Improved aerodynamic of the vehicle
- Vulnerable road users and making these more visible to the driver, in particular by reducing blind spots
- Reduction in damage or injury in the event of a collision
- The comfort and safety of the drivers

The Council position further states that COM shall submit as appropriate a legislative proposal to amend 2007/46. This means that the assessment will determine if it is necessary or not to amend already existing type approval safety legislation balancing, in a holistic approach, all aspect for passive and active safety.

From the manufacturers' point of view, the Council position is somewhat better balanced than the EP position. An elongation of the vehicle is granted if it fulfils the framework directive 2007/46 and infrastructure constraints defined by the turning circle. By assigning COM the possibility of conducting proper assessments and cost-benefit analyses on the introduction of new aerodynamics and safety requirements in the type approval legislation, requirements with highest lifesaving and environmental potential may result.

Aerodynamics is not well suited to become part of a certification procedure, since aerodynamics performance are too complex to regulate and since fuel efficiency is controlled by the market forces. If the institutions decide differently, the EU must develop a completely new system for the demonstration of aerodynamics improvements. This would require the insertion of a legal mandate for its inclusion under type approval during the planned revision of 2007/46 in 2015. The established procedure lead by COM's DG ENTR (Enterprise and Industry) is a proven approach ensuring the development of technology-neutral and balanced requirements.

The EP and the COM proposals are inconsistent with existing safety legislations. Safety requirements are covered by UNECE Regulations and connected to European legislation via GSR. To mandate safety requirements, 96/53 is hence not feasible since it is only an enabling legislation and not for type approval of vehicle safety. An elongation of the vehicle is already restricted by infrastructure and technical requirements, since the vehicle has to fulfil 2007/46. From the manufacturers' point of view, the connection to aerodynamics improvements is also improper, no standard methodology nor type approval regulation exist today.

Finally, if any new or revised safety type approval requirements are necessary, it should be implemented under the umbrella of GSR, handled by DG ENTR. Thereby, the development of the legislation may be less political and more technical. Any new requirements on aerodynamics need to comprise a new legislation to become a part of the type approval.

The COM intension was to develop an enabling legislation not requiring any lead time. The various institutional positions, however, do also contain specific demands on safety design requirements, which require lead times for necessary cost benefit assessments, developing technical requirements and finally designing and implementing the solutions in proper steps. The EP demands the implementation of passive safety requirements without a foregoing cost benefit analysis or a holistic technology-neutral approach, thereby excluding innovative active safety systems. In case the masses and dimensions legislation is kept enabling, without adding design-specific requirements on safety, a lead time may not become necessary. The safety requirements are anyway going to be assessed under the ongoing revision of the GSR, in which proper lead times will be set for the introduction of eventually new technology.

Given the EP proposal, the compromise from the Council is quite good, but it would be even better to disconnect the elongation of a vehicle from any safety or aerodynamics requirements and leave safety to the GSR development and aerodynamics to the market forces.

4. A Pragmatic Approach – the Vehicle Envelope

One essential aspect in facilitating a flexible dimension requirement is to balance the maximum allowed vehicle length with the infrastructure requirements, i.e. the swept area of the vehicle combination when cornering should not increase. Today, the demand in addition to total combination length, is that it must be able to turn in a circle with an outer radius of 12,5 metres and an inner radius of 5,3 metres. The maximum semitrailer dimensions are 12 metres from kingpin to the rearmost point and 2,04 metres to any point in front of kingpin. Total semitrailer length is thereby approximately 13,6 metres. The tractor is for natural reasons shorter than the maximum 12 metres, the length is instead limited by the total semitrailer combination length of 16,5 metres in 96/53. Implicitly, the maximum distance from the fifth wheel to the foremost point of the tractor is 4,5 metres (L in Figure 1), of which 2,35 metres implicitly becomes the cab length limitation.

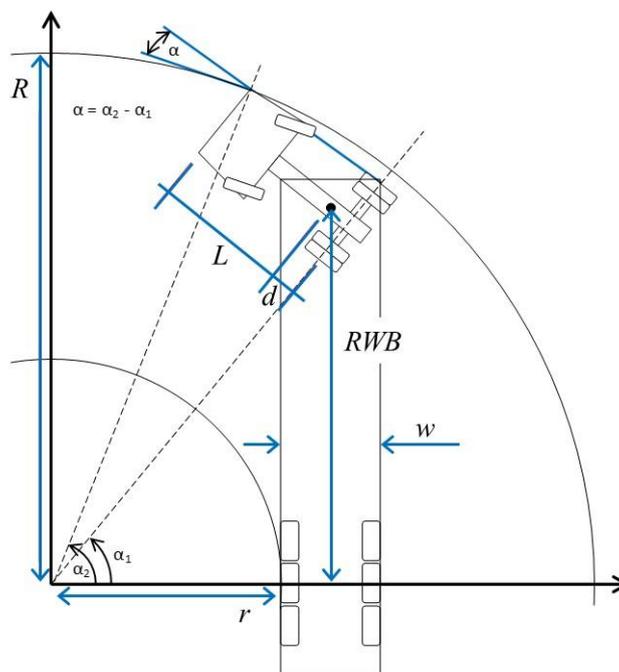


Figure 1. Turning Circle Requirement.

These demands are rather rigid and limits the possibilities to extend the front also in a way that does not infringe on the turning circle performance. In order to keep that requirement fulfilled, the tractor could be extended with a tapered front. Figures 1 and 2 illustrates the turning circle requirement and the parameters that determine the angle α of the tapered front that facilitates fulfilled unchanged turning performance.

A simple method will now be derived, illustrating a maintained turning circle, which could be used in a revised 96/53 as a deemed to comply-requirement for the tractor length. This principle already exist within the Directive for the semitrailer axle distance, kingpin to the centre of the axle group – the reference wheel base RWB . A simple analysis based on the parameters in Figure 1 is used including a square cab, i.e. no rounded corners. The radii of the turning circle R and r are set, while other parameters are variable; L , D , w and RWB . The front angle in the horizontal plane α is thereafter determined from the geometry.

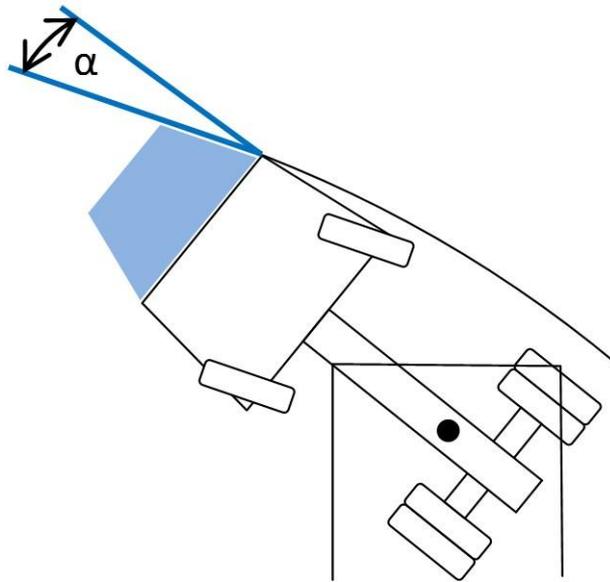


Figure 2. Tractor with Tapered Front including Indication of the Envelope.

As can be seen in Figure 2, the maximum angle α , composing a first order envelope, can be calculated from the difference between the two angles indicated in Figure 1, $\alpha = \alpha_2 - \alpha_1$. Thereby α can be resolved from the following equation.

$$\sin \alpha = (L + d)/R \quad (1)$$

Both L and R are set, while the value of d varies slightly between manufacturers as a result of the front overhang. The variation is small; all fall in the interval 0,43 to 0,67 metres, resulting in α between $23,2^\circ$ and $24,4^\circ$.

Now, a further limitation to the turning requirement is the RWB of the semitrailer, which according to 96/53 is deemed to comply if up to 8,11 metres when the width is at its maximum. The reason for having such a deemed to comply-requirement is the double legislation that applies via 96/53 and 1230/2012. The trailer manufacturers, and the hauliers, must be able to know in advance that a type approved semitrailer is allowed to be pulled by an approved tractor. It is assured by this approach, an approach that could be used also for an elongated tractor in a revised 96/53. Nevertheless, due to weight distribution, RWB for semitrailers offered on the market, is normally in the range 7,6 to 7,8 metres. The maximum

RWB that can manage a tractor with parameters L and d can be calculated from the basic geometrical relationships described in Figure 3, where also the parameter w indicating vehicle width is introduced. For simplicity it is set equal for the tractor as for the semitrailer.

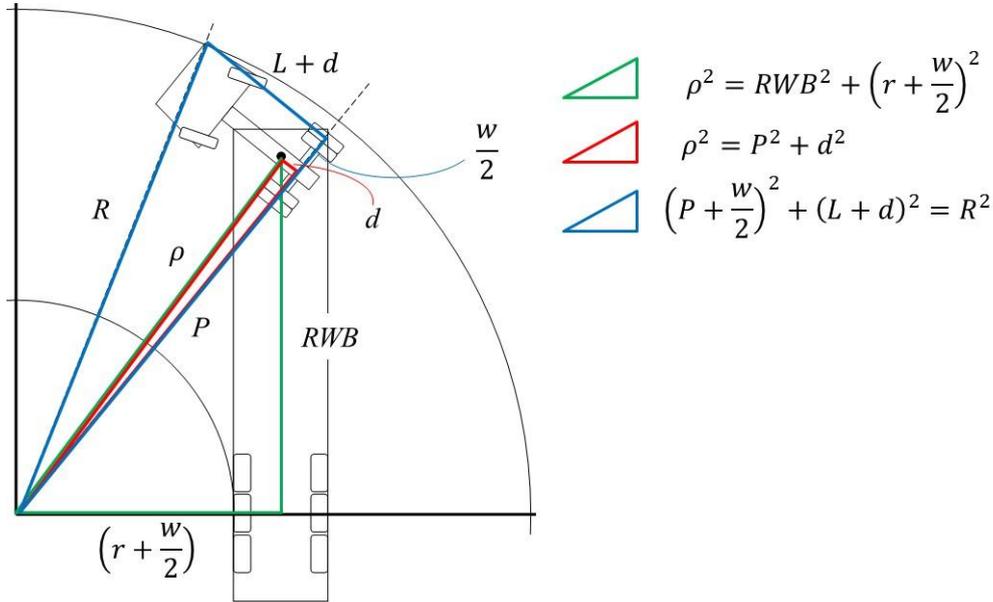


Figure 3. Geometrical Relations between Tractor and Semitrailer Parameters.

The relations in Figure 3 indicate the following equation.

$$RWB^2 = R^2 - L^2 - r^2 - rw - 2dL - w\sqrt{R^2 - (L + d)^2} \quad (2)$$

This equation indicates that semitrailers with RWB above 7,7 metres (varying slightly between tractors depending on the value of d) cannot be used if the turning circle requirement should be met. However, in real life, tractor cabs are conical with rounded corners due to aerodynamic performance. Thereby semitrailers with longer RWB can be managed within the turning circle. So, in order to refine the analysis, a conicity Δ of the cab is introduced, describing the tapering on each side in the foremost part of the cab compared to a totally square one. That assumption results in the following equation for maximum RWB .

$$RWB^2 = R^2 - L^2 - r^2 - rw - 2dL + \Delta w - (w - 2\Delta)\sqrt{R^2 - (L + d)^2} \quad (3)$$

By using measured values of the parameters d , w and Δ in the equation, it is revealed that tractors from European manufacturers fall in the interval 7,9 to 8,0 metres as maximum RWB in order to fulfil the turning circle requirements. Since standard semitrailers normally are offered with RWB in the range 7,6 to 7,8 metres, this approach is shown useful to derive a deemed to comply-requirement in a revised 96/53. Tractors on the European market, even if extended with a tapered front in angle α , will fulfil the turning circle requirement.

In addition to the angle α , a full envelope could be described if also the front end is defined. Existing legal demands such as previously described (FUP, lights and mirrors) limits the possibility to an unlimited extension of the front. Also practical demands, such as ground clearance angle will set a limit. This further analysis is not demonstrated in this paper, but a first order analysis has shown that without considerable layout changes in the tractor, it is difficult to extend the front more than 0,5 metres. With such changes, a maximum extension of up to one metre could be realised.

As described, when inside the envelope, the tractor should be considered deemed to comply with all semitrailers. This should be implemented in revised legislations 96/53 and 1230/2012.

5. Future Development

The COM proposal will now be negotiated in second reading between the new EP and the Council for approval under the ordinary legislative procedure. The elections to EP in May 2014 indicated some changes in the membership of the Transport Committee, which may provide some new inputs to the discussion. A final approval of the new law, after a second reading in EP, is expected during 2015.

Desirable results of those negotiations are that 96/53 develops into a more flexible legislation where infrastructure performance standards such as the turning circle requirement set the limit rather than fixed maximum dimensions. The envelope criteria presented is a preferred solution that fulfils these demands. The Directive should further remain an enabling, not an imposing, set of requirements. The proposed changes in safety requirements should be considered and analysed. In general, the technical development of vehicles has lead so far that active safety features have far more potential than passive, both in lifesaving potential and in cost efficiency. Regardless of the result of the analysis, new safety demands should be properly addressed in the GSR.

The Council proposal that COM shall assess the necessity to develop technical type approval requirements and submit, as appropriate, indicates that the policy unit in charge of type approval, DG ENTR will be responsible for the revision.

Independent of the ongoing revision of 96/53, a study of the content of GSR started in the beginning of 2014 by the COM and it also considers the proposed safety requirements in 96/53. The result of the study will affect the further development of the UNECE legislations if the implementation of new safety requirements is required. This has its own time table independent of the 96/53 legislation.

As outlined above, aerodynamics improvements do not present an appropriate legal base for an elongated truck front as included in the COM and EP proposals. This is not well suited as a requirement for several reasons; it is difficult to calculate or measure in absolute values, it is a whole vehicle property rather than a result of the front shape alone and fuel efficiency should remain the primary objective in order not to sub optimise. Some stakeholders has proposed the use of COM's DG CLIMA (Climate Action) methodology for aerodynamics within the CO₂ legislation, but this is not well suited for a complete vehicle approval since it is not accurate enough for evaluation of the relatively small aerodynamics improvements that may come from a limited redesign of the front.

Another main issue included in the COM proposal that remains to a certain extent in both the EP and the Council positions, and that should be removed in the final legislation, is that a relative type approval is proposed. It becomes a legally uncertain situation if a manufacturer is granted an approval based on whether it has improved its own design or not, rather than showing that an absolute demand is fulfilled.

In general, all lead times will be further negotiated. A proper lead time to use the possibility of elongation is necessary if safety type approval requirements are included, otherwise lead time for enabling an elongation of the front could be minimized.

6. Conclusions

Legislators are increasingly interested in the fuel efficiency of heavy trucks in order to reduce CO₂ emissions from transports, thereby also in aerodynamics performance. In a revision of the European weights and dimensions directive flexibility for innovation to enhance fuel efficiency including aerodynamics performance has therefore been addressed.

The legislative development has so far included input from COM, EP and the Council. The fuel efficiency initiatives have been mixed up with explicit demands on increased third party safety, improved aerodynamics and improved comfort and safety for the drivers, demands that have little to do with weights and dimensions of trucks and trailer.

Important for future development of European trucks is that the revised directive introduces flexibility for innovation and simple means of proving compliance. The vehicle envelope described in this paper can be used in a simple proof of compliance with the infrastructure. Other important aspects of the revision, from the manufacturers' viewpoint are:

- Aerodynamics performance should not be a new legal requirement for new elongated truck fronts as proposed by COM since that would hamper innovation.
- The existing safety requirements could very well be revised, but that should be done in the proper legislative environment, which is GSR under UNECE and not in 96/53.
- Relative approval should not be introduced, manufacturers must be able to relate to absolute demands.
- Enough lead time must be included for any imposing requirement, but is not necessary for enabling of an elongated truck front.

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