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Publishable Executive Summary

The aim of this document is to define the state-of-the-art regulatory framework regarding the freight transport market in a clear and meaningful format, providing a good starting input for the rest of the technical work packages (WP2-WP6), the Project Coordinator and the Project Officer. This report (D7.1 *Definition of the boundary conditions and current state of EU legislation*) represents the first deliverable of Work Package 7 named *Recommendations and roadmap for a new regulatory framework*.

The present report has been divided in three parts. Their objectives are described below:

Part A: Current state of the EU legislation
The main goal of this first part is to provide the reader the necessary input to understand how the policy making works and which outcomes from other projects can become a useful input for AEROFLEX project. The objectives of Part A are:

i. To present AEROFLEX background through the description of the results and take away messages achieved in other research funded projects like:
   - TRANSFORMERS (Grant Agreement No. 605170)
   - FALCON (CEDR Call 2015 Freight and Logistics in a Multimodal Context), and
   - FLUXNET (CEDR Call 2015 Freight and Logistics in a Multimodal Context)

   In case of TRANSFORMERS project, successor of AEROFLEX project, the recommendations and conclusions presented in its final report are considered.

ii. To describe the regulatory framework state of the art, including an explanation of the international discussion groups and the topics under discussion.

   Internationally speaking, there are two organisations that play a key role: The United Nations Economic Commissions for Europe (UNECE) and the European Commission (EC). Both have similar structures and mechanisms; they are divided into discussion groups which are again divided into topics of interest. The goal of this analysis is to identify which discussion/experts' groups have a direct relation to AEROFLEX solutions.

iii. To show the initial Regulatory Matrix. Part A finishes with the presentation of the preliminary Regulatory Matrix used to start the discussions with other Work Packages. In this matrix, a group of directions, regulations and standards are classified according to their nature (vehicle, infrastructure or use). The objective is to detect the regulations that could have an influence on the deployment of AEROFLEX solutions.

Part B: Definition of the boundary conditions
The main goal of Part B is to discuss the regulatory matrix affecting each Technical Work Packages (WP2-WP6) and identify the relevant aspects or regulations that might need a special attention.

iv. Regulation frame affecting AEROFLEX: For each Technical Work Package (WP2-WP5), their concept solutions are analysed from a regulatory point of view. Due to this deep analysis, a group of UN Regulations, EU Regulations, Directives and Standards are listed and classified into three categories: vehicle, use and infrastructure. Vehicle regulations include subjects like heavy duty vehicles emissions (UN Regulation No. 49), protection of the occupants (UN Regulation No. 29) or steering equipment (UN Regulation No. 79). Use regulations include regulations such as training of drivers or the road transport operators. Finally, infrastructure regulations are addressed to issues like vehicle access and manoeuvrability or tunnels in trans-European road network. As there are some regulations that might need comments, after each matrix there is a list of regulations followed by clarifications.

   The objective of this part is to delimitate the project scope and establish the boundary conditions, intended to be done in the next task.

This work has been made in accordance with other AEROFLEX partners and with the comments and suggestions from the Sounding Board thanks to the workshop held previously.

v. Topics of interest and open discussions: Regarding the current work in discussions groups, there are open discussions that are considered important because they can affect the technology solutions proposed by other technical work packages. Examples of active discussion groups are: the Intelligent Transport Systems and Automated Driving (ITS/AD) informal group of the WP29, the Automatic Commanded Steering Function (ACSF) informal working group of the GRVA, the Deployable Pedestrian Protection Systems (DPPS) informal working group of the GRSP or the Vulnerable Road Users proximity in low speed manoeuvres (VRU-Proxi) informal working group of the GRSG. In addition, this document includes a list of current regulations that are nowadays under discussions and which could be amended in the very near future. Apart from this list, some topics are outlined as they are considered relevant to AEROFLEX. Example of relevant topics are: the CO2 emissions and fuel consumption of heavy vehicles, very important nowadays due to the implementation of the new Vehicle Energy Consumption Calculation Tool (VECTO) in the homologation process, or the Cybersecurity Engineering (ISO/SAE 21434).

Part C: Outcomes from the Sounding Board workshops

The Sounding Board group has been involved since the beginning of the project and they have actively participated in the project through several meetings and workshops.

During the first 18 months of the projects, a total of three thematic workshops have been held. Each workshop has been focused on a different subject:

vi. Workshop on Logistics. This report includes the comments and conclusions of the workshop that took place on 7th of March 2018 in Dortmund, Germany. The objective was to invite the Sounding Board Members to participate in this logistics workshop to let them express their opinions or suggestions and pass them on to the other partners of the consortium.

vii. Workshop on Regulatory Framework. This workshop was held the 20th of February 2019 in Paris, at IFSTTAR facilities. This workshop was focused on the regulatory frame, and its conclusions and next steps are included in this report.

viii. Workshop on Intelligent Access Policies. The specific workshop took place at ACEA facilities the 6th of May 2019 with the objective to promote the concept of Intelligent Access and share the experiences of different project in several countries.

In conclusion, this document (Deliverable D7.1 – *Definition of the boundary conditions and current state of the EU legislation*) shows the results and outcomes from the first half part of the project.

This report is very important because it sets the basis for the *Book of Recommendations* (BoR). This BoR will be described in the following report (Deliverable D7.2 – *Book of Recommendation. Models validation and future regulatory framework proposals*). The BoR will be submitted at the end of the project and it will propose adjustments to homogenise standards and regulations.

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1 Purpose of the document

This document is the *AEROFLEX D7.1 Definition of the boundary conditions and current state of EU legislation* represents the first deliverable of Work Package 7 named *Recommendations and roadmap for a new regulatory framework*.

This main goal of this document is to analyse the state-of-the-art regulatory framework regarding the freight transport market in a clear and meaningful format, providing a good starting input for the rest of the technical work packages (WP2-WP6), the Project Coordinator and the Project Officer.

This deliverable is the result of Task 7.2 *Current state of the EU legislation and definition of the boundary conditions* and it will set a starting point for the following activities.

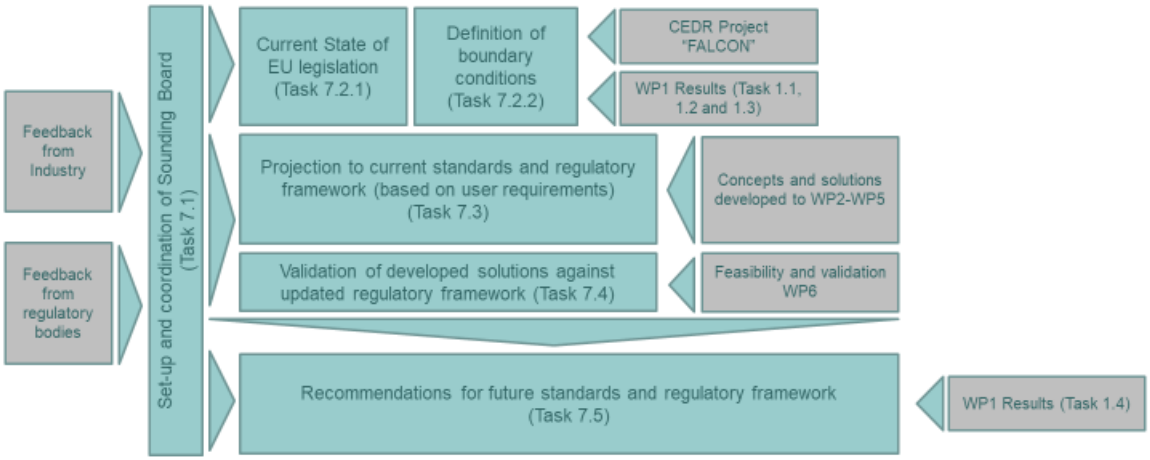


Figure 1-1 Work Package 7 activities and interactions

Due to the dimension of this report, it has been arranged in three parts in order to guide the reader through the document:

- Part A: Current state of the EU legislation
  The main goal of this first part is to provide the reader the necessary input to understand how the policy making works and which outcomes from other projects can become a useful input for AEROFLEX project.

- Part B: Definition of the boundary conditions
  The main goal of Part B is to discuss the regulatory matrix affecting each Technical Work Packages (WP2-WP6) and identify the relevant aspects or regulations that might need a special attention.

- Part C: Outcomes from the Sounding Board workshops
  This part summarizes the outcomes of the Sounding Board workshop held during the same period. In total, five meetings have been organized including three thematic workshops focused on logistics, regulations and intelligent access policies.

PART A:
Current state of EU legislation

2 AEROFLEX project background

2.1 TRANSFORMERS

The project TRANSFORMERS, which is the acronym for Configurable and Adaptable Trucks and Trailers for Optimal Transport Efficiency, finished in 2017 after 4 years of research. This project research was co-funded by EC and involved truck and trailer manufacturers, end users, suppliers and research institutes.

Having as a priority the current need to improve the traffic load and to reduce the CO2 emissions, the main goal of this project was to achieve 25 % energy load efficiency (in energy/tkm in a real-world application. To reach this objective, several key innovations were developed in parallel:

1. A configurable distributed Hybrid-on-Demand (HoD) Driveline for truck-trailer combination, rightsizing the driveline for each transport mission, enabling its integration to existing trucks and combinations. The HoD would include an advanced mission-based driveline management system that adapts its performance to their mission profile.
2. Development of several innovative complete vehicle aerodynamic measures, including guideline for selecting scenarios.
3. Development of innovative loading efficiency measures, including guideline for selecting scenarios.

All of this, by focusing on achieving these key innovations in fully compliance with the existing European legal and regulatory framework in terms of dimensions, weight and loads.

2.1.1 Link between TRANSFORMERS and AEROFLEX project

AEROFLEX project follows-up the TRANSFORMERS project that is why AEROFLEX will use the results and conclusions obtained in TRANSFORMERS to create their vehicle solutions, proposals and improvements. The relation between both projects is shown in the table below:

Table 2-1 Link between TRANSFORMERS and AEROFLEX

Work Packages	TRANSFORMERS	AEROFLEX
WP1	Use cases and requirements	Map and quantify load in EU and potential for configurable truck
WP2	Holistic simulations	Advanced Energy Management Power-Train (AEMPT)
WP3	Electric Hybrid-on-Demand Framework	Aerodynamic Features for the Complete Vehicle (AFCV)
WP4	Mission Adaptable Truck and Trailer Architecture	Smart Loading Units (SML)
WP5	Infrastructure aspects and compliance, Regulatory framework	Innovative Front-End Design for more Safety (IFEDS)
WP6	Demonstration, validation and evaluation	Demonstration, validation and analyses of feasibility
WP7	Dissemination and exploitation	Recommendations and roadmap for a new regulatory framework.

In the following lines, a brief explanation of some WP and their interaction will be shown.

- The identification of the end user requirements of road freight services and Key Performance Indicators were part of the project. The results of this analysis were summarised in TRANSFORMERS deliverable report 1.1. The AEROFLEX Work package 1 used these results for the description of European transport market analysis and the description of end user requirements in D1.1.

- TRANSFORMERS WP3 referred to the HoD driveline, which continues in AEROFLEX with WP2 Advanced Energy Management Power-Train (AEMPT).

- TRANSFORMERS WP4. This work package is split in two separate work packages in AEROFLEX: WP3 Aerodynamic Features for the Complete Vehicle (AFCV) and WP4 Smart Loading Units.

- Regarding the Regulatory Framework, TRANSFORMERS only had one task in WP5 focused on the compliance of the existing European regulation, named WP5 "Infrastructure aspects and compliance, Regulatory framework". The aim was to ensure that all the new concepts and vehicle configurations proposed would fully comply with the existing road infrastructures. In this direction, TRANSFORMES Deliverable 5.5 introduced the recommendations for EC wide regulatory framework (legislation) on dimensions and loads of vehicles. On the contrary, AEROFLEX project has one work package (WP7) dedicated to the analysis to the Regulatory framework and to give recommendations to allow the future implementation of AEROFLEX project Vehicle solutions.

Focusing on TRANSFORERS WP5 analysis, TRANSFORMERS project vehicle combinations presented solutions which nowadays cannot be easily implemented for cross-border intra EU road freight transport in the framework of the current EU rules on weights and dimensions EC Directive 96/53/EC as modified by Directive (EU) 2015/719 without having a potentially negative impact on the load capacity of the vehicle. EU rules provide a weight exemption of up to 1 tonne for rigid vehicles and for tractor units using alternative fuel technology. The extra weight of the innovations on the TRANSFORMERS energy efficiency or HoD combination is distributed over the entire vehicle combination and can only partially benefit from such a weight exemption.

The biggest impact of the additional weight of the HoD would be for cross-border intra-EU transports of weight sensitive goods. Also in circumstances where the allowed maximum authorized weight is higher than 40 tonnes, load capacity would be lost unless the weight exemption of 1 tonne is also applied to the full vehicle combination. So the TRANSFORMERS vehicle combination did not fully comply with the requirement allowing the extra tonne.

In addition, TRANSFORMERS WP5 compared fully loaded TRANSFORMERS vehicles to fully loaded current trucks (40 tonnes, 38 tonnes and 44 tonnes). Results showed that TRANSFORMERS vehicle solutions were less infrastructure aggressive than the 44 tonne articulated vehicle combination which are allowed in several EU Member States countries.

All these limitations and requirements will be further discussed and taken into account in AEROFLEX WP7.

2.1.2 TRANSFORMERS recommendations

As a summary of the points exposed in the previous section, the recommendations made by TRANSFORMERS partners are listed below as recommendations for amending the Directive 96/53/EC on weight and dimensions as amended by Directive (EU) 2015/719:

1. The extra ton allowance for alternative fuelled engine, battery or any other electric or energy saving device should also be allowed for articulated vehicle combinations, in order to balance this additional tonne between the tractor and the (semi-)trailer.

2. It should be examined how good guidance could be provided on the loading and related load distribution of trailers and semi-trailers (impact on safety barriers, driving stability of the truck), and on the longitudinal load distribution, i.e. the balance of axle loads (impact on pavements and on bridges). In this case, the guidance should be targeted at road freight transport operators and shippers on a general, systematic basis, and how compliance could be verified. The future version of Directive (EU) 2015/719 could provide some provisions on the height of the centre of gravity of the payload (impact on safety barriers, dynamic behaviour of the truck) and on the longitudinal load distribution, i.e. the balance of axle loads (impact on pavements and on bridges). This may be discussed with the relevant parties and DG MOVE.

3. The Directive should include a bridge formula, adapted to the European stock of bridges and allowing the current combinations complying with the Directive 96/53/EC revised in 2015. However, such a bridge formula should last for many years and prevent future heavier or longer combination to induce increased load effects in the existing bridges, which are mainly designed for a life of several decades.

To sum up, it is important to underline that the main objective of TRANSFORMERS, and subsequently AEROFLEX, is to provide solutions capable to go to market in the future. For this reason, the recommendations made in TRANSFORMERS should be taken into account in AEROFLEX.

2.2 FALCON

In 2015, the Conférence Européenne des Directeurs des Routes (CEDR) launched a call for Freight and Logistics in a Multimodal Context in order to understand what influences modal choice. The aim was to provide National Road Authorities (NRAs) with insight into the possibilities for optimizing multi-modality and the impact that these might have on road infrastructure. The research was expected to produce specific tools to enable NRAs to influence these choices.

One of the two projects funded by this research programme is FALCON, its final report was released in November 2017, providing a detailed review of the factors influencing modal choice. The other project funded is FLUXNET, described in the next section.

The objectives of the project were to provide the national road administrations with a handbook explaining the principles of freight markets, logistics strategies and multimodal transport as well as to compile Smart Infrastructure Access Policy to selected infrastructure network for future commercial vehicles. The project was divided into the following three parts:

- Part A: Understanding what influences modal choice
- Part B: How can infrastructure and infrastructure services affect modal choice?
- Part C: Fit for purpose road vehicles to influence modal choice (performance-based standards)

The results of the FALCON project part A were used in the WP1 and WP4 of the AEROFLEX project. WP1 described the transport market and its drivers in the D1.1. Here, the FALCON results about trends in the long road haulage and the firms' mode choice criteria were summarized. WP4 described the state of the art regarding intermodal transport in Europe in D4.1. Here, the description of intermodal transports and different stakeholders involved in the transhipment of goods are summarized from the FALCON project.

Regarding Part C, the annex B summarises the results of FALCON research about the European regulatory framework. Their research was an analysis of the regulations regarding different topics for EU International and other countries with specific requirements or exceptions (EU members or non-members) such as Sweden, Norway, Netherlands, Germany, France, Belgium or United Kingdom. The topics analysed were:

1. Vehicle dimension limits
2. Axle load limits
3. Weight limits
4. Manoeuvrability and traction
5. Brakes
6. Exhaust emission
7. Vehicle tyre noise
8. Relevant infrastructure features for a PBS scheme.

2.2.1 Review of Smart Infrastructure Access Policy SIAP in the world

The deliverable D3.3.1 of FALCON reviews the international regulations for commercial vehicle combinations. The so-called Smart Infrastructure Access Policy (SIAP) for regulation of heavy vehicles access to the road network has been implemented in Australia, Canada, and New Zealand. In South Africa and Sweden, implementation of a SIAP is under trial and investigation.

There are different approaches for implementing a Performance Based SIAP in a regulatory framework. One approach is to use Performance Based SIAP as an underlying basis for developing prescriptive regulations like the Canadian example where "vehicle-envelopes", defining the general vehicle layout, were developed using

performance based SIAP. Another approach is used in Australia where performance based SIAP is used to determine access requirement for different parts of the road network and is complementary to the general prescriptive regulations. Considering the different implementation approaches, the degree of flexibility in a performance-based regulation can vary considerably; greater flexibility might increase the risk of non-compliance if not complemented with a comprehensive enforcement strategy. In the Appendix (page 93), the Performance Based SIAP schemes in above-mentioned countries are briefly described.

2.3 FLUXNET

Apart from FALCON, there is another project funded by the Conference of European Directors of Roads through the same call for Freight and Logistics in a Multimodal Context, launched in 2015.

While FALCON aims to provide NRAs with a clearly written handbook explaining the principles of freight markets, logistics strategies, and how multimodal transport works and can be influenced, FLUXNET aims to provide insight into the tools for NRAs that help to optimise the multimodal use of the infrastructure networks by the freight and logistics sector. Special attention is being paid to the connection between land use and infrastructure planning. The project aims to provide an overview of potential “living labs” that offer the possibility to further explore the potential benefits of integrating multimodal transport networks, liveability and spatial planning.

Its final results are not published yet, but they will be available in the near future.

3 Regulatory Framework state of the art

In this chapter, the principal body stakeholders that influence AEROFLEX project will be defined. The main goal is to understand the policy making procedure, and all the bodies, working groups, discussions and initiatives that are being carried out by the regulatory bodies.

3.1 Vehicle and components regulatory frame

3.1.1 Regulations from the United Nations Economical commission of Europe (UNECE)

The United Nations Economic Commission of Europe (UNECE) was established in 1947 to encourage economic integration and cooperation among its member countries. It is one of the five regional commissions under the administrative direction of United Nations headquarters.

One of the main areas of work is Transport. Their main objective is to promote sustainable transport which is safe, clean and competitive, through the development of freight and personal mobility by inland transport modes, by improving traffic safety, environmental performance, energy efficiency, inland transport security and efficient service provision in the transport sector.

3.1.1.1 UN Regulations

In 1958 the United Nations Economic Commission from Europe, in Genève, established an integrated global system for the mutual recognition of vehicle-related product and subsystem approvals. These regulations are accepted by all signatories to the 1958 Agreement (all the countries from the European Union and some others not taking part in the EU) that have adopted each particular regulation within their respective regulatory systems.

Figure 3-1 Logo of the UNECE

Although voluntary, the UNECE regulatory process has been integrated directly into EU rulemaking such that the use of UN Regulations, where applicable, is often mandatory under EU law.

3.1.2 Regulations and Directives of the European Commission (EC) of the European Union

The European Commission (EC) is the executive body of the European Union responsible for proposing legislation, implementing decisions, upholding the Union's treaties and day-to-day running of the EU. The European Commission represents the interests of the EU as a whole.

Figure 3-2 Logo of the EC

The term 'Commission' refers to both the 28 Commissioners and the wider institution itself. There is one member per member state.

3.1.2.1 EU Regulations

Regulations (EU) from the European Union, in Brussels, (previously known as Regulations (EC) from European Commission), are the most direct form of EU law - as soon as they are passed, they have binding legal force throughout every Member State, on a par with national laws. National governments do not have to take action themselves to implement EU regulations. Regulations are passed either jointly by the EU Council and European Parliament, or by the Commission alone.

3.1.2.2 EU/EC Directives

Directives (EU) and Directives (EC) from the European Union and the European Commission in Brussels are addressed to national authorities, who must then take action to make them part of national law, and decisions, which apply in specific cases only, involving particular authorities or individuals.

The Directive 2007/46 EC regulates the vehicle type-approval in the European Union. It is the procedure whereby a Member State certifies that a type of vehicle, system, component or separate technical unit, satisfies the relevant administrative provisions and technical requirements. All the motor vehicles are classified in different categories according to its function and weigh. The technical requirements of all them are laid down in different regulatory act announced in an exhaustive list set out in Annex IV of the mentioned Directive (see page 78). The regulatory acts come from different regulation bodies such as (UNECE) Regulations, Regulations (EU) and Directives (EU), all of them equally mandatory.

3.1.2.3 New Type approval and Market Surveillance: Regulation (EU) 2018/858

On 14 June 2018, the Official Journal of the EU published the new vehicle Type-Approval Framework Regulation, whose new rules will be applicable from 1 September 2020.

This new regulation introduces a new testing regime to ensure vehicles remain within emission limits throughout their lifetime and clarifies the responsibilities of national type approval authorities, testing centres and market surveillance bodies, in order to make them more independent and prevent conflicts of interest.

This legislation also requires now every EU country to conduct a minimum number of checks on vehicles each year, at least 20 % of these tests will have to be emissions-related. The EU Commission will also be able to carry out tests and inspections of vehicles to verify compliance, to trigger EU-wide recalls and to impose administrative fines on carmakers per non-compliant vehicle.

Regarding other aspect like “Weights and Dimensions”, Member States may decide not to allow the registration or entry into service of vehicles that have been type-approved but that exceed the dimensions, weights and axle loads laid down in Annex I to Directive 96/53/EC.

At the request of the manufacturer, and subject to the agreement of the approval authority, virtual testing methods may be used in accordance with Annex VIII of this regulation. The Commission is empowered to updating the list of regulatory acts in respect of which virtual testing methods may be used by a manufacturer or a technical service and the specific conditions under which those virtual testing methods are to be used.

In addition, the Certificate of Conformity (CoC) - the document issued by the manufacturer which certifies that a produced vehicle conforms to the approved type of vehicle and complies with all regulatory acts at the time of its production - will follow standardised paper and electronic formats, to be drafted by the Commission by means of implementing acts.

3.2 Local legislations of vehicles use and infrastructures

The use of the vehicles such as traffic rules, driving licences or the general interaction between vehicles are regulated at for both the EU directives and the national regulations.

Local bodies can be identified as Ministries that directorate a public service, national/regional administrations or others.

3.3 Discussion groups

In this chapter, the discussion groups are identified, and the latest changes and news are described.

3.3.1 UNECE working groups and its new structure

On June 2018, the creation of a dedicated GR working group on automated and connected vehicle under the WP.29 was announced.

Before the creation of this specific group, all topics related to automated driving were managed in the "Informal Group on Intelligent Transport Systems/Automated Driving (ITS/AD)". This informal group was created in 2015 and it belonged to the GRRF (Working Group on Brakes and Running Gear).

Figure 3-3 Restructure of WP29

As the WP.29 was willing to maintain the structure of 6 working groups instead of creating a 7th, the GRRF seemed to be the only possible candidate for a conversion into a new GR for automated driving due to its coverage of relevant topics (brakes, vehicle dynamics, steering, etc.) and its deep involvement in automated vehicles related activities already as of today.

In alignment with this substitution, the following changes where considered:

- Re-allocation of all tyre-related activities under GRRF to GRB and renaming into GRBP
- Re-allocation of all tank vehicle safety-related activities under GRRF to GRSP
- Re-allocation coupling device-related activities under GRRF to GRSG
- Incorporation of all current activities of the IWG ITS/AD into GRVA

Since the creation of the group there has been 1 session meeting (September 2018), where an exchange of views on work priorities regarding vehicle automation and relevant technical items such as UN Regulations No. 79, 89, 90 and Task Force on Automated Vehicle Testing has been carried out.

3.3.1.1 Modular Vehicle Combination (MVC) Working Group of the GRVA

This working group was created in 2014, as a subgroup of the GRRF Working Group, with the aim to set a harmonized technical level so that countries that want to allow EMS vehicles can rely on harmonized technical requirements in the various regulation and not making national requirements. Vehicle combinations according to EMS system can already be accepted for international traffic, however different national requirements make that difficult.

The idea was to discuss the necessary topics that should be considered in order to set this "harmonized technical level". Some of the topics identified were:

- Truck intended for towing multiple trailers
- Trailer to be type approved for towing other trailers
- Dolly to become type approved
- Braking, steering and coupling systems in multiple trailer combinations
- Stability systems

Thanks to the discussions held in their meetings, they could identify which regulation needed to be amended and why. First discussions were focused on UN Regulation No. 13 (brakes), UN Regulation No. 55 (couplings) and UN Regulation No. 79 (steering).

During the second meeting of GRVA (05 January 2019) the continuation and extension of the working period for this subgroup was discussed and voted.

The 3rd of July 2019 an informal web meeting was done in order to define the objectives of the group that will be presented to GRVA during its next session in September 2019.

The group decided to divide into 2 steps the work:

- The first step includes the definition of the dolly vehicle with rigid drawbar, and all the possible combinations with other vehicles. A wide study of the compatibility and communication between the vehicles in terms its braking systems shall be done in this part.

- The second step will continue with the definition of new vehicle combinations and communication protocols between them.

3.3.2 Motor Vehicle Working Group (MVWG) – Subgroup on Masses and Dimensions

The first ever EU legislation on CO_2 emission standards for Heavy Duty Vehicles (HVD) have been recently proposed to reduce CO_2 emissions from the HDV sector in line with the objectives to the Paris agreement.
Compliance with the future CO_2 emission standards for heavy-duty vehicles will entail the adoption of fuel-saving technologies such as improving the aerodynamic performance of the vehicles by reducing the air drag.

Aerodynamically shaped, elongated cabin and aerodynamic flaps fitted at the rear of trucks or trailers are currently available technology with potential of improving the aerodynamic performance. However they have not been deployed yet due to the harmonized maximum length of vehicles allowed by Directive 96/53/EC on Weights & Dimensions laying down rules on the maximum authorised dimensions of motor vehicles circulating on the roads of the European Union in cross-border traffic. Directive (EU) 2015/7192, revising Directive 96/53/EC, provided the possibility for the circulation of trucks with elongated cabins on the market, subject to certain conditions under which vehicles equipped with elongated cabins may exceed standard dimensions, without increasing the load capacity. These conditions where:

a) Demonstration of an improved aerodynamic performance of vehicles or their combinations
b) Improving of drivers' visibility by reducing drivers' blind spots and so protecting vulnerable road users
c) Reduction in damage or injury caused to other road users in the event of a collision
d) Increase of the safety and comfort of drivers

Directive (EU) 2015/719 also proposed to foster the fitting of aerodynamic flaps at the rear of trailers/trucks to improve air drags. Directive (EU) 2015/719 requires that such elongated cabins and flaps are covered by EU type-approval rules. It requests in addition that the Commission assess the technical requirements needed in terms of type-approval for vehicles with elongated cabins and flaps. Finally, it also envisages a moratorium of three years after the implementation of the respective type-approval requirements to enforce the use of trucks with improved

aerodynamics of cabins in cross-border traffic. In this context, as part of the 3rd Mobility package, the Commission proposed to advance the date from which on more aerodynamic and/or safer cabins may circulate on EU roads.

Following intensive discussions and different studies, the various stakeholders seem now to agree in principle that the first condition relating to aerodynamic performance could be considered as being achieved if the elongated vehicle cabin shape remains with the boundaries of a certain 3-dimensional surface adjacent to the frontal plane of the cabin, the dimensions of which would be described in the TA legislation ('envelope approach'). Additional design requirements could also be taken into consideration in relation to points b) (vulnerable road users), c) (reduction in damage or injury) and d) (safety and comfort of the drivers), resulting e.g. in certain constraints for rake angles of the elongated cabin surface.

Following this assessment, the Commission decided to work swiftly on the basis of the envelope approach and adopt amendments to Regulation (EU) No. 1230/2012 through comitology with full participation of relevant stakeholders, for which the timetable is presented below (account has been taken of the time necessary for the adoption of the proposal on changing the moratorium). The amendments will also provide for type approval requirements of trucks/trailers with rear aerodynamic devices (flaps) beyond the currently permitted 500 mm and to provide requirements to ensure that these devices are safely attached to the vehicles. Finally, the amending proposal will also include provisions to take account of the increased laden mass of alternatively fuelled motor vehicles due to the electric battery or the hydrogen/natural gas containers.

In Table 3-1 the timeline for the implementation of the changes mentioned above is shown.

17 September 2018	Discussion of the 1st draft at the Subgroup meeting
18 October 2018	Discussion of the 1st draft at the Subgroup meeting
September/October 2018	Presentation of the 1st draft at Technical Committee
30 October 2018	Discussion at the TMCV
31 January 2019	Vote at Technical Committee Motor Vehicles
May 2019	Adoption by the Commission
June/July 2019	Publication in the Official Journal

Table 3-1. Schedule for the changes' implementation

4 Regulation frame & AEROFLEX

In this chapter, the regulatory matrix created within the project is presented. This matrix is a compilation of all the regulations identified according to the different technologies developed in the different WPs.

4.1 Analysis matrix

As a first step and in order to identify all the regulations that could affect the AEROFLEX project and the technologies developed in it, a general matrix was created. This general matrix included the regulations that were identified analysing each work package.

As a second step, this matrix was validated WP per WP looking for regulations not identified.

Finally, the matrix in Table 4-1 was created. This matrix is divided in UNECE regulations, EU regulations and directives and standards and it is analysed from the vehicle, use and infrastructure point of view.

In Part B, the boundary conditions of the regulatory framework have been analysed for each WP, for this reason, different matrix have been created and adapted to the scope of the WP.

		Vehicle	*Use*	*Infrastructure*
UNECE REGULATIONS	UN R10: Electromagnetic compatibility EMC	X		
	UN R13: Braking provisions to M, N and O vehicles	X		
	UN R17: Seats, their anchorage and head restraint	X		
	UN R29: Protection of the occupants of the car	X		
	UN R34: Fuel system safety (Fuel tanks protection)	X		
	UN R39: Prescription for Speedometer	X		
	UN R43: Safety glazing materials	X		
	UN R46: Devices for indirect vision	X		
	UN R48: Installation of lighting and light-signalling devices	X		
	UN R49: Emissions - heavy duty vehicles	X		
	UN R51: Sound emissions	X		
	UN R54: Tyres for commercial vehicles	X		
	UN R55: Coupling components	X		
	UN R58: Rear underrun protection	X		
	UN R61: Externals projection of the cab	X		
	UN R67: LPG Equipment and its installation	X		
	UN R73: Lateral protection	X		
	UN R79: Steering equipment	X		
	UN R89: Speed limitation device and installation	X		
	UN R93: Front underrun protection devices	X		
	UN R100: Electric power train	X		
	UN R102: Close-Coupling device	X		
	UN R105: Specific features for carriage of dangerous goods	X	X	X
	UN R109: Retreaded tyres	X		
	UN R110: CNG LNG Equipment and its installation	X		
	UN R117: Tyres: rolling resistance/sound emissions/ wet adhesion	X		
	UN R121: Hand control, tell tales and indicators	X		
	UN R122: Heating systems	X		
	UN R130: Lane Departure Warning System	X		

	UN R131: Advanced Emergency Braking System (AEBS)	X		
	UN R151: Blind Spot Information Systems	X		
EU directives & regulations	Regulation (EC) 1071/2009: Road transport operators		X	
	Regulation (EC) 1230/2012: Masses and dimensions	X	X	X
	Directive (EU) 2015/719: Masses and dimensions in international traffic	X	X	X
	Regulation (EC) 595/2009: Emissions from heavy duty vehicles	X		
	Directive (UE) 2010/48: Technical inspection on vehicles	X	X	
	Regulation (EU) 661/2009 General safety of motor vehicles	X		
	Directive (EC) 2007/46: Framework directive	X		
	Regulation EU 2018/858: Framework regulation	X		
	Directive (EC) 2003/59*2006/103: Training of drivers		X	
	Regulation (EC) 1003/2010: Rear registration plate	X		
	Regulation (EC) 109/2011: Spray suppression systems	X		
	Directive (EC) 2006/126: Driving licenses		X	
	Regulation (EU) 458/2011:Installation of tyres	X	X	
	Regulation (EU) 130/2012: Vehicle access and manoeuvrability	X		X
	Directive (EU) 2011/82: Exchange of information on traffic offences		X	X
	Directive (EC) 2004/54: Tunnels in Trans-European road network			X
	Regulation (EU) 1005/2010: Towing devices	X		
	Regulation (EU) 19/2011: Statutory plate and VIN	X		
	Regulation (EC) 561/2006: Social matters on road transport		X	X
	Directive (EU) 2014/45: on periodic roadworthiness tests		X	
	Regulation (EU) 351/2012: Lane Departure Warning Systems LDWS	X		
	Regulation (EU) 2017/2400: CO2 emissions and fuel consumption of heavy-duty vehicle	X		
	Regulation (EU) 2019/1242: CO2 emission performance for new heavy-duty vehicles.	X		
	Regulation (EU) 2019/1213 On-board weighing equipment	X		
	Proposal for regulation: R(EU) 2019/… New General Safety Regulation	X		
Standards	ISO 26262: Road vehicles - functional safety	X		
	ISO 11992: CAN Communication between truck and trailer	X		
	SAE J1939: Communication and diagnosis among vehicle components	X		
	EN 13044-1: Intermodal loading units		X	X
	EN 283: Swap bodies - Testing	X		X
	EN 16973: Road vehicles for combined transport - Vertical transhipment	X	X	X
	EN596-5: Railway specifications - Semi-trailer			X
	UIC 592: Intermodal loading units		X	X
	UIC 596-6: Codification system in combined transport		X	X
	UIC 571-4: Wagons in combined Transport		X	X

Table 4-1 Regulatory Matrix overview

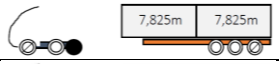
PART B:
Definition of the Boundary Conditions

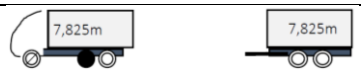
5 Regulatory analysis

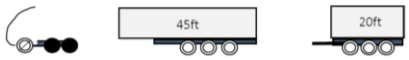
The objective of this chapter is to review the solutions presented by each technical Work Package and to analyse them according to the Regulatory Matrix created in page 20. The aim is to have a common knowledge of the regulatory gaps or conflicts that the solutions presented by each WP may face when starting the type-approval process.

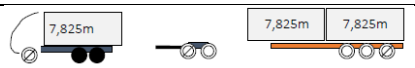
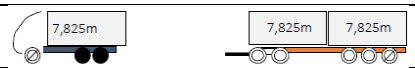
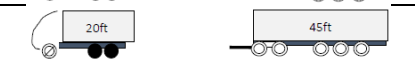
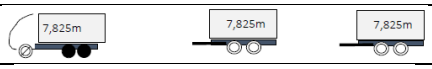
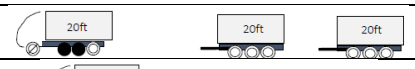
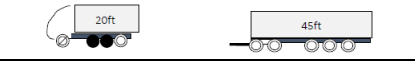
5.1 Masses and dimensions of the fleet

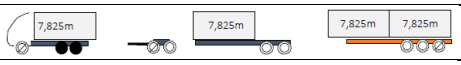
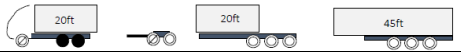
The different truck-trailer combinations have been considered for the project. Not all of them will be studied and tested. Among group 1 and 2, all can operate within Directive 96/53/EC (Weights and dimensions for international traffic), except for 1.2 and 1.4. The following figure shows the fleet considered for the project initially:

Group		Denomination	Schema
1 - Tractor	1.1	TR6x2-ST3 (45ft)	
	1.2	TR6x2-ST3 (2x7.8 m)	
	1.3	TR4x2-ST3 (13.6 m)	
	1.4	TR4x2-ST3 (14.9 m)	

Group		Denomination	Schema
2 - Rigid	2.1	TK6x2-CT2 (2x7.8m)	
	2.2	TK6x2-FT1+1 (2x7.8m)	
	2.3	TK6x2-CT3 (2x20ft)	

Group		Denomination	Schema
3 – Tractor	3.1	TR6x4-ST3-CT2 (45ft+20ft)	
	3.2	TR6x4-ST3-CT2 (3x7.8 m)	
	3.3	TR6x4-LT2-ST3 (3x7.8 m)	
	3.4	TR6x4-LT3-ST3 (20ft+45ft)	

Group		Denomination	Schema
4 - Rigid	4.1	TR6x4-DY2-ST3 (3x7.8m)	
	4.2	TR6x4-FT2+3 (3x7.8 m)	
	4.3	TR6x4-DY2-ST3 (20ft+45ft)	
	4.4	TR6x4-FT2+3 (20ft+45ft)	
	4.5	TK6x4-CT2-CT2 (3x7.8m)	
	4.6	TK8x4-CT3-CT3 (3x20ft)	
	4.7	TK8x4-FT2+3 (20ft+45ft)	

Group		Denomination	Schema
5 - Rigid	5.1	TK6x4-DY2-LT2-ST3 (4x7.8m)	
	5.2	TK6x4-DY2-LT3-ST3 (2x20ft+45ft)	
	5.3	TR6x4-CT2-CT2-CT2 (4x7.8m)	
	5.4	TR8x4-LT2+2-ST3 (4x7.8m)	
	5.5	TK8x4-LT2+3-ST3 (2x20ft+45ft)	

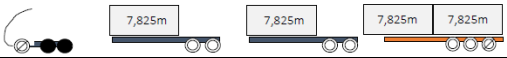
Group		Denomination	Schema
6 - Tractor	6.1	TR6x4-ST3-DY2-ST3 (2x45ft)	
	6.2	TR6x4-ST3-FT2+3 (2x45ft)	
	6.3	TR6x4-LT2-LT2-ST3 (2x7.8m+45ft)	
	6.4	TR6x4-LT3-LT3-St3 (2x20ft+45ft)	

Table 5-1 AEROFLEX fleet (based on results of FALCON)

5.2 WP2 matrix

WP2 - Advanced Energy Management Powertrain (AEMPT) primary objective is to investigate the feasibility and the potential of hybrid heavy duty trucks. This includes the technical feasibility, the commercial feasibility and the potential of distributed electric drivetrains as a migration step towards fully electric drivetrains.

In order to be able to gain the required results and findings standards, interfaces, protocols, and the architecture of an Advanced Energy Management Powertrain (AEMPT) will be developed within this WP. Further, an AEMPT for the complete vehicle will be developed and a demonstrator will be build based on a use case to demonstrate the capabilities of the AEMPT in real-world conditions.

After having discussed the matrix content with WP2, a few comments were made in some of the applicable regulations. The following matrix includes all the regulations that may be involved in the implementation of an AEMPT, however only the most relevant ones have been selected to describe the main modifications or changes to be taken into consideration in that particular regulation. Relevance has been divided in High, Medium and Low to determine how much effect may have the regulation to an AEMPT.

		Relevance	*Vehicle*	*Use*	*Infra.*
UNECE REGULATIONS	UN R10: Electromagnetic compatibility EMC	High	X		
	UN R13: Braking provisions to M, N and O vehicles	High	X		
	UN R39: Prescription for Speedometer	Low	X		
	UN R46: Devices for indirect vision	Low	X		
	UN R48: Installation of lighting and light-signalling devices	High	X		
	UN R49: Emissions - heavy duty vehicles	Low	X		
	UN R54: Tyres for commercial vehicles	Medium	X		
	UN R55: Coupling components	High	X		
	UN R67: LPG Equipment and its installation	Low	X		
	UN R79: Steering equipment	Medium	X		
	UN R89: Speed limitation device and installation	Low	X		
	UN R100: Electric power train	High	X		
	UN R102: Close-Coupling device	Medium	X		
	UN R105: Specific features for carriage of dangerous goods	Medium	X	X	X
	UN R109: Re-treaded tyres	Medium	X		
	UN R110: CNG LNG Equipment and its installation	Low	X		
	UN R117: Tyres: rolling resistance/sound emissions/ wet adhesion	Medium	X		

	UN R121: Hand control, tell tales and indicators	Low	X		
	UN R130: Lane Departure Warning System	Medium	X		
EU directives & regulations	Regulation (EC) 1230/2012: Masses and dimensions	High	X	X	X
	Directive (EU) 2015/719: Masses and dimensions in international traffic	High	X	X	X
	Regulation (EC) 595/2009: Emissions from heavy duty vehicles	High	X		
	Regulation (EU) 2017/2400: CO2 emissions and fuel consumption of heavy-duty vehicles	High	X		
	Regulation (EU) 2019/1242: CO2 emission performance for new heavy-duty vehicles.	High			
	Directive (UE) 2010/48: Technical inspection on vehicles	Low	X	X	
	Directive (EC) 2007/46: Framework directive	High	X		
	Regulation EU 2018/858: Framework regulation	High	X		
	Directive (EC) 2003/59*2006/103: Training of drivers	High		X	
	Regulation (EC) 1003/2010: Rear registration plate	Low	X		
	Regulation (EC) 109/2011: Spray suppression systems	Low	X		
	Directive (EC) 2006/126: Driving licenses	High		X	
	Regulation (EU) 458/2011: Installation of tyres	Medium	X	X	
	Directive (EC) 2004/54: Tunnels in Trans-European road network	Medium			X
	Regulation (EU) 1005/2010: Towing devices	Low	X		
	Regulation (EU)19/2011: Statutory plate and VIN	Low	X		
	Directive (EU) 2014/45: on periodic roadworthiness tests	High	X		
Standards	ISO 26262: Road vehicles - functional safety	Medium	X		
	ISO 11992: CAN Communication between truck and trailer	High	X		
	SAE J1939: Communication and diagnosis among vehicle components	Low	X		
	EN 16973: Road vehicles for combined transport - Vertical transhipment	Medium	X	X	X

Table 5-2 WP2 regulatory matrix

5.2.1 E-dolly

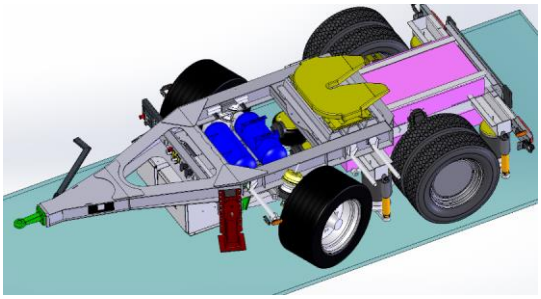


Figure 5-1 E-dolly

Regulation (EU) 2019/1242: CO2 emission performance standards for new heavy-duty vehicles.
This regulation applies to N2 and N3 categories of vehicles, however it is a good example of how future amendments and new vehicle regulations will focus on CO_2 emissions reductions from the road transport sector. The main objective is to reach at least a 40 % domestic reduction in economy-wide greenhouse gas emissions by 2030 compared to 1990.

Regulation (EU) 2017/2004: Determination of CO_2 emissions and fuel consumption of heavy-duty vehicles.
The regulation sets out the re rules for issuing licenses to operate a simulation tool (popularly called VECTO) with a view to determining CO_2 emissions and fuel consumption of new vehicles to be sold, registered or put into service in emissions and fuel consumption values thus determined.
It only applies to N2 and N3 vehicles, but it is a first step to future regulations that will cover other categories.

Regulation (EU) 2018/858 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles
In terms of Vehicle Type, before entering into the definition of an electric trailer (e-dolly or e-trailer), it must be noted that a non-electric dolly is not a standard trailer, therefore is not currently considered in Directive (EU) 2007/46 – Regulation (EU) 2018/858, for European Whole Vehicle Type Approval. Modifications shall be made to

(EU)2018/858 in order to consider dolly trailers inside the scope of the regulation. This same principle shall be applied for all those trailers or semi-trailers equipped to tow another trailer/semi-trailer.

Also, additionally new definitions shall be included for the electric dolly.

UN Regulation No. 55: Uniform provisions concerning the approval of Mechanical coupling components of combinations of vehicles

Dolly definition is included in Supplement 7 to the 01 series of amendments and defined as "a towing trailer designed for the sole purpose to tow a semi-trailer". However, there are other configurations/scenarios that shall be introduced in this regulation, such as centre axle trailers capable of carrying loads and equipped with coupling to tow a trailer, link-trailers (semi-trailer equipped with a fifth-wheel) and semi-trailers equipped with couplings to tow a trailer.

UN Regulation No. 100: Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train

Trailers are currently not included in the scope; therefore, the regulation shall be updated in order to include them. It shall be defined where the batteries may be located on the trailers.

In the case that the batteries or capacitors are located on the trailer, together with the amount of flow of electricity, the regulation shall include requirements with regard to the connection/disconnection of the power cables between the towing and towed vehicle, or even consider the possibility of having automatic connection/disconnection of such power cables in order to prevent the driver to handle HV cables and reducing the risk of possible injuries.

Regulation (EU) No. 1230/2012 type-approval requirements for masses and dimensions of motor vehicles and their trailers

In terms of masses and dimensions, dolly is not included in the definitions of this regulation. It shall be modified to include this type of vehicle. In addition, this type of vehicle shall still comply with the manoeuvrability requirements stated in Part D of Annex 1.

UN Regulation No. 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices

The e-dolly and e-trailer shall comply with the requirements of this regulation, specific for category O vehicles. However, modifications shall be made in this regulation in order to introduce the modular vehicle combinations. Currently the requirements for these types of combinations are included in the specific traffic regulations for each country where modular vehicle combinations are allowed.

UN Regulation No. 13: Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking

First of all, changes of regulation shall include provisions for towed vehicles with towing capacity (for example, dollies, link-trailers, etc.) that may not necessarily be provided with electric motors. Shall be introduced in the regulation in aspects related with the special braking circuits required by a dolly (these discussions are being held in the MVC (Modular Vehicle Combination) working group dependant from GRVA (former GRRF).

Other changes that shall be considered to be introduced in the regulation include the allowance of these towed vehicles with towing capacity, but which could additionally drive on its own under specific circumstances. Therefore, modification shall be made in the regulation, in order to introduce the scenario of having both brake torques of friction brake, the so-called endurance brakes and e-motors on trailers.

The introduction of MVC and electric trailers in the regulation shall also include the allowance of variable or adjustable distribution of brake power of the combination under certain dynamic conditions, controlled in all cases by a smart ECU.

Annex 16 of the Regulation describes de requirements of the compatibility between towing vehicles and trailers with respect to ISO11992 data communications. The ISO shall be modified (or a new one created) in order to include the requirement for an Automotive Ethernet signal on the ISO7638/ISO11992 connector.

UN Regulation No. 10: Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility

Any electric/electronic component or separate technical unit introduced in a EV (for example, the e-dolly) should be approved under this regulation. In addition, not only the separate components but the whole vehicle should be then tested and approved under the regulation in order to ensure the electromagnetic compatibility of the whole assembly working together.

In the case of an e-dolly, it is especially important to take into consideration the approval of the REESS (rechargeable energy storage system) and the coupling system for charging the REESS.

Directive 2006/126/EC of the European Parliament and of the Council of 20 December 2006 on driving licences

Currently, driving licences of categories C1E and CE consider only combinations of vehicles formed by tractor vehicle + 1 trailer or semi-trailer. Modifications shall be made in order to include in the scope the option of driving combinations of vehicles with more than one trailer or semi-trailer (it means, including dollys, link-trailers and others).

Directive (EU) 2003/59*2006/103 on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers

If Directive 2006/126/EC is to be modified, this directive would therefore be affected by those modifications.
In relation with modifications that may be implemented to UN Regulation No. 100, this directive shall also be modified to include training of drivers to handle HV cables.

Directive (EU) 2015/719 for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic

It shall be ensured that, when an e-dolly or e-trailer is used in a combination of vehicles, Article 10d of this directive is being complied and any data coming from any type of trailer or semi-trailer attached to the motor vehicle can be received and processed by the on-board system of the motor vehicle.
Modifications shall be introduced in the directive to increase the maximum length and total authorised weight of the MVC.

Directive 2014/45/EU: on periodic roadworthiness tests for motor vehicles and their trailers.

Modifications shall be introduced, together with the definitions in Regulation (EU) 2018/858, to include towed vehicles with towing capacity, and also e-dollies and e-trailers.

ISO 11992: Road vehicles – Interchange of digital information on electrical connections between towing and towed vehicles

This is related with UN Regulation No. 13, Annex 16. Changes may be required to this standard to include an Automotive Ethernet. If necessary, it shall be considered the creation of a new ISO for this.

5.3 WP3 matrix

WP3 - Aerodynamic Features for the Complete Vehicle (AFCV) key objective is to identify new concepts within aerodynamics available to complete vehicle combinations for different transport tasks and which of these concepts can be most widely applied for European fleets to gain maximum impact.

In the state-of-the-art report, a group of main regulation were identified and classified as follows:

		Impact	*Vehicle*	*Use*	*Infraest.*
UNECE REGULATIONS	UN R10: Electromagnetic compatibility EMC	High	X		
	UN R13: Braking provisions to M, N and O vehicles	Medium	X		
	UN R39: Prescription for Speedometer	Low	X		
	UN R46: Devices for indirect vision	Medium	X		
	UN R48: Installation of lighting and light-signalling devices	Medium	X		
	UN R49: Emissions - heavy duty vehicles	Medium	X		
	UN R51: Sound emissions	Medium	X		
	UN R54: Tyres for commercial vehicles	Low	X		
	UN R55: Coupling components	Low	X		
	UN R58: Rear underrun protection	High	X		
	UN R61: External projections cab of commercial vehicles	High	X		
	UN R67: LPG Equipment and its installation	Low	X		
	UN R73: Lateral protection	High	X		
	UN R79: Steering equipment	Medium	X		
	UN R89: Speed limitation device and installation	Low	X		
	UN R93: Front underrun protective devices	High	X		
	UN R100: Electric power train	Low	X		
	UN R102: Close-Coupling device	Low	X		
	UN R105: Specific features for carriage of dangerous goods	Medium	X	X	X
	UN R109: Re-treaded tyres	Low	X		
	UN R110: CNG LNG Equipment and its installation	Low	X		
	UN R117: Tyres: rolling resistance/sound emissions/ wet adhesion	Low	X		
	UN R121: Hand control, tell tales and indicators	Medium	X		
	UN R130: Lane Departure Warning System	Low	X		
EU directives & regulations	Regulation (EC) 1230/2012: Masses and dimensions	High	X	X	X
	Directive (EU) 2015/719: Masses and dimensions in international traffic	High	X	X	X
	Regulation (EC) 595/2009: Emissions from heavy duty vehicles	High	X		
	Regulation (EU) 2017/2400: CO2 emissions and fuel consumption of heavy-duty vehicles	High	X		
	Directive (UE) 2010/48: Technical inspection on vehicles	High	X	X	
	Directive (EC) 2007/46: Framework directive	High	X		
	Directive (EC) 2003/59*2006/103: Training of drivers	Medium		X	
	Regulation (EC) 1003/2010: Rear registration plate	Low	X		
	Regulation (EC) 109/2011: Spray suppression systems	Low	X		
	Directive (EC) 2006/126: Driving licenses	Medium		X	
	Regulation(EU) 458/2011:Installation of tyres	Low	X	X	
	Directive (EC) 2004/54: Tunnels in Trans-European road network	Medium			X
	Regulation (EU) 1005/2010: Towing devices	Low	X		
	Regulation (EU)19/2011: Statutory plate and VIN	Medium	X		

Table 5-3 WP3 regulatory matrix

The output of D.3.1 “Report on selection of concepts” from WP3 was an analysis of an extended list of different solutions that could be implemented. This list was divided into 4 categories: active geometry, passive geometry, active flow control and passive flow control. After some simulations, some of the solutions were rejected. The following chapters analyse the solutions presented in each category.

5.3.1 General requirements for aerodynamic solutions

The following regulations apply to all the solutions presented by WP3, so they should be considered in addition to all other regulations mentioned in the comments of each solution.

5.3.1.1 Regulation (EU) No. 1230/2012 type-approval requirements for masses and dimensions of motor vehicles and their trailers

This regulation applies to every M, N and O type vehicle. It defines the maximum masses and dimensions that the vehicles can reach, in order to maintain the normality in the traffic in all the conditions.

In this case, the activation of the different aerodynamic devices may vary the dimensions of the vehicles (e.g. movable boat-tail). To solve that, some exemptions may be applied, allowing upper limits in width or length to increase in certain roads.

Currently, the maximum authorised dimensions for vehicles of category N2 and N3 are (part C of Annex I of the Regulation):

- Length: 12,00 m.
- Width:
    - 2,55 m for any vehicle;
    - 2,60 m for vehicles fitted with a bodywork with insulated walls of at least 45 mm thick
- Height: 4,00 m

For category O, the dimensions shall not exceed (part D of Annex I of the Regulation)::

- Length:
    - Trailer: 12,00 m including drawbar
    - Semi-trailer: 12,00 m plus the front overhang
- Width:
    - 2,55 m for any vehicle;
    - 2,60 m for vehicles fitted with a bodywork with insulated walls of at least 45 mm thick, as referred to in Appendix 2 to Annex II to Directive 2007/46/EC.
- Height: 4,00 m.
- Front fitting radius of semi-trailer: 2,04 m.

In the list of devices that are not required to be taken into account for the determination of the outermost dimensions (Appendix 1 of Annex I of the Regulation), devices designed to reduce aerodynamic drag are considered. However, their dimensions are delimitated:

- Regarding the vehicle length, the devices cannot be longer than 500 mm from the outermost length of the vehicle and they cannot increase the length of the loading area. In addition, these devices must be retractable when stopped.
- Regarding the vehicle width, the devices cannot protrude by more than 50 mm from each side from the outermost width of the vehicle. They must be retractable and the total vehicle width shall not exceed 2650 mm.

The subgroup Masses & Dimensions belonging to the Motor Vehicle Working Group is working on a new set of amendments for this regulation. This Regulation will set the requirements of the motor vehicles and trailers with regard to their masses and dimensions, as well as for their aerodynamic devices. These amendments would introduce the following aspects:

- The aerodynamic devices have to be EC type-approved as a separate technical unit and marked according to it.
- Foldable devices shall be retractable when the vehicle is at stand-still in such a way that the maximum authorised width is not exceeded by more than 50 mm on each side of the vehicle and the maximum length do not exceed 200 mm. It should not increase the length of the loading area.
- It shall be possible to lock them in both the folded and in-use positions.
- Extra requirements for devices protruding > 500 mm:

  - It shall be possible for the operator to vary the position of the aerodynamic device and equipment by applying a force not exceeding 40 daN.
  - Both in folded position and in-use position, the devices shall withstand vertical and horizontal traction and push forces of 200 daN at a maximum pressure of 2.0 MPa.
  - For devices designed to improve aerodynamic performance of cabs must be foldable without protruding more than 50 mm on each side of the vehicle.
- The device shall be covered with energy absorbing material, harness below 60 Shore.
- All the material must not break into sharp fragments.
- They shall not impair forward field of vision, cooling and ventilation, exhaust, etc.
- They do not increase the length of the loading area.

5.3.1.2 Directive (EU) 2015/719 for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic

The regulation stablishes the maximum authorized dimensions and weight in national and international traffic.
On Annex I there are the maximum dimensions for all the vehicles and combinations with some exceptions that can be increased in cases of improved aerodynamics cabs or devices like slots.

5.3.1.3 Regulation (EU) No. 858/2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles

This regulation is described in chapter 3.1.2.3 New Type approval and Market Surveillance: Regulation (EU) 2018/858, page 16.

5.3.1.4 Directive 2014/45/EU on periodic roadworthiness tests for motor vehicles and their trailers

Periodical inspections may add requirements in order to check that the aerodynamic device is still working despite the time, and it is working in a correct way. Moreover, in case of failure of the system, a positive locking in the mechanism could be demanded in order to guarantee the safety of the system.

5.3.1.5 Regulation (EU) 2017/2400: CO2 emissions and fuel consumption of heavy-duty vehicles

The Annex VIII of the Regulation (EU) 2017/2400 sets out the test procedure for the determination of the air drag on the vehicles. If the system is activated by a control unit, for the purpose of this regulation, the device is considered Active aero device.

Vehicles equipped with active aero device shall demonstrate to the approval authority the following requirements:

- The device is always activated and effective to reduce the air drag at vehicle speed over 60 km/h.
- The device is installed and effective in similar manner on all vehicles of the family (means vehicles with similar shape and device).

All requirement established in this regulation must be considered and fulfilled.

All the data recorded during the test will be used on specific software that simulates de Co2 emissions of the vehicle, also taking into account other parameters and data from the axle, engine, transmission, tyres and other components fitted on the vehicle tested.

5.3.1.6 UN Regulation No. 10 Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility

All the sensors and actuators needed to activate and control the movable components must not interfere or modify the electromagnetic compatibility. The specific requirements that vehicles, components and separate technical units intended to be fitted in these vehicles' requirements are described in UN Regulation No. 10.
Electromagnetic compatibility may be checked in all driving conditions, or at least in the one declared as worst case. No. active aerodynamic device shall be activated accidentally by electromagnetic radiation.
It shall be demonstrated that vehicle performance is not adversely affected by such transmitter installations.

This regulation must be considered for all active geometries, both for truck and trailer.

5.3.2 Active geometry for the truck

5.3.2.1 Active air deflectors

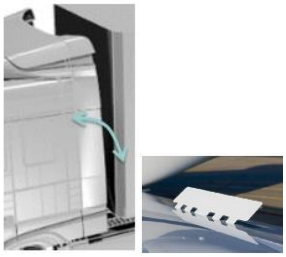


Figure 5-2 Active air deflectors for the truck

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 46: Uniform provisions concerning the approval of devices for indirect vision and of motor vehicles with regard to the installation of these devices
The implementation of the active air deflectors, given that they will probably increase the width of the vehicle in that area, may affect negatively to the vision area of the driver since the conventional exterior mirrors may not be sufficient for the purpose. Installation of additional devices for indirect vision (for example, cameras) may be considered in order to obtain the required flied of vision; in such case the requirements of point 6.2 of the Regulation may be fulfilled.

UN Regulation No. 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices
This Regulation may be taken into consideration since the active air deflectors solution may affect to visibility angles of some lighting and light signalling devices that are installed in both the tractor and the semi-trailer. Specifically, it may affect to visibility of the end-outline marker lamps (point 6.13 of the Regulation) and side-marker lamps and side retro-reflectors (points 6.18 and 6.17).
UN Regulation No. 61: Uniform provisions for the approval of commercial vehicles with regard to their external projections forward of the cab's rear panel

This solution is nowadays not covered by this Regulation, at least specifically or clearly, so it should be included as one of the devices which requirements are described in point 6 of the Regulation. Mainly, the requirements may be similar than the ones required for grilles, vents and access flaps.

UN Regulation No. 121: Uniform provisions concerning the location and identification of hand controls, tell-tales and indicators
When activating the air deflector, a tell-tale should be illuminated in order to be aware of its activation.

5.3.2.2 Active side skirt extension for the truck

Figure 5-3 Active side skirt Extension for the truck

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 13: Uniform provisions with regard to braking
Certain solutions might increase temperature when braking. So, this might be considered because a maximum temperature can't be overpassed when performing the braking tests.

UN Regulation No. 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices.
Similar approach has been considered as described in page 31.

UN Regulation No. 58: Uniform provisions concerning the approval of Rear Underrun Protection Devices (RUPDs) and their installation
This regulation applies to Rear Underrun Protection RUPDs which are intended to be fitted to vehicles of Categories M, N and O, and to its installation. Nowadays this regulation does not apply to tractive units for articulated vehicles; it only applies to categories M1, M2, M3, N1, O1 and O2.

UN Regulation No. 73: Lateral protection devices (LPD)
Nowadays it is possible to approve truck with lateral protection devices if they fulfil the requirements of this regulation (Annex I for truck and Annex II for the device). This device could have different positions that could be changed when the truck is stopped. But, as the regulation is nowadays, it is not possible to approve active devices that can change position while driving.

UN Regulation No. 105: Uniform provisions concerning the approval of vehicles intended for the carriage of dangerous goods with regard to their specific construction features
The implementation of this solution may be in conflict with point 5.1.3.2 of this Regulation, as in the event of any leakage under normal conditions of carriage, liquid fuel shall drain to the ground and not come into contact with the load or hot parts of the vehicle.
Furthermore, it may be considered that a covered underbody may affect to the exhaust system design and create additional heat in the rear part of the cabin due to reduction of air flowing through mechanical components of the tractor/truck (i.e. transmission, axles, brake cylinders and drums/discs…).

Regulation (EU) No. 458/2011: Type-approval requirements for motor vehicles and their trailers with regard to the installation of their tyres.
In case that the side skirts cover the front wheels in the side view in any position, it must be assessed that the steering mechanism reaches the locking point before impacting the adjustable side skirt. The approval authority may require this compliance by test or digitally.
Regulation (EU) No. 19/2011: Type-approval requirements for the manufacturer's statutory plate and for the vehicle identification number of motor vehicles and their trailers.
In the case of a statutory plate being fixed in one of the chassis' side, it should be visible in the stationary position, No. matter which one it is.

Regulation (EU) No. 351/2012: Type-approval of motor vehicles with regard to lane departure warnings systems.
In the case that the LDWS requires cameras installed in the vicinity of the adjustable side skirt, it must be checked that there is No. position that can prevent the camera from having the correct vision. In such a case, the testing required to fulfil the regulation may change to contemplate different configurations of the active aerodynamics.
As alternative, checking the correct vision on each camera may be proposed in order to ensure the correct working of the system.

UN Regulation No. 121: Uniform provisions concerning the location and identification of hand controls, tell-tales and indicators
When activating the air deflector, a tell-tale should be illuminated in order to be aware of its activation.

UN Regulation No. 122: Type-approval of motor vehicles with regard to heating systems
The heating systems might be altered or affected due to a limitation in the ventilation.

5.3.2.3 Inflatable gap sealing

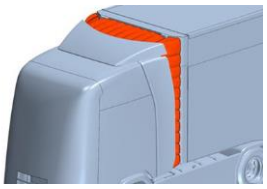


Figure 5-4 Inflatable gap sealing

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 13: Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking
In the case that the air to inflate the bladder is supplied by the existing air tanks of the tractor (braking and suspension air tanks), it shall be verified that the capacity of the air tanks is sufficient for the operation of all systems. In this regard, this Regulation may be involved in the inflatable gap sealing solution, as per requirements listed in Annex 7, and the vehicle shall still be able to comply with these requirements additionally to the bladder inflation.

UN Regulation No. 105: Uniform provisions concerning the approval of vehicles intended for the carriage of dangerous goods with regard to their specific construction features
Similar approach can be found in "Active side skirts" solution, page 32.

UN Regulation No. 121: Uniform provisions concerning the location and identification of hand controls, tell-tales and indicators
When activating the air deflector, a tell-tale should be illuminated in order to be aware of its activation.

UN Regulation No. 122: Type-approval of motor vehicles with regard to heating systems
Similar approach has been considered as described in page 32.

5.3.2.4 Extending air deflectors

Figure 5-5 Extending air deflectors

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. No other regulatory gaps have been identified so far.

5.3.2.5 Adjustable 5th Wheel

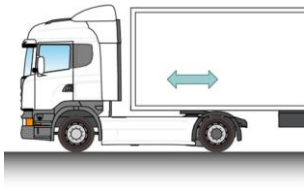


Figure 5-6 Adjustable 5th wheel

Taking into account that this solution will hardly be implemented in a mass production vehicle, due to its complexity and similarity in results with others solutions, such as the inflatable gap sealing, it has not been considered for study in this part.

5.3.2.6 Retractable trailer

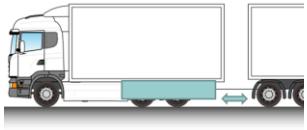


Figure 5-7 Retractable trailer

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 55: Uniform provisions concerning the approval of mechanical coupling components of combinations of vehicles
The coupling should fulfil the requirements described in this regulation

UN Regulation No. 58: Uniform provisions concerning the approval of Rear Underrun Protection Devices (RUPDs) and their installation
This regulation applies to Rear Underrun Protection RUPDs which are intended to be fitted to vehicles of Categories M, N and O, and to its installation. Nowadays this regulation does not apply to tractive units for articulated vehicles; it only applies to categories M1, M2, M3, N1, O1 and O2.

UN Regulation No. 73: Uniform provisions concerning the approval of: vehicles with regard to their lateral protection devices, lateral protection devices (LPD), and vehicles with regard to the installation of LPD of an approved type
The combination, when fully elongated, must guarantee the correct installation of the lateral protective devices, and in every possible position.

UN Regulation No. 121: Uniform provisions concerning the location and identification of hand controls, tell-tales and indicators
Due to the compromise in manoeuvrability due to the smaller gap between tractor and trailer, a special tell-tale may be required in order to indicate the situation of the coupling, avoiding uncertainty in the configuration for the driver.
Regulation (EU) No. 1230/2012 type-approval requirements for masses and dimensions of motor vehicles and their trailers
Even with a retracted trailer, a minimum manoeuvrability may be guaranteed. Special provisions could be developed, less restrictive but still demanding for this kind of configurations.

Directive (EU) 2015/719 for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic
The combination, when fully elongated, must be within the limits defined by this regulation. No. extra elongation for manoeuvrability requirements shall be allowed

Regulation (EU) No. 130/2012: requirements for motor vehicles with regard to vehicle access and manoeuvrability
This regulation establishes the requirements for the type approval of motor vehicles with regard to vehicle access, namely access steps, handholds and running boards as well as manoeuvrability, namely reversing devices. It is necessary to set out the specific procedures, tests and requirements for such type-approval.

5.3.2.7 Active ride height

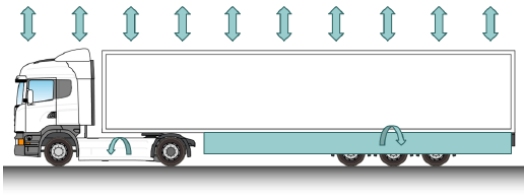


Figure 5-8 Active ride height

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 58: Uniform provisions concerning the approval of rear underrun protective devices and their installation
In all the ranges of configurations, the correct performance of the RUPD shall be guaranteed by checking that the height of the device above the ground is not too high.

UN Regulation No. 73: Uniform provisions concerning the approval of: vehicles with regard to their lateral protection devices, lateral protection devices (LPD), and vehicles with regard to the installation of LPD of an approved type
The combination, when fully elongated, must guarantee the correct installation of the lateral protective devices, and in every possible position.

UN Regulation No. 93: Uniform provisions concerning the approval of front underrun protective devices and their installation
In all the ranges of configurations, the correct performance of the RUPD shall be guaranteed by checking that the height of the device above the ground is not too high.

Regulation (EU) No. 1003/2010: Requirements for the space for mounting and the fixing of rear registration plates.
In every allowed configuration, rear registration plate must be within the installation limits defined by this regulation.

Regulation (EU) No. 458/2011: Type approval requirements for the installation of tyres
The requirements described in Annex II of this regulation should be considered, especially those regarding the tyre fitment, for example the space in which the wheel revolves.

5.3.3 Active geometry for the trailer

5.3.3.1 Adaptable trailer shape

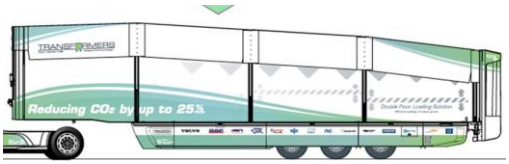


Figure 5-9 Adaptable trailer shape

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices
Similar approach can be found in “Active air deflectors” solution, page 31.

UN Regulation No. 58: Uniform provisions concerning the approval of rear underrun protective devices and their installation
Basing on the trailer developed in TRANSFORMERS, the adaptable trailer shape could superpose a movable component with the underrun protection. It shall be checked that No. movable component causes the distance between the RUPD and the latest component to be more than 500 mm.
If the component gets to cover the RUPD, special provisions related to this component's fragility may be added.

Regulation (EU) No. 1003/2010: Requirements for the space for mounting and the fixing of rear registration plates.
Basing on the trailer developed in TRANSFORMERS, the adaptable trailer shape could prevent the rear registration plate to be visible. It must be checked that this registration plate remains visible at the prescribed angles.

5.3.3.2 Active side skirt extensions for the trailer

Figure 5-10 Active side skirt extensions for the trailer

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices
Similar approach as in solution "Active air deflectors", page 30.

UN Regulation No. 73: Uniform provisions concerning the approval of: vehicles with regard to their lateral protection devices, lateral protection devices (LPD), and vehicles with regard to the installation of LPD of an approved type
First of all, it will be necessary to carry out test on the active side skirt extensions to determine whether they are in compliance with resistance and deformation requirements of part II of the Regulation (considering that the system is considered as a separate component, not part of the bodywork of the vehicle). If the test has been successful, then the device may get a type approval. After the approval is granted, it may then be installed on the vehicle, and checking will need to be carried out in order to ensure that the vehicle is fulfilling the requirements with regard to the installation of LPD of an approved type (as stated in Part III of the Regulation).
On the other hand, if the system is considered as part of the bodywork of the vehicle, then tests will need to be carried out on the vehicle. In the case of this scenario, it would then need to be in compliance with part I of the Regulation.
The Regulation may need to be modified in several points in order to introduce this LPD system, provided that there are some requirements that may not be applicable to the system (i.e. distance to rear wheel).

UN Regulation No. 79: Uniform provisions concerning the approval of vehicles with regard to steering equipment
Only to be considered if the vehicle (semi-trailers) includes steering equipment as defined in point 1 of the Regulation.
There is No. reference in the Regulation to requirements of the steering equipment regarding the concept of active side skirt extensions. Probably is not the proper Regulation to include requirements of the device itself, however it may be necessary to have a Regulation that include issues as, for example, the possible interference between the active side skirt extensions and the wheels of the semi-trailer in case of vehicles with steering equipment.

5.3.3.3 Movable boat-tail

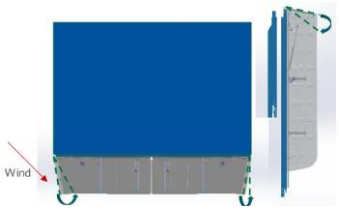


Figure 5-11 Movable boat-tail

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices
This Regulation may be taken into consideration since the movable boat-tail solution affects to visibility angles of some lighting and light signalling devices that are installed in the back of the semi-trailer. Specifically, it will affect to the conspicuity/contour marking (both lateral and rear), rear retro-reflectors and rear end-outline marker lamps, as indicated in points 6.21, 6.14 and 6.13 respectively.

UN Regulation No. 58: Uniform provisions concerning the approval of rear underrun protective devices and their installation
Requirements for installation of an approved RUPD, as described in point 16 of Part II of this Regulation may be considered when designing and implementing this solution. Specially, the requirements of maximum distance between the rearmost part of the vehicle and the RUPD (both before and after its maximum deformation) should be considered.

5.3.4 Passive geometry

5.3.4.1 Covered underbody

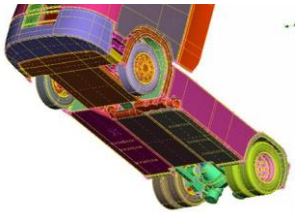


Figure 5-12 Covered underbody for the truck

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 105: Uniform provisions concerning the approval of vehicles intended for the carriage of dangerous goods with regard to their specific construction features
The implementation of this solution may be in conflict with point 5.1.3.2 of this Regulation, as in the event of any leakage under Normal conditions of carriage, liquid fuel shall drain to the ground and not come into contact with the load or hot parts of the vehicle.
Furthermore, it may be considered that a covered underbody may affect to the exhaust system design and create additional heat in the rear part of the cabin due to reduction of air flowing through mechanical components of the tractor/truck (i.e. transmission, axles, brake cylinders and drums/discs…).

UN Regulation No. 122: Type-approval of motor vehicles with regard to heating systems
The heating systems might be altered or affected due to a limitation in the ventilation.

5.3.4.2 Covered rear wheels

Figure 5-13 Covered read wheels

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 13: Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking
Certain solutions might increase temperature when braking. So, this might be considered because a maximum temperature can't be overpassed when performing the braking tests.

UN Regulation No. 73: Uniform provisions concerning the approval of: vehicles with regard to their lateral protection devices, lateral protection devices (LPD), and vehicles with regard to the installation of LPD of an approved type
First of all, it will be necessary to carry out test on the active side skirt extensions to determine whether they are in compliance with resistance and deformation requirements of part II of the Regulation (considering that the system is considered as a separate component, not part of the bodywork of the vehicle). If the test has been successful, then the device may get a type approval. After the approval is granted, it may then be installed on the vehicle, and checkings will need to be carried out in order to ensure that the vehicle is fulfilling the requirements with regard to the installation of LPD of an approved type (as stated in Part III of the Regulation)

On the other hand, if the system is considered as part of the bodywork of the vehicle, then tests will need to be carried out on the vehicle. In the case of this scenario, it would then need to be in compliance with part I of the Regulation.

The Regulation may need to be modified in several points in order to introduce this LPD system, provided that there are some requirements that may not be applicable to the system (i.e. distance to rear wheel).

UN Regulation No. 79: Uniform provisions concerning the approval of vehicles with regard to steering equipment
Only to be considered if the vehicle (semi-trailers) includes steering equipment as defined in point 1 of the Regulation.
There is No. reference in the Regulation to requirements of the steering equipment regarding the concept of active side skirt extensions. Probably is not the proper Regulation to include requirements of the device itself, however it may be necessary to have a Regulation that include issues as, for example, the possible interference between the active side skirt extensions and the wheels of the semi-trailer in case of vehicles with steering equipment.

Regulation (EU) No. 458/2011: Type approval requirements for the installation of their tyres
Similar approach as in solution "Active ride height", page 35.

UN Regulation No. 122: Type-approval of motor vehicles with regard to heating systems
The heating systems might be altered or affected due to a limitation in the ventilation.

5.3.4.3 Boat-tail

Figure 5-14 Boat-tail

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices
This Regulation may be taken into consideration since the movable boat-tail solution affects to visibility angles of some lighting and light signalling devices that are installed in the back of the semi-trailer. Specifically, it will affect to the conspicuity/contour marking (both lateral and rear), rear retro-reflectors and rear end-outline marker lamps, as indicated in points 6.21, 6.14 and 6.13 respectively.

UN Regulation No. 58: Uniform provisions concerning the approval of rear underrun protective devices and their installation
Requirements for installation of an approved RUPD, as described in point 16 of Part II of this Regulation may be considered when designing and implementing this solution. Specially the requirements of maximum distance between the rearmost part of the vehicle and the RUPD (both before and after its maximum deformation).

5.3.4.4 Trailer chassis covering

Figure 5-15 Trailer chassis covering

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 105: Uniform provisions concerning the approval of vehicles intended for the carriage of dangerous goods with regard to their specific construction features
The implementation of this solution may be in conflict with point 5.1.3.2 of this Regulation, as in the event of any leakage under normal conditions of carriage, liquid fuel shall drain to the ground and not come into contact with the load or hot parts of the vehicle.
Furthermore, it may be considered that a covered underbody may affect to the exhaust system design and create additional heat in the rear part of the cabin due to reduction of air flowing through mechanical components of the tractor/truck (i.e. transmission, axles, brake cylinders and drums/discs…).

5.3.5 Active flow control

5.3.5.1 Tangential blowing

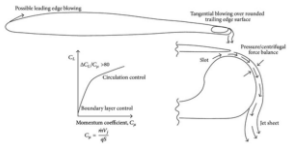


Figure 5-16 Tangential blowing

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 10: Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility

The tangential blowing system can be supplied by a compressor that is going to generate the jet sheet needed in order to control the boundary layer of the vehicle and reduce the drag where needed.

If the system used for obtaining this tangential blowing includes electrical or electronic equipment, then it should be tested with regard to this regulation.

The system has to fulfil the requirements regarding the immunity to radiated and conducted emissions that could cause confusion to the driver.

Furthermore, understanding that pulse blowing is a system that can act depending on the conditions of the vehicle (speed, air turbulence…), would mean that the trailer or the semitrailer is always connected with the truck electronically, and also should be tested to ensure the correct operation in all the environments and conditions.

UN Regulation No. 51: Uniform provisions concerning motor vehicles having at least four wheels with regard to their sound emissions

This regulation only applies to vehicles of category M and N, so trailers and semitrailers will be excluded. Trucks that could use tangential blowing in order to reduce the drag and improve the fuel consumption are subjected to this.

The addition of compressors or other devices to generate the tangential blowing will increase the sound of the vehicle during its normal driving. This sound level will be measured with the vehicle in motion and for the vehicle where stationary.

If the vehicle laden mass exceeds 2.800 kg, then it shall also be subjected to an additional measurement of the compressed air noise with the vehicle stationary.

5.3.5.2 Boundary layer suction

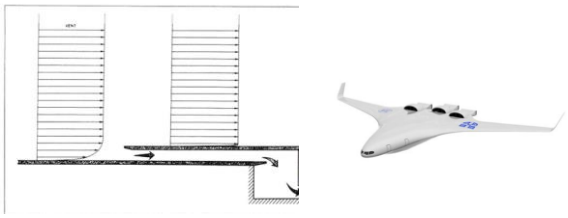


Figure 5-17 Boundary layer suction

UN Regulation No. 51: Uniform provisions concerning motor vehicles having at least four wheels with regard to their sound emissions

To create a boundary layer suction, slots or porous have to be added on the surface of the trucks in order to create a depression zone.

This can lead to increase the noise of the vehicle at high speeds. In that way, vehicles with this device should fulfil the noise requirements of this regulation.

UN Regulation No. 61: Uniform provisions for the approval of commercial vehicles with regard to their external projections forward of the cab's rear panel

Any commercial vehicle of category N with external projections on the forward part of the rear panel is subjected to this regulation.

Trailers and semitrailers are not included on this regulation.

Any component of the external surface of the vehicle shall not exhibit, directly outwards, any part likely to catch pedestrians, cyclists or motorcyclists.

If the boundary layer devices are not between the floor and the horizontal plane situated at 2.00m above the ground, then the provisions of the regulation shall not apply.

5.3.5.3 Plasma actuators

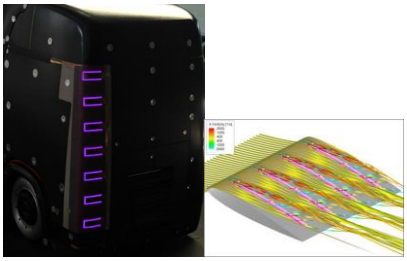


Figure 5-18 Plasma actuators

UN Regulation No. 10: Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility

Plasma actuators are driven by high-voltage AC signals across the electrodes. These devices shall be tested against radiated and conducted emissions that could cause wrong operation of the system. Moreover, trailers with this system will also be connected to the truck, and this will add more connexions and interaction between de combinations of the vehicles that should be tested regarding this regulation.

5.3.5.4 Synthetic jets

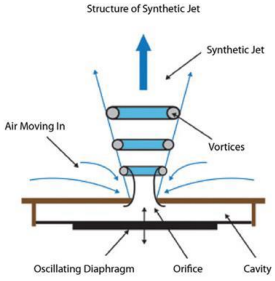


Figure 5-19 Synthetic jets

UN Regulation No. 10: Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility

Similar approach can be found in "Plasma actuators" solution, page 41.

5.3.5.5 Base Bleeding

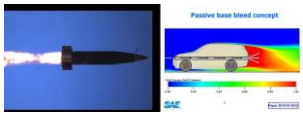


Figure 5-20 Base bleeding

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 51: Uniform provisions concerning motor vehicles having at least four wheels with regard to their sound emissions
Depending on the system used to generate the air mass flow, it can lead to bring on more No.ise. Active systems, like compressors are No.isier than passive systems like air deflectors.

5.3.6 Passive flow control

5.3.6.1 Vortex generators

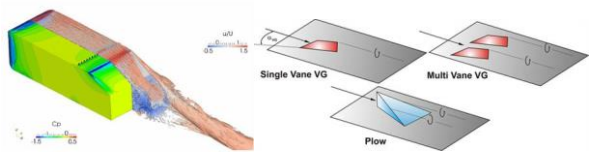


Figure 5-21 Vortex generators

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 61: Uniform provisions for the approval of commercial vehicles with regard to their external projections forward of the cab's rear panel
Vehicles that use vortex generators for reducing drag and improving the aerodynamics will have to take into account this regulation.
Any part of the vehicle considered as external projection shall be examined to reduce the risk of injures in an evet of impact.

5.3.6.2 Air Curtains

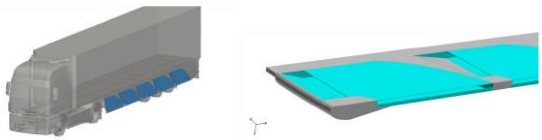


Figure 5-22 Air curtains

All regulations described in 5.3.1 General requirements for aerodynamic solutions, page 29 should be considered. In addition, other regulations that could have an impact are:

UN Regulation No. 73: Uniform provisions concerning the approval of: vehicles with regard to their lateral protection devices, lateral protection devices (LPD), and vehicles with regard to the installation of LPD of an approved type
On trailers where this option is applied as an extension of the side skirt, it should be evaluated these devices as lateral protection devices.
These devices could be approved a separate component or as a part of the vehicle. Both methods include some tests for these devices in order to ensure that the minimum requirements in case of impact are met.

As a summary of the different solutions have been created in Table 5-4 and Table 5-5.

	Active geometry solutions for the truck and the trailer	Active air deflector -truck	Active side skirt extension -truck	Inflatable gap seal	Extending air deflectors	Retractable trailer	Active ride height	Adaptable trailer shape	Active side skirt extension -trailer	Movable boat tail
UNECE REGULATIONS	UN R10: Electromagnetic compatibility EMC	General Impact								
	UN R13: Braking provisions to M, N and O vehicles	-	-	X	-	-	-	-	-	-
	UN R46: Devices for indirect vision	X	-	-	-	-	-	-	-	-
	UN R48: Installation of lighting and light-signalling devices	X	X	-	-	-	-	X	X	X
	UN R49: Emissions - heavy duty vehicles	General Impact								
	UN R55: Coupling components	-	-	X	-	X	X	-	-	-
	UN R58: Rear Underrun Protection	-	-	-	-	X	X	X	-	X
	UN R61: External projections cab of commercial vehicles	X	-	-	-	-	-	-	-	-
	UN R73: Lateral protection	-	X	-	-	X	-	-	X	-
	UN R79: Steering equipment	-	-	-	-	-	-	-	X	-
	UN R93: Front Underrun protective devices	-	-	-	-	-	X	-	-	-
	UN R102: Close-Coupling device	-	-	-	-	X	X	-	-	-
	UN R105: Specific features for carriage of dangerous goods	-	-	X	-	-	-	-	-	-
	UN R121: Hand controls, tell-tales and indicators	X	X	X	X	X	X	-	X	X
	UN R122: Heating systems	-	X	X	-	-	-	-	-	-
EU directives & regulations	Regulation (EU) 130/2012 Vehicle access and manoeuvrability	-	X	X	-	X	-	-	X	-
	Regulation (EU) 661/2009 General safety of motor vehicles	General Impact								
	Regulation (EC) 1230/2012: Masses and dimensions	General Impact								
	Directive (EU) 2015/719: Masses and dimensions in international traffic	General Impact								
	Regulation (EC) 595/2009: Emissions from heavy duty vehicles	General Impact								
	Directive (UE) 2010/48: Technical inspection on vehicles	General Impact								
	Directive (EC) 2007/46: Framework directive	General Impact								
	Regulation (EU) 2018/858: New framework directive	General Impact								
	Directive (EC) 2003/59*2006/103: Training of drivers	General impact								
	Regulation (EU) 351/2012: Lane Departure Warning Systems LDWS	-	X	-	-	-	-	-	-	-
	Regulation (EC) 1003/2010: Rear registration plate	-	-	-	-	-	X	X	X	-
	Directive (EC) 2006/126: Driving licenses	General impact								
	Regulation(EU) 458/2011:Installation of tyres	-	X	-	-	-	X	-	-	-
	Regulation (EU) 1005/2010: Towing devices	-	-	-	-	-	-	-	-	-
	Regulation (EU)19/2011: Statutory plate and VIN	-	X	-	-	-	-	-	-	-

Table 5-4 Regulatory matrix for active geometry solutions

		Passive geometry solutions for the truck and the trailer				Active flow control			
		Covered underbody	Covered rear wheels	Boat-tail	Trailer chassis covering	Tangential blowing	Boundary layer suction	Bade bleeding	Vortex generators
UNECE REGULATIONS	UN R10: Electromagnetic compatibility EMC	-	-	-	-	General Impact			
	UN R13: Braking provisions to M,N and O vehicles	-	X	-	-	-	-	-	-
	UN R39: Prescription for Speedometer	-	-	-	-	-	-	-	-
	UN R46: Devices for indirect vision	-	-	-	-	-	-	-	-
	UN R48: Installation of lighting and light-signalling devices	-	-	X	-	-	-	-	-
	UN R49: Emissions - heavy duty vehicles	-	-	-	-	-	-	-	-
	UN R51: Sound emissions	-	-	-	-	General Impact			
	UN R55: Coupling components	-	-	-	-	-	-	-	-
	UN R58: Rear Underrun Protection	-	-	X	-	-	-	-	-
	UN R61: External projections cab of commercial vehicles						X		X
	UN R73: Lateral protection	-	X	-	-	-	-	-	-
	UN R79: Steering equipment	-	X	-	-	-	-	-	-
	UN R89: Speed limitation device and installation	-	-	-	-	-	-	-	-
	UN R102: Close-Coupling devise	-	-	-	-	-	-	-	-
	UN R105: Specific features for carriage of dangerous goods	X	-	-	X	-	-	-	-
	UN R121: Hand control, tell tales and indicators	-	-	-	-	-	-	-	-
	UN R122: Heating systems	X	-	-	X	-	-	-	-
	UN R130: Lane Departure Warning System	-	-	-	-	-	-	-	-
EU directives & regulations	Regulation (EC) 1230/2012: Masses and dimensions	-	X	X	-	-	-	-	X
	Directive (EU) 2015/719: Masses and dimensions in international traffic	General Impact							
	Regulation (EC) 595/2009: Emissions from heavy duty vehicles	General Impact							
	Directive (UE) 2010/48: Technical inspection on vehicles	General Impact							
	Regulation (EU) 2017/2400: HD emissions	General Impact							
	Directive (EC) 2007/46: Framework directive	General Impact							
	Regulation (EU) 2018/858: New framework directive	General Impact							
	Directive (EC) 2003/59*2006/103: Training of drivers	General Impact							
	Regulation (EC) 1003/2010: Rear registration plate	-	-	-	-	-	-	-	-
	Regulation (EC) 109/2011: Spray suppression systems	-	-	-	-	-	-	-	-
	Directive (EC) 2006/126: Driving licenses	-	-	-	-	-	-	-	-
	Directive (EC) 2004/54: Tunnels in Trans-European road network	-	-	-	-	-	-	-	-
	Regulation (EU) 1005/2010: Towing devices	-	-	-	-	-	-	-	-
	Regulation (EU)19/2011: Statutory plate and VIN	-	-	-	-	-	-	-	-

Table 5-5 Regulatory matrix for passive geometry solutions and active flow control

5.4 WP4 matrix

The aim of WP4 Smart Loading Units is to investigate the potential to improve transport efficiency by flexible solutions for load optimization and load efficiency of vehicle combinations, considering the use of single trucks, tractor and semitrailer combinations (16.5 m), and truck, dolly and semitrailer combinations (25.25 m).

Figure 5-23 Craneable Smart Loading Unit

Bearing in mind the scope of work of WP4, the following comments were made for the regulations described below.

		Vehicle	*Use*	*Infraest.*
UNECE REGULATIONS	UN R10: Electromagnetic compatibility EMC	X		
	UN R13: Braking provisions to M, N and O vehicles	X		
	UN R29: Protection of the occupants of the car	X		
	UN R43: Safety glazing materials	X		
	UN R49: Emissions - heavy duty vehicles	X		
	UN R54: Tyres for commercial vehicles	X		
	UN R55: Coupling components	X		
	UN R58: Rear underrun protection	X		
	UN R61: Externals projection of the cab	X		
	UN R67: LPG Equipment and its installation	X		
	UN R73: Lateral protection	X		
	UN R89: Speed limitation device and installation	X		
	UN R100: Electric power train	X		
	UN R102: Close-Coupling device	X		
	UN R105: Specific features for carriage of dangerous goods	X	X	X
	UN R109: Re-treaded tyres	X		
	UN R110: CNG LNG Equipment and its installation	X		
	UN R117: Tyres: rolling resistance/sound emissions/ wet adhesion	X		
	UN R121: Hand control, tell tales and indicators	X		
	UN R130: Lane Departure Warning System	X		
	UN R131: Advanced Emergency Braking System (AEBS)	X		
EU directives & regulations	Regulation (EC) 1071/2009: Road transport operators		X	
	Regulation (EC) 1230/2012: Masses and dimensions	X	X	X
	Directive (EU) 2015/719: Masses and dimensions in international traffic	X	X	X
	Regulation (EC) 595/2009: Emissions from heavy duty vehicles	X		
	Directive (EC) 2007/46: Framework directive	X		
	Directive (EC) 2003/59*2006/103: Training of drivers		X	
	Regulation (EC) 1003/2010: Rear registration plate	X		
	Directive (EC) 2006/126: Driving licenses		X	
	Regulation (EU) 458/2011: Installation of tyres	X	X	
	Regulation (EU) 130/2012: Vehicle access and manoeuvrability	X		X
	Directive (EC) 2004/54: Tunnels in Trans-European road network			X
	Regulation (EU) 1005/2010: Towing devices	X		
	Regulation (EU)19/2011: Statutory plate and VIN	X		
	Regulation (EU) 2019/1213 On-board weighing equipment	X		
Standards	EN 13044-1: Intermodal loading units		X	X
	EN 283: Swap bodies - Testing	X		X
	EN 16973: Road vehicles for combined transport - Vertical transhipment	X	X	X
	EN 596-5: Railway specifications - Semi-trailer			X
	UIC 592: Intermodal loading units		X	X
	UIC 596-6: Codification system in combined transport		X	X
	UIC 571-4: Wagons in combined Transport		X	X

Table 5-6 WP4 Regulatory Matrix

Regulation (EC) 1071/2009: establishing common rules concerning the conditions to be complied with to pursue the occupation of road transport operator
This regulation establishes the common rules and conditions to pursue the occupation of road transport operator. Operators that are going to use smart loading units may need special requirements (such as trainings, qualification or new licenses) to be able and prepared to use new technology.

Directive 2006/126/EC: on driving licences
New smart loading units may require additional licenses for the drivers.

UN Regulation No. 61: uniform provisions for the approval of commercial vehicles with regard to their external projections forward of the cab's rear panel
The purpose of this regulation is to reduce the risk or severity of injuries sustained by a person coming into contact with the external surface of the vehicle in event of impact. This WP includes also the requirements for aerodynamic devices in Road-Rail Combined Transport. 5.2. The "external surface" of the vehicle shall not exhibit, directed outwards, any part likely to catch on pedestrians, cyclists or motor cyclists.

UN Regulation No. 105: uniform provisions concerning the approval of vehicles intended for the carriage of dangerous goods with regard to their specific construction features
The provisions of this Regulation apply to the construction of base vehicles of motor vehicles of category N and their trailers of category O1 intended for the transport of dangerous goods and which are subject to section 9.1.2. of Annex B to the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR).

Smart loading units for ADR vehicles may be different than others dedicated to other goods and carriage.

UN Regulation No. 130: provisions concerning the lane departure warning system
As WP4 also includes requirements for aerodynamic devices, this regulation may be affected depending on the position of the sensors with aerodynamic devices in active/passive position.

EN 13044: Identification and codification of intermodal loading units.
Intermodal loading units require certification to be transported by rail and must be fitted with a gauge code. In accordance with EN 13044, this codification for swap-bodies and semitrailers will be carried out directly by the manufacturer.

UIC 592: Intermodal Loading Units (other than semi-trailers) for vertical transhipment and suitable for carriage on wagons.
It lists the references for standardized intermodal loading units (ITUs) and sets minimum requirements for specific ITUs.

EN 16973: Road vehicles for combined transport - Semitrailer - Vertical transhipment.
This European Standard describes the railway-specific requirements relating to semi-trailers which are transported by rail with pocket wagons. The semi-trailers shall be suitable for handling by crane.

The semi-trailers rests with their wheels on the sunken loading area of the wagon and at the front with the fifth-wheel plate. The king pin is looked to the fifth-wheel plate, which secures the semi-trailer in all directions and must thus withstand the relevant forces.

EN 283: Swap bodies – Testing
Swap Body Testing is known as the most standard method of freight transportation in Europe, swap bodies are used between rail and road methods to carry goods across countries.

UIC 596-5: Railway specifications - Semi-trailer
This leaflet sets out regulations and provisions for semi-trailers with normal road transport characteristics for conveyance on fixed-recess carrier wagons. The provisions are valid for semi-trailers, gantry equipment/industrial trucks with grab handles, recess wagon types 1a and 1b in accordance with UIC Leaflet 571-4.

UIC 596-6: Conveyance of road vehicles on wagons
In order to facilitate and speed up transport in a reliable manner, a coding system for various elements of combined transport was established.
UIC 596-6 sets out the prescriptions for this system regarding ITUs, carrier wagons and lines.

UIC 571-4: Standard wagons - Wagons for combined transport
Describes the characteristics of the standard wagons used for road-rail traffic.

5.5 WP5 matrix

The objective of WP5 is to design a new Front-End Design to improve aerodynamics while improving vulnerable road user (VRU) protection.

		Impact	*Vehicle*	*Use*	*Infraest.*
UNECE REGULATIONS	UN R10: Electromagnetic compatibility EMC	Medium	X		
	UN R13: Braking provisions to M, N and O vehicles	Low	X		
	UN R29: Protection of the occupants of the car	High	X		
	UN R43: Safety glazing materials	High	X		
	UN R48: Installation of lighting and light-signalling devices	High			
	UN R49: Emissions - heavy duty vehicles	High	X		
	UN R54: Tyres for commercial vehicles	Low	X		
	UN R61: Externals projection of the cab	High	X		
	UN R73: Lateral protection	Low	X		
	UN R79: Steering equipment	High			
	UN R93: Front underrun protective devices	High			
	UN R100: Electric power train	Low	X		
	UN R105: Specific features for carriage of dangerous goods	Low	X	X	X
	UN R117: Tyres: rolling resistance/sound emissions/ wet adhesion	Low	X		
	UN R121: Hand control, tell tales and indicators	High	X		
	UN R130: Lane Departure Warning System	High	X		
	UN R131: Advanced Emergency Braking System (AEBS)	High	X		
	UN R151: Blind Spot Information Systems	High	X		
EU directives & regulations	Regulation (EC) 1071/2009: Road transport operators	Medium		X	
	Regulation (EC) 1230/2012: Masses and dimensions	High	X	X	X
	Directive (EU) 2015/719: Masses and dimensions in international traffic	High	X	X	X
	Regulation (EC) 595/2009: Emissions from heavy duty vehicles	High	X		
	Directive (EC) 2007/46: Framework directive	High	X		
	Directive (EC) 2003/59*2006/103: Training of drivers	Low		X	
	Regulation (EC) 1003/2010: Rear registration plate	Low	X		
	Directive (EC) 2006/126: Driving licenses	Low		X	
	Regulation (EU) 458/2011: Installation of tyres	Low	X	X	
	Regulation (EU) 130/2012: Vehicle access and manoeuvrability	Medium	X		X
	Directive (EC) 2004/54: Tunnels in Trans-European road network	Low			X
	Regulation (EU)19/2011: Statutory plate and VIN	High	X		
	Proposal for regulation: R(EU) 2019/… New General Safety Regulation	High			

Table 5-7 WP5 Regulatory Matrix

5.5.1.1 The envelope approach, an amendment to the Regulation (EU) No. 1230/2012 type-approval requirements for weights and dimensions of motor vehicles and their trailers

The chapter Motor Vehicle Working Group (MVWG) – Subgroup on Masses and Dimensions (page 18) already explains the context and reasons to introducing new amendments regarding aerodynamic flaps and elongated cabins, among others.

The WP5 of AEROFLEX project is in charge of designing an innovative Front End for more safety. In case this new cab becomes an elongated cab, it will have to comply with the requirements exposed in this regulation. In that case, the front face of the vehicle's cab will have to conform to parameters of the three-dimensional envelope as

set out in the Appendix 4 of Annex I and if the length of the loading area directly behind the cab doesn't exceed 10.5 m.

If any of the conditions set out in the Appendix are not met, the motor vehicle cab would not conform the parameters of the three dimensional envelope. One of the parameters that will define the envelope is the "rake", meaning the rearward inclination of the cab's front fascia from the vertical plane. The rake will be measured along the entire width of the cab, as located between the lower and the upper front fascia boundary lines, as it is shown in the following picture (currently, this angle is set at 3˚):

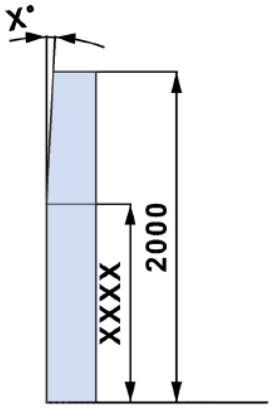


Table 5-8 Rake angle measurement

Another parameter that will define this envelope is the tapering of the sides. In the assessment zone, the front fascia will be tapered in such a way that the front part of the vehicle converges towards a common point that lies forward of the cab. Two symmetrical planes with a horizontal angle of 20˚ will define the boundaries for the tapering. No point of the actual surface should lie outward of the defined vertical plane.

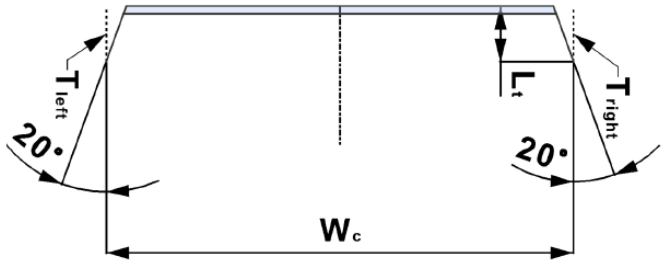


Table 5-9 Tapering envelope definition

Apart from complying with the dimensions of the elongated cab, the design will have to guarantee improvements regarding:

1. The comfort of the driver
2. The visibility
3. A safer situation in case of crashing against VRU
4. Aerodynamic performance

Finally, in case the cab is considered as elongated cab and all the requirements are fulfilled, the manufacturer shall indicate in the statutory plate with the following sentence: "95/53/EC ARTICLE 9A COMPLIANT".

5.5.1.2 New General Safety Regulation

On April 2019, the European Parliament approved the new General Safety Regulation with the oncoming rules requiring life-saving technologies in vehicles.

Safety features such as intelligent speed assistance and advanced emergency braking systems will have to be installed in new vehicles as from May 2022. Other advanced systems that will have to be fitted in the new vehicles are: alcohol interlock installation facilitation, driver drowsiness and attention warning, advanced driver distraction warning, emergency stop signal, reversing detection and event data recorder.

Regulation (EC) nº 661/2009 made the safety belt reminder system compulsory for the driver seat in all the passenger cars since 2014. Now it also becomes obligatory to fit for all front and rear seats of M1 and N1 vehicles, as well as front seats of N2, N3, M2 and M3 vehicles as from 1 September for new types and 1 September 2021 for all new motor vehicles.

The regulation also introduces amendments to enhance the direct visibility of pedestrians, cyclists and other vulnerable road users from the driver seat position.

5.5.1.3 Proposal for a new Regulation with regard to the Blind Spot Information System

The limited field of vision of the trucks, sometimes lead to collisions against cyclist during turning maneuvers at low speeds or standstill. Assistance systems are aimed to increase the safety of Vulnerable Road Users and reduce serious consequences.

The new regulation will ask for an early activation of an information signal in case a bicycle might be entering a critical area on the passenger side of the vehicle if the heavy vehicle would initiate a turn towards the bicycle. Additionally, the regulation also defines a different signal which should be given when the collision becomes unavoidable.

Currently, the proposal would be applied only for categories N2 and N3, but it is expected to include M2 and M3 in the near future.

5.5.1.4 Reinforcement of the lower front end

Different designs or passive safety concepts have been proposed after studying the most common accident scenarios where trucks are involved. With these concepts, current state of regulations is evaluated in order to verify its feasibility and search potential design gaps that should be legislated.

Is one of the common types of accident which the front of the truck hits the back of the car. This first solution considers improving the lower front-end area of the truck, in order to obtain a deformable structure able to absorb the energy in case of impact. Additionally, this structure could avoid the underrun of the car if it is close to the ground.

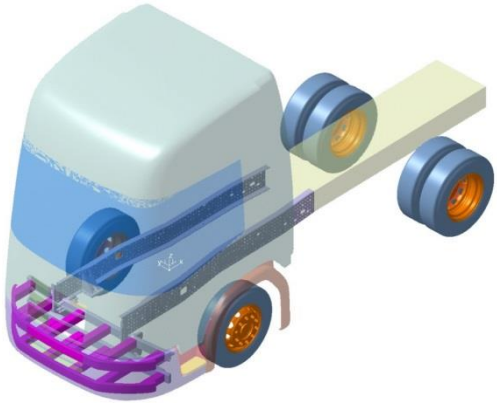


Figure 5-24 Reinforcement of the lower front end

UN Regulation 29: Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants of the cab of a commercial vehicle.
The new structure will lead to an elongated cab with different impact properties. It has to be tested and checked that this new shape is safe with regard to the protection of the occupants of the cab.
As this new design is still a "cab-over engine vehicle", it is necessary to test under frontal impact, intended to evaluate the resistance of the cab in frontal impact accident (defined as Test A in this Regulation). This test does not need to be carried if the manufacturer can show by computer simulation or calculations that the cab will not undergo dangerous deformation to the occupants under conditions of the test.
After testing, a survival space shall be exhibited allowing the accommodation of a manikin. Parts in contact with it, with a shore-hardness of less than 50 that can be moved away using a force of less than 100 N are not taken into account.

UN Regulation No. 43: Uniform provisions concerning the approval of safety glazing materials and their installation on vehicles.
Depending on the length of the lower safety structure, windscreen position or shape may be different from the current ones. According to this regulation, the windscreen shall be type approved for the vehicle type which is intended to be fitted.

UN Regulation No. 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices
If the shape of the front-end varies then the lights shall be adjusted and installed according to Regulation nº 48.

UN Regulation No. 79: Uniform provisions concerning the approval of vehicles with regard to steering equipment
The safety structure shall not interference the normal operation of the steering system. It shall be designed, constructed and fitted in such a way that it is capable of withstanding the efforts arising during the normal operation of the vehicle.

UN Regulation No. 93: Uniform provisions concerning the approval of front underrun protection devices (FUPDs), vehicles with regard to the installation of an FUPD of an approved type, and vehicles with regard to their front underrun protection (FUP)
This Regulation is important to ensure that the front underrun protection device fulfils prescribed requirements for safety.
The main purpose is to offer effective protection for vehicles of categories M1 and N1 against underrunning in the event of a frontal collision. The protection device shall meet these requirements:

- Adequate resistance to forces applied in parallel, satisfying some dimensional requirements of the regulation.
- For N3 vehicles, the section height of the device shall not be less than 120 m. Moreover, lateral extremities should be rounded with a radius of curvature of not less than 2.5 mm.

UN Regulation No. 130 & 131: with regard to the Lane Departure Warning System (LDWS) and Advanced Emergency Braking Systems (AEBS)
The new front-end design involves changing the position of the sensors of some active and assistant systems. In this case, the position of the sensors is not important but the manufacturer shall ensure that its operation and functionality is still fulfilled.

Regulation (EU) No 1230/2012: requirements for masses and dimensions of motor vehicles and their trailers
The regulation stablishes the dimensions of each category of vehicles. In the case of N3 vehicles, le maximum permitted length is 12 m. If the length of the cab is extended in order to install the structure, the total length of the cab will be increased, thus the loading area of the vehicle will be reduced.
Moreover, there are requirements regarding the manoeuvrability of the vehicle:
"6.3.1. The vehicle shall manoeuvre inside an area defined by two concentric circles, the outer circle having a radius of 12,50 m and the inner circle having a radius of 5,30 m".

Directive (EU) 2015/719: laying down for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic.

Regulation (EU) 96/53 establishes maximum dimensions of motor vehicles and their trailers. For articulated vehicles is limited to 16.50 m and for road trains is limited to 18.75m.
On the other side, Directive (EU) 2015/719 is an amendment that provides derogations from the maximum authorized weights and dimensions of vehicles and combinations for safety and emissions purposes. As it is stated in the following paragraph, vehicles that introduces concepts as safety structures, may be exempted of maximum length restrictions in a near future:

"(5) Enabling vehicles to have a new cab profile would contribute to improving road safety by reducing blind spots in the driver's vision, including those under the windscreen, and ought to help to save the lives of many vulnerable road users such as pedestrians or cyclists. ***A new cab profile could also incorporate energy absorption structures in the event of a collision.*** *Furthermore, the potential gain in the volume of the cab should improve the driver's safety and comfort. Once improved safety requirements for longer cabs have been developed, consideration can be given to whether it is appropriate to apply them to vehicles which do not benefit from the length extension."*

Currently, the European Commission is preparing a new legislative proposal to amend Regulation (EC) No 1230/2012. One of the concepts introduced to this proposal is the elongated cab. The new appendix 5 of the regulation, defines a three-dimensional cab envelope with some boundaries. Vehicles that comply with all the restrictions are considered as elongated cab, and can be larger than usual (maximum length pending to be discussed and approved by the Commission).

5.5.1.5 Introduction of absorbers

This scenario studies collisions where the front of the truck hits the back of another commercial vehicle (more than 3.5 tones). This is a critical case for the occupant of the truck that crashes into the back of the commercial vehicle.
The proposed solution is the extension of the front-end of the truck allowing the positioning of absorbers able to reduce the intrusion inside the truck cabin.

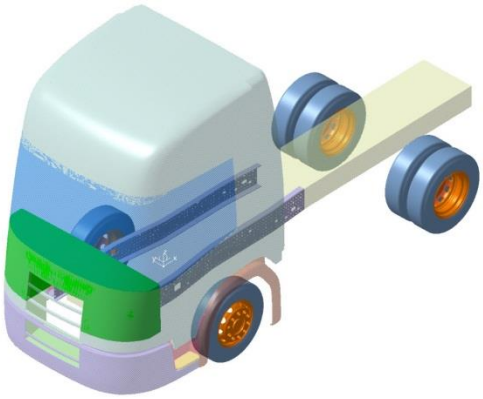


Figure 5-25 Introduction of absorbers

In term of regulations, this solution is very similar to 1st solution, so many of the regulations that were affected will be taken into account in concept.

UN Regulation 29: Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants of the cab of a commercial vehicle.
In the same line than the 1st option, shall be verified that this new structure fulfils all the requirements regarding the protection of the occupants of the cab.

UN Regulation No. 122: Uniform technical prescriptions concerning the approval of vehicles of categories M, N and O with regard to their heating systems.

Due to its proximity to the passenger compartment, this Regulation could affect to the design of this solution.
The regulation describes some requirements regarding the position of the heater such as:

- The heater shall not constitute a risk of fire. This shall be deemed to be met if the installation ensures an adequate distance to all the parts and suitable ventilation.
- Body sections and any other components in the vicinity of the heater must be protected from excessive heat and the possibility of fuel or oil contamination.

Taking into account this, the final version of the protective device could be modified in order to fulfil all the requirements.

UN Regulation No. 130 & 131: with regard to the Lane Departure Warning System (LDWS) and Advanced Emergency Braking Systems (AEBS)
Like the 1st option, systems that use sensors on the front end part of the vehicle shall ensure that all of them are still operative with the extension of the front.

Regulation (EU) No 1230/2012: requirements for masses and dimensions of motor vehicles and their trailers
Same approach than 1st option.

Directive (EU) 2015/719: laying down for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic.
Same approach than 1st option.

5.5.1.6 Flexible areas for impact mitigation

Impacts with pedestrian are also studied. In this case, solutions can be based on two options: Run over avoidance and impact mitigation.
For run over avoidance, implemented solution include the extension of the front bumper as close as possible to the ground, and in case of frontal collision, provide to the front end with a new shape that would deflect the pedestrian out of the path.
Regarding impact mitigation, some flexible areas will be created in order to reduce the impact on critical pedestrian zones (mainly head and pelvis).

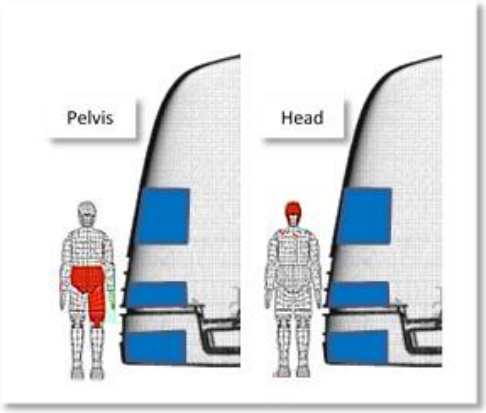


Figure 5-26 Flexible areas for impact mitigation

Regulation (EU) No 1230/2012: requirements for masses and dimensions of motor vehicles and their trailers
According to this regulation frontal protection devices for category N3 are required to be taken into account for the determination of the length dimensions. There are some exceptions explained on Appendix 1.

a) Where several devices are fitted at the front, the total protrusion of those devices shall not exceed 250 mm.
b) The total protrusion of the devices and equipment added to the length of the vehicle shall not exceed 750 mm.

6 Current work for regulations and open discussions

In this chapter, the different on going initiatives and Working Groups will be introduced.

6.1 Levels of Driving Automation

SAE standard J3016 provides a taxonomy describing the full range of levels of automation in on-road motor vehicles, from no driving automation (level 0) to full driving automation (level 5). The report provides detailed definitions for these six levels of driving automation in the context of motor vehicles and their operation on roadways.

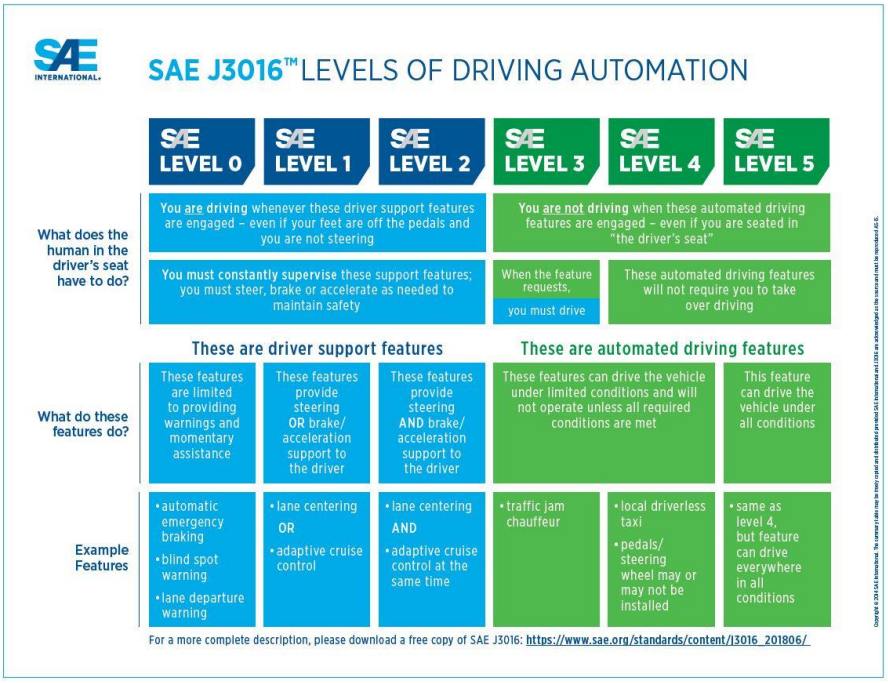


Figure 27 Levels of Driving Automation

6.2 Intelligent Transport Systems / Automated Driving (ITS/AD)

The World Forum for Harmonization of Vehicle Regulations (WP.29) promotes Intelligent Transport Systems (ITS) matters on-board of vehicles, such as Lane Departure Warnings Systems (LDWS), Advanced Emergency Braking Systems (AEBS) and on-board diagnostics (OBDs). Intelligent Transport Systems play an important role in shaping the future ways of mobility and the transport sector. However, the huge potentials and benefits can only be reaped if ITS solutions are put in place and internationally harmonized to the extent.

In response to the growing interest and application of Advanced Driver Assistance Systems (ADAS) technologies, as well as recognizing the amendment of 1968 Vienna Convention, it was proposed that the ITS Informal Group, should refocus its discussion on automated driving technologies and, as a result, changed its name to “Informal Group on ITS/Automated driving (IG-AD)”.

On 2016, a Task Force was established as a subgroup of the Informal Working Group on Intelligent Transport Systems / Automated Driving (IWG on ITS/AD) of WP.29 to address Cyber Security and Over-the-air (TF-CS/OTA) issues. The task force consisted of members of representatives from contracting parties and non-governmental organizations, e.g. FIA, CITA, ITU, OICA and CLEPA and were responsible to develop two Recommendations to be finished by March 2018. Since the group was established on December 2016, it had 9 physical meetings and 6 web meetings.

In order to deliver the recommendations to ITS/AD, TF-CS/OTA asked to extend the mandate until June 2018.

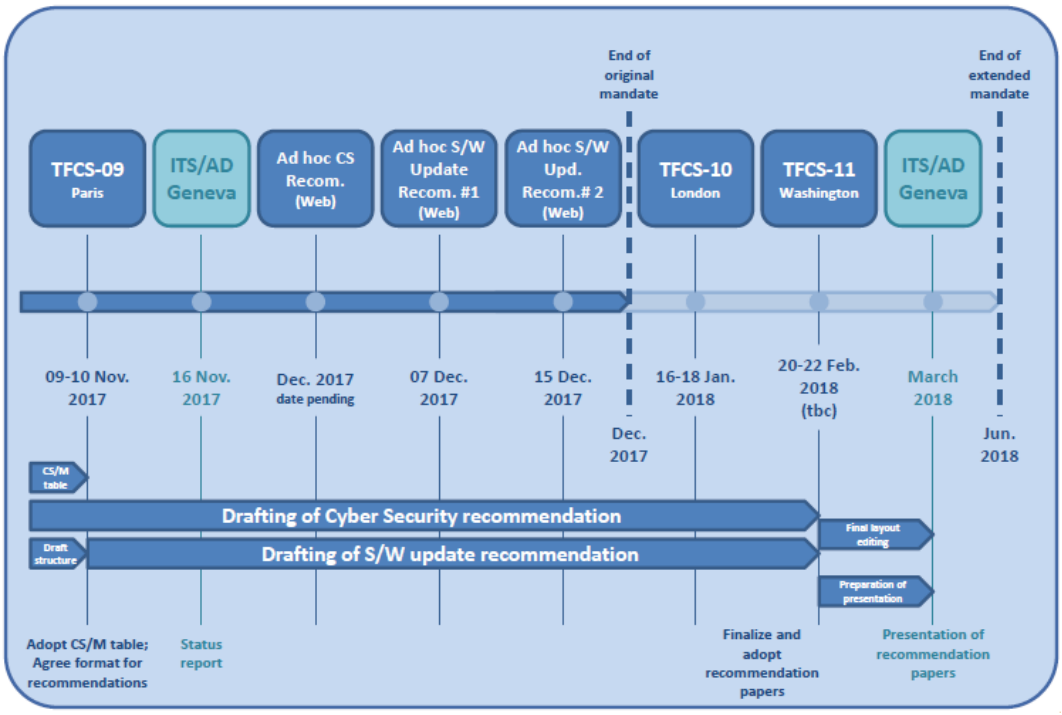


Figure 6-28 Workplan and timing of TF-CS/OTA group

During the World Forum for Harmonization of Vehicle Regulations on its 173rd session, of November 2017, it was agreed that the group (ITS/AD) should develop a new Regulation for cybersecurity with a sufficiently flexible approach to ensure the Regulation remained relevant given the rapid pace of progress in this field. WP.29 also noted that an approach, like that proposal for cybersecurity, would be adopted for over-the-air and wired software updates.

Both regulations on Cybersecurity and Software Updates will become important for this project since AEROFLEX introduces an Advanced Energy Management System to the vehicle. These systems are updated with new software versions several times during its whole life cycle to improve the performance, efficiency and all these changes shall be evaluated to ensure that the vehicle is still compliant with the relevant and affected regulations. Additionally, the manufacturers shall assure the vehicle safety in case of cyber-attacks and protect all the data from unauthorized access. Assessments shall be made to identify key threats and vulnerabilities to vehicles, and once identified set out key mitigations that will reduce or minimise them.
During the last meetings of the Informal Group ITS/AD, there were concluded some major results and actions to keep going the following meetings:

12th session, 22 June 2017

At WP.1 session of March 2017, the basic principles on the role of the driver in automated driving were discussed. Specifically, if the driver's secondary tasks could be allowed when the driver is able to take over the driving from the system.

Regarding Cyber Security and Data Protection, eighty-six threats related to security were identified, and how to prevent or mitigate these threats was discussed.

CS/OTA task forces terms of reference were approved. CS/OTA-TF will discuss on following meetings what type of document should be developed (regulation, guidelines or other) as an outcome.

13th session, 16 November 2017

At WP.1 session of September 2017, three items regarding automated driving were discussed. First of all it was agreed that secondary activities will be allowed, but as the Level 3 technologies are expected to be introduced into market in the near future, a further clarification regarding allowed secondary activities is needed.

It was decided to continue discussions on situations where the driver parks the vehicle by remotely controlling it from outside the vehicle.

Finally, a plan to create a guidance document regarding Levels 4 and 5 to be adopted in 2018 was decided.
To submit the automated driving definition table for developing the UN Regulation Table as a formal document to WP.29.

In order to embrace all the possible driving scenarios in the certification of automated driving, OICA proposed a regulation structure comprised of three elements: classical physical certification test, real-world driving test, and audit (simulation, self-declaration).

The documentation below includes the proposal for the definitions of automated driving and the general principles for developing a UN Regulation on automated vehicle.

ECE/TRANS/WP.29/2017/145

14th session, 15 March 2018

The conclusions of this meeting are not published yet, but the WP.29 of March, received a brief status report of the informal group exposed on the document ECE/TRANS/WP.29/1137. WP.29 noted and highlighted the importance for to group to reach a consensus on:

(a) the obligation for the manufacturer to possibly provide support for software updates during a defined time (e.g. 10 years)
(b) regulatory provisions on both software and hardware updates and
(c) the definition of a reference model for a secured vehicle

15th session, 21 June 2018

During the last meeting of the group, the terms of references of a new task force were presented. The group recognised the need of ensure the safety on vehicles fitted with advanced systems, so this dedicated group could focus in testing and assessing the functionalities of automated driving systems.

The objective of the task force, called Automated Vehicle testing, is to develop a regulatory regime that asses the vehicles automated systems so as to realise the potential road safety and associated benefits under real life traffic.

In this first proposal it is intended to propose a regulatory draft by June 2020.

On the other hand, a status report of Cyber Security and Software Over the Air recommendation handbooks was presented to the group. These recommendations are aimed to provide guidelines to technical services and approval authorities for assessing the manufacturers systems.

6.3 GRVA (Former GRRF)

6.3.1 Automatically Commanded Steering Function (ACSF)

The Informal Working Group on Automatically Commanded Steering Function (ACSF) was created on April 2015 with the aim to report to the WP29 about the increase of the current speed limitation for ACSF in UNECE Regulation No.79, which was 10 km/h.

During 2017, the Informal Working Group wrote a proposal for revision of the Terms of Reference on ACSF. The group should review the requirements and limitation associated with ACSF as defined in UN Regulation No. 79. The following issues shall be treated by the IWG:

- Review the current speed limitation of 10 km/h with the purpose of permitting ACSF functionality during interurban journeys.
- Define Human Machine Interface (HMI) requirements for communicating between ACSF-system and the driver (e.g. system status, malfunction, transition)
- Define requirements to enable the evaluation of ACSF during periodic technical inspection.
- Outstanding issues identified during the eighty-second session of GRRF shall be addressed. Constraints:
    - The driver shall be able to activate and deactivate the system.
    - The driver shall, at all times, be able to override the system.

The group divided the work in 3 steps (ECE/TRANS/WP.29/GRRF/84). The first step includes all the work related with less complex ACSF categories (CSF, CAT A and CAT B1, adopted by WP.29 in 171th session), to be completed by the eighty-second session of GRRF (September 2016).

As second step, there is included a function of a single manoeuvre (lane change) when commanded by the driver, to be completed by the eighty-fifth GRRF (December 2017).

Finally, further development of ACSF shall be completed by the eighty-eight session of GGRF of February 2019.

16th session, 23 January 2018

The target of this meeting was to define the basic requirements on Category B2 (ACSF-16-12). Before this, it was necessary to define the concept for this category between SAE level 2 or 3.
The contracting parties showed concern on the confusion associated with having ACSF of Category-B2 on basis of SAE Level 2 and 3 on the market. On level 2 side activities are not allowed, while Level 3 allows some specific secondary activities.

Finally, Contracting Parties agreed to work for ACSF of Category on basis of SAE Level 3.

The group also discussed about the inclusion of ACSF of Category 2. The main functional difference between C2 and existing category C is that while in category C the lateral movement towards lane marking is initiated automatically, with C2 the movement is initiated by further deliberate action of the driver.

The industry have a strong interest for ACSF-Ce because is more natural Human Machine Interface, as the driver has full control of the whole movement, and this permits to increase the maximum time between the Lane Change Procedure and the Lane Change Manoeuver.

17th session, 11 April 2018

During this meeting, the Informal Group worked on the driver monitoring system of the vehicles. With vehicles that use Level 3 systems, it's important to develop and provide technical means to detect that the driver is in position to take over control within the transition demand period. The main proposals of this group are: on the one hand to ensure that the driver is on the seat and with the belt fastened, and on the other hand to ensure that the driver is not sleeping and showing activity every few minutes (to be confirmed), detecting the eyelid or the head position.

18th to 22nd session

Since last year, five sessions from this informal group has been done. The group has been working on the requirements that should apply to "Automated Lane Keeping Systems (ALKS)". This system is defined as a function that is activated by the driver and keeps the vehicle within its lane by influencing the lateral movement and controls the longitudinal movement for extended periods without further driver command at low speed (to be defined, currently this value is set at 60 km/h).

At the present time has minor interest for this project, as it is intended to apply only for M1 vehicles.

6.3.2 Task Force on Cyber Security and Software Updates (CS/OTA)

This task force was stablished as a subgroup of ITS/AD to address Cyber Security and Software Updates (CS/SU) issues.
The task defines detailed guidance or measures on how to meet the objectives and requirements on CS/SU and considers what assessments or evidences could be required to demonstrate compliance for type approval.

Starting from the draft recommendations, two new draft UN Regulations are developed. Together with these Regulations, two guidance documents are developed by the group, defining the processes, procedures, and evidences that are required in each point. This way, the group wants to clarify and harmonize the understanding and testing of the technical services.

Both regulations introduce an innovative way of assessing and certificate: The need of assessing the management systems used by the manufacturers, and the approval of the vehicle type in a second step.

- It is also necessary to consider how to address post-production phase (stating when a vehicle type ends its production).
- There are no specific test provisions. An assessment of the manufacturer processes and procedures is performed.

Due to its complexity and innovative approach, a test phase has been performed where both Technical Services/Approval Authorities and manufacturers evaluated the requirements asked by each regulation, and the different evidences that the manufacturer could share to fulfil them. After this test phase, an interpretation document of the regulations and the requirements will be finished, and final amendments to the draft regulations will be implemented.

The diagram in Table 6-1 shows the expected timetable of the test phase and report proposals.

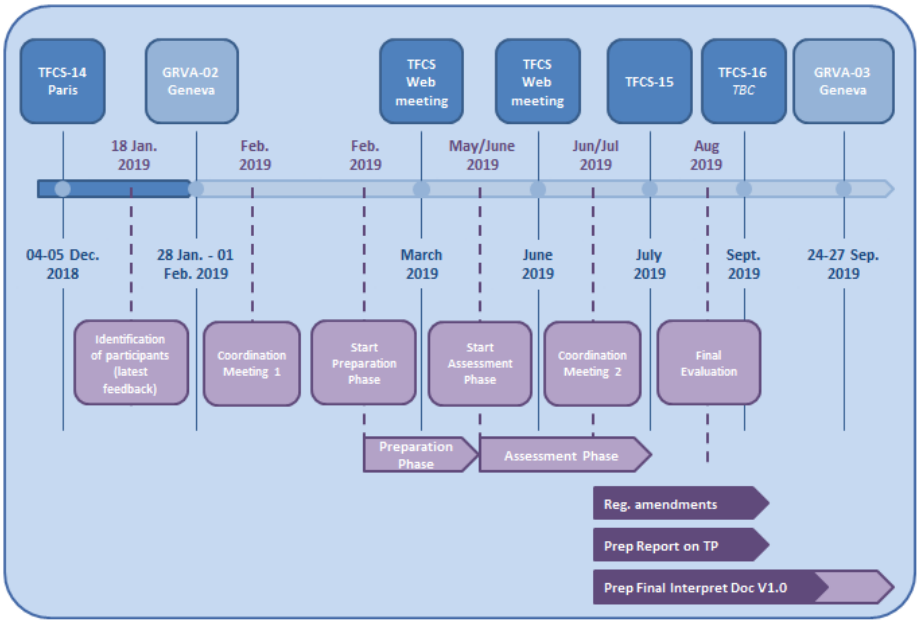


Table 6-1. Test Phase expected timetable

Cybersecurity Draft Regulation.

Defines the requirements to address key cyber threats and identified vulnerabilities, in order to assure the vehicle safety in case of cyber-attacks.
It also defines requirements for data protection from unauthorized access.

Software Over the Air Draft Regulation

Stablishes requirements for certification, ensuring the software updates safe execution to the vehicles, and how software changes should be managed and to ensure that they are performed safely and securely via an over-the-air updates also.

6.4 GRSP

6.4.1 Deployable Pedestrian Protection Systems (DPPS)

In 2005, GTR No.9 proposed a “Certification Standard for Type Approval Testing of Active Deployable Systems of the Bonner Area” (INF GR/PS/141 Rev. 1). Several Contracting parties had used this document as guideline to certify such systems.

With the upcoming popularity of such deployable systems, a more detailed and binding procedure began to be needed. This resulted in the authorization of WP.29 in November 2016 to develop an amendment for GTR No.9 in a Task Force. The intention was to develop a new annex covering the test procedure for DPPS where needed.

Since this Task Force was created in 2016, they have met 5 times. During the first discussions of the TF, it was noted that some new requirements may need to be defined, so the Chair asked to WP.29 to transform the TF-DPPS into an Informal Working Group. It was approved in March 2018.

The objective of the Informal Working Group on Deployable Pedestrian Protection Systems (Terms of Reference from IWG-DPPS/1/03) is to develop a proposal for a test procedure for DPPS such as active bonnets, external airbags etc. The procedure will serve for the testing of such systems to show compliance with the requirements of GTR No. 9. However, the IWG will also develop new and more detailed requirements, where needed, so that the new procedure guarantees that deployable systems are correctly activated as designed to protect pedestrians and other vulnerable road users, and provide the same level of protection to pedestrians and other vulnerable road users as non-deployable systems. Consequently, the relevant sections of GTR No. 9 will be amended.

Finally, the IWG DPPS shall also consider the development of a corresponding proposal to amend the UN Regulation 127 on Pedestrian Safety.

The work plan for this informal group is to submit an informal draft to GRSP by the end of 2018, and the formal proposal in May 2019. The adoption of the final document by WP.29 would be in November 2019.

Proposal for amendment to Regulation No 127

Since active suspensions are available, it is possible to change the height of the vehicle while driving. The amendment wants to ensure that active suspension systems are considered for type approval in any case, so new requirements are defined.

6.5 GRSG

6.5.1 Vulnerable Road Users (VRU-Proxi)

The informal working group on awareness of Vulnerable Road Users proximity in low speed manoeuvres (VRU-Proxi) shall develop a draft regulatory proposal that will enhance the driver's ability to detect vulnerable road users (VRU). It shall consider the approval of vehicles with regard to the direct field of vision, the approval of systems for the detection of VRU and the approval of devices for indirect vision.

On his first approach, the group shall focus on vehicles of categories m and N, but it shall also consider the relevance of addressing the vehicles of category O.

The informal working group also announced the intention to submit to GRSG session of April 2018 the revised proposal of the new Regulation on **Blind Spot Information System** (BSIS).

The current proposal (ECE/TRANS/WP.29/GRSG/2017/11) introduce the requirements for this system, intend to be fitted to heavy goods vehicles to protect vulnerable road users. The regulation applies to vehicles of categories N2 (>8 tonnes gross vehicle weight) and N3, but other vehicles may be approved if the manufacturer requires it.

Final proposal of UN Regulation No 151.

The final draft UN Regulation No 151 on BSIS had been adopted by WP.29 at the March 2019, and it is expected to enter into force in October 2019 (ECE/TRANS/WP.29/2019/28).

6.6 Regulations under discussion

All the specialized Working Parties (GRs) meet several times every year to discuss about all the existing regulations, and also about the necessity to create new ones. When certain modifications in the regulatory acts are agreed, the documents shall be presented in the WP.29 in order to be accepted.

The following table shows the modifications that the Working Parties announce during the WP.29 of March and June 2019, with the document that summarizes the changes for each regulation. This table only shows those Regulations that are related with the scope of the project.

It is important to remark that this list can grow during next months, and more proposals for amendments could be proposed:

Regulation	Current version	Document/s under discussion	Version to vote
R013: Braking provisions to M, N and O vehicles	R013.11 Supp. 16	No document	
R079: Steering equipment	R079.03	ECE/TRANS/WP.29/2019/73	R079.03 Supp 01
R043: Safety glazing materials	R043.01 Supp. 08	ECE/TRANS/WP.29/GRSG/2017/15	R043.01 Supp. 07
R067: LPG Equipment and its installation	R067.02	ECE/TRANS/WP.29/GRSG/2017/26; ECE/TRANS/WP.29/GRSG/2017/27	R067.01 Supp. 15
R110: CNG LNG Equipment and its installation	R110.03 Supp 01	ECE/TRANS/WP.29/2019/16	R110.04
R073: Lateral protection device	R073.01 Supp 01	ECE/TRANS/WP.29/2019/11	R073.01 Supp 02
R010: Electromagnetic compatibility	R010.05 Supp 01	ECE/TRANS/WP.29/2019/20	R010.06

Table 6-2 Proposal of amendments on the Regulations

6.7 ISO/SAE 21434: Road vehicles – Cybersecurity Engineering

Preparing the new edition of ISO 26262, there was the question if the standard should also consider cybersecurity. It was agreed that security is sufficiently large and special topic to warrant its own standard, hence the development of SAE Recommended Practice J3061 and ISO/SAE 21434.

ISO/SAE 21434 is still under development and will consider from the cybersecurity perspective where interactions are required with functional safety.

Industry also continues to develop standards for functional safety, with Edition 2 of ISO 26262 due to be published during Spring 2018.

This standard shall:

- Give uniform definition of notions relevant to automotive security.
- Specify minimum requirements on security engineering process and activities, and define –wherever possible- criteria for assessment.
- Describe the state of the art of security engineering in automotive E/E development.

The document will also specify the requirements for cybersecurity risk management for road vehicles, their components and interfaces, throughout engineering (concept, design, development…), production, operation, maintenance, and decommissioning.

A framework will be defined to include the requirements for a cybersecurity process and common language for communicating and managing cybersecurity risk among stakeholders.

The standard is applicable to road vehicles that include electrical and electronic (E/E) systems, their interfaces and their communications, but does not prescribe specific technology or solutions related to cybersecurity.

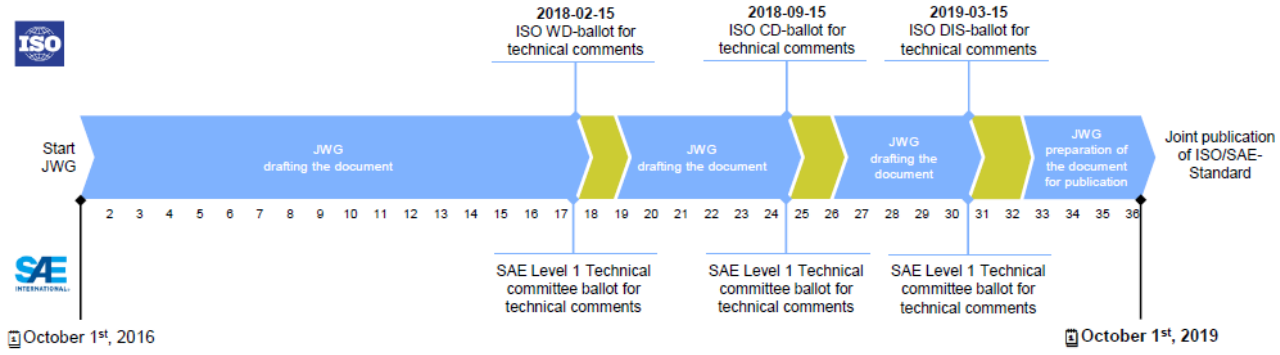


Figure 6-29 Overall Schedule. (TFCS-05-12 (OICA-CLEPA)

6.8 EU Regulation on CO2 emissions and fuel consumption of HD vehicles

Despite significant improvements in fuel efficiency, total CO2 emissions of the heavy-duty vehicle (HDV) fleets rose by over 30% between 1990 and 2007, mainly due to increasing road freight traffic, and are currently around 19% above 1990 levels.

Projections indicate that, without policy action, total emissions from HDVs would increase by up to 10% between 2010 and 2030.

Further action is therefore required to curb emissions from HDVs and deliver the objective set out in the Commission's 2016 Low-emission mobility strategy to reduce transport greenhouse gas emissions by at least 60% from 1990 levels by 2050.

The Commission has set that, as of 1 January 2019, truck manufacturers will have to calculate the CO2 emissions and fuel consumption of new vehicles they produce for the EU market, using the new Vehicle Energy Consumption Calculation Tool (VECTO). These CO2 emissions shall be below the limits stated by Regulation (EU) 2019/1242 setting the CO2 emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No. 595/2009 and (EU) 2018/956. This information will be declared for the registration of vehicles under the EU type-approval legislative framework, in application of the Regulation 2017/2400 implementing Regulation (EC) No 595/2009 of the European Parliament and of the Council as regards the determination of the CO2 emissions and fuel consumption of heavy-duty vehicles and amending Directive 2007/46/EC of the European Parliament and of the Council and Commission Regulation (EU) No 582/2011.

Member States and the European Commission will monitor and report (Regulation (EU) 2018/956, whose Annex I has been amended by Regulation (EU) 2018/888) the declared registration data on CO2 emissions and fuel consumption concerning new HDVs registered each calendar year. In an initial stage this Regulation is covering new trucks above 7.5 tonnes starting with vehicle groups 4,5, 9 and 10, which are the ones that contribute to most of the road transportation CO2 emissions. However, it has been discussed that a review of this Regulation will be necessary in 2022 in order to assess the modalities for implementation and, most important, to review the scope to cover also smaller lorries, as well as buses, coaches and trailers. With this new monitoring and reporting scheme, the Commission will collect the declared CO2 emissions and fuel consumption data via a monitoring and reporting system. The data will be made publicly available by the European Environment Agency on behalf of the Commission, starting in 2021 to cover data monitored during the reference period (July 2019 – June 2020). The new system will complement the existing EU reporting scheme for cars and vans.

Additionally, the new CO2 emissions standards regulation for HDVs (Regulation (EU) 2019/1242) which entered into force in Aug 2019 sets target levels for CO2 emissions of new trucks for 2025 and 2030.

- In 2025 , 15% below the reference period July 2019 – June 2020
- In 2030, at least 30% lower than in the reference period. This target shall be reviewed in 2022.
  Super-credits are used to award the sales of electric trucks, from 2025 from above a 2% benchmark.

Long haul EMS combinations for the time being fall in vehicle groups 5, 9, 10, 11 and 12, see Figure 6-30.

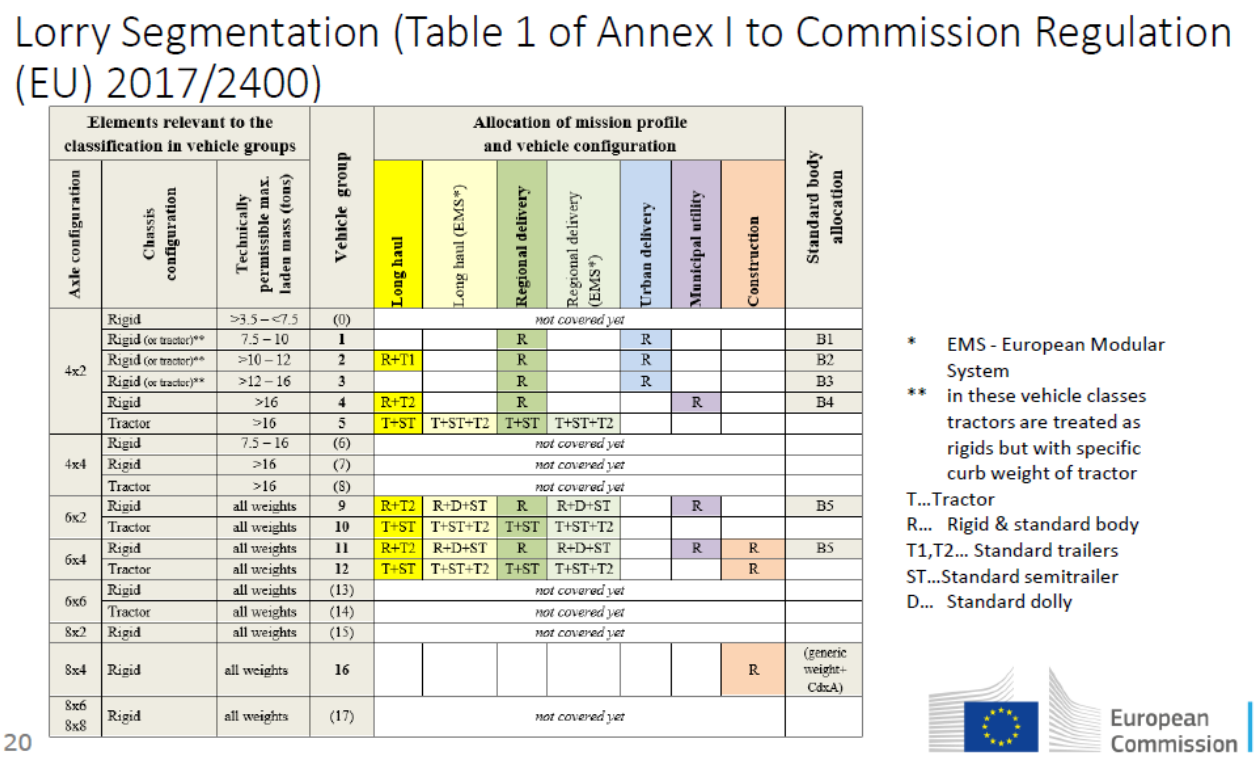


Figure 6-30 Lorry segmentation and allocation of mission profile and vehicle configuration for the EU CO2 Regulation (EU) 2017/2400.

A separate section has been reserved for this regulation in this deliverable, as it has a direct relationship with the efficiency improvements which are the core of WP2 to WP5.

VECTO is the new simulation tool that shall be used for the purposes of determining CO_2 emissions and fuel consumption of new vehicles according the Regulation (EU) 2017/2400, amendment of R(EC) 595/2009. VECTO is a simulation tool that combines test results and standard look-up values from different components of a heavy-duty vehicle to simulate the CO2 emission and fuel consumption of the whole vehicle.

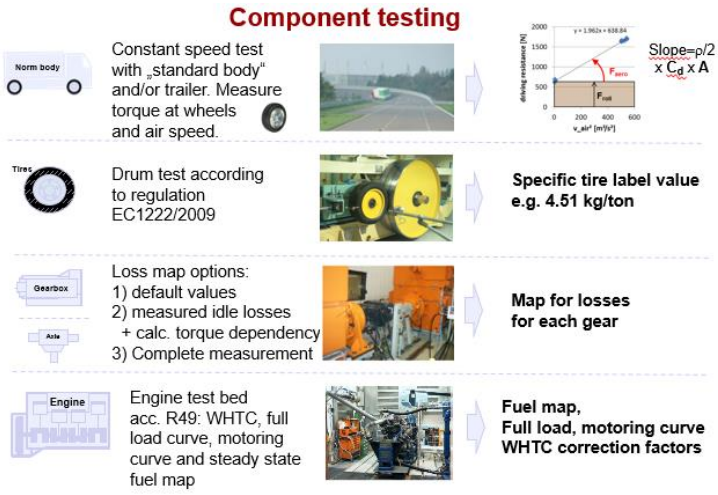


Figure 6-31 Component testing summary

This new regulation is not just based on CO_2 emissions and fuel consumption measurement, it goes even further beyond introducing the concept of "air drag measurement" in the vehicle homologation frame. A constant speed test is prescribed for the determination of C_dxA value of a truck with defined standard bodywork and a defined standard semi-trailer. This makes VECTO one of the main tools to be considered from the AEROFLEX project perspective.

Some of the most critical characteristics of the heavy-duty vehicles require more specific tools to process the tests results and obtain a more real and concrete value; the engine or the vehicle aerodynamics.

For air drag the air drag pre-processing tool is to be used which processes and makes the complex calculations based on measurement data from a test track to determine the C_dxA_{cr} (drag coefficient x cross sectional area) of the vehicle, which is one of the necessary parameters to be introduced in the main simulation tool in order to determine the CO2 and fuel values for each vehicle unit.

The influence on each WP is described below:

- WP2: As this working package is mainly focused on the powertrain management so that the main influence of VECTO could come for the part of the engine and also for the Smart Power Dolly (SPD) as these are the parts with a powertrain system that could have a different management.

  The powertrain system is the main source of pollutant emissions, so what is expected is that Regulation (EU)2017/2400 will push into more efficient powertrain systems. Nowadays there is no limit stated by the regulation to fulfil or not with it, but the influence that is going to be the commercial comparison between the different manufacturers according their VECTO values, could be even harder to achieve the aim.

- WP3: Working package 3 is for the Aerodynamics Features for the complete vehicle. To date only standard configurations and bodywork are used for the CO_2 determination.

  It has been already seen, thanks to VECTO simulations, that the aero package of a heavy-duty vehicle could mean a reduction of several l/100km and a proportional reduction of CO2 emissions.

  Nowadays there is no threshold stated for the Air Drag, but as this new regulation looks for more efficient vehicles in our roads, it is highly possible to have Air Drag limits in a short-middle future to comply based on current VECTO results.

- WP5: This working package's aim is the vehicle front end design; this is directly related with the working package 3, as the front end of the truck is the part with the biggest influence in the air drag of the vehicle.

Although the most aerodynamic front end is looked for, the vehicle shall comply also with all the security standards in case of collision with other vehicle or with a pedestrian, so in this case the design of the cabin shall have a really detailed development. CFD models and virtual testing according VECTO requirements will play a very relevant role in this part.

Regulation (EU) 2017/2400 deals with the CO2 emissions of the vehicle as a whole, instead of following the classical "engine-only" approach. This WP will follow the same strategy, so the proposals made will affect the complete vehicle, instead of studying the effect on the different WP separately. So far, however only standard trailers are to be used for the simulations.

6.8.1 VECTO future steps

Regulation (EU) 2017/2400 can be considered a first step towards a more stringent control of CO2 emissions and fuel consumption for HD vehicles. There are already new tenders and calls focused on further refinements of VECTO, also extending the tool to other vehicle groups and technologies.

These efforts essentially focus on:

1. The extension of VECTO to new vehicle categories: buses, medium lorries, trailers, etc.
2. The development of the simulation tool so it includes a couple of technologies or systems (i.e. certain types of transmissions and gear boxes, PCC – Predictive Cruise Control system, hybrid technologies like dual fuelled engines).
3. The preparation of legislation to amend the current regulation in order to include new aspects into the regulatory framework

As a consequence, this WP will follow closely and carefully every single initiative related to CO2 emissions and fuel consumption certification for HD vehicles, especially those related to new vehicle configurations.

6.9 European Commission: Road transport and logistics initiatives

In 2011 the European Commission adopted the White Paper Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system in the context of the Union's 2020 growth strategy. The general objective of this Roadmap is to define a long-term strategy to make the European Union (EU) transport system more efficient, safe and secure.

The Roadmap differs from earlier White Papers in its scope since it is based on a vision that spans four decades, up to 2050, but also sets earlier goals for 2020 and 2030.

This roadmap contains 40 concrete initiatives for the next decade to build a competitive transport system that will increase mobility, remove major barriers in key areas and fuel growth and employment. At the same time, the proposals will dramatically reduce Europe's dependence on imported oil and cut carbon emissions in transport by 60% by 2050.

By 2050, key goals will include:

- No more conventionally-fuelled cars in cities.
- 40% use of sustainable low carbon fuels in aviation; at least 40% cut in shipping emissions.
- A 50% shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport.
- All of which will contribute to a 60% cut in transport emissions by the middle of the century.

In this direction the following directives have been chosen to be analysed under the AEROFLEX project.

6.9.1 Directive 2015/719 amending Council Directive 96/53/EC laying down for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic

The above Directive (EU) 2015/719 aims to modify the current Directive 96/53/EC in order to adapt it to the new technological developments and changing market needs and to facilitate intermodal transport operations.

The amendments on the Directive 96/53/EC are focused on three main topics:

- The increase of the maximum authorized length,
- The increase of the maximum authorized weight,
- The implementation of controls to detect infractions in the previous topics.

One of the reasons that sponsor the increase of the maximum length is the attachment of foldable or retractable aerodynamic devices on the cab or the rear of the motor vehicle.

The increased maximum authorized weight is aimed to allow the motor vehicles to include alternative powertrain systems such as electrical motors or LNG adaptations of the engine. Since these variations from the classical gas oil systems tend to be heavier, the regulation considers increasing the maximum weight of the entire vehicle without modifying the maximum load weight.

The new maximum length will authorize the transportation of 45-foot containers, which as per today are required to have chamfered corners or oblige the Member State and the transporter to follow cumbersome administrative procedures.

In order to promote the use of intermodal transportation, including road transportation of 45-foot containers, the Directive also allows an increase of the maximum weight up to 44 tonnes for those three-axle motor vehicles and their trailers and up to 42 tonnes for those two-axle motor vehicles and their trailers.
Furthermore, the European Parliament and the European Council are planning a scheme of controls to detect infringements that shall be adopted by the Member States.

All the vehicles that fulfil the masses and dimensions limitation described in the amended Directive shall have no problems with driving through all European countries. However, even though the limits established in the Council Directive 96/53/EC will be replaced to allow higher masses and broader lengths, the Directive 2015/719 allows Member States to restrict the circulation of certain vehicles in specific parts of their road network. Routes shall be studied in order to prevent any restrictions of the vehicles in these specific areas.

Table 6-3 summarizes the local maximum permissible mass in goods transports for road traffic and the local bodies' stakeholders (updated in August 2015). In Appendix B, information gathered under FALCON project is also available.

	Maximum Weight					*Maximum dimensions*				Local regulation body
	Non-drive axle (t)	Drive axle (t)	Lorry2 axles (t)	Lorry 3 axles (t)	Road Train 4 axes (t)	Height (m)	Width (m)	Length (lorry or trailer)	Length (Road Train) (m)	
Austria	10	11.5	18	26	36	4	2.55 (3.1)	12	18.75	Federal Ministry of Transport Bundesanstalt für Verkehr Innovation and Technology
Belgium (8.1)	10	12	19	26	39	4	2.55 (3.1)	12	18.75	Federal Public Service Mobility and Transport GD Mobility and Road Safety Direction D1 (traffic regulations) Direction D2 (driving

										licence) Direction B1 (technical conditions of vehicle)
Bulgaria	10	11.5	18	26 (2)	36	4	2.55	12	18.75	Ministry of Interior Ministry of Transport, Information Technology and Communications
Croatia	10	11.5	18	26 (2)	36	4	2.55 (3.1)	12	18.75 (13.1)	Ministry of the Sea, Transport and Infrastructure
Czech Republic (4.1)	10	11.5	18	26 (2)	36	4	2.55 (3.1)	12	18.75	Ministry of Transport
Denmark	10	11.5	18	26 (36)	38	4	2.55 (3.1)	12	18.75	Danish Transport Authority
Estonia	10	11.5	18	26 (2, 34)	36 (4)	4	2.55 (3.1)	12	18.75	Ministry of Economic Affairs and Communications
Finland (1.1) (6)	10	11.5	18	26 (2)	36	4.20	2.60 (6.1)	12	25.25	Ministry of Transport and Communications
France	13/12 (31)	13/ 12 (31)	19	26	38	.-.	2.55 (3.1)	12	18.75	Ministère des transports STR TR4 -> R5
Germany	10	11.5	18	26 (2)	36	4	2.55 (3.1)	12	18.75	Ministry of Transport, Building and Urban Development Referat LA 23 (Vehicle Safety)
Greece	7 / 10	13	19	26	33 (20) / 38 (21)	4	2.55	12	18.75	Ministry of infrastructure, transport & networks Directorate of Vehicle Technology
Hungary	10 (37)	11.5 (37)	18 (38)	25 (39)	36 (40)	4	2.55 (3.1)	12	18.75 (14.1)	Ministry of National Development Transport Infrastructure Department
Ireland	10	11.5(9)	18	26 (43)	36	4.65	2.55 (3.1)	12	18.75 (7.1)	Road Safety Authority
Italy (2.1)	12	12	18	26 (2)	40	4	2.55 (3.1)	12	18.75	Ministero dell e Infrastrutture e dei Trasporti - Dipartimento per i Trasporti, la navigazione ed i sistemi informativi e statistici
Latvia	10	11.5	18	25 / 26 (46)	36	4	2.55 (3.1)	12	18.75	Latvian State Roads
Lithuania	10	11.5	18	26 (2)	36	4	2.55 (3.1)	12	18.75 (4.1)	Ministry of Transport and Communications
Luxembourg	10	12 (11)	19	26	44	4	2.55 (3.1)	12	18.75	Ministère du Développement durable et des Infrastructures Département des Transports
Malta	10	11.5	18	25	36	4	2.55 (3.1)	12	18.75	Transport Malta
Netherlands (8.1) (12)	10	11.5	21.5	21.5 / 30.5 (22)	40	4	2.55 (3.1)	12	18.75	Ministry of Infrastructure and the Environment
Poland	10	11.5	18	26 (2)	36	4	2.55 (3.1)	12	18.75	General Directorate of National Roads and Motorways
Portugal (2.1)	10 / 12 (49)	12	19	26	37	4 / 4.15 (2.1)	2.55 (3.1)	12	18.75	Instituto da Mobilidade e dos Transportes Terrestres
Romania	10	11.5	18	25 / 26 (46)	36	4	2.55	12	18.75	Romanian National Company of Motorways and National Roads
Slovakia	10	11.5	18	26 (2)	36	4	2.55 (3.1)	12	18.75	Ministry of Transport, Construction and Regional Development

Slovenia	10	11.5	18	25 / 26 (34)	36	4.2	2.55 (3.1)	12	18.75 (17.1)	Ministry of Transport
Spain	10	11.5	18	25 / 26 (34)	36 (33)	4 (11.1)	2.55 (3.1)	12	18.75 (12.1)	Dirección General de Tráfico Dirección General de Transporte Terrestre. Ministerio de Fomento
Sweden	10	11.5	18	26 (46)	38	.-.	2.60	24	25.25	Swedish Transport Administration
United Kingdom	10	11.5	18	26 (42)	38	.-.	2.55 (3.1)	12	18.75	Transport Technology and Standards Division, Department for Transport

(1.1) For vehicles registered in an EEA member country.
(2) Only with air suspension or similar, and ABS (Anti-lock Braking System)
(2.1) Increased values are applicable for certain types of transport (i.e. containers, motorcars, etc.); [2a. Increased value = 4.10 m].
(3.1) Vehicles at controlled temperatures = 2.60 m.
(4) 3 axle tractor + 1 axle trailer = 35t.
(4.1) Road train specialised in the carriage of cars: height = 4.20 m; length = 20.75 m5. European Modular System (EMS), or, in conformity with Directive 96/53/EC, Article 4.
(6) For vehicles registered in an EEA member country.
(6.1) Road train (total length over 22 m); width = 2.55 m as from 1 Jan 2010. Road train (>22m) units and coaches fitted with a new vehicle body on 1-Oct-2004 or later; width = 2.55 m. Vehicles at controlled temperatures.
(7.1) But may be allowed up to 22 m subject to certain restrictions.
(8.1) Under specific conditions EMS (European Modular System) combinations may have a max. length of 25.25 m and max. weight of 60 tons; Domestic transport of 45 ft containers is accepted with combinations of vehicles (tractor – trailer – container) of max. length of 17.27 m (B) or 17.30 m NL). The maximum overhang of the container to the rear of the semi-trailer shall not exceed 0.77 m (B).The maximum overhang of the container to the (rear) underrun protection shall not exceed 0.40 m (B) or 0.60 m (NL).
(9) Weight per drive axle: mechanical suspension (national traffic) = 10.5t; road friendly suspension (national traffic) = 11.5t; international traffic =11.5t.
(11.1)Auto-transport specialized in transporting vehicles, Cranes for removal of vehicles, Vehicles transporting containers approved for combined transport = 4.50 m.
(12.1) Road train specialised in the carriage of cars (loaded) = 20.55 m.
(13) Road train specialised in the carriage of cars (loaded) = 21 m.
(14.1) Lorry with two trailers = 24 m.
(17.1) Specialized in transporting vehicles (only on motorways, dual carriageways and major roads) = 22.00 m.
(20) 3 axle tractor + 1 axle trailer.
(21) 2 axle motor vehicle with 2 axle semi-trailer carrying a container = 40 t.
(22) Depending on the distance between the axles, number of driven axles, type of suspension and single or double mounted tire.
(31) 13t for trucks <40t, 1 t – for trucks between 40 t and 44t.
(34) When the driving axle is fitted with pneumatic suspension or recognized as equivalent to EU level, or where each driving axle is fitted with double tires and the MMA on each axle doesn't exceed 9'5 t =26t.
(36) When the driving axle is fitted with double tires and pneumatic suspension 26t, otherwise 24t.
(37) +20% if the vehicle fitted on the same axle: a. with four or more wheels at least 0.65 meters distance from each other and two independent suspension, b. three or more wheels fitted with independent suspension.
(38) 20t = only in national traffic.
(39) 26t = road friendly suspension.
(40) 38t = for a towing vehicle with a semi-trailer where the towing vehicle has a road friendly suspension and the wheelbase of the semi-trailer is ≥ 1.8m.
(42) Only with air suspension or similar.
(43) Provided that the vehicle is equipped with twin tyres and an air suspension system or an equivalent system on each driving axle, OR is equipped with twin tyres and 2 driving axles neither of which transmits to the surface of a road a weight in excess of 9.5 tonnes.
(46) For vehicles with three axles equipped with double mounted tires on running axle and with pneumatic suspension or an equivalent system to EU level, OR each running axle has double mounted tires and axle load less than 9,5 t.
(49) Increased values are applicable for certain types of transport.

Table 6-3 Maximum masses and dimensions and the local body that regulates it in each EU country.

Special attention should be taken regarding this directive. Changes in weight and dimensions are foreseen along the project duration so all the trucks taking part in the AEROFLEX project should comply with the maximum masses and dimensions.

6.9.2 Directive 1999/62/EC (amended by Directives 2006/38/EC and 2011/76/EC) : charging of heavy goods vehicles for the use of certain infrastructures: Eurovignette Directive

This directive aims to:

- Improve the functioning of the road transport internal market by reducing the differences in the levels and systems of tolls and user charges (vignettes) applicable in Member States;
- Take better account of the principles of fair and efficient pricing by providing for greater differentiation of tolls and user charges (vignettes) in line with costs associated with the road use.

Although the application of tolls and user charges (vignettes) is not mandatory for Member States, the Directive lays down certain rules to be followed by those Member States that wish to levy such charges. The most important of these framework conditions are:

- Tolls must be levied according to the distance travelled and the type of vehicle; user charges (vignettes) are scaled according to the duration of the use made of the infrastructure and to the vehicle's emission class;
- The directive does not permit to impose tolls and vignettes at the same time for the use of a single road section. Only as an exception can tolls be levied for the use of bridges, tunnels and mountain passes on networks where user charges (vignettes) are applied;
- National tolls and vignettes must be non-discriminatory, excessive rebates on tolls are forbidden;
- Charging schemes should cause as little hindrance as possible to the free flow of traffic, avoiding mandatory checks at the EU's internal borders;
- The Directive also stipulates that the maximum average tolls must be set in relation to the costs of constructing, operating and developing the infrastructure concerned. New tolling schemes must be notified;
- **Tolls may also include an "external cost charge" which reflects the cost of air pollution and of noise pollution provided that the external cost charges respect maximum values defined in the annex of the Directive;**
- The revenue should preferably be used to develop the trans-European network.

As an example, the condition highlighted above could include a charge reduction to aerodynamic trucks with less fuel consumption and less CO_2 emissions such as the AEROFLEX project trucks.

In Table 6-4 there is a summary of the charging modes for each EU country and the local bodies that regulate them. To understand the table, the following definitions should be explained:

- *User charges or Vignettes*. A charge based on pre-paying for access to the network for a period ranging from one day to one year
- *Eurovignette*. A single common vignette that provides access across all those countries, so is genuinely "interoperable". In three of those countries (Denmark, Belgium and Hungary), these systems are subject to plans to replace them.
- *Electronic network wide tolling.* This covers both GPS based and DSRC based distance tolling. Portugal's system is not on a network scale like most of the other examples.
- *Manual tolls.* Includes countries with significant amounts of tolling. Given quite a few countries have manual tolling; it is more a case of those for which manual tolls are regularly used on major highways, rather than only incidentally.
- *No tolls*. Latvia and the UK are developing *vignette* systems.

	Road user charges	*Local regulation bodies*
Austria	Electronic network-wide toll	Federal Ministry of Transport, Innovation and Technology
Belgium	Vignette / Electronic network-wide toll	Federal Public Service Mobility and Transport DG Land Transport
Bulgaria	Vignette	Road Infrastructure Agency
Croatia	Toll with physical barriers	Ministry of the Sea, Transport and Infrastructure
Czech Republic	Electronic network-wide toll	Ministry of Transport
Denmark	Vignette	SKAT
Estonia	Neither vignettes nor tolls	Ministry of Economic Affairs and Communications
Finland	Neither vignettes nor tolls	Ministry of Finance
France	Toll with physical barriers	APRR AREA
Germany	Electronic network-wide toll	Ministry of Transport, Building and Urban Development
Greece	Toll with physical barriers	Ministry of infrastructure, transport & networks
Hungary	Electronic network-wide toll	Ministry of National Development Transport Infrastructure Department
Ireland	Toll with physical barriers / Vignette	Department Of Environment Department Of Transport, tourisme and transport/Department of finance
Italy	Toll with physical barriers	Ministero delle Infrastrutture e dei Trasporti - Dipartimento per le Infrastrutture Autostrade per l'Italia Spa
Latvia	Vignette	Ministry of Transport, Land Transport Department
Lithuania	Vignette	Ministry of Transport and Communiactions
Luxembourg	Vignette / Electronic network-wide toll	Ministère du Développement durable et des Infrastructures Département des Transports
Malta		Transport Malta
Netherlands (12)	Vignette	Ministry of Finance, Tax Authority Tax and Customs Administration/Limburg/Department of International Issues
Poland	Electronic network-wide toll	General Directorate of National Roads and Motorways
Portugal	Electronic network-wide toll	Direcção - Geral das Contribuições e Impostos Estradas de Portugal, S.A Brisa, Auto- estradas de Portugal, S.A
Romania	Vignette	Romanian National Company of Motorways and National Roads,
Slovakia	Electronic network-wide toll	Ministry of Transport, Construction and Regional Development
Slovenia	Toll with physical barriers	Ministry of Transport
Spain	Toll with physical barriers	Dirección General de Carreteras
Sweden	Vignette	The County Tax Authority
United Kingdom	Vignette	Freight Policy & Lorry Charging Division Department for Transport

Table 6-4 Charging heavy goods vehicles in the EU and their local regulating bodies

In Figure 6-32, as a resume, the charging of heavy goods vehicles in the EU is shown (2015).

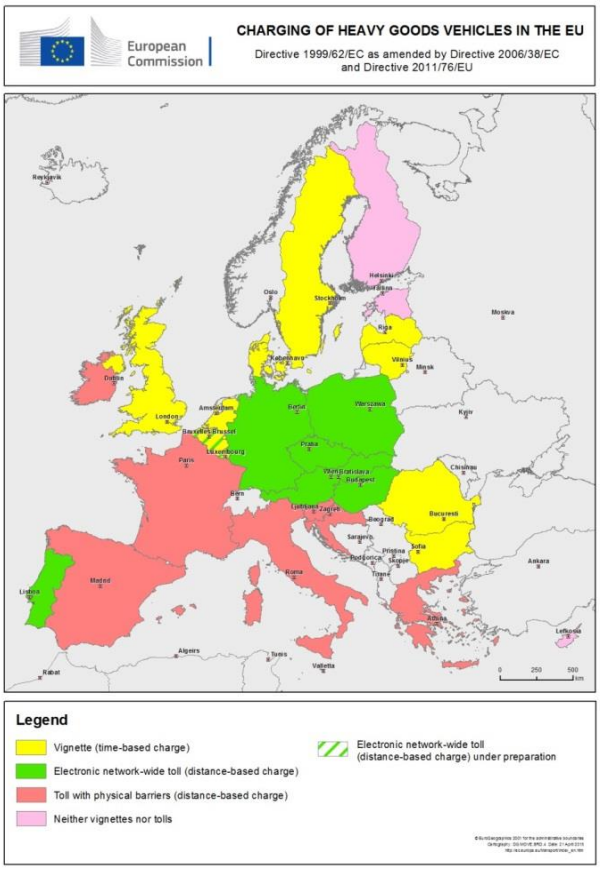


Figure 6-32 Charging of heavy goods vehicles in the EU

PART C:
Outcomes from the Sounding Board Workshops

7 Sounding board activities

The coordination of the Sounding Board as a main pillar of the project has been a success. The importance of having all these Sounding Members on board in the project has led to continue the work done during the preparation of the proposal by means of inviting new members to become part of the Sounding Board.

The group is composed by experts with different background, which makes the group very heterogeneous. Their expertise and experiences are considered very relevant for the project and its impact.

Since the beginning of the project, several activities have been planned. The following table summarizes the activities held from M1 to M24 of the project.

Date	Location	Type of meeting	Topic
March 18	Dortmund	Workshop	Logistics
May 18	Berlin	Meeting	Presentation to the AEROFLEX Executive Board in conjunction with the GA
October 18	Rotterdam	Meeting	Follow-up project in conjunction with the GA
February 19	Paris	Workshop	Regulatory Framework I
May 19	Brussels	Workshop	Intelligent Access I
May 19	Brussels	Meeting	Presentation to the DGs
September 19*	Paris	Workshop	Intelligent Access II
October 19*	Amsterdam	Workshop	Regulatory Framework II
May 20*	Barcelona	Meeting	Follow-up project in conjunction with the GA
*Planned activities			

Table 7-1 Sounding Board activities from M1-M24

In order to ease the communication between all the members (around 60 people have signed up), a specific portal has been created in the project site where all the documents used in the workshop have been uploaded.

The following sub-chapters summarize the conclusions and outcomes coming from the three thematic workshops.

7.1 Workshop on Logistics: outcomes and take away messages

On 7th March 2018 a Logistics Workshop was held in Dortmund (Germany). The necessity of having this Workshop was raised at the kick off meeting in October 2017 (Munich) by the Sounding Board Members.

Logistics in AEROFLEX Project is a crucial topic to be discussed and analysed. The vision of AEROFLEX is to support the vehicle manufacturers to achieve the coming challenges for road transport. While the regulatory part has been described in previous chapters, it is also important to have the vision of the Logistic operators.

For this reason, the objectives of the Workshop were settled as follow:

- To better understand the logistics requirements and opportunities for innovative vehicle concepts and loading units in a multi modal context
- Define criteria's and KPIs to judge the impact and the cost/benefit of new vehicle concepts and features on the logistics operation in a multimodal context (rail & maritime)
- Feasibility and impact assessment

WP1 was involved in the Workshop since they wanted to get input from the operators regarding:

- the needs and requirements of logistics service providers and shippers for new vehicle concepts, transport loading units
- the important indicators of the road transport/logistics market that should be addressed
- which criteria would influence the penetration of new vehicle concepts into the road and intermodal transport

WP4 was also participating in the Workshop since they needed input from the operators regarding:

- definition of use cases based on type of goods, countries and the specific transport conditions of operators
- definition of requirements and key performance indicators (KPI's) for the development of smart loading units
- these KPI's will then be selected to evaluate both efficiency of solutions and market acceptance in the transport industry

7.2 Workshop on Regulatory Framework: outcomes and take away messages

On 20th February 2019 a Workshop on the Regulatory Framework was held in Paris (France) at IFSTTAR facilities. The workshop had a participation of around 30 people, including participants from the authorities, international organisations, technical services, manufacturers and end user companies.

The objectives of the workshop were:

a) To update the SB members about the technical solutions other Work Packages were implementing
b) To discuss important regulatory gaps in the current regulatory framework and identify those which are more relevant for the implementation of these solutions

Two dynamic activities were organised to start discussions and exchange opinions. The following lines summarize some of the conclusions:

- E-dolly analysis:
  - All vehicles from the fleet could benefit of having a dolly. Even some combinations could benefit of having more than 1 dolly
  - The e-dolly is an "opener" to a lot of logistics solutions
  - The "Manager" is a key element to specific uses cases: low friction, very flat routes, etc.
  - Traffic regulations: the 25% weight combination distributed in more than 1 axle should be considered. Nowadays, this condition could be a barrier
  - The biggest barrier for its deployment is that the e-dolly can't be Type Approved with the current regulatory framework

- Craneability of the trailer:
  - Cost benefit analysis to choose which active/passive geometry solutions should be introduced in the market
  - Importance on the safety of the geometry solutions (some of the solutions proposed such as the active/passive flow control have not been tested enough to prove that they are safe in terms of EMC, PTI inspections, or user handling)

- Euro Modular System (EMS) combinations:
  - EMS combinations are already allowed in Belgium, Denmark, Finland, most German federal states, the Netherlands, Portugal, Spain, Sweden and, recently, Czech Republic
  - The maximum length and the weight of a normal vehicle combination are currently set to 22 meters and 44 tonnes, respectively. So, the move towards 25.25 m and 48 tonnes, which are the limits for EMS combinations in most countries, does not represent a drastic step
  - An additional issue of EMS nowadays is their cross-border use, which requires mutual consent between bordering countries. Such mutual consent exists in Benelux and Scandinavia already.

- General comments:
  - It is important that the European Commission (in particular DG MOVE, DG CLIMA and DG GROW) understand the benefits of further promoting the use of EMS combinations
  - Cross border is a main issue when talking about vehicles that do not comply with current masses and dimensions regulation
  - Infrastructure is another key element. More pilot test should be undertaken to detect barriers and solutions as soon as possible.

7.3 Workshop on Intelligent Access Policies

In May 2019, a specific workshop took place in Brussels, at ACEA facilities. The main objectives of this workshop were:

a) Spreading knowledge about the Intelligent Access concept
b) Exploration of the potential of the concept of Intelligent Access in two practical cases:
   1. Plans for increasing the maximum weight for regular trucks from 44T to 50T in Flanders
   2. The intended pilot project with the Super EcoCombi (SEC) (32m/60T) in The Netherlands. The ultimate goal of the concept of Intelligent Access is to use the capacity of the vehicles and the capacity of the infrastructure in the most optimal and safe way. The concept is rather new for Europe and in the world. Only Australia has a full implemented system; Sweden and Estonia are experimenting with it.

- Intelligent Access Program Australia
  - Speed of IT innovations makes it difficult for governments and their processes of policy-making, testing, implementation and review to keep pace with the digital evolution
  - Surveillance capacity of the digital regulation generates large volumes of offences for agencies to deal with
  - Roll out of digital regulation requires a new range of analytical skills and capabilities of public servants
  - Effective stakeholder management is essential for success of intelligent access

- IT-architecture of Intelligent Access System Sweden
  - A multi-provider model for both hardware and services, and performance and outcome-based specifications to promote innovation, competition and consumer choice
  - Supported by an independent certifier and auditor (TCA) to ensure technology and services works, and continues to work, as intended
  - Supports Co-operative ITS (C-ITS) applications – including Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I), both of which hold the promise of significant road safety gains – now and into the future
  - Actual status: demonstrations for 64-74T HCT, legal & institutional framework is not yet fully developed
  - EU harmonization challenges: “We can require on board weigh systems for Swedish vehicles but not for vehicles from countries relying on scales in the infrastructure for 96/53 monitoring”

- VELUB-RIS system: Intelligent Access in Estonia
  - The first driver for intelligent access was not enforcement, but to improve information services and to allow 48/52T timber trucks all year round
  - Create a separate data collection and data processing environment because it is a much more reliable solution than trying to create one system
  - Intelligent access works best when vehicles transmit mass data themselves instead of being dependent on the manually provided data by the truck driver
  - The VELUB RIS system pulls data from other information systems and validates it. Any errors in the work of the transmitting service were carried forward, which meant that the data of all vehicles was not received
    Laws and regulations allow data to be used for statistical purposes only

- Euro-Modular combinations in Spain
  - The authorization of Euro-Modular combinations in Spain had an impact not only technical but also social.
  - Political parties have taken position regarding the Euro-Modular combinations, some of them with a strong opposition. Most of the public opinions are not based on technical studies, but on assumptions.
  - For all the above-mentioned reasons, this is a sensitive issue which require special care. That's why setting a strong regulatory framework and a reliable and objective testing procedure is the key to success.

8 Conclusion

This document represents the first deliverable (D7.1 *Definition of the boundary conditions and current state of EU legislation*) of Work Package 7 named *Recommendations and roadmap for a new regulatory framework*. This deliverable is the result of Task 7.2 *Current state of the EU legislation and definition of the boundary conditions* and it will set a starting point for the following activities.

To understand how policy making works and which are the priorities at a European and Worldwide level, it is necessary to monitor and understand which are the topics that are being discussed in the discussion groups of the UNECE and in the EC. The amendments of the Regulation on Masses and Dimensions, the proposal for the new General Safety Regulation or the new Regulations for CO2 emissions and fuel consumption for heavy-duty vehicle are examples of this evolution.

Also, the increase in the number of countries that allow Euro Modular Systems (EMS), also known as *megatrucks*, *eco-combis, longliners, supertrucks…* and the efforts of some European countries to introduce the so-called Smart Infrastructure Access Policies, prove that the project is in line with the ambitions, priorities and strategies of the EU.

In order to set the boundary conditions in terms of legislation for AEROFLEX solutions, a first approach of the current regulatory framework has been developed through a regulatory matrix. This matrix has been analysed for each technical work package in order to identify the most relevant potential conflicts that might have an impact on the deployment of AEROFLEX solutions.

At this stage, the analysis for each work package has been done separately. In some cases, this analysis has been done using conceptual ideas as a base. The objective of this report is to use this analysis as a starting point and to continue with an iterative process to evaluate more in detail all the solutions that will be implemented.

Later on, once all the regulatory barriers and conflicts are identified, a compilation of recommendations addressed to policy makers and other stakeholders will be included in a final report called Book of Recommendations (BoR).

In addition, the group of experts intended to participate in some project discussions called Sounding Board have had several meetings and workshops during the first two years of the project. All the activities have been very well accepted with a high rate of participation. The Sounding Board group include stakeholders from different backgrounds and sectors. For this reason, this group it is considered an important pillar for AEROFLEX project.

Finally, taking this document as the first step to create the BoR, the work will continue through Tasks 7.3 Projection of the possible solutions to current regulatory framework and 7.4 Validation of developed solutions against updated regulatory framework. The final objective is to build this book including as much agreement and acceptance as possible.

9 References

9.1 Discussion groups

	Group or Organisation	*Document*	*Web Site Documentation*
1	GRRF, ACSF 16th session	(Secretary) Provisions for Category 2 - Level 3 - drafted while the 16th session	https://wiki.unece.org/display/trans/ACSF+16th+session
2	GRRF, ACSF 17th session	Reference Document - Development ACSF of Category B2	https://wiki.unece.org/display/trans/ACSF+17th+session
3	GRSG, VRU-Proxi 5th session	VRU-Proxi-05-02 (Japan) Proposal for amendments to Regulation No. 46	https://wiki.unece.org/display/trans/VRU-Proxi+5th+session
4		VRU-Proxi-05-06 (Germany) ECE-TRANS-WP29-GRSG-2017-11e_after March 14_full	
5		VRU-Proxi-05-10 (Israel) Blind Spot Information Systems 03-18	
6	GRSP, DPPS 4th Session	Scope and Limitations of the PDI-2 (Task 14)	https://wiki.unece.org/display/trans/Former+TF-DPPS+4th+session
7		JASIC proposals for document TF-DPPS/1/05-Rev.1	
8		Validity of Applying the Current Headform at Low Impact Speed	
9	ITS/AD 12th Session	(ITS_AD-12-07-2) Automated vehicle horizontal regulation – proposal	https://wiki.unece.org/pages/viewpage.action?pageId=50856157
10	ITS/AD 13th Session	(ITS_AD-13-03) Proposal for the Definitions of Automated Driving under WP.29 (Secretary)	https://wiki.unece.org/pages/viewpage.action?pageId=54427891
11	ITS/AD 14th Session	Proposal for the Definitions of Automated Driving under WP.29 (Tracked)	https://wiki.unece.org/pages/viewpage.action?pageId=56591466
12	ITS/AD 15th Session	Guidance to GRs concerning Automated Driving Technology-GE-final draft	https://wiki.unece.org/pages/viewpage.action?pageId=41451549
13	European Commission	EU Regulation on CO2 emissions and fuel consumption of HD vehicles	https://ec.europa.eu/clima/policies/transport/vehicles/heavy_en
14	European Commission	Road Infrastructure Charging – Heavy Goods Vehicles	http://ec.europa.eu/transport/modes/road/road_charging/charging_hgv_en.htm
15	ITF-OECD	Permissible maximum dimensions of lorries in Europe	https://www.itf-oecd.org/weights-and-dimensions
16	ITF-OECD	Permissible maximum weights of lorries in Europe	https://www.itf-oecd.org/weights-and-dimensions

10 References

10.1 Regulations/Directives

	Title	*Web Site Documentation*
1	UN R10: Electromagnetic compatibility EMC	https://www.unece.org/trans/main/wp29/wp29regs1-20.html
2	UN R13: Braking provisions to M, N and O vehicles	https://www.unece.org/trans/main/wp29/wp29regs1-20.html
3	UN R17: Seats, their anchorage and head restraint	https://www.unece.org/trans/main/wp29/wp29regs1-20.html
4	UN R29: Protection of the occupants of the car	https://www.unece.org/trans/main/wp29/wp29regs21-40.html
5	UN R34: Fuel system safety (Fuel tanks protection)	https://www.unece.org/trans/main/wp29/wp29regs21-40.html
6	UN R39: Prescription for Speedometer	https://www.unece.org/trans/main/wp29/wp29regs21-40.html
7	UN R43: Safety glazing materials	https://www.unece.org/trans/main/wp29/wp29regs41-60.html
8	UN R46: Devices for indirect vision	https://www.unece.org/trans/main/wp29/wp29regs41-60.html
9	UN R48: Installation of lighting and light-signalling devices	https://www.unece.org/trans/main/wp29/wp29regs41-60.html
10	UN R49: Emissions - heavy duty vehicles	https://www.unece.org/trans/main/wp29/wp29regs41-60.html
11	UN R51: Sound emissions	
12	UN R54: Tyres for commercial vehicles	https://www.unece.org/trans/main/wp29/wp29regs41-60.html
13	UN R55: Coupling components	https://www.unece.org/trans/main/wp29/wp29regs41-60.html
14	UN R58: Rear underrun protection	https://www.unece.org/trans/main/wp29/wp29regs41-60.html
15	UN R61: Externals projection of the cab	https://www.unece.org/trans/main/wp29/wp29regs61-80.html
16	UN R67: LPG Equipment and its installation	https://www.unece.org/trans/main/wp29/wp29regs61-80.html
17	UN R73: Lateral protection	https://www.unece.org/trans/main/wp29/wp29regs61-80.html
18	UN R79: Steering equipment	https://www.unece.org/trans/main/wp29/wp29regs61-80.html
19	UN R89: Speed limitation device and installation	https://www.unece.org/trans/main/wp29/wp29regs81-100.html
20	UN R93: Front underrun protection devices	https://www.unece.org/trans/main/wp29/wp29regs81-100.html
21	UN R100: Electric power train	https://www.unece.org/trans/main/wp29/wp29regs81-100.html
22	UN R117: Tyres: rolling resistance/sound emissions/ wet adhesion	https://www.unece.org/trans/main/wp29/wp29regs101-120.html
23	UN R121: Hand control, tell tales and indicators	https://www.unece.org/trans/main/wp29/wp29regs101-120.html
24	UN R122: Heating systems	https://www.unece.org/trans/main/wp29/wp29regs101-120.html
25	UN R130: Lane Departure Warning System	https://www.unece.org/trans/main/wp29/wp29regs121-140.html
26	UN R131: Advanced Emergency Braking System (AEBS)	https://www.unece.org/trans/main/wp29/wp29regs121-140.html
27	UN R151: Blind Spot Information Systems	https://www.unece.org/trans/main/wp29/wp29regs141-160.html
28	Regulation (EC) 1071/2009: Road transport operators	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009R1071
29	Regulation (EC) 1230/2012: Masses and dimensions	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R1230
30	Directive (EU) 2015/719: Masses and dimensions in international traffic	http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32015L0719
31	Regulation (EC) 595/2009: Emissions from heavy duty vehicles	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009R0595
32	Directive (UE) 2010/47: Technical inspection on vehicles	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32010L0047
33	Directive (EC) 2007/46: Framework directive	http://eur-lex.europa.eu/legal-content/En/ALL/?uri=celex:32007L0046
34	Regulation EU 2018/858: Framework regulation	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R0858
35	Regulation (EU) 661/2009 General safety of motor vehicles	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009R0661

36	Directive (EC) 2003/59*2006/103: Training of drivers	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2006.363.01.0344.01.ENG
37	Regulation (EC) 1003/2010: Rear registration plate	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32010R1003
38	Regulation (EC) 109/2011: Spray suppression systems	http://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX:32011R0109
39	Directive (EC) 2006/126: Driving licenses	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32006L0126
40	Regulation(EU) 458/2011:Installation of tyres	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32011R0458
41	Regulation(EU) 130/2012: Vehicle access and manoeuvrability	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R1229
42	Directive (EU)2011/82: Exchange of information on traffic offences	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32011L0082
43	Directive (EC) 2004/54: Tunnels in Trans-European road network	http://eur-lex.europa.eu/legal-content/ES/ALL/?uri=celex:32004L0054
44	Regulation (EU) 1005/2010: Towing devices	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32010R1005
40	Regulation (EU)19/2011: Statutory plate and VIN	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32011R0019
41	Regulation (EC) 561/2006: Social matters on road transport	http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006R0561
42	Directive (EC) 2006/38: charging of heavy goods vehicles for the use of certain infrastructures	http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32006L0038
43	Directive (EU) 2015/719: maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic	http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2015.115.01.0001.01.ENG
44	Directive (EC) 206/103: Taxation of heavy goods vehicles: Eurovignette Directive	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2006.363.01.0344.01.ENG
45	Directive (EU) 2014/45: on periodic roadworthiness tests	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0045
46	Regulation (EU) 351/2012: Lane Departure Warning Systems LDWS	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R0351
47	Regulation (EU) 2017/2400: CO2 emissions and fuel consumption of heavy-duty vehicle	https://eur-lex.europa.eu/eli/reg/2017/2400/oj
48	Regulation (EU) 2019/1213 On-board weighing equipment	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R1213
49	Proposal for regulation: R(EU) 2019/… New General Safety Regulation	http://www.europarl.europa.eu/doceo/document/TA-8-2019-0391_EN.html?redirect
50	ISO 26262: Road vehicles - functional safety	https://www.iso.org/standard/43464.html
51	ISO 11992: CAN Communication between truck and trailer	https://www.iso.org/standard/55046.html
52	SAE J1939: Communication and diagnosis among vehicle components	https://www.sae.org/standardsdev/groundvehicle/j1939a.htm
53	EN 13044-1: Intermodal loading units	http://www.aenor.es/aenor/normas/normas/fichanorma.asp?tipo=N&codigo=N0053045#.WvAFoH-x-00
54	EN 283: Swap bodies - Testing	http://www.aenor.es/aenor/normas/normas/fichanorma.asp?tipo=N&codigo=N0008453#.WvAFw3-x-00
55	EN 16973: Road vehicles for combined transport - Vertical transhipment	http://www.aenor.es/aenor/normas/normas/fichanorma.asp?tipo=N&codigo=N0059983#.WvAF4n-x-00
56	EN596-5: Railway specifications - Semi-trailer	http://www.aenor.es/aenor/normas/normas/fichanorma.asp?tipo=N&codigo=N0008891#.WvAGCn-x-00
57	UIC 592: Intermodal loading units	https://infostore.saiglobal.com/en-gb/standards/uic-592-ed-2-2013--1712534/
58	UIC 596-6: Codification system in combined transport	https://infostore.saiglobal.com/en-gb/standards/uic-596-6-ed-6-2014--1712532/
59	UIC 571-4: Wagons in combined Transport	https://infostore.saiglobal.com/en-gb/standards/uic-571-4-ed-6-2014--1712530/

10.2 AEROFLEX project background

	Project	*Document*	*Web Site Documentation*
1	TRANSFORMERS	Deliverables D5.1-D5.5	http://www.transformers-project.eu/downloads/#.WvAIgX-x9uE
2		Final Event Presentation	http://www.transformers-project.eu/downloads/#.WvAIgX-x9uE
3	FALCON	Call 2015 Freight and Logistics in a Multimodal Context	http://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2015/call-2015-freight-logistics-multimodal-context/
4		CEDR Call 2015 Summaries FALCON	http://www.cedr.eu/wpfb-file/cedr-call-2015_summaries-falcon-pdf/
5		CEDR Contractor Report	http://www.cedr.eu/wpfb-file/cr-2017-7_call-2015-freight-and-logistics-in-a-multimodal-context_understanding-what-influences-modal-choice-pdf/

10.3 Regulatory Framework state of the art

	Organisation	*Web Site Documentation*
1	European legislation	http://eur-lex.europa.eu/summary/chapter/transport.html?root_default=SUM_1_CODED%3D32,SUM_2_CODED%3D3202&locale=en
2	UNECE WP29	http://www.unece.org/trans/main/wp29/wp29regs.html
3	Vienna Convention	http://www.unece.org/index.php?id=26749
4	EU Regulation on CO2 emissions and fuel consumption of HD vehicles	https://ec.europa.eu/clima/policies/transport/vehicles/heavy_en

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Project partners:

#	Partner	Partner Full Name
1	MAN	MAN TRUCK & BUS AG
2	DAF	DAF Trucks NV
3	IVECO	IVECO S.p.A
4	SCANIA	SCANIA CV AB
5	VOLVO	VOLVO TECHNOLOGY AB
6	CRF	CENTRO RICERCHE FIAT SCPA
7	UNR	UNIRESEARCH BV
8	SCB	SCHMITZ CARGOBULL AG
9	VEG	VAN ECK BEESD BV
10	TIRSAN	TIRSAN TREYLER SANAYI VE TICARET A.S.
11	CREO	CREO DYNAMICS AB
12	MICH	MANUFACTURE FRANCAISE DES PNEUMATIQUES MICHELIN
13	WABCO	WABCO Europe BVBA-SPRL
14	CHALM	CHALMERS TEKNISKA HOEGSKOLA AB
15	DLR	DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV
16	FHG	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.
17	HAN	STICHTING HOGESCHOOL VAN ARNHEM ENNIJMEGEN HAN
18	IDIADA	IDIADA AUTOMOTIVE TECHNOLOGY SA
19	NLR	STICHTING NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM
20	TML	TRANSPORT & MOBILITY LEUVEN NV
21	TNO	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO
22	MHH	MEDIZINISCHE HOCHSCHULE HANNOVER
23	UIRR	UNION INTERNATIONALE DES SOCIETES DE TRANSPORT COMBINE RAIL-ROUTE SCRL
24	WABCO-NL	WABCO AUTOMOTIVE BV
25	WABCO-DE	WABCO GMBH

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Appendix

12 Appendix A – Risk table

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
1	[External / Legislation] Major change in legislation regarding vehicle dimensions, emissions and fuel efficiency reducing the impact of AEROFLEX targeted outcomes.	WP1, WP2, WP3, WP4, WP5	Major activities in WP7 on mapping current and future regulations and interaction via Sounding Board
2	[Internal / Management] Partner not performing as expected in the technical annex.	WP9	Regular synchronization and appropriate project monitoring and governance structure (See Section 3.2).
3	[Internal / Management] Confidentiality issues between the AEROFLEX partners or towards external partners.	WP1, WP2, WP3, WP4, WP5, WP6	Appropriate data and confidentiality management. Deployment of appropriate framework, e.g. data exchange platform with different access rights. Possibility to escalate at project management level (WP9) in case an issue is detected.
	[Technical] Accident data does not reveal sufficient level of information or access is not possible. Weighting		Check to ensure sufficient data is available and whether alternative datasources are needed.
4	of detailed data databases from national to European level difficult to achieve for benefit analysis.	WP5	Although the databases have been selected carefully, if needed, alternative data sources can be accessed. Data sources may not allow full scaling to European level. Partner experience will be used to create alternative analysis methods
5	[Technical] No authorization received from local authorities to perform tests with demonstrator vehicles on real roads	WP6	IDIADA maintains a strong link with public authorities and has often conduct similar tests with prior authorisation from both regional and national traffic authorities
6	[Technical] Changing environmental conditions during tests of reference and demonstrator vehicles can, which can influence comparability of testing results	WP6	Reference and demo tests are scheduled at the same season of the year. In the case the tests were moved in time, IDIADA has flexibility and experience to move the tests another time (e.g. at night temperatures are lower) in order to similar conditions among the different tests. IDIADA is
7	[Management] Lack of contributions and expertise from Sounding Board members and lack of attendants to Sounding Board meetings	WP7	All SB members have signed a Letter of Support and they will receive travel compensation as an incentive to attend the meeting
8	[Management] No coherent Interest of the Sounding Board members in the outcome (results and recommendations) of the AEROFLEX project.	WP7	The governance of the Sounding Board is setup in a way that all results and recommendations will be discussed with the technical members (TAA) and the policy/regulatory members (PRCG) separately. The finalization of all results, reporting and Book of Recommendations will be mutually agreed with the complete Sounding Board (CSG). See Task 7.1
9	[Technical] Simulations are too complex or not consistent with the background crash analysis based on the accidentology data	WP5	Simulations must be done using representative and simplified crash scenarios. They must represent adequately accident events avoiding variables that may increase the complexity of the simulations without additional value.

10	[Technical] Crash simulation state-of-the-art is mature and the main issue is the availability of open-source models.	WP5	The consortium has partners with experience with open-source models from NCAC in the US
11	[Technical] Interface problems when installing the scale model in the wind tunnel (either static connection to the wind tunnel balance or non-optimum dynamic behaviour between the moving belts and the wheels of the model).	WP3	CRF will share to NLR the geometry of wind tunnel ground and support system, to be included into the design of the model from the beginning. Periodic update of the progress to WP lead and partners. If relevant issues will persist that cannot be addressed by modification to the design of the scale model, the possibility to perform tests in another wind tunnel will be explored.
12	[Technical] Transient flow phenomena (related to blockage or Reynolds number) in the wind tunnel tests that prevent the identification of the most effective concepts.	WP3	Use CFD to compare drag benefit of selected concepts model in open-air and wind tunnel conditions (i.e. including wind tunnel geometry as boundaries in CFD simulations for verification)
13	[Technical] Difficult to interpret the results from the concept development due to differences in the methods used by the individual partners.		Agree on a common CFD strategy, including (but not being limited to) requirements on CAD input, boundary conditions and data output before the concept development simulations commences. Generic cases will be performed by multiple partners to converge to highest possible similarity in solutions. Limit the number of different CFD tools as much as possible (ideally to one or two CFD tools).
14	Poor convergence of the transient simulations, and as a consequence non-reliable time averaged results and/or too expensive simulations.	WP3	Run longer time-histories for verification (may require a big increase in the amount of computational resources required). Reduce the number of steady CFD simulations to release cpu hours for the transient runs
15	Wrong performance predictions due to over- simplified geometries in the CFD models.	WP3	Do not introduce simplifications of the geometries in the models. Verify that the simplifications do not influence the CdxA values.
16	Interface problems for the demonstrator related to shared responsibilities, potentially giving poor performance and increased risk for not meeting cost and time targets.	WP3	Define clear interfaces for the different parts of the demonstrator. Work with 3D CAD tools and make use of available tools for data exchange. Manufacturing of demonstration vehicles with its aerodynamic features should be based on final drawings (design freeze) to as large extent as possible, in order to avoid large deviations and thus assembling issues.
17	Deviation between results from on-road measurements compared to simulation results & wind tunnel measurements	WP3	Verify the fidelity of CFD models after the first wind tunnel campaign. Use the experience of the partners from on-road measurements, to identify critical components and reduce the risks. Co- operate closely with WP6.

13 Appendix B – Review of FALCON European regulatory framework research and conclusions

13.1 Length limits

	EU International	Sweden	Norway	Netherlands	Germany	France	UK	Belgium Flanders & Wallonia
Motor vehicle	12	12 (EMS)	12	12	12	12	12	12
Semitrailer	12 kingpin to rear 2.04 kingpin-front corner	12 kingpin to rear 2.04 kingpin-front corner (EMS)	12 kingpin to rear 2.04 kingpin-front corner	12 kingpin to rear 2.04 kingpin-front corner	12 kingpin to rear 2.04 kingpin-front corner	12 kingpin to rear 2.04 kingpin-front corner	12 kingpin to rear 2.04 kingpin-front corner 15.65 Total length, long semitrailer trial	12 kingpin to rear 2.04 kingpin-front corner
Trailer	12	12 (EMS)	12 (not timber)	12	12	12	12 (not drawbar)	12
Vehicle combination	16.5 Articulated vehicle 18.75 Road train	24 25.25 EMS	17.5 Articulated vehicle 19.5 Road train 24 Timber 25.25 EMS	16.5 Articulated vehicle 18.75 Road train 25.25 EMS	16.5 Articulated vehicle 18.75 Road train 20.75 Car transporter 25.25 EMS	16.5 Articulated vehicle 18.75 Road train	16.5 Articulated vehicle 18.75 Road train	16.5 Articulated vehicle 18.75 Road train 18 road trains that do not fulfil Table 4 25.25 EMS
Width	2.55 (2.6)1	2.55 (2.6) 1	2.55 (2.6) 1	2.55 (2.6) 1	2.55 (2.6) 1	2.55 (2.6) 1	2.55 (2.6) 1	2.55 (2.6) 1
Height	4	Not regulated	Not regulated	4	4	4	Not regulated	4

Table 13-1 Vehicle dimension limits (m)

[1] For conditioned vehicles (vehicles fitted with a bodywork with insulated walls of at least 45 mm thick)

	EU International	Sweden	Norway	Netherlands	Germany	France	UK	Belgium
Loading length behind the cabin	**15.65**	**21.86** (EMS)	**15.65**	**15.65** **21.82** (EMS)	**15.65**	**15.65**	**15.65**	**15.65**
From foremost point of the loading area to the rear end of the vehicle	**16.4**	**22.9** (EMS)	**17.15**	**16.4** (not EMS)	**16.4**	**16.4**	**16.4**	**16.4**
From rear axle of the motor vehicle to the front axle of the trailer	**>= 3**	**>= 3, 4, 5** [1]	**>= 3**	**>= 3**	**>=3**	**>=3**	**N/A**	**>=3**

Table 13-2 Additional constraints on the loading length and axle distance of road trains

[1] depends on axle configuration

13.2 Axle Load Limits

	EU International	Sweden (BK1)	Norway (BK10)	Netherlands	Germany	France	UK	Belgium
Single Axle Load Not a driving axle Driving axle	 10 11.5	 10 11.5	 10 11.5	 10 11.5	 10 11.5	 13 (12)[3] 13 (12)[3]	 10 11.5	 10 12
Bogie Load d < 1 (0.8/0.9) [1] m 1 (0.8/0.9) [1] <= d < 1.2 m 1.2 <= d < 1.3 m 1.3 <= d < 1.8 m d >= 1.8 m	 11 (11.5) [4] 16 16 18 (19) [6] 20	 11.5 16 16 18 (19) [6] 20	 10 15 16 18 (19) [6] 20	 11(11.5) [4] 16 16 18 (19) [6] as single axle	 11 (11.5) [4] 16 16 18 (19) [6] 20	 13.15 13.15+13(d-0.9) 13.15+13(d-0.9) 19 19	 11 (11.5) [4] 16 16 18 (19) [6] 20	 11 16 (17) [5] 17 (18) [5] 18 (20) [5] 20
Triple Axle Load d < 1 (0.9/1.14) [2] m 1 (0.9/1.14) [2] <= d <1.3 m 1.3 <= d <1.8 m d >= 1.8 m	 21 21 24 24	 21 21 24 24	 16 22 24 24	 21 21 24(27) [6] as single axle	 21 21 24 24	 22.05 22.05+13(d-0.9) 31.5 31.5	 21 21 24 24	 21(22) [5] 21(24) [5] 24(27) [5] as single axle

Table 13-3 Axle load limits (ton)

[1] 0.9 m for France, 0.8 m for Norway [2] 0.9 m for France, 1.14 for Belgium [3] For a 5-axled vehicle combination with 40<GVW<=44t [4] For driving axle [5] Air suspension [6] For motor vehicle, if driving axle is fitted with twin tyres and a) air suspension (or equivalent) or b) drive axle load does not exceed 9.5 ton

13.3 Weight Limits

	EU International	Sweden	Norway	Netherlands	Germany	France	UK	Belgium Flanders & Wallonia
Motor vehicle	**18/25(26)[1]//32** 2/3/4+ axles	**18/25(26)[1]/31(32)[1]** 2/3/4+ axles	**19/26/26-32** 2/3/4+ axles	**21.5/28-31.5/34(37)[1]** 2/3/4+ axles	**18/25(26)[1]/32** 2/3/4+ axles	**19/26/32** 2/3/4+ axles	**18/25(26)[1]/30(32)[1]** 2/3/4 axles	**19/26/32** 2/3/4 axles
Trailer Semitrailer	**18/24** 2/3 axles	**GVW/GCW table** for axle distance	**10/18,20/24,27** 1/2/3 axles ST or CT **20/28/30** 1/2/3 axles FT or DY-ST	Depends on the axle distance and number of axles	**18/24** 2/3 axles Trailer	**19/26** for 2/3 axles	**18/24** for 2/3 axles	**10/18/24** 1/2/3 axles Trailer **22-44** Semitrailer
Vehicle combination	**36/40** 4/5 axles Road train **36(38)[2]/40(44)[3]** 4/5 axles Articulated vehicle	**64** GVW/GCW table for axle distance	**50** GCW table for axle distance **60** EMS & timber	**50** **60** EMS	**28/36/40(44)[3]** 3/4/5 axles Road train **28/36(38)[2]/40(44)[3]** 3/4/5 axles Articulated vehicle	**38/40(44)[4]** 4/5 axles Road train **38/40(44)[4]** 4/5 axles Articulated vehicle	**26/36/40** 3/4/5 axles Road train **26/36(38)[2]/40(44)[3]** 3/4/5 axles Articulated vehicle	**29/35** TK2-CT1/2+ **36/42(44)[5]** TK3-CT1/2+ **39/44** 4/5 axles Other road trains **29/39/43(44)[5]** 3/4/5+ axles Articulated vehicle **60** EMS

Table 13-4 Vehicle weight limits (ton)

[1] If driving axle is fitted with twin tyres and a) air suspension (or equivalent) or b) drive axle load does not exceed 9.5 t
[2] If the semitrailer axle distance is bigger than 1.8m and the driving axle is fitted with twin tyres and air suspension
[3] If carrying a 45-feet ISO container, 42t for if the motor vehicle has two axles and 44t for if the motor vehicle has three axles
[4] If the single axle load does not exit 12t 5 With air suspension
CT=Centre Axle Trailer, FT=Full trailer, ST=Semitrailer, TK=Truck

13.4 Manoeuvrability and Traction

	EU International	Sweden	Norway	Netherlands	Germany	France	UK	Belgium
Outer & inner circle radius of the swept area (a 360° turn, if not stated otherwise)	**12.5 & 5.3**[1]	**12.5 & 5.3** Motor vehicle **12.5 & 2** (EMS) [2]	**12.5 & 5.3** **12.5 & 2** (timber) **13 & 2, 180°** EMS	**12.5 & 5.3, 270°** total length<=20 **14.5 & 6.5, 120°** 20< length<=23 **16.5 & 7.5, 120°** 23< length<=27	**12.5 & 5.3**	**12.5 & 5.3**	**12.5 & 5.3**	**12.5 & 5.3**
Rear swing out in a turn defined in the first row	**<= 0.8 (1.0) [3] m** Motor vehicle **<= 1.2 m** Articulated vehicle	**Not regulated**	**<= 0.8 (1.0) [3] m** Motor vehicle **Not regulated** Articulated vehicle	**<= 0.8 m** total length<=17 **<= 0.1.2 m** 17< length<=20 **<= 1.4 m** 20< length<=23 **<= 1.7 m** 23< length<=27	**<= 0.8 (1.0) [3] m** Motor vehicle **<= 1.2 m** Articulated vehicle	**<= 0.8 (1.0) [3] m** Motor vehicle **<= 1.2 m** Articulated vehicle	**<= 0.8 (1.0) [3] m** Motor vehicle **Not regulated** Articulated vehicle	**<= 0.8 (1.0) [3] m** Motor vehicle **Not regulated** Articulated vehicle
Steering axle load	**>= 20% of GVW**	**>= 20% of GVW**	**>= 20% of GVW**	**>= 20% of GVW**	**>= 20% of GVW**	**>= 20% of GVW**	N/A	**>= 20% of GVW**
Driving axles load	**>= 25% of GCW**	**Not regulated**	**Not regulated**	**>= 20% of GVW**	**>= 25% of GCW**	**>= 25% of GCW**	**>= 25% of GCW**	**>= 25% of GCW**
Engine power	**>= 5 kW/t**	**>= 5kW/t** (GCW <= 44 t) **>=220+2(GCW-44) kW** (GCW > 44 t)	**>= 5.15 kW/t** (GCW <= 40 t) **>= 206 kW** (GCW > 40 t)	**>= 3.68 kW/t**	**>= 5 kW/t**	**>= 5 kW/t**	N/A	**>= 5 kW/t**
Gradeability	**>= 12 %**[4]	**>= 12%**[4]	**>= 12 %**[4]	**>= 12 %**[4]	**>= 12 %**[4]	**>= 12 %**[4]	N/A	**>= 12 %**[4]

Table 13-5 Restrictions imposed by manoeuvrability and traction criteria

[1] Deemed to comply if wb <= [(12.5-2.04)2–(5.3+L/2)2]0.5where wb and L are wheelbase and width of the semitrailer
[2] Deemed to comply if axle distance <= 22.5m & wheelbase <= 8.15m
[3] For vehicles with retractable axles in the lifted position, or loadable axles in the unladen condition
[4] Starting five times within 5min at a grade with maximum load, for Sweden it is maximum load up to 44t.

13.5 Brakes

Criteria	Required level of performance
Braking deceleration	**5 m/s2** from 6 km/h with engaged engine **4 m/s2** from 90 (80) km/h* with disengaged engine **4 m/s2** from 60km/h, after 20 repeated braking from 60 to 30km/h **3.3 m/s2** from 60km/h, after 6 km continuous braking
Braking efficiency Ratio of achievable deceleration to the ideally supported deceleration by the tyre/pavement friction	**>=75%** on roads with friction coefficient of 0.8 & 0.3 with an initial speed of 50km/h
Braking stability on a straight path	**Judged Subjectively** in a 4 m/s2 deceleration from 90 (80) km/h[1]
Braking stability on a split friction surface, measured by required steering correction	**< 240° (120°)**[2] from 50 km/h on a surface with kH>0.5, kH/kL>2
Parking ability on a grade	**>=18 %** single vehicle loaded up to GVW **>=12 %** vehicle combination loaded up to GCW, unbraked trailer

Table 13-6 Heavy vehicles brake regulation in Europe

[1] Value in parenthesis is for tractors [2] Value in parenthesis is for the first 2 seconds

13.6 Exhaust Emission

	CO (mg/kWh)	THC (mg/kWh)	NMHC (mg/kWh)	CH4 (mg/kWh)	NOX (mg/kWh)	NH3 (ppm)	PM mass (mg/kWh)	PM number (#/kWh)
Compression Ignition (WHSC)	1500	130			400	10	10	8.0 x 1011
Compression Ignition (WHTC)	4000	160			460	10	10	6.0 x 1011
Positive Ignition (WHTC)	4000		160	500	460	10	10	6.0 x 1011

Table 13-7 Euro VI emission limits

CO: carbon monoxide, THC: total hydrocarbon, NMHC: non-methane hydrocarbons, CH_4: methane, NO_X: nitrogen oxides, NH_3: ammonia, PM: particulate matter, ppm: parts per million

13.7 Vehicle and Tyre Noise

	Heavy Vehicle	Normal Tyre	Traction Tyre
Noise limit [db]	82, 81, 79[1]	73[2]	75[2]

Table 13-8. Heavy vehicle and Tyre noise limits in Europe

[1] Limits for the three phases [2] Plus 1db for winter tyres

13.8 Relevant infrastructure features for a PBS scheme

In the previous sections the existing regulations on heavy vehicles in FALCON countries were reviewed. These regulations address the EMS or conventional heavy vehicles with a limited length and weight. Thus, to ensure safety and manoeuvrability of HCT vehicles, if allowed on the road, extra requirements are needed. One possible approach is to use PBS as in Australia, Canada, and New Zealand.

Infrastructure feature	Nominal Values
Road Grade	**Sweden:** main roads: 6-8%, minor roads: 10% **Norway:** 6% **Netherlands:** motorways: 3-4%, main roads: 4-5%, minor roads: 6-7% **Germany:** motorways: 4-6%, country roads: 4.5% - 8% **France:** motorways: 5-6%, main roads: 7%, hilly main roads: 10/8% (with/out snow) **UK:** motorways: 3%, carriageways 4-6%, hilly carriageways: 8% **Belgium:** 4-8%
Friction (winter maintenance)	**Sweden:** main roads: 0.35, minor roads: 0.25 **Norway:** main roads: 0.25, minor roads: 0.2 **Netherlands:** 0.32 **Germany:** motorways and country roads: 0.32 **France:** not regulated **UK:** not regulated **Belgium:** not regulated
Lane width	**Sweden:** motorways: 3.5-3.75m, main roads: 3.0-3.75m, minor roads: 2.75-3.25m **Norway:** 3.25-3.5m depending on speed limit **Netherlands:** motorway: 3.5m, main roads: 3.0-3.25m, minor roads: 2.75-3.1m **Germany:** motorways: 3.25- 3.75m, country roads: 3.25-3.5m **France:** main roads: 3.0-3.5m (larger on bridges) **UK:** 3.35-3.65 m (depending on number of lanes) **Belgium:** motorways and main roads: 3.5-3.75m, whole range: 2.50-3.75m
Crossfall	**Sweden:** 2.5-5.5% **Norway:** min 2% **Netherlands:** 2.5-7% **Germany:** motorways: 2.5-6%, country roads: 2.5-7% **France:** straight lanes: 2.5%, curves: 2.5-7% (proportional to 1/R) **UK:** 2.5-5% (desirable, 7% = absolute maximum) **Belgium:** min 2.5%
Road curvature depends on speed limit	**Sweden:** min 100-1200m **Norway:** min 125-800m **Netherlands:** 160-1500m **Germany:** motorways: min 280-900m, country roads: min 200-900m **France:** min120-600m (higher if no crossfall) **UK:** min 180-1020m (for crossfall of 5%) **Belgium:** min 120-1600m
Roundabout dimensions	**Sweden:** reference outer & inner circles radius of 12.5m & 2m **Norway:** reference outer & inner circles radius of 12.5m & 2m **Netherlands:** outer radius of 10.5-16m (rural), 12.75-18m (urban) **Germany:** outer radius of 17.5-20m (7.5m lane), 20-25m (7m lane) **France:** no guidelines **UK:** no guidelines, for Junctions: min circular corner radius 6m (urban), 10m (rural) **Belgium:** no guidelines

Table 13-9 Nominal value of the relevant infrastructure features for a PBS scheme

13.9 Conclusions of FALCON input to AEROFLEX project

As can be seen there are some differences in the applied length and weight limits in the studied countries, but there are also similarities which can be used to increase the cross-border fright transport efficiency. For instance, most of the studied countries, except from France and UK, allow the 25.25 m EMS vehicles on part/all of their road network. However, the weight limit of EMS vehicles in Germany is kept as the EU limit of 40/44 t, while the rest allow 60 t EMS vehicles. The axle load limits are quite similar; the lowest limits can be used as a base to ensure applicability in all countries. Based on the gathered information for the studied countries, the lowest dimension limits which ensure applicability in all of them are listed in Table 13-11 and Table 13-12. Additional restrictions should be conformed to ensure applicability in all the studied European countries, see Table 13-10.

Introducing a uniform PBS scheme for allowing HCT vehicles in Europe will advance the efficient freight transport. In a PBS scheme, as shown in the reviewed schemes in other regions, the performance of heavy vehicles with respect to safety, manoeuvrability and effects on the infrastructure will be assessed. To do so both vehicle design and infrastructure design should be considered, since they are highly related. If a heavy vehicle is to be permitted on a certain road network, features of the roads play a key role on the required level of performance from the vehicle. A list of relevant infrastructure features, along with their nominal values in the studied countries, is provided in this report.

The existing European environmental regulations, also in effect in the studied countries, are already performance based. Thus, many of these regulations can be applied to HCT vehicles as well. In some cases, some adaptations might be required; for instance, in the case of the prospective European regulation on fuel consumption, HCT vehicles should be considered when determining the typical mission profiles and the fuel consumption limits.

Outer & inner circle radius of the swept area (360° turn, if not stated otherwise)	**12.5 & 5.3 m** **12.5 & 2 m** EMS
Rear swing out in a turn defined in the first row	**<= 0.8 (1.0) 1 m** Motor vehicle **<= 1.2 m** Articulated vehicle
Steering axle load	**>= 20% of GVW**
Driving axles load	**>= 25% of GCW**
Engine power	**>= 5 kW/t**
Gradeability	**>= 12 %2**

Table 13-10 Traction and manoeuvrability criteria which should be conformed to ensure applicability in all the studied European countries

[1] For vehicles with retractable axles in the lifted position, or loadable axles in the unladen condition
[2] Starting five times within 5min at a grade with maximum load, for Sweden it is maximum load up to 44t.

Motor vehicle	**12**
Semitrailer	**12** Kingpin to rear **2.04** Kingpin-front corner
Trailer	**12**
Vehicle combination	**16.5** Articulated vehicle **18.75** Road train
Width	**2.55 (2.6)**[1]
Height	**4**
Loading length behind the cabin	**15.65**
From foremost point of the loading area to the rear end of the vehicle	**16.4**
From rear axle of the motor vehicle to the front axle of the trailer	**>= 3**

Table 13-11 Length limits which ensure applicability in all the studied European countries

[1] For conditioned vehicles (vehicles fitted with a bodywork with insulated walls of at least 45 mm thick)

Single axle load Not a driving axle Driving axle	 **10** **11.5**	
Bogie load d < 0.8 m 0.8 <= d < 1 1 <= d < 1.04 m 1.04 <= d < 1.2 m 1.2 <= d < 1.3 m 1.3 <= d < 1.8 m d >= 1.8 m	 **10** **11 (11.5)** [1] **13.15+13(d-0.9)** **15** **16** **18 (19)** [2] **19**	
Triple axle load d < 1 m 1 <= d <1.3 m 1.3 <= d <1.8 m d >= 1.8 m	 **16** **21** **24** **24**	
Motor vehicle	**18/25(26)**[3]**/32**	2/3/4+ axles
Trailer/Semitrailer	**10/18/24**	1/2/3 axles
Vehicle combination	**26/36(35)/40** **26/36(38)** [3]**/40(42,44)**[4] **60**	3/4/5 axles road train (TK2-CT2) 3/4/5 axles articulated vehicle EMS

Table 13-12 Weight limits which ensure applicability in all the studied European countries

[1] For driving axle

[2] For motor vehicle, if driving axle is fitted with twin tyres and a) air suspension (or equivalent) or b) drive axle load does not exceed 9.5 ton

[3] If the semitrailer axle distance is bigger than 1.8m and the driving axle is fitted with twin tyres and air suspension

[4] If carrying a 45-feet ISO container, 42t for if the motor vehicle has two axles and 44t for if the motor vehicle has three axles

13.10 Review of Performance Based SIAP in the world

13.10.1 Canada

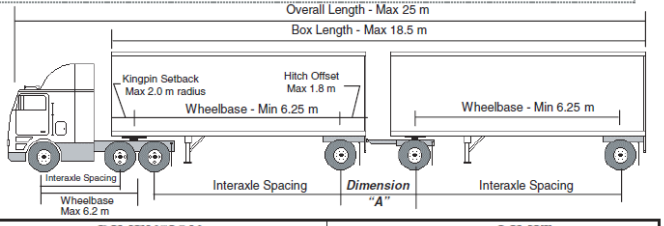
In 1987, the result of the Vehicle Weights and Dimension Study, a major research study to identify HCT vehicles with minimal impact on infrastructure and satisfactory dynamic performance, was presented. The study was undertaken for the Road Transport Association of Canada, by University of Michigan Transportation Research Institute. It included regulatory principles for interprovincial heavy vehicle weights and dimensions in Canada, based on the seven performance based standards below (VWDS 1987):

- Static rollover threshold
- Dynamic load transfer ratio
- Friction demand in a tight turn
- Braking efficiency
- Low-speed offtracking
- High-speed steady-state offtracking
- High-speed transient offtracking

A national implementation committee developed detailed specifications for the most common vehicles based on the regulatory principles. In this work, they used a prescriptive approach based on performance standards (VWDS 1987). These specifications were used to develop a national Memorandum of Understanding (MoU) on Vehicle Weights and Dimensions. All Canadian provinces implemented the MoU in 1989. The MoU was subsequently amended. The MoU defines eight vehicle categories based on the vehicle and axle configuration (NCHRP 2010).
Conclusively, PBS has been used in Canada as a basis for developing a prescriptive limits regulatory framework. Using the PBS and the results of a sensitivity analysis a set of size and weight limits, “vehicle envelopes”, defining the general vehicle layout were developed. This PBS/Prescriptive approach provides flexibility in design for various vehicle categories (Woodrooffe 2012). Examples of weight and length limits for one vehicle category are shown in Figure 13-1.

CATEGORY 2: A TRAIN DOUBLE

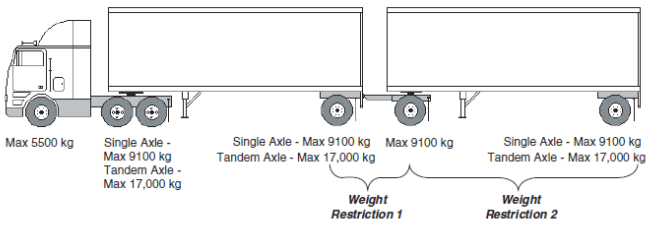
Part 1 - Dimension Limits



DIMENSION	LIMIT
Overall Length	Maximum 25 m
Overall Width	Maximum 2.6 m
Overall Height	Maximum 4.15 m
Box Length	Maximum 18.5 m
Tractor:	
Wheelbase	Maximum 6.2 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Lead Semitrailer	
Wheelbase	Minimum 6.25 m
Kingpin Setback	Maximum 2.0 m radius
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Hitch Offset	Maximum 1.8 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Second Semitrailer or Full Trailer	
Wheelbase	Minimum 6.25 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Interaxle Spacings	
Single Axle to Single or Tandem Axle	Minimum 3.0 m
Tandem Axle to Tandem Axle	Minimum 5.0 m
Dimension “A” (from the centre of last axle on the lead semitrailer to the centre of the first axle on the converter dolly or second trailer)	Not controlled

Category 2: A Train Double

Part 2 - Weight Limits



WEIGHT	LIMIT
Axle Weight Limits:	
Steering Axle	Maximum 5500 kg
Single Axle (dual tires)	Maximum 9100 kg
Tandem Axle:	
Axle Spread 1.2 m - 1.85 m	Maximum 17 000 kg
Weight Restriction 1: Sum of Axle Weights of Lead Semitrailer Plus Weight of Converter Dolly Axle	If Dimension "A" is less than 3 metres, the weight of the axle(s) on the lead semitrailer plus the weight of the converter dolly axle(s) is limited to a maximum of 17,000 kg for a two axle group or a maximum of 23,000 kg for a three axle group.
Weight Restriction 2: Sum of Axle Weights of Full Trailer or Second Semitrailer	The weight of the second trailer must not exceed the weight of the tractor drive axle(s) plus the weight of the axle(s) on the first semitrailer.
Gross Vehicle Weight Limits:	
Five Axles	Maximum 41 900 kg
Six Axles	Maximum 49 800 kg
Seven Axles	Maximum 53 500 kg
Eight Axles	Maximum 53 500 kg

Figure 13-1 Length & Weight envelopes for a train double in Canada (NCHRP 2010)

13.10.2 New Zealand

New Zealand is one of the first countries to use performance based standards for regulating heavy vehicles. PBS has been used in New Zealand as a guide within a generally prescriptive regulatory framework since about 1989 (OECD 2005). In 2002 the size and weight regulations were moved into the Vehicle Dimensions and Mass (VDAM) Rule (De Pont et al. 2016). Again, PBS were used to develop some aspects of the regulation, including a new rule which required that all heavy vehicles shall have a minimum Steady-state Rollover Threshold (SRT) of 0.35g (LTSA 2002). The reason for this was that heavy vehicles were frequently involved in rollover accidents; there is research showing that low SRT correlates with high rates of rollover accident (Winkler et al. 2000, Muller et al. 1999).

In New Zealand, the maximum legal length for vehicle combinations is 20m and the maximum legal gross combination weight is 44t. In 2010 the VDAM Rule was amended to allow High Capacity Transport (HCT) vehicles to operate on routes that can accommodate them (LTSA 2010). The requirements for route-specific permitting of HCT vehicles are not formally specified in regulations; however, in practice the regulators have used performance based standards to determine whether the route can accommodate these vehicles. The New Zealand transport agency has a draft document on the policies for permitting vehicles that are over 23m but no more than 25m in length (NZTA 2013).

Although a formalised PBS system does not exist in New Zealand, PBS has been recognised as a useful tool to guide the regulators. Initially the performance measures used were based on those defined in the Vehicle Weights and Dimension Study undertaken for the Road Transport Association of Canada by University of Michigan Transportation Research Institute (VWDS 1987, De Pont et al. 2016). The Australian measures have been used, since its establishment in 2008. It has been complemented with some New Zealand specific performance measures, such as dynamic load transfer in a single lane change manoeuvre and high speed steady-state offtracking at a lateral acceleration of 0.2g.

According to de Pont et. al., the VDAM Rule was under review as of 2016, and as part of this review, a set of PBS applicable to New Zealand was being formalised. This process is considering which performance measures are most relevant to New Zealand and what are the appropriate pass/fail criteria (De Pont 2016).

13.10.3 Australia

Australia has the most comprehensive existing PBS approach to regulation of HCT vehicles, development of which took almost 10 years. The National Transport Commission in Australia initiated the process around 1999 and the scheme went into operation in October 2007. The PBS scheme in Australia is a voluntary process and operates as an alternative to the prescriptive regulations; it allows operators to use vehicles which do not conform to the prescriptive limits on mass and dimension, if their performance comply to a set of standards, covering safety, manoeuvrability and infrastructure. The Australian Design Rules including brakes, couplings, suspensions and tyres remain a requirement for all heavy vehicles (Arredondo 2012, ARTSA 2003).

One of the major phases of the PBS schemed development in Australia was identification of the essential performance measures, for which the following criteria were considered (NRTC 1999):

- Relevance to replacing and augmenting prescriptive limits
- Relevance to the entire vehicle, the load carried and the vehicle-road interaction
- Perceptions of importance to the identified outcomes in all zones of vehicle operation
- Inter-relationships between measures, a key measure being representative of similar measures
- Comprehension by all stakeholders
- Ability to be enforced with confidence.

Maneuver	Safety Standard	Description
Accelerate from rest on an incline	1. Startability	Self-explanatory
Maintain speed on an incline	2. Gradeability	Self-explanatory
Cover 100m from the rest	3. Acceleration capability	Intersection/rail crossing clearance times.
Low-speed 90 degree turn	4. Low-speed swept path	'Corner cutting' of vehicle combination
	5. Frontal Swing	Swing out of the vehicle's front corner
	5a. Maximum of difference	The difference in frontal swing-out of adjacent vehicle units where one of them is semitrailer.
	5b. Difference of maxima	
	6. Tail swing	Swing-out of the vehicle's rear corner.
	7. Steer-tyre friction demand	Maximal friction utilized by steer-tyres.
Straight road of specified roughness and cross-slope	8. Tracking ability of a straight path	Total road width utilized by a vehicle as if responds to the uneven road at speed.
Constant radius turn (increasing speed) or tilt-table testing	9. Static rollover threshold	The maximum of steady lateral acceleration a vehicle can withstand before rolling over.
Single lane-change	10. Rearward amplification	'Whipping' effect as lateral accelerations are amplified in trailing units.
	11. High-speed transient off tracking	Overshoot of the rearmost trailing unit.
Pulse steer input	12. Yaw damping coefficient	The rate at which the yaw oscillations settle.
Brake from 60 km/h to rest	13. Directional stability under braking	Directional stability and controllability of the vehicle under heavy braking.

Table 13-13 Australian performance standards and manoeuvres (NTC 2008)

During the process of establishing the performance standards, relevant information on heavy vehicle investigation where performance based approach has been used was gathered, including information on links between the crash rates of heavy vehicles and performance measures. Furthermore, the performance of the existing Australian fleet was assessed with respect to the candidate standards, using simulation and models of 139 representative heavy vehicles. The selected vehicles covered a diverse range of vehicle configurations, freight transport tasks and operating situations. As part of the existing fleet study, results from several field studies with various heavy vehicles in Australia were also reviewed (NRTC 1999, NRTC 2002). Additionally, workshops with interested parties and stakeholders were organized in all Australian states, where the candidate performance standards were discussed and adjusted accordingly. The intention was to evaluate the potential costs and benefits of the PBS scheme for all stakeholders and to enhance its credibility (NRTC 2001).

The Australian PBS scheme consists of sixteen safety standards and four infrastructure related standards. Thirteen of the sixteen safety standards are summarized in Table 1. with a description of each standard and a description of the associated test or manoeuvre. The three remaining standards – overtaking provision, ride quality and handling quality – are under review and are not likely to form part of the scheme in the short term. The four infrastructure standards

are: pavement horizontal loading, pavement vertical loading, tyre contact pressure distribution and bridge loading. These standards are predominantly prescriptive due to the nature of the vehicle-infrastructure interaction. For each performance measure, four level of required performance are decided that correspond to different access to the road network. Level 1 represents unrestricted access to the Australian road network, with the most stringent performance criteria. Levels 2, 3 and 4 represent subsets of the road network, in increasing order of route restriction (NTC 2008).

Another important aspect of a PBS scheme development is the assessment and implementation procedure. Figure 13-2 depicts the application and decision-making procedure for the Australian PBS scheme. The decision is made by the PBS review panel, based on the recommendation by the panel's Secretariat and assessment results. The PBS review panel is made up from a representative from each Australia state and territory, the commonwealth and an independent chairperson and deputy person, in total 11 people. The assessor is a person who has applied to carry out assessment of vehicles and has been authorized by the PBS review panel (Arredondo 2012). Compliance of a vehicle with these standards is assessed either via physical testing or numerical modelling. Numerical modelling has proved very effective, and is the most common form of assessment due to the cost and effort involved in testing a prototype vehicle.

The assigned permit by the PBS review panel might include some operating conditions relevant to the usage of the vehicle; examples of such operating conditions are: fitting an underrun protection device, displaying a long vehicle sign, road friendly suspension for the tandem axles, etc. In some circumstances, Australian road authorities may also require the vehicle to operate under the Intelligent Access Program (IAP) and/or to fit the vehicle with on board mass monitoring. The IAP is a national program for remote monitoring of the vehicles and is capable of monitoring vehicles' route, time and speed (Arredondo 2012).

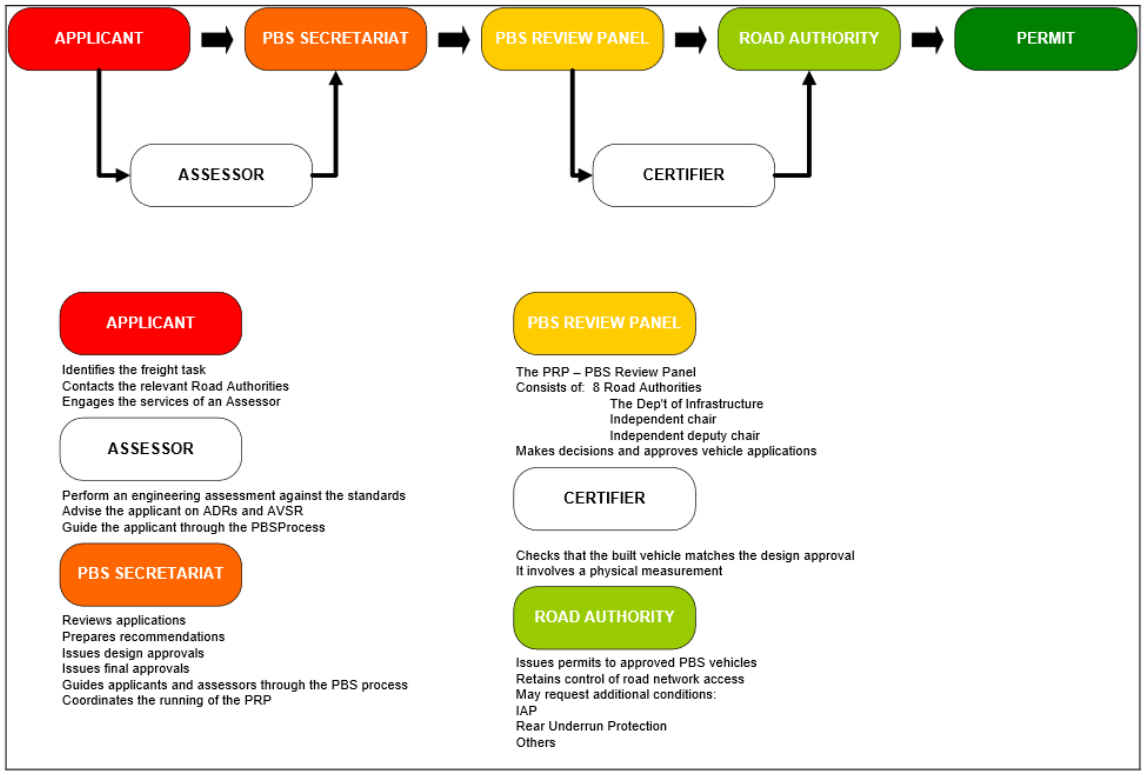


Figure 13-2 Decision-making procedure of the Australian PBS Scheme (Arredondo 2012)

13.10.4 South Africa

The existing legislation in South Africa, allows heavy vehicles with maximum overall length of 22m and maximum weight of 56t. However, in August 2004 a PBS committee was established to investigate the PBS approach and evaluate its potential in South Africa. Since 2008, demonstration projects of concept heavy vehicles are being carried out under the Road Transport Management System (RTMS) scheme. RTMS is an industry-led, voluntary self-regulation scheme, largely based on the Australian PBS scheme and suggested levels of performance. However, the infrastructure standards, such as the limits for axle loads and bridge formulas, are adapted to South African road traffic regulations and design codes of practice (Dessin et al. 2008, Nordengen 2012). The first two PBS demonstration projects were implemented in forestry industry, more specifically within Sappi Forests Ltd and Mondi Business Paper. The vehicles were designed and manufactured to comply with the Level 2 safety standards of the Australian PBS system and went into operation in November and December 2007. Both Sappi and Mondi vehicles were a truck-dolly-semitrailer combination; the Sappi PBS vehicle was 27m long with total mass of 67.5t, while the Mondi PBS vehicle had an overall length of 24m and total mass of 64.1t, see Fig. 4. The following extra safety features were incorporated in the design of one or both of the Sappi and Mondi vehicles:

- ABS and EBS
- Air suspension
- Pneumatic straps (self-tightening) for load securement
- Lift axles
- Underslung drawbar
- On-board load cells for payload control
- Central tyre inflation
- Vehicle tracking system
- Anti-rollover devices
- Special driver training

As of February 2017, the trial includes 215 participating vehicles, transporting commodities such as mining ore, timber, fuel, coal and sugar, with vehicles ranging in length from 22 to 40m, and in mass from 56 to 148t. To date, performance data for 92.4 million truck kilometres have been accumulated, together with data from conventional vehicles performing the same freight task on identical routes (the `baseline' vehicles). The data show that the demonstration vehicle fleet has yielded significant savings in terms of truck trips, fuel consumption, and emissions versus baseline vehicles. Furthermore, the demonstration vehicles yielded between a third and a half of the crash rate of the baseline vehicles, and have significantly fewer incidents of overloading, poor maintenance and other incidents (CSIR2017).

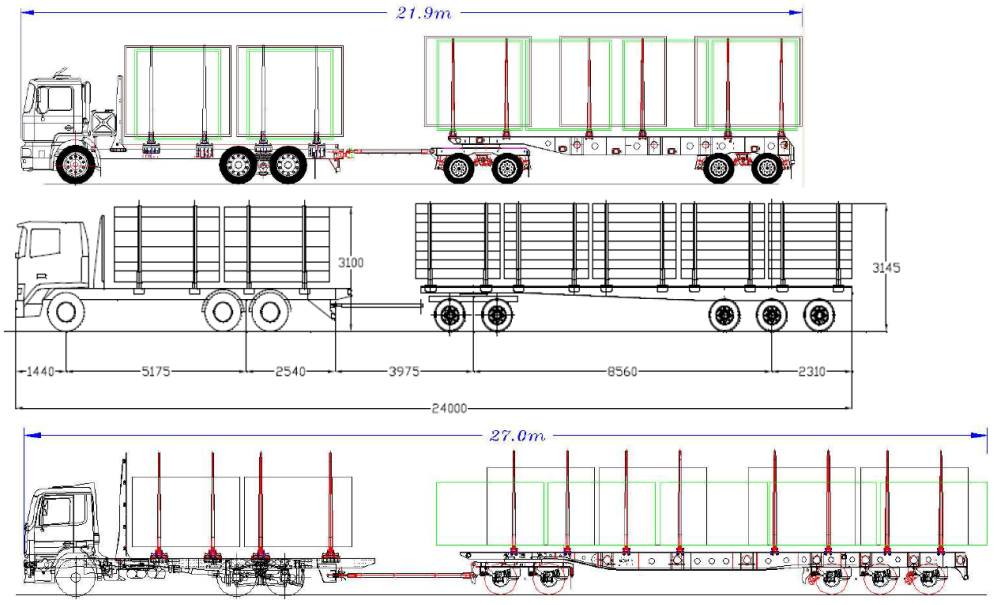


Figure 13-3 The baseline vehicle and Mondi and Sappi demonstration vehicles (Nordengen 2010)

13.10.5 Sweden

The existing legislation in Sweden allows heavy vehicle combinations with maximum length of 25.25m and maximum weight of 64t on the road network. The government is considering opening part of the road network for 74t vehicles. Accordingly, the Swedish government is undertaking a large research program to investigate the use of HCT vehicles in Sweden, part of which is the project "PBS for HCT in Sweden". The project objective is to investigate the applicability of PBS in Sweden and to propose a regulatory framework based on PBS by identifying a set of performance based standards suitable for Sweden, with attention to winter road conditions (Kharrazi et al. 2014). The project started at the end of 2013 with reviewing the existing regulations, PBS approaches in other countries and other relevant literature. All the three domains of safety, infrastructure and environment were considered in this review. The gathered information is available as a public report (Kharrazi et al. 2015).

During the project, a candidate set of performance measures was identified and examined. One of the investigated issues in the project is the required level of modelling details for assessing different performance measures. For instance, the carried investigation for the traction related performance measures showed that the model complexity could potentially be kept relatively low, without a significant loss in accuracy. However, for winter/low friction conditions a higher level of complexity might be required (Bruzelius et al. 2016). A primary outcome of the project is the results of a study on the correlation between heavy vehicles performance in summer and winter conditions, which can be used for assigning required performance levels that also ensure safety in winter conditions, sample results can be found in (Kharrazi 2016). The development of an open PBS tool has also started during the project, results of which are published in a public report (Jacobson et al. 2017).

There have been several trials with HCVs, as part of the HCV program in Sweden. Since 2009, 50 vehicles have been operating in the program, saving about 10 million litres of diesel and 25000 tons of CO2 (Skogforsk 2017).

13.10.6 Netherlands

Although Netherlands have not operated a PBS scheme to the extent of the Australia or Sweden, there has been a continual effort to increase the efficiency of the road freight transport through the implementation of High Capacity Vehicles (HVCs). This started in 2000 with four experimental vehicles, each 25.25 m in length and up to a maximum operational mass of 60 t using standardized loading units. Those vehicles were allowed to operate on highways, and primary roads from highways to distribution centres. The vehicles were forced to satisfy most of the European prescriptive safety regulations except the one on low speed cornering where more space was provided in terms of national exception. It implied that those vehicles could not be employed for a cross-border transport. Over the years the number of HCVs increased based on very positive results in terms of profitability and sustainability, which in 2013 resulted in legalization of HCVs on national basis.

Since then, the national heavy vehicle regulator (RDW) has provided an open-access digital map of the infrastructure network segments, which were granted by the exception to allow HCVs operation (see Fig. 5). In practice, if an operator requires an HCV to operate on a certain segment of the infrastructure, a request must be submitted to RDW to assess required infrastructure section. RDW will use a standard assessment procedure defined by CROW (2013), which reflects on the infrastructure and vehicle dimensions and vehicle manoeuvrability. If the proposed infrastructure segment satisfies the criteria, the road is "opened" and added to the map of allowable roads for HCVs to operate on (in green). In case of assessment failure, the segment is marked red, and no HCVs are granted access to this segment.

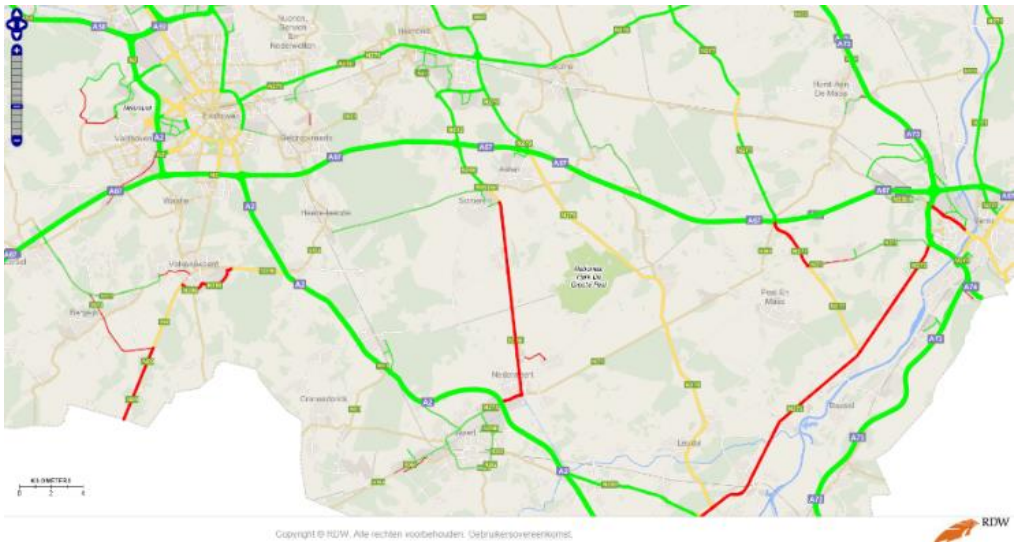


Figure 13-4 Infrastructure network in Netherlands, indicating open and restricted access segments for HCT in green and red respectively