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### ENSEMBLE

ENabling SafE Multi-Brand pLatooning for Europe

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# 1. EXECUTIVE SUMMARY

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## 1.1. Context and need of a multi brand platooning project

### *Context*

Platooning technology has made significant advances in the last decade, but to achieve the next step towards deployment of truck platooning, an integral multi-brand approach is required. Aiming for Europe-wide deployment of platooning, ‘multi-brand’ solutions are paramount. It is the ambition of ENSEMBLE to realise pre-standards for interoperability between trucks, platoons and logistics solution providers, to speed up actual market take-up of (sub)system development and implementation and to enable harmonization of legal frameworks in the member states.

### *Project scope*

The main goal of the ENSEMBLE project is to pave the way for the adoption of multi-brand truck platooning in Europe in order to improve fuel economy, traffic safety and throughput. This will be demonstrated by driving up to seven differently branded trucks in one (or more) platoon(s) under real-world traffic conditions across national borders. During the years, the project goals are:

- Year 1: setting the specifications and developing a reference design with acceptance criteria.
- Year 2: implementing this reference design on the OEM’s trucks as well as performing impact assessments with several criteria.
- Year 3: focus on testing the multi-brand platoons on test tracks and international public roads.

The technical results will be evaluated against the initial requirements. Also, the impact on fuel consumption, drivers and other road users will be established. In the end, all activities within the project aim to accelerate the deployment of multi-brand truck platooning in Europe.

### *Abstract of this Deliverable*

This deliverable starts with an update of the regulatory framework in which the ENSEMBLE project is working. This update consists of two parts:

- Analysis of the updates in the regulatory framework since the publication of the Deliverable 6.10, such as: R (EU) 2019/2144: New General Safety Regulation [3], WP29-177-19: Framework document on automated/autonomous vehicles or GRVA new structure;
- Exemption procedure for the EU approval of automated vehicles.

The deliverable continues with a review of the exemption procedures from past experiences and other projects in which some partners such as IVECO, MAN, IFSTTAR and DAIMLER have participated. A specific questionnaire was created and filled out by the task partners in order to analyse their answers and get an overall idea of exemption procedures in various countries.





In addition, this deliverable describes the existing exemption procedures in some of the Member States involved in this project, including its requirements in order to grant these exemptions.



## 2. INTRODUCTION

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### 2.1. Background

This document describes the final results obtained in subtask 6.3.2 “Exemption procedure for multi-brand platoon testing across borders in multiple Member States”, which is the second part of the main task 6.3 “Regulatory framework evolution for platooning”, led by IDIADA Automotive Technology. Specifically, this deliverable D6.12 is the updated version of D6.11: “V1 Report on mutual recognition” [1].

### 2.2. Aim

The aim of this Deliverable is threefold. The first part is to collect all the information available on the different exemption processes from various Member States and previous experiences from the members of the project. Special attention was paid to the information available in Spain, where the open road testing and public demo event took place (specifically in Barcelona), as well as Netherlands and Belgium, where initially demonstration was planned.

The second part further analyses the requirements of the different Member States and specially focusses on the requirements shared. The last part aims to pave the way to propose a mutual recognition of exemption procedures between involved Member States to expedite the testing phase of multi-brand platoons. This deliverable will not define this mutual recognition exemption procedure, but will propose a harmonized set of requirements, considering a future scenario where truck platooning is a reality.

### 2.3. Structure of this report

The core body of this report is divided into six sections:

1. **Section 1:** Executive summary
2. **Section 2:** Introduction and structure of this report
3. **Section 3:** Review of the current regulatory framework related to truck platooning. Some time has passed since D6.10 and D6.11 were submitted and the status of the work performed in UNECE and Brussels since then has evolved substantially. An explanation of the latest regulatory changes and discussions are described.
4. **Section 4:** Description of the past experiences related to platooning from the various partners involved in the project.
5. **Section 5:** Description of the state of the art of exemption procedures in the Member States where there is an existing framework. Special focus is on the procedures defined in Spain to



apply for the exemptions requested for the open road testing and the public demo held in Barcelona in September 2021. Additionally, special focus is on the procedures in Belgium and Netherlands related to get prototypes on the road. The section ends with a proposal for a mutual recognition approach.

6. **Section 6:** Conclusions.



## 3. PLATOONING AND UPCOMING REGULATIONS

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An increasing number of activities have been carried out in the different working groups from Geneva (UNECE) and the European Commission since Deliverable 6.10 [2] and Deliverable 6.11 [1] were submitted. In this section to better contextualize the present Deliverable, the regulatory framework will be analysed and updated so as to understand better the framework in which the ENSEMBLE project is working.

Note that, in this section only the Type-Approval concerns will be discussed. This section will not include considerations for permissions for each Road Authority at national level. For more information about driving permission at a national level, please refer to Section 5.

### 3.1. Introduction to the main updates

Up to now, requirements for platooning are not covered by any regulation or standard. On one hand, and with the purpose of improving road safety, in December 2019 the European Union introduced the General Safety Regulation (EU) 2019/2144, which introduces advanced safety requirements that will be regulated as of 2022 [3].

The European Commission decided that, due to its potential, platooning can bring safer, cleaner and more efficient transport in the future. As a consequence, relevant standards and a regulatory framework would be needed in order to encourage such technology in a safe manner.

Within UNECE and the World Forum for Harmonization of Vehicle Regulations (WP.29), GRVA (Group of Experts on Automated Driving) is the group that discusses all the aspects related to automated driving and proposes recommendations or guidelines that may become new UN Regulations.

During 2019, a framework document on automated/autonomous driving (WP29-177-19) [4] was presented as the basis for further development of a series of vehicle safety topics (always looking for a higher level of safety). The list included:

- System Safety
- Failsafe Response
- Human Machine interface (HMI)
- Object Event Detection and Response (OEDR)
- Operational Design Domain (ODD/OD)



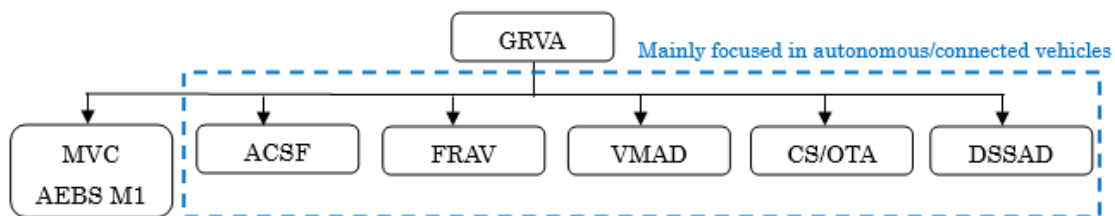
- Validation for System Safety
- Cybersecurity
- Software Updates
- Event Data Recorder (EDR)

These topics are dealt with or discussed in specific working groups directly dependent on GRVA.

### 3.1.1. GRVA structure

United Nations Regulations are standards that have been accepted and recognized by all the signatories of the 1958 agreement. Moreover, most of these regulations become mandatory under European laws.

As a result of the growing importance of automated and connected vehicles, in 2018 WP.29 started to develop a dedicated subsidiary Working Party on Automated/Autonomous and Connected Vehicles, called GRVA. Taking into account the main objectives reflected in the framework document for automated vehicles, different informal groups were established in order to address the different topics. The current structure can be seen in Figure 1.



**Figure 1. GRVA Informal Working Groups structure**

- ACSF: Automatically Commanded Steering Function
- FRAV: Functional Requirements for Automated and Autonomous vehicles
- VMAD: Validation Method for Automated Driving
- CS/OTA: Cyber Security and (OTA) software updates
- DSSAD: Data Storage System for Automated Driving

Due to the scope of each informal working group the ones that their activities may influence the development of a future platooning regulation are FRAV and VMAD. ACSF is mainly focused on this functions that are under the scope of UN R.79 . CS/OTA work applies to the manufacturer, the vehicles under production and the use life of the vehicle, however it does not apply to a technology specifically. In similar situation is the DSSAD informal working group as they are developing requirements for the DSSAD and EDR systems which do not have a direct impact on platooning.

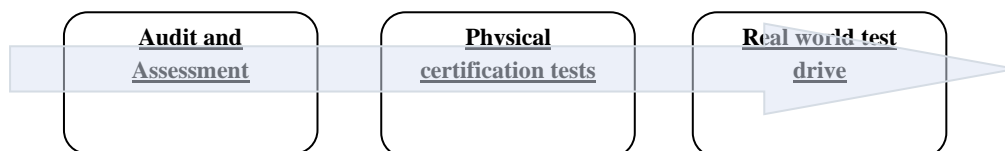
### *FRAV (Functional Requirements for Automated and Autonomous Vehicles)*

This informal working group is developing the functional requirements for automated/autonomous vehicles, in particular, the combination of different driving functions: longitudinal control, lateral control, environment monitoring, minimum risk manoeuvre, transition demand, human machine interface and driver monitoring. FRAV also takes into account the failsafe response in order to validate the system safety, which generally is also evaluated by the manufacturer during the development phase by implementing ISO 26262 for Functional Safety [5].

### *VMAD (Validation Method for Automated Driving)*

VMAD's objective is to develop an assessment method capable of validating the safety of automated systems based on a multi-pillar approach. This new certification approach includes audits, simulations, virtual testing, test track and open road testing. As for conventional test methods, it is not possible to evaluate all the challenges raised for automated driving. The new assessment and test method do not replace the current testing but complement it.

The group is developing a new certification approach based on the following pillars as described in Figure 2.



**Figure 2. Multi-Pillar Approach**

The first step of the certification starts with the audit of the development process. Analysis of the safety concept and functional safety must be performed on complex electronic systems within the classical certifications. Currently this evaluation is growing in importance, so it is necessary to standardize it. This first pillar is not limited to an audit, as some simulations can be used as validation of the system during the development process.

Once the initial assessment has been done, the next stage is to match the results obtained with proving ground tests. On proving ground, special cases can be reproduced in order to evaluate the real behaviour of the vehicle, focusing on scenarios and conditions considered as “*edge conditions*”.

Finally, the behaviour of the system on public roads is evaluated trying to achieve a given set of scenarios to cover all the possible common situations.

### **3.1.2. New General Safety Regulation (EU) 2019/2144**

In December 2019, a new version of the General Safety Regulation was published in the Official Journal of the European Union, its last correction was published in April 2021. This Regulation applies to vehicles of categories M, N and O, as defined in Article 4 of Regulation (EU) 2018/858 [6],



and to systems, components and separate technical units designed and constructed for such vehicles.

Over the past decades the developments introduced in vehicle safety have contributed to the reduction in the number of road fatalities and injuries. Following this path, the European Union's main objective is to reduce these numbers even more, through new safety measures for both vehicle occupants and vulnerable road users. It will gradually introduce advanced safety systems offering new possibilities to reduce casualties. Starting from July 2022, new motor vehicles must be equipped, among others, with the following systems:

- Intelligent speed assistance: system to aid the driver in maintaining the appropriate speed for the road environment by providing dedicated and appropriate feedback.
- Alcohol interlock installation facilitation: standardized interface that facilitates the fitting of aftermarket alcohol interlock devices in motor vehicles.
- Driver drowsiness and attention warning: system that assesses the driver's alertness through vehicle systems analysis and warns the driver if needed.
- Advanced driver distraction warning: system that helps the driver to continue to pay attention to the traffic situation and that warns the driver when he or she is distracted.
- Emergency stop signal: light-signalling function to indicate to other road users to the rear of the vehicle that a high retardation force is being applied to the vehicle relative to the prevailing road conditions. It is under the scope of Un Regulation N48 [19] and it shall be given by the simultaneous operation of all the stop or direction-indicator lamps. The emergency stop signal shall be switched ON-OFF automatically. It shall be displayed only while the vehicle is being driven at a speed higher than 50km/h and it has a deceleration higher than what is prescribed in UN R.13 and R13H for emergency braking.
- Reversing detection: system to make the driver aware of people and objects at the rear of the vehicle with the primary aim of avoiding collisions when reversing.
- Event data recorder: system with the sole purpose of recording and storing critical crash-related parameters and information shortly before, during and immediately after a collision.

Thanks to the technological progress of advanced vehicle safety systems, these new safety measures are already available.

According to clause 25 of the New General Safety Regulation, one of the functions that shall be regulated in upcoming years is platooning:

*“(25) Vehicle platooning has the potential to bring about safer, cleaner and more efficient transport in the future. In anticipation of the introduction of platooning*

*technology and the relevant standards, a regulatory framework with harmonized rules and procedures will be needed.”*

Additionally, in Article 3 regarding definitions, the Regulation is updated with “*vehicle platooning*” is introduced, among others:

*(24) ‘vehicle platooning’ means the linking of two or more vehicles in a convoy using connectivity technology and automated driving support systems which allow the vehicles to automatically maintain a set, close distance between each other when connected for certain parts of a journey and to adapt to changes in the movement of the lead vehicle with little to no action from the drivers.’*

Table 1 summarizes the application dates for systems regarding trucks.

**Table 1. Systems application dates for trucks according to Annex II of General Safety Regulation (EU)2019/2144**

<b>System</b>	<b>New Types</b>	<b>New Registrations</b>
Pedestrian and cyclist collision warning	July 2022	July 2024
Blind Spot Information System	July 2022	July 2024
Reversing Detection	July 2022	July 2024
Protection against Cyberattacks	July 2022	July 2024
Intelligent speed assistance	July 2022	July 2024
Emergency Stop Signal	July 2022	July 2024
Alcohol Interlock installation facilitation	July 2022	July 2024
Driver drowsiness and attention warning	July 2022	July 2024
Advanced driver distraction warning	July 2024	July 2026
Event Data Recorder	Jan 2026	Jan 2029
System to replace driver’s control	July 2022	July 2024
<b>Platooning</b>	<b>July 2022</b>	<b>July 2024</b>
Reversing motion	July 2022	July 2024





For automated vehicles and fully automated vehicles, the Regulation also adds a set of technical specifications that these vehicles shall comply with in order to add safety to the functions. So, in the case of platooning systems of SAE level 3 and higher, more technical requirements would be considered at the time of implementation. The list of technical requirements includes:

- Systems to replace the driver's control of the vehicle, including signalling, steering, accelerating and braking.
- Systems to provide the vehicle with real-time information on the state of the vehicle and the surrounding area.
- Driver availability monitoring systems.
- Event data recorders for automated vehicles.
- Harmonized format for the exchange of data for instance **for multi-brand vehicle platooning**.
- System to provide safety information to road users.

#### *Technical requirements for automated vehicles*

From all the technical requirements described above, most of them have been developed by the WP.29 or the European Commission. These requirements have evolved in parallel to the Regulations of the systems specified in Table 1 of this section, in order to ensure the full deployment of automated vehicles and systems. In the following list it is referenced in which regulation each technology is regulated:

- Pedestrian and cyclist collision warning → UN R.159
- Blind Spot Information System → UN R.151
- Reversing Detection → To be regulated
- Protection against Cyberattacks → UN R.155 and UN R.156
- Intelligent speed assistance → R (EU) 2021/1958
- Emergency Stop Signal → UN R.48, UN R.13 and UN R.13H
- Alcohol Interlock installation facilitation → R(EU) 2021/1243
- Driver drowsiness and attention warning → R(EU) 2021/1341
- Advanced driver distraction warning → Under development, draft available.



- Event Data Recorder → UN R.160
- Platooning → To be regulated
- Reversing motion → UN R.158

From all of the technologies regulated above it has been considered that Event Data Recorder it is worth to explain more detailed due to its connexion with the safety of the automated functions.

### Requirements for event data recorders

The event data recorders must be capable of recording and storing a period shortly before, during and after a collision. The regulation defines a minimum range of variables that should be collected, such as vehicle speed, braking, position of the vehicle on the road, state and activation of the safety systems, among others.

These systems will be permanently activated and will protect the data against misuse or threats. One of the main objectives of the implementation of the system is to create a standardized accident database, made available for all the National Authorities, for analysis and research.

Currently, two new regulations establishing the requirements and testing for Data Storage System for Automated Driving (DSSAD) and Event Data Recorder (EDR) are being discussed in an informal group of GRVA, subsidiary group of the World Forum of Harmonization (WP.29). In Table 2 it can be found to what level of vehicle coverage is focused each one of these regulations.

The purpose of the EDR is to collect data valuable for effective crash investigations and analysis of safety equipment performance. This data will help the Authorities in the understanding of crashes, so this will be mandatory both for vehicles fitted with automated systems and conventional vehicles. On the other hand, DSSAD are intended for determining who is responsible for the driving actions in a wide-time window. In this direction, UN Regulation 157 concerning Automated Lane Keeping Systems (ALKS) has been published and entry into force in January 2021. As the system is able to control longitudinal and lateral movement of the vehicle for extended periods without further driver command it is considered a SAE level 3. So far, this regulation is only applicable to M1 vehicles, up to a speed of 60km/h and its usage is limited to roads where pedestrian and cyclists are prohibited.



**Table 2. EDR and DSSAD vehicles coverage [7]**

Target Vehicle	Data relevant to	
	Accident Configuration	Who was driving
Vehicles	EDR	-
Automated/ Autonomous Vehicle		DSSAD

### 3.2. Exemption Procedure for the EU approval of automated vehicles

While there is not yet a new regulation establishing the platooning requirements, there are other procedures that allow an exemption for new technologies or new concepts. Any Member State may grant a provisional approval to these technologies for its territory.

In 2018, the European Commission presented a guideline for an exemption procedure for the EU approval of automated vehicles [8].

The main purpose of the document is to harmonize the approach of the Member States when approving unforeseen technologies under EU rules. These new concepts that are not compatible with existing rules, may obtain an exemption through Article 20 of Directive 2007/46/EC [9], which will be replaced by Article 39 of Regulation (EU) No 858/2018 [6] on vehicle approval and market surveillance. In Figure 3 it is shown to which levels of automation these two articles could be applied. With the guideline, this exception is standardized ensuring the safety of the vehicle, transparency between Member States and mutual recognition.

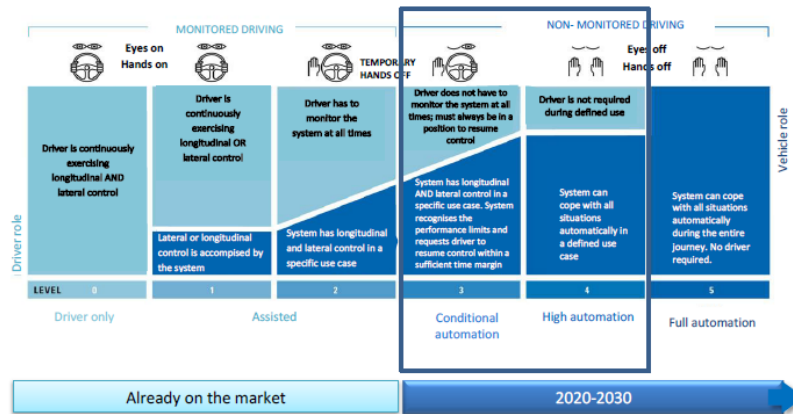
*“1. Member States may, on application by the manufacturer, grant an EC type-approval in respect of a type of system, component or separate technical unit that incorporates technologies or concepts which are incompatible with one or more regulatory acts listed in Part I of Annex IV, subject to authorization being granted by the Commission in accordance with the procedure referred to in Article 40(3)”*

The approval of the system may be granted by the European Commission by means of an implementing act based on the guidelines, giving validity to the approval that can be limited to 36 months or by number of units.

In May 2018, the European Commission adopted an EU strategy on automated and connected mobility, and part of the strategy was the creation of a guideline to ensure a harmonized approach for the exemption procedure for EU approval of automated vehicles.

The focus of the guidelines is automated vehicles that can drive themselves in a limited number of driving situations which are already being tested and are expected on a commercial basis in the near future, such as platooning.





**Figure 3. Levels where Article 20 of Directive 2007/46/EC / Article 39 of Regulation (EU) No 858/2018 could be applied**

The design and validation process must be agreed by the Technical Service and confirmed by the Approval Authority with the following requirements:

- Safety Requirements: it shall be checked that the automated vehicle mode can replace the driver action in the entire Operation Domain (OD) defined by the manufacturer. In automated driving mode, the vehicle shall not cause any traffic accident that is preventable and shall also follow the driving rules of the country.

It is also important to evaluate if the vehicle or the automated system has been designed according to any “safe-by-design” method. This means that during the development of the system, a safety concept has been used to cover the different steps of the process.

- Driver/passenger interaction: this includes various kinds of interactions. First of all, the driver shall recognize the status of the automated system and it shall only be activated when all the conditions of the operational domain are met. Secondly, if the system can require the driver to take control of the vehicle in certain conditions or environments, other systems have to be available, such as driver monitoring systems and specific warnings.
- Transition of the driving tasks: if the vehicle may request the intervention of the driver, this shall also be tested and validated in order to ensure that the system warns the driver in enough time.
- Minimum risk manoeuvre: when the system detects a situation out of the OD that could lead to a dangerous situation it shall be able to transfer to a minimal risk condition through a minimal risk manoeuvre. When this happens, the other road users shall be informed about the vehicle status in accordance with applicable traffic rules.

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- Event data recorders: as explained before, data recorders are needed in order to obtain data about the operational status of the system. In this case it is also required to collect data about who is responsible at a given moment.
  - Cybersecurity: while the new Regulation on cybersecurity is not yet published and in force, the guideline describes requirements for protecting the vehicle against hacking and threats. A risk assessment shall be performed by the manufacturer and the relevant mitigations presented.
  - Safety assessment and tests: systems shall be designed to cope with the risks that could impact safety functionality and failures. This can be achieved demonstrating that the system has been designed according to ISO 26262 [5], on Functional Safety or an equivalent method. The functional safety analysis is carried out by a Technical Service or Approval Authority, by means of manufacturer's documentation analysis as well as testing verification.
  - Information provision to automated vehicle users: it lays down the minimum documentation that the manufacturer must provide to vehicle users informing about all the relevant points of the vehicle.



## 4. PREVIOUS PROJECTS AND PAST EXPERIENCES

As described in Section 3 of deliverable D6.10 [2], there have been previous projects and experiences related to platooning such as COMPANION, CARTRE or ETPC. In order to collect all the information available, not only from the projects mentioned, but also from the experiences that the partners of the project might have, a questionnaire was shared within the consortium. This questionnaire was first mentioned in Section 4 of deliverable D6.11 [1]

The questionnaire was divided into four groups:

- Administrative Procedure: questions prepared in order to gather all the information regarding platooning legal procedure.
- Vehicle Control: questions prepared in order to find out the requirements of the vehicles and what tests the vehicles should perform before being allowed to test on the open road.
- Test Control: questions prepared in order to get the information related to test conditions, weather, test tracks or in which situations platooning is allowed.
- Other: questions prepared in order to get other relevant information such as what information OEMs take into account to do a platoon.

In the table below, the questions included in the Questionnaire are described.

**Table 3. Questionnaire classification**

Administrative Procedure	Is there already, an applicable law/legal procedure to get the license exemption to drive in platoon mode or similar?
	What is the expected duration of the administrative process?
	What is the required information from the driver?
	Is it mandatory to have a specific insurance?
	Is it needed to specify the route in the application for a permission?
	Is there any defined way to report an incident during testing?
	Who is the responsible for the procedure?
	How is the technical information presented to the road authority?
Vehicle Control	Is there any vehicle-type regulation to be exempted?
	Shall the vehicles be type-approved?
	How to declare the number of vehicles involved?
	How are those vehicles identified?
	Is there any way to register the on-board results?
Test Control	Is there a specific technology mandatory to test?

	Are third party witnesses required during testing?
	Which is the gap between truck limitation?
	Are extra visibility elements required?
	Is there any restriction due to climate conditions?
	Is there any actuation procedure in case of unexpected events?
	In which situations should the platoon break?
	Shall the technology be previously tested in test tracks?
Other	Is there any extra requirement not taken into account yet?
	Could previous tests with others road authorities be recognized?

#### 4.1. Questionnaire results

The questionnaire was launched during the first half of 2019 and was shared mainly with WP6 partners. The main objective was to get information from the different Member States through the past experiences from the partners.

The following feedback was received from the following partners:

- IVECO (Italy), Ministero delle Infrastrutture e dei Trasporti – MIT
- MAN Truck & Bus SE (Germany, Bavarian), Bayerisches Staatsministerium des Innern, fuer Bau und Verkehr (Bavarian State Ministry of the Interior, for Building and Transport, Germany, 2018)
- IFSTTAR (France)
- Daimler AG (Germany, Baden), GER State of Baden-Württemberg

ERTICO also provided information about the experience gathered in the European Truck Platooning Challenge (ETPC). Details collected by OEMs in the different countries where the ETPC took place were provided.

In the following sub-sections, a summary of the results obtained through the questionnaire are presented.

### 4.1.1. Administrative Procedure

It is important to identify which are the administrative procedures requested and asked in the different Member States. Table 4 shows the summary of the answers collected via questionnaire.

**Table 4. Administrative procedure questions**

Administrative Procedure				
QUESTION	IVECO	MAN Truck & Bus SE	IFSTTAR	Daimler AG
Is there, already, an applicable law/legal procedure to get the license exemption to drive in platoon mode or similar?	"Smart Road" decree law	<p>- Exemption to go below LSG: subject to the regulations of '§ 46 Abs. 2 Satz 1 StVO'</p> <p>- Exemption to operate modified vehicles: subject to the regulations of '§ 70 Abs. 1 Nr. 1 und 2 der StVZO'</p> <p>The procedure was to write an application to the ministry which described the plans for platooning operation specifically. The application also described a safety concept and safety measures, which were prepared by MAN and reviewed and observed by the German Technical Monitoring Association. The ministry referred to this presented information within the exemption. Additional requirements/measures were specified by the ministry.</p>	No law but a Decree will be signed by early 2020 in the "French Mobility" frame for Atlantes (A63 concessionaire). Each vehicle will require additional dedicated authorization in the current legal framework for autonomous / automated vehicle	No
What is the expected duration of the administrative process?	6 months	Approx. 6 months (partially due to the availability of a third party for evaluation, see answers below)	For the platooning trial in Aquitaine, the request was sent in December 2018. Still under investigation. Answer expected by Autumn 2019. But no standard duration, and it is the first request for	6 months (est.)





			platooning. There are a lot of questions to be resolved.	
What is the required information from the driver?	Drivers ID card and driving licence, training received	The MAN safety concept included selecting the drivers: <ul style="list-style-type: none"> <li>- drivers must possess a truck driver's licence (CE) for 5 years without pause</li> <li>- drivers must possess 5 years of professional logistics</li> <li>- max. 2 points in the German driving appropriateness index (Fahreignungsregister)</li> <li>- good level of health</li> <li>- good hearing</li> <li>- fluent knowledge of German language</li> <li>- specific safety and platooning training</li> </ul>	The driver must be updated with the continuous training plan. Some specific training will be likely required. The companies involved will have to deliver all the common legal papers.	Contact authority for details
Is it mandatory to have a specific insurance?	No, standard insurance	It was mandatory to have a liability insurance covering risks, which are resulting from operating highly or fully automated motor vehicles.	Under discussion. Provided that experimental framework is legally defined (Decree), extra insurance might not be needed.	Contact authority for details
Is it needed to specify the route in the application for a permission?	Yes; before to ask to the MIT, it is needed to ask for the permission to the road operators that operate the identified route	Yes, the route was specified	Yes. Only A63 will be open to platooning	Yes (it was 2016)
Is there any defined way to report an incident during testing?	Not specified	Not specified	Not yet fully specified, but a detailed report should be provided in case of any incident, to	Contact authority for details



			the local authorities and the DSR.	
Who is the responsible for the procedure?	MIT representative	respective MAN project leader, MAN head of departure	The request of exemption was introduced by Altandes (the motorway concessionaire). The procedure should be approved by the DGITM and DSR (MTES and Ministry of Interior). The liabilities are not yet fully decided. However, in the phase 1 (SAE level 1 or 2) the drivers and companies will remain responsible of their vehicles.	Ministerium für Verkehr und Infrastruktur Postfach 103452 70029 Stuttgart
How is the technical information presented to the road authority?	Request via certified e-mail (PEC) then F2F discussion	Application for an exceptional permission by written letter with annexes and with extensions by written letter and e-mail	Questionnaire + face to face meetings.	Mail

The main highlights of the questionnaire are as follow:

- MAN Truck & Bus SE replied based on platooning project EDDI in cooperation with DB Schenker. MAN described the procedure followed in Germany. Here, unlike the other countries, had an exception to driving in platoon mode. In the project, they prepared an application to the Ministry which described the plans for platooning, the safety concept and safety measures. The driver also had some requirements to evaluate the experience, the health, and aptitudes, for example the language.
- ETPC also gives information about the driver requirements, who needs to be trained in using platoon systems and during the test. Furthermore, the following trucks were required to have co-drivers.
- The administrative procedure for the MAN project had an approximate duration of six months.
- IVECO gives information about Italy, which has a decree “Smart Roads Decree” where platoon can be considered. The decree defines the requirement to test AV systems on



public roads e.g., automated to manual driver transition, cybersecurity and data recording. The procedure to be followed in order to obtain the ministry's AV testing authorization is also detailed in this document.

- France, as the French Institute of Science and Technology for Transport, Development and Networks (IFSTTAR), does not have any law to drive in platoon mode yet. They are working on a Decree to make a legal procedure. There is not much information about it, but it is known that A63 will be open to test platooning.

#### 4.1.2. Vehicle Control

It is important to identify all the requirements that Member States consider when providing an exemption. This part of the questionnaire focused on these requirements from the vehicle point of view.

**Table 5. Vehicle control questions**

Vehicle Control				
QUESTION	IVECO	MAN Truck & Bus SE	IFSTTAR	Daimler AG
Is there any vehicle-type regulation to be exempted?	Any	Does this question address the prototypes' road worthy certificate as opposed to the exemption from the road traffic regulations? If so, then the answer is yes. There was an exemption from the vehicle-type approval (comp. question about applicable law).	For the phase 1 (SAE level 1 or 2) no specific vehicles.	Exception according to §42 Abs. 2 StVO von §2 StVO
Shall the vehicles be type-approved?	Proto vehicles allowed with the specific plate	Generally, the basic vehicle must be type-approved (of course). For the prototypical parts, there must be an exemption from the type-approval.	No specific type-approval (but the standard one).	Technical report by certification authority (TÜV, DEKRA) needed
How to declare the number of vehicles involved?	Within the documentation it is needed to specify the involved vehicles VIN	Exact number was declared: - 3 vehicles for the highway operation - additionally 2 vehicles for tests on highways - trailers, noting that all combinations are allowed	At this stage, it is planned to have several platoons of 2 to 3 vehicles, may be 1 more later.	Contact authority for details



How are those vehicles identified?	Not specified	VIN	Not yet. But every single vehicle will have to be identified and will require a dedicated driving authorization (see above).	Contact authority for details
Is there any way to register the on-board results?	Everything is needed to be logged. Not specified the format	We saved some vehicle data to postprocess several values, which had to be generated and documented as a result of the conditions of the exemption.	Under investigation. The phase 0 of the project is devoted to the definition of the on-board and roadside instrumentation and the data collection and processing.	Contact authority for details

Table 5 details some of the truck requirements to drive in platoon mode.

Information about vehicle requirements from Germany was obtained through MAN and ETPC. It is important to highlight that in a project consisting of two trucks doing platooning, the ‘basic vehicle’ had to be type-approved and have an exemption for the specific functions to drive in platoon mode which are not included in the regulation.

In all cases, specific documentation is needed, type-approval/technical report and the vehicle needed to be identified (either through VIN or another way).

#### 4.1.3. Test Control

Not only vehicle requirements are important when applying for an exemption, also which conditions related to the tests need to be detailed and specified. The answers obtained are shown in Table 6.

**Table 6. Test control questions**

Test Control				
QUESTION	IVECO	MAN Truck & Bus SE	IFSTTAR	Daimler AG
Is there a specific technology mandatory to test?	Not specified	No additional conditions (in comparison to platooning operation in productive logistics)	Not yet defined.	Contact authority for details

Are third party witnesses required during testing?	Not specified	A THIRD PARTY had to execute an evaluation of the platooning system. This evaluation included tests, which were defined by the third party and executed by MAN. The third party required to be present during these tests.	The motorway police will be required at least for the first tests. The research providers (IFSTTAR, University of Bordeaux, etc.) will be monitoring all the tests.	Contact authority for details
Which is the gap between truck limitation?	Not specified, OEM responsibility	No specific number mentioned within the exemption. ('The minimum distance must only be undershot if a hazard of others is excluded.')	In the phase 1 and a level 1-2 (SAE) the gap will be at least 15 or 20 m. To be defined later.	Contact authority for details
Are extra visibility elements required?	Not specified	- stickers - yellow rotating light beacons	Some marks at the back of the last vehicle of each platoon is planned, but not yet fully specified. All-round identification light might be required.	Contact authority for details
Is there any restriction due to climate conditions?	Not specified	Clear sight, 'good weather', ambient temperature above +5°C, no severe wetness (in case of limited wetness, the gap must be increased to defined value)	The test will not be carried out under adverse weather conditions (heavy rains, fog, snow, etc.).	Contact authority for details
Is there any actuation procedure in case of	Not known	- (ideally) defined uncoupling sequence, triggered by driver or system	In case of unexpected event, the test may be suspended until the solution is found or the issue resolved.	Contact authority for details



unexpected events?		- if necessary, system override of the following driver (manual gap opening)		
In which situations should the platoon break?	Not specified	- system failure (v2v connection, sensor object loss, general system failures etc.) - accidents, construction sites, big motorway interchanges - system misuse	The project team will define the use cases and the situations of platoon break and ask for the approval of the authorities. The aim is not to break the platoon when going through entries and exits since entries and exits on A63 "lands" are low traffic roads.	Contact authority for details
Shall the technology be previously tested in test tracks?	Yes, 3000km on test track	Yes, tests defined, executed and documented by MAN Additional tests defined and supervised by a THIRD PARTY	Some specific features or measuring devices may be previously tested in test tracks. But to be decided case by case. No predefined list.	Contact authority for details

This part of the questionnaire was focused on the identification of specific test requirements such as weather limitation, the need to perform previous tests on a test track, the definition of the manoeuvres or traffic situations among others.

In some countries the vehicles shall be tested on test tracks before open road. In Italy for example, the truck shall be tested for three thousand kilometres. In other countries tests may be required but are not predefined.

It has been identified that the requirements related to the gap between trucks, can be defined by distance or by time. In some cases, this factor is defined during the test.

According to the experiences analysed, it has been identified that in Germany test requirements are partly defined. During the test, a third party must execute and do the evaluation of the system. The trucks must have stickers and yellow beacons to be easily identified. The tests, which shall be defined and documented by the OEM, shall be performed under good conditions, otherwise the gap between trucks must be increased.



During ETPC project in Germany, the following trucks had to have monitors with image (in colour) from a camera attached to the first truck. The second truck had to have an extra brake pedal. Also, they were equipped with surrounding lights in such a way that all surrounding traffic could recognize the platoon as such. Lights warn if a vehicle closes in or comes too close. The last vehicle in platoon had to have a big warning sign on the back 'keep distance, test vehicle', accompanied by a pictogram, with the same message.

As observed from the questionnaire, there are important factors that need to be taken into account:

- definition of the gap between vehicles,
- trucks signposting to be easily identified during the test,
- good weather conditions and how they may affect the test results and maximum speed.

#### 4.1.4. Other Information

This part of the questionnaire was aimed at considering any other requirements not taken into account in the previous table sections.

**Table 7. Other questions**

Other Information				
QUESTION	IVECO	MAN Truck & Bus SE	IFSTTAR	Daimler AG
Is the any extra requirement not taken into account yet?	Extra test can be requested, 3000km on simulation	Respective authorities must be informed before each platooning drive	The procedure of exemption is under investigation. It is the first request thus additional requirements may come at any time.	Contact authority for details
Could previous tests with others road authorities be recognized?	Not specified	No information available	This is the first test in France. Tests outside France may be considered for information.	Contact authority for details

Table 7 details these requirements not considered before. In any case, all tests should be analysed by the authorities, and depending on the features, these authorities have the right to request extra information on a case-by-case basis.

## 5. STATE OF THE ART OF EXISTING EXEMPTION PROCEDURES FOR OPEN ROAD TESTING

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After the analysis of the Questionnaire results, an in-depth analysis of the current exemption procedures for some Member States has been included in this section. At a first stage of the ENSEMBLE project it was not sure in which country the public demonstration will take place, the more likely candidates were Netherlands, Belgium and Spain. Finally, the event was carried out in the province of Cataluña in Spain in September of 2021.

Once all the information and assessments required in each exemption procedure are obtained, it is possible to align and harmonize all the requirements in one handbook that would make it easy for the manufacturers to apply the exemption in different countries. Of course, this is important for the ENSEMBLE project, but also generally for all automated and connected functionalities that will arise in the coming years.

The first step is the analysis of the different documentative and functional requirements to find a common point, if possible. In the event that the differences between procedures make it not possible to align them, a method covering all the requirements will be proposed.

It is important to remark that all the exemption procedures explained in this section are at national level and are not related in any case to type-approval. The exemption procedures are temporary and are intended for testing systems that are not already type-approved on open road. These licenses can cover both conventional and automated systems, but due to the high complexity of automated and connected vehicles, most of the countries have developed a dedicated procedure with specific requirements in order to assess the safety of these systems.

These documents are quickly evolving along with the technology because the importance of simulating real road conditions during testing is a key aspect of assessing it.

Section 5 includes information about the type-approval status of automated and connected systems, not regulated yet.





## 5.1. Netherlands: Connected automated vehicle admittance procedure

Under relevant European legislation, new technologies and functionalities are only allowed if they have been proven safe and operable. However, in order to validate safety and operability of the system, it is important to test on public roads with real conditions.

Accordingly, in July 2015 a new regulation came into force in the Netherlands, introducing provisions for open road testing, as long as the applicant meets certain previously set conditions.

These conditions are described in the admittance procedure for Connected & Automated Vehicles [17]. The functionalities or technologies under this procedure are:

- Automatic following
- Connected adaptive cruise control
- Lane keeping assist
- Vehicle following
- Lane change
- Traffic jam assist
- Overtaking
- Valet parking
- Collision avoidance
- Emergency stop
- Self-driving vehicles

The admittance procedure is performed through the Netherlands Vehicle Authority (RDW). The admittance procedure is based on a method whereby confidence is accrued gradually, step by step and in a repetitive manner. It is based on a wide-ranging risk analysis. Before permitting practical road testing, the RDW checks all applications of new technologies and functionalities. The main steps are:

- 1- Intake
- 2- Desk research
- 3- Testing on a closed proving ground
- 4- Admittance based on an exemption
- 5- Evaluation

### 5.1.1. The Netherlands Admittance Procedure

In the following section, a detailed description of each step is given.

#### 1- Intake

An application form shall be filled out by the applicant and sent to the RDW. This application form includes information about the intended tests, systems to be proven, places, dates and duration.

If the assessment of the plan is considered viable, then the Authority asks for more information such as:



- Why the technology that is going to be proven does not comply with any existing regulation.
- Safety measures taken into account and environmental considerations.
- Tests done in a secure environment (test track), and results obtained. In this step it is intended to demonstrate that a minimum level of safety has been obtained and tested.
- If it is a cooperative system, safety and reliability of data communication.
- Results of a risk control analysis such as the functional safety standard ISO 26262 or Failure Mode and Effect Analysis (FMEA).
- Results of Electromagnetic compatibility (EMC) test showing that adapted vehicles are not vulnerable to unwanted outside signals and do not transmit harmful radiation themselves.

## 2- Desk Research

At this second step, the national authority RDW, evaluates together with road authorities and road safety experts all the relevant factors involving the vehicle, infrastructure and behavioural aspects in detail. This evaluation considers that:

- The vehicle performance must be comparable to that of a vehicle without the new system.
- Roads to be considered from highway to city centre.
- Risks of the vehicle when the driver is using the system, and interaction with other traffic.

## 3- Testing in a proving ground

The next step is a test at a proving ground, which involves:

- physical inspection of the vehicle;
- 'happy flow test': checks that the system works as intended;
- 'stress test': checks that involve interaction between the technology or functionalities and the most important risks from the risk analysis.

## 4- Admittance on the basis of an exemption:

If the results of the above step are positive, and after consulting with the involved road authorities (national, province, municipality), a temporary admittance on the basis of an exemption is issued by the RDW.

Note that the road authorities may determine additional measures for the tests, such as the supervision by road inspectors or security for road traffic control centres.

The RDW may opt for specific requirements and conditions, e.g.:

- physical inspection of the vehicle;
- insurance;
- test site/test area and route;



- testing times (e.g. day or night, excluding rush hours);
- drivers' experience;
- type of test;
- monitoring and keeping a log.
- The exemption is valid for maximum one year.
- 

## 5- Evaluation

The RDW evaluates all practical testing with the parties involved. The evaluation results are used by the RDW as input for new regulations in the discussion groups of United Nations or European Commission.

### 5.2. Spain: Authorization to conduct tests or research trials of automated vehicles on roads open to general traffic

In order to promote the development of automated technologies, the Spanish Government has issued a law to authorize the testing of vehicles equipped with automated technologies in open road scenarios. However, the Spanish Government has made a clear distinction between vehicles with automated driving features (SAE L3 onwards) and vehicles equipped with driver support features (lower than SAE L3).

#### 5.2.1. Exemption procedure for vehicles equipped with automated features.

Vehicles with automated functions are regulated under the Instruction 15/V-113 [10]. This instruction was issued by the main Spanish body in charge of the traffic organization, the “*Dirección General de Tráfico (DGT)*” (General Directorate for Traffic) and was created with the aim of granting special authorizations to those automated vehicles which are tested in normal traffic conditions. This document was published in November 2015, and since then, all tests with automated vehicles on Spanish roads have to fulfil the requirements of this law.

As conventional and automated/connected vehicles are going to share the roads (and this should be done under the safest conditions) it is necessary to regulate them. However, it is important to remark that this instruction concerns only testing and not automated vehicles normal driving.

Vehicles authorized by this law are prototypes and their safety is not completely ensured, this is why the Spanish DGT (General Directorate for Traffic) asks for a safety assessment before the performance of the test in open road conditions.

These test vehicles can be derived from already approved vehicles (which means a vehicle which is on the market and to which the manufacturer is incorporating some automated technologies). Additionally, it is also possible for the manufacturer to test a completely new vehicle with these technologies already integrated. Of course, it is necessary for both kinds of vehicles to fulfil a minimum safety level in order to avoid compromising situations on the roads.



This authorization can be requested from the DGT by the vehicle manufacturer, the automated technologies component manufacturer or by an official laboratory. The universities and consortia involved in research projects are also allowed to apply for this authorization. In this case, the ENSEMBLE consortium could be the authorization's applicant.

The authorization holder is responsible for ensuring that the vehicles fulfil the minimum safety prescriptions to perform the test on public roads. The holder is also responsible for performing the test under authorized conditions. Any test or vehicle driving out of the declared boundaries must be done in manual driving mode.

Once the authorization is issued, it shall be valid for 2 years with the possibility to extend this period for another 2 years.

An important requirement for the test vehicle is that it must be properly registered and using a legal registration plate. If the vehicle is a prototype and has not been registered, then it is compulsory to get a temporary authorization according to the Spanish GRV (General Regulation on Vehicles).

### *Spanish requirements for obtaining the authorization*

The instruction has requirements for the manufacturer/applicant of the authorization, for the driver and, of course, for the test vehicle. In the following paragraphs instruction requirements are specified.

#### **Requirements for the manufacturer/applicant**

- The applicant must be a legally identifiable entity with legal personality.
- The entity must have experience regarding the activities for which it is applying for the accreditation or similar automotive test.
- The applicant must initiate the accreditation process with Entidad Nacional de Acreditación (ENAC).
- The applicant must provide to the DGT and the test laboratory a complete description of the test vehicle.

#### **Requirements for the drivers**

- It is mandatory for the applicant to declare a test driver (or some of them if necessary). No other drivers will be allowed to drive the vehicles during the test execution. In the ENSEMBLE case, it is necessary to declare the drivers for all the test vehicles.
- These designated drivers must provide a statement of their aptitudes. They also declare that they know the automated technologies installed on the vehicle and they have received training for the test required. In the ENSEMBLE project, the drivers are provided by the manufacturers, so they are responsible to inform the driver about the automated technologies they are driving.
- The driver of the automated vehicle will always be responsible for the driving of the vehicle.



- The drivers must be able to take full control of the vehicles during the test, whether it is inside the passenger compartment as if driving remotely. In the ENSEMBLE case, the drivers must take full control of the vehicles in the event of any risk situation for the occupants of the vehicles or other road users.
- The driver of the automated vehicle must be a holder, with a minimum of two years, of the driving license corresponding to the category of the vehicle subject to the test or tests. All the drivers of the ENSEMBLE project must fulfil this requirement.

### Requirements for the automated vehicle

- The vehicles subject to this instruction must be automated vehicles.
- Test vehicles must be uniquely identified by the applicant.
- It is mandatory to have insurance and keep it in force during the tests. It shall cover at least the civil liability for injuries/damage to other road users.
- In order to guarantee the safety and reliability of the vehicle, it is necessary to prove that the vehicle has got the certificate issued by an accredited Technical Service with regards to the fulfilment of the tests specified in annex II of the Instruction.
- It is also valid to prove to the Spanish DGT that the competent authority of another Member State has issued, through an equivalent prior control procedure, authorization to conduct tests on roads open to general traffic for the automated vehicles.

### *Submission of applications*

In order to prove the fulfilment of all the requirements mentioned above, the manufacturer is required to submit the following documentation to the DGT:

- An application document addressed to the DGT including minimum information about the test vehicles, the roads where the tests are going to be performed and the type of tests.
- A more complete description of the tests to be performed. This document shall include at least information regarding the following items:
  - o Description of the technology used in the vehicle, explaining among others the principles to ensure its safety and the activation mode. It is also requested to reflect the level of automation according to the SAE Levels defined in SAE J3016 [18].
  - o A detailed characterization of the tests to be performed. In the ENSEMBLE case it should reflect a description including: the number of the vehicles comprising



the platoon, the test speed, the manoeuvres to be performed (e.g., cut-in, cut-out...), scenarios to be tested (e.g., two/three lanes, highway exit...), ...

- It is necessary to prove to the authority that the driver has been trained to drive this vehicle using automated technologies. The plan used to train the drivers must be submitted to the DGT. Regarding the ENSEMBLE project, all the manufacturers should declare the training plans given to their drivers.
  - A clear description of the roads/areas where the tests are going to be performed. This is important because the DGT can set restrictions to the test vehicle (e.g.: maximum speed or escort vehicles...) or even to the other road users. Probably for a platooning test the DGT may oblige the vehicles to show a kind of signal/indicator to inform the other drivers about the excessive length of the platoon.
- It is mandatory to pay a fee to the DGT and they request to submit a proof of this payment. The amount of this fee is set by the Article 6 of Law 16/1979.
  - Additionally, a certificate from an accredited Technical Service confirming that the verifications set out in Annex II of the instruction has been fulfilled. It is important to remark that an equivalent document from a competent authority of another EU Member State can also be used. It means that the tests/verifications included in Annex II can be avoided if the same tests have been performed before on the open road in another EU member state and a document from an authority of this member state can be provided to the DGT.

The necessary tests and verifications to obtain the certificate from the accredited technical service will be described in Appendix D. In order to give this certificate, the laboratory needs to have technical documentation before the execution of the tests, the minimum content of the manufacturer's documentation is also included in Annex II of the instruction. The following flowchart gives an overview of the procedure to be followed in order to get the certificate from the accredited Technical Service.

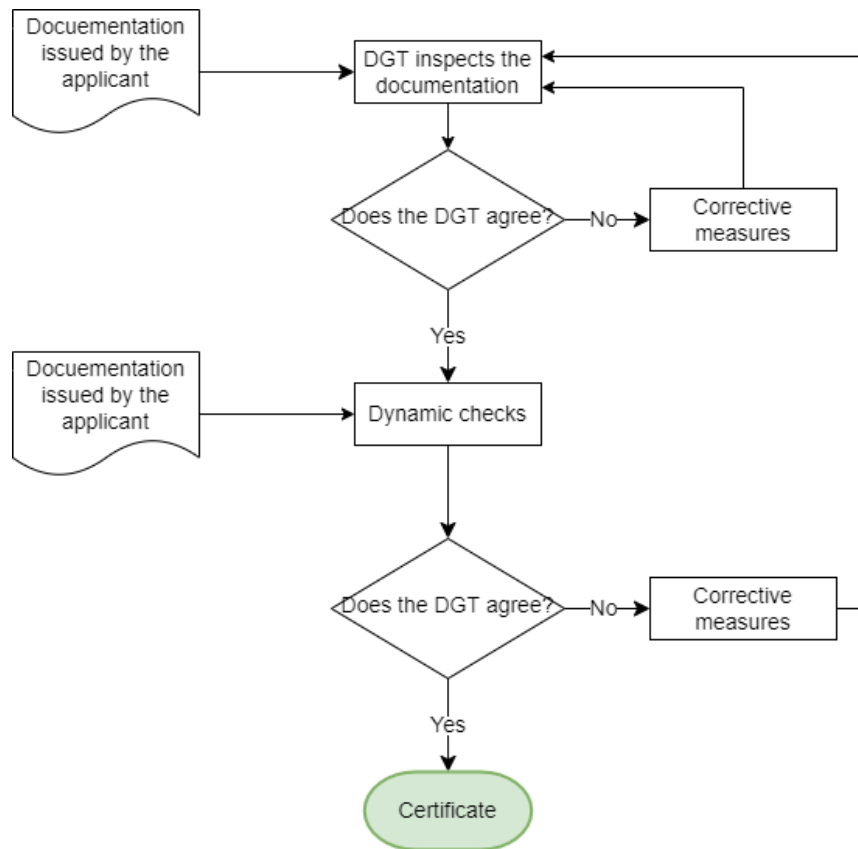


Figure 4. Flow chart of the Spanish procedure for vehicles  $\geq$  SAE L3

### Final decision

Once all the documentation has been submitted to the DGT, they have one month (maximum) to give a definitive answer to the applicant and this decision may be to reject or grant the authorization.

### 5.2.2. Exemption procedure for vehicles equipped with support function.

The exemption procedure for vehicles equipped with a support function with a SAE level lower than 3 is standardized through the TRAZA application [11]. TRAZA is an online application of the Subdirectorate-General for Mobility Management (DGT) where it is possible to apply for authorization of open-road tests for non automated vehicles. In order to test the platooning support function this is the procedure needed to be followed, if the system under test is the platooning autonomous function then the process described in chapter 5.2.1 shall be followed.

The process to obtain an authorization is simplified for vehicles equipped with support functions. As the vehicle is not fully automated and the driver is available to take full control of the vehicle at any time, the safety of the vehicle is not as compromised as in the previous case. However safety of the tested vehicle, as well as that of the other road users, is still the most important aspect that the DGT takes into account when assessing the applications.

In this case, the process starts by requesting access to use the TRAZA application by filling out a form and sending it by mail. For each type of authorisation the applicant wishes to manage it is needed to require a new registration. Once the access is granted it is needed to fill out information regarding the applicant, the tested vehicle and the itinerary that it is going to be followed during the test. Like in the previous case the vehicle shall have a legal registration plate, if it is a prototype it is possible to ask for a temporal authorisation.

The whole process to grant an authorization through TRAZA, since the request to access the application till the final decision of the DGT, is detailed in Section 6. Exemption procedure in Spain for platooning support function of this deliverable. In the following image you can find a flow chart of the process:

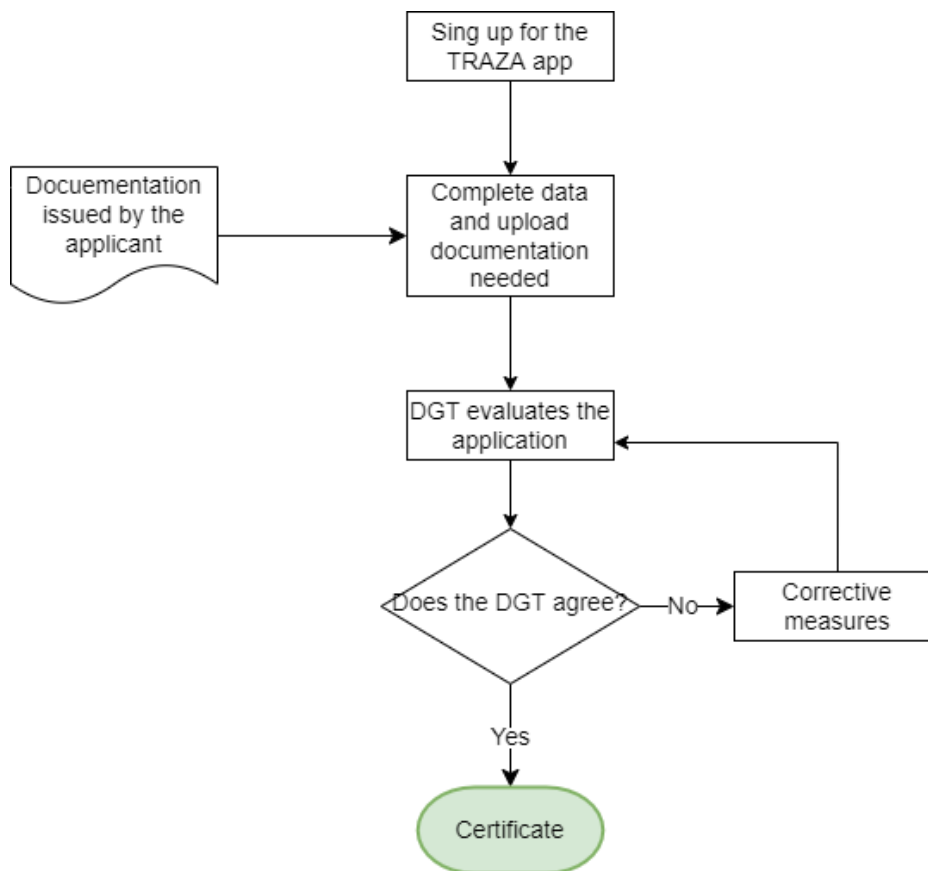


Figure 5. Flow chart of the Spanish procedure for vehicles <SAE L3

### 5.2.3. Procedure for Open Road Tests for Platooning

In the ENSEMBLE Deliverable 5.3: *Test results for obtaining the license exemptions*, [12] it is clearly explained the difference between an autonomous and a support function in the case of platooning.



In the table below (Table 8), the main differences between both functions are shown.

**Table 8. Differences between autonomous function and support function**

AUTONOMOUS FUNCTION	SUPPORT FUNCTION
Automation: SAE L4 (for the following trucks).	Automation: SAE L1
Both longitudinal and lateral motion of the following trucks is automated.	Only the longitudinal control (acceleration, braking) is automated for the following trucks. Lateral control (steering) is not automated.
Lead truck is manually driven. Can use ADAS functions but is not part of the platooning function.	Lead truck is manually driven. Can use ADAS functions but is not part of the platooning function.
Driver is mandatory in the lead truck. Drivers in the following trucks are optional.	Drivers have to be present in all the trucks.
The automated system is responsible for DDT (Dynamic Driving Task) and the system is the fallback.	Drivers in the following trucks are responsible for DDT (Dynamic Driving Task) and they are the fallback.
Operational Design Domain: Specific Hub to Hub driving routes on EU roads fall within the ODD, i.e., the vehicles drive autonomously on the highways and also on the route between the highways and the nearby transportation hubs.	Operational Design Domain: Can be used only on highways.
Time gap (TG): Since drivers are no longer responsible for DDT or are used as fallback, TGs can be lower than 1.4 s.	Time gap (TG): Minimum TG of 1.4 s has to be maintained between the trucks.

The relation between the function, level of automation and procedure to be followed is described in Table 9.

**Table 9. Function, level of driving automation and procedure relation for obtaining the exemption**

<b>FUNCTION</b>	<b>LEVEL OF DRIVING AUTOMATION</b>	<b>PROCEDURE TO FOLLOW</b>	<b>TESTS REQUIRED</b>
<b>Support function</b>	< SAE L3	TRAZA Application tool	No test required for obtaining the exemption
<b>Autonomous function</b>	≥ SAE L3	DGT Instruction 15/V-113	Sequence of tests explained in D6.11

In order to test the platooning support function, it is required to follow the process in the TRAZA application. This was the process followed to ask for the authorization of the ENSEMBLE open road tests carried out in Spain in September of 2021. If the future platooning autonomous function is to be tested in Spain the process described in the Instruction 15/V-113 shall be followed and tests in a proving ground shall be done prior to the open road testing.

#### **5.2.4. Exemption procedure followed for the open road tests carried out in Spain in September 2021**

A very important part of the ENSEMBLE project is to validate the project results on open road. In order to do so, WP5 worked on setting the necessary tests on test track to validate the system performance and safety. This work was carried out on September 2021 when the public demonstration was performed in Spain, where the platooning support function was tested under real life conditions.

As already mentioned in the previous chapters, for the platooning functions there are two different cases which also require two different approaches:

- Platooning Support Function: where the driver is responsible for the driving task. The vehicle system is performing the longitudinal control while the driver is in charge of the lateral control at all times.
- Platooning Autonomous Function: where the driver is not responsible anymore. The system performs the complete driving task within the specified operational design domain.

With the aim of providing a detailed explanation of the steps to be followed by the OEMs when applying for the exemptions in Spain, the following section has been defined. It is important to remark that this process is applicable only for testing of systems with a SAE Level lower than three, as it is the platooning support function tested in Spain.

### *General assessment of platooning as a support function*

The analysis will start with the assessment of the Platooning Support Function. The main properties of the Platooning Support Function are based on Adaptive Cruise Control (ACC) as defined in ISO-15622:2018 [15].

The first part is about the driver's responsibilities and the second part about the longitudinal coordinated automated control as described below.

This section will describe a possible minimum assessment for platooning as a support function taking into consideration what could be possibly implemented in the project.

### *The driver*

According to the ISO-15622, 2018, *"the driver is responsible for the full driving task, in line with the current state of the art support functions, and this will be clearly indicated via the HMI"*.

Considering this definition, it will be useful to have all the HMI strategies to test that they are implemented as intended. This could be tested in line with the requirements for HMI requirements in UN R79 for ADAS functions, that includes:

- Clear recognition of the signal stating the operation status (standby / working / deactivated).
- Check that this signal clearly indicates when the system is carrying out this platooning task.
- Check, if necessary, that additional signals (e.g., audible, haptics warnings) are implemented when sudden deactivation of the PSF occurs.
- These different requirements for the HMI will be checked for each one of the test cases discussed below, guaranteeing that the driver is always aware of the current state of the function.

### *Longitudinal coordinated automated control*

According to the ISO-15622, 2018, longitudinal coordinated automated control is performed for the complete speed range from 0 (brake to standstill; acceleration from standstill optional) to maximum cruise speed (depending on country regulations and OEM implementations).

At the moment, there is no specific UN regulation for an "ACC function". For resemblance, it should be considered to test the function as if it was an adjustable speed limitation device (ASLD) as described in UN R89. However, considering the particularities of the platooning system, overriding



by using the accelerator pedal may be dangerous. Therefore, other override methods are explored (such as leaving the platoon by steering away). The most useful information comes then from the HMI requirements included in the regulation, that are in line with what will be assessed in the tests.

### *Other considerations*

Besides the driving task responsibilities, there are other shared characteristics with the ACC function that will help to shape the test requirements, as they are described in Deliverable D5.7:

- Following distances according to ACC (specific for each OEM) with minimum distances such as the time gap is ranging between 1.4 s and 1.6 s. The driver selects the following distance.
- Limited decelerations ( < 3.5 m/s<sup>2</sup>).
- Under adverse conditions such as bad weather, slopes, etc., the drivers have the responsibility to increase the time gap or disengage platooning completely.

Again, for the conditions mentioned above, it would be necessary to check how the HMI would warn the driver in order to take this responsibility, with the test discussed below.

### *Safety of non-platooning functions in the vehicle*

It is important to bear in mind that independently of the platooning function, the vehicle must comply with the rest of partial approvals. This has been previously discussed in point 4.1.2, leading to the conclusion that, depending on the road authority, it can be demonstrated whether with the complete type-approval, or at least with a report stating its equivalence.

For the specific platooning Support Function developed in the project, OEMs have chosen to have an independent ECU for the platooning function, separating as much as possible this feature from the rest of the systems in the vehicle.

Also, most OEMs would use a “gateway” from this specific ECU to the vehicle dynamic control (accelerator, brake...), so this would at the end lead to an actuation at approved systems, but this system can be directly overridden with no further actuation.

Referring to regulations that are still being prepared, most of them will affect the platooning functions and components. As it has been explained in Section 5, cybersecurity and software update regulations are at a final development stage, and surely will have an impact on all the systems that require an approval.

This leads to the also discussed new “platooning” regulation, which has been recently announced to be elaborated in the 2019/2144 Regulation. This will imply, once implemented, not only its fulfilment, but the addition of the interaction with other regulations (such as the aforementioned CS and SU



regulations) to be taken into account, once it is known if this regulation will refer to platooning as an autonomous or as a supportive function.

### *Exemption procedure*

The National Road Traffic Authority in Spain is called *Dirección General de Tráfico* (DGT) and coordinates the traffic across the country. The DGT is a government department depending on the Interior Ministry of the Spanish Government and guarantees road safety. Among its responsibilities, DGT is also in charge of road traffic management and is responsible for the licence exemption process for testing on Spanish Roads (<http://www.dgt.es/es/>).

Since 2018, all the open road testing with a SAE level lower than three and other permits are handled through the software TRAZA. This software has been created to speed up the application process for different kinds of tests/request. The whole process, step by step with screenshots on how submit the request, is described in the ENSEMBLE Deliverable D6.11 [1].

As a summary, first it is needed to create a simulation where TRAZA asks details regarding the test, technical specifications of the vehicles to be tested and the route to be followed. Once all the simulation is finished, it can be printed and sent. The application can be completed online.

Even though it is not strictly requested by the DGT, it is a good practice to develop safety analysis before performing open road tests. They may bring up safety risks that need to be taken into account by the drivers that at a first point are not noticeable. In ENSEMBLE, this analysis was performed in the Work Package WP2 by developing a safety concept of the function, HARA and SOTIF.

Finally, and after the open road tests performed in IDIADA in September 2021, no other information or test result was requested for obtaining this license.

## **5.3. Flemish (BE) application procedure for testing a SAE L0 to L2 vehicle**

### **5.3.1. Introduction**

The action to make an inventory of this application procedure for testing, originated from the original idea about organizing the final event, including the public demonstration, as a cross border event between The Netherlands and Belgium.

Since platooning can play a big role in HUB-to-HUB logistics transports the idea raise to organize a public demo event as a platoon between a HUB in Rotterdam harbour and a Hub in Antwerp harbour, as the connecting highway E19 is very often frequented by truck traffic between the 2 harbours.

The action started an investigation on what the procedures should be, involving the right road authorities in Belgium (see further).

With the help of ETPC member MOW we got our first immediate contacts that helped a lot in establishing the insights.



Later, because of the COVID pandemic, it was decided that the public demo event was a separate event, apart from the final event. It was decided, to hold the public event at Barcelona, Spain, after the testing there. Therefore, the action for deploying the procedures was stopped in an early stage and was never actively initiated and executed. The below text is therefore a summary of the steps to be taken, as information and guidance for any future test in likely projects as ENSEMBLE.

### 5.3.2. Involved Belgian authorities

Belgium is a federal state. The main element of the sixth state reform is the transfer of a lot of powers from the federal state to the communities and regions. This holds also for mobility. The MOW<sup>1</sup> (Mobiliteit en Openbare Werken) is the department for mobility and public road works in the Flanders region where the E19 and the harbour of Antwerp are located.

However, in relation to compliance, homologation and registration of vehicles, the federal authority is still competent. This authority is the FOD (Federale Overheidsdienst) mobility<sup>2</sup>

Flemish contacts at MOW:

- Mr. Kristof Rombaut: Study responsible ITS, [kristof.rombaut@mow.vlaanderen.be](mailto:kristof.rombaut@mow.vlaanderen.be),
- Mrs. Julie Marien, policy ITS, [julie.marien@mow.vlaanderen.be](mailto:julie.marien@mow.vlaanderen.be)>
- Mr Thomas Christiaens, Team coordinator ITS, [thomas.christiaens@mow.vlaanderen.be](mailto:thomas.christiaens@mow.vlaanderen.be)
- Mr Nick Arys, Communications responsible, [nick.arys@mow.vlaanderen.be](mailto:nick.arys@mow.vlaanderen.be)
- Mr Eric Kenis, C-ITS, [ericjm.kenis@mow.vlaanderen.be](mailto:ericjm.kenis@mow.vlaanderen.be)

Belgian federal state contacts at FOD Mobility:

- Mr David Schoenmaekers, ITS responsible, [david.schoenmaekers@mobilit.fgov.be](mailto:david.schoenmaekers@mobilit.fgov.be)
- Mr Abde Jebari, Main contact and project responsible, [abde.jebari@mobilit.fgov.be](mailto:abde.jebari@mobilit.fgov.be)

The Flemish authority offered its help in organising and supporting the event but has no further legal authority on admitting any tests.

The federal authority outlined the procedure and is responsible for admission.

### 5.3.3. Federal procedure

By just raising an email towards Mr Abde Jebari and briefly explaining the project, a dedicated project is created. In our case the project ticket Ticket=VEHIC:14732 was created as the start of the procedure.

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<sup>1</sup> MOW: <https://www.vlaanderen.be/departement-mobiliteit-en-openbare-werken>

<sup>2</sup> FOD mobility <https://mobilit.belgium.be/nl>

There are 2 important documents to be considered:

1. Code of practice \_EN 2016\_09, describing the testing in real life conditions for automated and semi-automated vehicles (Such as Platoon Support function). The content can be found in this [16]. This document is a reference guide.
2. The actual request, by filling in the information that is required, stated in the document 'Formulaire de demande \_EN\_V4.docx'. Since there is no immediate reference on the website, the content has been reproduced in Appendix C of this deliverable..

As a reference we also communicated the documents that we filed for the Spanish Road authorities. The ENSEMBLE project did not take any further steps in this procedure.

#### **5.4. Austria: Code of Practice, Testing of Automated Driving on Public Roads**

In 2018, Austria developed and published a Code of Practice for testing automated vehicles on public roads [13].

The objective of the document is to provide support to the manufacturers and testing organizations on the development of new technologies related to automated and connected vehicles.

Vehicle manufacturers must ensure that automated vehicle technologies have been developed and tested extensively before they go into mass production. The initial tests must take place on private test grounds and tracks. As a minimum, these tests must demonstrate and ensure that a test driver or test manager can take manual control of the vehicle from the automated driving mode in order to ensure the necessary safety during testing.

Closely aligned to Belgium and UK Code of Practice, the document establishes requirements for the following topics:

- General Provisions;
- Requirements for the test driver and the test manager;
- Vehicle requirements.

The tests are regulated in the Ministry's Automatized Driving Regulation (AutomatFahrV [14]).

Only the following use cases are permitted at present after a permit has been issued: autonomous minibus (less than 20 kph), motorway pilot with automatic lane change and self-driving military vehicles. Depending on the different use case, evidence for a certain number of test kilometres needs to be provided. For vehicles or systems that are not currently regulated in accordance with the AutomatFahrV, the planned test shall be described by the manufacturer and can lead to a new amendment of the regulation for its inclusion.



As an important point, the tested vehicles shall be equipped with an accident data recording system, and the system shall be used during test operation. It shall not be possible to modify the data obtained.

## 5.5. France: Authorization to conduct automated vehicles tests on open roads

In France the performance of automated vehicles tests on open roads is regulated by *Ordonnance* n° 2016-1057 of August 3<sup>rd</sup>, 2016. It is a fairly short legal text signed by the president of the French Republic which establishes a regulatory framework for these tests.

The first article of this *Ordonnance* specifies that vehicles equipped with automated driving systems which are aimed at testing on open roads need a special authorization to guarantee the safety of the tests. This article was modified in 2019 in order to ensure the test vehicle will be equipped with the means to neutralize automated driving of the vehicle at any moment. So, a person must be constantly supervising the vehicle's behaviour (from inside or outside the vehicle).

The second article designates the Ministry of Transport in agreement with the Ministry of Interior as the entities to issue these authorizations. In a later modification in May 2019, it is stated that the driver will not be responsible when, in automated mode, the vehicle commits a traffic law offence. In this case, the responsibility lies with the requester of the testing authorization.

The content of the third article is aimed at indicating that the conditions to get the permissions and the content of the dossier necessary for requesting the authorization will be issued in a dedicated decree.

Finally, the last paragraph of the *Ordonnance* sets out corresponding responsibilities among the concerned Ministries.

In 2018, a different decree was published in order to regulate the authorizations: the *Décret n° 2018-211* of March 28<sup>th</sup>, 2018. One month later, a complementary decree was issued in order to define the content of the requesting dossier necessary to get the authorization.

The *Décret* 2018-211 is divided into five different titles:

- Title I: Issue of the testing authorization: Comprising articles from No. 1 to 7
- Title II: Certificate "WW DPTC": Article No. 8
- Title III: Conditions regarding the execution of the tests: Composed by two sections:
  - o Section I: General Conditions for testing from article No. 9 to 14
  - o Section II: Special provisions for vehicles assigned to a transport service: from article No. 15 to 17
- Title IV: Controls and Sanctions: Article No. 18
- Title V: Transitional provisions and final provisions: Articles No. 19 and 20





The certificate used for the temporary tests of partially or fully automated vehicles is named according to this regulation “WW DPTC”. “WW” is usually used in French vehicle plates as an identification for a temporary vehicle registration and DPTC comes from: “*Délégation Partielle ou Totale de Conduite*” that means “full or partial automated driving”

This decree allows the testing of fully or partially automated vehicles in the following cases: technical tests and fine tuning of the automated functions, verification of the vehicle performance under the real conditions or public demonstrators.

The public roads involved in the tests must be specified in the authorization and the performance of the tests is limited only to these mentioned areas. The permission is given for a maximum of two years, but it can be extended one additional time.

One important point is that the vehicle has to be equipped with the means to record the vehicle mode (conventional or automated driving). In case of accident, the requester must provide to the authorities the recording corresponding to five minutes before the accident.

During the automated mode driving, a driver must be available to control the vehicle at any moment, especially in case of emergency or when the vehicle is out of the operational domain. The driver has to be properly trained regarding the automated functions and the boundary conditions of the system.

Other restrictions are that the vehicle is not allowed to carry goods or people during the tests which are not included in the authorization. If the vehicle is dedicated to public transport, first it is mandatory to perform tests without passengers, and once the safety of the tests is demonstrated, then a second test stage with real passengers can be performed. When the tests are going to be carried out with real passengers, it shall be indicated for public information that the vehicle is equipped with automated driving technologies.

In the event that the conditions specified in the authorization are not fully met, the authorization may be suspended or additional restrictions may be added to the tests.

Finally, it is the French instruction which specifies the content of the requesting dossier necessary to get the *WW DPTC* certificate. It is the “*Arrêté du 17 avril 2018 relatif à l'expérimentation de véhicules à délégation de conduite sur les voies publiques*”. It is made up of 7 articles divided into 2 different sections and 5 technical annexes.

The first article is the scope of the law and the second one is dedicated to collecting some important definitions for the correct understanding of the instruction.

Section 1 is comprised of articles 3 and 4 and the whole section is related to the request for the authorization. The other articles are included in section 2 which is dedicated to the tracking of the tests.



Regarding the request for the authorization, it is important to fulfil the following items in order to finally get the permission:

- The applicant must be the owner of the vehicle or if otherwise, it is necessary to demonstrate the relationship between the requester and the owner of the test vehicle
- The authorization can be requested for one or more vehicles participating in the same tests
- All the documentation shall be filled out in the French language
- Every single modification of the conditions reflected in the authorization shall be immediately communicated to the corresponding authority
- The applying dossier must be comprised of the following documents properly filled in:
  - o Questionnaire according to Annex 1 to this instruction
  - o Technical features of the vehicle according to Annex 2 to this instruction
  - o Detailed tests explanation according to Annex 3 to this instruction
- A letter addressed to the French Transport Minister and Interior Minister duly signed by the applicant.
- In case of applying for an authorization renewal, it must be sent to the Ministry at least 3 months before the finalization of the previous authorization.
- A WW DPTC certificate is only valid for one single vehicle (addressed to one VIN).
- The certificate is only valid for the automated driving tests in the specified areas, however, it is valid in the whole French territory when the vehicle is driven in conventional mode.

The second section is dedicated to the tracking of the tests and in these articles the requirements for this tracking are covered. It is mandatory to fill in a six-monthly report according to Annex 5, with the information corresponding to the last period. This report must be sent to the French authorities during the month following the reported period. A final evaluation of the tests must also be sent to the authorities.

The French ministry is building a database with all these reports sent which can only be accessed by the French authority and it is not available for the public consultation. Please refer to Appendix B. Questionnaire for applying WW DPTC Certificate.

## 5.6. Mutual recognition approach

As observed, the different Member States each have their own requirements always looking for safety.

The main objective of the analysis above is to identify what Member States have in common and set the pillars for a possible future mutual recognition framework when testing automated driving vehicles on open roads.

Although the analysed countries ask for similar requirements, there are some differences on the processes. This would mean that a manufacturer should apply on each country with different documentation or tests for obtaining the license exemption on all of them.



### 5.6.1. Comparison of the different procedures.

As automated driving functions are diverse and not clearly specified, it is hard to define fixed requirements for a common procedure. For each exemption a separate assessment has to be made. This cannot be solved and is already an issue for the different Member States and all parties involved. Any change of a function that doesn't fit with an existing regulation or exemption needs to be reassessed.

However, if the process is assessed from the point of view of the whole procedure some similarities may be found. In the next table several aspects are compared between the procedures of Belgium, Netherlands and Spain. Only these countries are compared, as testing was initially planned there.

**Table 10. Comparison of procedures in Belgium, Netherlands and Spain**

	<b>Belgium</b>	<b>Netherlands</b>	<b>Spain</b>
<i>Who may be the applicant of the authorization?</i>	--	--	The vehicle manufacturer, the automated component manufacturer, official laboratory, universities and consortium involved in research projects.
<i>Which is the institution in charge of extending the approval?</i>	Federal Public Service Mobility and Transport (FOD)	Netherlands Vehicle Authority (RDW)	General Directorate for Traffic (DGT)
<i>Are there different procedures depending on SAE level of the system under test?</i>	Yes, the process described in this deliverable is valid until SAE L2.	No	Yes, for SAE < L3 TRAZA application, for a higher SAE level proving ground tests are required following Instruction 15/V-113.
<i>Requirements for the automated vehicle</i>	-Serial number and vehicle registration plate.	-Not specified, but may impose requirements	-Uniquely identified with a legal registration plate.



	<b>Belgium</b>	<b>Netherlands</b>	<b>Spain</b>
	-Insurance		-At least third party insurance.
<i>Requirements for the driver</i>	Complete a training plan	Not specified but may ask for specific driver experience	Minimum 2 years of driving license.  Statement of their aptitudes and declaration of knowledge of the system under test.
<i>Documentation to submit by the applicant</i>	<p>-Complete questionnaire where it is included a description of the test, a vehicle(s) description, registration of data, risk analysis validated by an external body and HMI system description among others.</p> <p>-Driving license for every test driver</p> <p>-Insurance policy</p> <p>-Risk analysis</p> <p>-Training plan for drivers</p> <p>-Roadworthiness test certificate.</p>	<p>Three packages of documentation:</p> <p>1.Initial application form with information regarding the intended tests, systems to be proven, places, dates and duration.</p> <p>2.Detailed information related to the technology, safety measures, risk analysis and electromagnetic compatibility.</p> <p>3. Results of the proving ground tests.</p>	<p>Two packages of documentation:</p> <p>1.Brief description of the vehicle, the place and the type of tests.</p> <p>2.-Description of the technology. (Safety, activation mode, SAE level...)</p> <p>-Description of the test (scenarios, place...)</p> <p>-Driver's identification and proof of their training</p> <p>-Proof of safety verification</p>

	<b>Belgium</b>	<b>Netherlands</b>	<b>Spain</b>
	- Audit of the internal tests -Photo of the vehicle		
<i>Are pre-tests in a proving ground requested?</i>	Yes	Yes	Yes
<i>Steps to follow</i>	<ol style="list-style-type: none"> <li>1.Fill out the questionnaire.</li> <li>2.Internal tests</li> <li>3.Send all the documentation together</li> </ol>	<ol style="list-style-type: none"> <li>1.Intake: application form.</li> <li>2.Desk research, evaluation by RDW and road authorities.</li> <li>3.Testing on a closed proving ground</li> <li>4.Admittance based on an exemption</li> <li>5.Evaluation of results after open road tests by the RDW</li> </ol>	<ol style="list-style-type: none"> <li>1.Submit 1<sup>st</sup> batch of documentation</li> <li>2.Evaluation by DGT</li> <li>3.Testing on a proving ground</li> <li>4.Submit 2<sup>nd</sup> batch of documentation</li> <li>5.Evaluation by DGT</li> </ol>

From the table above it is possible to conclude that for all countries their first priority is to ensure the safety of all the road users while the tests are being performed. As mentioned before, it is difficult to develop a common set of requisites for the different autonomous and automated functions that are in constant evolution, however from an administrative point of view the three countries analysed have a similar procedure. Netherlands and Spain require for a first batch of documentation: explaining the technology that wants to be tested, the place, the date and the type of tests. Once this documentation is submitted, the competent authority analyses it and they dictate whether it is possible to continue with the process or not. While in the case of Belgium this submission of a first proposal is not required, the applicant is in contact with the authorities, so even if there is no formal

submission the authorities are aware of the intentions of the applicant and they will warn in case something does not look correct.

Something that the three countries agree is the need to perform some proving ground tests before granting the authorisation for the open road tests. These tests need to be evaluated by a Technical Service, the authority itself or equivalent. Something that will vary from country to country is what tests are requested and their performance requirements.

Other important point for the three countries is the driver's training and abilities, special focus is put on their knowledge of the system. It is crucial that the driver knows how to safely activate and deactivate the system, and how to override the vehicle's control if needed.

### 5.6.2. Future recommendations

As discussed in this chapter every country has its own process and requirements for the authorization of open road tests of autonomous and automated functions. However, from the applicant point of view it is interesting that, in the future, getting the authorisation in one country will also allow testing in another country within the European Union. For some technologies which their functionality is linked to reading traffic signs or linked to the geographical position, it will be of special interest as it opens the possibility to easily organize cross-border tests.

Given that some countries currently accept other licenses, the best option would be to agree a common procedure for all the Member States, that would allow simplifying applications of OEM's that want to test automated technologies on open roads. In this case all the parties involved should agree assessment criteria to ensure minimum safety of the systems, and also technical requirements.

There are two paths to reach a common validation authorization between different countries in the European Union.

The first one is by signing bilateral agreements between different countries to accept each other's authorizations. In this case countries with a similar level of requisites and stipulations will sign an agreement of mutual recognition of these kinds of authorizations. However, this may lead to certain differences between the requirements and assessment methods.

It is important to note that there are some countries that are willing for this harmonization between procedures and mutual recognition in EU Member States, currently accept license exemptions previously given by other Member States. As example the Spanish Road Authority agrees on accepting license exemptions granted by other Member States.

The second possibility is that the European Union develops and issues a new regulation of application in the Member States. This regulation will establish a common regulatory framework, on one side regarding the process that OEMs and applicants should follow, this will not be a critical point as, from what has been analysed before, the steps to follow during the procedure are quite



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similar among countries. Nevertheless, it is necessary that this regulation establishes technical requirements and which kind of tests and analyses should be required as well as the methodology accepted for the analyses.

Other possible approach is to develop common procedures only for mature functions with a higher TRL (Technology Readiness Level). For example, for the Platooning Support Function of ENSEMBLE a pre-standard based on the specifications and requirements that the different manufacturers had could be developed. Then, any organization or company interested in developing their own platooning system will be able to refer to this pre-standard and its derived procedure.



## 6. SUMMARY AND CONCLUSION

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In this document, a brief, yet complete summary of the ongoing regulatory discussions both at a European and a global scale has been presented. This regulatory framework will cover in the long run all the requirements to approve vehicles with high levels of automation in the European Union.

A survey was sent to the involved OEMs to collect all the valuable information regarding their past experiences with platoon open road tests. A summary of the notable information from the past experiences is presented. It is worth noting that Germany and its different “Länder” are more specific regarding platooning requirements for open road testing. It is also remarked that other countries in the EU are committed to detailing their regulation for open road testing, so it includes the peculiarities of highly automated driving functions, such as platooning.

With the collected information from past experiences, and as a first step towards the harmonization of the license exemption, a broad analysis of the existing procedures of relevant European countries has been done. In this case, the criteria have been selected for the countries where open road testing and demonstration in ENSEMBLE was initially planned, i.e. Belgium, The Netherlands and Spain..

Due to the high complexity of automated systems, most of the requirements are not totally defined yet, and it is not possible to relate all the criteria defined on the procedures. However, it is clear that the main idea is to define a minimum safety level before testing on open road, and verify this through testing, documentation and functional safety assessments.

Finally, the open road tests of ENSMEBLE were carried out in Spain in September 2020, for this reason all the requirements for license exemptions of automated and connected vehicles are explained in detail for Spain. In this matter, Spain has different procedures depending on the SAE level of the system, as for SAE levels up to 2, i.e. driver support features, no proving ground tests are required. After an official discussion with the Spanish road authority and considering that in the Platooning Support Function the drivers are always responsible for the dynamic driving task and can overrule the system at any time, it was considered that an exemption procedure for conventional vehicles could be done in order to make things easier. This application is done through TRAZA, a Spanish Road Authority tool exclusive for allowing license exemptions for new technologies not covered by Instruction 15/V-113 [10].

As the platooning function is expected to be in constant development, there is a point where the Platooning Autonomous Function will need to be tested on open roads. Then, the procedures for higher automation levels have to be applied, as discussed in section 5.

To sum up, at this moment every country has its own procedure and asks for its own tests when it comes to grant authorizations for open road tests of automated and connected vehicles. It will be beneficial for OEMs and any organization that develops automated functions to have a common procedure and framework to look at, different approaches are discussed in this deliverable.





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## APPENDIX A: GLOSSARY

### Glossary

#### Definitions

Term	Definition
Platoon	A group of two or more automated cooperative vehicles in line, maintaining a close distance, typically such a distance to reduce fuel consumption by air drag, increase traffic safety by use of additional ADAS-technology, and improve traffic throughput because vehicles are driving closer together and taking up less space on the road.
Platoon Automation Levels	In analogy with the SAE automation levels subsequent platoon automation levels will incorporate an increasing set of automation functionalities, up to and including full vehicle automation in a multi-brand platoon in real traffic for the highest Platooning Automation Level. The definition of “platooning levels of automation” will comprise elements like e.g. the minimum time gap between the vehicles, whether there is lateral automation available, driving speed range, operational areas like motorways, etc. Three different levels are anticipated; called A, B and C.
Requirements	Description of system properties. Details of how the requirements shall be implemented at system level
Specifications	A group of two or more vehicles driving together in the same direction, not necessarily at short inter-vehicle distances and not necessarily using advanced driver assistance systems
Convoy	A truck platoon may be defined as trucks that travel together in convoy formation at a fixed gap distance typically less than 1 second apart up to 0.3 seconds. The vehicles closely follow each other using wireless vehicle-to-vehicle (V2V) communication and advanced driver assistance systems
Truck Platoon	Description of system properties. Details of how the requirements shall be implemented at system level
Scenario	A scenario is a quantitative description of the ego vehicle, its activities and/or goals, its static environment, and its dynamic environment. From the perspective of the ego vehicle, a scenario contains all relevant events. Scenario is a combination of a manoeuvre (“activity”), ODD and events

Manoeuvre (“activity”)	A particular (dynamic) behaviour which a system can perform (from a driver or other road user perspective) and that is different from standing still, is being considered a manoeuvre.
ODD (operational design domain)	The ODD should describe the specific conditions under which a given automation function is intended to function. The ODD is the definition of where (such as what roadway types and speeds) and when (under what conditions, such as day/night, weather limits, etc.) an automation function is designed to operate.
Event	An event marks the time instant at which a transition of a state occurs, such that before and after an event, the system is in a different mode.
Use case	<p>Use-cases describe how a system shall respond under various conditions to interactions from the user of the system or surroundings, e.g. other traffic participants or road conditions. The user is called actor on the system and is often but not always a human being. In addition, the use-case describes the response of the system towards other traffic participants or environmental conditions. The use-cases are described as a sequence of actions, and the system shall behave according to the specified use-cases. The use-case often represents a desired behaviour or outcome.</p> <p>In the ensemble context a use case is an extension of scenario which add more information regarding specific internal system interactions, specific interactions with the actors (e.g. driver, I2V) and will add different flows (normal &amp; alternative e.g. successful and failed in relation to activation of the system / system elements).</p>
Operational layer	The operational layer involves the vehicle actuator control (e.g. accelerating/braking, steering), the execution of the aforementioned manoeuvres, and the control of the individual vehicles in the platoon to automatically perform the platooning task. Here, the main control task is to regulate the inter-vehicle distance or velocity and, depending on the Platooning Level, the lateral position relative to the lane or to the preceding vehicle. Key performance requirements for this layer are vehicle following behaviour and (longitudinal and lateral) string stability of the platoon, where the latter is a necessary requirement to achieve a stable traffic flow and to achieve scalability with respect to platoon length, and the short-range wireless inter-vehicle communication is the key enabling technology.
Tactical layer	The tactical layer coordinates the actual platoon forming (both from the tail of the platoon and through merging in the platoon) and platoon dissolution. In addition, this layer ensures platoon cohesion on hilly roads, and sets the desired platoon velocity, inter-vehicle distances (e.g. to prevent damaging bridges) and lateral offsets to mitigate road wear. This is implemented through the execution of an interaction protocol using the short-range wireless inter-vehicle communication

	(i.e. V2X). In fact, the interaction protocol is implemented by message sequences, initiating the manoeuvres that are necessary to form a platoon, to merge into it, or to dissolve it, also taking into account scheduling requirements due to vehicle compatibility.
Strategic layer	The strategic layer is responsible for the high-level decision-making regarding the scheduling of platoons based on vehicle compatibility and Platooning Level, optimisation with respect to fuel consumption, travel times, destination, and impact on highway traffic flow and infrastructure, employing cooperative ITS cloud-based solutions. In addition, the routing of vehicles to allow for platoon forming is included in this layer. The strategic layer is implemented in a centralised fashion in so-called traffic control centres. Long-range wireless communication by existing cellular technology is used between a traffic control centre and vehicles/platoons and their drivers.
Service layer	The service layer represents the platform on which logistical operations and new initiatives can operate.
Leading truck	The first truck of a truck platoon
Following truck	Each truck that is following behind a member of the platoon, being every truck except the leading and the trailing truck, when the system is in platoon mode.
Trailing truck	The last truck of a truck platoon
Ego Vehicle	The vehicle from which the perspective is considered.
Platoon cohesion	Platoon cohesion refers to how well the members of the platoon remain within steady state conditions in various scenario conditions (e.g. slopes, speed changes).
Platoon formation	Platoon formation is the process before platoon engaging in which it is determined if and in what format (e.g. composition) trucks can/should become part of a new / existing platoon. Platoon formation can be done on the fly, scheduled or a mixture of both. Platoon candidates may receive instructions during platoon formation (e.g. to adapt their velocity, to park at a certain location) to allow the start of the engaging procedure of the platoon.
Platoon engaging	Using wireless communication (V2V), the Platoon Candidate sends an engaging request. When conditions are met the system starts to decrease the time gap between the trucks to the platooning time gap. A.k.a. join platoon
Platoon disengaging	The ego-vehicle decides to disengage from the platoon itself or is requested by another member of the platoon to do so. When conditions are met the ego-vehicle starts to increase the gap between the trucks to a safe non-platooning gap. The disengaging is completed when the gap

	is large enough (e.g. time gap of 1.5 seconds, which is depends on the operational safety based on vehicle dynamics and human reaction times is given). A.k.a. leave platoon
Platoon dissolve	All trucks are disengaging the platoon at the same time. A.k.a. decoupling, a.k.a. disassemble.
Platoon split	The platoon is split in 2 new platoons who themselves continue as standalone entities.
Emergency brake	Brake action with an acceleration of $<-4 \text{ m/s}^2$
Cut-in	A lane change manoeuvre performed by vehicles from the adjacent lane to the ego vehicle's lane, at a distance close enough (i.e., shorter than desired inter vehicle distance) relative to the ego vehicle.
Cut-out	A lane change manoeuvre performed by vehicles from the ego lane to the adjacent lane.
Cut-through	A lane change manoeuvre performed by vehicles from the adjacent lane (e.g. left lane) to ego vehicle's lane, followed by a lane change manoeuvre to the other adjacent lane (e.g. right lane).
Steady state	In systems theory, a system or a process is in a steady state if the variables (called state variables) which define the behaviour of the system or the process are unchanging in time. In the context of platooning this means that the relative velocity and gap between trucks is unchanging within tolerances from the system parameters.
Platoon candidate	A truck who intends to engage the platoon either from the front or the back of the platoon.
Time gap	Elapsed time to cover the inter vehicle distance by a truck indicated in seconds.

## Acronyms and abbreviations used in ENSEMBLE

Acronym / Abbreviation	Meaning
ABS	Anti-lock Braking System
ACC	Adaptive Cruise Control
ACSF	Automatically Commanded Steering Function

ADAS	Advanced driver assistance system
ADR	Agreement concerning the International Carriage of Dangerous Goods by Road
AEB	Automatic Emergency Braking (System, AEBS)
ASIL	Automotive Safety Integrity Level
ASN.1	Abstract Syntax Notation One
BTP	Basic Transport Protocol
C-ACC	Cooperative Adaptive Cruise Control
C-ITS	Cooperative ITS
CA	Cooperative Awareness
CAD	Connected Automated Driving
CAM	Cooperative Awareness Message
CCH	Control Channel
CS	Cyber Security
CSF	Corrective steering functions
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
DSRC	Dedicated Short-Range Communications
EC	European Commission
EMC	Electromagnetic Compatibility
ESF	Emergency steering function
ESP	Electronic Stability Program
ETSI	European Telecommunications Standards Institute
EU	European Union
FAD	Fully Automated Driving
FCW	Forward Collision Warning
FLC	Forward Looking Camera
FSC	Functional Safety Concept
GN	GeoNetworking



GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRVA	Working Party on Automated/Autonomous and Connected Vehicles
HAD	Highly Automated Driving
HARA	Hazard Analysis and Risk Assessment
HIL	Hardware-in-the-Loop
HMI	Human Machine Interface
HW	Hardware
I/O	Input/Output
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITC	Inland Transport Committee
ITS	Intelligent Transport System
IVI	Infrastructure to Vehicle Information message
LDWS	Lane Departure Warning System
LKA	Lane Keeping Assist
LCA	Lane Centering Assist
LRR	Long Range Radar
MAP	MapData message
MRR	Mid Range Radar
MVC	Modular Vehicle Combinations
OBD	On-Board Diagnostics
OS	Operating system
ODD	Operational Design Domain
OEM	Original Equipment Manufacturer
OTA	Over the air
PAEB	Platooning Autonomous Emergency Braking
PMC	Platooning Mode Control



QM	Quality Management
RCP	Remote Control Parking
RSU	Road Side Unit
SAE	SAE International, formerly the Society of Automotive Engineers
SCH	Service Channel
SDO	Standard Developing Organisations
SIL	Software-in-the-Loop
SPAT	Signal Phase and Timing message
SRR	Short Range Radar
SW	Software
TF	Task Force
UNECE	United Nations Economical Commission of Europe
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to any (where x equals either vehicle or infrastructure)
VDA	Verband der Automobilindustrie (German Association of the Automotive Industry)
VECTO	Vehicle Energy Consumption Calculation Tool
VMAD	Validation Method for Automated Driving
WIFI	Wireless Fidelity
WP	Work Package
WP.1	Working Party 1 - Global Forum for Road Traffic Safety
WP.29	Working Party 29 - World Forum for Harmonization of Vehicle Regulations



## APPENDIX B. QUESTIONNAIRE FOR APPLYING WW DPTC CERTIFICATE

Question	Answer	Remarks
Tests description		
What is the test type?	<ul style="list-style-type: none"> <li>- Technical tests and adjustments;</li> <li>- Performance evaluation in situation of use for which the DPTC vehicle is intended;</li> <li>- Public demonstration, especially during events</li> </ul>	
What are the objectives of the tests? (To be detailed)		
What is the autonomy level of delegated driving vehicles during the experimentation? (levels from 0 to 5 according to the SAE J3016 standard)	<ul style="list-style-type: none"> <li>- 0 ;</li> <li>- 1 ;</li> <li>- 2 ;</li> <li>- 3 ;</li> <li>- 4 ;</li> <li>- 5</li> </ul>	
What are the overall modalities of the tests? (Brief test description)		
Who are the stakeholders of the tests and their respective roles? (Manufacturers, transport operators, service providers, local authority, traffic police authorities, mobility organizing authorities, etc.)		
Test Conditions		
Location		
Starting date of the tests (Do not forget the preparation periods for the experiment, in particular for running a demonstration, etc.)		
End date of the tests		
Vehicle type	<ul style="list-style-type: none"> <li>- Private car;</li> <li>- Public transport of people;</li> <li>- Haulage ;</li> </ul>	



	- Agricultural vehicle; - Other	
Number of vehicles		
Tests carried out during the experiment (If it is not a pure demonstration operation or a presentation to the media)		
Road networks on which the tests will take place (complete the road network form and provide the plans and information necessary to process the request in the authorization request file)		
Will the vehicle be driven in conventional mode on road networks other than those used in automated mode, in particular to reach the experimental sites (connection route)? (Specify which ones)	- Yes ; - No	
Will the tests take place partially on roads closed to public traffic? (If yes, specify)	- Yes ; - No	
Is the route of the vehicle protected? (if yes, specify by what means)	- Yes ; - No	
Are additional equipment and facilities on the road planned for the tests? (If yes, specify: signals, roads, communication Please note: certain installations (in particular the installation of non-regulatory signals) may be subject to a specific authorization from the delegation for road safety and the General Directorate of Infrastructure, Transport and the Sea requiring a request for authorization separate from that concerning the circulation of CAV vehicles)	- Yes ; - No	
Are traffic police measures planned for the tests? (Modification of signaling, restriction of circulation, lowering of speed, change of priority regimes at intersections...)	- Yes ; - No	
What will be the interactions with the usual vehicle flows (private vehicles, bus, tram, clean sites, cycle lane, etc.)? (Specify the type and geometry - crossroads, roundabout ... - if necessary by means of attached diagrams)		
Are interactions with vulnerable users possible?	Pedestrians	- Yes ; ; - No
	Cyclists	- Yes ; ; - No



	2 motorized wheels	- Yes ; - No	
	Others (specify)	- Yes ; - No	
Maximum vehicle speed during tests (It can be different from the speed by construction of the vehicle)			
<b>Driving and boarding passengers</b>			
Is the person responsible for driving the vehicle on board the vehicle?		- Yes ; - No	
Who are the people responsible for driving (expert drivers, employees, service providers, etc.)?			
What are the means of control (lateral and / or longitudinal) available to the person responsible for driving the vehicle?			
If the person responsible for driving is not on board the vehicle: - specify where it is; - describe the feedback it has from the experimental vehicle and the experimental site; - specify the protocols for switching to autonomous mode and returning to conventional mode.			
Does the experimental protocol provide for the presence of a supervisor in the vehicle? (A supervisor is a different person from the driver, present in the car during the experiment, who has all the means to control the vehicle, and who during certain phases of the experiment, can become the driver of the car. If yes, specify the conduct of the supervisor and the procedures for transferring the conduct from the driver to the supervisor and from the supervisor to the driver.		- Yes ; - No	
When the vehicle is traveling in conventional mode, if applicable, specify who will be the driver and how?			
What is the type of driver's license of the persons responsible for driving the vehicle?			
Is the training of those responsible for driving the vehicle internal or external? (Specify its content)			
Besides the person (s) responsible for driving the vehicle, will there be other people in charge of the tests on board the vehicle?		- Yes ; - No	



(If yes, specify the context, the number, and if they are professionals and / or employees of the company)		
Besides the experimenters, will there be passengers in the vehicle? (If yes, the applicant has the obligation to comply with the prescriptions of <a href="#">decree n ° 2018-211 of March 28, 2018</a> and of this decree relating to the testing of vehicles with delegated driving on public roads)	- Yes ; - No	
Vehicle specifications		
Motorization	- Thermal; - Electric; - Hybrid; - Other	
Serial number (s) of vehicle (s)?		
Number of seats including driving position (s) if applicable		
Number of standing places including driving position (s) if applicable		
Maximum speed by vehicle construction		
What is the classification to which the vehicle belongs if there is an approved series configuration, if not the classification to which the vehicle could be attached?	- Bus or coach; - Articulated bus / coach; - Pick-up truck; - Moped; - Motorcycle; - Light motorcycle; - Heavy weights ; - Light motor quadricycle; - Heavy motor quadricycle; - Motor tricycle; - Public transport vehicle; - Private car; - Other	
In conventional mode, is the vehicle approved?	- Yes ; - No	
Has the vehicle been modified in relation to the homologation rules for this category? (If yes, describe these changes.)	- Yes ; - No	
Has the test vehicle been tested before the requested experiment? (If yes, specify in particular with regard to delegation systems, systems ensuring the safety of people on board and that of road users.)	- Yes ; - No	



<p>Does the vehicle have specific sound or light signals?                  (- If it is a modified homologated vehicle, specify if the vehicle will have specific warning devices;                  - In the case of an unlicensed vehicle, describe the audible and visual warning devices available to it;                  - If it is an electric vehicle, specify if it will have a courtesy warning to signal its presence)</p>	<p>- Yes ;                  - No</p>	
<p>In what form (s) does the mention <i>test vehicle with partial or total automated driving</i> appear in the vehicle?                  (specify locations, size, formats...)</p>		
<p>Indicate the data that is saved by the Event Data Recorder and the periods of retention of this data.                  (How and where are they saved? Under what conditions can these data be made available to the authorities in the event of an accident on the roads?)</p>		
<p>Will a logbook, handwritten or electronic, be present on board the vehicle?                  (If yes, specify the elements indicated in this journal)</p>	<p>- Yes ;                  - No</p>	
<p>Will the vehicle be supervised from a fixed checkpoint?                  Only during the experimentation phases?                  (If yes, describe)</p>	<p>- Yes ;                  - No</p>	
<p>Describe the systems of automated driving.                  (What automated systems? How does the vehicle go into automated driving mode? What are the driver alert systems?... Refer to the documents in the file for detailed descriptions)</p>		
<p>Implementation of a transport service</p>		<p>(Answer the following questions only if the vehicle (s) will be used for a transport service)</p>
<p>Authority organizing this transport service</p>		
<p>Nature of transport service</p>	<p>- public transport of people;                  - private transport of people;                  - haulage</p>	
<p>Partner transport operator (if applicable)</p>		
<p>What is the registration number of this operator in the passenger road transport register or in the goods road transport register, depending on the type of transport service provided?</p>		



How long is the experimentation phase without transport service (blank run)? (Indicate the period [start date, end date] and the program for this phase)		
If it is a public passenger transport service: describe the route and the stopping points of the planned routes.		
If it is a public passenger transport service: what are the time slots during which the service will be open?		
If it is a public passenger transport service: what information is available to the public concerning this service? (at the stops, website, multimodal information system, in the press, by flyers, etc.)		
If it is a public passenger transport service: how is each passenger informed that this service is based on automated technologies? (Specify if necessary)		
If it is a public passenger transport service: what are the conditions of access to this service, and what is the pricing policy applied? (Specify if necessary)		
If it is a public passenger transport service: what are the regulations applicable to passenger transport taken into account in the context of the tests? (Specify)		
Is your company registered in the electronic register of road transporters?	- Yes ; - No	
Specify the derogations from the decree of July 2, 1982 relating to the public transport of people.		
<b>Safety</b>		
How did you analyse the safety risks? (Specify the method used)		
Has the risk analysis been carried out by an external body? (If yes, specify)	- Yes ; - No	
What are the main risks associated with this test? (List and describe)		
What measures have been put in place to limit these risks? (List and describe)		



What are the procedures for detecting, analysing and handling incidents? (Type of corrective measures implemented, etc.)		
What security event recording system have you implemented? (Specify)		
<b>Cybersecurity</b>		
How did you analyse the risks related to cybersecurity? (Specify the method used)		
Has this risk analysis been carried out by an external body? (If yes, specify)	- Yes ; - No	
What are the main cybersecurity risks linked to this test? (List and describe)		
What measures have been put in place to limit these cybersecurity risks? (List and describe)		
What are the procedures for detecting, analysing and handling cybersecurity incidents? (Type of corrective measures implemented, etc.)		
How was cybersecurity taken into account? (Specify cybersecurity measures)		
What are the residual cybersecurity risks identified during security audits carried out on the information systems concerned by the test? (Specify)		
Did you use a service provider to carry out security audits of the information systems concerned by the test? (If yes, specify)	- Yes ; - No	
If you have used an audit provider, has it been the subject of a qualification by the ANSSI (Agence nationale de la sécurité des systèmes d'information) or by another body? (If yes, specify)	- Yes ; - No	
What security event recording system have you implemented? (Specify)		
<b>Consultation of stakeholders</b>		
Which road managers have been approached with?		
If traffic police measures on these infrastructures in direct relation to the tests, with which police authorities have steps been taken?		



(Specify which authorities, traffic police measures, dates of consultation, etc.)		
Are there any special demands on infrastructure managers? (If yes, specify: interventions, equipment, signals, road works, etc.)	- Yes ; - No	
By what means are the police and the emergency services informed of the conduct of the experiment and the specifics of the vehicle?		
By what means are other users informed of the tests (if necessary)?		
Does the applicant guarantee that the experiment will be covered by adequate insurance? (Specify the covered risks)	- Yes ; - No	





## APPENDIX C. FORMULAIRE DE DEMANDE FOR AUTHORISING TEST OF AUTOMATED VEHICLES ON BELGIAN PUBLIC ROADS



Federal Public Service  
Mobility and Transport

### Automated cars

## Procedure for authorizing tests on public roads

Submit the completed questionnaire below and the required documents to the FPS Mobility (vehicle@mobiliteit.fgov.be)

Question	Response
Applicant	
Name of the test organization	
Address	
Name of the applicant, role	
Telephone	
E-mail	
Website	
Description of the test	
Summarized description of the test	(Describe the changes with regard to the approved vehicle)
What level of automation does the vehicle have?	<input type="checkbox"/> 1 – driving assistance <input type="checkbox"/> 2 – partially automated <input type="checkbox"/> 3 – conditionally automated <input type="checkbox"/> 4 – highly automated <input type="checkbox"/> 5 – fully automated



Test period	
Operation of the vehicle and passenger on board	
Surname and first name of drivers	
Does the applicant confirm that these persons can resume control of the vehicle at any time?	(Specify)
Does the test protocol allow for a test assistant to be present?	(A test assistant is a person in charge of assisting the test driver or operator in conducting the test, by checking for example the digital information displays or other information feedback systems and by observing the movements of other road users)
Apart from the person or persons responsible for driving the vehicle, are there other people on board the vehicle in charge of testing?	(Specify the context, number, and if these are professionals and/or employees of the company)
Characteristics of vehicle 1	
Vehicle category	
Serial number of the vehicle	
Vehicle registration number	
Number of seats including the driver's seat	
Characteristics of vehicle 2	
Vehicle category	
Serial number of the vehicle	
Vehicle registration number	
Number of seats including the driver's seat	



Characteristics of vehicle 3	
Vehicle category	
Serial number of the vehicle	
Vehicle registration number	
Number of seats including the driver's seat	
Registration of data	
Are the automated vehicles being tested fitted with a data recording device which is capable of capturing data from the sensors and control systems associated with the automated features as well as other information concerning the vehicle's movement?	<input type="checkbox"/> YES <input type="checkbox"/> NO
Does this device record at least the following information?	
Whether the vehicle is operating in manual or automated mode	<input type="checkbox"/> YES <input type="checkbox"/> NO
Vehicle speed	<input type="checkbox"/> YES <input type="checkbox"/> NO
Steering command and activation	<input type="checkbox"/> YES <input type="checkbox"/> NO
Braking command and activation	<input type="checkbox"/> YES <input type="checkbox"/> NO
Operation of the vehicle's lights and indicators	<input type="checkbox"/> YES <input type="checkbox"/> NO
Use of the vehicle's audible warning system (horn)	<input type="checkbox"/> YES <input type="checkbox"/> NO
Sensor data concerning the presence of other road users or objects in the vehicle's vicinity	<input type="checkbox"/> YES <input type="checkbox"/> NO
Remote commands which may influence the vehicle's movement (if applicable)	<input type="checkbox"/> YES <input type="checkbox"/> NO
Location of the vehicle	<input type="checkbox"/> YES <input type="checkbox"/> NO
Safety	
A risk analysis has been carried out?	<input type="checkbox"/> YES <input type="checkbox"/> NO
If yes, then has the risk analysis been validated by an external body?	(Specify name of the body)
Are the on-board sensors and control systems sufficiently developed to be capable of appropriately responding to all types of	(Specify)



road user likely to be encountered during the test in question? (Particularly for more vulnerable road users)?	
All prototype automated controllers and other on-board systems should have a sufficient safety level built into them to be able to manage any risk of unauthorized access?	<input type="checkbox"/> YES <input type="checkbox"/> NO
Does the HMI system (Human Machine Interface) used meet the following requirements? <ul style="list-style-type: none"> <li>• Be easily and clearly understood by the test driver.</li> <li>• The driver is given clear indication of the vehicle driving mode - manual or automated.</li> <li>• Ensure that the driver is given sufficient warning to resume manual control when necessary.</li> <li>• Allow the driver to quickly and easily retake control of the vehicle when necessary.</li> </ul>	<input type="checkbox"/> YES <input type="checkbox"/> NO
Do the transition periods between manual and automated mode (and vice versa) involve minimal risk?	<input type="checkbox"/> YES <input type="checkbox"/> NO
In the event of a malfunction or failure of the automated driving system under test, is the test driver or operator made aware with an audible warning (possibly accompanied by a visual warning)?	<input type="checkbox"/> YES <input type="checkbox"/> NO
Are the vehicle's automated braking and steering systems designed to allow manual braking or steering in the event of failure?	<input type="checkbox"/> YES <input type="checkbox"/> NO
Are the software levels and revisions used on each vehicle to be tested clearly documented and recorded?	<input type="checkbox"/> YES <input type="checkbox"/> NO
Are they subject to documented tests?	<input type="checkbox"/> YES <input type="checkbox"/> NO
Applicant's undertaking	
The applicant undertakes to: <ul style="list-style-type: none"> <li>• inform the police and emergency services</li> </ul>	

- inform other road users of the test (if necessary)
- provide the FPS Mobility with summaries of incidents/accidents
- provide the FPS Mobility with a test summary

<b>Documents to be included</b>
Copy of the appropriate driving license for every test driver
Copy of an appropriate insurance policy for the test vehicle (after registration if not available during the application)
Risk analysis
Training plan for test drivers.
Copy of the roadworthiness test certificate (where appropriate)
Auditing record kept by the organiser of the test which shows that the internal tests have given sufficient results to be able to conduct tests on the public road network without this creating additional risks for road users
A photo of the automated vehicle

I, the undersigned, as duly approved representative of the test organiser, declare that the above responses are correct.

I undertake to immediately communicate to the administration any change that occurs following the authorization of the prototype.

Name, date and signature of the applicant:

## APPENDIX D. CERTIFICATE TO PERFORM ROAD TEST OF AUTOMATED VEHICLES

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One of the main parts of the authorization for testing on open roads in Spain, is the one related with the obtaining of the certificate issued by the accredited Technical Service. This procedure consists of three main parts:

- Documentation

The documentation shall be the basis for identifying the type of vehicle that is intended to be tested. The documentation required is briefly summarized below.

- Simplified technical specifications sheet: This is a relation of basic data of the vehicle regarding the masses and dimensions, brakes, engine, conventional steering system, and light devices. This document is regulated in Real Decreto 750/2010 and has a different format depending on the vehicle category.
- Technical specifications sheet: it is a document generated from the simplified technical specifications sheet but with more detailed data. The Technical Service will compare the information in this document with the test vehicle in order to verify that the data reflected in the sheet is appropriate.
- Risk assessment: In this document the manufacturer shall include an evaluation of the potential risks concerning the test and its probability of happening. Identified risks cannot be accepted for driving on public roads and shall be controlled or mitigated before the tests. All operational modes and potential failures of the vehicle shall be assessed. This assessment can be made by means of using a HARA (Hazard Risk Analysis), FMEA (Failure Mode Effects Analysis) or an equivalent method
- Control of software versions: It is mandatory to declare the software version of the autonomous systems, of course, the software version of the system to be tested on open road must be the same as the system tested in the laboratory.

In case of implementing new software versions during open road tests it is allowed to justify the safety of the new software versions by means of documentation, simulations or bench tests

- Emergency stop and override system: It is necessary for the applicant to bring to the Technical Service documentation that during the design phase of the vehicle the following considerations have been taken:
  - Emergency shutdown; It's mandatory to install in a place accessible to the driver an emergency button which stops the action of the actuators at any moment.
  - Override: the vehicle manufacturer must demonstrate to the Technical Service that the driver is able to override the actuation of the system by means of actuation on the brake pedal, the accelerator pedal or the steering wheels. That means that the system actuations must stop all the actuations in case the driver actuates one of the above-mentioned devices.



- Additionally, the manufacturer must prove that both systems are independent.
- Functionalities and test design scenarios: The manufacturer is required to provide a complete description of the AD functionalities working on the vehicle. The purpose of this information is to identify critical situations to be avoided during the open road tests.
- Scenarios: it is also important to define the scenarios to be evaluated during the open road test. It is important because authority will allow only the automated driving in the scenarios described in this section. For this section it is mandatory to include features of the scenario as the type of road, traffic conditions during the test, weather conditions or the manoeuvres to be performed.
- Restricted scenarios: It is equally important to include a description of the scenarios to be avoided by the vehicle during the tests. The description of these restricted situations must be detailed in the same way as the test scenarios.
- Cybersecurity: The manufacturer/applicant must demonstrate to the Technical Service that they have considered cybersecurity aspects during the system design phase.
- Electromagnetic Compatibility (EMC): It must be proven by the applicant that the electronic components used during the tests are not influenced by the working of other electronic devices to avoid unexpected reactions of the system. It is mandatory to fulfil the existing EMC regulations in order to prove this compatibility.

- Inspection

The inspection shall evaluate the parameters regarding exterior, interior, engine bay, wheels and wheel arches and others such as ballast, measuring equipment, display screens or auxiliary batteries.

The inspection shall be performed by an Authorized Technical Service and using the corresponding template for each category of vehicle (Annex III of the Instruction 15/V-113).

- Dynamic check

In addition to the documental verifications mentioned above, dynamic tests shall make it possible to certify that the vehicle can be driven manually, that it can regain manual control as required by the drivers or at the request of the operator and in automated driving mode can maintain the level of safety.

Several tests must be performed:

- Conventional driving: even if in automated driving mode, an occupant with access to the vehicle's manual controls. It is imperative that the vehicle can be driven in manual mode at any time.
- Override (steering wheel, brake pedal, accelerator pedal, emergency shutdown): At any stage of automated driving, driver override must be detected after applying a maximum torque at the wheel, when actuating on the brake pedal, when actuating on the accelerator pedal and when actuating emergency shutdown system, respectively.



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- Longitudinal control: to assess the ability of the vehicle to maintain the longitudinal control and to brake in an emergency.
    - Braking test: to check and ensure the correct operation of the braking system.
    - Automated emergency braking: to check and ensure the correct operation of the automated emergency braking system.
  - Lateral control: to assess the vehicle's ability to stay in a lane marked with road markings (solid/broken line). The vehicle must be able to stay in different conditions in a lane marked by road markings. It shall not be assessed whether the system is capable of operating on an open road without road markings.
  - Recognition and compliance with the traffic signs: To ensure the testing of vehicles with automated capabilities on public roads and sharing the road with others, it is essential to ensure that these vehicles in automated mode are able to recognize and respect both traffic signs and road markings, either vertical or horizontal signs.

