General Safety Regulation - Technical study to assess and develop performance requirements and test protocols for various measures implementing the new General Safety Regulation, for accident avoidance and vehicle occupant, pedestrian and cyclist protection in case of collisions

Intelligent Speed Assistance (ISA): Second Interim Report – Detailed development of requirements and tests

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EXECUTIVE SUMMARY

Intelligent Speed Assistance (ISA) means a system to aid the driver in maintaining the appropriate speed for the road environment by providing dedicated and appropriate feedback.

The revised General Safety Regulation (EU) 2019/2144 has entered into force and will help ensure the deployment of new advanced safety features with high potential of saving lives on EU roads. One of a package of measures to be implemented within this revision is the mandatory fitment of ISA to passenger cars, vans, trucks, buses and coaches.

The objective of the ISA work package was to develop draft technical annexes setting out requirements and test procedures for secondary type approval legislation for regulatory ISA systems for vehicle categories M_1, M_2, M_3, N_1, N_2 and N_3. This work package was divided into the following tasks:

- Task 1: Review and scope contents of draft technical annexes
- Task 2: Detailed development of requirements and tests
- Task 3: Trials of track-based test procedures
- Task 4: Consultations / liaison
- Task 5: Reporting, meetings and ad-hoc support

Task 1 and part of Task 4 were completed in 2019. This work made a preliminary recommendation for the contents of the draft technical annexes for the secondary type approval legislation for ISA, based on literature review and bilateral meetings with 14 stakeholders (3 automotive OEMs, 1 automotive & heavy vehicle OEM, 5 tier 1 suppliers, 2 test houses/technical services, 1 consumer test organisation, 1 non-government organisation, 1 academic organisation). The preliminary recommendations and relevant supporting information were documented in a report, Seidl *et al.* (2020), which was circulated to stakeholders for comment. Feedback was received from 13 stakeholders (1 OEM association, 2 automotive OEMs and 1 automotive & heavy vehicle OEM; 1 supplier association and 3 suppliers; 1 consumer test organisation; 4 non-government organisations).

Following this, the second stage of the work further developed the draft technical annexes taking into account comments from stakeholders on the report mentioned above and further stakeholder consultation. It was originally envisaged that this work would include trials of the track-based test procedures developed, but unfortunately this was not yet possible because of restrictions related to the COVID-19 pandemic. TRL is envisaging to perform the trials at a later date and is liaising with the European Commission on how to proceed in this regard.

This report details the draft technical annexes developed, including requirements, test procedures and associated performance limits, the thinking behind their development, and, where appropriate, justification for the text content, as well as recommendations for remaining work and the way forward.

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1 INTRODUCTION

TRL are providing support to the European Commission to develop the secondary type approval legislation for the following vehicle safety measures in the context of the General Safety Regulation (Regulation (EU) 2019/2144):

- AEB: Advanced Emergency Braking (light duty, vehicles and pedestrians/cyclists)
- DDR: Driver Drowsiness and Attention Monitoring, Driver Readiness Monitoring for Automated Driving & Advanced Distraction Recognition
- EDR: Event Data Recorder
- FFW: Frontal Full-Width Impact
- HED: Pedestrian and Cyclist Enlarged Head Impact Zone
- ISA: Intelligent Speed Assistance
- ELKS: Emergency Lane Keeping System
- REV: Reversing Safety
- TPM: Tyre Pressure Monitoring (heavy duty)
- VIS: Direct Vision & Pedestrian and Cyclist Detection (heavy duty)

This work package is related to Intelligent Speed Assistance (ISA), a system to aid the driver in maintaining the appropriate speed for the road environment by providing dedicated and appropriate feedback.

The objective of this work package is to develop draft technical annexes setting out requirements and test procedures for secondary type approval legislation for regulatory ISA systems for vehicle categories M_1, M_2, M_3, N_1, N_2 and N_3. This work package was divided into the following tasks:

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Following this, the second stage of the work further developed the draft technical annexes taking into account comments from stakeholders on the report mentioned above and further stakeholder consultation. It was originally envisaged that this work would include trials of the track-based test procedures developed, but unfortunately this was not possible because of restrictions related to the COVID-19 pandemic.

This report is divided into three main sections. The first section describes the approach taken to develop the requirements and tests and write the draft regulatory text. The second section describes the draft regulatory text, including the thinking behind it, and, where appropriate, justification for the text content. The third and final main section

describes the recommendations for remaining work and the way forward. Annexes 1–4 provide additional content; notably Annex 1 contains the entire draft regulatory text in continuous tables.

2 APPROACH

The principles and remit followed to develop the requirements and test procedures were the same as those reported previously (Seidl *et al.*, 2020). It is interesting to note that stakeholders emphasized the importance of the general principle that the regulation should not be design restrictive and thus, as far as possible, performance based, because they thought that this should help to enable competition, which in turn should lead to better and more cost-effective solutions.

The first step taken was to review and understand better stakeholder feedback to the first report, which made a preliminary outline recommendation for the contents of the draft technical annexes for the secondary type approval legislation. Part of this work involved a number of meetings with major stakeholder groups (for example ACEA and CLEPA), one of which the Commission was present at. In these meetings conceptual content was discussed, but no detailed draft text was shared. These meetings also allowed the development of some key ideas and highlighted some problems, as follows:

- Ideas which arose to resolve potential issues:
    - Catalogue of road signs
        - There are a large number of signs related to speed limits in the European Union, which are often different between member states. In many cases the speed limit associated with these signs is different for different vehicle categories. In order to prevent ambiguity, the regulation should define precisely the signs based upon which an approved ISA system should determine road speed limits (as a minimum) and the speed limits associated with those signs by vehicle class if appropriate. To achieve this, it was proposed that a catalogue of road signs should be made containing this information.
    - Cascaded warnings
        - To some extent, defining requirements for an effective warning indication for ISA involves obtaining a balance between making the warning intrusive enough so that it is noticeable and easily recognised by the driver, but not so intrusive that it annoys the driver so that they deactivate the system, thus losing any potential benefit from it. To help resolve this problem the idea of allowing the fitment of a cascaded acoustic warning (on top of a visual warning) with a time delay and related to the magnitude of the speeding was proposed.
    - Region- or country code setting
        - Knowledge of the current region or country of operation is required to determine implicit speed limits, i.e. those where a sign does not show a numerical value (e.g. a national speed limit sign or a motorway sign). In order to provide flexibility in the regulation to design systems which do not have a positioning capability (e.g. GPS), the idea was proposed to permit a manual or semi-automatic setting of the region- or country code.
- Problems which arose:
    - Mismatch of aspirations
        - The main problem that arose was an apparent mis-match of the aspirations between the European Parliament and European Commission, and the industry regarding the minimum capability of ISA systems that the regulation should mandate; the Parliament

and Commission arguably having somewhat higher aspirations than industry stakeholders.

- The industry proposed that minimum capability mandated should be an ISA system which would recognise numerical (explicit) signs only but with high reliability. An advantage of this proposal is that it should be possible to implement this type of system at a lower cost using camera technology that is currently readily available. A disadvantage is that coverage of the system may not be as high as for more advanced systems, for example it may not recognise urban speed limits in some member states which use implicit signs.
- The Parliament and Commission proposed that the minimum capability mandated should be higher and include:
    - At least recognition of key non-numerical signs,
    - A real-world based assessment of the performance of the ISA system, carried out by a technical service

  It was noted that an ISA system based on current readily available technology may require map data to achieve this level of capability, which entails additional cost compared to a camera-only based system. However, this cost could be minimised by using a reduced map stack, which only contains the required speed limit information, and not installing an on-board navigation system which is often included in current vehicles fitted with camera-map fusion systems. Nevertheless, it is acknowledged that newly integrating a positioning system and electronic map elements (in addition to a camera) into a vehicle's E/E architecture could be very challenging within the regulatory timeframe for certain vehicle models. Lastly, it should be stated that higher prevalence of explicit speed limit signs in European member states would make the task to determine the applicable speed limit considerably easier.

- Trucks speed limits
    - These are often quite different to those posted, vary with class of vehicle and can also vary with other aspects, e.g. the weight of the load that the truck is carrying.
    - Clearly, it is unrealistic to expect the minimum requirements for a regulated ISA system to take into account the weight of the load that the truck is carrying to determine the speed limit. Therefore, it was proposed that ISA systems on trucks should only be required to take into account the relevant speed limits in the catalogue, which is not intended to include load related ones, and other special variable conditions (that is, conditions which require information going beyond the current region or country of operation and the current road class, such as trailer status, prevailing environmental conditions, time of year, driver age or experience, or standing passengers) are excluded from the requirements unless the relevant electronic signals are available on the vehicle. However, further work will be required to determine precisely what speed limits the catalogue should contain for trucks.

In response to the ideas and problems above, the approach taken to develop and draft the requirements and procedures was as follows:

- Define requirements and test procedures in a technology neutral way, i.e. in a way that aims to allow all technologies included in the regulatory remit (set by Regulation (EU) 2019/2144) to be approved if they meet the minimum functional requirements and performance levels.

- Work to the aspiration level of the European Parliament and European Commission.
- Take a modular approach to allow implementation in a step-wise fashion if desired.
- Take industry stakeholder feedback into account, for example, by removing design restrictions, allowing different test procedures as far as possible, and permitting cascaded warnings and manual or semi-automatic region- or country-code setting.

3 DEVELOPMENT OF REQUIREMENTS AND TEST PROCEDURES

3.1 Subject matter, exemptions and definitions

3.1.1 Subject matter

The scope of mandatory ISA fitment is defined in Article 6 of Regulation (EU) 2019/2144, which refers to "all motor vehicle categories". Item D8 of Annex II specifies ISA as mandatory equipment for vehicle categories M_1, M_2, M_3, N_1, N_2 and N_3 from 5th July 2022 (new types) and 5th July 2024 (new registrations). Approval of separate technical units (STUs) shall be possible; component approval is not envisaged. The subject matter of the draft EC regulation is defined by reference to Regulation (EU) 2019/2144.

Draft text:

0.1	Subject matter This Regulation establishes detailed technical requirements and test procedures for the EC type approval of the vehicles referred to in Article 6 of Regulation (EU) 2019/2144 in respect of their Intelligent Speed Assistance system and of Intelligent Speed Assistance separate technical units ('STUs').

3.1.2 Exemptions

TRL did not, in this study, identify a need to exempt entire classes of vehicles based on technical reasons that would make fitment of ISA unfeasible. However, certain vehicles could be exempted from certain requirements based on characteristics of their usage (e.g. the necessity to exceed the road speed limit during their operation). Note that requirements for small series or individual approvals are not in scope of this study.

ACEA feedback on the first interim report suggested exemptions for ambulances and police vehicles. TRL agrees with this suggestion. Usage of such vehicles by private owners after they are sold on by public authorities at their end of service will be regulated by national construction and use requirements, which may or may not permit operation without ISA. Exemptions from the requirement to fit ISA as drafted by TRL below, based on the wording used in UN Regulation No. 17 (prohibition to install side-facing seats), could be included. It could also be considered to exempt relevant vehicles only from speed limit warning and speed control requirements, while still requiring speed limit information to be displayed to the driver. The European Commission will decide whether and which exemptions are adequate.

The industry suggestions to exempt:

- special purpose vehicles (M_xS and N_xS) was not applied because TRL identified no convincing justifications for entire classes of special purpose vehicles;
- off-road vehicles (M_xG and N_xG) was not applied because these vehicles will frequently be used on-road and should therefore be subject to the same requirement as other on-road vehicles;
- all top-speed limited vehicles (UN Regulation No. 89 on speed limitation devices) was not applied because these vehicles will still be used on roads with speed limits lower than their top speed (e.g. in urban areas, at roadworks, etc.);
- vehicles that have a limited area of operation, such as city buses, was not applied because, although the normal operation of these vehicles may be restricted to a specific geographical area in day-to-day use at least for a certain time following initial registration, based on EC type approval these vehicles will be allowed to be

sold and operated in the entire EU and should therefore be compatible with the infrastructure in all European countries.

Draft text:

0.2	[Exemptions Ambulances or vehicles intended for use by the armed services, civil defence, fire services and forces responsible for maintaining public order are exempted from the requirement to be equipped with an intelligent speed assistance system.]

3.1.3 Definitions

Definitions were drafted as required to ensure that the meaning of the draft text was clear and unambiguous. Note that the definition of 'Intelligent Speed Assistance' (ISA) is included by reference to Article 3 of Regulation (EU) 2019/2144:

> *"'intelligent speed assistance' means a system to aid the driver in maintaining the appropriate speed for the road environment by providing dedicated and appropriate feedback"*

Draft text:

0.3	Definitions For the purposes of this Regulation and in addition to the definitions laid down in Article 3 of Regulation (EU) 2018/858, the following definitions apply:
0.3.1	*"Speed limit information function (SLIF)"* comprises the speed limit determination system that determines the perceived speed limit, and an interface that communicates the perceived speed limit to the driver.
0.3.2	*"Speed limit warning function (SLWF)"* means a function that alerts the driver that the speedometer speed is exceeding the perceived speed limit.
0.3.3	*"Speed control function (SCF)"* means a function that attempts to limit the speedometer speed to a stable speed at or below the perceived speed limit.
0.3.4	"*Speed limit determination system*" means the specific hardware required to obtain the speed limit through the observation of road signs and signals, based on infrastructure signals or electronic map data, or both.
0.3.5	"*Speed limit feedback system*" means the specific hardware required to communicate the speed limit to the driver (SLIF HMI interface) and to provide feedback to the driver (SLWF or SCF).
0.3.6	*"Speedometer speed"* means the driving speed of the vehicle as displayed by the speedometer.
0.3.7	*"Road speed limit"* means the currently applicable maximum permitted legal driving speed at the vehicle's location for the category of vehicle that the ISA system is fitted to.
0.3.8	"*Explicit speed limit sign*" means an applicable road sign which shows a numerical value.
0.3.9	"*Implicit speed limit sign*" means an applicable road sign which does not show a numerical value.
0.3.10	*"Perceived speed limit"* means the road speed limit as obtained by the speed

	limit determination system.
0.3.11	"*Catalogue of road signs*" means the definitive list of national and regional variants of road sign types [and variable message sign types] based upon which ISA shall obtain the perceived speed limit.
0.3.12	"*Applicable road sign*" means a sign contained in the catalogue of road signs for the category of vehicle to be approved and which is applicable to at least one lane of the vehicle's carriageway, including both non-electronic signs and variable message signs, but not including speed limit road markings.
0.3.13	"*Common space*" means an area on which two or more information functions (for example, symbol) may be displayed, but not simultaneously.
0.3.14	"*Self-check*" means an integrated function that checks for a system failure on a continuous basis at least while the system is active.
0.3.15	*"Vehicle master control switch"* means the device by which the vehicle's on-board electronics system is brought, from being switched off, as in the case where a vehicle is parked without the driver being present, to normal operation mode.
0.3.16	"*Type of ISA STU*" means a combination of specific hardware which does not differ in such essential respects as the characteristics and functionality of the speed limit determination system and its performance when operated on a public road located within the territory of the European Union.
0.3.17	"*Vehicle type with regard to the installation of an ISA system*" means motor vehicles which do not differ in such essential respects as: (a) The characteristics and functionality of the speed limit determination system (b) Characteristics of the installation of the speed limit determination system within the vehicle which significantly influence its performance when operated on a public road located within the territory of the European Union (c) The characteristics and functionality of the speed limit feedback system

3.2 General requirements

3.2.1 Vehicle and STU approval and multi-stage vehicles

The general requirements on vehicle and STU approval set out the structure of the subsequent specific requirements, which are split into SLIF, SLWF and SCF. An ISA system is required to contain a SLIF and, at the choice of the manufacturer, either a SLWF or a SCF.

For approval of a vehicle with regard to an ISA system, all specific requirements apply, as referenced in point 1.1.1.

For approval of an ISA STU, point 1.1.3 applies, which references the specific requirements relating to the speed limit determination. This is intended to remove the burden of repeated testing of the speed limit determination system, e.g. camera or camera-and-map fusion system, for a manufacturer or tier 1 supplier if identical systems are used for different vehicle types. If an approved ISA STU is used for speed limit determination, the vehicle approval shall cover the vehicle-related specific requirements as referenced in point 1.1.2 (i.e. all requirements except 2.4.2).

Multi-stage type approvals shall be permissible as long as the ISA system and the relevant sensors are not modified at subsequent stages.

Draft text:

1.1	An ISA system shall comprise a SLIF and either a SLWF or a SCF.
1.1.1	Type approval of a vehicle with regard to the installation of an ISA system shall be subject to the vehicle and its system complying with: (a) System requirements laid down in points 2.1, 2.2 and 2.3, and (b) SLIF requirements laid down in point 2.4, and (c) SLWF requirements laid down in point 2.5 or SCF requirements laid down in point 2.6.
1.1.2	Where the motor vehicle is fitted with a type of ISA STU that has been type approved, the vehicle and its system shall have to comply with: (a) System requirements laid down in points 2.1, 2.2 and 2.3, and (b) SLIF requirements laid down in point 2.4.1, and (c) SLWF requirements laid down in point 2.5 or SCF requirements laid down in point 2.6.
1.1.3	Type approval of an ISA STU shall be subject to the STU complying with the SLIF requirements laid down in point 2.4.2.
1.1.4	In case of multi-stage type approval, the type approval granted at a previous stage in respect of the installation of an ISA system in the (base) vehicle shall remain valid, provided that the ISA system and the relevant sensors are not modified.

3.2.2 Real-driving error rate

Article 6, clause 1 (e) of Regulation (EU) 2019/2144 demands setting of performance targets for speed limit determination in real-driving operation:

> *"its performance targets shall be set in order to avoid or minimise the error rate under real driving conditions."*

This stipulation forms the basis for TRL's proposed real-world driving reliability requirements and tests (see Sections 3.3.2.2 and 3.4.1.3). The general requirement, as drafted below, applies the broad regulatory stipulation to minimise or eliminate errors in real driving conditions by referring to the technically feasible and thus more narrow conditions laid down in the specific requirements of the draft text (point 2.4.2.4).

Draft text:

1.2	Subject to specific requirements below, the ISA system shall be designed to avoid or minimise the error rate under real driving conditions.

3.2.3 Applicability of requirements in the European Economic Area (EEA)

The requirements for ISA, in particular relating to determining speed limits associated with applicable road signs, shall only apply on public roads, i.e. excluding private roads, e.g. car parks, where national standards for installation of road signs may not apply and where speed limits cannot be expected to be mapped reliably.

Some non-European Union (EU) member state countries, e.g. Turkey, use similar or identical road signs but may position them differently, have different rules regarding applicability and termination of speed limits and would not be covered in EU map data. ACEA suggested to state clearly that ISA requirements only apply on roads located within the EU to avoid ambiguity over whether these signs need to be detected by the approved system. TRL agrees with the suggestion of explicit location-based limitations.

The European Commission requested application of the requirements to the European Economic Area (EEA), consisting of the EU member states and Iceland, Liechtenstein and Norway, which are part of the EC type approval regime. Other countries, e.g. the United Kingdom or Switzerland, shall be free to apply the requirements in national regulation at their choosing. Note that other references in the draft regulation to the 'territory of the European Union' may need to change to 'territory of the European Economic Area', which was left to European Commission legal experts to investigate.

The validity of existing approvals shall not be impacted if the composition of the EEA subsequently changes, e.g. extension with new member states.

Draft text:

1.3	The requirements set out in this Regulation shall at least apply when the vehicle is operated on a public road located within the territory of the European Economic Area, as defined at the time the type approval is issued.

3.2.4 Privacy and data protection

The expectations of the European Parliament and the Council of the European Union with regard to privacy and data protection relating to ISA and other safety systems are set out in Recitals (10) and (14) of Regulation (EU) 2019/2144:

> Recital (10): *"[…] intelligent speed assistance […] are safety systems that have a high potential to reduce casualty numbers considerably. […] Any such safety systems should function without the use of any kind of biometric information of drivers or passengers, including facial recognition."*
>
> Recital (14): *"Any processing of personal data, such as information about the driver processed in event data recorders or information about the driver's drowsiness and attention or the driver's distraction, should be carried out in accordance with Union data protection law, in particular Regulation (EU) 2016/679 of the European Parliament and of the Council."*

From a technology perspective, future ISA systems could be envisaged which identify individual occupants using biometric information to offer personalised settings, collate speed limit compliance records for sharing with insurance providers, etc. The draft regulation shall ensure that the ISA functionality required for type-approval is offered without the need for drivers to provide consent to using biometric information.

Should other EU-specific type approval regulations stipulate recording of information about speed limit compliance, e.g. future event-data recorder (EDR) or data storage systems for automated driving (DSSA) requirements, this information may be provided by the type approved ISA system to avoid the necessity to install an additional system for that purpose.

Processing of personal data shall be carried out in accordance with applicable data protection legislation. However, TRL, in line with stakeholder feedback received, considers it not necessary to include a specific stipulation in the type approval regulation as relevant Union data protection law automatically applies.

Draft text:

1.4	Privacy and data protection
1.4.1	The ISA system shall offer the required functionality in the normal operation mode without the use of biometric information, including facial recognition, of any vehicle occupants.
1.4.2	The ISA system shall not continuously record nor retain any data related to incidents of exceeding the speed limit other than what is necessary in relation to perform the required ISA functionality or other European Union specific regulatory acts regarding vehicle approval.

3.3 Specific requirements

The specific requirements were divided into the following four main parts:

- ISA failure warning, control and provisions for Periodic Technical Inspection (PTI), the first two of which are related to the Human Machine Interface (HMI)
- Speed Limit Information Function (SLIF)
- Speed Limit Warning Function (SLWF)
- Speed Control Function (SCF)

3.3.1 ISA failure warning, control and provisions for Periodic Technical Inspection

Failure warning

Following a similar approach to other regulations (e.g. UN Regulations No. 130 and 152) text was drafted to require a constant optical failure warning signal for electrically detectable failures and non-electrical failures, such as sensor obscuration, excluding temporary obscuration, such as sun glare. This warning signal can also be used to indicate when the system is deactivated. In other regulations this signal is often mandated to be yellow. However, this requirement was dropped because systems which use other colours may already be in use, i.e. fitted to vehicles.

Draft text:

2.1	ISA failure warning
2.1.1	A constant optical warning signal shall be provided when there is a failure in the ISA system that prevents the requirements of this Regulation of being met.
2.1.1.1	There shall not be an appreciable time interval between each ISA self-check, and subsequently there shall not be a delay in illuminating the warning signal, in the case of an electrically detectable failure.
2.1.1.2	Upon detection of any non-electrical failure condition (for example, sensor obscuration excluding temporary obscuration such as sun glare), the failure warning signal as defined in point 2.1.1 shall be activated.

Control (Deactivation / re-activation)

Regulation (EU) 2019/2144, Article 6, clause 2 (b) requires:

> *"it shall be possible to switch off the [ISA] system; information about the speed limit may still be provided, and intelligent speed assistance shall be in normal operation mode upon each activation of the vehicle master control switch"*

Text was drafted to reflect these requirements, i.e. require fitment of a means to deactivate the ISA and its reinstatement upon each activation of the vehicle master control switch. However, for the Emergency Lane Keep System (ELKS) draft text, a stakeholder requested that the text related to the reinstatement be modified by adding the part in square brackets, see below:

> *"The ISA system shall be automatically reinstated in normal operation mode upon each activation of the vehicle master control switch, [at least provided the driver door is opened in-between]."*

This additional text is also included here to be consistent with the ELKS draft text. The reason given for it was to cover situations when the driver has not completed a journey and has, for example, switched their car off at traffic lights or in a traffic jam to save fuel or indeed has stalled the car. Reinstatement of the ISA in these situations could increase customer annoyance. As for the ELKS text, the Commission should consider whether or not this proposed modification should be included in the draft text.

Regulation (EU) 2019/2144, Recital (11) states in regard to the switch-off feature:

> *"[…] It should allow for intelligent speed assistance to be switched off for as long as necessary and to be easily switched back on by the driver. […] and the driver should always be made aware of whether the system is on or off."*

To help ensure that a driver is not discouraged from re-activating the ISA system after deactivating it and in line with Recital (11), draft text was added to require that it should not be more onerous to reactivate the system than deactivating it (point 2.2.1.3) and that the driver shall be informed when the system is deactivated (point 2.2.1.2). Note that TRL's initial suggestion in the first interim report (Seidl *et al.*, 2020) to require a specific ISA OFF tell-tale using a harmonised symbol has not been included in the draft text based on industry feedback. If a harmonised symbol is considered appropriate in the future, this should be included in UN Regulation No. 121.

In addition, in alignment with stakeholder feedback, draft text was written to permit automatic deactivation of the ISA when 'highly automated systems' and not the driver control the speed of the vehicle. It should be noted that 'highly automated systems' are SAE level 3 and above systems as defined in SAE J3016_201806[1] and do not include SAE level 2 systems such as Adaptive Cruise Control with lane centering. Care was taken to ensure that this was clear in the draft text by including reference to a definition of these systems, i.e. 'those systems which perform the object and event detection and response dynamic driving subtask' and to give an example of such a system, i.e. Automated Lane-Keeping System (ALKS) for low speed application.

ALKS for low speed application is a system which is activated by the driver and which keeps the vehicle within its lane for travelling speed of 60 km/h or less by controlling the lateral and longitudinal movements of the vehicle for extended periods without the need for further driver input which operates continuously under "hands off" driver supervision.

Draft text:

2.2	ISA control
2.2.1	It shall be possible for the driver to manually deactivate the ISA system. When deactivated, the ISA system shall continue determining the road speed, and information about the perceived speed limit may still be provided to the driver. The following conditions shall apply as appropriate.

[1] SAE J3016_201806 Available from: https://saemobilus.sae.org/content/j3016_201806

2.2.1.1	The ISA system shall be automatically reinstated in normal operation mode upon each activation of the vehicle master control switch, [*at least provided the driver door is opened in-between*].
2.2.1.2	A constant optical warning signal shall inform the driver that the ISA system has been deactivated. The failure warning signal specified in point 2.1.1 may be used for this purpose.
2.2.1.3	Following manual deactivation of the ISA system, it shall be possible for the driver to re-activate the system with no more than the number of actions required to deactivate it.
2.2.2	Automatic deactivation of ISA is permitted in situations when highly automated systems control the speed of the vehicle, that is, those systems which perform the object and event detection and response dynamic driving subtask, such as Automated Lane Keeping System (ALKS).

Periodic Technical Inspection (PTI)

Provisions for PTI were drafted based closely on those in UN Regulation No. 152 for Advanced Emergency Braking Systems (AEBS) for M_1 and N_1 vehicles.

Draft text:

2.3	Provisions for the Periodic Technical Inspection
2.3.1	At a Periodic Technical Inspection, it shall be possible to confirm the correct operational status of the ISA system by a visible observation of the failure warning signal status following a "power-ON" and any bulb check. In the case of the failure warning signal being in a common space, the common space must be observed to be functional prior to the failure warning signal status check.
2.3.2	At the time of type approval, the means to protect against simple unauthorised modification of the operation of the failure warning signal chosen by the manufacturer shall be confidentially outlined. Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status of the ISA system is available.

3.3.2 Speed Limit Information Function (SLIF) requirements

3.3.2.1 SLIF display

The draft text for the SLIF display was written taking the following high-level intent and justification into account:

- Display speed limit at least when it is exceeded
    - Regulation (EU) 2019/2144, Article 6, clause 2 (a) requires that "*it shall be possible for the driver to be made aware through the accelerator control or through dedicated, appropriate and effective feedback, that the applicable speed limit is exceeded*".
        - The regulation does not contain a requirement for a permanent speed limit information function (SLIF), but only requires feedback when the speed limit is exceeded. TRL interpret the requirement of 'effective' and 'appropriate' feedback to include providing the driver

with information about the current limit at least when exceeding it. Otherwise the driver would not be able to determine by how much the driving speed needs to be reduced or why it is being controlled by the vehicle.

- Stakeholder feedback supported a requirement for a non-permanent SLIF. A reason given for this was to allow other information to be displayed in place of the SLIF when the speed limit is not being exceeded, for example, for truck drivers, a recommended driving speed for economy or other reasons, which could be lower than the road speed limit.

- Display located in the direct field of view of the driver
  - Guidance was taken from:
    - UN Regulation No. 39 on speedometers, which requires that the display *"shall be located within the direct field of view of the driver and shall be clearly legible both day and night"*.
    - Euro NCAP Speed Assist System Assessment Protocol (Euro NCAP, 2019) requires that the display "*shall be clearly seen in the direct field of view of the driver, without the need for the head to be moved from the normal driving position".*
- Detailed display options
  - Euro NCAP have a requirement that *"the speed limit shall be shown using a traffic sign".* This requirement has influenced many current systems fitted to cars and vans.
  - UN Regulation No. 89 requires that adjustable speed limitation functions (ASLF) permanently indicate the adjustable speed limit value to the driver. Some systems achieve this via display on the speedometer.
  - Ideally, regulation should encourage competition as much as possible by enforcing the minimum required and not restricting design solutions. Stakeholder feedback supported this principle.
  - On this basis, two options were drafted; the first a display on the speedometer and the second a separate display using a numerical value or a symbol resembling a Vienna Convention speed limit traffic sign.
- Display permitted when ISA system switched off
  - Regulation (EU) 2019/2144, Article 6, clause 2 (b) stipulates that, *"information about the speed limit may still be provided"* when the ISA system is switched off.

Draft text:

2.4.1	SLIF display
2.4.1.1	The display of the SLIF shall be located in the direct field of view of the driver and be clearly legible both day and night. Additional display of the same information at other locations such as the navigation system display shall be permitted.
2.4.1.2	In the absence of conditions leading to the deactivation of the ISA system according to points 2.2.1 and 2.2.2, the SLIF shall display the perceived speed limit to the driver, at least when the speedometer speed is exceeding the perceived speed limit.

2.4.1.2.1	The perceived speed limit shall be displayed either: (a) on the speedometer in a manner that is noticeable and does not reduce the speedometer's legibility, or (b) in a separate display as a numerical value either using a symbol resembling a Vienna Convention speed limit traffic sign (display of additional sub-signs is permitted) or text consisting of the value and the unit of measurement (km/h).
2.4.1.3	When the ISA system is deactivated, display of the perceived speed limit is permitted.

3.3.2.2 Speed limit determination

Regulatory remit

Article 6, clause 1 (c) of Regulation (EU) 2019/2144 specifies the sources from which the ISA system shall be capable to derive speed limit information:

> *"the dedicated and appropriate feedback shall be based on speed limit information obtained through the observation of road signs and signals, based on infrastructure signals or electronic map data, or both, made available in-vehicle"*

Based on this, observation of (conventional, i.e. non-electronic) roads signs is a minimum functional requirement, which at the current state of technology is usually realised by an in-vehicle camera. Observation of signals, which is also a necessary requirement, can be interpreted to relate to items such as variable message signs, vehicle-to-infrastructure signals or electronic map data. Based on the current state of technology, the regulatory stipulation therefore includes, in principle, camera-only systems (with the ability to interpret variable message signs) and camera-map fusion systems but does not include map-only systems because these don't observe road signs.

The draft requirements for speed limit determination have therefore been written in a technology neutral way, i.e. in a way that aims to allow all technologies included in the regulatory remit above to be approved if they meet the minimum functional requirements and performance levels. One of the important aspects in this regard is to only require determination of speed limits which are indicated by an applicable road sign (which means a sign contained in the catalogue of road signs for the category of vehicle to be approved and which is applicable to at least one lane of the vehicle's carriageway, including both non-electronic signs and variable message signs, but not including speed limit road markings); other signs may be used by an advanced system but are not required. Note that the catalogue of road signs is yet to be defined and populated by the European Commission (see Section 4.1).

Functional requirements

In order to operate effectively, an ISA system must be capable of determining the speed limit that is currently in force for the specific vehicle and road upon which it is travelling. There are a number of important elements to this task:

- The system must be capable of recognising and correctly interpreting a range of permanent and temporary non-electronic road signs and electronic variable message signs.
- The system must know the country (and in some cases region) in which the vehicle is travelling.
- The system must know the class of road on which it is travelling.

For sign recognition and interpretation, the task splits into two relevant categories:

- Explicit speed limit signs, meaning signs (non-electronic and electronic) which show a numerical value: For passenger cars and vans, these signs can mostly be directly interpreted as the applicable speed limit. For heavy vehicles, the situation is more complex in that certain signs are not applicable to these vehicles because a lower implicit speed limit may apply based, for example, on the current country/region or road class. The requirements in point 2.4.2.2 specify that the ISA system shall be able to recognise (e.g. using camera input) and interpret those explicit signs where the associated road speed limit for the category of vehicle to be approved matches the numerical value shown on the sign.
- Implicit speed limit signs, meaning signs (non-electronic and electronic) which do not show a numerical value, such as city entry signs or national speed limit signs: For correct interpretation of the speed limit, these signs require knowledge of the current country/region and/or road class. The requirements in point 2.4.2.3 specify that the ISA system shall be able to determine (using all relevant system inputs, e.g. using camera input and map data where applicable) speed limits associated with implicit signs (and with explicit signs which are included in the catalogue of road signs but where the associated speed limit does not match the numerical value shown on the sign).

Irrespective of the type of system (camera-only or camera-map fusion), the requirements only include speed limits which are indicated by road signs contained in the catalogue of road signs (see definition 'applicable road sign'), and meet the criteria for sign design, size, positioning, condition and obscuration defined in point 2.4.2.2.2, and are encountered in the conditions defined in point 2.4.2.2.3. The rationale underlying this decision is that technology neutral requirements should in principle allow systems to determine the speed limit with information that is available to be obtained, in principle, from visual observation of the road scene by a human driver. ISA is not an automated driving feature but a driver assistance system which remains under the control of the driver and can only slow a vehicle down but not accelerate it to unsafe speeds. Therefore, the system should not be required to compensate for shortcomings in infrastructure design or maintenance, which would also make speed limit determination challenging for human drivers.

The country (and in some cases region) in which the vehicle is travelling can be derived automatically from on-board positioning systems (e.g. GNSS such as GPS) and map data, or from camera observation of the road signs encountered; the latter was described by stakeholders as less reliable at the current state of technology. In order to provide maximum flexibility, point 2.4.2.1 of the draft text permits either automatic detection (with the option to request confirmation of country changes by the driver for less reliable solutions) or manual setting by the driver. Manual setting would be the least convenient option for drivers, however might represent the solution that is easiest to implement. It should be noted that automatic country/region detection by GNSS would not require a full map-stack as used for a full navigation solution but could be realised in a more cost-effective way by using a reduced map stack only providing a country/region border layer.

The class of road on which the vehicle is travelling can be derived from on-board positioning and map data, or from camera observation of signs (e.g. motorway, expressway) and interpretation of road characteristics using machine vision (e.g. number of lanes, divided by central barrier); for the latter approach, advanced camera systems are required and it was described by stakeholders as less reliable at the current state of technology. Again, for vehicles without an on-board navigation system, a reduced map stack could be used which only provides the road class layer for Europe.

TRL suggests that other variable conditions which influence the applicable implicit speed limit and change frequently are not required to be taken into account for speed limit determination, unless the relevant electronic signals are available (point 2.4.2.3.2). Examples include trailer status, prevailing environmental conditions, time of year, driver age or experience, and standing passengers in buses and coaches. In these cases, TRL

proposes that manufacturers base the perceived speed limit to which the system defaults to, on the assumed most common condition in normal operation. The manufacturer is free to fit additional sensors to sense the current conditions and determine the correct road speed limit. In effect, this provision accepts that in certain variable conditions that cannot be detected by existing in-vehicle sensors, an incorrect speed limit will be determined that is too high or too low. The Commission should consider whether or not this provision should be included in the draft text.

Considering the challenges outlined above in deriving speed limits from implicit signs and for heavy vehicles in general, stakeholder feedback from industry suggested to focus requirements only on explicit signs (and require a high reliability for those) in order to ensure robust speed limit determination on road sections covered by explicit signs and accept the reduced coverage from excluding all implicit speed limits. In this study, TRL could not identify the proportions of the European road network which are covered by explicit and implicit signs. However, considering that in many countries implicit signs are often the only sign to indicate urban speed limits and the national speed limit on rural roads (i.e. the system would not work in these cases) both of which have a high casualty burden relating to vulnerable road users and vehicle occupants, respectively, TRL consider it necessary to include speed limits associated with implicit signs to provide adequate casualty benefits. Nevertheless, TRL support the industry suggestion to exclude from the set of required signs (at least initially) specific national variants which have characteristics that make them difficult to recognise (e.g., French city entry signs have different dimensions based on the length of the city name). Lastly, it should be stated that higher prevalence of explicit speed limit signs in European member states would make the task to determine the applicable speed limit considerably easier.

Real-world reliability requirements

Regulation (EU) 2019/2144 specifies that real-driving performance targets shall be set for ISA systems (see Section 3.2.2). Poor reliability of speed limit determination, i.e. failure to determine a road speed limit or incorrect determination, could cause driver annoyance, reduce confidence in and acceptance of the ISA system and increase drivers' inclination to deactivate the system, resulting in the loss of associated casualty benefits.

TRL specified, using information about established practice obtained in industry consultations, three performance metrics to measure real-world reliability in point 2.4.2.4.2 of the draft text:

- True positive rate (associated with event-based performance)
- False positive rate (associated with event-based performance)
- True positive distance (associated with distance-based performance)

TRL suggest that all three metrics shall be measured because they put emphasis on different aspects of reliability and present more challenges, respectively, on lower speed road segments where signs are repeated more frequently and high-speed segments where much positive test distance can be accumulated with few sign detections. The two event-based metrics are calculated on the basis of the number of sign passing events and aim to ensure, respectively, that a high number of applicable signs is interpreted correctly and that a low number of non-applicable signs or other roadside objects is used mistakenly to determine a speed limit. The distance-based metric aims to ensure that a high proportion of the distance driven is covered with correct speed limit information. Distance-based measurements take the retention period of speed limit information (i.e. after what distance after a sign passing event does the ISA system determine 'speed limit unknown') into account implicitly. TRL therefore decided, based on stakeholder feedback and to ensure design freedom by manufacturers and tier 1 suppliers, to not prescribe explicit minimum retention periods in the draft text.

The pass/fail thresholds for the above performance metrics, also specified in point 2.4.2.4.2, were defined by the European Commission and included in the report at their

request. In TRL's view, taking into account input from individual stakeholders, these values appear suitable to ensure an adequate minimum performance level and technical feasibility, however should be further confirmed in trials. Stakeholder have not had an opportunity to comment on these values before this report was written. When interpreting the thresholds it needs to be understood that the prescribed values take into account only stretches of road where the speed limit is indicated by a road sign contained in the catalogue and where the conditions outside the control of the in-vehicle system are favourable for system performance (i.e. only road signs which are of the correct size and design, positioned correctly, not materially damaged and not obscured, and which are encountered in conditions excluding fog or direct blinding sunlight). This means that shortcomings in infrastructure design or maintenance and environmental conditions that can be challenging for sign detection and recognition are not counted negatively towards system performance.

Some industry stakeholders were critical of implementing real-world reliability requirements taking into account implicit signs and asserted that camera-only technology available for implementation within the timeframe set by the regulation might not be able to provide sufficient reliability for customer satisfaction. (The stakeholder suggestion to focus on explicit signs only instead is discussed above). Other industry stakeholders and the European GNSS Agency, GSA, argued that the optimal solution were camera-map fusion systems because camera-only systems would incur additional cost for harmonising and better maintaining road signs, and because there will be situations where one of the sensors does not work and could be complemented by the other (e.g. bad weather for camera, tunnels for positioning technology). Implementation of camera-map fusion systems is considered more costly for vehicle manufacturers; however, it should be noted that there would not be a requirement for a full navigation map, but only the speed limit layer which is more cost effective. Nevertheless, it is acknowledged that newly integrating a positioning system and electronic map elements (in addition to a camera) into a vehicle's E/E architecture could be very challenging within the regulatory timeframe for certain vehicle models. It is important to note that trials of the real-world procedure were not in scope of this study and TRL therefore consider it important that an investigation is performed whether the suggested pass/fail thresholds can be met with different types of currently available systems before the procedure is implemented in legislation. Possible approaches could include a dedicated trial programme and / or implementation of the real-world reliability tests as a monitoring requirement for an initial phase before enforcement of pass/fail thresholds, as was done for the Real Driving Emissions (RDE) test procedure.

Stakeholder inputs to this study indicated that the reliability of speed limit determination of current systems can vary considerably between different countries, based on characteristics of the national infrastructure (road layout, sign positioning, frequency of signs, prevalence of explicit speed limit signs, etc.) or availability and accuracy of map data. To ensure adequate performance EU-wide, TRL therefore initially consulted on a suggestion to require extended real-world driving tests to be carried out by the manufacturer and performance be reported for all EU member states; see (Seidl *et al.*, 2020). Taking into account stakeholder feedback which emphasised the disproportionate effort involved in this approach and direction given by the European Commission, TRL developed the more efficient approach to require testing in at least one EU member state to be performed by the technical service and supplemented by additional documentation for audit that describes and evidences the due diligence activities performed by the manufacturer to ensure adequate EU-wide performance (see point 2.4.2.4.4). These manufacturer activities could include, for example, identification of and testing in the country that is considered most challenging for the specific system implemented (worst-case testing) and/or a quality assessment of the map data used throughout the EU.

Life cycle performance requirements

Regulation (EU) 2019/2144, Recital (10) states, for ISA and other regulated safety systems, that:

"It is […] necessary to ensure that those systems can be used safely throughout the life cycle of the vehicle"

For speed limit determination, ISA is heavily dependent on the infrastructure it operates in because a variety of factors impacting visual road sign observation can change over time (including the design, condition and positioning of road signs as well as the definition of their implicit meaning) and speed limits of specific roads change sometimes.

TRL have therefore drafted requirements on life cycle performance with the aim to balance the need for continued reliability of speed limit determination for safe operation with technical feasibility (point 2.4.2.4.5). The requirements shall ensure that the observation system continues to recognise changes to posted speed limits (e.g. by giving priority to detected signs over map information in relevant circumstances) and that frequent updates to map data are offered to vehicles owners, if applicable. Acknowledging the technical difficulties that would be associated with requiring recognition of new sign designs or types that were developed after type approval (note that hardware updates might be required in some cases, where the processing capabilities of cameras are not sufficient for additional classifiers), the requirements, as drafted, are limited to speed limits that were included in the catalogue of road signs at the time of approval.

An adequate time period after definite discontinuation of production still needs to be decided. The preliminary value of 10 years was defined by the European Commission and included in the report at their request.

Structure of the draft text

Based on the above considerations, a modular approach has been used to draft the speed limit determination requirements, which are divided into three main parts:

- Part 1: Speed limit determination through observation of explicit speed limit signs
- Part 2: Speed limit determination through observation of road signs and signals (explicit and implicit signs)
- Part 3: Speed limit determination real-world driving reliability

PART 1: Speed limit determination through observation of explicit speed limit signs

Draft text:

2.4.2	Speed limit determination
2.4.2.1	Region- or country-code setting To determine the current region or country of operation, the ISA system shall fulfil either requirement (a) or (b) below: (a) The system shall be able to automatically detect the region- or country-code and set it with or without user confirmation. (b) It shall be possible for the driver to manually set the region- or country-code. The user manual shall indicate that this procedure is required for correct operation. The system shall retain the manually set region- or country-code even after activation of the vehicle's master control switch.

2.4.2.2	Speed limit determination through observation of explicit speed limit signs
2.4.2.2.1	In the absence of conditions leading to the deactivation of the system according to points 2.2.1 and 2.2.2, the SLIF shall be able, through observation of road signs (using, for example, camera input only), to recognise all explicit speed limit signs where the associated road speed limit for the category of vehicle to be approved matches the numerical value shown on the sign, and determine the road speed limits no later than when the observation sensor of the speed limit determination system (for example, camera) passes the road sign, at least when: (a) the signs meet all criteria specified in point 2.4.2.2.2, and (b) the signs are encountered in the operational and environmental conditions specified in point 2.4.2.2.3 This shall be demonstrated in accordance with the relevant tests and documentation specified in point 3.1.
2.4.2.2.2	Criteria for road signs: (a) of a design and size conforming to the applicable standards in the member state concerned (b) positioned in a way conforming to the applicable standards in the member state concerned (for example relating to lateral distance to the road edge, height, rotation and tilt) (c) showing no damage (for example, fading, reduced retro-reflectivity, bending, cracking, vandalism) that materially affects their visual properties (d) not partially or fully covered (for example, foliage, snow or dirt obscuring the sign, or deliberate invalidation during roadworks)
2.4.2.2.3	Operational and environmental conditions: (a) full operating speed range of the vehicle (b) with unobstructed view of the road sign for a continuous period of at least 0.5 seconds (c) in all illumination conditions without direct blinding sunlight and dipped (passing) beam head lamps if necessary (d) in the absence of weather conditions affecting the visibility of road signs (for example, fog)

PART 2: Speed limit determination through observation of road signs and signals

Draft text:

2.4.2.3	Speed limit determination through observation of road signs and signals
2.4.2.3.1	In the absence of conditions leading to the deactivation of the system according to points 2.2.1 and 2.2.2, the SLIF shall be able, through observation of road signs and signals (using all relevant system inputs, for example, camera input and electronic map data where applicable), to determine the road speed limits associated with all applicable road signs (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1) no later than when a point positioned on the subject vehicle [25 m] rear of the observation sensor of the speed limit determination system (for example, camera) passes the road sign, at least when: (a) the signs meet all criteria specified in point 2.4.2.2.2, and (b) the signs are encountered in the operational and environmental conditions specified in point 2.4.2.2.3 This shall be demonstrated in accordance with the relevant tests specified in point 3.2.
2.4.2.3.2	The SLIF is not required to take into account special variable conditions influencing the road speed limit (that is, conditions which require information going beyond the current region or country of operation and the current road class, such as trailer status, prevailing environmental conditions, time of year, driver age or experience, or standing passengers) unless the relevant electronic signals are available on the vehicle. In the case that special variable conditions may be present and relevant electronic signals are not available, the speed limit determination shall default to the assumed most common condition in typical normal operation.

PART 3: Speed limit determination real-world driving reliability

Draft text:

2.4.2.4	Speed limit determination real-world driving reliability
2.4.2.4.1	In the absence of conditions leading to the deactivation of the system according to points 2.2.1 and 2.2.2, the SLIF shall be able, through observation of road signs and signals (using all relevant system inputs, for example, camera input and electronic map data where applicable), to reliably determine the road speed limits associated with all applicable road signs (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1), at least when: (a) the signs meet all criteria specified in point 2.4.2.2.2, and (b) the signs are encountered in the operational and environmental conditions specified in point 2.4.2.2.3
2.4.2.4.2	Reliable determination of the road speed limit is fulfilled if both performance requirements, (a) and (b), are met in real-world driving: (a) Event-based performance - True positive rate TP_E: The correct road speed limit shall be determined for at least [90] per cent of sign passing events. A sign passing event is an instance where the vehicle passes a road sign as specified in point 2.4.2.4.1 and where no special variable conditions according to point 2.4.2.3.2 apply. Instances where identical road signs are positioned on

	both sides of the carriageway shall be considered as a single sign passing event. - False positive rate FP_E: The false positive rate shall be less than or equal to [2 per 100 km] of driven distance. A false positive event is an instance where an object or a sign other than an applicable road sign is used to incorrectly determine the road speed limit (disregarding instances where a sign is positioned ambiguously to an extent that an average driver would be uncertain to which carriageway it applies or where special variable conditions according to point 2.4.2.3.2 apply). (b) Distance-based performance - True positive distance TP_D: The correct road speed limit shall be determined for at least [90] per cent of distance driven at least for road speed limits as specified in point 2.4.2.4.1 and where no special variable conditions according to point 2.4.2.3.2 apply. This shall be demonstrated in accordance with a real-world driving test as specified in point 3.3.
2.4.2.4.3	Before conducting the real-world driving test, in agreement between the Technical Service, the Type Approval Authority and the Manufacturer, a route outline shall be selected that is: (a) located on public roads within the territory of the European Union, and (b) unbiased, that is, chosen with the intention to generate a passed or failed test by virtue of the technical performance of the system and not by virtue of an extreme route choice.
2.4.2.4.4	To demonstrate system performance requirements European Union-wide, the Manufacturer shall provide technical documentation that contains at least: (a) The basic design of the system and a description of the speed limit determination system, including the sensors and, if applicable, electronic map data sources used. (b) Description of due diligence activities performed to provide evidence that the requirements in point 2.4.2.4.1 are met for operation in all European Union member states. Examples of relevant activities include: i. Worst-case European Union member state(s) identified, and testing performed in them to show requirements are met ii. For system that uses electronic map data, an assessment of the integrity and reliability of the electronic map data throughout all European Union member states which indicates that requirements are met and also make associated evidence available for audit. The Technical Service shall assess the documentation provided and audit associated evidence to judge that reasonable and adequate steps have been taken to ensure that the requirements in point 2.4.2.4.1 are met for operation in all European Union member states.
2.4.2.4.5	Life cycle performance
2.4.2.4.5.1	The Manufacturer shall ensure that the reliability of speed limit

	determination is maintained for at least [10 years] after the production of the approved type is definitely discontinued. This only applies to road speed limits as specified in point 2.4.2.4.1 in the version of this Regulation at the time the type approval was issued.
2.4.2.4.5.2	If electronic map data is used to achieve the required performance, the Manufacturer shall offer frequent data updates to vehicle owners. These updates shall be made available to vehicle owners free of charge. The user manual shall indicate that updates are required to maintain performance and explain the procedure to perform updates.

3.3.3 Speed Limit Warning Function (SLWF) requirements

The draft text for the SLWF was written taking the following high-level intent and justifications into account:

- Link of warning to speedometer speed
    - It was decided to link the warning to speedometer speed rather than true vehicle speed. The main reason for this was to reduce potential for driver confusion by ensuring a direct link of the warning to the speed indicated on the speedometer. This approach was supported by stakeholders although they also supported the idea of an adjustable warning threshold. However, an adjustable threshold was not deemed appropriate because mandatory ISA system should aim to enforce the applicable legal road speed limit. It could be argued that because a speedometer always under-predicts the true vehicle speed, allowing some upward adjustment would still ensure that the legal speed limit should not be exceeded. However, this cannot be guaranteed without knowing precisely how inaccurate the speedometer reading is (which is not known) and it could send the wrong message to the driver in terms of adhering to the speed limit.
- Warning indication
    - Drafting requirements for an effective warning indication for ISA is challenging because it involves obtaining a balance between making the warning intrusive enough so that it is noticeable and easily recognised by the driver, but not so intrusive that it annoys the driver so that they deactivate the system, thus losing any potential benefit from it. If the ISA system produces a large number of false warnings, i.e. gives a warning when the vehicle is not actually speeding, this can annoy a driver even more and thus is also an important factor.
    - Current ISA systems are usually designed to Euro NCAP criteria and often have a visual warning only, although some have an acoustic warning mostly implemented as an option which the driver can switch on or off.

      Regulation (EU) 2019/2144, Article 6, clause 2 (a) requires that:

      > *"it shall be possible for the driver to be made aware through the accelerator control, or through dedicated, appropriate and effective feedback, that the applicable speed limit is exceeded"*

      Based on consultations with the European Commission it was decided that an optical-only warning, for example a flashing traffic sign symbol in the instrument cluster, would not be sufficient to meet this requirement because it could not be considered to provide a comparable level of effectiveness as the preferred feedback mode through the accelerator pedal.
    - Recent research performed by stakeholders (Annex 2, recent research, industry stakeholder) shows that while a driver may not always recognise a

current visual only warning, they do recognise a visual warning coupled with an acoustic warning. However, the research also showed that most drivers would deactivate the ISA with the visual and acoustic warning.

An idea for a way forward was developed through discussion with stakeholders of the results of this research and how a balance between a sufficiently intrusive warning that would not be too annoying could be achieved. This was to permit implementation of a cascaded acoustic warning on top of a visual warning. The cascaded warning could be time-delayed compared to the visual warning and related to the magnitude of the speeding; if speeding is greater, the time delay for the acoustic warning could be less and / or the magnitude of the warning more.

- Further recent research performed by (Carsten *et al.*, 2020) (summary of results presented in Annex 3, recent research, transport safety stakeholder) confirmed the annoying nature of acoustic warnings and emphasized how much less annoying feedback through the accelerator pedal, by increasing the restoring force, was. However, interestingly it identified a speed control function as the least annoying form of feedback.
- On the basis of the above and following the principle of enforcing the minimum required and not restricting design solutions, performance requirements for the warning were drafted based on permitting the fitment of either a visual warning coupled with a cascaded acoustic or haptic warning or a haptic warning alone, provided through the accelerator control. It should be noted that:
    - This is a first draft of potential requirements which, ideally, need updating following further research. Also, further stakeholder consultation will be required to confirm and / or update the parameters in square brackets.
    - The requirements have been drafted so that a haptic warning through the accelerator control is not permitted at times when the speed of the vehicle is being controlled by a driver aid and the driver may not be touching the accelerator control (e.g. cruise control).
    - The parameters for the cascade requirements have been set through consideration of:
        - Lowest cascade time was set mainly by considering a vehicle driving from a non-urban area (speed limit 80 – 100 km/h) into an urban area (speed limit 50 km/h), the driver not noticing the sign and limiting the distance travelled at a high speed to 50–100 m (100 m @ 100 km/h = 100/27.8 = 3.6 sec; 50 m @ 80 km/h = 50/22.2 = 2.3 sec).
        - Highest cascade time was set mainly to allow commercial vehicles (CVs) to exceed the speed limit to overtake and for the operation of predictive cruise control. Note that if a CV driver speeds for more than one minute an entry will be made into the tachograph digital card.
        - The relationship to speedometer speed and true speed (Figure 1). Note that when exceeding speedometer speed by 10 per cent, because this is within the tolerance of the speedometer, the vehicle may not actually be exceeding the true road speed limit.

Speedo speed (km/h)	130	120	100	80	65	50	30
Lowest true speed	114.5	105.5	87.3	69.1	55.5	41.8	23.6
30 percent over	169	156	130	104	84.5	65	39
30 percent over true lowest	148.9	137.1	113.5	89.8	72.1	54.4	30.7
20 percent over	156	144	120	96	78	60	36
20 percent over true lowest	137.5	126.5	104.7	82.9	66.5	50.2	28.4
10 percent over	143.0	132.0	110.0	88.0	71.5	55.0	33.0
10 percent over true lowest	126.0	116.0	96.0	76.0	61.0	46.0	26.0

Figure 1: Relationship of percent over with speedometer speed and true speed

- The requirement that the warning shall be for at least 10 seconds or until the speedometer speed is equal to or below the perceived speed limit was aligned with Euro NCAP requirements under consideration that this is long enough to be noticed by the driver and that a warning for a longer time could lead to driver annoyance and potential system deactivation.
- Based on stakeholder feedback and the principle of not restricting design solutions, a requirement was added to allow the vehicle to be equipped with a means to suspend the SLWF warning to allow for the presentation of more critical warnings, if the manufacturer wishes to.
- Industry feedback suggested that a small speed tolerance for the visual warning threshold would be beneficial to avoid unnecessary visual warnings being provided due to small speed fluctuations in cruise control operation with a set speed identical to the road speed limit. This should be considered by the European Commission in further industry consultations.

Draft text:

2.5.1	In the absence of conditions leading to the deactivation of the ISA system according to points 2.2.1 and 2.2.2, if the perceived speed limit is known and the speedometer speed exceeds it, the SLWF shall warn the driver as specified in point 2.5.2.
2.5.2	The warning indication shall be provided by: (a) a visual warning and a cascaded acoustic or haptic warning; or (b) a haptic warning alone At times when the speed of the vehicle is actively controlled by a driver aid where the driver is not expected to be touching the accelerator control (for example, cruise control), the use of a haptic warning is not permitted and only option (a) with a cascaded acoustic warning is permitted.
2.5.2.1	Visual warning and cascaded acoustic or haptic warning The visual warning shall be noticeable and easily recognisable by the driver and be provided by flashing of the SLIF display or an additional visual signal adjacent to the SLIF display. It shall be provided within [2 seconds] that the speedometer speed exceeds the perceived speed limit and until the speedometer speed is equal to or below the perceived speed limit. The cascaded acoustic warning shall be noticeable by the driver, unique and easily recognisable and be provided by a continuous or intermittent

	sound signal [or by vocal information. Where vocal information is employed the Manufacturer shall ensure that it uses the language(s) of the market into which the vehicle is sold]. The acoustic warning may be varied to indicate the magnitude and / or time that the speed limit has been exceeded for. The cascaded haptic warning shall be noticeable by the driver and be provided through the accelerator control, for example by increasing the restoring force of the accelerator control. The cascaded acoustic or haptic warning shall be provided, at least, when any of the following conditions are met: (a) Speedometer speed exceeds perceived speed limit by greater than or equal to [30 per cent] for longer than [3 seconds] (b) Speedometer speed exceeds perceived speed limit by greater than or equal to [20 per cent] for longer than [10 seconds] (c) Speedometer speed exceeds perceived speed limit by greater than or equal to [10 per cent] for longer than [60 seconds] for at least 10 seconds or until the speedometer speed is equal to or below the perceived speed limit. [The manufacturer may offer means for the driver to temporarily suppress the acoustic warning for the period until the perceived speed limit changes.]
2.5.2.2	Haptic warning alone The haptic warning alone shall be noticeable by the driver and be provided through the accelerator control, for example by increasing the restoring force of the accelerator control. It shall be provided within [2 seconds] that the speedometer speed exceeds the perceived speed limit and until the speedometer speed is equal to or below the perceived speed limit.
2.5.3	If the vehicle is equipped with a means to suspend the SLWF warning to allow for the presentation of more critical warnings (for example, forward collision warning or lane keep assistance), the following shall apply. The Manufacturer shall provide a documentation package which gives access to the strategy and basic design of the system which controls the presentation of applicable warnings to the driver. The Technical Service shall assess that all applicable warnings are presented to the driver in a manner that is intuitive and understood easily.
2.5.4	The SLWF warning indication shall be demonstrated in accordance with the relevant tests specified in point 3.4.

3.3.4 Speed Control Function (SCF) requirements

Recent research performed by (Carsten *et al.*, 2020) (summary of results presented in Annex 3, recent research, transport safety stakeholder) compared five different feedback strategies for ISA in a driving simulator setting:

Visual warning and:

- Auditory warning
- Haptic (force feedback) pedal
- Vibrating pedal

- SCF and vibrating pedal
- SCF alone

The feedback strategies were compared to a baseline situation without feedback to determine their effect on speed compliance and other aspects including pleasantness/annoyance. The overall effectiveness of an ISA system will be a combination of its immediate impact on speeding (compliance) combined with annoyance, because drivers will be more likely to switch a system off if it is perceived as unpleasant or annoying.

SCF alone, the feedback mode covered in this section, was found to be effective at reducing driving speed to ensure speed limit compliance. Some other feedback modes have achieved greater reductions in speed; however, in TRL's understanding the desired effect is to reduce the speed to a level at or slightly below the road speed limit (compliance), but not necessarily to levels much lower than that. Regarding pleasantness/annoyance SCF alone was identified as the most favourable option of those investigated, both when driving alone or with a passenger. Overall, TRL consider SCF alone the most effective and therefore most desirable feedback mode.

Requirements for the SCF were drafted using input from UN Regulation No. 89 and Euro NCAP's Assessment Protocol – Safety Assist (Euro NCAP, 2019), and making adaptations where deemed necessary.

The functional requirement in point 2.6.1.1 was based on UN R89, however adapted to avoid any reference to restricting the fuel feed, in order to make it also applicable to electric vehicles.

In line with the SLWF stipulations and based on the considerations outlined in Section 3.3.3 the SCF requirements were based on speedometer speed rather than true speed. Note that this is different to UN R89 and Euro NCAP. Therefore, the proposed tolerance for the stabilised speed of –5/+0 km/h in relation to the perceived speed limit is in practice larger than Euro NCAP requirements because any speedometer tolerance permitted by UN Regulation No. 39 will add to underestimation of the speed (UN R39 grants only negative tolerance). This decision was taken to avoid imposing implicit speedometer accuracy requirements while still ensuring that the true speed and the speed indicated to the driver will not exceed the perceived speed limit. The permitted variation and rate of change of stabilised speed were taken from UN R89.

For situations where stable speed control cannot be achieved (overrun condition), e.g. during downhill driving, the system is required to issue a warning to ensure that drivers can rely on being made aware if the vehicle is speeding despite active SCF. Overrun warning requirements were included by reference to the corresponding SLWF requirements.

The SCF shall be overridable by the driver to conform with the stipulation in Article 6, clause 2 (d) of Regulation (EU) 2019/2144 that ISA "*shall not affect the possibility, for the drivers, of exceeding the system's prompted vehicle speed*". A positive action is required to avoid inadvertent overrides. The condition for re-initiation of the SCF ("*after the speedometer speed has dropped to a speed less than or equal to the perceived speed limit*"; point 2.6.1.5) was based on established practice by Euro NCAP.

Point 2.6.2 was added to clarify that ISA shall still support the driver while a driver aid is used for longitudinal control of the vehicle (e.g. cruise control). To offer maximum possible flexibility for manufacturers it shall be permissible for the vehicle to either continue limiting the vehicle speed using the SCF function or, alternatively, activate a SLWF.

Draft text:

2.6	SCF requirements
2.6.1	In the absence of conditions leading to the deactivation of the ISA system according to points 2.2.1 and 2.2.2, the SCF shall attempt to limit the speedometer speed to the perceived speed limit. This shall be demonstrated in accordance with the relevant tests specified in point 3.5.
2.6.1.1	The SCF shall attempt to limit the speedometer speed to a stabilised speed by reducing the vehicle's propulsion power (that is, driveline torque). The SCF shall not actuate the vehicle's service braking system except for vehicles of categories M_1 and N_1, where the vehicle's service braking system may be actuated. A permanent brake (for example, retarder) may be incorporated only if it operates after the SCF has restricted the propulsion power to a minimum.
2.6.1.2	The SCF intervention shall begin before or no later than [2 seconds] after the speedometer speed first exceeded the perceived speed limit.
2.6.1.3	When stable speed control has been achieved, the speedometer speed shall not vary by more than 4 per cent or 2 km/h, whichever is greater, and the rate of change of speedometer speed shall not exceed 0.2 m/s^2 when measured on a period greater than 0.1 seconds. The stabilised speed shall fall within the following range: (perceived speed limit minus 5 km/h) ≤ stabilised speed ≤ perceived speed limit
2.6.1.4	If the SCF is not able to achieve stable speed control at a stabilised speed equal to or below the perceived speed limit within [30 seconds] after the speedometer speed first exceeded the perceived speed limit, the system shall warn the driver in accordance with the requirements specified in point 2.5.2. The visual warning shall be provided immediately. The acoustic or haptic warning shall be provided immediately if any of the conditions (a), (b) or (c), specified in point 2.5.2.2, is met considering the period since the speedometer speed first exceeded the perceived speed limit.
2.6.1.5	It shall be possible for the driver to override the SCF intervention by performing a positive action such as depressing substantially the accelerator control. Accelerator control kickdown shall not be the only available positive action. When a positive action is applied the SCF shall be temporarily suspended without causing unduly strong acceleration and be re-initiated after the speedometer speed has dropped to a speed less than or equal to the perceived speed limit.
2.6.1.6	The SCF shall permit a normal use of the accelerator control for gear selection.
2.6.1.7	The SCF shall issue a brief and subtle acoustic signal every time the perceived speed limit changes to a different value.
2.6.2	At times when the speed of the vehicle is actively controlled by a driver aid rather than the driver (for example, cruise control), and in the absence of conditions leading to the deactivation of the ISA system according to points 2.2.1 and 2.2.2, either the SCF shall remain active in accordance with point 2.6.1 or a SLWF shall be activated in accordance with point 2.5.

3.4 Test procedures

3.4.1 SLIF test procedures

3.4.1.1 Speed limit determination through observation of explicit speed limit signs test

The approach taken to develop the test procedure to verify the requirements established in Section 3.3.2.2, Part 1 was to write in the style of the recent UN Regulation No. 152 on AEBS for M_1 and N_1 vehicles and other relevant regulations.

Points to note:

- The aim of the procedure is to check that the speed limit can be determined for all applicable explicit signs in the catalogue for which the road speed limit matches the numerical value on the sign, if they are in good condition and positioned correctly.
- The procedure requires that the sign is passed at a speed higher than indicated on it to ensure that the SLIF displays the speed limit which can be observed and checked. This keeps the test procedure as simple as possible. Passing at a speed lower than indicated, the SLIF may not display the speed and thus the speed limit would need to be read from the vehicle in some other way, e.g. off the Controller Area Network (CAN) bus.
- In case of time constraints, testing is allowed to proceed in conditions not quite ideal at the manufacturer's discretion.
- In the future, alternative equivalent and better procedures to assess may be developed. To permit use of these, a statement has been added that, by agreement between the manufacturer and the technical service, the test track-based procedure described can be replaced with a laboratory-based procedure that has been shown to be equivalent.
- The procedure has not yet been trialled due to current restrictions related to the COVID-19 pandemic

Draft text:

3.1	SLIF: Speed limit determination through observation of explicit speed limit signs test
3.1.1	Subject vehicle conditions
3.1.1.1	Test mass The vehicle mass shall be the unladen mass as declared by the Manufacturer.
3.1.1.2	Tyres The tyres shall be bedded and the pressure shall be as recommended by the Manufacturer for the vehicle.
3.1.1.3	Pre-test conditioning If requested by the Manufacturer the subject vehicle can be driven a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture to calibrate the sensor system, and the country- or region code can be set (manually or automatically) to the country or region of test.
3.1.2	Road signs The road signs used for the tests shall be explicit speed limit signs where the associated road speed limit for the category of vehicle to be approved

	matches the numerical value shown on the sign. They shall meet all criteria specified in point 2.4.2.2.2. A minimum of [5] different signs of the type above (including non-electronic road signs and those displayed on a variable message sign) as used in the member state where testing takes place shall be selected by the Technical Service for testing. The signs used for the tests shall be recorded in the test documentation. The Manufacturer shall demonstrate, through the use of documentation, compliance with all other explicit speed limit signs (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1) where the associated road speed limit for the category of vehicle to be approved matches the numerical value shown on the sign. Any such documentation shall be appended to the test report.
3.1.3	Testing conditions The tests shall be performed: (a) on a flat surface which is free from uneven patches, standing water, snow and ice, and provides the driver an unobstructed view of the road sign for a continuous period of at least 0.5 seconds (b) in all illumination conditions without direct blinding sunlight and dipped (passing) beam head lamps if necessary (c) in the absence of weather conditions affecting the visibility of signs (for example, fog) At the Manufacturer's discretion and with the agreement of the Technical Service the tests may be performed under conditions deviating from what is described above.
3.1.4	Test procedure Drive the subject vehicle in a smooth manner so that its attitude is stable past the road sign selected for testing at: (a) a speedometer speed greater than the sign indicates, and (b) a distance from the road edge such that the position of the sign meets applicable standards in the member state concerned. By agreement between the Manufacturer and the Technical Service the test track-based procedure described above can be replaced with a laboratory-based procedure that has been shown to be equivalent.
3.1.4.1	The test requirements are fulfilled if the SLIF displays the speed limit value shown on all road signs tested no later than when the observation sensor of the speed limit determination system (for example, camera) passes the signs.

3.4.1.2 Speed limit determination through observation of road signs and signals test

The aim of this test procedure is to verify the requirements established in Section 3.3.2.2, Part 2, i.e. to check that the correct speed limit can be determined for all applicable signs in the catalogue. How well this is achieved (i.e. the reliability) is checked in the real-world driving test procedure described in Section 3.4.1.3 below.

Points to note:

- To perform tests on a test track is permitted provided the SLIF does not require electronic map data to function. This proviso has been added to ensure that if

signal (e.g. map) data is required to determine the speed limit, representative data is used.

- For SLIF systems that use signal (e.g. map) data to determine the speed limit, tests may need to be performed on a public road. For these tests the sign has to be passed at a speed lower than the road speed limit for safety reasons. For SLIF systems that display the speed limit only when it is exceeded, observation of the SLIF will not be sufficient to check that the correct speed limit has been determined upon passing a sign; therefore, the technical service will need to liaise with the manufacturer to find another appropriate method, e.g. reading the information off the CAN bus..
- It is permitted to use appropriate results from the real-world driving reliability test, described in Section 3.4.1.3 below, for the purposes of this test procedure.
- The procedure has not yet been trialled due to current restrictions related to the COVID-19 pandemic

Draft text:

3.2	SLIF: Speed limit determination through observation of road signs and signals test
3.2.1	Subject vehicle conditions Subject vehicle conditions shall meet the requirements specified in point 3.1.1.
3.2.2	Road signs The road signs used for the tests shall be explicit and implicit speed limit signs. They shall meet all criteria specified in point 2.4.2.2.2. A minimum of [10] different signs of both explicit and implicit speed limit signs (including non-electronic road signs and those displayed on a variable message sign) as used in the member state where testing takes place shall be selected by the Technical Service for testing. The signs used for the tests shall be recorded in the test documentation. The Manufacturer shall demonstrate, through the use of documentation, compliance with all other applicable road signs (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1). Any such documentation shall be appended to the test report.
3.2.3	Testing conditions Testing conditions shall meet the requirements specified in point 3.1.3. With agreement between the Manufacturer and the Technical Service, the tests can be performed either: (a) on a public road, or (b) on a test track resembling a realistic road environment to allow the SLIF to determine the road type, provided the SLIF does not require electronic map data to function.
3.2.4	Test procedure Drive the subject vehicle in a smooth manner so that its attitude is stable past the road sign selected for testing at: (a) a speedometer speed: - equal to or at maximum [20 per cent] lower than the sign indicates for tests on a public road

	- [at least 10 per cent greater than the sign indicates for tests on test track] (b) at a distance from the road edge such that the position of the sign meets applicable standards in the member state concerned. By agreement between the Manufacturer and the Technical Service the test track or road-based procedure described above can be replaced with a laboratory-based procedure that has been shown to be equivalent.
3.2.4.1	The test requirements are fulfilled if the SLIF determines the road speed limits associated with all signs tested (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1) no later than when a point positioned on the subject vehicle [25 m] rear of the observation sensor of the speed limit determination system (for example, camera) passes the road signs. Appropriate results from the real-world driving reliability test can also be used to demonstrate fulfilment of the requirements.

3.4.1.3 Speed limit determination real-world driving reliability test

The aim of this test procedure is to verify the requirements established in Section 3.3.2.2, Part 3, i.e. to check that the SLIF can reliably determine the correct speed limit for all speed limits associated with applicable signs in the catalogue in real-world driving conditions where the signs could also be recognised and interpreted by a human driver, i.e. their condition and position meets applicable standards and environmental conditions allow the sign to be seen clearly.

Points to note:

- The real-world test procedure has been developed using a desk-based approach and trialling was not in scope of this study. Therefore, the procedure outlined should be considered a first step in the development of a procedure which needs to be trialled and updated appropriately to ensure consistent and meaningful results. Possible approaches to achieve this could include a dedicated trial programme and / or implementation of the real-world reliability tests as a monitoring requirement for an initial phase before enforcement of pass/fail thresholds, as was done for the RDE test procedure.
- It is acknowledged that it is challenging to ensure repeatability and reproducibility of a real-world test procedure. The test drive criteria laid down in point 3.3.1 and the associated requirements, in particular in points 2.4.2.4.1 and 2.4.2.4.2, aim to control test conditions to the level required without being overly restrictive and thus making arranging and performing of tests impossible. Again, these aspects should be verified as per the bullet point above.
- Requirements, such as the percentage of different types of road that should be driven on, the maximum distance that can be driven on one type of road in one go, and a consecutive route in which repeated parts are not counted, have been defined to try and ensure that the test drive passes an adequate number and variety of signs.
- To try and ensure that a consistent result is achieved from the test drive, requirements have been defined that the drive should be long enough to achieve sufficient sign passing events that the key performance metrics tend to a consistent value towards the end of the test drive. Initial values of at least 400 km for the length of the drive and +/- 5 per cent for variation in the key metrics are proposed.
- Signs passed during the test drive that do not meet the applicable standards for their condition and position and / or in environmental conditions preventing them being seen clearly should not contribute to the reliability assessment. It is

expected that these signs will be identified from analysis of video footage of the test drive.

Draft text:

3.3	SLIF: Speed limit determination real-world driving reliability test
3.3.1	The test drive shall: (a) be appropriate to measure the system's performance at correctly determining the road speed limit using the performance criteria specified in point 2.4.2.4.2. (b) involve driving on public roads within the territory of the European Union, as agreed between the Manufacturer, the Technical Service and the Type Approval Authority. (c) involve driving on urban roads, non-urban roads, and motorways/expressways/dual carriageways, where each of the three road types shall represent at least [20 per cent, 25 per cent and 25 per cent], respectively, of the total distance of the route. The route shall be one consecutive route with the same start and end point, where any repeated parts of the route in the same direction shall not count towards the test distance. The length of an individual section of urban road, non-urban road and motorway/expressway/dual carriageway travelled continuously shall not be greater than [20 km, 40 km and 40 km] respectively. (d) involve driving in daylight and darkness conditions, where darkness shall represent at least [20 per cent] of the total distance. (e) consist of a test distance greater than [400 km] and sufficient sign passing events such that the performance metrics TP_E and TP_D vary less than [+/- 5 per cent] within the final 50 km of the route when calculated on a continuous basis.
3.3.2	Performance metric calculation The performance metrics shall be calculated as: TP_E = (n(TP)/(n(TP)+n(FN))) * 100% FP_E = (n(FP)*100)/d_total TP_D = (d_correct/d_total) * 100% where: n(TP) – Number of sign passing events where the correct speed limit was concluded within [25 m] after passing the sign n(FN) – Number of sign passing events where no or an incorrect speed limit was concluded within [25 m] after passing the sign n(FP) – Number of false positive events d_total – Total distance driven for test drive where the road speed limit was indicated by a road sign as specified in point 2.4.2.4.1 and where no special variable conditions according to point 2.4.2.3.2 apply. d_correct – Distance driven for test drive where the road speed limit was indicated by a road sign as specified in point 2.4.2.4.1, where no special variable conditions according to point 2.4.2.3.2 apply, and during which the perceived speed limit matched the road speed limit.

3.4.2 SLWF: Speed limit warning function test

Two series of tests have been developed for the technical service to verify the SLWF requirements (see Section 3.3.3) for systems with:

- A visual warning and a cascaded acoustic or haptic warning consisting of;
  - tests to check that warnings are given as specified.
  - a test to check that a warning is not given when ISA is deactivated.
  - in the case of a system that has a cascaded haptic warning, a test to check that an acoustic warning is given when a driver aid where the driver is not expected to be touching the accelerator control (e.g. cruise control) is being used.
- A haptic warning alone
  - a test to check that the warning is given as specified.
  - a test to check that a warning is not given when ISA deactivated.
  - a test to check that an acoustic warning is given when a driver aid where the driver is not expected to be touching the accelerator control (e.g. cruise control) is being used.

Points to note:

- The procedure has not yet been trialled due to current restrictions related to the COVID-19 pandemic, but as it is simple this may not be necessary. However, it is noted that tolerances for the initial driving speed for the visual and cascaded acoustic or haptic warning tests are quite small if a low test speed limit is chosen; e.g., 1 to 8 per cent of 30 km/h is 30.3 to 32.4 km/h. For 50 km/h this is better; 1 to 8 per cent of 50 km/h is 50.5 km/h to 54 km/h, which could likely be achieved by a test driver.

Draft text

3.4	SLWF: Speed limit warning function test
3.4.1	Subject vehicle conditions Subject vehicle conditions shall meet the requirements specified in point 3.1.1.
3.4.2	Road signs The Technical Service shall select suitable road signs for the test that meet the requirements in point 3.1.2.
3.4.3	Testing conditions Testing conditions shall meet the requirements specified in point 3.1.3.
3.4.4	Test procedure for options (a) and (b) (a) Visual warning and cascaded acoustic or haptic warning Part 1:Warnings test The Technical Service shall select a test speed limit. The initial speed limit shall be at least 38 per cent higher than the test speed limit. The perceived speed limit shall be set at the initial speed limit. The subject vehicle shall be driven with an activated SLWF using the accelerator control in a smooth manner so that its attitude is stable past a

	road sign indicating the test speed limit at: (i) speedometer speeds: (1) Between [1 and 8] per cent higher than the test speed limit (2) Between [10 and 18] per cent higher than the test speed limit (3) Between [20 and 28] per cent higher than the test speed limit (4) Between [30 and 38] per cent higher than the test speed limit (ii) a distance from the road edge such that the position of the sign meets applicable standards in the member state concerned. Continue at a constant speed until an acoustic or haptic warning is noticed or for at least 60 seconds, whichever is sooner, and then slow down to a speedometer speed less than or equal to the test speed limit. Part 2: Deactivation (no warnings) test The ISA system shall be deactivated and a test repeated as in Part 1 at one speedometer speed selected by the Technical Service. Part 3: SLWF with driver aid control test In the case that the vehicle type may be equipped with a driver aid where the driver is not expected to be touching the accelerator control (for example, cruise control), one additional test shall be performed with an activated SLWF and the driver aid controlling the speed of the vehicle at one speedometer speed selected by the Technical Service. (b) Haptic warning alone Part 1: Warnings test The Technical Service shall select a test speed limit. The initial speed limit shall be at least 38 per cent higher than the test speed limit. The perceived speed limit shall be set at the initial speed limit. The subject vehicle shall be driven with an activated SLWF using the accelerator control in a smooth manner so that its attitude is stable past a road sign indicating the test speed limit at a speedometer speed at least 1 percent higher than the test speed limit and at a distance from the road edge such that the position of the sign meets applicable standards in the member state concerned. Continue at a constant speed until a haptic warning is noticed or for at least 60 seconds, whichever is sooner, and then slow down to a speedometer speed less than or equal to the test speed limit. Part 2: Deactivation (no warnings) test The ISA system shall be deactivated and a test repeated as in Part 1 at one speedometer speed selected by the Technical Service. Part 3: SLWF with driver aid control test In the case that the vehicle type may be equipped with a driver aid where the driver is not expected to be touching the accelerator control (for example, cruise control), the option (a) part 1 warnings tests shall be performed with an activated SLWF and the driver aid controlling the speed of the vehicle. By agreement between the Manufacturer and the Technical Service the test track-based procedures above can be replaced with laboratory-based procedures that have been shown to be equivalent.
3.4.4.1	The test requirements for options (a) and (b) are fulfilled if:

	(a) Visual warning and cascaded acoustic or haptic warning Part 1: Warnings test A visual warning compliant with the requirements set out in point 2.5.2.1 is provided within [2 seconds] of the vehicle passing the sign and a cascaded acoustic or haptic warning is present and noticeable as follows: (1) For speedometer speed between [1 and 8] per cent higher than the test speed limit no cascaded acoustic or haptic warning is presented, i.e. only a visual warning is presented. (2) For speedometer speed between [10 and 18] per cent higher than the test speed limit, from at least [60 seconds] after passing sign for at least 10 seconds or until speedometer speed equal or less than that the test speed limit (3) For speedometer speed between [20 and 28] per cent higher than the test speed limit, from at least [10 seconds] after passing sign for at least 10 seconds or until speedometer speed equal or less than that the test speed limit (4) For speedometer speed between [30 and 38] per cent higher than the test speed limit, from at least [3 seconds] after passing sign for at least 10 seconds or until speedometer speed equal or less than that the test speed limit Part 2: Deactivation (no warnings) test No warnings (visual, haptic or acoustic) are presented. Part 3: SLWF with driver aid control test Visual and acoustic warnings are presented as for part 1. (b) Haptic warning alone Part 1: Warnings test A haptic warning compliant with the requirements set out in point 2.5.2.2 is provided within [2 seconds] of the vehicle passing the sign Part 2: Deactivation (no warnings) test No haptic warning is presented Part 3: SLWF with driver aid control test Visual and acoustic warnings are presented as for option (a) part 1.

3.4.3 SCF test procedures

Five tests have been developed for technical services to verify the SCF requirements (see Section 3.3.4) and were based in large parts on the Euro NCAP Test Protocol – Speed Assist Systems (Euro NCAP, 2017):

- SCF acceleration test (point 3.5.3.1), to verify for three different test speeds that the SCF is able to limit the speedometer speed to within the required tolerance in a situation where the vehicle is being accelerated from below the speed limit. The test speeds were chosen to be representative of typical European urban, inter-urban and motorway speed limits, respectively. The calculation method for the stabilised speed is based on Euro NCAP's Assessment Protocol but has been modified to be based on speedometer speed rather than true speed (see Section 3.3.4). The calculation method employed in UN R89 is not used because it is

understood that for certain control characteristics the initiation condition prescribed in the regulation (beginning 10 seconds after first reaching the stabilised speed) might never be met and hence calculation would not be possible. Note that the proposed calculation method should be verified in trials before finalising the regulation.

- SCF response test (point 3.5.3.2), to verify that an SCF intervention is initiated in a situation where the vehicle is driven at a constant speed and the speed limit drops to a lower value. The test intends to verify only that an intervention in initiated but is not intended to check the performance at limiting the speed in this situation (note that a warning would be issued to the driver in case of an overrun). Therefore, the test speed has no impact on the test result and a low value (urban speed limit) was chosen pragmatically for ease of performing the test.
- SCF deactivation test (point 3.5.3.3), to verify that the SCF does not limit the vehicle speed and no alternative warning is issued when ISA is deactivated.
- SCF override test (point 3.5.3.4), to verify that the driver has the ability to accelerate past the speed limit by applying a positive action (override) and that, subsequently, SCF will limit the speed again once it has dropped below the speed limit.
- SCF overrun test (point 3.5.3.5), to verify that the SCF issues a warning in a situation where it is not able to limit the speed to the speed limit (e.g. downhill driving). This test will require, in most cases, a facility with a long downhill section, because pulling vehicles might not be practicable depending on vehicle weight and assistance systems installed. Such a facility might not be available at all technical services which is why a provision was included to allow the use of documentation for this test, with the consent of the Type Approval Authority.

The subject vehicle conditions prescribed for the tests are aligned with those defined for the SLIF test. Relevant characteristics of the vehicle to be tested (gearbox type, tyre size and gear selection) shall be chosen by the technical service to represent the worst case of the vehicle type.

The tests have been designed to be performed on a test track or alternatively on a chassis dynamometer in order to accommodate the test facilities available to technical services. The prescribed test track characteristics and ambient weather conditions are based on UN R89 with minor modifications to align with the conditions prescribed for SLIF and SLWF tests. To provide flexibility and allow testing to be performed also under conditions not meeting these requirements as long as the test result is not influenced, the draft text provides an option to deviate from these conditions if manufacturer and technical service agree. The prescribed chassis dynamometer characteristics are taken from UN R89. An accuracy of speed measurement is not prescribed because the vehicle's speedometer speed is used for the test.

It should be noted that the procedure has not yet been trialled due to current restrictions related to the COVID-19 pandemic.

Draft text:

3.5	SCF: Speed control function tests
3.5.1	Subject vehicle conditions
3.5.1.1	Subject vehicle conditions regarding test mass, tyres and pre-test conditioning shall meet the requirements specified in point 3.1.1.
3.5.1.2	The gearbox type, tyre size and gear selection for the tests shall be based on a worst-case selection for the type to be approved.
3.5.1.3	The settings of the drivetrain of the test vehicle shall conform to the

	specifications of the Manufacturer.
3.5.2	The tests shall be performed on a test track or on a chassis dynamometer.
3.5.2.1	Test track
3.5.2.1.1	The test track surface shall be suitable to enable a stabilised speed to be maintained and shall be free from uneven patches, standing water, snow and ice.
3.5.2.1.1.1	Gradients shall not exceed 2 per cent and shall not vary by more than 1 per cent excluding camber effects. For the SCF overrun test specified in point 3.5.3.5, any gradients are permitted.
3.5.2.1.2	Ambient weather conditions for track test
3.5.2.1.2.1	The mean wind speed measured at a height at least 1 m above the ground shall be less than 6 m/s with gusts not exceeding 10 m/s.
3.5.2.1.3	[At the Manufacturer's discretion and with the agreement of the Technical Service the tests may be performed under conditions deviating from what is described above.]
3.5.2.2	Chassis dynamometer
3.5.2.2.1	The equivalent inertia of the vehicle mass shall be reproduced on the chassis dynamometer with an accuracy of ± 10 per cent. The time shall be measured with an accuracy of 0.1 seconds.
3.4.2.2.2	The power absorbed by the brake during the test shall be set to correspond with the vehicle’s resistance to progress at the tested speeds. This power may be established by calculation and shall be set to an accuracy of ± 10 per cent.
3.5.3	Test procedures
3.5.3.1	SCF acceleration test
3.5.3.1.1	The test specified in point 3.5.3.1.2 shall be repeated for three different speed limits: (a) Urban speed limit: Initial speedometer speed ≤ 20 km/h; test speed limit = 50 km/h (b) Inter-urban speed limit: Initial speedometer speed ≤ 50 km/h; test speed limit = 80 km/h (c) Motorway speed limit: Initial speedometer speed ≤ 100 km/h; test speed limit = 130 km/h Only those tests where the test speed limit is lower than the vehicle’s maximum design speed have to be performed.
3.5.3.1.2	The subject vehicle shall be driven with an activated SCF within the initial speedometer speed range. The perceived speed limit shall be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit). The vehicle shall then be accelerated, without applying a positive override action, until an SCF intervention is initiated. While the intervention remains active, the vehicle shall be driven long enough to allow an assessment of the stabilised speed. During the test, the speedometer speed shall be recorded. The stabilised speed shall be calculated by averaging the speedometer speed over a time interval of 20 seconds beginning 10 seconds after the speedometer speed first reached the perceived speed limit minus 10 km/h.
3.5.3.1.3	The test requirements are fulfilled if the stabilised speeds lie within the

	following boundaries: (a) Urban speed limit: 45 km/h ≤ stabilised speed ≤ 50 km/h (b) Inter-urban speed limit: 75 km/h ≤ stabilised speed ≤ 80 km/h (c) Motorway speed limit: 125 km/h ≤ stabilised speed ≤ 130 km/h
3.5.3.2	SCF response test
3.5.3.2.1	The test specified in point 3.5.3.2.2 shall be performed at the urban speed limit with: 70 km/h ≤ initial speedometer speed ≤ 79 km/h; Initial speed limit = 80 km/h; Test speed limit = 50 km/h.
3.5.3.2.2	The subject vehicle shall be driven with an activated SCF at a constant speed within the initial speedometer speed range and the perceived speed limit shall be set to the initial speed limit so that no SCF intervention is active. The perceived speed limit shall then be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit) and the vehicle shall be driven at a constant speed within the initial speedometer speed range long enough to initiate an SCF intervention.
3.5.3.2.3	The test requirements are fulfilled if an SCF intervention is initiated no later than [2 seconds] after the vehicle's perceived speed limit was set to the test speed limit.
3.5.3.3	SCF deactivation test
3.5.3.3.1	The test specified in point 3.5.3.3.2 shall be performed at the urban speed limit with: Initial speedometer speed ≤ 35 km/h; Test speed limit = 50 km/h.
3.5.3.3.2	The subject vehicle shall be driven with a deactivated SCF within the initial speedometer speed range. The perceived speed limit shall be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit). The vehicle shall then be accelerated, without applying a positive override action, for more than [2 seconds] after the test speed limit has been exceeded.
3.5.3.3.3	The test requirements are fulfilled if no SCF intervention is initiated and no speed limit warning (visual, acoustic or haptic) is issued.
3.5.3.4	SCF override test
3.5.3.4.1	The test specified in point 3.5.3.4.2 shall be performed at the urban speed limit with: Initial speedometer speed ≤ 35 km/h; Test speed limit = 50 km/h; Final speedometer speed ≥ 65 km/h.
3.5.3.4.2	The subject vehicle shall be driven with an activated SCF within the initial speedometer speed range. The perceived speed limit shall be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit). The vehicle shall then be accelerated, without applying a positive override action, until an SCF intervention is initiated. While the intervention is

	active, a positive override action as specified by the Manufacturer shall be applied to accelerate the vehicle to the final speedometer speed range. The vehicle shall then be decelerated to a speedometer speed below the test speed limit and accelerated again, without applying a positive override action, until an SCF intervention is initiated.
3.5.3.4.3	The test requirements are fulfilled if: (a) the SCF intervention is temporarily suspended when the positive override action is applied, so that the vehicle can be accelerated to the final speedometer speed, and (b) an SCF intervention is initiated during the subsequent acceleration.
3.5.3.5	SCF overrun test
3.5.3.5.1	The test specified in point 3.5.3.5.2 shall be performed at the urban speed limit with: Test speed limit = 50 km/h; Final speedometer speed ≥ 65 km/h. If such a test cannot be practically achieved (for example due to limitations of the test facilities), with the consent of the Type Approval Authority this requirement may be demonstrated through the use of documentation.
3.5.3.5.2	The perceived speed limit shall be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit). The subject vehicle shall be driven with an activated SCF at a speed below the test speed limit. The vehicle shall then be forced into exceeding the test speed limit (without applying a positive override action, for example by downhill driving or pulling the vehicle) until a visual warning and an acoustic or haptic warning have been issued.
3.5.3.5.3	The test requirements are fulfilled if: (a) the SCF did not actuate the vehicle's service braking system (for vehicle categories other than M_1 and N_1), and (b) the system warns the driver in accordance with the requirements specified in point 2.5.2.

4 REMAINING STEPS

4.1 Catalogue of road signs

TRL have made suggestions in the first interim report (Seidl *et al.*, 2020) which types of signs should be included in the requirements based on the aim to realise adequate road safety benefits and under consideration of stakeholder input regarding the capabilities and limitations of current and near-future technology. As outlined in Section 2, stakeholders proposed to expand this list of sign types into a full catalogue of road signs, i.e. a definitive list of national and regional variants of road sign types and variable message sign types based upon which ISA shall obtain the perceived speed limit. This catalogue should be referenced in or become part of the regulation to form the basis of type approvals and should be updated and version controlled to provide traceability for market surveillance tests in later years. A reasonable transition period for new type approvals should be defined to allow sufficient time for system design when the catalogue is updated.

It is important to note that designing and populating such catalogue were not included in the scope of this study. Stakeholders, based on discussions with TRL, performed some initial work to scope the contents of a template for information that should be included in the catalogue. The results of this work are described in Annex 4, to be taken forward by the European Commission.

TRL suggest the following process to design and populate the catalogue of road signs:

Step 1: Decide what types of signs should be included in catalogue

- TRL have made suggestions in Section 4.3.1.3 of the first interim report (Seidl *et al.*, 2020) which types of speed limit signs should be included in the requirements.
- Note that specific national variants which have characteristics that make them difficult to recognise (e.g., French city entry signs have different dimensions based on the length of the city name) may be included from a later date than initial implementation.

Step 2: Create template of information required for signs

- The catalogue should contain information about the design of the relevant signs in each EU member state and the associated speed limit split by vehicle category and road class where applicable.
- Additional informative elements could be included regarding national requirements concerning aspects such as size and positioning of each sign type.
- Note that this may include information collected for potential use in the future, for example, associated speed limit by time of day.
- TRL have proposed a draft template; presented in Annex 4, Table 1.

Step 3: Populate template with information for each EU member state

Step 4: Implement process to update and version control the catalogue when signs and / or associated speed limits change in the future.

4.2 Trialling of draft test procedures

It was envisaged that this study would include trials of the track-based test procedures developed, but unfortunately this was not yet possible because of restrictions related to the COVID-19 pandemic. Some of the test procedures proposed are simple and / or based on established Euro NCAP protocols, so trials may not be necessary for all

procedures. TRL is envisaging to perform the trials at a later date and is liaising with the European Commission on how to proceed in this regard.

It is important to note that trials of the real-world reliability procedure were not included in the scope of this study and TRL therefore consider it important that an investigation is performed whether the proposed procedure is suitable and suggested pass/fail thresholds can be met with different types of currently available systems before the procedure is implemented in legislation. Possible approaches could include a dedicated trial programme and / or implementation of the real-world reliability tests as a monitoring requirement for an initial phase before enforcement of pass/fail thresholds, as was done for the Real Driving Emissions (RDE) test procedure.

5 ACKNOWLEDGMENTS

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7 ANNEX 1: DRAFT PERFORMANCE REQUIREMENTS AND TESTS

7.1 Subject matter, exemptions and definitions

0	Subject matter, exemptions and definitions
0.1	Subject matter This Regulation establishes detailed technical requirements and test procedures for the EC type approval of the vehicles referred to in Article 6 of Regulation (EU) 2019/2144 in respect of their Intelligent Speed Assistance system and of Intelligent Speed Assistance separate technical units ('STUs').
0.2	[Exemptions Ambulances or vehicles intended for use by the armed services, civil defence, fire services and forces responsible for maintaining public order are exempted from the requirement to be equipped with an intelligent speed assistance system.]
0.3	Definitions For the purposes of this Regulation and in addition to the definitions laid down in Article 3 of Regulation (EU) 2018/858, the following definitions apply:
0.3.1	*"Speed limit information function (SLIF)"* comprises the speed limit determination system that determines the perceived speed limit, and an interface that communicates the perceived speed limit to the driver.
0.3.2	*"Speed limit warning function (SLWF)"* means a function that alerts the driver that the speedometer speed is exceeding the perceived speed limit.
0.3.3	*"Speed control function (SCF)"* means a function that attempts to limit the speedometer speed to a stable speed at or below the perceived speed limit.
0.3.4	"*Speed limit determination system*" means the specific hardware required to obtain the speed limit through the observation of road signs and signals, based on infrastructure signals or electronic map data, or both.
0.3.5	"*Speed limit feedback system*" means the specific hardware required to communicate the speed limit to the driver (SLIF HMI interface) and to provide feedback to the driver (SLWF or SCF).
0.3.6	*"Speedometer speed"* means the driving speed of the vehicle as displayed by the speedometer.
0.3.7	*"Road speed limit"* means the currently applicable maximum permitted legal driving speed at the vehicle's location for the category of vehicle that the ISA system is fitted to.
0.3.8	"*Explicit speed limit sign*" means an applicable road sign which shows a numerical value.
0.3.9	"*Implicit speed limit sign*" means an applicable road sign which does not show a numerical value.
0.3.10	*"Perceived speed limit"* means the road speed limit as obtained by the speed limit determination system.
0.3.11	"*Catalogue of road signs*" means the definitive list of national and regional variants of road sign types [and variable message sign types] based upon which

	ISA shall obtain the perceived speed limit.
0.3.12	"*Applicable road sign*" means a sign contained in the catalogue of road signs for the category of vehicle to be approved and which is applicable to at least one lane of the vehicle's carriageway, including both non-electronic signs and variable message signs, but not including speed limit road markings.
0.3.13	"*Common space*" means an area on which two or more information functions (for example, symbol) may be displayed, but not simultaneously.
0.3.14	"*Self-check*" means an integrated function that checks for a system failure on a continuous basis at least while the system is active.
0.3.15	*"Vehicle master control switch"* means the device by which the vehicle's on-board electronics system is brought, from being switched off, as in the case where a vehicle is parked without the driver being present, to normal operation mode.
0.3.16	"*Type of ISA STU*" means a combination of specific hardware which does not differ in such essential respects as the characteristics and functionality of the speed limit determination system and its performance when operated on a public road located within the territory of the European Union.
0.3.17	"*Vehicle type with regard to the installation of an ISA system*" means motor vehicles which do not differ in such essential respects as: (a) The characteristics and functionality of the speed limit determination system (b) Characteristics of the installation of the speed limit determination system within the vehicle which significantly influence its performance when operated on a public road located within the territory of the European Union (c) The characteristics and functionality of the speed limit feedback system

7.2 Requirements

1	General requirements
1.1	An ISA system shall comprise a SLIF and either a SLWF or a SCF.
1.1.1	Type approval of a vehicle with regard to the installation of an ISA system shall be subject to the vehicle and its system complying with: (a) System requirements laid down in points 2.1, 2.2 and 2.3, and (b) SLIF requirements laid down in point 2.4, and (c) SLWF requirements laid down in point 2.5 or SCF requirements laid down in point 2.6.
1.1.2	Where the motor vehicle is fitted with a type of ISA STU that has been type approved, the vehicle and its system shall have to comply with: (a) System requirements laid down in points 2.1, 2.2 and 2.3, and (b) SLIF requirements laid down in point 2.4.1, and (c) SLWF requirements laid down in point 2.5 or SCF requirements laid down in point 2.6.
1.1.3	Type approval of an ISA STU shall be subject to the STU complying with the SLIF requirements laid down in point 2.4.2.
1.1.4	In case of multi-stage type approval, the type approval granted at a previous stage in respect of the installation of an ISA system in the (base) vehicle shall remain valid, provided that the ISA system and the relevant sensors are not modified.
1.2	Subject to specific requirements below, the ISA system shall be designed to avoid or minimise the error rate under real driving conditions.
1.3	The requirements set out in this Regulation shall at least apply when the vehicle is operated on a public road located within the territory of the European Economic Area, as defined at the time the type approval is issued.
1.4	Privacy and data protection
1.4.1	The ISA system shall offer the required functionality in the normal operation mode without the use of biometric information, including facial recognition, of any vehicle occupants.
1.4.2	The ISA system shall not continuously record nor retain any data related to incidents of exceeding the speed limit other than what is necessary in relation to perform the required ISA functionality or other European Union specific regulatory acts regarding vehicle approval.
2	Specific requirements
2.1	ISA failure warning
2.1.1	A constant optical warning signal shall be provided when there is a failure in the ISA system that prevents the requirements of this Regulation of

	being met.
2.1.1.1	There shall not be an appreciable time interval between each ISA self-check, and subsequently there shall not be a delay in illuminating the warning signal, in the case of an electrically detectable failure.
2.1.1.2	Upon detection of any non-electrical failure condition (for example, sensor obscuration excluding temporary obscuration such as sun glare), the failure warning signal as defined in point 2.1.1 shall be activated.
2.2	ISA control
2.2.1	It shall be possible for the driver to manually deactivate the ISA system. When deactivated, the ISA system shall continue determining the road speed, and information about the perceived speed limit may still be provided to the driver. The following conditions shall apply as appropriate.
2.2.1.1	The ISA system shall be automatically reinstated in normal operation mode upon each activation of the vehicle master control switch, [at least provided the driver door is opened in-between].
2.2.1.2	A constant optical warning signal shall inform the driver that the ISA system has been deactivated. The failure warning signal specified in point 2.1.1 may be used for this purpose.
2.2.1.3	Following manual deactivation of the ISA system, it shall be possible for the driver to re-activate the system with no more than the number of actions required to deactivate it.
2.2.2	Automatic deactivation of ISA is permitted in situations when highly automated systems control the speed of the vehicle, that is, those systems which perform the object and event detection and response dynamic driving subtask, such as Automated Lane Keeping System (ALKS).
2.3	Provisions for the Periodic Technical Inspection
2.3.1	At a Periodic Technical Inspection, it shall be possible to confirm the correct operational status of the ISA system by a visible observation of the failure warning signal status following a "power-ON" and any bulb check. In the case of the failure warning signal being in a common space, the common space must be observed to be functional prior to the failure warning signal status check.
2.3.2	At the time of type approval, the means to protect against simple unauthorised modification of the operation of the failure warning signal chosen by the manufacturer shall be confidentially outlined. Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status of the ISA system is available.
2.4	SLIF requirements
2.4.1	SLIF display
2.4.1.1	The display of the SLIF shall be located in the direct field of view of the driver and be clearly legible both day and night. Additional display of the same information at other locations such as the navigation system display shall be permitted.

2.4.1.2	In the absence of conditions leading to the deactivation of the ISA system according to points 2.2.1 and 2.2.2, the SLIF shall display the perceived speed limit to the driver, at least when the speedometer speed is exceeding the perceived speed limit.
2.4.1.2.1	The perceived speed limit shall be displayed either: (a) on the speedometer in a manner that is noticeable and does not reduce the speedometer's legibility, or (b) in a separate display as a numerical value either using a symbol resembling a Vienna Convention speed limit traffic sign (display of additional sub-signs is permitted) or text consisting of the value and the unit of measurement (km/h).
2.4.1.3	When the ISA system is deactivated, display of the perceived speed limit is permitted.
2.4.2	Speed limit determination
2.4.2.1	Region- or country-code setting To determine the current region or country of operation, the ISA system shall fulfil either requirement (a) or (b) below: (a) The system shall be able to automatically detect the region- or country-code and set it with or without user confirmation. (b) It shall be possible for the driver to manually set the region- or country-code. The user manual shall indicate that this procedure is required for correct operation. The system shall retain the manually set region- or country-code even after activation of the vehicle's master control switch.
2.4.2.2	Speed limit determination through observation of explicit speed limit signs
2.4.2.2.1	In the absence of conditions leading to the deactivation of the system according to points 2.2.1 and 2.2.2, the SLIF shall be able, through observation of road signs (using, for example, camera input only), to recognise all explicit speed limit signs where the associated road speed limit for the category of vehicle to be approved matches the numerical value shown on the sign, and determine the road speed limits no later than when the observation sensor of the speed limit determination system (for example, camera) passes the road sign, at least when: (a) the signs meet all criteria specified in point 2.4.2.2.2, and (b) the signs are encountered in the operational and environmental conditions specified in point 2.4.2.2.3 This shall be demonstrated in accordance with the relevant tests and documentation specified in point 3.1.
2.4.2.2.2	Criteria for road signs: (a) of a design and size conforming to the applicable standards in the member state concerned (b) positioned in a way conforming to the applicable standards in the member state concerned (for example relating to lateral distance to the road edge, height, rotation and tilt) (c) showing no damage (for example, fading, reduced retro-reflectivity, bending, cracking, vandalism) that materially affects their visual properties

	(d) not partially or fully covered (for example, foliage, snow or dirt obscuring the sign, or deliberate invalidation during roadworks)
2.4.2.2.3	Operational and environmental conditions: (a) full operating speed range of the vehicle (b) with unobstructed view of the road sign for a continuous period of at least 0.5 seconds (c) in all illumination conditions without direct blinding sunlight and dipped (passing) beam head lamps if necessary (d) in the absence of weather conditions affecting the visibility of road signs (for example, fog)
2.4.2.3	Speed limit determination through observation of road signs and signals
2.4.2.3.1	In the absence of conditions leading to the deactivation of the system according to points 2.2.1 and 2.2.2, the SLIF shall be able, through observation of road signs and signals (using all relevant system inputs, for example, camera input and electronic map data where applicable), to determine the road speed limits associated with all applicable road signs (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1) no later than when a point positioned on the subject vehicle [25 m] rear of the observation sensor of the speed limit determination system (for example, camera) passes the road sign, at least when: (a) the signs meet all criteria specified in point 2.4.2.2.2, and (b) the signs are encountered in the operational and environmental conditions specified in point 2.4.2.2.3 This shall be demonstrated in accordance with the relevant tests specified in point 3.2.
2.4.2.3.2	The SLIF is not required to take into account special variable conditions influencing the road speed limit (that is, conditions which require information going beyond the current region or country of operation and the current road class, such as trailer status, prevailing environmental conditions, time of year, driver age or experience, or standing passengers) unless the relevant electronic signals are available on the vehicle. In the case that special variable conditions may be present and relevant electronic signals are not available, the speed limit determination shall default to the assumed most common condition in typical normal operation.
2.4.2.4	Speed limit determination real-world driving reliability
2.4.2.4.1	In the absence of conditions leading to the deactivation of the system according to points 2.2.1 and 2.2.2, the SLIF shall be able, through observation of road signs and signals (using all relevant system inputs, for example, camera input and electronic map data where applicable), to reliably determine the road speed limits associated with all applicable road signs (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1), at least when: (a) the signs meet all criteria specified in point 2.4.2.2.2, and (b) the signs are encountered in the operational and environmental conditions specified in point 2.4.2.2.3

2.4.2.4.2	Reliable determination of the road speed limit is fulfilled if both performance requirements, (a) and (b), are met in real-world driving: (a) Event-based performance - True positive rate TP_E: The correct road speed limit shall be determined for at least [90] per cent of sign passing events. A sign passing event is an instance where the vehicle passes a road sign as specified in point 2.4.2.4.1 and where no special variable conditions according to point 2.4.2.3.2 apply. Instances where identical road signs are positioned on both sides of the carriageway shall be considered as a single sign passing event. - False positive rate FP_E: The false positive rate shall be less than or equal to [2 per 100 km] of driven distance. A false positive event is an instance where an object or a sign other than an applicable road sign is used to incorrectly determine the road speed limit (disregarding instances where a sign is positioned ambiguously to an extent that an average driver would be uncertain to which carriageway it applies or where special variable conditions according to point 2.4.2.3.2 apply). (b) Distance-based performance - True positive distance TP_D: The correct road speed limit shall be determined for at least [90] per cent of distance driven at least for road speed limits as specified in point 2.4.2.4.1 and where no special variable conditions according to point 2.4.2.3.2 apply. This shall be demonstrated in accordance with a real-world driving test as specified in point 3.3.
2.4.2.4.3	Before conducting the real-world driving test, in agreement between the Technical Service, the Type Approval Authority and the Manufacturer, a route outline shall be selected that is: (c) located on public roads within the territory of the European Union, and (d) unbiased, that is, chosen with the intention to generate a passed or failed test by virtue of the technical performance of the system and not by virtue of an extreme route choice.
2.4.2.4.4	To demonstrate system performance requirements European Union-wide, the Manufacturer shall provide technical documentation that contains at least: (c) The basic design of the system and a description of the speed limit determination system, including the sensors and, if applicable, electronic map data sources used. (d) Description of due diligence activities performed to provide evidence that the requirements in point 2.4.2.4.1 are met for operation in all European Union member states. Examples of relevant activities include: i. Worst-case European Union member state(s) identified, and testing performed in them to show requirements are met ii. For system that uses electronic map data, an assessment of the integrity and reliability of the electronic map data throughout all European Union member states which

	indicates that requirements are met and also make associated evidence available for audit. The Technical Service shall assess the documentation provided and audit associated evidence to judge that reasonable and adequate steps have been taken to ensure that the requirements in point 2.4.2.4.1 are met for operation in all European Union member states.
2.4.2.4.5	Life cycle performance
2.4.2.4.5.1	The Manufacturer shall ensure that the reliability of speed limit determination is maintained for at least [10 years] after the production of the approved type is definitely discontinued. This only applies to road speed limits as specified in point 2.4.2.4.1 in the version of this Regulation at the time the type approval was issued.
2.4.2.4.5.2	If electronic map data is used to achieve the required performance, the Manufacturer shall offer frequent data updates to vehicle owners. These updates shall be made available to vehicle owners free of charge. The user manual shall indicate that updates are required to maintain performance and explain the procedure to perform updates.
2.5	SLWF requirements
2.5.1	In the absence of conditions leading to the deactivation of the ISA system according to points 2.2.1 and 2.2.2, if the perceived speed limit is known and the speedometer speed exceeds it, the SLWF shall warn the driver as specified in point 2.5.2.
2.5.2	The warning indication shall be provided by: (a) a visual warning and a cascaded acoustic or haptic warning; or (b) a haptic warning alone At times when the speed of the vehicle is actively controlled by a driver aid where the driver is not expected to be touching the accelerator control (for example, cruise control), the use of a haptic warning is not permitted and only option (a) with a cascaded acoustic warning is permitted.
2.5.2.1	Visual warning and cascaded acoustic or haptic warning The visual warning shall be noticeable and easily recognisable by the driver and be provided by flashing of the SLIF display or an additional visual signal adjacent to the SLIF display. It shall be provided within [2 seconds] that the speedometer speed exceeds the perceived speed limit and until the speedometer speed is equal to or below the perceived speed limit. The cascaded acoustic warning shall be noticeable by the driver, unique and easily recognisable and be provided by a continuous or intermittent sound signal [or by vocal information. Where vocal information is employed the Manufacturer shall ensure that it uses the language(s) of the market into which the vehicle is sold]. The acoustic warning may be varied to indicate the magnitude and / or time that the speed limit has been exceeded for. The cascaded haptic warning shall be noticeable by the driver and be provided through the accelerator control, for example by increasing the restoring force of the accelerator control. The cascaded acoustic or haptic warning shall be provided, at least, when

	any of the following conditions are met: (a) Speedometer speed exceeds perceived speed limit by greater than or equal to [30 per cent] for longer than [3 seconds] (b) Speedometer speed exceeds perceived speed limit by greater than or equal to [20 per cent] for longer than [10 seconds] (c) Speedometer speed exceeds perceived speed limit by greater than or equal to [10 per cent] for longer than [60 seconds] for at least 10 seconds or until the speedometer speed is equal to or below the perceived speed limit. [The manufacturer may offer means for the driver to temporarily suppress the acoustic warning for the period until the perceived speed limit changes.]
2.5.2.2	Haptic warning alone The haptic warning alone shall be noticeable by the driver and be provided through the accelerator control, for example by increasing the restoring force of the accelerator control. It shall be provided within [2 seconds] that the speedometer speed exceeds the perceived speed limit and until the speedometer speed is equal to or below the perceived speed limit.
2.5.3	If the vehicle is equipped with a means to suspend the SLWF warning to allow for the presentation of more critical warnings (for example, forward collision warning or lane keep assistance), the following shall apply. The Manufacturer shall provide a documentation package which gives access to the strategy and basic design of the system which controls the presentation of applicable warnings to the driver. The Technical Service shall assess that all applicable warnings are presented to the driver in a manner that is intuitive and understood easily.
2.5.4	The SLWF warning indication shall be demonstrated in accordance with the relevant tests specified in point 3.4.
2.6	SCF requirements
2.6.1	In the absence of conditions leading to the deactivation of the ISA system according to points 2.2.1 and 2.2.2, the SCF shall attempt to limit the speedometer speed to the perceived speed limit. This shall be demonstrated in accordance with the relevant tests specified in point 3.5.
2.6.1.1	The SCF shall attempt to limit the speedometer speed to a stabilised speed by reducing the vehicle's propulsion power (that is, driveline torque). The SCF shall not actuate the vehicle's service braking system except for vehicles of categories M_1 and N_1, where the vehicle's service braking system may be actuated. A permanent brake (for example, retarder) may be incorporated only if it operates after the SCF has restricted the propulsion power to a minimum.
2.6.1.2	The SCF intervention shall begin before or no later than [2 seconds] after the speedometer speed first exceeded the perceived speed limit.
2.6.1.3	When stable speed control has been achieved, the speedometer speed shall not vary by more than 4 per cent or 2 km/h, whichever is greater, and the rate of change of speedometer speed shall not exceed 0.2 m/s^2 when measured on a period greater than 0.1 seconds. The stabilised speed shall

	fall within the following range: (perceived speed limit minus 5 km/h) ≤ stabilised speed ≤ perceived speed limit
2.6.1.4	If the SCF is not able to achieve stable speed control at a stabilised speed equal to or below the perceived speed limit within [30 seconds] after the speedometer speed first exceeded the perceived speed limit, the system shall warn the driver in accordance with the requirements specified in point 2.5.2. The visual warning shall be provided immediately. The acoustic or haptic warning shall be provided immediately if any of the conditions (a), (b) or (c), specified in point 2.5.2.2, is met considering the period since the speedometer speed first exceeded the perceived speed limit.
2.6.1.5	It shall be possible for the driver to override the SCF intervention by performing a positive action such as depressing substantially the accelerator control. Accelerator control kickdown shall not be the only available positive action. When a positive action is applied the SCF shall be temporarily suspended without causing unduly strong acceleration and be re-initiated after the speedometer speed has dropped to a speed less than or equal to the perceived speed limit.
2.6.1.6	The SCF shall permit a normal use of the accelerator control for gear selection.
2.6.1.7	The SCF shall issue a brief and subtle acoustic signal every time the perceived speed limit changes to a different value.
2.6.2	At times when the speed of the vehicle is actively controlled by a driver aid rather than the driver (for example, cruise control), and in the absence of conditions leading to the deactivation of the ISA system according to points 2.2.1 and 2.2.2, either the SCF shall remain active in accordance with point 2.6.1 or a SLWF shall be activated in accordance with point 2.5.

7.3 Test procedures

3	Test requirements
3.1	SLIF: Speed limit determination through observation of explicit speed limit signs test
3.1.1	Subject vehicle conditions
3.1.1.1	Test mass The vehicle mass shall be the unladen mass as declared by the Manufacturer.
3.1.1.2	Tyres The tyres shall be bedded and the pressure shall be as recommended by the Manufacturer for the vehicle.
3.1.1.3	Pre-test conditioning If requested by the Manufacturer the subject vehicle can be driven a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture to calibrate the sensor system, and the country- or region code can be set (manually or automatically) to the country or region of test.
3.1.2	Road signs The road signs used for the tests shall be explicit speed limit signs where the associated road speed limit for the category of vehicle to be approved matches the numerical value shown on the sign. They shall meet all criteria specified in point 2.4.2.2.2. A minimum of [5] different signs of the type above (including non-electronic road signs and those displayed on a variable message sign) as used in the member state where testing takes place shall be selected by the Technical Service for testing. The signs used for the tests shall be recorded in the test documentation. The Manufacturer shall demonstrate, through the use of documentation, compliance with all other explicit speed limit signs (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1) where the associated road speed limit for the category of vehicle to be approved matches the numerical value shown on the sign. Any such documentation shall be appended to the test report.
3.1.3	Testing conditions The tests shall be performed: (a) on a flat surface which is free from uneven patches, standing water, snow and ice, and provides the driver an unobstructed view of the road sign for a continuous period of at least 0.5 seconds (b) in all illumination conditions without direct blinding sunlight and dipped (passing) beam head lamps if necessary (c) in the absence of weather conditions affecting the visibility of signs (for example, fog) At the Manufacturer's discretion and with the agreement of the Technical Service the tests may be performed under conditions deviating from what is described above.
3.1.4	Test procedure Drive the subject vehicle in a smooth manner so that its attitude is stable

	past the road sign selected for testing at: (a) a speedometer speed greater than the sign indicates, and (b) a distance from the road edge such that the position of the sign meets applicable standards in the member state concerned. By agreement between the Manufacturer and the Technical Service the test track-based procedure described above can be replaced with a laboratory-based procedure that has been shown to be equivalent.
3.1.4.1	The test requirements are fulfilled if the SLIF displays the speed limit value shown on all road signs tested no later than when the observation sensor of the speed limit determination system (for example, camera) passes the signs.
3.2	SLIF: Speed limit determination through observation of road signs and signals test
3.2.1	Subject vehicle conditions Subject vehicle conditions shall meet the requirements specified in point 3.1.1.
3.2.2	Road signs The road signs used for the tests shall be explicit and implicit speed limit signs. They shall meet all criteria specified in point 2.4.2.2.2. A minimum of [10] different signs of both explicit and implicit speed limit signs (including non-electronic road signs and those displayed on a variable message sign) as used in the member state where testing takes place shall be selected by the Technical Service for testing. The signs used for the tests shall be recorded in the test documentation. The Manufacturer shall demonstrate, through the use of documentation, compliance with all other applicable road signs (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1). Any such documentation shall be appended to the test report.
3.2.3	Testing conditions Testing conditions shall meet the requirements specified in point 3.1.3. With agreement between the Manufacturer and the Technical Service, the tests can be performed either: (a) on a public road, or (b) on a test track resembling a realistic road environment to allow the SLIF to determine the road type, provided the SLIF does not require electronic map data to function.
3.2.4	Test procedure Drive the subject vehicle in a smooth manner so that its attitude is stable past the road sign selected for testing at: (a) a speedometer speed: - equal to or at maximum [20 per cent] lower than the sign indicates for tests on a public road - [at least 10 per cent greater than the sign indicates for tests on test track] (b) at a distance from the road edge such that the position of the

	sign meets applicable standards in the member state concerned. By agreement between the Manufacturer and the Technical Service the test track or road-based procedure described above can be replaced with a laboratory-based procedure that has been shown to be equivalent.
3.2.4.1	The test requirements are fulfilled if the SLIF determines the road speed limits associated with all signs tested (as defined in the catalogue of road signs for the category of vehicle to be approved, Annex 1) no later than when a point positioned on the subject vehicle [25 m] rear of the observation sensor of the speed limit determination system (for example, camera) passes the road signs. Appropriate results from the real-world driving reliability test can also be used to demonstrate fulfilment of the requirements.
3.3	SLIF: Speed limit determination real-world driving reliability test
3.3.1	The test drive shall: (a) be appropriate to measure the system's performance at correctly determining the road speed limit using the performance criteria specified in point 2.4.2.4.2. (b) involve driving on public roads within the territory of the European Union, as agreed between the Manufacturer, the Technical Service and the Type Approval Authority. (c) involve driving on urban roads, non-urban roads, and motorways/expressways/dual carriageways, where each of the three road types shall represent at least [20 per cent, 25 per cent and 25 per cent], respectively, of the total distance of the route. The route shall be one consecutive route with the same start and end point, where any repeated parts of the route in the same direction shall not count towards the test distance. The length of an individual section of urban road, non-urban road and motorway/expressway/dual carriageway travelled continuously shall not be greater than [20 km, 40 km and 40 km] respectively. (d) involve driving in daylight and darkness conditions, where darkness shall represent at least [20 per cent] of the total distance. (e) consist of a test distance greater than [400 km] and sufficient sign passing events such that the performance metrics TP_E and TP_D vary less than [+/- 5 per cent] within the final 50 km of the route when calculated on a continuous basis.
3.3.2	Performance metric calculation The performance metrics shall be calculated as: TP_E = (n(TP)/(n(TP)+n(FN))) * 100% FP_E = (n(FP)*100)/d_total TP_D = (d_correct/d_total) * 100% where: n(TP) – Number of sign passing events where the correct speed limit was concluded within [25 m] after passing the sign n(FN) – Number of sign passing events where no or an incorrect speed limit was concluded within [25 m] after passing the sign n(FP) – Number of false positive events

	d_total – Total distance driven for test drive where the road speed limit was indicated by a road sign as specified in point 2.4.2.4.1 and where no special variable conditions according to point 2.4.2.3.2 apply. d_correct – Distance driven for test drive where the road speed limit was indicated by a road sign as specified in point 2.4.2.4.1, where no special variable conditions according to point 2.4.2.3.2 apply, and during which the perceived speed limit matched the road speed limit.
3.4	SLWF: Speed limit warning function test
3.4.1	Subject vehicle conditions Subject vehicle conditions shall meet the requirements specified in point 3.1.1.
3.4.2	Road signs The Technical Service shall select suitable road signs for the test that meet the requirements in point 3.1.2.
3.4.3	Testing conditions Testing conditions shall meet the requirements specified in point 3.1.3.
3.4.4	Test procedure for options (a) and (b) (b) Visual warning and cascaded acoustic or haptic warning Part 1:Warnings test The Technical Service shall select a test speed limit. The initial speed limit shall be at least 38 per cent higher than the test speed limit. The perceived speed limit shall be set at the initial speed limit. The subject vehicle shall be driven with an activated SLWF using the accelerator control in a smooth manner so that its attitude is stable past a road sign indicating the test speed limit at: (i) speedometer speeds: (1) Between [1 and 8] per cent higher than the test speed limit (2) Between [10 and 18] per cent higher than the test speed limit (3) Between [20 and 28] per cent higher than the test speed limit (4) Between [30 and 38] per cent higher than the test speed limit (ii) a distance from the road edge such that the position of the sign meets applicable standards in the member state concerned. Continue at a constant speed until an acoustic or haptic warning is noticed or for at least 60 seconds, whichever is sooner, and then slow down to a speedometer speed less than or equal to the test speed limit. Part 2: Deactivation (no warnings) test The ISA system shall be deactivated and a test repeated as in Part 1 at one speedometer speed selected by the Technical Service. Part 3: SLWF with driver aid control test In the case that the vehicle type may be equipped with a driver aid where the driver is not expected to be touching the accelerator control (for example, cruise control), one additional test shall be performed with an activated SLWF and the driver aid controlling the speed of the vehicle at

	one speedometer speed selected by the Technical Service. (b) Haptic warning alone Part 1: Warnings test The Technical Service shall select a test speed limit. The initial speed limit shall be at least 38 per cent higher than the test speed limit. The perceived speed limit shall be set at the initial speed limit. The subject vehicle shall be driven with an activated SLWF using the accelerator control in a smooth manner so that its attitude is stable past a road sign indicating the test speed limit at a speedometer speed at least 1 percent higher than the test speed limit and at a distance from the road edge such that the position of the sign meets applicable standards in the member state concerned. Continue at a constant speed until a haptic warning is noticed or for at least 60 seconds, whichever is sooner, and then slow down to a speedometer speed less than or equal to the test speed limit. Part 2: Deactivation (no warnings) test The ISA system shall be deactivated and a test repeated as in Part 1 at one speedometer speed selected by the Technical Service. Part 3: SLWF with driver aid control test In the case that the vehicle type may be equipped with a driver aid where the driver is not expected to be touching the accelerator control (for example, cruise control), the option (a) part 1 warnings tests shall be performed with an activated SLWF and the driver aid controlling the speed of the vehicle. By agreement between the Manufacturer and the Technical Service the test track-based procedures above can be replaced with laboratory-based procedures that have been shown to be equivalent.
3.4.4.1	The test requirements for options (a) and (b) are fulfilled if: (a) Visual warning and cascaded acoustic or haptic warning Part 1: Warnings test A visual warning compliant with the requirements set out in point 2.5.2.1 is provided within [2 seconds] of the vehicle passing the sign and a cascaded acoustic or haptic warning is present and noticeable as follows: (1) For speedometer speed between [1 and 8] per cent higher than the test speed limit no cascaded acoustic or haptic warning is presented, i.e. only a visual warning is presented. (2) For speedometer speed between [10 and 18] per cent higher than the test speed limit, from at least [60 seconds] after passing sign for at least 10 seconds or until speedometer speed equal or less than that the test speed limit (3) For speedometer speed between [20 and 28] per cent higher than the test speed limit, from at least [10 seconds] after passing sign for at least 10 seconds or until speedometer speed equal or less than that the test speed limit (4) For speedometer speed between [30 and 38] per cent higher than the test speed limit, from at least [3 seconds] after passing sign for at least 10 seconds or until speedometer speed equal or less than that the test speed limit

	Part 2: Deactivation (no warnings) test No warnings (visual, haptic or acoustic) are presented. Part 3: SLWF with driver aid control test Visual and acoustic warnings are presented as for part 1. (b) Haptic warning alone Part 1: Warnings test A haptic warning compliant with the requirements set out in point 2.5.2.2 is provided within [2 seconds] of the vehicle passing the sign Part 2: Deactivation (no warnings) test No haptic warning is presented Part 3: SLWF with driver aid control test Visual and acoustic warnings are presented as for option (a) part 1.
3.5	SCF: Speed control function tests
3.5.1	Subject vehicle conditions
3.5.1.1	Subject vehicle conditions regarding test mass, tyres and pre-test conditioning shall meet the requirements specified in point 3.1.1.
3.5.1.2	The gearbox type, tyre size and gear selection for the tests shall be based on a worst-case selection for the type to be approved.
3.5.1.3	The settings of the drivetrain of the test vehicle shall conform to the specifications of the Manufacturer.
3.5.2	The tests shall be performed on a test track or on a chassis dynamometer.
3.5.2.1	Test track
3.5.2.1.1	The test track surface shall be suitable to enable a stabilised speed to be maintained and shall be free from uneven patches, standing water, snow and ice.
3.5.2.1.1.1	Gradients shall not exceed 2 per cent and shall not vary by more than 1 per cent excluding camber effects. For the SCF overrun test specified in point 3.5.3.5, any gradients are permitted.
3.5.2.1.2	Ambient weather conditions for track test
3.5.2.1.2.1	The mean wind speed measured at a height at least 1 m above the ground shall be less than 6 m/s with gusts not exceeding 10 m/s.
3.5.2.1.3	[At the Manufacturer's discretion and with the agreement of the Technical Service the tests may be performed under conditions deviating from what is described above.]
3.5.2.2	Chassis dynamometer
3.5.2.2.1	The equivalent inertia of the vehicle mass shall be reproduced on the chassis dynamometer with an accuracy of ± 10 per cent. The time shall be measured with an accuracy of 0.1 seconds.
3.4.2.2.2	The power absorbed by the brake during the test shall be set to correspond with the vehicle's resistance to progress at the tested speeds. This power may be established by calculation and shall be set to an accuracy of ± 10 per cent.

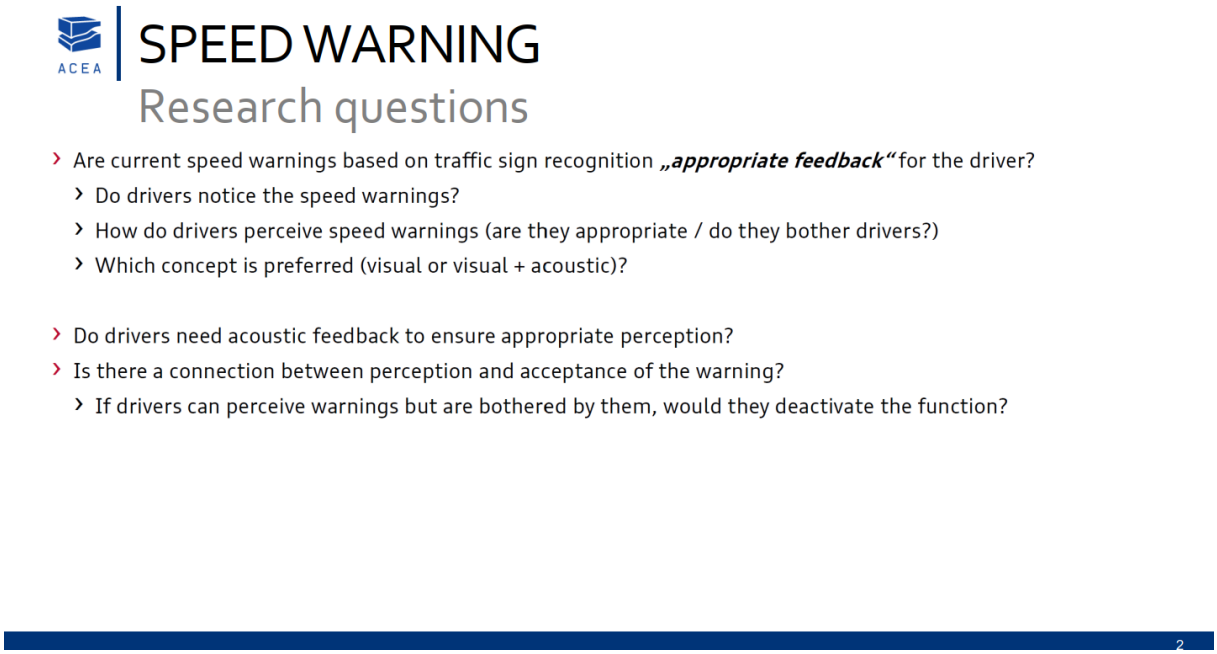
3.5.3	Test procedures
3.5.3.1	SCF acceleration test
3.5.3.1.1	The test specified in point 3.5.3.1.2 shall be repeated for three different speed limits: (a) Urban speed limit: Initial speedometer speed ≤ 20 km/h; test speed limit = 50 km/h (b) Inter-urban speed limit: Initial speedometer speed ≤ 50 km/h; test speed limit = 80 km/h (c) Motorway speed limit: Initial speedometer speed ≤ 100 km/h; test speed limit = 130 km/h Only those tests where the test speed limit is lower than the vehicle's maximum design speed have to be performed.
3.5.3.1.2	The subject vehicle shall be driven with an activated SCF within the initial speedometer speed range. The perceived speed limit shall be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit). The vehicle shall then be accelerated, without applying a positive override action, until an SCF intervention is initiated. While the intervention remains active, the vehicle shall be driven long enough to allow an assessment of the stabilised speed. During the test, the speedometer speed shall be recorded. The stabilised speed shall be calculated by averaging the speedometer speed over a time interval of 20 seconds beginning 10 seconds after the speedometer speed first reached the perceived speed limit minus 10 km/h.
3.5.3.1.3	The test requirements are fulfilled if the stabilised speeds lie within the following boundaries: (a) Urban speed limit: 45 km/h ≤ stabilised speed ≤ 50 km/h (b) Inter-urban speed limit: 75 km/h ≤ stabilised speed ≤ 80 km/h (c) Motorway speed limit: 125 km/h ≤ stabilised speed ≤ 130 km/h
3.5.3.2	SCF response test
3.5.3.2.1	The test specified in point 3.5.3.2.2 shall be performed at the urban speed limit with: 70 km/h ≤ initial speedometer speed ≤ 79 km/h; Initial speed limit = 80 km/h; Test speed limit = 50 km/h.
3.5.3.2.2	The subject vehicle shall be driven with an activated SCF at a constant speed within the initial speedometer speed range and the perceived speed limit shall be set to the initial speed limit so that no SCF intervention is active. The perceived speed limit shall then be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit) and the vehicle shall be driven at a constant speed within the initial speedometer speed range long enough to initiate an SCF intervention.
3.5.3.2.3	The test requirements are fulfilled if an SCF intervention is initiated no later than [2 seconds] after the vehicle's perceived speed limit was set to the test speed limit.
3.5.3.3	SCF deactivation test
3.5.3.3.1	The test specified in point 3.5.3.3.2 shall be performed at the urban speed

	limit with: Initial speedometer speed ≤ 35 km/h; Test speed limit = 50 km/h.
3.5.3.3.2	The subject vehicle shall be driven with a deactivated SCF within the initial speedometer speed range. The perceived speed limit shall be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit). The vehicle shall then be accelerated, without applying a positive override action, for more than [2 seconds] after the test speed limit has been exceeded.
3.5.3.3.3	The test requirements are fulfilled if no SCF intervention is initiated and no speed limit warning (visual, acoustic or haptic) is issued.
3.5.3.4	SCF override test
3.5.3.4.1	The test specified in point 3.5.3.4.2 shall be performed at the urban speed limit with: Initial speedometer speed ≤ 35 km/h; Test speed limit = 50 km/h; Final speedometer speed ≥ 65 km/h.
3.5.3.4.2	The subject vehicle shall be driven with an activated SCF within the initial speedometer speed range. The perceived speed limit shall be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit). The vehicle shall then be accelerated, without applying a positive override action, until an SCF intervention is initiated. While the intervention is active, a positive override action as specified by the Manufacturer shall be applied to accelerate the vehicle to the final speedometer speed range. The vehicle shall then be decelerated to a speedometer speed below the test speed limit and accelerated again, without applying a positive override action, until an SCF intervention is initiated.
3.5.3.4.3	The test requirements are fulfilled if: (a) the SCF intervention is temporarily suspended when the positive override action is applied, so that the vehicle can be accelerated to the final speedometer speed, and (b) an SCF intervention is initiated during the subsequent acceleration.
3.5.3.5	SCF overrun test
3.5.3.5.1	The test specified in point 3.5.3.5.2 shall be performed at the urban speed limit with: Test speed limit = 50 km/h; Final speedometer speed ≥ 65 km/h. If such a test cannot be practically achieved (for example due to limitations of the test facilities), with the consent of the Type Approval Authority this requirement may be demonstrated through the use of documentation.
3.5.3.5.2	The perceived speed limit shall be set to the test speed limit (for example by presenting the vehicle with a road sign displaying the test speed limit). The subject vehicle shall be driven with an activated SCF at a speed below the test speed limit. The vehicle shall then be forced into exceeding the test speed limit (without applying a positive override action, for example by

	downhill driving or pulling the vehicle) until a visual warning and an acoustic or haptic warning have been issued.
3.5.3.5.3	The test requirements are fulfilled if: (a) the SCF did not actuate the vehicle's service braking system (for vehicle categories other than M_1 and N_1), and (b) the system warns the driver in accordance with the requirements specified in point 2.5.2.

8 ANNEX 2: RECENT RESEARCH – INDUSTRY STAKEHOLDER

Source: European Automobile Manufacturers Association (ACEA)



SPEED WARNING
Method

- N=25 subjects (Audi employees with license to drive prototypes)
- Participants drive a specified route with different speed limits and speed limit warning function (SLWF) turned on
- **Within factors:** visual feedback compared to visual & acoustic feedback

TN	1st Drive	2nd Drive
1	Visual & acoustic FB	Only visual FB
2	Visual & acoustic FB	Only visual FB
3	Visual & acoustic FB	Only visual FB
4	Visual & acoustic FB	Only visual FB
5	Visual & acoustic FB	Only visual FB
6	Visual & acoustic FB	Only visual FB
7	Visual & acoustic FB	Only visual FB
8	Visual & acoustic FB	Only visual FB
9	Visual & acoustic FB	Only visual FB
10	Visual & acoustic FB	Only visual FB
11	Visual & acoustic FB	Only visual FB
12	Visual & acoustic FB	Only visual FB
13	Visual & acoustic FB	Only visual FB
14	Only visual FB	Visual & acoustic FB
15	Only visual FB	Visual & acoustic FB
16	Only visual FB	Visual & acoustic FB
17	Only visual FB	Visual & acoustic FB
18	Only visual FB	Visual & acoustic FB
19	Only visual FB	Visual & acoustic FB
20	Only visual FB	Visual & acoustic FB
21	Only visual FB	Visual & acoustic FB
22	Only visual FB	Visual & acoustic FB
23	Only visual FB	Visual & acoustic FB
24	Only visual FB	Visual & acoustic FB
25	Only visual FB	Visual & acoustic FB

Participants drive with Offset = 0 km/h
(warnings at 31, 51, 61, 71, 101 km/h)

Participants drive the same test track twice

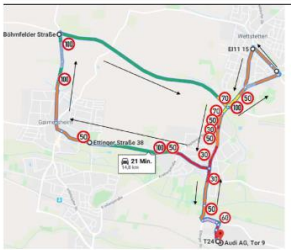
- Once with only visual warning, one with visual and acoustic (sequence permutated: Group 1: A-B, Group 2: B-A)
- Participants were asked after every speed warning, if they "perceived something from the vehicle". To divert attention, this question was also asked after PEA-hints, aLDW interventions and in random places without anything to perceive.

3

SPEED WARNING
Study Schedule and Test Track

~70 minutes slot length

Introduction, demographic data 10 minutes	1st drive 20 minutes	Post task questionnaire 5 minutes	2nd drive 20 minutes	Post task questionnaire 5 minutes	Post study questionnaire 10 minutes
▸ Age group ▸ Gender ▸ Yearly mileage ▸ Car (make, model, year) ▸ Prior experience ADAS	▸ Interviewer's observations ▸ Recording of driving data	▸ Acceptance Scale (van der Laan) ▸ Items perceptibility, manner of warning, likelihood of deactivation	▸ Interviewer's observations ▸ Recording of driving data	▸ Acceptance Scale (van der Laan) ▸ Items perceptibility, manner of warning, likelihood of deactivation	▸ Prior knowledge of speed limits on driven route ▸ Preference for speed warning ▸ Likes and dislikes



Start and end at Audi AG, outside Tor 9
- Road with speed limit at 30 km/h
- Road with speed limit at 50 km/h
- Road with speed limit at 60 km/h
- Road with speed limit at 70 km/h
- Road with speed limit at 100 km/h

Speed limit warning will be displayed with a 0 km/h tolerance to the posted limit!

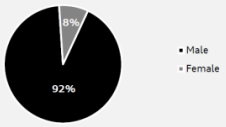
4

SPEED WARNING

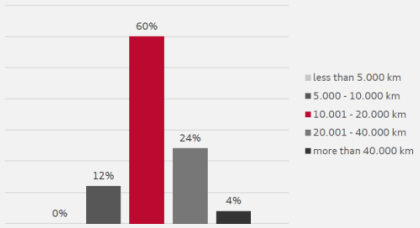
Demographic Data

N=25, reported are relative frequencies

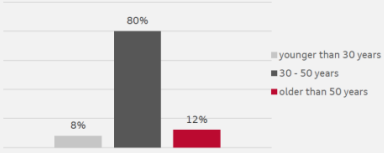
Gender



Annual mileage in km



Age



The participants were mainly male (n=23) and belonged to the age group „30 to 50 years“ (n=20). More than half of the participants reported that they had an annual mileage of 10.001 – 20.000 km (n=15).

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SPEED WARNING

Perceptions of Speed Warning based on Traffic Sign Recognition

N=25, reported are absolute frequencies and relative frequencies

	Frequencies Only Visual FB	Frequencies Visual and Acoustic FB
Warnings in total	455	511
Warnings perceived	374 (~ 82%)	511 (≙100%)
Warnings not perceived	81 (~18%)	0

It becomes clear, that the “Visual and Acoustic FB” performed slightly better: All warnings that occurred during the drive were perceived. However, it is also important to stress, that 82% of all warnings were perceived with the “Only Visual FB”.

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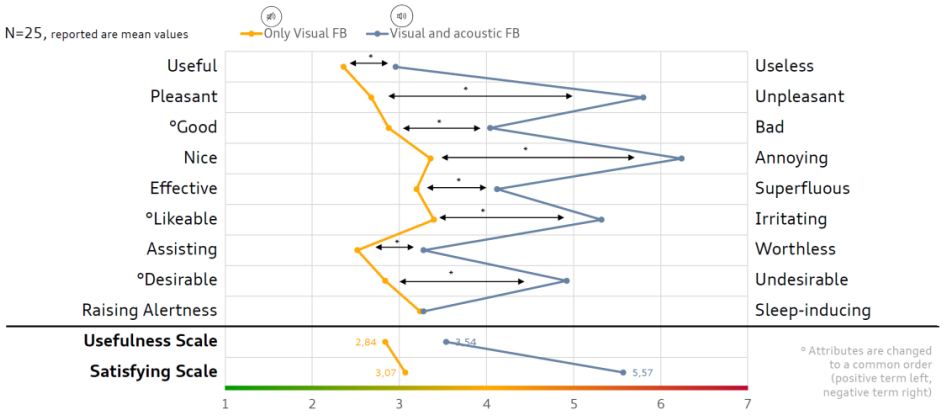
SPEED WARNING

Van der Laan Acceptance Scale

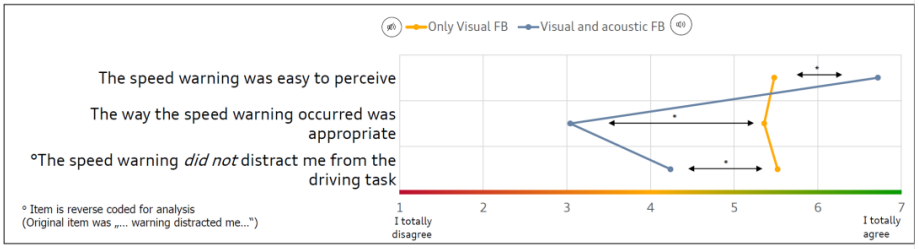


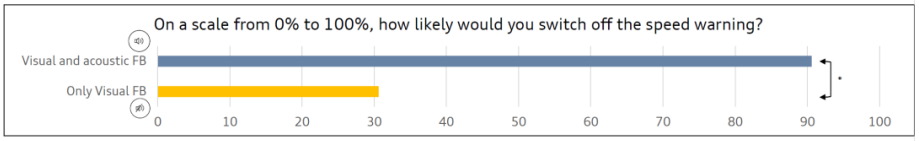
The „Only Visual FB" performs „better" in terms of the Van der Laan Acceptance Scale. Apart from the pair „Raising Alertness – Sleep-inducing" all differences are statistically significant (*p<.05*).

7

SPEED WARNING

Overall Assessment





Apart from the perception, the „Only Visual FB" performs „better" with regard to appropriateness and distraction. All differences are statistically significant (p<.05). Almost all participants said, that it is very likely that they would turn the „Visual and acoustic FB" off. In contrast, only $^1/_3$ of the participants stated, that it is very likely that they would turn the „Only Visual FB" off.

8

SPEED WARNING

Ideal Speed Warning – Open Questions

Preferred warning type? (N=24)

Only visual FB (n=6)	25%
Visual and acoustic FB (n=1)	4%
Individual configuration (n=8)	33%
Others, please specify (n=9)	38%
Only Acoustic FB (n=0)	0%
No preference (n=0)	0%

For instance:

- definition of a tolerance criterion which is accompanied by visual and acoustic feedback
- feedback at 10% speeding

- development of a warning cascade (e.g. 1!, 2. flashing, 3. acoustic feedback

9

SPEED WARNING

Summary

Visual & acoustic feedback

Pros:
- participants percieved the **visual & acoustic** feedback in **100%** of all cases

Cons:
- on average, **visual & acoustic** feedback was rated to be annoying and unpleasant
- **visual & acoustic** feedback is likely to increase the number of deactivations of a speed limit warning function (in this study about **90%** would deactivate this functionality)

Visual feedback

Pros:
- **visual** feedback was accepted by the majority (high usefulness and satisfying scores).
- **visual** feedback is likely to reduce deactivations **(30%)** compared to **visual & acoustic** feedback **(90%)**

Cons:
- **18%** of all cases were not perceived when there was only **visual** feedback

Visual & acoustic feedback

Recommendations:
- users should be able to adjust the feedback type (**visual** or **visual & acoustic**)
- **visual & acoustic** feedback (without offset) increases the number of system deactivations compared to **visual** feedback
- in case of **visual & acoustic** feedback an offset should be provided to ensure user acceptance
- a warning cascade could increase user acceptance

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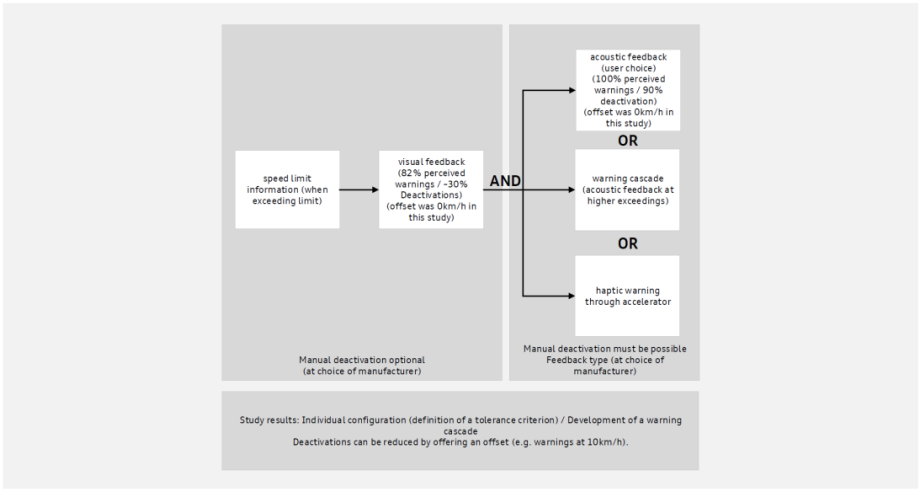
SPEED WARNING
Summary



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ACEA

European Automobile Manufacturers Association

ACEA represents the 16 major Europe-based car, van, truck and bus manufacturers

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9 ANNEX 3: RECENT RESEARCH – TRANSPORT SAFETY STAKEHOLDER

The following slides show a summary of the University of Leeds' ISA Interface Study (Carsten *et al.*, 2020), available in full at: https://environment.leeds.ac.uk/download/downloads/id/5102/isa_interface_study_accessible.pdf

The European Transport Safety Council's (ETSC) accompanying policy briefing document is available at: https://etsc.eu/wp-content/uploads/ISA-PolicyBriefing-InterfaceStudy.pdf

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ISA Interface Study

Oliver Carsten

Funded by ETSC European Transport Safety Council

Laboratory

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Experimental design

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- Within participant, i.e. each participant drove in each of the conditions
- 6 conditions:
  - Baseline with no ISA
  - 5 x ISA, **all with visual warning**:
    1. Auditory warning
    2. Haptic (force feedback) pedal
    3. Vibrating pedal
    4. Speed control + vibrating pedal
    5. Speed control
- Baseline first, then the ISA alternatives in counter-balanced order

- Prior ethics approval

Experimental procedure

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1. Practice drive
2. Baseline drive
3. NASA TLX (workload) questionnaire on baseline drive
4. ISA drives x 5
5. After each drive:
   - NASA TLX
   - Van der Laan usefulness and satisfaction
   - Annoyance scale as if on own
   - Annoyance scale as if with passenger

- Total time approx. 2.5 hours

NASA TLX on workload

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DEFINITION OF 6 FACTORS WHICH DESCRIBE THE LOADS PLACED ON AN INDIVIDUAL DURING THE DRIVING TASK

MENTAL DEMAND
This refers to the 'thinking' component of the driving task. For example, consciously making decisions about the traffic environment or deciding how to respond to the scenarios. How much of this type of thinking, deciding, calculating, remembering, looking, searching, etc. did you need to do? Was the task easy or demanding, simple or complex in this respect?

PHYSICAL DEMAND
How much physical activity was required (e.g. operating brake, clutch and accelerator, steering the vehicle, using the indicator, etc.)? Was the drive easy or demanding, slow or brisk, slack or strenuous in this respect?

NASA TLX on workload

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TIME PRESSURE
Did you feel you had enough time to adequately perform the driving task?

PERFORMANCE
How satisfied were you with your performance in achieving the goals of the driving task i.e. safe driving?

EFFORT
How hard did you have to work (mentally and physically) to achieve your level of performance? Did you feel stretched or comfortable during the drive?

FRUSTRATION LEVEL
How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the driving task?

NASA TLX on workload

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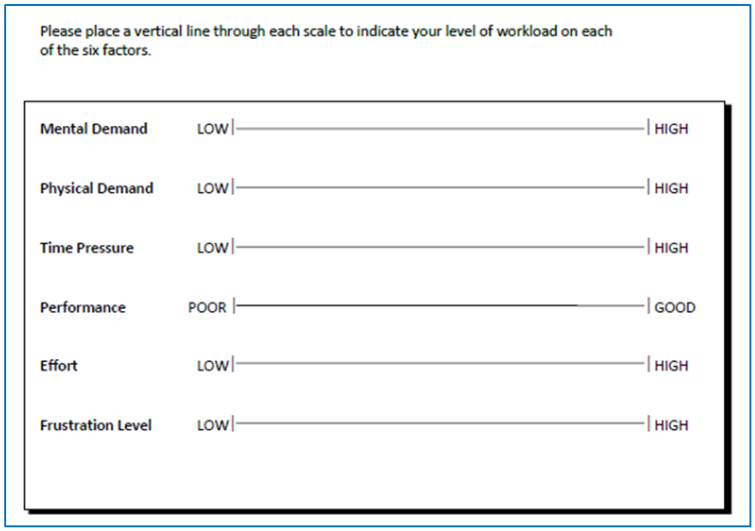

Please place a vertical line through each scale to indicate your level of workload on each of the six factors.

Mental Demand	LOW	HIGH
Physical Demand	LOW	HIGH
Time Pressure	LOW	HIGH
Performance	POOR	GOOD
Effort	LOW	HIGH
Frustration Level	LOW	HIGH

Van der Laan usefulness and satisfaction

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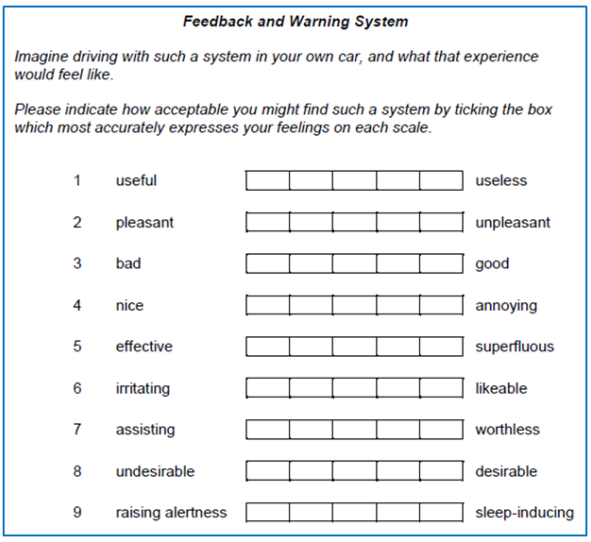

Feedback and Warning System

Imagine driving with such a system in your own car, and what that experience would feel like.

Please indicate how acceptable you might find such a system by ticking the box which most accurately expresses your feelings on each scale.

1	useful		useless
2	pleasant		unpleasant
3	bad		good
4	nice		annoying
5	effective		superfluous
6	irritating		likeable
7	assisting		worthless
8	undesirable		desirable
9	raising alertness		sleep-inducing

Annoyance questionnaire

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Pleasantness Questionnaire

Imagine driving on your own with such a system in your own car, and what that experience would feel like.

Please place a vertical line through the scale below to indicate how pleasant or annoying you found the feedback and warnings that you experienced on your last drive.

Pleasant |——————————————————| **Annoying**

Now imagine driving with such a system in your own car, but also having a passenger in the front seat accompanying you.

Please place a vertical line through the scale below to indicate how pleasant or annoying you would have found the feedback and warnings that you experienced on your last drive.

Pleasant |——————————————————| **Annoying**

Road

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- Length 14.3 km
- All UK speed limits
- Auditory messages to encourage feeling of being in a hurry

Participants

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- 30 in total
- 15 male, 15 female
- Mean age: 43.5 years (SD 14.5)
- Holding full UK licence
- Driving at least 3 days per week or 50 miles per week

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Speed compliance

20 mph limit

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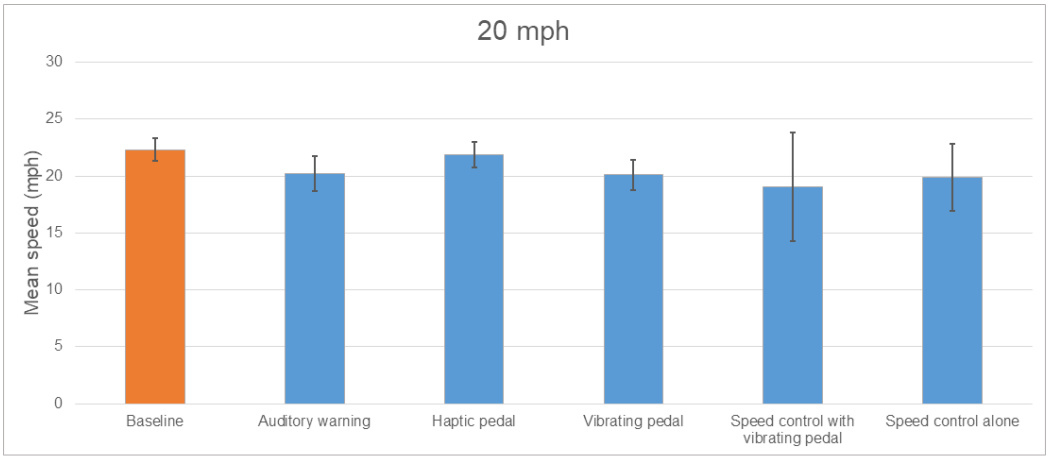

30 mph limit

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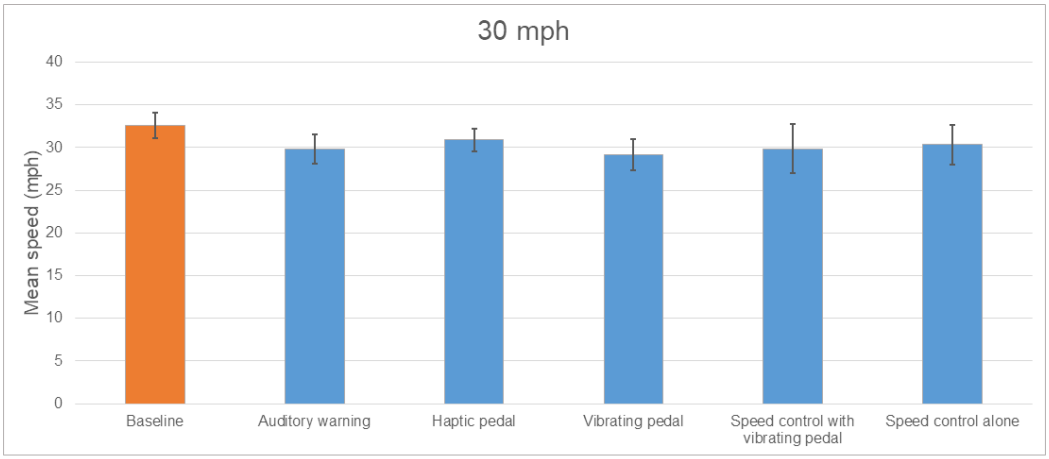

40 mph limit

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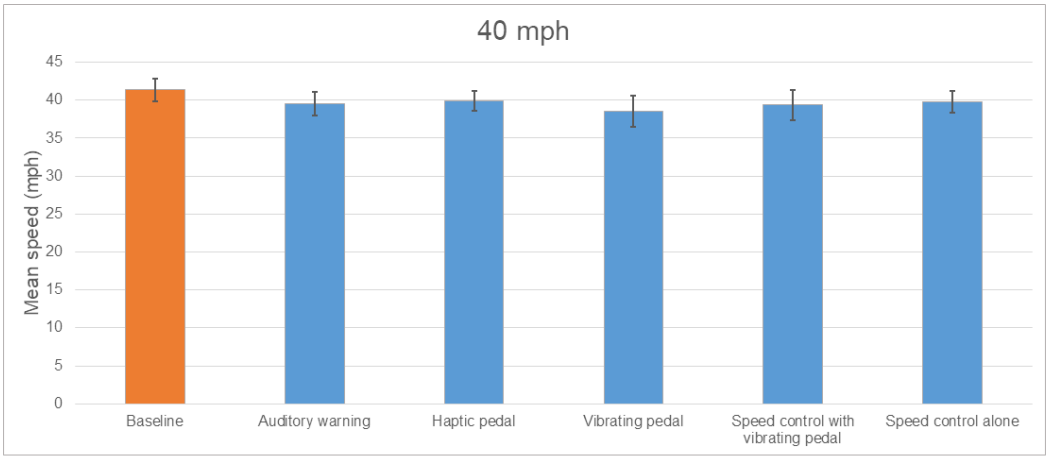

50 mph limit

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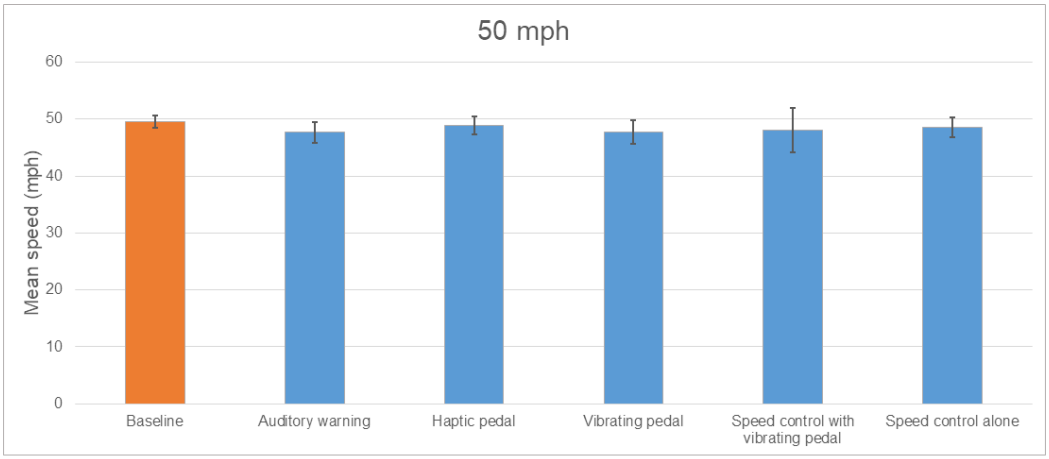

60 mph limit

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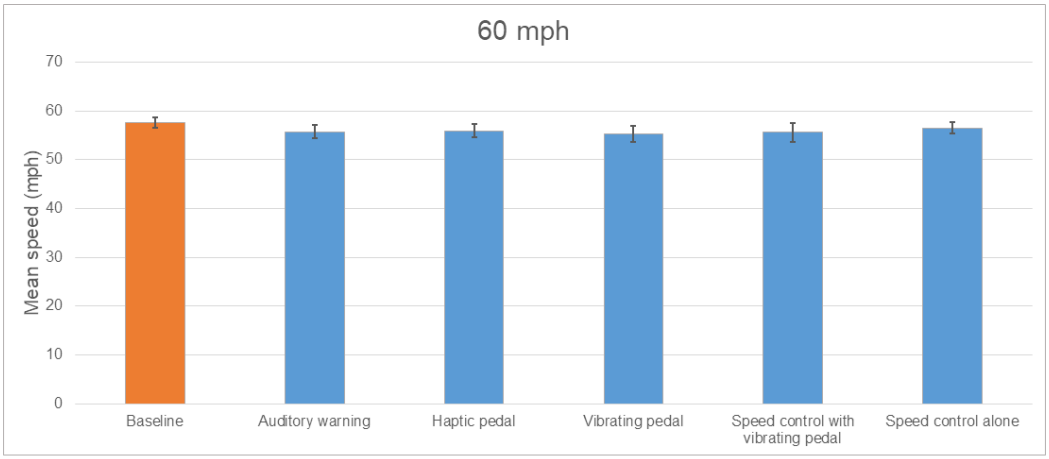

70 mph limit

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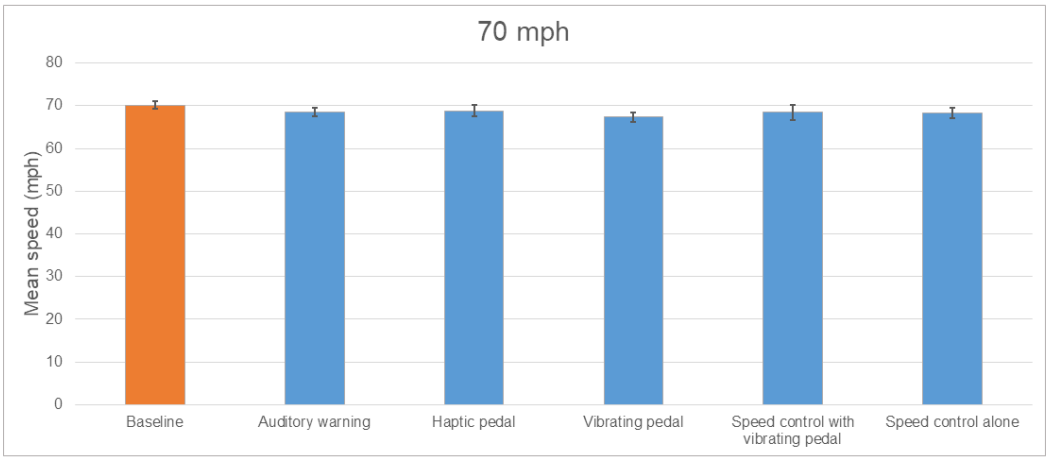

Total

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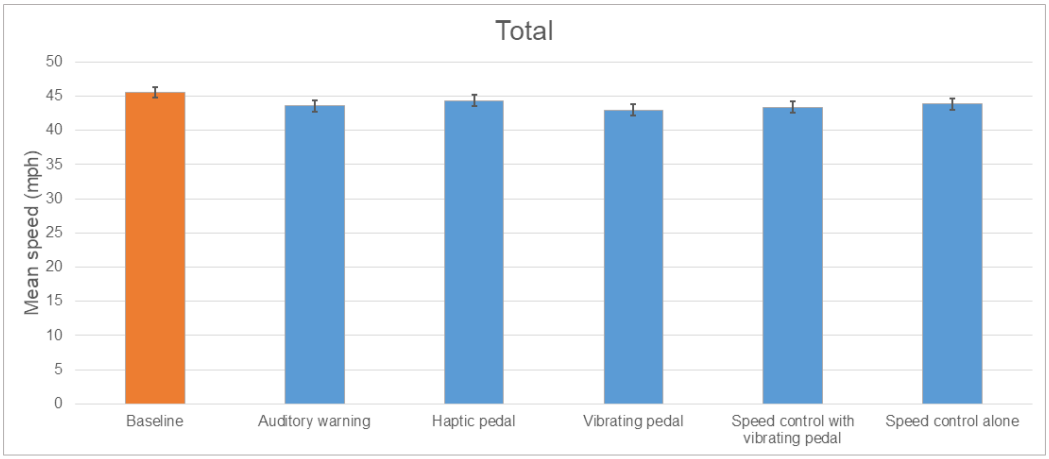

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Questionnaires

NASA TLX, mental demand

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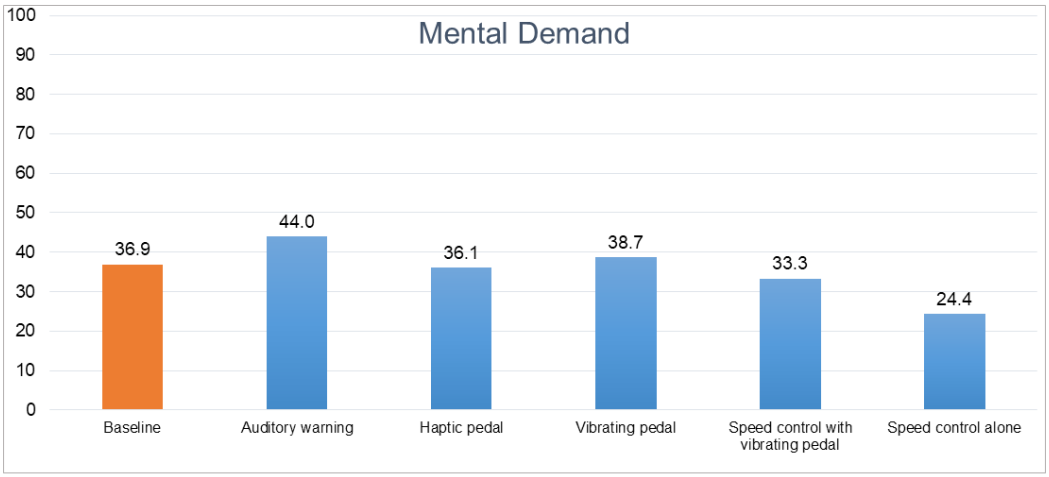

NASA TLX, physical demand

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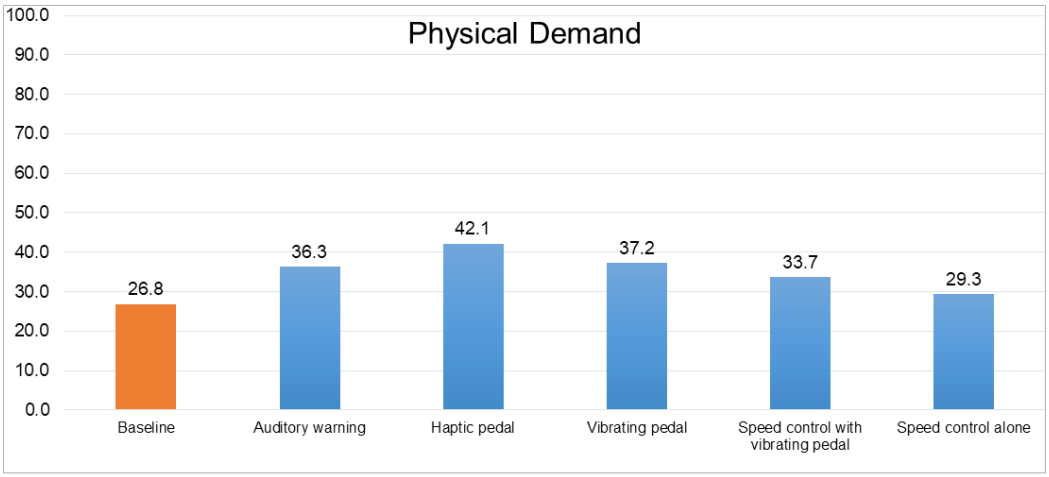

NASA TLX, time pressure

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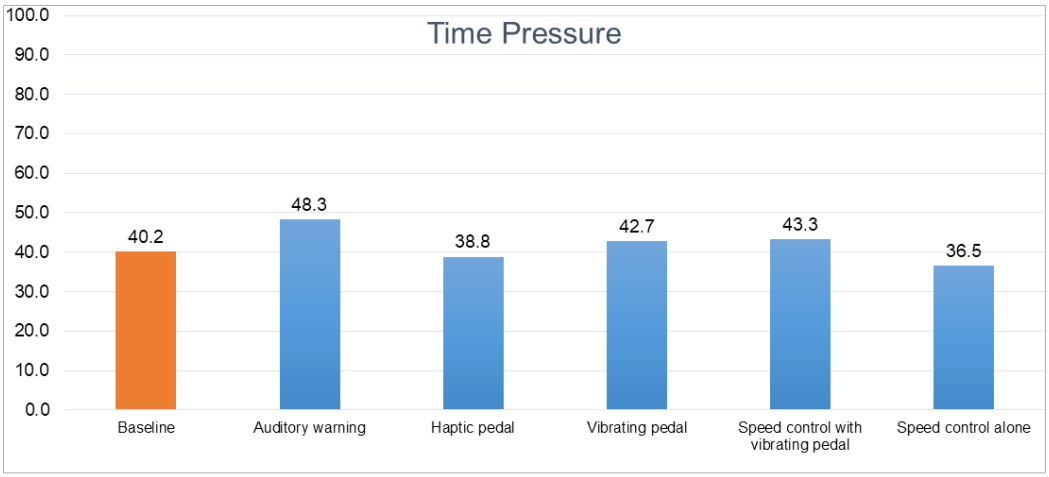

NASA TLX, performance

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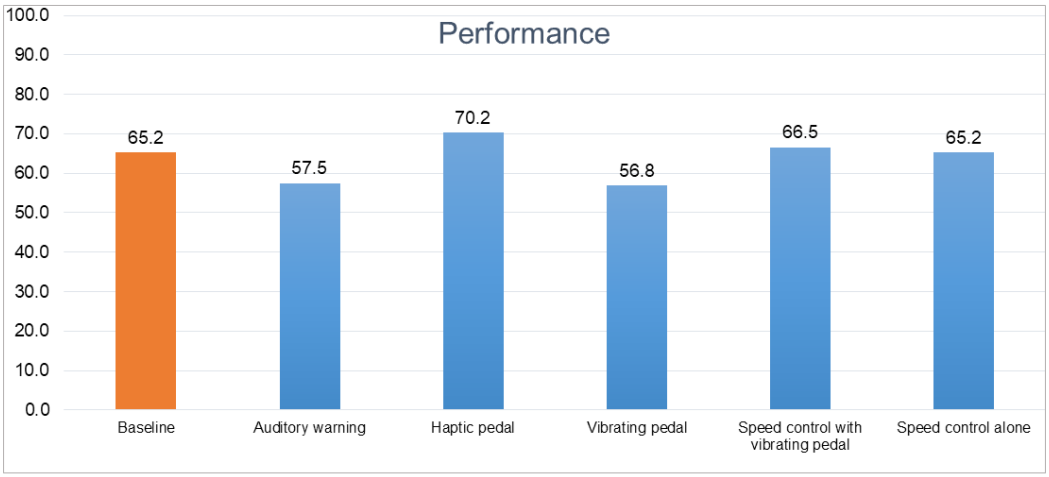

NASA TLX, effort

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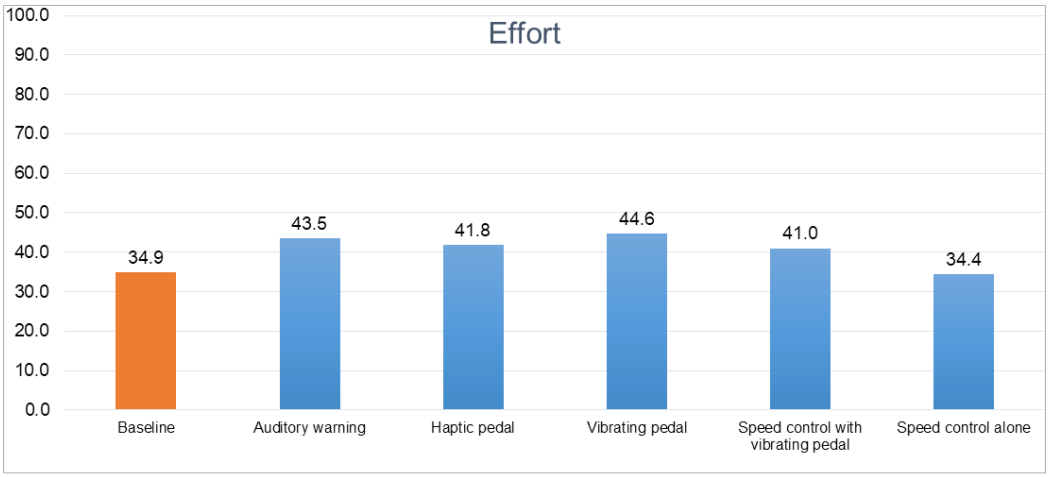

NASA TLX, frustration

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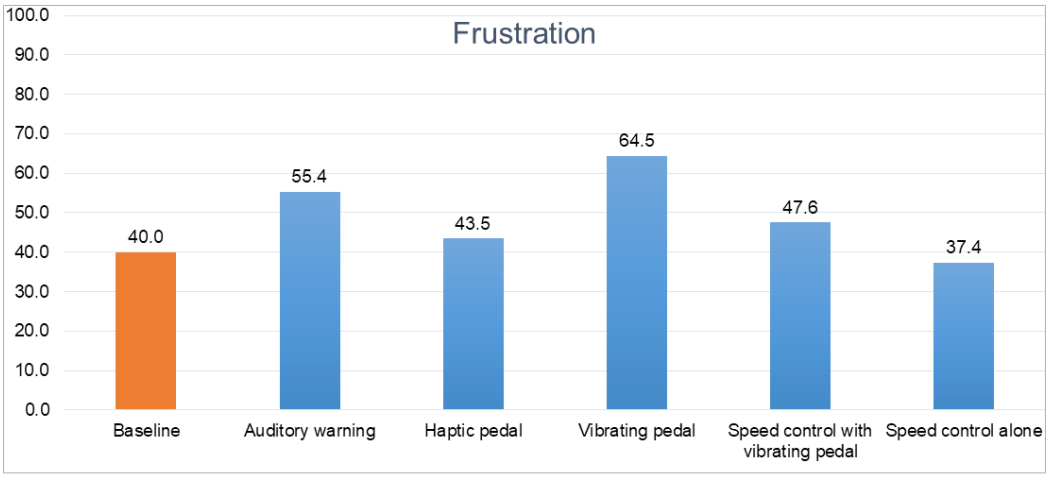

Van der Laan

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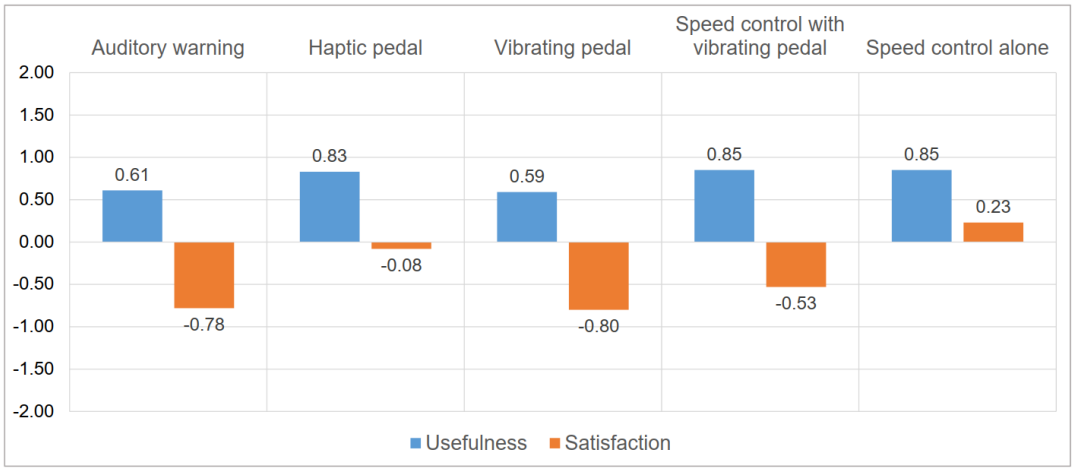

Pleasant or annoying

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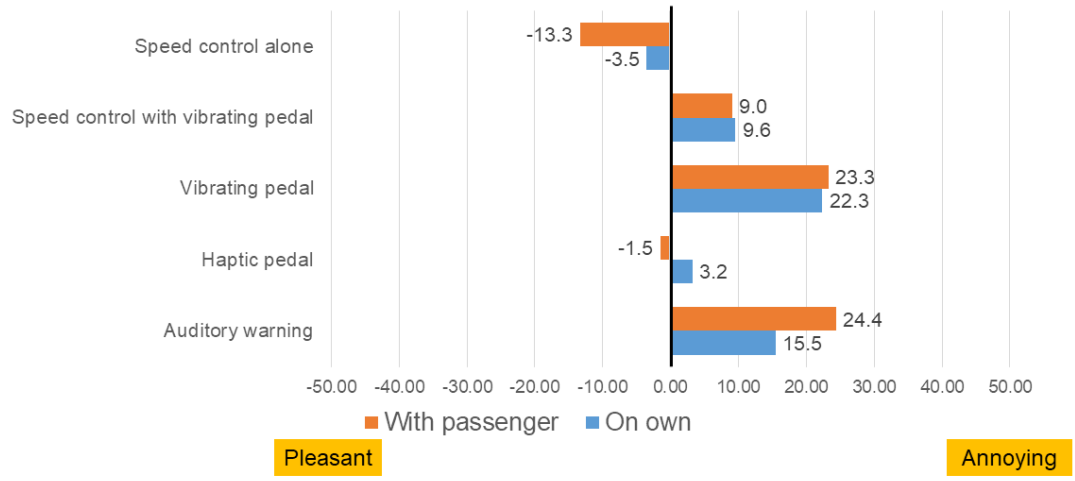

Discussion

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- Overall effectiveness of a system will be combination of its immediate impact on speeding combined with its usage
- If a system is considered to be unpleasant or annoying, it will be switched off
- This would suggest that neither the Auditory Warning nor the Vibrating Pedal (without Speed Control) are good choices
- The most positive rating on the Pleasant/Annoying scale was for Speed Control Alone, followed by the Haptic Pedal and Speed Control with Vibrating Pedal. Each of those three systems can therefore be considered to have reasonable acceptance.

10 ANNEX 4: CATALOGUE OF ROAD SIGNS – POTENTIAL CONTENTS

Normative elements required for each applicable road sign (by EU member state):

- Description / type;
- Design variants with pictograms (note that variable message signs should be included); and
- Associated road speed limits by vehicle category (and permissible maximum mass, if applicable) and road class.

Informative elements that could be included to avoid inefficiencies created by individual system designers having to collect information:

- Additional sign properties, for example dimensions with tolerances, colours and font (size, colour, shape), material, retro-reflectivity, etc.;
- Position, for example, minimum and maximum distance from road edge, minimum and maximum height, variation of angle to road about z-axis, sign rotation around x-axis, number of signs on same pole, etc.;
- National requirements for repeater signs and conditions for implicit speed limit termination;
- Associated road speed limits by special variable conditions, for example trailer status, prevailing environmental conditions, time of year, driver age or experience, standing passengers, etc.

ACEA have supplied an Excel spreadsheet to the Commission which contains an initial draft of potential information they propose should be included in a catalogue (Figure 2).

TRL's proposed draft template, taking into account ACEA's suggestions, is presented in Table 1.

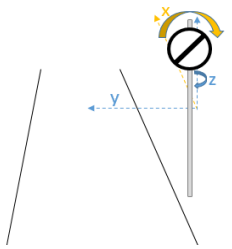
				NAME OF MEMBER STATE				
				NAME, ADDRESS OF THE ROAD AUTHORITY IN CHARGE AS WELL AS: ALL OTHER RELATED ROAD AUTHORITIES WORKING AND IMPLEMENTING SIGNS ALL PRIVATE ORGANISATIONS RESPONSIBLE FOR PRIVATIZED ROADS ALL AGENCIES, OFFICES AND COMMUNES WORKING ON ROADS (E.G. CONSTRUCTION SITES) PLACING SPEED LIMITS				
#	DESCRIPTION	VIENNA CONF.	REQUIRED	SIGNS	TRAFFIC RULE	PROPERTIES	POSITION	REMARK
1	Numerical road signs including temporary and variable message signs		YES	CREATE OVERVIEW AND DATABASE INCLUDING **EACH POSSIBLE** AND **USED SIGN** IN THE SPECIFIC COUNTRY. OVERVIEW CONTENTS ALL: - DESIGN VARIANTS (WITH PICTOGRAMM) INCLUDING LED SIGNS - RESOLUTION AND FORMAT TO BE DEFINED - IN WHICH SIGNS MAY THIS SIGNS BE INCLUDED AND WITH WHICH DIMENSIONS AND POSITIONING? LIST ALL SIGNS - ...	CREATE OVERVIEW AND DATABASE OF **FORMER** (BUT STILL USED), **CURRENT AND FUTURE** TRAFFIC RULES. OVERVIEW CONTENTS ALL: - TRAFFIC RULES - USED EXEMPTIONS FOR VEHICLE CATEGORIES IN THE MEMBER STATE WITH ITS REQUIREMENTS FOR SPEED - USED ESEMPTIONS DUE TO TIME, WEATHER, SEASON, AREA ... - DEFINITIONS OF VALIDITY OF SPEED LIMITS BASED ON TIME, DISTANCE, INFRASTRUCTURE (E.G. SPEED LIMIT IS VALID UNTIL NEXT CROSSING, REGULATION FOR END OF SPEED LIMIT AT CONSTRUCTION ZONES ...) - DEFINITION OF NEEDED AMOUNT AND POSITIONING OF SIGNS - PERIOD OF CLEANING, MAINTENANCE AND EXCHANGE OF SIGNS - INFOSYSTEM TO AUTHORITY ABOUT DIRTY OR DAMAGED SIGNS - SPEED LIMIT RULES FOR COMBINATION OF FIXED SIGNS AND TEMPORARY LED SIGNS (E.G. FIXED SIGN WITH VALUES SETS SPEED LIMIT AND 200M FURTHER DOWN THE ROAD A TEMPORARY LED SIGN IS NOT SHOWING ANY LIMIT [BLACK SCREEN]. IS THE FIXED SIGN THEN VALID OR THE SPEED LIMIT HIGHER?) - PROCESS OF SIGN DESIGN CHANGES IN THE COUNTRY - ...	CREATE OVERVIEW AND DATABASE INCLUDING **EACH POSSIBLE** AND **USED** SIGN IN THE SPECIFIC COUNTRY. OVERVIEW CONTENTS ALL: - DIMENSIONS MIN AND MAX - COLOUR (RAL, ...) AND FONT (SIZE, COLOUR, SHAPE). DO DIFFERENT COLORS CAUSE DIFFERENT MEANINGS AS E.G. MOTORWAY SIGN BLUE/GREEN IN ITALY?) - MATERIAL -RETROREFLECTIVITY - WIDTH OF OUTER RING, THICKNES AND AMOUNT OF ALL LINES, SYMBOLS AND BORDERS - RESOLUTION AND BRIGHTNESS OF LED SIGNS - USED PICTOGRAMMS AND THEIR VARIANTS - SHAPE OF EDGES, USED RADIUS - 3D CONTOUR OF SIGN ITSELF OR PRINTING ON IT - ...	CREATE OVERVIEW AND DATABASE FOR **POSITIONING OF SIGNS** IN THE SPECIFIC COUNTRY. OVERVIEW CONTENTS: - POSITIONS USED (LEFT, RIGHT, ABOVE, PAINTED ON STREET) - MIN AND MAX DISTANCE FROM ROAD EDGE - MIN AND MAX HEIGHT - VARIANTS OF ANGLE TO ROAD (AROUND Z AXIS OF SIGN POLE) - SIGN ROTATION (AROUND X AXIS) - AMOUNT OF SIGNS PER STREET TYPE (BOTH SIDE OF THE ROAD OR ONLY LEFT/RIGHT/ABOVE) - MEASURES FOR KEEPING VISIBILITY (TIMEFRAME FOR CUTTING TREES, PARKING PROHIBITION, ...) - AMOUNT OF SIGNS ON THE SAME POLE - AMOUNT AND WAYS OF ARANGING THE SIGNS TOGETHER - ...	PLEASE ADD HERE ALL **POSSIBLE** ADDITIONAL **INFORMATION**. THIS COULD BE: - SIGN ACCORDING OR NOT ACCORDING TO VIENNA CONVENTION **- IF SO DESCRIPE DIFFERENCES** - HOW WILL SIGNS BE PERMANENTLY OR TEMPORARILY **INVALIDATED** (E.G. IN CONSTRUCTION ZONES) SO THAT THEY ARE NO LONGER RECOGNIZED BY THE CAMERA (E.G. COVERED, TURNED, DEMOUNTED) - HOW ARE SIGNS ADDITIONAL MARKED OR POSITIONED TO DECIDE FOR WHICH STREET THEY ARE VALID (E.G. PARALLEL ROADS) - ALL VARIANTS OF ADDITIONAL INFO SIGNS (E.G. WET, SNOW, TIME OF DAY WHERE SPEED LIMIT IS VALID, ...)	
2	End of speed limit or 'national speed limit applies' signs		YES					
3	End of specific speed limit or speed limit zone signs		YES					
4	Place name signs used to indicate the presence of a speed limit and their associated cancellation signs		YES					
5	Urban area signs and their associated cancellation signs		YES					
6	Home zone or residential zone signs		YES					
7	Motorway regulations apply signs		YES					
8	Expressway regulations apply signs		YES					
9	Vehicle category specific signs		YES					
10	Additional conditions apply (including rain, snow, time of day, arrows, distance or advance warning)		NO					

Figure 2: Overview of draft template for catalogue of road signs, supplied by ACEA to the European Commission as Excel spreadsheet

Table 1: TRL's proposed template for the catalogue of road signs

Catalogue of Road Signs for Intelligent Speed Assistance (ISA) systems									
Version: [version number]									
Applicable from: [date]									
EU member state: [member state name]									
Vehicle category: [M_1 / M_2 / M_3 / N_1 / N_2 / N_3]									
Normative elements:					**Informative elements:**				
Sign type	**Sign variant**	**Description**	**Pictogram**	**Associated road speed limit for vehicle category concerned**	**Sign properties**	**Sign position**	**Repeater signs and termination**	**Special variable conditions**	**Additional information**
1	**A**	Description of variant A of sign type 1	Pictogram of variant A of sign type 1	All road types: [x km/h] OR Urban, extra-urban, expressway, motorway: [w, x, y, z km/h] AND/OR Split by permissible maximum mass	National standards concerning: - Dimensions with tolerances - Colours and font (size, colour, shape) - Material - Retro-reflectivity - Width of outer ring - Thickness and amount of all lines, symbols and borders - Resolution and brightness of variable message signs - etc.	National standards concerning: - Positions used (left, right, above) - Minimum and maximum distance from road edge - Minimum and maximum height - Variation of angle to road about z-axis - Sign rotation around x-axis - Number of signs on same pole - etc.	National standards concerning: - Distance between repeater signs - Number of repeater signs - conditions for implicit speed limit termination	Associated road speed limits by special variable conditions: - Trailer status - prevailing environmental conditions - time of year - driver age or experience - standing passengers - etc.	Other information: - How are signs temporarily invalidated (e.g. at road works)? - How are signs marked or positioned to indicate applicable carriageway?

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