



# **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): Interim report



## **EUROPEAN COMMISSION**

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## EXECUTIVE SUMMARY

TRL are providing support to the European Commission to develop the General Safety Regulation (GSR), specifically the secondary type approval legislation for a range of vehicle safety measures. The work reported is related to the Intelligent Speed Assistance (ISA) safety measure. ISA is a system to aid the driver in maintaining the appropriate speed for the road environment by providing dedicated and appropriate feedback. The objective was to develop draft technical annexes setting out requirements and test procedures for secondary type approval legislation for ISA systems for vehicle categories M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub>, N<sub>1</sub>, N<sub>2</sub> and N<sub>3</sub>.

Within the legislative remit as laid down by the co-legislators in General Safety Regulation (EU) 2019/2144, defined by the European Parliament and the Council for the Commission, TRL was presented with some key questions relating to the two principal functionalities of ISA systems, namely determining the applicable road speed limit and providing feedback to the driver. These included:

- Determining the applicable road speed limit:
  - Which road signs and signals should the system be required to recognise?
  - Which metrics (key performance indicators) should be used to measure the performance of camera-only as well as map and camera fusion systems in regulation?
  - How can the functionality and performance (in all European member states, in a variety of real road conditions) be tested in an effective and efficient way?
  - Which minimum performance levels should be required in real-road conditions?
  - How should performance in changing infrastructure environments after approval be regulated?
- Providing feedback to the driver:
  - Should visual speed limit information to the driver be required?
  - Which feedback functions should be permissible?
  - What are suitable test procedures for the feedback functions?

To address these and other questions and to develop recommendations for regulation contents, TRL performed bi-lateral consultations with industry experts, technical analysis and reviews of: speed limits and their indication in EU member states, existing test procedures and standards, and existing speed assistance systems on the market.

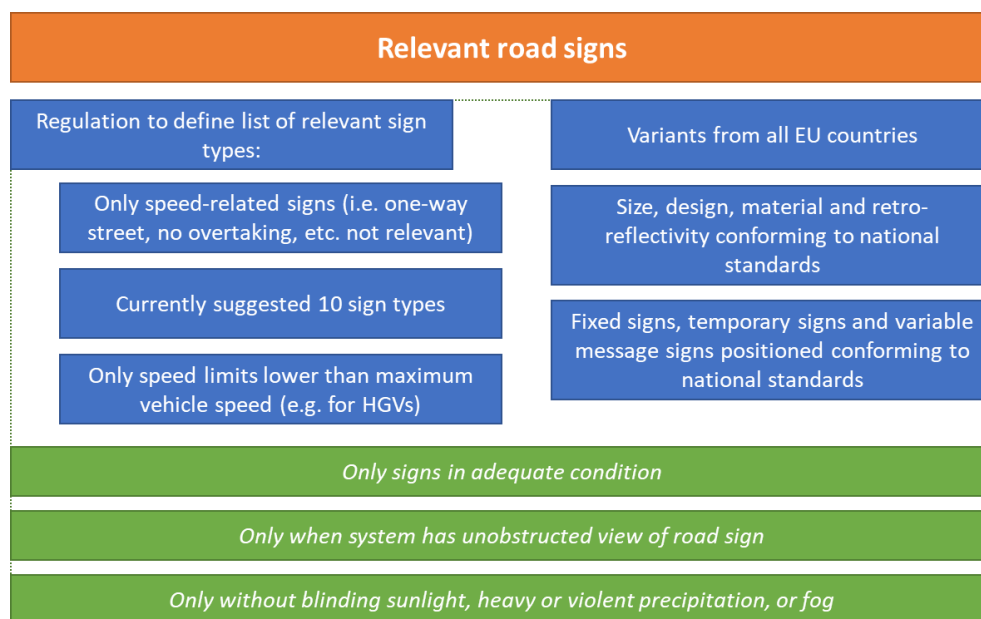
TRL determined the following items should be covered in the ISA type approval regulation:

- Definitions
- Subject matter (scope) and exemptions
- Requirements
  - Functional requirements for speed limit determination
  - Real-road performance of speed limit determination
  - Performance in changing infrastructure environments
  - Speed limit information
  - Speed limit feedback (warning or speed control)
  - Deactivation

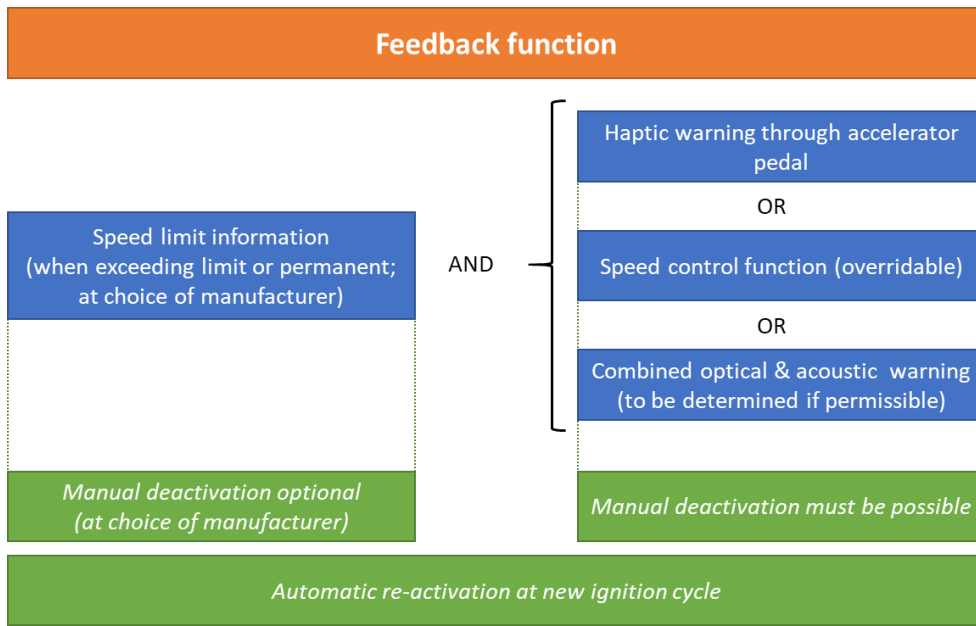
- Self-check and failure warning
- Provisions for the periodic technical inspection
- Privacy and data protection
- Assessment procedures
  - Test procedure for functional requirements of speed limit determination
  - Documentation procedure for real-road performance of speed limit determination
  - Test procedure for speed limit warning
  - Test procedure for speed control

TRL's preliminary recommendations on regulation contents for each of these items are discussed in the main body of the report. The following figures present a high-level overview of the recommendations on selected aspects:

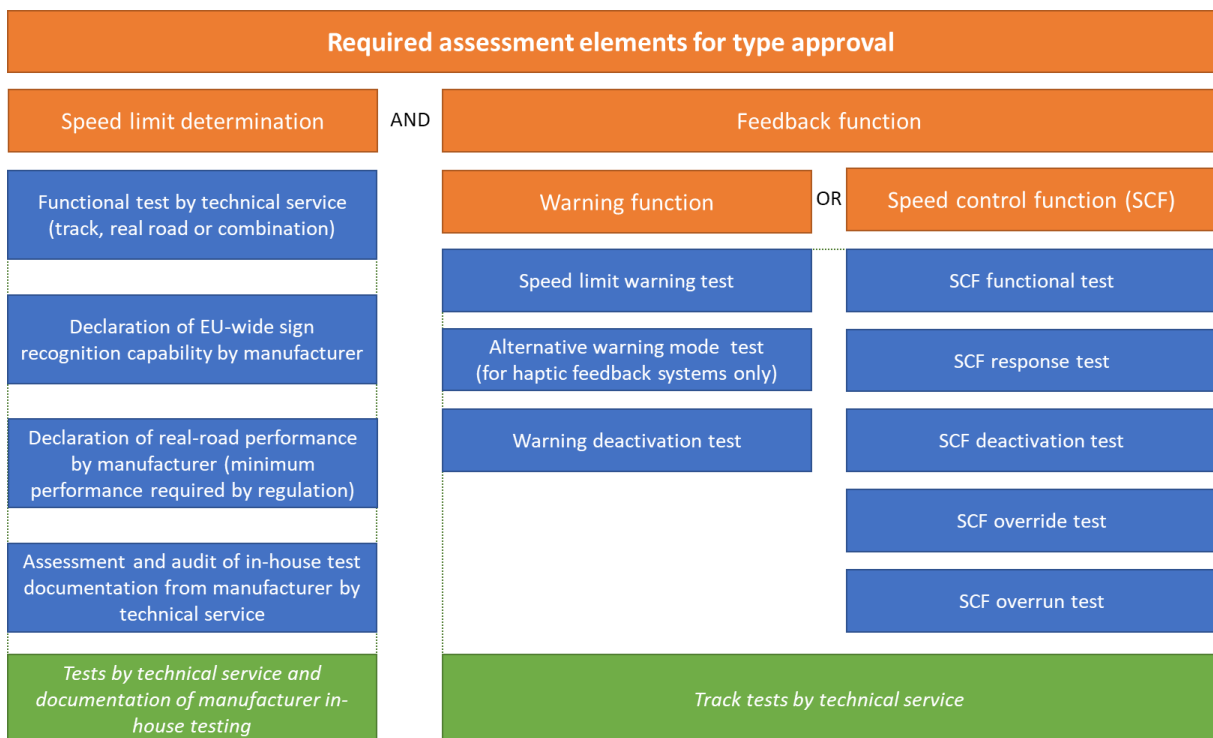
- Relevant road signs: Figure 1
- Speed limit information and feedback modes: Figure 2
- Test and assessment procedures: Figure 3



**Figure 1: TRL's recommendation regarding relevant road signs, i.e. signs that need to be recognised with a defined minimum level of performance**



**Figure 2: TRL’s recommendation regarding speed limit information and feedback modes**



**Figure 3: TRL’s recommendation regarding test and assessment procedures for type approval**

## 1 INTRODUCTION

TRL are providing support to the European Commission to develop the General Safety Regulation (GSR), specifically the secondary type approval legislation for the following vehicle safety measures:

- 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<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub>, N<sub>1</sub>, N<sub>2</sub> and N<sub>3</sub>.

This report is the interim deliverable on ISA giving an overview of the review and consultation activities undertaken, the level of expert involvement acquired, and a preliminary list of items to be covered in the ISA type approval regulation and TRL's view of an initial outline of potential regulation contents for consultation with the Commission and stakeholders.



## 2 PRINCIPLES AND REMIT

### 2.1 Principles

The principles TRL followed to support the European Commission in developing new secondary type approval regulation for Intelligent Speed Assistance (ISA) systems are listed below, in terms of general principles and those specific to ISA. These were derived from the insights brought by consultations with the European Commission, the legal framework as laid down by the co-legislators in General Safety Regulation (EU) 2019/2144, and expert stakeholders.

- General
  - The regulation should not be design restrictive and, as far as possible, should be performance-based.
  - A minimum level of performance should be ensured by the developed regulation, utilising currently and readily available technology, in line with the current timescales for implementation.
- ISA
  - ISA is an active safety system which assists the driver, who should have control of the vehicle at all times. An ISA system should:
    - Determine the speed limit for the driven road based on observation of road signs and signals, with current state of technology typically using a camera or camera & map-based system
    - Alert the driver (through the accelerator control) if the vehicle is exceeding the posted speed limit, automatically limit the driving speed, or provide other feedback
    - Not cause annoyance to the driver with unnecessary speed alerts or restrictions, which will encourage drivers to switch off the system completely

For the purposes of regulation and as laid out in more detail in Section 2.2 TRL interpret ISA systems as a combination of three elements:

- Speed limit determination
- Providing information to the driver on the current limit
- Providing feedback to the driver when the vehicle travels faster than the speed limit

The core of these is the speed limit determination, i.e. the capability of the system to perceive the speed limit for the section of the road on which the vehicle is travelling at any given moment. Typically, this would be accomplished by visually perceiving and interpreting information from speed limit road signs, or by combining visually perceived information with data from a digital map.

The second element is the Speed Limit Information Function (SLIF), which provides information to the driver on the speed limit currently in force for that vehicle to assist them in maintaining the speed of the vehicle within the legal speed limit.

The third element is the Speed Limit Warning Function (SLWF), which provides feedback to the driver when the vehicle is exceeding the posted speed limit. This feedback could also be provided via a Speed Control Function (SCF) that actively controls the speed of the vehicle via torque reduction or the application of the service brakes.

## 2.2 Remit

The remit of the Commission's mandate for secondary type approval legislation for ISA was set and informed by the General Safety Regulation (EU) 2019/2144 that entered into force on 5 January 2020 and that will apply as from 6 July 2022.

An ISA system is defined in Article 3 as:

- *"a system to aid the driver in maintaining the appropriate speed for the road environment by providing dedicated and appropriate feedback".*

TRL has interpreted this to mean that an ISA system should be implemented as a driver aid, giving them feedback in order to alert them to the current speed limit and help them not exceed it.

The GSR will require the fitment of ISA systems for the vehicle categories: M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub>, N<sub>1</sub>, N<sub>2</sub> and N<sub>3</sub>. The requirement will apply to new types from 6<sup>th</sup> July 2022, and to new vehicles from 7<sup>th</sup> July 2024.

ISA and other systems are being mandated due to their potential for a significant reduction in road casualties; by assisting drivers in knowing and self-enforcing European speed limits. The European Parliament and the Council have therefore mandated that ISA systems should be subjected to European type-approval regulation and able to pass standardised tests. Recital 10 also states expectations regarding privacy and data protection and operability throughout a vehicle's life cycle in relation to ISA and other systems:

- *"[...] intelligent speed assistance [... has] a high potential to reduce casualty numbers considerably [and] should function without use of any kind of biometric information of drivers or passengers, including facial recognition. Therefore, harmonised rules and test procedures for the type-approval of vehicles as regards those systems and for the type-approval of those systems as separate technical units should be established at Union level. The technological progress of those systems should be taken into account in every evaluation of the existing legislation, in order to be future proof, strictly adhering to the principle of privacy and data protection, and to reduce or to eliminate accidents and injuries in road transport. It is also necessary to ensure that those systems can be used safely, throughout the life cycle of the vehicle".*

Recital 14 does not explicitly mention ISA systems but explains how the recording of information, to Event Data Recorders, must conform to data protection and privacy laws. Information from ISA systems about alleged speed violations might be relevant in this context.

- *"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 advanced driver distraction, should be carried out in accordance with Union legislation on data protection, in particular Regulation (EU) 2016/679 of the European Parliament and of the Council. Event data recorders should operate on a closed-loop system, in which the data stored is overwritten, and which does not allow the vehicle or driver to be identified. In addition, the driver drowsiness and attention warning or advanced driver distraction warning should not continuously record nor retain any data other than what is necessary in relation to the purposes for which they were collected or otherwise processed within the closed-loop system. Furthermore, the processing of personal data collected through the 112-based eCall in-vehicle system is subject to specific safeguards."*

The General Safety Regulation makes a proclamation on the operation of ISA systems in Recital 11;

- *"It should be possible to switch off intelligent speed assistance, for instance, when a driver experiences false warnings or inappropriate feedback as a result of inclement weather conditions, temporarily conflicting road markings in construction zones, or misleading, defective or missing road signs. Such a*

*switch-off feature should be under the control of the driver. 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. When the system is switched off, information about the speed limit may be provided. The system should be always active when switching the ignition on and the driver should always be made aware of whether the system is on or off”.*

TRL considers this statement to be in regard to general operation and use of the ISA system and how it presents itself to the driver. In order to avoid driver annoyance the system should be capable of being switched off, especially in conditions in which it is objectively using incorrect speed limits. A single button press operation would not be excluded as long as it clearly stated its function to the driver. As an ISA system would be classified as an assistance system, it should be relatively easy to switch the system back on. The ease of switching the systems back on may also allow for systems which can have speeding feedback suppressed but still display the speed limit to the driver. TRL interprets the final sentence of the statement above to mean that any ISA system should be turned on with the activation of the master control switch. The driver must be informed permanently if the system is off or on, for example via a tell tale.

Within Section 2 of Article 6, the following minimum specifications for ISA are listed;

- *“(a) 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;”*

TRL has interpreted this to mean that the driver should be made aware of excessive speed through such methods as, but not restricted to, feedback conveyed through the accelerator pedal, for instance using pedal vibration, increased resetting force of the pedal or a ‘dead pedal’ speed control function. The above statement includes other forms, such as potentially acoustic, optical, or other haptic feedback, providing that they are effective (i.e. causes the driver to keep the speed below the limit or lower it accordingly), appropriate (i.e. ensures the driver is aware of the speed limit when being at risk of accelerating past or already exceeding it) and dedicated (i.e. cannot be confused by the driver for any other warning or alert).

Functionality for an Intelligent Speed Assistance system can also include a suppressed state, as defined below in the GSR, where the SCF and SWF can be deactivated but the SLIF may operate normally;

- *“(b) it shall be possible to switch off the 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;”*

The Regulation explicitly states the information upon which the feedback to the driver shall be based;

- *“(c) 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;”*

TRL, after consultation with the European Commission, moved forward with the interpretation that ‘observation’ of roads signs was considered 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, future vehicle-to-infrastructure signals or electronic map data. The statement above therefore includes camera-only systems (if they can interpret variable message signs) and camera & map fusion systems, but does not include map-only ISA systems.

As the intention of the co-legislator was to deem ISA as a driver assistance system, the proclamation also states the following;

- *“(d) it shall not affect the possibility, for the drivers, of exceeding the system’s prompted vehicle speed;”*

TRL understands this statement to mean that drivers will be able to overcome a potential speed control function by applying a positive action (override). This has been interpreted to be a method of allowing drivers to negotiate hazardous scenarios or overcome incorrect warnings or limitations.

TRL interprets the final statement on Intelligent Speed Assist to relate to its capabilities to determine the applicable speed limit in real-world conditions, specifically, including an aspect to reduce (to an acceptable minimum) or eliminate the false reporting of speed limits. It is written as follows;

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

To address the final specification, TRL will be exploring and stipulating minimum ISA performance requirements.

### 3 REVIEWS AND CONSULTATIONS

#### 3.1 Review of speed limits and their indication in EU member states

Speed limits and the methods by which they are indicated to road users are set at a national level and thus vary significantly between EU member states (Table 1). Speed limit signs and other signs with implicit speed limits attached broadly comply with the 1968 Vienna Convention on Road Signs and Signals<sup>1</sup> in all EU and EEA member states, although Ireland, Malta, Andorra and Lichtenstein are not signatories to the convention. This national variation is the source of some difficulty to the manufacturers of ISA systems, who must ensure that the database of sign types and speed limits used by their system includes data for all EU nations.

This section outlines the types of road sign that are used to communicate speed limits across Europe and seeks to illustrate the level of variation seen between member states. This section is not intended to be a definitive list of European speed limits or road signs.

##### 3.1.1 Fixed road signs for indicating the applicable speed limit

###### 3.1.1.1 Numerical signs

All EU and EEA countries use a round sign with a red rim and a number written in black numerals to indicate the speed limit for a particular road (Figure 4). The background of the sign is white in all EU and EEA countries except Finland, Sweden and Iceland where it is yellow (Figure 5).



**Figure 4: the design of road sign commonly employed to indicate the current speed limit**

(This road sign image is in the [public domain](#) according to the copyright law of [Austria](#) because it is part of the Austrian Straßenverkehrszeichenverordnung (Road Traffic Sign Ordinance), or other statutes, ordinances or official decrees proclaimed officially (§ 7 Abs. 1 UrhG).

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<sup>1</sup> [https://www.unece.org/fileadmin/DAM/trans/conventn/Conv\\_road\\_signs\\_2006v\\_EN.pdf](https://www.unece.org/fileadmin/DAM/trans/conventn/Conv_road_signs_2006v_EN.pdf)



**Figure 5: a speed limit sign with a yellow background as used in Finland, Sweden and Iceland** (This file is in the public domain in Finland because it is a part of a decision or a statement issued by a public authority or other public body in Finland. Section 9 of the Finnish Copyright Act specifies that no copyright exists in such material.)

The number conveys the speed limit for that section of road in kilometres per hour in all EU member states except the U.K., where the limit is given in miles per hour.

In the Republic of Ireland, which shares a land border with the U.K., and Malta, the sign also shows km/h under the number (Figure 6).



**Figure 6: a speed limit sign from the Republic of Ireland that includes 'km/h' under the number** (This work is ineligible for [copyright](#) and therefore in the [public domain](#) because it consists entirely of information that is [common property and contains no original authorship](#).)

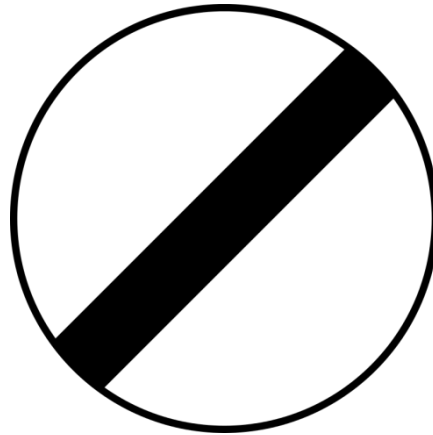
Most EU and EEA countries have signs to indicate the entrance to a speed limit 'zone', i.e. usually an urban area in which all of the roads within the 'zone' have a speed limit below the normal national limit for that type of road. The design of these signs differs between countries, but all incorporate the standard round speed limit sign (Figure 7).



**Figure 7: speed limit zone signs from Austria (L)** (This road sign image is in the public domain according to the copyright law of Austria because it is part of the Austrian Straßenverkehrszeichenverordnung (Road Traffic Sign Ordinance), or other statutes, ordinances or official decrees proclaimed officially (§ 7 Abs. 1 UrhG).) **Finland (C)** (This file is in the public domain in Finland because it is a part of a decision or a statement issued by a public authority or other public body in Finland. Section 9 of the Finnish Copyright Act specifies that no copyright exists in such material.) **and Luxembourg (R)** (This work is ineligible for [copyright](#) and therefore in the [public domain](#) because it consists entirely of information that is [common property and contains no original authorship](#).) showing a range of the designs used across Europe to indicate the entrance to a speed limit zone.

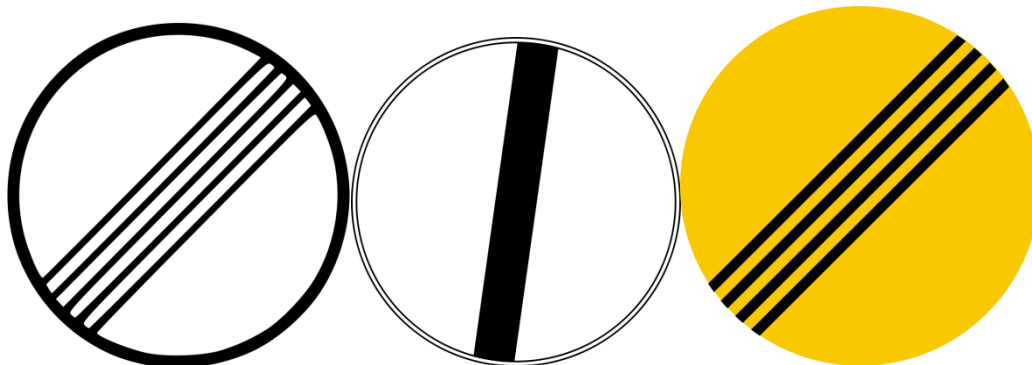
### 3.1.1.2 Non-numerical signs

Most EU and EEA countries use some variation of sign which shows a diagonal black stripe on a white background (Figure 8) to indicate that a particular speed restriction no longer applies beyond that point.



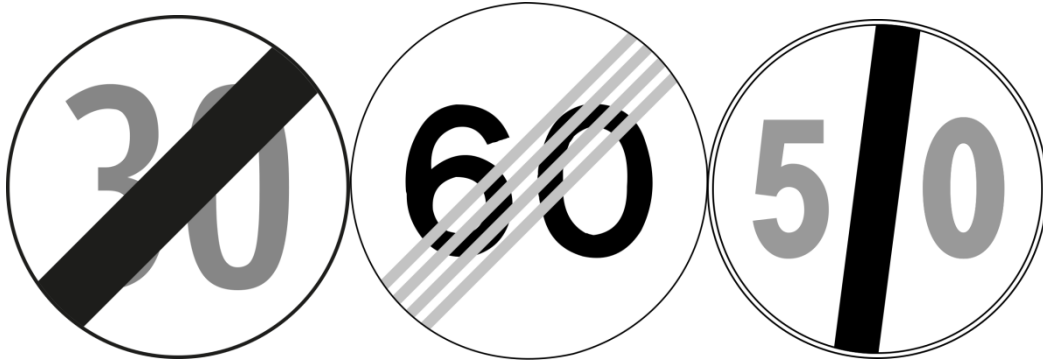
**Figure 8: end of speed limit sign** (This road sign image is in the [public domain](#) according to the copyright law of [Austria](#) because it is part of the Austrian Straßenverkehrszeichenverordnung (Road Traffic Sign Ordinance), or other statutes, ordinances or official decrees proclaimed officially (§ 7 Abs. 1 UrhG).)

The detailed design of these signs varies between countries (Figure 9) and while their basic meaning is similar in all countries that use it, the specific speed limit that applies beyond the sign depends on the category of road, country and class of vehicle. This type of sign might therefore be a challenge for manufacturers to deal with reliably and are likely to require specific validation activities to be undertaken for each country.



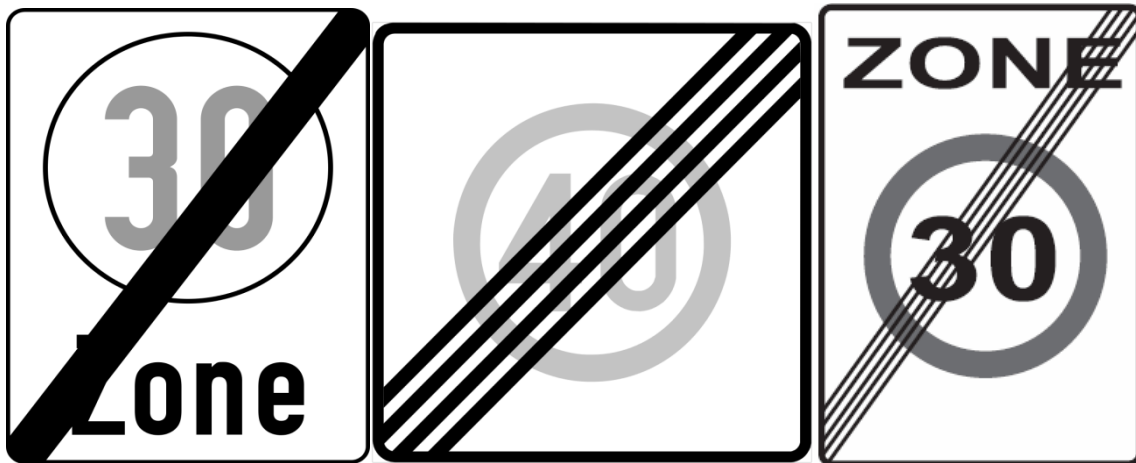
**Figure 9: examples of end of speed limit signs from Estonia (L)** (According to the Republic of Estonia Copyright Act (passed on November 11, 1992; consolidated text May 2006): § 5. Results of intellectual activities to which this Act does not apply 1) ideas, images, notions, theories, processes, systems, methods, concepts, principles, discoveries, inventions, and other results of intellectual activities which are described, explained or expressed in any other manner in a work; 2) works of folklore; 3) legislation and administrative documents (acts, decrees, regulations, statutes, instructions, directives) and official translations thereof; 4) court decisions and official translations thereof; 5) official symbols of the state and insignia of organisations (flags, coats of arms, orders, medals, badges, etc.); 6) news of the day; 7) facts and data; 8) ideas and principles which underlie any element of a computer program, including those which underlie its user interfaces. Hence it is assumed that this image has been released into the public domain. However, in some instances the use of this image might be regulated by other laws.) **Italy (C)** (I, the copyright holder of this work, release this work into the public domain. This applies worldwide. In some countries this may not be legally possible; if so: I grant anyone the right to use this work for any purpose, without any conditions, unless such conditions are required by law.) **and Iceland (R)** (This image is in the [public domain](#) because it depicts an [Icelandic road sign](#), produced by the [The Icelands Public Roads Administration](#) (Vegagerðin). The image may be used freely.)

Many EU and EEA countries also use a similar sign but incorporating a number to indicate the end of a specific speed limit (Figure 10). Once again, the speed limit that is in force beyond the sign is dependent on the country, class of road and category of vehicle.



**Figure 10: examples of the variety of signs used to indicate the end of a specific speed limit across the EU and EEA. Examples here from Austria (L)** (This road sign image is in the public domain according to the copyright law of Austria because it is part of the Austrian Straßenverkehrszeichenverordnung (Road Traffic Sign Ordinance), or other statutes, ordinances or official decrees proclaimed officially (§ 7 Abs. 1 UrhG).) **Greece (C)** (I, the copyright holder of this work, release this work into the public domain. This applies worldwide. In some countries this may not be legally possible; if so: I grant anyone the right to use this work for any purpose, without any conditions, unless such conditions are required by law.) **and Italy (R)** (I, the copyright holder of this work, release this work into the public domain. This applies worldwide. In some countries this may not be legally possible; if so: I grant anyone the right to use this work for any purpose, without any conditions, unless such conditions are required by law.)

Those countries that employ speed limit zones (Figure 7) employ nationally specific signs to indicate the end of those zones (Figure 11). These signs typically feature a monochrome version of the zone entrance sign crossed through with one or several diagonal black stripes.



**Figure 11: examples of the variety of signs used across the EU and EEA to indicate the end of a speed limit zone. Examples here from Austria (L)** (This road sign image is in the public domain according to the copyright law of Austria because it is part of the Austrian Straßenverkehrszeichenverordnung (Road Traffic Sign Ordinance), or other statutes, ordinances or official decrees proclaimed officially (§ 7 Abs. 1 UrhG).) **Finland (C)** (This file is in the public domain in Finland because it is a part of a decision or a statement issued by a public authority or other public body in Finland. Section 9 of the Finnish Copyright Act specifies that no copyright exists in such material.) **and Luxembourg (R)** (This work is ineligible for copyright and therefore in the public domain because it consists entirely of information that is common property and contains no original authorship.)

### 3.1.1.3 Place name signs used as speed limit indicators

Many EU and EEA countries have implied speed limits in urban areas which are not marked by numerical speed limit signs. These limits may be indicated by the presence of a place name sign or a pictographic 'urban area' sign (Figure 12). The end of these built-up areas is marked by a corresponding sign to indicate the end of the speed limit (Figure 13). The design of these signs and the speed limit they imply varies between countries.





**Figure 12: Place name signs used to indicate the start of a built-up area and thus a lower speed limit in France (L)** (By Vince 99 - Own work, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=7018139>) **and Germany (C)** (By Erste Hochladung: Andreas06; komplette Dateineuerstellung durch Mediatus - Vorgaben der Straßenverkehrsordnung 1992, des Verkehrsblatts und den dazugehöriger DIN-Normen, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=997842>) **and a pictographic sign used for the same purpose in Finland (R)** (By Unknown - Finnish Transport Agency, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=4594397>) **Netherlands (Below)** (By Unknown)



**Figure 13: Signs indicating the end of a built-up area and thus a higher speed limit in France (L)** (By Vince 99 - Own work, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=7018095>) **Germany (C)** (By Erstes Hochladen: Andreas 06, neu interpretiert und digital umgezeichnet durch Mediatus - Novelle der Straßenverkehrs-Ordnung 1992, Verkehrsblatt, DIN-Normen, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=997876>) **Finland (R)** (By Unknown - Finnish Transport Agency, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=733290>) **Netherlands (Below)** (By Unknown)

Countries that use place name signs to imply a speed limit employ a sign with a different design when the sign is only intended to mark the entrance to a town or village where no speed limit change is implied (Figure 14).



**Figure 14: An example of a German place name sign, that is intended to mark the entrance to a town or village, without implying a change in speed limit for that road.** (By Andreas 06; new drawing: Mediatus - de:Strassenverkehrs-Ordnung (German Road Regulations) 1992, Verkehrsblatt, DIN-Normen, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=1005489>)

### 3.1.1.4 Residential area signs

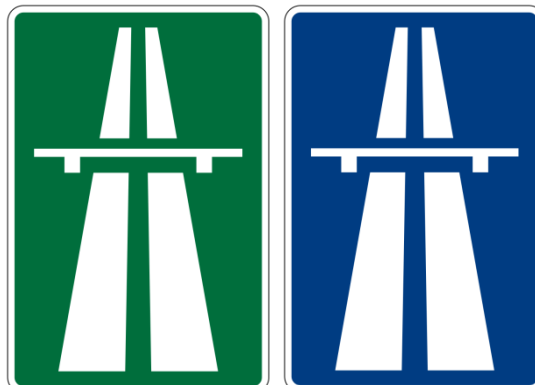
Many EU and EEA countries employ 'Residential Area' or 'Home Zone' signs (Figure 15). The design and legal implications of these signs varies between countries; in the UK they have no specific speed limit attached to them, but in several EU countries the 'Residential Area' sign is used to denote a lower speed limit. Some but not all countries that use the 'Residential Area' sign to denote a specific speed limit incorporate a traditional speed limit roundel into the design of the sign. The end of the residential area is marked by a corresponding sign, the specific meaning of which, in speed limit terms, is dependent on national regulations.



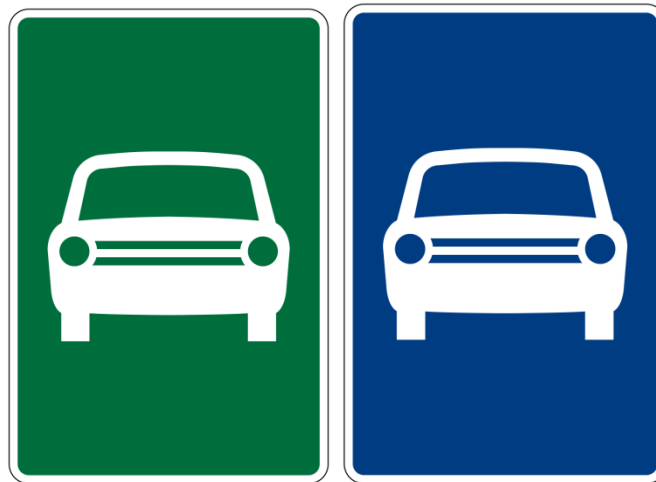
**Figure 15: 'Home Zone' or residential area signs from the UK (L)** (By Traffic signs are Crown copyright. You may reproduce traffic signs free of charge and without having to seek permission, but you must reproduce them accurately and not in a misleading context (e.g. not on roadside billboards where they could mislead drivers). (ref [1]), OGL v1.0, <https://commons.wikimedia.org/w/index.php?curid=12753434>) **and France (R)** (By Roulex 45 self-made from source above - Arrêté du 7 novembre 2008 relatif à la création d'un panneau de signalisation routière pour les zones de rencontre et à la modification de la signalisation de l'aire piétonne, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=7422852>) **Italy and unknown (Below)** (By Unknown)

### 3.1.2 Motorway and expressways

Many EU and EEA countries have implicit speed limits on their motorways and expressways. The start of motorway regulations, and thus the associated speed limit, is usually indicated by a sign similar to the ones shown in Figure 16, and the start of expressway regulations by a sign similar to the ones shown in Figure 17.



**Figure 16: Signs used to indicate the start of motorway regulations** (By United Nations - Vienna Convention on Road Signs and Signals, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=68939309>)



**Figure 17: Signs used to indicate the start of expressway regulations** (By United Nations - Vienna Convention on Road Signs and Signals, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=68940789>)

### 3.1.3 Other signs that may be mistaken for speed limit signs

#### 3.1.3.1 Advance warning signs

Many member states employ signs to give a warning in advance of reaching a section of road with a lower speed limit, either on the same section of road, or when leaving the main carriageway. These advance warning signs generally use the conventional speed limit roundel (Figure 4) combined with a sub-sign indicating that the new speed limit applies a certain distance ahead (Figure 18), or an arrow to indicate that the limit applies to a slip-road leaving the main carriageway.

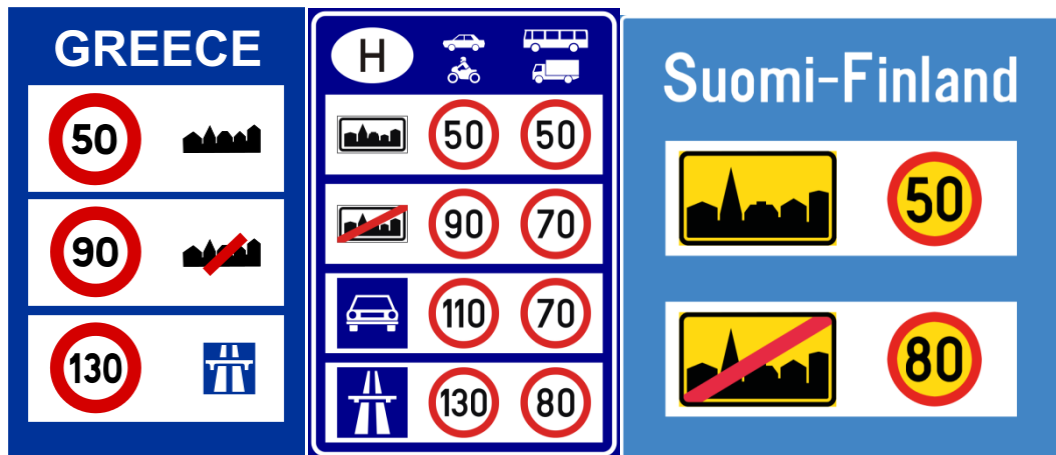


**Figure 18: Advance warning signs indicating that a speed limit is in force some distance ahead of the sign.(L)** (You may re-use this information (not including logos or third-party material) free of charge in any format or medium, under the terms of the Open Government Licence v2.0. To view this licence, visit [www.nationalarchives.gov.uk/doc/open-government-licence/version/3](http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3) or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or e-mail: [psi@nationalarchives.gsi.gov.uk](mailto:psi@nationalarchives.gsi.gov.uk)) **Belgium**  
**reduction of speed limit in 300 m (R)** (By Unknown)

#### 3.1.3.2 Signs at national borders

Most EU and EEA countries have signs on roads that cross their national borders that indicate the standard national speed limits for the various categories of road in that country (Figure 19). Clearly the potential difficulty presented by these signs is that the presence of the standard, round speed limit sign in their design makes them susceptible to being read as indicating a speed limit for the section of road to which they are adjacent. Given that their designs vary from country to country it is difficult for

manufacturers to employ a single filtering technique to deal with all such signs that might be encountered in the EU or EEA.



**Figure 19: signs posted at national borders to show the national speed limits for the various categories of road that may be encountered in that country from Greece (L)** (This work is ineligible for [copyright](#) and therefore in the [public domain](#) because it consists entirely of information that is [common property and contains no original authorship](#).) **Hungary (C)** (This work is not covered by copyright. According to the Hungarian copyright act of 1999: I.4 The protection provided by this Act shall not cover legal provisions, other means of state direction, court and other official resolutions, announcements and documents issued by an authority or other official organ, as well as standards made obligatory by law and other similar regulations. I.7 The expressions of folklore may not enjoy copyright protection. However, this may not prejudice copyright protection due to the author of a folk-art-inspired work of individual and original nature.) **and Finland (R)** (This file is in the public domain in Finland because it is a part of a decision or a statement issued by a public authority or other public body in Finland. Section 9 of the Finnish Copyright Act specifies that no copyright exists in such material.)

### 3.1.3.3 Signs indicating numerical limits for other parameters

There are a wide variety of numerically based 'limit' signs that could easily be mistaken for speed limit signs. Examples of such signs include those indicating a limit of a vehicle's maximum height, width or weight (Figure 20). These signs always incorporate features that differentiate them from speed limit signs, e.g. dimension arrows or letters to indicate their unit of measurement ('m' or 'T') but nevertheless may be a source of false detections for an ISA system, particularly in countries e.g. the Republic of Ireland that include letters in their speed limit signs (Figure 6).



**Figure 20: Numerical limit signs, that have the potential to be confused with speed limit signs, indicating maximum values for vehicle height (L)** (By Gigillo83 - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=38690556>) **width (C)** (By Gigillo83 - KRESZThe Hungarian Highway Code, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=31680336>) **and Weight (R)** (By Peeperman - Own work, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=10125764>)

### 3.1.3.4 Minimum speed limit and advisory speed limit signs

Many EU and EEA countries employ minimum speed limit signs to indicate that vehicles must travel above a certain speed. These are often seen in tunnels or on bridges where it is important to maintain a steady flow of traffic. While the design of these signs, and their corresponding cancellation signs, varies subtly between countries, all follow an essentially similar template (Figure 21).



**Figure 21: A minimum speed limit sign (L) and its corresponding cancellation sign (R), in this case both from Austria** (By 3247 - Straßenverkehrszeichenverordnung (StVZO), BGBl. 1998 II 1205-1227, 1220., Public Domain, <https://commons.wikimedia.org/w/index.php?curid=1100049>)

Many EU and EEA countries employ advisory speed limit signs to advise drivers to reduce speed for specific hazards. These advisory limits are not enforced in the same way as conventional speed limits. Advisory limits may be indicated by permanently fixed signs, for example at a sharp bend in the road, or by LED signs that are activated temporarily in response to a specific event, e.g. an obstruction in the road (Figure 22). The design of these signs varies from country to country. LED signs used to indicate advisory speed limits can be distinguished from those used to indicate mandatory variable limits as the latter incorporate a red roundel in their design.

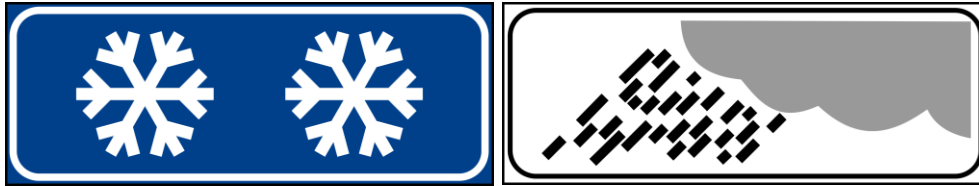


**Figure 22: Advisory maximum speed limit signs, in this case fixed signs from the Czech Republic (L)** (By Frisky007 - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=10803559>) **and the UK (C)** (By UK Government - UK Traffic signs image database, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=17332626>) **and a temporarily activated LED sign from the UK (R)** (You may re-use this information (not including logos or third-party material) free of charge in any format or medium, under the terms of the Open Government Licence v2.0. To view this licence, visit [www.nationalarchives.gov.uk/doc/open-government-licence/version/3](http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3) or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or e-mail: [psi@nationalarchives.gsi.gov.uk](mailto:psi@nationalarchives.gsi.gov.uk))

### 3.1.4 Conditional, part-time and temporary speed limits

#### 3.1.4.1 Conditional speed limits

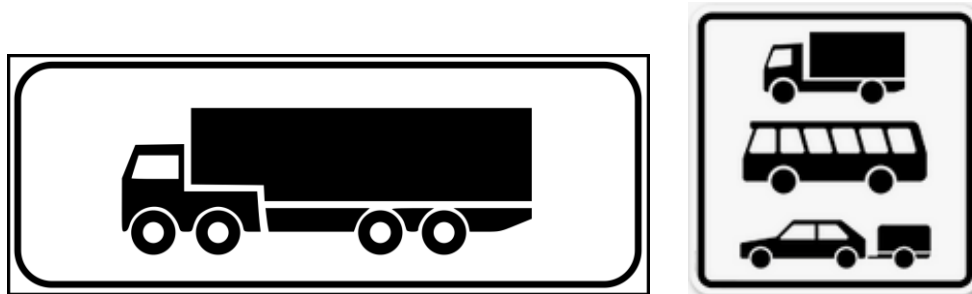
Some member states have speed limits that are only applied under specific circumstances. Examples of these conditional speed limits include those applied during wet weather, or when it is snowing. These conditional limits are often indicated using sub-signs, small additional signs usually mounted underneath the main road sign which add conditions to the requirement shown in the main sign (Figure 23).



**Figure 23: Italian sub-signs indicating that the restriction shown in the main sign only applies when there is snow or ice on the road (L)** (By F l a n k e r - Own work, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=1719448>) **or when it is raining (R)** (By Gigillo83 - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=10759320>)

#### 3.1.4.2 Speed limits applied to specific categories of vehicle

Member states usually apply a lower national speed limit to vehicles in the heavier categories (M2, M3, N2 and N3) and those that are towing trailers. Usually these alternate limits prescribe a different value to the speed limit on all roads where the national speed limit applies. Specific limits may be applied some categories of vehicles under specific circumstances. These specific speed limits may be indicated using a pictographic sub-sign (Figure 24).



**Figure 24: A pictographic sub-sign indicating that the restriction shown on the main sign only applies to large goods vehicles (L)** (By Gigillo83 - Own work, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=15593111>) **Germany for large goods vehicles, buses and motor vehicles with trailers (R)** (By Unknown)

#### 3.1.4.3 Part-time limits

Part-time limits are used where a specific hazard regularly exists at a certain time, for example the start of the school day or where a limit exists to reduce pollution or nuisance to people living nearby. Part-time limits may be indicated using a sub-sign showing the times at which the limit is in force (Figure 25), or using LED signs, although fixed signs with flashing beacons to indicate that the limit is in force are also used (Figure 26). This style of signage may present a particular challenge to read accurately, since it requires a system that is able to recognise the part-time nature of the limit and the method by which the limit is shown to be active.



**Figure 25: A sub-sign indicating that the restriction indicated by the main sign, which would be fixed above the sub-sign, is only in force between the hours of 07:30 and 19:00.** (By Gigillo83 - Own work, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=15593934>) **Netherlands limit during specific timeframe (R)** (By Unknown)



**Figure 26: a part time 20mph speed limit sign which only applies when the beacons are flashing** (This file is licensed under the [Creative Commons Attribution-Share Alike 2.0 Generic](https://creativecommons.org/licenses/by-sa/2.0/) license. Stanley Howe / *Approach to Kirkton of Skene School* / [CC BY-SA 2.0](https://creativecommons.org/licenses/by-sa/2.0/))

Finland and Sweden have seasonal speed limits that apply in the winter months. These seasonal limits reduce the speed limit on motorways and rural trunk roads.

#### 3.1.4.4 Temporary speed limits

Speed limits are often lowered on a temporary basis while road maintenance is underway. These temporary limits are often legally enforceable and are generally indicated by temporarily positioned versions of the fixed signs used in that country.

#### 3.1.5 Variable speed limit signs

Some member states employ variable speed limits on some roads. These limits are legally enforceable, often with dedicated fixed speed cameras. The limits are indicated using LED signs which are either hung on gantries above the carriageway, or supported on posts alongside it. The sign displayed with LEDs mimics the design of the fixed speed limit signs employed across Europe (Figure 4) and include a red roundel around a numerical value.

#### 3.1.6 Road sign positioning and design

The position and design of road signs is under the control of individual member states. Each member state has a set of standards for the positioning and design of road signs which it applies. The national standards for road sign may include parameters such as the colours of road sign components, reflectivity, size, font and the design of standard pictograms.

A European standard (EN 12966) exists for variable message signs, which specifies their visual and physical characteristics. This standard applies to all variable message signs including those used to indicate temporary and variable speed limits.

#### 3.1.7 Speed limits in force across the European Union

Speed limits are under the control of member states. While there are similarities between the speed limit setting policies of all member states, in that all states have 'national speed limits', which apply a common limit to specific classes of roads, e.g. urban roads, extra-urban roads, motorways etc., the values chosen for these national speed limits differs between member states. Table 1 provides an overview of the limits in force in each of the EU member states. In addition to the variations of chosen speed limit value the regulations concerning conditional speed limits also varies between member states, with some member states applying specific limits to young or inexperienced drivers or applying seasonal or weather dependent speed limits.

**Table 1: Examples of speed limits in force across the European Union**

Country	Vehicle Type	Speed Limit: Urban Road	Speed Limit: Non-Urban	Speed Limit: Motorways/ Expressways	Comments
Austria	Passenger cars & vans	50 [km/h]	100 [km/h]	130 [km/h]	
Belgium	Passenger cars & vans	50 [km/h]	70 [km/h] Flemish Region, 90 [km/h] Other areas	120 [km/h]	20 [km/h] in residential areas, 30 [km/h] near schools and in streets with cycle paths
Bulgaria	Passenger cars & vans	50 [km/h]	90 [km/h]	140 [km/h] Motorways, 120 [km/h] Expressways	
Croatia	Passenger cars & vans	50 [km/h]	90 [km/h]	130 [km/h]	
Cyprus	Passenger cars & vans	50 [km/h]	80 [km/h]	100 [km/h]	30 [km/h] for Pedestrian Zones
Czech Republic	Passenger cars & vans	50 [km/h]	90 [km/h]	130 [km/h] Motorways, 110 [km/h] Expressways	80 [km/h] in built-up areas
Denmark	Passenger cars & vans	50 [km/h]	80 [km/h]	130 [km/h]	
Estonia	Passenger cars & vans	50 [km/h]	90 [km/h]	90 [km/h]	Motorways/Express ways; Summer time speed limit - 110 [km/h]
Finland	Passenger cars & vans	50 [km/h]	80 [km/h]		Motorways/Express ways: Always displayed by traffic signs (80 km/h, 100 km/h, 120 km/h); Vans 80 km/h or 100 km/h
France	Passenger cars & vans	50 [km/h]	80 [km/h] (some are 90 [km/h])	130 [km/h] Motorways, 110 [km/h] Expressways	Motorways/Express ways: 100 [km/h] in rainy/wet conditions, 50 [km/h] if the visibility is less than 50 m



Country	Vehicle Type	Speed Limit: Urban Road	Speed Limit: Non-Urban	Speed Limit: Motorways/ Expressways	Comments
Germany	Passenger cars & vans	50 [km/h]	100 [km/h]	130 [km/h]	Many German autobahns have no speed limit, although a maximum speed may be recommended
Greece	Passenger cars & vans	50 [km/h]	90 [km/h]	130 [km/h] Motorways, 110 [km/h] Expressways	
Hungary	Passenger cars & vans	50 [km/h]	90 [km/h]	130 [km/h] Motorways, 110 [km/h] Expressways	
Ireland	Passenger cars & vans	50 [km/h]	80 [km/h] and 100 [km/h]	120 [km/h]	
Italy	Passenger cars & vans	50 [km/h]	90 [km/h]	130 [km/h]	
Latvia	Passenger cars & vans	50 [km/h]	90 [km/h] (80 [km/h] for gravel roads)	-	
Lithuania	Passenger cars & vans	50 [km/h]	70 [km/h], 90 [km/h] asphalt and concrete roads (80 [km/h] for less than 2 years of experience)	130 [km/h] Motorways, 110 [km/h] Expressways	Motorway: 130 km/h from April to October; 110 km/h from November to March. For drivers with under 2 years of driving experience – 100 km/h. Highway: 120 km/h from April to October; 110 km/h from November to March. For drivers with under 2 years of driving experience – 90 km/h.

Country	Vehicle Type	Speed Limit: Urban Road	Speed Limit: Non-Urban	Speed Limit: Motorways/ Expressways	Comments
Luxembourg	Passenger cars & vans	50 [km/h]	90 [km/h]	130 [km/h] (110 [km/h] in the rain)	
Malta	Passenger cars	50 [km/h]	80 [km/h]	80 [km/h]	
	Passenger vans	40 [km/h]	60 [km/h]	60 [km/h]	
Netherlands	Passenger cars & vans	50 [km/h]	80 [km/h]	130 [km/h], 120 [km/h] and 100 [km/h] Motorways/Expressways	Reduced daytime limit on motorways (100 km/h) from 2020
Poland	Passenger cars & vans	50 [km/h] (5 am -11pm), 60 [km/h] (11pm - 5am)	90 [km/h]	140 [km/h] Motorways, 110 [km/h] Expressways; 100 [km/h] on single carriageway (expressway)	20 [km/h] in residential areas
Portugal	Passenger cars & vans	50 [km/h]	90 [km/h]	120 [km/h] Motorways, 100 [km/h] Expressways	
Romania	Passenger cars & vans	50 [km/h]	90 [km/h] and 100 [km/h]	130 [km/h]	
Slovakia	Passenger cars & vans	50 [km/h]	90 [km/h]	130 [km/h] (90 [km/h] in built-up areas)	
Slovenia	Passenger cars & vans	50 [km/h] (30 [km/h] – in speed limit zones; 10 [km/h] – in pedestrian zones where traffic is allowed)	90 [km/h]	130 [km/h] Motorways, 110 [km/h] Expressways	

Country	Vehicle Type	Speed Limit: Urban Road	Speed Limit: Non-Urban	Speed Limit: Motorways/ Expressways	Comments
Spain	Passenger cars & vans	50 [km/h]	80 [km/h] for vans and light lorries, 90 [km/h] for passenger cars, pick-ups and multi-purpose vehicles	90 [km/h] for vans and light lorries, 100 [km/h] for multi-purpose vehicles, 120 [km/h] for passenger cars and pick-ups	
Sweden	Passenger cars & vans	50 [km/h]	70 [km/h]	110 [km/h]	
United Kingdom	Passenger cars & vans	48 [km/h]	96 [km/h]	112 [km/h]	

## 3.2 Review of existing test procedures and standards

### 3.2.1 Euro NCAP: Safety Assist Assessment and Test Protocols

Euro NCAP have developed and published an Assessment Protocol for vehicle Safety Assist systems (Euro NCAP, 2019). The protocol details the evaluation criteria Euro NCAP technicians and engineers apply when assessing passenger vehicle technologies. The Safety Assist protocol describes performance evaluations of the following technologies: Seat Belt Reminder, Lane Support Systems, Autonomous Emergency Braking and Speed Assist Systems. Euro NCAP's test procedure for speed assist systems is defined in (Euro NCAP, 2017)

Euro NCAP uses ISA to refer to a specific type of speed assist system that incorporates a Speed Limit Information Function (SLIF) and Speed Limit Function (SLF). This definition of ISA differs from the regulatory definition in that it strictly contains a speed control function.

#### 3.2.1.1 Assessment of speed limit information function

A SLIF is a system capable of knowing and communicating the posted or implicit speed limit, relevant to the particular vehicle and conditions, to the driver. Such a system might include a camera, map or a combination of both informing the SLIF of the relevant speed limit. The speed limit information can be obtained via an integrated vehicle system or by a connected mobile device.

Under Euro NCAP's Safety Assist Assessment Protocol, a SLIF will only be eligible for scoring if it is switched on by default at the start of every journey.

The Safety Assist Assessment Protocol, describes the general requirements for a SLIF system, starting with the way in which information should be shown to the driver. All SLIF information should be shown to the driver, either permanently or at the driver's request, in their direct field of view, without the need for the head to be moved from the normal driving position, through a Human-Machine Interface (HMI) either via the instrument cluster/dashboard or a heads-up display. The applicable speed limit should be

displayed using a symbol representing a speed limit sign. The speed limit information must also be displayed at the beginning of the next journey.

The driver should be able to access accurate and up to date speed limit information, quickly and with little effort, for the road they are driving on. The SLIF must also indicate the applicable speed limit in the presence of conditional speed limits or indicate the presence of a conditional speed limit that the system does not recognise but also display the original (non-conditional) speed limit. Systems which can properly identify road conditions and act accordingly will gain additional points (according to the Euro NCAP scoring system) based on the number of additional, "advanced", functions the system is able to demonstrate (Table 2).

**Table 2: ISA advanced functions scoring chart (Euro NCAP, 2019)**

Advanced Functions		Points	Required Action
Weather	Rain/Wetness	2	Show correct speed limit
	Snow/Icy	2	Warning only and ignore if irrelevant
Time	Time	3	Show correct speed limit
Distance	Distance for/in	1	Show correct speed limit
Arrows	Arrows	1	Show correct speed limit or ignore if irrelevant
Vehicle Categories	Other Vehicle/Weight Categories	1	Ignore if irrelevant
Implicit Speed Limits	Highway/Motorway	2	Show correct speed limit
	City Entry/Exit	3	
	Residential Zones	2	
Dynamic Speed Limits	Dynamic Speed Signs Including Roadworks	3	Show correct speed limit
TOTAL		20	

Each advanced function is scored on a pass/fail basis, passes equate to the points listed for each individual action. For example, a SLIF which can read a road signs that indicates that a different limit applies when the road is icy and subsequently applies the correct speed limit will receive a pass and the full 2 points. The final score for the advanced functions is a weighted score and is calculated by multiplying the initial score (derived from the totalling of awarded points for each passed advanced function) by 0.025. As their test protocol is reliant on the infrastructure available in the vicinity of their test centres, which obviously varies from country to country, Euro NCAP take a pragmatic approach to the scoring of this test; so a system which achieves more than 12 out of the total 20 points will be awarded the whole score for system accuracy, i.e. 0.5. This reflects the difficulty of testing all of the advanced functions in a single test session. If the system relies on map data, the maps must be updated automatically at least every quarter, without requiring any action from the user for the first six years of registration.

### 3.2.1.2 Assessment of speed limit warning function

Euro NCAP specifies that a visual warning should be issued by the SLWF when the vehicle exceeds the posted speed limit by at least 5 km/h. Euro NCAP neither requires nor prohibits the use of audible or haptic warning signals.

Euro NCAP permits the SLWF to be switched off by the driver. There are no provisions to state how easy the switch on/off the system should be, with the implication being that a single button press may be sufficient. This provision is added in order to allow the driver to cancel warnings due to false information and inaccurate or temporarily void speed limits.

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Euro NCAP permits speed limit warnings to be indicated using either a flashing icon representing traffic sign communicating the speed limit, or an additional visual signal adjacent to the traffic sign icon. The protocol also allows for the use of an additional display to indicate the set speed ( $V_{adj}$ ) of a manually set speed limiter in cases where  $V_{adj}$  is different from the posted speed limit. A key ISA performance indicator is the speed warning threshold; Euro NCAP therefore states that a warning should commence when the driven/indicated speed of the vehicle is exceeding the speed limit by more than 5 km/h. To allow for vehicle speedometer and system accuracy, a positive/negative offset is allowed but may be no larger than 10 km/h. A warning will be issued to the driver after exceeding the speed limit by 5 km/h for more than 10 seconds but the visual warning will persist for the duration of exceeding the limit. However, the warning sequence does not need to be reinitiated every time the speed limit is exceeded until the indicated speed is reduced to 5 km/h below the indicated speed.

### 3.2.1.3 Assessment of speed control function

Euro NCAP require that Speed Control Function (SCF) must be capable of being easily deactivated at any time via a simple operation and must be switched off by default at the start of a journey.

Euro NCAP specifies three different types of SCF:

- Speed Limitation Function (SLF)
- Intelligent Speed Assistance (ISA)
- Intelligent Adaptive Cruise Control (i-ACC)

A SLF allows the driver to manually set an adjustable limiting speed for the vehicle ( $V_{adj}$ ). The driver may choose to exceed  $V_{adj}$  by applying a positive action, e.g. pushing the accelerator into the kick-down position. When the vehicle exceeds  $V_{adj}$ , the system will alert the driver via audible, visual or haptic feedback.

A SLF may also set a semi-permanent top speed for the vehicle, for example when snow tyres are fitted. The most widely adopted method for restricting speed is to restrict power to the engine by limiting fuel flow, as explored by (European Transport Safety Council, 2017).

An ISA (using Euro NCAP's definition for a moment) uses information derived from the SLIF to automatically set the maximum speed of the vehicle. This change should take effect within five seconds of a new speed limit coming into force. The driver may or may not be required to confirm this setting prior to it taking effect.

I-ACC uses information from the SLIF to vary the maximum speed of an adaptive cruise control system. The driver is able to exceed the set limit by depressing the accelerator.

### 3.2.1.4 Test for speed limit warning function

Euro NCAP's test procedure for speed assist systems is defined in (Euro NCAP, 2017), which describes their definitions, measuring equipment, valid testing conditions and the test procedure. As the protocol is a confirmatory procedure (to verify the manufacturer's claims) it does not test the vehicle's ISA system as a whole but focuses on the effectiveness of the SLIF function. The effectiveness of a SLIF system is evaluated according to its ability to perceive the 10 categories of speed limit (Table 2). Unless a test track contains all relevant types of European speed signs, the test protocol requires the vehicle to be driven for at least 100 km. The confirmatory drive is required to take place on a mixture of public urban and rural roads (including highways) while the SLIF's reaction to conditional speed limits is verified and recorded.

Notes are taken by the assessor on any discrepancies between the posted speed limit and the SLIF's indicated speed limit shown to the driver. If the function is available, the protocol states that the vehicle should be driven both manually and in cruise control mode. This test method does not give detail on test conditions and country location but

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would give a limited understanding of system performance under conditions experienced on the day of testing. Euro NCAP apply a 12 out of 20 accuracy threshold to account for weather conditions not being present, such as rain or snow, at the time of testing. It also allows for there being no dynamic speed limits being in place on the 100 km test route. Therefore, a system can still be considered accurate if it receives 12 advanced function points, without being tested in adverse conditions or being exposed to road works or temporary speed limits.

As many SLIF systems are fitted with a warning or control function, Euro NCAP makes provisions for their testing. It is not reasonable to expect an assessor to break the speed limit on any part of the European road network in order to evaluate the response of the SLWF/SCF. Therefore, Euro NCAP makes allowances for testing on tracks or proving ground, providing the following statement is followed (section 4.1.1.1); "*where speed signs are installed and should cover at least three different speed limits*". In order to prompt a response from the SLIF/SLWF systems, the VUT (vehicle under test) will be accelerated to at least 10 km/h over the  $V_{\text{limit}}$  (legal/sign posted speed limit). This speed will be maintained long enough in order to assess the total/complete warning sequence.

### 3.2.1.5 Test for speed control function

The test protocol finally outlines controlled track testing of speed control functions. These tests are also confirmatory and are therefore performed at three different simulated speed limits:

- City roads (e.g. 50km/h or 30mph)
- Inter-Urban roads (e.g. 80km/h or 50mph)
- Highways (e.g. 120km/h or 70mph)

This procedure tests the activation of the warning system, how and when the vehicle alerts the driver and its response to the imposed speed limit. As these tests are conducted on a closed road test track, this test focuses on the speed control function only. It does not require the system to read, and display to the driver, an imposed speed limit. The  $V_{\text{adj}}$  will be set to the imposed speed limit, e.g. 120 km/h; the VUT will then be accelerated to a steady speed above this limit. The test driver will wait for, and record, the response of the speed limitation function. If the SLIF correctly identifies that the vehicle speed is above  $V_{\text{adj}}$  and the SCF slows the vehicle in response, it cannot slow the vehicle by more than 5 km/h below  $V_{\text{adj}}$ . If it does, this will be regarded as a failure and receive a score of 0 (for the tested speed). Failing to pass all three test speeds will result in a total score of 0 for the Speed Control Function Test (the maximum score, upon passing all three tests, is 1.5). The test procedure sets out that the test track must be free of standing water, snow or ice and the gradient must not exceed 2 percent.

## 3.2.2 London bus service limited: The Bus Safety Standard

### 3.2.2.1 ISA assessment protocol

Transport for London (TfL), in conjunction with TRL, recently announced new standards which new buses deployed on the London network in the future must meet. The scope of the standard is M<sub>3</sub> class II London buses, (i.e. MGWV > 5 tonnes and a capacity exceeding 22 passengers)

The intention of these standards, as presented in TfL's summary document (TfL, 2018), is to help progress to London's 2041 vision zero casualty target through the introduction of buses with improved designs and fitted with countermeasures to reduce accidents, injuries and fatalities. One of the standards is dedicated to the fitment of ISA systems. This standard treats ISA as an assistance system to aid the driver in staying below the posted speed limit. The standard describes ISA systems as not intending to absolve the driver of the responsibility to keep the vehicle below the speed limit. However, ISA should act to limit accelerator input to prevent the bus exceeding the speed limit. The

standard differs from others by not including a warning to the driver, for exceeding the speed limit, unless a fault is present. The detailed specifications for the ISA assessment and other aspects of the standards can be found within the London Bus Service's attachments for the specification of new buses, (London Bus Services Limited, 2019).

As with the Euro NCAP assessments for passenger cars, the TfL Bus Safety Standard has brought an element of rating for busses on the London network. The (London Bus Services Limited, 2019) specification document lists a series of attachments which the manufacturers must comply with in order for their vehicle to meet the minimum ratings. Attachment 17 describes the Intelligent Speed Assistance Assessment Protocol which applies to vehicles categorised as M<sub>3</sub>; Class I and Class II (maximum mass exceeding 5 tonnes and a carrying capacity exceeding 22 passengers). The assessment has been described as a method for testing the ability of an ISA system, fitted to a bus, "*to restrict the speed of the bus to the prevailing speed limit*". The inherent spirit of the assessment is to encourage the fitment of ISA technologies which do not allow the driver of the bus to override the ISA and exceed the posted speed limit (i.e. hard-limiting systems). This presents a potential conflict with the remit defined for the GSR (see Section 2.2)

Section 7 of Attachment 17 requires that manufacturers must submit a series of 'pre-test' documents to the assessor/test house detailing the functionality of the ISA system. There is a possible conflicting statement in the assessment protocol which requires evidence (from a certified body) to confirm that; "*the system has been tested and approved as per the requirements of adjustable speed limitation devices within Regulation No 89 of the Economic Commission for Europe of the United Nations (UN/ECE)*", which do not apply for European Whole Vehicle Type approval.

Attachment 17 continues to describe the required documents to be presented to test houses or assessor for assessment. From this list it was possible to identify key documents which could inform a list of documents to be submitted to test houses for the purposes of European regulation, including the following:

- "A statement describing how the ISA system operates",
- "A schematic diagram and description of where the ISA system obtains the vehicle speed information",
- "A statement confirming for which option the ISA is specified" (could be altered to give the option for SLWF or SCF functionality),
- "A statement as to whether speed restriction is assisted by any system, and a description of the operation of this system",
- "A statement as to whether a function that provides an over speed notification to the bus driver is fitted, and provide details of the form of this notification"
- "Instructions regarding how the ISA system is enabled and disabled".

The attachment which follows (Attachment 18) provides guidance on ISA systems to be fitted to London buses. It describes an ISA system as a combination of an on-board map of speed limits (known as the Digital Speed Map, created and maintained by TfL) and a GPS locator. The ISA could then limit the speed of the bus via two methods:

- Limiting further accelerator input, when the bus meets the speed limit (limits can be exceeded; in areas where gravity allows the bus to exceed the limit, momentarily when the bus enters a lower speed zone or there is a lag between the implementation of a speed limit and the updating of the reference Digital Speed Map), or
- by doing the above and activating regenerative braking

ISA systems for London buses can utilise road maps with information about the speed limits for the driven roads but it is not mandatory. The maps provided by TfL will need to be updated and version numbers recorded by the operators. However, there is an

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understanding (as described in the guidance notes) that there may be a time lag or missing information from the Digital Speed Map (as may be the case with temporary speed restrictions, such as road works), preventing a timely implementation of the speed limit. It may also be likely that sloping (downhill) roads will incidentally cause the bus to exceed the speed limit. The ISA system will not apply disc/air brakes or accelerate to meet the speed limit, this will always be the responsibility of the driver and a continued depression of the accelerator will maintain the existing speed. However, the system can limit further accelerator input or utilise regenerative braking.

### 3.2.2.2 ISA test procedure

TfL specifies a comprehensive test procedure for the Vehicle Under Test (VUT). It has been separated into two options for ISA testing. However, as with Euro NCAP testing the VUT's ISA system can be tested on-road but needs to have completed the track testing first. In order to pass the ISA assessment, the VUT must pass the checklists within; pre-test submissions (including a statement describing how the ISA system operates), system checks (i.e. physically observing a connection between the GPS and ISA system, if the connection cannot be observed the vehicle would have failed the test), track tests and on-road tests. Any single failure within the four assessment checklists will result in the failure of the entire ISA system. The assessment protocol provides documentation to mark the test results against.

The Bus Safety Standard breaks ISA testing into two phases. The initial phase allows a manufacturer to choose between one of two track tests. The second phase is conducted upon successful completion of the first phase and is a real road test (on a route to be determined by the technical service). Of the first phase tests, option one is a speeding alert test without speed reduction. Option 2 is also a speeding alert test but also tests the speed reduction method, which explicitly excludes the use of foundation brakes.

As the first phase of the testing is conducted on a test track, but because any bus operating on the London network will rely on the Digital Speed Map (DSM), sections of the test track/facility will have to be entered into the DSM. This will be a complication but should not prevent the tests being performed.

It should be noted that official speed limit maps for the system are provided by TfL. Therefore, it is not a subject of the test protocol to assess the performance of speed limit determination in varying locations and condition, which remains one of the major challenges for defining type approval procedures for ISA systems.

## 3.3 Market review of ISA systems

The GSR (as described in Section 2.2) requires ISA systems to be fitted to vehicle categories M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub>, N<sub>1</sub>, N<sub>2</sub> and N<sub>3</sub>. TRL are aware of the prevalence of ISA systems fitted to M<sub>1</sub> (encouraged by Euro NCAP) and to a lesser extent N<sub>1</sub> vehicle categories. Encouraged through TfL's Bus Safety Standard (see Section 3.2.2), M<sub>3</sub> vehicles fitted with ISA systems are entering the market. These are equipped mostly with map-only systems specific to London, which will not be sufficient to meet future European type approval requirements (see Section 2.2). TRL are not aware of current implementation of ISA systems in other vehicle categories, but the capabilities and challenges in determining the road speed limit are expected to translate well between categories.

Euro NCAP conducts ISA system testing within its SAS (Safety Assist System) protocol. TRL consulted with Euro NCAP to gain a broad understanding of the varying levels of ISA capability within the current European vehicle fleet. The assessment procedure is wide ranging and requires both an exchange of documentation between the manufacturer and Euro NCAP and a 100km confirmatory test drive conducted by a Euro NCAP testing facility on local public roads (see Section 3.2). Euro NCAP gives a normalised score of the SA systems which are available for public viewing and this score contributes to the whole vehicle star rating.



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10 sign recognition capabilities were evaluated (as outlined in Table 2) on the 100 km confirmatory test drive but some conditions may never be driven in (such as snow/rain or dynamic signs, while overhead LED gantry signs may not have been on the selected route) and as such were displayed as 'n/a' in the original recordings. However, for this report, individual scores are not of interest and any capabilities not tested have been displayed as fail, for simplicity. This caveat applies to both Table 3 and Table 4, all vehicles tested from 2018 to 2019 (from January to October).

In Table 3, 16 vehicles which used systems that could read road side signage or rely on map information but three still required the driver to manually set the speed limit warning (described as  $V_{adj}$ ). Unlike some systems from the 2018 fleet, none of the vehicles evaluated in 2019 had a manual speed limit warning function; rather the ISA systems are configured to automatically inform the driver of the speed limit on the driven road. It is therefore possible to assume that manufacturers (and customers) are driving the industry towards ISA systems which are system advised, with little need for speed confirmation from the driver.

Of the 51 vehicles tested by Euro NCAP in 2018-19, 36 were able to use the information collected by the SLIF to propose a maximum speed setting for the speed limit function (SLF). Of the 36 vehicles; 26 were fitted with camera-only systems, 9 were camera and map fusion systems and only 1 was fitted with a map-only ISA system. Euro NCAP did not provide any data on how many of these cars required confirmation from the driver to set the SLF.

For those vehicles which have a SLIF system fitted, the majority (32 out of the 36) could achieve a pass mark for at least 4 of the 10 assessed capabilities. Only two of the 36 vehicles were capable of passing all requirements, a large and a small off-road vehicle fitted with camera and map fusion system. Vehicles which were fitted with a camera-only ISA system were capable of passing 5 out of 10 of the capabilities. In contrast, vehicles fitted with a camera-map fusion system were, on average, capable of achieving a pass mark for 6 or 7 of the capabilities.

According to the data presented in Table 3 and Table 4, implicit speed limits and some weather conditions seem to be an issue for camera-only systems (noting that the system may not have experienced those weather conditions at the time of testing and thus received a mark of n/a). Across both years, a camera-only system was not presented which was able to pass all 10 capabilities. However, informed by those presented, TRL surmised that it may be possible for manufacturers to achieve this in the future as all capabilities were fulfilled by at least one of the camera-only systems.

Camera-map fusion systems were more capable of detecting implicit speed limits and dynamic speed limits. TRL interpreted this to mean that those vehicles with fusion systems could usually utilise the larger amount of information available to increase system confidence and accuracy in detecting the true speed limit. The fusion of map and camera data allows the cameras to determine road types based on location and visual information, regarding road layout; allowing fusion systems to more accurately determine implicit speed limits.

**Table 3: Euro NCAP Speed Assistance system capabilities overview 2018**

Make & Model	Category	Stars	Year	SA (Normalised Score)	SAS	Setting Warning	Setting Speed (Vadj)	SLIF Type	Subsign Recognition	Rain	Snow	Distance	Time	Arrows	Vehicle Category	Implicit Highway	Implicit City	Implicit Residential	Dynamic Limits
Audi A6	Executive	5	2018	76	1.3		Manually Set												
Audi A7	Executive	5	2018	76	1.3		Manually Set												
Audi Q3	Small Off-Road	5	2018	85	1.3		Manually Set												
BMW X5	Large Off-Road	5	2018	75	2.8	System advised	System advised	Camera & Map		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Citroën Berlingo	Small MPV	4	2018	68	2.3	System advised	System advised	Camera		X	X	X	X	✓	✓	X	X	X	X
FIAT Panda	Supermini	0	2018	7	0														
Ford Focus	Small Family Car	5	2018	75	2.5	System advised	System advised	Camera		X	X	✓	X	✓	✓	✓	X	✓	✓
Ford Tourneo Connect	Small MPV	4	2018	75	2.5	System advised	System advised	Camera		X	X	✓	X	✓	✓	✓	X	✓	✓
Hyundai NEXO	Large Off-Road	5	2018	80	1.7	System advised	Manually Set	Camera & Map		✓	X	X	X	✓	X	✓	X	✓	X
Hyundai Santa Fe	Large Off-Road	5	2018	76	1.3		Manually Set												
Jaguar I Pace	Executive	5	2018	81	2.5	System advised	System advised	Camera & Map		✓	✓	X	X	✓	✓	X	X	X	✓
Jeep Wrangler	Large Off-Road	1	2018	32	1.3		Manually Set												
Lexus ES	Large Family Car	5	2018	77	2.4	System advised	System advised	Camera		X	✓	✓	X	X	✓	X	X	X	✓
Mazda 6	Large Family Car	5	2018	73	2.4	System advised	System advised	Camera & Map		X	X	X	X	✓	✓	✓	✓	X	X
Mercedes-Benz A-Class	Small Family Car	5	2018	75	3	System advised	System advised	Camera		✓	✓	✓	✓	✓	✓	✓	✓	X	✓
Nissan Leaf	Small Family Car	5	2018	71	1.9	System advised	Manually Set	Camera & Map		✓	✓	✓	X	X	✓	✓	✓	✓	✓
Opel/Vauxhall Combo	Small MPV	4	2018	68	2.3	System advised	System advised	Camera		X	X	X	X	✓	✓	X	X	X	X
Peugeot 508	Large Family Car	5	2018	79	2.5	System advised	System advised	Camera		✓	✓	✓	X	✓	✓	X	X	X	✓
Peugeot Rifter	Small MPV	4	2018	68	2.3	System advised	System advised	Camera		X	X	X	X	✓	✓	X	X	X	X
Suzuki Jimny	Supermini	3	2018	50	1.3		Manually Set												
Volvo V60	Large Family Car	5	2018	76	2.5	System advised	System advised	Camera		✓	✓	X	X	✓	✓	X	X	X	✓
Volvo XC40	Small Off-Road	5	2018	76	2.5	System advised	System advised	Camera		✓	✓	✓	X	✓	✓	X	X	X	✓
VW Touareg	Large Off-Road	5	2018	81	1.9	System advised	Manually Set	Camera & Map		✓	X	X	✓	✓	✓	✓	✓	✓	✓

**Table 4: Euro NCAP Speed Assistance system capabilities overview 2019**

Make & Model	Category	Stars	Year	SA (Normalised Score)	SAS	Setting Warning	Setting Speed (Vadj)	SLIF Type	Subsign Recognition	Rain	Snow	Distance	Time	Arrows	Vehicle Category	Implicit Highway	Implicit City	Implicit Residential	Dynamic Limits
Audi e-tron	Large Off-Road	5	2019	76	1.3		Manually set												
Audi A1	Supermini	5	2019	80	1.3		Manually set												
BMW 1 Series	Supermini	5	2019	72	2.5	System advised	System advised	Camera	✓	✓	✓	X	✓	✓	X	X	X	X	✓
BMW 3 Series	Large Family Car	5	2019	76	2.5	System advised	System advised	Camera	✓	✓	✓	X	✓	✓	X	X	X	X	✓
BMW Z4	Roadster Sport	5	2019	76	2.5	System advised	System advised	Camera	✓	✓	✓	X	✓	✓	X	X	X	X	✓
Citroen C5 Aircross (Safety Pack)	Small Off-Road	5	2019	82	2.5	System advised	System advised	Camera	✓	✓	✓	X	✓	✓	X	X	X	X	✓
DS 3 Crossback (Safety Pack)	Small Off-Road	5	2019	76	2.6	System advised	System advised	Camera	✓	✓	✓	X	✓	✓	X	X	X	X	✓
Ford Focus	Small Family Car	5	2019	75	2.5	System advised	System advised	Camera	X	X	✓	X	✓	✓	✓	X	X	X	✓
Honda CR-V	Large Off-Road	5	2019	76	2.5	System advised	System advised	Camera	✓	✓	X	X	X	✓	X	X	X	X	✓
Jeep Cherokee	Small Off-Road	4	2019	69	1.3		Manually set												
Kia Ceed	Small Family Car	5	2019	73	1.3		Manually set												
Land Rover Range Rover Evoque	Small Off-Road	5	2019	73	1.3		Manually set												
Lexus UX	Small Off-Road	5	2019	77	2.4	System advised	System advised	Camera	X	✓	✓	X	X	✓	X	X	X	X	✓
Mazda 3	Small Family Car	5	2019	73	2.4	System advised	System advised	Camera & Map	X	X	X	X	✓	✓	✓	✓	✓	X	X
Mercedes-Benz B-Class	Small MPV	5	2019	75	2.9	System advised	System advised	Camera	✓	✓	✓	X	✓	✓	✓	✓	✓	X	✓
Mercedes-Benz CLA	Small Family Car	5	2019	75	3	System advised	System advised	Camera	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓
Mercedes-Benz EQC	Small Off-Road	5	2019	75	3	System advised	System advised	Camera & Map	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mercedes-Benz G-Class	Large Off-Road	5	2019	72	2.7	System advised	System advised	Camera & Map	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓
Mercedes-Benz GLE	Large Off-Road	5	2019	78	3	System advised	System advised	Camera	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓
Peugeot 208	Supermini	4	2019	71	2.5	System advised	System advised	Camera	✓	✓	X	X	✓	✓	X	X	X	X	✓
Renault Clio	Supermini	5	2019	75	2.5	System advised	System advised	Camera	X	✓	✓	X	✓	✓	X	X	X	X	✓
SsangYong Korando	Small Family Car	5	2019	74	1.6		Manually set	Camera	✓	X	X	X	✓	X	X	X	X	X	X
Seat Tarraco	Large Off-Road	5	2019	79	1.3		Manually set												
Skoda Scala	Small Family Car	5	2019	76	1.3		Manually set												
Toyota Corolla	Small Family Car	5	2019	77	2.4	System advised	System advised	Camera	X	✓	✓	X	X	✓	X	X	X	X	✓
Toyota RAV4	Small Off-Road	5	2019	77	2.4	System advised	System advised	Camera	X	✓	✓	X	X	✓	X	X	X	X	✓
Tesla Model 3	Large Family Car	5	2019	94	2.8	System advised	System advised	Map based	✓	✓	✓	X	X	✓	✓	✓	✓	✓	X
VW T-Cross	Small MPV	5	2019	80	1.3		Manually set												

### **3.4 Initial expert consultations**

Consultations with a number of industry experts were held in order for TRL to understand capabilities and limitations of current and future generations of ISA systems and validation strategies commonly applied.

The consultations were held as 2-hour teleconferences or face-to-face meetings. The meeting format was bilateral, i.e. TRL and stakeholders representing one company at a time, and structured by questions in a topic guide shared with the stakeholder in advance of the meeting. The meetings were non-public exchanges at a technical level and notes will not be published.

TRL's invitation for bilateral meetings was extended to industry through ACEA and CLEPA and individually to other organisations. TRL held 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) and received written input from 1 bus OEM.

The topic guide contained introductory information for the stakeholders (TRL task and timelines, ISA terminology, remit of the Commission's mandate for ISA) and questions relating to the following aspects:

- Functionality of current and future systems (camera-only or camera & map fusion; fusion of inputs; map update strategy)
- Validation approaches applied in industry and suitability for type-approval (track vs. real road validation, test protocols, test conditions, key performance indicators used)
- HMI aspects for speed limit information function, speed limit warning function and speed control function
- Evaluation approaches for HMI
- Detection and recognition capabilities of current and future camera systems (types of road signs, country capabilities, performance in non-ideal conditions)
- Aspects specific to heavy vehicles (M2, M3, N2, N3)

The answers provided by stakeholders informed the proposed contents for the ISA type approval regulation in Section 4, including items such as the choice of test track or real road testing, the makeup of testing by the technical service vs. documentation of in-house testing, reasonable expectations of capabilities of current and near future systems, items relevant for vehicles other than passenger cars.

The authors thank the stakeholders involved in the bi-lateral consultations for their inputs, without which development of this report would not have been possible.

## 4 PROPOSED CONTENTS FOR ISA TYPE APPROVAL REGULATION

### 4.1 Introduction

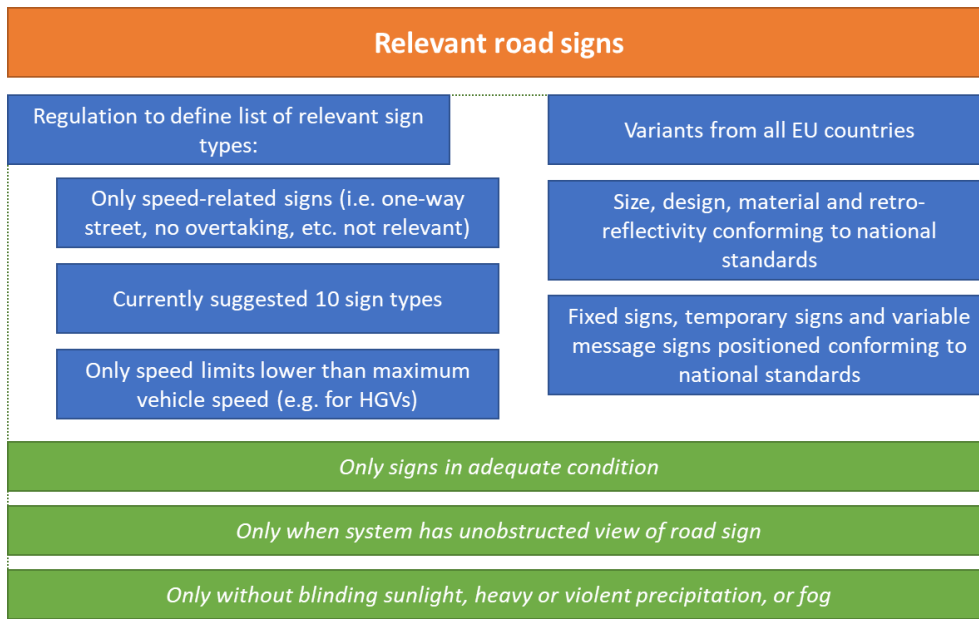
The following sub-sections are intended to provide a basis for stakeholder discussion. They do not pre-empt the exact contents or wording of a future regulation, but reflect TRL's current position on potential requirements and test procedures that could be recommended within the given legislative remit of the Commission and taking into account the state of technology readiness and industry best-practice as established in the review and consultation tasks.

Each element addressed in the sections 'requirements' and 'assessment procedures' is covered with the same structure:

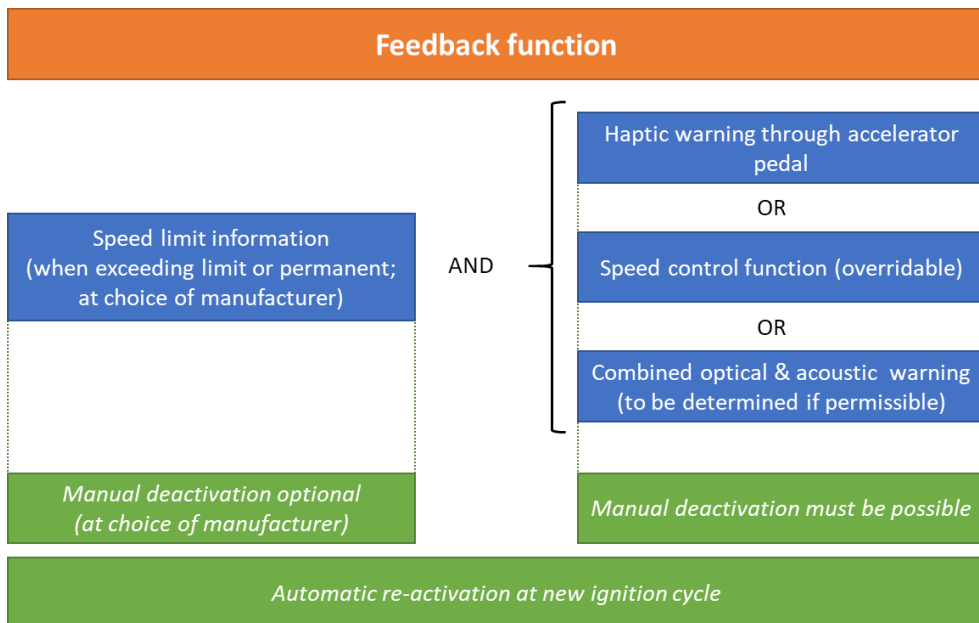
- **Background and source material:** This section summarises the relevant parts of the General Safety Regulation which define the remit set by the legislator and cite relevant parts of existing procedures (e.g. Euro NCAP) and UN regulations.
- **High-level intent and justification:** Sets out what the future regulation should achieve in TRL's view and provides TRL's considerations and rationale.
- **Initial outline of regulation contents:** Contains text reflecting TRL's current position on potential contents of the ISA regulation at this point in the project. Most elements are not yet phrased as regulatory text but the intent is to clearly communicate potential contents for feedback from stakeholders. Other elements that are taken over from existing regulations are already phrased in regulatory language. Annex 1 provides the contents of this sub-section as one consecutive text for all items (identical text as contained in this section).
- **Questions for stakeholders:** Contains a list of questions where TRL require further input from stakeholders, for example to define limit values or take a decision between two possible approaches. Note that beside the stated questions, TRL also seek wider general feedback on the approach and contents suggested. Any feedback should be provided with a rationale explaining the position and where appropriate provide evidence-based justifications.

The following figures present a high-level overview of TRL's preliminary recommendations on regulation contents for selected aspects:

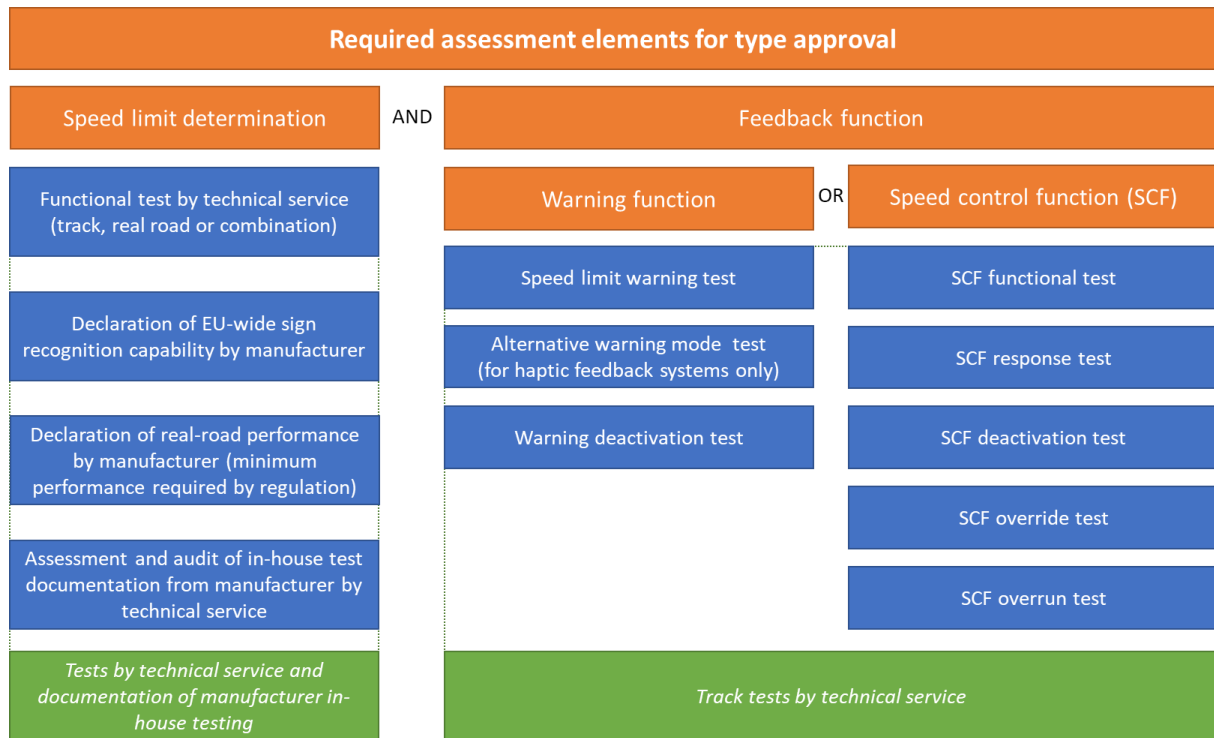
- Relevant road signs: Figure 27
- Speed limit information and feedback modes: Figure 28
- Test and assessment procedures: Figure 29



**Figure 27: TRL’s recommendation regarding relevant road signs, i.e. signs that need to be recognised with a defined minimum level of performance**



**Figure 28: TRL’s recommendation regarding speed limit information and feedback modes**



**Figure 29: TRL's recommendation regarding test and assessment procedures for type approval**

## 4.2 Definitions and scope

### 4.2.1 Definitions

#### 4.2.1.1 Draft definitions

The following draft definitions are suggested based on the General Safety Regulation and developed by TRL as required:

- 'common space' means an area on which two or more information functions (e.g. symbol) may be displayed, but not simultaneously
- '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
- 'feedback speed limit' is the currently set speed above which the ISA system provides feedback to the driver
- 'perceived speed limit' is the current maximum permitted speed as perceived by the ISA system
- 'relevant road sign' means a physical road sign, or a variable message sign, of a type specified in the catalogue of functional requirements
- 'road sign and signal observation system' means all parts of the ISA system required to detect and recognise a road sign or signal (e.g. camera and associated ECUs)
- 'road speed limit' is the currently applicable maximum permitted driving speed at the vehicle's location
- 'self-check' means an integrated function that checks for a system failure on a continuous basis at least while the system is active

- 'speed control function' (SCF) means a function which limits or controls the driving speed to the feedback speed limit
- 'speed limit information function' (SLIF) means a function that communicates the perceived speed limit to the driver
- 'speed limit feedback' means a speed limit warning or speed control
- 'speed limit warning function' (SLWF) means a function that alerts the driver that the driving speed is exceeding the feedback speed limit
- 'type of ISA STU' means a combination of specific hardware which does not differ in such essential respects as the characteristics, functionality, capability [and performance] of speed limit determination [and speed limit feedback].
- 'vehicle type with regard to the installation of an ISA system' means motor vehicles that do not differ in such essential respects as the characteristics of the integration within the vehicle as well as the characteristics, functionality, capability and performance of speed limit determination and speed limit feedback.

#### 4.2.1.2 Questions for stakeholders

- Q1. Are any changes to the draft definitions required? Please suggest alternative wording and provide justification or explanation.
- Q2. Are additional definitions required? Please suggest terms and definitions and provide justification or explanation.

#### 4.2.2 Subject matter and exemptions

##### 4.2.2.1 Initial outline of regulation contents

- The ISA regulation:
  - will apply to the vehicle categories defined in the GSR, i.e. M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub>, N<sub>1</sub>, N<sub>2</sub> and N<sub>3</sub>.
  - will establish detailed technical requirements and test procedures for the EC type-approval of vehicles of the categories above in respect of their intelligent speed assistance (ISA) system and of ISA separate technical units (STUs).
- For vehicle and STU approval a similar approach to the eCall regulation could be considered where parts of the assessments can be performed on STUs. The exact split is to be determined.
- Note: Small series approval, multi-stage vehicles, individual approval scheme or ISA component approval are not in scope of TRL's work.
- Stakeholders suggested to define the following exemptions:
  - Special purpose vehicles (SPV), i.e. M<sub>x</sub>S and N<sub>x</sub>S: TRL seek additional input; please note questions in Section 4.2.2.2.
  - Off-road vehicles (ORV), i.e. M<sub>x</sub>G and N<sub>x</sub>G: TRL seek additional input; please note questions in Section 4.2.2.2.
  - Vehicles which are top-speed limited (UN Regulation No. 89 on speed limitation devices): While being top-speed limited, these vehicles will still be used on roads with speed limits lower than their top speed (e.g. in urban areas, at roadworks, etc.) which is why an exemption is not appropriate. However, TRL suggest reducing the catalogue of relevant road



signs for these vehicles to signs denoting a speed limit lower than their top speed. See Section 4.3.1.

- Vehicles that have a limited area of operation, e.g. city buses: While the normal operation of these vehicles may be restricted in day-to-day use the vehicles will still be allowed to be operated in the EU if they hold European type approval and therefore should be compatible with the infrastructure in all European countries. TRL seek additional input; please note questions in Section 4.2.2.2.

#### 4.2.2.2 Questions for stakeholders

Q3. Regarding requested exemption for special purpose vehicles:

- a) Please provide a justification for exempting these categories, if relevant separately for individual codes (SA, SB, ...).

Q4. Regarding requested exemption for off-road vehicles:

- a) Please provide a justification for exempting these categories.
- b) How many off-road vehicles of categories M<sub>x</sub>G and N<sub>x</sub>G are registered per year across the EU?

Q5. Regarding requested exemption for vehicles that have a limited area of operation:

- a) Please provide a justification for exempting these vehicles or appropriate reductions in requirements.

## 4.3 Requirements

### 4.3.1 Functional requirements for speed limit determination

#### 4.3.1.1 Background and source material

- GSR legislative remit:
  - *"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;"*
    - Observation of 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, future vehicle-to-infrastructure signals or electronic map data.
    - The statement above therefore includes camera-only systems (if they can interpret variable message signs) and camera & map fusion systems, but does not include map-only systems.
- Euro NCAP:
  - Requirements are defined in the Section 4.4 of the assessment protocol (Euro NCAP, 2019):
    - *"The speed limit information could either be provided by vehicle-integrated devices or by mobile devices connected to the vehicle network."*
    - The assessment protocol implicitly requires that speed limits indicated by numerical speed signs are perceived (via camera or map) on motorways, rural and city roads.
    - Additionally, Euro NCAP defines 'Advanced Functions' which attract additional points (Table 5).

**Table 5: Euro NCAP Advanced Functions**

Euro NCAP advanced functions		Required Action
<b>Weather</b>	Rain / Wetness	Show correct speed limit
<b>Weather</b>	Snow / Icy	Warning only and ignore if irrelevant
<b>Time</b>	Time	Show correct speed limit
<b>Distance</b>	Distance for / in	Show correct speed limit
<b>Arrows</b>	Arrows	Show correct speed limit or ignore if irrelevant
<b>Vehicle Categories</b>	Other vehicle / weight categories	Ignore if irrelevant
<b>Implicit Speed Limits</b>	Highway / Motorway	Show correct speed limit
<b>Implicit Speed Limits</b>	City Entry / Exit	Show correct speed limit
<b>Implicit Speed Limits</b>	Residential zones	Show correct speed limit
<b>Dynamic Speed Limits</b>	Dynamic speed signs including roadworks	Show correct speed limit

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#### 4.3.1.2 *High-level intent and justification*

- The requirements should be defined in a performance-based manner in order to not be design restrictive or technology specific. In line with the legislative remit, they should prescribe the observation of a certain set of road signs and signals and allow support by electronic map data.
- Member states in which the system must function
  - The ISA system must be capable of operating correctly in all EU member states.
  - While it is likely that a vehicle will be type approved in a single EU member state, the technical service undertaking the type approval assessment must satisfy themselves that the system has the capability to operate appropriately in all of the other member states.
  - The implication being that the system must have a 'database' of speed limits and their associated road signs and regulations that includes a comprehensive data set for all EU member states.
- Acceptable methods of speed limit determination
  - This task could in part be accomplished using data for the current position derived from maps, however, allowance must be made for the fact that speed limits may be subject to permanent or temporary changes, or might be variable:
    - National or local authorities may choose to make a permanent change to the speed limit for a given road.
    - The speed limit might be lowered temporarily, for example while road maintenance is being conducted.
    - The speed limit might be routinely variable e.g. as a method for managing congestion.
  - A simple map-based system would not be capable of keeping track of these dynamic changes and would thus be prone to displaying incorrect speed limits to the driver, and consequently either annoying the driver at times when the perceived speed limit was lower than the road speed limit, or failing to warn the driver that they were exceeding the limit when the road speed limit was lower than the perceived speed limit. This aligns with the GSR requiring the observation of road signs.
  - At the time of writing no map-based system with the capability to be updated in real time in response to temporary and variable speed limits is available on the market. Thus, the most likely solution to this requirement would utilise a machine vision system (camera) to pick up the same visual cues that a human driver would rely on to determine the applicable speed limit for the road.
  - The requirements shall therefore be defined so that, with current technology, they can be fulfilled by both camera-only systems and camera & map fusion systems, without restricting future developments, such as cloud support or vehicle to infrastructure communication.
- 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 know:
  - the country (and in some cases region) in which the vehicle is travelling: according to stakeholders, the current country code can be derived from positioning systems (e.g. GNSS such as GPS; note that passenger cars have positioning capability due to eCall) or from observation of the traffic sign types encountered; the latter was described by stakeholders as less reliable.

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- the category of vehicle to which it is fitted: this is constant over the lifetime of the vehicle and can be therefore be coded into the system
  - the class of road on which it is travelling: according to stakeholders this can be derived from map data or from observation of signs (e.g. motorway, expressway) and road characteristics using machine vision (e.g. number of lanes, divided by central barrier); the latter was described by stakeholders as less reliable.
  - Additionally, the system must be capable of recognising and correctly interpreting a range of permanent, variable and temporary road signs which may or may not display a numeric value for the speed limit in force. The rationale for defining the set of relevant road signs is discussed below; see Section 3.1 for background.
  - Roads with numerically signposted speed limits
    - The system must be capable of recognising and correctly interpreting numerically signposted speed limits (Figure 4 or Figure 5). While this task is by no means trivial, with the exception of the units of measurement in use (km/h vs mph), all the information required by the system is immediately available to it by reading the relevant road sign.
    - The system must also be capable of recognising when the vehicle is within the boundaries of a speed limit zone (Figure 7). This task is very similar to the requirement to recognise numerically signposted speed limits, but with the added complication that the same speed limit might apply to a whole network of roads within the zone without confirmatory signs being displayed on each individual road.
  - Roads with non-numerical signposted speed limits
    - The system must be capable of recognising and correctly interpreting a range of non-numerically signposted speed limits. This task is somewhat more complex than that described above as, not only must the system recognise that a road side item is a relevant road sign, but it must then apply the correct interpretation to that sign, which may be different for signs of identical appearance in different countries, or on different roads. Examples of such non-numeric signs are:
      - End of speed limit, or national speed limit applies (Figure 8 or Figure 9)
      - End of a specific speed limit (Figure 10)
      - End of a speed limit zone (Figure 11)
      - Place name signs used to indicate speed limits and their corresponding cancellation signs (Figure 12 and Figure 13)
      - Residential or home zone signs (Figure 15)
      - Motorway and expressway signs (Figure 16 and Figure 17)
    - Each of these relies on the system knowing the country or region in which it is operating and the applicable national speed limit for that class of road. The group of 'end of speed limit' signs may be particularly challenging to interpret correctly as the speed limit that applies beyond them will vary depending on the class of road on which they are posted and the category of vehicle to which the system is fitted. Place name signs, residential zone and motorway or expressway signs will at least convey a single speed limit for each member state, although those limits will vary from country to country.
  - Implicit speed limits communicated by means other than road signs
    - Some speed limits are communicated by means other than road signs. For example, in the U.K. 'dual carriageways' – roads in which traffic travelling in
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opposite directions are separated by a barrier or central reservation, have a 70mph national speed limit, which is indicated only by the separation of the carriageways. These roads are often marked with 'national speed limit applies' signs (Figure 5) whose meaning is changed by the separation of the carriageways. That national speed limit is different depending on the category of the vehicle concerned. The system must be able to determine the correct speed limit for the category of vehicle on this class of road.

- The U.K. also has a convention that the presence of streetlights in a built-up area indicates that a 30mph speed limit applies unless a contradicting road sign is posted. While this regulation is retained in U.K. law, explicit signage is routinely used to indicate 30mph speed limits in built up areas. It is therefore not necessary for a system to be capable of inferring a specific speed limit from the presence of street lighting.
- Conditional speed limits based on vehicle or driver parameters
  - Most EU member states apply lower speed limits for heavier categories of vehicles. The system will be required to be configured for the category of vehicle to which it is fitted and apply the appropriate speed limit.
  - Many member states employ pictographic or text based sub-signs to indicate that an alternate speed limit applies to some categories of vehicles. As these sub-signs are usually appended to a numerical speed limit sign the system must recognise and interpret the sub-sign and, if appropriate to that category of vehicle, apply the indicated speed limit.
  - Some countries have different national speed limits for certain types of driver, e.g. those who are below a certain age or have limited driving experience. While it may be theoretically possible to devise a system that is capable of identifying the driver, perhaps based on information they supply, and thus establish their age or driving experience, no such system currently exists or is proposed. The system will therefore not be required to identify the age or driving experience of the driver and thus determine that the lower limit is in force. In this case the perceived speed limit would be that for the category of vehicle and class of road and the driver would maintain responsibility for ensuring that they observe the lower speed limit.
  - Some countries apply different speed limits when a vehicle is towing a trailer. Currently available systems do not have the capability to recognise when the vehicle has a trailer attached. The system would therefore not be required to identify that the vehicle was towing and thus determine that a lower limit is in force. In this case the perceived speed limit would be that for the category of vehicle and class of road and the driver would maintain responsibility for ensuring that they observe the lower speed limit when towing.
- Conditional speed limits based on weather or season
  - Some member states have seasonal speed limits which apply different national speed limits at different times of year to account for changing driving conditions. Typically, these are indicated using variable message signs (e.g. LED) or by the national authorities physically exchanging speed limit signs for ones of a different value.
  - Some member states apply different speed limits under specific meteorological conditions, e.g. when it is raining, foggy or snowing. These conditional limits are typically indicated using pictographic sub-signs. Stakeholders indicated that these sub-signs can be difficult to interpret correctly. It can also be difficult to detect some of the meteorological conditions indicated by these signs, given currently available technology. Given the difficulty correctly reading these road signs and of clearly defining and identifying these conditions the system is not required to interpret the sub-sign but only identify

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that additional conditions apply and, as minimum functionality, disregard the sign.

- Conditional speed limits based on time of day or days of the week
  - Some member states employ part time speed limits, which only apply at certain times of day or on certain days of the week. The conditions under which these speed limits apply are indicated using text based sub-signs. Stakeholders indicated that these signs are difficult to interpret correctly using current machine vision systems. Given the difficulty of correctly interpreting these sub-signs the system is not required to interpret the sub-sign but only identify that additional conditions apply and, as minimum functionality, disregard the sign..
- Retention of speed limit information
  - The system must be capable of retaining the information that it collects regarding the current speed limit for the road on which the vehicle is travelling for a to be defined minimum distance depending on the road type after the last observed road sign.
  - The system must be capable of retaining the value of the currently applicable road speed limit when the vehicle's main power control is cycled, i.e. the system must retain its perceived speed limit when the vehicle is parked.
- Time taken to update the perceived limit
  - The system must be capable of processing the information that it collects in a timely manner so that the system's perceived limit is updated within [5] seconds of entering a new speed limit.

#### 4.3.1.3 *Initial outline of regulation contents*



- Note: This section defines the basic functional requirements for speed limit determination from observation of road signs and signals, i.e. requirements to ensure for example that all the necessary classifiers are implemented in the system camera. It is recognised that observing road signs is a probabilistic process and cannot be achieved under all conditions and with 100% performance. Performance aspects are covered in another section (Section 4.3.2).
- The system shall be able to detect and correctly classify road signs in order to perceive the road speed limit. This requirement applies to:
  - relevant sign types as defined in the catalogue,
  - road signs of all EU member states where a particular sign type is in use at the time of approval,
  - road signs of a size, design, material and retro-reflectivity conforming to the applicable standards in the member state concerned at the time of approval,
  - fixed signs, temporary signs and variable message signs, positioned in a way conforming to the applicable standards in the member state concerned at the time of approval, e.g. relating to lateral distance to the road edge, height and orientation (rotation, tilt),
  - road signs indicating a road speed limit that is lower than the vehicle's maximum speed plus [10 km/h] (Note: For example, top-speed-limited HGVs do not need to recognise speed limit signs with values more than [10 km/h] higher than their top speed. The tolerance is included to cover situations where a speed limiter may be exceeded with gravity assistance).
- The system may (note: optional) be able to detect and classify other road signs.

- The perceived speed limit from observed relevant road signs shall match the road speed limit with regard to the numerical value and the unit of measurement (km/h or mph). This applies to both numerical and non-numerical road signs contained in the catalogue. Note: This will require knowledge of the current country-code and road class in some instances.
- The system shall be able to detect if relevant road signs apply only to particular vehicle categories/classes, indicated by sub-signs, and perceive the correct speed limit.
- The system shall be able to detect if relevant road signs apply only under additional conditions, indicated by sub-signs or additional information on the sign (e.g. rain, snow, time of day, distance or advance warning), and [either disregard the sign (result: previously applicable speed limit or speed limit unknown) or] perceive the correct speed limit based on the relevant conditions.
- The system shall be designed with measures to disregard for the purpose of speed limit determination (e.g. by probability algorithms with or without map support) at least these categories:
  - non-applicable road signs (i.e. those that are not applicable to the vehicles carriageway or lane, including overview signs posted at national borders),
  - non-speed-related road signs (e.g. vehicle weight limits, vehicle width limits), and
  - extraneous items that are not road signs (e.g. speed limit stickers used on HGVs).
- The system shall be designed to ensure that speed limits determined from applicable relevant road signs are preferred to map-derived speed limits.
- The system shall be able to set the perceived speed limit within [5 seconds] of passing the relevant road sign.
- The system shall retain the perceived speed limit (even after an ignition cycle) until:
  - It is replaced by a new perceived speed limit (from observation of road signs or signals or map data); or
  - It is replaced by 'speed limit unknown', based on criteria that may include but are not limited to:
    - The ISA system is deactivated
    - The vehicle is suspected to drive off-road
    - The vehicle is suspected to have turned onto a different type of road (e.g. away from a major road)
    - The system has not observed a road sign or signal for a distance of at least [x km] on motorways/expressways, [y km] on non-urban roads, or [z km] on urban roads.

**Table 6: Required capabilities for the determination of perceived speed limits (catalogue of relevant sign types)**

Description	Examples	System required to set perceived speed limit?
Numerical road signs including temporary and variable message signs		Yes – applying the correct units of measurement for the member state in which the vehicle is located
End of speed limit or 'national speed limit applies' signs		Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle
End of specific speed limit or speed limit zone signs		Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle
Place name signs used to indicate the presence of a speed limit and their associated cancellation signs		Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle
Urban area signs and their associated cancellation signs		Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle
Home zone or residential zone signs		Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle
Motorway regulations apply signs		Yes – taking into account the appropriate national speed limit for the category of vehicle
Expressway regulations apply signs		Yes – taking into account the appropriate national speed limit for the category of vehicle



Vehicle category specific signs		Yes – taking into account the category of vehicles
Additional conditions apply (including rain, snow, time of day, arrows, distance or advance warning)		No – the system should be capable of recognising that an additional condition applies that means that the speed limit may not be in force for that section of road and either disregard or set correct limit based on conditions.

#### 4.3.1.4 Questions for stakeholders

- Q6. Please provide feedback on the suggested requirements above.
- Q7. Is it possible for camera-only systems to fulfil the suggested functional requirements, in particular considering aspects such as identifying the country code or road class (e.g. identify U.K. dual carriageways)? Or are infrastructure changes by Member States required to make the speed limits easier to interpret? If so, what changes?
- Q8. The suggested requirements regarding conditional speed limits only include correct interpretation of vehicle category specific limits, but not of weather-, distance- or time-dependent limits. Could Member States make changes to infrastructure that would allow easier detection of weather, distance- or time-dependent limits so that this functionality could be expected from a baseline system?
- Q9. For what distance after last observing a road sign should the system be required to continue to retain the perceived speed limit?
- Q10. Some stakeholders have reported that it may be difficult to reliably interpret sub-signs, for example those indicating specific conditions under which the posted limit applies. If the system is able to identify that a sub-sign is present, but is unable to interpret its meaning, how should the system behave (should it retain the previous perceived speed limit or should it set the perceived speed limit to unknown)?

## 4.3.2 Real-road performance of speed limit determination

### 4.3.2.1 Background and source material

- GSR legislative remit:
  - ISA's "*performance targets shall be set in order to avoid or minimise the error rate under real driving conditions.*"
- Euro NCAP:
  - Euro NCAP requests a performance declaration from manufacturers:
    - Based on internal testing (by manufacturer or tier 1), the manufacturer declares a 'coverage' rate per country and per speed limit category (see **Figure 30** of the 2020 version of the declaration table).
    - Test conditions for internal testing are not specified by Euro NCAP.
    - To pass the assessment, certain 'coverage' levels need to be achieved (defined as the percentage of correctly recognised signs):
      - General speed limit signs need to be covered >95% for all EU countries.
      - To achieve points for other speed limit signs (advanced function), the coverage for all Euro NCAP countries (France, Germany, Italy, Luxembourg, Netherlands, Spain, Sweden and United Kingdom) needs to be >95% and the coverage for at least half of all EU countries needs to be ≥50%.

	General			Conditional speed limits										
				Weather		Time	Distance		Arrows	Vehicle Categories	Implit speed limits			Dynamic Speed Limits
	Highway/Motorway	Rural	City	Rain/Wetness	Snow/Icy	Time	Distance for	Distance in	Arrows	Other vehicle/weight	Highway/Motorway	City Entry/Exit	Residential Zones	Dynamic speed signs (including roadworks)
Austria	Yes	Yes	Yes					No						
Belgium	Yes	Yes	Yes					No						
Bulgaria	Yes	Yes	Yes	N/A				No						
Croatia	Yes	Yes	Yes					No						
Cyprus	Yes	Yes	Yes	N/A	N/A	N/A	N/A	No	N/A	N/A				
Czech Republic	Yes	Yes	Yes					No						
Denmark	Yes	Yes	Yes	N/A				No						
Estonia	Yes	Yes	Yes					No			N/A		N/A	
Finland	Yes	Yes	Yes	N/A	N/A			No						
France	Yes	Yes	Yes					Yes						
Germany	Yes	Yes	Yes					Yes						
Greece	Yes	Yes	Yes			N/A		No						
Hungary	Yes	Yes	Yes					No						
Ireland	Yes	Yes	Yes	N/A	N/A	N/A		No	N/A	N/A			N/A	
Italy	Yes	Yes	Yes					Yes						
Latvia	Yes	Yes	Yes					No						
Lithuania	Yes	Yes	Yes					Yes						
Luxembourg	Yes	Yes	Yes					Yes						
Malta	Yes	Yes	Yes					Yes			N/A	N/A	N/A	
Netherlands	Yes	Yes	Yes		N/A			Yes	N/A					
Poland	Yes	Yes	Yes	N/A	N/A			Yes						
Portugal	Yes	Yes	Yes					Yes					N/A	
Romania	Yes	Yes	Yes					Yes						
Slovakia	Yes	Yes	Yes					Yes						
Slovenia	Yes	Yes	Yes					Yes						
Spain	Yes	Yes	Yes			N/A		Yes						
Sweden	Yes	Yes	Yes	N/A	N/A			Yes			N/A			
United Kingdom	Yes	Yes	Partial	N/A	N/A	N/A		Yes	N/A					
	Fail			Fail	Fail	Fail	Fail	Pass	Fail	Fail	Fail	Fail	Fail	Fail

**Yes** High coverage > 95%

**Partial** Medium coverage 50-95%

**No** Low coverage < 50%

**N/A** Not existing in this country

**Pass** in case Euro NCAP member states (France, Germany, Italy, Luxembourg, Netherlands, Spain, Sweden and United Kingdom) are "Yes" or "N/A" and on the

**Figure 30: Euro NCAP Speed Assist System performance declaration from 2020; note: N/A denotes speed limit types which are not used in the corresponding country**

4.3.2.2 High-level intent and justification

- Adequate performance of speed limit determination in the real world shall be ensured, as per the legislative remit. Systems with an inappropriately high error rate would arguably be switched off by drivers and therefore not create road safety benefits.
- In order for the regulation to be technology neutral, minimum performance thresholds shall be set that can be achieved with and without map-support.
- Stakeholders indicated that system performance usually varies between countries, due to varying infrastructure condition (e.g. road sign deterioration), but also due to market considerations (requiring highest performance for 'key markets') or differing amounts of training data for camera algorithms being available.
  - While acknowledging that differences in infrastructure may not allow the same performance in all countries, the European regulation shall ensure an adequate minimum level of performance in all EU members states to ensure that safety benefits for consumers are realised in all countries.
  - The performance requirements shall be defined in order to ensure that aspects not in control of the vehicle manufacturer (such as deteriorated, damaged, inadequately positioned or obstructed road signs, or extreme weather conditions) will not negatively affect the performance rating. Only relevant road sign types (as per defined catalogue) shall be considered for performance assessment.
- Track testing is not suitable to measure performance:

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- The detection and recognition of speed signs is probabilistic and the success rate in real driving conditions is influenced by a large variety of factors (e.g. lighting conditions, scene background, driving speed). A representative set of all of these factors cannot be recreated reliably on a test track without unreasonable effort.
  - Test track measurements of map-supported systems do not reflect their on-road performance.
  - Stakeholder commented that the detection and recognition algorithms might not work or not exhibit the same performance in artificial environments as in real-world conditions (due to advanced plausibility checks and interpretation of road scenes).
  - Real-world performance testing:
    - In-house performance validation by manufacturers or tier 1 suppliers involves, according to stakeholders, test drives in mostly all EU countries as well as simulations covering hundreds to tens of thousands of kilometres per country.
    - It would not be efficient for the technical service to repeat such an extensive performance evaluation. Therefore, it is suggested to assess the real road performance based on a declaration of system performance from the system manufacturer and supporting documentation to evidence the underlying validation testing (carried out by the manufacturer or supplier).
    - The underlying test conditions will be defined at a high level in legislation; the manufacturer shall make test reports, including details of test conditions and results, available for review/audit by the technical service.
    - A defined minimum level of performance shall be required to pass this type approval assessment (pass-fail threshold).
  - Performance declaration:
    - The declaration shall report performance separately for each member state.
    - The declaration shall use specified performance metrics: Based on stakeholder interviews, the most commonly used key performance indicators are: true positive detection rate (percentage of signs passed) and false positive detection rate (number per distance driven), or overall percentage of distance with correct speed limit. To align with current industry practice, the choice between these metrics shall be left to the manufacturer.
    - The performance declaration shall be included in the test report to the type approval authority.
  - The suggested performance requirements are described in section 4.3.2.3, criteria for the underlying validation testing and documentation in Section 4.4.2.3.

#### 4.3.2.3 Initial outline of regulation contents

- The system shall be able to detect and recognise the road signs defined in Section 4.3.1.3 and to reliably determine the road speed limit at least in the following conditions:
  - When operated within a speed range of [10 km/h – 160 km/h or maximum design vehicle speed]
  - On urban roads, non-urban roads and motorways/expressways (dual carriageways)
  - Without blinding sunlight, heavy or violent precipitation, or fog

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- With unobstructed view of road signs for a continuous period of at least [0.x seconds], e.g. no vehicles in front blocking the view, no foliage obscuring the sign, no snow or dirt covering the sign
  - With road signs:
    - of a size, design, material and retro-reflectivity conforming to the applicable standards in the member state concerned
    - positioned in a way conforming to the applicable standards in the member state concerned, e.g. relating to lateral distance to the road edge, height and orientation (rotation, tilt)
    - in adequate condition, i.e. showing no damage (e.g. fading, bending, cracking, vandalism) that materially affects their visual properties
    - not deliberately invalidated, e.g. during roadworks
  - Reliable determination of the road speed limit is fulfilled if both of the following two criteria are met in each EU member state under the (favourable) conditions defined above:
    - Event-based performance:
      - The correct perceived speed limit is concluded in at least [xx% of sign passing events] for the signs and conditions described above; and
      - non-applicable road signs (i.e. those that are not applicable to the vehicles carriageway, lane, vehicle type or current conditions) or similar objects (false positives) are not used to incorrectly determine the perceived speed limit at a rate higher than [x per 100 km of driven distance].
    - Distance-based performance: The perceived speed limit matches the road speed limit for at least [xx% of distance driven] at least where the speed limit was indicated by a road sign contained in relevant catalogue and passed in the conditions described above.

#### 4.3.2.4 Questions for stakeholders

Q11. Please provide feedback on the suggested requirements above.

Q12. Are the proposed KPI metrics (event-based performance and distance-based performance) suitable and in alignment with current industry practice?

Q13. What performance (preferably expressed in the defined KPI metrics) can be achieved by camera-only systems available for inclusion in vehicles by 2022 (what is technically feasible)? Note that road signs that are e.g. obscured, damaged or positioned incorrectly are not counted for this performance measurement, which makes the performance measurement less stringent. Please also consider the test conditions in Section 4.4.2.3.

Q14. What minimum performance thresholds would you suggest for both of the KPI metrics, taking into account technical feasibility by 2022 and customer satisfaction? Note that road signs that are e.g. obscured, damaged or positioned incorrectly are not counted for this performance measurement, which makes the performance measurement less stringent. Please also consider the test conditions in Section 4.4.2.3.

Q15. Considering the introduction by 2022, which is the state of art today? And what is expected for 2022? Which limitations exist from the road

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infrastructure and, if so, which requirements should be applied from 2022?  
Please justify.

#### 4.3.3 Performance in changing infrastructure environments

##### 4.3.3.1 Background and source material

- ISA is heavily dependent on the infrastructure it operates in because a variety of factors that can change over time influence the observation performance of the camera (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 frequently.
- GSR legislative remit:
  - Recital 10 *"It is [...] necessary to ensure that those systems can be used safely throughout the life cycle of the vehicle"*
  - ISA's *"performance targets shall be set in order to avoid or minimise the error rate under real driving conditions."*
- Euro NCAP do not address all aspects of this topic comprehensively, but do require frequent map updates (Euro NCAP, 2019):
  - Section 4.4.3 *"If map-based data is required to achieve any of the points up to 12 the speed limits must be updated frequently (at least quarterly) and automatically for the first six years, without user action. (except] sending DVD/USB to customer allowed)."*

##### 4.3.3.2 High-level intent and justification

- Stakeholders reported different update strategies and support periods of map-supported systems, including over-the-air as well as offline updates (by customer or technician), including updates provided free of charge as well as costed.
- TRL understand that it is the manufacturer's responsibility to ensure that vehicles continue to comply with the type approval requirements, including achieving the required performance level under the conditions suggested in 4.3.2.3, for a defined period after first registration of a vehicle.
- It is therefore not intended to require a specific map update (or software update) strategy but rather require that the minimum performance level is met throughout the life cycle of the vehicle. It will be at the manufacturer's discretion how this requirement is met.
- Certain cases of substantial infrastructure changes, however, would require potential hardware updates or substantial updates of the camera software and should therefore in TRL's view not be in the manufacturer's responsibility for already approved vehicle types (see Table 7).
- TRL suggest establishing a format for dialogue between local road authorities, manufacturers, suppliers and the European Commission in which such changes are announced and discussed to enable appropriate reactions on all sides.

**Table 7: Scenarios of infrastructure changes**

Change of infrastructure scenario after type approval	How could existing systems perceive correct speed limit?	Would existing systems be required to perceive correct speed limit based on suggested requirements?	Update of type-approval legislation required to ensure compliance of future systems?
The applicable speed limit of a specific road has changed (e.g. by posting a road sign)	System can perceive through camera observation of posted limit and/or map update	Approved system <u>is</u> required to perceive new speed limit if it is indicated by a sign contained in the catalogue of relevant signs	No
The condition of road signs in a member state has deteriorated since the time of type approval	System can still perceive through camera observation of posted limit and/or map information	Approved system <u>is</u> still required to perceive the correct speed limit with the required performance, but only for those signs that still meet the minimum requirements for sign condition stated in section 4.3.2.3	No; for new approval technical service to ensure that the manufacturer's real-road performance testing reflects recent conditions and is not out of date
A member state has changed the implicit value associated with a relevant road sign	System can perceive through update of software parameters (speed limit associated with implicit sign) and/or map update	Approved system <u>is</u> required to perceive new implicit speed limit value	No; for new approval technical service to be aware of recent relevant changes and check manufacturers reflect them
A member state has changed the design of an existing type of relevant road sign	Recognition of new road sign designs might require re-training the camera software or addition of classifiers (possible hardware limitations); or map update	Approved system <u>not</u> required to perceive new road sign design because not contained in catalogue of relevant signs	No, requirement refers to " <i>designs conforming to the applicable standards in the member state concerned at the time of approval</i> ", i.e. a new approval will need to include the new design; technical service to ensure in audit
A member state has changed the rules for positioning road signs	Recognition of road signs that do not meet the previous positioning rules might require update of software parameters (plausibility check); or map update	Approved system <u>not</u> required to perceive new road sign positions because not contained in catalogue of relevant signs	No, requirement refers to signs " <i>positioned in a way conforming to the applicable standards in the member state concerned at the time of approval</i> ", i.e. a new approval will need to cover the new positions; technical service to ensure in audit
A member state has created a new type of road-sign, which is not included in the set of relevant road signs	Recognition of new road sign types would require addition of classifiers in the camera software (possible hardware limitations); or map update	Approved system <u>not</u> required to perceive new road sign type because not contained in catalogue of relevant signs	Yes, update annex of relevant road signs in type-approval legislation

#### 4.3.3.3 *Initial outline of regulation contents*

- The manufacturer shall ensure that the real-road performance of speed limit determination of registered vehicles meets the requirements for at least [4 years] after first registration of the vehicle even in changing infrastructure conditions.
  - This only applies to road sign types contained in the catalogue of relevant signs at the time of approval that are of a design and positioning conforming to the standard applied in the member state concerned at the time of approval.
- The manufacturer shall outline the measures planned to ensure compliance to the technical service, including, where applicable, the map update and software update strategy. This information shall be subject to discussion and agreement between the technical service and vehicle manufacturer.

#### 4.3.3.4 *Questions for stakeholders*

Q16. Please provide feedback on the suggested requirements above.

Q17. Do you agree that the list of scenarios outlined in Table 7 is complete or should other scenarios be added?

Q18. Are the proposed requirements technically feasible, e.g. updating the implicit value associated with a relevant road sign in a certain country?

Q19. Do the proposed requirements meet the right balance between technical and administrative effort for implementation and utility for vehicle users?



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## 4.3.4 Speed limit information

### 4.3.4.1 Background and source material

- GSR legislative remit:
  - *"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. Note: Warning or speed control functions are covered in Section 4.3.5.
  - The regulation furthermore stipulates that information about the speed limit *'may still be provided'* when the system is switched off.
- Euro NCAP criteria (Euro NCAP, 2019), Section 4.4.1 on SLIF general requirements:
  - *"The speed limit shall be shown using a traffic sign and 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, i.e. instrument cluster or head-up display.*
  - *The speed limit information must be shown or accessible at any time with a simple operation and needs to be shown at the start of the next journey (excluding the initialization period).*
  - *The indicated speed limit information may indicate the level of reliability of the speed limit.*
  - *In the presence of conditional speed limits [...] the system needs to either properly identify and show (for example when raining) the applicable speed limit or alternatively, needs to indicate the presence of a conditional speed limit which the system is not able to compute, in addition to the non-conditional speed limit."*

### 4.3.4.2 High-level intent and justification

- Information about the applicable speed limit shall be provided via an optical signal, in line with current SLIF designs on existing vehicles.
- Leave choice to the manufacturer if the speed limit information is displayed permanently or only at times when the ISA system is providing feedback (warning or speed control function active, see Section 4.3.5).
- Leave choice to the manufacturer if speed limit information is still being provided when the ISA system is switched off.
- The visual representation should resemble a road sign or a numerical value with the correct unit (km/h or mph), in line with common SLIF designs. A colour display should not be required.
- The information should be clearly seen in direct field of view of the driver without the need to turn the head sideways from the normal driving position. The intention is to have speed limit information included in the instrument cluster or head-up display, but to avoid using screens in the centre console or rear-view

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mirror, in order to ensure that this important information for the driving task is readily available to the driver.

- The requirements shall ensure that a vehicle for the continental European market with a speedometer in km/h shall display all speed limits in km/h (and vice versa); when driven in an EU region with mph speed limits, the system shall convert the number to km/h (and vice versa).

#### 4.3.4.3 *Initial outline of regulation contents*

- In normal operation mode the system shall display the numerical value of the perceived speed limit to the driver when feedback is active (i.e. a warning being provided or speed control function restricting the speed); information at other times is permitted (optional).
- The system may still display the perceived speed limit to the driver when the ISA system is deactivated (optional).
- The optical representation shall either be a symbol resembling a speed limit traffic sign (e.g. Vienna Convention signs C, 14; C, 17 or E, 9 or visual representations of other speed limit signs common in the country concerned; display of additional sub-signs permitted if required), or a numerical value with the unit of measurement (km/h or mph).
- The optical representation shall be clearly seen in direct field of view of the driver without the need to turn the head sideways from the normal driving position. It shall be visible even by daylight.
- The optical representation shall use the main units of the speedometer (if switchable, the currently active setting); converting speed limits from other units if required.
- The optical representation may indicate the level of reliability of the speed limit or the presence of a conditional speed limit (optional).

#### 4.3.4.4 *Questions for stakeholders*

Q20. Please provide feedback on the suggested requirements above.

Q21. Should the design of the optical representation of the speed limit information be prescribed in more detail in order to achieve standardisation across different manufacturers (e.g. by requiring a symbol rather than permitting text such as '50 km/h', or prescribing a minimum size?)

Q22. Do you agree with the requirement to convert speed limits from mph to km/h (or vice versa) to match the main unit of the speedometer (i.e. displaying 70 mph as 112 km/h in a continental approved vehicle, which is being driven in the UK unless the speedometer has been switched to mph)? Alternatively, it could be permitted to display the unit together with the symbol when it is different from the standard unit.

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#### 4.3.5 Speed limit feedback (warning or speed control)

##### 4.3.5.1 Background and source material

- GSR legislative remit:
  - Requirement 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"*, i.e.
    - legislator's preference is feedback through the accelerator control
    - other feedback modes acceptable if dedicated, appropriate and effective
  - ISA *"shall not affect the possibility, for the drivers, of exceeding the system's prompted vehicle speed"*, i.e.
    - system must be overridable
- Related EuroNCAP criteria (Euro NCAP, 2019):
  - SLWF criteria (Section 4.4.4): *"Speed Limit Information Functions that meet the warning requirements below to indicate the driver that Vlimit is exceeded will score for Warning Function. [...]"*
    - *The warning shall be a flashing traffic sign used to communicate the speed limit or an additional visual signal adjacent to the traffic sign.*
    - *The warning commences when Vindicated is exceeding Vlimit by more than 5km/h (3 mph). A negative and/or positive offset with respect to the known speed limit is allowed but may not be larger than 10 km/h (5 mph).*
    - *The driver continues to be informed for the duration of the time that Vlimit is exceeded by more than 5 km/h, with a total duration of at least 10 seconds. Gaps of less than 1 second, which allow for signals which flash are ignored, but the signal may not start with a gap. If the signal is not continuous for the first 10 seconds, it needs to be repeated every 30 seconds or less, resulting in a minimum total duration of at least 10 seconds.*
    - *The warning sequence does not need to be reinitiated for each exceedance of Vlimit until Vindicated has reduced to more than 5km/h below Vlimit."*
  - SCF criteria:
    - Automatic setting of the speed (Section 4.5.2.2): *"An automatic setting is using the speed limit information from the SLIF to set the Vadj with or without driver confirmation. [...]"*
      - *The system should adopt, or offer the driver to adopt, an adjusted Vadj within 5s after a change in the speed limit.*
      - *If Vadj is set to a speed lower than the current vehicle speed, the system starts to limit the vehicle speed to the new Vadj or shall initiate a warning (section 0) no later than 30s after Vadj has been set.*
      - *A negative and/or positive offset with respect to the known speed limit is allowed but may not be larger than 10 km/h (5 mph). This offset is included in Vadj.*
      - *The Vadj in the automatic mode of an ISA system may be retained at the end of a journey.*

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- *Where  $V_{adj}$  is set to the speed limit advised by the SLIF, the indication of  $V_{adj}$  may be suppressed.*
  - Speed Control (Section 4.5.3):
    - *"The vehicle speed shall be limited or controlled to  $V_{adj}$ .*
    - *It shall still be possible to exceed  $V_{adj}$  by applying a positive action – e.g. kickdown (SLF/ISA) or depressing the accelerator (iACC).*
    - *After exceeding  $V_{adj}$  by applying a positive action, the speed control function shall be reactivated when the vehicle speed drops to a speed less than or equal to  $V_{adj}$ .*
    - *The speed control function shall permit a normal use of the accelerator control for gear selection.*
    - *The speed control function shall ensure that when stable speed control has been achieved,  $V_{stab}$  shall be within  $-5/+0$  km/h of  $V_{adj}$  (see test protocol)*
    - *When the speed control function is not able to limit to and/or maintain  $V_{adj}$  and  $V_{adj}$  is exceeded by more than 5 km/h an audio-visual warning is issued, with a total duration of at least 10 seconds. No warning needs to be given when  $V_{adj}$  is exceeded as a result of a positive action.*
    - *Gaps of less than 1 second, which allow for signals which flash are ignored, but the signal may not start with a gap. If the signal is not continuous for the first 10 seconds, it needs to be repeated every 30 seconds or less, resulting in a minimum total duration of at least 10 seconds.*
    - *For systems where active braking is applied to maintain and/or limit the speed, this warning requirement does not apply.*
    - *Note: The warning signal does not preclude temporary interruption of the indication for safety reasons."*
  - Specifications of warning signals in other regulations:
    - Regulations for some safety system, such as corrective steering functions (UN Regulation No. 79) or safety-belt reminders (UN Regulation No. 16), specify detailed requirements for optical or acoustic intervention warnings. Some other regulations do not specify such details as the warning durations but just the warning mode (optical, acoustic, haptic).
    - Example of relevant stipulations in UN Regulation No. 79:
      - *"5.1.6.1.1. Every CSF intervention shall immediately be indicated to the driver by an optical warning signal which is displayed for at least 1 s or as long as the intervention exists, whichever is longer."*
      - *"5.1.6.1.2.2. In the case of two or more consecutive interventions [...] an acoustic warning signal shall be provided by the system [...]. Starting with the third [...] the acoustic warning signal shall continue for at least 10 seconds longer than the previous warning signal."*
    - Example of relevant stipulations in UN Regulation No. 16:
      - *"8.4.2.1. Visual warning*

- 8.4.2.1.1. *The visual warning shall be so located as to be readily visible and recognisable in the daylight and at night time by the driver and distinguishable from other alerts.*
- 8.4.2.1.2. *Visual warning shall be a steady or flashing tell-tale.”*
- “8.4.2.2. *Audible warning*
  - 8.4.2.2.1. *The audible warning shall consist of a continuous or an intermittent (pauses shall not exceed 1 second) sound signal [...]*
  - 8.4.2.2.2. *The audible warning shall be easily recognized by the driver.”*
- “8.4.2.3.1. *The first level warning shall be at least a visual warning activated for 30 seconds or longer for [...] and for 60 seconds or longer for [...]*”
- “8.4.2.4.1 *The second level warning shall be a visual and audible signal activated for at least 30 seconds not counting periods in which the warning may stop for up to 3 seconds [...]*”

#### 4.3.5.2 High-level intent and justification

- Leave choice to the manufacturer if a speed limit warning function (SLWF) or a speed control function (SCF) is used to implement ISA. The regulation will specify permissible feedback modes and requirements for both. Note: A SCF is also considered as ‘feedback’ because when trying to accelerate beyond the applicable limit, the driver feels that further depression of the accelerator control does not lead to a speed increase.
- All vehicle manufacturer stakeholders consulted expressed reservations against prescribing haptic feedback through the accelerator for ISA. Reasons cited were: ineffective when driver is using cruise control, the cost of integration was high, haptic feedback channel was not seen as appropriate for speed-related warnings, haptic feedback used for eco features by some manufacturers which means the channel cannot be used for two purposes without causing driver confusion.
- Stakeholders provided reference to a Sensory Modality Design Tool<sup>2</sup>, developed on behalf of the US Department of Transportation’s Federal Highway Administration (Campbell *et al.*, 2004). Based on characteristics of the message to be conveyed (urgency, complexity, etc.) it helps designers determine the most appropriate display modality for presenting in-vehicle information elements out of visual, auditory, tactile. Based on this tool, a manufacturer stakeholder deemed the most appropriate feedback modality to alert the driver to be auditory.
- Some vehicle manufacturer stakeholders also expressed reservations against a requirement for acoustic feedback, due to an alleged driver preference for visual only warnings. Some manufacturers include acoustic warning as a feature the driver can choose to activate.
- TRL’s intention is to base requirements on Euro NCAP as far as legislative stipulations (effective, dedicated, appropriate) are met. Notable differences:
  - Haptic feedback through the accelerator control shall be accepted as per GSR. Include stipulations that ensure alternative warning mode when using cruise control systems.

<sup>2</sup> <https://www.fhwa.dot.gov/publications/research/safety/03065/10.cfm>

- Other haptic feedback channels, e.g. steering wheel or seat, shall not be accepted because these are linked to vehicle controls or elements unrelated to the driving speed and as such not considered dedicated and appropriate for speed-related feedback.
- Based on consultations with the Commission, an optical-only warning, for example a flashing traffic sign symbol in the instrument cluster, shall not be accepted because it is not considered to provide a comparable level of effectiveness as the preferred feedback mode through the accelerator pedal.
- A combined optical & acoustic warning, for example a dedicated speed warning sound and a flashing traffic sign symbol or speed limit value in the instrument cluster, may be deemed permissible if it can provide a comparable level of effectiveness as the preferred feedback mode through the accelerator pedal. (Pending further evidence, see stakeholder questions)
- Note that feedback (i.e. warning or speed control) must be default on with each vehicle start-up as GSR stipulation (see Section 4.3.6). Note: A default on SCF would not be compatible with current Euro NCAP requirements.
- The feedback threshold (for warning or control) shall be set automatically based on the perceived speed limit. Relying on driver confirmation of each speed limit (which is accepted by Euro NCAP for SCF) would not be accepted because it is not considered to fulfil the GSR stipulations that the system needs to provide effective feedback in normal operation mode.
- No upward speed tolerance or adjustable offset as foreseen in Euro NCAP because the mandatory system should aim to enforce the applicable legal speed limit (or a speed slightly below that). Feedback requirements therefore to be based on actual driving speed (e.g. independently measured GPS speed in test). Alternatively, it shall be permitted to commence feedback when the speedometer speed is exceeding the limit, which would mean a lower speed.
- A SCF, if implemented, must be overridable based on the GSR stipulations. However, for some commercial fleets there will be a desire to operate vehicles with non-overridable ISA systems to increase road safety in well-mapped operating environments. Transport for London's Bus Safety Standard (see Section 3.2.2), for instance, contains such a requirement. Please consider the stakeholder question in this context.

#### 4.3.5.3 Initial outline of regulation contents

- In normal operation mode the system shall provide dedicated, appropriate and effective feedback to the driver when the driving speed is exceeding the feedback speed limit.
- At the choice of the manufacturer the feedback requirement can be realised via a speed limit warning function (SLWF) or with a speed control function (SCF), as specified below.
- The perceived speed limit shall be set automatically as feedback speed limit, i.e. without driver confirmation, within [5 seconds] after change in the perceived speed limit.
- An offset of the feedback speed limit relative to the perceived speed limit shall not be allowed.

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- The feedback does not need to be reinitiated for each exceedance of the feedback speed limit until the driving speed has reduced to more than 5 km/h (3 mph) below the feedback speed limit.
  - The feedback speed limit shall be retained at the end of a journey.
  - Possible feedback modes:
    - Haptic feedback through the accelerator control:
      - Preference by legislator for this feedback mode. Pedal vibration, increased resetting force of the pedal, or similar solutions shall be permissible.
      - The feedback shall last for a total duration of at least [10 seconds]. Gaps of less than 1 second, which are part of a haptic sequence are ignored, but the feedback may not start with a gap. If the signal is not continuous for the first [10 seconds], it needs to be repeated every [30 seconds or less], resulting in a minimum total duration of at least [10 seconds].
      - The haptic warning signal shall be detectable in all typical driving conditions, when the driver's foot is in contact with the accelerator control.
      - When the vehicle speed is controlled by a driver aid rather than the driver (e.g. adaptive/intelligent/normal cruise control, where the driver must be expected to not be touching the accelerator control), the driving speed shall automatically be adapted or a feedback of a different permitted mode (e.g. optical & acoustic) be issued.
      - Permit use of this feedback mode also for other warnings that are intended to prompt the driver to reduce speed, e.g. excessive speed for current road conditions or distance warnings (voluntary systems, not required for type approval).
      - It shall be permissible for speed limit feedback to be temporarily superseded by more critical warnings, e.g. forward collision warning or lane keep assistance. Definition of this warning strategy shall be left to the manufacturer.
    - Combined optical & acoustic feedback (to be determined if permissible, pending further evidence, see stakeholder questions):
      - The feedback shall last for a total duration of at least [10 seconds]. Gaps of less than 1 second, which are part of flashing optical signals or sound sequences are ignored, but the feedback may not start with a gap. If the signal is not continuous for the first [10 seconds], it needs to be repeated every [30 seconds or less], resulting in a minimum total duration of at least [10 seconds].
      - The optical warning shall use the optical speed limit information (4.3.4) in a flashing mode. It shall be visible even by daylight; the satisfactory condition of the signals must be easily verifiable by the driver from the driver's seat.
      - The acoustic warning signal shall be audible in all typical driving conditions. It shall be dedicated to speed limit warnings, i.e. a discernible sound used only for this system.
      - It shall be permissible for speed limit feedback to be temporarily superseded by more critical warnings, e.g. forward collision warning or lane keep assistance. Definition of this warning strategy shall be left to the manufacturer.
    - Speed control function:

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- A 'dead pedal' SCF shall be permissible (i.e. driveline torque is limited to avoid acceleration beyond the system speed limit; application of foundation brakes shall not be permissible to avoid rapid deceleration).
  - The SCF shall limit or control the driving speed to the feedback speed limit or the equivalent speedometer speed.
  - It shall be possible to exceed the feedback speed limit by performing a positive action, e.g. accelerator control kickdown. This override function shall allow a smooth and safe override and not result in immediate, unanticipated, inappropriate acceleration.
  - The speed control function shall permit a normal use of the accelerator control for gear selection.
  - The SCF shall ensure that when stable speed control has been achieved, the driving speed shall be within  $-5/+0$  km/h of the feedback speed limit.
  - If the feedback speed limit is set to a speed lower than the current driving speed, the SCF shall start to limit the vehicle speed to the new feedback speed limit no later than [30 seconds] after the new feedback speed limit is set.
  - When the SCF is not able to limit to and/or maintain the feedback speed limit an optical & acoustic warning is issued, with a total duration of at least 10 seconds. No acoustic or haptic warning needs to be given when the feedback speed limit is exceeded as a result of a positive action, but the driver shall be informed of the feedback speed limit.
  - The optical & acoustic warning shall last for a total duration of at least [10 seconds]. Gaps of less than 1 second, which are part of flashing optical signals or sound sequences are ignored, but the feedback may not start with a gap. If the signal is not continuous for the first [10 seconds], it needs to be repeated every [30 seconds or less], resulting in a minimum total duration of at least [10 seconds].
  - The optical warning shall use the speed limit information symbol (4.3.4) in a flashing mode. It shall be visible even by daylight; the satisfactory condition of the signals must be easily verifiable by the driver from the driver's seat.
  - The acoustic warning signal shall be audible in all typical driving conditions. It shall be dedicated to speed limit warnings, i.e. a discernible sound used only for this system.
  - When the vehicle speed is controlled by a driver aid rather than the driver (e.g. adaptive/intelligent/normal cruise control), the driving speed shall automatically be adapted or an optical & acoustic warning as described above be issued.

#### 4.3.5.4 Questions for stakeholders

Q23. Please provide feedback on the suggested requirements above.

Q24. Are there feedback modes other than those discussed above which should be considered for permission in the regulation?

Q25. TRL seek evidence on the effectiveness and appropriateness of different feedback modes in order to make a final choice of permissible modes. Evidence could come from HMI evaluations, driving simulator studies, field



trials or similar activities. Of particular interest is the effectiveness of combined optical & acoustic feedback compared to haptic feedback through the accelerator control.

Q26. In order to allow commercial fleets that desire a non-overridable ISA system to utilise the type approved system it could be considered to permit an optional secondary mode that does not allow driver override (hard-limiting function), which can be activated post-registration by qualified personnel only (not by the driver). Would the optional secondary mode post-registration be a viable solution for commercial vehicle OEMs to offer their customers non-overridable ISA systems (in markets where this does not contravene construction & use regulations or similar requirements governing post-registration modifications)?

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## 4.3.6 Deactivation

### 4.3.6.1 Background and source material

- GSR legislative remit:
  - Article 6.2.(b): *"it shall be possible to switch off the 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"* AND
  - Recital (11): *"It should be possible to switch off intelligent speed assistance, for instance, when a driver experiences false warnings or inappropriate feedback as a result of inclement weather conditions, temporarily conflicting road markings in construction zones, or misleading, defective or missing road signs. Such a switch-off feature should be under the control of the driver. 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. When the system is switched off, information about the speed limit may be provided. The system should be always active when switching the ignition on and the driver should always be made aware of whether the system is on or off."*
- Related EuroNCAP criteria (Euro NCAP, 2019):
  - SLWF criteria (Section 4.4.4):
    - *"The warning function may be switched ON/OFF by the driver where the last user mode may be used. "*
  - SCF criteria - Activation / de-activation of the function (Section 4.5.1):
    - *"The speed control function must be capable of being activated/de-activated at any time with a simple operation.*
    - *At the start of a new journey, the system should be de-activated by default."*


### 4.3.6.2 High-level intent and justification

- Driver must be able to switch feedback or entire ISA system off. Note that the GSR prescribes for certain other systems (including AEBS and ELKS) that a *"sequence of actions"* shall be required by the driver to switch the system off. This requirement does not apply to ISA. Therefore, the implementation of the deactivation operation shall be left to the discretion of the manufacturer.
- Easy re-activation must be possible.
- Require a tell-tale to make the driver aware when the system is deactivated.
- The system, including provision of feedback (i.e. warning or speed control) must be default on with each vehicle start-up. Note: A default on SCF would not be compatible with current Euro NCAP requirements, which presents a conflict between regulated ISA systems and those encouraged by Euro NCAP at the moment.

### 4.3.6.3 Initial outline of regulation contents

- It shall be possible for the driver to manually deactivate the ISA system or the ISA feedback function via an ISA OFF control (information about the speed limit may still be provided).

- The ISA OFF control shall allow the driver to re-activate ISA with a single action.
- ISA shall be automatically reinstated in normal operation mode at the initiation of each new ignition cycle.
- The ISA OFF control shall be installed so as to comply with the relevant requirements and transitional provisions of UN Regulation No. 121 in its 01 series of amendments or any later series of amendments.
- A constant optical warning signal shall inform the driver that the ISA feedback function has been deactivated (ISA OFF tell-tale).
- The ISA OFF control and ISA OFF tell-tale shall be identified by the following symbols. The identification of the ISA OFF control shall be capable of being illuminated whenever the position lamps are activated. The ISA OFF tell-tale shall constantly emit light as long as the ISA feedback function is deactivated.

Item	Symbol	Function	Illumination	Colour
Intelligent Speed Assistance (ISA) "OFF"		Control	Yes	
		Tell-Tale	Yes	Yellow
	or "ISA OFF"			

#### 4.3.6.4 Questions for stakeholders

Q27. Please provide feedback on the suggested requirements above.

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## 4.3.7 Self-check and failure warning

### 4.3.7.1 Background and source material

- GSR legislative remit:
  - Recital 10: *'It is [...] necessary to ensure that those systems can be used safely, throughout the life cycle of the vehicle'*
- Regulations for other safety systems, such as ESC (UN Regulation No. 140) or AEBS (UN Regulation No. [152]), specify requirements for malfunction indicators or failure warnings.
- Relevant stipulations in UN Regulation No. [152]:
  - *"5.1.4.1 A failure warning when there is a failure in the AEBS that prevents the requirements of this Regulation of being met. The warning shall be as specified in paragraph 5.5.4.*
  - *5.1.4.1.1 There shall not be an appreciable time interval between each AEBS self-check, and subsequently there shall not be a delay in illuminating the warning signal, in the case of an electrically detectable failure.*
  - *5.1.4.1.2 If the system has not been initialised after a cumulative driving time of 15 seconds above a speed of 10km/h, information of this status shall be indicated to the driver. This information shall exist until the system has been successfully initialised.*
  - *5.1.4.3 Upon detection of any non-electrical failure condition (e.g. sensor blindness or sensor misalignment), the warning signal as defined in paragraph 5.1.4.1. shall be illuminated.*
  - *5.5.4 The failure warning referred to in paragraph 5.1.4.1. shall be a constant yellow optical warning signal."*

### 4.3.7.2 High-level intent and justification

- Require implementation of a system self-check.
- Include failure warning requirements equivalent to those in existing regulations to ensure that the operational status of the ISA system can be easily verified by the driver.

### 4.3.7.3 Initial outline of regulation contents

- A warning shall be provided when there is a failure in the ISA system that prevents the requirements of this Regulation of being met.
- There shall not be an appreciable time interval between each ISA self-check, and subsequently there shall not be a delay in illuminating the failure warning signal, in the case of an electrically detectable failure.
- Upon detection of any non-electrical failure condition (e.g. sensor blindness or sensor misalignment), the warning signal shall be provided.
- The ISA OFF tell-tale shall be used for the failure warning (see Section 4.3.6).

### 4.3.7.4 Questions for stakeholders

Q28. Please provide feedback on the suggested requirements above.

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#### 4.3.8 Provisions for the periodic technical inspection

##### 4.3.8.1 Background and source material

- GSR legislative remit:
  - Recital 10: *'It is [...] necessary to ensure that those systems can be used safely, throughout the life cycle of the vehicle'*
- Regulations for other safety systems, such as ESC (UN Regulation No. 140) or AEBS (UN Regulation No. [152]), specify requirements to ensure that the correct operational status of the systems can be verified during a periodic technical inspection (PTI) with limited effort.
- Relevant stipulations in UN Regulation No. [152], Section 5.6:
  - *"5.6.1 At a Periodic Technical Inspection, it shall be possible to confirm the correct operational status of the AEBS 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.*
  - *5.6.2 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 AEBS is available."*

##### 4.3.8.2 High-level intent and justification

- Include PTI requirements equivalent to those in existing regulations to ensure that the operational status of the ISA system can be easily verified during a PTI.

##### 4.3.8.3 Initial outline of regulation contents

- 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.
- 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.

##### 4.3.8.4 Questions for stakeholders

Q29. Please provide feedback on the suggested requirements above.

Q30. Are any particular considerations required regarding PTI for vehicles of categories other than passenger cars and vans, i.e. M<sub>2</sub>, M<sub>3</sub>, N<sub>2</sub> or N<sub>3</sub>?

### 4.3.9 Privacy and data protection

#### 4.3.9.1 Background and source material

- GSR legislative remit:
  - 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.*”
    - While ISA is not explicitly mentioned in recital 14, data relating to instances of exceeding the speed limit could be relevant in this context if the driver can be directly or indirectly identified.

#### 4.3.9.2 High-level intent and justification

- Include requirements to ensure that the stipulations above are fulfilled for the approved system while not restricting future developments.
- No suggestion to include tests.

#### 4.3.9.3 Initial outline of regulation contents

- The ISA system shall offer the required functionality in the default normal operation mode without the use of biometric information, including facial recognition, of any vehicle occupants.
- 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 legal requirements (e.g. in case a future EDR regulation required recording).
- Any processing of personal data shall be carried out in accordance with Union data protection law.

#### 4.3.9.4 Questions for stakeholders

Q31. Please provide feedback on the suggested requirements above.

Q32. Are the suggested requirements at risk of restricting future technological developments that could increase safety (e.g. recognising young drivers to provide stronger support)? What developments could be envisaged and what stipulations would be required to enable them?

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## 4.4 Assessment procedures

### 4.4.1 Test procedure for functional requirements of speed limit determination

#### 4.4.1.1 Background and source material

- Procedure to assess the functional requirements described in Section 4.3.1
- Euro NCAP perform a public road test drive (Euro NCAP, 2017). While major discrepancies between the speed limit and the indicated limit in this test are recorded and discussed with the manufacturer, there are no specific pass-fail thresholds defined:
  - Test for the SLIF (Section 4.1)
    - *"Drive around for at least 100km on public roads, covering urban and rural roads and highways. During the drive, the reaction of the SLIF with respect to conditional speed limits needs to be verified and recorded.*
    - *The car should be driven in both manual and cruise control mode.*
    - *Identify any major discrepancies between the signed speed limit and the speed limit indicated by the SLIF."*

#### 4.4.1.2 High-level intent and justification

- The aim of the assessment procedure is to ensure that the road sign and signal observation system (e.g. camera) offers the required minimum functionality. Note: Performance of the system is assessed separately (Section 4.4.2).
- The functional assessment of the speed limit determination shall consist of two parts: a functional test and a declaration of EU-wide capability.
- The functional test is suggested to consist of a basic check that the road sign and signal observation system (e.g. camera) of the ISA system has the ability to recognise the catalogue of relevant sign types in the country of test:
  - The aim is to witness that the basic functionality of detecting and recognising the relevant sign types is ensured.
  - This basic functionality shall be fulfilled purely by observation of road signs and signals, i.e. without map support even in camera-map fusion systems. This will ensure that the system will be able to react to changing infrastructure environments and variable speed limits.
  - To provide maximum flexibility, the functional test for type approval shall not require a real road environment unless it is necessary for the system to work. The test shall be able to be performed on a test track, a public road, or a combination. Stakeholders have commented that not all systems can be evaluated in artificial environments (such as test tracks). The most suitable arrangement may depend on system characteristics (e.g. camera-only or camera-map-fusion system; what features are taken into account for plausibility checks) and characteristics of the available test facilities (can all required signs and road types be replicated on-track). To be chosen in agreement between technical service and manufacturer.
  - As this is not a measurement of performance, it is not necessary to prescribe a real road drive or minimum distance to cover; one sample of each sign is enough to demonstrate that the basic functionality exists. Also, the test conditions shall be favourable so as not to adversely affect the system function.

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- Some systems take into account the current country code and only use the country-specific classifiers, i.e. signs from other countries would not be recognised. The signs used for the test shall therefore be chosen from signage available in the country where the test takes place.
  - To check if the system successfully recognised a speed limit, the technical service shall rely on the in-vehicle SLIF (if accessible permanently) or alternatively electronic vehicle signals (e.g. CAN bus recordings) to be made accessible in collaboration with the applicant.
  - The declaration of EU-wide capability is suggested to consist of a signed statement by the manufacturer and test documentation:
    - The aim is to confirm that road signs included in the relevant catalogue, but of a design of other countries than that of the type approval test, are included in the camera classifiers, i.e. can generally be detected and recognised. Note: This is not a declaration of performance, but of general functionality.

#### 4.4.1.3 Initial outline of regulation contents

- Functional test of road sign and signal observation system (e.g. camera):
  - Test conditions:
    - The test shall be performed on a test track or, at the manufacturer's request, partially or fully on a public road.
    - Environmental visibility conditions shall not adversely affect the system's operation:
      - ambient illumination conditions of at least [2000 Lux] without direct blinding sunlight;
      - no heavy or violent rain, no sleet or snow, no hail and no 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.
    - The vehicle headlights (low beam) may be set to automatic or on. High beams shall not be used.
  - Road signs:
    - Selection
      - Use at least one sign of each of these categories of relevant signs (see Section 4.3.1.3):
        - Numerical speed limit
        - Numerical speed limit displayed on variable message sign
        - Numerical speed limit zone
        - End of specific speed limit
        - End of speed limit ('national speed limit applies')
        - End of speed limit zone
        - Place name
        - Urban area
        - Home zone/residential zone



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- Motorway regulation apply
  - Expressway regulations apply
  - Numerical speed limit with vehicle category-specific sub sign
  - Additional conditions apply
  - The signs used for the test shall meet the requirements stipulated in Section 4.3.1.3, i.e. be of a size, design, material and retro-reflectivity conforming to the applicable standards in the member state or region where the test takes place (the 'region of test').
  - If signs of an individual categories do not exist within the sign catalogue of the member state or region of test, they shall not be assessed in the functional test, but only covered with the additional documentation.
  - The signs used for the test shall be recorded.
  - Condition and positioning:
    - The signs shall be in good condition (i.e. not be visibly deteriorated).
    - The signs shall be positioned in accordance with the requirements stipulated in Section 4.3.1.3, i.e. positioned in a way conforming to the applicable standards in the region of test.
    - The set up shall ensure a plausible scenario for the system, considering the following elements:
      - Plausible road characteristics for each speed limit: e.g. Dual carriageway for any speed limits higher than 100 km/h
      - Plausible steps in speed reduction cascades: e.g. reduction from 130 km/h to 50 km/h should contain multiple intermediate steps
    - The condition, set up and positioning shall be recorded.
  - ISA functional test:
    - Drive the vehicle past the road signs described above at the speed indicated by the sign or up to [20 km/h] lower.
    - Check that the perceived or feedback speed limit is updated to the correct value indicated by the test signs in accordance with the requirements described in Section 4.3.1.3, i.e. within [5 seconds] after passing the sign.
    - For systems supported by speed limit maps, it shall be checked that the road sign and signal observation system (e.g. camera) correctly recognised the test signs, e.g. by observation of electronic vehicle signals (e.g. CAN bus recordings).
    - Road signs of all categories defined above need to be successfully recognised. If a test sign is not detected or recognised at first passing the test for this sign shall be repeated. If the system fails to detect the sign repeatedly, this case shall be investigated by the applicant. The test may be repeated on a real road if the artificial track environment caused detection issues.

- After one of the tests, drive for a distance of at least [x km] without new speed limit input to check that the perceived speed limit is retained for the required minimum distance for the concerned road type, as specified in Section 4.3.1.3.
- After one of the tests switch the vehicle off and restart the engine to check that the perceived speed limit is retained after an ignition cycle, as specified in Section 4.3.1.3.
- Declaration of EU-wide sign recognition capability:
  - The vehicle manufacturer shall declare that the road sign and signal observation system (e.g. camera) has the capabilities required according to Section 4.3.1.3 and checked in the ISA functional test with the equivalent signage of all EU member states at the time of approval.
  - This declaration shall contain a matrix of the relevant sign categories and member states, confirming the ability to detect, recognise and interpret for each of the fields where signs exist in the country concerned.
  - This declaration shall be appended to the test report.
- Additional technical information to be made available to the technical service:
  - The vehicle manufacturer shall give access to test documentation that allows the technical service to assess the contents of the declaration, e.g. by review of test recordings of specific sign types being recognised.

#### 4.4.1.4 Questions for stakeholders

Q33. Please provide feedback on the suggested assessment procedure above.

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#### 4.4.2 Documentation procedure for real-road performance of speed limit determination

##### 4.4.2.1 Background and source material

- Procedure to document the performance requirements described in Section 4.3.2:
  - ISA's "performance targets shall be set in order to avoid or minimise the error rate under real driving conditions."
- Related EuroNCAP procedures:
  - Euro NCAP requests a performance declaration from manufacturers based on internal testing (see Section 4.3.2).
  - Test conditions for this internal testing are not specified by Euro NCAP.

##### 4.4.2.2 High-level intent and justification

- The aim of the procedure is to ensure that the system (camera or camera & map, if fitted) delivers a sufficient level of performance in correctly determining the road speed limit in real-world conditions; i.e. in different countries and varying environmental conditions.
- As discussed in Section 4.3.2, the performance shall be declared by the manufacturer based on internal testing of the full system (i.e. including speed limit map-support, if this is part of the type approved system). The test programme design and reported results shall be assessed by the technical service.
- This section intends to:
  - define some key criteria the underlying test programme needs to meet,
  - define the technical documentation to be made available, and
  - define how the technical documentation shall be assessed by the technical service.

##### 4.4.2.3 Initial outline of regulation contents

- Criteria for underlying performance testing (performed by manufacturer or tier 1):
  - The performance test programme shall:
    - Measure the system's performance in correctly determining the road speed limit based on one of the key performance indicators defined in Section 4.3.2.3
    - Consist of real-driving tests, or representative simulation tests, or a combination of both
    - Involve tests for all EU member states
    - Involve tests of urban roads, non-urban roads, and motorways/expressways/dual carriageways, where each of the three road types shall represent at least [25% of the validation distance or sign passing events for each country]
    - Contain a mix of the relevant road signs that can be encountered on each road type, where each of the signs shall represent at least [x% of the sign passing events]
    - Contain a mix of conditions, including daylight/darkness and dry/light to moderate precipitation, that is broadly representative of real-world usage profiles

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- Repeated runs of the same road sections or repeated simulations of passing the same road sign shall be disregarded for the performance evaluation.
  - An instance where road signs with identical speed limits are positioned on both sides of the carriageway shall be considered as a single sign passing event.
  - Non-speed related road signs shall be disregarded for the performance evaluation. Speed-related road signs that are not included in the relevant catalogue (e.g. weather/time-dependent sub-signs) may be disregarded for the performance evaluation.
  - Road signs that do not conform with the conditions described in Section 4.3.2.3 (e.g. signs in inadequate condition or not positioned in accordance with applicable standards) may be disregarded for the performance evaluation.
  - Road signs encountered in environmental conditions not conforming with those described in Section 4.3.2.3 (e.g. heavy rain or blinding sunlight) may be disregarded for the performance evaluation.
  - Sufficient testing shall be conducted to evidence performance in each member state of a level that meets or exceeds the required minimum thresholds [at a statistically significant level].
  - Declaration of system performance:
    - The vehicle manufacturer shall declare the performance of the ISA system to the technical service based on previous performance testing.
    - The performance declaration shall be appended to the test report (see examples in Table 8 and Table 9) and contain the following information:
      - The performance shall be reported based on both KPIs defined in section 4.3.2.3 (event-based and distance-based).
      - The performance shall be reported separately per EU member state.
      - The declaration shall state the test distance (driving or simulation) and the number of sign passing events per member state and road type.
  - Additional technical information to be made available to the technical service:
    - The vehicle manufacturer shall provide a test report that allows the technical service to assess the quality of the test programme and contain at least:
      - approach taken for the real-road performance testing, including details about the test setup for physical testing and the validity of simulation approaches
      - mix of driving conditions (e.g. daylight/darkness and precipitation/dry conditions)
      - locations of test routes (physical or simulation) or samples of sign passing events
      - date range of the test drives or samples used for testing
      - statistical calculations demonstrating sufficient testing
  - Assessment of the performance declaration and additional technical documentation:
    - The technical service shall perform:

- a check that the reported performance levels meet the required minimum thresholds as define in Section 4.3.2.3,
- a review of the test report to confirm that the underlying test programme meets the criteria defined above,
- an audit of the test report:
  - to ensure that the underlying test evidence corresponds with the reported results to a level of overall effect such that the performance declaration is confirmed as being adequate.
  - using means, at the choice of the technical service, such as: review of test recordings from selected parts of the validation drives or instances where sign passing events were disregarded, or re-performing parts of the validation drives.

**Table 8: Example table for event-based ISA performance declaration**

EU member state	Event-based performance (true positive)	False-positive rate	Number of sign passing events tested (physical/simulation)		
			Urban road	Non-urban road	Motorway/expressway
Austria	xx%	xx per 100 km	xx / xx	xx / xx	xx / xx
Belgium					
Bulgaria					
Croatia					
Cyprus					
Czech Republic					
Denmark					
Estonia					
Finland					
France					
Germany					
Greece					
Hungary					
Ireland					
Italy					
Latvia					
Lithuania					
Luxembourg					
Malta					
Netherlands					
Poland					
Portugal					
Romania					
Slovakia					
Slovenia					
Spain					
Sweden					
United Kingdom					

**Table 9: Example table for distance-based ISA performance declaration**

EU member state	Distance-based performance	Test distance (physical/simulation)		
		Urban road	Non-urban road	Motorway/expressway
Austria	xx%	xx km / xx km	xx km / xx km	xx km / xx km
Belgium				
Bulgaria				
Croatia				
Cyprus				
Czech Republic				
Denmark				
Estonia				
Finland				
France				
Germany				
Greece				
Hungary				
Ireland				
Italy				
Latvia				
Lithuania				
Luxembourg				
Malta				
Netherlands				
Poland				
Portugal				
Romania				
Slovakia				
Slovenia				
Spain				
Sweden				
United Kingdom				

#### 4.4.2.4 Questions for stakeholders

Q34. Please provide feedback on the suggested assessment procedure above.

Q35. Please also consider the questions in Section 4.3.2.4

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### 4.4.3 Test procedure for speed limit warning

#### 4.4.3.1 Background and source material

- The procedure will document and assess the functional requirements described in Section 4.3.4 and 4.3.5 for the speed limit warning function (applicable if this is the chosen feedback mode).
- Related EuroNCAP procedure (Euro NCAP, 2017):
  - Test for the Speed Control Function (Section 4.1.1)
    - *“The tests will be performed during the test drive or on a dedicated test track where speed signs are installed and should cover at least three different speed limits.*
    - *The vehicle shall be accelerated up to a speed at least 10km/h greater than  $V_{limit}$*
    - *This speed shall be maintained long enough to be able to assess the complete warning sequence”.*

#### 4.4.3.2 High-level intent and justification

- The assessment procedure aims to ensure that the speed limit warning method offers the required minimum functionality (warning the driver when the speed of the vehicle exceeds the feedback speed limit, as informed by the road speed limit, and displaying the feedback speed limit to the driver). The assessment procedure for the speed limit warning function shall consist of three parts: a warning, an alternative warning mode test and a deactivation test (whereby the ISA is turned off).
- A deactivation test shall be included to aid technical services in determining if the presented ISA system is functioning as intended by not activating a warning when then driver exceeds the feedback speed limit. If the driver switches the ISA system off, the SLWF must not issue a warning of excessive speed, even if the SLIF continues to display speed limit information to the driver.
- The purpose of this series of tests is not to assess the speed limit determination; so it shall be left to the discretion of the technical service, in agreement with the manufacturer, as to how to adjust the feedback speed limit as per test requirements. This can, for example, be done by using appropriate road signs set up alongside a track, by programming a track-specific map or by other ways of manipulating the feedback speed limit for this test.
- A SLWF system must be capable of operating at any road speed limit, however, for the purposes of testing (regardless of the agreed upon method) the testing of a SLWF may only require one test speed (km/h or mph to be chosen dependent on the standard speedometer setting of the vehicle under test and the location of test).
- The alternative warning applies to systems which provide haptic feedback through the accelerator control in vehicles offering driver aids such as cruise control and ACC. The function must work over a range of speeds however, for confirmation of the warning, only one speed is required for testing.
- According to the functional requirements (Section 4.3.1.3), the system only needs to observe road signs indicating a road speed limit that is lower than the vehicle’s maximum speed. Any tests carried out shall be limited to driving speeds lower than the maximum design speed of the vehicle concerned.



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#### 4.4.3.3 Initial outline of regulation contents

- Test Conditions:
  - The tests shall be performed on a track whereby:
    - The test surface shall be suitable for enabling stabilised speed to be maintained and shall be free from uneven patches.
    - The test surface shall be free of standing water, snow or ice.
  - Vehicle preparation:
    - The tyres shall be bedded and the pressure shall be as specified by the manufacturer for the vehicle.
    - The wheel size used shall be the largest size approved for the vehicle under test.
- Speed limit warning test:
  - Test procedure:
    - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
    - With the ISA and SLWF activated, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall then be accelerated to 10 km/h above the feedback speed limit.
    - The vehicle will be kept at this new speed, long enough for an assessment of the entire warning sequence (as specified by the manufacturer).
    - The vehicle will then be decelerated to more than 5 km/h below the feedback speed limit (to re-instate warning), and the procedure above will be repeated.
    - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
  - Pass/fail criteria:
    - A warning complying with the specifications in Section 4.3.5.3 shall be given in both test runs when the real speed of the vehicle exceeds the feedback speed limit.
    - Information about the feedback speed limit complying with the specifications in Section 4.3.4.3 shall be given in both test runs at least when the real speed of the vehicle exceeds the feedback speed limit.
- Speed limit alternative warning mode test:
  - Note: This test applies to systems providing haptic feedback through the accelerator control in vehicles which offer driver aids for longitudinal control (e.g. cruise control, ACC). The aim is to test the requirement for an alternative warning mode in case cruise control is used.
  - Test procedure:
    - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
    - With the ISA and SLWF activated, the vehicle shall be run at the test speed, with a driver aid controlling the speed (e.g. cruise control, ACC). The driver's foot shall not contact the accelerator

- control. Ensure that the feedback speed limit is then being set to a speed, at least, 10 km/h lower than the test speed.
- The vehicle will be kept at the test speed, long enough for an assessment of the entire warning sequence (as specified by the manufacturer).
  - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
- Pass/fail criteria:
    - A warning complying with the specifications in Section 4.3.5.3 for alternative warning modes in case of default haptic feedback and speed control by a driver aid shall be given.
    - Information about the feedback speed limit complying with the specifications in Section 4.3.4.3 shall be given at least when the real speed of the vehicle exceeds the feedback speed limit.
- Speed limit warning deactivation test:
    - Test procedure:
      - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
      - With the ISA deactivated, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall then be accelerated to 10 km/h above the feedback speed limit.
      - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
    - Pass/fail criteria:
      - The SLWF shall not engage, allowing the vehicle to exceed the feedback speed limit without a warning being issued.
      - Information about the feedback speed limit may be given to the driver.

#### 4.4.3.4 Questions for stakeholders

Q36. Please provide feedback on the suggested assessment procedure above.

#### 4.4.4 Test procedure for speed control

##### 4.4.4.1 Background and source material

- The procedure will document and assess needs to test the aspects required in Section 4.3.4 and 4.3.5 for the speed control function (applicable if this is the chosen feedback mode).
- Related EuroNCAP procedure (Euro NCAP, 2017):
  - Test for the Speed Control Function (Section 4.2)
    - *“The tests will be performed at three different test speeds typical for the following road types:*
      - *City roads (e.g. 50 km/h or 30 mph)*
      - *Inter-Urban roads (e.g. 80 km/h or 50 mph)*
      - *Highways (e.g. 120 km/h or 70 mph)*
    - *With the Speed Control Function activated set  $V_{adj}$ . In case of a Speed Limitation Function the vehicle shall be run at a speed of 15 [km/h] below  $V_{adj}$ . The vehicle shall then be accelerated to engage the SLF, without applying a positive action.*
    - *Set  $V_{adj}$  to 120 [km/h] and accelerate the vehicle to engage the SLF. Lower  $V_{adj}$  to a speed low enough to trigger the audiovisual warning and measure how long it takes for the vehicle to initiate this warning.*
    - *Set  $V_{adj}$  to 50 [km/h] or a speed applicable at the road where the vehicle is tested and force the vehicle into an overrun condition (e.g. pulling or downhill) where the engine braking is not able to maintain the speed of  $V_{adj}$ . Measure the speed at which the warning is initiated.”*
- UN Regulation No. 89 defines test procedures for speed limitation devices (SLD, i.e. top-speed limiters) and adjustable speed limitation devices (ASLD, driver adjustable speed) (UNECE, 1992):
  - It is TRL’s understanding that in the EU, only the aspects in relation to SLD for  $M_2$ ,  $M_3$ ,  $N_2$  and  $N_3$  apply. Other parts of the UN Regulation are not applicable, even not on an if-fitted basis.
  - Therefore, the procedures defined in Regulation 89 are not applicable to ISA systems, but elements of Annex 6 (Tests and performance requirements for ASLD) were used to inform the proposed SCF test procedure.
  - Test of the adjustable speed limitation function/device (Annex 6, Section 1.5):
    - *“With the ASLF/D deactivated, for each gear ratio selected for the chosen test speed  $V_{adj}$ , the technical service shall:*
      - *(a) Either measure the forces required on the accelerator control;*
      - *(b) Or measure the accelerator control position;*
    - *To maintain  $V_{adj}$  and a speed ( $V_{adj}^*$ ) which is 20% or 20 km/h (whichever is the greater) faster than  $V_{adj}$ .”*
    - *With the ASLF/D activated and set at  $V_{adj}$ , the vehicle shall be run at a speed of 10km/h below  $V_{adj}$ . The vehicle shall then be accelerated by either increasing the force on the accelerator control or adjusting*

*the accelerator control position over a period of  $1s \pm 0.2s$  to that required to maintain  $V_{adj}^*$ . This force or position shall then be maintained for a period of at least 30 seconds after the vehicle speed has stabilised."*

- *The instantaneous vehicle speed shall be recorded during the test in order to establish the curve of the speed versus the time and during the operation of the ASLF/D as appropriate. The accuracy of the speed measurement shall be  $\pm 1$  per cent. The accuracy of the time measurement shall be less than 0.1 s.*
- *The test shall be considered satisfactory if the following conditions are met:*
  - *The stabilized speed ( $V_{stab}$ ) reached by the vehicle shall not exceed  $V_{adj}$  by more than 3 km/h*
    - *After  $V_{stab}$  is reached for the first time:*
      - *$V_{max}$  shall not exceed  $V_{stab}$  by more than 5 per cent;*
      - *the rate of change of speed shall not exceed 0.5 m/s<sup>2</sup> when measured over a period greater than 0.1 s;*
      - *the stabilized speed conditions specified in paragraph 1.5.4.1.2. shall be attained within 10 s of first reaching  $V_{stab}$ ;*
    - *When stable speed control has been achieved:*
      - *speed shall not vary by more than 3 km/h of  $V_{stab}$ ;*
      - *the rate of change of speed shall not exceed 0.2 m/s<sup>2</sup> when measured over a period greater than 0.1 s;*
      - *$V_{stab}$  is the average speed calculated for a minimum time interval of 20 seconds beginning 10 seconds after first reaching  $V_{stab}$ ;*
    - *Tests in acceleration shall be carried out and the acceptance criteria verified for each gear ratio allowing in theory  $V_{adj}^*$  to be achieved."*

#### 4.4.4.2 High-level intent and justification

- The aim of the assessment procedure is to ensure that the speed control method offers the required minimum functionality (speed limiting, to that stated by the SLIF system, with override). The assessment procedure for the speed control function shall consist of three parts: a functional test, a deactivation test (whereby the ISA is turned off), a response test and an overrun test.
- The functional test is suggested to consist of a basic check that the speed control function (i.e. a dead pedal), override (e.g. kick-down) and overrun warning of the ISA system;
  - The aim is to witness that the basic functionality of using SLIF information to restrict the vehicle speed to the feedback threshold and allowing for override functionality.
  - A track based overrun test shall be included in order to check the functionality of an SCF i.e. does it issue an alert when it is not able to

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conform the vehicle to the speed limit in scenarios such as travelling downhill.

- A deactivation test shall be included to aid technical services in determining if the presented ISA system is functioning as intended by not controlling vehicle speed when switched off. If the driver switches the ISA system off, the SCF must not continue to control the speed of the vehicle, even if the SLIF continues to display speed limit information to the driver.
- The purpose of this series of tests is not to assess the speed limit determination; so it shall be left to the discretion of the technical service, in agreement with the manufacturer, as to how to activate the vehicle's SCF (to adjust the feedback speed limit as per test requirements). This can, for example, be done by using appropriate road signs set up alongside a track, by programming a track-specific map or by other ways of manipulating the feedback speed limit for this test.
- Regardless of the chosen method; the testing of a fitted SCF must take into account a range of speeds, for speed limits most typical of three road types, City roads, Inter-Urban roads and Highways. (km/h or mph to be chosen dependant on the standard speedometer setting of the vehicle under test and the location of test).
- According to the functional requirements (Section 4.3.1.3), the system only needs to observe road signs indicating a road speed limit that is lower than the vehicle's maximum speed. Any tests carried out shall be limited to driving speeds lower than the maximum design speed of the vehicle concerned.

#### 4.4.4.3 Initial outline of regulation contents

- Test Conditions:
  - The tests shall be performed on a test track whereby:
    - The test surface shall be suitable for enabling stabilised speed to be maintained and shall be free from uneven patches. Gradients shall not exceed 2 percent (this does not apply to the overrun test).
    - The test surface shall be free of standing water, snow or ice.
  - Vehicle preparation:
    - The vehicle mass shall be no less than the minimum kerb weight declared by the manufacturer.
    - The tyres shall be bedded and the pressure shall be as specified by the manufacturer for the vehicle.
    - Wheel size, gearbox type and gear selected for test shall follow a worst case approach.
  - Ambient Conditions:
    - The mean wind speed measured at least 1 m above the ground shall be less than 6 m/s with gusts not exceeding 10 m/s.
- SCF functional test:
  - Test procedure:
    - With the ISA (and SCF) activated, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall then be accelerated to engage the SCF, without applying a positive action. The vehicle shall be run at three different road speeds limits, most representative of three distinct road types (or closest multiple of 10 km/h below the maximum vehicle speed, whichever is lower):

- City roads (e.g. 50 km/h or 30 mph)
  - Inter-Urban roads (e.g. 80 km/h or 50 mph)
  - Highways (e.g. 120 km/h or 70 mph)
  - The vehicle will be kept at the test speed, long enough for an assessment of the stabilised vehicle speed.
  - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
- Pass/fail criteria:
  - The SCF shall ensure that when stable speed control has been achieved, the stabilised vehicle speed shall be within -5/+0 km/h of the feedback speed limit. The SCF must not use the service brakes to do so.
  - The stabilised vehicle speed means the mean real vehicle speed when operating. It is calculated as the average real vehicle speed over a time interval of 20 seconds beginning 10 seconds after first reaching the feedback speed limit.
- SCF response test:
  - Test procedure:
    - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
    - With the ISA (and SCF) activated, the feedback speed limit shall be set to a high speed (at least 20 km/h higher than the tested speed limit). The vehicle shall be run just below the high perceived speed limit without applying a positive action and without engaging the SCF. While driving, the feedback speed limit shall be set to the tested speed limit.
    - The test will last for a minimum of 30 seconds after the ISA accepts the lower feedback speed limit, or until the real speed of the vehicle matches the feedback speed limit (whichever occurs first).
    - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
  - Pass/fail criteria:
    - The SCF should start to limit the vehicle speed to the road limit no later than 30 s after the new road speed limit has been adopted as the new feedback speed limit.
    - Information about the feedback speed limit complying with the specifications in Section 4.3.4.3 shall be given when the vehicle speed is exceeding the feedback speed limit.
- SCF deactivation test:
  - Test procedure:
    - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
    - With the ISA (and SCF) switched OFF, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall

- 
- then be accelerated to engage the SCF, without applying a positive action.
- Pass/fail criteria:
    - The SCF shall not engage, allowing the vehicle to exceed the feedback speed limit without applying a positive action.
    - With the ISA system switched off, the driver should not receive warnings from the ISA system.
    - Information about the feedback speed limit may be given to the driver.
  - SCF override test:
    - Test procedure:
      - The test shall be run at a representative City road speed limit (existent in the region of test).
      - With the ISA (and SCF) activated, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall then be accelerated to engage the SCF, without applying a positive action.
      - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
      - Once the vehicle reaches the feedback speed limit and the stabilised vehicle speed has been established, the assessor shall override the feedback limit by applying a positive action; as specified by the manufacturer e.g. kickdown.
    - Pass/fail criteria:
      - The override function shall allow a smooth and safe override and not result in immediate, unanticipated, inappropriate acceleration.
  - SCF overrun test:
    - Test procedure:
      - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
      - With the ISA (and SCF) activated, the vehicle shall be run at a speed just below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit.
      - Force the vehicle into an overrun condition (e.g. pulling or downhill) where the engine braking is not able to maintain the feedback speed limit.
      - Measure the speed at which the overrun warning is initiated.
    - Pass/fail criteria:
      - When the SCF is not able to limit to and/or maintain the feedback speed limit:
        - a warning complying with the specifications in Section 4.3.5.3 shall be given., and
        - information about the feedback speed limit complying with the specifications in Section 4.3.4.3 shall be given.

*4.4.4.4 Questions for stakeholders*

Q37. Please provide feedback on the suggested assessment procedure above.

Q38. At present, is it feasible to perform overrun testing at European test facilities?

Q39. Are there quantifiable bounding values to override functions in current vehicles? Kickdown points and required force/velocity? Relating to: "override function shall allow a smooth and safe override and not result in immediate, unanticipated, inappropriate acceleration".



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**GLOSSARY**

Term	Definition
<b>AEBS</b>	Advanced Emergency Braking Systems
<b>EDR</b>	Event Data Recorder
<b>ELKS</b>	Emergency Lane Keeping Systems
<b>GSR</b>	General Safety Regulation
<b>HMI</b>	Human-Machine Interface
<b>ISA</b>	Intelligent Speed Assistance
<b>PTI</b>	Periodic Technical Inspection
<b>SAS</b>	Speed Assist System
<b>SCF</b>	Speed Control Function
<b>SLIF</b>	Speed Limit Information Function
<b>SLWF</b>	Speed Limit Warning Function
<b>TfL</b>	Transport for London
<b>VUT</b>	Vehicle under test

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## **Annex 1 SUMMARY OF INITIAL OUTLINE OF REGULATION CONTENTS**

This annex provides an identical copy of the text contained in the sub-sections 4.x.x.3 (initial outline of regulation contents) to allow continuous reading. They do not pre-empt the exact contents or wording of a future regulation, but reflect TRL's current position on potential requirements and test procedures that could be recommended within the given legislative remit of the Commission and taking into account the state of technology readiness and industry best-practice as established in the review and consultation tasks.

### **Annex 1.1 Definitions**

- 'common space' means an area on which two or more information functions (e.g. symbol) may be displayed, but not simultaneously
- '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
- 'feedback speed limit' is the currently set speed above which the ISA system provides feedback to the driver
- 'perceived speed limit' is the current maximum permitted speed as perceived by the ISA system
- 'relevant road sign' means a physical road sign, or a variable message sign, of a type specified in the catalogue of functional requirements
- 'road sign and signal observation system' means all parts of the ISA system required to detect and recognise a road sign or signal (e.g. camera and associated ECUs)
- 'road speed limit' is the currently applicable maximum permitted driving speed at the vehicle's location
- 'self-check' means an integrated function that checks for a system failure on a continuous basis at least while the system is active
- 'speed control function' (SCF) means a function which limits or controls the driving speed to the feedback speed limit
- 'speed limit information function' (SLIF) means a function that communicates the perceived speed limit to the driver
- 'speed limit feedback' means a speed limit warning or speed control
- 'speed limit warning function' (SLWF) means a function that alerts the driver that the driving speed is exceeding the feedback speed limit
- 'type of ISA STU' means a combination of specific hardware which does not differ in such essential respects as the characteristics, functionality, capability [and performance] of speed limit determination [and speed limit feedback].
- 'vehicle type with regard to the installation of an ISA system' means motor vehicles that do not differ in such essential respects as the characteristics of the integration within the vehicle as well as the characteristics, functionality, capability and performance of speed limit determination and speed limit feedback.

### **Annex 1.2 Subject matter (scope) and exemptions**

- The ISA regulation:
  - will apply to the vehicle categories defined in the GSR, i.e. M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub>, N<sub>1</sub>, N<sub>2</sub> and N<sub>3</sub>.

- 
- will establish detailed technical requirements and test procedures for the EC type-approval of vehicles of the categories above in respect of their intelligent speed assistance (ISA) system and of ISA separate technical units (STUs).
  - For vehicle and STU approval a similar approach to the eCall regulation could be considered where parts of the assessments can be performed on STUs. The exact split is to be determined.
  - Note: Small series approval, multi-stage vehicles, individual approval scheme or ISA component approval are not in scope of TRL's work.
  - Stakeholders suggested to define the following exemptions:
    - Special purpose vehicles (SPV), i.e. M<sub>x</sub>S and N<sub>x</sub>S: TRL seek additional input
    - Off-road vehicles (ORV), i.e. M<sub>x</sub>G and N<sub>x</sub>G: TRL seek additional input
    - Vehicles which are top-speed limited (UN Regulation No. 89 on speed limitation devices): While being top-speed limited, these vehicles will still be used on roads with speed limits lower than their top speed (e.g. in urban areas, at roadworks, etc.) which is why an exemption is not appropriate. However, TRL suggest reducing the catalogue of relevant road signs for these vehicles to signs denoting a speed limit lower than their top speed. See Section 4.3.1.
    - Vehicles that have a limited area of operation, e.g. city buses: While the normal operation of these vehicles may be restricted in day-to-day use the vehicles will still be allowed to be operated in the EU if they hold European type approval and therefore should be compatible with the infrastructure in all European countries. TRL seek additional input

## Annex 1.3 Requirements

### Annex 1.3.1 Functional requirements for speed limit determination


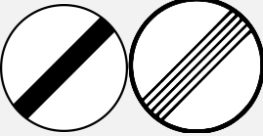
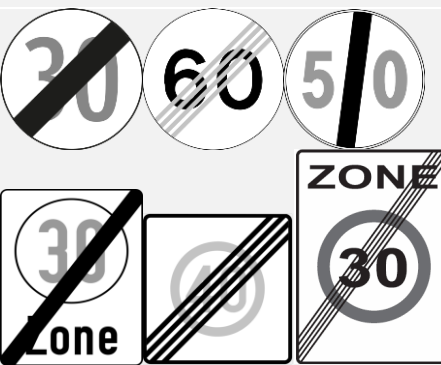




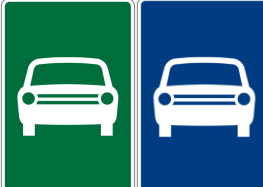

- Note: This section defines the basic functional requirements for speed limit determination from observation of road signs and signals, i.e. requirements to ensure for example that all the necessary classifiers are implemented in the system camera. It is recognised that observing road signs is a probabilistic process and cannot be achieved under all conditions and with 100% performance. Performance aspects are covered in another section (Section 4.3.2).
- The system shall be able to detect and correctly classify road signs in order to perceive the road speed limit. This requirement applies to:
  - relevant sign types as defined in the catalogue,
  - road signs of all EU member states where a particular sign type is in use at the time of approval,
  - road signs of a size, design, material and retro-reflectivity conforming to the applicable standards in the member state concerned at the time of approval,
  - fixed signs, temporary signs and variable message signs, positioned in a way conforming to the applicable standards in the member state concerned at the time of approval, e.g. relating to lateral distance to the road edge, height and orientation (rotation, tilt),
  - road signs indicating a road speed limit that is lower than the vehicle's maximum speed plus [10 km/h] (Note: For example, top-speed-limited HGVs do not need to recognise speed limit signs with values more than [10


km/h] higher than their top speed. The tolerance is included to cover situations where a speed limiter may be exceeded with gravity assistance).

- The system may (note: optional) be able to detect and classify other road signs.
- The perceived speed limit from observed relevant road signs shall match the road speed limit with regard to the numerical value and the unit of measurement (km/h or mph). This applies to both numerical and non-numerical road signs contained in the catalogue. Note: This will require knowledge of the current country-code and road class in some instances.
- The system shall be able to detect if relevant road signs apply only to particular vehicle categories/classes, indicated by sub-signs, and perceive the correct speed limit.
- The system shall be able to detect if relevant road signs apply only under additional conditions, indicated by sub-signs or additional information on the sign (e.g. rain, snow, time of day, distance or advance warning), and [either disregard the sign (result: previously applicable speed limit or speed limit unknown) or] perceive the correct speed limit based on the relevant conditions.
- The system shall be designed with measures to disregard for the purpose of speed limit determination (e.g. by probability algorithms with or without map support) at least these categories:
  - non-applicable road signs (i.e. those that are not applicable to the vehicles carriageway or lane, including overview signs posted at national borders),
  - non-speed-related road signs (e.g. vehicle weight limits, vehicle width limits), and
  - extraneous items that are not road signs (e.g. speed limit stickers used on HGVs).
- The system shall be designed to ensure that speed limits determined from applicable relevant road signs are preferred to map-derived speed limits.
- The system shall be able to set the perceived speed limit within [5 seconds] of passing the relevant road sign.
- The system shall retain the perceived speed limit (even after an ignition cycle) until:
  - It is replaced by a new perceived speed limit (from observation of road signs or signals or map data); or
  - It is replaced by 'speed limit unknown', based on criteria that may include but are not limited to:
    - The ISA system is deactivated
    - The vehicle is suspected to drive off-road
    - The vehicle is suspected to have turned onto a different type of road (e.g. away from a major road)
    - The system has not observed a road sign or signal for a distance of at least [x km] on motorways/expressways, [y km] on non-urban roads, or [z km] on urban roads.

**Table 10: Required capabilities for the determination of perceived speed limits (catalogue of relevant sign types)**

Description	Examples	System required to set perceived speed limit?
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<p>Numerical road signs including temporary and variable message signs</p>		<p>Yes – applying the correct units of measurement for the member state in which the vehicle is located</p>
<p>End of speed limit or 'national speed limit applies' signs</p>		<p>Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle</p>
<p>End of specific speed limit or speed limit zone signs</p>		<p>Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle</p>
<p>Place name signs used to indicate the presence of a speed limit and their associated cancellation signs</p>		<p>Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle</p>
<p>Urban area signs and their associated cancellation signs</p>		<p>Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle</p>
<p>Home zone or residential zone signs</p>		<p>Yes – taking into account the appropriate national speed limit for the class of road and category of vehicle</p>
<p>Motorway regulations apply signs</p>		<p>Yes – taking into account the appropriate national speed limit for the category of vehicle</p>
<p>Expressway regulations apply signs</p>		<p>Yes – taking into account the appropriate national speed limit for the category of vehicle</p>
<p>Vehicle category specific signs</p>		<p>Yes – taking into account the category of vehicles</p>

Additional conditions apply (including rain, snow, time of day, arrows, distance or advance warning)		No – the system should be capable of recognising that an additional condition applies that means that the speed limit may not be in force for that section of road and either disregard or set correct limit based on conditions.
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### Annex 1.3.2 Real-road performance of speed limit determination

- The system shall be able to detect and recognise the road signs defined in Section 4.3.1.3 and to reliably determine the road speed limit at least in the following conditions:
  - When operated within a speed range of [10 km/h – 160 km/h or maximum design vehicle speed]
  - On urban roads, non-urban roads and motorways/expressways (dual carriageways)
  - Without blinding sunlight, heavy or violent precipitation, or fog
  - With unobstructed view of road signs for a continuous period of at least [0.x seconds], e.g. no vehicles in front blocking the view, no foliage obscuring the sign, no snow or dirt covering the sign
  - With road signs:
    - of a size, design, material and retro-reflectivity conforming to the applicable standards in the member state concerned
    - positioned in a way conforming to the applicable standards in the member state concerned, e.g. relating to lateral distance to the road edge, height and orientation (rotation, tilt)
    - in adequate condition, i.e. showing no damage (e.g. fading, bending, cracking, vandalism) that materially affects their visual properties
    - not deliberately invalidated, e.g. during roadworks
- Reliable determination of the road speed limit is fulfilled if both of the following two criteria are met in each EU member state under the (favourable) conditions defined above:
  - Event-based performance:
    - The correct perceived speed limit is concluded in at least [xx% of sign passing events] for the signs and conditions described above; and
    - non-applicable road signs (i.e. those that are not applicable to the vehicles carriageway, lane, vehicle type or current conditions) or similar objects (false positives) are not used to incorrectly determine the perceived speed limit at a rate higher than [x per 100 km of driven distance].
  - Distance-based performance: The perceived speed limit matches the road speed limit for at least [xx% of distance driven] at least where the speed limit was indicated by a road sign contained in relevant catalogue and passed in the conditions described above.

### Annex 1.3.3 Performance in changing infrastructure environments

- The manufacturer shall ensure that the real-road performance of speed limit determination of registered vehicles meets the requirements for at least [4 years] after first registration of the vehicle even in changing infrastructure conditions.
  - This only applies to road sign types contained in the catalogue of relevant signs at the time of approval that are of a design and positioning conforming to the standard applied in the member state concerned at the time of approval.
- The manufacturer shall outline the measures planned to ensure compliance to the technical service, including, where applicable, the map update and software update strategy. This information shall be subject to discussion and agreement between the technical service and vehicle manufacturer.

### Annex 1.3.4 Speed limit information

- In normal operation mode the system shall display the numerical value of the perceived speed limit to the driver when feedback is active (i.e. a warning being provided or speed control function restricting the speed); information at other times is permitted (optional).
- The system may still display the perceived speed limit to the driver when the ISA system is deactivated (optional).
- The optical representation shall either be a symbol resembling a speed limit traffic sign (e.g. Vienna Convention signs C, 14; C, 17 or E, 9 or visual representations of other speed limit signs common in the country concerned; display of additional sub-signs permitted if required), or a numerical value with the unit of measurement (km/h or mph).
- The optical representation shall be clearly seen in direct field of view of the driver without the need to turn the head sideways from the normal driving position. It shall be visible even by daylight.
- The optical representation shall use the main units of the speedometer (if switchable, the currently active setting); converting speed limits from other units if required.
- The optical representation may indicate the level of reliability of the speed limit or the presence of a conditional speed limit (optional).

### Annex 1.3.5 Speed limit feedback (warning or speed control)

- In normal operation mode the system shall provide dedicated, appropriate and effective feedback to the driver when the driving speed is exceeding the feedback speed limit.
- At the choice of the manufacturer the feedback requirement can be realised via a speed limit warning function (SLWF) or with a speed control function (SCF), as specified below.
- The perceived speed limit shall be set automatically as feedback speed limit, i.e. without driver confirmation, within [5 seconds] after change in the perceived speed limit.



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- An offset of the feedback speed limit relative to the perceived speed limit shall not be allowed.
  - The feedback does not need to be reinitiated for each exceedance of the feedback speed limit until the driving speed has reduced to more than 5 km/h (3 mph) below the feedback speed limit.
  - The feedback speed limit shall be retained at the end of a journey.
  - Possible feedback modes:
    - Haptic feedback through the accelerator control:
      - Preference by legislator for this feedback mode. Pedal vibration, increased resetting force of the pedal, or similar solutions shall be permissible.
      - The feedback shall last for a total duration of at least [10 seconds]. Gaps of less than 1 second, which are part of a haptic sequence are ignored, but the feedback may not start with a gap. If the signal is not continuous for the first [10 seconds], it needs to be repeated every [30 seconds or less], resulting in a minimum total duration of at least [10 seconds].
      - The haptic warning signal shall be detectable in all typical driving conditions, when the driver's foot is in contact with the accelerator control.
      - When the vehicle speed is controlled by a driver aid rather than the driver (e.g. adaptive/intelligent/normal cruise control, where the driver must be expected to not be touching the accelerator control), the driving speed shall automatically be adapted or a feedback of a different permitted mode (e.g. optical & acoustic) be issued.
      - Permit use of this feedback mode also for other warnings that are intended to prompt the driver to reduce speed, e.g. excessive speed for current road conditions or distance warnings (voluntary systems, not required for type approval).
      - It shall be permissible for speed limit feedback to be temporarily superseded by more critical warnings, e.g. forward collision warning or lane keep assistance. Definition of this warning strategy shall be left to the manufacturer.
    - Combined optical & acoustic feedback (to be determined if permissible, pending further evidence, see stakeholder questions):
      - The feedback shall last for a total duration of at least [10 seconds]. Gaps of less than 1 second, which are part of flashing optical signals or sound sequences are ignored, but the feedback may not start with a gap. If the signal is not continuous for the first [10 seconds], it needs to be repeated every [30 seconds or less], resulting in a minimum total duration of at least [10 seconds].
      - The optical warning shall use the optical speed limit information (4.3.4) in a flashing mode. It shall be visible even by daylight; the satisfactory condition of the signals must be easily verifiable by the driver from the driver's seat.
      - The acoustic warning signal shall be audible in all typical driving conditions. It shall be dedicated to speed limit warnings, i.e. a discernible sound used only for this system.
      - It shall be permissible for speed limit feedback to be temporarily superseded by more critical warnings, e.g. forward collision warning


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or lane keep assistance. Definition of this warning strategy shall be left to the manufacturer.

- Speed control function:
  - A 'dead pedal' SCF shall be permissible (i.e. driveline torque is limited to avoid acceleration beyond the system speed limit; application of foundation brakes shall not be permissible to avoid rapid deceleration).
  - The SCF shall limit or control the driving speed to the feedback speed limit or the equivalent speedometer speed.
  - It shall be possible to exceed the feedback speed limit by performing a positive action, e.g. accelerator control kickdown. This override function shall allow a smooth and safe override and not result in immediate, unanticipated, inappropriate acceleration.
  - The speed control function shall permit a normal use of the accelerator control for gear selection.
  - The SCF shall ensure that when stable speed control has been achieved, the driving speed shall be within  $-5/+0$  km/h of the feedback speed limit.
  - If the feedback speed limit is set to a speed lower than the current driving speed, the SCF shall start to limit the vehicle speed to the new feedback speed limit no later than [30 seconds] after the new feedback speed limit is set.
  - When the SCF is not able to limit to and/or maintain the feedback speed limit an optical & acoustic warning is issued, with a total duration of at least 10 seconds. No acoustic or haptic warning needs to be given when the feedback speed limit is exceeded as a result of a positive action, but the driver shall be informed of the feedback speed limit.
  - The optical & acoustic warning shall last for a total duration of at least [10 seconds]. Gaps of less than 1 second, which are part of flashing optical signals or sound sequences are ignored, but the feedback may not start with a gap. If the signal is not continuous for the first [10 seconds], it needs to be repeated every [30 seconds or less], resulting in a minimum total duration of at least [10 seconds].
  - The optical warning shall use the speed limit information symbol (4.3.4) in a flashing mode. It shall be visible even by daylight; the satisfactory condition of the signals must be easily verifiable by the driver from the driver's seat.
  - The acoustic warning signal shall be audible in all typical driving conditions. It shall be dedicated to speed limit warnings, i.e. a discernible sound used only for this system.
  - When the vehicle speed is controlled by a driver aid rather than the driver (e.g. adaptive/intelligent/normal cruise control), the driving speed shall automatically be adapted or an optical & acoustic warning as described above be issued.

## Annex 1.3.6 Deactivation

- It shall be possible for the driver to manually deactivate the ISA system or the ISA feedback function via an ISA OFF control (information about the speed limit may still be provided).
- The ISA OFF control shall allow the driver to re-activate ISA with a single action.
- ISA shall be automatically reinstated in normal operation mode at the initiation of each new ignition cycle.
- The ISA OFF control shall be installed so as to comply with the relevant requirements and transitional provisions of UN Regulation No. 121 in its 01 series of amendments or any later series of amendments.
- A constant optical warning signal shall inform the driver that the ISA feedback function has been deactivated (ISA OFF tell-tale).
- The ISA OFF control and ISA OFF tell-tale shall be identified by the following symbols. The identification of the ISA OFF control shall be capable of being illuminated whenever the position lamps are activated. The ISA OFF tell-tale shall constantly emit light as long as the ISA feedback function is deactivated.

Item	Symbol	Function	Illumination	Colour
Intelligent Speed Assistance (ISA) "OFF"		Control	Yes	
		Tell-Tale	Yes	Yellow
	or "ISA OFF"			

## Annex 1.3.7 Self-check and failure warning

- A warning shall be provided when there is a failure in the ISA system that prevents the requirements of this Regulation of being met.
- There shall not be an appreciable time interval between each ISA self-check, and subsequently there shall not be a delay in illuminating the failure warning signal, in the case of an electrically detectable failure.
- Upon detection of any non-electrical failure condition (e.g. sensor blindness or sensor misalignment), the warning signal shall be provided.
- The ISA OFF tell-tale shall be used for the failure warning (see Section 4.3.6).

## Annex 1.3.8 Provisions for the periodic technical inspection

- 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.
- 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.

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- Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status of the ISA system is available.

#### Annex 1.3.9 Privacy and data protection

- The ISA system shall offer the required functionality in the default normal operation mode without the use of biometric information, including facial recognition, of any vehicle occupants.
- 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 legal requirements (e.g. in case a future EDR regulation required recording).
- Any processing of personal data shall be carried out in accordance with Union data protection law.

### **Annex 1.4 Assessment procedures**

#### Annex 1.4.1 Test procedure for functional requirements of speed limit determination

- Functional test of road sign and signal observation system (e.g. camera):
  - Test conditions:
    - The test shall be performed on a test track or, at the manufacturer's request, partially or fully on a public road.
    - Environmental visibility conditions shall not adversely affect the system's operation:
      - ambient illumination conditions of at least [2000 Lux] without direct blinding sunlight;
      - no heavy or violent rain, no sleet or snow, no hail and no 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.
    - The vehicle headlights (low beam) may be set to automatic or on. High beams shall not be used.
  - Road signs:
    - Selection
      - Use at least one sign of each of these categories of relevant signs (see Section 4.3.1.3):
        - Numerical speed limit
        - Numerical speed limit displayed on variable message sign
        - Numerical speed limit zone
        - End of specific speed limit
        - End of speed limit ('national speed limit applies')
        - End of speed limit zone

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- Place name
  - Urban area
  - Home zone/residential zone
  - Motorway regulation apply
  - Expressway regulations apply
  - Numerical speed limit with vehicle category-specific sub sign
  - Additional conditions apply
  - The signs used for the test shall meet the requirements stipulated in Section 4.3.1.3, i.e. be of a size, design, material and retro-reflectivity conforming to the applicable standards in the member state or region where the test takes place (the 'region of test').
  - If signs of an individual categories do not exist within the sign catalogue of the member state or region of test, they shall not be assessed in the functional test, but only covered with the additional documentation.
  - The signs used for the test shall be recorded.
  - Condition and positioning:
    - The signs shall be in good condition (i.e. not be visibly deteriorated).
    - The signs shall be positioned in accordance with the requirements stipulated in Section 4.3.1.3, i.e. positioned in a way conforming to the applicable standards in the region of test.
    - The set up shall ensure a plausible scenario for the system, considering the following elements:
      - Plausible road characteristics for each speed limit: e.g. Dual carriageway for any speed limits higher than 100 km/h
      - Plausible steps in speed reduction cascades: e.g. reduction from 130 km/h to 50 km/h should contain multiple intermediate steps
    - The condition, set up and positioning shall be recorded.
  - ISA functional test:
    - Drive the vehicle past the road signs described above at the speed indicated by the sign or up to [20 km/h] lower.
    - Check that the perceived or feedback speed limit is updated to the correct value indicated by the test signs in accordance with the requirements described in Section 4.3.1.3, i.e. within [5 seconds] after passing the sign.
    - For systems supported by speed limit maps, it shall be checked that the road sign and signal observation system (e.g. camera) correctly recognised the test signs, e.g. by observation of electronic vehicle signals (e.g. CAN bus recordings).
    - Road signs of all categories defined above need to be successfully recognised. If a test sign is not detected or recognised at first passing the test for this sign shall be repeated. If the system fails to

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detect the sign repeatedly, this case shall be investigated by the applicant. The test may be repeated on a real road if the artificial track environment caused detection issues.

- After one of the tests, drive for a distance of at least [x km] without new speed limit input to check that the perceived speed limit is retained for the required minimum distance for the concerned road type, as specified in Section 4.3.1.3.
- After one of the tests switch the vehicle off and restart the engine to check that the perceived speed limit is retained after an ignition cycle, as specified in Section 4.3.1.3.
- Declaration of EU-wide sign recognition capability:
  - The vehicle manufacturer shall declare that the road sign and signal observation system (e.g. camera) has the capabilities required according to Section 4.3.1.3 and checked in the ISA functional test with the equivalent signage of all EU member states at the time of approval.
  - This declaration shall contain a matrix of the relevant sign categories and member states, confirming the ability to detect, recognise and interpret for each of the fields where signs exist in the country concerned.
  - This declaration shall be appended to the test report.
- Additional technical information to be made available to the technical service:
  - The vehicle manufacturer shall give access to test documentation that allows the technical service to assess the contents of the declaration, e.g. by review of test recordings of specific sign types being recognised.

#### Annex 1.4.2 Documentation procedure for real-road performance of speed limit determination

- Criteria for underlying performance testing (performed by manufacturer or tier 1):
  - The performance test programme shall:
    - Measure the system's performance in correctly determining the road speed limit based on one of the key performance indicators defined in Section 4.3.2.3
    - Consist of real-driving tests, or representative simulation tests, or a combination of both
    - Involve tests for all EU member states
    - Involve tests of urban roads, non-urban roads, and motorways/expressways/dual carriageways, where each of the three road types shall represent at least [25% of the validation distance or sign passing events for each country]
    - Contain a mix of the relevant road signs that can be encountered on each road type, where each of the signs shall represent at least [x% of the sign passing events]
    - Contain a mix of conditions, including daylight/darkness and dry/light to moderate precipitation, that is broadly representative of real-world usage profiles
  - Repeated runs of the same road sections or repeated simulations of passing the same road sign shall be disregarded for the performance evaluation.

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- An instance where road signs with identical speed limits are positioned on both sides of the carriageway shall be considered as a single sign passing event.
  - Non-speed related road signs shall be disregarded for the performance evaluation. Speed-related road signs that are not included in the relevant catalogue (e.g. weather/time-dependent sub-signs) may be disregarded for the performance evaluation.
  - Road signs that do not conform with the conditions described in Section 4.3.2.3 (e.g. signs in inadequate condition or not positioned in accordance with applicable standards) may be disregarded for the performance evaluation.
  - Road signs encountered in environmental conditions not conforming with those described in Section 4.3.2.3 (e.g. heavy rain or blinding sunlight) may be disregarded for the performance evaluation.
  - Sufficient testing shall be conducted to evidence performance in each member state of a level that meets or exceeds the required minimum thresholds [at a statistically significant level].
  - Declaration of system performance:
    - The vehicle manufacturer shall declare the performance of the ISA system to the technical service based on previous performance testing.
    - The performance declaration shall be appended to the test report (see examples in Table 11 and Table 12) and contain the following information:
      - The performance shall be reported based on both KPIs defined in section 4.3.2.3 (event-based and distance-based).
      - The performance shall be reported separately per EU member state.
      - The declaration shall state the test distance (driving or simulation) and the number of sign passing events per member state and road type.
  - Additional technical information to be made available to the technical service:
    - The vehicle manufacturer shall provide a test report that allows the technical service to assess the quality of the test programme and contain at least:
      - approach taken for the real-road performance testing, including details about the test setup for physical testing and the validity of simulation approaches
      - mix of driving conditions (e.g. daylight/darkness and precipitation/dry conditions)
      - locations of test routes (physical or simulation) or samples of sign passing events
      - date range of the test drives or samples used for testing
      - statistical calculations demonstrating sufficient testing
  - Assessment of the performance declaration and additional technical documentation:
    - The technical service shall perform:
      - a check that the reported performance levels meet the required minimum thresholds as define in Section 4.3.2.3,
      - a review of the test report to confirm that the underlying test programme meets the criteria defined above,

- an audit of the test report:
  - to ensure that the underlying test evidence corresponds with the reported results to a level of overall effect such that the performance declaration is confirmed as being adequate.
  - using means, at the choice of the technical service, such as: review of test recordings from selected parts of the validation drives or instances where sign passing events were disregarded, or re-performing parts of the validation drives.



**Table 11: Example table for event-based ISA performance declaration**

EU member state	Event-based performance (true positive)	False-positive rate	Number of sign passing events tested (physical/simulation)		
			Urban road	Non-urban road	Motorway/expressway
Austria	xx%	xx per 100 km	xx / xx	xx / xx	xx / xx
Belgium					
Bulgaria					
Croatia					
Cyprus					
Czech Republic					
Denmark					
Estonia					
Finland					
France					
Germany					
Greece					
Hungary					
Ireland					
Italy					
Latvia					
Lithuania					
Luxembourg					
Malta					
Netherlands					
Poland					
Portugal					
Romania					
Slovakia					
Slovenia					
Spain					
Sweden					
United Kingdom					

**Table 12: Example table for distance-based ISA performance declaration**

EU member state	Distance-based performance	Test distance (physical/simulation)		
		Urban road	Non-urban road	Motorway/expressway
Austria	xx%	xx km / xx km	xx km / xx km	xx km / xx km
Belgium				
Bulgaria				
Croatia				
Cyprus				
Czech Republic				
Denmark				
Estonia				
Finland				
France				
Germany				
Greece				
Hungary				
Ireland				
Italy				
Latvia				
Lithuania				
Luxembourg				
Malta				
Netherlands				
Poland				
Portugal				
Romania				
Slovakia				
Slovenia				
Spain				
Sweden				
United Kingdom				

#### Annex 1.4.3 Test procedure for speed limit warning

- Test Conditions:
  - The tests shall be performed on a track whereby:
    - The test surface shall be suitable for enabling stabilised speed to be maintained and shall be free from uneven patches.
    - The test surface shall be free of standing water, snow or ice.
  - Vehicle preparation:

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- The tyres shall be bedded and the pressure shall be as specified by the manufacturer for the vehicle.
  - The wheel size used shall be the largest size approved for the vehicle under test.
  - Speed limit warning test:
    - Test procedure:
      - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
      - With the ISA and SLWF activated, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall then be accelerated to 10 km/h above the feedback speed limit.
      - The vehicle will be kept at this new speed, long enough for an assessment of the entire warning sequence (as specified by the manufacturer).
      - The vehicle will then be decelerated to more than 5 km/h below the feedback speed limit (to re-instate warning), and the procedure above will be repeated.
      - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
    - Pass/fail criteria:
      - A warning complying with the specifications in Section 4.3.5.3 shall be given in both test runs when the real speed of the vehicle exceeds the feedback speed limit.
      - Information about the feedback speed limit complying with the specifications in Section 4.3.4.3 shall be given in both test runs at least when the real speed of the vehicle exceeds the feedback speed limit.
  - Speed limit alternative warning mode test:
    - Note: This test applies to systems providing haptic feedback through the accelerator control in vehicles which offer driver aids for longitudinal control (e.g. cruise control, ACC). The aim is to test the requirement for an alternative warning mode in case cruise control is used.
    - Test procedure:
      - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
      - With the ISA and SLWF activated, the vehicle shall be run at the test speed, with a driver aid controlling the speed (e.g. cruise control, ACC). The driver's foot shall not contact the accelerator control. Ensure that the feedback speed limit is then being set to a speed, at least, 10 km/h lower than the test speed.
      - The vehicle will be kept at the test speed, long enough for an assessment of the entire warning sequence (as specified by the manufacturer).
      - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
    - Pass/fail criteria:

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- A warning complying with the specifications in Section 4.3.5.3 for alternative warning modes in case of default haptic feedback and speed control by a driver aid shall be given.
  - Information about the feedback speed limit complying with the specifications in Section 4.3.4.3 shall be given at least when the real speed of the vehicle exceeds the feedback speed limit.
  - Speed limit warning deactivation test:
    - Test procedure:
      - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
      - With the ISA deactivated, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall then be accelerated to 10 km/h above the feedback speed limit.
      - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
    - Pass/fail criteria:
      - The SLWF shall not engage, allowing the vehicle to exceed the feedback speed limit without a warning being issued.
      - Information about the feedback speed limit may be given to the driver.

#### Annex 1.4.4 Test procedure for speed control

- Test Conditions:
  - The tests shall be performed on a test track whereby:
    - The test surface shall be suitable for enabling stabilised speed to be maintained and shall be free from uneven patches. Gradients shall not exceed 2 percent (this does not apply to the overrun test).
    - The test surface shall be free of standing water, snow or ice.
  - Vehicle preparation:
    - The vehicle mass shall be no less than the minimum kerb weight declared by the manufacturer.
    - The tyres shall be bedded and the pressure shall be as specified by the manufacturer for the vehicle.
    - Wheel size, gearbox type and gear selected for test shall follow a worst case approach.
  - Ambient Conditions:
    - The mean wind speed measured at least 1 m above the ground shall be less than 6 m/s with gusts not exceeding 10 m/s.
- SCF functional test:
  - Test procedure:
    - With the ISA (and SCF) activated, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall

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then be accelerated to engage the SCF, without applying a positive action. The vehicle shall be run at three different road speeds limits, most representative of three distinct road types (or closest multiple of 10 km/h below the maximum vehicle speed, whichever is lower):

- City roads (e.g. 50 km/h or 30 mph)
- Inter-Urban roads (e.g. 80 km/h or 50 mph)
- Highways (e.g. 120 km/h or 70 mph)
- The vehicle will be kept at the test speed, long enough for an assessment of the stabilised vehicle speed.
- The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
- Pass/fail criteria:
  - The SCF shall ensure that when stable speed control has been achieved, the stabilised vehicle speed shall be within -5/+0 km/h of the feedback speed limit. The SCF must not use the service brakes to do so.
  - The stabilised vehicle speed means the mean real vehicle speed when operating. It is calculated as the average real vehicle speed over a time interval of 20 seconds beginning 10 seconds after first reaching the feedback speed limit.
- SCF response test:
  - Test procedure:
    - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
    - With the ISA (and SCF) activated, the feedback speed limit shall be set to a high speed (at least 20 km/h higher than the tested speed limit). The vehicle shall be run just below the high perceived speed limit without applying a positive action and without engaging the SCF. While driving, the feedback speed limit shall be set to the tested speed limit.
    - The test will last for a minimum of 30 seconds after the ISA accepts the lower feedback speed limit, or until the real speed of the vehicle matches the feedback speed limit (whichever occurs first).
    - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
  - Pass/fail criteria:
    - The SCF should start to limit the vehicle speed to the road limit no later than 30 s after the new road speed limit has been adopted as the new feedback speed limit.
    - Information about the feedback speed limit complying with the specifications in Section 4.3.4.3 shall be given when the vehicle speed is exceeding the feedback speed limit.
- SCF deactivation test:
  - Test procedure:
    - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).

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- With the ISA (and SCF) switched OFF, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall then be accelerated to engage the SCF, without applying a positive action.
  - Pass/fail criteria:
    - The SCF shall not engage, allowing the vehicle to exceed the feedback speed limit without applying a positive action.
    - With the ISA system switched off, the driver should not receive warnings from the ISA system.
    - Information about the feedback speed limit may be given to the driver.
  - SCF override test:
    - Test procedure:
      - The test shall be run at a representative City road speed limit (existent in the region of test).
      - With the ISA (and SCF) activated, the vehicle shall be run at a speed of 15 km/h below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit. The vehicle shall then be accelerated to engage the SCF, without applying a positive action.
      - The technical service is required to compare the real speed (e.g. independently measured with GPS) of the vehicle to the feedback speed limit.
      - Once the vehicle reaches the feedback speed limit and the stabilised vehicle speed has been established, the assessor shall override the feedback limit by applying a positive action; as specified by the manufacturer e.g. kickdown.
    - Pass/fail criteria:
      - The override function shall allow a smooth and safe override and not result in immediate, unanticipated, inappropriate acceleration.
  - SCF overrun test:
    - Test procedure:
      - The test shall be run at one representative road speed limit at the choice of the technical service (existent in the region of test).
      - With the ISA (and SCF) activated, the vehicle shall be run at a speed just below the road speed limit. Ensure that the feedback speed limit is set to the road speed limit.
      - Force the vehicle into an overrun condition (e.g. pulling or downhill) where the engine braking is not able to maintain the feedback speed limit.
      - Measure the speed at which the overrun warning is initiated.
    - Pass/fail criteria:
      - When the SCF is not able to limit to and/or maintain the feedback speed limit:
        - a warning complying with the specifications in Section 4.3.5.3 shall be given., and

- information about the feedback speed limit complying with the specifications in Section 4.3.4.3 shall be given.





