

The present document was prepared by the Chair of the GRE Task Force “Autonomous Vehicle Signalling Requirements” (AVSR), as a result based on the discussions in the GRE TF AVSR and on the comments received from different CPs and NGOs.

GRE Taskforce on Autonomous Vehicle Signalling Requirements (AVSR)

OUTCOME OF THE DISCUSSION

The task of the Task force is given by the following questions:

1. Is there a safety requirement for AV’s to provide signals to indicate their status and to communicate their next intended actions?
2. If so, shall such signals
 - be visual,
 - audible,
 - or a combination of both?

After review of the relevant publications based on human factors research on autonomous vehicles and clarification of a common understanding of the task as well as the positions of Contracting Parties, the Task force came to the following conclusions:

With regard to the question #1 → Do we need an indicator?

The Task force discussed the question and came to the conclusion that the decision about this principal question is not in the mandate of this task force. The following discussion based on the assumption, that a “driving mode indicator” is needed (see ISO definition).

In this context a “driving mode indicator” means a device which informs other road users that the vehicle is actively in autonomous driving mode.

Some publications do see a need for this “driving mode indicator”, e. g.:

- to enable the conspicuity and identification of autonomous vehicles for enforcement authorities (e.g. police) in order to fully understand the traffic situation and to use adequate measures, if necessary (see also rules No.5 & No.16 of “Ethics Commission: Automated and Connected Driving” /6/)¹;
- that pedestrians, authorities and/or other road users can identify the status of these vehicles. Additionally, such an indicator makes them aware of who has the control of the vehicle, so they can more easily assess the situation and act accordingly

¹ Remarks from BMVI (Germany) after consultation with the relevant part of the ministry in charge of the ethics commission: There is no general demand for a permanent "driving mode indicator" resulting from Rule 5 or 16.

Rule 5 mentions only a "signal for persons at risk". However, this probably presupposes a dangerous situation and does not start from the normal driving situation.

Rule 16 underlines that it is important to know if (and when) a human driver, still have responsibilities. "(..) In the case of driverless systems, the human-machine interface must be designed in such a way that at any time it is clear and apparent on which side the individual responsibility lies, especially the responsibility for control. The distribution of responsibility (and thus of accountability), for instance with regard to the time and access arrangements, should be documented and stored. (..)" A reference to a permanent 'driving mode indicator' here either is not recognizable either.

- autonomous vehicles sometimes are different to normal vehicles with regard to their behaviour (e.g. their reaction time especially with regard to manoeuvres specific for autonomous vehicles).

Even if the autonomous vehicles are acting identical to the human driver, there are situations (e.g. with police) where it is essential to know who has the control of the vehicle – especially on Level 3 vehicles where the driver is still sitting behind the steering wheel while e.g. playing with his mobile phone.

Nevertheless, the necessity to define such a function indicating that a vehicle is in autonomous driving mode concluded not in a common position within the Task Force. For the moment some contracting parties have the official position that an indicator is unnecessary for autonomous vehicles (due to the possibility of misuse and/or misinterpretation). However recent studies do not show the evidence of misuse.

Therefore the discussion was focused on the question, based on the assumption that such an indicator is needed
→ Shall such signals

- be visual,
- audible,
- or a combination of both?

As a consequence of the discussion about this question the group concluded, that it should be a visible function (under normal traffic conditions and active autonomous driving),

- see ISO TR 23049 /1/, Paragraph 7 points out among other things:
 - « Auditory signals generally are advised when the frequency of use is relatively low and the messaging is of a warning or awareness-raising nature (and surrounding sound levels support the use of auditory signals). The visual modality, while very powerful in terms of specificity, may demand additional attention by road users. However, visual signalling is primarily used for communication that is more frequent. »
- See also Document No. ITS/AD-15-05a-Rev1 (15th ITS/AD, 21 June 2018) /3/
Conclusion on Page 8:
 - „- Vulnerable Road Users (VRUs) expect some external communication interacting with autonomous vehicles.
 - The majority of human sensing is guided by visual interaction.
 - Road users are experienced with light signals!“
- This is pointed out in “The Mind’s Eye”, by Susan Hagen, page 35 /4/
 - “More than 50 percent of the cortex, the surface of the brain, is devoted to processing visual information,” points out Williams, the William G. Allyn Professor of Medical Optics. “Understanding how vision works may be a key to understanding how the brain as a whole works.”

Nevertheless the discussion clearly pointed out that:

- many existing studies on “Autonomous Vehicles” deal with different questions, different intentions and different methods of analysis and most of the current studies are not specific enough to the question if the marker/signals should be mandatory, optional or even prohibited.
- therefore this fact demands more research and requires that the additional researches should be well defined to answer specific question.

For the visible function it must be defined, when and under which conditions this signal should be activated. In this context, e. g. interaction with police, the interaction with other road drivers shall be taken into account, depending from the level of autonomous driving.

In conjunction with these findings the group identified also a number of challenges, as e. g.

- the risk of misuse by other vulnerable road users or the potential misuse by other drivers, e. g. at high speed driving etc.
- the potential danger to create an overflow of signals or to create “light pollution”, which could cause misinterpretation of other signals in traffic.

Regarding any next steps, the following questions have to be investigated, if the principle concept for a “driving mode indicator” as presented by the TF AVSR is accepted:

- Are different intensity levels needed for night and day, and
- which will be the best light distribution to the front, to the side and to the rear of the vehicle to reach the best performance for the “driving mode indicator”.
- Should this indication (signal) be presented permanently while the vehicle is in autonomous mode, or only in specified cases, which shall be defined explicitly, and
- is it necessary on level 3? (see also SAE J 3016 /2/)...
- And for the final text in Regulation LSD, the colour boundaries and intensities or luminance values must be specified on the base of the research findings.

With regard to audible signals:

- audible signals are unnecessarily disturbing
see Convention on road traffic, Vienna on 8 November 1968, Amendment 1 /5/
ARTICLE 7 General rules
4. Drivers shall take care that their vehicles do not inconvenience road users or the occupants of properties bordering on the road, for example, by causing noise or raising dust or smoke where they can avoid doing so.
- see also ISO TR 23049 /1/ Paragraph 7

With regard to audible signal as an information to other road users we shall bear in mind, that the directional behavior of an audible signal is unclear and for the necessary discrimination to other audible signal it is necessary to generate more than one level, different frequencies, etc. (which again is in serious conflict with Article 7 of the Vienna Convention).

This does not exclude in further discussions that audible signals, which could support e.g. handicapped peoples in communicative scenarios, may be taken into account.

This outcome should be addressed by the chairman of GRE to WP.29 and GRVA with the question whether WP.29 could support the view of the task force and to ask for further guidance to continue the work and change the status of the group from a Task force to an informal working group.

References:

- /1/ ISO/TR 23049:2018, Road Vehicles – Ergonomic aspects of external visual communication from automated vehicles to other road users; Technical Committee: [ISO/TC 22/SC 39 Ergonomics](#)
- See also Document [AVSR-03-03e.docx](#): Outlines of ISO TR 23049 “External communication from automated vehicles to other road users”
- /2/ SAE J 3016:2018-06-15 Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles
- See also Document [AVSR-02-20e.docx](#): SAE Abstract of J 3134
- /3/ [ITS/AD-15-05a-Rev1.pdf](#) (15th ITS/AD, 21 June 2018):
- Light Signalling and Lighting Requirements for ADS Vehicles; GTB Document No. CE-5523
- /4/ “The Mind’s Eye”, by Susan Hagen, page 35
- http://www.rochester.edu/pr/Review/V74N4/pdf/0402_brainscience.pdf
- /5/ Convention on road traffic, Vienna on 8 November 1968, Amendment 1;
- Chapter XI. Transport and Communications B., Road Traffic TITLE 19. -
- https://treaties.un.org/doc/Treaties/1977/05/19770524%2000-13%20AM/Ch_XI_B_19.pdf
- /6/ Report of the Ethics Commission about Automated and Connected Driving – June 2017
- German Federal Ministry of Transport and Digital Infrastructure
- See Document [AVSR-05-05E.PDF](#): Report of Ethics Commission - Automated and connected driving (English translation)

Further literature which was sent to the Task force is listed in the following document:
[AVSR-05-06e.xlsx](#): (Secretariat) Overview of available studies