

**Draft Text for
FRAV Recommendations on
ADS External Light-Signalling**

This text has been prepared for consideration by FRAV during its 31st session (September 2022). The text aims to summarize the consensus outcomes of FRAV deliberations on ADS external light signals for ADS vehicles to date.

Summary

- FRAV does *not* recommend **establishing UN** requirements for *mandatory* installation of additional light-signalling devices beyond those requirements established for manually driven vehicles.
- FRAV **believes that** existing light-signalling devices **may be suitable (if permitted)** to signal initiation of an automated fallback response designed to place the ADS vehicle in a minimal risk condition.
- FRAV recommends the establishment of uniform provisions for a light signal to communicate the operational status of the ADS *if fitted on an ADS vehicle and under certain conditions*.
- **FRAV notes that means other than light-signalling may be suitable to achieve safety needs.**
- **FRAV recommends continued monitoring of research into ADS signalling and the safety of interactions between other road users and ADS vehicles.**

Background

Pursuant to deliberations during its November 2021 session, AC.2 tasked GRVA and its Informal Working Group on Functional Requirements for Automated Vehicles (FRAV) to determine the conditions, if any, under which an ADS external lighting signal should be activated and recommend to GRE to whom the signal should be displayed (drivers in other vehicles, other road users) and from where it should be visible (e.g., front, rear, side).

FRAV consulted with the GRE Task Force on Autonomous Vehicle Signalling Requirements (AVSR), reviewed outcomes of these and other deliberations and research projects, surveyed its experts, and deliberated on the issue across its sessions between March 2021 and September 2022.

Recommendations

1. FRAV does not recommend **establishing UN** requirements for mandatory installation of additional light-signalling devices beyond those requirements established for manually driven vehicles.

FRAV recommends that ADS be required to operate the vehicle in accordance with traffic laws. These laws prescribe requirements for signalling to other road users¹ (ORU) and are deemed sufficient to address road-safety needs.

Research and documented real-world cases indicate that identifiers unique to ADS vehicles **may** raise risks of changes in ORU behaviours that adversely impact road safety. ADS safety requirements **aim to** ensure predictable ADS behaviours designed to prioritize collision avoidance. Foreknowledge of ADS operation of a vehicle has been shown to alter risk assessments of other road users, resulting in higher-risk behaviours when interacting with these vehicles. ADS responses to mitigate these higher-risk ORU behaviours may result in traffic disruptions that may introduce further road-safety risks.

2. FRAV **believes that** existing light-signalling devices **may be suitable (if permitted)** to signal initiation of an automated fallback response designed to place the ADS vehicle in a minimal risk condition (MRC).

Under certain conditions, an ADS may need to place the ADS vehicle in a stable and stopped condition that minimizes the risk of a crash. Depending upon the ADS configuration, such conditions may include fallback-user incapacitation (e.g., medical emergency), failed fallback-user response to an ADS transition demand, or a condition that prevents the ADS from safely performing the Dynamic Driving Task.

FRAV recommends that ADS signal initiation of a safety-critical automated fallback response to ORU in a manner consistent with similar expectations applied to human drivers **if permissible under national or regional legislation**.

3. FRAV recommends the establishment of uniform provisions for a light signal to communicate the operational status of the ADS if fitted on an ADS vehicle and under certain conditions.

While FRAV does not recommend mandatory **UN requirements for the** installation of light-signalling devices unique to ADS vehicles, **FRAV recognizes that Contracting Parties may wish to mandate or permit the use of external light signals to meet specific national or regional safety needs**.

For example, FRAV notes instances where signalling to road-safety agents² such as law enforcement may be justified. FRAV notes traffic laws that prohibit human drivers from engaging in certain non-driving-related activities (NDRA). However, FRAV anticipates traffic laws that may permit additional NDRA while an ADS is operating the vehicle. Means to enable law enforcement to determine whether a vehicle is under ADS operation may therefore be justifiable in order to facilitate enforcement of such laws regarding permissible NDRA.

In this regard, FRAV does not exclude the potential usefulness of a light signal to address specific interactions with road-safety agents **or other road users**. FRAV notes that means other than a light

¹ FRAV defines “other road user” as any entity using a roadway and capable of safety-relevant interaction with an ADS vehicle.

² “Road-safety agent” is defined by FRAV as a human being engaged in directing traffic, enforcing traffic laws, maintaining/constructing roadways, and/or responding to traffic incidents.

signal may address such interactions. For example, telecommunications technologies may enable dissemination of information to designated or authorized recipient(s).

FRAV emphasizes that decisions on whether to require, permit, or prohibit the use of such external light signals rests with the individual Contracting Parties. FRAV's concern is to promote harmonization should one or more Contracting Parties wish to allow or require such signals.

In the event that Contracting Parties wish to permit the use of a light-signal to communicate the operational status of ADS vehicles, FRAV recommends the establishment of uniform provisions to facilitate harmonization of such devices if fitted on the vehicle. FRAV recommends that such signals avoid confusion or interference with other lighting or light signals and be:

- Activated upon ADS detection of **a road user with a justified safety need to be informed of the ADS operational status**, and
- **Positioned to facilitate recognition by the intended recipient(s) of the signal without indiscriminately signalling ADS operation of the vehicle.**
- ~~Illuminated for a duration necessary to meet the relevant safety need.~~

4. FRAV recommends continued monitoring of research into ADS signalling and the safety of interactions between other road users and ADS vehicles.

FRAV recognizes that understanding of ORU interactions with ADS vehicles will evolve over time, including risks and benefits of external signalling. The present FRAV recommendations do not preclude further consideration of external signalling to address safety needs that may emerge from future research and analysis of real-world interactions. The present recommendations highlight that external signals specific to ADS vehicles may have risks, benefits, and uncertainties that should be carefully weighed.

List of reference documents

Reference documents in addition to those identified by the AVSR Task Force (see AVSR-05-06 for literature review and especially the 2nd AVSR session for studies).

European Commission, Directorate-General for Mobility and Transport, Montalvo, C., Willemsen, D., Hoedemaeker, M. (2020). Study on the effects of automation on road user behaviour and performance: final report, Publications Office. <https://data.europa.eu/doi/10.2832/431870>.

Shubham Soni, Nagarjun Reddy, Anastasia Tsapi, Bart van Arem, Haneen Farah, Behavioral adaptations of human drivers interacting with automated vehicles, Transportation Research Part F: Traffic Psychology and Behaviour, Volume 86, 2022, Pages 48-64, ISSN 1369-8478, <https://doi.org/10.1016/j.trf.2022.02.002>.

Aramrattana, M., Fu, J. and Selpi (2022), Behavioral adaptation of drivers when driving among automated vehicles, Journal of Intelligent and Connected Vehicles, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/JICV-07-2022-0031>.

Help with providing other reference documents mentioned during sessions, including Waymo experiences with adverse ORU behaviours.