Contents

5.11 Recommendations on safe use of the ADS by ADS users

5.11.1. Scope and purpose.

5.11.1.1. This section provides recommendations on the interaction processes between the user and the ADS vehicle to obtain a safe use of an ADS vehicle.

5.11.1.2. These recommendations do not apply to ADS vehicles designed without accommodations for a user.

> **Commented [BR(1):** passenger in a bus are considered a user, like passengers using a robotaxi;
> Where to cover external human machine interaction (f.ex. for intervention of humans that are near the automated vehicle and should see a need for an emergency stop).

5.11.1.3. User is short for ADS user

5.11.2 ADS vehicles with accommodations for a user

5.11.2.1. The ADS will signal the presence of a fault that prevents the ADS from performing the DDT functions required by its feature(s) pursuant to para. 4.9.

> **Commented [BR(2):** check

5.11.2.2. The ADS will signal its intention to place the vehicle in an MRC to the ADS user(s).

5.11.2.3. The ADS users are: driver, fall-back user, passenger in the driving seat, passenger

> **Commented [BR(3):** defined?

5.11.2.4. The ADS may control the operation of closures, if available, as relevant to occupant safety, or to restrict or enable access to compartments. Controls related to closures may be disabled by the ADS.

5.11.2.5. The ADS HMI will provide information and signals clearly noticeable under all operating conditions, multimodal if needed, simple and unambiguously.

5.11.2.6. The vehicle controls may be disabled, suppressed, de-activated, inhibited or by other means made unavailable, as needed to limit errors in operation, misuse and reduce ambiguous states of vehicle control.

5.11.2.7 The vehicle shall indicate its ADS capabilities in terms of their automated [features] and their ODD.
5.11.2.8 The ADS will be designed to prevent misuse and errors in operation by the user.

> **Commented [BR(4):** Not sure where this fits

(a) The vehicle controls dedicated to the ADS will be clearly distinguishable from other controls to accommodate only the appropriate interactions.
(b) The ADS HMI need to take into account potential impairments of users (such as colour blindness, impaired hearing) which do not require specific hardware adaptations of the vehicle.

5.11.3 ADS vehicles that have no ODD exit and permit manual driving by ADS users.
5.11.3.1 Scope
5.11.3.1.1 These recommendations apply to the following users: driver, passenger in the driver seat, passenger.

5.11.3.1.2 The ADS shall detect whether there is a user in the driver seat.

> **Commented [BR(5):** Or is this already covered somewhere

5.11.3.1.3. If there is upon ADS activation no passenger in the driver seat, vehicle controls related to the DDT may be disabled, suppressed, deactivated, inhibited, or by other means made unavailable to the user.

5.11.3.1.4. If there is no passenger in the driver seat the following recommendations do not apply and only the recommendations under 5.11.2 are relevant.

5.11.3.2. General recommendations
5.11.3.2.1. The ADS will inform the passenger in the driving seat on

(a) ADS status information.
(b) Any failure of the ADS.

5.11.3.3 Recommendations on the ADS activation when in motion

5.11.3.3.1 The ADS will ensure a safe ADS activation.

    (a)   The ADS will inform the user that preconditions for activation are met.
    (b)   The activation will follow a common sequence of actions and states.
    (c)   The ADS will provide confirmation that the system is activated.

5.11.2.4. Recommendations on the ADS deactivation while in motion (Take-over)

5.11.2.4.1 The ADS will be designed to ensure a safe user-initiated takeover process.

    (a)   The ADS will allow the user to initiate a take-over process
    (b)   The ADS will momentarily delay deactivation of driving control when immediate human resumption of control could compromise safety
    (c)   The take-over process will follow a common sequence of actions and states
    (d)   The ADS will verify that the user is in stable control of the vehicle to complete the user-initiated takeover of control process.
    (e)   The ADS will provide specific feedback of the completion of of the deactivation of the ADS.
    (f)   The deactivation shall return control of the DDT to the driver without any continuous control assistance (temporarily intervening safety systems such as ESC will remain activated).
    (g)   If applicable upon ADS deactivation, the vehicle controls, indicators, warnings and tell-tales will be restored to an activated state.
    (h)   If applicable ADS features operating control of closures, will no longer influence closures or the controls associated with closures.
    (i)   If applicable, controls associated with the operation of the ADS feature will no longer influence the ADS feature.

5.11.2.5 Recommendation on Documentation for users

5.11.2.5.1 The ADS will be supported by documentation and tools to facilitate user understanding of the functionality and operation of the system covering at least:
    (a)   A description on the permitted transitions of roles and the procedure for those transitions.

5.11.2.6 Documentation for the audit

5.11.2.6.1. The ADS manufacturer / vehicle manufacturer (as appropriate) will provide documentation available for audit on:
(a) The details of their user-centred design process
(b) Its intended educational approach for theoretical and practical training

5.11.4 ADS vehicles with an ODD exit and that permit manual driving by ADS users.

5.11.4.1 Scope

5.11.4.1.1 These recommendations deal with the following user roles: driver, fall-back user, passenger (in the driver seat)

5.11.4.2 General recommendations

5.11.4.2.1 When activating an ADS feature all functions of that feature are activated

5.11.4.2.2 While an ADS feature is active it will inform the user in the driving seat on:
(a) ADS status information.
(b) The availability of automated features (ADS).
(c) Responsibilities for the user.
(d) Permitted NDRA (or not-permitted NDRA).
(f) "Standard" information that support situation awareness.
(g) Any failure of the ADS.

Commented [BR(6)]: Necessary? I mean makes sense if there are certain failures the may have an effect on certain functions.

Commented [BR(7)]: See ISO/TR 21959-1:2020(E). The ToR states that we should refer to standards etc as much as possible.

Commented [BR(8)]: Means that the ADS has taken over the DDT

Commented [BR(9)]: See ISO/TR 21959-1:2020(E). The ToR states that we should refer to standards etc as much as possible.

Commented [BR(10)]: Can g, h and i be combined in the sense that the ADS no longer has influence on anything (except on status and failure). e.g., After deactivation the ADS shall have no influence at all over the vehicle and shall only indicate relevant status information.
With no influence is meant also restoring

(h) Upcoming actions or change in roles.
(I) Estimated time until transition of control in nominal conditions (when applicable).

5.11.4.2.3 While the ADS is not active it will inform the driver:
(a) ADS status information.
(b) The availability of automated features (ADS).
(c) Any failure of the ADS.

5.11.4.2.4 The ADS shall have a Driver Monitoring System to support correct engagement of the [fallback] user.

5.11.4.2.5. Any form of deactivation will return control of the DDT to the driver without any continuous control assistance (temporarily intervening safety systems such as ESC will remain activated).

5.11.4.2 Recommendation of ADS feature activation
5.11.4.2.1 The ADS shall ensure a safe ADS feature activation.

  (a) The ADS shall provide prompt feedback when the user attempts to enable unavailable features.
  (b) The ADS shall inform the user that preconditions for feature activation are met.
  (c) The activation shall follow a common sequence of actions and states.
  (d) The ADS shall provide confirmation that the system is activated.
  (e) An ADS feature activation resulting in a change of user role will inform the user about this change in roles and corresponding responsibilities.

> **Commented [BR11]:** See ISO/TR 21959-1:2020(E). The ToR states that we should refer to standards etc as much as possible.

5.11.4.3 Transition of Control
5.11.4.3.1 The ADS shall ensure a safe transition of control.

  (a) A transition of control in nominal situations should be indicated in timely manner to support that the fallback user may re-engage to the driving task as appropriate.
  (b) The Transition of control process shall follow a common sequence of actions and states.
  (c) The ADS shall
       a. continuously verify whether the fallback user is available for the Transition of Control and
       b. adapt the Transition of Control process, including the time budget where feasible, to the state of the fallback user and/or to the ADS. (and suggest a minimum time budget)
       c. provide a warning when the user is not available when required.
  (d) Transition of control shall return control of the DDT to the driver without any continuous control assistance (temporarily intervening safety systems such as ESC will remain activated).
  (e) The ADS shall verify that the fallback user is in stable control of the vehicle to complete the Transition of Control process.
  (f) During transition, the ADS shall remain active until the Transition of control has been completed or the ADS reaches a minimal risk condition.
  (g) The ADS shall provide specific feedback of the completion of the transition of control.
  (h) If applicable upon ADS deactivation, the vehicle controls, indicators, warnings and tell-tales will be restored to an activated state.
  (i) If applicable ADS features operating control of closures, will no longer influence closures or the controls associated with closures.
  (j) If applicable, controls associated with the operation of the ADS feature will no longer influence the ADS feature.

> **Commented [BR12]:** See ISO/TR 21959-1:2020(E). The ToR states that we should refer to standards etc as much as possible.

> **Commented [BR13]:** Can h, i and j be combined in the sense that the ADS no longer has influence on anything (except on status and failure). e.g., After deactivation the ADS shall have no influence at all over the vehicle and shall only indicate relevant status information.
> With no influence is meant also restoring

5.11.4.4. Recommendations on the ADS deactivation while in motion (Take-over)
5.11.4.4.1 The ADS will be designed to ensure a safe user-initiated takeover process.

  (a) The ADS will allow the user to initiate a take-over process
  (b) The ADS will momentarily delay deactivation of driving control when immediate human resumption of control could compromise safety
  (c) The take-over process will follow a common sequence of actions and states

> **Commented [BR14]:** See ISO/TR 21959-1:2020(E). The ToR states that we should refer to standards etc as much as possible.

(d) The ADS will verify that the user is in stable control of the vehicle to complete the user-initiated takeover of control process.
(e) The ADS will provide specific feedback of the completion of of the deactivation of the ADS.
(f) The deactivation shall return control of the DDT to the driver without any continuous control assistance (temporarily intervening safety systems such as ESC will remain activated).
(g) If applicable upon ADS deactivation, the vehicle controls, indicators, warnings and tell-tales will be restored to an activated state.
(h) If applicable ADS features operating control of closures, will no longer influence closures or the controls associated with closures.
(i) If applicable, controls associated with the operation of the ADS feature will no longer influence the ADS feature.

> **Commented [BR(15):** Can g, h and i be combined in the sense that the ADS no longer has influence on anything (except on status and failure). e.g., After deactivation the ADS shall have no influence at all over the vehicle and shall only indicate relevant status information.
> With no influence is meant also restoring

5.11.4.5 Recommendations on documentation for users

5.11.4.5.1 The ADS shall be supported by documentation and tools to facilitate user understanding of the functionality and operation of the system covering at least:
(a) An operational description of the ADS feature capabilities and limitations (the information should also refer to specific scenarios and/or ODD).
(b) A description of the roles and responsibility of driver/user and ADS when an ADS (feature) is on/off.
(c) A description on the permitted transitions of roles and the procedure for those transitions.
(d) A general overview of NDRA allowed when an ADS feature is active.

5.11.4.6. Recommendations on documentation for audit

5.11.4.6.1 The ADS manufacturer / vehicle manufacturer (as appropriate) shall provide documentation available for audit on:
(a) The details of their user-centred design process
(b) Its intended educational approach for theoretical and practical training

5.11.5 ADS system designs that prohibit a user to perform the DDT (e.g. shuttle, robotaxi, bus)

5.11.5.1 Scope

5.11.5.1.1 The user in the vehicle is a passenger.

5.11.5.2. General Recommendations

5.11.5.2.1 The ADS shall provide users with means to request to stop the fully automated vehicle.
5.11.5.2.2 The ADS vehicle shall provide safety-related information to the passengers.
5.11.5.2.3 The ADS will verify that it is safe for the users to start driving

5.11.6 Remote operation of ADS vehicles
To be determined.

5

Introduction

This section provides safety-related recommendations to support user interactions with automated driving systems (ADS). It is noted that the recommendations vary depending on user role, system design and tasks to be performed by the user during the use of the vehicle with ADS.

"Human-Machine Interaction and Operator Information" were identified as key areas to address within Functional Requirements for Automated Vehicles (FRAV).

The recommendations in this document focus mainly on safe interaction needs for three specific roles the human being may be required to perform when utilising an ADS: 1) passengers (in the driver seat), 2) fallback user, and 3) driver, also noting that these roles may change depending on the ADS design while using ADS

This document also provides general recommendations relevant to the safe design of controls, displays, information, and warnings for ADS activation, deactivation, and usage.

These recommendations are informed by prior UNECE regulations that support safe user interactions with advanced driver assistance systems (ADAS).

Human interaction with automation has had a troubled history so, in order not to repeat the mistakes of technology-driven automation, it is necessary to develop recommendations based on human factors, which is an established multidisciplinary science that applies knowledge of human abilities and limitations to the design and evaluation of technology for improved safety and usability.

To avoid hazardous automation mode confusion due to a lack of clarity about human and ADS responsibilities, or varying capabilities and ODD between ADS, it is essential to provide users with the appropriate information, in a suitable format, related to their current role and status of the ADS.

While these recommendations are focused on human-centred design to achieve minimum levels of safety, it is recognized that following them will also help to improve ADS usability and user experience.

Given the challenges of developing a common set of safety recommendations for diverse ADS capabilities, vehicle types, and user roles, this document endeavours to prioritise minimum safety needs for higher-risk applications (i.e., ADS vehicles that can also be driven manually).

The recommendations in this document are designed to establish a minimum that manufacturers are expected to consider in order to avoid compromising safety.

It should also be noted that it is a novel challenge for a regulatory body to develop safety recommendations for vehicle systems that perform the entire driving task rather than a more traditional focus on limited functions for specific vehicle classes where a driver is always available to intervene.

ADS present further challenges to regulators because they require new regulatory concepts, tools, and methodologies to assess and monitor the admitted vehicles in addition to those historically used for previous vehicle technologies and systems.

Accordingly, while the recommendations herein are attempting to be objectively verifiable, further work may be needed to refine the requirements into more readily verifiable specifications for ADS as understanding and experience increase.

While this document recognizes the importance of innovation to the development of ADS by providing flexible recommendations to accommodate progress, there are some limits because innovation can never be prioritised over safety.

Where manufacturers do not follow specific recommendations herein, they will be expected to provide evidence that such designs will not compromise safety.

These recommendations provide direction for potential future regulations and support the industry by explaining the expected outcome, while allowing for flexibility in design.

> **Commented [BR(16)]:** To be placed somewhere (Annex?)

A **high-level commonality in the interaction processes and interface** between the vehicle and a user for all brands and models will help drivers to develop and apply a mental model[1] of how their responsibilities relate to the level of automation and of how to interact with the systems. It will also help to reduce the risk of user confusion (e.g., mode confusion) when changing between vehicles with ADS from different manufacturers. Such commonality cannot be defined now, but it is vital to establish it as a goal of future design.

> **Commented [BR(17)]:** To be placed somewhere. Annex?

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[1] A mental model is an explanation of someone's thought process about how something works in the real world.