

**HF-working stream: Proposed detailed HF-related requirements**

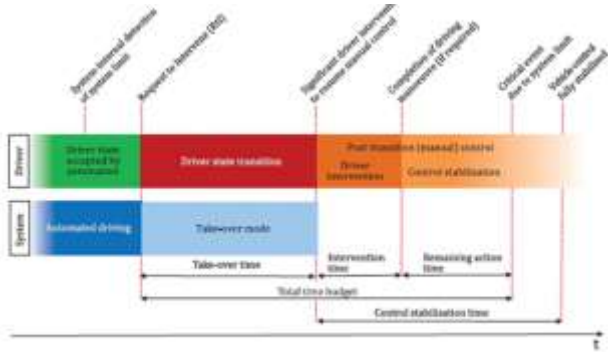
The safety requirements and provisions described below aim to ensure a safe interaction between the user and the ADS. This is achieved by increasing the usability of the technology, simplicity in the perception of the user and an appropriate mental model of the ADS. The need for an appropriate mental model has been stated by, for example, Halasz and Moran (1983): “.... the psychological function of a mental model of a system is to provide an effective problem space [...] in which the user can reason about the operations available on the system.” All the requirements below have been derived to achieve these safety-related considerations.

Halasz, F. G., & Moran, T. P. (1983). Mental models and problem solving in using a calculator. In Proceedings of CH1’83 Human Factors in Computing Systems. New York: ACM

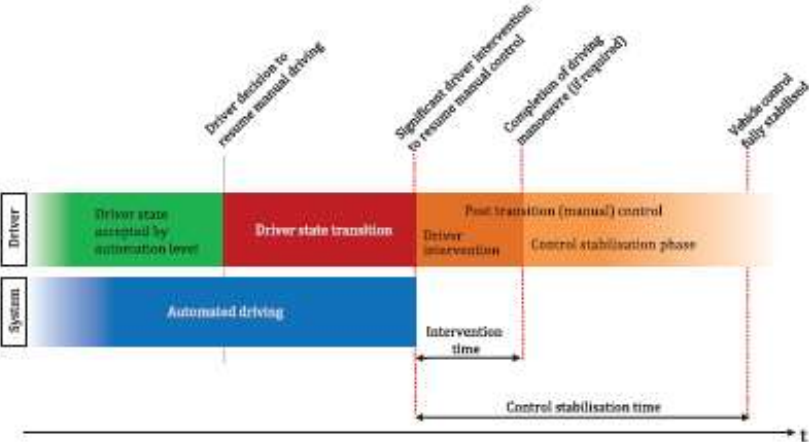
|   | Safety Requirement  | Provisions  | Comments |
|---|---|---|----------|
|   | The ADS shall interact safely with the authorized user in the vehicle                                   |   |          |
| 9 | User interaction with and the interface of ADS (features) shall have a high-level commonality of design | 1) The ADS should be designed to foster a level of trust that is aligned with its capabilities and limitations to ensure proper use of the system <sup>1</sup><br>2) The operation of the interaction shall have in common:<br>a) [use of common sequence of states in the transition/activation/overriding/...]<br>3) The interaction should be simplified:<br>a) [Limit the number of roles]<br>b) [Limit the number of potential transitions]<br>c) [Limit the number of settings]<br>d) [Limit the number of different interaction modes] |          |

<sup>1</sup> Calibrated Trust: A state where the automation user’s trust in the automation, as well as their use of the automation, is appropriately adjusted to the actual performance of the automation (McGuirl & Sarter, 2006). See P. 89 [Human Factors Design Guidance for Level 2 and Level 3 Automated Driving Concepts \(nhtsa.gov\)](https://www.nhtsa.gov/human-factors-design-guidance-for-level-2-and-level-3-automated-driving-concepts)

|    |   |  |  |
|----|---|--|--|
| 10 | The ADS HMI shall provide clear and unambiguous information to the user | <ol style="list-style-type: none"> <li>1) The vehicle shall indicate its ADS capabilities in terms of their automated [features] and their ODD.</li> <li>2) The ADS shall inform the user on the current conditions:                         <ol style="list-style-type: none"> <li>a) ADS status information</li> <li>b) The availability of automated features</li> <li>c) User Role</li> <li>d) Responsibility</li> <li>e) Permitted NDRA</li> <li>f) Potential roles to activate</li> <li>g) "Standard" information                                 <ol style="list-style-type: none"> <li>i) Vehicle speed, range and Time to Fuel</li> </ol> </li> <li>h) ADS failure information</li> </ol> </li> <li>3) The ADS shall inform the user on the upcoming conditions:                         <ol style="list-style-type: none"> <li>a) ODD boundaries</li> <li>b) Upcoming actions or change in roles</li> <li>c) Oncoming decisions/manoeuvres</li> <li>d) Estimated time until take over in normal conditions</li> <li>e) Transition related communication.</li> </ol> </li> <li>4) The ADS shall ensure that safety related information is prioritised and presented in a clear and unambiguous manner.</li> </ol> |  |
| 11 | The ADS shall be designed to prevent misuse and errors in operation     | <ol style="list-style-type: none"> <li>1) The ADS shall be designed to prevent inadvertent activation or deactivation</li> <li>2) The controls dedicated to the ADS shall be clearly distinguishable from other controls</li> <li>3) The ADS shall provide feedback when the user attempts to enable unavailable functions</li> </ol>  |  |
| 12 | The ADS shall be designed to assure a safe ADS feature activation       | <ol style="list-style-type: none"> <li>1) The ADS shall inform the user that preconditions for activation are met</li> <li>2) The activation should follow a common sequence of actions and states                         <ol style="list-style-type: none"> <li>a) Common sequence to be a pass/fail criterion</li> </ol> </li> <li>3) The ADS shall provide confirmation that the system is activated</li> </ol>  |  |

|           |   |  |  |
|-----------|---|--|--|
| <p>13</p> | <p>An ADS which permits or can request a user intervention shall be designed to assure a safe Transition of Control</p> | <ol style="list-style-type: none"> <li>1) The interaction shall follow a common sequence of actions and states in the Transition of control (change of user roles)             <ol style="list-style-type: none"> <li>a) Common sequence to be a pass/fail criterion</li> </ol> </li> </ol>  <p style="text-align: center;">Figure 2 – System-initiated transition from automated to manual driving <sup>2</sup></p> <ol style="list-style-type: none"> <li>2) Transition of control shall return to a common default user role (to prevent mode confusion and other risks)             <ol style="list-style-type: none"> <li>a) This shall normally be a fully engaged driver without any control assistance (conventional driver; safety systems such as ESC will remain activated)</li> <li>b) Common default user to be a pass/fail criterion</li> </ol> </li> <li>3) The ADS shall continuously verify whether the user is available for the Transition of Control and             <ol style="list-style-type: none"> <li>a) adapt the Transition of Control process, including the time budget where feasible, to the state of the user and/or to the ADS.</li> <li>b) warn the user if not available when required</li> <li>c) register user response indicating readiness for transfer of control</li> </ol> </li> <li>4) The ADS shall verify that the user is in stable control of the vehicle to complete the Transition of Control process</li> <li>5) During transition, the ADS shall remain active until the Transition of control has been completed or the ADS reaches a minimal risk condition</li> </ol> | <p>Transition of control = the process of handing over control from vehicle to user.<br/>Transfer of control = the moment when the control actually changes from vehicle to user</p> |
|-----------|---|--|--|

<sup>2</sup> Reference: ISO/TR 21959-1:2020(E)

|           |   |   |  |
|-----------|---|---|--|
| <p>14</p> | <p>The ADS which permits a transition of control shall be designed to assure a safe user initiated take over.</p> | <ol style="list-style-type: none"> <li>1) The user is allowed to initiate a take-over process of the ADS</li> <li>2) The deactivation shall follow a common sequence of actions and states in the transition of control (change of user roles)             <ol style="list-style-type: none"> <li>a) Common sequence to be a pass/fail criterion</li> </ol> </li> </ol>  <p>(ISO/TR 21959-1:2020(E))</p> <ol style="list-style-type: none"> <li>3) The ADS may momentarily delay deactivation of driving control when immediate human resumption of control could compromise safety.</li> <li>4) The ADS shall provide clear, specific feedback of the completion of a user initiated take over.             <ol style="list-style-type: none"> <li>a) The clear and specific feedback shall be a pass/fail criterion</li> </ol> </li> <li>5) The user initiated take over shall return to a common default user role being the driver.             <ol style="list-style-type: none"> <li>a) This shall normally be a fully engaged driver without any control assistance systems with the exception of mandated systems (conventional driver)</li> <li>b) Common default user role to be a pass/fail criterion</li> </ol> </li> </ol> |  |
| <p>15</p> | <p>The use of the ADS shall be supported by documentation and tools to facilitate the authorized user</p>         | <p><b>Documentation:</b><br/>The ADS manufacturer / vehicle manufacturer (as appropriate) should create documentation available for audit on:</p>   |  |

|               |  |   |                                |
|---------------|--|---|--------------------------------|
|               | in understanding the functionality and operation of the system   | <ol style="list-style-type: none"> <li>1. Its intended educational approach:                         <ol style="list-style-type: none"> <li>a. Theoretical and practical training</li> <li>b. How its HMI design aligns with common HMI and interaction</li> </ol> </li> <li>2. Owner's manual describing at least:                         <ol style="list-style-type: none"> <li>a. An operational description of ADS' (features) capabilities and limitations (the information should also refer to specific scenarios)</li> <li>b. A description of the roles and responsibility of driver/user and ADS when an ADS (feature) is on/off</li> <li>c. A description on the permitted transitions of roles and the procedure for those transitions</li> <li>d. A general overview of NDRA allowed when an ADS feature is active</li> </ol> </li> </ol> <p><b>Tools (in-vehicle):</b></p> <ol style="list-style-type: none"> <li>3. The ADS supports the user in correct operation (coaching)</li> <li>4. The ADS gives prompt feedback on erroneous operation</li> </ol> |                                |
| 16            | The integration of an ADS which permits a transition of control with the entire vehicle HMI shall be assured | <ol style="list-style-type: none"> <li>1) The entire HMI design should be defined and the integration with ADS HMI assured by analysis and/or test.</li> <li>2) The vehicle and ADS HMI needs to take into account potential impairments of users (such as colour blindness, impaired hearing) which do not require specific hardware adaptations of the vehicle.</li> </ol>  |                                |
| in a footnote | ADS manufacturers shall follow a human centred design process of the vehicle.                                | <ol style="list-style-type: none"> <li>1) Analyses of user needs and risk, setting safety and usability objectives, as well as specifying user requirements and ensuring user understanding and context</li> <li>2) Producing design solutions to meet these requirements</li> <li>3) Conducting evaluations, particularly real world testing on real users (i.e., not the engineers developing the products)</li> <li>4) Human factors design and testing activities should be assigned to qualified personnel, with clearly defined roles and responsibilities, including process oversight and sign-off.</li> </ol>  | Will be included in a footnote |

|         |  |   |   |
|---------|--|---|---|
|         |  | 5) Device performance should be monitored in the field and this information should be used to set future design targets and evaluate <sup>3</sup> designs against these requirements.   |   |
| new II  | Accessibility and usability  | The ADS should be able to appropriately interact with users with disabilities both on board and approaching/leaving the ADS vehicle   | Proposed by EC. Discussed 26 October. Check where and how to address.<br><br>Addressed in 16  |
| new III | Passenger-carrying ADS vehicles that may operate without a fallback user shall provide means for ensuring passenger safety. <del>information and communication with [a remote operator/user in charge/human driver/remote assistance personnel] a remote operation dispatcher/assistance personnel</del> | <ol style="list-style-type: none"> <li>1. For the safety of the occupants, the ADS vehicle should:                             <ol style="list-style-type: none"> <li>a) Stop in accordance with the designated route;</li> <li>b) Open the service doors when at a stop and close them before starting moving again;</li> <li>c) Achieve a minimum-risk condition (MRC) by demand of the vehicle occupants upon application of the designated control (button);</li> <li>d) Provide sound notification to the occupants in the case of emergency braking.</li> </ol> </li> <li>2. For the occupant information, the ADS vehicle should provide audio messages to the occupants about approaching a stop and starting the motion after a stop.</li> <li>3. The ADS vehicle should provide voice communication between the occupant compartment and a remote operation dispatcher/assistance personnel.</li> </ol> | Provisions might be overlapping with other SR. Sarunas to check which provisions may overlap. |

<sup>3</sup> Evaluation should include an analysis of the user’s correct interpretation of the actual driving mode and its affiliated responsibilities and (driving) tasks:

- In the moment of a mode transition.
- While driving with the same automation mode for a certain period of time