

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

The performance topics and detailed requirements 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.

As is now indicated in the overall safety topic with user we mean at the moment: ‘authorised user in the vehicle’. With this we hope to indicate that the PTs 9-15 relate to L3/L4 driving where a user is involved that may need to take over. This also means that L5 still needs to be addressed. As well as remote driving and L4 robo-taxis.

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

General comment: distinguish between within ADS and across ADS  
 Where do we address users with specific needs?

	Performance Topic	Detailed Requirements	Comments
	The ADS should interact safely with the authorized user in the vehicle		
9 new	User interaction with and the interface of ADS (features) should have high-level commonality of design The authorized user should be able to use all vehicles with ADS capabilities.	1) The ADS should be designed to foster a level of trust that is relevant to its capabilities and limitations to ensure proper use of the system <sup>1</sup> (Canada) 2) The ADS (features) should use interfaces with high-level of commonality 3) The operation of the interaction should have in common:	Possibilities for 1: a) [buttons] b) [signalling] c) [interior lighting]

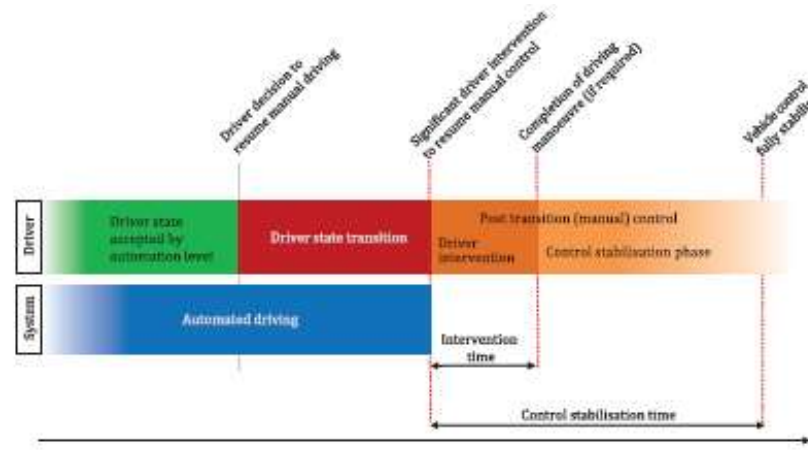
<sup>1</sup> Calibrated Trust: A state where the automation user’s trust in the automation, as well as their use of the automation, is appropriately adjusted to the actual performance of the automation (McGuirl & Sarter, 2006). See P. 89 [Human Factors Design Guidance for Level 2 and Level 3 Automated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

		<ul style="list-style-type: none"> <li>a) [use of common sequence of states in the transition/activation/overriding/...]</li> <li>4) The interaction should be simplified:                             <ul style="list-style-type: none"> <li>a) [Limit the number of roles]</li> <li>b) [Limit the number of potential transitions]</li> <li>c) [Limit the number of settings]</li> <li>d) [Limit the number of different interaction modes]</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>d) [steering wheel retraction]</li> <li>e) [...]</li> </ul> <p>Definition of commonality</p>
10	The ADS HMI <del>should</del> shall provide clear and unambiguous information on current and upcoming conditions to the user	<ul style="list-style-type: none"> <li>1) The vehicle should indicate its ADS capabilities in terms of their automated features and their ODD.</li> <li>2) The ADS should inform the user on the current conditions:                             <ul style="list-style-type: none"> <li>a) ADS status information</li> <li>b) <b>The availability of automated features</b></li> <li>c) User Role</li> <li>d) Responsibility</li> <li>e) Permitted NDRA</li> <li>f) Potential roles to activate</li> <li>g) <b>“Standard” information</b> <ul style="list-style-type: none"> <li>i) <b>Vehicle speed, range and Time to Fuel</b></li> </ul> </li> <li>h) ADS failure information</li> </ul> </li> <li>3) The ADS should inform the user on the upcoming conditions:                             <ul 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> </ul> </li> <li>4) <b>The ADS should ensure safety related information is prioritised and presented in a clear and unambiguous manner.</b></li> </ul>	<p>Open issues:</p> <p>Which information needs to be presented continuously?</p> <p>Which information needs to be presented where?</p> <p>What kind of information falls under 1a) ADS status information?</p> <p>What kind of information falls under 1h) Availability of automated features</p> <p><b>OICA/CLEPA indicated that 2g can be removed</b></p>
11	The ADS <del>should</del> shall be designed to prevent misuse and errors in operation	<ul style="list-style-type: none"> <li>1) The ADS should be designed to prevent inadvertent activation or deactivation</li> <li>2) The controls dedicated to the ADS should be clearly distinguishable from other controls</li> </ul>	

		3) The ADS should provide feedback when the user attempts to enable unavailable functions	
12	The ADS <del>should</del> <b>shall</b> be designed to assure a safe ADS feature activation	<ol style="list-style-type: none"> <li>1) The ADS should inform the user that preconditions for activation are met</li> <li>2) <b>The activation should follow a common sequence of actions and states</b> <ol style="list-style-type: none"> <li>a) Common sequence to be a pass/fail criterion</li> </ol> </li> <li>3) The ADS should provide confirmation that the system is activated</li> </ol>	
13	The ADS <del>should</del> <b>shall</b> be designed to assure a safe Transition Of Control	<ol style="list-style-type: none"> <li>1) The interaction should follow a common sequence <b>of actions and states</b> 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> <div data-bbox="667 574 1268 915" data-label="Diagram"> </div> <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 should return to a common default user role (to prevent mode confusion and other risks)             <ol style="list-style-type: none"> <li>a) This should normally be fully engaged driving (conventional driver)</li> <li>b) Common default user to be a pass/fail criterion</li> </ol> </li> <li>3) The ADS should continuously verify whether the user is available for the transition of control and warn the user if not available when required</li> <li>4) The ADS should verify that the driver is in stable control of the vehicle to complete the Transfer of Control to the user</li> <li>5) During transition, the ADS should remain active until the transfer of control has been completed or the ADS reaches a minimal risk condition</li> </ol>	Check with different ADS
14	The ADS <del>should</del> <b>shall</b> be designed to assure a safe user initiated take over	1) <b>The user is allowed to initiate a take-over process of the ADS</b>	USA: 3 should only apply in special circumstances.

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

- 2) The ADS should monitor the driver's fatigue condition and issue a takeover request early enough where a takeover is not impaired by the driver's condition. (Canada)
- 3) The deactivation should follow a common sequence of actions and states in the transition of control (change of user roles)
  - a) Common sequence to be a pass/fail criterion



(ISO/TR 21959-1:2020(E))

- 4) The ADS may delay deactivation of driving control when immediate human resumption of control could compromise safety.
- 5) The ADS should provide a clear feedback of the successful user initiated take over using acoustic and visual signals (Canada)
  - a) The clear feedback should be a pass/fail criterion
- 6) The user initiated take over should return to a common default user role being the driver
  - a) This should normally be a fully engaged driver without any control assistance (conventional driver)
  - b) Common default user role to be a pass/fail criterion

Reply: True. A strategy needs to be considered based on different cases. If a first attempt prevention is enough or the ADS has a better overview of complex traffic situations and prevents the takeover. Or other solutions.

safe and unsafe conditions  
 examples: traffic density, distance to other vehicles, clear view, not-mid-manoevres, ...

UK: About 3: concern about there ever being a case where the user cannot retake control of the vehicle.

There will be situations where the ADS fails to properly perceive the situation. If a system starts to perform a manoeuvre because it thinks that is the correct course of action, but the user can clearly see it is wrong and has the ability to intervene, then they should be able to.

Additionally it seems likely that the public would be more willing to initially take up ADS if they know they can always take back control, particularly when many of the technologies are new.

			<p>Situations where it would actually be unsafe for the human to take control would be very rare.                  Would a warning indicating the danger to the user be sufficient?</p> <p>3 is taken from ISO                  4 is based on ECE/TRANS/WP.29/1140                  6a is based on results on EU co-funded project Have-It</p>
15	<p>The ADS manufacturer OEM should shall provide tools for the authorized user to learn about system functionality and operation.</p>	<p>Process requirements:</p> <ol style="list-style-type: none"> <li>1) ADS manufacturer OEM should describe the possible educational approach:                         <ol style="list-style-type: none"> <li>a) Theoretical and practical training</li> <li>b) How it aligns with common HMI and interaction</li> </ol> </li> <li>2) ADS manufacturer OEM should provide documented information on ADS (features) capabilities and limitations (the information should also refer to specific scenarios)</li> </ol> <p>ADS type requirements:</p> <ol style="list-style-type: none"> <li>3) ADS manufacturer OEM should provide documented information on roles and responsibility of driver/user and ADS when ADS (feature) is on/off</li> <li>4) ADS manufacturer OEM should provide documented information on allowed transition of roles and procedure for the transition (activation/deactivation, ToC, Override)</li> <li>5) ADS manufacturer OEM should provide a general overview list of NDRA allowed when an ADS feature is active</li> <li>6) The ADS supports the user in correct operation (coaching)</li> <li>7) The ADS gives prompt feedback on erroneous operation</li> </ol>	<p>USA: Only apply to an authorized user (not e.g. a child).                  Reply: Done</p> <p>Question: How should allowed NDRA be indicated.                  Reply: No idea yet but will be relevant at a more detailed level</p> <p>OICA/CLEPA: This PT should be addressed somewhere else</p> <p>1 – 5: Support the general mental model (common understanding)</p>

			6 – 7: <i>Support the applied mental model (understanding the ADS-specifics)</i>
new	Human Factors process requirements for safe and usable ADS HMI/ safety management systems (SMS) approach	<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> <li>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.</li> </ol>	<p>Proposed by Canada. Discussed 26 October. Check with SG3 VMAD</p> <p>Updated by Canada (purple text)</p>
new	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.
16 next time	ADS vehicles that may operate without a <b>[user-in-charge/in-vehicle driver]</b> <del>should</del> shall provide means for ensuring occupant safety, occupant information and occupant communication with <del>{a remote operator/user-in-charge/human driver/remote assistance personnel}</del> a	<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) Provide stops in the places according to the designated route;</li> <li>b) Provide opening the service doors at the vehicle stop and closing them before starting the motion after the stop;</li> <li>c) Provide means for the emergency stop of a vehicle by the occupants («emergency brake»);</li> <li>d) Provide sound notification of the occupants in the case of emergency braking.</li> </ol> </li> </ol>	Proposed by Russia. To be discussed 30 November 2021

<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

	remote operation dispatcher/assistance personnel	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.  3) The ADS vehicle should provide voice communication between the occupant compartment and a remote operation dispatcher/assistance personnel.	
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	Old Performance Topic	Included in new Performance Topic	New Performance Topic
The ADS should interact safely with the user			
9	Activation of an ADS feature should only be possible when the conditions of its ODD have been met	12	12: The ADS should assure a safe ADS feature activation
10	The user should be informed about the ADS status (when the ADS is activated) with regards to ODD	10	10: The ADS should provide clear and unambiguous information to the user
11	The user should be permitted to take over control from the ADS, if the ADS is designed to request and enable intervention by a human driver	14	14: The ADS should assure a safe user initiated take over
12	The ADS should safely manage transitions of control to the user	13, 14	13: The ADS should assure a safe Transition Of Control 14: The ADS should assure a safe user initiated take over
13	The ADS should safely respond to user input errors	11	11: The ADS should prevent misuse and errors in operation
14	The ADS should provide feedback to the user on its operational status	10	10: The ADS should provide clear and unambiguous information to the user
15	The ADS should warn the user of failures to fulfill user roles and responsibilities	10	10: The ADS should provide clear and unambiguous information to the user
16 (Not covered here)	ADS vehicles that may operate without a <b>[user-in-charge/in-vehicle driver]</b> should provide means for occupant communication with <b>[a remote operator/user-in-charge/human driver/remote assistance personnel]</b>		