

<b><u>Report of the fourth meeting of the Informal Working Group on Functional Requirements for Automated and Autonomous Vehicles (IWG FRAV)</u></b>	
Venue	Web conference
Date	8 September 2020
Documents	Submissions for the session can be found on the <a href="#">FRAV-04 UNECE wiki page</a> .
Status: <u>Adopted</u>	

<i>Agenda and previous session report adopted.</i>	FRAV adopted the draft agenda (FRAV-04-01-Rev.2) with minor revision to reallocate the documents to be considered under each agenda item. FRAV also adopted the draft report of the previous session (FRAV-03-02) without revision.
<i>The FRAV leadership reviewed the status of work and desired outcomes for the 4<sup>th</sup> session.</i>	<p>The FRAV co-chairs and secretary provided a slide deck to review open issues from the 3<sup>rd</sup> session and orient the discussions for the 4<sup>th</sup> session.</p> <p>The 3<sup>rd</sup> session raised three principal issues:</p> <ul style="list-style-type: none"> <li>• Nature and content of the ODD chapter of Document 5</li> <li>• Nature and content of the System Safety chapter of Document 5</li> <li>• FRAV response to VMAD's request for input after the September GRVA</li> </ul> <p>Regarding the ODD chapter, the co-chairs wished FRAV to reach a working consensus on the chapter contents. FRAV has discussed whether the chapter could contain information regarding an ADS that might fall outside the definition of Operational Design Domain. In particular, FRAV discussed the SAE and BSI taxonomies that imply an ODD definition limited to external or environmental operating conditions. China, supported by other stakeholder comments, proposed that other conditions may be significant in understanding and assessing an ADS such as the driver state, activities other than driving, or design prerequisite to wear the safety belt.</p> <p>Regarding the System Safety chapter, the co-chairs wished to reach a working consensus on the chapter contents. FRAV agreed during its 2<sup>nd</sup> session that System Safety included ADS design and general operational safety. During the 3<sup>rd</sup> session, FRAV noted that terms such as functional safety and operational safety refer to methods for validating an ADS design and therefore would involve VMAD. FRAV discussed the concept that system safety, under FRAV, could focus on functions required to continuously perform the Dynamic Driving Task (DDT) as defined by SAE.</p> <p>Regarding the VMAD request, the co-chairs wished to reach a working consensus on a plan to address the 142 proposals for possible ADS requirements gathered during the 2<sup>nd</sup> FRAV session and any other proposals for requirements. Depending upon the outcomes of the 4<sup>th</sup> session, the proposals might be considered in terms of their impact on the ODD and System Safety chapters and on the remaining Document 5 chapters focused on aspects of ADS operational performance.</p>

<p><i>FRAV agreed to conserve the current ODD definition while allowing for additional items under the chapter as warranted.</i></p> <p><i>The “ODD chapter” will serve to record consensus on requirements for manufacturer descriptions of an ADS and its features.</i></p>	<p>The co-chair from the United States of America opened the discussion on the ODD chapter. The co-chair asked FRAV to consider two main points:</p> <ul style="list-style-type: none"><li>• Whether FRAV agreed that the “ODD chapter” could include additional items that may be required in a manufacturer description of an ADS and its feature(s), and</li><li>• Whether FRAV wished to change the chapter and/or the definition of ODD during the session.</li></ul> <p>OICA stressed the importance of providing clear and harmonized guidelines for the description of an ODD based upon existing standards and other literature.</p> <p>SAFE noted the importance of the word “design” in ODD and the intent of an ODD description to enable a manufacturer to articulate the specifications to which the ADS was designed. In this regard, Document 5 could use a different term if needed to ensure that the descriptions provide the information required by safety authorities.</p> <p>The US co-chair stated that the descriptions should cover information that governments may require manufacturers to provide which could include requirements related to the ADS design.</p> <p>SAE submitted that FRAV seems to agree that Document 5 should use the generally accepted definition of ODD under established standards while allowing for the possibility of other constraints or elements that governments may wish to establish under regulatory requirements.</p> <p>The Netherlands suggested that the diagram prepared by Germany during the earlier exchange of information regarding whether an ADS may have more than one ODD may be useful in illustrating that ADS features have different ODD and other design constraints (reproduced for convenience as document FRAV-04-16).</p> <p>FRAV agreed to conserve the definition of ODD used in Document 5 (FRAV-03-05-Rev.1) while accepting that additional elements for manufacturer descriptions of an ADS may be added under this ODD chapter. FRAV understands ODD as capturing external vehicle conditions. As FRAV considers ADS requirements, the group can reach decisions on elements for inclusion in the ODD chapter and the appropriate placement of minimum requirements related to ADS performance under ODD or other conditions in Document 5.</p> <p>As a result, FRAV confirmed that manufacturers will be required to provide descriptions of an ADS and its features. The current ODD chapter will be used to record FRAV consensus on any requirements related to manufacturer descriptions of the ADS and its features, including items that FRAV may determine are outside the scope of the ODD definition. FRAV will reconsider the chapter title and structure before finalizing Document 5.</p>
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<p><i>FRAV received views on terms related to “system safety”.</i></p> <p><i>FRAV agreed on the need to differentiate between “functional requirements” and “functional safety”.</i></p>	<p>The US co-chair introduced the issues raised concerning the term “system safety” and its significance to the FRAV mandate.</p> <p>OICA-CLEPA presented a paper including definitions and views on the various terms associated with this concept (FRAV-04-04). OICA-CLEPA noted current definitions for ADS (hardware and software capable of performing the entire DDT) and ADS feature (an application of ADS capabilities specific to an ODD), explaining that the feature definition helps to derive the applicable requirements and traffic scenarios. The paper defined ADS functions as referring to requisite ADS capabilities necessary to perform the DDT within an ODD from which requirements may also be derived.</p> <p>The paper proposed four categories of requirements: functional requirements, functional safety requirements, operational requirements, and operational safety requirements. OICA-CLEPA noted that functional and operational safety have specific connotations related design considerations that should be taken into account in the development of a system with regard to failures (such as under ISO 26262) and performance under normal operation (such as ISO 21448). Because these aspects relate to the design phase of ADS, they would not be applicable to the work under FRAV. OICA-CLEPA’s position was that functional and operational safety should be considered by VMAD such as done under UN Regulation No. 79.</p> <p>The remaining two areas (functional requirements and operational requirements) would be addressed by FRAV. Functional requirements refer to requisite system capabilities such as a requirement for driver monitoring or a sensor perception range commensurate with the speed boundaries and stopping distances of the ADS vehicle. Operational requirements refer to ADS feature behaviors such as driving performance, interaction with other road users, HMI, transfer of control to the user, or Minimal Risk Maneuver performance.</p> <p>Therefore, system safety would provide the broadest description of the safety requirements where functional and operational requirements would provide the level of detail necessary to enable derivation of requirements specific to an ADS and its features within an ODD. The functional and operational levels would be broad enough to enable FRAV to define requirements under the different Document 5 chapters.</p> <p>SAE interpreted the use of “system safety” under the AV Framework Document as referring the accepted engineering term for optimizing safety by identifying and eliminating risks. SAE argued against the use of “functional requirements” given the confusion with the “functional safety” engineering method. SAE sees meaningful distinctions between basic process requirements and ADS performance requirements. SAE proposed a breakdown between process requirements (system safety processes manufacturers use to ensure proper design and development) and performance requirements that particular ADS and/or feature operating within its ODD must satisfy. SAE interprets para. 9(f) of the AV Framework Document as breaking down system safety into expected behavioral competencies.</p>
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<p><i>FRAV discussed the use of terms such as “functional requirement”, “operational requirement”, and “performance requirement”.</i></p> <p><i>FRAV agreed that “performance requirement” more accurately captured its mandate.</i></p> <p><i>Performance requirements may address ADS functions and features.</i></p> <p><i>The JRC urged FRAV to differentiate between nominal driving and emergency/failure situations in the requirements.</i></p>	<p>The OICA-CLEPA and SAE input presented FRAV with two options for developing Document 5 and individual requirements. OICA-CLEPA supported the differentiation between functional requirements and functional safety because the latter should be considered by VMAD and is already well understood under the ISO standards. OICA-CLEPA stressed a need to have the levels of abstraction regarding ADS, ADS features, and ADS functions and to differentiate functional requirements from functional safety, suggesting that functional requirements and operational requirements could be useful as headers when considering the remaining chapters of Document 5. The European Commission supported the OICA-CLEPA paper in terms of providing useful definitions for discussing aspects. Responding to an EC request for clarification, SAE stated that a distinction between functional requirements and operational requirements did not seem useful or to be the intention of the AV Framework Document. SAE reiterated that para. 9(f) provides the basis for functional requirements. SAE saw a more useful structure in considering requirements for nominal behavior and behavior in critical or crash situations (to address unexpected behavior of other road users).</p> <p>Based on the discussion, the US co-chair observed that the term “functional requirements” as chosen for the group by WP.29 was perhaps not selected with a specific technical engineering definition in mind. FRAV could as easily have been called the “Performance Requirements for Automated Vehicles” group. FRAV, in the co-chair’s view, is mandated to develop performance requirements which may in some cases address ADS functions.</p> <p>In response, OICA-CLEPA agreed that “performance requirements” highlights the purpose of the group. SAE agreed that this different terminology might have been more suitable. The SAE expert, drawing on his previous experience as a NHTSA official, viewed performance requirements as measurable specifications as opposed to process-related requirements. SAE noted that the VMAD Audit Pillar goes heavily into assessing whether the processes used by the manufacturer in the ADS development were appropriate. Performance requirements imply third-party testing to determine compliance with measurable specifications.</p> <p>The EC Joint Research Centre noted that VMAD is looking at direct test methods as well as assessment of manufacturer documentation under the Audit Pillar. The VMAD discussions have raised questions regarding the distinction between normal ADS operations and performance in emergency or failure situations. It would be useful for FRAV to consider how to make this distinction under the ADS requirements. JRC has been discussing the use of on-road tests for normal performance with emergency/failure situations addressed in track tests.</p>
<p><i>FRAV agreed to remove the chapter on “system safety” from Document 5.</i></p> <p><i>FRAV agreed to describe system safety in terms of the overall objectives of Document 5.</i></p>	<p>In response to the US co-chair’s query regarding reporting on the discussion conclusions, the FRAV secretary asked for confirmation that performance requirements would cover all aspects, including ADS features and functions. If so, the secretary asked whether this consensus should result in the deletion of a chapter dedicated to “system safety”.</p> <p>FRAV agreed that the chapter should be removed. However, FRAV agreed that Document 5 should explain the decision given its prominence in the WP.29 AV Framework Document, especially its use in the Annex in conjunction with the term “Functional Safety”. Document 5 should explain how “system safety” is generally understood within the community of ADS developers. In addition, Document 5 should explain the overall goals of ADS system safety.</p>

<p><i>FRAV agreed to discuss needs for requirements to support system safety assessment with VMAD.</i></p>	<p>The EC requested clarification regarding the allocation of responsibilities between FRAV and VMAD given the OICA-CLEPA input. OICA-CLEPA affirmed the understanding the FRAV would establish requirements and VMAD would establish methods to determine compliance with the requirements. However, OICA-CLEPA noted that the VMAD assessment of functional and operational safety would involve requirements related to the design phase such as whether the manufacturer has performed hazard and risk analysis and/or implemented sufficient redundancies to mitigate such risks during fault and normal operation. OICA-CLEPA believes that VMAD should address this aspect.</p> <p>The VMAD co-chair from Japan noted that the evaluation of system safety is an objective of the group. In this regard, the co-chair stressed a need for requirements to underpin such an evaluation. The co-chair stated that VMAD had not discussed the issue (as described by OICA-CLEPA) internally. The co-chair proposed that even for an aspect such as functional safety, there should be some underlying requirements to support the assessment. The co-chair urged that the FRAV and VMAD leaderships discuss the allocation of responsibilities for providing requirements that would serve as a basis for the assessment of functional and operational safety under the VMAD methods.</p> <p>The EC supported the VMAD co-chair comment and stressed the importance of defining the acceptable levels of residual risk. The EC suggested that such a definition of acceptable risk was inherent in the mandate of FRAV. The EC anticipated that this concept of acceptable residual risk would be addressed by FRAV under the rubric of system safety.</p>
<p><i>Japan proposed that FRAV select a method for translating the high-level safety concepts of the AV Framework Document into measurable performance criteria.</i></p>	<p>Japan presented document FRAV-04-13 discussing an overall requirement for system safety representing the principal level for ADS safety. Japan proposed that FRAV should translate the Safety Vision of the AV Framework Document<sup>1</sup> into measurable performance criteria. Japan submitted that FRAV already has four candidate methods for such criteria:</p> <ul style="list-style-type: none"> <li>• Competent and careful human-driver model</li> <li>• State-of-the-art and technological feasibility</li> <li>• Safety envelope</li> <li>• Positive risk balance compared with human driver</li> </ul> <p>Japan proposed that FRAV consider the strengths and weaknesses of these and possibly other methods to reach agreement on the optimal approach (whether one method or a combination of the methods).</p> <p>Japan provided a table that could be used to evaluate the methods based on the following aims for requirements:</p> <ul style="list-style-type: none"> <li>• Improvement of road transport (individual and fleet)</li> <li>• Performance-based</li> <li>• Technology-neutral</li> <li>• Measurable criteria</li> <li>• Social acceptance</li> <li>• Feasibility</li> </ul> <p>Japan requested FRAV to consider filling in the table towards assessing the methods for their strengths and weaknesses in meeting the safety goals.</p>

<sup>1</sup> “The level of safety to be ensured by automated/autonomous vehicles implies that “an automated/autonomous vehicle shall not cause any non-tolerable risk”, meaning that automated/autonomous vehicle systems, under their automated mode ([ODD/OD]), shall not cause any traffic accidents resulting in injury or death that are reasonably foreseeable and preventable.”

<p><i>Germany proposed that FRAV should translate the high-level concepts of the AV Framework Document into measurable specifications through a step-by-step process of derivation.</i></p>	<p>Germany presented document FRAV-04-15 explaining views on a top-down approach to establishing individual requirements (ref. document FRAV-03-03). Germany highlighted the Safety Vision and “system safety” paragraphs of the AV Framework Document.<sup>2</sup> Germany noted that “free of unreasonable risk” implies the existence of “reasonable risk” (i.e., acceptable residual risk). The Safety Vision speaks to crashes caused by an ADS but not to ADS avoidance of crashes due to the behavior of other road users. In both cases, there exists an element of human judgment in defining “acceptable risk” and responding to other road user actions.</p> <p>Germany presented a “V” model to describe a process moving from high-level concepts under FRAV (upper left of the “V”) towards more specific requirements that would be used by VMAD test methods and eventually to address operation and maintenance issues at the upper right side of the “V”.</p> <p>Germany suggested that it may be premature to discuss the methods for defining performance criteria. Germany proposed to move through the “V” from concepts to verifiable specifications that can be tested under the VMAD methods. The high concept “does not cause unreasonable safety risks” would be refined to produce specifications such as “avoid Scenario X or mitigate accident in Scenario Y” that can be verified under testing. The verifiable specifications would be derived by moving in steps to arrive at the optimal level of detail. Germany suggested that FRAV begin with the high-level concepts and consider the methods highlighted by Japan after the concepts had reached a specification level where performance criteria would be needed. Germany believes that this iterative process would support transparency in the derivation of specifications.</p> <p>Germany highlighted that defining “reasonably foreseeable and preventable” (RFaP) depends upon the baseline perspective (foreseeable by whom or what and preventable based on what criteria or technology). In this regard, RFaP needs to be defined through specifications. Therefore, FRAV needs a developmental process through which to derive technical specification from the high-level RFaP concepts. Germany prefers to base specifications on physical limitations but acknowledges the availability of other approaches such as the safety envelope or driver model.</p>
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<sup>2</sup> Supra footnote 1. Para. 9(a): “When in the automated mode, the automated/autonomous vehicle should be free of unreasonable safety risks to the driver and other road users and ensure compliance with road traffic regulations.”

<p><i>FRAV discussed the possible methods for defining performance specifications.</i></p>	<p>The Netherlands asked whether “technical specification” is the right term for describing the RFaP given overall safety goals that could involve more than technical specifications for an ADS. The US co-chair suggested that the specifications might be described as being “objective” or “measurable”. Germany supported the use of “measurable” but stressed the need for an agreed methodology to derive the specifications.</p> <p>The Netherlands proposed that avoidance of situations with a probability to lead to a collision (as noted in Germany’s presentation) should receive particular attention.</p> <p>The US co-chair observed that criteria based on the concept of a “good driver” may be difficult given differences in views on driving behavior across different countries and cultures. Specifications based upon human driving performance measures could be difficult to define and implement under a global approach.</p> <p>Japan stressed the importance of reaching practical conclusions on defining the meaning of “safe enough”. As a first step, Japan believes that minimum ADS performance should be equal to that of a careful and competent human driver. Japan anticipates that social acceptance of ADS may eventually result in demands for higher levels of performance than a diligent human driver based on ADS technical capabilities.</p> <p>Germany supported the US co-chair perspective, preferring to focus on physical performance limits. The specifications might be informed by levels achieved by human drivers, but global specifications would be better defined based upon measurable performance described in technical terms.</p> <p>The VMAD co-chair from the Netherlands cited a model developed by the International Commission for Driver Testing (CIECA) that specifies the capabilities required to operate a vehicle. Driving behaviors may differ across markets but the requirements for basic capabilities appear to be similar across countries.</p> <p>OICA-CLEPA supported the top-down approach to defining requirements and the aim to translate “reasonable and preventable” into measurable performance specifications. However, OICA-CLEPA noted that the “V” model developed at the first FRAV session in Berlin supported the development of broad, high-level requirements applicable across most, if not all, ADS configurations. FRAV would develop more detailed specifications in cases where they are needed under the VMAD assessment methods. OICA-CLEPA expressed concern that the method proposed by Germany would imply a cascading effort to derive technical specifications for configurations of ADS and their performance. OICA-CLEPA recalled that FRAV aimed to avoid this method because previous WP.29 efforts (e.g., UN R79, UN R157) have shown it to be impractical and unsustainable in the long term and likely to result in conflicting requirements.</p> <p>OICA-CLEPA also expressed concern that the examples of “avoiding Scenario X or mitigating Scenario Y” would interfere with the VMAD work. OICA-CLEPA supported an FRAV focus on performance requirements for use under the VMAD methods which involve scenario-based assessments. OICA-CLEPA cautioned against confusing the FRAV focus with consideration of scenarios and scenario-based assessments.</p> <p>SAE noted that the measurement of human-relative safety is not a simple matter but supported the presentations from Japan and Germany for orienting discussions. SAE supported the step-by-step approach towards defining the appropriate level of specifications for performance.</p>
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<p><i>VMAD plans to use on-highway ADS to prove its NATM concept.</i></p> <p><i>VMAD wants to be sure the FRAV and VMAD “generic” plans are compatible.</i></p>	<p>FRAV requested the VMAD co-chairs to clarify their anticipated short-term needs to support FRAV planning. The VMAD co-chairs noted their scheduled sessions directly following the current FRAV session. The near-term goal is to describe the integration of the NATM elements and then use highway ADS as the example for the NATM. VMAD would like FRAV support to define performance requirements for such highway-use ADS.</p> <p>VMAD is presently at a generic level and would like to confirm that the FRAV aims are compatible with the VMAD intentions. Both groups would follow the “V” model so a near-term interest is to ensure compatibility of the parallel efforts at the current high levels.</p>
<p><i>FRAV and VMAD will hold a joint leadership session on 17 September.</i></p>	<p>FRAV and VMAD will hold a joint leadership session to discuss their activities and their alignment on 17 September. Per the session discussion, the agenda will include:</p> <ul style="list-style-type: none"> <li>• Handling requirements for validation of functional and operational safety</li> <li>• Status reporting to the September GRVA session</li> </ul> <p>The FRAV co-chair from China stressed the need for FRAV to define its next steps and plans to move forward efficiently.</p>