This is a revision of Document 5 building from FRAV-03-05-Rev.1. Previously considered text is shaded in green, meaning that FRAV has reviewed and accepted the text under its working consensus. This status does not mean the text has been formally approved by FRAV for submission to GRVA and/or WP.29. Document 5 only reflects FRAV discussions to date pending further work.

New paragraphs and changes to the previous version of Document 5 are shaded in blue. In the case of changes to pre-existing text (whether considered by FRAV or not), the proposal for revised text is in the second column for comparison against the earlier text in the first column.

Unshaded text is carried over from FRAV-03-05-Rev.1 and has not yet been discussed/accepted as working text by FRAV.

Current Text and Proposals (green = accepted, blue = new text for consideration, unshaded = not yet discussed)	Alternative text to previously considered text	*Explanatory remarks*
1. Background		
1.1. Under its Terms of Reference (WP.29/1147/Annex V), the Informal Working Group on Functional Requirements for Automated/Autonomous Vehicles (FRAV) has been established by WP.29 under the Working Party on Automated/Autonomous and Connected Vehicles (GRVA) to develop functional (performance) requirements for automated[/autonomous] vehicles, in particular, the combination of the different functions for driving: • longitudinal control (acceleration, braking and road speed) • lateral control (lane discipline) • environment monitoring (headway, side, rear) • minimal risk maneuver • transition demand • HMI (internal and external) • driver monitoring.		

1.2.	This work should also cover the requirements for Functional Safety. FRAV has been further mandated to pursue this work in line with the following principles/elements described in the WP.29 Framework Document on Automated/Autonomous Vehicles (WP.29/2019/34/Rev.2, hereafter, the Framework Document): • System safety • Failsafe Response • HMI/Operator information • OEDR (Functional Requirements).		
1.3.	The Framework Document established one deliverable specific to functional performance requirements for automated vehicles. GRVA was requested to submit a document on "common functional requirements [based] on existing national/regional guidelines and other relevant reference documents (1958 and 1998 Agreements)" for consideration during the 180th (March 2020) session of WP.29.		

1.4.	Although not specified in the FRAV Terms of Reference, the Framework Document implies and GRVA has requested that FRAV provide the basis for this submission to WP.29. Therefore, FRAV considered a "Comparison table of ADS Guidelines in USA, Canada, Japan, EU, Australia and China" (VMAD-01-04) prepared by OICA. At its first session (FRAV-01, 9-10 October 2019, Berlin), FRAV further considered a table of "common AV safety elements" (FRAV-01-13) whereby OICA distilled its comparison table into a single set of elements. Pursuant to an FRAV request, OICA aligned its table with the Framework Document in a revised document (FRAV-01-13/Rev.1).		
1.5.	The basis for this present document was an effort to transpose the FRAV-01-13/Rev.1 table into a format suitable for long-term development of more detailed provisions as well as for use in FRAV meeting sessions (e.g., projection on a screen). Originally presented as FRAV-02-05, FRAV has decided to reserve the number "05" for future versions. For example, FRAV will use FRAV-03-05 for this document as considered during its 3rd session (FRAV-03, 14-15 April 2020, Paris), FRAV-04-05 during its 4th session (FRAV-04, 8-9 September 2020, Santa Clara), and so on.		
1.6.	Due to travel and other restrictions imposed by health authorities in response to the COVID-19 pandemic, FRAV indefinitely postponed its scheduled 3rd session (April 2020) and began soliciting stakeholder input via a series of questions and emails.		*Added via FRAV-03-05.*

1.7.	On 30 March, the Secretary, pursuant to a work plan agreed by the FRAV co-chairs, requested stakeholder input on the preamble to the ODD chapter of Document 5. The request also asked for input regarding the relationship between an ODD and a vehicle to clarify whether a vehicle can be considered to have more than one ODD (FRAV-03-05-Add.1).		*Added via FRAV-03-05.*
1.8.	After two iterations, the Secretary distributed a third draft preamble including draft definitions for the terms "ADS", "ADS feature", and "ODD" (FRAV-03-05-Add.2). These terms were used in the draft to stipulate that a manufacturer should describe the ODD of each feature enabled by an ADS. Two stakeholders raised technical reservations; however, no stakeholders opposed continuing to elaborate Document 5 based upon the interim text. Therefore, the Secretary distributed an updated version of Document 5 containing the revised text (FRAV-03-05) on 8 May 2020.		*Added via FRAV-03-05.*
1.9.	FRAV accepted a simplified definition of "ADS" because SAE J3016 presents several concepts requiring further consideration: • Value of the DDT in drafting requirements, • Whether an ADS may not have an ODD (i.e., at Level 5), • Use of the levels of automation as a short-hand way to categorize an ADS. Without prejudice, FRAV set aside these open issues until such time as they may be pertinent to drafting specific text in Document 5.		

1.10. On 8 May 2020, the Secretary circulated a request for input on elements to include in the ODD description (FRAV-03-05-Add.3). Stakeholder comments focused on the purpose of the ODD description and criteria for determining elements to include in the description. The comments suggested a close association between ODD elements and the high-level functional performance requirements. FRAV agreed that ODD elements enable the application of high-level requirements to specific ADS configurations. Therefore, FRAV agreed to address ODD elements in the course of defining functional performance requirements (FRAV-03-05-Add.4).		
1.11. On 8 June, the Secretary circulated a request for comments regarding the "System Safety" chapter of Document 5. The document proposed a scope and purpose for the chapter based on the text of the AV Framework Document. The comments showed diverse interpretations of "system safety" across FRAV stakeholders. The comments also underscored that FRAV and VMAD had mandates to address "system safety". The diversity of views did not provide a basis for reaching consensus.		
1.12. The Secretary provided a revised version of the request for comments (FRAV-03-05-Add.5) explaining the outcomes of the comments and consultations with stakeholders on 16 July. This document proposed an alternative approach to addressing "system safety" under FRAV. The approach noted stakeholder input regarding ADS functions and their relation to performance of the		

DDT. Per J3016, the document noted that the DDT referred to continuous functions a driver must perform such as controlling the vehicle motion and monitoring the vehicle environment. The document proposed a "triangular approach" where the System Safety chapter would address ADS functions required to operate the vehicle in traffic (functional requirements), the ODD chapter would cover ODD elements plus other operational design constraints as may be identified, and the remainder of Document 5 would cover operational performance requirements.		
1.13. FRAV held its 3rd session via web conference on 28 July.		
1.13.1. FRAV confirmed its high-level understanding of ODD descriptions and their use to define an ADS feature. Subject to further discussions, FRAV agreed that ODD refers to operating conditions external to the vehicle and that an ADS may have other (e.g., internal) operational conditions to be determined.		
1.13.2. FRAV confirmed its view from the 2nd session that "system safety" covered broad safety aspects, including functional and operational safety. ADS integrate functions that enable the features to operate the vehicle within the ODD. The feature may share ADS functions and/or rely on functions unique to the feature.		

1.13.3. FRAV considered the "triangular approach" but could not reach consensus on the precise meanings and relevance to FRAV of terms such as "functional safety", "operational safety", "functional requirement", "operational requirement", and "system safety".		
1.14. FRAV held its 4th session via web conference on 8 September to resolve open issues regarding the ODD and System Safety chapters of Document 5.		
1.14.1. FRAV confirmed its interpretation of the definition of ODD as referring to external conditions of the vehicle. Nonetheless, FRAV confirmed that additional constraints important in the description of an ADS may be warranted. FRAV agreed to proceed with work on enumerating conditions and constraints that may be important in assessing a specific ADS configuration under the ODD chapter. Once these elements have been enumerated, FRAV will consider structural changes to the ODD chapter as may be warranted.		
1.14.2. FRAV discussed the issues surrounding the term "system safety". FRAV discussed the difference between requirements and methods such as in "functional requirements" and the methods described under "functional safety" standards. FRAV concluded that use of the term "functional" results in ambiguity and risks confusion between requirements and methods. As a result, FRAV preferred the term "performance requirements" to		

address functional and operational safety requirements.		
1.14.3. FRAV concluded that system safety is a broad field of activity. The overall objective of FRAV safety requirements and the assessment methods being developed under VMAD is to ensure "system safety". Therefore, FRAV agreed to remove "system safety" as a chapter of Document 5. Nonetheless, FRAV agreed that "system safety" required explanation as an overarching concept and starting point for requirements in Document 5.		
1.14.4. FRAV discussed methodologies for defining the ADS performance limits. FRAV considered four general approaches: • A "careful and competent driver model" • A "state-of-the-art" method based on technological feasibility • A "safety envelope" method, and • A "positive risk balance" compared with human driver. FRAV concluded that the group should begin with conceptual starting points to guide an iterative process towards defining high-level performance requirements applicable across ADS configurations. FRAV agreed to continue consideration of possible methods for defining performance thresholds. Japan proposed six criteria for assessing the approaches to setting performance limits (FRAV-04-13):		

• Limits conducive to road transport improvement • Limits would be performance based • Limits would be technology neutral • Limits would be measurable • Limits conducive to social acceptance • Feasibility of the limits		
1.15. FRAV held its 5th session via web conference on 15 October 2020 to discuss the description of "system safety" and starting points for the elaboration of performance requirements.		
1.15.1. FRAV agreed upon five starting points that each capture a key aspect of ADS safety: • ADS should drive safely. • ADS should interact safely with the user. • ADS should manage safety-critical situations. • ADS should safely manage failure modes. • ADS should maintain a safe operational state.		
1.15.2. FRAV agreed to develop ±10 sub-elements under each starting point as a step towards defining ADS performance requirements. FRAV agreed to work from an initial review of national and regional guidelines (FRAV-05-06) prepared by OICA/CLEPA.		
1.15.3. Japan suggested that stakeholders rate the proposed methodologies for setting performance limits using its table of proposed criteria (FRAV-05-04).		

2. Purpose of this document		
2.1. FRAV has prepared this document to provide a structure for fulfillment of the objectives defined in its Terms of Reference. This structure aims to promote coordination between the work of FRAV and that of other WP.29 informal working groups addressing areas related to automated driving. In particular, the document aims to facilitate alignment between FRAV and the work of the GRVA Informal Working Group on Validation Methods for Automated Driving (VMAD). VMAD has been tasked to develop a New Assessment/Test Method to include assessment of compliance with the common functional performance requirements to be developed by FRAV. 2.2. FRAV proposes to progressively refine this document as an instrument towards the delivery of proposals for functional performance requirements. Final decisions on the proposals rest with WP.29 and the Contracting Parties. As such, this document does not propose a legal text. The document aims to inform WP.29 and the Contracting Parties and support such decisions as WP.29 and the Contracting Parties may wish to take.	2.1. FRAV has established this document to facilitate and document its work. Known as "Document 5", this text is updated periodically to reflect the current working consensus of the group. 2.2. This document provides a basis for periodically reporting FRAV progress to GRVA and WP.29. The document also aims to inform other WP.29 informal working groups, and especially the GRVA Informal Working Group on Validation Methods for Automated Driving (VMAD), on FRAV activities and progress. 2.3. This document does not constitute a formal or informal text for submission to GRVA or WP.29. FRAV will issue such proposals in separate documents as determined and approved by the group.	*This proposal for revised text aims to reflect the current FRAV understanding and usage of this document. In particular, the text emphasizes that Document 5 is an internal tool of FRAV. Given the complexity of the discussions, it is important to ensure that eventual FRAV proposals to GRVA and WP.29 have been fully considered by the FRAV stakeholders, including within their organizations. Therefore, this proposal seeks to establish a clear line between text accepted for Document 5 to facilitate FRAV discussions and eventual text that FRAV may agree to submit as proposals to GRVA and/or WP.29.*

3. Abbreviations, Acronyms, and Definitions 3.1. The introduction of automated driving systems and related technologies has resulted in a proliferation of new terms and concepts. This chapter defines abbreviations, acronyms, and terms as used in this document. 3.2. Acronyms and Abbreviations 3.2.1. ADS: Automated Driving System		*Introduced in FRAV-03-05-Rev.1*
3.2.2. DDT: Dynamic Driving Task		*Proposal to add DDT per the proposal to define "function".*
3.2.2. ODD: Operational Design Domain		
3.3. Definitions		
3.3.1. *"Automated Driving System (ADS)"* means the hardware and software that are collectively capable of operating a vehicle on a sustained basis.	3.3.1. *"Automated Driving System (ADS)"* means the hardware and software that are collectively capable of performing the entire DDT on a sustained basis.	*Based on the current discussions and proposal to define "function" in terms of DDT-related hardware and software that enables features to operate within their ODD, this proposal would replace "operating the vehicle" with "performing the entire DDT" where the DDT refers to the functions required to operate a vehicle in traffic (and a function refers to a discrete hardware/software element designed to perform a portion of the DDT).*
3.3.2. *"(ADS) feature"* means an application of ADS hardware and software designed specifically for use within an ODD.		*Introduced in FRAV-03-05-Rev.1*

3.2.3. *"(ADS) function"* means an application of ADS hardware and software designed to perform a specific portion of the DDT.		*Proposal to define a "function" as an element of an ADS designed to perform an aspect of the DDT. The expectation is that FRAV may draft requirements for specific capabilities that must be present in the design of an ADS but are not strictly performance requirements. For example, performance requirements related to safe positioning on the roadway inherently require the means to detect roadway infrastructure and objects in the vehicle environment in order to determine safe positioning.*
~~3.2.2. *"Dynamic driving task (DDT)"* means all of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints, and including without limitation: Lateral vehicle motion control via steering (operational); Longitudinal vehicle motion control via acceleration and deceleration (operational); Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical); Object and event response execution (operational and tactical); Maneuver planning (tactical); and Enhancing conspicuity via lighting, signaling and gesturing, etc. (tactical).~~	3.2.4. *"Dynamic driving task (DDT)"* means the real-time functions collectively required to operate a vehicle in on-road traffic.	*Proposal for a simplified J3016 definition of DDT to facilitate the current discussions. The proposed definition of "function" is based upon the understanding of the DDT as being the capabilities required to safely operate a vehicle (monitoring the roadway, being in control of the vehicle motion, "situational awareness" of the traffic environment, signaling to other road users, etc.). FRAV may be expected to refine or elaborate the definition as work progresses.*
3.3.5. "Operational Design Domain (ODD)" means the operating conditions under which an ADS feature is specifically designed to function.		*Introduced in FRAV-03-05-Rev.1*

3.2.3. *"Minimal risk condition"* means a condition to which a user or an automated driving system may bring a vehicle in order to reduce the risk of a crash when a given trip cannot or should not be completed.		*Not addressed in this document.*
3.2.4. *"Minimal risk maneuver"* means a procedure automatically performed by the automated driving system to place the vehicle in a minimal risk condition in a manner that minimizes risks in traffic.		*Not addressed in this document.*
3.2.5. *"New Assessment/Test Method (NATM)"* means the tools and methodologies for the assessment of automated vehicle safety performance under development by the GRVA Informal Working Group on Validation Methods for Automated Driving (VMAD).		*Not addressed in this document.*
3.2.6. *"Operating environment"* means the reasonably foreseeable conditions which a vehicle can be expected to encounter when in automated mode.		*Not addressed in this document.*
3.2.8. *"Transition demand"* is a logical and intuitive procedure to transfer the dynamic driving task from automated control by the system to human driver control.		*Not addressed in this document.*

4. ADS Safety Requirements 4.1. Driving a motor vehicle in traffic is a complex task requiring continuous awareness of roadway conditions, control of the vehicle motion, interactions with other road users, and adaptation of the vehicle motion to changes in roadway conditions. 4.2. The automation of driving obligates manufacturers, safety authorities, and other stakeholders in road transportation to ensure that Automated Driving Systems perform safely in traffic. 4.3. The assurance of ADS safety involves attention to specific performance and behavioral competencies required to operate a vehicle in traffic and the application of methods and practices to verify that ADS perform as intended. 4.4. This document addresses minimum requirements necessary to ensure that an ADS is safe for use on public roads. 4.5. Unlike human drivers broadly licensed to operate a vehicle on all roadways, ADS may be designed to operate under specific conditions. 4.6. In order to ensure public safety while benefiting from the potential of ADS to reduce crashes, injuries, and deaths (especially related to human driving errors), manufacturers and safety authorities anticipate a prudent and gradual introduction of these technologies. 4.7. As a result, stakeholders anticipate a wide variety of ADS applications carefully designed to operate within their performance limits.		*Per the FRAV-04 decision to remove the "System Safety" chapter and describe the overall "system safety" goals in a "preamble", this text proposes a new "ADS Safety Requirements" chapter to describe the overall intentions.* *This section also would explain the overall strategy for requiring manufacturer descriptions of the ADS (ODD plus other constraints FRAV may define) that enable application of the high-level performance requirements to a specific ADS. In this regard, "safety requirements" = "ADS description requirements" + "ADS performance requirements".*

4.8. This document describes requirements designed to ensure that ADS perform safely on public roadways. 4.9. The safety requirements address ADS in two ways. The document first defines conditions that may describe or limit the use of an ADS based on the manufacturer's assessment of its capabilities. The document then describes minimum performance requirements to ensure safe use of ADS. 4.10. The performance requirements apply to ADS regardless of their individual configurations. The definition of conditions that may impact performance requires manufacturers to fully describe the intended uses and limitations of an individual ADS. 4.11. In combination, the ADS descriptions and the ADS performance requirements ensure that each ADS can be assessed for safe operation. 4.12. These safety requirements for ADS descriptions and performance are designed to enable the validation of ADS safety prior to their introduction on the market.		
4.13. The safety of an ADS may be considered from five fundamental perspectives: • ADS should drive safely. • ADS should interact safely with the user. • ADS should manage safety-critical situations. • ADS should safely manage failure modes. • ADS should maintain a safe operational state.		*This paragraph presents the FRAV-05 "starting points". The expectation would be to describe each starting point based on FRAV's consensus on the "next level" items describing the different elements that fall under each starting point.*
4.13.1. The ADS should drive safely.		

4.13.2. The ADS should interact safely with the user.		
4.13.3. The ADS should manage safety-critical situations.		
4.13.4. The ADS should safely manage failure modes.		
4.13.5 The ADS should maintain a safe operational state.		

5. Operational Design Domain (ODD)		
5.1. This chapter concerns the description of an Operational Design Domain (ODD).		
5.2. For the assessment of vehicle safety, the vehicle manufacturer should describe the ODD of each ADS feature available on the vehicle in accordance with the provisions of this chapter.		
5.3. The purpose of an ODD description is to inform determinations on the requirements and scenarios applicable to an ADS feature.		

5.4. The ODD description shall include (at a minimum):		*FRAV has agreed to consider requirements for the content of an ODD description during the course of drafting proposals for functional requirements. As noted above, the ODD description should be aligned with the requirements in a manner that facilitates decisions on which requirements are applicable to a given ADS.*

5.4.1. Roadway types [Road conditions (motorways/expressways, general roads, number of lanes, existence of lane marks, roads dedicated to automated driving vehicles, etc.)]		*Not addressed in this document.*
5.4.2. Geographic area [Geographical area (urban and mountainous areas, geofence setting, etc.)]		*Not addressed in this document.*
5.4.3. Speed range		*Not addressed in this document.*
5.4.4. Environmental conditions [Environmental conditions (weather, night-time limitations, etc.)]		*Not addressed in this document.*
5.4.5. V2X dependencies (e.g., dependence on connectivity and availability of vehicle, infrastructure or other external sources of data)		*Not addressed in this document.*
5.4.6. Other constraints [Other conditions that must be fulfilled for the safe operation of the ADS.]		*Not addressed in this document. FRAV notes the proposal from China to define "ODC" as a broader level of design constraints than covered by ODD. FRAV has agreed in principle that ODD refers to ambient conditions (i.e., conditions surrounding the vehicle). FRAV has agreed that other design constraints (such as reliance on the user to fulfill safety-critical roles outside the ADS capabilities) may be relevant to manufacturer descriptions of an ADS. FRAV has agreed to further consider the structure and content of this chapter once the group has a better understanding and consensus on the items that should be covered by the ADS descriptions.*

6. ADS Performance Requirements		*This addition proposes to group all the ADS performance requirements under a single heading. Based on future FRAV decisions, subsections could be added to group categories of requirements in whatever way seems best.*

~~4. System Safety [System Behavior]~~		*This chapter is deleted. The "safety candidates" originally described under this chapter have been kept for future reference.*

—NO CHANGES HAVE BEEN MADE FROM THE PREVIOUS VERSION AFTER THIS POINT—

4.1. It is necessary to clearly define the split in responsibilities between the driver and the ADS.		*Not addressed in this document.*
4.2. When in 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. This level of safety implies that an automated/autonomous vehicle shall not cause any non-tolerable risk [introduce unreasonable risks], meaning that automated/autonomous vehicle systems, while in automated mode, shall not cause any traffic accidents [incidents/events] resulting in [destruction of property,] injury or death that were reasonably foreseeable and preventable.		*Not addressed in this document.*
4.3. In terms of its alignment with the NATM structure, System Safety is closely associated with the Audit phase(s) under development by VMAD where manufacturer documentation provides a basis for an assessment of vehicle system design safety and safe performance across traffic scenarios applicable to the vehicle.		*Not addressed in this document.*

4.4.	Requirements under consideration include:		*Not addressed in this document.*
4.4.1.	The Automated Driving System (ADS) shall react to unforeseen situations in a way that minimizes risk.		*Not addressed in this document.*
4.4.2.	The vehicle shall demonstrate adequate mitigation of risks (e.g. approaching ODD boundaries), safe driving behavior and good Human Machine Interface.		*Not addressed in this document.*
4.4.3.	The system shall minimize the risks to vulnerable road users (VRU) in the case of an imminent collision (e.g., hit vehicle instead of VRU)		*Not addressed in this document.*
4.4.4.	When in the automated driving mode, the vehicle shall not cause any traffic collision that are rationally [reasonably] foreseeable and preventable. Any avoidable accident shall be avoided.		*Not addressed in this document.*
4.4.5.	When in automated driving mode, the automated vehicle drives and shall replace the driver for all the driving tasks for all the situations which can be reasonably expected in the ODD.		*Not addressed in this document.*
4.4.6.	[The nominal operation of the ADS shall result in equal or safer performance than a human driver. i.e. achieve a neutral or positive risk balance.] [The overall safety target shall be at least as good as manual driving, i.e. P (accident with fatalities)< 10-8 /h and P(accident with light or severe injuries) <10-7/h.]		*Not addressed in this document.*
4.4.7.	Activation and use of the vehicle in automated mode shall only be possible within the boundaries of the automated driving system's operational design domain.		*Not addressed in this document.*
4.4.8.	If an update renders the system obsolete or otherwise no longer supported, it shall not permit activation		*Not addressed in this document.*

4.4.9. Dynamic behavior in road traffic		*Not addressed in this document.*
4.4.9.1. When in automated driving mode,		*Not addressed in this document.*
4.4.9.1.1. The vehicle shall respond to reasonably foreseeable conditions within its operating environment without causing an event resulting in [destruction of property,] injury or death; [The system shall adapt to the driving conditions (reduce speed on wet/snowy/icy/gravel roads or due to visibility factors, road geometry)] [The system shall anticipate possible collisions and act in a manner to reduce their possibility of occurrence] [The Automated Driving System (ADS) shall not cause any traffic accidents that are reasonably foreseeable and preventable.]		*Not addressed in this document.*
4.4.9.1.2. The vehicle shall not disrupt the normal flow of traffic [The Automated Driving System (ADS) shall have predictable behavior] [The System shall behave in a way that maintains the safe flow of traffic and is predictable to other road users and "comfortable" to occupants (following distance, lane centering, gradual acceleration/braking/steering, proper signaling)] [That Automated Driving System (ADS) shall have predictable behaviour.]		*Not addressed in this document.*

4.4.9.1.3. The vehicle shall comply with all applicable road traffic laws except in cases where compliance would conflict with the above subparagraphs. [The System must comply with the traffic rules but may temporarily bend these rules (during an emergency, uncommon or edge case situation), if such actions reduce safety risks or are required for the safe flow of traffic (e.g., crossing a double centre line to go around an obstacle)] [The ADS shall drive in accordance with the traffic rules.		*Not addressed in this document.*
4.4.9.1.4. The ADS shall prioritize actions that will maintain the safe flow of traffic and prevent collisions with other road users and objects.		*Not addressed in this document.*

6.	Execution of Dynamic Driving Tasks		*Not addressed in this document.*
6.1.	This chapter refers to physical demonstration that a vehicle can safely respond to reasonably foreseeable conditions applicable to its vehicle automation system. Vehicle automation systems will execute dynamic driving tasks (DDT). The DDT encompasses all of the real-time operational and tactical functions required to operate a vehicle in on-road traffic including without limitation: • Lateral vehicle motion control via steering (operational) • Longitudinal vehicle motion control via acceleration and deceleration (operational) • Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical) • Object and event response execution (operational and tactical) • Maneuver planning (tactical) • Enhancing conspicuity via lighting, signaling and gesturing, etc. (tactical).		*Not addressed in this document.*
6.2.	For simplification purposes, SAE J3016 refers to the third and fourth items collectively as Object and Event Detection and Response (OEDR). In line with its Terms of Reference and the Framework Document, FRAV accepts this shorthand, describing the DDT as the complete OEDR and longitudinal/lateral motion control.		*Not addressed in this document.*
6.3.	This chapter is closely associated with the physical testing phase(s) of the NATM proposals under discussion within VMAD (e.g., manufacturer on-road and track testing, third-party track and real-world testing).		*Not addressed in this document.*

6.4.	Object and Event Detection and Response (OEDR)		*Not addressed in this document.*
6.4.1.	*"Object and Event Detection and Response (OEDR)"* means the detection by an ADS of circumstances that are relevant to the immediate driving task, as well as the implementation of the appropriate response to such circumstances.		*Not addressed in this document.*
6.4.2.	The ADS shall have OEDR capabilities that support safe and appropriate actions when subjected to reasonably foreseeable scenarios within the ODD.		*Not addressed in this document.*
6.4.3.	The automated driving system shall detect and classify objects and events that may be reasonably expected within its operational domain. [The system shall be able to classify static and dynamic objects in its defined field of view which are foreseeable in the OD (at minimum, it must classify: light vehicles, heavy vehicles, pedestrians, cyclists, motorcyclist, emergency vehicles, animals, traffic control devices, traffic signs …)]		*Not addressed in this document.*
6.4.4.	Objects and events include, but are not limited to, the following:		*Not addressed in this document.*
6.4.4.1.	The system shall be able to detect the roadway		*Not addressed in this document.*
6.4.4.2.	The system shall be able to identify lane location (w/, w/o markings)		*Not addressed in this document.*
6.4.4.3.	The system shall be able to detect and identify lane markings		*Not addressed in this document.*
6.4.4.4.	The system shall be able to detect objects in its defined field of view		*Not addressed in this document.*
6.4.4.5.	The system shall be able to estimate the speed and heading of objects		*Not addressed in this document.*
6.4.4.6.	The system shall be able to recognize and respond to traffic control devices, traffic signs and infrastructure including the state of traffic control devices		*Not addressed in this document.*

6.4.4.7. The system shall be able to detect indications of object intent (e.g., turn signal, acceleration, location in lane, body position, eye glaze)		*Not addressed in this document.*
6.4.4.8. The system shall be able to predict the behavior of detected objects and take appropriate action to reduce the risk of collisions		*Not addressed in this document.*
6.4.4.9. The system shall treat objects which cannot be classified with increased uncertainty		*Not addressed in this document.*
6.4.4.10. The system shall be able to recognize and react to service providers with responsibilities to direct traffic (e.g., police, construction worker)		*Not addressed in this document.*
6.4.4.11. The system shall take into consideration that other road users may not respect traffic laws		*Not addressed in this document.*
6.4.4.12. The system shall detect and respond appropriately to emergency service vehicles (e.g., yielding the right of way at intersections)		*Not addressed in this document.*
6.4.4.13. The system sensors shall be capable of detecting objects within the lane in front of the vehicle up to at least the minimal braking distance required for the vehicle to come to a full stop		*Not addressed in this document.*
6.4.4.14. The system shall not allow a lane change unless the rear sensors are capable of detecting objects to the immediate sides and in both rear adjacent lanes at a distance that would allow the maneuver without requiring hard braking of an oncoming vehicle		*Not addressed in this document.*

6.4.4.15. The automated driving system shall detect conditions within its operating environment that fall outside the boundaries of its operational design domain. [The ADS must be capable of identifying when conditions defining the ODD are met and predicting when they will no longer be met.] [The automated driving system shall detect and respond to conditions within its operating environment that indicate the approach of boundaries of its operational design domain as defined in paragraph 3.2.[explanation: for safe driving it is needed that detection and reaction are before the actual exceedance of the ODD]		*Not addressed in this document.*
6.5. Longitudinal and lateral motion control		*Not addressed in this document.*
6.5.1. Normal Driving		*Not addressed in this document.*
6.5.1.1. The automated driving system shall execute longitudinal and lateral maneuvers in response to objects and events within its operational design domain.		*Not addressed in this document.*
6.5.1.2. The automated driving system shall execute such maneuvers without causing outcomes resulting in injury or death.		*Not addressed in this document.*
6.5.1.3. The automated driving system shall execute such maneuvers without disrupting the normal flow of the surrounding traffic. [The vehicle shall be able to keep a safe distance with other vehicles in front, exhibit caution in occluded areas, leave time and space for others in lateral maneuvers, be cautious with right-of-ways and if a traffic collision can be safely avoided without causing another it shall be avoided.] [When in the automated driving mode, the vehicle shall, as far as possible, have a predictable and careful behaviour and shall allow an appropriate interaction with other road users (e.g. obey to orders by authorities or		*Not addressed in this document.*

	communication with other road users when needed).]		
6.5.2.	Other Driving		*Not addressed in this document.*
6.5.2.1.	The automated driving system shall execute a failsafe [safe fallback] response when the conditions defined for its operational design domain are not present.		*Not addressed in this document.*
6.5.2.2.	The automated driving system shall execute an emergency response when conditions for the execution of a failsafe [safe fallback] response are not present.		*Not addressed in this document.*
7.	Human-Machine Interface/Operator Information		*Not addressed in this document.*
7.1.	This chapter refers to internal and external human interactions with the automated vehicle and automation system. As with conventional vehicles, human ability to safely use the vehicle cannot involve significant learning curves. Therefore, automated vehicles will require a level of uniformity in their interactions with human users. To the extent that an automated system relies upon human involvement for safe operation, the automated vehicle will require measures to minimize risks of misuse and abuse and to respond safely in cases where the human driver fails to fulfill minimum requirements for safe use. Automated/autonomous vehicles that may require the driver to assume control of the driving task will require the means to assess driver awareness and readiness to perform the full driving task. In addition, automated vehicles will need means to interact safely with other road users (e.g. by means of external HMI on operational status of the vehicle, etc.).		*Not addressed in this document.*

7.2. Requirements under consideration include:		*Not addressed in this document.*
7.2.1. Activation and deactivation		*Not addressed in this document.*
7.2.1.1. The activation of the ADS shall only be possible when the conditions of the ODD are met.		*Not addressed in this document.*
7.2.1.2. The vehicle manufacturer shall define the operational design condition under which the automated driving system is designed to be activated, operated and deactivated.		*Not addressed in this document.*
7.2.1.3. Human override of system control		*Not addressed in this document.*
7.2.1.3.1. When the driver takes over control on his own (manual deactivation/override), the system shall not disturb the driver take over by inappropriate action (e.g. by switching off light by night).		*Not addressed in this document.*
7.2.1.3.2. Means shall be provided to humans (driver or if no driver, passenger or operation control center) to deactivate or override immediately the automated mode in an easy manner (deliberate action).The system may however momentarily delay deactivation (and may include a driver take over request if there is a driver) when an immediate human deactivation could compromise safety.		*Not addressed in this document.*
7.2.1.3.3. Means shall be provided to the user to deactivate or override the ADS in an easy manner. The ADS may however momentarily delay deactivation if safety is compromised by the immediate input of the user.		*Not addressed in this document.*
7.2.1.3.4. When necessary the ADS shall protect the vehicle control against inadvertent or undeliberate [unintentional] user intervention.		*Not addressed in this document.*
7.2.1.4. The ADS deactivation shall only be performed when it has been verified that the user has taken over control.		*Not addressed in this document.*

7.2.2.	Vehicles equipped with automated driving systems that may require driver intervention (e.g., transition demand) shall detect if the driver is available to take over the driving task by continuously monitoring the driver. [Demonstration of driver availability (awareness, readiness and engagement) and override feature] [If the system shall monitor the take-over-ready driver, in the case of a level 3 system, the driver must remain available for system operation. In the case of a level 4+ system, a take-over request shall not be issued to a driver who is unavailable.] [If the system is designed to request the driver to take over under some circumstances, the system shall monitor whether the driver is ready to take over driving from the system. It shall ensure through appropriate design (e.g. driver monitoring system) and warnings that the driver remains available to respond to take over request and prevent any foreseeable and preventable misuse by the driver in the OD.] [When the ADS is active it shall be capable of determining the user's status.] [If the system is designed to request and enable the user to take over control under some circumstances, the ADS shall ensure through appropriate design and warnings that the user remains available to respond to the takeover request.]		*Not addressed in this document.*
7.2.3.	The system shall have intuitive user controls and communications systems. [If the vehicle has multiple systems with varying degrees of driver interaction, distinct symbols and activation methods shall be used to avoid mode confusion] [The mode concept shall be designed in a way that minimizes mode confusion at the user and system level.]		*Not addressed in this document.*

7.2.4. The vehicle shall also be designed to minimize potential effects of errors from the vehicles' users, inside and outside of the vehicle, and of other road users.		*Not addressed in this document.*
7.2.5. Information shall be available to the vehicle's user that clearly defines their responsibilities, the procedures to comply with a takeover requests, and possible consequences if they do not comply.		*Not addressed in this document.*
7.2.6. The vehicle shall clearly communicate to the user: [The ADS shall communicate critical messages to vehicle's users and other road users when needed.]		*Not addressed in this document.*
7.2.6.1. Status of the automated driving system [Communication of the system status to the driver] [The system HMI will clearly indicate if the system is active, available or disabled] [The ADS shall clearly inform user about the operational status (operational, failure, etc.) in an unambiguous manner.]		*Not addressed in this document.*
7.2.6.1.1. System availability		*Not addressed in this document.*
7.2.6.1.2. System mode active		*Not addressed in this document.*
7.2.6.2. System malfunction [Communication of malfunctions to the driver] [The system shall clearly communicate degraded operation, malfunctions, failures, required system maintenance, emergency conditions, ongoing minimal risk manoeuvres or take-over requests to the driver/occupants.] [The system shall be equipped with a monitoring system that can detect: faults, malfunctions or other abnormalities of system components and monitor system performance.]		*Not addressed in this document.*
7.2.6.3. Critical messages [Communication of critical messages to the driver]		*Not addressed in this document.*
7.2.6.4. Transition demand [Communication of Take-over request to the driver.] [The system shall clearly		*Not addressed in this document.*

communicate the need, and provide the driver sufficient time for take-over requests]		
7.2.6.5. Initiation of minimal risk maneuver [Recognition of MRM in operation by the driver]		*Not addressed in this document.*
7.2.6.6. Status of driver availability [Driver availability and override possibility (if required, based on level of automation)]		*Not addressed in this document.*
7.2.6.7. AV should include driver engagement monitoring in cases where drivers could be involved (e.g. take over requests) in the driving task to assess driver awareness and readiness to perform the full driving task		*Not addressed in this document.*
7.2.6.8. The system shall communicate with occupants, authorities, owners, operators or first responders after an abnormality/fault is detected, after a collision or after otherwise manoeuvred to a minimal risk condition.		*Not addressed in this document.*
7.2.7. The vehicle shall signal to other road users [Demonstration of signaling features. Interaction with other road users.]:		*Not addressed in this document.*
7.2.7.1. Intentions to undertake dynamic driving tasks [The system shall clearly communicate its intentions to pedestrians, cyclists and other road users (e.g., turn signals, speed change, high beam flash, other external communication)] [When needed, communication with other road users shall provide sufficient information about the vehicle's status and intention.]		*Not addressed in this document.*
7.2.7.2. Initiation of a minimal risk maneuver		*Not addressed in this document.*
7.2.7.3. Other safety-critical information.		*Not addressed in this document.*
7.2.8. Activities other than driving		*Not addressed in this document.*
7.2.8.1. Non-driving activities allowed in the AD mode shall be consistent with the available delay for the driver to takeover after a system request.		*Not addressed in this document.*

7.2.8.2. The driver shall be made aware of the use and the limits of the automated driving mode, as well as which tasks other than driving may be enabled by the system for the driver (This is only about the technical capability of the system and without prejudice to national traffic rules).		*Not addressed in this document.*
7.2.8.3. If applicable, activities other than driving that are provided by the ADS to the user once the ADS is activated shall be automatically suspended as soon as the ADS issues a transition demand or is deactivated.		*Not addressed in this document.*
7.2.9. Vehicles without driver controls		*Not addressed in this document.*
7.2.9.1. For vehicles designed to operate only with no driver (e.g. driverless shuttles), a communication function shall be provided to send an emergency notification to an operation control centre. A camera and voice communication device shall be provided in the vehicle so that an operation control centre can monitor the situation inside the vehicle.		*Not addressed in this document.*
7.2.9.2. For ADS designed to operate with no driver present in the vehicle e.g. driverless shuttles, an audio and visual communication channel shall be provided to exchange emergency notifications.		*Not addressed in this document.*
8. Failsafe [Safe Fallback] Response		*Not addressed in this document.*
8.1. Each automated/autonomous vehicle must be able to detect system failures and when the conditions of its ODD are no longer present (ODD exit). In such cases, the vehicle must have appropriate fallback strategies to ensure safety, including transition of control to the driver and minimal risk maneuver(s) in the event that a transition to the driver cannot be safely executed. This chapter describes such “failsafe responses”.		*Not addressed in this document.*

8.2.	The ADS shall be equipped with appropriate technical measures that continuously monitor system performance, perform fault detection and hazard analysis, signal any detected malfunctions that affect the system performance, and ultimately take corrective actions or revert to a minimal risk condition when needed.		*Not addressed in this document.*
8.3.	The ADS should therefore be designed, to the extent practicable, to function predictably, controllably, and safely in the presence of faults and failures affecting the system performance.		*Not addressed in this document.*
8.4.	In case of failure impacting the safety of the ADS, an appropriate control strategy shall be in place as long as the failure exists.		*Not addressed in this document.*
8.5.	When in automated driving mode,		*Not addressed in this document.*
8.5.1.	The vehicle shall automatically initiate a failsafe response or sequence of failsafe responses in response to detection of conditions outside its operational design domain for a duration not to exceed [time limit].		*Not addressed in this document.*
8.5.2.	Failsafe responses shall only be initiated when conditions permit their completion.		*Not addressed in this document.*
8.5.3.	Upon crossing the function ODD limits, the system shall take action to minimize risks (e.g., re-enter function ODD limits, revert to minimal risk condition, transition to driver, emergency manoeuvre) and notify the occupants the ODD boundary has been crossed		*Not addressed in this document.*
8.5.4.	The system shall not cross and re-enter function ODD limits cyclically and shall seek other actions to minimize risks if this occurs		*Not addressed in this document.*
8.5.5.	The system shall have appropriate redundancies that allow it to, at minimum, execute an emergency stop in the case of any system failure or emergency		*Not addressed in this document.*

8.5.6. The system shall take appropriate measures when a system abnormality/fault is detected in order to reduce risk (degraded mode, limp mode, revert to minimal risk condition etc.)		*Not addressed in this document.*
8.6. Failsafe responses include:		*Not addressed in this document.*
8.6.1. Transition demand [Takeover of DDT (if required, based on level of automation)]		*Not addressed in this document.*
8.6.1.1. The system shall be capable of transferring control back to the user in a safe manner.		*Not addressed in this document.*
8.6.1.2. The system shall be able to determine whether or not the user has taken over.		*Not addressed in this document.*
8.6.1.3. The system may request the driver to take over with a sufficient lead time in particular when		*Not addressed in this document.*
8.6.1.3.1. the driver overrides the system or		*Not addressed in this document.*
8.6.1.3.2. when the system determines that it is difficult to continue automated driving mode, such as when the situation becomes outside the OD, or when a problem has occurred to the automated vehicle.		*Not addressed in this document.*
8.6.1.4. The system shall give sufficient lead time to the driver to take over and shall remain in the automated driving mode as long as the driver has not taken over, and/or will otherwise transfer to a minimum risk manoeuvre. [The ADS shall remain active as long as the vehicle's user has not taken over, or the ADS has reached a Minimal Risk Condition (MRC).]		*Not addressed in this document.*
8.6.1.5. The system shall be designed to enable the driver to clearly recognize the take over request from the system.		*Not addressed in this document.*
8.6.1.6. The system shall be able to determine whether or not the driver has taken over. This verification shall at least include a criterion on vehicle lateral control by the driver unless the vehicle is already stopped.		*Not addressed in this document.*

8.6.1.7. When the driver takes over after a system request, the system shall give back control to the driver with a vehicle configuration maximizing driver controllability (e.g. wipers ON in case of rain, headlamps ON by night).		*Not addressed in this document.*
8.7. Minimal risk maneuver		*Not addressed in this document.*
8.7.1. When the system detects that it is difficult to continue in the automated driving mode, it shall be able to transfer to a minimal risk condition (with or without take over request) through a minimal risk manoeuvre.		*Not addressed in this document.*
8.7.2. The Minimal Risk Manoeuvre (MRM) shall be capable of achieving an MRC when a given trip cannot or should not be completed for example in case of a failure in the ADS or other vehicle systems.		*Not addressed in this document.*
8.7.3. Fallback strategies shall take into account that users may be inattentive, drowsy, or otherwise impaired, and shall therefore be implemented in a manner that will facilitate safe operation and minimize erratic driving behaviour.		*Not addressed in this document.*
8.7.4. The system shall be able to, at minimum, bring the vehicle to a gradual stop if the driver has not taken over the driving task after the provided take-over time.		*Not addressed in this document.*
8.7.5. A minimum risk manoeuvre shall be performed in case of shock in the best possible way, according to vehicle operational status and current situation.		*Not addressed in this document.*
8.7.6. During the whole MRM, the driver can take over in usual way.		*Not addressed in this document.*
8.7.7. The minimum risk manoeuvre shall lead to a vehicle stop.		*Not addressed in this document.*

8.7.8.	The Minimum Risk Manoeuvre (MRM) shall comply with traffic rules. MRM settings for automated vehicles may include measures to stay in or change the lane while warning to the surrounding and automatically stop the vehicle in a safe manner on the side of the road.		*Not addressed in this document.*
8.7.9.	The driver may be asked to take over at the end of the minimum risk manoeuvre (e.g. to park on the side of the road in case of level 3 lane keeping system). If the driver does not respond to the take over request, the vehicle shall be stopped in parking mode and the AD mode shall be desactivated.		*Not addressed in this document.*
8.8.	Emergency maneuver		*Not addressed in this document.*
8.8.1.	The system shall anticipate a function crossing the ODD boundaries and seek to remain within the function's ODD limits		*Not addressed in this document.*
8.8.2.	The system shall be able to execute emergency manoeuvres in an attempt to avoid imminent hazards		*Not addressed in this document.*
8.9.	[Crashworthiness/compatibility]		*Not addressed in this document.*
8.10.	Post-crash behavior [Post-crash behaviors (Collision Notification to Occupants and Emergency services; Return to a safe state)]		*Not addressed in this document.*
8.10.1.	Following a collision, the vehicle shall be brought to a complete stop to the best capabilities of the system and shall be brought to a minimal-risk state		*Not addressed in this document.*
8.10.2.	The system shall inform the occupants and contact emergency service providers, owners and/or operators		*Not addressed in this document.*
8.10.3.	Prior to re-activation, the system shall conduct self-diagnostics to ensure it is capable of operation		*Not addressed in this document.*
8.10.4.	Upon direction by emergency personnel or authorised user, the system, if able, shall move off the roadway		*Not addressed in this document.*

8.10.5. After detection of a first significant shock while driving (e.g. frontal collision with airbags triggering or lateral collision during an insertion), the vehicle shall:		*Not addressed in this document.*
8.10.5.1. inhibit AD mode reactivation until proper operation has been verified,		*Not addressed in this document.*
8.10.5.2. immediately attempt to achieve a safe state in the best possible way, according to vehicle operational status and current situation		*Not addressed in this document.*
8.10.6. The ADS may also, simultaneously, request the user to takeover vehicle control if vehicle and current situation are sufficiently controllable.		*Not addressed in this document.*
9. [In-use Performance] [Safety of In-use Vehicles]		*Not addressed in this document.*
9.1. Inspections/Repair/Modifications processes		*Not addressed in this document.*
9.1.1. Not within the scope of UNECE's Informal Working Group – Functional Requirements for Automated vehicles (FRAV).		*Not addressed in this document.*
9.2. Maintenance of existing level of crashworthiness (for vehicles carrying occupants)		*Not addressed in this document.*
9.2.1. Requirements covered by UNECE's Working Party on Passive Safety (GRSP)		*Not addressed in this document.*
9.3. Vehicle state monitoring		*Not addressed in this document.*
9.3.1. Any safety related failures regarding the roadworthiness of the ADS shall be systematically reported to the vehicle user.		*Not addressed in this document.*
10. Consumer education and training		*Not addressed in this document.*
11. Other items for consideration (not clear where to position in document)		*Not addressed in this document.*
11.1. Demonstration of activation/deactivation of AV mode.		*Not addressed in this document.*
11.2. The system Software and Hardware versions shall be accessible		*Not addressed in this document.*
11.3. Dealing with fault conditions separately from operational requirements (UK)		*Not addressed in this document.*