Consolidated Proposals to
Amend the Draft Text of the
FRAV Interim Submission to WP.29

This table covers FRAV discussions through the 36th session. Unshaded table cells have not yet been reviewed in session by FRAV.

Discussed and accepted as of the 36th session.

Discussed without reaching consensus as of the 36th session

1.	Introduction		
1.1.	This section provides background information concerning the deliberations on safety requirements for Automated Driving Systems (ADS).		
New paragraph		(SAE) The meaning of ADS is central to the work of FRAV because the ADS definition provides the scope of FRAV's mandate. The WP.29 Framework document on automated/autonomous vehicles (ECE/TRANS/WP.29/2019/34/Rev.2) is the source of that mandate. The Framework states that its purpose is to provide guidance to GRs "by identifying key principles for the safety and security of automated/autonomous vehicles of levels 3 and higher." As the source of relevant definitions, the Framework cites WP.29 ECE/TRANS/WP.29/1140, which provides a table showing levels of automation and cites SAE J3016 as the source of those levels. Under J3016, an ADS is defined as: "The hardware and software that are collectively capable of performing the entire	

		[Dynamic Driving Task] on a sustained basis, regardless of whether it is limited to a specific operational design domain (ODD); this term is used specifically to describe a Level 3, 4, or 5 driving automation system." [add a footnote citing J3016 and the corresponding ISO doc with identical definition]. Accordingly, understanding what an ADS is and how it relates to the human role in driving is important to understanding the requirements that FRAV recommends.	
1.2.	ADS present challenges to the safety regulator that require new concepts, tools, and methodologies in addition to those historically used for previous vehicle technologies and systems.		
1.3.	This section explains the considerations behind the recommendations for ensuring ADS safety presented in this document.		
1.4.	Driving		
1.4.1.	Driving is a complex activity with traffic laws and codes of behaviour based upon human cognitive strengths and weaknesses.		
1.4.2.	Driving involves three behavioural levels: strategic, tactical, and operational.		
1.4.3.	The strategic level concerns general trip planning such as determination of trip goals, the route to be used, the modal choice, and evaluation costs and risks associated with these decisions.		
1.4.4.	The tactical level involves manoeuvring the vehicle in traffic during a trip, including perceiving and assessing of the driving		

	environment, deciding and planning on a specific manoeuvre (e.g., on whether and when to overtake another vehicle), and executing the manoeuvre.		
1.4.5.	The operational level concerns vehicle-stabilisation capabilities (e.g., making micro-corrections to steering, braking and accelerating to maintain lane position in traffic).		
1.4.6.	For example, a decision to drive from home to a workplace involves a strategic assessment of the current conditions, the risks involved in driving under those conditions, and the probability for arriving at work on time. While driving, the driver makes tactical decisions based on conditions encountered along the way such as to change lanes or turn onto another street. In changing lanes, the driver makes a tactical assessment that the lane change is feasible, actuates the direction indicators and steers the vehicle while maintaining an appropriate speed, often with continuous adjustments on the operational level.		
1.4.7.	These behavioural levels relate to perception, information processing, and decision making under uncertainty. Driving can be considered an exercise in risk management within the context of achieving strategic goals. Drivers assess and respond in real time to perceived risks (including the behaviours of other road users) in the road environment.		
1.4.8.	The real-time tactical and operational functions required to operate a vehicle in on-road traffic are collectively known as the	The real-time tactical and operational functions required to operate a vehicle in on-road traffic are collectively known as the	

	Dynamic Driving Task (DDT). As noted above, these functions may be performed within the context of strategic goals, but the DDT itself excludes such strategic functions. These functions may overlap or operate in combination such as in a tactical decision in response to road conditions to deviate from the original strategy to follow a particular route. Strategic decisions, however, can be made during a trip. For example, when deciding to leave the motorway for lesser roads.	Dynamic Driving Task (DDT) which involves longitudinal and lateral control and the Object Event Detection and Response (OEDR). As noted above, these functions may be performed within the context of strategic goals, but the DDT itself excludes such strategic functions. These functions may overlap or operate in combination such as in a tactical decision in response to road conditions to deviate from the original strategy to follow a particular route.	
1.4.9.	Although the DDT comprises several subtasks (sensing, cognitive processing, action), the DDT itself refers to performing the whole driving task within its Operational Design Domain (ODD). Within the ODD, the ADS or the driver performs the DDT. A system that cannot perform the entire DDT can only assist the driver's performance of the DDT.		
1.4.10.	Tactical functions include but are not limited to manoeuvre planning and execution, enhancing conspicuity (lighting, signalling, gesturing, etc.), and managing interactions with other road users. Tactical functions generally occur over a period of seconds.		
1.4.11.	Operational functions include but are not limited to lateral vehicle motion control (steering) and longitudinal vehicle motion control (acceleration and deceleration). This operational effort involves split-second reactions, such as making micro-corrections while driving.		

1.4.12.	The DDT cannot be apportioned between a driver and a driving system because these functions are interdependent and operate as a whole. Operational and tactical functions are inherent in monitoring the driving environment (object and event detection, recognition, classification, and response preparation) and in object and event response execution.		
1.5.	Automated Driving		
1.5.1.	While the previous section concerns driving in general, human and automated driving have notable differences.		
1.5.2.	Unlike human drivers broadly licensed to operate a vehicle on all roadways under all conditions, ADS may be designed for specific purposes and to operate under specific conditions.	(FRAV-33-40) Unlike human drivers broadly licensed to operate a vehicle on all roadways under all conditions, ADS may be designed for specific purposes and to operate under specific conditions and may not be capable of extrapolating appropriate responses to unexpected events.	
1.5.3.	The diversity of ADS and ADS vehicle configurations requires attention to the roles, if any, that a vehicle user may play in the use of the vehicle. ADS vehicles may, or may not, be designed to carry human occupants. They may, or may not, be designed to be driven by a human being. They may permit or prohibit driver activation of the ADS while the vehicle is moving.		
1.5.4.	Safety requirements must account for the role(s) a user may have in the use of the ADS and/or ADS vehicle such as driver or passenger. These human-user roles may		

	involve vehicle occupants, or they may be external to the vehicle.		
1.5.5.	Roles may change during the course of a trip. For example, in some configurations, a driver may activate the ADS while the vehicle is moving such that the ADS becomes the sole vehicle operator (i.e., performing the DDT within the ODD of the activated feature) and the driver shifts to the role of fallback user. For safety reasons, this fallback-user role might entail an obligation to remain receptive and responsive to ADS requests to assume control over the vehicle (i.e., to return to the role of driver). In other configurations, human occupants might not be expected to play any DDT-relevant role during the course of an entire trip.	Roles may change during the course of a trip. For example, ~~in some configurations~~, when a driver activates a level 3 ADS while the vehicle is moving, the ADS becomes the sole vehicle operator (i.e., performing the DDT) and the driver shifts to the role of fallback user. For safety reasons, this fallback-user role entails an obligation to remain receptive and responsive to ADS requests to assume control over the vehicle (i.e., to return to the role of driver).	
1.5.6.	The requirements recommended in this document address misuse prevention and the safety of user interactions such as transitions of vehicle control; however, the fallback-user role also suggests traffic laws to codify obligations of fallback users to maintain their readiness to drive the vehicle during a trip.	(FRAV-33-35) The requirements recommended in this document address misuse prevention and the safety of user interactions such as transitions of vehicle control; however, the compulsory fallback-user role also indicates the necessity of traffic laws to codify obligations of compulsory fallback users to maintain their readiness to drive the vehicle during a trip. (FRAV-33-40) The requirements recommended in this document address misuse prevention and the safety of user interactions such as transitions of vehicle control~~; however, the fallback-user role also suggests traffic laws to codify obligations of fallback users to maintain their readiness to drive the vehicle during a trip~~.	*From this point, FRAV decided to jump ahead in its review of the text and proposal to Section 2. FRAV may wish to return to its review of the introductory section later.*

1.5.7.	The conditions under which an ADS is designed to operate are known as the Operational Design Domain (ODD), including aspects such as roadway speed limits, road designs (surface, geometry, infrastructure, etc.), weather conditions, and traffic densities. The ODD may include constraints or limitations on ADS use such as maximum vehicle speed, maximum rate of rainfall, or road type.	(FRAV-33-33) The conditions under which an ADS is designed to operate are known as the Operational Design Domain (ODD), which include but are not limited to aspects such as roadway speed limits, road designs (surface, geometry, infrastructure, etc.), weather conditions, and traffic densities. The ODD may include constraints or limitations on ADS use such as maximum vehicle speed, maximum rate of rainfall, or road type.	
1.5.8.	The ADS requirements must address the diversity of driving conditions that may arise singly and in combination within the ODD.	(FRAV-33-40) The ADS requirements must address the diversity of driving conditions and behaviours that may arise singly and in combination within the ODD.	
1.5.9.	In addition, the requirements must address ADS that may be designed to operate in more than one ODD. As long as the ADS safely performs the DDT within each ODD, there is no reason to limit the definition of sets of ADS capabilities designed to operate the vehicle under separate sets of ODD conditions.		
1.5.10.	Driver performance of the DDT is based on human physical, sensory, and cognitive capabilities. ADS performance of the DDT is based on hardware and software. Therefore, the definition of DDT as applied to an ADS must be understood in these terms.	(FRAV-33-33) Driver performance of the DDT is based on human physical, sensing, and cognitive capabilities. ADS performance of the DDT is based on hardware and software to achieve comparable capabilities as human drivers have. Therefore, the definition of DDT as applied to an ADS must be understood in these terms of hardware and software.	

		(FRAV-33-40) Proposal to delete.	
1.5.11.	For an ADS, the operational and tactical functions of the DDT can be logically grouped under three general categories:		
1.5.11.1.	Sensing and Perception		
	ADS sensing and perception includes monitoring the driving environment via object and event detection, recognition, and classification. These functions include perceiving other vehicles and road users, the roadway and its fixtures, objects in the vehicle's driving environment, and relevant environmental conditions, including sensing ODD boundaries, if any, of the ADS feature and positional awareness relative to driving conditions.	(FRAV-33-33) ADS' sensing and perception functions include monitoring the driving environment to achieve object and event detection, recognition, and classification. These functions include perceiving other vehicles and road users, the roadway and its fixtures, objects in the vehicle's driving environment, and relevant environmental conditions, including sensing ODD boundaries, if any, of the ADS feature and positional awareness relative to driving conditions. (FRAV-33-40) ADS sensing and perception includes monitoring the driving environment via object and event detection, recognition, and classification. These functions include perceiving other vehicles and road users, the roadway and its fixtures, objects in the vehicle's driving environment, and relevant environmental conditions, including sensing ODD boundaries, if any, of the ADS feature and positional awareness relative to driving conditions. Level 4 and 5 ADS systems should also sense and perceive additional aspects of vehicle performance related to the driving task (i.e., worn tyres, vehicle	

		damage, vehicle load/aerodynamic imbalances).	
1.5.11.2.	Planning and Decision		
	Planning and decision include anticipation and prediction of actions that other road users may take, response preparation, and manoeuvre planning.		
1.5.11.3.	Control		
	Control refers to object and event response execution via lateral and/or longitudinal motion control and enhancing vehicle conspicuity via lighting and signalling.	(FRAV-33-33) Control refers to response execution via lateral and/or longitudinal motion control and enhancing vehicle conspicuity via lighting and signalling. (FRAV-33-40) Control refers to ~~object and event response execution via~~ lateral and/or longitudinal motion control and enhancing vehicle conspicuity via lighting and signalling.	
1.6.	Automated Driving Systems		
1.6.1.	Based on the above, ADS need to be understood in terms that cover the DDT (tactical and operational functions required to operate the vehicle in traffic) and the ODD (conditions under which such ADS capabilities are made available to a user).	(FRAV-33-40) Based on the above, ADS need to be described in terms that cover the DDT (tactical and operational functions required to operate the vehicle in traffic) and the ODD (conditions under which such ADS capabilities are made available to a user).	
1.6.2.	An ADS consists of hardware and software that are collectively capable of performing the entire DDT on a sustained basis within one or more ODD.	(FRAV-33-40) Proposal to delete.	
1.6.3.	Driving automation systems that require human support to fulfil aspects of the DDT fall below the level of an ADS.	(FRAV-33-08)	

		Driving automation systems that require human intervention to perform aspects of the DDT fall below the level of an ADS. (FRAV-33-33) Driving automation systems that require human support to fulfil aspects of the DDT within the ODD of the ADS fall below the level of an ADS. (FRAV-33-40) Driving automation systems that cannot fully perform the DDT fall below the level of an ADS. ADS systems of Level 3 may require a human driver for DDT-fallback.	
1.6.4.	In order to cover the diversity of ADS configurations, uses, and limitations on use, these recommendations define ADS in terms of functions and features.		
1.7.	ADS functions	(FRAV-33-09) ADS functions: DDT Performance Capabilities	
1.7.1.	ADS integrate subsets of hardware and software (i.e., functions) designed to perform aspects of the DDT.	(FRAV-33-33) ADS integrate subsets of hardware and software (i.e., functions) designed to perform one or more aspects of the DDT. (FRAV-33-40) Proposal to delete.	
1.7.2.	ADS functions, in general, correspond to system-level capabilities integrated into the ADS design.	(FRAV-33-40) Proposal to delete.	
1.7.3.	A function enables the ADS to perform one or more elements of the DDT.	(FRAV-33-33)	

		A function enables the ADS to perform one or more elements of the DDT (e.g., sensing the environment). (FRAV-33-40) Proposal to delete.	
1.7.4.	In addition to DDT-specific functions, an ADS function may contribute to ensuring the safe operational state of the ADS and/or preventing use when the ADS is not in a safe operational state.	Delete here and move to 1.7.9.1. (FRAV-33-09, supporting comment in FRAV-33-33, item 38). (FRAV-33-40) In addition to DDT-specific functions, an ADS function may contribute to ensuring the safe operational state of the ADS and/or preventing use when the ADS is not in a safe operational state or if the ADS is outside its ODD.	
1.7.5	ADS functions may also ensure the correct use of the ADS and safe interactions with a user such as in transitions of control.	(FRAV-33-09) Proposal to delete here and address the provision under 1.7.9. "Safe Use of ADS and ADS vehicles" as "additional ADS capabilities" not specific to DDT performance.	
1.7.6.	Functions represent the first level of safety that an ADS must fulfil. These functions correspond to essential capabilities without which an ADS cannot be deemed safe for use in traffic.		
1.7.7.	However, functions that enable performance of the DDT and functions that ensure safe use, including the safety of user interactions, involve distinctly different objectives and requirements.	(FRAV-33-09) However, functions that enable performance of the DDT and capabilities that ensure safe use, including the safety of user interactions, involve distinctly different objectives and requirements. (FRAV-33-33)	

		However, functions that enable performance of the DDT and functions that ensure safe use, including the safety of user interactions, have distinctly different objectives and requirements. (FRAV-33-40) Proposal to delete.	
1.7.8.	Safe ADS performance of the DDT		
1.7.8.1.	Requirements to ensure safe ADS performance of the DDT address the functional and behavioural objectives described by the WP.29 Framework Document on Automated Vehicles: ADS operation of the vehicle shall not cause crashes or disrupt traffic and ADS shall avoid crashes where preventable.	(FRAV-33-05) Requirements to ensure safe ADS performance of the DDT address the functional and behavioural objectives described by the WP.29 Framework Document on Automated Vehicles: ADS operation of the vehicle shall not cause crashes or disrupt traffic and ADS shall avoid crashes where reasonably foreseeable and preventable. (FRAV-33-36) Requirements to ensure safe ADS performance of the DDT address the functional and behavioural objectives described by the WP.29 Framework Document on Automated Vehicles: ADS vehicles shall not cause any traffic accidents resulting in injury or death that are reasonably foreseeable and preventable. (FRAV-33-40) Proposal to delete.	
1.7.8.2.		(FRAV-33-36) The safety benefit from ADS is achieved when ADS performance is safer than conventional human driver performance.	

		From this perspective, in general, the safety level of ADS performance shall be equal to or higher than the safety level of careful and competent human driver performance.	
1.7.8.2.	The requirements recommended in this document aim to ensure that each ADS is capable of performing the entire DDT to the extent necessary to operate the vehicle within its ODD. Because the performance of tactical and operational functions is dependent on the prevailing traffic conditions, these DDT requirements specify that the ADS must demonstrate behavioural competencies across traffic scenarios covering its ODD. The behavioural competencies inherently require functional capabilities to perform the DDT.	(FRAV-33-33) The requirements recommended in this document aim to ensure that each ADS is capable of performing the entire DDT to the extent necessary to operate the vehicle within the ODD of the ADS. Because the performance of tactical and operational functions is dependent on the prevailing traffic conditions, these DDT requirements specify that the ADS must demonstrate behavioural competencies across traffic scenarios covering its ODD. The behavioural competencies inherently require functional capabilities to perform the DDT.	
1.7.8.3.	These recommendations intentionally omit specifications for individual DDT functions. As noted above, performance of the DDT is dependent on traffic conditions where such functions cannot be limited to representative specifications. For example, a representative crash test at 56 kph ensures safety at lower speeds. This approach cannot be applied to driving where safety involves real time tactical and operational adaptation to dynamic road conditions. Tactical and operational functions are interdependent where the complexity of their interactions needs to be assessed under diverse traffic conditions.	(FRAV-33-10 supported by FRAV-33-40) These recommendations intentionally omit specifications for individual DDT functions. For example, the recommendations do not include specific specifications for lateral or longitudinal control as a general matter. As noted above, performance of the DDT is dependent on traffic conditions where such functions cannot be limited to representative specifications. For example, there is no way to specify a particular measure of lateral control that would be appropriate in all circumstances. ADS safety involves real time tactical and operational adaptation to dynamic road conditions in the ODD. Tactical and operational functions are interdependent where the complexity of their interactions needs to be assessed under diverse traffic conditions.	

		(FRAV-33-33) These recommendations intentionally omit specifications for individual DDT functions. As noted above, performance of the DDT is dependent on traffic conditions where such functions cannot be limited to representative specifications. For example, a representative crash test at 60 kph ensures safety at lower speeds. This approach cannot be applied to driving where safety involves real time tactical and operational adaptation to dynamic road conditions. Tactical and operational functions are interdependent where the complexity of their interactions needs to be assessed under diverse traffic conditions.	
1.7.8.4.	By ensuring that an ADS will be subjected to traffic scenarios covering its ODD, the assessment of the behavioural competencies demonstrated by the ADS under those scenarios verifies the capability of the ADS to perform the entire DDT necessary to navigate its ODD.	(FRAV-33-10) By ensuring that an ADS will be subjected to traffic scenarios fairly representative of what the ADS is reasonably likely to encounter in its ODD, the assessment of the behavioural competencies demonstrated by the ADS under those scenarios verifies the capability of the ADS to perform the entire DDT necessary to navigate its ODD. (FRAV-33-33) By ensuring that the assessment of the behavioural competencies of an ADS will be subjected to traffic scenarios covering its ODD, it can be demonstrated that the ADS under those scenarios has the capability to perform the entire DDT necessary to navigate its ODD. The ADS must also be subjected to scenarios outside the ODD of	

		its features to show that they indeed cannot be activated outside the ODD. (FRAV-33-40) Proposal to delete.	

1.7.9.	Safe use of ADS and ADS vehicles	(FRAV-33-11) Additional ADS Capabilities: Safe use of ADS and ADS vehicles	
		(FRAV-33-11) In addition to DDT-specific functions, an ADS may require capabilities that contribute to ensuring the safe operational state of the ADS and/or preventing use when the ADS is not in a safe operational state.	
1.7.9.1.	Ensuring the safety of interactions between ADS and their users demands a human-centred focus on user needs, strengths, and weaknesses.		
1.7.9.2.	Trust often determines automation usage. Operators may not use a reliable automated system if they believe it to be untrustworthy. Conversely, they may continue to rely on automation even when it malfunctions. ADS should be designed to foster a level of trust that is aligned with their capabilities and limitations to ensure proper use.	(FRAV-33-33, FRAV-33-35) Trust often determines automation usage. Users may not use a reliable automated system if they believe it to be untrustworthy. Conversely, they may continue to rely on automation even when it malfunctions. ADS should be designed to foster a level of trust that is aligned with their capabilities and limitations to ensure proper use.	
1.7.9.3.	These recommendations address user understanding of the ADS configuration, intended uses, and limitations on use, simplicity in defining and communicating user roles and responsibilities, clarity and commonality across ADS controls, requests, and feedback, and both misuse prevention as well as safeguards in the event of misuse.	(FRAV-33-06) These recommendations address user understanding of the ADS configuration, intended uses, and limitations on use, simplicity in defining and communicating user roles and responsibilities, clarity and commonality across ADS controls, requests, and feedback, and both prevention of reasonably foreseeable misuse as well as safeguards in the event of reasonably foreseeable misuse.	

1.7.9.4.	The recommendations encourage Safety Management Systems that integrate Human-Centred Design Processes to ensure safe interactions between ADS and their users.	(FRAV-33-40) Proposal to consolidate 1.7.9.4. and 1.7.9.5. in a single paragraph.	
1.7.9.5.	These human-centred processes should include analyses by qualified personnel of user needs and risk, setting safety and usability objectives, specifying user requirements and ensuring user understanding and context to produce design solutions that meet the requirements.		
1.7.9.6.	ADS should be evaluated, particularly under real-world testing on real users (i.e., not the people who are developing the products).	(FRAV-33-33) ADS should be evaluated, particularly under real-world testing with a representative group of naive users (i.e., not the people who are developing the products). (FRAV-33-40) Proposal to delete.	
1.7.9.7.	ADS performance should be monitored in the field and this information should be used to set future design targets and evaluate designs against these requirements.	(FRAV-33-40) Proposal to delete.	
1.7.9.8.	These recommendations for user safety align with this human-centred approach to identify functions that must be integrated into ADS designs to ensure safe interactions and prevent misuse.		
1.8.	ADS features		
		(FRAV-33-12) An ADS feature refers to an application of ADS capabilities designed for use within a defined ODD. In the case of an ADS designed to operate within a single ODD, the ADS and the ADS feature are	

		synonymous. Examples of ADS features are highway-only driving and automated parking.	
1.8.1.	Although an ADS performs the entire DDT on a sustained basis, an ADS may be designed to operate within more than one ODD.	(FRAV-33-12) Although an ADS performs the entire DDT on a sustained basis, an ADS with separate ADS features may be designed to operate within more than one ODD.	
1.8.2.	Each set of ODD-specific capabilities has a unique set of constraints defining the conditions under which the ADS may be used.		
1.8.3.	An ADS feature refers to an application of ADS capabilities designed for use within a defined ODD. In the case of an ADS designed to operate within a single ODD, the ADS and the ADS feature are synonymous.	(FRAV-33-12) Move to first paragraph of section 1.8 with modification.	
1.8.4.	ADS functions enable each ADS feature to operate the vehicle within the ODD of the feature. ADS functions may be used by more than one ADS feature and ADS features may use some or all of the ADS functions.		
1.8.5.	This document recommends a feature-based assessment of ADS. In cases where an ADS has more than one feature (i.e., is designed to operate in more than one ODD), each feature should be assessed to ensure that the ADS provides the functions necessary for performance of the entire DDT within the ODD of each feature.	(FRAV-33-40) This document recommends a feature-based assessment of ADS. In cases where an ADS has more than one feature (i.e., is designed to operate in more than one ODD), each feature should be assessed to ensure that the ADS provides the functions necessary for performance of the entire DDT within the feature's ODD.	
2.	Purpose		
2.1.	This document provides recommendations for safety requirements for ADS. This		

	output is intended to support future initiatives under the 1958, 1997, and/or 1998 Agreements.		
2.2.	Usage of the verbal forms "shall" (indicating an obligatory provision) and "may" (indicating a permissive provision) should be understood within the context of providing recommendations per the preceding paragraph.		
3.	Terms and Definitions		
	This section defines terms used in this document. Use of these terms and their definitions is recommended in the development of legal requirements related to ADS and ADS vehicles.		
3.1.	*"Automated Driving System (ADS)"* means the hardware and software that are collectively capable of performing the entire DDT on a sustained basis regardless of whether it is limited to a specific operational design domain (ODD).		
3.2.	*"(ADS) feature"* means an application of ADS hardware and software designed specifically for use within an ODD.		
3.3.	*"(ADS) function"* means an ADS hardware and software capability designed to perform a specific portion of the DDT.		
3.4.	*"ADS vehicle"* means a vehicle equipped with an ADS.		
3.5.	*"Behavioural competency"* means an expected and verifiable capability of an ADS feature to operate a vehicle within the ODD of the feature.		

3.6.	*"Driver"* means a human being who performs in real time part or all of the DDT.		
3.7.	*"Dynamic Driving Task (DDT)"* means the real-time operational and tactical functions required to operate the vehicle in on-road traffic. (See Section I.A. for general background and especially Section I.B., paragraphs 25-29, for application to ADS.)	(FRAV-33-14) *"Dynamic Driving Task (DDT)"* means the real-time operational and tactical functions required to operate the vehicle in on-road traffic. The DDT excludes strategic functions such as trip scheduling and selection of destinations and waypoints. The operational and tactical functions of the DDT can be logically grouped under three general categories: Sensing and perception, including: Monitoring the driving environment via object and event detection, recognition, and classification. Perceiving other vehicles and road users, the roadway and its fixtures, objects in the vehicle's driving environment and relevant environmental conditions. Sensing the ODD boundaries, if any, of the ADS feature. Positional awareness. Planning and decision, including: Prediction of actions of other road users. Response preparation. Manoeuvre planning. Control, including:	Henrik: further elaborate "strategic" part (as raised in intro comments where strategic decisions may be made during trip). *Open issue: Full definition with red text in definitions section or first-line (simple) definition in definitions section with elaboration in annex (where annex part of definition).*

		Object and event response execution. Lateral vehicle motion control. Longitudinal vehicle motion control. Enhancing conspicuity via lighting and signalling.	
3.8.	*"(ADS) fallback response"* means an ADS-initiated transition of control or an ADS-controlled procedure to place the vehicle in a minimal risk condition.		
3.9.	*"Fallback user"* means a user designated to assume the role of driver upon completion of a transition of control.		SAE: sees fallback as ADS response in falling back to user or MRC. TOC fallback but user intervention (absent ADS request) not an ADS fallback. J3016 addresses by fallback-ready user and user initiated a driver. TOC definition limited to ADS fallback to user.
3.9.1.	*Issue to address situations and safety concerns. How best to cover? Consider integrating "expected to take control" into FBU definition.*	(FRAV-33-35) *"Compulsory fallback user"* means a fallback user who must take control of the vehicle and assume the role of a driver when an ADS requests a transition of control.	NL reservation (currently only sees fallback user with no qualifiers). ESTC: "must" raise legal aspect under WP.1; be careful about introducing into vehicle regulation. ITU: "compulsory" used in other proposals; "discretionary" not used, so is additional word adding value? [maybe inherent in "fallback user" def?]-3.10.1. looks like update to 3.10. def. Links to "ready" user.
3.9.2.		(FRAV-33-35) *"Discretionary fallback user"* means a fallback user who may take control of the vehicle through a user-initiated transition of control.	JP: Is this really a fallback user since user is initiating? UK: current "fallback user" definition not clear on compulsory and aim to address two distinct situations: where user expected to respond and not. Also address where user initiates to take control but ADS has to manage. No monitor requirement for discretionary FBU. NL: "must" should not be in def and design needs to ensure safety in TOC to user, user intervention, etc. Term virtually requirement. UK: user request to take back control must be permitted by ADS so term to address this.
3.10.	*"Minimal Risk Condition (MRC)"* means a stable and stopped state of the vehicle that reduces the risk of a crash.		
3.11.	*"Operational Design Domain (ODD)"* means the operating conditions under which		

	an ADS feature is specifically designed to function.		
3.12.	*"Operational functions"* refer to basic capabilities such as to control lateral and longitudinal motion of the vehicle.		
3.13.	*"Other road user (ORU)*" means any entity using a roadway and capable of safety-relevant interaction with an ADS vehicle. *Address interpretation concerns:* *Is "user" "human"?* *Meaning of "safety-relevant interaction"* *Definition of "roadway"* *"entity" versus "user"* *What term(s) needed to write clear requirements?*	(FRAV-33-33) "Other road user (ORU)" means any human being using a roadway.	NL: definition of roadway (under some laws could include pedestrian walkways); seems to exclude small child relative to safety-relevant interaction. UK: safety-relevant interpreted as situational: child could have safety-relevant interaction. ETSC: Agree roadway needs clarification (UK would include pedestrian walkways). China: original intent "entity" to have broad coverage beyond human beings: any object capable of safety-relevant interaction. Japan: "user" specific to human where animals, etc. are "obstacles". SAFE: supports "entity" since ADS vehicles, robotics, draft animals, etc. "Human" too restrictive. ITU: problem here is "other road users" (as opposed to "other road occupants"). Differentiation and tendency to think of users as human. SAE: for specificity, could refer to "human road user" as needed. May be necessary to define "roadway". Interactions with driverless vehicles covered by original text. See chat. CITA: "user = human" seems to be source of confusion. Germany: Support keeping original: flexibility; some questions on meaning of "other" road user (e.g., ADS vehicle in platoon).
3.14.	*"Priority vehicle"* means a vehicle subject to exemptions, authorizations, and/or right-of-way under traffic laws while performing a specified function.		
3.15.	*"Real time"* means the actual time during which a process or event occurs.		
3.16.	*"Road-safety agent"* means a human being engaged in directing traffic, enforcing traffic laws, maintaining/constructing		

	roadways, and/or responding to traffic incidents.		
3.17.	*"Tactical functions"* refer to the real-time planning, decision, and execution of manoeuvres.		
3.18.	*"Traffic scenario"* means a description of one or more real-world driving situations that may occur during a given trip.		SAFE: support keeping original ISO 34501 for expanded definition. SAE: will need to ensure FRAV and VMAD common definitions going forward (i.e., in common document definitions section). Japan: need to align FRAV and VMAD definitions. Canada: propose that FRAV/VMAD secretaries develop table of definitions so IWG can see any differences and reconcile.
3.18.1.	*"Critical scenario"* means a traffic scenario representing unusual and/or unexpected objects, object behaviours, and/or road conditions.		D: Failure under failure scenarios. SAE agrees. UK: not all critical scenarios would require an emergency manoeuvre. SAE agrees. China agrees. Unexpected road condition: sink hole, lightning strike, whatever is sudden/unusual. ITU: ADS will handle weird situations; sees critical as something that comes up that is dangerous, that's a problem (could include mud on sensors/blindness) D: critical if time component, blindness not in this pot, for keeping NL version SAFE: scenario defined by content, not ADS behaviour. China agrees. Japan: aim to align with VMAD definition. "Who" ADS vehicle, objects/ORU? Gather "scenario" definitions together. ETSC: loophole permitting to say "unexpected". SAE: no gap because scenarios defined by regulation (must be addressed). Diff with EU reg. (CLEPA)
3.18.2.	*"Failure scenario"* means a traffic scenario representing a system failure that		

	compromises the capability of the ADS to perform the entire DDT.		
3.18.3.	*"Nominal scenario"* means a traffic scenario representing usual and/or expected objects, object behaviours and/or road conditions.	(FRAV-33-36) *"Nominal scenario"* means a traffic scenario containing a situation that reflects regular and non-critical driving manoeuvres. (FRAV-33-41 Rename "Nominal traffic scenario".	UK: take offline and address under DDT workstream on consultation with VMAD. NL: Supports ensuring alignment between FRAV and VMAD.
3.22.	*"Transition of control (TOC)"* means a procedure by which the ADS hands over dynamic control of the vehicle to the fallback user such that the fallback user is given the role of driver upon completion.	(FRAV-33-40) Proposal to reconsider towards improving the wording.	
3.23.	*"(ADS) User"* means a human being using an ADS where dynamic control of the vehicle is entirely maintained on a sustained basis by the ADS performance of the DDT.		
3.24.	*"Useful life (of an ADS vehicle)"* means the duration during which an ADS vehicle is in an operational state under which it may be driven on public roads regardless of the operational state of the ADS.		
4.	ADS Documentation		
	This section concerns the availability and/or provision of information regarding an ADS and its features and/or ADS vehicle. Unless otherwise specified, "documentation" should be understood as agnostic regarding the form or format for substantiation of such information.		*This statement aims to ensure neutrality regarding the regulatory regime. The information must be available (i.e., the manufacturer has done this work). Whether the information must be provided to a safety authority would be established in the specific regulations used by a Contracting Party (e.g., in a type-approval documentation package).*

4.1.	The manufacturer shall provide written information on the ADS configuration and the intended uses and limitations on the use of its feature(s).		Canada: clarify intended recipients of information. If for end user, written documentation (e.g., owner's manual) considered insufficient.
4.2.	The manufacturer shall describe the information and approach to be made available to the public to promote a correct understanding of the intended uses and limitations on the use of the ADS and its feature(s).		
4.3.	The manufacturer shall establish terms for the correct use of the ADS and its feature(s).		
4.4.	The manufacturer shall provide written information on the roles and responsibilities of the ADS vehicle user(s), including on permissible user activities while the ADS is performing the DDT.		
4.5.	The manufacturer shall provide written instructions for the activation and deactivation of the ADS.		
4.6.	The manufacturer shall provide written information on ADS responses to ADS vehicle user interventions in the dynamic control of the vehicle.		
4.7.	The manufacturer shall provide written descriptions of the transfer of control procedures, including ADS notifications and fallback user responses.		
4.8.	The manufacturer shall provide written descriptions of the transfer of control procedures, including ADS notifications and fallback user responses.		

4.9.	The manufacturer shall establish the ODD conditions and boundaries of each ADS feature in measurable and/or verifiable terms in accordance with Appendix A.		
4.10.	The manufacturer shall list the potential faults identifiable by the diagnostic system(s) of the ADS.		
5.	ADS Safety Requirements		
	The following subsections recommend criteria for validating the safety of ADS and/or ADS vehicles.		
5.1. *(new paragraph then renumber)*		(FRAV-33-36) As a general concept, the safety level of ADS shall be higher than conventional human driver performance in order to ensure the safety benefit from ADS. Subsections 5.8, 5.9. and 5.10. shall follow this concept and shall ensure the ADS performance at least to the level at which a competent and careful human driver could minimize the unreasonable safety risks to the drivers and other road users. Experts to give further consideration. Return to it at a future session.	ETSC: low level of ambition, expecting much higher safety level than human drivers. EU numerical target. Germany: "overall level": some cases better, some may not. Japan: rm "equal to". Establishing overall level resulting from requirements important. Equal to or better that C&C driver (as opposed to higher than all drivers). SAE: EU numerical target an example, not requirement. Acceptance criteria explained to technical service. Agree with expectation but translating from ODD-specific performance makes target aspirational rather than valid criteria against which an ADS could be evaluated. Incorporating C&C driver as a performance model (but models have limitations depending on situations). EU reg requires manufacturers to explain acceptance criteria. Don't see this general statement as adding value since result of more specific requirements. Concept of aggregate target useful to developers but not useful in this regulatory context. Japan: two perspectives for safety: inside ODD (ODD specific) but also general broad performance regardless of ODD. NL: Sees value in setting requirement even if data to support application of value to assessment would come later.
5.1.	Subsections 5.8, 5.9, and 5.10 concern ADS performance of the DDT. The recommended requirements have been		

	drafted for worldwide application. These requirements, therefore, do not specify technical performance limits due to the diversity of ODD-specific conditions and requirements that may influence safe performance of the DDT.		
5.2.	Driving involves real-time risk management under prevailing traffic conditions. Therefore, safe ADS performance of the DDT depends upon the conditions presented under each individual scenario.		
5.3.	Annex A provides a recommended approach to scenario generation and to the establishment of ADS behavioural competencies to be demonstrated under these scenarios. Each scenario is associated with one or more behavioural competencies.		
5.4.	The ODD-based approach to scenario generation provides analytical methods to ensure that the scenarios cover the ODD of the ADS feature(s). These scenarios address nominal, critical, and failure situations to enable assessments in accordance with the WP.29 Framework Document on Automated Vehicles (FDAV).		
5.5.	The behavioural competencies define ADS responses that comply with the following global requirements (Subsections 5.8, 5.9, and 5.10) within the bounds of a relevant safety model quantifying dimensions for assessment of ADS performance (as described in Annex A). The behavioural competencies align with the layer of abstraction of the scenario to provide verifiable criteria at the functional layer		

	down to measurable criteria at the concrete layer of abstraction.		
5.6.	Compliance with the recommended requirements under Subsections 5.8., 5.9., and 5.10. is determined by verifying that the ADS demonstrates the behavioural competencies associated with the scenarios relevant to the ODD of its features.		
5.7.	These requirements shall be applied in the definition of behavioural competencies to be demonstrated under traffic scenarios.		
5.8.	ADS Performance of the DDT under Nominal Traffic Scenarios		
5.8.1.	The following recommendations address the Framework document on automated/autonomous vehicles (ECE/TRANS/WP.29/2019/34/Rev.2) guidance that ADS vehicles shall not cause traffic accidents or disrupt traffic.		
5.8.2.	Compliance with this broad objective can be verified by subjecting the ADS and/or ADS vehicle to nominal traffic scenarios representing usual and expected traffic conditions and behaviours. By minimizing risk factors outside the ADS nominal performance of the DDT, the impact of the ADS driving behaviour on other road users and the flow of traffic can be isolated.		
5.8.3.	This section recommends requirements for assessing ADS performance of the DDT under normal operational and driving conditions.		

5.8.4.	The ADS shall be capable of performing the entire Dynamic Driving Task (DDT) within the ODD of its feature(s).		
5.8.4.1.	The ADS shall operate the vehicle at safe speeds.		
5.8.4.2.	The ADS shall maintain appropriate distances from other road users by controlling the longitudinal and lateral motion of the vehicle.		
5.8.4.3.	The ADS shall adapt its driving behaviour to the surrounding traffic conditions (e.g., by avoiding disruption to the flow of traffic).		
5.8.4.4.	The ADS shall adapt its driving behaviour in line with safety risks (e.g., by giving all road users and passengers the highest priority).		
5.8.5.	The ADS shall recognise the conditions and boundaries of the ODD of its feature(s) pursuant to the manufacturer's declaration under paragraph [4.9].		
5.8.6.	The ADS shall be able to determine when the conditions are met for activation of each feature.		
5.8.6.1.	The ADS shall detect and respond when one or more ODD conditions are not fulfilled by preventing possible activation.	The ADS shall prevent activation of a feature unless the ODD conditions of the feature are met.	*To be confirmed. FRAV agreed to split the original text into two requirements): (a) The ADS should prevent activation if the ODD conditions are not fulfilled, and (b) The ADS should respond by a TOC fallback or fallback to an MRC when the ADS is active and the ODD conditions are no longer fulfilled.*
5.8.6.2.	The ADS shall detect and respond when one or more ODD conditions are no longer fulfilled by executing a transition of control or by placing the vehicle in an MRC.	The ADS shall execute a fallback response when one or more ODD conditions of the feature in use are no longer met.	

5.8.7.	The ADS shall be able to anticipate foreseeable exits from the ODD of each feature.		
5.8.8.	The ADS shall detect and respond to objects and events relevant to its performance of the DDT. See Appendix B.		
5.8.9.	The ADS shall recognize markings and signals used to indicate priority vehicles within the ODD of its feature(s).		
5.8.10.	The ADS shall classify priority vehicles within the ODD of its feature(s) in accordance with the relevant traffic law(s).		
5.8.11.	The ADS shall detect and respond to priority vehicles in service in accordance with the relevant traffic law(s).		
5.8.12.	The driving behaviour of the ADS shall not require other road users to take evasive action to avoid a collision with the ADS vehicle.	(FRAV-33-31, FRAV-33-32) Delete.	*Should be further refined for clarity/precision—elaborate on pass/fail criteria.*
5.8.13	The driving behaviour of the ADS shall not cause a collision.		*Should be further refined for clarity/precision—elaborate on pass/fail criteria.*
5.8.14.	The ADS shall comply with traffic rules and regulations relevant to its performance of the DDT. See Annex B for a method for converting traffic rules and regulations into elements applicable to scenario generation and the establishment of behavioural competencies.		
5.8.15.	ADS shall comply with the traffic laws in nominal conditions, except when in specific circumstances or when necessary to enhance the safety of the vehicle's occupants and/or other road users.	(FRAV-33-33) ADS shall comply with the traffic laws in nominal conditions, except in specific circumstances or when it is necessary to	UK: rationale that compliance under all situation (nominal, critical, failure) required with limited exceptions under critical or failure scenario. Japan: Agrees that exceptions to compliance should be very limited. Can provide future input to clarify exceptions.

		enhance the safety of the vehicle's occupants and/or other road users. (FRAV-33-35) ADS shall comply with the traffic laws in critical and failure conditions, except when in specific circumstances or when necessary to enhance the safety of the vehicle's occupants and/or other road users.	SAE: could also need exemptions under nominal situations. Experts to confer to provide revised proposal. The ADS shall comply with traffic rules and regulations except when in specific circumstances deviation is necessary to enhance the safety of the vehicle's occupants and/or other road users.
5.8.17.	The ADS shall interact safely with other road users.		
5.8.18.	The ADS shall avoid collisions with safety-relevant objects where possible.		
5.8.19.	The ADS shall signal intended changes of direction.		
5.8.20.	The ADS shall signal its intention to place the vehicle in an MRC.		
5.8.21.	The ADS shall signal its operational status in accordance with national rules.		
5.8.22.	The ADS shall avoid collisions with safety-relevant objects where possible.		
5.9.	ADS Performance of the DDT under Critical Traffic Scenarios		
5.9.1.	The following recommendations address the Framework document on automated/autonomous vehicles (ECE/TRANS/WP.29/2019/34/Rev.2) guidance that ADS vehicles shall not cause any traffic accidents resulting in injury or death that are reasonably foreseeable and preventable.		

5.9.2.	Compliance with this broad objective can be verified by subjecting the ADS and/or ADS vehicle to critical traffic scenarios representing unusual or unexpected traffic conditions, objects, and/or object behaviours that elevate road safety risks. By introducing foreseeable external risk factors into scenarios, the capability of the ADS to manage safety-critical events that may arise within its ODD can be assessed.		
5.9.3.	This section recommends requirements for assessing the ADS performance of the DDT under critical driving conditions.		
5.9.4.	The ADS shall execute a fallback response in the event of a failure in the ADS and/or other vehicle system that prevents the ADS from performing the DDT.		
5.9.4.1.	In the absence of a fallback-ready user, the ADS should fall back directly to a Minimal Risk Condition (MRC).		
5.9.4.2.	If the ADS is designed to request and enable intervention by a human driver, the ADS should execute an MRM in the event of a failure in the transition of control to the user.		
5.9.4.2.1.	Upon completion of an MRM, a user may be permitted to assume control of the vehicle.		
5.9.4.2.2.	The user should be permitted to override the ADS to assume full control over the vehicle.		
5.9.5.	The ADS shall signal its intention to place the vehicle in an MRC.		

5.9.5.1.	The ADS should signal its intention to place the vehicle in an MRC to the ADS user or vehicle occupants as well as other road users (e.g., by hazard lights).		
5.9.6.	In the event of a collision, the ADS shall stop the vehicle in an MRC.		
5.9.6.1	*Addressed in 5.12.1.9. under in-use safety.* The ADS shall not resume travel until the safe operational state of the ADS vehicle has been verified.	(FRAV-33-31, FRAV-33-32) ADS reactivation should not be possible until the safe operational state of the ADS has been verified.	SAE: Talks about reactivation so assumes ADS has deactivated (which we removed above). NL: point of SAE that ADS shall not resume travel. Assumption that ADS still in control, brings vehicle to MRC, and does not resume travel until safe state verified. OICA/CLEPA: vehicle inherent in ADS operational state. May not be required.
5.9.7.	Decision: take discussion offline to reach agreement on proposal.	(FRAV-33-40) ~~The ADS shall avoid disruption to flow of traffic where possible.~~	CA: three items under nominal scenarios. Position that same aspects should be addressed in critical scenarios while recognizing limitations under critical event to achieve the aims. UK: Considering something similar to ensure that nominal scenario requirements still apply under critical scenarios where possible. Perhaps a first statement at the beginning of the section. OICA/CLEPA: not optimal to repeat other requirements as much as capture implicit requirement to meet nominal. Not necessary or beneficial to restate accepted principle for regulations. CA: Agree don't need three additions as long as covering concept of meeting safety as possible under critical events.

5.9.8.		(FRAV-33-40) ~~The ADS shall avoid non-compliance with the traffic laws, rules and regulations where possible.~~	
5.9.9.		(FRAV-33-40) ~~The ADS shall attempt to minimize collision severity.~~	
5.10.	ADS Performance of the DDT under System Failure Scenarios		
5.10.1.	The following recommendations address the Framework document on automated/autonomous vehicles (ECE/TRANS/WP.29/2019/34/Rev.2) guidance regarding the assurance of system safety and responses to system failures that compromise the capability of the ADS to perform the entire DDT.		

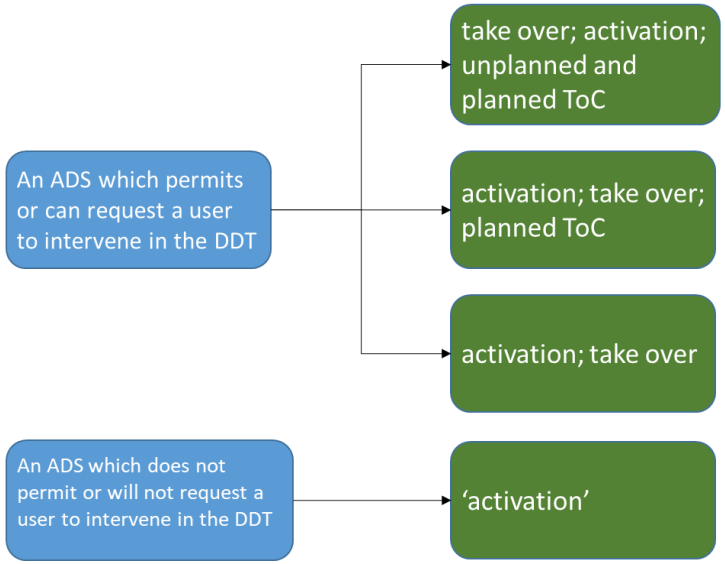
5.10.2.	The ADS shall detect faults, malfunctions, and abnormalities that compromise its capability to perform the entire DDT within the ODD of its feature(s) per the manufacturer's documentation under Section 4. *Open point: single statement or top point with two subpoints?*	(FRAV-33-31, FRAV-33-32) The ADS shall detect and respond to system malfunctions and abnormalities relevant to its performance of the DDT. (FRAV-33-40) The ADS shall detect faults, malfunctions, and abnormalities that compromise its capability to perform the entire DDT within the ODD of its feature(s) per the manufacturer's documentation under Section 4. Level 4 and 5 ADS systems shall detect abnormal vehicle performance related to the driving task (ie. worn tyres, vehicle damage, vehicle load/aerodynamic imbalances). (Moved from 5.12.) The ADS shall perform self-diagnosis of system integrity in accordance with the manufacturer documentation provided under Section 4.	CA: fallback user responsibility for vehicle state where L4/5 may not have such a user able to assess the vehicle state. OICA/CLEPA: Taken from previously agreed text supported by points further down. Use of levels not consistent with document. SAE: CA question correct: driverless has higher burden given absence of qualified user. ADS would need to detect such failures beyond ADS itself. Text on left appropriate. OICA/CLEPA: consider middle proposal within context of subpoints. Two points capture left text. Propose to keep the top plus subpoints. ETSC: ADS responsible for safety. Responsibility should not be shifted to user. If ADS driving, ADS responsible. If human driving, human responsible. SAE: J3016-"DDT-performance relevant"

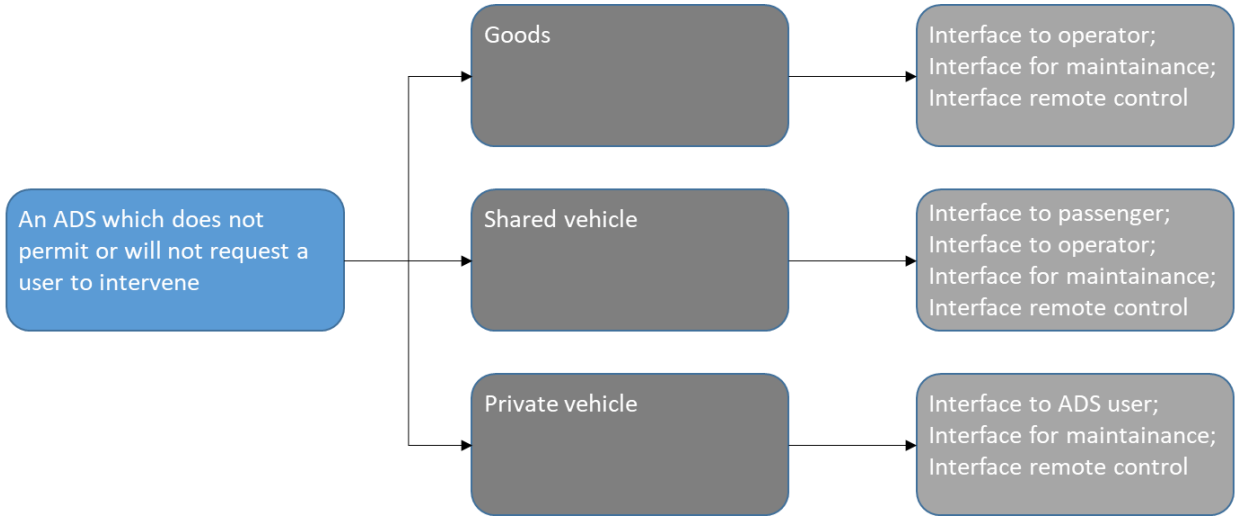
5.10.2.3.	The ADS may continue to operate in the presence of faults that do not prevent that ADS from fulfilling the safety requirements applicable to the ADS.	These requirements were approved by FRAV; however, the subpoints were moved from para. 5.12. per the decision. Given the overlapping statements, FRAV may wish to improve the text to remove redundancies.	
5.10.2.3.1.	In response to a fault, the ADS may limit the ODD to enable activation and use of a feature impacted by the fault provided that the ADS continues to provide the functions necessary to perform the entire DDT within the limited ODD.		
5.10.2.3.2.	The ADS shall prohibit activation of an ADS feature in the presence of a fault in an ADS function that compromises the ADS capability to perform the entire DDT within the ODD of the feature.		
5.10.2.3.3.	The limited operation of the ADS should comply to the normally applicable safety requirements.		
5.10.4.	Remote and/or in-vehicle physical termination of the availability of the ADS or its feature(s) to the user by an authorized entity shall be possible in ADS vehicles.	(FRAV-33-31, FRAV-33-32) For situations where the ADS is not able to perform the DDT safely, the ADS should have the function to prevent activation. If the ADS has OTA functionality, this function may be activated remotely if the authorities or the vehicle manufacturer determine that the ADS is unsafe.	First sentence: OICA: Improvements made to other requirements covers this safety need. JP: Keep sentence, consider placement in text—prevent activation when ADS cannot perform DDT. Open issue to resolve placement under activation Second sentence: OICA: Outside FRAV ADS requirements, relevant to cybersecurity. UK: Do need a way to remotely disable ADS if needed. Needs reconciliation. SAE: Need to differentiate deactivation from preventing activation where unsafe. See red text in blue.

5.11.	Interactions between Users of ADS Vehicles and the ADS	(FRAV-33-40) Proposal to review section for applicability to Level 3/4/5 ADS (i.e., address items that seem exclusive to L2 DCAS).	CA: Some text suggested driver supervision and ambiguity over who is in control. Should review to limit focus on ADS and avoid confusion with L2 user relationships. OICA: DDT has extensive comments where this section has fewer comments. OICA had trouble developing comments tied to questions over structure, applicability, issues raised in "flowchart" input. Suggest more productive to plan extensive discussion of section during March session. NL: User workstream and FRAV had discussions, considered flowchart but did not fit into format. Open to continued discussion but would like to prepare for March discussion. Suggests discussion perhaps week before March session. OICA/CLEPA: happy to have preparatory discussion before session.

5.11.1.	Until now it has always been clear who's driving, who is responsible for performing the driving task, not only for controlling the vehicle but also for perceiving and interpreting the environment and for choosing a cause of action. That clarity is fading with the introduction of automation in the vehicle and will become even less clear with the introduction of automated driving systems (ADSs) where it concerns vehicles equipped with ADS that can also be driven by a human being inside the vehicle.	(FRAV-33-35) Delete paragraph.	UK: Introductory text and agreed last session to discuss with NL, OICA. Have not had discussion. Worried that came across as saying there would be times when would not know user role/relationship.
5.11.2.	In vehicles that can still be driven by a human every part of the driving task that is not automated needs to be performed by a human and every part of the driving task that is not 'perfectly' automated needs to be compensated for by a human. It therefore has to be clear who performs which part of the driving task during a trip. It has to be clear what a human can and cannot do while the ADS performs (a part of) the driving task. It has to be clear when the ADS can no longer perform the driving task and the human has to take over. It has to be clear if the ADS is activated or can be activated. This kind of clarity is essential for safety, essential for a safe use of the ADS. And this clarity is provided through the interaction between the human and the ADS. The interaction is more than the interface and includes for example how an ADS 'behaves' in the perception of its user (e.g., if braking then standby mode; not only how much it decelerates).		Same as above.
5.11.3.	The following recommendations mainly focus on vehicles that can also be driven by a human. The recommendations applying to		OICA: Concern with overall approach to section. Provided input on HMI flowchart in workstream. Did not reach concrete

	vehicles that cannot be driven by a human being will be indicated in ????		outcome but addresses general issues that may need solutions in order to discuss specific requirements in context. OICA/CLEPA developing proposal for March session to resolve concerns. Absence of comments may signal general issues that make it difficult to comment on specific points. Suggest postponing detailed discussion until flowchart can be transposed into a proposal. May provide context and more concrete proposals for requirements. Communicated this view to Rino and believe better discussed with new proposal.
	Considerations Vehicle that can (still) be driven by a user Vehicle that can be driven by maintenance personnel (not 'ordinary' user) or steward		

	Vehicle that can be driven by remote operator 

			
5.11.3.1.	The ADS and its features shall have a high-level commonality of design of the user interaction, and the interface.		
5.11.3.1.1.	The ADS should be designed to foster a level of trust that is aligned with its capabilities and limitations to ensure proper use of the system.		
5.11.3.1.2.	The operation of the interaction shall at least have in common:		
	(a) The sequence of actions and states in the activation of the ADS.		
	(b) The sequence of actions and states in the transition of control process from the ADS to the user.		
	(c) The sequence of actions and states in the de-activation of the ADS.		

	(d) The role of the user after a transition of control from the ADS to the user or after the deactivation of the ADS. This role shall normally be a fully engaged driver without any control assistance (temporarily intervening safety systems such as ESC will remain activated).		
5.11.3.1.3.	The interaction should be simplified:		
	(a)	(FRAV-33-36) (a) Limit the number of roles (FRAV-33-40) Clarify meaning of "limit"	
	(b) [Limit the number of potential transitions].	(FRAV-33-40) Clarify meaning of "limit"	
	(c) [Limit the number of settings].	(FRAV-33-40) Clarify meaning of "limit"	
	(d) [Limit the number of different interaction modes].	(FRAV-33-40) Clarify meaning of "limit"	
5.11.4.	A high-level commonality in the interaction processes between the vehicle and a user for all brands and models helps drivers to develop and apply a single mental model of how their responsibilities relate to the level of automation and of how to interact with the systems. It also helps to reduce the risk of user confusion (e.g., mode confusion) when changing vehicle.		
5.11.4.1.	The ADS HMI shall provide clear, conspicuous and unambiguous information to support comprehension by the user.		
5.11.4.1.1.	The vehicle shall indicate its ADS capabilities in terms of their automated [features] and their ODD.		

5.11.4.1.2.	The ADS shall inform the user on the current conditions:		
	(a) ADS status information.		
	(b) The availability of automated features.		
	(c) Responsibility.	(FRAV-33-36) (c) User roles *(note: clarify whether proposal to replace or supplement original text.)*	
	(d) Permitted NDRA or not-permitted NDRA.		
	(e) Potential roles to activate.		
	(f) "Standard" information.		
	(i) [.....]		
	(g) ADS failure information.	(Moved from para. 5.10.) The ADS shall signal failures compromising its capability to perform the entire DDT relevant to the ODD of its feature(s).	
5.11.4.1.3.	The ADS shall inform the user in time on the upcoming conditions:		
	(a) ODD boundaries.		
	(b) Upcoming actions or change in roles.		
	(c) Oncoming decisions/manoeuvres.		
	(d) Estimated time until take over in normal conditions.		
	(e) Transition-related communication.		
5.11.4.1.4.	The ADS shall ensure that safety related information is prioritised and presented in a clear and unambiguous manner.		
5.11.5.	To ensure that there is no mode confusion or a lack of clarity about responsibilities of the ADS and the user or a lack of clarity about		

	the capabilities of the ADS it is essential that specific kind of information needs be presented such that the information is well received and well understood.		
5.11.5.1.	The ADS shall be designed to prevent misuse and errors in operation by the user.		
5.11.5.1.1.	The controls dedicated to the ADS shall be clearly distinguishable from other controls.		
5.11.5.1.2.	The ADS shall be designed to prevent inadvertent activation or deactivation.		
5.11.5.1.3.	The ADS shall provide feedback when the user attempts to enable unavailable functions.		
5.11.6.	For a safe use of the ADS mode confusion needs to be avoided. Therefore, it is essential that an ADS cannot be activated by mistake within the ODD nor that it can de-activated. Misuse of the ADS can for example be that a fall-back user is sleeping while the ADS performs the driving task.	(FRAV-33-35) For a safe use of the ADS mode confusion needs to be avoided. Therefore, it is essential that an ADS cannot be activated by mistake within the ODD nor that it can de-activated by mistake. Misuse of the ADS can for example be that a compulsory fall-back user is sleeping while the ADS performs the driving task.	Look at UK submission for 37th session for tomorrow.
5.11.6.1.	The ADS shall ensure safe ADS feature activation.		
5.11.6.1.1.	The ADS shall inform the user that preconditions for activation are met.		
5.11.6.1.2.	The activation shall follow a common sequence of actions and states.		
5.11.6.1.3.	The ADS shall provide confirmation that the system is activated.		
5.11.7.	Paragraphs 5.11.6.1, 5.11.8, and 5.11.9. strongly rely on the commonality concept. That's why some of the detailed provisions are also presented under paragraph 5.11.3.1.		

	To avoid mode confusion after a transition of control the transition should be to a fully engaged driver without any assistance. If assistance would still be possible this could, for example, be indicated and the user could activate that specific kind of ADAS.		
5.11.8.	An ADS which permits a transition of control shall be designed to ensure safe transitions of control.	(FRAV-33-35) An ADS which may request a transition of control shall be designed to ensure safe transitions of control to a compulsory fallback user.	
5.11.8.1.	The Transition of control process shall follow a common sequence of actions and states.		
5.11.8.2.	Transition of control shall return to a common default user role.		
	(a) The role of the user after a transition of control from the ADS to the user or after the deactivation of the ADS. This role shall normally be a fully engaged driver without any control assistance (temporarily intervening safety systems such as ESC will remain activated).		
5.11.8.3.	The ADS shall continuously verify whether the user is available for the Transition of Control and	(FRAV633-35) The ADS shall continuously verify whether the compulsory fallback user is available for the Transition of Control and	
	(a) adapt the Transition of Control process, including the time budget where feasible, to the state of the user and/or to the ADS.	(FRAV-33-35) (a) adapt the Transition of Control process, including the time budget where feasible, to the state of the compulsory fallback user and/or to the ADS.	
	(b) warn the user if not available when required.	(b) warn the compulsory fallback user if not available when required	

	(c) register user response indicating readiness for transfer of control.	(FRAV-33-35) register compulsory fallback user response indicating readiness for transfer of control	
5.11.8.4.	The ADS shall verify that the user is in stable control of the vehicle to complete the Transition of Control process.	(FRAV-33-35) The ADS shall verify that the compulsory fallback user is in stable control of the vehicle to complete the Transition of Control process	
5.11.8.5.	During transition, the ADS shall remain active until the Transition of control has been completed or the ADS reaches a minimal risk condition.		
5.11.9.	An ADS which permits user-initiated takeovers of control shall be designed to ensure a safe user-initiated takeover process.		
5.11.9.1.	Such ADS shall allow the user to initiate a take-over process.	(FRAV-33-35) Such ADS shall allow the fallback user to initiate a take-over process.	
5.11.9.2.	The deactivation shall follow a common sequence of actions and states in the transition of control (change of user roles).		
5.11.9.3.	The ADS shall momentarily delay deactivation of driving control when immediate human resumption of control could compromise safety.	(FRAV-33-35) The ADS shall warn and momentarily delay deactivation of driving control when immediate human resumption of control could compromise safety. The fallback user shall have the capability to override such a delay.	
5.11.9.4.	The ADS shall provide clear, specific feedback of the completion of a user initiated take over.		
5.11.9.5.	The user initiated take over shall return to a common default user role being the driver.		

	(a) The role of the user after a transition of control from the ADS to the user or after the deactivation of the ADS. This role shall normally be a fully engaged driver without any control assistance (temporarily intervening safety systems such as ESC will remain activated).	(FRAV-33-35) (a) The role of the fallback user after a transition of control from the ADS to the user or after the deactivation of the ADS. This role shall normally be a fully engaged driver without any control assistance (temporarily intervening safety systems such as ESC will remain activated)	
5.11.10.	The ADS shall be supported by documentation and tools to facilitate user understanding of the functionality and operation of the system.		
5.11.10.1.	The ADS manufacturer / vehicle manufacturer (as appropriate) shall provide documentation available for audit on:		
5.11.10.1.1.	The details of their user-centred design process		
5.11.10.1.2.	Its intended educational approach:		
	(a) Theoretical and practical training.		
	(b) How its HMI design aligns with common HMI and interaction.		
5.11.10.1.3.	Owner's manual describing at least:		
	(a) An operational description of ADS' (features) capabilities and limitations (the information should also refer to specific scenarios).		
	(b) A description of the roles and responsibility of driver/user and ADS when an ADS (feature) is on/off .		
	(c) A description on the permitted transitions of roles and the procedure for those transitions.		

	(d) A general overview of NDRA allowed when an ADS feature is active.		
5.11.10.2.	The ADS manufacturer / vehicle manufacturer (as appropriate) shall create the following in-vehicle tools such that:		
	(a) The ADS supports the user in correct operation (coaching)		
	(b) The ADS gives prompt feedback on erroneous operation.		
5.11.11.	The documentation and tools that are provided by the ADS manufacturer / vehicle manufacturer on the ADS will ensure that the user of an ADS can develop a general mental model of how the system functions, its capabilities, the user responsibilities and a more specific mental model of how to interact with the systems. A correct mental model is necessary for correct usage and expectations of the ADS.		
5.11.11.1.	The HMI of an ADS which permits a transition of control shall be integrated with the entire vehicle HMI.		
Insert new para.	*Reinsert text omitted during transposition.*	(FRAV-33-36) The entire HMI design should be defined and the integration with ADS HMI assured by analysis and/or test.	
5.11.11.1.1.	The vehicle and ADS HMI need to take into account potential impairments of users (such as colour blindness, impaired hearing) which do not require specific hardware adaptations of the vehicle.		
5.11.12.	To avoid mode confusion, it has to be clear to the user the differences between the different levels of automation that can be		

	available in a vehicle so that an ADAS mode can never be confused with an ADS mode.		
5.11.12.1.	A dedicated ADS vehicle shall provide vehicle occupants with means to request a minimal risk manoeuvre to stop the fully automated vehicle.		
5.11.12.2.	A dedicated ADS shall ensure that it operates within operational relevant legal boundaries.	(FRAV-33-35) An ADS which can operate without permitting transitions of control shall only operate when it has been ensured by the ADS or by other means that relevant legal requirements which are not related to the DDT (e.g. wearing of seatbelts, maximum vehicle loading) are fulfilled.	
5.11.13.		(FRAV-33-27) The ADS vehicle shall be equipped with a Data Storage System for Automated Driving (DSSAD).	
5.12.	Safety throughout the Useful Life of the ADS		
5.12.1.	This section addresses the safe use of an ADS during the useful life of the ADS vehicle.		Reconsider wording. NL: Is this safety of the vehicle throughout the useful life of the ADS or focused on safety of the ADS? Intro paragraph describes scope/aims of section.
5.12.1.2.	The ADS shall be accessible for the purposes of maintenance and repair to authorized persons.	(FRAV-33-40) Clarify “accessible”.	
5.12.1.3.	The ADS shall be designed to protect against unauthorized access to and modification of the ADS functions.		

5.12.1.3.1.	The measures ensuring protection from unauthorized access should be provided in alignment with engineering best practices.		
5.12.1.4.	ADS safety shall be ensured in the event of discontinued production, support, and/or maintenance.	(FRAV-33-40) ADS safety shall be ensured in the event of discontinued production, support, and/or maintenance. An entity should always remain responsible for the ADS. In the event that no entity retains responsibility for the ADS, the system should be decommissioned.	OICA: See requirement from R157: Manufacturer shall have process to manage continued compliance…. Can provide proposal for next session.
6.	Appendices		
A.	ODD Descriptions for ADS Features		
	This appendix provides guidelines for the documentation of ODD conditions under which an ADS is designed to operate. These guidelines promote consistency across manufacturer descriptions of each ODD to facilitate use of this information in ADS assessments.		
	ODD Documentation		
	1. To the extent provided, the documentation shall use the terms and measurement units provided in the Compendium of ODD Conditions.		
	2. The manufacturer may describe additional conditions where not provided for in the Compendium of ODD Conditions.		
	3. Each ODD condition and/or boundary shall be defined in measurable and/or verifiable terms.		

	Compendium of ODD Conditions	(FRAV-33-40) Delete heading and following contents.	
	1. Precipitation (rain, snow)		
	2. Time of day (light intensity, including the case of the use of lighting devices)		
	3. Visibility		
	4. Road and lane markings		
B.	Objects and Events		
	This appendix provides a listing of objects and events that may be relevant to ADS performance of the DDT within the ODD of a feature.		
	1. Motor vehicle 2. Motorcycle 3. Cyclist 4. Pedestrian 5. Stationary obstacle 6. Road accident scene 7. Road safety agent 8. Law enforcement agent 9. Emergency vehicle		
C.	Material to be Included in the Owner's Manual		
	This appendix provides a list of information that shall be provided at a minimum in the vehicle owner's manual and imbedded multimedia tutorial.		
	1. An operational description of ADS' (features) capabilities and limitations (the information should also refer to specific scenarios).		

	2. A description of the roles and responsibility of driver/user and ADS when an ADS (feature) is on/off.	2. A description of the roles and responsibility of driver/user and ADS when an ADS (feature) is active/inactive. (FRAV-33-29)	
	3. A description on the permitted transitions of roles and the procedure for those transitions.		
	4. A general overview of Non-Driving Related Activities (NDRA) allowed when an ADS feature is active.		

7.	Annexes		
Annex A.	Approach to Derive Verifiable Performance		The following remarks in this column are provided by the secretary to note areas for consideration to improve consistency with the main text.
1.	Purpose of the annex.		General comment: The grammatical tone should be declarative. FRAV is providing its recommendations on guidelines for drafting possible future ADS regulations. For example, phrases with “can be used” should be revised to “may be used” because FRAV is recommending granting permission to use this approach as a satisfactory methodology for translating high-level requirements into verifiable thresholds for pass/fail determinations.
1.1.	This annex provides an overview on the approach to be used to derive verifiable performance criteria for the certification or, as relevant, for self-certification of ADS, based on the manufacturer/ ADS developer’s description of the Operational Design Domain (ODD) of the ADS.		The purpose of the annex should be linked to the requirements (i.e., this approach is specific to determining verifiable criteria for pass/fail assessment of ADS compliance with DDT performance requirements). References to specific regulatory regimes (e.g., self-certification) should be avoided in line with the FRAV mandate. The text covers scenario generation, behavioural competencies, and the application of the high-level requirements, ODD descriptions, traffic-rule analysis, and safety models within this context. It may be beneficial to link the explanation of the purpose of the annex to these aspects for clarity and consistency with the entire text.

1.2.	Operational design domain (ODD) refers to: *Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics. (SAE J3016)*		"ODD" is defined in the text. Care should be taken to align the annex with the terms and definitions provided in the text. Definition of "roadway" is an open issue under the ORU definition (3.13.). The proposal for a space to list ODD conditions to guide the manufacturer's description of the ODD is an open issue (6.A.).
1.3.	Given a specific ODD, it is crucial for the ADS to ensure that: • It can operate safely within its ODD under conditions reasonably expected in the ODD • it will be used only within its ODD • It can monitor whether it is inside/outside its ODD and respond appropriately.		The explanation here may be elaborated to link with requirements for DDT performance.
1.4.	The conditions constituting the ODD in which the ADS was designed to operate will help determine which ADS competencies are required. For example, if an ADS has an ODD which comprises of roads with non-signalised junctions, one of the required behavioural competencies for the ADS in that ODD could potentially be "unprotected left or right turn". However, the same behavioural competency may not be required if the ODD of an ADS is limited to motorways or highways with signalised junctions.		Editorial consistency.

2.	Introduction and approach.		
2.1.	The concept of "behavioural competencies" is useful in determining the safety of the performance of the Dynamic Driving Task (DDT) by an Automated Driving System (ADS).		
2.2.	The Automated Vehicle Safety Consortium ("AVSC")) has provided these definitions[1]: • *Behaviour: Specific goal-oriented actions directed by an engaged ADS in the process of completing the DDT or DDT fallback within the ODD (if applicable) at a variety of timescales.* • *Behavioural Competency: Expected and measurable capability of an ADS feature operating a vehicle within its ODD.*		The text defines "behavioural competency". Care should be taken to align the annex and the terms and definitions provided in the text.
2.3.	Behavioural competencies can be described with different abstraction levels, similarly to functional, logical, and concrete scenarios. Refinement of the competencies from a functional to a more concrete level is possible by following the approach proposed in these guidelines.		
2.4.	Such competencies track the three broad categories of driving situations that may be encountered in performance of the DDT: nominal, critical, and failure.		Note link to paras. 5.8., 5.9., and 5.10. corresponding to DDT performance requirements under nominal, critical, and failure situations.

[1] AVSC Best Practice for Evaluating Behavioral Competencies for Automated Driving System Dedicated Vehicles (ADS-DVs).

2.4.1.	Nominal driving situations are those in which behaviour of other road users and the operating conditions of the given ODD are reasonably foreseeable (e.g. other traffic participants operating in line with traffic regulations) and no failures occur that are relevant to the ADS's performance of the DDT.		Ensure consistency with definitions of "traffic scenario" (3.18) and "nominal scenario" (3.18.3.).
2.4.2.	Critical driving situations are those in which the behaviour of one or more road users (e.g., violating traffic regulations, …) and/or a sudden and not reasonably foreseeable change of the operating conditions of the given ODD (e.g. sudden storm, damaged road infrastructure, …) creates a situation that may result in an immediate risk of collision. In this case, as it is recognised that in some cases the ADS may not be able to avoid a collision, the ADS performance are compared with safety model performance to set the threshold between where avoidance is required and where it is not feasible, but mitigation may be possible.		Ensure consistency with definitions of "traffic scenario" (3.18) and "critical scenario" (3.18.1.).
2.4.3.	Failure situations involve those in which the ADS or another vehicle system experiences a fault or failure that removes or reduces the ADS's ability to perform the DDT, such as sensor or computer failure or a failed propulsion system.		Ensure consistency with definitions of "traffic scenario" (3.18) and "failure scenario" (3.18.2.). FRAV may wish to consider user failures given draft requirements referring to ADS fallback to MRC in the event of inadequate or absent user response to transition request/demand.

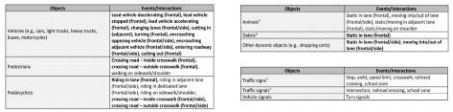
2.5.	Concrete performance requirements depend on the specific situations the ADS encounters, on a reference behaviour that is deemed appropriate for a human driver or a technical system, and on assumptions (e.g. friction values, reaction times) about the behaviour of the vehicle and other road users. Since it is virtually impossible to write a regulation that sets out verifiable criteria for every combination of these variables, this document aims at providing a set of different reference behaviours or safety models together with an overview of the characteristics and required assumptions that can be useful in deriving verifiable performance criteria in some situations. The aim is then to assist those who develop concrete regulations with the selection and parameterization of functions or selection of scalars as pass/fail criteria.		Consider for consistency with text (e.g., “verifiable” rather than “concrete”, “behavioural competency” rather than “reference behaviour”). Consider for clarity and consistency with relevant WP.29 regulation terminology (e.g., “friction values” == “road adhesion”?).

2.6.	For this, the following is needed: • An overview of reasonable expectations (which might occur in different ODDs), • An overview of reference behaviours / safety models that define the boundary between avoidable accidents and mitigation (note that these reference behaviours will not be used for anything else than providing this boundary as a performance criterion). • A matrix combining suggested reference behaviours / safety models with driving situations.		Consider for consistency (e.g., undefined term "reference behaviours"). Consider tone and word choice (e.g., "needed" implies requirement, annex provides guidelines for establishing valid criteria for assessing performance under scenarios). Statements should be declarative rather than passive (provide explicit explanation): "This annex provides procedures to…" aligned with the establishment of verifiable criteria to determine compliance with the requirements. For example, Para. 5.5. states "The behavioural competencies define ADS responses that comply with the following global requirements (Subsections 5.8, 5.9, and 5.10)…". The outcome of the guidelines is more than "suggested reference behaviours/safety models". The outcome establishes whether a behavioural competency defined for a scenario is valid such that an ADS response consistent with the behavioural competency establishes compliance with the requirements of paras. 5.8, 5.9., and/or 510.

3.	Behavioural competencies identification.		
3.1.	The approach suggests a series of analytical frameworks that could help to derive measurable criteria appropriate for the specific application. These frameworks are divided into: • ODD Analysis, • Driving Situation Analysis, • OEDR Analysis.		
3.1.1.	ODD analysis.		
3.1.1.1.	This analysis represents the first step with the aim to identify the characteristics of the ODD. An ODD may consist of stationary physical elements (e.g., physical infrastructure), environmental conditions, dynamic elements (e.g., reasonably expected traffic level and composition, vulnerable road users) and operational constraints to the specific ADS application. Various sources provide useful guidance for precisely determining the elements of a particular ODD and their format definition.[2,3, 4, 5]		Consider link to ODD description requirements (i.e., the description provides the ODD elements relevant to ADS feature performance of the DDT). The references to external sources of information for ODD descriptions relates to the open issue on guidelines for these required descriptions. FRAV agreed that guidelines to promote uniformity in terms and measurement units would be beneficial.
3.1.1.2.	As part of this activity, the level of detail of the ODD definition using the ODD attributes will also need to be established.		Consider clarification (e.g., requirement for manufacturer ODD description in measurable/verifiable terms, how is the level of detail established and by whom?)
3.1.2.	Driving situation analysis.		"Driving situation" is an undefined term. Is this different from "scenario"?

[2]; E.g., *AVSC Best Practice for Describing an Operational Design Domain: Conceptual Framework and Lexicon*; and *A Framework for Automated Driving System Testable Cases and Scenarios* (NHTSA).
[3] *E.g. BSI PAS 1883:2020 Operational Design Domain (ODD) taxonomy for an automated driving system (ADS) - Specification*
[4] ASAM OpenODD
[5] Road Vehicles — Test scenarios for automated driving systems — Taxonomy for operational design domain

3.1.2.1.	In the driving situation analysis, the behaviours of other road users that are reasonably expected and presence of roadway characteristics in the ODD are explored in more detail by mapping actors with appropriate properties and defining interactions between the objects.		Consider link with traffic-rule analysis. Explanation appears similar to the outcomes described in the codification of traffic rules for application to ADS.
3.1.2.2.	An example of this analysis is given in [Table 1], where static and dynamic behaviours of other objects (including other road users) that the ADS is reasonably expected to encounter within the ODD are described. In the case of vehicles, this includes behaviours such as “acceleration”, “deceleration”, “cut-in”; for pedestrians, examples of dynamic behaviours include “crossing road”, “walking on sidewalk”, etc. Some of these behaviours may involve nominal situations (e.g., lead vehicle deceleration at a rate reasonably expected in light of traffic and other circumstances within the bounds of physical limitations) while others may involve critical situations (e.g., sudden cut-ins or unpredictable pedestrian or cyclist behaviour, including behaviours that may violate local traffic laws such as crossing a road outside a designated cross walk).		

3.1.2.3.	The behaviour of other road users and the condition of physical objects within the ODD may fall at any point along a continuum of likelihood. For example, deceleration by other vehicles may range from what is expected and reasonable in the traffic circumstances, to unreasonable but somewhat likely rapid deceleration, to extremely unlikely (e.g., a sudden cut-in combined with full braking on a clear high-speed road). The analysis of the ODD and reasonably expected driving situations within the ODD should make distinctions that include an estimate of the likelihood of situations to ensure that the ADS's performance is evaluated based on response to reasonably likely occurrences involving nominal, critical and failure situations but not on the expectation that the ADS will avoid or mitigate the most extremely unlikely occurrences.		
Table 1.			Refer to FRAV-31-19 for original image.

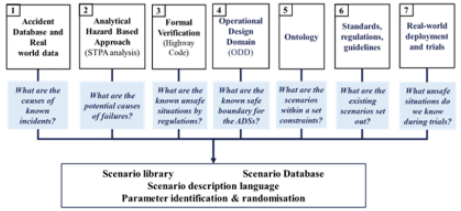
3.1.3.	3.1.3. Object and Event~~s~~ Detection and Response (OEDR) Analysis: Behavioural competency identification		OEDR=Object and Event Detection and Response. "Behavioural competency"
3.1.3.1.	Once the objects and their reasonably expected behaviours have been identified, it is possible to map the appropriate ADS response, which can be expressed as a behavioural competency. The detailed response is derived from more general and applicable functional requirements, as developed by FRAV. The acceptable ADS response will vary depending on whether the driving situation involves nominal, critical, or failure characteristics.		Revise for consistency. The text should not refer to FRAV (it would be approved by GRVA for submission to WP.29 to become a WP.29 document independent of FRAV). The requirements are specified under paras. 5.8., 5.9., and 5.10. FRAV may wish to clarify the general concept for establishing the validity of a behavioural concept. The concept appears to be that a behavioural competency is valid when it meets the high-level requirements, including compliance with traffic rules. In cases of deviation, a competency may still be valid based on a safety model (e.g., where the expected outcome of the ADS response under a scenario is a collision because the safety model demonstrates that the collision is unavoidable).
3.1.3.2.	The outcome of the analysis is a set of behaviour competencies that can be applied to the events characterizing the ODD. [Table 2] provides a qualitative example of a matching event – response.		
Table 2.			Refer to FRAV-31-19 for the original image.

3.1.3.3.	The combination of objects, events, and their potential interaction, as a function of the ODD, constitute the set of nominal or critical situations pertinent to the ADS under analysis.		
3.2.	Nominal situation competencies.		Consider alignment with “scenario” definitions.
3.2.1.	In these situations, ADS competencies can often be derived by applying traffic laws of the country where the ADS is intended to operate, as well as by applying general safe driving principles for situations not addressed adequately by current traffic laws for human drivers. Examples of such competencies may include adherence to legal requirements to maintain a safe distance from vehicles ahead, provide pedestrians the right of way, obey traffic signs and signals, etc. Of course, some nominal competencies (e.g., safe merging, safely proceeding around road hazards) may not be explicitly articulated or mandated by traffic laws. In some instances, traffic laws may provide wide discretion for the driver to determine the safest response to a particular situation (for example, how to respond to adverse weather conditions). As such not all traffic laws are stated with sufficient specificity to provide a clear basis for defining a competency.		Consider direct reference to annex on codification of traffic rules.

3.2.2.	Therefore, an approach to codify rules of the road to provide additional specificity was developed in Paragraph [6]. Additionally, application of models involving safe driving behaviour may be needed in addition to reference to codified rules of the road in developing behavioural competencies for nominal driving situations.		Consider direct reference to annex on codification of traffic rules.
3.3.	Critical situation competencies.		Consider alignment with “scenario” definitions.
3.3.1.	The development of these competencies requires analysis of (1) what constitutes such unreasonable behaviour by ORUs and/or a sudden change of the operating conditions that are not reasonably foreseeable and (2) what constitutes an appropriate ADS response to avoid or mitigate the imminent crash. Additionally, it is also important to identify the occurrence of unplanned emergent behaviour in critical situations.		
3.3.2.	Analysis of the first type may be based on a variety of methodologies, including e.g. IEEE 2846-2022 (which offers guidance on what behaviours by other road users are reasonably foreseeable) and other models of reasonable driving behaviour. Analysis of the second factor may be based on various models of acceptable human driving behaviour in crash imminent situations.		Consider direct reference to the annex on development of safety models.
3.3.3.	Hazard identification methods (e.g. STPA as mentioned in SAE J3187) which analyse the system design for functional and operational insufficiencies can help identify the occurrence of emergent behaviour which may lead to critical situations.		Consider relevance to/alignment with VMAD Audit pillar provisions.

Table 3.	[PLACEHOLDER [Include a table with example of ORU unreasonable behaviour – running a red traffic light]		
3.3.4.	Development of behavioural competencies for critical driving situations faces several challenges. No general consensus exists on the appropriate models for the behaviour of ORUs or appropriate responses by the ADS to unreasonable ORU behaviours that make a crash imminent.		Consider based on “safety model” draft text when available.
3.4.	Failure situation competencies.		Consider alignment with “scenarios” definitions.
3.4.1.	FRAV requirements include management of various failure modes. As noted above, failure situations involve those in which the ADS or another vehicle system experiences a fault or failure that removes or reduces the ADS’s ability to perform the DDT, such as sensor or computer failure or a failed propulsion system.		Remove reference to FRAV. Link to para. 5.10. on DDT performance under failure scenarios.
3.4.2.	In developing the behavioural competencies appropriate for failure situations, the objective is to describe the ability of the ADS to detect and respond safely to specific types of faults and failures. Depending upon the nature and extent of the fault or failure, the responses can include identifying a minor fault for immediate repair after trip completion, responding to a significant fault with restrictions (such as limp-home mode) for the remainder of the trip, or responding to major failures by achieving a minimal risk condition. Communication of the fault or failure condition to vehicle users may also be a desirable ADS behavioural competency.		Consider referencing relevant requirements under para. 5.10.

3.4.3.	An example of Failure Competencies is reported in [Table 4].		
Table 4.	PLACEHOLDER [Insert table with example of Failure Competences]		
4.	Scenario identification.		FRAV may wish to consider positioning scenarios before behavioural competencies given the all the references to scenarios in the preceding paragraphs. Reconcile use of "scenario generation" and "scenario identification".
4.1.	To ensure that the behavioural competences identified in the previous paragraphs are ready to be assessed through the application of simulations or physical testing, ODD-relevant scenarios must be developed. Scenario creation involves use of assumptions concerning the actions of road users that incorporate realistic parameters.		Reconcile term "scenario creation". Consider alignment with VMAD methods (e.g., "virtual testing", "track testing", "real-world testing"/"real-world test drive").
4.2.	This approach suggests two complementary methodologies to derive reasonably expectable situations which might occur for a given ODD: • Knowledge-based (e.g., goal-based) • Data-based.		"Reasonably expectable situations" == "reasonably foreseeable scenarios" (for consistency with definitions)? Consider choosing either "knowledge-based" or "goal-based" to avoid inconsistent terminology in text.

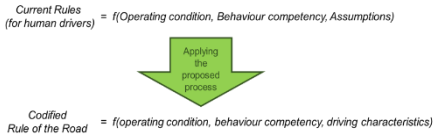
4.2.1.	A knowledge-driven scenario generation approach utilizes domain specific (or expert) knowledge to identify hazardous events systematically and create scenarios. A data driven approach utilizes the available data (e.g. accident databases, insurance records) to identify and classify occurring scenarios. [Figure x] illustrates various data-based and knowledge-based scenario generation methods.		Consider sections to differentiate and address knowledge-based and data-based scenario development? The text mixes the two approaches and appears to direct the reader to the "rules of the road" annex for knowledge-based scenario generation and to the "safety models" annex for data-based scenario generation.
Figure 1.			Refer to FRAV-31-19 for original figure.
4.2.2.	Accident datasets and field data can be analysed to identify accident hotspots and scenario parameters which contribute to causation of accidents carrying high levels of severity.		
4.2.3.	Knowledge based methods, or other formal techniques can be used to analyse the characteristics of the ADS architecture and identify system failures and hazardous situations [see SAE J3187]. The analysis is then converted into a set of abstract/logical scenarios together with their corresponding pass/fail criteria.		

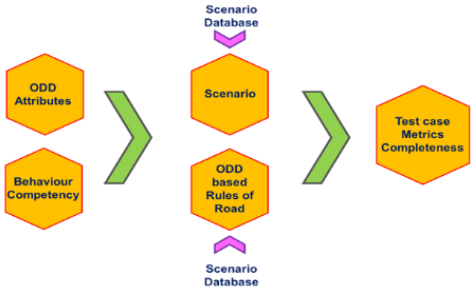
4.2.4.	Other knowledge-based methods include the formal analysis approach with the highway code rules for scenario generation. Each of the highway code rules describes a hypothetical driving scenario with the corresponding behaviour and ODD elements. The ODD is a specification set out by the manufacturer of an ADS and it defines the operating conditions within which the ADS can operate safely. Formal models are generated via a model template to create the mathematical representations of those scenarios, collecting the combinations of ODD and behaviour parameters. The analysis reports the manoeuvre parameters that are close of violating the pass criteria and produce scenarios that represent these set of violations. Other knowledge-based methods use formal representation of the ODD and behaviour competencies of the ADS for scenario generation.		
4.2.5.	Furthermore, the existing scenarios already defined in the standards, regulations, or guidelines (Option 6 - KB) can also be utilized for the testing of ADS, for example the scenarios set out in ISO 22737 and NCAP. ISO 22737 has been developed for low-speed automated driving systems (LSAD) and the NCAP provides a set of testing scenarios for the safety assurance of vehicles. Option 7 (DB) includes the scenarios that occur during real world trials and deployments. Such scenarios might have not been considered pre-deployment but are key learnings.		Review for clarity. What do “Option 6” and “Option 7” refer to? The references to ISO and NCAP should be further considered. FRAV has not discussed these items. Are we singling out particular sources over other possible sources? Which “NCAP” is being referred to? Where is the exact location? In principle, the annex recommends procedures for generating scenarios relevant to assessing whether an ADS meets the performance requirements. Do the cited existing standards meet this aim?

4.3.	Assumptions: Logical to concrete.		
4.3.1.	Assumptions concerning the actions of other road users may need to account for cultural differences in driving styles in different geolocations, making it impracticable to harmonise these assumptions across different domains. Therefore, evidence should be provided to support the assumptions made. Existing standards e.g. IEEE 2846-2022 provide a set of assumptions to be considered by ADS safety-related models for an initial set of driving situations. Additionally, several other tools including data collection campaigns performed during the development phase, real-world accident analysis and realistic driving behaviour evaluations, constraint randomisation, Bayesian optimisation besides others can be used to inform values for such assumptions.		

5.	Application of Rules of Road as Pass criteria and requirements		Consider positioning within context of explanations of criteria/behavioural competencies. The order moves from criteria/competencies to scenarios and here back to criteria. Consider revision of section given the separate annex providing a fuller explanation of the methodology. In principle, the explanation in this annex might focus on the function of the traffic-rule codification method (i.e., the "rules of the road" annex provides a methodology for ensuring scenario coverage of traffic rules and situations that may arise within the ODD of an ADS feature and provides legal directives for driver responses that contribute to defining valid behavioural competencies under those scenarios).
5.1.	An approach to define an acceptance criterion related to nominal driving situations is to evaluate the ADS performance against the rules of the road. Furthermore, [FRAV ADS Safety Topics] mentions that "The ADS should comply with traffic rules" (in all driving conditions). It is challenging to test against this requirement in the absence of codified rules of the road.		Revise to remove reference to FRAV. The reference should be to para. 5.8.15. (Requirement to comply with traffic rules). "Acceptance criterion" seems to be a reference to "behavioural competencies". Consider revising "rules of the road" to "traffic rules" for consistency with the requirements.
5.2.	Codified rules of the road also enable the verification of the requirement "the ADS should comply with traffic rules".		Same as above.

5.3.	Development of functional requirements and test scenarios involves careful description of the behaviours of the road users and the physical circumstances (i.e. the scenery) in which the behaviours occur. If one compares the scope of ODD and the content of current rules of the road for human drivers (e.g., UK's Highway Code or the 1968 Vienna Convention, Chapter 2), a large overlap of scenery aspects and environmental conditions aspects can be observed. It is plausible to follow an ODD based approach and an ODD taxonomy, to model the environmental and scenery aspects of the rules of the road. In addition, road user behaviours need to be described. Behaviour can be further divided into ego (vehicle under test) behaviours and actor behaviours. The relevant behavioural competency describes the expected and measurable behaviour of the ego vehicle in the scenario.		FRAV agreed to use "safety requirements" rather than "functional requirements" and the text refers to "traffic scenarios" rather than "test scenarios". Given the international scope of the guidelines, it may be preferable not to single out the UK Highway Code in this specific paragraph.
5.4.	Any rule of the road can be classified into two categories: • Doing some behaviour somewhere • Not doing some behaviour somewhere.		
5.5.	While doing or not doing some behaviour can be defined as part of ADS's behaviour competencies, "somewhere" could be considered as part of the "operating condition" or part of the ODD definition. The approach is summarised in [Figure 2].		

Figure 2.			Refer to FRAV-31-19 for full-sized figure.
5.6.	**Example:** The UK Highway Code (HC)[1], Rule 195 states (Zebra crossing): *"As you approach a zebra crossing: look out for pedestrians waiting to cross and be ready to slow down or stop to let them cross; you MUST give way when a pedestrian has moved onto a crossing"*.		
Figure 3.	 *Figure 1: Example of zebra crossing from UK's Highway Code:* *Source: https://www.gov.uk/guidance/the-highway-code/rules-for-pedestrians-1-to-35#rule19*		Refer to FRAV-31-19 for full-sized figure.
5.7.	From this rule, one can extract the "operating condition or ODD" variables, as well as the behaviour competencies. While "zebra crossing" and "pedestrian" define the operating condition; and "slow down or stop" defines the behaviour competency, the rule doesn't mention how long should the vehicle be stopped. This is an implicit assumption made by the driver. However, for ADSs, such assumptions will need to be specified. We foresee such assumptions being specific to countries, regions, and cultures.		

5.8.	The proposed process helps makes the "implicit assumptions" in the rules for human drivers into explicit rules. In other words, the proposed process enables to turn "undefined" attributes in the rules of the road (for human drivers) to "defined" attributes in the codified rules of the road.		Consider "recommended" rather than "proposed" given the context of the document.
5.9.	Using rules of the road as pass criteria.		
5.9.1.	[Figure 10] illustrates the use of codified rules of the road as a pass criterion for scenario-based testing activities. Every test scenario definition will have ODD and behaviour competency attributes defined. Every rule of the road will also have ODD and behaviour competency attributes as part of its definition. Therefore, it is possible to map every scenario to a corresponding rule(s) of the road using ODD and behaviour tags or labels in a scenario catalogue (VMAD SG1).		Remove reference to VMAD. In principle, the document would refer to the NATM Scenario Catalogue.
Figure 4.			Refer to FRAV-31-19 for full-sized figure.

5.9.2.	This approach would allow the test engineer to map each scenario to a corresponding rule (or set of rules). These rules can then serve as the pass criteria during the scenario-based testing approach. This approach can thus enable engineers and authorities to show/assess compliance to traffic rules by making the rules of the road verifiable		Consider revising for consistency with the purpose of the document (i.e., guidelines for ADS safety requirements for application under the WP.29 Agreements; verifiable performance criteria rather than enabling "test engineers and authorities…").
6.	Application of Safety Models as pass criteria and requirements for critical situations		Consider positioning within context of explanations of criteria/behavioural competencies. The order moves from criteria/competencies to scenarios to criteria here. Consider revising given the separate annex on safety-model development to focus on the usage of safety models in assessing compliance with requirements. In principle, safety models enable the establishment of valid behavioural competency relevant to scenarios where deviation from the high-level requirements is unavoidable (e.g., the expected outcome is a collision, evasive manoeuvre, etc.).

6.1.	The aim of this section is to further specify the methodology to derive the threshold to separate between collisions that have to be avoided and those where only mitigation is required. The aim is NOT to prescribe a specific behaviour of the ADS in any given critical situation; this is only about the outcome. In a mathematical & logical sense, for any given situation, there will be a function depending on variables that partly describe scenario, delivering a Boolean "true" or "false" for whether the collision needs to be avoided, and vice versa for whether mitigation is acceptable: $Avoidance[0;1] = f_{safetymodel}(scenario\ variable\ 1, scenario\ variable\ 2, \dots)$, $Mitigation[0;1] = 1 - f_{safetymodel}(scenario\ variable\ 1, scenario\ variable\ 2, \dots)$.		Refer to FRAV-31-19 for full-sized equations example.
6.2.	It is envisioned that concrete ADS regulations, built using the guidelines as specified here, may contain either a concrete scalar threshold (example: avoid accidents for a driving speed below 42 km/h, see UN R152), or formulate a concrete $f_{\text{safetymodel}}$ where all parameters are specified (simplified example from UN R157: when cut-ins of other vehicles occur before a specific TTC, the collision needs to be avoided, the resulting function would be: $f_{\text{safetymodel}}$ = [1 for $TTC_{LaneIntrusion} > (v_{rel}/(2 \cdot 6\text{m/s}^2) + 0.35s)$; 0 otherwise].		Remove references to UN Regulations. The FRAV mandate stipulates guidelines applicable under all WP.29 Agreements.

6.3.	Choosing appropriate model(s) depends, amongst others, on: • the balance between risk to the ADS itself vs. risk towards the accident partner (e.g. for pedestrians, it would very likely be acceptable to have a slightly increased risk for the typically belted ADS occupants when the risk for the pedestrian would be significantly reduced, e.g. by earlier or stronger brake intervention), • the assumed anticipation level *(e.g. is it feasible to anticipate actions of other traffic parameters and start countermeasures earlier, or will it be a simple reaction to faults),* • the environmental condition parameters. *(e.g. what level of friction is typically available where the ADS are travelling),* • the balance between efficiency and acceptable remaining risk *(e.g. passing a pedestrian with no acceptable risk would be possible only with very low speeds, which would render the current sidewalk close to streets infrastructure useless).*		

6.4.	These factors will be different for different situations, or in other words: there would be different $f_{safetymodel,i}$ for different critical situations anticipated to occur in the operational domain of the concrete ADS regulation in pseudo-code: Example Regulation XXX = {Situation / parameter range 1, avoidance = $f_{safetymodel,1}$(parameters *a*,*b*,*c*); # address pedestrian accidents in urban areas Situation / parameter range 2, avoidance = $f_{safetymodel,2}$(parameters *d*,*e*,*f*); # address car-car accidents with cut-in on motorways…}.		
6.5.	The following paragraphs summarize the safety performance models that can be used to assess the behavioural competency of an ADS based on the scenario.		

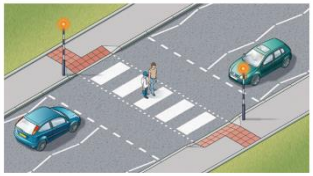
6.5.1.	Review of Safety Models		

6.5.1.1.	Based on an initial literature review, safety performance models for the ADS behaviour include:
	• Careful & Competent human driver (CC, Ref.: UNECE Reg. 157 Annex 3 §3.3).
	  ○ *This model assumes the characteristics of a typical driver with regard to threat detection, reaction time delay, brake application to identify what a human intervention to e.g. a cut-in maneuver would be.*
	• Fuzzy Surrogate Safety Model (FSSM, Ref.. UNECE Reg. 157 Annex 3 §3.4).
	• Kinematic Lane Change (K-LC).
	• Last-Point-to-Steer (LPS, Ref.: AEBS HDV 03.03).
	  ○ *This model assumes an emergency braking intervention in longitudinal traffic is justified as soon as a collision cannot be avoided by steering (=the last past to steer has passed). Typically, the last point to steer for speeds > ca. 30 km/h is later than the last point to brake.*
	• Responsibility Sensitive Safety (RSS, Ref.: Shalev-Shwartz et al., 2017).
	• Safety Force Field (SFF, Ref.: D.Nister et al., 2019).
	• Safety Zone (SZ, Ref.: AEBS HDV 03.03).
			Ensure references to UN Regulations as citations (i.e., direct quote, not using UN Regulation as an example). If citation, use footnote to cite the source.

7.	Performance Evaluation and Targets		
7.1.	As previously highlighted, nominal situations are considered reasonably foreseeable and preventable for a given ODD and therefore it is expected that the ADS would be capable of handling them without any resulting collision.		
7.2.	On the other hand, failure situations are performed to assess the ADS ability to recognise faults / failures in the system and respond in compliance with the principles highlighted by FRAV.		Remove reference to FRAV.
7.3.	For the purpose of defining performance criteria in critical situations, those where others are at fault & behaving unforeseeable and the collision might potentially not be prevented have to be analysed further. In these situations, it is proposed that safety models are used to explore and compare the ADS performance with mathematical formulations to derive what is deemed as preventable or where mitigation strategy is needed.		

Annex B.	An Approach to Defining Codified Rules of the Road		Reconcile use of "traffic rules" in the requirements with "rules of the road" here. Consider further alignment with requirements and main body (e.g., references to requirements, etc.) Clarify what specifically is being proposed/recommended (e.g., clarify how this framework would be used in assessing compliance with requirements under the NATM? How do the outcomes of this framework factor into the NATM? The framework appears to provide a method for ensuring that scenarios cover the situations described in traffic rules applicable to the ODD of the ADS feature(s) and that behavioural competencies associated with these scenarios are valid per the traffic rules.). Is FRAV proposing that manufacturers demonstrate that traffic rules applicable to the ODD of the ADS feature(s) have been codified? Note that images must be editable by the UNECE translation services.
1.	This annex presents a framework for codifying the rules of the road to govern the behaviour of ADSs. The approach may be used to define "good behaviour" to inform validation and verification processes (including for scenario-based testing) for nominal scenarios.		

2.	Current rules of the road (for human drivers) have three components: *Rule of road* (for human drivers) = *Operating condition + Behaviour competency + Assumptions (implicit)*		
3.	Operating conditions include both ODD aspects and vehicle states (e.g., system failures, hardware failures etc.). Every set of traffic laws or behaviour rules (for human drivers) defined in any country are based on an understanding of the expected behaviours of human drivers. As a result they do not explicitly define all aspects of the expected driving behaviour but can be argued to include "implicit assumptions" based on this understanding.		
4.	Following the process (illustrated in section 4), a "codified" rule of the road for an automated driving system, will also have three components: Codified Rule of road = Operating condition + Behavioural competency + Driving decisions		Consider clarification/alignment with concepts presented in main body (i.e., DDT, behavioural competencies, scenarios, etc. definitions). The DDT is described as perception, planning and decision, and control. Behavioural competency is the expected behaviour. Perception seems related to "operating condition" (related to "traffic scenario"?). "Driving decisions" related to "planning and decision"? Could an order aligned with main body be "traffic scenario + planning and decision + behavioural competency"?
5.	The process of codification helps identify where "implicit assumptions" about driving behaviour are present in the rules for human drivers. The codified rules of the road help to turn "undefined" attributes in the rules of the road (for human drivers) to "defined" attributes in the codified "rules of the road".		Consider alignment with scenario generation and behavioural competencies (i.e., how traffic rules may describe a traffic scenario and expected/required driver response/behaviour).

6.	Taking an example of the UK road rules where behaviour (for human drivers) is governed by the Highway Code (HC)[6], the methodology is further explained. UK's Highway Code Rule 195 states (Zebra crossing): *Rule 195: "As you approach a zebra crossing: look out for pedestrians waiting to cross and be ready to slow down or stop to let them cross; you MUST give way when a pedestrian has moved onto a crossing"*		
Figure 1.	 *Figure 1: Example of zebra crossing from UK's Highway Code:* *Source: https://www.gov.uk/guidance/the-highway-code/rules-for-pedestrians-1-to-35#rule19*		Refer to FRAV-33-39 for full-sized image.

[6] UK Highway Code: https://www.gov.uk/guidance/the-highway-code.

7.	From this rule, one can extract the "operating condition or ODD" variables, as well as the behaviour competencies. "Zebra crossing" and "pedestrian" define the operating condition; and "slow down or stop" defines the behaviour competency. However, the rule doesn't mention for how long the vehicle should be stopped, or when it is considered safe to proceed again. There is an "implicit assumption" made based on typical human (the driver behaviour), and it is not considered necessary for the rule to define this. However, for an ADS, such assumptions how long the vehicle is stopped for, and when it moves off again will be determined by the automated driving system and its analysis of the relevant parameters specific to that situation and will need to be specified. For every concrete scenario being tested, the driving decisions exhibited by ADS will need to be explainable.		
8.	Figure 2 illustrates this process. After following the codification process of defining the "rules of the road", there will be no underlying "assumptions" (see section 4). Furthermore, for all areas or jurisdiction or country, there will be a minimum set of behaviour code rules which will have consistent "driving characteristics" – the base or common set of rules of the road (for ADS).		
Figure 2.			Refer to FRAV-33-39 for full-sized image.

9.	The codification methodology is a four-step process.		Reconcile “step” and “phase”.
9.1.	Step 1: Identify terms and construct a vocabulary: The natural language text of the rule is analysed and words that are associated with the ODD or behaviour of actors in the rule are identified. These terms taken together are used to identify the component of the rule that can be codified.		
9.2.	Phase 2: Identify unspecified terms: Some terms are unclear because they are not unequivocal or absolute and therefore require clarification. In some cases, these terms are codified as is, when a meaning can be inferred, while in others, comments are provided to highlight why the terms are not defined, and how they may be elaborated.		
9.3.	Phase 3: Query / Update/ Add ODD and Behaviour terms: Terms defining predicates (representing facts whose truth may be evaluated) and functions (representing non-Boolean properties – such as ADS attributes, action labels) are identified. The codified rule will consist of these predicates and functions. The outcome of Phase 3 is an intermediate rule that is in its minimal form.		

9.4.	Phase 4: Express rule in first order logic: For each rule of the road, a single codified rule, or a set of rules are written. The predicates and functions identified in Phase 3, together with the structure of constraints from Phase 1 are used to construct the rule(s). The output of Phase 2 provides insights concerning the rule and gaps that exist in its codification. Phase 4 uses the vocabulary to identify which sub-rules are to be converted to First Order Logic and then perform the conversion.		
10.	Codification Example: Rule 162 (of the UK Highway Code).		
10.1.	Rule 162 of the UK's Highway Code is used to illustrate the four phases of the codification process. The rule is stated below.		
10.1.1.	Rule Text Before overtaking you should make sure - the road is sufficiently clear ahead - road users are not beginning to overtake you - there is a suitable gap in front of the road user you plan to overtake.		
10.2.	The following sections take this rule through each phase, explaining how each component of the codification process works.		
10.2.1.	Phase 1: Identify Terms and Construct a Vocabulary		

10.2.1.1.	In this phase, terms are identified to generate a vocabulary of predicates. The terms extracted from the ruleset are those relevant to: • ODD (Scenery, Actor, Environment) & Behaviour • Rule/Parameter qualifiers: such as 'when', 'limit', 'does not mean', etc. which affect the meaning of the statement • Other important terms that need to be reviewed and clarified in Phase 2.		
10.2.1.2.	Sub-rules that do not contain rules that are actionable for an ADS are not codified.		
10.2.1.3.	Example: Rule 162 (Phase 1: Identify Terms) The rule is re-stated below highlighting important terms. **Before overtaking** you should **make sure** the **road** is **sufficiently clear ahead** **road users** are **not beginning** to **overtake you** there is a **suitable gap in front of the road user you plan to overtake**. Terms that are ODD and behaviour related are in bold and underline, while other terms that are relevant to giving the rule meaning are in bold.		Refer to FRAV-33-39 for full-sized image.

10.2.2.	Phase 2: Identify Unspecified Terms		
10.2.2.1.	Using domain specific concepts, each minimal statement is fleshed out to clarify any underspecified (unquantified) terms, ambiguous or abstract terms. For instance, if a broad statement is made requiring further qualification, such as, “unsafe road layouts or junctions”, it must be identified that a further qualification is necessary and what this may look like. In this case, it is important to specify which road layouts or junctions are unsafe. This may be done using relative terms – for instance, with respect to the ODD of the vehicle or in absolute terms – enumerating a list of unsafe road layouts and junctions. This should however not be confused with a rule that expresses a general requirement where the absence of specification of an ODD concept makes the rule applicable to all instances of that concept. For instance, if road type or weather condition is not qualified in the rule’s text, then the rule is applicable to all roads and weather conditions. It is only the vague components of a rule that must be fleshed out to make the rule complete from the perspective of an ADS.		Clarify “domain specific”. Clarify “ODD concept”. Consider explanation given the ODD description as required in para. 4.9.
10.2.2.2.	Example: Rule 162 (Phase 2: Identify Unspecified Terms)		
10.2.2.2.1.	This phase involves the identification of the terms that are unclear and that need to be clarified. These are the terms that are absolute so make the rule subjective and hence need to be investigated and resolved.		

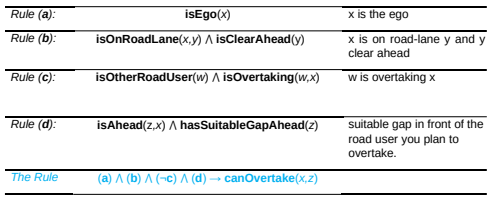
<table>
<tr><td>10.2.2.2.2.</td><td>From the example above, the terms that do not remain fully specified are as follows:

<table><tr><th>Term</th><th>Specification Required</th></tr><tr><td>Sufficiently clear ahead</td><td>How is sufficiently clear ahead defined? Time To Collision (TTC) of any oncoming vehicle evaluated against time for maneouvre</td></tr><tr><td>Suitable gap</td><td>What is a suitable gap? Twice the stopping distance may be a good definition to consider.</td></tr><tr><td>*Overtaking is an action that is applicable to vehicles that are ahead of the ego*</td><td>This is an assumption that is understood by a human reader.</td></tr></table></td><td></td><td>Refer to FRAV-33-39 for full-sized image.</td></tr>
<tr><td>10.2.3.</td><td>Phase 3: Identify Predicates and Functions</td><td></td><td></td></tr>
<tr><td>10.2.3.1.</td><td>In this phase, each rule is reduced to its minimal form by identifying predicates and functions that form the core facts of the rule. These are the terms that provide meaning to the rule. Once terms are identified, it is important to establish which terms are synonyms or antonyms. For terms that are synonymous, a single term is chosen to be used in place of all terms that are equivalent in meaning to it. In this manner a normalized vocabulary may be constructed.</td><td></td><td></td></tr>
<tr><td>10.2.3.2.</td><td>This exercise focuses on the key aspects of the rule of the road and eliminates the unimportant phrases or terms that cannot be actioned as part of this process.</td><td></td><td></td></tr>
</table>

<table>
<tr><td>10.2.3.3.</td><td>Example: Rule 162 (Phase 3: Identify Predicates and Functions)</td><td></td><td></td></tr>
<tr><td>10.2.3.3.1.</td><td>The non-highlighted terms are removed and only terms that are important to the meaning of the rule are kept.

Before overtaking make sure
• road sufficiently clear ahead
• road users not beginning to overtake you
• suitable gap in front of the road user you plan to overtake.</td><td></td><td>Refer to FRAV-33-39 for full-sized image.</td></tr>
<tr><td>10.2.3.3.2.</td><td>The terms identified are converted into predicates. For Rule 162, we construct the following predicates:

<table><tr><th>Predicate</th><th>Description</th></tr><tr><td>isEgo(x)</td><td>x is the Ego</td></tr><tr><td>isAhead(x,y)</td><td>x is ahead of y</td></tr><tr><td>isOtherRoadUser(x)</td><td>x is a non-Ego object</td></tr><tr><td>isSufficientlyClearAhead(x)</td><td>x is sufficiently clear ahead</td></tr><tr><td>isOvertaking(x,y)</td><td>x is overtaking y</td></tr><tr><td>hasSuitableGapAhead(x)</td><td>There is a suitable gap ahead of x</td></tr><tr><td>canOvertake(x,y)</td><td>x can overtake y</td></tr><tr><td>isOnRoadLane(x,y)</td><td>x is on road-lane y</td></tr></table></td><td></td><td>Refer to FRAV-33-39 for full-sized image.</td></tr>
<tr><td>10.2.4.</td><td>Phase 4: Express Rule in First Order Logic</td><td></td><td></td></tr>
<tr><td>10.2.4.1.</td><td>Each rule is then expressed using the normalized vocabulary in first-order logic. The normalized vocabulary is a collection of predicates and predicate parameters, representing concepts in the rule of the road, that are re-used across the codified ruleset.</td><td></td><td></td></tr>
</table>

10.2.4.2.	Phase 4: Express Rule in First-Order Logic		Continuation of example?
10.2.4.2.1.	Rule 162 is a rule that identified whether an overtake manoeuvre can be performed. If the conditions of the rule are true, then an overtake manoeuvre can be acted upon, otherwise it must be abandoned. Further, this rule implicitly also identifies which actor the ego can overtake.		
10.2.4.2.2.	For ease of understanding, the rule may be broken down into four logical statements, that are logically related, with the relationship being stated as the last rule. The predicates that were produced as an outcome of Phase 1 are used to construct the logic specification for the rule.		
10.2.4.2.3.	The parameters for the rules: the ego vehicle (x), the lane (y), other actor (w), and actor being overtaken (z).		
10.2.4.2.4.	The rules are as follows:  *Rule (a):* **isEgo**(*x*) — x is the ego *Rule (b):* **isOnRoadLane**(*x,y*) ∧ **isClearAhead**(*y*) — x is on road-lane y and y clear ahead *Rule (c):* **isOtherRoadUser**(*w*) ∧ **isOvertaking**(*w,x*) — w is overtaking x *Rule (d):* **isAhead**(*z,x*) ∧ **hasSuitableGapAhead**(*z*) — suitable gap in front of the road user you plan to overtake. *The Rule:* **(a)** ∧ **(b)** ∧ (¬**c**) ∧ **(d)** → **canOvertake**(*x,z*)		See FRAV-33-39 for full-sized image.
10.2.4.2.5.	The symbol "¬" when used as a prefix to a logic sentence (such as "c" which denotes Rule (c)) indicates the negation of the logic sentence. In this context, in English, the rule may be read as: If "a" is true, and "b" is true, and "c" is false, and "d" is true, then x can overtake z. The truth asserted is hierarchically asserted within the sub-rules.		

10.3.	Codification Example: Rule from the 1968 Vienna Convention		Note: There may be some sensitivity in reference to 1968 Vienna Convention: Not all WP.29 Contracting Parties adhere to the Convention (i.e., consider whether example may be taken from the 1949 Geneva Convention).
10.3.1.	The rule is stated below (Chapter 2 – Rules of the Road – Article 11 (Overtaking – 11)).		
10.3.1.1.	VC Rule Text *A vehicle shall not overtake another vehicle which is approaching a pedestrian crossing marked on the carriageway or signposted as such, or which is stopped immediately before the crossing, otherwise than at a speed low enough to enable it to stop immediately if a pedestrian is on the crossing.*		
10.3.2.	The following sections take this rule through each phase, explaining how each component of the codification process works.		

<table>
<tr><td>10.3.2.1.</td><td>Phase 1: Identify Terms and Construct a Vocabulary</td><td></td><td></td></tr>
<tr><td>10.3.2.1.1.</td><td>Example: VC Rule (Phase 1: Identify Terms)</td><td></td><td></td></tr>
<tr><td>10.3.2.1.2.</td><td>The rule is re-stated below highlighting important terms.

A vehicle shall not <u>overtake</u> another <u>vehicle</u> which is <u>approaching</u> a <u>pedestrian crossing</u> marked on the <u>carriageway</u> or <u>signposted</u> as such, or which is <u>stopped immediately</u> before the <u>crossing</u>, otherwise than at a <u>speed</u> <u>low enough</u> to enable it to <u>stop</u> <u>immediately</u> if a <u>pedestrian</u> is on the <u>crossing</u>.

Terms that are ODD and behaviour related are in bold and underline, while other terms that are relevant to giving the rule meaning are in bold.</td><td></td><td></td></tr>
<tr><td>10.3.2.2.</td><td>Phase 2: Identify Unspecified Terms</td><td></td><td></td></tr>
<tr><td>10.3.2.2.1.</td><td>Example: VC Rule (Phase 2: Identify Unspecified Terms)</td><td></td><td></td></tr>
<tr><td>10.3.2.2.2.</td><td>From the example above, the terms that remain underspecified are as follows:

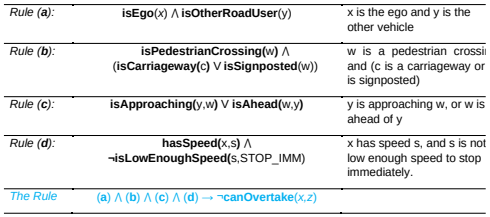
<table><tr><th>Term</th><th>Specification Required</th></tr><tr><td>Immediately</td><td>How is immediately defined? A distance may be used to define this.</td></tr><tr><td>Low enough</td><td>What speed is considered low enough? This could be a function of distance to the pedestrian, or an absolute threshold.</td></tr><tr><td>*Overtaking is an action that is applicable to vehicles that are ahead of the ego*</td><td>This is an assumption that is understood by a human reader.</td></tr></table></td><td></td><td>See FRAV-33-39 for full-sized image.</td></tr>
</table>

<table>
<tr><td>10.3.3.</td><td>Phase 3: Identify Predicates and Functions</td><td></td><td></td></tr>
<tr><td>10.3.3.1.</td><td>Example: VC Rule (Phase 3: Identify Predicates and Functions)</td><td></td><td></td></tr>
<tr><td>10.3.3.2.</td><td>The non-highlighted terms are removed and only terms that are important to the meaning of the rule are kept.

Shall not <u>overtake</u> <u>another vehicle</u>
• <u>approaching</u> <u>pedestrian crossing</u> on <u>carriageway</u> or <u>signposted</u>,
• or <u>stopped</u> <u>immediately</u> before <u>crossing</u>,
otherwise <u>speed</u> <u>low enough</u> enable <u>stop immediately</u> if <u>pedestrian</u> on <u>crossing</u>.</td><td></td><td></td></tr>
<tr><td>10.3.3.3.</td><td>The terms identified are converted into predicates. For the VC Rule, we construct the following predicates:

<table>
<tr><th>Predicate</th><th>Description</th></tr>
<tr><td>isEgo(x)</td><td>x is the Ego</td></tr>
<tr><td>canOvertake(x,y)</td><td>x can overtake y</td></tr>
<tr><td>isApproaching(x,y)</td><td>x is approaching y</td></tr>
<tr><td>isPedestrianCrossing(x)</td><td>x is a pedestrian crossing</td></tr>
<tr><td>isCarriageway(x)</td><td>x is a carriageway</td></tr>
<tr><td>isSignposted(x)</td><td>x is signposted</td></tr>
<tr><td>isStopped(x)</td><td>x is stopped</td></tr>
<tr><td>isAhead(x,y)</td><td>x is ahead of y</td></tr>
<tr><td>hasSpeed(x,y)</td><td>x has speed y</td></tr>
<tr><td>isLowEnoughSpeed(x,y)</td><td>x is a low enough speed for action y</td></tr>
</table>
</td><td></td><td>See FRAV-33-39 for full-sized image.</td></tr>
</table>

10.3.4.	Phase 4: Express Rule in First Order Logic		
10.3.4.1.	Phase 4: Express Rule in First-Order Logic		
10.3.4.2.	The rule determines overtaking behaviour for a vehicle that is close to a pedestrian crossing. The rule contains conditions that would prevent a vehicle from overtaking another, but simultaneously provides an exception, that of being slow enough to stop. Further, the ability of the vehicle to stop is independent of whether there is an actor (such as a pedestrian) on the crossing. The rule makes references to the vehicle having a slow enough speed to stop immediately, which has been identified as an ambiguous phrase and represented as a predicate in Phase 3. To represent the action of stopping immediately, we use the constant "STOP_IMM".		
10.3.4.3.	For ease of understanding, the rule may be broken down into four logical statements, that are logically related, with the relationship being stated as the last rule. The predicates that were produced as an outcome of Phase 1 are used to construct the logic specification for the rule.		
10.3.4.4.	The parameters for the rules: the ego vehicle (x), the other actor (y), the pedestrian crossing (w), the carriageway (c), the speed of the ego (s).		

10.3.4.5.	The rules are as follows:  *Rule (a):* **isEgo**(*x*) ∧ **isOtherRoadUser**(y) — x is the ego and y is the other vehicle *Rule (b):* **isPedestrianCrossing**(w) ∧ (**isCarriageway**(c) ∨ **isSignposted**(w)) — w is a pedestrian crossi and (c is a carriageway or is signposted) *Rule (c):* **isApproaching**(y,w) ∨ **isAhead**(w,y) — y is approaching w, or w is ahead of y *Rule (d):* **hasSpeed**(x,s) ∧ ¬**isLowEnoughSpeed**(s,STOP_IMM) — x has speed s, and s is not low enough speed to stop immediately. *The Rule* (**a**) ∧ (**b**) ∧ (**c**) ∧ (**d**) → ¬**canOvertake**(*x*,*z*)		See FRAV-33-39 for full-sized image.
10.3.4.6.	The symbol "¬" when used as a prefix to a predicate indicates the negation of the predicate. In this context, in English, the rule may be read as: If "a" is true, and "b" is true, and "c" is true, and "d" is true, then x cannot overtake z. Note that the exception condition, that of being slow, is used in its negative form to assert that the vehicle cannot overtake, since this is explicit in the rule. It is left to interpretation if a positive rule, specifically allowing the vehicle to overtake is necessary. If so, a new rule that allows a vehicle to overtake must be written. This would depend on the interpretation of the rule.		
10.4.	Bibliography		
10.4.1.	NHTSA - A Framework for Automated Driving System Testable Cases and Scenarios[7]		
10.4.2.	Waymo's Safety Report (see behaviour competencies)[8]		

[7] https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/13882-automateddrivingsystems_092618_v1a_tag.pdf
[8] https://storage.googleapis.com/waymo-uploads/files/documents/safety/2021-03-waymo-safety-report.pdf

10.4.3.	CETRAN - Scenario Categories for the Assessment of Automated Vehicles[9]		
Annex C	[Safety models.]		

[9] https://cetran.sg/wp-content/uploads/2020/01/REP200121_Scenario_Categories_v1.7.pdf