Submission to NTC
Discussion paper – Clarifying control of automated vehicles

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Prepared by ADVI Centre of Excellence

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Australia & New Zealand Driverless Vehicle Initiative

1. Preamble

What is ADVI?

The Australia and New Zealand Driverless Vehicle Initiative (ADVI) is the national peak advisory body for autonomous vehicle technology and is a trusted adviser to government and industry partners.

Led and coordinated by the Australian Road Research Board (ARRB), the ADVI initiative is now a cooperative partnership program comprising of more than 100 Australian and international organisations, and is funded by partners from a range of sectors.

ADVI has three core programs of work:

1. Scientific research: field trial development and evaluation, research programme development, knowledge transfer and dissemination, scientific quality and rigour.
2. Informing policy and risk: identification of emerging risks and concerns, social research, development of position papers and supporting materials.
3. Media and advocacy: promotion and public participation, industry and media engagement, government relations and public awareness.

The ADVI initiative is managing the safe and successful introduction of driverless vehicles onto Australian roads, and will ultimately position Australia as an international role model in the development of new technologies and attract developers, innovation and investors.

ADVI brought the first successful on-road test of a driverless vehicle anywhere in the southern hemisphere, and more on-road testing in real-world conditions will be a key part of future research and evaluation efforts. ADVI and ADVI partners individually have, and continue to, work very closely with the Police across the nation, to safely run events, pilots and demonstrations on and around public roads. To this end we are well placed to understand the importance of enforcement agencies to support and protect the interests of the community in relation to these emerging technologies.

ADVI's role is to investigate and help inform the development of robust national policy; performance criteria; legislation; regulation; business models and operational procedures; and processes to pave the way for the introduction of self-driving vehicles to Australian roads.

Running parallel with those efforts, work is also underway to raise public awareness and encourage a change in mindset through knowledge-sharing, demonstrations, and simulated and in-field investigation trials.

Who to contact for further information?

The contact person for this submission is Ms Rita Excell Executive Director of the Australia and New Zealand Driverless Vehicle Centre of Excellence rita.excell@advi.org.au

2. Feedback relating to the NTC Clarifying control of automated vehicles discussion paper

Summary

ADVI welcomes the objectives of the "Clarifying control of automated vehicles discussion paper", April 2017. NTC as part of the ADVI collaboration has access to the widest ecosystem to rapidly explore how this emerging technology should be introduced into Australia and ADVI has drawn upon that expertise to inform this response.

While it is acknowledged that this discussion paper has been prompted from a request from the Ministerial Council to explore enforcement, we believe a focus on achieving compliance through developing a performance based criteria is an approach more appropriate than focussing on enforcement, which builds on the success of other performance based standards in Australia.

Clarifying what constitutes control for the purposes of the Australian Road Rules and other applicable legislation, is seen to be a necessary step in supporting the safe and successful introduction of existing, and future, automated and highly automated driving systems into Australia. Even though there may be some existing jurisdictional differences in legislative wording, ADVI supports a safety management system approach to addressing this issue of control - underpinned by the Safe System philosophy - which has been widely adopted in Australia, and an approach that works towards ensuring the definition of control is consistently adopted across Australia.

The Safe System recognises that the driver, the infrastructure and the vehicle play a key role in a crash occurring, with the last two being those that can be controlled and better managed to ensure that the severity of crashes when they do occur, do not cause death or serious injury to human life. It is important to note that currently the issue of control is legally relevant to more than just collisions/crashes and the injuries they cause.

The definition of 'control' serves to define whether a vehicle user/driver is in breach of the Australian Road Rules or other applicable legislative traffic offices, even when no collision/crash occurs. If this definition is not consistent across Australia, this may result in the same behaviour (e.g. not placing hands on the wheel when the vehicles is operating in automated mode) being treated as a traffic offence in one jurisdiction but not in another. Discussion of 'control' in the road safety context must also include consideration of the traffic offences context.

Currently it is appropriate to keep the driver as the person in control of the vehicle, however in doing so we need to ensure that technology companies and car manufacturers do not offset all responsibility to the driver. Consideration should be given to working with vehicle manufacturers to avoid misuse of the technology by drivers, by encouraging the use of on-board monitoring systems to confirm that the driver is still supervising, rather than just having the driver acknowledge this requirement to remain in control, when the system is first engaged.

Much of the long-term safety benefits are yet to be realised, given:

- the technology and hardware for automated safety features is under development;
- the way in which the technology and human behaviour will interact, along with how these vehicles will interact with other vehicles; and
- the infrastructure system itself is still being tested.

Further how control will shift from one entity to another is also currently uncertain and is likely to be inconsistent across different manufacturers. Control and liability concerns mean that automated vehicles will need to log actions in significant detail. This will enable the tracing of causation of incidents and tracking which entity had control at a given point in time. With automated driving systems able to move across different levels of automation depending on the vehicle function, it needs to be acknowledged in regulation that "control" can be somewhat fluid. In this situation, there needs to be a form of "black box" technology that can record and track this important information. This will need to apply to both collisions/incidences and will also need to be implemented in a form that is usable for compliance checks or enforcement. Consideration needs to be given as to whether enforcement and insurance entities should have access to this data.

Until full automation is achieved (level 5) and while driving is shared between a human driver and the automated driving system, liability will still be attached (at least in part) to the human driver – meaning there will still be requirement for both personal insurance and manufacturers liability insurance. Fully automated vehicles have the potential to take control of the driving task and significantly reduce risks associated with human errors.

It is natural to expect that these 'human' risks will persist in semi-autonomous vehicles during transition of control from human to vehicle. However, what is currently unknown is the possibility of new risks being introduced by the autonomous technology itself – particularly at level 5 automation. In this situation, it is difficult to anticipate how we monitor and enforce "control" for the purposes of collision and incident avoidance and the Australian Road Rules and other applicable legislation unless access to 'black box' data is readily available to enforcement and insurance entities.

Please see ADVI's responses to the discussion paper's consultation questions in the following table.

NTC Question	Response
Do you agree with the assumptions and objectives underpinning the NTC's work to develop national enforcement guidelines? If not, what other assumptions or objectives should be considered?	Agree. However, there should also be a review of Road Rule 297 itself. The steering wheel is only one mechanism by which control of driving functions is achieved by drivers. Others include, for example, accelerator and brake pedals, indicators, gears, etc. We propose that in the longer term that there is a shift away from just enforcement of the driver to compliance with performance based guidelines which takes a more holistic approach involving all three key elements of the Safe System[1], the drivers, the vehicles and the road infrastructure.
Do you agree that national enforcement guidelines should clarify issues of control and proper control based on SAE International Standard J3016 Levels of Driving Automation? If not, what other approach should be considered?	Partially Agree. Driving itself involves the performance of multiple functions - route finding; route following; velocity and lateral control; crash avoidance; traffic rule compliance; and vehicle monitoring (e.g. monitoring status displays, such as fuel remaining). (Brown, 1986[2]). Control of the vehicle by a driver is required to perform all of these functions. An automated vehicle may control the performance of all of some or all of these functions at any one time, and may transition during a journey from one SAE level of driving automation to another depending on which functions are being automated. Thus, clarification of issues of control and proper control should not be based solely only on *SAE International Standard J3016 Levels of Driving Automation.* The national enforcement guidelines should give consideration to those driving functions that are under the control of the vehicle or the driver. Drivers and vehicles do not control levels of automation; they control the performance of driving functions. Thus, the frame of reference for issues of control and proper control should give due consideration to the driving functions that are under the control of either the vehicle or driver, or both. It is also noted that the role of the SAE Standards is based on a vehicle perspective only, we recommend a wider approach will be required which includes the road and the driver (human or technology). In this context, it will be necessary to allow for the transition of control between the driver and the road system e.g. when the Level 3 automated vehicle hands back control (or the driver must take back control) if the dynamic driving task (DDT) can no longer be performed by the automated system.

[1] http://roadsafety.gov.au/nrss/safe-system.aspx

[2] Brown, I. (1986) Functional requirements of driving. Paper presented at the Berzelius Symposium on Cars and Casualties, Stockholm, Sweden.

NTC Question	Response
	The following provides guidance on how these other factors could be included: • from a road perspective include consideration of – **Operational design domain** permitted by road agencies; • from the perspective of enforcement of who is in control consider the overall **DDT**: - which would include the driver, the back office (service provider), and the automated system.
For the purposes of enforcing proper control, is there value in grouping levels of driving automation according to whether vehicles are capable of automated operation?	As noted, driving itself involves the performance of multiple functions, which may be under the control of the driver or the vehicle (or both), depending on the operational design domain (ODD) of the vehicle. For the purposes of enforcing proper control, there could be value in grouping those driving functions that are being controlled by either the driver, the vehicle or both. A key input of the Safe System approach is '*developing road rules and enforcement strategies to encourage compliance and manage non-compliance with the road rules*'. At Level 3 automation, it is particularly critical to ensure that drivers understand their role in controlling the vehicle (ultimately through enforcement activities) to reduce the potential for death and injury. For the purposes of educating consumers about levels of automation, there is some value in grouping the levels as proposed. But for industry/commercial/technical and regulatory audiences, more granularity is needed. We also are strongly of the opinion that data needs to be kept clarifying what happened in the lead up to an incident. An example of this currently exists under the – Intelligent Access Program – where data must be kept, and made available by an accredited independent authority. The latter is open for discussions regarding whether it is necessary for a third party to hold this data or just the data be required to be kept and then made available.
Do you agree that the human driver should remain in control of a vehicle with partial or conditional automation, and that the automated driving system should be in control of a vehicle operating at high or full automation? If not, why?	ADVI agree with the NTC that the human driver must remain in control of vehicles with partial or conditional automation. Vehicle manufacturers and suppliers should continue to be liable to compensate persons injured as a result of product/technical failures, equally there is ongoing need for comprehensive insurance, CTP, third party property insurance to provide adequate protection for consumers. If the approach of intermittent transition of control/liability at Level 3 is adopted at this stage, then AV systems will have to be recognised in legislation as having 'proper control' when engaged. Otherwise they cannot be legally deployed.

NTC Question	Response
In the event that the automated driving system is determined to be in control of a vehicle operating with conditional automation, should road traffic laws introduce obligations on the human driver as supervisor of the automated driving system?	For clarity and safety at this phase of AV development and deployment, ADVI consider that human drivers should be required to supervise the technology (as a minimum). As noted previously, driving itself involves the performance of multiple functions - route finding; route following; velocity and lateral control; crash avoidance; traffic rule compliance; and vehicle monitoring (e.g. monitoring status displays, such as fuel remaining). (Brown, 1986[3]). For vehicles with conditional automation, vehicle monitoring may take on a new meaning: the requirement for the driver to monitor the status of vehicle automation (specifically, to monitor for and respond to takeover requests and automation failures). Traffic laws that introduce obligations on the human driver as supervisor of the automated driving system could be effective in encouraging drivers to remain fit to take back control of the vehicle if required.
Do you agree with the suggested indicators of proper control for each level of driving automation (outlined in Table 2 on page 34 of this paper)? Are there any other indicators that should be included in the guidelines?	Control, in the human factors literature, refers to the selection and execution of responses, along with the feedback loops that allow humans to determine that the control response has been executed in the manner that was intended. (Wickens, Lee, Liu & Gordon Becker, 2004). "Proper" control in driving, in a general sense, might be defined as the *appropriate* selection and execution of responses, which vary according to the driving function being performed, and the traffic context in which it is being performed. In current generation vehicles, control is required for the performance of Brown's (1986[4]) functional driving activities: that is, route finding, route following, velocity and lateral control, collision avoidance, rule compliance and vehicle monitoring. The physical vehicle controls required to support performance of these activities vary according to the functional driving activity. For example, for collision avoidance, the horn, accelerator, brakes and steering wheel may be critical. For vehicle monitoring, the windscreen wiper controls may be required when a driver detects that the windscreen is dirty. The definition of "proper control" should thus take into account the driving function for which control of the vehicle is required, and the physical devices that are available for use by the driver to exercise that control. Being asleep, being drowsy, or being distracted are not the only indicators of "proper control" that should be considered in the guidelines. These are driver states that will influence the degree

[3]/[4] Brown, I. (1986) Functional requirements of driving. Paper presented at the Berzelius Symposium on Cars and Casualties, Stockholm, Sweden.

NTC Question	Response
	of driver control the driver will be able to exercise when required to take back control of a vehicle. The indicators of proper control are considered to still be too restrictive. In particular with Level 3 and above we really need to understand the capabilities of these technologies and driving systems before prescribing the driver state. For example, do we expect the human to have had specific training or physical or cognitive ability, similar to the current licencing requirements, to be able to use this technology in the Level 3/4/5? ADVI acknowledges that there is a significant demand for people with medical conditions that currently restrict them from having a driving licence, who are seeking to use these vehicles with Level 3 and above technology. Consideration should be given to how safe access to these people will be facilitated. We also suggest consideration is given to changing the first row in your table to identify who is in control, by referencing the role of the system together with the human see Table 2. It is assumed the context for the indicators for L4 are that the vehicle is travelling in L4 mode. That is, it isn't being driven. Suggest at least L3 indicators should be provided if L4 vehicle is being driven.
Should special consideration be given to automated parking functions that are partially automated and can only operate without the driver holding the steering wheel?	This is a mainstream application and reflects the need to have an agile set of guidelines supported by legislation that allows for technology advancements to be used legally by drivers as soon as possible.
Should the national enforcement guidelines also clarify the application of due care and attention offences to automated vehicles? If so, what behaviours usually penalised under these offences require clarification when applied to automated vehicles?	The legal requirement to exercise due care is key to the current and future driving task. The interpretation of due care would have to expand to include the following considerations: • The technology available to the driver at the time • The driver is permitted to use the technology at that time and place by the local roads' agency (legislation). • If the technology was operating • Whether the driver was operating the system in accordance with the manufacturer's requirements • The driver's level of training and competency to operate these features • If the technology should or should not have been selected to be used in this location/application. Yes. The key issue here is to clarify what it means to be "ready to intervene" when an automated vehicle requests that a driver take back control of it. To be ready to intervene, a driver must (a) be attentive and responsive to a takeover request, (b) have

NTC Question	Response
	situational awareness of the unfolding traffic situation, (c) know how to respond to the unfolding traffic situation based on that awareness, and (d) be in a fit state to respond (not distracted, drugged, drunk, sleepy, fatigued etc).
Do you agree that the guidelines should not apply the *proper control* test to the automated driving system until the automated driving system and automated driving system entity are recognised in legislation? If not, what alternative approach should be considered?	It is debateable whether it is suitable for the automated driving system to be recognised in the guidelines for 'proper control' ahead of legislation. More technical, legal and (multi-jurisdictional) policy work is needed. For example, it is stated in the discussion paper that "A human driver can perform actions that lead them to not having *proper control* of a vehicle – such as inattention, distraction and failure to properly handle the steering wheel. However, these indicators of proper control are not relevant to automated vehicles because an automated driving system cannot perform these unsafe and risky behaviours". It cannot be assumed that an automated vehicle will not be inattentive (due to distraction or some other mechanism of inattention) or fail to properly steer the vehicle. If the algorithms that control vehicle functions are not properly designed, it is possible that the "attention" of the vehicle will not be focussed on those activities most critical for safe driving (if, for example, the algorithms do not properly prioritise where the "attention" of the vehicle should be focussed), or that steering movements may not be optimal to avoid a collision in a given traffic scenario. Indicators of *proper control* should be adjusted to be made more relevant to automated vehicles, as the capabilities and limitations of the algorithms that control automated vehicles become transparent. For optimum clarity and greater confidence of the emerging technology it is preferable that the legislation is developed first.
Do you agree that the guidelines should only specify enforcement agency interaction with automated vehicles once the technology capability of automated vehicles is more developed and enforcement practices implemented in overseas jurisdictions? If not, what alternative approach should be considered?	Agree, we feel that Australia should monitor and align with enforcement practices internationally, but not wait for these to be in place before developing our own guidelines. Australia can be an early adopter and recipient of the benefits of the highly automated driving technologies and as such should progress with the development of model guidelines. Model guidelines for safe compliance should be developed in the context of the extant regulations and legislation informed through a collaborative approach with industry, policy-makers and researchers. ADVI as a collaboration provides the medium to achieve this approach.

Table 2: Suggested examples of indicators of *proper control*, by level of driving automation with recommended inclusion of 'Who is in Control'

Proper control	Levels 0–2 Human-driven	Level 3 Vehicle capable of automation	Level 4 Vehicle capable of automation	Some level 4 and all level 5 Dedicated automation
	Human in control because he or she is required to perform all or part of the driving task	Human in control because he or she is required to perform a fallback role	Human not in control but will be requested to, and may, resume control when automated driving system reaches the limits of its operational design domain	No human driver
Who is in control	Human	Human/system (only on certain APPROVED dynamic tasks)	System/System (only on certain APPROVED dynamic driving tasks)	SYSTEM
Current indicators of *proper control*				
At least one hand on the steering wheel	Yes[21]	No	No	NA
Seated in the driver's seat	Yes[22]	Yes	No[23]	NA
Suggested indicators of *proper control*				
Not asleep	Yes	Yes	No	NA
Not have closed eyes or show signs of drowsiness	Yes	Yes	No	NA
Not reading or viewing a device or thing unrelated to navigation or driving[24]	Yes	Yes	No	NA

[21] Would not apply to self-parking operations that safely allow the human driver to stand outside of the vehicle during the self-park manoeuvre.
[22] Would not apply to self-parking operations that safely allow the human driver to stand outside of the vehicle during the self-park manoeuvre.
[23] In a highly automated vehicle the vehicle can come to a safe stop if the human driver does not resume the driving task. Therefore the soon-to-be driver does not have to be seated in the driver's seat when the vehicle is operating in highly automated mode.
[24] In addition to any behaviours explicitly prohibited by law such as the use of a mobile phone while driving.