ABI

Thatcham Research
Safer cars, fewer crashes

REGULATING AUTOMATED DRIVING

THE UK INSURER VIEW

Thatcham Research
Safer cars, fewer crashes

ABI

CONTENTS

FOREWORD

James Dalton, Director of General Insurance Policy, ABI

Over the past decade, the insurance industry has worked increasingly to build a positive inter-dependence with vehicle manufacturers, as the industry's focus has shifted from being purely about financial risk transfer to being about preventing claims in the first place.

The insurance industry strongly supports the development of automated driving technology – which we see as the logical conclusion to work over several decades to reduce the numbers of people killed or seriously injured on the roads. Insurers have been closely involved in the development of the Automated and Electric Vehicles Bill proposals, which will guarantee that nobody will be treated differently by insurers if they choose to drive an automated vehicle.

However, we know all too well from conventional vehicles that drivers often misunderstand what their vehicles can and can't do. Therefore, consistent standards are needed so that those taking up automated driving technology can do so with confidence.

The insurance industry is committed to continuing to work closely with manufacturers. A consistent approach to safety regulation as proposed in this paper should not be seen as a barrier to innovation. These proposals will give insurers the confidence to actively encourage consumers to switch to automated technology and are designed to ensure the benefits of this innovation are maximised.

Peter Shaw, CEO Thatcham Research

The development and availability of Automated Driving Systems is challenging International regulators to make change in order to determine how such systems may be legally sold and driven on our roads.

The Automated Driving Insurance Group (ADIG) was formed in late 2015 by Thatcham Research and the ABI to consider the impacts of automation on Motor Insurance in the UK and to guide the industry towards a coordinated position to allow a powerful and consistent voice, aligned with international and government legislators.

FOREWORD - CONTINUED

This document outlines the agreed position of the ADIG Members on the anticipated new laws governing Auto Driving and specifically Automated Steering and importantly also provides guidance from the Insurers on the need for post-accident data for autonomous cars to enable liability to be established.

Special thanks go to Tim Marlow, Head of Autonomous and Connected Vehicle Research, Ageas (UK) Limited and Matthew Avery, Director of Insurance Research at Thatcham who co-authored this document. Also, thanks go to David Williams, Technical Director, AXA Insurance as chairman of the Automated Driving Insurance Group and the members of the ADIG who developed the position contained herein.

1. EXECUTIVE SUMMARY

The development and availability of automated driving systems is a new challenge for the international regulators who determine what systems can be legally sold and driven on our roads. Discussions on the technical requirements for safe automated steering systems are already actively underway with the UNECE's Working Party 29 and their ACSF sub-group are expected to progress increasingly advanced degrees of automated driving over the next few years – up to the point where cars will be capable of overtaking and changing lane without the physical intervention of a human driver.

Improved road safety is expected to be one of the main benefits of automation. In order to realise these benefits, the transition phase must be carefully managed and there must be careful attention given to the safety features that will underpin this. Insurers see two clear levels of automation, those that support the driver (Assistance) and those that fully automate control (Automated).

The insurance industry has a core interest in these technological developments and the associated regulatory processes, because of their impact on liability, how claims are handled and in underwriting. These definitions, set internationally, are ultimately those that will inform the definitions of what is and is not an automated car, and therefore which vehicles will be subject to the new insurance requirements set by the Automated and Electric Vehicles Bill.

The most commonly used definition of levels of automation is the Society of Automotive Engineers (SAE) which identifies six separate levels (L0-L5) describing increasing levels of vehicle capability and decreasing levels of driver involvement. These are used in this document for ease of understanding to the widest possible audience. However, it is recognised that this system is not used in regulations governing vehicle construction because such regulations must provide precise functional and performance definitions that are valid in isolation without relying on interpretations of driver responsibility.

Insurers are highly supportive of, driver Assistance systems – both those that act in the brief moments before a collision (SAE L1) or support, but not replace a driver (SAE L2) and those that deliver full Automated Driving (SAE L4 on). However, where the vehicle can execute most manoeuvres unaided by the driver, but where the driver is expected to intervene (potentially at very short notice) in an emergency (SAE L3) there are significant concerns about public confusion and safety, which may be exacerbated by SAE L1, 2, 3 and 4 systems becoming available on similar vehicles at the same time.

Vehicle manufacturers argue that SAE L3 systems can be safe, provided that drivers use them 'as intended'. However, it is not clear how different drivers will understand and use these types of systems. Insurers insist that any automated system is always

1. EXECUTIVE SUMMARY

designed to prevent accidents, that system functionality is clear to all, and that the system can fail safe even in the event of a technical failure allowing a potentially out-of-the-loop driver adequate time to regain control.

Under the terms of the Automated and Electric Vehicles Bill, the Government will define what constitutes an automated vehicle. The insurance industry believes a vehicle should only be sold to the public as an 'automated' vehicle when it reaches a level of automation where a driver can safely disengage in the knowledge that the car has sufficient capabilities to deal with virtually all situations it may encounter on the road, avoid almost all conceivable crash types and continue to function adequately even in the event of a partial system failure (SAE L4). If regulators allow the development of vehicles that could be described as SAE L3, then the insurance industry proposes that these should only be permitted with high levels of robustness and redundancy that largely mimic SAE L4 functionalities.
A list of minimum system requirements have been defined that:

- **Maximise safety benefits** by requiring speed limit and safe following compliance
- **Minimise risks**, for example strict hands-on controls, three strikes (hands-on warnings) and you're out and a safe stop at the side of the road capability.

Vehicle manufacturers are very keen to bring Automated Driving technology to market as quickly as possible and many claim they already have systems that are capable. It is questionable whether the current process of regulatory development can produce the necessary range of new and amended technical requirements sufficiently quickly. It is therefore appropriate that regulators consider alternative regulatory approaches for Automated Driving concurrently with Assisted systems and that these new "light touch" regulations should:

- Develop rapid and robust technical requirements e.g. ensuring **fully redundant systems**;
- Be available to guide vehicle manufacturers as soon as possible: prevent unregulated systems being sold as Automated where they require driver intervention to be safe;
- Be designed and categorised as Automated vehicles and be capable of recording event data that allows both insurers and vehicle manufacturers the unambiguous identification of liability.

Vehicles developed which require the driver as part of their back-up redundancy (SAE L2/3) should not be considered to be 'Automated Vehicles' and the provisions of the Automated and Electric Vehicles Bill would not apply. Similarly, relaxation of the Highway Code should not be considered until the vehicles are rigorously defined as 'Automated'. A new streamlined regulatory framework, may help to achieve this in the timeframe demanded by the pace of technical development.

1. EXECUTIVE SUMMARY

This paper focuses on the near term regulatory position regarding passenger car automation, however the themes contained herein would also be applicable to vans and trucks although some recommendations may differ depending on vehicle type and use.

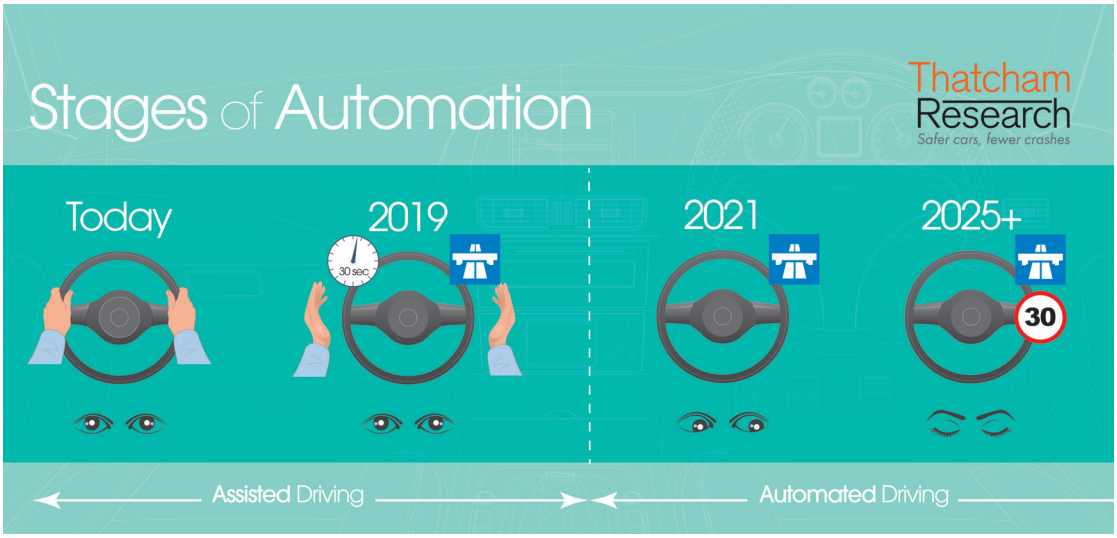
2. BACKGROUND

Automated Driving is being seen as a major technological advance that will offer far reaching social and economic benefits. Governments and vehicle manufacturers all indicate a likely near term implementation date for these systems and vehicles are already evolving towards ever higher levels of assisted driving. However, the regulations governing the construction and use of vehicles are complex and rapid and transformational technological changes such as Auto Drive present a significant challenge.

The insurance industry has a core interest in both the technological and associated regulatory changes because of the need to ensure the safety of their customers and the impact of changes on liability, cost, and underwriting. The insurance industry is highly supportive of ADAS at SAE L1 and 2 (SAE, 2014), where they act only in the brief moments before a collision or where they act only to support and not replace driver inputs. However, at SAE L3 the driver is not needed for the driving task but must be capable of resuming control at any moment. The technology in production that is approaching that level, and the systems currently under development, have diverse capabilities and widely differing user interfaces. We see very significant potential for public confusion around the responsibilities of the driver of such vehicles and a wide variation in the level of risk associated with each vehicle. This will make the accurate pricing of insurance for these vehicles very difficult. Analysis suggests that the total number of claims will probably be lower on aggregate with these technologies, because they are sold with the benefits of more sophisticated pre-crash ADAS that will be active on all roads even during manual driving. However, the analysis also suggests a risk of an increase in collisions on motorways during highly assisted driving where both system and an inattentive driver miss unusual hazards that would still be obvious to an alert driver and where systems execute stops in live running lanes because their driver is unresponsive. The proportion of catastrophic claims in these collision types may be higher than most crashes and these can be extremely damaging to individual insurers and the wider reputation of automation, potentially setting back market adoption significantly. Where insurers are concerned that the risk of having to deal with consequences of these catastrophic claims is too high, they may be reluctant to offer cover for these vehicles, even when their impact on the overall volume of road accidents is positive.

In combination, these risks to insurers demand that a vehicle should only be classified as an Automated Vehicle, once it is at SAE L4. Insurers would prefer that systems requiring the driver to act as a redundant backup (i.e. SAE L3) should be carefully controlled by regulations to control misuse and maximise safe use. Motor Insurers seek clarity for both the customer and the industry in the level of automation available and feel it is essential to create a clear distinction between Assisted Driving (SAE L2) and Automated Driving (SAE L4) and feel that the intermediate (SAE L3) systems should not be encouraged.

Stages of Automation - Driver Assistance vs Automated Driving



However, insurers accept that some sections of the vehicle manufacturing industry see the technologies at SAE level 3 as vital stepping stones in the development of full automation. If this incremental development approach is to be permitted then the insurers consider that strict controls are necessary in both the type approval regulations governing the construction of new vehicles and the national legislation governing how vehicles are permitted to be used.

Insurers propose a two-step approach that allows the development of robust regulations regarding Assisted Driving systems whilst allowing the parallel definition of less prescriptive "light touch" regulations surrounding Automated Driving. This will help to ensure the rapid proliferation of Automated systems to deliver the perceived benefits whilst ensuring vehicle manufacturers, frustrated with the current complex regulatory system, are not allowed to sell inferior technology to gain technical lead.

Minimum functionalities for both Assisted and Automated driving technologies are also defined to ensure that drivers are aware of their vehicle's limitations, are kept as safe as possible and that adequate information is available to insurers in the event of an incident.

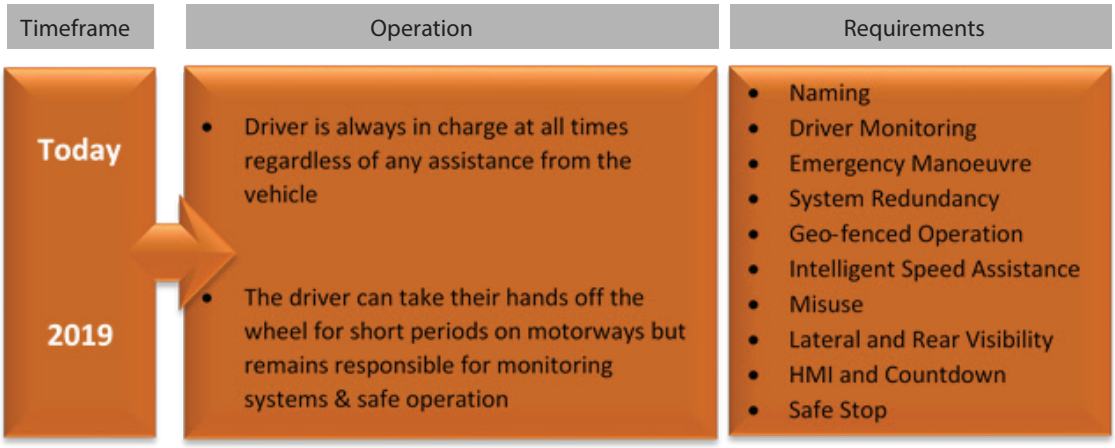
In June 2017, the UK government announced the introduction of the Automated and Electric Vehicles Bill. This is expected to supersede the Vehicle Technology and Aviation Bill. The Bill, outlined in the Queen's Speech will ensure the UK continues to be at the forefront of developing new technology in electric and automated road vehicles. The Bill will:

- allow the regulatory framework to keep pace with the fast evolving technology for electric cars, helping improve air quality
- provide for the installation of charging points for electric and hydrogen vehicles
- extend compulsory motor vehicle insurance to cover the use of automated vehicles, and to compensate third party victims where 'caused by' an autonomous vehicle in the absence of fault on the driver.

3. CURRENT REGULATORY APPROACH, ASSISTED DRIVING (≤ SAE L3, 2019)

Regulations controlling UK vehicle design are defined at an International Level within the UN and the Geneva Working Party 29. These groups help define future regulations governing vehicle type approval that regulates manufacturing. The UK is a fully contracted party to all relevant agreements. Regulations relating to Assisted and Automated Driving are focused around the automation of steering (Regulation 79). The Regulators do not use the SAE Levels due to the vagueness of their definitions and have therefore decided to use an alphabetical A-E description relating to steering functionality.

Currently, assisted and automated driving functions that involve prolonged periods of automatically applied steering at speeds in excess of 10 km/h are not permitted by R79, though flexible interpretation of the requirements has allowed some systems to gain approval.



3. CURRENT REGULATORY APPROACH, ASSISTED DRIVING (≤ SAE L3, 2019)

Work is underway to amend this regulation to permit greater levels of automated steering and either in the existing Regulation or in proposed amendments, the following definitions of automated steering functions have been made:

- Corrective Steering Functions (CSF), for example assistance to keep the vehicle within its lane;
- Automatically Commanded Steering Functions (ACSF) categories A to E covering low speed manoeuvring, continuous lane keeping systems, and automated lane change systems;
- Emergency Steering Functions (ESF), for the avoidance of imminent collisions;
- Autonomous steering functions, are defined as any automated steering function capable of activating at least partly on the basis of a signal generated off-board the vehicle.

Five Categories of ACSF

A	Low speed manoeuvring (Remote Controlled Parking)	a function that operates at a speed no greater than 10 KM/H to assist the driver, on demand, in low speed manoeuvring or parking operations.
B1 &2	Lane keeping and Guidance	[a function which is initiated/activated by the driver and which keeps the vehicle within its lane by influencing the lateral movement of the vehicle.]
C	Lane change (Lane change commanded by the driver	[a Category B-System including] a function which can perform a single manoeuver (e.g. lane change) when commanded by the driver
D	Lane change (System indicates possibility of a lane change, driver confirms)	[a Category B-System including] a function which can indicate the possibility of a single manoeuvre (e.g. lane change) but performs that function only following a confirmation by the driver.]
E	Lane change (Lane changes are performed automatically by the system)	[a Category B-System including] a function which is [initiated/activated] by the driver and which can continuously determine the possibility of a manoeuvre (e.g. lane change) and complete these manoeuvers for extended periods without further driver command/confirmation.

The proposals for the first set of amendments to R79 are expected to be in force by 2018 and have been developed to the extent where it is no longer realistically possible to influence their content. They cover corrective steering functions and ACSF of categories A and B1 only (Note ACSF-B1 systems only assist the driver to keep in-lane but do not allow prolonged periods unaided). In practice this means, lane keep assist systems that act only briefly to prevent lane departure (CSF), remote control parking systems (ACSF-A) and lane keep assist systems capable of continuously helping the driver to stay in lane but not capable of doing it without driver input. The regulatory control on such systems is relatively light:

- Remote control parking devices must operate on a 'deadman's handle' basis and only in close proximity to the vehicle;

3. CURRENT REGULATORY APPROACH, ASSISTED DRIVING (≤ SAE L3, 2019)

- Continuous lane keep assist must monitor drivers hands-on wheel: visual warning at 15 seconds, audio-visual at 30 seconds and full deactivation at one minute;
- No emergency or minimum risk manoeuvres are defined.

Future ACSF Developments – Towards Automation

Proposals are now being developed for how more advanced systems should be regulated, with decisions on regulations that would be in effect from 2019 onwards are likely to be taken in the coming months. These proposals include discussion of lane control systems capable of keeping vehicles in lane without driver input for prolonged periods (ACSF-B2) and systems capable of executing lane changes initiated by the driver (ACSF-C), initiated by the system but confirmed by the driver (ACSF-D) and without driver input (ACSF-E). Emergency Steering Functions may also be included. It is understood that the driver will retain ultimate responsibility for safe operation of the vehicle with all of these systems.

Insurers do not consider that these should be considered as 'Automated Vehicles'. This will mean that the provisions of the Automated and Electric Vehicles Bill would not apply and that such vehicles would be covered under conventional motor insurance without any extension to cover operation in an Automated Mode.

3. CURRENT REGULATORY APPROACH, ASSISTED DRIVING (≤ SAE L3, 2019)

The insurance industry recommends the following requirements for ACSF-B2, ACSF-C, ACSF-D, or ACSF-E Systems:

1) Terminology to describe system functionality should be accurate and descriptive. The use of words that suggest a higher level of automation than offered are unacceptable;
2) Safety benefits should be maximised by requiring that systems limit vehicle speed to the posted limit for the road and enforce the two second rule for following distance;
3) Systems shall be geo-fenced to enforce operation only on roads of Motorway standard;
4) The system must be able to stop the vehicle for a stationary object, either in its lane or encroaching into its lane by a greater amount that it can safely avoid without itself exiting the lane, at any speed up to the lower of 130 km/h or its maximum designed operating speed. For ACSF-E systems avoiding the obstructing vehicle via an automated lane change is also permissible;
5) The vehicle will monitor driver hands-on wheel. Initial 'place hands on-wheel' warning to be issued after no more 30 seconds of driver inattentiveness;
a) For ACSF-E systems, alternative 'driver present' monitoring such as use of vehicle infotainment system may allow an increased hands-off time, only if strong supporting evidence is presented;
6) System deactivation should occur if hands-on is not detected, despite warnings, for no more than one minute.
7) A three strikes and you're out' rule should be implemented to avoid driver abuse of systems;
8) For ACSF-E vehicles, automated lane changes should only be executed when the sensor system has sufficient rearward view to be confident that the manoeuvre can be completed without driver observation or intervention;
9) The minimum risk manoeuvre should initiate a safe stop if drivers become disengaged and the system deactivates. For ACSF-B2, ACSF-C and ACSF-D vehicles, this will be a disengagement of the system allowing the vehicle to slow down and ultimately stop with hazard lights operating. AEB and ELK systems will remain active during the process of stopping. For ACSF-E systems the vehicle will be required to pull over to the side of the road, as far out of running lanes as possible;
10) For ACSF-E systems a degree of system redundancy should be available. This should, as a minimum, cover sensors and should allow the system to safely operate in a "limp home" mode or to a "safe stop" in the event of a single sensor failure. Adequate warning of the situation should be given to the driver.

4. ALTERNATIVE REGULATORY APPROACH (LIGHT TOUCH), AUTOMATED DRIVING (SAE L4 AND BEYOND)

Technical requirements

The Automated and Electric Vehicles Bill proposes that the Government must define what is meant by an automated vehicle and must ensure that an automated vehicle can always be identified easily. However, the nature of the definition is effectively at the discretion of the Government. The text of the bill is reproduced below:

- The Secretary of State must prepare, and keep up to date, a list of all motor vehicles that:
  (a) are or might be used on roads or in other public places in Great Britain, and
  (b) are in the Secretary of State's opinion designed or adapted to be capable, in at least some circumstances or situations, of safely driving themselves without having to be monitored by an individual.

- The list may identify vehicles:
  (a) by type,
  (b) by reference to information recorded in a registration document issued under regulations made under section 22 of the Vehicle Excise and Registration Act 1994, or
  (c) in some other way.

- The Secretary of State must publish the list when it is first prepared and each time it is revised.

The insurance industry consider that the real societal benefits of assisted and automated driving will be achieved when SAE L4 and L5 are reached. Thus, the industry considers it essential that the definition made under the proposed legislation above reflects this level of technical development. It is therefore considered that any vehicle classified by legislation as an Automated Vehicle, will need to identify the Operational Design Domain(s) in which it is capable of 'driving itself'. It may be more consumer friendly for these to be referred to as Automated Modes, or 'permitted uses'. The number and type of these is likely to significantly affect risk and insurers need to be able to identify and price that risk.

The following are considered to be key requirements of an Automated Vehicle, which may be able to offer one or more Automated Modes in specific Design Domains (such as on Motorways and fully separated dual carriageways, low-speed urban roads, car parks etc.)

4. ALTERNATIVE REGULATORY APPROACH (LIGHT TOUCH), AUTOMATED DRIVING (SAE L4 AND BEYOND)

1) A clear and descriptive naming convention is used that clearly states an Automated Driving system is available. Terminology should clearly differentiate from that used to describe Assisted Driving functionality.

2) A **safe system of operation must be supported**. Either:

a) The system must be able to determine (utilising all the information available to it from on-board and off-board sources) **in what circumstances it is able to offer its driver an Automated Mode of operation**, taking into account:-

- The environment in which it is operating (type of road, car park, private drive etc);
- Traffic conditions, road pavement conditions etc.
- Weather
- Connectivity
- Speed limit and/or average traffic speed

Or, **as a minimum:**

b) For each Automated Mode, the system must be geo-fenced to those roads and/or locations where it is deemed safe to operate, e.g. a system designed to provide Automated Driving on motorways and fully separated dual carriageways with grade-separated junctions should be restricted to operation on such roads. The system should also be able to take into account:-

- Traffic conditions, road pavement conditions etc.
- Weather
- Speed limit and/or average traffic speed

3) The human driver in an Automated Vehicle operating in Automated Mode shall not be considered a redundant system or solution.

4) Transitions of control or **handovers** (from Manual to Automated or vice versa) must go through a properly planned and executed "offer and confirm" process. In this way, the Automated mode is only ever engaged, either:

a) After the vehicle has understood the planned journey and/or parking manoeuvre and confirmed it is safe to operate in the Automated Mode including where that Automated Mode will become available and where, if applicable, any handover back to manual control will need to take place; or

b) Within the appropriate geo-fenced area. Again, the vehicle must also indicate where, if applicable, any handover to manual control will need to have been completed

5) Once in an Automated Mode of operation, the vehicle must be able to deal with all situations it would reasonably be expected to encounter within that environment, without monitoring or intervention from the driver, until the point of handover from the Automated Mode back to Manual operation. For example, whilst operating on a

4. ALTERNATIVE REGULATORY APPROACH (LIGHT TOUCH), AUTOMATED DRIVING (SAE L4 AND BEYOND)

motorway, it should expect to deal with road-works or pedestrians on the hard shoulder next to a broken-down car.

6) Should the vehicle become aware of a situation (e.g. adverse weather or unsuitable road conditions) that necessitates a handover to the driver's manual control earlier than the planned handover point, this is permissible provided that a minimum of **60 seconds notice** is given to the driver that there will be a revised handover point.

7) Should the driver fail to respond to a request for hand-over to manual control, whether this is at the original planned handover point or at an earlier point requested by the vehicle as described in point 5) above, the vehicle must execute a **'safe stop'** or **'safe harbour'** manoeuvre – that is it must safely navigate to and stop at a location away from the main running lanes of the carriageway such as a hard shoulder or refuge and the hazard warning lights should be engaged.

8) A vehicle in an Automated Mode should enforce compliance with the designated speed limit. However, consideration could be given to introducing risk adaptive speed control that can vary dependent on environment or conditions.

9) Ideally, sufficient redundancy will be included to allow an Automated Vehicle operating in an Automated Mode to 'fail operational', i.e. it will continue normally with its journey but notify the driver of the issue. As a minimum, the vehicle must fail in a safe manner so that if, for example, a sensor or other component fails then there must be sufficient redundancy for the vehicle to complete the planned journey in a reduced speed 'limp home' mode or similar or to execute a **'safe stop'** or **'safe harbour'** manoeuvre.

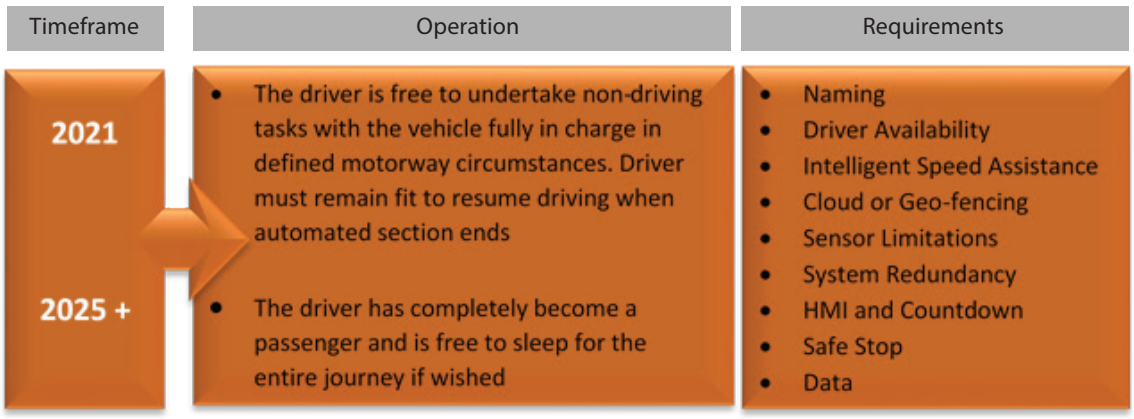
10) An Automated Vehicle may be certified as such at the point of initial deployment or following the introduction of a software or hardware upgrade that enables the functionality of a new or improved Automated Mode.

11) Data shall be recorded in the event of a collision and made available on an equal basis to both manufacturer and insurer such that questions of status of automated systems, extent of driver input and liability can be quickly **and impartially assessed**.

The insurers' position will be that when the above requirements are met, the regulation of vehicle use (Road Traffic Act, Construction & Use Regulations and the Highway Code etc.) can be relaxed to permit the driver to undertake other activity. However, they must remain fit to resume driving if the whole journey is not automated (i.e. in all cases except SAE L5 and some SAE L4 urban operations). A vehicle that is certified as an Automated Vehicle will include cover under its applicable Motor Insurance for liability, referenced in its certification, arising out of its operating in an Automated Mode. Where there is clear fault or failure in the systems providing that Automated Mode the motor insurer will be able to pursue recovery against the manufacturer and/or their systems' supplier(s).

4. ALTERNATIVE REGULATORY APPROACH (LIGHT TOUCH), AUTOMATED DRIVING (SAE L4 AND BEYOND)

The continued use of Motor Insurance, rather than Product Liability, means that the UK can insure automated driving within a well-established compulsory insurance regime, which is underpinned by an effective enforcement regime through the Motor Insurance Database. All authorised motor insurers in the UK are obliged to pay a levy to the Motor Insurers' Bureau that allows all victims of uninsured and untraced drivers to be fully compensated. The Automated and Electric Vehicles Bill proposals are intended to ensure automated vehicles can interact with the processes already in place for manual cars. In the longer term the Government may want to transfer the requirement for a compulsory insurance policy onto the individual automated vehicle, rather than leaving it on each individual driver, but discussion of such a step is beyond the scope of this paper.



Implementing the technical requirements in Regulation

The shift to highly assisted (SAE L3) and automated (SAE L4/5) driving is a more substantial technical change than type approval has had to deal with before. The implications of the technical changes go beyond only vehicle construction and will affect the way vehicles are used and potentially the way roads are managed. The timetable of change required to avoid regulation becoming an excessive barrier to the introduction of automated vehicles is very challenging. The US regulatory system has allowed them to react very quickly, with a code of practice already introduced and enabling at least high level control over the basic principles highly automated systems should conform to. In Europe, we are close to clarifying requirements for a small selection of SAE L1

4. ALTERNATIVE REGULATORY APPROACH (LIGHT TOUCH), AUTOMATED DRIVING (SAE L4 AND BEYOND)

and L2 ADAS that in some cases have been on the market for a while. Where the regulations have failed to keep pace with technical developments, it has encouraged manufacturers to work around the current inflexible rules to get their product to market.

However, a lack of uniformity in regulatory requirements around the world is also commonly cited as a potentially significant barrier to the rapid and safe deployment of automation. The USA has quickly gone its own way but in parallel with its code of practice has recommended exploring a range of different complementary and alternative regulatory tools, including pre-market approval. In Europe, changes are being progressed through the UNECE Regulatory process. This leads to robust and consistent standards but it is time consuming, with the consequent risks reported above.

There is a considerable risk that regulation could become a partial barrier to innovation and commercial exploitation of Automated Vehicles. Therefore, the insurers propose that in parallel with the current track of regulatory development, an alternate range of light touch regulatory options should be considered that will allow the faster definition of guidance to vehicle manufacturers whilst not allowing inappropriate 'work-arounds' to get product to market. This should consider broadening the scope of stakeholders consulted in the development of vehicle type approval to include stakeholders affected in areas of vehicle use or road management and could also include, for example:

- Self-certification instead of pre-market approval for some or even all aspects of performance
- A US-style code of practice to allow greater flexibility
    - Temporarily, for new technologies introduced before robust harmonised UNECE regulations are completed, e.g. through article 20 of Directive 2007/46/EC (subject to consideration of any BREXIT effect); and/or
    - Permanently, perhaps embedded as part of amended annex(es) on complex electronic control systems (e.g. R79 Annex 6)

These options would need to be studied and decisions completed with some urgency, principally to avoid being another potentially delaying factor to the regulatory process for automated vehicles but also because there may be interactions with other Government priorities such as the BREXIT negotiations and/or trade negotiations with the USA.

4. ALTERNATIVE REGULATORY APPROACH (LIGHT TOUCH), AUTOMATED DRIVING (SAE L4 AND BEYOND)

The need for open and standardised data access

Once a vehicle is capable of driving itself the condition of insurance and, in particular, liability will shift. This is especially relevant in the UK market where the covered risk relates to the driver and not the vehicle, a position which differs from many European countries. It is therefore especially relevant that adequate data is recorded to ensure that liability can be identified and rapid compensation offered.

In order to identify the at fault party (either the car or the driver) adequate and open access to crash data is vital. Although proposals are in place for the provision of mandatory Data Storage System for Automated driving (DSSA) there are limitations in these existing proposals that will not allow an efficient and fair insurance claims process. Therefore, international insurers have proposed augmented requirements, including the ability to read event data without specialist tools and the provision to transmit this data immediately after an event. It is also important that all events are covered and not just those severe crashes that lead to airbag deployment.

Standardised non-discriminating access to this data for all parties with a legitimate interest in an individual case (owner of the vehicle, driver, insurer, vehicle manufacturer, supplier, authorities) should be guaranteed. An independent trustee for the DSSA could possibly guarantee impartial access, while providing for data security and data protection.

5. CONCLUSION

Vehicle Automation offers society and individuals huge benefits in increased mobility and safety. The British Insurers support this adoption but concerns remain around the gradual increase in the levels of automation and the potential confusion and greater risks that these intermediate systems may offer. Using the SAE L2 systems should be clearly identified as "Driver Assistance" and be designed, marketed and controlled in such a way to avoid confusion and misuse. Only SAE L4 systems (and beyond) should be labelled as "Automated" but must be able to completely replace the driver in their relevant use domain – no reliance on the driver can be permitted.

However, SAE L3 systems that offer SAE L4 automation but rely on the driver to take back control in the event of a system failure, should be discouraged since they are open to driver misinterpretation and misuse. If such systems are regulated, Insurers would wish to see minimum technical requirements that push performance as close to SAE L4 operation as possible, including geo-fenced use, the provision of driver monitoring and a "safe stop" functionality. Going forward, a more dynamic approach to system approval should be considered since the current regulations governing steering or braking function alone cannot appear to keep pace with technological developments. As the design of these new regulations governing Assisted and Automated systems are imminent, the needs of the Insurers should be considered a priority if insurance underwriting is not to impede adoption.

ANNEXE A: SUPPORTING INFORMATION

Overview of key legislation

A wide range of complex national and international regulations apply to the construction of vehicles, how they are used or both. Some of the more important regulatory mechanisms affecting the UK are summarised below:

- **The UK Road Traffic Regulation Act**: defines access to the road infrastructure, speed limits, access restriction by vehicle type/road class etc.
- **The UK Road Traffic Act**: governs how vehicles are used, defines liabilities and mandatory insurance and defines the UK legal framework for construction standards of vehicles.
- **The Vienna Convention**: An international treaty made between United Nations members intended to harmonise high level traffic requirements to facilitate international traffic while maintaining basic standards of safety. The UK has signed this treaty and UK traffic Acts are based upon it but it has not been formally ratified by Parliament so is not legally binding. The Vienna Convention was amended in 2016 such that Automated Driving is permitted as long as the driver can over-ride the system at any time, or the vehicle demonstrates compliance with applicable UNECE Regulations.
- **The UK Construction and Use (C&U) Regulations**: Acts & Treaties require parliamentary approval. Within the limits set by Acts & Treaties, Regulations can be amended by the Minister and provide regularly updated in-depth requirements. Combined with the UK Vehicle Approval Regulations, C&U implements European Type Approval in the UK.
- **EU Type Approval Framework**: Defines minimum safety and environmental performance and facilitates free trade in the sale of new vehicles. Pre-sale approval is mandatory. Once approved in one member-state it can be sold in all member states (reciprocal approval).
- **United Nations Economic Commission for Europe (UNECE) Regulations**: Promote global harmonisation of vehicle regulations in 53+countries. The UK is a fully contracted party to all relevant agreements. UNECE Regulations are not mandatory, each country chooses whether to adopt each one and they become legally binding once adopted. The EU adopt many and implement them through type approval, making them mandatory in the EU. The UK separately adopts most of the same regulations such that Brexit would have little effect.
- **The Highway Code**: Advises UK drivers how to stay legal, but is not legally binding by itself.

ANNEXE A: SUPPORTING INFORMATION

Discussion of the issues around the current Regulation 79 proposals

Currently, assisted and automated driving functions that involve prolonged periods of automatically applied steering at speeds in excess of 10 km/h are not permitted by R79, though flexible interpretation of the requirements has allowed some systems onto EU roads. Amendments to clearly and explicitly permit the next generation of automation technology are in progress. However, in addition to removing barriers to sale, the amendments seek to set minimum standards of performance for the systems.

Competing pressures create some important questions:

- **Timing and balance:** Minimised risks versus delayed benefits and/or stifled innovation?
- **Maximising benefits:** How can the potential safety gains best be captured?
- **Minimising risks:**
  - How to limit the occurrence of situations outside the systems capability?
  - Driver as a redundant back-up: How to maintain driver engagement?
  - How to re-engage distracted drivers and prevent abuse?
  - What is the best 'fail safe' strategy when drivers are disengaged?

At present, the amendments are prepared in Geneva technical committees by Government and vehicle industry with limited insurance industry input. The aim of this paper is to:

- Start the development of a common insurance industry position (UK, EU and beyond).
- Initiate stronger insurer input into wider regulatory development in vehicle automation.

A range of different categories of automated steering have been defined:

- Corrective Steering Functions, for example assistance to keep straight in cross winds;
- Automatically Commanded Steering Functions (ACSF) categories A to E covering low speed manoeuvring, continuous lane keeping systems, and automated lane change systems

ANNEXE A: SUPPORTING INFORMATION

- Emergency Steering Functions, for the avoidance of imminent collisions.

The developments have been divided into two stages. Stage 1 developed requirements for corrective steering systems, remote control parking systems (ACSF-A) and continuous lane keeping systems that assist not replace the driver (ACSF-B1), all effectively SAE level 2 systems. Stage 1 has been approved, will enter into force in time for 2018 production **and cannot be changed before implementation**. The main changes are:

- Remote parking is permitted: requires a 'Deadman's handle' and limited range.

- Continuous lane keep assist is permitted (all roads); requires 'hands-on' monitoring with visual warning at 15 seconds hands-off, audio-visual warning at 30 seconds and deactivation at one minute. No fail-safe manoeuvres are defined.

Stage 2 will cover systems that can keep lane and/or partially or fully execute lane changes without driver input and is intended to enter into force in time for vehicle approvals in 2019. Depending on eventual specification of requirements for driver engagement these could be considered SAE level 2 or 3, and some stakeholders have referred to this stage as level 2.5. Thus, this stage will involve critical decisions about the extent to which the driver can act as a redundant back-up, how to maintain engagement and what to do if those strategies fail. The definition of the requirements for stage 2 systems remains open but the following potential requirements have been discussed:

- Restricting to Motorway use only

- Up to three minutes without detecting 'hands-on' the steering wheel before implementing warning

- Possible use of driver monitoring or use of the vehicle infotainment system as alternative means of ensuring engagement

- Emergency manoeuvre capability to brake for a stationary object from 130km/h (80mph)

- Minimum risk manoeuvre in the event of driver disengagement to involve a simple stop in lane.

ANNEXE A: SUPPORTING INFORMATION

Defining an insurance industry position on these 2019 requirements is the main goal of this paper because the outcome could have significant implications on the risks and liabilities presented by vehicles approved in 2019. Valet parking and emergency steering functions will become important considerations in a comparable time frame but will be considered separately to simplify the message.

Timing and Balance

All indications so far from Thatcham's Claim of the Future (CoF) modelling show a positive net effect of these technologies, despite the risks that they could cause new types of collisions and a change in the average cost per claim. The advanced end of the vehicle market is in position to start selling systems now and some manufacturers expect their technology to be significantly more capable than the systems envisaged for the 2019 regulation. This creates the risk that Government Regulation becomes a barrier preventing improvement in road safety, the opposite of its objective. This creates significant time pressure.

On the other hand, the current regulatory changes are all being made within the steering regulation (UNECE R79). This risks too narrow a focus on the steering aspects of systems and/or regulatory confusion where a steering regulation controls aspects of braking, driver monitoring, location services etc. There is, therefore a debate as to whether a separate regulation covering assisted and automated driving should be created, to provide a more robust regulatory consideration of the automated system as a whole. This debate includes consideration of possible alternative regulatory mechanisms and is potentially complex in its own right.

Maximising the benefits

The benefits of driver assistance and automation come from eliminating driver errors that contribute to causing collisions. As an example, a selection of factors recorded as contributory in police reported GB injury crashes is shown below, source: (DfT, 2016).

Contributory factor	All Roads	Motorways	
	All Crashes	Fatal Crashes	All Crashes
Failed to look properly	44%	27%	35%
Failed to judge others path/speed	22%	14%	32%
Exceeding the speed limit	5%	15%	3%
Following too close	6%	2%	16%
Travelling too fast for conditions	7%	11%	10%

The accurate measurement of speed and trajectory and the 'always on' vigilance of assisted and automated systems is expected to improve on human performance and given the frequency of failures to look and failures to judge as contributory factors will be the main source of benefits. However, the systems will also fully monitor and control speed and the distance to the vehicle in front. There is, therefore, an opportunity to maximise benefits by enforcing improved compliance with the posted speed limit and good following practise (e.g. the two second rule) during assisted/automated driving.

Enforcing compliance with the speed limit does not necessarily help in collisions where the vehicle was travelling too fast for the conditions. Future systems may present an opportunity for risk adaptive speed control, to travel at a speed appropriate for the level of risk (e.g. 30km/h (20mph) in a dense pedestrian environment in adverse weather, 130km/h (80mph) on an empty straight motorway in fine conditions).

Minimising the risk

Increasing assistance and automation reduces driver workload. This can lead to disengagement from the driving task, poor concentration, drowsiness and/or distraction by non-driving tasks (e.g. smartphone). There is growing evidence that this substantially degrades the ability of the driver to react to situations requiring their intervention. Thus, it is essential that any vehicle operating assistance systems that require the driver as a redundant backup must use measures to control the risk. These measures must consider:

- Minimising the chances of the vehicle encountering situations it cannot deal with;
- Maintaining driver engagement
- Mechanisms for re-engaging drivers
- Fail-safes in case drivers cannot be re-engaged

Restricting (e.g. Geo-fencing) the use of systems

The risk of the vehicle encountering situations the assistance system cannot deal with can be minimised by restricting where it can be used. It has been proposed that the 2019 amendments to R79 restrict automated lane change system to motorways only. Consideration could also be given to lighting and weather condition restrictions. At least one manufacturer claims systems functional in urban areas will reach the market by that time. Therefore, it may be appropriate to take a more flexible approach, requiring the manufacturer to define the conditions under which the system is designed to work (the use case) and requiring that it can only be activated within that use case.

Maintaining driver engagement

2018 systems (ACSF-B1) will be required to maintain driver engagement by use of a proxy measure: ensuring that their hands remain on the wheel. If no steering input is detected for 15 seconds, the driver is assumed inattentive and a warning sequence is initiated.

Systems capable of fully controlling the steering task in defined driving conditions and those capable of executing lane changes will generally be more sophisticated systems less likely to encounter a problem requiring driver intervention. Thus, many stakeholders will argue that the 2019 systems should allow longer periods without detecting hands-on the wheel before intervention. However, human factors research suggests a further reduced workload will increase the chance of driver disengagement. Thus, systems that take full lane keeping and lane change control but still require the driver as back-up may need more stringent driver engagement control, not less.

It has been claimed that drivers engaged with a well-designed on-board infotainment system do not become sleepy and can react to take over requests very quickly because communication can be issued directly through the system the driver is engaged with. Evidence of engagement with an appropriate system could substitute for 'hands-on' detection and enable extended periods of hands-off driving, while retaining an effective human backup. However, this can only be effective where the system is sufficiently capable to issue a warning. Situations where sensors fail to detect the risk (e.g. stationary vehicles in highly offset positions) remain a concern.

Re-engaging the driver

The 2018 systems require warning after 15 seconds without 'hands-on' detection. If the driver responds, the system can reset until another 15 seconds without hands-on is detected. There is no limit to how often this can occur. Thus, a driver writing an e-mail could tweak the wheel in response to a warning every 15 seconds and continue ignoring the road for a prolonged period. This could be prevented by detecting the pattern and escalating to deactivation if continued.

If the driver does not respond to the 15 seconds visual warning, he is confirmed inattentive with an audio visual warning following at 30 seconds and deactivation at 60 seconds. Once deactivated, there is nothing to prevent immediate reactivation. An alert driver should be able to respond to a warning in only two or three seconds. A disengaged driver should be capable of a basic response in less than 30 seconds, even if situational awareness remains impaired.

Failing safe

Where a driver remains disengaged, the system must fail as safely as possible. Where an imminent collision risk exists, an emergency manoeuvre is required. Where it does not, a minimum risk manoeuvre is appropriate. In situations combining an inattentive driver and an imminent crash risk that the system can't recognise, there may be no warning, emergency or minimum risk manoeuvre.

For emergency manoeuvres, the system must be capable of stopping in response to a stationary object in the carriageway from a speed of 130km/h (80mph). If the system is capable of fully automated lane changes, it must also be able to undertake an emergency lane change and assess the lowest risk option. Drivers should always retake control after emergency manoeuvres.

Current generation systems will slowly stop in lane. A vehicle stationary in the lane is an extremely unusual event on high speed highways and presents a serious collision risk to following traffic. On many high speed roads there is a formal hard shoulder or at least significant space to the side of the road that should nominally be a safer place to stop. Vehicles capable of automated lane changes will be capable of moving to the side of the road for a safer stop.

Alternative Regulatory Mechanisms

The UNECE Regulatory process has the important goal of global harmonisation of standards. However, as a consequence, many different Governments must agree on the standards and it can consequently be slow. Better ways of approaching this, at least in the short term, may be available, for example, via a new Regulatory Framework for Automated Vehicles.

It should be noted that although both are signatories of the UNECE process to harmonise technical automotive regulations, the US and the EU take a different approach to implementing the requirements. In the US, technical requirements are set and the legal environment is such that if there is no requirement prohibiting a system or characteristic, then it is legal. Manufacturers are required to self-certify that they comply with the requirements and the Government has extensive powers of redress against the manufacturer if they are subsequently proven not to comply. The EU operates a comprehensive pre-market approval system where the technical requirements may be similar but Governments or their agents take prototypes and defined sets of information from manufacturers and independently certify that the vehicles comply with the requirements.

ANNEXE A: SUPPORTING INFORMATION

There are advantages and disadvantages to both approaches. In self certification, the responsibility for assessing a vehicle is compliant with whatever technical requirements that exist rests with the manufacturer. This can give the Government more flexibility in setting standards. For the industry, it can reduce the administrative burden of proving compliance but it can increase the risks of subsequent legal action in the event of problems because they lack the 'certainty' that a Government issued certificate of conformity can provide. With pre-market approval, the Government takes the responsibility for proof of compliance which provides independent assessment to the benefit of public trust and provides manufacturers with certainty of compliance. However, the additional responsibilities and need for impartiality in testing procedures can lead to a more prescriptive approach to the setting of technical requirements and the procedures necessary to prove compliance.

In September 2016 the US Department of Transport and NHTSA issued a new Federal Automated Vehicles Policy; a 116 page document setting out new guidelines for manufacturers. The ability to issue guidance in this non-mandatory way fits much more easily in the US self-certification approach to regulation than it does within the EUs more prescriptive pre-market approval system. This flexibility has enabled the US to introduce requirements much more quickly than has been possible in the combined EU/UNECE approach. However, there are concerns in the US that it grants too much leeway to vehicle manufacturers and the NHTSA guidelines contains a section considering what additional regulatory tools may be necessary. This includes the adoption of at least some element of pre-market approval.

In a post-Brexit United Kingdom there may be significant merit in working closely with the US to identify a more harmonised approach based on the best combination of both the approach to technical requirements and how they are implemented by self-certification and/or pre-market approval. This could ensure future safety of all types of Automated Vehicles, whilst maximising the speed with which regulations can adapt to technical progress and minimising unnecessary constraints on manufacturers.

Whichever method of implementing technical requirements is chosen, the regulations must require a safe system of operation and that all foreseeable issues have been addressed within the particular mode of Automated operation, e.g. on a Motorway the vehicle can stop for and/or safely avoid stationary and moving objects in the roadway up to the certified safe speed of operation or road speed limit. It must also deal with the ability of manufacturers to upgrade software and hardware on the vehicle to improve operation and performance. This should involve re-certification of the new version and provide continuing evidence of safe system of operation.

ANNEXE A: SUPPORTING INFORMATION

Conceptually, a four stage certification process might be feasible. This could be based on the proven practices operated in the commercial aviation world between the US Federal Aviation Authority and aircraft manufacturers and their suppliers and would operate as follows:-

Rules Framework – This would be set at UNECE under the suggested new Automated Vehicles regulation but should be 'lighter touch' and less prescriptive at a detailed level. It should therefore set out at a higher level:

- What should be compulsory for or on an Automated Vehicle, including consideration of the existing US DoT / NHTSA guidance;
- What should be expressly prohibited;

Design Validation – This would be a submission from the manufacturer setting out:

- Details of the proposed vehicle systems and/or update to be applied;
- Confirmation of compliance with the compulsory aspects of the Rules Framework;
- An appropriate submission if there is any requested exemption to the compulsory aspects;
- A submission setting out that the vehicle will provide a safe system of operation and addressing how each aspect of the expectations in the US DoT / NHTSA guidance are intended to be satisfied or dealt with
- Details of failure modes and how the risks of each failure will be mitigated within the proposed systems
- Details of intended testing to be undertaken by the manufacturer prior to deployment

Preliminary Certification – This would be the stage at which the vehicle could be initially deployed and would include:

- A submission of detailed testing carried out and the results therefrom
- Confirmation that the vehicle complies with all aspects of the Rules Framework and Design Validation stages
- Confirmation that the vehicle continues to comply with a safe system of operation and details of any limitation and/or concerns that the manufacturer may have
- Details of guidance, education and instructions to be provided to the end user or operator on the operation of the Automated Modes to be provided on the vehicle

ANNEXE A: SUPPORTING INFORMATION

Validation and Final Certification – This would be the final part of the process and would include:

- A detailed set of standard 'real world' tests pertinent and relevant to the applicable Automated Modes carried out by a suitably qualified independent testing body
- Such tests should be carried out by a (potentially new) independent certification body that would be likely to have a number of potential stakeholders including DfT / C-CAV, VCA, the DVSA, the motor manufacturers, the insurance industry, and safety organisations such as Euro NCAP.
- Such a body in the UK would probably require similar powers to NHTSA in the US, including the ability to undertake in-service spot checking of continuing compliance, such that existing powers of recall (currently implemented through DVSA) could be used, and if necessary adapted, to allow the authorities to require manufacturers to make changes where vehicles in service did not match up to submitted testing results or where a problem became apparent later
- Some £100 million has been allocated to the set-up of independent Automated Vehicle testing facilities in the UK. While this would be an excellent way to set up the appropriate organisation and infrastructure, it is important that collaboration with the stakeholders outlined is ensured and that appropriate existing facilities, e.g. MIRA, Millbrook and Thatcham Research are included in the proposal.
- The independent body would issue final certification and assessment of vehicle performance of the vehicle through the test programme

ANNEXE B: DATA INFORMATION

The Identification of Automated Driving Systems and the Provision of Data Recording and Storage suitable for the Insurance Industry

It is unarguable that the market entry of Automated Driving systems requires development of an international standard for the transparent storage of an agreed minimum level of vehicle-related information. This is critical to ensure that, in the event of a collision, it can easily be established whether the driver, or the vehicle, was in control of the vehicle at the time and Global Regulators already use the term Data Storage System for Automated driving (DSSA) to identify the necessary process.

Many modern vehicles already have the capability to store crash data in their internal network. Where manufacturers voluntarily fit data recorders, the US Government mandates that they must contain a certain minimum dataset, standardises the format of this data and ensures it can be downloaded using a standardised tool. The European Union propose mandating a similar capability from 2022.

Although those proposals are in place for the provision of mandatory DSSA, there are limitations that will not allow an efficient and fair insurance claims process.

Therefore, international insurers want to augment those already proposed to include:

(1) The identification, classification, fit and functionality of the system
(2) Identification as to the status of the automation system(s) (automated mode, transition of control, manual driver mode).
(3) Is capable of recording and storing data at all times, including when stationary, in any geographic location and in all automation modes and collects and stores data when appropriately triggered.
(4) GPS location of the event – (to ensure appropriate system use).
(5) Applies to all systems capable of continuously controlling the steering for a time, including remote parking or distance control systems and whether or not in combination with any automated lane change or speed control functions (ACSF-A and ACSF-B2 up to E) as defined in proposed amendments to UNECE Regulation 79.
(6) Records and stores data 30 seconds before and 15 secs after an incident and stores it for at least six months.
(7) Records and stores data in all incidents, including minor crashes, insufficient to trigger the Supplementary Restraint System (SRS) e.g. Seat Belt Pre-tensioners and Airbags.
(8) Allows insurers neutral, unbiased access to decoded data either by direct access or via over the air telematics links through a neutral third party data handler.
(9) Resists attempts to manipulate or delete recorded and stored data.

ANNEXE B: DATA INFORMATION

Data Fields to be recorded and stored are:

I. GPS-event time stamp
II. GPS-event location
III. Automated Status – on or off
IV. Automated Mode - Parking or Driving
V. Automated Transition time stamp
VI. Record of Driver Intervention of steering or braking, throttle or indicator
VII. Time since last driver interaction
VIII. Driver Seat Occupancy
IX. Driver Belt Latch

It is our position that a set of technical and occupant information data has to be recorded that will allow a fact based assessment of the cause of any collision involving vehicles that have Automated Driving systems.

It follows that we must ensure, through implementation of the above proposals, that:

- The presence of systems capable of Automated Driving is openly identifiable.
- System status is known at the time of the incident.
- It is possible for the driver as well as the owner of the vehicle to exonerate themselves and be able to prove potential manufacturer liability; and vice versa protection of vehicle manufacturers and suppliers against unjustified claims.
- Motor insurers have a level playing field with vehicle manufacturers in terms of the information needed to establish liability when a vehicle capable of Automated Driving is involved in an incident.
- The continuous improvement of Assisted and Automated Driving systems and the optimisation of road safety.

Accordingly, standardised non-discriminating access to these data for all parties with a legitimate interest in an individual case (owner of the vehicle, driver, insurer, vehicle manufacturer, supplier, authorities) should be guaranteed.

Additionally, an independent trustee for the management of DSSA data (for example the Motor Insurers Bureau for UK located incidents) would guarantee impartial access, while providing for data security and data protection.

Conclusion

The technical requirements for DSSA should be harmonised internationally through the UNECE and implemented in Europe through EU Whole Vehicle Type approval in a timeframe matched to that of the automation systems themselves.