Assuring the safety of connected and automated vehicle trials on the public highway

Guidance for insurers

endeavour

TRL THE FUTURE OF TRANSPORT

Foreword

This document is one out of a suite of three stakeholder specific guidance documents on the safety assurance of trials. This document is aimed at insurers involved in testing and trialling connected and automated vehicles (CAVs) within the UK. The other two documents are aimed at local authorities and trialling organisations. These documents have been developed by TRL as a key output from our work on CAV safety assurance within Project Endeavour.

1. Introduction

1.1 What is safety assurance and what does it mean for insurers?

1.1.1 What is safety assurance and why is it important?

As CAVs are evolving, there is an increasing demand to test and trial them on the UK road network. Demonstrating the safety of CAV trials is vital to ensure that there is strong public confidence in CAVs and related mobility services. As such, ensuring best practice approaches to safety assurance during public trials is key to the successful introduction of CAVs onto UK roads.

Safety assurance can be defined as a method of demonstrating that a CAV under test has the required processes and controls in place to ensure that the risks have been assessed and mitigated to as low as reasonably practicable (ALARP). The safety assurance process can also be a useful opportunity for stakeholders to share information and learn from one another, which ultimately helps drive innovation.

1.1.2 What does safety assurance mean for insurers?

For CAV trials, trialling organisations (TOs) should provide safety assurance to several key stakeholders and decision-makers. Insurers are one of the key stakeholders for CAV trials.

Having reviewed the information on safety of a CAV trial, the fundamental question for insurers is will they take on the risk? For some, their market is elsewhere and insuring CAV trials is not a good fit at present. Others have been actively involved in CAV trials for some years. The advantages and disadvantages of the different approaches taken by insurers are summarised in **Table 1**. Some insurers will find they are somewhere in the middle, with a focus on monitoring and knowledge gathering, without direct involvement in a CAV trial. In this instance, insurers will benefit from at least some understanding of safety assurance to help them plan for future CAV trials, and eventually for wider CAV deployment.

Table 1: Summary table of potential insurer approaches to CAV trials

No engagement → **Active involvement under writing trials**

Advantages:	Advantages:
▪ No risk or potential for loss ▪ No need to change their processes to include CAVs ▪ Can learn from observing the experience of others	▪ Potential to learn from claims experience ▪ Early insight about how processes in claims, pricing, and underwriting might need to change ▪ Reputational gain associated with involvement in CAV trials
Disadvantages:	**Disadvantages:**
▪ No direct learning or experience gained	▪ Claims process might be very expensive and litigious due to the novel technical area ▪ Risk of reputational damage if a serious or fatal incident occurs

1.2 What progress has been made to date in safety assurance for CAV trials?

1.2.1 Safety assurance requirements, standards and guidance documents

Figure 1 provides a snapshot of some of the key requirements, standards and guidance documents that have been produced related to general trial safety and the specific requirements of a safety case.

Figure 1: CAV safety regulations, standards and guidance landscape

The requirements, standards and guidance documents of most relevance to safety assurance include:

- The DfT Code of Practice for automated vehicle trialling – this code of practice provides guidance on trialling automated vehicle technologies on public roads or in public places in the UK. It makes recommendations on how to maintain safety and minimise potential risks. There is also guidance on how to improve the transparency of trials and how to engage with the public, authorities and other relevant bodies when planning trials.
- BSI PAS 1881 Assuring the Safety of Automated Vehicle Trials and Testing – this standard is intended to support the safe testing and trialling of CAVs. It specifies best practice for safety cases for automated vehicle trials and development testing in the UK to demonstrate that activities can be undertaken safely.

The team at TRL has played a key role in developing current guidance and standards for CAV trials. We co-authored BS PAS 1881 – Assuring safety for automated vehicle trials and testing and the Zenzic Safety Case Framework for CAV testing and trialling across all the UK testbeds.

In addition to the above, whilst not directly related to safety assurance, legislation which is of particular relevance to insurers is the Automated and Electric Vehicles Act 2018. This legislation enables insurers to offer insurance to the owners of AVs for driverless activities. The purpose of this legislation is to amend the existing compulsory third party insurance framework by extending it to cover the use of automated vehicles. Currently the law relating to motor insurance is focused on the idea that human drivers must have personal insurance to cover compensation to third parties for personal injuries and / or property damage caused by them when they are driving. This legislation introduces the notion that an insurer or owner can be liable for the consequences of an accident caused by the actions of an AV at a time when it is not under the immediate physical control of a human being.

1.2.2 Safety assurance within CAV testing and trials

Alongside the development of safety assurance documentation, there has been extensive testing and trialling activity underway within the UK. At TRL, we've been gaining experience in safety assurance due to our involvement in a wide range of these trials including GATEWAY, Streetwise, DRIVEN and the HelmUK HGV platooning trials. TRL also led the build of the Smart Mobility Living Lab (SMLL) in London – the UK's most advanced real-world connected environment for testing future mobility technologies. For the SMLL we have put all the necessary processes in place to ensure that any trials are conducted safely and in line with current best practice, guidance and standards.

Exposure to diverse projects of different scales and nature has allowed us at TRL to develop deep technical understanding of a range of elements related to safety assurance including: creating and reviewing safety cases, undertaking risk assessments, developing risk mitigation strategies, supporting trials, conducting emergency response tests, and establishing testbed procedures.

1.3 Project Endeavour – improving safety assurance for future CAV trials

Project Endeavour is a collaborative, consortium led project, part-funded by the Centre for Connected and Autonomous Vehicles (CCAV) and delivered in partnership with Innovate UK. It is a mobility project designed to fast-track the introduction of connected and automated vehicle (CAV) services across the UK and maximise the potential of this new technology to shape the future of mobility. TRL is a key partner in Project Endeavour and we are bringing our safety and compliance expertise to deliver a dedicated safety assurance workstream. The focus of this workstream is to improve the level of understanding of safety assurance among all stakeholders. Also, to promote the adoption of a streamlined and consistent approach to safety assurance amongst stakeholders to help reduce barriers to trialling and innovation across the UK.

To help define the activity within the safety assurance workstream on Project Endeavour, TRL conducted a series of interviews with stakeholders involved in CAV trials including: trialling organisations, highway and local authorities, testbeds and landowners, insurers and insurance bodies. Their input is gratefully acknowledged. The aim of this engagement was to find out more about their current involvement and capabilities in conducting and supporting CAV trials, their future aspirations, and the areas in which we may assist them in fulfilling those aspirations. This stakeholder engagement identified that there were some key gaps in knowledge and inconsistencies in the approach taken towards safety assurance of CAV trials. To address this, one output of the project is to develop bespoke stakeholder specific guidance documents for trialling organisations, local authorities and insurers.

1.4 What this guidance document is and what it includes

This guidance document is aimed at insurers involved in CAV trialling within the UK.

Within our engagement with insurers, the main finding was that insurers currently have different levels of engagement with CAV trials, and differing future plans. The role of the law firms and insurance associations is to support the insurers with the transition towards CAV trials, and eventually towards CAVs driving on UK roads as part of a mixed fleet.

This guidance document aims to provide some high-level technical guidance about BSI PAS 1881 Assuring the Safety of Automated Vehicle Trials and Testing, which will become increasingly important to insurers as they underwrite CAV trials and eventually type-approved CAVs in deployment. The document sets out a suggested process for insurers to follow when considering underwriting CAV trials. It also includes some case studies which highlight examples of where elements of this process have previously been well executed.

This document concludes by outlining some further services which TRL is able to offer to help further assist insurers in reviewing the safety assurance of CAV testing and trialling activities.

2. Understanding more about safety assurance

2.1 Understanding risk

Safety cases can help insurers to better understand the financial and reputational risk of insuring a CAV trial vehicle. The key for insurers currently insuring conventional vehicles is to understand the risk so that they can price confidently and accurately to win the business from consumers and fleets. Currently, this risk is based on factors such as the vehicle's make, model, age, mileage, and the driver's age, gender and address.

The principle with CAV trials is no different; insurers still need to understand the risk. The problem is that the vehicles and their performance are different and less well understood. Therefore, the safety case becomes the substitute for the normal (vehicle and driver) pricing factors.

2.1 What is a safety case?

It is fast becoming less appropriate to consider vehicle safety in terms of discrete sub-systems; a holistic approach is now commonly required. Safety cases have been used for decades in other safety-critical industries as best practice for assuring system safety to stakeholders, including regulators.

A safety case is a structured argument supported by a body of evidence which demonstrates that all the safety risks have been identified and appropriate controls have been put in place to minimise the risk of harm. BS PAS 1881 – Assuring safety for automated vehicle trials and testing sets out the requirements for these safety cases, alongside legislative and stakeholder requirements. The main areas of a safety case are summarised in **Figure 2** below.

Figure 2: The main elements of a safety case

BS PAS 1881 – Assuring safety for automated vehicle trials and testing states that the safety case shall include details of who is insuring the trial, vehicles and safety drivers or operators and any specific equipment. The safety case must also include the insurance certification.

2.3 Operational versus functional safety

CAV trials offer insurers a means to learn about operational safety as well as functional safety. Functional safety concerns the ability of a system to operate correctly according to its inputs and to respond to faults and failures in a safe manner. It chiefly comprises the vehicle, it's software, and their combined performance capability. This is the part of CAV performance that might be tested on a track, by consumer ratings or regulatory tests. These tests are limited by time, practicality and cost to cover a small number of scenarios in which the vehicle will be expected to perform.

Operational safety is the identification and management of all risks associated with completing any activities within the defined operating environment. It is constrained during a trial to a particular operating area or route, but the real-world conditions that might arise are significantly more varied and complex. This is where insurers might see the additional value of being involved in CAV trials, because a trial is much closer to the level of performance they would have to underwrite if these vehicles entered the market. **Figure 3** provides are overview of the different information provided by functional safety and operational safety in the context of the real world in which vehicles are insured.

Figure 3: An overview of the different information provided by functional safety and operational safety

3. Process for insurers

Our discussions with insurers have revealed an overall process that might be used for safety assurance in order to support the decision on whether to insure a vehicle as part of a CAV trial. This is summarised in the process flow in **Figure 4**.

Figure 4: Process flow diagram for reviewing a CAV trial

4. Case studies

4.1 AXA – How AXA is shaping the future of autonomous vehicles

AXA Group is a leading insurance company heavily involved in future mobility. Since 2015, AXA UK and AXA XL have been proactively involved in the trialling of connected and autonomous vehicles (CAV) in the UK having realised the potential of this technology for achieving safer, cleaner and more accessible roads. Combined, AXA UK and XL have been partners on multiple consortia trialling CAVs including DRIVEN, FLOURISH, Capri, UK Autodrive, Robopilot, VENTURER and VI-DAS. The role AXA played in these consortiums was providing advice on safety, regulation, liability and data, including publishing thought-piece reports and provision of insurance for some trials. AXA XL currently provides insurance for the Oxbotica vehicle as part of Project Endeavour.

Furthermore, in 2018, AXA provided evidence for the Automated and Electric Vehicles Act (AEVA) 2018, which ensured a smooth transition for consumers using CAVs with the creation of a single insurance model. From AXA's perspective, AEVA laid the foundations for CAVs but further work is required on areas including data provision and ownership, clarity of regulation and consumer awareness. AXA want to ensure these challenges are addressed and the UK continues the pioneering work of industry and Government in researching and developing connected and automated mobility. That's why, in partnership with Burges-Salmon, AXA are engaging with Government and the Law Commission through a new cross-party Parliamentary group to support self-driving technologies safe and effective deployment across the UK, including examining the regulation that will underpin the technology's safe deployment.

4.1.1 Safety case construction

From AXA's participation in trialling new innovations, they understand the importance of putting in place a robust safety case to protect every person and vehicle within the trial environment and have expert teams to discuss safety case construction with TOs. This included the Capri project which aimed to build passenger, regulatory and market confidence in low-speed dual-mode autonomous pods and culminated in trials at the Queen Elizabeth Olympic Park. Their experiences of reviewing safety cases highlighted six areas of importance that TOs should consider when building safety cases:

Risk assessment: A strong safety case, regularly reviewed and updated, will support an effective and safe trial by identifying all risks and hazards relevant to the Operational Design Domain (ODD), how they will be mitigated and any controls that should be applied.

Standards, validation and testing: Manufacturers should maximise the functionality of the vehicle and ensure it can be evidenced that the technical components meet high standards. Ensuring vehicle functionality must be a strategic process in which the vehicle operates effectively when tested against the original design.

Safety personnel: CAV trials often require two different types of safety personnel, Stewards and Marshals. Both have clear training and compliance requirements which must be met and evidenced within the safety case.

Appropriate insurance cover: Trialling any CAV technology must be compliant with UK laws, including ensuring there is appropriate insurance cover in place for both the trial activity and the environment where the vehicle will be used.

Communication plan: CAVs operate in an interactive environment. A high level of stakeholder engagement formalised within the safety case framework is necessary to ensure all those in the ODD remain educated and informed throughout the lifecycle of the trial.

Independent review: The safety case process should be collaborative and include an element of independent review which can balance commercial interest and offer sufficient scrutiny.

4.1.2 Handover from vehicle to occupant

The VENTURER project was one of the first trialling projects in the UK and assessed CAV-enabling technology and the ways users responded to it, in particular the handover phase between vehicle and driver. During testing in Bristol, AXA and the project partners recognised that whilst the vehicle technology was being developed, there would be a long period with vehicles having the ability to 'switch' between automated and manual modes. One consideration for insurers of CAVs is to understand that 'switch'. If Safety Drivers are permitted to disengage from the driving task, how long does it take for them to have full alertness and situational awareness to be able to respond at the same level as they would have if they had been driving in manual mode continuously. Ensuring new UK regulation for CAVs covers the entire handover period effectively will be an important step towards safe deployment.

4.1.3 Data in trials

Through CAV trials, AXA learned how data fuels the effective operation of self-driving technology. Significant quantities of data are produced through LiDAR, Radar, and high definition video monitoring the driving environment, which in the real world could process over 4TB per day per vehicle. Data is not only essential for the safe functioning of a CAV but for insurers, it is integral to understand the change in risk and establish liability in the result of an incident. The collection of data through the duration of a trial is therefore a key component of maintaining safety and insurability.

4.1.4 Impact of CAVs on insurers

CAV technology has the potential to remove the cause of 90% of road traffic accidents – driver error. For this reason, AXA believes there could be a significant reduction in UK road accidents when this technology becomes common place. In the long-term when technology becomes more sophisticated and repair costs fall, motor insurance premiums could decrease significantly, with many predicting reductions by around 50%.

4.2 Streetwise safety case approval process

4.2.1 Project overview

The StreetWise project aimed to develop and demonstrate the technology, safety validation methods, insurance and service models required to deliver an automated shared mobility solution, targeted at replacing the personal urban commuter car.

The project consortium included:

- Five (the project lead) – a UK-based company who are highly competent and experienced in the vehicle engineering, machine learning, artificial intelligence and safety fields.
- TRL – who developed the safety case for public road testing in Bedfordshire and for the London-based trials.
- Direct Line Group – who underwrote the insurance.

Other project partners included Transport for London, Claytex, Warwick Manufacturing Group, Oxford University Torr Vision Group and McLaren Applied Technologies.

4.2.2 Safety case approval process

Five, TRL and Direct Line Group worked closely together throughout the project through regular liaison, on-site reviews and by following a gated approval process. The process involved TRL acting as independent safety assessors and Direct Line Group acting as insurance/liability assessors, to ensure that the vehicle and latest automated driving system (ADS) were safe for use on public roads. The approval process assessed the implementation of changes to either existing or new ADS functionality, for example changes to existing functionality might have involved improving the system's behaviour on approach to or at certain road features. Equally, new functionality allowed Five to expand the Operational Design Domain (ODD) to increase automated operation.

The method ensured that a robust safety and insurance approval process was applied to manage safety and to scrutinise proposed on-road activities. Similarly, any changes that could affect the trial design and safety case, such as updates to safety driver training and changes to the existing base vehicle, were also discussed and evaluated ahead of implementation and inclusion in the safety case.

4.2.3 Key benefits of this approach

Five, TRL and Direct Line Group demonstrated that the process was effective throughout the project and it allowed Five to incrementally scale-up automated operation from their base in Bedfordshire in readiness for public road operation in London. In turn, it provided valuable learning for TRL and Direct Line Group and allowed both parties to follow and examine the ADS functionality throughout the development journey to ensure safe public road operations.

The gated approval process provides a real-life blueprint for other projects and insurers to follow for future CAV trials and remains a key part of the safety assurance ahead of any automated public road operation in the UK.

Figure 5: Five's automated test vehicle

TRL services

TRL has significant safety assurance expertise which has been developed through experience in several CAV trials. Therefore, TRL are well-placed to support insurers in a variety of safety assurance activities for CAV trials as described below. To find out more about our Team and the Services we offer, please email enquiries@trl.co.uk.

Independent safety case review

TRL has previously developed and reviewed safety cases for a range of CAV projects including GATEWAY, Streetwise, DRIVEN and the HelmUK HGV platooning trials. TRL also co-authored BS PAS 1881 – Assuring safety for automated vehicle trials and testing as well as the latest Zenzic Safety Case Framework.

Based on this experience, we are ideally placed to provide insurers with independent safety assurance for CAV trials including:

- Independent review of entire safety cases
- Independent review of specific safety case elements (e.g. operational risk assessment, route safety assessment, emergency response plan, operational guidance).

Compliance audits

TRL can provide audit services to ensure that TOs are operating in adherence with their safety case, specific safety case elements or guidance, or to a defined process or procedure. This might include checking training records and ensuring adherence with mitigations outlined in the risk assessment.

We can also monitor and audit compliance with the safety case during trial activities to ensure that all operational guidance and controls are being followed, including reviewing evidence of safety monitoring.

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