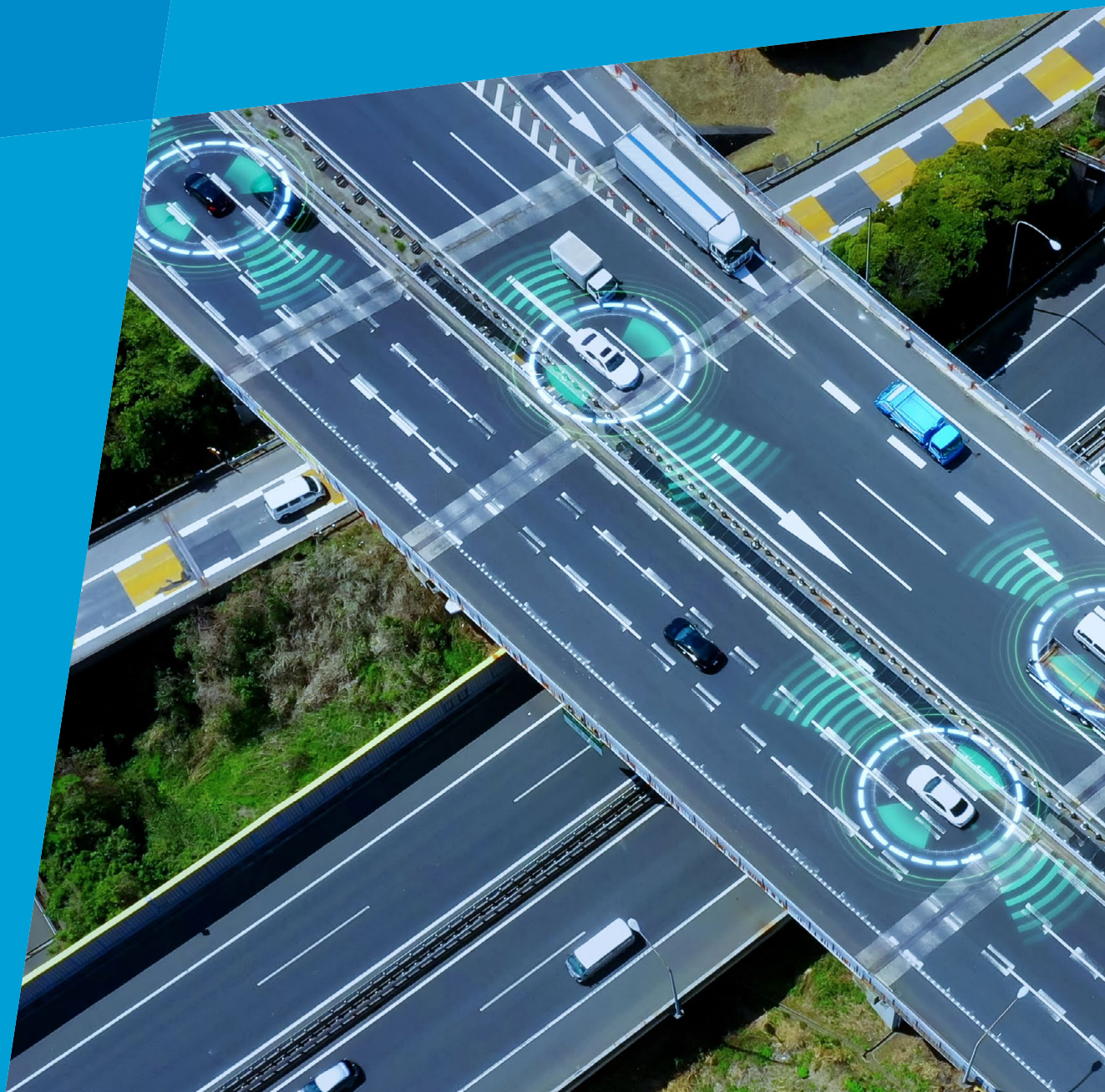
national highways

Safety risk assurance for connected and autonomous vehicle (CAV) trials on the strategic road network (SRN)

Guidance Document



Contents

1 Foreword

I'm delighted to share our guidance document on safety risk assurance for connected and autonomous vehicle (CAV) trials on the strategic road network (SRN). It outlines the approach we expect trialling organisations to follow when carrying out safety risk assessments for trials of CAV technology and services on our network. This guidance document sets out a flexible methodology, which allows CAV trials to meet National Highways' expectations whilst building upon existing safety frameworks.

We believe CAVs may transform how road users travel, creating more integrated, reliable and safer journeys. We welcome the growing demand to trial these innovative technologies and services on our network. We're keen to continue working with CAV trialling organisations and support them to get their trials on-road safely.

We want everyone who works with us and everyone who travels on our network to get home, safe and well. I believe through active collaboration we can deliver safer and better roads which connect people and connect our country. We are looking forward to continuing to collaborate and build strong relationships with CAV trialling organisations. This will allow us all to realise the benefits that these technologies can deliver on the strategic road network and beyond.

Dr Joanna White

Roads Development Divisional Director
National Highways

2 Terms and definitions

Term	Definition
Assurance	The processes for making, recording and implementing decisions.
Feature	Property of the CAV trial activity that can be expected to affect the complexity of the safety risk assessment and assurance process.
Hazard	A source of potential harm which poses a threat to relevant populations.
Hazard identification	A process by which hazards are identified.
Mitigation measure	To reduce or alleviate the hazard safety risk through the use of qualitative or quantitative actions.
RACI matrix	A map which breaks down roles and responsibilities in relation to the safety case development process. RACI stands for Responsible, Accountable, Consulted, Informed.
Safety objective	What the CAV trial activity expects to achieve in terms of safety performance.
Safety risk	The combination of the likelihood and consequence of a specified hazard being realised.
Safety risk assessment process	Overarching process surrounding safety risk assessment that includes planning and preparation through to monitoring and review.
Strategic Road Network (SRN)	This is the network of motorways and major A-roads in England and for which we are responsible for operating, managing, maintaining and improving. We are appointed as the highway, street and traffic authority for the SRN.
Sub-population	An identifiable part or subdivision of a larger population (e.g. users – motorcyclists, large goods vehicle drivers).

3 Introduction

3.1 Background

We welcome the growing demand to trial connected and autonomous vehicle (CAV) technology and services on the strategic road network (SRN).

CAV technologies have the potential to deliver a wide range of benefits such as safer roads, faster delivery of projects and improved customer experience. We wish to support trials which will safely develop and introduce these technologies to our network.

We understand the risks associated with the strategic road network and we are keen to work with you (the CAV trialling organisation) to make sure these risks are appropriately and proportionately accounted for in your CAV trial activity's safety case.

3.2 Purpose

As highway authority, we must have regard for the safety of our road users and protect and improve the safety of our network. This is enacted through General Guidance 104: Requirements for Safety Risk Assessment (GG 104) [1].

This guidance document sets out the approach we expect CAV trialling organisations to follow when carrying out safety risk assessments for trials of CAV technology on our network. It describes how we will engage with you and the resources available to support your trial through the safety risk assessment process.

This guidance document:

- Makes it easier for you to engage with us by having a single point of contact who will help you engage with wider specialists.
- Enables you to benefit from our knowledge and experience of the strategic road network to identify and assess hazards and manage the safety risks associated with your CAV trial activity.
- Provides a flexible approach, which builds on the Department for Transport (DfT) Code of Practice (CoP): Automated vehicle trialling [2] and other established safety frameworks for CAV trialling organisations.
- Encourages collaboration, knowledge sharing and innovation by working together towards a common goal of robust and proportionate safety risk management.

3.3 Existing standards and general requirements

We recognise that there are existing safety case frameworks available for CAV trialling organisations to use, including:

- Department for Transport (DfT), Code of Practice (CoP): Automated vehicle trialling [2]
- British Standards Institute (BSI), Publicly Available Specification (PAS) 1881: 2022 Assuring the operational safety of automated vehicles – Specification [3]
- Other established safety case frameworks

We expect you to prepare a safety case that aligns with one or more of the current safety case frameworks, whilst also meeting our specific expectations which are set out in this guidance document. This provides assurance that the safety risks are managed in accordance with the principles of GG 104.

We anticipate that you will have detailed knowledge of, and comply with, relevant legal and regulatory requirements.

3.4 Use of the term 'safety case'

The use of the term 'safety case' within highways is not affiliated with the same legal obligations as other industries such as nuclear and rail, where there is a legal obligation to produce them.

3.5 Updates to the guidance document

It is possible that this guidance document will be subject to future updates based on feedback from users of this document.

The frequency or scale of future updates has not been set to retain maximum flexibility, so we can respond appropriately to any feedback.

Should you have any questions or feedback regarding this document, please contact our CAV team.

National Highways CAV team
CAVtestbed@nationalhighways.co.uk

4 Roles and responsibility

The CAV trialling organisation is accountable for developing the safety case for CAV on-road vehicle trials, and ensuring it reflects the guidance outlined in existing safety case frameworks. This guidance document sets out National Highways' specific expectations, which apply when the CAV trial activity environment includes our network.

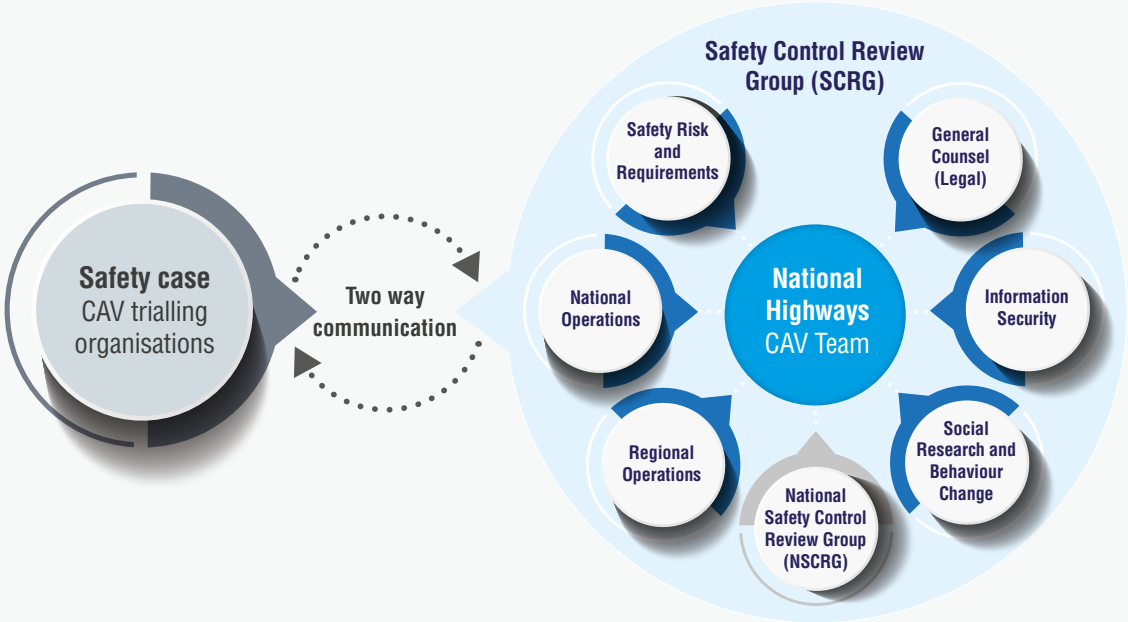
The safety case should cover:

- **Operational safety** – the identification and management of all risks associated with completing any activities within the defined operating environment. The interaction of a systemically safe vehicle with the operating environment (including the route, safety driver or operator, passengers, other road users and road workers) should be considered.
- **Cyber security** – the trustworthiness of data and vehicle communications should not compromise privacy and roadside infrastructure.
- **System safety** – safety of a system such that it can operate correctly according to its inputs and to respond to faults and failures in a safe manner.

We have a wealth of expertise and understanding of operational safety risks on the strategic road network and we are well placed to support you in identifying hazards and assessing risk. We will require assurance that you have appropriately managed the safety risks across operational safety, cyber security and system safety.

Our CAV team will be your main point of contact and will facilitate discussions with other parts of our organisation when necessary. The teams outlined in Figure 4-1 will only be involved in your CAV trial activity when their input is required.

Figure 4-1: *Two-way communication between CAV trialling organisation and National Highways CAV team*



We encourage you to engage with us at the earliest opportunity as this will bring the following benefits:

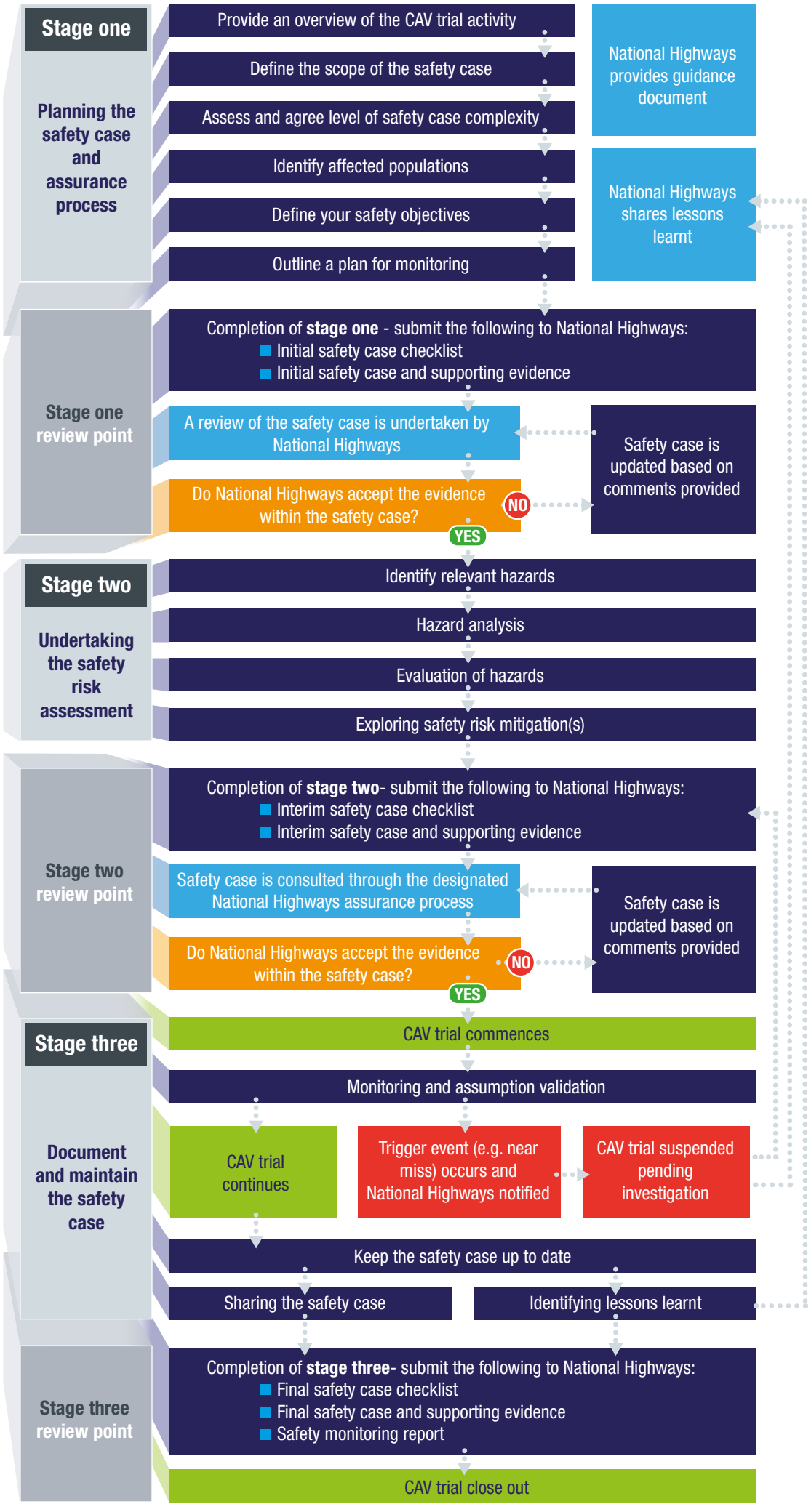
- Informed decision making – we have an abundance of knowledge and understanding of the operational safety risks that occur on our network that we can share with you.
- Understand needs – successful outcomes can be achieved if we work together to clearly understand each other's needs and expectations for your CAV trial activity. For example, you may wish to access specific technology assets and need to understand our requirements for system safety and cyber security.
- Operational guidance – we can provide advice on the proposed route(s) and operational information for our network, such as planned roadworks and closures.

5 Overview of safety case development process

We have developed a process to help you produce a safety case for your CAV trial activity that meets our safety assurance requirements. The process primarily focuses on operational safety.

It includes three review points where the safety case will be reviewed by National Highways. We will either accept the evidence within the safety case for the proposed CAV trial activity, or provide feedback enabling it to be improved and resubmitted. This approach allows us to carry out an initial review and give you an early indication of whether your proposal is likely to meet our expectations, before you have committed significant time and expense to developing the safety case. A high-level overview of the safety case development process is presented below. Further details for each stage is provided in the next sections of the guidance document.

We understand that safety cases for CAV trials will vary in style and content, as trials differ in type and complexity. To allow flexibility and to retain confidence that the safety case expectations have been met, we have developed a safety case development checklist. This checklist allows you to confirm that you have met the expectations by signposting relevant evidence from the safety case. The checklist is included in Appendix C and should be completed incrementally as you develop the safety case. It should be provided to our CAV team alongside the safety case, ahead of the outlined review points and on completion of your trial.


Stage one
Planning the safety case and assurance process
Provide an overview of the CAV trial activity
Define the scope of the safety case
Assess and agree level of safety case complexity
Identify affected populations
Define your safety objectives
Outline a plan for monitoring
National Highways provides guidance document
National Highways shares lessons learnt
Stage one review point
Completion of stage one - submit the following to National Highways:
Initial safety case checklist
Initial safety case and supporting evidence
A review of the safety case is undertaken by National Highways
Safety case is updated based on comments provided
Do National Highways accept the evidence within the safety case?
NO
YES
Stage two
Undertaking the safety risk assessment
Identify relevant hazards
Hazard analysis
Evaluation of hazards
Exploring safety risk mitigation(s)
Stage two review point
Completion of stage two- submit the following to National Highways:
Interim safety case checklist
Interim safety case and supporting evidence
Safety case is consulted through the designated National Highways assurance process
Safety case is updated based on comments provided
Do National Highways accept the evidence within the safety case?
NO
YES
Stage three
Document and maintain the safety case
CAV trial commences
Monitoring and assumption validation
CAV trial continues
Trigger event (e.g. near miss) occurs and National Highways notified
CAV trial suspended pending investigation
Keep the safety case up to date
Sharing the safety case
Identifying lessons learnt
Stage three review point
Completion of stage three- submit the following to National Highways:
Final safety case checklist
Final safety case and supporting evidence
Safety monitoring report
CAV trial close out

6 Operational safety

6.1 Stage one
Planning the safety case and assurance process

Stage one covers the period between your initial contact with our CAV team and reaching agreement on the scope and complexity of the safety case; this will be proportionate to the level of safety risk associated with your CAV trial activity.

The checklist should be used to demonstrate where each of these steps has been completed within the safety case and its supporting evidence.

6.1.1 **Step one –** Provide an overview of the CAV trial activity

We expect you to provide a comprehensive written description of the CAV trial activity that you wish to carry out on our network. This should include (but is not be limited to):

- Objectives of the trial
- Description of the connected / automated features being deployed
- Society of Automotive Engineers (SAE) Level of Automation / ITS UK Connected Vehicle Scale
- Number and type of vehicles
- Duration of trial
- Measures to mitigate safety risk including the role of any safety drivers

We would also welcome a description of the operational design domain (ODD) of your CAV trial activity, including the type of roads, traffic and weather that you plan your trial to operate in. BSI PAS 1883: 2020 Operational Design Domain (ODD) taxonomy for an automated driving system – Specification [4] provides a common classification for describing the ODD which we would recommend using as a template.

6.1.2 **Step two –** Define the scope of the safety case

The next step is to define the scope of the safety case. This should cover the following:

- The purpose of the safety case. This is best articulated as a question that the safety case aims to address.
- The scope of the safety case. This should explicitly detail what is included and what is excluded.

6.1.3 **Step three –** Assess and agree level of safety case complexity

We expect the effort undertaken on safety risk assessment activities to be proportionate to the complexity of the CAV trial activity. GG 104 has an established framework for assessing and agreeing the level of safety risk assessment required and expects trials to follow this.

The CAV trial activity's safety case should document:

- The rationale for determining each category type for the six activity features
- The overall outcome of the categorisation process

The complexity of the safety case can be determined by considering six generic features. Table 6-1 is based on the categorisation framework outlined in GG 104 but it has been tailored to CAV trials. It provides a broad set of questions that need to be considered but may not provide a full representation of your CAV trial activity.

Table 6-1: Categorisation table of activity type

	Feature	Feature questions to be considered	Selection criteria	
			Type	Indicator
1	**Extent of prior experience of activity** The degree of knowledge available from the CAV trialling organisation having undertaken the activity previously or the degree to which knowledge is available from the activity being undertaken in other industries or organisations.	■ Is there operational experience / safety data available from previous trials that suggests the safety objective will be met? ■ How similar is the operating environment of the previous trials? ■ Is the experience local to this trial or to somewhere else in the UK? ■ If there is no relevant UK experience, is there relevant experience overseas?	A	Significant experience. Previous safety studies and data are available, and some activity features are codified in a standard or formal procedure.
			B	Limited experience - but transferable experience elsewhere in the UK or internationally. There might also be local / site specific issues to consider that can affect the relevance of the available experience.
			C	No previous applicable experience.
2	**Statutory & formal processes & procedures** Consideration of the applicability of current standards, formal processes and procedures, guidance and legislation.	■ Is the trial activity covered by existing standards? ■ In order to implement the trial activity will a change need to be made to existing legislation? What is the extent of this change? ■ What legislation (if any) imposes additional safety related duties on the trial activity?	A	The activity is substantially or entirely within the scope of existing standards, guidance, formal processes or procedures and applicable legislation.
			B	The activity is largely within the scope of existing standards, guidance, formal processes or procedures. The activity may need minor changes to existing legislation.
			C	Activities that are not within the scope of existing standards, formal processes, procedures or existing legislation, and require new ones or significant changes to existing legislation to be developed.
3	**Impact on the organisation** (National Highways) The effect that the activity will have on current National Highways processes, procedures, structure, roles and responsibilities, competencies, policies and strategy, in addition to contractual and workforce arrangements.	■ Will the trial activity have an impact on National Highways operational procedures? ■ Will the trial activity have an impact on the activities carried out on connected infrastructure? ■ Will any new responsibilities be required? ■ What are the competency requirements for the trial activity? Are they currently covered?	A	The activity has no / a minor impact on any of these factors for a finite / short period of time.
			B	The activity can lead to permanent minor changes to any of these factors. These minor changes can introduce new roles and responsibilities, policies, contractual and workforce arrangements. The activity can require a change to organisational arrangements. Length of time National Highways is affected by the decision to undertake the activity is medium term.
			C	The activity has significant impact on any of these factors. The activity can change core safety roles and responsibilities. Length of time National Highways is affected by the decision to undertake the activity is long term.

	Feature	Feature questions to be considered	Selection criteria	
			Type	Indicator
4	**Activity scale** Consideration of the size and/ or scale of the activity. Does or can the activity have an impact on the road network, either directly or indirectly?	■ Will the trial activity have a local/regional/ national impact? ■ Does the trial activity involve the wider roll-out of a previous trial? ■ Is there potential for wider roll-out of the trial activity?	A	The activity is limited in nature or scale.
			B	The activity is significant in nature or scale.
			C	The activity is wide ranging across the network, and/or significantly impacts infrastructure, interventions or workforce.
5	**Technical** Measure of technical and / or technological novelty and / or innovation the activity involves.	■ Have the methodologies and/or technologies associated with the trial activity been applied elsewhere? ■ Are previous risk assessments / safety data associated with the technology available? ■ Will there be any modifications to the technology for the proposed trial activity that have not yet been applied on previous trials? ■ What Society of Automotive Engineers (SAE) level of automation or ITS UK Connected Vehicle Scale is this trial aiming to support?	A	Processes, techniques, methodologies and/or technologies involved are currently in widespread use and re-examination is unlikely to be needed. (Commercial off-the-shelf (COTS))
			B	Some experience of the processes, techniques, methodologies and/or technologies. The experience can be from use in either another application, or by another road authority, supplier, industry or perhaps from overseas. Some bespoke elements but used elsewhere.
			C	Activities that use new processes, techniques, methodologies and/or technologies for which there is no previous experience in the UK or elsewhere. Completely novel / bespoke to the CAV trialling organisation.
6	**Stakeholder impact and interest** The quantity and/ or impact of stakeholders, their interest in and resulting ability to influence or/ impact on the safety activity. The degree to which these safety issues (as perceived) are capable of being understood and fully addressed.	■ Which organisations/ individuals can be considered as stakeholders? ■ How many stakeholders are there? ■ What kind of influence does each of the stakeholders have? ■ Which stakeholders have the most influence? ■ Are there any key stakeholders on which the trial 'go ahead' depends?	A	Activities for which the quantity and/or impact of stakeholders, their interest in and resulting ability to influence or impact the activity is low.
			B	Activities that have only a single or a few stakeholders but their impact, in terms of their attitude towards, or ability to influence the activities may be significant. Alternatively, it will represent an activity that has several stakeholders but the amount, or type, of safety issues involved are limited.
			C	Activities for which there are a large number of stakeholders and their impact in terms of their attitude towards, or ability to influence may be significant. Stakeholders with a strong interest in the potential safety impact of the activity on themselves. Activities where there are conflicting needs arising from different stakeholders or stakeholder groups.

The results of the categorisation process should be used by you to determine the complexity and rigour expected in undertaking the specific risk assessment for your CAV trial activity. We will advise on the level of assessment that is likely to be sufficient based on the following three categories:

- **Type A**
- **Type B**
- **Type C**

The overall activity categorisation outcome is guided below.

Type A	**Type** B	**Type** C
■ Where all activity features are categorised as Type A ■ Where three or more features are categorised as Type A	■ Where all activity features are categorised as Type B ■ Where three or more features are categorised as Type B	■ Where all activity features are categorised as Type C ■ Where three or more features are categorised as Type C

Where there is an equal distribution between two or more category types, the overall activity categorisation will be governed by their relative importance (this will be more subjective - but the decision and rationale should always be documented).

To help further, the three categories can be interpreted as follows:

- **Type A** – a basic level of safety risk management is expected, through the application of a safety risk assessment which will require our CAV team to accept that the safety case evidence meets National Highways expectations.
- **Type B** – a moderate level of safety risk management is expected, which may require additional safety risk assessment processes. A Safety Control Review Group (SCRG) will be established to accept that the safety case evidence meets National Highways expectations.
- **Type C** – a rigorous level of safety risk management is expected, as many of the features of the CAV trial activity fall outside of existing experience and processes. All decisions and justifications are expected to be recorded and an extensive safety risk assessment to be undertaken. A SCRG and the National Safety Control Review Group (NSCRG) will both have to accept that the safety case evidence meets National Highways expectations.

A brief description of the role of SCRG and NSCRG can be found in Appendix D.

The result of the overall activity categorisation outcome will be agreed with us at the end of stage one before work to implement the appropriate safety risk assessment begins.

6.1.4 **Step four –** Identify affected populations

We expect you to clearly identify within the safety case all relevant populations (including sub-populations) and record how each is or can be affected by the CAV trial activity.

Sub-populations are an identifiable part or subdivision of a larger population (e.g. users can be broken down into motorcyclists, large goods vehicle drivers).

The populations likely to be relevant to trials on our network are included in Table 6-2.

Table 6-2: Relevant populations using the SRN (both motorway and all-purpose trunk roads (APTR))

Classification	Population
Workers	People directly employed by National Highways and who work on the motorway and APTR either permanently e.g. traffic officers, or periodically e.g. those undertaking site visits; AND People in a contractual relationship with National Highways, including our national vehicle recovery contract operatives, all workers engaged in traffic management activities and incident support services, and any other activities where traffic is present, such as persons carrying out survey and inspection work.
Users	All road users, including the police and emergency services, equestrians, cyclists and pedestrians, as well as those others, who are at work but are not in a contractual relationship with National Highways such as privately contracted vehicle recovery and vehicle repair providers.
Other parties	Other parties include any person or persons who could be affected by the strategic road network, but who are neither using it, nor working on it i.e. living or working adjacent to the motorway and all-purpose trunk roads, using other transport networks that intersect with the motorway and APTR.

(Source – GG 104 Table 1.3 *Populations on the motorway and all-purpose trunk roads)*

6.1.5 **Step five –** Define your safety objective(s)

Our vision is that no one will be killed or seriously injured whilst travelling or working on our network by 2040. We therefore propose the following safety objective for your CAV trial activity:

"The operation of the CAV trial activity will not adversely affect the safety of any population on the strategic road network and will not be a contributory factor in any incident or near miss."

6.1.6 **Step six –** Outline a plan for monitoring

It is crucial that the safety performance of your CAV trial activity is accurately monitored and evaluated to ensure that it is operating as expected.

We expect the safety case to outline a detailed plan for monitoring which sets out the safety monitoring activities that will take place during your trial (Stage 3).

6.1.7 **Stage one -** Review point

End of stage one - review point

At the end of stage one, you should submit the following to our CAV team:

- Initial safety case development checklist
- Initial safety case and any supporting evidence

They will advise if any other parties within National Highways need to be consulted and they will facilitate this where required.

This review point will decide the categorisation outcome and the resulting assurance arrangements.

End of stage one – stage gate point

There are two outcomes at the end of stage one:

Proceed with undertaking the safety risk assessment (stage two).

OR

Feedback will be provided to you so that our safety concerns can be addressed and an amended safety case resubmitted.

6.2 Stage two
Undertaking the safety risk assessment

During stage two, you will need to prepare the safety case to determine whether the overall safety objective for your CAV trial activity is likely to be achieved and to also demonstrate that an appropriate level of safety risk assessment has been undertaken to assess the expected safety performance of your trial.

6.2.1 **Step seven –** Identifying relevant hazards

We expect you to identify and document the foreseeable hazards associated with your CAV trial activity.

To assist in determining the foreseeable risks associated with CAV trials, a generic CAV hazard log has been developed. This provides a list of the top generic operational safety hazards identified for the strategic road network.

To receive a copy of the generic CAV hazard log, please contact our CAV team (CAVtestbed @nationalhighways.co.uk).

6.2.2 **Step eight –** Hazard analysis

We expect you to analyse the hazards identified, and to understand the likelihood and resulting impact if those risks are realised.

6.2.3 **Step nine –** Evaluation of hazards

We expect you to undertake an evaluation of hazards for each relevant population. The evaluation criteria depends on the conditions under which the highway is operating, whether it be normal operation or outside of normal operation. Definitions of both modes of operation can be found in GG 104 and the evaluation criteria for each are included in Table 6-3.

Table 6-3: Safety risk decision criteria for normal and outside normal operations

Population	Normal operation	Outside normal operation
Workers	ALARP	ALARP
Users	Reasonably required	ALARP
Other parties	Reasonably required	ALARP

Reasonably required - to demonstrate that something is reasonably required, all suitable potential mitigations to reduce safety risks are assessed. Where the cost of a mitigation identified in the assessment is, in the reasonable opinion of those carrying out the assessment, proportionate to the benefit derived, that measure can be deemed as reasonably required.

ALARP - in this document the term as low as is reasonably practicable (ALARP) is used in preference to the term so far as is reasonably practicable (SFAIRP), which is used in the HASAWA [5]. Reasonably practicable involves weighing a risk against the effort, time and money needed to control it.

6.2.4 **Step ten –** Exploring safety risk mitigation(s)

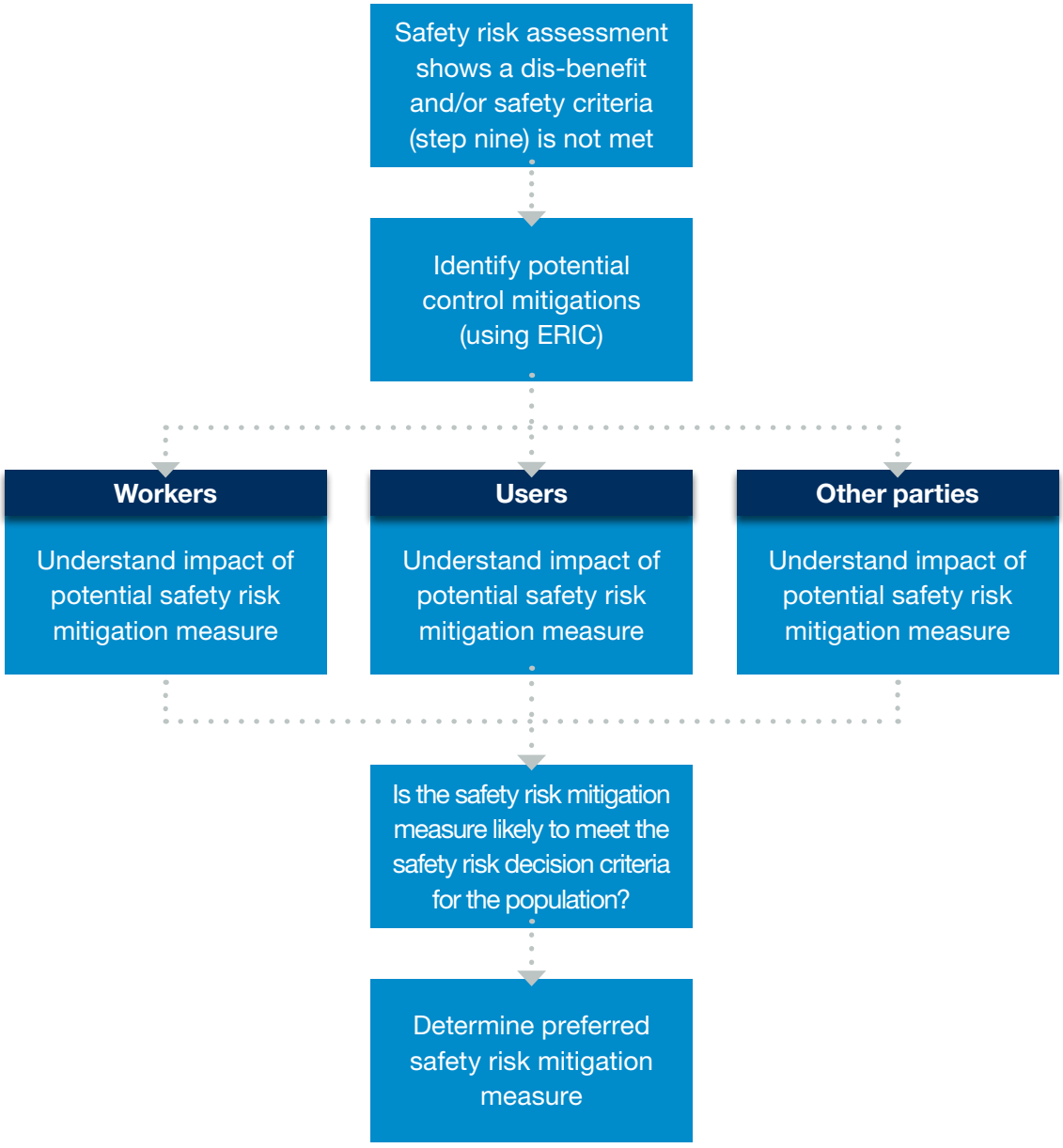
We expect you to explore safety risk mitigations when the outcome from the safety risk assessment falls into one of the categories below:

- Shows a safety risk dis-benefit
- It does not meet the safety objective
- Does not align with as low as is reasonably practicable (ALARP)
- Is less than what is considered or deemed to be as reasonably required

Safety risk mitigation measures should follow the Eliminate, Reduce, Isolate and Control (ERIC) hierarchy in accordance to the Management of Health and Safety at Work Regulations 1999 [6].

A diagram demonstrating the process of exploring safety mitigations is shown below.

Figure 6-1: Process of exploring safety risk mitigations



6.2.5 **Stage two –** Review point

End of stage two - review point

At the end of stage two, you should submit the following to our CAV team:

- Interim safety case development checklist
- Interim safety case and any supporting evidence

Our CAV team will facilitate a review by the appropriate parties within National Highways. The parties involved are determined by the trial's level of complexity. For Type B and C CAV trial activities, it is expected that the trial will present their safety case to a multi-disciplinary forum (the NSCRG and/or SCRG) as defined within Appendix D.

End of stage two – stage gate point

There are two outcomes at the end of stage two:

We accept the evidence within the safety case for your proposed CAV trial activity and you can commence your trial.

OR

Feedback is provided to you so that our safety concerns can be addressed and an amended safety case resubmitted.

6.3 Stage three
Document and maintain the safety case

Stage three covers the period when your CAV trial activity is being undertaken. It is important that the safety case is updated, and the safety performance of your CAV trial activity is monitored to ensure it is operating as expected. The safety case will be maintained and updated throughout the duration of the trial to reflect the outcome of the safety monitoring and to confirm whether the safety objective is being met or not. Lessons learnt from the trial will also be identified to inform future trials.

6.3.1 **Step eleven –** Monitoring and assumption validation

We expect your CAV trial activity to fulfil its monitoring activities as outlined in step six (outline a plan for monitoring) and produce a safety monitoring report.

It is crucial that the safety performance of your CAV trial activity is accurately monitored and evaluated. This is to ensure it is operating as expected and, if not, corrective action(s) is taken within the safety case.

At the end of your trial, the safety case should be updated to include the outcome of the safety monitoring and evaluation that has taken place. It should also confirm whether assumptions were valid or not, and whether the safety objective is being met or not.

6.3.2 **Step twelve –** Keep the safety case up to date

Safety cases are live documents and you are expected to regularly review and update the safety case throughout the life of your CAV trial activity.

If anything changes that affects your CAV trial activity, it will be necessary for you to check whether the safety case is still valid. A change to the safety case outcomes will require a re-submission of the safety case to National Highways.

6.3.3 **Step thirteen –** Sharing the safety case

Once your CAV trial activity is complete, we expect you to provide us with a final safety case.

6.3.4 **Step fourteen –** Identifying lessons learnt

It will be beneficial for a final debrief to be held between you and our CAV team to identify any lessons learnt that could improve the safety case development process for future CAV trials.

6.3.5 **Stage three –** Review point

End of stage three - review point

At the end of stage three, trials should submit the following to our CAV team:

- Final safety case checklist
- Final safety case and any supporting evidence
- Safety monitoring report

End of stage three – stage gate point

There will be one formal outcome at the end of stage three:

Those conducting the trial can proceed to CAV trial close out.

7 Cyber security

7.1 Context

Cyber risks for CAV technology and services are expected to increase as they become more interconnected with our surrounding infrastructure. As new technologies, processes and opportunities are introduced, the scope for cyber-events increases. This could lead to an impact on road safety, the operational efficiency of the strategic road network, loss of personal data and undermine public confidence in the deployment of technology and services.

It is important that security and cyber security considerations are built in from the very beginning of the safety case development and the impacts to road safety are understood and communicated appropriately.

As an Operator of Essential Service under the Network and Information Systems (NIS) Regulations 2018 [10], National Highways have a legal obligation to protect the strategic road network.

7.2 Principles and guidance for assuring the security of automated technologies

Enabling innovation and interoperability are key objectives for the successful deployment of CAV technology and services across the strategic road network. We therefore do not intend to specify security requirements that could lead to constrained design solutions. Instead, we are keen to promote outcome-based principles that enable good security practices and outcomes to be deployed by CAV trialling organisations.

We have worked closely with the DfT and the Centre for Connected and Autonomous Vehicles (CCAV) to develop guidance and standards that integrate road authority requirements. We expect a demonstration of adherence to the following published guidance and standards as part of an MCH 1514 application (please see section 7.3 for further details):

- Key Principles of Cyber Security for CAV [11]
- BSI PAS 1885: The fundamental principles of automotive cyber security. Specification. [12]
- BS 10754-1:2018: Information technology. Systems trustworthiness - Governance and management specification [13]

7.3 MCH 1514 ‘Code of Connection’ process

Trials that connect with National Highways systems must comply with the process set out in MCH 1514 ‘Code of Connection’ [7], a formal risk management process that applies to all deployments of technology that interact with National Highways’ systems on the strategic road network.

This is our internal security assurance process, and compliance ensures that cyber security risks are identified and managed to within a tolerable level before commencement of your trial. The process calls for independent assurance in the form of security testing to validate the configuration and implementation of the solution and suitable remediation in advance of commencing the CAV trial activity.

The Code of Connection application process consists of two deliverables which we expect you to complete:

- Application Document Set (ADS)
- Risk Assessment

Upon request, our CAV team will provide you with the ADS template for completion and the following supporting documents:

- MCH 1514 – Annex A Guidance notes for completing the ADS [8]
- MCH 2452 – Risk Assessment Methodology [9]

Our CAV team will facilitate discussions for you at the earliest opportunity with the Information Security team, so timescales and the security requirements can be clarified during stage one ‘planning the safety case and assurance process’.

Support from our Information Security team is available throughout the safety case development process to support CAV trials in the delivery of the ADS and supporting risk assessment.

8 System safety

We expect you to provide assurance that a safe systems development process for the trial has been followed and the necessary tests have been conducted to demonstrate the level of functionality required for the identified CAV trial activity.

System safety assurance should consider appropriate standards and guidance, as provided in DfT CoP [2] and BSI PAS 1881 [3].

Appendix A References

[1] Design Manual for Roads and Bridges, GG 104 Requirements for safety risk assessment
www.standardsforhighways.co.uk/prod/attachments/0338b395-7959-4e5b-9537-5d2bdd75f3b9?inline=true

[2] The Department for Transport Code of Practice: Automated vehicle trialling
www.gov.uk/government/publications/trialling-automated-vehicle-technologies-in-public/code-of-practice-automated-vehicle-trialling

[3] BSI PAS 1881: 2022 Assuring the operational safety of automated vehicles - Specification
www.bsigroup.com/en-GB/CAV/pas-1881/

[4] BSI PAS 1883: 2020 Operational Design Domain (ODD) Taxonomy for an Automated Driving System – Specification
www.bsigroup.com/en-GB/CAV/pas-1883/

[5] Health and Safety at Work Act 1974

[6] Management of Health and Safety at Work Regulations 1999

[7] MCH1514: 'Code of Connection'

[8] MCH1514: Annex A Guidance notes for completing the ADS

[9] MCH2452: Risk Assessment Methodology

[10] Network and Information Systems (NIS) Regulations 2018
www.legislation.gov.uk/uksi/2018/506/made

[11] Key Principles of Cyber Security for CAV
www.gov.uk/government/publications/principles-of-cyber-security-for-connected-and-automated-vehicles/the-key-principles-of-vehicle-cyber-security-for-connected-and-automated-vehicles

[12] BSI PAS 1885: The fundamental principles of automotive cyber security. Specification.
www.shop.bsigroup.com/products/the-fundamental-principles-of-automotive-cyber-security-specification

[13] BS 10754-1:2018: Information technology. Systems trustworthiness - Governance and management specification
www.shop.bsigroup.com/products/information-technology-systems-trustworthiness-governance-and-management-specification

Appendix B
Glossary of terms and abbreviations

Acronym	Description
ADS	Application Document Set
ALARP	As low as reasonably practicable
APTR	All-purpose trunk roads
BSI	British Standards Institute
CAV	Connected and autonomous vehicle
CCAV	Centre for Connected and Autonomous Vehicles
CoP	Code of Practice
COTS	Commercial off-the-shelf
DfT	Department for Transport
ERIC	Eliminate, reduce, isolate and control
GG	General Guidance
HASAWA	Health and Safety at Work Act
KSI	Killed or seriously injured
NIS	Network and Information Systems
NSCRG	National safety control review group
PAS	Publicly Available Specification
SAE	Society of Automotive Engineers
SFAIRP	So far as is reasonably practicable
SCRG	Safety control review group
SRN	Strategic road network

Appendix C Safety case development checklist template

Name of CAV trial activity project / testbed	
Trial programme timescales (date to date)	
Name(s) of key parties	
Comprehensive description of CAV trial activity	

Confirmation (Yes/No)	**Link to evidence (Please refer to section / clause number within safety case)**
Prerequisite activities	
Prerequisite one	CAV trial activity complies with relevant legal requirements
Prerequisite two	Safety case complies with existing safety case frameworks
Prerequisite three	CAV trial activity complies with testbed safety case (where applicable)

Prerequisite four (see section 7)	CAV trial activity demonstrates the requirement to connect / not connect with National Highways technology systems
Prerequisite five (see section 8)	System safety has been reviewed and managed by CAV trial activity accordingly
Stage one	**Planning the safety case and assurance process**
Step one	Provide an overview of the CAV trial activity
Step two	Define the scope of the safety case
Step three	Assess and agree level of safety case complexity
Step four	Identify affected populations

Step five	Define your safety objective(s)	
Step six	Outline a plan for monitoring	
Stage one – review point *Documents provided to National Highways*	Initial safety case checklist	
	Initial safety case and supporting evidence	
Stage two	**Undertaking the safety risk assessment**	
Step seven	Identify relevant hazards	
Step eight	Hazard analysis	
Step nine	Evaluation of hazards	

Step ten	Exploring safety risk mitigations	
Stage two – review point *Documents provided to National Highways*	Interim safety case checklist	
	Interim safety case and supporting evidence	
Stage three	**Document and maintain the safety case**	
Step eleven	Monitoring and assumption validation	
Step twelve	Keep the safety case up to date	
Step thirteen	Sharing the safety case	
Step fourteen	Identifying lessons learnt	
Stage three – review point *Documents provided to National Highways*	Final safety case checklist	
	Final safety case and supporting evidence	
	Safety monitoring report	

Appendix D National Highways assurance arrangements for CAV trial safety cases

The results of the categorisation process at stage one (planning the safety case and assurance process) will be used by the National Highways CAV team to determine the appropriate assurance arrangements. This is illustrated in the below tables.

CAV trial safety risk assurance responsibilities for National Highways

	Type A Basic	Type B Moderate	Type C Rigorous
Preparation of safety case			
CAV trialling organisation / supplier	Accountable	Accountable	Accountable
Assurance that the safety case is in place for CAV trial			
National Highways Connected and Autonomous Vehicles Team[1]	Responsible	Responsible	Responsible
Digital Services Directorate[2]	Consulted	Consulted	Consulted
Operational Safety			
National Highways Safety Risk and Requirements Team	Informed	Consulted	Consulted
National Highways Operations Team - Senior User - National	Informed	Consulted	Consulted
National Highways Operations Team - Senior User - Regional	Informed	Consulted	Consulted
National Highways Social Research and Behaviour Change Team	Informed	Informed	Consulted
National Highways General Counsel	Informed	Informed	Consulted
System Safety			
National Highways Connected and Autonomous Vehicles Team	Informed	Informed	Informed
Cyber Security			
National Highways Information Security Team	Consulted	Consulted	Consulted

[1] The CAV trial organisation is accountable for the overall risks associated with the trial. This reflects the guidance outlined in both the DfT CoP [2] and BSI PAS 1881 [3]. The National Highways CAV team is expected to be responsible for ensuring National Highways procedures have been followed and, if not, escalating the issue in accordance with the defined process.

[2] The involvement of the Digital Services Directorate will be based upon the type of trial that is defined within the safety planning process, such as connected vehicle trials.

CAV trial safety risk assurance arrangements for National Highways

	Type A Basic	Type B Moderate	Type C Rigorous
Assurance group			
Safety Control Review Group (SCRG)		Required	Required
Acceptance that safety case meets National Highways expectations			
National Highways Connected and Autonomous Vehicles Team	Responsible		
SCRG		Responsible	Responsible
National safety control review group (NSCRG)			Consulted

- **Type A** – National Highways CAV team will either accept the evidence within the safety case for the proposed CAV trial activity or provide feedback, enabling it to be improved and resubmitted.
- **Type B** – SCRG will either accept the evidence within the safety case for the proposed CAV trial activity or provide feedback, enabling it to be improved and resubmitted.
- **Type C** – SCRG and NSCRG will either accept the evidence within the safety case for the proposed CAV trial activity or provide feedback, enabling it to be improved and resubmitted.

Safety Control Review Group (SCRG) Role

SCRG provides a forum for reviewing and accepting 'safety work' associated with a CAV trial activity on the strategic road network. The SCRG will comprise of representatives who are involved in undertaking the CAV trial activity or who will be affected by the CAV trial activity. For CAV trial activities which have been categorised as a type 'B' or 'C' an SCRG is convened to consult, review and accept the evidence within the safety case.

National Safety Control Review Group (NSCRG) Role

NSCRG reviews and advises on complex or unique safety issues and network consistency items. For CAV trial activities which have been categorised as a type 'C', NSCRG is convened to consult, review, and accept the evidence within the safety case.

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