PAS 1881:2022

Assuring the operational safety of automated vehicles – Specification

Centre for Connected & Autonomous Vehicles

bsi.

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Foreword

This PAS was sponsored by the UK's Centre for Connected and Autonomous Vehicles (CCAV). Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 30 April 2022.

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Acknowledgement is also given to the members of a wider review panel who were consulted in the development of this PAS.

This PAS is not to be regarded as a British Standard. It will be withdrawn in the event it is superseded by a British Standard.

The PAS process enables a specification to be rapidly developed in order to fulfil an immediate need in industry. A PAS can be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Supersession

This PAS supersedes PAS 1881:2020, which is withdrawn.

Relationship with other publications

PAS 1881 has been developed as part of a wider programme sponsored by CCAV in conjunction with the Department for Transport (DfT), Innovate UK and Zenzic to develop a suite of standardization products to promote the safe testing and deployment of automated vehicles in the UK and inform wider international standardization activity.

This PAS is intended to be read in conjunction with:

- standards and guidance on functional safety, cybersecurity, safety of the intended function and other PAS Standards, including:
  - PAS 1880, *Guidelines for developing and assessing control systems for automated vehicles*
  - PAS 1882, *Data collection and management for automated vehicle trials for the purpose of incident investigation – Specification*
  - PAS 1883, *Operational Design Domain (ODD) taxonomy for an automated driving system (ADS) – Specification*
  - PAS 1884, *Safety operators in automated vehicle testing and trialling – Guide;* and
  - PAS 1885, *The fundamental principles of automotive cyber security – Specification;*

- where applicable to the trial, safety and stakeholder requirements:
  - the DfT's *Code of practice: Automated vehicle trialling* [1];
  - Transport for London's (TfL) *Connected and autonomous vehicles: Guidance for London trials* [2]; and
  - National Highway's *GG104: Requirements for safety risk assessment* [3]; and
- existing legislation applicable to the use of vehicles on public roads and private land in the UK.

Information about this document

This is a full revision of the PAS, and introduces the following principal changes:

- requirement for a supporting safety management system;
- inclusion of testing and trials on private land with public access; and
- removal of guidance on systems safety.

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Use of this document

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentation conventions

The provisions of this PAS are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

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Compliance with a PAS cannot confer immunity from legal obligations.

In particular, attention is drawn to the following specific regulations:

- Road Traffic Regulation Act 1984 [4];
- Road Vehicles (Construction and Use) Regulations 1986 [5];
- Road Traffic Act 1988 [6];
- UK General Data Protection Regulation (UK GDPR) [7];
- Road Vehicles (Approval) Regulations 2020 [8];
- Data Protection Act 2018 [9]; and
- Automated and Electric Vehicles Act 2018 [10].

Introduction

As automated vehicle technologies are developed, there is an increasing demand to test and deploy automated driving technologies on the UK road network and private land. There has been significant UK government and industry investment in the development of automated vehicle technology, and the UK government is committed to:

a) ensuring that automated vehicle trials and ongoing technology testing are conducted safely and securely; and

b) building public and consumer trust and acceptance of the technology.

An automated vehicle approval and authorization process for deployment is currently being developed on behalf of the UK government, but until this has been finalized and implemented, it is important that safety is maintained through the effective assessment and management of risk and documented within a safety case. Prior to the implementation of a government automated vehicle approval process, the requirements detailed in this PAS can be used, in line with good practice, to demonstrate the safety of initial deployment of services provided by automated vehicles (including the movement of vehicles, goods and passengers).

This PAS supports the UK government's commitment by creating a standardized and consistent approach to safety case development and encourages safety to be prioritized during technology development, trials and testing. Safety cases are live documents that evolve as technology matures and testing becomes more advanced. They are also unique to a specific trial or programme of tests and can vary in complexity to ensure they are proportionate to the level of risk posed. Safety cases can be independently reviewed and audited but approval can only be based on that version of the documentation. The revision of this PAS, therefore, includes a section on the safety management system that underpins the development of a safety case. This enables an organization to be assessed against the processes used to develop safety cases, rather than the individual safety case content. Verification and validation are also important parts of the operational safety case to ensure that the control measures are adequate to control the risk.

Safety cases for automated vehicles can be categorized into two interdependent areas.

1) Systems safety is achieved through ensuring adequate functional safety, safety of the intended functionality (SOTIF) and cybersecurity. This forms an integral part of the vehicle development and includes the vehicle specification, design, implementation, and verification and validation of the automated vehicle's functions. Systems safety assessments can also be risk-based assessments that identify the vehicle's minimum safety and security requirements for achieving an acceptable level of risk, and ensure that this level of risk has been achieved.

2) Operational safety assurance takes into account:
   i) the use of the system,
   ii) the interaction of an automated vehicle within the operating environment, including the operating area, safety driver or remote operator, passengers and other road users and road workers, and
   iii) any additional control measures needed to ensure that it can be operated safely.

Systems safety and operational safety are intrinsically linked, but this PAS focuses on the operational safety and references the required outputs from systems safety assessments.

A safety case is a structured argument supported by a body of evidence that demonstrates that the safety risks have been identified, managed and reduced as low as reasonably practicable (ALARP) and to an acceptable level. The safety case includes (but is not limited to) risks associated with the vehicle, the automated driving system and the operating environment, and takes into account risks to all affected parties, such as other vehicles, vulnerable road users, the safety driver or operator, passengers, road workers and infrastructure. The safety case also provides assurance to stakeholders, including highway authorities, road operators, landowners, leaseholders and insurers. The content of the safety case can be summarized within a publicly available safety case to provide assurance and information to members of the public. The safety case is a live document that, when updated to reflect changes and learning throughout a trial, promotes continuous improvement and safety assurance.

The safety case framework detailed in this PAS has been developed for automated vehicle trials but is based on existing safety standards and safety governance good practice, including the DfT's *Code of practice* [1], which recommends that trialling organizations develop a detailed safety case before conducting trials in public domains. This PAS expands the requirements of the DfT's *Code of practice* [1] and aligns with the requirements of other PAS Standards, including PAS 1882, PAS 1883, PAS 1884 and PAS 1885. This safety case framework has been applied to a number of automated vehicle trials and has been continually refined and updated to reflect learning from those trials and input from stakeholders. The safety case framework also considers published and developing international standards, as well as the emerging UK CAV approval process, to ensure alignment and a smooth transition from design through to testing and deployment.

1 Scope

This PAS specifies requirements for operational safety cases and the supporting safety management system for automated vehicle trials and testing in the UK to demonstrate that the operation of automated vehicles can be undertaken safely and securely within the defined operating environment.

It covers the development of an operational safety case to demonstrate that the risks to all affected parties throughout the operation of automated vehicles are reduced as low as reasonably practicable (ALARP) and to an acceptable level. This includes operational risk assessments, training, safety monitoring, compliance and permissions granted. It is applicable to all real-world testing environments, including testbeds, public domains and privately owned land and to all levels of driving automation systems.

***NOTE 1** A safety case developed for proving grounds or test tracks might not need to include all elements detailed in this PAS.*

This PAS does not cover the systems safety of the vehicle; for example, functional safety, safety of the intended functionality (SOTIF) and cybersecurity assessments, but does rely on their outputs. This PAS does not include the safety case requirements for the testing of a connected vehicle that is not also automated.

This PAS is intended for use by trialling organizations, including private developers and original equipment manufacturers (OEMs), developing safety cases for automated vehicle trials and testing. Prior to the implementation of a government approval and authorization process, the requirements of this PAS can be used to demonstrate the safe deployment of automated vehicles.

***NOTE 2** Compliance with this PAS does not guarantee acceptance of the safety case by relevant organizations, and other criteria, such as additional requirements imposed by highways authorities, might need to be met to enable testing to take place.*

This PAS might be of interest to organizations requiring assurance that a safety case has been developed in line with good practice; for example, highway authorities, road operators, landowners, leaseholders and insurers. It might also be of interest to organizations developing and implementing automation in off-highway environments.