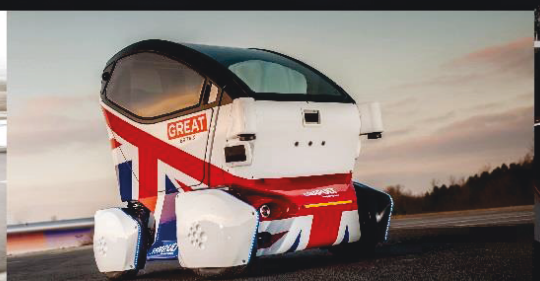
Department for Transport

The Pathway to Driverless Cars:
A Code of Practice for testing

Moving Britain Ahead









July 2015

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Department for Transport
Great Minster House
33 Horseferry Road
London SW1P 4DR
Telephone 0300 330 3000
General enquiries https://forms.dft.gov.uk
Website www.gov.uk/dft



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1. Introduction

1.1 The UK government recognises the potential benefits of driverless and automated vehicle technologies, particularly the potential to improve road safety and reduce casualties. The government therefore wishes to support and facilitate the development and introduction of these technologies to our roads.

1.2 For this reason the government conducted a detailed review of existing legislation to establish the regulatory situation with regards to testing of these technologies and their longer term introduction to the market. *The Pathway to Driverless Cars* review was published by the Department for Transport in February 2015 and concluded:

"Real-world testing of automated technologies is possible in the UK today, providing a test driver is present and takes responsibility for the safe operation of the vehicle; and that the vehicle can be used compatibly with road traffic law."

The review identified a number of actions that the UK government will take including the publication of this Code of Practice to promote safety during the testing phase. It also included a timetable for clarification and necessary changes to legislation to allow these technologies to come to market.

1.3 Manufacturers have a responsibility to ensure that highly and fully automated vehicle technologies undergo thorough testing and development before being brought to market. Much of this development can be done in test laboratories or on dedicated test tracks and proving grounds. However to help ensure that these technologies are capable of safely handling the many varied situations that they may encounter throughout their service life, it is expected that controlled 'real world' testing will also be necessary. Testing of automated vehicle technologies on public roads or in other public places should therefore be facilitated while ensuring that this testing is carried out with the minimum practicable risk.

1.4 The publication of this Code of Practice is intended to help manufacturers and those organising testing of these technologies by providing clear guidelines and recommendations for measures that should be taken to maintain safety during this testing phase.

1.5 This Code of Practice is non-statutory but has been developed to promote responsible testing. It should be used by testing organisations in conjunction with detailed knowledge of the legal, regulatory and technological landscape. Failure to follow the Code may be relevant to liability in any legal proceedings. Similarly, compliance with the Code does not guarantee immunity from liability in such circumstances.

2. Aim, scope and definitions

Aim

2.1 This Code of Practice provides guidance for anyone wishing to conduct testing of highly or fully automated vehicle technologies on public roads or in other public places in the UK. It details recommendations which the government believes should be followed to maintain safety and minimise potential risks.

2.2 Our vision is that through careful testing, well designed automated vehicles will be developed which, when operating in an automated mode, will display exemplary driving characteristics, improving the safety of all road users.

Scope

2.3 This Code of Practice is intended to apply:

- Whenever highly or fully automated vehicle technologies are being tested on public roads or in other public places in the UK.
- To testing of a wide range of vehicles, from smaller automated pods and shuttles, through to more conventional road going vehicles such as cars, vans and heavy duty vehicles.

Highly or fully automated vehicles are those which, when sold commercially, would be marketed on the basis that they would allow a driver to disengage from the task of driving for some or all of the duration of the journey.

2.4 The Code is not intended to apply to the testing and development of advanced driver assistance systems or to tests carried out on private test tracks or other areas not accessible by the public. Testers may nevertheless wish to consider whether the guidelines may be relevant to these situations.

Definitions

2.5 For the purposes of this document the following definitions should be understood:

Highly automated vehicle

2.6 A vehicle in which a driver is required to be present and can take manual control at any time. However in certain situations, the vehicle can offer an automated mode which allows the driver to ‘disengage’ from the driving task and undertake other tasks.

2.7 When highly automated vehicles first come to market, they may offer an automated mode under certain very specific driving conditions such as motorway cruising or in low speed conditions. As the technology develops, the vehicle may be able to

undertake driving duties in an automated mode for an increasing range of different driving conditions.

Fully automated vehicle

2.8 This means a vehicle in which a driver is not necessary. The vehicle is designed to be capable of safely completing journeys without the need for a driver in all traffic, road and weather conditions that can be managed by a competent human driver.

2.9 When fully automated vehicles come to market, occupants will be able to engage in tasks other than driving for the entire journey. Fully automated vehicles may still offer a full set of controls to allow a driver to resume manual control if they so wish. (Note: For the purposes of testing, this Code of Practice requires that a fully automated vehicle has the facility for manual control to be resumed at any time).

Driver or test driver

2.10 A driver or test driver should normally be interpreted as the person who is seated in the vehicle in a position where they are able to control the speed and direction using manual controls at any time. This person may be referred to as the driver even when the vehicle is operating in an automated mode. For further information see Chapter 4.

Test operator

2.11 A test operator is someone who oversees testing of an automated vehicle without necessarily being seated in the vehicle, since some automated vehicles might not have conventional manual controls and/or a driver's seat. In this case it is expected that a 'test operator' would still be able to over-ride automated operation of the vehicle at any time. For further information see Chapter 4.

Test assistant

2.12 A test assistant would assist the test driver or test operator in conducting tests, for example by monitoring digital information displays or other information feedback systems and by observing the movements of other road users. For further information see Chapter 4.

Public road

2.13 In this Code, public road means any highway or other road to which the public have access.

Construction and Use Regulations

2.14 In this Code the term "Construction and Use Regulations" means, for Great Britain, the Road Vehicles (Construction and Use) Regulations 1986 and, for Northern Ireland, the Motor Vehicles (Construction and Use) Regulations (Northern Ireland) 1999, both as amended.

3. General requirements

Safety requirements

3.1 Responsibility for ensuring that testing of these technologies on public roads or in other public places is conducted safely always rests with those organising the testing. Compliance with these guidelines alone should not be considered to be sufficient to ensure that all reasonable steps to minimise risk have been taken.

3.2 **Vehicles under test on public roads must obey all relevant road traffic laws**. It is the responsibility of testing organisations to satisfy themselves that all tests planned to be undertaken comply with all relevant existing laws and that the vehicles involved are roadworthy, meet all relevant vehicle requirements, and can be used in a way that is compatible with existing UK road traffic law (see Chapter 5).

3.3 **The relevant road traffic laws include regulation 100 (or regulation 115 in Northern Ireland) of Construction and Use Regulations. Broadly these highlight that it is an offence to use a motor vehicle or trailer in such a way that it would present a danger to other road users.**

3.4 Testing organisations should:

- Ensure that test drivers and operators hold the appropriate driving licence and have received appropriate training (see Chapter 4).
- Conduct risk analysis of any proposed tests and have appropriate risk management strategies.
- Be conscious of the effect of the use of such test vehicles on other road users and plan trials to manage the risk of adverse impacts.

Insurance

3.5 **The statutory requirements on the holding of insurance will apply whilst a vehicle is being tested. Anyone conducting tests of automated vehicles on public roads or in other public places must therefore hold appropriate insurance or otherwise comply with the statutory requirements.**

Infrastructure and transport authorities

3.6 Testing organisations should consider the need to engage with the relevant transport and highway authorities with responsibility for the areas in which the tests will be conducted.

3.7 Any specific infrastructure requirements that are considered necessary to support testing, including traffic signing, will need to be agreed with the appropriate authorities responsible for the roads.

Engagement

3.8 Testing organisations should consider the benefits of developing a public relations and media communications strategy to:

- Educate the public regarding the potential benefits of automated vehicles.
- Explain the general nature of the tests to be undertaken.
- Explain the implications for other road users, if any, and what steps are being taken to mitigate any risks.
- Provide reassurance and address any concerns that the public may have. Particular consideration should be given to the concerns of more vulnerable road users including disabled people, those with visual or hearing impairments, pedestrians, cyclists, motorcyclists, children and horse riders.

3.9 It is strongly recommended that those wishing to conduct testing of highly and fully automated vehicles on public roads or in other public places should engage with the local emergency services. This should include, where possible, establishing a single point of contact with local police and fire services to facilitate co-operation in the event of an investigation.

3.10 The availability of technical advice to the emergency services should also be discussed and agreed so that those attending an incident can be aware of any unusual features of automated vehicles. Testing organisations should also consider providing vehicle registration numbers of the vehicles under test to the local police.

4. Test driver, operator and assistant requirements

Requirements for a test driver / operator to oversee testing

4.1 During testing of automated vehicles on public roads or in other public places, a suitably licenced and trained test driver or test operator should supervise the vehicle at all times and be ready and able to over-ride automated operation if necessary. Details of licencing and training are specified in paragraphs 4.7 to 4.14.

4.2 The test driver or test operator will be responsible for ensuring the safe operation of the vehicle at all times whether it is in a manual or automated mode. The test driver or operator should be familiar with and understand the systems under test, their capabilities and any limitations, and be able to anticipate the need to intervene and resume manual control if necessary.

4.3 The test driver or test operator should be authorised to perform this role by the organisation responsible for conducting the testing. Testing organisations should have robust risk management, process and training procedures in place for test drivers and operators, and should ensure they hold the appropriate UK driving licence, or recognised equivalent.

4.4 Testers should note that regulation 104 (or regulation 120 in the regulations for Northern Ireland) of the Construction and Use Regulations is applicable to use of prototype vehicles on public roads. This regulation states:

"No person shall drive or cause or permit any other person to drive, a motor vehicle on a road if he is in such a position that he cannot have proper control of the vehicle or have a full view of the road and traffic ahead."

Note: Regulation 104 (or regulation 120 for Northern Ireland) does not apply for testing of automated vehicles in locations other than public roads.

4.5 **Test operators must still observe the road traffic laws that apply when vehicles are used in public places that are not public roads. This includes the traffic laws that protect the public from careless or dangerous driving, and restrict where vehicles can be driven.**

4.6 In locations other than public roads, and where the vehicle's maximum speed is limited to a maximum of 15 mph, testing should be overseen by a test operator who can, as a minimum, apply an emergency stop control.

Licence requirements

4.7 **The test driver or test operator must hold the appropriate category of driving licence for the vehicle under test, if testing on a public road.** This is true even if testing a vehicle's ability to operate entirely in an automated mode. It is strongly

recommended that the licence holder also has several years' experience of driving the relevant category of vehicle.

4.8 In the case of a prototype vehicle which cannot easily be categorised, the nearest equivalent conventional category of licence would be expected to be held.

4.9 The testing organisation should not use test drivers or operators whose driving history indicates that they may present a particular risk.

4.10 For testing not conducted on the public road, it is strongly recommended that the test driver or test operator holds the appropriate category of licence for the vehicle, however this is not a legal requirement.

Test driver or operator training

4.11 Test drivers and operators supervising public road testing of automated vehicles will need skills over and above those of drivers of conventional vehicles. For example it will be important to ensure they have an excellent understanding of the capabilities, and potential limitations of the technologies under test, and are already familiar with the characteristics of the vehicle, preferably through extensive experience of tests conducted on closed roads or test tracks.

4.12 The responsibility for ensuring test drivers and operators have received the appropriate training and are competent lies with the testing organisation. Testing organisations should develop robust procedures to ensure the competency of test drivers and operators.

4.13 Test drivers and operators should be familiar with the capabilities of the automated systems under test, and be aware of the situations in which it may be necessary to intervene. Training should cover potentially hazardous situations that may be encountered and the appropriate action to take when resuming manual control.

4.14 Training in the process for transitioning between conventional manual control and an automated mode will be particularly important. It is critical to safety that those conducting tests are fully aware of exactly how control is passed between the test driver or test operator and the vehicle.

Test driver hours

4.15 Test drivers and operators should remain alert and ready to intervene if necessary throughout the test period.

4.16 Testing organisations should develop robust procedures to ensure that test drivers and operators are sufficiently alert to perform their role and do not suffer fatigue. This could include setting limits for the amount of time that test drivers or operators perform such a role per day and the maximum duration of any one test period.

Test driver / operator behaviour

4.17 Testing organisations should have in place clear rules regarding test driver and operator behaviour, and ensure that these are known and understood.

4.18 The rules should cover any restrictions on use of alcohol and drugs, over and above existing legal restrictions. This will help prevent a test driver or operator's judgement and ability to perform their role from being impaired.

4.19 **All existing laws regarding driver behaviour, for example prohibiting use of a hand-held mobile phone or other similar hand-held device, complying with speed limits, continue to apply even if the vehicle is operating in an automated mode.**

4.20 Test drivers and operators should be conscious of their appearance to other road users, for example continuing to maintain gaze directions appropriate for normal driving.

Test assistants

4.21 Depending on the nature of the tests being undertaken and the vehicle involved, a test assistant should be considered.

4.22 For example if the vehicle is a conventional car which has been adapted to include automated technologies, and is being tested on public roads a test assistant could assist the test driver by monitoring digital information displays or other information feedback systems related to the operation of the automated technologies.

5. Vehicle requirements

General vehicle requirements

5.1 **Any organisation wishing to test automated vehicle technologies on public roads or in other public places must ensure that the vehicles under test can be used in a way compatible with existing UK road traffic law.**

5.2 **The vehicle must be roadworthy and must, if used on a public road, meet the relevant national in-service requirements, detailed in the Construction and Use Regulations. A test vehicle which is over three years old (or four years old in Northern Ireland) must also have a valid MOT.**

Maturity of technologies under test

5.3 Organisations wishing to test automated vehicles on public roads or in other public places will need to ensure that the vehicles have successfully completed in-house testing on closed roads or test tracks.

5.4 Organisations should determine, as part of their risk management procedures, when sufficient in-house testing has been completed to have confidence that public road testing can proceed without creating additional risk to road users. Testing organisations should maintain an audit trail of such evidence.

5.5 Vehicle sensor and control systems should be sufficiently developed to be capable of appropriately responding to all types of road user which may typically be encountered during the test in question. This includes more vulnerable road users for example disabled people, those with visual or hearing impairments, pedestrians, cyclists, motorcyclists, children and horse-riders.

Data recording

5.6 Automated vehicles under test should be fitted with a data recording device which is capable of capturing data from the sensor and control systems associated with the automated features as well as other information concerning the vehicle's movement.

5.7 As a minimum this device should record the following information (preferably at 10Hz or more):

- Whether the vehicle is operating in manual or automated mode
- Vehicle speed
- Steering command and activation
- Braking command and activation
- Operation of the vehicle's lights and indicators

- Use of the vehicle's audible warning system (horn)
- Sensor data concerning the presence of other road users or objects in the vehicle's vicinity
- Remote commands which may influence the vehicle's movement (if applicable)

5.8 This data should be able to be used to determine who or what was controlling the vehicle at the time of an incident. The data should be securely stored and should be provided to the relevant authorities upon request. It is expected that testing organisations will cooperate fully with the relevant authorities in the event of an investigation.

5.9 In addition, testers may wish to consider fitting vehicles under test with a video and audio recording system. However this should not be considered as an alternative to the data recording requirements specified in paragraph 5.7.

Data protection

5.10 **Testing is likely to involve the processing of personal data. For example, if data is collected and analysed about the behaviour or location of individuals in the vehicle, such as test drivers, operators and assistants, and those individuals can be identified, this will amount to the processing of personal data under the Data Protection Act 1998. The project team must therefore ensure that the data protection legislation is complied with, including the requirements that the personal data is used fairly and lawfully, kept securely and for no longer than necessary.**

5.11 Guidance for organisations on complying with the data protection laws can be found on the Information Commissioner's Office's website.[1] We recommend that projects consider whether to undertake a privacy impact assessment as described in the Information Commissioner's Office's Code of Practice.[2]

5.12 Undertaking a privacy impact assessment is not a legal requirement, but is a useful tool to help a project comply with the data protection laws. As recognised in the Information Commissioner's Office's Code of Practice, the privacy impact assessment can be developed flexibly and proportionately, depending on how complex or straightforward the privacy issues are for a particular project.

Cyber security

5.13 As has already been stated in Chapter 4, a requirement for testing is that a test driver or operator oversees the movements of the vehicle under test and is capable of implementing a manual over-ride at any time.

5.14 Nevertheless, manufacturers providing vehicles, and other organisations supplying parts for testing will need to ensure that all prototype automated controllers and other vehicle systems have appropriate levels of security built into them to manage any risk of unauthorised access.

[1] Information Commissioner's Office, Guide to data protection, available here: https://ico.org.uk/for-organisations/guide-to-data-protection

[2] Information Commissioner's Office, *Conducting Privacy Impact Assessments – Code of Practice*, available here: https://ico.org.uk/media/for-organisations/documents/1595/pia-code-of-practice.pdf

5.15 Testing organisations should consider adopting the security principles set out in BSI PAS754 Software Trustworthiness - Governance and management - Specification or an equivalent.

Process for transition between automated and manual modes

5.16 An important area for the safety of automated vehicle testing is the management of the transitions from manual control to an automated mode and, in particular, from an automated mode back to manual control.

5.17 The system which is used should:

- Be easily and clearly understood by the test driver.
- Ensure that the driver is given clear indication of whether the vehicle is in manual or automated mode.
- Ensure that the driver is given sufficient warning to resume manual control when necessary.
- Allow the driver to quickly and easily retake control of the vehicle when necessary.

5.18 Ensuring that the transition periods between manual and automated mode involve minimal risk will be an important part of the vehicle development process and one which would be expected to be developed and proven during private track testing prior to testing on public roads or other public places.

Failure warning

5.19 In the event of a malfunction or failure of the automated driving systems under test, the test driver or operator should be made aware with an audible warning which may be accompanied by a visual warning.

5.20 Vehicle automated braking and steering systems should be designed such that in the event of failure, manual braking and steering is still possible.

Software levels

5.21 It is expected that automated driving systems will rely on the interaction and correct operation of several computers and electronic control modules. It will be important that:

- Software levels and revisions running on each vehicle to be tested are clearly documented and recorded.
- All software and revisions have been subjected to extensive and well documented testing. This should typically start with bench testing and simulation, before moving to testing on a closed test track or private road. Only then should tests be conducted on public roads or other public places.