Report on standardisation prospective for automated vehicles (RoSPAV)
Contents

Introduction .................................................................................................................................................. iii
1 Scope .......................................................................................................................................................... 1
2 Abbreviations .......................................................................................................................................... 1
3 Organization of the international standardisation for automotive ......................................................... 1
4 List of current projects and standards ..................................................................................................... 2
5 Future needs, opportunities and recommendations ............................................................................... 9
  5.1 Vehicle system – Reaction of the vehicle ............................................................................................ 9
  5.2 Human factor ....................................................................................................................................... 9
  5.2.1 Driver monitoring system ................................................................................................................ 9
  5.2.2 Internal HMI and external HMI ...................................................................................................... 9
  5.3 Safety requirements ............................................................................................................................ 10
  5.3.1 Perception ..................................................................................................................................... 10
  5.3.2 Data Storage System for AD (DSS-AD) ........................................................................................ 10
  5.3.3 Specific aspects for electric vehicles (EV) ..................................................................................... 10
  5.3.4 Validation ...................................................................................................................................... 11
  5.4 Data communication – Connectivity .................................................................................................. 11
  5.5 Mobility – Digital mapping system ................................................................................................... 11
  5.6 Vehicle/Infrastructure Integration – Infrastructure signs .................................................................. 12
6 Way forward ........................................................................................................................................... 13
Annex A Information on international standardisation ................................................................................. 14
  A.1 Overview of ISO organization ........................................................................................................... 14
  A.2 ISO/TC 22 Road vehicles ..................................................................................................................... 14
     A.2.1 General ........................................................................................................................................ 14
     A.2.2 SC 31 Data communication .......................................................................................................... 15
     A.2.3 SC 32 Electrical and electronic components and general system aspects ................................... 16
     A.2.4 SC 33 Vehicle dynamics and chassis components .................................................................... 17
     A.2.5 SC 35 Lighting and visibility ....................................................................................................... 17
     A.2.6 SC 37 Electrically propelled vehicles ........................................................................................... 18
     A.2.7 SC 39 Ergonomics ....................................................................................................................... 18
Annex B Information on regulation for AD .................................................................................................. 21
  B.1 Overview of the committees in charge of global regulation .............................................................. 21
Bibliography .............................................................................................................................................. 22
Introduction

All over the world, expectations for automated driving are increasing every day. There are many reasons for this trend. The first one is Road Safety. Every year, road accidents cause 1.25 million deaths and up to 50 million injuries worldwide. These figures are likely to explode with the development of emerging countries. Improving safety is therefore a key issue. However, since 80% to 90% of accidents are attributable to human error, it is to be hoped that total or partial automation of driving reduce their number or severity.

The two other benefits are expected in terms of pollutant emissions and traffic congestion reduction. In addition, more efficient and inclusive mobility allows more people to move in better and sustainable conditions: carpooling, on-demand and automated transport for elderly or disabled people are promising and helps to revitalise the regions. Especially for commercial vehicles, transport efficiency gains are foreseen both with respect to goods and public transport. The gains consist of e.g. improvements to traffic flow, more precise deliveries, and reduced need for drivers doing manual driving. Finally, the possibility for drivers to engage in other activities while driving delegation is active, facilitates acceptability within a business model related to increasing customer value.

Automated driving and its associated innovations therefore generate a revolution that affects the role of the drivers and their activities that can be performed during the journey, but also physical and digital infrastructure, freight transport and many professions. New needs are also arising to make sure both driver and passengers can be informed about what the automated vehicle is doing (compare to how airplane pilots constantly investigate and get informed about what an autopilot is doing in order to be ready to take over in case that is required). Even in the case of single mode, higher level automation, occupants riding with the vehicle need to be both informed about, and able to influence the journey.

The increasing expectations resulting from all these different benefits of automated driving require preparing the framework for its deployment with the necessary standards to ensure the interoperability of driving behaviours, methodologies at the highest level of state of the art, and finally to improve the acceptability of drivers, citizens and authorities. Furthermore, those standards are helpful as a basis for international regulation (see Annex B).

An important aspect to investigate is the communication between automated vehicles and other road users. This is especially important regarding Vulnerable Road Users, but also with the other vehicles - both manually driven and automated. Communication between the automated vehicle and other road users will not take place in the same way as in the case of manually driven vehicles. This communication will therefore need to be investigated including establishment of common approaches. This is valid for a range of communication means, from external visual or auditory communication, to V2X data transfers that can secure common information can be used across different road users.

Finally, it is important that people get used to seeing these shuttles and autonomous vehicles on the roads. Therefore, conducting experiments in different countries validates different concepts of individual and collective mobility in real situations, while promoting their deployments.

In 2017, ISO/TC 22 Road vehicles created an ad hoc group (ADAG for Automated Driving Ad hoc Group) in order to propose a consolidated mid-to-long term TC 22 roadmap of automated driving standards development (resolution 914 in October 2017).

The main tasks were:

- To set up the mapping of needed AD projects developed/to be developed in ISO/TC 22 sub-committees;
- To coordinate mapping of actions being taken by ISO/TC 22 sub-committees so as to identify gaps and redundancies as well as opportunities for collaboration;
To promote and facilitate collaborative action to align ISO/TC 22 sub-committees’ activities so as to close gaps in an optimal manner;

To provide ISO/TC 22 with practical guidance for approaches needed to ensure effective global action to address AD standardisation issues, including options to improve coordination with other organizations (i.e. ISO/IEC JTC 1…)/committees (i.e. ISO/TC 204…);

To explore the feasibility of developing global goals and ambitions related to AD standardisation in cooperation with other organizations/committees;

To regularly report on work progress to the ISO/TC 22 SAG.

The result of ADAG’s work is summarized in the following document before the group was disbanded.

Many thanks to all ADAG participants, and in particular to its convenor Mr. Christian ROUSSEAU (FR).
Report on standardisation prospective for automated vehicles (RoSPAV)

1 Scope

This document provides an overview (dated 2019):

- of ISO/TC 22 standards and drafts applicable to the automated driving (AD), with inputs coming from ISO/TC 204 and some complements from SAE International, and;
- of future needs, opportunities and recommendations.

2 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD</td>
<td>Automated driving</td>
</tr>
<tr>
<td>ADAG</td>
<td>Automated driving ad hoc group</td>
</tr>
<tr>
<td>ADAS</td>
<td>Advanced driver-assistance systems</td>
</tr>
<tr>
<td>DSS-AD</td>
<td>Data storage system for AD</td>
</tr>
<tr>
<td>EDR</td>
<td>Event data recorder</td>
</tr>
<tr>
<td>E/E</td>
<td>Electric and electronic</td>
</tr>
<tr>
<td>ePTI</td>
<td>Electronic periodic technical inspection</td>
</tr>
<tr>
<td>EV</td>
<td>Electric vehicle</td>
</tr>
<tr>
<td>HMI</td>
<td>Human-machine interface</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent transport systems</td>
</tr>
<tr>
<td>MMI</td>
<td>Man-machine interface</td>
</tr>
<tr>
<td>MRM</td>
<td>Minimal risk maneuver</td>
</tr>
<tr>
<td>ODD</td>
<td>Operational domain design</td>
</tr>
<tr>
<td>SAG</td>
<td>Strategic advisory group</td>
</tr>
<tr>
<td>SOTIF</td>
<td>Safety of the intended functionality</td>
</tr>
<tr>
<td>V2V</td>
<td>Vehicle-to-vehicle</td>
</tr>
<tr>
<td>V2X</td>
<td>Vehicle-to-everything</td>
</tr>
</tbody>
</table>

3 Organization of the international standardisation for automotive

This document provides an overview of ISO/TC 22 activities in automated driving (AD) related to road vehicles. The main sub-committees involved in AD are:

- SC 31 Data communication,
- SC 32 Electrical and electronic components and general system aspects,
- SC 33 Vehicle dynamics and chassis components,
- SC 35 Lighting and visibility
- SC 37 Electrically propelled vehicles,
SC 39 Ergonomics.

It also takes into account inputs coming from ISO/TC 204 and some complements from SAE.

Details are given in Annex A.

4 List of current projects and standards

A list of the current projects and standards is reflecting in Table 1.

Note The status of each project or standard listed in this table corresponds to an inventory in May 2019. Complementary information is available on the ISO website.

Table 1 — Structure of SAE International committee “On-road automated driving”

<table>
<thead>
<tr>
<th>Topics</th>
<th>Structure (TC/SC/WG)</th>
<th>Short description (scope/reference doc)</th>
</tr>
</thead>
</table>
| Total system functionality     | TC 204/WG 14 Vehicle/roadway warning and      | ISO 22078 Bicyclist detection and collision mitigation systems (BDCMS) — Performance requirements and test procedures
| and behaviour                  | control systems                               | Intended to provide emergency braking of equipped vehicles in order to mitigate collision severity between the subject vehicle and a bicyclist. BDCMS detect bicyclists forward of the subject vehicle, determine if the detected bicyclists is in a hazardous situation with respect to the subject vehicle, and initiate emergency braking if a hazardous situation exists and a collision imminent. Systems that include other countermeasures such as evasive steering are outside the scope of this document — Well consistent with ISO 19206-4 (SC33/WG16)
| Vehicle system                | TC 204/WG 14 Vehicle/roadway warning and      | ISO 23375 Collision evasive lateral manoeuvre systems (CELM) — Performance requirements and test procedures
|                               | control systems                               | Safety system aiming at supporting the driver’s vehicle operation in avoiding collisions with objects in the forward path of the vehicle. When a collision is predicted, CELM controls the lateral movement of the vehicle by generating yaw moment.
|                               |                                               | ISO 21202 Partially automated lane change systems (PALS) — Functional/operational requirements and test procedures
|                               |                                               | PALS performs part or all of lane change tasks under the driver’s supervision and initiation. PALS is intended to function on roads with visible lane markings, where non-motorized vehicles and pedestrians are prohibited (e.g. Access controlled highway), and to perform a lane change into a lane with traffic moving in the same direction. Support on sections of roadway having temporary or irregular lane markings (such as roadwork zones) is not within the scope of this document.
|                               |                                               | ISO 23792 Motorway chauffeur systems
|                               |                                               | Part 1 Framework and general requirements
|                               |                                               | Part 2 Performance requirements and test procedures for In-lane Driving
|                               |                                               | ISO 23793 Fallback functions for automated driving systems
|                               |                                               | Part 1: Framework
| Vehicle control | TC 204/WG 14 Vehicle/roadway warning and control systems | Part 2: Performance requirements and test procedures for Emergency Stopping
ISO 15622 Intelligent transport systems — Adaptive cruise control systems — Performance requirements and test procedures
ISO 20035 Intelligent transport systems — Cooperative adaptive cruise control systems (CACC) — Performance requirements and test procedures
ISO 16787 Intelligent transport systems — Assisted parking system (APS) — Performance requirements and test procedures
ISO 21717 Intelligent transport systems — Partially automated in-lane driving systems (PADS) — Performance requirements and test procedures
ISO 20900 Intelligent transport systems — Partially automated parking systems (PAPS) — Performance requirements and test procedures

| Vehicle control | TC 204/WG 14 Vehicle/roadway warning and control systems | ISO 11270 Intelligent transport systems — Lane keeping assistance systems (LKAS) — Performance requirements and test procedures
ISO 22839 Intelligent transport systems — Forward vehicle collision mitigation systems — Operation, performance, and verification requirements
ISO 19237 Intelligent transport systems — Pedestrian detection and collision mitigation systems (PDCMS) — Performance requirements and test procedures
ISO 19638 Intelligent transport systems — Road boundary departure prevention systems (RBDPS) — Performance requirements and test procedures

| TC 22/SC 33/WG 3 Active security functions | ISO 22735 Test method to evaluate the performance of lane-keeping assistance systems (LKAS)
ISO 22733 Test method to evaluate the performance of autonomous emergency braking systems (AEBS)
Part 1: Car-to-car
Part 2: Car-to-pedestrian

| TC 22/SC 33/WG 11 Simulation Correlation models/object | ISO 19364 Vehicle dynamic simulation and validation — Steady-state circular driving behaviour
Method for comparing computer simulation results from a vehicle mathematical model to measured test data for an existing vehicle according to steady-state circular driving tests as specified in ISO 4138 or the Slowly Increasing Steer Test that is an alternative to ISO 4138. The comparison is made for the purpose of validating the simulation tool for this type of test when applied to variants of the tested vehicle.
ISO 19365 Validation of vehicle dynamic simulation — Sine with dwell stability control testing
ISO 22140 Vehicle dynamic simulation and validation — Lateral transient response test methods

| TC 22/SC 33/WG 11 Simulation Correlation models/object | ISO 19364 Vehicle dynamic simulation and validation — Steady-state circular driving behaviour
Method for comparing computer simulation results from a vehicle mathematical model to measured test data for an existing vehicle according to steady-state circular driving tests as specified in ISO 4138 or the Slowly Increasing Steer Test that is an alternative to ISO 4138. The comparison is made for the purpose of validating the simulation tool for this type of test when applied to variants of the tested vehicle.
ISO 19365 Validation of vehicle dynamic simulation — Sine with dwell stability control testing
ISO 22140 Vehicle dynamic simulation and validation — Lateral transient response test methods

| TC 22/SC 33/WG 11 Simulation Correlation models/object | ISO 19364 Vehicle dynamic simulation and validation — Steady-state circular driving behaviour
Method for comparing computer simulation results from a vehicle mathematical model to measured test data for an existing vehicle according to steady-state circular driving tests as specified in ISO 4138 or the Slowly Increasing Steer Test that is an alternative to ISO 4138. The comparison is made for the purpose of validating the simulation tool for this type of test when applied to variants of the tested vehicle.
ISO 19365 Validation of vehicle dynamic simulation — Sine with dwell stability control testing
ISO 22140 Vehicle dynamic simulation and validation — Lateral transient response test methods

| TC 22/SC 33/WG 11 Simulation Correlation models/object | ISO 19364 Vehicle dynamic simulation and validation — Steady-state circular driving behaviour
Method for comparing computer simulation results from a vehicle mathematical model to measured test data for an existing vehicle according to steady-state circular driving tests as specified in ISO 4138 or the Slowly Increasing Steer Test that is an alternative to ISO 4138. The comparison is made for the purpose of validating the simulation tool for this type of test when applied to variants of the tested vehicle.
ISO 19365 Validation of vehicle dynamic simulation — Sine with dwell stability control testing
ISO 22140 Vehicle dynamic simulation and validation — Lateral transient response test methods

| TC 22/SC 33/WG 11 Simulation Correlation models/object | ISO 19364 Vehicle dynamic simulation and validation — Steady-state circular driving behaviour
Method for comparing computer simulation results from a vehicle mathematical model to measured test data for an existing vehicle according to steady-state circular driving tests as specified in ISO 4138 or the Slowly Increasing Steer Test that is an alternative to ISO 4138. The comparison is made for the purpose of validating the simulation tool for this type of test when applied to variants of the tested vehicle.
ISO 19365 Validation of vehicle dynamic simulation — Sine with dwell stability control testing
ISO 22140 Vehicle dynamic simulation and validation — Lateral transient response test methods
In automotive industry, vehicle dynamic simulation is widely used to replace expensive, time consuming and sometimes dangerous physical tests for the purpose of product design, performance verification, homologation, etc. For example, UN/ECE Regulation No. 13-H, “Uniform provisions concerning the approval of passenger cars with regard to braking” allow simulation to evaluate the performance of ESC (electronic stability control) system.

<table>
<thead>
<tr>
<th>TC 22/SC 33/WG 16</th>
<th>ISO 19206 Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions</th>
</tr>
</thead>
</table>
| Active safety test equipment/Targets | Part 1 Passenger vehicle rear-end targets  
Part 2 Pedestrian targets  
Part 3 Passenger vehicle 3D targets  
Part 4 Bicyclist targets  
Part 5 Powered two-wheeler targets  
Part 6 Research data and guidelines for surrogate animal targets |

| TC 22/SC 33/WG 9 | ISO 34501 Terms and definitions of test scenarios for automated driving systems  
ISO 34502 Engineering framework and process of scenario-based safety evaluation  
ISO 34503 Taxonomy for operational design domain for automated driving systems  
ISO 34504 Scenario attributes and categorization  
ISO 34505 Evaluation of test scenarios for automated driving systems |
| Test scenario of autonomous driving vehicle |

<p>| Driving environment recognition | — |
| — | — |</p>
<table>
<thead>
<tr>
<th>Topics</th>
<th>Structure (TC/SC/WG)</th>
<th>Short description (scope/reference doc)</th>
</tr>
</thead>
</table>
| **Symbols**                   | TC 22/SC 39/WG 5     | ISO 2575 Symbols for controls, indicators and telltales  
New symbol proposed for “automated driving”                                                                                                                                                                                                 |
| **Transition process**        | TC 22/SC 39/WG 8     | TR 21959 Human performance and state in the context of automated driving  
Part 1: Common underlying concepts (Published)  
Document introduces basic common underlying concepts related to driver performance and state in the context of automated driving. The concepts are applicable for human factors assessment/evaluations using driving simulators, tests on restricted roadways (e.g., test tracks) or tests on public roads.  
Part 2: Considerations in designing experiments to investigate transition processes (Published)  
Document focuses on system-initiated and human-initiated transitions from a higher level to a lower level of automated driving. Human factors and system factors that can influence takeover performance are included. Document will aid research design by ensuring that important factors are considered and support consistency across studies enabling meaningful comparisons of findings. |
| **External visual communication** | TC 22/SC 39/WG 8     | ISO/TR 23049 Ergonomic aspects of external visual communication from automated vehicles to other road users  
ISO/TR 23735 Ergonomic design guidance for external visual communication from automated vehicles to other road users  
ISO/TR 23720 Methods for evaluating other road user behaviour in the presence of automated vehicle external communication |
| **Driver monitoring**         | TC 22/SC 39/WG 8     | ISO 5236 Ergonomic aspects of driver monitoring and system interventions in the context of automated driving  
Still under discussion at preliminary stage, to be officialised |
| **Terms and definitions**     | SAE Driving Automation Systems Committee | SAE J3114 Human factors definitions for automated driving and related research topics  
This Information Report covers the human factors issues involving the integration of driving automation system features into the vehicle, focusing on issues that affect driver/user performance and experience through the driver/user-vehicle-interface (DVI). This report is intended to aid research and facilitate improved DVI design and usability by establishing working definitions for key concepts of levels 2 through 4 driving automation system features (SAE J3016), and to provide references to relevant research. This report serves as a complementary document to SAE J3016. |
<table>
<thead>
<tr>
<th>Topics</th>
<th>Structure (TC/SC/WG)</th>
<th>Short description (scope/reference doc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cybersecurity</td>
<td>TC 22/SC 32/WG 11</td>
<td>ISO/SAE 21434 Road vehicles — Cybersecurity engineering</td>
</tr>
<tr>
<td></td>
<td>Cybersecurity &amp; SAE J3061 Committee</td>
<td>Specifies requirements for cybersecurity risk management for road vehicles, E/E system components and interfaces, throughout engineering, production, operation, maintenance, and decommissioning</td>
</tr>
<tr>
<td>Safety</td>
<td>TC 22/SC 32/WG 8</td>
<td>ISO 26262 Road vehicles — Functional safety — 12 parts</td>
</tr>
<tr>
<td></td>
<td>Functional safety</td>
<td>ISO/PAS 21448 Road vehicles — Safety of the intended functionality</td>
</tr>
<tr>
<td></td>
<td>STPA recommended practices task force within SAE Functional Safety Committee</td>
<td>WIP – safety</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The purpose of this workgroup is to align industry (automotive/aerospace) best practices and translate them across the automotive industry regarding the implementation and use of STPA (Systems Theoretic Process Analysis) within automotive controls, automotive HMI, and autonomous driving applications, and to explore focus areas suited for STPA use, or for supplementing other safety tools. The scope of this effort intends to provide both educational materials and recommended practices regarding how STPA may be applied within a safety assessment process focusing on automotive vehicle safety-critical content.</td>
</tr>
<tr>
<td>Software update</td>
<td>TC 22/SC 32/WG 12</td>
<td>ISO 24089 Road vehicles — Software Update engineering</td>
</tr>
<tr>
<td></td>
<td>Software update</td>
<td>New standard for WP29 software update Recommendation &amp; Regulation. Specifies requirements for software update process and product</td>
</tr>
<tr>
<td>Data storage</td>
<td>ADS Data Logger Task Force within SAE Event Data Recorder Committee</td>
<td>J3197 ADS Data Logger</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Defining of the data elements that are unique to ADS and providing additional background of the events leading up to a collision in the absence of an eye-witness account. The EDR and Data Logger will capture information leading up to the collision.</td>
</tr>
<tr>
<td>Topics</td>
<td>Structure (TC/SC/WG)</td>
<td>Short description (scope/reference doc)</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>-----------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>In-vehicle networks</td>
<td>TC 22/SC 31/WG 3  In-vehicle networks</td>
<td><strong>ISO 16845 Controller area network (CAN) conformance test plan</strong> — 2 parts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 1: Data link layer and physical signalling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 2: High-speed medium access unit — Conformance test plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>ISO 21111 In-vehicle Ethernet</strong> — 10 parts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 1: General information and definitions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 2: Common physical layer device specification and media independent interfaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 3: Optical 1-Gbit/s physical layer device specification and conformance test plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 4: General requirements and test methods of optical Gigabit Ethernet components</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 5: Optical 1-Gbit/s physical layer system specification and interoperability test plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 6: Electrical 100-Mbit/s physical layer device specification and conformance test plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 7: Electrical 100-Mbit/s physical layer system specification and interoperability test plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 8: Electrical 100-Mbit/s component requirements and test methods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 9: Data link layer requirements and conformance test plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 10: Application to network layer requirements and test plans</td>
</tr>
<tr>
<td>Vehicle domain — data collection system</td>
<td>TC 22/SC 31/WG 8  Vehicle domain service (VDS)</td>
<td><strong>ISO 23239 Vehicle domain data collection service</strong> — 4 parts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 1: General information and use case definitions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 2: Application layer and sequence requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 3: Network and transport layer requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 4: Physical and data link layer requirements</td>
</tr>
<tr>
<td>Sensor data interface for automated driving functions</td>
<td>TC 22/SC 31/WG 9  Sensor data interface for automated driving functions</td>
<td><strong>ISO 23150 Data communication between sensors and data fusion unit for automated driving functions</strong> — Logical interface</td>
</tr>
<tr>
<td>Topics</td>
<td>Structure (TC/SC/WG)</td>
<td>Short description (scope/reference doc)</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>----------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Mobility</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Vehicle/Infrastructure Integration              | TC 204/WG 14 Vehicle/roadway warning and control systems | ISO 22737 Low-speed automated driving (LSAD) systems for limited operational design domains — Performance requirements, system requirements and performance test procedures  
This document specifies the limited operational design domain, system requirements, minimum performance requirements and performance test procedures for safe operation of low-speed automated driving (LSAD) systems which will operate on pre-defined routes. Low-speed automated driving (LSAD) systems are designed to operate at Level 4 automation in accordance to SAE J3016, within specific operational design domains (ODD). |
|                                                |                      | ISO 23374 Automated valet parking systems (AVPS)  
Requirements and test procedures for the vehicle operation of an automated valet parking system (AVPS). The vehicle operation is a level 4 driving automation feature and realized by the cooperation of functionalities implemented to the vehicle and equipment installed to the parking facility for the purpose of AVPS. |
|                                                |                      | ISO 4272 Truck platooning systems (TPS)  
ISO 4273 Automated braking during low speed manoeuvring (ABLS) |
| Taxonomy and Definitions                        | TC 204/WG 14 Vehicle/roadway warning and control systems | ISO/SAE PAS 22736 Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles  
J3016 ORAD committee — Definitions task force |
5 Future needs, opportunities and recommendations

5.1 Vehicle system – Reaction of the vehicle

The reaction of the car is supposed to be standardised in case of failures and risky behaviours: the details of minimal risk manoeuvres depending on the level of automation and the use cases (e.g. for electric vehicles (EV) specificities) could be described in such standard in order to ensure coexistence in mixed traffic.

In such a standard, it is necessary to define when this function is activated (activation criteria and modalities).

In this context, ADAG recommends considering specificities and current standards of EVs.

A material for starting point is ISO 23793 Intelligent transport systems — Fallback functions for automated driving systems, under development within TC 204/WG 14 for level 3 and more. TC 22/SC 33 could be associated.

5.2 Human factor

5.2.1 Driver monitoring system

The standardisation of the different DMS levels and features will have to take into account the following topics:

- the levels of automation,
- the driver's roles,
- the use cases,
- the operational domain design (ODD),
- the customer prerequisites or customer personalization,
- etc.

The different ad hoc standards are supposed to address metrics (detection criteria, for e.g. drowsiness monitoring) and methodology for assessment.

In this context, TC 22/SC 39 already published ISO/TR 21959-1 Human performance and state in the context of automated driving — Part 1: Common underlying concepts (considered as a starting material).

ADAG recommends this work be achieved possibly in a joint working group between TC 22 and TC 204 with TC 22/SC 39 as a responsible committee, in order to have all the needed relevant contributing skills.

5.2.2 Internal HMI and external HMI

Standards for HMI internal messages are detected as future needs. They depend on:

- the level of automation,
- the use cases,
- the operational domain design (ODD).

Such standard is supposed to describe the HMI of the car, especially in case of take-over requests, different drivers behaviours and different driving situations.

This work can be achieved in the different working groups within TC 22/SC 39, and in possible cooperation with relevant WGs of TC 204. See the main scope of each working group in A.2.7.
In addition, in terms of specifications for external HMI, the signalling of the driving intentions to the other users, and indication of the operational status of the vehicle (depending on the level of automation) can be described. Furthermore, this broader approach can also be introduced for both automated vehicles and electric vehicles (see 5.3.3).

5.3 Safety requirements

5.3.1 Perception

ADAG recommends the outputs of the perception sensors and the results of the context analysis be evaluated through a standard giving a methodology for assessment, independently of the technology.

The definition of common requirements between all the stakeholders (including the vehicle manufacturers) is also recommended in order to quantify the performance of sensors perception, with a common assessment methodology. Sensor performance differs for each ADS performance requirement, and it could be thought as a category of detailed design. For standardization, it is essential to clarify the relationship between sensors key performance with the system request.

The overall system validation needs a standardised assessment of the sensors perception in order to demonstrate the consistency and performance proof.

Various TC 22 subcommittees (SC 31, SC 32, SC 33) are intended to contribute on this transversal topic, possibly under responsibility of SC 32.

5.3.2 Data Storage System for AD (DSS-AD)

The event data recorder (EDR) makes it possible to document the embedded system operations a few seconds before a crash. With the automated vehicle, a complementary system, the data storage system for automated driving (DSSAD) is also required.

The DSSAD provides information on how the driving delegation is activated, how the driver is asked to take over and whether this is followed by a driver positive action or if a minimal risk manoeuvre is undertaken by system control.

In this context, even if the EDR and DSSAD remain independent of each other, it seems necessary to ensure the complementarity of the two systems through the development of standards.

ADAG confirms the necessity to ensure the EDR and DSS-AD functional complementarity, even if EDR and DSS-AD remain independent of each other. Regular reviews and updates of the different current available standards and regulations (WP29) ensure a correct integration in the ecosystem.

Furthermore, some parts of the process are not standardised yet: data access process and suppression process (who is in control, in charge...).

ADAG concludes to set up a small group with various contributions from different SCs: TC 22/SC 31 (leading, to be confirmed), TC 22/SC 32, in order to fill the gap between EDR and DSSAD.

5.3.3 Specific aspects for electric vehicles (EV)

In autonomous EVs the availability of the power supply is crucial but however the availability of the EV power supply depends also heavily on protection measures against electric shock or other hazards such as thermal incidents and fires. Minimal risk manoeuvre is difficult to achieve in case of some kind of protections.
The consistency between both standards (ISO 6469-2 and -3 Electrical safety specifications, vehicle operational safety, and ISO 17409 Safety requirements for conductive power transfer) needs to be checked and adapted to EV automated driving, specifically in case of MRM:

- Requirements for redundancy for critical EV functions in case of AD functions (power supply and MRM),
- AD impacts on EV fail safe disposal.

The minimal risk manoeuvre for AD-EV is supposed to be defined consistently with the minimal risk conditions for all vehicles.

In addition, an approach could be considered for both AVs and EVs regarding how the surroundings get informed via a combination of kinematic behaviour (partly looked into by TC 22/SC 39/WG 8), external visual communication (already looked into by SC 39/WG 8), and external sound (see 5.2.2).

### 5.3.4 Validation

To assess the reliability of an autonomous vehicle, real data are supposed to be available representing the many real-life scenarios. The integration of those scenarios in database allows simulation and physical testing. ADAG recommends standardising the methodology and the tools capable of different validation activities in order to demonstrate validation completeness.

The aim is also to reach a clear consistency with SOTIF working group and Functional safety.

The methodologies of AD validations are to be defined in TC 22 standardisation activities:

- Validation based on test scenarios for AD (acting TC 22/SC 33/WG 9),
- ISO PAS 21448 Safety of the Intended Functionality (acting TC 22/SC 32/WG 8 – also in charge of ISO 26262),
- ISO 21434 Cybersecurity engineering (acting TC 22/SC 32/WG 11).

Concerning infrastructure, it is feasible to associate with TC 204 and CEN/TC 226 "Road equipment".

### 5.4 Data communication – Connectivity

Connectivity is recognized as an enabler of vehicle automation. Two devices need to be interoperable to ensure connectivity, which is then achieved through related standards. Those standards are already or on the way to be defined for connected vehicles and infrastructures.

In the meantime, automated vehicles have specific performance requirement for any connectivity features. In order to ensure functional and operational interoperability, complementary standards dedicated to AD performance requests are to be developed. In complement, SC31 proposed to discuss with relevant bodies the standardization of:

- Open interface (ePTI...);
- Requirements for containers;
- Data communication (Ethernet and IP communication, electrical and optical very high-speed communication...).

### 5.5 Mobility – Digital mapping system

Automated vehicle needs reliable digital mapping and geolocation systems. Many different stakeholders are involved in mapping activities. To be effective, a digital mapping system based on state-of-the-art and standardised digital map and geolocation systems is necessary and guarantees to passengers a safe journey. The industry needs to identify the specific needs of AD guidance and current vehicles navigation.
It is therefore necessary to share the needs of the automotive industry with the digital mapping systems industry. Even when the smartest artificial intelligence algorithms or resources is implemented, geolocation based on accurate digital map remains the backup for safe operations.

Lots of stakeholders already have specified proprietary digital mapping systems, some being closed or patented and some being open source.

The automotive industry identified a need for discussion between stakeholders’ different platforms in order to harmonize the available standards related to digital mapping systems.

ADAG recommended to write a Technical Report on the needs of the car industry, to be drafted between TC 22 and TC 204 (in connexion with TC 204/WG 3 on ITS database technology).

5.6 Vehicle/Infrastructure Integration – Infrastructure signs

Road signs are contributing to the holistic safety. The lack of standardisation can be dangerous at all level of development, especially with regards to horizontal and vertical signs, which are key for automated driving.

A first priority is to standardise an assessment methodology of the perception characteristics of the triptych composed of infrastructure signs (horizontal and vertical road signs), sensors and data processing.

In this context, the design of horizontal and vertical road signs for the perception is supposed to meet a worldwide standard.

As a starting point, CEN/TC 226 “Road equipment” already published standards covering properties for signs infrastructures. It also set up a new WG dedicated on road adaptation for ADAS/AD, to define a relation between sensor performances and marking characteristics.

ADAG recommends to develop a TC 22 technical report be proposed in order to define the needs of the car industry, in relation with TC 204 and CEN/TC 226.
6 Way forward

Further to ADAG work, ISO/TC 22 has decided to continue the coordination activity related to automated driving through a permanent coordination group as defined by the following resolutions adopted during the plenary meeting in June 2019.

**RESOLUTION 941 – Follow-up activity for ADAG**

TC22 agreed to create a coordination group, specific to AD projects. This group shall consist of a representative from each concerned SC to ensure the coordination of new projects. TC204 is invited to participate in this group to improve the coordination also between TC22 and TC204. Ideally that coordination group should be co-chaired by one expert from ISO TC22 and one from ISO TC204. ToR for this group shall be provided by SAG of TC22 in conjunction with TC204 before end of September 2019.

**RESOLUTION 942 – Coordination of automated driving topics within the ISO community**

ISO TC22 is proposing ISO TMB to create a small and efficient consulting group that should help to avoid overlapping project initiatives within the ISO community. Relying on the knowledge of the experts being active in ISO TC22 and ISO TC204, ISO TC22 recommend ISO TMB to support that consulting initiative. TC22 is offering to overtake the responsibility to manage that initiative, ideally with help of TC204.

This new coordination group is supposed to use this document as a basis for its future guidance.
Annex A

Information on international standardisation

A.1 Overview of ISO organization

ISO is an independent and non-governmental international organization. It is a community of experts, nominated by their national standardisation organization in Technical Committees (TC and its sub-committees SC, and Working Groups WG), in order to share knowledge and develop voluntary, consensus-based, market relevant International Standards.

In ISO, two main Technical Committees (TC 22 and TC 204) are in charge of standardisation in the field of automotive industry.

Another committee ISO/TC 241 “Road traffic safety management systems” is beginning a standardisation work on ethical considerations for automated driving.

A.2 ISO/TC 22 Road vehicles

A.2.1 General

This Committee deals with “all questions of standardisation concerning compatibility, interchangeability and safety, with particular reference to terminology and test procedures (including the characteristics of instrumentation) for evaluating the performance of the following types of road vehicles and their equipment (as defined in the relevant items of Article 1 of the convention on Road Traffic, Vienna — 1968):

- mopeds (item m);
- motor cycles (item n);
- motor vehicles (item p);
- trailers (item q);
- semi-trailers (item r);
- light trailers (item s);
- combination vehicles (item t);
- articulated vehicles (item u)."

Road vehicles concern vehicles for both private and commercial transport of people and goods. In the case of automation, vehicles for commercial transports are of specific importance as they can provide direct societal benefits to traffic flow and more precise deliveries.

ISO/TC 22 is currently composed by 11 sub-committees, as introduced in Figure A.1.
The main sub-committees involved in the standardisation on automated driving are:

- SC 31 Data communication;
- SC 32 Electrical and electronic components and general system aspects;
- SC 33 Vehicle dynamics and chassis components;
- SC 35 Lighting and visibility;
- SC 39 Ergonomics.

Additionally, SC 37 Electrically propelled vehicles is also considered. Automated vehicles are also often electric vehicles. As electric vehicles are more silent, precaution is needed to inform other road users about where they are. There are several common use cases showing how both automated and electric vehicles need to communicate with several road users.

### A.2.2 SC 31 Data communication

The scope of SC 31 focuses on data communication for vehicle applications, including amongst many other: data buses and protocols, V2X communication, diagnostics, test protocols, interfaces, data formats, and content (see Figure A.2).
A.2.3 SC 32 Electrical and electronic components and general system aspects

The SC 32 scope contains amongst other: electrical and electronic components, electromagnetic compatibility, environmental conditions, functional safety, cybersecurity and software updates (see Figure A.3).
A.2.4 SC 33 Vehicle dynamics and chassis components

SC 33 is dedicated to lateral and longitudinal vehicle dynamics and controls/systems/functions affecting vehicle dynamics. It includes also automated driving, means and performance of collision avoidance and mitigation (see Figure A.4)

Figure A.3 — Structure of ISO/TC 22/SC 32 Electrical and electronic components and general system aspects

A.2.5 SC 35 Lighting and visibility

The scope of SC 35 is to secure standards for lighting, safety glazing, and visibility systems (see Figure A.5). Automated driving needs specific attention with respect to external visual communication with lights and cleaning devices for lights and sensors.

Figure A.4 — Structure of ISO/TC 22/SC 33 Vehicle dynamics and chassis components

Figure A.5 — Structure of ISO/TC 22/SC 35 Lighting and visibility
A.2.6 SC 37 Electrically propelled vehicles

Its scope covers specific aspects of electrically propelled road vehicles, electric propulsion systems, related components and their vehicle integration (see Figure A.6).

![SC 37 Electrically propelled vehicles](image)

Figure A.6 — Structure of ISO/TC 22/SC 37 Electrically propelled vehicles

A.2.7 SC 39 Ergonomics

The purpose of SC 39 is to publish standards on the interaction of the driver with its environment and the automated systems (on-board and off-board). It is composed with the following working groups (see Figure A.7):

- WG3 covers positioning of controls and information so that occupants can interact with the automated vehicle.
- WG5 covers development of specific symbols needed to inform occupants and other road users or people coming in contact with the automated vehicle.
- WG7 covers support for defining and measuring occupant positions when connections to vehicle controls will not be needed at all time.
- WG8 covers how vehicle control will be handed over between a driver and the vehicle, as well as how the vehicle can communicate with surrounding road users.

![SC 39 Ergonomics](image)

Figure A.7 — Structure of ISO/TC 22/SC 39 Ergonomics

A.3 ISO/TC 204 Intelligent Transport Systems
This committee specifies the information, the communication and the control systems in the field of urban and rural surface transportation, including intermodal and multimodal aspects thereof, traveller information, traffic management, public transport, commercial transport, emergency services and commercial services in the intelligent transport systems (ITS) field (see Figure A.8).

The in-vehicle transport information and control systems are not in the scope of ISO/TC 204.

![TC 204 Intelligent transport systems](image)

**Figure A.8 — Structure of ISO/TC 204 Intelligent transport systems**

### A.4 SAE International

SAE is an international standards development organization in the global ground vehicle and aerospace sectors. Their stated mission is to advance mobility knowledge and solutions for the benefit of humanity. SAE standards are led by councils made up of industry experts to guide the development of standards in targeted mobility industry sectors:

- Aerospace Council
- Motor Vehicle Council
- Truck and Bus Council
- Construction and Agriculture Council
- Specialized Vehicle and Equipment Council
- Systems Management Council

The on-road automated driving committee (ORAD) is the SAE committee dedicated to developing standards for automated driving systems; however, SAE considers this emerging technology area diverse, requiring many technical discipline areas and efforts from other committees. These include advanced driver assistance systems (ADAS), active safety systems, human factors, and cybersecurity committees. Thus, there are many SAE standards committees contributing to automated driving systems. SAE International is composed of several standardisation committees on various topics: aerospace,
automotive, construction machinery, agricultural and off-road vehicles, trucks and buses. A dedicated committee deals with on-road automated driving, with several task forces.

Figure A.9 — Structure of SAE International committee “On-road automated driving”
Annex B

Information on regulation for AD

B.1 Overview of the committees in charge of global regulation

The figure below shows the committees in charge of global regulations.

Figure B.1 — Overview of the committees in charge of global regulations
Bibliography

