



SURFACE VEHICLE RECOMMENDED PRACTICE

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Automated Driving System Test Facility Safety Practices

RATIONALE

In testing, the safety of all persons involved is of primary importance, with processes, procedures, and appropriate measures implemented to ensure people are not knowingly put at risk.

Safety practices at traditional automotive proving grounds and test facilities are well established based on proven practice and experience with vehicle development. The development of ADS and ADS-operated vehicles have brought about the need for unique tests, methodologies, and testing environments compared to traditional vehicles and systems, adding further layers of complexity and additional hazards that must be accounted for when mitigating risk. To ensure test facility safety, when conducting testing and evaluations of ADS, different requirements, approaches, and considerations are necessary.

Test facility program/operations management play a key role in helping to maintain safety while conducting testing of ADS-operated vehicles. With the continued growth of testing conducted at test facilities, which are both dedicated to and modified to accommodate ADS testing, it is important that safety be designed-in to the infrastructure, process and procedures, as well as in the mindset of all those involved.

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1. SCOPE

This SAE Recommended Practice provides guidance for test facilities in identifying potential hazards, and safety risks, along with requirements and recommendations related specifically to testing of automated driving systems (ADS) and ADS-operated vehicles. Herein after, for the purposes of this document, utilization of the term “test facilities” implies those conducting testing of ADS or ADS-operated vehicles, unless otherwise noted.

References made to safety within this recommended practice apply only to test method safety and driving safety on and during testing at an ADS test facility and do not apply to vehicle design or safety performance.

Safety practices for on-road testing, operation, and related deployment are not covered within this document.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J3016	Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles
SAE J3018	Safety-Relevant Guidance for On-Road Testing of Prototype Automated Driving System (ADS)-Operated Vehicles
SAE J3206	Taxonomy and Definition of Safety Principles for Automated Driving System (ADS)
ISO/SAE 21434	Road Vehicles - Cybersecurity Engineering
AVSC00001201911	AVSC Best Practice for In-Vehicle Fallback Test Driver Selection, Training, and Oversight Procedures for Automated Vehicles Under Test
AVSC00002202004	AVSC Best Practice for Describing an Operational Design Domain: Conceptual Framework and Lexicon
AVSC00007202107	AVSC Information Report for Adapting a Safety Management System (SMS) for Automated Driving System (ADS) SAE Level 4 and 5 Testing and Evaluation

2.1.2 BSI Publications

Copies of these documents are available online at <https://www.bsigroup.com>.

PAS 1883:2020	Operational design domain taxonomy for an automated driving system (ADS) - Specification
PAS 1884:2021	Safety operators in automated vehicle testing and trialling - Guide

2.1.3 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ISO 26262-1:2018	Road Vehicles - Functional Safety - Part 1: Vocabulary
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2.1.4 Other Publications

Manual on Uniform Traffic Control Devices for Streets and Highways, <https://mutcd.fhwa.dot.gov>.

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J3061	Cybersecurity Guidebook for Cyber-Physical Vehicle Systems
SAE J3063	Active Safety Systems Terms and Definitions
SAE J3116	Active Safety Pedestrian Test Mannequin Recommendation
SAE J3122	Test Target Correlation - Radar Characteristics
SAE J3157	Active Safety Bicyclist Test Targets Recommendation
SAE J3187	System Theoretic Process Analysis (STPA) Recommended Practices for Evaluations of Safety-Critical Systems in Any Industry
SAE J3216	Taxonomy and Definitions for Terms Related to Cooperative Driving Automation for On-Road Motor Vehicles
SAE J3234/1	Active Safety Roadside Metal Guardrail Surrogate Recommendation
AVSC00003202006	AVSC Best Practice for Passenger-Initiated Emergency Trip Interruption
AVSC00004202009	AVSC Best Practice for Data Collection for Automated Driving System-Dedicated Vehicles (ADS-DVs) to Support Event Analysis
AVSC00005202012	AVSC Best Practice for First Responder Interactions with Fleet-Managed Automated Driving System-Dedicated Vehicles (ADS-DVs)
AVSC00006202103	AVSC Best Practice for Metrics and Methods for Assessing Safety Performance of Automated Driving Systems (ADS)
AVSC00008202111	AVSC Best Practice for Evaluation of Behavioral Competencies for Automated Driving System Dedicated Vehicles (ADS-DVs)

2.2.2 BSI Publications

Copies of these documents are available online at <https://www.bsigroup.com>.

PAS 1881:2020	Assuring Safety of AV Trials
PAS 1882:2021	Data Collection for Incident Investigation
BSI Flex 1890 v4:2022-0	Connected and automated vehicles - Vocabulary

2.2.3 Code of Federal Regulations (CFR) Publications

Available from United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

49 CFR Part 563 Event Data Recorders

2.2.4 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ISO/TR 4804:2020 Safety and cybersecurity for automated driving systems - Design, verification and validation

ISO/DIS 21448:2022 Road vehicles - Safety of the intended functionality

ISO/TR 21718:2019 Spatio-temporal data dictionary for cooperative ITS and automated driving systems 2.0

2.2.5 UL Publications

Available from UL, 333 Pfingsten Road, Northbrook, IL 60062-2096, Tel: 847-272-8800, www.ul.com.

UL 4600 Evaluation of Autonomous Products

2.2.6 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-STD-882E System Safety

2.2.7 ITU Publications

Available from International Telecommunication Union, Place des Nations, 1211 Geneva 20 Switzerland, <https://www.itu.int/>.

ITU-T X.1371 Security threats to connected vehicles

2.2.8 Other Publications

ETAVEP - Enablers of Testing Autonomous Vehicle at Existing Proving grounds. <https://www.vinnova.se/p/etavep---enablers-for-testing-autonomous-vehicles-at-existing-proving-grounds/>

NTSB Safety Report 20/01 Safety Risks to Emergency Responders from Lithium-Ion Battery Fires in Electric Vehicles

UNECE Addendum 156 - UN Regulation No. 157, Uniform provisions concerning the approval of vehicles with regard to Automated Lane Keeping Systems

3. DEFINITIONS

3.1 ACTIVE SAFETY SYSTEM (SAE J3063) [QUOTED]

Active safety systems are vehicle systems that sense and monitor conditions inside and outside the vehicle for the purpose of identifying perceived present and potential dangers to the vehicle, occupants, and/or other road users, and automatically intervene to help avoid or mitigate potential collisions via various methods, including alerts to the driver, vehicle system adjustments, and/or active control of the vehicle subsystems (brakes, throttle, suspension, etc.).

Further detail can be found in SAE J3063.

3.2 DRIVERLESS OPERATION [OF AN ADS-EQUIPPED VEHICLE] (SAE J3016) [QUOTED]

On-road operation of an ADS-equipped vehicle that is unoccupied, or in which on-board users are not drivers or in-vehicle fallback-ready users.

Further detail can be found in SAE J3016.

3.3 DYNAMIC DRIVING TASK (DDT) (SAE J3016) [QUOTED]

All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints, and including, without limitation, the following subtasks:

- a. Lateral vehicle motion control via steering (operational).
- b. Longitudinal vehicle motion control via acceleration and deceleration (operational).
- c. Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical).
- d. Object and event response execution (operational and tactical).
- e. Maneuver planning (tactical).
- f. Enhancing conspicuity via lighting, sounding the horn, signaling, gesturing, etc. (tactical).
- g. Further detail can be found in SAE J3016.

3.4 [DYNAMIC DRIVING TASK (DDT)] FALLBACK (SAE J3016) [QUOTED]

The response by the user to either perform the DDT or achieve a minimal risk condition: (1) after occurrence of a DDT performance-relevant system failure(s) or (2) upon operational design domain (ODD) exit, or the response by an ADS to achieve minimal risk condition, given the same circumstances.

Further detail can be found in SAE J3016.

3.5 FALLBACK TEST DRIVER (FTD) (SAE J3018) [QUOTED]

A person specially trained and skilled in supervising the performance of prototype ADS-operated vehicles in on-road traffic for testing purposes.

Further detail can be found in SAE J3018.

3.6 IN-VEHICLE FALLBACK TEST DRIVER (IFTD) (SAE J3018) [QUOTED]

A fallback test driver of a prototype ADS-operated vehicle who is capable of appropriately responding to unexpected ADS and vehicle behaviors in a variety of operating situations, including hazardous ones, by exercising in-vehicle braking, accelerating, steering, and transmission position selection input devices.

Further detail can be found in SAE J3018.

3.7 OBJECT AND EVENT DETECTION AND RESPONSE (OEDR) (SAE J3016) [QUOTED]

The subtasks of the DDT that include monitoring the driving environment (detecting, recognizing, and classifying objects and events and preparing to respond as needed) and executing an appropriate response to such objects and events (i.e., as needed to complete the DDT and/or DDT fallback).

Further detail can be found in SAE J3016.

3.8 REMOTE FALLBACK TEST DRIVER (RFTD) (SAE J3018) [QUOTED]

A fallback test driver of a prototype ADS-operated vehicle in driverless operation, who, from a location remote to the vehicle, is capable of appropriately responding to unexpected ADS and vehicle behaviors in a variety of operating situations, including hazardous ones, using wireless means.

Further detail can be found in SAE J3018.

3.9 OPERATIONAL DESIGN DOMAIN (ODD) (SAE J3016) [QUOTED]

Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics.

Further detail can be found in SAE J3016.

3.10 ROAD USERS (SAE J3216) [QUOTED]

A traffic participant on or adjacent to an active roadway for the purpose of traveling from one location to another.

Further detail can be found in SAE J3216.

3.11 TEST PASSENGER (SAE J3018) [QUOTED]

A person(s) in a test vehicle during on-road testing who has no role in supervising the ADS or operating the vehicle in a fallback capacity, but who may provide test support functions.

Further detail can be found in SAE J3018.

3.12 TRAFFIC PARTICIPANT (SAE J3216) [QUOTED]

Entities whose actions influence travel in the transportation environment, which may include road users engaged in travel upon or across publicly accessible roadways and road operators.

Further detail can be found in SAE J3216.

3.13 [HUMAN] USER (SAE J3016) [QUOTED]

A general term referencing the human role in driving automation.

Further detail can be found in SAE J3016.

3.14 [HUMAN] DRIVER (SAE J3016) [QUOTED]

A user who performs in real time part or all of the DDT and/or DDT fallback for a particular vehicle.

Further detail can be found in SAE J3016.

3.15 IN-VEHICLE DRIVER (SAE J3016) [QUOTED]

A driver who manually exercises in-vehicle braking, accelerating, steering, and transmission gear selection input devices in order to operate a vehicle.

Further detail can be found in SAE J3016.