

SURFACE VEHICLE RECOMMENDED PRACTICE

J3018™

DEC2020

Issued 2015-03
Revised 2020-12

Superseding J3018 SEP2019

(R) Safety-Relevant Guidance for On-Road Testing of Prototype Automated Driving System (ADS)-Operated Vehicles

RATIONALE

This document provides safety-relevant guidance for in-vehicle fallback test driver training and for testing prototype automated driving systems (ADS) equipped on test vehicles operated in mixed-traffic environments on public roads (hereafter, prototype ADS-operated vehicles). This document is being substantially updated in order to incorporate content from Automated Vehicle Safety Consortium (AVSC) publication 00001201911: "AVSC Best Practice for In-Vehicle Fallback Test Driver Selection, Training, and Oversight Procedures for Automated Vehicles Under Test" and to re-classify this document as an SAE Recommended Practice, rather than an SAE Information Report.

It is assumed that the prototype ADS-operated vehicles that are the subject of this guidance have been developed using standardized methods for safer product development including, but not limited to:

- A systems engineering approach (i.e., V-model).
- Adherence to a recognized system safety process(es) for identifying hazards and implementing strategies for mitigating them.
- Implementation of an electrical/electronic (E/E) architecture (system/hardware/software levels) capable of implementing hazard mitigation concepts and strategies.
- Analysis and testing of identified hazard mitigation strategies (hardware and software).

Prototype ADS-operated vehicles that are based on existing production vehicles rely on the existing vehicle's E/E architecture, as adapted for ADS. Prototype ADS technology provided via added hardware and software modules that are not integrated according to the vehicle manufacturer's specifications, should be checked to ensure that they do not interfere with base vehicle hardware or software systems. As such, they should abide by the following general principles:

- All hardware and software interfaces between production- and development-level hardware and software should be analyzed and tested for operational integrity, including analysis of failure modes and effects.
- Developmental software added to a vehicle (including that equipped on added hardware modules) should be monitored and/or include self-diagnostics for safety-critical functions, which should be verified for efficacy prior to on-road testing. Alternatively, system-level approaches to ensuring developmental software safety (e.g., shadow mode testing) is also acceptable.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2020 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
http://www.sae.org

SAE WEB ADDRESS:

Full document details: SAE J3018_202012

For more information on this standard, visit
https://www.sae.org/standards/content/J3018_202012

Documents

Document Sharing Hub

Test program/operations management plays a key role in helping to maintain safety while conducting on-road testing of prototype ADS-operated vehicles. Unexpected behaviors (including incidents) should be reported accurately and consistently for later root-cause analysis and resolution. A manager in charge of prototype ADS-operated vehicle testers should explain to them the organization's specific rules about testing and documentation, as well as any hardware/software updates that impact the performance of the ADS-operated vehicles. Novice testers should be paired with more experienced testers to learn the appropriate reactions in various situations.

Real-time calibration/tuning of ADS software during testing should be allowed only after evaluation by qualified personnel (e.g., development engineer, lead calibrator, and/or designated safety engineer), indicating that the change does not pose unacceptable risk for on-road testing.

1. SCOPE

This document provides preliminary¹ safety-relevant guidance for in-vehicle fallback test driver training and for on-road testing of vehicles being operated by prototype conditional, high, and full (Levels 3 to 5) ADS, as defined by SAE J3016. It does not include guidance for evaluating the performance of post-production ADS-equipped vehicles. Moreover, this guidance only addresses testing of ADS-operated vehicles as overseen by in-vehicle fallback test drivers (IFTD).

These guidelines do not address:

- Remote driving, including remote fallback test driving of prototype ADS-operated test vehicles in driverless operation. (Note: The term "remote fallback test driver" is included as a defined term herein and is intended to be addressed in a future iteration of this document. However, at this time, too little is published or known about this type of testing to provide even preliminary guidance.)
- Testing of driver support features (i.e., Levels 1 and 2), which rely on a human driver to perform part of the dynamic driving task (DDT) and to supervise the driving automation feature's performance in real time. (Refer to SAE J3016.)
- Closed-course testing.
- Simulation testing (except for training purposes).
- Component-level testing.

These guidelines also do not address prototype vehicle and IFTD performance data collection and retention. The collection of data invokes various legal and risk management considerations that users of this document should nevertheless bear in mind, such as:

- Maintaining auditable procedures and documentation.
- Adhering to applicable privacy laws and principles.
- Ensuring adequate data collection and recording integrity to support post-crash forensic analysis.

¹ This SAE Recommended Practice incorporates recommendations based on the experience of AVSC members, as well as participating Task Force and On-Road Automated Driving System Committee members.

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

2.1.2 Other Publications

U.S. Department of Defense Technology Readiness Levels, Defense Acquisition Guidebook (2010).

Automated Vehicle Safety Consortium (AVSC) publication 00001201911: "AVSC Best Practice for In-Vehicle Fallback Test Driver Selection, Training, and Oversight Procedures for Automated Vehicles Under Test."

3. DEFINITIONS²

3.1 AUTOMATED DRIVING SYSTEM (ADS) (SAE J3016)

The hardware and software that are collectively capable of performing the entire DDT on a sustained basis, regardless of whether it is limited to a specific operational design domain (ODD); this term is used specifically to describe a Level 3, 4, or 5 driving automation system.

3.2 CONVENTIONAL DRIVER (SAE J3016)

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

NOTE: An IFTD who assumes operation of a prototype ADS-operated vehicle becomes a conventional (test) driver.

3.3 DYNAMIC DRIVING TASK (SAE J3016)

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:

- Lateral vehicle motion control via steering (operational).
- Longitudinal vehicle motion control via acceleration and deceleration (operational).
- Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical).
- Object and event response execution (operational and tactical).
- Maneuver planning (tactical).
- Enhancing conspicuity via lighting, signaling and gesturing, etc. (tactical).

² Definitions from SAE J3016 quoted herein do not include explanatory notes and illustrations provided in SAE J3016. Users of this document (SAE J3018) are encouraged to download a free copy of SAE J3016 (https://saemobilus.sae.org/content/J3016_201706/) should they require additional information or clarification.

3.4 DRIVER SUPPORT (DRIVING AUTOMATION SYSTEM) FEATURE (SAE J3016)

A general term for Level 1 and 2 driving automation system features.

NOTE: Level 1 (driver assistance) and Level 2 (partial automation) features are capable of performing only part of the DDT, and thus require a driver to perform the remainder of the DDT, as well as to supervise the feature's performance while engaged. As such, these features, when engaged, support, but do not replace, a driver in performing the DDT.

3.5 DYNAMIC DRIVING TASK (DDT) FALLBACK (SAE J3016)

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

3.6 FALLBACK TEST DRIVER

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

NOTE: Unlike a “fallback-ready user,” which is a unique term defined in SAE J3016 for Level 3 features, a fallback-test driver (FTD) is a trained automotive test driver who continuously supervises the performance of an ADS-operated prototype vehicle in real-time and intervenes whenever necessary to prevent a hazardous event by overriding the ADS to manually perform the DDT. By contrast, a fallback-ready user of a Level 3 ADS-operated vehicle is only expected to perform the fallback in response to a system-issued request to intervene, or to a kinesthetically apparent vehicle failure, and is not expected to supervise the real-time performance of the ADS or to avoid hazardous events.

3.6.1 IN-VEHICLE FALLBACK TEST DRIVER (IFTD)

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.

NOTE: An IFTD becomes a conventional (test) driver after s/he assumes performance of the complete DDT.

3.6.2 REMOTE FALLBACK TEST DRIVER (RFTD)

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.

NOTE 1: “Capable of appropriately responding,” in this context, means having the technical means to operate the vehicle from a remote location.

NOTE 2: The term “remote fallback test driver” is included as a defined term herein, and is intended to be addressed in a future iteration of this document. However, at this time, too little is published or known about this type of testing to provide even preliminary guidance

3.7 LEVEL OR CATEGORY 1 - DRIVER ASSISTANCE (SAE J3016)

The sustained and ODD-specific execution by a driving automation system of either the lateral or the longitudinal vehicle motion control subtask of the DDT (but not both simultaneously), with the expectation that the driver performs the remainder of the DDT.

3.8 LEVEL OR CATEGORY 2 - PARTIAL DRIVING AUTOMATION (SAE J3016)

The sustained and ODD-specific execution by a driving automation system of both the lateral and longitudinal vehicle motion control subtasks of the DDT, with the expectation that the driver completes the object and event detection and response (OEDR) subtask and supervises the driving automation system.