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Introduction

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 34505

Road vehicles — Test scenarios for automated driving systems — Scenario evaluation and test case generation

*Véhicules routiers — Scénarios d'essai pour les systèmes de
conduite automatisée — Évaluation de scénarios et génération
de cas de test*

ICS: 43.020

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2024-06-25

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2024-09-17

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 22, *Road Vehicles*, Subcommittee SC 33, *Vehicle dynamics and chassis components*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In recent years, the rapid development of automated driving technology with improving safety and comfort has become an important development direction of modern automobile technology, and the test evaluation of automated driving systems (ADSs) based on test scenario has become a common method of the world.

A scenario is a sequence of scenes usually including the ADS(s)/subject vehicle(s), and its/their interactions in the process of performing the dynamic driving task (DDT). A test scenario is a scenario intended for testing and assessment of ADS(s) or subject vehicle(s) in its operational environment (see ISO 34501). A test case is a set of test inputs (stimulation), steps, platform, and expected results (pass / fail criteria) developed for a particular test objective, such as to exercise a particular program path, architectural element (SW unit, ..., vehicle level) or to verify compliance with a specific requirement (test case will be defined later in this document). In order to perform the test, test case is needed to supplement some additional items to scenario, which include but not limited to test objectives, execution conditions, platforms, steps and expected results. Another important topic is how to choose the right test scenario for a particular ADS function.

The Document is the basis of generating and evaluating scenario-based test cases for ADSs. The development of appropriate international standards supports the testing and evaluation of ADSs, which will accelerate the mass production of ADSs.

This Document is used to harmonize and standardize the evaluation of scenarios and the procedure and methodology of the generation of test cases for ADSs on a global scale.

There is an initiative under consideration to accompany this Document by a further standardization project which will define/specify requirements and recommendations for scenario databases.

Road vehicles — Test scenarios for automated driving systems — Scenario evaluation and test case generation

1 Scope

This Document defines a methodology to evaluate scenarios and provides a procedure extending test scenarios to test cases for a given function in a traceable way based on the testability. This Document also defines necessary characteristics of a test case that include but are not limited to unified identifier, test objective, inputs, steps, platform and expected results.

This Document describes methods and criteria to evaluate the test case (e.g., frequency, criticality, complexity of a scenario), the coverage concerning functional and technical requirements, operational domain (OD) and test criteria, and also the optimizing of the set of prioritized test cases.

This Document is applicable to Level 3 and higher ADS as defined in ISO/SAE PAS 22736.^[1] The focus of this Document is on safety (Functional safety and Safety of the intended functionality (SOTIF)), in general the content is also applicable to non-safety relevant test scenarios.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 34501:2022, *Road vehicles — Test scenarios for automated driving systems — Vocabulary*

ISO 34502:2022, *Road vehicles — Test scenarios for automated driving systems — Scenario based safety evaluation framework*

ISO 34503:2022, *Road vehicles — Test scenarios for automated driving systems – Taxonomy for operational design domain*

ISO 34504:2022, *Test scenarios for automated driving systems – Scenario categorization*

ISO 26262-2:2018, *Road vehicles — Functional safety — Part 2: Management of functional safety*

ISO 26262-3:2018, *Road vehicles — Functional safety — Part 3: Concept phase*

ISO 21448:2022, *Road vehicles — Safety of the intended functionality*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 34501, ISO 34502, ISO 34503 and ISO 34504 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

Prospective scenario criticality

measurable criteria to reflect the number and ranking of the risk factors in the scenario

Note 1 to entry: The prospective scenario criticality describes in prospective the possible collision and its impact to the safety of the traffic participants and the passenger(s) of the ADS equipped vehicle and is based on definition 3.1 in ISO 34502.

Note 2 to entry: The measurement for the prospective scenario criticality can be a weighted sum of expected time to collision and expected relative velocity at the collision time.

Note 3 to entry: Knowledge of the ADS can be considered while estimating the criticality of the scenario, but it is not necessary to consider it as the real safety assessment of ADS is done after testing the scenario.

Note 4 to entry: Due to the different operational design domain (ODD) and DDT definition of each ADS, the prospective scenario criticality rating may be different for each ADS.

Note 5 to entry: For some ODD attributes, the scenarios at the boundary of ODD are more critical compared to the non-ODD boundary. Nevertheless, attributes inside ODD can also cause risks.

EXAMPLE A rather uncritical scenario is driving with low velocity (e.g., on traffic jam) on a highway with a leading vehicle and nominal weather conditions and standard road infrastructure (see “Nominal scenario”). A rather critical scenario is driving with an ADS at higher velocity on a multi city road having a cut in with a much lower velocity directly before the ADS. The relative velocity of the ADS and the cut in vehicle is high and thus the probability of a collision and impact is potentially high. In this example the prospective scenario criticality metric as described in Note 2 to entry can be used.

3.2

Scenario complexity

measurable criteria to reflect dimensionality factors

Note 1 to entry: Dimensionality factors are factors or condition of a scenario that, if present, increases the number of possible combinations of relevant scenario parameters that may influence the ADS driving task.

EXAMPLE 1 Scenario factors can describe the behavior of the participating road users, the defined road infrastructure and the environmental conditions.

Note 2 to entry: Factors, influencing the complexity, can be systematically classified into the following (see ISO 34502 Annex A, Annex B and Annex C):

- The complexity factor information of road e.g., road construction.
- The complexity factor information of infrastructure.
- The complexity factor information of temporary manipulations.
- The complexity factor information of objects e.g., the number and the type of dynamic traffic participants and behavior of dynamic traffic participants.
- The complexity factor information of environment e.g., various weather conditions.
- The complexity factor information of digital information.

Note 3 to entry: The complexity of a scenario can correlate with the amount of effort, that is necessary to realize the scenario because of the high number of scenario attributes to be considered.

Note 4 to entry: As far as virtual testing is concerned, a higher scenario complexity means a bigger effort to implement the higher number of scenario attributes. When the scenario is tested in real world the effort can be defined by the time or costs to realize the scenario.

EXAMPLE 2 A rather noncomplex scenario is driving on a 2-lane highway without other influencing traffic participants. A rather complex scenario is driving on a 4-lane highway with dense traffic in rainy conditions.

3.3

Scenario exposure

probability of occurrence of a scenario

Note 1 to entry: For concrete scenarios (concrete values of continuous parameters) the probability is typically not zero as the concrete scenarios represent scenarios in the area.

Note 2 to entry: It can be measured via calculating the occurrence frequency of a scenario in the real driving.

3.4

Scenario evaluation

Systematic determination of the extent to which a scenario meets a specified criterion

Note 1 to entry: Definition is based on evaluation definition of [\[3\]](#)

3.5

Test case

set of test inputs (stimulation), steps, platform and expected results (pass / fail criteria) developed for a particular test objective

Note 1 to entry: Test objectives could be used to exercise a particular program path or to verify compliance of the SUT with a specific requirement or architectural element (e.g., SW unit level or vehicle level).

Note 2 to entry: The test case includes test scenarios and considers the ODD or target operational domain (TOD). Details on TOD are defined in ISO 34503.

Note 3 to entry: [Subclause 6.4](#) describes how to extend scenarios to test cases and will define the characteristics of test cases.

Note 4 to entry: Depending on the detailed definition of a test scenario the test case can be equal to the test scenario or a superset of a test scenario. E.g., the pass / fail criteria can be included in the test scenario or can be added to the test scenario such that the test case compound by the test scenario and the pass / fail criteria.

3.6

Nominal scenario

a traffic scenario containing reasonably foreseeable situations that reflect normal condition and non-critical driving maneuvers

[SOURCE: ECE-TRANS-WP.29-2022-1426 [\[12\]](#)]

Note 1 to entry: Traffic scenario means a description of one or more real-world driving situations that may occur during a given trip.

3.7

Macroscopic evaluation

evaluation of the performance of an ADS based on a single, executed test scenario

Note 1 to entry: Details on macroscopic evaluation are state in ISO 34502 4.2.2.

3.8

Microscopic evaluation

evaluation of the performance of an ADS based on a single, executed test scenarios

3.9

ADS feature

ADS's design-specific functionality at a given level of driving automation within a particular ODD, if applicable

[SOURCE: ISO TS 5083]

3.10

diagnostics / diagnostic process

process including the detection process of possible malfunctions, the identification of the likely root cause of these malfunctions and the appraisal of its relevance for the operation of the vehicle

[SOURCE: ISO 20077-1:2017]

4 Introduction and overview

4.1 General

In [Clause 4](#) the overview is given. The traceability is a clause overarching topic which is further described in ISO 26262-2:2018. In [Clause 5](#) the inputs are defined to evaluate the scenarios. Before the scenario evaluation the test objective will be defined. In [Clause 6](#) the scenario evaluation activities that need to be performed before the test execution are described, this is done by evaluating the scenario characteristics, extending the scenarios to test cases and optimizing the set of test cases. The reduction or combination can also be done more early on test scenario level. The relations between the scenarios and other artifacts which is defined in [Clause 5](#) will be used as an input to [Clause 6](#), to evaluate whether the selected scenarios are appropriate for the tested ADS feature. The investigations to analyze the test cases concerning initialization of the test run and monitoring during test execution is described in [Clause 7](#). After test execution the comparison of the initial specified and the resulting test case, the evaluation of the resulting test case concerning physical principle and probability in reality can be found in [Clause 8](#). A detailed workflow of this document can be found in [Figure 1](#).

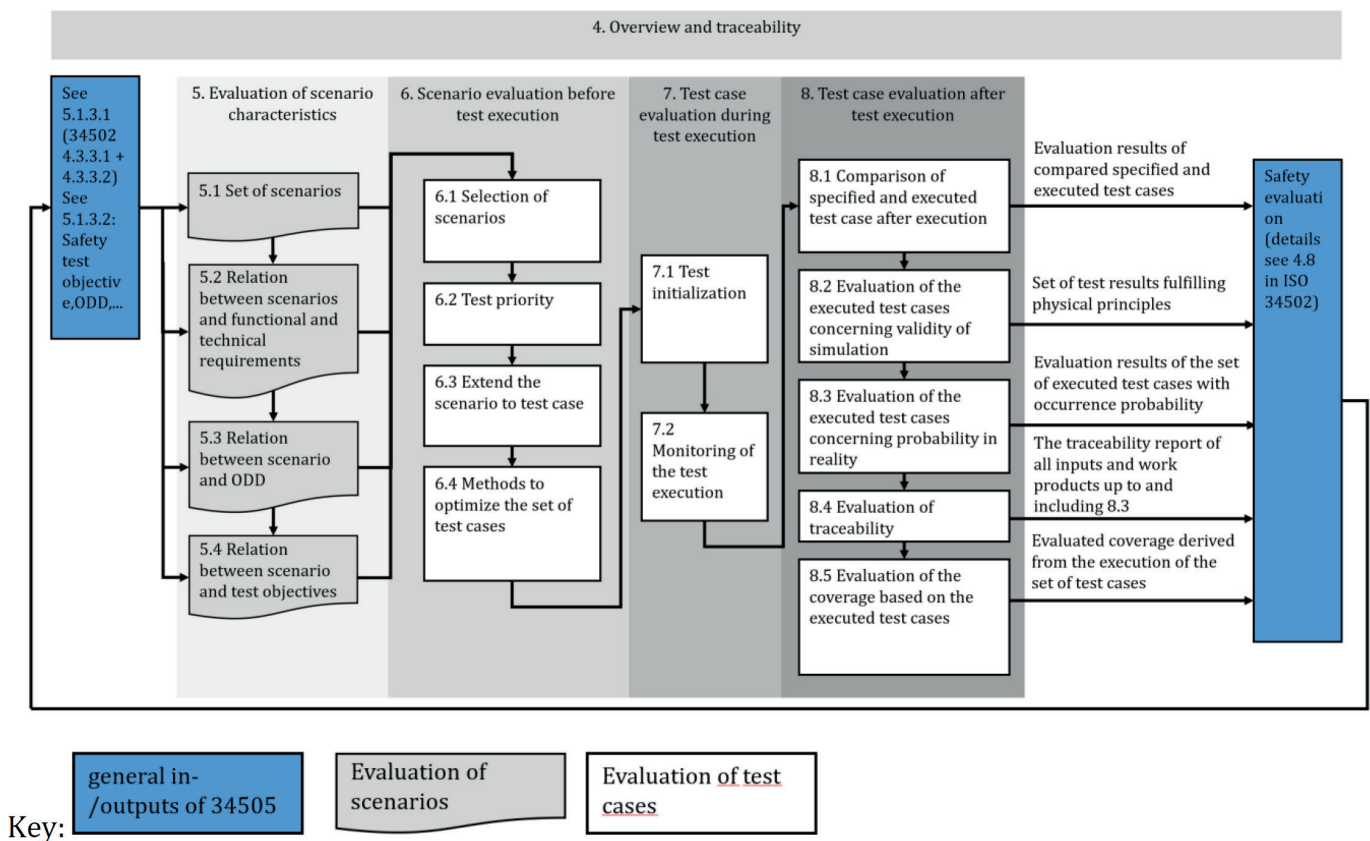


Figure 1 — ISO 34505 flow

4.2 Requirements for compliance

When claiming compliance with this document, each requirement shall be met unless a rationale is provided, demonstrating that the non-compliance is deemed acceptable, i.e., the corresponding objectives are still achieved.

5 Evaluation of scenario characteristics

5.1 Purpose

In this clause the inputs and their connection to the scenario evaluation is described. The scenario characteristics include scenarios and their relation to other artifacts, like ODD or requirements. The relation of scenarios to functional requirements, technical requirements, ODD or test objectives can be direct or indirect (e.g., the functional requirement is linked to ODD, and the scenario is linked to the functional requirement. Then the scenario is indirect linked to the ODD). In this clause the inputs (from ISO 34502 and ISO 21448:2022) are detailed with focus of scenario evaluation.

The scenarios can include but not limited to misuse and triggering conditions.

5.2 Set of scenarios

5.2.1 Objectives

Scenario-based verification and validation methods include an adequate representation or coverage of relevant scenarios to effectively verify and validate an ADS. The objective of [5.2](#) is to define and specify the set of scenarios that are required during scenario-based verification and validation.

For detailed descriptions of set of scenarios see ISO 34502; 4.4.

5.2.2 General

ISO 34502 describes a scenario-based approach for limited access highways how to get the set of scenarios (multiple scenario abstraction levels possible) for safety test objectives and related safety requirements. This set of scenarios can be extended to reflect the non-safety test objectives. When scenario in general is used in this Document it could be a functional, abstract, logical or concrete scenario.

In case there is a general, pre-existing scenario set (e.g., a scenario database), the scenarios are analyzed whether they fit to the defined ADS, ODD, and whether they are relevant concerning the safety concept and the specified requirements.

5.2.3 Input to this clause

5.2.3.1 Prerequisites

Based on the procedure in ISO 34502 the scenarios shall be specified to be realizable and in accordance with the physical principles.

The following information shall be available (see ISO 34502; 4.3.3.1 and 4.3.3.2):

- i. safety test objectives in accordance with ISO 34502; 4.2;
- ii. item definition in accordance with ISO 26262-3:2018, Clause 5;
- iii. specification of the functionality in accordance with ISO 21448:2022 (e.g., functional requirements);
- iv. capabilities of the ADS (e.g., according to [\[3\]](#) Annex F);
- v. description of ODD;