IVISTA

China Intelligent Vehicle Index

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Intelligent Cruise Index
Navigation Pilot System Test Protocol
(Highway)

(Version 2023)

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Navigation Pilot System (Highway) Test Protocol

1 Scope

This document specifies the test methods for IVISTA China Intelligent Vehicle Index - Intelligent Cruise Index - Navigation Pilot System (Highway).

2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute indispensable provisions of this document. For dated references, only the dated edition applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB 1589-2016 Limits of Dimensions, Axle Load and Masses for Motor Vehicles, Trailers and Combination Vehicles

GB 5768.2-2022 Road Traffic Signs and Markings - Part 2: Road Traffic Signs

GB 5768.3-2009 Road Traffic Signs and Markings - Part 3: Road Traffic Markings

GB 5768.4-2017 Road Traffic Signs and Markings - Part 4: Work Zone

GB 5768.5-2017 Road Traffic Signs and Markings - Part 5: Speed Limit

GB/T 20608-2006 Intelligent Transportation Systems - Adaptive Cruise Control Systems - Performance Requirements and Test Procedures

GB/T 24720-2009 Traffic Cones

GB/T 40429-2021 Taxonomy of Driving Automation for Vehicles

JTG H30-2015 Safety Work Rules for Highway Maintenance (Industry Standard of the People's Republic of China)

ISO 21448 Road Vehicles - Safety of the Intended Functionality

ISO 34502 Road Vehicles - Engineering Framework and Process of Scenario-based Safety Evaluation

ECE R157 Uniform provisions concerning the approval of vehicles with regards to Automated Lane Keeping System

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1

inertial frame

the inertial frame specified in ISO 8855:2011, in which the X axis points towards the front of the vehicle, the Y axis towards the left side of the driver and the Z axis upwards (right-hand coordinate system)

Viewed from the origin to the positive directions of X, Y and Z axes, the roll, pitch and yaw rotate clockwise around the X, Y and Z axes respectively. This frame is used for both left-hand and right-hand drive VUTs.

3.2

navigation pilot; NP

a type of intelligent driving system that supports navigation map and/or high-precision map and can realize point-to-point traffic in such areas as trunk roads, ramps and intersections within highways, expressways and urban roads

3.3

subject vehicle; SV

specifically, the vehicle to be tested with a navigation pilot system (highway)

3.4

time to collision; TTC

time obtained by dividing the distance between the VUT and the target by the instantaneous relative speed between the VUT and the target

3.5

operational design domain; ODD

external environmental conditions suitable for the functional operation of the driving automation system as determined during system design

Note: Typical external environmental conditions include roads, traffic, weather and lighting.

[Source: GB/T 40429-2021, 2.11]

3.6

operational design condition; ODC

a generic term for various conditions suitable for the functional operation of the driving automation system as determined during system design, including ODD, vehicle status, driver status and other necessary conditions

[Source: GB/T 40429-2021, 2.12]

4 Test Requirements

4.1 Proving ground and test environment

4.1.1 Requirements for proving ground

For closed field test, the proving ground shall meet the following conditions:

a) The test road surface shall be dry without visible moisture;

b) The peak adhesion coefficient of the test road surface shall be greater than 0.8;

c) The test road shall be flat without apparent pits, cracks and other defects, with a horizontal flatness of less than 1% and a length of 500 m at least;

d) A single test lane shall be 3.75 m wide, and lane boundary lines shall be white or yellow solid or dotted lines;

e) The test road for the curve test shall consist of a straight section and a curved section whose length shall ensure that the vehicle can run for at least 5 s. The curved section shall consist of two parts: the constant curvature part and the variable curvature part. The curvature of the constant curvature part is given in Table 1. The variable curvature part connects the straight section and the constant curvature part, and its curvature shows a linear change along with the length of the curved section, gradually increasing from 0 to C, and with the curvature change rate (dc/ds) not

exceeding 4×10^{-5} m^{-2}, as shown in Fig. 1.

Table 1 Relation between Curve Radius and Curvature

Curve Radius R/m	500
Curvature C/m^{-1}	0.002

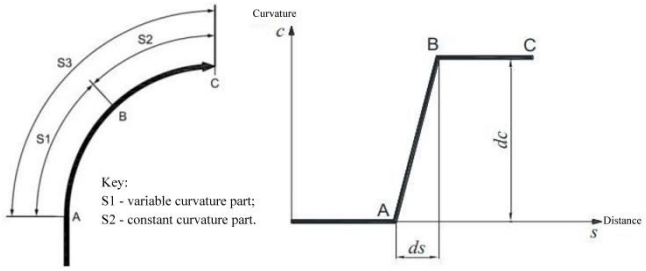


Fig. 1 Schematic Diagram of Curvature at the Curve

4.1.2 Requirements for test environment

The closed field test and the open road test shall be conducted in good weather and in a normal lighting environment.

Note: The daytime period refers to the interval between sunrise time and sunset time, both of which shall be subject to the information released by the local meteorologic bureau.

4.2 Test equipment

4.2.1 Target object

4.3.1.1 Flexible target and traffic cone

a) The TV shall be a mass-produced M1 passenger car, or a flexible target object that has surface characteristic parameters representative of M1 passenger cars and can adapt to the sensor system. For specific requirements, see ISO 19206-3.

b) The technical parameters of the traffic cone target object shall meet the requirements of GB/T 24720-2009 and GB 5768.4-2017, with a recommended size of 90 cm * 45 cm.

Fig. 2 Appearance of Passenger Car and Traffic Cone Target Objects

c) The highway anti-collision buffer vehicle TV shall be a mass-produced anti-collision buffer vehicle, or a flexible target object that has surface characteristic parameters representative of anti-collision buffer vehicles and can adapt to the sensor system. Its overall dimensions and technical parameters shall meet the requirements of GB 1589-2016, and its main dimensional requirements are shown in Table 2.

Fig. 3 Appearance of Anti-collision Buffer Vehicle Target Object

Table 2 Main Dimensions of Flexible Target Object of Anti-collision Buffer Vehicle

Dimensions	Value (mm)
Total vehicle length	7000±50
Total vehicle width	2050±50
Total vehicle height	2850±50
Wheelbase	3850±50
Length of anti-collision cushion	1000±20
Width of anti-collision cushion	2050±50
Height of anti-collision cushion	1000±20

Note 1: For flexible targets, after relevant national standards are published, the requirements of those national standards will prevail.

Note 2: If the enterprise considers the target object non-conforming to the requirements of the SV's sensor for the target, please contact the IVISTA Management Center.

4.3.1.2 Real vehicle target object

In the passenger car TV cut-out scenario for vehicle safety test, TV1 is a real vehicle target object (M1 passenger car), with a body length range of 475 cm to 500 cm and a width range of 178 cm to 193 cm at the widest part of the body. There is no limitation on vehicle color.

4.2.2 Data acquisition equipment

a) The closed field test equipment shall meet the following requirements:

- The sampling and storage frequency of dynamic data shall not be less than 100 Hz, and DGPS time shall be used for data synchronization between the SV and the target object;
- The speed accuracy of the SV and the target object shall not be more than 0.1 km/h;
- The longitudinal deceleration accuracy of the SV and the target object shall not be greater than 0.1 m/s^2;
- The lateral and longitudinal position accuracy of the SV and the target object shall not be greater than 0.03 m;
- The installation and operation of the test equipment shall not affect the normal operation of the VUT and its navigation pilot system (highway).

b) The open road test equipment shall meet the following requirements:

- The sampling and storage frequency of dynamic data shall not be less than 50 Hz;
- The resolution of video acquisition equipment shall not be less than (1920*1080) pixels, and the video sampling frame rate shall not be less than 30 fps;

- The speed acquisition accuracy of the SV shall not be more than 0.1 km/h;
- The acceleration acquisition accuracy of the SV shall not be more than 0.1 m/s^2;
- The acquisition accuracy of lateral and longitudinal offset between the SV and the surrounding vehicles shall not be more than 0.1 m;
- The installation and operation of the test equipment shall not affect the normal operation of the VUT and its navigation pilot system (highway).

4.3 Vehicle preparation

4.3.1 VUT

The requirements for the VUT are as follows:

a) The VUT shall be new with a travelled mileage of not more than 5000 km;

b) The VUT shall meet the following HMI requirements:

- Its operation mode shall be convenient for manual activation and deactivation of the navigation pilot system (highway);
- The system status prompt information shall be clearly visible.

c) The mass of the VUT shall lie between the complete vehicle curb mass plus the total mass of the driver and the test equipment and the maximum allowable total mass. No change shall be made to the load status of the VUT after the test starts.

4.3.2 System initialization

The requirements for system initialization are as follows:

a) If necessary, the navigation pilot system (highway) may be initialized prior to the test, including the calibration of sensors such as radars and cameras;

b) Before the start of the test, the VUT's manufacturer may include the test road information of the proving ground in its product map or is allowed to change the activation conditions of the navigation pilot system (highway), but in either case, it is necessary to prove that the way adopted will not change the safety of the navigation pilot system (highway) of the VUT.

4.3.3 Vehicle status confirmation

The requirements for vehicle status confirmation are as follows:

a) The VUT shall be equipped with original new tires designated by the vehicle manufacturer. The tire pressure shall be the standard cold tire pressure recommended by the vehicle manufacturer. If more than one value is recommended for tire pressure, the tire shall be inflated to the pressure with the lightest load;

b) The VUT shall be refueled to not less than 90% of the fuel tank capacity, with other fluids such as oil and water (e.g. coolant, brake fluid and engine oil) added at least to the minimum indicated position. During the closed field test, the fuel shall not be lower than 50% of the fuel tank capacity;

c) The active hood system of the VUT, if equipped, shall be disabled before the test equipment is installed in the closed field test;

d) The mass of the VUT shall lie between the complete vehicle curb mass plus the total mass of the driver and the test equipment (with the total mass of the driver and the test equipment not exceeding 200 kg) and the maximum allowable total mass. No change shall be made to the status of the VUT after the test starts.

e) For off-vehicle-chargeable new energy vehicles, the traction battery shall be fully charged according to 5.1 of GB/T 18385-2005. For non-off-vehicle-chargeable new energy vehicles, the test shall be prepared in their normal operation states. During the closed field test, the power of the vehicle shall not be less than 50% SOC.

4.3.4 Functional check

Before the test, it shall be checked whether the navigation pilot system (highway) functions, buttons, instruments and on-board central control screen of the VUT work properly.

4.3.5 Function settings

The requirements or function settings are as follows:

a) During the closed field test, the vehicle-following time gap of the NP function (highway) of the VUT shall be set to the lowest level;

b) During the open road test, the vehicle-following time gap of the NP function (highway) of the VUT shall be set to the middle level; if the number of time gap levels is even, the vehicle-following time gap of the NP function (highway) of the VUT shall be set to the level that is one level higher than the middle level, as shown in Fig. 4;

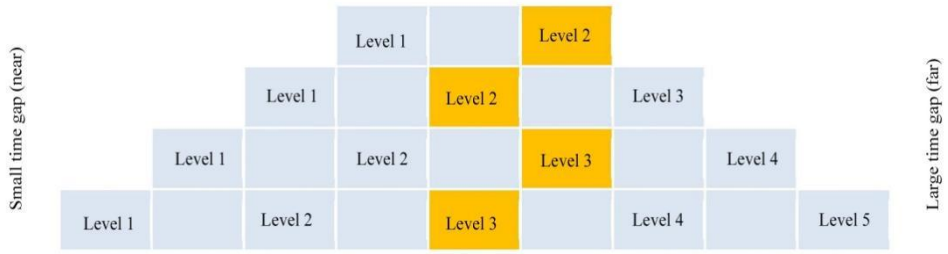


Fig. 4 Schematic Diagram of Time Gap Level Setting

c) If the VUT is provided with multiple driving modes, unless otherwise specified, it shall be set to the standard mode throughout the test;

d) If the VUT has a lane change aggressiveness setting that is adjustable, unless otherwise specified, the lane change aggressiveness shall be set to the standard mode throughout the test. If the VUT does not have a lane change aggressiveness setting or the setting cannot be adjusted, the lane change aggressiveness shall be set to the default mode of the VUT throughout the test;

e) If the AEB, FCW, LDW and LDP functions of the VUT are settable, they shall be set to the lowest level during the closed field test;

f) If the AEB, FCW, LDW and LDP functions of the VUT are settable, they shall be set to the middle level during the open road test; if the number of levels is even, they shall be set to the middle earlier level, as shown in Fig. 5.

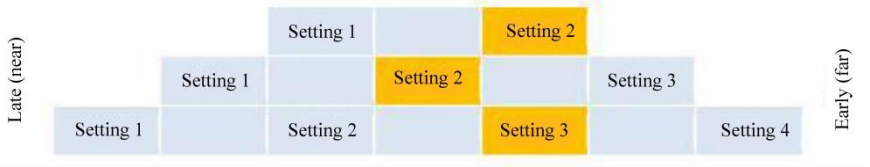


Fig. 5 Schematic Diagram of Alarm Levels

4.4 Test records

The requirements for test records are as follows:

a) The record of the closed field test process shall contain the following:

- software and hardware version information of the SV navigation pilot system (highway);
- SV control mode;
- position information of the SV's geometric center or center of mass;
- longitudinal and lateral speeds of the SV;
- longitudinal and lateral acceleration of the SV;
- in-vehicle conditions reflecting the driver and HMI status;
- video information reflecting the SV's running status;
- position and motion data of the target object.

b) The record of the open road test process shall contain the following:

- SV control mode;
- video information on traffic conditions outside the SV;
- information on lateral and longitudinal offset between the SV and the surrounding vehicles;
- video and audio information on driver interaction status inside the SV;
- information on SV movement status.

4.5 Test photos

The requirements for test photos are as follows:

a) Before the test equipment is installed, photos shall be taken of the VUT at front left 45° and of the vehicle nameplate;

b) After the test equipment is installed, photos shall be taken of the test equipment inside and outside the VUT.

5 Test Methods

5.1 Overview

Navigation pilot system (highway) tests include closed field test, open road test and simulation test.

5.2 Closed field test

5.2.1 Provided that the test is valid, the closed field test shall be conducted once under each test condition.

5.2.2 In all test scenarios regarding the closed field, unless otherwise specified, the settings shall not be changed and the driver shall neither operate the accelerator and brake pedals nor perform manual assisted steering. The driver shall place both hands on the steering wheel or apply certain torque in due course, so as to avoid the disabling of HNP system during the test.

5.2.3 The closed field test shall be carried out in each test scenario according to the declared score of SV speed provided by the VUT's manufacturer (hereinafter referred to as "enterprise's declared score").

5.2.4 In the closed field test, the test conditions for passing score, enterprise's declared score and excellence score are as follows:

a) Test condition for passing score: the condition for testing the SV at 60 km/h in each

test scenario;

b) Test condition for enterprise's declared score: the condition for testing the SV at the speed declared by the enterprise in each test scenario;

c) Test condition for excellence score: the condition for testing the SV at 120 km/h in each test scenario.

5.2.5 If the VUT's manufacturer provides an enterprise's declared score, the closed field test includes the following 3 cases, as shown in Fig. 6:

a) In case of vehicle speed corresponding to the enterprise's declared score ≤ that corresponding to the passing score (60 km/h), the test shall be conducted in the corresponding closed field scenario as per the test condition for passing score;

b) In case of vehicle speed corresponding to the passing score (60 km/h) < that corresponding to the enterprise's declared score < that corresponding to the excellence score (120 km/h), the test shall be conducted in the corresponding closed field scenario as per the test condition for enterprise's declared score. If the SV fails to pass the test condition for enterprise's declared score, the test shall be conducted in the corresponding scenario again as per the test condition for passing score;

c) In case of vehicle speed corresponding to the enterprise's declared score ≥ that corresponding to the excellence score (120 km/h), the test shall be conducted in the corresponding closed field scenario as per the test condition for excellence score. If the SV fails to pass the test condition for excellence score, the test shall be conducted in the corresponding scenario again as per the test condition for passing score.

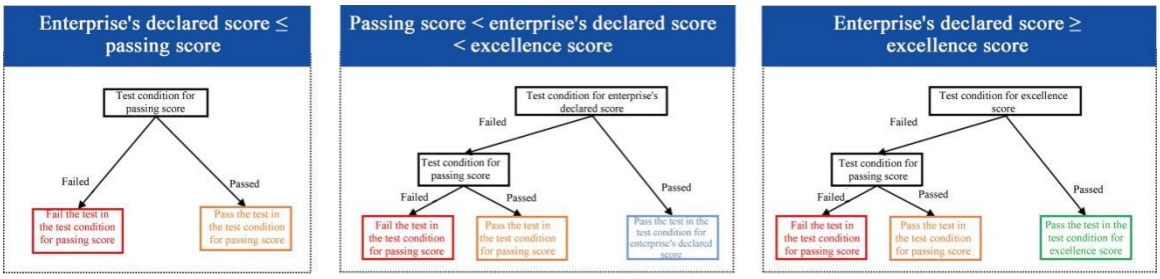


Fig. 6 Three Cases of Closed Field Test

5.2.6 If the VUT's manufacturer does not provide an enterprise's declared score, a test shall be conducted in the corresponding scenario as per the test condition for passing score.

5.2.7 See Annex A for detailed rules for closed field test.

5.3 Open road test

5.3.1 The open road test is a test conducted in the specified test scenario and test condition on the specified test route, where the SV runs with its HNP function activated. If the parameters of the SV and surrounding vehicles are within the specified range for valid test and no traffic accident happens, it is considered that the corresponding test condition is completed once. Each test condition is required to be completed at least 3 times.

5.3.2 See Annex B for detailed rules for open road test.

5.3.3 The open road test includes the following 2 routes:

a) Route I: intra-city highway, with its route of CAERI - Lijia Interchange - G75 Lanzhou-Haikou Expressway (starting point) - North Ring Interchange - G50 Shanghai-Chongqing Expressway - East Ring Interchange - Yudu Avenue (not tested) - Renhe Interchange - G50 Shanghai-Chongqing Expressway - North Ring

Interchange - G75 Lanzhou-Haikou Expressway - Lijia Interchange (ending point) - CAERI, with a total distance of about 34 km, as shown in Fig. 7.

Fig. 7 Test Route I

b) Route II: inter-city highway, with its route of G5013 Science City Toll Station (starting point) - Wangu Interchange - G8515 Longshui Lake Toll Station - Wangu Interchange - G5013 Dazu East Toll Station - Wangu Interchange - G8515 Yongxi Toll Station - Wangu Interchange - G5013 Science City Toll Station (ending point), with a total distance of about 160 km, as shown in Fig. 8.

Fig. 8 Test Route II

5.4 Simulation test

5.4.1 The simulation test includes two parts: basic scenario test and scenario generalization test. The basic scenario test is to verify the consistency between the simulation test results and the closed field test results, and the test scenario and condition are the same as those of the closed field test. The scenario generalization test is a high-coverage, dangerous edge test on the VUT based on the closed field test.

5.4.2 This test protocol does not specify the simulation test mode. The test may be conducted in hardware-in-the-loop (HIL) test mode, software-in-the-loop (SIL) test mode, model-in-the-loop (MIL) test mode, vehicle-in-the-loop (VIL) test mode or cloud simulation mode.

5.4.3 The simulation test may be conducted by the following 3 methods:

a) Witness test: The VUT's manufacturer or its supplier shall carry out the simulation test by itself, and the qualified official witnesses of IVISTA China Intelligent Vehicle Index shall review the test report and the simulation tools or relevant supporting materials used in the test;

b) On-site test: The qualified official testers of IVISTA China Intelligent Vehicle Index shall go to the VUT's manufacturer or its supplier to review the simulation tools of the VUT's manufacturer or its supplier, and use them to carry out the simulation test;

c) Third-party test: The simulation test shall be carried out by a qualified third-party organization.

5.4.4 See Annex C for detailed rules for simulation test.

Annex A

Detailed Rules for Closed Field Test

A.1 Stationary passenger car ahead

A.1.1 Scenario description

The SV cruises in a straight lane at the specified set speed and gradually approaches the stationary passenger car TV that stops ahead in the same lane after its speed becomes stable, as shown in Fig. A.1.

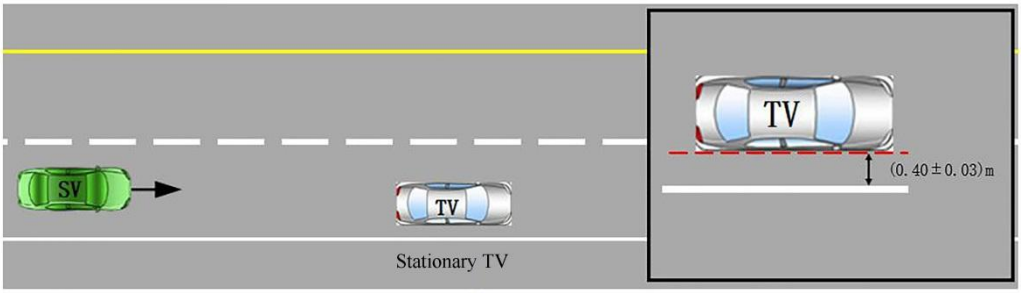


Fig. A.1 Schematic Diagram of Stationary Passenger Car Ahead Scenario

A.1.2 Test method

a) The TV is placed stationary ahead in the SV's lane according to Fig. A.1;

b) The set speed of the SV is set according to the rules in 5.2.5 and 5.2.6. The summary of test conditions is shown in Table A.1;

c) The SV activates its HNP function, cruises in the straight lane at the set speed V_{SV} (i.e., the GPS speed) in b), and gradually approaches the TV ahead after its speed becomes stable.

Table A.1 Test Conditions

Type	Set Speed of SV, V_{SV} (km/h)
Test condition for passing score	60
Test condition for enterprise's declared score	65
	70
	75
	80
	85
	90
	95
	100
	105
	110
	115
Test condition for excellence score	120

Note: This table is applicable to the following scenarios in the closed field test: stationary passenger car ahead, stationary passenger car ahead - TV being skewed, stationary passenger car ahead (on a curve), traffic cone avoidance, and stationary anti-collision buffer vehicle ahead.

A.1.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV does not collide with the TV, and the SV brakes to 0 km/h or avoids the TV through system steering;

b) The SV collides with the TV;

c) When TTC = 2.0 s between the SV and the TV, the SV does not brake, and the driver actively deviates out of the lane to avoid collision.

A.1.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) Recording of valid data begins when the clearance between the SV and the TV is 250 m.

A.2 Stationary passenger car ahead - TV being skewed

A.2.1 Scenario description

The SV cruises in a straight lane at the specified set speed and gradually approaches the stationary passenger car TV that stops ahead in the same lane after its speed becomes stable, as shown in Fig. A.2.

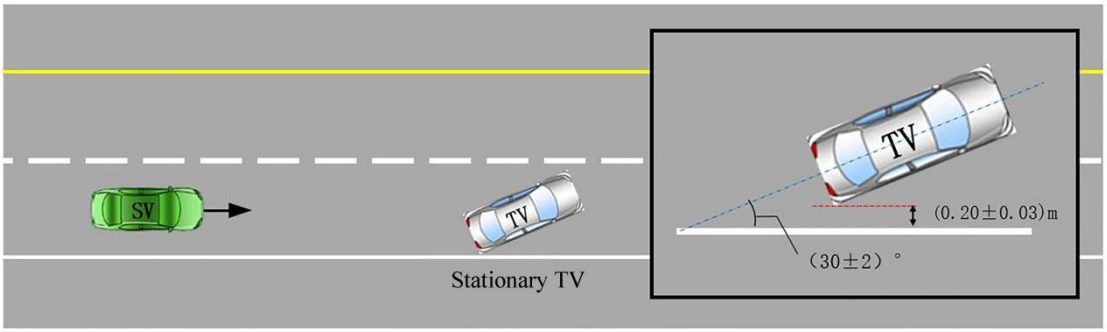


Fig. A.2 Schematic Diagram of Stationary Passenger Car Ahead - TV Being Skewed Scenario

A.2.2 Test implementation method

a) The TV is placed stationary ahead in the SV's lane according to Fig. A.2;

b) The set speed of the SV is set according to the rules in 5.2.5 and 5.2.6. The summary of test conditions is shown in Table A.1;

c) The SV activates its HNP function, cruises in the straight lane at the set speed V_{SV} (i.e., the GPS speed) in b), and gradually approaches the TV ahead after its speed becomes stable.

A.2.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV does not collide with the TV, and the SV brakes to 0 km/h or avoids the TV through system steering;

b) The SV collides with the TV;

c) When TTC = 2.0 s between the SV and the TV, the SV does not brake, and the driver actively deviates out of the lane to avoid collision.

A.2.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) Recording of valid data begins when the clearance between the SV and the TV is

250 m.

A.3 Stationary passenger car ahead (on a curve)

A.3.1 Scenario description

The SV runs into a curve from a straight lane at the specified set speed and gradually approaches the stationary TV in the same lane on the curve ahead after reaching the set speed in the straight lane, as shown in Fig. A.3.

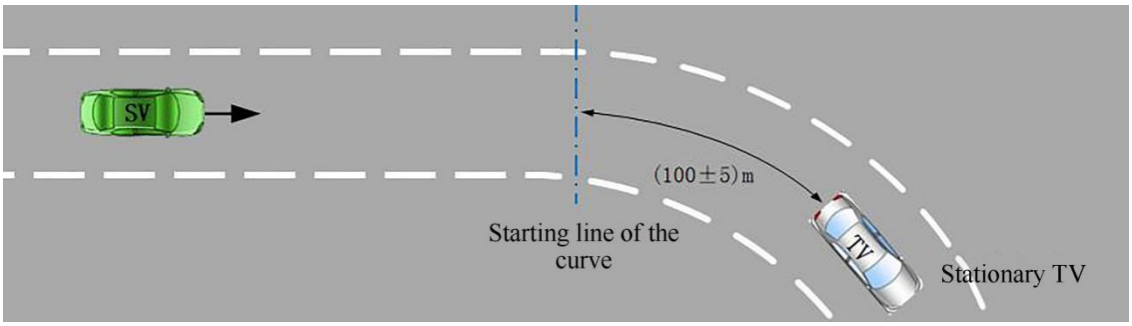


Fig. A.3 Schematic Diagram of Stationary Passenger Car Ahead (on a Curve) Scenario

A.3.2 Test implementation method

a) The TV is placed stationary in the middle of the SV's lane according to Fig. A.3, and the curve has a radius of 500 m;

b) The set speed of the SV is set according to the rules in 5.2.5 and 5.2.6. The summary of test conditions is shown in Table A.1;

c) The SV activates its HNP function, runs into the curve from the straight lane at the set speed V_{SV} (i.e., the GPS speed) in b), and gradually approaches the target object.

A.3.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV does not collide with the TV, and the SV brakes to 0 km/h or avoids the TV through system steering;

b) The SV collides with the TV;

c) When TTC = 2.0 s between the SV and the TV, the SV does not brake, and the driver actively deviates out of the lane to avoid collision.

A.3.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) Recording of valid data begins when the clearance between the SV and the starting line of the curve is 250 m.

A.4 Passenger car TV cut-in

A.4.1 Scenario description

The SV cruises in a straight lane at the specified set speed, and the passenger car TV runs in the adjacent lane at a speed lower than that of the SV. When the SV approaches the TV after its speed becomes stable, the TV suddenly cuts in ahead of the SV from the adjacent lane, as shown in Fig. A.4.

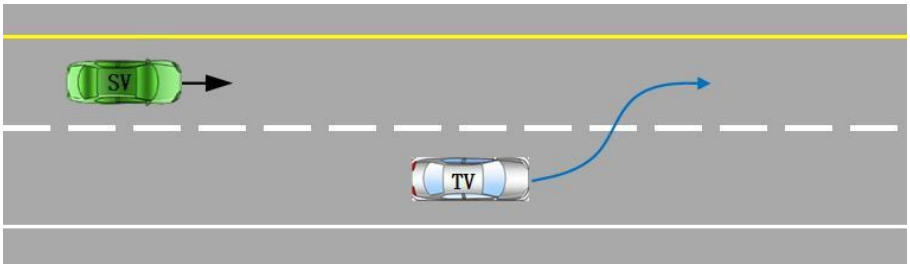


Fig. A.4 Schematic Diagram of Passenger Car TV Cut-in Scenario

A.4.2 Test implementation method

a) The set speed of the SV is set according to the rules in 5.2.5 and 5.2.6. The summary of test conditions is shown in Table A.2;

b) The SV activates its HNP function and cruises stably in the straight lane at the speed V_{SV} (i.e., the GPS speed) set in a). The TV runs at a constant speed of V_{TV} (i.e., the GPS speed) in the adjacent lane. When the TV is at the given test distance ahead of the SV, it cuts into the SV's running lane along the lane change trajectory (the given test distance shall meet this requirement: TTC = 2.0 s between the SV and the TV at the triggering time when the lateral offset of the TV reaches 0.375 m), as shown in Fig. A.5;

c) The TV cut-in trajectory consists of 6 curved sections and 1 straight section, as shown in Fig. A.5 and Table A.2.

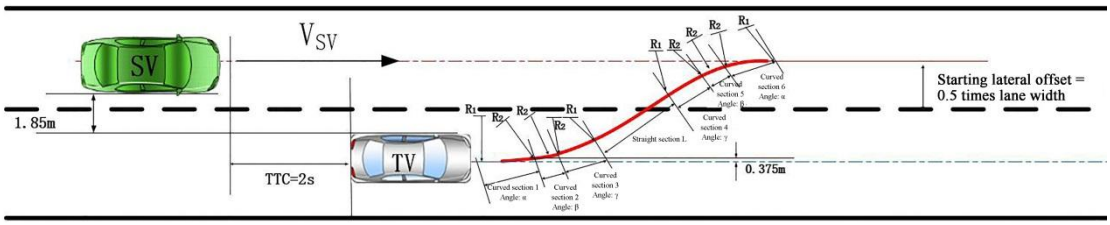


Fig. A.5 Schematic Diagram of Passenger Car TV Cut-in Trajectory

A.4.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV decelerates to avoid collision and follows the TV;

b) The SV collides with the TV.

A.4.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The speed error of the TV shall not exceed ±1 km/h;

b) The error between the actual longitudinal offset between the SV and the TV and the value specified in Table A.2 shall not exceed 5% at the moment when the TV starts to cut in;

c) When the TV runs stably in the adjacent lane of the SV, the lateral deviation between its running trajectory and the centerline of the lane line shall not exceed ±0.1 m;

d) After the TV cuts into the main lane and runs stably, the lateral deviation between its running trajectory and the centerline of the lane line shall not exceed ±0.1 m.

Table A.2 Parameters of Passenger Car TV Cut-in Trajectory

S/N	Set Speed of SV, V_{SV} (km/h)	Speed of TV, V_{TV} (km/h)	Curved Section 1			Curved Section 2		Curved Section 3			Straight Section L	Curved Section 4			Curved Section 5		Curved Section 6		
			Starting Radius R1 (m)	Ending Radius R2 (m)	Angle α (°)	Arc Section Radius R2 (m)	Angle β (°)	Starting Radius R2 (m)	Ending Radius R1 (m)	Angle γ (°)	Straight Section Length L (m)	Starting Radius R1 (m)	Ending Radius R2 (m)	Angle γ (°)	Arc Section Radius R2 (m)	Angle β (°)	Starting Radius R2 (m)	Ending Radius R1 (m)	Angle α (°)
1	60	15	1500	15	4.00	15	10.00	15	1500	4.00	5.2	1500	15	4.00	15	10.00	15	1500	4.00
2	60	35	1500	80	2.20	80	4.50	80	1500	2.20	7.2	1500	80	2.20	80	4.50	80	1500	2.20
3	60	50	1500	200	1.20	200	3.60	200	1500	1.20	8.8	1500	200	1.20	200	3.60	200	1500	1.20
4	65	20	1500	30	3.60	30	6.50	30	1500	3.60	5.4	1500	30	3.60	30	6.50	30	1500	3.60
5	65	40	1500	120	1.75	120	4.00	120	1500	1.75	7.2	1500	120	1.75	120	4.00	120	1500	1.75
6	65	55	1500	250	1.00	250	3.00	250	1500	1.00	15.6	1500	250	1.00	250	3.00	250	1500	1.00
7	70	15	1500	15	4.00	15	10.00	15	1500	4.00	5.2	1500	15	4.00	15	10.00	15	1500	4.00
8	70	30	1500	60	2.50	60	5.00	60	1500	2.50	6.6	1500	60	2.50	60	5.00	60	1500	2.50
9	70	45	1500	150	1.50	150	3.80	150	1500	1.50	8.6	1500	150	1.50	150	3.80	150	1500	1.50
10	70	60	1500	280	0.80	280	3.20	280	1500	0.80	16.4	1500	280	0.80	280	3.20	280	1500	0.90
11	75	20	1500	30	3.60	30	6.50	30	1500	3.60	5.4	1500	30	3.60	30	6.50	30	1500	3.60
12	75	35	1500	80	2.20	80	4.50	80	1500	2.20	7.2	1500	80	2.20	80	4.50	80	1500	2.20
13	75	50	1500	200	1.20	200	3.60	200	1500	1.20	8.8	1500	200	1.20	200	3.60	200	1500	1.20
14	75	65	1500	300	0.70	300	3.00	300	1500	0.70	20.0	1500	300	0.70	300	3.00	300	1500	0.70
15	80	20	1500	30	3.60	30	6.50	30	1500	3.60	5.4	1500	30	3.60	30	6.50	30	1500	3.60
16	80	40	1500	120	1.75	120	4.00	120	1500	1.75	7.2	1500	120	1.75	120	4.00	120	1500	1.75
17	80	60	1500	280	0.80	280	3.20	280	1500	0.80	16.4	1500	280	0.80	280	3.20	280	1500	0.90
18	85	25	1500	40	3.00	40	6.00	40	1500	3.00	6.0	1500	40	3.00	40	6.00	40	1500	3.00
19	85	45	1500	150	1.50	150	3.80	150	1500	1.50	8.6	1500	150	1.50	150	3.80	150	1500	1.50
20	85	65	1500	300	0.70	300	3.00	300	1500	0.70	20.0	1500	300	0.70	300	3.00	300	1500	0.70
21	90	30	1500	60	2.50	60	5.00	60	1500	2.50	6.6	1500	60	2.50	60	5.00	60	1500	2.50
22	90	40	1500	120	1.75	120	4.00	120	1500	1.75	7.2	1500	120	1.75	120	4.00	120	1500	1.75

23	90	60	1500	280	0.80	280	3.20	280	1500	0.80	16.4	1500	280	0.80	280	3.20	280	1500	0.90
24	95	35	1500	80	2.20	80	4.50	80	1500	2.20	7.2	1500	80	2.20	80	4.50	80	1500	2.20
25	95	45	1500	150	1.50	150	3.80	150	1500	1.50	8.6	1500	150	1.50	150	3.80	150	1500	1.50
26	95	65	1500	300	0.70	300	3.00	300	1500	0.70	20.0	1500	300	0.70	300	3.00	300	1500	0.70
27	100	40	1500	120	1.75	120	4.00	120	1500	1.75	7.2	1500	120	1.75	120	4.00	120	1500	1.75
28	100	55	1500	250	1.00	250	3.00	250	1500	1.00	15.6	1500	250	1.00	250	3.00	250	1500	1.00
29	100	65	1500	300	0.70	300	3.00	300	1500	0.70	20.0	1500	300	0.70	300	3.00	300	1500	0.70
30	105	45	1500	150	1.50	150	3.80	150	1500	1.50	8.6	1500	150	1.50	150	3.80	150	1500	1.50
31	105	60	1500	280	0.80	280	3.20	280	1500	0.80	16.4	1500	280	0.80	280	3.20	280	1500	0.90
32	105	65	1500	300	0.70	300	3.00	300	1500	0.70	20.0	1500	300	0.70	300	3.00	300	1500	0.70
33	110	50	1500	200	1.20	200	3.60	200	1500	1.20	8.8	1500	200	1.20	200	3.60	200	1500	1.20
34	110	55	1500	250	1.00	250	3.00	250	1500	1.00	15.6	1500	250	1.00	250	3.00	250	1500	1.00
35	110	60	1500	280	0.80	280	3.20	280	1500	0.80	16.4	1500	280	0.80	280	3.20	280	1500	0.90
36	115	55	1500	250	1.00	250	3.00	250	1500	1.00	15.6	1500	250	1.00	250	3.00	250	1500	1.00
37	115	60	1500	280	0.80	280	3.20	280	1500	0.80	16.4	1500	280	0.80	280	3.20	280	1500	0.90
38	115	65	1500	300	0.70	300	3.00	300	1500	0.70	20.0	1500	300	0.70	300	3.00	300	1500	0.70
39	120	60	1500	280	0.80	280	3.20	280	1500	0.80	16.4	1500	280	0.80	280	3.20	280	1500	0.90

A.5 Passenger car TV cut-out

A.5.1 Scenario description

The SV follows TV1 stably in a straight lane at the specified set speed, and TV2 remains stationary in the middle of the same lane ahead of TV1. When TV1 approaches TV2, TV1 suddenly cuts out from its lane to the adjacent lane, as shown in Fig. A.6.

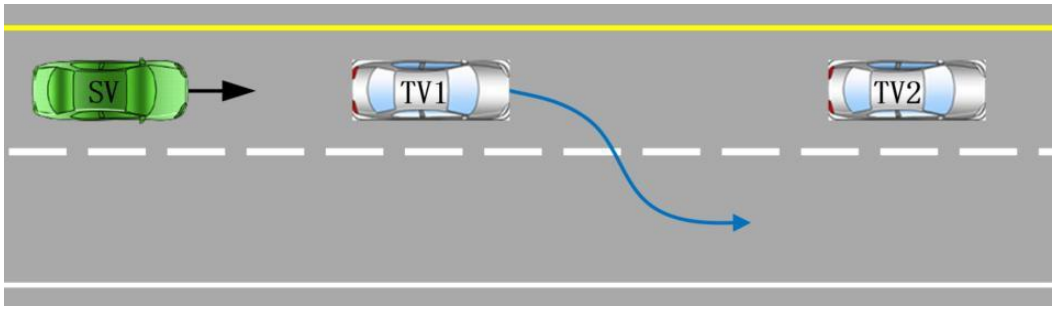


Fig. A.6 Schematic Diagram of Passenger Car TV Cut-out Scenario

A.5.2 Test implementation method

a) TV2 remains stationary in the middle of the lane ahead of TV1;

b) The set speed of the SV is set according to the rules in 5.2.5 and 5.2.6. The summary of test conditions is shown in Table A.3;

c) The SV activates its HNP function and follows TV1 to cruise stably in the straight lane at the set speed V_{sv} (i.e., the GPS speed) set in b). When the distance between TV1 and TV2 (D_{TV1_TV2}) meets the triggering conditions, TV1 cuts out along the lane change trajectory to the adjacent lane;

d) The TV1 cut-out trajectory consists of 2 arc sections and 1 straight section. Its schematic diagram and trajectory parameters are shown in Fig. A.7 and Table A.3, respectively.

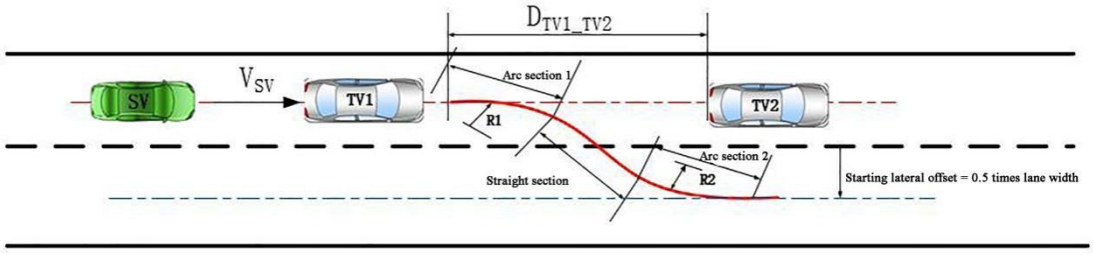


Fig. A.7 Schematic Diagram of Passenger Car TV Cut-out Trajectory

Table A.3 Parameters of Passenger Car TV Cut-out Trajectory

Type	V_{SV}, V_{TV1} (km/h)	D_{TV1_TV2}(m)	Arc Radius R1, R2 (m)	Straight Section Length (m)	Angle between Trajectory and Lane Line (°)
Test condition for passing score	60	30	36.90	21.05	8.17
	60	50	36.90	21.05	8.17
	60	80	36.90	21.05	8.17
Test condition for enterprise's declared score	65	32	43.03	22.77	7.57
	65	50	43.03	22.77	7.57
	65	80	43.03	22.77	7.57
	70	35	49.77	24.48	7.04

	70	50	49.77	24.48	7.04
	70	80	49.77	24.48	7.04
	75	38	57.06	26.21	6.57
	75	60	57.06	26.21	6.57
	75	90	57.06	26.21	6.57
	80	40	64.85	27.93	6.17
	80	60	64.85	27.93	6.17
	80	90	64.85	27.93	6.17
	85	43	73.14	29.67	5.81
	85	60	73.14	29.67	5.81
	85	90	73.14	29.67	5.81
	90	46	81.94	31.39	5.48
	90	70	81.94	31.39	5.48
	90	100	81.94	31.39	5.48
	95	49	91.24	33.12	5.20
	95	70	91.24	33.12	5.20
	95	100	91.24	33.12	5.20
	100	53	101.05	34.85	4.94
	100	70	101.05	34.85	4.94
	100	100	101.05	34.85	4.94
	105	57	111.36	36.59	4.70
	105	80	111.36	36.59	4.70
	105	110	111.36	36.59	4.70
	110	61	122.17	38.32	4.49
	110	80	122.17	38.32	4.49
	110	110	122.17	38.32	4.49
	115	65	133.40	40.04	4.30
	115	90	133.40	40.04	4.30
	115	120	133.40	40.04	4.30
Test condition for excellence score	120	70	145.20	41.78	4.12
	120	90	145.20	41.78	4.12
	120	120	145.20	41.78	4.12

A.5.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV slows down and stops behind TV2;

b) The SV collides with TV2.

A.5.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The speed error of TV1 shall not exceed ±1 km/h;

b) The lateral offset between TV1 and the lane centerline shall not exceed ±0.2 m

A.6 Traffic cone avoidance

A.6.1 Scenario description

The SV cruises in a straight lane at the specified set speed and gradually approaches the traffic cone area ahead in the same lane after its speed becomes stable, as shown in Fig. A.8.

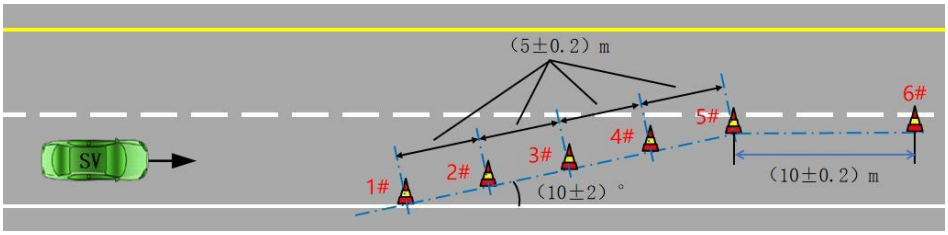


Fig. A.8 Schematic Diagram of Traffic Cone Avoidance Scenario

A.6.2 Test implementation method

a) The traffic cones are placed ahead in the SV's lane according to Fig. A.8;

b) The set speed of the SV is set according to the rules in 5.2.5 and 5.2.6. The summary of test conditions is shown in Table A.1;

c) The SV activates its HNP function, cruises in the straight lane at the set speed V_{SV} (i.e., the GPS speed) in b), and runs towards the traffic cones ahead in the same lane after its speed becomes stable.

A.6.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV brakes to 0 km/h and stops in front of the traffic cones or avoids the traffic cones through system steering;

b) The SV collides with a traffic cone;

c) When TTC = 2.0 s between the SV and traffic cone 3#, the SV does not brake, and the driver actively deviates out of the lane to avoid collision.

A.6.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) Recording of valid data begins when the longitudinal clearance between the SV and traffic cone 3# is 250 m.

A.7 Stationary anti-collision buffer vehicle ahead

A.7.1 Scenario description

The SV cruises in a straight lane at the specified set speed and gradually approaches the stationary anti-collision buffer vehicle TV that stops ahead in the same lane after its speed becomes stable, as shown in Fig. A.9.

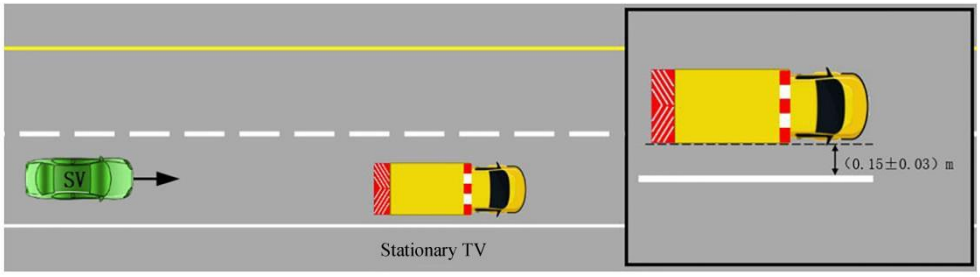


Fig. A.9 Schematic Diagram of Stationary Anti-collision Buffer Vehicle Ahead Scenario

A.7.2 Test method

a) The TV is placed stationary ahead in the SV's lane according to Fig. A.9;

b) The set speed of the SV is set according to the rules in 5.2.5 and 5.2.6. The summary of test conditions is shown in Table A.1;

c) The SV activates its HNP function, cruises in the straight lane at the set speed V_{SV} (i.e., the GPS speed) in b), and gradually approaches the TV ahead after its speed becomes stable.

A.7.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV does not collide with the TV, and the SV brakes to 0 km/h or avoids the TV through system steering;

b) The SV collides with the TV;

c) When TTC = 2.0 s between the SV and the TV, the SV does not brake, and the driver actively deviates out of the lane to avoid collision.

A.7.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) Recording of valid data begins when the clearance between the SV and the TV is 250 m.

Annex B

Detailed Rules for Open Road Test

B.1 Test scenarios

The open road test scenarios are shown in Table B.1.

Table B.1 List of Open Road Test Scenarios

Type	Scenario		
Basic scenarios	Highway	Within a section	Stop-and-go traffic
			Tunnel passing
			Navigation for lane change at the lane end
		At a ramp	Highway off-ramp (with 0/1 surrounding vehicle)
			Route selection in ramp (with 0/1 surrounding vehicle)
			Highway on-ramp (with 0/1 surrounding vehicle)
Challenging scenarios	Highway	At a ramp	Highway off-ramp (with 2/3 surrounding vehicles)
			Highway on-ramp (with 2/3 surrounding vehicles)

B.2 Stop-and-go traffic

B.2.1 Scenario description

The SV activates its HNP function, runs on the road according to the specified route, and gradually runs into the congested section ahead, as shown in Fig. B.1. This scenario includes 1 test condition.

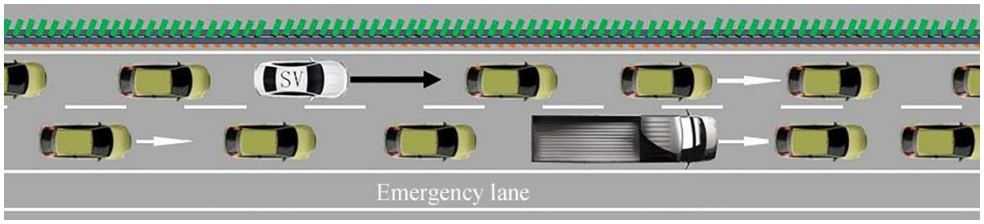


Fig. B.1 Schematic Diagram of Stop-and-Go Traffic

B.2.2 Test location

a) Lijia - North Ring Interchange section of G75 Lanzhou-Haikou Expressway, defined as test route I;

b) North Ring Interchange - Lijia section of G75 Lanzhou-Haikou Expressway, defined as test route I.

Note: The sections above are about 6.3 km long and contain at least two lanes, with a dotted middle lane line.

B.2.3 Test implementation method

a) The tester sets the starting and ending points of the on-board navigation system as per the test route requirements to ensure that the SV runs along the path that passes through the selected congested section;

b) The SV activates its HNP function and runs along the path planned by the on-board navigation system to pass through the congested section;

c) The fulfillment status and data of the driving task by the SV shall be recorded each time the SV completes the stop-and-go traffic test.

B.2.4 Conditions for end of test

a) The SV leaves the specified route within the specified time period;

b) The SV has a traffic accident;

c) The EPB of the SV is activated when the test is conducted under a single stop-and-go traffic condition;

d) The ongoing test of the SV is interrupted by the tester taking over the vehicle to ensure driving safety.

B.2.5 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test: In a single stop-and-go traffic test, if the EPB of the SV is activated, the result of this stop-and-go traffic test will not be included in the score.

B.3 Tunnel passing

B.3.1 Scenario description

The SV activates its HNP function, runs on the road according to the specified route, and gradually runs into the tunnel ahead, as shown in Fig. B.2. This scenario includes 1 test condition.

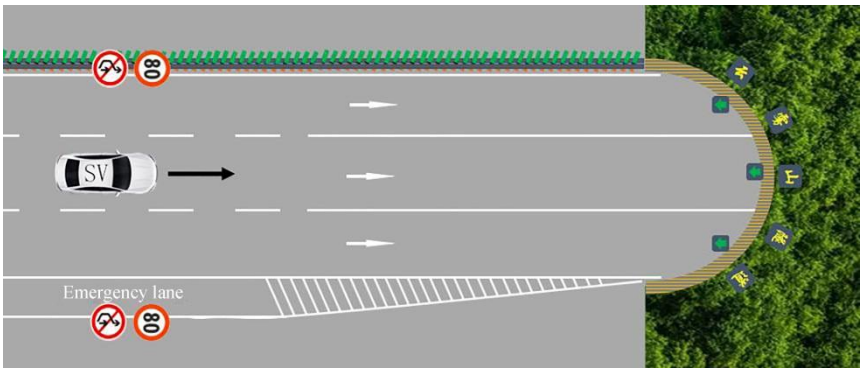


Fig. B.2 Schematic Diagram of Tunnel Passing

B.3.2 Test location

Based on the actual condition, the test can be carried out at any of the following locations:

a) Jinyunshan Tunnel of G5013 Chongqing-Chengdu Expressway (about 2690 m long), without lane reduction inside, defined as test route II;

b) Yunwushan Tunnel of G5013 Chongqing-Chengdu Expressway (about 3335 m long), without lane reduction inside, defined as test route II;

c) Bayueshan Tunnel of G5013 Chongqing-Chengdu Expressway (about 3302 m long), without lane reduction inside, defined as test route II;

d) Jiudingshan Tunnel of G5013 Chongqing-Chengdu Expressway (about 1398 m long), without lane reduction inside, defined as test route II.

B.3.3 Test implementation method

a) The tester sets the starting and ending points of the on-board navigation system as per the test route requirements to ensure that the SV runs along the path that passes through the selected tunnel;

b) The SV activates its HNP function and runs along the path planned by the on-board navigation system to pass through the tunnels above, respectively;

c) The fulfillment status and data of the driving task by the SV shall be recorded each time the SV runs through a tunnel.

B.3.4 Conditions for end of test

a) The tail of the SV completely leaves the tunnel;

b) Where a danger happens during the test, the tester takes over the vehicle to ensure driving safety;

c) The SV has a traffic accident.

B.3.5 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

During the test, there is no construction or traffic accident that leads to jammed lanes in the tunnel.

B.4 Navigation for lane change at the lane end

B.4.1 Scenario description

The SV activates its HNP function and runs on the road according to the specified route. As there is lane merging ahead, the SV needs to change its lane based on navigation information, as shown in Fig. B.3. This scenario includes 6 test conditions according to the different number of surrounding vehicles around the SV. See Table B.2 for details.

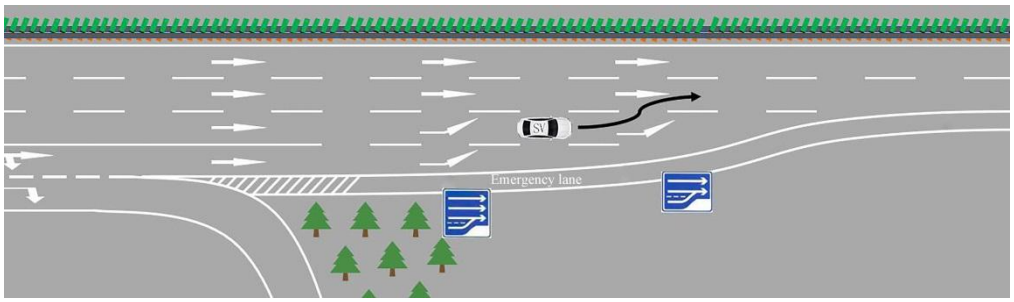


Fig. B.3 Schematic Diagram of Navigation for Lane Change at the Lane End

B.4.2 Test location

North Ring Interchange - Lijia (near Jinkai Interchange) section of G75 Lanzhou-Haikou Expressway, defined as test route I.

B.4.3 Test implementation method

a) The tester sets the starting and ending points of the on-board navigation system as per the test route requirements to ensure that the SV runs along the section that passes through the selected lane reduction section;

b) The SV activates its HNP function and runs along the path planned by the on-board navigation system to pass through the lane reduction section from the third or fourth lane from the left;

c) The test starts 20 s before the first lane narrowing road marking comes out, at which point recording of valid test data begins;

d) The fulfillment status and data of the driving task by the SV shall be recorded each time the SV runs through a lane reduction section.

B.4.4 Conditions for end of test

a) All running wheels of the SV roll into the narrowed two lanes;

b) The SV has a traffic accident;

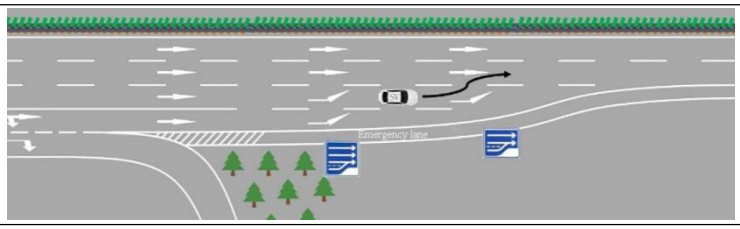
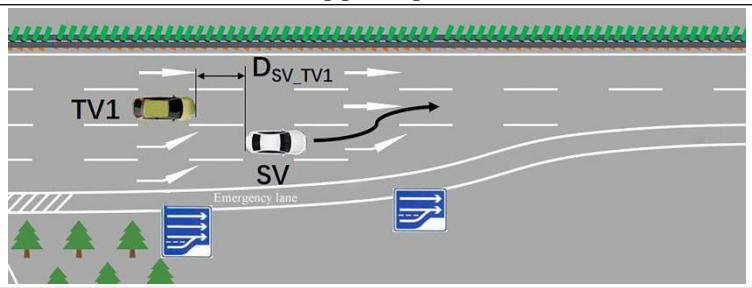
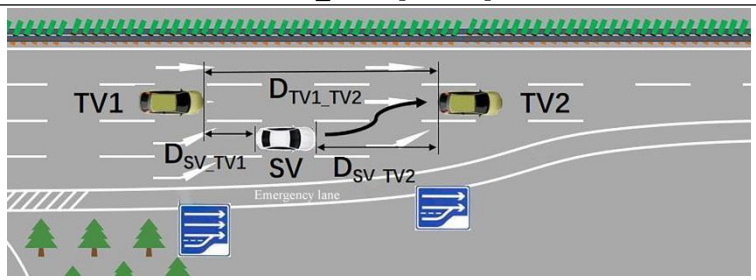
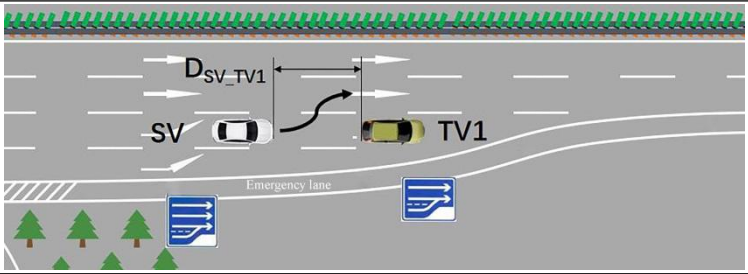
c) The ongoing test of the SV is interrupted by the tester taking over the vehicle to ensure driving safety;

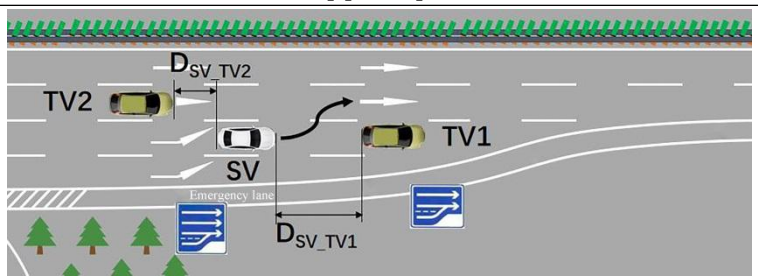
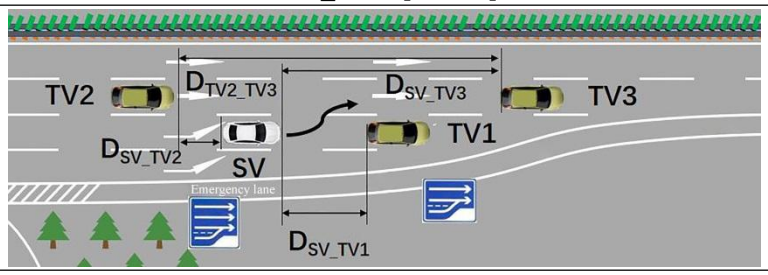
d) The SV fails to change its lane timely, causing any of its running wheels to cross a solid line or roll into the emergency lane.

B.4.5 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test. See "Validity Parameter Range" in Table B.2 for details.

Table B.2 List of Test Conditions for Navigation for Lane Change at the Lane End

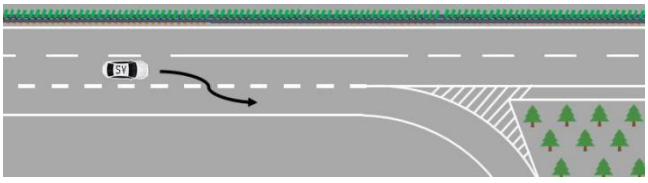
<table>
<tr><th colspan="2">Test Condition</th><th>Validity Parameter Range</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">No surrounding vehicle ahead in the SV's lane and in the adjacent lane</td><td>None</td></tr>
<tr><td> 
</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">No surrounding vehicle ahead in the SV's lane and 1 surrounding vehicle in the adjacent lane</td><td>The longitudinal offset between the SV and TV1 meets: DSV_TV1=[-60,-2],[2,100]m</td></tr>
<tr><td> 
</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">No surrounding vehicle ahead in the SV's lane and 2 surrounding vehicles in the adjacent lane</td><td>The longitudinal offset between the SV and TV1 meets: DSV_TV1=[-60,-2],[2,100]m
The longitudinal offset between the SV and TV2 meets: DSV_TV2=[-60,-2],[2,100]m
The longitudinal offset between TV1 and TV2 meets: DTV1_TV2=[20,150]m</td></tr>
<tr><td> 
</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">1 surrounding vehicle ahead in the SV's lane and no surrounding vehicle in the adjacent lane</td><td>The longitudinal offset between the SV and TV1 meets: DSV_TV1=[2,100]m</td></tr>
<tr><td> 
</td></tr>
</table>

Test Condition		Validity Parameter Range
5	1 surrounding vehicle ahead in the SV's lane and 1 surrounding vehicle in the adjacent lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[2,120]m The longitudinal offset between the SV and TV2 meets: DSV_TV2=[-60,-2],[2,100]m
		
6	1 surrounding vehicle ahead in the SV's lane and 2 surrounding vehicles in the adjacent lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[2,120]m The longitudinal offset between the SV and TV2 meets: DSV_TV2=[-60,-2],[2,100]m The longitudinal offset between the SV and TV3 meets: DSV_TV3=[-60,-2],[2,100]m The longitudinal offset between TV2 and TV3 meets: DTV2_TV3=[20,150]m
		

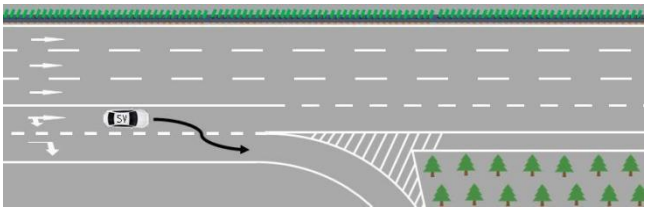
B.5 Highway off-ramp

B.5.1 Scenario description

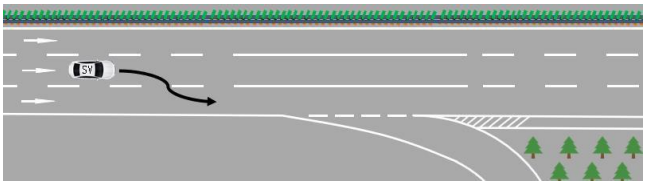
The SV activates its HNP function and runs on the road according to the specified route. It exits from the main road of the highway to the deceleration lane ahead based on navigation information, so as to enter the ramp, as shown in Fig. B.4. This scenario includes 5 test conditions according to the different number of surrounding vehicles around the SV. See Table B.3 for details.



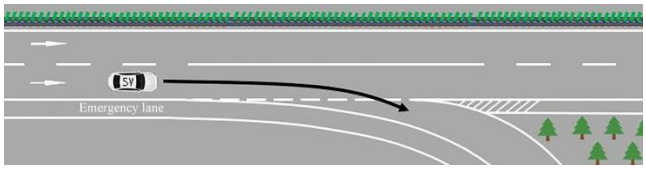
a) G75 Lanzhou-Haikou Expressway - North Ring Interchange



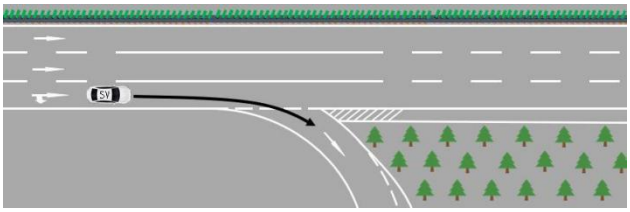
b) G50 Shanghai-Chongqing Expressway - North Ring Interchange



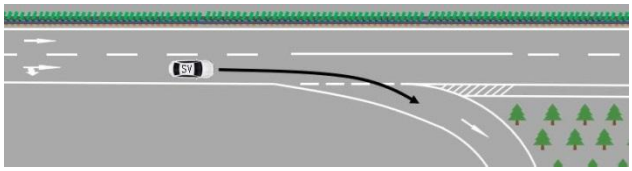
c) G50 Shanghai-Chongqing Expressway - East Ring Interchange



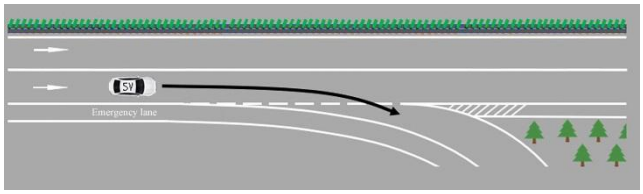
d) G75 Lanzhou-Haikou Expressway - Lijia Interchange



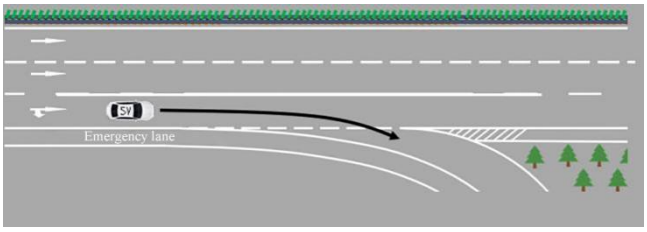
e) G5013 Chongqing-Chengdu Expressway - Wangu Interchange (to Longshui Lake Toll Station)



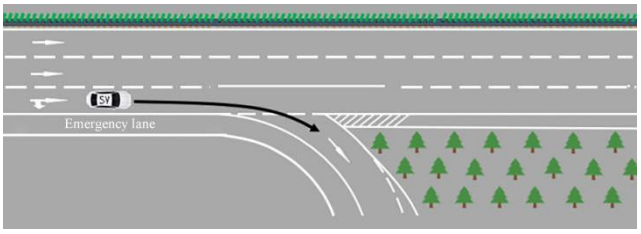
f) G8515 Guang'an-Luzhou Expressway - Longshui Lake Interchange (to Longshui Lake Toll Station)



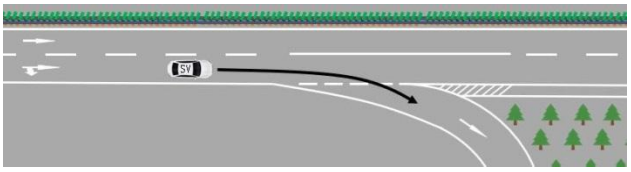
g) G8515 Guang'an-Luzhou Expressway - Wangu Interchange (to Dazu East Toll Station)



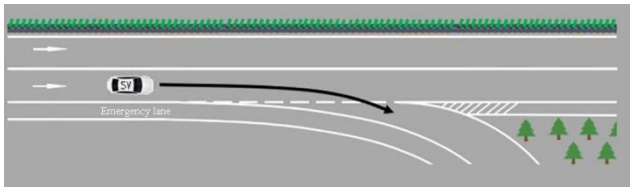
h) G5013 Chongqing-Chengdu Expressway - Dazu East Interchange (to Dazu East Toll Station)



i) G5013 Chongqing-Chengdu Expressway - Wangu Interchange (to Yongxi Toll Station)



j) G8515 Guang'an-Luzhou Expressway - Yongxi Interchange (to Yongxi Toll Station)



k) G8515 Guang'an-Luzhou Expressway - Wangu Interchange (to Science City Toll Station)

Fig. B.4 Schematic Diagram of Highway Off-ramp Scenario

B.5.2 Test location

Based on the actual condition, the test can be carried out at any of the following locations:

a) G75 Lanzhou-Haikou Expressway - North Ring Interchange section, defined as test route I;

b) G50 Shanghai-Chongqing Expressway - North Ring Interchange section, defined as test route I;

c) G50 Shanghai-Chongqing Expressway - East Ring Interchange section, defined as test route I;

d) G75 Lanzhou-Haikou Expressway - Lijia Interchange section, defined as test route I;

e) G5013 Chongqing-Chengdu Expressway - Wangu Interchange (to Longshui Lake Toll Station) section, defined as test route II;

f) G8515 Guang'an-Luzhou Expressway - Longshui Lake Interchange (to Longshui Lake Toll Station) section, defined as test route II;

g) G8515 Guang'an-Luzhou Expressway - Wangu Interchange (to Dazu East Toll Station) section, defined as test route II;

h) G5013 Chongqing-Chengdu Expressway - Dazu East Interchange (to Dazu East Toll Station) section, defined as test route II;

i) G5013 Chongqing-Chengdu Expressway - Wangu Interchange (to Yongxi Toll

Station) section, defined as test route II;

j) G8515 Guang'an-Luzhou Expressway - Yongxi Interchange (to Yongxi Toll Station) section, defined as test route II;

k) G8515 Guang'an-Luzhou Expressway - Wangu Interchange (to Science City Toll Station) section, defined as test route II.

B.5.3 Test implementation method

a) The tester sets the starting and ending points of the on-board navigation system as per the test route requirements to ensure that the SV runs along the path that passes through the selected highway off-ramp scenario;

b) The SV activates its HNP function and runs along the path planned by the on-board navigation system to pass through the highway off-ramp section;

c) The test starts when the THW between the SV and the ramp exit is 120 s, at which point recording of valid test data begins;

d) The fulfillment status and data of the driving task by the SV shall be recorded each time the SV runs through a highway off-ramp section.

B.5.4 Conditions for end of test

a) All running wheels of the SV roll into the ramp;

b) The SV has a traffic accident;

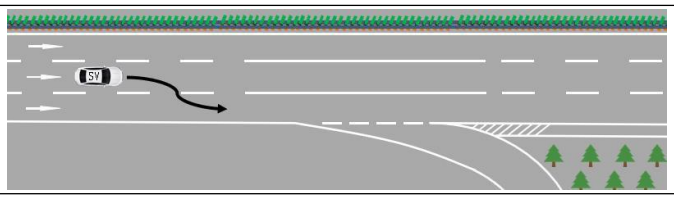
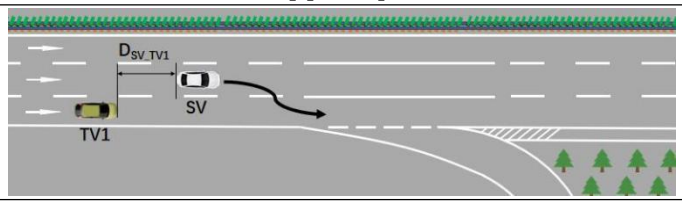
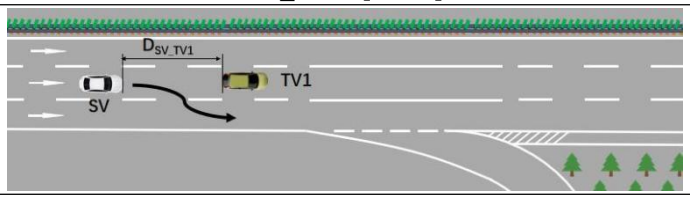
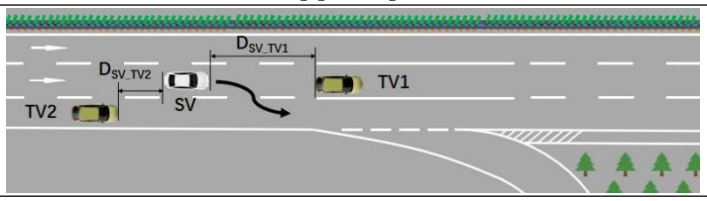
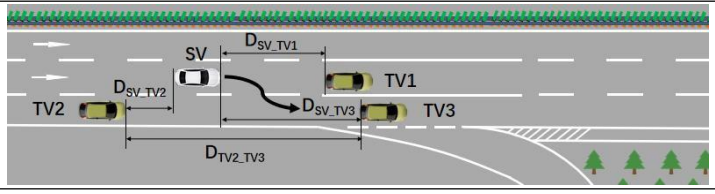
c) The ongoing test of the SV is interrupted by the tester taking over the vehicle to ensure driving safety;

d) The SV fails to exit from the highway to the ramp timely, resulting in that the SV has not yet merged into the ramp while any of its running wheels has crossed a solid line or rolled into the diversion line area/ramp exit.

B.5.5 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test. See "Validity Parameter Range" in Table B.3 for details.

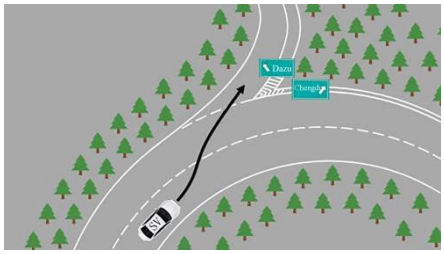
Table B.3 List of Highway Off-ramp Test Conditions

Test Condition		Validity Parameter Range
1	No surrounding vehicle ahead in the SV's lane and in the adjacent lane	None
		
2	No surrounding vehicle ahead in the SV's lane and 1 surrounding vehicle in the adjacent lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[-60,-2],[2,100]m
		
3	1 surrounding vehicle ahead in the SV's lane and no surrounding vehicle in the adjacent lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[2,100]m
		
4	1 surrounding vehicle ahead in the SV's lane and 1 surrounding vehicle in the adjacent lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[2,120]m The longitudinal offset between the SV and TV2 meets: DSV_TV2=[-60,-2],[2,100]m
		
5	1 surrounding vehicle ahead in the SV's lane and 2 surrounding vehicles in the adjacent lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[2,120]m The longitudinal offset between the SV and TV2 meets: DSV_TV2=[-60,-2],[2,100]m The longitudinal offset between the SV and TV3 meets: DSV_TV3=[-60,-2],[2,100]m The longitudinal offset between TV2 and TV3 meets: DTV2_TV3=[20,150]m
		

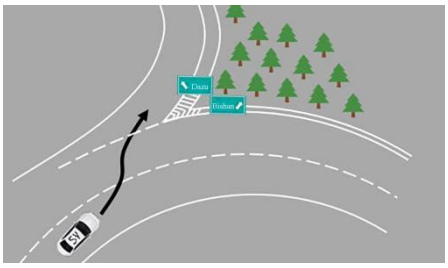
B.6 Route selection in ramp

B.6.1 Scenario description

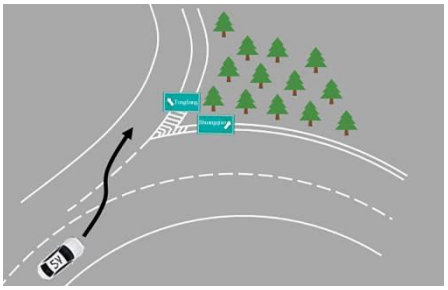
The SV activates its HNP function and runs on the ramp according to the specified route. As there is a diversion on the ramp ahead, the SV needs to select the correct route to continue running based on navigation information, as shown in Fig. B.5. This scenario includes 2 test conditions.



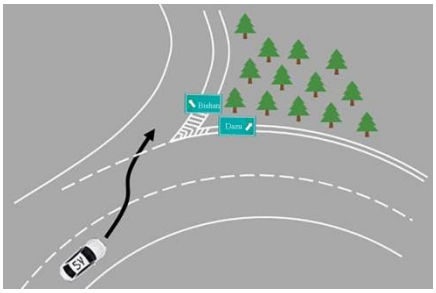
a) G5013 Chongqing-Chengdu Expressway - G8515 Guang'an-Luzhou Expressway via Wangu Interchange (to Longshui Lake Toll Station)



b) Guang'an-Luzhou Expressway - G5013 Chongqing-Chengdu Expressway via Wangu Interchange (to Dazu East Toll Station)



c) G5013 Chongqing-Chengdu Expressway - G8515 Guang'an-Luzhou Expressway via Wangu Interchange (to Yongxi Toll Station)



d) G8515 Guang'an-Luzhou Expressway - G5013 Chongqing-Chengdu Expressway via Wangu Interchange (to Science City Toll Station)

Fig. B.5 Schematic Diagram of Route Selection in Ramp

B.6.2 Test location

a) G5013 Chongqing-Chengdu Expressway - G8515 Guang'an-Luzhou Expressway via Wangu Interchange (to Longshui Lake Toll Station) section, with internal diversion ramp in Wangu Interchange, defined as test route II;

b) G8515 Guang'an-Luzhou Expressway - G5013 Chongqing-Chengdu Expressway via

Wangu Interchange (to Dazu East Toll Station) section, with internal diversion ramp in Wangu Interchange, defined as test route II;

c) G5013 Chongqing-Chengdu Expressway - G8515 Guang'an-Luzhou Expressway via Wangu Interchange (to Yongxi Toll Station) section, with internal diversion ramp in Wangu Interchange, defined as test route II;

d) G8515 Guang'an-Luzhou Expressway - G5013 Chongqing-Chengdu Expressway via Wangu Interchange (to Science City Toll Station) section, with internal diversion ramp in Wangu Interchange, defined as test route II;

B.6.3 Test implementation method

a) The tester sets the starting and ending points of the on-board navigation system as per the test route requirements to ensure that the SV runs along the path that passes through the selected section;

b) The SV activates its HNP function and runs along the path planned by the on-board navigation system to pass through the Y-shaped section inside the ramp based on navigation information;

c) Recording of valid test data begins when the SV starts to exit the ramp from the highway;

d) The fulfillment status and data of the driving task by the SV shall be recorded each time the SV passes through this scenario.

B.6.4 Conditions for end of test

a) The SV runs to the correct ramp based on navigation information, and all of its running wheels roll into the correct ramp;

b) The SV has a traffic accident;

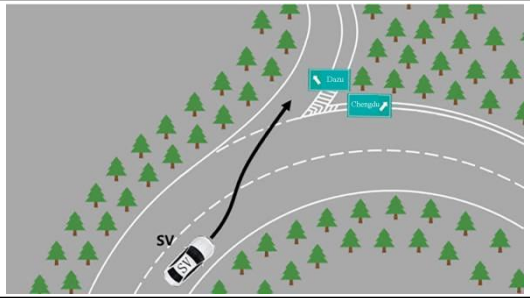
c) The ongoing test of the SV is interrupted by the tester taking over the vehicle to ensure driving safety;

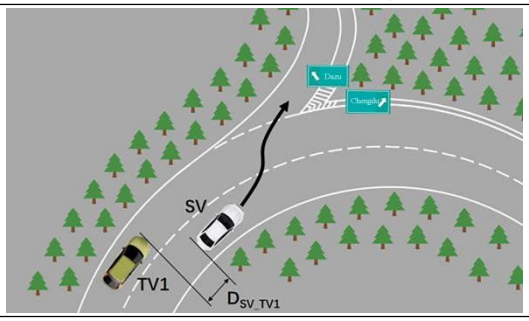
d) The SV fails to run into the correct ramp, any of the SV's running wheels crosses a solid line, or the SV runs into the diversion area.

B.6.5 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test. See "Validity Parameter Range" in Table B.4 for details.

Table B.4 List of Test Conditions for Route Selection in Ramp

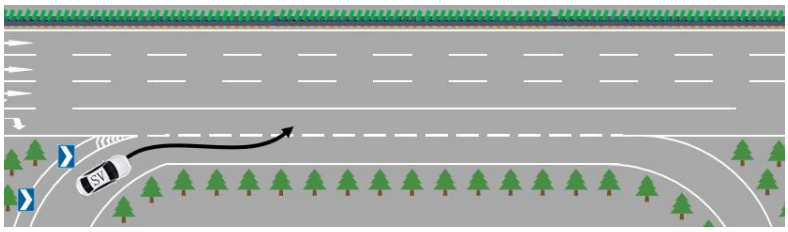
Test Condition		Validity Parameter Range
1	No surrounding vehicle ahead in the SV's lane and in the adjacent lane	None
		
2	No surrounding vehicle ahead in the SV's lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[-60,-2],[2,100]m

Test Condition		Validity Parameter Range
	and 1 surrounding vehicle in the adjacent lane	

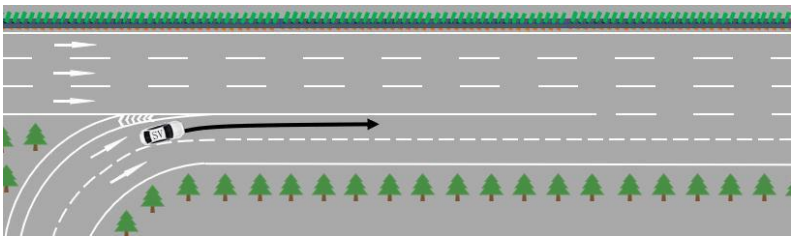
B.7 Highway on-ramp

B.7.1 Scenario description

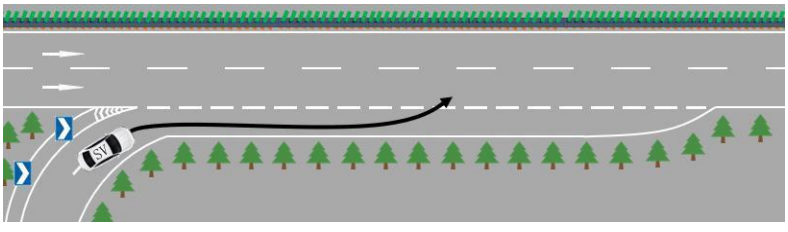
The SV activates its HNP function, runs on the road according to the specified route, and merges into the main lane of the highway from the ramp based on navigation information, as shown in Fig. B.6. This scenario includes 5 test conditions according to the different number of surrounding vehicles around the SV. See Table B.5 for details.



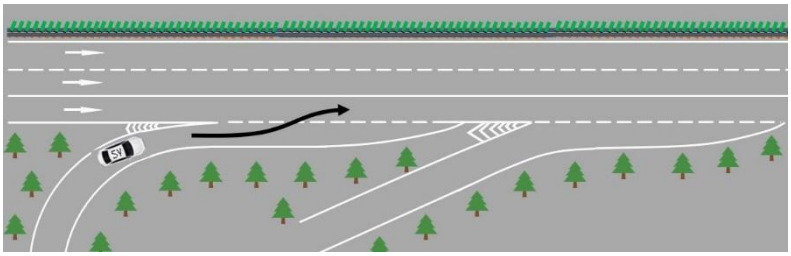
a) North Ring Interchange - G50 Shanghai-Chongqing Expressway (Chongqing Inner Ring Expressway)



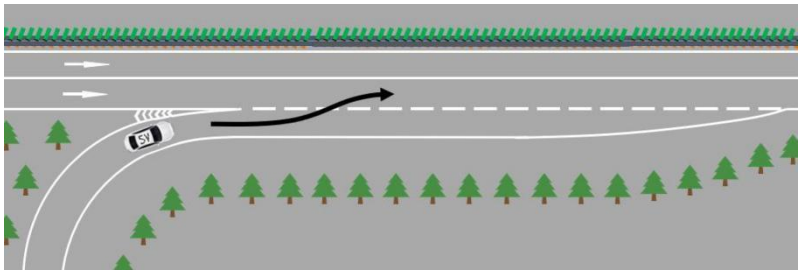
b) North Ring Interchange - G75 Lanzhou-Haikou Expressway



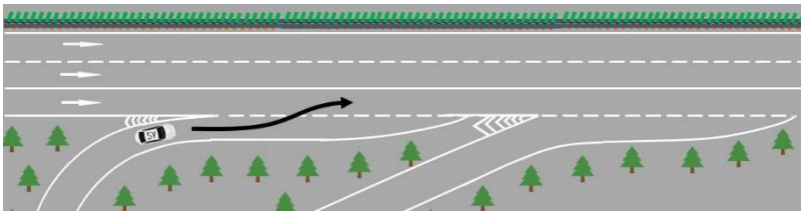
c) Wangu Interchange - G8515 Guang'an-Luzhou Expressway (to Longshui Lake Toll Station)



d) Wangu Interchange - G5013 Chongqing-Chengdu Expressway (to Dazu East Toll Station)



e) Wangu Interchange - G8515 Guang'an-Luzhou Expressway (to Yongxi Toll Station)



f) Wangu Interchange - G5013 Chongqing-Chengdu Expressway (to Science City Toll Station)

Fig. B.6 Schematic Diagram of Highway On-ramp Scenario

B.7.2 Test location

Based on the actual conditions of the SV and the surrounding vehicles, the test can be carried out at any of the following locations:

a) North Ring Interchange - G50 Shanghai-Chongqing Expressway (Chongqing Inner Ring Expressway) section, defined as test route I;

b) North Ring Interchange - G75 Lanzhou-Haikou Expressway section, defined as test route I;

c) Wangu Interchange - G8515 Guang'an-Luzhou Expressway (to Longshui Lake Toll Station) section, defined as test route II;

d) Wangu Interchange - G5013 Chongqing-Chengdu Expressway (to Dazu East Toll Station) section, defined as test route II;

e) Wangu Interchange - G8515 Guang'an-Luzhou Expressway (to Yongxi Toll Station) section, defined as test route II;

f) Wangu Interchange - G5013 Chongqing-Chengdu Expressway (to Science City Toll Station) section, defined as test route II.

B.7.3 Test implementation method

a) The tester sets the starting and ending points of the on-board navigation system as per the test route requirements to ensure that the SV runs along the section that passes through the selected highway on-ramp section;

b) The SV activates its HNP function and runs along the path planned by the on-board navigation system to pass through the highway on-ramp section;

c) The test starts when the THW between the SV and the acceleration lane end is 60 s, at which point recording of valid test data begins;

d) The fulfillment status and data of the driving task by the SV shall be recorded each time the SV runs through a highway on-ramp section.

B.7.4 Conditions for end of test

a) All running wheels of the SV roll into the main road of the highway;

b) The SV has a traffic accident;

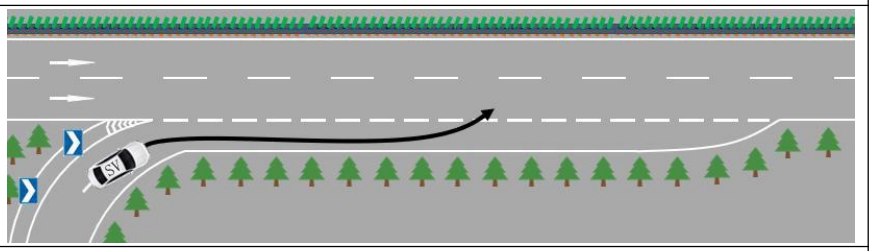
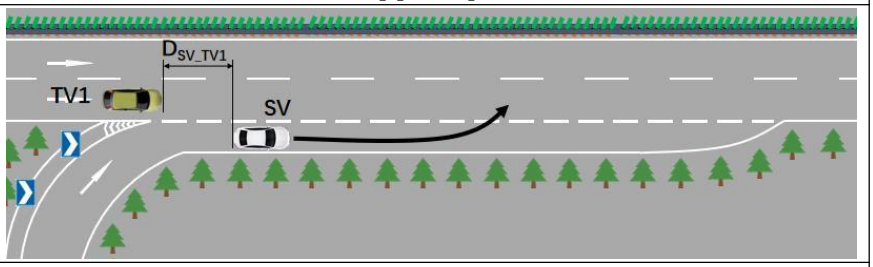
c) The ongoing test of the SV is interrupted by the tester taking over the vehicle to ensure driving safety;

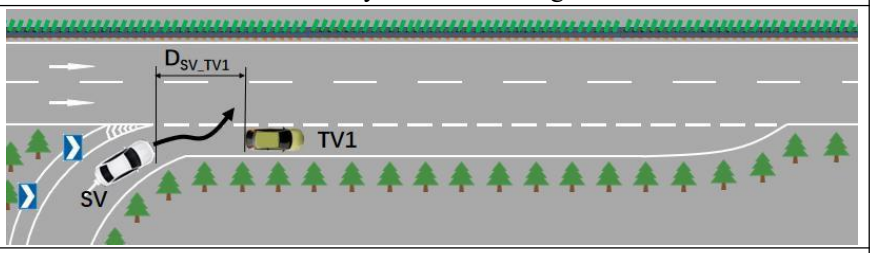
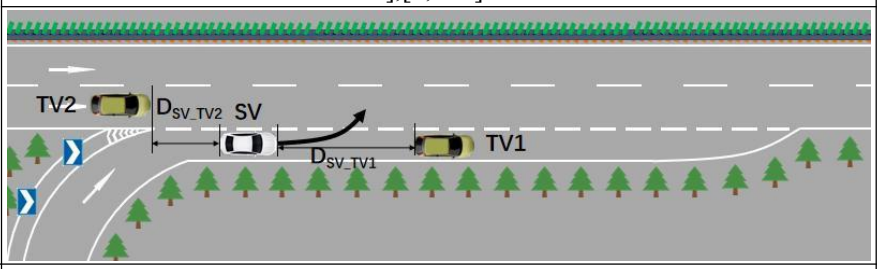
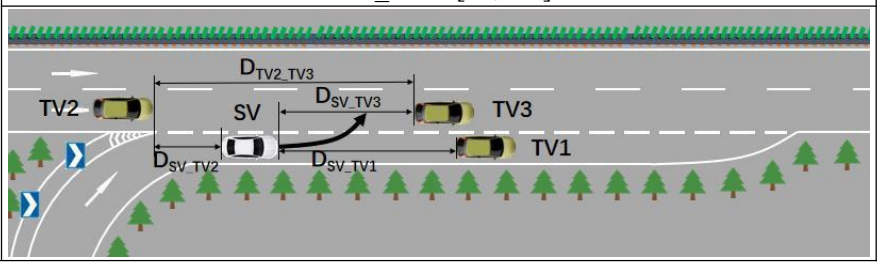
d) The SV fails to merge into the main road from the ramp timely, causing any of its running wheels to cross a solid line or roll into the diversion line area/emergency lane.

B.7.5 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test. See "Validity Parameter Range" in Table B.5 for details.

Table B.5 List of Highway On-ramp Test Conditions

Test Condition		Validity Parameter Range
1	No surrounding vehicle ahead in the SV's ramp and in the adjacent lane	None 
2	No surrounding vehicle ahead in the SV's ramp and 1 surrounding vehicle in the adjacent lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[-60,-2],[2,100]m 
3	1 surrounding vehicle ahead in the SV's ramp	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[2,100]m

Test Condition		Validity Parameter Range
	and no surrounding vehicle in the adjacent lane	
4	1 surrounding vehicle ahead in the SV's ramp and 1 surrounding vehicle in the adjacent lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[2,120]m The longitudinal offset between the SV and TV2 meets: DSV_TV2=[-60,-2],[2,100]m 
5	1 surrounding vehicle ahead in the SV's ramp and 2 surrounding vehicles in the adjacent lane	The longitudinal offset between the SV and TV1 meets: DSV_TV1=[2,120]m The longitudinal offset between the SV and TV2 meets: DSV_TV2=[-60,-2],[2,100]m The longitudinal offset between the SV and TV3 meets: DSV_TV3=[-60,-2],[2,100]m The longitudinal offset between TV2 and TV3 meets: DTV2_TV3=[20,150]m 

Annex C

Detailed Rules for Simulation Test

C.1 Parameter settings for simulation test scenarios

In the simulation test, the default parameter settings for the test scenarios are shown in Table C.1.

Table C.1 Default Parameters for Simulation Test Scenarios

S/N	Type	Details
1	Default parameters for road	Slope: flat; Lane line width: 0.15 m; Radius of curvature: 0 m.
2	Default parameters for transportation infrastructure	Anti-glare facilities: Yes; Highway guardrail: Yes.
3	Default parameters for temporary road conditions	Road surface condition: dry; Lane line status: clear.
4	Default parameters for movement status	SV type: passenger car; TV type: passenger car; SV offset: 0.
5	Default parameters for road traffic environment	Lighting: front lighting; Weather: sunny.

C.2 Basic scenario test

The test scenarios and test conditions of the basic scenario test are the same as those of the closed field test. See Table C.2 for details. In the basic scenario test, simulation tests shall be carried out for all test scenarios and test conditions of the closed field test.

Table C.2 Simulation Parameters for Basic Scenario Test

<table>
<tr><td colspan="6">Scenario I: Stationary Passenger Car Ahead</td></tr>
<tr><td colspan="5">Set Speed of SV, V_{SV} (km/h)</td><td>TV Type</td></tr>
<tr><td colspan="5">60-120 (take a speed point every 5)</td><td>Passenger car</td></tr>
<tr><td colspan="6">Scenario II: Stationary Passenger Car Ahead - TV Being Skewed</td></tr>
<tr><td colspan="3">Set Speed of SV, V_{SV} (km/h)</td><td>Angle with Skewed TV</td><td colspan="2">TV Type</td></tr>
<tr><td colspan="3" rowspan="2">60-120 (take a speed point every 5)</td><td>30°</td><td colspan="2" rowspan="2">Passenger car</td></tr>
<tr><td>-30°</td></tr>
<tr><td colspan="6">Scenario III: Stationary Passenger Car Ahead (on a Curve)</td></tr>
<tr><td colspan="3">Set Speed of SV, V_{SV} (km/h)</td><td>Curve Radius (m)</td><td colspan="2">TV Type</td></tr>
<tr><td colspan="3">60-120 (take a speed point every 5)</td><td>500</td><td colspan="2">Passenger car</td></tr>
<tr><td colspan="6">Scenario IV: Passenger Car TV Cut-in</td></tr>
<tr><td>V_{SV} (km/h)</td><td>V_{TV1} (km/h)</td><td>D_{TV1_TV2} TTC(s)</td><td>Curved Sections 1, 2 and 3</td><td>Straight Section Length (m)</td><td>Curved Sections 4, 5 and 6</td></tr>
<tr><td>60</td><td>15, 35, 50</td><td rowspan="10">2.0</td><td colspan="3" rowspan="10">See Table A.2 for details</td></tr>
<tr><td>65</td><td>20, 40, 55</td></tr>
<tr><td>70</td><td>15, 30, 45, 60</td></tr>
<tr><td>75</td><td>20, 35, 50, 65</td></tr>
<tr><td>80</td><td>20, 40, 60</td></tr>
<tr><td>85</td><td>25, 45, 65</td></tr>
<tr><td>90</td><td>30, 40, 60</td></tr>
<tr><td>95</td><td>35, 45, 65</td></tr>
<tr><td>100</td><td>40, 55, 65</td></tr>
</table>

105	45, 60, 65			
110	50, 55, 60			
115	60, 65			
120	60			
Scenario V: Passenger Car TV Cut-out				
V_{SV}, V_{TV1} (km/h)	D_{TV1_TV2} (m)	Arc Radius R1, R2 (m)	Straight Section Length (m)	Angle between Trajectory and Lane Line (°)
60	30, 50, 80	36.90	21.05	8.17
65	32, 50, 80	43.03	22.77	7.57
70	35, 50, 80	49.77	24.48	7.04
75	38, 60, 90	57.06	26.21	6.57
80	40, 60, 90	64.85	27.93	6.17
85	43, 60, 90	73.14	29.67	5.81
90	46, 70, 100	81.94	31.39	5.48
95	49, 70, 100	91.24	33.12	5.20
100	53, 70, 100	101.05	34.85	4.94
105	57, 80, 110	111.36	36.59	4.70
110	61, 80, 110	122.17	38.32	4.49
115	65, 90, 120	133.40	40.04	4.30
120	70, 90, 120	145.20	41.78	4.12
Scenario VI: Traffic Cone Avoidance				
Set Speed of SV, VSV (km/h)		Obstacle Type		
60-120 (take a speed point every 5)		Traffic cone		
Scenario VII: Stationary Anti-collision Buffer Vehicle Ahead				
Set Speed of SV, VSV (km/h)		TV Type		
60-120 (take a speed point every 5)		Anti-collision buffer vehicle		

C.3 Scenario generalization test

C.3.1 Stationary TV ahead

C.3.1.1 Scenario description

The SV cruises in a straight lane at the specified set speed and gradually approaches the TV ahead in the same lane, as shown in Fig. C.1.

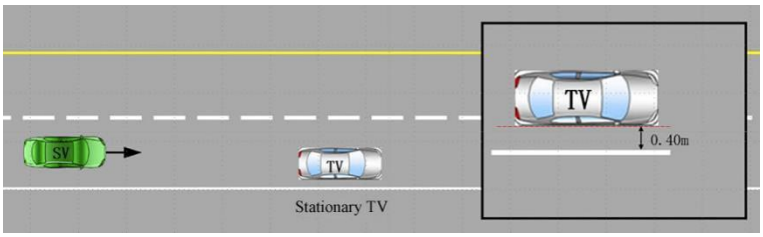


Fig. C.1 Schematic Diagram of Scenario

C.3.1.2 Test method

a) The TV remains stationary ahead in the SV's lane, with a distance of 0.4 m (record as -0.4) from the right solid line or 0.4 m (record as +0.4) from the left dotted line;

b) The SV cruises in the straight lane at the set speed V_{SV} and approaches the TV ahead in the main lane. See Table C.3 for specific parameters.

Table C.3 Test Scenario Parameters

Set Speed of SV, V_{SV} (km/h)	Distance from Lane Line (m)	TV Type
125	+0.4	Passenger car
130		
125	-0.4	
130		
110-130 (take a speed point every 5)	+0.4	Bus
	-0.4	
110-130 (take a speed point every 5)	+0.4	Heavy-duty truck
	-0.4	

C.3.1.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV does not collide with the TV, and the SV brakes to 0 km/h or avoids the TV through system steering;

b) The SV collides with the TV;

a) The SV deviates out of the target lane during running.

C.3.1.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) Recording of valid data begins when the clearance between the SV and the TV is 250 m.

C.3.2 Stationary passenger car ahead (on a curve)

C.3.2.1 Scenario description

The SV runs into a curve from a straight lane at the specified set speed and gradually approaches the stationary TV in the same lane on the curve ahead, as shown in Fig. C.2.

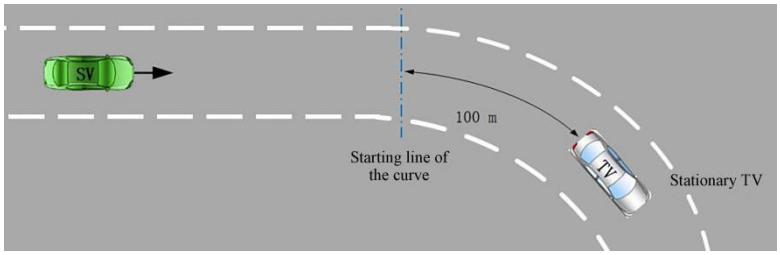


Fig. C.2 Schematic Diagram of Scenario

C.3.2.2 Test method

a) The TV remains stationary in the middle of the main lane, and the starting line of the curve is 100 m away from the tail of the TV along the centerline of the curve;

b) The SV cruises in the straight lane at the set speed V_{SV}, gradually runs into the curve and approaches the TV ahead. See Table C.4 for specific parameters.

Table C.4 Test Scenario Parameters

Set Speed of SV, V_{SV} (km/h)	Curve Radius (m)
125	500
130	
100-120 (take a speed point every 5)	300
100-120 (take a speed point every 5)	400
110-130 (take a speed point every 5)	600

C.3.2.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV does not collide with the TV, and the SV brakes to 0 km/h or avoids the TV through system steering;

b) The SV collides with the TV;

c) The SV deviates out of the target lane during running.

C.3.2.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) The target object shall be placed at the curve with constant curvature;

c) Recording of valid data begins when the clearance between the SV and the TV is 250 m.

C.3.3 Passenger car TV cut-in

C.3.3.1 Scenario description

The SV cruises in a straight lane at the specified set speed, and the TV runs in the adjacent lane at a speed lower than that of the SV. When the SV gradually approaches the TV after its speed becomes stable, the TV cuts in ahead of the SV from the adjacent lane, as shown in Fig. C.4.

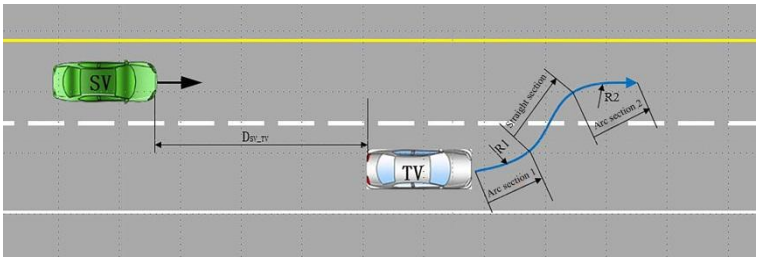


Fig. C.3 Schematic Diagram of Scenario

C.3.3.2 Test method

a) The SV cruises stably in the straight lane at V_{SV}, and the TV runs at a constant speed of V_{TV} in the adjacent lane;

b) The TV cuts into the SV's running lane along the lane change trajectory ahead of the SV at the given moment. See Table C.5 for specific parameters.

Table C.5 Test Scenario Parameters

V_{SV}, V_{TV1} (km/h)	TTC (s)	Arc Radius R1, R2 (m)	Straight Section Length (m)	Angle between Trajectory and Lane Line (°)
100, 50	1.8	104.05	34.85	4.94
100, 55	1.8	104.05	34.85	4.94
100, 60	1.8	104.05	34.85	4.94
105, 45	1.8	113.36	36.59	4.70
105, 50	1.8	113.36	36.59	4.70
105, 55	1.6	113.36	36.59	4.70
110, 60	1.6	122.17	38.32	4.49
110, 65	1.6	122.17	38.32	4.49
110, 70	1.6	122.17	38.32	4.49
115, 45	1.6	133.40	40.04	4.30
115, 50	1.6	133.40	40.04	4.30
115, 60	2.0	133.40	40.04	4.30
125, 50	2.0	145.20	41.78	4.22
125, 55	2.0	145.20	41.78	4.22
125, 65	2.0	145.20	41.78	4.22
130, 60	2.0	150.40	43.68	4.55
130, 70	2.0	150.40	43.68	4.55

C.3.3.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV slows down and follows the TV or avoids the TV through system steering;

b) The SV collides with the TV;

c) The SV deviates out of the target lane during running.

C.3.3.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) The TV reaches the set speed V_{TV} at the start of cut-in;

c) The error between the actual longitudinal offset between the SV and the TV and the specified value shall not exceed 5% at the moment when the TV starts to cut in;

d) The SV remains in the lane before the TV cuts in.

C.3.4 Passenger car TV cut-out

C.3.4.1 Scenario description

The SV follows TV1 stably in a straight lane at the specified set speed, and TV2 remains stationary in the middle of the same lane ahead of TV1. When TV1 approaches TV2, TV1 cuts out from its lane to the adjacent lane, as shown in Fig. C.4.

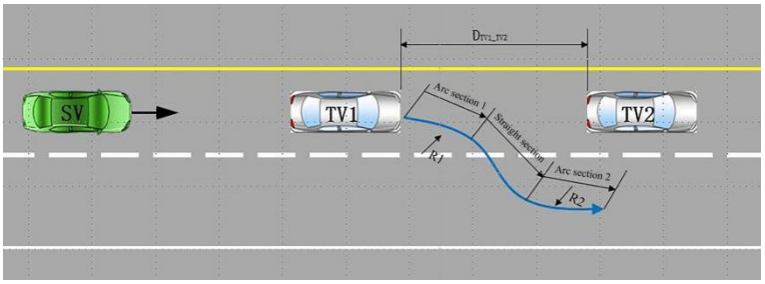


Fig. C.4 Schematic Diagram of Scenario

C.3.4.2 Test method

a) TV2 remains stationary in the middle of the lane ahead of TV1;

b) The SV follows TV1 and cruises stably in the straight lane at the set speed Vsv, with a time headway (THW) of 2.2 s. When the distance between TV1 and TV2 (D_{TV1_TV2}) meets the triggering conditions, TV1 cuts out along the lane change trajectory to the adjacent lane. See Table C.6 for specific parameters.

Table C.6 Test Scenario Parameters

V_{SV}, V_{TV1} (km/h)	D_{TV1_TV2} (m)	Arc Radius R1, R2 (m)	Straight Section Length (m)	Angle between Trajectory and Lane Line (°)
100	60	101.05	34.85	4.94
105	70	111.36	36.59	4.70
110	70	122.17	38.32	4.49
110	100	122.17	38.32	4.49
115	55	133.40	40.04	4.30
115	80	133.40	40.04	4.30
115	110	133.40	40.04	4.30
120	80	145.20	41.78	4.12
120	110	145.20	41.78	4.12
125	100	145.20	41.78	4.12
125	110	145.20	41.78	4.12
130	100	145.20	41.78	4.12
130	100	145.20	41.78	4.12

C.3.4.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV slows down and stops behind TV2 or avoids the TV through system steering;

b) The SV collides with the TV;

c) The SV deviates out of the target lane during running.

C.3.4.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) The TV reaches the set speed V_{TV} at the start of cut-out;

c) The error between the actual longitudinal offset to the TV and the specified value shall not exceed 5% at the moment when the TV starts to cut out;

d) The SV remains in the lane before the TV cuts out.

C.3.5 Obstacle avoidance

C.3.5.1 Scenario description

The SV cruises in a straight lane at the specified set speed and gradually approaches the obstacles ahead in the same lane after its speed becomes stable, as shown in Fig. C.5.

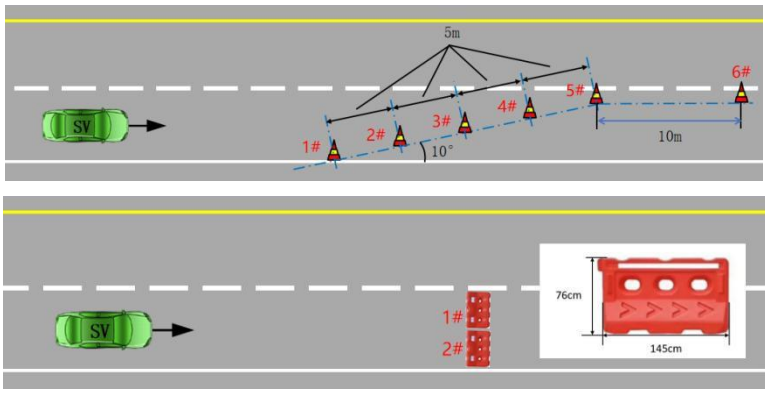


Fig. C.5 Schematic Diagram of Scenario

C.3.5.2 Test method

a) The TV remains stationary in the middle of the SV's running lane;

b) The SV cruises in the straight lane at the set speed V_{SV} and approaches the obstacles ahead in the main lane. See Table C.7 for specific parameters.

Table C.7 Test Scenario Parameters

Set Speed of SV, VSV (km/h)	Obstacle Type
125, 130	Traffic cone
80-130 (take a speed point every 5)	Water-filled barrier

C.3.5.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV does not collide with the obstacles, and the SV brakes to 0 km/h or avoids the obstacles through steering;

b) The SV collides with an obstacle;

c) The SV deviates out of the target lane during running.

C.3.5.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) Recording of valid data begins when the clearance between the SV and the obstacle is 250 m.

C.3.6 Stationary special vehicle ahead

C.3.6.1 Scenario description

The SV cruises in a straight lane at the specified set speed and gradually approaches the special vehicle ahead after its speed becomes stable, as shown in Fig. C.8.

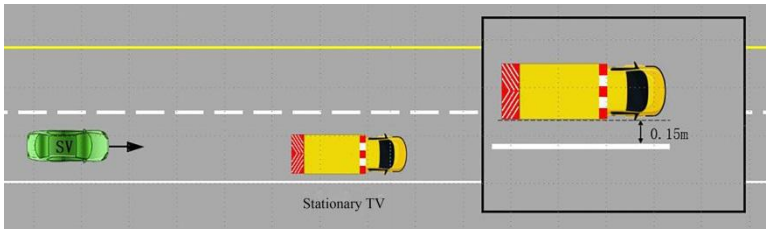


Fig. C.8 Schematic Diagram of Scenario

C.3.6.2 Test method

a) The TV remains stationary ahead in the SV's lane, with a distance of 0.15 m (record as -0.15) from the right solid line or 0.15 m (record as +0.15) from the left dotted line;

b) The SV cruises in the straight lane at the set speed V_{SV} and approaches the TV ahead in the main lane. See Table C.8 for specific parameters.

Table C.8 Test Scenario Parameters

Set Speed of SV, V_{SV} (km/h)	Distance from Lane Line (m)	TV Type
125, 130	+0.15	Anti-collision buffer vehicle
	-0.15	
110-130 (take a speed point every 5)	+0.15	Ambulance
	-0.15	
110-130 (take a speed point every 5)	+0.15	Fire truck
	-0.15	

C.3.6.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV does not collide with the TV, and the SV brakes to 0 km/h or avoids the TV through system steering;

b) The SV collides with the TV;

c) The SV deviates out of the target lane during running.

C.3.6.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) Recording of valid data begins when the clearance between the SV and the TV is 250 m.

C.3.7 Emergency braking of vehicle ahead

C.3.7.1 Scenario description

The SV runs stably in the main lane at the set speed, and the TV runs stably at the set speed in the same lane ahead of the SV at a certain distance apart. When the SV approaches the TV, the TV "suddenly" applies emergency braking, as shown in Fig. C.7.

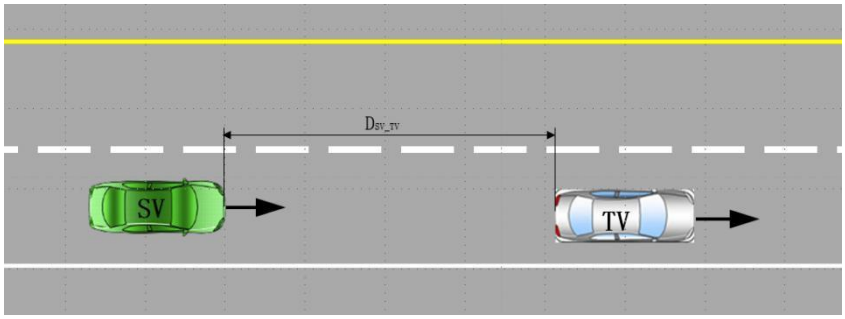


Fig. C.7 Scenario of Emergency Braking of Vehicle Ahead

C.3.7.2 Test method

a) The SV is placed on the road and cruises in the lane at the set speed V_{SV};

a) The TV runs stably at the set speed V_{TV} in the same lane of the SV;

b) When the TV is at the given test distance (D_{SV_TV}) ahead of the SV, it applies emergency braking. See Table C.9 for specific parameters.

Table C.9 Test Scenario Parameters

V_{SV}, V_{TV} (km/h)	D_{SV_TV} (m)	TV Type
110	30-60 (take a distance point every 10)	Passenger car
120	30-60 (take a distance point every 10)	Bus
130	30-60 (take a distance point every 10)	Heavy-duty truck

C.3.7.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV slows down and stops behind the TV or avoids the TV through system steering;

b) The SV collides with the TV;

C.3.7.4 Description of test scenario parameters

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) The TV reaches the set speed V_{TV};

c) The error between the actual longitudinal offset between the SV and the TV and the specified value shall not exceed 5% when the TV applies emergency braking;

d) Before the TV starts to apply emergency braking, the SV and the TV remain in the same lane, and the TV is ahead of the SV.

C.3.8 TV cut-in at the moment of obstruction of the SV's field of view

C.3.8.1 Scenario description

The SV runs side by side and in the same direction in the main lane at the set speed, and its field of view of the adjacent lane is blocked by TV1 (large vehicle). Meanwhile, TV2 is running ahead of TV1 and changing its lane to cut into the SV's lane, as shown in Fig. C.8.

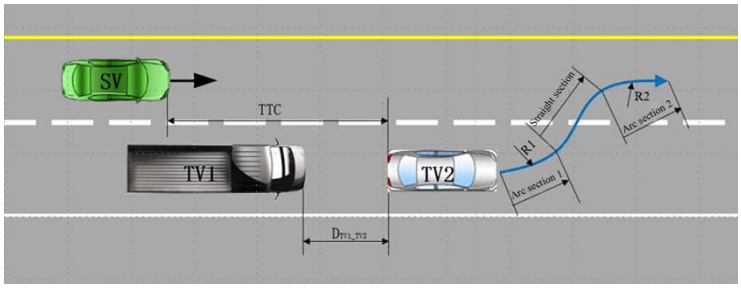


Fig. C.8 Schematic Diagram of Scenario

C.3.8.2 Test method

a) The SV cruises stably at V_{SV} in the straight lane, while TV1 and TV2 run at a constant speed of V_{TV} in the adjacent lane;

b) When TV2 is at the given distance ahead of the SV, it cuts into the SV's running lane along the lane change trajectory. See Table C.10 for specific parameters.

Table C.10 Test Scenario Parameters

V_{SV}, V_{TV1}, V_{TV2} (km/h)	TTC (s)	D_{TV1_TV2} (m)	Arc Radius R1, R2 (m)	Straight Section Length (m)	Angle between Trajectory and Lane Line (°)	TV Type (TV1, TV2)
80, 60, 60	2.0	30	120	7.2	4.2	Heavy-duty truck, passenger car
85, 65, 65	2.0	50	140	20	4.2	Bus, bus
90, 40, 40	2.0	80	120	7.2	4.0	Bus, passenger car
90, 50, 50	2.0	33	120	7.2	4.0	Bus, passenger car
95, 45, 45	1.8	50	150	8.6	3.8	Heavy-duty truck, passenger car
100, 55, 55	1.8	80	145	15.6	3.8	Bus, bus
100, 70, 70	1.8	36	145	15.6	3.8	Heavy-duty truck, passenger car
105, 60, 60	1.8	60	145	16.4	3.2	Bus, passenger car
110, 55, 55	2.0	90	135	15.6	3.2	Heavy-duty truck, passenger car
115, 60, 60	2.0	39	135	16.4	3.2	Bus, bus
120, 65, 65	2.0	60	135	20	3.8	Bus, passenger car
120, 70, 70	2.0	90	140	20	3.8	Bus, bus
125, 70, 70	2.0	90	140	20	3.8	Bus, bus
130, 70, 70	2.0	90	140	20	3.8	Bus, bus

C.3.8.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV slows down and stops behind TV2 or avoids it through system steering;

b) The SV collides with TV2;

C.3.8.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) TV1 reaches the set speed V_{TV1};

c) TV2 reaches the set speed V_{TV2} at the start of cut-in;

d) The error between the actual longitudinal offset between the SV and TV2 and the specified value shall not exceed 5% at the moment when TV2 starts to cut in;

e) The SV remains in the lane before TV2 cuts in.

C.3.9 Construction area passing

C.3.9.1 Scenario description

The SV runs stably in the main lane at the set speed, and the TV is about to cut into the adjacent lane due to road construction ahead, as shown in Fig. C.9.

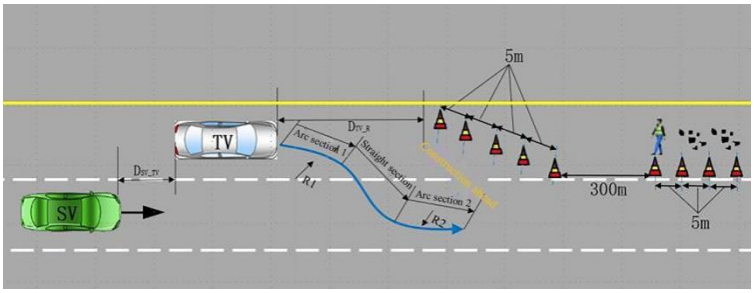


Fig. C.9 Schematic Diagram of Scenario

C.3.9.2 Test method

a) The SV cruises stably at the set speed V_{SV} in the main lane, and the TV runs at a constant speed of V_{TV} in the adjacent lane of the SV.

b) When the actual longitudinal offset (D_{TV_R}) between the TV and the road construction area meets the triggering conditions, the TV cuts out to the adjacent lane along the lane change trajectory. See Table C.11 for specific parameters.

Table C.11 Test Scenario Parameters

V_{SV}, V_{TV} (km/h)	D_{SV_R} (m)	TTC (s)	Arc Radius R1, R2 (m)	Straight Section Length (m)	Angle between Trajectory and Lane Line (°)	TV Type
80, 60	40	2.0	130	15.8	4.0	Passenger car
80, 60	40	2.0	130	15.8	4.0	Bus
90, 60	40	2.0	130	16.4	4.2	Passenger car
90, 60	40	2.0	140	16.4	4.2	Bus
90, 60	40	2.0	140	16.4	4.2	Heavy-duty truck
110, 55	50	1.8	140	15.6	4.6	Passenger car
110, 55	50	1.8	140	15.6	4.6	Bus
110, 55	50	1.8	135	15.6	4.6	Heavy-duty truck
120, 65	60	2.0	135	20	3.0	Passenger car
120, 65	60	2.0	135	20	3.0	Bus
120, 65	60	2.0	130	20	3.0	Heavy-duty truck
125, 70	70	2.0	130	16.4	3.2	Bus
130, 70	70	2.0	130	16.4	3.2	Bus
130, 70	70	2.0	130	16.4	3.2	Heavy-duty truck

C.3.9.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV stops or avoids the TV through actively steering;

a) The SV collides with the TV.

C.3.9.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) The TV reaches the set speed V_{TV};

c) The error between the actual longitudinal offset between the SV and the TV and the specified value shall not exceed 5% at the moment when the TV starts to cut in;

d) The SV remains in the lane before the TV cuts in.

C.3.10 On-ramp

C.3.10.1 Scenario description

The SV merges into the main road from the ramp at the set speed. When the SV is about to cut into the main road, the TV on the adjacent ramp is also about to merge into the main road at the set speed, as shown in Fig. C.10.

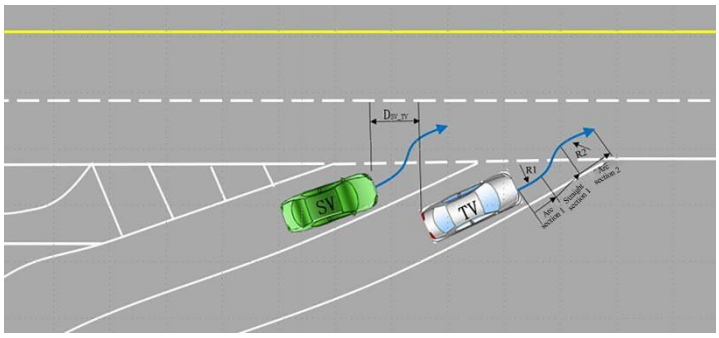


Fig. C.10 Schematic Diagram of Scenario

C.3.10.2 Test method

a) The SV runs stably at the set speed V_{SV} on the ramp; the TV runs stably at V_{TV} on the adjacent ramp of the SV;

b) The SV cuts into the main road lane from the ramp along the lane change trajectory; the TV also cuts into the main road lane from the ramp along the lane change trajectory. See Table C.12 for specific parameters.

Table C.12 Test Scenario Parameters

VSV, VTV (km/h)	TTC (s)	Arc Radius R1, R2 (m)	Straight Section 1 Length (m)	Angle between Trajectory and Lane Line (°)	TV Type
40, 20	2.0	130	16.4	4.2	Passenger car
40, 20	2.0	130	16.4	4.2	Bus
40, 20	2.0	130	16.4	4.2	Heavy-duty truck
50, 30	2.0	135	12.8	3.6	Passenger car
50, 30	2.0	135	12.8	3.6	Bus
50, 30	1.8	135	12.8	3.6	Heavy-duty truck
50, 30	1.8	140	8.6	3.8	Bus
60, 35	1.8	140	16.4	4.0	Passenger car

60, 35	2.0	140	16.4	4.0	Bus
60, 35	2.0	150	16.4	4.0	Heavy-duty truck
70, 45	2.0	150	8.6	3.8	Passenger car
70, 45	1.8	150	8.6	3.8	Bus

C.3.10.3 Conditions for end of test

The test is deemed to end when one of the following conditions occurs:

a) The SV stops or avoids the TV through actively steering;

b) The SV collides with the TV.

C.3.10.4 Test validity requirements

To ensure test validity, the following shall be guaranteed throughout the test:

a) The SV reaches the set speed V_{SV};

b) The TV reaches the set speed V_{TV};

c) Before the SV starts to cut into the main road, the TV keeps running on the adjacent ramp of the SV;

d) The error between the actual longitudinal offset between the SV and the TV and the specified value shall not exceed 5% at the moment when the TV starts to cut in.

C.4 Template of simulation test result report

See Tables C.13 and C.14 for the templates of test process integrity report and simulation test result report.

Table C.13 Template of Test Process Integrity Report

<table>
<tr><td colspan="5">Test Process Integrity Report</td></tr>
<tr><td>No.</td><td>Description</td><td colspan="3">Information Record</td></tr>
<tr><td>1</td><td>Test mode</td><td colspan="3">HIL test</td></tr>
<tr><td rowspan="11">2</td><td rowspan="11">Test bench software and hardware configuration</td><td rowspan="6">Software and version</td><td>Scenario simulation software</td><td>(Specify the software name and version)</td></tr>
<tr><td>Scenario dynamics software</td><td>(Specify the software name and version)</td></tr>
<tr><td>Test management software</td><td>(Specify the software name and version)</td></tr>
<tr><td>Automated test software</td><td>(Specify the software name and version)</td></tr>
<tr><td>.....</td><td></td></tr>
<tr><td rowspan="5">Hardware</td><td>Video black-box</td><td>√</td></tr>
<tr><td>Radar black-box</td><td>√</td></tr>
<tr><td>Ultrasonic radar simulator</td><td></td></tr>
<tr><td>GNSS positioning simulator</td><td></td></tr>
<tr><td>Real-time simulation hardware platform</td><td>√</td></tr>
<tr><td>.....</td><td></td></tr>
</table>

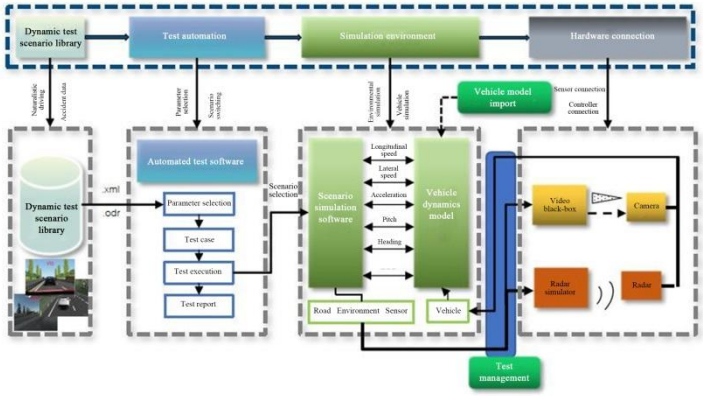
		Key photos		
3	Dynamics calibration	Longitudinal test condition	Start with wide open throttle (WOT)	
			……	
		Lateral test condition	Steady circle	
			……	
4	Device under test	Object under test	Examples: millimeter-wave radar, front-view camera	
		Function description	Examples: ACC, AEB, LDW and other functions	
5	Simulation platform architecture diagram			

Table C.14 Template of Simulation Test Result Report

Simulation Test Report							
Test time							
Test location							
Test mode		Example: HIL test					
Software and hardware information		Examples: Scenario simulation software - (specify the software name and version) Scenario dynamics software - (specify the software name and version) Automated test software - (specify the software name and version) Automated test and rating platform - (specify the software name and version)					
Basic Scenario Test							
Scenario 1 - Stationary Passenger Car TV							
S/N	Case No.	VSV, VTV1 (km/h)	D_{TV1_TV2} (m)	Arc Radius (m)	Straight Section Length (m)	Safety	Regulatory Compliance
1	CutOut_001	60	30	36.9	21.05	Passed	Passed
2	CutOut_002	60	50	36.9	21.05	Passed	Passed
3	CutOut_003	60	80	36.9	21.05	Passed	Passed

4	CutOut_004	65	32	43.03	22.77	Passed	Failed
5	CutOut_005	65	50	43.03	22.77	Failed	Passed
6	CutOut_006	65	80	43.03	22.77	Failed	Failed
……	……	……	……	……	……	……	……
Scenario Generalization Test							
Scenario 1 - Stationary TV Ahead							
S/N	Case No.	V_{SV}, V_{TV1} (km/h)	D_{SV_TV} (m)	Arc Radius (m)	Straight Section Length (m)	Safety	Regulatory Compliance
1	CutOut_001	120	30	36.9	21.05	Passed	Passed
2	CutOut_002	120	30	36.9	21.05	Passed	Passed
3	CutOut_003	120	50	36.9	21.05	Passed	Passed
4	CutOut_004	125	50	43.03	22.77	Failed	Passed
5	CutOut_005	125	60	43.03	22.77	Passed	Failed
6	CutOut_006	125	60	43.03	22.77	Failed	Failed
……	……	……	……	……	……	……	……

C.5 Record template of simulation test data template

Table C.15 Simulation Test Data Template

frame_ id	frame_ time	actor_ name	actor_ relative_ x	actor_ velocity_ x	actor_ acceleration _x	actor_ lane_ id	actor_ dist_to_ goal	actor_ relative_ y	actor_ velocity_ y	actor_ acceler-ation_ y	……
1	0	SV	44.1	0	2	-1	10	3.5	0.01	0.001	……
2	1	SV	44.2	5	-2.21E -05	-1	12	3.5	0.01	0.001	……
3	2	SV	44.3	10	2	-1	14	3.5	0.01	0.002	……
4	3	SV	44.4	15	-2.21E -05	-1	16	3.5	0.01	0.001	……
5	4	SV	44.5	20	2	-1	18	3.5	0.01	0.001	……
6	5	SV	44.6	25	-2.21E -05	-1	20	3.5	0.01	0.002	……
……	……	……	……	……	……	……	……	……	……	……	……