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National Highway Traffic Safety Administration

OPPOSING TRAFFIC SAFETY ASSIST SYSTEM CONFIRMATION TEST

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16. Abstract

This draft test procedure provides specifications used by the National Highway Traffic Safety Administration to research opposing traffic safety assist (OTSA) system performance on light vehicles with gross vehicle weight ratings (GVWR) of up to 10,000 lbs. (4,536 kg). The expected operating domain for OTSA includes paved undivided roadways supporting moderate speed traffic. Crash imminent and false positive tests are defined.

Each test scenario begins with the subject vehicle (SV) driven straight behind a lead vehicle (LV). At the same time, a single principal other vehicle (POV) is driven in a lane to the left of the SV but in the opposite direction. As the two vehicles approach each other, an SV lane deviation towards the POV is initiated. For the crash imminent tests, the POV is driven in a lane adjacent to that of the SV with timing that requires an OTSA intervention to prevent the SV from being laterally displaced to within 1.5 ft (0.46 m) of the POV. False positive tests are performed with one lane initially separating the SV and POV, but conclude with the SV traveling in a lane adjacent to that of the POV to evaluate the propensity of an OTSA system to inappropriately activate in a non-critical driving scenario that does not present a safety risk to the SV occupants.

For all tests described in this document, the POV is a strikeable object with the characteristics of a compact passenger car.

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OPPOSING TRAFFIC SAFETY ASSIST SYSTEM CONFIRMATION TEST

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GLOSSARY

ACC	adaptive cruise control
ADAS	Advanced Driver Assistance System
ASTM	formerly known as the American Society for Testing and Materials, and as ASTM International since 2001
GVT	Global Vehicle Target
GVWR	gross vehicle weight rating
LCC	lane centering control
lidar	light detection and ranging
LV	lead vehicle
MUTCD	Manual on Uniform Traffic Control Devices
OTSA	opposing traffic safety assist
PFC	peak friction coefficient
POV	principal other vehicle
SAE	formerly known as the Society of Automotive Engineers, and as SAE International since 2006
SV	subject vehicle
TTC	time-to-collision

1.0 PURPOSE AND APPLICATION

This draft test procedure provides specifications used by the National Highway Traffic Safety Administration (NHTSA) to research opposing traffic safety assist (OTSA) system performance on light vehicles with gross vehicle weight ratings (GVWR) of up to 10,000 lbs. (4,536 kg). The expected operating domain for OTSA includes paved undivided roadways supporting moderate speed traffic. Examples include primary roads without limited access; secondary and connecting roads; and local, neighborhood, and rural roads.

The tests contained in this document are intended for evaluation of Society of Automotive Engineers (SAE) automation level 0, 1, 2, or 3 vehicles that use sensors such as radar, cameras, and/or lidar to detect nearby objects. Although it is impossible to predict what technologies could be used by future OTSA systems (e.g., vehicle-to-vehicle communication), it is believed that modifications to these procedures, when deemed appropriate, could be used to accommodate the evaluation of (1) alternative or more advanced OTSA systems, and/or (2) higher level automated vehicles.

Note: *The subject vehicle (SV) driver shall not provide manual[1] inputs to the accelerator pedal, brake pedal, or steering wheel when the tests described in this document are performed with the SV operating in SAE automation level 2 or 3 within the applicable validity periods. This provision is intended to eliminate the potential for OTSA operation from being unintendedly affected by the SV driver while tests are being safely performed within the controlled confines of a test track, and does not constitute an endorsement by NHTSA for drivers to remove their hands from the steering wheel while operating their vehicle on public roads.*

2.0 GENERAL REQUIREMENTS

This document describes the methods used by NHTSA to assess OTSA operation on the test track. Each test scenario begins with the SV driven straight behind a lead vehicle (LV). At the same time, a single principal other vehicle (POV) is driven in a lane to the left of the SV but in the opposite direction. As the two vehicles approach each other, an SV lane deviation towards the POV is initiated.

Crash imminent and false positive tests are defined. For the crash imminent tests, the POV is driven in a lane adjacent to that of the SV with timing that requires an OTSA intervention to prevent the SV from being laterally displaced to within 1.5 ft (0.46 m) of the POV. False positive tests are performed with one lane initially separating the SV and POV, but conclude with the SV traveling in a lane adjacent to that of the POV to evaluate the propensity of an OTSA system to inappropriately activate in a non-critical driving scenario that does not present a safety risk to the SV occupants.

[1] In the context of this document, manual inputs are those not automatically controlled by the SV itself. Manual steering, throttle, and brake applications may be input by the SV driver, a robotic controller, etc.

Scenarios 1, 2, and 4 are performed with the SV operating in either SAE automation level 0 or 1. For these tests, the SV lane deviations are initiated with manual steering. Scenarios 3 and 5 are performed with the SV operating in either SAE automation level 2 or 3. For these tests, automated steering is used to command the SV lane deviation.

Scenarios 1, 2, and 3 are crash imminent tests:

- In scenario 1, the lane deviation is performed with low lateral velocity to simulate an unintended drift, and it is not preceded by activation of the turn signal.
- In scenario 2, the lane deviation is performed with higher lateral velocity to simulate a deliberate lane change, and is preceded by activation of the turn signal.
- In scenario 3, the lane deviation (should one occur) is preceded by activation of the turn signal, however the magnitude of the SV lateral velocity depends to that commanded by the SV's automatic lane change function (if so-equipped).

Scenarios 4 and 5 are false positive tests:

- Scenario 4 is performed in a manner nearly identical to scenario 2 however the POV is initially offset by one lane, and the SV nominally performs a single lane change into the left adjacent lane. The SV lane change is preceded by activation of the turn signal in scenario 4.
- Scenario 5 is performed in a manner nearly identical to scenario 3 however the POV is initially offset by one lane, and the SV nominally performs an automated single lane change into the left adjacent lane after activation of the turn signal.

For all tests described in this document, the POV is a strikeable object with the characteristics of a compact passenger car[2]. At no time shall the SV contact the POV during the conduct of any trial described in this document.

3.0 DEFINITIONS

Opposing Traffic Safety Assist (OTSA): An advanced driver assistance system whose active interventions are designed to bring a driver's vehicle back into the original travel lane after a path deviation causes it to move towards an oncoming vehicle driven in an adjacent lane. OTSA activation shall automatically occur regardless of whether the driver has activated the turn signal prior to the lane deviation.

[2] POV specifications are described in S4.5.

4.0 PRETEST AND FACILITY REQUIREMENTS

4.1 Road Test Surface

The road test surface used for the tests described in this document shall be dry (without visible moisture on the surface), straight, and flat, with a consistent slope between level and one percent. The road surface shall be constructed from asphalt or concrete and shall be free of irregularities, undulations, and/or cracks that could cause the SV to pitch excessively. The surface shall be free of excessive tire skid marks, pavement seam sealer, and/or other high-contrast surface markings that could potentially confound lane line identification and/or tracking.

The road test surface must produce a peak friction coefficient (PFC) of at least 0.9 when measured using an American Society for Testing and Materials (ASTM) E1136 standard reference test tire, in accordance with ASTM Method E 1337-90, at a speed of 64.4 km/h (40 mph), without water delivery [1]. The test track PFC shall be documented.

4.2 Line Markings

The tests described in this document require up to three straight travel lanes. The lines used to delineate each lane shall meet Federal Highway Administration specifications as required by the Manual on Uniform Traffic Control Devices (MUTCD) and be considered in “very good condition” [2].

4.2.1 Lane Line Styles

The lane line style used for the tests described in this document shall be discontinuous dashed, solid, or a combination thereof.

4.2.2 Line Marking Color and Reflectivity

Lane line marking color shall be white or yellow. Lane line marker color and reflectivity shall meet all applicable standards. These standards include those from the International Commission of Illumination for color and the ASTM on lane marker reflectance. Methods for determining lane marker characteristics are discussed in the Road Departure Crash Warning Systems (RDCWS) Field Operational Test (FOT) by the National Institute of Standards and Technology (NIST) [3].

4.2.3 Line Marker Width

The width of the edge line marker shall be 4 to 6 in (10 to 15 cm). This is a normal width for longitudinal pavement markings under Section 3A.05 of the MUTCD [2].

4.3 Lane Width

Each lane required by this test procedure shall be delineated with two lane lines. Measured from inside edge to inside edge, these lines shall be spaced 12 to 14 ft (3.7 to 4.3 m) apart.

4.4 Ambient Conditions

4.4.1 Ambient Temperature

The ambient temperature shall be between 45°F (7°C) and 104°F (40°C).

4.4.2 Wind Speed

The maximum wind speed shall be no greater than 22 mph (35 km/h).

4.4.3 Inclement Weather

Tests should not be performed during periods of inclement weather. This includes, but is not limited to, rain, snow, hail, fog, smoke, or ash.

4.4.4 Visibility

The tests shall be conducted during daylight hours with good atmospheric visibility defined as an absence of fog and the ability to see clearly for more than 3 miles (4.8 km). Tests shall not be conducted with the SV oriented into the sun during very low sun angle conditions, where the sun is oriented 15 degrees or less from horizontal and potential camera "washout" or system inoperability could result.

4.5 Lead Vehicle Specifications

The LV may be either (1) a realistic surrogate vehicle that satisfies the specifications defined in section 4.5.1, or (2) an actual (i.e., real) passenger car that satisfies the specifications described in S4.5.2.

4.5.1 Surrogate Vehicle

A surrogate vehicle suitable for the tests described in this document shall have the characteristics of a compact passenger car. This is intended to maximize the ability of the SV to detect the LV and/or POV in the most realistic manner possible without compromising SV driver safety and minimizing the potential for SV damage. An appropriate surrogate vehicle must possess the following attributes:

A. Accurate physical characteristics (e.g., visual, dimensional, etc.) when viewed from any approach angle

   i. Body panels and rear bumper shall be white in color.

   ii. Simulated body panel gaps shall be present.

   iii. The simulated rear glass and tires shall be dark gray or black.

   iv. A rear-mounted United States specification license plate, or reflective simulation thereof, shall be installed.

B. Reflective properties representative of a high-volume passenger car when viewed from any approach angle by radar (e.g., 24 GHz and 76-77 GHz bands) and lidar (e.g., 905 or 1550 nm) sensors.

C. Remains consistently shaped (e.g., visually, dimensionally, internally, and from a RADAR sensing perspective) within each test series.

D. Resistant to damage resulting from repeated SV-to-POV impacts.

E. Inflicts minimal to no damage to the SV, even in the event of multiple impacts.

The test conductor shall present documentation that objectively qualifies how the surrogate vehicle used to perform the tests described in this document satisfies the requirements of S4.5.1.

Note: *NHTSA intends to use the Global Vehicle Target (GVT) as the POV for the tests described in this document [4]. The GVT is a full-sized artificial vehicle designed to appear realistic to the sensors used by automotive safety systems and automated vehicles: radar, camera, and lidar. Appropriate radar characteristics are achieved by using a combination of radar reflective and radar absorbing material enclosed within the GVT's vinyl covers. The GVT is dimensionally similar to a 2013 Ford Fiesta hatchback and is secured to a low-profile robotic platform using Velcro attachment points. Internally, the GVT consists of a vinyl-covered foam structure. If a test vehicle impacts the it at low speed, the GVT is designed to separate, and is typically pushed off and away from the platform, which is then pushed against the ground and stops as the test vehicle is driven over it. At higher impact speeds, the GVT breaks apart as the SV essentially drives through it. The GVT can be repeatedly struck from any approach angle without harm to those performing the tests or the vehicles being evaluated. Reassembly of the GVT occurs on top of the robotic platform and takes a team of 3 to 5 people approximately 7 to 10 minutes to complete. The robotic platform that supports the GVT is preprogrammed and allows the GVT's movement to be accurately and repeatedly choreographed with the test vehicle and/or other test equipment required by a pre-crash scenario using closed-loop control.*

4.5.2 Actual Vehicle

If the test conductor uses an actual vehicle as the LV, it shall be a high-production passenger car between 175 to 197 in (445 to 500 cm) long, and 70 to 76 in (178 to 193 cm) wide measured at the widest part of the vehicle. The color of the actual vehicle used as the LV is unrestricted.

4.6 Principal Other Vehicle Specifications

To safely perform tests where the POV remains in a travel lane adjacent to the SV for the duration of the test trial (i.e., the scenarios described in S5.3.6, S5.3.7, and S5.3.8), the POV shall be a realistic surrogate vehicle. For the trials where the POV is initially driven two lanes away from that of the SV (i.e., the scenarios described in S5.3.9 and S5.3.10), the POV may be either (1) a realistic surrogate vehicle, or (2) an actual (i.e., real) passenger car that satisfies the specifications described in S4.5.2.

4.7 Instrumentation Required

4.7.1 Sensors and Sensor Locations

An overview of the sensors used for the tests described in this document is provided in Table 1.

Table 1. Recommended Measurements and Measurement Specifications.

Type	Output	Range	Resolution	Accuracy
Various	Lateral and Longitudinal position of SV, LV, and POV	650 ft (200 m)	2 in (5 cm)	At least 3.9 in (10 cm) absolute
Speed Sensors	SV lateral and longitudinal velocity; LV and POV longitudinal velocity	0.1 – 62 mph (0.1 -100 km/h)	0.1 mph (0.2 km/h)	+/- 0.25% of full scale range
Rate Sensor	SV, LV, and POV yaw rates	+/- 100 deg/s	0.01 deg/s	+/- 0.25% of full scale range
Accelerometers	SV lateral and longitudinal accelerations	+/- 2g	0.001g	+/- 0.01% of full scale range
Position Sensor	SV throttle and brake pedal positions	0 – 100 percent (normalized)	0.1 percent	0.1 percent
Load Cell	SV brake pedal force	0 – 300 lbf (1.3 kN)	0.1 lbf (0.4 N)	+/- 0.05% of full scale range
Steering Wheel Angle Sensor	SV steering wheel angle	±360 degrees	1 degree	2 degrees
Steering Wheel Torque Sensor	SV steering wheel torque	±500 in. lbf (56 Nm)	5 in. lbf (0.6 Nm)	5 in. lbf (0.6 Nm)
Data Flag	Turn Signal Indicator Status	0 – 10 VDC (nominally)	N/A	Output response ≤ 10 ms
Video recorded messages	Visual/audible vehicle instructions, notifications, and/or alerts presented to the driver	N/A	At least 720p	N/A
Vehicle Dimensional Measurements	Location of SV, LV, and POV GPS antennas; SV, LV, and POV centerlines; front-most SV and POV bumper positions; and rear-most LV bumper position.	N/A	0.04 in (1 mm)	0.04 in (1 mm)
SV-to-POV Static Range	Distance to POV reference point (typically the longitudinal center of gravity (CG)) and rear-most POV bumper position.	N/A	2 in (5 cm)	At least 3.9 in (10 cm) absolute

4.7.1.1 Vehicle Position

The position of the SV, LV, and POV relative to their respective travel lanes, and the position of the SV relative to the LV and POV, shall be measured within the test validity period. The sensors used for these measurements are not constrained provided they meet the range, resolution, and accuracy specifications provided in Table 1.

4.7.1.2 Vehicle Speed

The lateral and longitudinal velocities of the SV, LV, and POV shall be measured within the test validity period. The sensors used for these measurements are not constrained, provided they meet the range, resolution, and accuracy specifications provided in Table 1.

4.7.1.3 Yaw Rate

SV yaw rate shall be measured. Alternatively, differentially-corrected GPS data may be used to calculate yaw rate in lieu of direct measurement, provided the resulting accuracy is comparable.

4.7.1.4 Vehicle Acceleration

Lateral and longitudinal acceleration of the SV shall be measured within the test validity period, and shall meet the range, resolution, and accuracy specifications provided in Table 1.

4.7.1.5 SV Brake Pedal Force

SV brake pedal force shall be measured to ensure that the driver did not manually apply the foundation brakes during the test validity period using a single axis load cell securely attached to the brake pedal. If the SV driver manually applies force to the brake pedal within the validity period, the test trial is not valid and shall be repeated.

4.7.1.6 SV Accelerator Pedal Position

SV accelerator pedal position shall be measured to ensure that the driver did not manually apply an input within the validity period during tests performed with cruise control enabled (conventional or adaptive). If the driver manually applies an accelerator pedal input within the validity period, the test trial is not valid and shall be repeated. SV throttle pedal position shall be expressed as a percentage of the wide-open throttle (WOT) pedal position.

4.7.1.7 SV Brake Pedal Force

SV brake pedal force shall be measured to ensure that the driver did not manually apply the foundation brakes during the test validity period using a single axis load cell securely attached to the brake pedal. If the SV driver manually applies force to the brake pedal within the validity period, the test trial is not valid and shall be repeated.

4.7.1.8 SV Accelerator Pedal Position

SV accelerator pedal position shall be measured to ensure that the driver did not manually apply an input within the validity period during tests performed with cruise control enabled (conventional or adaptive). If the driver manually applies an accelerator pedal input within the validity period, the test trial is not valid and shall be repeated. SV throttle pedal position shall be expressed as a percentage of the wide-open throttle (WOT) pedal position.

4.7.1.9 SV Instructions, Notifications, and/or Alerts

The data acquisition system shall record any visual/audible vehicle instructions, notifications, and/or alerts presented to the SV driver. Use of a high resolution digital video camera synchronized with the other recorded data channels is recommended for this purpose.

5.0 TEST EXECUTION AND TEST REQUIREMENTS

All tests performed in this document shall be performed with the SV operating in either SAE automation level 0, 1, 2, or 3 and the SV transmission in "drive." For safety reasons, and to ensure the SV is properly initialized before each trial is initiated, it is anticipated a test driver will be present in the SV driver's seat. OTSA system performance shall be evaluated in accordance with the test procedures described in S5.3.6, S5.3.7, S5.3.7, S5.3.7, and S5.3.10.

5.1 Pre-Test Initialization and Calibration

5.1.1 Instrumentation Initialization

All instrumentation shall be secure and properly configured. With all instrumentation off, the SV, LV, and POV shall be driven to an outdoor location unobstructed by buildings, overpasses, or other structures capable of interfering with the ability of the GPS equipment to acquire satellite-based position information and real-time base station corrections (where applicable). At this location, the instrumentation shall be turned on, and static and dynamic GPS initializations be performed.

1. Static initialization

    A. Where applicable, the transmissions of the SV and LV shall be placed in park and the POV system brake enabled (robotic platforms).

    B. The SV, LV, and POV shall remain at rest until transmissions from at least six (6) GPS satellites have been obtained and indicated by the vehicle's respective instrumentation.

2. Dynamic initialization

   A. The SV, LV, and POV shall be driven in a straight line, at a speed of at least 35 mph (56.3 km/h) for at least 350 ft (107 m).

   B. The SV, LV, and POV shall be driven in three (3) figure eight patterns. The radii of the turns shall be approximately 20 ft (6 m).

   C. Steps 5.1.1.2.A and 5.1.1.2.B shall be repeated until the respective instrumentation indicates that the required accuracies for position and heading have been achieved (e.g., GPS equipment is operating with real-time kinematic integer accuracy).

5.1.2 Static Instrumentation Calibration

Calibration data shall be collected prior to the tests specified in S5.3.6, S5.3.7, S5.3.8, S5.3.9, and S5.3.10 to assist in resolving uncertain test data.

1. The SV and LV shall be centered in the same travel lane with the same orientation (i.e., each must face the same direction).

2. The front-most location of the SV shall be positioned such that it just contacts a vertical plane that defines the rearmost location of the LV. This is the "zero position."

3. The SV-to-LV zero position shall be documented prior to, and immediately after, conduct of a test series.

   A. If the zero-position reported by the data acquisition system differs by more than ±2 in (±5 cm) from that measured during collection of the pre-test static calibration data file, the pre-test longitudinal offset shall be adjusted to output zero and another pre-test static calibration data file collected.

   B. **If the zero-position reported by the data acquisition system differs by more than ±2 in (±5 cm) from that measured during collection of the post-test static calibration data file, the tests performed between collection of that post-test static calibration data file and the last valid pre-test static calibration data file shall be repeated.**

4. The SV and POV shall be centered in the same travel lane with an opposing orientation.

5. The front-most location of the SV shall be positioned such that it just contacts a vertical plane that defines the front-most location of the POV. This is the "zero position."

6. The SV-to-POV zero position shall be documented prior to, and immediately after, conduct of a test series.

   A. If the zero-position reported by the data acquisition system differs by more than ±2 in (±5 cm) from that measured during collection of the pre-test static calibration data file, the pre-test longitudinal offset shall be adjusted to output zero and another pre-test static calibration data file collected.

   B. **If the zero-position reported by the data acquisition system differs by more than ±2 in (±5 cm) from that measured during collection of the post-test static calibration data file, the tests performed between collection of that post-test static calibration data file and the last valid pre-test static calibration data file shall be repeated.**

7. Static data files shall be collected prior to, and immediately after, conduct of the test series described in S5.3.6, S5.3.7, S5.3.8, S5.3.9, and S5.3.10. The pre-test static files shall be reviewed prior to test conduct to confirm that all data channels are operational and have been properly configured.

5.2 OTSA Pre-Test System Initialization

Some SVs may require a brief period of initialization (e.g., verification of sensor alignment and detection readiness) before their respective OTSA system performance can be properly assessed. If a manufacturer-specific initialization procedure is required, NHTSA will obtain the appropriate procedure from the respective vehicle manufacturer, and provide it to the Contractor. The Contractor shall perform any NHTSA-provided initialization schedule prior to performing the tests described in this test document.

5.3 Test Scenarios

5.3.1 General Test Requirements

For tests described in S5.3.6, S5.3.7, S5.3.8, S5.3.9, and S5.3.10 of this document, the following requirements shall be satisfied during the respective validity periods:

1. The SV driver seatbelt must be latched.

2. If any load has been placed on the SV front passenger seat (e.g., for instrumentation, etc.), the vehicle's front passenger seatbelt must be latched.

3. When operating the SV in automation level 0 within the validity period, SV speed shall be maintained by either (1) the SV driver or robotic controller manually modulating the SV

accelerator pedal, or (2) use of conventional cruise control unless the SV OTSA system automatically terminates its operation[3].

4. Operating the SV in automation level 1 requires SV Adaptive Cruise Control (ACC), not the vehicle's lane centering system, be enabled and in operation unless the SV OTSA system automatically terminates its operation[4].

5. Operating the SV in automation level 2 or 3 requires ACC and Lane Centering Control (LCC) both be enabled and in operation.

6. The SV driver shall not provide manual inputs to the SV accelerator or brake pedals while the SV speed is being actively modulated with conventional cruise control or ACC.

7. When the SV is being operated in automation level 0 or 1, the SV yaw rate must not exceed ±1.0 deg/s from the onset of the validity period until the initiation of the SV lane deviation.

8. The LV centerline shall not deviate more than ±0.8 ft (±0.25 m) from the center of the LV travel lane within the validity period.

9. The left side of the POV shall not deviate more than 3.3 ± 0.8 ft (1 ± 0.25 m) from the inboard edge of the lane line immediately to its left within the validity period.

5.3.2 Adaptive Cruise Control Settings

ACC systems typically provide the operator with a range of settings to incrementally adjust the following distance from the front of the SV to the rear of the vehicle ahead of it. Provided the SV is so-equipped, the SV ACC shall be set to the farthest headway setting available.

5.3.3 Lane Centering Control Settings

In the context of this document, LCC systems <u>continuously</u> provide the steering inputs needed to keep the SV centered in its travel lane. Unlike ACC (where applicable), it is not anticipated the vehicles evaluated with the tests described in this document will be equipped with LCC systems that provide operator-selectable settings, modes, etc. other than on, off, and standby. LCC shall only be used during the tests described in S5.3.8 and S5.3.10.

5.3.4 Lane Keeping Support Settings

LKS systems (also known as Lane Keeping Assist or LKA systems) are intended to automatically provide the <u>brief</u> heading corrections needed to bring the vehicle away from a lane line after it

[3] Where applicable. A OTSA system intervention may not terminate cruise control operation for all vehicles.

[4] Where applicable. A OTSA system intervention may not terminate ACC operation for all vehicles.

has been crossed or if a crossing has been deemed imminent. Since LKS interventions have the potential for confounding the ability to evaluate OTSA operation and effectiveness, the SV's LKS system (where applicable) shall be switched off for all tests described in this document.

5.3.5 Data Collection Interval

Data collection for all trials described in this document shall be initiated at the onset of the validity period, and end at least 5 seconds after completion of any termination condition.

5.3.6 OTSA Scenario 1: SV Departure into Oncoming POV Lane, No SV Turn Signal, Manual Steering

OTSA Scenario 1 is designed to evaluate the OTSA system's ability to detect and respond to an oncoming POV after an SV lane deviation creates a crash-imminent driving situation. Specifically, the OTSA system is expected to intervene in a manner that prevents any part of the SV from being within 1.5 ft (0.46 m) of any part of the POV. In this scenario, the lane deviation is commanded manually, occurs with low lateral velocity, and is not preceded by activation of the turn signal (see Figure 1).

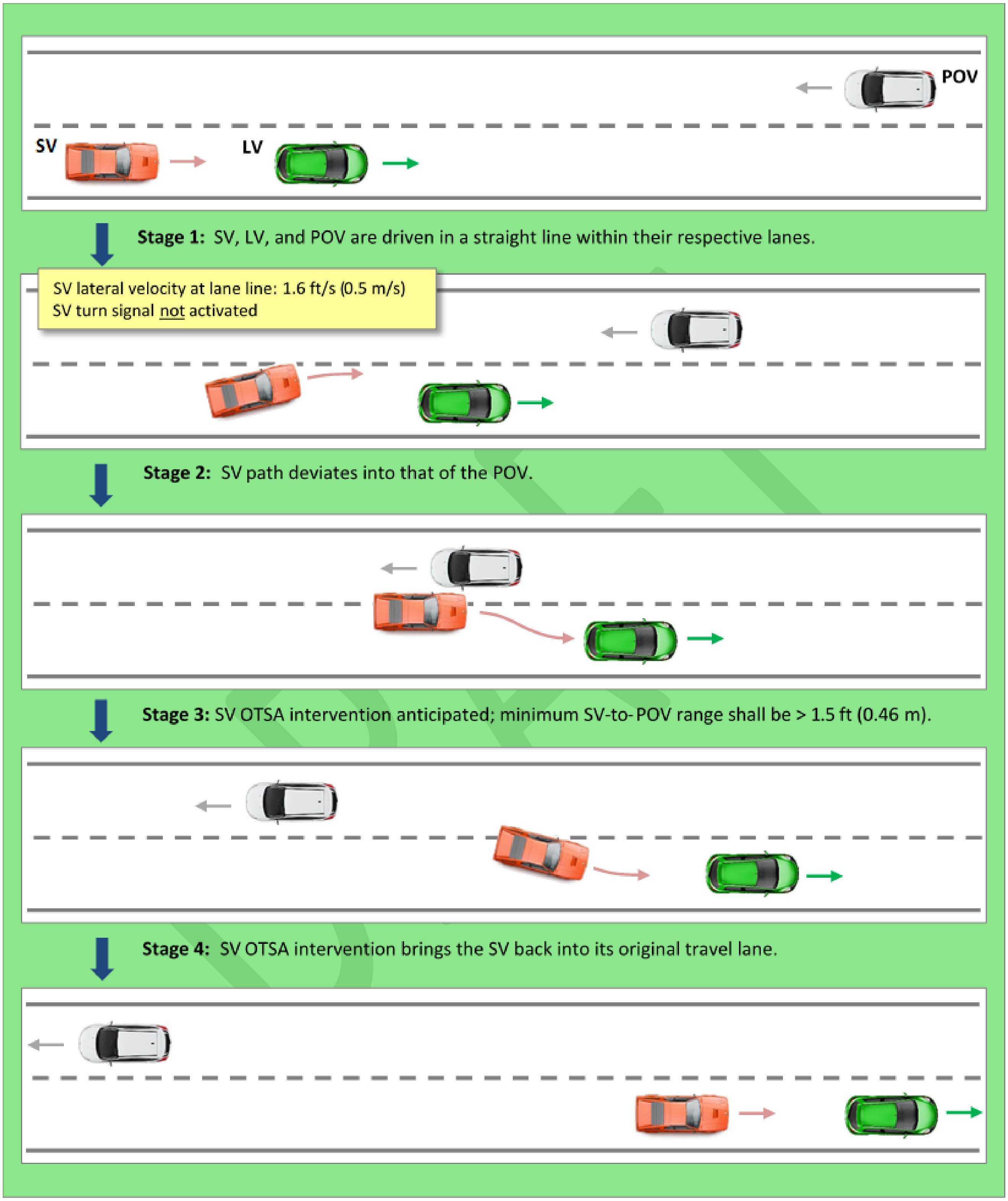

Figure 1. OTSA Scenario 1 (SV turn signal not activated).

5.3.6.1 Staging

Each OTSA Scenario 1 trial begins with the SV at rest and laterally offset from the center of its travel lane[5]. As shown in Figure 2, the offset magnitude is calculated by adding two lateral components: (1) the lateral distance travelled along a 3,937 ft (1200 m) radius curve until the desired heading angle (Θ_{SV}) towards the left lane line is realized, and (2) the lateral distance traveled during a short period of steady state driving at a constant lateral velocity of 1.6 ± 0.3 ft/s (0.5 ± 0.1 m/s) before the SV reaches the left lane line.

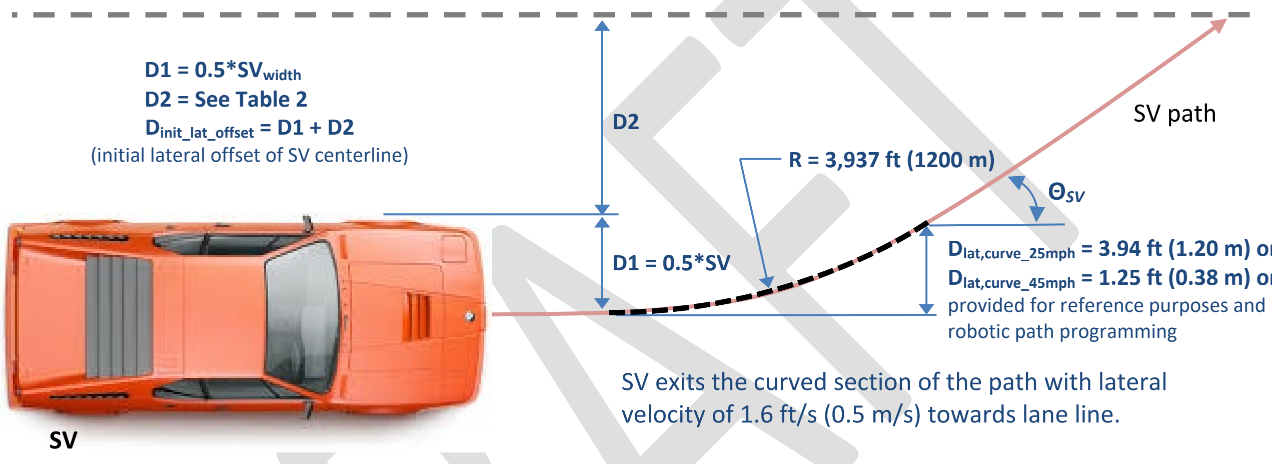

Figure 2. Input parameters used to define the SV path deviation during OTSA Scenario 1.

The LV shall be positioned ahead of the SV, at rest in the center of the SV travel lane. The orientation of the LV shall be the same as that of the SV. The SV-to-LV headway specifications are shown in Table 2.

The orientation of the POV shall be opposite of the SV and LV. Longitudinally, the front of the POV shall be positioned approximately 2,625 ft (800 m) from the front of the SV in an adjacent lane[6]. The left side of the POV (i.e., the side of the POV closest to the SV) shall be laterally offset 3.3 ft (1 m) from the inboard edge of the lane line immediately to its left.

5.3.6.2 Test Choreography

Table 2 presents an overview of the SV, LV, and POV speeds, positions, and timing used to perform the OTSA Scenario 1 tests.

[5] Specification of a lateral offset is intended to insure the SV is being operated at the desired lateral velocity before its OTSA system intervenes. This eliminates the likelihood of the SV OTSA system attempting to apply a correction away from the POV at the same time the SV is being steered towards it.

[6] This specification is provided as a recommendation to assist with test configuration. Provided all validity criteria are satisfied during test conduct, this value may be adjusted as necessary.

- The SV, LV, and POV shall be accelerated to the desired speeds shown in Table 2.

- To maximize test efficiency, it is recommended the SV and LV remain at or near the desired headway shown in Table 2 as they approach the desired speed.[7]

- Use of manual throttle modulation or conventional cruise control to maintain SV speed during tests performed in automation level 0 is acceptable provided that SV speed and SV-to-LV headway remain within the tolerances shown in Table 2 from the onset of the validity period to initiation of the SV lane deviation.

- Tests performed in automation level 1 require the SV ACC be enabled, initialized, and actively maintaining SV-to-LV headway no later than the onset of the validity period. The SV ACC is used to maintain SV speed and SV-to-LV headway from the onset of the validity period to initiation of the SV lane deviation.

- The left side of the SV shall not deviate more than 5.35 ± 0.8 ft (1.63 ± 0.25 m) from the inboard edge of the lane line immediately to its left from the onset of the validity period to initiation of the SV path deviation.

- When the longitudinal time-to-collision (TTC) between the SV and POV is within the tolerances shown in Table 2, manual steering and the input parameters described in Figure 2 are used to initiate the SV lane deviation shown in Figures 1 and 2. The intent of this deviation is to redirect the heading of the SV into the forward path of the POV.

- The SV driver shall release the steering wheel[8] within 250 ms of the SV exiting the 3,937 ft (1200 m) radius curve used to define the SV path deviation.

[7] Beginning a test trial with the SV-to-LV headway at or near the target value helps reduce the time required to establish steady state later in the maneuver (i.e., just before the onset of the validity period). Correcting large deviations from the desired headway after the SV and LV are near the desired test speed can require considerable testing real estate, and negatively affect the experimenters' ability to achieve the required test choreography within the length of track defined by the initial conditions of Section 5.3.6.1.

[8] When performing the tests with a robotic steering machine that does not completely decouple from the SV steering wheel during the test trial, it is important the equipment have negligible-to-no effect on the torque required to turn the steering wheel (i.e., low inertia and low drag) to best emulate the situation where a human driver is operating the vehicle with their hands removed from the steering wheel.

Table 2. OTSA Scenario 1 Test Specifications (SV turn signal is not activated, manual SV lane deviation).

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-LV Headway[3]	SV Left Turn Signal Activation	SV Path Deviation				SV Path Tolerance (Until SV steering wheel is released)	Number of Trials
	SV and LV	POV	SV[1] (See D2 from Figure 2)	POV[2]			Initiation Timing (SV-to-POV Longitudinal TTC)	Steering Release Timing	Heading Angle, Θ_{SV}	Lateral Velocity		
	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	5.35 ± 0.8 ft (1.63 ± 0.25 m)		65.6 ± 3.3 ft (20 ± 1 m)		7.6 to 8.4 s		2.56 degrees			3
Level 0 (Manual speed control, LCC off)	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	5.35 ± 0.8 ft (1.63 ± 0.25 m)	3.3 ± 0.8 ft (1 ± 0.25 m)	98.4 ± 3.3 ft (30 ± 1 m)	N/A	6.1 to 6.5 s	Within 250 ms of achieving desired SV heading angle	1.43 degrees	1.6 ± 0.3 ft/s (0.5 ± 0.1 m/s)	±0.8 ft (±0.25 m)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	5.35 ± 0.8 ft (1.63 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)		6.1 to 6.5 s		1.43 degrees			3
	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	5.35 ± 0.8 ft (1.63 ± 0.25 m)		65.6 ± 3.3 ft (20 ± 1 m)		7.6 to 8.4 s		2.56 degrees			3
Level 0 (Conventional cruise control, LCC off)	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	5.35 ± 0.8 ft (1.63 ± 0.25 m)	3.3 ± 0.8 ft (1 ± 0.25 m)	98.4 ± 3.3 ft (30 ± 1 m)	N/A	6.1 to 6.5 s	Within 250 ms of achieving desired SV heading angle	1.43 degrees	1.6 ± 0.3 ft/s (0.5 ± 0.1 m/s)	±0.8 ft (±0.25 m)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	5.35 ± 0.8 ft (1.63 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)		6.1 to 6.5 s		1.43 degrees			3

[1] Until initiation of lane deviation; measured from the left side of the SV to the inboard edge of the lane line immediately to its left.
[2] Measured from the left side of the POV to the inboard edge of the lane line immediately to its left
[3] While staging and within the validity period.

Table 3. OTSA Scenario 1 Test Specifications (SV turn signal is not activated, manual SV lane deviation; continued).

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-LV Headway[3]	SV Left Turn Signal Activation	SV Path Deviation				SV Path Tolerance (Until SV steering wheel is released)	Number of Trials
	SV and LV	POV	SV[1] (See D2 from Figure 2)	POV[2]			Initiation Timing (SV-to-POV Longitudinal TTC)	Steering Release Timing	Heading Angle, Θ_{SV}	Lateral Velocity		
	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	5.35 ± 0.8 ft (1.63 ± 0.25 m)		65.6 ± 3.3 ft (20 ± 1 m)		7.6 to 8.4 s		2.56 degrees			3
Level 1 **(ACC-based speed control, LCC off)**	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	5.35 ± 0.8 ft (1.63 ± 0.25 m)	3.3 ± 0.8 ft (1 ± 0.25 m)	98.4 ± 3.3 ft (30 ± 1 m)	N/A	6.1 to 6.5 s	Within 250 ms of achieving desired SV heading angle	1.43 degrees	1.6 ± 0.3 ft/s (0.5 ± 0.1 m/s)	±0.8 ft (±0.25 m)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	5.35 ± 0.8 ft (1.63 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)		6.1 to 6.5 s		1.43 degrees			3

[1] Until initiation of lane deviation; measured from the left side of the SV to the inboard edge of the lane line immediately to its left.
[2] Measured from the left side of the POV to the inboard edge of the lane line immediately to its left
[3] While staging. SV-to-LV headway within the validity period is actively controlled by the SV ACC set to the farthest setting.

5.3.6.3 Validity Period

1. The valid test interval begins three (3) seconds before the SV driver initiates the SV path deviation.

2. For all trials, the valid test interval ends:

   A. When the lateral position of the SV is ≤ 1.5 ft (0.46 m) from the POV; or

   B. Five (5) seconds after the SV has established a heading away from the POV and is completely within its original travel lane; or

   C. One (1) second after the SV travels ≥ 1 ft (0.3 m) beyond the inboard edge of the lane line separating the SV travel lane from one adjacent and to the right of it (see Figure 3).

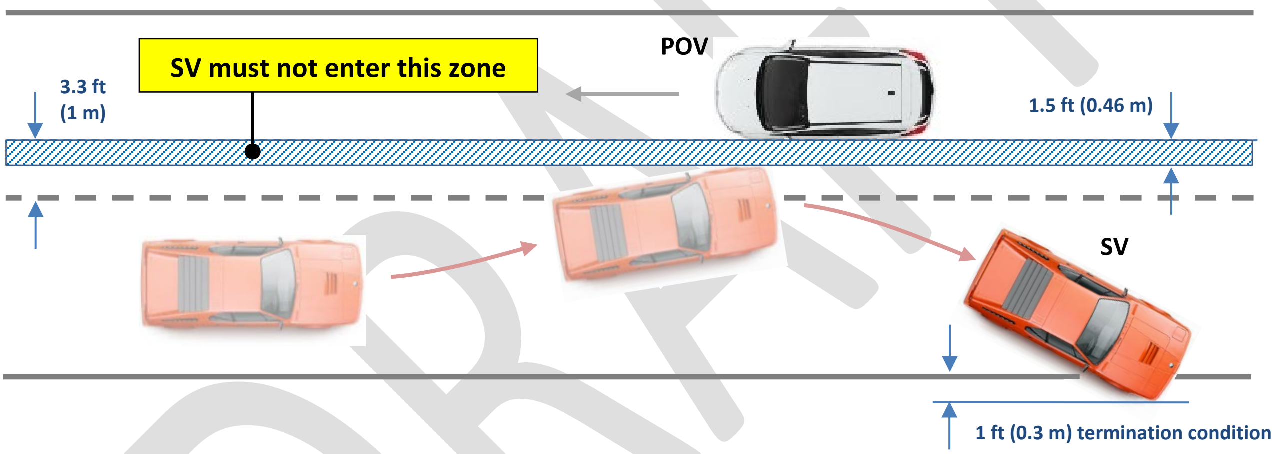

Figure 3. Valid test interval conclusion condition 2C (secondary lane departure).

5.3.6.4 End-of-Test Instructions

1. For tests where the lateral position of the SV becomes ≤ 1.5 ft (0.46 m) from the POV, at any time during the validity period, the SV shall immediately be steered away from the POV to prevent an SV-to-POV impact. Use of a robotic steering machine configured to instantly and automatically perform this operation (i.e., via closed loop control based on a continuous monitoring of SV-to-POV lateral position) is highly recommended. The SV driver shall bring the SV to a stop after the POV avoidance maneuver is complete.

2. For tests where the lateral position of the SV does not become ≤ 1.5 ft (0.46 m) from the POV, the SV driver shall manually apply force to the brake pedal after the validity period is complete, bring the SV to a stop (if necessary), and place the transmission in park.

5.3.6.5 Evaluation Criteria

The OTSA system is expected to intervene in a manner that prevents the lateral distance between the SV and POV from becoming too small. However, the OTSA intervention shall also not result in the SV departing its lane to the right. Specifically,

1. The lateral position of the SV shall not be ≤ 1.5 ft (0.46 m) from the POV within the validity period.

2. The SV OTSA intervention shall not cause the SV to travel ≥ 1 ft (0.3 m) beyond the inboard edge of the lane line separating the SV travel lane from one adjacent and to the right of it within the validity period during any valid test.

5.3.7 OTSA Scenario 2: SV Departure into Oncoming POV Lane, SV Turn Signal Enabled, Manual Steering

Compared to OTSA Scenario 1, OTSA Scenario 2 differs in four ways. In OTSA Scenario 2,

- The SV lane position prior to initiation of the SV lane deviation.

- The SV lane deviation process:

    - Is preceded by activation of the turn signal.

    - Is initiated at a closer SV-to-POV TTC.

    - Occurs with higher lateral velocity.

Like OTSA Scenario 1, OTSA Scenario 2 is designed to evaluate the OTSA system's ability to detect and respond to an oncoming POV after an SV lane deviation creates a crash-imminent driving situation, and the OTSA system is still expected to intervene in a manner that prevents any part of the SV from being within 1.5 ft (0.46 m) of any part of the POV. An overview of OTSA Scenario 2 is shown in Figure 4.

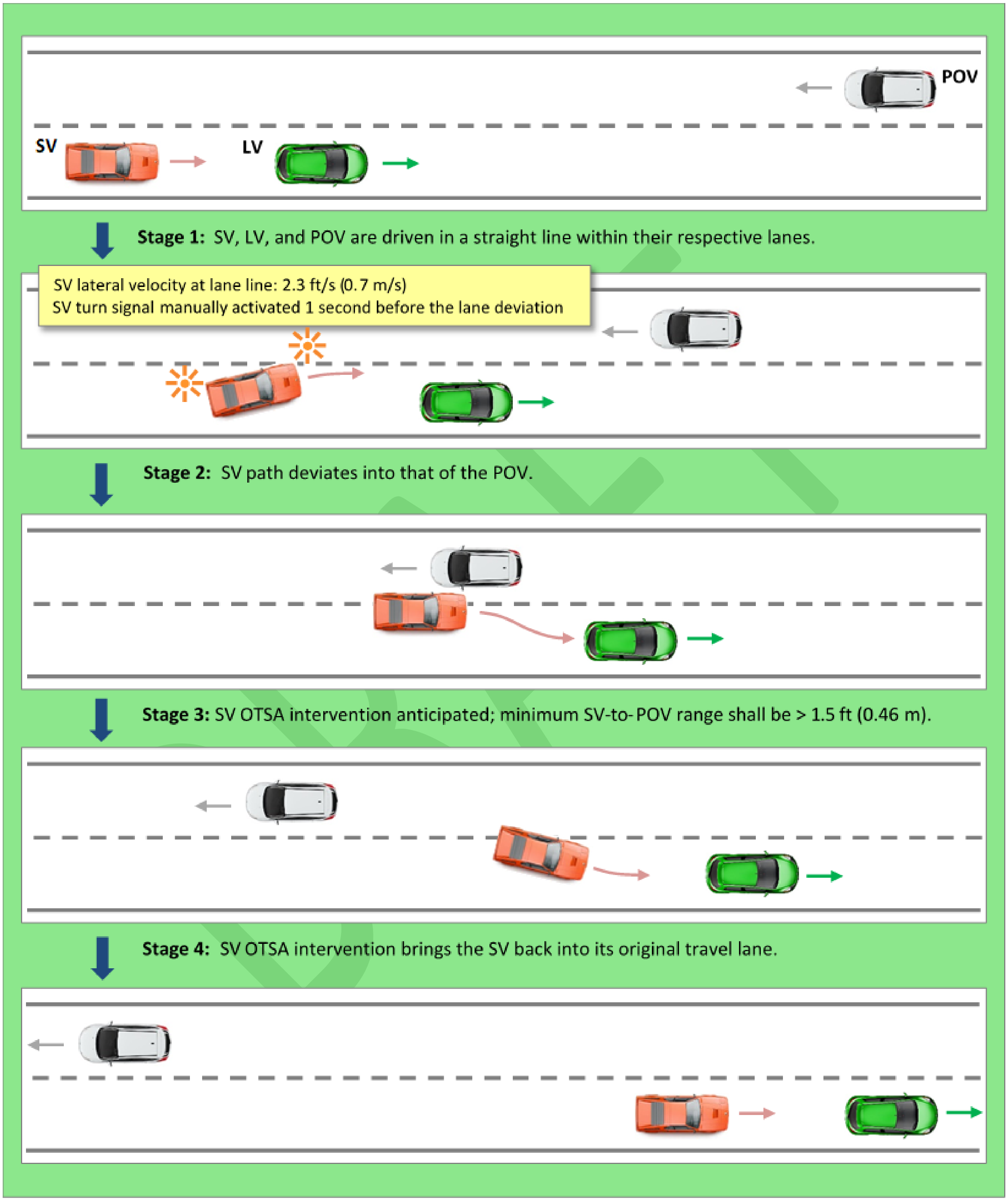

Figure 4. OTSA Scenario 2 (SV turn signal activated).

5.3.7.1 Staging

Each OTSA Scenario 2 trial begins with the SV at rest and laterally offset from the center of its travel lane. As shown in Figure 5, the offset magnitude is calculated by adding two lateral components: (1) the lateral distance travelled along a 2,625 ft (800 m) radius curve until the desired heading angle (Θ_{SV}) towards the left lane line is realized, and (2) the lateral distance traveled during a short period of steady state driving at a constant lateral velocity of 2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s) before the SV reaches the left lane line.

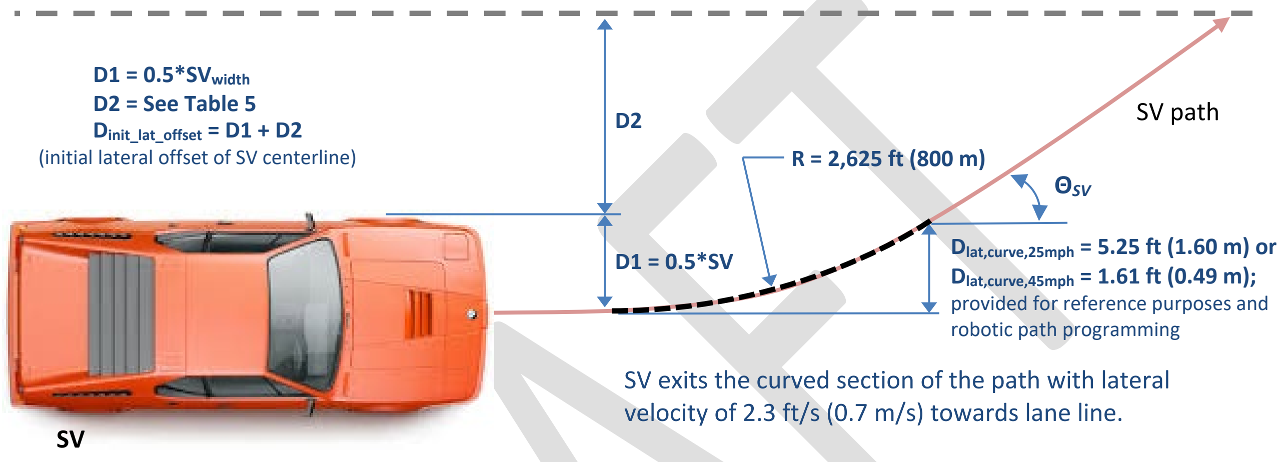

Figure 5. Input parameters used to define the SV path deviation during OTSA Scenario 2.

The LV and POV staging used for OTSA Scenario 2 shall be identical to that used in OTSA Scenario 1 (defined in Section 5.3.6.1).

5.3.7.2 Test Choreography

Table 3 presents an overview of the SV, LV, and POV speeds, positions, and timing used to perform the OTSA Scenario 2 tests. The OTSA Scenario 2 test choreography is identical to that used for OTSA Scenario 1, previously described in Section 5.3.6.2, except for the following details:

- The initial distance between the left side of the SV and the inboard edge of the lane line immediately to its left differs, and changes as a function of SV speed. These values, and OTSA Scenario 2 test tolerances, are shown in Table 3

- The left SV turn signal is activated when the longitudinal TTC between the SV and POV is within the tolerances shown in Table 3.

- When the longitudinal TTC between the SV and POV is within the tolerances shown in Table 3, manual steering and the input parameters described Figure 5 shall be used to initiate the SV lane deviation shown in Figures 4 and 5.

- The lateral velocity of the SV path deviation shall be 2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s) before the SV reaches the left lane line.

5.3.7.3 Validity Period

The valid test interval begins three (3) seconds before the SV driver activates the SV's left turn signal. The conditions defining the end of the valid test interval are identical to those specified for OTSA Scenario 1 (defined in Section 5.3.6.3).

5.3.7.4 End-of-Test Instructions

The end-of-test instructions for OTSA Scenario 2 shall be identical to those specified for OTSA Scenario 1 (defined in Section 5.3.6.4).

5.3.7.5 Evaluation Criteria

The evaluation criteria for OTSA Scenario 2 shall be identical to those specified for OTSA Scenario 1 (defined in Section 5.3.6.5).

Table 3. OTSA Scenario 2 Test Specifications (SV turn signal is activated, manual SV lane deviation).

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-LV Headway[3]	SV Left Turn Signal Activation (SV-to-POV Longitudinal TTC)	SV Path Deviation				SV Path Tolerance (Until SV steering wheel is released)	Number of Trials
	SV and LV	POV	SV[1] (See D2 from Figure 5)	POV[2]			Initiation Timing (SV-to-POV Longitudinal TTC)	Steering Release Timing	Heading Angle, Θ_{SV}	Lateral Velocity		
	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	6.23 ± 0.8 ft (1.90 ± 0.25 m)		65.6 ± 3.3 ft (20 ± 1 m)	7.6 ± 0.5 s	6.4 to 6.9 s		3.61 degrees			3
Level 0 (Manual speed control, LCC off)	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)	3.3 ± 0.8 ft (1 ± 0.25 m)	98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.4 to 4.6 s	Within 250 ms of achieving desired SV heading angle	2.01 degrees	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	±0.8 ft (±0.25 m)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.4 to 4.6 s		2.01 degrees			3
	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	6.23 ± 0.8 ft (1.90 ± 0.25 m)		65.6 ± 3.3 ft (20 ± 1 m)	7.6 ± 0.5 s	6.4 to 6.9 s		3.61 degrees			3
Level 0 (Conventional cruise control, LCC off)	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)	3.3 ± 0.8 ft (1 ± 0.25 m)	98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.4 to 4.6 s	Within 250 ms of achieving desired SV heading angle	2.01 degrees	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	±0.8 ft (±0.25 m)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.4 to 4.6 s		2.01 degrees			3

[1] Until initiation of lane deviation; measured from the left side of the SV to the inboard edge of the lane line immediately to its left.
[2] Measured from the left side of the POV to the inboard edge of the lane line immediately to its left.
[3] While staging and within the validity period.

Table 3. OTSA Scenario 2 Test Specifications (SV turn signal is activated, manual SV lane deviation; continued).

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-LV Headway[3]	SV Left Turn Signal Activation (SV-to-POV Longitudinal TTC)	SV Path Deviation				SV Path Tolerance (Until SV steering wheel is released)	Number of Trials
	SV and LV	POV	SV[1] (See D2 from Figure 5)	POV[2]			Initiation Timing (SV-to-POV Longitudinal TTC)	Steering Release Timing	Heading Angle, Θ_{SV}	Lateral Velocity		
	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	6.23 ± 0.8 ft (1.90 ± 0.25 m)		65.6 ± 3.3 ft (20 ± 1 m)	7.6 ± 0.5 s	6.4 to 6.9 s		3.61 degrees			3
Level 1 **(ACC-based speed control, LCC off)**	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)	3.3 ± 0.8 ft (1 ± 0.25 m)	98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.4 to 4.6 s	Within 250 ms of achieving desired SV heading angle	2.01 degrees	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	±0.8 ft (±0.25 m)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.4 to 4.6 s		2.01 degrees			3

[1] Until initiation of lane deviation; measured from the left side of the SV to the inboard edge of the lane line immediately to its left.
[2] Measured from the left side of the POV to the inboard edge of the lane line immediately to its left.
[3] While staging. SV-to-LV headway within the validity period is actively controlled by the SV ACC set to the farthest setting.

5.3.8 OTSA Scenario 3: SV Departure into Oncoming POV Lane, SV Turn Signal, Automated Steering

OTSA Scenario 3 is also designed to evaluate the OTSA system's ability to detect and respond to an oncoming POV after an SV lane deviation creates a crash-imminent driving situation, and the OTSA system is still expected to intervene in a manner that prevents any part of the SV from being within 1.5 ft (0.46 m) of any part of the POV. Like those used during OTSA Scenario 2 evaluations, OTSA Scenario 3 tests require the SV's left turn signal be activated prior to commanding the SV lane deviation. However, in OTSA Scenario 3 the lane deviation is automatically initiated after the SV turn signal is activated, and the process of performing the lane deviation is automated.[9] To facilitate activation of the SV's automated lane change feature, the SV shall be operated in automation level 2 or 3 within the validity period.[10] An overview of OTSA Scenario 3 is shown in Figure 6.

[9] The automated lane deviation described in Section 5.3.8 is the first stage of an automated lane change feature. The SV OTSA system must intervene during this stage to insure the SV does not impact the POV.

[10] Automated lane changes cannot be performed without first enabling the SV's ACC and LCC (i.e., operating the SV in automation 2 or 3).

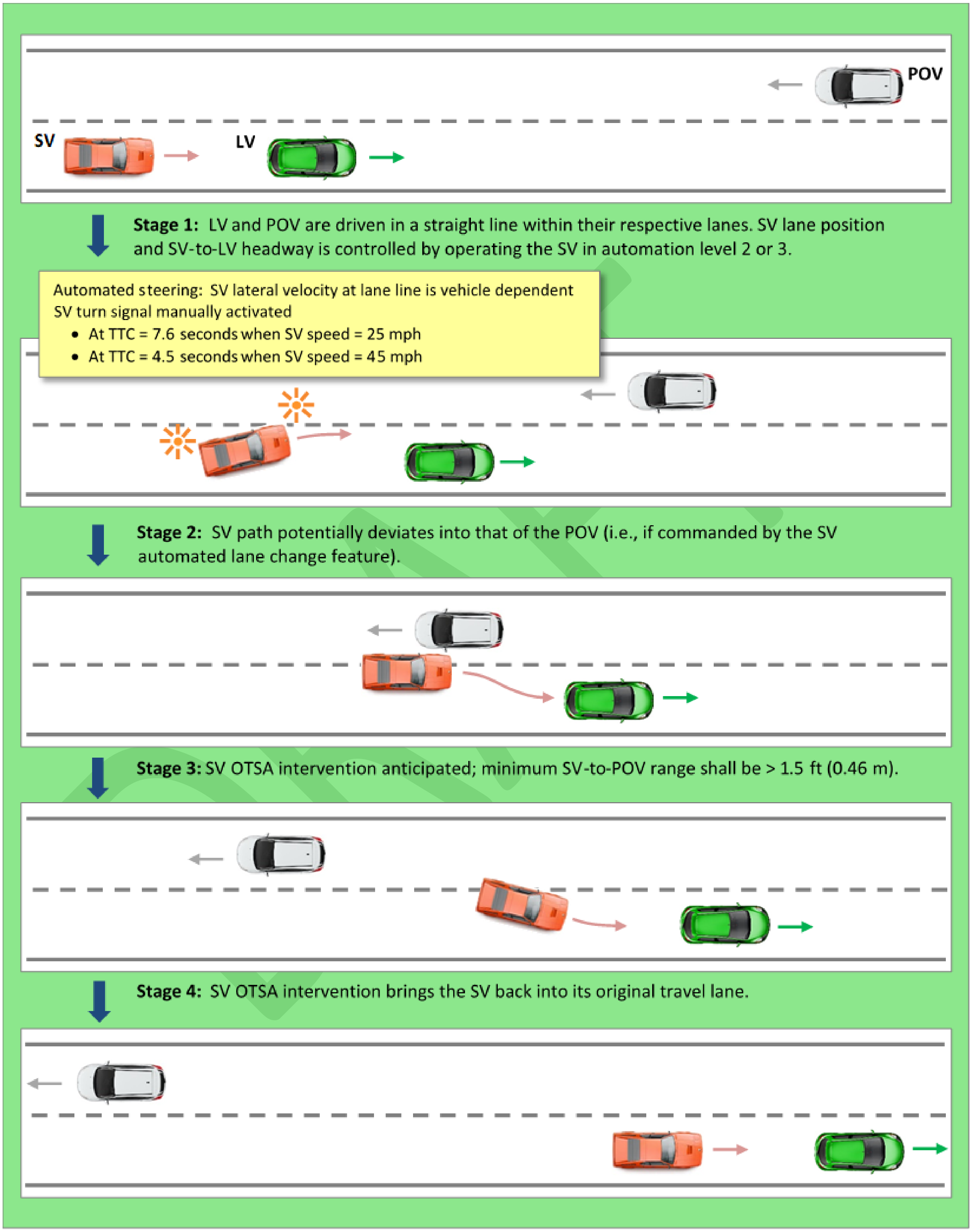

Figure 6. OTSA Scenario 3 (SV turn signal is activated, and its lane deviation is automated).

5.3.8.1 Staging

Each OTSA Scenario 3 trial shall begin with the SV at rest in the center of the SV travel lane.

The LV and POV staging used for OTSA Scenario 3 shall be identical to that used in OTSA Scenario 1 (defined in Section 5.3.6.1) and OTSA Scenario 2 (defined in Section 5.3.7.1).

5.3.8.2 Test Choreography

Table 4 presents an overview of the SV, LV, and POV speeds, positions, and timing used to perform the OTSA Scenario 3 tests. The OTSA Scenario 3 test choreography is identical to that used for OTSA Scenario 2[11], previously described in Section 5.3.7.2, except for the following details:

- The SV LCC shall be enabled, initialized, and actively maintaining SV lane position no later than the onset of the validity period. The SV LCC shall be used to maintain SV lane position from the onset of the validity period to initiation of the SV lane deviation.

- The lateral position of the SV from the onset of the validity period to initiation of the SV path deviation is unrestricted since it is maintained by the SV's LCC system.

- The longitudinal TTC between the SV and POV when the SV initiates its lane deviation is unrestricted since it is controlled by the SV's automated lane change system.

- The lateral velocity of the SV path deviation is unrestricted since it is controlled by the SV's automated lane change system.

Note: The left SV turn signal activation timing used for OTSA Scenarios 2 and 3 is identical.

[11] Each of the four differences described in Section 5.3.8.2 also differ from the respective OTSA Scenario 1 specifications. OTSA Scenario 2 is referenced in Section 5.3.8.2 since it is more closely related to OTSA Scenario 3, as they both include use of a turn signal.

Table 4. OTSA Scenario 3 Test Specifications (SV turn signal is activated, automated lane deviation).

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-LV Headway[3]	SV Left Turn Signal Activation (SV-to-POV Longitudinal TTC)	SV Path Deviation				SV Path Tolerance	Number of Trials
	SV and LV	POV	SV[1]	POV[2]			Initiation Timing	Steering Release Timing	Heading Angle, Θ_{SV}	Lateral Velocity		
Level 2 or 3 **(ACC-based speed control, LCC on)**	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	Nominally centered	3.3 ± 0.8 ft (1 ± 0.25 m)	65.6 ± 3.3 ft (20 ± 1 m)	7.6 ± 0.5 s	N/A (vehicle-dependent since the lane deviation is automated)	N/A (all steering inputs are provided by the SV within the validity period)	N/A (vehicle-dependent since the lane deviation is automated)	N/A (vehicle-dependent since the lane deviation is automated)	N/A (vehicle-dependent since the lane deviation is automated)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)			98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s						3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)			98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s						3

[1] Actual position is vehicle-dependent since it is actively controlled by the SV LCC.
[2] Measured from the left side of the POV to the inboard edge of the lane line immediately to its left.
[3] While staging. SV-to-LV headway within the validity period is actively controlled by the SV ACC set to the farthest setting.

5.3.8.3 Validity Period

The conditions defining the onset of the valid test interval are identical to those specified for OTSA Scenario 2 (defined in Section 5.3.7.3).

The conditions defining the end of the valid test interval are identical to those specified for OTSA Scenario 1 (defined in Section 5.3.6.3) and OTSA Scenario 2 (defined in Section 5.3.7.3).

5.3.8.4 End-of-Test Instructions

The end-of-test instructions for OTSA Scenario 3 shall be identical to those specified for OTSA Scenario 1 (defined in Section 5.3.6.4) and OTSA Scenario 2 (defined in Section 5.3.7.4).

5.3.8.5 Evaluation Criteria

The evaluation criteria for OTSA Scenario 3 shall be identical to those specified for OTSA Scenario 1 (defined in Section 5.3.6.5) and OTSA Scenario 2 (defined in Section 5.3.7.5).

5.3.9 OTSA Scenario 4: OTSA False Positive Assessment with SV Lane Change, SV Turn Signal Enabled, and Manual Steering

Compared to OTSA Scenario 2, OTSA Scenario 4 differs in three ways. In OTSA Scenario 4,

- The POV travel lane is two lanes to the left of the SV's initial travel lane.
- The SV completes a single lane change into the left adjacent, open lane (i.e., not only a path deviation).
- Results from OTSA Scenario 4 tests performed with a POV are compared with results from otherwise equivalent tests to assess the presence of an OTSA intervention.

The OTSA Scenario 4 test is designed to evaluate whether the OTSA system detects and responds to a non-threatening POV while the SV completes a single lane change. For these tests, the POV is driven in a lane two lanes to the left of the SV's initial travel lane. The SV lane change is preceded by activation of the turn signal, is commanded manually, and occurs with the same lateral velocity used during OTSA Scenario 2. An OTSA intervention is not anticipated during the conduct of OTSA Scenario 4. An overview of OTSA Scenario 4 is shown in Figure 7.

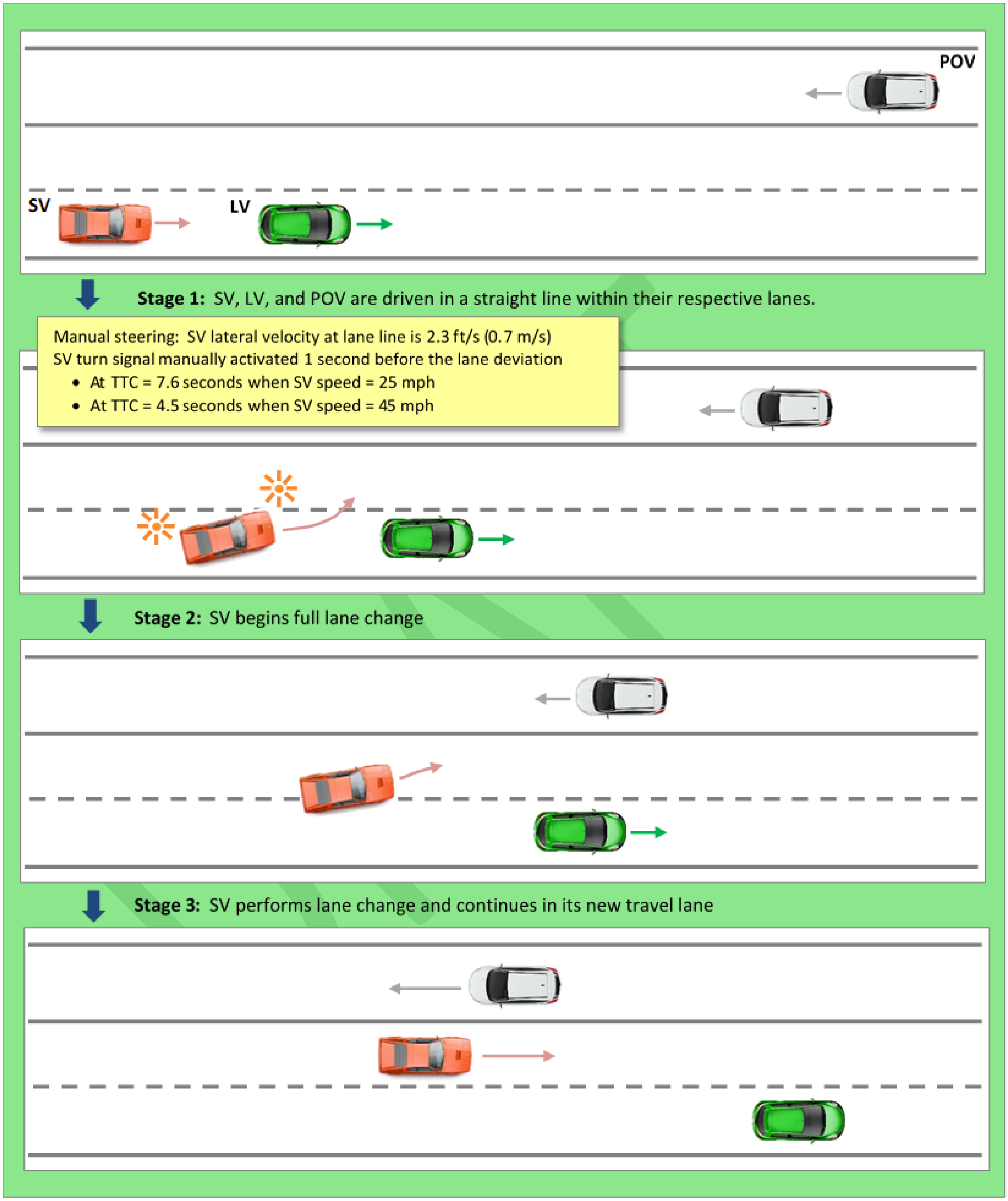

Figure 7. OTSA Scenario 4 (false positive assessment, SV turn signal activated, manual lane change).

5.3.9.1 Staging

Initial staging of the SV and LV will be identical to OTSA Scenario 2 (defined in Section 5.3.7.1). POV staging will also be identical to OTSA Scenario 2 (defined in Section 5.3.7.1), with the exception of one open lane between the SV and POV initial travel lanes, to the left of the SV initial travel lane.

5.3.9.2 Test Choreography

Table 5 presents an overview of the SV, LV and POV speeds, positions, and timing used to perform the OTSA Scenario 4 tests. The OTSA Scenario 4 test choreography is identical to that used for OTSA Scenario 2, previously described in Section 5.3.7.2, except that when the longitudinal TTC between the SV and POV is within the tolerances shown in Table 5, manual steering and input parameters described in Figure 8 shall be used to initiate an SV lane change (i.e., not just an SV heading change).

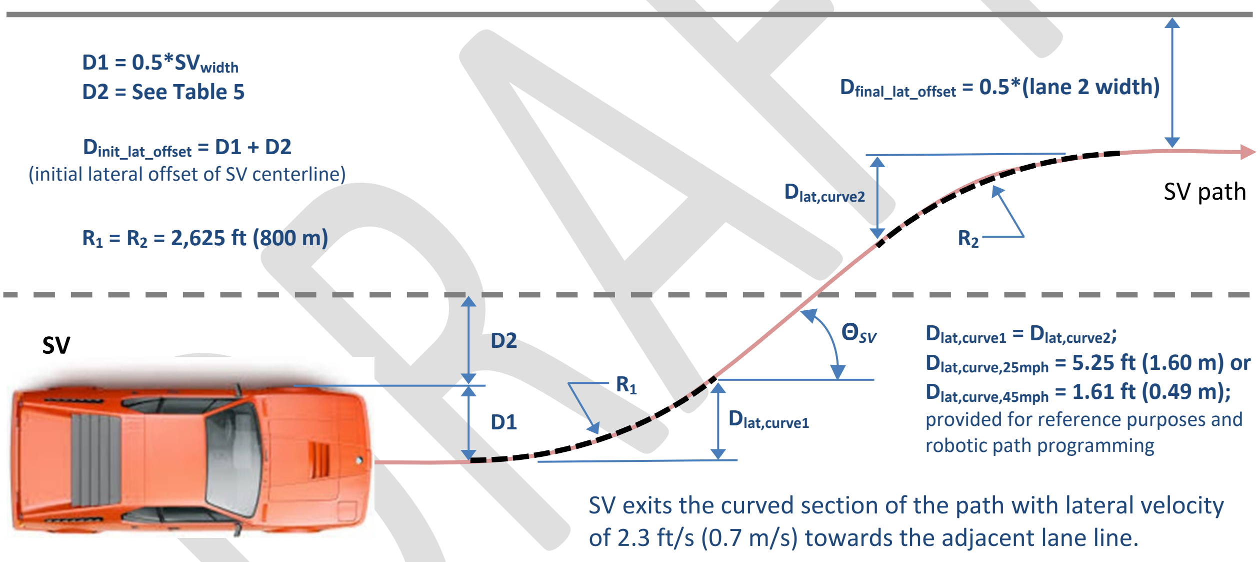

Figure 8. SV Lane Change, False Positive Scenario.

5.3.9.3 Validity Period

1. The valid test interval begins three (3) seconds before the SV driver activates the SV's left turn signal.

2. The valid test interval ends:

    A. Five (5) seconds after the SV has completed the single lane change into the left lane adjacent to the SV's original travel lane without an OTSA intervention; or

B. One (1) second after an OTSA intervention causes the SV to travel ≥ 1 ft (0.3 m) beyond the inboard edge of the lane line separating the post lane change SV travel lane and one adjacent and to the right of it (see Figure 9).

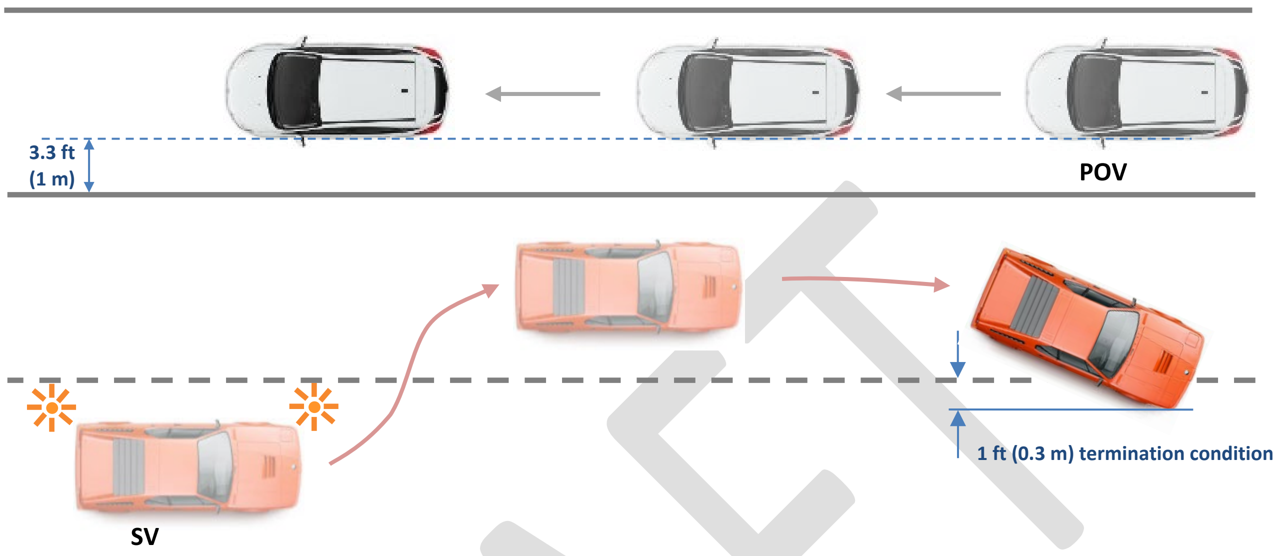

Figure 9. Valid test interval conclusion condition described in S5.3.9.3.2.B.

5.3.9.4 End-of-Test Instructions

The end-of-test instructions for OTSA Scenario 4 shall be identical to those specified for OTSA Scenario 1 in Section 5.3.6.4.

Table 5. OTSA Scenario 4 Test Specifications (SV turn signal is activated, manual SV lane deviation).

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-LV Headway[3]	SV Left Turn Signal Activation (SV-to-POV Longitudinal TTC)	SV Path Deviation				SV Path Tolerance (Until SV steering wheel is released)	Number of Trials
	SV and LV	POV	SV[1] (See D2 from Figure 8)	POV[2]			Initiation Timing (SV-to-POV Longitudinal TTC)	Steering Release Timing	Heading Angle, Θ_{SV}	Lateral Velocity		
Level 0 **Manual speed control, LCC off**	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	6.23 ± 0.8 ft (1.90 ± 0.25 m)	3.3 ± 0.8 ft (1 ± 0.25 m)	65.6 ± 3.3 ft (20 ± 1 m)	7.6 ± 0.5 s	6.3 to 6.9 s	N N/A (SV steering is not released within the validity period)	3.61 degrees	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	±0.8 ft (0.25 m)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.3 to 4.6 s		2.01 degrees			3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.3 to 4.6 s		2.01 degrees			3
Level 0 **(Conventional cruise control, LCC off)**	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	6.23 ± 0.8 ft (1.90 ± 0.25 m)	3.3 ± 0.8 ft (1 ± 0.25 m)	65.6 ± 3.3 ft (20 ± 1 m)	7.6 ± 0.5 s	6.3 to 6.9 s	N/A (SV steering is not released within the validity period)	3.61 degrees	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	±0.8 ft (0.25 m)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.3 to 4.6 s		2.01 degrees			3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.3 to 4.6 s		2.01 degrees			3

[1] Until initiation of lane deviation; measured from the left side of the SV to the inboard edge of the lane line immediately to its left.
[2] Measured from the left side of the POV to the inboard edge of the lane line immediately to its left.
[3] While staging and within the validity period.

Table 5. OTSA Scenario 4 Test Specifications (SV turn signal is activated, manual SV lane deviation; continued).

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-LV Headway[3]	SV Left Turn Signal Activation (SV-to-POV Longitudinal TTC)	SV Path Deviation				SV Path Tolerance (Until SV steering wheel is released)	Number of Trials
	SV and LV	POV	SV[1] (See D2 from Figure 8)	POV[2]			Initiation Timing (SV-to-POV Longitudinal TTC)	Steering Release Timing	Heading Angle, Θ_{SV}	Lateral Velocity		
Level 1 **(ACC-based speed control, LCC off)**	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	6.23 ± 0.8 ft (1.90 ± 0.25 m)	3.3 ± 0.8 ft (1 ± 0.25 m)	65.6 ± 3.3 ft (20 ± 1 m)	7.6 ± 0.5 s	6.3 to 6.9 s	N/A (SV steering is not released within the validity period)	3.61 degrees	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	±0.8 ft (±0.25 m)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.3 to 4.6 s		2.01 degrees			3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	4.99 ± 0.8 ft (1.52 ± 0.25 m)		98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s	4.3 to 4.6 s		2.01 degrees			3

[1] Until initiation of lane deviation; measured from the left side of the SV to the inboard edge of the lane line immediately to its left.
[2] Measured from the left side of the POV to the inboard edge of the lane line immediately to its left.
[3] While staging and within the validity period.

5.3.9.5 Evaluation Criteria

An OTSA system intervention shall not occur within the OTSA Scenario 4 validity period. To objectively assess whether an OTSA intervention has occurred, the SV response measured during conduct of the OTSA Scenario 4 tests performed with a POV shall be compared to comparable baseline tests performed without a POV.

(a) Performing OTSA Scenario 4 Baseline Trials

Baseline tests shall begin with the SV being driven at the desired speed in the center of the SV travel lane. After three (3) seconds, the SV driver shall engage the left turn signal indicator and initiate a single lane change into the left adjacent lane using the path shown in Figure 8. Since no POV is present during conduct of the baseline trials, no OTSA system interventions are expected.

In agreement with the OTSA Scenario 4 trials performed with a POV, the SV lateral position shall not deviate more than 1.6 ft (0.5 m) during the following baseline trial intervals:

- From the onset of the validity period defined in S5.3.9.3 to initiation of the SV lane change, and
- During the lane change described in Figure 8, and
- From completion of the lane change until the end of the validity period defined in S5.3.9.3.

Subject vehicle yaw rate data from each of the three baseline trials shall be synchronized in time and averaged to generate a composite data trace. Using this composite, two additional data traces shall be created, with values ±1 deg/s of the composite at each instant in time to define the upper and lower bounds, respectively, of an "acceptability corridor." A description of how the acceptability corridor, shown in Figure 10, is used to determine whether a OTSA Scenario 4 false positive intervention occurred during a given evaluation trial is provided in S5.3.9.5.b.

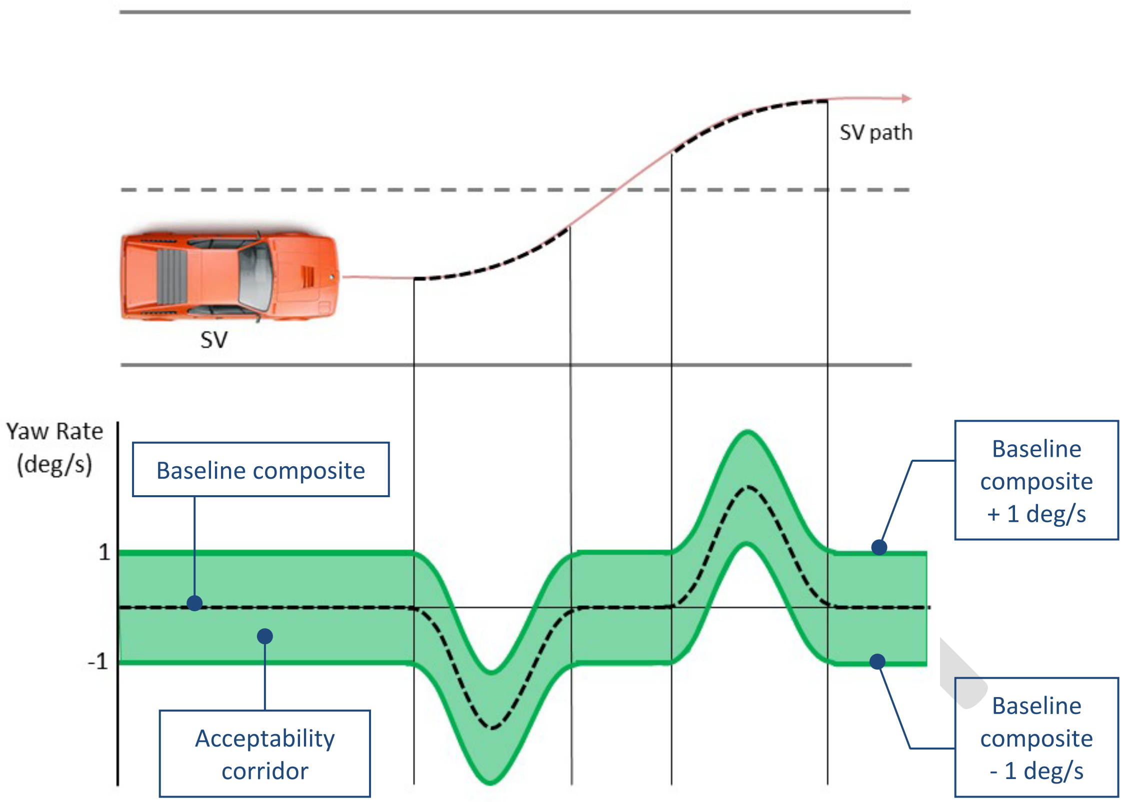

Figure 10. Definition of a yaw rate acceptability corridor.

(b) Comparison of Baseline and Evaluation Trials

Determination of whether a false positive OTSA intervention occurred during an OTSA Scenario 4 evaluation trial requires comparison of the SV yaw rate data collected during that trial with the acceptability corridor defined by the corresponding baseline data composite using the following steps:

1. Synchronization of the evaluation trial with the baseline composite so that the onsets of the respective lane changes occur with 20 ms of each other.

2. Comparison of the SV yaw rate data collected during the evaluation trial with that defined by acceptability corridor. The SV yaw rate data collected during the evaluation trial shall not exceed the boundaries of the baseline acceptability corridor within the applicable validity period. An example of the comparison used to assess the occurrence of a OTSA false positive intervention is shown in Figure 11.

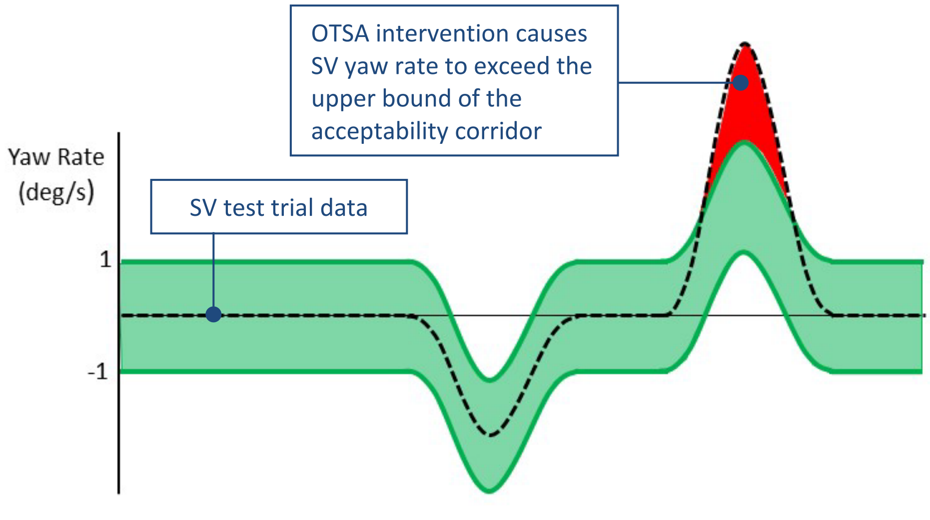

Figure 11. OTSA false positive example.

5.3.10 OTSA Scenario 5: OTSA False Positive Assessment with SV Lane Change, SV Turn Signal Enabled, and Automated Steering

Compared to OTSA Scenario 4, OTSA Scenario 5 differs in two ways. In OTSA Scenario 5,

- The SV's initial and final lane position is dependent on the SV LCC system.
- The path taken by the SV during the lane change lane depends on the operation of SV's automated lane change system.

Like OTSA Scenario 4, OTSA Scenario 5 is designed to evaluate whether the OTSA system detects and responds to a non-threatening POV while the SV completes a single lane change. However, in OTSA Scenario 5 the lane deviation is automatically initiated after the SV turn signal is activated and the process of performing the lane deviation is automated. To facilitate activation of the SV's automated lane change feature, the SV shall be operated in automation level 2 or 3 within the validity period.[12] An OTSA intervention is not anticipated during the conduct of OTSA Scenario 5. An overview of OTSA Scenario 5 is shown in Figure 12.

[12] Automated lane changes cannot be performed without first enabling the SV's ACC and LCC (i.e., operating the SV in automation 2 or 3).

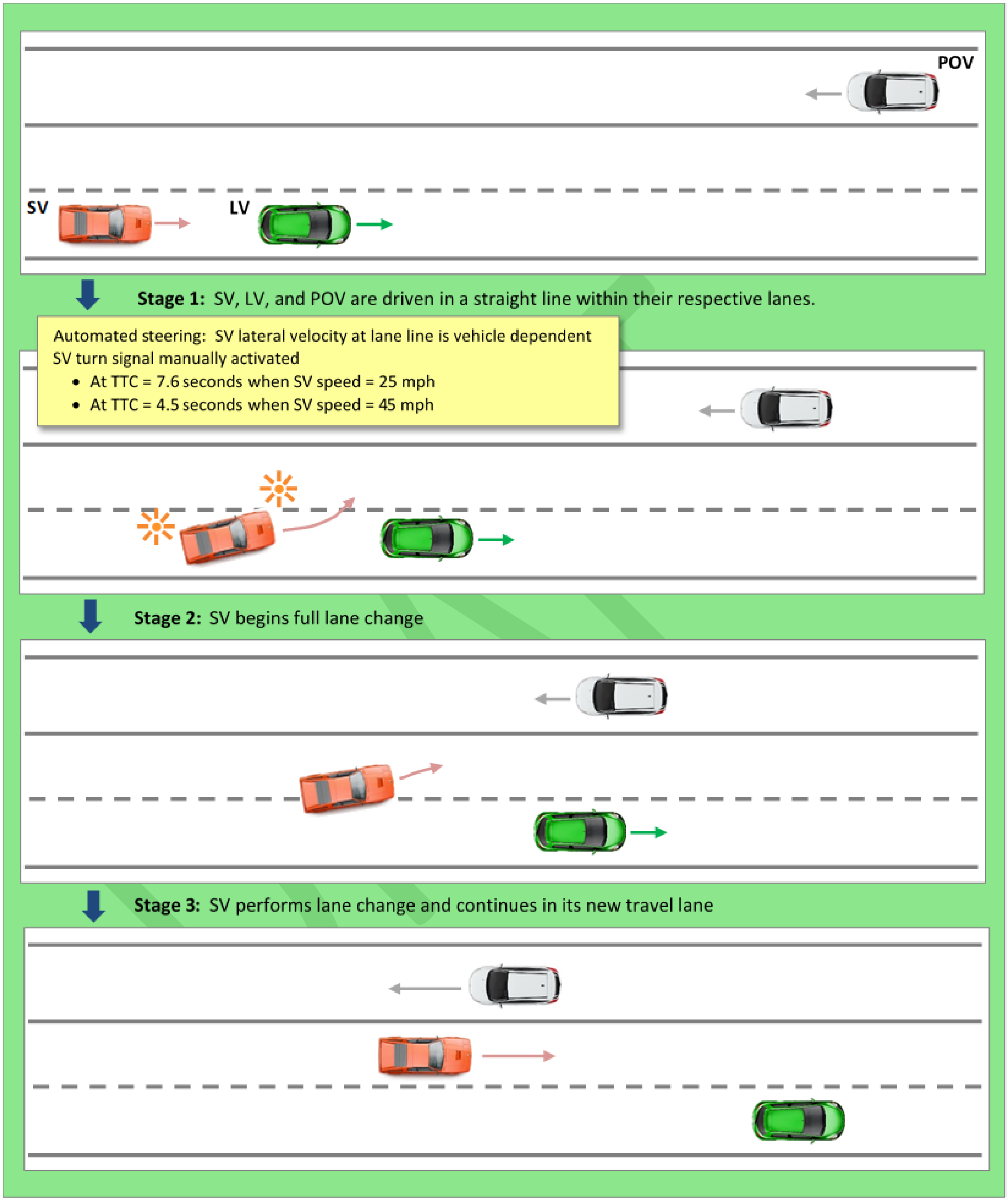

Figure 12. OTSA Scenario 5 (false positive assessment, SV turn signal activated, automated lane change).

5.3.10.1 Staging

The staging for OTSA Scenario 5 shall be identical to that used in OTSA Scenario 4 (defined in Section 5.3.9.1), except the initial position of the SV will be the center of the lane to then be dictated by level 2 or 3 automation.

5.3.10.2 Test Choreography

Table 6 presents an overview of SV, LV, and POV speeds, positions, and timing used to perform the OTSA Scenario 5 tests. The OTSA Scenario 5 test choreography is identical to that used to OTSA Scenario 4, previously described in Section 5.3.9.2, except for the following details:

- The SV LCC shall be enabled, initialized, and actively maintaining SV lane position no later than the onset of the validity period. The SV LCC shall be used to maintain SV lane position from the onset of the validity period to initiation of the SV lane deviation.

- The lateral position of the SV from the onset of the validity period to initiation of the SV path deviation is unrestricted since it is maintained by the SV's LCC system.

- The time between when the driver activating the SV turn signal indicator and when the SV initiates its lane deviation is unrestricted since it is controlled by the SV's automated lane change system.

- The longitudinal TTC between the SV and POV when the SV initiates its lane deviation is unrestricted since it is controlled by the SV's automated lane change system.

- The lateral velocity of the SV path deviation is unrestricted since it is controlled by the SV's automated lane change system.

Note: The left SV turn signal activation timing used for OTSA Scenarios 4 and 5 is identical.

5.3.10.3 Validity Period

1. The valid test interval begins three (3) seconds before the SV driver activates the SV's left turn signal.

2. The valid test interval ends:

   A. Five (5) seconds after the SV has completed the single lane change into the left lane adjacent to the SV's original travel lane without an OTSA intervention; or

   B. One (1) second after an OTSA intervention causes the SV to travel ≥ 1 ft (0.3 m) beyond the inboard edge of the lane line separating the post lane change SV travel lane and one adjacent and to the right of it (shown previously in Figure 9).

Table 5. OTSA Scenario 5 Test Specifications (SV turn signal is activated, automated lane deviation).

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-LV Headway[3]	SV Left Turn Signal Activation (SV-to-POV Longitudinal TTC)	SV Path Deviation				SV Path Tolerance	Number of Trials
	SV and LV	POV	SV[1]	POV[2]			Initiation Timing	Steering Release Timing	Heading Angle, Θ_{SV}	Lateral Velocity		
Level 2 or 3 **(ACC-based speed control, LCC on)**	25 ± 1 mph (40.2 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)	Nominally centered	3.3 ± 0.8 ft (1 ± 0.25 m)	65.6 ± 3.3 ft (20 ± 1 m)	7.6 ± 0.5 s	N/A (vehicle-dependent since the lane deviation is automated)	N/A (all steering inputs are provided by the SV within the validity period)	N/A (vehicle-dependent since the lane deviation is automated)	N/A (vehicle-dependent since the lane deviation is automated)	N/A (vehicle-dependent since the lane deviation is automated)	3
	45 ± 1 mph (72.4 ± 1.6 km/h)	25 ± 1 mph (40.2 ± 1.6 km/h)			98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s						3
	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)			98.4 ± 3.3 ft (30 ± 1 m)	5.5 ± 0.5 s						3

[1] Actual position is vehicle-dependent since it is actively controlled by the SV LCC.
[2] Measured from the left side of the POV to the inboard edge of the lane line immediately to its left.
[3] While staging. SV-to-LV headway within the validity period is actively controlled by the SV ACC set to the farthest setting.

5.3.10.4 End-of-Test Instructions

The end-of-test instructions for OTSA Scenario 5 shall be identical to those specified for OTSA Scenario 1 in Section 5.3.6.4.

5.3.10.5 Evaluation Criteria

An OTSA system intervention shall not occur within the OTSA Scenario 5 validity period. To objectively assess whether an OTSA intervention has occurred, the SV response measured during conduct of the OTSA Scenario 5 tests performed with a POV shall be compared to comparable baseline tests performed without a POV.

(a) Performing OTSA Scenario 5 Baseline Trials

Baseline tests shall begin with enabling and initialization of the SV LCC and/or ACC while the SV is driven at the desired speed in the center of the SV travel lane. After three (3) seconds, and without touching the steering wheel, the SV driver shall engage the left turn signal indicator and initiate an automatic lane change into the left adjacent lane. Since no POV is present during conduct of the baseline trials, no OTSA system interventions are expected.

Subject vehicle yaw rate data from each of the three baseline trials shall be synchronized in time and averaged to generate a composite data trace. Using this composite, two additional data traces shall be created, with values ±1 deg/s than the composite at each instant in time to define the upper and lower bounds, respectively, of the OTSA yaw rate acceptability corridor (previously shown in Figure 10).

(b) Comparison of Baseline and Evaluation Trials

Determination of whether a false positive OTSA intervention occurred during an OTSA Scenario 5 evaluation trial requires comparison of the SV yaw rate data collected during that trial with the acceptability corridor defined by the corresponding baseline data composite using the following steps:

1. Synchronization of the evaluation trial with the baseline composite so that the onsets of the respective lane changes occur with 20 ms of each other.

2. Comparison of the SV yaw rate data collected during the evaluation trial with that defined by acceptability corridor. The SV yaw rate data collected during the evaluation trial shall not exceed the boundaries of the baseline acceptability corridor within the applicable validity period. An example of the comparison used to assess the occurrence of a OTSA false positive intervention was previously shown in Figure 11.

6.0 REFERENCES

1. ASTM Standard E 1337-90 (2008). *Standard Test Method for Determining Longitudinal Peak Braking Coefficient of Paved Surfaces Using a Standard Reference Test Tire.* ASTM International, West Conshohocken, PA, 2011.

2. Federal Highway Administration. Manual on Uniform Traffic Control Devices. http://mutcd.fhwa.dot.gov/index.htm.

3. Szabo, S., Norcross, R. (2006, February). *Recommendations for Objective Test Procedures for Road Departure Crash Warning Systems.* NISTIR 7288. Gaithersburg, MD: US Department of Commerce.

4. Forkenbrock, G.J., Snyder, A.C., Davis, I.J., O'Harra, B.C. (2018, March). *A Test Track Comparison of the Global Vehicle Target (GVT) and NHTSA's Strikeable Surrogate Vehicle (SSV)*. (Report No. DOT HS TBD TBD). Washington, DC: US Department of Transportation.

7.0 DATA SHEETS

SUBJECT VEHICLE (SV) INFORMATION			
NHTSA Vehicle No.		Vehicle Identification Number (VIN)	
Vehicle Make/Model/Body Style		Date of Manufacture	
Vehicle Width (in. or mm)		Vehicle Length (in. or mm)	
Vehicle Test Weight (lbs. or kg)	GVWR (lbs. or kg)	Front GAWR (lbs. or kg)	Rear GAWR (lbs. or kg)
Driver Seatbelt Buckled?	Front Passenger Seatbelt Buckled?	Airbags Disabled?	
Cruise Control (conventional)			
Operational Speed Range (mph or km/h)		Method to Engage (stalk, button, etc.)	
Adaptive Cruise Control (ACC)			
Operational Speed Range (mph or km/h)	Method to Engage (stalk, button, etc.)	Number of Headway Settings	
Lane Centering Control (LCC)			
Operational Speed Range (mph or km/h)		Method to Engage (stalk, button, etc.)	
SAE Automation Level 2 or 3 Driving			
Process to engage automation level 2 or 3 driving			

LEAD VEHICLE (LV) INFORMATION
LV Model Year/Make/Model/Body Style

PRINCIPAL OTHER VEHICLE (POV) INFORMATION	
POV Description (e.g., surrogate design)	POV Construction Type / Materials (e.g., carbon fiber shell)
POV Moving Platform Description (if applicable)	POV Moving Platform Material (if applicable)

GENERAL TEST FACILITY INFORMATION		
Facility Designation (e.g., "VDA west edge")	Test Surface (e.g., asphalt, concrete)	Surface Condition
Lane Line Description		
SV and LV Orientation (e.g., "North")	POV Orientation (e.g., "South")	

PRETEST CONDITIONS (complete before each test scenario is evaluated)			
Time	Ambient Temperature (°F or °C)	Wind Speed (mph or km/h)	Wind Direction
Ambient Condition Description (e.g., "overcast")			
SV-to-LV Distance During Static Cal, Measured (in. or mm)		SV-to-LV Distance During Static Cal, Displayed (in. or mm)	
SV-to-POV Distance During Static Cal, Measured (in. or mm)		SV-to-POV Distance During Static Cal, Displayed (in. or mm)	

POST-TEST CONDITIONS (complete after each test scenario is evaluated)			
Time	Ambient Temperature (°F or °C)	Wind Speed (mph or km/h)	Wind Direction
Ambient Condition Description (e.g., "overcast")			
SV-to-LV Distance During Static Cal, Measured (in. or mm)		SV-to-LV Distance During Static Cal, Displayed (in. or mm)	
SV-to-POV Distance During Static Cal, Measured (in. or mm)		SV-to-POV Distance During Static Cal, Displayed (in. or mm)	

Table A1. OTSA Scenario 1 Test Performance Summary (SV turn signal is not activated, manual SV lane deviation).

Trial #	Manual Speed Control, LCC Off (Automation Level 0)			Conventional Cruise Control On, LCC Off (Automation Level 0)			ACC On, LCC Off (Automation Level 1)		
	Lane Deviation? [1]	Manual Avoidance? [2]	Secondary Departure? [3]	Lane Deviation? [1]	Manual Avoidance? [2]	Secondary Departure? [3]	Lane Deviation? [1]	Manual Avoidance? [2]	Secondary Departure? [3]
1									
2									
3									

[1] Lane Deviation = Maximum SV incursion into the POV travel lane, measured from the left inboard edge of the SV travel lane line.

[2] Manual Avoidance Required = SV operator and/or SV steering robot were required to steer the SV away from the POV to avoid an SV-to-POV collision.

[3] Secondary Departure = Maximum SV incursion into a lane adjacent and to the right of the SV travel lane, measured from the right inboard edge of the SV travel lane line.

Table A2. OTSA Scenario 2 Test Performance Summary (SV turn signal is activated, manual SV lane deviation).

Trial #	Manual Speed Control, LCC Off (Automation Level 0)			Conventional Cruise Control On, LCC Off (Automation Level 0)			ACC On, LCC Off (Automation Level 1)		
	Lane Deviation? [1]	Manual Avoidance? [2]	Secondary Departure? [3]	Lane Deviation? [1]	Manual Avoidance? [2]	Secondary Departure? [3]	Lane Deviation? [1]	Manual Avoidance? [2]	Secondary Departure? [3]
1									
2									
3									

[1] Lane Deviation = Maximum SV incursion into the POV travel lane, measured from the left inboard edge of the SV travel lane line.

[2] Manual Avoidance Required = SV operator and/or SV steering robot were required to steer the SV away from the POV to avoid an SV-to-POV collision.

[3] Secondary Departure = Maximum SV incursion into a lane adjacent and to the right of the SV travel lane, measured from the right inboard edge of the SV travel lane line.

Table A3. OTSA Scenario 3 Test Performance Summary (SV turn signal is activated, automated SV lane deviation).

Trial #	ACC On, LCC On (Automation Level 2 or 3)			
	Lane Deviation Initiated? [1]	Lane Deviation? [2]	Manual Avoidance? [3]	Secondary Departure? [4]
1				
2				
3				

[1] Lane Deviation Initiated = Did the SV automated lane change system automatically initiate an SV lane deviation after the SV left turn signal was activated?

[2] Lane Deviation = Maximum SV incursion into the POV travel lane, measured from the left inboard edge of the SV travel lane line.

[3] Manual Avoidance Required = SV operator and/or SV steering robot were required to steer the SV away from the POV to avoid an SV-to-POV collision.

[4] Secondary Departure = Maximum SV incursion into a lane adjacent and to the right of the SV travel lane, measured from the right inboard edge of the SV travel lane line.

Table A4. OTSA Scenario 4 Test Performance Summary (SV turn signal is activated, manual SV lane change).
False Positive Assessment

Trial #	Manual Speed Control, LCC Off (Automation Level 0)		Conventional Cruise Control On, LCC Off (Automation Level 0)		ACC On, LCC Off (Automation Level 1)	
	OTSA Intervention? [1]	Secondary Departure? [2]	OTSA Intervention? [1]	Secondary Departure? [2]	OTSA Intervention? [1]	Secondary Departure? [2]
1						
2						
3						

[1] OTSA Intervention = SV yaw rate acceptability corridor magnitude exceeded.

[2] Secondary Departure = Maximum SV incursion into a lane adjacent and to the right of the SV travel lane, measured from the right inboard edge of the SV travel lane line.

Table A5. OTSA Scenario 5 Test Performance Summary (SV turn signal is activated, automated SV lane change).
False Positive Assessment

Trial #	ACC On, LCC On (Automation Level 2 or 3)	
	OTSA Intervention? [1]	Secondary Departure? [2]
1		
2		
3		

[1] OTSA Intervention = SV yaw rate acceptability corridor magnitude exceeded.

[2] Secondary Departure = Maximum SV incursion into a lane adjacent and to the right of the SV travel lane, measured from the right inboard edge of the SV travel lane line.