# BLIND SPOT DETECTION SYSTEM RESEARCH TEST
# NCAP-DRI-BSD-20-06

## 2020 Land Rover Range Rover Sport HSE


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**17 December 2020**

**Final Report**


**Prepared Under Contract No. DTNH22-14-D-00333**

**U. S. DEPARTMENT OF TRANSPORTATION**
**National Highway Traffic Safety Administration**
**1200 New Jersey Avenue, SE**
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| 16. Abstract<br>These tests were conducted on the subject 2020 Land Rover Range Rover Sport HSE in accordance with the specifications of the National Highway Traffic Safety Administration's most current Test Procedure in docket NHTSA-2019-0102-0010, BLIND SPOT DETECTION SYSTEM CONFIRMATION TEST, to confirm the performance of a Blind Spot Detection system. The preliminary BSD requirements were met for 18 out of 71 valid trials. | | | |
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Section I

# INTRODUCTION

This test evaluates Blind Spot Detection (BSD) systems on light vehicles with gross vehicle weight ratings (GVWR) of under 10,000 pounds as specified in the National Highway Traffic Safety Administration's (NHTSA's) "Blind Spot Detection System Confirmation Test", dated June 2019. BSD technology uses sensors to detect the presence of other vehicles in the equipped vehicle's left and right blind zone. The procedures described herein emulate two straight-road, real-world scenarios in which the Subject Vehicle's (SV's) blind zone is breached by a single Principal Other Vehicle (POV). Although it is impossible to predict what technologies could be used by future BSD systems, it is believed that minor modifications to these procedures, when deemed appropriate, could be used to accommodate the evaluation of alternative or more advanced BSD systems.

The BSD system tests described in this document and prescribed by NHTSA involve two different test scenarios: 1) straight lane converge and diverge maneuvers and 2) a straight lane pass-by. In the first scenario, the POV is driven at the same speed as the SV, at a constant headway. After a brief period of steady-state driving, the POV enters, then exits the SV blind zone from the side of the vehicle. In the second scenario, the POV is driven by the SV in an adjacent lane at a speed greater than the SV. During this pass-by, the POV enters, then exits the SV's blind zone. In both scenarios, BSD performance is assessed by comparing the proximity of the POV to the SV at the time of the BSD alert to the SV blind zone. The test scenarios are conducted at multiple speeds, and on both sides of the vehicle, to the left and right, as indicated in the specific test methodologies.

Section II

# DATA SHEETS

**BLIND SPOT DETECTION**

**DATA SHEET 1: TEST RESULTS SUMMARY**

**(Page 1 of 1)**

**2020 Land Rover Range Rover Sport HSE**

VIN: *SALWR2SU9LA71xxxx*

Test Date: *11/6/2020*

System Setting: *Warning Only*

| | Number of valid test runs for which acceptability criteria[1] were: | | |
|---|---|---|---|
| | **Met** | **Not met** | **Valid trials** |
| **Test 1 - Straight Lane Converge and Diverge** | | | |
| 45 mph - Left | *4* | *3* | *7* |
| 45 mph - Right | *1* | *7* | *8* |
| Overall Test 1: | *4* | *11* | *15* |
| **Test 2 - Straight Lane Pass-by** | | | |
| POV 50 mph - Left | *0* | *7* | *7* |
| POV 50 mph - Right | *0* | *7* | *7* |
| POV 55 mph - Left | *0* | *7* | *7* |
| POV 55 mph - Right | *0* | *7* | *7* |
| POV 60 mph - Left | *0* | *7* | *7* |
| POV 60 mph - Right | *0* | *7* | *7* |
| POV 65 mph - Left | *7* | *0* | *7* |
| POV 65 mph - Right | *7* | *0* | *7* |
| Overall Test 2: | *14* | *42* | *56* |
| **Overall:** | ***18*** | ***53*** | ***71*** |

[1] The acceptability criteria listed herein are used only as a guide to gauge system performance, and are identical to the Pass/Fail criteria given in NHTSA's most current Test Procedure in docket NHTSA-2019-0102-0010, BLIND SPOT DETECTION SYSTEM CONFIRMATION TEST.

**BLIND SPOT DETECTION**

**DATA SHEET 2: VEHICLE DATA**

**(Page 1 of 1)**

**2020 Land Rover Range Rover Sport HSE**

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## TEST VEHICLE INFORMATION

VIN: *SALWR2SU9LA71xxxx*

Body Style: *SUV* Color: *Portofino Blue*

Date Received: *6/19/2020* Odometer Reading: *62 mi*

## DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Jaguar Land Rover Ltd.*

Date of manufacture: *01/20*

Vehicle Type: *MPV*

## DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *275/45 R21*

Rear: *275/45 R21*

Recommended cold tire pressure: Front: *250 kPa (37 psi)*

Rear: *300 kPa (44 psi)*

## TIRES

Tire manufacturer and model: *Pirelli Scorpion*

Front tire size: *275/45 R21 110Y*

Rear tire size: *275/45 R21 110Y*

Front tire DOT prefix: *XN 8M 325E*

Rear tire DOT prefix: *XN 8M 325E*

**BLIND SPOT DETECTION**

**DATA SHEET 3: TEST CONDITIONS**

**(Page 1 of 2)**

**2020 Land Rover Range Rover Sport HSE**

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## GENERAL INFORMATION

Test date: *11/6/2020*

## AMBIENT CONDITIONS

Air temperature: *13.9 C (57 F)*

Wind speed: *0.0 m/s (0.0 mph)*

**X** Windspeed ≤ 10 m/s (22 mph)

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

**X** Tests were conducted during daylight hours with good atmospheric visibility (defined as an absence of fog and the ability to see clearly for more than 5000 meters). The tests were not conducted with the vehicle oriented into the sun during very low sun angle conditions, where the sun is oriented 15 degrees or less from horizontal, and camera “washout” or system inoperability results.

All tests were also conducted such that there were no overhead signs, bridges, or other significant structures over, or near, the testing site. Except for the POV, each trial shall be conducted with no vehicles, obstructions, or stationary objects within one lane width of either side the SV path.

## VEHICLE PREPARATION

**Verify the following:**

All non-consumable fluids at 100% capacity: **X**

Fuel tank is full: **X**

Tire pressures are set to manufacturer's recommended cold tire pressure: **X**

Front: *250 kPa (37 psi)*

Rear: *300 kPa (44 psi)*

## WEIGHT

Weight of vehicle as tested including driver and instrumentation

| | | | |
|---|---|---|---|
| Left Front: | *653.6 kg (1441 lb)* | Right Front: | *591.5 kg (1304 lb)* |
| Left Rear: | *587.9 kg (1296 lb)* | Right Rear: | *666.3 kg (1469 lb)* |
| | | Total: | *2499.3 kg (5510 lb)* |

**BLIND SPOT DETECTION**

**DATA SHEET 4: BLIND SPOT DETECTION SYSTEM OPERATION**

**(Page 1 of 4)**

**2020 Land Rover Range Rover Sport HSE**

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**General Information**

Name of the BSD option, option package, etc., as shown on the Monroney label:

*Blind Spot Monitor, available on all models. It is optional on SE versions where the Drive Pack option provides the Blind Spot Monitor system. It is standard on all other models.*

Type and location of sensors the system uses:

*Side Obstacle Detection Control Modules are located in the left rear and right rear, behind the rear bumper.*

System setting used for test (if applicable):

*Warning Only*

**Method(s) by which the driver is alerted**

**X** Visual:

| | Type | Location | Description |
|---|---|---|---|
| **X** | Symbol | *Upper corners of the outside rearview mirrors.* | *Blind spot symbol.* |
| | Word | | |
| | Graphic | | |

____ Audible – Description:

____ Haptic:

| | | | |
|---|---|---|---|
| ____ | Steering Wheel | ____ | Seatbelt |
| ____ | Pedals | ____ | Steering Torque |
| ____ | Seat | ____ | Brake Jerk |

Description of alert:

*The Blind Spot Monitor system monitors an area adjacent to, and approximately 28 ft (8.5 m) behind, the vehicle. When the system detects an overtaking vehicle, the amber warning icon:*

- *Flashes if the relevant turn signal is being used.*
- *Illuminates continuously if the relevant turn signal is not being used.*
- *Extinguishes when the system no longer detects a vehicle in the monitored area.*

**System Function**

What is the speed range over which the system operates?

Minimum: *10 km/h (6 mph)*

Maximum: *180 km/h (112 mph)*

If the system requires an initialization sequence/procedure, please provide a description of the process required to initialize the system.

*No initialization is required.*

If the system requires the driver to operate their turn signal indicator during lane change in order to activate, please provide a description.

*BSD works irrespective of direction indicators being activated by the driver. When the BSD system detects object AND side turn indicator is operated, the exterior rearview mirror icon flashes to a solid on state.*

If the vehicle is equipped with a method to activate/deactivate the system(s) please provide a description of how this is accomplished. If the system is deactivated by this method, does it reactivate upon each ignition cycle?

*The system can be switched on and off via the Driver assistance instrument panel menu. Left/Right and Up/Down and Select buttons located on the left side of the steering wheel are used to access the vehicle menus. The menu hierarchy is:*

*Driver Assistance*

*Collision Avoidance*

*Blind Spot Assist - Select:*

*Off*

*Steering Assist*

*Alert Only*

*The selected state remains set until the driver alters the setting.*
*See Appendix A, Figures A11 and A12.*

If the vehicle is equipped with a method to adjust the range setting/sensitivity or otherwise influence the operation of BSD, please provide a description.

*No range/sensitivity adjustment is provided.*

If the system deactivates due to damage to the sensors, how is this indicated to the driver?

*The instrument panel and touchscreen display messages to inform the driver of any performance or system issues.*

If the system deactivates due to repeated BSD activations:

- How is this indicated to the driver?
- Can deactivation be avoided (e.g., by cycling the ignition after each BSD activation)?
- How can the system be reactivated?

*N/A*

If the system deactivates or its effectiveness is reduced due to periods of inactivity:

- How is this indicated to the driver?
- Can deactivation be avoided?
- How can the system be reactivated?

*The system will not deactivate or reduce effectiveness due to periods of inactivity.*

If there are other driving modes or conditions (such as weather) that render the system inoperable or reduce its effectiveness please provide a description.

*For a more comprehensive list of driving modes or conditions that render the BSD system inoperable, please see Owner's Manual, pages 200-201 shown on Appendix B, pages B-4 through B-5.*

Notes:

Section III

# TEST PROCEDURES

## A. Test Procedure Overview

Two test scenarios were used, as follows:

Test 1. Straight Lane Converge and Diverge
Test 2. Straight Lane Pass-by

An overview of each of the test procedures follows.

For the purposes of this document, headway is defined as the longitudinal distance from the front-most point of the POV to the rear-most point of the SV, regardless of the relative lateral (lane) positions of the SV and POV. When the front-most part of the POV is ahead of the rear-most point on the SV, the headway is negative.

### 1. TEST 1 – STRAIGHT LANE CONVERGE AND DIVERGE

The Straight Lane Converge and Diverge Test evaluates the ability of the Blind Spot Detection (BSD) system to detect and respond to a vehicle that enters and exits the blind zone from a lane outside of the blind zone area. This test scenario is depicted in Figure 1. In this scenario, the test begins with the POV two lanes away from the SV. After both vehicles have reached their designated speeds and headway overlap, the POV begins a single lane change maneuver so that it is travelling in the lane next to the SV and holds this relative position for at least 2.5 seconds. The POV then begins a lane change maneuver back to its original lane, moving outside of the SV's blind zone.

This test was performed with the POV on both the left- and right-hand sides of the SV. The SV and POV turn signals were not active during any of the tests.

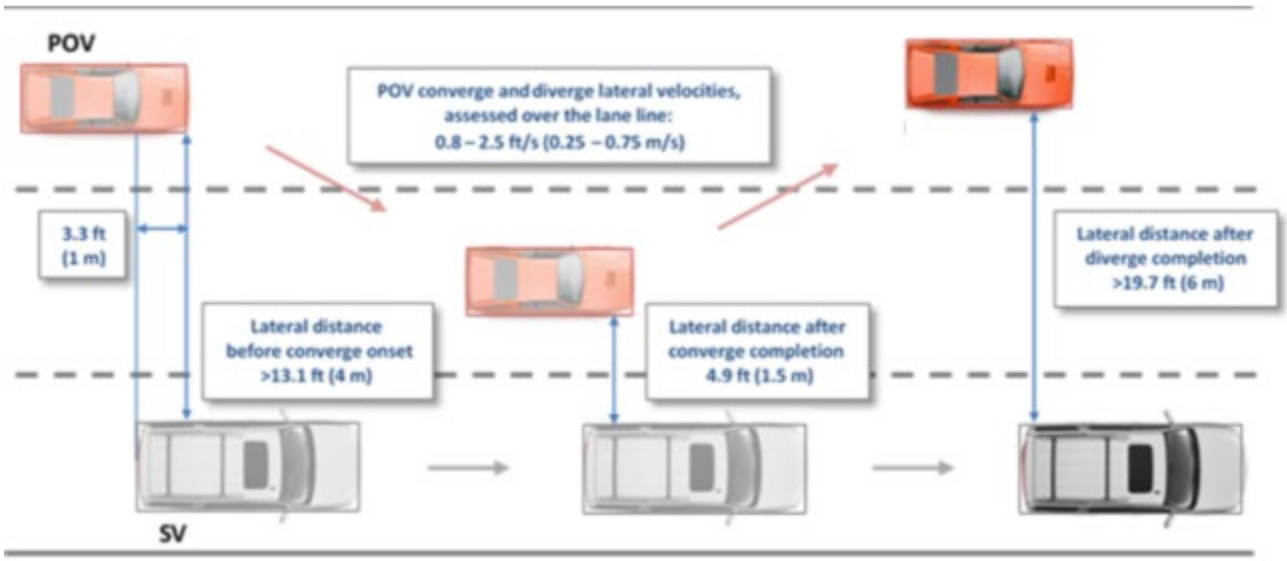



Figure 1. Straight Lane Converge and Diverge Test
(POV converge and diverge from the left is shown)

a. Procedure

The SV began in the center of a travel lane, with its longitudinal axis oriented parallel to the roadway edge. The POV began two lanes away from the SV, with its longitudinal axis oriented parallel to the roadway edge. Both vehicles then accelerated to a nominal speed of 45 mph (72.4 km/h). The nominal speed and specified headway overlap between the front bumper of the POV and the rear bumper of SV was maintained, within tolerance, throughout the test. As shown in Figure 1, the specified headway for this test was -3.3 ft (-1.0 m) resulting in a longitudinal overlap. The specified speed for both the SV and POV was 45 mph (72.4 km/h).

Once the specified speed and headway were stabilized and maintained for at least 2.5 seconds, the POV performed a “converge” lane change into the lane adjacent to the SV using a lateral velocity between 0.8 ft/s and 2.5 ft/s (0.25 to 0.75 m/s).

Once the lane change was completed, the POV continued in a straight line for at least 2.5 seconds, and then performed a “diverge” lane change back into its original lane using a lateral velocity between 0.8 ft/s and 2.5 ft/s (0.25 to 0.75 m/s).

The test concluded once the POV was back in its original lane and had been driving straight for at least 1.0 second.

The validity period for this test started 2.5 seconds prior to initiating the first POV lane change and ended 1.0 second after completion of the final POV lane change. For an individual test trial to be valid, the following requirements must have been met throughout the validity period:

- The SV and POV speeds could not deviate from the specified speed by more than 1.0 mph (1.6 km/h) during the entire test trial interval.
- The SV yaw rate could not exceed ±1 deg/s for the entire test interval.
- The POV yaw rate could not exceed ±1 deg/s when not performing a lane change maneuver.
- The POV lateral velocity during a lane change maneuver must have been 0.8 to 2.5 ft/s (0.25 to 0.75 m/s), assessed at the instant the vehicle first crossed the lane line separating the initial and adjacent travel lanes.
- The headway overlap from the front of the POV to the rear of the SV bumper must have been within 3.3 ± 1.6 ft (1.0 ± 0.5 m) for the entire test interval.
- The lateral offset between the widest point of the SV (not including side mirrors) and the widest point of the POV (not including side mirrors) must have been
    - greater than 13.1 ft (4 m) before the POV begins the converge lane change,
    - within 4.9 ± 1.6 ft (1.5 ± 0.5 m) when the POV is in the lane adjacent to the SV, and
    - greater than 19.7 ft (6 m) after the POV completes the diverge lane change.

After the test validity period ended, the SV driver manually applied force to the brake pedal, bringing the vehicle to a stop, and placed the transmission in park. The POV was also braked to a stop, and the test trial was complete.

b. Number of Test Trials

Seven valid trials per POV approach direction were performed for the Straight Lane Converge and Diverge Test scenario, for a total of 14 tests overall. If the test conductor performed more than 7 trials per approach direction within this scenario, the first 7 trials satisfying all test tolerances per approach direction were used to assess the SV performance.

c. Evaluation Criteria

The performance requirement for this series of tests is that the BSD system must be presented by a time no later than 300 ms after any part of the POV enters the SV blind zone defined by the intersections of lines A, C, D, and E for left side tests and of lines A, C, F, and G for right side tests (as shown in Figure 3), and shall remain on while any part of the POV resides within the SV blind zone. During the diverge portion of the test scenario, the BSD alert may remain active when the lateral distance between the SV and the POV is greater than 9.8 ft (3 m) but less than or equal to 19.7 ft (6 m). The BSD shall not be active once the lateral distance between the SV and the POV is greater than 19.7 ft (6 m).

## 2. TEST 2 – STRAIGHT LANE PASS-BY

This test evaluates the ability of the BSD system to detect and respond to a vehicle which approaches and then passes by the SV in an adjacent lane. This test scenario, depicted in Figure 2, was performed with the POV on both the left- and right-hand side of the SV, with four different POV speed configurations on each side: 50 mph, 55 mph, 60 mph, and 65 mph.

The SV and POV turn signals were not active during any of the tests.

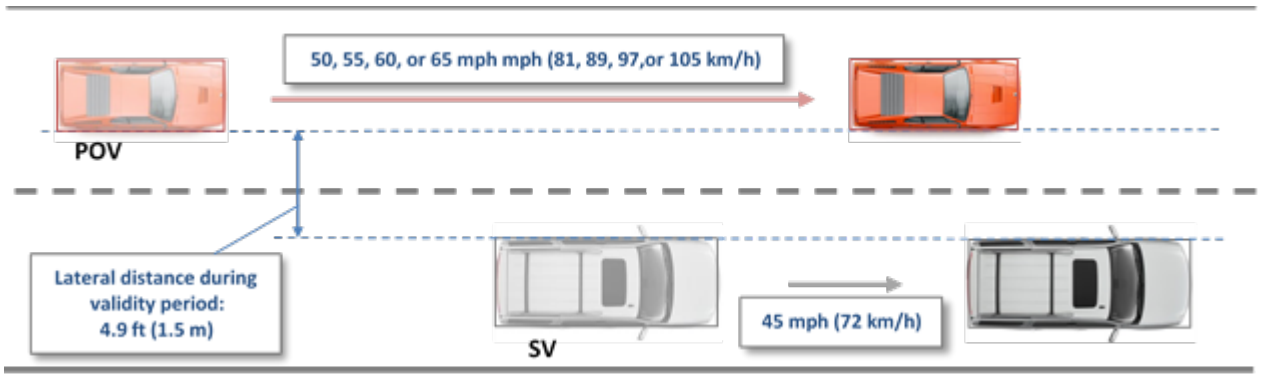



Figure 2. Straight Lane Pass-by Test
(Left-side POV Pass-by is shown)

### a. Procedure

The SV is started in the center of a travel lane, with its longitudinal axis oriented parallel to the roadway edge. The POV is started in an adjacent lane on either the left or right side of the SV, with its longitudinal axis oriented parallel to the roadway edge, and behind the SV blind zone area.

The SV is then accelerated to a nominal speed of 45 mph (72.4 km/h) and the POV is accelerated to a nominal speed of either 50 mph (80.5 km/h), 55 mph (88.5 km/h), 60 mph (96.6 km/h), or 65 mph (104.6 km/h) depending on the test configuration. Both vehicles continue straight in their respective lanes.

The Straight Lane Pass-by Test parameters are defined in Table 1. The test validity period begins 4.0 seconds before the front-most part of the POV passes beyond a plane defined by the rear-most part of the SV perpendicular to the SV centerline. The test validity period ends 2.0 seconds after the rear-most point of the POV passes beyond a plane defined by the front-most point of the SV perpendicular to the SV centerline.

**Table 1. Straight Lane Pass-by Test Scenarios**

| Parameter | Test Scenario | | | |
|---|---|---|---|---|
| | Straight Lane 45/50 | Straight Lane 45/55 | Straight Lane 45/60 | Straight Lane 45/65 |
| SV Speed | 45 ± 1 mph (72.4 ± 1.6 km/h) | 45 ± 1 mph (72.4 ± 1.6 km/h) | 45 ± 1 mph (72.4 ± 1.6 km/h) | 45 ± 1 mph (72.4 ± 1.6 km/h) |
| POV Speed | 50 ± 1 mph (80.5 ± 1.6 km/h) | 55 ± 1 mph (88.5 ± 1.6 km/h) | 60 ± 1 mph (96.6 ± 1.6 km/h) | 65 ± 1 mph (104.6 ± 1.6 km/h) |
| Differential Speed | 5 ± 1 mph (8.0 ± 1.6 km/h) | 10 ± 1 mph (16.1± 1.6 km/h) | 15 ± 1 mph (24.1 ± 1.6 km/h) | 20 ± 1 mph (32.2 ± 1.6 km/h) |
| Starting Headway Distance (nominally a 4 second gap) at validity period onset | 29.3 ft (8.9 m) | 58.7 ft (17.9 m) | 88.0 ft (26.8 m) | 117.3 ft (35.8 m) |

For an individual test trial to be valid, the following requirements must have been met throughout the validity period:

- The SV speed could not deviate from the nominal speed by more than 1.0 mph (1.6 km/h) during the entire test interval.
- The POV speed could not deviate from the nominal speed by more than 1.0 mph (1.6 km/h) during the entire test interval.
- The SV yaw rate could not exceed ±1 deg/s for the entire test interval.
- The POV yaw rate could not exceed ±1 deg/s for the entire test interval.
- The lateral offset between the widest point of the SV (not including side mirrors) and the widest point of the POV (not including side mirrors) must have been within 4.9 ± 1.6 ft (1.5 ± 0.5 m) for the entire test interval.

After the test validity period ended, the SV driver manually applied force to the brake pedal, bringing the vehicle to a stop, and placed the transmission in park. The POV was also braked to a stop, and the test trial was complete.

b. Number of Test Trials

Seven valid trials for each POV pass-by side and speed were performed for the Straight Lane Pass-by Test scenario, for a total of 56 test trials overall. If the test conductor performed more than 7 trials per approach direction within this scenario, the first 7 trials satisfying all test tolerances per test condition were used to assess the SV performance.

c. Evaluation Criteria

The performance requirement for this series of tests is that the BSD alert must be presented by a time no later than 300 ms after the front-most part of the POV enters the blind zone defined by the intersections of lines A, C, D, and E for left side tests and of lines A, C, F, and G for right side tests, and shall remain on while the front-most point of the POV lies behind line A. The BSD alert shall not be active once the longitudinal distance between the front-most part of the SV and the rear-most part of the POV exceeds the BSD termination distances specified in Table 2.

**Table 2. Straight Lane Pass-by BSD Evaluation Criteria**

| SV Speed | POV Speed | BSD Onset Headway[1] (SV ahead of POV) | BSD Termination Distance[2] (POV ahead of SV) |
|---|---|---|---|
| 45 ± 1 mph (72.4 ± 1.6 km/h) | 50 ± 1 mph (80.5 ± 1.6 km/h) | Within 300 ms after $\overline{BC}$ = 18.3 ft (5.6 m) | >7.3 ft (2.2 m) |
| | 55 ± 1 mph (88.5 ± 1.6 km/h) | Within 300 ms after $\overline{BC}$ = 36.7 ft (11.2 m) | >14.7 ft (4.5 m) |
| | 60 ± 1 mph (96.6 ± 1.6 km/h) | Within 300 ms after $\overline{BC}$ = 55.0 ft (16.8 m) | >22.0 ft (6.7 m) |
| | 65 ± 1 mph (104.6 ± 1.6 km/h) | Within 300 ms after $\overline{BC}$ = 73.3 ft (22.4 m) | >29.3 ft (8.9 m) |

[1] The BSD onset headway is the longitudinal distance when the rear-most part of the SV is ahead of the front-most part of the POV. The BSD onset headway criteria nominally corresponds to 2.5 seconds before the front-most part of the POV passes by the rear-most part of the SV.

[2] The BSD termination distance is the longitudinal distance when the rear-most part of the POV is ahead of the front-most part of the SV. The BSD termination distance criteria nominally corresponds to 1 second after the rear-most part of the POV passes by the front-most part of the SV.

## B. Pre-Test Initialization and Calibration

A zero calibration was performed to align the lateral and longitudinal zero for the vehicles immediately before and after testing. The “zero position” was determined by positioning the SV and POV such that the centerline of the front-most location of the POV was aligned with the centerline of the rear-most location of the SV. Longitudinally, the front-most point of the front bumper of the POV was placed at the rear-most point of the rear bumper of the SV.

Static calibrations were then performed by placing the SV and POV transmissions in park, where applicable. Data were then collected for approximately 10 seconds using data from at least six GPS satellites. If the pre-test and post-test zero-positions reported by the data acquisition system differed by more than ±2 in (±5 cm) then the tests performed between the pre-test and post-test static calibrations were repeated.

## C. Vehicle’s Blind Zone

The SV blind zones, for the purpose of this test, are defined by two rectangular regions adjacent to the sides of the SV, as shown in Figure 3.

The width of each rectangle is 8.2 ft (2.5 m) and is represented by lines parallel to the longitudinal centerline of the vehicle. The width of the rectangle begins 1.6 ft (0.5 m) from the outermost edge of the SV’s body, excluding the side view mirrors.

The length of the rectangle starts at the rear-most portion of the SV’s side view mirrors, perpendicular to the longitudinal centerline of the vehicle, and continues to a distance dependent on the differential speed between the SV and POV or SOV. To calculate the distance for the length of the rectangle that extends beyond the rear bumper of the SV, the following equation is used and corresponds to the length from point B to point C in Figure 3.

$$\overline{BC} = 2.5\Delta v\ (ft/s\ to\ ft)$$

where,

> $\Delta v$ is the differential speed between the POV and the SV. A positive $\Delta v$ indicates that the POV is travelling faster than the SV.

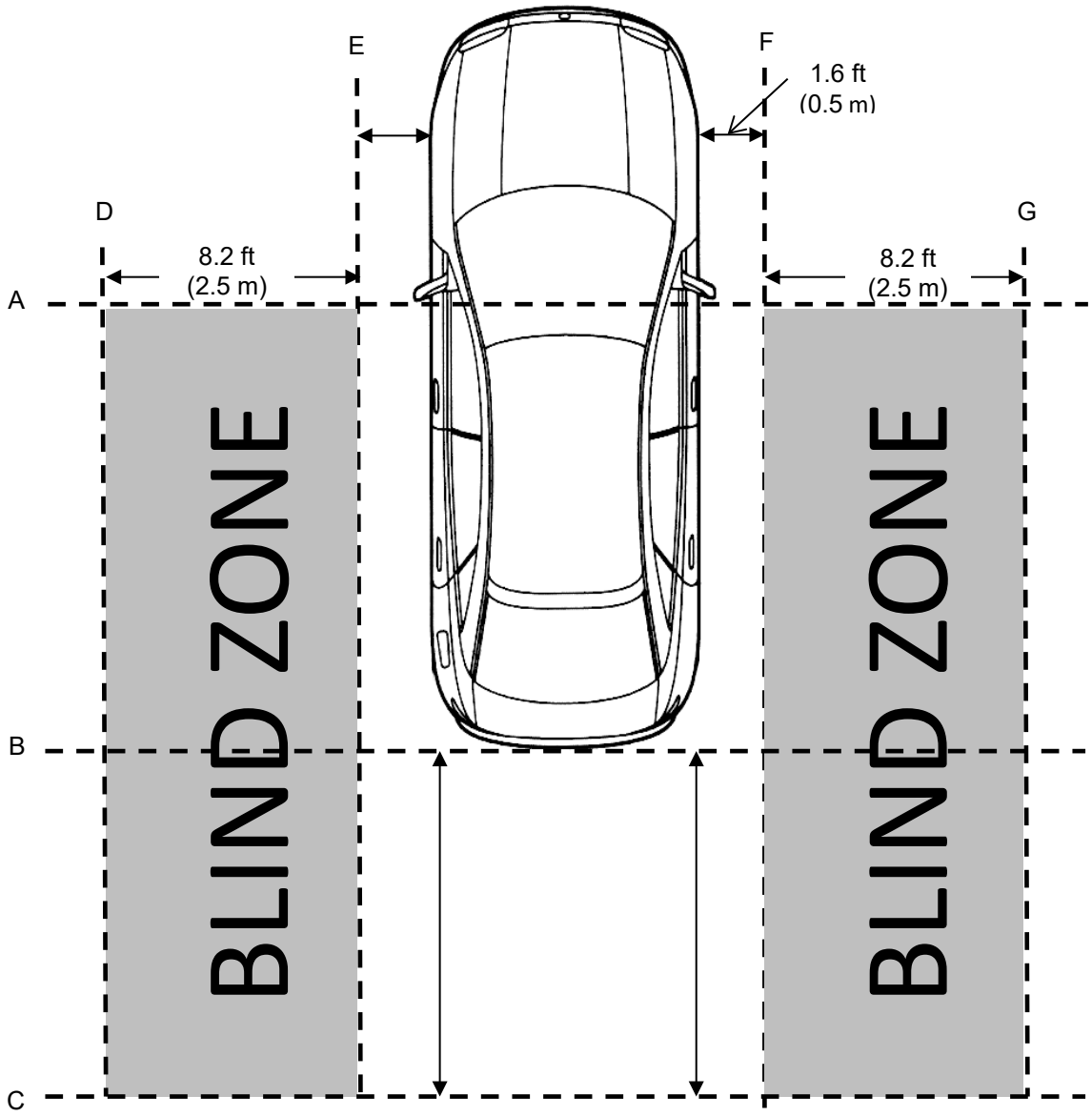



Figure 3. Vehicle Blind Zone Areas

Table 3 details the difference in length from point B to point C of the blind zone for the different speeds used in the tests.

**Table 3. B to C Blind Zone Distance**

| SV-to-POV Differential Speed | B to C Distance (Nominal TTC = 2.5s) |
|---|---|
| 5 ± 1 mph (8.0 ± 1.6 km/h) | 18.3 ft (5.6 m) |
| 10 ± 1 mph (16.1 ± 1.6 km/h) | 36.7 ft (11.2 m) |
| 15 ± 1 mph (24.1 ± 1.6 km/h) | 55.0 ft (16.8 m) |
| 20 ± 1 mph (32.2 ± 1.6 km/h) | 73.3 ft (22.4 m) |

For the Straight Lane Converge and Diverge Test scenario where there is no speed differential between the SV and POV, the B to C distance is given as 9.8 ft (3 m).

### D. Principal Other Vehicle

The vehicle used as the Principal Other Vehicle (POV) was a 2006 Acura RL. This vehicle met the test requirements that the POV be a high-production mid-sized passenger car from 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, exclusive of signal lamps, marker lamps, outside rearview mirrors, flexible fender extensions, and mud flaps, determined with doors and windows closed and the wheels in the straight-ahead position. Vehicle loading consisted of the driver plus equipment and instrumentation.

### E. Throttle Controller

The POV was equipped with a programmable throttle controller which was used during the Straight Lane Converge and Diverge Test scenarios to modulate both speed and headway overlap between the SV and the POV. The throttle controller system consisted of the following components:

- Electronically controlled servo motor, mounted on an aluminum rail system and installed in the vehicle
- Real time computer (Arduino)

- Laptop computer, used to program and enable the throttle controller

## F. Instrumentation

Table 4 lists the sensors, signal conditioning, and data acquisition equipment used for these tests.

## Table 4. Test Instrumentation and Equipment

| Type | Output | Range | Accuracy, Other Primary Specs | Mfr, Model | Serial Number | Calibration Dates Last Due |
|---|---|---|---|---|---|---|
| Differential Global Positioning System | Position, Velocity | Latitude: ±90 deg<br>Longitude: ±180 deg<br>Altitude: 0-18 km<br>Velocity: 0-1000 knots | Horizontal Position: ±1 cm<br>Vertical Position: ±2 cm<br>Velocity: 0.05 km/h | Trimble GPS Receiver,<br>5700 (base station and in-vehicle) | 00440100989 | N/A |
| Multi-Axis Inertial Sensing System | Position;<br>Longitudinal, Lateral, and Vertical Accels;<br>Lateral, Longitudinal and Vertical Velocities;<br>Roll, Pitch, Yaw Rates;<br>Roll, Pitch, Yaw Angles | Accels ± 10g, Angular Rate ±100 deg/s, Angle >45 deg, Velocity >200 km/h | Accels .01g, Angular Rate 0.05 deg/s, Angle 0.05 deg, Velocity 0.1 km/h | Oxford Inertial + | 2258 | By: Oxford Technical Solutions<br>Date: 5/3/2019<br>Due: 5/3/2021 |
| | | | | Oxford Inertial + | 2182 | Date: 9/16/2019<br>Due: 9/16/2021 |
| Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW) | Distance and Velocity to lane markings (LDW) and POV (FCW) | Lateral Lane Dist: ±30 m<br>Lateral Lane Velocity: ±20 m/sec<br>Longitudinal Range to POV: ±200 m<br>Longitudinal Range Rate: ±50 m/sec | Lateral Distance to Lane Marking: ±2 cm<br>Lateral Velocity to Lane Marking: ±0.02m/sec<br>Longitudinal Range: ±3 cm<br>Longitudinal Range Rate: ±0.02 m/sec | Oxford Technical Solutions (OXTS),<br>RT-Range | 97 | N/A |
| Microphone | Sound<br>(to measure time at alert) | Frequency Response:<br>80 Hz – 20 kHz | Signal-to-noise: 64 dB, 1 kHz at 1 Pa | Audio-Technica AT899 | N/A | N/A |

## Table 4. Test Instrumentation and Equipment (continued)

| Type | Output | Range | Accuracy, Other Primary Specs | Mfr, Model | Serial Number | Calibration Dates Last Due |
|---|---|---|---|---|---|---|
| Light Sensor | Light intensity (to measure time at alert) | Spectral Bandwidth: 440-800 nm | Rise time < 10 msec | DRI designed and developed Light Sensor | N/A | N/A |
| Accelerometer | Acceleration (to measure time at alert) | ±5g | ≤ 3% of full range | Silicon Designs, 2210-005 | N/A | N/A |
| Tire Pressure Gauge | Vehicle Tire Pressure | 0-100 psi | < 1% error between 20 and 100 psi | Omega DPG8001 | 18111410000 | By: DRI<br>Date: 5/4/2020<br>Due: 5/4/2021 |
| Platform Scales | Vehicle Total, Wheel, and Axle Load | 2200 lb/platform | 0.1% of reading | Intercomp SW wireless | 0410MN20001 | By: DRI<br>Date: 4/20/2020<br>Due: 4/20/2021 |
| Coordinate Measurement Machine | Inertial Sensing System Coordinates | 0-8 ft<br>0-2.4 m | ±.0020 in.<br>±.051 mm<br>(Single point articulation accuracy) | Faro Arm, Fusion | UO8-05-08-06636 | By: DRI<br>Date: 1/6/2020<br>Due: 1/6/2021 |

| Type | Description | Mfr, Model | Serial Number |
|---|---|---|---|
| Data Acquisition System | Data acquisition is achieved using a dSPACE MicroAutoBox II. Data from the Oxford IMU, including Longitudinal, Lateral, and Vertical Acceleration, Roll, Yaw, and Pitch Rate, Forward and Lateral Velocity, Roll and Pitch Angle are sent over Ethernet to the MicroAutoBox. The Oxford IMUs are calibrated per the manufacturer's recommended schedule (listed above). | dSPACE Micro-Autobox II 1401/1513 | |
| | | Base Board | 549068 |
| | | I/O Board | 588523 |
| Throttle Controller | Arduino based, servo actuated controller for managing POV speed | DRI developed | N/A |

# APPENDIX A

Photographs

LIST OF FIGURES


Figure A1. Front View of Subject Vehicle


Figure A2. Rear View of Subject Vehicle

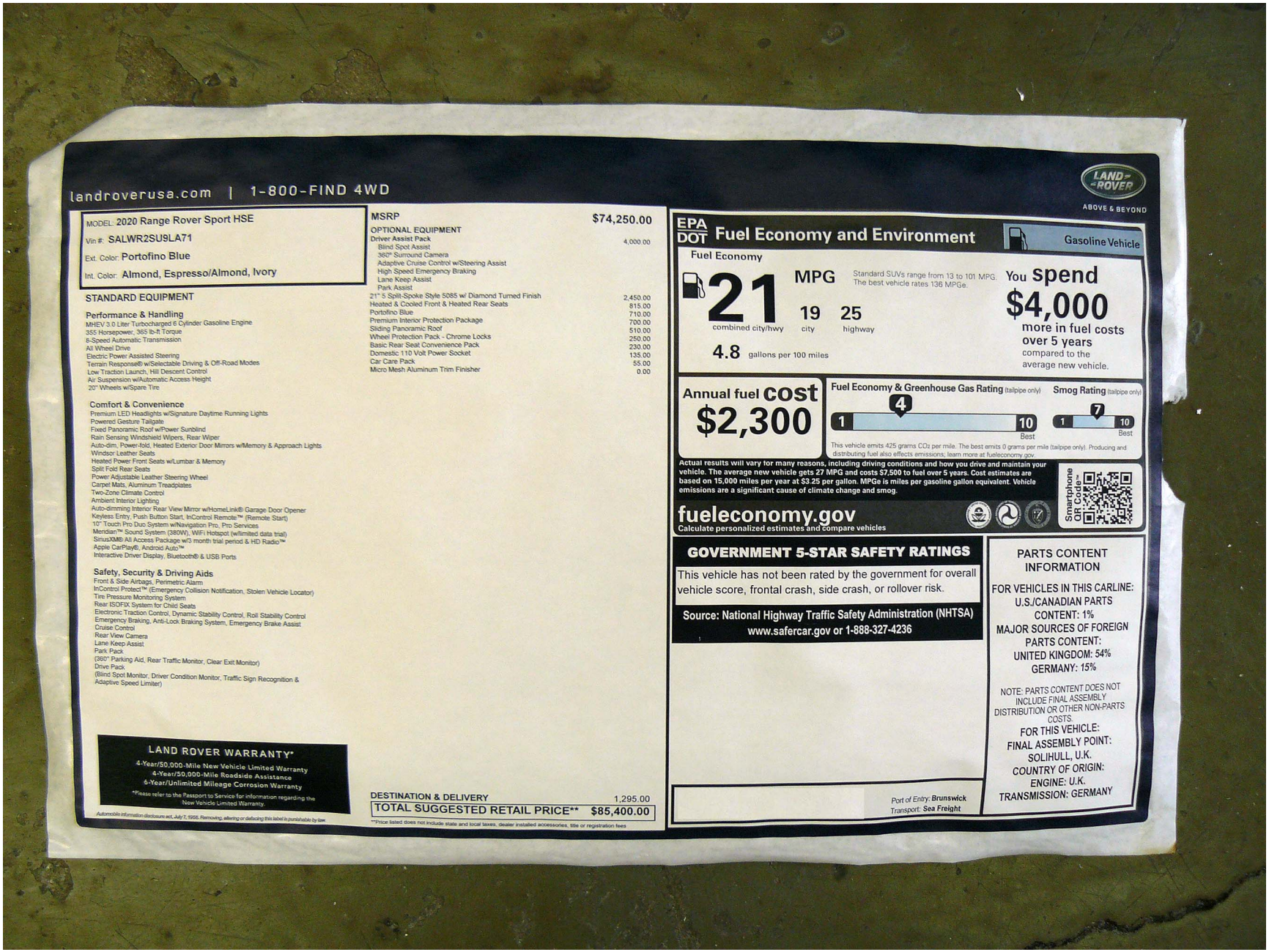



Figure A3. Window Sticker (Monroney Label)

Figure A4. Vehicle Certification Label

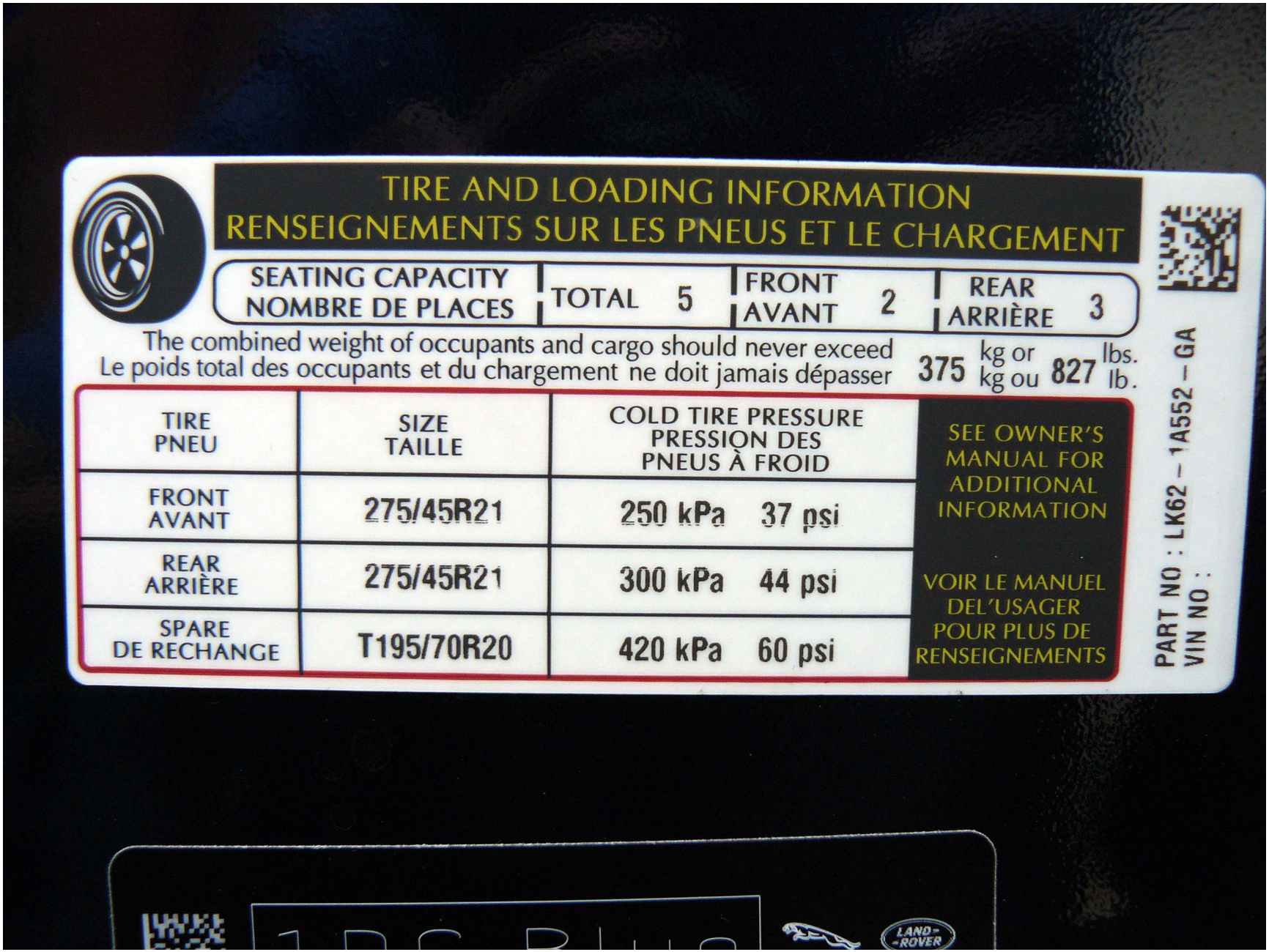



Figure A5. Tire Placard


Figure A6. Front View of Principal Other Vehicle

Figure A7.  Rear View of Principal Other Vehicle


Figure A8. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A9. Sensors for Detecting Visual Alerts

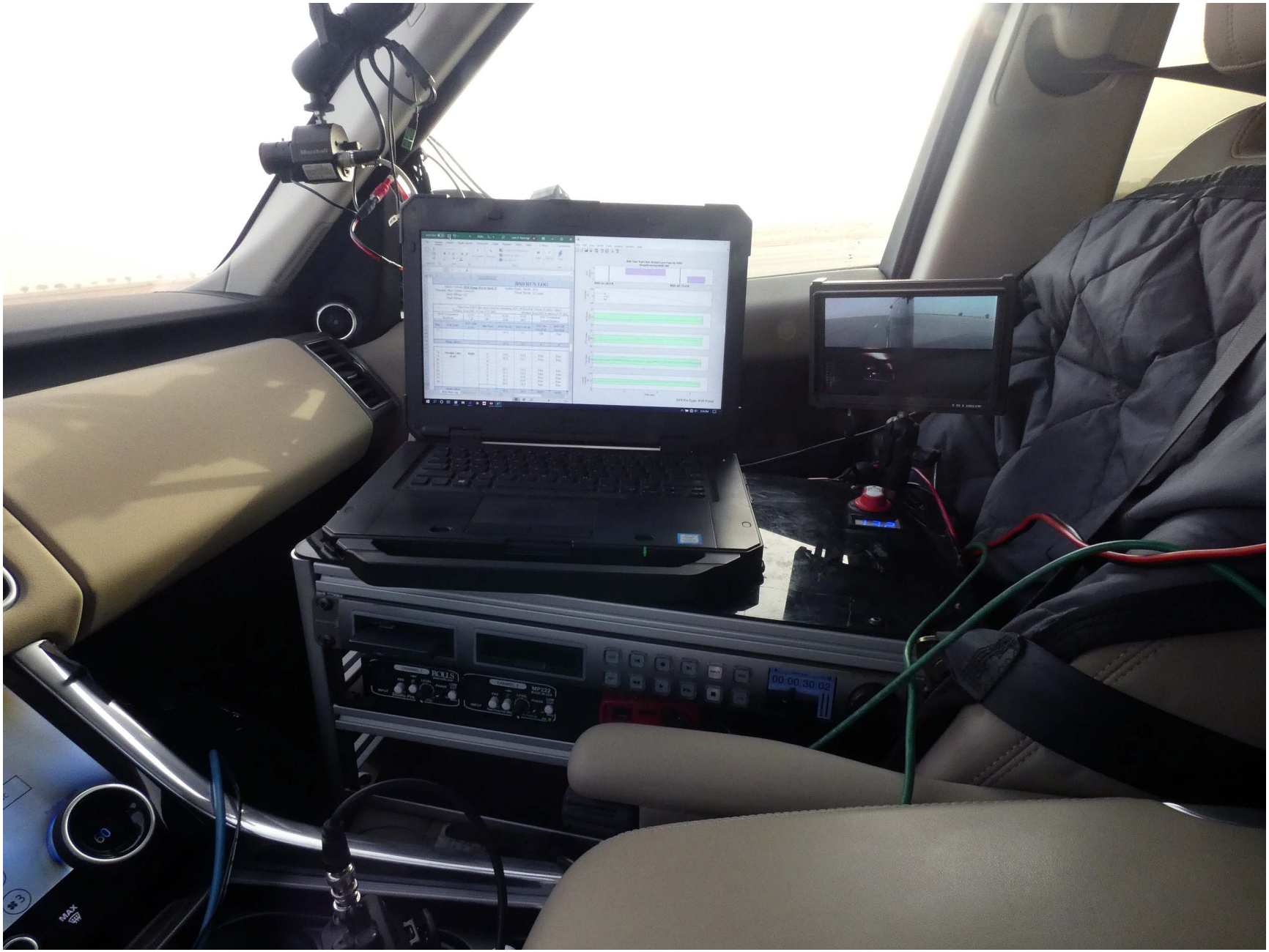


Figure A10. Computer Installed in Subject Vehicle

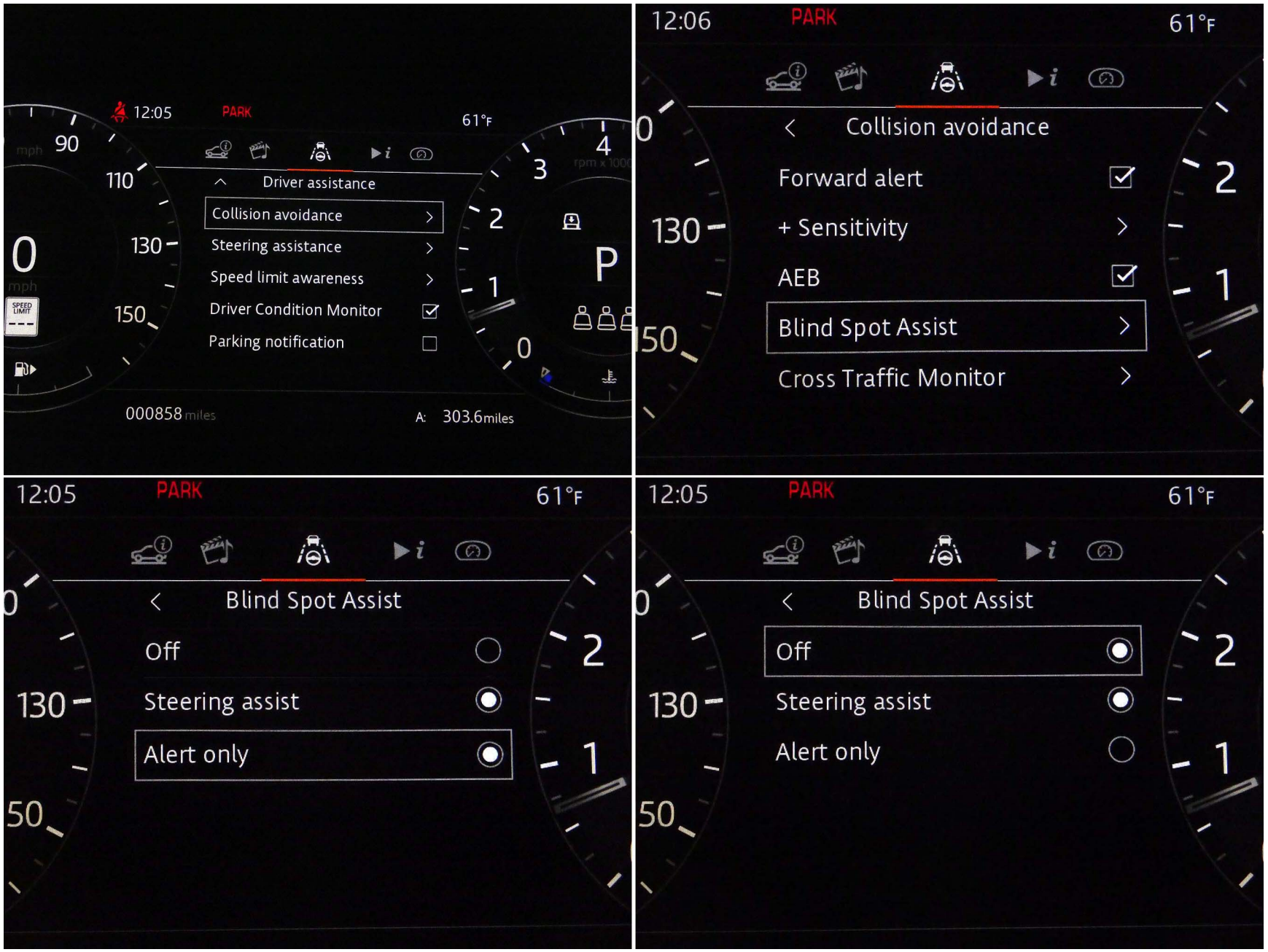



Figure A11. System Setup Menus


Figure A12. Controls for Interacting with System Menus

Figure A13. Visual Alert

# APPENDIX B

Excerpts from Owner's Manual

The high-speed emergency braking feature attempts to slow the vehicle automatically if it detects that a collision with a slower vehicle ahead is unavoidable. The high-speed emergency braking feature operates at all speeds. The feature also operates if forward alert is switched off.

A warning sounds if the high-speed emergency braking feature detects that a collision is imminent. The high-speed emergency braking feature automatically applies the brakes if it detects that a collision is unavoidable. The instrument panel displays **IEB system not available (was activated)** after the high-speed emergency braking feature has been activated.

***Note:*** *The high-speed emergency braking feature does not work again until the system has been reset by a retailer/ authorized repairer.*

## HIGH-SPEED EMERGENCY BRAKING LIMITATIONS

Make sure the following warnings have been read and fully understood before driving the vehicle. The high-speed emergency braking feature does not take away the requirement to always drive with due care and attention. Driving without due care and attention could result in an accident, leading to serious injury or death.

### ⚠WARNING

**The high-speed emergency braking feature may not react to slow-moving vehicles.**

### ⚠WARNING

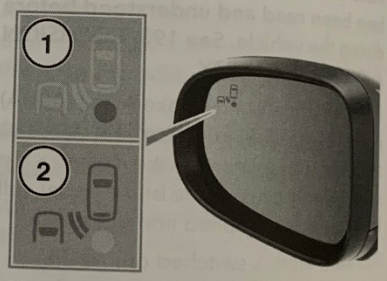
**The high-speed emergency braking feature does not react to stationary vehicles or vehicles traveling in the opposite direction.**

The distance required to slow or stop the vehicle is dependent on the condition of the vehicle's tires and the road surface.

## BLIND SPOT MONITOR

### ⚠WARNING

**Make sure the relevant safety warnings have been read and understood before driving the vehicle. See 193, COLLISION AVOIDANCE SAFETY.**



E210991

The blind spot monitor system monitors an area adjacent to, and approximately 28 ft (8.5 m) behind, the vehicle. When the system detects an overtaking vehicle, the amber warning icon (**1**):

- Flashes if the relevant turn signal is being used.
- Illuminates continuously if the relevant turn signal is not being used.
- Extinguishes when the system no longer detects a vehicle in the monitored area.



During initializ
flash in both d
A warning indi
door mirrors w
system is disab
a system fault.
The blind spot
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**assistance** inst
**65, INSTRUM**

**BLIND SPO
LIMITATION**

The blind spot
operate when:

- Reverse (**R**)
- The vehicle
(10 km/h).
- The radar s
stop workin
- The door m
- An electrica
to a Jaguar
trailer socke

***Note:*** *The
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again, to en
system.*

The blind spot

- Works most
highways.
- Monitors an
ft (3.3 m) fro
and approxi
the vehicle.

During initialization, the warning icons flash in both door mirrors.

A warning indicator (**2**) illuminates in the door mirrors when the blind spot monitor system is disabled, not active, or there is a system fault.

The blind spot monitor system can be switched on and off via the **Driver assistance** instrument panel menu. See **65, INSTRUMENT PANEL MENU**.

## BLIND SPOT MONITOR LIMITATIONS

The blind spot monitor system does not operate when:

- Reverse (**R**) or Park (**P**) is selected.
- The vehicle's speed is below 6 mph (10 km/h).
- The radar sensors become blocked or stop working.
- The door mirrors stop working.
- An electrical connector is connected to a Jaguar Land Rover approved trailer socket.

  ***Note:*** *The blind spot monitor system remains disabled if a trailer is disconnected from the trailer socket while the engine is still running. Switch the vehicle's ignition off, then back on again, to enable the blind spot monitor system.*

The blind spot monitor system:

- Works most effectively on multi-lane highways.
- Monitors an area of approximately 11 ft (3.3 m) from the side of the vehicle, and approximately 28 ft (8.5 m) behind the vehicle.
- May register false targets if traveling along a narrow lane.
- Does not work accurately if the sensors are misaligned due to bumper modifications, impact damage, etc.

The instrument panel and touchscreen display messages to inform the driver of any performance or system issues.

## BLIND SPOT MONITOR RADIO FREQUENCY SPECTRUM REGULATION STATEMENTS

### United States of America

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

***Note:*** *The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.*

### Canada

This device complies with Industry Canada Standard IC - RSS-210 and IC-RSS-251.

Operation is subject to the following two conditions:

1. this device may not cause interference, and
2. this device must accept any interference, including interference that may cause undesired operation of the device.

Frequency of operation: 24.05GHz - 24.25GHz.

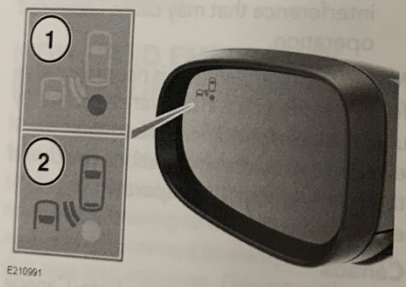
Field strength: Not greater than 2.5V/m peak (0.25V/m average) at a distance of 3 meters.

## CLOSING VEHICLE SENSING

### ⚠WARNING

**Make sure the relevant safety warnings have been read and understood before driving the vehicle. See 193, COLLISION AVOIDANCE SAFETY.**

The closing vehicle sensing system monitors an area adjacent to, and up to approximately 230 ft (70 m) behind, the vehicle. Closing vehicle sensing is automatically switched on when the blind spot monitor system is switched on. See **198, BLIND SPOT MONITOR**.




An amber warning icon (**1**) is located in each door mirror. The icon:

- Illuminates continuously if the detected vehicle enters the area monitored by the blind spot monitor system, and the relevant turn signal is not being used. See **198, BLIND SPOT MONITOR**.
- Flashes if the detected vehicle enters the area monitored by the blind spot monitor system, and the relevant turn signal is being used. See **198, BLIND SPOT MONITOR**.

A warning indicator (**2**) illuminates in the door mirrors when the closing vehicle sensing system is disabled, not active, or there is a system fault.

## CLOSING VEHICLE SENSING LIMITATIONS

The closing vehicle sensing system does not operate when:

- Reverse (**R**) or Park (**P**) is selected.
- The vehicle's speed is below 6 mph (10 km/h).
- The sensors become blocked.
- The blind spot monitor system is not operating.
- The vehicle is traveling around a tight bend.
- An electrical connector is connected to a Jaguar Land Rover approved trailer socket.

***Note:*** *The closing vehicle sensing system remains disabled if a trailer is disconnected from the trailer socket while the engine is still running. Switch the vehicle's ignition off, then back on again, to enable the closing vehicle sensing system.*

The closing vehicle sensing system:

- Works most effectively on multi-lane highways.
- Monitors an area of approximately 11 ft (3.3 m) from the side of the vehicle, and approximately 230 ft (70 m) behind the vehicle.

- May register false targets if traveling along a narrow lane.
- Does not work accurately if the sensors are misaligned due to bumper modifications, impact damage, etc.

The instrument panel and touchscreen display messages to inform the driver of any performance or system issues.

## BLIND SPOT ASSIST

### ⚠WARNING

**Make sure the relevant safety warnings have been read and understood before driving the vehicle. See 193, COLLISION AVOIDANCE SAFETY.**

The blind spot assist system applies corrective steering inputs if:

- A vehicle is detected in the blind spot monitor area, and:
- A lane change maneuver is attempted.

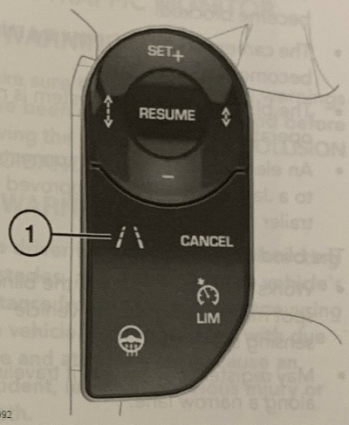
If a lane change maneuver is initiated while a risk is detected, the relevant door mirror displays a flashing vehicle warning icon.

At the same time, a rotational force is applied to the steering wheel to counter the lane change. The instrument panel displays a warning icon when a rotational force is applied to the steering wheel. The Head-Up Display (HUD) also displays a warning.

**Note:** *Blind spot assist operates irrespective of the turn signals being used.*

If required, the steering input provided by the blind spot assist system can be overridden in order to complete a lane change maneuver.

The blind spot assist system can be switched on and off via the **Driver assistance** instrument panel menu. See **65, INSTRUMENT PANEL MENU**.




When switched on, the blind spot assist system must then be activated. Press the button located on the steering wheel (**1**) to activate the blind spot assist system. Press the button a second time to deactivate the system. The button icon illuminates to confirm system status.

***Note:*** *The steering wheel button (**1**) also controls operation of the lane departure warning and Lane Keep Assist (LKA) systems. See **211, LANE DEPARTURE WARNING** and **213, LANE KEEP ASSIST (LKA)**.*

## BLIND SPOT ASSIST LIMITATIONS

The blind spot assist system does not operate when:

- Reverse (**R**) or Park (**P**) is selected.

- The vehicle's speed is below 40 mph (64 km/h) or above 112 mph (180 km/h).
- The sensors in the rear bumper become blocked.
- The camera under the rear-view mirror becomes blocked.
- The blind spot monitor system is not operating.
- An electrical connector is connected to a Jaguar Land Rover approved trailer socket.

The blind spot assist system:

- Works in conjunction with the blind spot monitor and closing vehicle sensing systems.
- May register false targets if traveling along a narrow lane.
- Does not work accurately if the sensors are misaligned due to bumper modifications, impact damage, etc.

The instrument panel displays messages to inform the driver of any performance or system issues.

## FORWARD TRAFFIC MONITOR

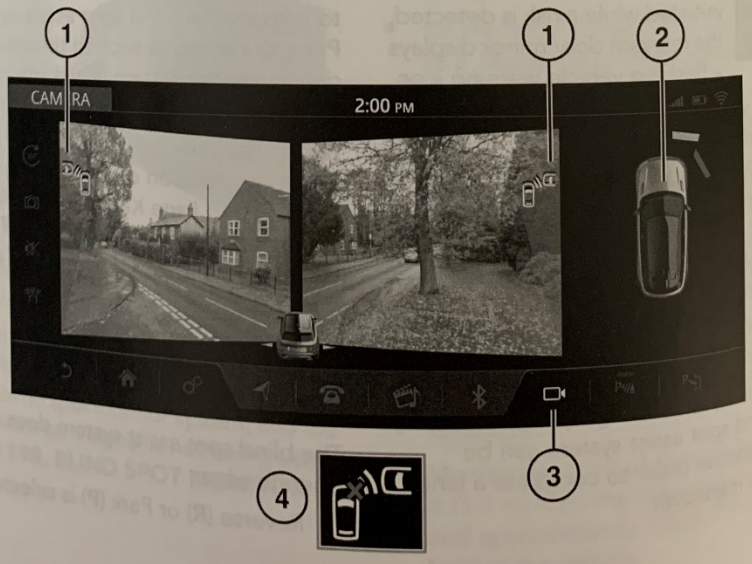
### ⚠WARNING

**Make sure the relevant safety warnings have been read and understood before driving the vehicle. See 193, COLLISION AVOIDANCE SAFETY.**

### ⚠WARNING

**The driver is responsible for detecting obstacles, and estimating the vehicle's distance from them, when maneuvering the vehicle. Failure to drive with due care and attention could cause an accident, leading to serious injury or death.**

***Note:*** *The quality of the camera views may vary in different lighting conditions.*



1. **Vehicle warning** icon.
2. Parking aid plan view.
3. **Camera** icon.
4. **Feature disabled** icon.

The forward traffic monitor feature assists the driver when exiting from an intersection or parking space. The feature increases the visibility available to the driver when carrying out a low speed, forward maneuver.

The feature operates when the vehicle is traveling at speeds of up to 4 mph (6 km/h), down to a standstill. Visual and audible alerts are no longer generated once the vehicle reaches a speed of 4 mph (6 km/h). The touchscreen continues to display camera views at speeds above 4 mph (6 km/h).

***Note:*** *The feature is not autonomous.*

Access to the feature is via the **CAMERA** or **PARKING AID** screens.

Switch the feature on by touching the **camera** icon (**3**) shortly before attempting a low speed, forward maneuver.

The touchscreen displays the **vehicle warning** icon (**1**) on the relevant side(s) of the screen if an imminent risk of a side impact is detected. An audible warning also sounds.

The feature detects vehicles from either side, traveling at speeds of up to 40 mph (64 km/h), with a time to collision of 3 seconds.

The touchscreen displays the **feature disabled** icon (**4**) if the feature is not available, or a fault is detected. The instrument panel also displays a message if a camera or sensor is blocked.

If a fault is not rectified when the engine is switched off and then on again, consult a retailer/authorized repairer.

## REAR TRAFFIC MONITOR

### ⚠WARNING

**Make sure the relevant safety warnings have been read and understood before driving the vehicle. See 193, COLLISION AVOIDANCE SAFETY.**

### ⚠WARNING

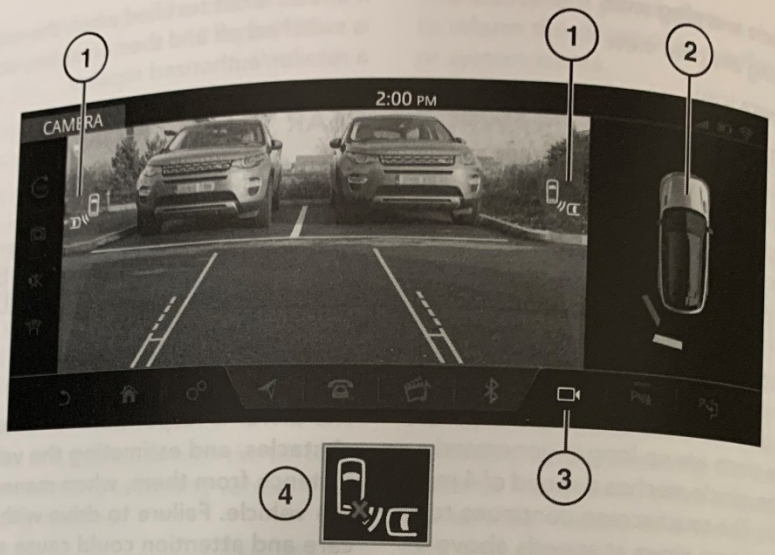
**The driver is responsible for detecting obstacles, and estimating the vehicle's distance from them, when maneuvring the vehicle. Failure to drive with due care and attention could cause an accident, leading to serious injury or death.**

### ⚠WARNING

**The rear camera and bumper must be kept clean and free from debris or obstructions, e.g., ice, frost, snow, leaves, mud, or insects. Failure to keep the rear camera and bumper clear may result in miscalculations, or false indications. Miscalculations and false indications could cause an accident, leading to serious injury or death.**

***Note:*** *The quality of the camera views may vary in different lighting conditions.*

***Note:*** *Depending on the vehicle specification and market in which the vehicle is used, an audible and visual warning is provided during a reversing maneuver.*




1. **Vehicle warning** icon.
2. Parking aid plan view.
3. **Camera** icon.
4. **Feature disabled** icon.

The rear traffic monitor feature assists the driver when carrying out a reversing manoeuvre.

The rear traffic monitor feature automatically activates when all the following conditions exist:

- The touchscreen is displaying either the **CAMERA** or **PARKING AIDS** screen.
- Reverse (**R**) gear is selected.
- The vehicle is traveling at speeds of less than 10 mph (16 km/h).

To switch from the **CAMERA** view to the **PARKING AIDS** view, touch the parking aid plan view (**2**). To switch from the **PARKING AIDS** view to the **CAMERA** view, touch the **camera** icon (**3**).

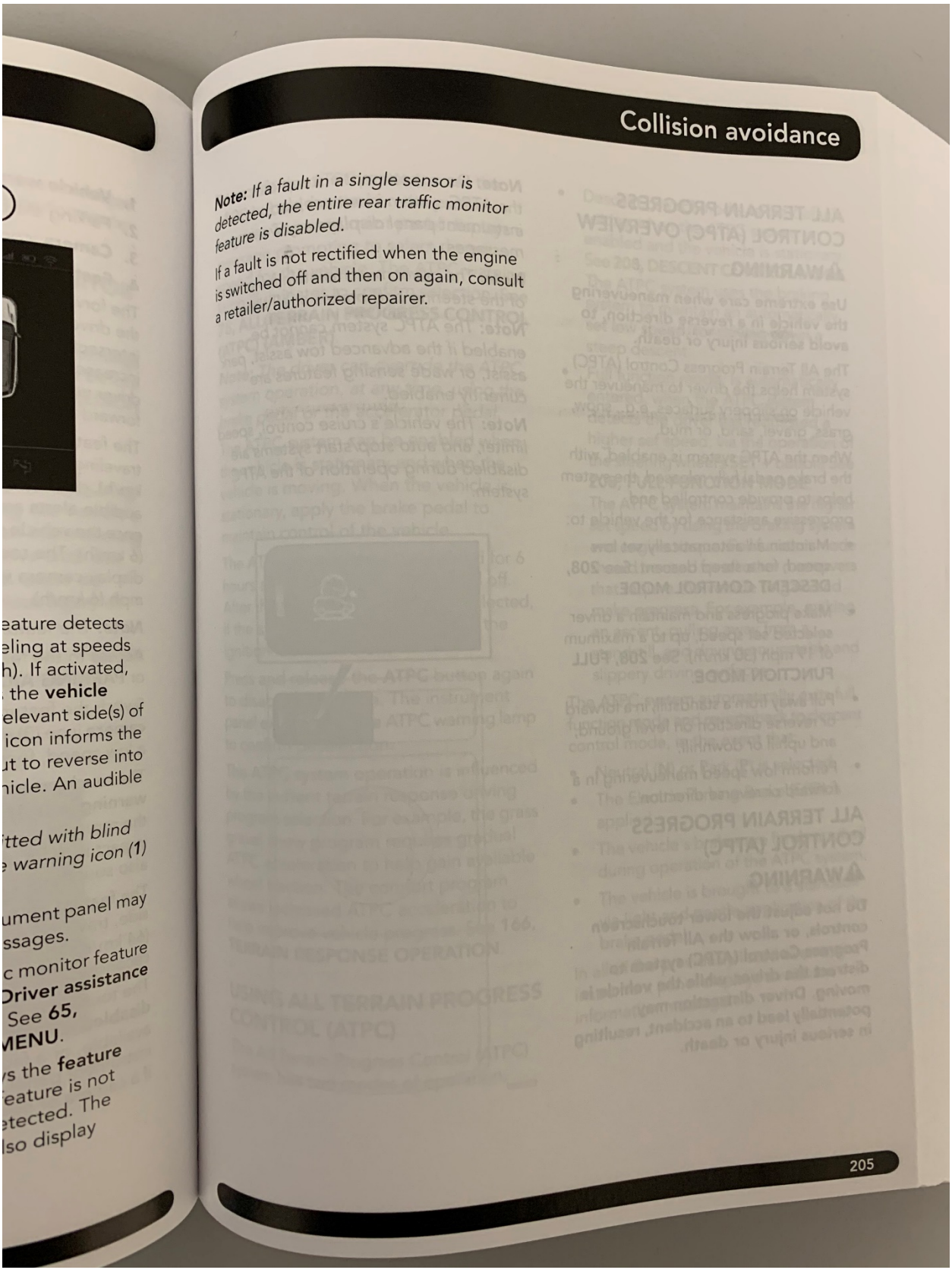
The rear traffic monitor feature detects cross traffic vehicles traveling at speeds of up to 34 mph (55 km/h). If activated, the touchscreen displays the **vehicle warning** icon (**1**) on the relevant side(s) of the screen. The warning icon informs the driver the vehicle is about to reverse into the path of a moving vehicle. An audible warning also sounds.

***Note:*** *For vehicles not fitted with blind spot monitor, the vehicle warning icon (1) does not appear.*

The touchscreen or instrument panel may also display warning messages.

If required, the rear traffic monitor feature can be disabled via the **Driver assistance** instrument panel menu. See **65, INSTRUMENT PANEL MENU**.

The touchscreen displays the **feature disabled** icon (**4**) if the feature is not available, or a fault is detected. The instrument panel may also display messages.



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See **65,**
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***Note:*** *If a fault in a single sensor is detected, the entire rear traffic monitor feature is disabled.*

If a fault is not rectified when the engine is switched off and then on again, consult a retailer/authorized repairer.

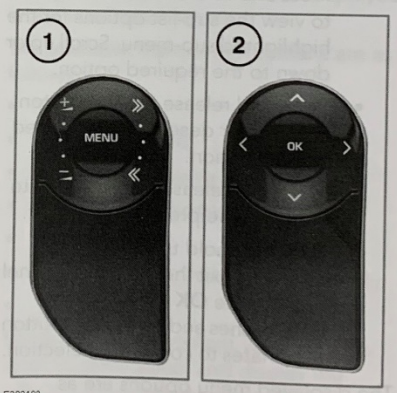
1. **CHARGE** zone: When the vehicle is decelerating during braking or overrun, the electric motor regenerates energy and supplies a charge to the hybrid battery. The charge zone indicates the instantaneous amount of the regenerated energy.
2. **0% POWER**: Indicates when there is no energy being consumed or regenerated.
3. Power gauge marker: Moves to indicate the current power being delivered by the engine and the electric motor.
4. **ECO** zone: Driving in this zone helps to reduce energy consumption.
5. Engine start marker: Displays when the Electric Vehicle (EV) mode is active and indicates the maximum power output of the electric motor. If the current power demand exceeds the start marker position, the engine is started for temporary use. In this event the EV mode is suspended and the engine start marker illuminates gray. If the EV mode is deselected or canceled the engine start marker extinguishes.
6. **READY** or **OFF** status: Indicates when the vehicle is ready to be driven.
7. **EV**: Illuminates to confirm selection of the EV mode via the center console button. See **135, ELECTRIC VEHICLE (EV) MODE**.
   If selected, **SAVE** replaces **EV**. See **138, SAVE**.
8. **100% POWER**: Indicates the maximum power output for the engine.
9. **BOOST** zone: Indicates when the engine and the electric motor are combined to increase the total power output.
10. Gear selector status display.
11. Hybrid battery charge gauge: Indicates the state of charge.

## INSTRUMENT PANEL MENU

### ⚠WARNING

**Do not operate the instrument panel controls while the vehicle is moving. Doing so may cause driver distraction, potentially resulting in an accident and causing serious injury or death.**

Use the instrument panel menus to configure the instrument panel display and some vehicle features. Use the controls mounted on the left side of the steering wheel to display and navigate through the instrument panel menus.




E200493

Operate the instrument panel menus as follows:

1. **MENU** button: Press and release to display the instrument panel menus. The **MENU** button extinguishes and the **OK** button illuminates. The menus do not display if the instrument panel displays any warning or information messages. In this event, press the **OK** button to clear each message after reading and taking any required action. See **66, WARNING AND INFORMATION MESSAGES**.
2. Operate the buttons as follows:
   - Press the **>** button or the **<** button, to scroll through and highlight the required main menu option, displayed at the top of the information panel. The relevant sub-menu list is automatically displayed.
   - Press the ∧ button or the ∨ button, to scroll through the sub-menu list and highlight the required menu.
   - Press and release the **OK** button, to view the sub-list options for the highlighted sub-menu. Scroll up or down to the required option.
   - Press and release the **OK** button to select or deselect the required sub-list option.
   - Press and release the **<** button to return to the previous menu list.
   - Press and hold the **<** button to close and exit the instrument panel menus. The **OK** button extinguishes and the **MENU** button illuminates to confirm deselection.

The displayed menu options are as follows:

- **Phone**: Only available when a phone is connected.
- **Media**.
- **Driver assistance**.
- **Trip**.
- **Display**. The interactive driver display is configurable. Use the **Display layout** menu to select a **Two dial**, **One dial**, **Full map**, **Media**, or a **Driver assistance** view.
- **Head-up display**.
- **Vehicle settings**.

### ⚠WARNING

**Before making any changes to the Vehicle settings, make sure to read and fully understand the relevant sections and topics of the Owner's Handbook. Failure to do so can lead to serious injury or death.**

- **Vehicle info**: Some options are only available before the engine starts.

## WARNING AND INFORMATION MESSAGES

### ⚠WARNING

**Do not ignore any warning or information messages displayed in the instrument panel. Take appropriate action as soon as possible. Failure to do so may result in death, serious injury, or serious damage to the vehicle.**

The instrument panel displays warning messages if specific driver action is required, or to accompany illuminated warning lamps. For example, in the event that a vehicle system fault is detected.

The instrument panel displays information messages if specific driver action is required, or for driver information. For example, to confirm and assist with the selection or deselection of some vehicle features.

To extinguish an instrument panel warning or information message, press the **OK** button on the steering wheel controls.

***Note:*** *Extinguishing displayed warning and information messages does not clear or rectify a detected fault.*

***Note:*** *If a warning message is manually extinguished, the instrument panel illuminates an amber or red warning lamp until the cause of the message is rectified.*

If a persistent fault is detected, the warning message displays each time the ignition is switched on. In this event, follow any on-screen instructions or seek qualified assistance.

Instrument panel messages are displayed in order of importance. If more than one instrument panel message is active, each message is displayed in turn for 2 seconds. High importance warning messages are displayed first. The displayed warning messages can also be accompanied by an audible tone.

Some warning messages can also display the handbook symbol. For information regarding warning messages and any action required, refer to the warning and information lamps section of the Owner's Handbook. Follow any on-screen instructions, if displayed. The instrument panel displays a warning message until the detected fault is rectified.

## USING THE TRIP COMPUTER

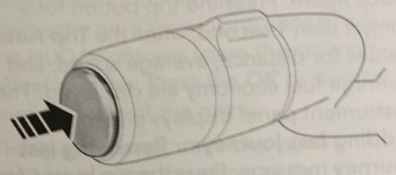
The trip computer displays information and stores data for a series of trips.

A trip is the distance traveled since the last memory reset via the trip computer. The maximum trip distance display is 9 999.9 (km or miles). The trip distance then automatically resets to zero.

Select the **Trip** and **Trip bank** instrument panel menus to display the required trip, i.e., **Trip A**, **Trip B**, or **Trip Auto**. See **65, INSTRUMENT PANEL MENU**.

The trip computer can be configured to display the trip units in miles or km. Select the **Trip** and **Units** instrument panel menus.

To configure the trip content options to be available for display in the instrument panel, select the **Trip** and **Content** instrument panel menus.



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Press and release the trip button to change the trip content option displayed in the instrument panel.

The available trip content options are as follows:

- **Date**.
- **Average speed**.
- **Average economy**.
- **Instantaneous economy**.
- **Range**.
- **Battery range**: Hybrid vehicles only.
- **Trip distance**.

Some of the trip content values can be reset to zero. Select and display the relevant trip content option. Press and hold the trip buttons for 2 seconds.

The distance, average speed, and average fuel economy values for the trips can be reset. Set the trip computer display to show the required trip to reset. Press and hold the trip button until the instrument panel displays the **Resetting** message.

Select the **Trip** and **Trip Auto** instrument panel menus to automatically reset **Trip Auto** each time the ignition is switched on.

Select the **Trip bank** and **Trip Auto** instrument panel menus to add, or remove, another trip figure to the **Trip Auto** figure. Press the trip button for longer than 1 second, when the **Trip Auto** values for distance, average speed, and average fuel economy are displayed. The instrument panel displays either the **Adding last journey** or **Removing last journey** message. Press the trip button for longer than 1 second to select the desired option. The previous trip information is added to, or removed from, the **Trip Auto** value. The new total is displayed. There is no limit to the number of times this can be done before the ignition is switched off.

## RANGE

The **Range** and **Battery range** displays show the predicted distance in miles or km that the vehicle can travel. See **67, USING THE TRIP COMPUTER**.

**Range**: Displays the total predicted driving distance for the current fuel tank level and the amount of charge in the hybrid battery.

predicted driving distance for the amount of charge in the hybrid battery.

## SERVICE INTERVAL INDICATOR

The next oil service interval can be displayed via the **Vehicle info** and **Next service** instrument panel menus. See **65, INSTRUMENT PANEL MENU**.

***Note:*** *Dependent on the vehicle's specification, other fluid intervals and capacities may also be displayed.*

The oil service interval displays as a distance left until the service is due. If the distance is exceeded, the display shows a negative (-) value to indicate that a service is overdue.

## HEAD-UP DISPLAY (HUD)

### ⚠WARNING

**Do not operate or adjust the Head-Up Display (HUD) system while the vehicle is moving. Doing so may cause driver distraction, potentially resulting in an accident and causing serious injury or death.**

***Note:*** *The HUD system may take more time to display in extreme temperatures, allowing the system to operate at the correct temperatures.*

***Note:*** *The full HUD image may not be viewed correctly while wearing polarized sunglasses.*

***Note:*** *Do not place anything over the HUD unit, which is located above the instrument panel, next to the windshield.*

***Note:*** *In the interest of safety, only operate or adjust the HUD system when it is safe to do so.*

The HUD system projects some of the information currently displayed in the instrument panel onto the inside of the windshield.

Use the **Head-up display** and **Enable HUD** instrument panel menus to switch the HUD system **On** or **Off**. See **65, INSTRUMENT PANEL MENU**.

The HUD system also displays some instrument panel warning lamps. See **72, WARNING LAMPS AND INDICATORS**.

Use the **Head-up display** and **HUD content** instrument panel menus to view a list of vehicle features for the HUD system to display. Select the required **On** or **Off** option for each feature. The HUD system only displays the vehicle features that are currently displayed in the instrument panel.

***Note:*** *The position and format of the displayed HUD information varies due to priority and the number of features currently switched on or off.*

Setting the correct HUD position is important. The correct position is dependent on a number of conditions, including the height of the driver and the seat position.

***Note:*** *Before setting the position of the HUD, make sure that the driver's seat is correctly positioned. The HUD level should be set horizontally, within the driver's vision.*

Use the **Head-up display** and **Position** instrument panel menus to set the HUD position. Follow the on-screen instructions to adjust the HUD position using the steering wheel controls. Press the **OK** button to confirm and exit the menu. Preferences are stored using the driver's seat memory store button. See **29, SEAT POSITION MEMORY**.

The brightness of the HUD display is set automatically to suit the current ambient light conditions. To manually adjust the brightness, use the **Head-up display** and **Brightness** instrument panel menus. Follow the on-screen instructions to adjust the HUD brightness using the steering wheel controls. Press the **OK** button to confirm and exit the menu.

The speedometer units displayed in the HUD system are the same as the instrument panel's speedometer units.

If cleaning is required, follow the cleaning instructions. See **375, CLEANING SCREENS AND DISPLAYS**.

# APPENDIX C

Run Log

Subject Vehicle: **2020 Land Rover Range Rover Sport HSE** Date: **11/6/2020**

Test Engineer: **K. Nagao**

| Run | Test Type | BSD Side (L/R) | Valid Run? | BSD On (ft) | BSD Off (ft) | Acceptability Criteria met[1] | | | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | BSD On | BSD Off | Overall | |
| 31 | **Converge/ Diverge** | **Left** | Y | -0.6 | 15.0 | No | No | No | |
| 32 | | | N | | | | | | Lateral velocity, no warning |
| 33 | | | Y | | | No | No | No | No warning |
| 34 | | | Y | 0.9 | 7.2 | Yes | Yes | Yes | |
| 35 | | | Y | | | No | No | No | No warning |
| 36 | | | Y | 0.7 | 7.1 | Yes | Yes | Yes | |
| 37 | | | Y | | | No | No | No | No warning |
| 38 | | | N | | | | | | Lateral velocity |
| 39 | | | N | | | | | | Ran out of space |
| 40 | | | N | | | | | | POV yaw |
| 41 | | | Y | 0.8 | 7.4 | Yes | Yes | Yes | |
| 42 | **Static Run** | | | | | | | | |
| | | | | | | | | | |
| 43 | **Converge/ Diverge** | **Right** | N | | | | | | Unable to find convergence |
| 44 | | | Y | 0.1 | 8.2 | Yes | Yes | Yes | |

[1] The acceptability criteria listed herein are used only as a guide to gauge system performance, and are identical to the Pass/Fail criteria given in NHTSA's most current Test Procedure in docket NHTSA-2019-0102-0010, BLIND SPOT DETECTION SYSTEM CONFIRMATION TEST.

| Run | Test Type | BSD Side (L/R) | Valid Run? | BSD On (ft) | BSD Off (ft) | Acceptability Criteria met[1] | | | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | BSD On | BSD Off | Overall | |
| 45 | **Converge/ Diverge** | **Right** | N | | | | | | POV yaw, lateral distance |
| 46 | | | N | | | | | | POV yaw |
| 47 | | | Y | | | No | No | No | No warning |
| 48 | | | Y | -4.6 | 11.6 | No | No | No | |
| 49 | | | N | | | | | | POV yaw |
| 50 | | | Y | | | No | No | No | No warning |
| 51 | | | N | | | | | | POV yaw |
| 52 | | | Y | | | No | No | No | No warning |
| 53 | | | Y | | | No | No | No | No warning |
| 54 | | | Y | | | No | No | No | No warning |
| 55 | | | Y | -1.5 | 7.1 | No | Yes | No | |
| | | | | | | | | | |
| 1 | **Static Run** | | | | | | | | |
| 2 | **Straight Lane 45/50** | **Left** | Y | -6.2 | 9.0 | No | Yes | No | |
| 3 | | | Y | -6.4 | 10.1 | No | Yes | No | |
| 4 | | | Y | -3.6 | 10.1 | No | Yes | No | |
| 5 | | | Y | -5.0 | 10.4 | No | Yes | No | |
| 6 | | | Y | -4.0 | 10.1 | No | Yes | No | |
| 7 | | | Y | -3.4 | 9.8 | No | Yes | No | |
| 8 | | | Y | -3.9 | 9.4 | No | Yes | No | |
| | | | | | | | | | |
| 56 | **Straight Lane 45/50** | **Right** | Y | -6.5 | 8.9 | No | Yes | No | |

| Run | Test Type | BSD Side (L/R) | Valid Run? | BSD On (ft) | BSD Off (ft) | Acceptability Criteria met[1] | | | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | BSD On | BSD Off | Overall | |
| 57 | **Straight Lane 45/50** | **Right** | Y | -5.9 | 8.8 | No | Yes | No | |
| 58 | | | Y | -4.4 | 8.2 | No | Yes | No | |
| 59 | | | Y | -4.7 | 8.8 | No | Yes | No | |
| 60 | | | Y | -6.8 | 8.3 | No | Yes | No | |
| 61 | | | Y | -4.8 | 9.4 | No | Yes | No | |
| 62 | | | Y | -4.7 | 10.2 | No | Yes | No | |
| | | | | | | | | | |
| 9 | **Straight Lane 45/55** | **Left** | Y | -20.9 | 16.7 | No | Yes | No | |
| 10 | | | Y | -22.4 | 14.6 | No | Yes | No | |
| 11 | | | Y | -23.3 | 16.4 | No | Yes | No | |
| 12 | | | Y | -21.7 | 15.1 | No | Yes | No | |
| 13 | | | Y | -23.6 | 16.1 | No | Yes | No | |
| 14 | | | Y | -23.3 | 17.5 | No | Yes | No | |
| 15 | | | Y | -22.0 | 16.5 | No | Yes | No | |
| | | | | | | | | | |
| 63 | **Straight Lane 45/55** | **Right** | Y | -20.6 | 13.2 | No | Yes | No | |
| 64 | | | Y | -23.6 | 16.3 | No | Yes | No | |
| 65 | | | N | | | | | | POV speed |
| 66 | | | Y | -22.5 | 14.9 | No | Yes | No | |
| 67 | | | Y | -22.9 | 15.4 | No | Yes | No | |
| 68 | | | Y | -22.9 | 15.9 | No | Yes | No | |
| 69 | | | Y | -23.1 | 13.2 | No | Yes | No | |
| 70 | | | Y | -23.0 | 14.4 | No | Yes | No | |

| Run | Test Type | BSD Side (L/R) | Valid Run? | BSD On (ft) | BSD Off (ft) | Acceptability Criteria met[1] | | | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | BSD On | BSD Off | Overall | |
| 16 | **Straight Lane 45/60** | **Left** | N | | | | | | SV speed |
| 17 | | | Y | -43.5 | 21.7 | No | Yes | No | |
| 18 | | | Y | -41.5 | 22.7 | No | Yes | No | |
| 19 | | | Y | -40.5 | 21.7 | No | Yes | No | |
| 20 | | | Y | -39.5 | 23.4 | No | Yes | No | |
| 21 | | | Y | -39.8 | 24.8 | No | Yes | No | |
| 22 | | | Y | -41.8 | 23.9 | No | Yes | No | |
| 23 | | | Y | -41.8 | 23.3 | No | Yes | No | |
| | | | | | | | | | |
| 71 | **Straight Lane 45/60** | **Right** | Y | -40.0 | 21.6 | No | Yes | No | |
| 72 | | | Y | -41.7 | 23.2 | No | Yes | No | |
| 73 | | | Y | -40.8 | 21.9 | No | Yes | No | |
| 74 | | | Y | -41.9 | 22.8 | No | Yes | No | |
| 75 | | | Y | -41.5 | 22.7 | No | Yes | No | |
| 76 | | | Y | -40.9 | 21.7 | No | Yes | No | |
| 77 | | | Y | -41.8 | 23.7 | No | Yes | No | |
| | | | | | | | | | |
| 24 | **Straight Lane 45/65** | **Left** | Y | 30.4 | 31.2 | Yes | Yes | Yes | |
| 25 | | | Y | 28.1 | 29.5 | Yes | Yes | Yes | |
| 26 | | | Y | 28.9 | 30.2 | Yes | Yes | Yes | |
| 27 | | | Y | 29.4 | 31.4 | Yes | Yes | Yes | |
| 28 | | | Y | 27.1 | 27.8 | Yes | Yes | Yes | |
| 29 | | | Y | 28.6 | 30.0 | Yes | Yes | Yes | |

| Run | Test Type | BSD Side (L/R) | Valid Run? | BSD On (ft) | BSD Off (ft) | Acceptability Criteria met[1] | | | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | BSD On | BSD Off | Overall | |
| 30 | **Straight Lane 45/65** | **Left** | Y | 29.7 | 29.1 | Yes | Yes | Yes | |
| | | | | | | | | | |
| 78 | **Straight Lane 45/65** | **Right** | Y | 29.8 | 30.5 | Yes | Yes | Yes | |
| 79 | | | Y | 30.4 | 28.3 | Yes | Yes | Yes | |
| 80 | | | N | | | | | | POV speed |
| 81 | | | N | | | | | | POV speed |
| 82 | | | Y | 29.1 | 29.8 | Yes | Yes | Yes | |
| 83 | | | Y | 31.5 | 28.4 | Yes | Yes | Yes | |
| 84 | | | Y | 31.5 | 29.6 | Yes | Yes | Yes | |
| 85 | | | Y | 30.1 | 28.6 | Yes | Yes | Yes | |
| 86 | | | Y | 29.3 | 29.0 | Yes | Yes | Yes | |

# APPENDIX D

## Time History Plots

LIST OF FIGURES

**Description of Time History Plots**

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from both the Subject Vehicle (SV) and Principal Other Vehicle (POV) with overlaid pass/fail and validity envelopes and thresholds.

Several of the plots include green envelopes (boxes) that are provided to verify test validity. For plots with green envelopes, the test is valid if the time-varying data is completely within the envelope boundaries.

Plots shown herein are grouped by test type and are presented sequentially within a given test type. Each time history plot consists of data relevant to the test type under consideration, and therefore the data channels plotted vary according to test type. The test types (shown in the plot titles) include:

- Straight Lane Converge/Diverge
- Straight Lane Pass-by (SV at 45 mph, POV at 50 mph)
- Straight Lane Pass-by (SV at 45 mph, POV at 55 mph)
- Straight Lane Pass-by (SV at 45 mph, POV at 60 mph)
- Straight Lane Pass-by (SV at 45 mph, POV at 65 mph)

**Sub-plots**

Time history figures include the following sub-plots:

- BSD Warning – displays the Blind Spot Detection alert (which can be audible, visual, or haptic). Depending on the type of BSD alert or instrumentation used to measure the alert, this can be any of the following:

    - Filtered, rectified, and normalized sound signal. The vertical scale is 0 to 1.
    - Filtered, rectified, and normalized acceleration (i.e., haptic alert, such as steering wheel vibration). The vertical scale is 0 to 1.
    - Normalized light sensor signal. The vertical scale is 0 to 1.

    The magenta envelopes indicate pass/fail criteria. For a test to meet the BSD-on criterion, the trace must be greater than a threshold of 0.5 and completely within the first envelope. The envelope begins 300 ms after the POV enters the SV Blind Zone and ends when the POV is no longer in the SV Blind Zone for

Converge/Diverge tests and when the front-most part of the POV is in front of line A[1] for Straight Lane Pass-by test.

For a test to meet the BSD-off criterion, the trace must be less than a threshold of 0.5 and completely within the second envelope. The envelope begins when the lateral distance between the POV and SV is greater than 6 m (19.7 ft) for Converge/Diverge Tests and when the longitudinal distance between the rear-most part of the POV and the front-most part of the SV exceeds the BSD termination headway specified in Table 4 of the test procedure. The envelope ends at the end of the test.

The bold black vertical lines indicate BSD-on and BSD-off. The value shown for BSD-on represents the distance[2] between the POV and 300 ms into SV's Blind Zone. A negative value means the BSD warning activated after 300 ms of the POV entering the SV's blind zone and the warning was late. The value shown for BSD-off for Converge/Diverge tests represents the lateral distance between the POV and SV relative to the 6 m (19.7 ft) BSD-off requirement. The value shown for BSD-off for Pass-by tests represents the longitudinal distance between the POV and SV relative to the BSD termination headway for a given test speed. A negative value means the BSD warning deactivated after the lateral distance between the POV and SV was greater than 6 m (19.7 ft) for Converge/Diverge tests or the longitudinal distance between the POV and SB was greater than the BSD termination headway for Pass-by tests and the warning was late.

- Headway (ft) – for Converge/Diverge tests, this is the longitudinal distance from the front of the POV to the rear of the SV. A negative value for headway indicates that the front of the POV is forward relative to the rear of the SV. For Straight Lane Pass-by tests, two headway traces are shown. The distance from the front of the POV to the rear of the SV is shown in *black* and the distance from the front of the SV to the rear of the POV is shown in *green*. Additionally, there are colored markers with values to indicate critical events.
    - Yellow Marker – BSD warning activates
    - Black Marker – POV enters the SV Blind Zone
    - Cyan Marker – 300 ms after the POV enters the SV Blind Zone
    - Red Marker – POV exits the SV Blind Zone
    - Green Marker – BSD warning deactivates
    - Blue Marker – BSD termination headway

[1] Line A is defined as the line that connects the rearmost part of the SV side mirror housings and runs perpendicular to the SV's longitudinal centerline
[2] Lateral distance for Converge and Diverge Scenarios and longitudinal distance for Pass-by Scenarios

- SV Speed (mph) – speed of the SV.
- POV Speed (mph) – speed of the POV.
- Yaw Rate (deg/sec) – yaw rate of the SV and POV. Overlapping validity envelopes are shown for the Converge/Diverge tests. The darker green indicates the validity envelope for the POV.
- Lateral Distance (ft) – lateral distance from the widest point (not including side mirrors) on the side of the SV to the widest point (not including side mirrors) on the side of the POV.
- Lateral Velocity (ft/s) – lateral velocity of the POV for Converge/Diverge tests only. Bold vertical black lines are provided to indicate the allowable lateral velocity range. A green dot indicates a valid value.

**Color Codes**

Color codes have been adopted to easily identify which data correspond to which vehicle, as well as to indicate the types of envelopes and thresholds used in the plots.

Color codes can be broken into four categories:

1. Time-varying data
2. Pass/Fail envelopes, validation envelopes and thresholds
3. Individual data points
4. Text

1. Time-varying data color codes:
   - Blue = Subject Vehicle data
   - Magenta = Principal Other Vehicle data
   - Brown = Relative data between SV and POV (i.e., TTC, lateral distance and headway distance)

2. Pass/Fail envelopes, validation envelopes and threshold color codes:
   - Magenta envelope = time varying data must be within the envelope at all times for a passing run
   - Green envelope = time varying data must be within the envelope at all times in order to be valid

- Black threshold (Solid) = time varying data must cross this threshold in the time period shown in order to be valid

3. Individual data point color codes:
   - Green circle = passing or valid value at a given moment in time
   - Red asterisk = failing or invalid value at a given moment in time

4. Text color codes:
   - Green = passing or valid value
   - Red = failing or invalid value

**Other Notations**

- No Wng – No warning was detected.
- On Late – Indicates that the BSD warning activated after the allowable criteria.
- Off Early – Indicates that the BSD warning deactivated before the allowable criteria.
- Off Late – Indicates that the BSD warning deactivated after the allowable criteria.
- POV – Indicates that the value for the Principal Other Vehicle was out of bounds.
- SV – Indicates that the value for the Subject Vehicle was out of bounds.

The minimum (worst) GPS fix type is displayed in the lower right corner of each page. The only valid fix type is RTK fixed (displayed in green). If the fix type during any portion of the test was anything other than RTK fixed, then “RTK Fixed OR LESS!!” is displayed in red.

Examples of time history plots for the Straight Lane Converge/Diverge and Straight Lane Pass-by are shown in Figures D1 through D4. These show examples of passing and failing runs for both test types. Time history data plots for the tests of the vehicle under consideration herein are provided beginning with Figure D5.

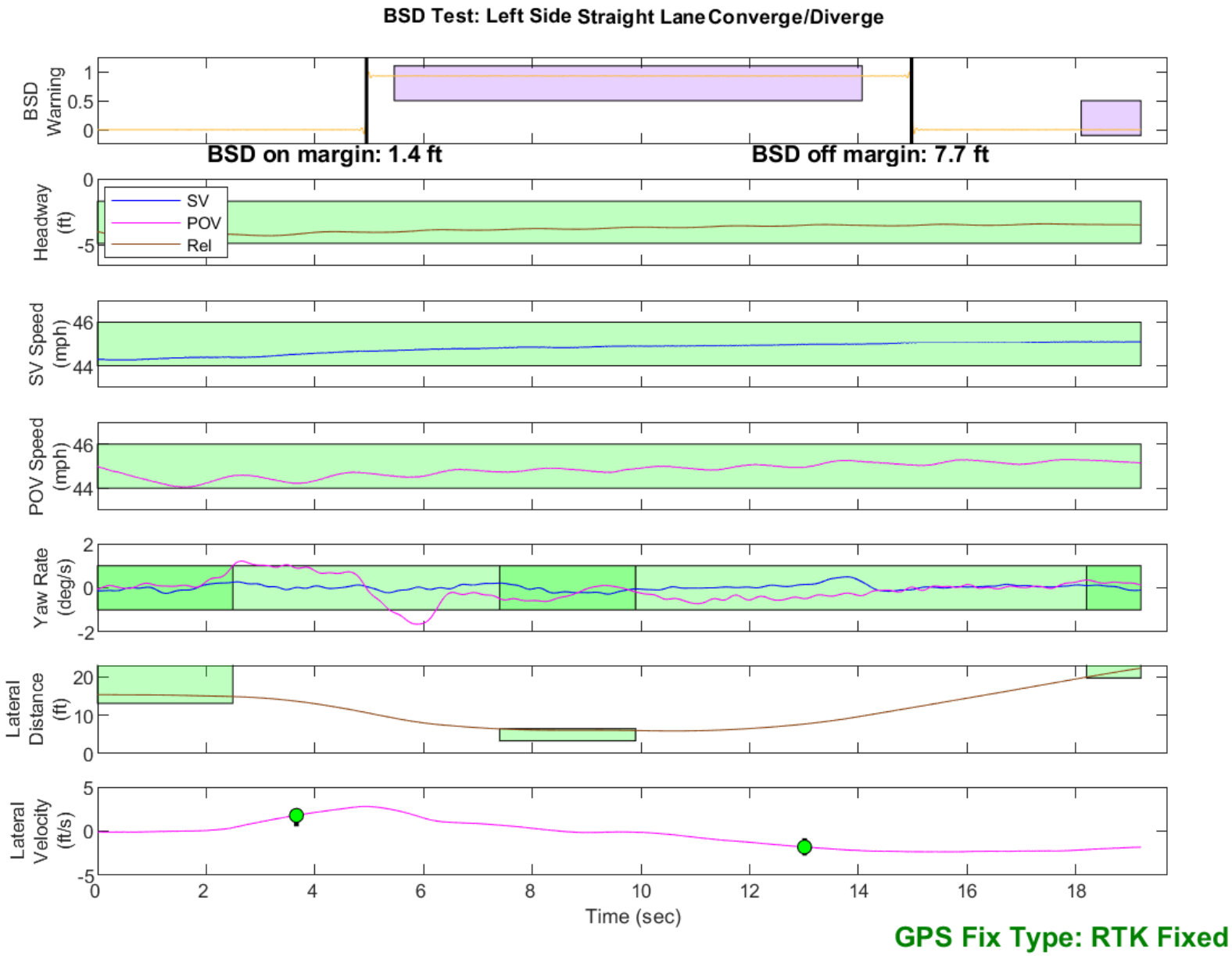


Figure D1. Example Time History for Straight Lane Converge/Diverge Test, Passing

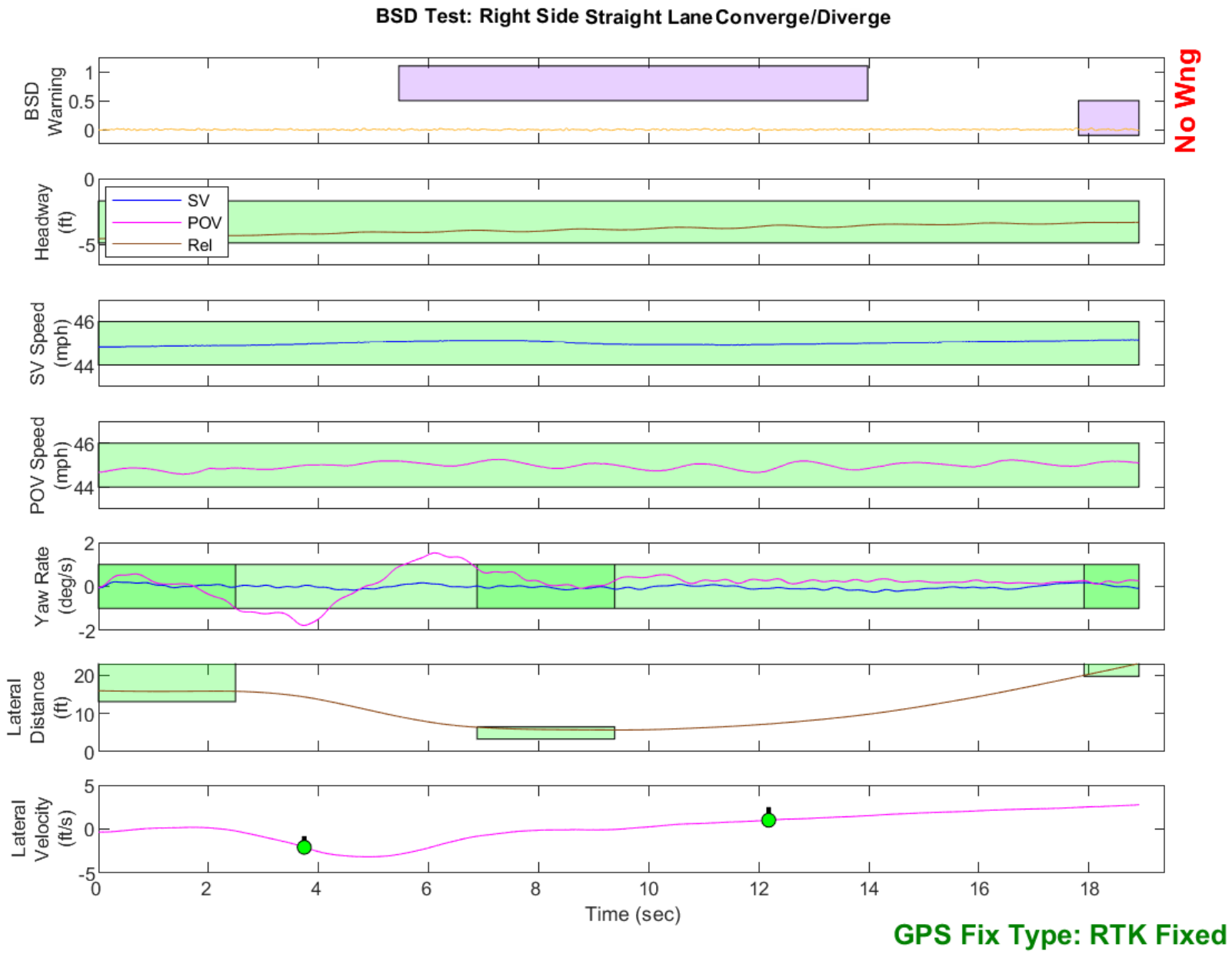


Figure D2. Example Time History for Straight Lane Converge/Diverge Test, Failing

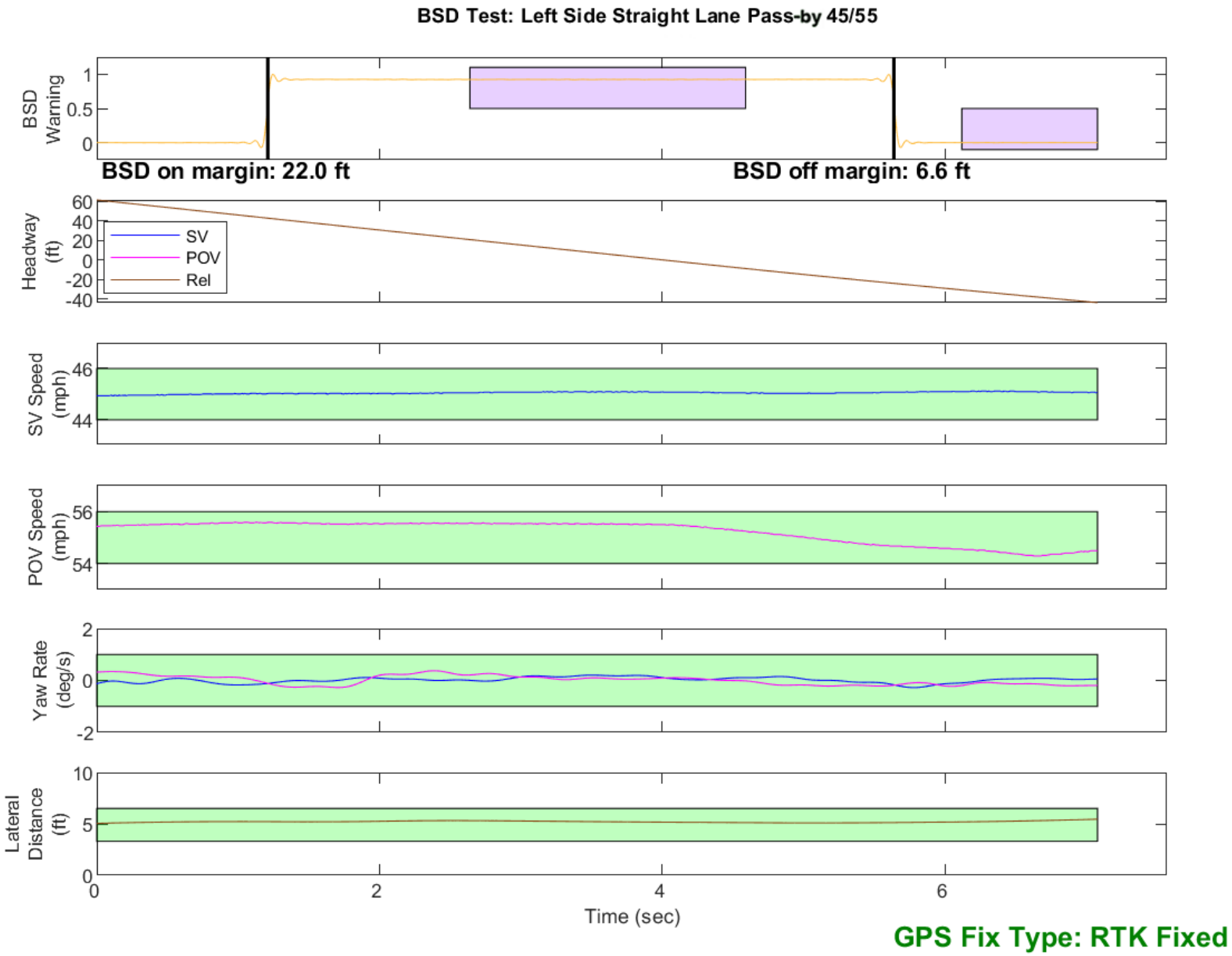


Figure D3. Example Time History for Straight Lane Pass-By Passing

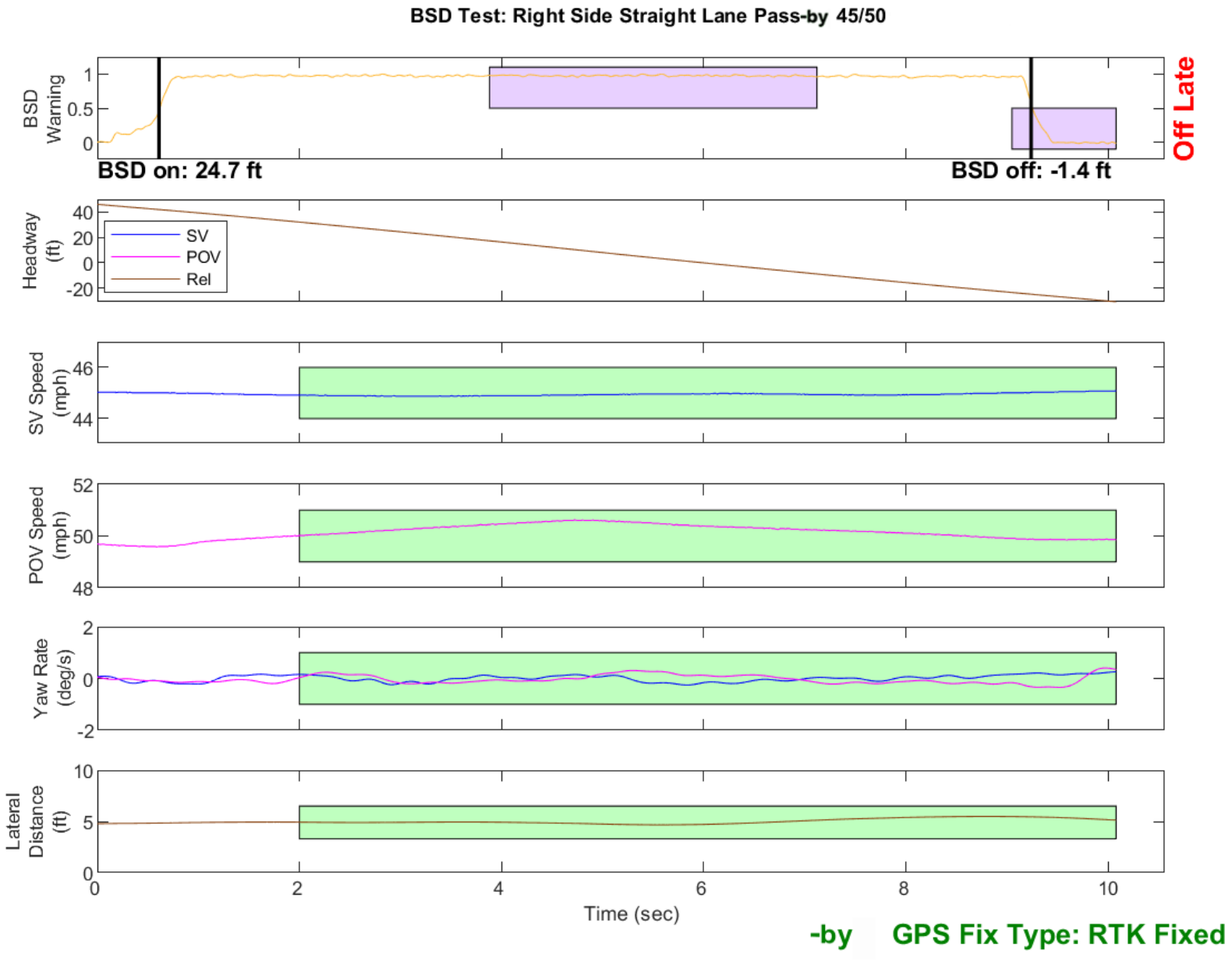


Figure D4. Example Time History for Straight Lane Pass-by Test, Failing

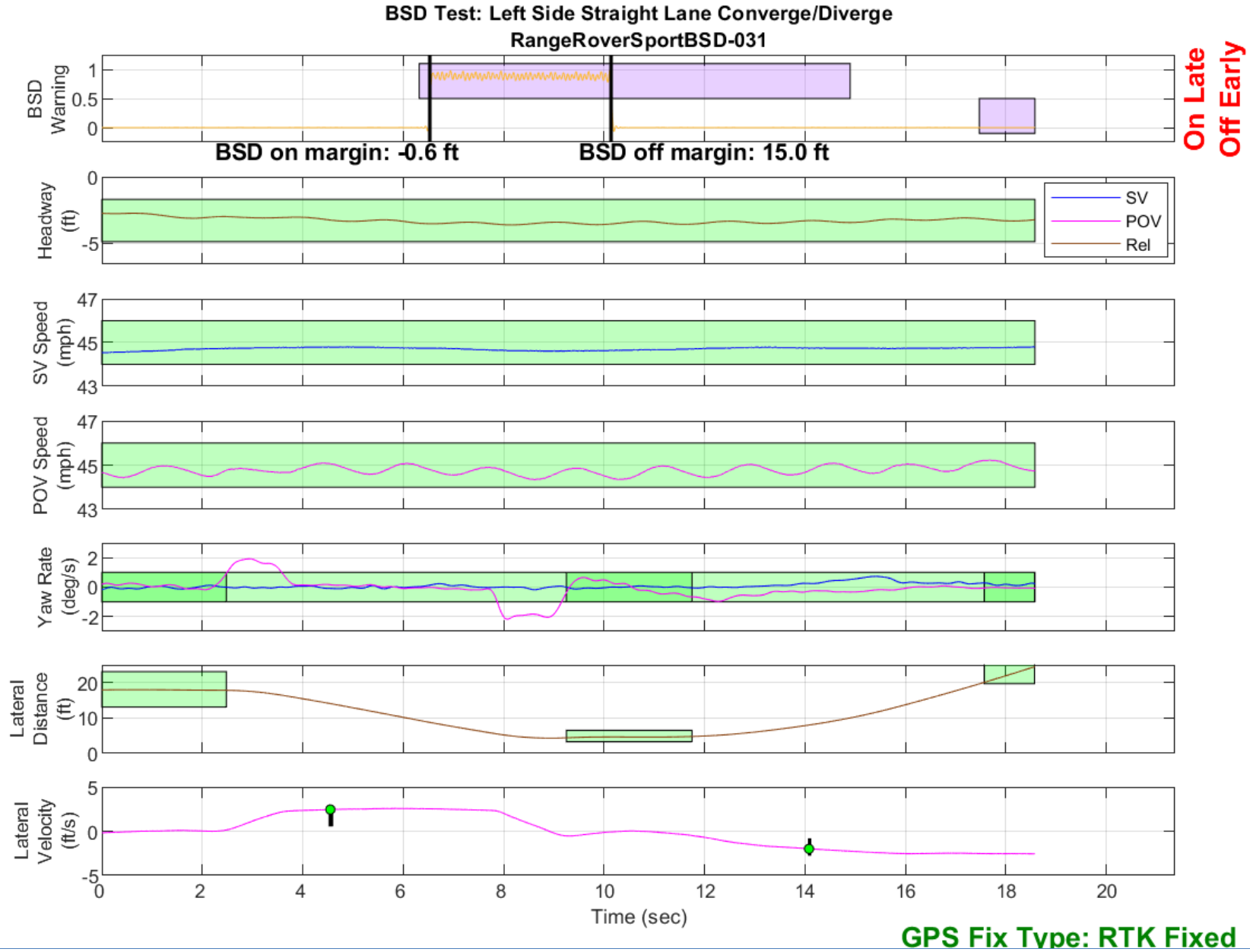


Figure D5. BSD Run 31, Straight Lane Converge/Diverge

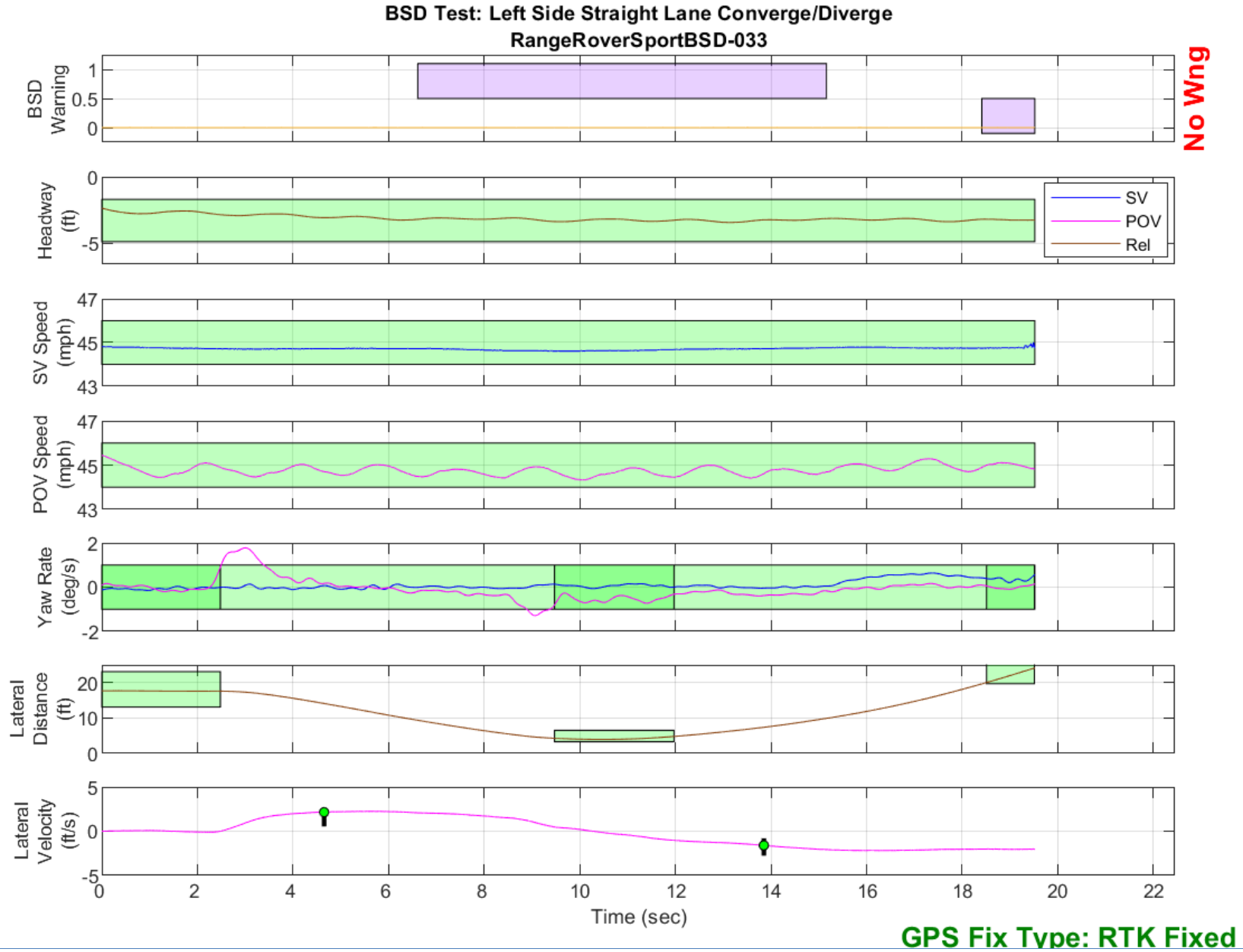


Figure D6. BSD Run 33, Straight Lane Converge/Diverge

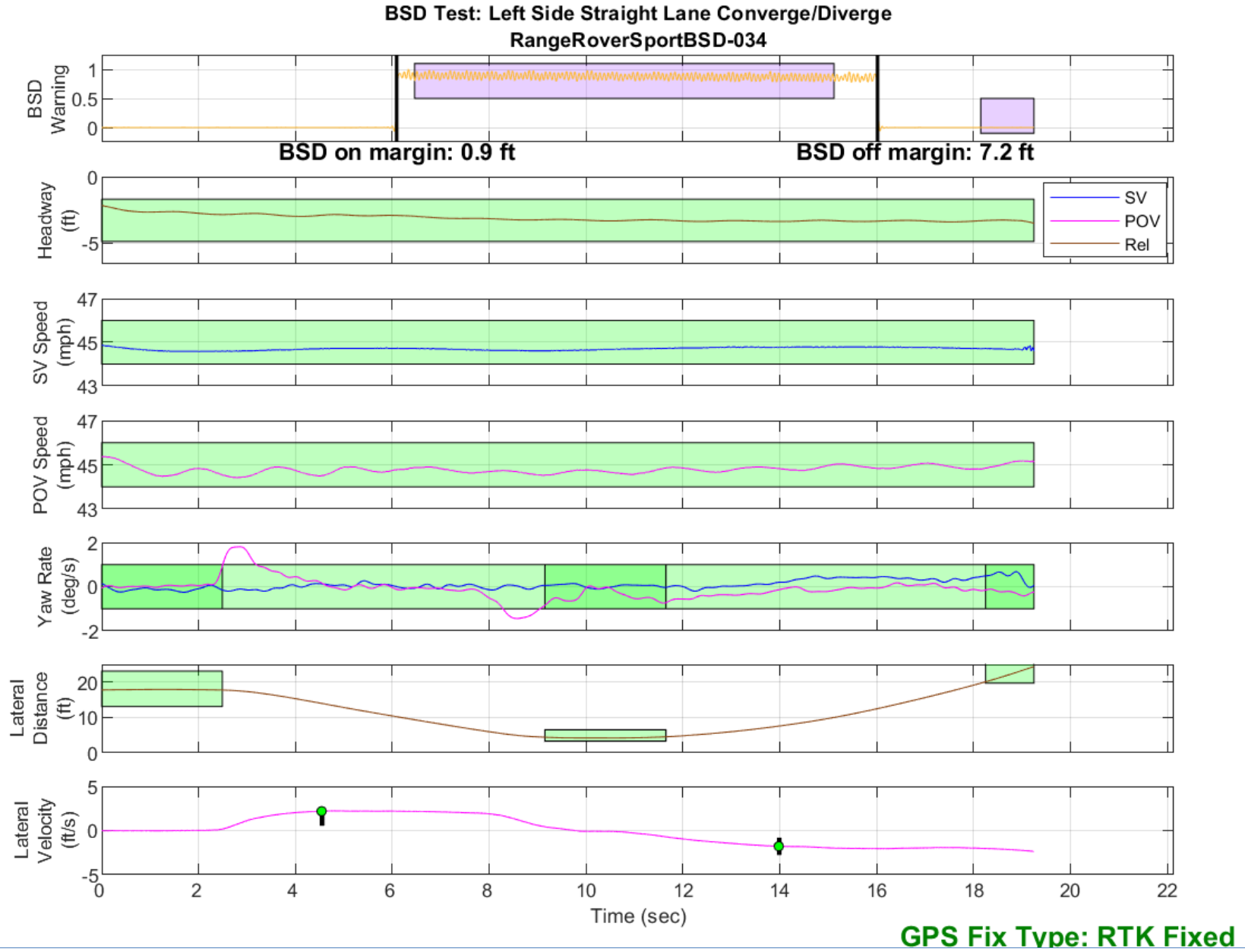


Figure D7. BSD Run 34, Straight Lane Converge/Diverge

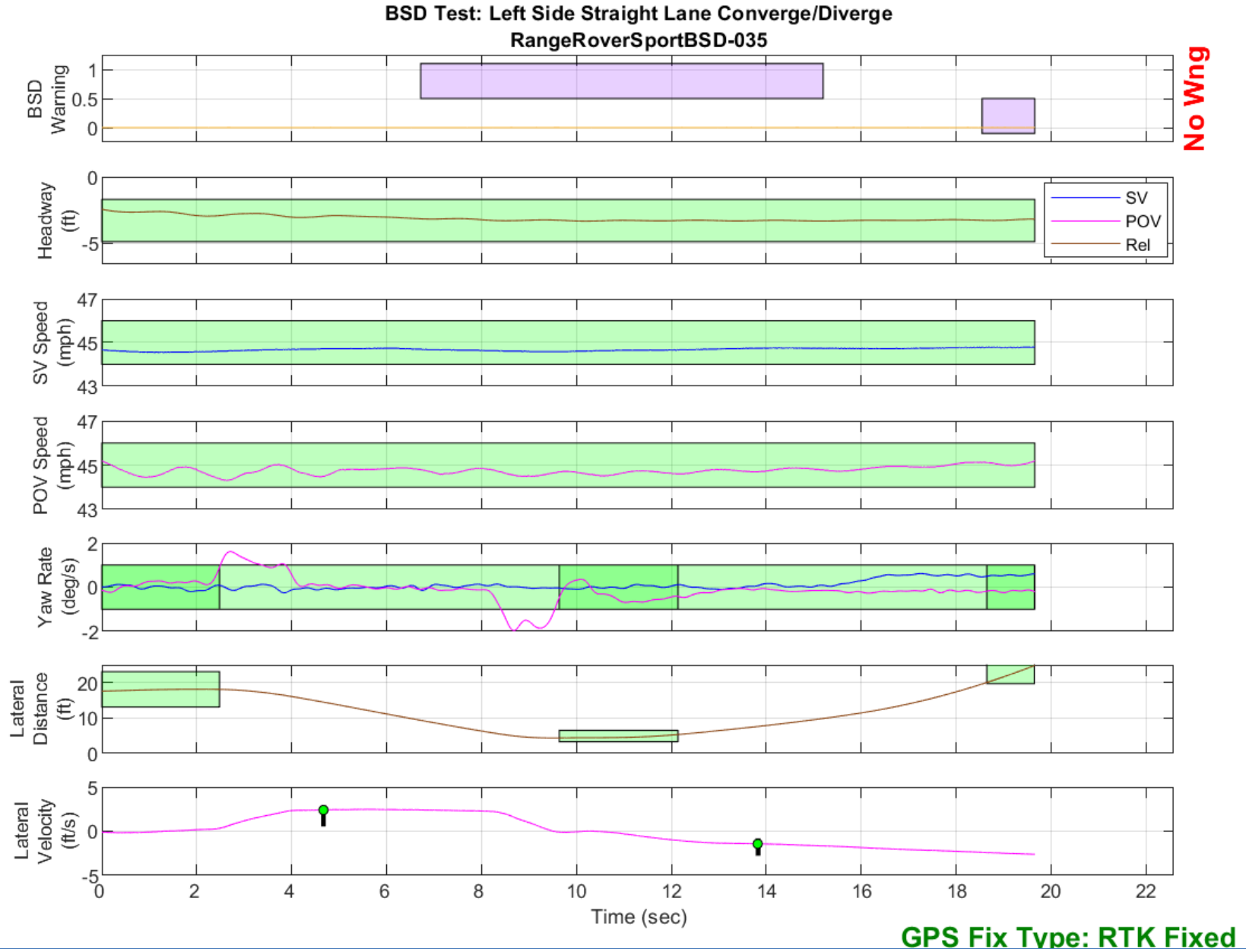


Figure D8. BSD Run 35, Straight Lane Converge/Diverge

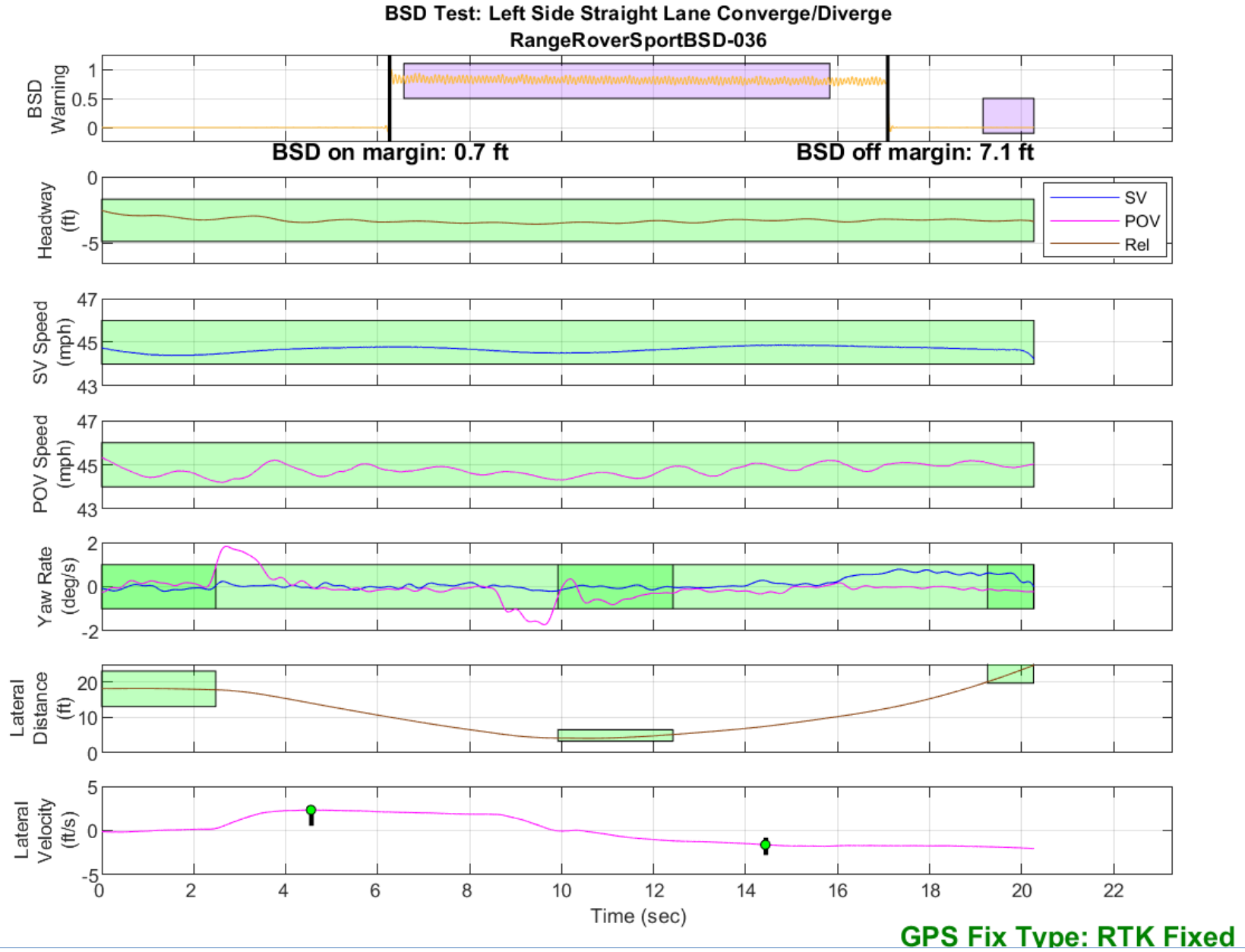


Figure D9. BSD Run 36, Straight Lane Converge/Diverge

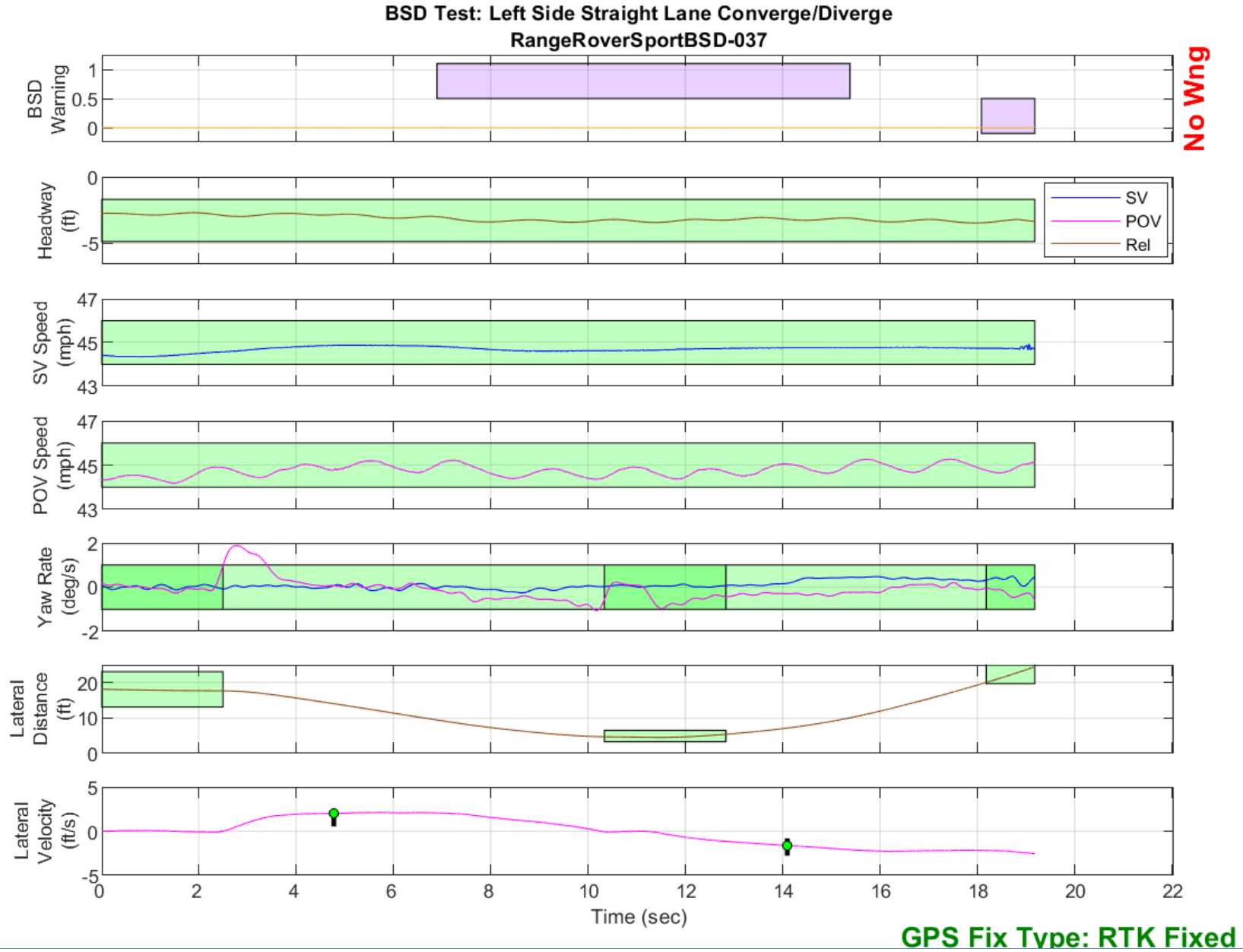


Figure D10. BSD Run 37, Straight Lane Converge/Diverge

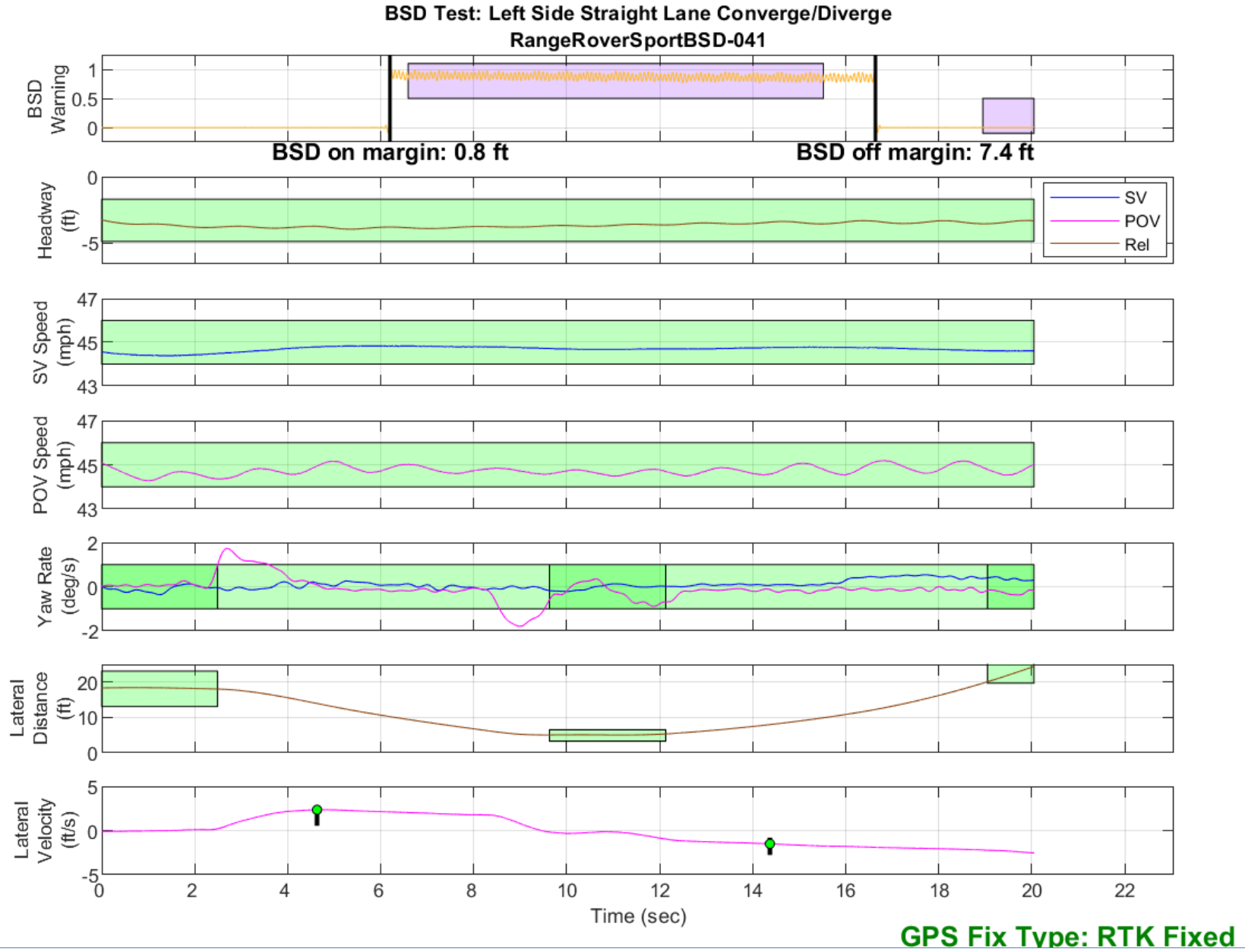


Figure D11. BSD Run 41, Straight Lane Converge/Diverge

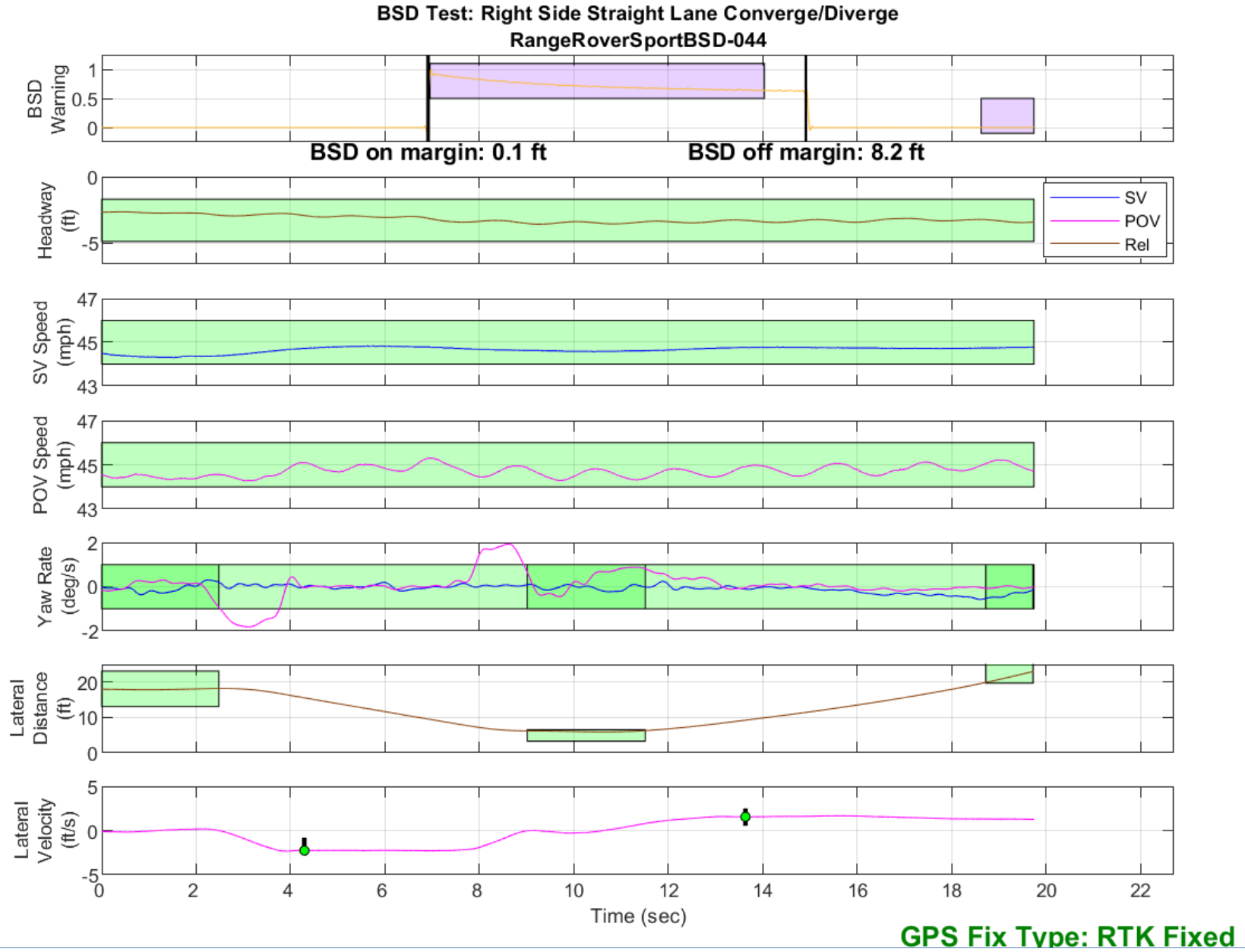


Figure D12. BSD Run 44, Straight Lane Converge/Diverge

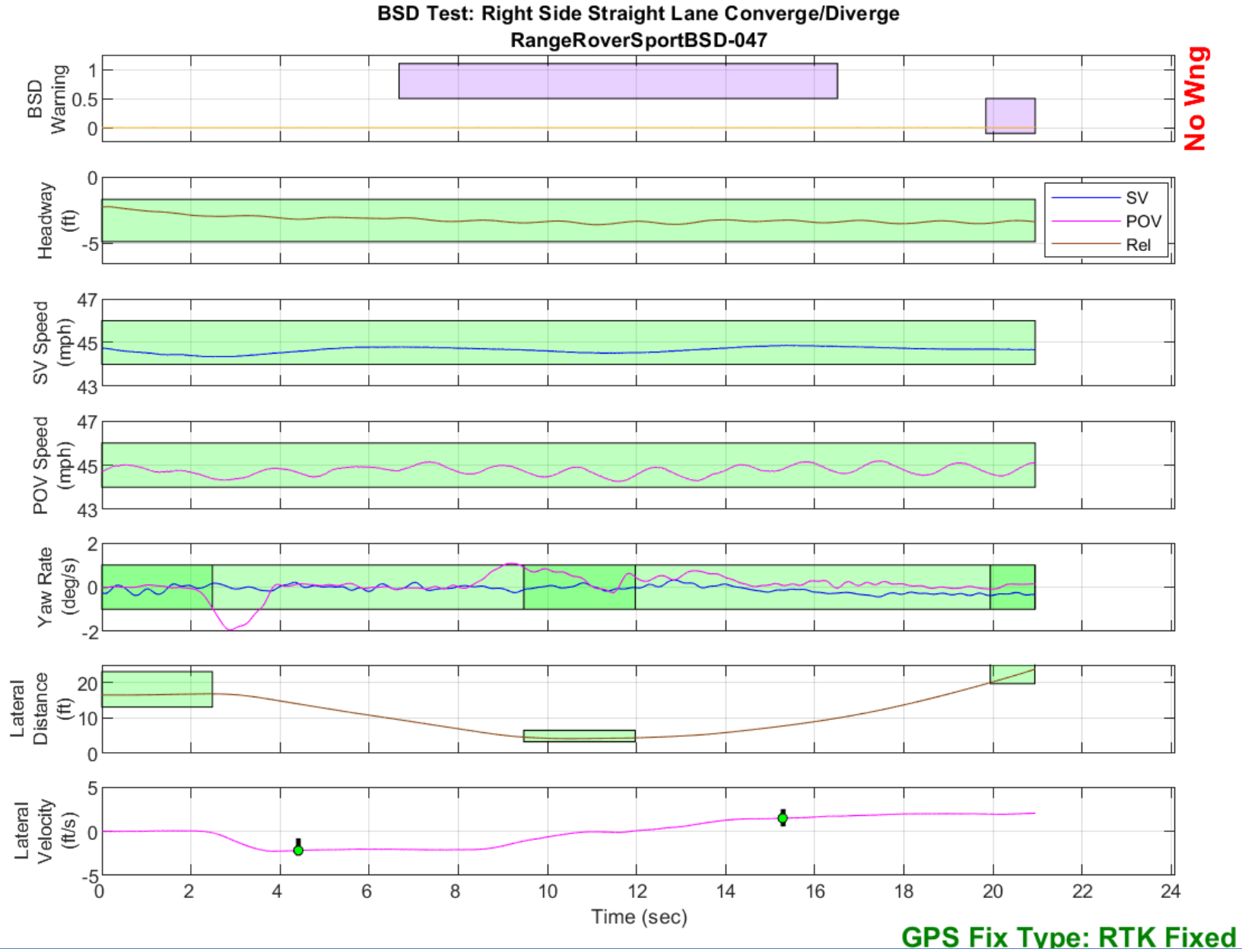


Figure D13. BSD Run 47, Straight Lane Converge/Diverge

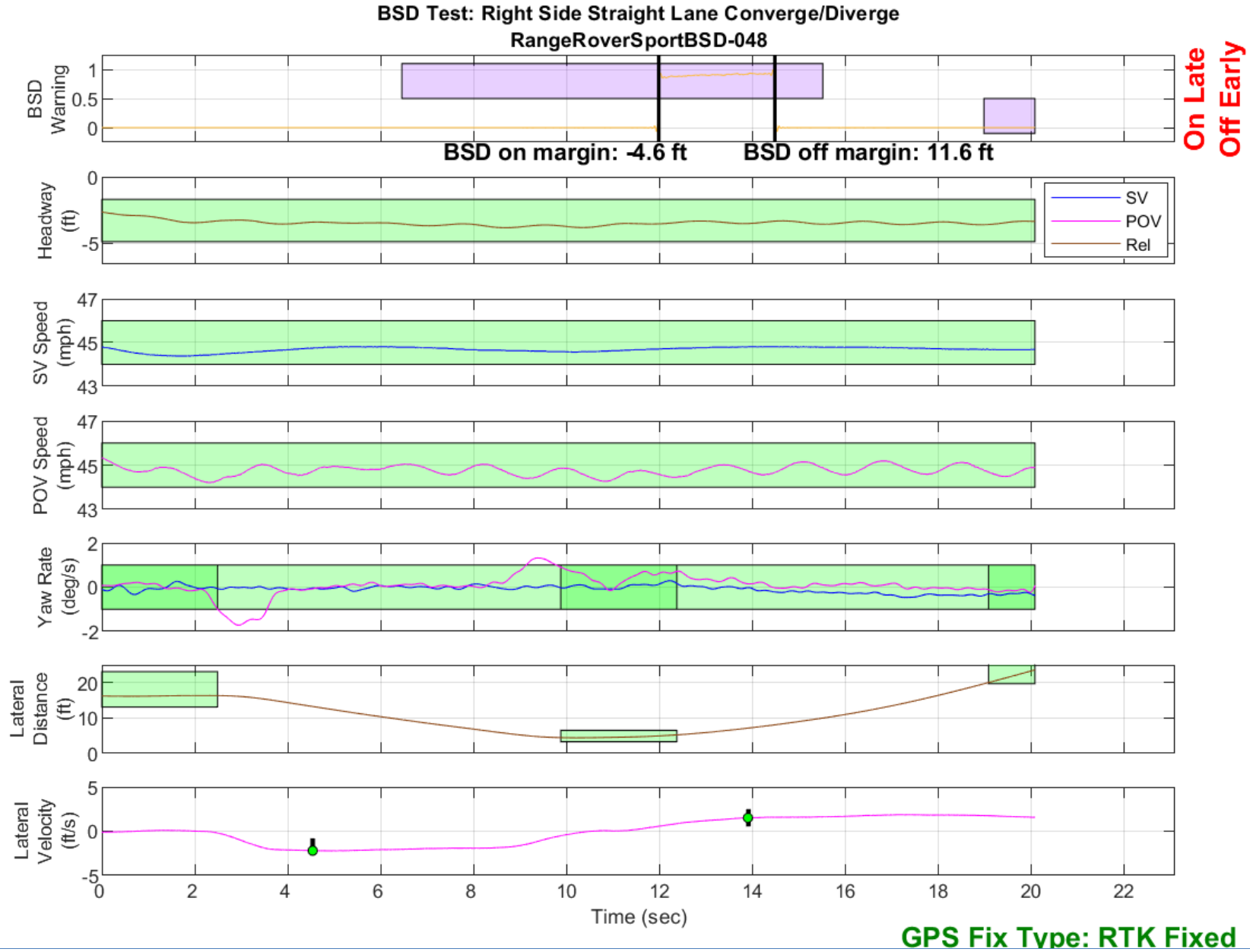


Figure D14. BSD Run 48, Straight Lane Converge/Diverge

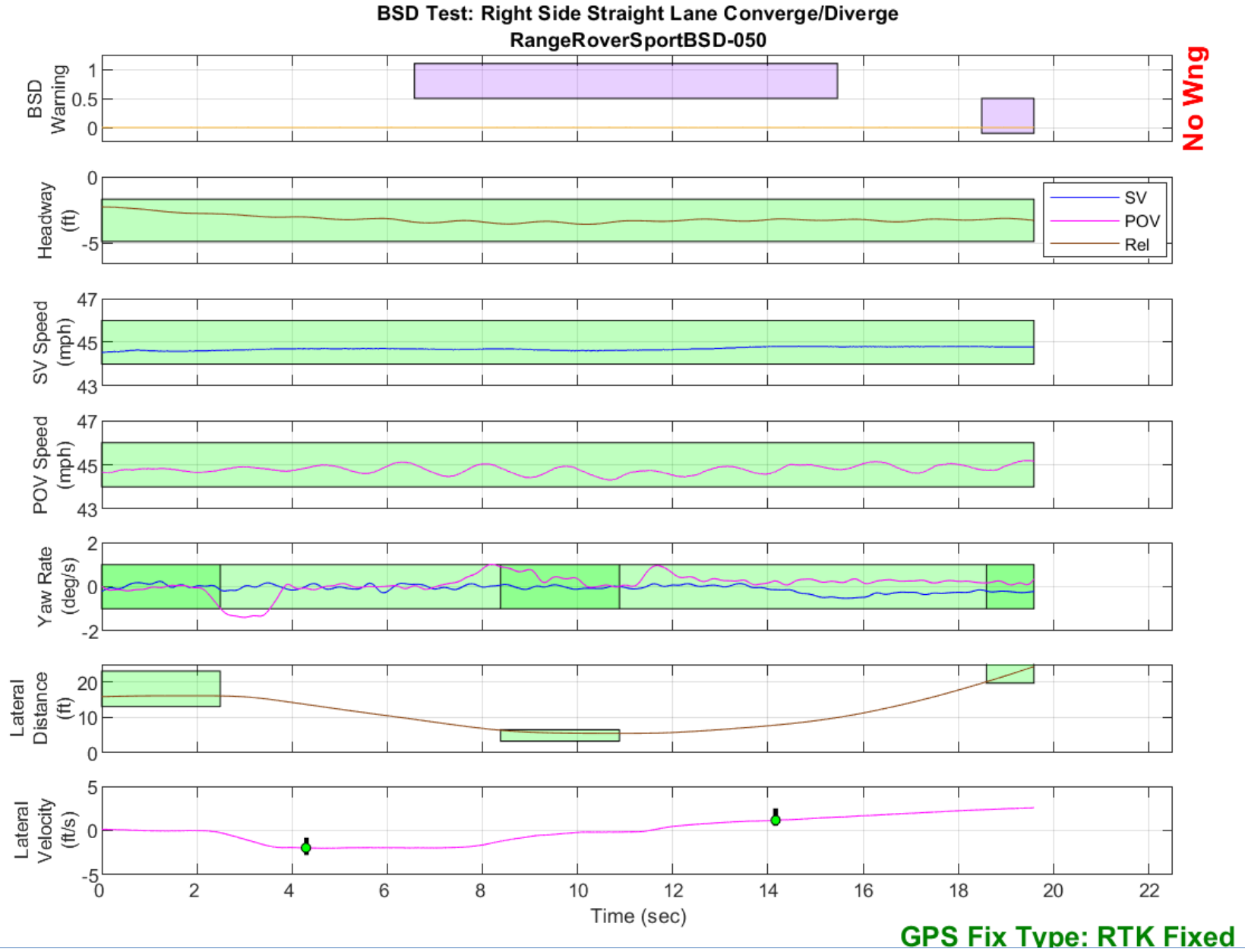


Figure D15. BSD Run 50, Straight Lane Converge/Diverge

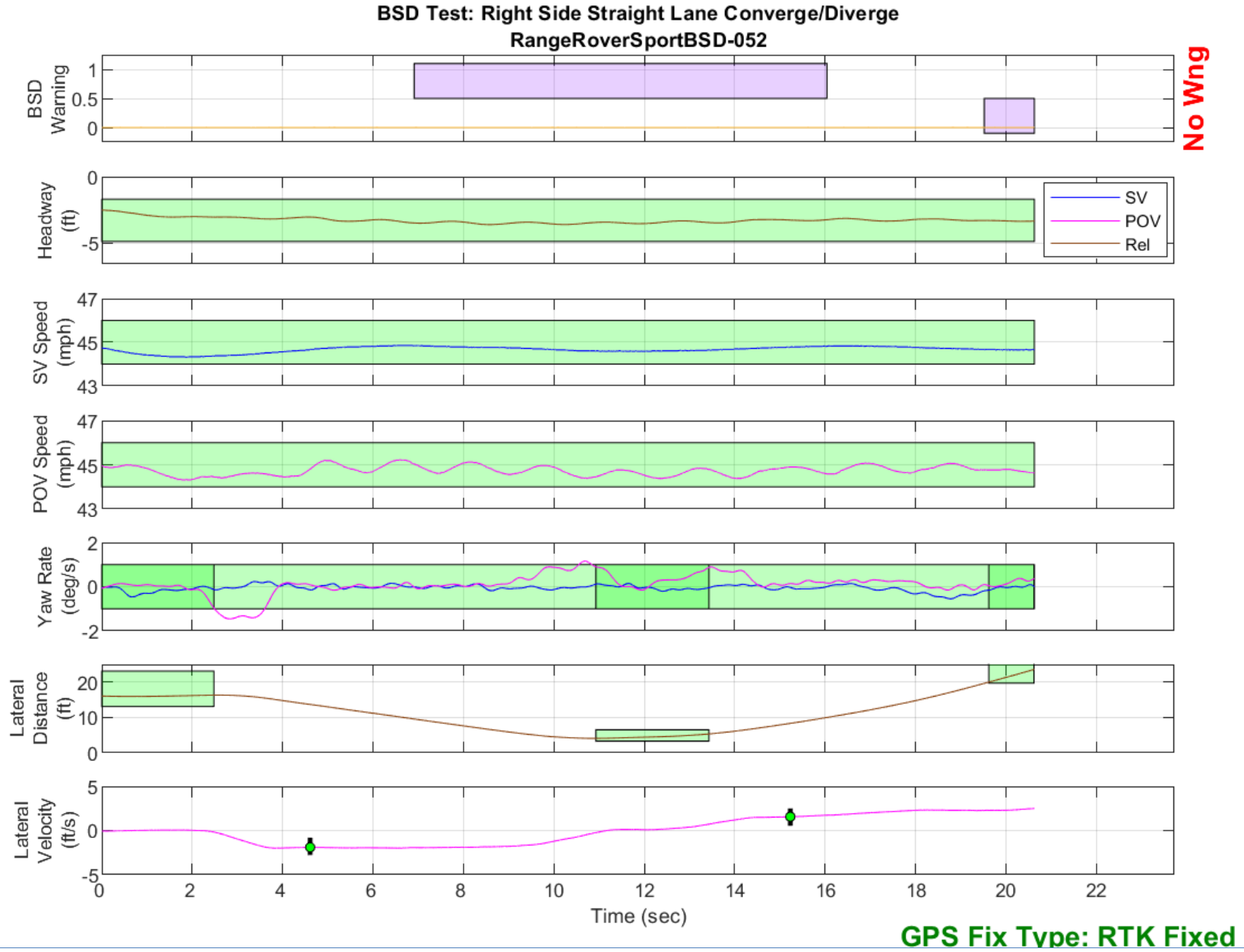


Figure D16. BSD Run 52, Straight Lane Converge/Diverge

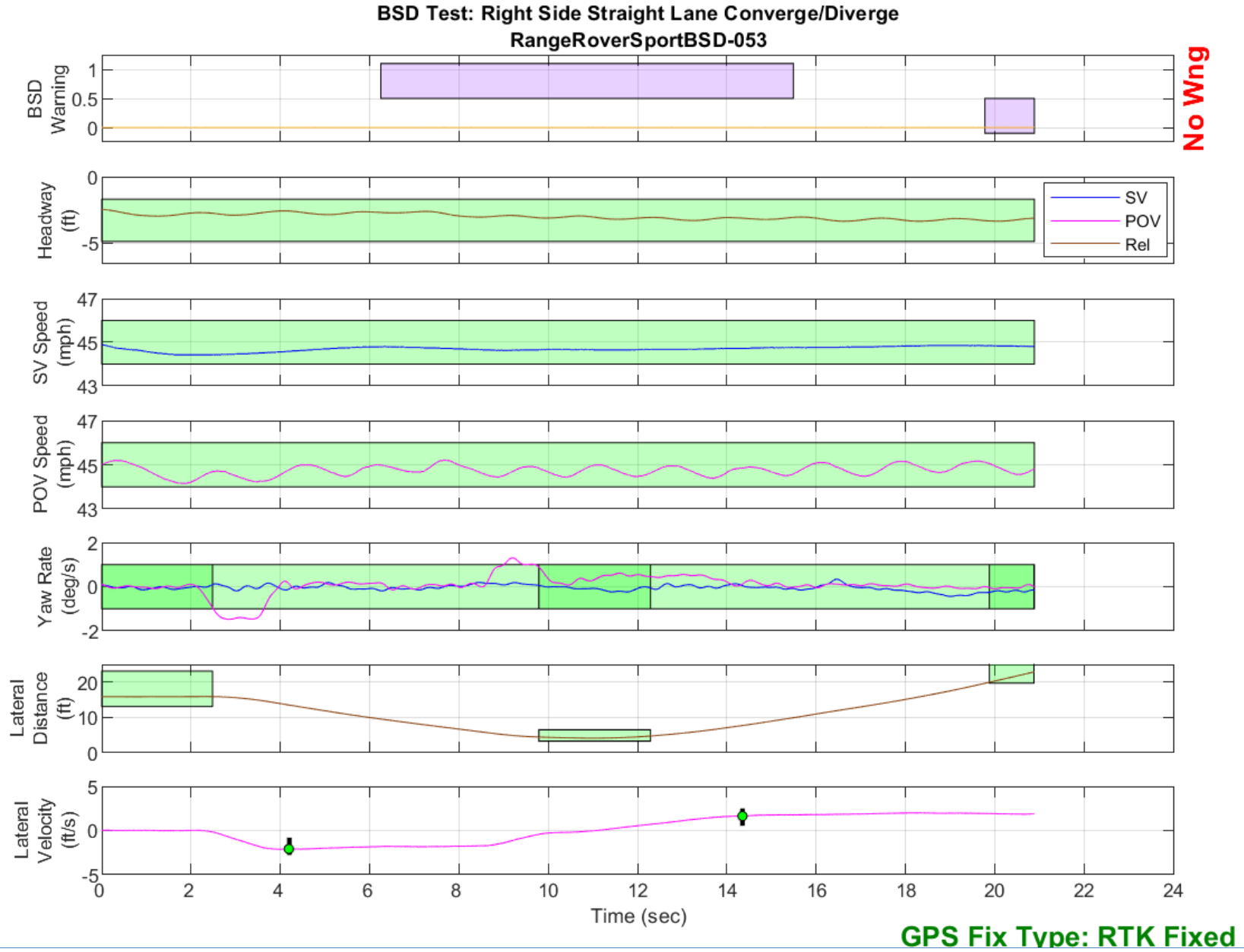


Figure D17. BSD Run 53, Straight Lane Converge/Diverge

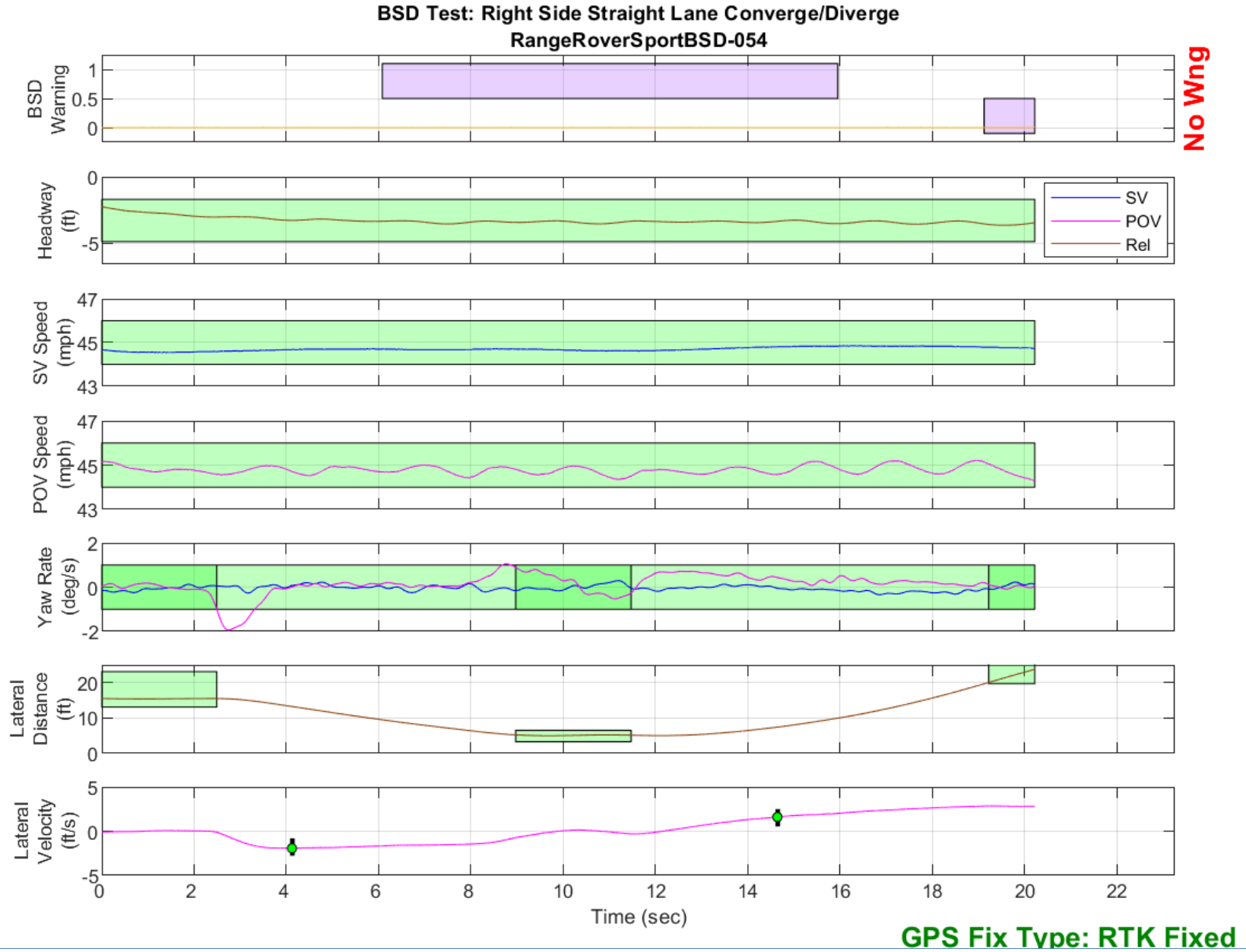


Figure D18. BSD Run 54, Straight Lane Converge/Diverge

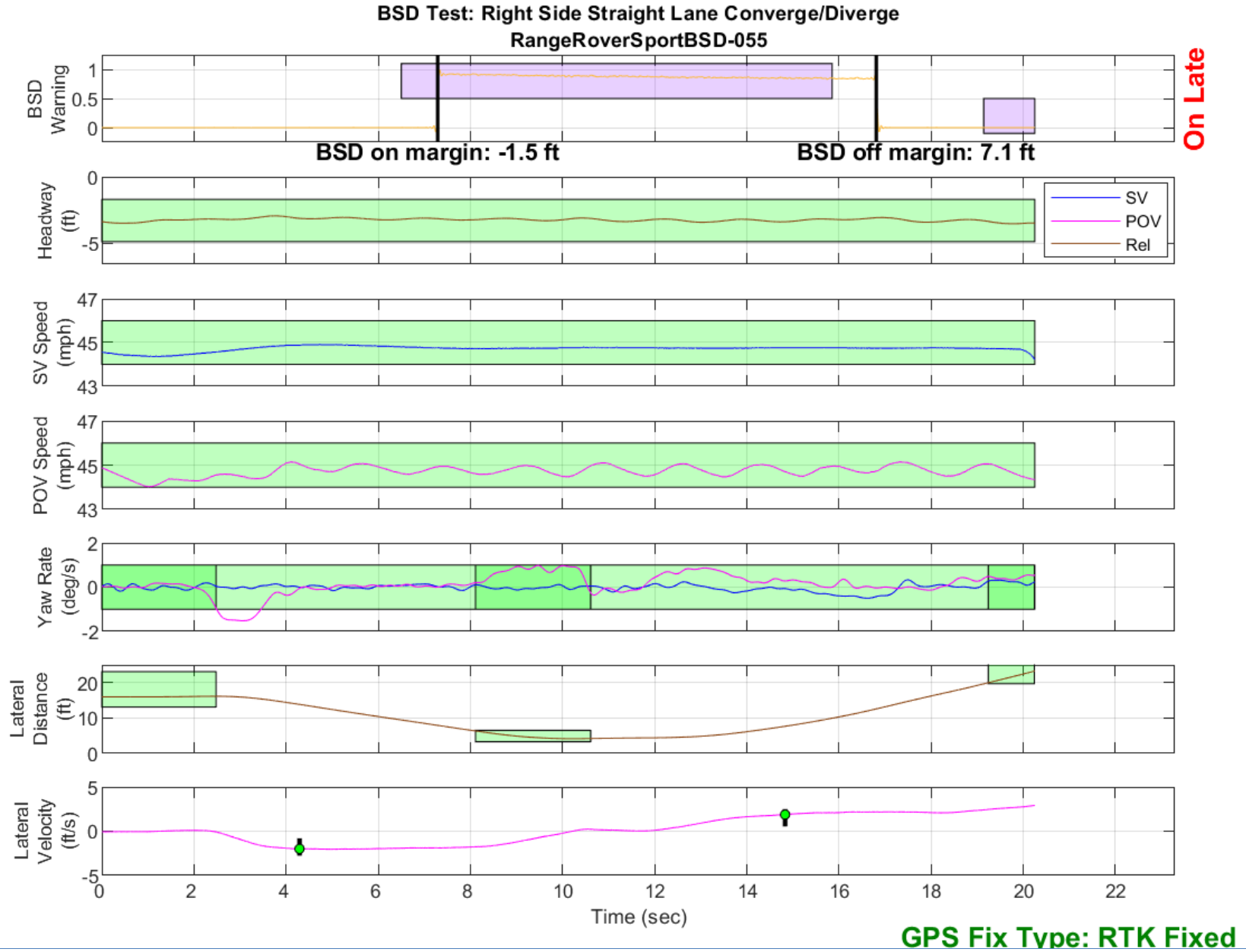


Figure D19. BSD Run 55, Straight Lane Converge/Diverge

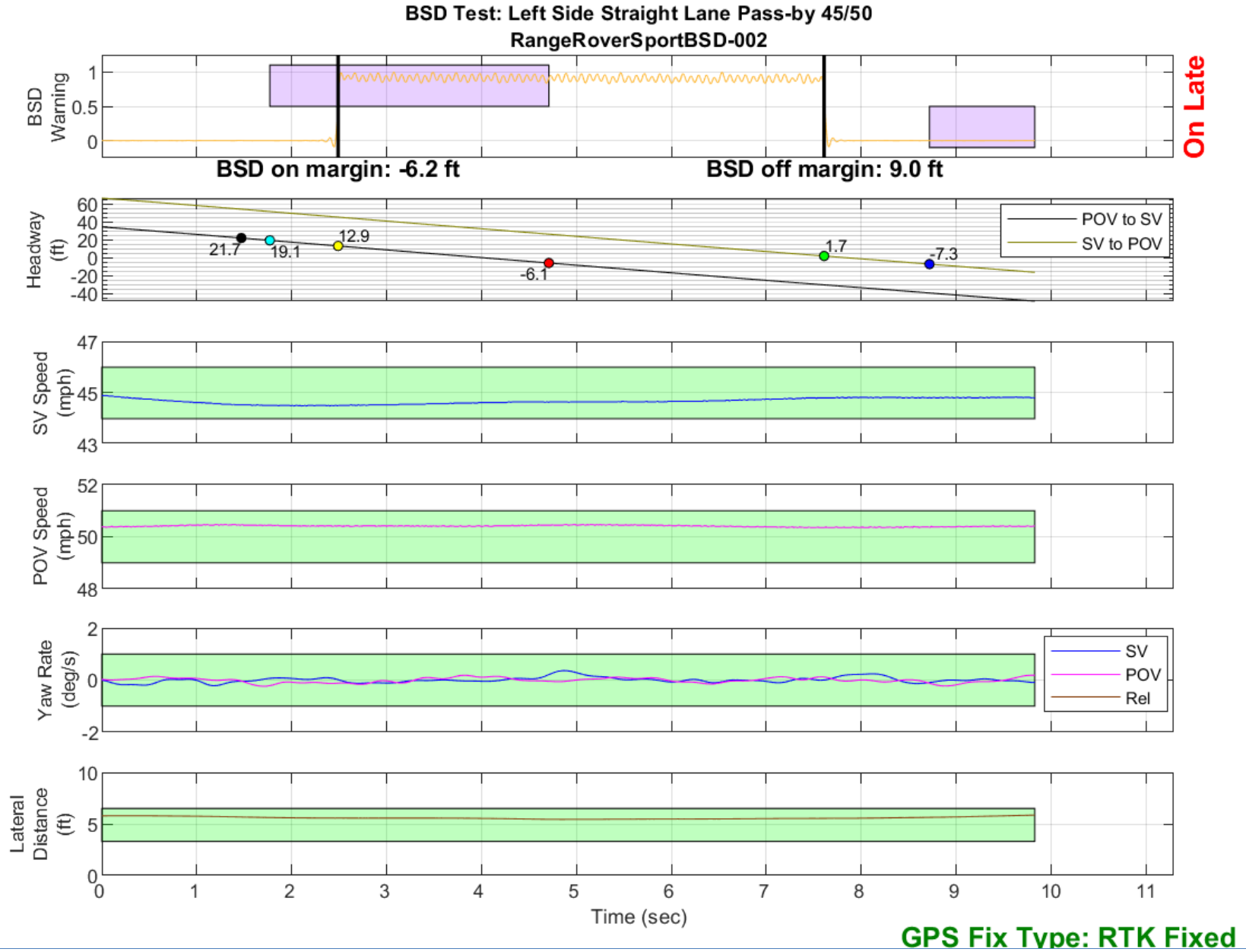


Figure D20. BSD Run 2, Straight Lane Pass-by, SV 45 mph, POV 50 mph

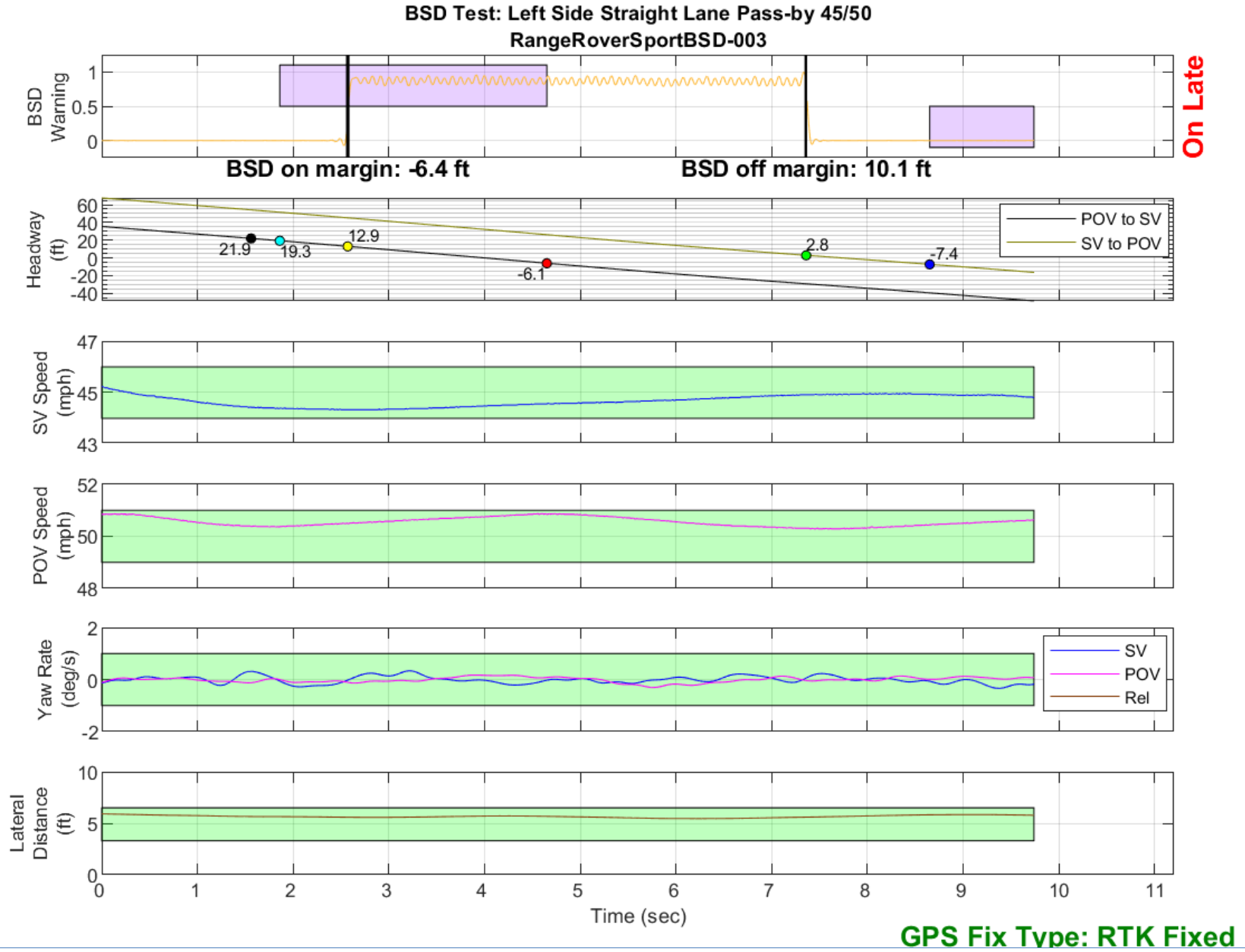


Figure D21. BSD Run 3, Straight Lane Pass-by, SV 45 mph, POV 50 mph

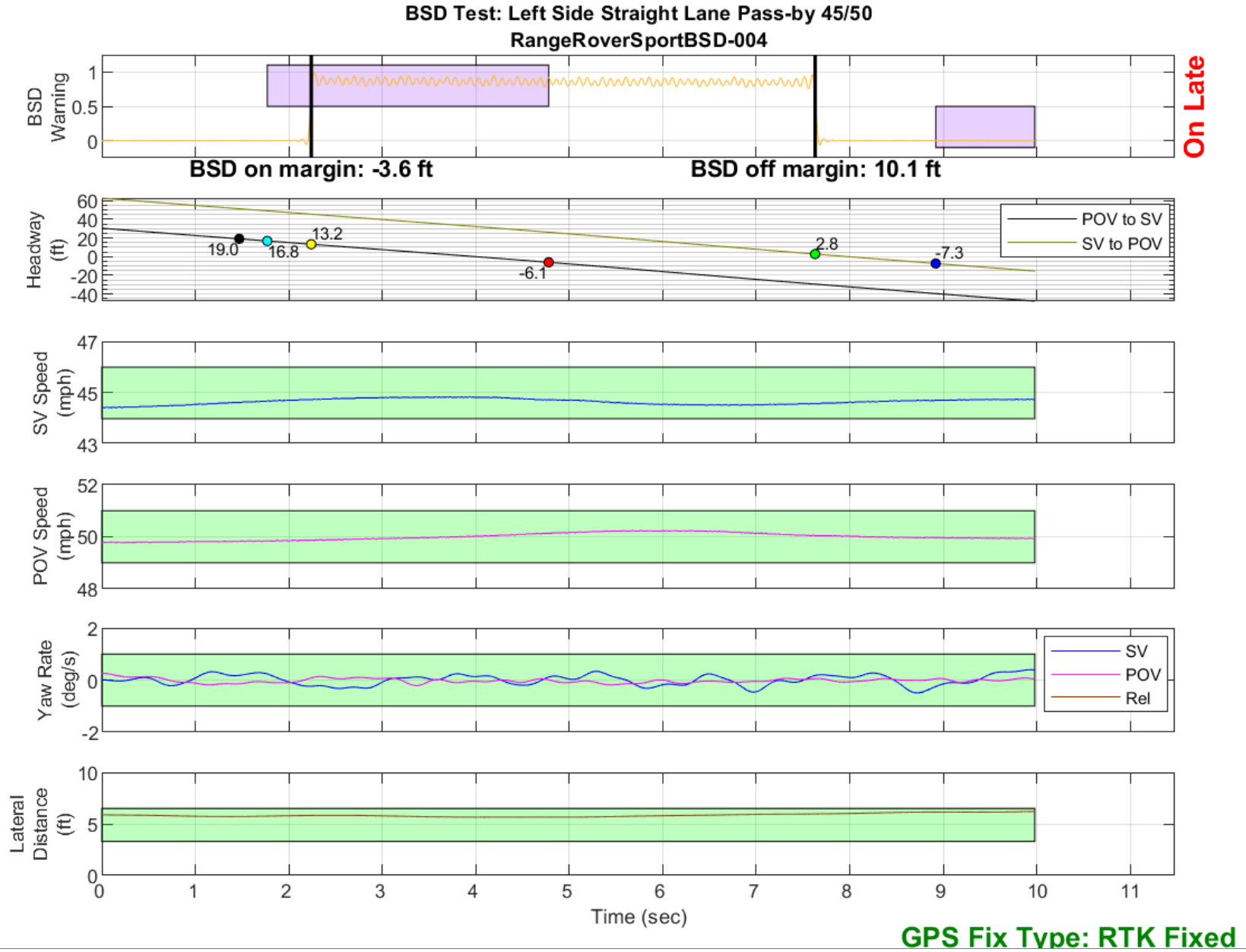


Figure D22. BSD Run 4, Straight Lane Pass-by, SV 45 mph, POV 50 mph

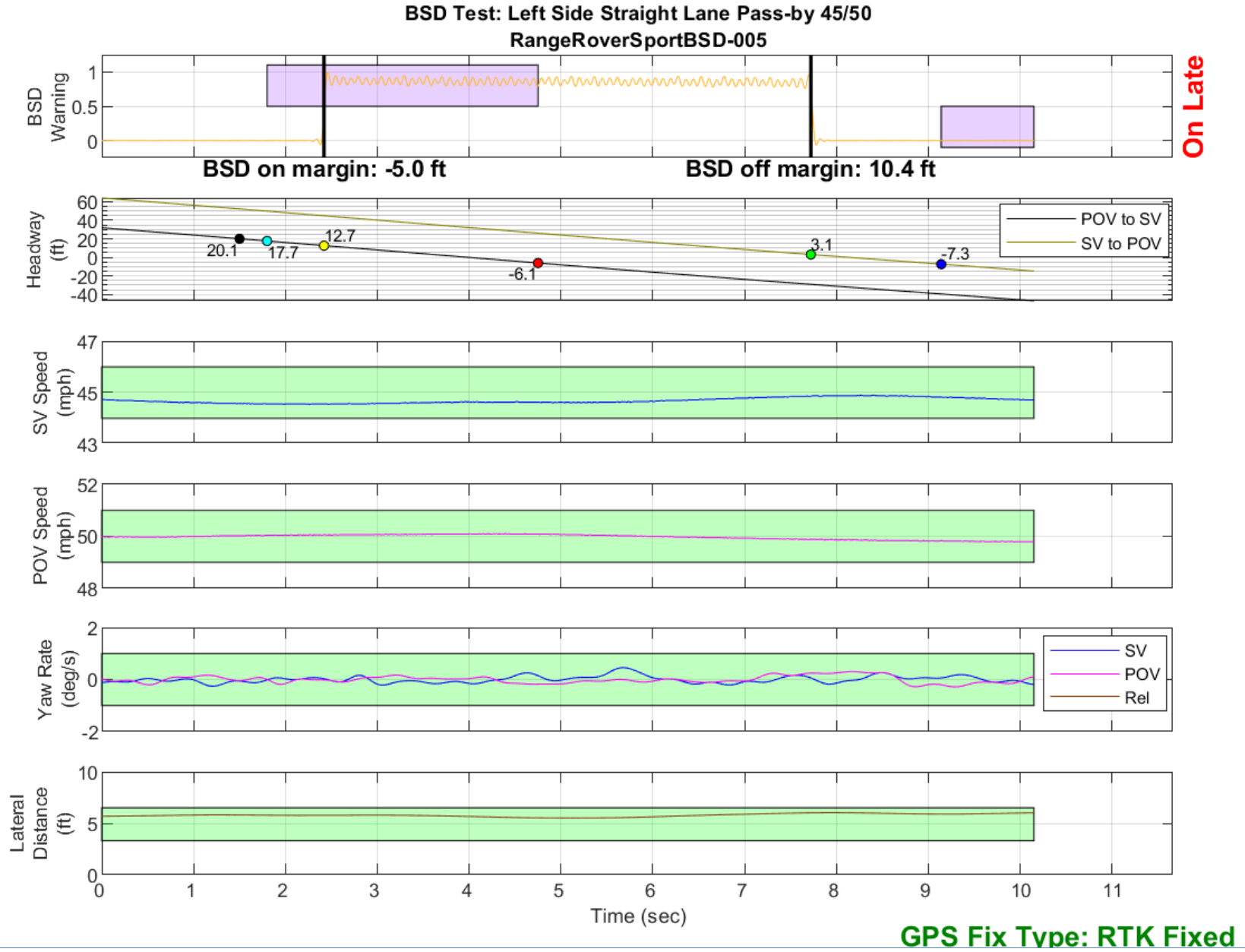


Figure D23. BSD Run 5, Straight Lane Pass-by, SV 45 mph, POV 50 mph

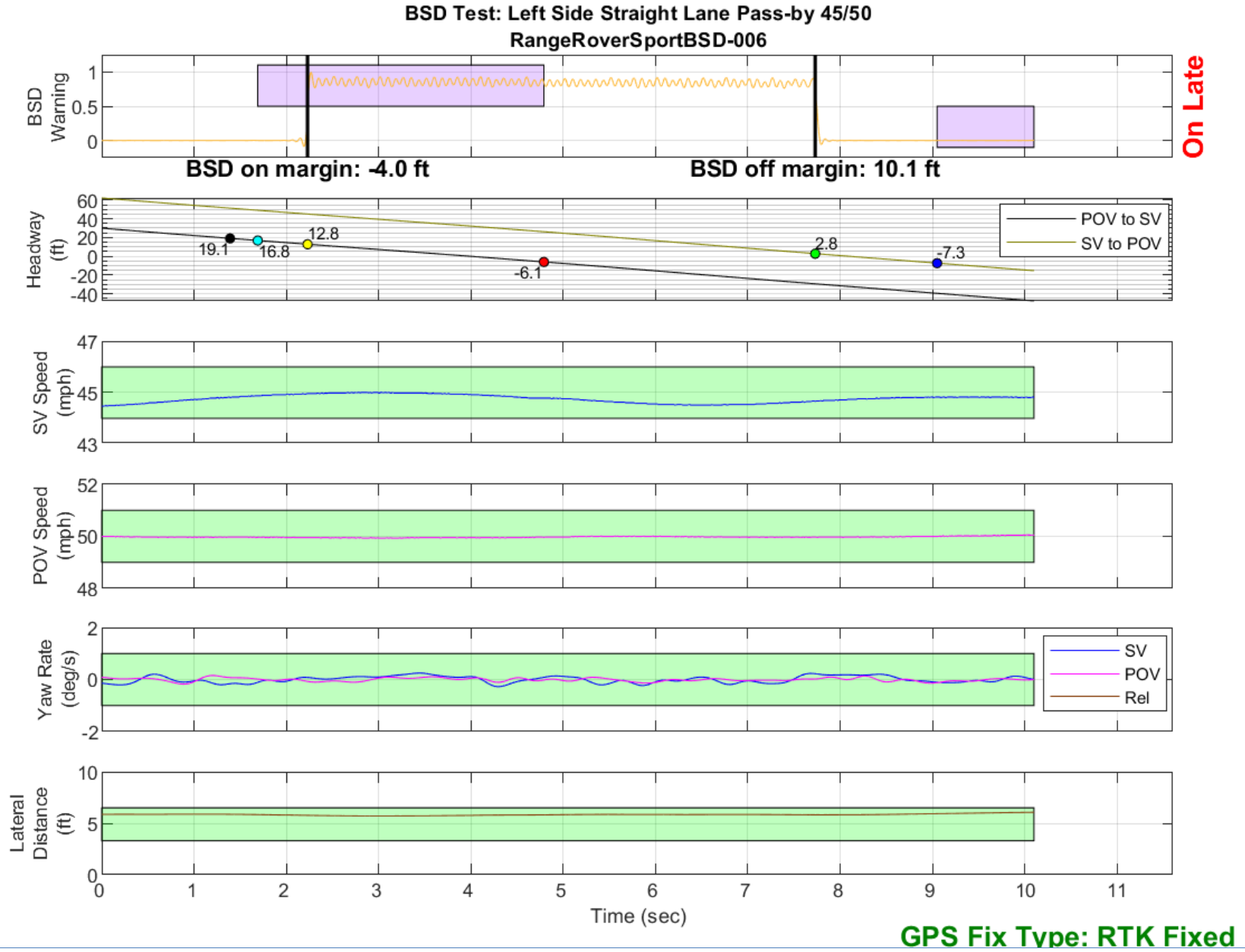


Figure D24. BSD Run 6, Straight Lane Pass-by, SV 45 mph, POV 50 mph

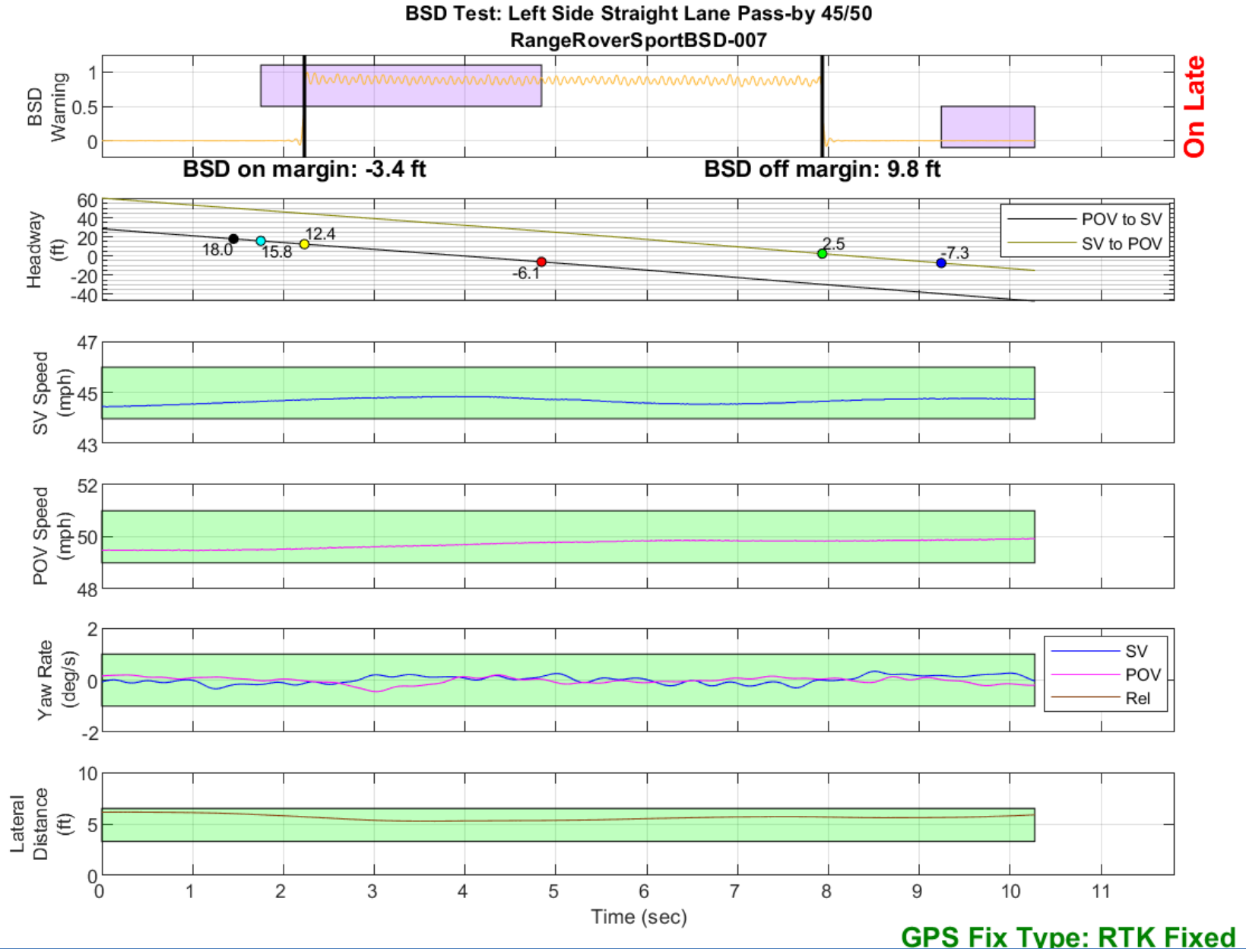


Figure D25. BSD Run 7, Straight Lane Pass-by, SV 45 mph, POV 50 mph

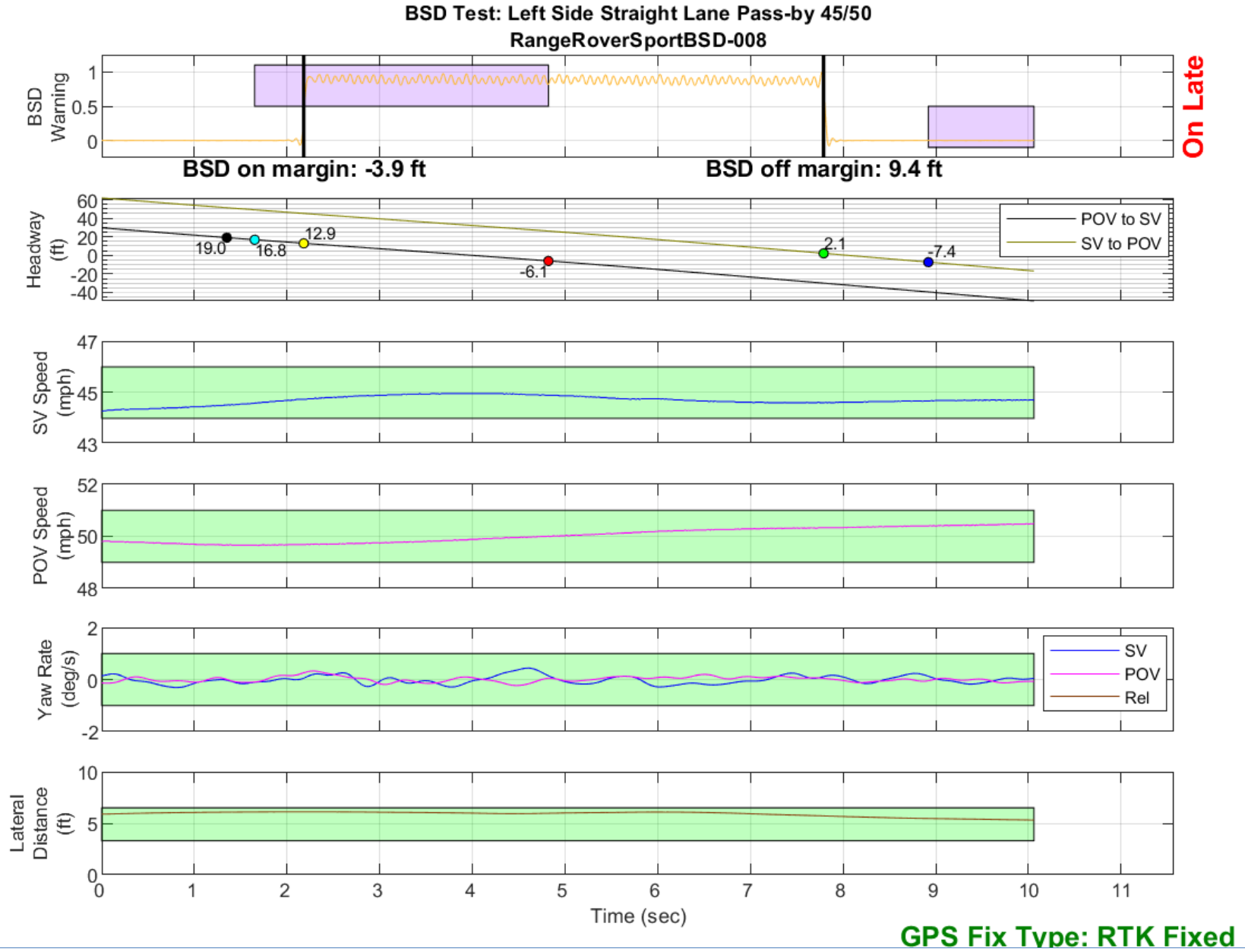


Figure D26. BSD Run 8, Straight Lane Pass-by, SV 45 mph, POV 50 mph

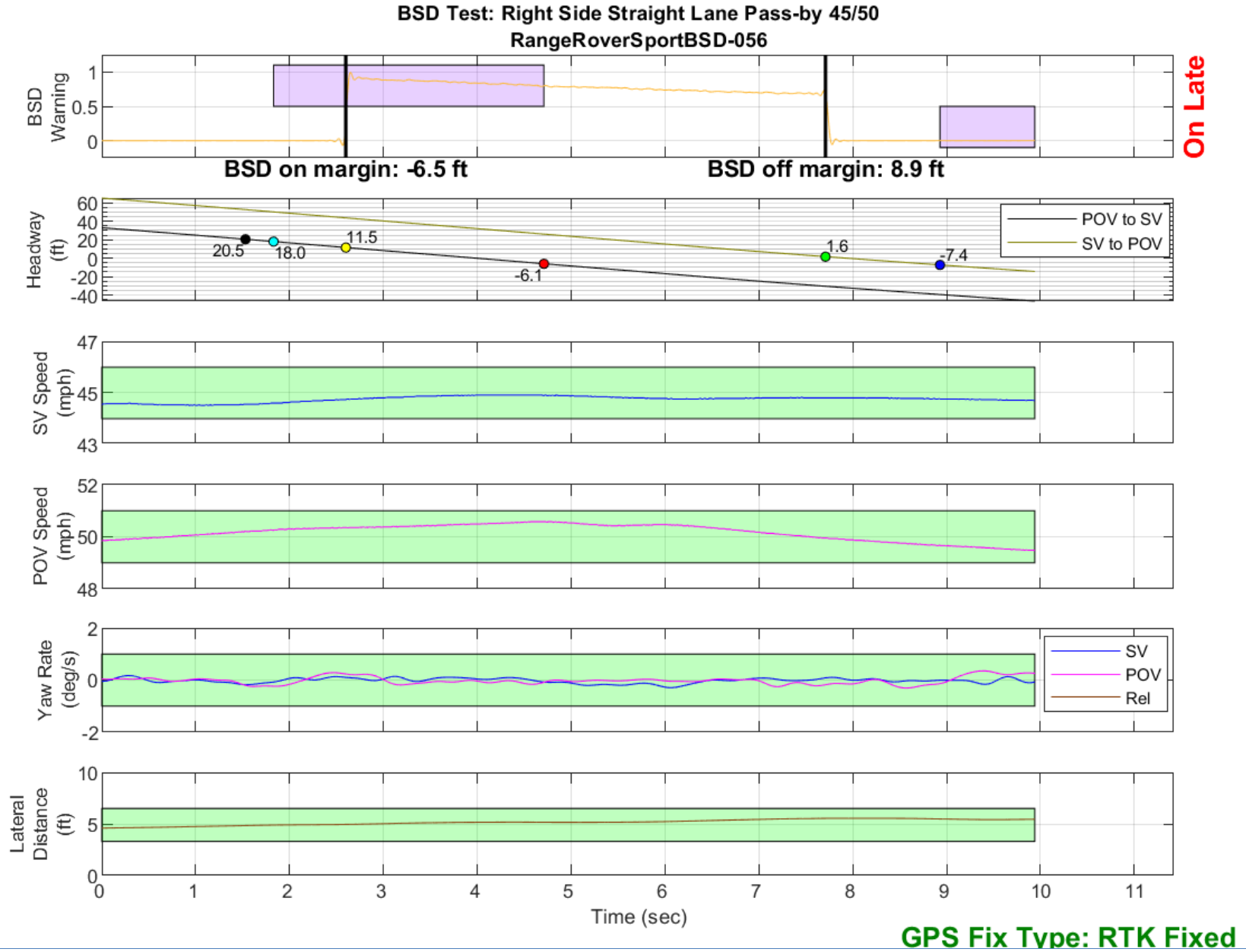


Figure D27. BSD Run 56, Straight Lane Pass-by, SV 45 mph, POV 50 mph

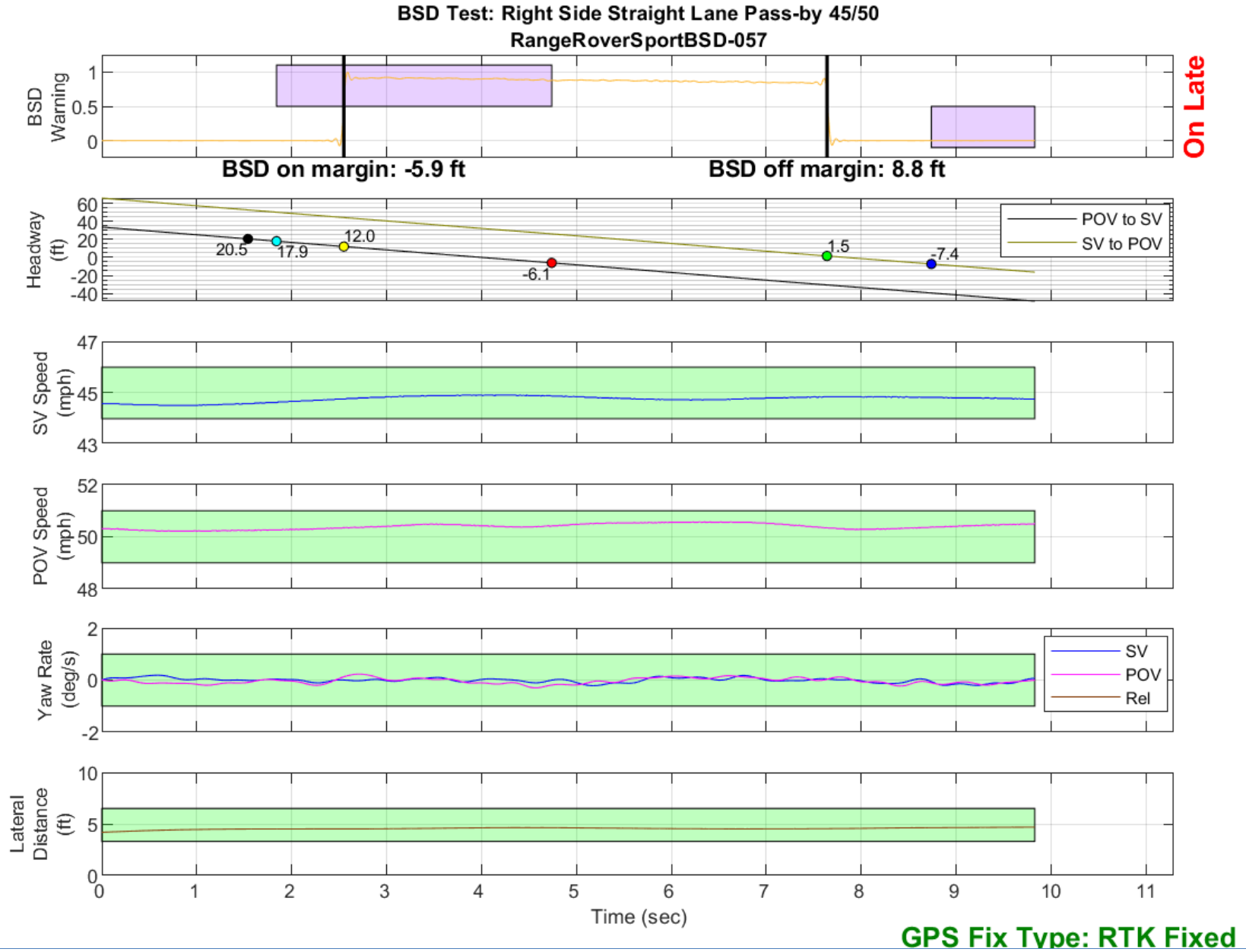


Figure D28. BSD Run 57, Straight Lane Pass-by, SV 45 mph, POV 50 mph

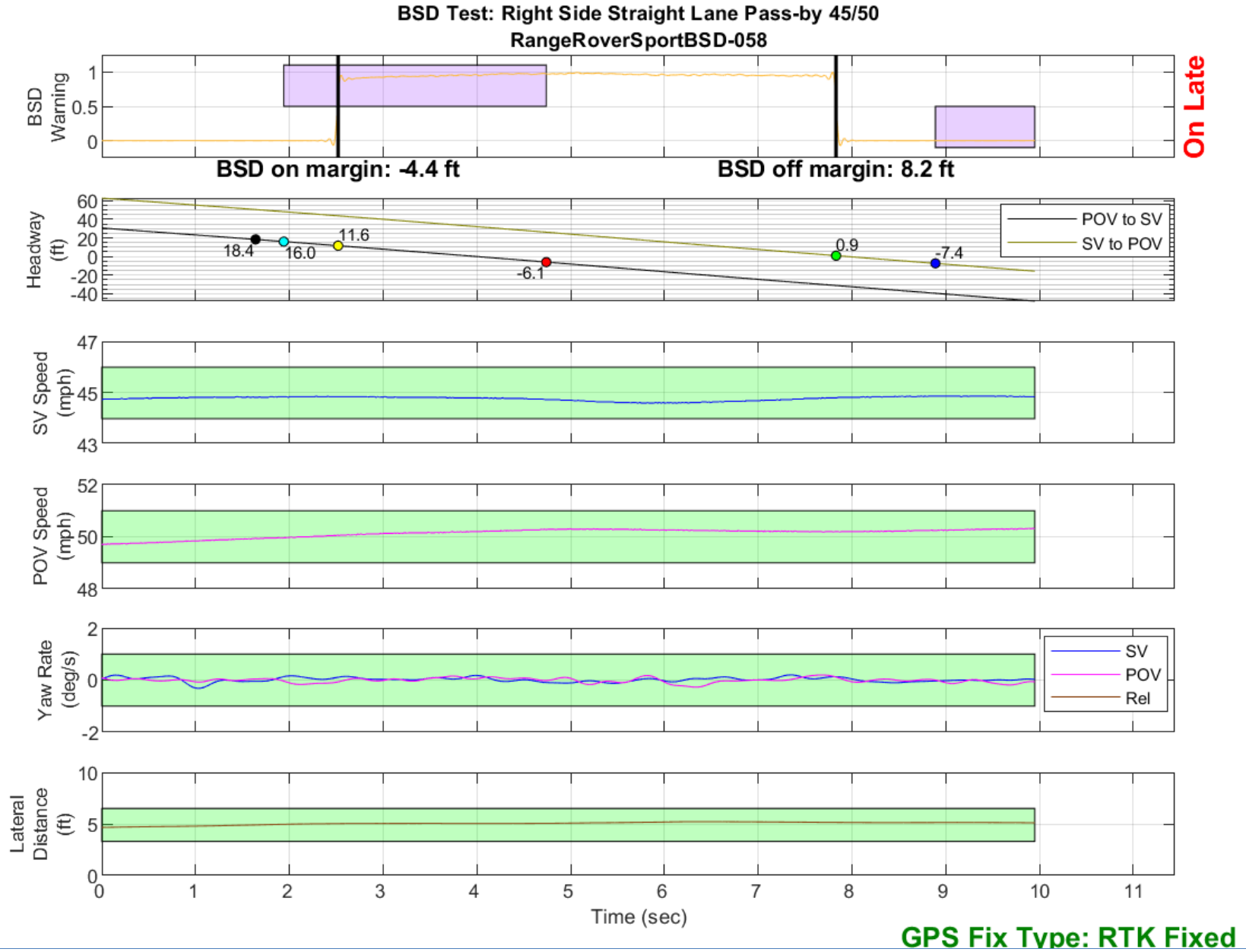


Figure D29. BSD Run 58, Straight Lane Pass-by, SV 45 mph, POV 50 mph

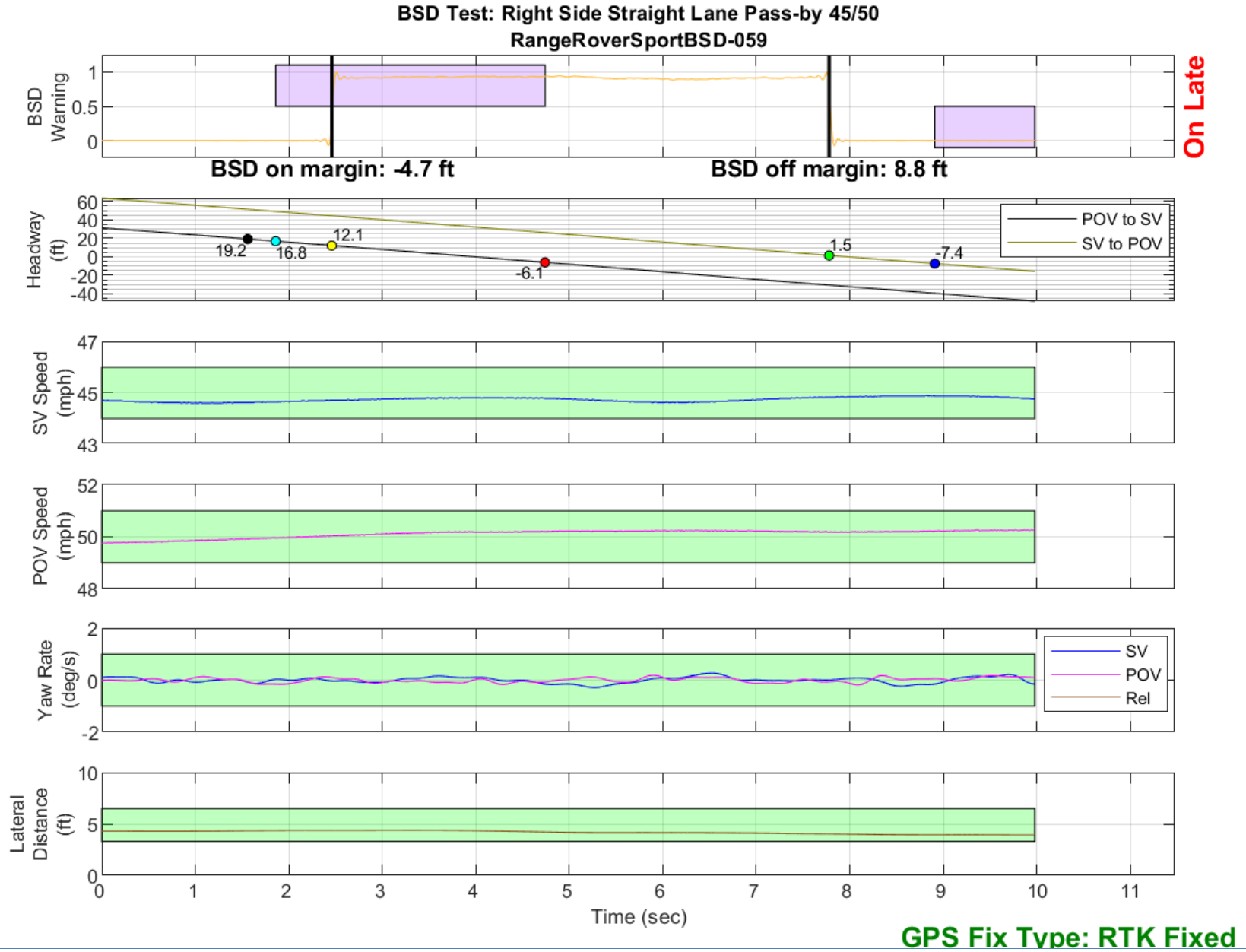


Figure D30. BSD Run 59, Straight Lane Pass-by, SV 45 mph, POV 50 mph

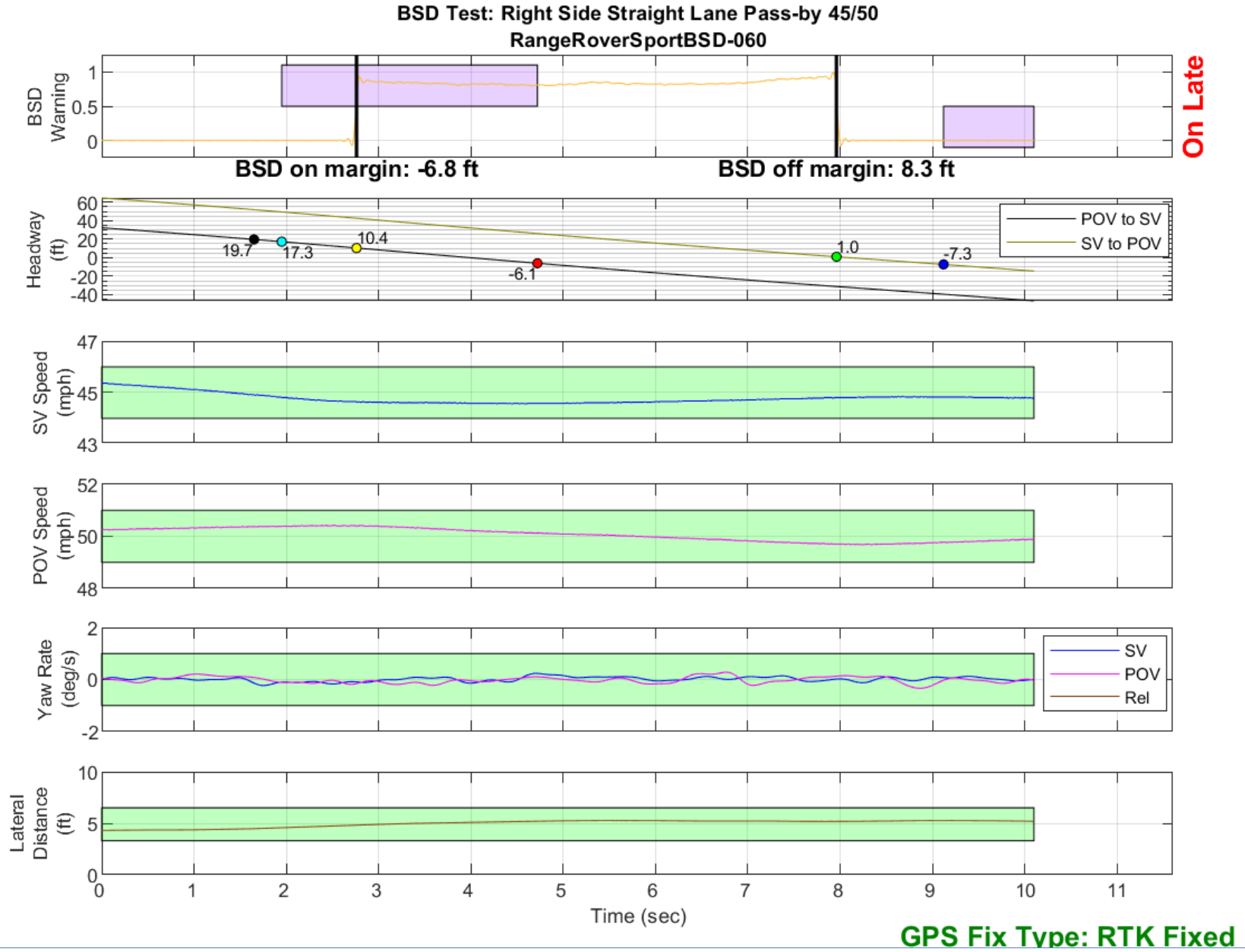


Figure D31. BSD Run 60, Straight Lane Pass-by, SV 45 mph, POV 50 mph

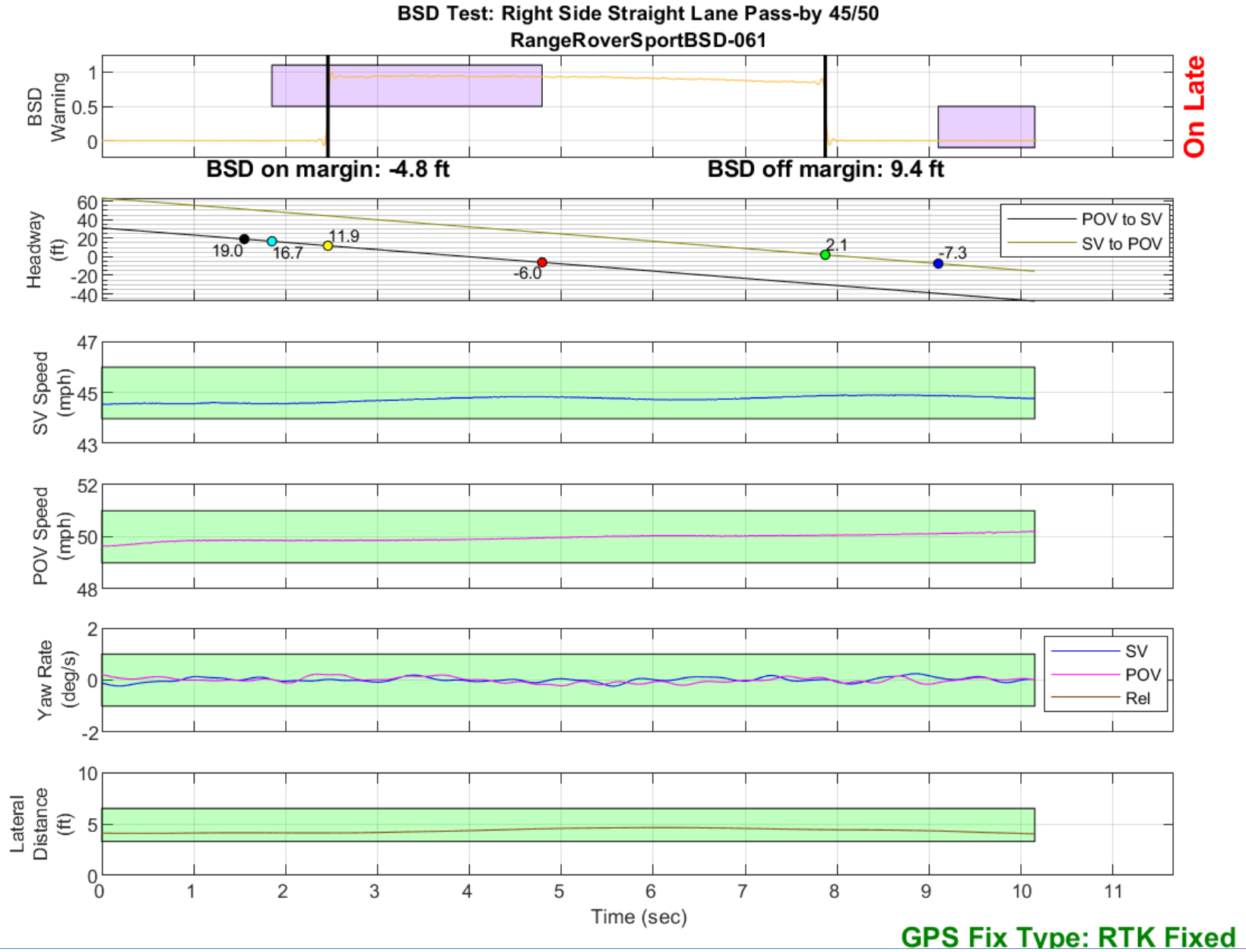


Figure D32. BSD Run 61, Straight Lane Pass-by, SV 45 mph, POV 50 mph

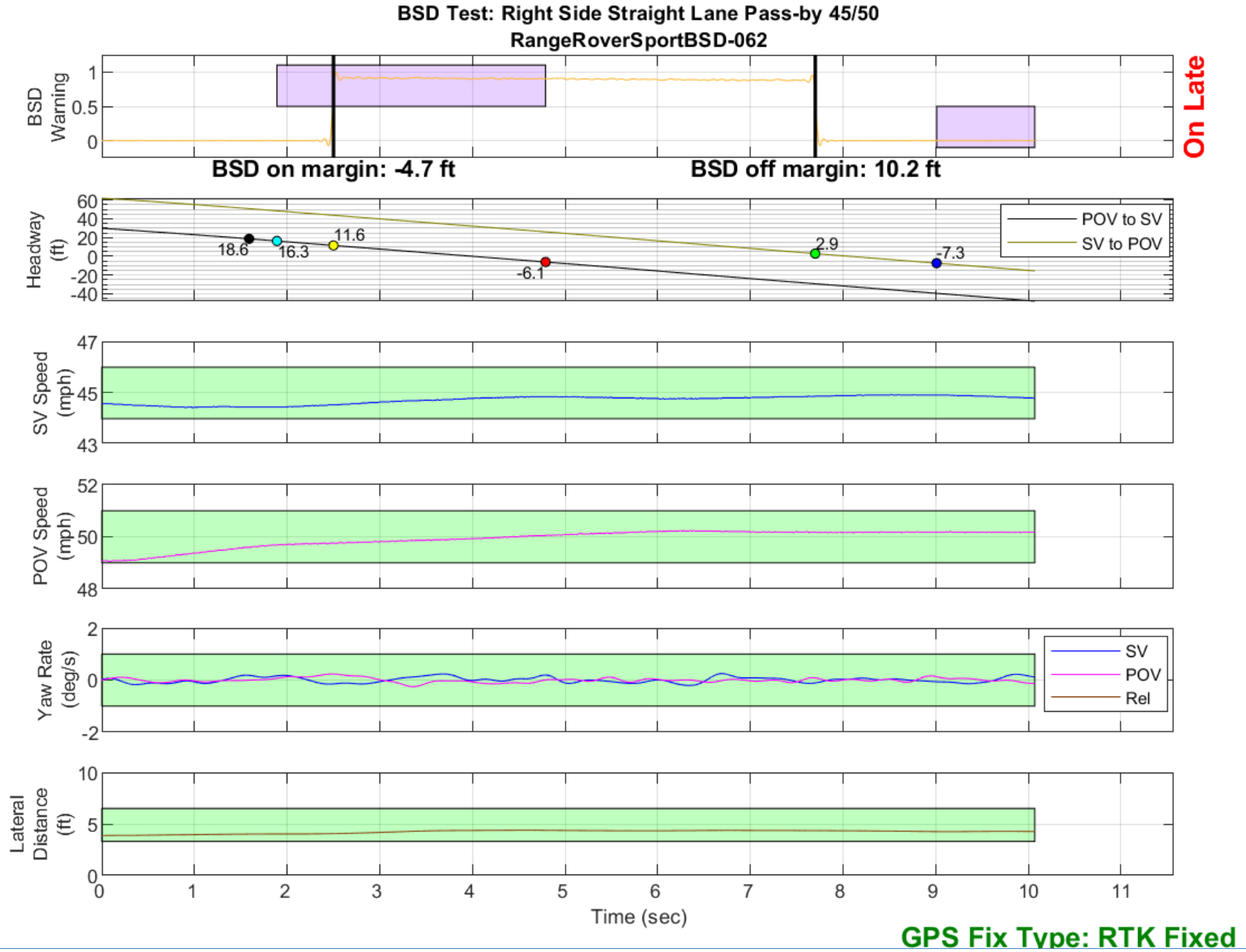


Figure D33. BSD Run 62, Straight Lane Pass-by, SV 45 mph, POV 50 mph

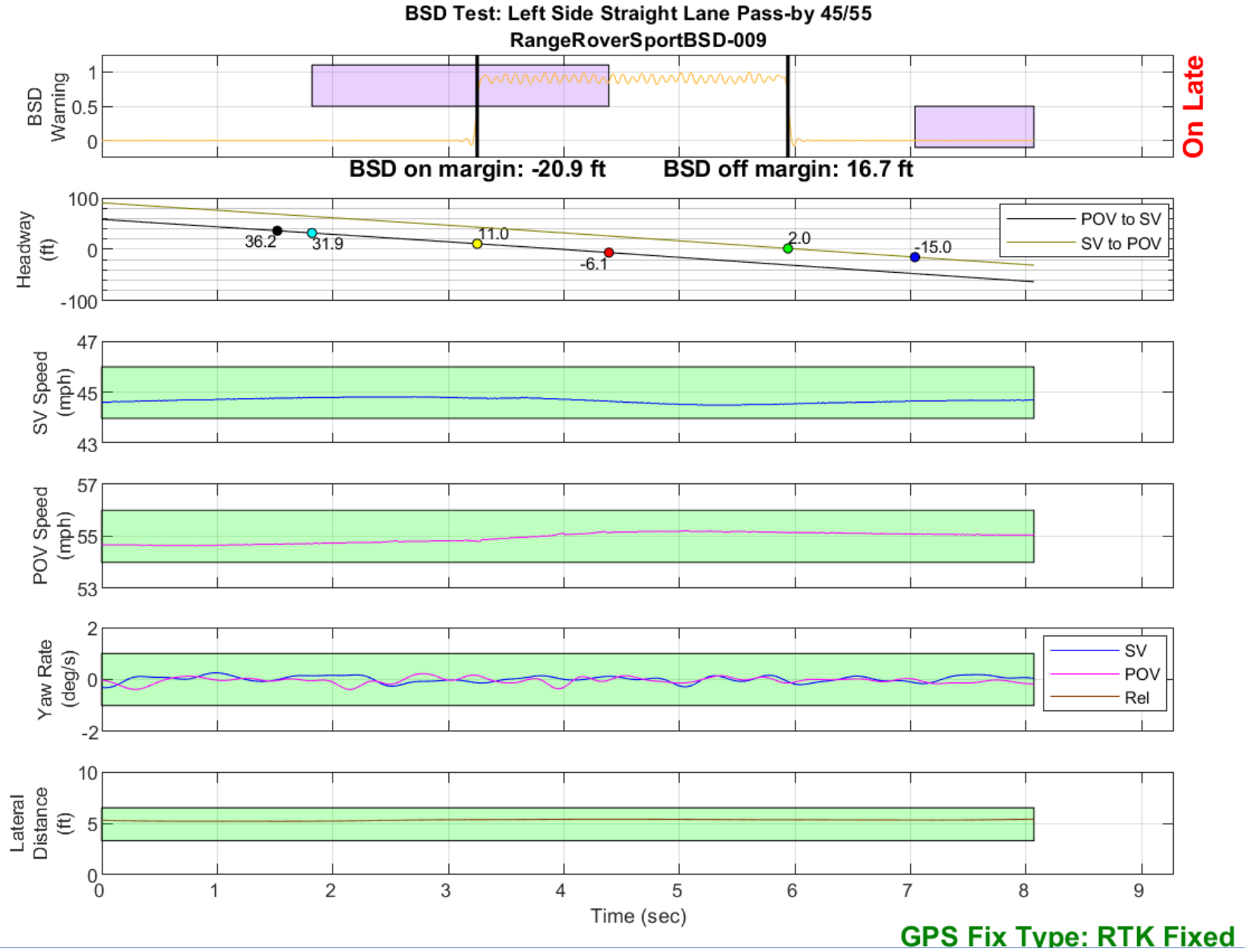


Figure D34. BSD Run 9, Straight Lane Pass-by, SV 45 mph, POV 55 mph

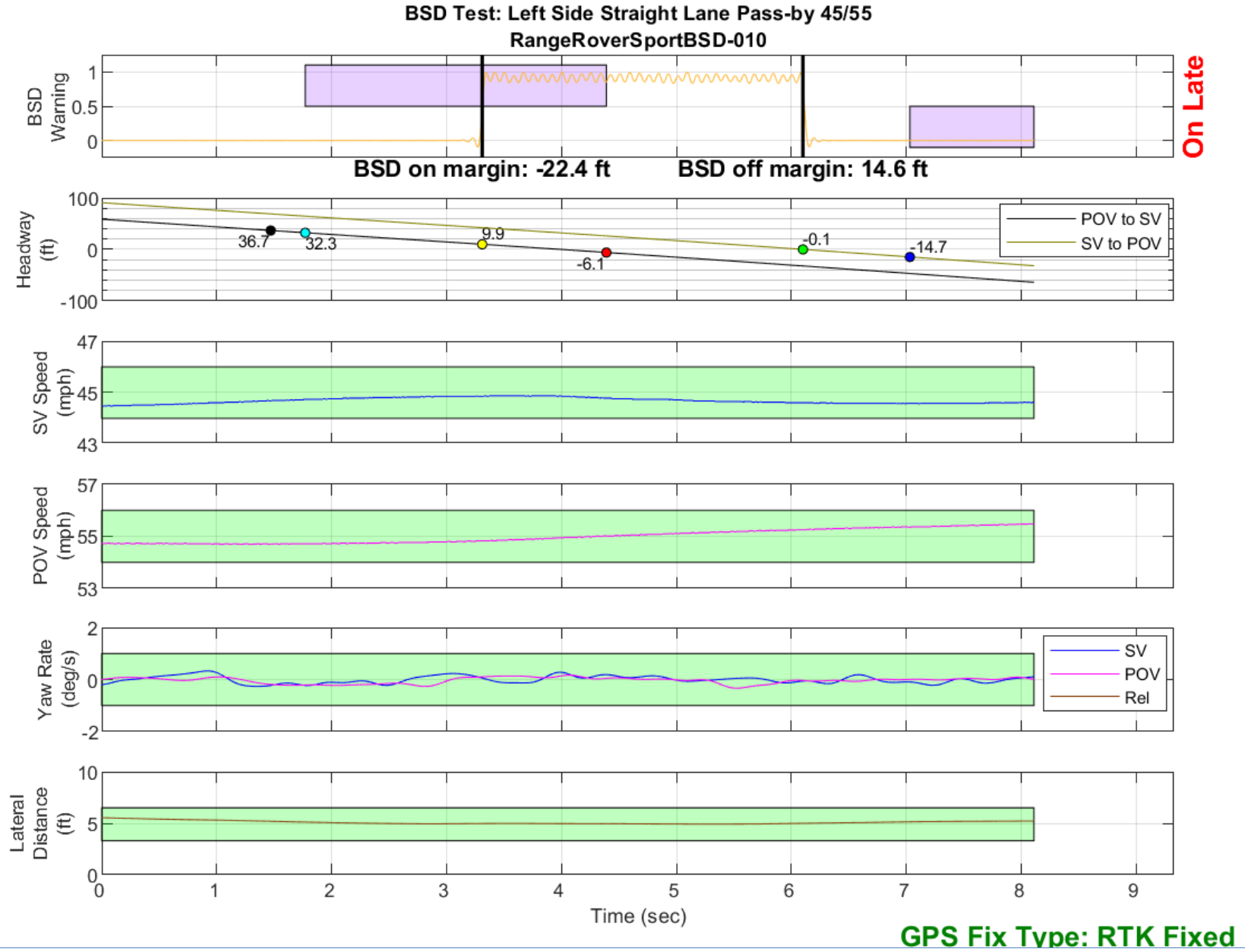


Figure D35. BSD Run 10, Straight Lane Pass-by, SV 45 mph, POV 55 mph

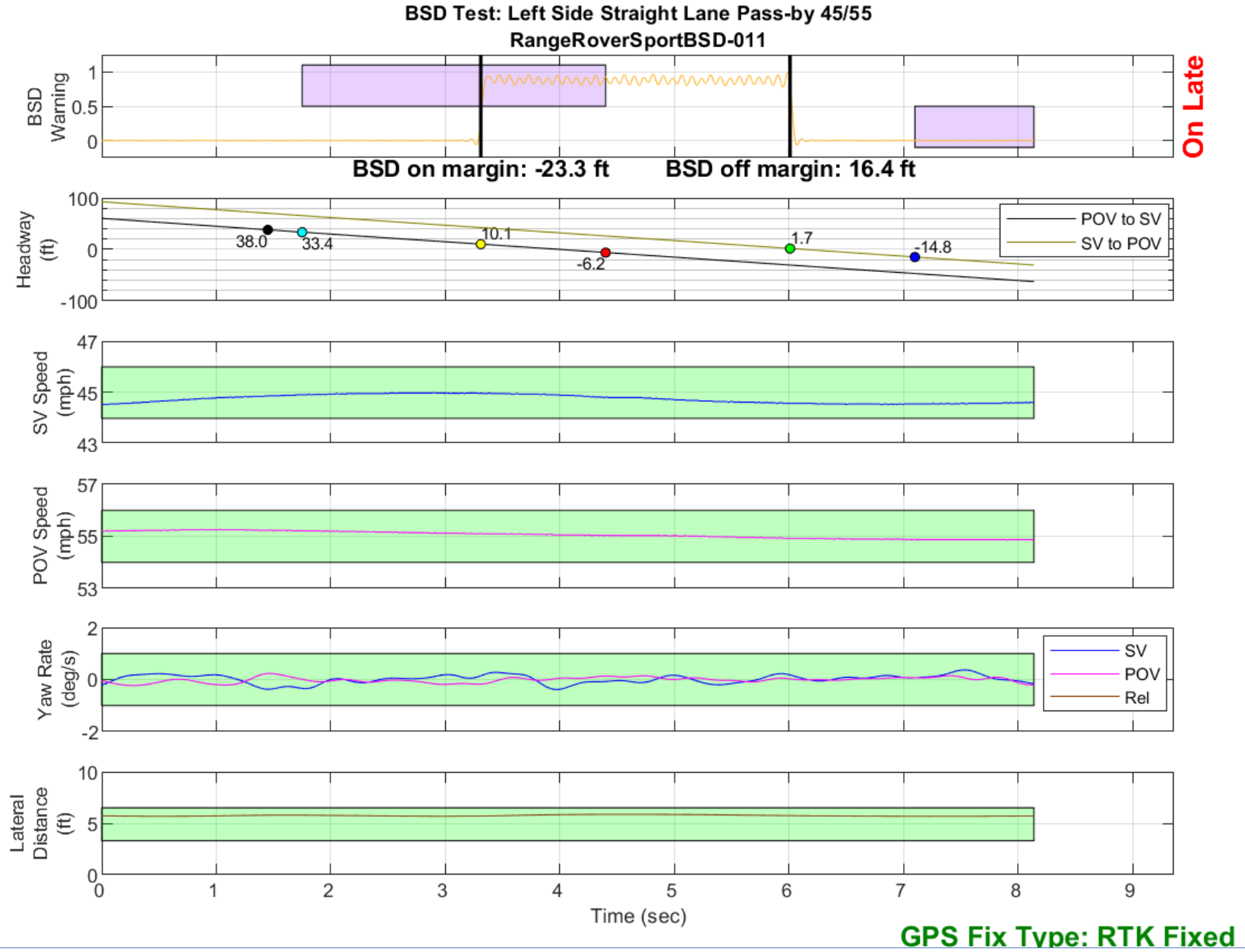


Figure D36. BSD Run 11, Straight Lane Pass-by, SV 45 mph, POV 55 mph

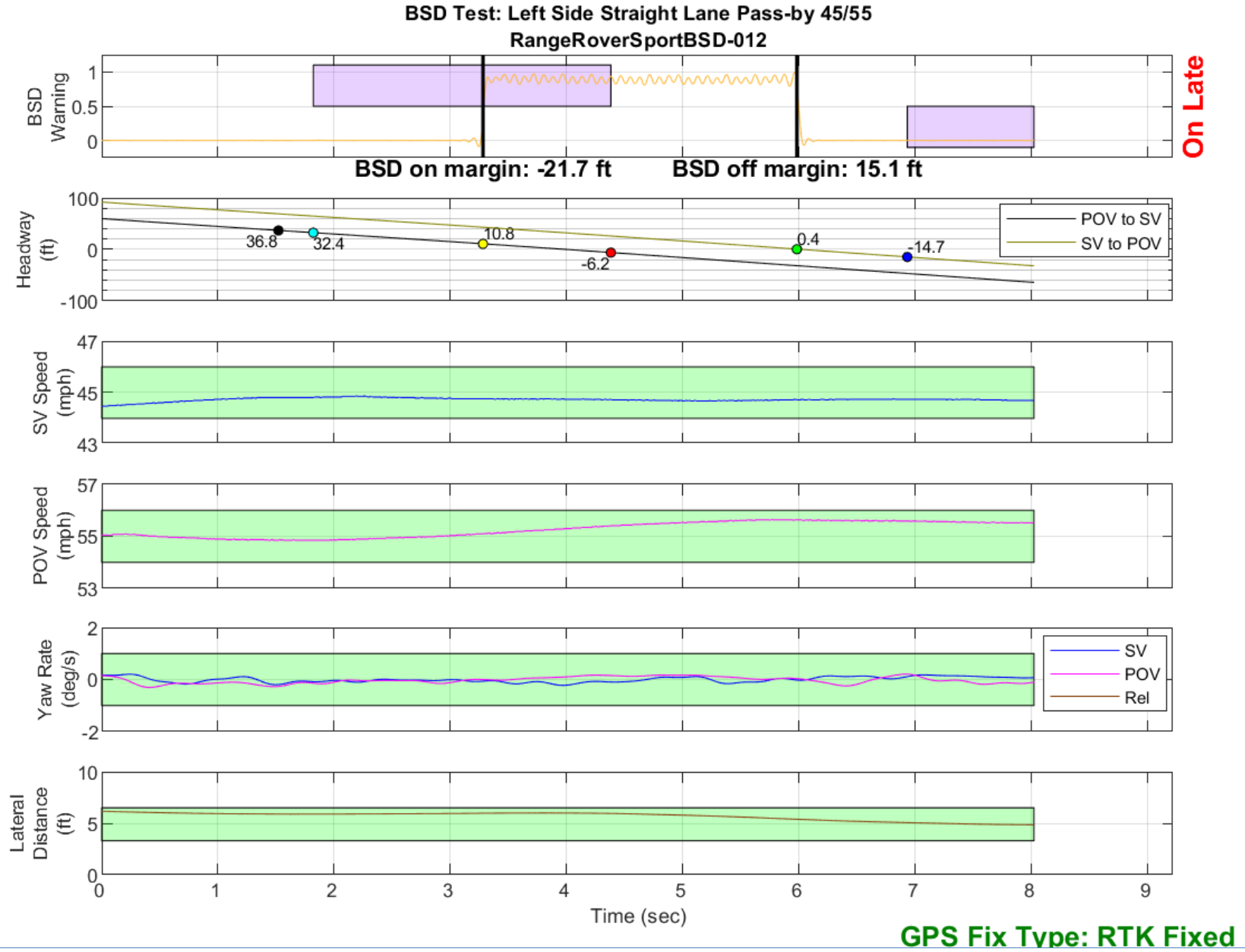


Figure D37. BSD Run 12, Straight Lane Pass-by, SV 45 mph, POV 55 mph

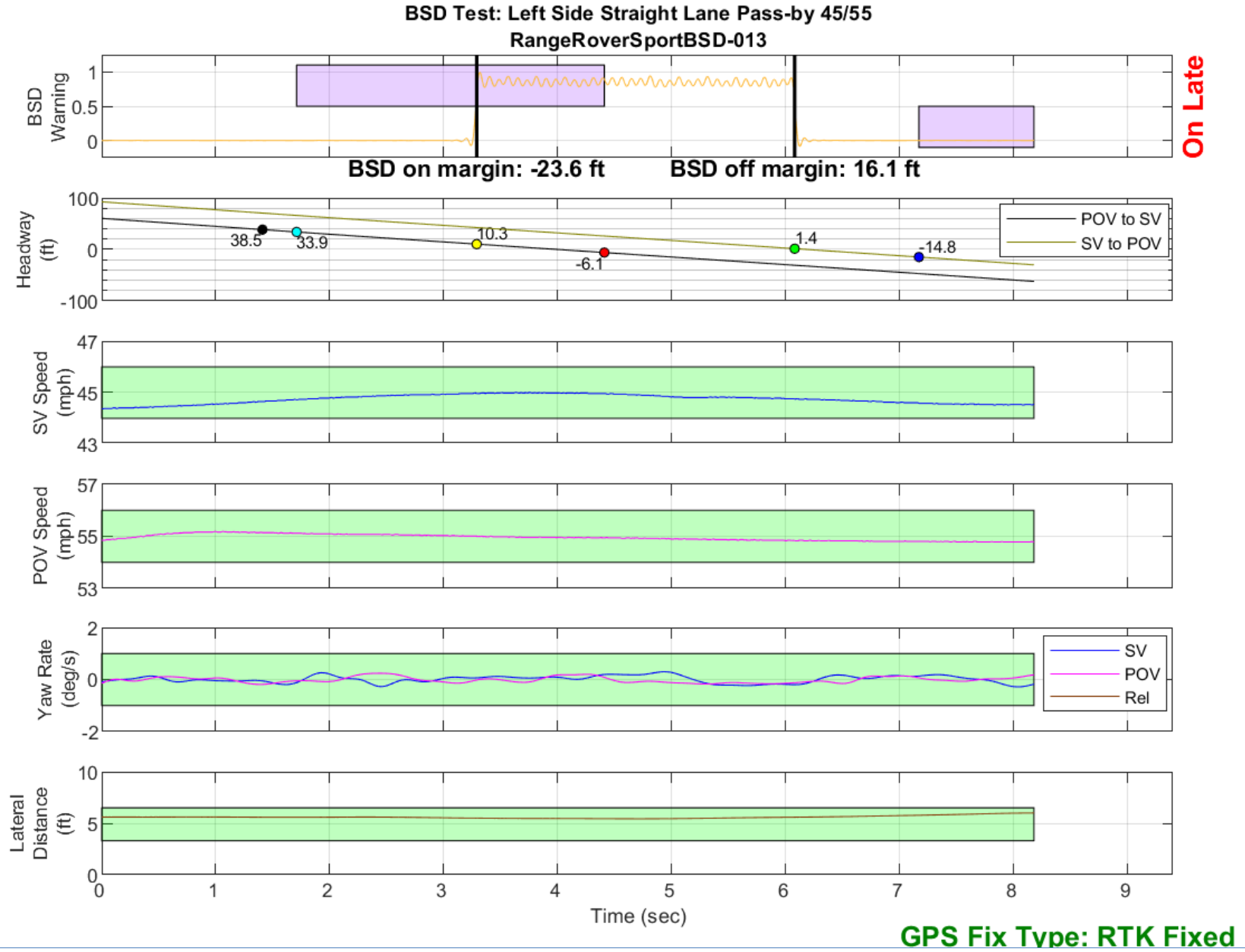


Figure D38. BSD Run 13, Straight Lane Pass-by, SV 45 mph, POV 55 mph

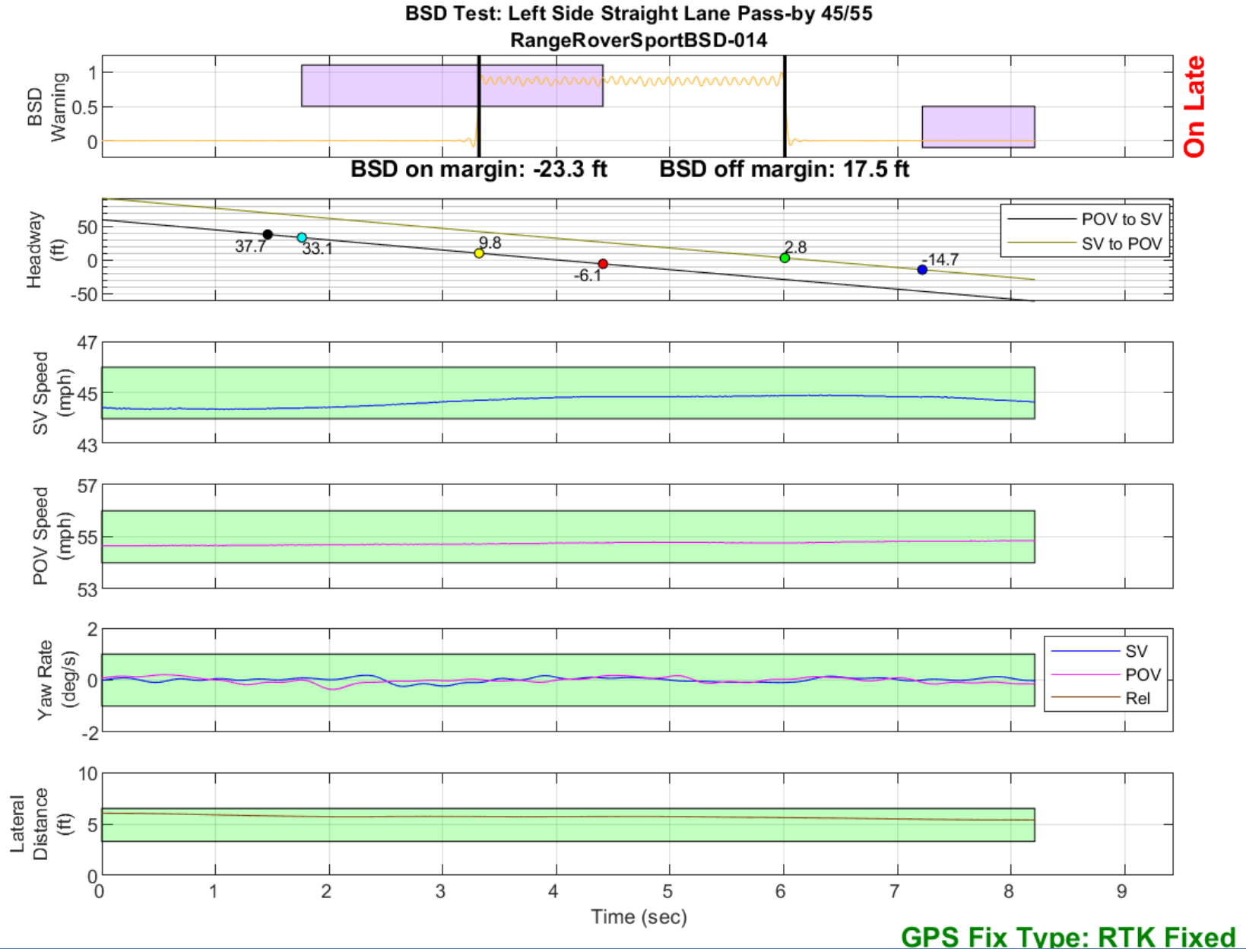


Figure D39. BSD Run 14, Straight Lane Pass-by, SV 45 mph, POV 55 mph

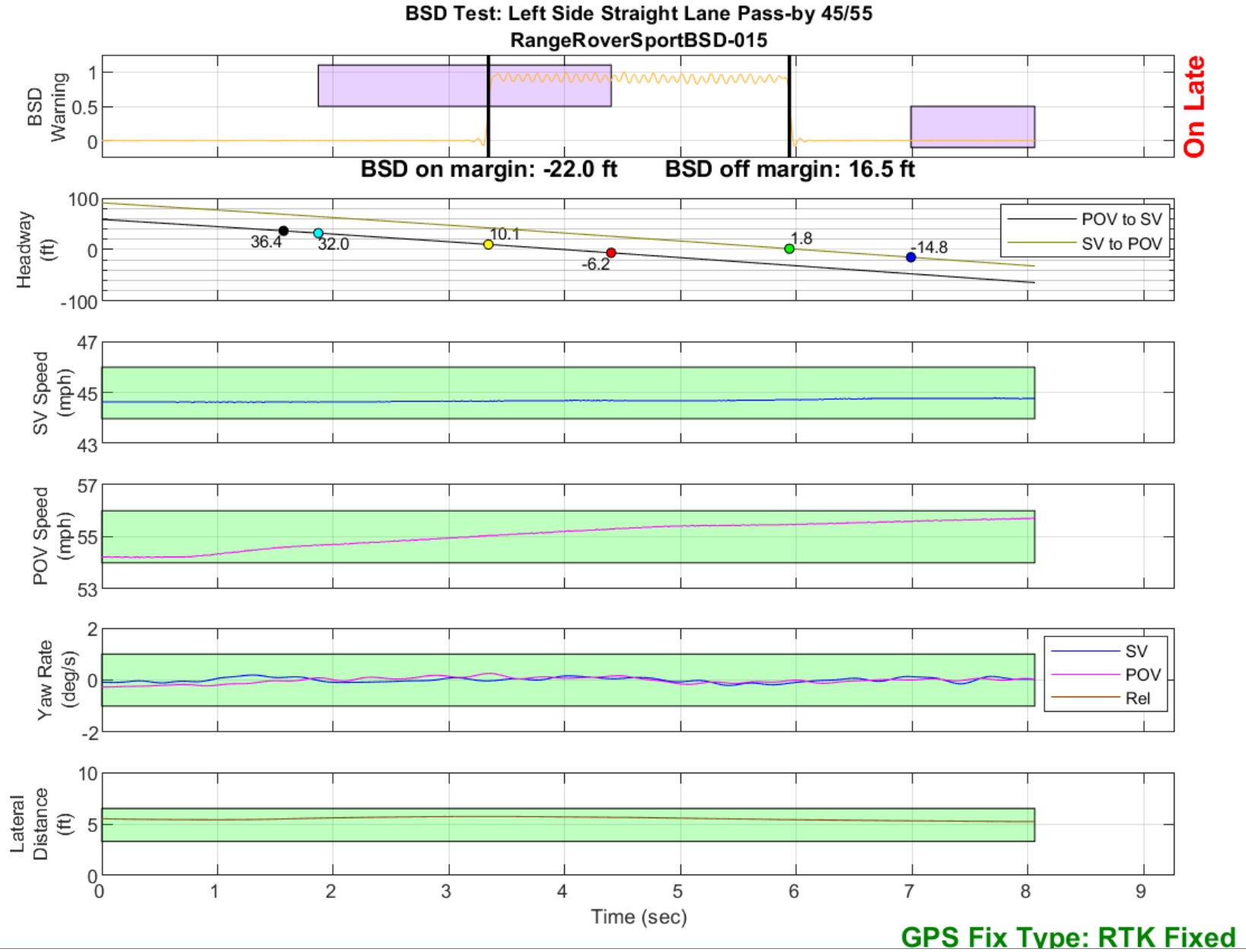


Figure D40. BSD Run 15, Straight Lane Pass-by, SV 45 mph, POV 55 mph

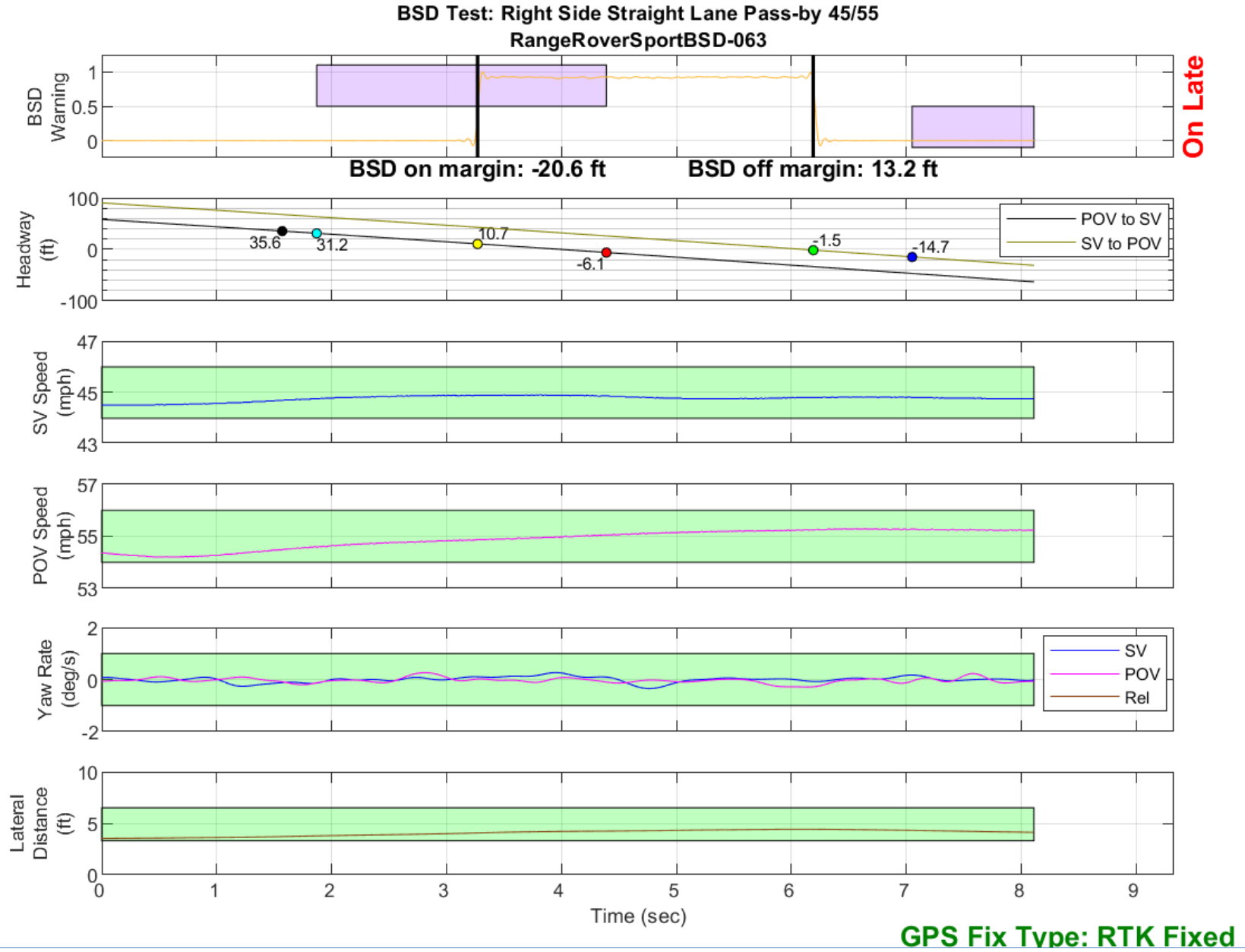


Figure D41. BSD Run 63, Straight Lane Pass-by, SV 45 mph, POV 55 mph

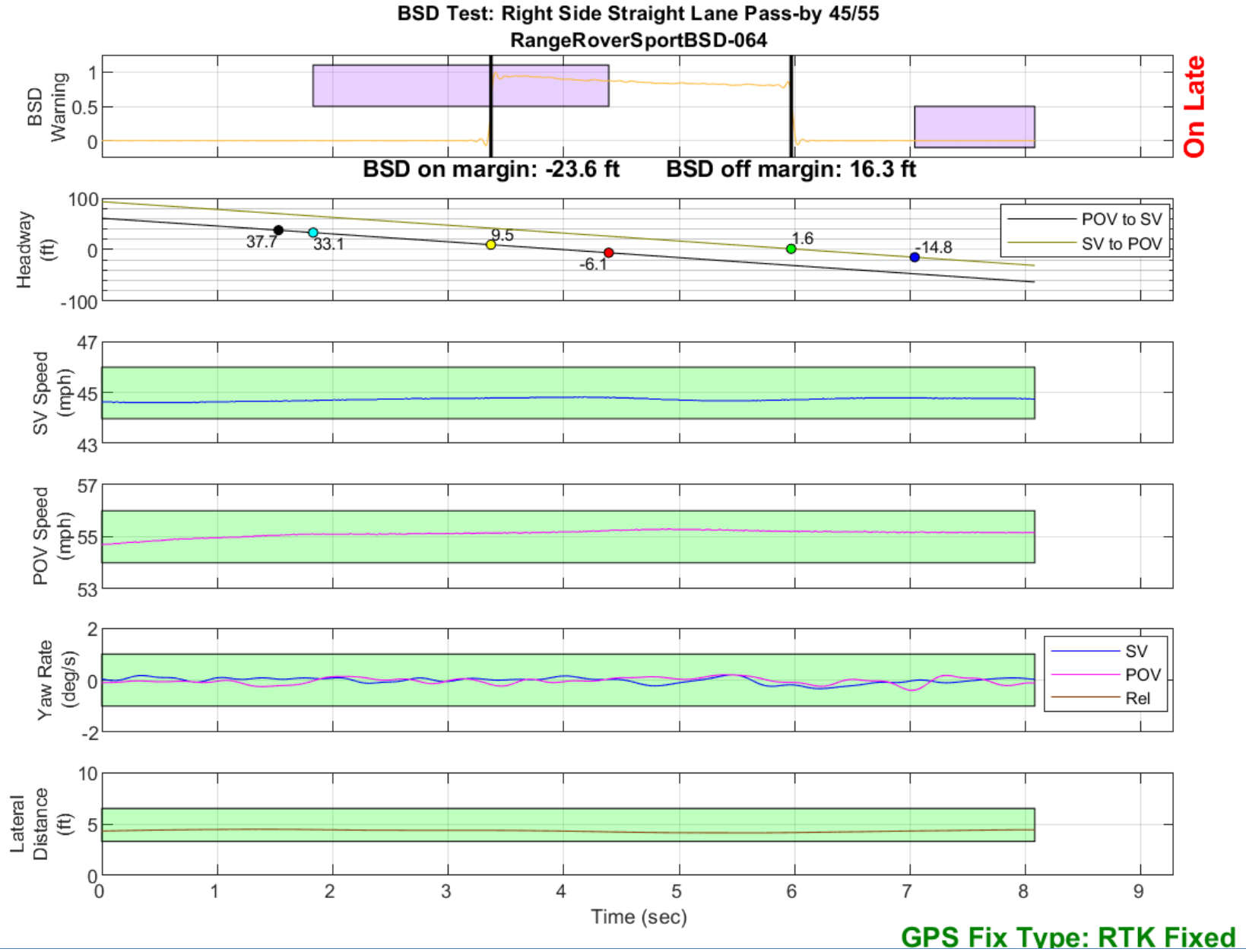


Figure D42. BSD Run 64, Straight Lane Pass-by, SV 45 mph, POV 55 mph

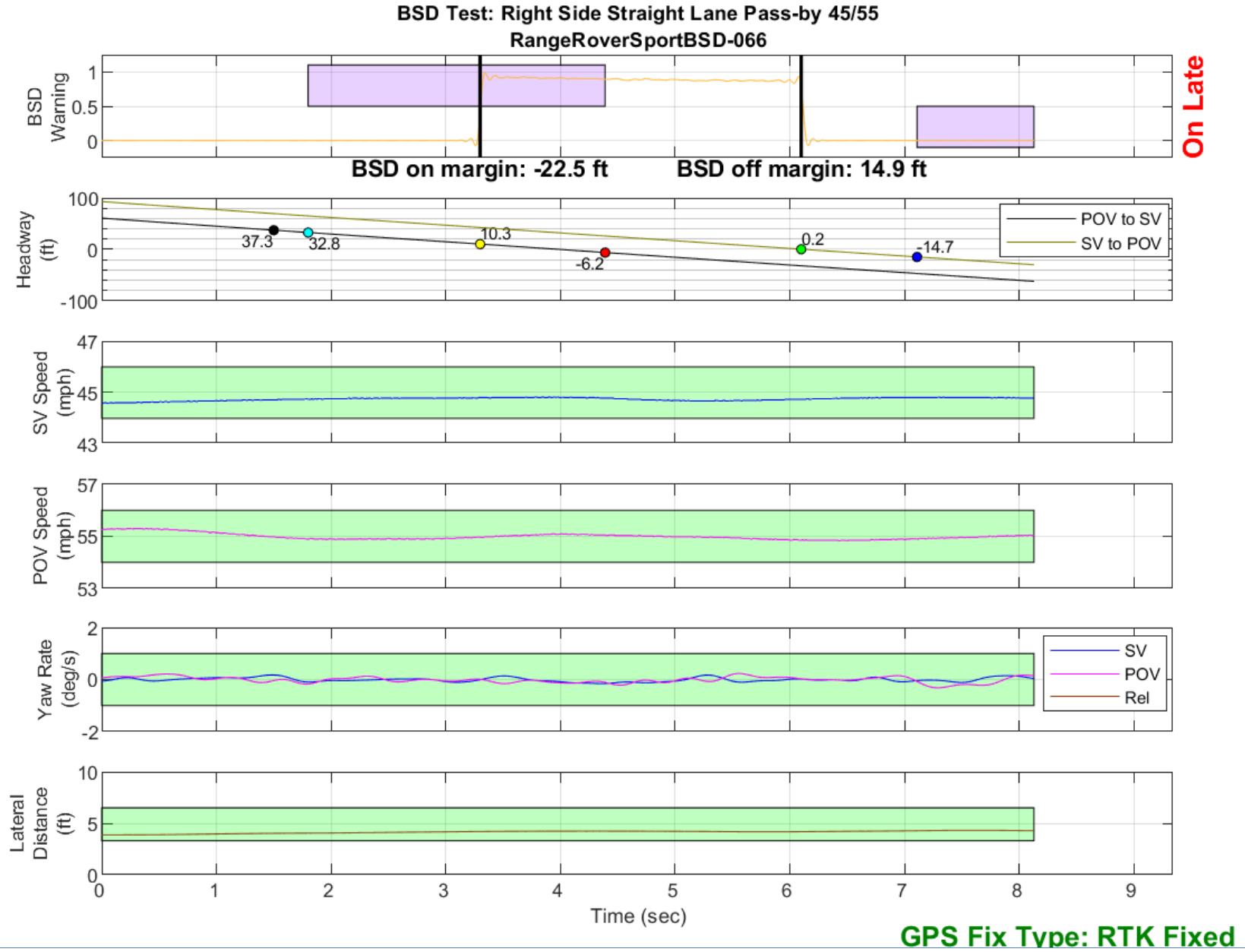


Figure D43. BSD Run 66, Straight Lane Pass-by, SV 45 mph, POV 55 mph

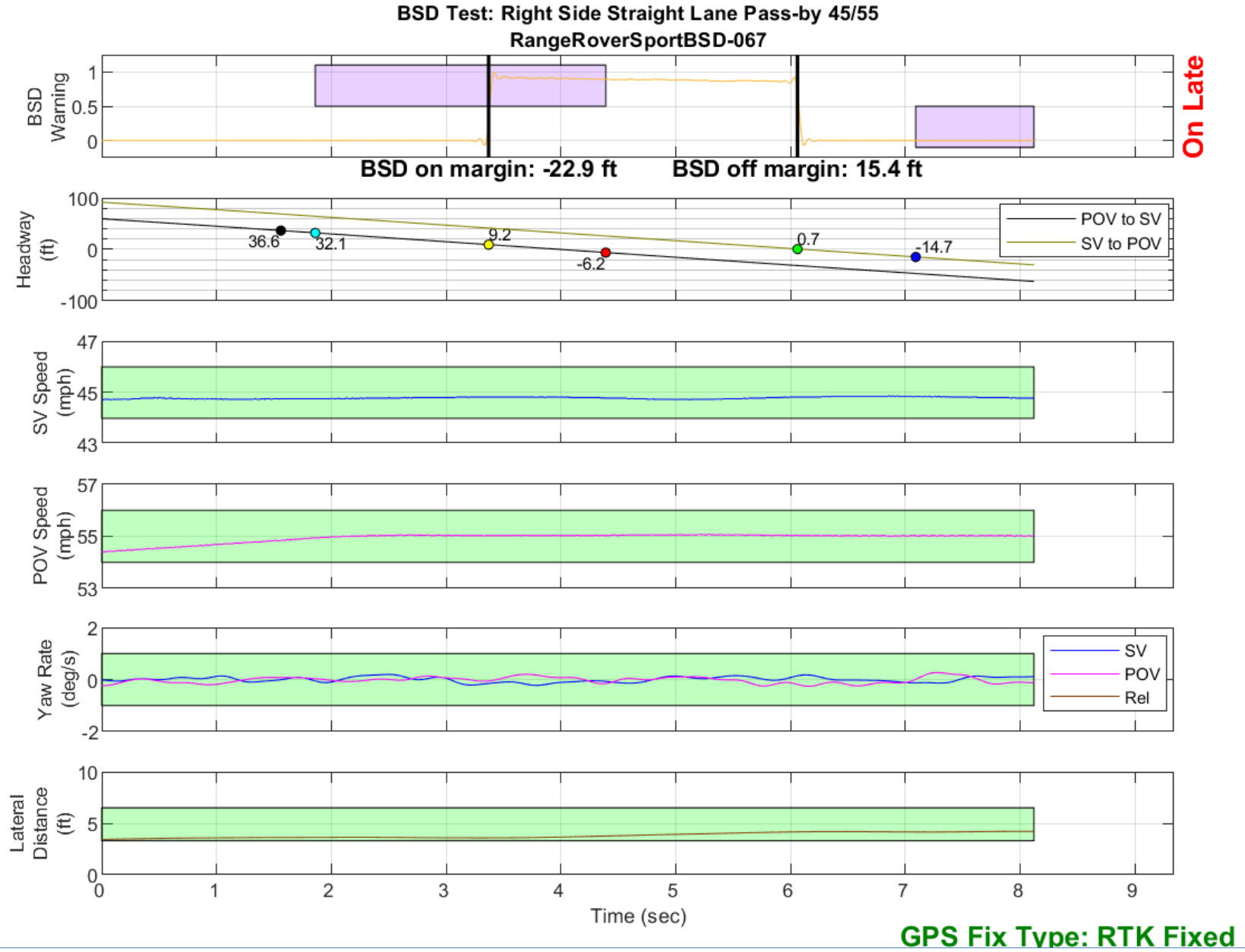


Figure D44. BSD Run 67, Straight Lane Pass-by, SV 45 mph, POV 55 mph

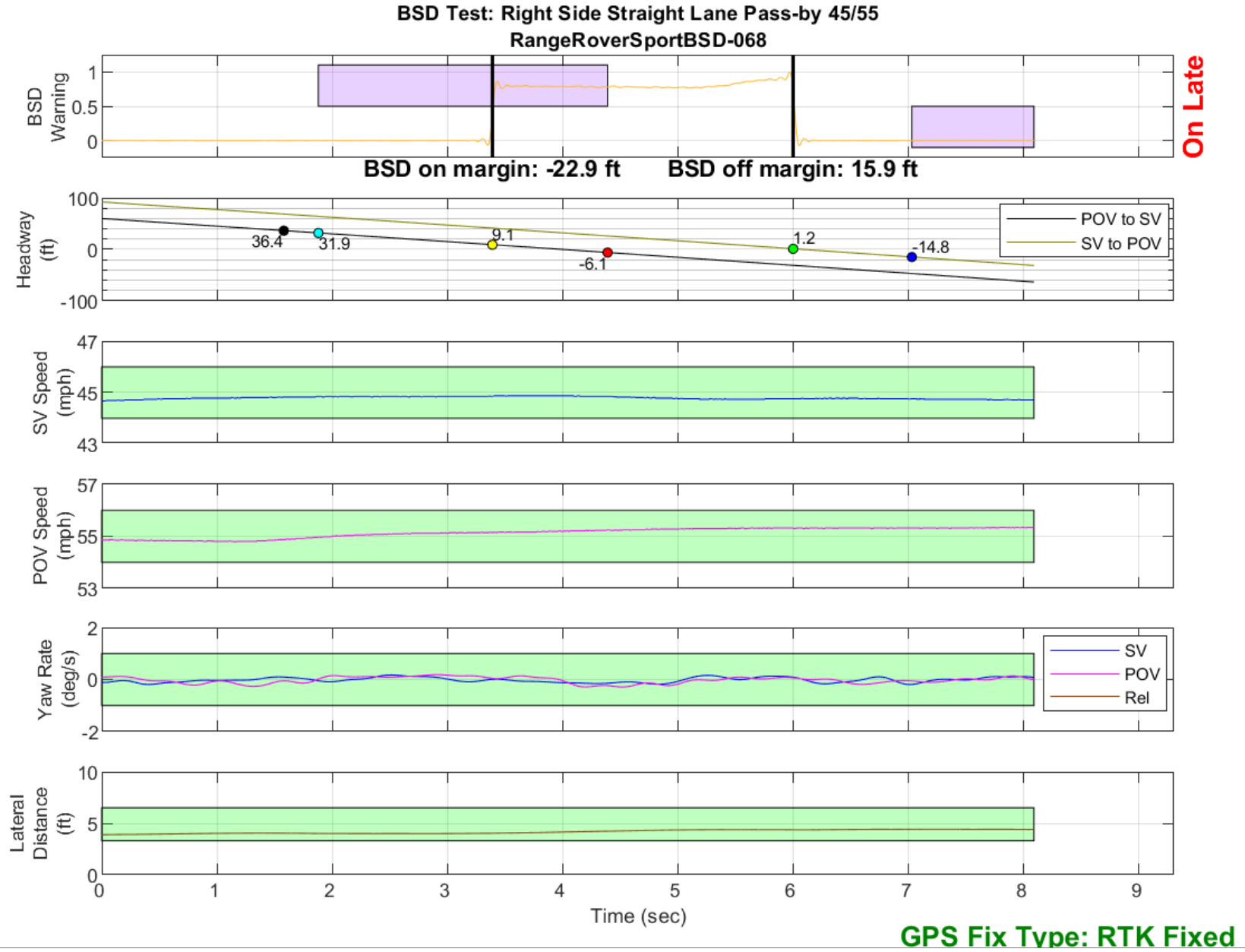


Figure D45. BSD Run 68, Straight Lane Pass-by, SV 45 mph, POV 55 mph

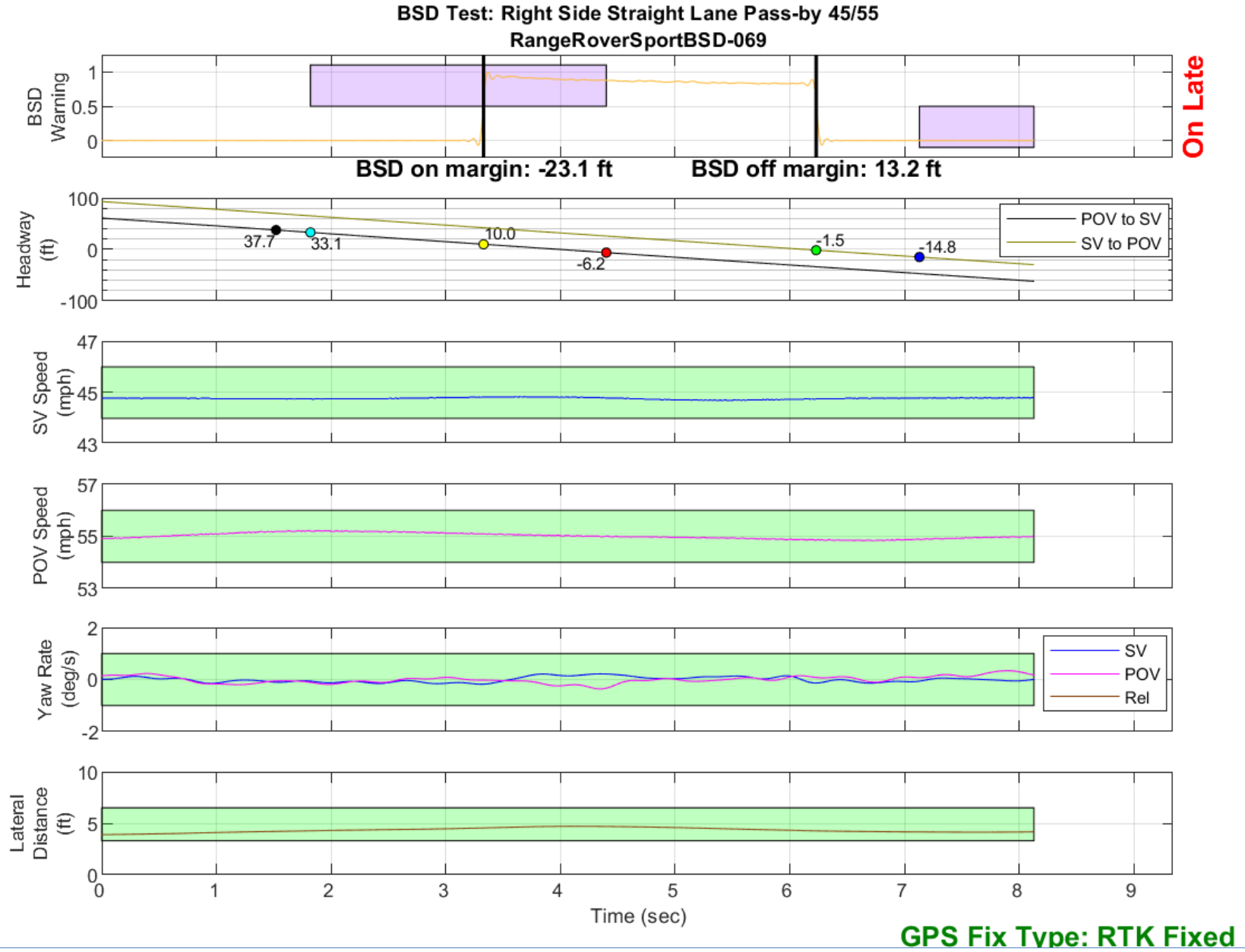


Figure D46. BSD Run 69, Straight Lane Pass-by, SV 45 mph, POV 55 mph

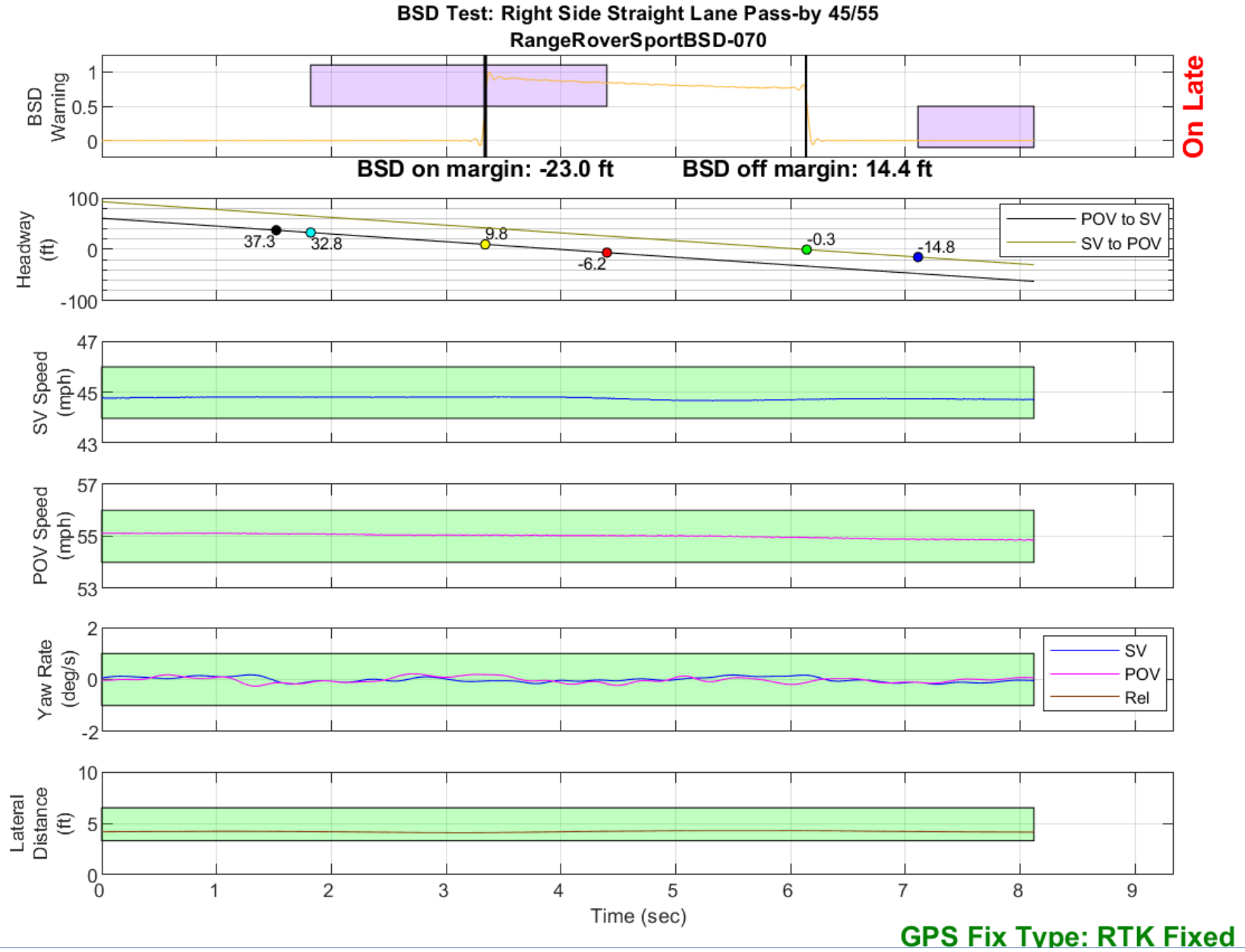


Figure D47. BSD Run 70, Straight Lane Pass-by, SV 45 mph, POV 55 mph

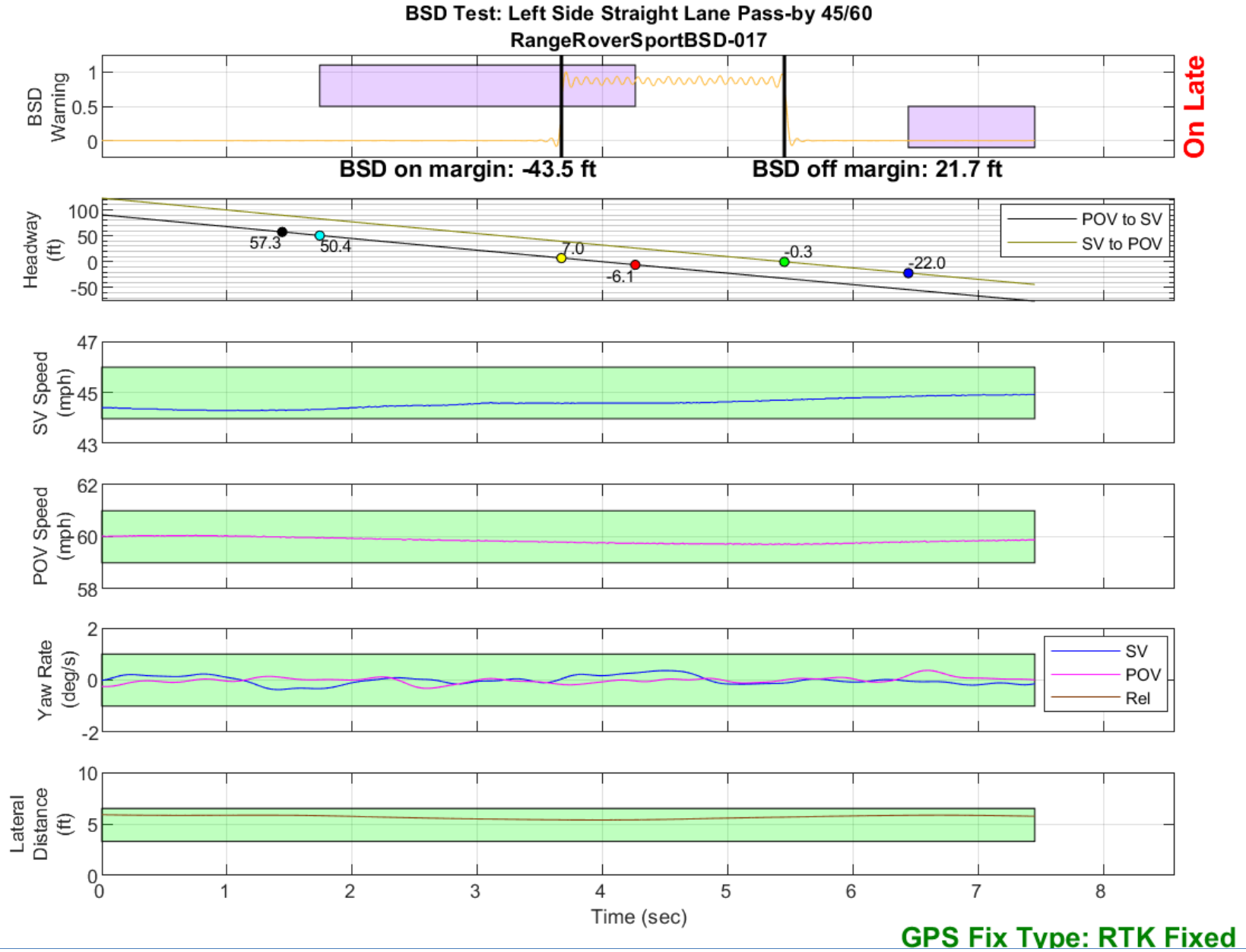


Figure D48. BSD Run 17, Straight Lane Pass-by, SV 45 mph, POV 60 mph

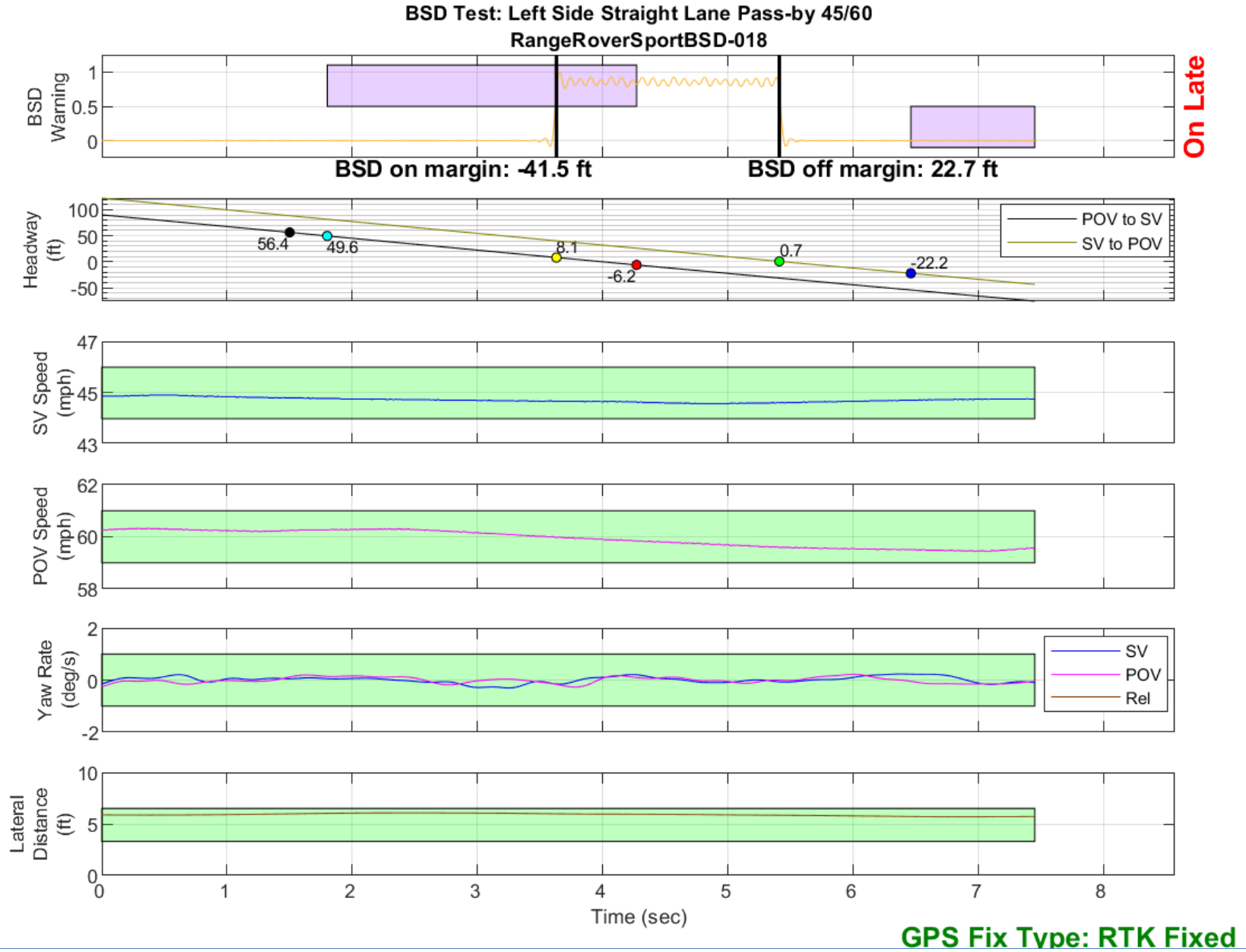


Figure D49. BSD Run 18, Straight Lane Pass-by, SV 45 mph, POV 60 mph

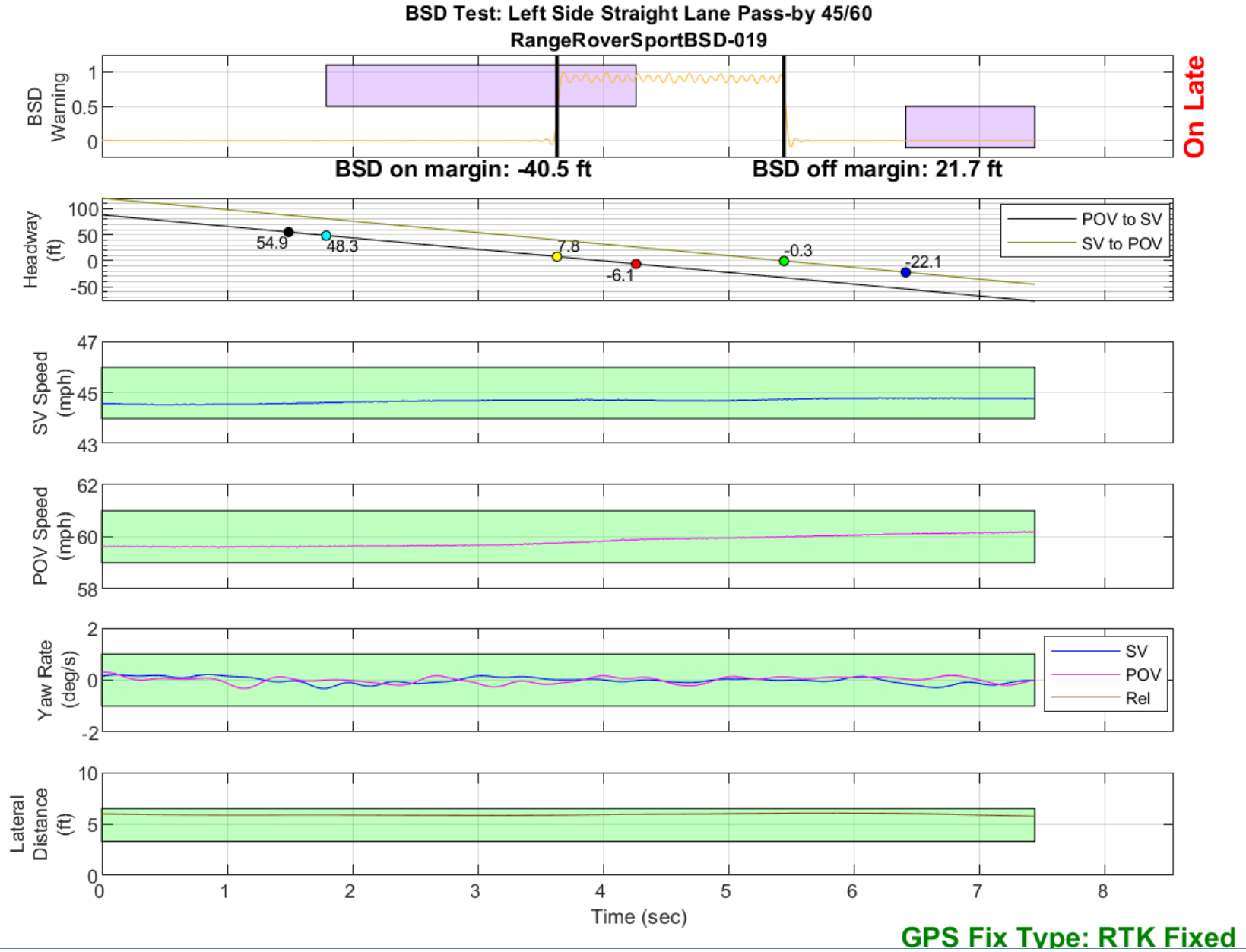


Figure D50. BSD Run 19, Straight Lane Pass-by, SV 45 mph, POV 60 mph

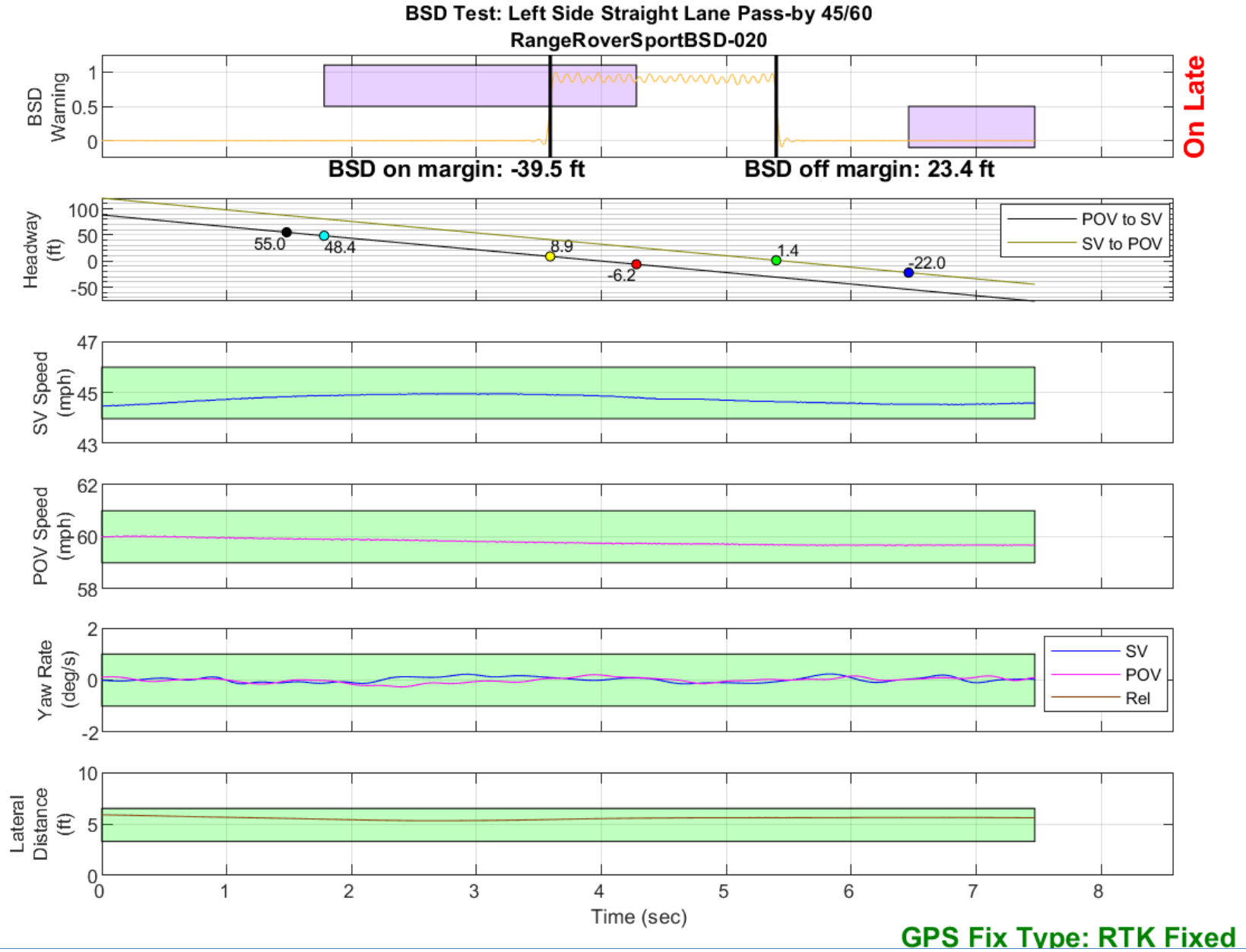


Figure D51. BSD Run 20, Straight Lane Pass-by, SV 45 mph, POV 60 mph

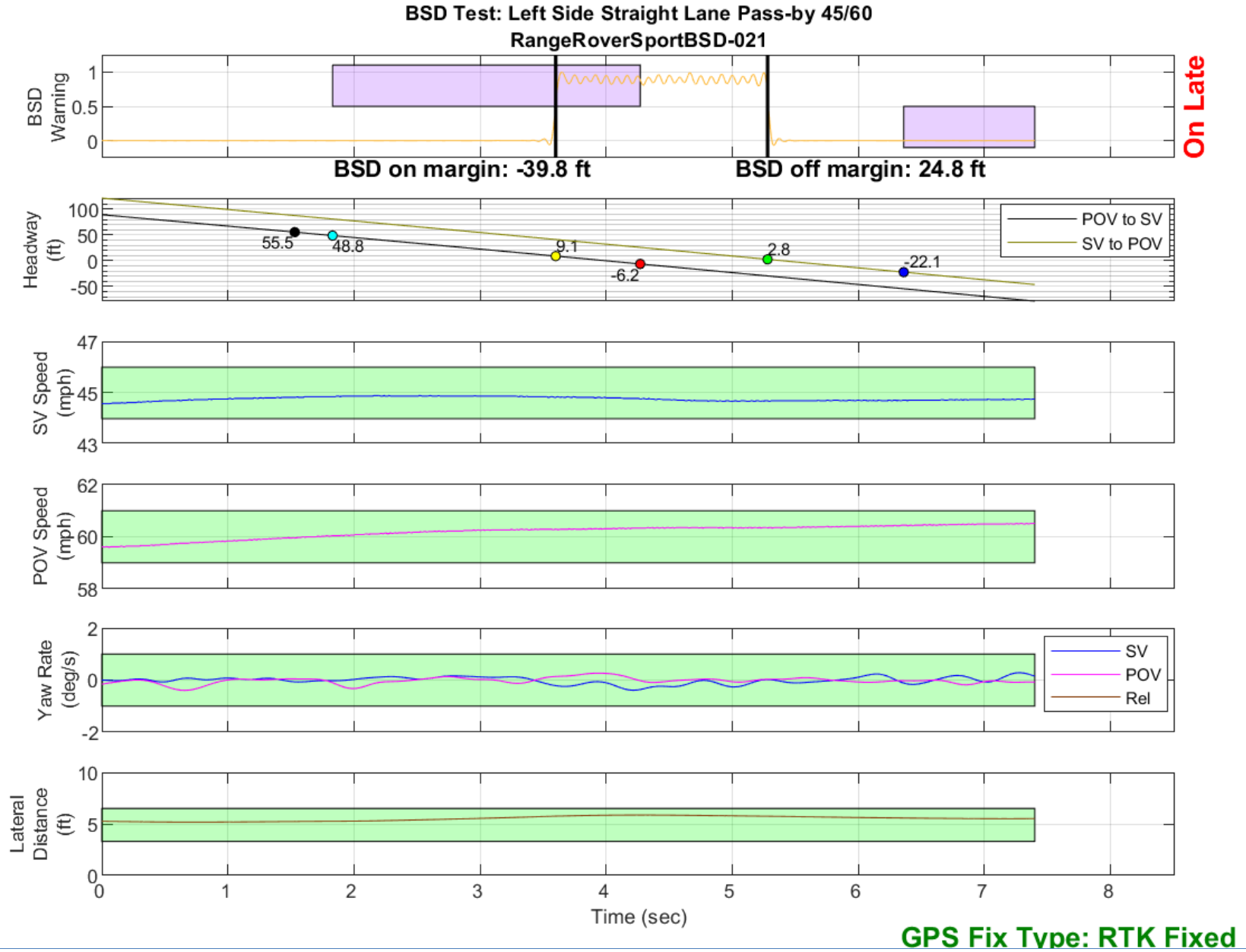


Figure D52. BSD Run 21, Straight Lane Pass-by, SV 45 mph, POV 60 mph

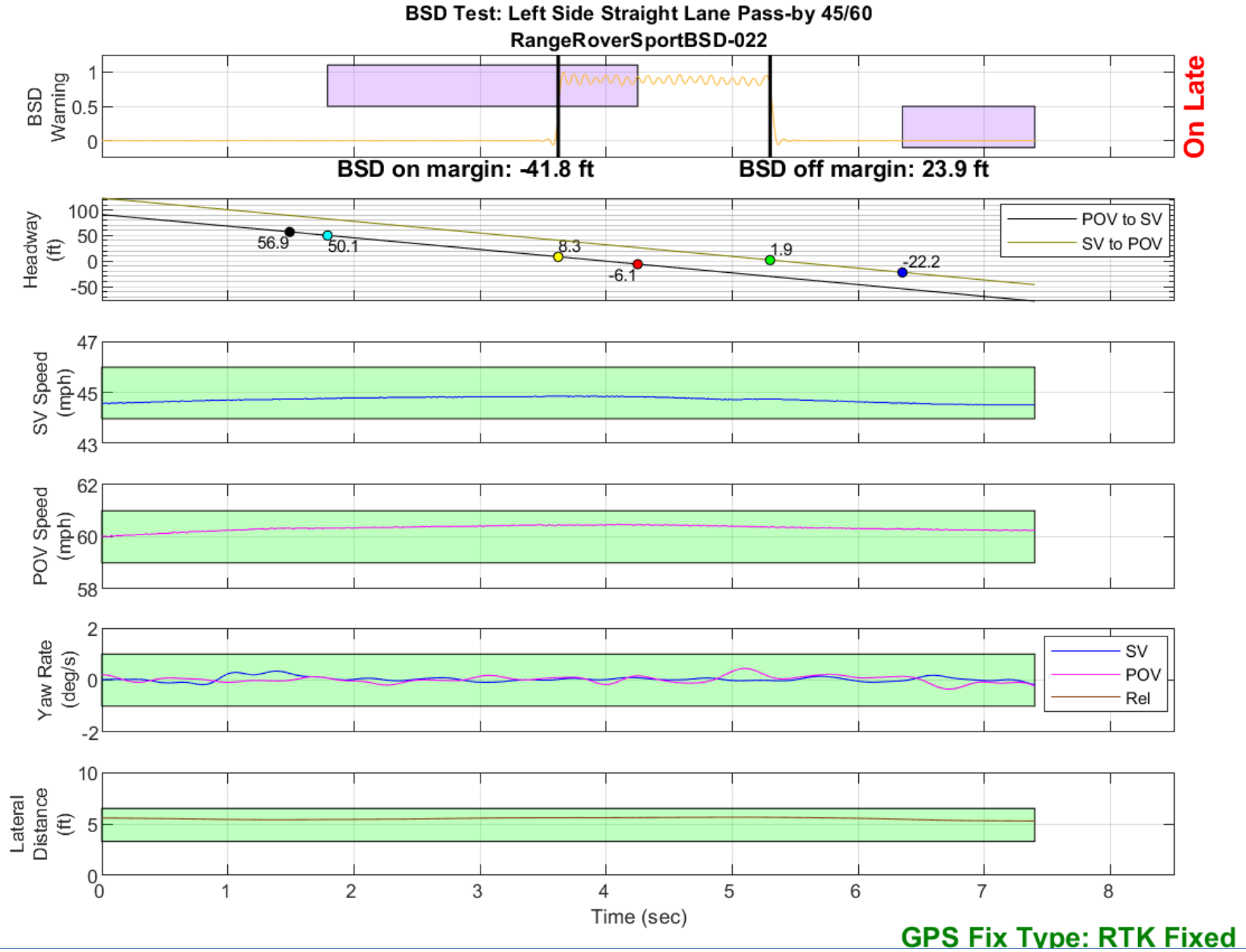


Figure D53. BSD Run 22, Straight Lane Pass-by, SV 45 mph, POV 60 mph

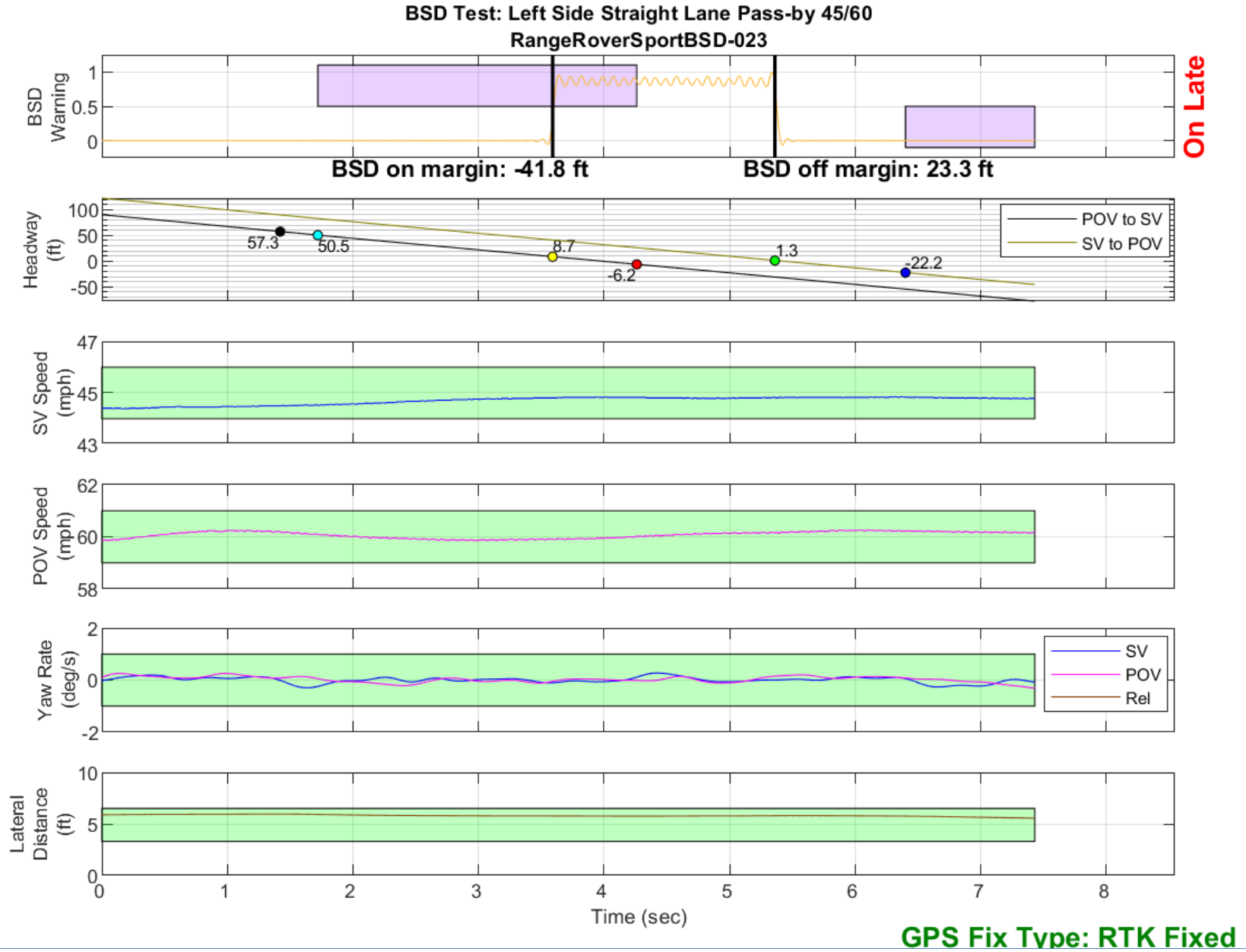


Figure D54. BSD Run 23, Straight Lane Pass-by, SV 45 mph, POV 60 mph

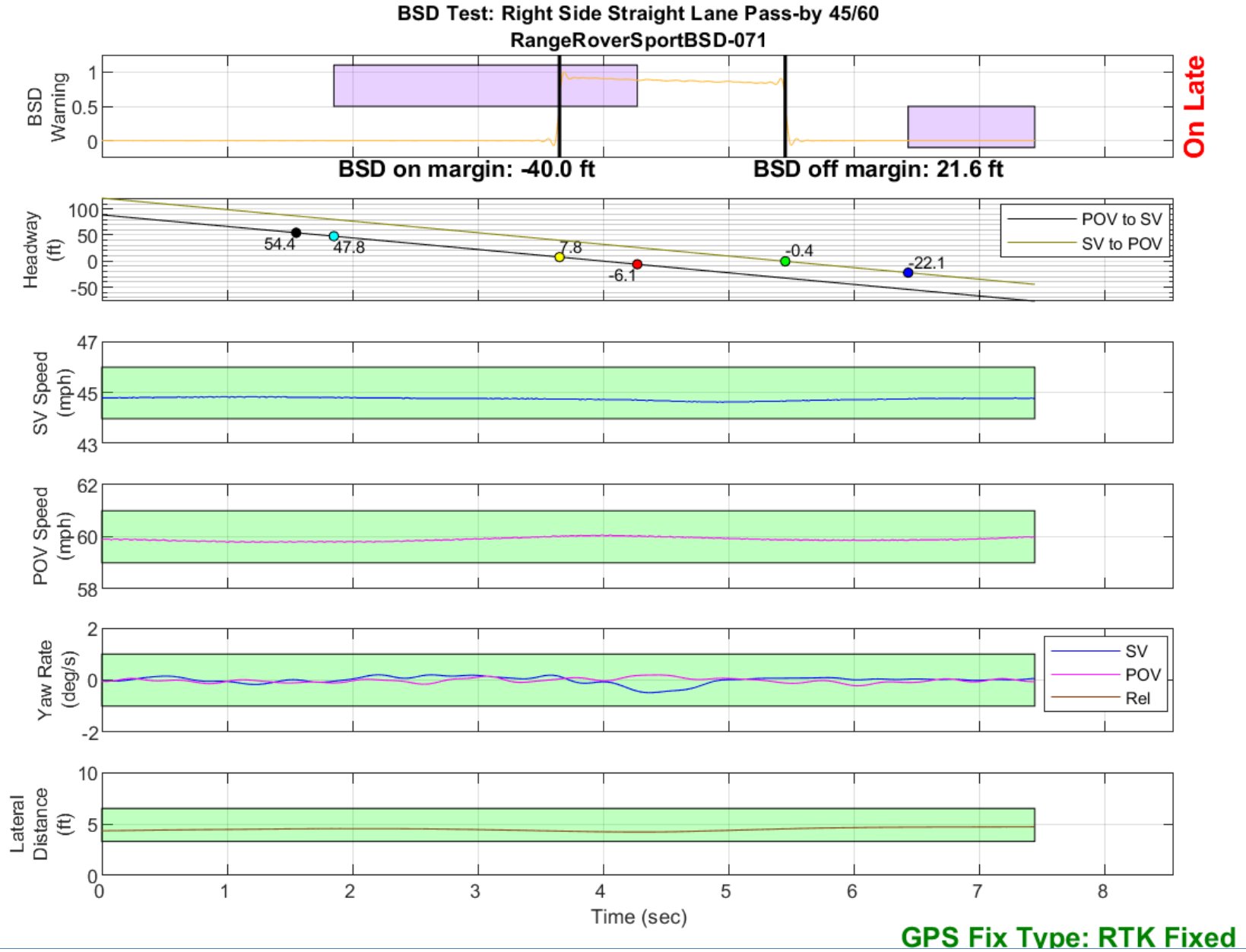


Figure D55. BSD Run 71, Straight Lane Pass-by, SV 45 mph, POV 60 mph

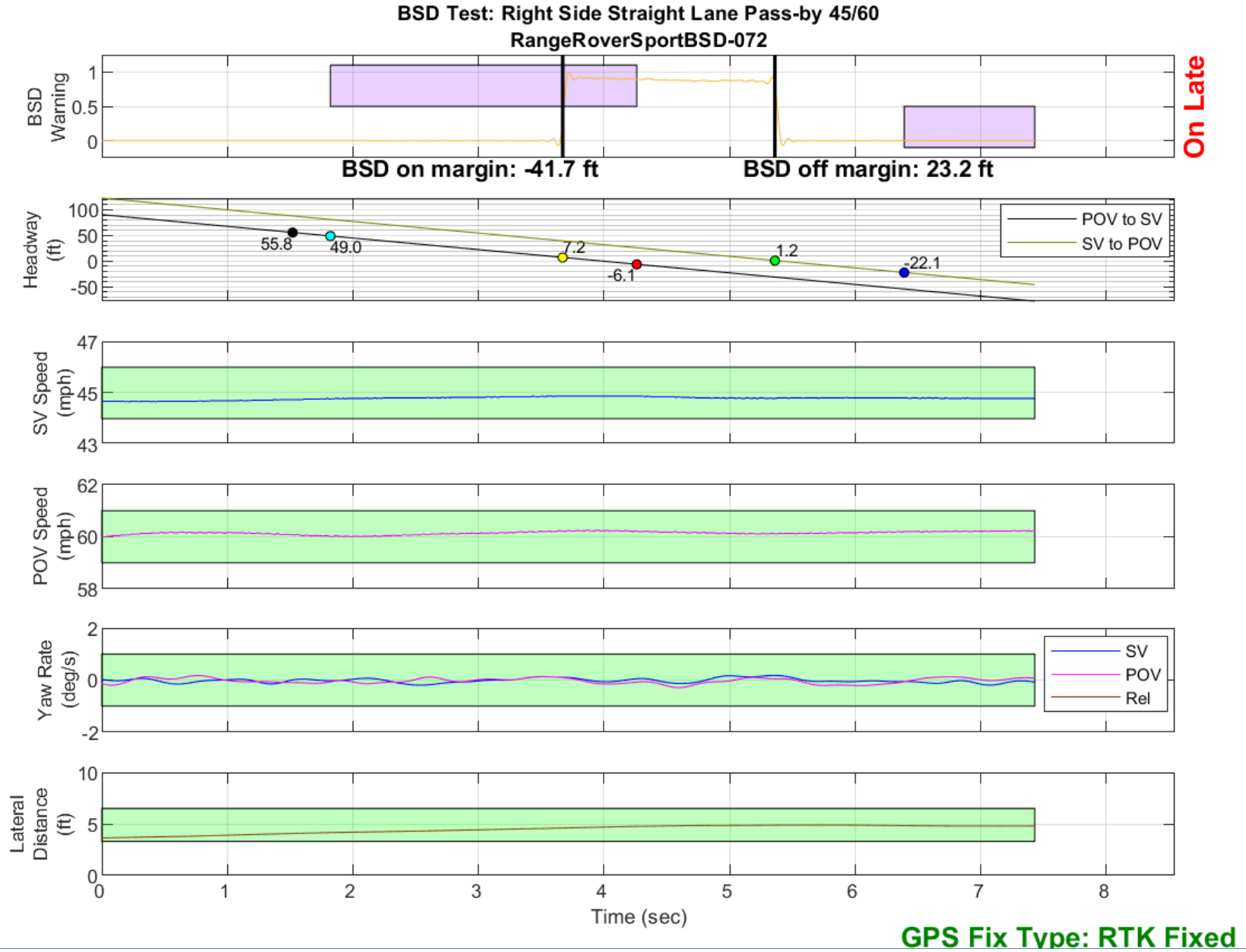


Figure D56. BSD Run 72, Straight Lane Pass-by, SV 45 mph, POV 60 mph

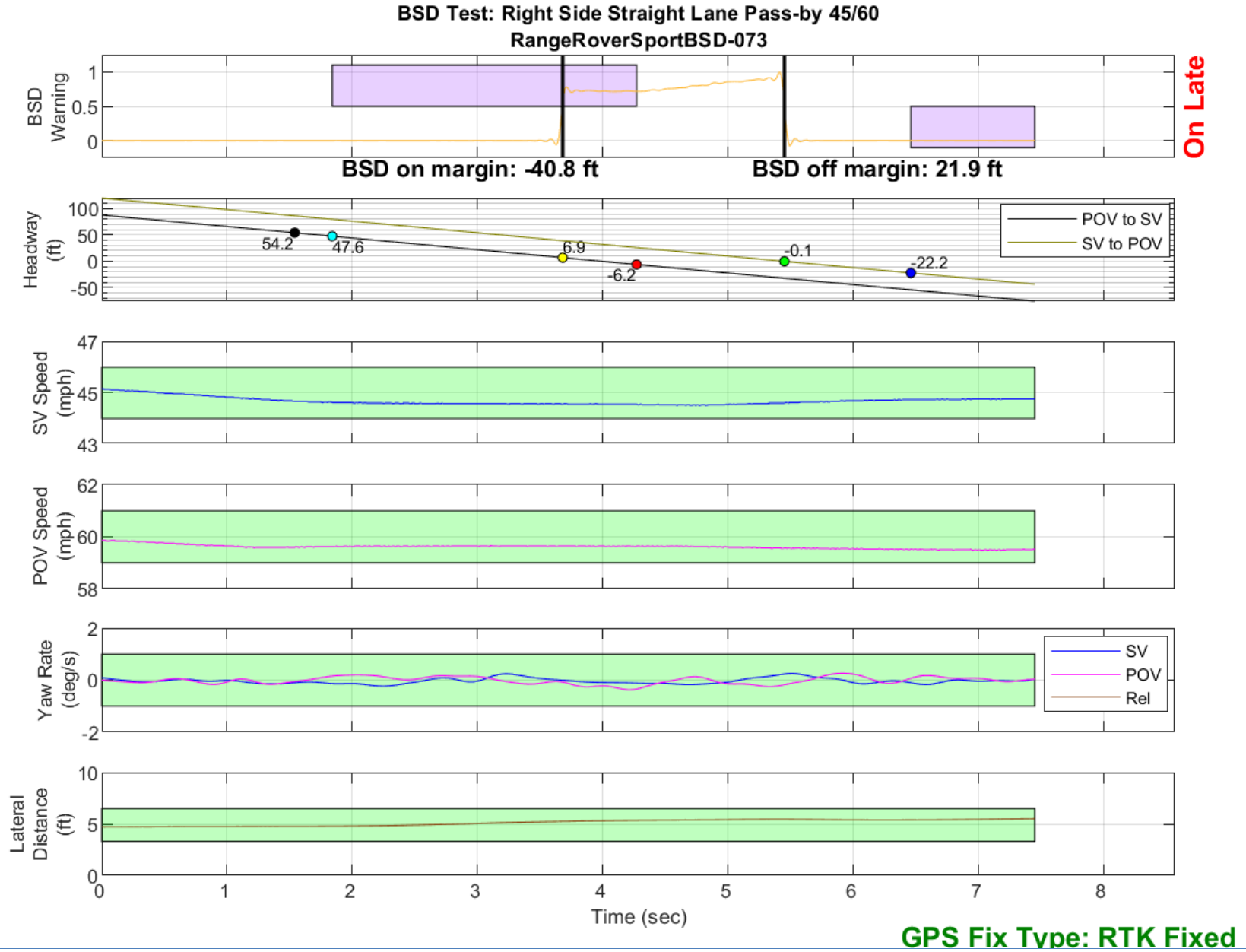


Figure D57. BSD Run 73, Straight Lane Pass-by, SV 45 mph, POV 60 mph

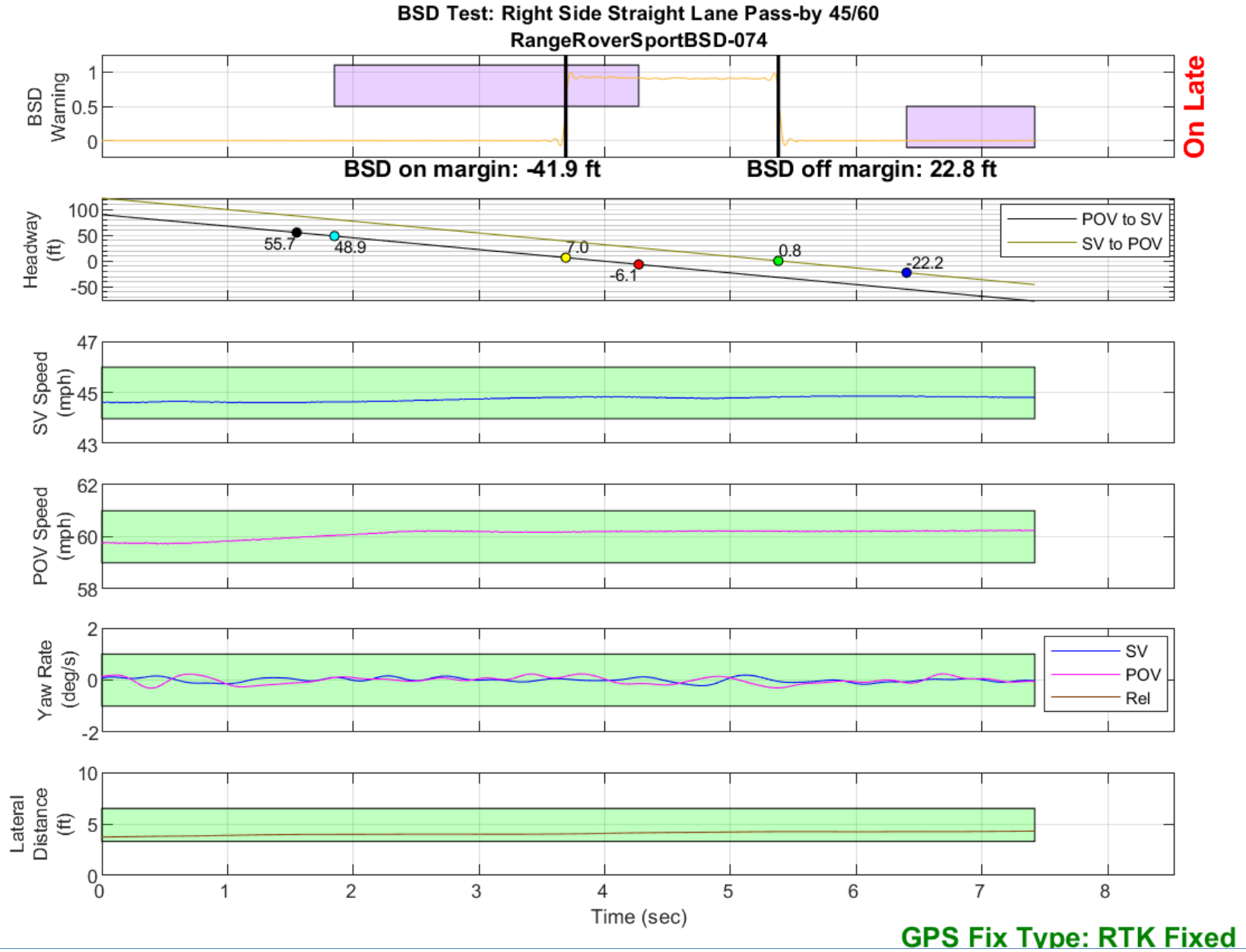


Figure D58. BSD Run 74, Straight Lane Pass-by, SV 45 mph, POV 60 mph

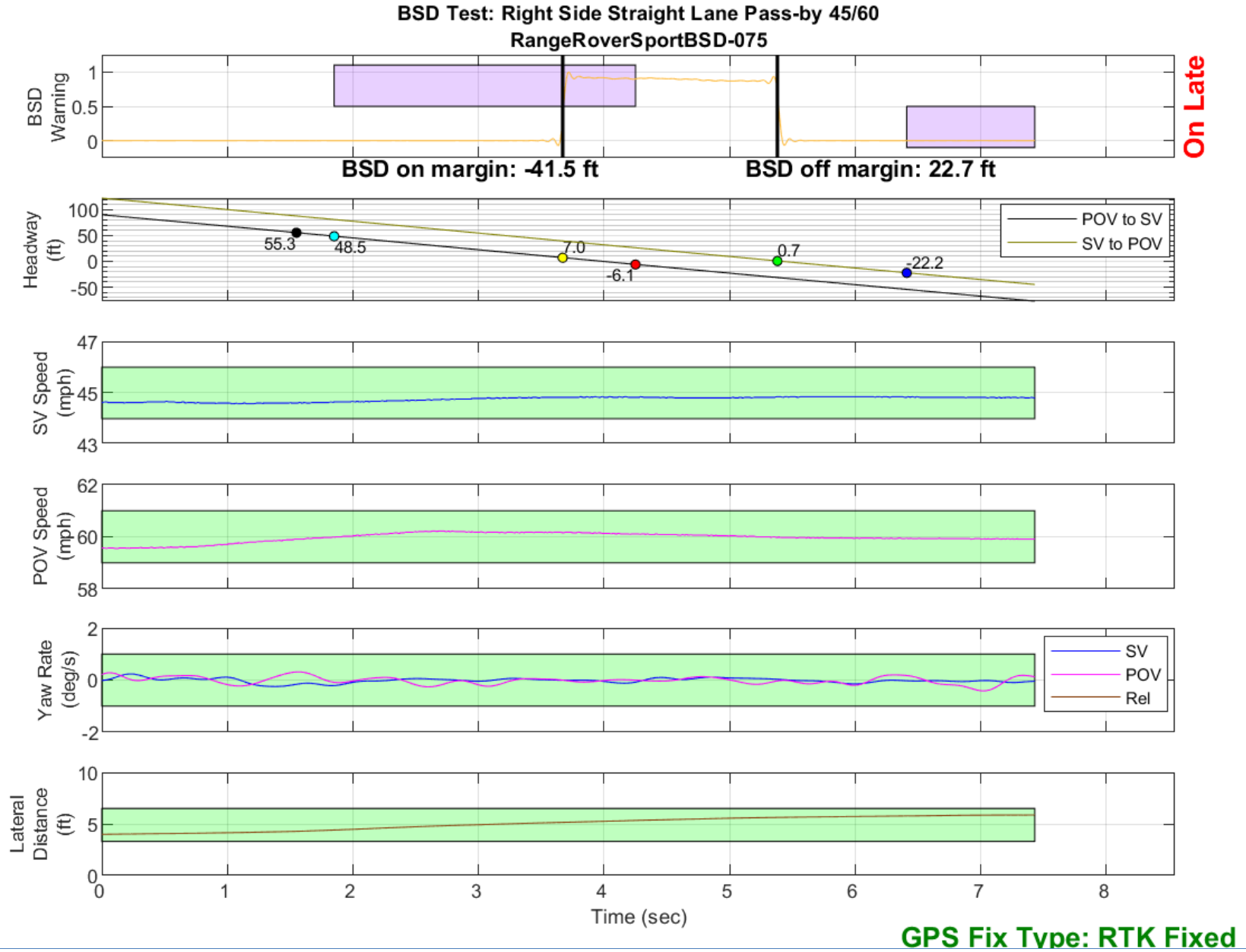


Figure D59. BSD Run 75, Straight Lane Pass-by, SV 45 mph, POV 60 mph

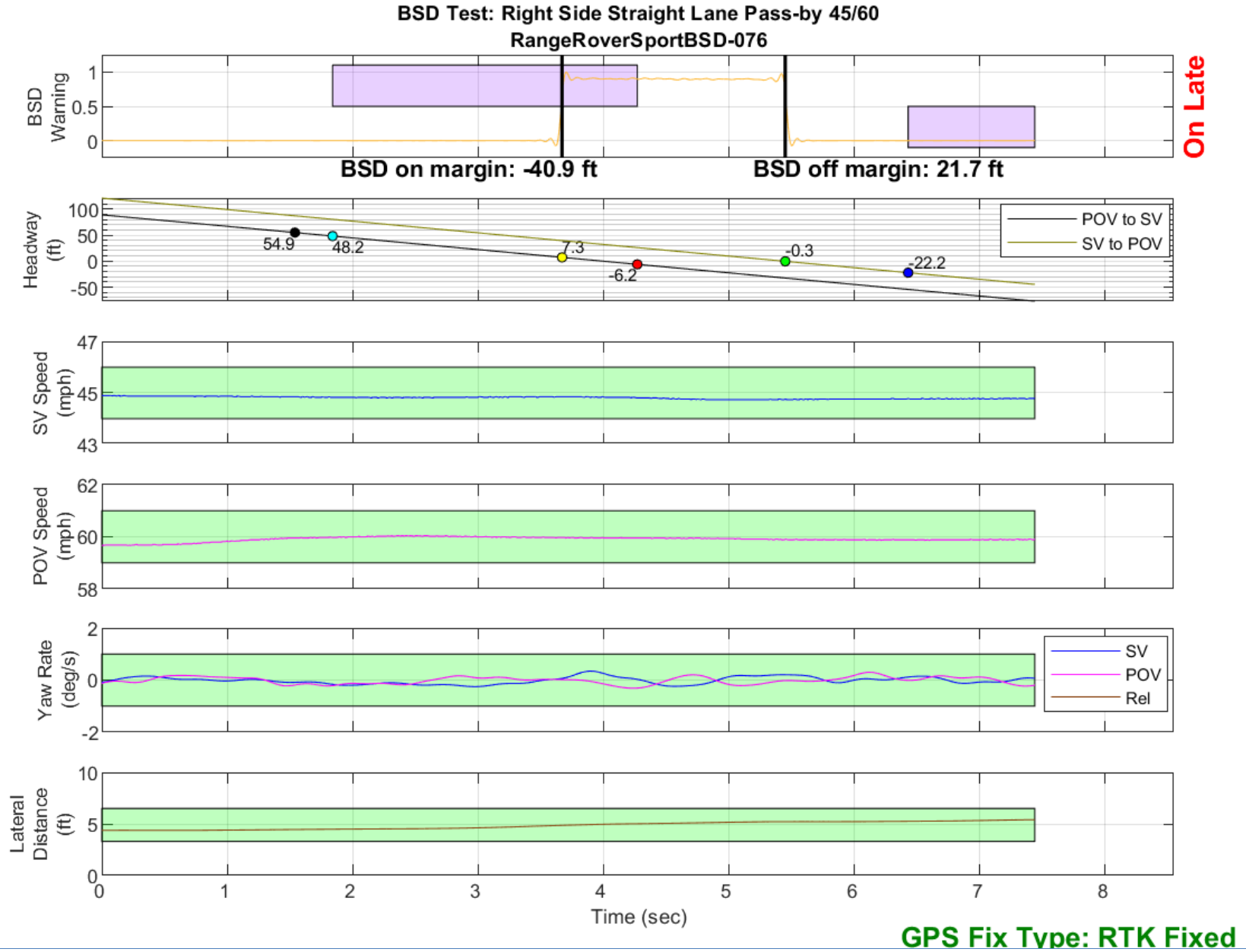


Figure D60. BSD Run 76, Straight Lane Pass-by, SV 45 mph, POV 60 mph

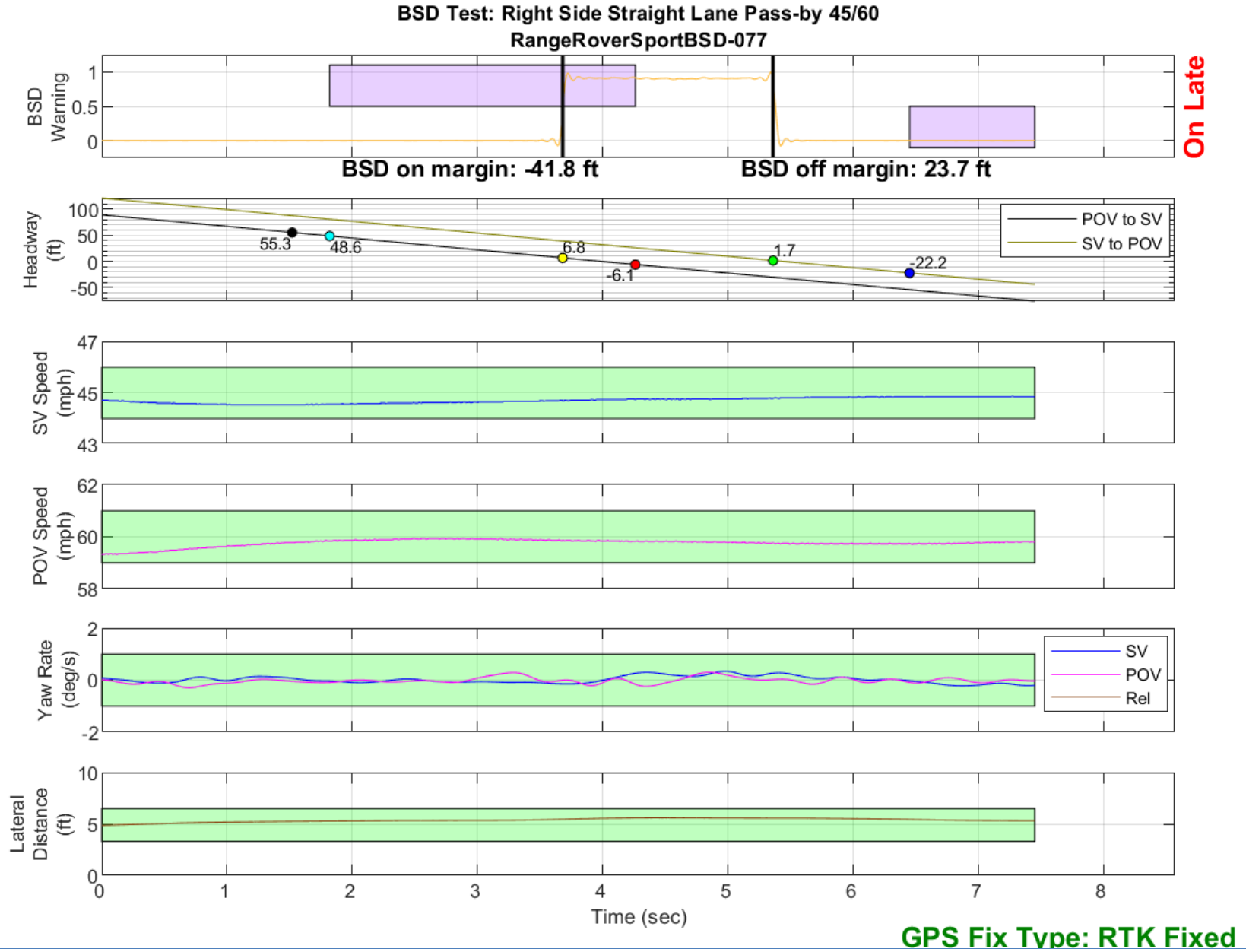


Figure D61. BSD Run 77, Straight Lane Pass-by, SV 45 mph, POV 60 mph

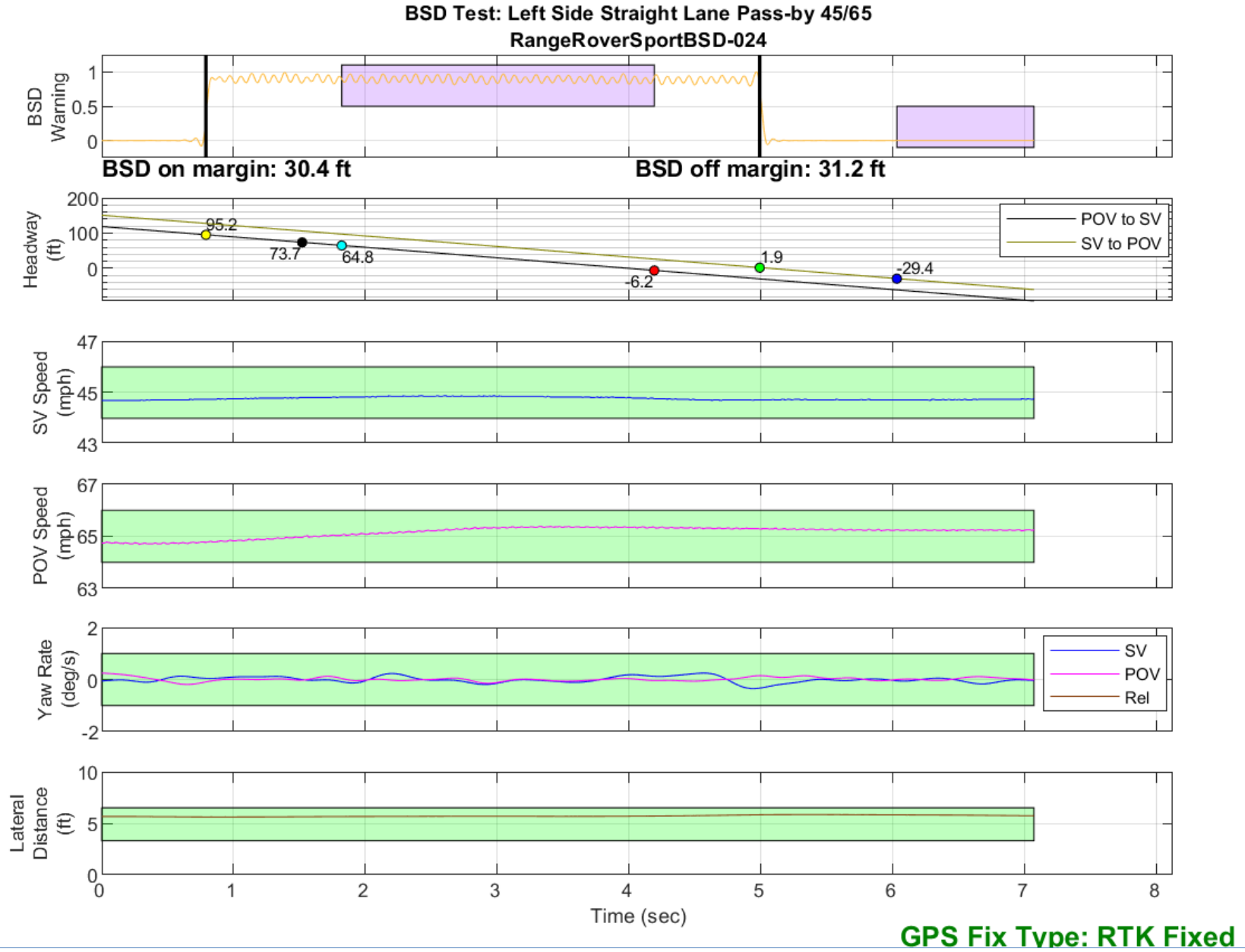


Figure D62. BSD Run 24, Straight Lane Pass-by, SV 45 mph, POV 65 mph

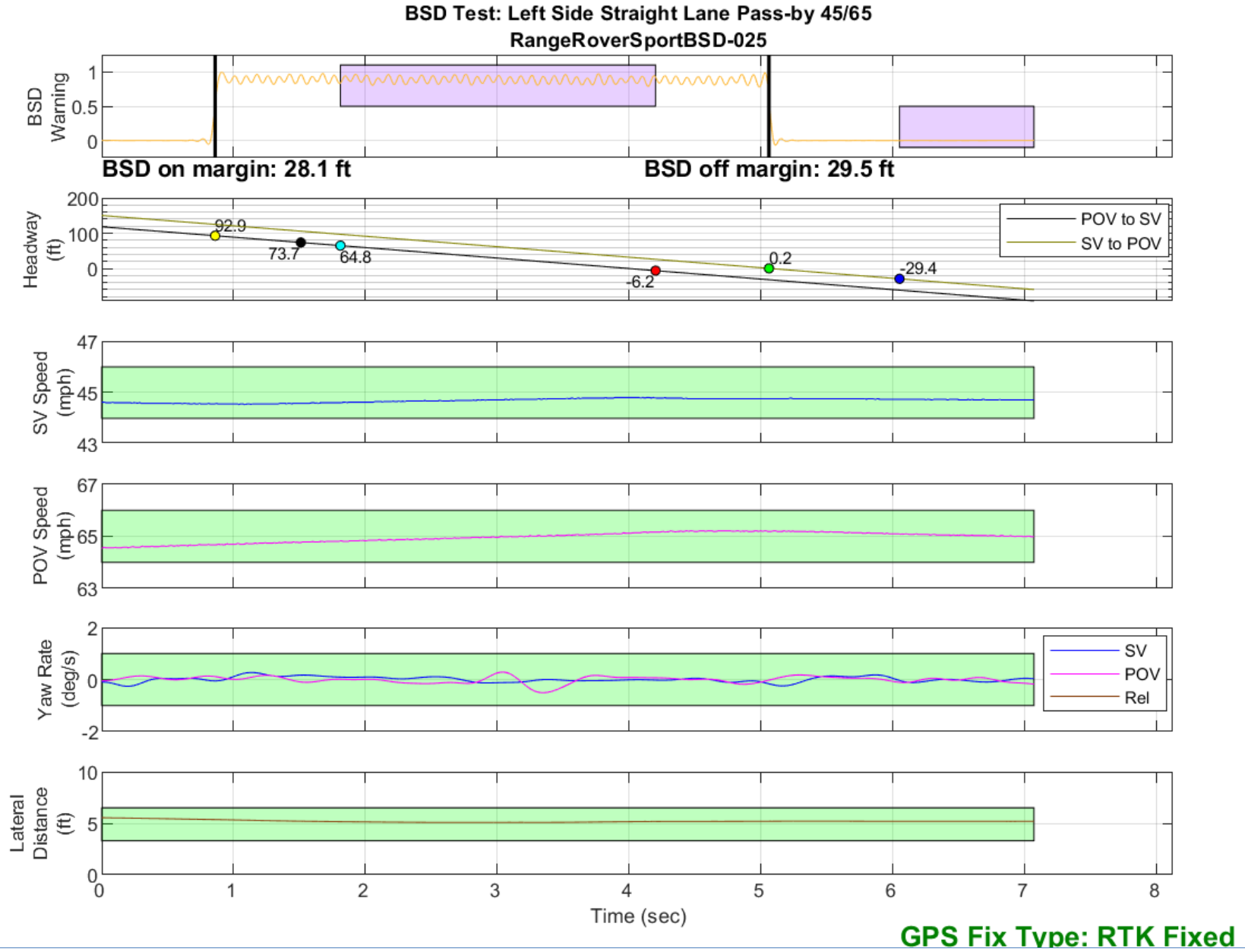


Figure D63. BSD Run 25, Straight Lane Pass-by, SV 45 mph, POV 65 mph

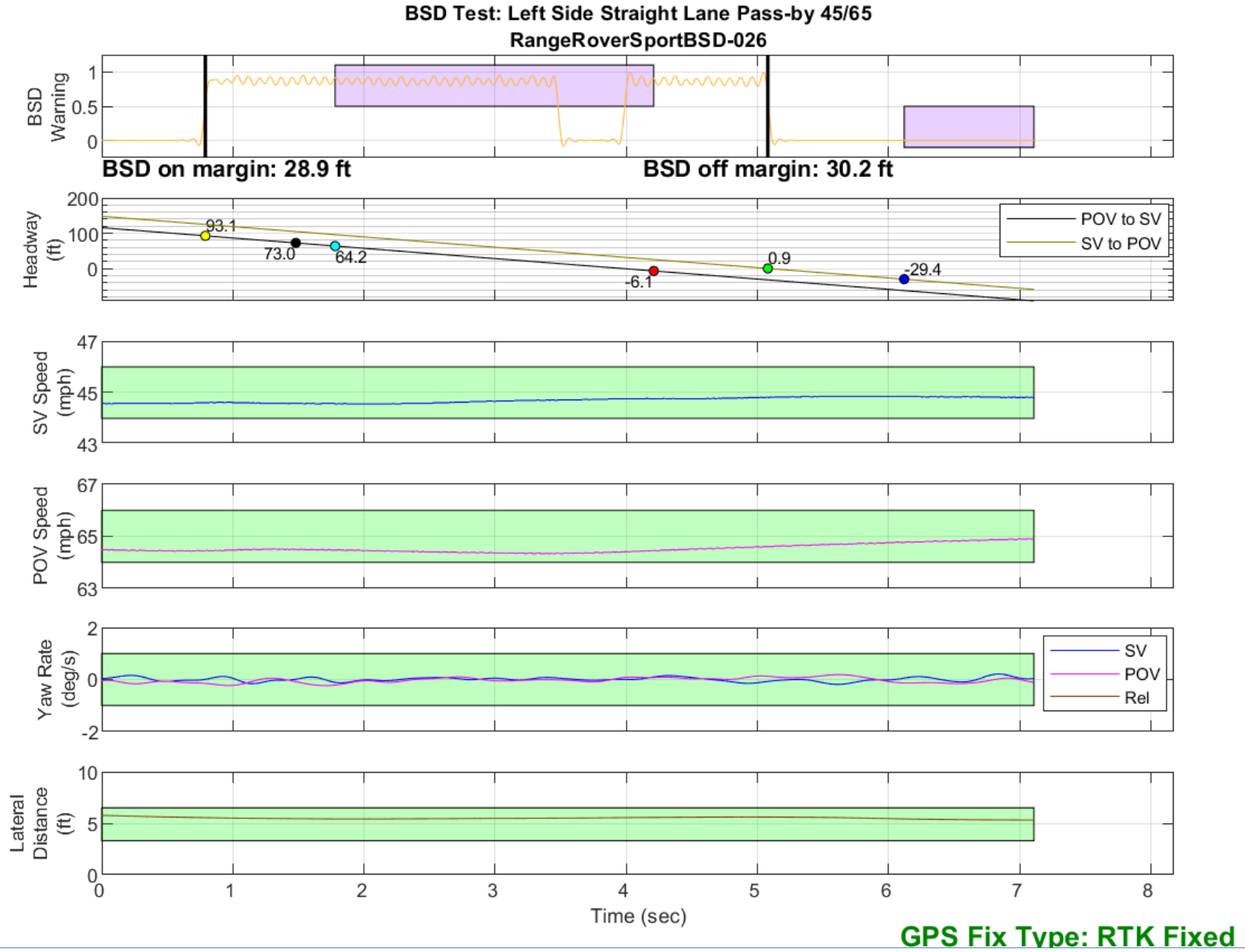


Figure D64. BSD Run 26, Straight Lane Pass-by, SV 45 mph, POV 65 mph

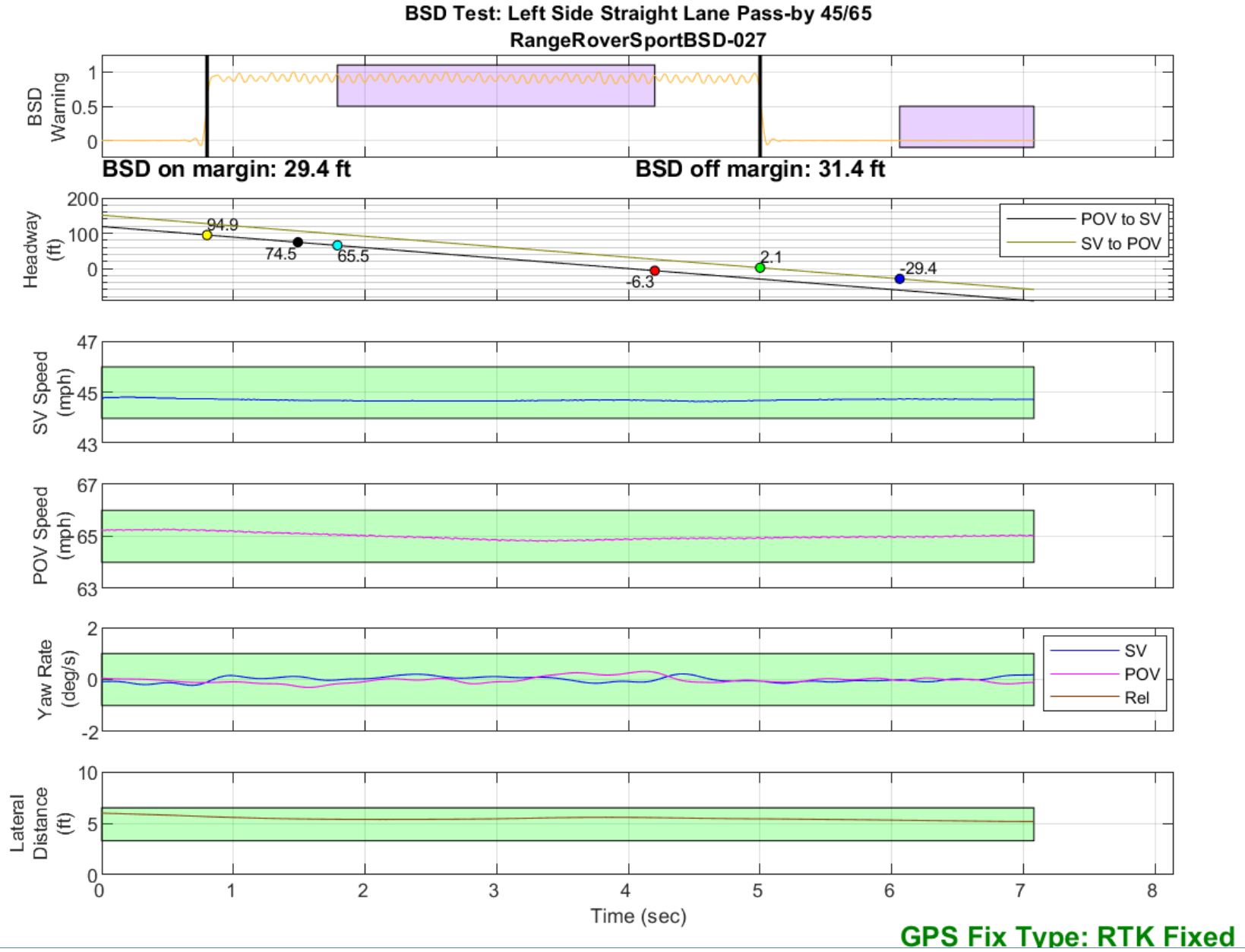


Figure D65. BSD Run 27, Straight Lane Pass-by, SV 45 mph, POV 65 mph

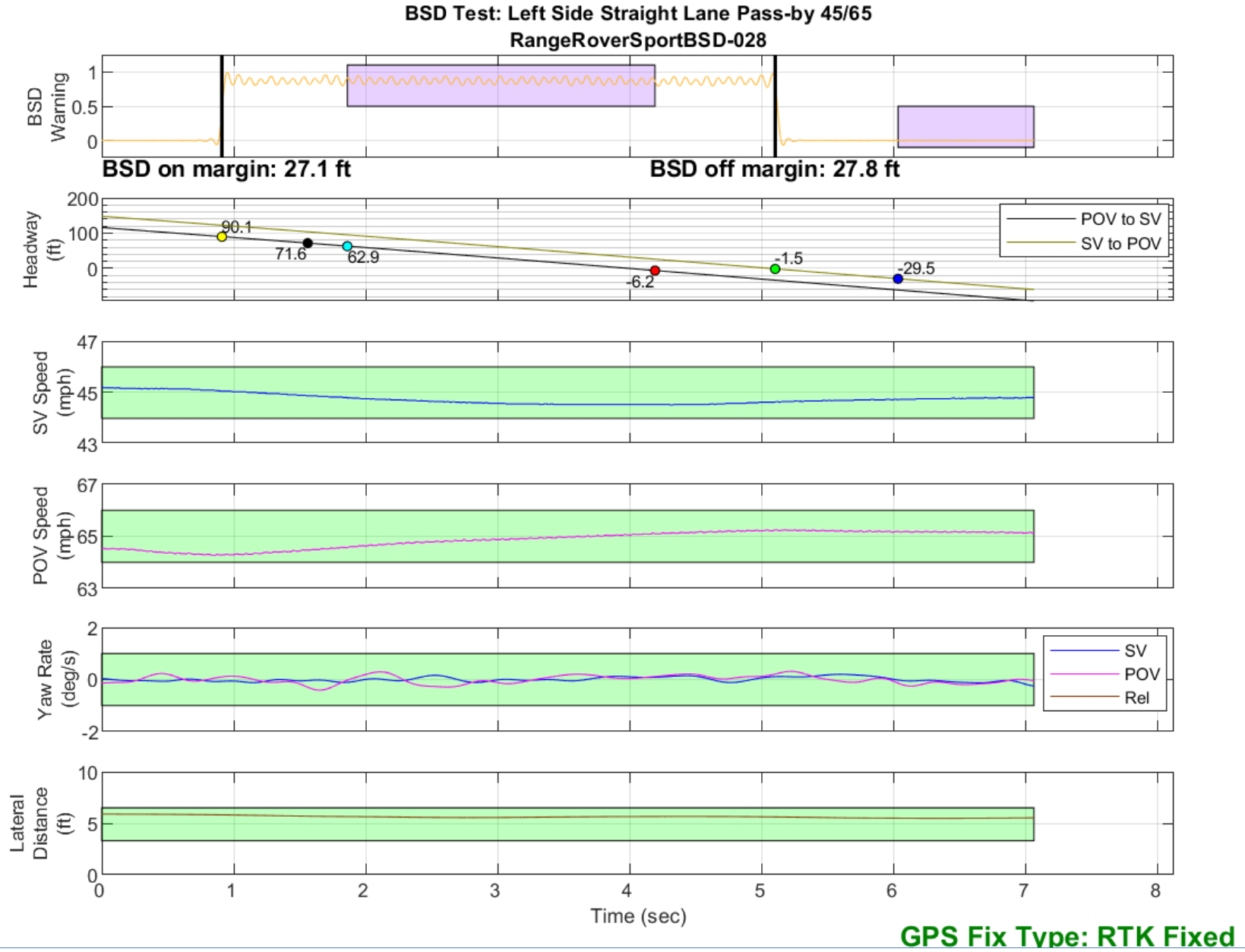


Figure D66. BSD Run 28, Straight Lane Pass-by, SV 45 mph, POV 65 mph

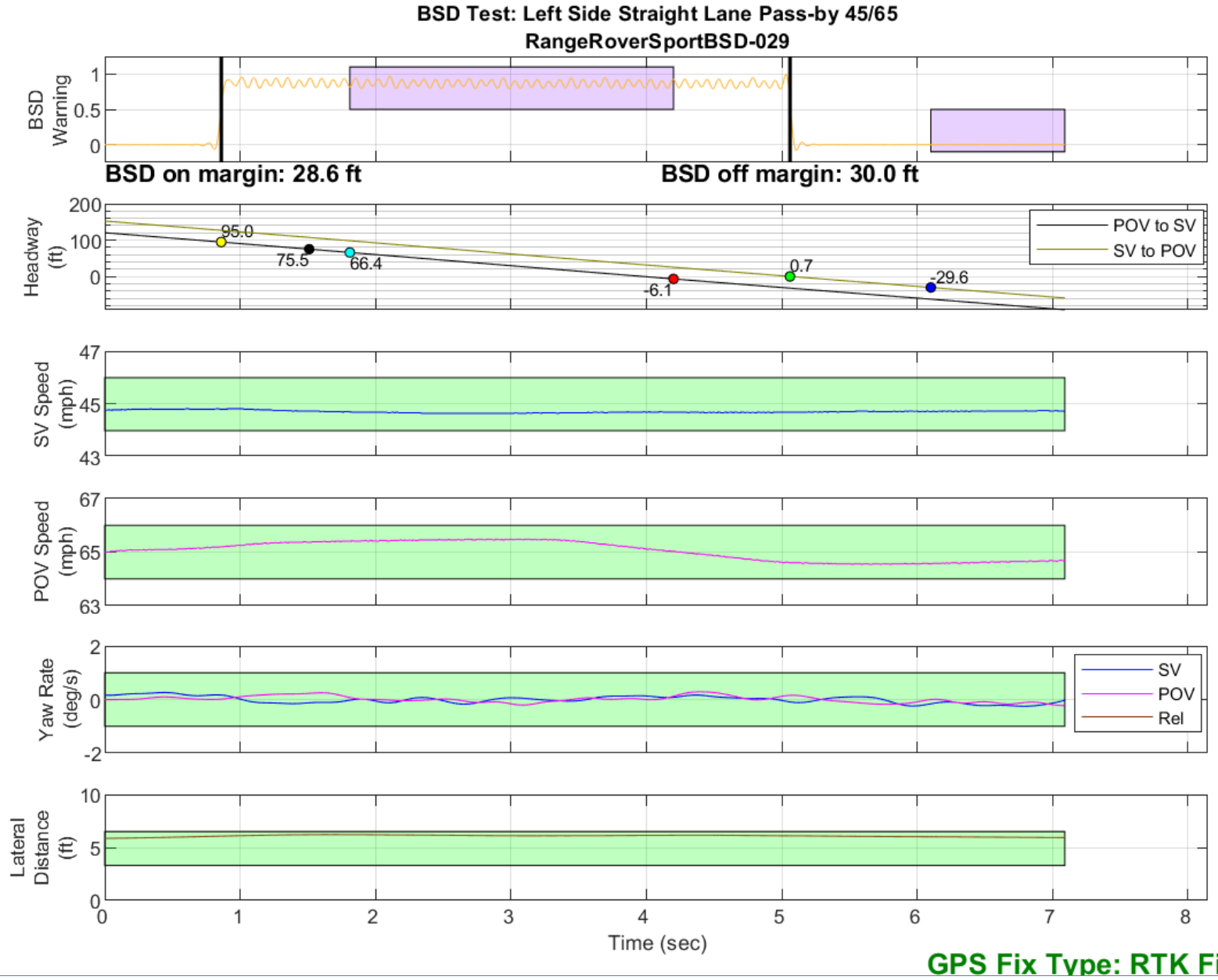


Figure D67. BSD Run 29, Straight Lane Pass-by, SV 45 mph, POV 65 mph

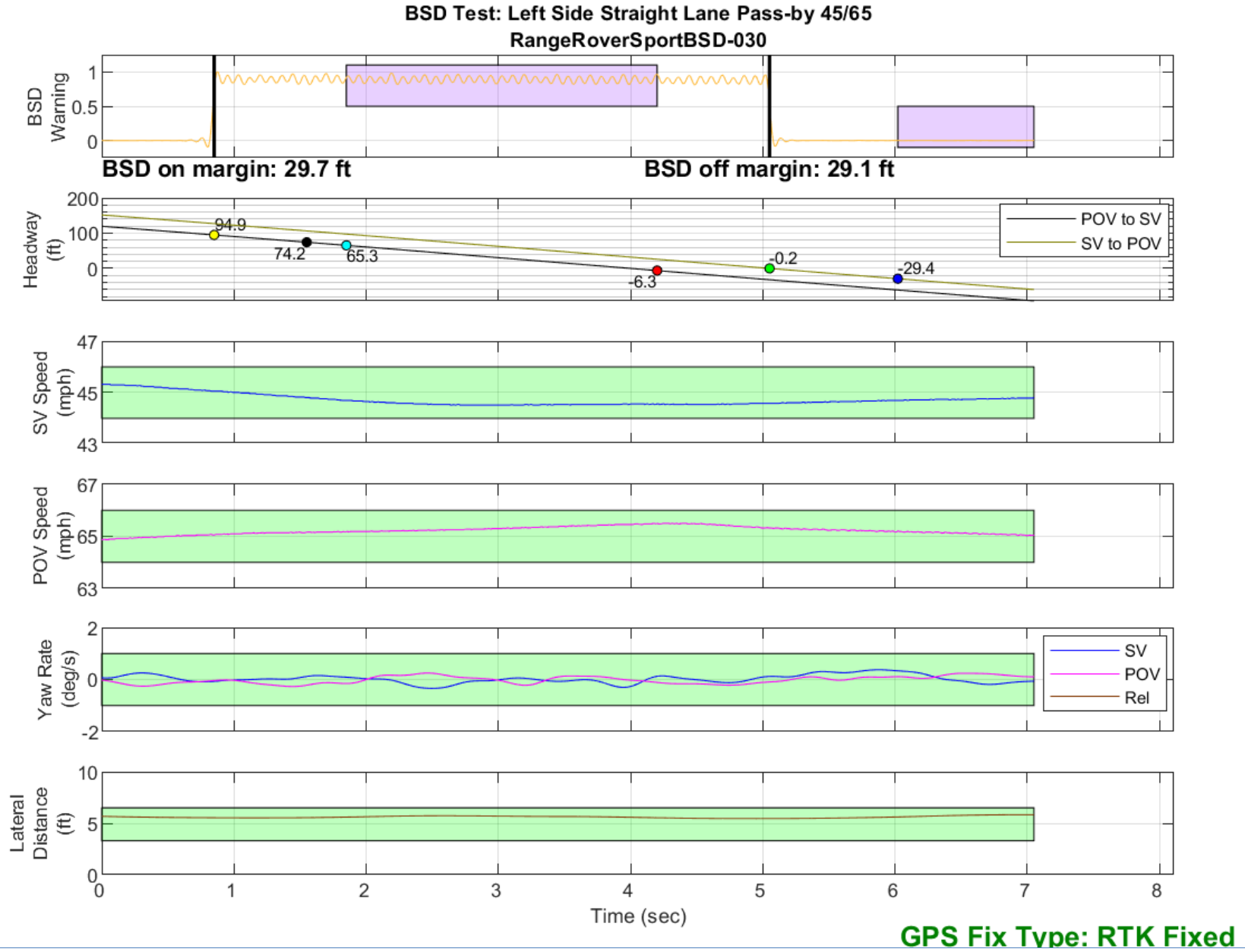


Figure D68. BSD Run 30, Straight Lane Pass-by, SV 45 mph, POV 65 mph

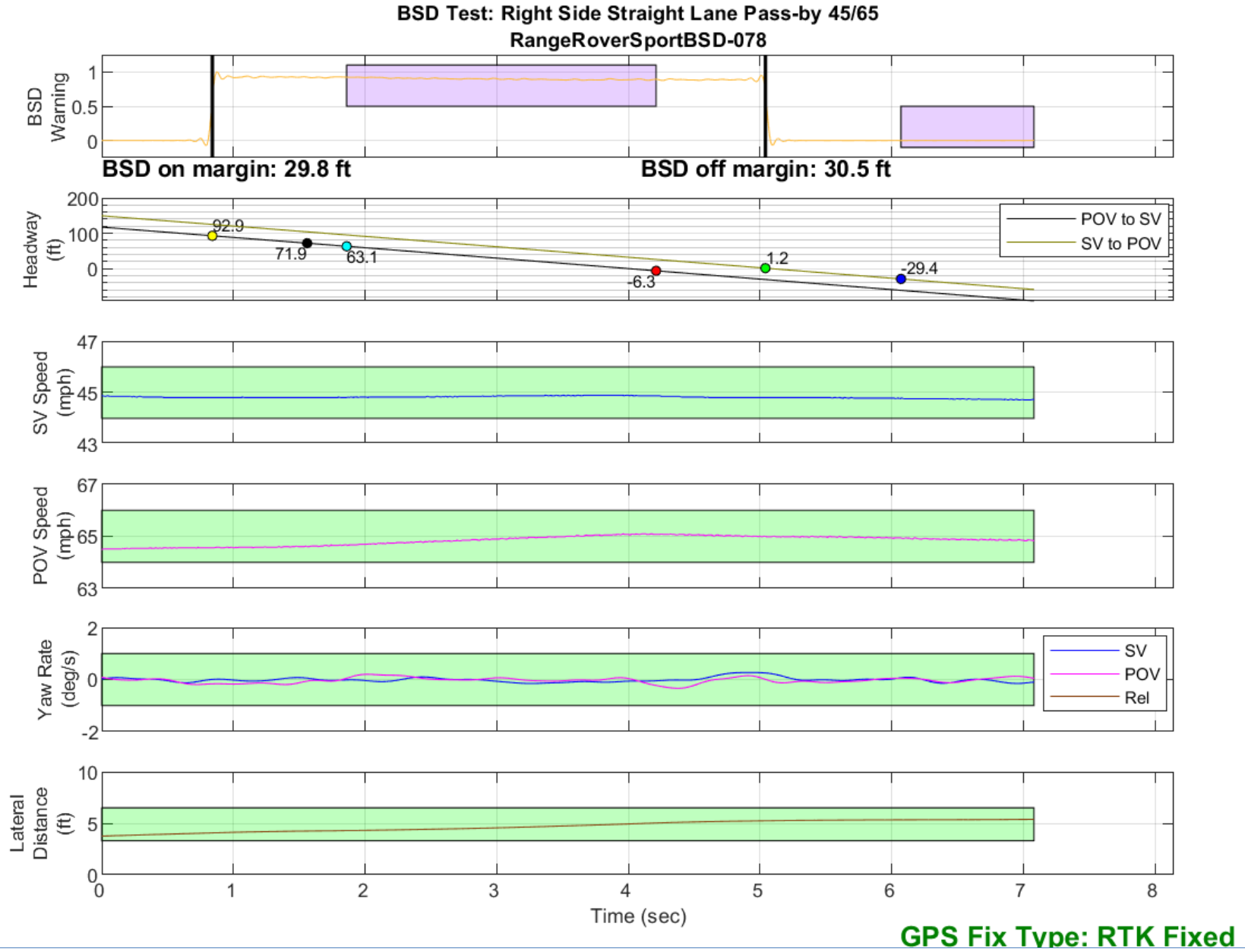


Figure D69. BSD Run 78, Straight Lane Pass-by, SV 45 mph, POV 65 mph

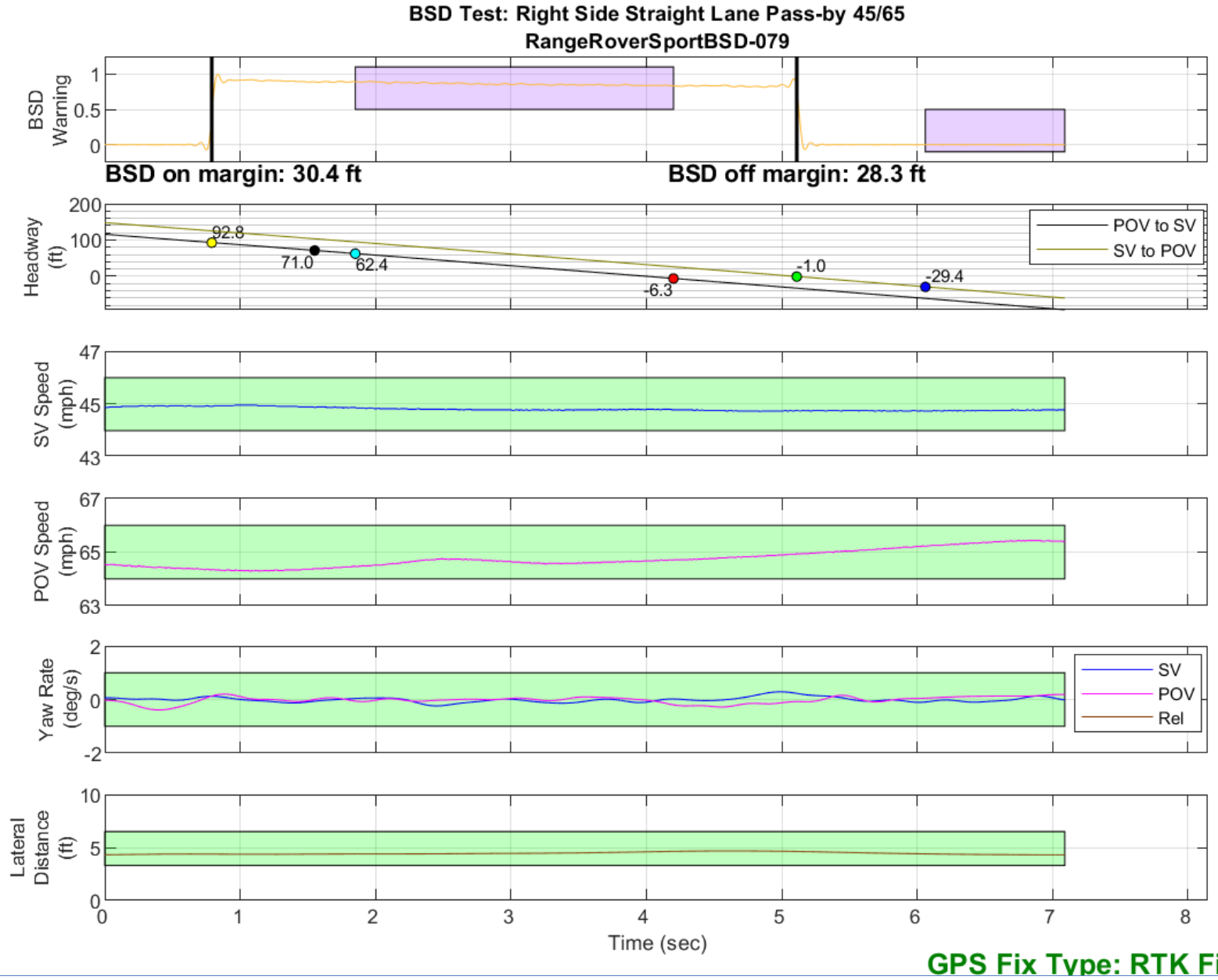


Figure D70. BSD Run 79, Straight Lane Pass-by, SV 45 mph, POV 65 mph

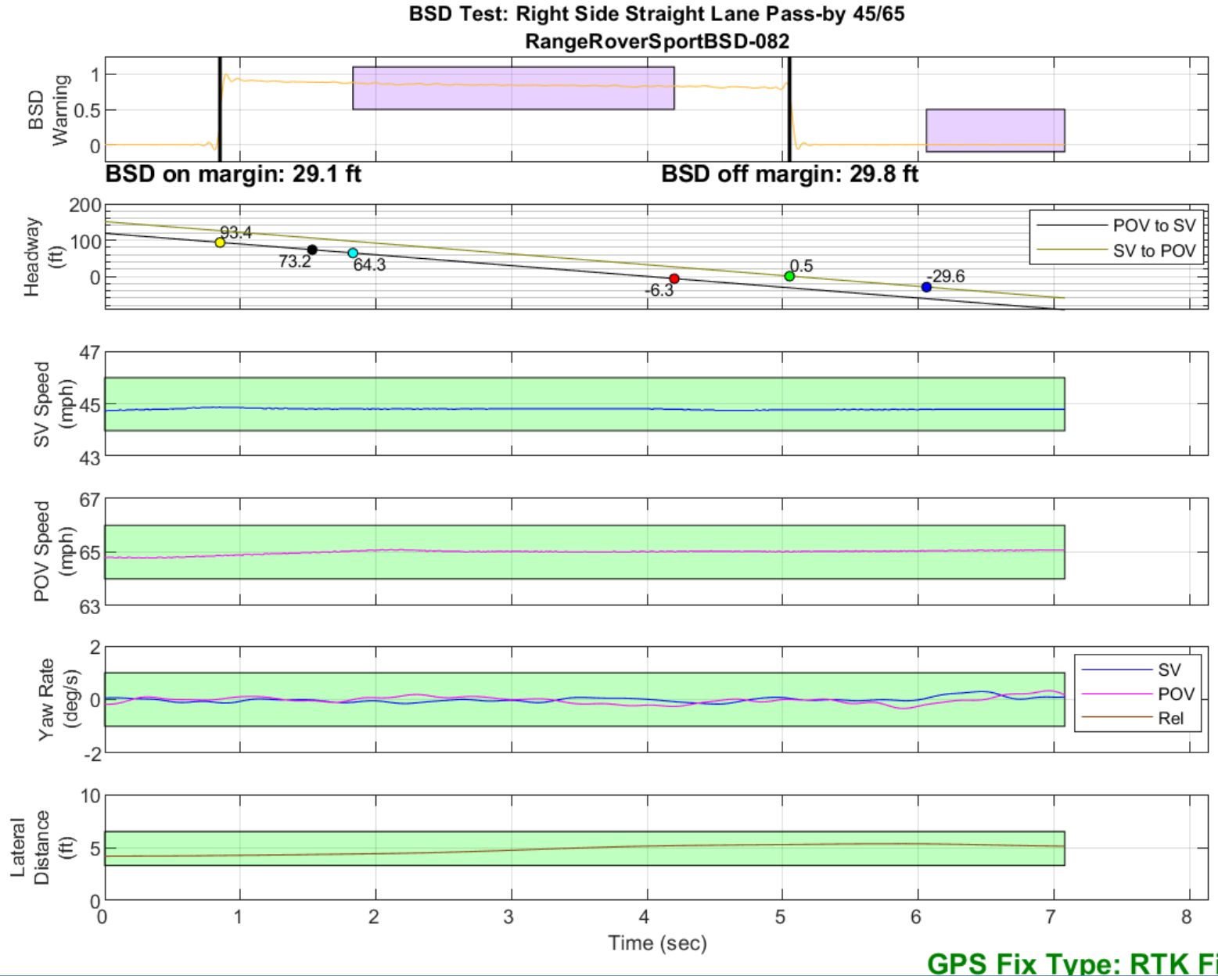


Figure D71. BSD Run 82, Straight Lane Pass-by, SV 45 mph, POV 65 mph

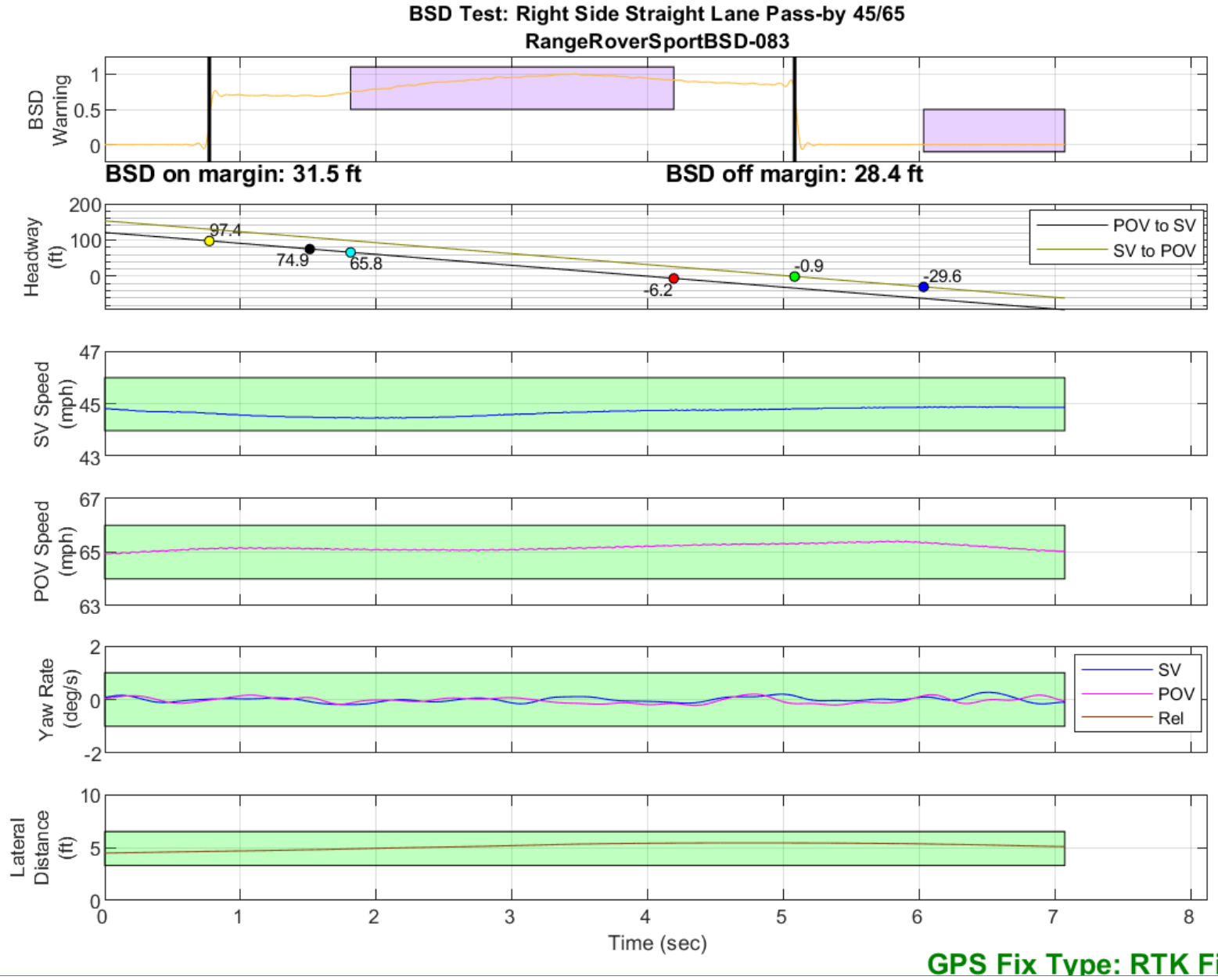


Figure D72. BSD Run 83, Straight Lane Pass-by, SV 45 mph, POV 65 mph

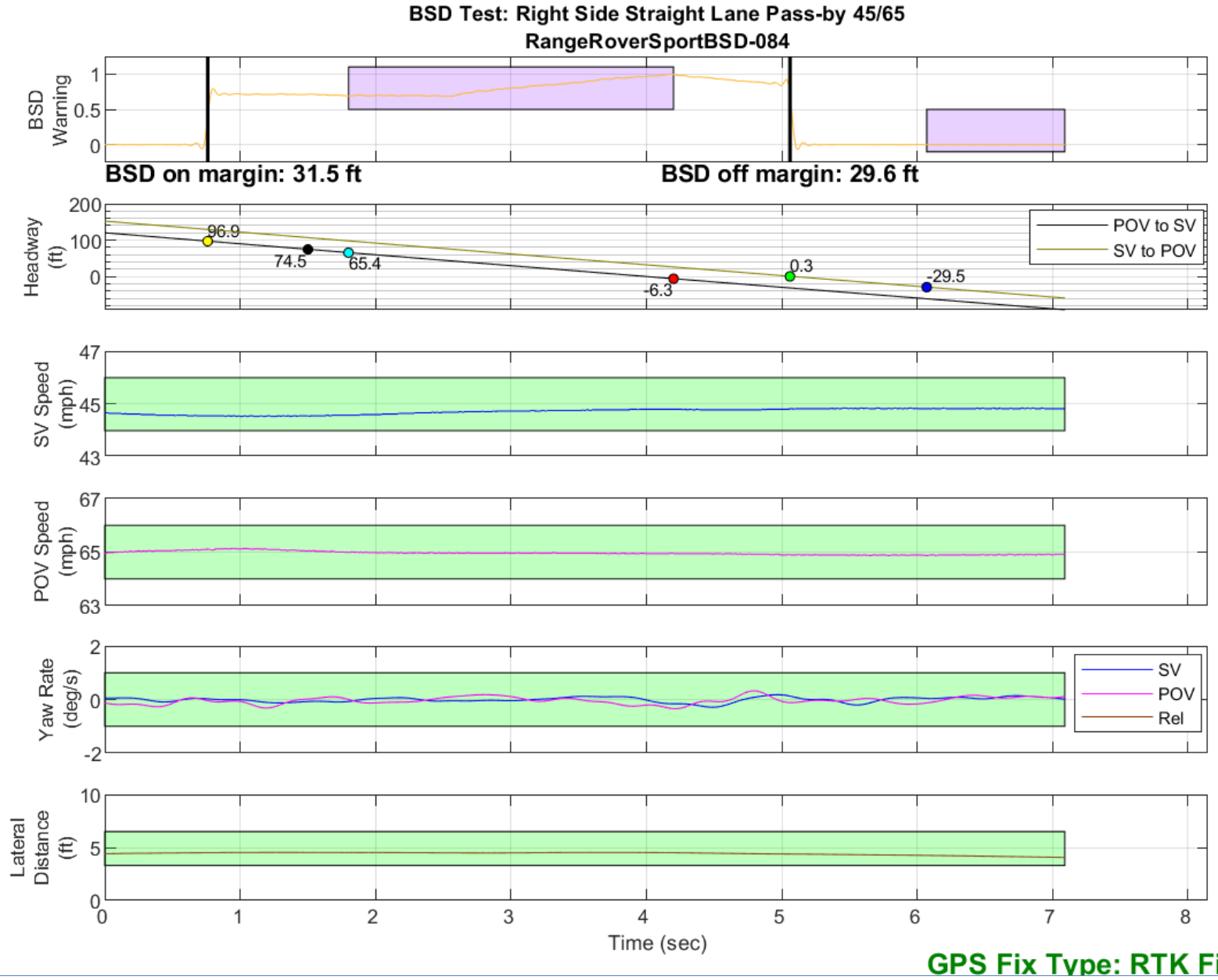


Figure D73. BSD Run 84, Straight Lane Pass-by, SV 45 mph, POV 65 mph

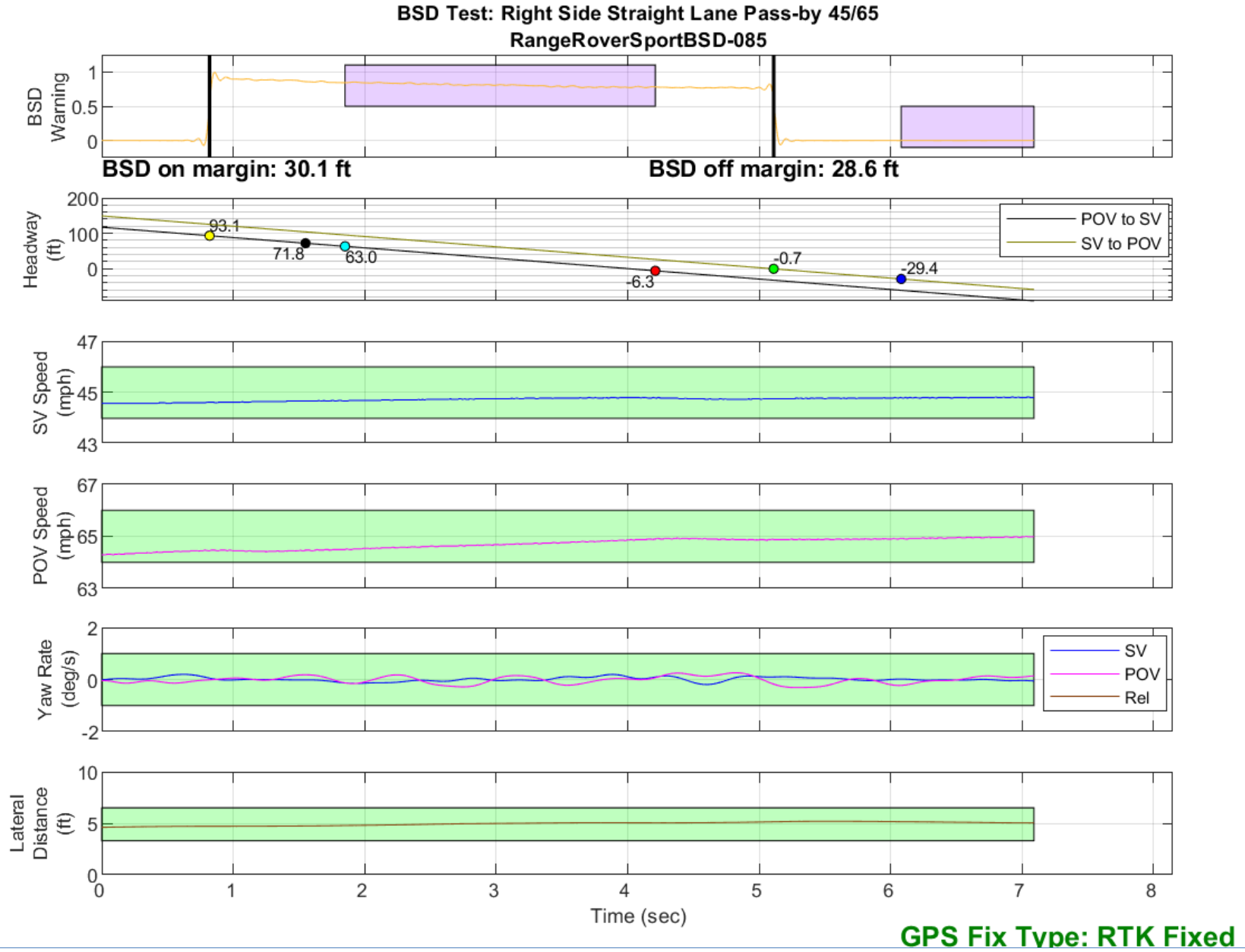


Figure D74. BSD Run 85, Straight Lane Pass-by, SV 45 mph, POV 65 mph

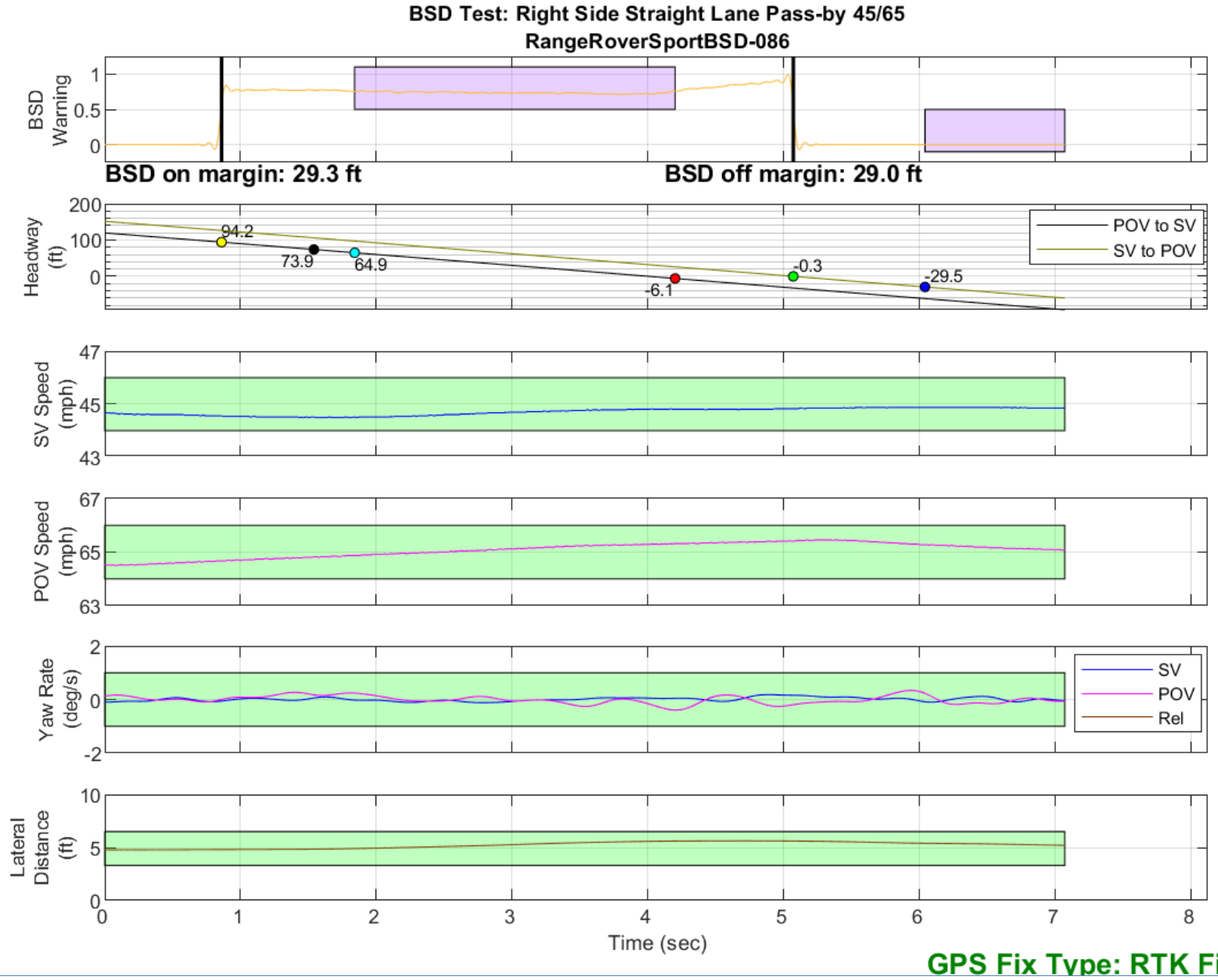


Figure D75. BSD Run 86, Straight Lane Pass-by, SV 45 mph, POV 65 mph