BLIND SPOT DETECTION SYSTEM RESEARCH TEST
NCAP-DRI-BSD-20-07

2020 Mercedes-Benz GLC 300 4MATIC SUV

DYNAMIC RESEARCH, INC.
355 Van Ness Avenue, STE 200
Torrance, California 90501

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Final

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Prepared By: J. Lenkeit — Program Manager
J. Robel — Test Engineer

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16. Abstract These tests were conducted on the subject 2020 Mercedes-Benz GLC 300 4MATIC SUV in accordance with the specifications of the New Car Assessment Program'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 vehicle met the preliminary requirements for the Straight Lane Converge/Diverge scenario, and for all speed combinations of the Straight Lane Pass-by scenario. Overall, the vehicle met the preliminary requirements for 74 out of 75 valid test runs.			
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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 (SV) 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) 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 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

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2020 Mercedes-Benz GLC 300 4MATIC SUV

VIN: *WDC0G8EB8LF72xxxx*

Test Date: *7/17/2020*

System Setting: *System on*

	Number of valid test runs for which acceptability criteria were:		
	Met	**Not met**	**Valid trials**
Test 1 - Straight Lane Converge and Diverge			
45 mph - Left	*8*	*0*	*8*
45 mph - Right	*8*	*0*	*8*
Overall Test 1:	*16*	*0*	*16*
Test 2 - Straight Lane Pass-by			
POV 50 mph - Left	*9*	*0*	*9*
POV 50 mph - Right	*8*	*0*	*8*
POV 55 mph - Left	*7*	*0*	*7*
POV 55 mph - Right	*8*	*0*	*8*
POV 60 mph - Left	*6*	*0*	*6*
POV 60 mph - Right	*6*	*0*	*6*
POV 65 mph - Left	*7*	*0*	*7*
POV 65 mph - Right	*7*	*1*	*8*
Overall Test 2:	*58*	*1*	*59*
Overall:	***74***	***1***	***75***

[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

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2020 Mercedes-Benz GLC 300 4MATIC SUV

TEST VEHICLE INFORMATION

VIN: *WDC0G8EB8LF72xxxx*

Body Style: *SUV* Color: *Brilliant Blue Metallic*

Date Received: *6/1/2020* Odometer Reading: *94 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Daimler AG Stuttgart*

Date of manufacture: *09/19*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *235/60R18*

Rear: *235/60R18*

Recommended cold tire pressure: Front: *270 kPa (39 psi)*

Rear: *320 kPa (46 psi)*

TIRES

Tire manufacturer and model: *Pirelli Scorpion Verde All Season*

Front tire size: *235/60R18 103H*

Rear tire size: *235/60R18 103H*

Front tire DOT prefix: *93 K3 T899*

Rear tire DOT prefix: *93 K3 T899*

BLIND SPOT DETECTION

DATA SHEET 3: TEST CONDITIONS

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2020 Mercedes-Benz GLC 300 4MATIC SUV

GENERAL INFORMATION

Test date: *7/17/2020*

AMBIENT CONDITIONS

Air temperature: *30.0 C (86 F)*

Wind speed: *1.5 m/s (3.5 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: *270 kPa (39 psi)*

Rear: *320 kPa (46 psi)*

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*514.8 kg (1135 lb)*	Right Front:	*509.4 kg (1123 lb)*
Left Rear:	*469.0 kg (1034 lb)*	Right Rear:	*469.9 kg (1036 lb)*
		Total:	*1963.1 kg (4328 lb)*

BLIND SPOT DETECTION

DATA SHEET 4: BLIND SPOT DETECTION SYSTEM OPERATION

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2020 Mercedes-Benz GLC 300 4MATIC SUV

General Information

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

Blind Spot Assist - standard equipment

Type and location of sensors the system uses:

Blind Spot Assist and Active Blind Spot Assist use two lateral, rear-facing radar sensors mounted at the rear bumper corners.

System setting used for test (if applicable):

System on

Method(s) by which the driver is alerted

X Visual:

	Type	Location	Description
X	Symbol	*Inset in the outside mirror glass*	*Triangle, shows a red alert*
	Word		
	Graphic		

X Audible – Description:

Repeated beep

Haptic:

	Steering Wheel		Seatbelt
	Pedals		Steering Torque
	Seat		Brake Jerk

Description of alert:

If a vehicle is detected at speeds above approximately 8 mph (12 km/h) and this vehicle subsequently enters the monitoring range directly next to your vehicle, the warning lamp in the outside mirror lights up red.

If a vehicle is detected close to the side of your vehicle, the red warning lamp in the outside mirror flashes. If you switch on the turn signal indicator in the corresponding direction, a warning tone sounds once. If the turn signal indicator remains switched on, all other detected vehicles are indicated only by the flashing of the red warning lamp.

The alert location is shown in Appendix A, Figure A13.

System Function

What is the speed range over which the system operates?

Minimum: 12 km/h (8 mph)

Maximum: 200 km/h (125 mph)

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

If a vehicle is detected at speeds above approximately 8 mph (12 km/h) and this vehicle subsequently enters the monitoring range directly next to your vehicle, the warning lamp in the outside mirror lights up red.

If a vehicle is detected close to the side of your vehicle, the red warning lamp in the outside mirror flashes. If you switch on the turn signal indicator in the corresponding direction, a warning tone sounds once. If the turn signal indicator remains switched on, all other detected vehicles are indicated only by the flashing of the red warning lamp.

If the vehicle 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?

Controls on the right side of the steering wheel or a touch pad located in the center console can be used to interact with the multimedia system menus. The hierarchy is:

Settings

Assistance

Blind Spot Assist (or Active Blind Spot Assist if so equipped)

Select or deselect

See Appendix A, Figures A11 and Owner's Manual, page 245 shown in Appendix B, Figure B-5.

System does not automatically reactivate upon each ignition cycle.

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 adjustments are provided.

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

Manufacturer specified proprietary calibration procedure (confidential).

BLIND SPOT DETECTION

DATA SHEET 4: BLIND SPOT DETECTION SYSTEM OPERATION

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2020 Mercedes-Benz GLC 300 4MATIC SUV

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

If the system is unavailable, the display appears in the multifunction display.

If the system deactivates due to repeated BSI activations:

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

The system does not deactivate due to repeated activations.

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

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

Yes. If the system is unavailable, the message appears in the multifunction display.

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

System limitations are described on page 243 of the Owner's Manual, shown in Appendix B, Figure B-3.

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.

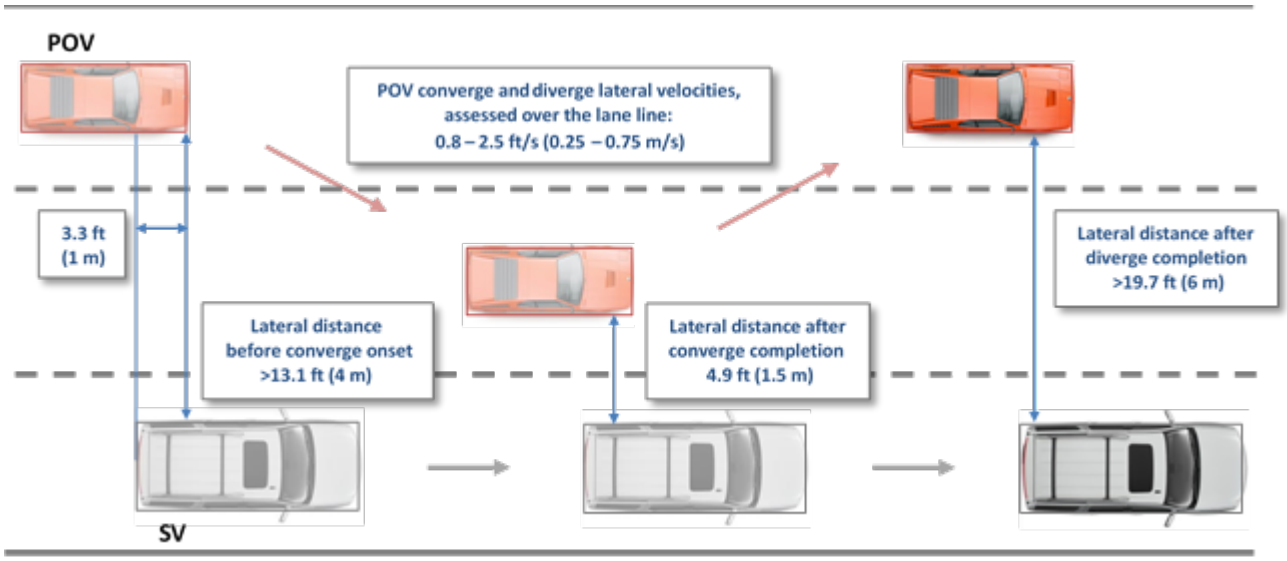


Figure 1. Straight Lane Converge and Diverge Test
(POV converge and diverge from the left is shown)

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 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 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 sides 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.

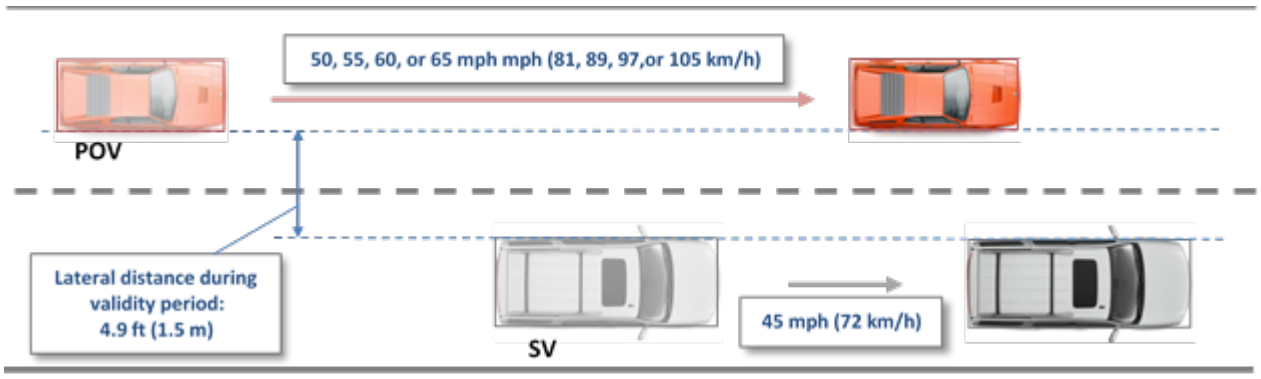


Figure 2. Straight Lane Pass-by test
(Left-side POV Pass-by is shown)

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 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 ± 1.6 km/h)	45 ± 1 mph (72 ± 1.6 km/h)	45 ± 1 mph (72 ± 1.6 km/h)	45 ± 1 mph (72 ± 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 Headway[2] (POV ahead of SV)
45 ± 1 mph (72 ± 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)	>29.3ft (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 headway 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 headway 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 correspond to the length from point B to point C in Figure 3.

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

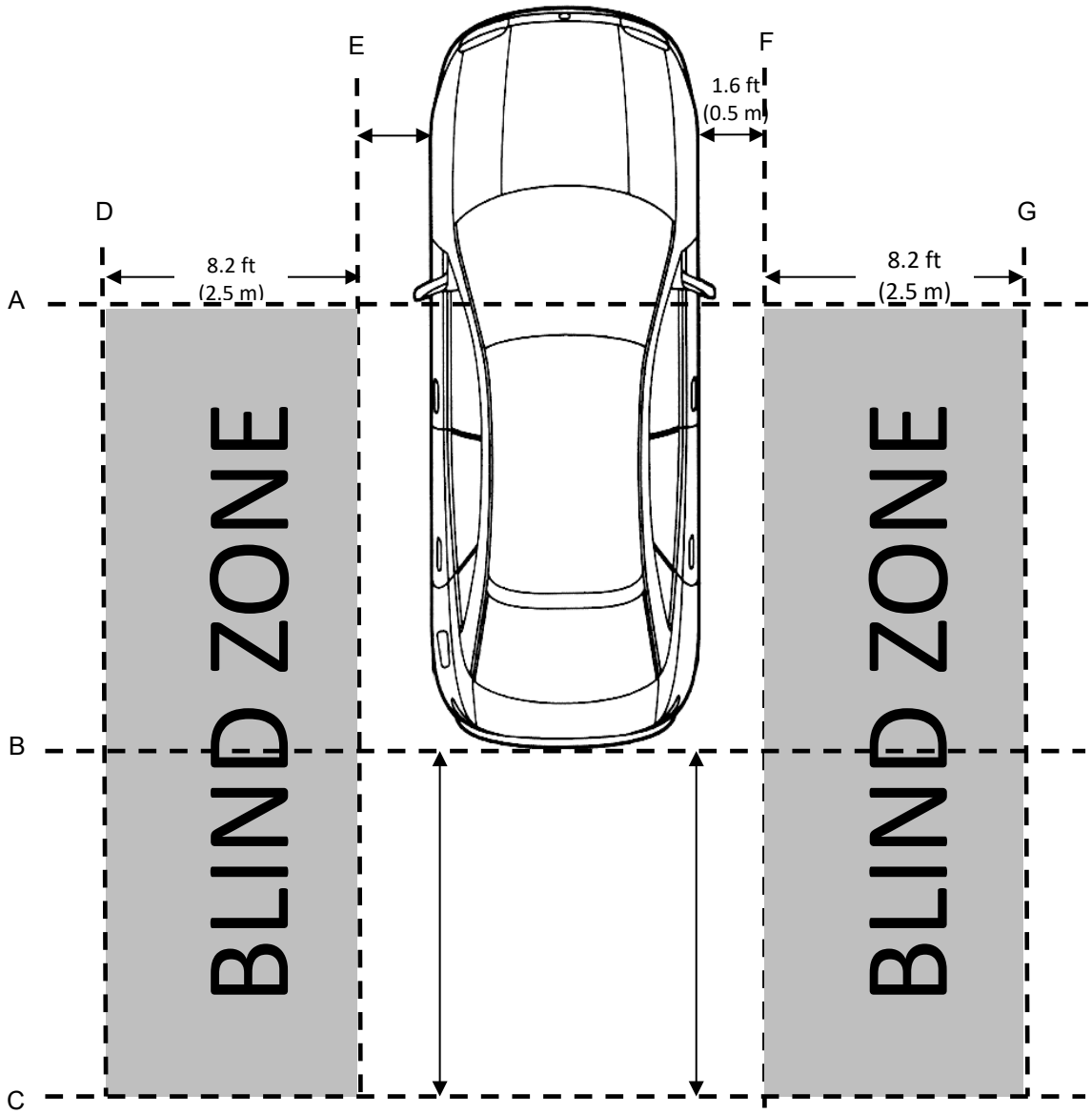


Figure 3. Vehicle Blind Zone Areas

where,

Δv is the differential speed between the POV and the SV. A positive Δv indicates that the POV is travelling faster than the SV.

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 Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	NA
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Accels ± 10g, Angular Rat	Accels .01g, Angular Rate	Oxford Inertial +	2258	By: Oxford Technical Solutions Date: 5/3/2019 Due: 5/3/2021
				Oxford Inertial +	2182	Date: 9/16/2019 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 Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	NA
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	NA	NA

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	NA	NA
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	NA	NA
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and	Omega DPG8001	18111410000	By: DRI Date: 5/4/2020 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 Date: 4/20/2020 Due: 4/20/2021
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2020 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	NA

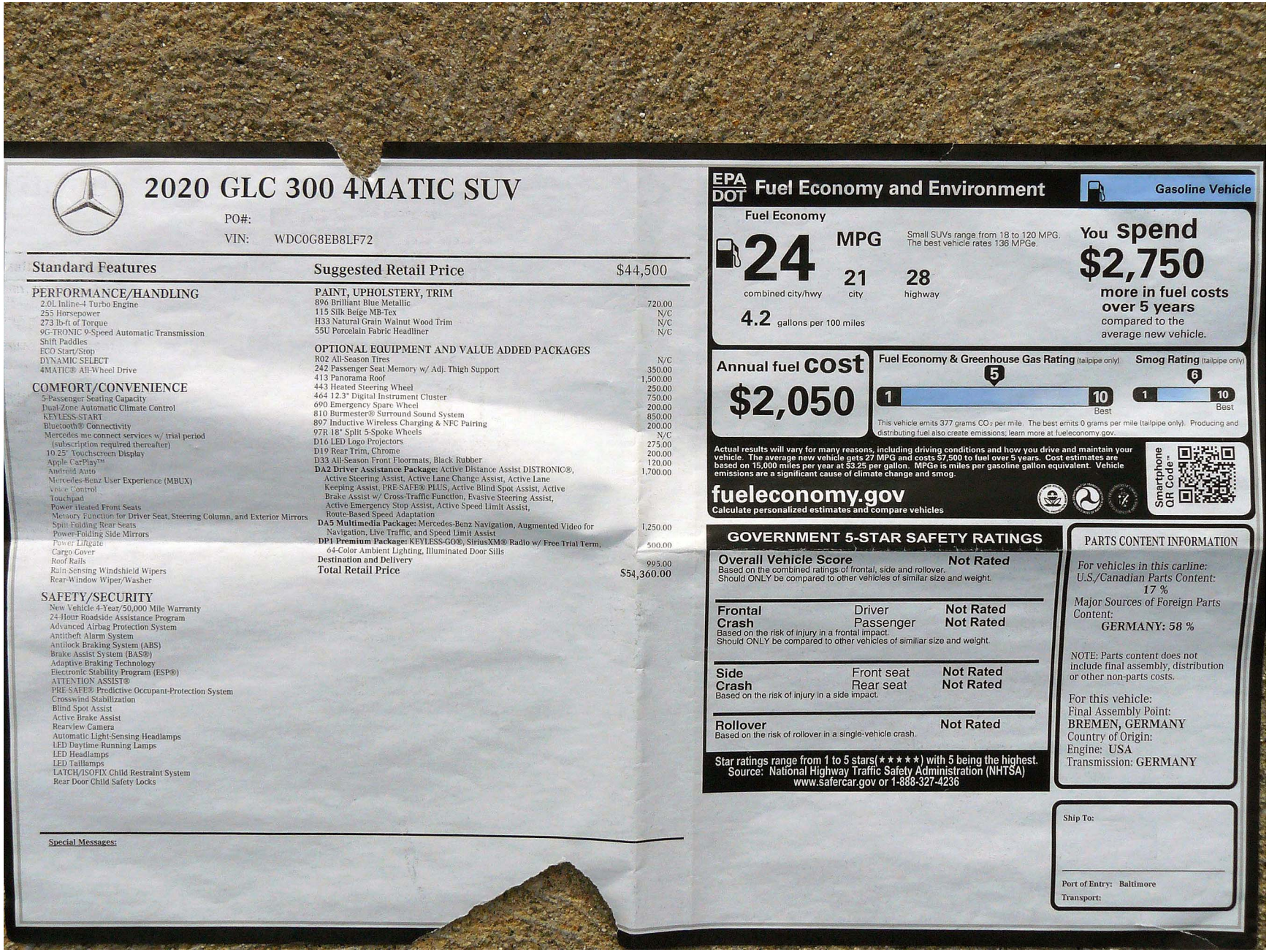
APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle



2020 GLC 300 4MATIC SUV

PO#:

VIN: WDC0G8EB8LF72

Standard Features

PERFORMANCE/HANDLING
- 2.0L Inline-4 Turbo Engine
- 255 Horsepower
- 273 lb-ft of Torque
- 9G-TRONIC 9-Speed Automatic Transmission
- Shift Paddles
- ECO Start/Stop
- DYNAMIC SELECT
- 4MATIC® All-Wheel Drive

COMFORT/CONVENIENCE
- 5-Passenger Seating Capacity
- Dual-Zone Automatic Climate Control
- KEYLESS-START
- Bluetooth® Connectivity
- Mercedes me connect services w/ trial period (subscription required thereafter)
- 10.25" Touchscreen Display
- Apple CarPlay™
- Android Auto
- Mercedes-Benz User Experience (MBUX)
- Voice Control
- Touchpad
- Power Heated Front Seats
- Memory Function for Driver Seat, Steering Column, and Exterior Mirrors
- Split-Folding Rear Seats
- Power-Folding Side Mirrors
- Power Liftgate
- Cargo Cover
- Roof Rails
- Rain-Sensing Windshield Wipers
- Rear-Window Wiper/Washer

SAFETY/SECURITY
- New Vehicle 4-Year/50,000 Mile Warranty
- 24-Hour Roadside Assistance Program
- Advanced Airbag Protection System
- Antitheft Alarm System
- Antilock Braking System (ABS)
- Brake Assist System (BAS®)
- Adaptive Braking Technology
- Electronic Stability Program (ESP®)
- ATTENTION ASSIST®
- PRE-SAFE® Predictive Occupant-Protection System
- Crosswind Stabilization
- Blind Spot Assist
- Active Brake Assist
- Rearview Camera
- Automatic Light-Sensing Headlamps
- LED Daytime Running Lamps
- LED Headlamps
- LED Taillamps
- LATCH/ISOFIX Child Restraint System
- Rear Door Child Safety Locks

Suggested Retail Price $44,500

PAINT, UPHOLSTERY, TRIM

896 Brilliant Blue Metallic	720.00
115 Silk Beige MB-Tex	N/C
H33 Natural Grain Walnut Wood Trim	N/C
55U Porcelain Fabric Headliner	N/C

OPTIONAL EQUIPMENT AND VALUE ADDED PACKAGES

R02 All-Season Tires	N/C
242 Passenger Seat Memory w/ Adj. Thigh Support	350.00
413 Panorama Roof	1,500.00
443 Heated Steering Wheel	250.00
464 12.3" Digital Instrument Cluster	750.00
690 Emergency Spare Wheel	200.00
810 Burmester® Surround Sound System	850.00
897 Inductive Wireless Charging & NFC Pairing	200.00
97R 18" Split 5-Spoke Wheels	N/C
D16 LED Logo Projectors	275.00
D19 Rear Trim, Chrome	200.00
D33 All-Season Front Floormats, Black Rubber	120.00
DA2 Driver Assistance Package: Active Distance Assist DISTRONIC®, Active Steering Assist, Active Lane Change Assist, Active Lane Keeping Assist, PRE-SAFE® PLUS, Active Blind Spot Assist, Active Brake Assist w/ Cross-Traffic Function, Evasive Steering Assist, Active Emergency Stop Assist, Active Speed Limit Assist, Route-Based Speed Adaptation	1,700.00
DA5 Multimedia Package: Mercedes-Benz Navigation, Augmented Video for Navigation, Live Traffic, and Speed Limit Assist	1,250.00
DP1 Premium Package: KEYLESS-GO®, SiriusXM® Radio w/ Free Trial Term, 64-Color Ambient Lighting, Illuminated Door Sills	500.00
Destination and Delivery	995.00
Total Retail Price	$54,360.00

Special Messages:

EPA DOT Fuel Economy and Environment

Gasoline Vehicle

Fuel Economy

24 MPG combined city/hwy

21 city

28 highway

Small SUVs range from 18 to 120 MPG. The best vehicle rates 136 MPGe.

4.2 gallons per 100 miles

You **spend $2,750** more in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost $2,050

Fuel Economy & Greenhouse Gas Rating (tailpipe only): 5 (1 – 10 Best)

Smog Rating (tailpipe only): 6 (1 – 10 Best)

This vehicle emits 377 grams CO_2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create emissions; learn more at fueleconomy.gov.

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 27 MPG and costs $7,500 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $3.25 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fueleconomy.gov
Calculate personalized estimates and compare vehicles

Smartphone QR Code™

GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score Not Rated
Based on the combined ratings of frontal, side and rollover.
Should ONLY be compared to other vehicles of similar size and weight.

Frontal Crash — Driver: Not Rated; Passenger: Not Rated
Based on the risk of injury in a frontal impact.
Should ONLY be compared to other vehicles of similiar size and weight.

Side Crash — Front seat: Not Rated; Rear seat: Not Rated
Based on the risk of injury in a side impact.

Rollover Not Rated
Based on the risk of rollover in a single-vehicle crash.

Star ratings range from 1 to 5 stars(★★★★★) with 5 being the highest.
Source: National Highway Traffic Safety Administration (NHTSA)
www.safercar.gov or 1-888-327-4236

PARTS CONTENT INFORMATION

For vehicles in this carline:
U.S./Canadian Parts Content:
17 %
Major Sources of Foreign Parts Content:
GERMANY: 58 %

NOTE: Parts content does not include final assembly, distribution or other non-parts costs.

For this vehicle:
Final Assembly Point:
BREMEN, GERMANY
Country of Origin:
Engine: **USA**
Transmission: **GERMANY**

Ship To:

Port of Entry: Baltimore
Transport:

Figure A3. Window Sticker (Monroney Label)

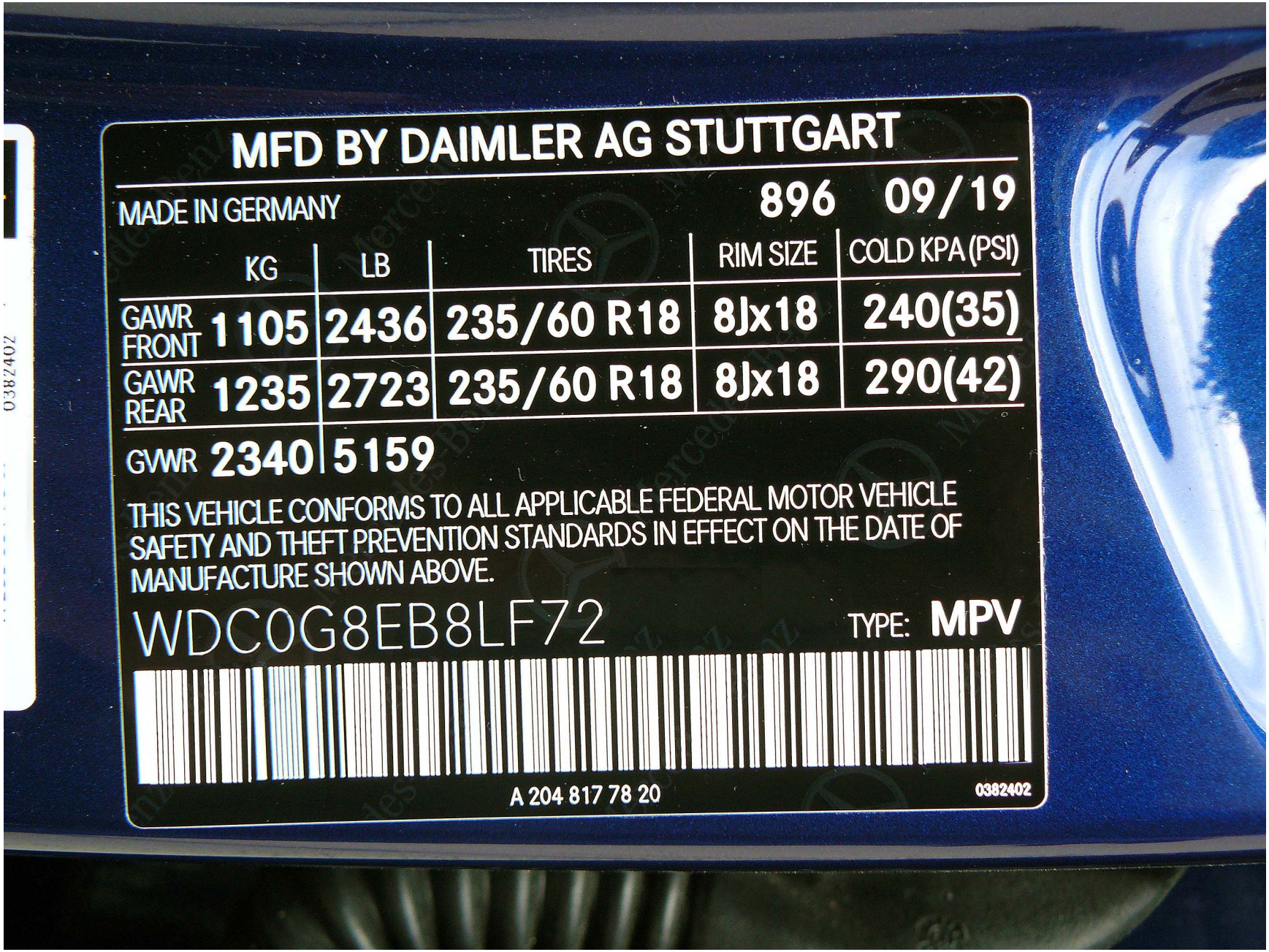


Figure A4. Vehicle Certification Label

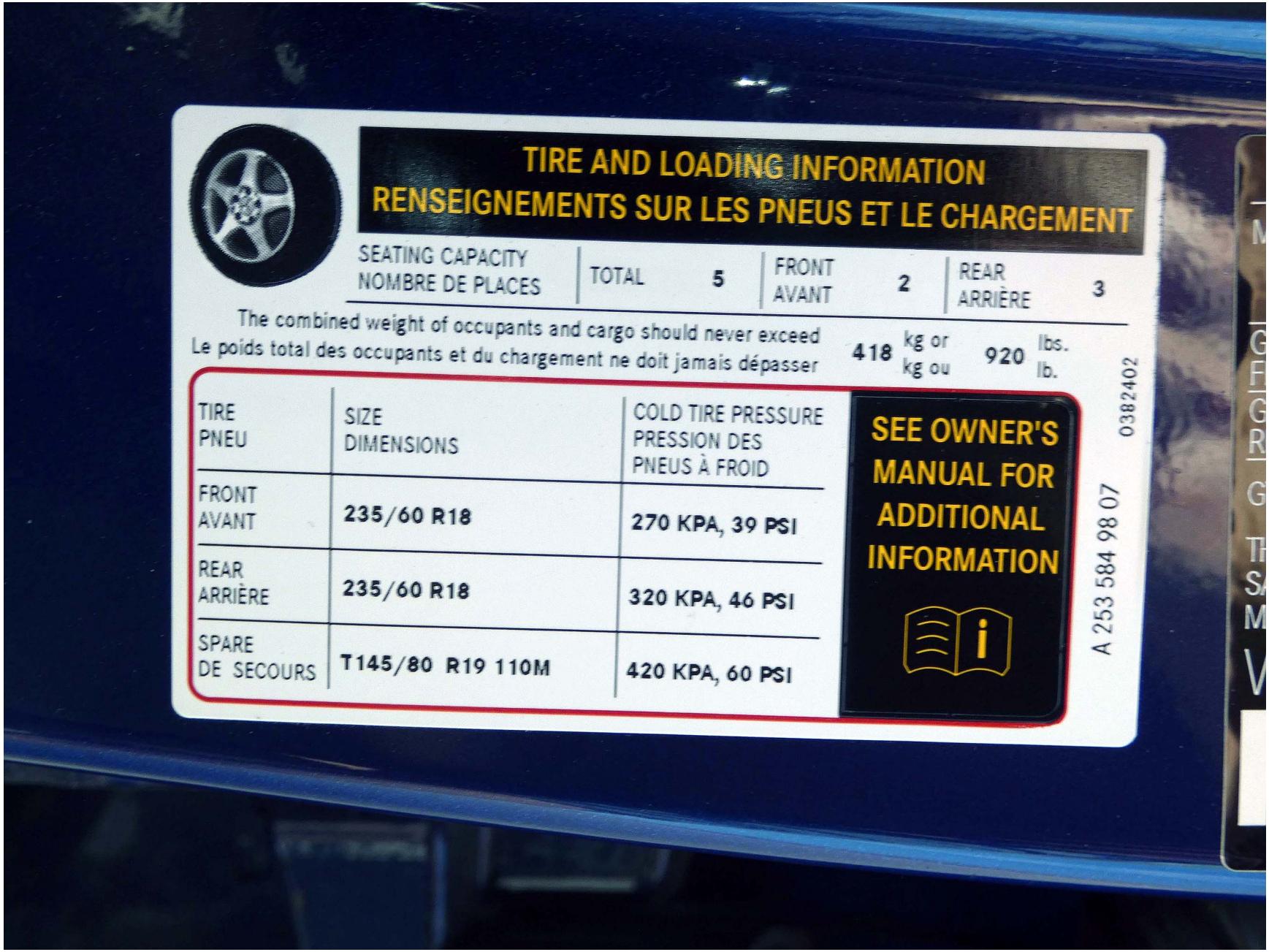


Figure A5. Tire Placard

Figure A6. Front View of Principal Other Vehicle

Figure A7. Rear View of Principal Other Vehicle

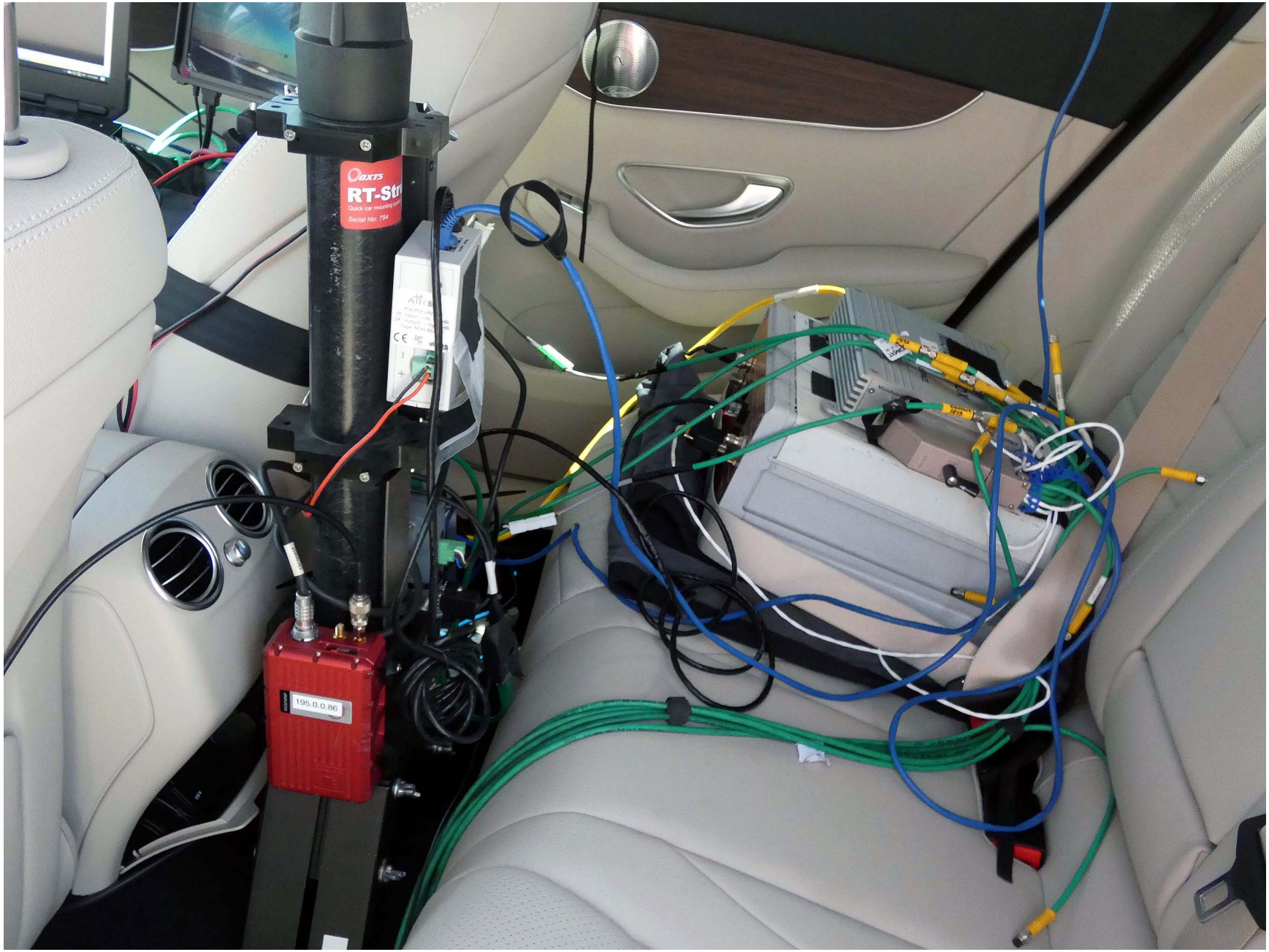


Figure A8. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A9. Sensors for Detecting Visual Alerts

Figure A10. Computer Installed in Subject Vehicle

Figure A11. System Setup Menus

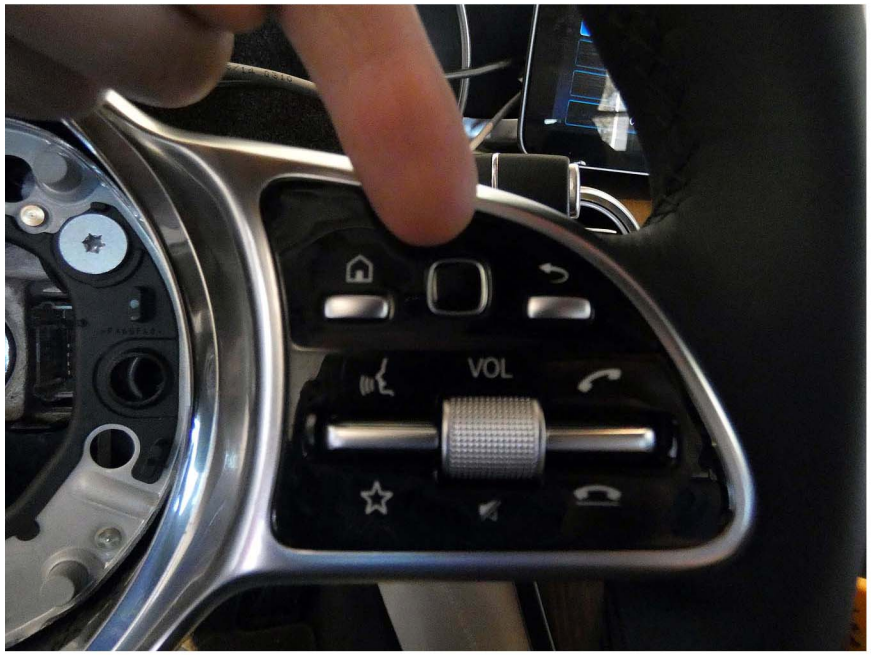


Figure A12. Controls for Interacting with System Menus

Figure A13. Visual Alert

APPENDIX B

Excerpts from Owner's Manual

Multimedia system:
→ ⌂ ▸▸ Settings ▸▸ Assistance ▸▸ Traffic Sign Assist

Activating/deactivating automatic adoption of speed limits (only vehicles with Driving Assistance Package)

- Select Limit Adoption.
- Activate or deactivate the function.
  The speed limits detected by Traffic Sign Assist are automatically adopted by Active Distance Assist DISTRONIC.

ⓘ If one of the following systems is activated, the speed detected can be manually adopted as the speed limit:
- Active Distance Assist DISTRONIC
- Cruise control
- Variable limiter

Further information (→ page 203).

Displaying detected traffic signs in the media display

- Select Display in Central Display.
- Activate or deactivate the function.

Adjusting the type of warning

- Select Visual & Audible, Visual or Off.

Adjusting the warning threshold
This value determines the speed at which a warning is issued when exceeded.

- Select Warning Threshold.
- Set the desired speed.

Blind Spot Assist and Active Blind Spot Assist with exit warning

Function of Blind Spot Assist and Active Blind Spot Assist with exit warning
Blind Spot Assist and Active Blind Spot Assist use two lateral, rear-facing radar sensors to monitor the area up to 130 ft (40 m) behind and 10 ft (3 m) next to your vehicle.

If a vehicle is detected at speeds above approximately 8 mph (12 km/h) and this vehicle subsequently enters the monitoring range directly next to your vehicle, the warning lamp in the outside mirror lights up red.

If a vehicle is detected close to the side of your vehicle, the red warning lamp in the outside mirror flashes. If you switch on the turn signal indicator in the corresponding direction, a warning tone sounds once. If the turn signal indicator remains switched on, all other detected vehicles are indicated only by the flashing of the red warning lamp.

If you overtake a vehicle quickly, no warning is given.

⚠ **WARNING** Risk of accident despite Blind Spot Assist

Blind Spot Assist does not react to vehicles approaching and overtaking you at a greatly different speed.

As a result, Blind Spot Assist cannot warn drivers in this situation.

- Always pay careful attention to the traffic situation and maintain a safe distance at the side of the vehicle.

Blind Spot Assist and Active Blind Spot Assist are only aids. They may fail to detect some vehi-

cles and are no substitute for attentive driving. Always ensure that there is sufficient distance to the side for other road users and obstacles.

Exit warning

The exit warning is an additional function of Blind Spot Assist and can warn vehicle occupants about approaching vehicles when leaving the vehicle when stationary.

⚠ WARNING Risk of accident despite exit warning

The exit warning reacts neither to stationary objects nor to vehicles approaching you at a greatly different speed.

As a result, the exit warning cannot warn drivers in these situations.

▶ Always pay particular attention to the traffic situation when opening the doors and make sure there is sufficient clearance.

If there is a vehicle in the monitoring range, this is indicated in the outside mirror. If a vehicle occupant opens the door on the side with the warning, a warning tone sounds and the warning lamp in the outside mirror starts to flash.

This additional function is only available when Blind Spot Assist is activated and up to a maximum of three minutes after the ignition has been switched off. The exit warning is no longer available once the warning lamp in the outside mirror flashes three times.

The exit warning is only an aid and not a substitute for the attention of vehicle occupants. The responsibility for opening and closing the doors and for leaving the vehicle remains with the vehicle occupants.

System limits

Blind Spot Assist and Active Blind Spot Assist may be limited in the following situations:

- If there is dirt on the sensors or the sensors are obscured
- In poor visibility, e.g. due to fog, heavy rain or snow
- If there are narrow vehicles, e.g. bicycles or motorbikes
- If the road has very wide or narrow lanes
- If vehicles are not driving in the middle of their lane

Warnings may be issued in error when driving close to crash barriers or similar solid lane borders. Always make sure that there is sufficient distance to the side for other traffic or obstacles.

Warnings may be interrupted when driving alongside long vehicles, for example trucks, for a prolonged time.

Blind Spot Assist is not operational when reverse gear is engaged.

Blind Spot Assist is not operational when a trailer is coupled to the vehicle and the electrical connection has been correctly established.

The exit warning may be limited in the following situations:

- When the sensors are covered by adjacent vehicles in narrow parking spaces
- When people approach the vehicle
- In the event of stationary or slowly moving objects

Function of brake application (Active Blind Spot Assist)

ⓘ The brake application function is only available for vehicles with a Driving Assistance Package.

If Active Blind Spot Assist detects a risk of a side impact in the monitoring range, a course-correcting brake application is carried out. This is designed to help you avoid a collision.

The course-correcting brake application is available in the speed range between approximately 20 mph (30 km/h) and 125 mph (200 km/h).

⚠ **WARNING** Risk of accident despite brake application of Active Blind Spot Assist

A course-correcting brake application cannot always prevent a collision.

- ▶ Always steer, brake or accelerate yourself, especially if Active Blind Spot Assist warns you or makes a course-correcting brake application.
- ▶ Always maintain a safe distance at the sides.

⚠ **WARNING** Risk of accident despite Active Blind Spot Assist

Active Blind Spot Assist does not react to the following:

- If vehicles overtake too closely on the side, placing them in the blind spot area
- Vehicles approaching and overtaking you at a greatly different speed

As a result, Active Blind Spot Assist may neither give warnings nor intervene in such situations.

- ▶ Always pay careful attention to the traffic situation and maintain a safe distance at the side of the vehicle.

If a course-correcting brake application occurs, the red warning lamp flashes in the outside mirror and a warning tone sounds. In addition, a display 1 indicating the danger of a side collision appears in the multifunction display.

In rare cases, the system may make an inappropriate brake application. This brake application may be interrupted at any time if you steer slightly in the opposite direction or accelerate.

System limits

Either a course-correcting brake application appropriate to the driving situation, or none at all, may occur in the following situations:

- Vehicles or obstacles, e.g. crash barriers, are located on both sides of your vehicle.
- A vehicle approaches too closely on the side.
- You have adopted a sporty driving style with high cornering speeds.
- You brake or accelerate significantly.
- A driving safety system intervenes, e.g. ESP® or Active Brake Assist.
- ESP® is deactivated.
- A loss of tire pressure or a faulty tire is detected.
- You are driving with a trailer and the electrical connection to the trailer hitch has been correctly established.

Activating/deactivating Blind Spot Assist or Active Blind Spot Assist

Multimedia system:

Settings » Assistance

▶ Activate or deactivate Blind Spot Assist.

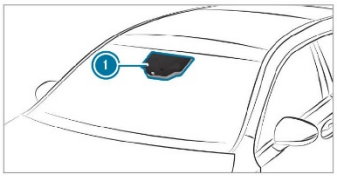
or

▶ Activate or deactivate Act. Blind Spot Assist.

ⓘ Depending on the vehicle's equipment, Blind Spot Assist or Active Blind Spot Assist is available.

Active Lane Keeping Assist

Function of Active Lane Keeping Assist



Active Lane Keeping Assist monitors the area in front of your vehicle by means of multifunction camera 1. It serves to protect you against unintentionally leaving your lane. You will be warned by vibration pulses in the steering wheel and guided by a course-correcting brake application back into your lane.

You are warned by vibration pulses in the steering wheel in the following circumstances:

- Active Lane Keeping Assist detects a lane marking.
- A front wheel drives over this lane marking.

You will also be guided back into your lane by means of a course-correcting brake application if the following conditions are met:

- Active Lane Keeping Assist detects lane markings on both edges of the lane.
- A front wheel drives over a solid lane marking.

You can activate or deactivate the Active Lane Keeping Assist warning.

Active Lane Keeping Assist can neither reduce the risk of an accident if you fail to adapt your

Status displays on the assistant display:

- ATTENTION ASSIST: deactivated
- Light lane markings: Active Lane Keeping Assist enabled
- Green lane markings: Active Lane Keeping Assist active
- Gray radar waves next to vehicle: Blind Spot Assist or Active Blind Spot Assist enabled
- Green radar waves next to vehicle: Blind Spot Assist or Active Blind Spot Assist active
- Active Distance Assist DISTRONIC displays (→ page 201)
- Active Lane Change Assist displays (→ page 209)

Calling up displays on the Trip menu

On-board computer:

→ Trip

Standard display (example)

1 Trip distance
2 Total distance

Trip computer (example)

1 Total distance
2 Driving time
3 Average speed
4 Average fuel consumption

ⓘ You can view information about the journey in the left-hand area of the Instrument Display.

▶ **To select a display:** swipe upwards or downwards on the left-hand Touch Control.

Displays on the Trip menu:

- Standard display
- Range and current fuel consumption

Display messages	Possible causes/consequences and ▶ Solutions
Active Lane Keeping Assist Inoperative	* Active Lane Keeping Assist is malfunctioning. ▶ Consult a qualified specialist workshop.
Blind Spot Assist Currently Unavailable See Operator's Manual	* Blind Spot Assist is temporarily unavailable. The system limits have been reached (→ page 242). ▶ Drive on. Once the cause of the problem is no longer present, the system will be available again. or ▶ If the display message does not disappear, stop the vehicle in accordance with the traffic conditions and restart the engine. ▶ If necessary, clean the rear bumper. If the bumper is especially dirty, the sensors in the bumper may be malfunctioning.
Blind Spot Assist Inoperative	* Blind Spot Assist is malfunctioning. ▶ Consult a qualified specialist workshop.
Blind Spot Assist Not Available When Towing a Trailer See Operator's Manual	* When you establish the electrical connection to the trailer, Blind Spot Assist is unavailable. ▶ Press the left-hand Touch Control and acknowledge the display message.
Active Blind Spot Assist Currently Unavailable See Operator's Manual	* Active Blind Spot Assist is temporarily unavailable. The system limits have been reached (→ page 242).

Display messages	Possible causes/consequences and ▶ Solutions
	▶ Drive on. Once the cause of the problem is no longer present, the system will be available again. or ▶ If the display message does not disappear, stop the vehicle in accordance with the traffic conditions and restart the engine.
Active Blind Spot Assist Inoperative	* Active Blind Spot Assist is malfunctioning. ▶ Consult a qualified specialist workshop.
Active Blind Spot Asst. Not Available When Towing a Trailer See Operator's Manual	* When you establish the electrical connection to the trailer, Active Blind Spot Assist is unavailable. ▶ Press the left-hand Touch Control and acknowledge the display message.
Traffic Sign Assist Currently Unavailable See Operator's Manual	* Traffic Sign Assist is temporarily unavailable. ▶ Drive on. Once the cause of the problem is no longer present, the system will be available again.
Traffic Sign Assist Inoperative	* Traffic Sign Assist is malfunctioning. ▶ Stop the vehicle in accordance with the traffic conditions and restart the engine. ▶ If the display message continues to be displayed, consult a qualified specialist workshop.

APPENDIX C

Run Log

Subject Vehicle: **2020 Mercedes-Benz GLC 300 4MATIC SUV** Date: **7/17/2020**

Test Engineer: **J. Robel**

Run	Test Type	BSD Side (L/R)	Valid Run?	BSD On (ft)	BSD Off (ft)	Acceptability Criteria met[1]			
						BSD On	BSD Off	Overall	Notes
1	**Static Run**								
11	**Converge/ Diverge**	**Left**	N						POV diverge
12			N						POV diverge
13			N						Headway, POV yaw, lateral velocity
14			N						SV, POV speed, lateral velocity
15			N						Multiple problems
16			N						SV speed, lateral velocity
17			N						Multiple problems
18			N						Multiple problems
19			N						Multiple problems
20			N						SV speed, lateral velocity
21			N						Multiple problems
22			N						Lateral velocity
23			N						Ran out of track
24			N						Lateral velocity
25			N						Lateral velocity
26			Y	1.5	7.7	Yes	Yes	Yes	
27			N						Ran out of track

[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	
28	Converge/ Diverge (cont.)	Left	Y	1.5	7.7	Yes	Yes	Yes	
29			N						Headway, lateral velocity
30			N						Ran out of track
31			N						Yaw, lateral distance
32			N						Headway lateral velocity
33			N						Lateral velocity
34			N						Ran out of track
35			Y	1.4	8.1	Yes	Yes	Yes	
36			Y	1.4	7.9	Yes	Yes	Yes	
37			N						POV speed
38			Y	1.6	8.1	Yes	Yes	Yes	
39			Y	1.5	7.7	Yes	Yes	Yes	
40			Y	1.7	7.9	Yes	Yes	Yes	
41			Y	1.6	7.9	Yes	Yes	Yes	
105	Converge/ Diverge	Right	N						Ran out of track
106			N						SV speed, lateral distance, lateral velocity
107			Y	1.1	8.2	Yes	Yes	Yes	
108			Y	0.8	8.1	Yes	Yes	Yes	
109			Y	0.8	8.2	Yes	Yes	Yes	
110			N						Headway, POV speed, lateral velocity
111			Y	0.9	8.2	Yes	Yes	Yes	
112			N						Lateral velocity
113			Y	0.8	8.1	Yes	Yes	Yes	

Run	Test Type	BSD Side (L/R)	Valid Run?	BSD On (ft)	BSD Off (ft)	Acceptability Criteria met[1]			
						BSD On	BSD Off	Overall	Notes
114	Converge/ Diverge (cont.)	Right	Y	1.0	8.2	Yes	Yes	Yes	
115			Y	0.9	8.1	Yes	Yes	Yes	
116			Y	1.1	8.0	Yes	Yes	Yes	
117			N						Lateral distance, lateral velocity
2	Straight Lane 45/50	Left	Y	11.5	16.3	Yes	Yes	Yes	
3			Y	8.5	16.1	Yes	Yes	Yes	
4			Y	13.9	16.9	Yes	Yes	Yes	
5			Y	11.7	16.1	Yes	Yes	Yes	
6			Y	13.5	16.2	Yes	Yes	Yes	
7			Y	10.8	16.0	Yes	Yes	Yes	
8			Y	12.4	16.8	Yes	Yes	Yes	
9			Y	13.9	16.7	Yes	Yes	Yes	
10			Y	11.8	16.1	Yes	Yes	Yes	
66	Straight Lane 45/50	Right	Y	11.9	15.2	Yes	Yes	Yes	
67			Y	11.8	15.6	Yes	Yes	Yes	
68			Y	12.8	15.7	Yes	Yes	Yes	
69			Y	12.8	15.3	Yes	Yes	Yes	
70			Y	11.3	15.4	Yes	Yes	Yes	
71			Y	11.2	15.5	Yes	Yes	Yes	
72			Y	11.4	15.3	Yes	Yes	Yes	
73			Y	11.6	15.1	Yes	Yes	Yes	

Run	Test Type	BSD Side (L/R)	Valid Run?	BSD On (ft)	BSD Off (ft)	Acceptability Criteria met[1]			
						BSD On	BSD Off	Overall	Notes
42	**Straight Lane 45/55**	**Left**	Y	8.2	22.0	Yes	Yes	Yes	
43			Y	9.2	22.1	Yes	Yes	Yes	
44			Y	8.2	22.1	Yes	Yes	Yes	
45			Y	9.0	22.8	Yes	Yes	Yes	
46			Y	8.6	21.9	Yes	Yes	Yes	
47			N						Lateral distance
48			Y	8.8	22.7	Yes	Yes	Yes	
49			Y	9.8	22.7	Yes	Yes	Yes	
74	**Straight Lane 45/55**	**Right**	Y	8.4	21.3	Yes	Yes	Yes	
75			Y	8.9	21.2	Yes	Yes	Yes	
76			Y	7.2	21.1	Yes	Yes	Yes	
77			Y	6.9	21.5	Yes	Yes	Yes	
78			Y	8.9	21.3	Yes	Yes	Yes	
79			Y	8.9	21.2	Yes	Yes	Yes	
80			Y	8.7	21.3	Yes	Yes	Yes	
81			Y	8.0	21.8	Yes	Yes	Yes	
50	**Straight Lane 45/60**	**Left**	N						POV speed
51			Y	6.3	27.9	Yes	Yes	Yes	
52			N						Lateral distance
53			Y	5.3	28.0	Yes	Yes	Yes	
54			Y	7.0	28.8	Yes	Yes	Yes	
55			N						Lateral distance
56			Y	6.5	27.8	Yes	Yes	Yes	

Run	Test Type	BSD Side (L/R)	Valid Run?	BSD On (ft)	BSD Off (ft)	Acceptability Criteria met[1]			
						BSD On	BSD Off	Overall	Notes
57	**Straight Lane 45/60 (cont.)**	**Left**	Y	5.5	28.4	Yes	Yes	Yes	
58			Y	6.1	27.9	Yes	Yes	Yes	
82	**Straight Lane 45/60**	**Right**	N			Yes	Yes	Yes	POV speed
83			Y	6.3	27.3	Yes	Yes	Yes	
84			Y	5.9	27.8	Yes	Yes	Yes	
85			N			Yes	Yes	Yes	Lateral distance
86			Y	5.4	27.0	Yes	Yes	Yes	
87			Y	5.9	27.5	Yes	Yes	Yes	
88			N						POV speed
89			N			Yes	Yes	Yes	
90			Y	6.0	27.1	Yes	Yes	Yes	
91			Y	4.1	27.6	Yes	Yes	Yes	
59	**Straight Lane 45/65**	**Left**	Y	2.6	34.0	Yes	Yes	Yes	
60			Y	2.4	33.7	Yes	Yes	Yes	
61			Y	3.0	33.3	Yes	Yes	Yes	
62			Y	4.1	33.6	Yes	Yes	Yes	
63			Y	4.1	33.4	Yes	Yes	Yes	
64			Y	4.0	33.2	Yes	Yes	Yes	
65			Y	2.7	34.4	Yes	Yes	Yes	

Run	Test Type	BSD Side (L/R)	Valid Run?	BSD On (ft)	BSD Off (ft)	Acceptability Criteria met[1]			
						BSD On	BSD Off	Overall	Notes
92	**Straight Lane 45/65**	**Right**	N						POV speed
93			N						POV speed
94			Y	2.4	32.4	Yes	Yes	Yes	
95			N						Yaw
96			N						Lateral distance
97			Y	-0.3	33.1	No	Yes	No	
98			N						POV speed
99			Y	2.1	33.3	Yes	Yes	Yes	
100			Y	4.5	32.6	Yes	Yes	Yes	
101			N	4.4	33.1	Yes	Yes	Yes	POV speed
102			Y	0.9	33.1	Yes	Yes	Yes	
103			Y	3.7	32.3	Yes	Yes	Yes	
104			Y	2.7	33.8	Yes	Yes	Yes	
118	End of track static								POV right lane
119	End of track static								POV left lane
120	Start of track static								POV right lane
121	Start of track static								POV left lane

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.

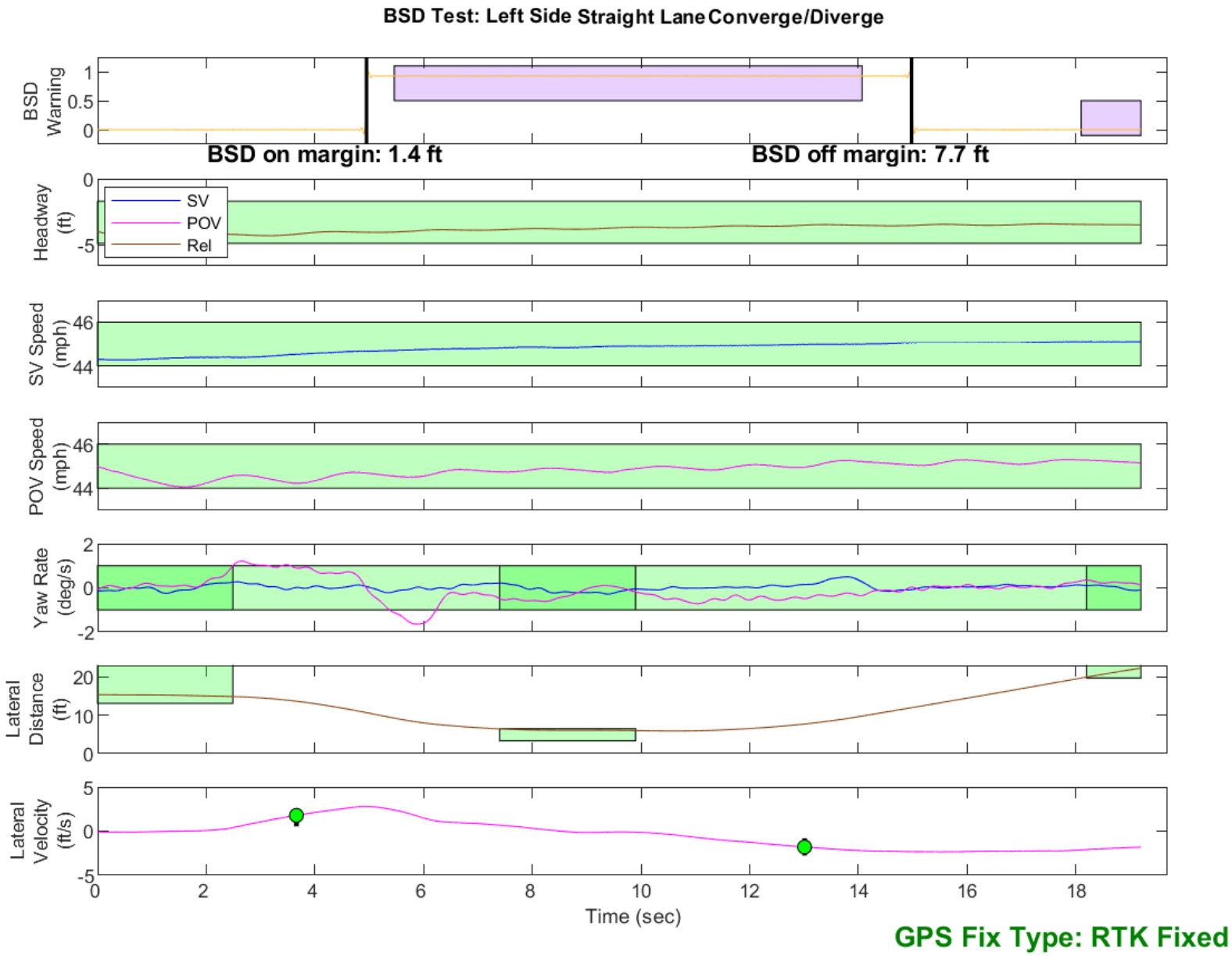


Figure D1. Example Time History for Straight Lane Converge/Diverge Test, Passing

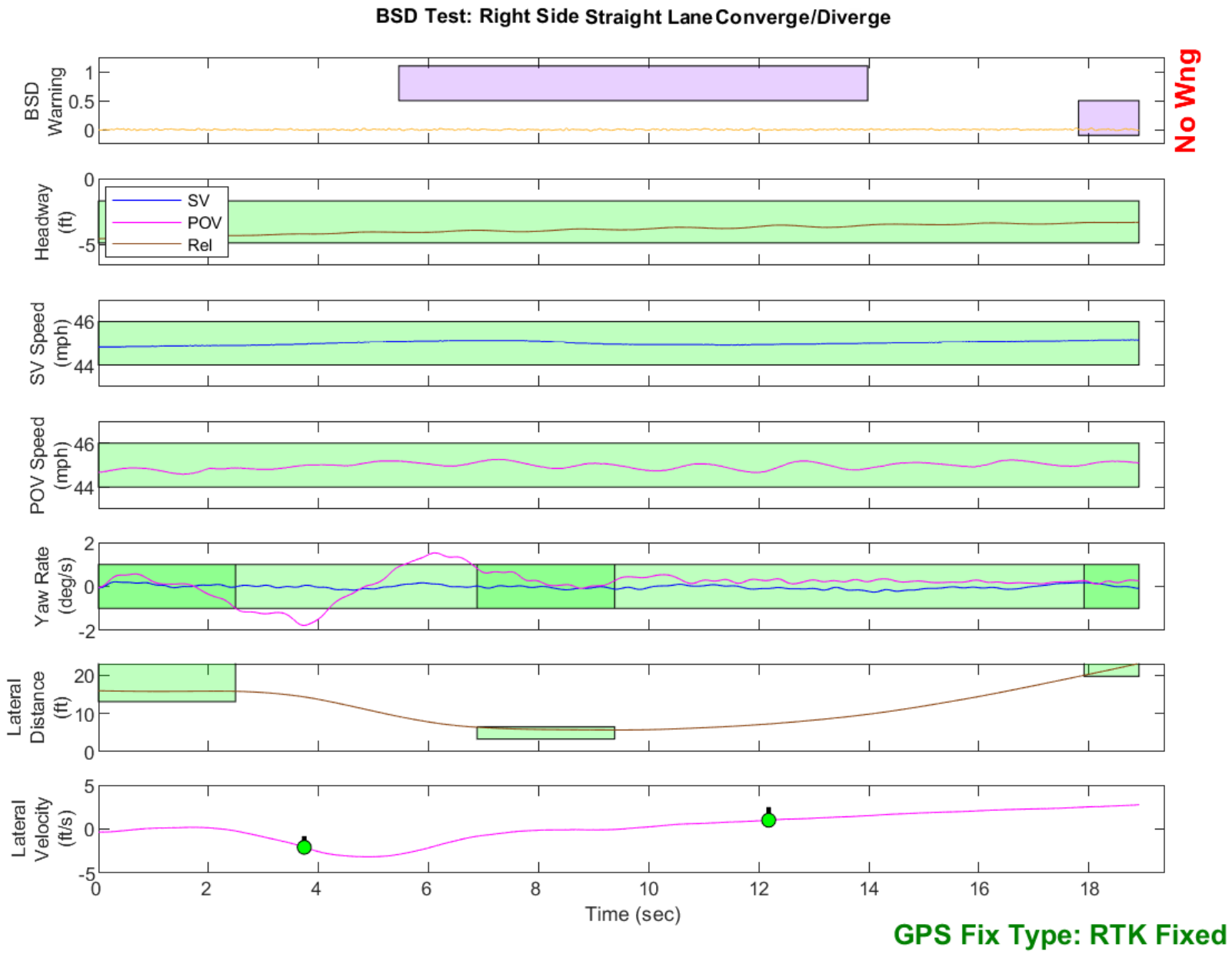


Figure D2. Example Time History for Straight Lane Converge/Diverge Test, Failing

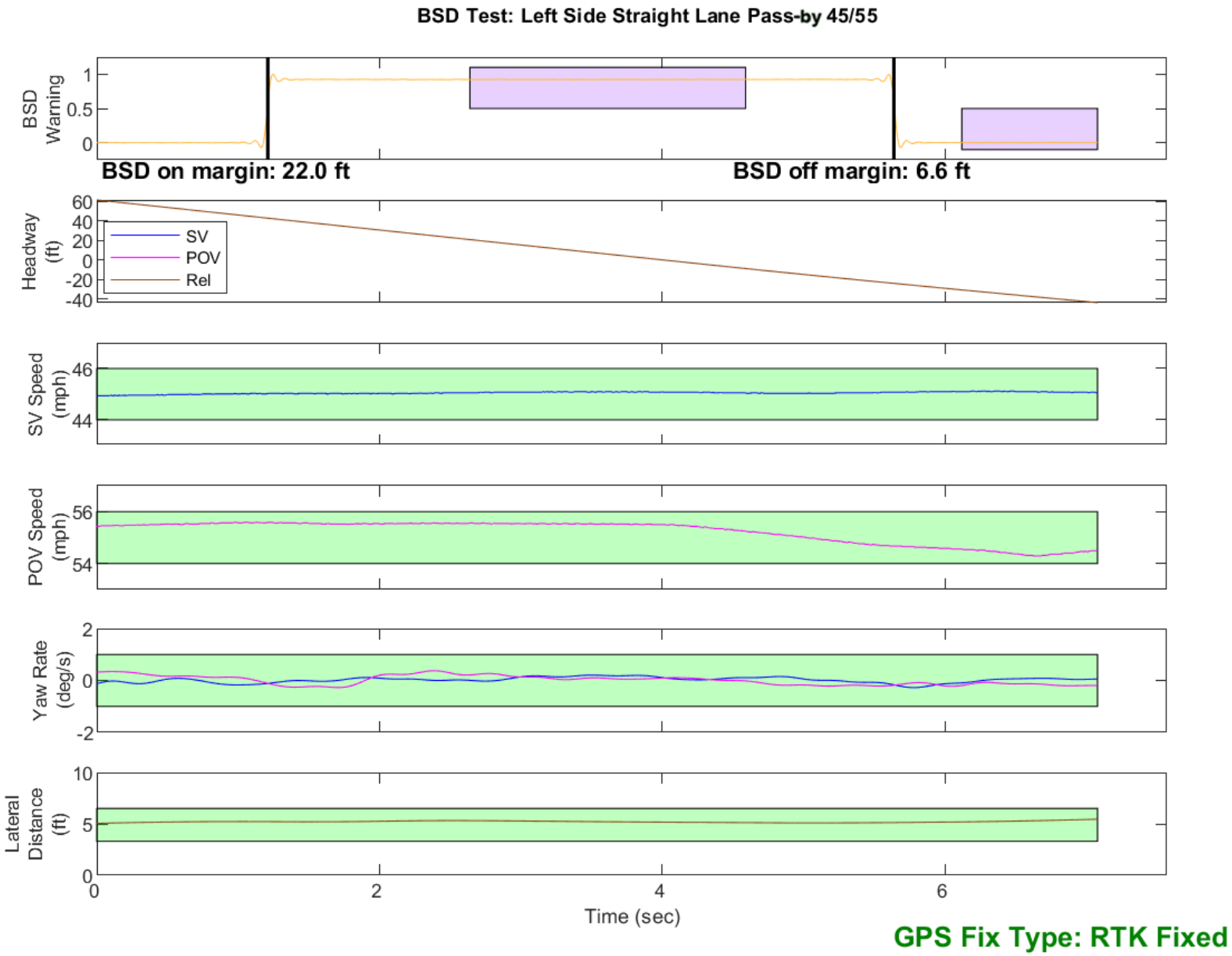


Figure D3. Example Time History for Straight Lane Pass-By Passing

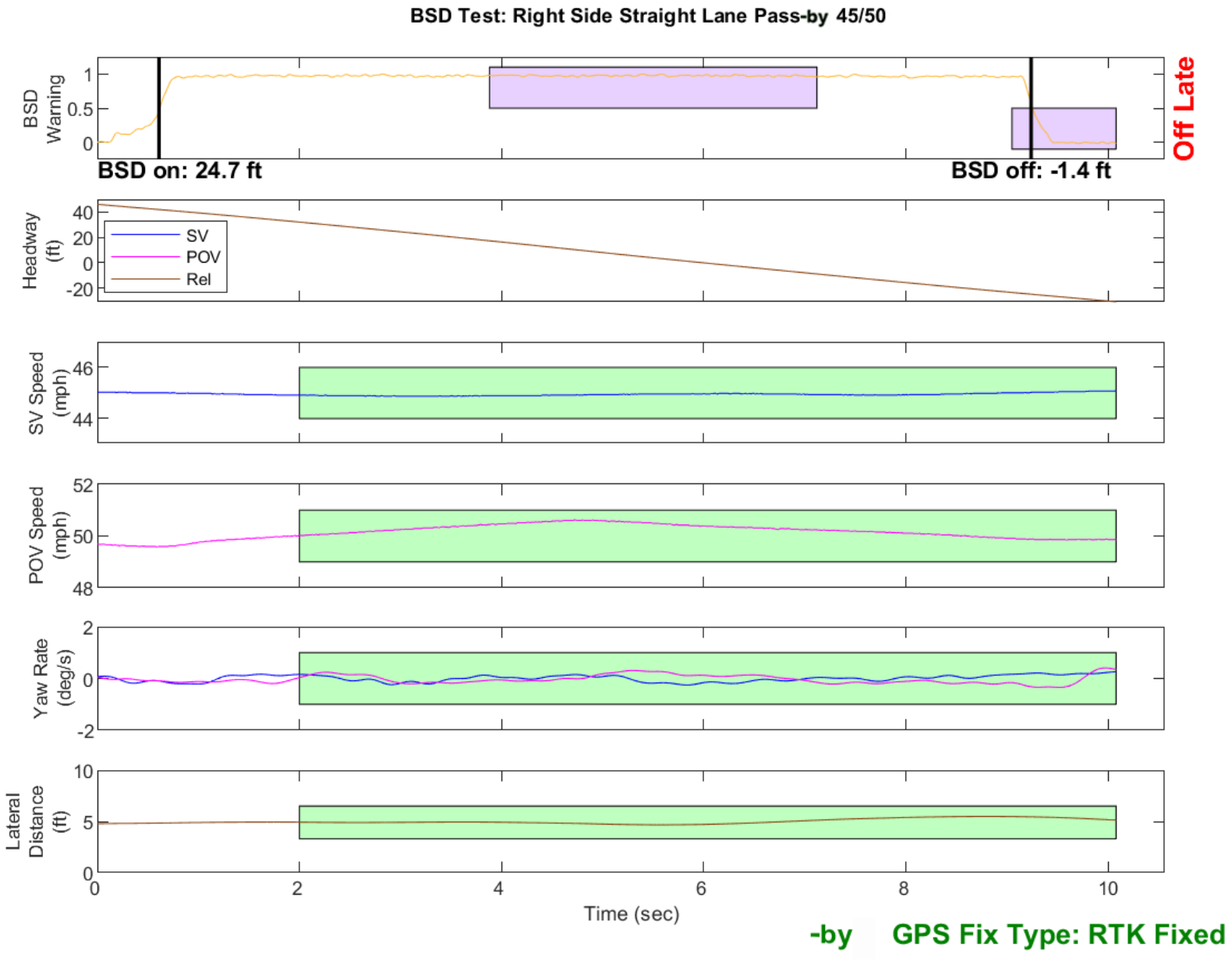


Figure D4. Example Time History for Straight Lane Pass-by Test, Failing

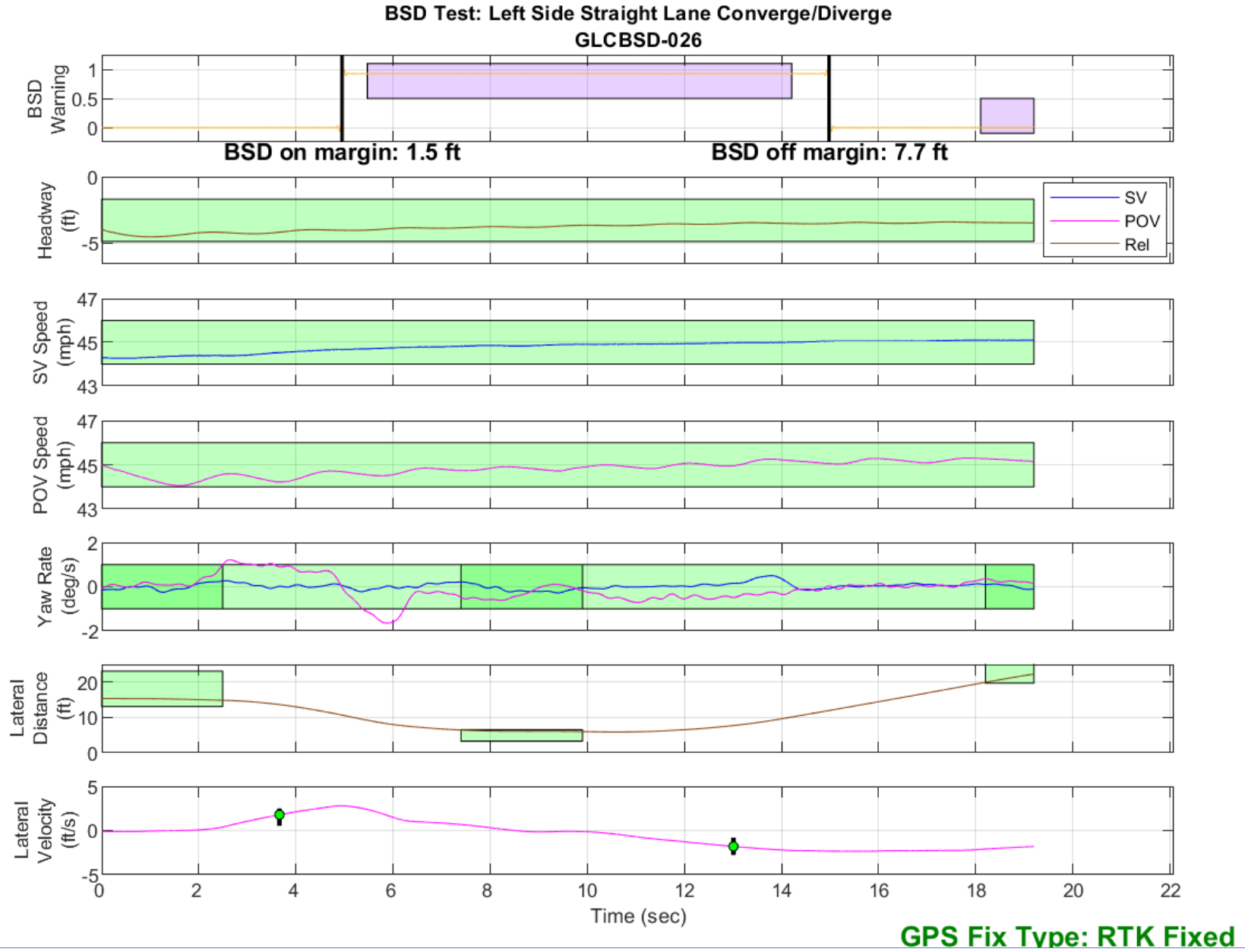


Figure D5. BSD Run 26, Straight Lane Converge/Diverge

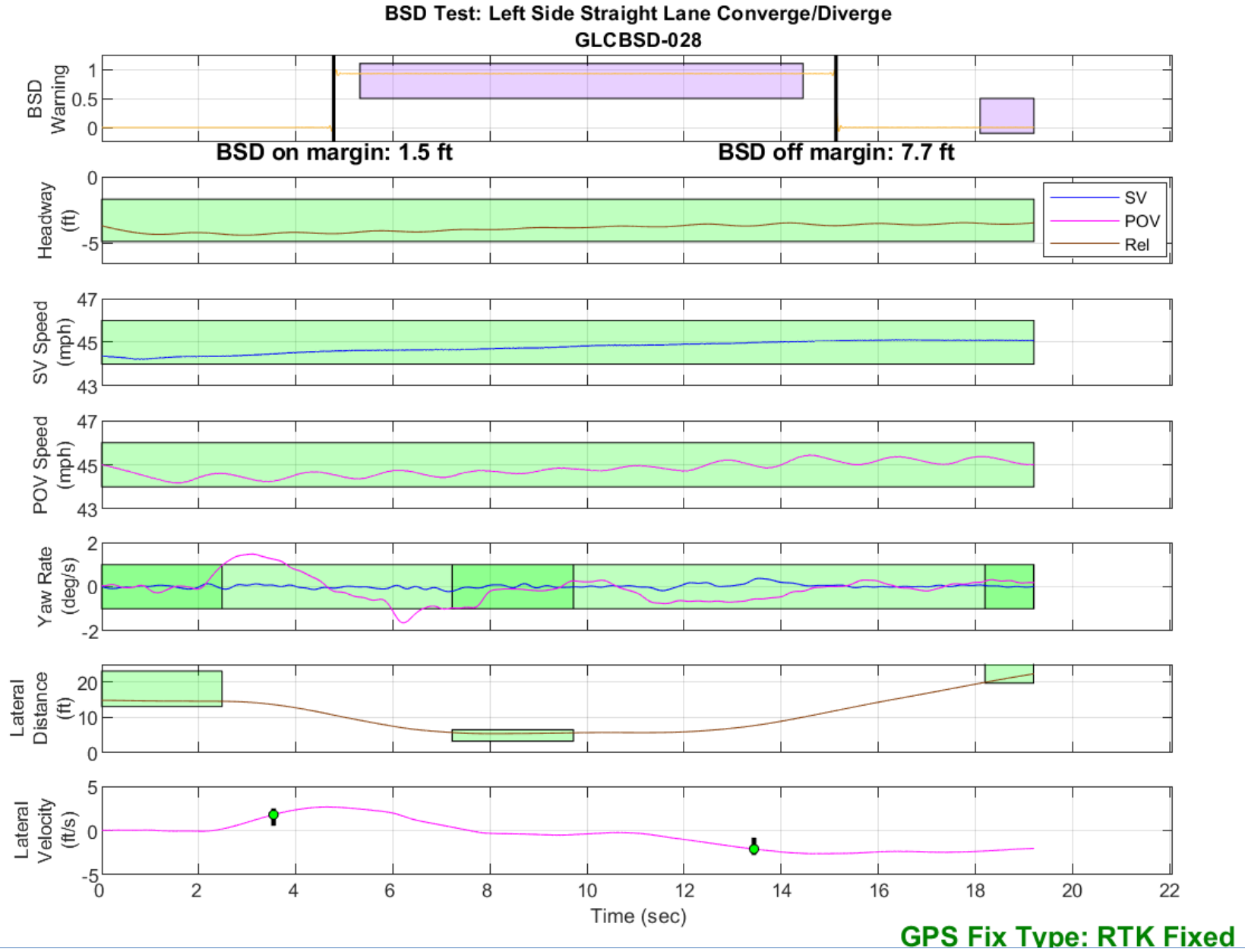


Figure D6. BSD Run 28, Straight Lane Converge/Diverge

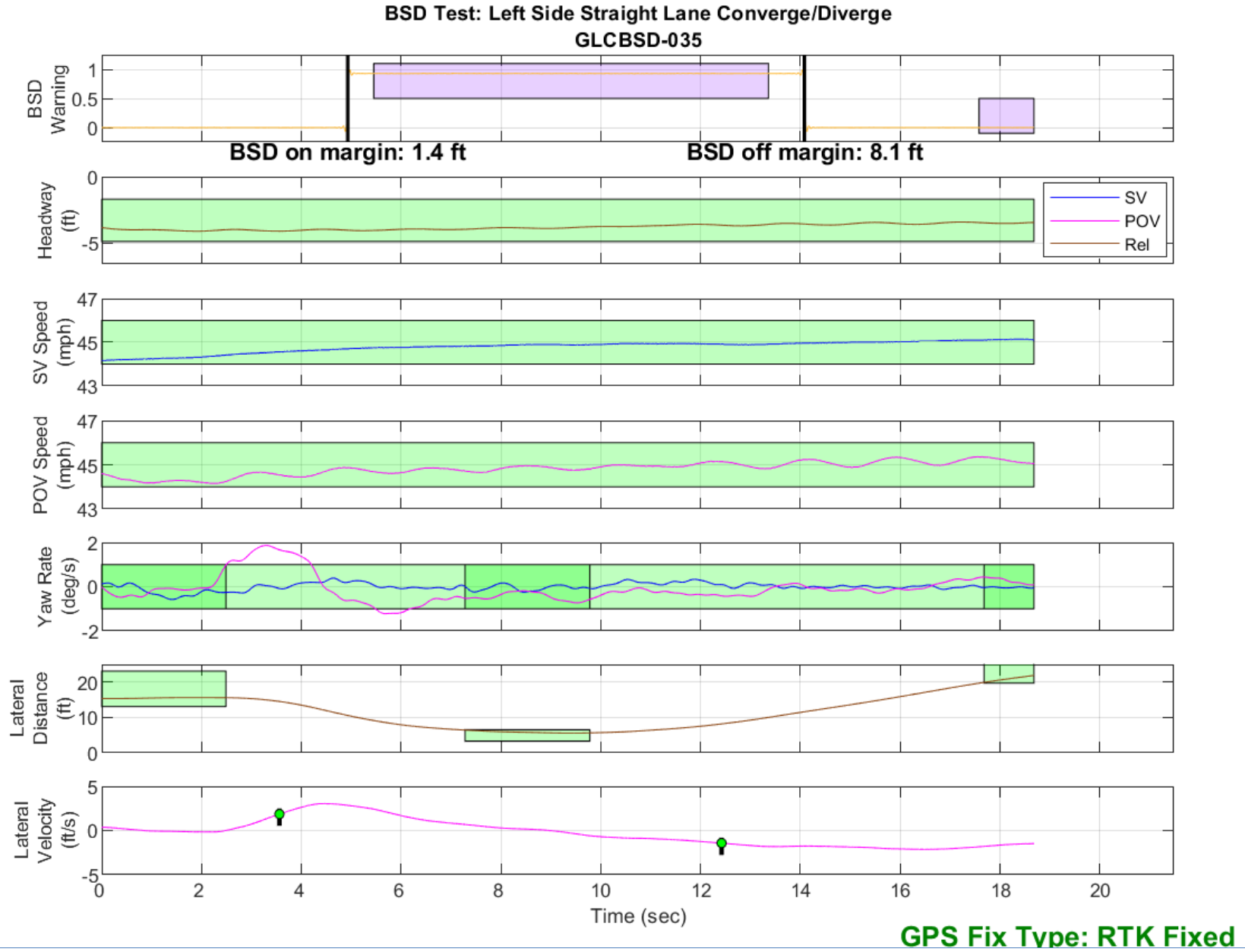


Figure D7. BSD Run 35, Straight Lane Converge/Diverge

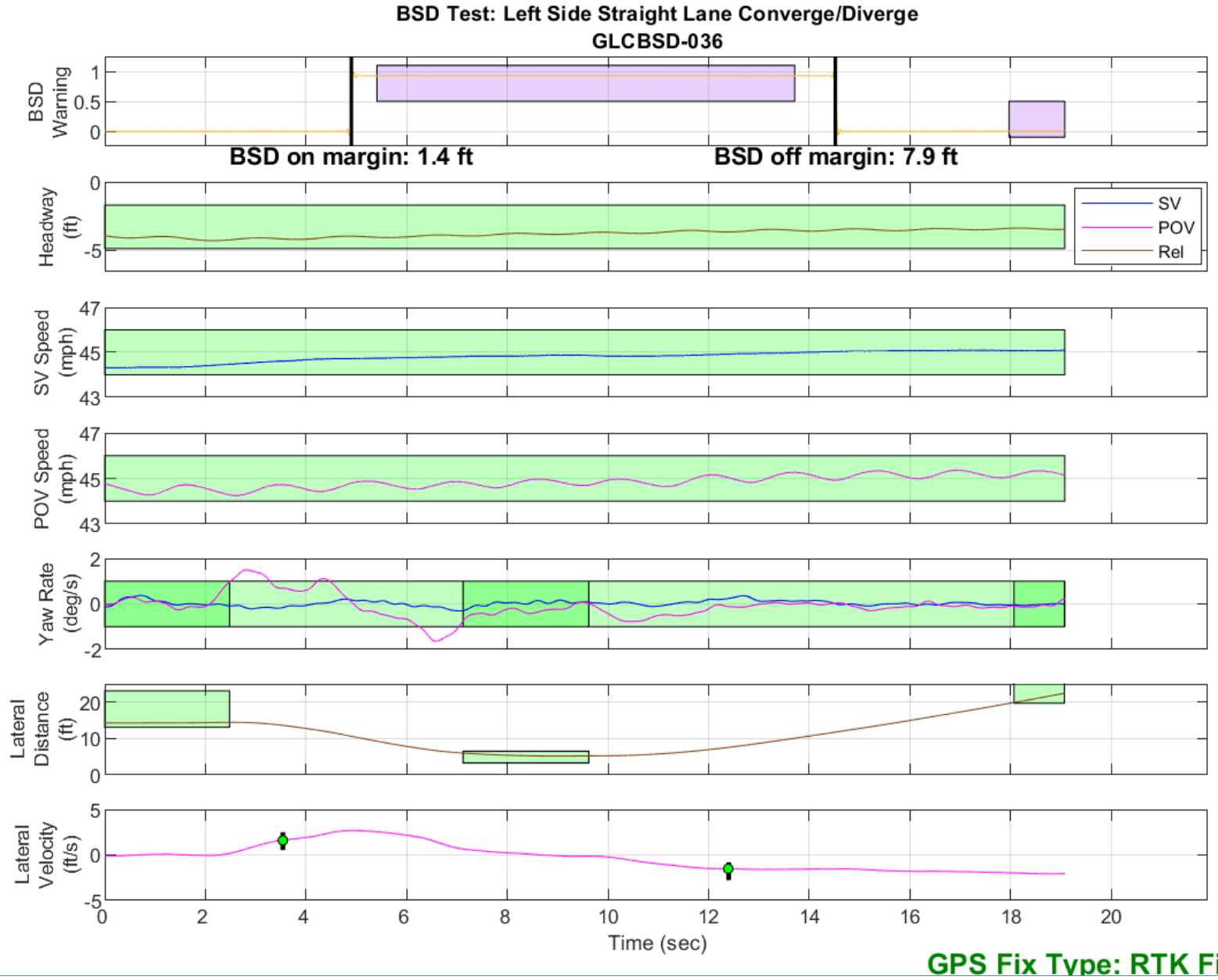


Figure D8. BSD Run 36, Straight Lane Converge/Diverge

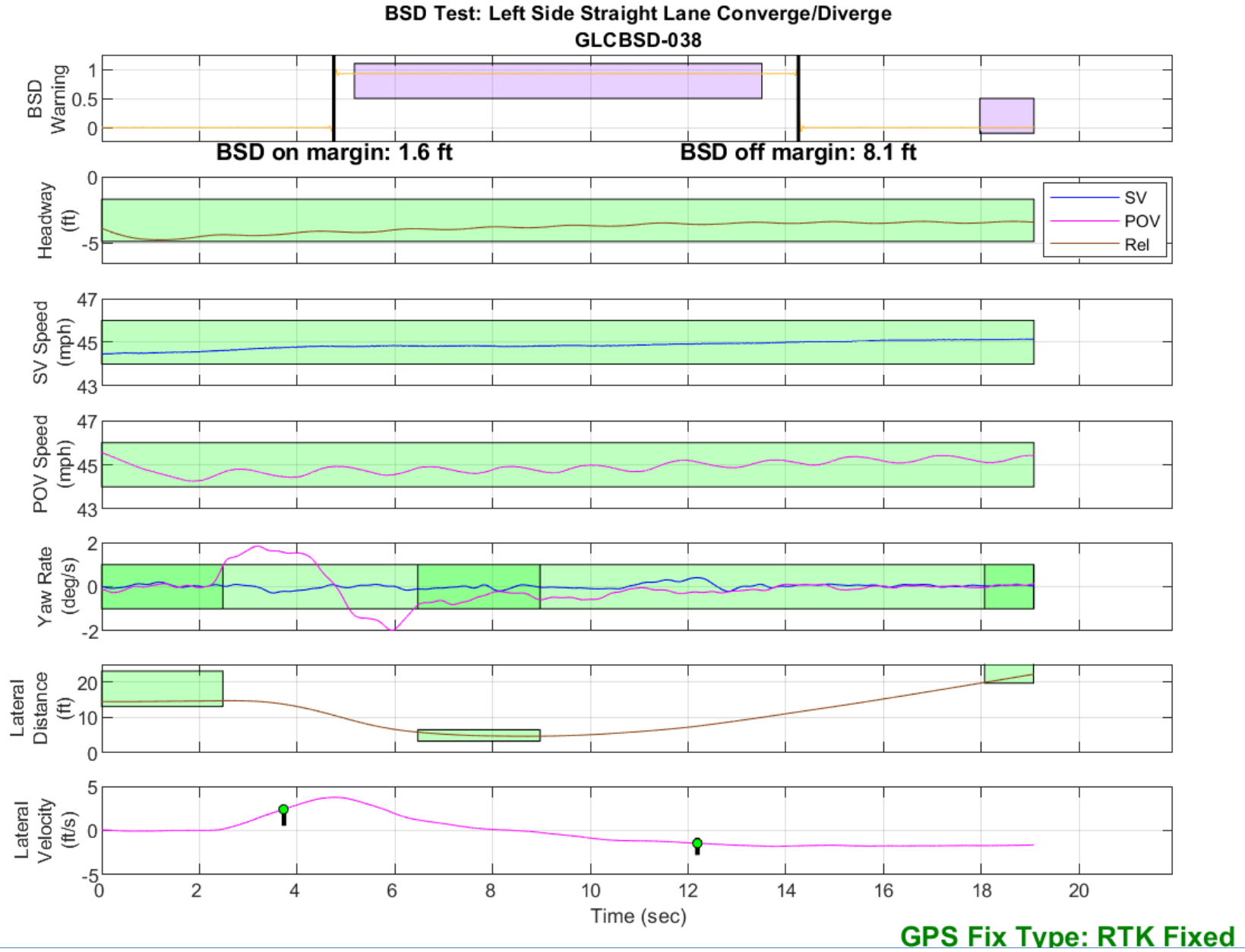


Figure D9. BSD Run 38, Straight Lane Converge/Diverge

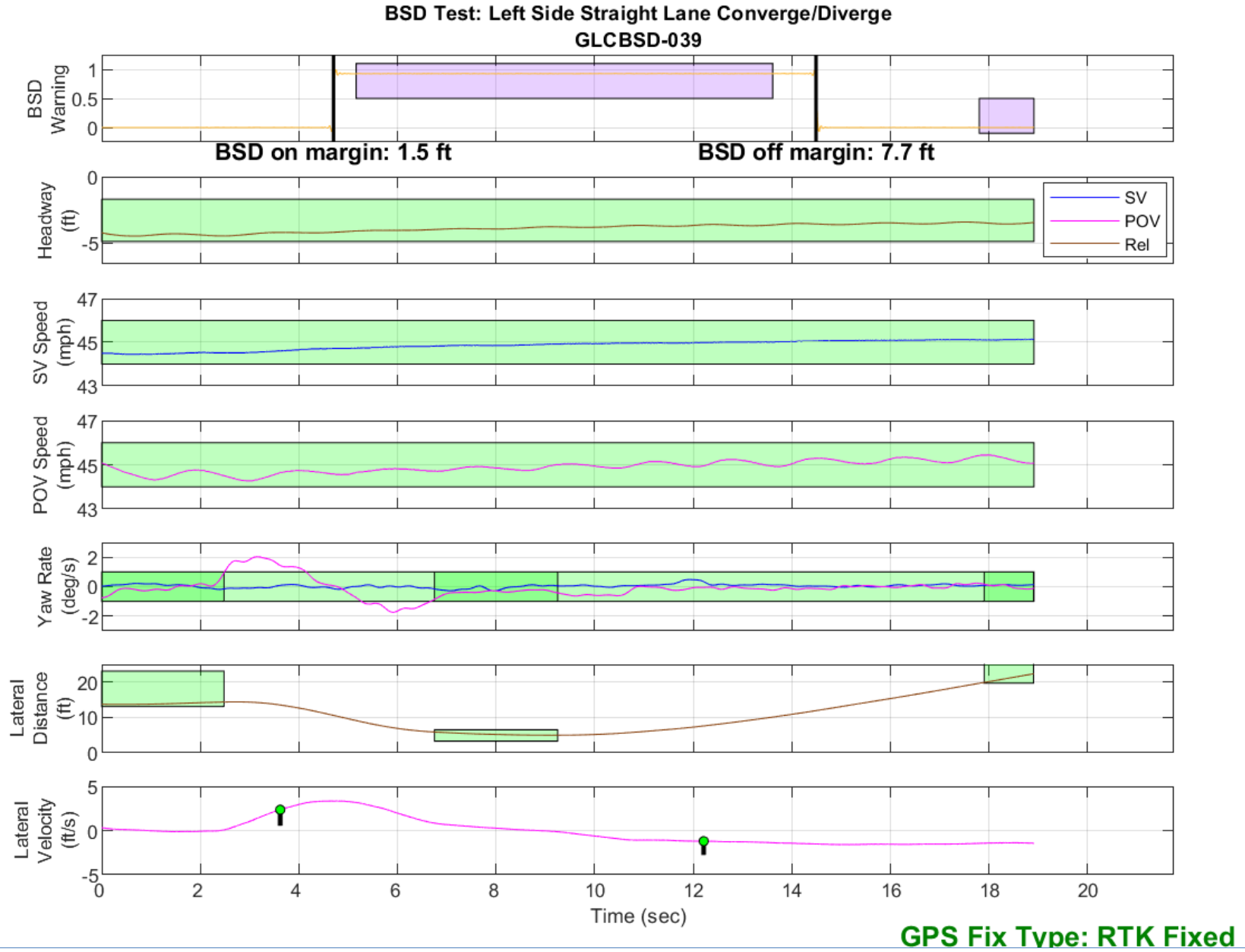


Figure D10. BSD Run 39, Straight Lane Converge/Diverge

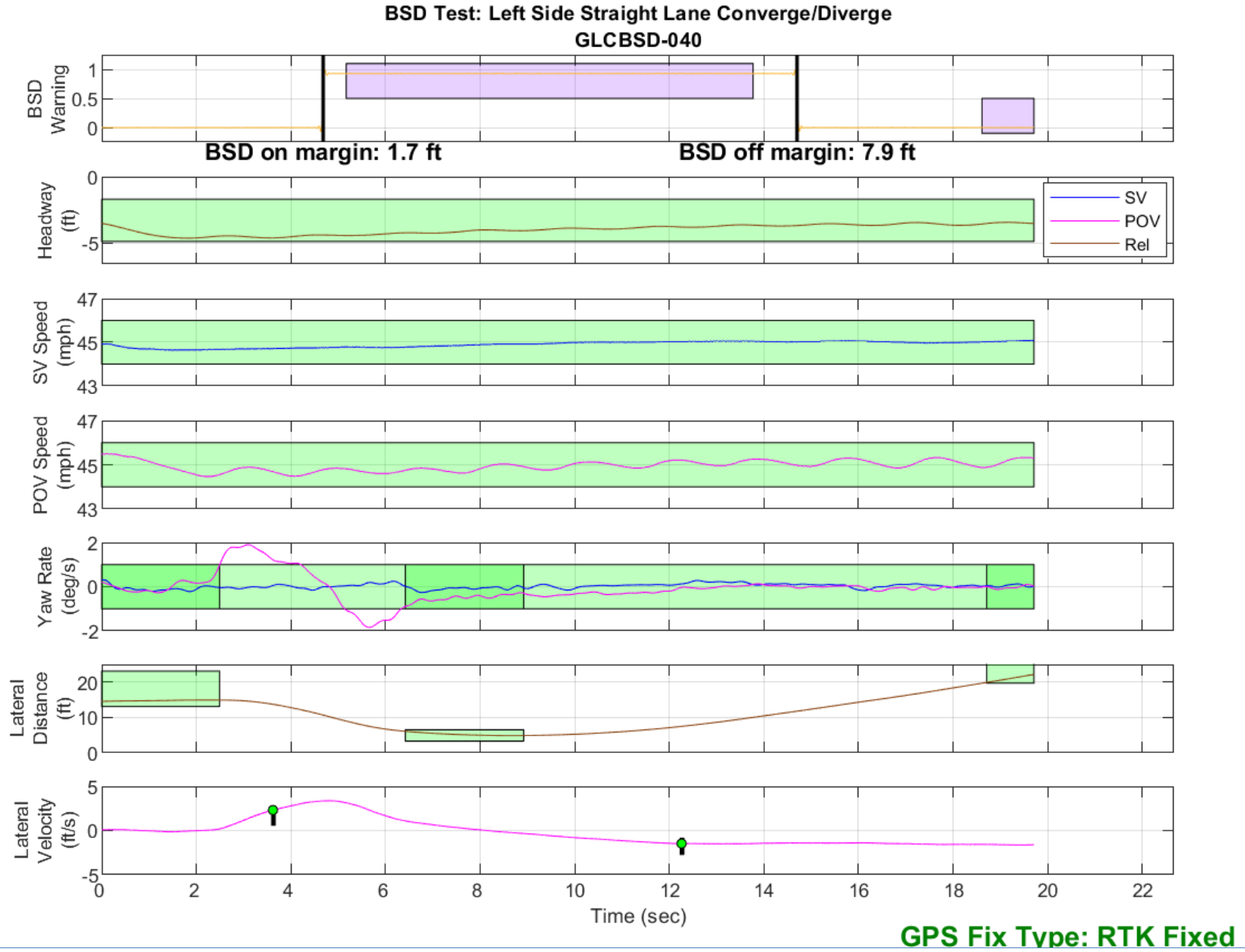


Figure D11. BSD Run 40, Straight Lane Converge/Diverge

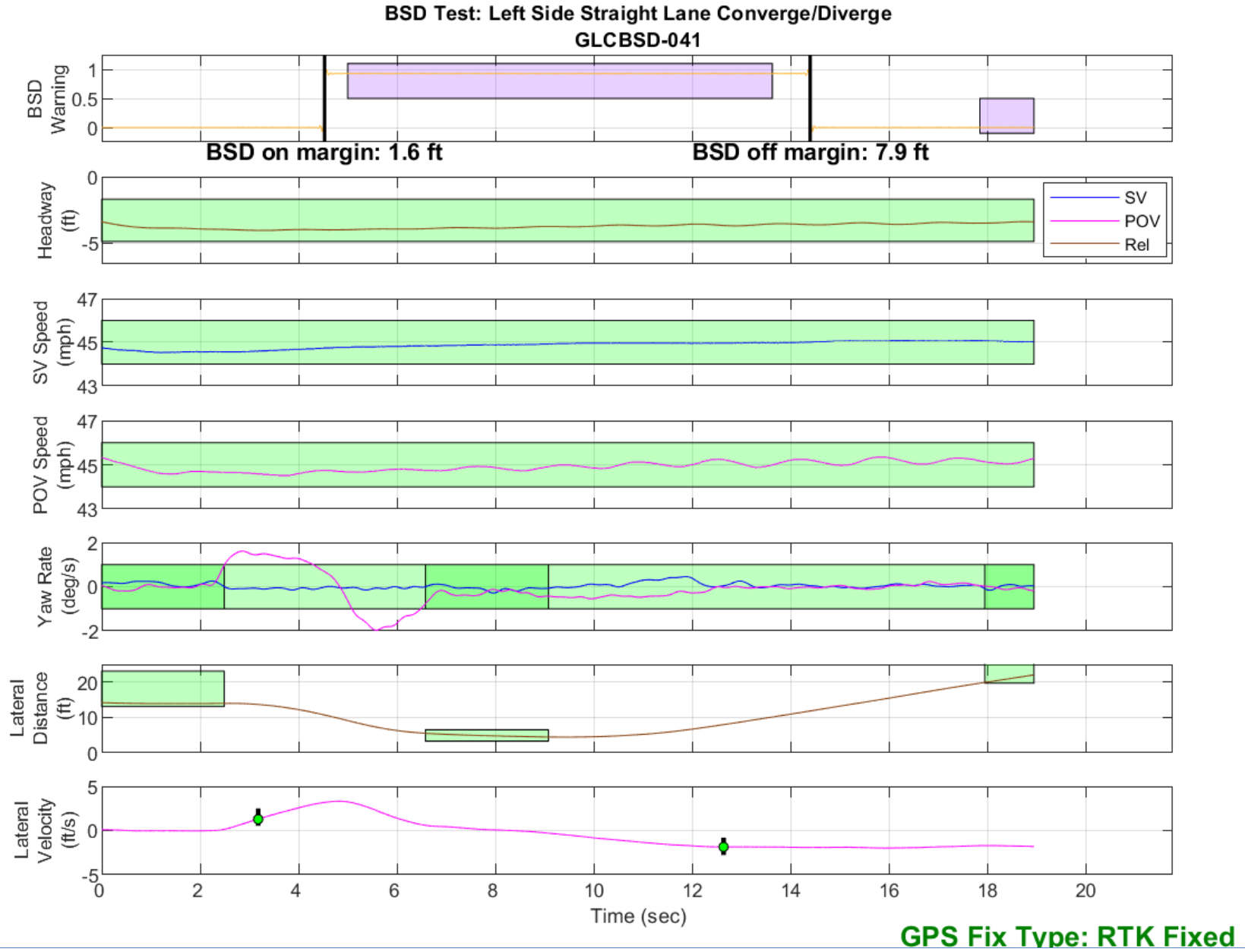


Figure D12. BSD Run 41, Straight Lane Converge/Diverge

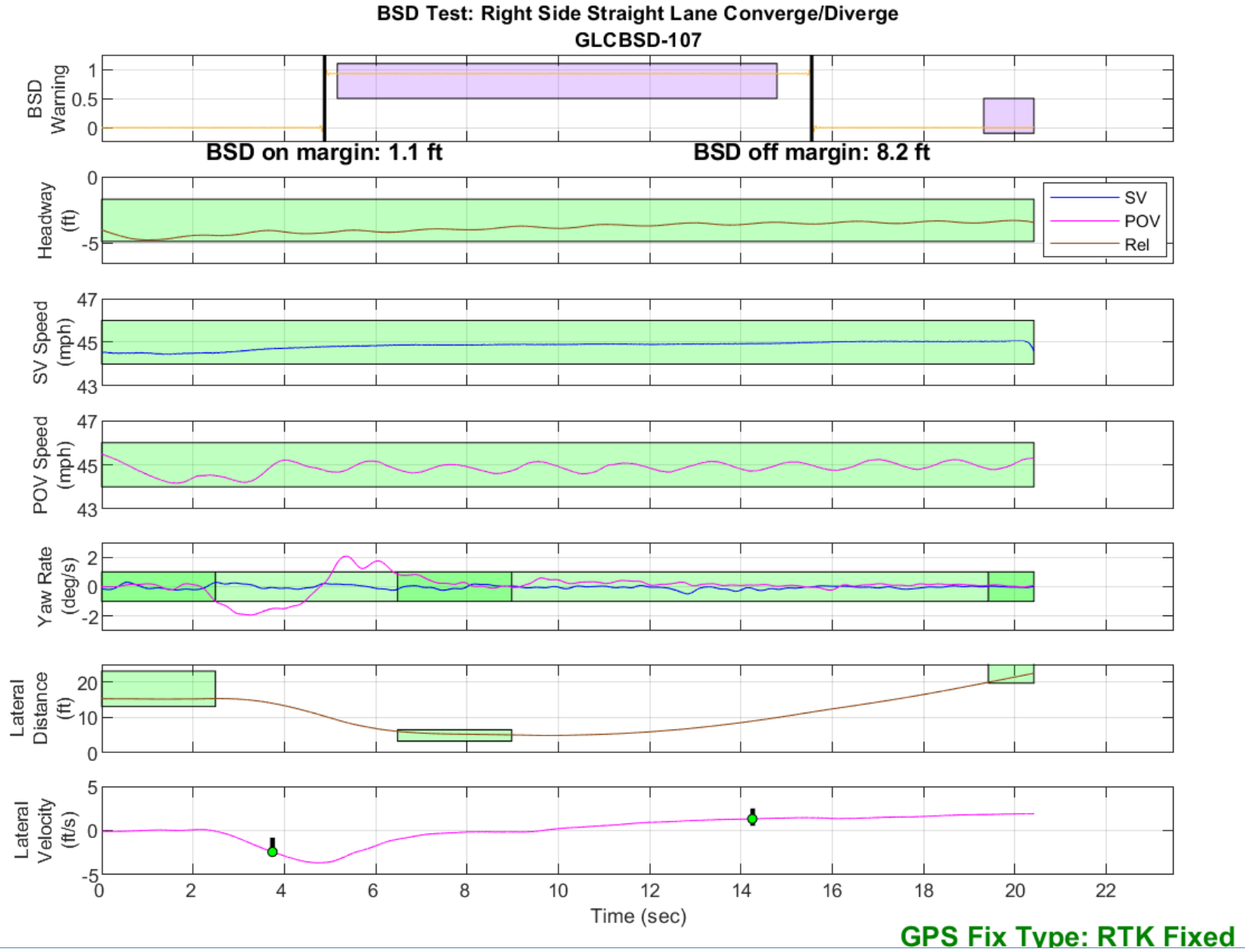


Figure D13. BSD Run 107, Straight Lane Converge/Diverge

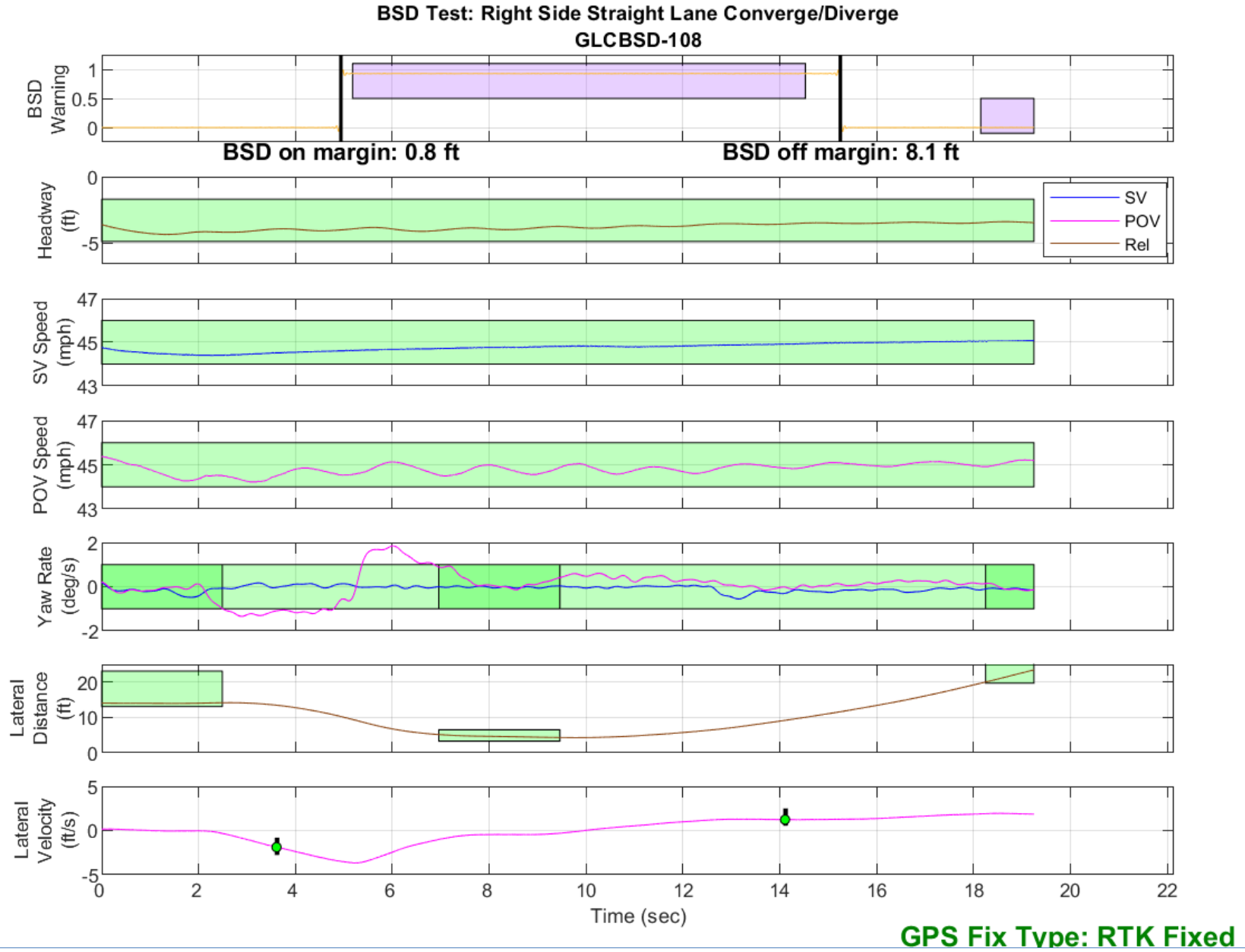


Figure D14. BSD Run 108, Straight Lane Converge/Diverge

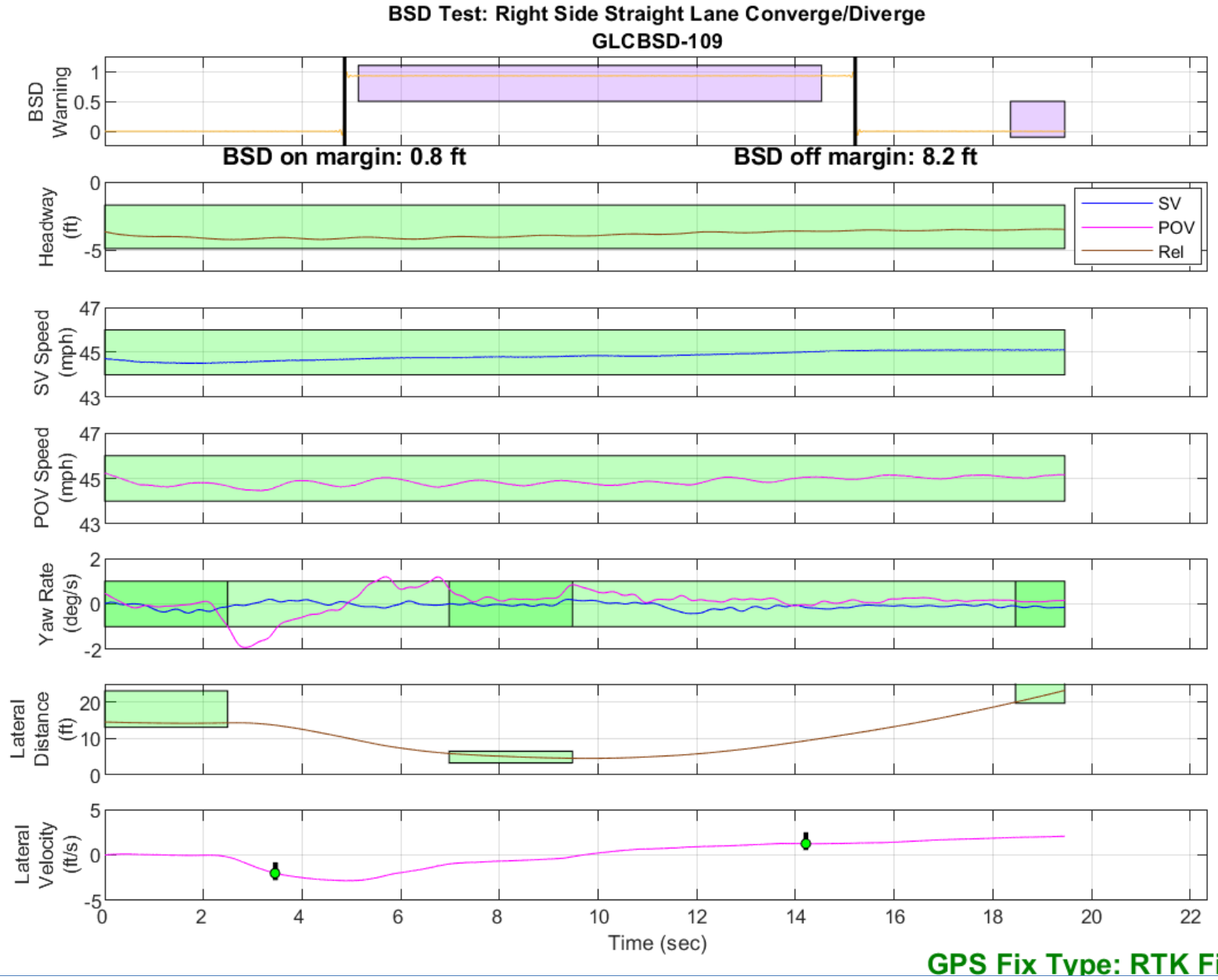


Figure D15. BSD Run 109, Straight Lane Converge/Diverge

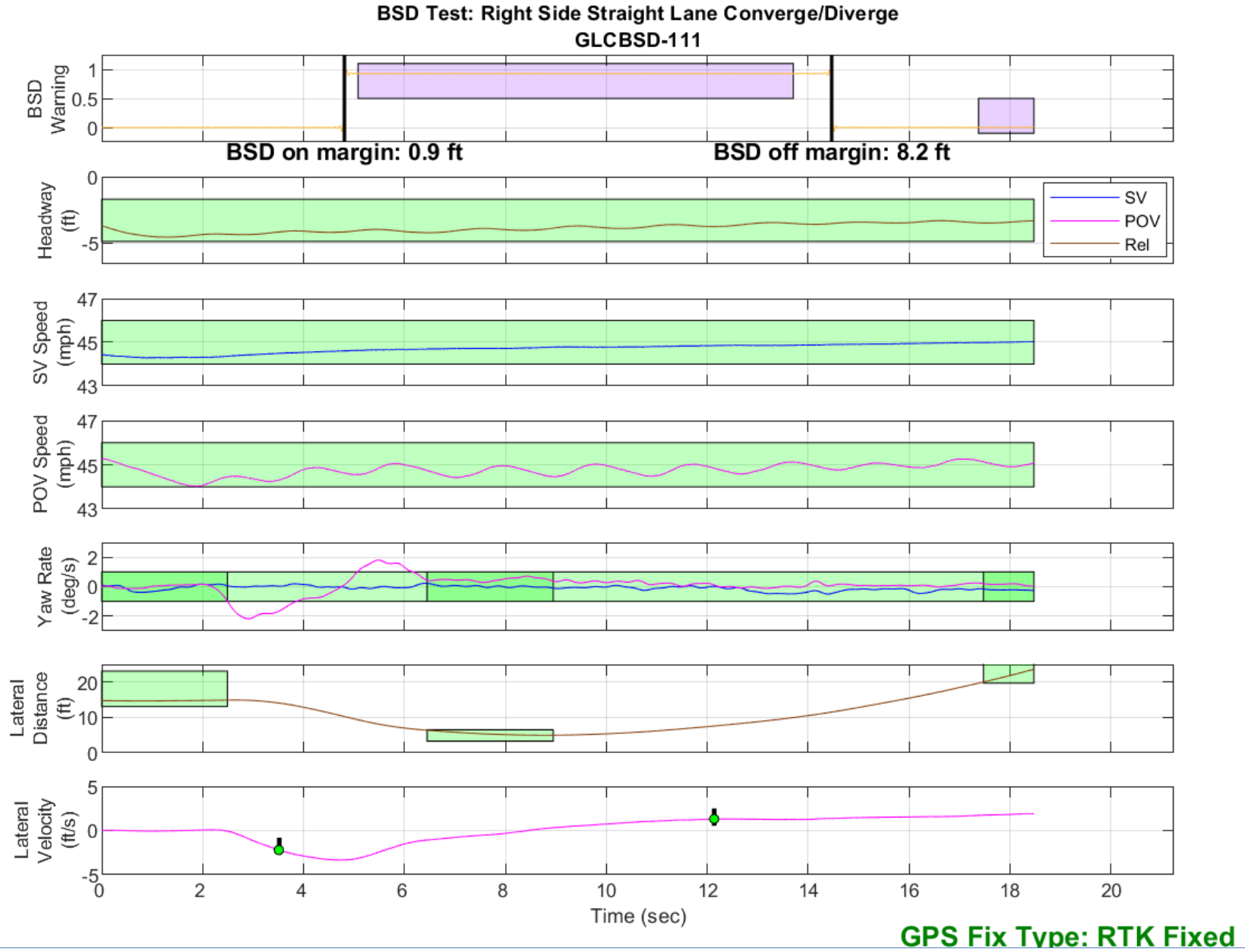


Figure D16. BSD Run 111, Straight Lane Converge/Diverge

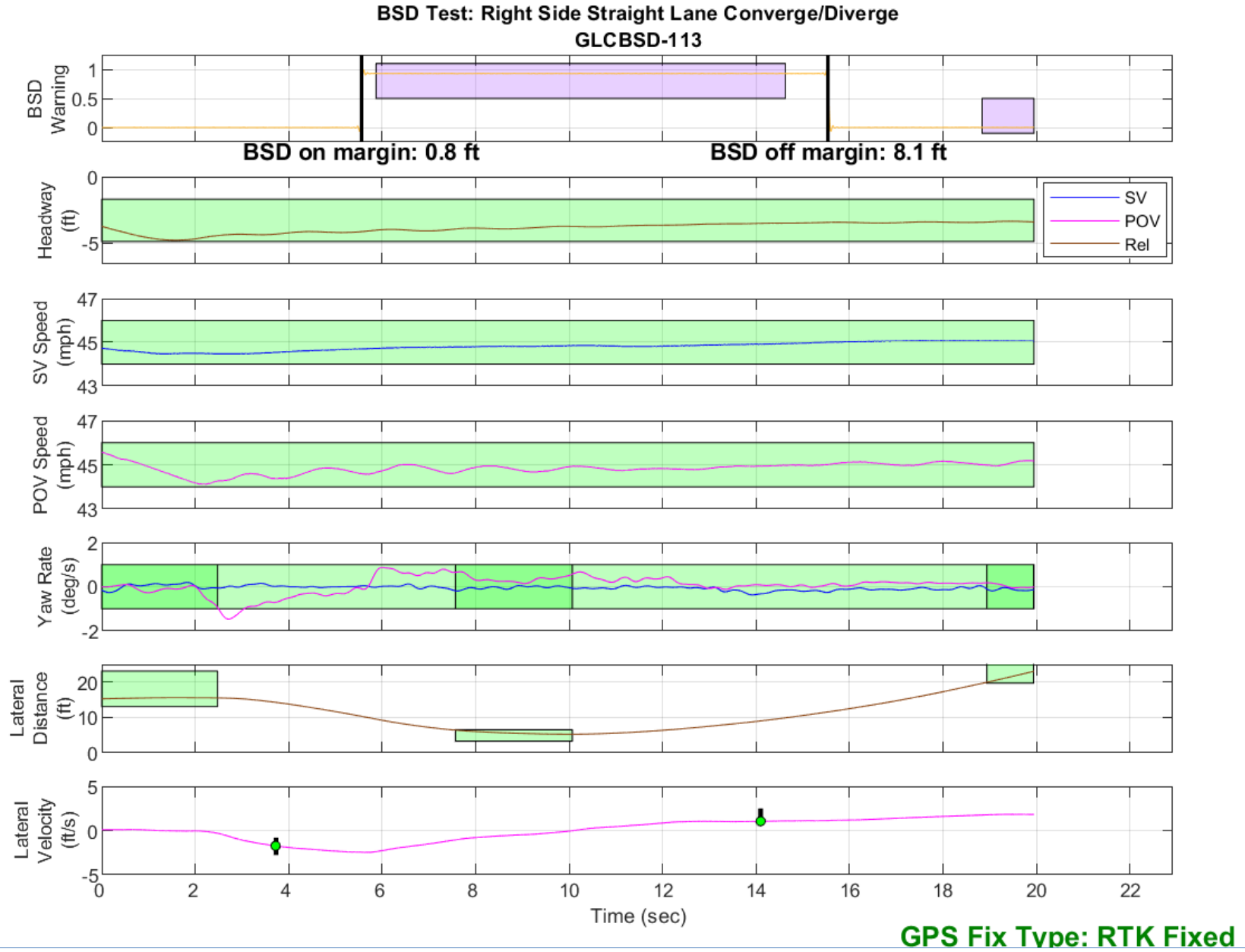


Figure D17. BSD Run 113, Straight Lane Converge/Diverge

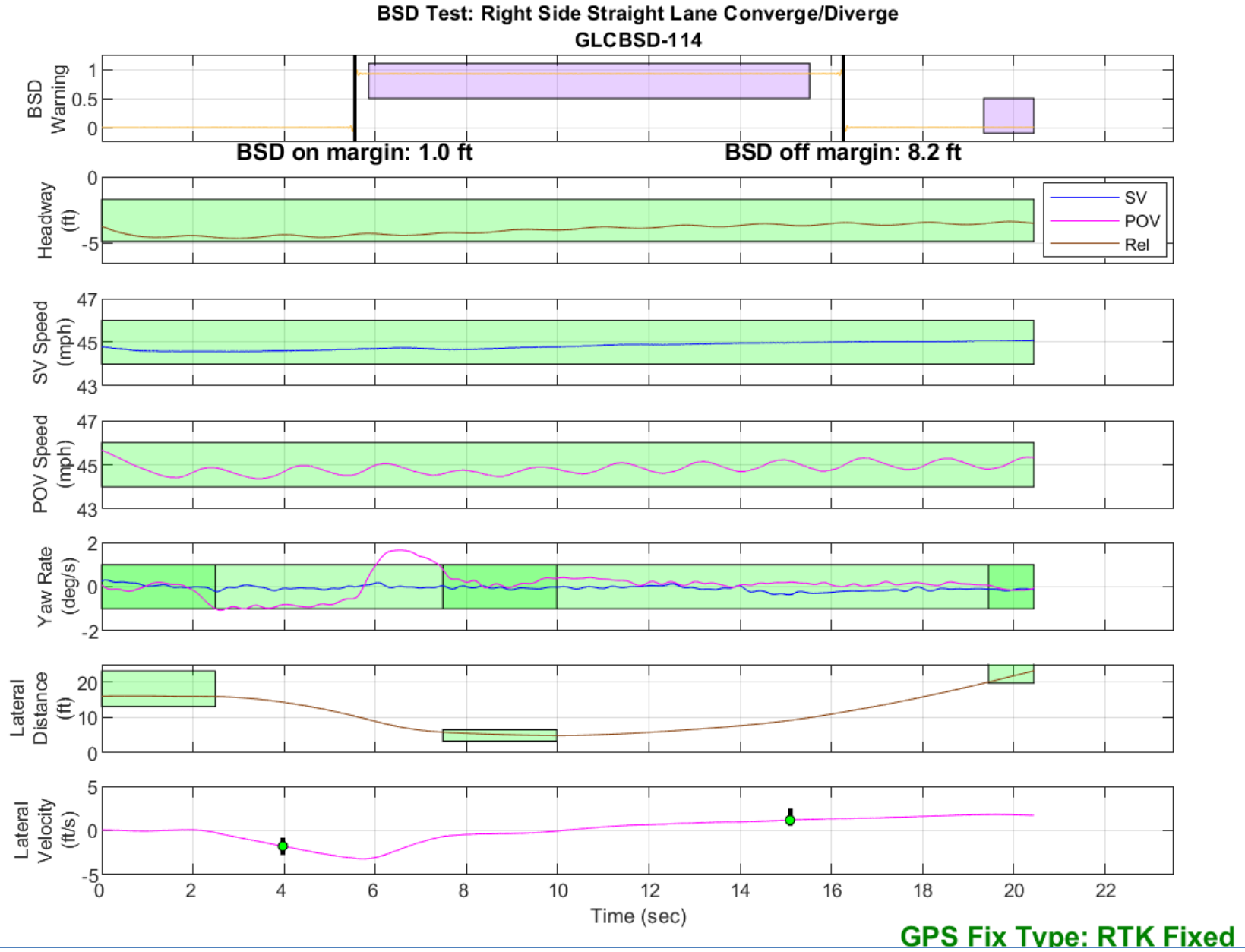


Figure D18. BSD Run 114, Straight Lane Converge/Diverge

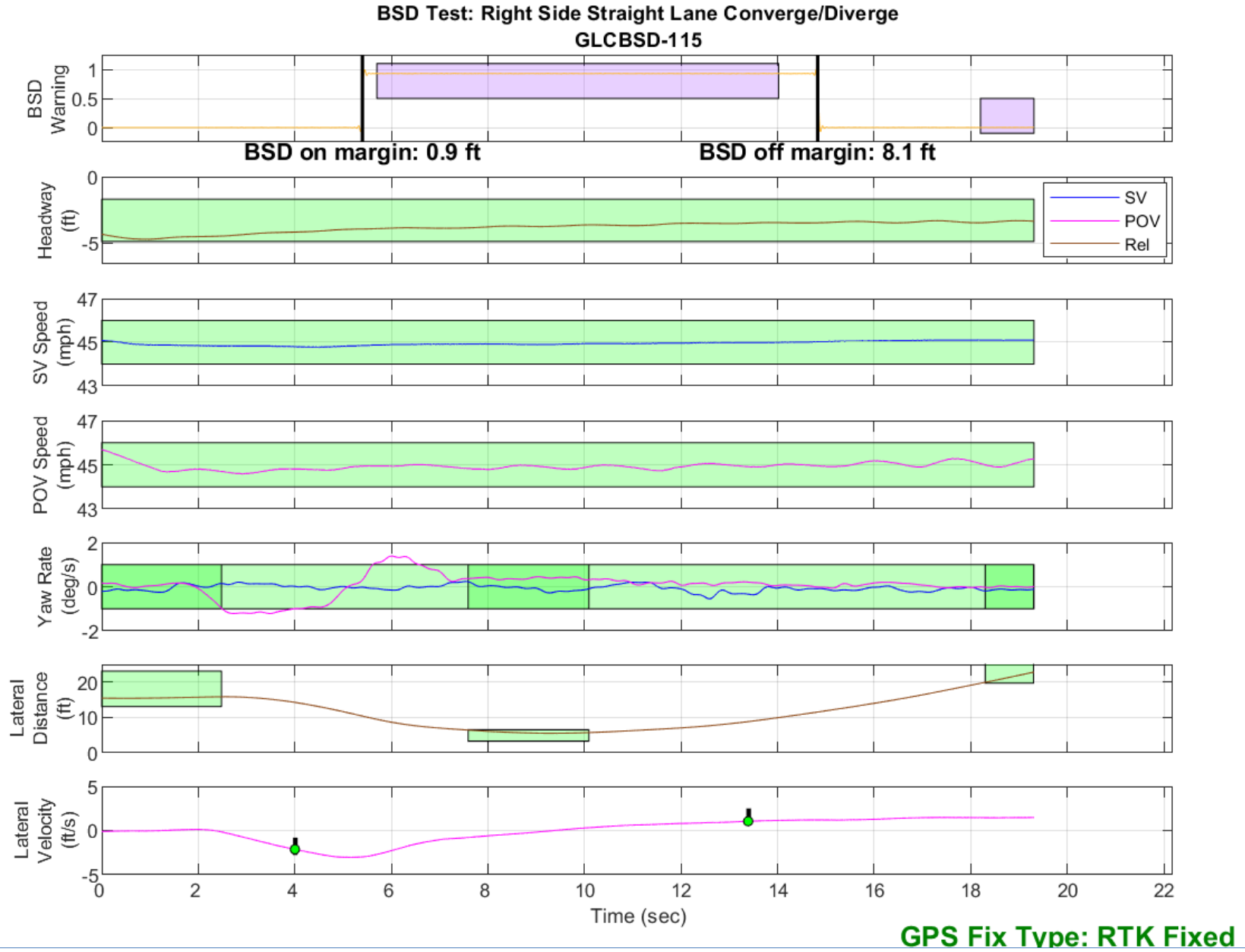


Figure D19. BSD Run 115, Straight Lane Converge/Diverge

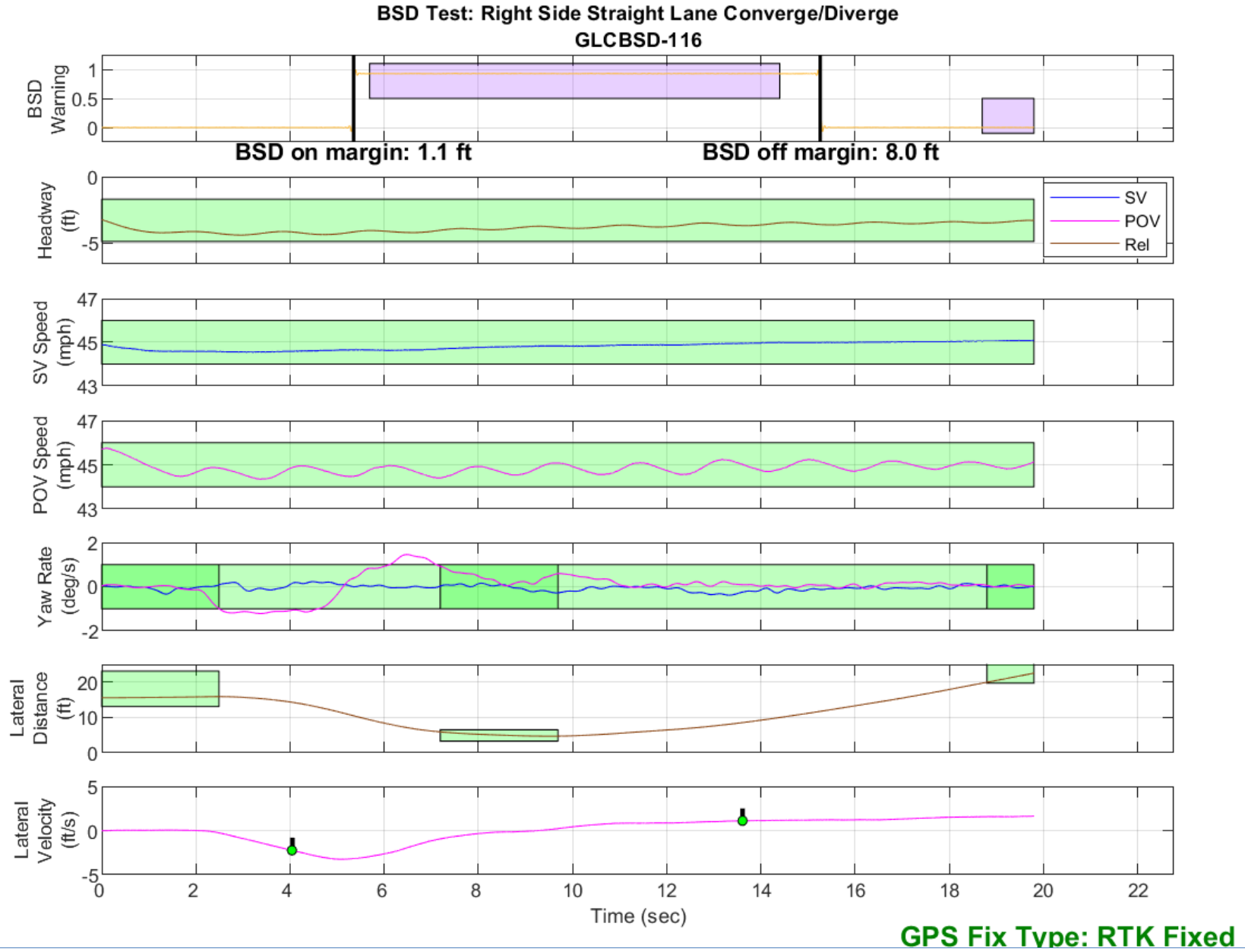


Figure D20. BSD Run 116, Straight Lane Converge/Diverge

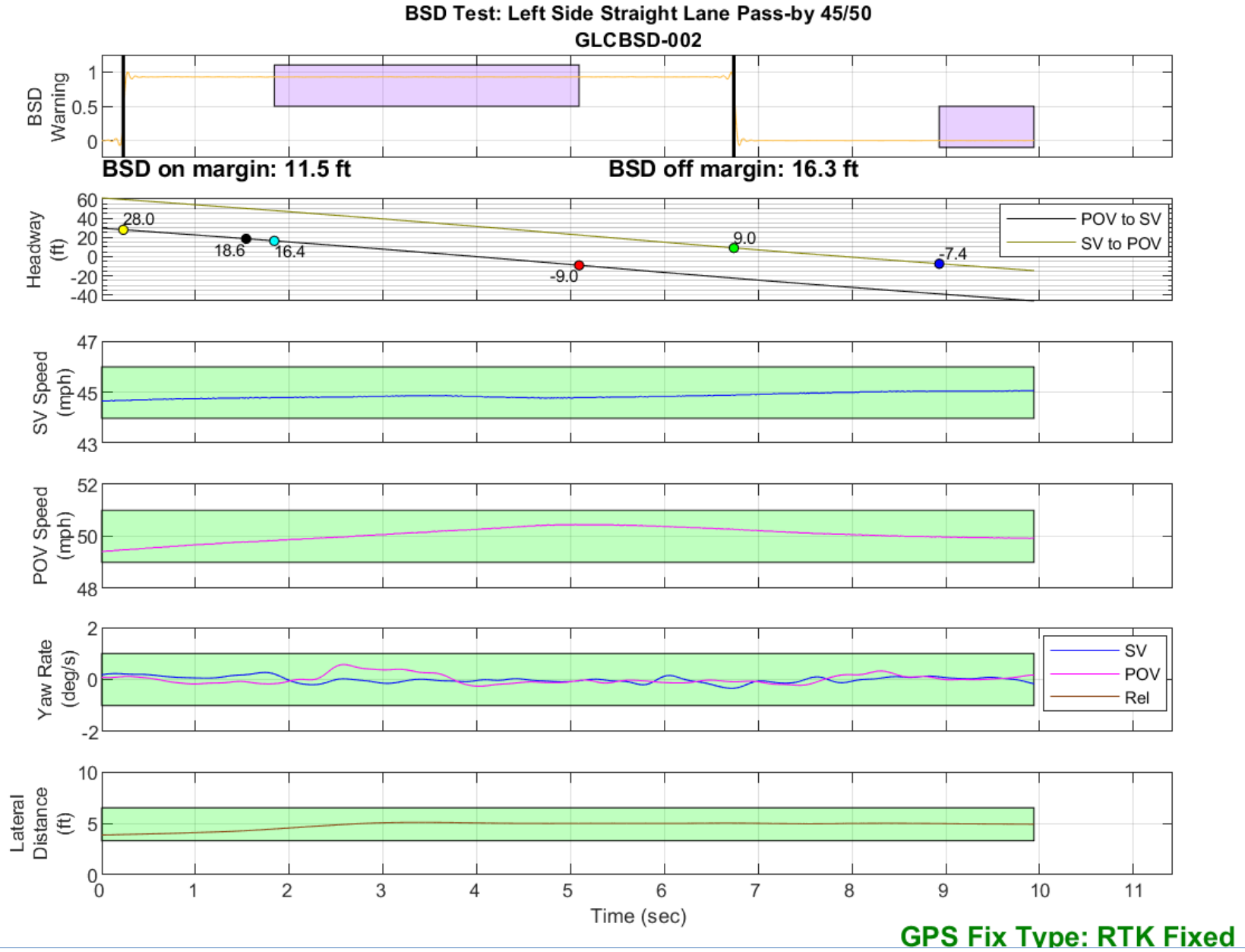


Figure D21. BSD Run 2, Straight Lane Pass-by, SV 45 mph, POV 50 mph

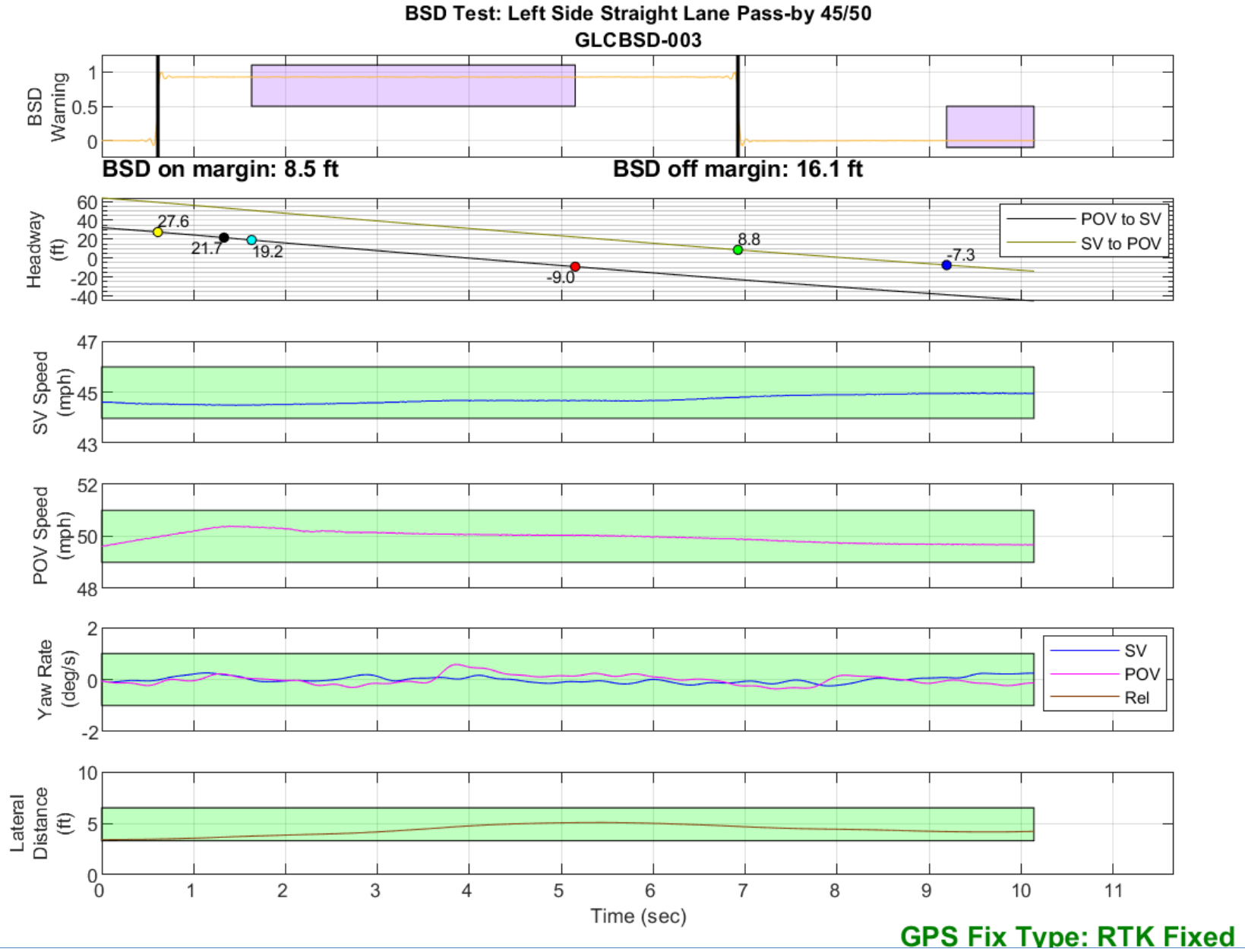


Figure D22. BSD Run 3, Straight Lane Pass-by, SV 45 mph, POV 50 mph

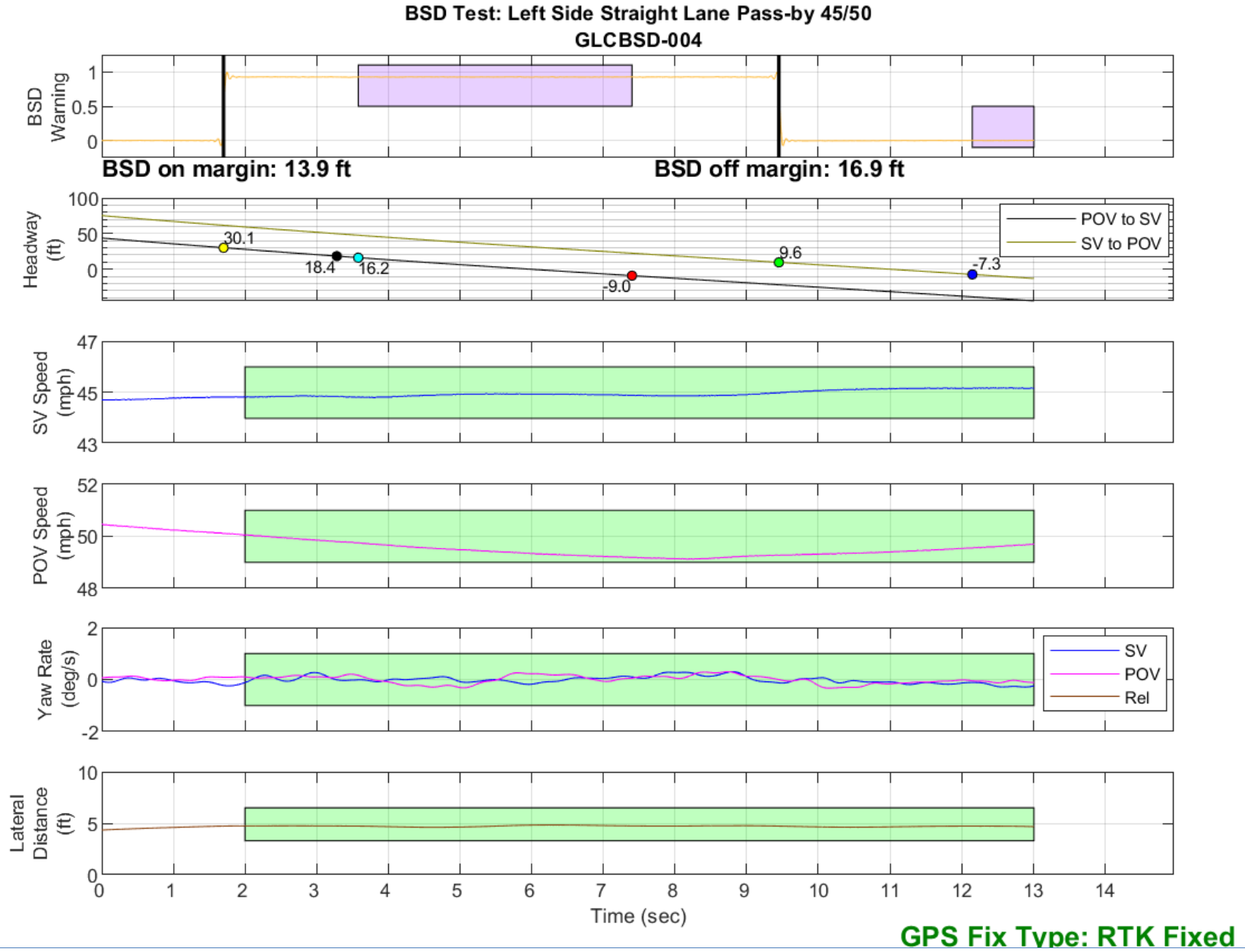


Figure D23. BSD Run 4, Straight Lane Pass-by, SV 45 mph, POV 50 mph

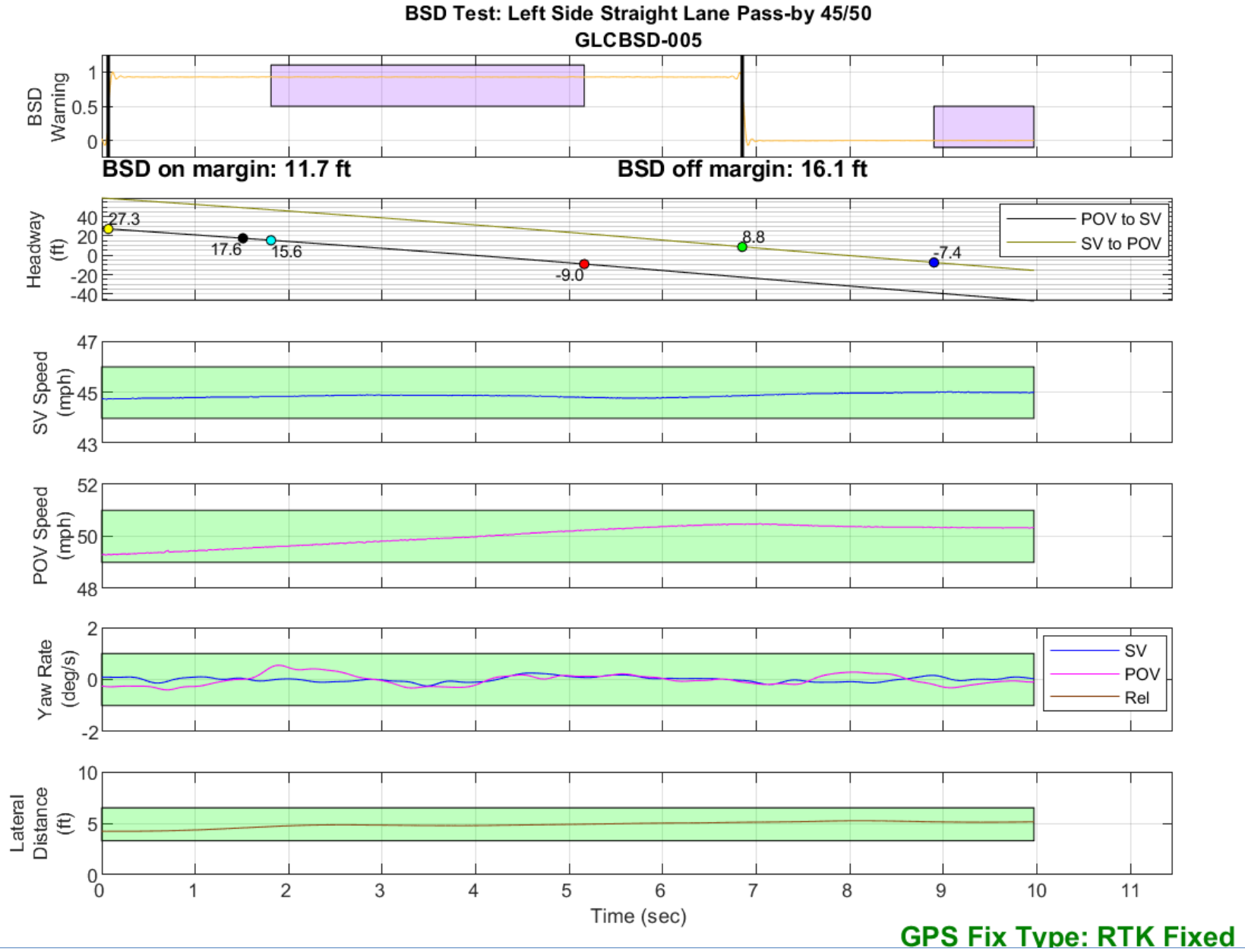


Figure D24. BSD Run 5, Straight Lane Pass-by, SV 45 mph, POV 50 mph

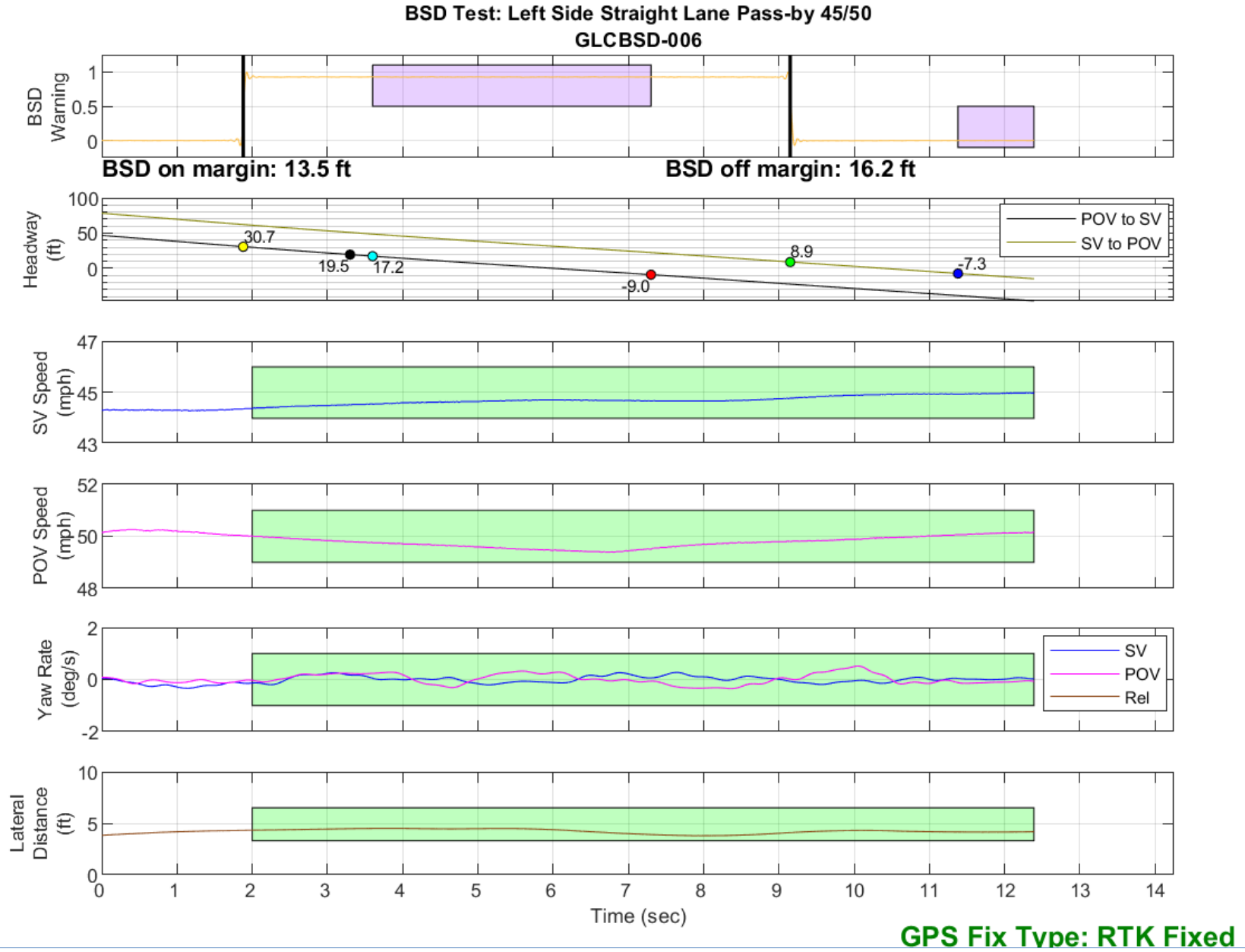


Figure D25. BSD Run 6, Straight Lane Pass-by, SV 45 mph, POV 50 mph

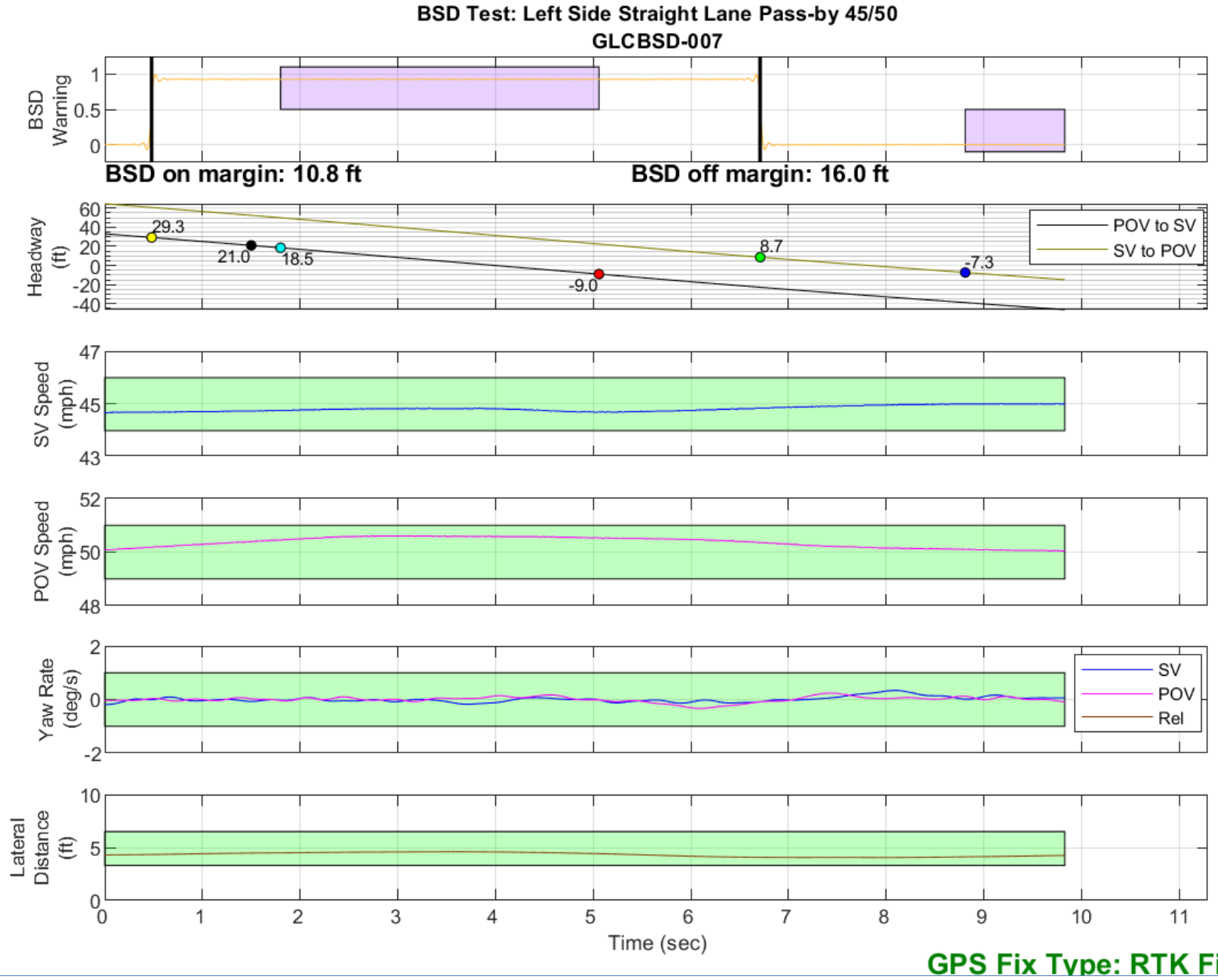


Figure D26. BSD Run 7, Straight Lane Pass-by, SV 45 mph, POV 50 mph

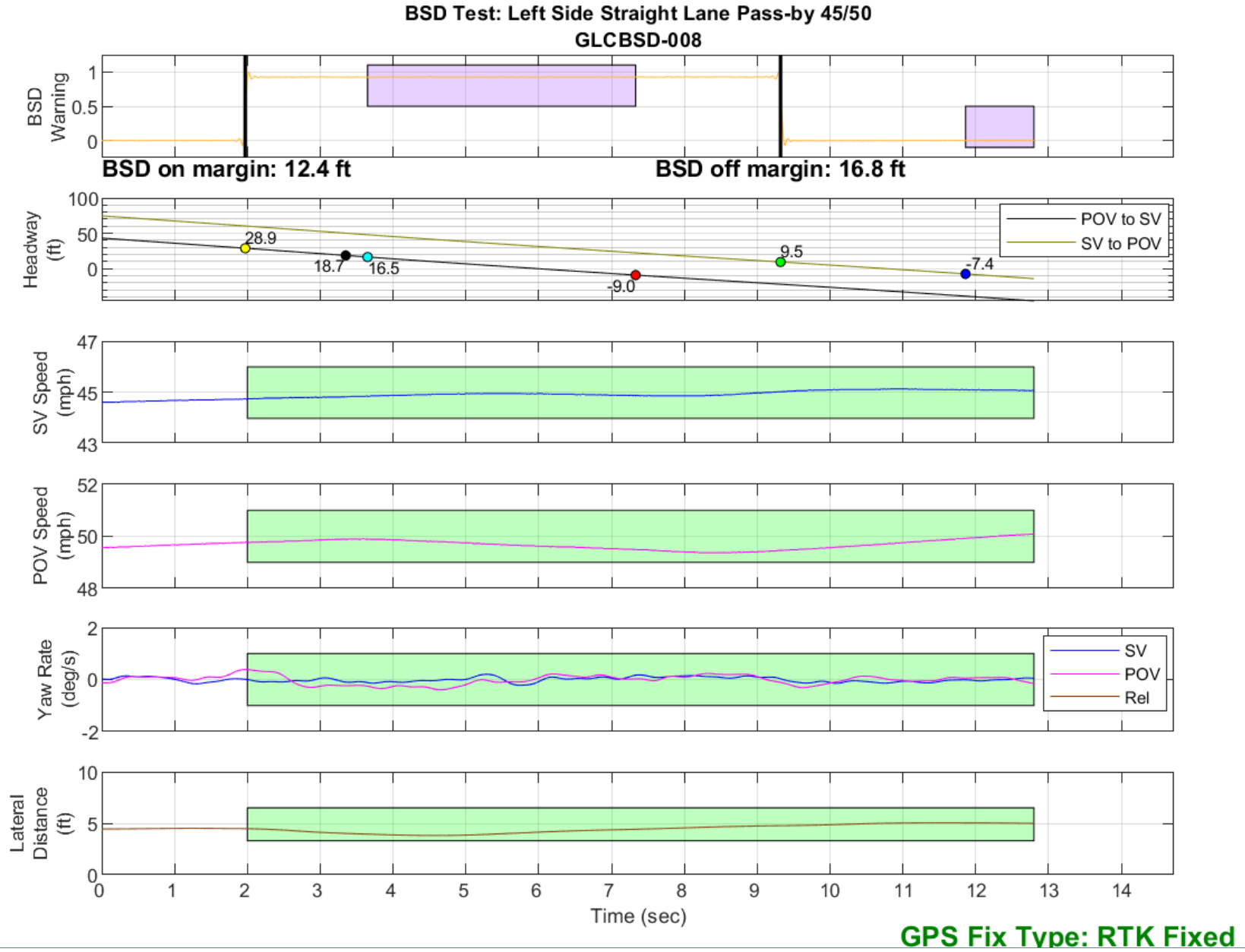


Figure D27. BSD Run 8, Straight Lane Pass-by, SV 45 mph, POV 50 mph

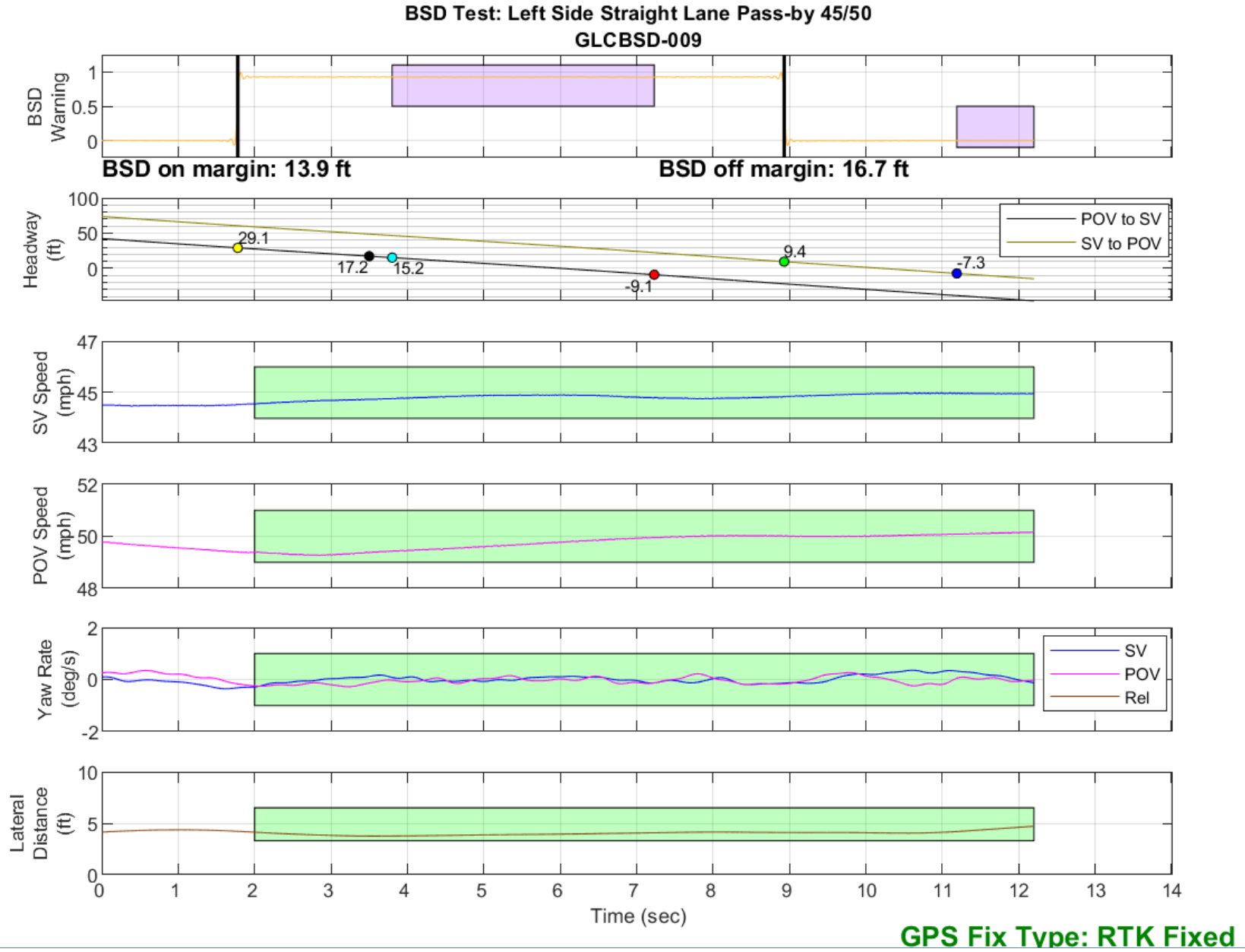


Figure D28. BSD Run 9, Straight Lane Pass-by, SV 45 mph, POV 50 mph

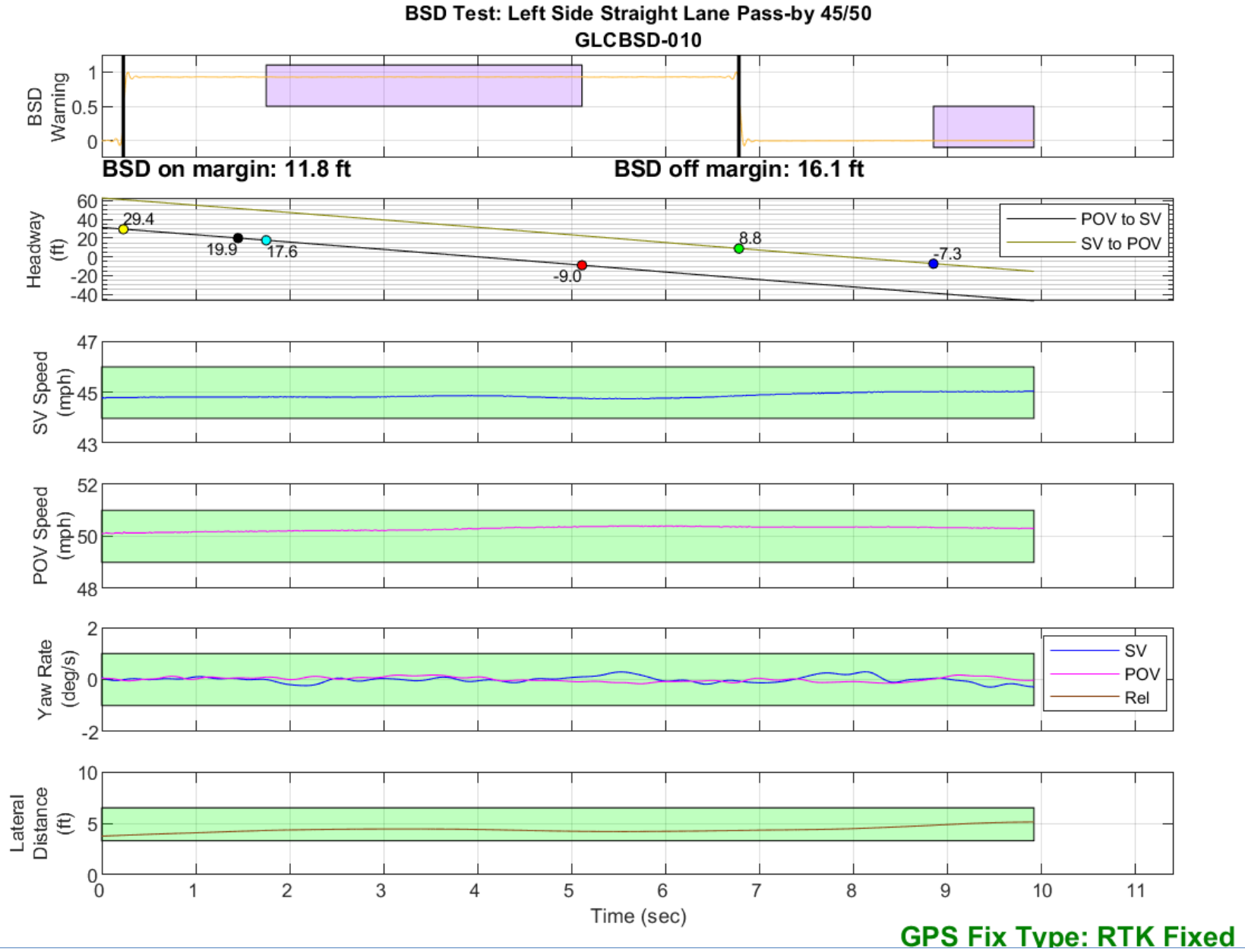


Figure D29. BSD Run 10, Straight Lane Pass-by, SV 45 mph, POV 50 mph

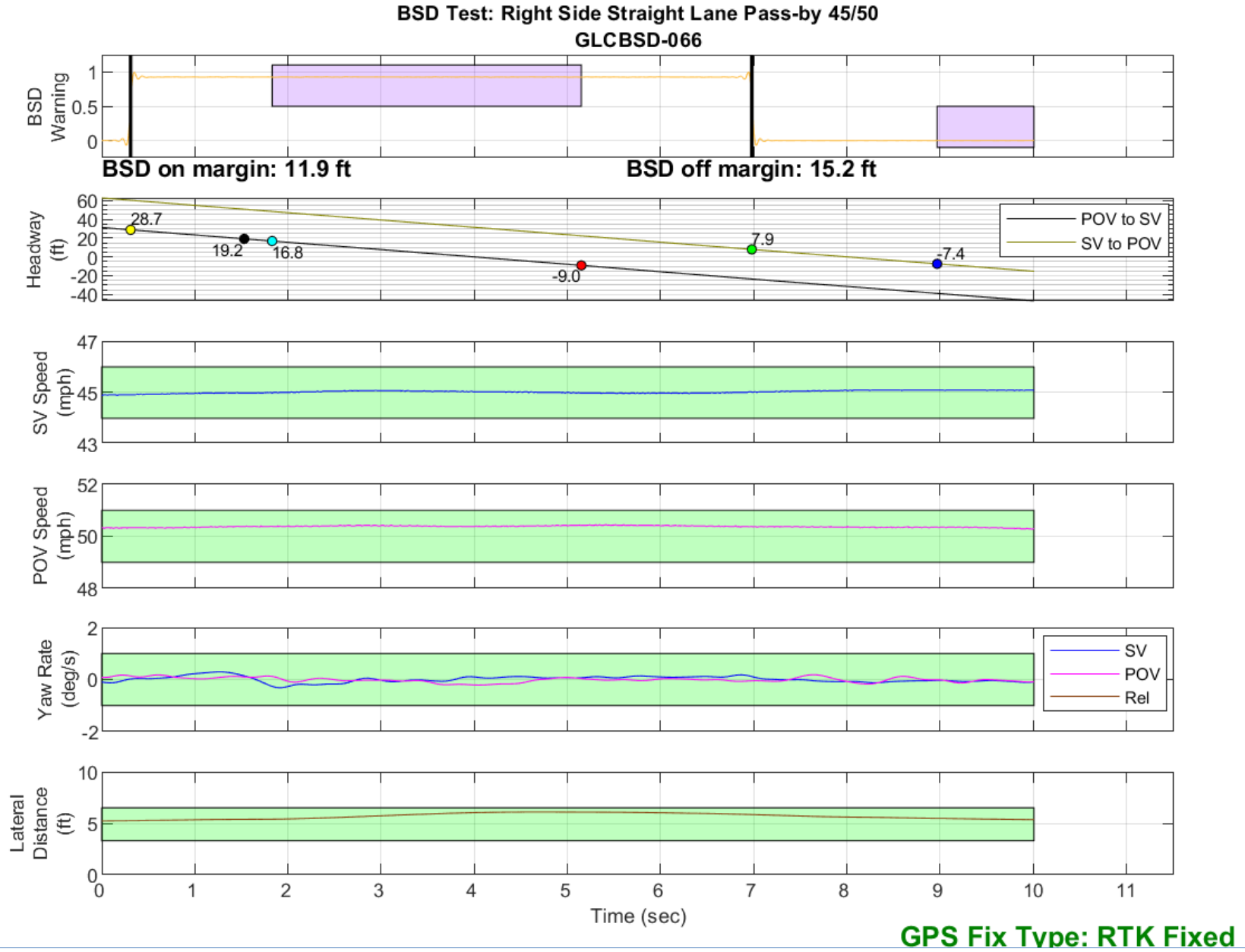


Figure D30. BSD Run 66, Straight Lane Pass-by, SV 45 mph, POV 50 mph

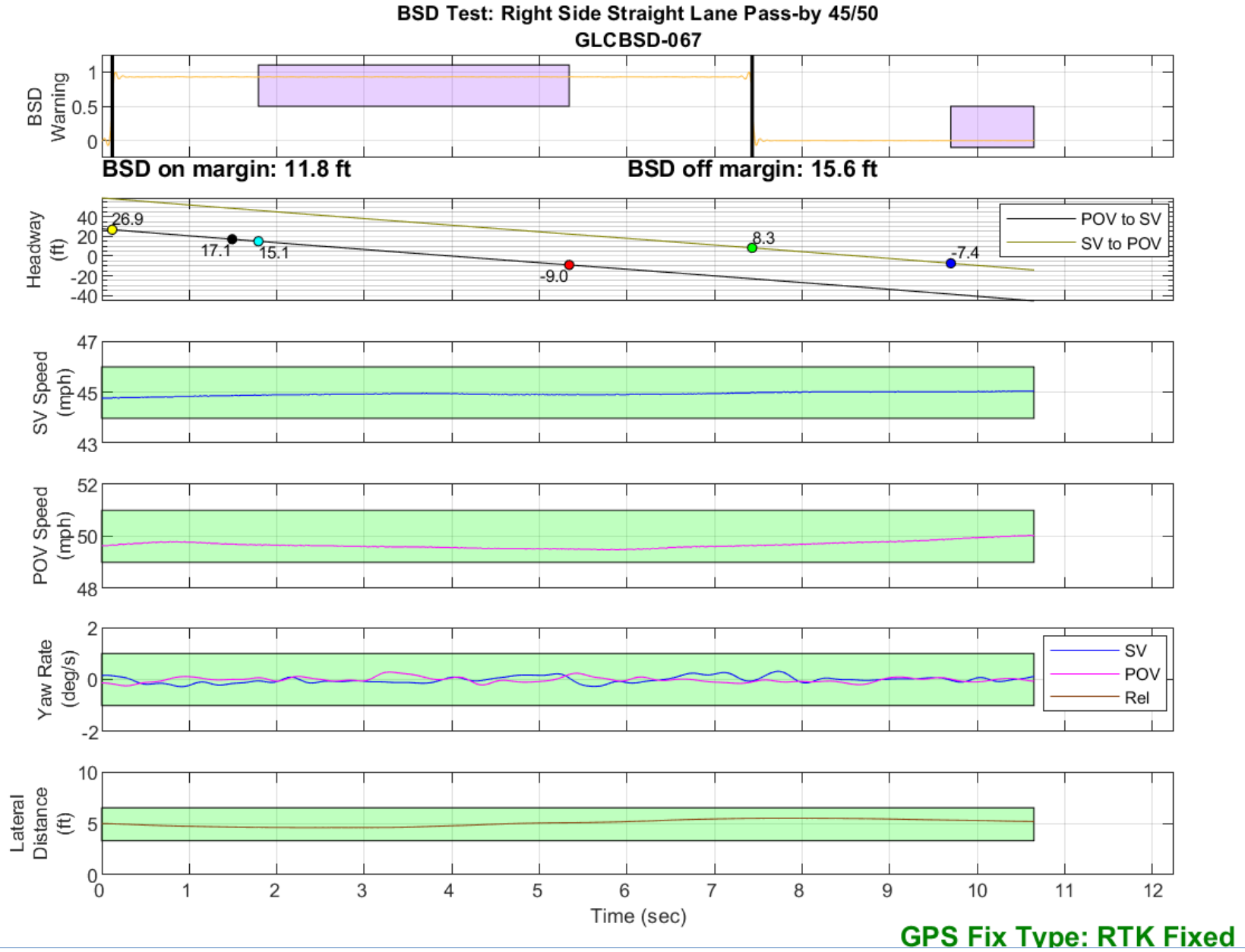


Figure D31. BSD Run 67, Straight Lane Pass-by, SV 45 mph, POV 50 mph

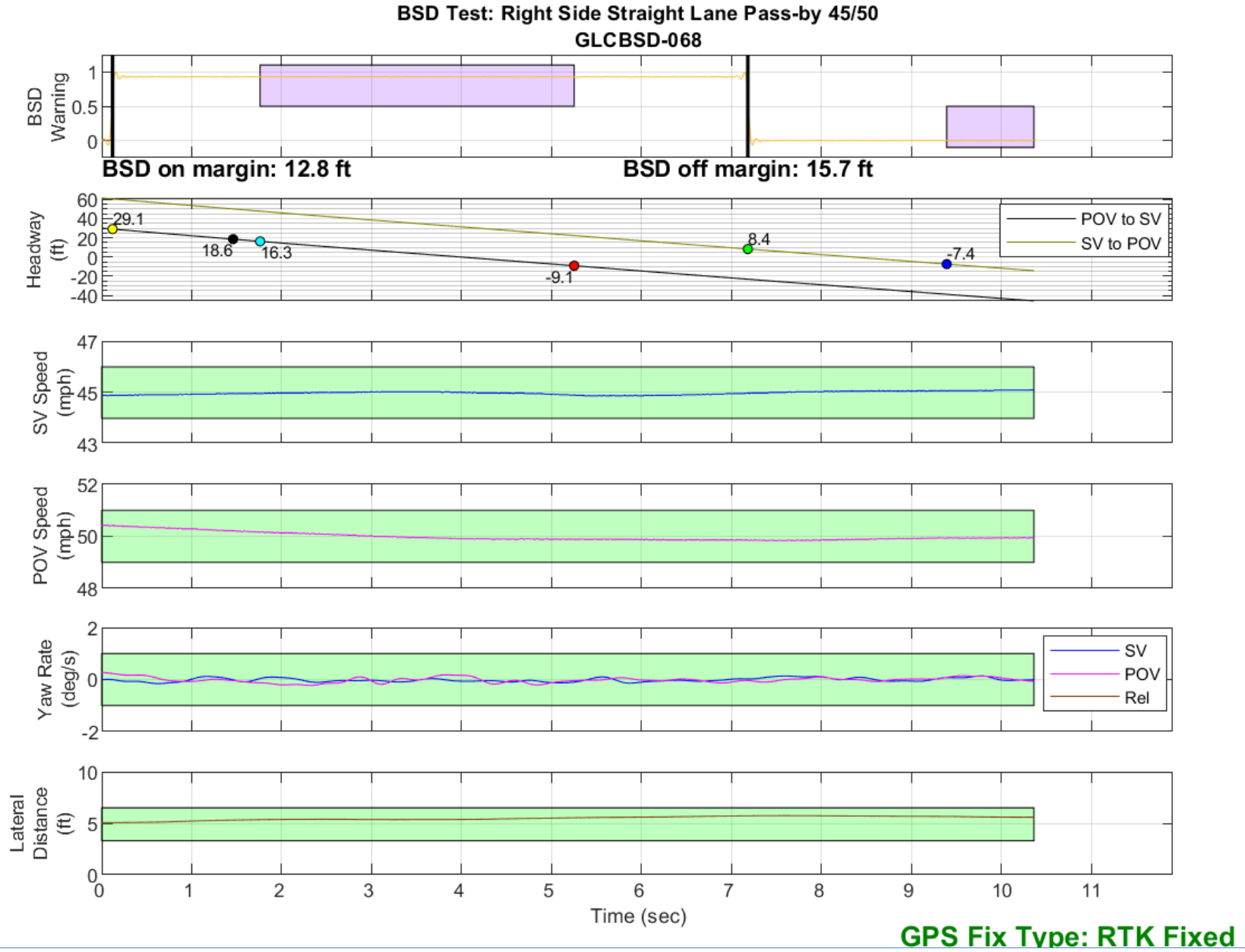


Figure D32. BSD Run 68, Straight Lane Pass-by, SV 45 mph, POV 50 mph

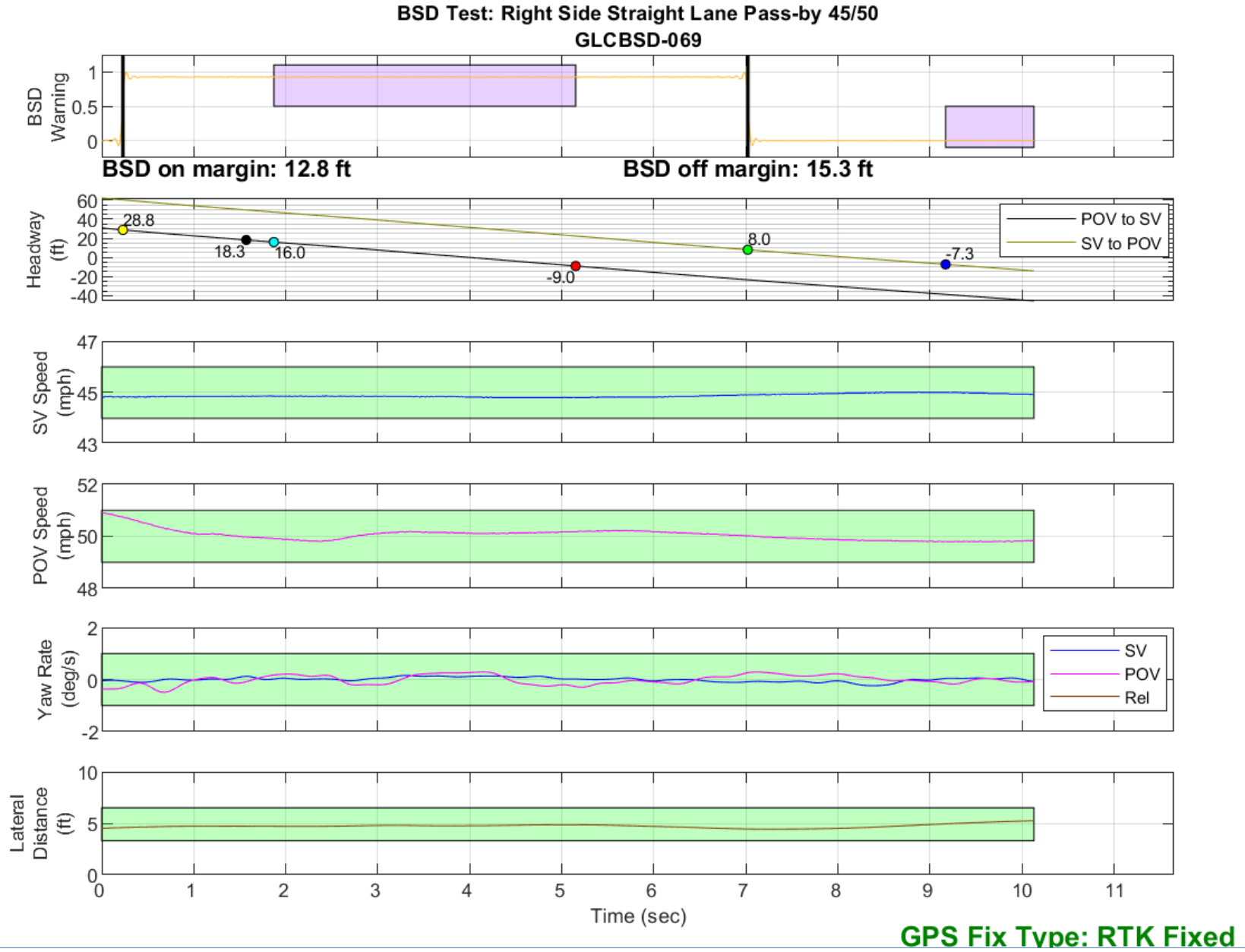


Figure D33. BSD Run 69, Straight Lane Pass-by, SV 45 mph, POV 50 mph

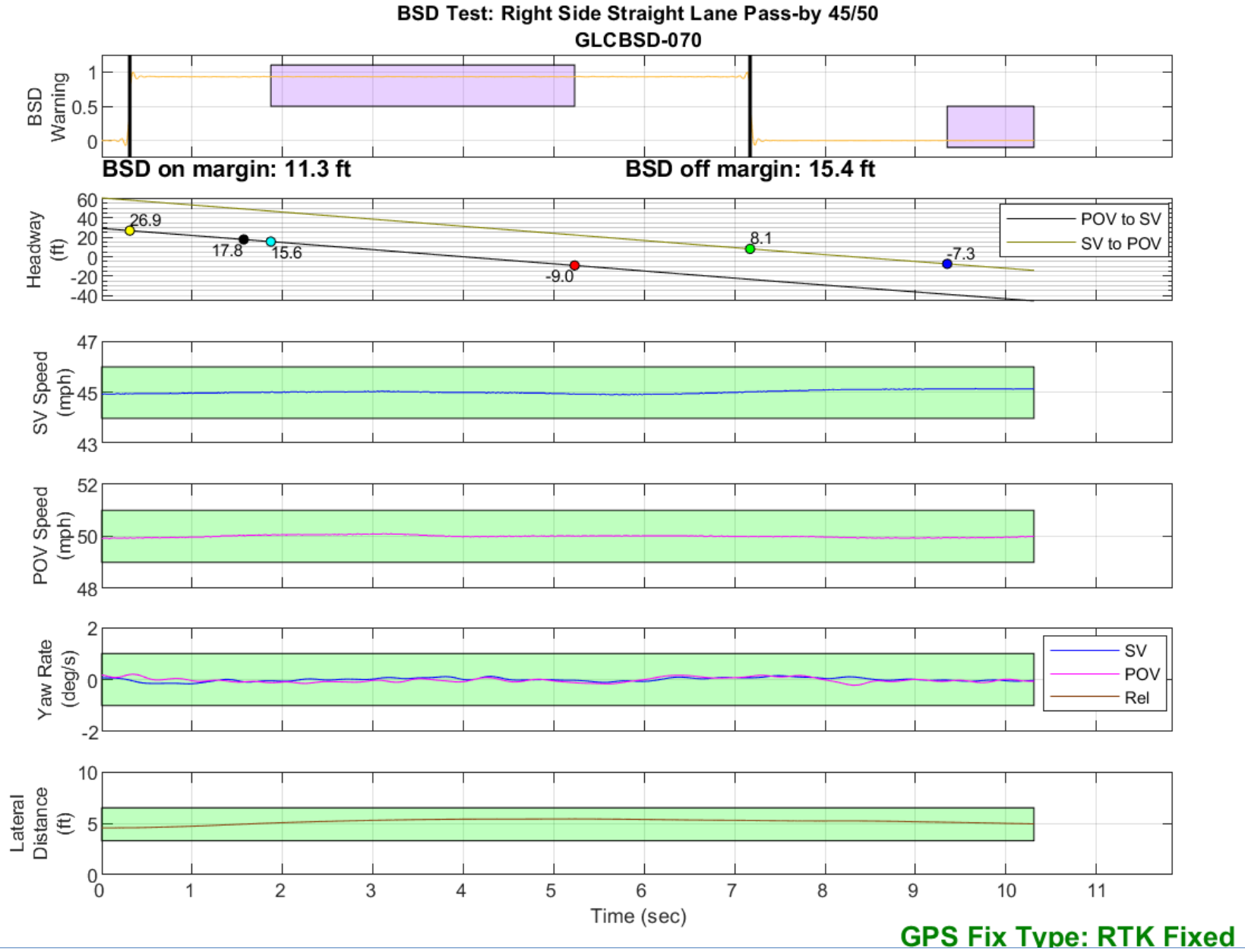


Figure D34. BSD Run 70, Straight Lane Pass-by, SV 45 mph, POV 50 mph

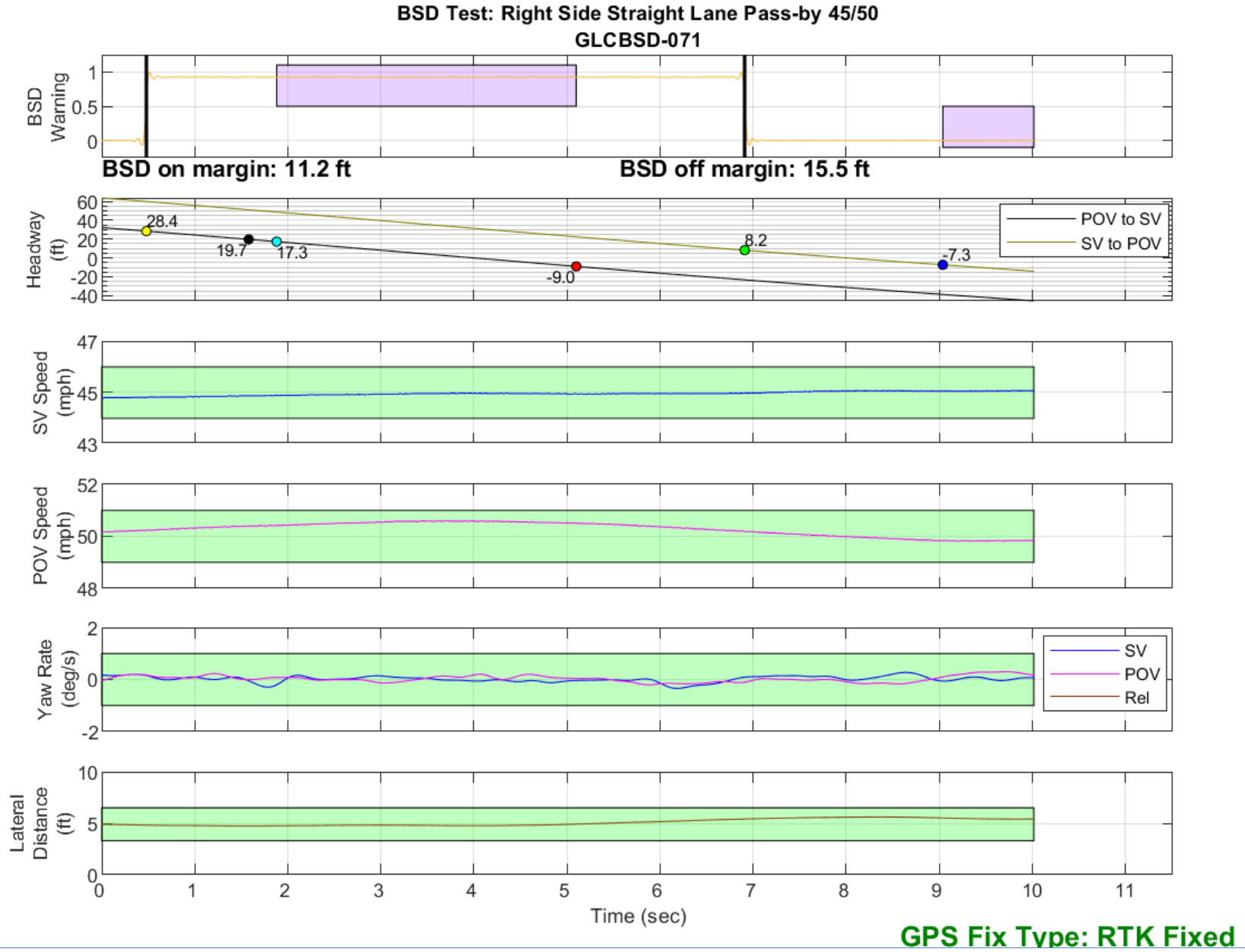


Figure D35. BSD Run 71, Straight Lane Pass-by, SV 45 mph, POV 50 mph

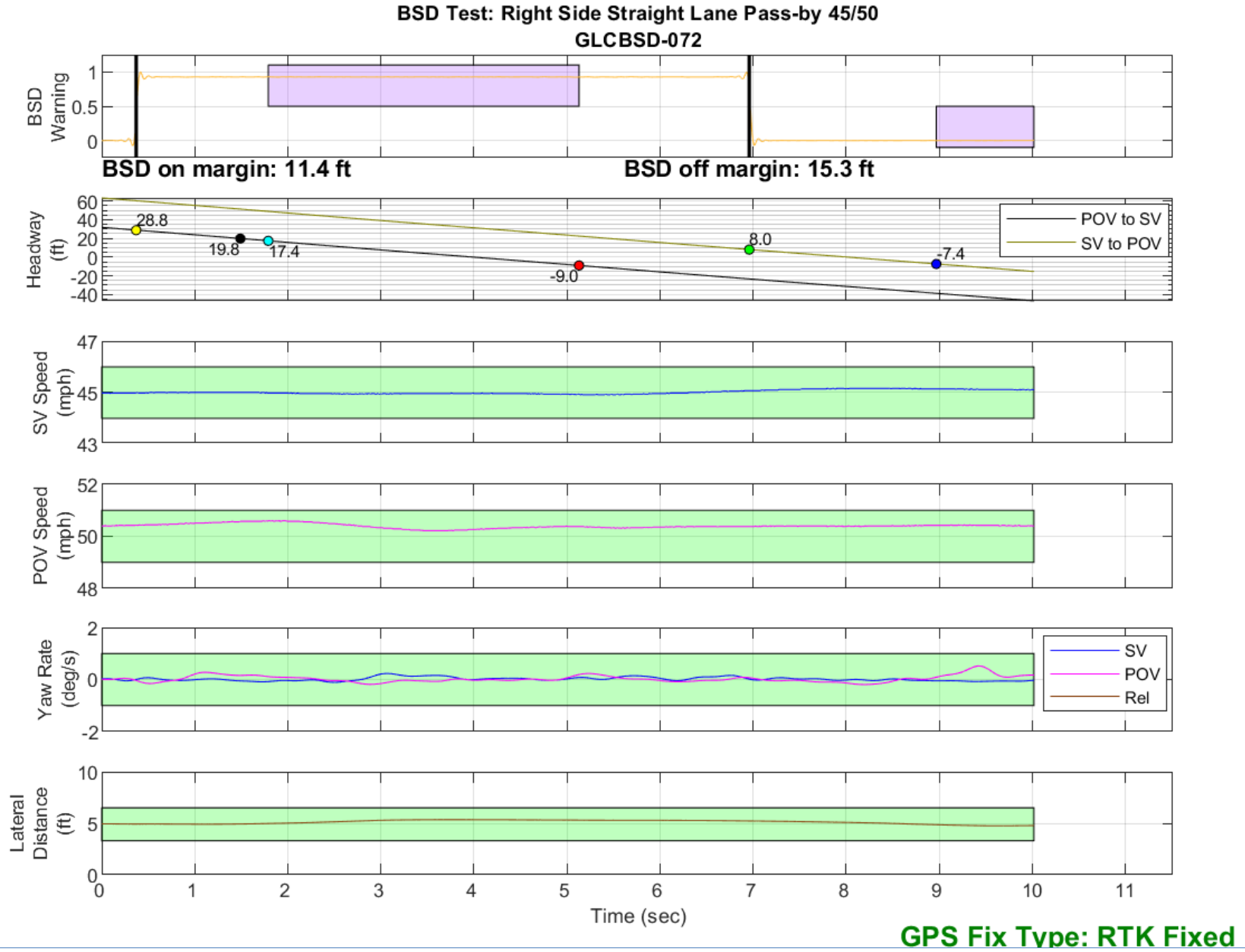


Figure D36. BSD Run 72, Straight Lane Pass-by, SV 45 mph, POV 50 mph

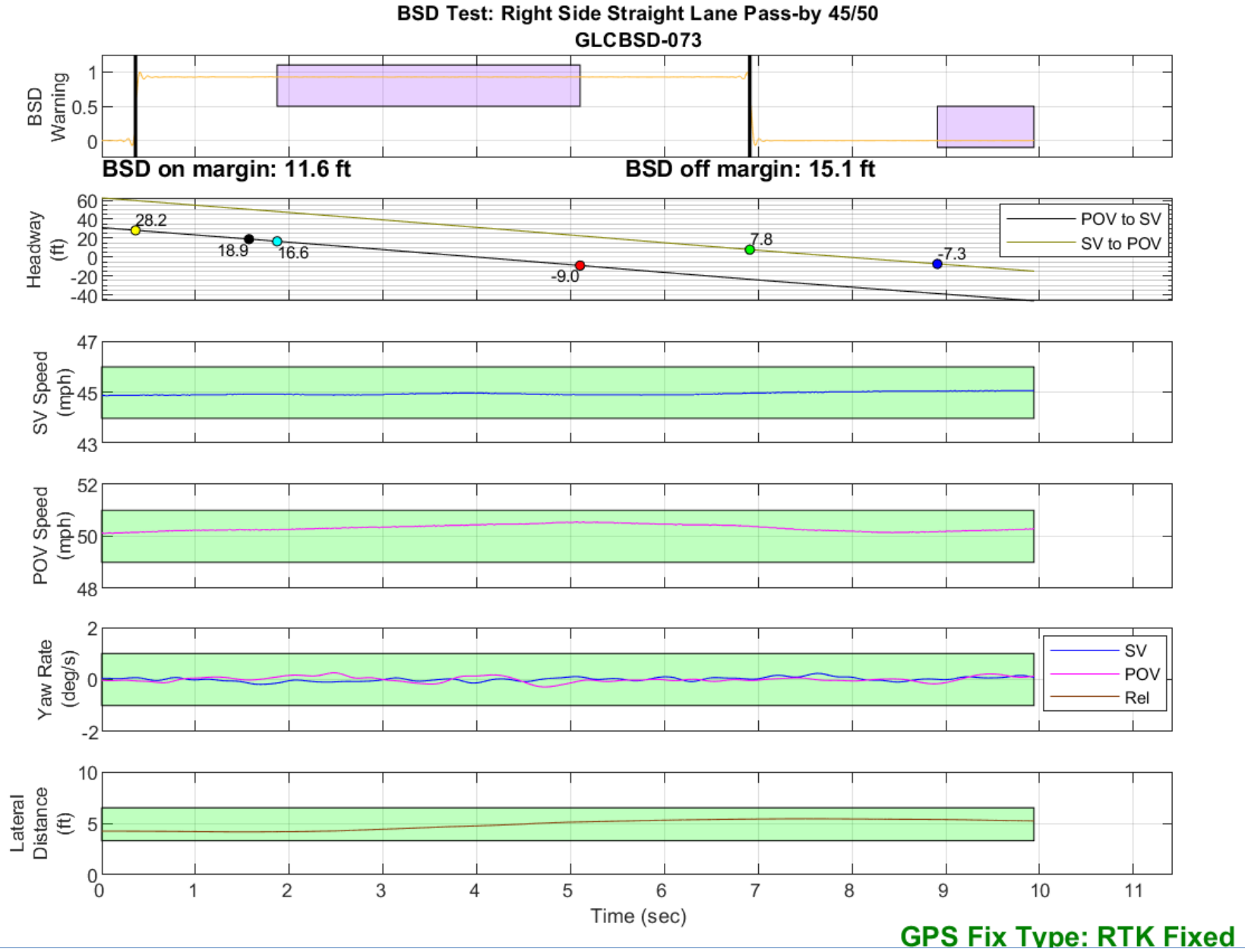


Figure D37. BSD Run 73, Straight Lane Pass-by, SV 45 mph, POV 50 mph

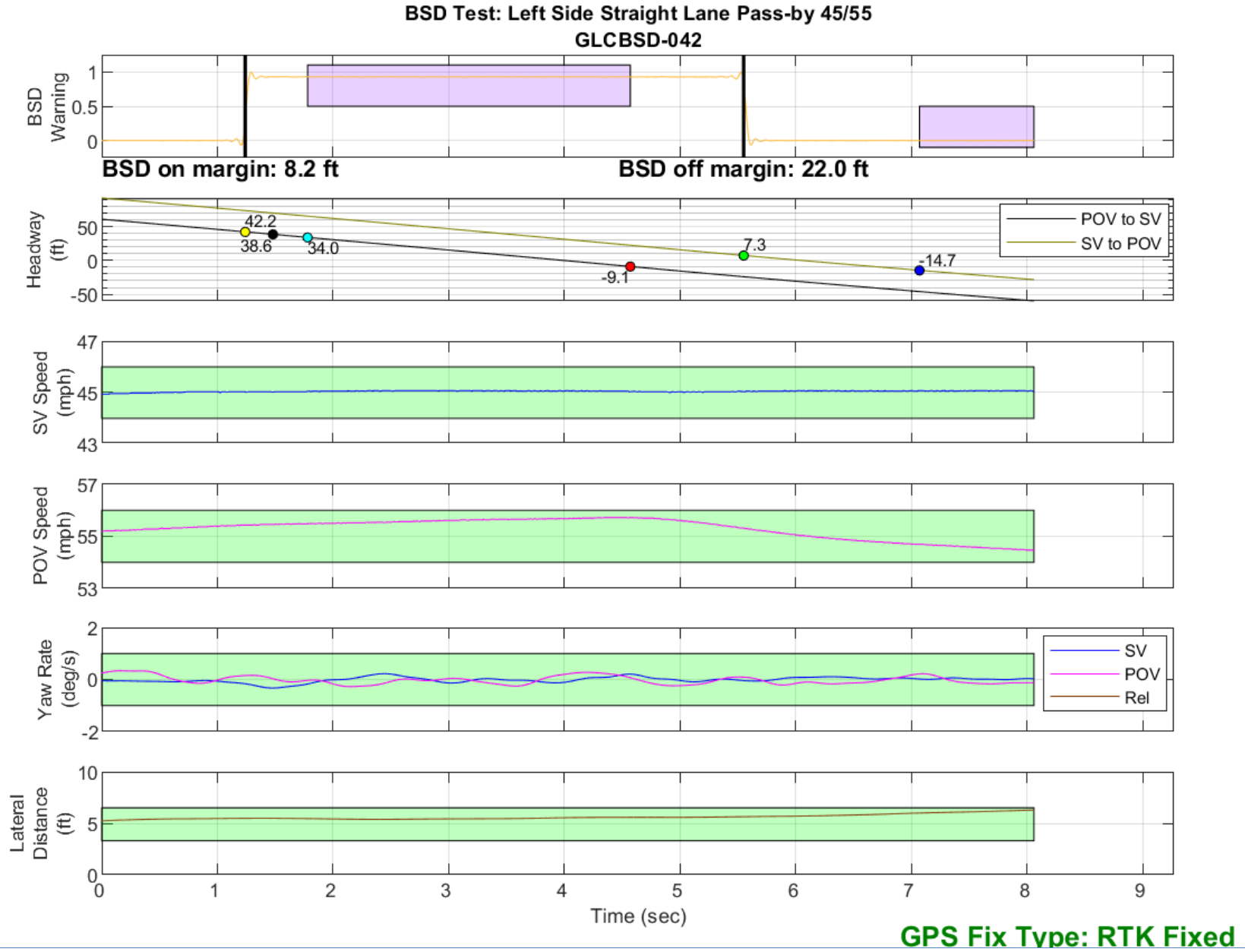


Figure D38. BSD Run 42, Straight Lane Pass-by, SV 45 mph, POV 55 mph

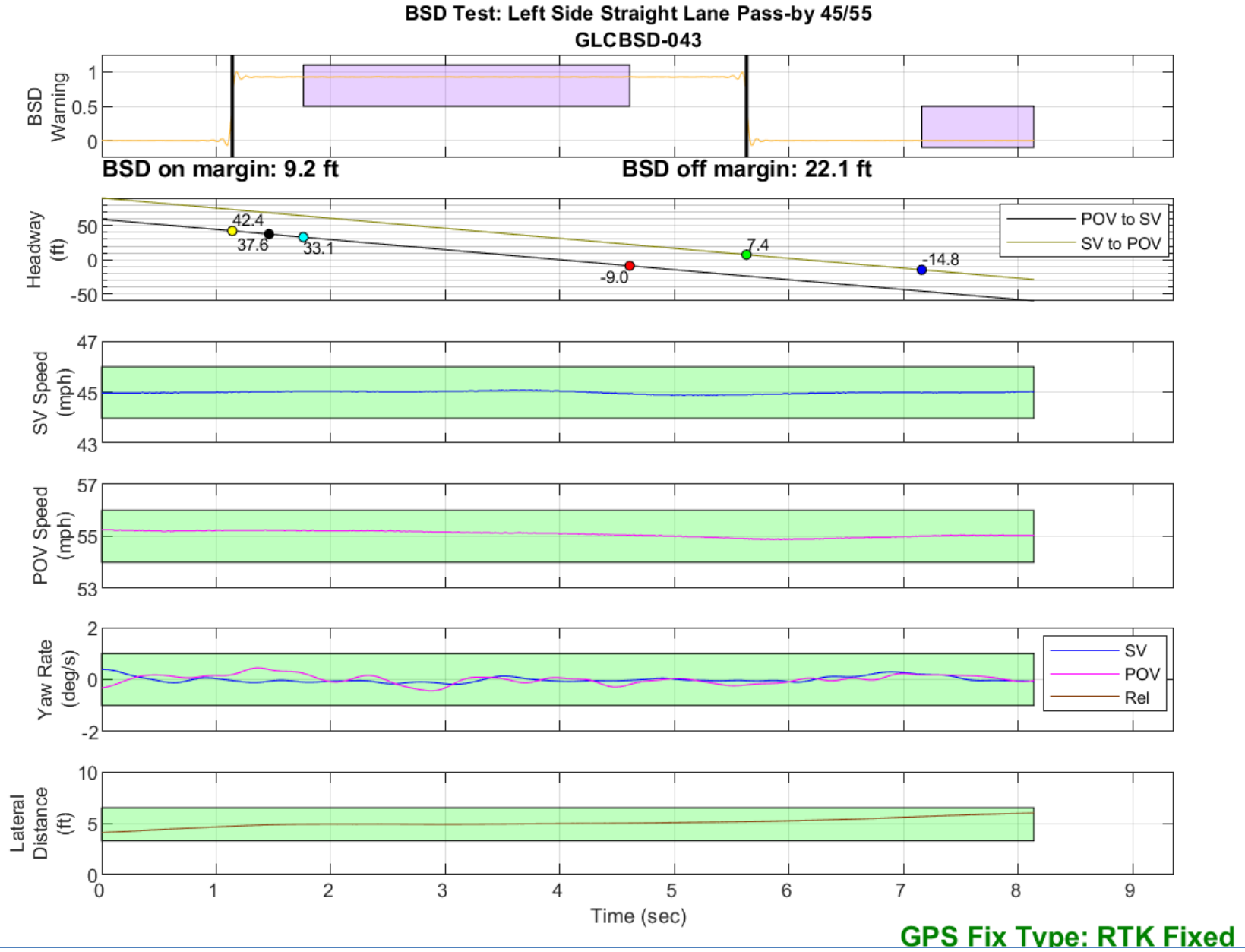


Figure D39. BSD Run 43, Straight Lane Pass-by, SV 45 mph, POV 55 mph

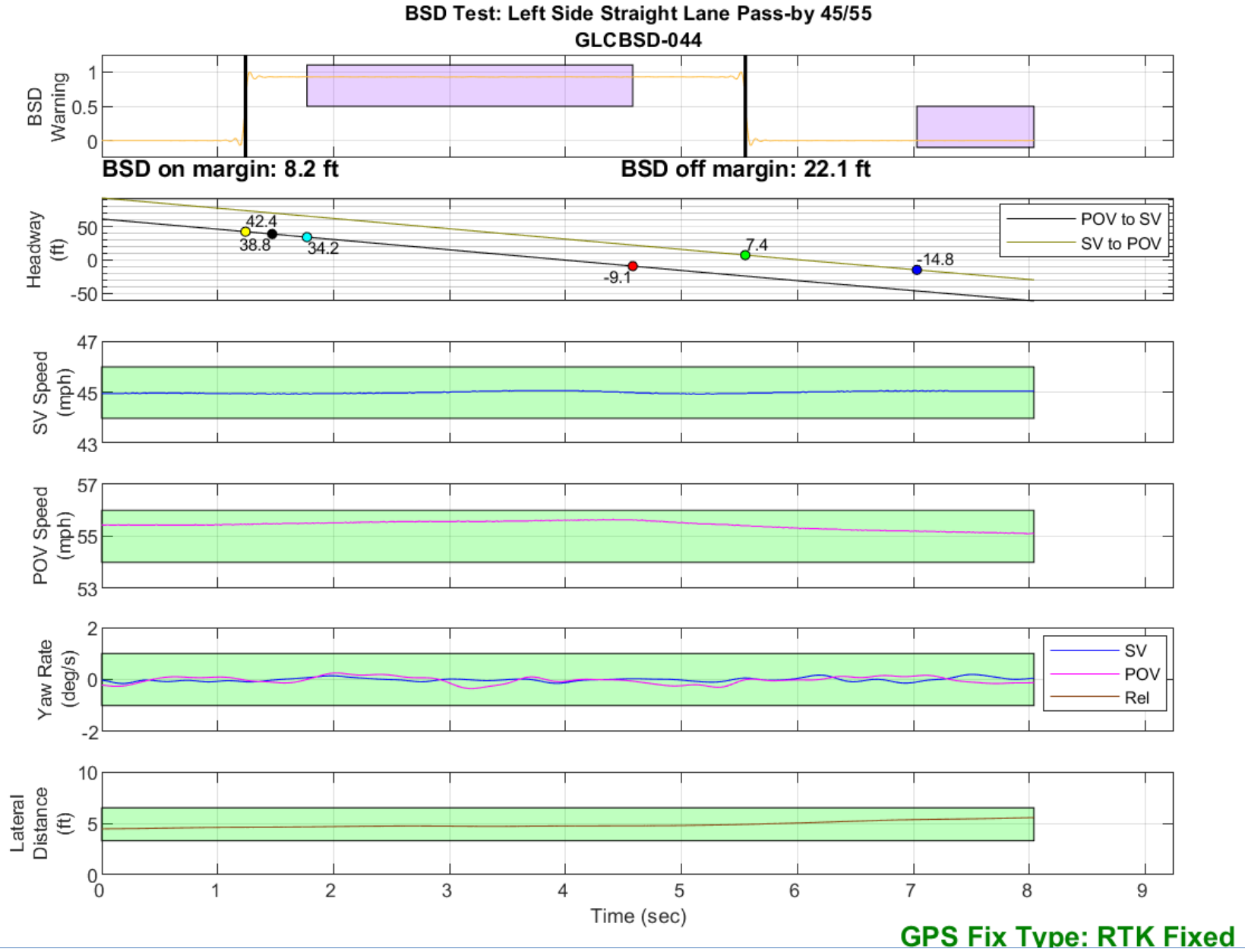


Figure D40. BSD Run 44, Straight Lane Pass-by, SV 45 mph, POV 55 mph

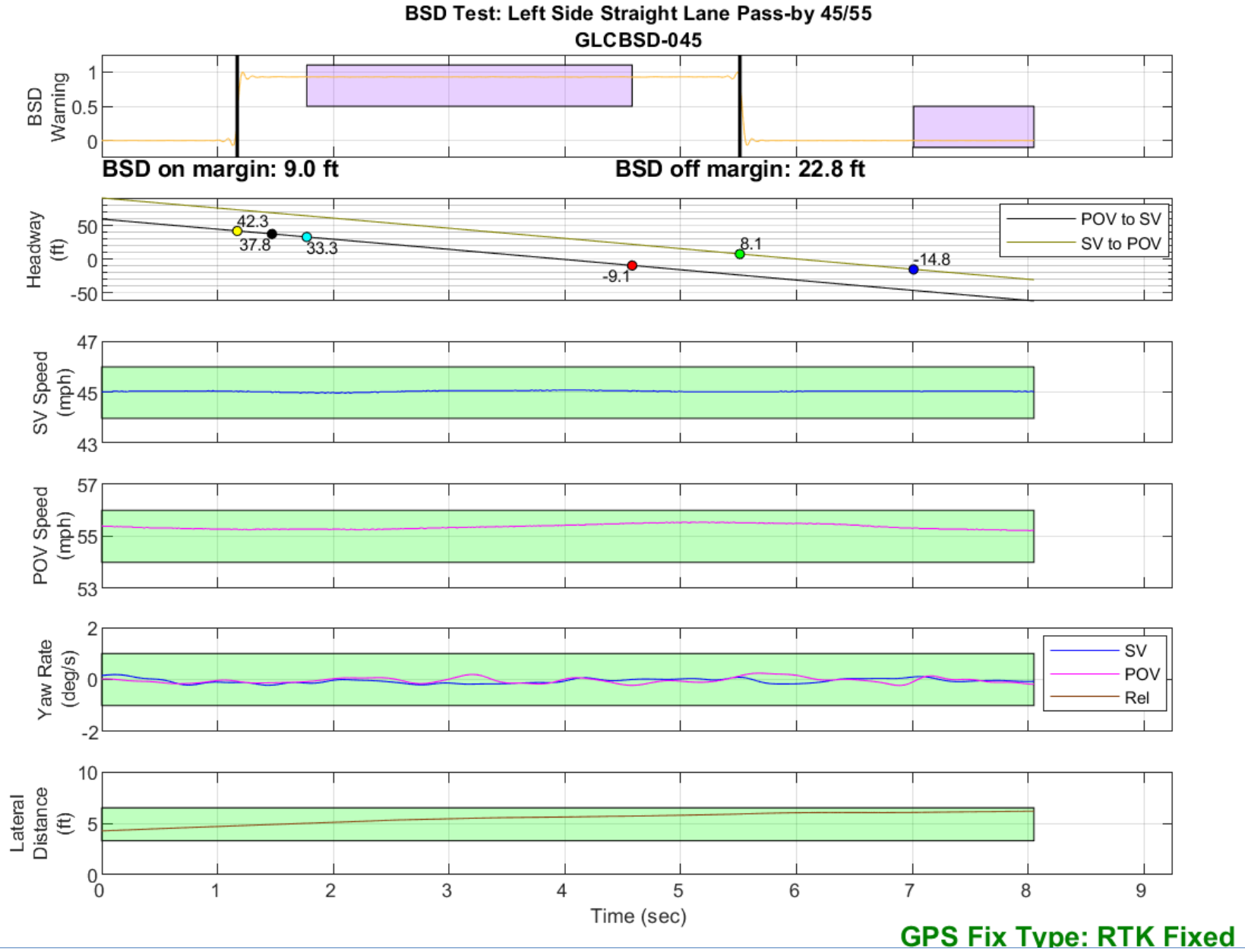


Figure D41. BSD Run 45, Straight Lane Pass-by, SV 45 mph, POV 55 mph

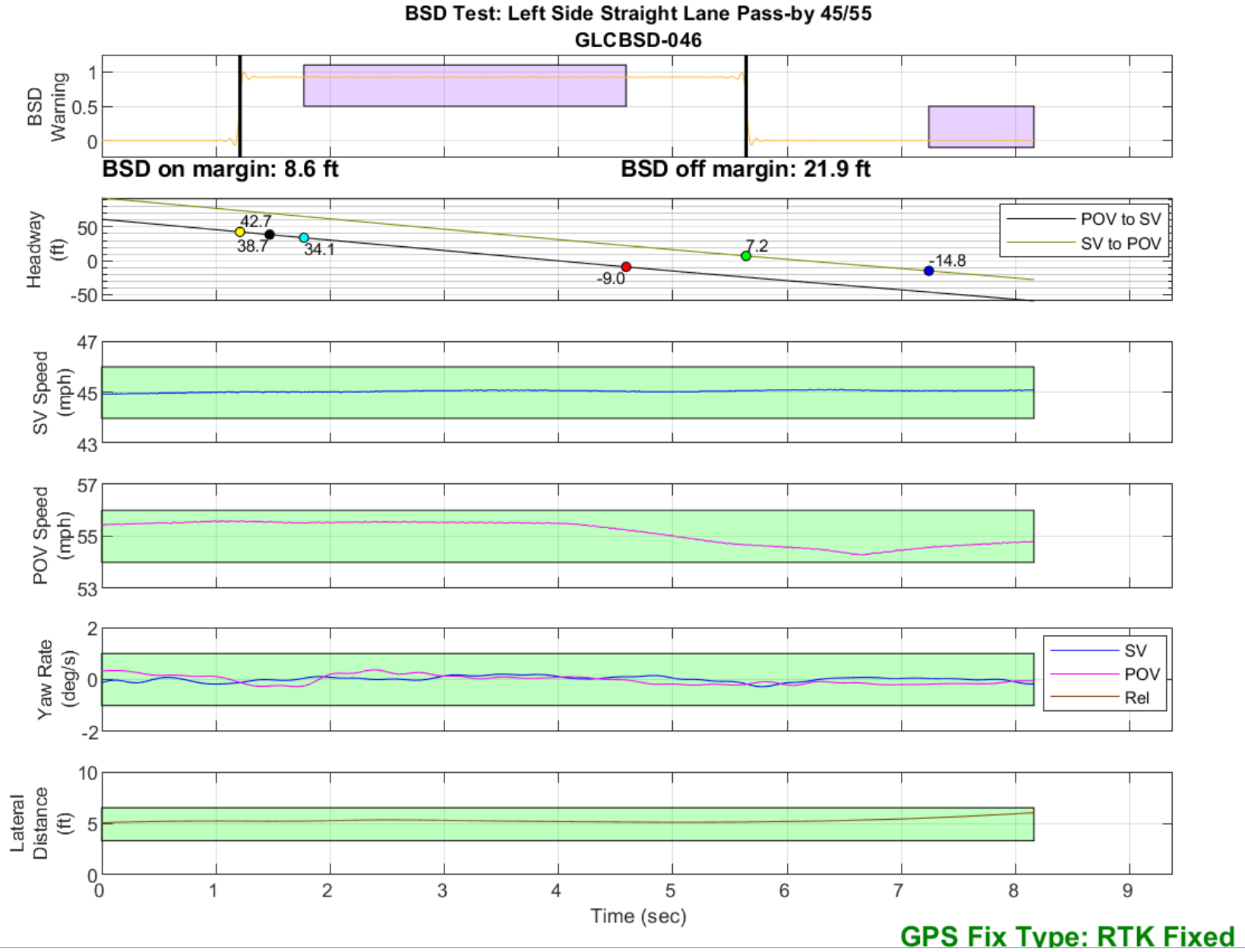


Figure D42. BSD Run 46, Straight Lane Pass-by, SV 45 mph, POV 55 mph

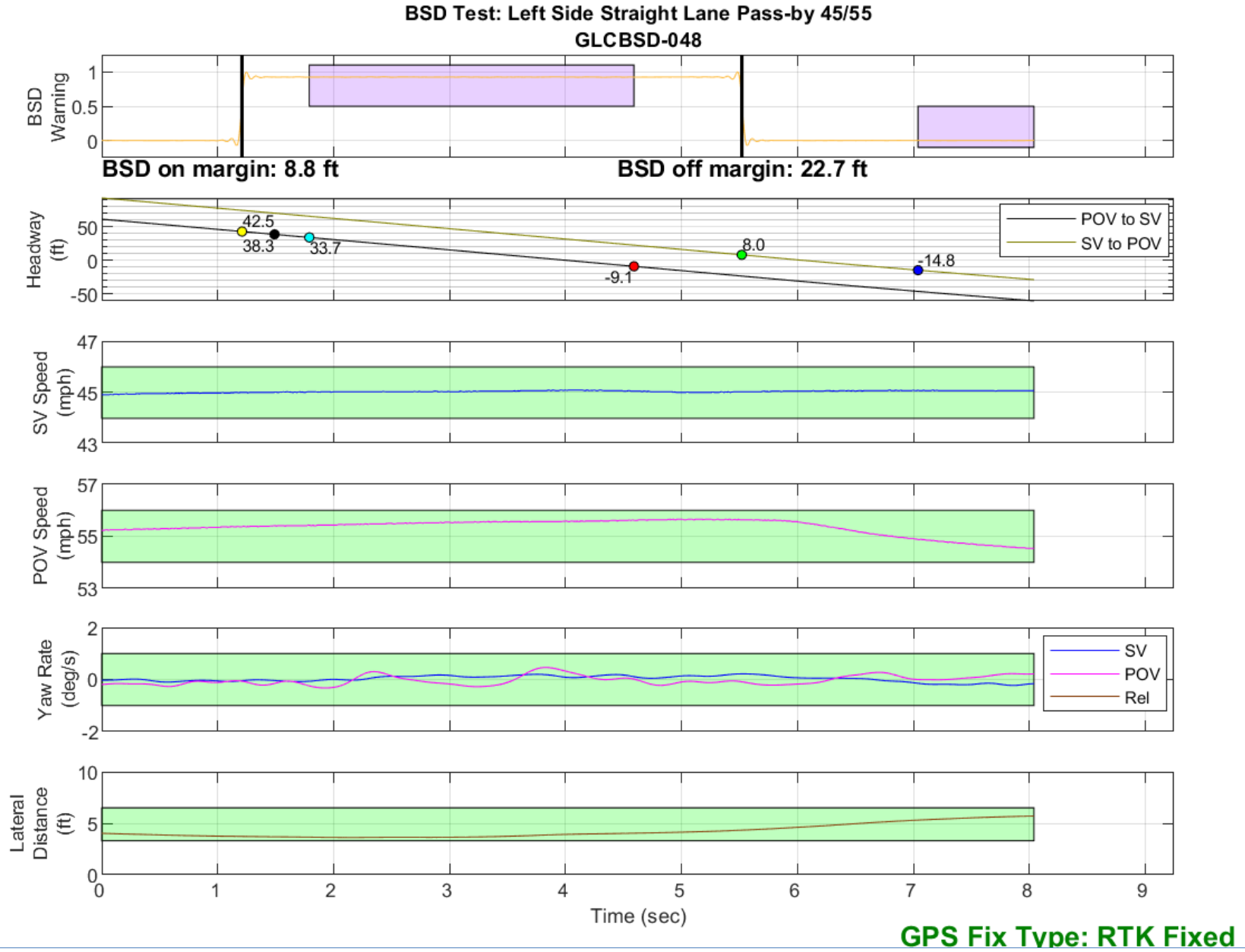


Figure D43. BSD Run 48, Straight Lane Pass-by, SV 45 mph, POV 55 mph

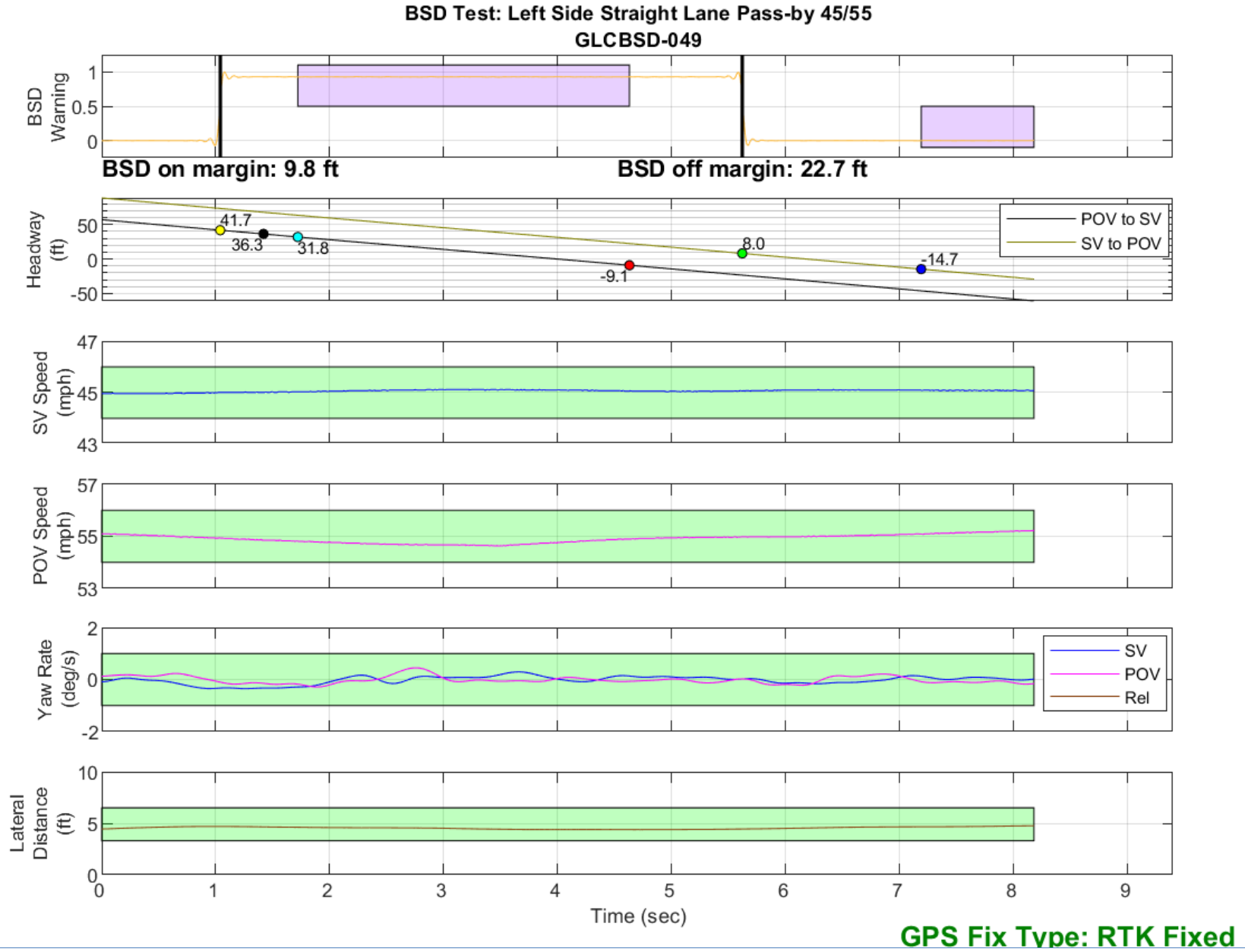


Figure D44. BSD Run 49, Straight Lane Pass-by, SV 45 mph, POV 55 mph

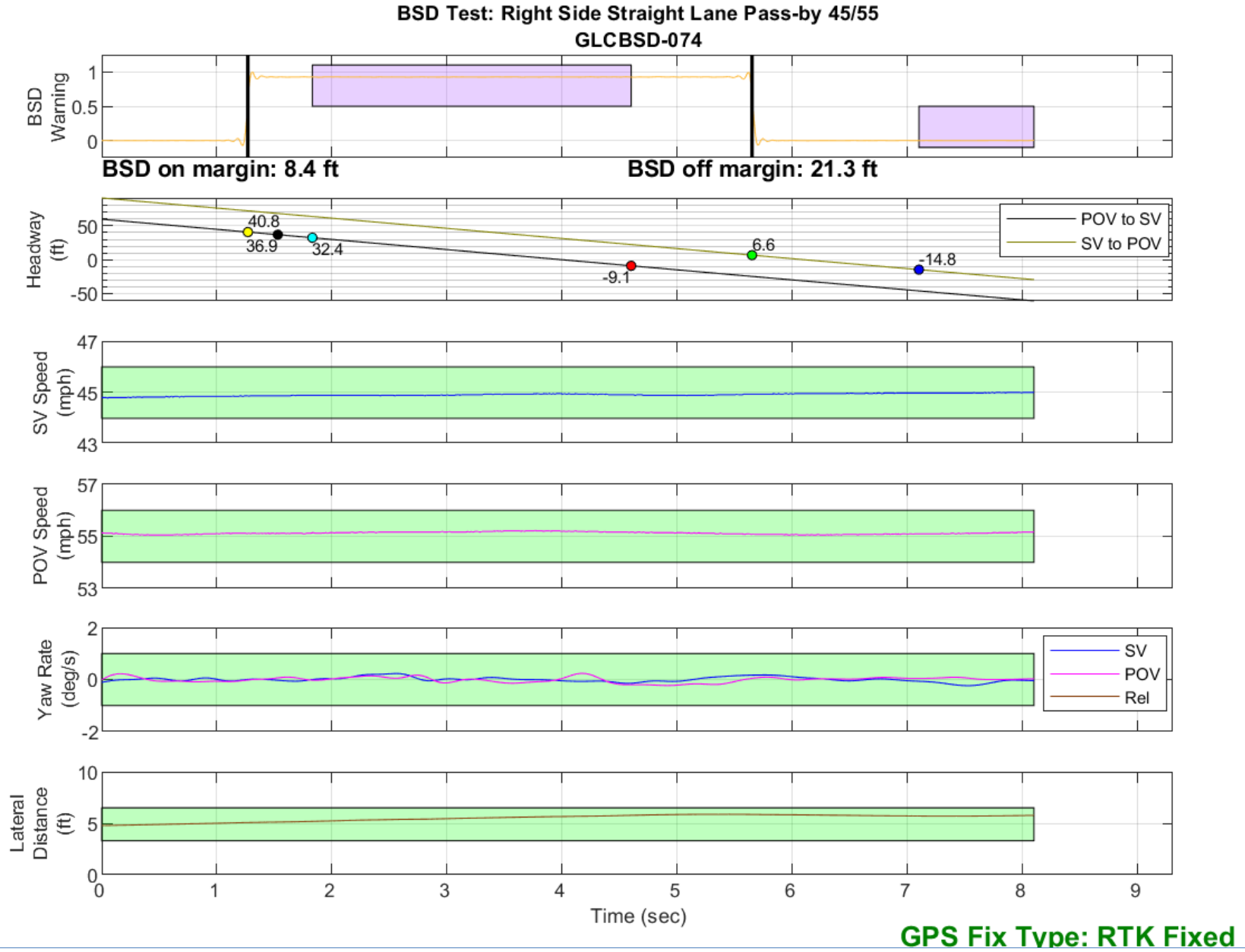


Figure D45. BSD Run 74, Straight Lane Pass-by, SV 45 mph, POV 55 mph

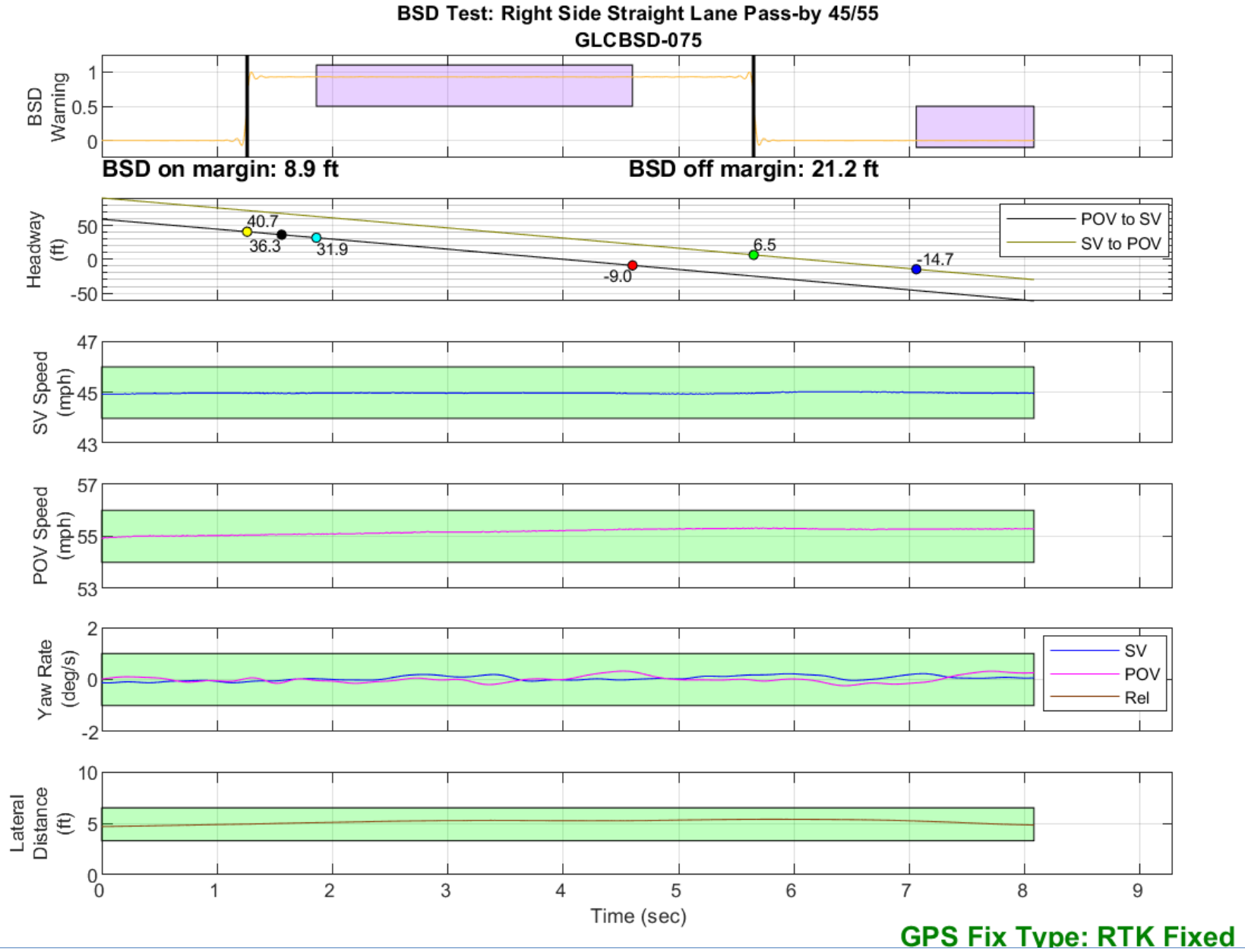


Figure D46. BSD Run 75, Straight Lane Pass-by, SV 45 mph, POV 55 mph

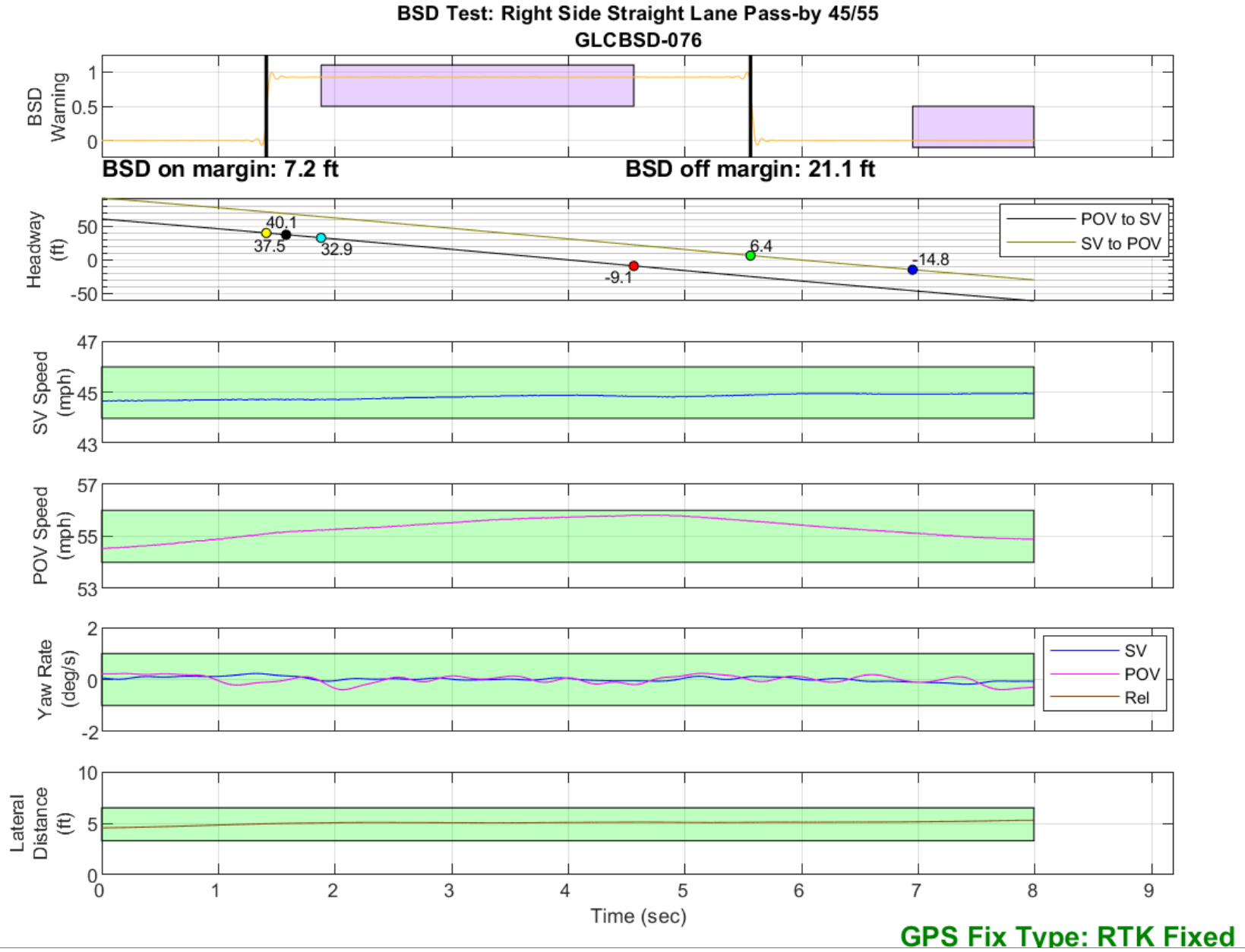


Figure D47. BSD Run 76, Straight Lane Pass-by, SV 45 mph, POV 55 mph

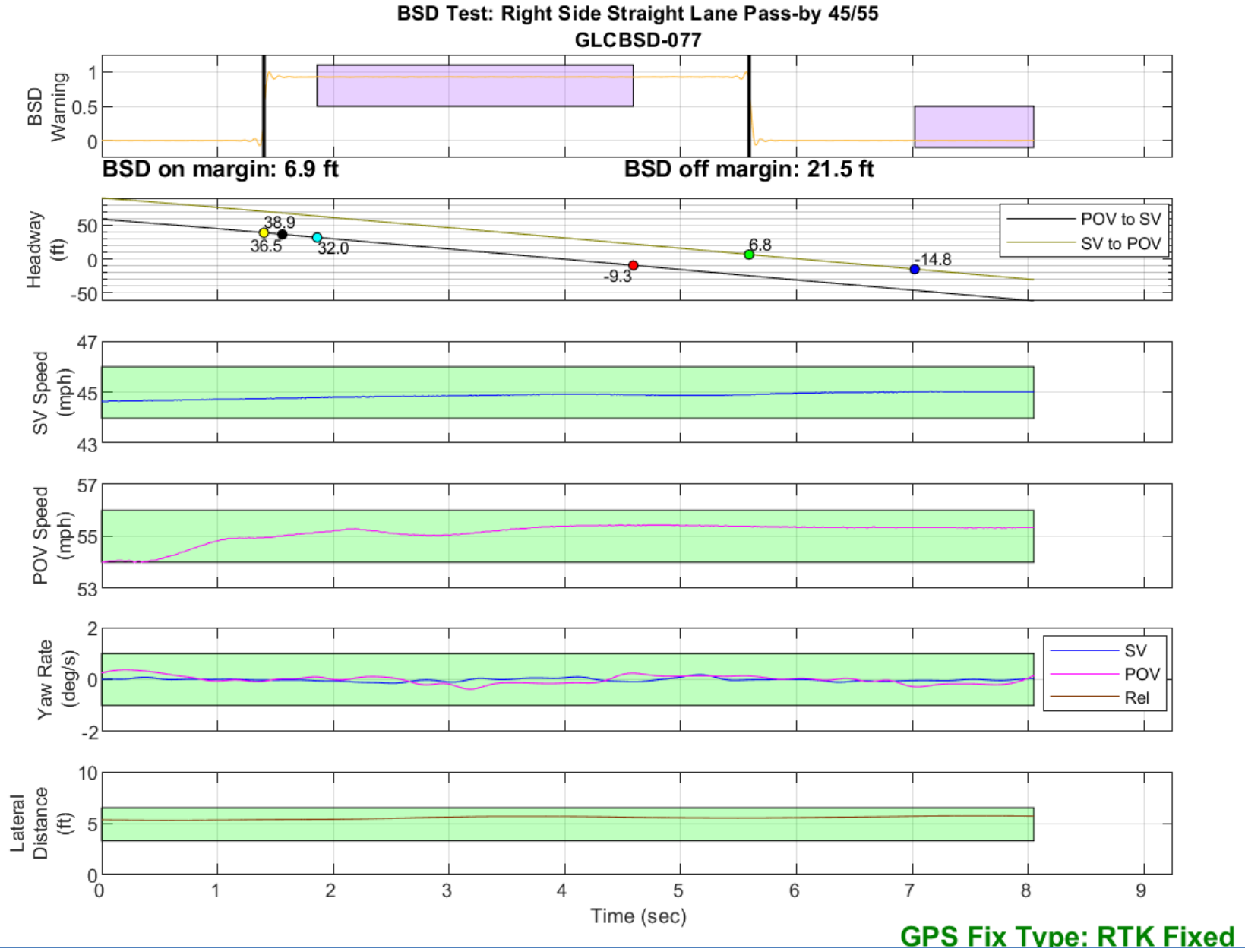


Figure D48. BSD Run 77, Straight Lane Pass-by, SV 45 mph, POV 55 mph

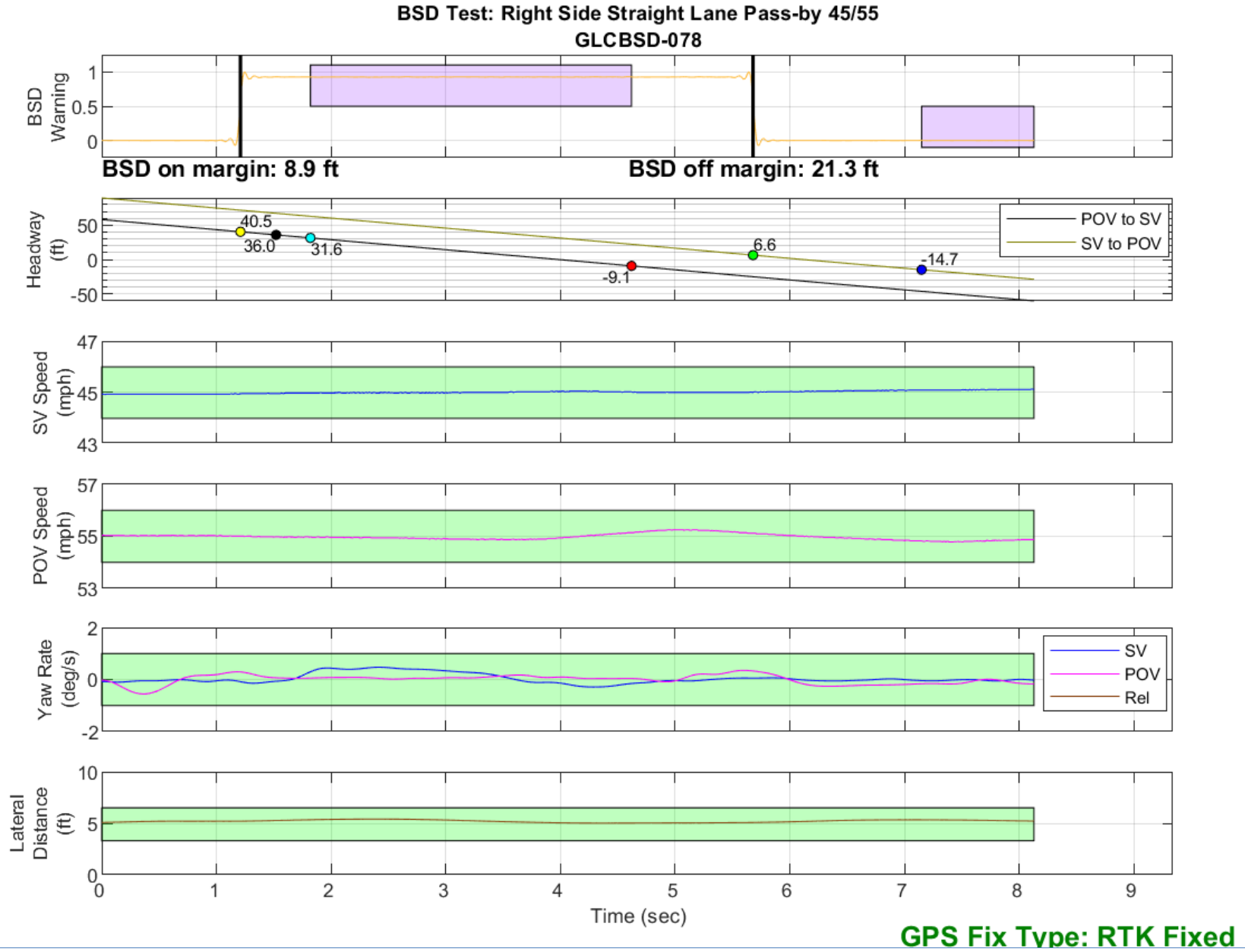


Figure D49. BSD Run 78, Straight Lane Pass-by, SV 45 mph, POV 55 mph

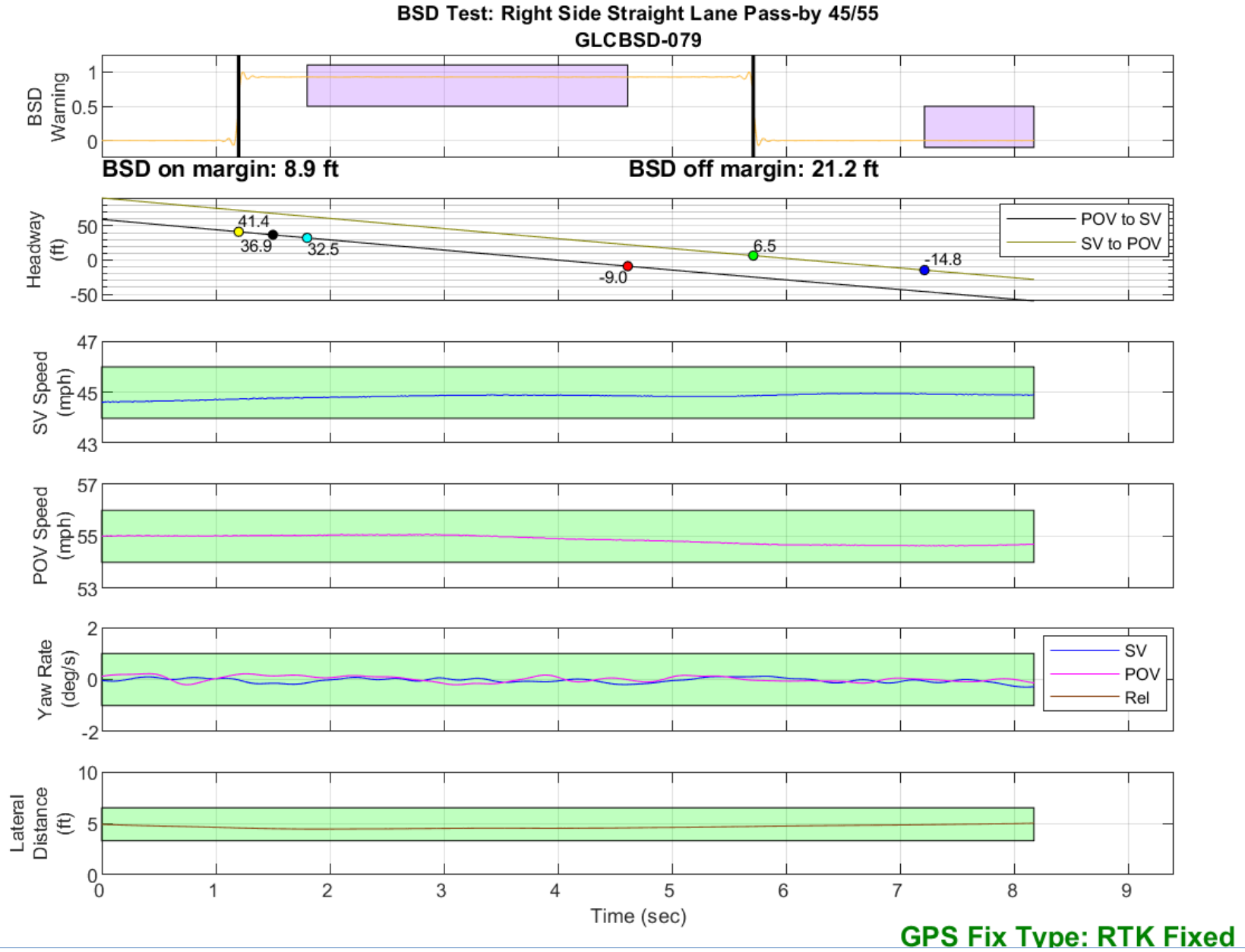


Figure D50. BSD Run 79, Straight Lane Pass-by, SV 45 mph, POV 55 mph

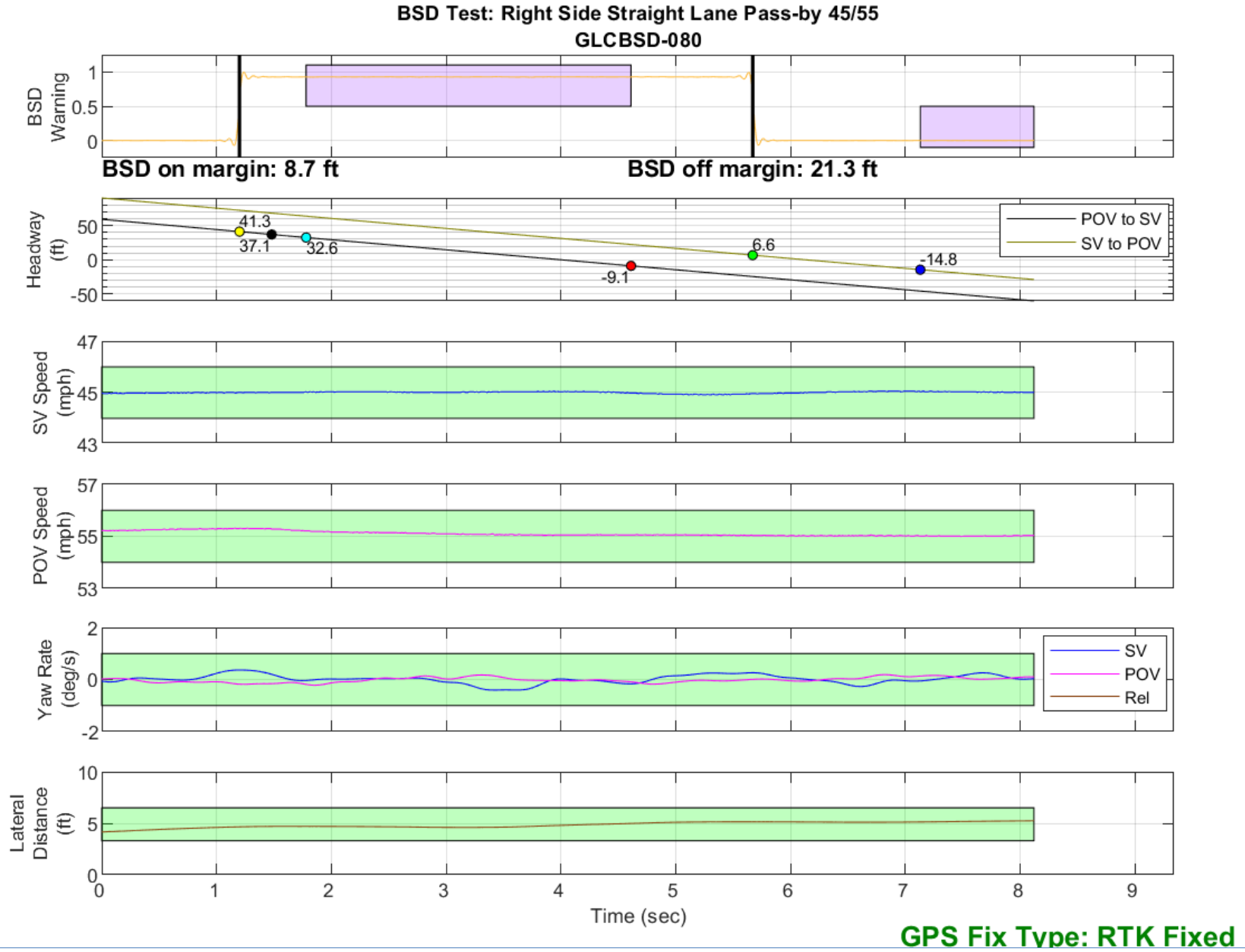


Figure D51. BSD Run 80, Straight Lane Pass-by, SV 45 mph, POV 55 mph

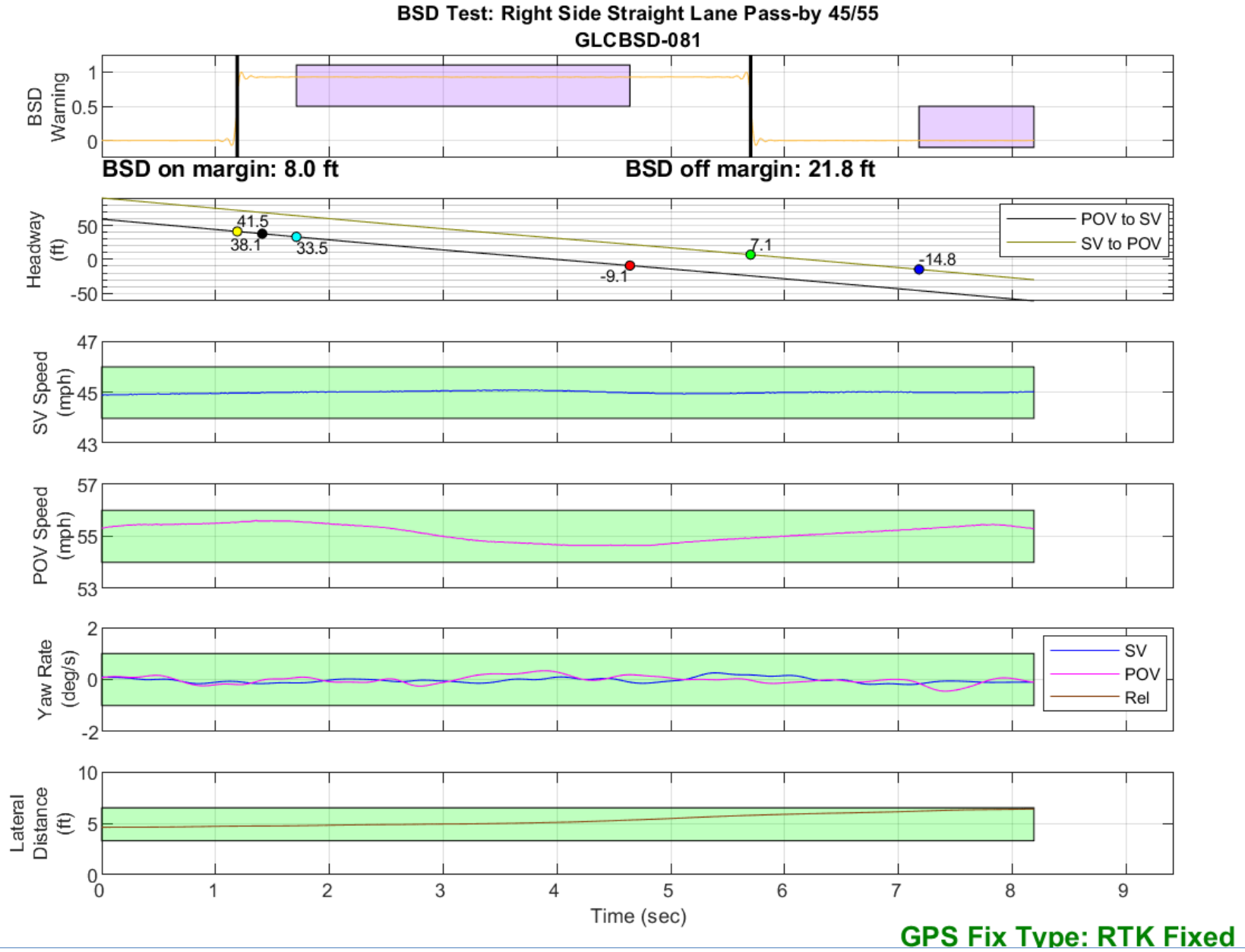


Figure D52. BSD Run 81, Straight Lane Pass-by, SV 45 mph, POV 55 mph

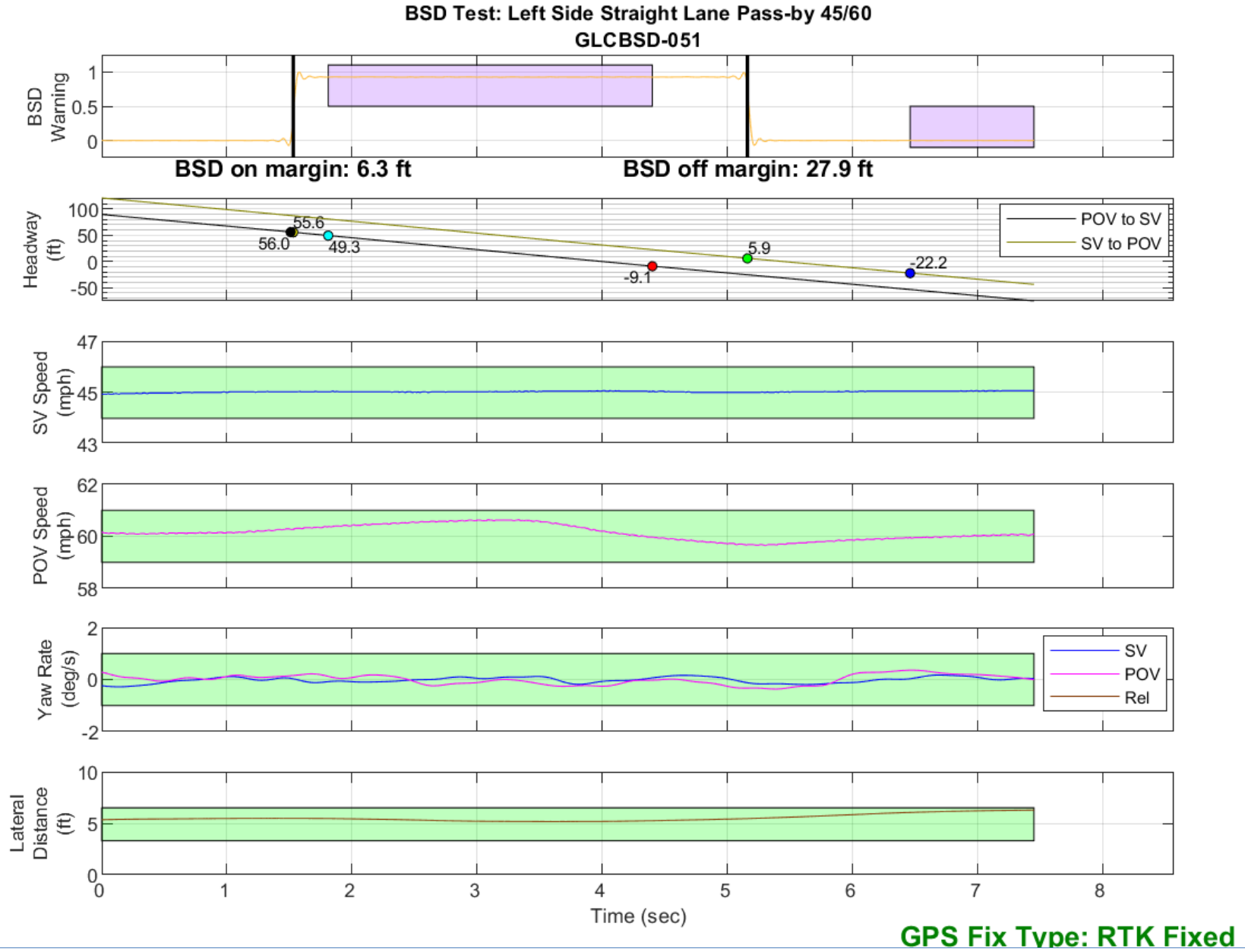


Figure D53. BSD Run 51, Straight Lane Pass-by, SV 45 mph, POV 60 mph

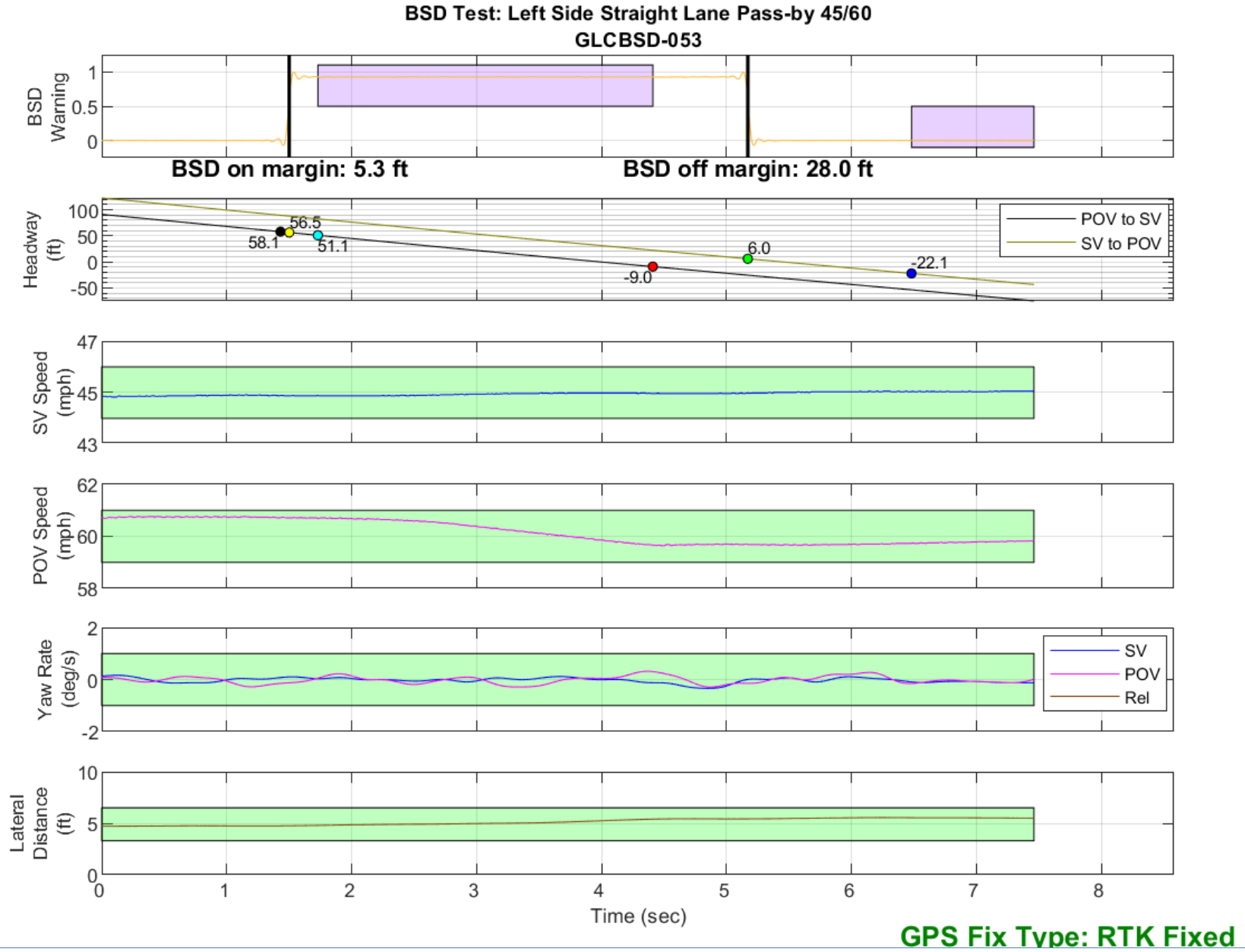


Figure D54. BSD Run 53, Straight Lane Pass-by, SV 45 mph, POV 60 mph

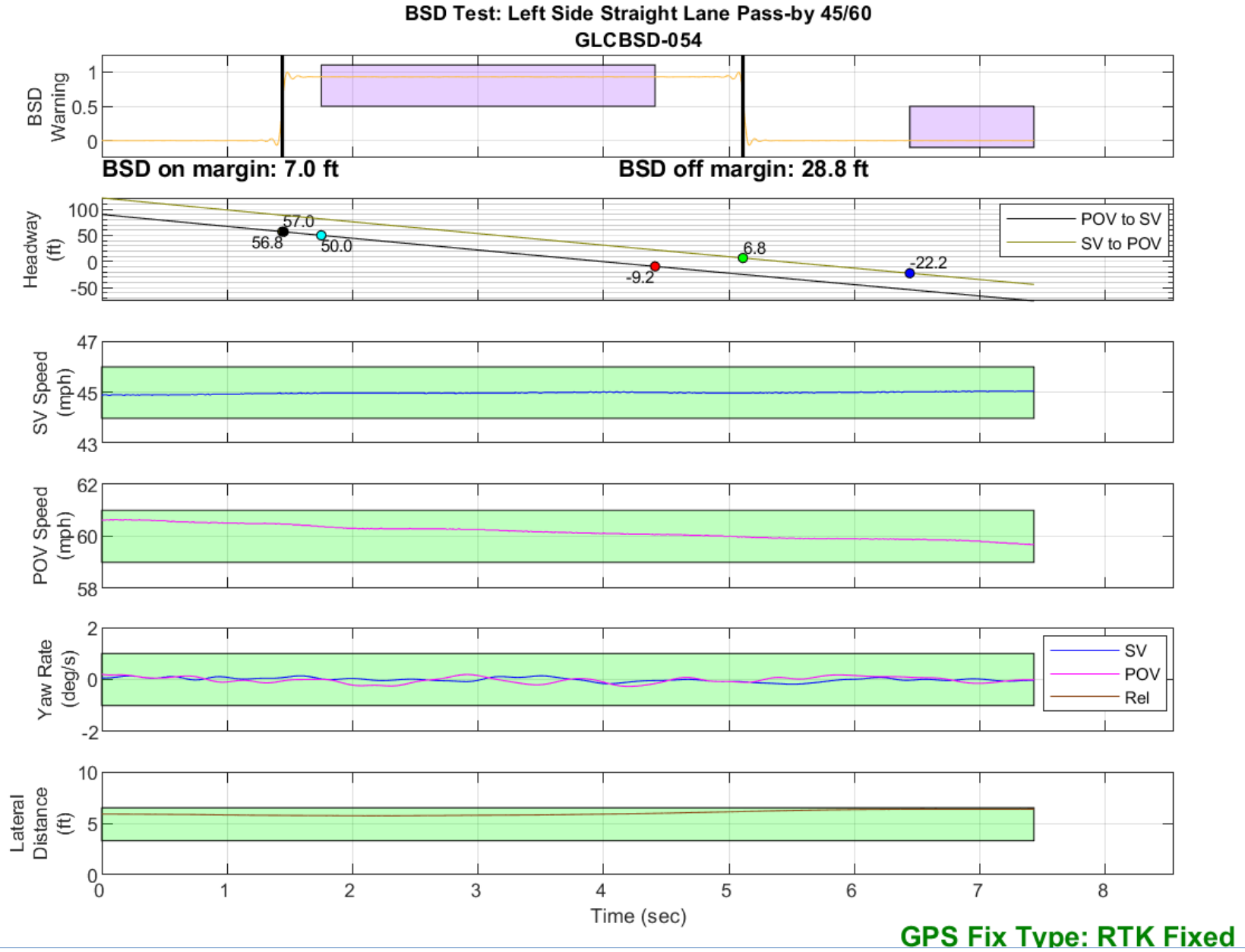


Figure D55. BSD Run 54, Straight Lane Pass-by, SV 45 mph, POV 60 mph

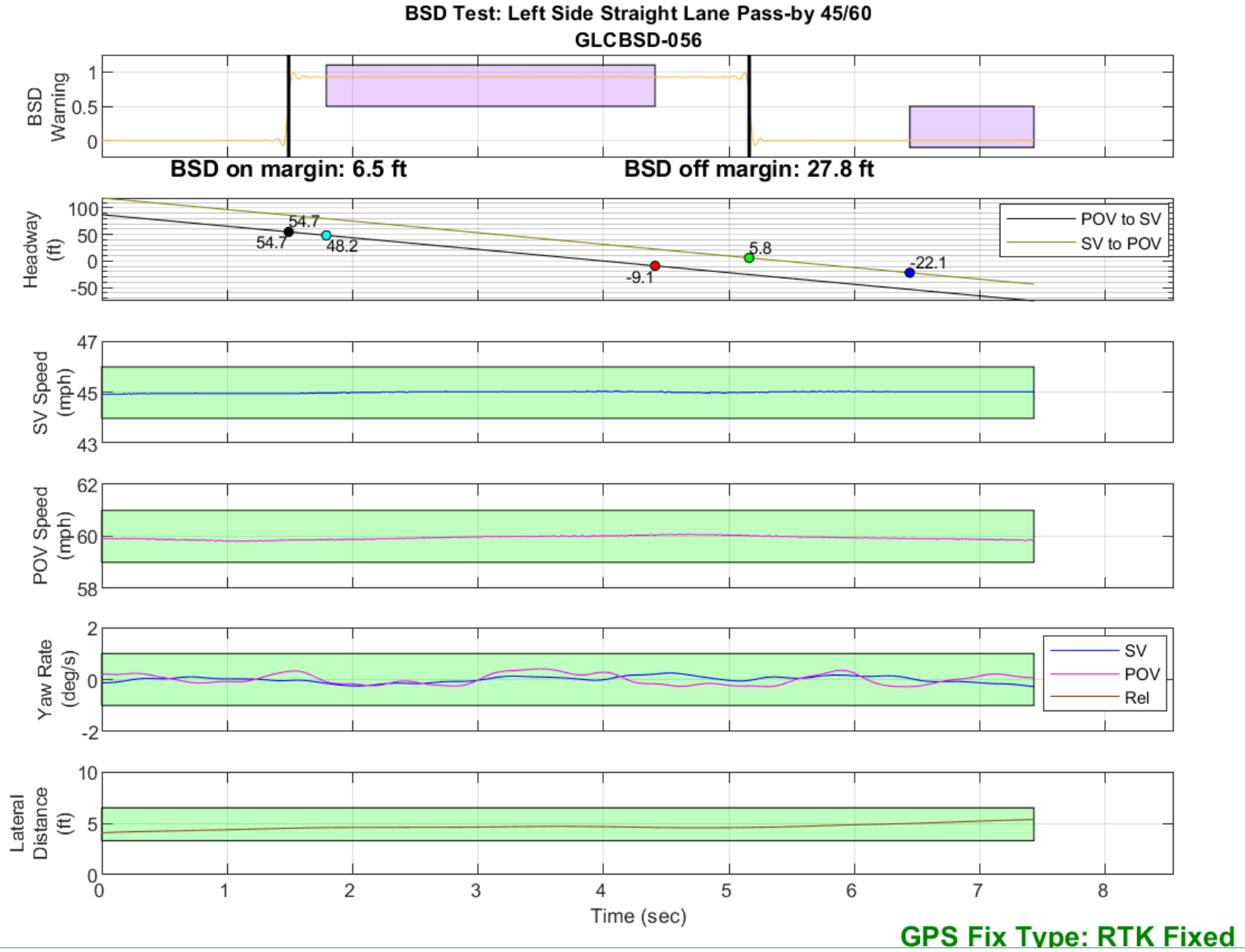


Figure D56. BSD Run 56, Straight Lane Pass-by, SV 45 mph, POV 60 mph

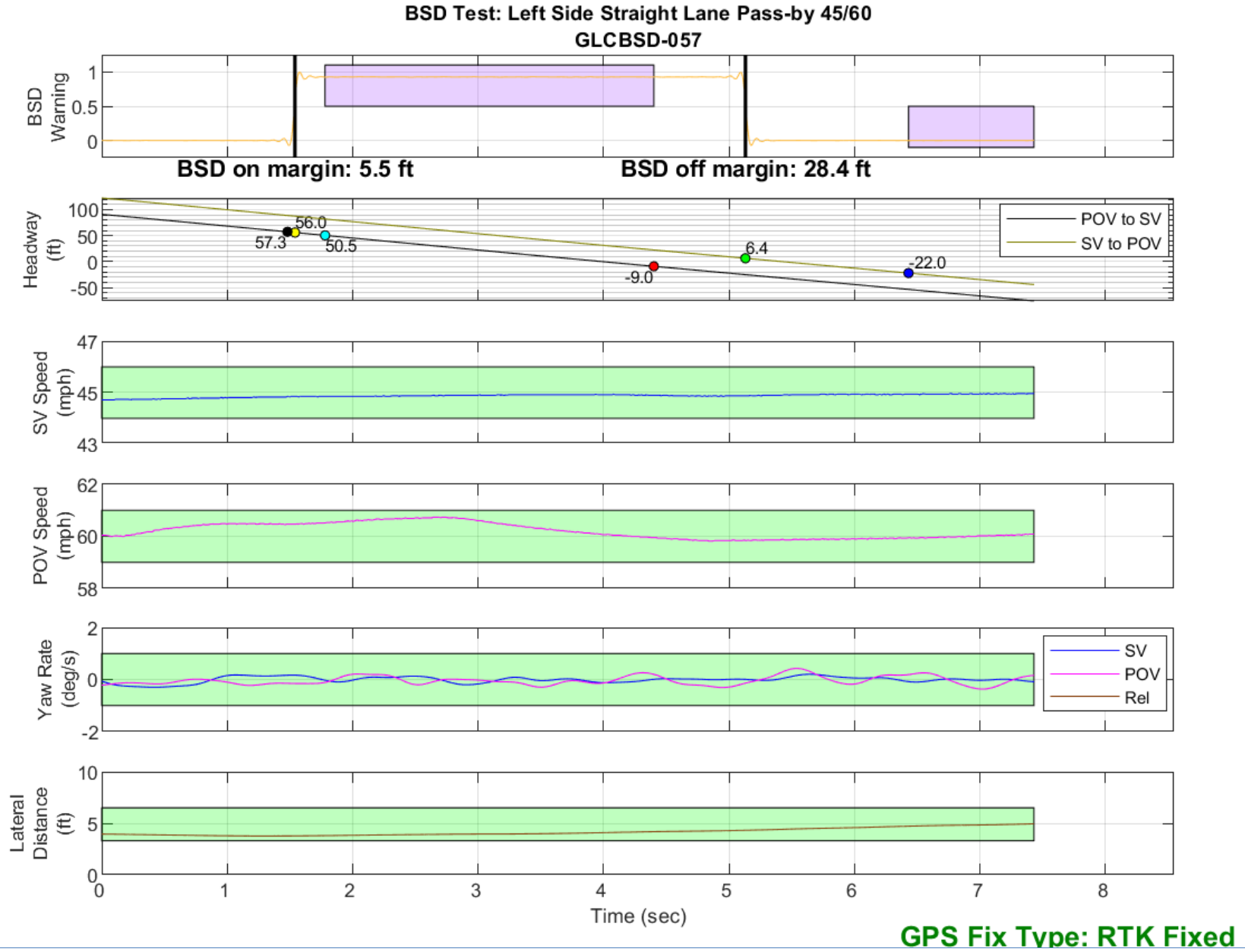


Figure D57. BSD Run 57, Straight Lane Pass-by, SV 45 mph, POV 60 mph

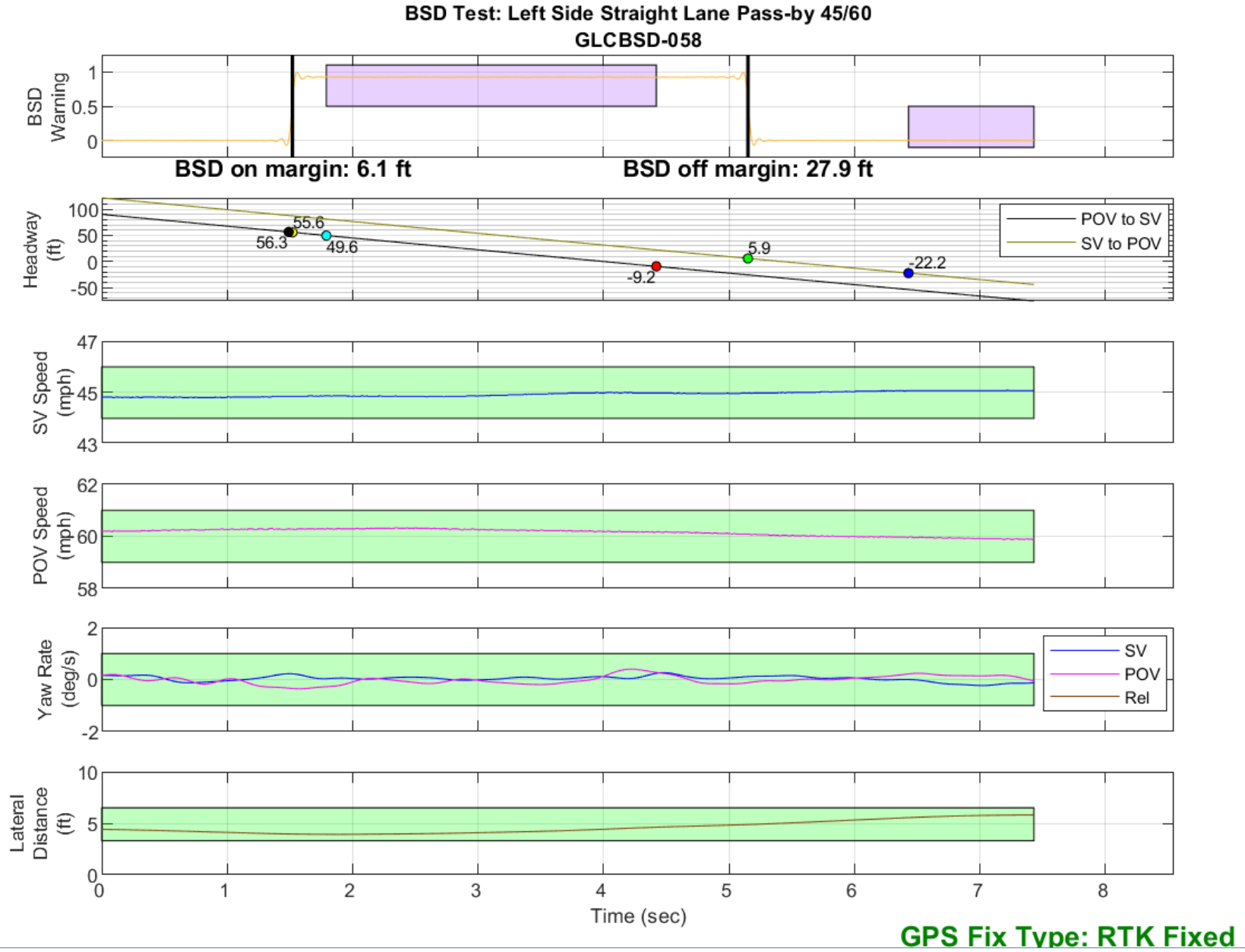


Figure D58. BSD Run 58, Straight Lane Pass-by, SV 45 mph, POV 60 mph

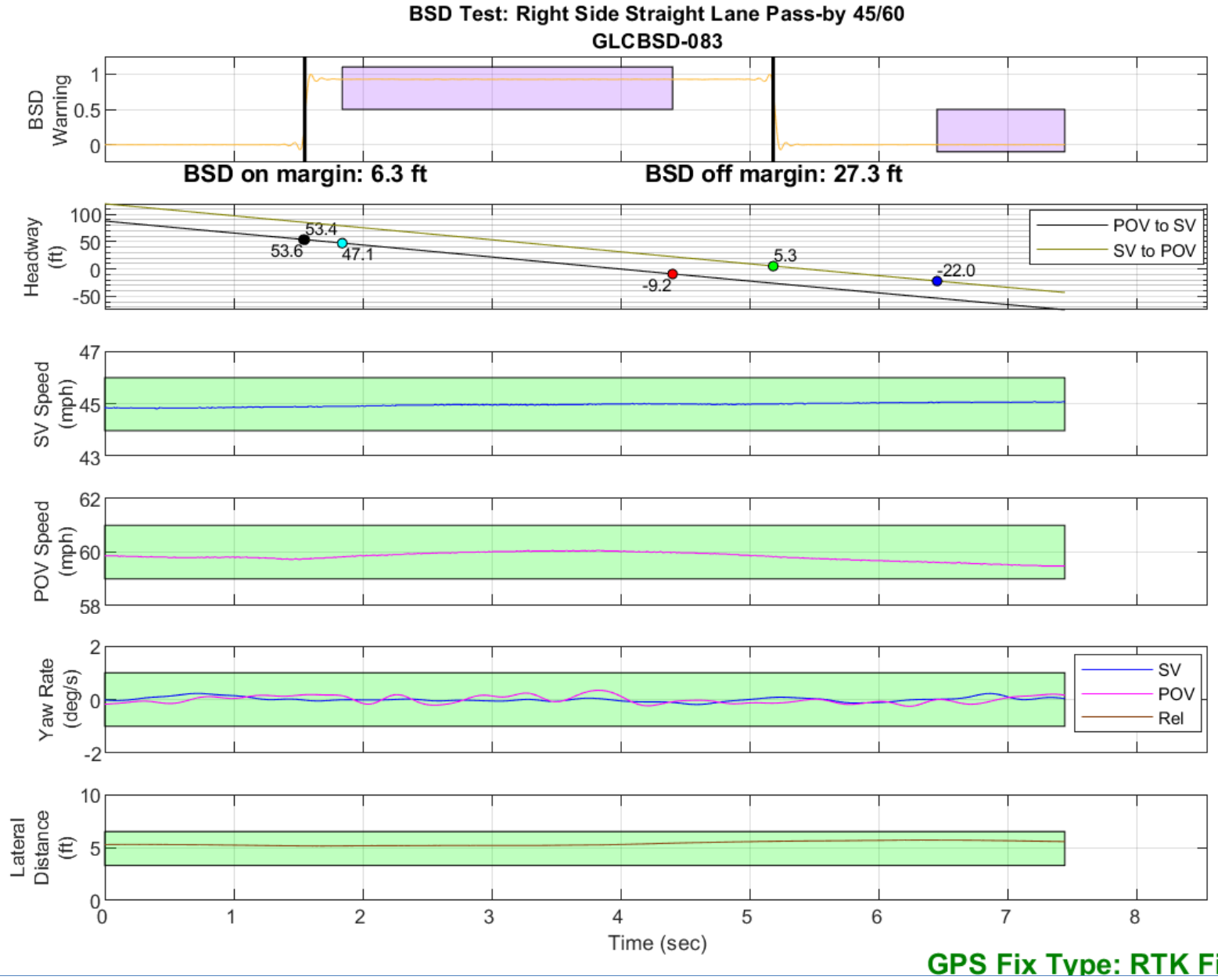


Figure D59. BSD Run 83, Straight Lane Pass-by, SV 45 mph, POV 60 mph

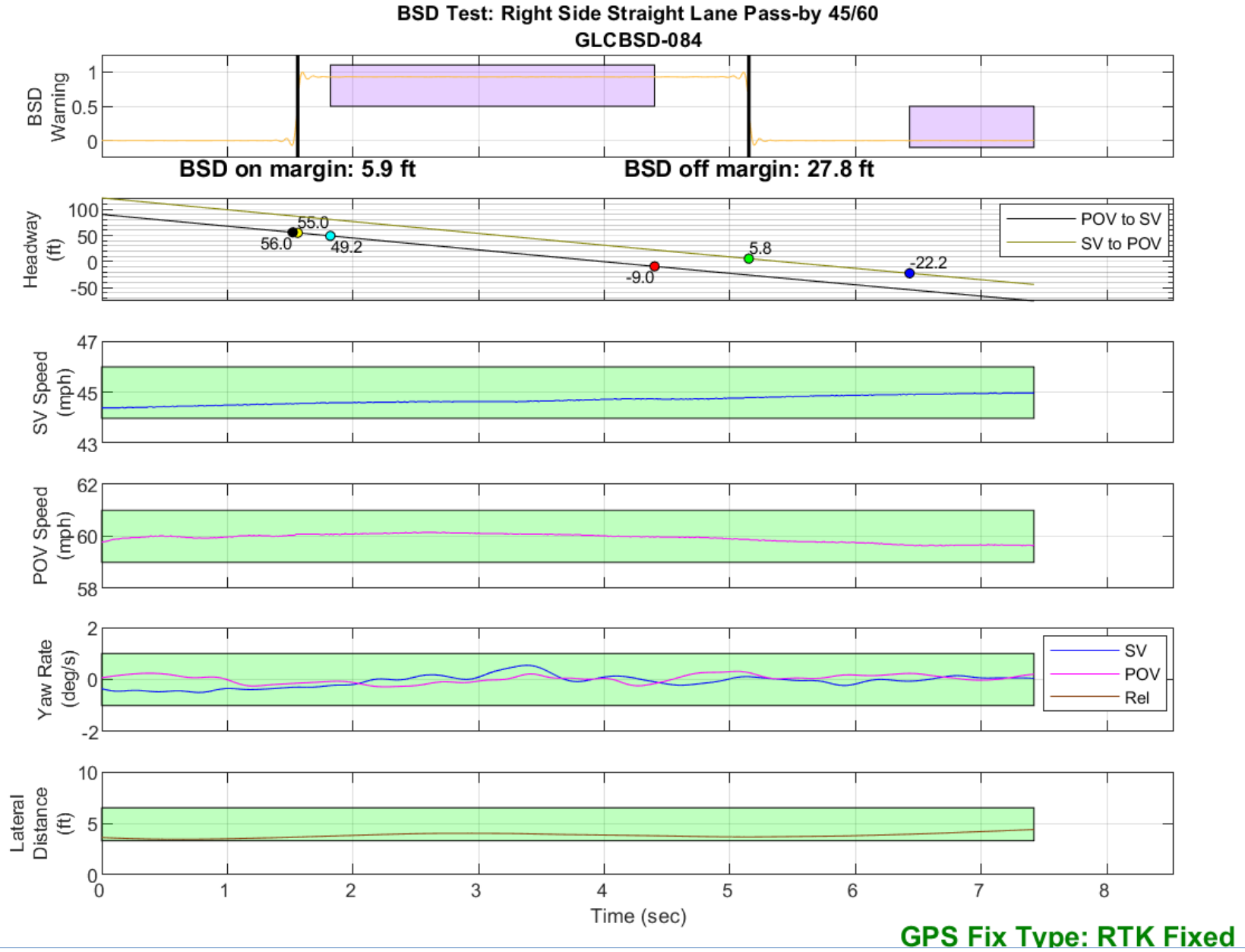


Figure D60. BSD Run 84, Straight Lane Pass-by, SV 45 mph, POV 60 mph

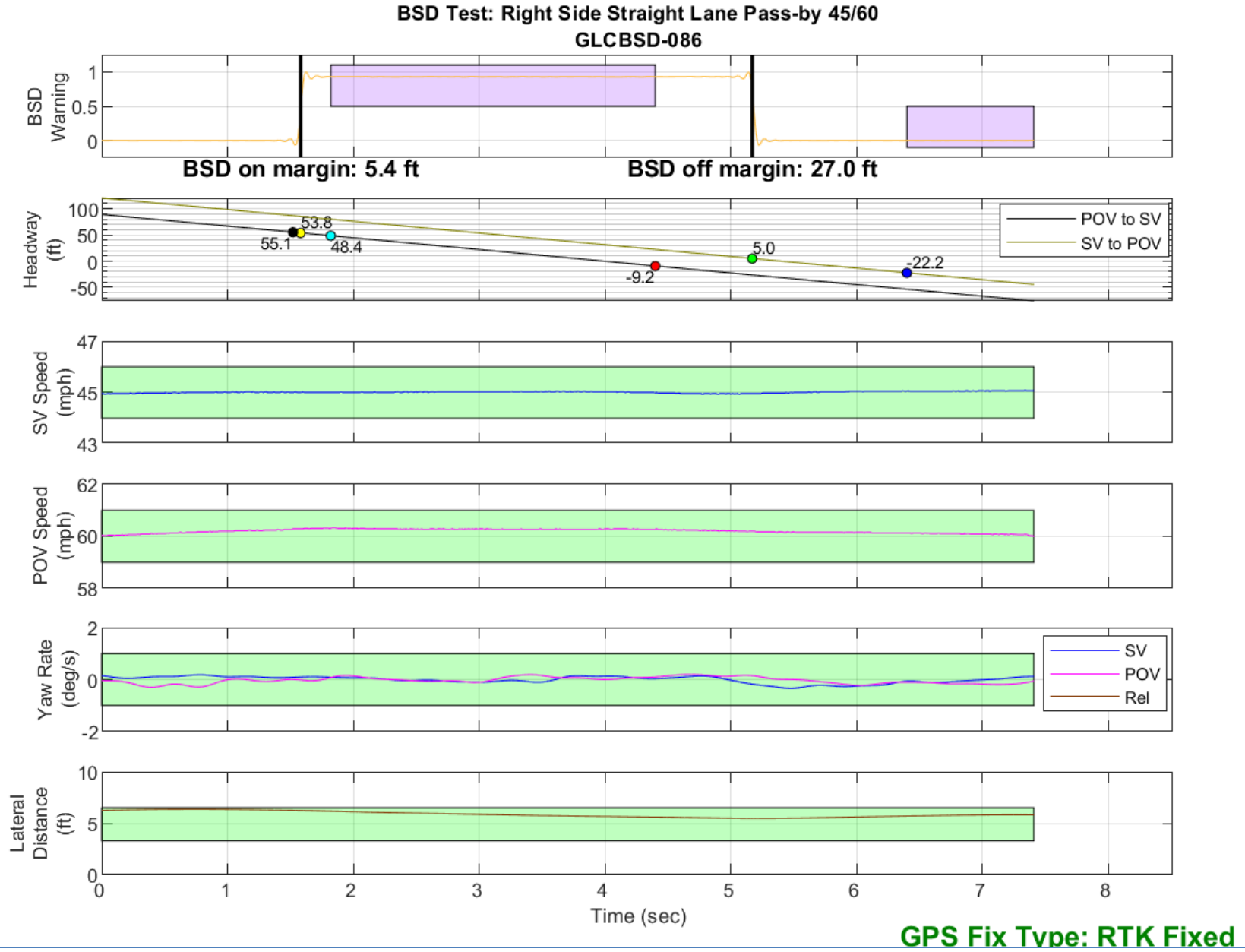


Figure D61. BSD Run 86, Straight Lane Pass-by, SV 45 mph, POV 60 mph

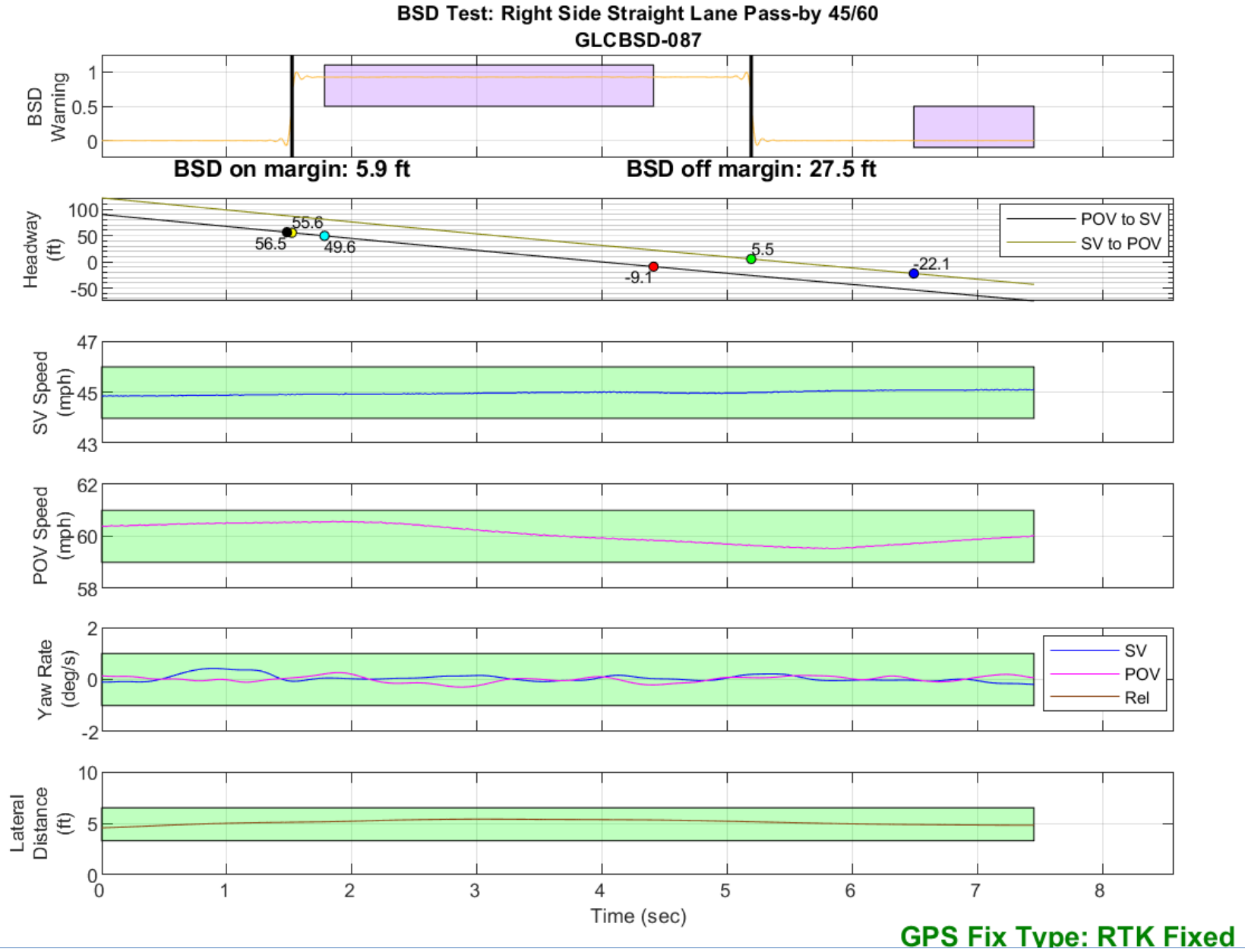


Figure D62. BSD Run 87, Straight Lane Pass-by, SV 45 mph, POV 60 mph

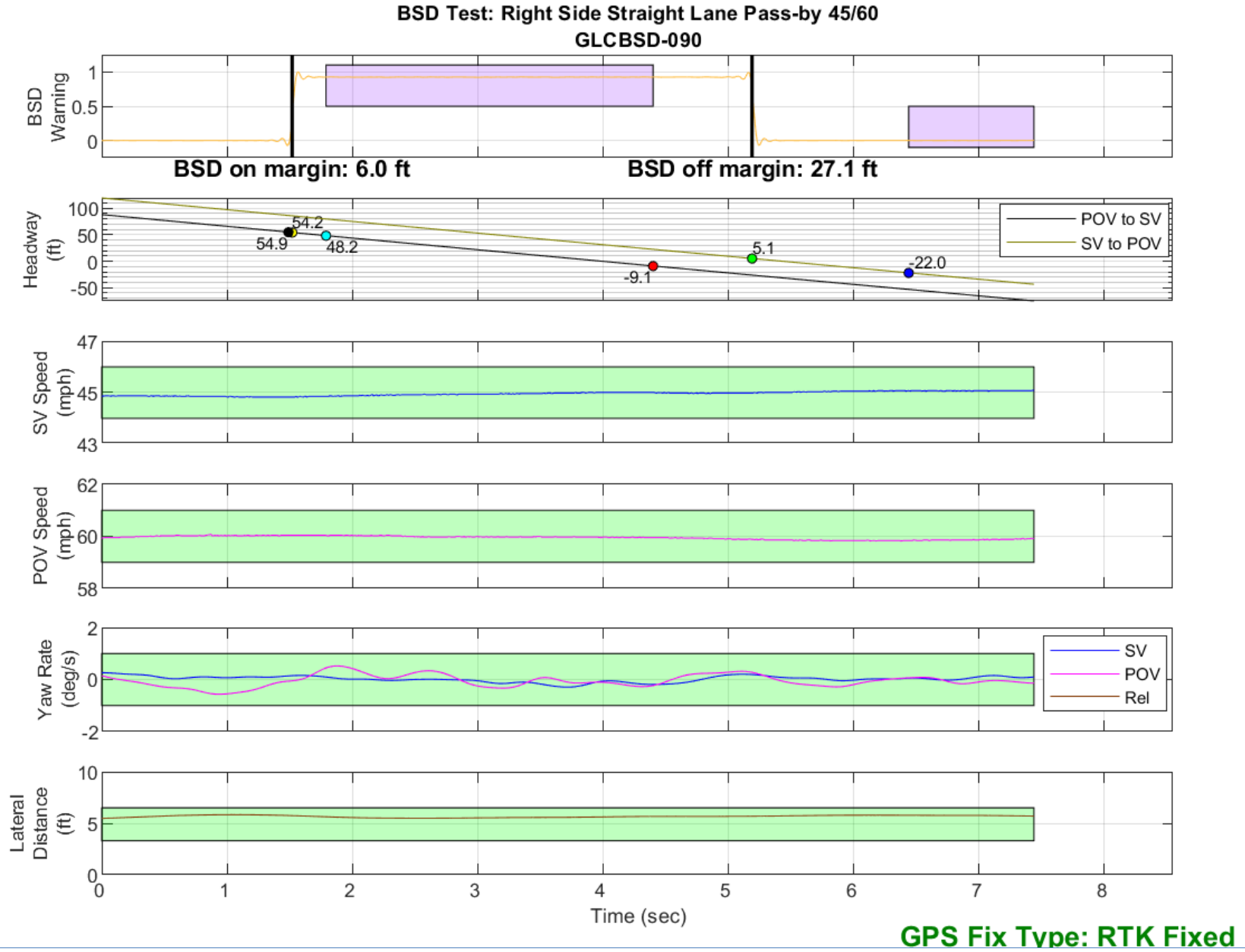


Figure D63. BSD Run 90, Straight Lane Pass-by, SV 45 mph, POV 60 mph

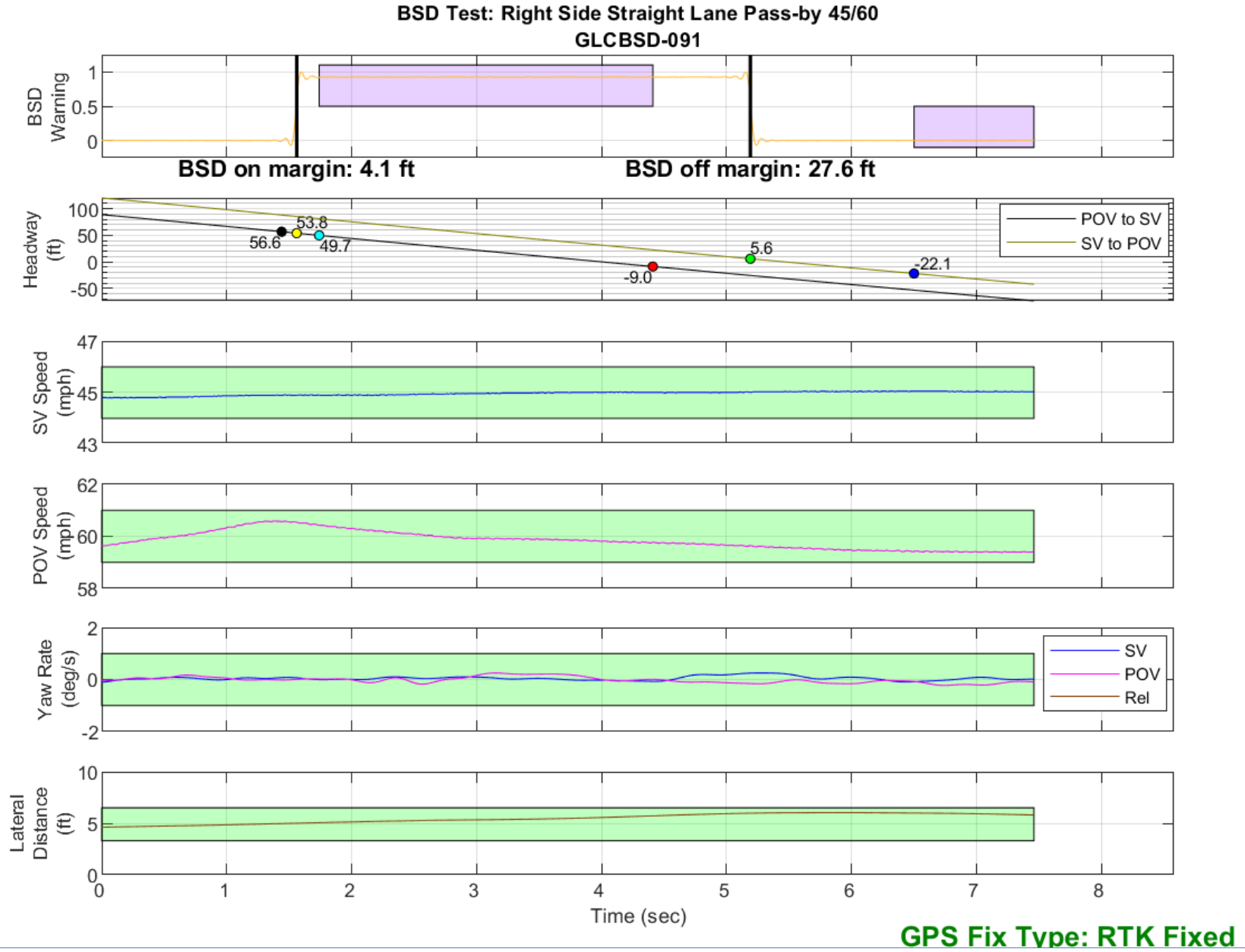


Figure D64. BSD Run 91, Straight Lane Pass-by, SV 45 mph, POV 60 mph

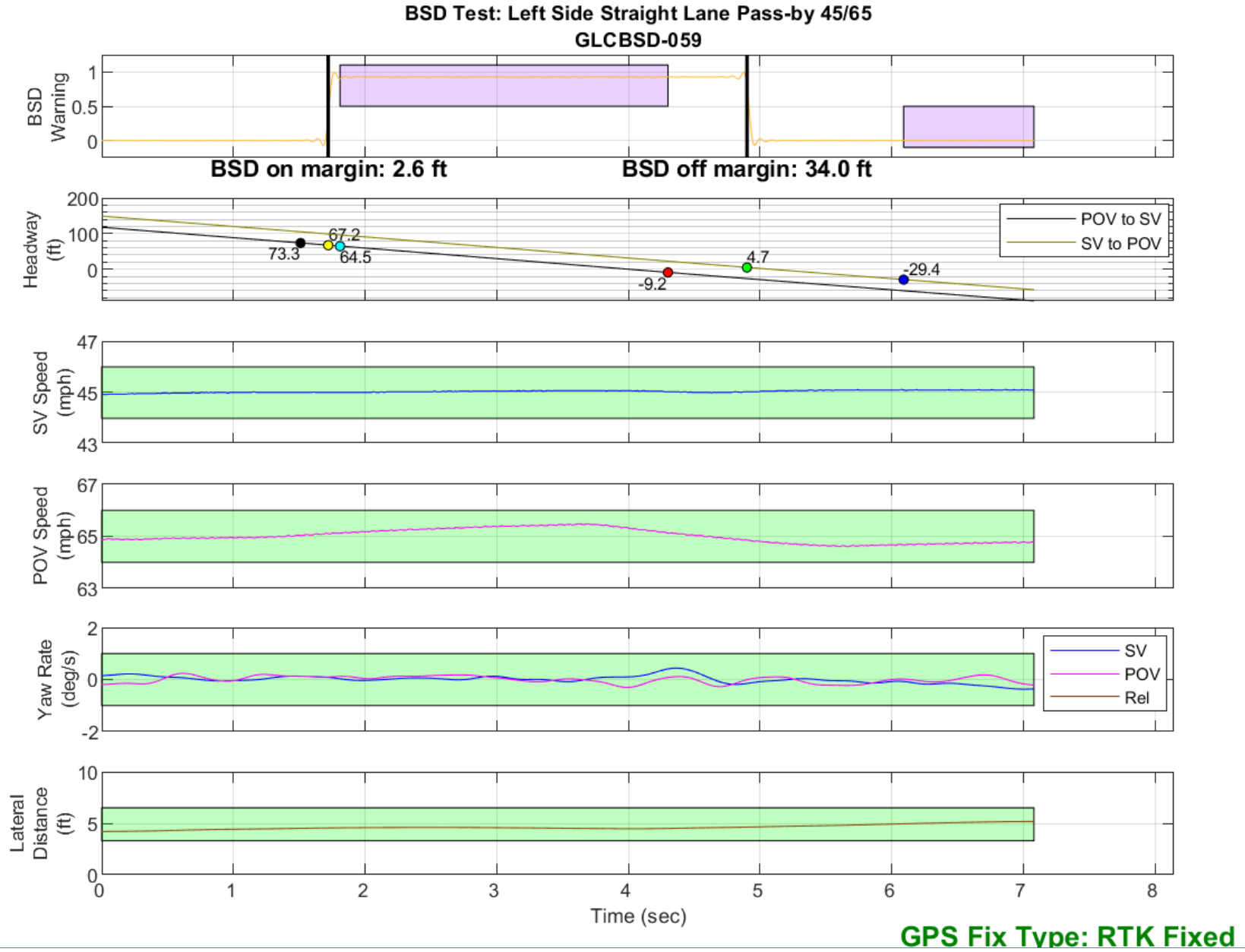


Figure D65. BSD Run 59, Straight Lane Pass-by, SV 45 mph, POV 65 mph

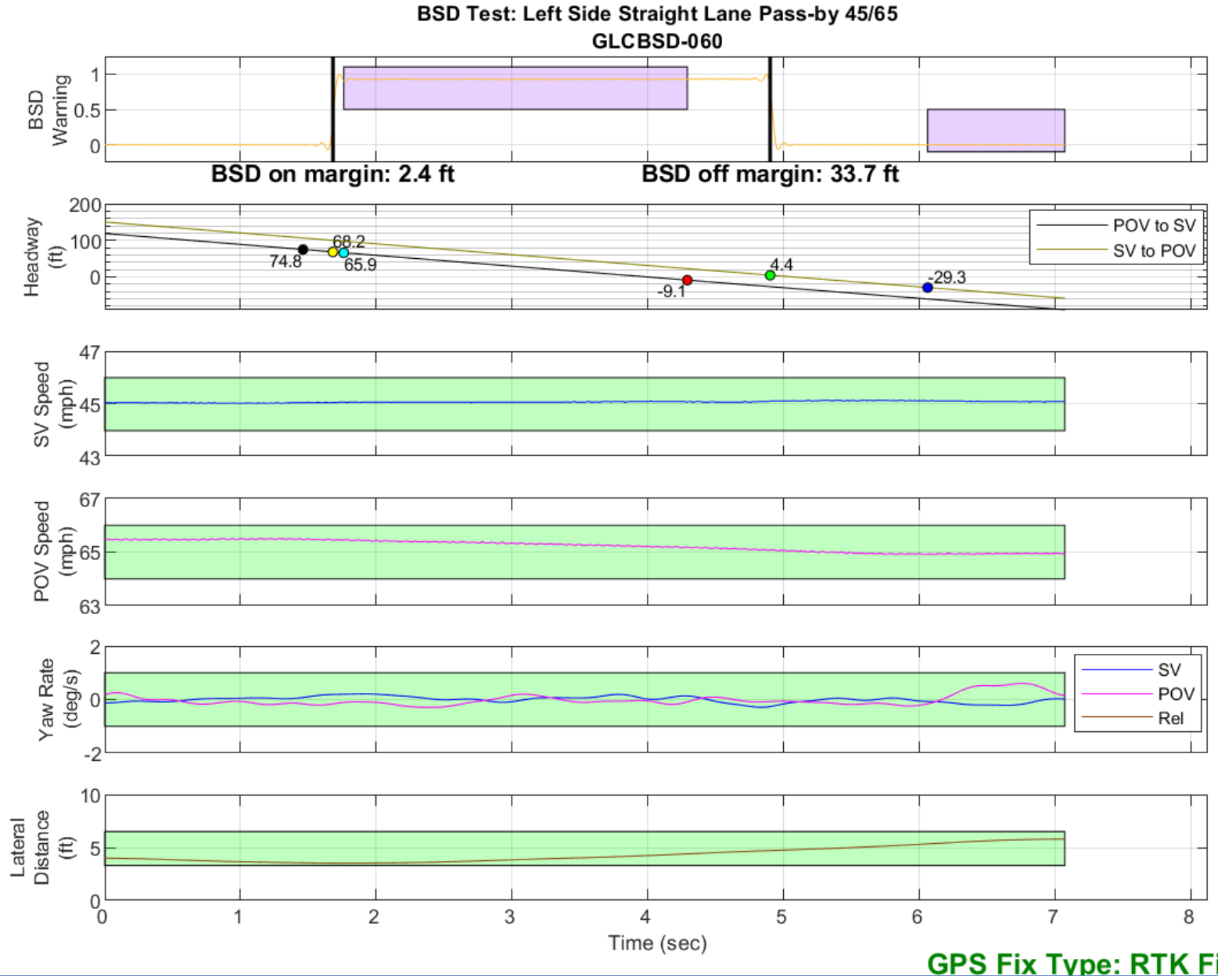


Figure D66. BSD Run 60, Straight Lane Pass-by, SV 45 mph, POV 65 mph

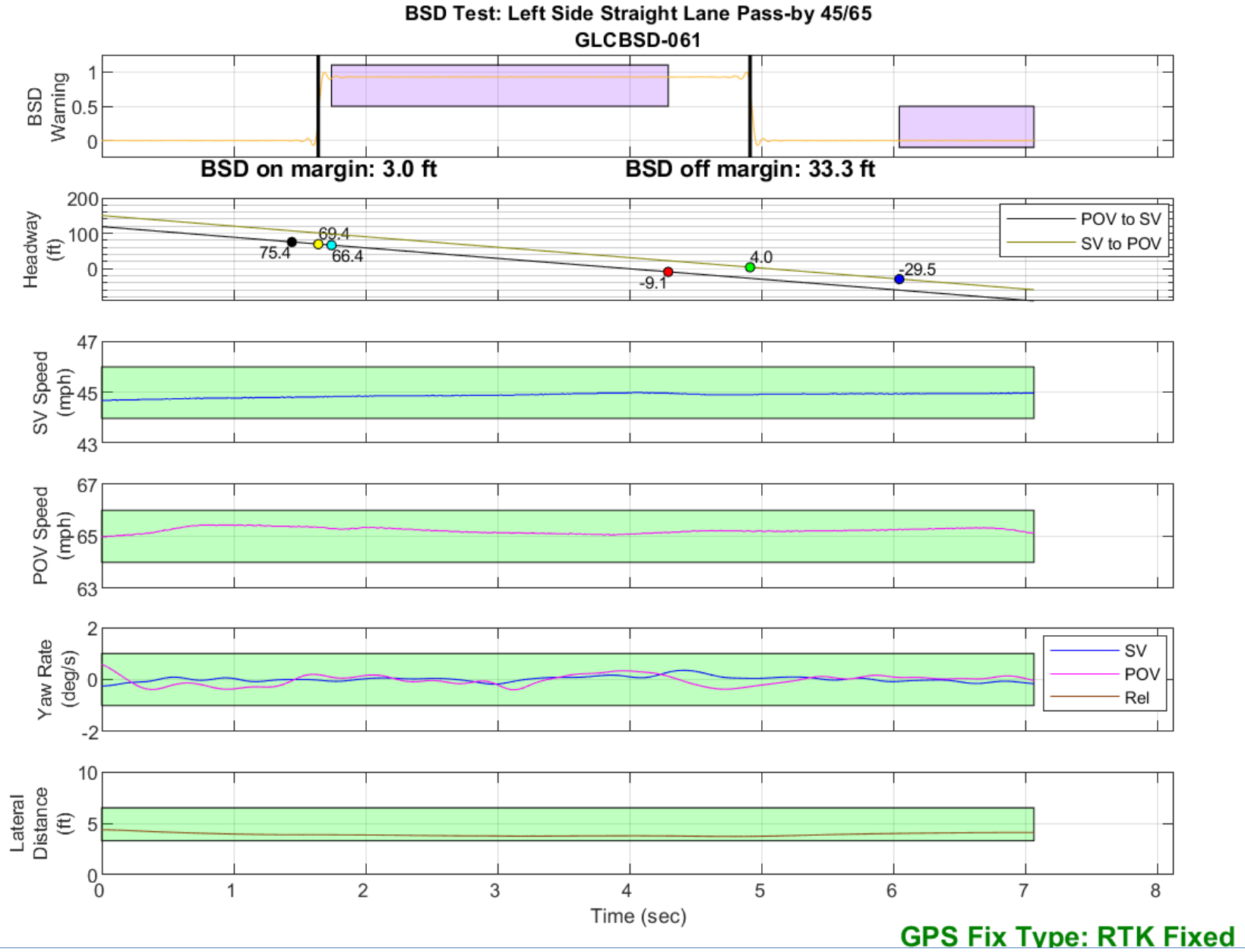


Figure D67. BSD Run 61, Straight Lane Pass-by, SV 45 mph, POV 65 mph

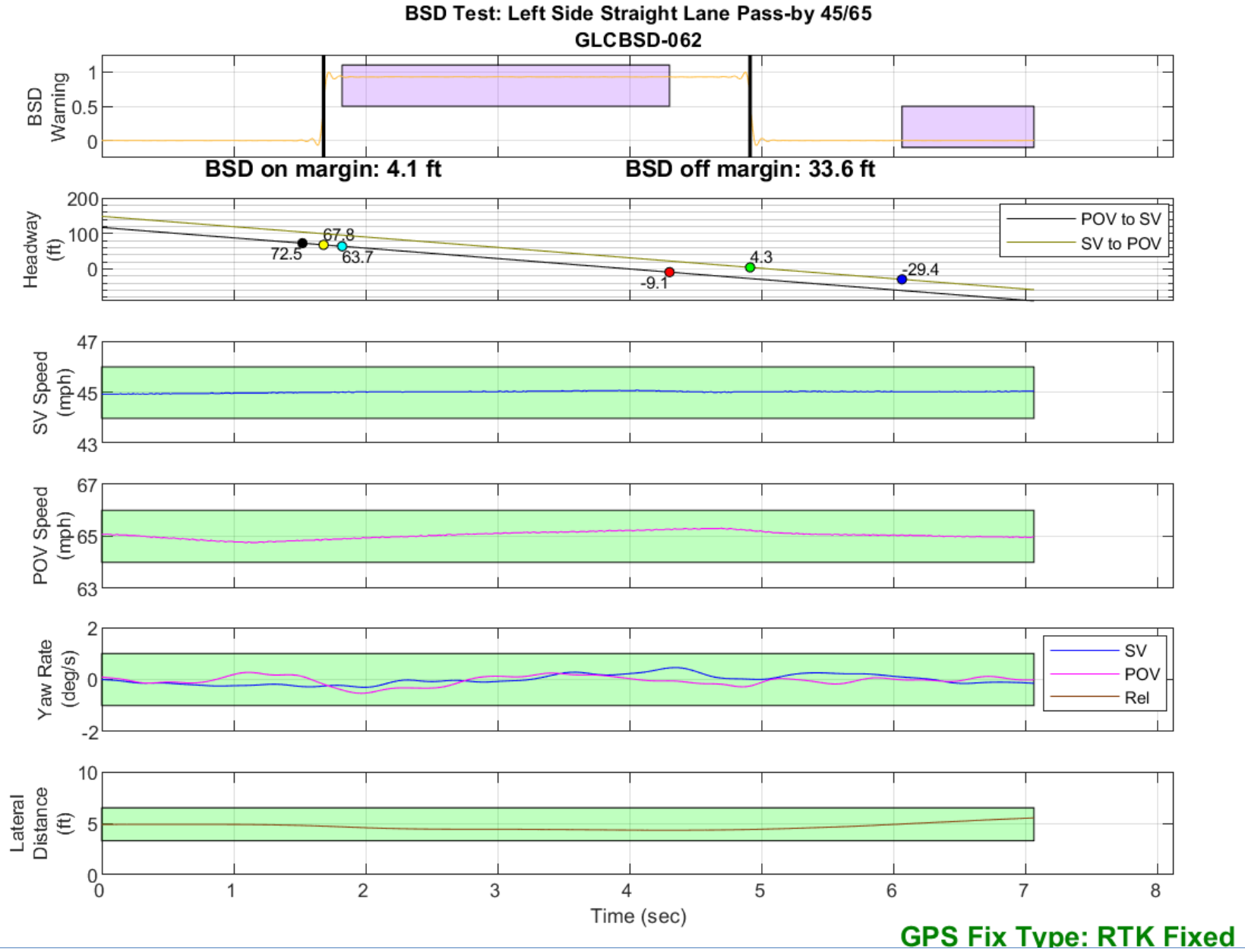


Figure D68. BSD Run 62, Straight Lane Pass-by, SV 45 mph, POV 65 mph

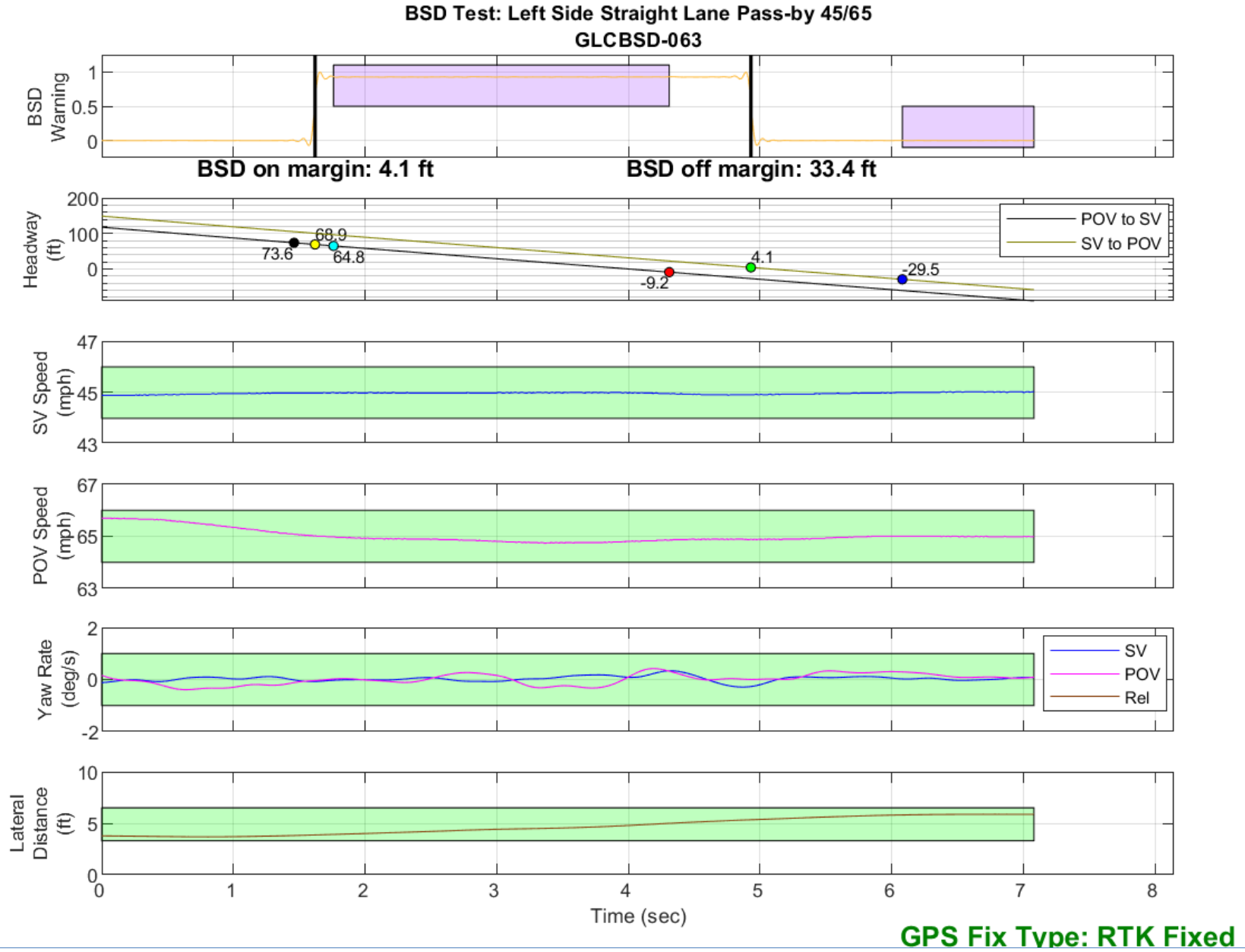


Figure D69. BSD Run 63, Straight Lane Pass-by, SV 45 mph, POV 65 mph

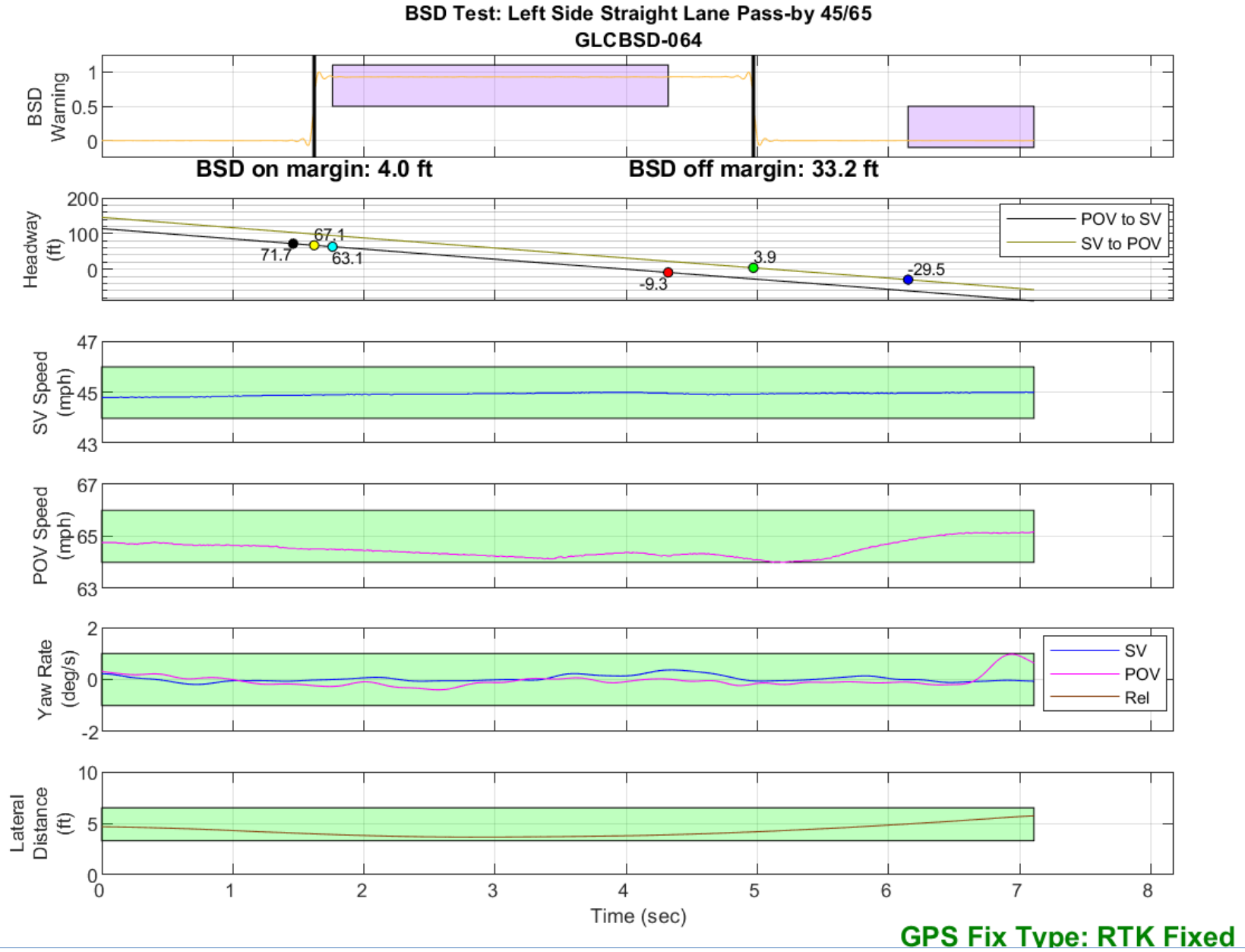


Figure D70. BSD Run 64, Straight Lane Pass-by, SV 45 mph, POV 65 mph

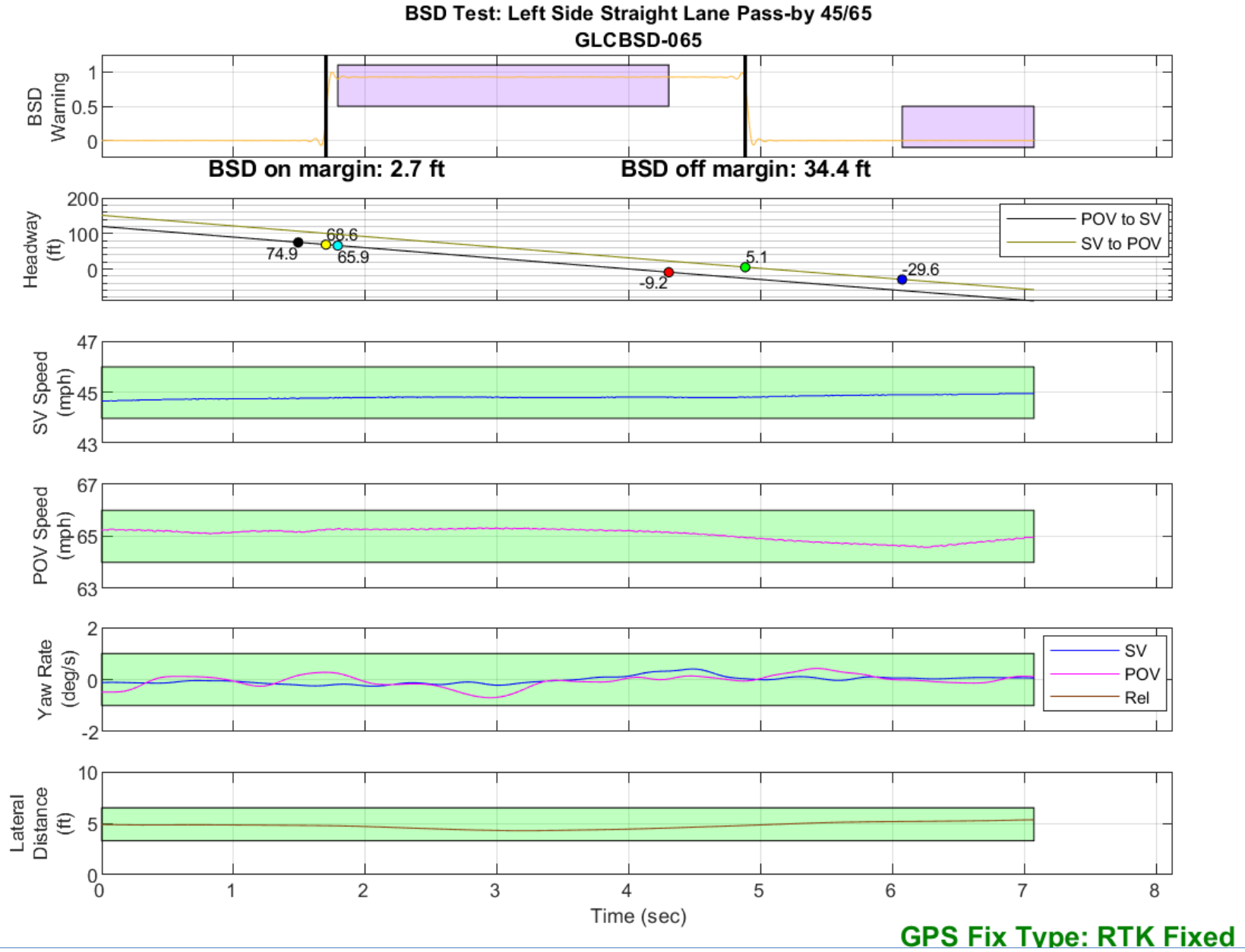


Figure D71. BSD Run 65, Straight Lane Pass-by, SV 45 mph, POV 65 mph

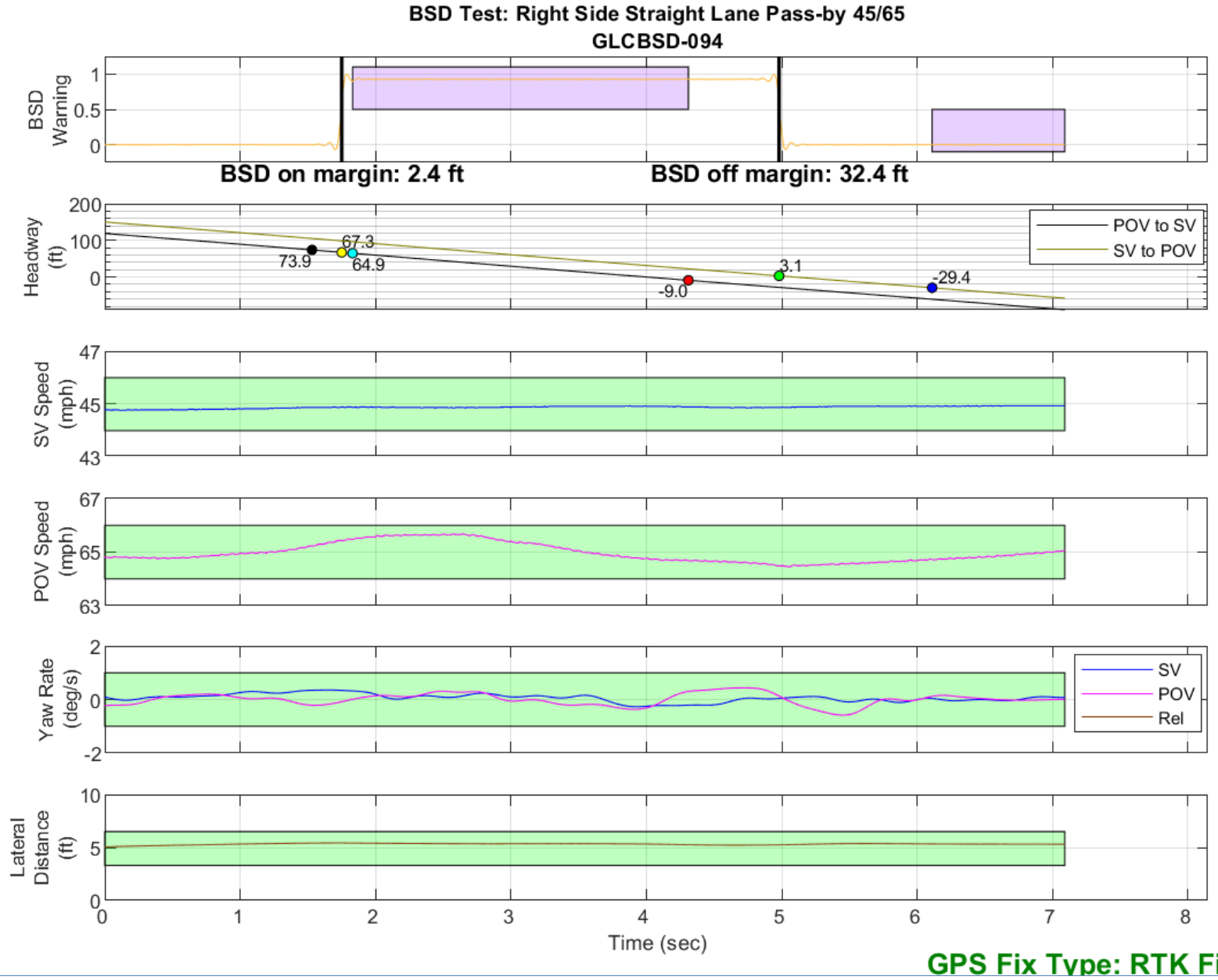


Figure D72. BSD Run 94, Straight Lane Pass-by, SV 45 mph, POV 65 mph

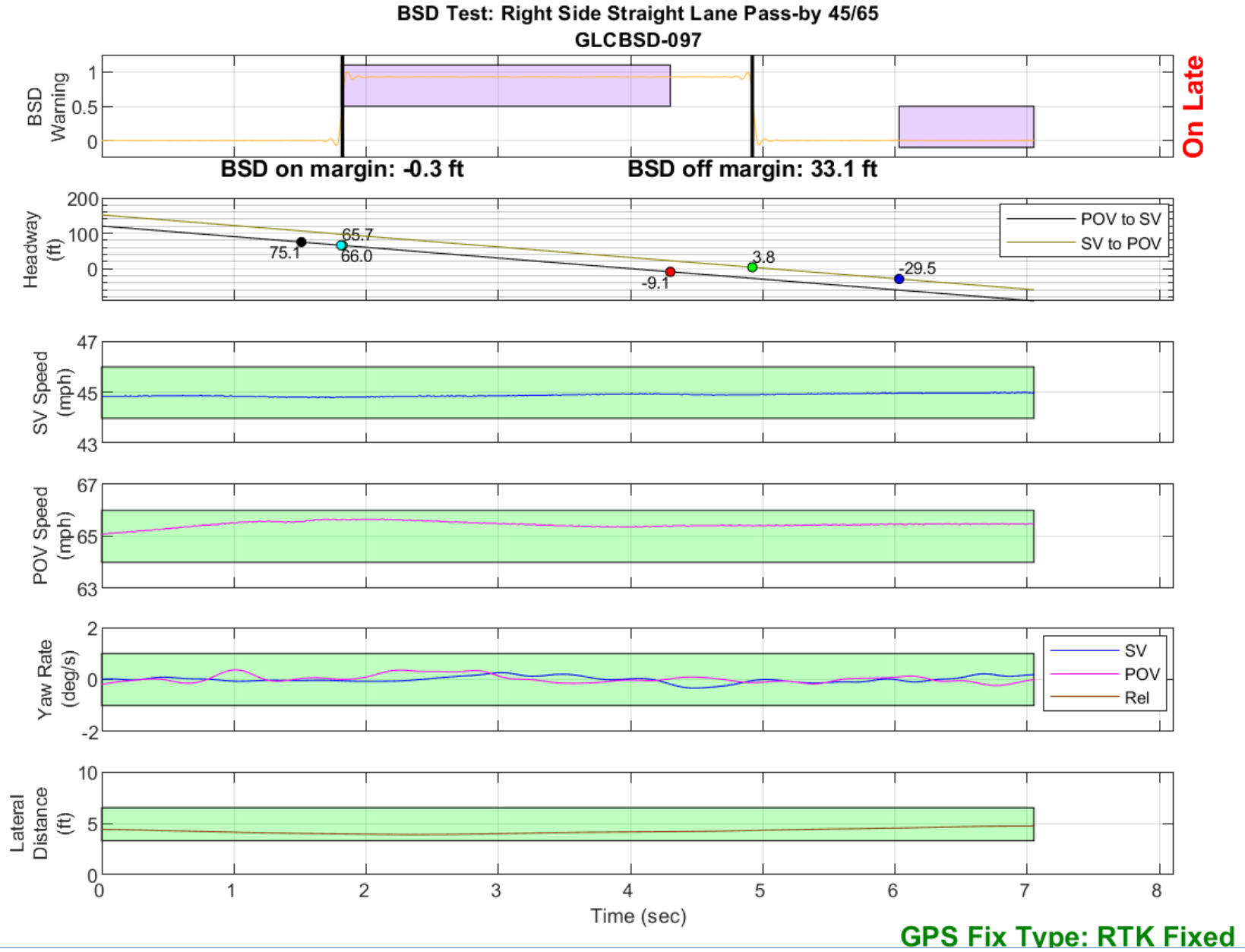


Figure D73. BSD Run 97, Straight Lane Pass-by, SV 45 mph, POV 65 mph

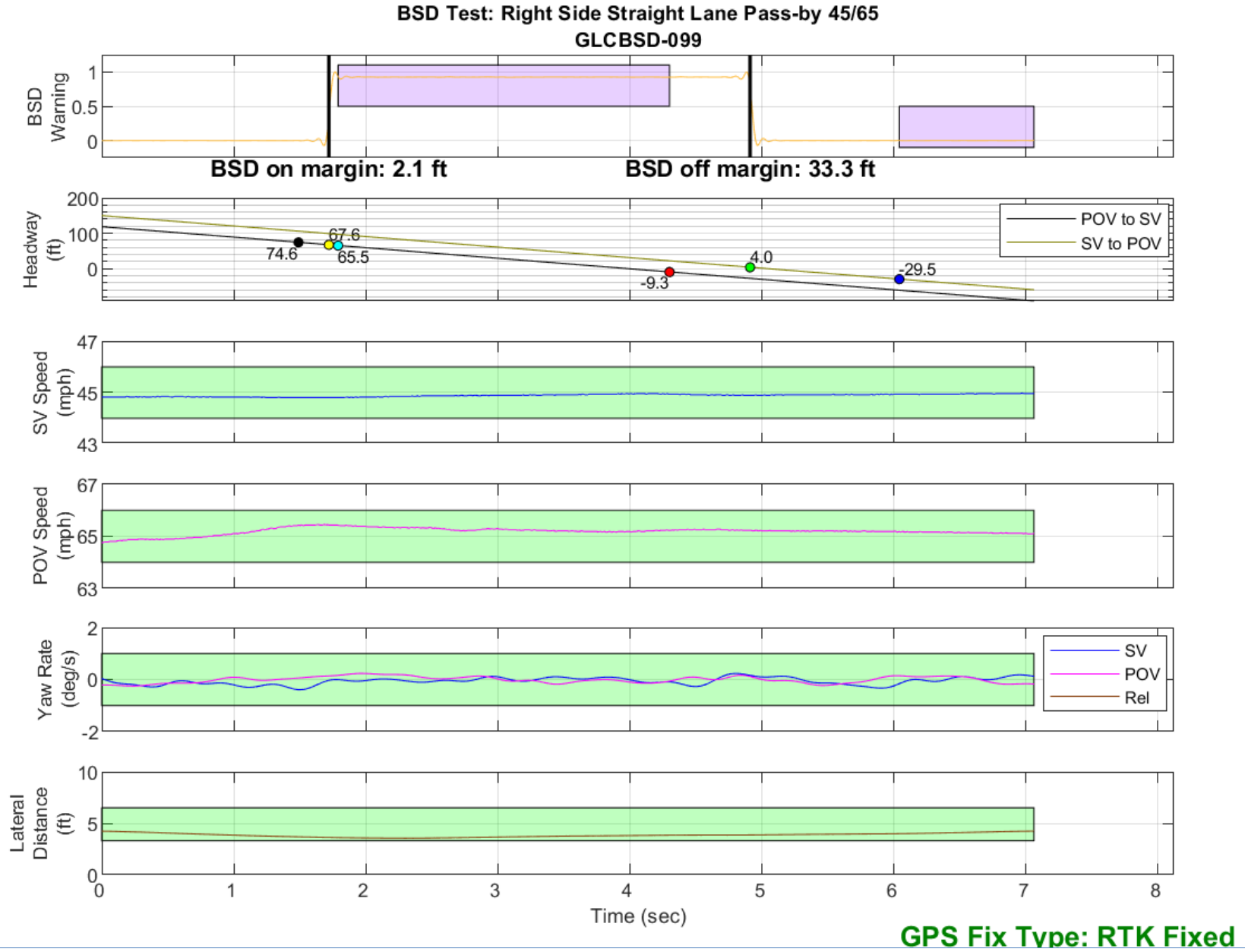


Figure D74. BSD Run 99, Straight Lane Pass-by, SV 45 mph, POV 65 mph

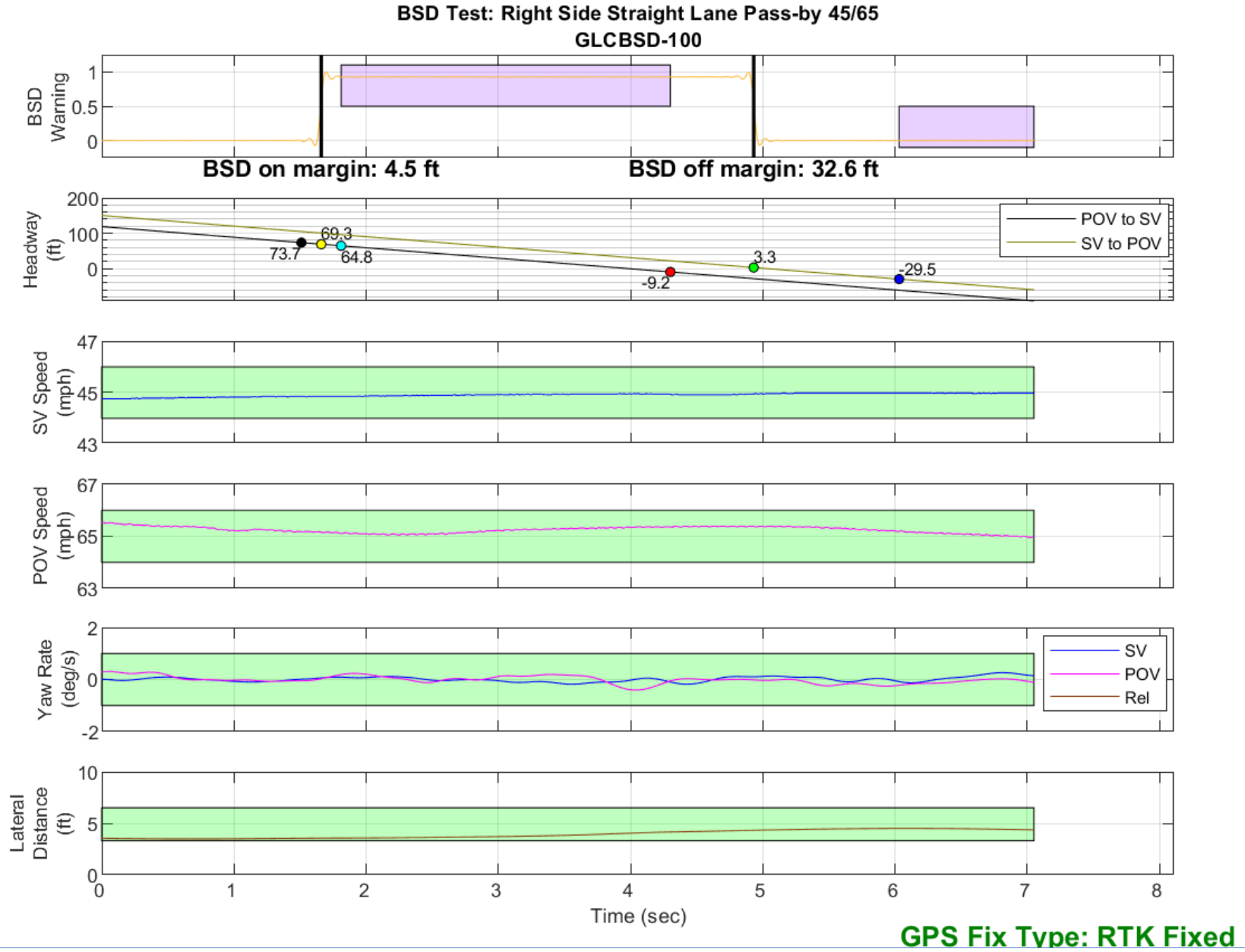


Figure D75. BSD Run 100, Straight Lane Pass-by, SV 45 mph, POV 65 mph

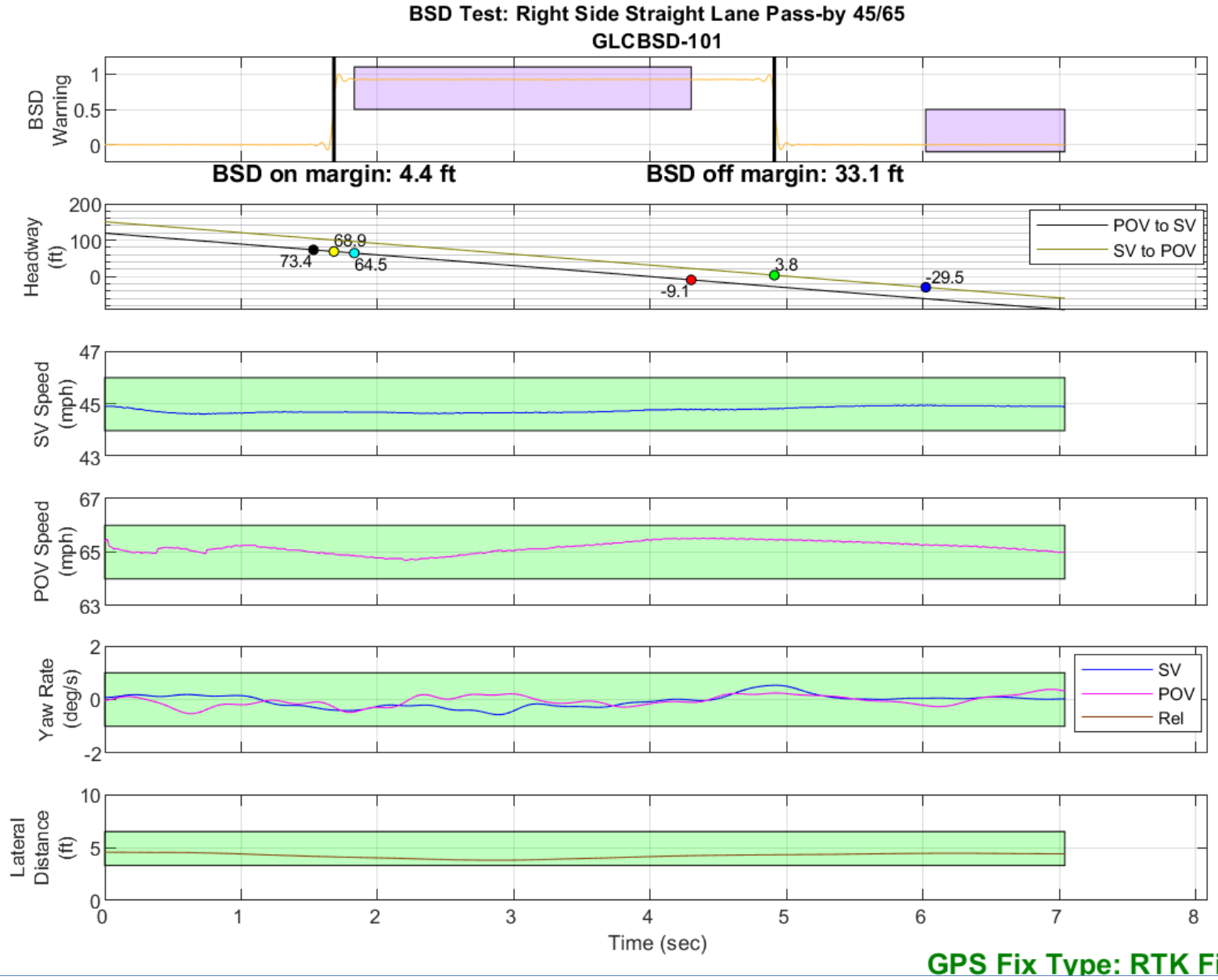


Figure D76. BSD Run 101, Straight Lane Pass-by, SV 45 mph, POV 65 mph

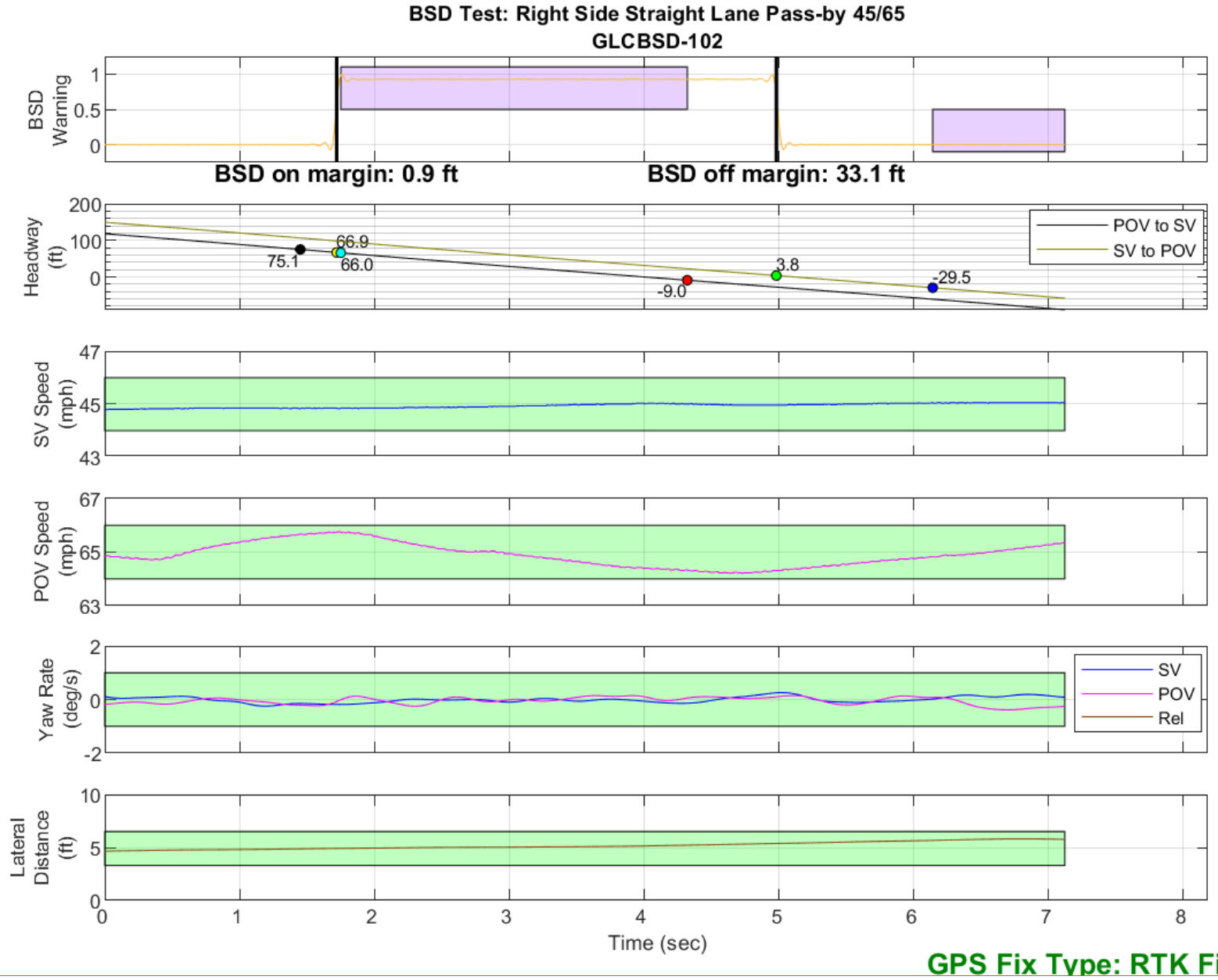


Figure D77. BSD Run 102, Straight Lane Pass-by, SV 45 mph, POV 65 mph

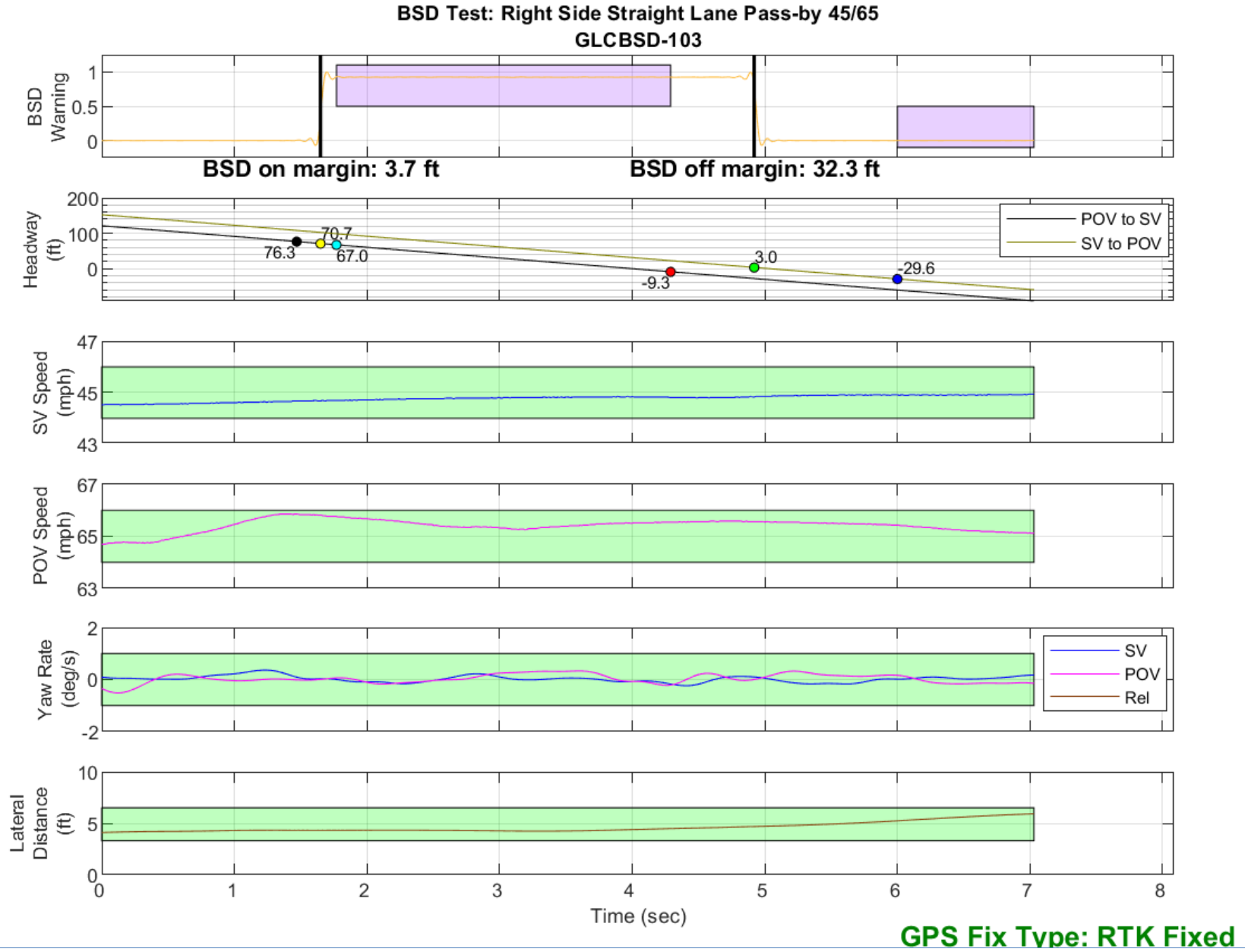


Figure D78. BSD Run 103, Straight Lane Pass-by, SV 45 mph, POV 65 mph

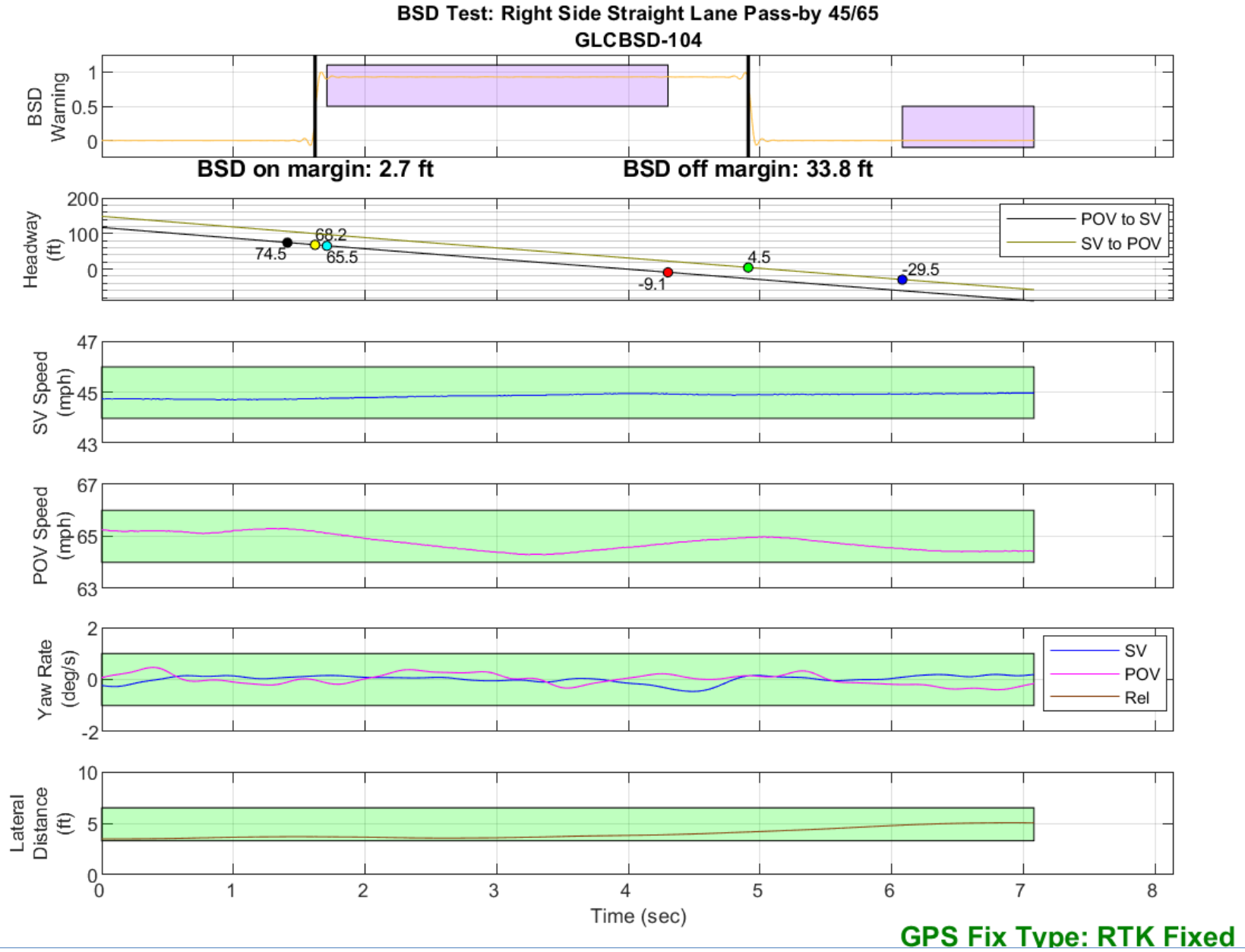


Figure D79. BSD Run 104, Straight Lane Pass-by, SV 45 mph, POV 65 mph