BLIND SPOT DETECTION SYSTEM RESEARCH TEST
NCAP-DRI-BSD-20-09

2020 Volkswagen Jetta 1.4T SEL

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

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Final Report

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U. S. DEPARTMENT OF TRANSPORTATION
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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 Volkswagen Jetta 1.4T SEL 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 vehicle met the requirements of the Straight Lane Converge/Diverge test scenario for both left and right at all speeds. It also met the requirements for the Straight Lane Pass-by test scenario for 44 of 58 valid trials. Overall, it met the requirements for 58 of 72 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

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2020 Volkswagen Jetta 1.4T SEL

VIN: *3VWEB7BU2LM02xxxx*

Test Date: *7/27/2020*

System Setting: *Default*

	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	*7*	*0*	*7*
45 mph - Right	*7*	*0*	*7*
Overall Test 1:	*14*	*0*	*14*
Test 2 - Straight Lane Pass-by			
POV 50 mph - Left	*7*	*0*	*7*
POV 50 mph - Right	*7*	*0*	*7*
POV 55 mph - Left	*0*	*7*	*7*
POV 55 mph - Right	*6*	*1*	*7*
POV 60 mph - Left	*4*	*3*	*7*
POV 60 mph - Right	*6*	*1*	*7*
POV 65 mph - Left	*7*	*2*	*9*
POV 65 mph - Right	*7*	*0*	*7*
Overall Test 2:	*44*	*14*	*58*
Overall:	***58***	***14***	***72***

[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 Volkswagen Jetta 1.4T SEL

TEST VEHICLE INFORMATION

VIN: *3VWEB7BU2LM02xxxx*

Body Style: *Sedan* Color: *Deep Black Pearl*

Date Received: *7/16/2020* Odometer Reading: *13 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Volkswagen de Mexico S.A. de C.V.*

Date of manufacture: *01/20*

Vehicle Type: *Passenger Car*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *205/55 R17*

Rear: *205/55 R17*

Recommended cold tire pressure: Front: *250 kPa (36 psi)*

Rear: *250 kPa (36 psi)*

TIRES

Tire manufacturer and model: *Hankook Kinergy GT*

Front tire size: *205/55 R17 91H*

Rear tire size: *205/55 R17 91H*

Front tire DOT prefix: *15M581BHQ*

Rear tire DOT prefix: *15M581BHQ*

BLIND SPOT DETECTION

DATA SHEET 3: TEST CONDITIONS

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2020 Volkswagen Jetta 1.4T SEL

GENERAL INFORMATION

Test date: *7/27/2020*

AMBIENT CONDITIONS

Air temperature: *38.9 C (102 F)*

Wind speed: *0.5 m/s (1.2 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 (36 psi)*

Rear: *250 kPa (36 psi)*

BLIND SPOT DETECTION

DATA SHEET 3: TEST CONDITIONS

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2020 Volkswagen Jetta 1.4T SEL

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*455.4 kg (1004 lb)*	Right Front:	*427.7 kg (943 lb)*
Left Rear:	*335.7 kg (740 lb)*	Right Rear:	*314.8 kg (694 lb)*
		Total:	*1533.6 kg (3381 lb)*

BLIND SPOT DETECTION

DATA SHEET 4: BLIND SPOT DETECTION SYSTEM OPERATION

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2020 Volkswagen Jetta 1.4T SEL

General Information

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

Blind Spot Monitor, shown as Active Blind Spot Monitor & Rear Traffic Alert on the Monroney label.

Optional Driver Assistance Package on S trim; standard on all other trims.

Type and location of sensors the system uses:

Two Medium Range Radar sensors located in the rear bumper.

System setting used for test (if applicable):

Default

Method(s) by which the driver is alerted

X Visual:

	Type	Location	Description
X	Symbol	*Outside mirrors*	*Blind Spot symbol*
____	Word		
____	Graphic		

____ Audible – Description:

____ Haptic:

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

Description of alert:

If a vehicle is travelling alongside or approaching in the adjacent lane and the turn signal is not activated, the yellow LED symbol in the mirror will remain constantly on and dim while the adjacent vehicle is detected. If the turn signal is activated, the LED will flash bright yellow to indicate a critical situation.

See Figure A14 in Appendix A.

System Function

What is the speed range over which the system operates?

Minimum: 14.4 km/h (9 mph)

Maximum: 248 km/h (155 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.

If a vehicle is detected in the blind spot and the turn signal is not activated, the yellow LED symbol in the mirror will remain constantly on and dim while the adjacent vehicle is detected. If the turn signal is activated, the LED will flash bright yellow to indicate a critical situation.

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?

There are three methods for enabling/disabling the Blind Spot Monitoring system:

1. Using the Multi-Media (touch screen) Interface in the center of the console:

Select "Vehicle"

"Settings"

"Assistance Systems"

"Blind Spot Monitor"

Select or deselect to enable/disable

See Appendix A, Figure A11.

2. Push the button on the left side of the steering wheel; “Assist Systems" is displayed at the top-center of the instrument panel.

Use the down arrow on the right side of the steering wheel to select “Blind Spot Monitor”

Toggle the “OK” button on the right side of the steering wheel to enable/disable the Blind Spot Monitor system.

3. Use the button on the right side of the steering wheel to scroll through the menu items displayed in the instrument panel until "Assist Systems" is displayed at the top-center of the instrument panel.

Use the down arrow on the right side of the steering wheel to select “Blind Spot Monitor”

Toggle the “OK” button on the right side of the steering wheel to enable/disable the Blind Spot Monitor system.

See Appendix A, Figures A12 and A13.

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 possible.

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

If the system is inoperable, a message will appear in the instrument cluster.

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?

The system does not deactivate as a result of repeated activations.

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?

If the radars are blind, there is a message in the instrument cluster and the system suspends itself. The system is reactivated automatically after driving past stationary or moving metal objects for a sufficient period of time. System suspension can be avoided by making sure there are not extended periods of time without detectable objects within the sensor's field of vision.

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

Only use the "Blind Spot" Monitor on paved roads.

Among other possibilities, the "Blind Spot" Monitor may not interpret the traffic situation correctly in the following situations:

- *In tight curves*
- *When driving in the center of two lanes*
- *When lanes have different widths*
- *When the road is raised*
- *In poor weather conditions*
- *When there is equipment installed on the side of the road, such as high or offset guard rails*

"Blind Spot" Monitor driving conditions are described on page 140 of the Owner's Manual. This page is reproduced in Appendix B, page B-7.

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.

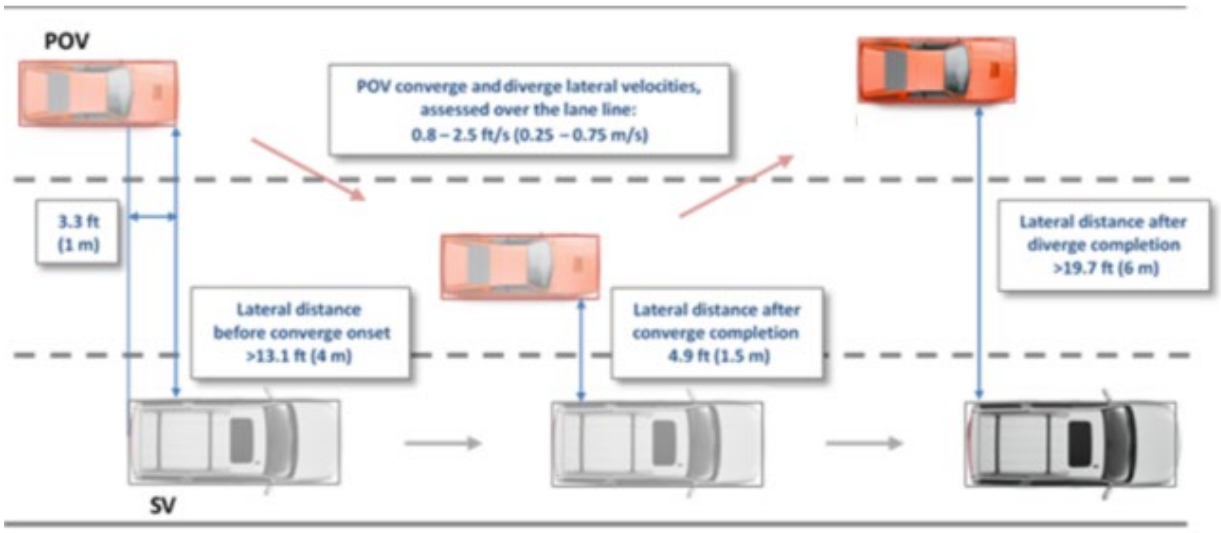

Figure 1. Straight Lane Converge and Diverge Test
(POV converge and diverge from the left is shown)

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.

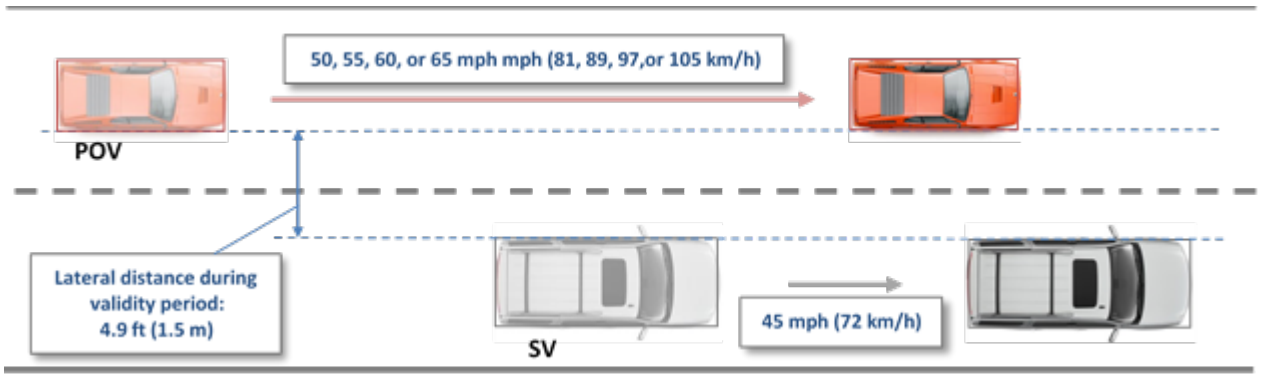

Figure 2. Straight Lane Pass-by Test
(Left-side POV Pass-by is shown)

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)	>29.3ft (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 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,

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

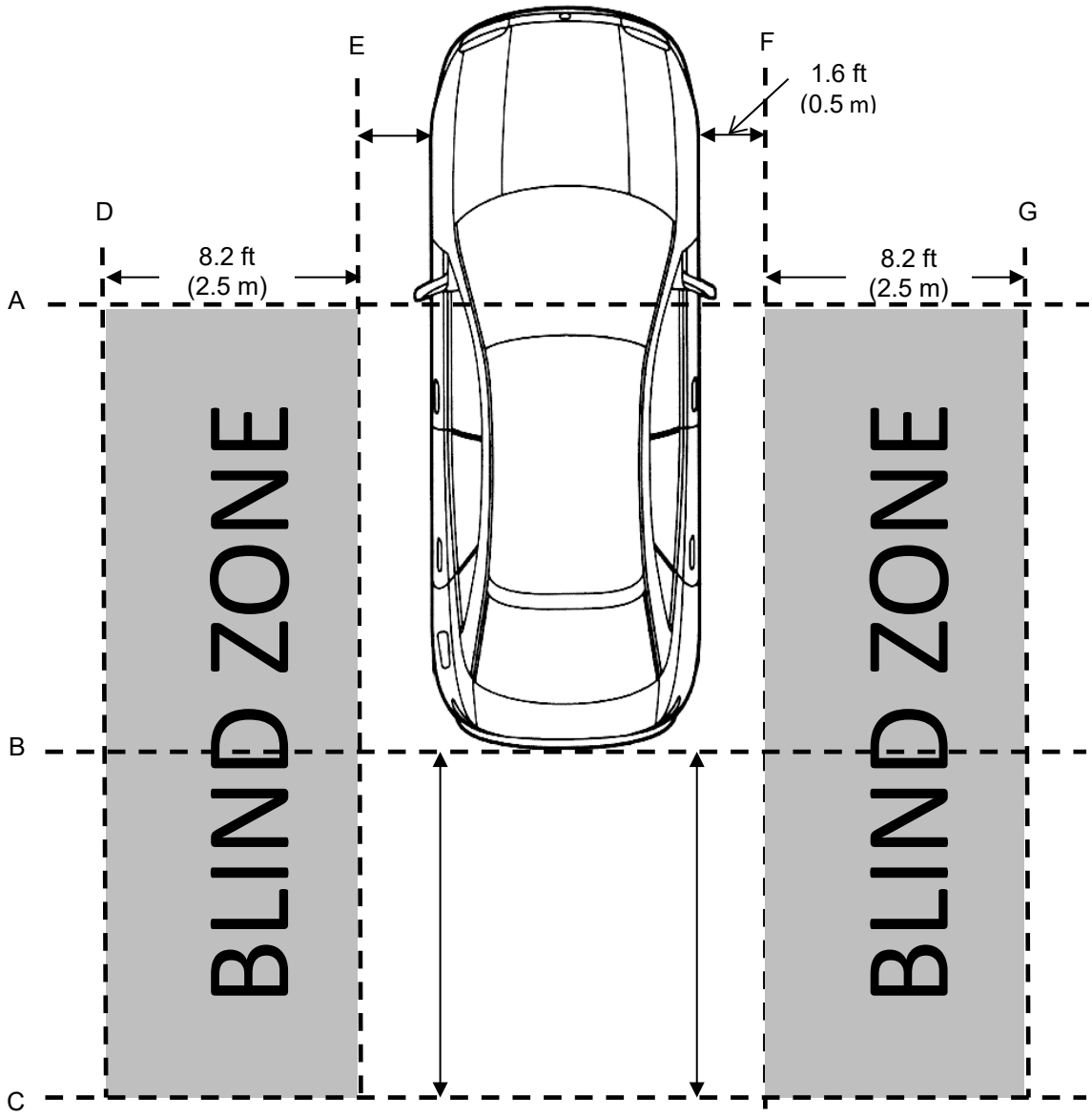

Figure 3. Vehicle Blind Zone Areas

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 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 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 Date: 5/3/2019 Due: 5/3/2021
				Oxford Inertial +	2258	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	< 1% error between 20 and 100 psi	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

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

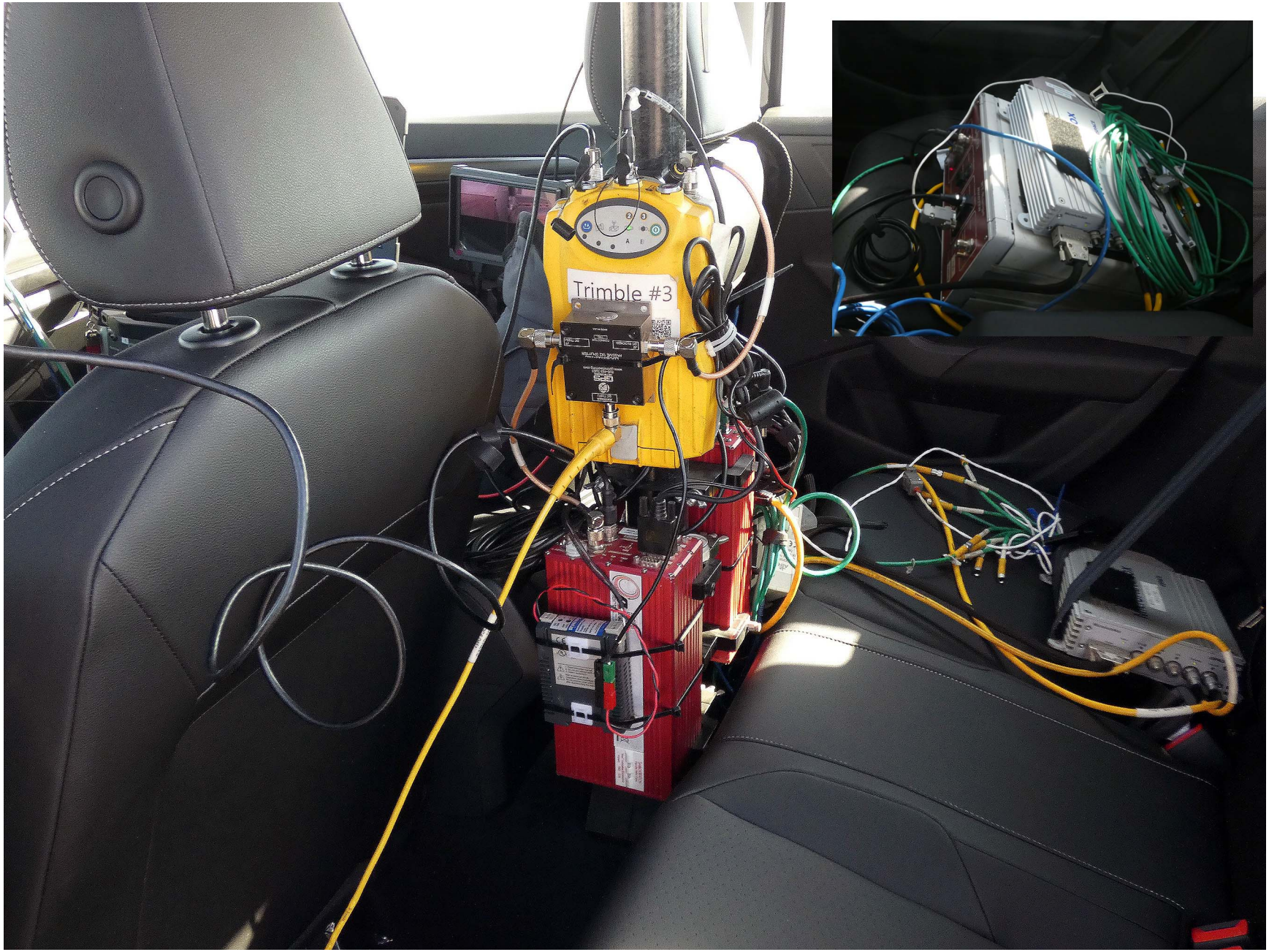

Figure A8. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A9. Sensors for Detecting Visual Alerts

Figure A10. Computer Installed in Subject Vehicle

Figure A11. System Setup Menus (page 1 of 2)

Figure A12. System Setup Menus (page 2 of 2)

Figure A13. Controls for Interacting with System Menus

Figure A14. Visual Alert

APPENDIX B

Excerpts from Owner's Manual

Driver's side

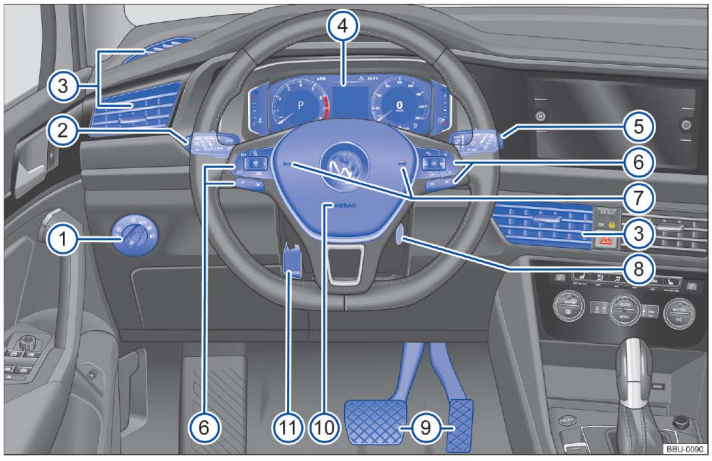

Fig. 7 Driver's side overview.

Key for fig. 7:

①	Light switch	86
②	Turn signal and high beam lever	86, 88
③	Vents	97
④	Instrument cluster	16
	— With warning and indicator lights	14
⑤	Windshield wiper/washer lever	92
⑥	Multifunction steering wheel controls:	
	— For driver assistance systems	130
	— For menu selection	25
	— For accepting telephone calls **OK**	
	— For audio, navigation ⏮⏭	
	— For adjusting the volume 🔈🔊	
	— For voice operation activation (may not function depending on the equipment)	
	— In order to switch between the current and previous menus **VIEW**	17
⑦	Horn	
⑧	Ignition lock	110
⑨	Pedals	103
⑩	Location of driver's front airbag	
⑪	Lever for adjusting the steering wheel position	77 ◁

	Driving light failure → page 91
	Rain/light sensor malfunction → page 93
	Windshield wiper malfunction → page 93
	Washer fluid level too low → page 93
	Steering malfunction → page 126
	Do not continue to drive! Tire pressure low → page 251
	Do not continue to drive! Tire Pressure Monitoring System faulty → page 251
	Collision warning deactivated → page 138
	Adaptive cruise control (ACC) not available → page 135
	Lane Assist switched on, but not active → page 139
	Lane Assist switched on, but not active → page 139
	Blind Spot Monitor active → page 141
EPC	Engine control malfunction → page 115
	Exhaust system malfunction → page 220
	Particulate filter clogged with soot → page 219
	Engine RPM limited → page 115
	Transmission malfunction → page 118, → page 123
	Adaptive chassis control (DCC) malfunction → page 128
	Press the brake pedal. → page 123
	Turn signals → page 91
	Speed stored, regulation active → page 133

CRUISE	Speed stored, regulation active → page 130
	Lane Assist active → page 139
	Lane Assist active → page 139
	High beams or headlight flasher → page 88
	Outside temperature is below +39 °F (+4 °C) → page 20
	Start/Stop system active → page 116
	Start/Stop system not available → page 116
eco	Economical driving condition → page 21
	Service due → page 24
	Engine coolant temperature too high → page 19
	High beam control active → page 88
	Distance warning → page 137
	Cruise control switched on → page 130
	Cruise control system malfunction → page 131
	Adaptive Cruise Control (ACC) regulates, no vehicle driving ahead is detected → page 133
	Adaptive Cruise Control (ACC) regulates, vehicle driving ahead is detected → page 133
	Eco driving mode → page 128
	Comfort driving mode → page 128
	Normal driving mode → page 128
	Individual driving mode → page 128
	Sport driving mode → page 128
	Mobile phone connected via Bluetooth® → page 20

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Driver assistance systems button

Please read the introductory information and heed the Warnings and Notice ⚠ on page 16.

Depending on the equipment, the driver assistance systems button is either located on the turn signal and high beams lever or on the multifunction steering wheel. Using this button, the driver assistance systems can be switched on or off in the **Assist systems** menu.

- Press the button briefly to open the **Assist systems** menu.
- Select the driver assistance system and switch it on or off. A "check mark" indicates if a driver assistance system is switched on.
- Confirm the selection with the OK/RESET button in the windshield wiper lever or the OK button in the multifunction steering wheel.

Or you can also switch the driver assistance systems on and off in the Infotainment system vehicle settings → page 27. ◁

Service menu

Please read the introductory information and heed the Warnings and Notice ⚠ on page 16.

Depending on the equipment, settings can be applied in the service menu.

Opening the service menu

To open the service menu, select the **Range** information profile in the instrument cluster and press and hold the OK button on the multi-function steering wheel for approximately four seconds. You can now navigate in the menu as usual using the buttons on the multi-function steering wheel.

Resetting the service interval display

Select the **Service** menu and follow the instructions on the instrument cluster display.

Resetting the oil change service

Select the **Reset oil change service** menu and follow the instructions on the instrument cluster display.

Resetting the driving data

Select the **Reset trip** menu and follow the instructions on the instrument cluster display to reset the trip odometer.

Engine code

Select the **Engine code** menu. The engine code will appear in the instrument cluster display.

Setting the time

Select the **Time** menu and set the correct time using the △ or ▽ arrow buttons.

Copyright

Select the **Copyright** menu to access the copyright information. ◁

Service interval display

Please read the introductory information and heed the Warnings and Notice ⚠ on page 16.

Displays about service events appear in the instrument cluster display and in the Infotainment system.

There are different versions of the instrument cluster and Infotainment system; therefore, the versions and appearances of the displays may vary.

Fixed service intervals are specified for vehicles with the **fixed oil change service**.

Intervals are determined individually on vehicles with the **flexible oil change service**. Oil change services only need to be performed if the vehicle requires it. The specific operating conditions and the personal driving style are also taken into consideration. The service early warning message is first displayed 30 days prior to the calculated service due date. The displayed remaining distance to be traveled is always rounded to 60 miles (100 km) and the remaining time is rounded to whole days.

Service notification

If a service or an inspection is due in the near future, a service notification will be displayed when the ignition is switched on.

The specified mileage or time is the distance or time until the next service can be completed.

Service event

When a **service is due** or an **inspection is due**, a warning chime will sound and a wrench symbol may appear on the instrument cluster display for a few seconds together with one of the following messages when you switch on the ignition:

- **Inspection now!**
- **Oil change now!**
- **Oil change service and inspection now!**

thorized Volkswagen dealer or authorized Volkswagen Service Facility.

Some menu items can only be accessed when the vehicle is stationary.

Trip data → page 21.

Assistance systems.

Navigation.

Audio.

Telephone.

Vehicle status → page 22.
Views → page 17.
Driver personalization (user selection) → page 30. ◁

Operation using the multi-function steering wheel

Please read the introductory information and heed the Warnings and Notice ⚠ on page 25.

Fig. 17 Right side of the multi-function steering wheel: buttons for operating the menus and information displays in the instrument cluster

Menus cannot be accessed when a priority 1 warning message is displayed → page 22. Some warning messages can be confirmed and dismissed with the OK button on the multi-function steering wheel → fig. 17.

Selecting a menu or information display

- Switch the ignition on.
- Driver personalization: select a user.
- If a message or vehicle icon is displayed, press the OK → fig. 17 button, repeatedly if necessary.
- To display a menu and to scroll through the menu, press the ⊟ or ⊞ button → fig. 17.
- To open the displayed menu or information display, press the OK button → fig. 17 or wait until the menu or the information display opens automatically after several seconds.

Applying settings in the menus

- Press the △ or ▽ arrow buttons → fig. 17 in the displayed menu until the desired menu item is marked. The item is marked with a frame around it.
- Press the OK → fig. 17 button to apply the desired changes. A "checkmark" indicates if the function or system is activated.

Returning to menu selection

- Press the ⊟ or ⊞ button → fig. 17.

VIEW button on the multi-function steering wheel

Vehicles with analog instrument cluster:

- You can switch between the current and previous menu using the VIEW button → fig. 17.

Vehicles with a digital instrument cluster:

- You can use the VIEW button → fig. 17 to switch between the classic display of dials, the large platform without information profiles, and the enhanced view with highlighted information profiles. The classic display shows the large dials on the right and left side, and the selected information profile is displayed in the center. Press and hold the VIEW button to select from the preset information profiles in the list:

Classic View without information profiles.

Automatic The information profiles adjust to the selected driving mode. Only for vehicles with Driving Mode Selection.

Preset 1 Individual selection of information profiles

Preset 2 Individual selection of information profiles

Preset 3 Only on vehicles with standard factory-installed navigation system

If warning messages about malfunctions appear when the ignition is switched on, settings or information displays may not appear as described. If this is the case, have malfunctions corrected by an authorized Volkswagen dealer or authorized Volkswagen Service Facility. ◁

Operation and displays in the Infotainment system

Introduction

This Infotainment system consolidates essential vehicle systems in a central control panel, such as menu settings, radio, or a navigation system.

General information for operation

The relevant information for the settings in the **Vehicle settings** menu is included in the following section.

System settings and vehicle information display

Depending on the version, you can press the **MENU** and open the menu **Vehicle** or after pressing the button CAR, open the menu **Settings** and tap the respective function keys to display information or to adjust settings:

- Vehicle settings (setup) → page 27.
- Think Blue. Trainer → page 105.
- Depending on vehicle equipment: Performance monitor → page 28.
- Depending on vehicle equipment: Lap timer → page 29.
- Volkswagen Digital Cockpit.
- Active media
- Trip data
- Vehicle status
- Energy consumers
- Radio station selection

WARNING

Driver distraction can cause accidents and injuries. Operating the Infotainment system can distract you from traffic.

- Always drive attentively and responsibly.

After starting the engine when the 12 V vehicle battery is severely drained or is a replacement, system settings (time, date, personal convenience settings, and programming) and user profiles may be adjusted or deleted. Check and correct the settings after the 12 V vehicle battery is sufficiently recharged. ◁

Vehicle settings menu

Please read the introductory information and heed the Warnings and Notice ⚠ on page 27.

You can switch individual functions and systems on and off and adjust settings in the vehicle settings menu in the Infotainment system.

Opening the Vehicle settings menu

- Switch the ignition on.
- If necessary, switch the Infotainment system on.
- Depending on how your vehicle is equipped, press the MENU button or function key → page 27 and open the **Vehicle** menu in the Infotainment system.
- **OR:** Depending on how your vehicle is equipped, press the CAR button or function key.
- Depending on how your vehicle is equipped, open the **Settings** menu.
- To open other menus in the **Settings** menu or to adjust settings in the menu items, tap on the respective function keys.

If the checkbox in the function key is activated ☑, that function is switched on.

Tap the ⇦ function key to return to the previous menu. ◁

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If the driver does not respond to this, the system warns the driver with a brief braking action and then becomes passive.

Steering wheel vibration

The following situations may cause the steering wheel to vibrate:

— The corrective steering intervention is not sufficient to keep the vehicle in the lane.

— A lane is no longer detected during a sharp corrective steering intervention by the system. ◁

Troubleshooting

Please read the introductory information and heed the Warnings and Notice ⚠ on page 138.

Malfunction message, system switches off

— Clean the windshield → page 287.

— Check the windshield for damage in the camera lens area.

The system is functioning differently than expected

— The camera view area should be cleaned regularly and kept free of snow and ice.

— Do not cover the camera view area.

— Check the windshield for damage in the camera lens area.

— Do not mount any objects on the steering wheel. If you are uncertain or have questions, get professional assistance. ◁

"Blind Spot" Monitor

Introduction

Radar sensors monitor the area behind the vehicle. The system measures the distance and difference in speed to other vehicles and informs the driver through visual signals in the exterior mirrors.

System limitations

Only use the "Blind Spot" Monitor on paved roads.

Among other possibilities, the "Blind Spot" Monitor may not interpret the traffic situation correctly in the following situations:

— In tight curves

— When driving in the center of two lanes

— When lanes have different widths

— When the road is raised

— In poor weather conditions

— When there is equipment installed on the side of the road, such as high or offset guard rails

⚠ WARNING

The intelligent technology of the "Blind Spot" Monitor cannot overcome the natural laws of physics and it can only operate within the limits of the system. Do not allow the increased convenience provided by the "Blind Spot" Monitor to tempt you into taking risks. Careless or unintended use of the "Blind Spot" Monitor can cause accidents and serious injuries. The system cannot replace the driver's attention.

- Always adapt your speed and distance to vehicles ahead based on the visual, weather, road, and traffic conditions.
- Always keep your hands on the steering wheel so that you are prepared to steer at any time.
- Pay attention to the indicator lights in the exterior mirrors and in the instrument cluster display and act accordingly.
- Always pay attention to the area around your vehicle.
- Never use the "Blind Spot" Monitor if the radar sensors are dirty, covered, or damaged. The function of the system may be impaired in such cases.
- Sunlight may reduce the visibility of the indicator light in the exterior mirrors.

Some settings can be saved in the driver personalization user profiles and can be changed automatically when the user account is switched → page 30. ◁

Driving with the "Blind Spot" Monitor

Please read the introductory information and heed the Warnings and Notice ⚠ on page 140.

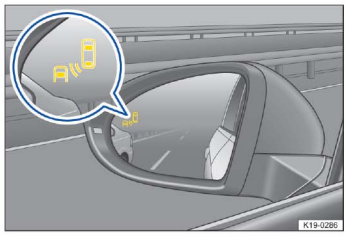

Fig. 115 In the exterior mirror: Blind Spot Monitor indicator.

Switching on and off

- Depending on the equipment, use the button for driver assistance systems → page 26.
- **OR:** use the **Assist systems** menu in the instrument cluster.
- **OR:** depending on the equipment, go to the **Driver assistance** menu in the Infotainment system → page 27.

When the "Blind Spot" Monitor is ready for operation, the yellow indicator light turns on one time briefly in the mirrors.

The last saved system setting is also kept after the ignition is switched off and back on.

System function

The activated "Blind Spot" Monitor is active at speeds above 9 mph (15 km/h).

The faster another vehicle approaches, the sooner the display in the exterior mirror will turn on.

The yellow indicator light → fig. 115 *turns on* in the respective exterior mirror in the following situations:

- When your vehicle is passed.
- When passing another vehicle and the difference in speed between the two vehicles is up to approximately 6 mph (10 km/h). There is no indicator if the passing speed is clearly faster.

If a vehicle was detected in the blind spot and the turn signal on the side where the vehicle was detected is activated → page 140, then the yellow indicator light *flashes*.

On vehicles with Lane Assist, the yellow indicator light will *flash* even without activating the turn signal when leaving a lane if Lane Assist is switched on (Active "Blind Spot" Monitor). You will be notified of a potential critical situation (information level, warning level) with corrective steering. Corrective steering also occurs if the turn signal is activated for the respective side. If the corrective steering is overridden by the driver, an additional warning is given with a steering wheel vibration.

Automatic deactivation

The radar sensors for the "Blind Spot" Monitor switch off automatically if, for example, a permanent obstruction over a radar sensor is detected. For example, this could be from ice or snow covering the radar sensor.

A message will appear in the instrument cluster display.

If the "Blind Spot" Monitor was deactivated automatically, the system can only be reactivated after switching the ignition off and back on. ◁

Troubleshooting

Please read the introductory information and heed the Warnings and Notice ⚠ on page 140.

"Blind Spot" Monitor malfunction

The yellow indicator light turns on.

- Get professional assistance.

System is malfunctioning

- Clean the radar sensors or remove the sticker or attachments from the radar sensors, exterior mirrors, and the bumper → page 287.
- Check if there is any noticeable damage.

The system is functioning differently than expected

There are several possible causes:

- The radar sensors could be dirty. The sensor range could also be impaired by soap residue, coatings, dirt, or snow → page 287.
- The system conditions are not met → page 140.
- The radar sensors could be covered by water.
- The vehicle could be damaged in the radar sensor area, for example from parking barriers.
- The coverage areas of the radar sensors could be blocked by attachments, for example by bicycle carriers.

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– The paint may have been changed or other structural modifications may have bee made near the radar sensors, for example to the front of the vehicle or to the suspension.
– The rear bumper must only be painted with vehicle paint that is approved by Volkswagen. Other types of paint may impair the function or cause it to malfunction.
– The side mirrors may be covered with after-market tinting films. ◁

APPENDIX C

Run Log

Subject Vehicle: **2020 Volkswagen Jetta 1.4T SEL** Date: **7/27/2020**

Test Engineer: **J. Robel**

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	
2	Converge/ Diverge	Left	N						Ran out of Track
3			N						POV speed, lateral velocity
4			N						POV speed
5			N						Lateral velocity
6			N						Lateral velocity
7			Y	1.9	1.6	Yes	Yes	Yes	
8			Y	2.4	2.2	Yes	Yes	Yes	
9			Y	2.2	2.6	Yes	Yes	Yes	
10			Y	2.3	2.0	Yes	Yes	Yes	
11			Y	2.0	1.0	Yes	Yes	Yes	
12			Y	2.2	2.2	Yes	Yes	Yes	
13			Y	2.1	2.3	Yes	Yes	Yes	
48	Converge/ Diverge	Right	N						Converge not found
49			Y	1.8	3.0	Yes	Yes	Yes	
50			N						Yaw, lateral distance

[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	
51	Converge/ Diverge (cont.)	Right	N						Yaw, lateral distance
52			Y	4.4	2.3	Yes	Yes	Yes	
53			Y	2.4	1.7	Yes	Yes	Yes	
54			N						Yaw, lateral distance
55			Y	1.8	1.5	Yes	Yes	Yes	
56			Y	1.8	2.1	Yes	Yes	Yes	
57			N						Yaw, lateral velocity
58			N						Lateral velocity
59			Y	2.0	1.6	Yes	Yes	Yes	
60			Y	1.9	1.7	Yes	Yes	Yes	
14	Straight Lane 45/50	Left	Y	7.1	15.7	Yes	Yes	Yes	
15			Y	6.1	14.6	Yes	Yes	Yes	
16			Y	6.8	13.9	Yes	Yes	Yes	
17			Y	8.4	13.1	Yes	Yes	Yes	
18			Y	8.5	14.3	Yes	Yes	Yes	
19			Y	5.2	15.3	Yes	Yes	Yes	
20			Y	7.1	12.8	Yes	Yes	Yes	
61	Straight Lane 45/50	Right	Y	8.7	7.7	Yes	Yes	Yes	
62			Y	8.0	11.4	Yes	Yes	Yes	
63			Y	6.1	12.7	Yes	Yes	Yes	
64			Y	5.8	12.8	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	
65	**Straight Lane 45/50 (cont.)**	**Right**	Y	5.7	14.5	Yes	Yes	Yes	
66			Y	6.5	12.6	Yes	Yes	Yes	
67			Y	7.1	13.2	Yes	Yes	Yes	
21	**Straight Lane 45/55**	**Left**	Y	-0.9	15.7	No	Yes	No	
22			N						Control desk error
23			Y	-0.7	18.9	No	Yes	No	
24			Y	-0.6	16.0	No	Yes	No	
25			Y	-0.6	16.1	No	Yes	No	
26			Y	-0.3	16.5	No	Yes	No	
27			Y	-1.6	17.8	No	Yes	No	
28			Y	-2.5	16.8	No	Yes	No	
68	**Straight Lane 45/55**	**Right**	Y	-0.9	19.1	No	Yes	No	
69			Y	0.8	17.2	Yes	Yes	Yes	
70			Y	0.6	17.2	Yes	Yes	Yes	
71			Y	0.8	17.7	Yes	Yes	Yes	
72			Y	1.5	15.8	Yes	Yes	Yes	
73			Y	0.9	16.7	Yes	Yes	Yes	
74			Y	0.4	16.2	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	
29	**Straight Lane 45/60**	**Left**	Y	1.1	19.0	Yes	Yes	Yes	
30			Y	0.0	17.4	Yes	Yes	Yes	
31			Y	-0.9	22.3	No	Yes	No	
32			Y	0.4	19.7	Yes	Yes	Yes	
33			Y	-0.2	20.1	No	Yes	No	
34			Y	1.0	18.9	Yes	Yes	Yes	
35			Y	-0.7	21.3	No	Yes	No	
75	**Straight Lane 45/60**	**Right**	Y	-0.4	21.7	No	Yes	No	
76			Y	0.8	20.6	Yes	Yes	Yes	
77			Y	1.1	20.7	Yes	Yes	Yes	
78			Y	0.5	20.6	Yes	Yes	Yes	
79			Y	0.7	19.3	Yes	Yes	Yes	
80			Y	2.2	18.2	Yes	Yes	Yes	
81			Y	1.6	16.6	Yes	Yes	Yes	
36	**Straight Lane 45/65**	**Left**	Y	0.6	20.2	Yes	Yes	Yes	
37			N						POV speed
38			N						Lateral distance
39			Y	-0.9	23.3	No	Yes	No	
40			Y	1.2	21.1	Yes	Yes	Yes	
41			Y	1.7	22.5	Yes	Yes	Yes	
42			Y	0.6	20.1	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	
43	**Straight Lane 45/65 (cont.)**	**Left**	Y	-0.3	24.3	No	Yes	No	
44			N						POV speed
45			Y	1.1	24.6	Yes	Yes	Yes	
46			Y	1.2	21.4	Yes	Yes	Yes	
47			Y	2.0	21.4	Yes	Yes	Yes	
82	**Straight Lane 45/65**	**Right**	Y	1.8	27.3	Yes	Yes	Yes	
83			Y	0.6	25.4	Yes	Yes	Yes	
84			Y	2.3	24.1	Yes	Yes	Yes	
85			Y	2.4	23.0	Yes	Yes	Yes	
86			Y	3.3	22.7	Yes	Yes	Yes	
87			Y	1.4	22.5	Yes	Yes	Yes	
88			Y	3.2	21.3	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.

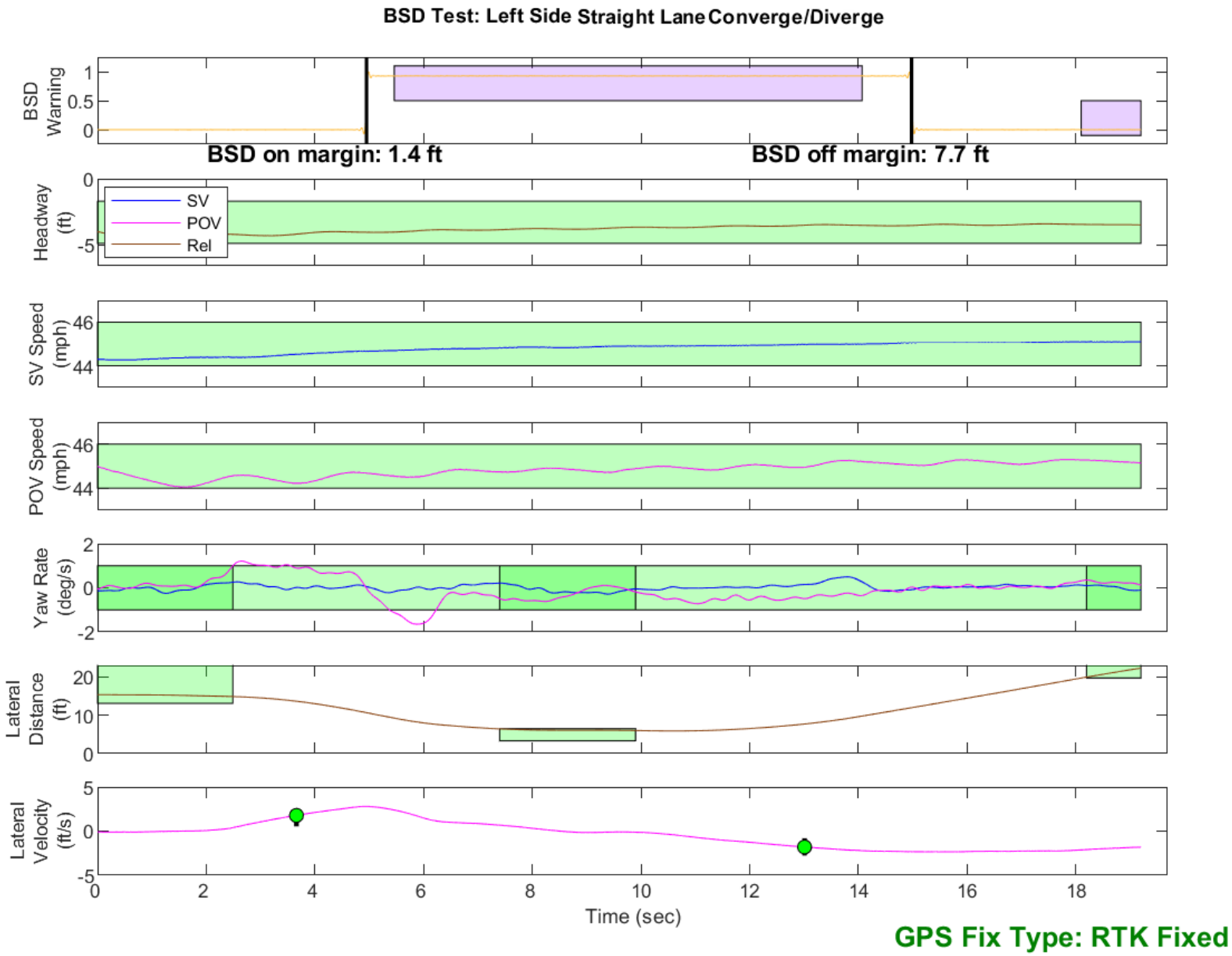

Figure D1. Example Time History for Straight Lane Converge/Diverge Test, Passing

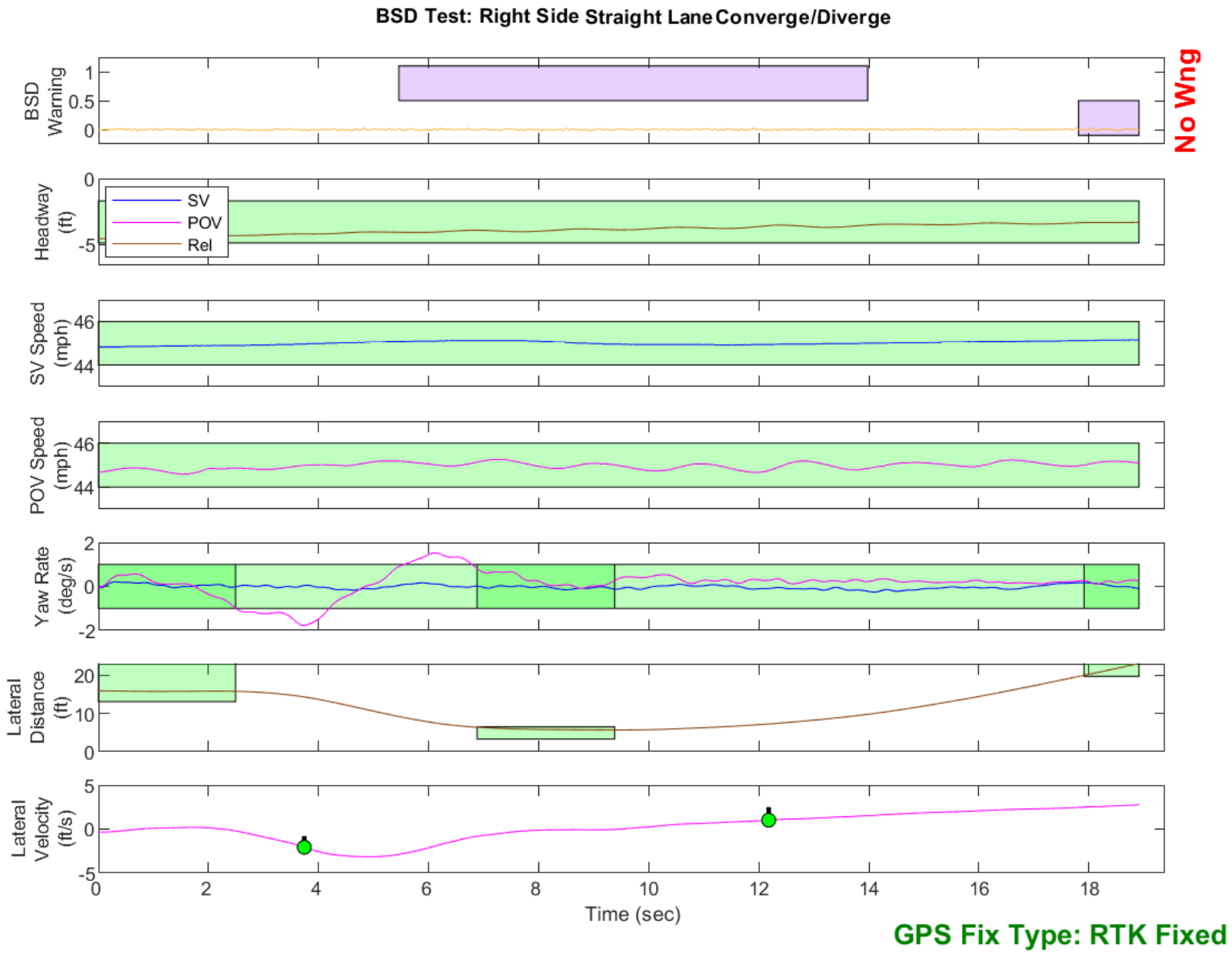

Figure D2. Example Time History for Straight Lane Converge/Diverge Test, Failing

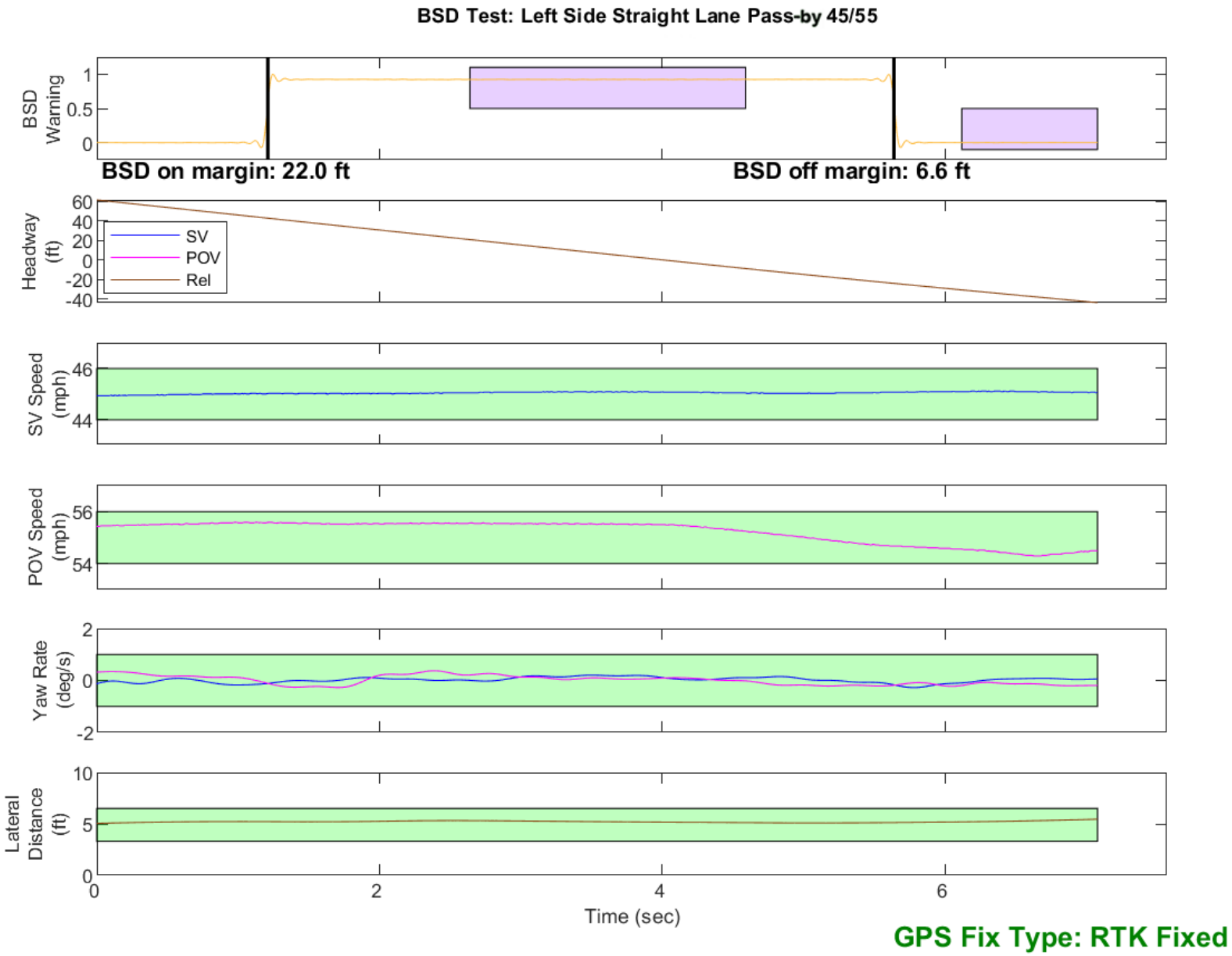

Figure D3. Example Time History for Straight Lane Pass-By Passing

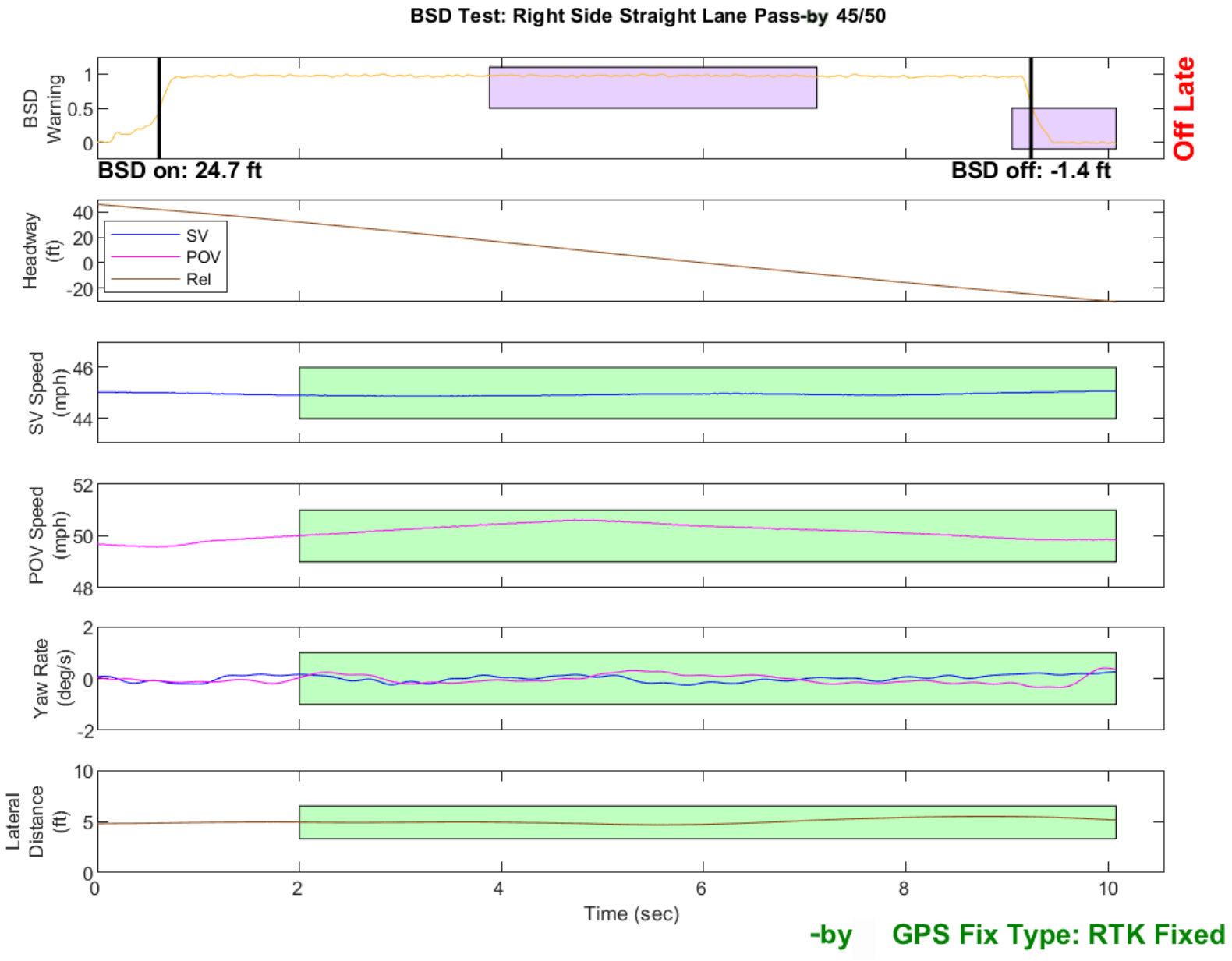

Figure D4. Example Time History for Straight Lane Pass-by Test, Failing

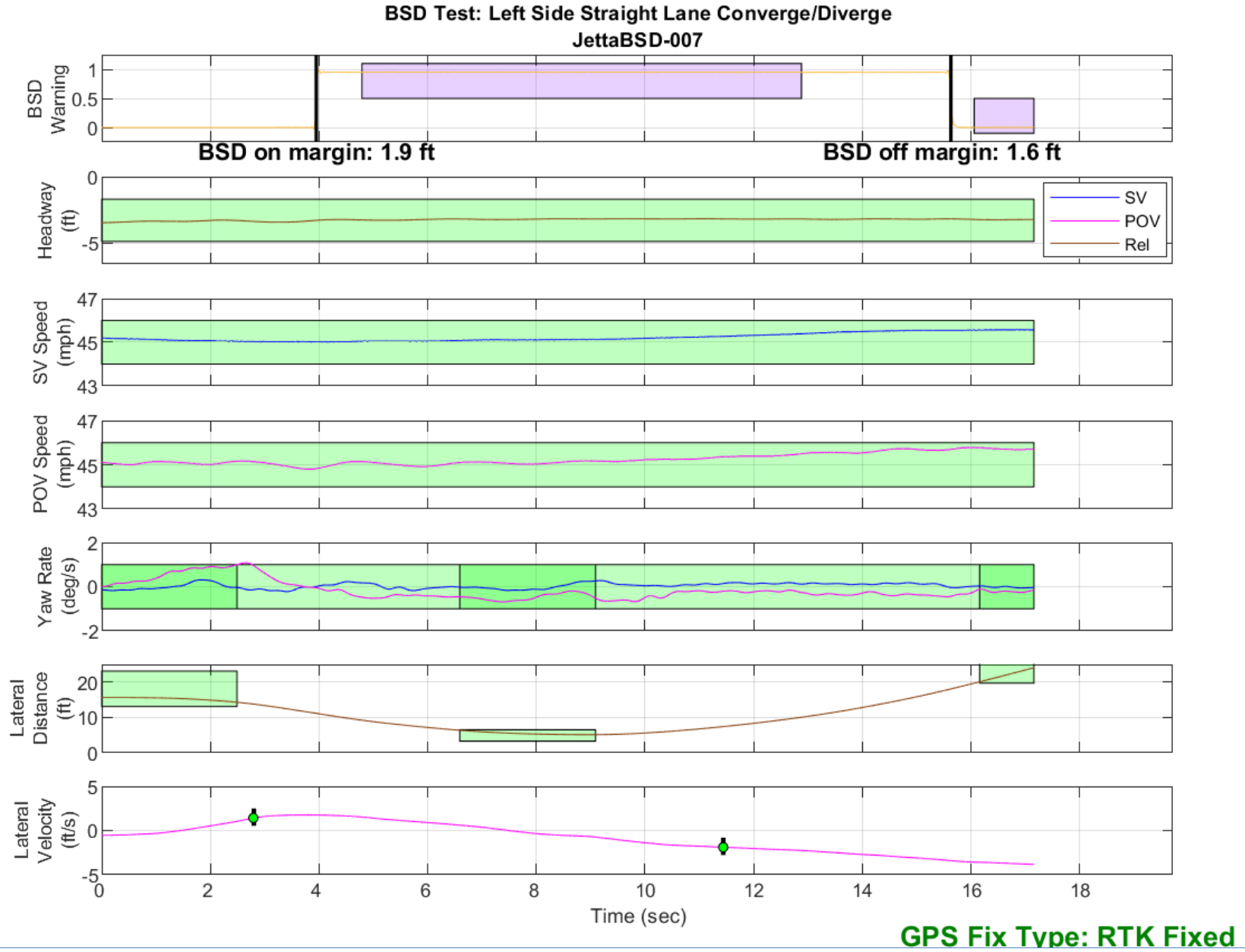

Figure D5. BSD Run 7, Straight Lane Converge/Diverge

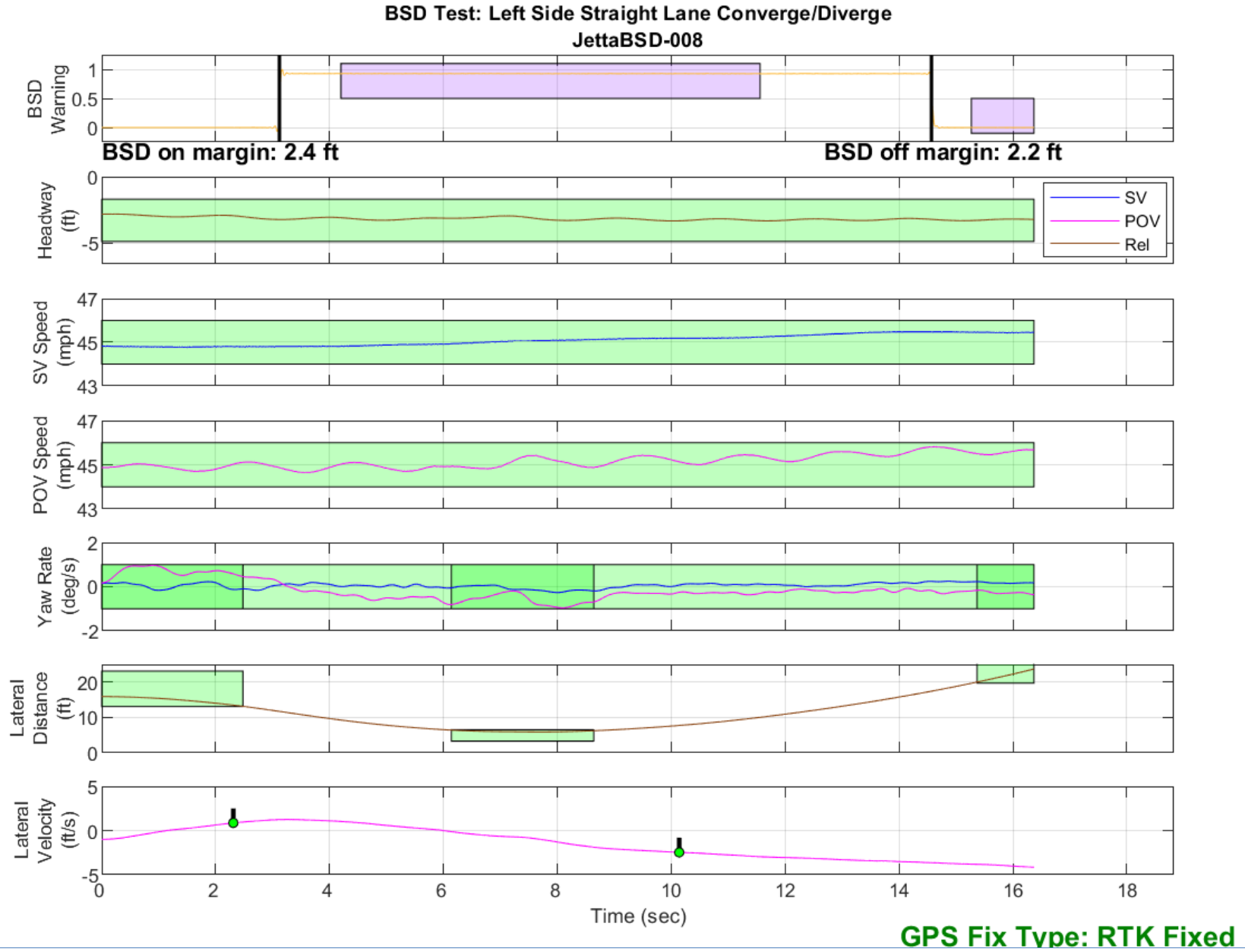

Figure D6. BSD Run 8, Straight Lane Converge/Diverge

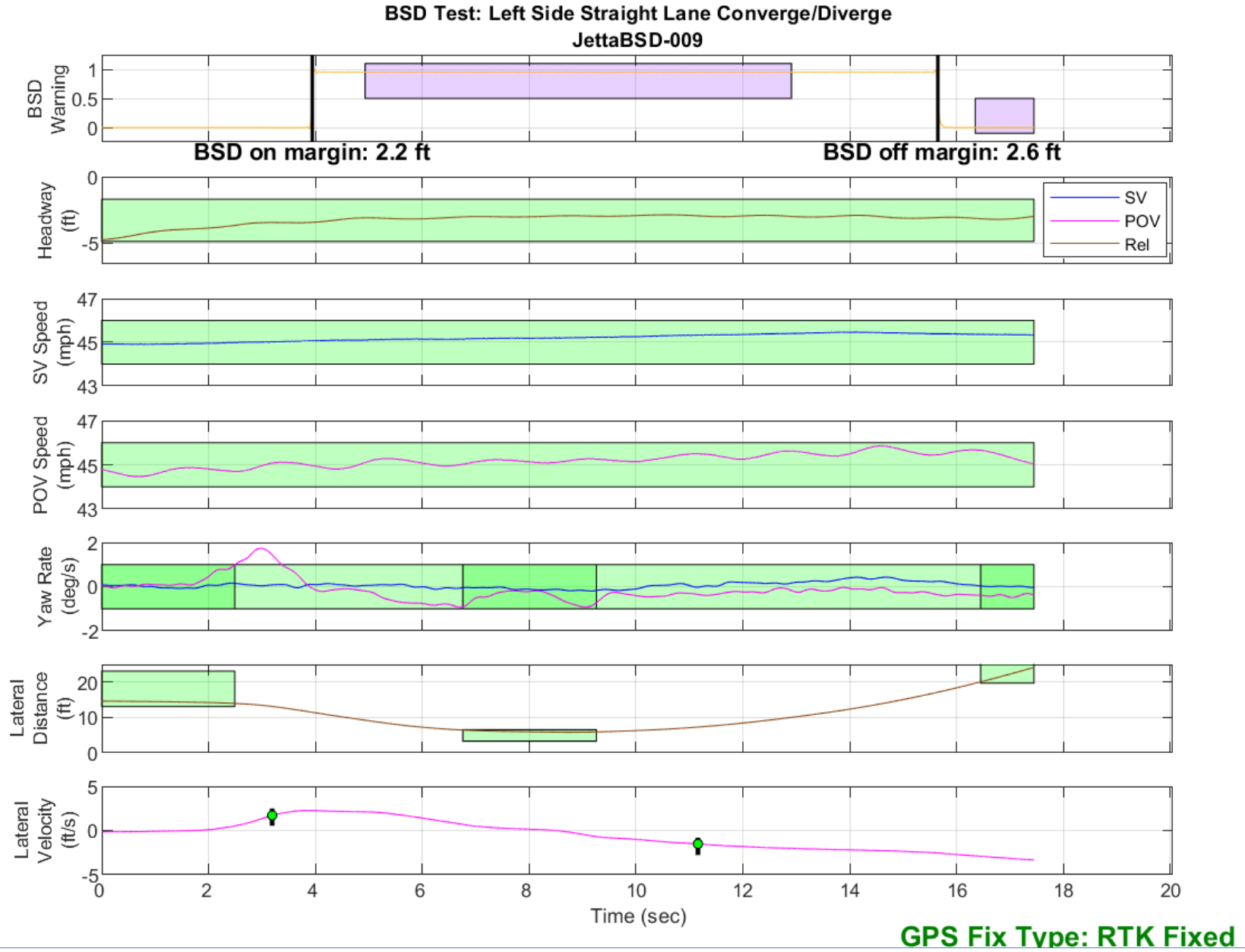

Figure D7. BSD Run 9, Straight Lane Converge/Diverge

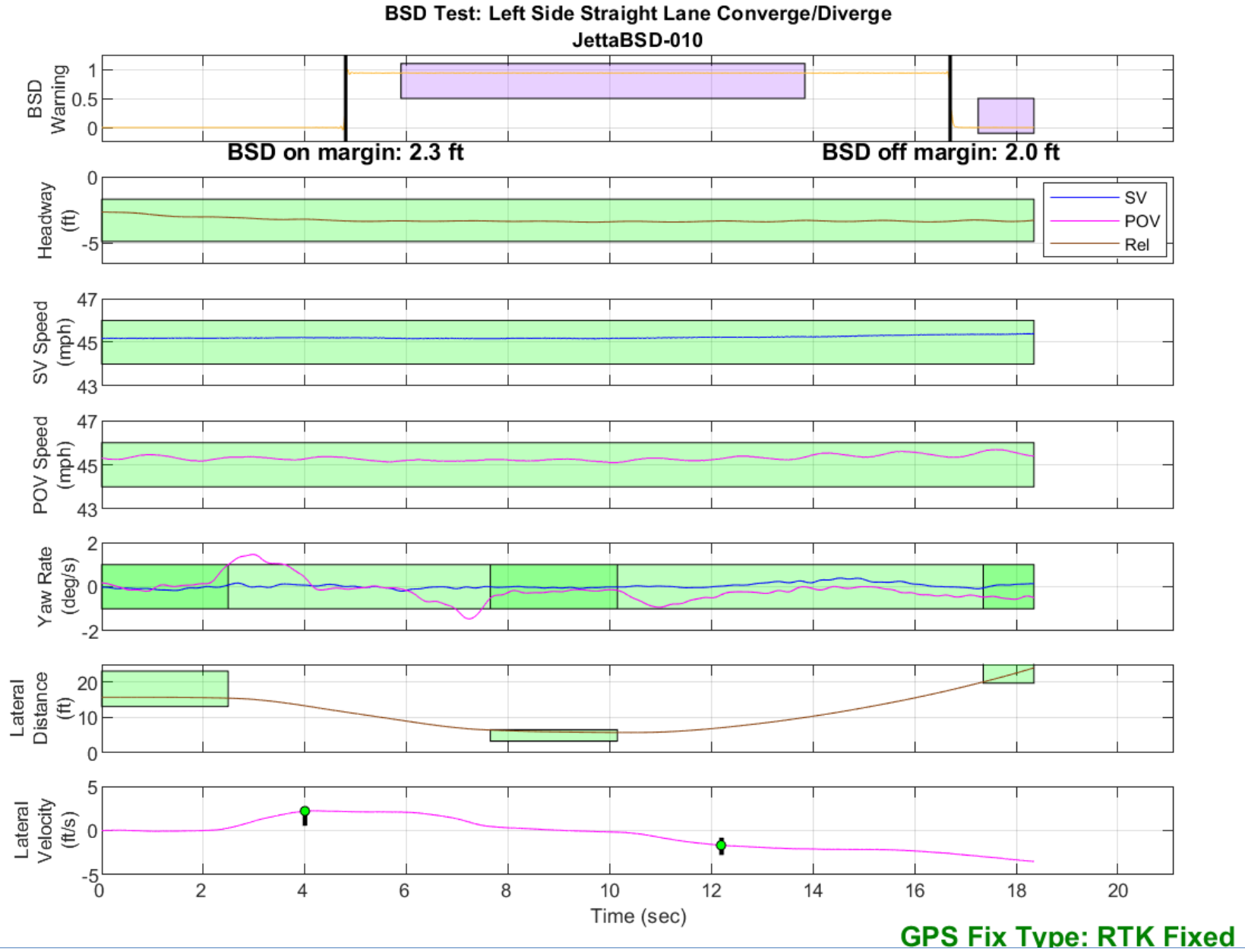

Figure D8. BSD Run 10, Straight Lane Converge/Diverge

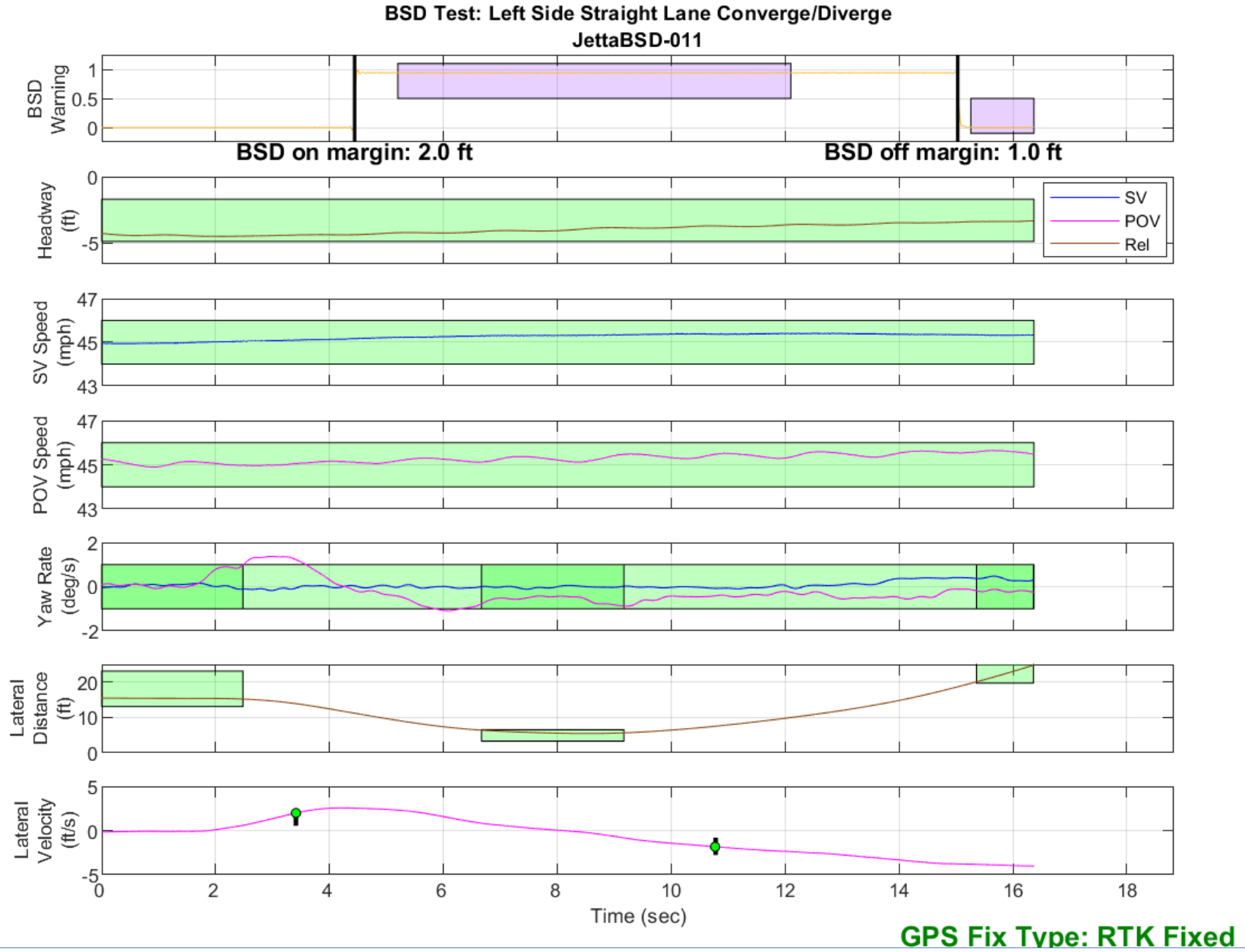

Figure D9. BSD Run 11, Straight Lane Converge/Diverge

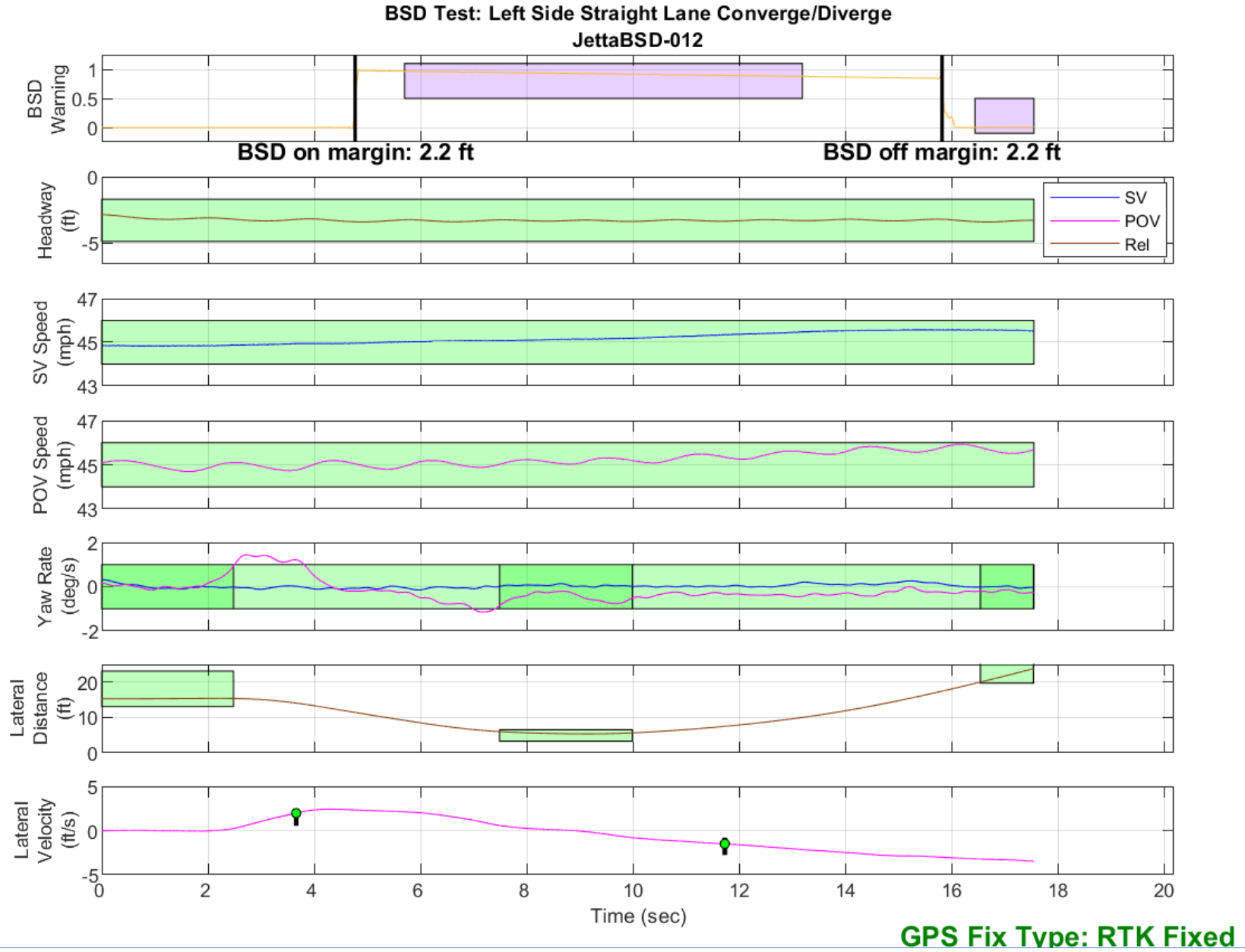

Figure D10. BSD Run 12, Straight Lane Converge/Diverge

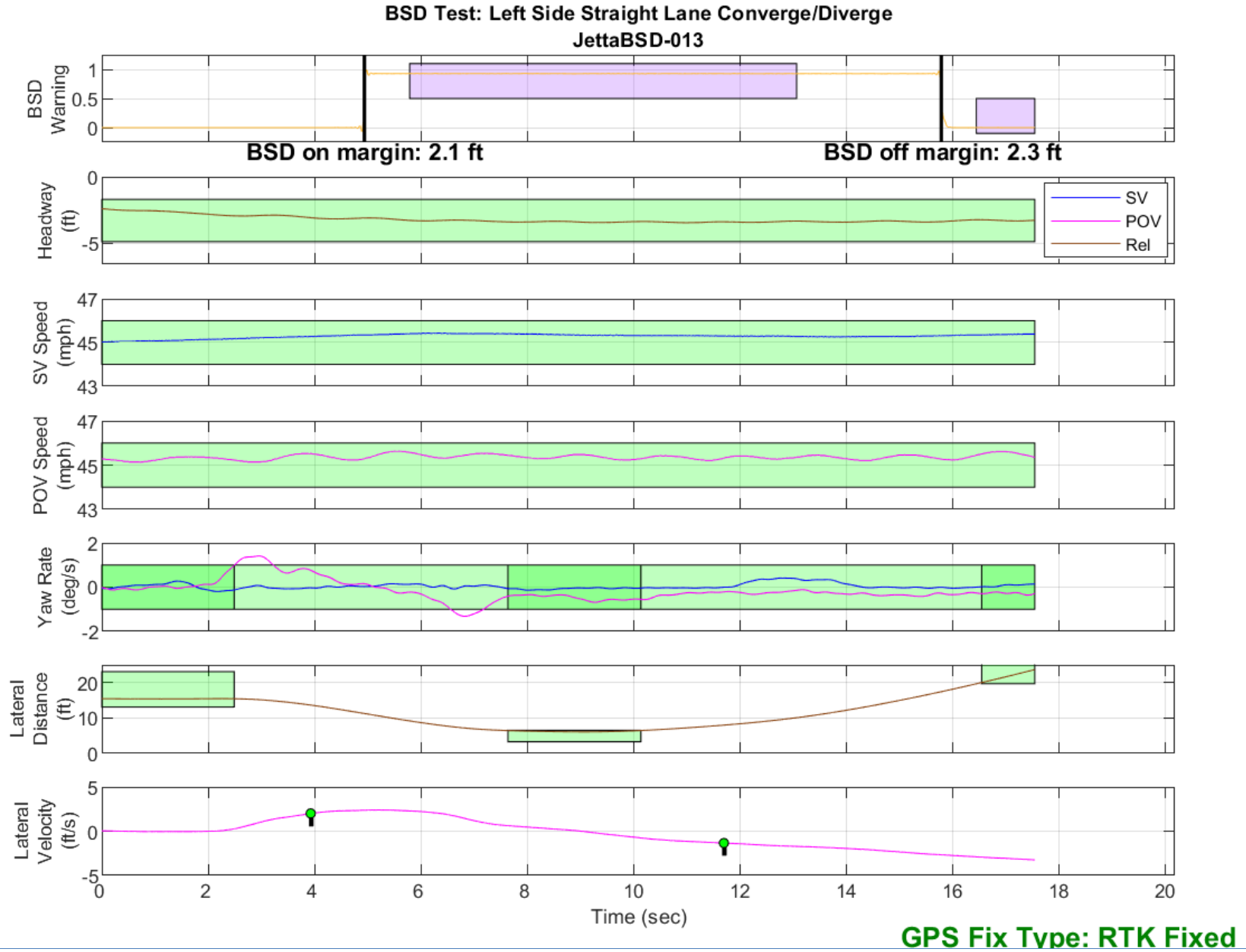

Figure D11. BSD Run 13, Straight Lane Converge/Diverge

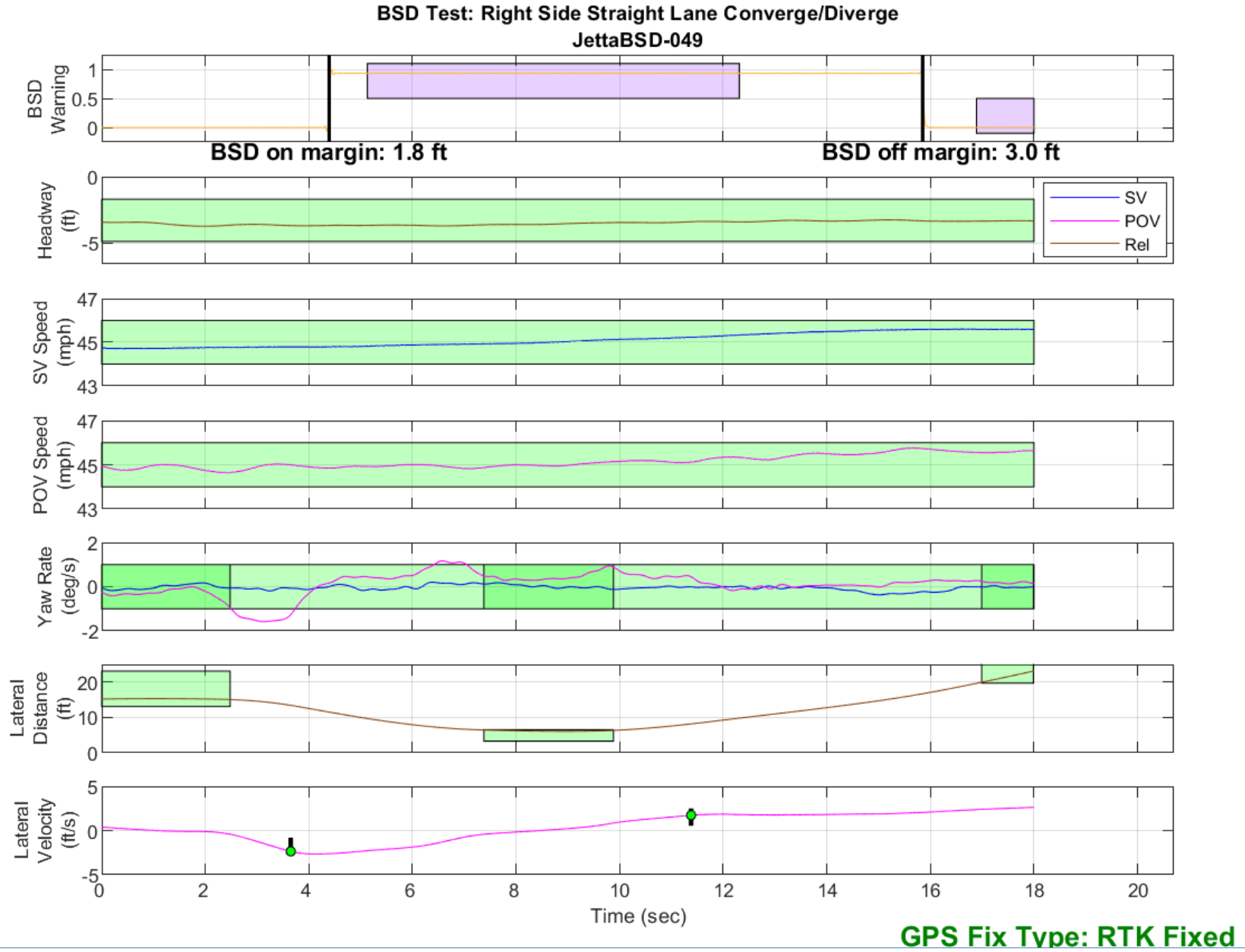

Figure D12. BSD Run 49, Straight Lane Converge/Diverge

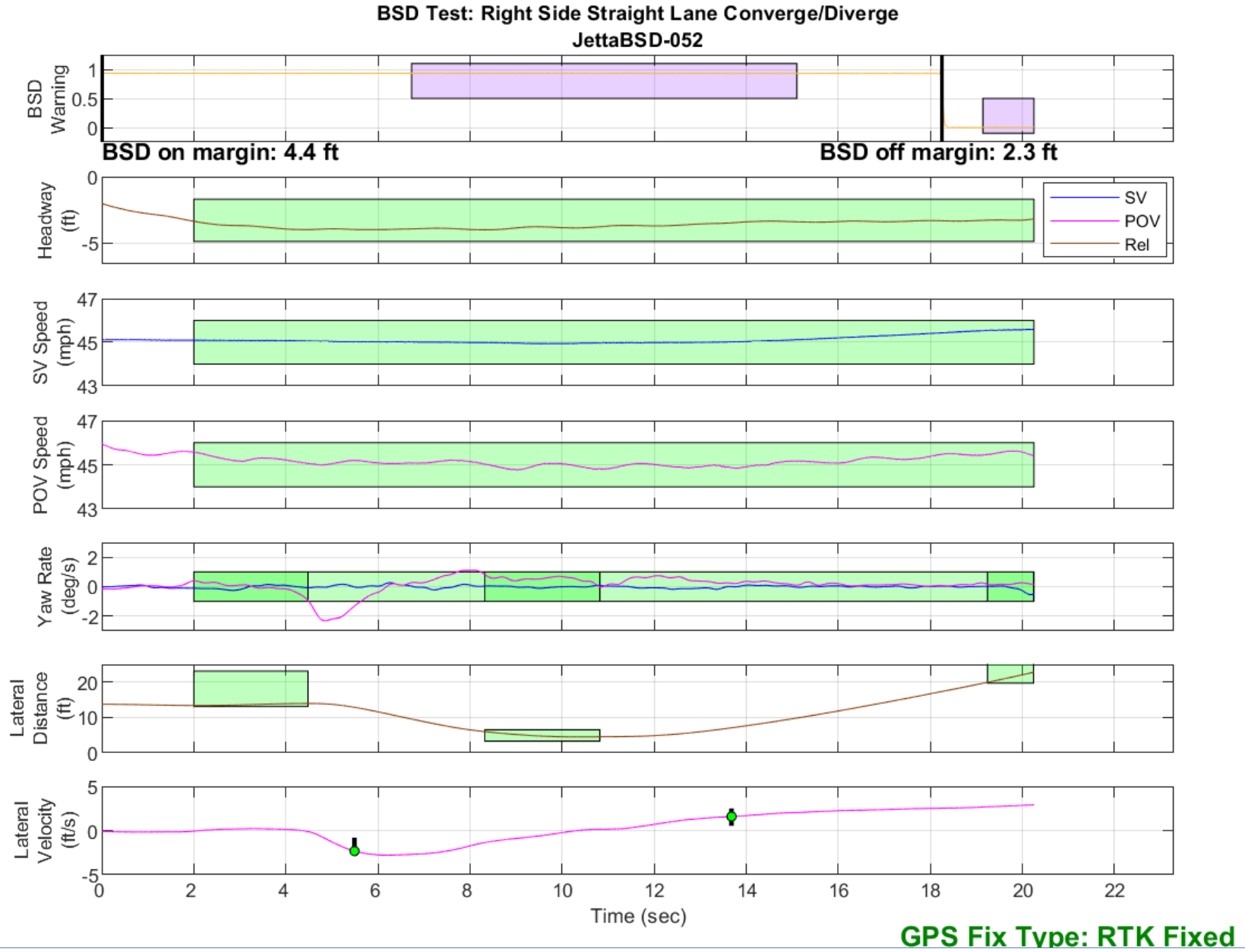

Figure D13. BSD Run 52, Straight Lane Converge/Diverge

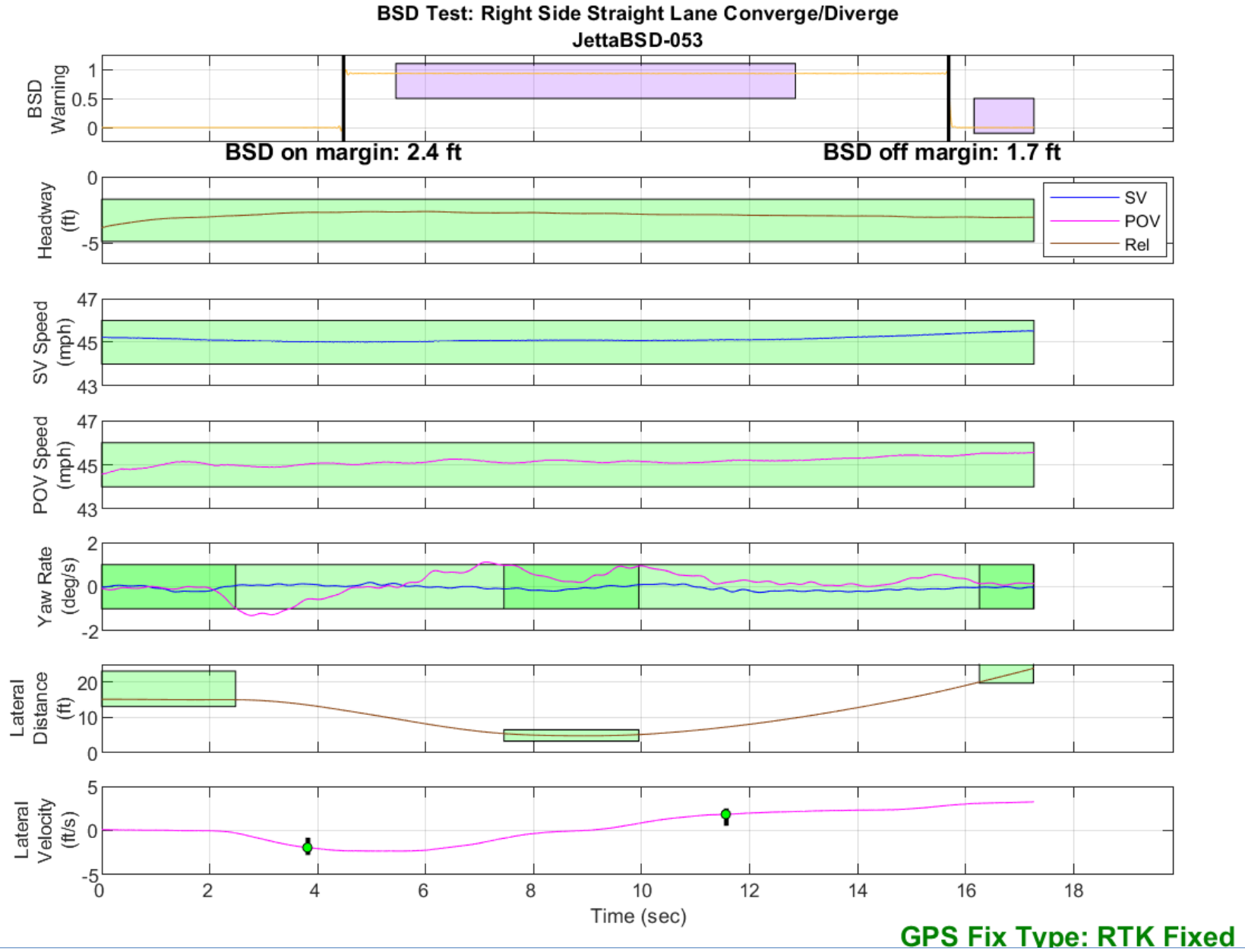

Figure D14. BSD Run 53, Straight Lane Converge/Diverge

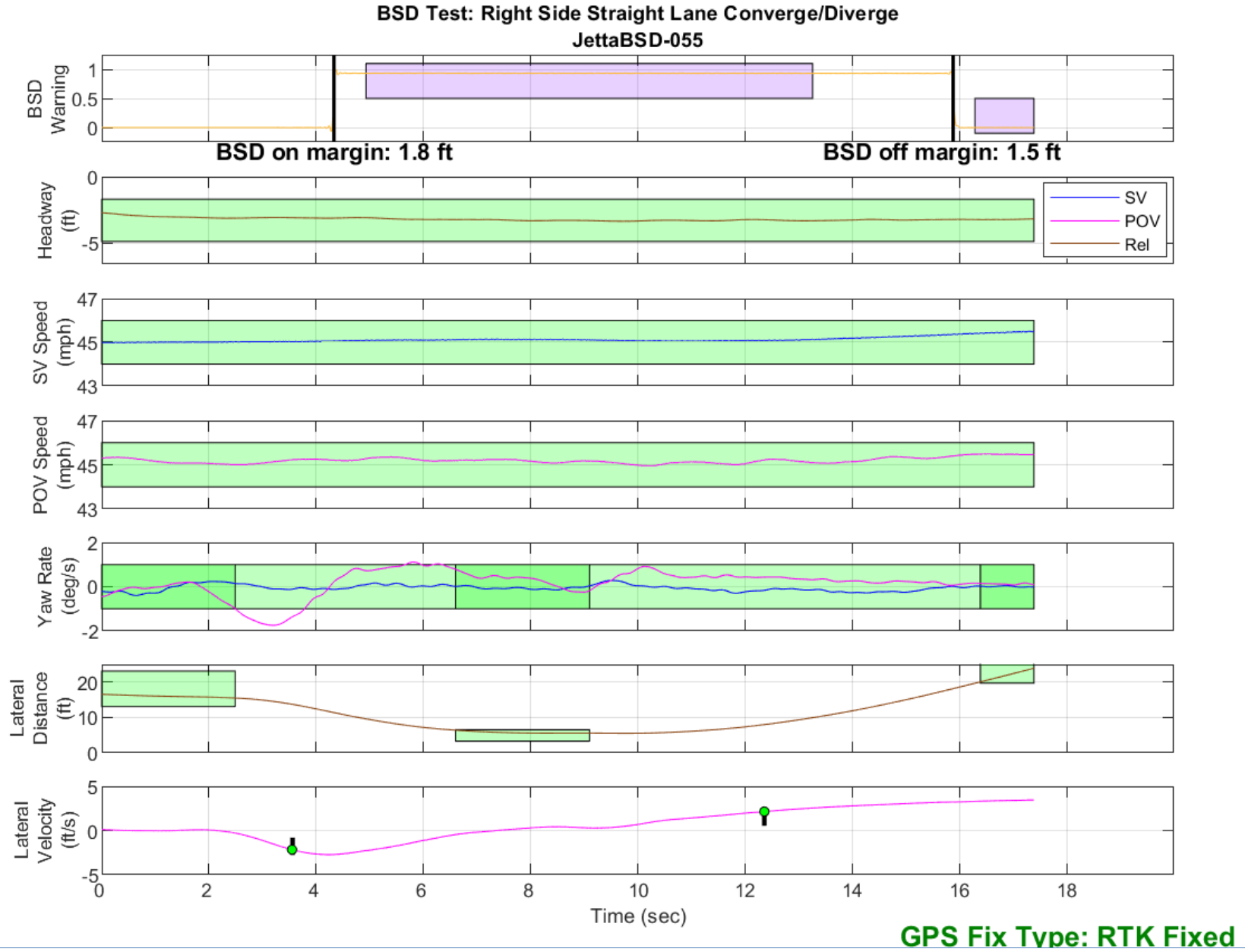

Figure D15. BSD Run 55, Straight Lane Converge/Diverge

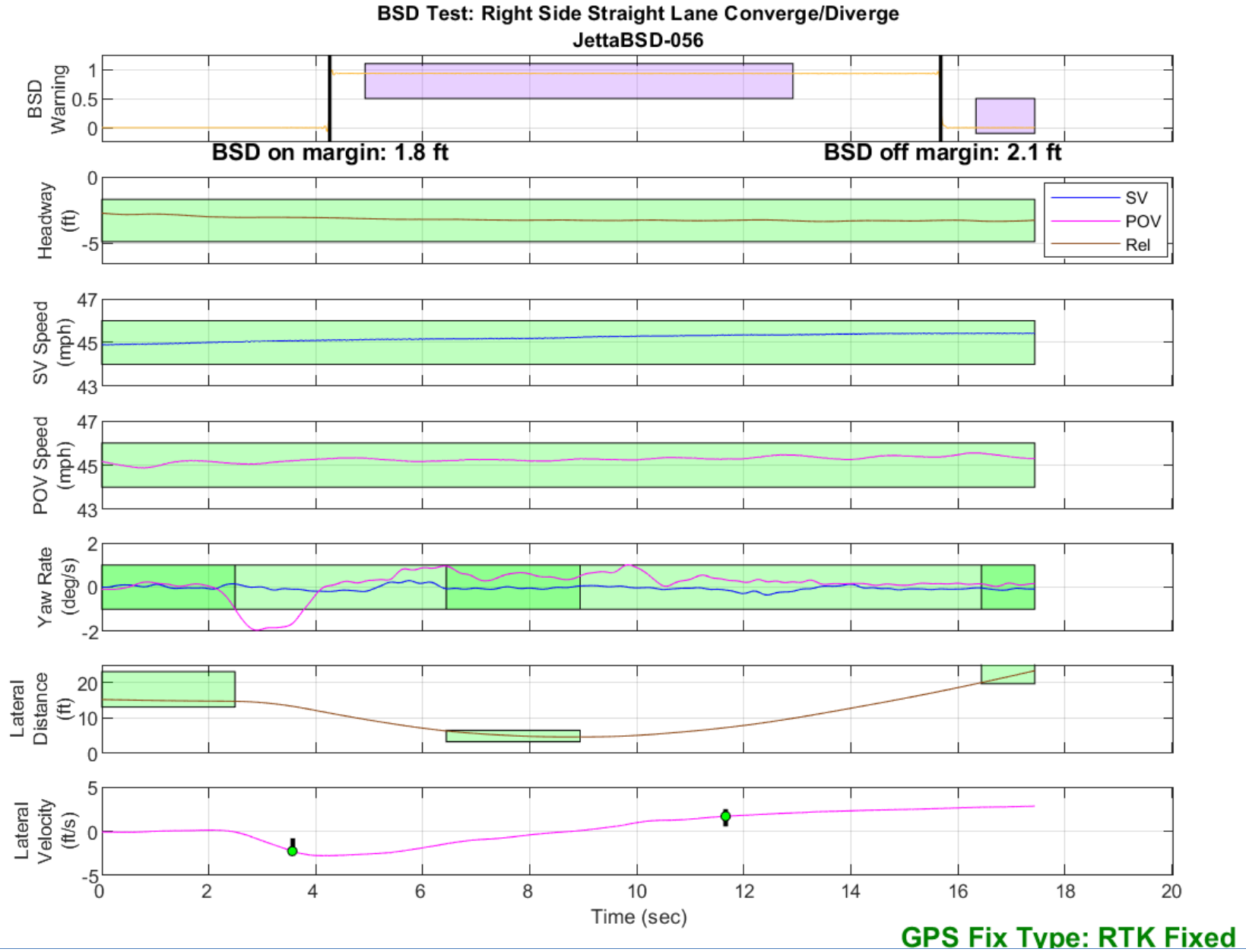

Figure D16. BSD Run 56, Straight Lane Converge/Diverge

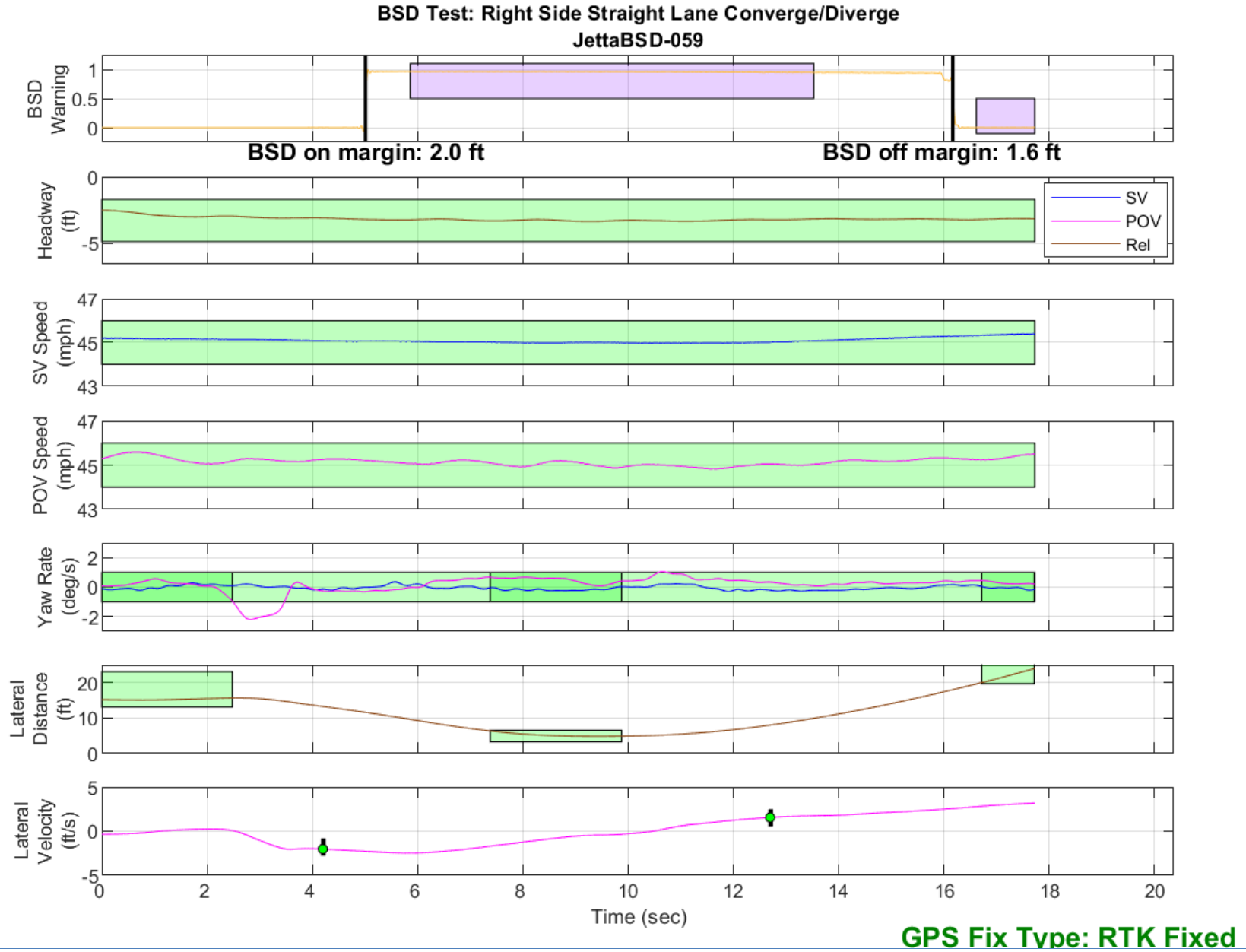

Figure D17. BSD Run 59, Straight Lane Converge/Diverge

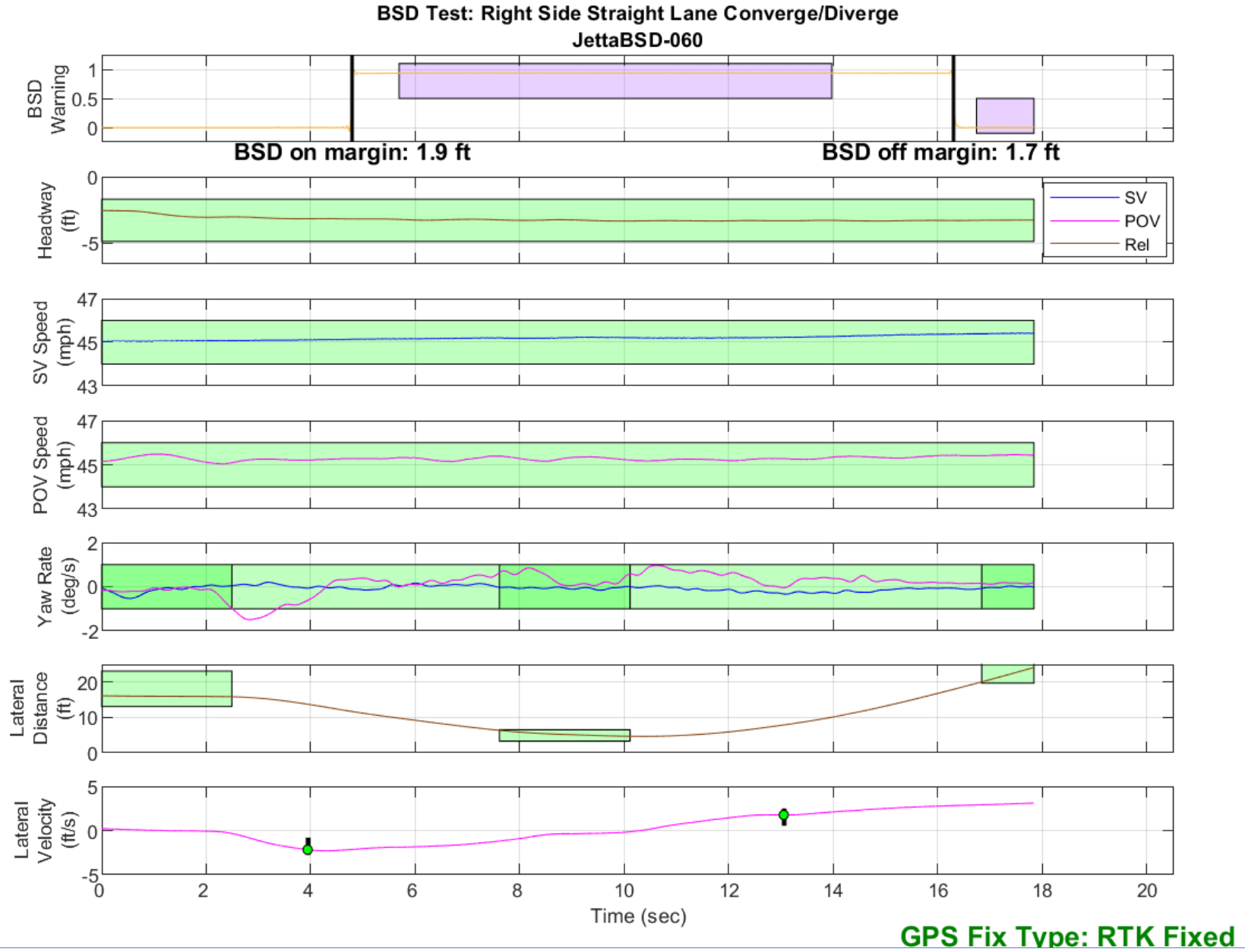

Figure D18. BSD Run 60, Straight Lane Converge/Diverge

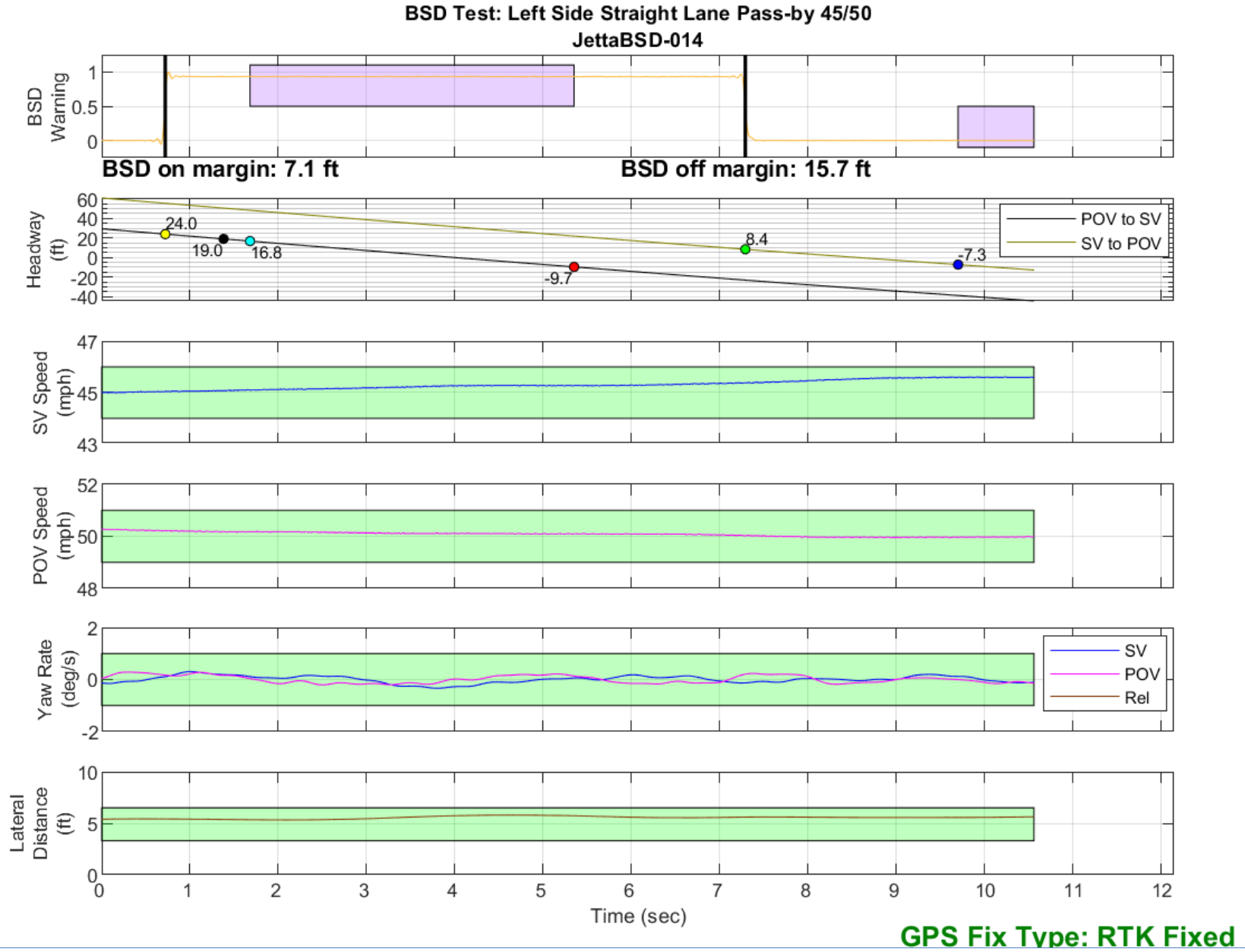

Figure D19. BSD Run 14, Straight Lane Pass-by, SV 45 mph, POV 50 mph

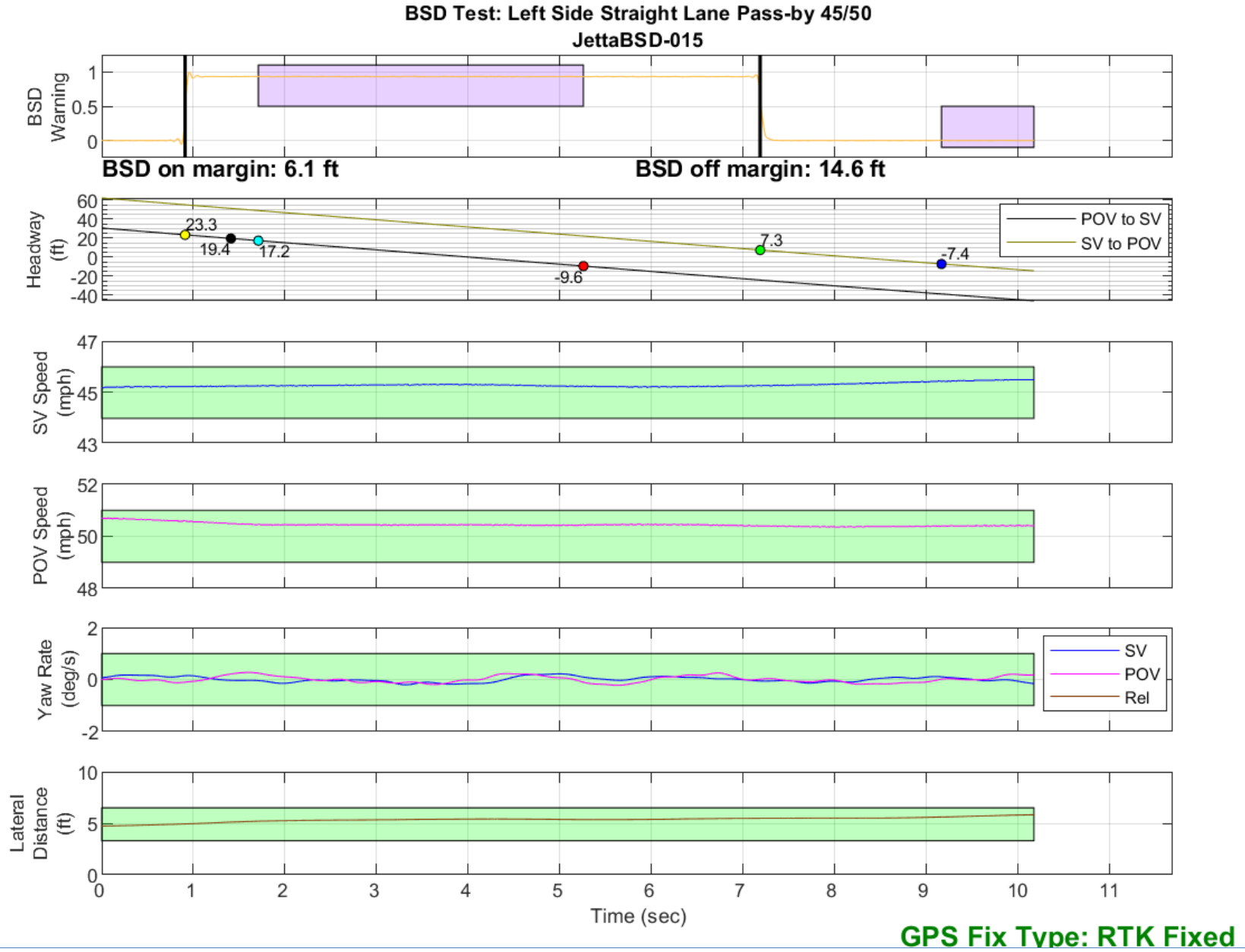

Figure D20. BSD Run 15, Straight Lane Pass-by, SV 45 mph, POV 50 mph

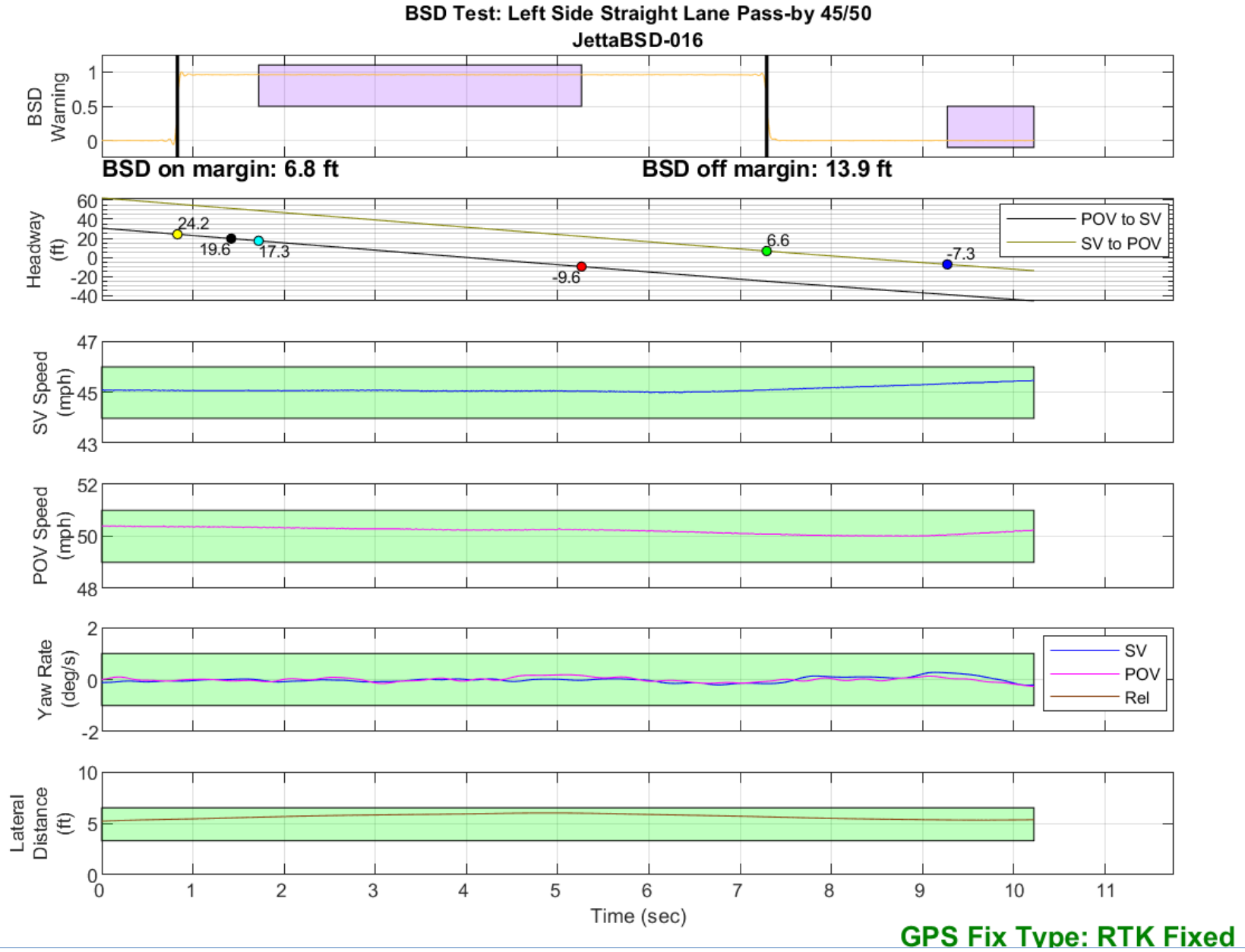

Figure D21. BSD Run 16, Straight Lane Pass-by, SV 45 mph, POV 50 mph

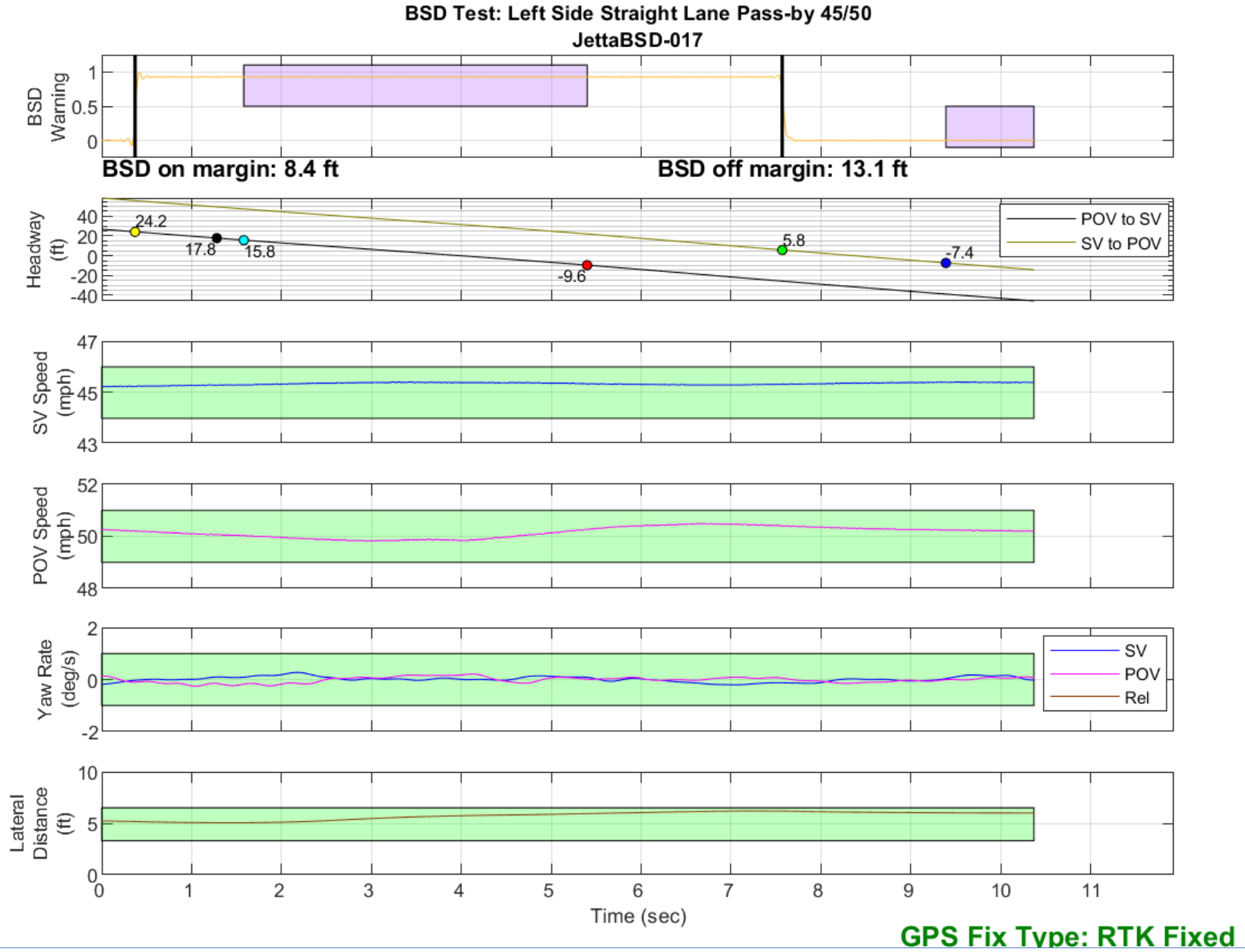

Figure D22. BSD Run 17, Straight Lane Pass-by, SV 45 mph, POV 50 mph

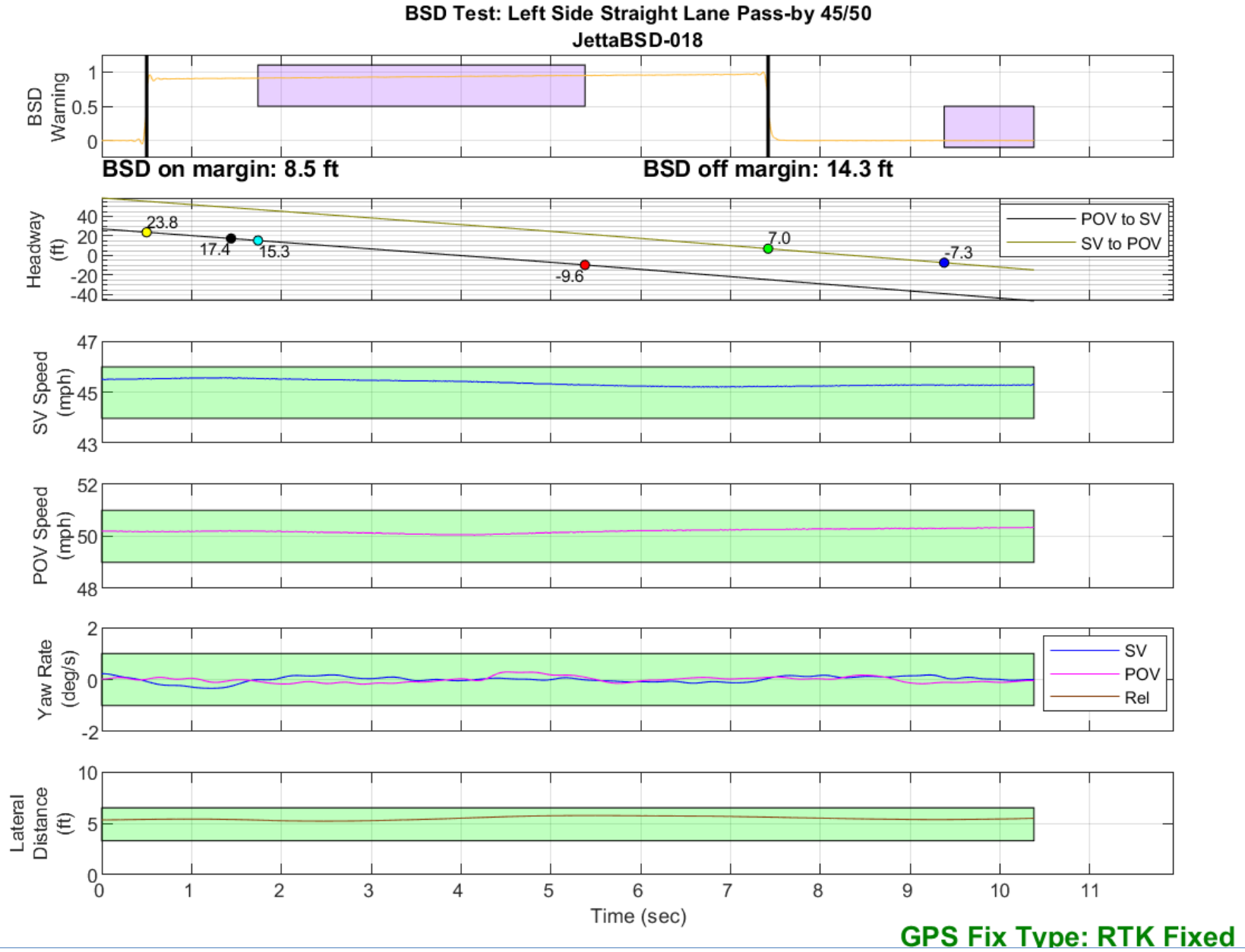

Figure D23. BSD Run 18, Straight Lane Pass-by, SV 45 mph, POV 50 mph

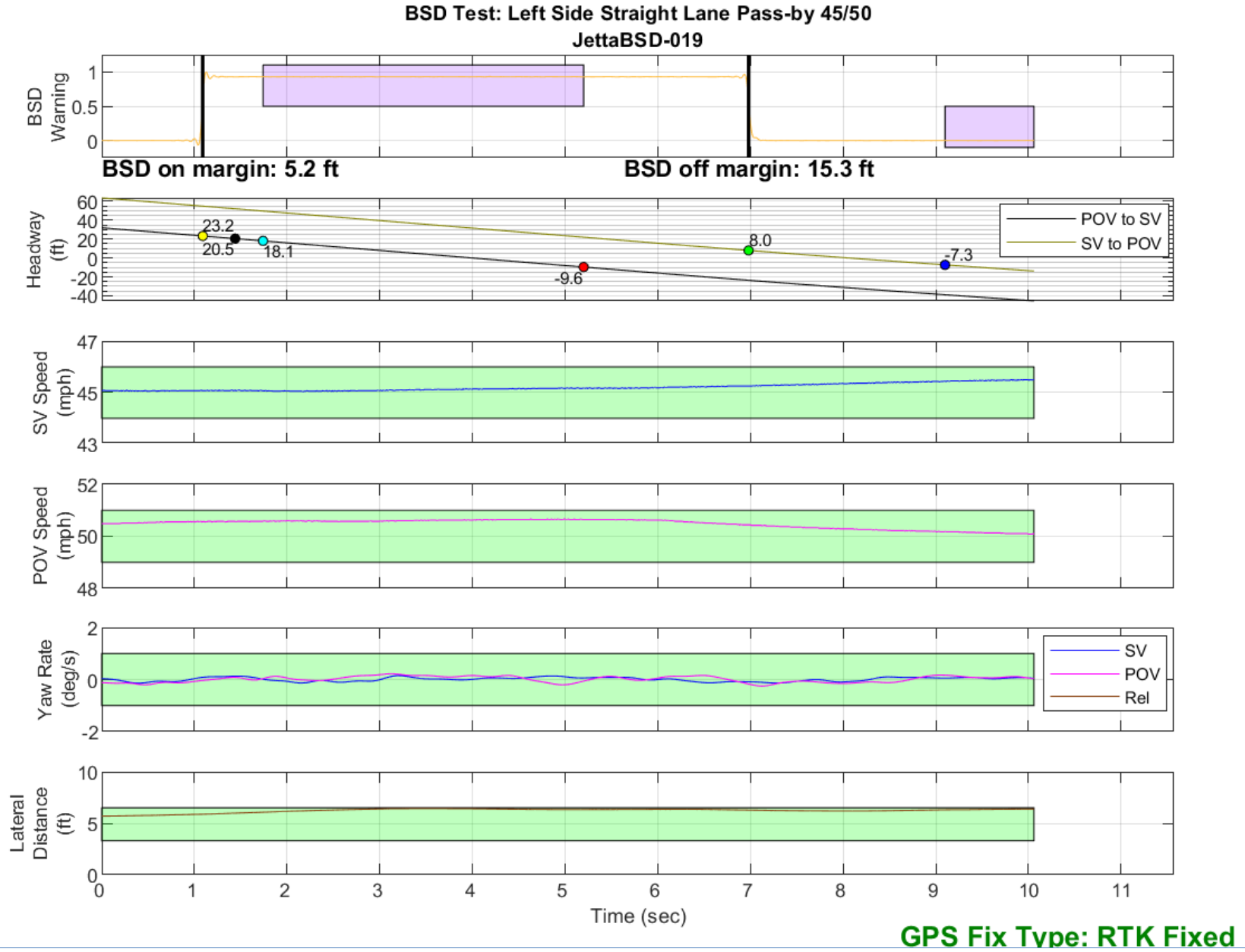

Figure D24. BSD Run 19, Straight Lane Pass-by, SV 45 mph, POV 50 mph

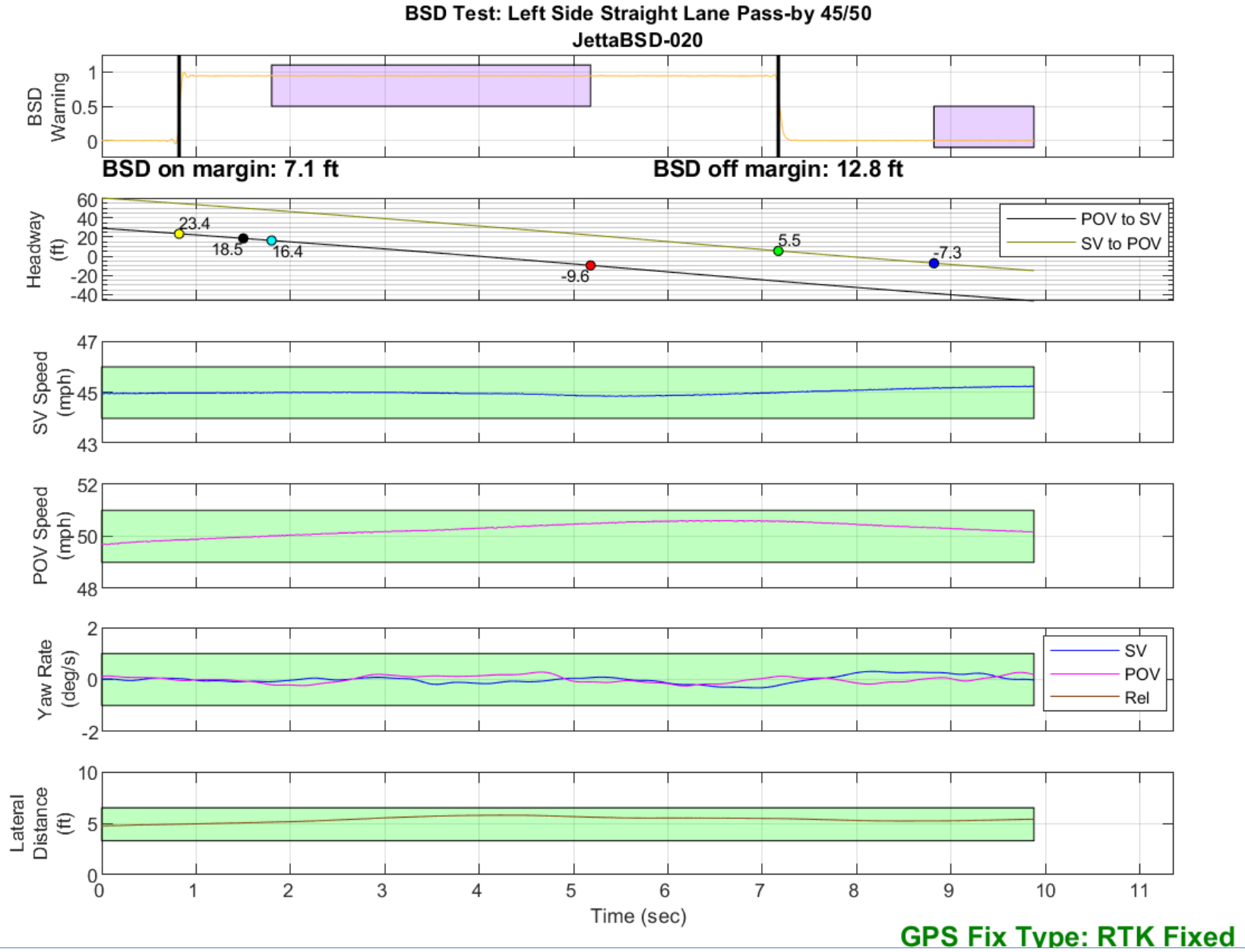

Figure D25. BSD Run 20, Straight Lane Pass-by, SV 45 mph, POV 50 mph

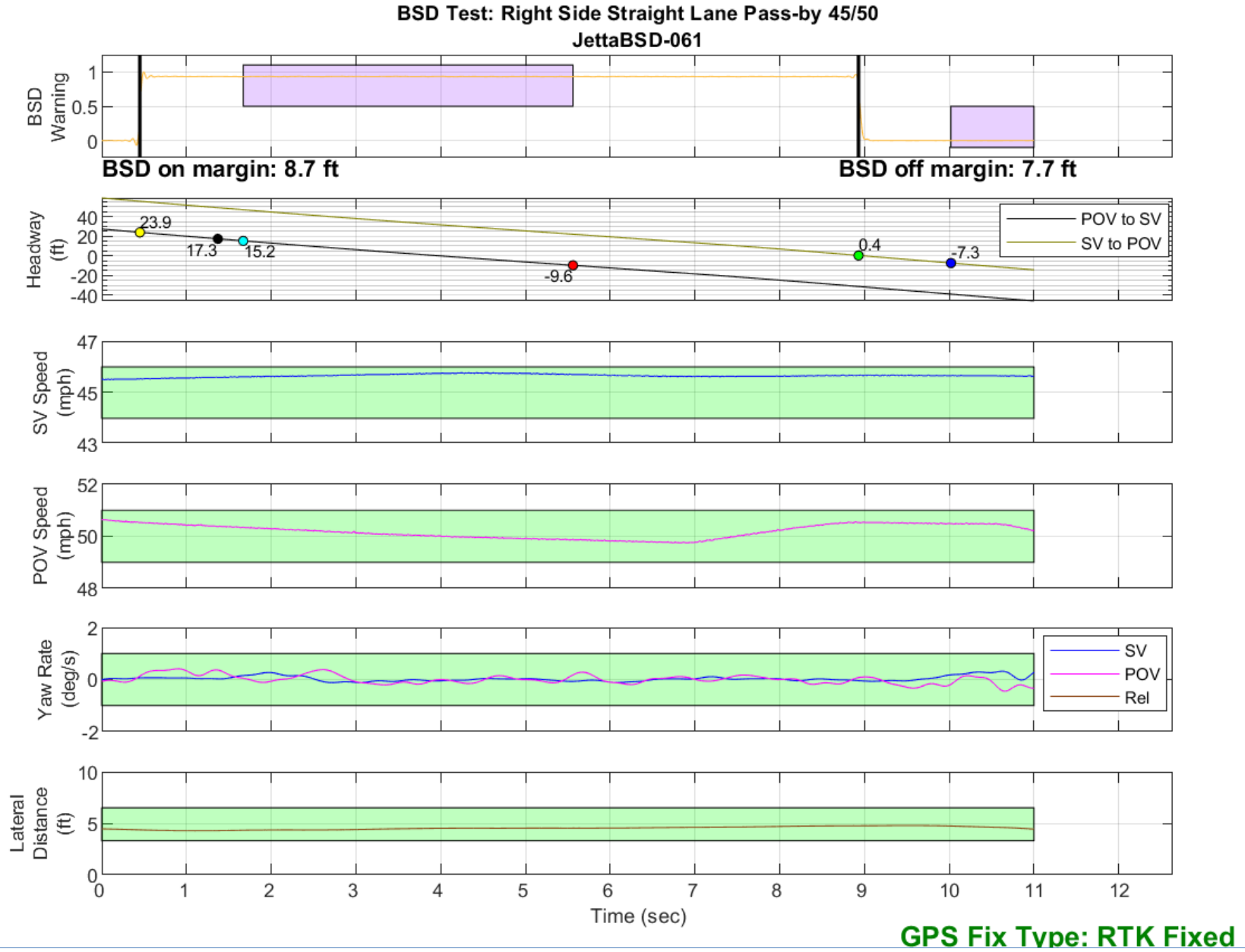

Figure D26. BSD Run 61, Straight Lane Pass-by, SV 45 mph, POV 50 mph

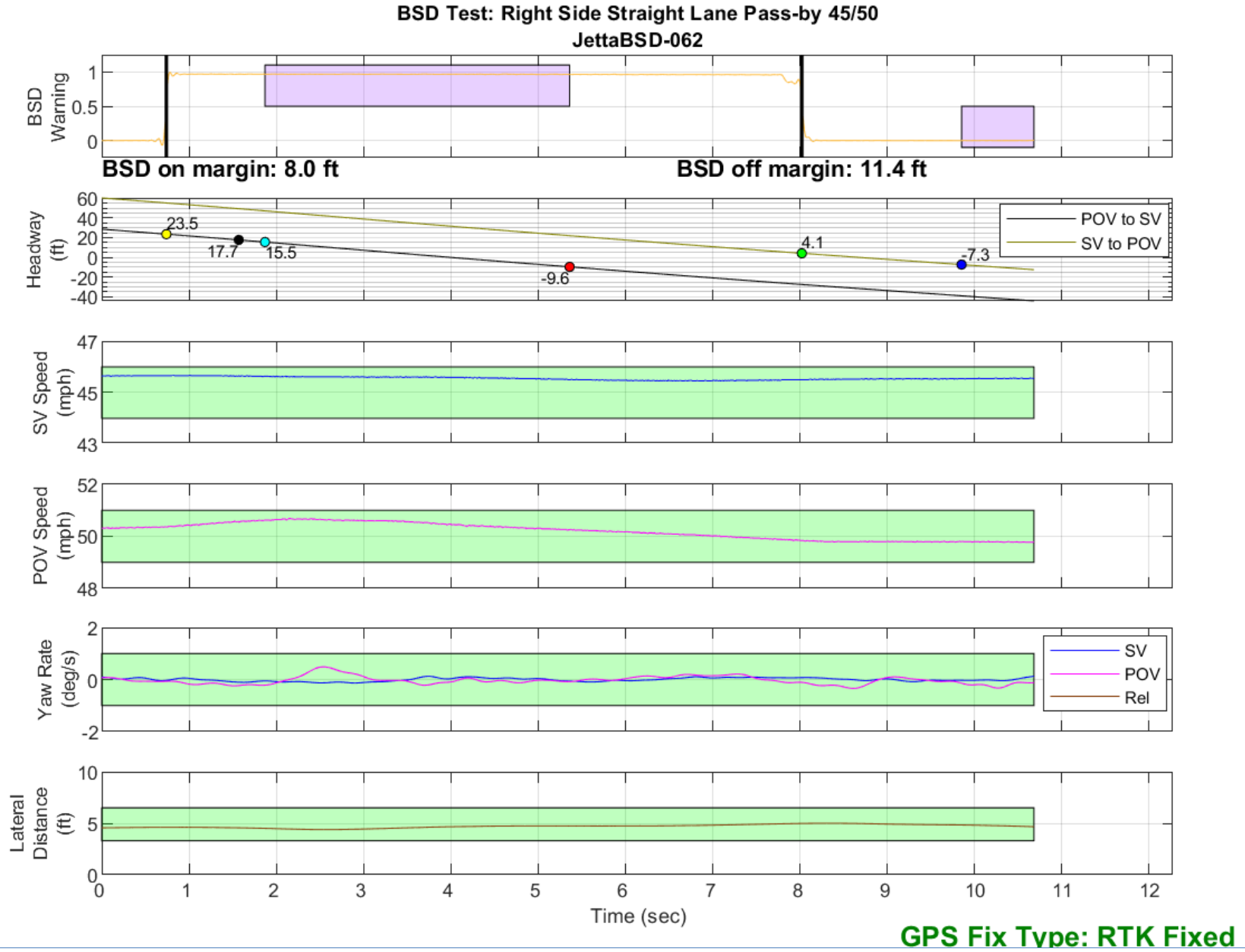

Figure D27. BSD Run 62, Straight Lane Pass-by, SV 45 mph, POV 50 mph

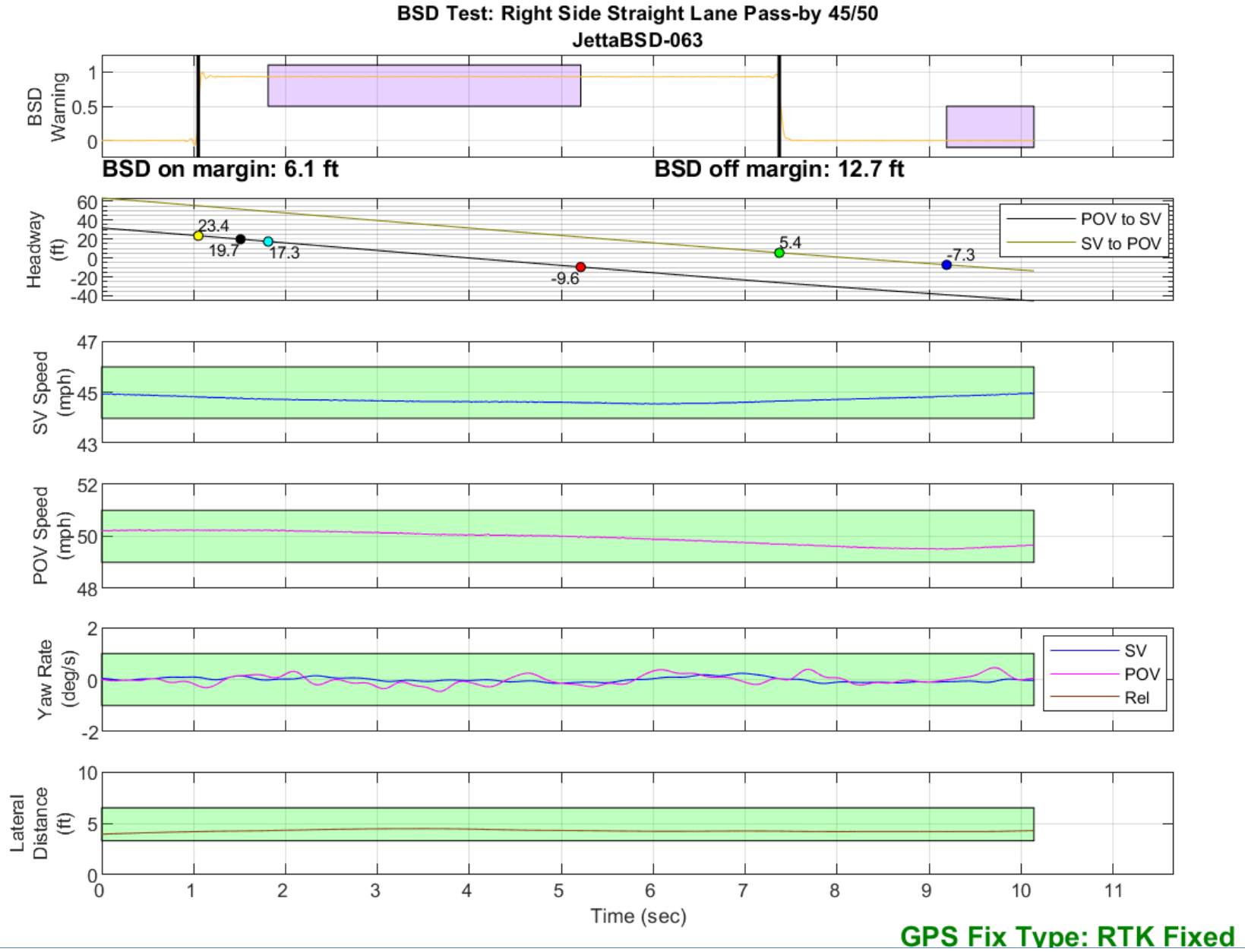

Figure D28. BSD Run 63, Straight Lane Pass-by, SV 45 mph, POV 50 mph

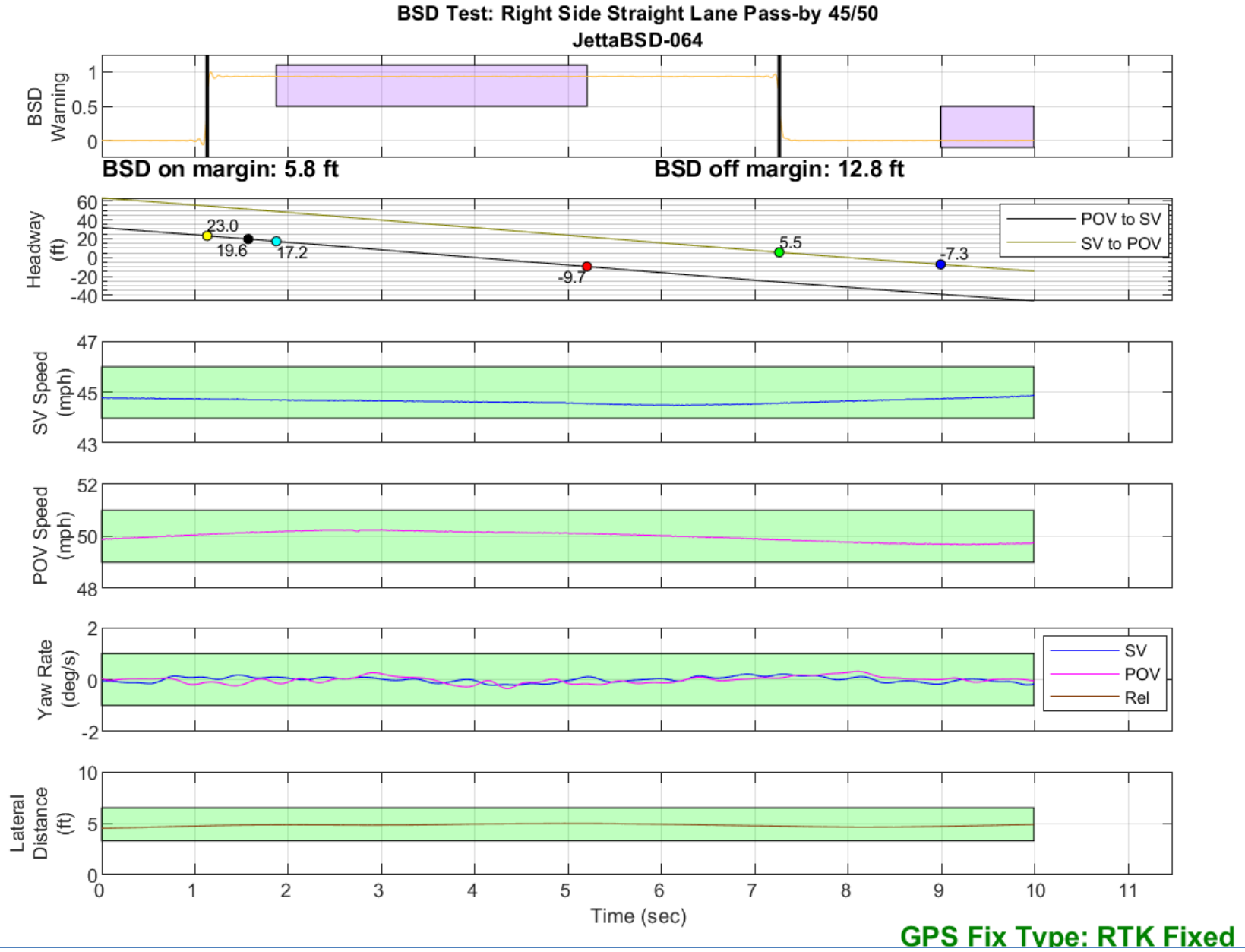

Figure D29. BSD Run 64, Straight Lane Pass-by, SV 45 mph, POV 50 mph

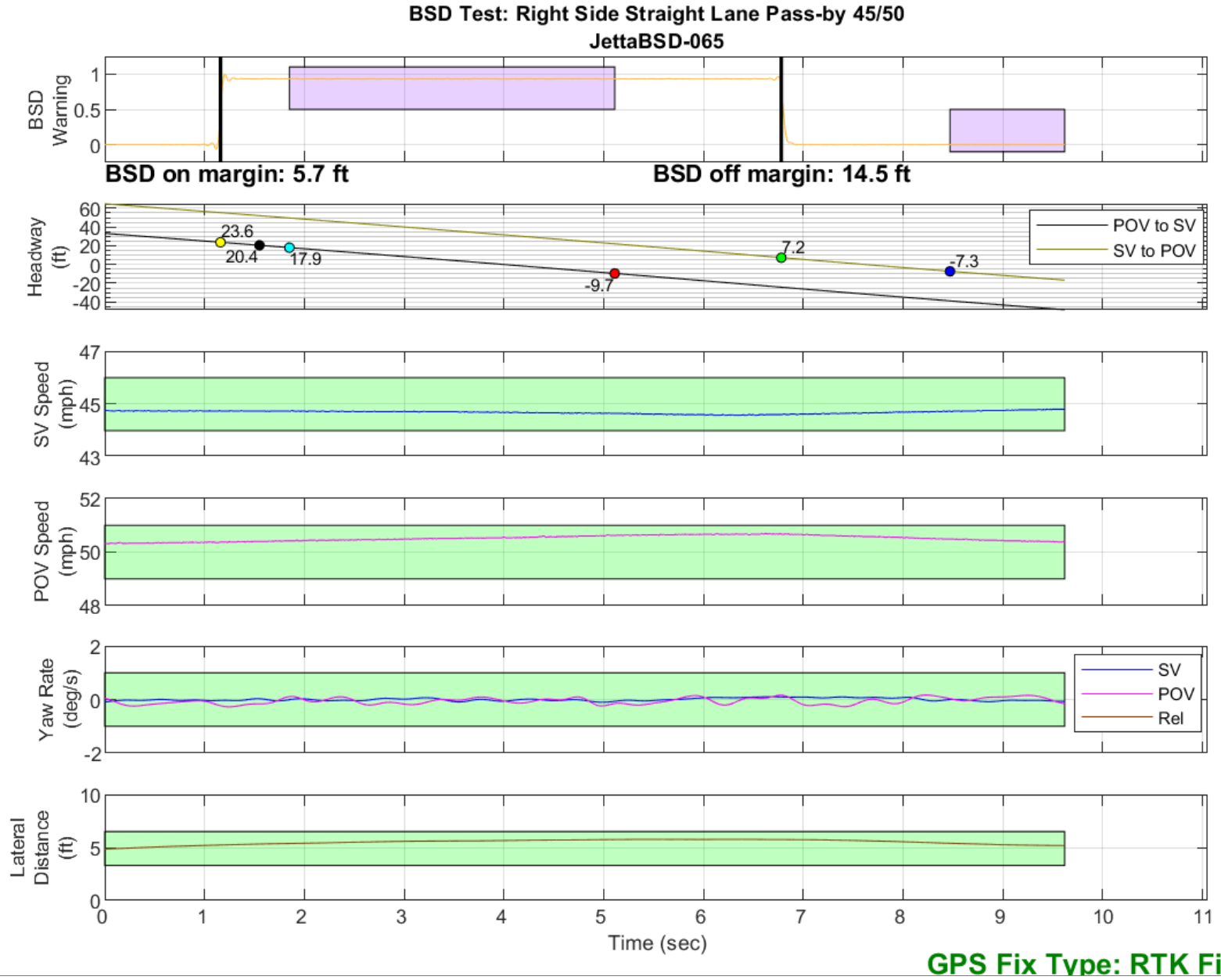

Figure D30. BSD Run 65, Straight Lane Pass-by, SV 45 mph, POV 50 mph

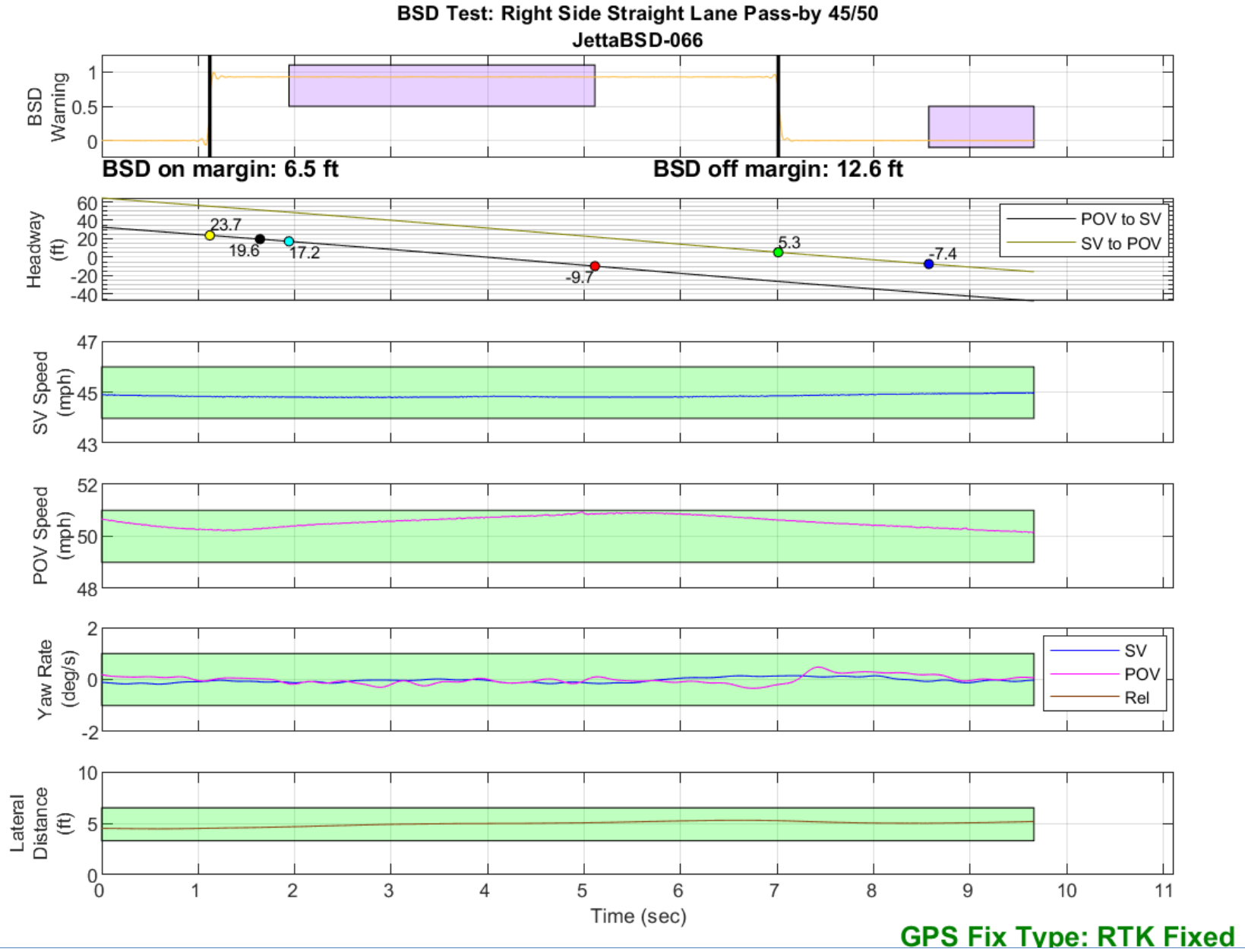

Figure D31. BSD Run 66, Straight Lane Pass-by, SV 45 mph, POV 50 mph

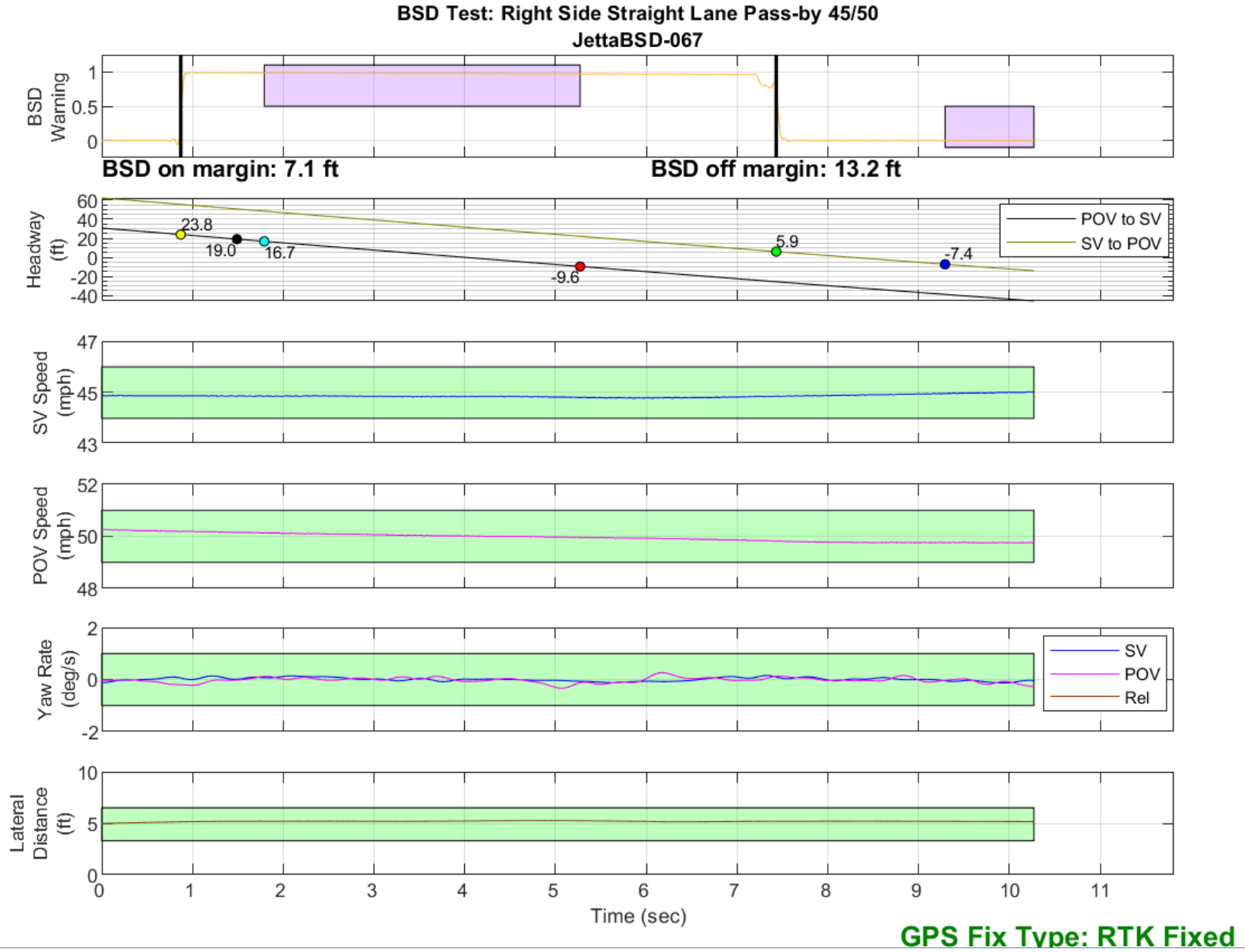

Figure D32. BSD Run 67, Straight Lane Pass-by, SV 45 mph, POV 50 mph

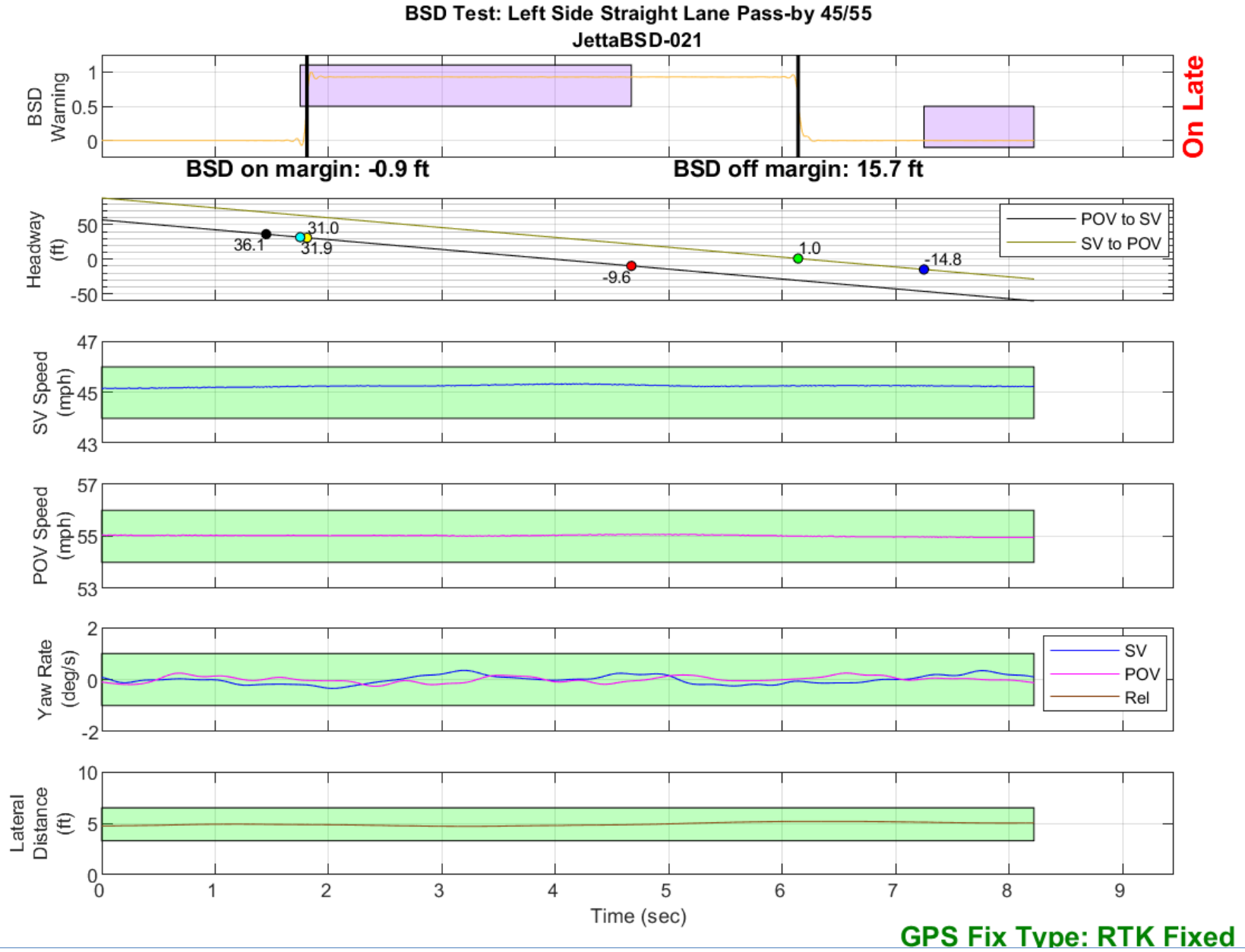

Figure D33. BSD Run 21, Straight Lane Pass-by, SV 45 mph, POV 55 mph

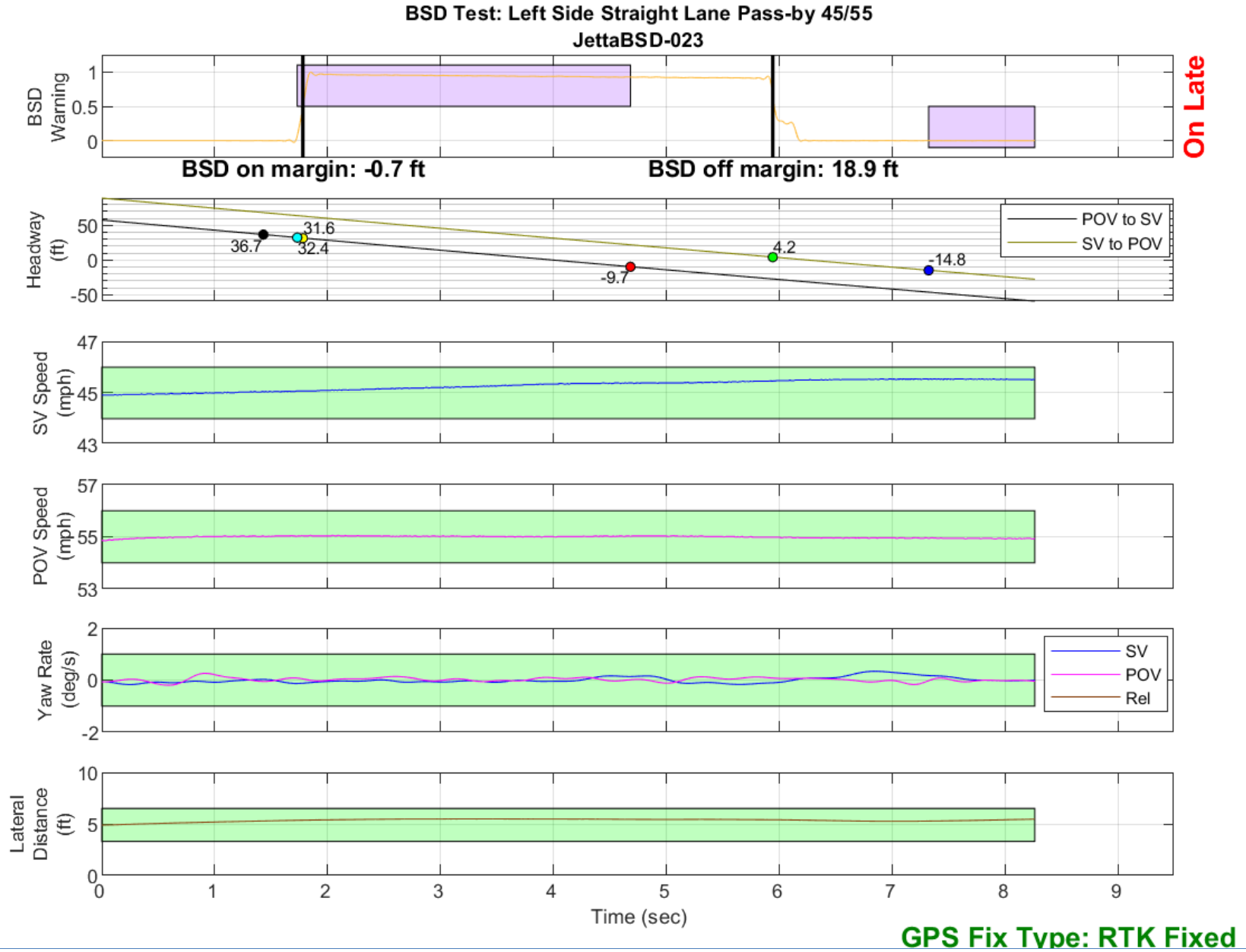

Figure D34. BSD Run 23, Straight Lane Pass-by, SV 45 mph, POV 55 mph

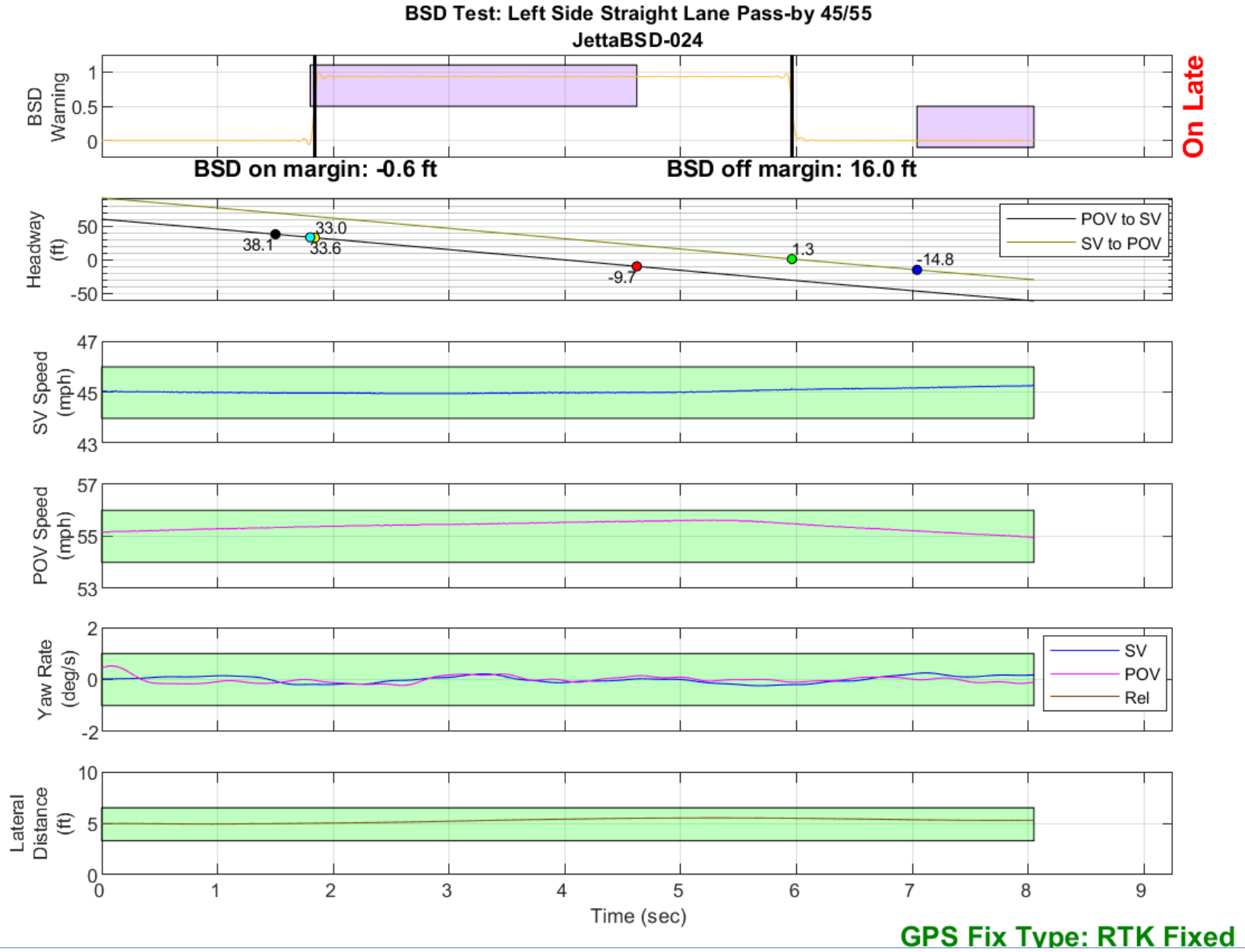

Figure D35. BSD Run 24, Straight Lane Pass-by, SV 45 mph, POV 55 mph

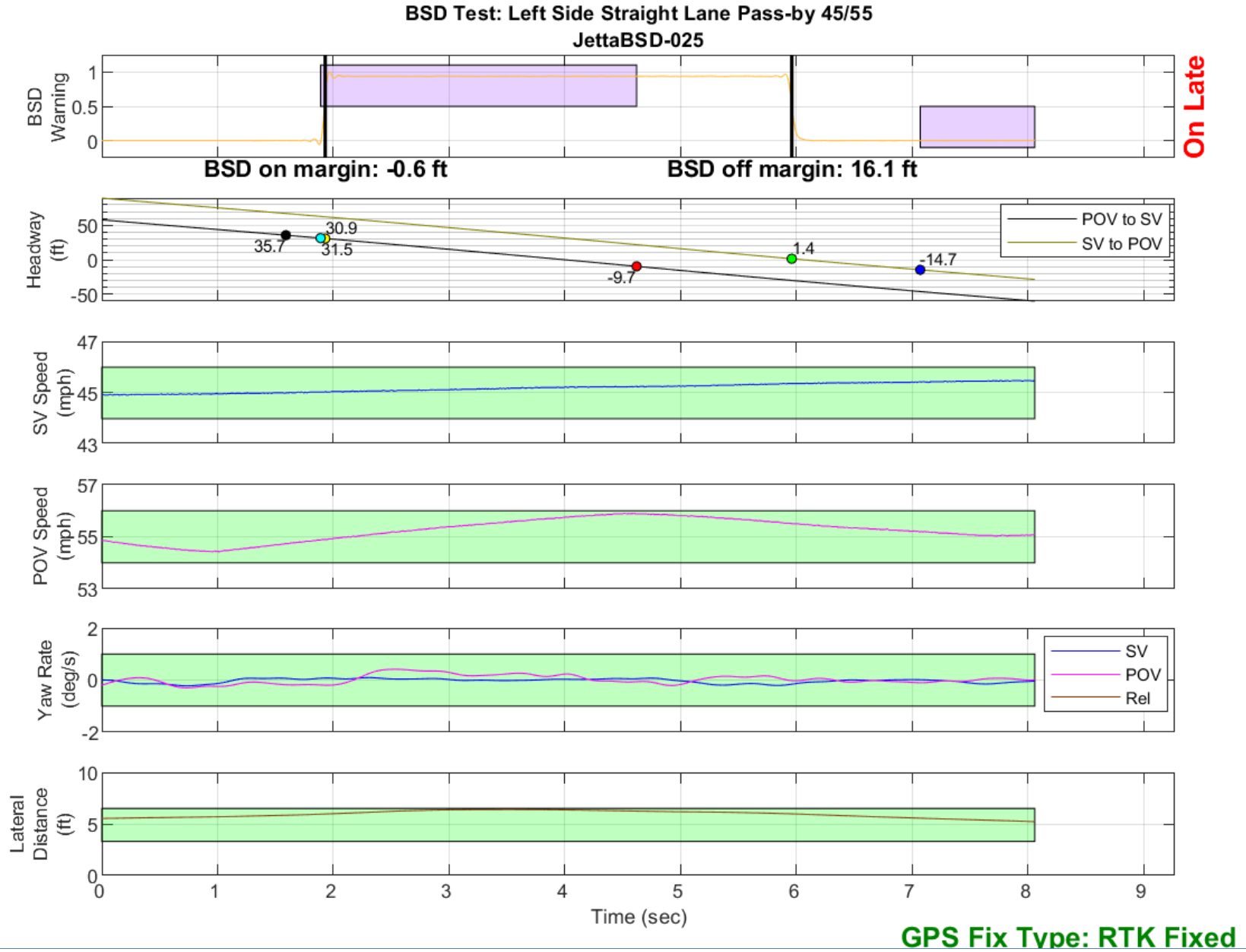

Figure D36. BSD Run 25, Straight Lane Pass-by, SV 45 mph, POV 55 mph

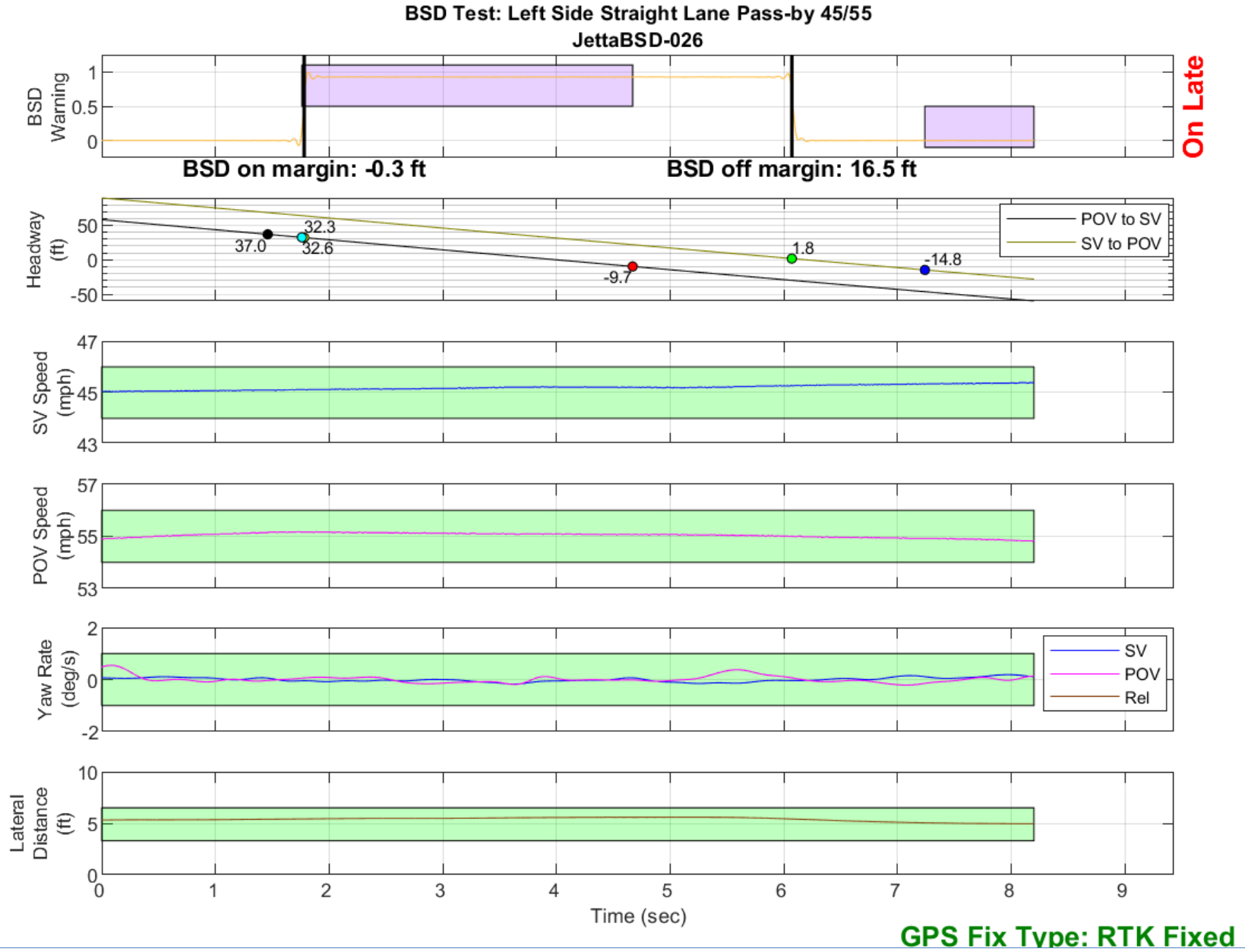

Figure D37. BSD Run 26, Straight Lane Pass-by, SV 45 mph, POV 55 mph

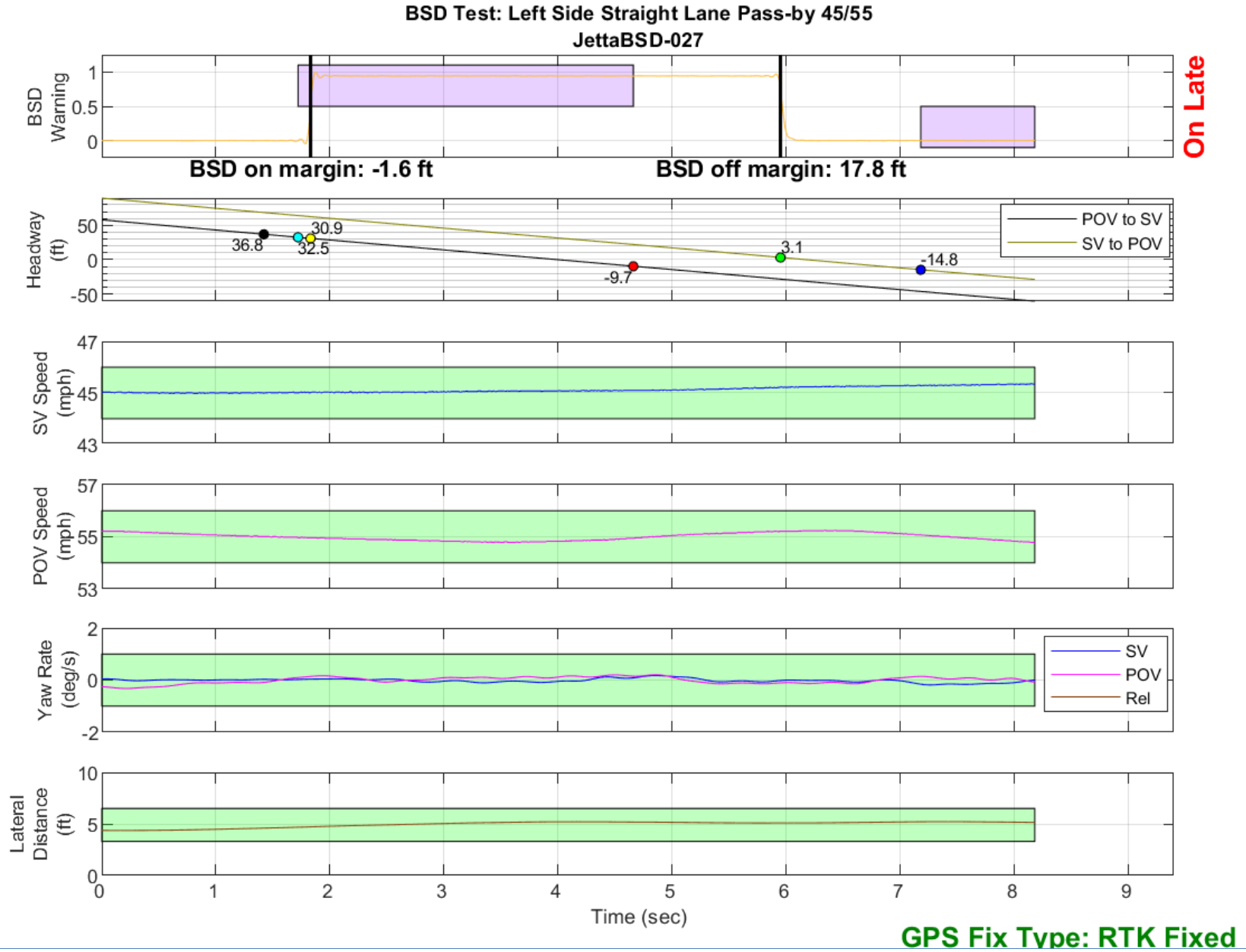

Figure D38. BSD Run 27, Straight Lane Pass-by, SV 45 mph, POV 55 mph

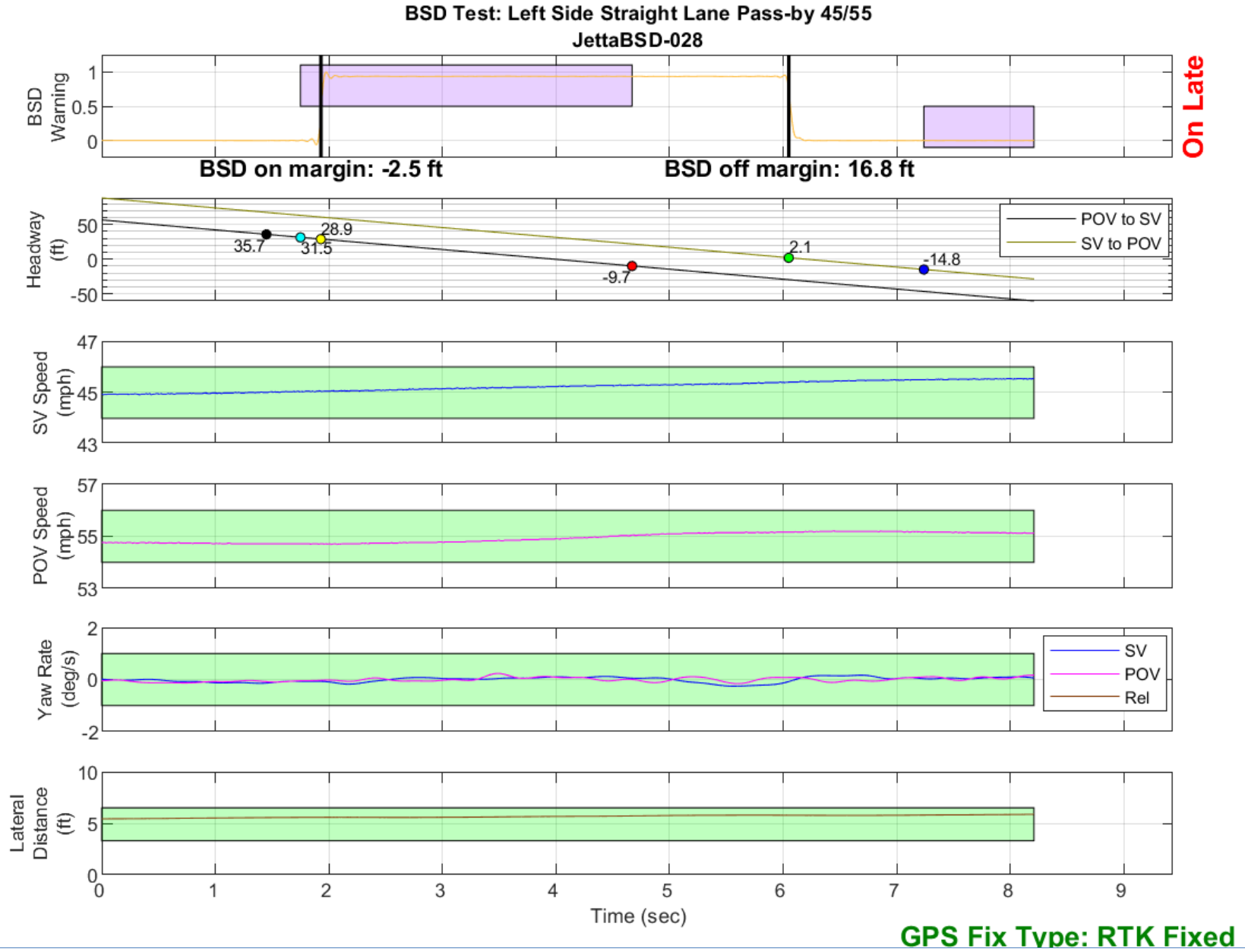

Figure D39. BSD Run 28, Straight Lane Pass-by, SV 45 mph, POV 55 mph

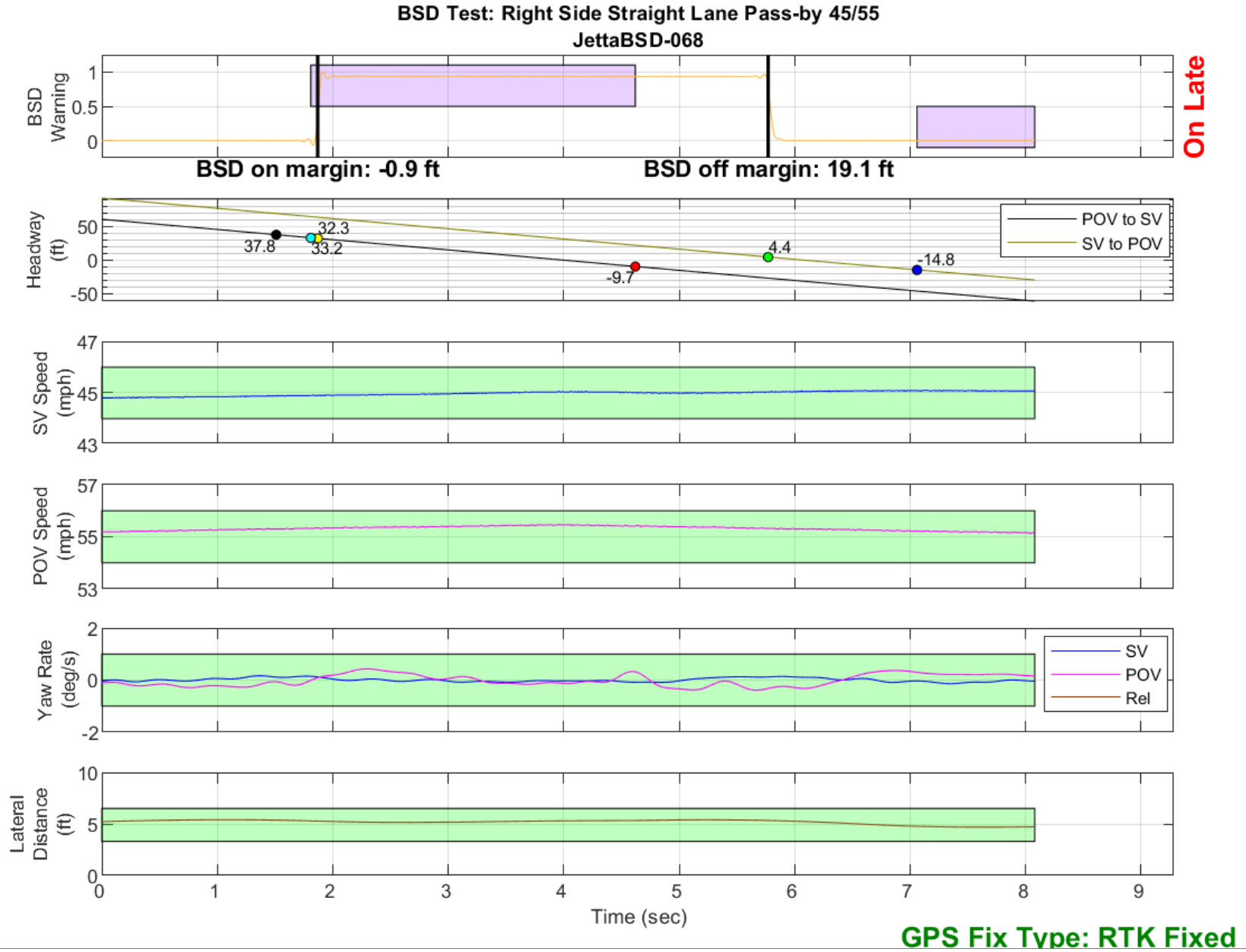

Figure D40. BSD Run 68, Straight Lane Pass-by, SV 45 mph, POV 55 mph

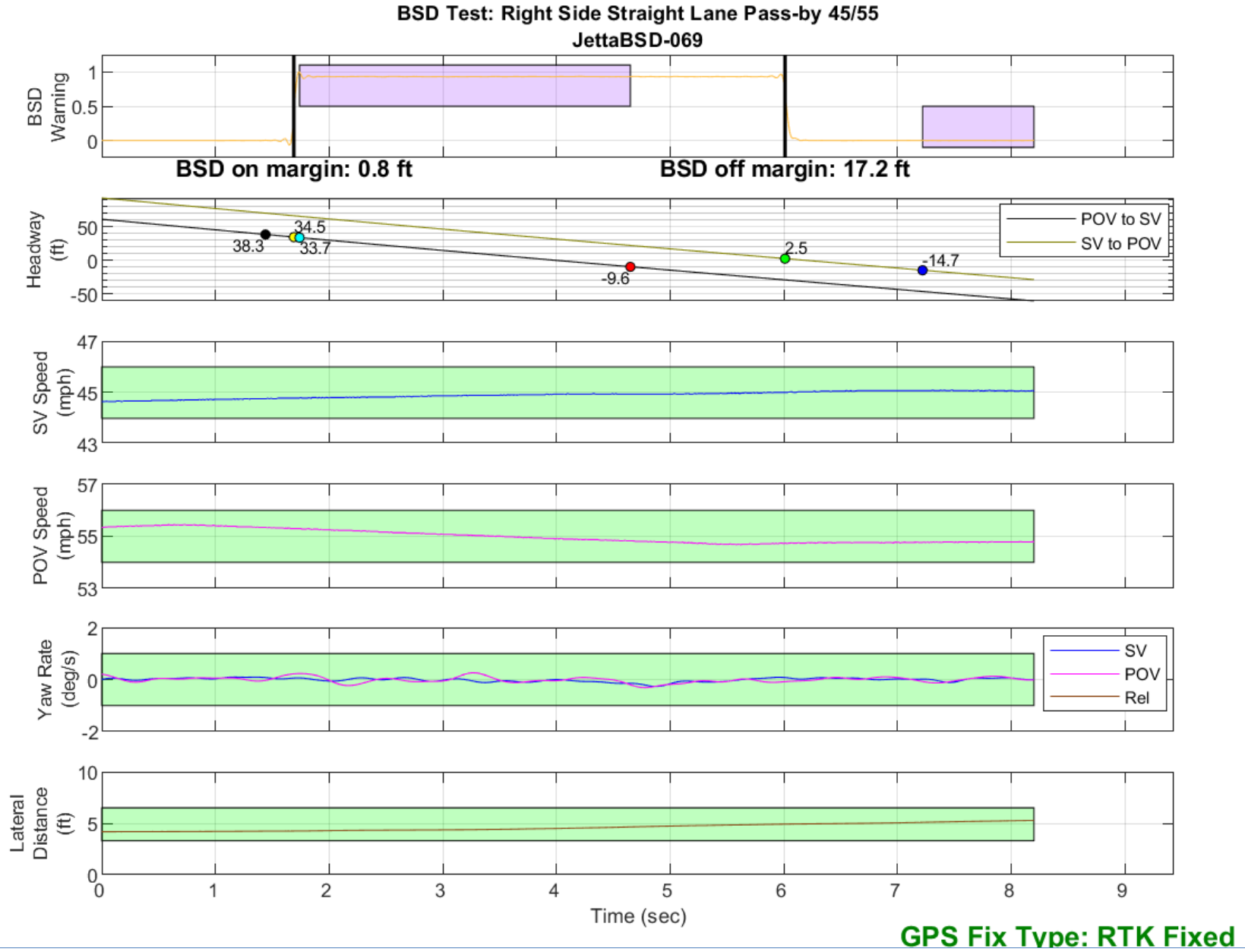

Figure D41. BSD Run 69, Straight Lane Pass-by, SV 45 mph, POV 55 mph

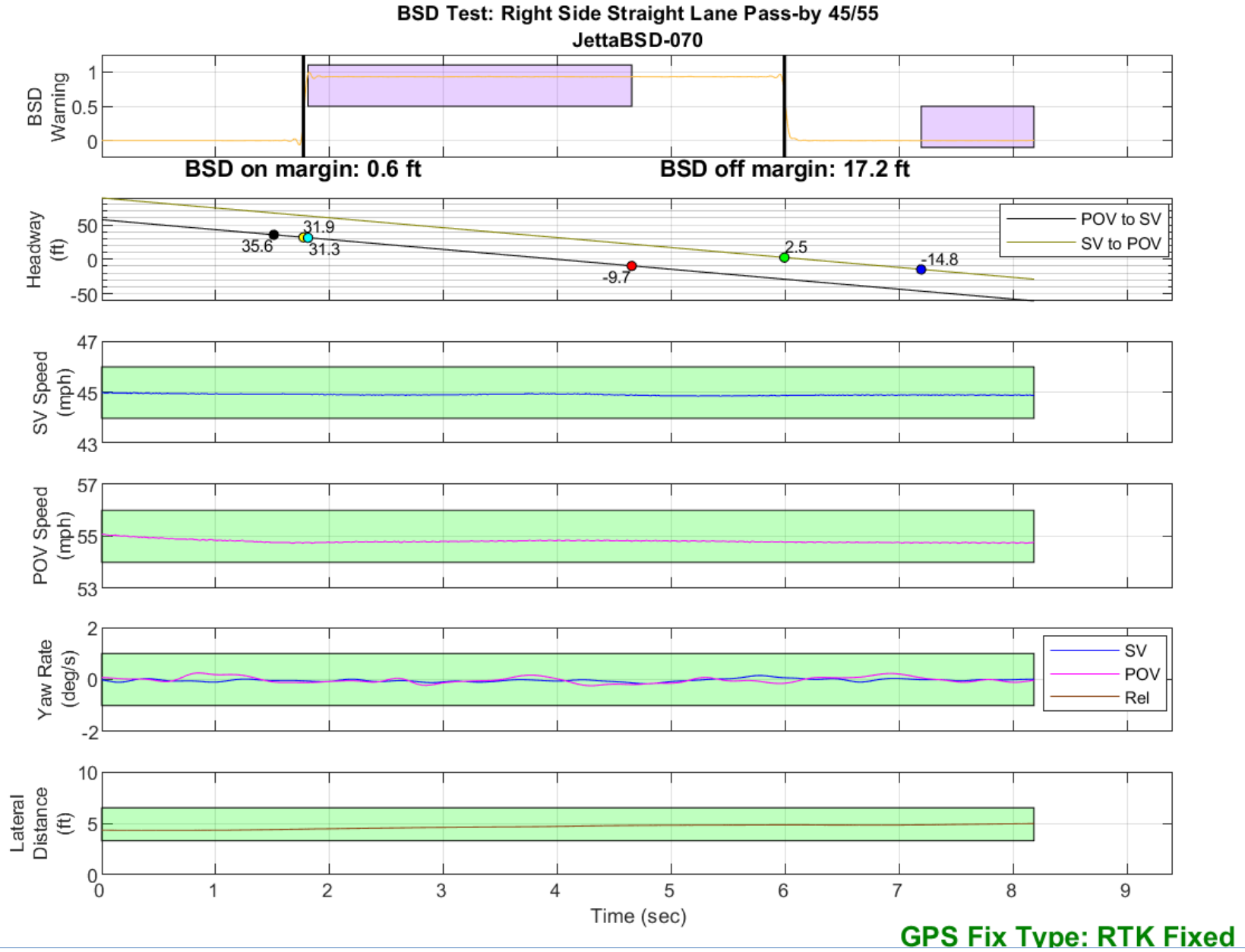

Figure D42. BSD Run 70, Straight Lane Pass-by, SV 45 mph, POV 55 mph

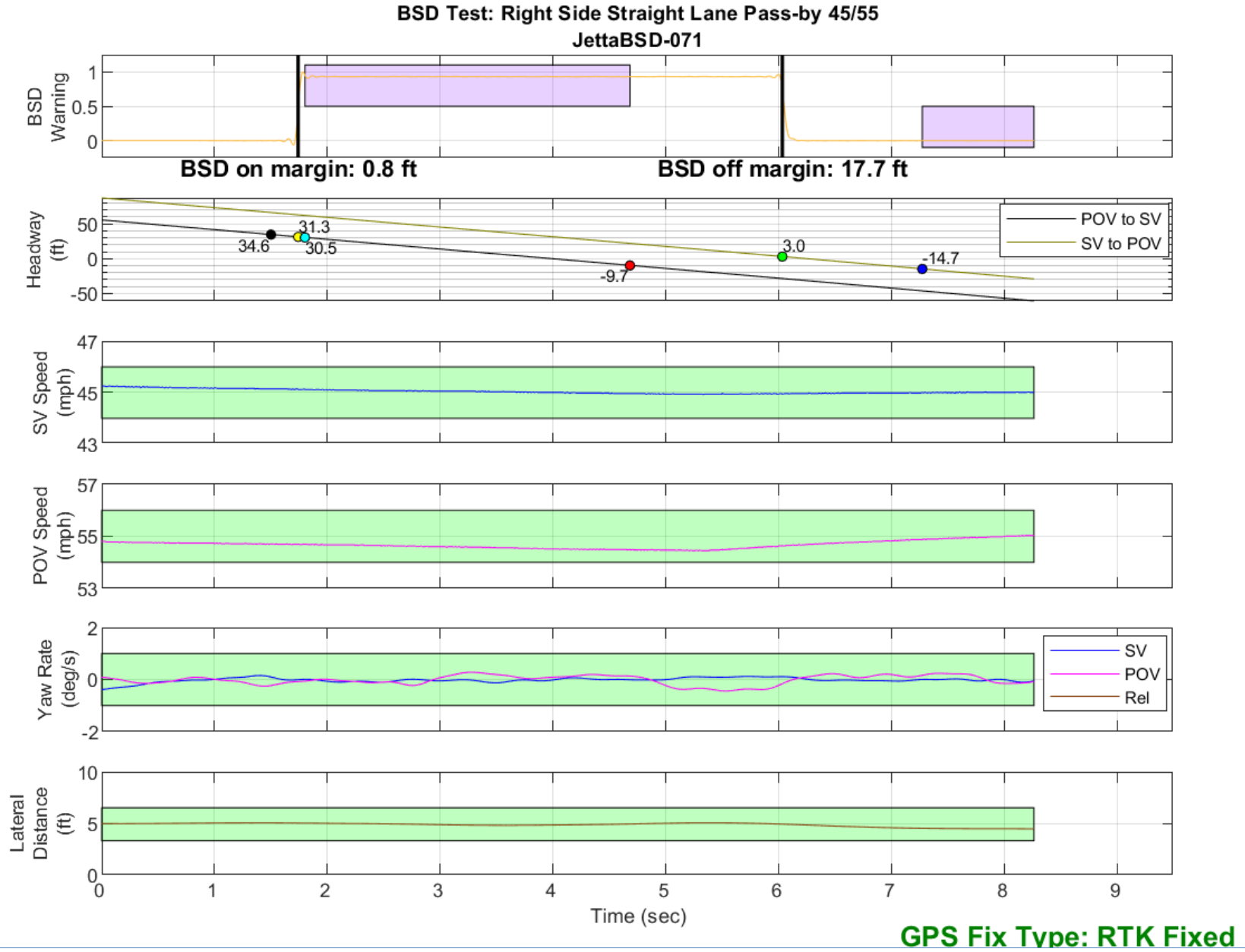

Figure D43. BSD Run 71, Straight Lane Pass-by, SV 45 mph, POV 55 mph

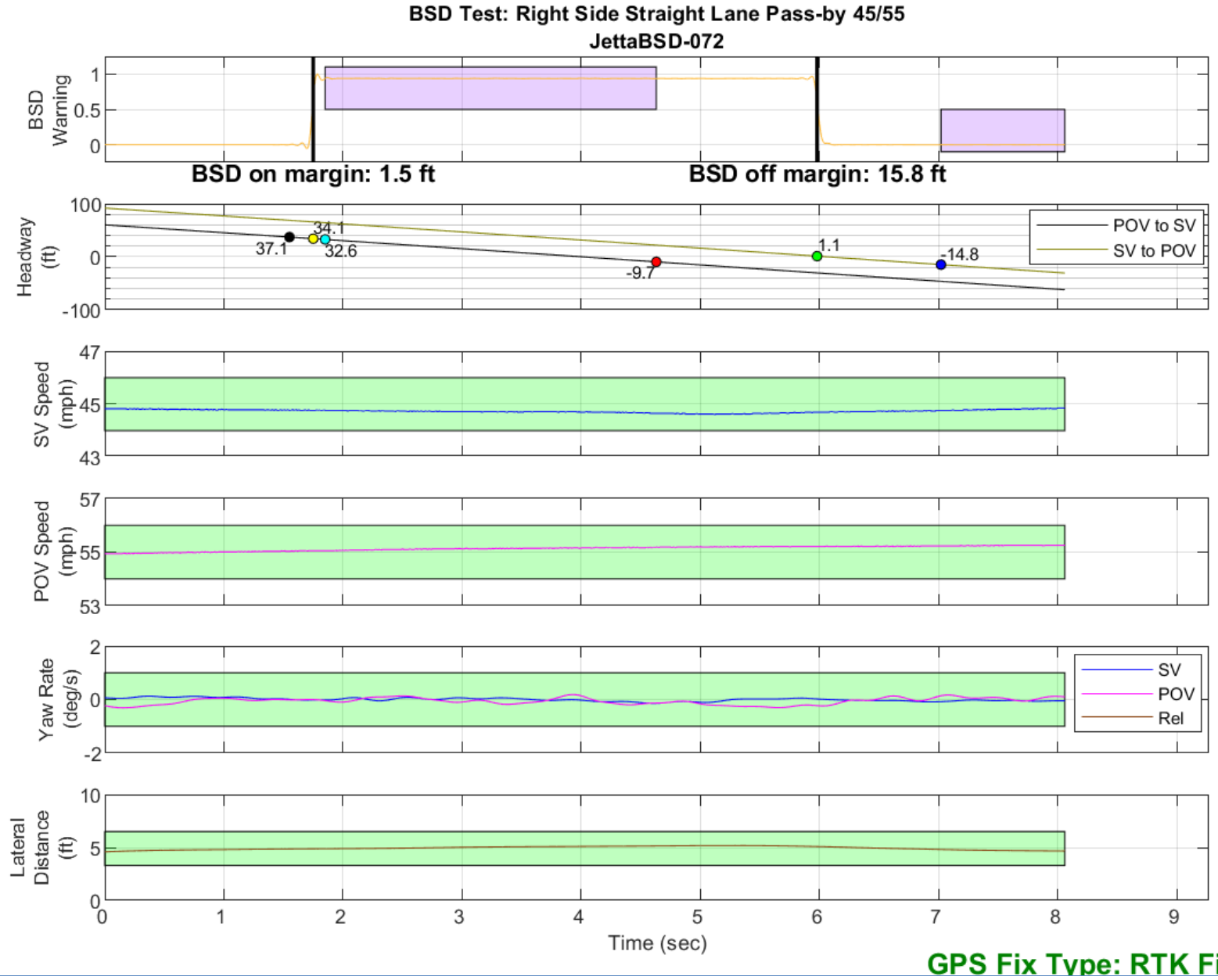

Figure D44. BSD Run 72, Straight Lane Pass-by, SV 45 mph, POV 55 mph

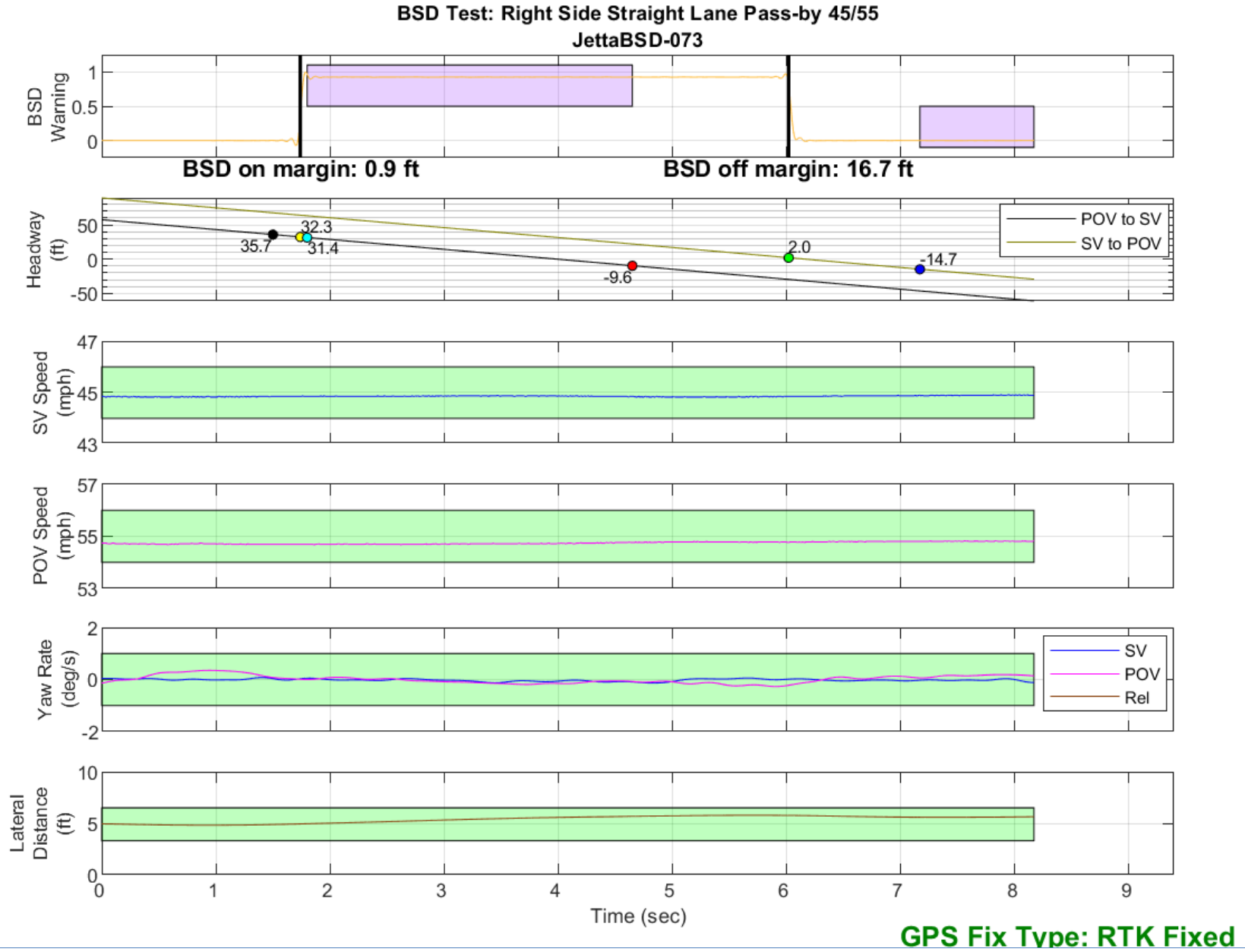

Figure D45. BSD Run 73, Straight Lane Pass-by, SV 45 mph, POV 55 mph

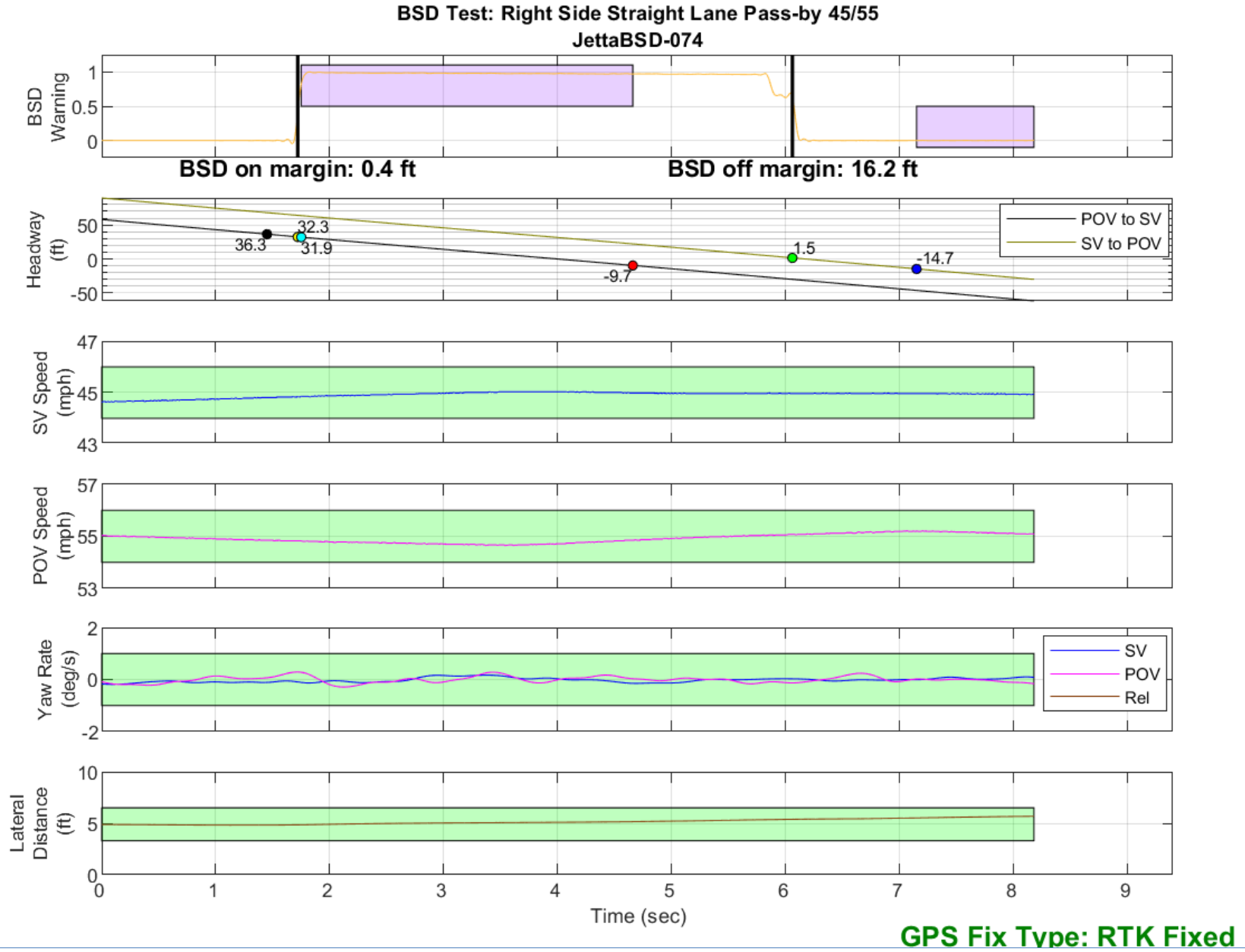

Figure D46. BSD Run 74, Straight Lane Pass-by, SV 45 mph, POV 55 mph

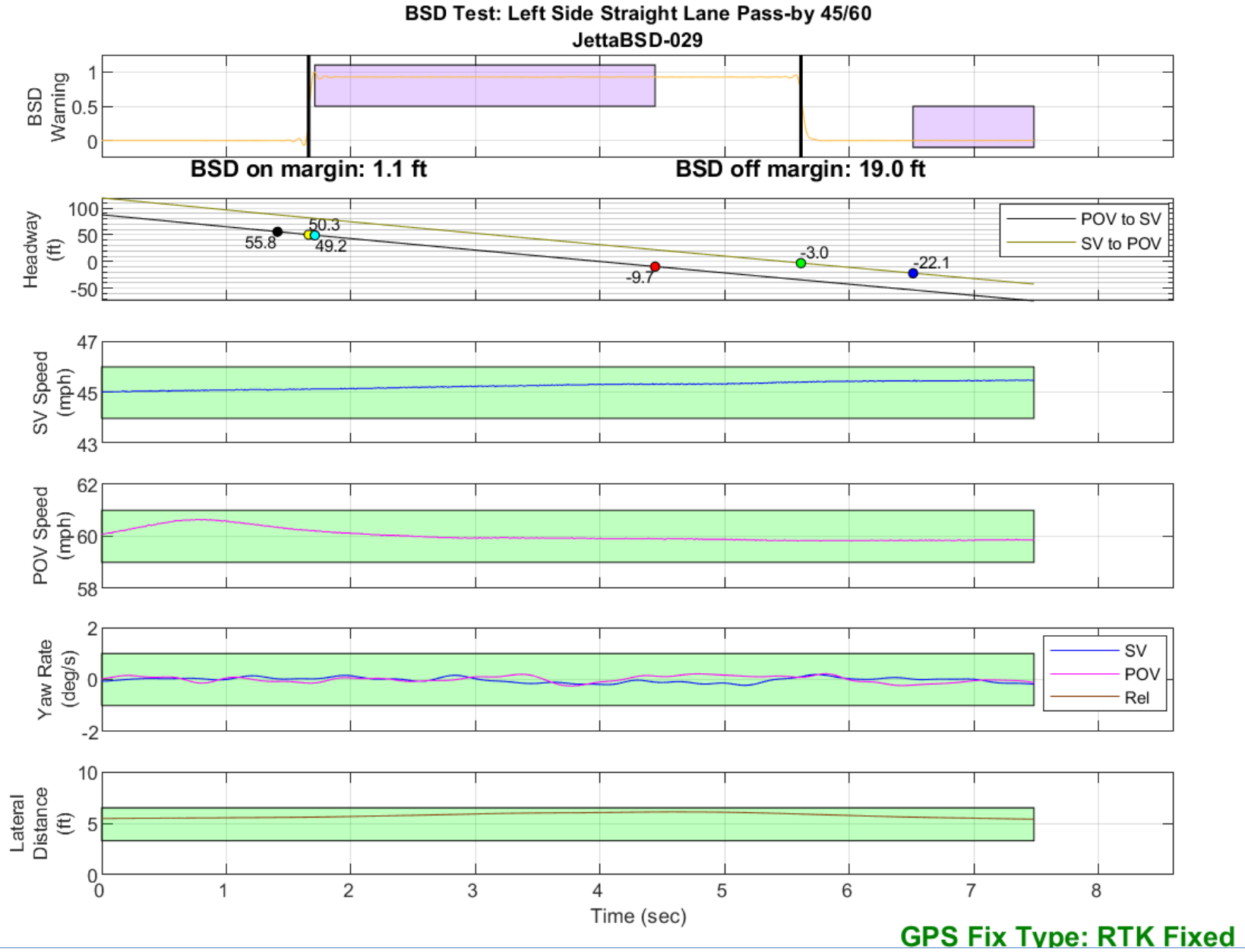

Figure D47. BSD Run 29, Straight Lane Pass-by, SV 45 mph, POV 60 mph

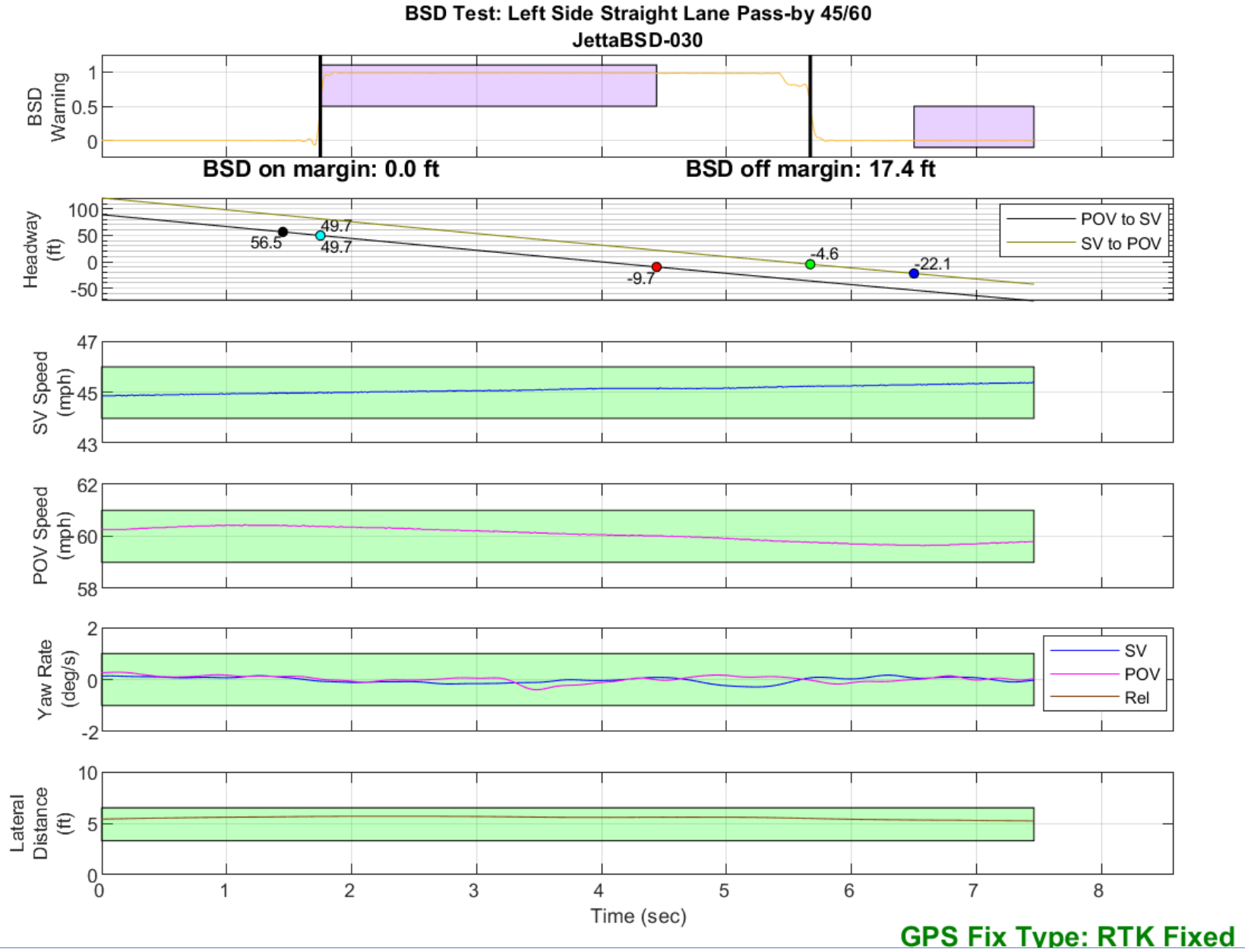

Figure D48. BSD Run 30, Straight Lane Pass-by, SV 45 mph, POV 60 mph

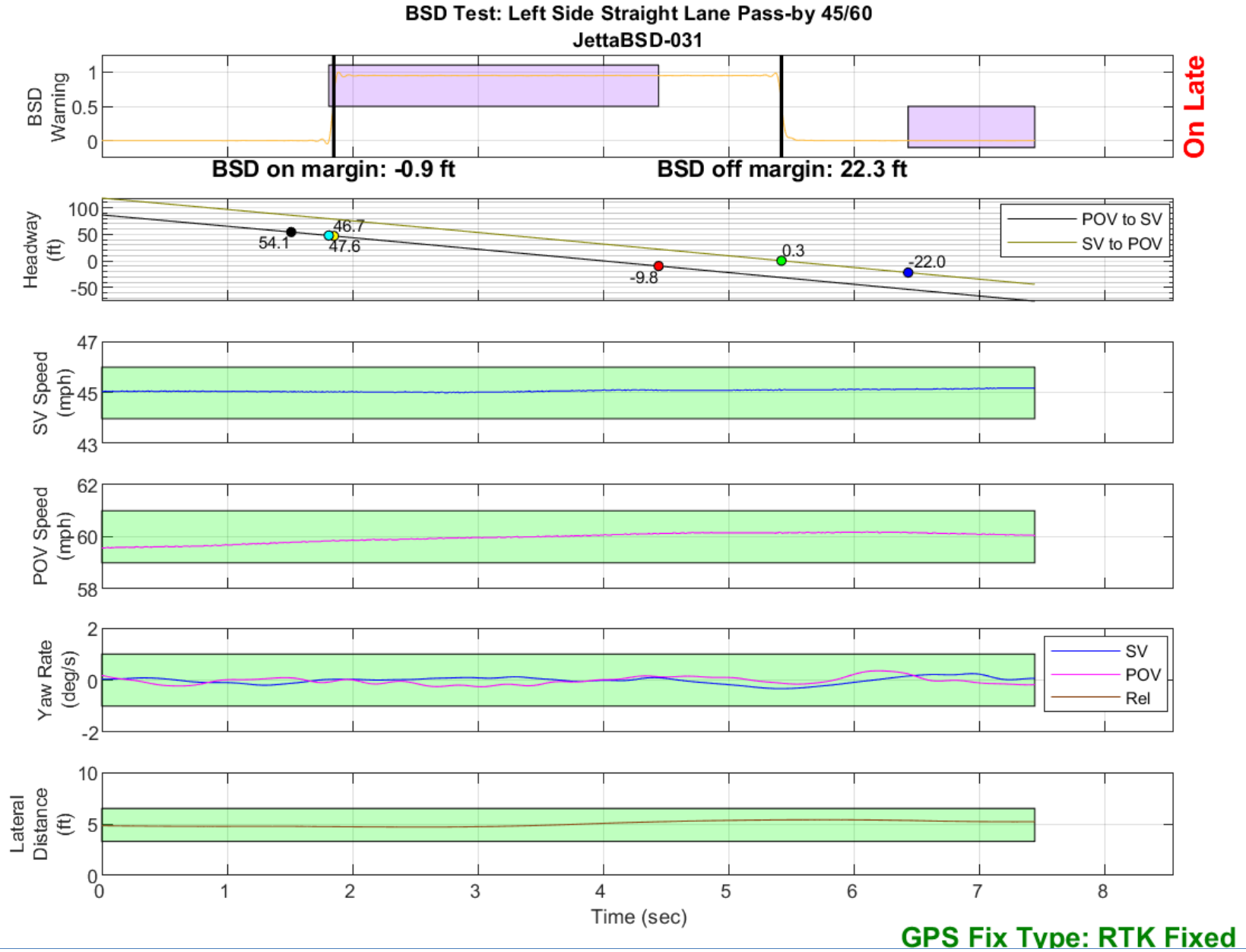

Figure D49. BSD Run 31, Straight Lane Pass-by, SV 45 mph, POV 60 mph

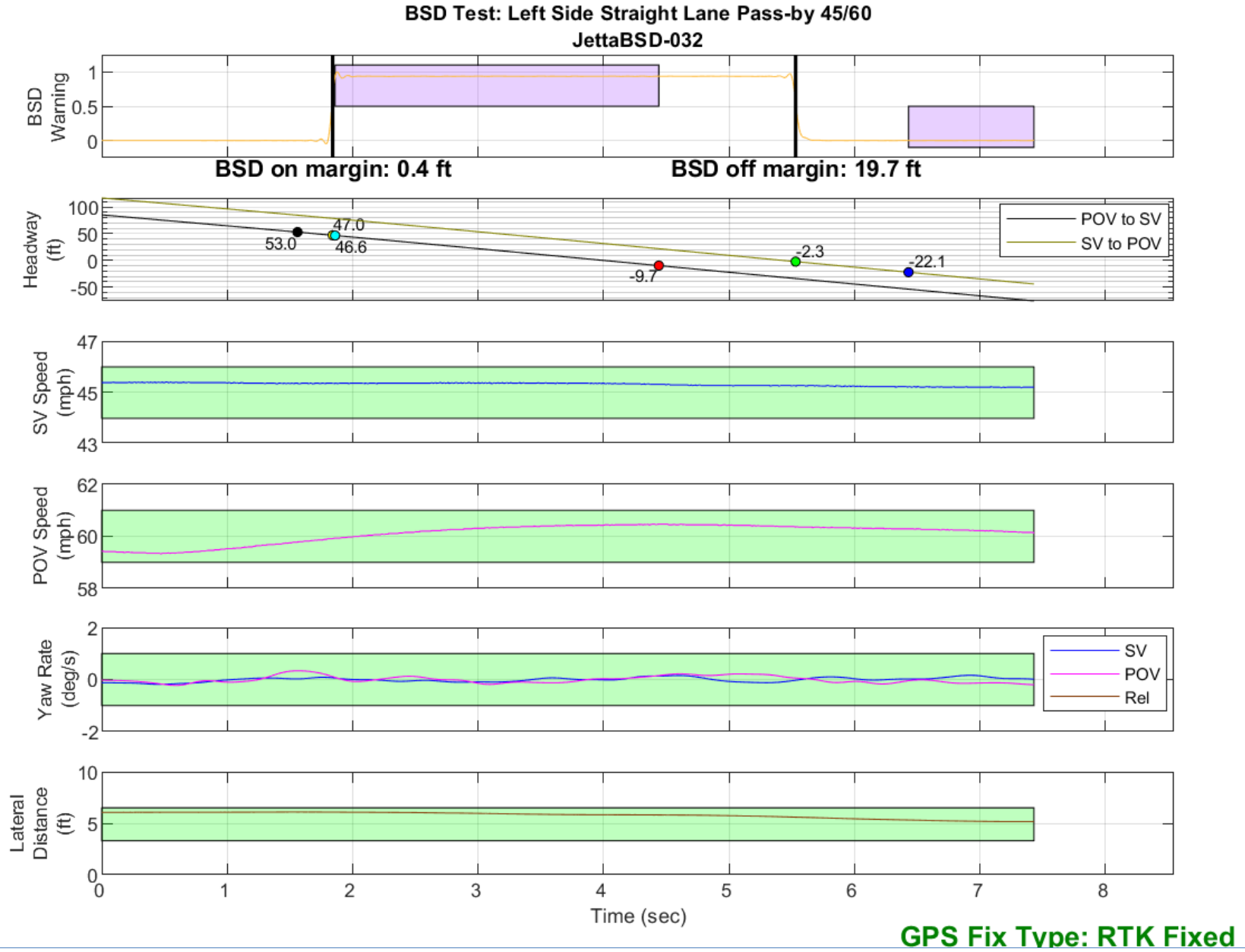

Figure D50. BSD Run 32, Straight Lane Pass-by, SV 45 mph, POV 60 mph

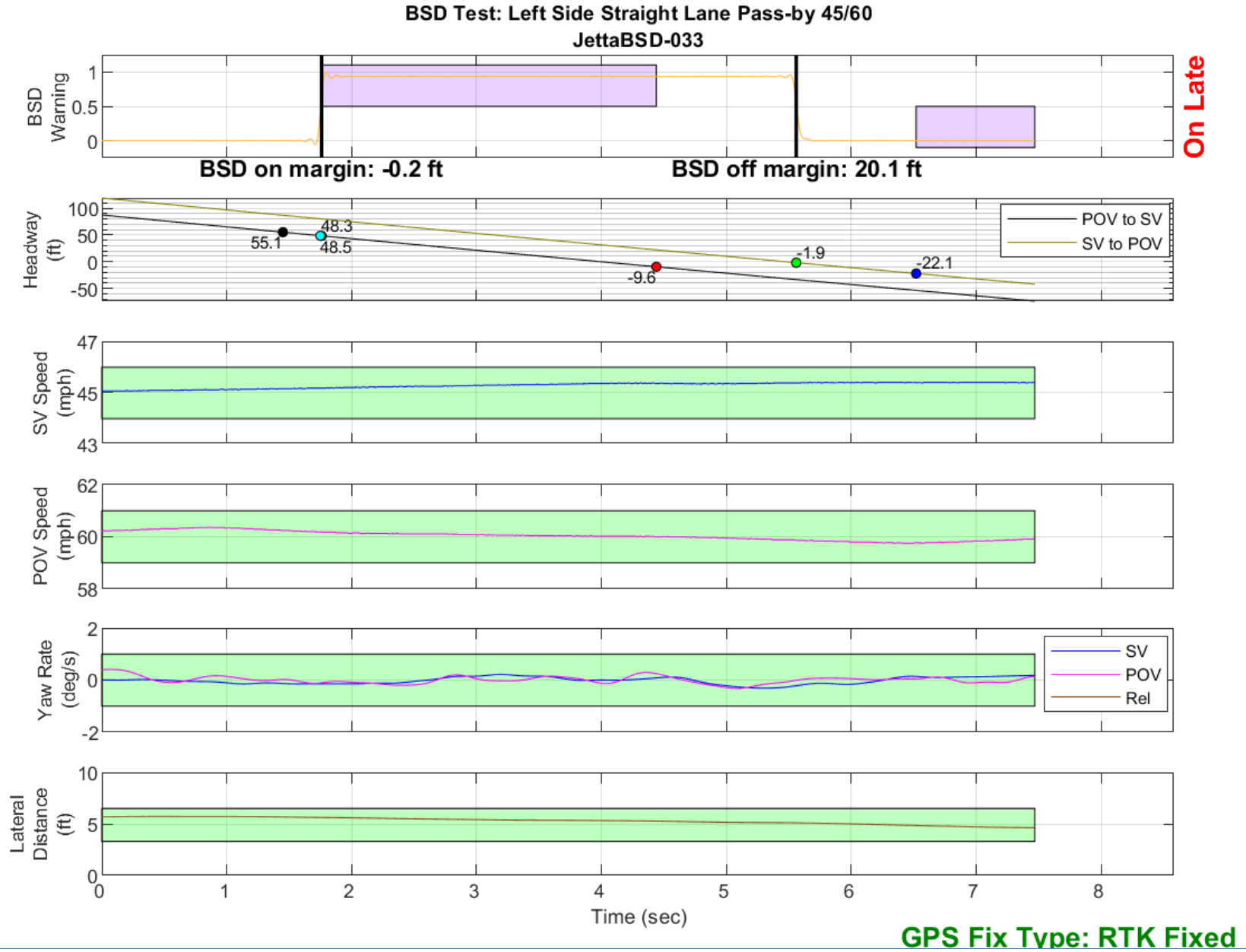

Figure D51. BSD Run 33, Straight Lane Pass-by, SV 45 mph, POV 60 mph

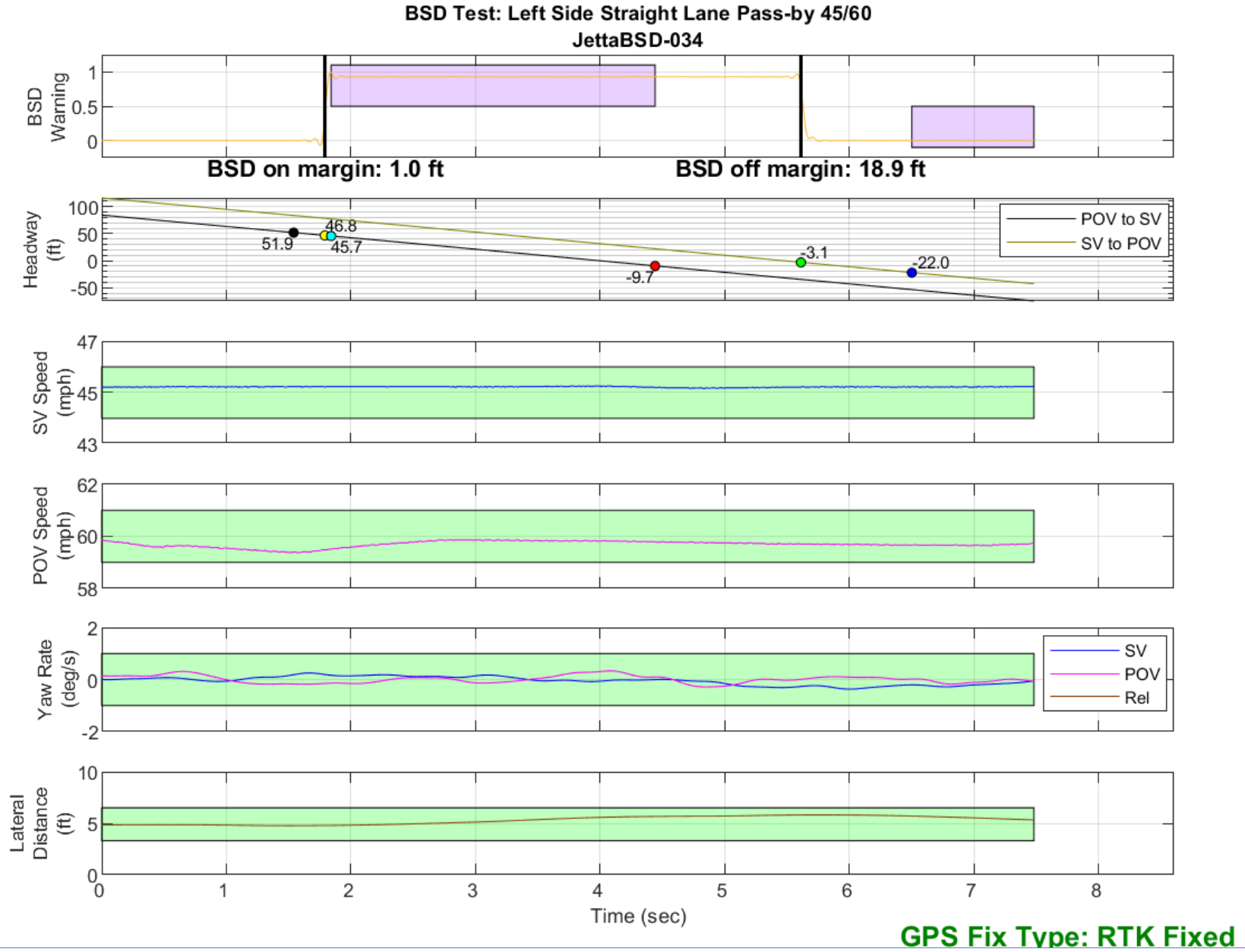

Figure D52. BSD Run 34, Straight Lane Pass-by, SV 45 mph, POV 60 mph

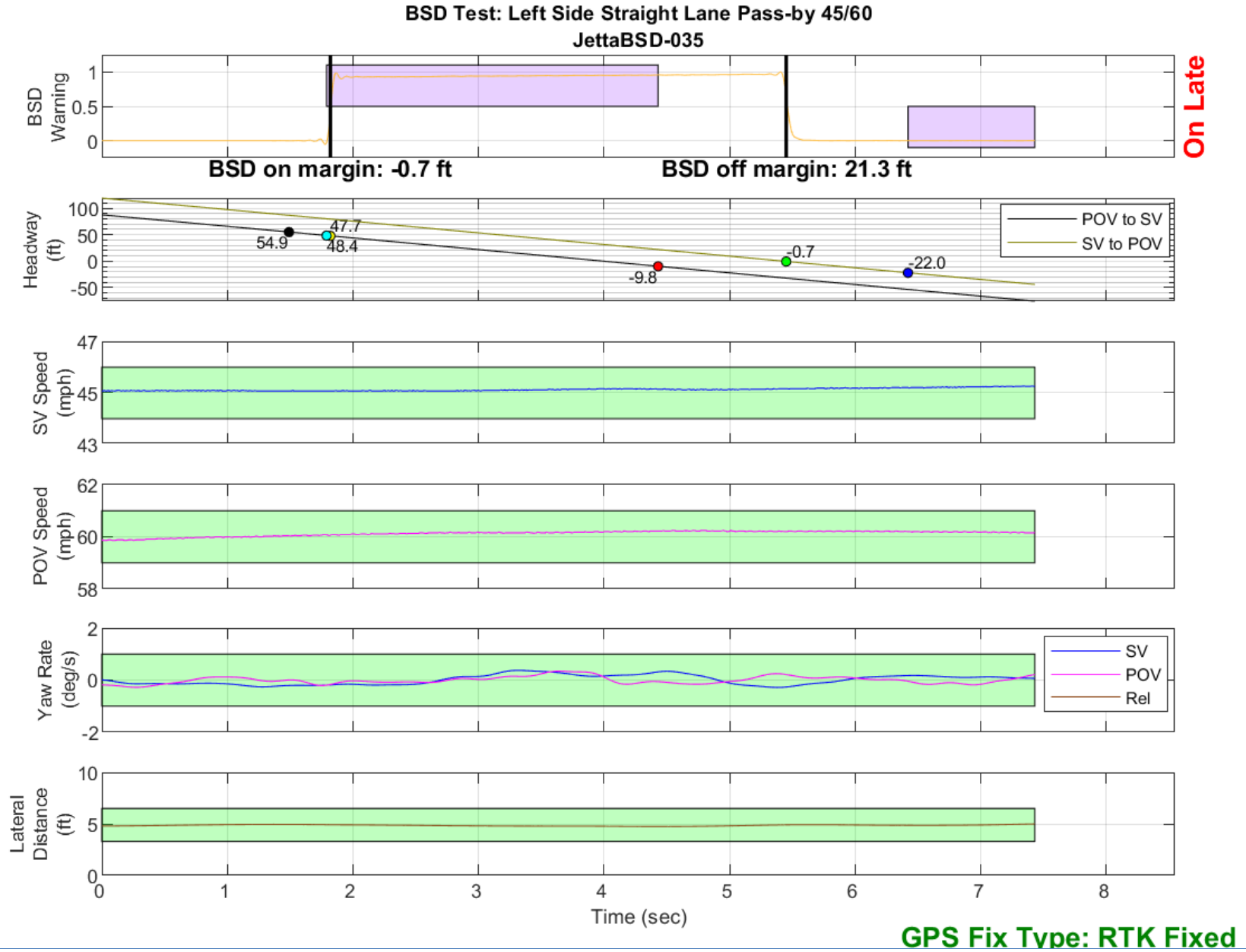

Figure D53. BSD Run 35, Straight Lane Pass-by, SV 45 mph, POV 60 mph

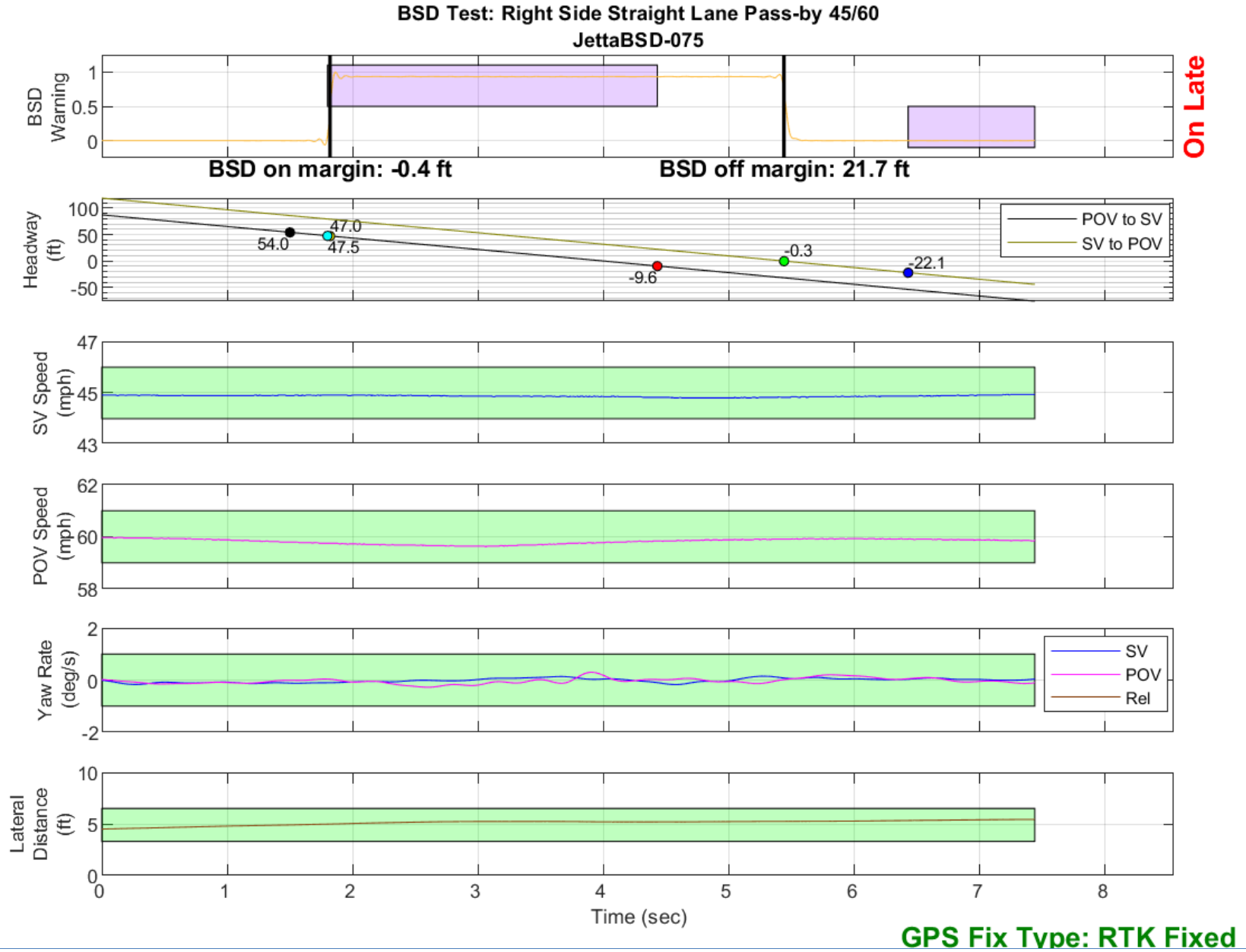

Figure D54. BSD Run 75, Straight Lane Pass-by, SV 45 mph, POV 60 mph

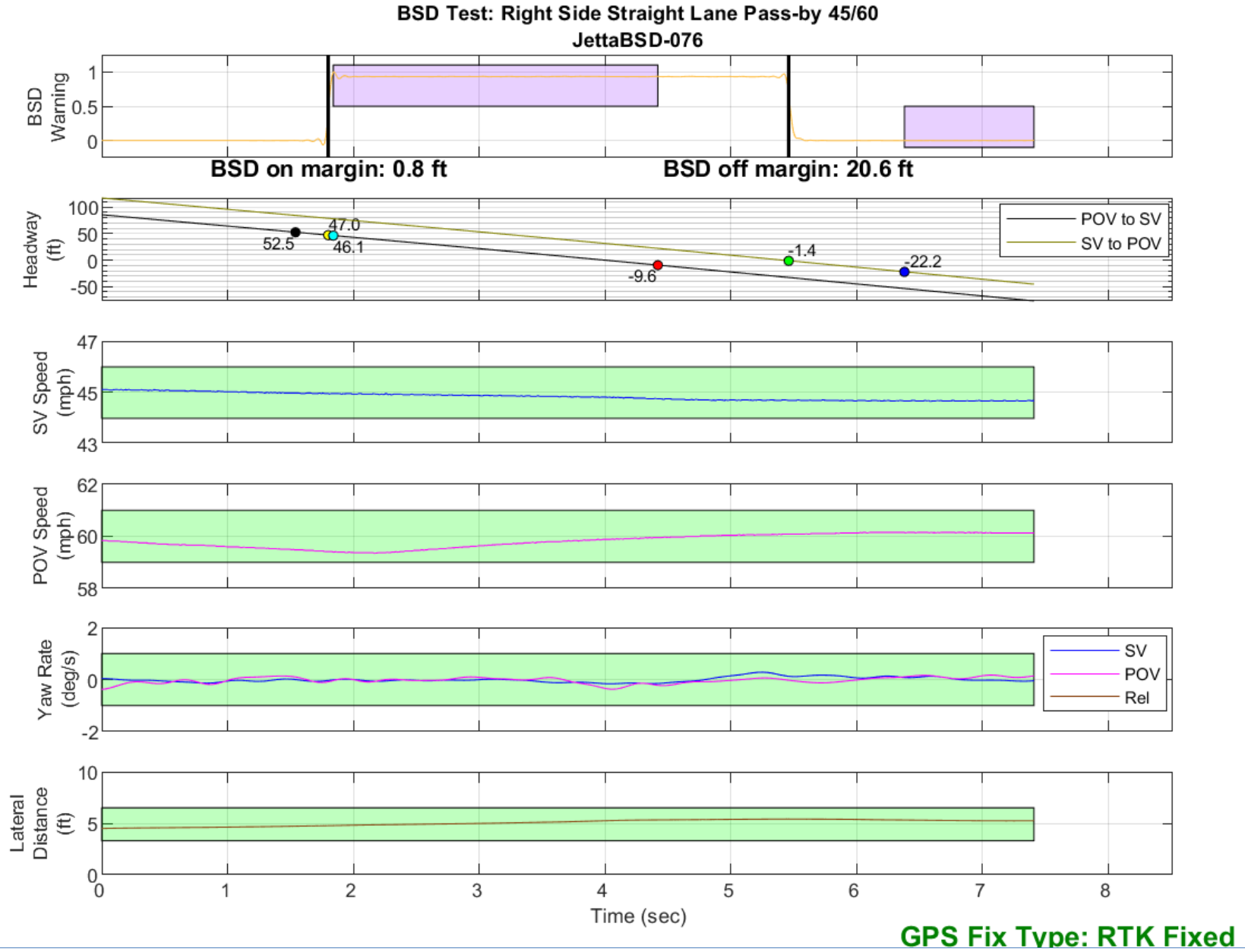

Figure D55. BSD Run 76, Straight Lane Pass-by, SV 45 mph, POV 60 mph

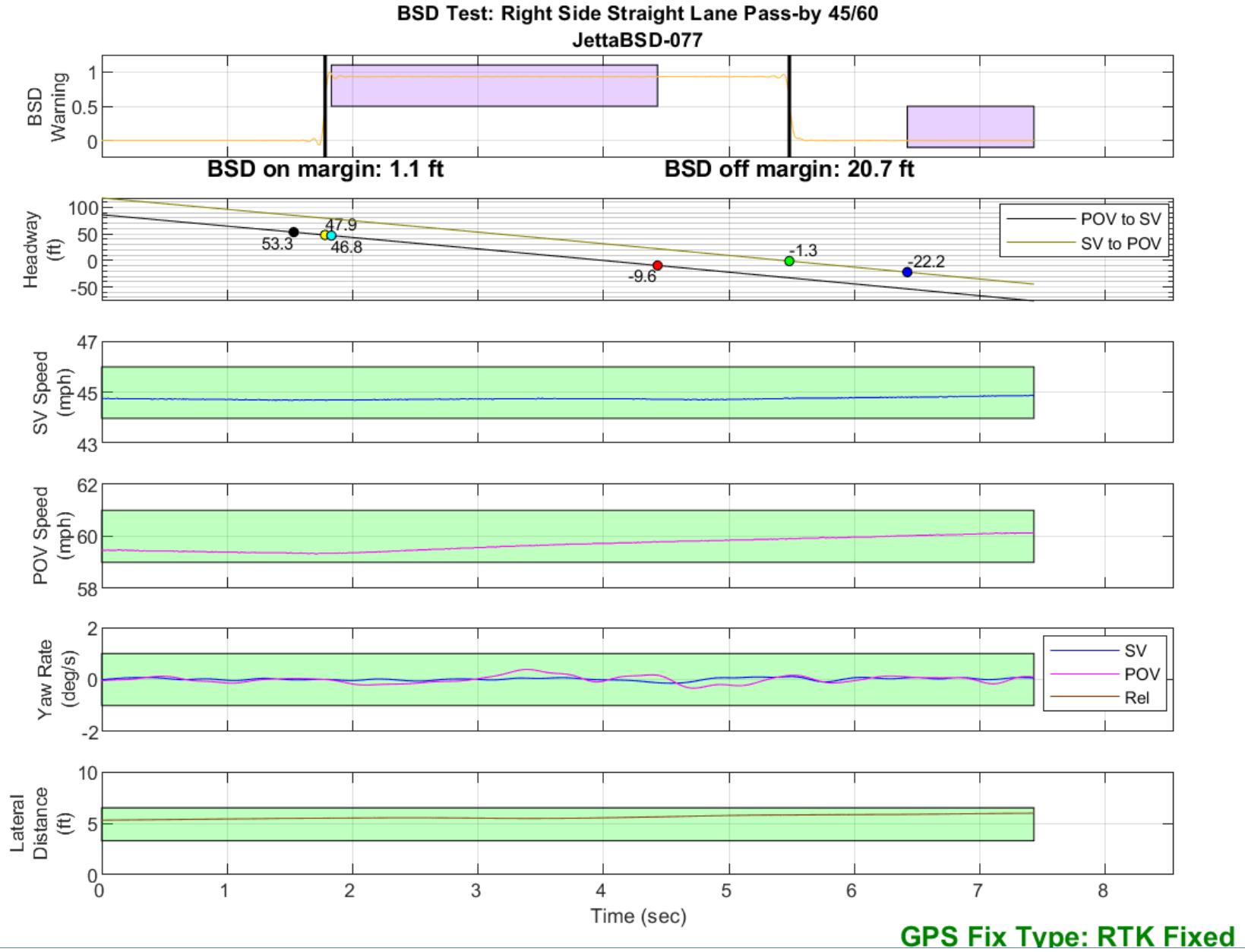

Figure D56. BSD Run 77, Straight Lane Pass-by, SV 45 mph, POV 60 mph

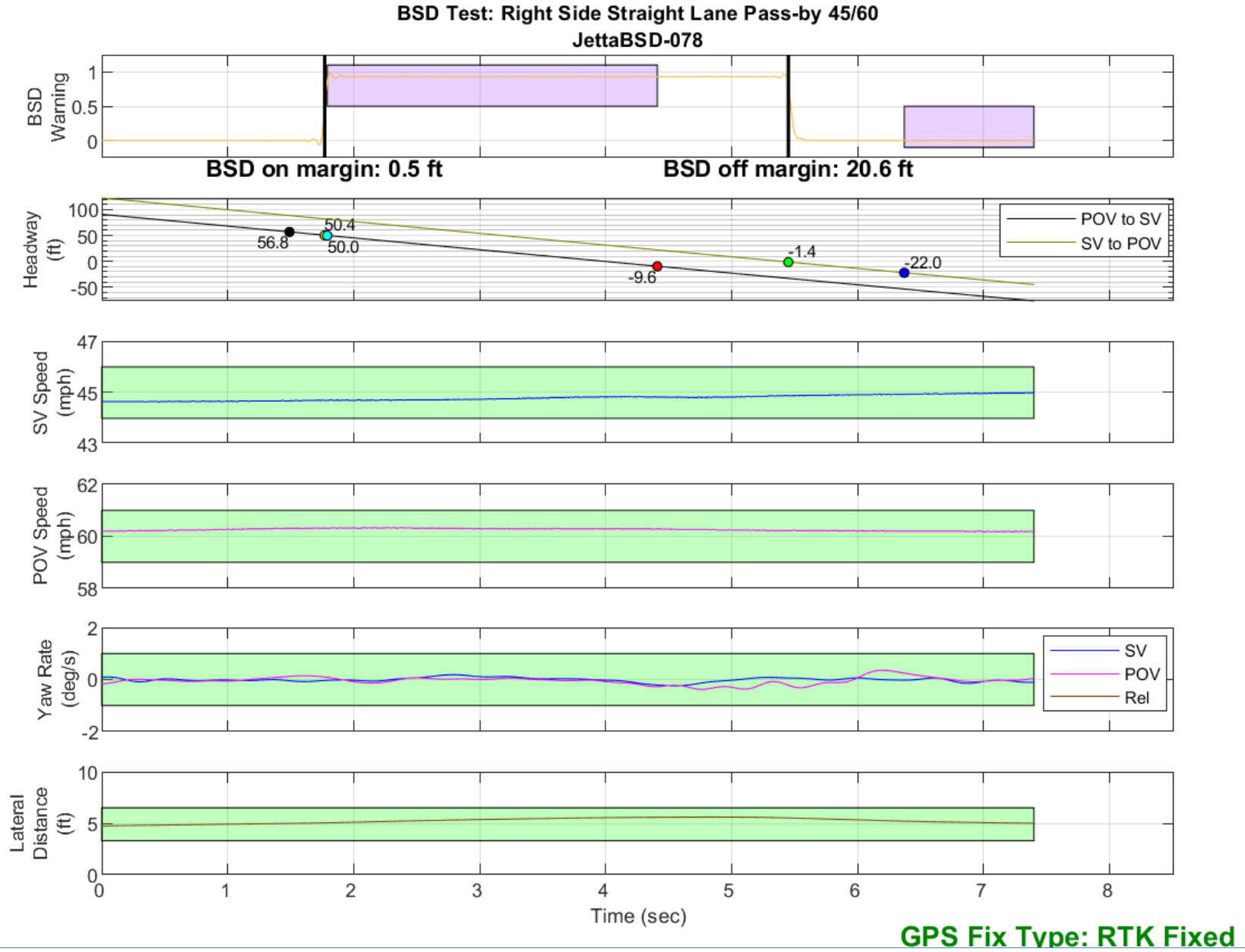

Figure D57. BSD Run 78, Straight Lane Pass-by, SV 45 mph, POV 60 mph

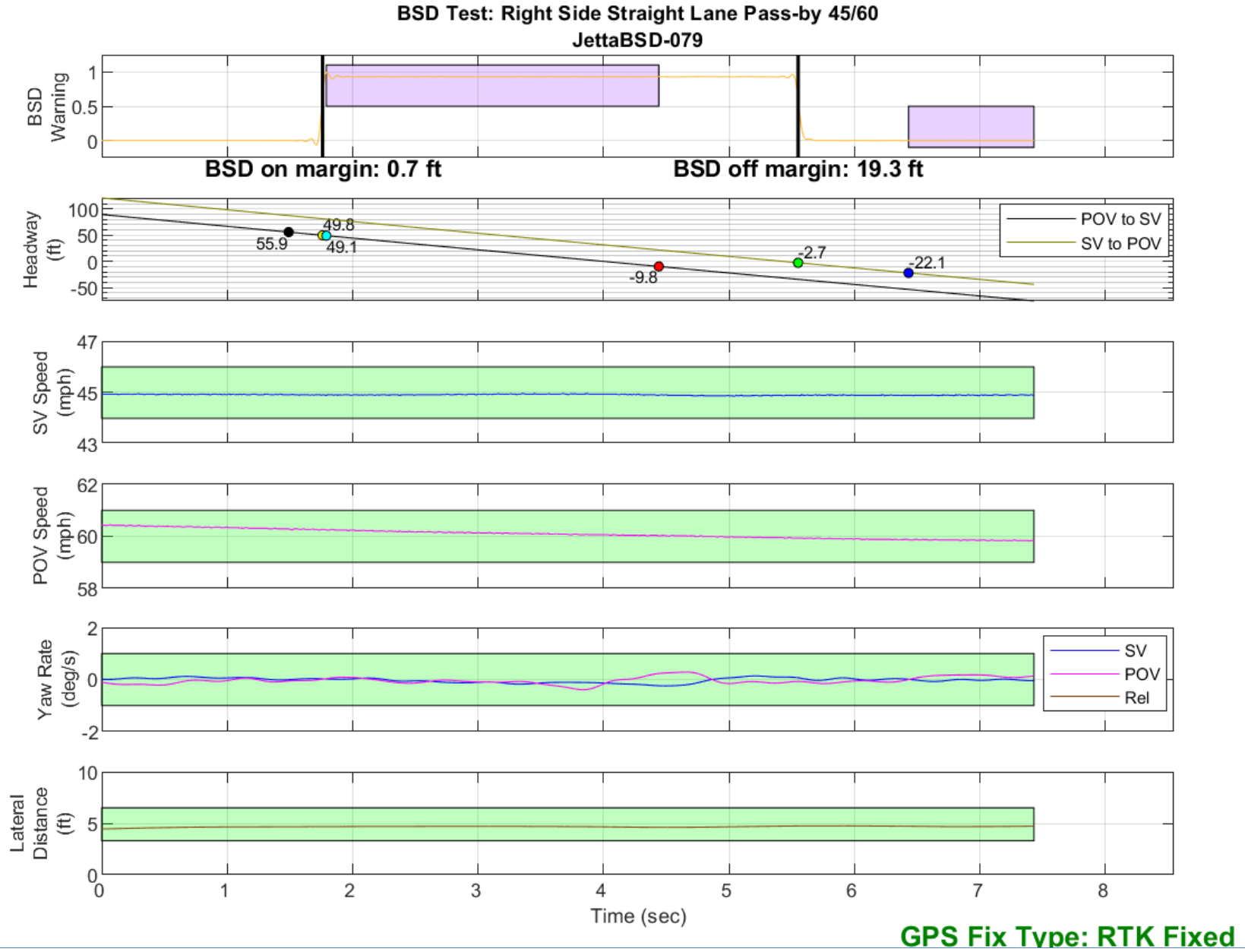

Figure D58. BSD Run 79, Straight Lane Pass-by, SV 45 mph, POV 60 mph

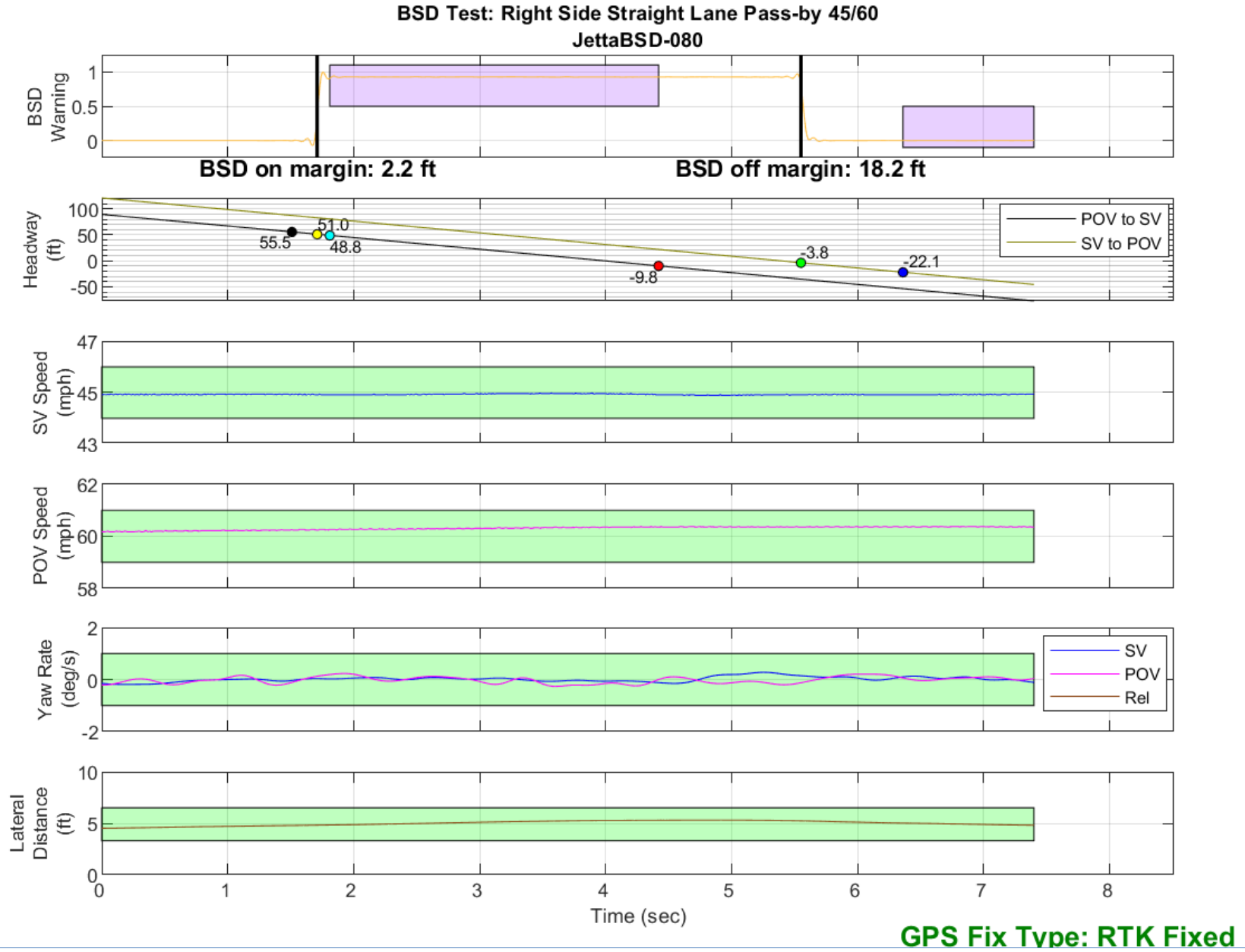

Figure D59. BSD Run 80, Straight Lane Pass-by, SV 45 mph, POV 60 mph

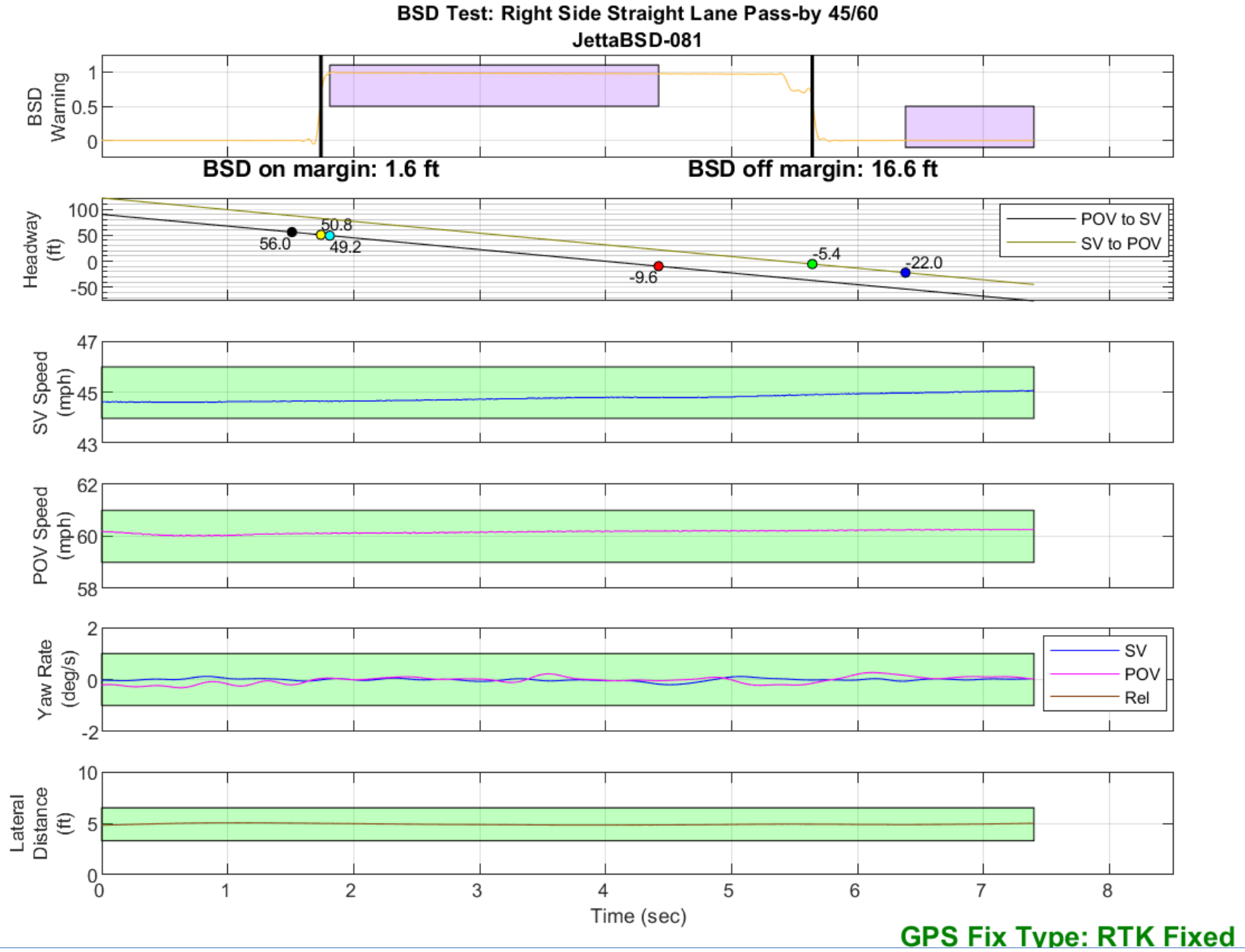

Figure D60. BSD Run 81, Straight Lane Pass-by, SV 45 mph, POV 60 mph

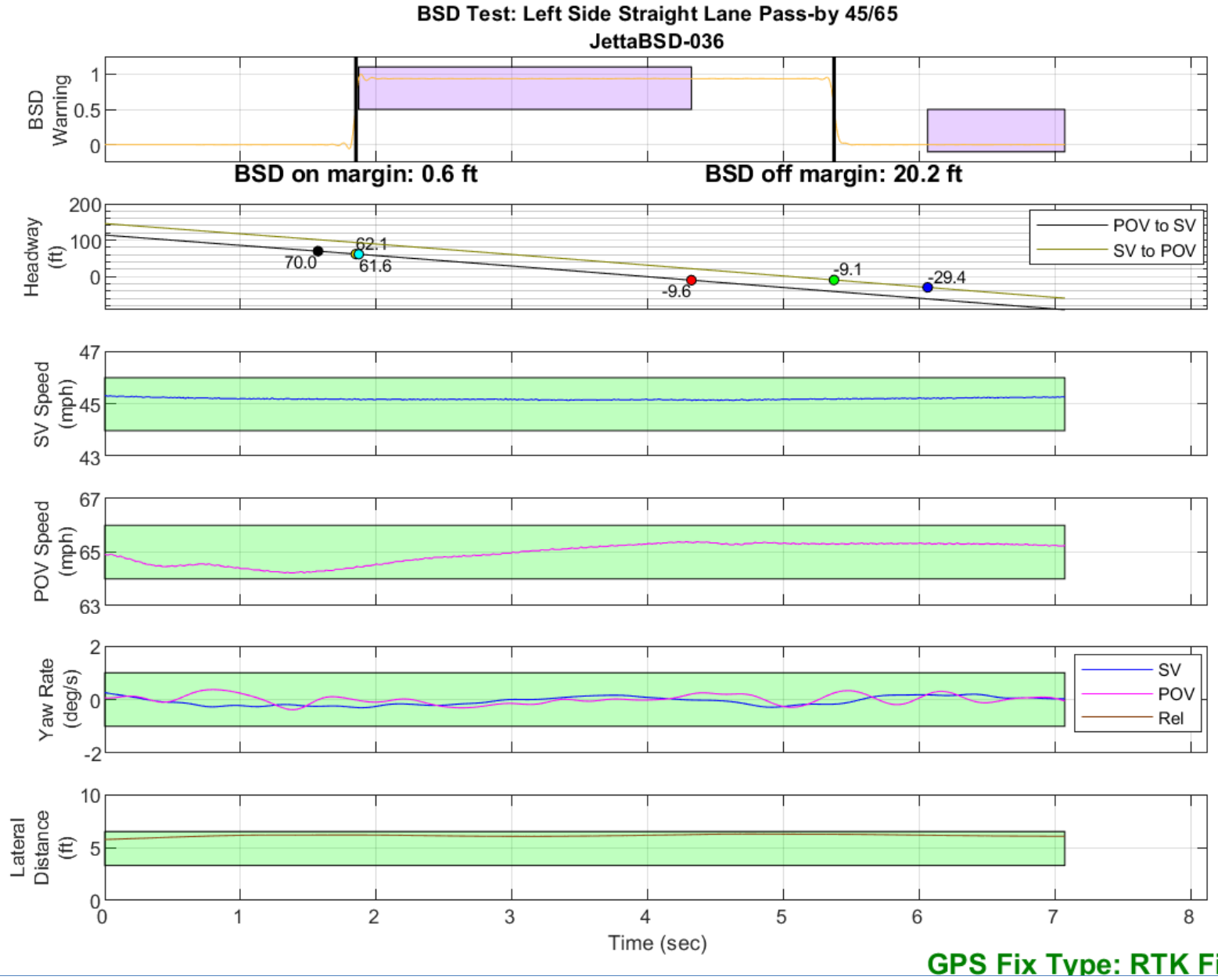

Figure D61. BSD Run 36, Straight Lane Pass-by, SV 45 mph, POV 65 mph

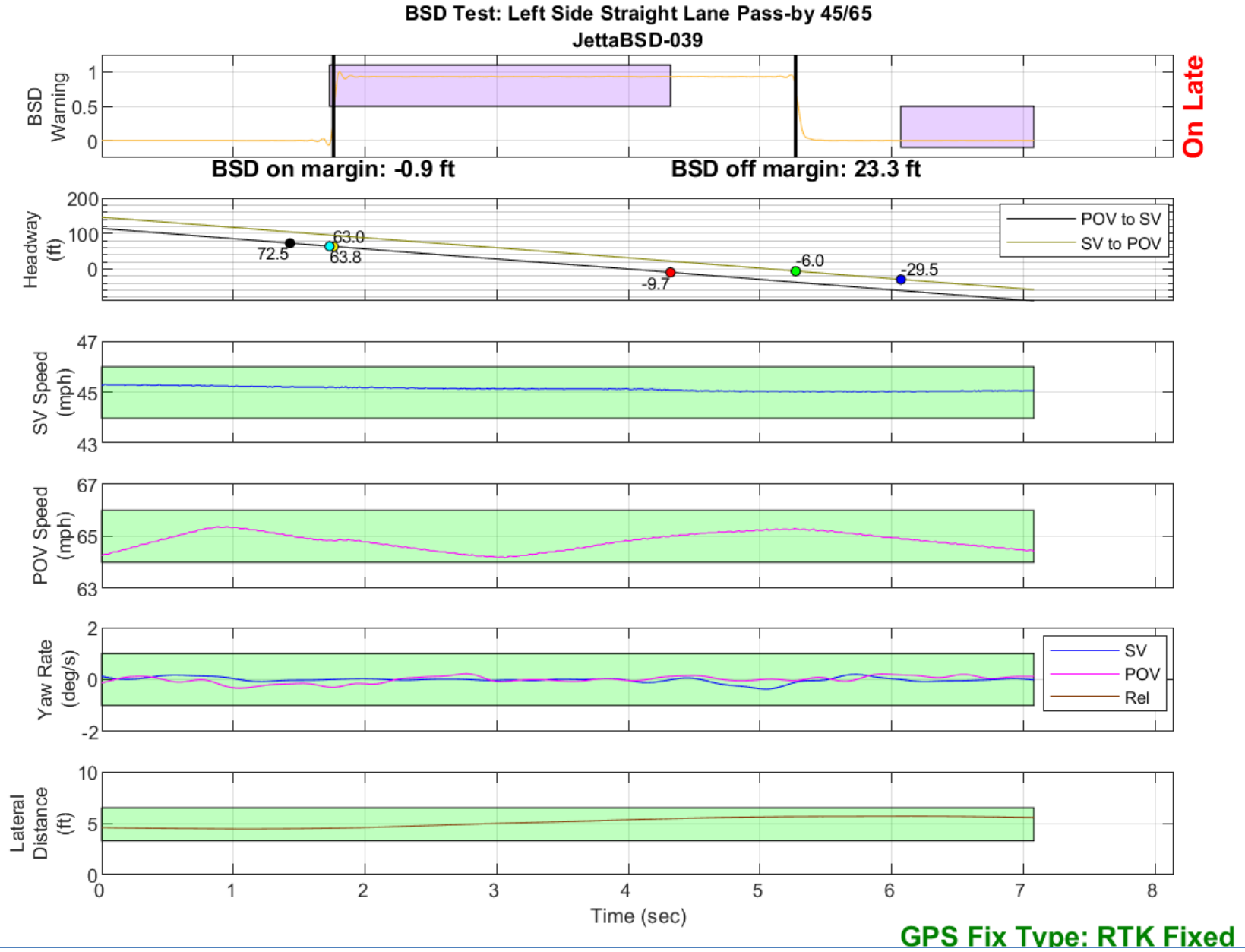

Figure D62. BSD Run 39, Straight Lane Pass-by, SV 45 mph, POV 65 mph

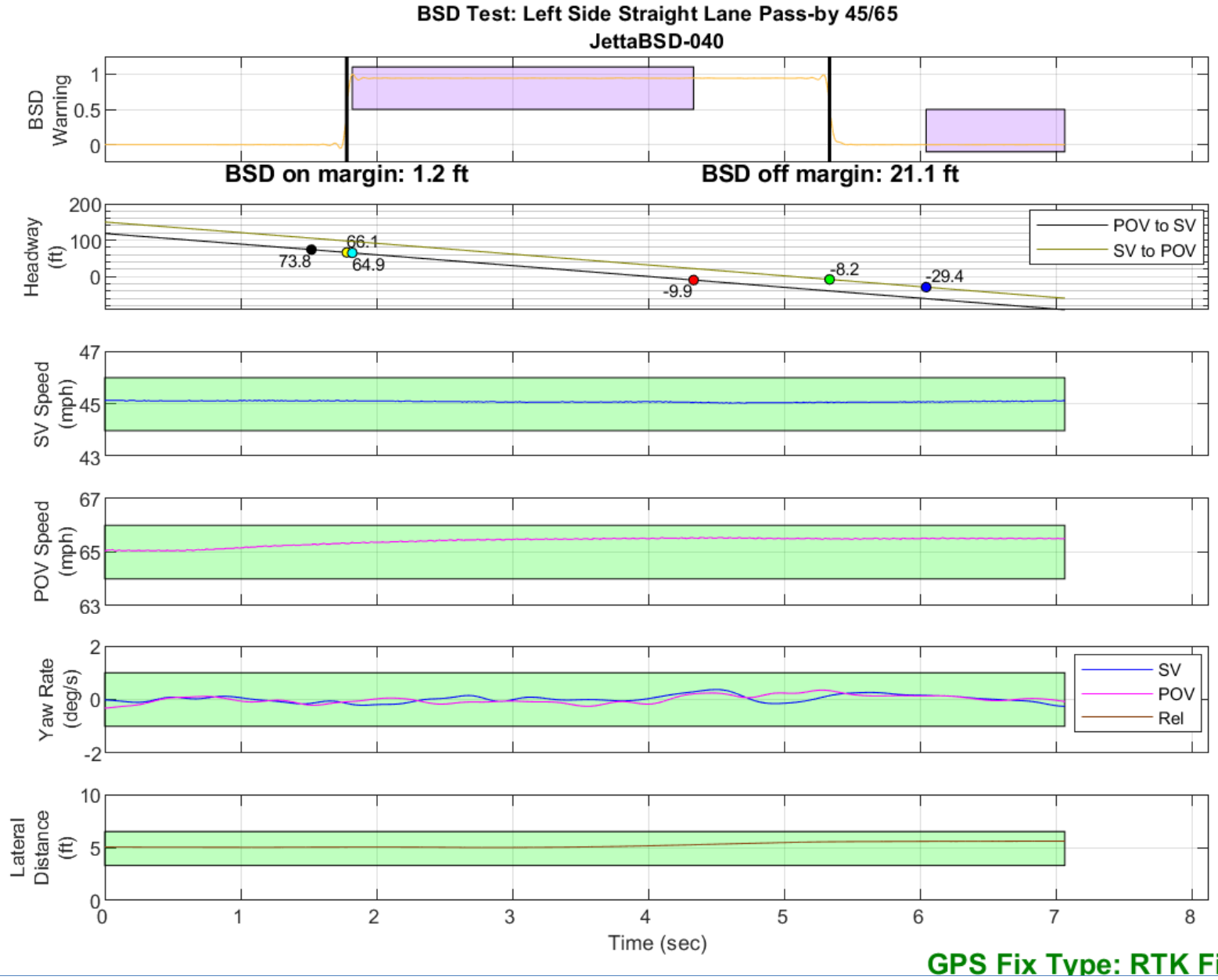

Figure D63. BSD Run 40, Straight Lane Pass-by, SV 45 mph, POV 65 mph

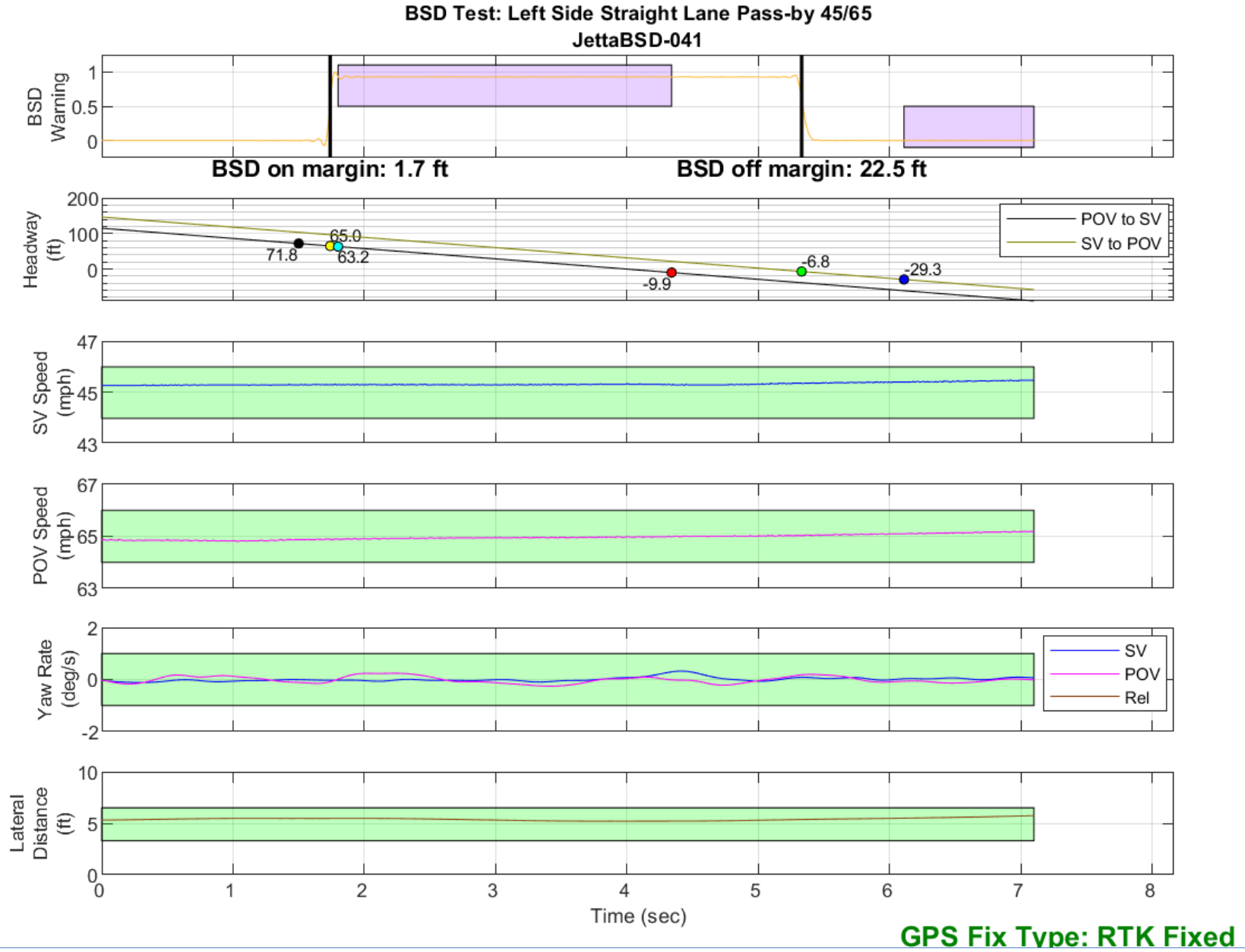

Figure D64. BSD Run 41, Straight Lane Pass-by, SV 45 mph, POV 65 mph

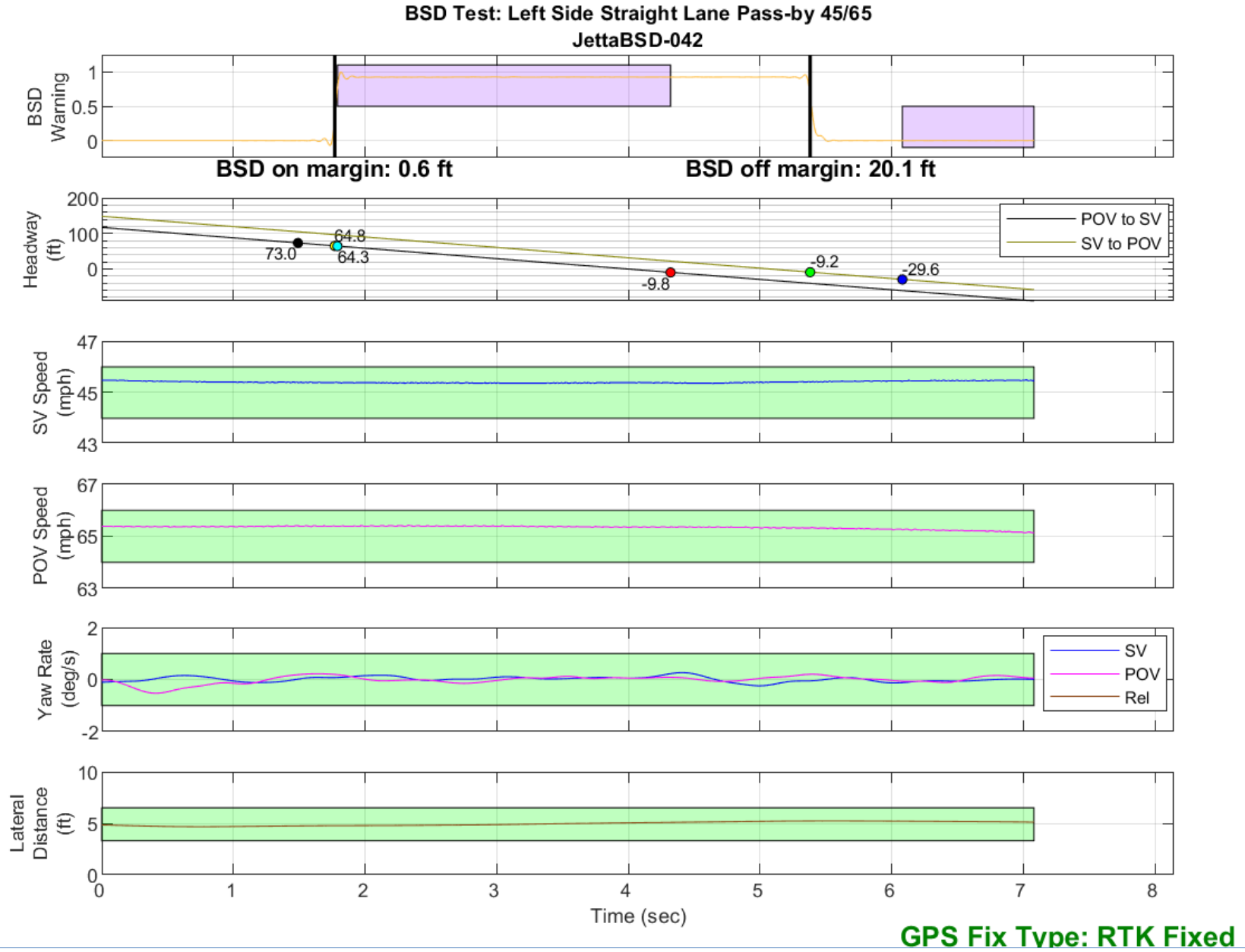

Figure D65. BSD Run 42, Straight Lane Pass-by, SV 45 mph, POV 65 mph

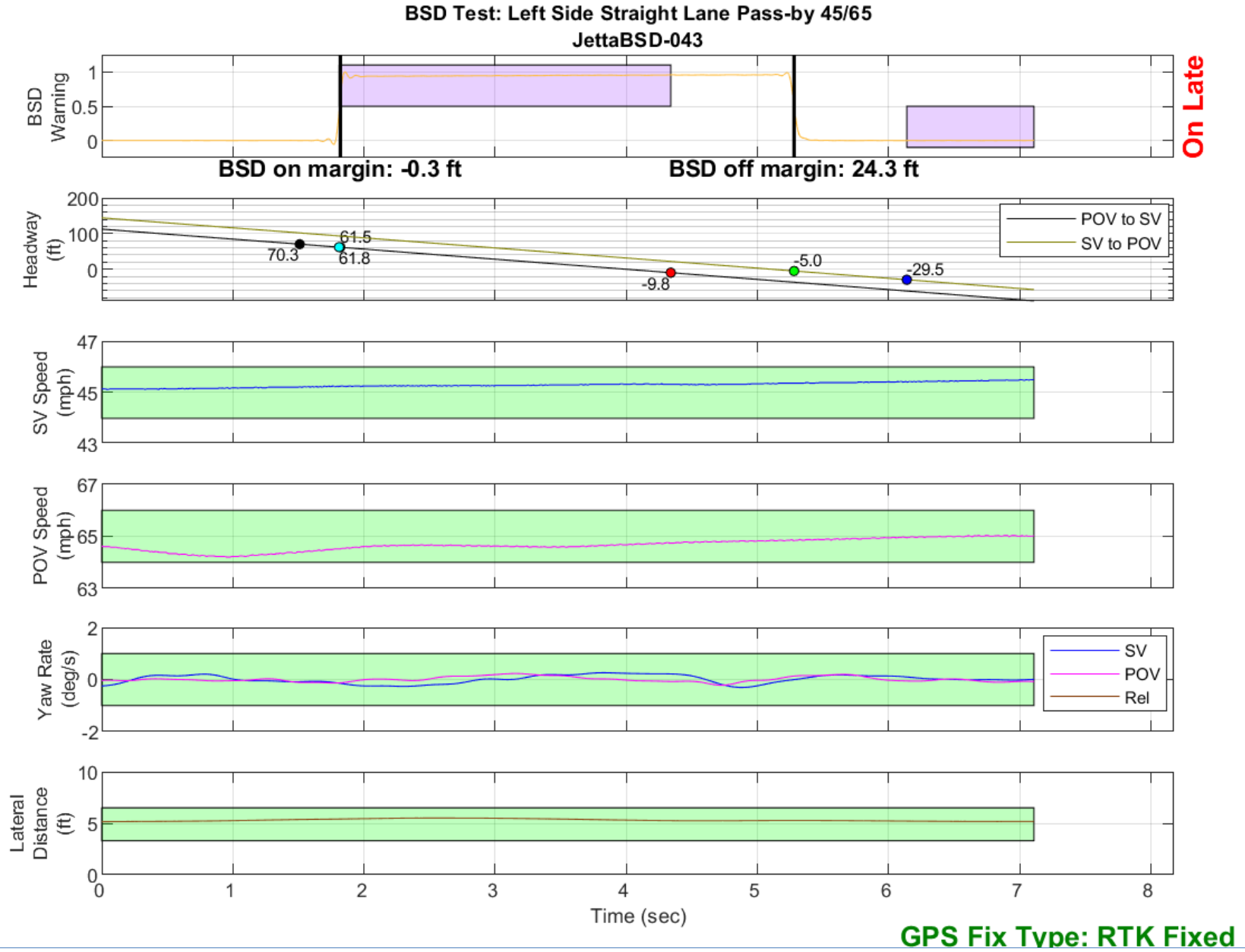

Figure D66. BSD Run 43, Straight Lane Pass-by, SV 45 mph, POV 65 mph

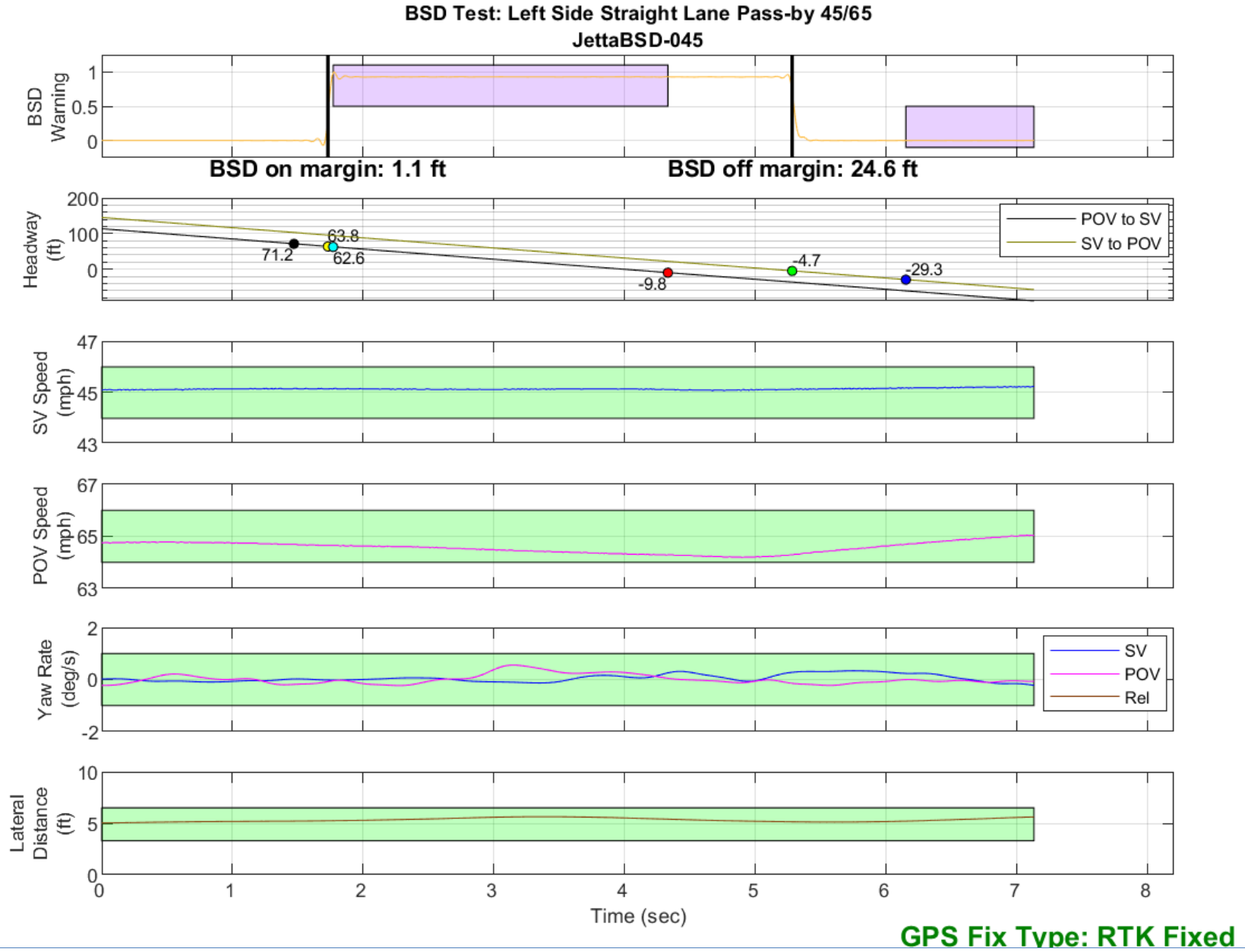

Figure D67. BSD Run 45, Straight Lane Pass-by, SV 45 mph, POV 65 mph

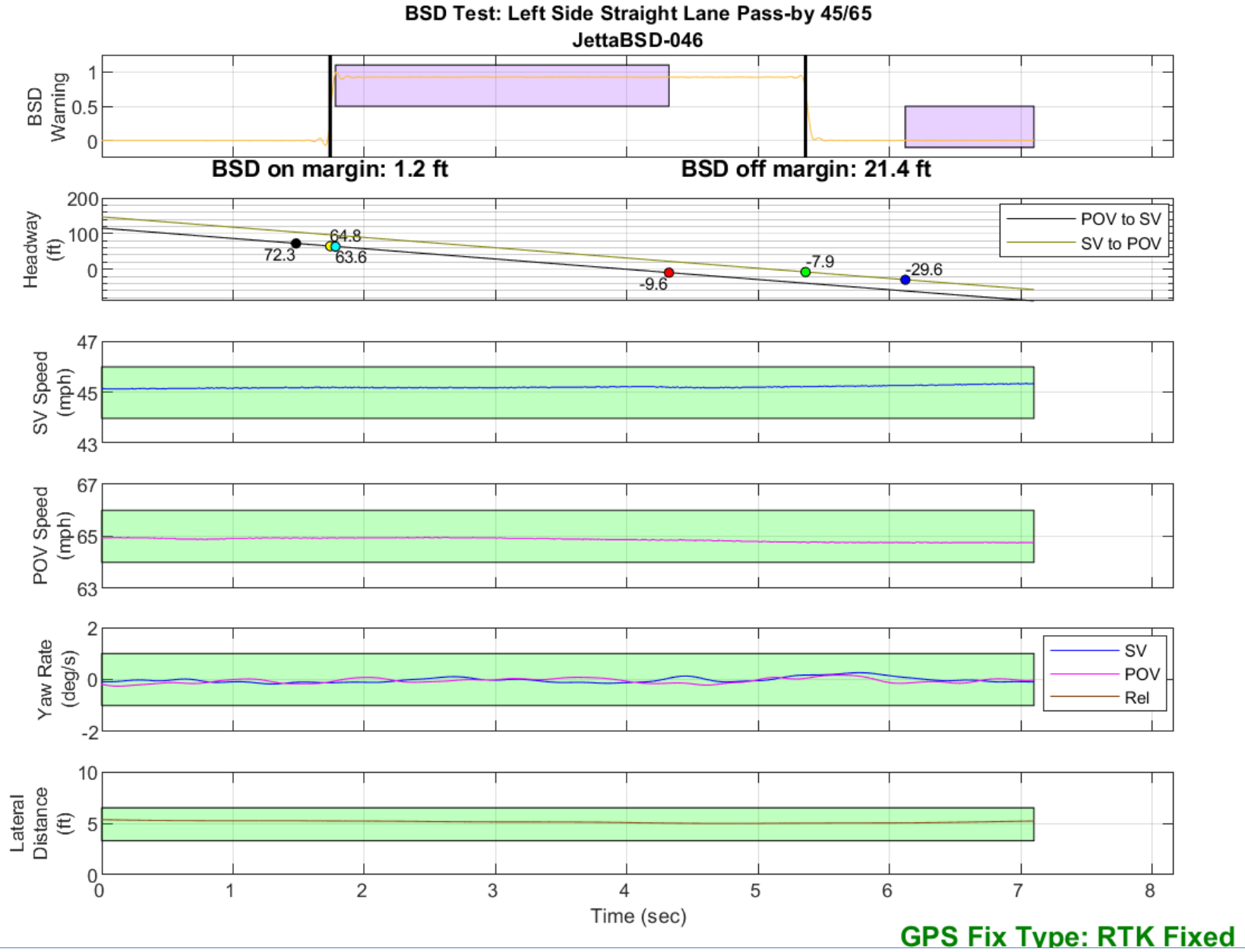

Figure D68. BSD Run 46, Straight Lane Pass-by, SV 45 mph, POV 65 mph

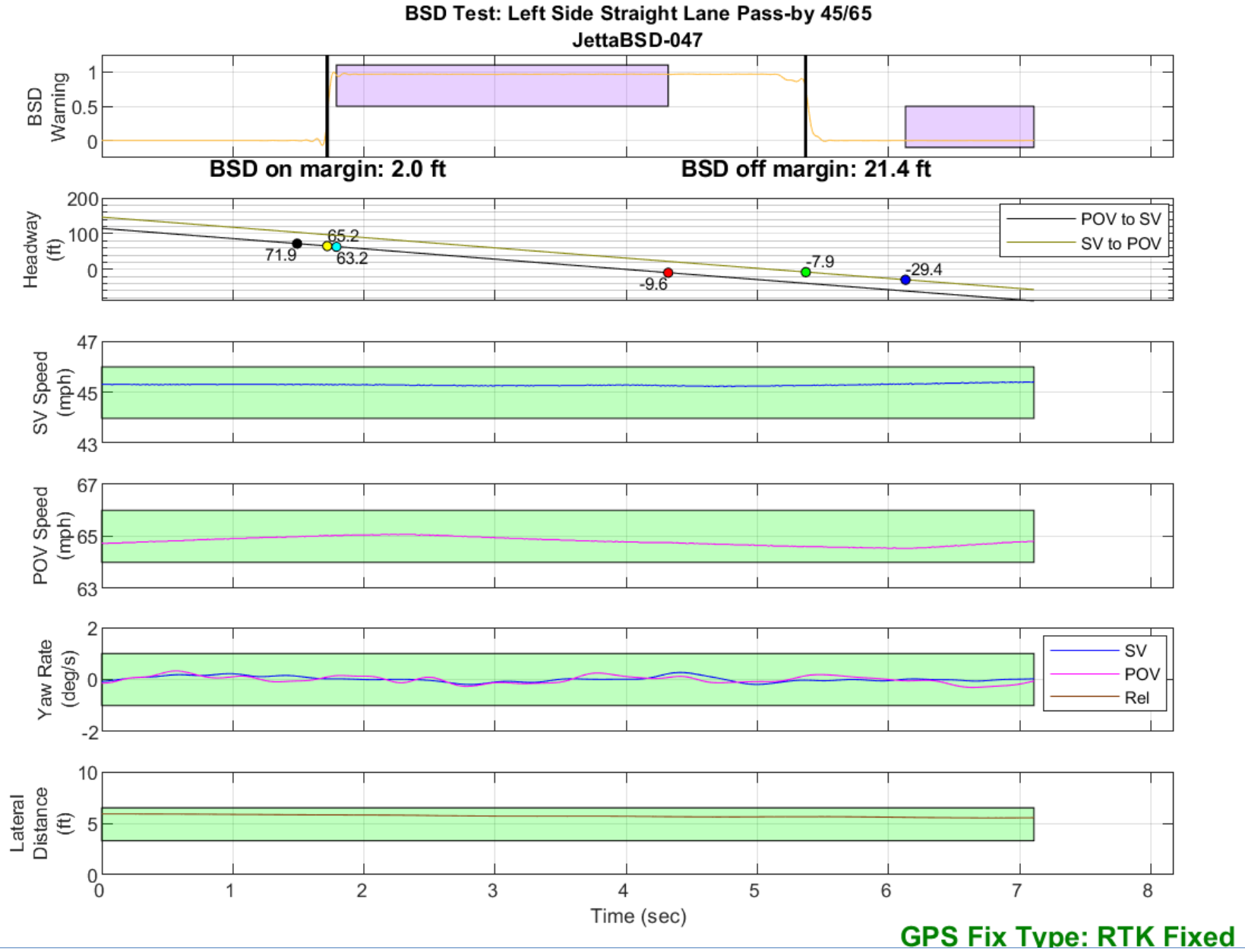

Figure D69. BSD Run 47, Straight Lane Pass-by, SV 45 mph, POV 65 mph

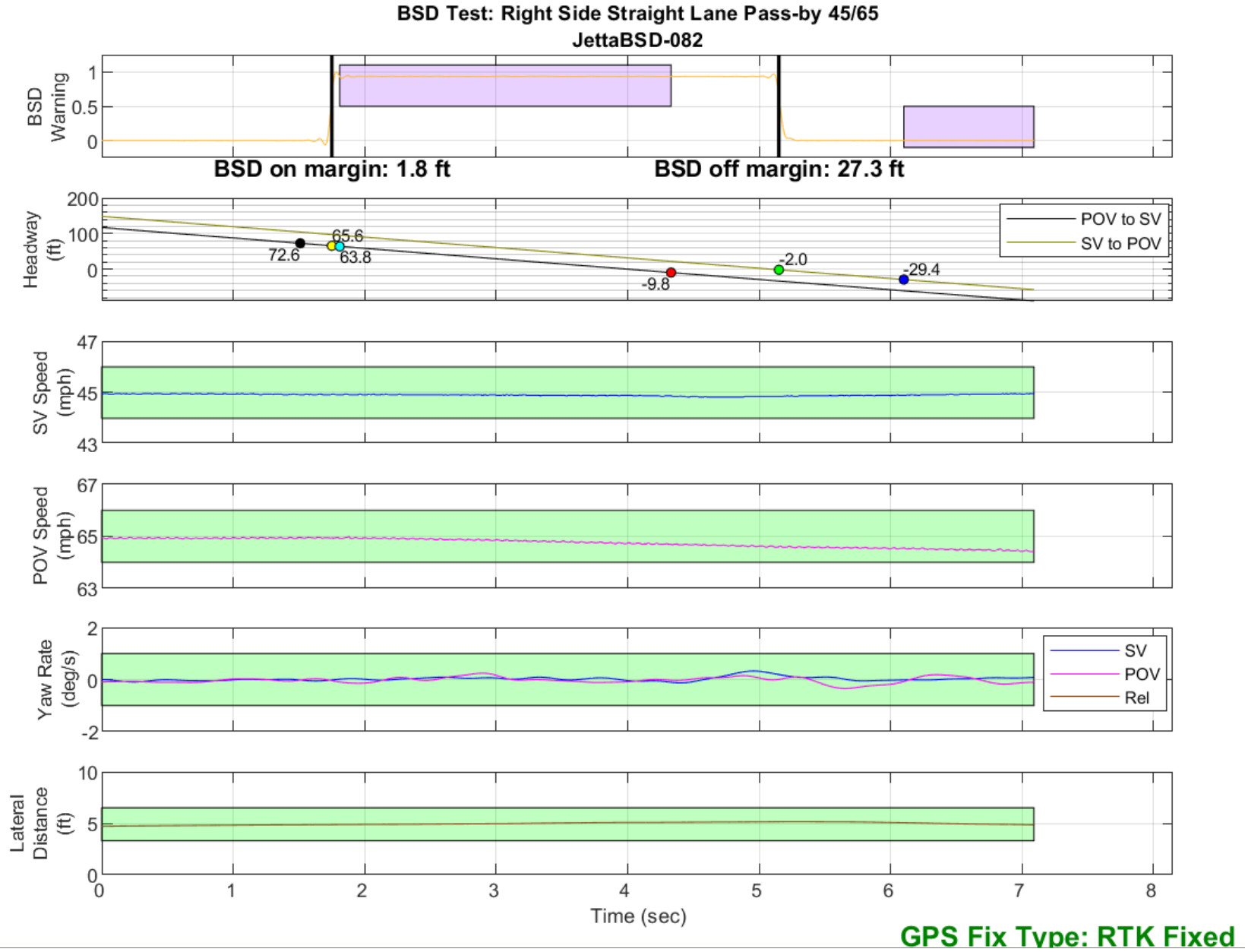

Figure D70. BSD Run 82, Straight Lane Pass-by, SV 45 mph, POV 65 mph

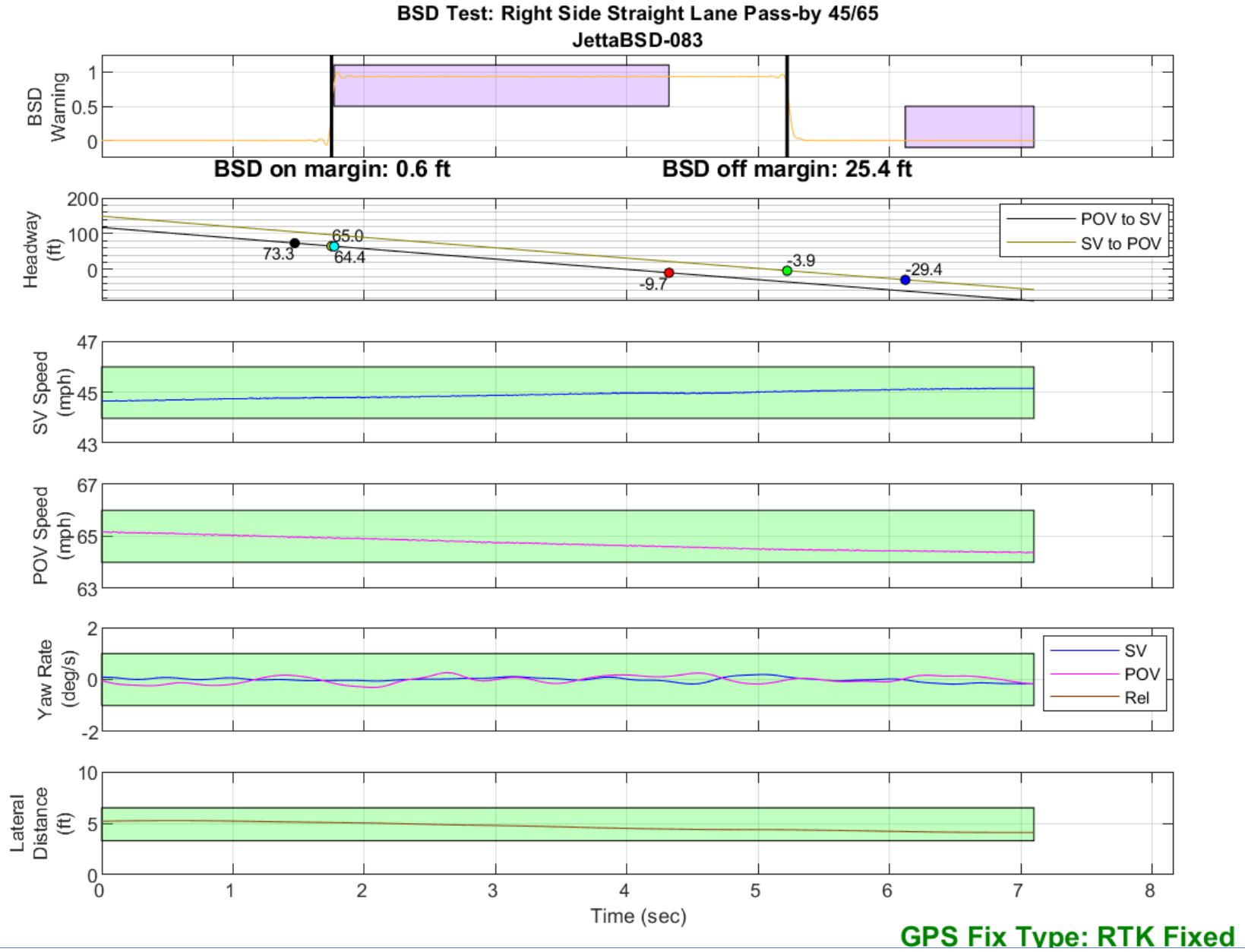

Figure D71. BSD Run 83, Straight Lane Pass-by, SV 45 mph, POV 65 mph

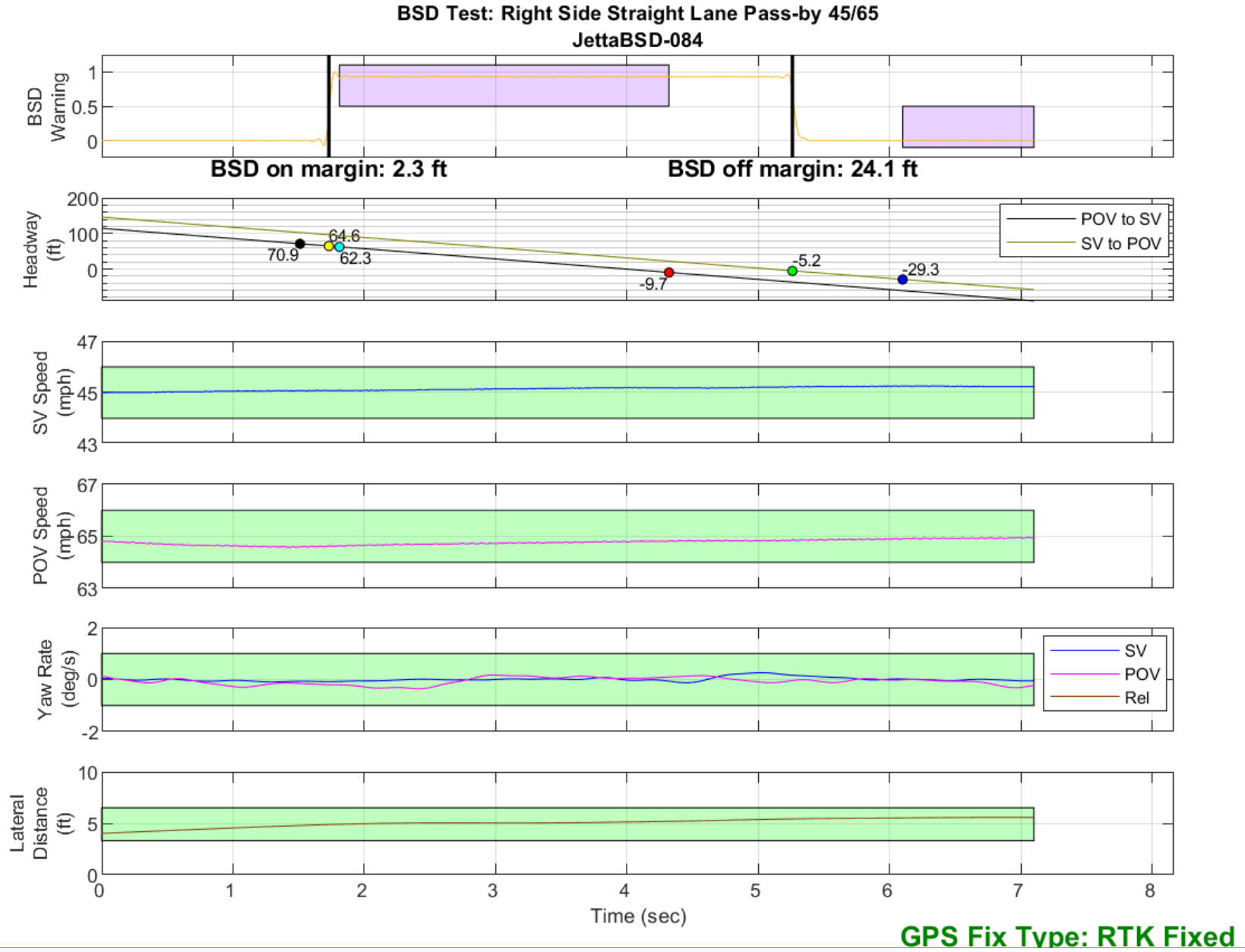

Figure D72. BSD Run 84, Straight Lane Pass-by, SV 45 mph, POV 65 mph

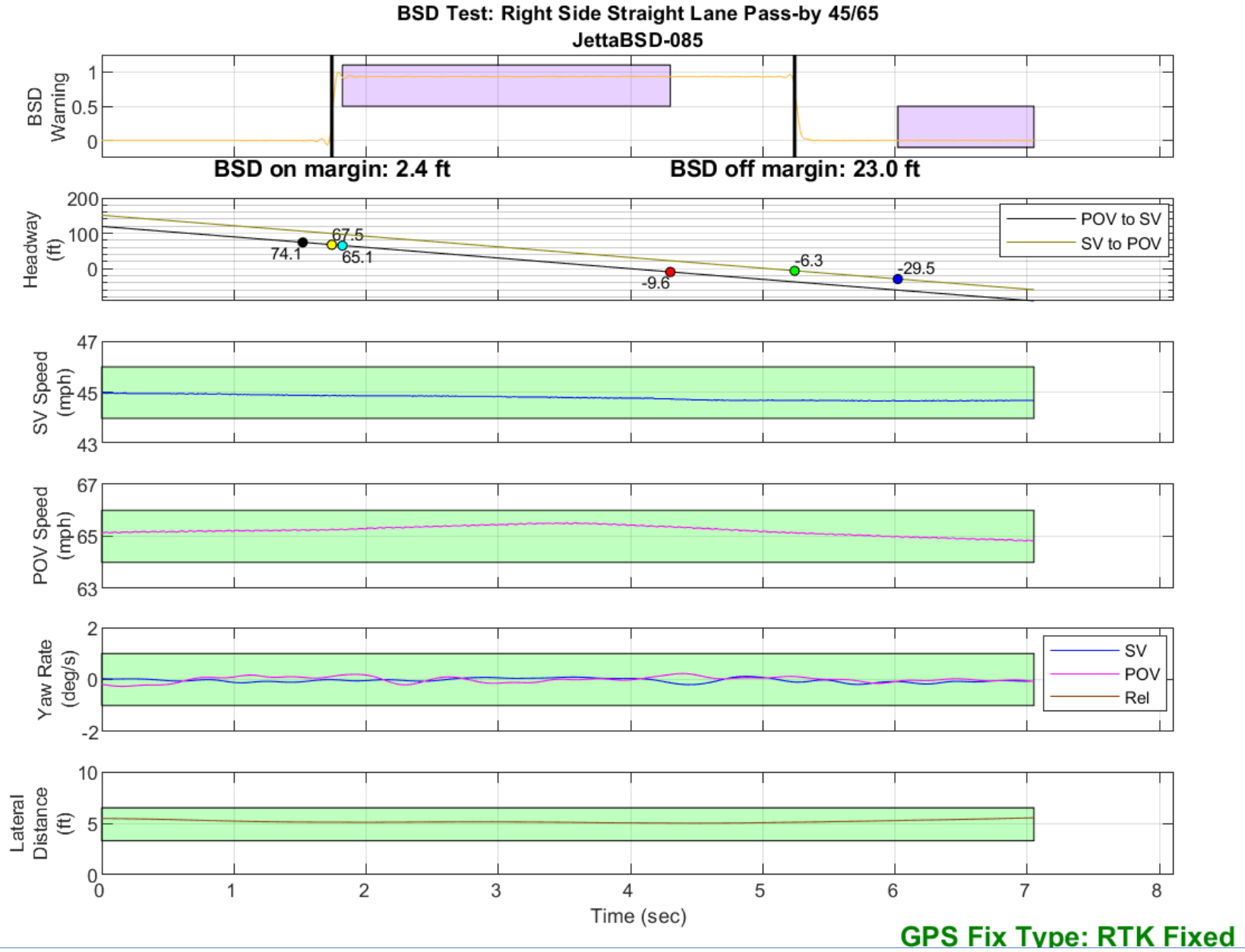

Figure D73. BSD Run 85, Straight Lane Pass-by, SV 45 mph, POV 65 mph

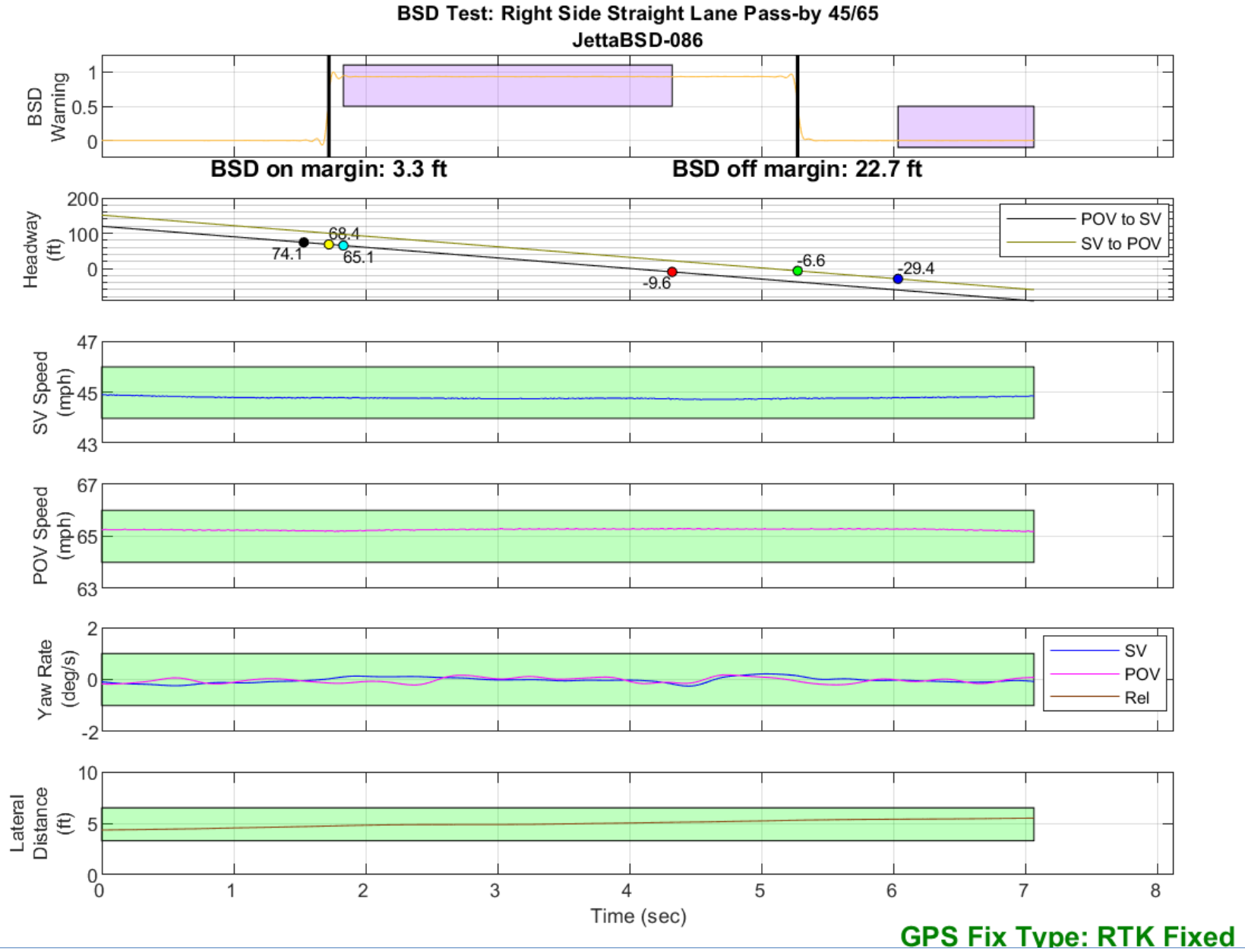

Figure D74. BSD Run 86, Straight Lane Pass-by, SV 45 mph, POV 65 mph

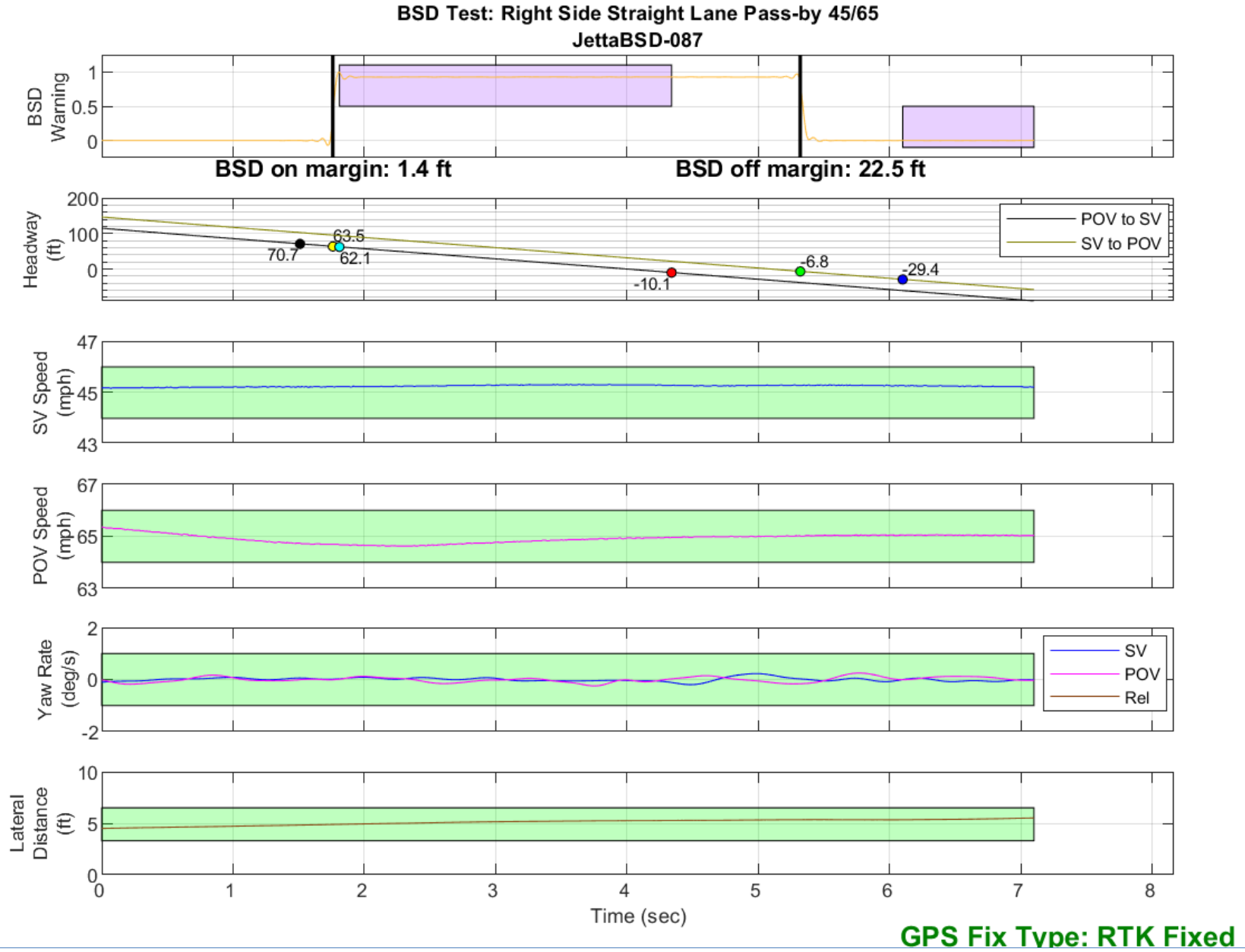

Figure D75. BSD Run 87, Straight Lane Pass-by, SV 45 mph, POV 65 mph

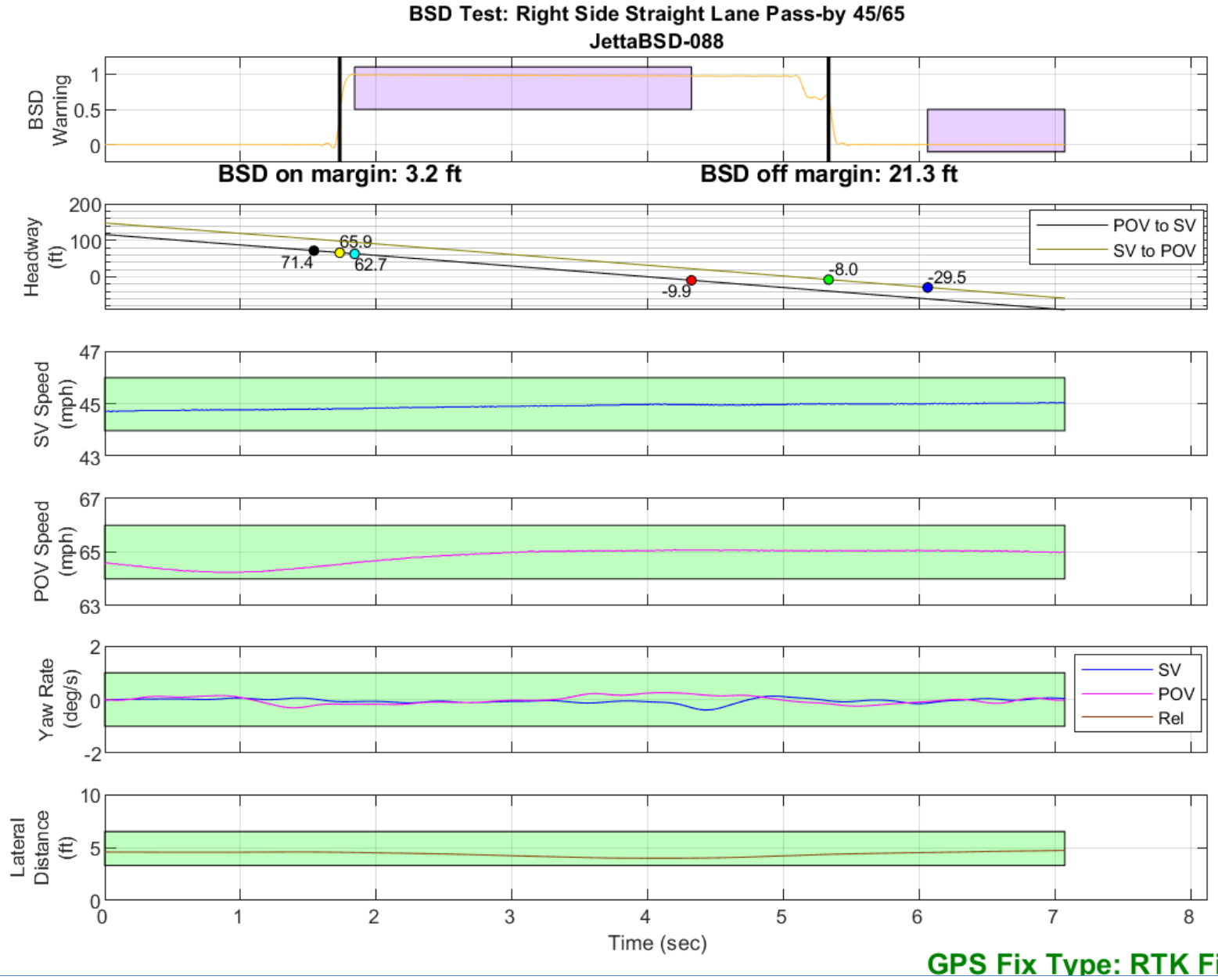

Figure D76. BSD Run 88, Straight Lane Pass-by, SV 45 mph, POV 65 mph