NCAP-KAR-DR-21-11

NEW CAR ASSESSMENT PROGRAM (NCAP)

DYNAMIC ROLLOVER RESISTANCE TEST

VOLKSWAGEN AG GERMANY

2021 VOLKSWAGEN ID.4 BEV RWD 5-DOOR MPV

PREPARED BY:

APPLUS IDIADA KARCO ENGINEERING, LLC.

9270 HOLLY ROAD

ADELANTO, CA 92301

JUNE 23, 2021

FINAL REPORT

PREPARED FOR:

U.S. DEPARTMENT OF TRANSPORTATION

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

NEW CAR ASSESSMENT PROGRAM

MAIL CODE: NRM-110

1200 NEW JERSEY AVE, SE

WASHINGTON, D.C. 20590

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15. Supplementary Notes			
16. Abstract An NCAP Dynamic Rollover Maneuver (Fishhook) Test was conducted on a 2021 Volkswagen ID.4 BEV RWD 5-Door MPV by Applus+ IDIADA KARCO Engineering, LLC. on June 16, 2021. The vehicle did not experience two-wheel lift. The vehicle's steering angle at 0.3 g lateral acceleration at 50 mph was 25.9 degrees.			
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SECTION I
INTRODUCTION

The National Highway Traffic Safety Administration (NHTSA) has engaged Applus+ IDIADA KARCO Engineering, LLC to conduct dynamic rollover testing and gather data from that testing as part of NHTSA's New Car Assessment Program (NCAP).

The purpose of the testing reported herein was to determine if a 2021 Volkswagen ID.4 BEV RWD 5-Door MPV would experience tip-up, defined as simultaneous two-wheel lift of two inches or more at an entry speed of 50 mph or less in the Dynamic Rollover Test Procedure developed by NHTSA. This procedure may be found at www.regulations.gov, docket item NHTSA-2006-26555-0136.

The testing reported herein was accomplished under contract 693JJ920D000011.

SECTION II
VEHICLE PREPARATION

A. TEST VEHICLE

The test vehicle was new or in as-new condition, meaning the vehicle had been driven no more than 500 miles prior to the start of dynamic rollover testing. It was acquired through a commercial rental/leasing company. Details of the test vehicle are given in Table 1.

B. TIRES

All tires used were new, and of the same make, model, size, and DOT specification of those installed on the vehicle when purchased new. Tire inflation pressures were in accordance with the recommendations indicated on each vehicle's identification placard. To further reduce the possibility of tire debeading, the tires were mounted to the rims without the use of tire mounting lubricant. Tire specifications are listed in Table 2.

C. VEHICLE LOADING

The multi-passenger load, described in the Fishhook Procedure, was used for all tests. The load and positioning of the load in the vehicle are listed in Table 3.

In addition to water dummies, the loading included instrumentation, a steering machine, and outriggers. Test vehicle bumper assemblies were removed for outrigger installation. The reduction in vehicle weight due to the removal of the bumpers was offset by the additional weight of the outriggers and their mounting system. The outrigger system typically outweighs the bumper assemblies.

Table 1. Test Vehicle Data

General Data					
Model year, make, model	2021 Volkswagen ID.4 BEV				
VIN	WVGRMPE29MP02xxxx				
Body style	MPV				
Number of doors	5				
Trim level	-				
Seating positions	Front:	2nd row	3rd row	4th row	5th row
	2	3			
Electronic stability control	Yes				
4-Wheel ABS (Yes/No)	Yes				
Power steering (Yes/No)	Yes				
Major optional equipment	-				
Odometer at start of testing	60 miles				
Drivetrain					
Engine cylinder arrangement	N/A				
Engine displacement	N/A				
Transmission type	Automatic				
Drive arrangement	RWD				
Chassis					
Track width	F: 66.3 in (1685 mm), R: 65.2 in (1655 mm)				
Wheelbase	109.0 in (2770 mm)				
Curb weight	4593 lb (2083.5 kg)				
Certification Data from Vehicle's Label					
Vehicle manufactured by	Volkswagen AG Germany				
Date of manufacture	03/21				
GVWR	5644 lb (2560 kg)				
GAWR Front	2491 lb (1130 kg)				
GAWR Rear	3263 lb (1480 kg)				

Table 2. Tire Information

Tire Manufacturer	Hankook
Tire Model	Kinergy AS x EV
Tire Size	Front: 235/55R19 Rear: 255/50R19
Load rating	Front: 105 Rear: 107
Speed rating	Front: T Rear: T
Treadwear grade	Front: 500 Rear: 500
Traction grade	Front: A Rear: A
Temperature grade	Front: A Rear: A
Location of “Recommended Tire Pressure” label	Driver’s door jamb
Recommended cold tire pressure	Front: 42 psi, (290 kPa) Rear: 42 psi, (290 kPa)
DOT code (8 last digits)	Front: 9UH0 2220 Rear: 9UH0 4120

Table 3. Vehicle Loading

Water dummy and other loading	Multi-Passenger Configuration 3 water dummies in second row
Water dummy weight	132 lb (60 kg)
Fuel level	N/A
Weight as Tested	
Left front	1251 lb (567.5 kg)
Right front	1274 lb (578.0 kg)
Left rear	1367 lb (620.0 kg)
Right rear	1311 lb (594.5 kg)
Total weight	5203 lb (2360.0 kg)

D. STEERING CONTROLLER

Precise steering control is accomplished using a steering machine designed and constructed by ABD. It can provide up to 45 ft-lb torque and at rates over 1000 deg/sec. The integrated angle encoder has an unlimited range with a resolution of 0.25 degrees and an accuracy of ±0.25 degrees. The steering motor is controlled by RC8 software from ABD, which also acts as the data acquisition system.

E. REAL-TIME CONTROLLER AND DATA ACQUISITION

Data acquisition is achieved using a MOSES Meas X, which also serves as the real-time system for the steering controller. Data from the OXTS, 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 MOSES MeasX. The Oxford IMUs are calibrated per the manufacturer's recommended schedule (Table 5).

Two video cameras were used to record the Fishhook runs. They were positioned nominally as shown in Figure 1. The recorded video was reviewed after the Fishhook runs to check for any two-wheel lift. If any two-wheel lift was observed, four infrared distance measuring sensors for measurement of wheel lift (two sensors at each wheel) were then mounted for use in subsequent confirmation Fishhook tests.

F. EQUIPMENT WEIGHT

Table 4 lists the equipment and associated weights outlined in the NHTSA Laboratory Test Procedure for Dynamic Rollover and the equipment at Applus+ IDIADA KARCO Engineering, LLC used for this specific test program.

Table 4. Weight of In-Cab Test Equipment

Equipment	Location	Equipment Weight (lb)	
		NHTSA*	IDIADA
Data Acquisition System	Front passenger seat	58	35
GPS Inertial unit	At the chassis in a flat and rigid surface		7
Steering Machine	Handwheel	31	51
Steering Machine Electronics Box	Passenger row foot well behind the front passenger seat. If vehicle does not have a rear passenger row foot well, the Electronics Box should be placed in the front passenger seat footwell.	39	39
	Total	**128**	**132**

* Table A.1 from US DOT NHTSA - Laboratory Test Procedure for Dynamic Rollover - The Fishhook Maneuver Test Procedure - New Car Assessment Program (NCAP) - March 2013

G. SENSORS

A list of the sensors is given in Table 5.

H. OTHER VEHICLE PREPARATION

In addition to installation and preparation discussed above, the test vehicle was prepared as follows:

- Front and rear bumpers were removed.
- Outrigger mounts were installed in the bumper locations and titanium outriggers were fastened to these mounts.
- Airbags were removed or otherwise disabled.

Photographs of the vehicle tested are given in Appendix A.

Table 5. Sensor Specifications

Type	Measured Variable	Sensor	Range	Resolution	Accuracy	Specifics	Serial Number	Calibration	Unit
Multi-Axis Inertial Sensing System *Distance Measuring System* *Radar Speed Sensor* *Data Flag (Roll Rate Flag)*	Longitudinal speed Lateral speed Longitudinal acc. Lateral acc. Roll angle Pitch angle Yaw angle Roll rate Pitch rate Yaw rate	GPS inertial unit	- - ±100 ±100 ±100 ±100 ±100 ±100 ±100 ±100	0.01 º/s 0.01 m/s2	±0.1 ±0.1 ±0.1 ±0.1 ±0.05 ±0.05 ±0.1 ±0.1 ±0.1 ±0.1	OXTS (RT)	1611	By: IDIADA Date: 6/16/2020 Due: 6/16/2022	km/h km/h m/s² m/s² º º º º/s º/s º/s
Angle Encoder[1] *Data Flag (Handwheel Command Flag)*	Steering angle Steering torque	Steering wheel robot	>1000 60	0.25 deg	±0.20 ±0.25	ABD	769/17	By: IDIADA Date: 8/01/2019 Due: 8/01/2021	º Nm
Infrared Distance Measuring System	Tire wheel lift	Height sensors	300-700	0.01 mm	±0.8	OPTImess	OMS 4140-3098 OMS 4140-4506 OMS 4140-4508 OMS 4140-4509	By: IDIADA Date: 7/7/2020 Due: 7/7/2021	mm
Load Cell	Brake Pedal Force	Load Cell	±600	-	±0.5	Novatech	48305	By: IDIADA Date: 3/27/2020 Due: 3/27/2021	N
Acquisition system	-	Acquisition system	200	-	-	IDIADA Moses MEAS X	180749	By: IDIADA Date: 05/21/2020 Due: 05/21/2022	-

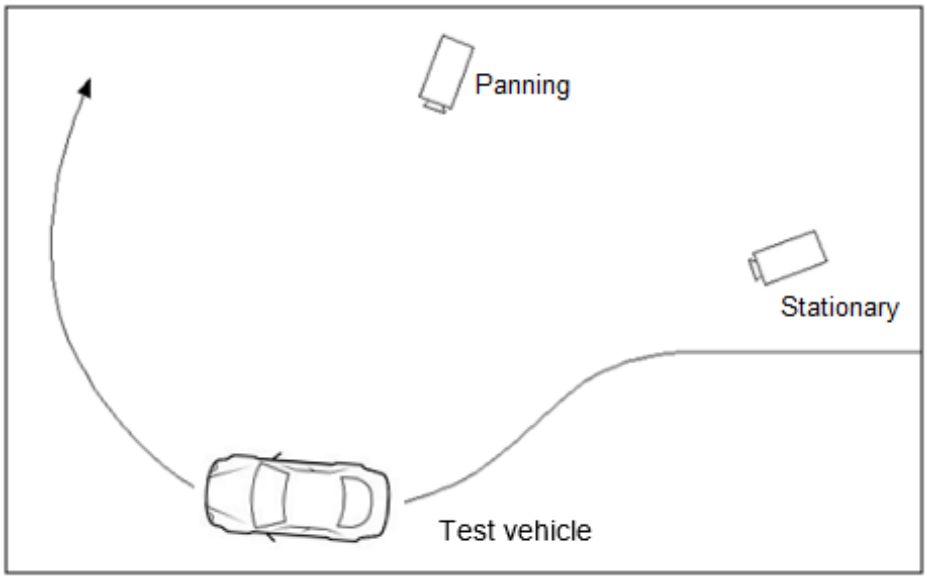


Figure 1. Nominal Position of Video Cameras for Fishhook Tests

SECTION III
TEST PROCEDURES

A. TEST PROCEDURE OVERVIEW

This test was conducted in accordance with NHTSA's NCAP Rollover Resistance Test Procedure (Fishhook) as described in the Federal Register (68 FR 59250). Detailed descriptions of the test procedure, pass/fail criteria, and data acquisition specifications may be found at docket NHTSA-2001-9663.

There are two major components of the test procedure, the Slowly Increasing Steer (SIS) pre-test and the Fishhook test.

The Slowly Increasing Steer (SIS) maneuver was used to characterize the steady state lateral dynamics of each vehicle, and is based on the "Constant Speed, Variable Steer" test defined in SAE J266. The maneuver is used to determine the handwheel angle that produces a lateral acceleration of 0.3 g at 50 mph. This handwheel angle is then used to determine the magnitude of steering to be used for the NHTSA Fishhook maneuver.

SIS tests were performed at a constant speed of 50 mph. Handwheel angle was input at a rate of 13.5 deg/sec, from 0 to an angle that provided at least 0.55 g. Three tests were conducted in each direction, and the data for the six runs were averaged to obtain the handwheel angle that produced 0.3 g at 50 mph.

The Fishhook test is a programmed steering maneuver that is implemented via the steering controller. The vehicle was initially steered in one direction and then the steering was reversed. The timing, magnitude and rate of the steering were prescribed by the Fishhook Procedure.

To begin the maneuver, the vehicle was driven in a straight line at a speed slightly greater than the desired entrance speed. The driver then released the throttle. When the vehicle was at the target speed, the steering controller automatically initiated the steering maneuver. Following completion of the steering reversal, the handwheel position was maintained for 3 seconds, and then returned to zero angle in 2 seconds.

The tests were conducted in both left-right and right-left directions. The “Default” test series used a handwheel angle equal to 6.5 times the handwheel angle that produced 0.3 g at 50 mph in the SIS tests, and initial vehicle speeds beginning at 35 mph and concluding up to 50 mph (if no two-wheel lift occurs). Supplemental tests were also done, as specified in the Fishhook Procedure.

A. TEST CONDITIONS

1. Test Surface

The tests were conducted on the Vehicle Dynamics Area (VDA) at HONDA Proving Center facility, located in Cantil, California, on 6/16/2021. The VDA has a smooth, flat (slope less than 0.5% throughout) asphaltic concrete surface. Its dimensions are as shown in Figure 2. The test was accomplished using an ASTM E1136 tire with an inflation pressure of 35 (±0.5) psi at a test speed of 40 (±0.5) mph. The net slip angle of the test tire for each test run was 7.5 deg. The surface friction measurement results are shown in Table 6.

Table 6. Lateral Surface Friction

Date of surface friction measurements	6/16/2021
Average lateral friction coefficient	0.92
Date of peak braking friction measurements	11/9/2020
Peak braking coefficient	0.92

2. Fishhook Handwheel Angles

The 0.3 g handwheel angle obtained from the SIS tests and the handwheel angles used in the Fishhook tests are shown in Table 7.

Table 7. Handwheel Angles

0.3 g handwheel angle (from SIS tests at 50 mph)	25.9º
5.5 scalar handwheel angle for Fishhook Test	142.5º
6.5 scalar handwheel angle for Fishhook Test	168.4º

3. Weather Conditions

The weather conditions, recorded at the end of testing, are shown in Table 8.

Table 8. Weather Conditions

Ambient temperature	99.4 ºF (37.4 ºC)
Wind Speed	2.2 mph (1.0 m/s)
Wind Direction	E

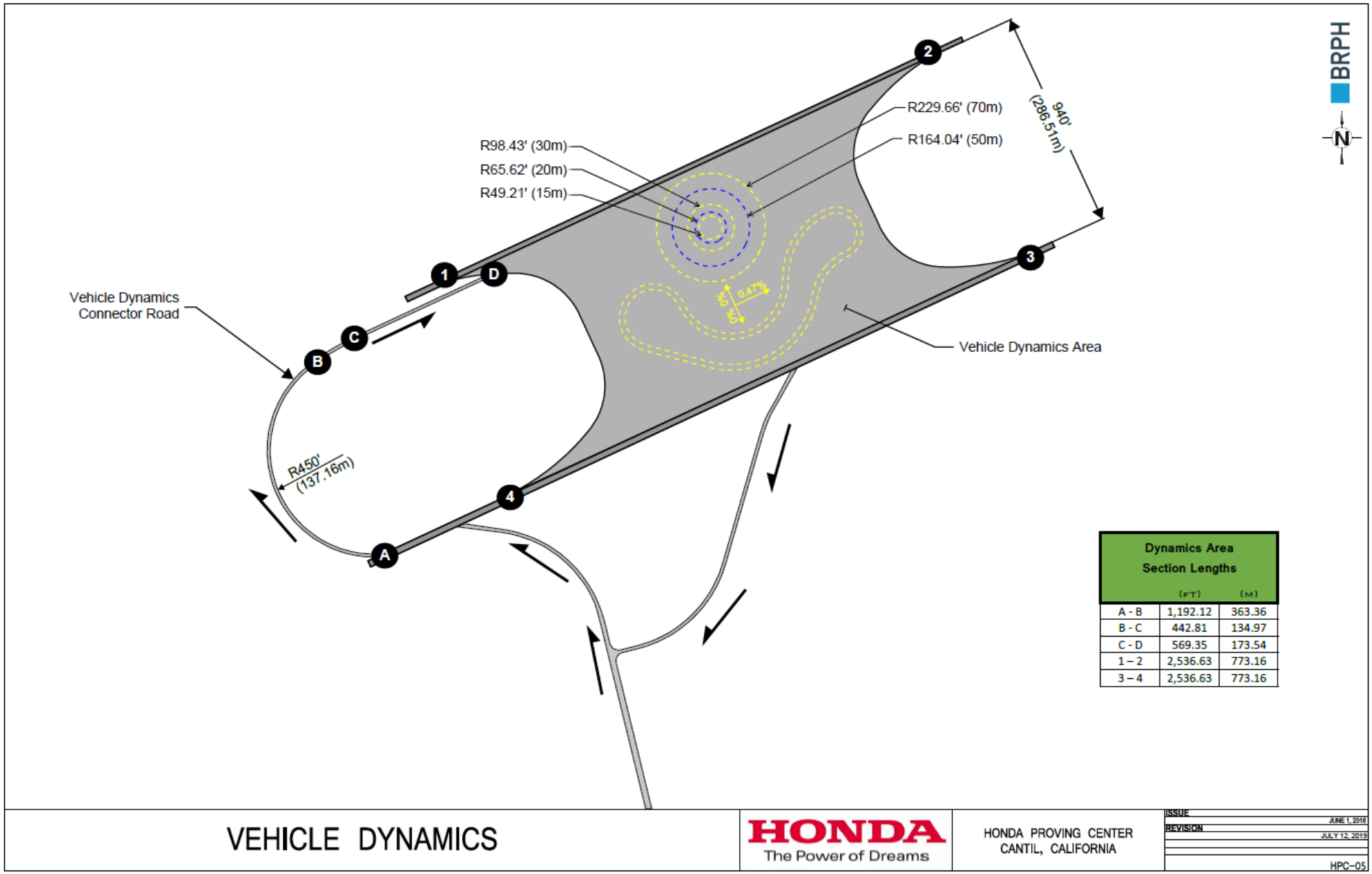


Figure 2. Vehicle Dynamics Area at Honda Proving Center

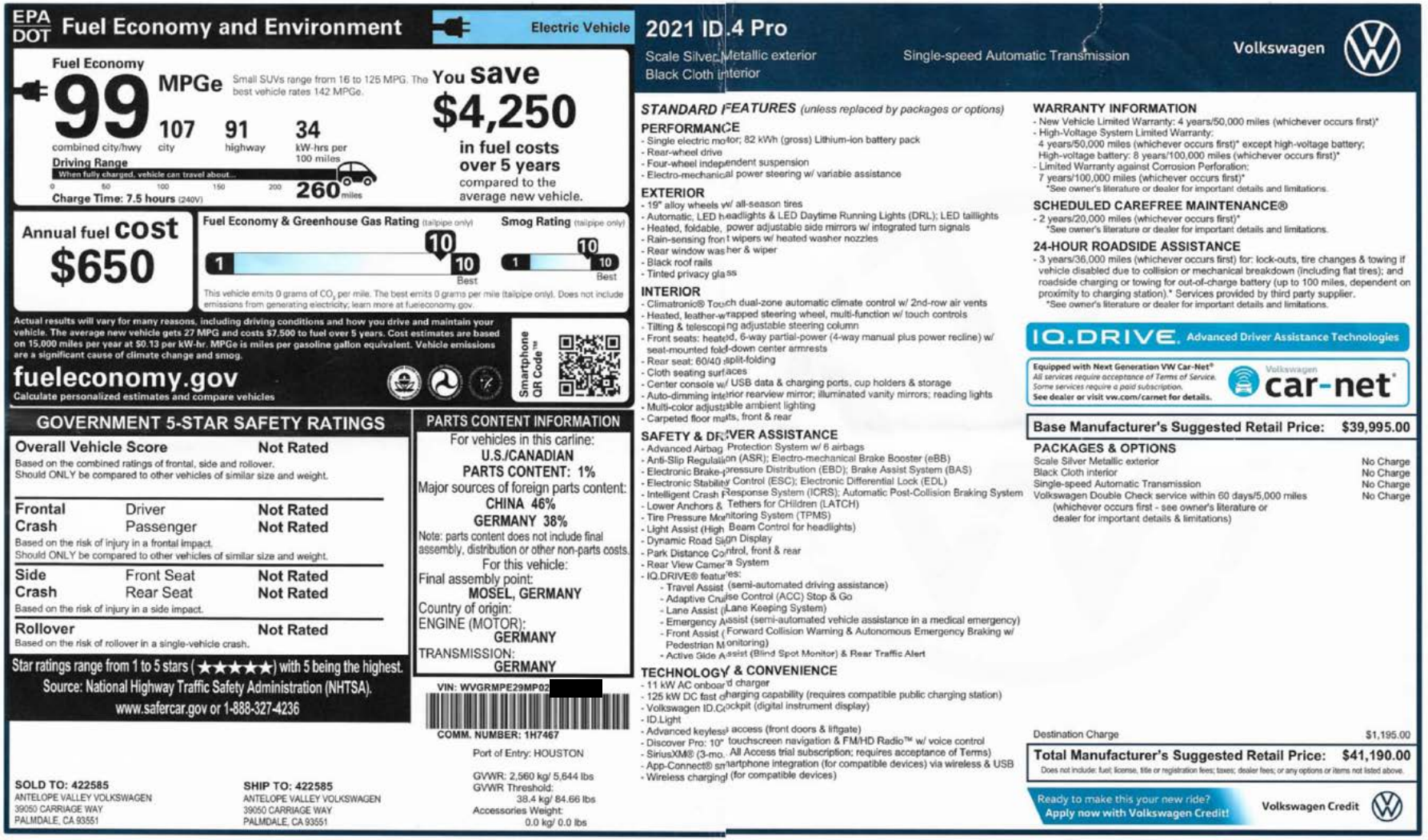
SECTION IV
RESULTS

There is Appendix A with the photographic documentation. The test run log is given in Appendix B. A summary of the Slowly Increasing Steer Test is given in Appendix C. Appendix D contains time history plots for the 50 mph runs and any runs which resulted in two-wheel lift. For the 2021 Volkswagen ID.4 BEV RWD 5-Door MPV, there was no two-wheel lift at any test condition.

APPENDIX A

PHOTOGRAPHS

LISTE OF FIGURES



EPA DOT **Fuel Economy and Environment**

Electric Vehicle

Fuel Economy

99 MPGe

Small SUVs range from 16 to 125 MPG. The best vehicle rates 142 MPGe.

107	91	34
combined city/hwy	city	highway
		kW-hrs per 100 miles

Driving Range

When fully charged, vehicle can travel about...

0 50 100 150 200 **260** miles

Charge Time: 7.5 hours (240V)

You save $4,250 in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost $650

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

Smog Rating (tailpipe only): 1 — 10 — 10 Best

This vehicle emits 0 grams of CO_2 per mile. The best emits 0 grams per mile (tailpipe only). Does not include emissions from generating electricity; 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 $0.13 per kW-hr. 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 similar 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: 1%
Major sources of foreign parts content:
CHINA 46%
GERMANY 38%
Note: parts content does not include final assembly, distribution or other non-parts costs.

For this vehicle:
Final assembly point:
MOSEL, GERMANY
Country of origin:
ENGINE (MOTOR):
GERMANY
TRANSMISSION:
GERMANY

VIN: WVGRMPE29MP02[redacted]

COMM. NUMBER: 1H7467

Port of Entry: HOUSTON

GVWR: 2,560 kg/ 5,644 lbs
GVWR Threshold: 38.4 kg/ 84.66 lbs
Accessories Weight: 0.0 kg/ 0.0 lbs

SOLD TO: 422585
ANTELOPE VALLEY VOLKSWAGEN
39050 CARRIAGE WAY
PALMDALE, CA 93551

SHIP TO: 422585
ANTELOPE VALLEY VOLKSWAGEN
39050 CARRIAGE WAY
PALMDALE, CA 93551

2021 ID.4 Pro

Scale Silver Metallic exterior
Black Cloth interior

Single-speed Automatic Transmission

Volkswagen

STANDARD FEATURES (unless replaced by packages or options)

PERFORMANCE
- Single electric motor; 82 kWh (gross) Lithium-ion battery pack
- Rear-wheel drive
- Four-wheel independent suspension
- Electro-mechanical power steering w/ variable assistance

EXTERIOR
- 19" alloy wheels w/ all-season tires
- Automatic, LED headlights & LED Daytime Running Lights (DRL); LED taillights
- Heated, foldable, power adjustable side mirrors w/ integrated turn signals
- Rain-sensing front wipers w/ heated washer nozzles
- Rear window washer & wiper
- Black roof rails
- Tinted privacy glass

INTERIOR
- Climatronic® Touch dual-zone automatic climate control w/ 2nd-row air vents
- Heated, leather-wrapped steering wheel, multi-function w/ touch controls
- Tilting & telescoping adjustable steering column
- Front seats: heated, 6-way partial-power (4-way manual plus power recline) w/ seat-mounted fold-down center armrests
- Rear seat: 60/40 split-folding
- Cloth seating surfaces
- Center console w/ USB data & charging ports, cup holders & storage
- Auto-dimming interior rearview mirror; illuminated vanity mirrors; reading lights
- Multi-color adjustable ambient lighting
- Carpeted floor mats, front & rear

SAFETY & DRIVER ASSISTANCE
- Advanced Airbag Protection System w/ 6 airbags
- Anti-Slip Regulation (ASR); Electro-mechanical Brake Booster (eBB)
- Electronic Brake-pressure Distribution (EBD); Brake Assist System (BAS)
- Electronic Stability Control (ESC); Electronic Differential Lock (EDL)
- Intelligent Crash Response System (ICRS); Automatic Post-Collision Braking System
- Lower Anchors & Tethers for CHildren (LATCH)
- Tire Pressure Monitoring System (TPMS)
- Light Assist (High Beam Control for headlights)
- Dynamic Road Sign Display
- Park Distance Control, front & rear
- Rear View Camera System
- IQ.DRIVE® features:
  - Travel Assist (semi-automated driving assistance)
  - Adaptive Cruise Control (ACC) Stop & Go
  - Lane Assist (Lane Keeping System)
  - Emergency Assist (semi-automated vehicle assistance in a medical emergency)
  - Front Assist (Forward Collision Warning & Autonomous Emergency Braking w/ Pedestrian Monitoring)
  - Active Side Assist (Blind Spot Monitor) & Rear Traffic Alert

TECHNOLOGY & CONVENIENCE
- 11 kW AC onboard charger
- 125 kW DC fast charging capability (requires compatible public charging station)
- Volkswagen ID.Cockpit (digital instrument display)
- ID.Light
- Advanced keyless access (front doors & liftgate)
- Discover Pro: 10" touchscreen navigation & FM/HD Radio™ w/ voice control
- SiriusXM® (3-mo. All Access trial subscription; requires acceptance of Terms)
- App-Connect® smartphone integration (for compatible devices) via wireless & USB
- Wireless charging (for compatible devices)

WARRANTY INFORMATION
- New Vehicle Limited Warranty: 4 years/50,000 miles (whichever occurs first)*
- High-Voltage System Limited Warranty: 4 years/50,000 miles (whichever occurs first)* except high-voltage battery; High-voltage battery: 8 years/100,000 miles (whichever occurs first)*
- Limited Warranty against Corrosion Perforation: 7 years/100,000 miles (whichever occurs first)*
  *See owner's literature or dealer for important details and limitations.

SCHEDULED CAREFREE MAINTENANCE®
- 2 years/20,000 miles (whichever occurs first)*
  *See owner's literature or dealer for important details and limitations.

24-HOUR ROADSIDE ASSISTANCE
- 3 years/36,000 miles (whichever occurs first) for: lock-outs, tire changes & towing if vehicle disabled due to collision or mechanical breakdown (including flat tires); and roadside charging or towing for out-of-charge battery (up to 100 miles, dependent on proximity to charging station).* Services provided by third party supplier.
  *See owner's literature or dealer for important details and limitations.

IQ.DRIVE. Advanced Driver Assistance Technologies

Equipped with Next Generation VW Car-Net®
All services require acceptance of Terms of Service.
Some services require a paid subscription.
See dealer or visit vw.com/carnet for details.

Volkswagen car-net®

Base Manufacturer's Suggested Retail Price:	**$39,995.00**

PACKAGES & OPTIONS

Scale Silver Metallic exterior	No Charge
Black Cloth interior	No Charge
Single-speed Automatic Transmission	No Charge
Volkswagen Double Check service within 60 days/5,000 miles (whichever occurs first - see owner's literature or dealer for important details & limitations)	No Charge

Destination Charge	$1,195.00
Total Manufacturer's Suggested Retail Price:	**$41,190.00**

Does not include: fuel; license, title or registration fees; taxes; dealer fees; or any options or items not listed above.

Ready to make this your new ride?
Apply now with Volkswagen Credit!

Volkswagen Credit

Figure A1. Monroney Label

Figure A2. Right Front View, Test Vehicle As-Delivered

Figure A3. Left Rear View, Test Vehicle As-Delivered

Figure A4. Left Front View, Test Vehicle in Test Condition

Figure A5. Right Rear View, Test Vehicle in Test Condition

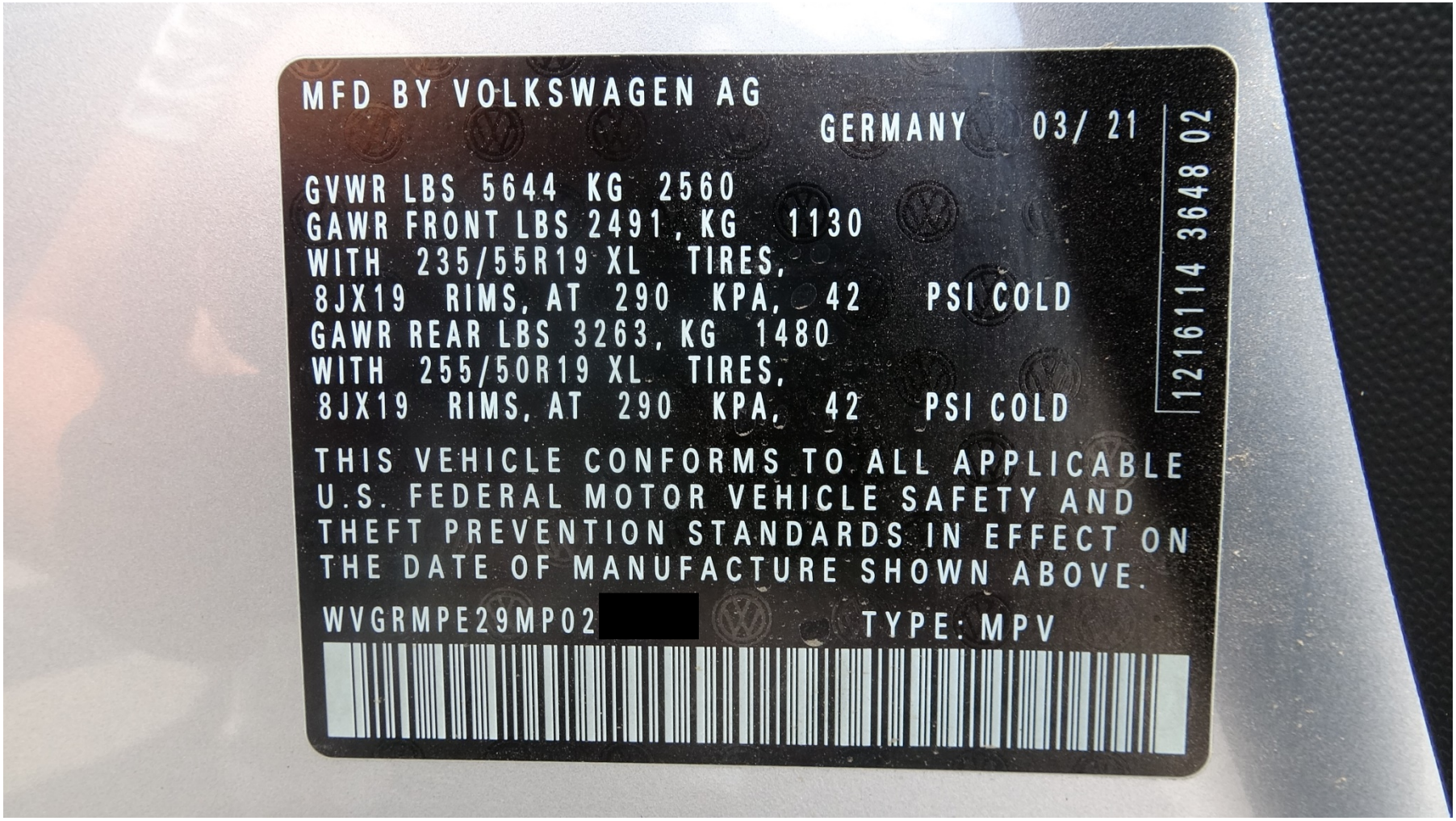


Figure A6. Vehicle's Certification Label

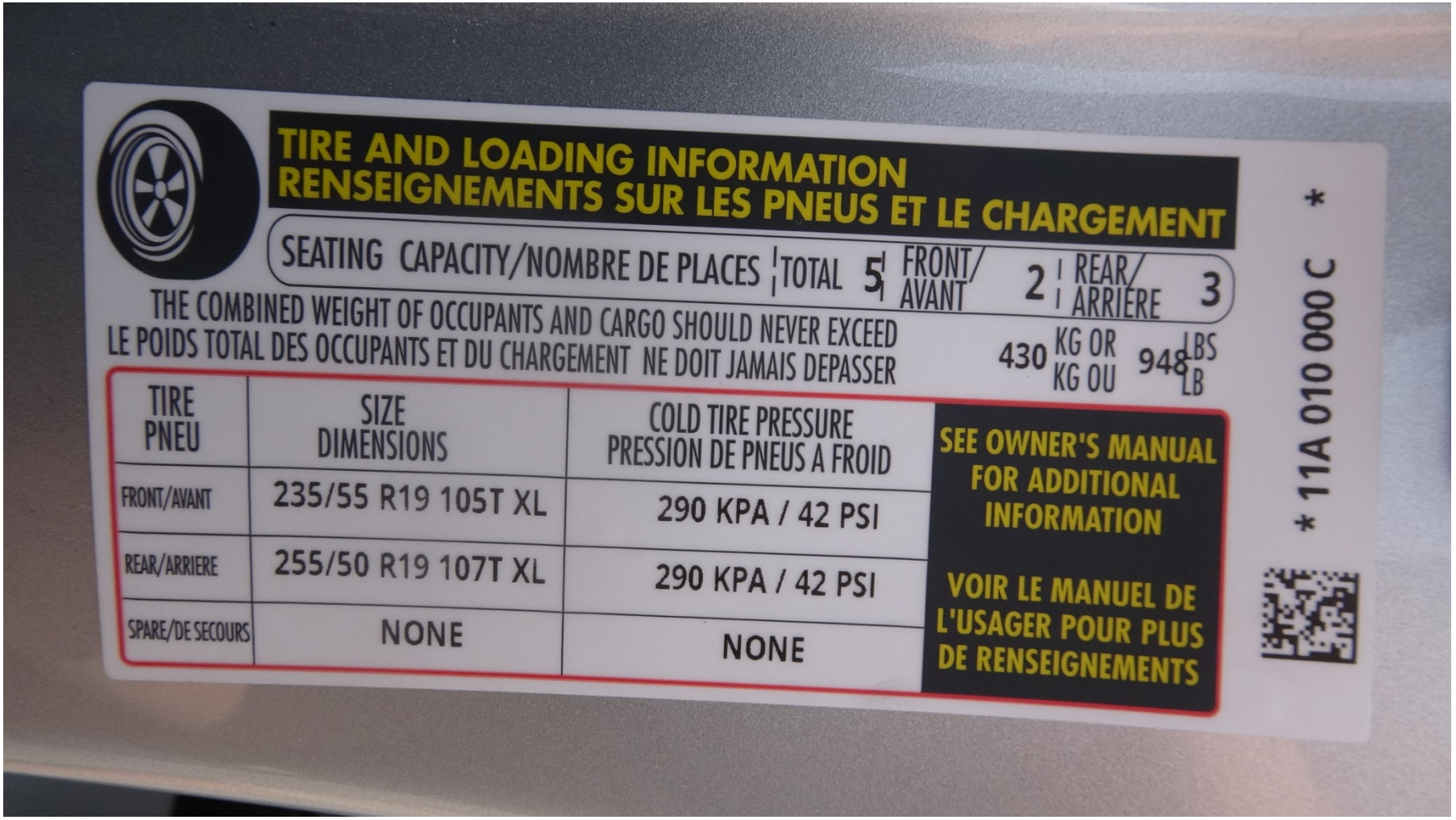


Figure A7. Vehicle’s Tire Information Placard

Figure A8. Instrumentation in Test Vehicle

Figure A9. Steering Controller and Computer

Figure A10. Ballast Condition

APPENDIX B

TEST RUN LOG

Vehicle: **2021 VOLKSWAGEN ID.4 BEV RWD 5-DOOR MPV** Driver: **Omar Gonzalez** Date: **6/16/2021**

Run Number	Test Type	Speed (mph)	Handwheel Angle (deg)	Dir. of First Steer	2 Wheel Lift	Notes
1	Tire Warm-Up	35	30.0	Left	N/A	Resulted in ay = 0.23g
2	"	"	56.5	"	"	Resulted in ay = 0.40g
3	"	"	"	"	"	
4	"	"	"	"	"	
5	2x SWA last cycle	"	113.0	"	"	2x SWA last cycle
6	Static	0	0	N/A	N/A	
7	Steady State	50	0	N/A	N/A	
8	**Slowly Increasing Steer**	50	30.0	Left	N/A	
9	"	"	37.1	Left	"	HW angle at 0.3 g = -26.6
10	"	"	"	Left	"	HW angle at 0.3 g = -26.8
11	"	"	"	Left	"	HW angle at 0.3 g = -26.5
12	"	"	"	Right	"	HW angle at 0.3 g = 25.1
13	"	"	"	Right	"	HW angle at 0.3 g = 25.2
14	"	"	"	Right	"	HW angle at 0.3 g = 25.4
						Average = **25.9**
15	**Fishhook 6.5 Scalar**	35	168.4	Left	No	
16	"	40	"	"	"	
17	"	45	"	"	"	
18	"	47.5	"	"	"	
19	"	50	"	"	"	
20	**Fishhook 6.5 Scalar**	35	168.4	Right	No	
21	"	40	"	"	"	
22	"	45	"	"	"	

Run Number	Test Type	Speed (mph)	Handwheel Angle (deg)	Dir. of First Steer	2 Wheel Lift	Notes
23	“	47.5	“	“	"	
24	"	50	"	"	"	
25	**Fishhook 5.5 Scalar**	45	142.5	Left	No	
26	"	47.5	"	"	"	
27	"	50	"	"	"	
28	**Fishhook 5.5 Scalar**	45	142.5	Right	No	
29	"	47.5	"	"	"	
30	"	50	"	"	"	

APPENDIX C
SLOWLY INCREASING STEER TEST WORKSHEET

Applus IDIADA

Slowly Increasing Steer

dynasoft

Vehicle: 2021 Volkswagen ID.4
Test Date: 06/16/2021
Analysis Date: 06/16/2021
Analysed by: EL
Executed by: OG
Configuration: ESC on

Weight Condition: Test condition
Test Track: Dynamic Platform
Test Speed: 50 mph

Run	Dir of Steer	Start speed [mph]	End speed [mph]	Speed red [%]	Index of ay	HW angle [deg] at 0.3g	ay [g] 0.3g index	6.5x HW angle [deg]	Ramp time [sec] at 6.5x	5.5x HW angle [deg]	Ramp time [sec] at 5.5x	R2	Zero Begin index	Zero End index
sis_002	L	50.0	0.1	99.8	602	-26.6	-0.300	-172.8	-0.2399	-146.2	-0.2030	0.9699	0	166
sis_003	L	50.1	-0.1	100.2	594	-26.8	-0.300	-174.2	-0.2419	-147.4	-0.2047	0.9966	0	172
sis_004	L	49.8	0.0	99.9	594	-26.5	-0.300	-172.1	-0.2391	-145.6	-0.2023	0.9918	0	155
sis_005	R	50.1	0.4	99.3	577	25.1	0.300	163.0	0.2264	137.9	0.1916	0.9981	0	141
sis_006	R	50.0	-0.0	100.1	577	25.2	0.300	163.8	0.2275	138.6	0.1925	0.9868	0	133
sis_007	R	50.1	0.0	99.9	595	25.4	0.300	165.4	0.2297	139.9	0.1943	0.9786	0	167

Mean: 25.9

Steering Controller Input values

Scalar 6.5 values:

Initial HW angle: 168.4 deg

Reversal HW angle: -168.4 deg

Scalar 5.5 values:

Initial HW angle: 142.5 deg

Reversal HW angle: -142.5 deg

APPENDIX D

TIME HISTORY PLOTS

LIST OF FIGURES

FILENAME: FH_019

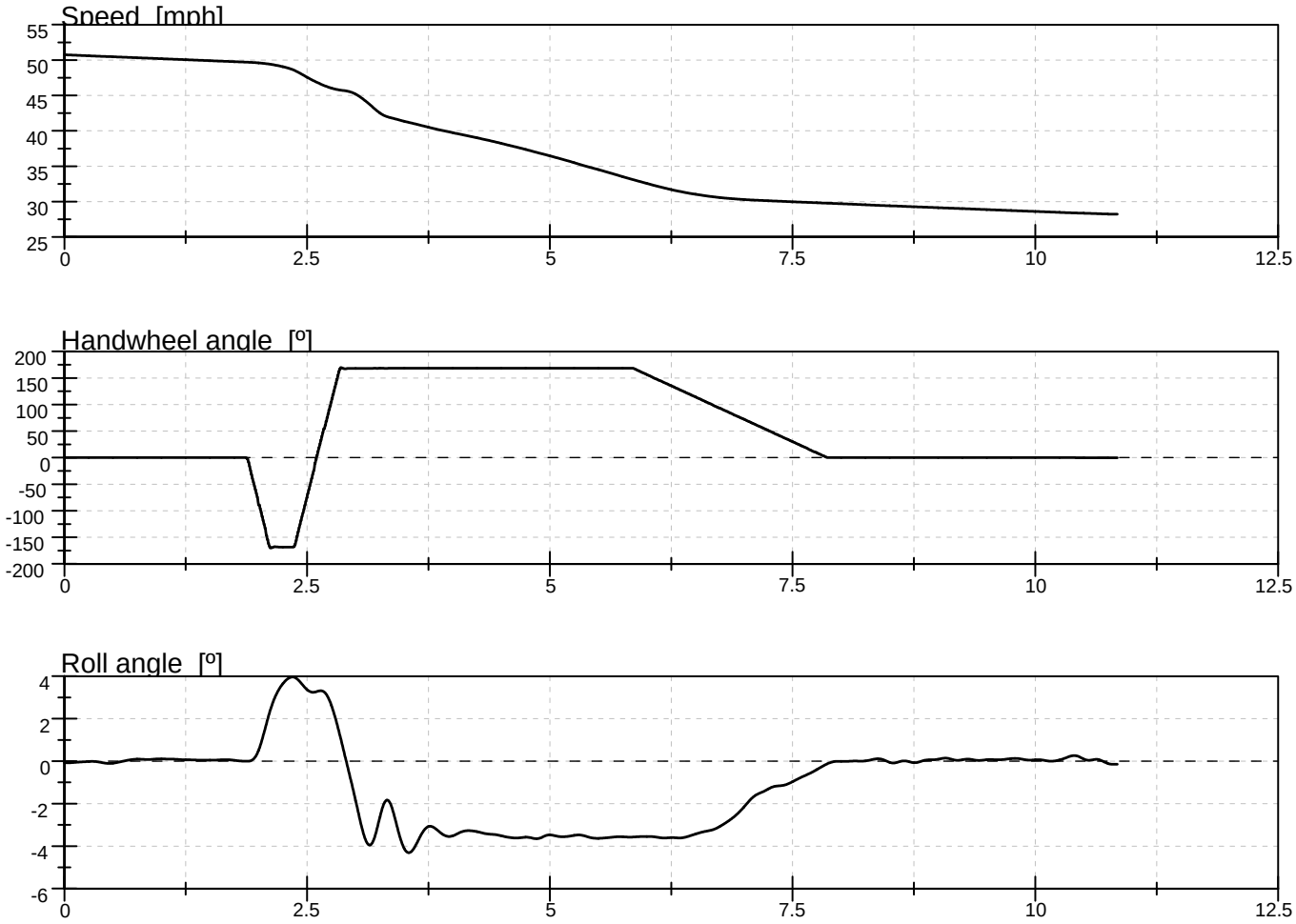


Figure D1. Vehicle Speed, Handwheel Angle, and Roll Angle Time History Plots for Default Test Series, L-R, 50 mph

FILENAME: FH_019

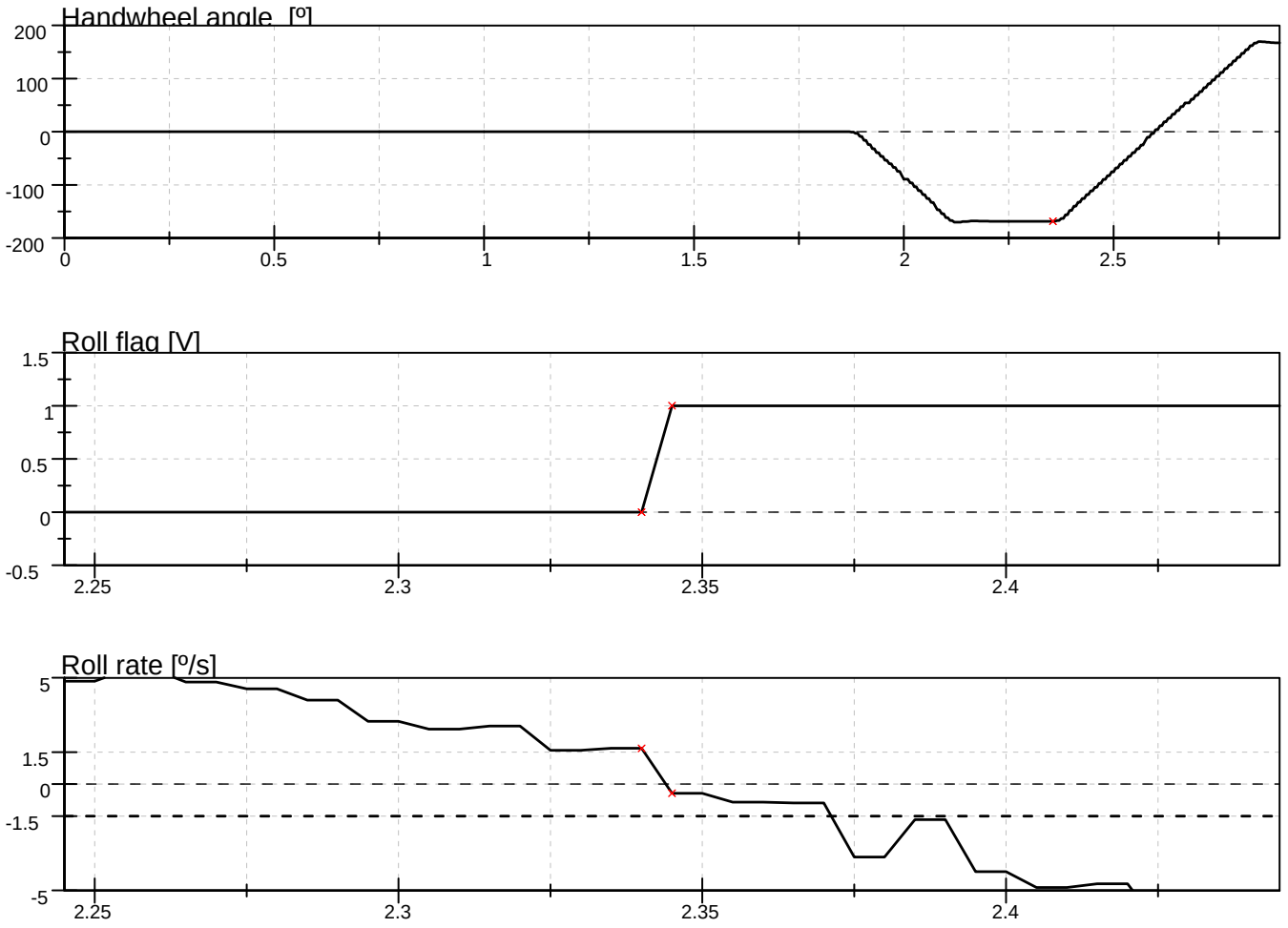


Figure D2. Steering Machine Operation Time History Plots for Default Test Series, L-R, 50 mph

FILENAME: FH_019

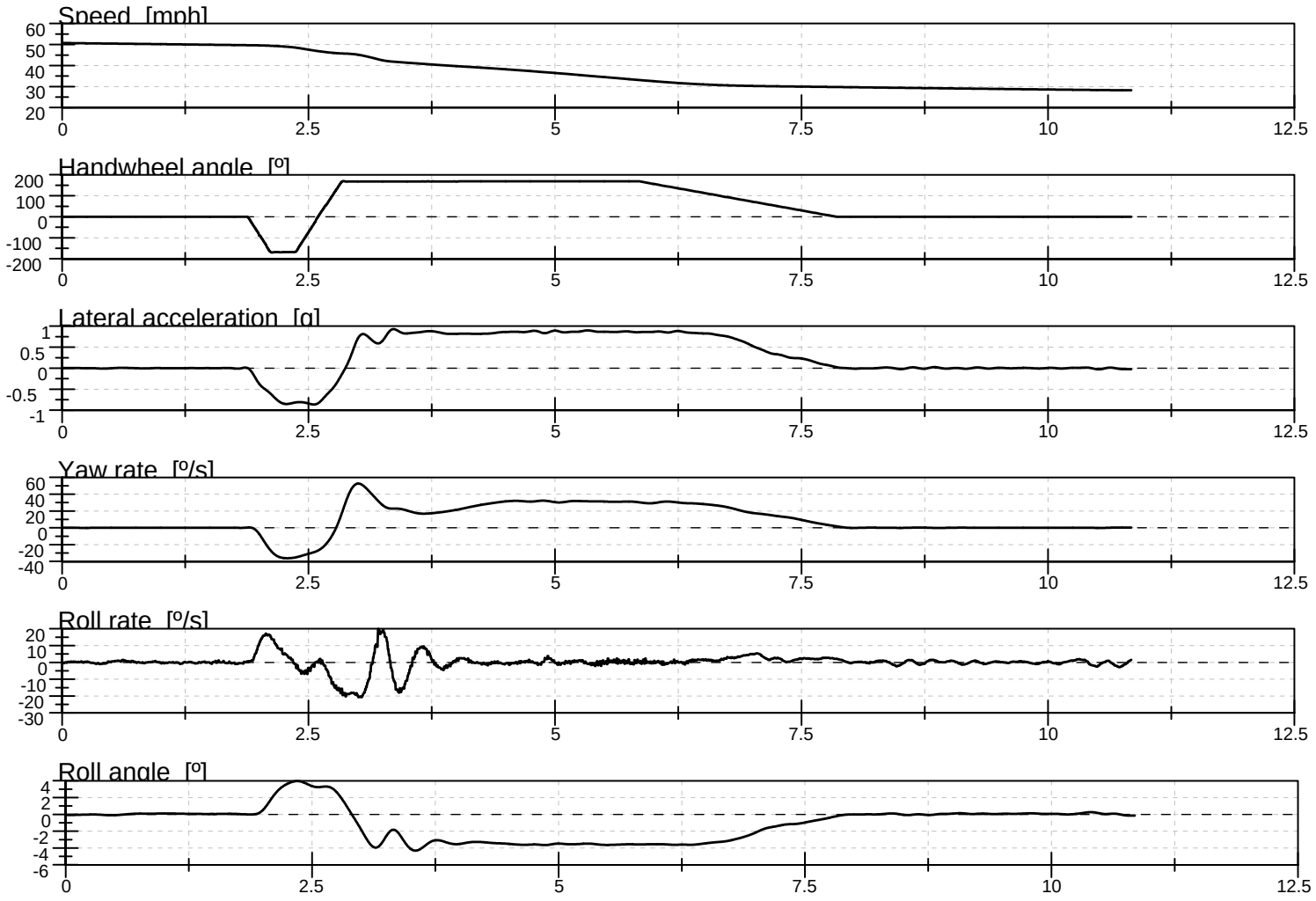


Figure D3. Yaw Rate, Roll Rate, and Lateral Acceleration Time History Plots For Default Test Series, L-R, 50 mph

FILENAME: FH_019

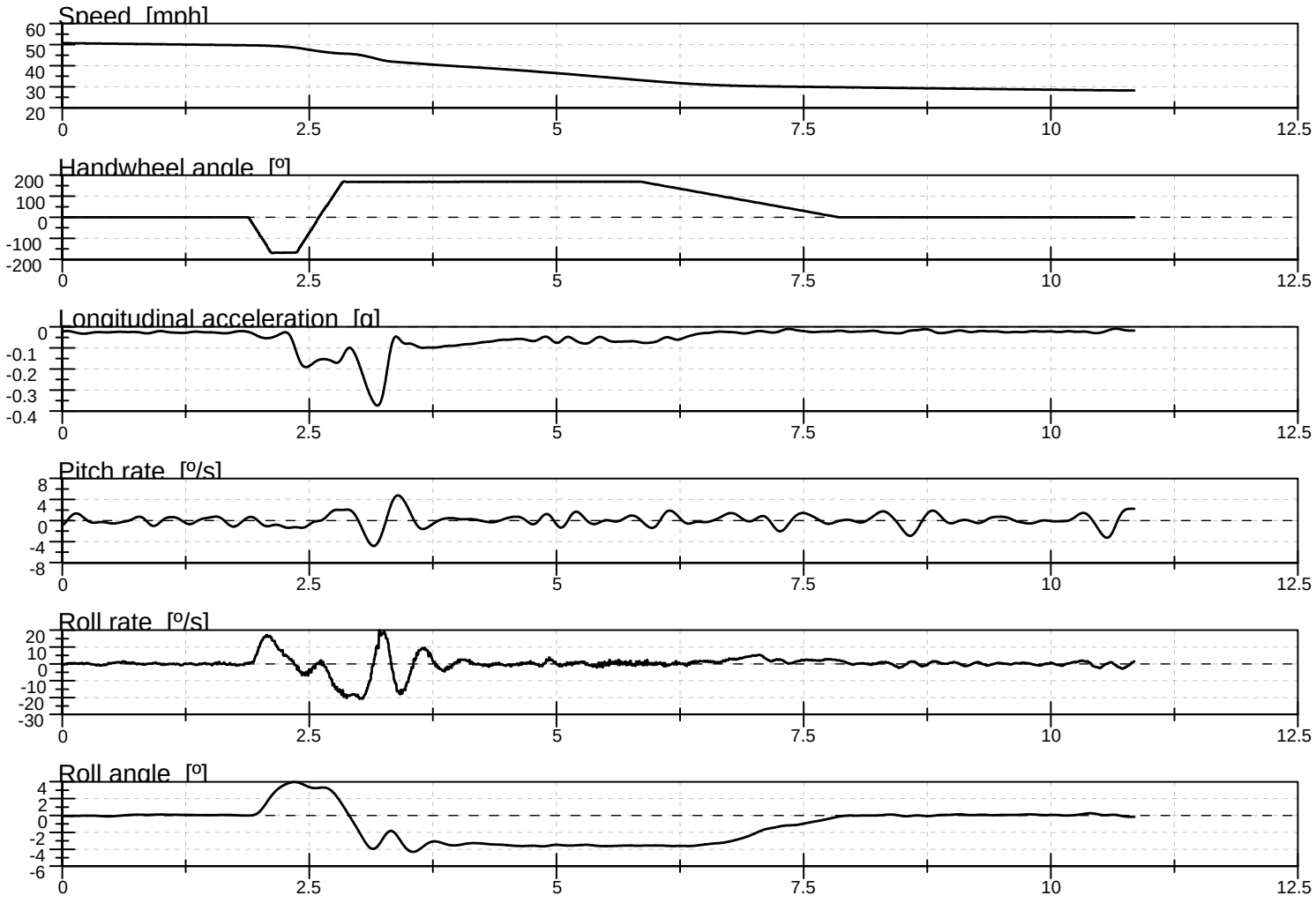


Figure D4. Pitch Rate and Longitudinal Acceleration Time History Plots for Default Test Series, L-R, 50 mph

FILENAME: FH_024

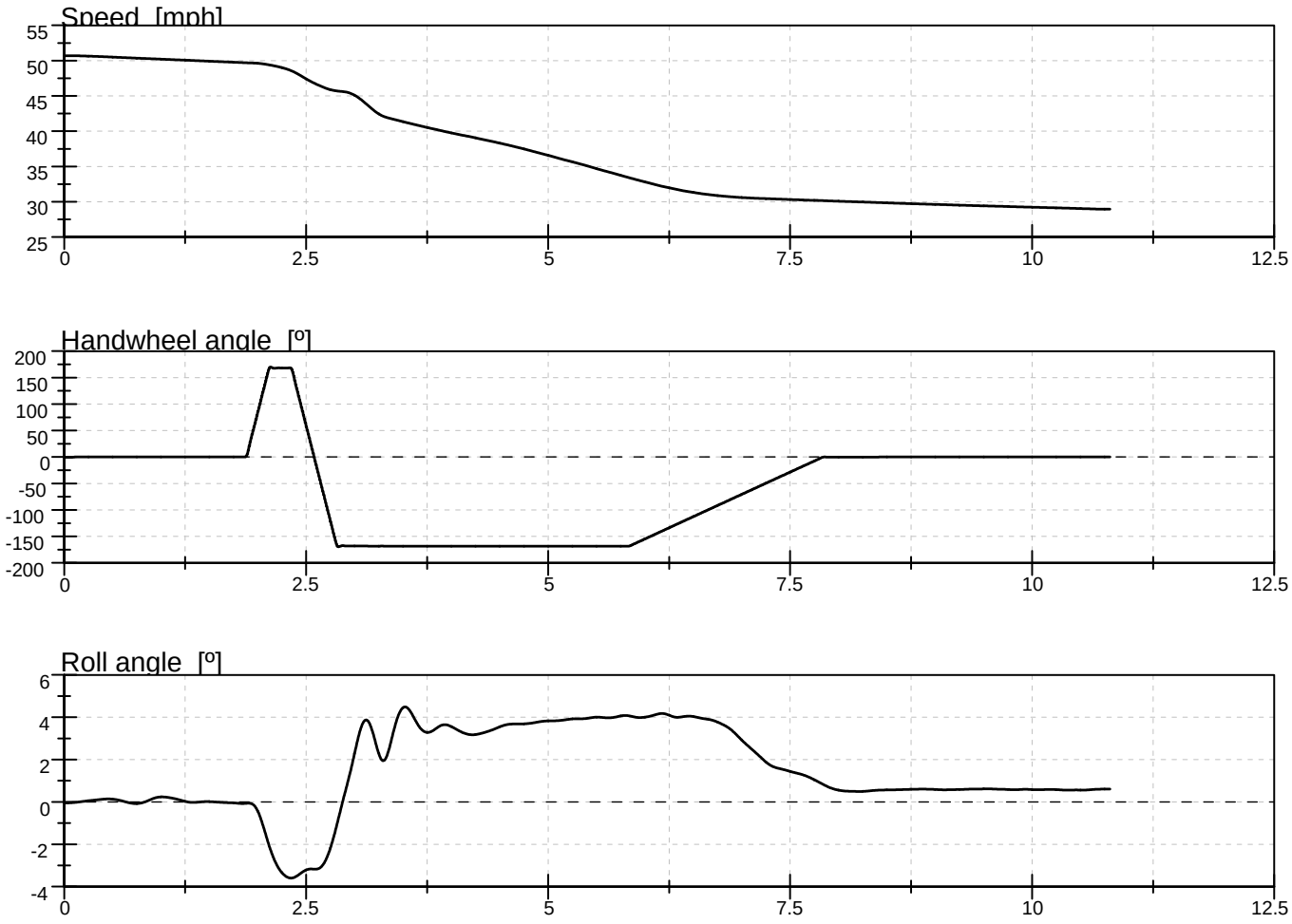


Figure D5. Vehicle Speed, Handwheel Angle, and Roll Angle Time History Plots for Default Test Series, R-L, 50 mph

FILENAME: FH_024

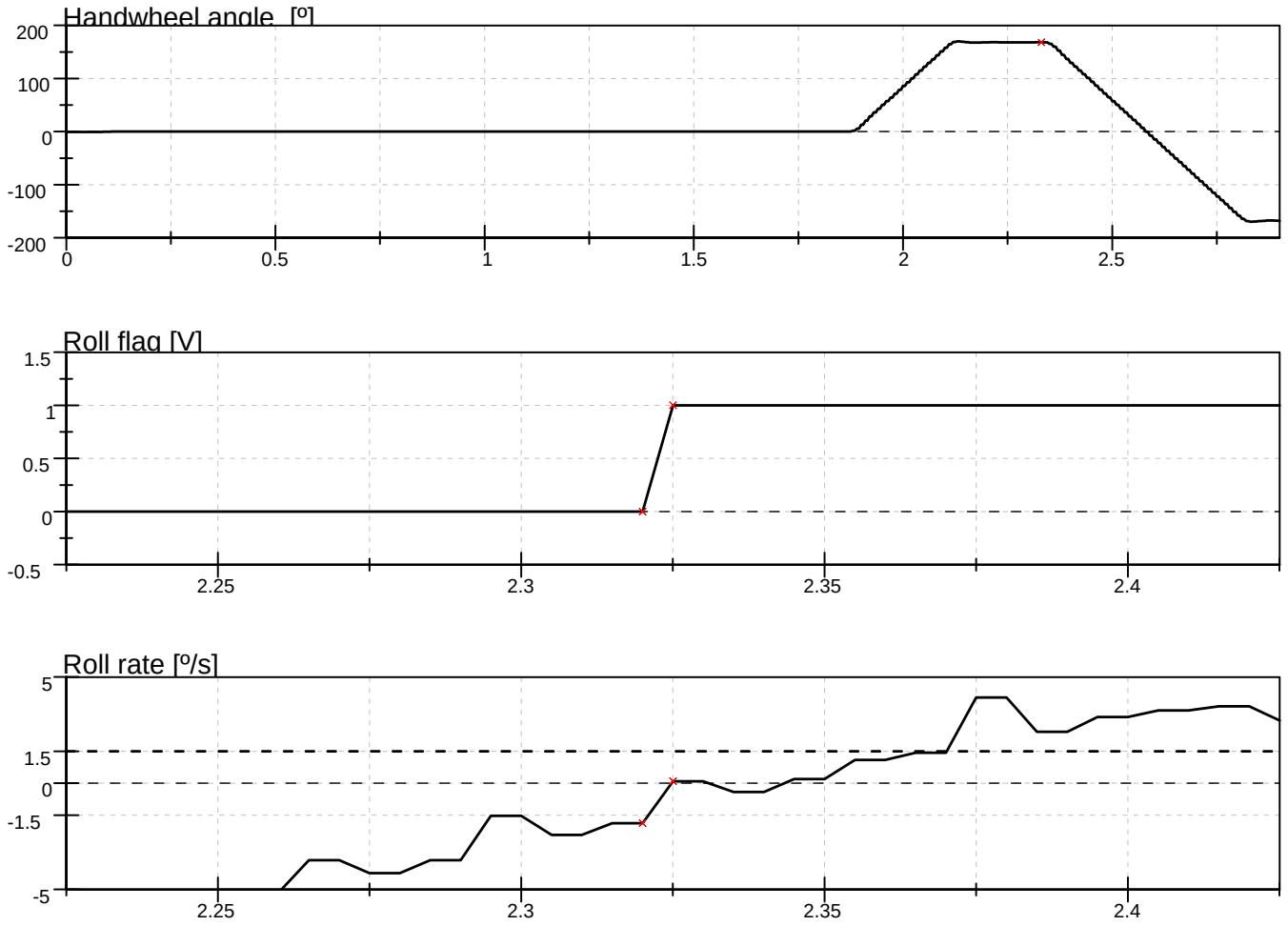


Figure D6. Steering Machine Operation Time History Plots for Default Test Series, R-L, 50 mph

FILENAME: FH_024

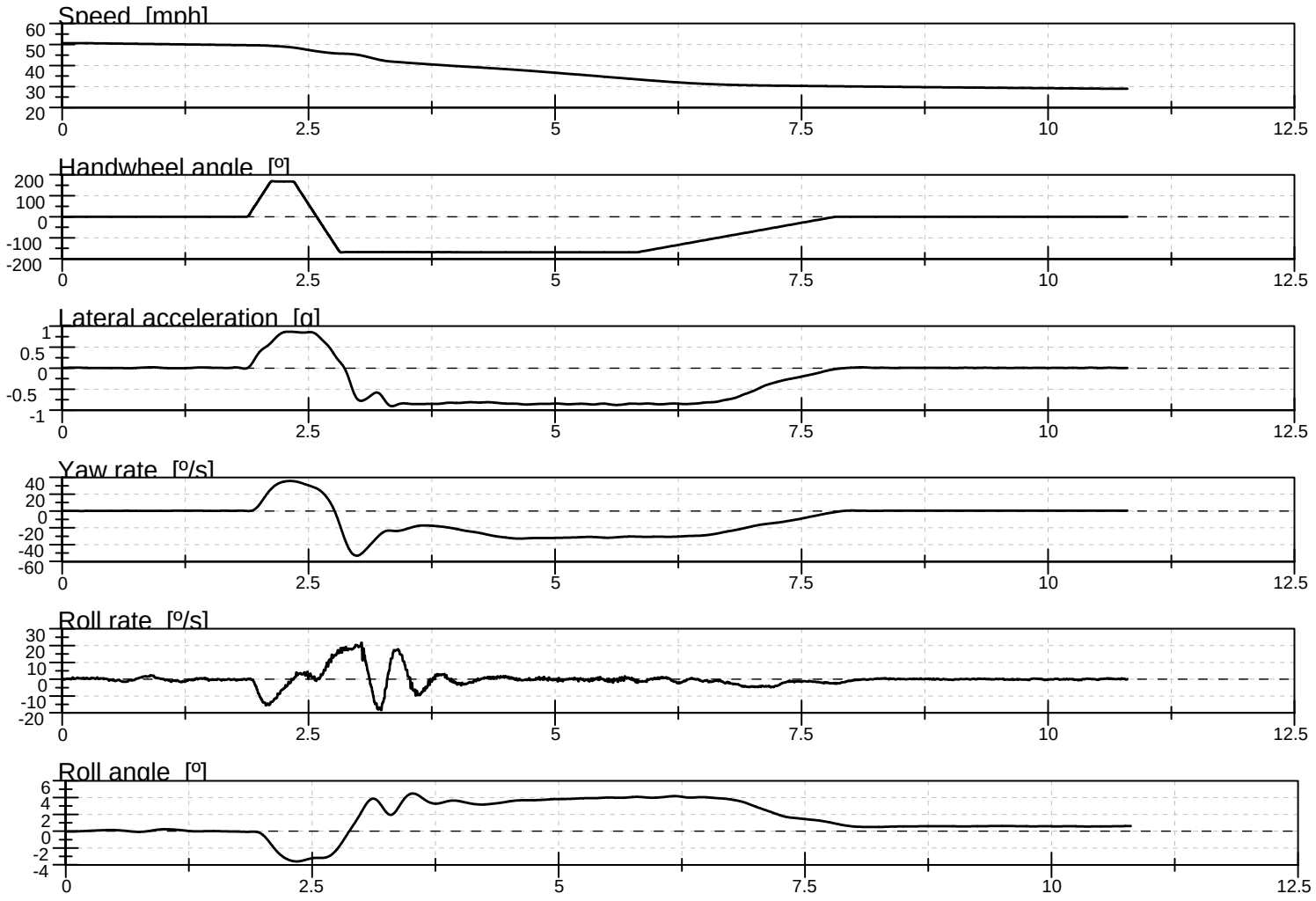


Figure D7. Yaw Rate, Roll Rate, and Lateral Acceleration Time History Plots for Default Test Series, R-L, 50 mph

FILENAME: FH_024

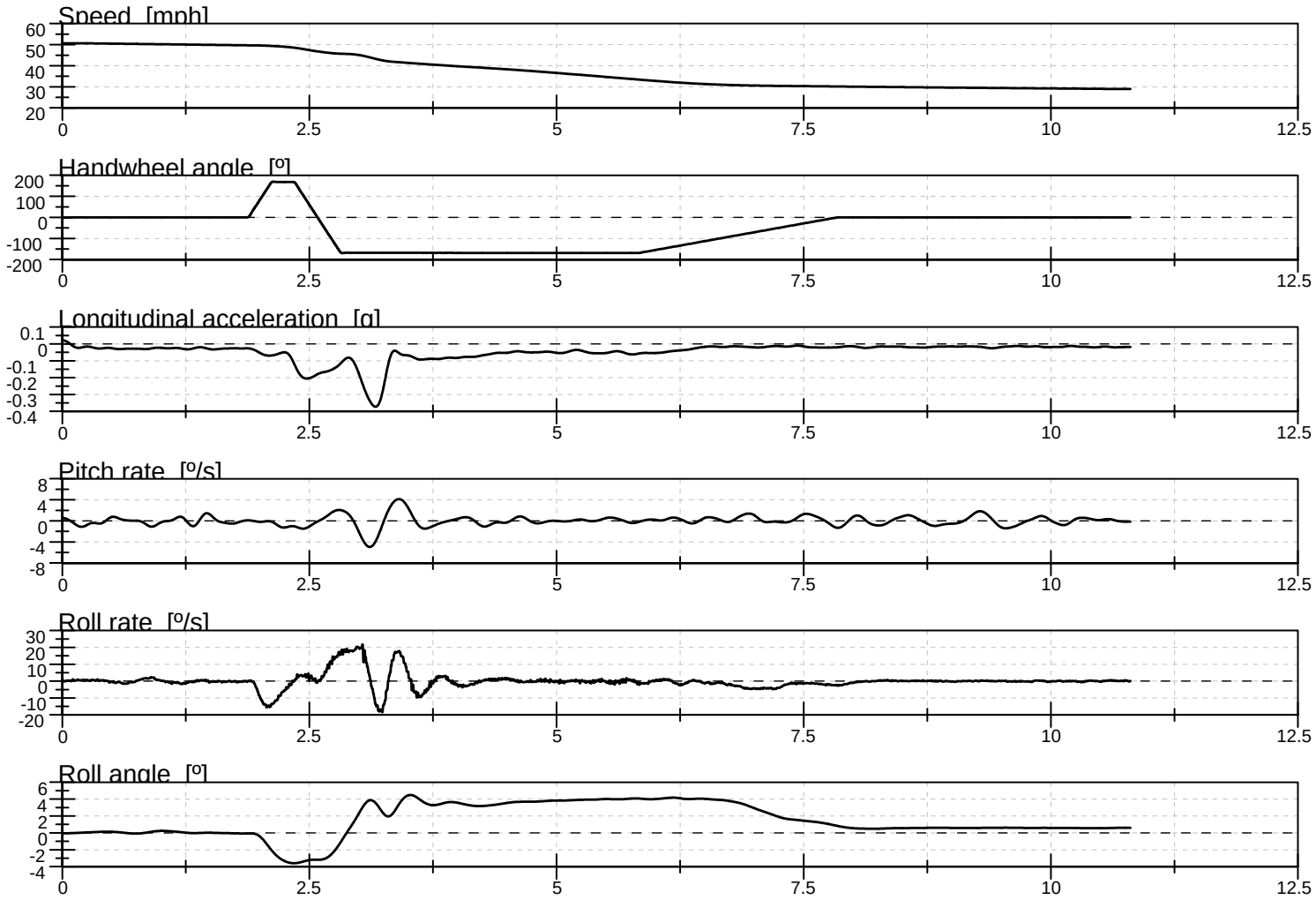


Figure D8. Pitch Rate and Longitudinal Acceleration Time History Plots or Default Test Series, R-L, 50 mph

FILENAME: FH_027

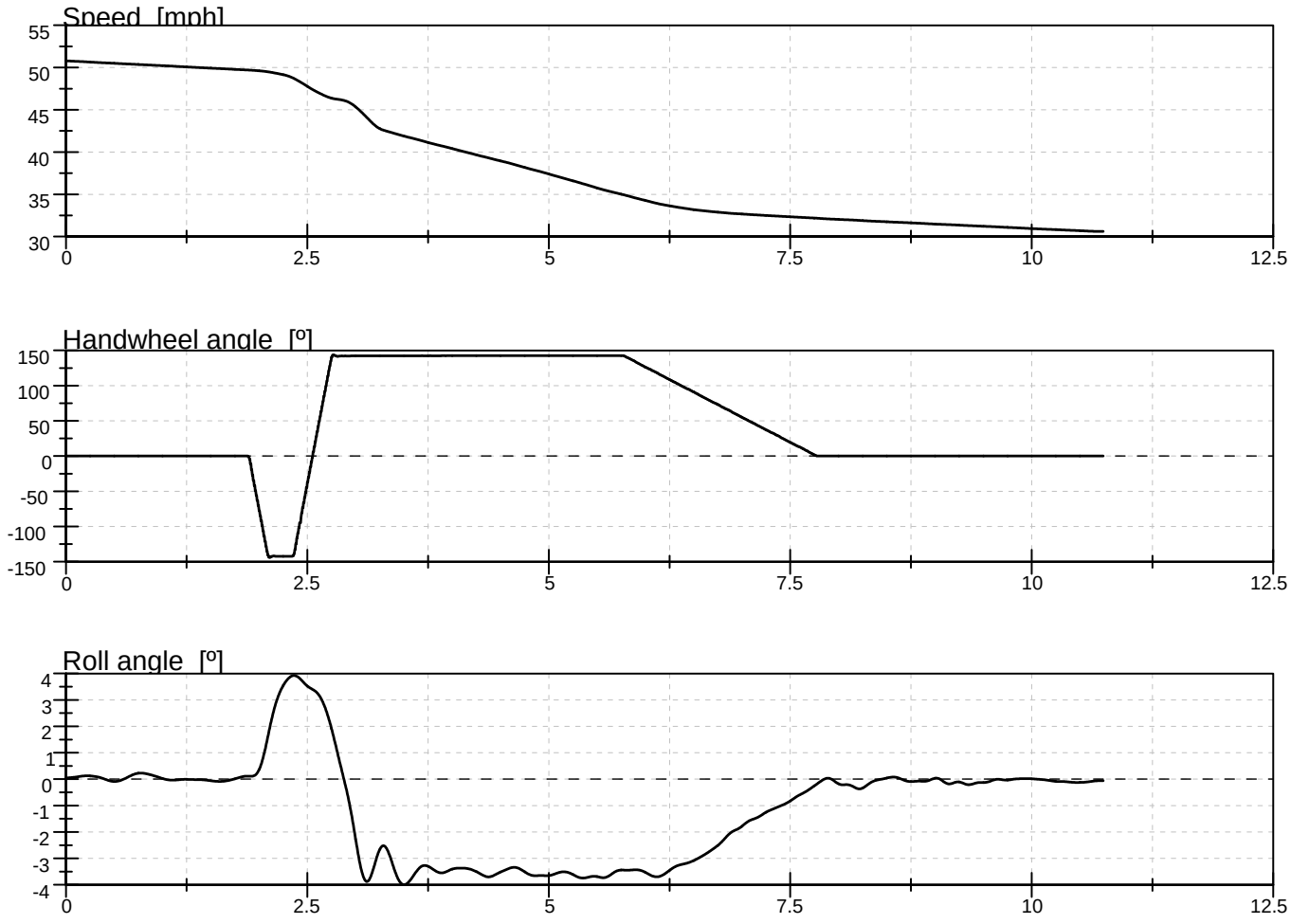


Figure D9. Vehicle Speed, Handwheel Angle, and Roll Angle Time History Plots for Supplemental 2 Test Series, L-R, 50 mph

FILENAME: FH_027

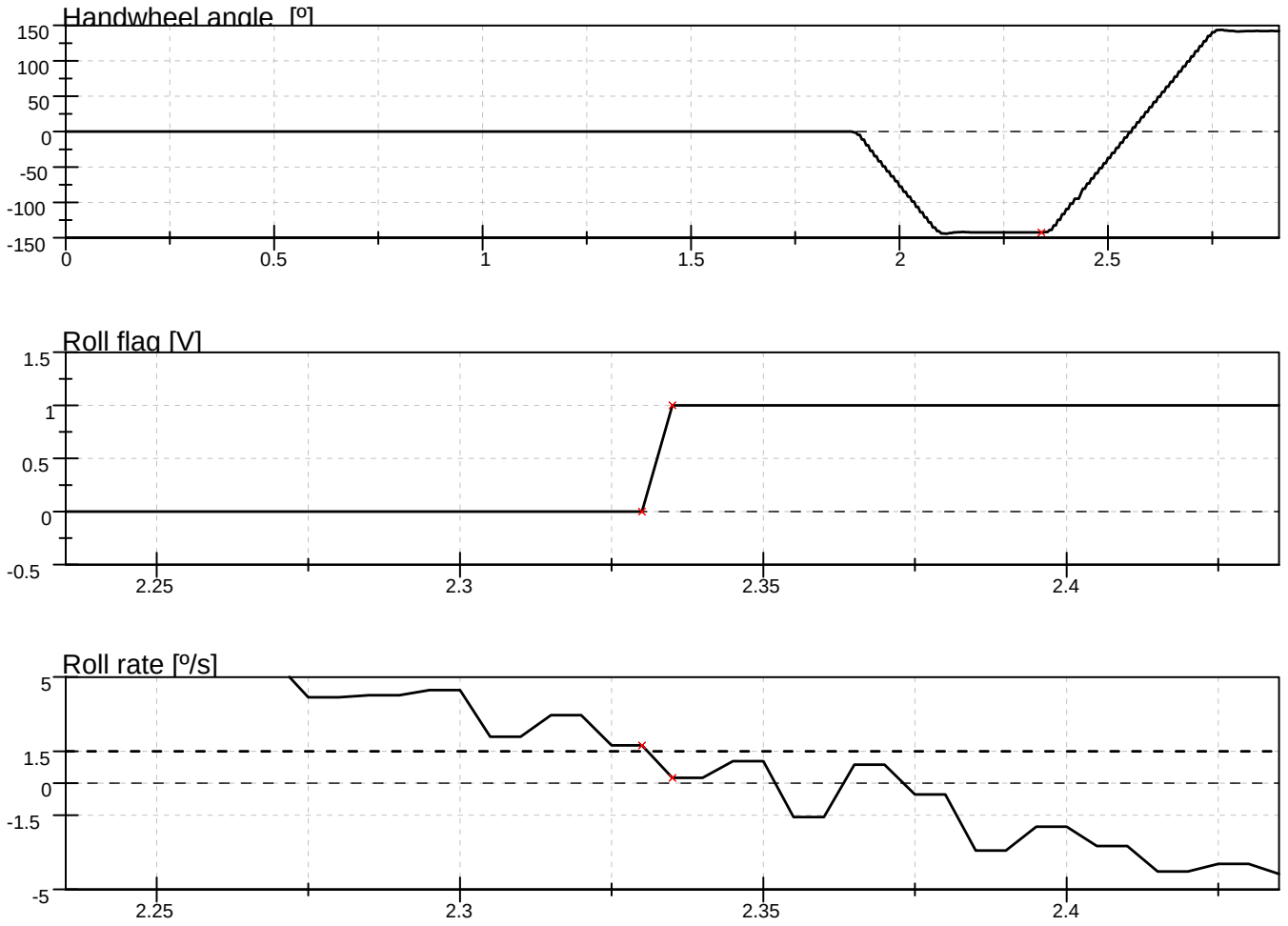


Figure D10. Steering Machine Operation Time History Plots for Supplemental 2 Test Series, L-R, 50 mph

FILENAME: FH_027

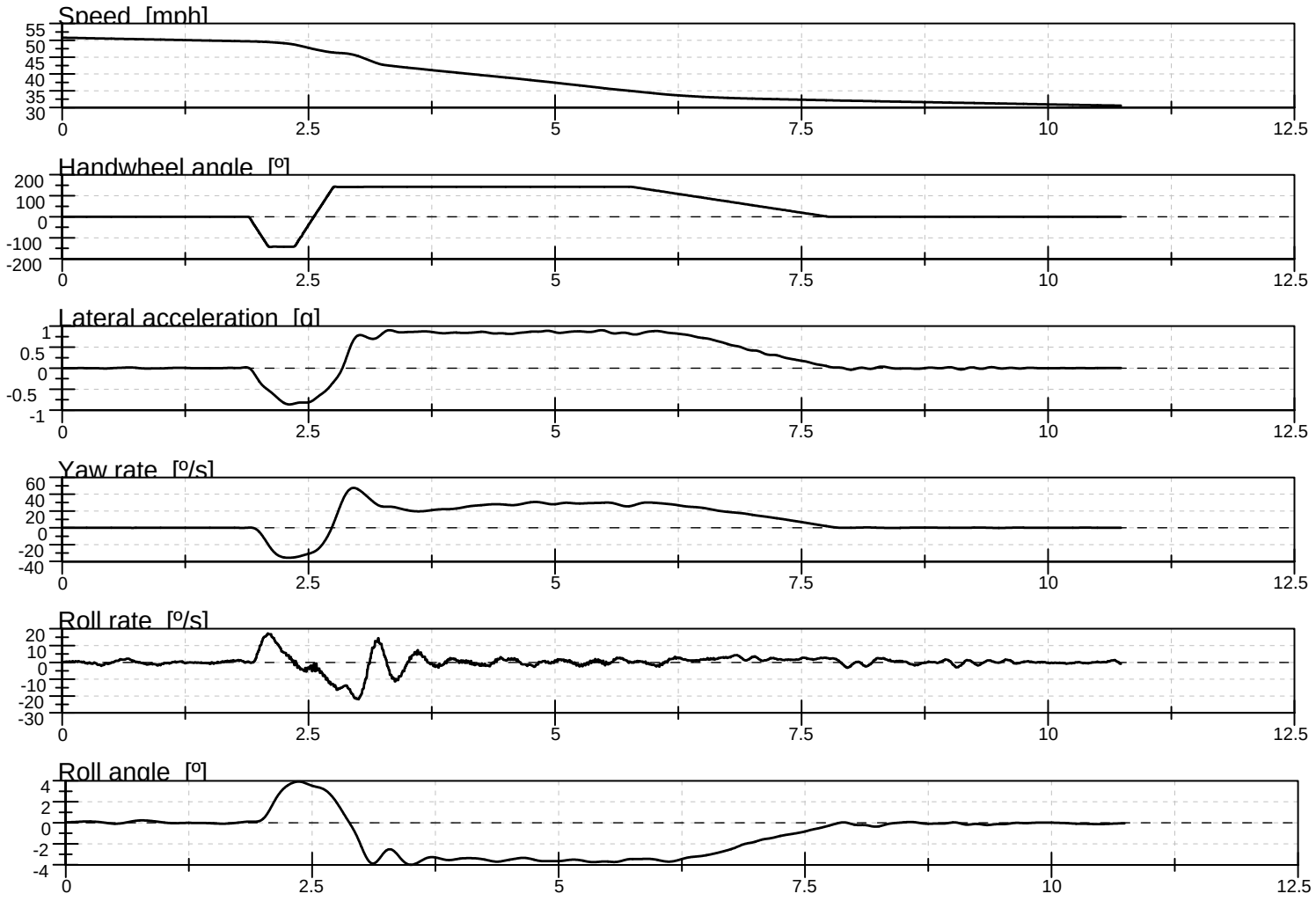


Figure D11. Yaw Rate, Roll Rate, and Lateral Acceleration Time History Plots for Supplemental 2 Test Series, L-R, 50 mph

FILENAME: FH_027

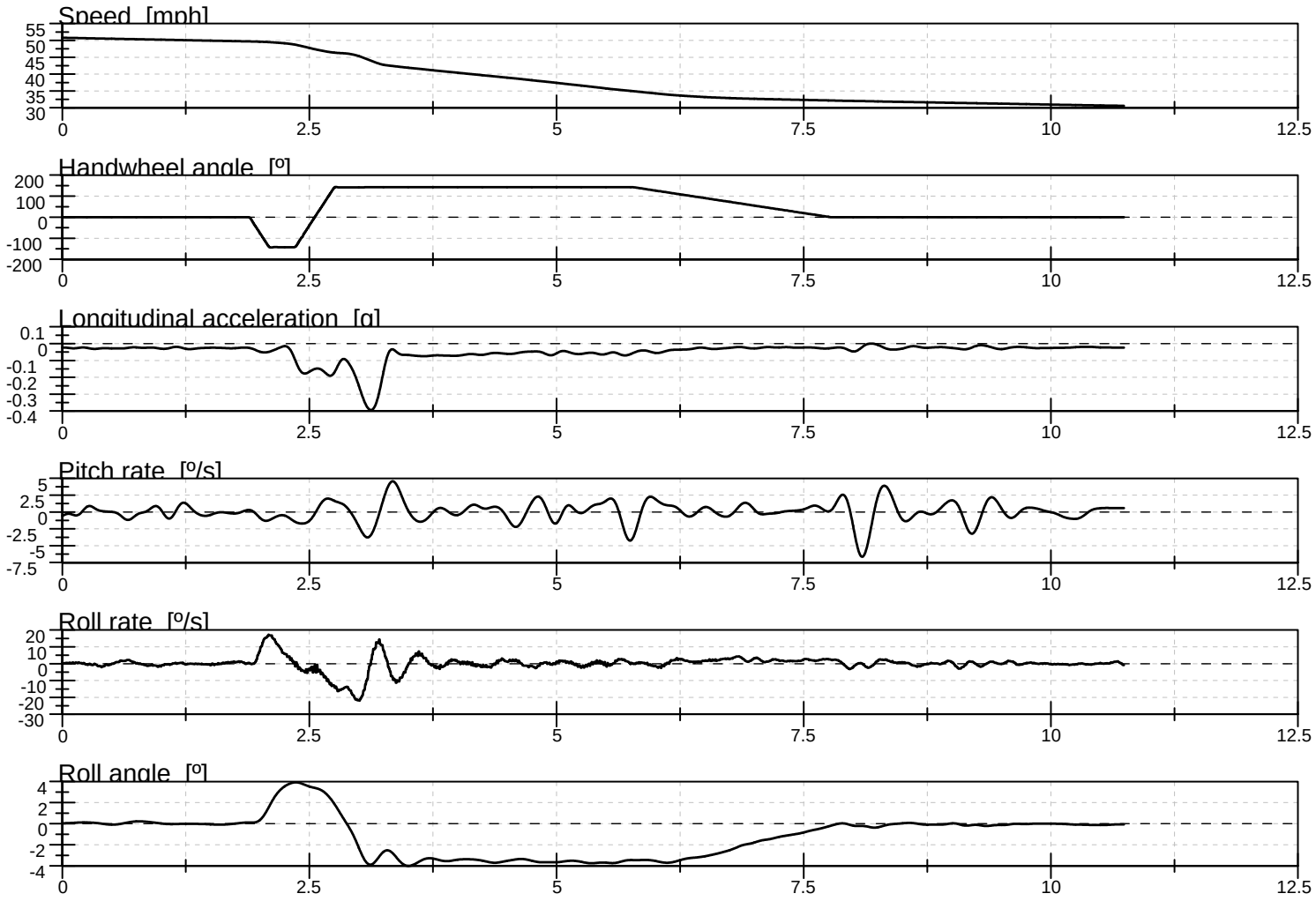


Figure D12. Pitch Rate and Longitudinal Acceleration Time History Plots for Supplemental 2 Test Series, L-R, 50 mph

FILENAME: FH_030

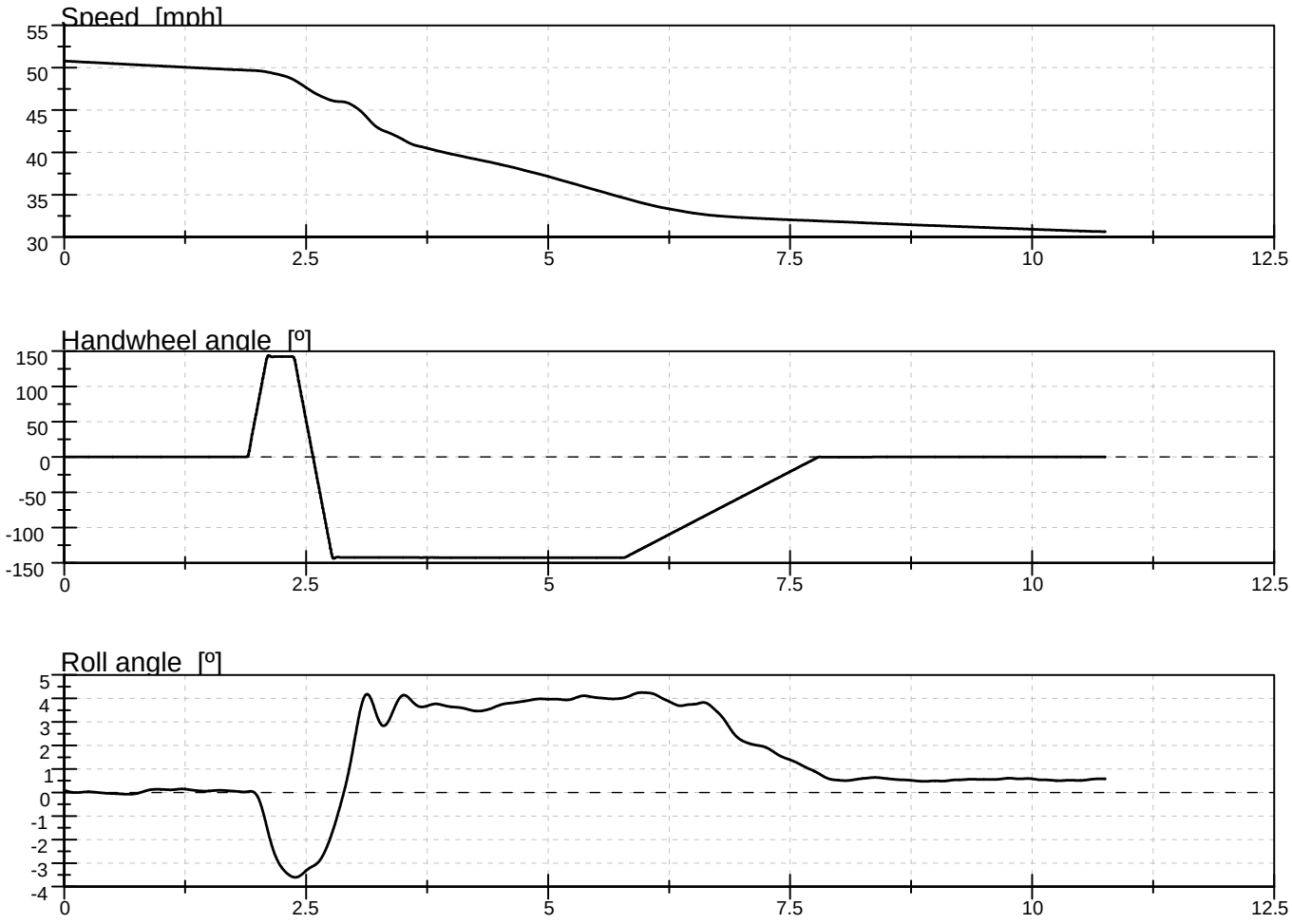


Figure D13. Vehicle Speed, Handwheel Angle, and Roll Angle Time History Plots for Supplemental 2 Test Series, R-L, 50 mph

FILENAME: FH_030

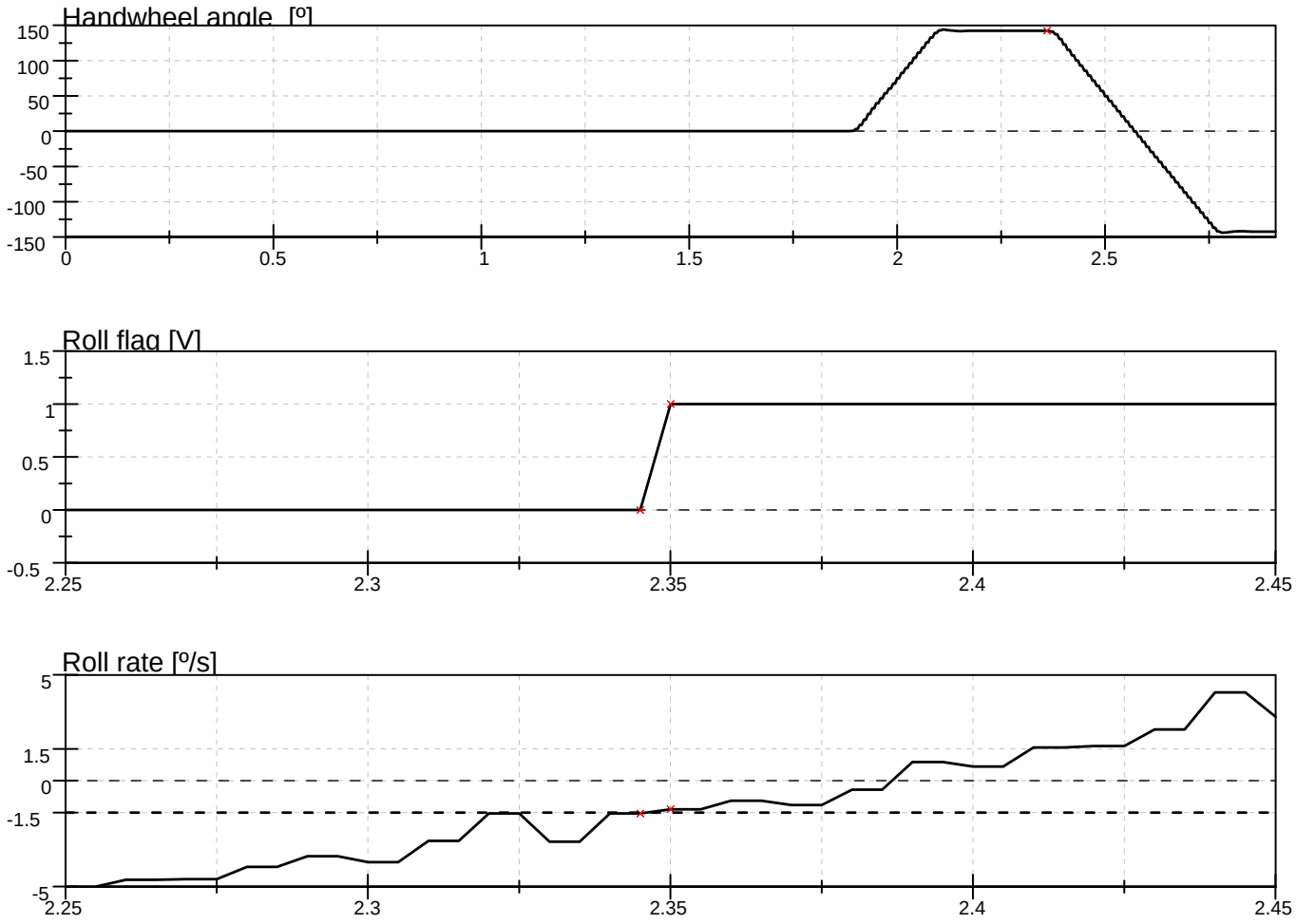


Figure D14. Steering Machine Operation Time History Plots for Supplemental 2 Test Series, R-L, 50 mph

FILENAME: FH_030

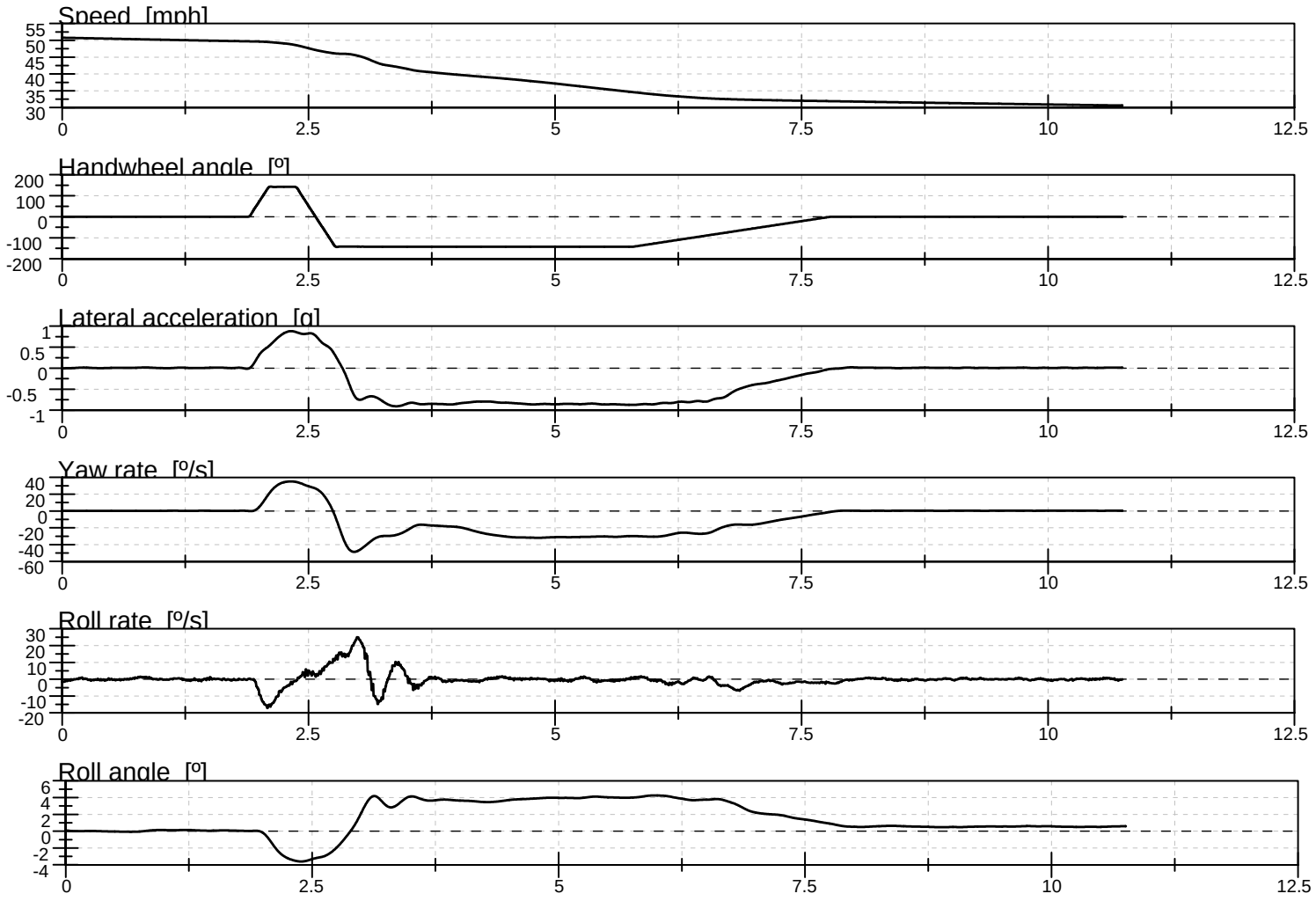


Figure D15. Yaw Rate, Roll Rate, and Lateral Acceleration Time History Plots for Supplemental 2 Test Series, R-L, 50 mph

FILENAME: FH_030

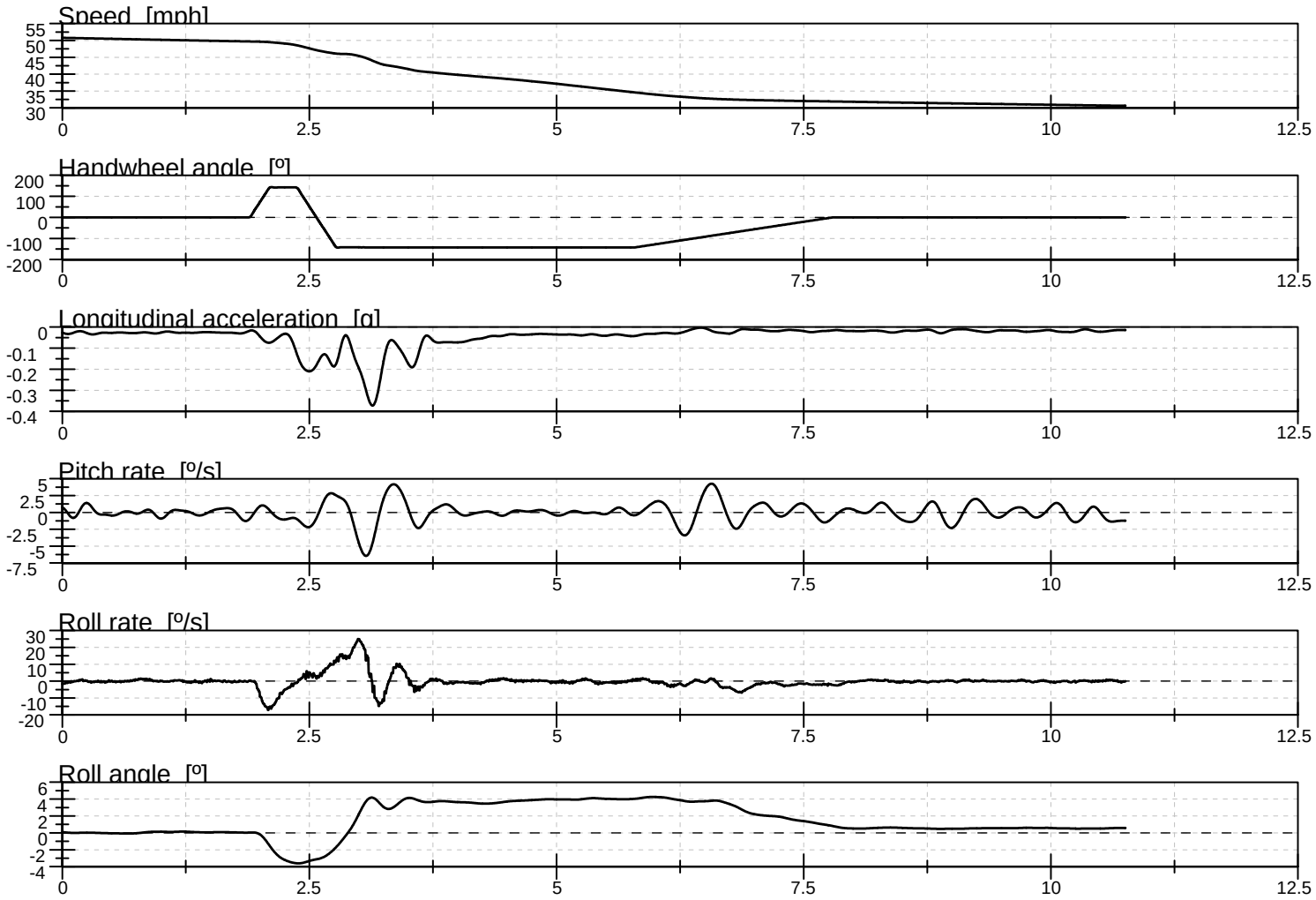


Figure D16. Pitch Rate and Longitudinal Acceleration Time History Plots for Supplemental 2 Test Series, R-L, 50 mph