126-DRI-09-002

SAFETY COMPLIANCE TESTING FOR FMVSS 126
Electronic Stability Control Systems

Kia
2009 Borrego LX
NHTSA No. C90512

DYNAMIC RESEARCH, INC.
355 Van Ness Avenue, STE 200
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October 29, 2009

FINAL REPORT

Prepared Under Contract No.: DTNH22-08-D-00098

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
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Washington, DC 20590

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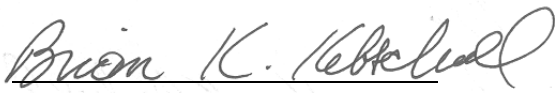
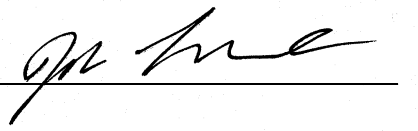
Prepared By: 

Approved By: 

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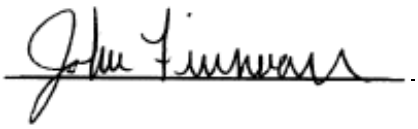
Accepted By: 

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16. Abstract A test was conducted on a 2009 Kia Borrego, NHTSA No. C90512, in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-126-02 for the determination of FMVSS 126 compliance. Test failures identified were as follows: None			
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1.0 PURPOSE OF COMPLIANCE TEST

The purpose of this test is to determine if the test vehicle, a 2009 Kia Borrego, meets the minimum equipment and performance requirements stated in Federal Motor Vehicle Safety Standard (FMVSS) 126, "Electronic Stability Control Systems."

2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS

Testing of the 2009 Kia Borrego was conducted at Dynamic Research, Inc (DRI) in accordance with NHTSA TP-126-02, dated November 19, 2008.

The vehicle was inspected to ensure it was equipped with an ESC system that:

- Augments vehicle directional stability by applying and adjusting brake torques individually at each wheel to induce a correcting yaw moment to a vehicle;
- Is computer controlled with the computer using a closed-loop algorithm to limit vehicle oversteer and to limit vehicle understeer;
- Has a means to determine the vehicle's yaw rate and to estimate its side slip or side slip derivative with respect to time;
- Has a means to monitor driver steering inputs;
- Has an algorithm to determine the need, and a means to modify engine torque, as necessary, to assist the driver in maintaining control of the vehicle; and
- Is operational over the full speed range of the vehicle (except at vehicle speeds less than 20 km/h (12.4 mph), when being driven in reverse, or during system initialization).

The vehicle was subjected to a 0.7 Hz sine with dwell steering maneuver to ensure that it would meet the stability and responsiveness requirements of the standard as follows:

- At 1.0 second after completion of a required sine with dwell steering input, the yaw rate of the vehicle must not exceed 35 percent of the first peak value of yaw rate recorded after the steering wheel angle changes sign (between first and second peaks during the same test run).

2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS (CONTINUED)

- At 1.75 seconds after completion of a required sine with dwell steering input, the yaw rate of the vehicle must not exceed 20 percent of the first peak value of yaw rate recorded after the steering wheel angle changes sign (between first and second peaks during the same test run).

- The lateral displacement of the vehicle center of gravity with respect to its initial straight path must be at least 1.83 m (6 feet) (for vehicles with a GVWR of 3,500kg (7,716 lb) or less) when computed 1.07 seconds after the Beginning of Steer (BOS) at the specified steering wheel angles.

System malfunction simulations were executed to verify vehicle could identify and indicate a malfunction.

The vehicle's ESC System appears to meet the performance and equipment requirements as required by FMVSS 126. The test results are summarized on the following summary sheet.

2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS (CONTD)

Data Summary Sheet (Page 1 of 2)

Vehicle: *2009 Kia Borrego*

NHTSA No *C90512* VIN: *KNDJJ741X95012203*

Vehicle Type: *MPV* Manufacture Date: *5/08*

Laboratory: *Dynamic Research, Inc.*

REQUIREMENTS:	**PASS/FAIL**
ESC Equipment and Operational Characteristics (Data Sheet 2)	
The vehicle is to be equipped with an ESC system that meets the equipment and operational characteristics requirements. (S126, S5.1, S5.6)	***PASS***
ESC Malfunction Telltale (Data Sheet 3)	
Vehicle is equipped with a telltale that indicates one or more ESC system malfunctions. (S126, S5.3)	***PASS***
"ESC Off" and other System Controls and Telltale (Data Sheet 3,4)	
Vehicle is equipped with an ESC off telltale indicating the vehicle has been put into a mode that renders the ESC system unable to satisfy the performance requirements of the standard, if such a mode exists. (S5.5.1)	***PASS***
If provided, off control and other system controls as well as the ESC off telltale meets the operational requirements (S126, S5.4, S5.4.1,S5.4.2, S5.5.4, and S5.5.9)	***PASS***

2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS (CONTD)

Data Summary Sheet (Page 2 of 2)

REQUIREMENTS:	PASS/FAIL
Vehicle Lateral Stability (Data Sheet 8)	
Yaw Rate Ratio at 1 second after COS is less than 35% of peak value. (S126, S5.2.1)	***PASS***
Yaw Rate Ratio at 1.75 seconds after COS is less than 20% of peak value. (S126, S5.2.2)	***PASS***
Vehicle Responsiveness (Data Sheet 8)	
Lateral displacement at 1.07 seconds after BOS is at least 1.83 m (6 feet) for vehicles with a GVWR of 3,500kg (7,716 lb) or less, and 1.52 m (5 feet) for vehicles with a GVWR greater than 3,500 Kg (7,716 lb). (S126, S5.2.3)	***PASS***
ESC Malfunction Warning (Data Sheet 9)	
Warning is provided to driver after malfunction occurrence. (S126. S5.3)	***PASS***
Malfunction telltale stayed illuminated as long as malfunction existed and must extinguish after malfunction was corrected. (S126, S5.3.7)	***PASS***

3.0 TEST DATA

Data Sheet 1 (Page 1 of 2)
TEST VEHICLE INSPECTION AND TEST PREPARATION

Vehicle: *2009 Kia Borrego :MPV*

NHTSA No *C90512* Data sheet completion date: *7/24/2009*

VIN: *KNDJJ741X95012203* Manufacture Date: *5/08*

GVWR (kg): *2650* Front GAWR (kg): *1300* Rear GVWR (kg): *1650*

Seating Positions Front: *2* Mid: *3* Rear: *2*

Odometer reading at time of inspection: *141 (226) miles (km)*

DESIGNATED TIRE SIZE(S) FROM VEHICLE LABELING:

Front Axle: *P245/70 R17* Rear Axle: *P245/70 R17*

INSTALLED TIRE SIZE(S) ON VEHICLE (from tire sidewall)

	Front Axle	Rear Axle
Tire Manufacturer:	*Hankook*	*Hankook*
Tire Model:	*Radial RA07*	*Radial RA07*
Tire Size:	*P245/70 R17*	*P245/70 R17*

TIN Left Front: *T7M0 AEH 2508* Right Front: *T7M0 AEH 2508*

Left Rear: *T7M0 AEH 2508* Right Rear: *T7M0 AEH 2508*

Are installed tire sizes same as labeled tire sizes? *Yes*
If no, contact COTR for further guidance

DRIVE CONFIGURATION(S):(mark all that apply)

☑ Two Wheel Drive (2WD) ☐ Front Wheel Drive ☑ Rear Wheel Drive

☐ All Wheel Drive (AWD)

☐ Four Wheel Drive Automatic - differential no locked full time (4WD Automatic)

☐ Four Wheel Drive (High Gear Locked Differential 4WD HGLD)

☐ Four Wheel Drive Low Gear (4WD Low)

☐ Other Describe

3.0 TEST DATA (CONTD)

Data Sheet 1 (Page 2 of 2)
TEST VEHICLE INSPECTION AND TEST PREPARATION

DRIVE CONFIGURATIONS AND MODES: (ex. default, performance, off)

(For each of the vehicle's drive configurations identify available operating modes)

Drive Configuration: *2WS*
Mode: *Default*
Drive Configuration:
Mode:
Drive Configuration:
Mode:

VEHICLE STABILITY SYSTEMS (Check applicable technologies):

☑ ESC ☑ Traction Control ☑ Roll Stability Control

☐ Active Suspension ☑ Electronic Throttle Control ☐ Active Steering

☑ ABS

List other systems:

REMARKS:

RECORDED BY: *J Brubacher* DATE RECORDED: *7/24/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/10/2009*

3.0 TEST DATA (CONTD)

Data Sheet 2 (Page 1 of 2)
ESC SYSTEM HARDWARE AND OPERATIONAL CHARACTERISTICS

Vehicle: *2009 Kia Borrego*

NHTSA No *C90512* Data Sheet Completion Date: *7/24/2009*

ESC SYSTEM IDENTIFICATION

Manufacturer/Model *Mando / MGH-40-ESC*

ESC SYSTEM HARDWARE (Check applicable hardware)

☑ Electronic Control Unit ☑ Hydraulic Control Unit

☑ Wheel Speed Sensors ☑ Steering Angle Sensor

☑ Yaw Rate Sensor ☑ Lateral Acceleration Sensor

List other Components: *Engine management interface*

ESC OPERATIONAL CHARACTERISTICS

System is capable of generating brake torque at each wheel — *_X_ Yes (Pass) ____ No (Fail)*
List and describe Components: *Electronics Control unit can command individual brake torques to hydraulic control unit and individual brakes*

System is capable of determining yaw rate — *_X_ Yes (Pass) ____ No (Fail)*
List and describe Components: *Yaw rate sensor*

System is capable of monitoring driver steering input — *_X_ Yes (Pass) ____ No (Fail)*
List and describe Components: *Steering wheel angle sensor*

System is capable of estimating side slip or side slip derivative — *_X_ Yes (Pass) ____ No (Fail)*
List and describe Components: *Yaw Rate & Lateral Acceleration sensor, Steering Angle sensor, Logic*

3.0 TEST DATA (CONTD)

Data Sheet 2 (Page 2 of 2)
ESC SYSTEM HARDWARE AND OPERATIONAL CHARACTERISTICS

ESC OPERATIONAL CHARACTERISTICS (continued)

System is capable of modifying engine torque during ESC activation. — _X_ Yes (Pass) ____ No (Fail)

Method used to modify torque: *Electronic control unit, CAN (Controller Area Network)*

System is capable of activation at speeds of 20 km/h (12.4 mph) and higher. — _X_ Yes (Pass) ____ No (Fail)

Speed system becomes active: *15* km/h

System is capable of activation during the following driving phases. — _X_ Yes (Pass) ____ No (Fail)

Driving phases during which ESC is capable of activation: *Acceleration, deceleration, coasting, during activation of ABS and during activation of ABS or Traction Control*

Vehicle manufacturer submitted documentation explaining how the ESC mitigates understeer — _X_ Yes (Pass) ____ No (Fail)

DATA INDICATES COMPLIANCE: _X_ Yes (Pass) ____ No (Fail)

REMARKS:

RECORDED BY: *J Brubacher* DATE RECORDED: *7/24/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/04/2009*

3.0 TEST DATA (CONTD)

Data Sheet 3 (Page 1 of 2)
ESC MALFUNCTION AND OFF TELLTALES

Make: *2009 Kia Borrego*

NHTSA No *C90512* Data sheet completion date: *8/04/2009*

ESC Malfunction Telltale

Vehicle is equipped with malfunction telltale? *Yes*

Telltale Location *Instrument panel near temperature gauge (Figure 6)*

Telltale Color *Amber*

Telltale symbol or abbreviation used

or **ESC**

☐ Vehicle uses this symbol

☐ Vehicles uses this abbreviation

☑ Neither symbol or abbreviation is used

If different than identified above, make note of any message, symbol or abbreviation used.

Refer to Figure 6. The "ESC" telltale identifies when the ESC system is activating. The "ESC OFF" telltale identifies when the ESC system has malfunctioned or has been turned off.

Is telltale part of a common space? *No*

Is telltale also used to indicate activation of the ESC system? *No (see explanation above.*

If yes explain telltale operation during ESC activation:

3.0 TEST DATA (CONTD)

Data Sheet 3 (Page 2 of 2)
ESC MALFUNCTION AND OFF TELLTALES

"ESC OFF" Telltale (if provided)

Vehicle is equipped with "ESC OFF" telltale? *Yes*

Is "ESC Off" telltale combined with "ESC Malfunction" telltale utilizing a two part telltale? *No. The same telltale is utilized for indicating a malfunction and when the system has been turned off but the telltale is not a two part telltale.*

Telltale Location *Instrument panel near temperature gauge (Figure 6)*

Telltale Color *Amber*

Telltale symbol or abbreviation used

or **ESC OFF**

☐ Vehicle uses this symbol
☑ Vehicle uses this abbreviation
☐ Neither symbol or abbreviation is used

If different than identified above, make note of any message, symbol or abbreviation used.

Is telltale part of a common space? *No*

DATA INDICATES COMPLIANCE: ***Pass***

(Vehicle is compliant if equipped with a malfunction telltale)

Remarks: *"ESC OFF" illuminates when the ESC has been manually switched off and also when there is an ESC malfunction. "ESC" indicator flashes when ESC is functioning, i.e., ESC is intervening.*

RECORDED BY: *J Lenkeit* DATE RECORDED: *8/11/2009*
APPROVED BY: *B Kebschull* DATE APPROVED: *9/10/2009*

3.0 TEST DATA (CONTD)

Data Sheet 4 (Page 1 of 3)
ESC AND ANCILLARY SYSTEM CONTROLS

Make: *2009 Kia Borrego*

NHTSA No *C90512* Data sheet completion date: *8/04/2009*

"ESC OFF" Controls Identification and Operational Check:

Is the vehicle equipped with a control or controls whose purpose is to deactivate the ESC system or place the ESC system in a mode or modes that may no longer satisfy the performance requirements of the standard? X Yes ___ No

Type of control or controls provided? (mark all that apply)

- ☑ Dedicated "ESC Off" control
- ☐ Multi-functional control with an "ESC Off" mode
- ☐ Other (describe)

Identify each control location, labeling and selectable modes.

First Control: Location *Left side of dash (refer to Figure 5.7)*
Labeling *ESC OFF*
Modes *ESC on/off*

Second Control: Location _____
Labeling _____
Modes _____

Identify standard or default drive configuration *RWD*

Verify standard or default drive configuration selected. X Yes ___ No

Does the "ESC Off" telltale illuminate upon activation of the dedicated ESC off control or selection of the "ESC Off" mode on the multi-function control?

X Yes ___ No (Fail)

Does the "ESC Off" telltale extinguish when the ignition is cycled from "On" ("Run") to "Lock" or "Off" and then back again to the "On" ("Run")

X Yes ___ No (Fail)

If no, describe how the off control functions

3.0 TEST DATA (CONTD)

Data Sheet 4 (Page 2 of 3)
ESC AND ANCILLARY SYSTEM CONTROLS

If a multi-function control is provided, cycle through each mode setting on the control and record which modes illuminate the "ESC Off" telltale. Also, for those modes that illuminate the ESC Off" telltale identify if the telltale extinguishes upon cycling the ignition system.

Control Mode	"ESC Off" telltale illuminates upon activation of control? (Yes/No)	"ESC Off" telltale extinguishes upon cycling ignition? (Yes/No)
None		

For each mode that illuminates the "ESC Off" telltale, did the telltale extinguish when the ignition was cycled from "On" ("Run") to "Lock" or "Off" and then back again to the "On" ("Run") position? _____Yes _____No (Fail)

Other System Controls that have an ancillary effect on ESC Operation:

Is the vehicle equipped with any ancillary controls that upon activation may deactivate the ESC system or place the ESC system in a mode or modes that may no longer satisfy the performance requirements of the standard?

_____Yes __X__No

Ancillary Control: System *None*

Control Description _____

Labeling _____

Ancillary Control: System _____

Control Description _____

Labeling _____

Ancillary Control: System _____

Control Description _____

Labeling _____

3.0 TEST DATA (CONTD)

Data Sheet 4 (Page 3 of 3)
ESC AND ANCILLARY SYSTEM CONTROLS

Activate each control listed above and record whether the control illuminates the "ESC Off" telltale. Also, record warnings or messages provided regarding the ESC system.

Ancillary Control	Control Activates "ESC Off" Telltale? (Yes/No)	Warnings or Messages Provided
None		

For those controls that illuminate the "ESC Off" telltale above identify if the "ESC Off" telltale extinguishes upon cycling the ignition system.

Ancillary Control	"ESC Off" telltale extinguishes upon cycling ignition? (Yes/No)
None	

For each control that illuminates the "ESC Off" telltale, did the telltale extinguish when the ignition is cycled from "On" ("Run") to "Lock" or "Off" and then back again to the "On" ("Run") position? If the control activated places the vehicle into a low-range four-wheel drive configuration designed for low-speed, off–road driving, the ESC system may remain turned off after the ignition has been cycled off and then back on and therefore the "ESC Off" telltale may not extinguish.

_____Yes _____No (Fail)

DATA INDICATES COMPLIANCE: ***Pass***

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *8/04/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/10/2009*

3.0 TEST DATA (CONTD)

Data Sheet 5 (Page 1 of 3)
TEST TRACK AND VEHICLE DATA

Vehicle: *2009 Kia Borrego*

NHTSA No *C90512* Data sheet completion date: *8/05/2009*

Test Track Requirements: Test surface slope (0-1%) *0.5%*

Peak Friction Coefficient (at least 0.9) *0.94*

Test track data meets requirements: *Yes*

If no, explain:

Full Fluid Levels: Fuel *Yes* Coolant *Yes* Other Fluids *Yes*

(specify) *Oil, ATF*

Tire Pressures: Required; Front Axle *220* KPA Rear Axle *220* KPA

Actual; LF *220* KPA RF *220* KPA

LR *220* KPA RR *220* KPA

Vehicle Dimensions: Front Track Width *163.1* cm Wheelbase *289.6* cm

Rear Track Width *164.1* cm

Vehicle Weight Ratings: GAWR Front *1300* KG GAWR Rear *1650* KG

Unloaded Vehicle Weight (UVW):

Front axle	*1015.0*	KG	Left Front	*521.1*	KG	Right Front	*493.9*	KG
Rear axle	*950.6*	KG	Left Rear	*476.7*	KG	Right Rear	*473.9*	KG

Total UVW *1965.6* KG

Baseline Weight and Outrigger Selection (only for MPVs, Trucks, Buses)

Calculated baseline weight (UVW + 73kg) *2038.6* KG

Outrigger size required ("Standard" or "Heavy") *Standard*

Standard - Baseline weight under 2772 kg (6000 lb)
Heavy - Baseline weight equal to or greater than 2772 kg (6000 lb)

3.0 TEST DATA (CONTD)

Data Sheet 5 (Page 2 of 3)
TEST TRACK AND VEHICLE DATA

UVW with Outriggers: (only for MPVs, Trucks, Buses)

Front axle	*1054.9* KG	Left Front	*533.8* KG	Right Front	*521.1* KG
Rear axle	*964.5* KG	Left Rear	*490.7* KG	Right Rear	*473.5* KG

Total UVW with outriggers *2019.1* KG

Loaded Vehicle Weight w/Driver and Instrumentation (no Ballast)

Front axle	*1143.8* KG	Left Front	*600.5* KG	Right Front	*543.3* KG
Rear axle	*1039.5* KG	Left Rear	*537.9* KG	Right Rear	*501.6* KG

Vehicle Weight *2183.3* KG

Ballast Required =

[Total UVW with Outriggers (if applicable)]	+ *168* KG	- [Loaded Weight w/Driver and Instrumentation)]
= *2019.1* KG	+ *168* KG	- *2183.3* KG

= *3.8* KG

Total Loaded Vehicle Weight w/Driver and Instrumentation and Ballast

Front axle	*1144.7* KG	Left Front	*600.9* KG	Right Front	*543.8* KG
Rear axle	*1042.1* KG	Left Rear	*539.2* KG	Right Rear	*502.9* KG

Total UVW *2186.8* KG

3.0 TEST DATA (CONTD)

Data Sheet 5 (Page 3 of 3)
TEST TRACK AND VEHICLE DATA

Center of Gravity and Inertial Sensing System Location at Loaded Vehicle Condition:

x-distance (longitudinal)	Point of reference is the front axle centerline. (Positive from front axle toward rear of vehicle.)
y-distance (lateral)	Point of reference is the vehicle centerline. (Positive from the center toward the right.)
z-distance (vertical)	Point of reference is the ground plane. Positive from the ground up.)

Locations:

	Center of Gravity		Inertial Sensing System	
x-distance	*54.33* in	*138* cm	*69.92* in	*177.6* cm
y-distance	*-1.37* in	*-3.48* cm	*-0.25* in	*-0.64* cm
z-distance	*26.29* in	*66.77* cm	*+23.5* in	*+59.6* cm

Roof Height	*69.18*	in	*175.7*	cm
Distance between ultrasonic sensors	*88.4*	in	*224.6*	cm

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *8/05/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/10/2009*

3.0 TEST DATA (CONTD)

Data Sheet 6 (Page 1 of 3)
BRAKE AND TIRE CONDITIONING

Vehicle: *2009 Kia Borrego*

NHTSA No *C90512*

Measured tire pressure: LF *220* KPA RF *220* KPA

LR *220* KPA RR *220* KPA

Wind Speed *2.2* m/s (10 m/sec (22 mph) max for passenger cars; 5m/sec (11 mph) max for MPVs and trucks)

Ambient Temperature (7°C (45°F) - 40°C (104°F)) *29.4* °C

Brake Conditioning Time: *11:20:00 AM* Date: *8/05/2009*

56 km/h (35 mph) Brake Stops

Number of stops executed (10 required) *10* Stops

Observed deceleration rate range (.5g target) *0.45 – 0.55* g

72 km/h (45 mph) Brake Stops

Number of stops executed (3 required) *3* Stops

Number of stops ABS activated (3 required) *3* Stops

Observed deceleration rate range *0.8 – 0.9* g

72 km/h (45 mph) Brake Cool Down Period

Duration of cool down period (5 minutes min.) *5* Minutes

3.0 TEST DATA (CONTD)

Data Sheet 6 (Page 2 of 3)
BRAKE AND TIRE CONDITIONING

Tire Conditioning series No. 1 Time: *11:39:00 AM* Date: *8/05/2009*

Measured cold tire pressure LF *234* KPA RF *248* KPA

LR *241* KPA RR *248* KPA

Wind Speed *2.2* m/s (10 m/sec (22 mph) max for passenger cars; 5m/sec (11 mph) max for MPVs and trucks)

Ambient Temperature (7°C (45°F) - 40°C (104°F)) *29.4*°C

30 meter (100 ft) Diameter Circle Maneuver				
Test Run	Steering Direction	Target Lateral Acceleration (g)	Observed Lateral (g)	Observed Vehicle Speed (Km/h)
1-3	Clockwise	0.5 – 0.6	*0.5 – 0.6*	*32*
4-6	Counterclockwise	0.5 – 0.6	*0.5 – 0.6*	*32*

5-1 Hz Cycle Sinusoidal Steering Maneuver to Determine Steering Wheel Angle for 0.5-0.6 g Lateral Acceleration					
Test Run	Data File	Vehicle Speed Km/h(mph)	Steering Wheel Angle (degrees)	Target Peak Lateral Acceleration (g)	Observed Peak Lateral Acceleration (g)
1	2	56 ± 2 (35 ± 1)	*60*	0.5 - 0.6	*0.44*
2	3	56 ± 2 (35 ± 1)	*80*	0.5 - 0.6	*0.58*
3		56 ± 2 (35 ± 1)		0.5 - 0.6	
4		56 ± 2 (35 ± 1)		0.5 - 0.6	

Steering wheel angle that corresponds to a peak 0.5-0.6 g lateral acceleration: *80* degrees

10-1 Hz Cycle Sinusoidal Steering Maneuver					
Test Run	Data File	Vehicle Speed Km/h (mph)	Steering Wheel Angle (degrees)	Target Peak Lateral Acceleration (g)	Observed Peak Lateral Acceleration (g)
1-3	4-6	56 ± 2 (35 ± 1)	*80* (cycles 1-10)	0.5 - 0.6	*0.56*
4	7	56 ± 2 (35 ± 1)	*80* (cycles 1-9)	0.5 - 0.6	*0.56*
			160 (cycle10)*	NA	*0.74*

* The steering wheel angle used for cycle 10 should be twice the angle used for cycles 1-9

3.0 TEST DATA (CONTD)

Data Sheet 6 (Page 3 of 3)
BRAKE AND TIRE CONDITIONING

Tire Conditioning series No. 2 Time: *2:45:00 PM* Date: *8/05/2009*

Measured cold tire pressure LF *245* KPA RF *245* KPA

LR *245* KPA RR *240* KPA

Wind Speed *0.9* m/s (10 m/sec (22 mph) max for passenger cars; 5m/sec (11 mph) max for MPVs and trucks)

Ambient Temperature (7°C (45°F) - 40°C (104°F)) *32.2*°C

30 meter (100 ft) Diameter Circle Maneuver				
Test Run	Steering Direction	Target Lateral Acceleration (g)	Observed Lateral (g)	Observed Vehicle Speed (Km/h)
1-3	Clockwise	0.5 - 0.6	*.05 - 0.6*	*33 – 34*
4-6	Counterclockwise	0.5 - 0.6	*.05 - 0.6*	*33 - 34*

Steering wheel angle that corresponds to a peak 0.5-0.6 g lateral acceleration: *80*

10-1 Hz Cycle Sinusoidal Steering Maneuver					
Test Run	Data File	Vehicle Speed Km/h (mph)	Steering Wheel Angle (degrees)	Target Peak Lateral Acceleration (g)	Observed Peak Lateral Acceleration (g)
1-3	16-18	56 ± 2 (35 ± 1)	*80* (cycles 1-10)	0.5 - 0.6	*0.56*
4	19	56 ± 2 (35 ± 1)	*80* (cycles 1-9)	0.5 - 0.6	*0.56*
			160 (cycle10)*	NA	*0.74*

* The steering wheel angle used for cycle 10 should be twice the angle used for cycles 1-9

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *8/05/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/11/2009*

3.0 TEST DATA (CONTD)

Data Sheet 7 (Page 1 of 2)
SLOWLY INCREASING STEER (SIS) MANEUVER

Vehicle: *2009 Kia Borrego*

NHTSA No *C90512*

Measured tire pressure: LF *240* KPA RF *235* KPA

LR *240* KPA RR *235* KPA

Wind Speed *1.8* m/s

(10 m/sec (22 mph) max for passenger cars; 5m/sec (11 mph) max for MPVs and trucks)

Ambient Temperature (7°C (45°F) - 40°C (104°F)) *32*°C

Selected drive configuration *RWD (default)*

Selected Mode: *default*

Preliminary Left Steer Maneuver:

Lateral Acceleration measured at 30 degrees steering wheel angle

$a_{y,30\text{degrees}}$ = *0.35* g

Assuming a linear relationship the following ratio should be used to calculate the steering wheel angle at 0.55g:

$$\frac{30\,\text{degrees}}{a_{\text{y,30degrees}}} = \frac{\delta_{SIS}}{0.55\,\text{g}}$$

δ_{sis} = *47.14* degrees (@.55g)

δ_{sis} = *50* degrees (rounded)

Steering Wheel Angle at Corrected 0.3g Lateral Acceleration:

Maneuver	Initial Steer Direction	Time Clock	Steering Wheel Angle to nearest 0.1 (degrees)	Data Run	Good/NG
1	Left	*1:37:00 PM*	*-28.7*		*Good*
2	Left	*1:41:00 PM*	*-29.2*		*Good*
3	Left	*1:46:00 PM*	*-29.6*		*Good*
4	Left				
5	Left				
1	Right	*1:51:00 PM*	*30.3*		*Good*
2	Right	*1:56:00 PM*	*30.8*		*Good*
3	Right	*2:01:00 PM*	*30.6*		*Good*
4	Right				
5	Right				

3.0 TEST DATA (CONTD)

Data Sheet 7 (Page 2 of 2)
SLOWLY INCREASING STEER (SIS) MANEUVER

Average Overall Steering Wheel Angle:

$$\delta_{0.3\ g,\ overall} = (\left| \delta_{0.3\ g,\ left\ (1)} \right| + \left| \delta_{0.3\ g,\ left\ (2)} \right| + \left| \delta_{0.3\ g,\ left\ (3)} \right| + \delta_{0.3\ g,\ right\ (1)} + \delta_{0.3\ g,\ right\ (2)} + \delta_{0.3\ g,\ right\ (3)}) / 6$$

$\delta_{0.3\ g,\ overall}$ = 29.9 degrees

[to nearest 0.1 degree]

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *8/05/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/11/2009*

3.0 TEST DATA (CONTD)

Data Sheet 8 (Page 1 of 3)
VEHICLE LATERAL STABILITY AND RESPONSIVENESS

Tire conditioning completed	☑Yes	☐ No
ESC system is enabled	☑Yes	☐ No
On track calibration checks have been completed	☑Yes	☐ No
On track static data file for each sensor obtained	☑Yes	☐ No

Selected Drive Configuration: *RWD (default)*

Selected Mode: *default*

Overall steering wheel angle ($\delta_{0.3\ g,\ overall}$) *29.9* degrees

Lateral Stability Test Series No. 1 – Counterclockwise Initial Steer Direction

Maneuver #	Clock Time (1.5 – 5.0 min max between runs)	Commanded Steering Wheel Angle[1]		Yaw Rates (degrees/sec)			YRR at 1.0 sec after COS [≤ 35%]		YRR at 1.75 sec after COS [≤ 20%]	
		Scalar (* $\delta_{0.3\ g}$)	Angle (degrees)	$\dot{\psi}_{Peak}$	$\dot{\psi}_{1.0sec}$	$\dot{\psi}_{1.75sec}$	%	Pass/Fail	%	Pass/Fail
1	3:11:00 PM	1.5	45	12.8	-0.2	-0.2	-1.7	Pass	-1.8	Pass
2	3:16:00 PM	2	60	17.4	0.1	0.0	0.4	Pass	0.1	Pass
3	3:19:00 PM	2.5	75	21.8	0.2	0.3	1.1	Pass	1.2	Pass
4	3:22:00 PM	3	90	27.3	0.3	0.1	1.0	Pass	0.4	Pass
5	3:25:00 PM	3.5	105	32.9	0.5	-0.1	1.6	Pass	-0.2	Pass
6	3:28:00 PM	4	120	37.5	0.1	0.2	0.3	Pass	0.6	Pass
7	3:31:00 PM	4.5	135	41.0	-0.1	0.0	-0.3	Pass	0.0	Pass
8	3:33:00 PM	5	150	42.7	-0.1	-0.2	-0.1	Pass	-0.4	Pass
9	3:36:00 PM	5.5	164	44.0	0.1	0.1	0.2	Pass	0.2	Pass
10	3:39:00 PM	6	179	45.1	0.2	0.0	0.3	Pass	0.1	Pass
11	3:41:00 PM	6.5	194	46.9	-0.3	-0.2	-0.7	Pass	-0.4	Pass
12	3:44:00 PM	7	209	45.5	0.0	0.2	-0.1	Pass	0.4	Pass
13	3:47:00 PM	7.5	224	45.3	0.0	0.0	0.0	Pass	0.0	Pass
14	3:50:00 PM	8	239	46.9	0.2	0.0	0.3	Pass	0.1	Pass
15	3:53:00 PM	8.5	254	42.6	-0.2	0.0	-0.4	Pass	0.0	Pass
16	3:58:00 PM	9	269	45.8	-0.1	-0.1	-0.2	Pass	-0.2	Pass
17	4:01:00 PM		270	45.6	0.2	0.0	0.4	Pass	0.1	Pass

1. Maneuver execution should continue until a steering wheel angle magnitude factor of 6.5*$\delta_{0.3\ g,\ overall}$ or 270 degrees is utilized, whichever is greater provided the calculated magnitude of 6.5*$\delta_{0.3\ g,\ overall}$ is less than or equal to 300 degrees. If 6.5*$\delta_{0.3\ g,\ overall}$ is less than 270 degrees maneuver execution should continue by increasing the steering wheel angle magnitude by multiples of 0.5*$\delta_{0.3\ g,\ overall}$ without exceeding the 270 degree steering wheel angle.

3.0 TEST DATA (CONTD)

Data Sheet 8 (2 of 3)
VEHICLE LATERAL STABILITY AND RESPONSIVENESS

Lateral Stability Test Series No. 2 – Clockwise Initial Steer Direction

Maneuver #	Clock Time (1.5 – 5.0 min max between runs)	Commanded Steering Wheel Angle[1]		Yaw Rates (degrees/sec)			YRR at 1.0 sec after COS [< 35%]		YRR at 1.75 sec after COS [< 20%]	
		Scalar (* $\delta_{0.3\,g}$)	Angle (degrees)	$\dot{\psi}_{Peak}$	$\dot{\psi}_{1.0sec}$	$\dot{\psi}_{1.75sec}$	%	Pass/Fail	%	Pass/Fail
1	4:03:00 PM	1.5	45	-13.4	0.1	0.0	-0.6	Pass	0.2	Pass
2	4:06:00 PM	2	60	-18.1	-0.1	-0.1	0.7	Pass	0.7	Pass
3	4:08:00 PM	2.5	75	-22.7	0.0	0.0	0.0	Pass	-0.2	Pass
4	4:11:00 PM	3	90	-27.9	-0.2	0.0	0.7	Pass	0.1	Pass
5	4:14:00 PM	3.5	105	-32.8	-0.2	-0.1	0.6	Pass	0.4	Pass
6	4:16:00 PM	4	120	-37.6	-0.2	-0.2	0.6	Pass	0.4	Pass
7	4:18:00 PM	4.5	135	-40.7	0.0	0.0	-0.1	Pass	0.1	Pass
8	4:20:00 PM	5	150	-43.8	0.0	0.1	0.1	Pass	-0.3	Pass
9	4:23:00 PM	5.5	164	-45.0	0.0	-0.1	0.1	Pass	0.3	Pass
10	4:25:00 PM	6	179	-45.6	0.0	0.1	0.0	Pass	-0.2	Pass
11	4:28:00 PM	6.5	194	-46.8	0.0	-0.1	0.1	Pass	0.1	Pass
12	4:30:00 PM	7	209	-46.0	0.1	0.1	-0.3	Pass	-0.2	Pass
13	4:33:00 PM	7.5	224	-48.0	0.1	0.1	-0.1	Pass	-0.2	Pass
14	4:35:00 PM	8	239	-46.7	-0.1	-0.1	0.2	Pass	0.2	Pass
15	4:37:00 PM	8.5	254	-49.9	-0.1	0.0	0.2	Pass	0.0	Pass
16	4:40:00 PM	9	269	-55.5	-0.1	-0.1	0.1	Pass	0.2	Pass
17	4:43:00 PM		270	-50.4	-0.2	0.0	0.4	Pass	0.0	Pass

1. Maneuver execution should continue until a steering wheel angle magnitude factor of $6.5*\delta_{0.3\,g,\,overall}$ or 270 degrees is utilized, whichever is greater provided the calculated $6.5*\delta_{0.3\,g,\,overall}$ is less than or equal to 300 degrees. If $6.5*\delta_{0.3\,g,\,overall}$ is less than 270 degrees maneuver execution should continue by increasing the steering wheel angle magnitude by multiples of $0.5*\delta_{0.3\,g,\,overall}$ without exceeding the 270 degree steering wheel angle.

During execution of the sine with dwell maneuvers were any of the following events observed?

Rim-to-pavement contact	☐ Yes	☑ No
Tire debeading	☐ Yes	☑ No
Loss of pavement contact of vehicle tires	☐ Yes	☑ No
Did the test driver experience any vehicle loss of control or spinout?	☐ Yes	☑ No

If "Yes" explain the event and consult with the COTR. _____

3.0 TEST DATA (CONTD)

Data Sheet 8 (3 of 3)
VEHICLE LATERAL STABILITY AND RESPONSIVENESS

Responsiveness – Lateral Displacement

Maneuver #	Initial Steer Direction	Commanded Steering Wheel Angle ($5.0*\delta_{0.3\ g,\ overall}$ or greater)		Calculated Lateral Displacement[1]	
		Scalar $*\delta_{0.3\ g}$	Angle (degrees)	Distance (m)	Pass/Fail
8	Counterclockwise	5	150	-2.9	Pass
9	Counterclockwise	5.5	164	-2.9	Pass
10	Counterclockwise	6	179	-2.9	Pass
11	Counterclockwise	6.5	194	-3.0	Pass
12	Counterclockwise	7	209	-3.0	Pass
13	Counterclockwise	7.5	224	-2.9	Pass
14	Counterclockwise	8	239	-2.9	Pass
15	Counterclockwise	8.5	254	-2.9	Pass
16	Counterclockwise	9	269	-2.9	Pass
17	Counterclockwise		270	-2.9	Pass
8	Clockwise	5	150	2.7	Pass
9	Clockwise	5.5	164	2.8	Pass
10	Clockwise	6	179	2.9	Pass
11	Clockwise	6.5	194	2.9	Pass
12	Clockwise	7	209	2.9	Pass
13	Clockwise	7.5	224	2.9	Pass
14	Clockwise	8	239	2.9	Pass
15	Clockwise	8.5	254	2.9	Pass
16	Clockwise	9	269	3.0	Pass
17	Clockwise		270	3.0	Pass

1. Lateral displacement should be $\geq$ 1.83 m (6 ft) for vehicle with a GVWR of 3,500 kg (7,716 lb) or less; and $\geq$ 1.52 m (5 ft) for vehicles with GVWR greater than 3,500 kg (7,716 lb).

DATA INDICATES COMPLIANCE: ☑ PASS ☐ FAIL

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *8/05/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/11/2009*

3.0 TEST DATA (CONTD)

Data Sheet 9 (Page 1 of 2)
MALFUNCTION WARNING TESTS

Vehicle: *2009 Kia Borrego*

NHTSA No *C90512* Data Sheet Completion Date: *8/05/2009*

TEST 1

METHOD OF MALFUNCTION SIMULATION:

Describe method of malfunction simulation:

Remove ABS2 fuse

MALFUNCTION TELLTALE ILLUMINATION:

Telltale illuminates and remains illuminated after ignition locking system is activated and if necessary the vehicle is driven at least 2 minutes as specified.

X Yes _____ No

Time for telltale to illuminate after ignition system is activated and vehicle speed of 48 ± 8 km/h (30 ± 5mph) is reached.

0 Seconds (must be within 2 minutes) X Pass _____ Fail

ESC SYSTEM RESTORATION

Telltale extinguishes after ignition locking system is activated and if necessary the vehicle is driven at least 2 minutes as specified.

X Yes _____ No

Time for telltale to extinguish after ignition system is activated and vehicle speed of 48 ± 8 km/h (30 ± 5mph) is reached.

0 Seconds (must be within 2 minutes) X Pass _____ Fail

TEST 1 DATA INDICATES COMPLIANCE: PASS/FAIL

Remarks: Vehicle did not require any driving for malfunction identification or system restoration.

RECORDED BY: *B Kebschull* DATE RECORDED: *8/05/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/11/2009*

3.0 TEST DATA (CONTD)

Data Sheet 9 (Page 2 of 2)
MALFUNCTION WARNING TESTS

Vehicle: *2009 Kia Borrego*

NHTSA No *C90512* Data Sheet Completion Date: *8/05/2009*

TEST 2

METHOD OF MALFUNCTION SIMULATION:

Describe method of malfunction simulation:

Disconnect left front wheel speed sensor

MALFUNCTION TELLTALE ILLUMINATION:

Telltale illuminates and remains illuminated after ignition locking system is activated and if necessary the vehicle is driven at least 2 minutes as specified.

X Yes _____ No

Time for telltale to illuminate after ignition system is activated and vehicle speed of 48 ± 8 km/h (30 ± 5mph) is reached.

0 Seconds (must be within 2 minutes) X Pass _____ Fail

ESC SYSTEM RESTORATION

Telltale extinguishes after ignition locking system is activated and if necessary the vehicle is driven at least 2 minutes as specified.

X Yes _____ No

Time for telltale to extinguish after ignition system is activated and vehicle speed of 48 ± 8 km/h (30 ± 5mph) is reached.

0 Seconds (must be within 2 minutes) X Pass _____ Fail

TEST 2 DATA INDICATES COMPLIANCE: PASS/FAIL

Remarks: Vehicle did not require any driving for malfunction identification or system restoration.

RECORDED BY: *B Kebschull* DATE RECORDED: *8/05/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/11/2009*

4.0 TEST EQUIPMENT LIST AND CALIBRATION INFORMATION (1 OF 2)

TABLE 1. TEST INSTRUMENTATION

Type	Output	Range	Resolution	Accuracy	Specifics	Serial Number	Calibration
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	1 psi 6.89 kPa	0.5 psi 3.45 kPa	Ashcroft D1005PS	1039350	By: Innocal Date:1/15/09 Due: 1/15/10
Platform Scales	Vehicle Total, Wheel, and Axle Load	8000 lb 35.6 kN	0.5 lb 2.2 N	±1.0% of applied load	Intercomp Model SWII	24032361	By: Intercomp Date:1/29/09 Due: 1/29/10
Automated Steering Machine with Steering Angle Encoder	Handwheel Angle	±800 deg	0.25 deg	±0.25 deg	Heitz Automotive Testing Model: Sprint 3	60304	By: Heitz Date:1/29/09_ Due: 1/29/10
Multi-Axis Inertial Sensing System	Longitudinal, Lateral, and Vertical Acceleration Roll, Yaw, and Pitch Rate	Accelerometers: ±2 g Angular Rate Sensors: ±100 deg/s	Accelerometers: ≤10 ug Angular Rate Sensors: ≤0.004 deg/s	Accelerometers: ≤0.05% of full range Angular Rate Sensors: 0.05% of full range	BEI Technologies Model: MotionPAK MP-1	0767	By:Systron Donner Date:12/11/08 Due: 12/11/09
Radar Speed Sensor and Dashboard Display	Vehicle Speed	0-125 mph 0-200 km/h	0.009 mph .014 km/h	±0.25% of full scale	A-DAT Corp. Radar Model: DRS-6 Display Model: RD-2	1400.604	By: ADAT Date:1/5/09 Due:1/5/10
Ultrasonic Distance Measuring System	Left and Right Side Vehicle Height	5-24 inches 127-610 mm	0.01 inches .254 mm	±0.25% of maximum distance	Massa Products Corporation Model: M-5000/220	DOT-NHTSA D2646	By: DRI Date:3/16/09 Due: 3/16/10
Ultrasonic Distance Measuring System	Left and Right Side Vehicle Height	5-24 inches 127-610 mm	0.01 inches .254 mm	±0.25% of maximum distance	Massa Products Corporation Model: M-5000/220	DOT-NHTSA D2647	By: DRI Date:3/16/09 Due: 3/16/10

4.0 TEST EQUIPMENT LIST AND CALIBRATION INFORMATION (2 OF 2)

TABLE 1. TEST INSTRUMENTATION (CONTD)

Type	Output	Range	Resolution	Accuracy	Specifics	Serial Number	Calibration
Data Acquisition System [Includes amplification, anti-aliasing, and analog to digital conversion.]	Record Time; Velocity; Distance; Lateral, Longitudinal, and Vertical Accelerations; Roll, Yaw, and Pitch Rates; Steering Wheel Angle.	Sufficient to meet or exceed individual sensors	200 Hz	Sufficient to meet or exceed individual sensors	SoMat eDaq ECPU processor	MSHLB.03-2476	By: Somat Date:1/13/09 Due: 1/14/10
Data Acquisition System [Includes amplification, anti-aliasing, and analog to digital conversion.]	Record Time; Velocity; Distance; Lateral, Longitudinal, and Vertical Accelerations; Roll, Yaw, and Pitch Rates; Steering Wheel Angle.	Sufficient to meet or exceed individual sensors	200 Hz	Sufficient to meet or exceed individual sensors	SoMat High level Board EHLS	MSHLS.03-3182	By: Somat Date:1/14/09 Due: 1/15/10
Load Cell	Vehicle Brake Pedal Force	0-300 lb 0-1.33 kN	1 lb 4.44 N	±0.05% of full scale	Lebow 3663-300	767	By: Davis Date:2/3/09 Due: 2/3/10
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm Fusion	Q12-05-08-06717	By: Faro Date: 2/11/09 Due: 2/11/10
Outriggers	No output. Safety Item.	N/A	N/A	N/A	DRI manufactured Aluminum meeting the weight and MOI specifications of Docket 2007-27662-11	N/A	N/A

5.0 PHOTOGRAPHS (1 of 14)

Figure 5.1. Left Front View of Test Vehicle

5.0 PHOTOGRAPHS (2 of 14)

Figure 5.2. Right Rear View of Test Vehicle

5.0 PHOTOGRAPHS (3 of 14)

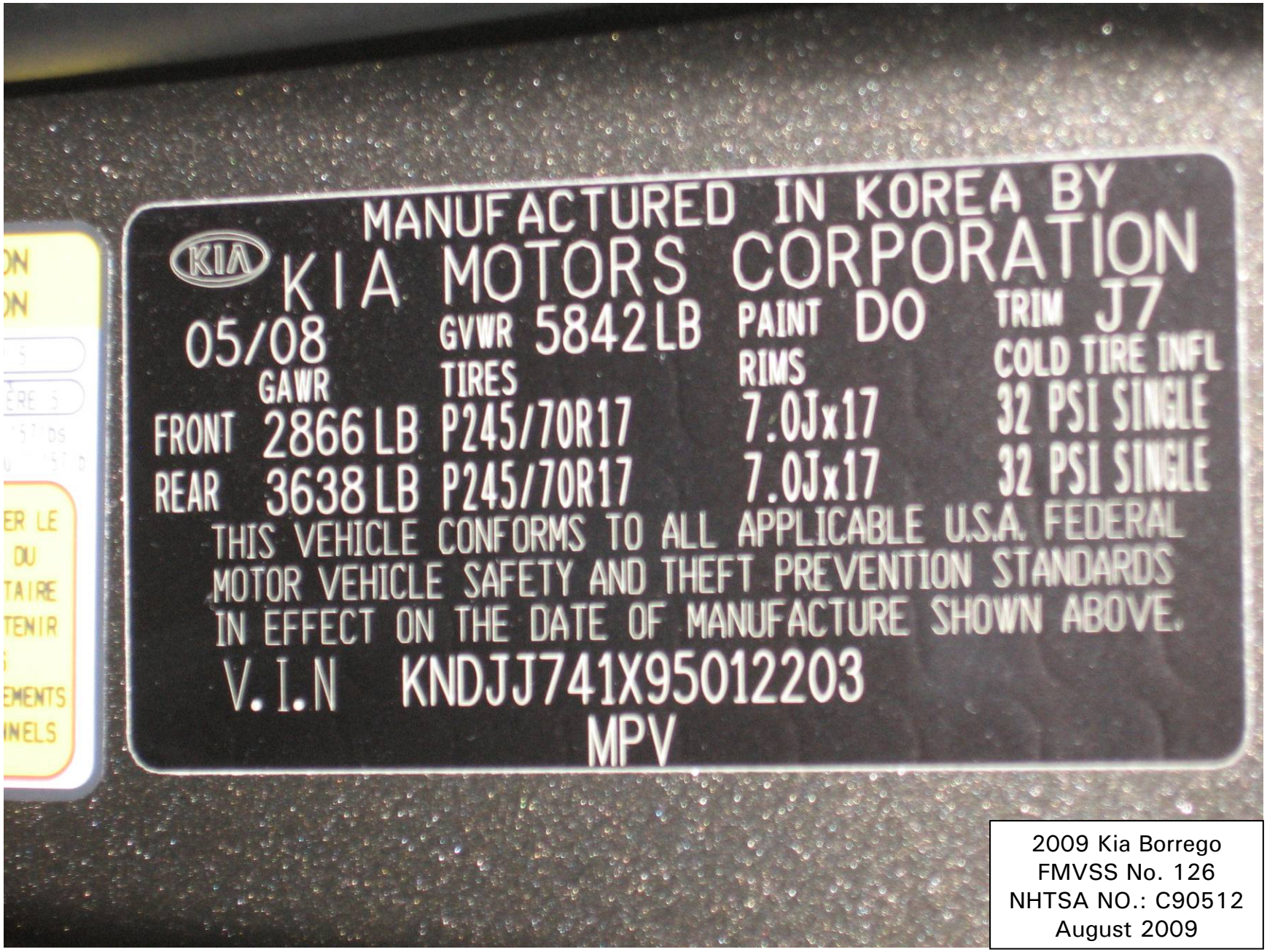


Figure 5.3. Vehicle Certification Label

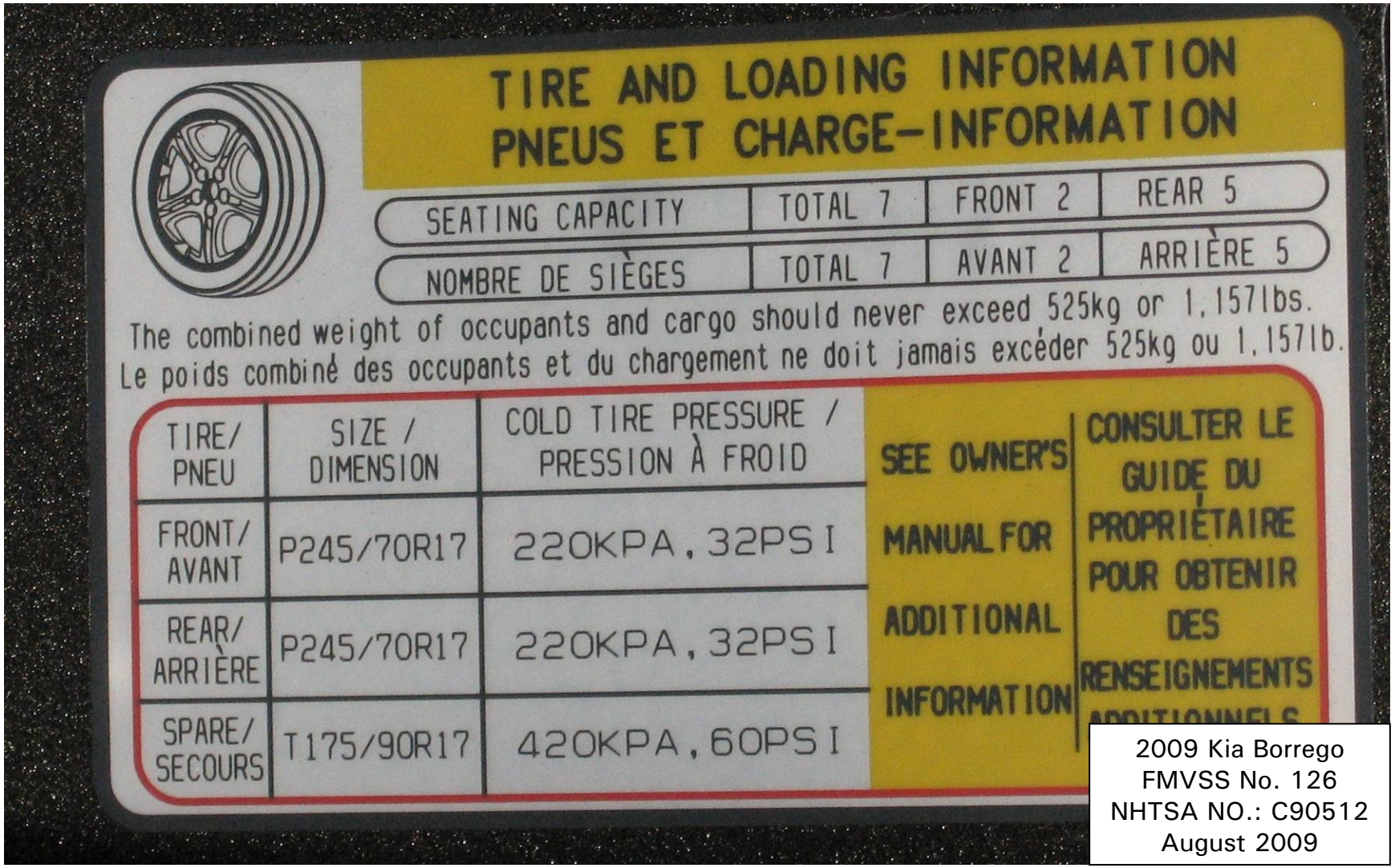


Figure 5.4. Vehicle Placard

5.0 PHOTOGRAPHS (5 of 14)

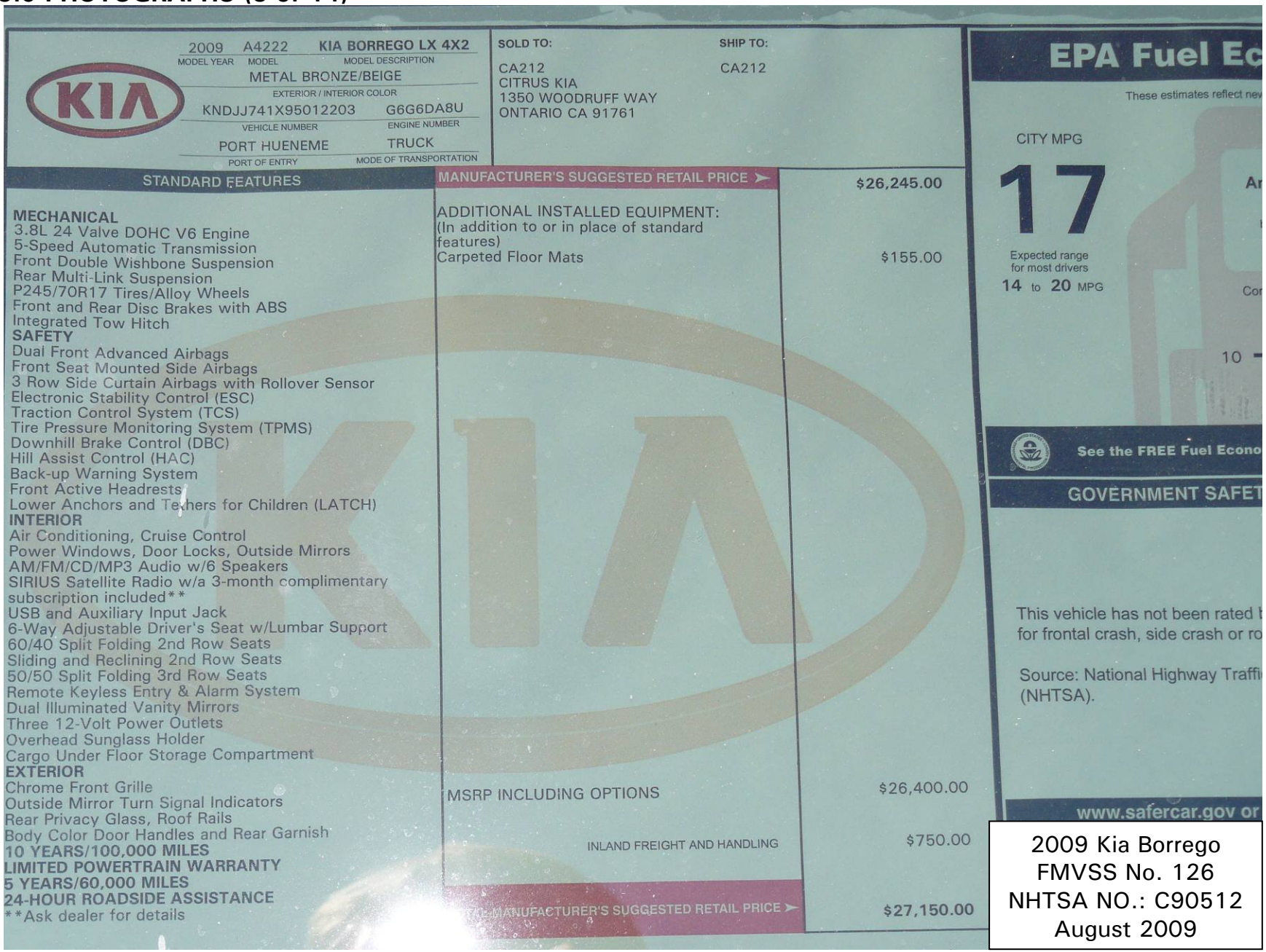


Figure 5.5. Window Sticker (Monroney Label)

5.0 PHOTOGRAPHS (6 of 14)

Figure 5.6. Telltales for ESC Actuation, Malfunction and ESC Off

5.0 PHOTOGRAPHS (7 of 14)

Figure 5.7. ESC Off Control Switch

5.0 PHOTOGRAPHS (8 of 14)

Figure 5.8. Front View of Vehicle As-Tested

5.0 PHOTOGRAPHS (9 of 14)

Figure 5.9. Rear View of Vehicle As-Tested

5.0 PHOTOGRAPHS (10 of 14)

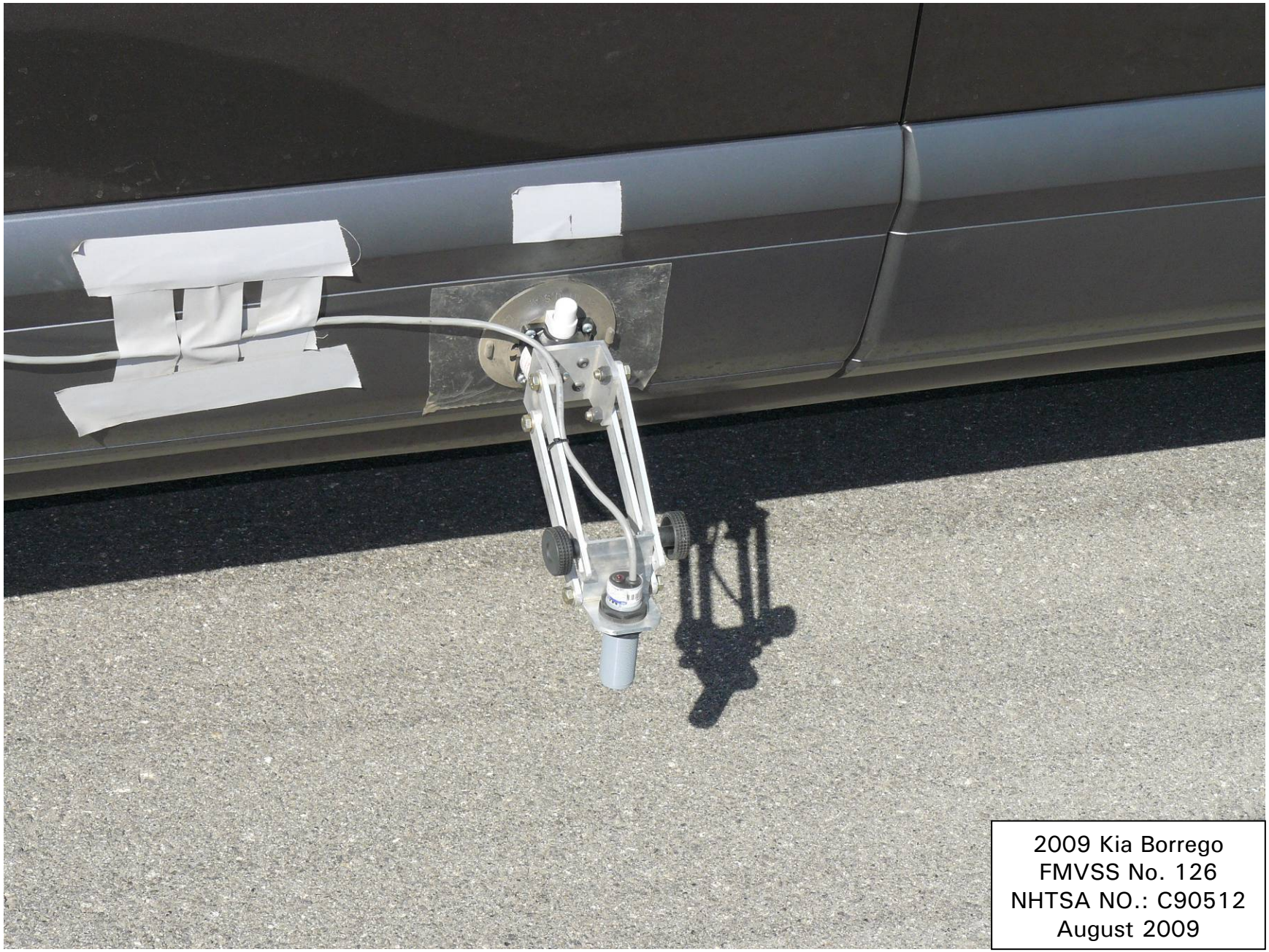


Figure 5.10. Ultrasonic Height Sensor Mounted on Left Side of Vehicle for Determining Body Roll Angle

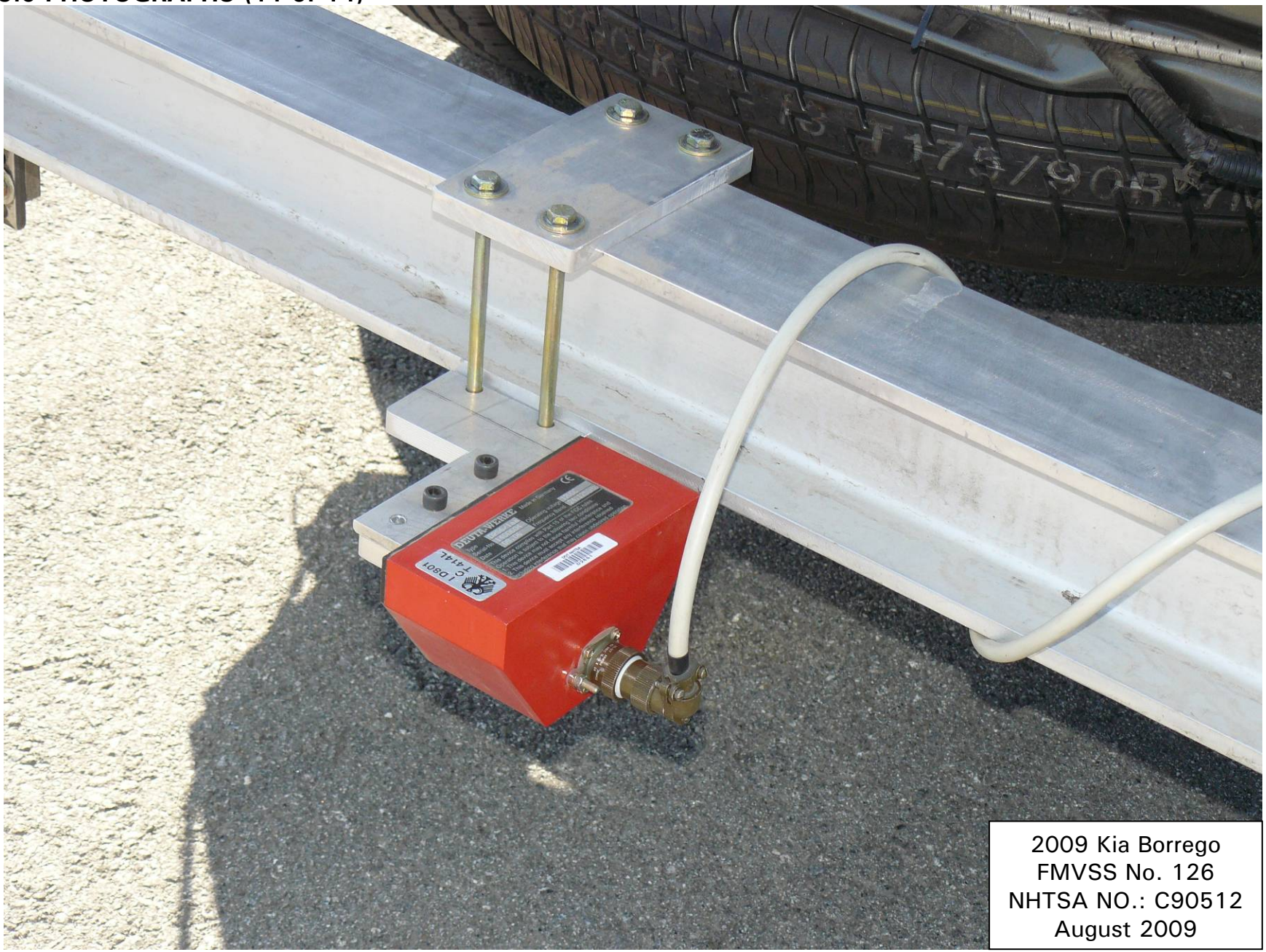


Figure 5.11. Rear Outrigger, Mount and Speed Sensor

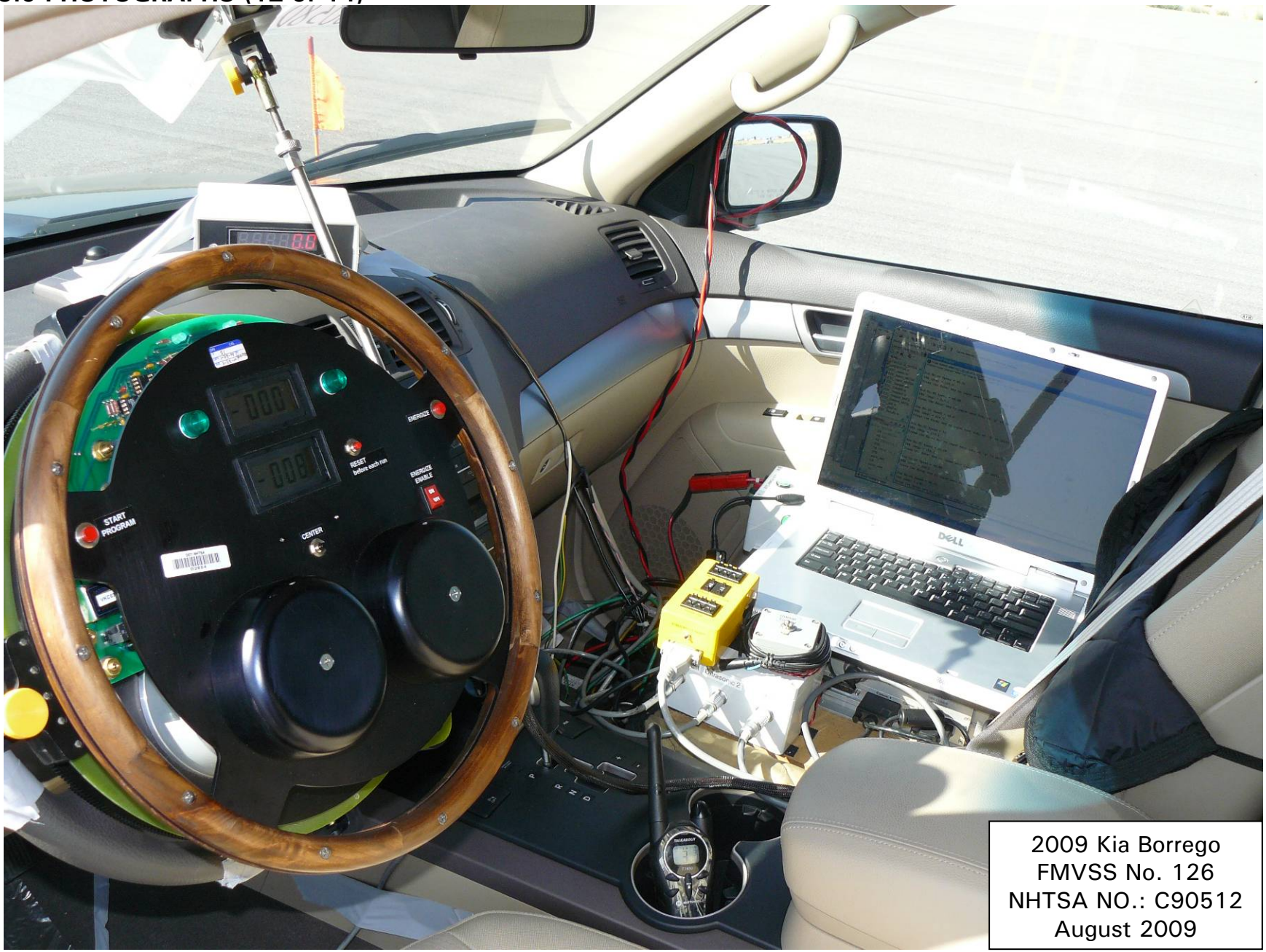


Figure 5.12. Steering Controller and Data Acquisition Computer

Figure 5.13. Inertial Measurement Unit Mounted in Vehicle

5.0 PHOTOGRAPHS (14 of 14)

Figure 5.14. Brake Pedal Load Cell

6.0 DATA PLOTS (1 of 4)

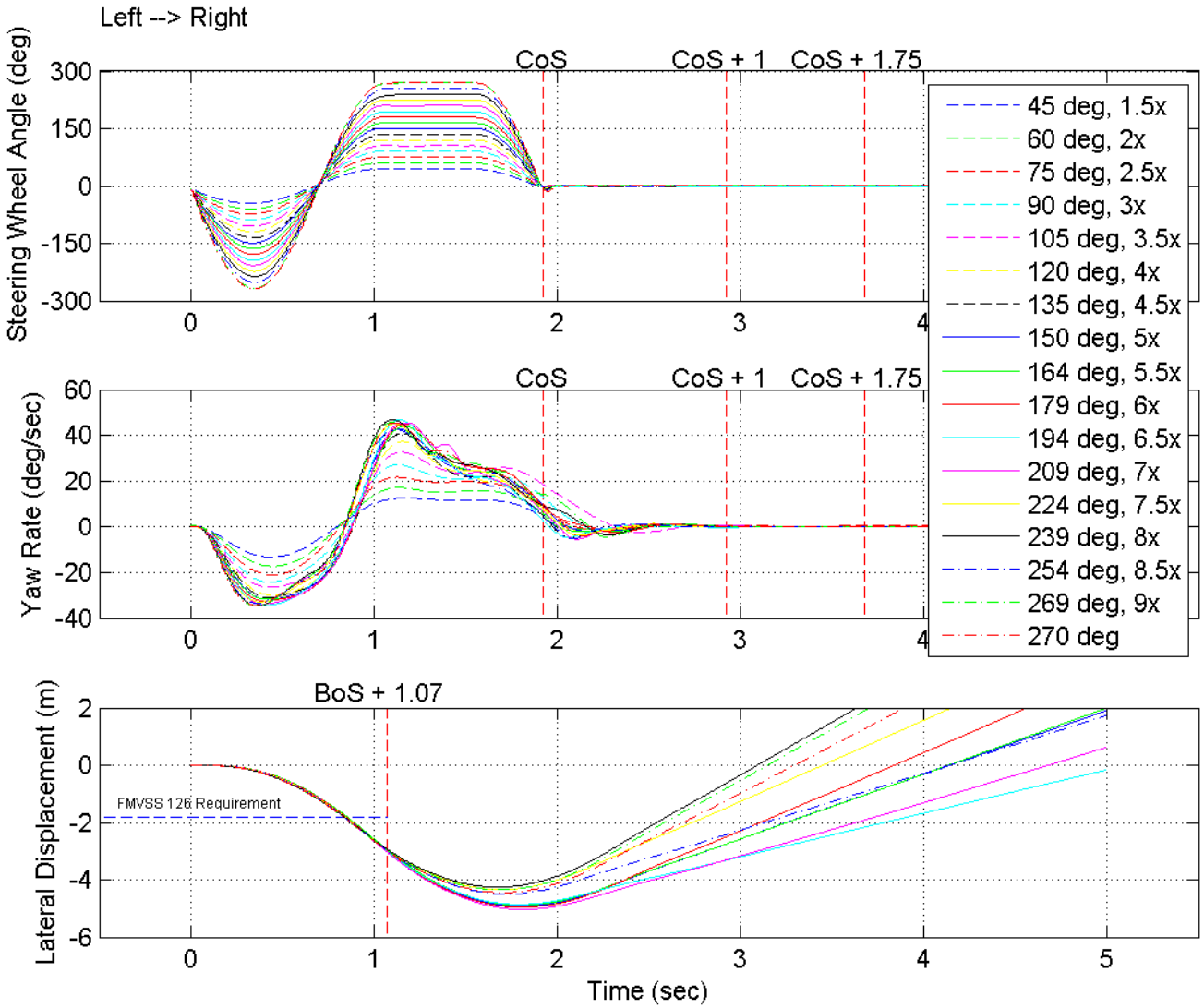


Figure 6.1. Steering Wheel Angle, Yaw Rate and Lateral Displacement for L-R Series

6.0 DATA PLOTS (2 of 4)

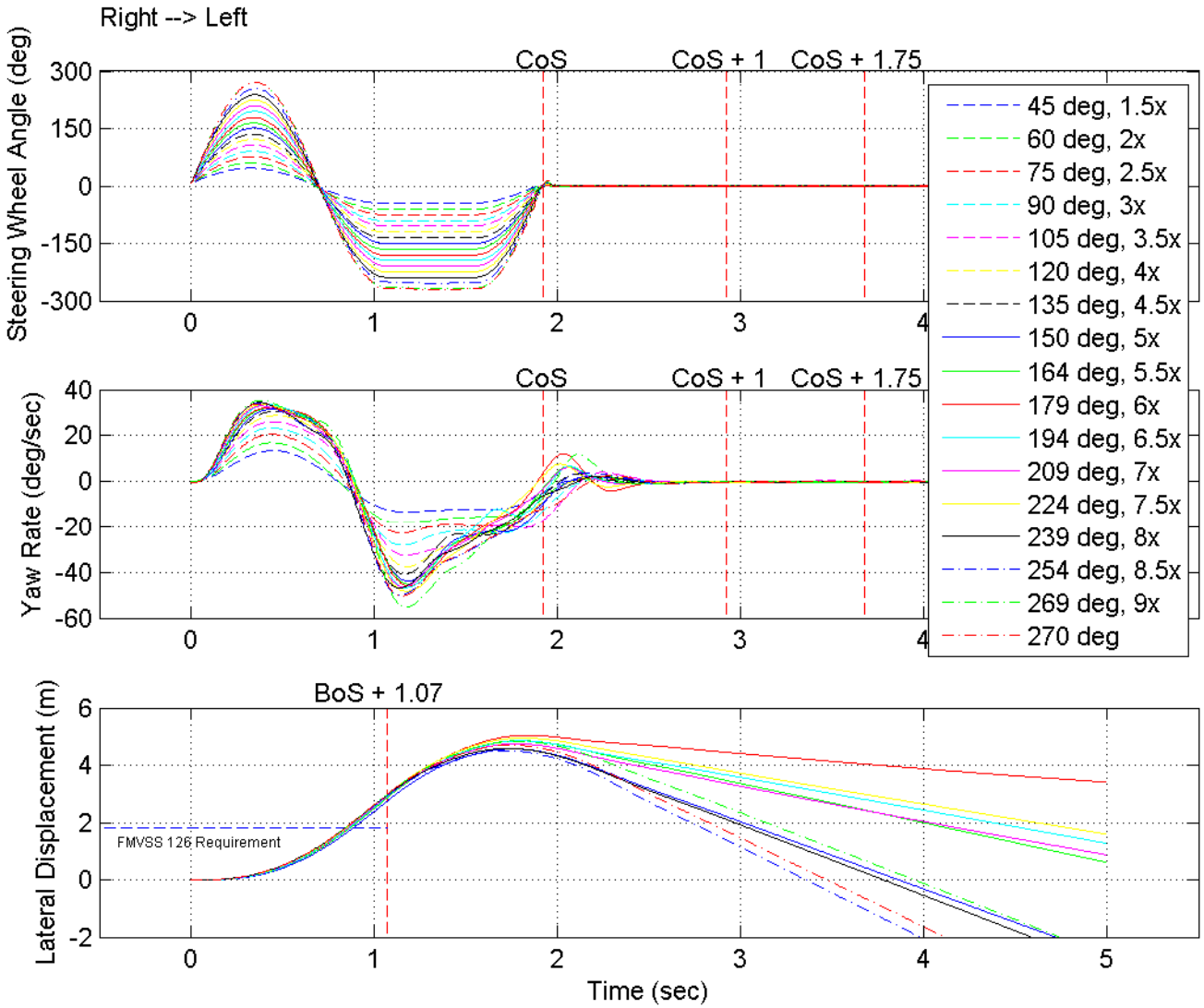


Figure 6.2. Steering Wheel Angle, Yaw Rate and Lateral Displacement for R-L Series

6.0 DATA PLOTS (3 of 4)

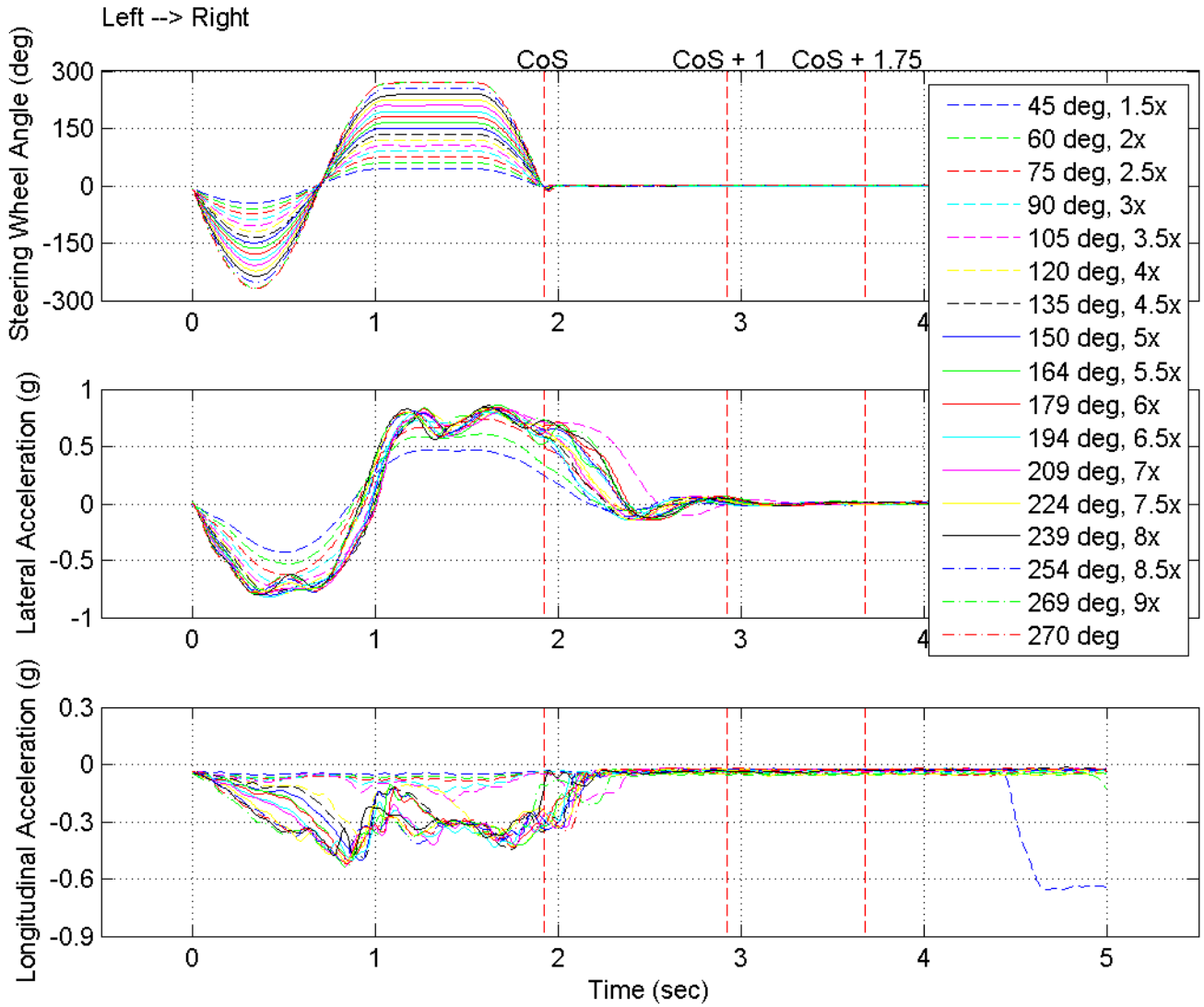


Figure 6.3. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for L-R Series

6.0 DATA PLOTS (4 of 4)

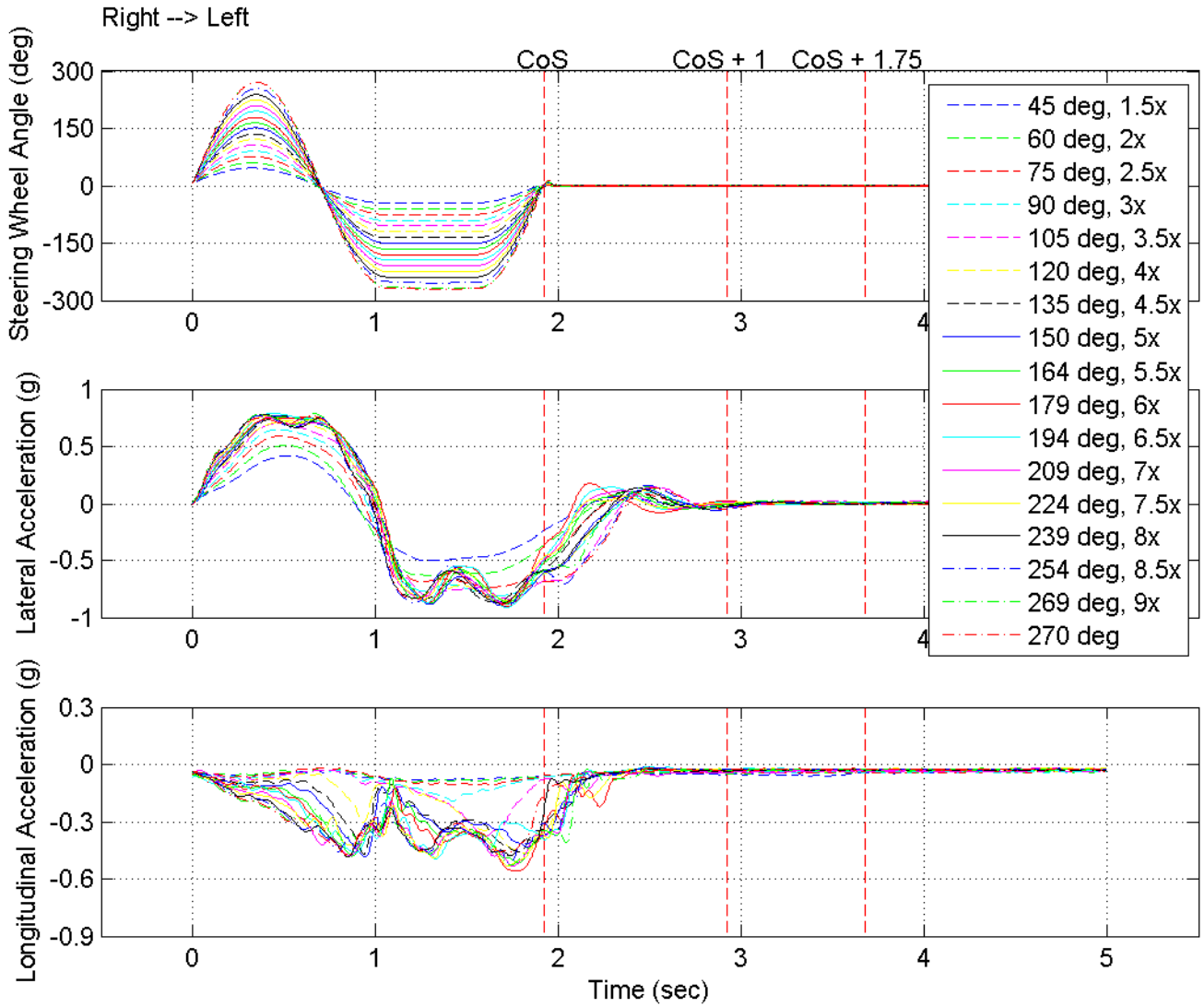
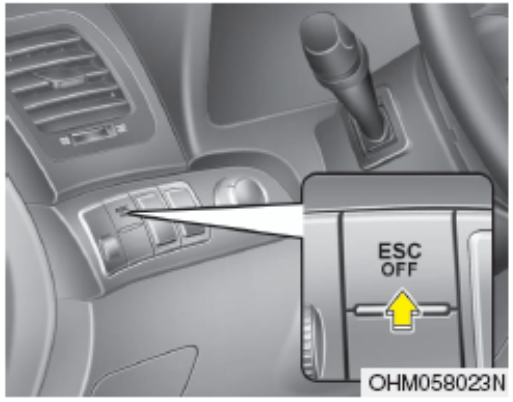


Figure 6.4. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for R-L Series

7.0 OTHER DOCUMENTATION

7.1 OWNER'S MANUAL PAGES
7.2 VEHICLE ARRIVAL CONDITION REPORT
7.3 VEHICLE COMPLETION CONDITION REPORT
7.4 SINE WITH DWELL TEST RESULTS
7.5 SLOWLY INCREASING STEER TEST RESULTS
7.6 INERTIAL SENSING SYSTEM LOCATION COORDINATES

7.1 OWNER'S MANUAL PAGES



E070500AHM-EU

Electronic stability control (ESC)

The Electronic Stability control (ESC) system is designed to stabilize the vehicle during cornering maneuvers. ESC checks where you are steering and where the vehicle is actually going. ESC applies the brakes on individual wheels and intervenes with the engine management system to stabilize the vehicle.

⚠ WARNING

Never drive too fast according to the road conditions or too quickly when cornering. Electronic stability control (ESC) will not prevent accidents. Excessive speed in turns, abrupt maneuvers and hydroplaning on wet surfaces can still result in serious accidents. Only a safe and attentive driver can prevent accidents by avoiding maneuvers that cause the vehicle to lose traction. Even with ESC installed, always follow all the normal precautions for driving - including driving at safe speeds for the conditions.

The Electronic Stability Control (ESC) system is an electronic system designed to help the driver maintain vehicle control under adverse conditions. It is not a substitute for safe driving practices. Factors including speed, road conditions and driver steering input can all affect whether ESC will be effective in preventing a loss of control. It is still your responsibility to drive and corner at reasonable speeds and to leave a sufficient margin of safety.

When you apply your brakes under conditions which may lock the wheels, you may hear a "tik-tik" sound from the brakes, or feel a corresponding sensation in the brake pedal. This is normal and it means your ESC is active.

✱ NOTICE

A click sound may be heard in the engine compartment when the vehicle begins to move after the engine is started. These conditions are normal and indicate that the Electronic Stability Control System is functioning properly.

E070501AUN-EU

ESC operation

ESC ON condition

- When the ignition is turned ON, ESC and ESC OFF indicator lights illuminate for approximately 3 seconds, then ESC is turned on.
- Press the ESC OFF button for at least half a second after turning the ignition ON to turn ESC off. (ESC OFF indicator will illuminate). To turn the ESC on, press the ESC OFF button (ESC OFF indicator light will go off).
- When starting the engine, you may hear a slight ticking sound. This is the ESC performing an automatic system self-check and does not indicate a problem.

When operating

When the ESC is in operation, ESC indicator light blinks.

- When the Electronic Stability Control is operating properly, you can feel a slight pulsation in the vehicle. This is only the effect of brake control and indicates nothing unusual.
- When moving out of the mud or slippery road, pressing the accelerator pedal may not cause the engine rpm (revolutions per minute) to increase.

E070502AUN-EU

ESC operation off

ESC OFF state

- To cancel ESC operation, press the ESC OFF button (ESC OFF indicator light illuminates).
- If the ignition switch is turned to LOCK position when ESC is off, ESC remains off. Upon restarting the engine, the ESC will automatically turn on again.

■ ESC indicator light (blinks)

ESC

■ ESC OFF indicator light (comes on)

ESC
OFF

E070503AEN-EU

Indicator light

When the ignition switch is turned ON, the indicator light illuminates, then goes off if ESC system is operating normally.

The ESC indicator light blinks whenever ESC is operating.

The ESC OFF indicator light comes on when either the ESC is turned off with the button, or ESC fails to operate when turned on.

⚠ CAUTION

Driving with varying tire or wheel sizes may cause the ESC system to malfunction. When replacing tires, make sure they are the same size as your original tires.

⚠ WARNING

The Electronic Stability Control system is only a driving aid; use precautions for safe driving by slowing down on curved, snowy, or icy roads. Drive slowly and don't attempt to accelerate whenever the ESC indicator light is blinking, or when the road surface is slippery.

E070504AEN-EU

ESC OFF usage

When driving

- It's a good idea to keep the ESC turned on for daily driving whenever possible.
- To turn ESC off while driving, press the ESC OFF button while driving on a flat road surface.

Never press the ESC OFF button while ESC is operating (ESC indicator light blinks).

If ESC is turned off while ESC is operating, the vehicle may slip out of control.

✱ NOTICE

- **When operating the vehicle on a dynamometer, ensure that the ESC is turned off (ESC OFF light illuminated). If the ESC is left on, it may prevent the vehicle speed from increasing, and result in false diagnosis.**
- **Turning the ESC off does not affect ABS or brake system operation.**

⚠ WARNING

Never press the ESC OFF button while ESC is operating.

If the ESC is turned off while ESC is operating, the vehicle may go out of control.

To turn ESC off while driving, press the ESC OFF button while driving on a flat road surface.

E070505AHM-EU

Hill-start assist control (HAC) (if equipped)

A vehicle has the tendency to slip back on a steep hill when it starts to go after stopping. The Hill-start Assist Control (HAC) prevents the vehicle from slipping back by operating the brakes automatically for about 2 seconds. The brakes are released when the accelerator pedal is depressed or after about 2 seconds.

⚠ WARNING

The HAC is activated only for about 2 seconds, so when the vehicle is starting off always depress the accelerator pedal.

✱ NOTICE

- **The HAC does not operate when the transmission shift lever is in the P (Park) or N (Neutral) position.**
- **The HAC activates even though the ESC is off but it does not activate when the ESC has malfunctioned.**

7.2 VEHICLE ARRIVAL CONDITION REPORT

CONTRACT NO.: DTNH22-08-D-00098
DATE RECEIVED: 7/24/2009

From: *Competitive Vehicle Services*

Purpose ☑ Initial Receipt
☐ Received via Transfer
☐ Present Vehicle Condition

To: *Dynamic Research, Inc*

Vehicle VIN: *KNDJJ741X95012203* NHTSA NO.: *C90512*

Model Year: *2009* Odometer Reading: 141 *Miles*
Make: *Kia* Body Style: *MPV*
Model: *Borrego* Body Color: *Metal Bronze*
Manufacture Date: *5/08* Dealer: *Competitive Vehicle Services*
GVWR (kg/lb) *2855 (5842)* Price: *Leased*

☑ All options listed on the "Window Sticker" are present on the test vehicle
☑ Tires and wheel rims are new and the same as listed
☑ There are no dents or other interior or exterior flaws
☑ The vehicle has been properly prepared and is in running condition
☑ The glove box contains an owner's manual, warranty document, consumer information, and extra set of keys
☑ Proper fuel filler cap is supplied on the test vehicle
☑ Place vehicle in storage area
☑ Inspect the vehicle's interior and exterior, including all windows, seats, doors, etc., to confirm that each system is complete and functional per the manufacturer's specifications. Any damage, misadjustment, or other unusual condition that could influence the test program or test results shall be recorded. Report any abnormal condition to the NHTSA COTR before beginning any test.

NOTES:

RECORDED BY: *J Brubacher* DATE RECORDED: *7/24/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *8/10/2009*

7.3 VEHICLE COMPLETION CONDITION REPORT

CONTRACT NO.: DTNH22-08-D-00098
DATE RELEASED: 8/21/2009

Vehicle VIN: *KNDJJ741X95012203* NHTSA NO.: *C90512*

Model Year: *2009* Odometer Reading: *Miles*
Make: Kia Body Style: *MPV*
Model: *Borrego* Body Color: *Metal Bronze*
Manufacture Date: *5/08* Dealer: *Competitive Vehicle Services*
GVWR (kg/lb) *2855 (5842)* Price: *Leased*

LIST OF FMVSS TESTS PERFORMED BY THIS LAB: *FMVSS 126*

X THERE ARE NO DENTS OR OTHER INTERIOR OR EXTERIOR FLAWS

X THE VEHICLE HAS BEEN PROPERLY MAINTAINED AND IS IN RUNNING CONDITION

X THE GLOVE BOX CONTAINS AN OWNER'S MANUAL, WARRANTY DOCUMENT, CONSUMER INFORMATION, AND EXTRA SET OF KEYS

X PROPER FUEL FILLER CAP IS SUPPLIED ON THE TEST VEHICLE.

REMARKS:

Equipment that is no longer on the test vehicle as noted on Vehicle Arrival Condition Report:

None

Explanation for equipment removal:

None

Test Vehicle Condition:

Good

RECORDED BY: *J Lenkeit* DATE RECORDED: *8/20/2009*

APPROVED BY: *B Kebschull* DATE APPROVED: *8/20/2009*

7.4 SINE WITH DWELL TEST RESULTS

2009 Kia Borrego
NHTSA No. C90512
Date of Test 8/05/2009
Date Created 8/05/2009

File	SWA @ 5deg Ct	MES	Time @ 5deg	COS	Time @ COS	MOS	Time @ MOS	YRR1	YR1	YRR1 Ct	YRR175	YR175	YRR175 Ct	2nd Yaw Peak	2nd Yaw Peak Ct	Lat Disp	Lat. Acc. 1.07s	1st SWA Peak	1st SWA Peak Ct	2nd SWA Mean
	(deg)	(mph)	(s)		(s)		(sec)	(%)	(deg/s)		(%)	(deg/s)		(deg/s)		(ft)	(g)	(deg)		(deg)
21	710	48.93	3.543	1091	5.446	847	4.226	-1.72	-0.22	1291	-1.78	-0.23	1441	12.83	946		0.34	45.08	775	44.84
22	709	48.86	3.537	1090	5.445	846	4.225	0.4	0.07	1290	0.1	0.02	1440	17.4	937		0.43	60.04	775	59.94
23	708	49.6	3.532	1090	5.444	846	4.225	1.1	0.24	1290	1.15	0.25	1440	21.84	935		0.48	74.96	775	74.88
24	707	49.66	3.529	1090	5.444	846	4.225	0.97	0.26	1290	0.35	0.1	1440	27.3	935		0.49	89.86	775	89.89
25	707	49.68	3.527	1090	5.443	846	4.224	1.57	0.52	1290	-0.15	-0.05	1440	32.86	938		0.46	104.9	775	104.89
26	706	49.8	3.525	1091	5.446	846	4.224	0.26	0.1	1291	0.58	0.22	1441	37.46	940		0.39	120.02	775	120.04
27	706	49.63	3.524	1091	5.447	846	4.225	-0.28	-0.11	1291	-0.02	-0.01	1441	41	937		0.41	135.17	775	135.17
28	706	49.54	3.523	1091	5.447	846	4.225	-0.11	-0.05	1291	-0.37	-0.16	1441	42.72	936	-9.54	0.43	150.08	775	150.21
29	706	49.61	3.523	1091	5.447	847	4.226	0.19	0.08	1291	0.2	0.09	1441	43.97	940	-9.51	0.41	164.02	775	164.22
30	706	49.66	3.523	1091	5.446	847	4.226	0.33	0.15	1291	0.09	0.04	1441	45.1	940	-9.66	0.38	179.02	775	179.07
31	706	49.72	3.523	1091	5.446	847	4.228	-0.66	-0.31	1291	-0.37	-0.17	1441	46.85	935	-9.74	0.47	193.8	775	194.11
32	706	49.56	3.522	1091	5.447	847	4.227	-0.07	-0.03	1291	0.35	0.16	1441	45.52	942	-9.78	0.37	208.98	775	209.01
33	706	49.74	3.522	1090	5.445	847	4.227	-0.04	-0.02	1290	0.04	0.02	1440	45.25	929	-9.47	0.62	223.77	776	224.18
34	706	49.73	3.523	1090	5.445	847	4.227	0.33	0.15	1290	0.09	0.04	1440	46.94	927	-9.47	0.66	237.02	778	239.33
35	706	49.66	3.523	1090	5.445	847	4.228	-0.4	-0.17	1290	-0.02	-0.01	1440	42.59	931	-9.61	0.61	252.86	777	254.19
36	706	49.46	3.524	1090	5.445	847	4.228	-0.16	-0.07	1290	-0.16	-0.07	1440	45.75	927	-9.6	0.66	267.62	777	269.23
37	706	49.64	3.523	1090	5.445	847	4.228	0.38	0.17	1290	0.05	0.02	1440	45.63	929	-9.64	0.63	268.97	776	270.23
38	710	49.45	3.543	1091	5.447	847	4.227	-0.55	0.07	1291	0.24	-0.03	1441	-13.38	943		-0.35	45.8	776	45.46
39	709	49.82	3.536	1090	5.445	847	4.226	0.72	-0.13	1290	0.68	-0.12	1440	-18.06	939		-0.42	60.74	775	60.47
40	708	49.66	3.532	1090	5.444	847	4.226	-0.03	0.01	1290	-0.19	0.04	1440	-22.66	938		-0.44	75.66	775	75.43
41	707	49.43	3.529	1090	5.444	847	4.226	0.67	-0.19	1290	0.13	-0.04	1440	-27.9	939		-0.45	90.65	775	90.37
42	707	49.4	3.527	1090	5.444	846	4.225	0.57	-0.19	1290	0.44	-0.14	1440	-32.83	943		-0.38	105.42	775	105.59
43	706	49.47	3.524	1090	5.445	846	4.225	0.57	-0.22	1290	0.39	-0.15	1440	-37.59	943		-0.35	120.82	775	120.46
44	706	49.64	3.523	1091	5.446	846	4.225	-0.05	0.02	1291	0.09	-0.03	1441	-40.68	941		-0.34	135.82	775	135.61
45	706	49.8	3.522	1091	5.446	847	4.226	0.1	-0.04	1291	-0.27	0.12	1441	-43.77	943	8.94	-0.28	150.84	775	150.59
46	706	50	3.522	1091	5.446	846	4.225	0.05	-0.02	1291	0.31	-0.14	1441	-44.97	944	9.2	-0.2	164.87	775	164.48
47	706	49.86	3.521	1091	5.448	847	4.226	0.02	-0.01	1291	-0.15	0.07	1441	-45.64	945	9.39	-0.19	179.71	775	179.5
48	706	49.5	3.522	1091	5.449	847	4.228	0.05	-0.02	1291	0.12	-0.06	1441	-46.76	940	9.43	-0.35	194.63	775	194.44
49	706	49.63	3.522	1091	5.448	847	4.229	-0.31	0.14	1291	-0.22	0.1	1441	-46.03	939	9.42	-0.38	209.11	776	209.55
50	706	49.58	3.522	1091	5.45	847	4.228	-0.11	0.05	1291	-0.17	0.08	1441	-48	942	9.59	-0.3	224.55	776	224.57

File	SWA @ 5deg Ct	MES	Time @ 5deg	COS	Time @ COS	MOS	Time @ MOS	YRR1	YR1	YRR1 Ct	YRR175	YR175	YRR175 Ct	2nd Yaw Peak	2nd Yaw Peak Ct	Lat Disp	Lat. Acc. 1.07s	1st SWA Peak	1st SWA Peak Ct	2nd SWA Mean
	(deg)	(mph)	(s)		(s)		(sec)	(%)	(deg/s)		(%)	(deg/s)		(deg/s)		(ft)	(g)	(deg)		(deg)
51	706	49.82	3.522	1091	5.446	847	4.227	0.21	-0.1	1291	0.24	-0.11	1441	-46.68	935	9.54	-0.52	238.64	777	239.66
52	706	49.98	3.522	1091	5.447	847	4.227	0.23	-0.12	1291	-0.01	0	1441	-49.87	935	9.57	-0.56	253.47	777	254.68
53	706	49.72	3.522	1091	5.447	847	4.228	0.14	-0.08	1291	0.17	-0.09	1441	-55.45	941	9.68	-0.34	268.39	776	269.54
54	706	49.64	3.522	1090	5.444	847	4.228	0.35	-0.18	1290	0.04	-0.02	1440	-50.43	936	9.72	-0.47	269.77	777	270.57

7.5 SLOWLY INCREASING STEER TEST RESULTS

2009 Kia Borrego
NHTSA No. 90512
Date of Test 8/05/2009
Date Created 8/05/2009

File	EventPt	DOS	MES	Mean SPD	AYcount_3	THETAENCF_3	AYCG_CD2_3	r_squared	ZeroBegin	ZeroEnd
			(mph)	(mph)		(deg)	(g)			
p_Bor10s.mat	701	1	49.90862312	49.98879018	1130	-28.67865635	-0.297652472	0.994224	501	701
p_Bor11s.mat	721	1	49.84229299	49.79330449	1139	-29.18621156	-0.30490157	0.996032	521	721
p_Bor12s.mat	708	1	49.87293891	49.93483467	1145	-29.59209288	-0.308223266	0.991622	508	708
p_Bor13s.mat	699	0	49.75061082	49.84569958	1153	30.29401845	0.301145903	0.996245	499	699
p_Bor14s.mat	700	0	49.94340846	50.05437143	1162	30.83921112	0.312016574	0.990327	500	700
p_Bor15s.mat	700	0	49.96428488	50.01276131	1158	30.58541034	0.288796571	0.992864	500	700
Averages						29.9	0.302122725965108			

Scalars	Steering Angles (deg)
1.5	45
2	60
2.5	75
3	90
3.5	105
4	120
4.5	135
5	150
5.5	164
6	179
6.5	194
7	209
7.5	224
8	239
8.5	254
9	269
9	270

7.6 INERTIAL SENSING SYSTEM LOCATION COORDINATES

Vehicle:	**2009 Kia Borrego**		
NHTSA No.:	C90512		
Measurement date:	8/3/2009		
Wheelbase:	114.0	Faro Arm S/N:	Q12-05-08-06717
Units	Inches	Certification date:	2/11/2009

CMM Measurements

Coordinate system: SAE (X,Y,Z positive forward, to the right, and downward, respectively)
Origin defined at 48" point on lateral arm of measurement fixture, projected onto the ground plane.

	Ref X	Rex Y	Ref Z
M_PLANE001_Ground_Plane	-	-	0.000
M_Line_Y_Axis	2.391	-3.661	0.000
M_Point_48_Ref	0.000	0.000	-
M_CIRCLE001_I_Left_Rear_Wheel_Axle	-31.489	12.592	-14.349
M_Point_IMU_side	12.596	46.224	-23.472
M_Point_ROOF	-	-	-69.176
Motion Pak reference point taken from mid height of unit left side			
Motion Pak Width = 3.05" ==> ½ W = 1.525			
Motion_PAK_Location	12.596	47.749	-23.472

Measurement Notes

1. The Faro arm is positioned just to the left of the vehicle, near the rear door
2. A "centerline jig" is used in the Faro arm measurement. The jig consists of a long beam with a 4 ft lateral arm that is perpendicular to the beam. The jig is placed on the ground underneath the vehicle with the long beam positioned along the centerline of the vehicle, such that the lateral arm extends to the left, slightly forward of the left rear tire. The lateral arm has a marked indentation point which is located 48.00" from the edge of the centerline beam.
3. The Faro arm is used to make the following measurements:
   - Three points on the ground, which establishes the ground plane
   - Two points along the lateral arm, and projected onto the ground plane. This establishes the origin.
   - One point at the 48 inch reference point on the lateral arm. This establishes the origin.
   - Three points on the left rear wheel or wheel cover. The Faro arm then computes the center point of the wheel.
   - One point to establish the height of the highest point on the roof of the vehicle.

Coordinate Measurements Calculated for S7D (Matlab Program)

Coordinate system: X, Y, Z positive rearward, to the right, and upward, respectively.
Origin defined as follows: X axis: front axle, Y axis: vehicle centerline, Z axis: ground plane.

	Ref X	Rex Y	Ref Z
Motion_PAK_Location in S7D (Matlab program) coordinate system	**69.915**	**-0.251**	**23.472**

Calculation Notes

1. X axis value is the difference between the wheelbase and the calculated distance from the rear axle centerline to the IMU (the value must be positive and less than the wheelbase.
2. Y axis value is -48.00 (the Y axis offset of the measurement origin in the S7D coordinate system) plus the measured Y axis value (a negative value indicates the IMU is to the left of the vehicle centerline, and a positive value indicates it is to the right).
3. Z axis value is from the ground plane up to the center of the IMU (value must be positive).