126-DRI-10-010
SAFETY COMPLIANCE TESTING FOR FMVSS 126
Electronic Stability Control Systems

Hyundai Motor Manufacturing Alabama LLC
2010 Hyundai Santa Fe AWD
NHTSA No. CA0518

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22 November, 2010

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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16. Abstract A test was conducted on a 2010 Hyundai Santa Fe AWD , NHTSA No. CA0518, 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 2010 Hyundai Santa Fe AWD, 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 2010 Hyundai Santa Fe AWD 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 was tested in both the AWD “automatic” and AWD “locked” drive configurations. 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: *2010 Hyundai Santa Fe AWD*

NHTSA No. *CA0518* VIN: *5NMSHDAG2AH346041*

Vehicle Type: *MPV* Manufacture Date: *11/09*

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: *2010 Hyundai Santa Fe AWD MPV*

NHTSA No. *CA0518* Data Sheet Completion Date: *5/27/2010*

VIN *5NMSHDAG2AH346041* Manufacture Date: *11/09*

GVWR (kg): *2360.0* Front GAWR (kg): *1350.0* Rear GAWR (kg): *1450.0*

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

Odometer reading at time of inspection: *95 miles (152 km)*

DESIGNATED TIRE SIZE(S) FROM VEHICLE LABELING:

Front axle: *P235/60 R18* Rear axle: *P235/60 R18*

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

		Front Axle		Rear Axle
	Tire Manufacturer:	*Kumho*		*Kumho*
	Tire Model:	*Solus KL21*		*Solus KL21*
	Tire Size:	*P235/60 R18*		*P235/60 R18*
TIN	Left Front:	*27CO YPL9 4209*	Right Front:	*27CO YPL9 4209*
	Left Rear:	*27CO YPL9 4209*	Right Rear:	*27CO YPL9 4209*

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
- [X] 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)
- [X] Other (Describe) *AWD Locked*

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: *Automatic AWD*
Mode: *ESC on*
Drive Configuration: *Automatic AWD*
Mode: *ESC off*
Drive Configuration: *AWD Locked*
Mode: *ESC on*
Drive Configuration: *AWD Locked*
Mode: *ESC off*

VEHICLE STABILITY SYSTEMS (Check applicable technologies):

List other systems:

[X] ESC	[X] Traction Control	[X] Roll Stability Control
[ ] Active Suspension	[ ] Electronic Throttle Control	[ ] Active Steering
[X] ABS		

REMARKS:

RECORDED BY: *P Broen* DATE RECORDED: *5/27/2010*
APPROVED BY: *J Lenkeit* DATE APPROVED: *6/7/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2010 Hyundai Santa Fe AWD MPV*

NHTSA No *CA0518* Data Sheet Completion Date: *5/21/2010*

ESC SYSTEM IDENTIFICATION

Manufacturer/Model *Mobis, Bosch ESP 8.1*

ESC SYSTEM HARDWARE (Check applicable hardware)

[X] Electronic Control Unit	[X] Hydraulic Control Unit
[X] Wheel Speed Sensors	[X] Steering Angle Sensor
[X] Yaw Rate Sensor	[X] Lateral Acceleration Sensor

List other Components: _____

ESC OPERATIONAL CHARACTERISTICS

System is capable of generating brake torque at each wheel — [X] Yes (Pass) [ ] No (Fail)
Brief explanation: *The outputs of the brake slip controller are transformed to the required pressure values in the wheel brake cylinders with due consideration of the engine management for engine drag reduction. These nominal pressure values are then converted to adequate actuation commands for the hydraulic unit.*

System is capable of determining yaw rate — [X] Yes (Pass) [ ] No (Fail)
Brief explanation: *Measured by the yaw rate sensor.*

System is capable of monitoring driver steering input — [X] Yes (Pass) [ ] No (Fail)
Brief explanation: *Measured by the steering sensor.*

System is capable of estimating side slip or side slip derivative — [X] Yes (Pass) [ ] No (Fail)
Brief explanation: *The ESC ECU collects information from the steering angle sensor, wheel speed sensor and yaw rate sensor, and are used to calculate an estimated side slip or the side slip derivative.*

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: *In the case of gasoline engines electronic throttle control, ignition spark timing and fuel delivery are controlled to reduce the torque*

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: *14.4 km/h*

System is capable of activation during the following driving phases: **X** Yes (Pass) ___ No (Fail)

- acceleration
- braking
- coasting
- during activation of ABS or traction control

Driving phases during which ESC is capable of activation:
Acceleration, braking, coasting, 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: *Joe Kelly* DATE RECORDED: *5/21/2010*
APPROVED BY: *Brian Kebschull* DATE APPROVED: *5/28/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2010 Hyundai Santa Fe AWD MPV*

NHTSA No. *CA0518* Data Sheet completion date: *5/21/2010*

ESC Malfunction Telltale

Vehicle is equipped with malfunction telltale? *Yes*

Telltale Location: *The malfunction telltale is located in the instrument cluster, to the left and above the speedometer, which is located in the center of the instrument cluster. (Figure 5.6)*

Telltale Color: *Amber*

Telltale symbol or abbreviation used

or **ESC**

- [X] 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*

Is telltale also used to indicate activation of the ESC system? *Yes*

If yes explain telltale operation during ESC activation:

ESC malfunction telltale (shown above) blinks to indicate that the ESC is operating, remains solid when ESC malfunctions.

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*

Telltale Location: *The "ESC OFF" Telltale is located in the instrument cluster, to the left and above the speedometer, which is located in the center of the instrument cluster. (Figure 5.6)*

Telltale Color: *Amber*

Telltale symbol or abbreviation used

or **ESC OFF**

- [X] 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 ***Yes***

(Vehicle is compliant if equipped with a malfunction telltale)

Remarks:

RECORDED BY: *Joe Kelly* DATE RECORDED: *5/21/2010*

APPROVED BY: *Brian Kebschull* DATE APPROVED: *5/28/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2010 Hyundai Santa Fe AWD MPV*

NHTSA No. *CA0518* Data Sheet completion date: *5/28/2010*

"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)

- [X] 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 of the steering wheel, above the knee bolster (Figure 5.7)*
	Labeling	*Sliding car symbol with the word "OFF"*
	Modes	*ESC is turned off when this button is pressed*
Second Control:	Location	
	Labeling	
	Modes	

Identify standard or default drive *AWD (automatic)*

Verify standard or default drive configuration **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") position?

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)
NA		

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?

_X_ NA ___ Yes ___ No

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? **X** Yes ___ No

Ancillary Control: System *AWD Lock*

Control Description *Push button to lock front and rear axles*

Labeling *Symbol of four tires, axles, driveshaft and the word "Lock" (see figure 5.7)*

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
AWD Lock	*No*	*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)
NA	

For each ancillary 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 activating the control 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) X NA

DATA INDICATES COMPLIANCE: PASS

Remarks:

RECORDED BY: *Brian Kebschull* DATE RECORDED: *5/28/2010*
APPROVED BY: *J Lenkeit* DATE APPROVED: *6/14/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2010 Hyundai Santa Fe AWD MPV*

NHTSA No. *CA0518* Data Sheet completion date: *5/28/2010*

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

Peak Friction Coefficient (at least 0.9) *0.941*

Test track data meets requirements: *Yes* If no, explain:

Full Fluid Levels: Fuel *Yes* Other Fluids *Yes* (specify)

Coolant *Yes* *Oil, brake fluid, washer fluid*

Tire Pressures:

Required; Front Axle *230* KPA Rear Axle *230* KPA

Actual; LF *230* KPA RF *230* KPA

LR *230* KPA RR *230* KPA

Vehicle Dimensions: Front Track Width *161.5* cm Wheelbase *270.0* cm

Rear Track Width *162.1* cm

Vehicle Weight Ratings: GAWR Front *1350.0* KG GAWR Rear *1450.0* KG

Unloaded Vehicle Weight (UVW):

Front Axle *1051.9* KG Left Front *533.9* KG Right Front *518.0* KG

Rear Axle *762.4* KG Left Rear *377.8* KG Right Rear *384.6* KG

Total UVW *1814.3* KG

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

Calculated baseline weight (UVW + 73kg) *1887.3* 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 *1088.2* KG Left front *548.4* KG Right front *539.8* KG

Rear axle *802.4* KG Left rear *401.9* KG Right rear *400.5* KG

Total UVW with outriggers *1890.6* KG

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

Front axle *1159.8* KG Left front *598.7* KG Right front *561.1* KG

Rear axle *875.5* KG Left rear *445.0* KG Right rear *430.5* KG

Vehicle Weight *2035.3* KG

Ballast Required =

[Total UVW with Outriggers (if applicable)]		+ *168*	KG	- [Loaded Weight w/Driver and Instrumentation)]	
= *1890.6*	KG	+ *168*	KG	- 2035.3	KG

= *23.3* KG

Total Loaded Vehicle Weight w/Driver and Instrumentation and Ballast

Front axle *1169.8* KG Left front *599.2* KG Right front *570.6* KG

Rear axle *889.5* KG Left rear *447.7* KG Right rear *441.8* KG

Total UVW *2059.3* 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	*45.9* in	*116.6* cm	*67.6* in	*171.6* cm
y-distance	*-0.5* in	*-1.4* cm	*-0.5* in	*-1.3* cm
z-distance	*25.6* in	*65.0* cm	*23.4* in	*59.3* cm
Roof Height	*67.3* in	*171.0* cm		
Distance between ultrasonic sensors	*88.0* in	*223.5* cm		

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *5/28/2010*
APPROVED BY: *J Lenkeit* DATE APPROVED: *6/14/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2010 Hyundai Santa Fe MPV AWD (Unlocked)*

NHTSA No. *CA0518*

Measured tire pressure: LF *236* KPA RF *237* KPA

LR *234* KPA RR *234* 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)) *17* °C

Brake Conditioning Time: *8:02:00 AM* Date: *5/28/2010*

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	*0.9-1.0*	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 6)
BRAKE AND TIRE CONDITIONING

Tire Conditioning series No. 1	Time:	*8:18:00 AM*		Date:	*5/28/2010*	
Measured cold tire pressure	LF	*244*	KPA	RF	*243*	KPA
	LR	*238*	KPA	RR	*239*	KPA
Wind Speed *2.1* 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)) *17.1* °C

30 meter (100 ft) Diameter Circle Maneuver				
Test Run	Steering Direction	Target Lateral Acceleration (g)	Observed Lateral Acceleration (g)	Observed Vehicle Speed (Km/h)
1-3	Clockwise	0.5 – 0.6	*0.5-0.6*	*31.2 - 32.8*
4-6	Counterclockwise	0.5 – 0.6	*0.5-0.6*	*32 - 33.6*

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	*0.41*
2	3	56 ± 2 (35 ± 1)	*80*	0.5 - 0.6	*0.53*
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	*0.53*
4	*7*	56 ± 2 (35 ± 1)	*80* (cycles 1-9)	0.5 - 0.6	*0.53*
			160 (cycle10)*	NA	*0.76*

* 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 6)
BRAKE AND TIRE CONDITIONING

Tire Conditioning series No. 2 Time: *9:49:00 AM* Date: *5/28/2010*

Measured cold tire pressure LF *247* KPA RF *236* KPA

LR *237* KPA RR *232* KPA

Wind Speed *3.4* 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)) *18.7* °C

30 meter (100 ft) Diameter Circle Maneuver				
Test Run	Steering Direction	Target Lateral Acceleration (g)	Observed Lateral Acceleration (g)	Observed Vehicle Speed (Km/h)
1-3	Clockwise	0.5 - 0.6	*0.5-0.6*	*31.2 - 32.8*
4-6	Counterclockwise	0.5 - 0.6	*0.5-0.6*	*31.2 - 32.8*

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	*16-18*	56 ± 2 (35 ± 1)	*80* (cycles 1-10)	0.5 - 0.6	*0.53*
4	*19*	56 ± 2 (35 ± 1)	*80* (cycles 1-9)	0.5 - 0.6	*0.53*
			160 (cycle 10)*	NA	*0.76*

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

Remarks:

RECORDED BY: *Brian Kebschull* DATE RECORDED: *5/28/2010*

APPROVED BY: *J Lenkeit* DATE APPROVED: *6/14/2010*

3.0 TEST DATA (CONTD)

Data Sheet 6 (Page 4 of 6)
BRAKE AND TIRE CONDITIONING

Vehicle: *2010 Hyundai Santa Fe MPV AWD (Locked)*

NHTSA No. *CA0518*

Measured tire pressure: LF *237* KPA RF *242* KPA

LR *234* KPA RR *238* KPA

Wind Speed *4.1* 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)) *18.2* °C

Brake Conditioning Time: *1:10:00 PM* Date: *5/28/2010*

56 km/h (35 mph) Brake Stops

Number of stops executed (10 required)	*10*	Stops
Observed deceleration rate range (.5g target)	*.45 - .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	*.9-1*	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 5 of 6)
BRAKE AND TIRE CONDITIONING

Tire Conditioning series No. 1	Time:	*1:45:00 PM*		Date:	*5/28/2010*	
Measured cold tire pressure	LF	*253*	KPA	RF	*251*	KPA
	LR	*248*	KPA	RR	*247*	KPA
Wind Speed *2.4* 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)) *18.5*°C

30 meter (100 ft) Diameter Circle Maneuver				
Test Run	Steering Direction	Target Lateral Acceleration (g)	Observed Lateral Acceleration (g)	Observed Vehicle Speed (Km/h)
1-3	Clockwise	0.5 – 0.6	*.5 - .6*	*30.4 - 32*
4-6	Counterclockwise	0.5 – 0.6	*.5 - .6*	*30.4 - 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	*0.37*
2	3	56 ± 2 (35 ± 1)	*90*	0.5 - 0.6	*0.53*
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:
90 **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)	*90* (cycles 1-10)	0.5 - 0.6	*0.53*
4	*7*	56 ± 2 (35 ± 1)	*90* (cycles 1-9)	0.5 - 0.6	*0.53*
			180 (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 6 of 6)
BRAKE AND TIRE CONDITIONING

Tire Conditioning series No. 2 Time: *2:25:00 PM* Date: *5/28/2010*

Measured cold tire pressure LF *253* KPA RF *252* KPA

LR *248* KPA RR *247* KPA

Wind Speed *4.3* 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)) *22.5* °C

30 meter (100 ft) Diameter Circle Maneuver				
Test Run	Steering Direction	Target Lateral Acceleration (g)	Observed Lateral Acceleration (g)	Observed Vehicle Speed (Km/h)
1-3	Clockwise	0.5 - 0.6	*.5 - .6*	*30.4 - 32*
4-6	Counterclockwise	0.5 - 0.6	*.5 - .6*	*30.4 - 32*

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

90 **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	*16-18*	56 ± 2 (35 ± 1)	*90* (cycles 1-10)	0.5 - 0.6	*0.53*
4	*19*	56 ± 2 (35 ± 1)	*90* (cycles 1-9)	0.5 - 0.6	*0.53*
			180 (cycle 10)*	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: *5/28/2010*

APPROVED BY: *J Lenkeit* DATE APPROVED: *6/14/2010*

3.0 TEST DATA (CONTD)

Data Sheet 7 (Page 1 of 4)
SLOWLY INCREASING STEER (SIS) MANEUVER

Vehicle: *2010 Hyundai Santa Fe MPV AWD (Unlocked)*

NHTSA No. *CA0518*

Measured tire pressure: LF *246* KPA RF *244* KPA

LR *241* KPA RR *240* 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)) *16.1* °C

Selected drive configuration *AWD (Unlocked)*

Selected Mode: *Standard- ESC on*

Preliminary Left Steer Maneuver:

Lateral Acceleration measured at 30 degrees steering wheel angle

$a_{y,30degrees}$ = *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} = *47.1* degrees (@.55g)

δ_{sis} = *50* degrees (rounded)

Steering Wheel Angle at Corrected 0.3g Lateral Acceleration:

Maneuver	Initial Steer Direction	Time Clock (5 min max between runs)	Steering Wheel Angle to nearest 0.1° (degrees)	Data Run	Good/NG
1	Left	*9:02:09 AM*	*-28.5*	*10*	*Good*
2	Left	*9:06:11 AM*	*-28.7*	*11*	*Good*
3	Left	*9:10:00 AM*	*-28.2*	*12*	*Good*
4	Left				
5	Left				
1	Right	*9:13:41 AM*	*28.7*	*13*	*Good*
2	Right	*9:17:37 AM*	*28.1*	*14*	*Good*
3	Right	*9:21:01 AM*	*28.8*	*15*	*Good*
4	Right				
5	Right				

3.0 TEST DATA (CONTD)

Data Sheet 7 (Page 2 of 4)
SLOWLY INCREASING STEER (SIS) MANEUVER

Average Overall Steering Wheel Angle:

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

$\delta_{0.3\ g,\ overall}$ = *28.5* degrees

[to nearest 0.1 degree]

Remarks:

RECORDED BY: *Brian Kebschull* DATE RECORDED: *5/28/2010*
APPROVED BY: *J Lenkeit* DATE APPROVED: *6/14/2010*

3.0 TEST DATA (CONTD)

Data Sheet 7 (Page 3 of 4)
SLOWLY INCREASING STEER (SIS) MANEUVER

Vehicle: *2010 Hyundai Santa Fe MPV AWD (Locked)*

NHTSA No. *CA0518*

Measured tire pressure: LF *252* KPA RF *252* KPA

LR *249* KPA RR *247* KPA

Wind Speed *3* 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)) *20.9* °C

Selected drive configuration *AWD Lock*

Selected Mode: *Standard - ESC on*

Preliminary Left Steer Maneuver:

Lateral Acceleration measured at 30 degrees steering wheel angle

$a_{y,30degrees}$ = *0.34* 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} = *48.5* degrees (@.55g)

δ_{sis} = *50* degrees (rounded)

Steering Wheel Angle at Corrected 0.3g Lateral Acceleration:

Maneuver	Initial Steer Direction	Time Clock (5 min max between runs)	Steering Wheel Angle to nearest 0.1° (degrees)	Data Run	Good/NG
1	Left	*2:30:36 PM*	*-29.1*	*10*	*Good*
2	Left	*2:34:46 PM*	*-29.5*	*11*	*Good*
3	Left	*2:37:48 PM*	*-29.4*	*12*	*Good*
4	Left				
5	Left				
1	Right	*2:40:50 PM*	*28.9*	*13*	*Good*
2	Right	*2:43:51 PM*	*28.9*	*14*	*Good*
3	Right	*2:46:51 PM*	*28.6*	*15*	*Good*
4	Right				
5	Right				

3.0 TEST DATA (CONTD)

Data Sheet 7 (Page 4 of 4)
SLOWLY INCREASING STEER (SIS) MANEUVER

Average Overall Steering Wheel Angle:

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

$\delta_{0.3\ g,\ overall}$ = *29.0* degrees

[to nearest 0.1 degree]

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *5/28/2010*
APPROVED BY: *J Lenkeit* DATE APPROVED: *6/14/2010*

3.0 TEST DATA (CONTD)

Data Sheet 8 (Page 1 of 6)
VEHICLE LATERAL STABILITY AND RESPONSIVENESS

Vehicle: *2010 Hyundai Santa Fe MPV AWD (Unlocked)*

NHTSA No. *CA0518* Data sheet completion date: *5/28/2010*

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

Selected Drive Configuration: *AWD(Unlocked)*

Selected Mode: *Default- ESC On*

Overall steering wheel angle ($\delta_{0.3\ g,\ overall}$) *28.5* 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
21	*10:10*	*1.5*	*43*	*12.4*	*-0.2*	*-0.1*	*-1.2*	*Pass*	*-0.5*	*Pass*
22	*10:13*	*2.0*	*57*	*16.4*	*0.0*	*0.1*	*-0.1*	*Pass*	*0.3*	*Pass*
23	*10:16*	*2.5*	*71*	*19.8*	*0.0*	*0.0*	*0.0*	*Pass*	*-0.2*	*Pass*
24	*10:20*	*3.0*	*86*	*23.8*	*0.0*	*-0.1*	*0.0*	*Pass*	*-0.2*	*Pass*
25	*10:23*	*3.5*	*100*	*29.5*	*0.0*	*-0.1*	*0.0*	*Pass*	*-0.5*	*Pass*
26	*10:27*	*4.0*	*114*	*33.2*	*0.1*	*0.1*	*0.3*	*Pass*	*0.2*	*Pass*
27	*10:30*	*4.5*	*128*	*36.6*	*-0.1*	*-0.1*	*-0.3*	*Pass*	*-0.2*	*Pass*
28	*10:33*	*5.0*	*143*	*40.9*	*-0.2*	*0.0*	*-0.5*	*Pass*	*0.1*	*Pass*
29	*10:36*	*5.5*	*157*	*42.9*	*-0.1*	*0.0*	*-0.1*	*Pass*	*0.0*	*Pass*
30	*10:38*	*6.0*	*171*	*43.1*	*-0.2*	*-0.1*	*-0.4*	*Pass*	*-0.2*	*Pass*
31	*10:40*	*6.5*	*185*	*45.1*	*-0.2*	*0.0*	*-0.4*	*Pass*	*0.0*	*Pass*
32	*10:43*	*7.0*	*200*	*47.1*	*0.1*	*0.0*	*0.2*	*Pass*	*0.1*	*Pass*
33	*10:46*	*7.5*	*214*	*48.8*	*0.5*	*0.1*	*1.1*	*Pass*	*0.2*	*Pass*
34	*10:49*	*8.0*	*228*	*51.4*	*0.3*	*0.0*	*0.5*	*Pass*	*0.1*	*Pass*
35	*10:52*	*8.5*	*242*	*49.8*	*0.5*	*0.0*	*1.0*	*Pass*	*0.1*	*Pass*
36	*10:55*	*9.0*	*257*	*51.9*	*0.5*	*0.0*	*1.0*	*Pass*	*0.0*	*Pass*
*38**	*11:05*	-	*270*	*53.4*	*1.6*	*-0.2*	*3.0*	*Pass*	*-0.4*	*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 6)
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
39	*11:10*	*1.5*	*43*	*-13.0*	*0.0*	*0.0*	*-0.2*	*Pass*	*0.2*	*Pass*
40	*11:14*	*2.0*	*57*	*-17.3*	*-0.1*	*0.0*	*0.3*	*Pass*	*-0.2*	*Pass*
41	*11:16*	*2.5*	*71*	*-21.2*	*0.0*	*0.1*	*-0.1*	*Pass*	*-0.5*	*Pass*
42	*11:20*	*3.0*	*86*	*-25.8*	*0.1*	*-0.1*	*-0.4*	*Pass*	*0.4*	*Pass*
43	*11:23*	*3.5*	*100*	*-30.0*	*0.0*	*-0.1*	*-0.1*	*Pass*	*0.2*	*Pass*
44	*11:26*	*4.0*	*114*	*-31.1*	*0.0*	*0.0*	*0.0*	*Pass*	*-0.1*	*Pass*
45	*11:29*	*4.5*	*128*	*-38.9*	*0.0*	*0.2*	*0.0*	*Pass*	*-0.5*	*Pass*
46	*11:32*	*5.0*	*143*	*-37.7*	*0.2*	*0.1*	*-0.4*	*Pass*	*-0.3*	*Pass*
47	*11:35*	*5.5*	*157*	*-41.8*	*0.2*	*0.3*	*-0.5*	*Pass*	*-0.8*	*Pass*
48	*11:38*	*6.0*	*171*	*-43.6*	*0.1*	*0.1*	*-0.3*	*Pass*	*-0.1*	*Pass*
*52**	*11:57*	*6.5*	*185*	*-47.2*	*0.3*	*0.2*	*-0.7*	*Pass*	*-0.5*	*Pass*
53	*12:00*	*7.0*	*200*	*-46.8*	*0.1*	*0.1*	*-0.2*	*Pass*	*-0.2*	*Pass*
54	*12:05*	*7.5*	*214*	*-48.4*	*0.0*	*0.0*	*0.0*	*Pass*	*0.0*	*Pass*
55	*12:08*	*8.0*	*228*	*-49.7*	*0.1*	*0.1*	*-0.2*	*Pass*	*-0.2*	*Pass*
56	*12:11*	*8.5*	*242*	*-51.0*	*0.1*	*0.1*	*-0.1*	*Pass*	*-0.2*	*Pass*
57	*12:14*	*9.0*	*257*	*-51.6*	*-0.1*	*-0.1*	*0.1*	*Pass*	*0.3*	*Pass*
58	*12:18*	-	*270*	*-53.2*	*-0.3*	*-0.1*	*0.5*	*Pass*	*0.2*	*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	[X] No
Tire debeading	[ ] Yes	[X] No
Loss of pavement contact of vehicle tires	[ ] Yes	[X] No
Did the test driver experience any vehicle loss of control or spinout?	[ ] Yes	[X] No

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

3.0 TEST DATA (CONTD)

DATA SHEET 8 (3 of 6)
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
28	*Counter Clockwise*	*5.0*	*143*	*-3.0*	*Pass*
29	*Counter Clockwise*	*5.5*	*157*	*-3.1*	*Pass*
30	*Counter Clockwise*	*6.0*	*171*	*-3.2*	*Pass*
31	*Counter Clockwise*	*6.5*	*185*	*-3.2*	*Pass*
32	*Counter Clockwise*	*7.0*	*200*	*-3.3*	*Pass*
33	*Counter Clockwise*	*7.5*	*214*	*-3.3*	*Pass*
34	*Counter Clockwise*	*8.0*	*228*	*-3.3*	*Pass*
35	*Counter Clockwise*	*8.5*	*242*	*-3.3*	*Pass*
36	*Counter Clockwise*	*9.0*	*257*	*-3.3*	*Pass*
38	*Counter Clockwise*	-	*270*	*-3.3*	*Pass*
46	*Clockwise*	*5.0*	*143*	*2.8*	*Pass*
47	*Clockwise*	*5.5*	*157*	*2.9*	*Pass*
48	*Clockwise*	*6.0*	*171*	*3.1*	*Pass*
52	*Clockwise*	*6.5*	*185*	*3.1*	*Pass*
53	*Clockwise*	*7.0*	*200*	*3.1*	*Pass*
54	*Clockwise*	*7.5*	*214*	*3.2*	*Pass*
55	*Clockwise*	*8.0*	*228*	*3.2*	*Pass*
56	*Clockwise*	*8.5*	*242*	*3.3*	*Pass*
57	*Clockwise*	*9.0*	*257*	*3.2*	*Pass*
58	*Clockwise*	-	*270*	*3.2*	*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: **Run 37 was no good, Runs 49-51 were no good due to a speed trigger problem*

RECORDED BY: *B Kebschull* DATE RECORDED: *5/28/2010*

APPROVED BY: *J Lenkeit* DATE APPROVED: *6/14/2010*

3.0 TEST DATA (CONTD)

Data Sheet 8 (Page 4 of 6)
VEHICLE LATERAL STABILITY AND RESPONSIVENESS

Vehicle: *2010 Hyundai Santa Fe MPV AWD (Locked)*

NHTSA No. *CA0518* Data sheet completion date: *5/28/2010*

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

Selected Drive Configuration: *AWD- Locked*

Selected Mode: *Standard -ESC on*

Overall steering wheel angle ($\delta_{0.3\ g,\ overall}$) *29.0* 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
22	*15:05*	*1.5*	*44*	*13.11*	*0.03*	*0.11*	*0.25*	*Pass*	*0.87*	*Pass*
23	*15:10*	*2.0*	*58*	*17.18*	*0.16*	*0.12*	*0.92*	*Pass*	*0.69*	*Pass*
24	*15:13*	*2.5*	*73*	*20.69*	*0.12*	*0.11*	*0.56*	*Pass*	*0.54*	*Pass*
25	*15:17*	*3.5*	*87*	*30.81*	*0.00*	*-0.12*	*0.00*	*Pass*	*-0.37*	*Pass*
26	*15:19*	*3.0*	*102*	*25.21*	*0.07*	*0.12*	*0.26*	*Pass*	*0.49*	*Pass*
27	*15:22*	*4.0*	*116*	*32.49*	*-0.04*	*0.12*	*-0.12*	*Pass*	*0.36*	*Pass*
28	*15:25*	*4.5*	*131*	*38.33*	*0.15*	*0.07*	*0.38*	*Pass*	*0.18*	*Pass*
29	*15:28*	*5.0*	*145*	*42.00*	*0.46*	*0.05*	*1.09*	*Pass*	*0.13*	*Pass*
30	*15:30*	*5.5*	*160*	*43.73*	*0.24*	*0.10*	*0.55*	*Pass*	*0.22*	*Pass*
31	*15:33*	*6.0*	*174*	*46.69*	*0.28*	*-0.05*	*0.61*	*Pass*	*-0.11*	*Pass*
*33**	*15:52*	*6.5*	*189*	*47.50*	*0.64*	*0.15*	*1.35*	*Pass*	*0.32*	*Pass*
34	*15:56*	*7.0*	*203*	*47.86*	*0.30*	*-0.02*	*0.63*	*Pass*	*-0.03*	*Pass*
35	*15:57*	*7.5*	*218*	*49.65*	*0.51*	*0.03*	*1.03*	*Pass*	*0.05*	*Pass*
36	*16:01*	*8.0*	*232*	*52.29*	*0.48*	*0.08*	*0.92*	*Pass*	*0.15*	*Pass*
37	*16:04*	*8.5*	*247*	*52.76*	*1.43*	*-0.04*	*2.71*	*Pass*	*-0.08*	*Pass*
38	*16:05*	*9.0*	*261*	*54.08*	*2.32*	*0.18*	*4.29*	*Pass*	*0.33*	*Pass*
39	*16:08*	*9.3*	*270*	*55.23*	*0.78*	*0.18*	*1.41*	*Pass*	*0.33*	*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 (5 of 6)
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
40	*16:10*	*1.5*	*44*	*-13.21*	*0.02*	*0.05*	*-0.14*	*Pass*	*-0.36*	*Pass*
41	*16:13*	*2.0*	*58*	*-17.73*	*0.01*	*0.04*	*-0.05*	*Pass*	*-0.24*	*Pass*
42	*16:15*	*2.5*	*73*	*-22.09*	*-0.11*	*0.02*	*0.48*	*Pass*	*-0.11*	*Pass*
43	*16:18*	*3.0*	*87*	*-26.39*	*-0.17*	*-0.29*	*0.63*	*Pass*	*1.12*	*Pass*
44	*16:21*	*3.5*	*102*	*-30.27*	*-0.02*	*-0.01*	*0.06*	*Pass*	*0.04*	*Pass*
45	*16:23*	*4.0*	*116*	*-32.29*	*0.13*	*0.02*	*-0.40*	*Pass*	*-0.06*	*Pass*
46	*16:26*	*4.5*	*131*	*-37.23*	*0.16*	*0.22*	*-0.42*	*Pass*	*-0.60*	*Pass*
47	*16:29*	*5.0*	*145*	*-41.24*	*0.12*	*0.10*	*-0.29*	*Pass*	*-0.25*	*Pass*
48	*16:32*	*5.5*	*160*	*-43.21*	*0.14*	*0.12*	*-0.32*	*Pass*	*-0.28*	*Pass*
49	*16:35*	*6.0*	*174*	*-46.04*	*0.03*	*-0.07*	*-0.07*	*Pass*	*0.15*	*Pass*
50	*16:37*	*6.5*	*189*	*-47.95*	*0.34*	*0.14*	*-0.70*	*Pass*	*-0.30*	*Pass*
51	*16:40*	*7.0*	*203*	*-50.43*	*0.13*	*0.11*	*-0.26*	*Pass*	*-0.21*	*Pass*
52	*16:43*	*7.5*	*218*	*-49.37*	*0.21*	*0.19*	*-0.43*	*Pass*	*-0.39*	*Pass*
53	*16:46*	*8.0*	*232*	*-53.30*	*0.03*	*0.04*	*-0.05*	*Pass*	*-0.08*	*Pass*
54	*16:50*	*8.5*	*247*	*-54.91*	*-0.27*	*-0.11*	*0.50*	*Pass*	*0.20*	*Pass*
55	*16:52*	*9.0*	*261*	*-53.75*	*0.13*	*0.12*	*-0.25*	*Pass*	*-0.21*	*Pass*
56	*16:55*	*9.3*	*270*	*-55.75*	*-0.06*	*0.03*	*0.11*	*Pass*	*-0.05*	*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	[X] No
Tire debeading	[ ] Yes	[X] No
Loss of pavement contact of vehicle tires	[ ] Yes	[X] No
Did the test driver experience any vehicle loss of control or spinout?	[ ] Yes	[X] No

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

3.0 TEST DATA (CONTD)

DATA SHEET 8 (6 of 6)
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
29	*Counter Clockwise*	*5.0*	*145*	*-3.0*	*Pass*
30	*Counter Clockwise*	*5.5*	*160*	*-3.1*	*Pass*
31	*Counter Clockwise*	*6.0*	*174*	*-3.2*	*Pass*
33	*Counter Clockwise*	*6.5*	*189*	*-3.3*	*Pass*
34	*Counter Clockwise*	*7.0*	*203*	*-3.3*	*Pass*
35	*Counter Clockwise*	*7.5*	*218*	*-3.3*	*Pass*
36	*Counter Clockwise*	*8.0*	*232*	*-3.3*	*Pass*
37	*Counter Clockwise*	*8.5*	*247*	*-3.3*	*Pass*
38	*Counter Clockwise*	*9.0*	*261*	*-3.5*	*Pass*
39	*Counter Clockwise*	*9.3*	*270*	*-3.4*	*Pass*
47	*Clockwise*	*5.0*	*145*	*2.9*	*Pass*
48	*Clockwise*	*5.5*	*160*	*3.0*	*Pass*
49	*Clockwise*	*6.0*	*174*	*3.1*	*Pass*
50	*Clockwise*	*6.5*	*189*	*3.1*	*Pass*
51	*Clockwise*	*7.0*	*203*	*3.1*	*Pass*
52	*Clockwise*	*7.5*	*218*	*3.2*	*Pass*
53	*Clockwise*	*8.0*	*232*	*3.2*	*Pass*
54	*Clockwise*	*8.5*	*247*	*3.2*	*Pass*
55	*Clockwise*	*9.0*	*261*	*3.2*	*Pass*
56	*Clockwise*	*9.3*	*270*	*3.2*	*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: **Run 32 no good, equipment malfunction*

RECORDED BY: *B Kebschull* DATE RECORDED: *5/28/2010*

APPROVED BY: *J Lenkeit* DATE APPROVED: *6/14/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2010 Hyundai Santa Fe AWD MPV*

NHTSA No. *CA0518* Data Sheet Completion Date: *5/28/2010*

TEST 1

MALFUNCTION SIMULATION: Describe method of malfunction simulation

Disconnected LF 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.

[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.

[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*

Remarks: *After malfunction was caused, malfunction telltale illuminated immediately upon ignition. Also, the ABS telltale illuminated (steadily) and the AWD malfunction telltale flashed on and off continuously. After the system was restored, all telltales extinguished immediately upon vehicle ignition. No driving was required*

RECORDED BY: *Brian Kebschull* DATE RECORDED: *5/28/2010*

APPROVED BY: *J Lenkeit* DATE APPROVED *6/14/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2010 Hyundai Santa Fe AWD MPV*

NHTSA No. *CA0518* Data Sheet Completion Date: *5/28/2010*

TEST 2

MALFUNCTION SIMULATION: Describe method of malfunction simulation

Disconnected brake switch

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.

[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.

[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

Remarks: *After the malfunction was caused, the ESC malfunction telltale did not illuminate immediately upon vehicle ignition. Rather, the brake pedal had to be depressed and released two times. The only telltale that illuminated was the ESC malfunction telltale. After the system was restored, the telltale extinguished immediately upon vehicle ignition. No driving was required*

RECORDED BY: *Brian Kebschull* DATE RECORDED: 5/28/2010

APPROVED BY: *J Lenkeit* DATE APPROVED *6/14/2010*

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: DRI Date:2/25/10 Due: 2/25/11
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: American Scale Date: 2/25/10 Due: 2/25/11
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: DRI Date: 2/25/10 Due: 2/25/11
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:11/23/09 Due: 11/23/10
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: DRI Date:3/2/10 Due:3/2/11
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:2/26/10 Due: 2/26/11
						DOT-NHTSA D3272	By: DRI Date:2/26/10 Due: 2/26/11

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: DRI Date:2/9/10 Due: 2/9/11
					SoMat High level Board EHLS	MSHLS.03-3182	By: DRI Date: 2/9/10 Due: 2/9/11
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	Operationally verified by DRI prior to test
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	UO8-05-08-06636	By: Faro Date: 8/18/09 Due: 8/18/10
Outriggers	No output. Safety Item.	NA	NA	NA	DRI manufactured Aluminum meeting the weight and MOI specifications of Docket 2007-27662-11	NA	NA

5.0 PHOTOGRAPHS (1 of 14)

Figure 5.1. Front View of Test Vehicle

5.0 PHOTOGRAPHS (2 of 14)

Figure 5.2. Rear View of Test Vehicle

5.0 PHOTOGRAPHS (3 of 14)

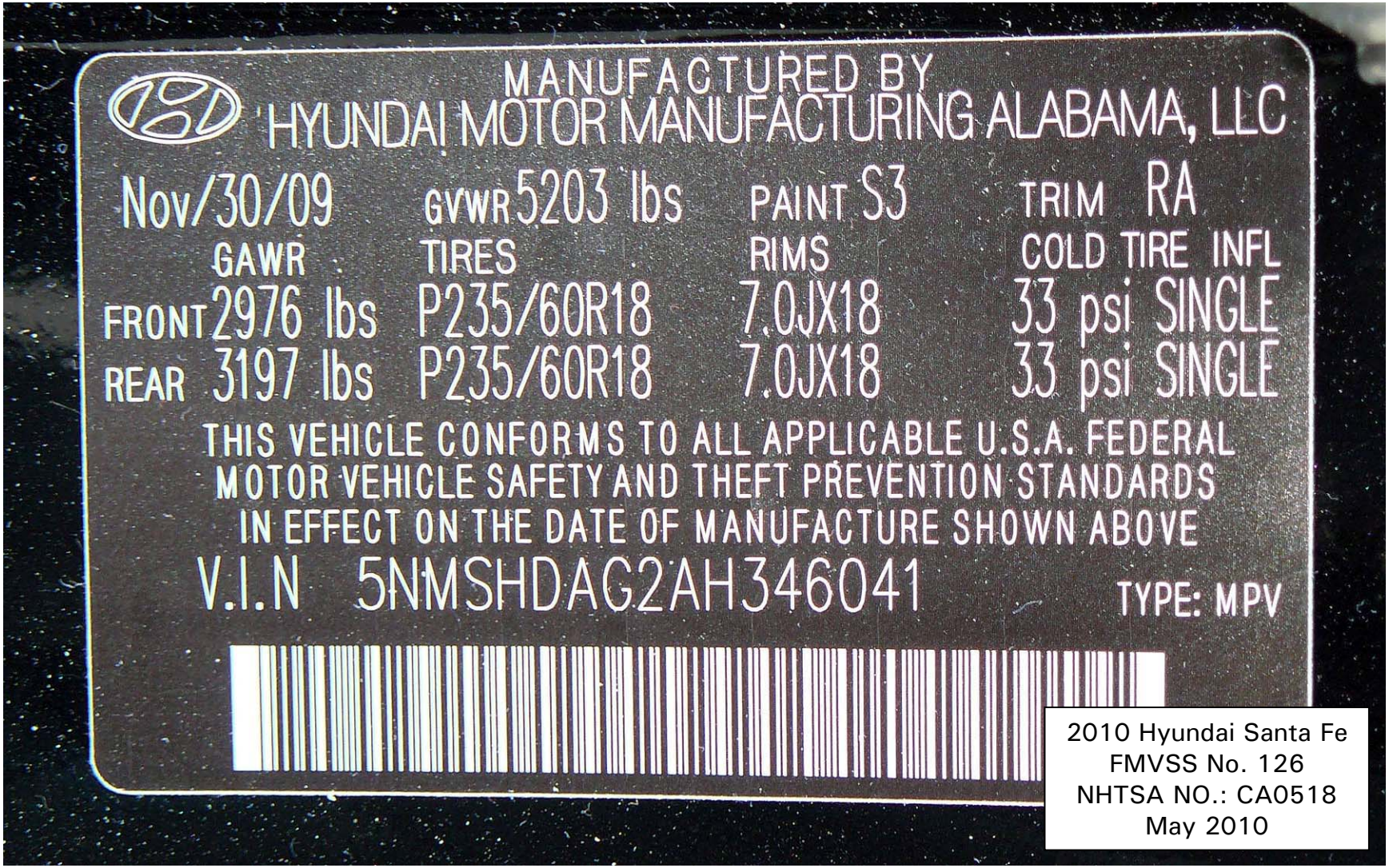

Figure 5.3. Vehicle Certification Label

5.0 PHOTOGRAPHS (4 of 14)

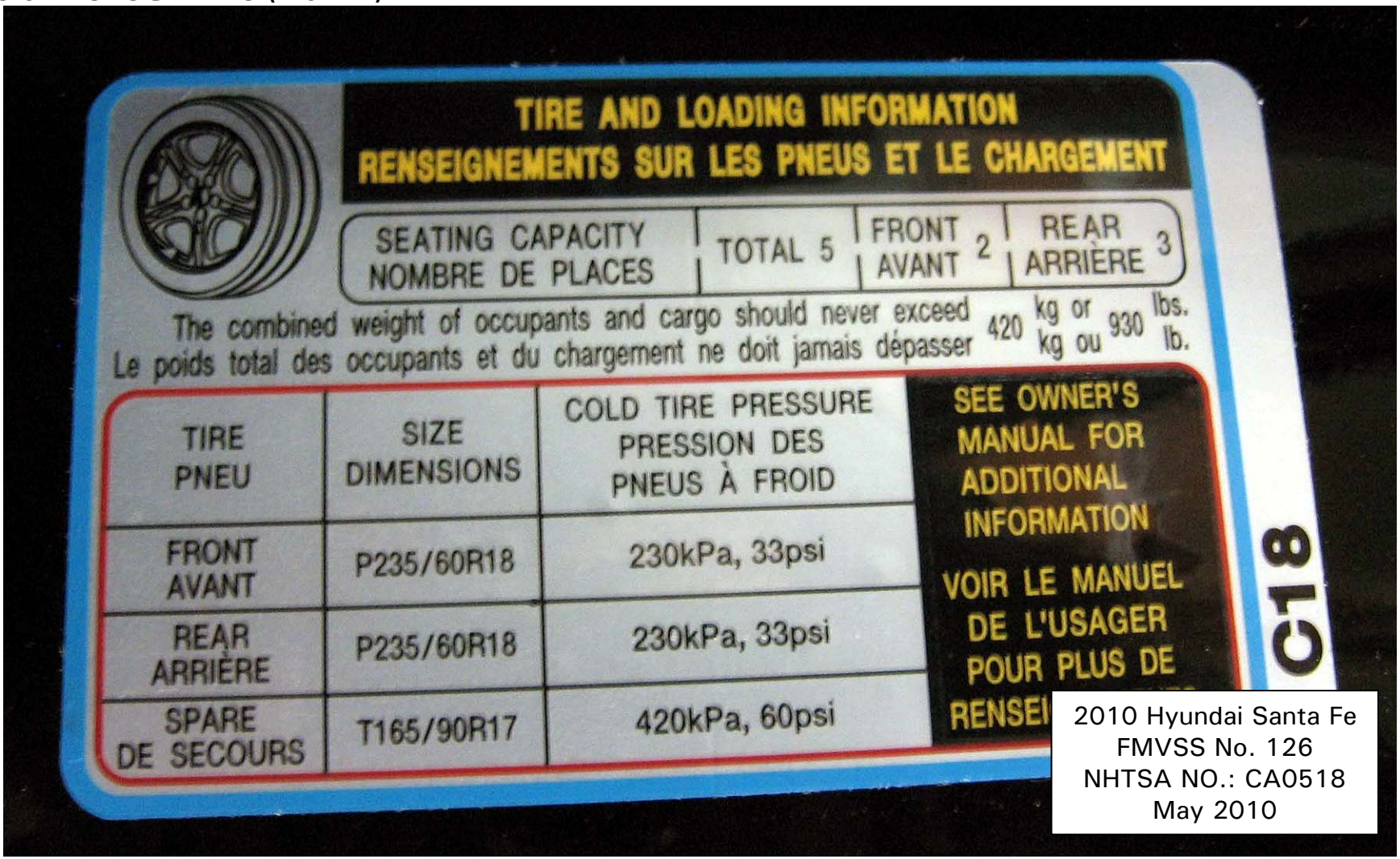

Figure 5.4. Vehicle Placard

5.0 PHOTOGRAPHS (5 of 14)

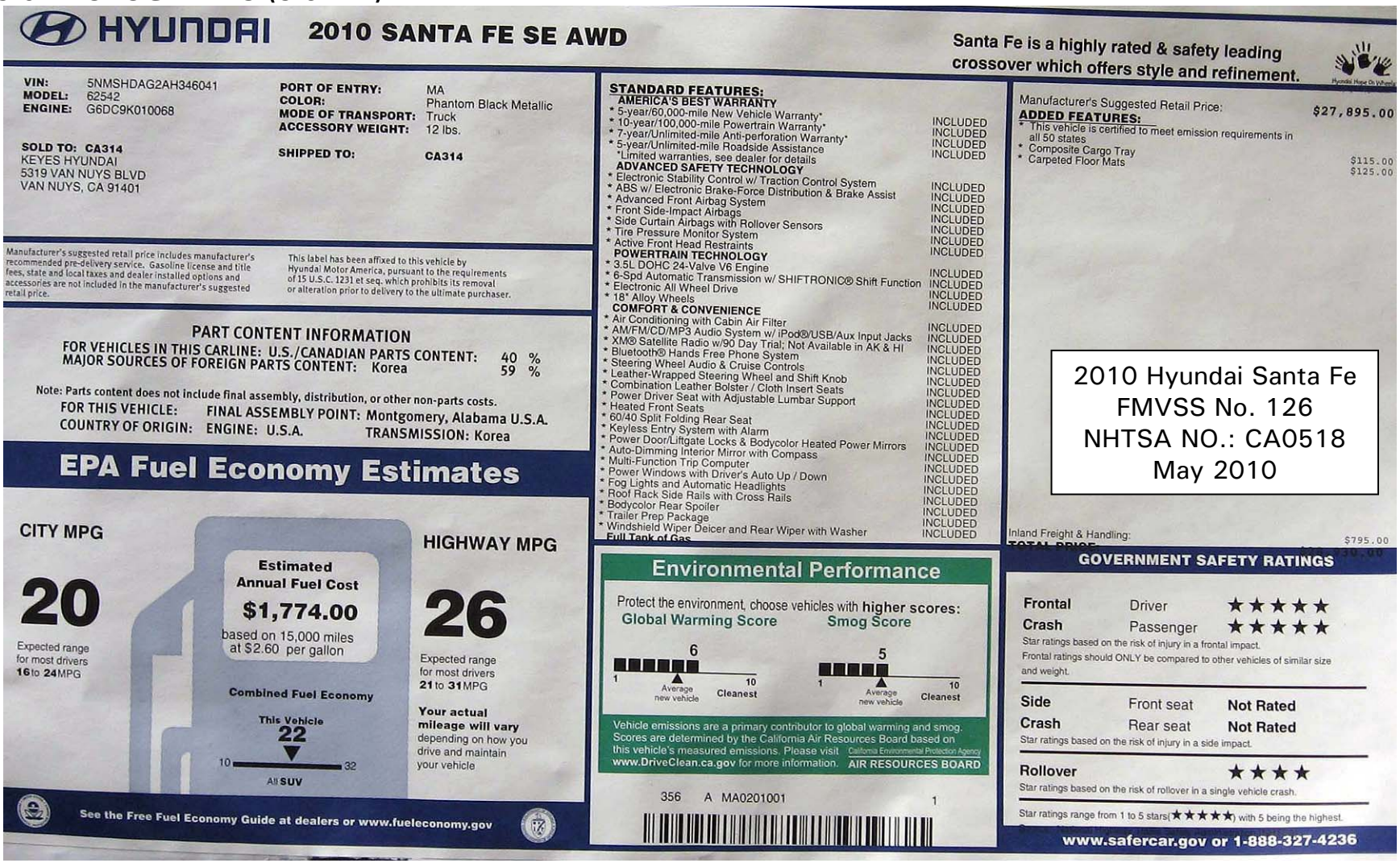

Figure 5.5. Window Sticker (Monroney Label)

5.0 PHOTOGRAPHS (6 of 14)

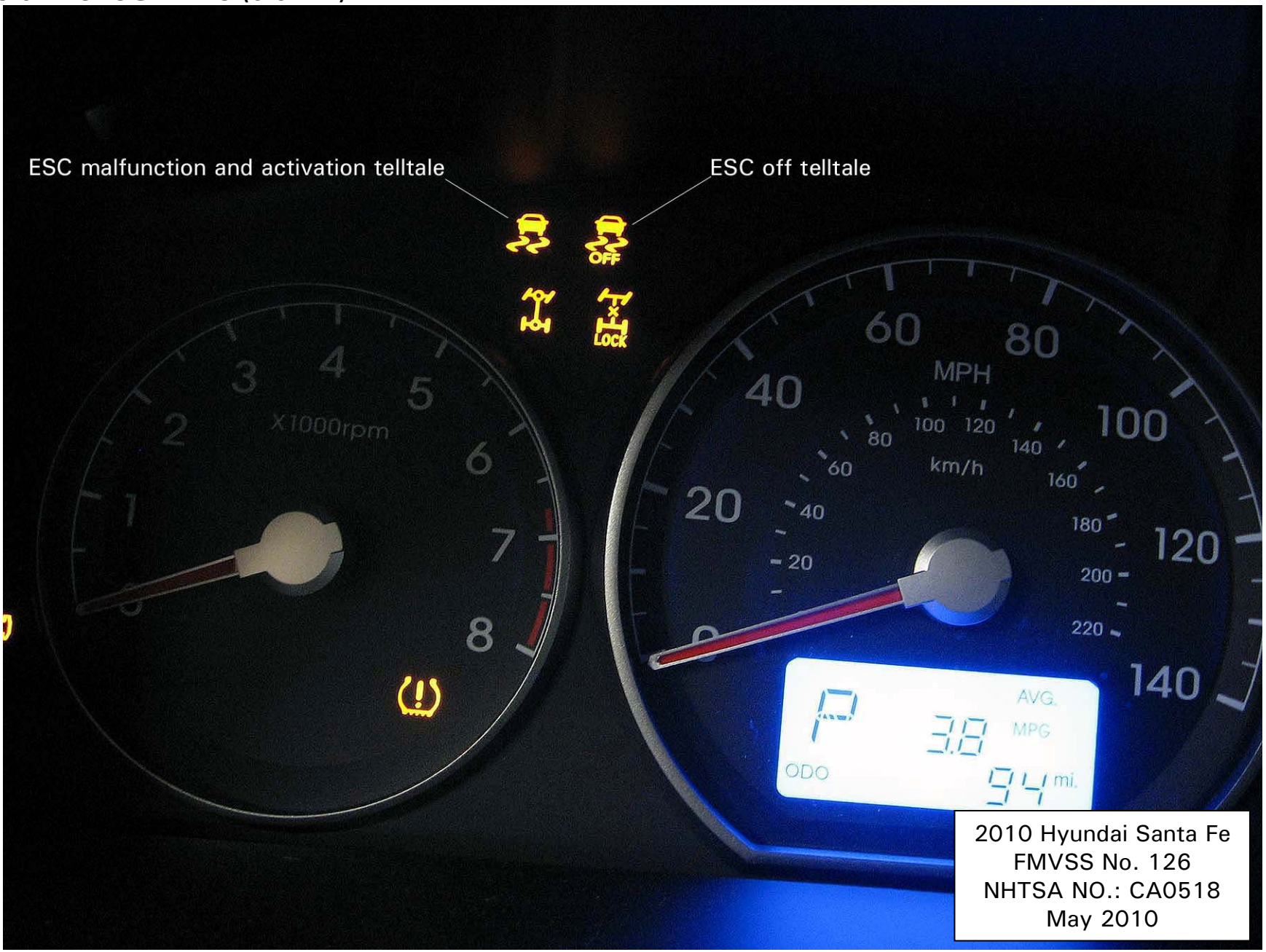

Figure 5.6. Telltale for ESC Malfunction and ESC Off

5.0 PHOTOGRAPHS (7 of 14)

Figure 5.7. ESC Off and AWD Lock Control Switches

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)

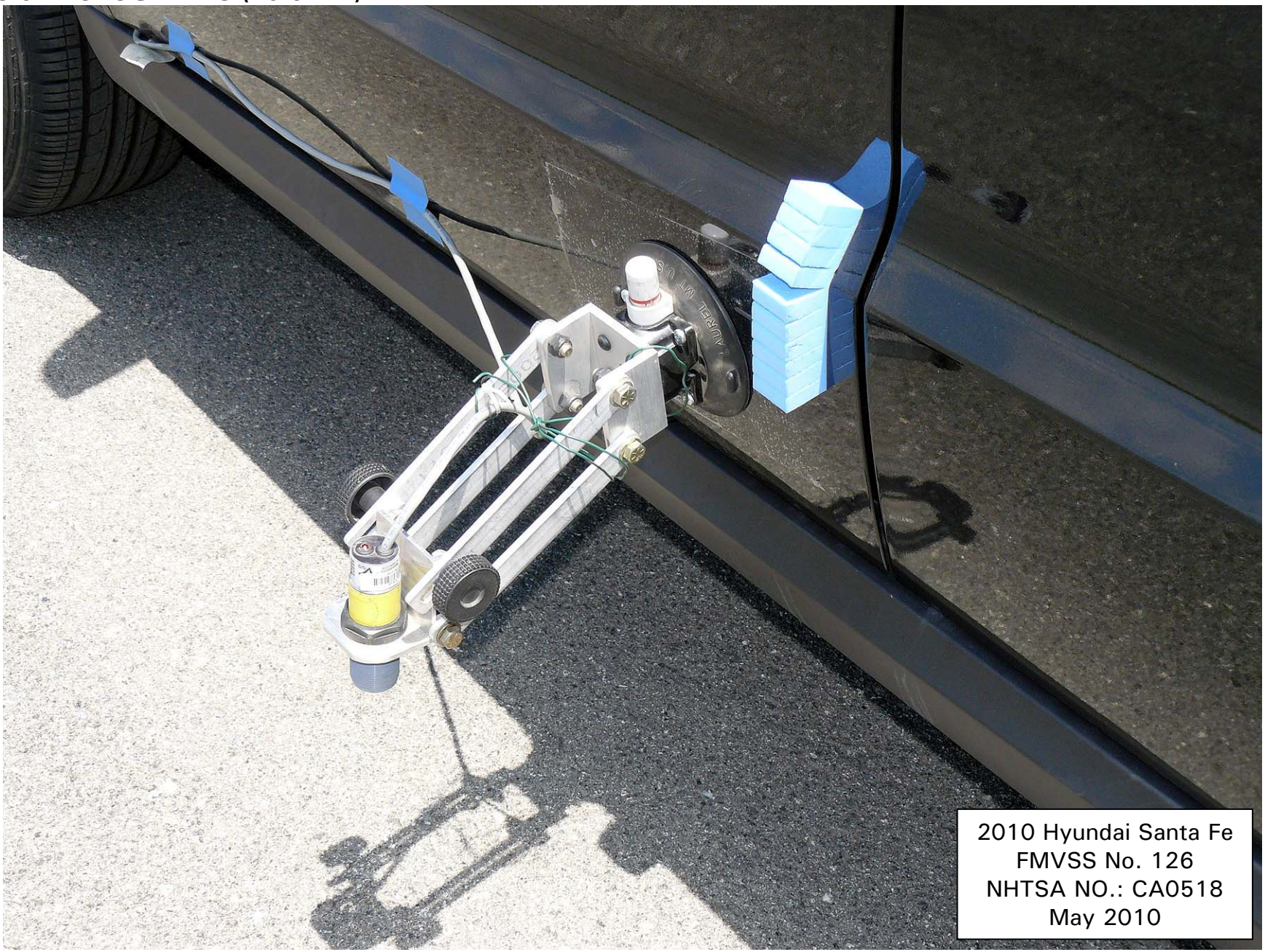

Figure 5.10. Ultrasonic Height Sensor Mounted on Left Side of Vehicle for Determining Body Roll Angle

5.0 PHOTOGRAPHS (11 of 14)

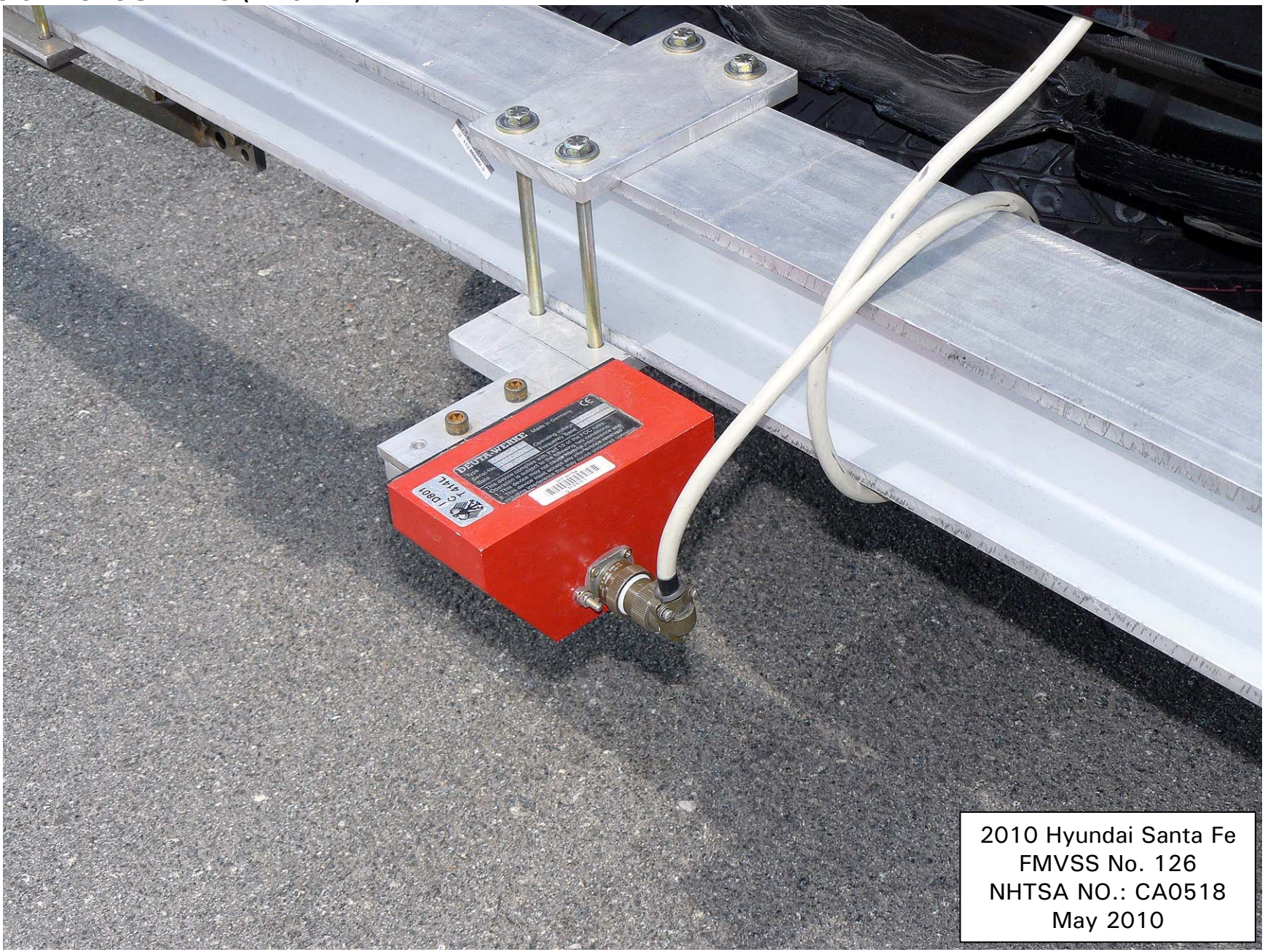

Figure 5.11. Rear Outrigger, Mount and Speed Sensor

5.0 PHOTOGRAPHS (12 of 14)

Figure 5.12. Steering Controller and Data Acquisition Computer

5.0 PHOTOGRAPHS (13 of 14)

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 8)

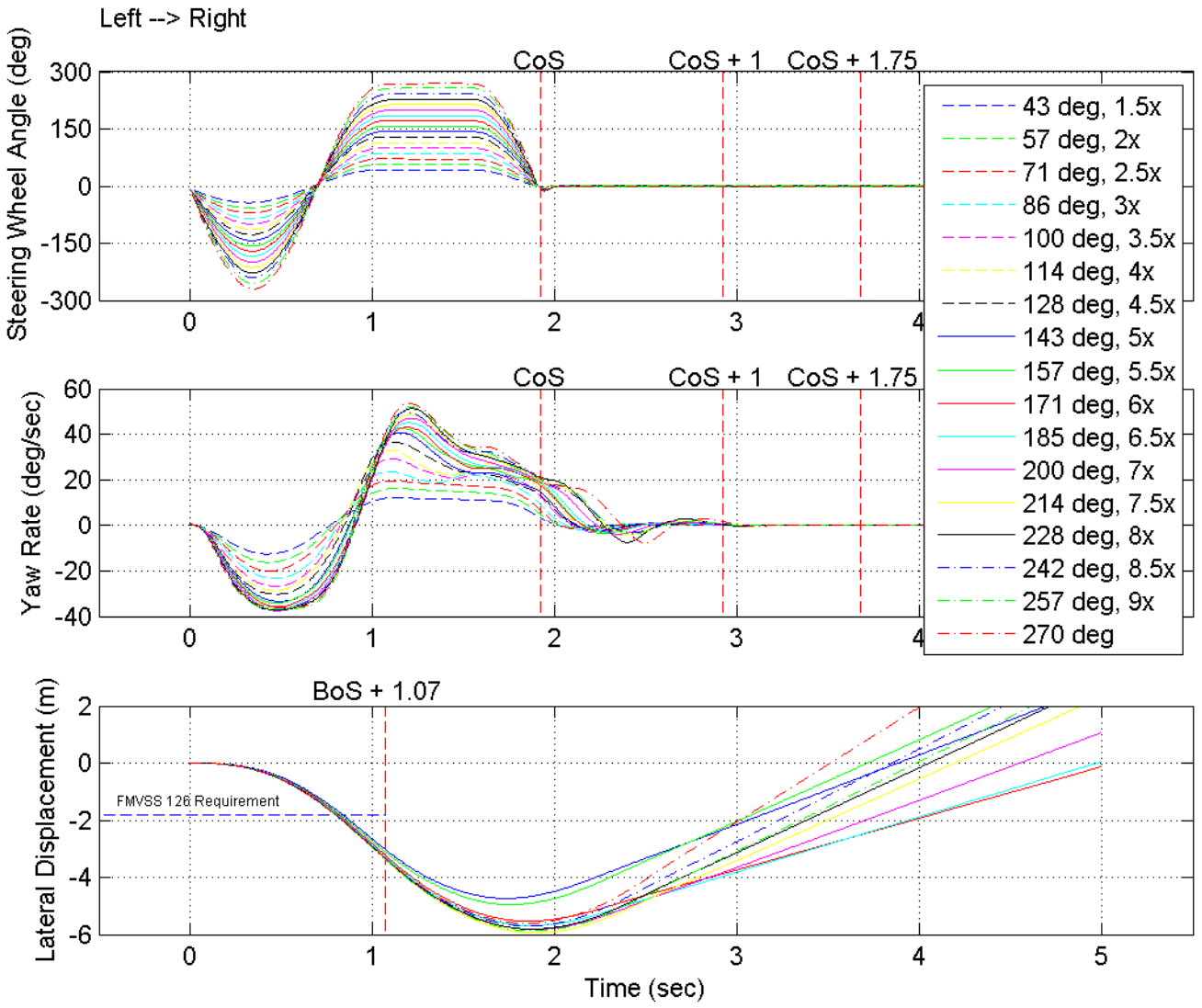

Figure 6.1. Steering Wheel Angle, Yaw Rate and Lateral Displacement for L-R Series (AWD Unlocked)

6.0 DATA PLOTS (2 of 8)

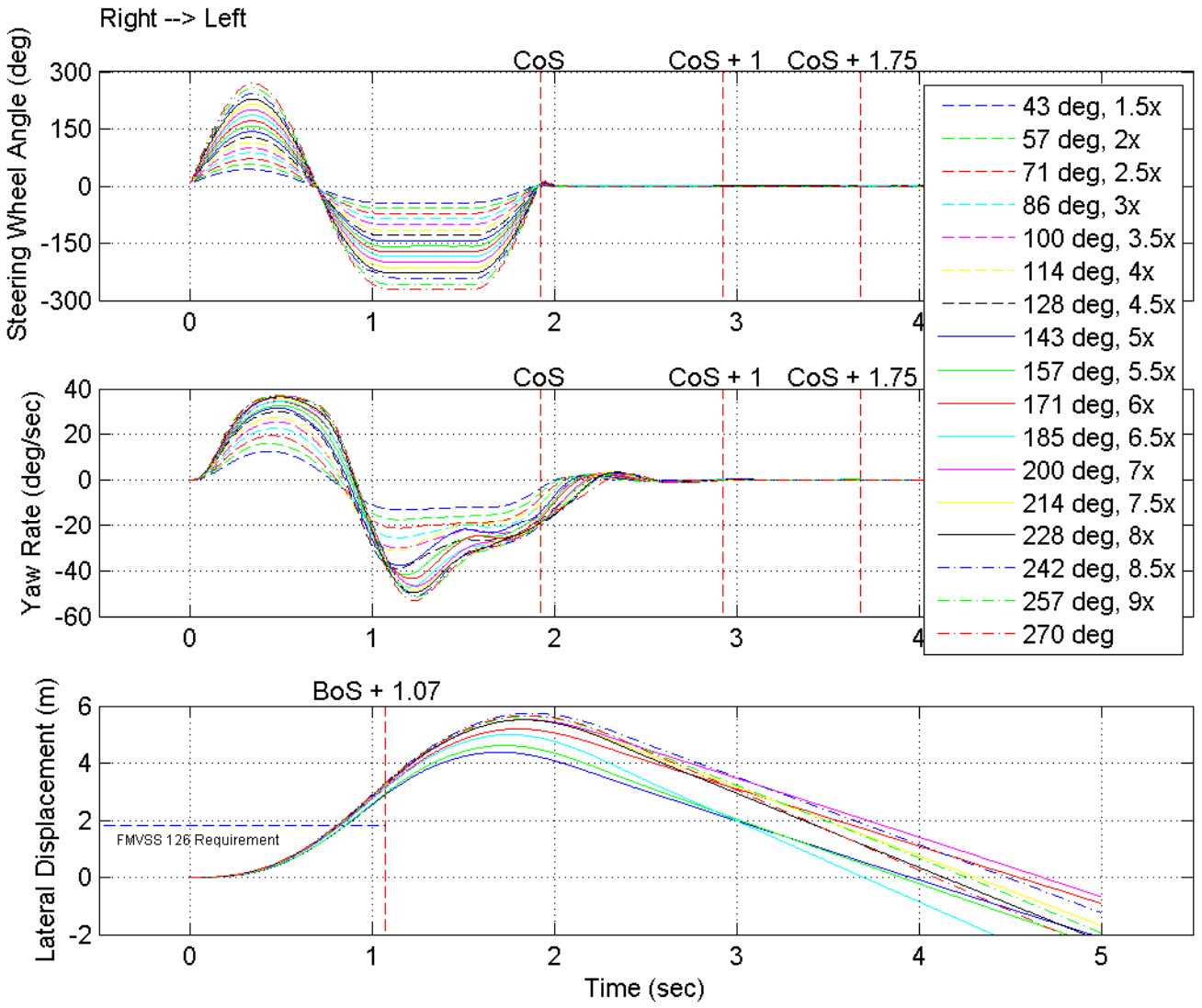

Figure 6.2. Steering Wheel Angle, Yaw Rate and Lateral Displacement for R-L Series (AWD Unlocked)

6.0 DATA PLOTS (3 of 8)

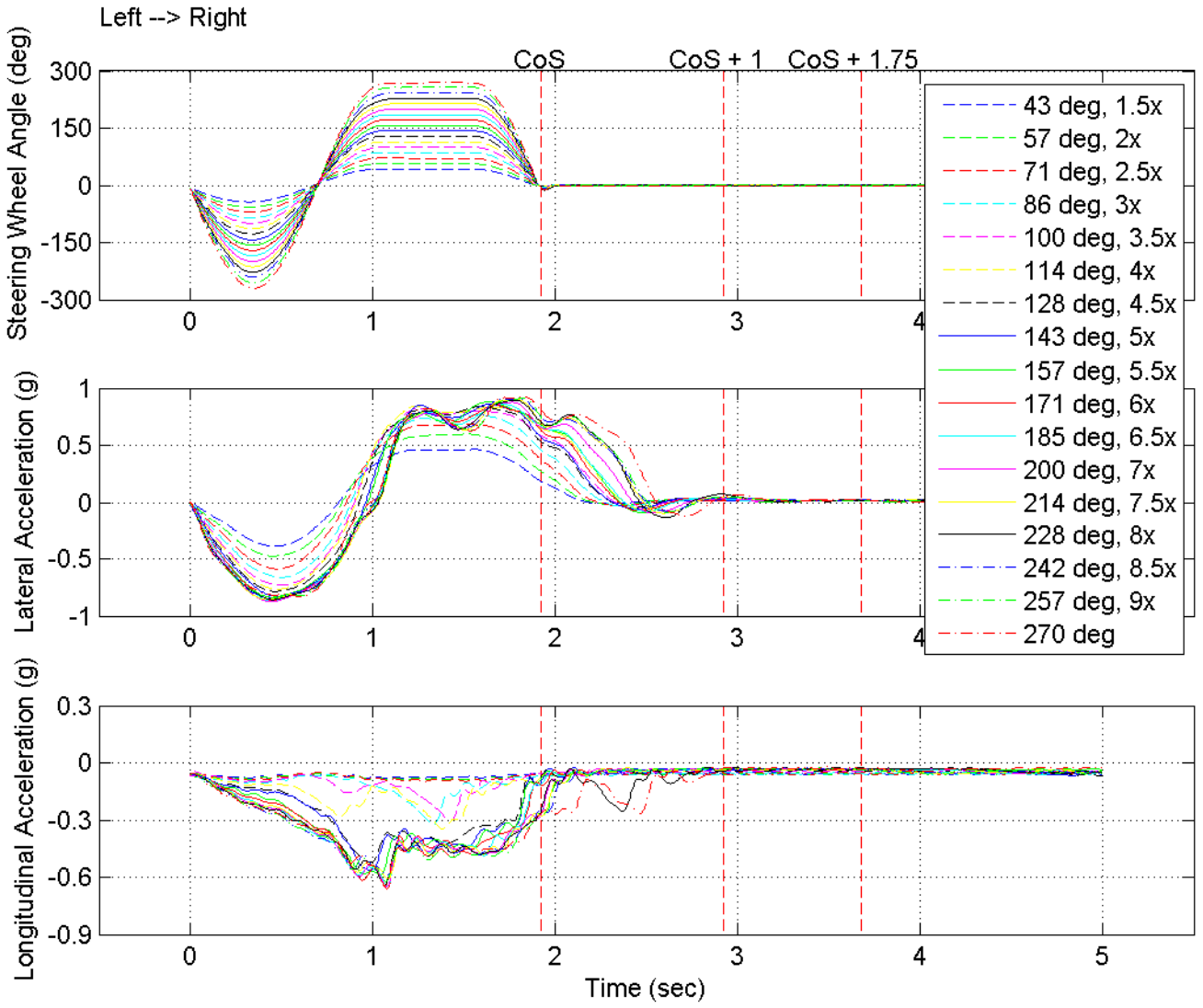

Figure 6.3. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for L-R Series (AWD Unlocked)

6.0 DATA PLOTS (4 of 8)

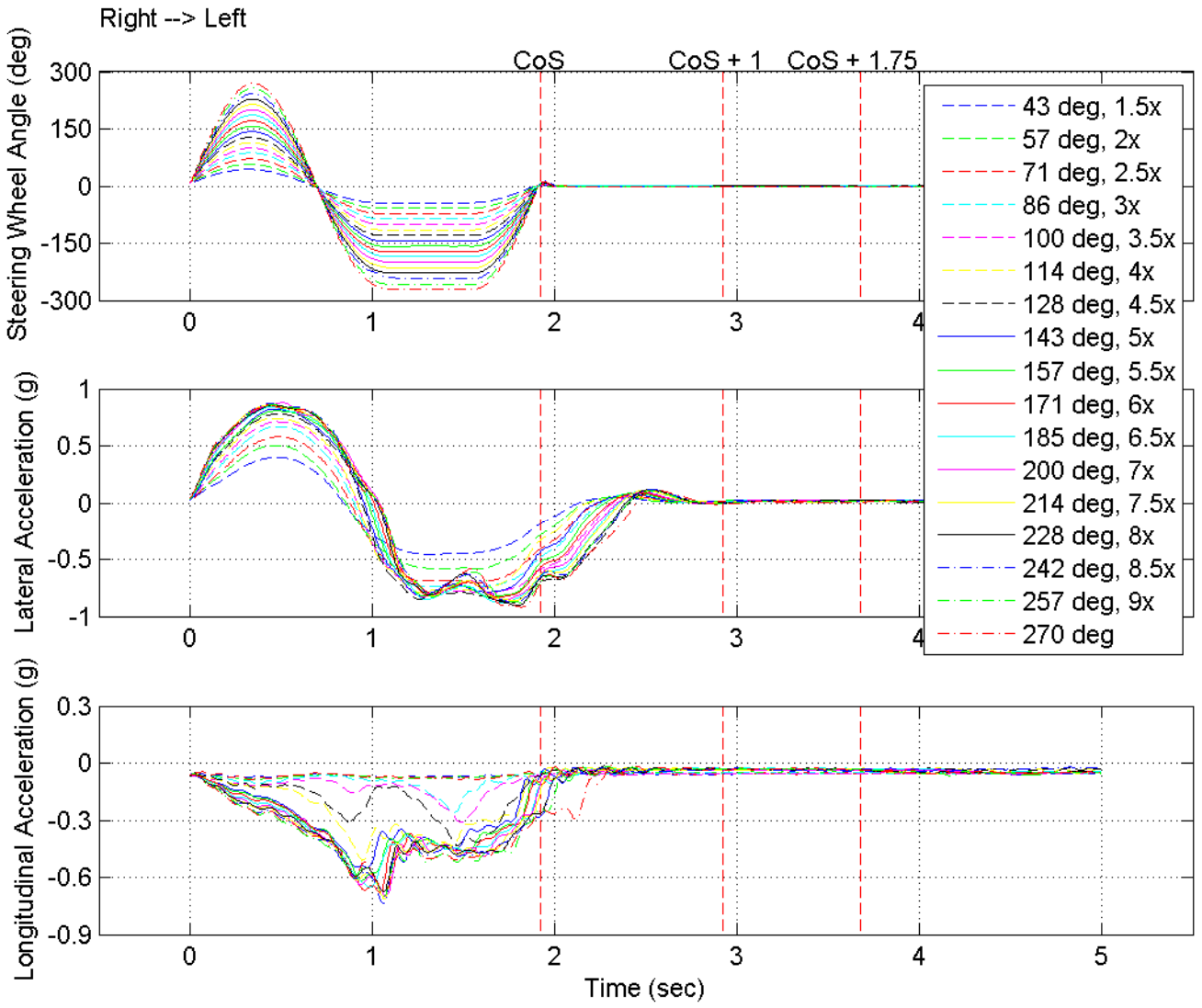

Figure 6.4. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for R-L Series (AWD Unlocked)

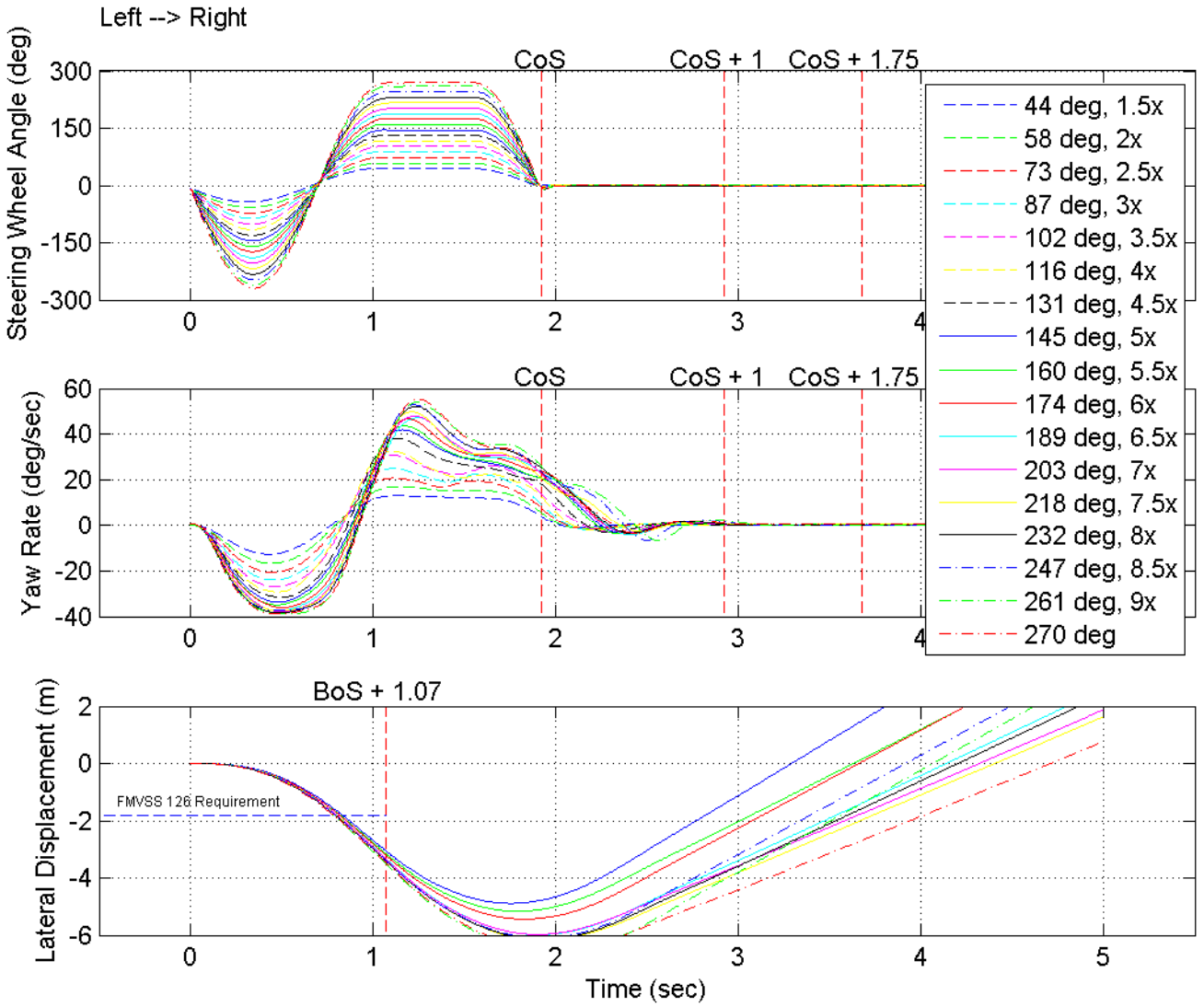

Figure 6.5. Steering Wheel Angle, Yaw Rate and Lateral Displacement for L-R Series (AWD Locked)

6.0 DATA PLOTS (6 of 48)

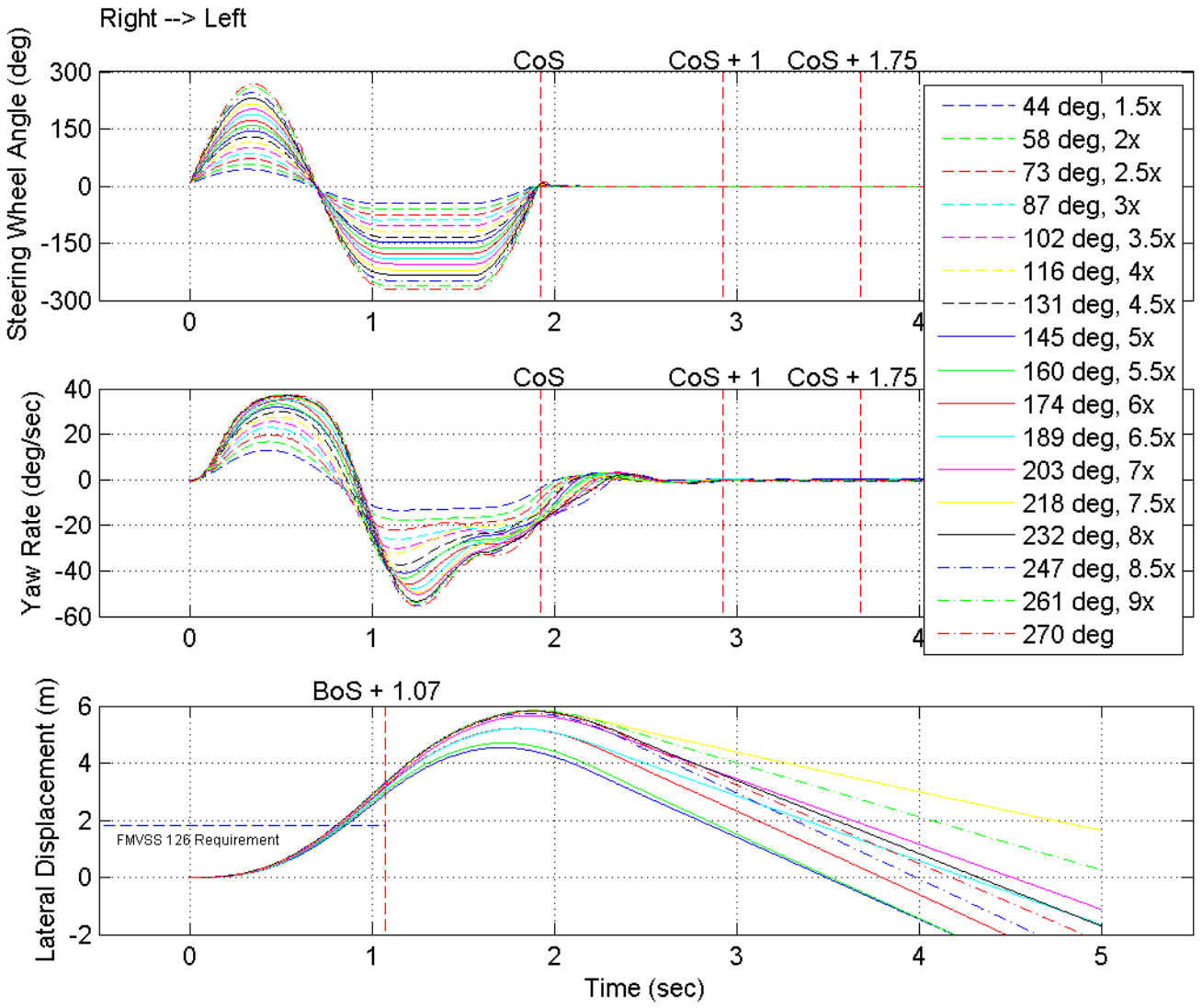

Figure 6.6. Steering Wheel Angle, Yaw Rate and Lateral Displacement for R-L Series (AWD Locked)

6.0 DATA PLOTS (7 of 8)

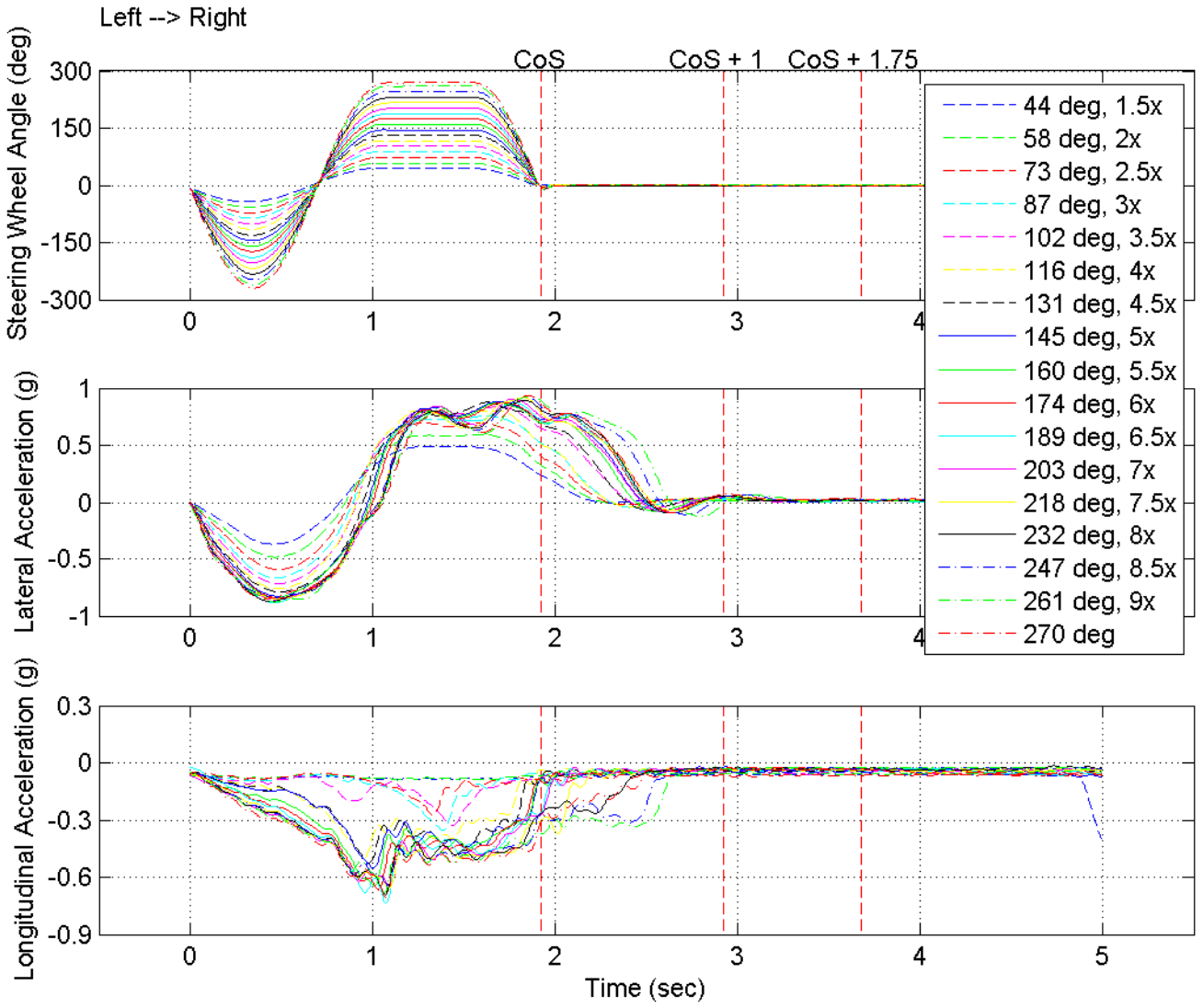

Figure 6.7. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for L-R Series (AWD Locked)

6.0 DATA PLOTS (8 of 8)

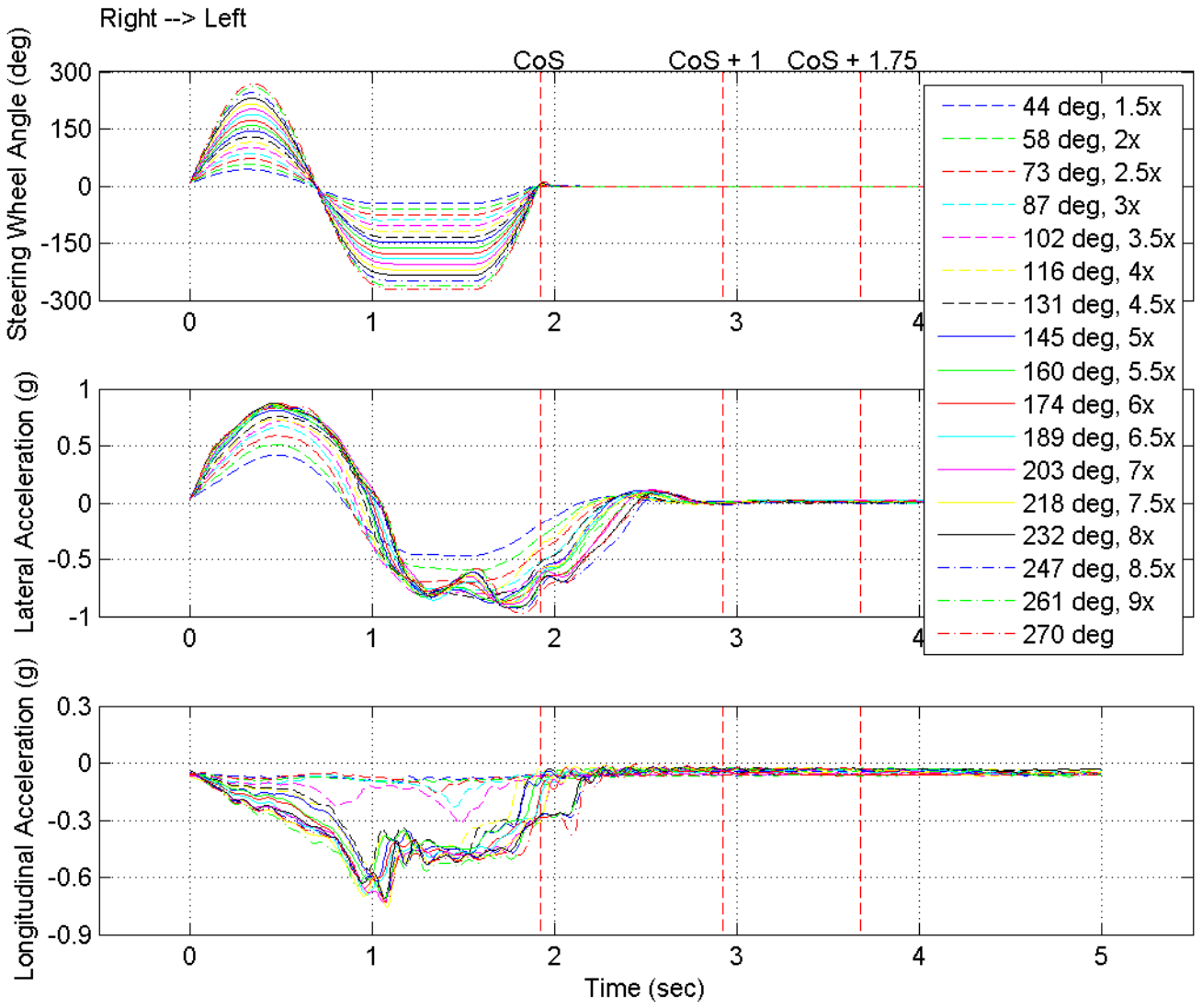

Figure 6.8. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for R-L Series (AWD Locked)

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

INSTRUMENT CLUSTER

1. Tachometer
2. Engine coolant temperature gauge
3. Fuel gauge
4. Speedometer
5. Turn signal indicators
6. Warning and indicator lights (if equipped)
7. Odometer/Trip computer (if equipped)

* The actual cluster in the vehicle may differ from the illustration.
For more details refer to the "Gauges" in the next pages.

OCM040050N

⚠ CAUTION

Prolonged driving with the Emission Control System Malfunction Indicator Light illuminated may cause damage to the emission control systems which could effect drivability and/or fuel economy.

⚠ CAUTION

If the Emission Control System Malfunction Indicator Light illuminates, potential catalytic converter damage is possible which could result in loss of engine power. Have the Engine Control System inspected as soon as possible by an authorized HYUNDAI dealer.

ESC (Electronic Stability Control) indicator (if equipped)

The ESC indicator will illuminate when the ignition switch is turned ON, but should go off after approximately 3 seconds. When the ESC is on, it monitors the driving conditions. Under normal driving conditions, the ESC indicator will remain off. When a slippery or low traction condition is encountered, the ESC will operate, and the ESC indicator will blink to indicate the ESC is operating.

But, if the ESC system malfunctions the indicator illuminates and stays on. Take your vehicle to an authorized HYUNDAI dealer and have the system checked.

ESC OFF indicator (if equipped)

The ESC OFF indicator will illuminate when the ignition switch is turned ON, but should go off after approximately 3 seconds. To switch to ESC OFF mode, press the ESC OFF button. The ESC OFF indicator will illuminate indicating the ESC is deactivated.

Cruise indicator (if equipped)

CRUISE indicator

The indicator illuminates when the cruise control system is enabled.

The cruise indicator in the instrument cluster is illuminated when the cruise control ON-OFF button on the steering wheel is pushed.

The indicator goes off when the cruise control ON-OFF button is pushed again. For more information about the use of cruise control, refer to "Cruise control system" in section 5.

ALL WHEEL DRIVE (AWD) (IF EQUIPPED)

Engine power can be delivered to all front and rear wheels for maximum traction. AWD is useful when extra traction is required on road, such as, when driving on slippery, muddy, wet, or snow-covered roads. These vehicles are not designed for challenging off-road use. Occasional off-road use such as established unpaved roads and trails are OK. It is always important when traveling off-highway that the driver carefully reduces the speed to a level that does not exceed the safe operating speed for those conditions. In general, off-road conditions provide less traction and braking effectiveness than normal road conditions. The driver must be especially alert to avoid driving on slopes which tilt the vehicle to either side.

These factors must be carefully considered when driving off-road. Keeping the vehicle in contact with the driving surface and under control in these conditions is always the driver's responsibility for the safety of him/herself and his or her passengers.

⚠ WARNING - Off road driving

This vehicle is designed primarily for on road use although it can operate effectively off road. However, it was not designed to drive in challenging off-road conditions. Driving in conditions that exceed the vehicle's intended design or the driver's experience level may result in severe injury or death.

Tight corner brake effect

⚠ CAUTION - AWD

When turning sharply on a paved road at low speed while in all wheel drive, steering control will be difficult.

Tight corner brake effect is a unique characteristic of all wheel drive vehicles caused by the difference in tire rotation at the four wheels and the zero-degree alignment of the front wheels and suspension.

Sharp turns at low speeds should be carried out with caution.

7.1 OWNER'S MANUAL PAGES

ALL Wheel Drive (AWD) transfer mode selection

Transfer mode	Selection button	Indicator light	Description
AWD AUTO (AWD LOCK is deactivated)		 LOCK (Indicator light is not illuminated)	• When driving in AWD AUTO mode, the vehicle operates similar to conventional 2WD vehicles under normal operating conditions. However, if the system determines that there is a need for the AWD mode, the engine's driving power is distributed to all four wheels automatically without driver intervention. • When driving on normal roads and pavement, the vehicle moves similar to conventional 2WD vehicles.
AWD LOCK		 LOCK (Indicator light is illuminated)	• This mode is used for climbing or descending sharp grades, off-road driving, driving on sandy and muddy roads, etc., to maximize traction. • This mode automatically begins to deactivate at speeds above 30 km/h (19 mph) and is shifted to AWD AUTO mode at speed above 40 km/h (25 mph). If the vehicle decelerates to speeds below 30 km/h (19 mph), however, the transfer mode is shifted into AWD LOCK mode again.

✻ NOTICE

- When driving on normal roads, deactivate the AWD LOCK mode by pushing the AWD LOCK button (the indicator light goes off). Driving on normal roads with AWD LOCK mode(especially, when cornering) may cause mechanical noise or vibration. The noise and vibration will disappear when the AWD LOCK mode is deactivated. Some parts of the power train may be damaged by prolonged driving with the noise and vibration.
- When the AWD LOCK mode is deactivated, a shock may be felt as the drive power is delivered entirely to the front wheels. This shock is not a mechanical failure.

W-78

⚠ CAUTION

- *If the ABS warning light is on and stays on, you may have a problem with the ABS. In this case, however, your regular brakes will work normally.*
- *The ABS warning light will stay on for approximately 3 seconds after the ignition switch is ON. During that time, the ABS will go through self-diagnosis and the light will go off if everything is normal. If the light stays on, you may have a problem with your ABS. Contact an authorized HYUNDAI dealer as soon as possible.*

⚠ CAUTION

- *When you drive on a road having poor traction, such as an icy road, and operate your brakes continuously, the ABS will be active continuously and the ABS warning light may illuminate. Pull your vehicle over to a safe place and stop the engine.*
- *Restart the engine. If the ABS warning light is off, then your ABS system is normal. Otherwise, you may have a problem with the ABS. Contact an authorized HYUNDAI dealer as soon as possible.*

✻ NOTICE

When you jump start your vehicle because of a drained battery, the engine may not run as smoothly and the ABS warning light may turn on at the same time. This happens because of the low battery voltage. It does not mean your ABS is malfunctioning.

- Do not pump your brakes!
- Have the battery recharged before driving the vehicle.

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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 at individual wheels and intervenes in the engine management system to stabilize the vehicle.

⚠ WARNING

Never drive too fast for 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.

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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.

7.1 OWNER'S MANUAL PAGES

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.

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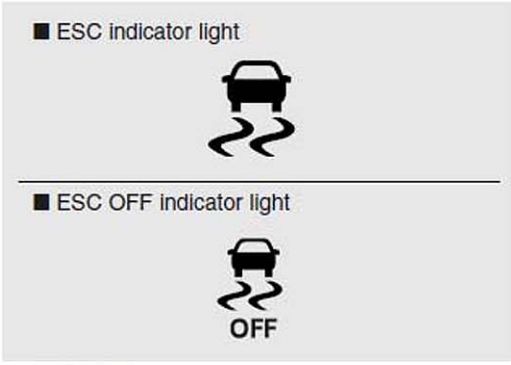
ESC operation off

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.



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Indicator light

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

The ESC indicator light blinks whenever ESC is operating or illuminates when ESC fails to operate.

The ESC OFF indicator light comes on when the ESC is turned off with the button.

⚠ 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.

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ESC OFF usage

When driving

- ESC should be 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.

⚠ WARNING

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.

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Good braking practices

⚠ WARNING

- **Whenever you leave or park your vehicle, always set the parking brake as far as possible and fully engage the vehicle's transaxle into the P (Park) position. If the parking brake is not fully engaged, the vehicle may move inadvertently and injure yourself and others.**
- **All vehicles should always have the parking brake fully engaged when parking to avoid inadvertent movement of the vehicle which can injure occupants or pedestrians.**

- After being parked, check to be sure the parking brake is not engaged and that the parking brake indicator light is out before driving away.
- Driving through water may get the brakes wet. They can also get wet when the vehicle is washed. Wet brakes can be dangerous! Your vehicle will not stop as quickly if the brakes are wet. Wet brakes may cause the vehicle to pull to one side.

7.2 VEHICLE ARRIVAL CONDITION REPORT

CONTRACT NO.: DTNH22-08-D-00098
DATE: *5/18/10*

From: *Automotive Allies*

To: Dynamic Research, Inc

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

Vehicle VIN: *5NMSHDAG2AH346041* NHTSA NO.: *CA0518*
Model Year: *2010* Odometer Reading: *95* Miles
Make *Hyundai* Body Style: *MPV*
Model: *Santa Fe AWD* Body Color: *Black*
Manufacture Date: *11/09* Dealer: *Automotive Allies*
GVWR (kg/lb) *2360/5203* 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: *As new*

RECORDED BY: *J Lenkeit* DATE RECORDED: *5/18/2010*

APPROVED BY: *P Broen* DATE APPROVED: *5/19/2010*

7.3 VEHICLE COMPLETION CONDITION REPORT

CONTRACT NO.: *DTNH22-08-D-00098*
DATE: *6/11/10*

Vehicle VIN: *5NMSHDAG2AH346041* NHTSA NO.: *CA0518*
Model Year: *2010* Odometer Reading: *187* Miles
Make: *Hyundai* Body Style: *MPV*
Model: *Santa Fe AWD* Body Color: *Black*
Manufacture Date: *11/09* Dealer: *Automotive Allies*
GVWR (kg/lb) *2360 (5203)* Price: *Leased*

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

☒ THERE ARE NO DENTS OR OTHER INTERIOR OR EXTERIOR FLAWS

☒ THE VEHICLE HAS BEEN PROPERLY MAINTAINED 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

REMARKS:

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

Explanation for equipment removal:

Test Vehicle Condition:
As new

RECORDED BY: *J Lenkeit* DATE RECORDED: *6/11/10*

APPROVED BY: *B Kebschull* DATE APPROVED: *6/15/10*

7.4 SINE WITH DWELL TEST RESULTS

2010 Hyundai Santa Fe MPV AWD (Unlocked)
NHTSA No.: CA0518
Date of Test : *5/28/2010*
Date Created: *5/28/2010*

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

File	SWA @ 5deg Ct	MES	Time @ 5deg	COS	Time @ COS	MOS	Time @ MOS	YRR1	YR1	YRR 1 Ct	YRR 175	YR175	YRR17 5 Ct	2nd Yaw Peak	2nd Yaw Peak Ct	Lat Disp	Lat. Acc. 1.07 s	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	49.88	3.545	1091	5.45	847	4.23	-1.20	-0.15	1291	-0.53	-0.07	1441	12.44	937	-3.97	0.37	43.14	775	42.86
22	709	49.89	3.538	1090	5.44	846	4.23	-0.06	-0.01	1290	0.29	0.05	1440	16.38	936	-5.15	0.45	57.14	775	56.80
23	708	49.82	3.533	1090	5.44	846	4.23	-0.04	-0.01	1290	-0.17	-0.03	1440	19.83	930	-6.21	0.51	71.07	775	70.83
24	707	50.31	3.53	1090	5.44	846	4.23	0.02	0.00	1290	-0.20	-0.05	1440	23.80	926	-7.30	0.55	86.07	775	85.82
25	707	50.25	3.528	1090	5.44	847	4.23	-0.04	-0.01	1290	-0.48	-0.14	1440	29.50	929	-8.22	0.58	99.87	775	99.67
26	707	50.34	3.527	1090	5.44	847	4.23	0.30	0.10	1290	0.20	0.07	1440	33.16	928	-8.68	0.62	113.98	775	113.63
27	706	50.18	3.525	1090	5.44	846	4.23	-0.27	-0.10	1290	-0.17	-0.06	1440	36.57	931	-9.29	0.56	128.08	775	127.79
28	706	50.24	3.523	1090	5.44	846	4.23	-0.45	-0.19	1290	0.06	0.02	1440	40.89	938	-9.77	0.48	143.12	775	142.62
29	706	50.29	3.523	1090	5.44	846	4.23	-0.11	-0.05	1290	0.02	0.01	1440	42.86	938	-10.04	0.45	157.07	775	156.58
30	706	50.27	3.523	1090	5.44	846	4.23	-0.36	-0.15	1290	-0.20	-0.09	1440	43.08	944	-10.42	0.21	171.04	775	170.49
31	706	50.34	3.522	1090	5.44	846	4.23	-0.36	-0.16	1290	0.04	0.02	1440	45.13	946	-10.58	0.17	185.08	775	184.56
32	706	50.19	3.523	1090	5.44	847	4.23	0.23	0.11	1290	0.09	0.04	1440	47.13	949	-10.72	0.13	199.98	775	199.54
33	706	49.98	3.522	1090	5.44	847	4.23	1.11	0.54	1290	0.22	0.11	1440	48.78	948	-10.87	0.11	214.03	775	213.61
34	706	50.19	3.523	1090	5.44	847	4.23	0.54	0.28	1290	0.05	0.03	1440	51.35	950	-10.78	0.14	228.16	775	227.71
35	706	50.09	3.523	1090	5.44	847	4.23	1.00	0.50	1290	0.07	0.04	1440	49.77	944	-10.81	0.21	241.96	776	241.61
36	706	50.17	3.523	1090	5.44	847	4.23	1.04	0.54	1290	-0.01	0.00	1440	51.93	949	-10.91	0.15	256.76	776	256.67
38	706	50.28	3.523	1090	5.44	847	4.23	3.04	1.62	1290	-0.35	-0.18	1440	53.41	948	-10.77	0.21	269.41	776	269.63

7.4 SINE WITH DWELL TEST RESULTS

2010 Hyundai Santa Fe MPV AWD (Unlocked)
NHTSA No.: CA0518
Date of Test : *5/28/2010*
Date Created: *5/28/2010*

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

File	SWA @ 5deg Ct	MES	Time @ 5deg	COS	Time @ COS	MOS	Time @ MOS	YRR1	YR1	YRR 1 Ct	YRR 175	YR175	YRR17 5 Ct	2nd Yaw Peak	2nd Yaw Peak Ct	Lat Disp	Lat. Acc. 1.07 s	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)
39	710	50.27	3.545	1091	5.45	847	4.23	-0.20	0.03	1291	0.17	-0.02	1441	-13.03	944	4.05	-0.36	43.73	775	43.61
40	709	50.36	3.538	1090	5.44	847	4.23	0.33	-0.06	1290	-0.18	0.03	1440	-17.29	940	5.09	-0.44	57.79	775	57.58
41	708	50.29	3.533	1090	5.44	847	4.23	-0.09	0.02	1290	-0.46	0.10	1440	-21.22	938	6.09	-0.50	71.72	775	71.52
42	707	50.27	3.53	1090	5.44	847	4.23	-0.44	0.11	1290	0.39	-0.10	1440	-25.79	935	7.09	-0.53	86.66	775	86.55
43	707	50.35	3.528	1090	5.44	846	4.23	-0.10	0.03	1290	0.22	-0.07	1440	-29.99	938	7.77	-0.54	100.46	775	100.39
44	707	50.27	3.526	1090	5.45	847	4.23	-0.02	0.01	1290	-0.08	0.02	1440	-31.07	934	8.34	-0.56	114.46	775	114.53
45	706	50.41	3.524	1090	5.44	846	4.23	0.03	-0.01	1290	-0.45	0.17	1440	-38.89	935	9.04	-0.56	128.55	775	128.58
46	706	50.26	3.523	1090	5.44	846	4.23	-0.43	0.16	1290	-0.27	0.10	1440	-37.70	937	9.33	-0.50	143.53	775	143.50
47	706	50.02	3.522	1090	5.44	846	4.23	-0.49	0.21	1290	-0.78	0.32	1440	-41.79	943	9.48	-0.41	157.59	775	157.48
48	706	50.3	3.522	1090	5.44	846	4.23	-0.33	0.14	1290	-0.14	0.06	1440	-43.59	950	10.10	-0.28	171.46	775	171.40
52	706	50.23	3.522	1090	5.44	846	4.23	-0.71	0.33	1290	-0.45	0.21	1440	-47.16	948	10.05	-0.36	185.65	775	185.40
53	706	50.08	3.522	1090	5.44	847	4.23	-0.20	0.09	1290	-0.24	0.11	1440	-46.83	955	10.33	-0.11	200.41	775	200.32
54	706	50.16	3.522	1089	5.44	846	4.23	0.03	-0.01	1289	0.03	-0.02	1439	-48.41	953	10.46	-0.14	214.44	775	214.45
55	706	50.07	3.522	1090	5.44	847	4.23	-0.20	0.10	1290	-0.23	0.11	1440	-49.70	952	10.50	-0.17	228.52	775	228.53
56	706	50.07	3.523	1090	5.44	847	4.23	-0.11	0.05	1290	-0.20	0.10	1440	-50.98	955	10.67	-0.14	242.28	775	242.56
57	706	50.26	3.523	1090	5.44	847	4.23	0.13	-0.07	1290	0.26	-0.13	1440	-51.56	955	10.55	-0.10	257.15	776	257.45
58	706	50.35	3.523	1090	5.44	847	4.23	0.52	-0.27	1290	0.24	-0.13	1440	-53.15	953	10.64	-0.11	269.69	776	270.54

7.4 SINE WITH DWELL TEST RESULTS

2010 Hyundai Santa Fe MPV AWD (Locked)
NHTSA No.: CA0518
Date of Test : *5/28/2010*
Date Created: *5/28/2010*

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

File	SWA @ 5deg Ct	MES	Time @ 5deg	COS	Time @ COS	MOS	Time @ MOS	YRR1	YR1	YRR 1 Ct	YRR 175	YR175	YRR17 5 Ct	2nd Yaw Peak	2nd Yaw Peak Ct	Lat Disp	Lat. Acc. 1.07 s	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)
22	710	50.27	3.54	1090	5.45	846	4.23	0.25	0.03	1290	0.87	0.11	1440	13.11	938	-3.89	0.36	44.05	775	43.92
23	709	50.38	3.54	1090	5.45	847	4.23	0.92	0.16	1290	0.69	0.12	1440	17.18	939	-5.19	0.43	58.13	775	57.88
24	708	50.36	3.53	1090	5.44	846	4.23	0.56	0.12	1290	0.54	0.11	1440	20.69	932	-6.55	0.47	73.04	775	72.79
26	707	50.31	3.53	1090	5.44	847	4.23	0.26	0.07	1290	0.49	0.12	1440	25.21	932	-7.33	0.50	87.08	775	86.77
25	707	50.24	3.53	1090	5.44	846	4.23	0.00	0.00	1290	-0.37	-0.12	1440	30.81	931	-8.27	0.54	101.86	775	101.70
27	707	50.47	3.53	1090	5.44	846	4.23	-0.12	-0.04	1290	0.36	0.12	1440	32.49	930	-8.81	0.57	116.01	775	115.68
28	706	50.25	3.53	1090	5.44	846	4.23	0.38	0.15	1290	0.18	0.07	1440	38.33	934	-9.39	0.53	131.00	775	130.76
29	706	50.36	3.52	1090	5.44	847	4.23	1.09	0.46	1290	0.13	0.05	1440	42.00	939	-9.90	0.46	145.03	775	144.66
30	706	50.12	3.52	1090	5.44	846	4.23	0.55	0.24	1290	0.22	0.10	1440	43.73	942	-10.19	0.42	159.96	775	159.62
31	706	50.10	3.52	1090	5.44	846	4.23	0.61	0.28	1290	-0.11	-0.05	1440	46.69	946	-10.37	0.33	173.97	775	173.56
33	706	50.64	3.52	1090	5.44	846	4.23	1.35	0.64	1290	0.32	0.15	1440	47.50	956	-10.72	0.07	189.11	775	188.58
34	706	50.29	3.52	1090	5.44	847	4.23	0.63	0.30	1290	-0.03	-0.02	1440	47.86	952	-10.80	0.09	202.83	775	202.51
35	706	50.43	3.52	1090	5.44	847	4.23	1.03	0.51	1290	0.05	0.03	1440	49.65	949	-10.96	0.10	217.90	775	217.75
36	706	49.69	3.52	1090	5.44	847	4.23	0.92	0.48	1290	0.15	0.08	1440	52.29	954	-10.98	0.07	231.77	776	231.73
37	706	50.26	3.52	1090	5.44	847	4.23	2.71	1.43	1290	-0.08	-0.04	1440	52.76	952	-10.99	0.12	246.86	776	246.68
38	706	50.23	3.52	1090	5.44	847	4.23	4.29	2.32	1290	0.33	0.18	1440	54.08	956	-11.34	0.05	260.54	776	260.65
39	706	50.16	3.52	1090	5.45	847	4.23	1.41	0.78	1290	0.33	0.18	1440	55.23	957	-11.22	0.00	269.23	777	269.52

7.4 SINE WITH DWELL TEST RESULTS

2010 Hyundai Santa Fe MPV AWD (Locked)
NHTSA No.: CA0518
Date of Test : *5/28/2010*
Date Created: *5/28/2010*

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

File	SWA @ 5deg Ct	MES	Time @ 5deg	COS	Time @ COS	MOS	Time @ MOS	YRR1	YR1	YRR 1 Ct	YRR 175	YR175	YRR17 5 Ct	2nd Yaw Peak	2nd Yaw Peak Ct	Lat Disp	Lat. Acc. 1.07 s	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)
40	710	50.35	3.54	1091	5.45	847	4.23	-0.14	0.02	1291	-0.36	0.05	1441	-13.21	941	4.10	-0.36	44.77	775	44.60
41	709	50.09	3.54	1090	5.44	847	4.23	-0.05	0.01	1290	-0.24	0.04	1440	-17.73	948	5.21	-0.43	58.80	775	58.59
42	708	50.49	3.53	1090	5.44	847	4.23	0.48	-0.11	1290	-0.11	0.02	1440	-22.09	937	6.31	-0.49	73.68	775	73.50
43	707	50.37	3.53	1090	5.44	846	4.23	0.63	-0.17	1290	1.12	-0.29	1440	-26.39	936	7.13	-0.52	87.70	775	87.51
44	707	50.36	3.53	1090	5.44	846	4.23	0.06	-0.02	1290	0.04	-0.01	1440	-30.27	935	7.76	-0.55	102.50	775	102.33
45	706	50.36	3.53	1090	5.45	846	4.23	-0.40	0.13	1290	-0.06	0.02	1440	-32.29	932	8.41	-0.53	116.46	775	116.45
46	706	50.22	3.52	1090	5.44	846	4.23	-0.42	0.16	1290	-0.60	0.22	1440	-37.23	939	8.87	-0.48	131.62	775	131.45
47	706	50.00	3.52	1090	5.44	846	4.23	-0.29	0.12	1290	-0.25	0.10	1440	-41.24	942	9.38	-0.41	145.59	775	145.42
48	706	50.13	3.52	1090	5.44	846	4.23	-0.32	0.14	1290	-0.28	0.12	1440	-43.21	942	9.70	-0.45	160.58	775	160.42
49	706	50.30	3.52	1090	5.44	846	4.23	-0.07	0.03	1290	0.15	-0.07	1440	-46.04	948	10.08	-0.30	174.55	775	174.37
50	706	50.25	3.52	1090	5.44	847	4.23	-0.70	0.34	1290	-0.30	0.14	1440	-47.95	952	10.05	-0.24	189.64	775	189.40
51	706	50.17	3.52	1090	5.44	847	4.23	-0.26	0.13	1290	-0.21	0.11	1440	-50.43	957	10.31	-0.11	203.41	775	203.23
52	706	50.45	3.52	1090	5.44	847	4.23	-0.43	0.21	1290	-0.39	0.19	1440	-49.37	959	10.48	-0.04	218.47	775	218.25
53	706	50.29	3.52	1090	5.44	847	4.23	-0.05	0.03	1290	-0.08	0.04	1440	-53.30	957	10.60	-0.06	232.48	775	232.29
54	706	50.35	3.52	1090	5.44	847	4.23	0.50	-0.27	1290	0.20	-0.11	1440	-54.91	955	10.64	-0.09	247.34	775	247.45
55	706	49.99	3.52	1090	5.44	847	4.23	-0.25	0.13	1290	-0.21	0.12	1440	-53.75	956	10.63	-0.06	261.00	776	261.49
56	706	50.44	3.52	1090	5.44	847	4.23	0.11	-0.06	1290	-0.05	0.03	1440	-55.75	957	10.60	-0.05	269.85	776	270.32

7.5 SLOWLY INCREASING STEER TEST RESULTS

2010 Hyundai Santa Fe MPV AWD (Unlocked)
NHTSA No.: *CA0518*
Date of Test: *5/28/2010*
Date Created: *5/28/2010*

File	EventPt	DOS	MES	Mean SPD	AYcount_3	THETAENCF_3	AYCG_CD2_3	r_squared	ZeroBegin	ZeroEnd
			(mph)	(mph)		(deg)	(g)			
10	700	1	50.3	50.0	1122	-28.5	-0.30	0.997	500	700
11	700	1	50.1	50.2	1129	-28.7	-0.30	0.998	500	700
12	700	1	50.0	50.1	1124	-28.2	-0.29	0.996	500	700
13	700	0	50.2	50.4	1128	28.7	0.30	0.997	500	700
14	717	0	50.0	50.3	1120	28.1	0.29	0.996	517	717
15	700	0	50.3	50.3	1131	28.8	0.30	0.999	500	700
				Averages		28.5	0.30			

Scalars	Steering Angles (deg)
1.5	43
2.0	57
2.5	71
3.0	86
3.5	100
4.0	114
4.5	128
5.0	143
5.5	157

Scalars	Steering Angles (deg)
6.0	171
6.5	185
7.0	200
7.5	214
8.0	228
8.5	242
9	257
9.3	270

7.5 SLOWLY INCREASING STEER TEST RESULTS

2010 Hyundai Santa Fe MPV AWD (Locked)
NHTSA No.: *CA0518*
Date of Test: *5/28/2010*
Date Created: *5/28/10*

File	EventPt	DOS	MES (mph)	Mean SPD (mph)	AYcount_3	THETAENCF_3 (deg)	AYCG_CD2_3 (g)	r_squared	ZeroBegin	ZeroEnd
10	700	1	49.6	49.7	1138	-29.1	-0.31	0.997	500	700
11	701	1	49.8	49.7	1144	-29.5	-0.30	0.997	501	701
12	701	1	49.7	49.8	1143	-29.4	-0.30	0.996	501	701
13	705	0	49.6	49.7	1131	28.9	0.30	0.993	505	705
14	716	0	49.7	49.7	1131	28.9	0.30	0.997	516	716
15	716	0	49.6	49.6	1127	28.6	0.31	0.994	516	716
				Averages		29.0	0.30			

Scalars	Steering Angles (deg)
1.5	44
2.0	58
2.5	73
3.0	87
3.5	102
4.0	116
4.5	131
5.0	145
5.5	160
6.0	174

Scalars	Steering Angles (deg)
6.5	189
7.0	203
7.5	218
8.0	232
8.5	247
9.0	261
9.3	270

7.6 INERTIAL SENSING SYSTEM LOCATION COORDINATES

Vehicle: **2010 Hyundai Santa Fe AWD MPV** NHTSA No.: CA0518

Wheelbase: 106.3 Inches Faro Arm S/N: U08-05-08-06636

Measurement date: Certification date: 8/18/2009

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	Ref Y	Ref Z
M_PLANE001_Ground_Plane	-	-	0.000
M_Line_Y_Axis	-1.722	-3.381	0.000
M_Point_48_Ref	0.000	0.000	-
M_CIRCLE001_I_Left_Rear_Wheel_Axle	-32.477	11.966	13.605
M_Point_IMU_side	6.248	45.956	-23.351
M_Point_ROOF	-	-	-67.331
Motion Pak reference point taken from mid height of unit left side			
Motion Pak Width = 3.05" ==> 1/2 W = 1.525			
Motion_PAK_Location	6.248	47.481	-23.351

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 y axis.
   - 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	Ref Y	Ref Z
Motion_PAK_Location in S7D (Matlab program) coordinate system	**67.575**	**-0.519**	**23.351**

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).