126-DRI-11-003
SAFETY COMPLIANCE TESTING FOR FMVSS 126
Electronic Stability Control Systems

Mazda Motor Corporation
2012 Mazda 5
NHTSA No. CC5403

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

4 November 2011

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
1200 New Jersey Avenue, SE
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Washington, DC 20590

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Prepared By: Brian K. Kebschull

Approved By: [signature]

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16. Abstract A test was conducted on a 2012 Mazda 5 , NHTSA No. CC5403, 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 2012 Mazda 5, 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 2012 Mazda 5 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).

- For steering inputs of scalar 5 and greater, 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 3,500 kg (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: *2012 Mazda 5*

NHTSA No. *CC5403* VIN: *JM1CW2CL3CO105648*

Vehicle Type: *Passenger Car* Manufacture Date: *12/10*

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: *2012 Mazda 5 Passenger Car*

NHTSA No. *CC5403* Data Sheet Completion Date: *5/31/2011*

VIN *JM1CW2CL3CO105648* Manufacture Date: *12/10*

GVWR (kg): *2125* Front GAWR (kg): *1056* Rear GAWR (kg): *1084*

Seating Positions Front: *2* Mid: Rear: *4*

Odometer reading at time of inspection: *59 miles (94.4 km)*

DESIGNATED TIRE SIZE(S) FROM VEHICLE LABELING:

Front axle: *205/50 R17* Rear axle: *205/50 R17*

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

		Front Axle		Rear Axle
	Tire Manufacturer:	*Toyo*		*Toyo*
	Tire Model:	*Proxes A18*		*Proxes A18*
	Tire Size:	*205/50 R17*		*205/50 R17*
TIN	Left Front:	*N3H4 CC2 4710*	Right Front:	*N3H4 CC2 4710*
	Left Rear:	*N3H4 CC2 4710*	Right Rear:	*N3H4 CC2 4710*

Are installed tire sizes same as labeled tire sizes? *Yes*

If no, contact COTR for further guidance

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

[X] Two Wheel Drive (2WD) [X] 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: *Front wheel drive*
Mode: *Default, ESC on*
Drive Configuration: *Front wheel drive*
Mode: *ESC off*
Drive Configuration:
Mode:

VEHICLE STABILITY SYSTEMS (Check applicable technologies):

List other systems:

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

REMARKS:

RECORDED BY: *J Lenkeit* DATE RECORDED: *5/31/2011*
APPROVED BY: *B Kebschull* DATE APPROVED: *6/2/2011*

3.0 TEST DATA (CONTD)

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

Vehicle: *2012 Mazda 5 Passenger Car*

NHTSA No *CC5403* Data Sheet Completion Date: *5/31/2011*

ESC SYSTEM IDENTIFICATION

Manufacturer/Model *Continental Automotive Systems/MK60EC*

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 hydraulic control unit is able to control the brake torque for each wheel by adjusting the hydraulic pressure. To create the brake torque, the ESC system controls the valve and pump to increase/decrease each wheel pressure.*

System is capable of determining yaw rate — [X] Yes (Pass) / [ ] No (Fail)
Brief explanation: *The actual yaw rate signal is supplied by yaw rate sensor which resides in the RCM (Restrain Control Module).*

System is capable of monitoring driver steering input — [X] Yes (Pass) / [ ] No (Fail)
Brief explanation: *The driver steering input is calculated based on the relative steering wheel angle signal.*

System is capable of estimating side slip or side slip derivative — [X] Yes (Pass) / [ ] No (Fail)
Brief explanation: *The side slip angle is estimated by the hydraulic control unit which calculates the vehicle behavior based on the wheel speed inputs, the steering wheel angle inputs, the yaw rate signal inputs, and the lateral acceleration input. The side slip derivative is calculated by the hydraulic control unit. The wheel speed signal is supplied by active wheel speed sensor. The actual lateral G signal is supplied by lateral G sensor which resides in the RCM.*

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: *The engine control will be activated during under-steering condition. The engine torque is modified by the following:*
- Controlling the throttle by the electronic throttle control.
- Reducing the spark and cutting the fuel.

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:
All of the above.

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: *B Kebschull* DATE RECORDED: *5/31/2011*
APPROVED BY: *J Lenkeit* DATE APPROVED: *6/2/2011*

3.0 TEST DATA (CONTD)

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

Vehicle: *2012 Mazda 5 Passenger Car*

NHTSA No. *CC5403* Data Sheet completion date: *5/31/2011*

ESC Malfunction Telltale

Vehicle is equipped with malfunction telltale? *Yes*

Telltale Location: *Center of instrument panel (IP)*

Telltale Color: *Yellow*

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:

Telltale flashes when DSC (ESC) system activates

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: *Lower right corner of IP*

Telltale Color: *Yellow*

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: *B Kebschull* DATE RECORDED: *5/31/2011*

APPROVED BY: *P Broen* DATE APPROVED: *6/1/2011*

3.0 TEST DATA (CONTD)

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

Vehicle: *2012 Mazda 5 Passenger Car*

NHTSA No. *CC5403* Data Sheet completion date: *5/31/2011*

"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 *On dashboard to the left of the driver*
Labeling *ESC off icon is shown (car with slip lines, "OFF")*
Modes *On/off (off turns off traction control also)*

Second Control: Location ____
Labeling ____
Modes ____

Identify standard or default drive configuration *FWD*

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?

_____ NA **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?

_____ NA **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? ____ Yes __X__ No

Ancillary Control: System *NA*

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 ancillary 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
NA		

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: *B Kebschull* DATE RECORDED: *5/31/2011*
APPROVED BY: *P Broen* DATE APPROVED: *6/1/2011*

3.0 TEST DATA (CONTD)

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

Vehicle: *2012 Mazda 5 Passenger Car*

NHTSA No. *CC5403* Data Sheet completion date: *6/1/2011*

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

Peak Friction Coefficient (at least 0.9) *0.96*

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

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

Coolant *Yes* *Oil, Washer Fluid, Brake 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 *151.8* cm Wheelbase *275.0* cm

Rear Track Width *150.5* cm

Vehicle Weight Ratings: GAWR Front *1056* kg GAWR Rear *1084* kg

Unloaded Vehicle Weight (UVW):

Front Axle *894.0* kg Left Front *451.3* kg Right Front *442.7* kg

Rear Axle *693.1* kg Left Rear *346.1* kg Right Rear *347.0* kg

Total UVW *1587.1* kg

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

Calculated baseline weight (UVW + 73kg) *1660.1* kg

Outrigger size required ("Standard" or "Heavy") *None*

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 *NA* kg Left front *NA* kg Right front *NA* kg

Rear axle *NA* kg Left rear *NA* kg Right rear *NA* kg

Total UVW with outriggers *NA* kg

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

Front axle *968.4* kg Left front *490.3* kg Right front *478.1* kg

Rear axle *761.2* kg Left rear *388.3* kg Right rear *372.9* kg

Vehicle Weight *1729.6* kg

Ballast Required =

[Total UVW with Outriggers (if applicable)]		+ *168*	kg	- [Loaded Weight w/Driver and Instrumentation)]	
= *1587.1*	kg	+ *168*	kg	- 1729.6	kg

= *25.5* kg

Total Loaded Vehicle Weight w/Driver and Instrumentation and Ballast

Front axle *979.8* kg Left front *491.7* kg Right front *488.1* kg

Rear axle *776.1* kg Left rear *394.2* kg Right rear *381.9* kg

Total UVW *1755.9* 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	*47.8*	in	*121.5*	cm	*66.0*	in	*167.7*	cm
y-distance	*-0.3*	in	*-0.7*	cm	*-0.6*	in	*-1.6*	cm
z-distance	*24.2*	in	*61.5*	cm	*17.1*	in	*43.5*	cm
Roof Height					*63.717*	in	*161.8*	cm
Distance between ultrasonic sensors					*81.0*	in	*205.7*	cm

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *6/1/2011*
APPROVED BY: *J Lenkeit* DATE APPROVED: *6/3/2011*

3.0 TEST DATA (CONTD)

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

Vehicle: *2012 Mazda 5 Passenger Car*

NHTSA No. *CC5403*

Measured tire pressure: LF *240* kPa RF *237* kPa

LR *238* kPa RR *234* kPa

Wind Speed *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* °C

Brake Conditioning Time: *10:20:00 AM* Date: *6/1/2011*

56 km/h (35 mph) Brake Stops

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

Observed deceleration range (0.5g target) *0.5- 0.52* 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 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: *10:37:00 AM* Date: *6/1/2011*

Measured cold tire pressure LF *256* kPa RF *256* kPa

LR *252* kPa RR *248* kPa

Wind Speed *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)) *19.8*°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*	*28.8 - 32*
4-6	Counterclockwise	0.5 – 0.6	*0.5 - 0.6*	*28.8 - 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	*0.39*
2	3	56 ± 2 (35 ± 1)	*80*	0.5 - 0.6	*0.51*
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	*0.52*
4	*7*	56 ± 2 (35 ± 1)	*80* (cycles 1-9)	0.5 - 0.6	*0.52*
			160 (cycle10)*	NA	*0.75*

* 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: *12:00:00 PM* Date: *6/1/2011*

Measured cold tire pressure LF *263* kPa RF *260* kPa

LR *252* kPa RR *246* kPa

Wind Speed *2.9* 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)) *22* °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*	*30.4 - 32*
4-6	Counterclockwise	0.5 - 0.6	*0.5 - 0.6*	*30.4 - 32*

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	*0.52*
4	*19*	56 ± 2 (35 ± 1)	*80* (cycles 1-9)	0.5 - 0.6	*0.52*
			160 (cycle 10)*	NA	*0.75*

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

Remarks:

RECORDED BY: *P Broen* DATE RECORDED: *6/1/2011*

APPROVED BY: *J Lenkeit* DATE APPROVED: *6/3/2011*

3.0 TEST DATA (CONTD)

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

Vehicle: *2012 Mazda 5 Passenger Car*

NHTSA No. *CC5403*

Measured tire pressure: LF *259* kPa RF *257* kPa

LR *255* kPa RR *249* kPa

Wind Speed *5* m/s

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

Ambient Temperature (7°C (45°F) - 40°C (104°F)) *23* °C

Selected drive configuration *Default-FWD*

Selected Mode: *Default- 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	*11:38*	*-27.3*	*10*	*Good*
2	Left	*11:38*	*-27.5*	*11*	*Good*
3	Left	*11:39*	*-28.1*	*12*	*Good*
4	Left				*Good*
5	Left				
1	Right	*11:40*	*27.6*	*13*	*Good*
2	Right	*11:43*	*26.8*	*14*	*Good*
3	Right	*11:46*	*26.8*	*15*	*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:

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

$\delta_{0.3\ g,\ overall}$ = *27.3* degrees

[to nearest 0.1 degree]

Remarks:

RECORDED BY: *P Broen* DATE RECORDED: *6/1/2011*
APPROVED BY: *J Lenkeit* DATE APPROVED: *6/3/2011*

3.0 TEST DATA (CONTD)

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

Vehicle: *2012 Mazda 5 Passenger Car*

NHTSA No. *CC5403* Data sheet completion date: *6/1/2011*

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: *Default- FWD*

Selected Mode: *Default- ESC on*

Overall steering wheel angle ($\delta_{0.3\ g,\ overall}$) *27.3* 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	12:24	1.5	41	12.71	-0.07	0.10	-0.58	PASS	0.75	PASS
22	12:29	2.0	55	17.23	-0.12	-0.06	-0.71	PASS	-0.33	PASS
23	12:33	2.5	68	19.26	0.05	-0.01	0.26	PASS	-0.05	PASS
24	12:36	3.0	82	23.53	0.13	0.22	0.54	PASS	0.93	PASS
25	12:39	3.5	96	29.16	-0.24	-0.11	-0.82	PASS	-0.37	PASS
26	12:43	4.0	109	34.90	-0.25	-0.10	-0.72	PASS	-0.29	PASS
27	12:45	4.5	123	38.68	-0.22	-0.11	-0.57	PASS	-0.29	PASS
28	12:49	5.0	136	42.23	-0.46	-0.43	-1.09	PASS	-1.02	PASS
29	12:51	5.5	150	45.78	-0.55	-0.50	-1.19	PASS	-1.08	PASS
30	12:55	6.0	164	49.24	-0.17	-0.08	-0.34	PASS	-0.17	PASS
31	12:57	6.5	177	51.98	0.00	0.01	0.01	PASS	0.03	PASS
32	13:00	7.0	191	53.85	-0.07	-0.14	-0.13	PASS	-0.26	PASS
33	13:03	7.5	205	54.33	-0.25	-0.11	-0.46	PASS	-0.19	PASS
34	13:06	8.0	218	56.77	0.84	0.33	1.47	PASS	0.57	PASS
35	13:09	8.5	232	58.77	0.40	-0.06	0.67	PASS	-0.11	PASS
36	13:12	9.0	246	61.33	0.49	0.07	0.80	PASS	0.11	PASS
37	13:15	9.5	259	61.17	-0.06	-0.17	-0.10	PASS	-0.28	PASS
39	13:22	-	270	61.60	-0.24	0.21	-0.39	PASS	0.34	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
40	13:28	1.5	41	-13.11	0.06	0.14	-0.46	*PASS*	-1.09	*PASS*
41	13:32	2.0	55	-18.13	-0.09	-0.19	0.48	*PASS*	1.05	*PASS*
42	13:35	2.5	68	-20.31	0.10	-0.10	-0.47	*PASS*	0.51	*PASS*
43	13:38	3.0	82	-25.65	-0.22	-0.32	0.86	*PASS*	1.23	*PASS*
44	13:41	3.5	96	-29.89	0.04	-0.02	-0.13	*PASS*	0.07	*PASS*
45	13:44	4.0	109	-35.96	-0.03	-0.04	0.09	*PASS*	0.11	*PASS*
46	13:46	4.5	123	-41.23	0.00	-0.08	0.01	*PASS*	0.19	*PASS*
47	13:49	5.0	136	-44.26	0.10	0.06	-0.23	*PASS*	-0.13	*PASS*
48	13:52	5.5	150	-47.61	-0.08	-0.17	0.16	*PASS*	0.36	*PASS*
49	13:55	6.0	164	-51.02	0.07	-0.06	-0.13	*PASS*	0.12	*PASS*
50	13:58	6.5	177	-54.41	0.31	0.13	-0.57	*PASS*	-0.23	*PASS*
51	14:00	7.0	191	-57.13	0.19	0.04	-0.33	*PASS*	-0.07	*PASS*
52	14:03	7.5	205	-58.78	-0.06	-0.13	0.10	*PASS*	0.22	*PASS*
53	14:06	8.0	218	-61.47	-0.26	-0.12	0.42	*PASS*	0.19	*PASS*
54	14:09	8.5	232	-63.85	-0.77	-0.28	1.20	*PASS*	0.44	*PASS*
55	14:12	9.0	246	-64.22	-0.34	-0.06	0.53	*PASS*	0.10	*PASS*
56	14:15	9.5	259	-66.90	-0.77	-0.23	1.15	*PASS*	0.34	*PASS*
57	14:18	-	270	-66.07	-0.76	-0.27	1.16	*PASS*	0.41	*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 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
28	Counter Clockwise	5.0	136	-3.1	*PASS*
29	Counter Clockwise	5.5	150	-3.1	*PASS*
30	Counter Clockwise	6.0	164	-3.3	*PASS*
31	Counter Clockwise	6.5	177	-3.3	*PASS*
32	Counter Clockwise	7.0	191	-3.3	*PASS*
33	Counter Clockwise	7.5	205	-3.3	*PASS*
34	Counter Clockwise	8.0	218	-3.4	*PASS*
35	Counter Clockwise	8.5	232	-3.4	*PASS*
36	Counter Clockwise	9.0	246	-3.4	*PASS*
37	Counter Clockwise	9.5	259	-3.3	*PASS*
39	Counter Clockwise	-	270	-3.4	*PASS*
47	Clockwise	5.0	136	3.0	*PASS*
48	Clockwise	5.5	150	3.1	*PASS*
49	Clockwise	6.0	164	3.1	*PASS*
50	Clockwise	6.5	177	3.2	*PASS*
51	Clockwise	7.0	191	3.2	*PASS*
52	Clockwise	7.5	205	3.3	*PASS*
53	Clockwise	8.0	218	3.3	*PASS*
54	Clockwise	8.5	232	3.3	*PASS*
55	Clockwise	9.0	246	3.3	*PASS*
56	Clockwise	9.5	259	3.3	*PASS*
57	Clockwise	-	270	3.3	*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: *P Broen* DATE RECORDED: *6/1/2011*

APPROVED BY: *J Lenkeit* DATE APPROVED: *6/3/2011*

3.0 TEST DATA (CONTD)

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

Vehicle: *2012 Mazda 5 Passenger Car*

NHTSA No. *CC5403* Data Sheet Completion Date: *6/1/2011*

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 ± 5 mph) 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 ± 5 mph) is reached.

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

TEST 1 DATA INDICATES COMPLIANCE: *PASS*

Remarks: *Malfunction telltale illuminated immediately upon ignition (no driving was necessary). After the wheel speed sensor was reconnected, the telltale extinguished immediately upon ignition (no driving was necessary). Note: The ABS malfunction telltale also illuminated while the sensor was disconnected, and extinguished when it was reconnected.*

RECORDED BY: *B Kebschull* DATE RECORDED: *6/1/2011*

APPROVED BY: *P Broen* DATE APPROVED *6/1/2011*

3.0 TEST DATA (CONTD)

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

Vehicle: *2012 Mazda 5 Passenger Car*

NHTSA No. *CC5403* Data Sheet Completion Date: *6/1/2011*

TEST 2

MALFUNCTION SIMULATION: Describe method of malfunction simulation

Disconnected ABS pump motor 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.

X Yes ___ No

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

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

TEST 2 DATA INDICATES COMPLIANCE: PASS

Remarks: *Malfunction telltale illuminated immediately upon ignition (no driving was necessary). After the fuse was re-installed, the telltale did not extinguish immediately upon ignition, but extinguished as soon as driving began and the speed exceeded approximately 5 mph.*

RECORDED BY: *B Kebschull* DATE RECORDED: *6/1/2011*

APPROVED BY: *P Broen* DATE APPROVED *6/1/2011*

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:2/22/11 Due: 2/22/12
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: DRI Date: 2/23/11 Due: 2/23/12
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: 3/30/11 Due: 3/30/12
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: 3/8/11 Due: 3/8/12
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: 5/3/11 Due: 5/3/12
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: 2/22/11 Due: 2/21/12
						DOT-NHTSA D3272	By: DRI Date: 2/22/11 Due: 2/22/12

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: 3/29/11 Due: 3/29/12
					SoMat High level Board EHLS	MSHLS.03-3182	By: DRI Date: 3/29/11 Due: 3/29/12
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; DRI Date: 11/7/10 Due: 11/7/11
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 15)

Figure 5.1. Front View of Test Vehicle

5.0 PHOTOGRAPHS (2 of 15)

Figure 5.2. Rear View of Test Vehicle

5.0 PHOTOGRAPHS (3 of 15)

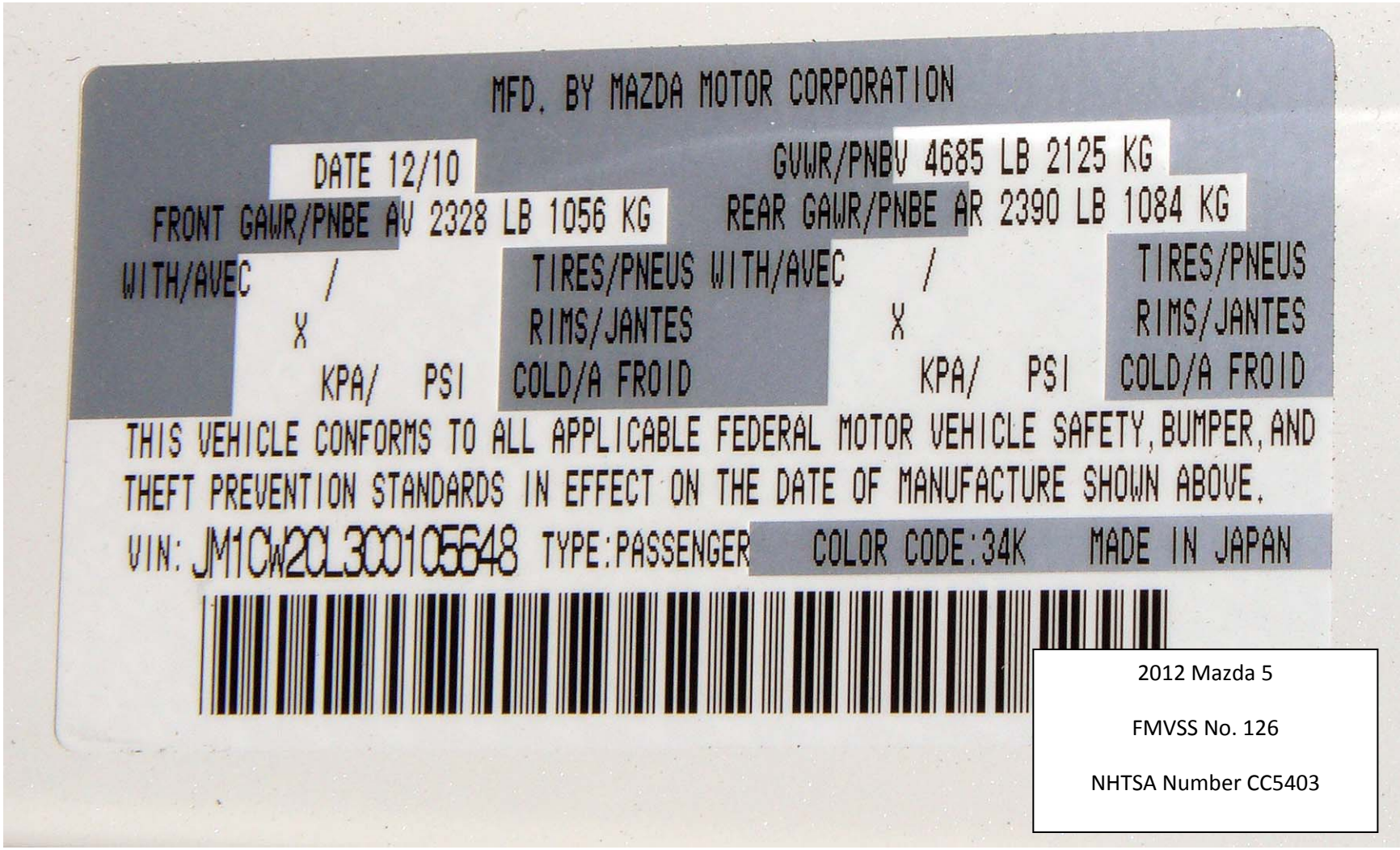


Figure 5.3. Vehicle Certification Label

5.0 PHOTOGRAPHS (4 of 15)

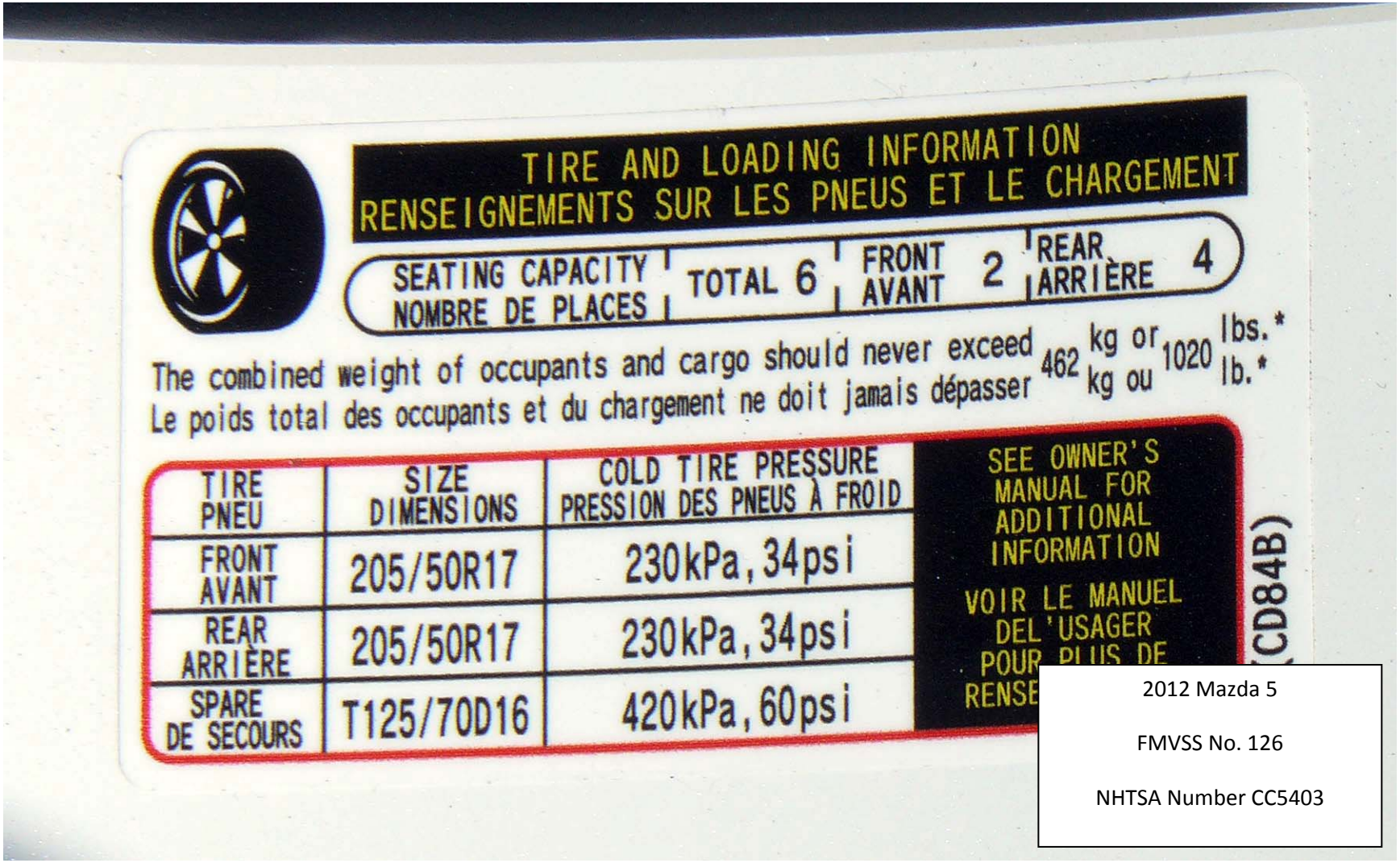


Figure 5.4. Vehicle Placard

5.0 PHOTOGRAPHS (5 of 15)

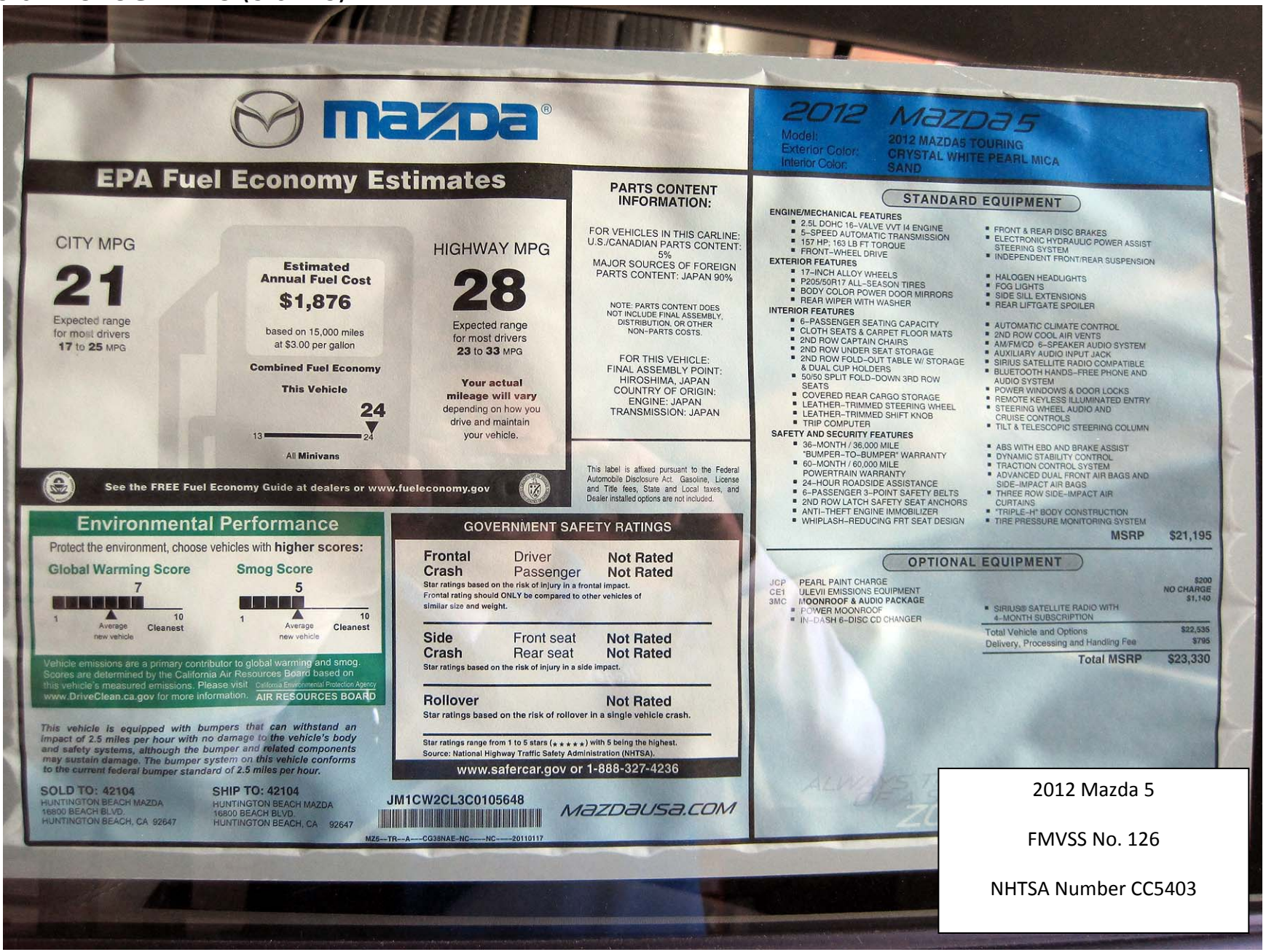


Figure 5.5. Window Sticker (Monroney Label)

5.0 PHOTOGRAPHS (6 of 15)

Figure 5.6. Front View of Vehicle as Tested

5.0 PHOTOGRAPHS (7 of 15)

Figure 5.7. Rear View of Vehicle as Tested

5.0 PHOTOGRAPHS (8 of 15)

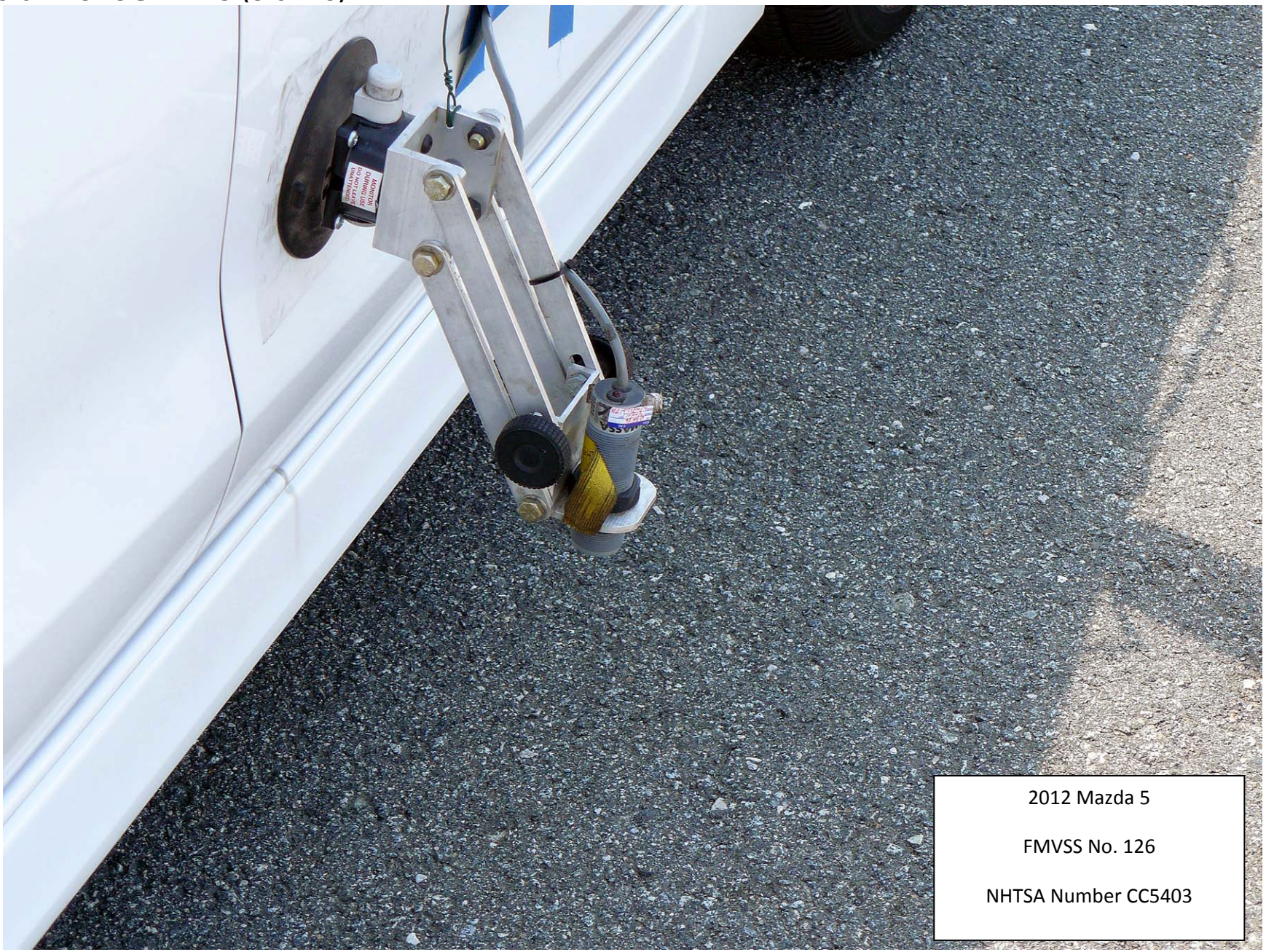
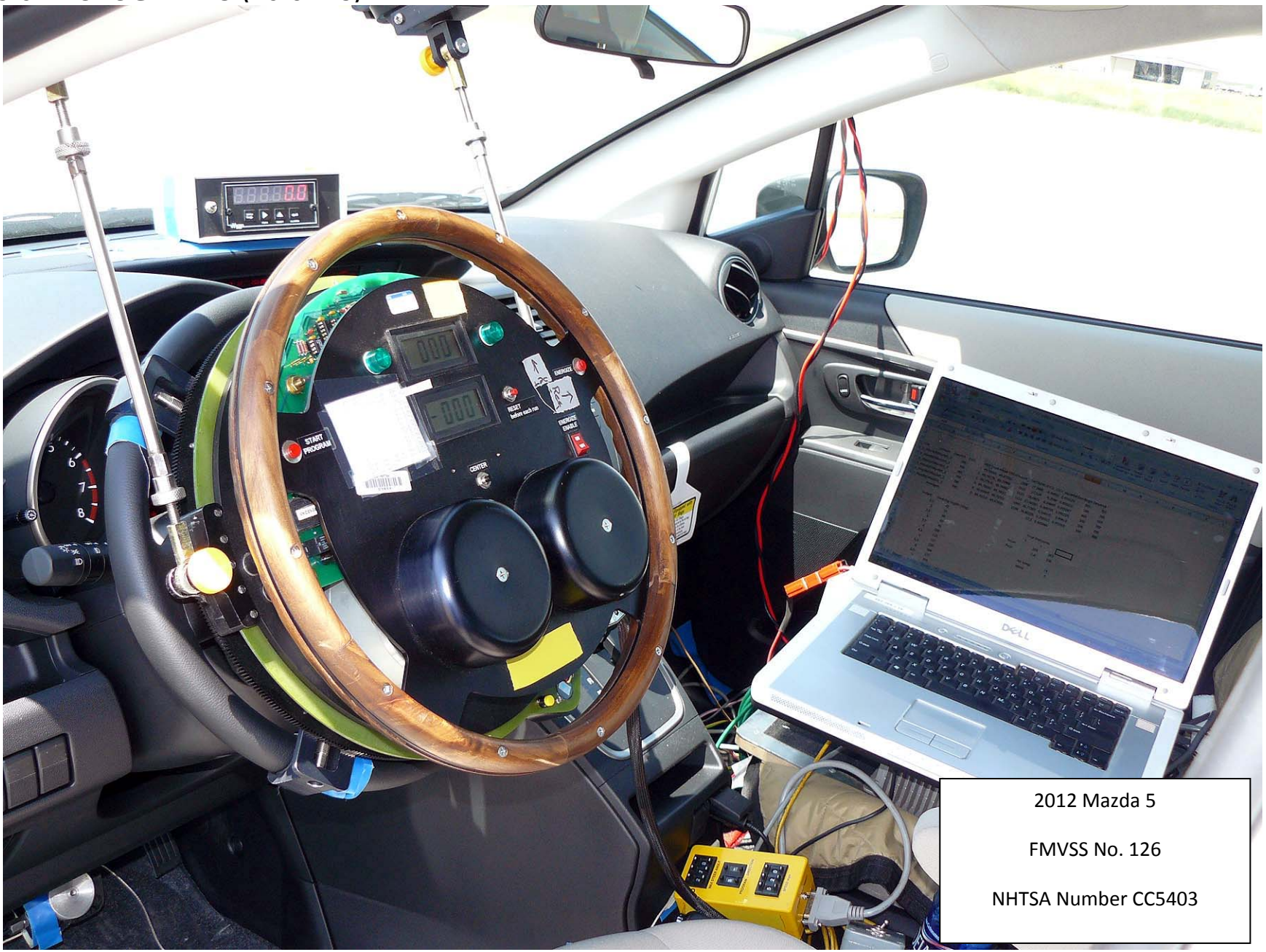


Figure 5.8. Ultrasonic Height Sensor Mounted on Side of Vehicle for Determining Body Roll Angle

5.0 PHOTOGRAPHS (9 of 15)

Figure 5.9. Rear Mounted Speed Sensor

5.0 PHOTOGRAPHS (10 of 15)



2012 Mazda 5

FMVSS No. 126

NHTSA Number CC5403

Figure 5.10. Steering Controller and Data Acquisition Computer

5.0 PHOTOGRAPHS (11 of 15)

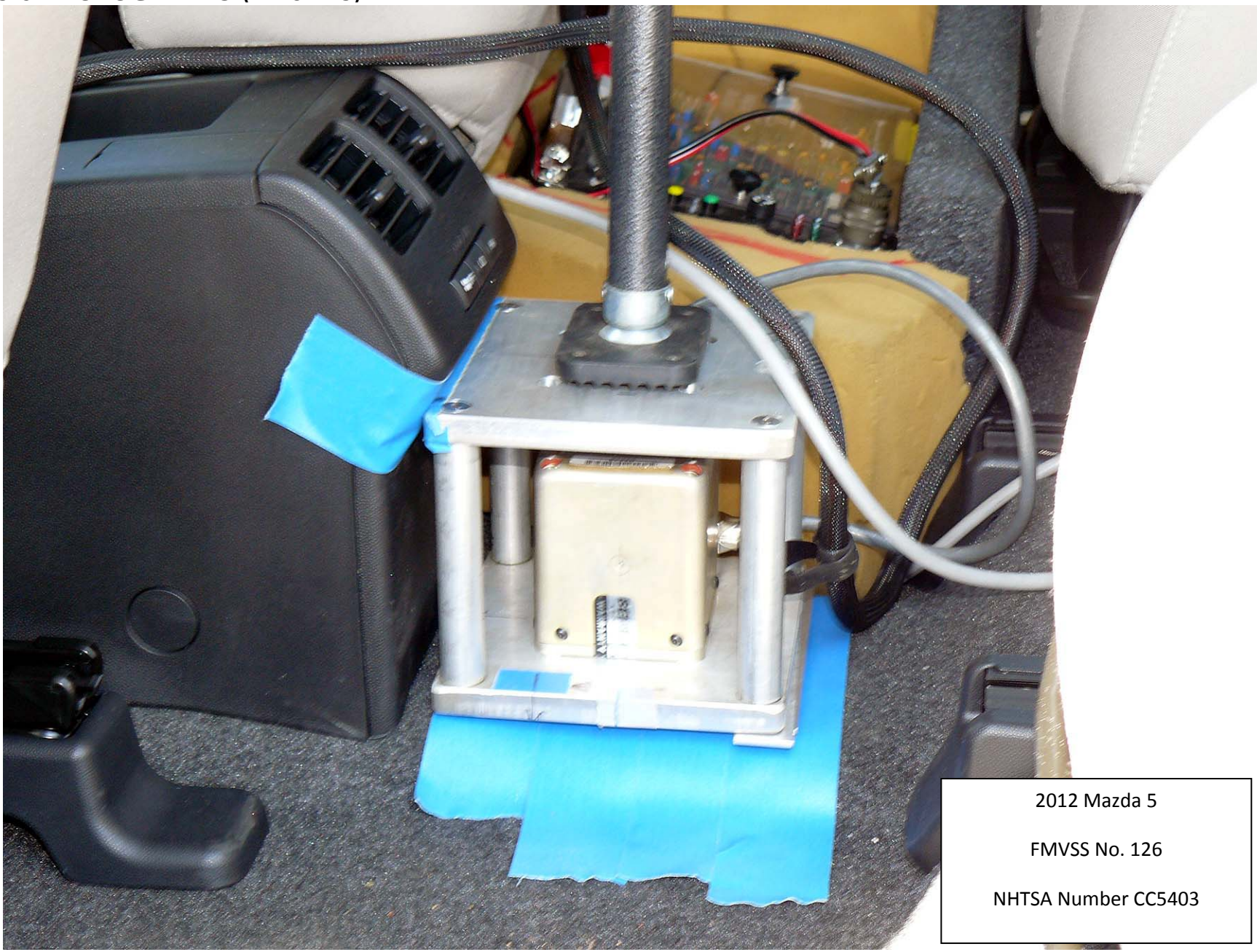


Figure 5.11. Inertial Measurement Unit Mounted in Vehicle

5.0 PHOTOGRAPHS (12 of 15)

Figure 5.12. Brake Pedal Load Cell

5.0 PHOTOGRAPHS (13 of 15)

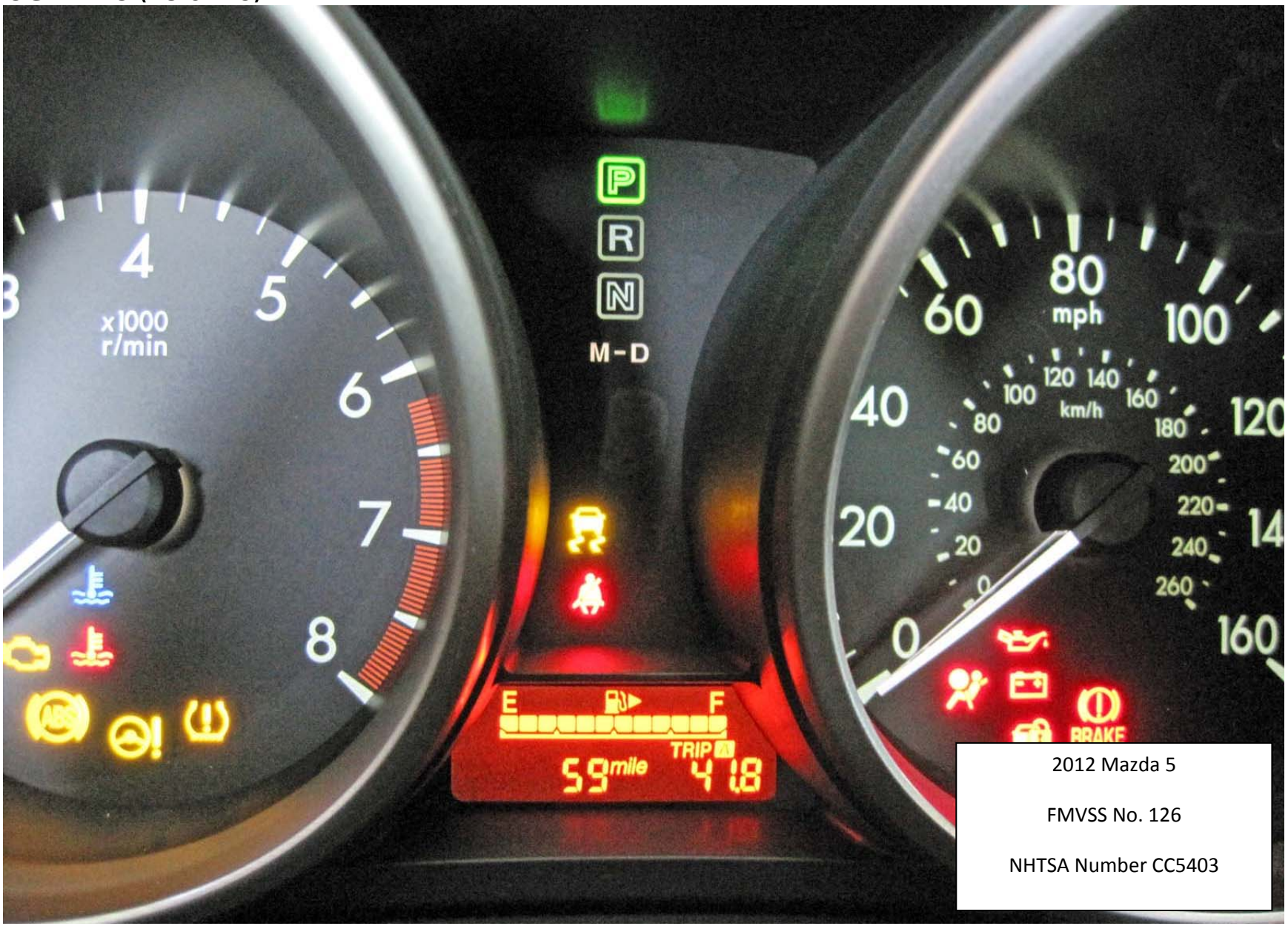


Figure 5.13. Telltale for DSC (ESC) Malfunction and DSC (ESC) Activation

5.0 PHOTOGRAPHS (14 of 15)

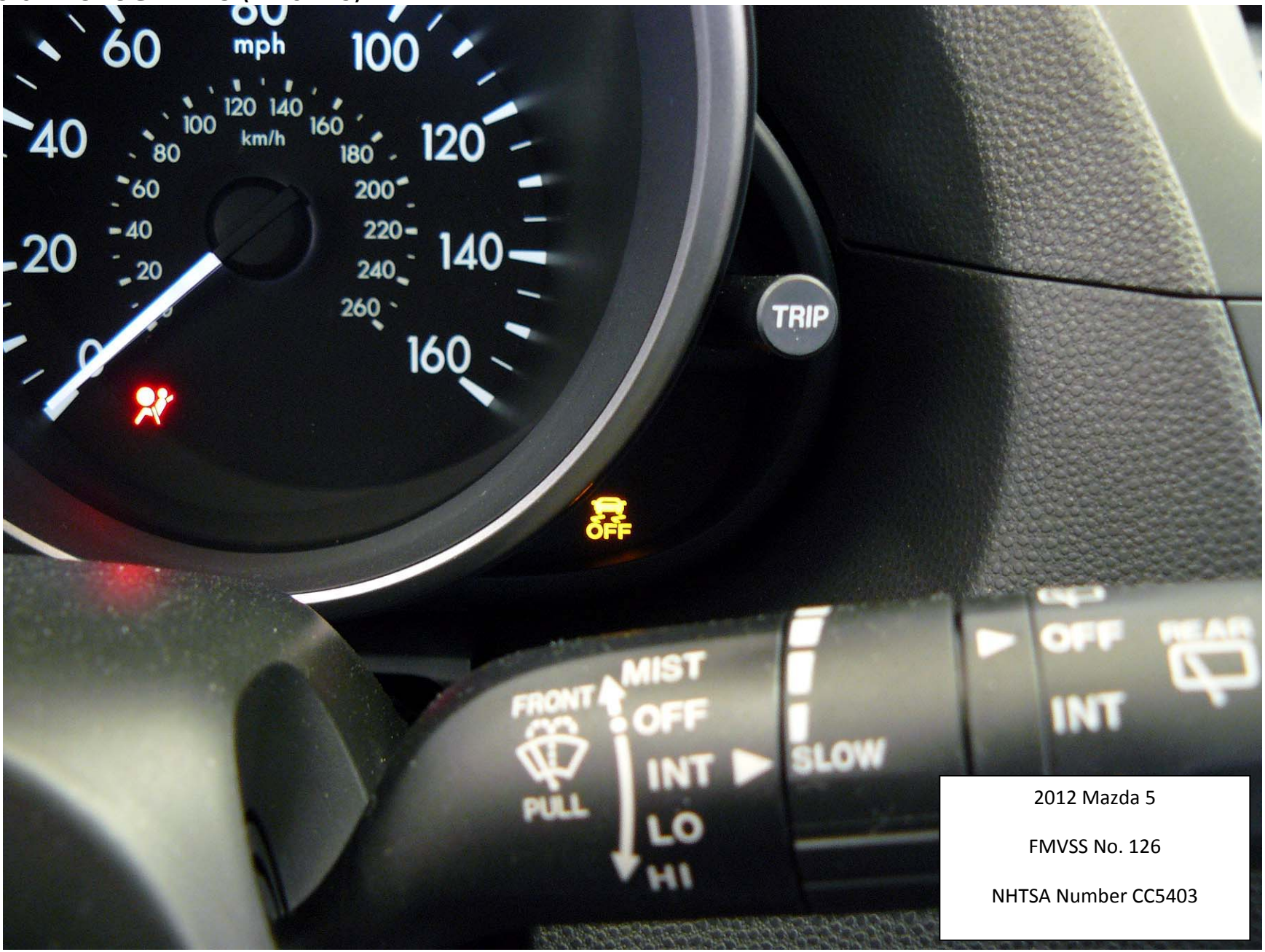


Figure 5.14. Telltale for DSC (ESC) Off

5.0 PHOTOGRAPHS (15 of 15)

Figure 5.15. DSC (ESC) Off Control Switch

6.0 DATA PLOTS (1 of 4)

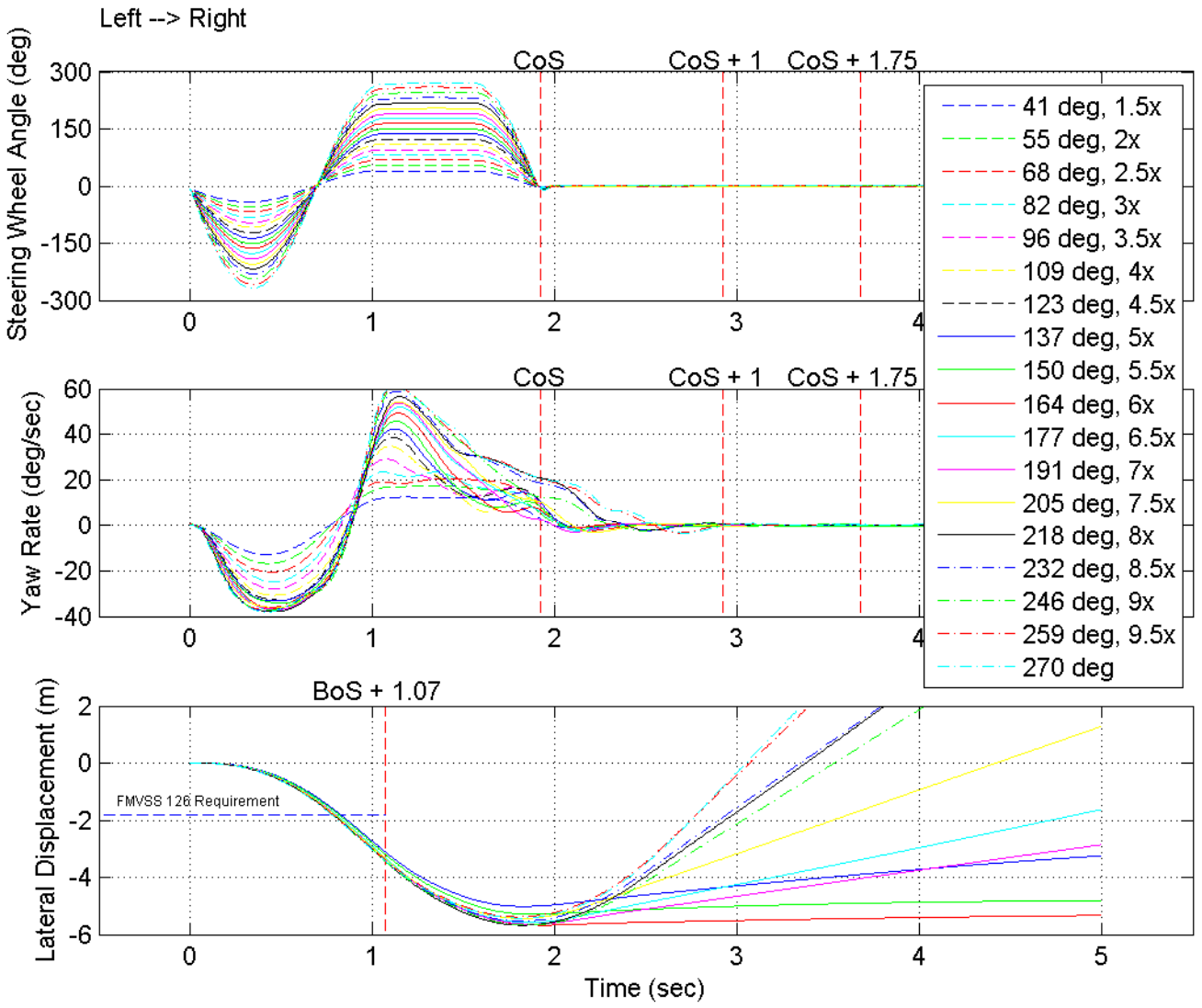


Figure 6.1. Steering Wheel Angle, Yaw Rate and Lateral Displacement for L-R Series

6.0 DATA PLOTS (2 of 4)

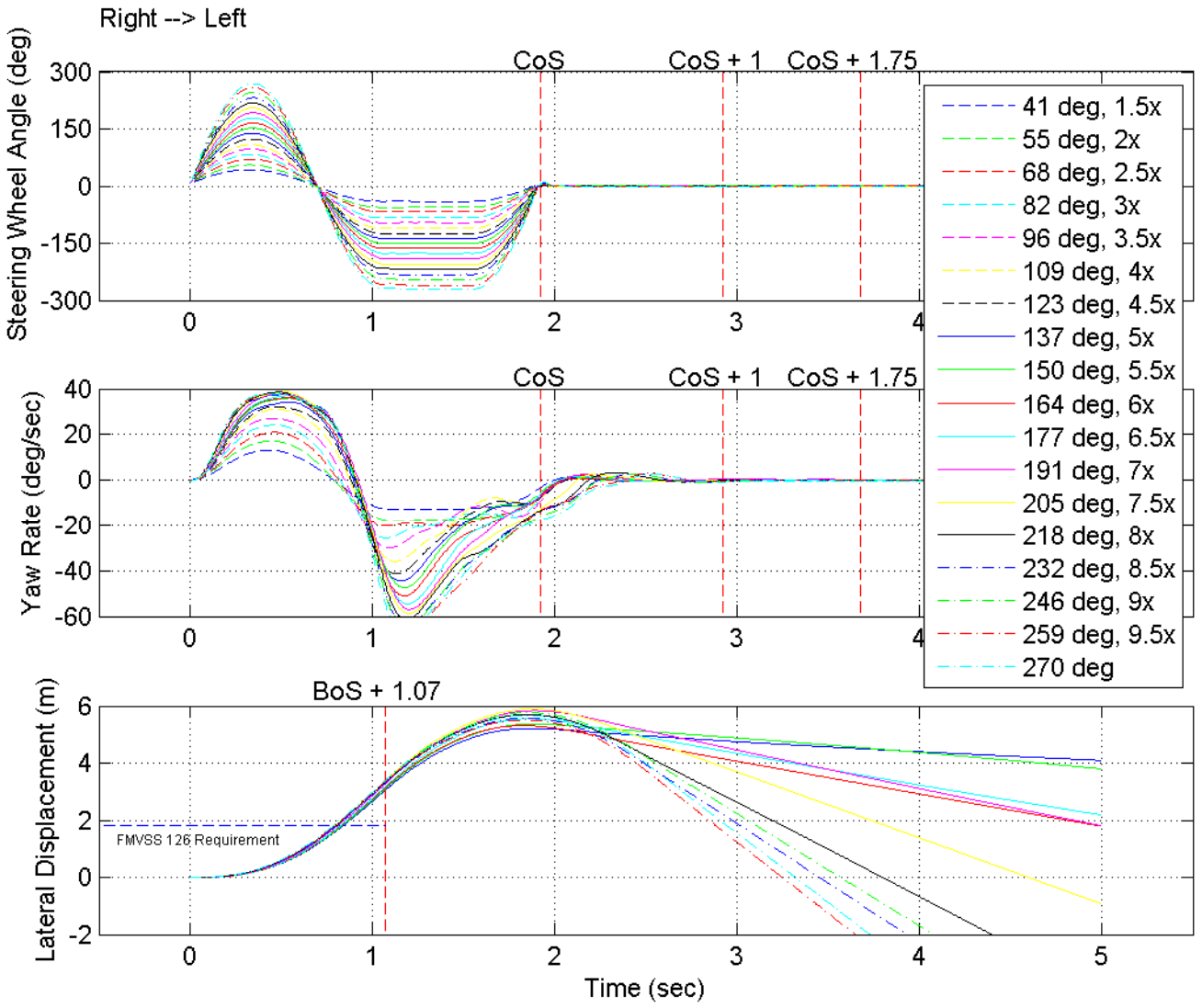


Figure 6.2. Steering Wheel Angle, Yaw Rate and Lateral Displacement for R-L Series

6.0 DATA PLOTS (3 of 4)

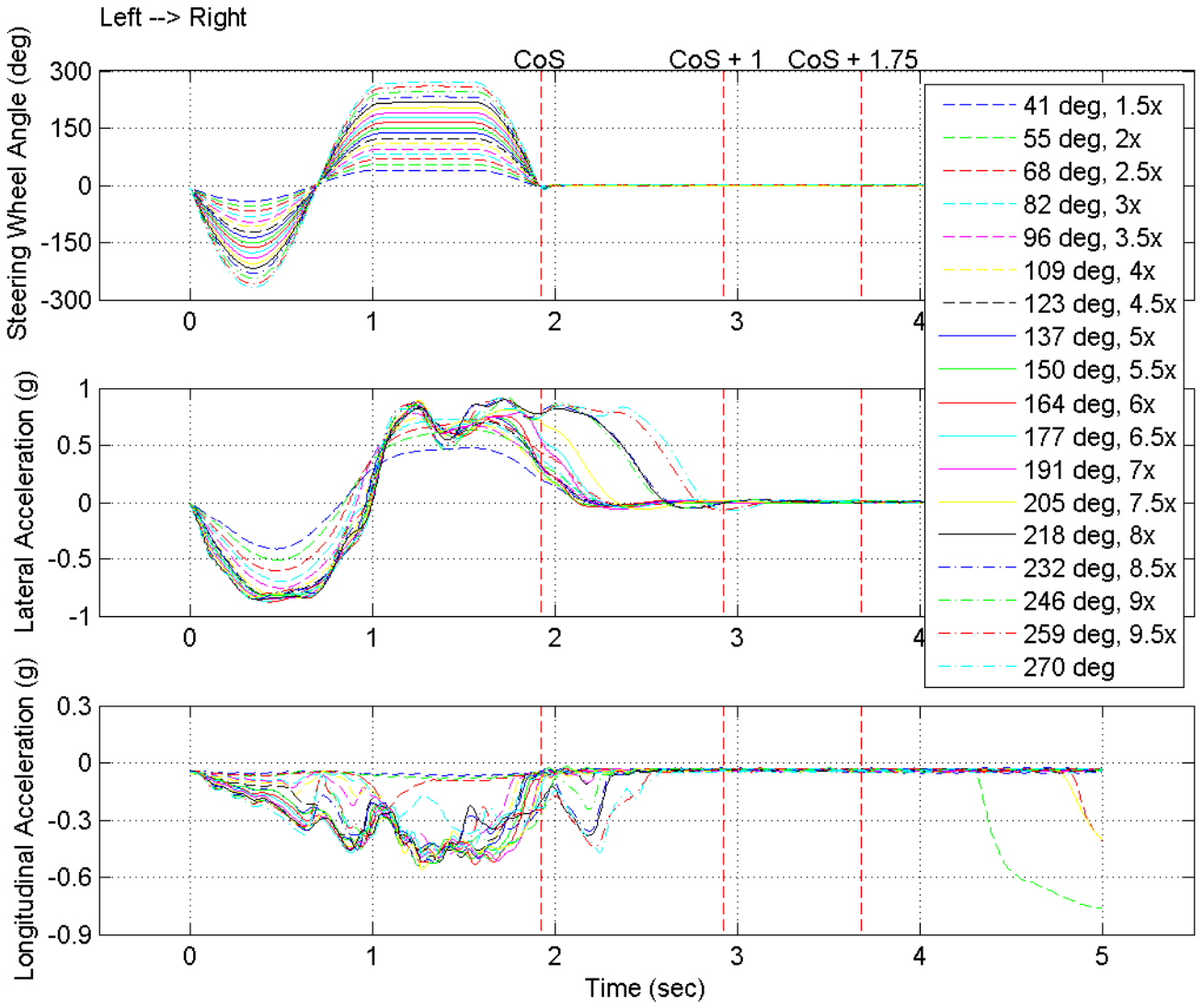


Figure 6.3. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for L-R Series

6.0 DATA PLOTS (4 of 4)

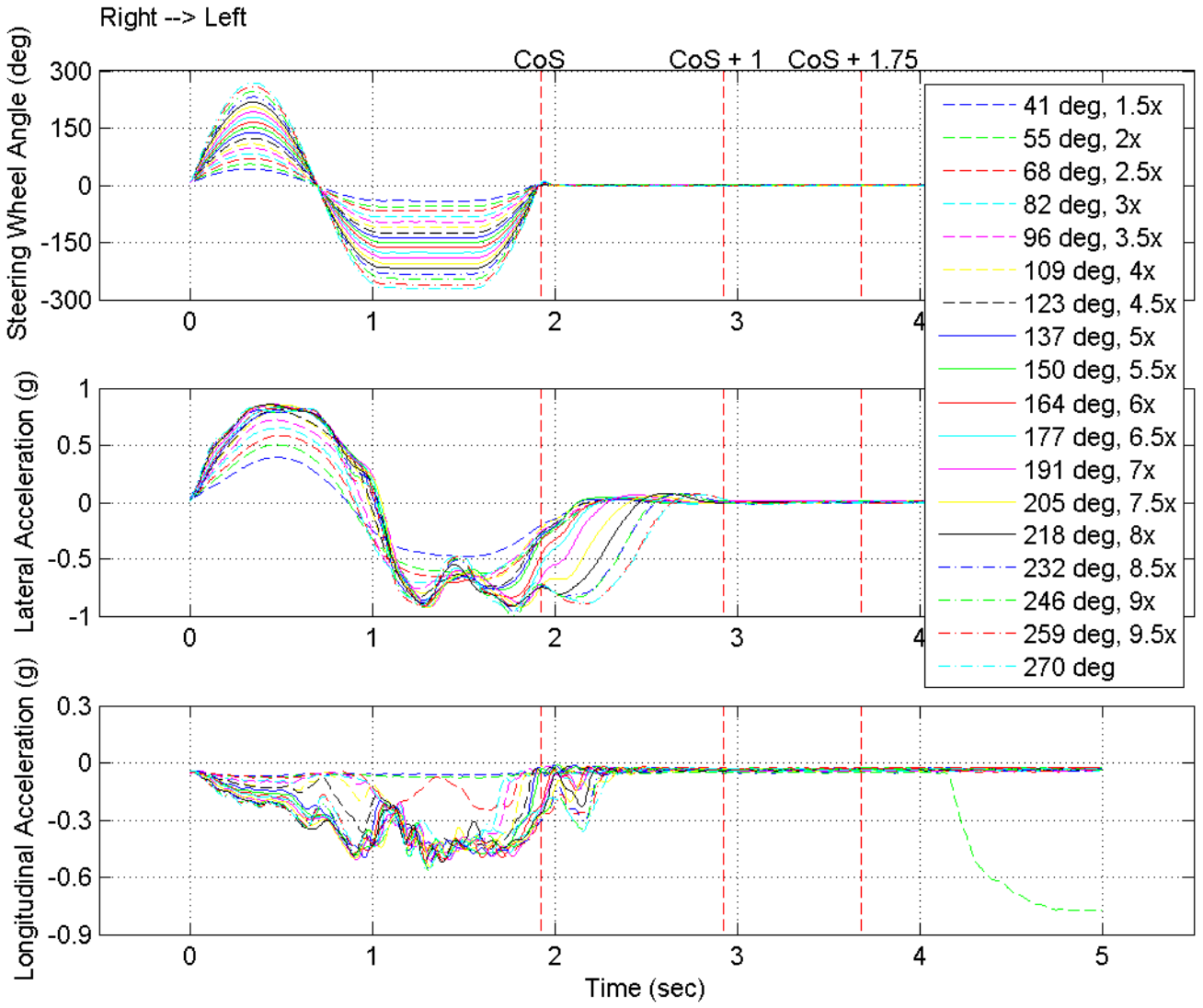


Figure 6.4. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for R-L Series

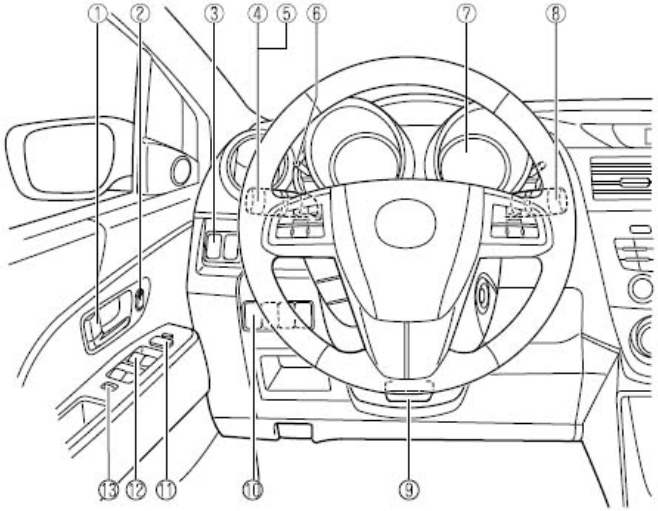
7.0 OTHER DOCUMENTATION

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

Interior Overview

Interior Equipment (View A)



Traction Control System (TCS)

The Traction Control System (TCS) enhances traction and safety by controlling engine torque and braking. When the TCS detects driving wheel slippage, it lowers engine torque and operates the brakes to prevent loss of traction.

This means that on a slick surface, the engine adjusts automatically to provide optimum power to the drive wheels, limiting wheel spin and loss of traction.

⚠ WARNING

Do not rely on the traction control system as a substitute for safe driving:

The traction control system (TCS) cannot compensate for unsafe and reckless driving, excessive speed, tailgating (following another vehicle too closely), and hydroplaning (reduced tire friction and road contact because of water on the road surface). You can still have an accident.

Use snow tires or tire chains and drive at reduced speeds when roads are covered with ice and/or snow:

Driving without proper traction devices on snow and/or ice-covered roads is dangerous. The traction control system (TCS) alone cannot provide adequate traction and you could still have an accident.

NOTE

To turn off the TCS, press the DSC OFF switch (page 5-25).

▼TCS/DSC Indicator Light

This indicator light stays on for a few seconds when the ignition is switched ON. If the TCS or DSC is operating, the indicator light flashes.

If the light stays on, the TCS or DSC may have a malfunction and they may not operate correctly. Take your vehicle to an Authorized Mazda Dealer.

NOTE

- *In addition to the indicator light flashing, a slight lugging sound will come from the engine. This indicates that the TCS is operating properly.*
- *On slippery surfaces, such as fresh snow, it will be impossible to achieve high rpm when the TCS is on.*

Dynamic Stability Control (DSC)

The Dynamic Stability Control (DSC) automatically controls braking and engine torque in conjunction with systems such as ABS and TCS to help control side slip when driving on slippery surfaces, or during sudden or evasive maneuvering, enhancing vehicle safety.

Refer to ABS (page 5-8) and TCS (page 5-23).

DSC operation is possible at speeds greater than 20 km/h (12 mph).

⚠ WARNING

Do not rely on the dynamic stability control as a substitute for safe driving:

The dynamic stability control (DSC) cannot compensate for unsafe and reckless driving, excessive speed, tailgating (following another vehicle too closely), and hydroplaning (reduced tire friction and road contact because of water on the road surface). You can still have an accident.

⚠ CAUTION

- *The DSC may not operate correctly unless the following are observed:*
  - *Use tires of the correct size specified for your Mazda on all four wheels.*
  - *Use tires of the same manufacturer, brand and tread pattern on all four wheels.*
  - *Do not mix worn tires.*
- *The DSC may not operate correctly when tire chains are used or a temporary spare tire is installed because the tire diameter changes.*

NOTE

After switching the ignition ON, a clicking sound may be heard behind the dashboard. This sound is the result of the DSC system self-check operation and does not indicate an abnormality.

▼TCS/DSC Indicator Light

This indicator light stays on for a few seconds when the ignition is switched ON. If the TCS or DSC is operating, the indicator light flashes.

If the light stays on, the TCS or DSC may have a malfunction and they may not operate correctly. Take your vehicle to an Authorized Mazda Dealer.

7.1 OWNER'S MANUAL PAGES

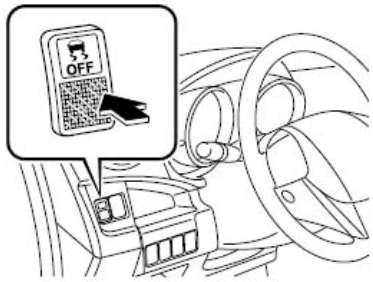
▼DSC OFF Indicator Light

This indicator light stays on for a few seconds when the ignition is switched ON.
It also illuminates when the DSC OFF switch is pressed and TCS/DSC is switched off (page 5-25).

If the light stays on when the TCS/DSC is not switched off, take your vehicle to an Authorized Mazda Dealer. The dynamic stability control may have a malfunction.

▼DSC OFF Switch

Press the DSC OFF switch to turn off the TCS/DSC. The DSC OFF indicator light will illuminate.



Press the switch again to turn the TCS/DSC back on. The DSC OFF indicator light will go out.

NOTE

- *When DSC is on and you attempt to free the vehicle when it is stuck, or drive it out of freshly fallen snow, the TCS (part of the DSC system) will activate. Depressing the accelerator will not increase engine power and freeing the vehicle may be difficult. When this happens, turn off the TCS/DSC.*
- *If the TCS/DSC is off when the engine is turned off, it automatically activates when the ignition is switched ON.*
- *Leaving the TCS/DSC on will provide the best stability.*

7.1 OWNER'S MANUAL PAGES

Warning/Indicator Lights and Beep Sounds

▼Headlight High-Beam Indicator Light

This light indicates one of two things:
- The high-beam headlights are on.
- The turn signal lever is in the flash-to-pass position.

▼Shift Position Indicator Light (Automatic Transaxle)

This indicates the selected shift position.

In manual mode, the "M" of the shift position indicator illuminates and the numeral for the selected gear displays in the gear position indicator.

▼Low Engine Coolant Temperature Indicator Light (Blue)

When the ignition is switched ON, the light illuminates momentarily and then turns off.
The light illuminates continuously when the engine coolant temperature is low and turns off after the engine has reached normal operating temperature.

NOTE

If the low engine coolant temperature indicator light remains illuminated after the engine has been sufficiently warmed up, the temperature sensor could have a malfunction. Consult an Authorized Mazda Dealer.

▼TCS/DSC Indicator Light

This indicator light stays on for a few seconds when the ignition is switched ON. If the TCS or DSC is operating, the indicator light flashes.

If the light stays on, the TCS or DSC may have a malfunction and they may not operate correctly. Take your vehicle to an Authorized Mazda Dealer.

7.1 OWNER'S MANUAL PAGES

NOTE

- *In addition to the indicator light flashing, a slight lugging sound will come from the engine. This indicates that the TCS is operating properly.*
- *On slippery surfaces, such as fresh snow, it will be impossible to achieve high rpm when the TCS is on.*

▼DSC OFF Indicator Light

This indicator light stays on for a few seconds when the ignition is switched ON.
It also illuminates when the DSC OFF switch is pressed and TCS/DSC is switched off (page 5-25).

If the light stays on when the TCS/DSC is not switched off, take your vehicle to an Authorized Mazda Dealer. The dynamic stability control may have a malfunction.

▼Cruise Main Indicator Light (Amber)/Cruise Set Indicator Light (Green) *

The indicator light has two colors.

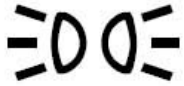
Cruise Main Indicator Light (Amber)

The indicator light illuminates amber when the ON switch is pressed and the cruise control system is activated.

Cruise Set Indicator Light (Green)

The indicator light illuminates green when a cruising speed has been set.

▼Lights-On Indicator Light



This indicator light illuminates when the exterior lights and dashboard illumination are on.

▼Power Steering Malfunction Indicator Light

This indicator light illuminates when the ignition is switched ON, and turns off when the engine is started.

7.2 VEHICLE ARRIVAL CONDITION REPORT

CONTRACT NO.: DTNH22-08-D-00098
DATE: *5/20/2011*

From: *Automotive Allies*

To: *Dynamic Research, Inc*

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

Vehicle VIN: *JM1CW2CL3C0105648* NHTSA NO.: *CC5403*
Model Year: *2012* Odometer Reading: *59* Miles
Make *Mazda* Body Style: *Passenger Car*
Model: *5* Body Color: *White*
Manufacture Date: *12/10* Dealer: *Automotive Allies*
GVWR (kg/lb) *2125/4685* 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 Lenkeit* DATE RECORDED: *5/20/2011*

APPROVED BY: *B Kebschull* DATE APPROVED: *6/2/2011*

7.3 VEHICLE COMPLETION CONDITION REPORT

CONTRACT NO.: *DTNH22-08-D-00098*
DATE: *6/13/2011*

Vehicle VIN: *JM1CW2CL3C0105648* NHTSA NO.: *CC5403*
Model Year: *2012* Odometer Reading: *114* Miles
Make: *Mazda* Body Style: *Passenger Car*
Model: *5* Body Color: *White*
Manufacture Date: *12/10* Dealer: *Automotive Allies*
GVWR (kg/lb) *2125 (4685)* 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 delivered, like new.

RECORDED BY: *J Lenkeit* DATE RECORDED: *6/13/2011*

APPROVED BY: *P Broen* DATE APPROVED: *6/13/2011*

7.4 SINE WITH DWELL TEST RESULTS

2012 Mazda 5 Passenger Car
NHTSA No.: *CC5403*
Date of Test : *6/1/2011*
Date Created: *6/1/2011*

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	711	50.23	3.546	1091	5.446	847	4.227	-0.6	-0.07	1291	0.75	0.10	1441	12.71	948	-4.06	0.37	41.15	776	40.88
22	709	50.00	3.539	1090	5.444	847	4.226	-0.7	-0.12	1290	-0.33	-0.06	1440	17.23	961	-5.24	0.45	55.15	775	54.86
23	708	50.28	3.535	1090	5.444	846	4.225	0.3	0.05	1290	-0.05	-0.01	1440	19.26	919	-6.52	0.50	68.01	775	67.95
24	708	50.14	3.531	1090	5.444	846	4.225	0.5	0.13	1290	0.93	0.22	1440	23.53	920	-7.63	0.52	82.01	775	81.80
25	707	50.17	3.528	1090	5.444	846	4.225	-0.8	-0.24	1290	-0.37	-0.11	1440	29.16	924	-8.46	0.55	96.06	775	95.91
26	707	50.18	3.527	1090	5.445	846	4.225	-0.7	-0.25	1290	-0.29	-0.10	1440	34.90	927	-9.40	0.51	108.84	775	108.90
27	706	49.97	3.525	1090	5.444	846	4.225	-0.6	-0.22	1290	-0.29	-0.11	1440	38.68	930	-9.91	0.48	123.16	775	122.87
28	706	50.01	3.524	1090	5.444	846	4.225	-1.1	-0.46	1290	-1.02	-0.43	1440	42.23	931	-10.07	0.52	137.12	775	136.94
29	706	50.29	3.524	1090	5.445	846	4.225	-1.2	-0.55	1290	-1.08	-0.50	1440	45.78	933	-10.33	0.51	150.20	775	149.97
30	706	50.06	3.523	1090	5.443	846	4.225	-0.3	-0.17	1290	-0.17	-0.08	1440	49.24	936	-10.80	0.48	164.25	775	163.79
31	706	50.16	3.522	1090	5.443	846	4.225	0.0	0.00	1290	0.03	0.01	1440	51.98	937	-10.73	0.46	177.20	775	176.81
32	706	50.07	3.523	1090	5.441	847	4.226	-0.1	-0.07	1290	-0.26	-0.14	1440	53.85	937	-10.86	0.47	191.12	775	190.65
33	706	50.21	3.523	1090	5.443	847	4.226	-0.5	-0.25	1290	-0.19	-0.11	1440	54.33	936	-10.84	0.52	205.06	775	204.62
34	706	50.11	3.522	1090	5.442	846	4.225	1.5	0.84	1290	0.57	0.33	1440	56.77	937	-11.09	0.45	217.86	776	217.58
35	706	50.12	3.522	1090	5.442	846	4.225	0.7	0.40	1290	-0.11	-0.06	1440	58.77	933	-11.04	0.52	231.68	776	231.68
36	706	50.24	3.523	1090	5.443	846	4.225	0.8	0.49	1290	0.11	0.07	1440	61.33	933	-11.14	0.49	245.24	777	245.72
37	706	50.19	3.523	1090	5.443	847	4.226	-0.1	-0.06	1290	-0.28	-0.17	1440	61.17	932	-10.98	0.57	258.65	777	259.72
39	706	50.10	3.523	1090	5.442	846	4.225	-0.4	-0.24	1290	0.34	0.21	1440	61.60	931	-11.08	0.57	268.58	776	269.60

7.4 SINE WITH DWELL TEST RESULTS

2012 Mazda 5 Passenger Car
NHTSA No.: *CC5403*
Date of Test : *6/1/2011*
Date Created: *6/1/2011*

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	711	49.77	3.546	1091	5.446	847	4.226	-0.5	0.06	1291	-1.09	0.14	1441	-13.11	938	4.05	-0.35	41.72	775	41.65
41	709	49.95	3.538	1090	5.444	847	4.226	0.5	-0.09	1290	1.05	-0.19	1440	-18.13	937	5.24	-0.44	55.86	775	55.58
42	708	50.11	3.534	1090	5.444	847	4.226	-0.5	0.10	1290	0.51	-0.10	1440	-20.31	922	6.36	-0.49	68.98	775	68.61
43	708	50.15	3.531	1090	5.445	846	4.225	0.9	-0.22	1290	1.23	-0.32	1440	-25.65	924	7.29	-0.52	82.87	775	82.54
44	707	50.07	3.528	1090	5.445	846	4.225	-0.1	0.04	1290	0.07	-0.02	1440	-29.89	927	8.19	-0.50	96.91	775	96.60
45	707	50.20	3.526	1090	5.444	846	4.225	0.1	-0.03	1290	0.11	-0.04	1440	-35.96	933	9.12	-0.40	109.72	775	109.45
46	706	50.03	3.525	1090	5.445	846	4.225	0.0	0.00	1290	0.19	-0.08	1440	-41.23	934	9.48	-0.41	123.80	775	123.60
47	706	50.25	3.524	1090	5.444	847	4.226	-0.2	0.10	1290	-0.13	0.06	1440	-44.26	938	9.86	-0.29	137.94	775	137.44
48	706	50.14	3.522	1090	5.442	846	4.225	0.2	-0.08	1290	0.36	-0.17	1440	-47.61	941	10.07	-0.24	150.85	775	150.40
49	706	50.12	3.522	1090	5.443	847	4.226	-0.1	0.07	1290	0.12	-0.06	1440	-51.02	941	10.23	-0.29	164.79	775	164.44
50	706	50.21	3.522	1090	5.442	847	4.226	-0.6	0.31	1290	-0.23	0.13	1440	-54.41	945	10.34	-0.18	177.74	775	177.47
51	706	50.11	3.522	1090	5.441	847	4.226	-0.3	0.19	1290	-0.07	0.04	1440	-57.13	947	10.66	-0.13	191.55	775	191.41
52	706	50.17	3.522	1090	5.442	847	4.226	0.1	-0.06	1290	0.22	-0.13	1440	-58.78	947	10.86	-0.10	205.38	775	205.42
53	706	50.22	3.522	1090	5.442	847	4.226	0.4	-0.26	1290	0.19	-0.12	1440	-61.47	944	10.74	-0.22	218.34	776	218.41
54	706	49.87	3.522	1090	5.443	847	4.226	1.2	-0.77	1290	0.44	-0.28	1440	-63.85	944	10.69	-0.27	232.15	776	232.52
55	706	50.05	3.522	1090	5.443	847	4.226	0.5	-0.34	1290	0.10	-0.06	1440	-64.22	944	10.97	-0.23	245.65	777	246.66
56	706	49.88	3.522	1090	5.443	847	4.226	1.2	-0.77	1290	0.34	-0.23	1440	-66.90	943	10.85	-0.34	259.28	777	260.52
57	706	50.07	3.523	1090	5.443	847	4.227	1.2	-0.76	1290	0.41	-0.27	1440	-66.07	942	10.97	-0.30	269.13	776	270.58

7.5 SLOWLY INCREASING STEER TEST RESULTS

2012 Mazda 5 Passenger Car
NHTSA No.: *CC5403*
Date of Test: *6/1/2011*
Date Created: *6/1/2011*

File	EventPt	DOS	MES (mph)	Mean SPD (mph)	AYcount_3	THETAENCF_3 (deg)	AYCG_CD2_3 (g)	r_squared	ZeroBegin	ZeroEnd
10	705	1	49.500	49.673	1108	-27.269	-0.309	0.993	505	705
11	700	1	49.768	49.730	1115	-27.524	-0.295	0.995	500	700
12	665	1	49.780	49.745	1123	-28.083	-0.298	0.996	465	665
13	700	0	49.781	49.760	1111	27.562	0.300	0.995	500	700
14	700	0	49.637	49.736	1099	26.774	0.305	0.996	500	700
15	700	0	49.753	49.880	1100	26.803	0.299	0.996	500	700
				Averages		27.3				

Scalars	Steering Angles (deg)
1.5	41
2.0	55
2.5	68
3.0	82
3.5	96
4.0	109
4.5	123
5.0	137

Scalars	Steering Angles (deg)
5.5	150
6.0	164
6.5	177
7.0	191
7.5	205
8.0	218
8.5	232
9.0	246

Scalars	Steering Angles (deg)
9.5	259
9.9	270

7.6 INERTIAL SENSING SYSTEM LOCATION COORDINATES

Vehicle: **2012 Mazda 5 Passenger Car** NHTSA No.: CC5403

Wheelbase: 108.25 Inches Faro Arm S/N: U08-05-08-06636

Measurement date: 5/31/2011 Certification date: 11/7/10

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	2.519		0.000
M_Point_48_Ref	0.000	0.000	-
M_CIRCLE001_I_Left_Rear_Wheel_Axle	-31.301	14.398	-11.795
M_Point_IMU_side	10.926	45.865	-17.113
M_Point_ROOF	-	-	-63.717
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	10.926	47.390	-17.113

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	**66.023**	**-0.610**	**17.113**

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).