126-DRI-10-005
SAFETY COMPLIANCE TESTING FOR FMVSS 126
Electronic Stability Control Systems

Toyota Motor Manufacturing, Indiana, Inc.
2011 Toyota Sienna
NHTSA No. CB5100

DYNAMIC RESEARCH, INC.
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23 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 2011 Toyota Sienna , NHTSA No. CB5100, 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 2011 Toyota Sienna, 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 2011 Toyota Sienna was conducted at Dynamic Research, Inc (DRI) in accordance with NHTSA TP-126-02, dated November 19, 2008.

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

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

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

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

2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS (CONTINUED)

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

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

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

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

2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS (CONTD)

Data Summary Sheet (Page 1 of 2)

Vehicle: *2011 Toyota Sienna*

NHTSA No. *CB5100* VIN: *5TDKK3DC6BS010864*

Vehicle Type: *MPV* Manufacture Date: *2/10*

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: *2011 Toyota Sienna MPV*

NHTSA No. *CB5100* Data Sheet Completion Date: *4/15/2010*

VIN *5TDKK3DC6BS010864* Manufacture Date: *2/10*

GVWR (kg): *2715.0* Front GAWR (kg): *1405.0* Rear GAWR (kg): *1405.0*

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

Odometer reading at time of inspection: *25 miles (40 km)*

DESIGNATED TIRE SIZE(S) FROM VEHICLE LABELING:

Front axle: *P235/60 R17* Rear axle: *P235/60 R17*

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

		Front Axle		Rear Axle
	Tire Manufacturer:	*Firestone*		*Firestone*
	Tire Model:	*FR710*		*FR710*
	Tire Size:	*P235/60 R17*		*P235/60 R17*
TIN	Left Front:	*W2OU GKD 0310*	Right Front:	*W2OU GKD 0310*
	Left Rear:	*W2OU GKD 0310*	Right Rear:	*W2OU GKD 0310*

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: *FWD (Standard)*
Mode: *Default- ESC on*
Drive Configuration: *FWD (Standard)*
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: *4/15/2010*
APPROVED BY: *B Kebschull* DATE APPROVED: *5/3/2010*

3.0 TEST DATA (CONTD)

Data Sheet 2 (Page 1 of 2)

ESC SYSTEM HARDWARE AND OPERATIONAL CHARACTERISTICS

Vehicle: *2011 Toyota Sienna MPV*

NHTSA No *CB5100* Data Sheet Completion Date: *4/15/2010*

ESC SYSTEM IDENTIFICATION

Manufacturer/Model *ADVICS CO., Ltd. 44540-08170*

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: *Engine Control System, VSC (ESC) Computer, Master Cylinder Pressure Sensor*

ESC OPERATIONAL CHARACTERISTICS

System is capable of generating brake torque at each wheel — [X] Yes (Pass) [ ] No (Fail)
List and describe Components: *VSC, (ESC) by way of solenoid valves, controls the fluid pressure generated by the pump and applies it to each wheel cylinder in the following 3 modes: pressure reduction, pressure holding and pressure increase modes. As a result, the tendency to front wheel skid or rear wheel skid is controlled.*

System is capable of determining yaw rate — [X] Yes (Pass) [ ] No (Fail)
List and describe Components: *Yaw rate sensor to detect yaw rate*

System is capable of monitoring driver steering input — [X] Yes (Pass) [ ] No (Fail)
List and describe Components: *Steer angle sensor to detect steering angle*

System is capable of estimating side slip or side slip derivative — [X] Yes (Pass) [ ] No (Fail)
List and describe Components: *Vehicle State Evaluation Module of the VSC software estimates side slip angle based on estimated sideslip derivative. Vehicle side slip derivative is estimated as the difference between the estimated yaw rate and the actual measured yaw rate detected by the yaw sensor. The estimated yaw rate is derived from the measured lateral acceleration and the estimated vehicle speed.*

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. Method used to modify torque: *Throttle control is used to regulate engine output*

X Yes (Pass)
___ No (Fail)

System is capable of activation at speeds of 20 km/h (12.4 mph) and higher

Speed system becomes active: *15 km/h*

X Yes (Pass)
___ No (Fail)

System is capable of activation during the following driving phases:
- acceleration
- braking
- coasting
- during activation of ABS or traction control

X Yes (Pass)
___ No (Fail)

Driving phases during which ESC is capable of activation:
Acceleration, deceleration, coasting, during activation of the ABS or traction control

Vehicle manufacturer submitted documentation explaining how the ESC mitigates understeer

X Yes (Pass)
___ No (Fail)

DATA INDICATES COMPLIANCE: **X** Yes (Pass)
___ No (Fail)

REMARKS:

RECORDED BY: *J Lenkeit* DATE RECORDED: *4/15/2010*
APPROVED BY: *B kebschull* DATE APPROVED: *5/3/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2011 Toyota Sienna MPV*

NHTSA No. *CB5100* Data Sheet completion date: *4/15/2010*

ESC Malfunction Telltale

Vehicle is equipped with malfunction telltale? *Yes*

Telltale Location: *Instrument panel upper right of speedometer (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.

Vehicle is also equipped with a multi-information center which displays "Check VSC System" in event of ESC malfunction (Figure 5.7)

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:

If the vehicle is in danger of slipping or if any of the drive wheels spins, the slip indicator (shown above) flashes to indicate that the ESC and/or TCS systems are operating

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: *Instrument panel. Lower right center of tachometer (Figure 5.8)*

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: *John Lenkeit* DATE RECORDED: *4/15/2010*

APPROVED BY: *Brian Kebschull* DATE APPROVED: *4/20/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2011 Toyota Sienna MPV*

NHTSA No. *CB5100* Data Sheet completion date: *4/16/2010*

"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)

- [ ] Dedicated "ESC Off" Control
- [X] Multi-functional control with an "ESC Off" mode
- [ ] Other (describe)

Identify each control location, labeling and selectable modes.

First Control: Location *Left knee bolster (Figure 5.9)*
Labeling *"Slip" symbol + "OFF"*
Modes *TCS off, ESC and TCS off, ESC and TCS on*

Second Control: Location ___
Labeling ___
Modes ___

Identify standard or default drive configuration *FWD*

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

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

X Yes ___ No (Fail)

Does the "ESC Off" telltale extinguish when the ignition is cycled from "on" ("Run") to "Lock" or "Off" and then back again to the "On" ("Run") 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)
TCS Off	*No*	
ESC and TCS off	*Yes*	*Yes*

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 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 *None*

Control Description _____

Labeling _____

Ancillary Control: System _____

Control Description _____

Labeling _____

Ancillary Control: System _____

Control Description _____

Labeling _____

3.0 TEST DATA (CONTD)

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

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

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

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

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

For each 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: *ESC OFF button is located on the dashboard to the left of steering wheel. Pushing it once briefly turns traction control off ("TRAC OFF" telltale shows at lower left area of IP. ESC is still on). Pushing it and holding it for approximately 3 seconds additionally turns ESC off (both "TRAC OFF" and ESC off telltales illuminate). The system returns to normal mode by briefly pressing the ESC OFF switch in either TCS-OFF or ESC-OFF mode or by cycling the ignition.*

RECORDED BY: *J Lenkeit* DATE RECORDED: *4/16/2010*
APPROVED BY: *B Kebschull* DATE APPROVED: *4/22/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2011 Toyota Sienna MPV*

NHTSA No. *CB5100* Data Sheet completion date: *4/23/2010*

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

Peak Friction Coefficient (at least 0.9) *0.953*

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

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

Coolant *Yes* *Oil*

Tire Pressures:

Required; Front Axle *240* KPA Rear Axle *240* KPA

Actual; LF *240* KPA RF *240* KPA

LR *240* KPA RR *240* KPA

Vehicle Dimensions: Front Track Width *171.5* cm Wheelbase *302.9* cm

Rear Track Width *164.5* cm

Vehicle Weight Ratings: GAWR Front *1405.0* KG GAWR Rear *1405.0* KG

Unloaded Vehicle Weight (UVW):

Front Axle *1116.3* KG Left Front *573.3* KG Right Front *543.0* KG

Rear Axle *871.4* KG Left Rear *434.1* KG Right Rear *437.3* KG

Total UVW *1987.6* KG

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

Calculated baseline weight (UVW + 73kg) *2060.6* KG

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

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

3.0 TEST DATA (CONTD)

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

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

Front axle *1155.8* KG Left front *598.3* KG Right front *557.5* KG

Rear axle *906.3* KG Left rear *445.0* KG Right rear *461.3* KG

Total UVW with outriggers *2062.0* KG

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

Front axle *1265.6* KG Left front *659.9* KG Right front *605.7* KG

Rear axle *959.5* KG Left rear *472.1* KG Right rear *487.4* KG

Vehicle Weight *2225.1* KG

Ballast Required =

[Total UVW with Outriggers (if applicable)]		+ *168*	KG	- [Loaded Weight w/Driver and Instrumentation)]	
= *2062.0*	KG	+ *168*	KG	- 2225.1	KG

= *4.9* KG

Total Loaded Vehicle Weight w/Driver and Instrumentation and Ballast

Front axle *1266.7* KG Left front *659.9* KG Right front *606.8* KG

Rear axle *963.4* KG Left rear *473.6* KG Right rear *489.8* KG

Total UVW *2230.1* 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	*51.5*	in	*130.9*	cm	*60.3*	in	*153.2*	cm
y-distance	*-0.6*	in	*-1.4*	cm	*-0.3*	in	*-0.9*	cm
z-distance	*26.0*	in	*65.9*	cm	*20.3*	in	*51.6*	cm
Roof Height					*68.313*	in	*173.5*	cm
Distance between ultrasonic sensors					*90.75*	in	*230.5*	cm

Remarks:

RECORDED BY: *Brian Kebschull* DATE RECORDED: *4/23/2010*
APPROVED BY: *J Lenkeit* DATE APPROVED: *5/3/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2011 Toyota Sienna MPV*

NHTSA No. *CB5100*

Measured tire pressure: LF *258* KPA RF *259* KPA

LR *254* KPA RR *257* 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)) *20* °C

Brake Conditioning Time: *9:58:00 AM* Date: *4/23/2010*

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	*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:	*10:10:00 AM*		Date:	*4/23/2010*	
Measured cold tire pressure	LF	*267*	KPA	RF	*266*	KPA
	LR	*261*	KPA	RR	*264*	KPA
Wind Speed *0.5* 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*°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*	*32 - 33.6*
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	*0.29*
2	3	56 ± 2 (35 ± 1)	*110*	0.5 - 0.6	*0.48*
3	4	56 ± 2 (35 ± 1)	*120*	0.5 - 0.6	*0.51*
4		56 ± 2 (35 ± 1)		0.5 - 0.6	

Steering wheel angle that corresponds to a peak 0.5-0.6 g lateral acceleration:
120 **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	*5-7*	56 ± 2 (35 ± 1)	*120* (cycles 1-10)	0.5 - 0.6	*0.51*
4	*8*	56 ± 2 (35 ± 1)	*120* (cycles 1-9)	0.5 - 0.6	*0.51*
			240 (cycle10)*	NA	*0.71*

* 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: *11:55:00 AM* Date: *4/23/2010*

Measured cold tire pressure LF *265* KPA RF *261* KPA

LR *260* KPA RR *255* 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* °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*	*32 - 33.6*
4-6	Counterclockwise	0.5 - 0.6	*0.5-0.6*	*32 - 33.6*

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

120 **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	*17-19*	56 ± 2 (35 ± 1)	*120* (cycles 1-10)	0.5 - 0.6	*0.51*
4	*20*	56 ± 2 (35 ± 1)	*120* (cycles 1-9)	0.5 - 0.6	*0.51*
			240 (cycle 10)*	NA	*0.71*

* 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: *4/23/2010*

APPROVED BY: *J Lenkeit* DATE APPROVED: *5/3/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2011 Toyota Sienna MPV*

NHTSA No. *CB5100*

Measured tire pressure: LF *272* KPA RF *271* KPA

LR *265* KPA RR *266* 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* °C

Selected drive configuration *FWD*

Selected Mode: *Default*

Preliminary Left Steer Maneuver:

Lateral Acceleration measured at 30 degrees steering wheel angle

$a_{y,30degrees}$ = *0.29* 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} = *56.9* degrees (@.55g)

δ_{sis} = *60* 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	*10:49:11 AM*	*-33.8*	*11*	*Good*
2	Left	*10:51:00 AM*	*-33.6*	*12*	*Good*
3	Left	*10:54:04 AM*	*-33.4*	*13*	*Good*
4	Left				
5	Left				
1	Right	*10:57:05 AM*	*33.8*	*14*	*Good*
2	Right	*10:59:06 AM*	*34.2*	*15*	*Good*
3	Right	*11:02:07 AM*	*34.5*	*16*	*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:

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

$\delta_{0.3\ g,\ overall}$ = *33.9* degrees

[to nearest 0.1 degree]

Remarks:

RECORDED BY: *Brian Kebschull* DATE RECORDED: *4/23/2010*
APPROVED BY: *J Lenkeit* DATE APPROVED: *5/3/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2011 Toyota Sienna MPV*

NHTSA No. *CB5100* Data sheet completion date: *4/23/2010*

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: *FWD (Default)*

Selected Mode: *Default*

Overall steering wheel angle ($\delta_{0.3\ g,\ overall}$) *33.9* degrees

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

Maneuver #	Clock Time (1.5 – 5.0 min max between runs)	Commanded Steering Wheel Angle[1]		Yaw Rates (degrees/sec)			YRR at 1.0 sec after COS [≤ 35%]		YRR at 1.75 sec after COS [≤ 20%]	
		Scalar (* $\delta_{0.3\ g}$)	Angle (degrees)	$\dot{\psi}_{Peak}$	$\dot{\psi}_{1.0sec}$	$\dot{\psi}_{1.75sec}$	%	Pass/Fail	%	Pass/Fail
23	12:24	1.5	51	13.05	-0.01	-0.02	-0.11	PASS	-0.18	PASS
24	12:29	2	68	17.18	0.05	-0.03	0.31	PASS	-0.19	PASS
25	12:32	2.5	85	21.47	0.14	0.06	0.64	PASS	0.27	PASS
26	12:34	3	102	24.9	0.18	0.03	0.71	PASS	0.11	PASS
27	12:37	3.5	119	26.82	-0.12	-0.08	-0.45	PASS	-0.31	PASS
28	12:39	4	136	31.01	-0.23	-0.17	-0.73	PASS	-0.56	PASS
29	12:42	4.5	153	37.05	-0.11	-0.05	-0.3	PASS	-0.13	PASS
30	12:44	5	170	39.05	0.18	0.11	0.46	PASS	0.29	PASS
31	12:47	5.5	186	43.85	-0.88	-0.19	-2	PASS	-0.44	PASS
32	12:50	6	203	46.92	-0.2	-0.04	-0.43	PASS	-0.09	PASS
33	12:53	6.5	220	50.97	0.34	-0.04	0.67	PASS	-0.08	PASS
34	12:56	7	237	53.28	-0.59	-0.2	-1.11	PASS	-0.38	PASS
35	12:58	7.5	254	54.68	-0.38	-0.23	-0.7	PASS	-0.42	PASS
37	13:05	8	271	56.54	-1.55	-0.07	-2.75	PASS	-0.13	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	13:17	1.5	51	-13.48	-0.04	0.1	0.33	PASS	-0.74	PASS
41	13:20	2	68	-17.93	0.01	0.13	-0.04	PASS	-0.74	PASS
42	13:23	2.5	85	-22.74	-0.24	-0.05	1.04	PASS	0.24	PASS
43	13:26	3	102	-25.61	-0.1	0.12	0.4	PASS	-0.46	PASS
44	13:29	3.5	119	-26.5	0.11	-0.04	-0.42	PASS	0.14	PASS
45	13:34	4	136	-31.43	0.12	0.18	-0.37	PASS	-0.57	PASS
46	13:38	4.5	153	-36.29	0.21	0.09	-0.58	PASS	-0.24	PASS
47	13:41	5	170	-40.52	-0.28	-0.02	0.7	PASS	0.06	PASS
48	13:43	5.5	186	-43.94	-0.69	0	1.57	PASS	0	PASS
49	13:46	6	203	-48.69	0.86	0.48	-1.77	PASS	-0.98	PASS
50	13:49	6.5	220	-50.96	2.24	-0.01	-4.39	PASS	0.01	PASS
51	13:51	7	237	-53.67	0.55	0.09	-1.02	PASS	-0.16	PASS
52	13:54	7.5	254	-55.97	2.54	0.19	-4.53	PASS	-0.34	PASS
53	13:57	8	271	-56.87	1.26	0.19	-2.22	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 6.5*$\delta_{0.3\,g,\,overall}$ is less than or equal to 300 degrees. If 6.5*$\delta_{0.3\,g,\,overall}$ is less than 270 degrees maneuver execution should continue by increasing the steering wheel angle magnitude by multiples of 0.5*$\delta_{0.3\,g,\,overall}$ without exceeding the 270 degree steering wheel angle.

During execution of the Sine with Dwell maneuvers were any of the following events observed?

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

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

3.0 TEST DATA (CONTD)

DATA SHEET 8 (3 of 3)
VEHICLE LATERAL STABILITY AND RESPONSIVENESS

Responsiveness – Lateral Displacement

Maneuver #	Initial Steer Direction	Commanded Steering Wheel Angle (5.0*$\delta_{0.3\ g,\ overall}$ or greater)		Calculated Lateral Displacement[1]	
		Scalar *$\delta_{0.3\ g}$	Angle (degrees)	Distance (m)	Pass/Fail
30	Counter Clockwise	5.0	170	-2.85	PASS
31	Counter Clockwise	5.5	186	-2.97	PASS
32	Counter Clockwise	6.0	203	-3.01	PASS
33	Counter Clockwise	6.5	220	-3.06	PASS
34	Counter Clockwise	7.0	237	-3.09	PASS
35	Counter Clockwise	7.5	254	-3.10	PASS
37	Counter Clockwise	8.0	271	-3.11	PASS
47	Clockwise	5.0	170	2.71	PASS
48	Clockwise	5.5	186	2.80	PASS
49	Clockwise	6.0	203	2.87	PASS
50	Clockwise	6.5	220	2.90	PASS
51	Clockwise	7.0	237	2.88	PASS
52	Clockwise	7.5	254	2.89	PASS
53	Clockwise	8.0	271	2.94	PASS

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

DATA INDICATES COMPLIANCE: ☑ PASS ☐ FAIL

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *4/23/2010*

APPROVED BY: *J Lenkeit* DATE APPROVED: *5/3/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2011 Toyota Sienna MPV*

NHTSA No. *CB5100* Data Sheet Completion Date: *4/23/2010*

TEST 1

MALFUNCTION SIMULATION: Describe method of malfunction simulation

Disconnect brake light 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 1 DATA INDICATES COMPLIANCE: *PASS*

Remarks: *Telltale takes approximately 3 seconds to illuminate after ignition on (no driving was required). ABS telltale also illuminated. After switch was re-connected, telltale extinguished approximately 3 seconds after ignition on.*

RECORDED BY: *Brian Kebschull* DATE RECORDED: *4/23/2010*

APPROVED BY: *J Lenkeit* DATE APPROVED *5/3/2010*

3.0 TEST DATA (CONTD)

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

Vehicle: *2011 Toyota Sienna MPV*

NHTSA No. *CB5100* Data Sheet Completion Date: *4/23/2010*

TEST 2

MALFUNCTION SIMULATION: Describe method of malfunction simulation

Disconnected steering wheel angle 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 as.

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: *Telltale illuminated immediately after ignition on (no driving was required). After switch was re-connected, telltale extinguished immediately after ignition on*.

RECORDED BY: *Brian Kebschull* DATE RECORDED: 4/23/2010

APPROVED BY: *J Lenkeit* DATE APPROVED *5/3/2010*

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	Functionally verified by DRI prior to testing
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.	N/A	N/A	N/A	DRI manufactured Aluminum meeting the weight and MOI specifications of Docket 2007-27662-11	N/A	N/A

5.0 PHOTOGRAPHS (1 of 16)

Figure 5.1. Front View of Test Vehicle

5.0 PHOTOGRAPHS (2 of 16)

Figure 5.2. Rear View of Test Vehicle

5.0 PHOTOGRAPHS (3 of 16)

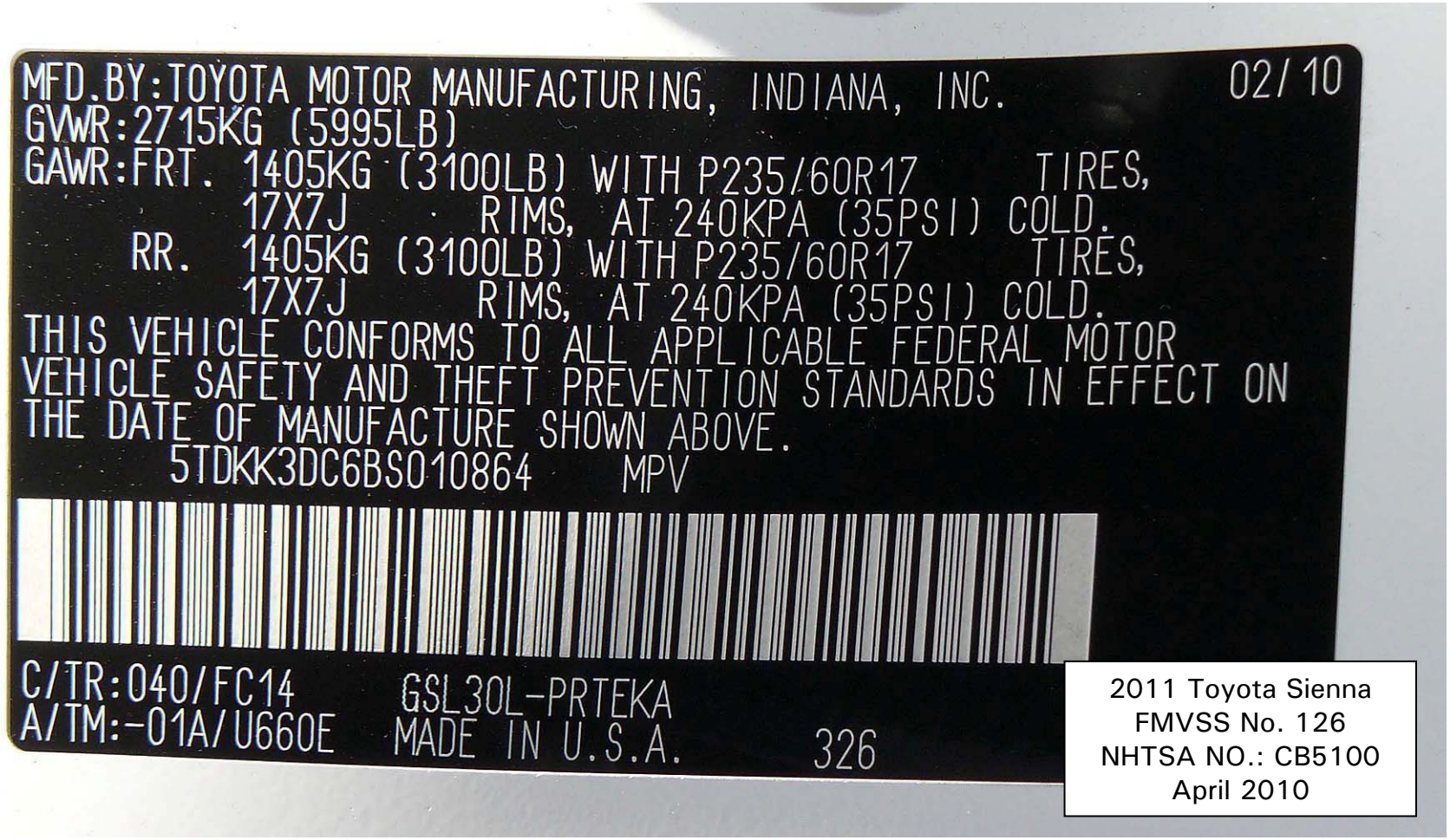


Figure 5.3. Vehicle Certification Label

5.0 PHOTOGRAPHS (4 of 16)

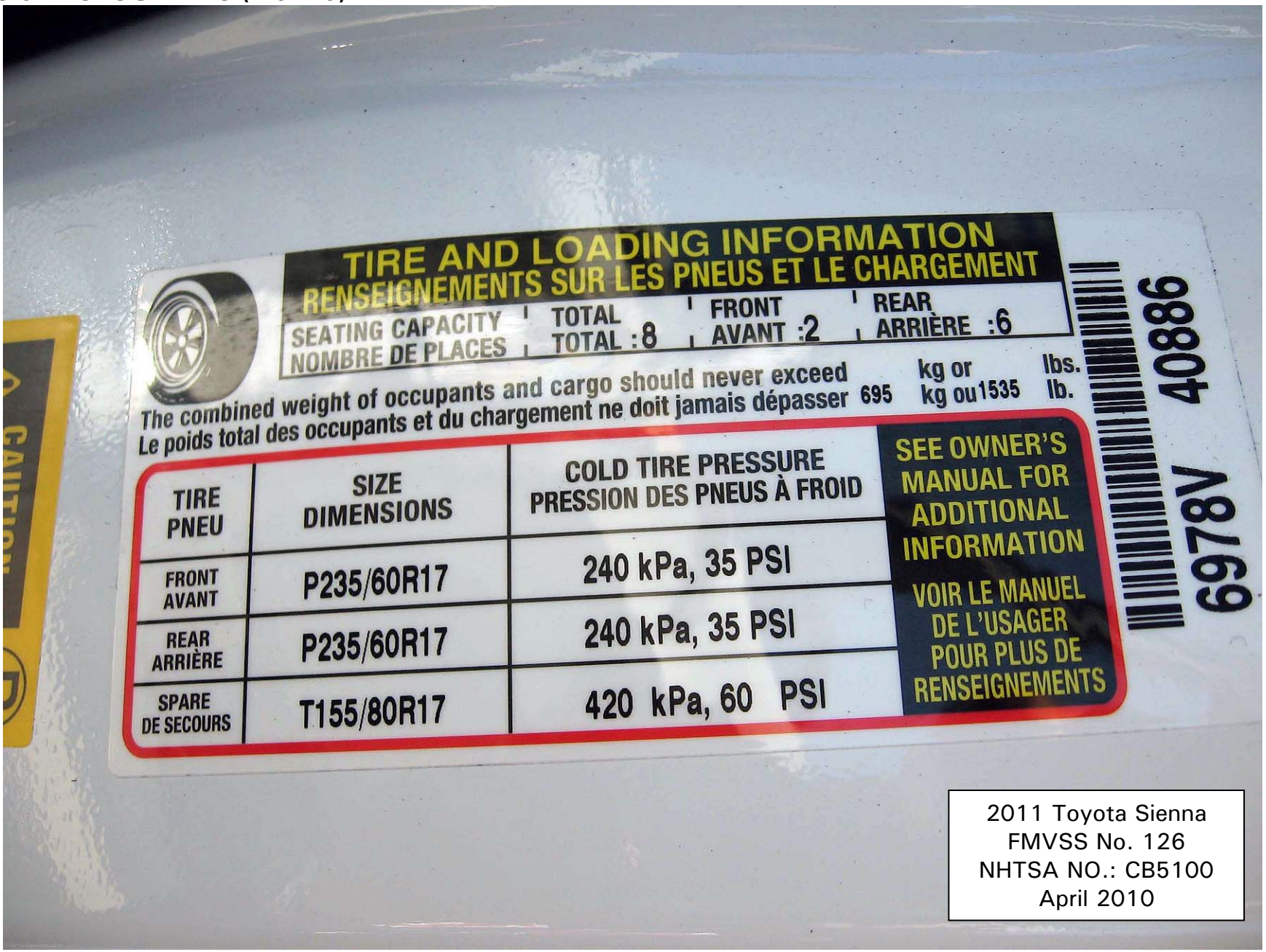


Figure 5.4. Vehicle Placard

5.0 PHOTOGRAPHS (5 of 16)

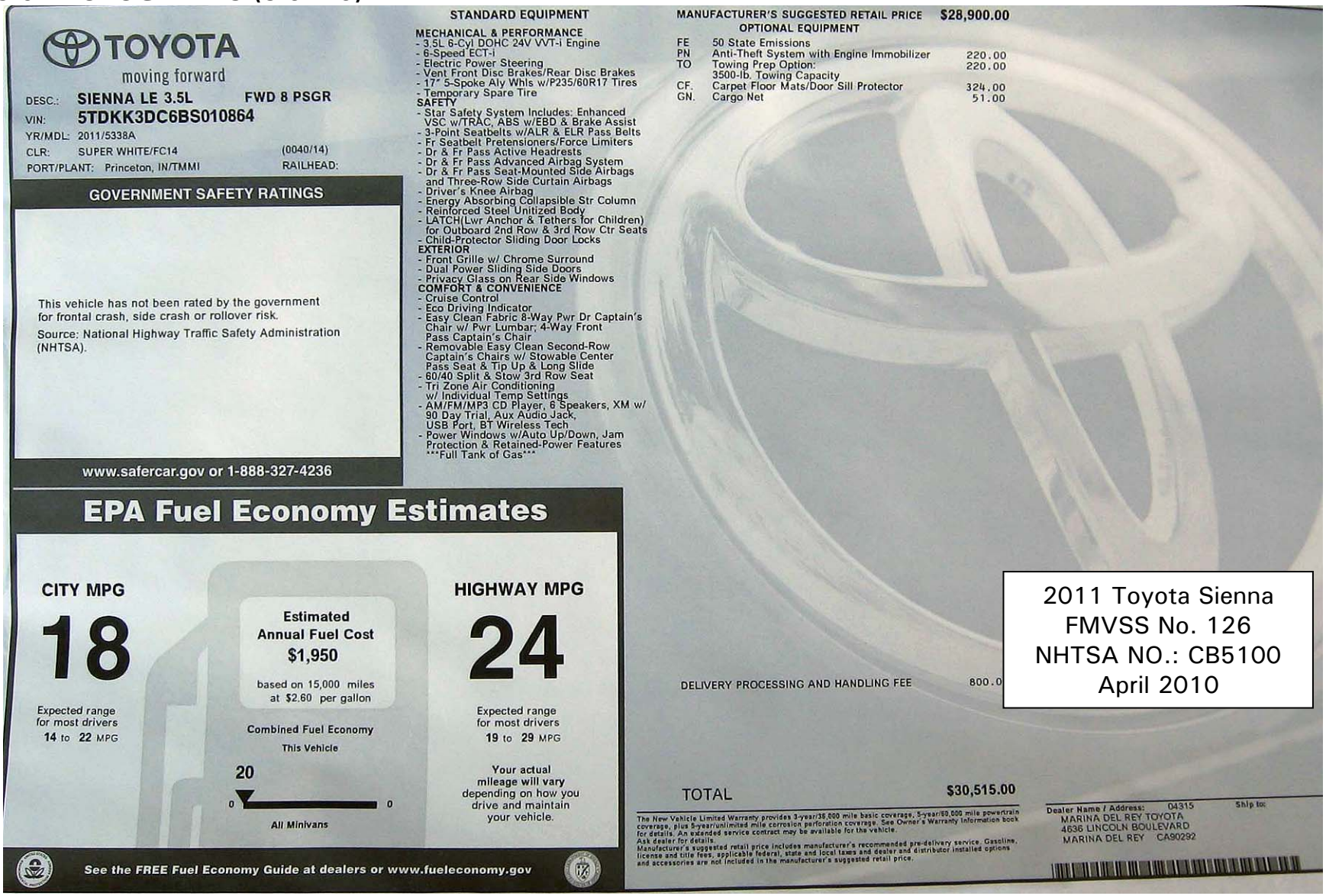


Figure 5.5. Window Sticker (Monroney Label)

Figure 5.6. Telltale for ESC Malfunction

5.0 PHOTOGRAPHS (7 of 16)

Figure 5.7. ESC Malfunction Warning on Information Center

5.0 PHOTOGRAPHS (8 of 16)

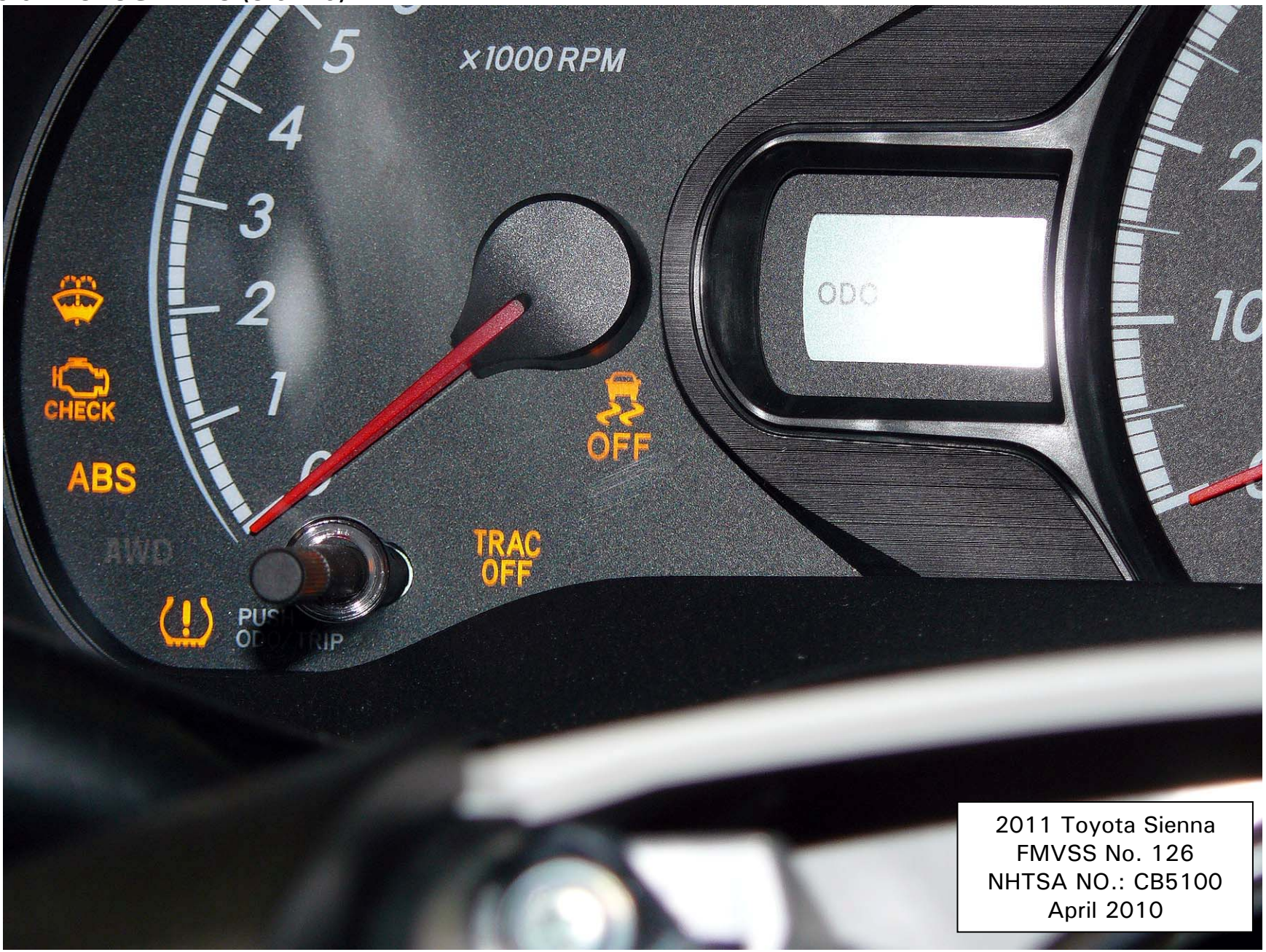


Figure 5.8. Telltale for ESC Off

5.0 PHOTOGRAPHS (9 of 16)

Figure 5.9. ESC Off Control Switch

Figure 5.10. Front View of Vehicle As-Tested

5.0 PHOTOGRAPHS (11 of 16)

Figure 5.11. Rear View of Vehicle As-Tested

Figure 5.12. Ultrasonic Height Sensor Mounted on Left Side of Vehicle for Determining Body Roll Angle

5.0 PHOTOGRAPHS (13 of 16)

Figure 5.13. Rear Outrigger, Mount and Speed Sensor

5.0 PHOTOGRAPHS (14 of 16)

Figure 5.14. Steering Controller and Data Acquisition Computer

5.0 PHOTOGRAPHS (15 of 16)

Figure 5.15. Inertial Measurement Unit Mounted in Vehicle

5.0 PHOTOGRAPHS (16 of 16)

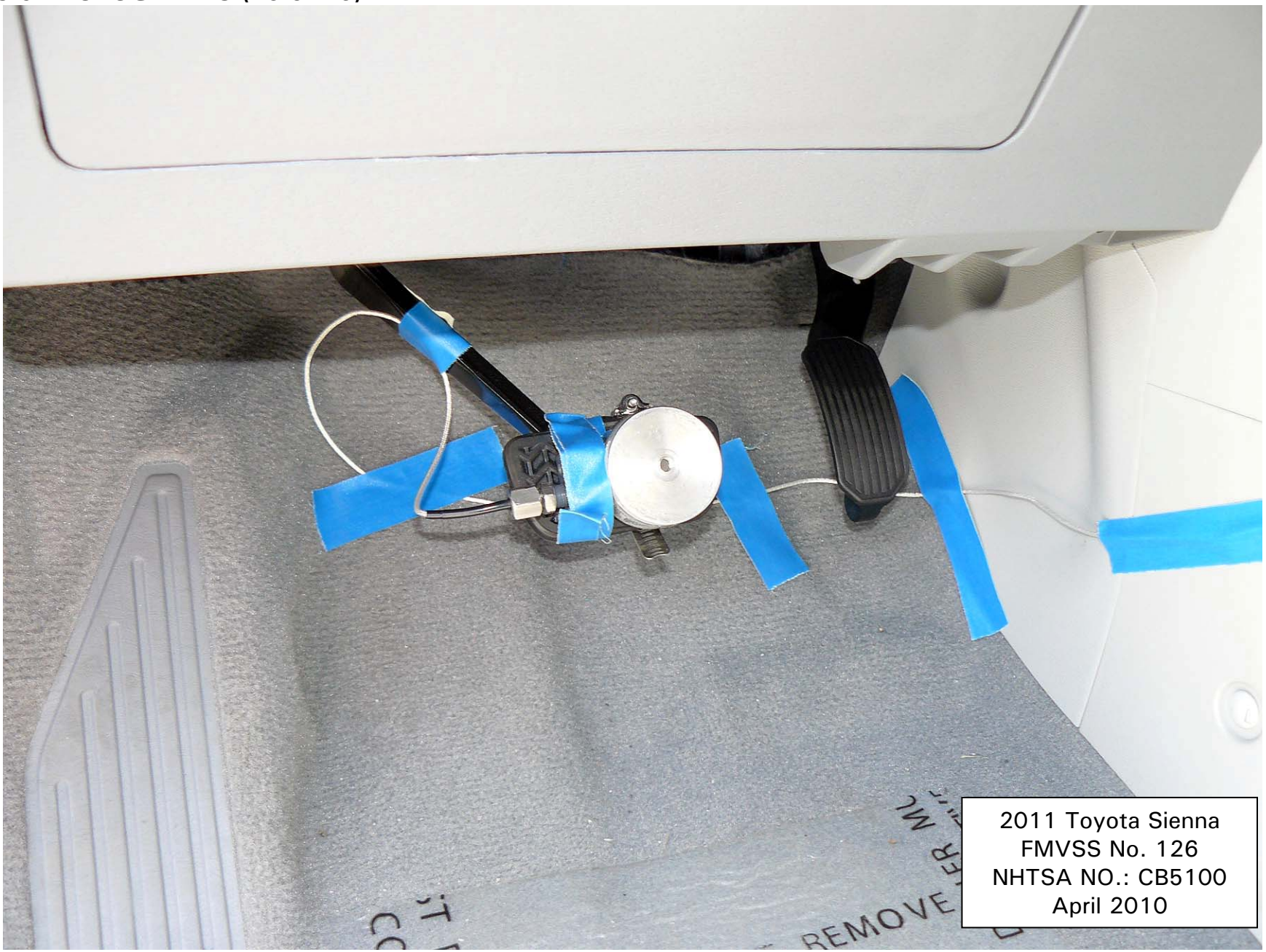


Figure 5.16. Brake Pedal Load Cell

6.0 DATA PLOTS (1 of 4)

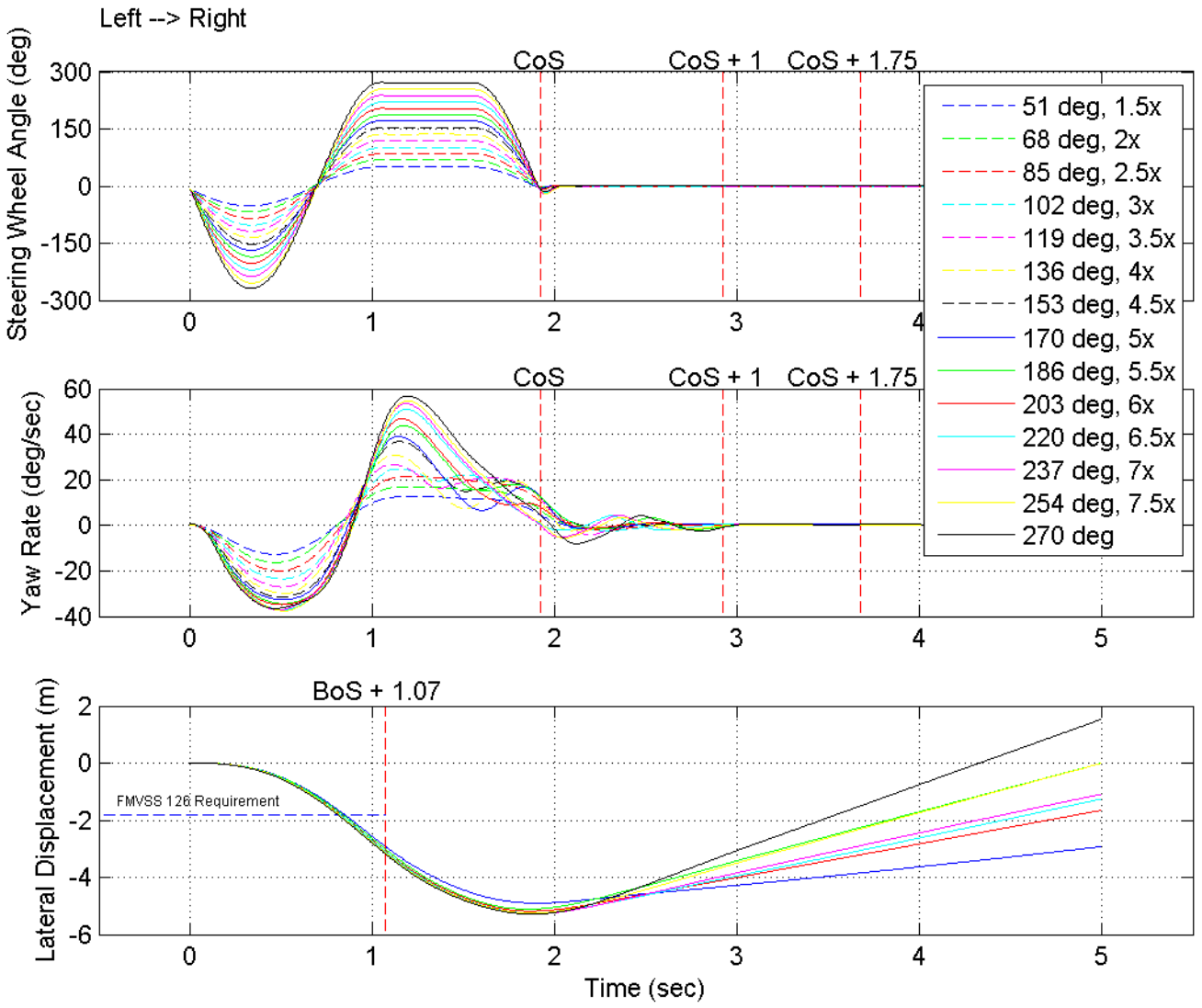


Figure 6.1. Steering Wheel Angle, Yaw Rate and Lateral Displacement for L-R Series

6.0 DATA PLOTS (2 of 4)

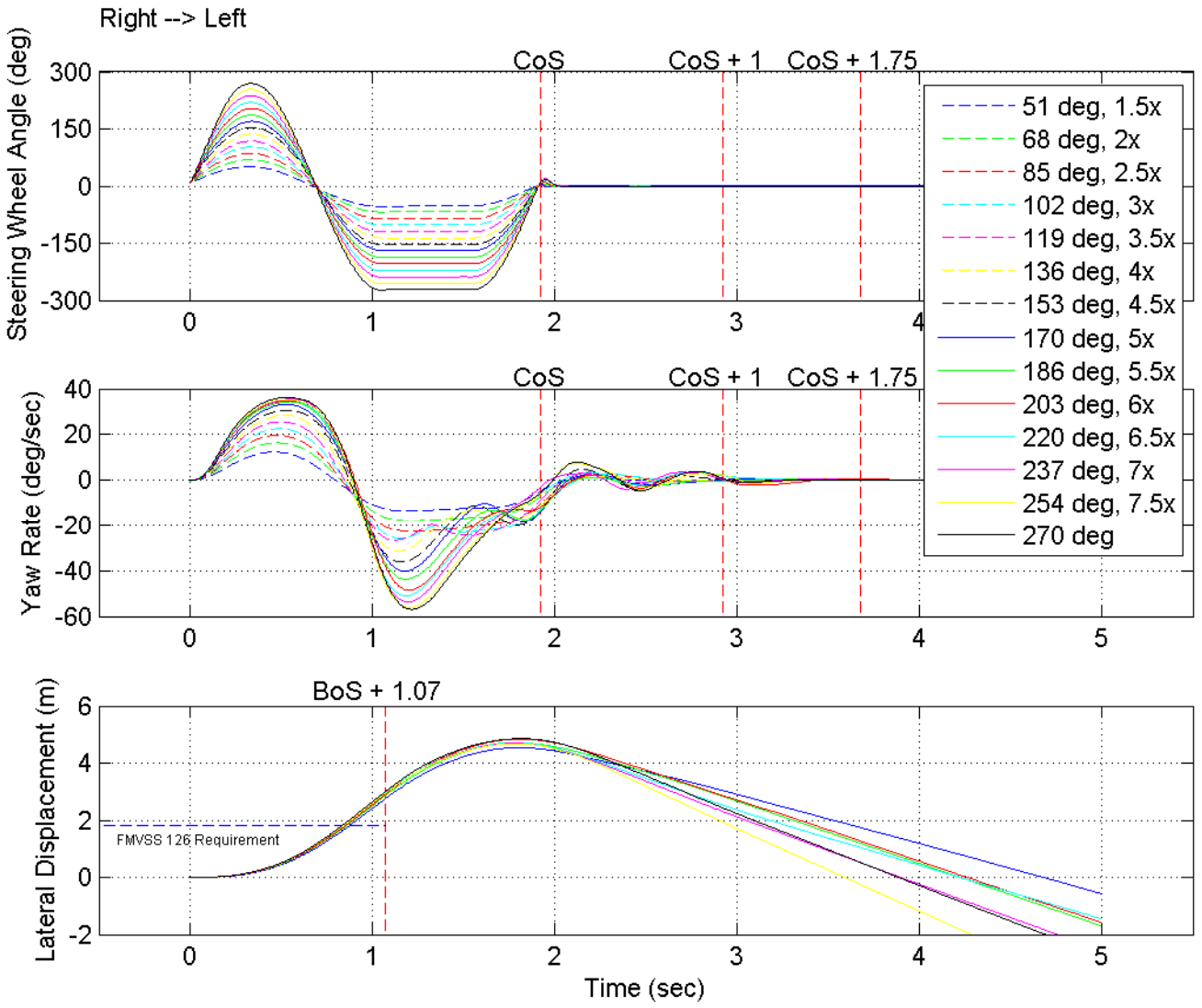


Figure 6.2. Steering Wheel Angle, Yaw Rate and Lateral Displacement for R-L Series

6.0 DATA PLOTS (3 of 4)

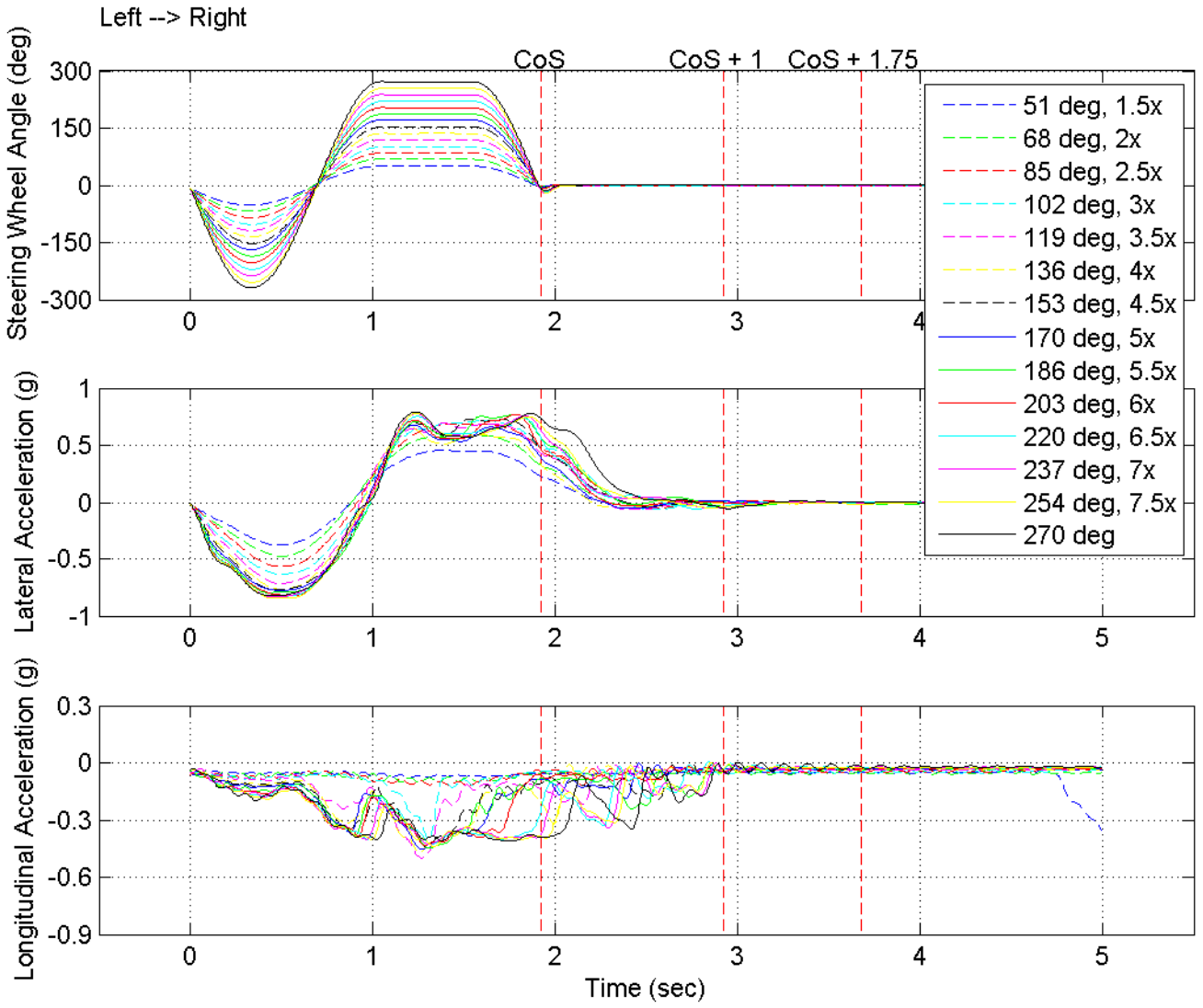


Figure 6.3. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for L-R Series

6.0 DATA PLOTS (4 of 4)

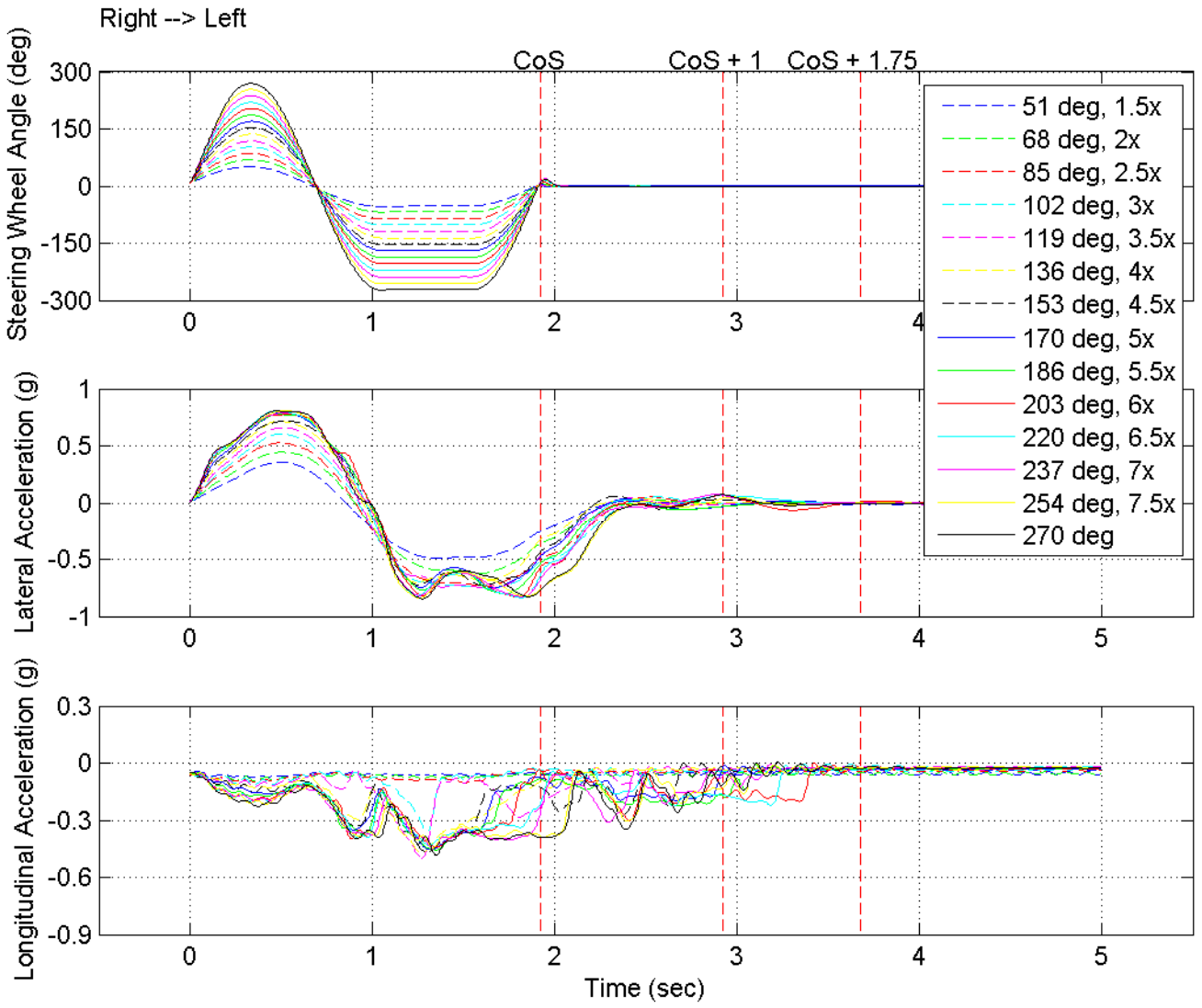


Figure 6.4. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for R-L Series

7.0 OTHER DOCUMENTATION

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

7.1 OWNER'S MANUAL PAGES

*1, 2 Slip indicator (→P. 300, 305)

*1 VSC OFF indicator (→P. 301)

*1 "TRAC OFF" indicator (→P. 301)

Shift position indicators (→P. 223)

*1 Eco Driving Indicator Light (→P. 249) (if equipped)

*1, 3 "PCS" warning (→P. 307) (if equipped)

*1: These lights turn on when the "ENGINE START STOP" switch is turned to IGNITION ON mode (vehicles with a smart key system) or the engine switch is turned to the "ON" position (vehicles without a smart key system) to indicate that a system check is being performed. They will turn off after the engine is started, or after a few seconds. There may be a malfunction in a system if a light does not come on, or if the lights do not turn off. Have the vehicle inspected by your Toyota dealer.

*2: The light flashes to indicate that the system is operating.

*3: The light flashes faster than usual to indicate that the system is operating.

7.1 OWNER'S MANUAL PAGES

Driving assist systems

To help enhance driving safety and performance, the following systems operate automatically in response to various driving situations. Be aware, however, that these systems are supplementary and should not be relied upon too heavily when operating the vehicle.

ABS (Anti-lock Brake System)

Helps to prevent wheel lock when the brakes are applied suddenly, or if the brakes are applied while driving on a slippery road surface

Brake assist

Generates an increased level of braking force after the brake pedal is depressed, when the system detects a panic stop situation

VSC (Vehicle Stability Control)

Helps the driver to control skidding when swerving suddenly or turning on slippery road surfaces

Enhanced VSC (Enhanced Vehicle Stability Control)

Provides cooperative control of the ABS, TRAC, VSC and EPS.
Helps to maintain directional stability when swerving on slippery road surfaces by controlling steering performance.

TRAC (Traction Control)

Helps to maintain drive power and prevent the drive wheels from spinning when starting the vehicle or accelerating on slippery roads

Hill-start assist control (if equipped)

→P. 305

EPS (Electric Power Steering)

Employs an electric motor to reduce the amount of effort needed to turn the steering wheel

7.1 OWNER'S MANUAL PAGES

Active Torque Control 4WD (AWD models only)

Automatically switches from front-wheel drive to AWD (All-Wheel Drive) according to driving conditions, helping to ensure reliable handling and stability. Examples of conditions where the system will switch to AWD are when cornering, going uphill, starting off or accelerating, and when the road surface is slippery due to snow or rain etc.

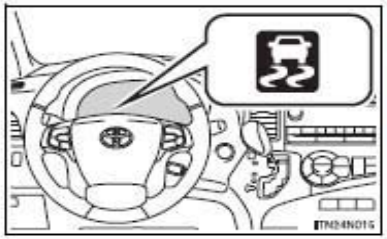
VDIM (Vehicle Dynamics Integrated Management) (if equipped)

Provides integrated control of the ABS, brake assist, TRAC, VSC, hill-start assist control, and EPS systems
Helps to maintain vehicle stability when swerving on slippery road surfaces by controlling the brakes and engine output

PCS (Pre-Collision System) (if equipped)

→P. 307

When the Enhanced VSC/TRAC systems are operating



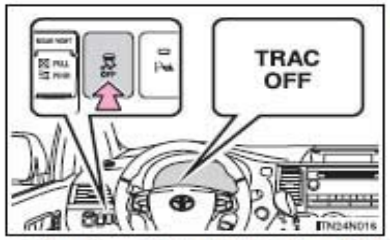
If the vehicle is in danger of slipping or if any of the drive wheels spins, the slip indicator light flashes to indicate that the Enhanced VSC/TRAC systems are operating.

7.1 OWNER'S MANUAL PAGES

Disabling TRAC and VSC system

If the vehicle gets stuck in fresh snow or mud, TRAC and VSC may reduce power from the engine to the wheels. You may need to turn the system off to enable you to rock the vehicle in order to free it.

Turning off the TRAC system only

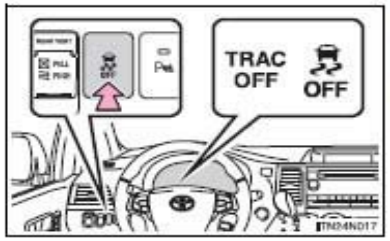


To turn the TRAC system off, quickly press and release the button.

The TRAC OFF indicator light will come on.

Push the button again to turn the system back on.

Turning off both TRAC and VSC systems



To turn the TRAC and VSC systems off, press and hold the button for more than 3 seconds while the vehicle is stopped.

The TRAC OFF indicator light and VSC OFF indicator light will come on.

Press the button again to turn the systems back on.

7.1 OWNER'S MANUAL PAGES

Sounds and vibrations caused by ABS, brake assist, Enhanced VSC and TRAC

- A sound may be heard from the engine compartment when the engine is started or just after the vehicle begins to move. This sound does not indicate that a malfunction has occurred in any of these systems.
- Any of the following conditions may occur when the above systems are operating. None of these indicates that a malfunction has occurred.
  - Vibrations may be felt through the vehicle body and steering.
  - A motor sound may be heard after the vehicle comes to a stop.
  - The brake pedal may pulsate slightly after ABS is activated.
  - The brake pedal may move down slightly after ABS is activated.

EPS operation sound

When the steering wheel is operated, a motor sound (whirring sound) may be heard. This does not indicate a malfunction.

Reactivation of the TRAC and VSC systems after turning off the engine

Turning off the engine after turning off the TRAC and VSC systems will automatically reactivate them.

Reactivation of the TRAC system linked to vehicle speed

When only the TRAC system is turned off, the TRAC system will turn on when vehicle speed increases. However, when both TRAC and VSC systems are turned off, the systems will not turn on even when vehicle speed increases.

7.1 OWNER'S MANUAL PAGES

Reduced effectiveness of the EPS system

The effectiveness of the EPS system is reduced to prevent the system from overheating when there is frequent steering input over an extended period of time. The steering wheel may feel heavy as a result. Should this occur, refrain from excessive steering input or stop the vehicle and turn the engine off. The EPS system should return to normal within 10 minutes.

CAUTION

■ ABS does not operate effectively when

- Tires with inadequate gripping ability are used (such as excessively worn tires on a snow covered road).
- The vehicle hydroplanes while driving at high speed on wet or slick roads.

■ Stopping distance when ABS is operating will exceed that of normal conditions

The ABS is not designed to shorten the vehicle's stopping distance. Always maintain a safe distance from the vehicle in front of you in the following situations.

- When driving on dirt, gravel or snow-covered roads
- When driving with tire chains
- When driving over bumps in the road
- When driving over roads with potholes or roads with uneven surfaces

■ TRAC may not operate effectively when

Directional control and power may not be achievable while driving on slippery road surfaces, even if the TRAC system is operating.
Do not drive the vehicle in conditions where stability and power may be lost.

7.1 OWNER'S MANUAL PAGES

CAUTION

When Enhanced VSC is activated

The slip indicator light flashes. Always drive carefully. Reckless driving may cause an accident. Exercise particular care when the indicator light flashes.

When TRAC and VSC systems are turned off

Be especially careful and drive at a speed appropriate to the road conditions. As these are the systems to ensure vehicle stability and driving force, do not turn the TRAC and VSC systems off unless necessary.

Replacing tires

Make sure that all tires are of the specified size, brand, tread pattern and total load capacity. In addition, make sure that the tires are inflated to the recommended tire pressure level.

The ABS and Enhanced VSC systems will not function correctly if different tires are installed on the vehicle.

Contact your Toyota dealer for further information when replacing tires or wheels.

Handling of tires and suspension

Using tires with any kind of problem or modifying the suspension will affect the driving assist systems, and may cause the system to malfunction.

Active Torque Control 4WD system

- The AWD system of this vehicle is intended to ensure driving stability on normal roads. It is not designed for use in demanding situations such as rally driving.
- Take care when driving on slippery road surfaces.

7.2 VEHICLE ARRIVAL CONDITION REPORT

CONTRACT NO.: DTNH22-08-D-00098
DATE: *4/1/2010*

From: *Automotive Allies*

To: Dynamic Research, Inc

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

Vehicle VIN: *5TDKK3DC6BS010864* NHTSA NO.: *CB5100*
Model Year: *2011* Odometer Reading: *25* Miles
Make *Toyota* Body Style: *MPV*
Model: *Sienna* Body Color: *White*
Manufacture Date: *2/10* Dealer: *Automotive Allies*
GVWR (kg/lb) *2715/5995* 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: *4/1/2010*

APPROVED BY: *B Kebschull* DATE APPROVED: *4/2/2010*

7.3 VEHICLE COMPLETION CONDITION REPORT

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

Vehicle VIN: *5TDKK3DC6BS010864* NHTSA NO.: *CB5100*
Model Year: *2011* Odometer Reading: *70* Miles
Make: *Toyota* Body Style: *MPV*
Model: *Sienna* Body Color: *White*
Manufacture Date: *2/10* Dealer: *Automotive Allies*
GVWR (kg/lb) *2715 (5995)* 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:

RECORDED BY: *J Lenkeit* DATE RECORDED: *5/5/10*

APPROVED BY: *Brian Kebschull* DATE APPROVED: *5/5/10*

7.4 SINE WITH DWELL TEST RESULTS

2011 Toyota Sienna MPV
NHTSA No.: CB5100
Date of Test : *4/23/2010*
Date Created:

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)
23	710	49.64	3.542	1091	5.446	847	4.227	-0.11	-0.01	1291	-0.18	-0.02	1441	13.05	953	-3.77	0.29	51.08	775	50.91
24	709	49.52	3.536	1090	5.445	847	4.226	0.31	0.05	1290	-0.19	-0.03	1440	17.18	960	-4.92	0.35	67.89	775	67.95
25	708	49.99	3.531	1090	5.444	846	4.225	0.64	0.14	1290	0.27	0.06	1440	21.47	951	-6.05	0.38	84.74	775	84.86
26	707	49.58	3.529	1090	5.445	847	4.226	0.71	0.18	1290	0.11	0.03	1440	24.9	936	-7.01	0.39	101.58	775	101.63
27	707	49.93	3.527	1090	5.444	846	4.225	-0.45	-0.12	1290	-0.31	-0.08	1440	26.82	930	-7.93	0.42	118.5	775	118.81
28	706	49.9	3.525	1090	5.444	846	4.225	-0.73	-0.23	1290	-0.56	-0.17	1440	31.01	933	-8.55	0.42	135.56	775	136
29	706	49.86	3.525	1090	5.444	847	4.226	-0.3	-0.11	1290	-0.13	-0.05	1440	37.05	937	-8.99	0.4	152.69	775	152.94
30	706	49.92	3.524	1090	5.443	847	4.226	0.46	0.18	1290	0.29	0.11	1440	39.05	937	-9.36	0.37	169.72	775	169.96
31	706	49.88	3.525	1090	5.443	847	4.226	-2	-0.88	1290	-0.44	-0.19	1440	43.85	942	-9.74	0.31	185.92	775	185.96
32	706	50.17	3.524	1090	5.441	846	4.225	-0.43	-0.2	1290	-0.09	-0.04	1440	46.92	941	-9.88	0.35	203.11	775	202.9
33	706	49.72	3.524	1090	5.441	846	4.225	0.67	0.34	1290	-0.08	-0.04	1440	50.97	945	-10.03	0.29	220.42	775	219.99
34	706	50.25	3.525	1089	5.44	847	4.226	-1.11	-0.59	1289	-0.38	-0.2	1439	53.28	945	-10.14	0.31	237.51	775	236.9
35	707	50.35	3.526	1090	5.442	847	4.226	-0.7	-0.38	1290	-0.42	-0.23	1440	54.68	946	-10.18	0.32	254.4	775	253.87
37	706	50.15	3.525	1090	5.444	847	4.227	-2.75	-1.55	1290	-0.13	-0.07	1440	56.54	947	-10.21	0.29	270.36	775	269.7

7.4 SINE WITH DWELL TEST RESULTS

2011 Toyota Sienna MPV

NHTSA No.: CB5100

Date of Test : *4/23/2010*

Date Created : *4/23/2010*

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	709	49.75	3.54	1090	5.444	847	4.227	0.33	-0.04	1290	-0.74	0.1	1440	-13.48	950	3.69	-0.29	51.76	775	51.45
41	708	49.94	3.535	1090	5.444	847	4.227	-0.04	0.01	1290	-0.74	0.13	1440	-17.93	951	4.79	-0.34	68.61	775	68.36
42	708	50.01	3.531	1090	5.444	847	4.226	1.04	-0.24	1290	0.24	-0.05	1440	-22.74	953	5.75	-0.38	85.5	775	85.37
43	707	49.96	3.527	1090	5.443	847	4.226	0.4	-0.1	1290	-0.46	0.12	1440	-25.61	937	6.52	-0.39	102.33	775	102.17
44	706	50.07	3.525	1090	5.443	847	4.226	-0.42	0.11	1290	0.14	-0.04	1440	-26.5	932	7.35	-0.38	119.27	775	119.19
45	706	50.08	3.524	1090	5.444	847	4.226	-0.37	0.12	1290	-0.57	0.18	1440	-31.43	935	8.07	-0.39	136.58	775	136.35
46	706	49.97	3.523	1090	5.443	847	4.226	-0.58	0.21	1290	-0.24	0.09	1440	-36.29	938	8.44	-0.36	153.69	775	153.28
47	706	49.96	3.523	1090	5.442	847	4.226	0.7	-0.28	1290	0.06	-0.02	1440	-40.52	942	8.9	-0.29	169.96	775	169.18
48	706	50.01	3.524	1090	5.442	847	4.227	1.57	-0.69	1290	0	0	1440	-43.94	944	9.18	-0.27	187.05	775	186.21
49	706	49.93	3.524	1089	5.44	847	4.226	-1.77	0.86	1289	-0.98	0.48	1439	-48.69	947	9.42	-0.25	204.13	775	203.18
50	706	49.71	3.524	1089	5.44	847	4.226	-4.39	2.24	1289	0.01	-0.01	1439	-50.96	945	9.5	-0.35	221.31	775	220.26
51	706	49.76	3.523	1090	5.441	846	4.225	-1.02	0.55	1290	-0.16	0.09	1440	-53.67	947	9.46	-0.34	238.24	775	237.24
52	706	50.25	3.524	1090	5.443	846	4.225	-4.53	2.54	1290	-0.34	0.19	1440	-55.97	949	9.47	-0.32	255.23	775	254.12
53	706	50.24	3.524	1090	5.445	847	4.227	-2.22	1.26	1290	-0.34	0.19	1440	-56.87	951	9.64	-0.25	270.99	775	270.12

7.5 SLOWLY INCREASING STEER TEST RESULTS

2011 Toyota Sienna MPV
NHTSA No.: *CB5100*
Date of Test: *4/23/2010*
Date Created*: 4/23/2010*

File	EventPt	DOS	MES (mph)	Mean SPD (mph)	AYcount_3	THETAENCF_3 (deg)	AYCG_CD2_3 (g)	r_squared	ZeroBegin	ZeroEnd
11	700	1	50.5065	50.5946	1207	-33.8	-0.2984	0.9985	500	700
12	681	1	50.7199	50.6104	1203	-33.6	-0.3042	0.9965	481	681
13	700	1	50.8230	50.6983	1202	-33.4	-0.3015	0.9992	500	700
14	719	0	50.7792	50.7430	1205	33.8	0.3019	0.9981	519	719
15	700	0	50.7498	50.7407	1212	34.2	0.2977	0.9954	500	700
16	700	0	50.5741	50.6940	1215	34.5	0.3051	0.9986	500	700
				Averages		33.9	0.3014			

Scalars	Steering Angles (deg)
1.5	51
2.0	68
2.5	85
3.0	102
3.5	119
4.0	136
4.5	153
5.0	169

Scalars	Steering Angles (deg)
5.5	186
6.0	203
6.5	220
7.0	237
7.5	254
-	270

7.6 INERTIAL SENSING SYSTEM LOCATION COORDINATES

Vehicle:	**2011 Toyota Sienna MPV**	NHTSA No.:	CB5100
Wheelbase:	119.25 Inches	Faro Arm S/N:	U08-05-08-06636
Measurement date:	4/7/2010	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	2.396	9.801	0.000
M_Point_48_Ref	0.000	0.000	-
M_CIRCLE001_I_Left_Rear_Wheel_Axle	-37.500	10.273	-13.290
M_Point_IMU_side	21.426	46.140	-20.316
M_Point_ROOF	-	-	-68.313
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	21.426	47.665	-20.316

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	**60.324**	**-0.335**	**20.316**

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).