# 126-DRI-09-003

## SAFETY COMPLIANCE TESTING FOR FMVSS 126
## Electronic Stability Control Systems

**Nissan**
**2009 Pathfinder**
**NHTSA No. C95210**


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


**November 19, 2009**

**FINAL REPORT**


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


**U. S. DEPARTMENT OF TRANSPORTATION**
**National Highway Traffic Safety Administration**
**Enforcement**
**Office of Vehicle Safety Compliance**
**1200 New Jersey Avenue, SE**
**West Building, 4th Floor (NVS-221)**
**Washington, DC 20590**

Prepared for the Department of Transportation, National Highway Traffic Safety Administration, under Contract No. DTNH22-08-D-00098.



Prepared By: Brian K. Kebschull

Approved By: [signature]

Approval Date: November 19, 2009

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted By: [signature]

Acceptance Date: 11/23/09

| | | | |
|---|---|---|---|
| 1. Report No.<br><br>126-DRI-09-003 | 2. Government Accession No. | 3. Recipient's Catalog No. | |
| 4. Title and Subtitle<br><br>Final Report of FMVSS 126 Compliance Testing of 2009 Nissan Pathfinder multipurpose passenger vehicle, NHTSA No. C95210 | | 5. Report Date<br><br>November 19, 2009<br><br>6. Performing Organization Code<br><br>DRI | |
| 7. Author(s)<br>John F. Lenkeit, Technical Director<br>Brian Kebschull, Principal Engineer | | 8. Performing Organization Report No.<br><br>DRI-TM-09-68 | |
| 9. Performing Organization Name and Address<br><br>Dynamic Research, Inc.<br>355 Van Ness Ave, STE 200<br>Torrance, CA 90501 | | 10. Work Unit No.<br><br>11. Contract or Grant No.<br><br>DTNH22-08-D-00098 | |
| 12. Sponsoring Agency Name and Address<br>U.S. Department of Transportation<br>National Highway Traffic Safety Administration Enforcement<br>Office of Vehicle Safety Compliance<br>1200 New Jersey Avenue, SE,<br>West Building, 4th Floor (NVS-221)<br>Washington, D.C. 20590 | | 13. Type of Report and Period Covered<br><br>Final Test Report<br>August 26 to November 19, 2009<br><br>14. Sponsoring Agency Code<br><br>NVS-220 | |
| 15. Supplementary Notes | | | |
| 16. Abstract<br><br>A test was conducted on a 2009 Nissan Pathfinder, NHTSA No. C95210, 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.<br>Test failures identified were as follows: None | | | |
| 17. Key Words<br><br>Compliance Testing<br>Safety Engineering<br>FMVSS 126 | | 18. Distribution Statement<br><br>Copies of this report are available from:<br><br>NHTSA Technical Information Services (TIS)<br>(NPO 411)<br>1200 New Jersey Avenue, SE<br>Washington, D.C. 20590<br>Email: tis@nhtsa.dot.gov<br>FAX: (202) 493-2833 | |
| 19. Security Classif. (of this report)<br>Unclassified | 20. Security Classif. (of this page)<br><br>Unclassified | 21. No. of Pages<br><br>71 | 22. |

## TABLE OF CONTENTS

## 1.0 PURPOSE OF COMPLIANCE TEST

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

## 2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS

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

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

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

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

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

## 2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS (CONTINUED)

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

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

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

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

## 2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS (CONTD)

### Data Summary Sheet (Page 1 of 2)

---

Vehicle: *2009 Nissan Pathfinder*

NHTSA No *C95210* VIN: *5N1AR18U99C618299*

Vehicle Type: *MPV* Manufacture Date: *7/09*

Laboratory: *Dynamic Research, Inc.*

---

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

## 2.0 TEST PROCEDURE AND DISCUSSION OF RESULTS (CONTD)

### Data Summary Sheet (Page 2 of 2)

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

## 3.0 TEST DATA

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

---

Vehicle: *2009 Nissan Pathfinder :MPV*

NHTSA No *C95210* Data sheet completion date: *8/24/2009*

VIN: *5N1AR18U99C618299* Manufacture Date: *7/09*

GVWR (kg): *2722* Front GAWR (kg): *1279* Rear GVWR (kg): *1588*

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

Odometer reading at time of inspection: *17 (27) miles (km)*

---

**DESIGNATED TIRE SIZE(S) FROM VEHICLE LABELING:**

Front Axle: *P245/75 R16* Rear Axle: *P245/75 R16*

---

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

| | Front Axle | Rear Axle |
|---|---|---|
| Tire Manufacturer: | *General* | *General* |
| Tire Model: | *Grabber AW* | *Grabber AW* |
| Tire Size: | *P245/75 R16* | *P245/75 R16* |

**TIN** Left Front: *A370 3PR 1809* Right Front: *A370 3PR 1809*

Left Rear: *A370 3PR 1809* Right Rear: *A370 3PR 1809*

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

---

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

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

☐ All Wheel Drive (AWD)

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

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

☐ Four Wheel Drive Low Gear (4WD Low)

☐ Other Describe

## 3.0 TEST DATA (CONTD)

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

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

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

Drive Configuration: *2WD*
Mode: *Default*
Drive Configuration:
Mode:
Drive Configuration:
Mode:

**VEHICLE STABILITY SYSTEMS (Check applicable technologies):**

☑ ESC ☑ Traction Control ☑ Roll Stability Control

☐ Active Suspension ☑ Electronic Throttle Control ☐ Active Steering

☑ ABS

List other systems:

REMARKS:

RECORDED BY: *J Brubacher* DATE RECORDED: *8/26/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/1/2009*

## 3.0 TEST DATA (CONTD)

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

---

Vehicle: *2009 Nissan Pathfinder*

NHTSA No *C95210* Data Sheet Completion Date: *9/8/2009*

---

**ESC SYSTEM IDENTIFICATION**

Manufacturer/Model *Continental-Teves ABS / TCS / VDC Unit MK25E*

ESC SYSTEM HARDWARE (Check applicable hardware)

☑ Electronic Control Unit ☑ Hydraulic Control Unit

☑ Wheel Speed Sensors ☑ Steering Angle Sensor

☑ Yaw Rate Sensor ☑ Lateral Acceleration Sensor

List other Components: *Engine management interface*

---

**ESC OPERATIONAL CHARACTERISTICS**

System is capable of generating brake torque at each wheel — *_X_ Yes (Pass) ____ No (Fail)*

List and describe Components: *Hydraulic Control unit with Integrated Electronic Control unit can command individual brake torques to hydraulic control unit and individual brakes*

System is capable of determining yaw rate — *_X_ Yes (Pass) ____ No (Fail)*

List and describe Components: *Yaw rate sensor*

System is capable of monitoring driver steering input — *_X_ Yes (Pass) ____ No (Fail)*

List and describe Components: *Steering wheel angle sensor*

System is capable of estimating side slip or side slip derivative — *_X_ Yes (Pass) ____ No (Fail)*

List and describe Components: *Yaw Rate & Lateral Acceleration sensor, Steering Angle sensor, Logic*

## 3.0 TEST DATA (CONTD)

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

---

**ESC OPERATIONAL CHARACTERISTICS (continued)**

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

Method used to modify torque: *Engine management interface*

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)*

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

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

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

REMARKS:

---

RECORDED BY: *J Brubacher* DATE RECORDED: *9/8/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/1/2009*

## 3.0 TEST DATA (CONTD)

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

Make: *2009 Nissan Pathfinder*

NHTSA No *C95210* Data sheet completion date: *9/8/2009*

**ESC Malfunction Telltale**

Vehicle is equipped with malfunction telltale? *Yes*

Telltale Location *Instrument panel near fuel gauge (Figure 5.6)*

Telltale Color *Yellow*

Telltale symbol or abbreviation used

or **ESC**

☐ Vehicle uses this symbol

☐ Vehicles uses this abbreviation

☑ Neither symbol or abbreviation is used

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

*Refer to Figure 5.6. The system identifies an ESC malfunction by illuminating both the "VDC OFF" and "SLIP" telltales.*

Is telltale part of a common space? *No*

Is telltale also used to indicate activation of the ESC system? *The "SLIP" iluminates to indicate activation at the ESC system (see Figure 5.6).*

If yes explain telltale operation during ESC activation:

## 3.0 TEST DATA (CONTD)

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

**"ESC OFF" Telltale (if provided)**

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

Is "ESC Off" telltale combined with "ESC Malfunction" telltale utilizing a two part telltale? *No. The same telltale indicates both ESC Off and ESC malfunction. It is not a two part telltale.*

Telltale Location *Instrument panel near fuel gauge (Figure 5.6)*

Telltale Color *Yellow*

Telltale symbol or abbreviation used


or **ESC OFF**

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

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

Is telltale part of a common space? *No*

**DATA INDICATES COMPLIANCE:** ***Pass***

(Vehicle is compliant if equipped with a malfunction telltale)

Remarks:

---

RECORDED BY: *J Brubacher* DATE RECORDED: *9/8/2009*
APPROVED BY: *B Kebschull* DATE APPROVED: *10/1/2009*

## 3.0 TEST DATA (CONTD)

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

Make: *2009 Nissan Pathfinder*

NHTSA No *C95210* Data sheet completion date: *9/8/2009*

**"ESC OFF" Controls Identification and Operational Check:**

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

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

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

Identify each control location, labeling and selectable modes.

First Control: Location *Center console (refer to Figure 5.7)*
Labeling *VDC OFF*
Modes *VDC ON/OFF*

Second Control: Location _____
Labeling _____
Modes _____

Identify standard or default drive configuration *2WD*

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

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

X Yes ___ No (Fail)

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

X Yes ___ No (Fail)

If no, describe how the off control functions

## 3.0 TEST DATA (CONTD)

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

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

| Control Mode | "ESC Off" telltale illuminates upon activation of control? (Yes/No) | "ESC Off" telltale extinguishes upon cycling ignition? (Yes/No) |
|---|---|---|
| *No multifunction controls provided* | | |
| | | |
| | | |

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

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

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

_____ Yes __X__No

Ancillary Control: System None

Control Description _____

Labeling _____

Ancillary Control: System _____

Control Description _____

Labeling _____

Ancillary Control: System _____

Control Description _____

Labeling _____

## 3.0 TEST DATA (CONTD)

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

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

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

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

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

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

__X__ Yes _____ No (Fail)

**DATA INDICATES COMPLIANCE:** ***Pass***

Remarks:

---

RECORDED BY: *B Kebschull* DATE RECORDED: *9/8/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/1/2009*

## 3.0 TEST DATA (CONTD)

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

---

Vehicle: *2009 Nissan Pathfinder*

NHTSA No *C95210* Data sheet completion date: *9/15/2009*

---

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

Peak Friction Coefficient (at least 0.9) *0.95*

Test track data meets requirements: *Yes*

If no, explain:

---

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

(specify) *Oil, ATF*

---

**Tire Pressures:** Required; Front Axle *240* KPA Rear Axle *240* KPA

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

LR *240* KPA RR *240* KPA

---

**Vehicle Dimensions:** Front Track Width *158* cm Wheelbase *284.8* cm

Rear Track Width *158* cm

**Vehicle Weight Ratings:** GAWR Front *1279* KG GAWR Rear *1588* KG

**Unloaded Vehicle Weight (UVW):**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Front axle | *992* | KG | Left Front | *499* | KG | Right Front | *493* | KG |
| Rear axle | *997* | KG | Left Rear | *498* | KG | Right Rear | *499* | KG |

Total UVW *1989* KG

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

Calculated baseline weight (UVW + 73kg) *2062* 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 | *1042* KG | Left Front | *524* KG | Right Front | *518* KG |
| Rear axle | *1036* KG | Left Rear | *518* KG | Right Rear | *518* KG |

Total UVW with outriggers *2078* KG

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

| | | | | | |
|---|---|---|---|---|---|
| Front axle | *1119* KG | Left Front | *566* KG | Right Front | *552* KG |
| Rear axle | *1126* KG | Left Rear | *581* KG | Right Rear | *544* KG |

Vehicle Weight *2244* KG

**Ballast Required** =

| [Total UVW with Outriggers (if applicable)] | + *168* KG | - [Loaded Weight w/Driver and Instrumentation)] |
|---|---|---|
| = *2078* KG | + *168* KG | - *2244* KG |

= *2* KG

**Total Loaded Vehicle Weight w/Driver and Instrumentation and Ballast**

| | | | | | |
|---|---|---|---|---|---|
| Front axle | *1119* KG | Left Front | *567* KG | Right Front | *553* KG |
| Rear axle | *1127* KG | Left Rear | *583* KG | Right Rear | *545* KG |

Total UVW *2246* 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 | *56.3* in | *142.9* cm | *71.92* in | *182.7* cm |
| y-distance | *-0.7* in | *-1.8* cm | *-0.53* in | *-1.3* cm |
| z-distance | *26.3* in | *66.7* cm | *25.39* in | *64.5* cm |

| | | | | |
|---|---|---|---|---|
| Roof Height | *69.2* | in | *175.6* | cm |
| Distance between ultrasonic sensors | *86.2* | in | *219.1* | cm |

Remarks:

RECORDED BY: *B Kebschull* DATE RECORDED: *9/8/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/1/2009*

## 3.0 TEST DATA (CONTD)

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

---

Vehicle: *2009 Nissan Pathfinder*

NHTSA No *C95210*

---

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

LR *240* KPA RR *240* KPA

Wind Speed *2.1* m/s (10 m/sec (22 mph) max for passenger cars; 5m/sec (11 mph) max for MPVs and trucks)

Ambient Temperature (7°C (45°F) - 40°C (104°F)) *24* °C

Brake Conditioning Time: *9:35:00 AM* Date: *9/15/2009*

56 km/h (35 mph) Brake Stops

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

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

72 km/h (45 mph) Brake Stops

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

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

Observed deceleration rate range *0.85* g

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

Duration of cool down period (5 minutes min.) *6* Minutes

## 3.0 TEST DATA (CONTD)

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

---

**Tire Conditioning series No. 1** Time: *10:05:00 AM* Date: *9/15/2009*

Measured cold tire pressure LF *260* KPA RF *261* KPA

LR *258* KPA RR *257* KPA

Wind Speed *1.5* 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)) *23*°C

| 30 meter (100 ft) Diameter Circle Maneuver | | | | |
|---|---|---|---|---|
| Test Run | Steering Direction | Target Lateral Acceleration (g) | Observed Lateral (g) | Observed Vehicle Speed (Km/h) |
| 1-3 | Clockwise | 0.5 – 0.6 | *0.5 – 0.6* | *32 - 34* |
| 4-6 | Counterclockwise | 0.5 – 0.6 | *0.5 – 0.6* | *32 - 34* |

| 5-1 Hz Cycle Sinusoidal Steering Maneuver to Determine Steering Wheel Angle for 0.5-0.6 g Lateral Acceleration | | | | | |
|---|---|---|---|---|---|
| Test Run | Data File | Vehicle Speed Km/h(mph) | Steering Wheel Angle (degrees) | Target Peak Lateral Acceleration (g) | Observed Peak Lateral Acceleration (g) |
| 1 | 2 | 56 ± 2 (35 ± 1) | *60* | 0.5 - 0.6 | *0.44* |
| 2 | 3 | 56 ± 2 (35 ± 1) | *80* | 0.5 - 0.6 | *0.55* |
| 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 | *0.55* |
| 4 | 7 | 56 ± 2 (35 ± 1) | *80* (cycles 1-9) | 0.5 - 0.6 | *0.55* |
| | | | *160* (cycle10)* | NA | *0.74* |

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

## 3.0 TEST DATA (CONTD)

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

---

**Tire Conditioning series No. 2** Time: *11:43:00 AM* Date: *9/15/2009*

Measured cold tire pressure LF *259* KPA RF *255* KPA

LR *255* KPA RR *250* KPA

Wind Speed *2.5* 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)) *24*°C

| 30 meter (100 ft) Diameter Circle Maneuver | | | | |
|---|---|---|---|---|
| Test Run | Steering Direction | Target Lateral Acceleration (g) | Observed Lateral (g) | Observed Vehicle Speed (Km/h) |
| 1-3 | Clockwise | 0.5 - 0.6 | *.05 - 0.6* | *32 - 34* |
| 4-6 | Counterclockwise | 0.5 - 0.6 | *.05 - 0.6* | *32 - 34* |

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

| 10-1 Hz Cycle Sinusoidal Steering Maneuver | | | | | |
|---|---|---|---|---|---|
| Test Run | Data File | Vehicle Speed Km/h (mph) | Steering Wheel Angle (degrees) | Target Peak Lateral Acceleration (g) | Observed Peak Lateral Acceleration (g) |
| 1-3 | 16-18 | 56 ± 2 (35 ± 1) | *80* (cycles 1-10) | 0.5 - 0.6 | *0.55* |
| 4 | 19 | 56 ± 2 (35 ± 1) | *80* (cycles 1-9) | 0.5 - 0.6 | *0.55* |
| | | | *160* (cycle10)* | NA | *0.73* |

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

Remarks:

---

RECORDED BY: *B Kebschull* DATE RECORDED: *9/15/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/1/2009*

## 3.0 TEST DATA (CONTD)

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

Vehicle: *2009 Nissan Pathfinder*

NHTSA No *C95210*

Measured tire pressure: LF *259* KPA RF *261* KPA

LR *258* KPA RR *258* KPA

Wind Speed *2.0* 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)) *23*°C

Selected drive configuration *2WD (default)*

Selected Mode: *Normal*

**Preliminary Left Steer Maneuver:**

Lateral Acceleration measured at 30 degrees steering wheel angle

$a_{y,30\text{degrees}}$ = *0.30* g

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

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

$\delta_{sis}$ = *55* degrees (@.55g)

$\delta_{sis}$ = *60* degrees (rounded)

**Steering Wheel Angle at Corrected 0.3g Lateral Acceleration:**

| Maneuver | Initial Steer Direction | Time Clock | Steering Wheel Angle to nearest 0.1 (degrees) | Data Run | Good/NG |
|---|---|---|---|---|---|
| 1 | Left | *10:52:00 AM* | *-37.3* | *10* | *Good* |
| 2 | Left | *10:56:00 AM* | *-37.2* | *11* | *Good* |
| 3 | Left | *11:00:00 AM* | *-37.5* | *12* | *Good* |
| | Left | | | | *Good* |
| | Left | | | | |
| 4 | Right | *11:02:00 AM* | *36.1* | *13* | *Good* |
| 5 | Right | *11:05:00 AM* | *35.5* | *14* | *Good* |
| 6 | Right | *11:09:00 AM* | *34.7* | *15* | *Good* |
| | Right | | | | |
| | Right | | | | |

## 3.0 TEST DATA (CONTD)

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

**Average Overall Steering Wheel Angle:**

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

$\delta_{0.3\ g,\ overall}$ = 36.4 degrees

[to nearest 0.1 degree]

Remarks:

---

RECORDED BY: *B Kebschull* DATE RECORDED: *9/15/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/1/2009*

## 3.0 TEST DATA (CONTD)

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

Vehicle: *2009 Nissan Pathfinder*
NHTSA No *C95210* Data sheet completion date: *9/15/2009*

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

Selected Drive Configuration: *2WD (default)*
Selected Mode: *default*

Overall steering wheel angle ($\delta_{0.3\ g,\ overall}$) *36.4* degrees

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

| Maneuver # | Clock Time (1.5 – 5.0 min max between runs) | Commanded Steering Wheel Angle[1] | | Yaw Rates (degrees/sec) | | | YRR at 1.0 sec after COS [< 35%] | | YRR at 1.75 sec after COS [< 20%] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Scalar (* $\delta_{0.3\ g}$) | Angle (degrees) | $\dot{\psi}_{Peak}$ | $\dot{\psi}_{1.0sec}$ | $\dot{\psi}_{1.75sec}$ | % | Pass/Fail | % | Pass/Fail |
| 1 | 12:04:00 PM | 1.5 | 55 | 15.5 | -0.3 | -0.2 | -1.9 | *PASS* | -1.5 | *PASS* |
| 2 | 12:08:00 PM | 2 | 73 | 20.4 | -0.4 | 0.0 | -1.9 | *PASS* | 0.1 | *PASS* |
| 3 | 12:12:00 PM | 2.5 | 91 | 16.6 | -0.2 | 0.1 | -1.3 | *PASS* | 0.6 | *PASS* |
| 4 | 12:16:00 PM | 3 | 109 | 18.4 | -0.5 | -0.3 | -2.7 | *PASS* | -1.8 | *PASS* |
| 5 | 12:19:00 PM | 3.5 | 127 | 19.4 | -0.5 | -0.2 | -2.5 | *PASS* | -1.2 | *PASS* |
| 6 | 12:23:00 PM | 4 | 146 | 27.1 | -0.3 | -0.2 | -1.2 | *PASS* | -0.8 | *PASS* |
| 7 | 12:26:00 PM | 4.5 | 164 | 38.6 | -0.7 | -0.5 | -1.7 | *PASS* | -1.2 | *PASS* |
| 8 | 12:29:00 PM | 5 | 182 | 36.7 | -0.4 | -0.1 | -1.1 | *PASS* | -0.4 | *PASS* |
| 9 | 12:32:00 PM | 5.5 | 200 | 39.7 | -0.5 | -0.2 | -1.3 | *PASS* | -0.4 | *PASS* |
| 10 | 12:35:00 PM | 6 | 218 | 45.8 | -0.9 | -0.3 | -2.1 | *PASS* | -0.7 | *PASS* |
| 11 | 12: 37:00 PM | 6.5 | 237 | 45.6 | -0.7 | -0.3 | -1.5 | *PASS* | -0.6 | *PASS* |
| 12 | 12: 41:00 PM | 7 | 255 | 48.4 | -0.7 | -0.3 | -1.5 | *PASS* | -0.6 | *PASS* |
| 13 | 12:44:00 PM | | 270 | 49.4 | -0.7 | -0.2 | -1.4 | *PASS* | -0.4 | *PASS* |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

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

## 3.0 TEST DATA (CONTD)

# DATA SHEET 8 (2 of 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 |
| 14 | 12:44:00 PM | 1.5 | 55 | -15.8 | 0.3 | 0.1 | -1.6 | *PASS* | -0.8 | *PASS* |
| 15 | 12:47:00 PM | 2.0 | 73 | -21.9 | 0.4 | 0.1 | -1.8 | *PASS* | -0.4 | *PASS* |
| 16 | 12:51:00 PM | 2.5 | 91 | -16.6 | 0.5 | 0.0 | -3.2 | *PASS* | -0.0 | *PASS* |
| 17 | 12:54:00 PM | 3.0 | 109 | -16.7 | 0.4 | 0.0 | -2.6 | *PASS* | -0.2 | *PASS* |
| 18 | 12:57:00 PM | 3.5 | 127 | -23.2 | 0.5 | 0.1 | -2.0 | *PASS* | -0.5 | *PASS* |
| 19 | 01:00:00 PM | 4.0 | 146 | -27.4 | 0.6 | 0.2 | -2.1 | *PASS* | -0.6 | *PASS* |
| 20 | 01:03:00 PM | 4.5 | 164 | -30.1 | 0.4 | 0.0 | -1.2 | *PASS* | 0.1 | *PASS* |
| 21 | 01:05:00 PM | 5.0 | 182 | -34.5 | 0.3 | 0.1 | -0.9 | *PASS* | -0.2 | *PASS* |
| 22 | 01:07:00 PM | 5.5 | 200 | -41.8 | 0.4 | 0.0 | -0.9 | *PASS* | 0 | *PASS* |
| 23 | 01:10:00 PM | 6.0 | 218 | -44.1 | 0.3 | 0.0 | -0.8 | *PASS* | 0.1 | *PASS* |
| 24 | 01:13:00 PM | 6.5 | 237 | -45.0 | 0.4 | 0.1 | -0.9 | *PASS* | -0.1 | *PASS* |
| 25 | 01:15:00 PM | 7.0 | 255 | -45.7 | 0.8 | 0.0 | -1.6 | *PASS* | 0 | *PASS* |
| 26 | 01:18:00 PM | | 270 | -47.6 | 0.9 | 0.2 | -1.9 | *PASS* | -0.5 | *PASS* |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

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

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

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

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

## 3.0 TEST DATA (CONTD)

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

**Responsiveness – Lateral Displacement**

| Maneuver # | Initial Steer Direction | Commanded Steering Wheel Angle (5.0*$\delta_{0.3\ g,\ overall}$ or greater) | | Calculated Lateral Displacement[1] | |
|---|---|---|---|---|---|
| | | Scalar *$\delta_{0.3\ g}$ | Angle (degrees) | Distance (m) | Pass/Fail |
| 8 | Counterclockwise | 5 | 182 | -2.7 | *PASS* |
| 9 | Counterclockwise | 5.5 | 200 | -2.8 | *PASS* |
| 10 | Counterclockwise | 6 | 218 | -2.8 | *PASS* |
| 11 | Counterclockwise | 6.5 | 237 | -2.9 | *PASS* |
| 12 | Counterclockwise | 7 | 255 | -2.9 | *PASS* |
| 13 | Counterclockwise | 7.5 | 270 | -2.9 | *PASS* |
| | | | | | |
| 21 | Clockwise | 5 | 182 | 2.6 | *PASS* |
| 22 | Clockwise | 5.5 | 200 | 2.7 | *PASS* |
| 23 | Clockwise | 6 | 218 | 2.7 | *PASS* |
| 24 | Clockwise | 6.5 | 237 | 2.7 | *PASS* |
| 25 | Clockwise | 7 | 255 | 2.8 | *PASS* |
| 26 | Clockwise | 7.5 | 270 | 2.9 | *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: *9/15/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/01/2009*

## 3.0 TEST DATA (CONTD)

### Data Sheet 9 (Page 1 of 3)
### MALFUNCTION WARNING TESTS

Vehicle: *2009 Nissan Pathfinder*

NHTSA No *C95210* Data Sheet Completion Date: *9/15/2009*

### TEST 1

**METHOD OF MALFUNCTION SIMULATION:**

Describe method of malfunction simulation:

*Disconnect 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 as specified

X Yes ____ No

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

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

**ESC SYSTEM RESTORATION**

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

X Yes ____ No

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

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

**TEST 1 DATA INDICATES COMPLIANCE: PASS/FAIL Pass**
(see Remarks Below)

## 3.0 TEST DATA (CONTD)

### Data Sheet 9 (Page 2 of 3)
### MALFUNCTION WARNING TESTS

Vehicle: *2009 Nissan Pathfinder*

NHTSA No *C95210* Data Sheet Completion Date: *9/15/2009*

### TEST 1- Continued

**METHOD OF MALFUNCTION SIMULATION:**

**Remarks:** When the sensor was disconnected the “VDC Off” and “SLIP” telltales illuminated indicating a malfunction. When the sensor was reconnected and the ignition was turned on, both telltales remained illuminated even after driving the vehicle for 2 minutes at the required speed. If the battery was disconnected and reconnected , and the ignition was turned on, the "SLIP" telltale extinguished. After driving the vehicle for several seconds the "VDC OFF" telltale also extinguished. The manufacturer stated that the system includes voltage and thermal logic and that logic may have prevented the telltales from extinguishing at first due to the voltage draw from the compliance test equipment installed in the vehicle. The test instrumentation was removed from the vehicle and the vehicle was set aside for several hours. The same malfunction was then repeated two times and both times the "VDC OFF" and "SLIP" telltales extinguished when the malfunction was corrected as required by the standard.

RECORDED BY: *B Kebschull* DATE RECORDED: *9/15/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/01/2009*

## 3.0 TEST DATA (CONTD)

### Data Sheet 9 (Page 3 of 3)
### MALFUNCTION WARNING TESTS

Vehicle: *2009 Nissan Pathfinder*

NHTSA No *C95210* Data Sheet Completion Date: *9/15/2009*

### TEST 2

**METHOD OF MALFUNCTION SIMULATION:**

Describe method of malfunction simulation: *Disconnect 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 as specified.

X Yes ____ No

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

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

**ESC SYSTEM RESTORATION**

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

X Yes ____ No

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

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

**TEST 1 DATA INDICATES COMPLIANCE: PASS/FAIL Pass**
(see Remarks Below)

Remarks: When LF wheel speed sensor disconnected, “VDC off” and “SLIP” telltales illuminated. When reconnected and ignition on, both icons extinguished within 2 or 3 seconds (without driving).

RECORDED BY: *B Kebschull* DATE RECORDED: *9/15/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/01/2009*

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

### TABLE 1. TEST INSTRUMENTATION

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

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

### TABLE 1. TEST INSTRUMENTATION (CONTD)

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

## 5.0 PHOTOGRAPHS (1 of 14)


Figure 5.1. Left Front View of Test Vehicle

## 5.0 PHOTOGRAPHS (2 of 14)


Figure 5.2. Right Rear View of Test Vehicle

## 5.0 PHOTOGRAPHS (3 of 14)

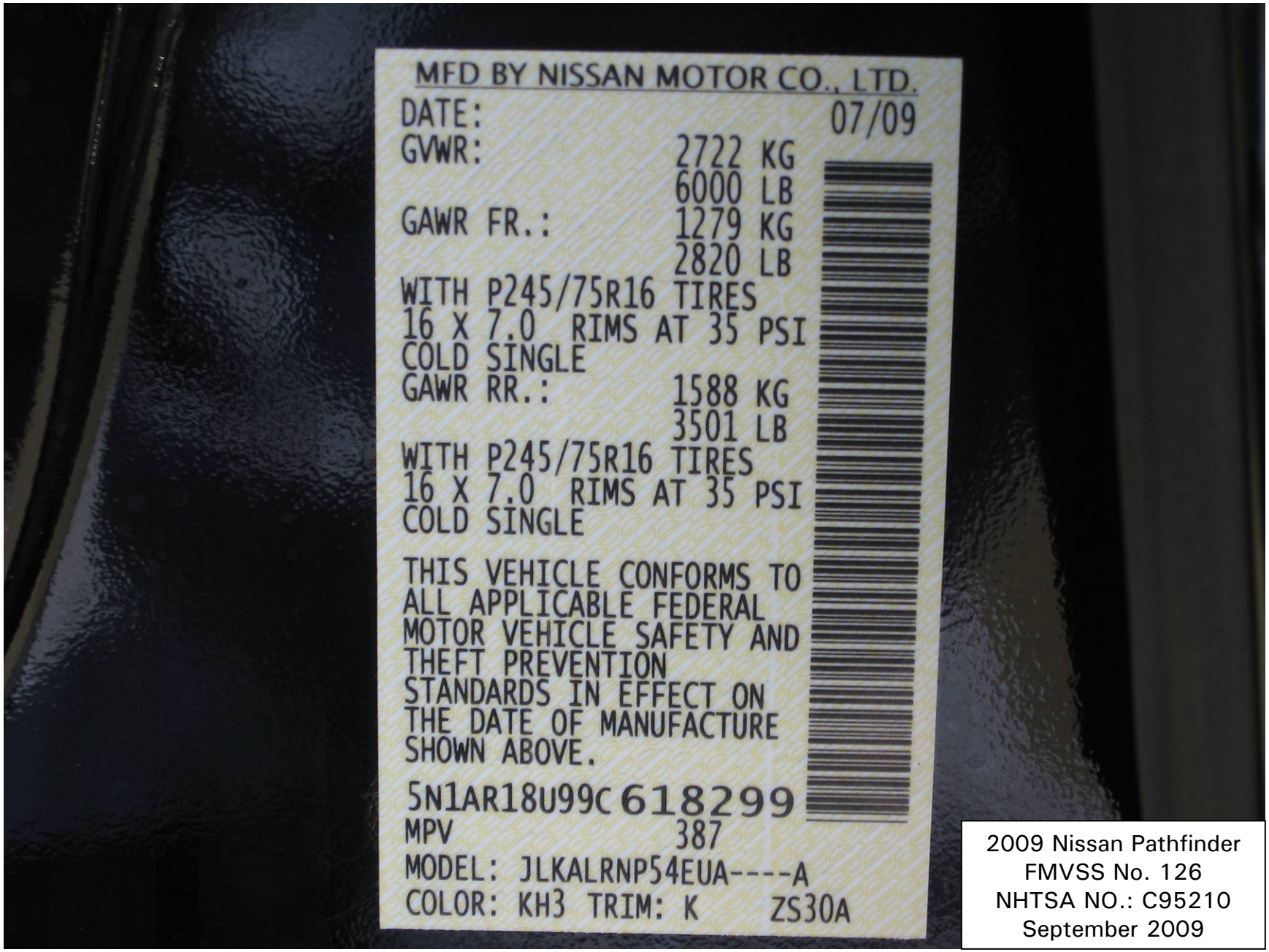



Figure 5.3. Vehicle Certification Label

## 5.0 PHOTOGRAPHS (4 of 14)

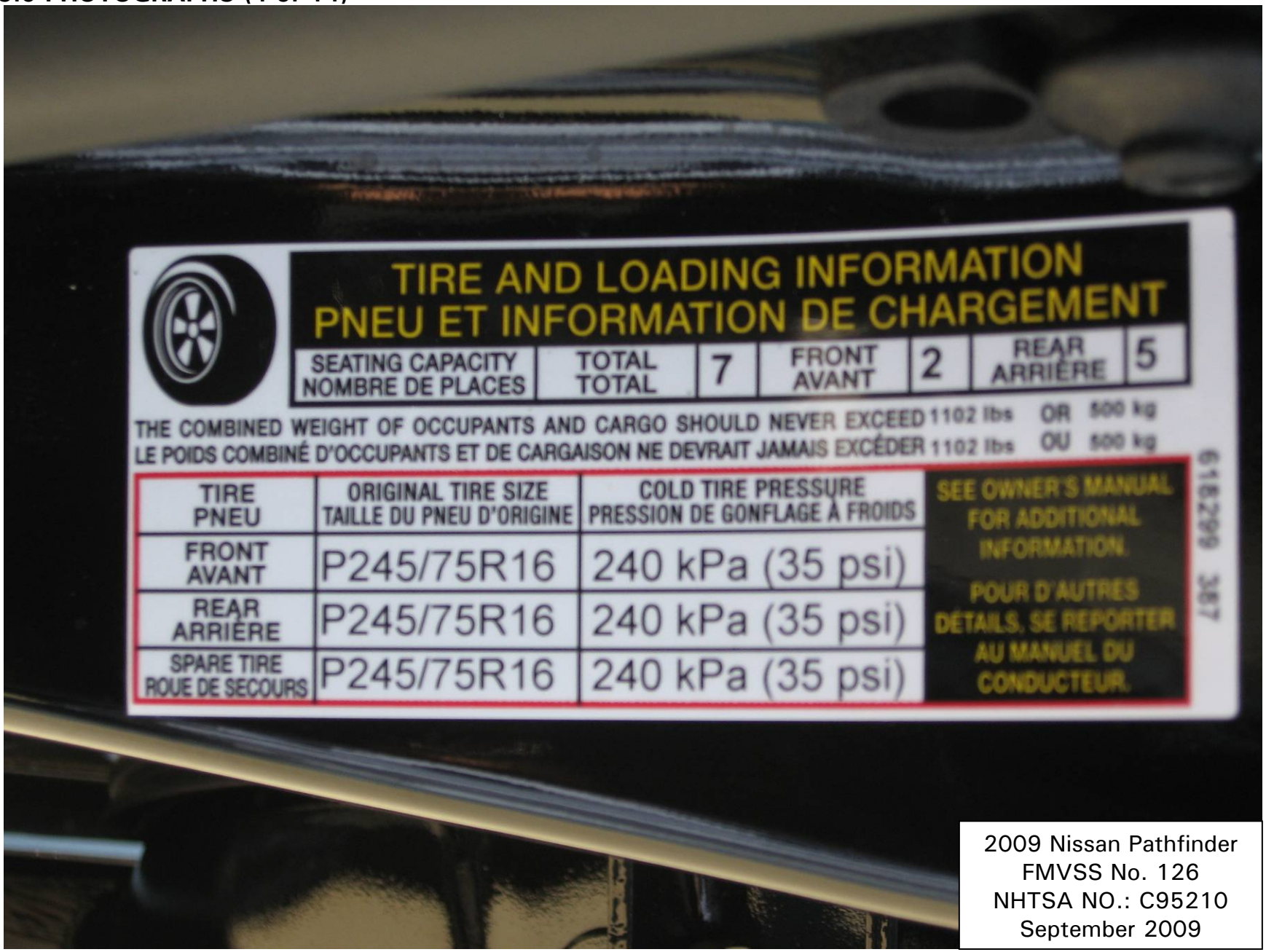



Figure 5.4. Vehicle Placard

## 5.0 PHOTOGRAPHS (5 of 14)

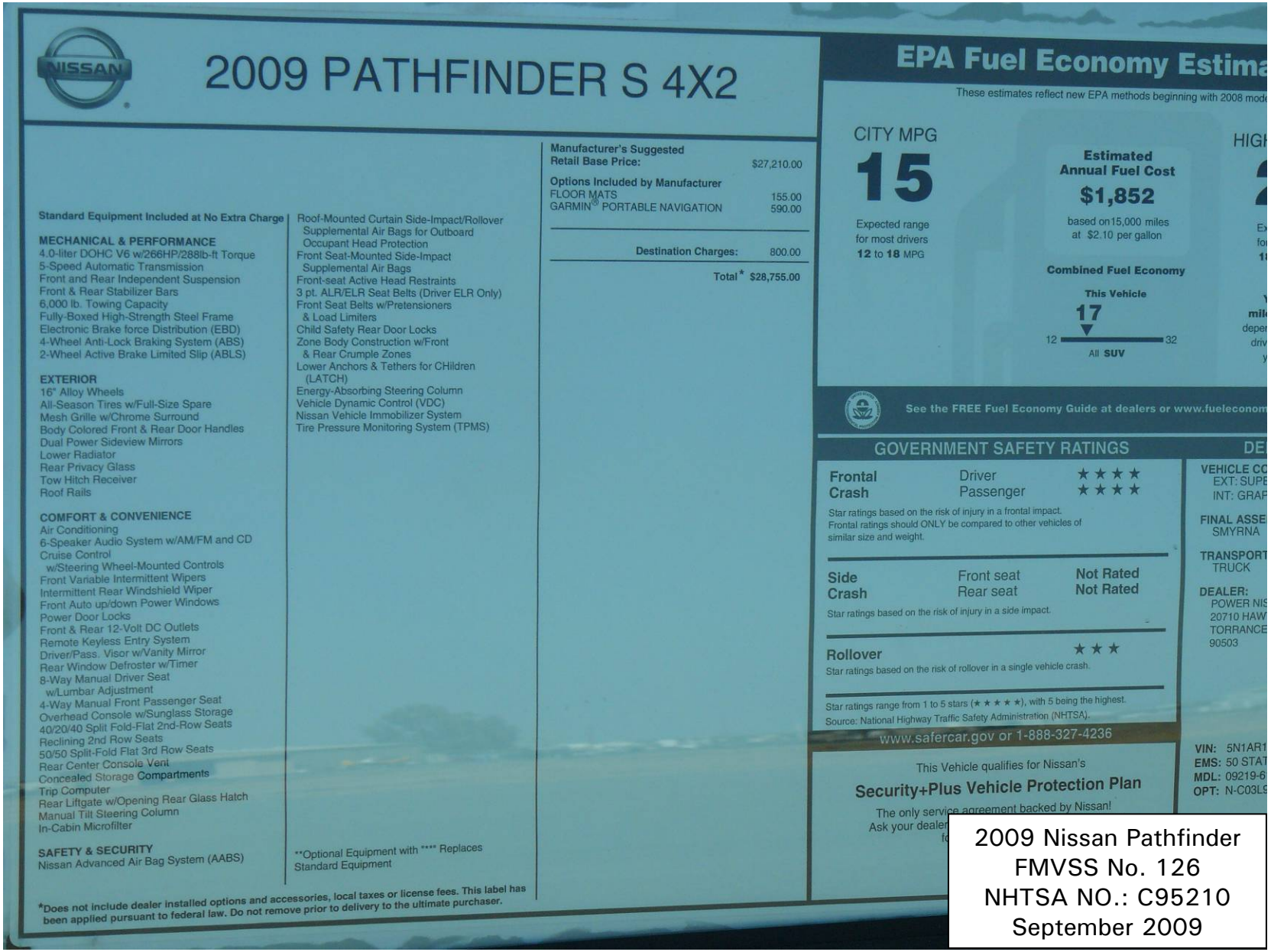



Figure 5.5. Window Sticker (Monroney Label)

**5.0 PHOTOGRAPHS (6 of 14)**


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

## 5.0 PHOTOGRAPHS (7 of 14)


Figure 5.7. VDC Off Control Switch

## 5.0 PHOTOGRAPHS (8 of 14)


Figure 5.8. Front View of Vehicle As-Tested

## 5.0 PHOTOGRAPHS (9 of 14)


Figure 5.9. Rear View of Vehicle As-Tested

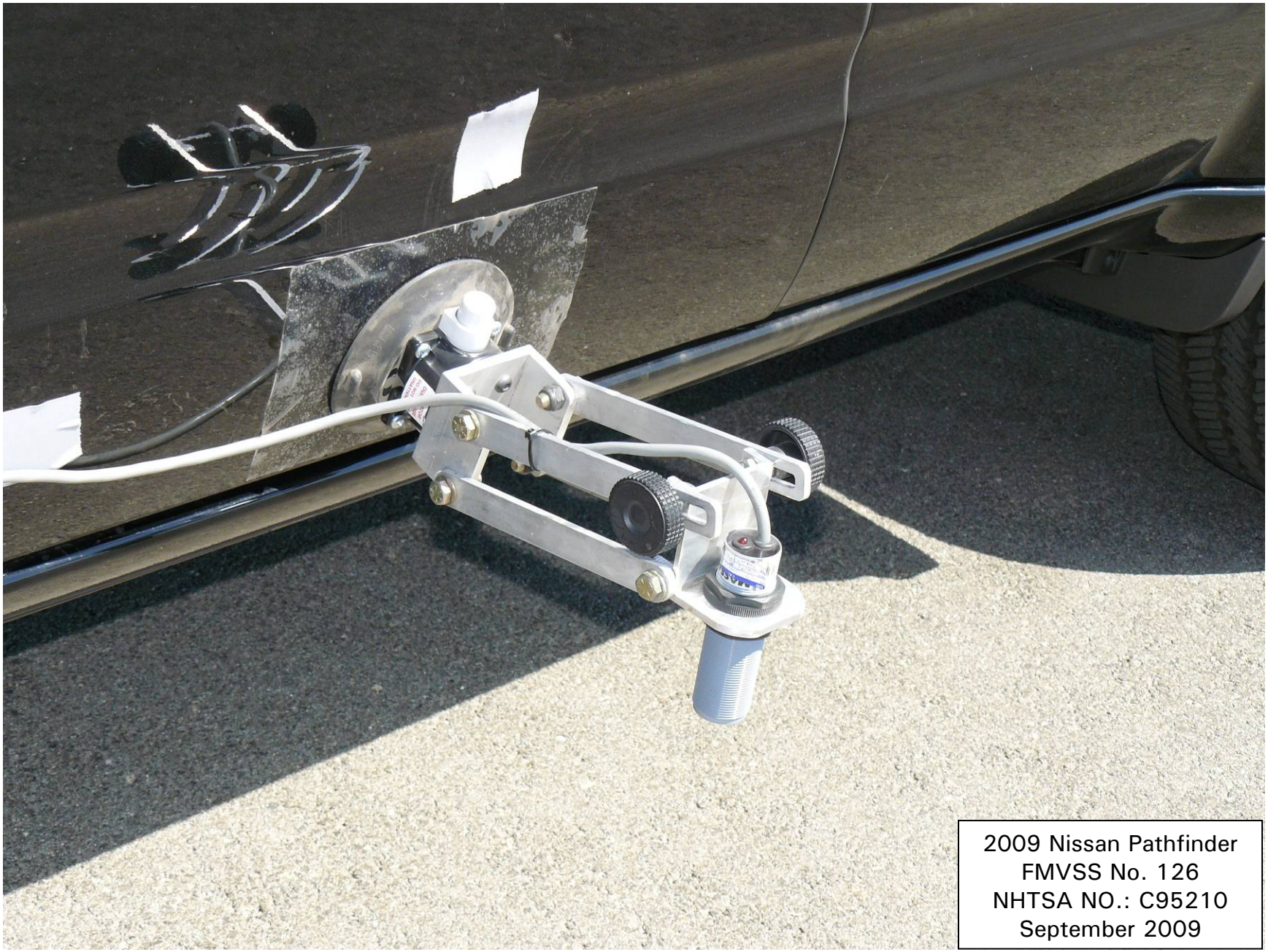



Figure 5.10. Ultrasonic Height Sensor Mounted on Left Side of Vehicle for Determining Body Roll Angle

## 5.0 PHOTOGRAPHS (11 of 14)

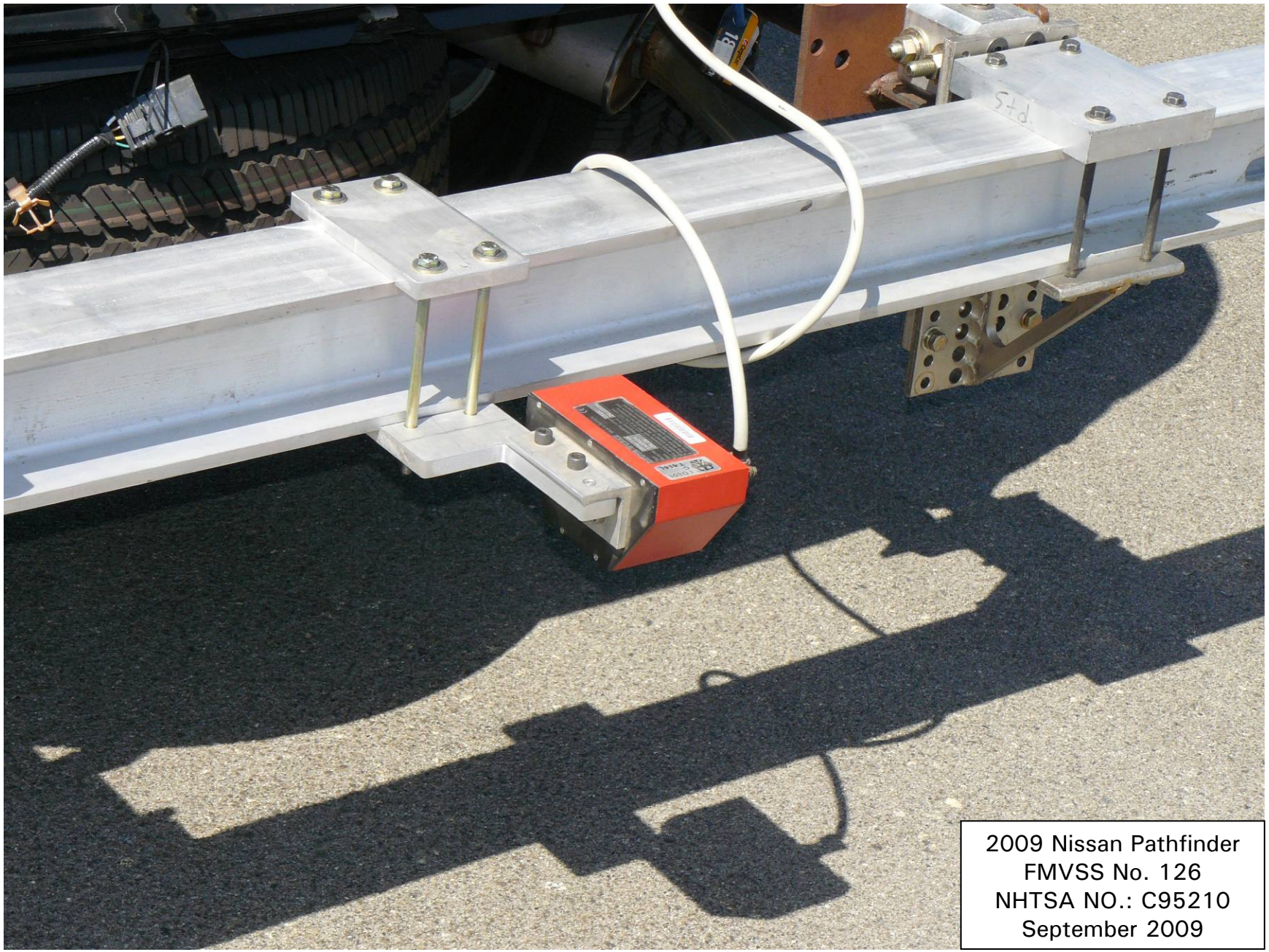



Figure 5.11. Rear Outrigger, Mount and Speed Sensor

## 5.0 PHOTOGRAPHS (12 of 14)

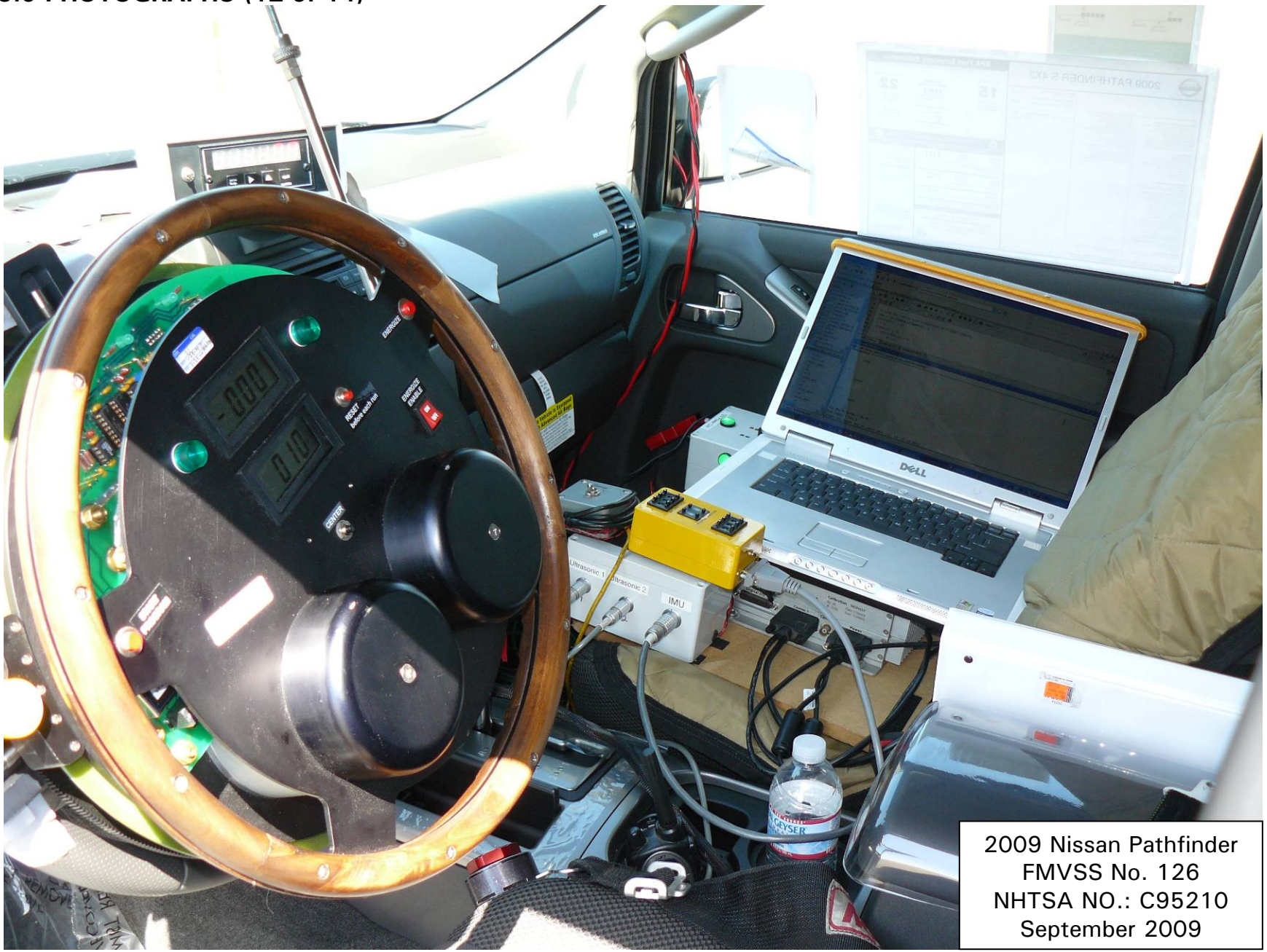



Figure 5.12. Steering Controller and Data Acquisition Computer

## 5.0 PHOTOGRAPHS (13 of 14)


2009 Nissan Pathfinder
FMVSS No. 126
NHTSA NO.: C95210
September 2009

Figure 5.13. Inertial Measurement Unit Mounted in Vehicle

## 5.0 PHOTOGRAPHS (14 of 14)

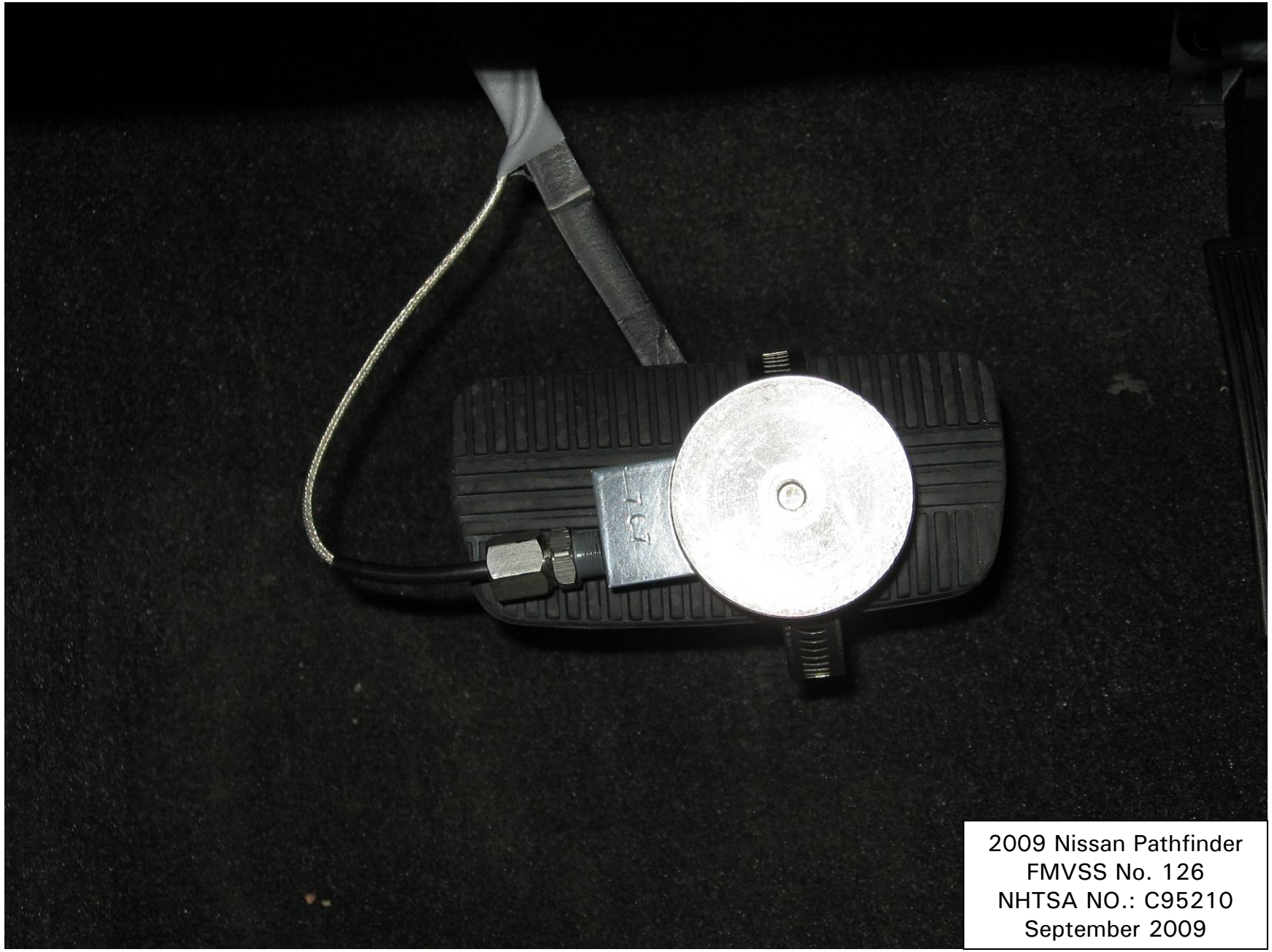



Figure 5.14. Brake Pedal Load Cell

## 6.0 DATA PLOTS (1 of 4)

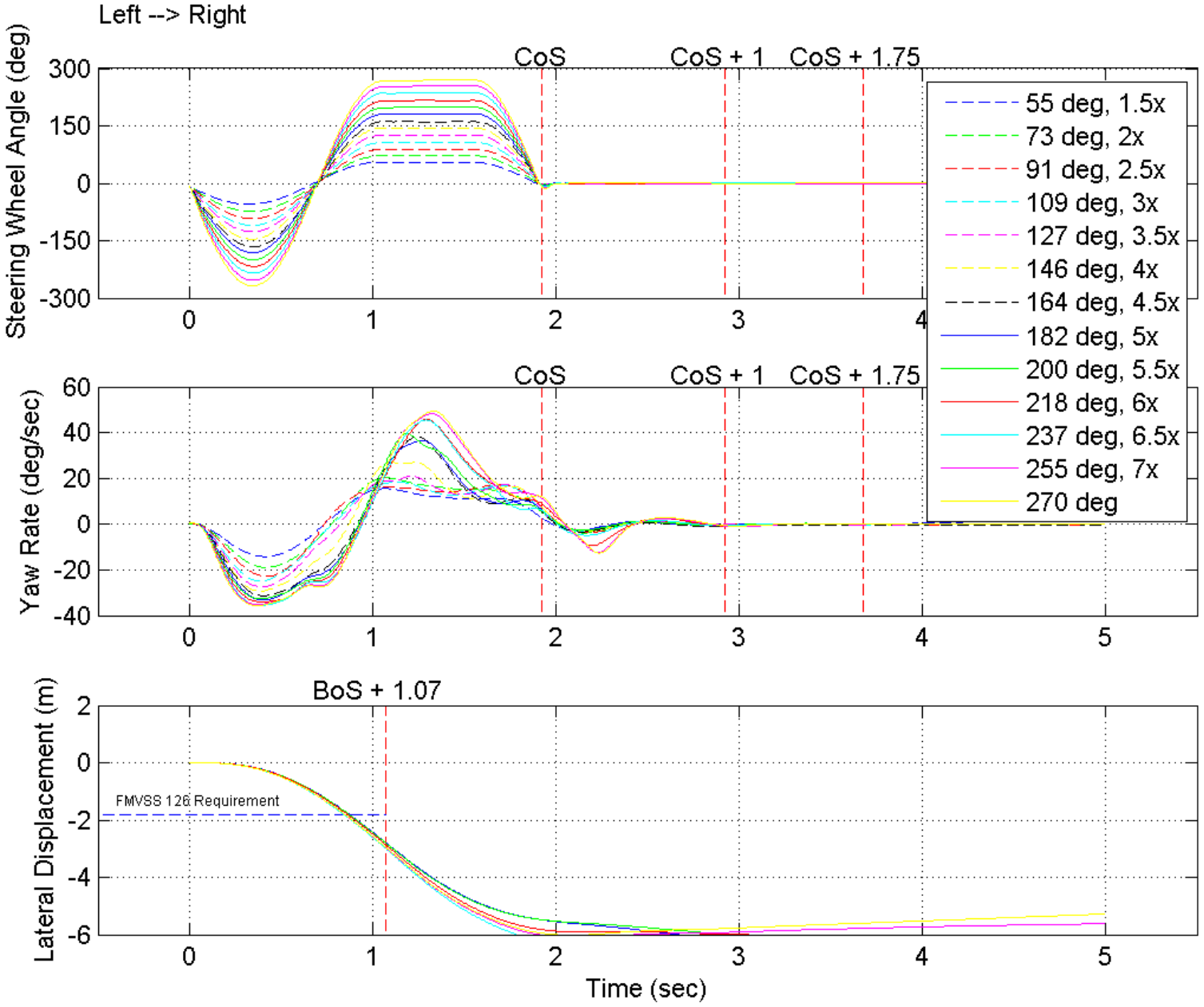



Figure 6.1. Steering Wheel Angle, Yaw Rate and Lateral Displacement for L-R Series

## 6.0 DATA PLOTS (2 of 4)

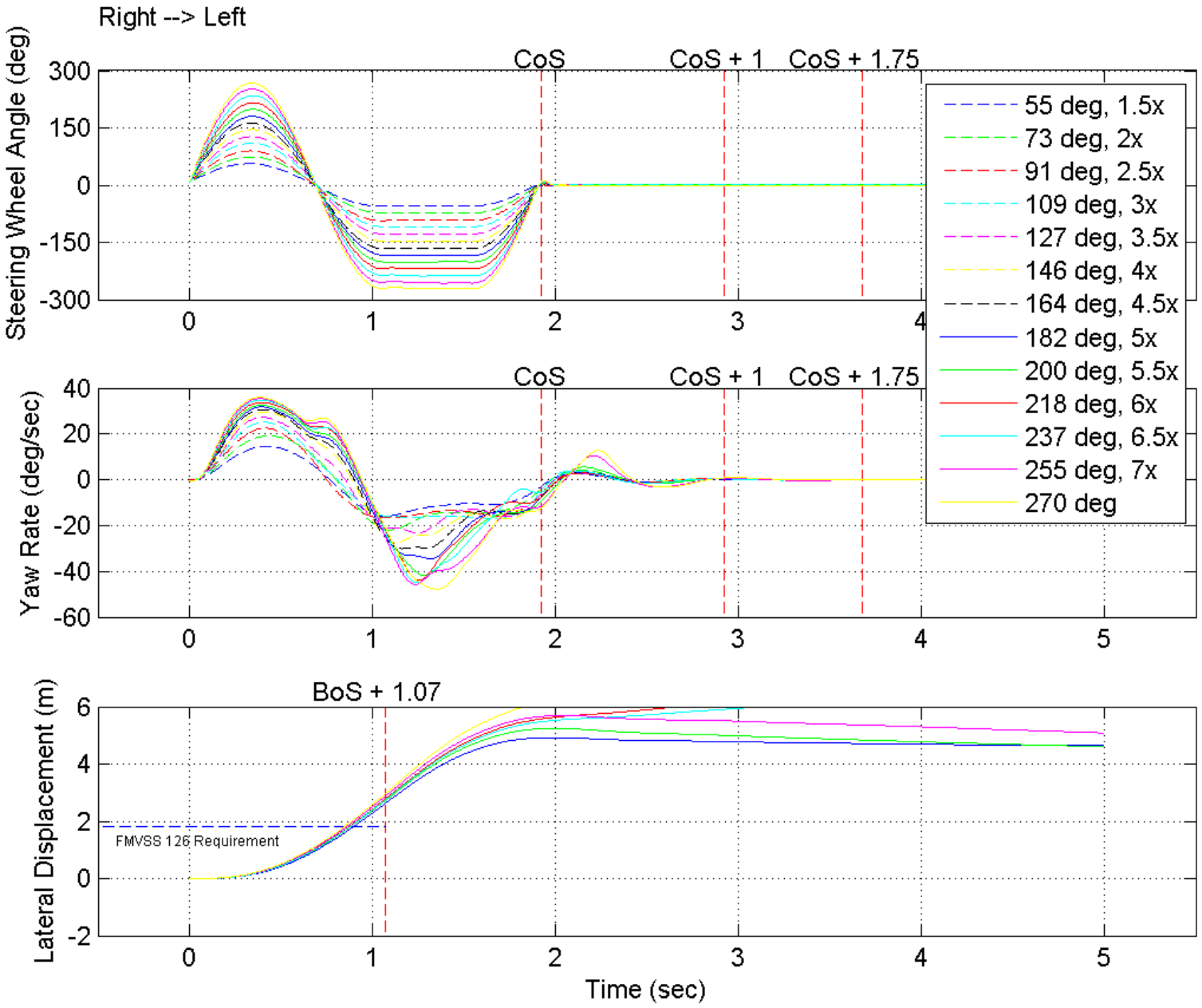



Figure 6.2. Steering Wheel Angle, Yaw Rate and Lateral Displacement for R-L Series

## 6.0 DATA PLOTS (3 of 4)

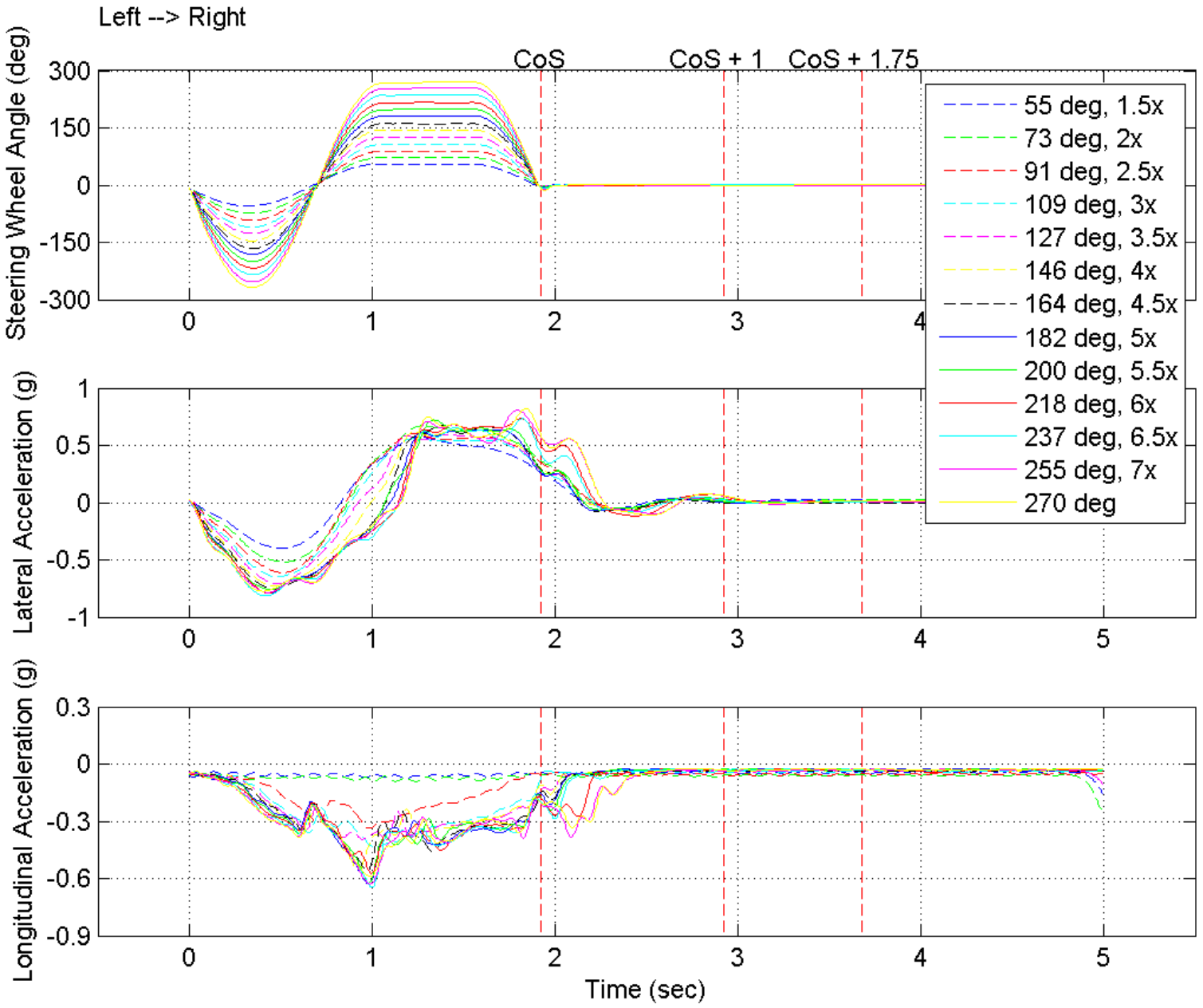



Figure 6.3. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for L-R Series

## 6.0 DATA PLOTS (4 of 4)

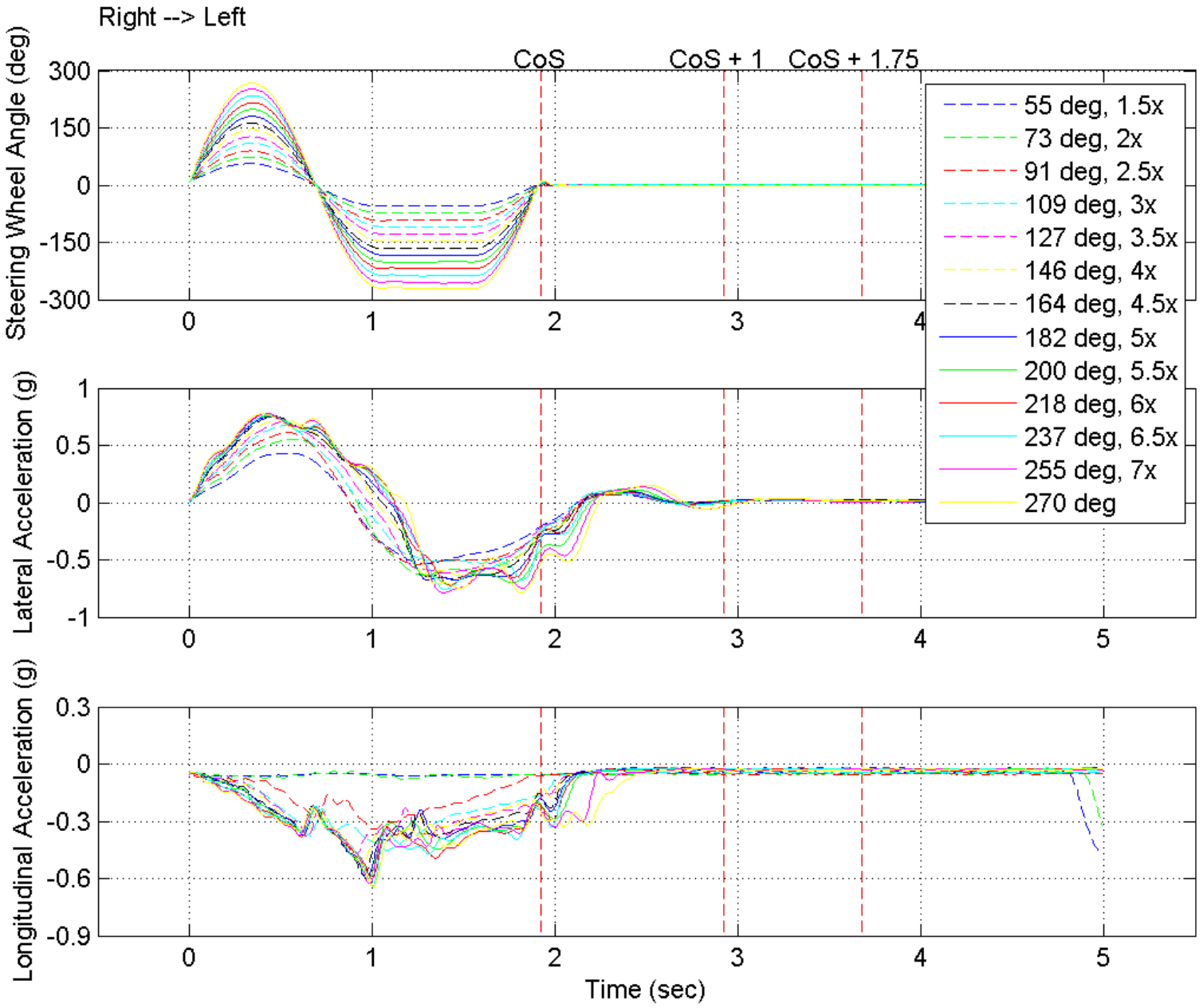


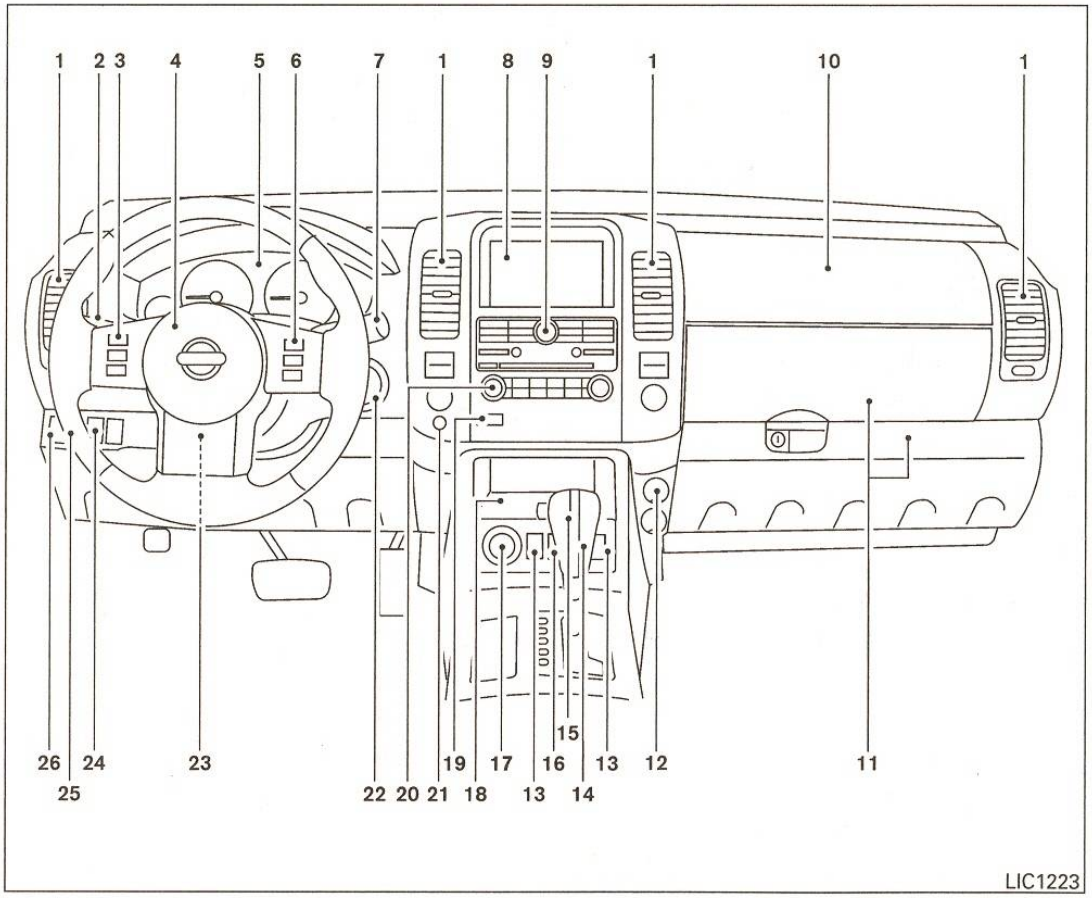

Figure 6.4. Steering Wheel Angle, Lateral Acceleration and Longitudinal Acceleration for R-L Series

# 7.0 OTHER DOCUMENTATION

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

## 7.1 OWNER'S MANUAL PAGES

### INSTRUMENT PANEL



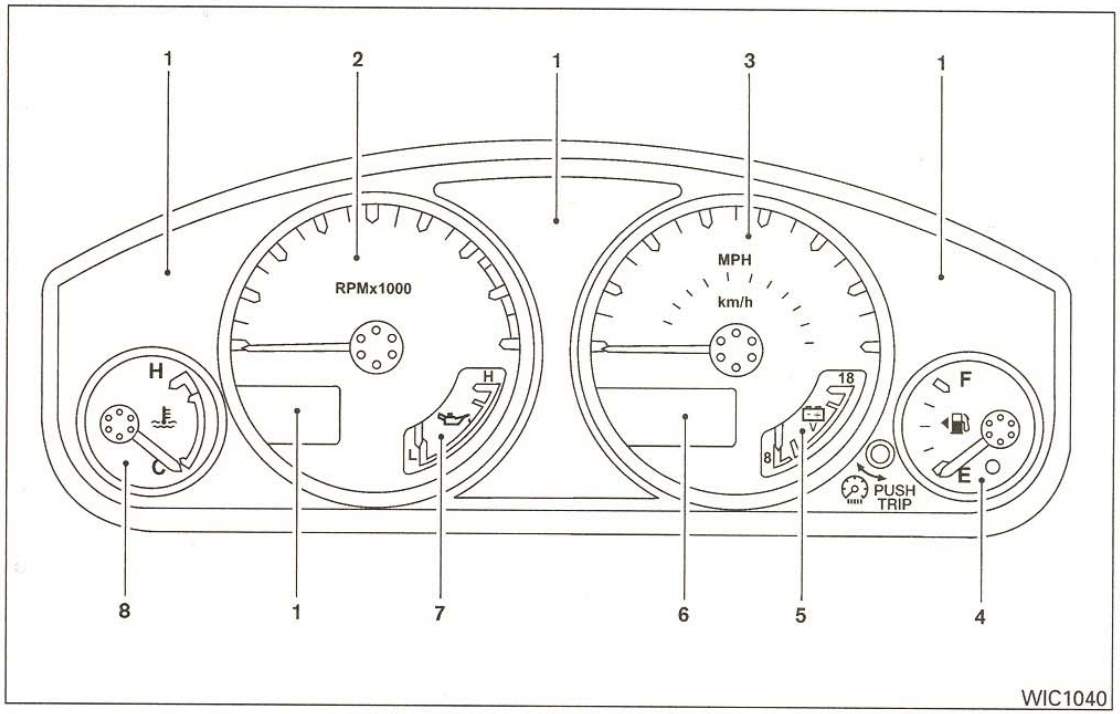

1. Ventilators (P. 4-37)
2. Headlight/fog light (if so equipped)/turn signal switch (P. 2-28)
3. Steering wheel switch for audio control (if so equipped) (P. 4-86)
4. Driver supplemental air bag/horn (P. 1-41, P. 2-33)
5. Meters, gauges and warning/indicator lights (P. 2-3, 2-13)
6. Cruise control main/set switches (P. 5-20)
7. Windshield wiper/washer switch and rear window wiper/washer switch (P. 2-26, P. 2-27)
8. Navigation system* (if so equipped)
9. Navigation system* controls (if so equipped)
10. Front passenger supplemental air bag (P. 1-41)
11. Upper and lower glove box (P. 2-40)
12. Power outlet (P. 2-36)
13. Heated seat switch (if so equipped) (P. 2-34)
14. Hill descent control switch (if so equipped) (P. 2-35)
15. Shift selector (P. 5-14)

16. Vehicle dynamic control (VDC) OFF switch (P. 2-34)
17. 4WD shift switch (if so equipped) (P. 5-22)
18. Storage
19. Passenger air bag status light (P. 1-50)
20. Climate controls (P. 4-38, 4-45)
21. Hazard warning flasher switch (P. 2-32)
22. Ignition switch (P. 5-9)
23. Tilt steering wheel control (P. 3-25)
24. Heated steering wheel switch (if so equipped)
25. Pedal position adjustment switch (if so equipped) (P. 3-25)
26. Outside mirror controls (P. 3-29)

*: Refer to the separate Navigation System Owner's Manual (if so equipped).

**See the page number indicated in parentheses for operating details.**

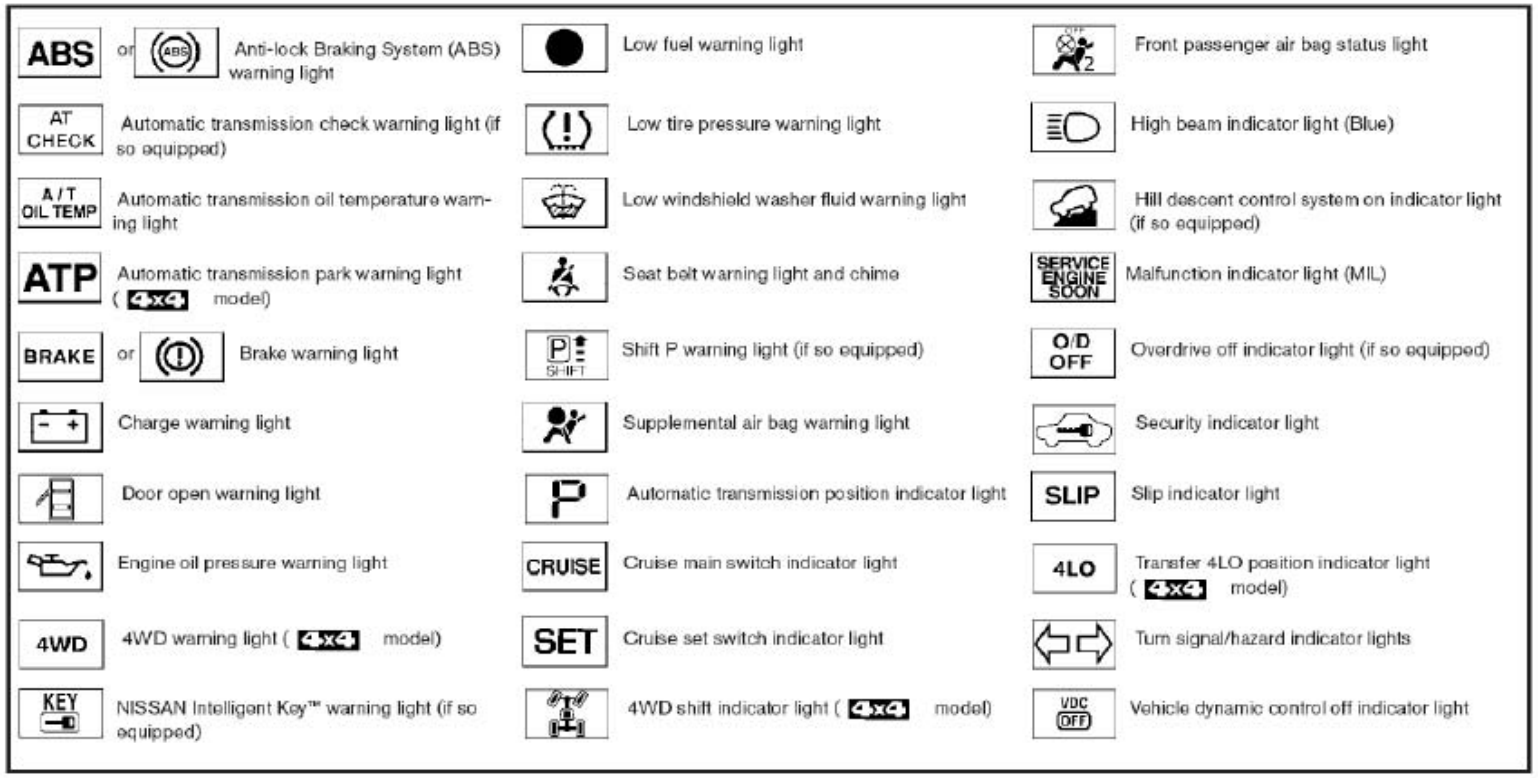
## METERS AND GAUGES




1. Warning/indicator lights
2. Tachometer
3. Speedometer
4. Fuel gauge
5. Voltmeter
6. Odometer/Twin trip odometer/Trip computer (if so equipped)
7. Engine oil pressure gauge
8. Engine coolant temperature gauge

**Instruments and controls** 2-3

## WARNING/INDICATOR LIGHTS AND AUDIBLE REMINDERS



to the N position with the brake pedal depressed, then depress and turn the 4WD shift switch to 4LO or 4H.

You cannot move the transfer 4WD shift switch between 4H and 4LO unless you stop the vehicle and shift the shift selector to the N position with the brake pedal depressed.

**Part time 4WD (if so equipped)**

The 4LO indicator light must stop blinking and remain illuminated or turn off before shifting the transmission into gear. If the shift selector is shifted from the N position to any other gear when the 4LO indicator light is blinking, the vehicle may move unexpectedly.

When you shift between 4H and 4LO, stop the vehicle and shift the transmission selector lever to the N position with the brake pedal depressed, then depress and turn the 4WD shift switch to 4LO or 4H.

You cannot move the transfer 4WD shift switch between 4H and 4LO unless you stop the vehicle and shift the shift selector to the N position with the brake pedal depressed.

### Turn signal/hazard indicator lights

The appropriate light flashes when the turn signal switch is activated.



Both lights flash when the hazard switch is turned on.

### Vehicle Dynamic Control off indicator light

This indicator light comes on when the Vehicle Dynamic Control off switch is pushed to OFF, the transfer case is in the 4LO position ( 4x4 model), or when the Vehicle Dynamic Control system is not functioning properly. This indicates the Vehicle Dynamic Control system is not operating.

Push the Vehicle Dynamic Control off switch again or restart the engine and the system will operate normally. See "Vehicle Dynamic Control (VDC) system" in the "Starting and driving" section of this manual.

The Vehicle Dynamic Control light also comes on when you place the ignition switch in the ON position. The light will turn off after about 2 seconds if the system is operational. If the light stays on or comes on along with the SLIP indicator light while you are driving, have the Vehicle Dynamic Control system checked by a NISSAN dealer.

If the battery is removed or discharged, the Vehicle Dynamic Control system is disabled and the VDC indicator light will not turn off after 2 seconds when the ignition switch is placed in the ON position. To reset the system, you must perform the reset procedure. Refer to "Vehicle Dynamic Control (VDC) system" in the "Starting and driving" section of this manual.

If the light does not go off after performing the reset procedure, have the traction control system checked by a NISSAN dealer.

While the Vehicle Dynamic Control system is operating, you might feel slight vibration or hear the system working when starting the vehicle or accelerating, but this is normal.

## AUDIBLE REMINDERS

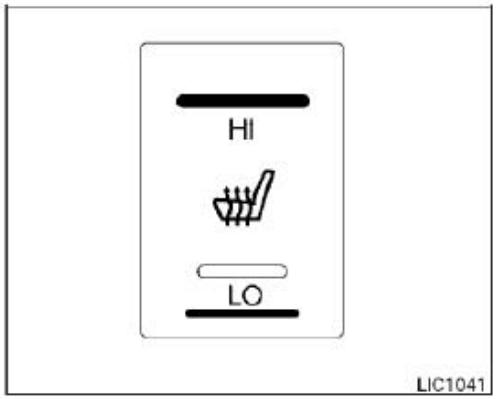
### Brake pad wear warning

The disc brake pads have audible wear warnings. When a disc brake pad requires replacement, it makes a high pitched scraping sound when the vehicle is in motion, whether or not the brake pedal is depressed. Have the brakes checked as soon as possible if the warning sound is heard.

### Key reminder chime

A chime sounds if the driver's door is opened while the key is left in the ignition switch. Remove the key and take it with you when leaving the vehicle.

## HEATED SEAT (if so equipped)




The front seats are warmed by built-in heaters (if so equipped).

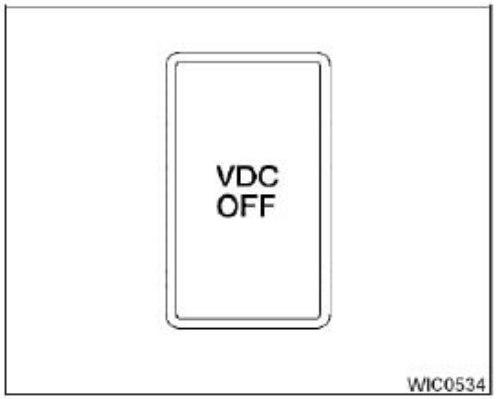
1. Start the engine.
2. Push the LO or HI position of the switch, as desired, depending on the temperature. The indicator light in the switch will illuminate.

   The heater is controlled by a thermostat, automatically turning the heater on and off. The indicator light will remain on as long as the switch is on.
3. When the seat is warmed or before you leave the vehicle, be sure to turn the switch off.

**⚠CAUTION**

- **Do not use the seat heater for extended periods or when no one is using the seat.**
- **Do not put anything on the seat which insulates heat, such as a blanket, cushion, seat cover, etc. Otherwise, the seat may become overheated.**
- **Do not place anything hard or heavy on the seat or pierce it with a pin or similar object. This may result in damage to the heater.**
- **Any liquid spilled on the heated seat should be removed immediately with a dry cloth.**
- **When cleaning the seat, never use gasoline, benzine, thinner, or any similar materials.**
- **If any abnormalities are found or the heated seat does not operate, turn the switch off and have the system checked by your NISSAN dealer.**
- **The battery could run down if the seat heater is operated while the engine is not running.**

## VEHICLE DYNAMIC CONTROL (VDC) OFF SWITCH




The vehicle should be driven with the Vehicle Dynamic Control (VDC) system on for most driving conditions.

If the vehicle is stuck in mud or snow, the VDC system reduces the engine output to reduce wheel spin. The engine speed will be reduced even if the accelerator is depressed to the floor. If maximum engine power is needed to free a stuck vehicle, turn the VDC system off.

To turn off the VDC system, push the VDC OFF switch. The VDC OFF indicator will come on.

Push the VDC OFF switch again or restart the engine to turn on the system. See "Vehicle Dynamic Control (VDC) system" in the "Starting and driving" section.

**⚠ WARNING**

- **While driving on a slippery surface, be careful when braking, accelerating or downshifting. Abrupt braking or accelerating could cause the wheels to skid and result in an accident.**
- **If the engine is not running or is turned off while driving, the power assist for the brakes will not work. Braking will be harder.**

### Wet brakes

When the vehicle is washed or driven through water, the brakes may get wet. As a result, your braking distance will be longer and the vehicle may pull to one side during braking.

To dry the brakes, drive the vehicle at a safe speed while lightly pressing the brake pedal to heat up the brakes. Do this until the brakes return to normal. Avoid driving the vehicle at high speeds until the brakes function correctly.

### Parking brake break-in

Break-in the parking brake shoes whenever the stopping effect of the parking brake is weakened or whenever the parking brake shoes and/or drum/rotors are replaced, in order to assure the best brake performance.



This procedure is described in the vehicle service manual and can be performed by a NISSAN dealer.

## ANTI-LOCK BRAKING SYSTEM (ABS)

**⚠ WARNING**

- **The Anti-lock Braking System (ABS) is a sophisticated device, but it cannot prevent accidents resulting from careless or dangerous driving techniques. It can help maintain vehicle control during braking on slippery surfaces. Remember that stopping distances on slippery surfaces will be longer than on normal surfaces even with ABS. Stopping distances may also be longer on rough, gravel or snow covered roads, or if you are using tire chains. Always maintain a safe distance from the vehicle in front of you. Ultimately, the driver is responsible for safety.**
- **Tire type and condition may also affect braking effectiveness.**
  - **When replacing tires, install the specified size of tires on all four wheels.**
  - **When installing a spare tire, make sure that it is the proper size and type as specified on the Tire and Loading Information label. See "Tire and Loading Information label" in the "Technical and consumer information" section of this manual.**
  - **For detailed information, see "Wheels and tires" in the "Maintenance and do-it-yourself" section of this manual.**

The Anti-lock Braking System (ABS) controls the brakes so the wheels do not lock during hard braking or when braking on slippery surfaces. The system detects the rotation speed at each wheel and varies the brake fluid pressure to prevent each wheel from locking and sliding. By preventing each wheel from locking, the system helps the driver maintain steering control and helps to minimize swerving and spinning on slippery surfaces.

### Using the system

Depress the brake pedal and hold it down. Depress the brake pedal with firm steady pressure, but do not pump the brakes. The ABS will operate to prevent the wheels from locking up. Steer the vehicle to avoid obstacles.

**⚠WARNING**

**Do not pump the brake pedal. Doing so may result in increased stopping distances.**

### Normal operation

The ABS operates at speeds above 3 - 6 MPH (5 - 10 km/h).

When the ABS senses that one or more wheels are close to locking up, the system electronically controls the pressure applied to each brake.

This action is similar to pumping the brakes very quickly. You may feel a pulsation in the brake pedal and hear a noise from under the hood or feel a vibration from the actuator when it is operating. This is normal and indicates that the ABS is operating properly. However, the pulsation may indicate that road conditions are hazardous and extra care is required while driving.

### Self-test feature

The ABS includes electronic sensors, electric pumps, hydraulic solenoids and a computer. The computer has a built-in diagnostic feature that tests the system each time you start the engine and move the vehicle at a low speed in forward or reverse. When the self-test occurs, you may hear a "clunk" noise and/or feel a pulsation in the brake pedal. This is normal and does not indicate a malfunction. If the computer senses a malfunction, it switches the ABS off and illuminates the ABS warning light on the instrument panel. The brake system then operates normally, but without anti-lock assistance.

If the ABS warning light illuminates during the self-test or while driving, have the vehicle checked by a NISSAN dealer.

## ACTIVE BRAKE LIMITED SLIP (ABLS) SYSTEM

- ABLS is a form of traction control using sensors from the Anti-lock Brake System (ABS) to transfer power from a slipping drive wheel to a wheel with more traction. The ABLS system applies braking to the slipping wheel, which helps redirect power to another wheel.
- On 4WD models the ABLS system operates in both 4H and 4LO modes. If 4WD mode is engaged, the ABLS system will operate for both drive axles. On 2WD vehicles, the ABLS system operates on the drive axle only.
- The ABLS system is always ON unless the system detects brake pad overheating. If high brake pad temperature is detected, it will turn OFF, but normal brake function will continue. ABLS will function even when the VDC system is turned OFF.

**⚠WARNING**

**The ABLS system provides increased traction, but will not prevent accidents due to abrupt steering operation or by careless driving or dangerous driving practices. Reduce vehicle speed and be especially careful when driving and cornering on slippery surfaces, and always drive carefully.**

## VEHICLE DYNAMIC CONTROL (VDC) SYSTEM

The Vehicle Dynamic Control (VDC) system uses various sensors to monitor driver inputs and vehicle motion. Under certain driving situations, the system will control braking and engine output to help keep the vehicle on its steered path.

- When the Vehicle Dynamic Control (VDC) system is operating, the **SLIP** indicator in the instrument panel blinks.
- If the 4WD transfer case is shifted into 4LO the VDC OFF indicator light will come on and the VDC system will be turned off. See "Transfer case shifting procedures" earlier in this section.
- If the SLIP indicator blinks, the road conditions may be slippery. Be sure to adjust your speed and driving to these conditions. See "Slip indicator light", and "Vehicle Dynamic Control (VDC) off indicator light" in the "Instruments and controls" section.

If the battery is removed or discharged, the Traction Control System may be disabled and the **SLIP** and VDC OFF indicator lights will not turn off after 2 seconds when the ignition switch is turned to the ON position.

Perform the following procedure to reset the system:

- Start the engine and set the steering wheel in the straight forward position.
- Drive the vehicle at speeds above 10 mph (15 km/h) for at least 10 minutes.
- The VDC OFF indicator light should go off indicating the traction control system is operational.
- If you interrupt the reset procedure by turning the ignition off, you will need to restart the reset procedure.

If after driving the vehicle for more than 10 minutes and the **SLIP** and VDC OFF lights remain illuminated in the instrument panel, have the vehicle dynamic control system checked by a NISSAN dealer.

If the vehicle is operated with the Vehicle Dynamic Control system off using the VDC OFF switch, VDC and Traction Control System (TCS) functions will be turned off. The **SLIP** indicator will flash if wheel spin is detected. The ABS will still operate with the VDC system off.

When the VDC system is operating, you may feel a pulsation in the brake pedal and hear a noise or vibration from under the hood. This is normal and indicates that the VDC system is working properly.

The computer has a built in diagnostic feature that tests the system each time you start the engine and move the vehicle forward or in reverse at a slow speed. When the self-test occurs, you may hear a clunk noise and/or feel a pulsation in the brake pedal. This is normal and is not an indication of a malfunction.

**⚠WARNING**

- **The Vehicle Dynamic Control system is designed to help maintain traction with the road service but does not prevent accidents due to abrupt steering operation at high speeds or by careless or dangerous driving techniques. Reduce vehicle speed and be especially careful when driving and cornering on slippery surfaces and always drive carefully.**
- **If brake related parts such as brake pads, rotors and calipers are not standard equipment or are extremely deteriorated, the Vehicle Dynamic Control system may not operate properly and the Vehicle Dynamic Control off indicator light may come on.**

## TRACTION CONTROL SYSTEM (TCS)

- **Do not modify the vehicle's suspension. If suspension parts such as shock absorbers, struts, springs, stabilizer bars, bushings and wheels are not NISSAN approved for your vehicle or are extremely deteriorated the Vehicle Dynamic Control system may not operate properly. This could adversely affect vehicle handling performance, and the VDC OFF indicator light may come on.**
- **When driving on extremely inclined surfaces such as higher banked corners, the Vehicle Dynamic Control system may not operate properly and the VDC OFF indicator light may come on. Do not drive on these types of roads.**
- **When driving on an unstable surface such as a turntable, ferry, elevator or ramp, the Vehicle Dynamic Control off indicator light may illuminate. This is not a malfunction. Restart the engine after driving onto a stable surface.**
- **If wheels or tires other than the recommended ones are used, the Vehicle Dynamic Control system may not operate properly and the Vehicle Dynamic Control off indicator light may come on.**
- **The Vehicle Dynamic Control system is not a substitute for winter tires or tire chains on a snow covered road.**

When accelerating on slippery surfaces the tire may spin or slip. With the vehicle Traction Control System (TCS), sensors detect these movements and control the braking and engine output to help improve vehicle road traction.

- When the TCS is operating, the **SLIP** indicator in the instrument panel blinks.
- If the **SLIP** indicator blinks, the vehicle may be under slippery conditions. Be sure to drive carefully. See "Slip indicator light" and "Traction Control System (TCS) off indicator light" in the "Instruments and controls" section of this manual.
- If a malfunction occurs in the system, the **SLIP** and TCS OFF indicator lights come on in the instrument panel.

As long as these lights are on, the traction control function is canceled. The vehicle will behave like a vehicle without the system.

**⚠WARNING**

- **The Traction Control System is designed to help maintain traction with the road surface but does not prevent accidents due to abrupt steering operation at high speeds or by careless or dangerous driving techniques. Reduce vehicle speed and be especially careful when driving and cornering on slippery surfaces and always drive carefully.**
- **If brake related parts such as brake pads, rotors and calipers are not standard equipment or are extremely deteriorated, the Traction Control System may not operate properly and the TCS OFF indicator light may come on.**
- **Do not modify the vehicle's suspension. If suspension parts such as shock absorbers, struts, springs, bushings and wheels are not standard equipment or are extremely deteriorated, the Traction Control System may not operate properly and the TCS OFF indicator light may come on.**

- **When driving on extremely inclined surfaces such as higher banked corners, the Traction Control System may not operate properly and the TCS OFF indicator light may come on. Do not drive on these types of roads.**
- **If wheels or tires other than the recommended ones are used, the Traction Control System may not operate properly and the TCS OFF indicator light may come on.**
- **The Traction Control System is not a substitute for winter tires or tire chains on a snow covered road.**

## HILL DESCENT CONTROL SYSTEM (if so equipped)

**⚠ WARNING**

- **Never rely solely on the hill descent control system to control vehicle speed when driving on steep down hill grades. Always drive carefully and attentively when using the hill descent control system and decelerate the vehicle speed by depressing the brake pedal if necessary. Be especially careful when driving on frozen, muddy or an extremely steep downhill roads. Failure to control vehicle speed may result in a loss of control of the vehicle and possible serious injury or death.**
- **The hill descent control may not control the vehicle speed on a hill under all load or road conditions. Always be prepared to depress the brake pedal to control vehicle speed. Failure to do so may result in a collision or serious personal injury.**

The hill descent control system helps maintain vehicle speed when driving under 15-21 mph (25-35 km/h) on steeper downhill grades. Hill descent control is useful when engine braking alone in 4H or 4L cannot control vehicle speed. Hill descent control applies the vehicle brakes to control vehicle speed allowing the driver to concentrate on steering while reducing the burden of brake and accelerator operation.

- When additional braking is required on steep downhill roads activate the hill descent control system by pushing the switch ON, see "Hill descent control switch" in the "Instruments and controls" section.
- Once the system is activated the indicator light will remain on in the instrument panel, see "Hill descent control system on indicator light" in the "Instruments and controls" section.

If the accelerator or brake pedal is depressed while the hill descent control system is on, the system will stop operating temporarily. As soon as the accelerator or brake pedal is released, the hill descent control system begins to function again if the hill descent control operating conditions are fulfilled.

For the best results, when descending steep downhill grades, the hill descent control switch should be ON and the selector lever in 2 (Second gear) or 1 (Low gear) for engine braking.

## HILL START ASSIST SYSTEM (if so equipped)

**⚠ WARNING**

- **Never rely solely on the hill start assist system to prevent the vehicle from moving backward on a hill. Always drive carefully and attentively. Depress the brake pedal when the vehicle is stopped on a steep hill. Be especially careful when stopped on a hill on frozen or muddy roads. Failure to prevent the vehicle from rolling backwards may result in a loss of control of the vehicle and possible serious injury or death.**
- **The hill start assist system is not designed to hold the vehicle at a standstill on a hill. Depress the brake pedal when the vehicle is stopped on a steep hill. Failure to do so may cause the vehicle to roll backwards and may result in a collision or serious personal injury.**
- **The hill start assist may not prevent the vehicle from rolling backwards on a hill under all load or road conditions. Always be prepared to depress the brake pedal to prevent the vehicle from rolling backwards. Failure to do so may result in a collision or serious personal injury.**

The hill start assist system automatically keeps the brakes applied to help prevent the vehicle from rolling backwards in the time it takes the driver to release the brake pedal and apply the accelerator when the vehicle is stopped on a hill.

Hill start assist will operate automatically under the following conditions:

- The selector lever is shifted to a forward or reverse gear.
- The vehicle is stopped completely on a hill by applying the brake.

The maximum holding time is 2 seconds. After 2 seconds the vehicle will begin to roll back and hill start assist will stop operating completely.

Hill start assist will not operate when the shift selector is shifted to N or P or on a flat and level road.

## COLD WEATHER DRIVING

### FREEING A FROZEN DOOR LOCK

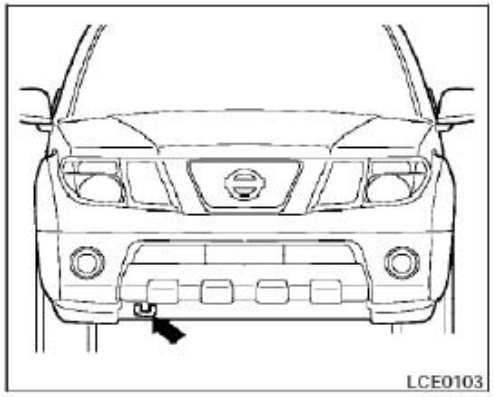
To prevent a door lock from freezing, apply deicer through the key hole. If the lock becomes frozen, heat the key before inserting it into the key hole or use the remote keyless entry keyfob (if so equipped).

### ANTI-FREEZE

In the winter when it is anticipated that the temperature will drop below 32°F (0°C), check the anti-freeze to assure proper winter protection. For details, see "Engine cooling system" in the "Maintenance and do-it-yourself" section of this manual.

### BATTERY

If the battery is not fully charged during extremely cold weather conditions, the battery fluid may freeze and damage the battery. To maintain maximum efficiency, the battery should be checked regularly. For details, see "Battery" in the "Maintenance and do-it-yourself" section of this manual.




VEHICLE RECOVERY (freeing a stuck vehicle)

**⚠ WARNING**

- **Stand clear of a stuck vehicle.**
- **Do not spin your tires at high speed. This could cause them to explode and result in serious injury. Parts of your vehicle could also overheat and be damaged.**

**⚠ CAUTION**

- **Tow chains or cables must be attached only to the main structural members of the vehicle or the towing hooks (if so equipped). Otherwise, the vehicle body will be damaged.**
- **Use the towing hook (if so equipped) only to free a vehicle stuck in sand, snow, mud, etc. Never tow the vehicle for a long distance using only the towing hook.**
- **The towing hook is under tremendous force when used to free a stuck vehicle. Never pull the hook at an angle.**
- **Always pull the cable straight out from the front or rear of the vehicle.**
- **Pulling devices should be routed so they do not touch any part of the suspension, steering, brake or cooling systems.**
- **Pulling devices such as ropes or canvas straps are not recommended for use in vehicle towing or recovery.**

### Pulling a stuck vehicle

If your vehicle is stuck in sand, snow, mud, etc., use a tow strap or other device designed specifically for vehicle recovery. Always follow the recovery device manufacturer's instructions.

Attach the tow strap to the towing hook.

### Rocking a stuck vehicle

If your vehicle is stuck in sand, snow, mud, etc., use the following procedure:

1. Turn off the Vehicle Dynamic Control System.
2. Make sure the area in front and behind the vehicle is clear of obstructions.
3. Turn the steering wheel right and left to clear an area around the front tires.
4. Slowly rock the vehicle forward and backward.
   - Shift back and forth between R (Reverse) and D (Drive).
   - Apply the accelerator as little as possible to maintain the rocking motion.
   - Release the accelerator pedal before shifting between R and D.
   - Do not spin the tires above 35 mph (55 km/h).
5. If the vehicle can not be freed after a few tries, contact a professional towing service to remove the vehicle.

## CHECKING BULBS

With all doors closed, apply the parking brake and place the ignition switch in the ON position without starting the engine. The following lights will come on:

, BRAKE or , , , , 4WD

The following lights come on briefly and then go off:

ABS or , , SLIP, , VDC OFF, 4LO , , OFF

**If any light fails to come on, it may indicate an open circuit in the electrical system. Have the system repaired promptly.**

## WARNING LIGHTS

**ABS** or Anti-lock Braking System (ABS) warning light

When the ignition switch is placed in the ON position, the Anti-lock Braking System (ABS) warning light illuminates and then turns off. This indicates the ABS is operational.

If the ABS warning light illuminates while the engine is running, or while driving, it may indicate the ABS is not functioning properly. Have the system checked by a NISSAN dealer.

If an ABS malfunction occurs, the anti-lock function is turned off. The brake system then operates normally, but without anti-lock assistance. See "Brake system" in the "Starting and driving" section.

AT CHECK Automatic transmission check warning light (if so equipped)

When the ignition switch is placed in the ON position, the light comes on for about 2 seconds. If the light comes on at any other time, it may indicate the automatic transmission system is not functioning properly. Have the system checked by a NISSAN dealer.

A/T OIL TEMP Automatic transmission oil temperature warning light

This light comes on when the automatic transmission oil temperature is too high. If the light comes on while driving, reduce the vehicle speed as soon as safely possible until the light turns off.

**⚠ CAUTION**

**Continued vehicle operation when the A/T oil temperature warning light is on may damage the automatic transmission.**

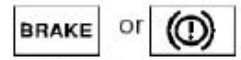
**ATP** Automatic transmission park warning light ( 4x4 model)

**⚠ WARNING**

- **If the ATP light is ON, this indicates that the automatic transmission P (Park) position will not function and the transfer case is in neutral.**
- **When parking, always make sure that the 4WD shift indicator light illuminates and the parking brake is set. Failure to engage the transfer position in 2WD, AUTO, 4H or 4LO could result in the vehicle moving unexpectedly, resulting in serious personal injury or property damage.**

- **Part time 4WD: Shift the 4WD switch into the 2WD, 4H or 4LO position again to turn off the ATP warning light when the shift selector is in the P position and the ATP warning light is ON. (Before shifting the 4WD switch into the 4LO position, move the shift selector into the N position once, shift the shift selector into P again and make sure the ATP warning light is OFF.)**
- **All mode 4WD: The warning light may come on when the ignition switch is ON and the shift selector is shifted to the P position while shifting the transfer case between 4H and 4LO. Shift the 4WD shift switch to the 2WD, AUTO, 4H, or 4LO position again to turn off the ATP warning light when the warning light comes on. (Before shifting the 4WD switch into the 4LO position or out of 4LO in the 4H position, move the shift selector into the N position.) Shift the shift selector into the P position and make sure that the 4WD shift indicator light is ON and the ATP warning light is OFF.)**

This light indicates that the automatic transmission parking function is not engaged. If the transfer control is not secured in any drive position while the shift selector is in the P (Park) position, the transmission will disengage and the drive wheels will not lock.

BRAKE or  Brake warning light

This light functions for both the parking brake and the foot brake systems.

**Parking brake indicator**

When the ignition switch is placed in the ON position, the light comes on when the parking brake is applied.

**Low brake fluid warning light**

When the ignition switch is placed in the ON position, the light warns of a low brake fluid level. If the light comes on while the engine is running with the parking brake not applied, stop the vehicle and perform the following:

1. Check the brake fluid level. Add brake fluid as necessary. See "Brake fluid" in the "Maintenance and do-it-yourself" section of this manual.
2. If the brake fluid level is correct, have the warning system checked by a NISSAN dealer.

**⚠WARNING**

- **Your brake system may not be working properly if the warning light is on. Driving could be dangerous. If you judge it to be safe, drive carefully to the nearest service station for repairs. Otherwise, have your vehicle towed because driving it could be dangerous.**
- **Pressing the brake pedal with the engine stopped and/or a low brake fluid level may increase your stopping distance and braking will require greater pedal effort as well as pedal travel.**
- **If the brake fluid level is below the MINIMUM or MIN mark on the brake fluid reservoir, do not drive until the brake system has been checked at a NISSAN dealer.**

 Charge warning light

If this light comes on while the engine is running, it may indicate the charging system is not functioning properly. Turn the engine off and check the generator belt. If the belt is loose, broken, missing, or if the light remains on, see a NISSAN dealer immediately.

## 7.2 VEHICLE ARRIVAL CONDITION REPORT

CONTRACT NO.: DTNH22-08-D-00098
DATE RECIEVED: 8/24/2009

From: *Power Nissan Torrance*

To: *Dynamic Research, Inc*

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

**Vehicle** VIN: *5N1AR18U99C618299* NHTSA NO.: *C95210*

Model Year: *2009* Odometer Reading: *17 Miles*
Make: *Nissan* Body Style: *MPV*
Model: *Pathfinder* Body Color: *Black*
Manufacture Date: *7/09* Dealer: *Competitive Vehicle Services*
GVWR (kg/lb) *2722 (6000)* 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:

Small dent on hood.
Owner's manual and spare keys not supplied, have been requested. (These were supplied subsequently)

RECORDED BY: *J Brubacher* DATE RECORDED: *8/25/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *9/16/2009*

## 7.3 VEHICLE COMPLETION CONDITION REPORT

CONTRACT NO.: DTNH22-08-D-00098
DATE RELEASED: *10/7/2009*

---

**Vehicle** VIN: *5N1AR18U99C618299* NHTSA NO.: *C95210*

Model Year: *2009* Odometer Reading: *79 Miles*
Make: *Nissan* Body Style: *MPV*
Model: *Pathfinder* Body Color: *Black*
Manufacture Date: *7/09* Dealer: *Competitive Vehicle Services*
GVWR (kg/lb) *2722 (6000)* Price: *Leased*

---

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

_____ THERE ARE NO DENTS OR OTHER INTERIOR OR EXTERIOR FLAWS

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

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

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

REMARKS:

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

*None*

Explanation for equipment removal:

*None*

Test Vehicle Condition:

*Small dent in hood*

---

RECORDED BY: *J Brubacher* DATE RECORDED: *10/7/2009*

APPROVED BY: *J Lenkeit* DATE APPROVED: *10/7/2009*

## 7.4 SINE WITH DWELL TEST RESULTS

2009 Nissan Pathfinder
NHTSA No. C95210
Date of Test 9/15/2009
Date Created 10/01/2009

| File | SWA @ 5deg Ct | MES | Time @ 5deg | COS | Time @ COS | MOS | Time @ MOS | YRR1 | YR1 | YRR1 Ct | YRR175 | YR175 | YRR175 Ct | 2nd Yaw Peak | 2nd Yaw Peak Ct | Lat Disp | Lat. Acc. 1.07s | 1st SWA Peak | 1st SWA Peak Ct | 2nd SWA Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (deg) | (mph) | (s) | | (s) | | (sec) | (%) | (deg/s) | | (%) | (deg/s) | | (deg/s) | | (ft) | (g) | (deg) | | (deg) |
| 21 | 709 | 49.15 | 3.54 | 1091 | 5.448 | 847 | 4.228 | -1.85 | -0.29 | 1291 | -1.5 | -0.23 | 1441 | 15.53 | 924 | | 0.37 | 54.8 | 775 | 54.96 |
| 22 | 708 | 49.16 | 3.533 | 1091 | 5.446 | 847 | 4.227 | -1.87 | -0.38 | 1291 | 0.14 | 0.03 | 1441 | 20.41 | 923 | | 0.43 | 72.7 | 775 | 72.73 |
| 23 | 707 | 50.11 | 3.53 | 1091 | 5.447 | 847 | 4.227 | -1.34 | -0.22 | 1291 | 0.57 | 0.09 | 1441 | 16.56 | 922 | | 0.42 | 90.54 | 775 | 90.62 |
| 24 | 707 | 50.27 | 3.527 | 1091 | 5.446 | 847 | 4.226 | -2.73 | -0.5 | 1291 | -1.78 | -0.33 | 1441 | 18.39 | 934 | | 0.37 | 108.47 | 775 | 108.47 |
| 25 | 706 | 50.48 | 3.525 | 1090 | 5.445 | 847 | 4.226 | -2.54 | -0.49 | 1290 | -1.18 | -0.23 | 1440 | 19.36 | 936 | | 0.23 | 126.52 | 775 | 126.43 |
| 26 | 706 | 50.43 | 3.524 | 1090 | 5.444 | 846 | 4.225 | -1.2 | -0.32 | 1290 | -0.79 | -0.21 | 1440 | 27.12 | 927 | | 0.13 | 145.5 | 775 | 145.22 |
| 27 | 706 | 50.02 | 3.524 | 1090 | 5.444 | 846 | 4.225 | -1.72 | -0.66 | 1290 | -1.21 | -0.47 | 1440 | 38.56 | 954 | -8.55 | -0.01 | 163.57 | 775 | 163.08 |
| 28 | 706 | 49.92 | 3.523 | 1090 | 5.444 | 847 | 4.226 | -1.12 | -0.41 | 1290 | -0.37 | -0.14 | 1440 | 36.72 | 961 | -8.98 | -0.08 | 181.57 | 776 | 181.39 |
| 29 | 706 | 50.11 | 3.523 | 1090 | 5.443 | 847 | 4.226 | -1.27 | -0.5 | 1290 | -0.37 | -0.15 | 1440 | 39.67 | 944 | -9.05 | -0.02 | 199.59 | 776 | 199.45 |
| 30 | 706 | 50.08 | 3.524 | 1090 | 5.443 | 847 | 4.226 | -2.06 | -0.94 | 1290 | -0.68 | -0.31 | 1440 | 45.79 | 966 | -9.25 | -0.18 | 216.31 | 777 | 217.54 |
| 31 | 706 | 50.5 | 3.523 | 1090 | 5.442 | 847 | 4.226 | -1.54 | -0.7 | 1290 | -0.62 | -0.28 | 1440 | 45.61 | 965 | -9.67 | -0.18 | 234.41 | 777 | 236.76 |
| 32 | 706 | 50.27 | 3.524 | 1090 | 5.442 | 847 | 4.227 | -1.53 | -0.74 | 1290 | -0.58 | -0.28 | 1440 | 48.44 | 972 | -9.58 | -0.12 | 252.77 | 776 | 254.6 |
| 33 | 706 | 50.29 | 3.524 | 1090 | 5.441 | 847 | 4.226 | -1.37 | -0.68 | 1290 | -0.37 | -0.18 | 1440 | 49.42 | 973 | -9.55 | -0.1 | 267.89 | 776 | 269.1 |
| 34 | 709 | 50.23 | 3.539 | 1092 | 5.451 | 847 | 4.228 | -1.63 | 0.26 | 1292 | -0.8 | 0.13 | 1442 | -15.76 | 924 | | -0.37 | 55.61 | 776 | 55.56 |
| 35 | 708 | 50.39 | 3.533 | 1091 | 5.448 | 847 | 4.226 | -1.83 | 0.4 | 1291 | -0.37 | 0.08 | 1441 | -21.89 | 927 | | -0.41 | 73.47 | 775 | 73.29 |
| 36 | 707 | 49.88 | 3.529 | 1091 | 5.449 | 847 | 4.226 | -3.24 | 0.54 | 1291 | -0.03 | 0 | 1441 | -16.64 | 922 | | -0.38 | 91.28 | 775 | 91.16 |
| 37 | 707 | 49.95 | 3.527 | 1091 | 5.448 | 847 | 4.226 | -2.57 | 0.43 | 1291 | -0.24 | 0.04 | 1441 | -16.7 | 952 | | -0.27 | 109.07 | 775 | 109 |
| 38 | 706 | 50.05 | 3.524 | 1091 | 5.447 | 847 | 4.226 | -1.95 | 0.45 | 1291 | -0.47 | 0.11 | 1441 | -23.22 | 956 | | -0.17 | 127.13 | 775 | 127.03 |
| 39 | 706 | 50.17 | 3.523 | 1090 | 5.445 | 847 | 4.226 | -2.11 | 0.58 | 1290 | -0.57 | 0.16 | 1440 | -27.36 | 934 | | -0.1 | 145.98 | 775 | 146.18 |
| 40 | 706 | 50.37 | 3.523 | 1090 | 5.444 | 847 | 4.226 | -1.24 | 0.37 | 1290 | 0.1 | -0.03 | 1440 | -30.14 | 940 | | -0.02 | 163.85 | 775 | 164.15 |
| 41 | 706 | 50.35 | 3.522 | 1090 | 5.443 | 847 | 4.226 | -0.86 | 0.3 | 1290 | -0.18 | 0.06 | 1440 | -34.53 | 970 | 8.46 | 0.05 | 181.9 | 776 | 182.24 |
| 42 | 706 | 50.3 | 3.522 | 1090 | 5.443 | 847 | 4.226 | -0.86 | 0.36 | 1290 | 0 | 0 | 1440 | -41.8 | 964 | 8.79 | 0.12 | 199.64 | 776 | 200.36 |
| 43 | 706 | 50.33 | 3.523 | 1090 | 5.444 | 847 | 4.227 | -0.77 | 0.34 | 1290 | 0.09 | -0.04 | 1440 | -44.05 | 958 | 8.98 | 0.16 | 217.03 | 777 | 218.43 |
| 44 | 706 | 50.56 | 3.523 | 1090 | 5.443 | 847 | 4.227 | -0.86 | 0.39 | 1290 | -0.11 | 0.05 | 1440 | -45.02 | 956 | 8.9 | 0.09 | 235.11 | 778 | 237.45 |
| 45 | 706 | 50.23 | 3.524 | 1090 | 5.442 | 847 | 4.227 | -1.64 | 0.75 | 1290 | 0.04 | -0.02 | 1440 | -45.66 | 955 | 9.23 | 0.06 | 253.02 | 776 | 255.24 |
| 46 | 706 | 50.46 | 3.523 | 1090 | 5.441 | 847 | 4.227 | -1.9 | 0.91 | 1290 | -0.49 | 0.24 | 1440 | -47.63 | 979 | 9.49 | 0.17 | 268.45 | 776 | 269.89 |

## 7.5 SLOWLY INCREASING STEER TEST RESULTS

2009 Nissan Pathfinder
NHTSA No. 90512
Date of Test 8/15/2009
Date Created 10/01/2009

| File | EventPt | DOS | MES (mph) | Mean SPD (mph) | AYcount_3 | THETAENCF_3 (deg) | AYCG_CD2_3 (g) | r_squared | ZeroBegin | ZeroEnd |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 700 | 1 | 50.19 | 50.49 | 1258 | -37.30 | -0.2974 | 0.9941 | 500 | 700 |
| 11 | 706 | 1 | 49.41 | 49.84 | 1255 | -37.15 | -0.3094 | 0.9961 | 506 | 706 |
| 12 | 700 | 1 | 50.13 | 49.98 | 1261 | -37.50 | -0.3012 | 0.9966 | 500 | 700 |
| 13 | 697 | 0 | 49.69 | 49.88 | 1239 | 36.12 | 0.3033 | 0.9960 | 497 | 697 |
| 14 | 705 | 0 | 49.68 | 49.54 | 1229 | 35.49 | 0.3011 | 0.9987 | 505 | 705 |
| 15 | 705 | 0 | 50.19 | 50.32 | 1218 | 34.72 | 0.2967 | 0.9981 | 505 | 705 |
| | | | | | Averages | 36.40 | 0.3015 | | | |

| Scalars | Steering Angles (deg) |
|---|---|
| 1.5 | 55 |
| 2.0 | 73 |
| 2.5 | 91 |
| 3.0 | 109 |
| 3.5 | 127 |
| 4.0 | 146 |
| 4.5 | 164 |
| 5.0 | 182 |
| 5.5 | 200 |
| 6.0 | 218 |
| 6.5 | 237 |
| 7.0 | 255 |
| 7.5 | 270 |

## 7.6 INERTIAL SENSING SYSTEM LOCATION COORDINATES

| | | | |
|---|---|---|---|
| Vehicle: | **2009 Nissan Pathfinder** | | |
| NHTSA No.: | C95210 | | |
| Measurement date: | 9/08/2009 | | |
| Wheelbase: | 112.2 | Faro Arm S/N: | U08-05-08-06636 |
| Units | Inches | 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 | Rex Y | Ref Z |
|---|---|---|---|
| M_PLANE001_Ground_Plane | - | - | 0.0000 |
| M_Line_Y_Axis | 2.465 | -2.619 | 0.0000 |
| M_Point_48_Ref | 0.000 | 0.000 | - |
| M_CIRCLE001_I_Left_Rear_Wheel_Axle | -22.826 | 13.544 | -14.323 |
| M_Point_IMU_side | 17.452 | | -25.3907 |
| M_Point_ROOF | - | - | -69.135 |
| | | | |
| Motion Pak reference point taken from mid height of unit left side | | | |
| Motion Pak Width = 3.05" ==> ½ W = 1.525 | | | |
| Motion_PAK_Location | 17.452 | 47.469 | -25.3907 |

Measurement Notes

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

**Coordinate Measurements Calculated for S7D (Matlab Program)**

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

| | Ref X | Rex Y | Ref Z |
|---|---|---|---|
| **Motion_PAK_Location in S7D (Matlab program) coordinate system** | **71.922** | **-0.531** | **25.391** |

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).