**REPORT NUMBER: 305-MGA-2011-004**

# SAFETY COMPLIANCE TESTING FOR FMVSS 305
## Electric Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection

**NISSAN MOTOR CO., LTD.**
**2011 NISSAN LEAF 5-DR HATCHBACK**
**NHTSA NUMBER: CB5205**

**PREPARED BY:**
**MGA RESEARCH CORPORATION**
**5000 WARREN ROAD**
**BURLINGTON, WI 53105**

**Test Date: September 23, 2011**

**Report Date: October 20, 2011**

**FINAL REPORT**

**PREPARED FOR:**
**U.S. DEPARTMENT OF TRANSPORTATION**
**NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION**
**ENFORCEMENT**
**OFFICE OF VEHICLE SAFETY COMPLIANCE**
**1200 NEW JERSEY AVENUE, SE**
**WEST BUILDING (NVS-220)**
**WASHINGTON, DC 20590**

This publication is distributed by the U.S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof. If trade or manufacturers' names or products are mentioned it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products or manufacturers.

Prepared by: _____
Donna Janovicz, Project Manager

Approved by: _____
Joe Fleck, Project Engineer

Approval Date: September 30, 2011

FINAL REPORT ACCEPTANCE BY OVSC:

Edward E. Chan

Digitally signed by Edward E. Chan
DN: cn=Edward E. Chan, o=National Highway Traffic Safety Administration, ou=Office of Vehicle Safety Compliance, email=ed.chan@dot.gov, c=US
Date: 2011.10.19 10:25:01 -04'00'

Accepted by: _____

Acceptance Date: _____

## Technical Report Documentation Page

| | | |
|---|---|---|
| *1. Report No.*<br>305-MGA-2011-004 | *2. Government Accession No.* | *3. Recipient's Catalog No.* |
| *4. Title and Subtitle*<br>Final Report of FMVSS 305 Compliance Testing of 2011 Nissan Leaf 5-Dr Hatchback;<br>NHTSA No.: CB5205 | | *5. Report Date*<br>October 20, 2011<br>*6. Performing Organization Code*<br>MGA |
| *7. Author(s)*<br>Donna Janovicz, Project Manager<br>Joe Fleck, Project Engineer | | *8. Performing Organization Report No.*<br>305-MGA-2011-004 |
| *9. Performing Organization Name and Address*<br>MGA Research Corporation<br>5000 Warren Road<br>Burlington, WI 53105 | | *10. Work Unit No.*<br>*11. Contract or Grant No.*<br>DTNH22-07-D-00062 |
| *12. Sponsoring Agency Name and Address*<br>U.S. Department of Transportation<br>National Highway Traffic Safety Administration<br>Office of Vehicle Safety Compliance (NVS-220)<br>1200 New Jersey Ave, SE<br>Washington, DC 20590 | | *13. Type of Report and Period Covered:*<br>Final Test Report<br>09/23/2011<br>*14. Sponsoring Agency Code*<br>NVS-220 |
| *15. Supplementary Notes* | | |

*16. Abstract*

An indicant compliance test was conducted on the subject 2011 Nissan Leaf 5-Dr Hatchback in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-305-01 for the determination of FMVSS 305 compliance. Test failures identified were as follows:

None

| | | | |
|---|---|---|---|
| *17. Key Words*<br>Compliance Testing<br>Safety Engineering<br>FMVSS 305 | | *18. Distribution Statement*<br>Copies of this report are available from:<br>National Highway Traffic Safety Administration<br>Technical Information Services (TIS)<br>Room E12-100 East Building<br>1200 New Jersey Ave.<br>Washington, D.C. 20590<br>e-mail: tis@nhtsa.dot.gov<br>Fax: 202-493-2833 | |
| *19. Security Classif. (of this report)*<br>Unclassified | *20. Security Classif. (of this page)*<br>Unclassified | *21. No. of Pages*<br>30 | 22. Price |

Form DOT F1700.7 (8-72)

TABLE OF CONTENTS

## SECTION 1
## PURPOSE OF COMPLIANCE TEST

This electric vehicle, a 2011 Nissan Leaf 5-Dr Hatchback, (NHTSA No. CB5205), in conjunction with the FMVSS 214P impact, was tested to FMVSS 305.

The test was performed in accordance with the specifications of the Office of Vehicle Safety Compliance (OVSC) Test Procedure TF-305-01 to determine indicant compliance to the requirements of Federal Motor Vehicle Safety Standard (FMVSS) 305, “Electric Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection”.

Based on the test results, the 2011 Nissan Leaf 5-Dr Hatchback appears to meet the requirements of FMVSS 305 testing.

This program is sponsored by the National Highway Traffic Safety Administration (NHTSA), under Contract No. DTNH22-07-D-00062.

The following data sheets document the results of the FMVSS 305 test.

## TEST NOTES

None

## SECTION 2
## DATA SHEETS

## DATA SHEET NO. 1

## TEST VEHICLE SPECIFICATIONS

Test Vehicle: 2011 Nissan Leaf 5-Dr Hatchback NHTSA No. CB5205

### TEST VEHICLE INFORMATION

| | |
|---|---|
| Year/Make/Model/Body Style | 2011 Nissan Leaf 5-Dr Hatchback |
| NHTSA No. | CB5205 |
| Color | Black |
| Date Received | 6/10/2011 |
| Odometer Reading | 6 miles |
| Selling Dealer | Puente Hills Nissan |

### DATA FROM CERTIFICATION LABEL

| | |
|---|---|
| Manufactured By | Nissan Motor Co. Ltd. |
| Date of Manufacture | 4/11 |
| VIN: | JN1AZ0CP3BT002476 |

| | |
|---|---|
| GVWR (kg) | 1960 |
| GAWR Front (kg) | 1000 |
| GAWR Rear (kg) | 965 |

### DATA FROM VEHICLE'S TIRE PLACARD & SIDEWALL

| Measured Parameter | Front | Rear |
|---|---|---|
| Location of Placard of Vehicle | Door Latch Post | |
| Recommended Tire Size | P205/55R16 | P205/55R16 |
| Recommended Cold Tire Pressure | 250 kPa | 250 kPa |
| Size of Tires on Test Vehicle | P205/55R16 | P205/55R16 |
| Type of Spare Tire | None, tire sealant & inflator kit in place of spare tire | |

### VEHICLE CAPACITY DATA

| Measured Parameter | Front | Rear | Third | Total |
|---|---|---|---|---|
| Type of Front Seats | Bucket | Split Bench | | |
| Number of Occupants | 2 | 3 | | 5 |
| Capacity Weight (VCW) (kg) | | | | 390 |
| Number of Occupants x 68 kg | | | | 340 |
| Cargo Weight (RCLW) (kg) | | | | 50 |

### ELECTRIC VEHICLE PROPULSION SYSTEM

| | |
|---|---|
| Type of Electric Vehicle (Electric/Hybrid): | Electric |
| Propulsion Battery Type: | Lithium-Ion |
| Nominal Voltage (V): | 360 V |
| Physical Location of Automatic Propulsion Battery Disconnect: | Inside the Battery Pack System |
| Auxiliary Battery Type: | Lead Acid Battery |

**DATA SHEET 2**

**PRE-TEST DATA**

Test Vehicle: 2011 Nissan Leaf 5-Dr Hatchback NHTSA No. CB5205

**CALCULATION OF TARGET TEST WEIGHT (TTW)**

| Measured Parameter | Units | Value |
|---|---|---|
| Unloaded Vehicle Weight (UVW) | kg | 1529.0 |
| Rated Cargo & Luggage Weight (RCLW) | kg | 50 |
| Weight of 1 P572U ATD (ES-2re) Dummy | kg | 77.1 |
| TARGET TEST WEIGHT | kg | 1656.1 |

Note: The target weight is calculated including tolerances as specified in each vehicle crash test procedure.

**TEST VEHICLE WEIGHTS**

| | Units | As Delivered | | | Fully Loaded | | | As Tested | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Front Axle | Rear Axle | Total | Front Axle | Rear Axle | Total | Front Axle | Rear Axle | Total |
| Left | kg | 431.8 | 337.9 | | 463.6 | 390.5 | | 463.1 | 386.0 | |
| Right | kg | 430.0 | 329.3 | | 435.4 | 366.6 | | 452.7 | 346.6 | |
| Ratio | % | 56.4 | 43.6 | | 54.3 | 45.7 | | 55.6 | 44.4 | |
| Totals | kg | 861.8 | 667.2 | 1529.0 | 899.0 | 757.1 | 1656.1 | 915.8 | 732.6 | 1648.4 |

**TIRE PRESSURES**

| | Units | LF | RF | RR | LR |
|---|---|---|---|---|---|
| As Delivered | kPa | 250 | 250 | 250 | 250 |
| As Tested | kPa | 250 | 250 | 250 | 250 |

**PROPULSION BATTERY SYSTEM DATA (COTR SUPPLIED DATA)**

| | | |
|---|---|---|
| Electrolyte Fluid Type: | Organic Electrolyte | |
| Electrolyte Fluid Specific Gravity: | 1.192 g/ml, estimated | |
| Electrolyte Kinematic Viscosity (centistokes): | | |
| Electrolyte Fluid Color: | Clear | |
| Propulsion Battery Coolant Type, Color, Specific Gravity (if applicable): | Air | |
| Location of Battery Modules: | | Inside Passenger Compartment |
| | X | Outside Passenger Compartment |

**DATA SHEET 2 (CONTINUED)**

**PRE-TEST DATA**

**MEASURE AND RECORD BATTERY STATE OF CHARGE**

| | | |
|---|---|---|
| **X** | Maximum State of Charge recommended by manufacturer: | 400 V |
| **X** | Test Voltage (≥95% of Maximum State of Charge): | 387 |
| | Test Voltage (Within Normal Operating Voltage Range): | |

**VEHICLE CHASSIS GROUND POINT(S) LOCATION(S)**

| | |
|---|---|
| Details of Vehicle Chassis Ground Point(s) & Location(s) | On Vehicle Exterior Located at Right Front Fender with Paint Removed |
| Details of Vehicle High Voltage (HV) Location(s) | Located Underneath Vehicle Between HV Battery and Electrical Drive |

**PROPULSION BATTERY SYSTEM**

| | |
|---|---|
| Details of Propulsion Battery Components | HV Battery Located Outside Passenger Compartment Underneath Vehicle<br><br>HV Inverter Located Under Hood |

## DATA SHEET 3

## PRE-IMPACT ELECTRIC ISOLATION MEASUREMENTS & CALCULATIONS

Test Vehicle: 2011 Nissan Leaf 5-Dr Hatchback NHTSA No. CB5205

### VOLTMETER INFORMATION

| | |
|---|---|
| Make: | Fluke |
| Model: | 11 |
| Serial Number: | 68541895 |
| Internal Impedance Value (MΩ): | > 10 MΩ < 100 pF |
| Resolution (V): | 600 |
| Last Calibration Date: | 7/24/2011 |

### PROPULSION BATTERY VOLTAGE

Measurement shall be made with propulsion battery connected to the vehicle propulsion system, and the vehicle in the “ready-to-drive” (Propulsion motor(s) activated) position.

If voltage measurement is not at the voltage or within the normal operating voltage range specified by the manufacturer, the battery must be charged.

| | |
|---|---|
| Vb (V): | 387.4 |

### PROPULSION BATTERY TO VEHICLE CHASSIS

Vehicle chassis point(s) determined and supplied to contractor by COTR.

| | |
|---|---|
| V1 (V): | 124.6 |
| V2 (V): | 345.1 |

### PROPULSION BATTERY TO VEHICLE CHASSIS ACROSS RESISTOR

The known resistance Ro (in ohms) should be approximately 500 times the normal operating voltage of the vehicle (in volts) per SAE J1766.

| | |
|---|---|
| Ro (Ω): | 200200 Ω |

## DATA SHEET 3 (CONTINUED)

## PRE-IMPACT ELECTRICAL ISOLAITON MEASUREMENTS & CALCULATIONS

### ELECTRICAL ISOLATION MEASUREMENT

Note: If measured voltage is zero and results in a division by zero, record “Zero Volts”. This “zero voltage” condition is considered as being compliant.

| | |
|---|---|
| V1’ (V): | 2.3 |
| Ri1 = Ro (1 + V2/V1) [(V1-V1’)/V1’] | |
| Ri1 (Ω): | 40129K |
| V2’ (V): | 2.8 |
| Ri2 = R0 (1 + V1/V2) [(V2-V2’)/V2’] | |
| Ri2 (Ω): | 33311K |
| Ri = The lesser of Ti1 and Ri2 | |
| Ri Pre-Test ((Ω): | 33311K |
| Ri/Vb (Ω/V): | 85986.2 |
| Minimum Electrical Isolation Value is 500 Ω/V | |

Note: Measured 7 minutes 22 seconds before impact.

| | Yes | No, Fail |
|---|---|---|
| Is the measured Electrical Isolation Value ≥ 500 Ω/V? | X | |

**DATA SHEET 4**

**POST-IMPACT DATA**

Test Vehicle: 2011 Nissan Leaf 5-Dr Hatchback NHTSA No. CB5205

**VOLTMETER INFORMATION**

| | |
|---|---|
| Make: | Fluke |
| Model: | 11 |
| Serial Number: | 68541895 |
| Internal Impedance Value (MΩ): | > 10 MΩ < 100 pF |
| Nominal Propulsion Battery Voltage (Vb) (V): | 360 |

**PROPULSION BATTERY VOLTAGE**

NOTE: Record V1, V2, V1', V2' voltage measurements immediately after the impacted vehicle **comes to rest.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| V1 = | 1.1 | V | Impact Time: | 0 | Minutes | 43 | s |
| V2 = | 0.3 | V | Impact Time: | 0 | Minutes | 54 | s |
| V1' = | 0.0 | V | Impact Time: | 0 | Minutes | 48 | s |
| V2' = | 0.0 | V | Impact Time: | 0 | Minutes | 56 | s |

**ELECTRICAL ISOLATION MEASUREMENT**

Note: If measured voltage is zero and results in a division by zero, record "Zero Volts". This "zero voltage" condition is considered as being compliant.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ri1 = Ro (1 + V2/V1) [(V1-V1')/V1'] | | | | | | | |
| Ri1 = | 0 | Ω | Impact Time: | 0 | Minutes | 54 | s |
| Ri2 = Ro (1 + V1/V2) [(V2-V2')/V2'] | | | | | | | |
| Ri2 = | 0 | Ω | Impact Time: | 0 | Minutes | 56 | s |
| Ri = The lesser of Ri1 and Ri2 | | | | | | | |
| Ri = | 0 | Ω | Impact Time: | 0 | Minutes | 56 | s |
| Ri/Vb = electrical Isolation Value/Nominal Battery Voltage | | | | | | | |
| Minimum Electrical Value is 500 Ω/V | | | | | | | |
| Ri/Vb = | 0 | Ω/V | Impact Time: | 0 | Minutes | 56 | s |

| | Yes | No, Fail |
|---|---|---|
| Is the measured Electrical Isolation Value ≥ 500 Ω/V? | X | |

**DATA SHEET 4 (CONTINUED)**

**POST-IMPACT DATA**

**PROPULSION BATTERY SYSTEM COMPONENTS**

| Describe Propulsion Battery Module movement within the passenger compartment [Supply photographs as appropriate]: |
|---|
| Not Applicable |

| | Yes | No |
|---|---|---|
| Has the Propulsion Battery Module moved within the passenger compartment? | | X |

| Describe intrusion of an outside Propulsion Battery Component into the passenger compartment [Supply photographs as appropriate]: |
|---|
| None |

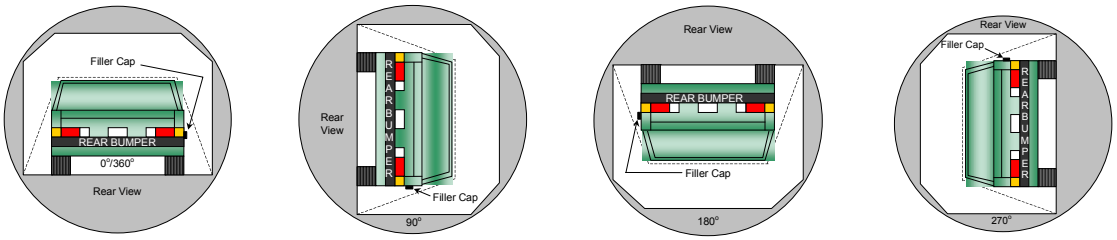
| | Yes | No |
|---|---|---|
| Has an outside Propulsion Battery Component intruded into the passenger compartment? | | X |

| | Yes | No |
|---|---|---|
| Is propulsion battery electrolyte spillage visible in the passenger compartment? | | X |

**DATA SHEET 5**

**STATIC ROLLOVER TEST DATA**

Test Vehicle: 2011 Nissan Leaf 5-Dr Hatchback NHTSA No. CB5205




**0/360** **90** **180** **270**

**REAR VIEW**

**DETERMINATION OF PROPULSION BATTERY ELECTROYTE COLLECTION TIME PERIOD**

| Rollover Stage | Rotation Time (spec. 1-3 min) | | | | FMVSS 301 Hold Time | | Total Time | | | | Next Whole Minute Interval | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0° - 90° | 2 | minutes | 02 | seconds | 5 | minutes | 7 | minutes | 02 | seconds | 8 | minutes |
| 90° - 180° | 1 | minutes | 57 | seconds | 5 | minutes | 6 | minutes | 57 | seconds | 7 | minutes |
| 180° - 270° | 1 | minutes | 50 | seconds | 5 | minutes | 6 | minutes | 50 | seconds | 7 | minutes |
| 270° - 360° | 2 | minutes | 01 | seconds | 5 | minutes | 7 | minutes | 01 | seconds | 8 | minutes |

**ACTUAL TEST VEHICLE PROPULSION BATTERY ELECTROLYTE SPILLAGE**

| Rollover Stage | Propulsion Battery Electrolyte Spillage (L) | Spillage Location |
|---|---|---|
| 0° to 90° | 0 | |
| 90° to 180° | 0 | |
| 180° to 270° | 0 | |
| 270° to 360° | 0 | |

Total Spillage: _____0____L

| | Yes | No |
|---|---|---|
| Is the total spillage of propulsion battery electrolyte greater than 5.0 Liters? | | X |
| Is propulsion battery electrolyte spillage visible in the passenger compartment? | | X |

**DATA SHEET 5 (CONTINUED)**

**STATIC ROLLOVER TEST DATA**

Test Vehicle: 2011 Nissan Leaf 5-Dr Hatchback NHTSA No. CB5205

**VOLTMETER INFORMATION**

| | |
|---|---|
| Make: | Fluke |
| Model: | 11 |
| Serial Number: | 68541895 |
| Internal Impedance Value (MΩ): | > 10 MΩ < 100 pF |
| Nominal Propulsion Battery Voltage (Vb) (V): | 360 |

**ELECTRICAL ISOLATION MEASUREMENT**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| V1 = | 0.0 | V | 90° | Time: | 2 | Minutes | 22 | s |
| V1 = | 0.0 | V | 180° | Time: | 2 | Minutes | 20 | s |
| V1 = | 0.0 | V | 270° | Time: | 2 | Minutes | 19 | s |
| V1 = | 0.0 | V | 360° | Time: | 2 | Minutes | 25 | s |
| V2 = | 0.0 | V | 90° | Time: | 2 | Minutes | 19 | s |
| V2 = | 0.0 | V | 180° | Time: | 2 | Minutes | 15 | s |
| V2 = | 0.0 | V | 270° | Time: | 2 | Minutes | 15 | s |
| V2 = | 0.0 | V | 360° | Time: | 2 | Minutes | 38 | s |
| V1' = | 0.0 | V | 90° | Time: | 2 | Minutes | 15 | s |
| V1' = | 0.0 | V | 180° | Time: | 2 | Minutes | 12 | s |
| V1' = | 0.0 | V | 270° | Time: | 2 | Minutes | 12 | s |
| V1' = | 0.0 | V | 360° | Time: | 2 | Minutes | 30 | s |
| V2' = | 0.0 | V | 90° | Time: | 2 | Minutes | 13 | s |
| V2' = | 0.0 | V | 180° | Time: | 2 | Minutes | 09 | s |
| V2' = | 0.0 | V | 270° | Time: | 2 | Minutes | 08 | s |
| V2' = | 0.0 | V | 360° | Time: | 2 | Minutes | 34 | s |
| Vb = | 0.0 | V | 90° | Time: | 2 | Minutes | 10 | s |
| Vb = | 0.0 | V | 180° | Time: | 2 | Minutes | 03 | s |
| Vb = | 0.0 | V | 270° | Time: | 2 | Minutes | 04 | s |
| Vb = | 0.4 | V | 360° | Time: | 2 | Minutes | 20 | s |

**DATA SHEET 5 (CONTINUED)**

**STATIC ROLLOVER TEST DATA**

Test Vehicle: 2011 Nissan Leaf 5-Dr Hatchback NHTSA No. CB5205

**ELECTRICAL ISOLATION CALCULATION**

Note: If measured voltage is zero and results in a division by zero, record "Zero Volts". This "zero voltage" condition is considered as being compliant.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ri1 = Ro (1 + V2/V1) [(V1-V1')/V1'] | | | | | | | | |
| Ri1 = | Zero Volts | Ω | 90° | Time: | 2 | Minutes | 19 | s |
| Ri1 = | Zero Volts | Ω | 180° | Time: | 2 | Minutes | 15 | s |
| Ri1 = | Zero Volts | Ω | 270° | Time: | 2 | Minutes | 15 | s |
| Ri1 = | Zero Volts | Ω | 360° | Time: | 2 | Minutes | 38 | s |
| Ri2 = Ro (1 + V1/V2) [(V2-V2')/V2'] | | | | | | | | |
| Ri2 = | Zero Volts | Ω | 90° | Time: | 2 | Minutes | 13 | s |
| Ri2 = | Zero Volts | Ω | 180° | Time: | 2 | Minutes | 09 | s |
| Ri2 = | Zero Volts | Ω | 270° | Time: | 2 | Minutes | 08 | s |
| Ri2 = | Zero Volts | Ω | 360° | Time: | 2 | Minutes | 34 | s |
| Ri = The lesser of Ri1 and Ri2 | | | | | | | | |
| Ri = | Zero Volts | Ω | 90° | Time: | 2 | Minutes | 19 | s |
| Ri = | Zero Volts | Ω | 180° | Time: | 2 | Minutes | 15 | s |
| Ri = | Zero Volts | Ω | 270° | Time: | 2 | Minutes | 15 | s |
| Ri = | Zero Volts | Ω | 360° | Time: | 2 | Minutes | 38 | s |
| Ri/Vb = Electrical Isolation Value/Nominal Battery Voltage<br>Minimum Electrical Isolation Value is 500 Ω /V | | | | | | | | |
| Ri/Vb = | Zero Volts | Ω/V | 90° | Time: | 2 | Minutes | 19 | s |
| Ri/Vb = | Zero Volts | Ω/V | 180° | Time: | 2 | Minutes | 15 | s |
| Ri/Vb = | Zero Volts | Ω/V | 270° | Time: | 2 | Minutes | 15 | s |
| Ri/Vb = | Zero Volts | Ω/V | 360° | Time: | 2 | Minutes | 38 | s |

| | Yes | No, Fail |
|---|---|---|
| Is the measured Electrical Isolation Value ≥ 500 Ω/V? | X | |

# APPENDIX A

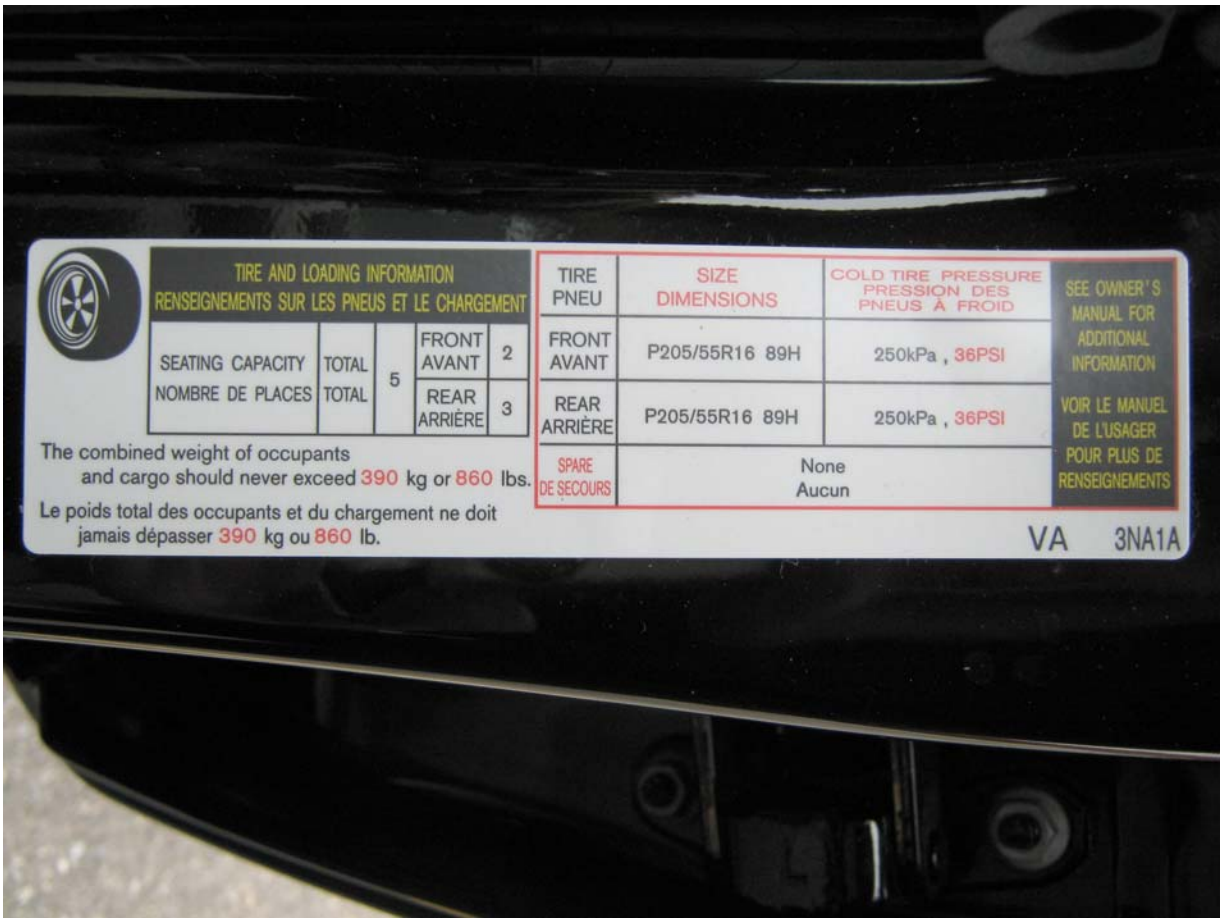
# PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

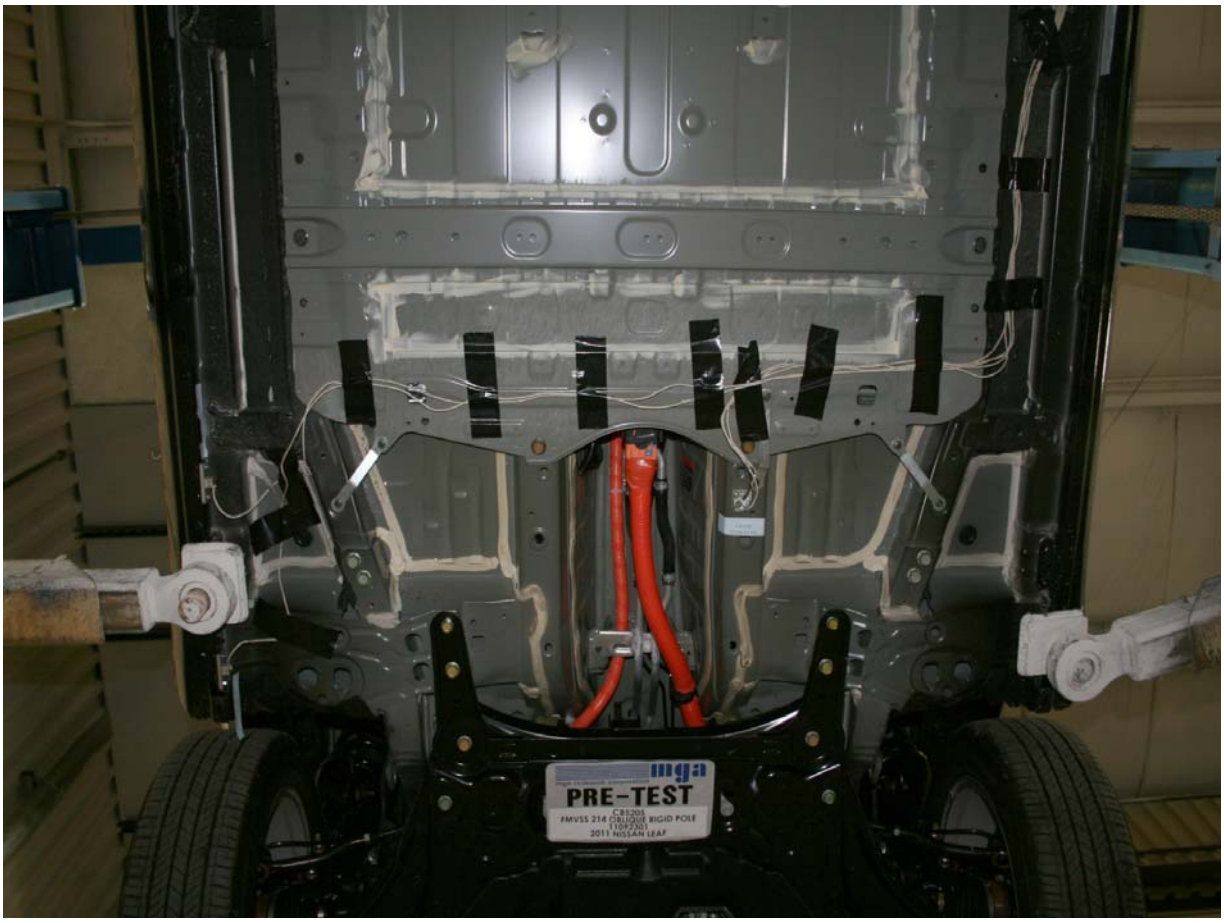
As Delivered Right Front ¾ View of Test Vehicle


As Delivered Left Rear ¾ View of Test Vehicle


Vehicle's Certification Label

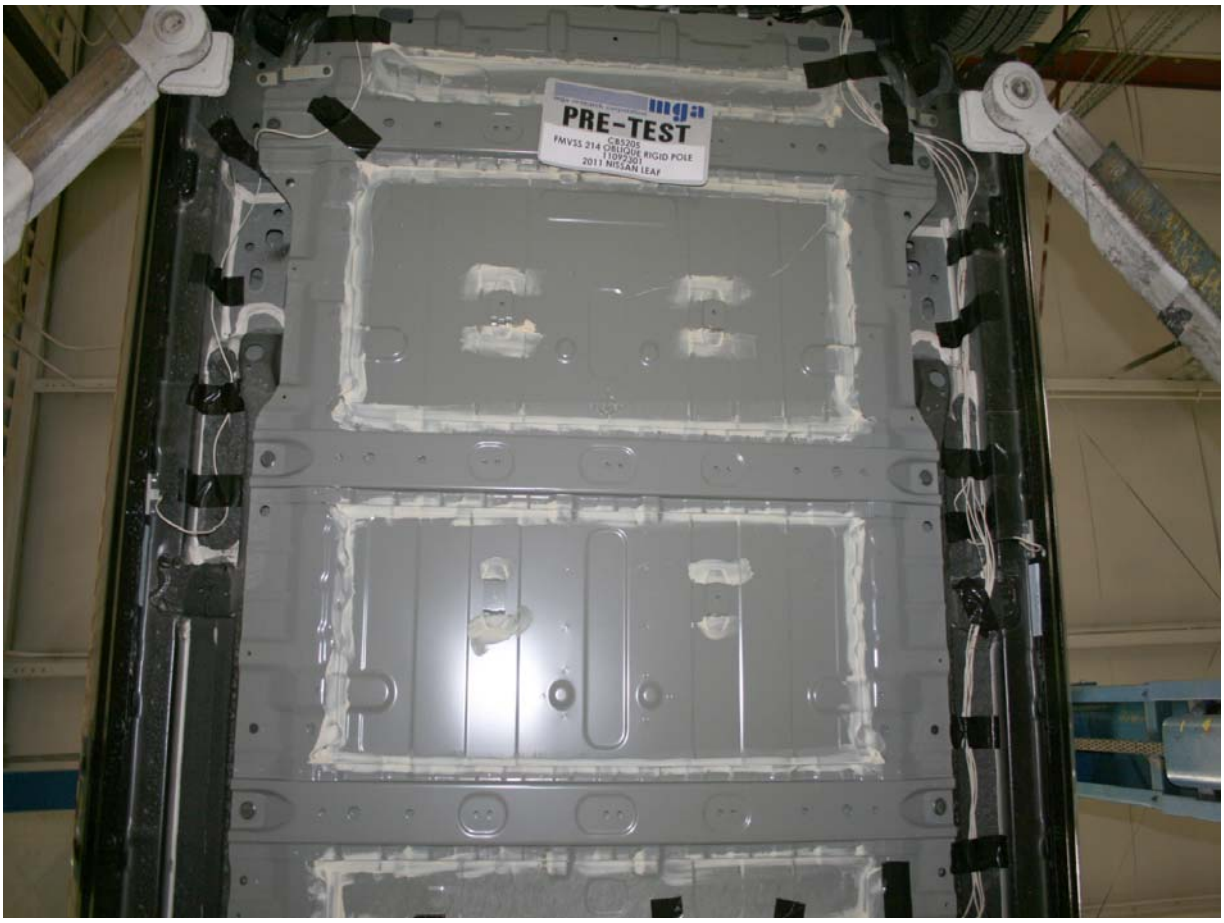



Vehicle's Tire Information Placard or Label

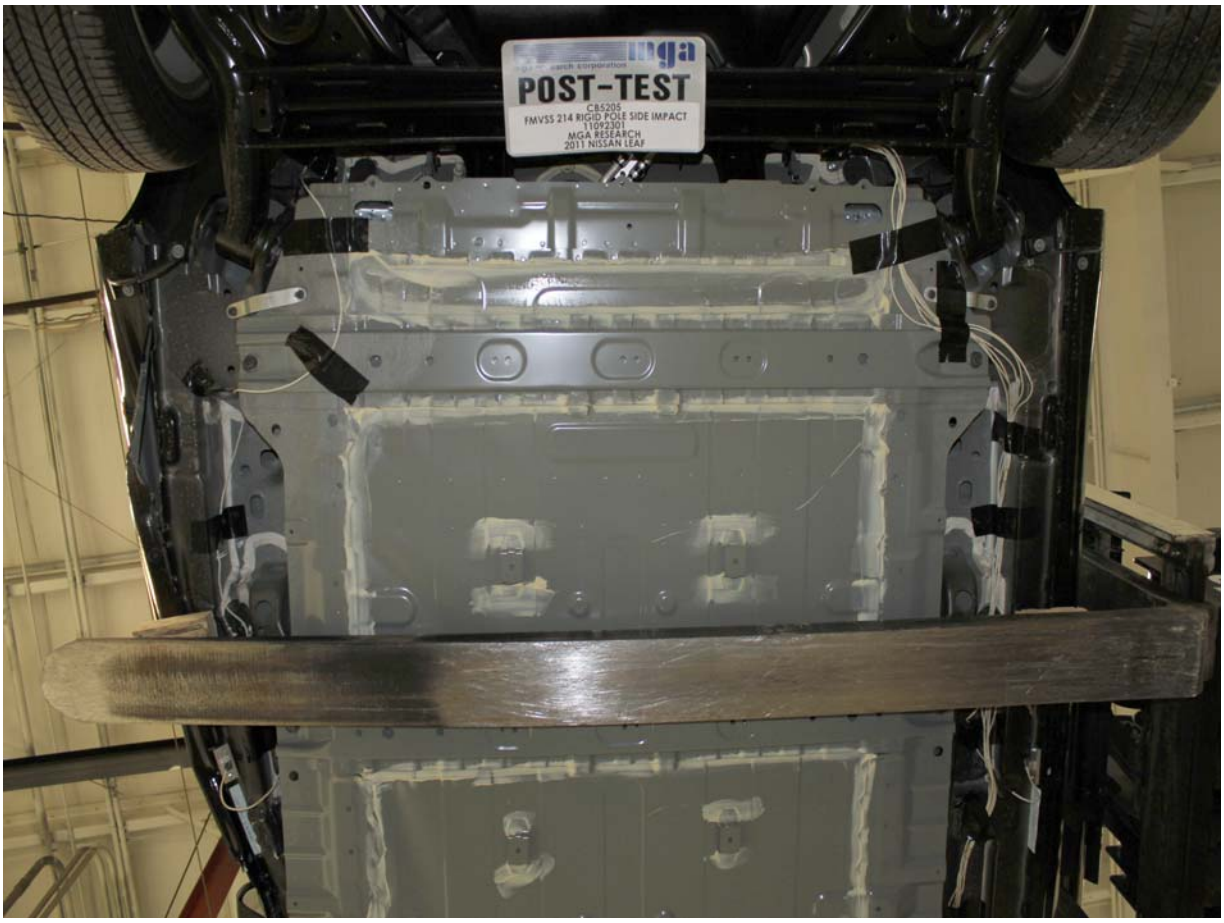


Pre-Test View of Propulsion Battery (Front View)

Post-Test View of Propulsion Battery (Front View)



Pre-Test View of Propulsion Battery (Rear View)



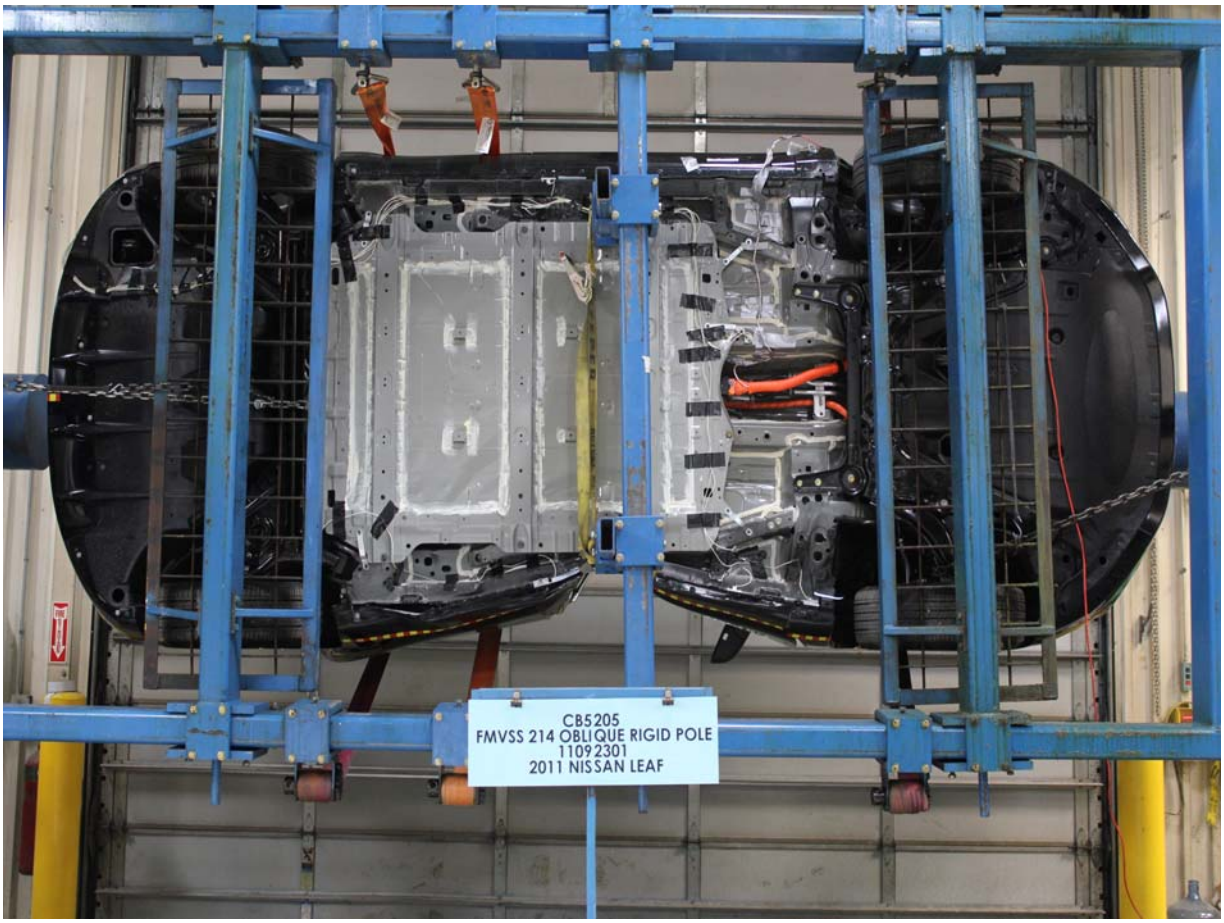
Post-Test View of Propulsion Battery (Rear View)


Pre-Test View of Electric Propulsion Drive

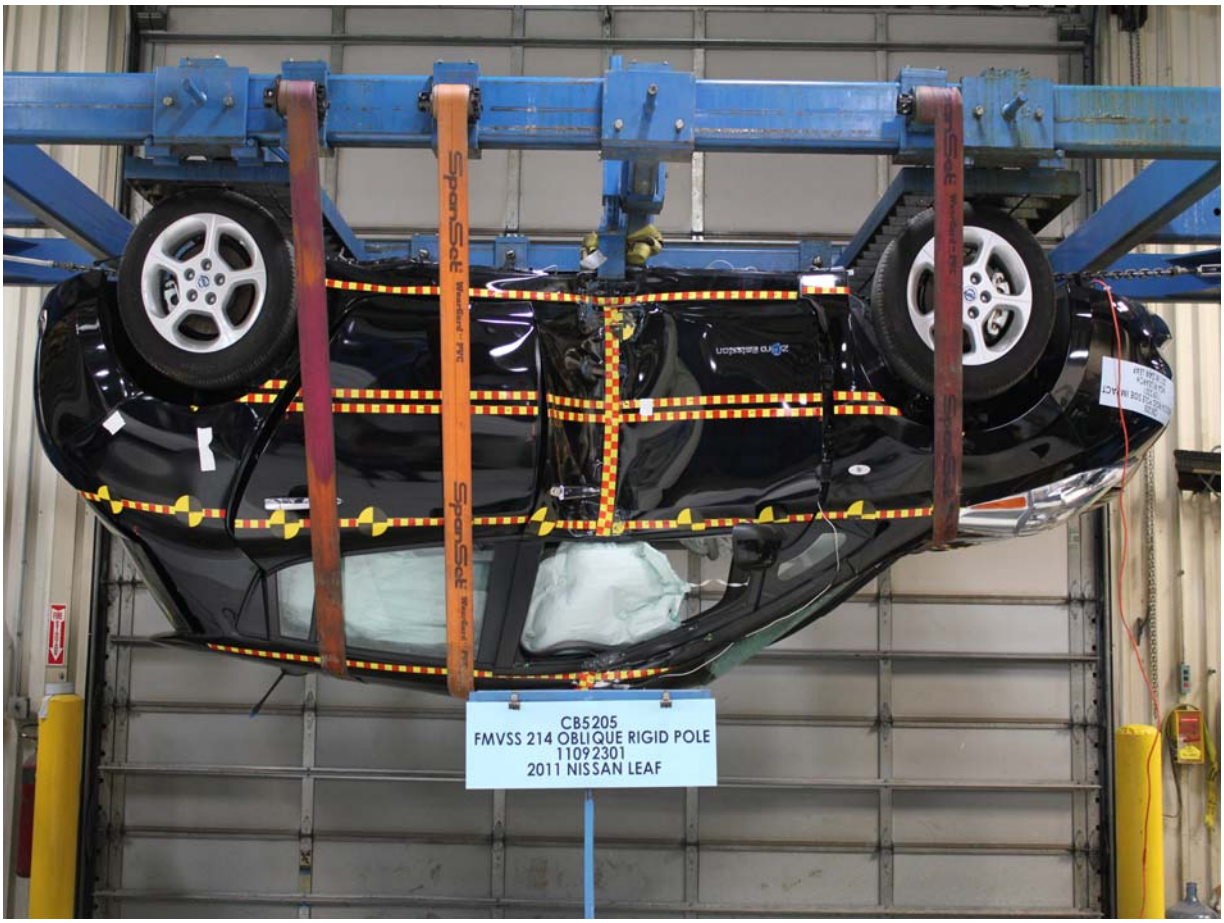

Post-Test View of Electric Propulsion Drive

Pre-Test View of Vehicle's Passenger Compartment Adjacent to Propulsion Battery


Post-Test View of Vehicle's Passenger Compartment Adjacent to Propulsion Battery




Vehicle at 90 Degrees on Static Rollover Device




Vehicle at 180 Degrees on Static Rollover Device


Vehicle at 270 Degrees on Static Rollover Device


Vehicle at 360 Degrees on Static Rollover Device


Manual High Voltage Service Disconnect

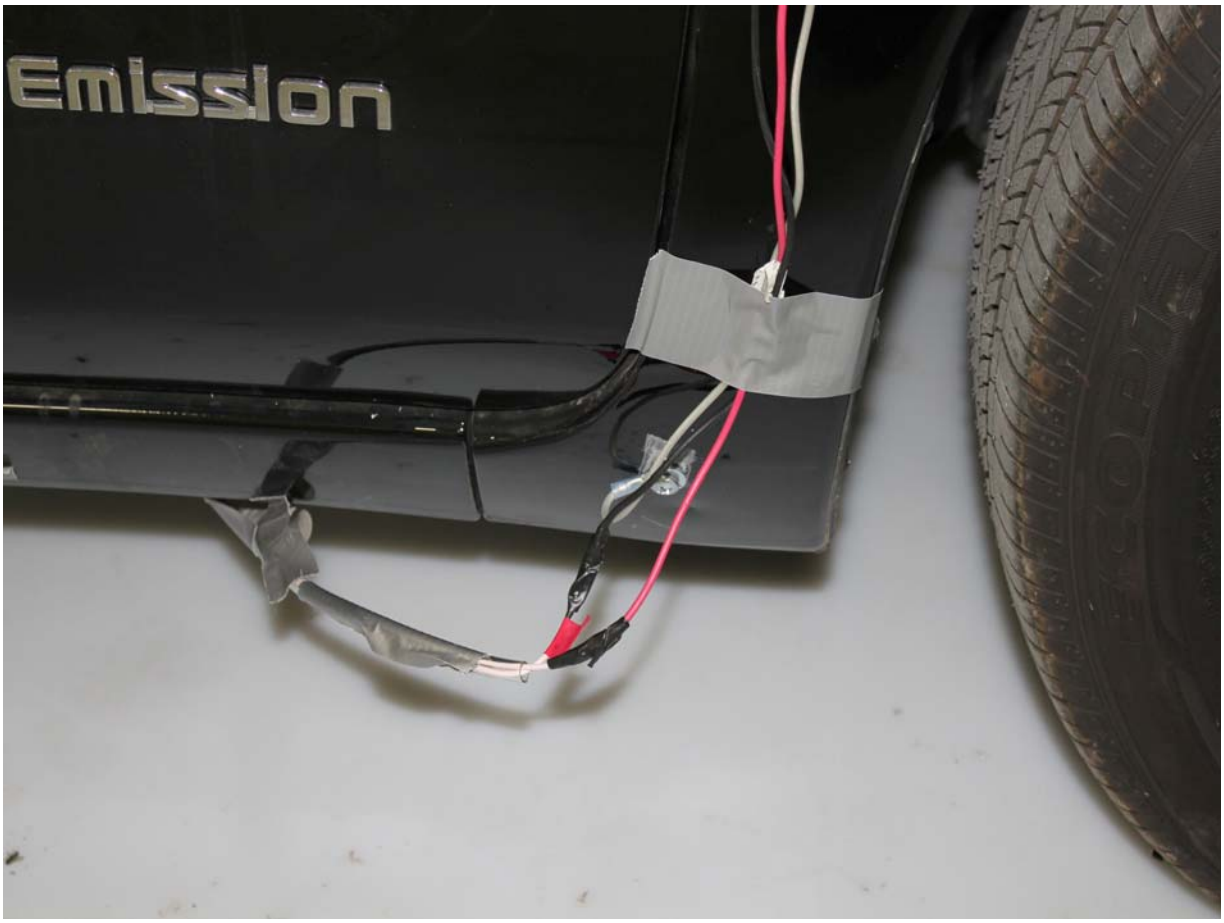

Manual High Voltage Service Disconnect

Drive Motor High Voltage Warning

Vehicle Charging Warning Label


Vehicle Charging Warning Location

High Voltage Location



Ground Location/Close-up of Leads Attached