

REPORT NUMBER: 305-MGA-2013-004

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

**TOYOTA MOTOR MANUFACTURING CANADA INC.
2012 Toyota RAV4 EV 5-Dr SUV
NHTSA NUMBER: CC5108**

**PREPARED BY:
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Test Date: February 6, 2013

Report Date: March 1, 2013

FINAL REPORT

**PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
ENFORCEMENT
OFFICE OF VEHICLE SAFETY COMPLIANCE
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Technical Report Documentation Page

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				14. Sponsoring Agency Code NVS-220	
15. Supplementary Notes					
16. Abstract An indicant compliance test was conducted on the subject 2012 Toyota RAV4 EV 5-Dr SUV 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.					
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SECTION 1
PURPOSE OF COMPLIANCE TEST

This electric vehicle, a 2012 Toyota RAV4 EV 5-Dr SUV, (NHTSA No. CC5108), in conjunction with the FMVSS 201P 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 TP-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 2012 Toyota RAV4 EV 5-Dr SUV appears to meet the requirements of FMVSS 305 testing.

This program is sponsored by the National Highway Traffic Safety Administration (NHTSA), under Contract No. DTNH22-12-D-00268.

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

TEST NOTES

None.

MGA does not endorse or certify products. The manufacturer's name appears solely for identification purposes.

SECTION 2
DATA SHEETS

DATA SHEET NO. 1
TEST VEHICLE SPECIFICATIONS

Test Vehicle: 2012 Toyota RAV4 EV 5-Dr SUV

NHTSA No. CC5108

TEST VEHICLE INFORMATION

Year/Make/Model/Body Style	2012 Toyota RAV4 EV 5-Dr SUV
NHTSA No.	CC5108
Color	Blizzard Pearl
Date Received	11/05/2012
Odometer Reading	69 km
Selling Dealer	Autowest Toyota/Hayward

DATA FROM CERTIFICATION LABEL

Manufactured By	TOYOTA MOTOR MANUFACTURING CANADA INC.
Date of Manufacture	07/12
VIN	2T3YL4DV8CW001114

GVWR (kg)	2270
GAWR Front (kg)	1160
GAWR Rear (kg)	1200

DATA FROM VEHICLE'S TIRE PLACARD & SIDEWALL

Measured Parameter	Front	Rear
Location of Placard of Vehicle	Left Side B-Post	
Recommended Tire Size	225/65R17	225/65R17
Recommended Cold Tire Pressure	220 kPa	220 kPa
Size of Tires on Test Vehicle	225/65R17	225/65R17
Type of Spare Tire	None	

VEHICLE CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total
Type of Front Seats	Bucket	Bench		
Number of Occupants	2	3		5
Capacity Weight (VCW) (kg)				395
Number of Occupants x 68 kg				340
Cargo Weight (RCLW) (kg)				55

ELECTRIC VEHICLE PROPULSION SYSTEM

Type of Electric Vehicle (Electric/Hybrid)	Electric
Electric Energy Storage/Device	Lithium Ion
Nominal Voltage (V)	386.0 V
Physical Location of the High Voltage Source Automatic Disconnect	Internal to Battery Enclosure
Auxiliary Battery Type	Sealed Lead-Acid Battery

**DATA SHEET 2
PRE-TEST DATA**

Test Vehicle: 2012 Toyota RAV4 EV 5-Dr SUV

NHTSA No. CC5108

CALCULATION OF TARGET TEST WEIGHT (TTW)

Measured Parameter	Units	Value
Unloaded Vehicle Weight (UVW)	kg	1845.2
Rated Cargo & Luggage Weight (RCLW)	kg	55
Weight of 1 P572U ATD (SID H3) Dummy	kg	80.7
TARGET TEST WEIGHT	kg	1980.9

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	516.6	397.8		558.8	459.1		564.3	445.0	
Right	kg	528.9	401.9		528.9	436.8		539.8	426.8	
Ratio	%	56.7	43.3		54.8	45.2		55.9	44.1	
Totals	kg	1045.5	799.7	1845.2	1087.7	895.9	1983.6	1104.1	871.8	1975.9

TIRE PRESSURES

	Units	LF	RF	RR	LR
As Delivered	kPa	220	220	220	220
As Tested	kPa	220	220	220	220

DATA SHEET 2 (CONTINUED)

PRE-TEST DATA

**ELECTRIC ENERGY STORAGE CONVERSION/DEVICE SYSTEM DATA
(COTR SUPPLIED DATA)**

Electrolyte Fluid Type	Organic Electrolyte (Mainly Composed of Alkyl Carbonate)	
Electrolyte Fluid Specific Gravity	1.1 – 1.5 g/cmL	
Electrolyte Kinematic Viscosity (centistokes)	1 – 6 x 10 ⁻² cm ² /s	
Electrolyte Fluid Color	Clear	
Electric Energy Storage/Conversion System Coolant Type, Color, Specific Gravity (if applicable)	50/50 BASF Glysantin G48 (Ethyl Glycol) Blue	
Location of Battery Modules		Inside Passenger Compartment
	X	Outside Passenger Compartment
	Underneath the Vehicle	
Electric Energy Storage/Conversion System State of Charge	X	Maximum State of Charge
		Range of Normal Operating Voltage
Maximum State of Charge	386.0 V	
Test Voltage - No less than 95% of maximum State of Charge	380.2 V	
Range of Normal Operating Voltage		
Test Voltage – Within Normal Operative Voltage Range		
Test Vehicle Equipped with Electrical Isolation Monitoring	Not Stated	

VEHICLE CHASSIS GROUND POINT(S) LOCATION(S)

Details of Vehicle Chassis Ground Point(s) & Location(s)	Screw on Right Rear Fender The paint was cleared away from the area to ensure a good ground connection.
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ELECTRIC ENERGY STORAGE/CONVERSION TEST POINTS

Details of Electric Energy Storage/Conversion System Test Points	Front of Battery Pack High Voltage Cable Leads That Go to Drive System
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DATA SHEET 3

PRE-IMPACT ELECTRIC ISOLATION MEASUREMENTS & CALCULATIONS

Test Vehicle: 2012 Toyota RAV4 EV 5-Dr SUV

NHTSA No. CC5108

VOLTMETER INFORMATION

Make	Fluke
Model	11
Serial Number	68541895
Internal Impedance Value (MΩ)	> 10 MΩ < 100 pF
Resolution (V)	.001 Volts
Last Calibration Date	12/17/2012

ELECTRIC ENERGY STORAGE/CONVERSION SYSTEM VOLTAGE

Measurement shall be made with Energy Storage/Conversion System connected to the vehicle propulsion system, and the vehicle in the “ready-to-drive” (propulsion system energized) 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)	380.2
--------	-------

ELECTRIC ENERGY STORAGE/CONVERSION SYSTEM TO VEHICLE CHASSIS

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

V1 (V)	164.7
V2 (V)	157.8

ELECTRIC ENERGY STORAGE/CONVERSION SYSTEM 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)	197000
--------	--------

DATA SHEET 3 (CONTINUED)

PRE-IMPACT ELECTRICAL ISOLATION 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)	27.6
$R_{i1} = R_o (1 + V_2/V_1) [(V_1 - V_1')/V_1']$	
Ri1 (Ω)	1916155
V2' (V)	26.2
$R_{i2} = R_o (1 + V_1/V_2) [(V_2 - V_2')/V_2']$	
Ri2 (Ω)	2022291
Ri = The lesser of Ri1 and Ri2	
Ri Pre-Test ((Ω)	1916155
Ri/Vb (Ω/V)	5040
Minimum Electrical Isolation Value is 500 Ω/V	

Note: Measurements completed within 15 minutes prior to impact.

Is the measured Electrical Isolation Value	Yes, Pass	No, Fail
≥500 Ω/V without electrical isolation monitoring	X	
≥100 Ω/V with electrical isolation monitoring		

**DATA SHEET 4
POST-IMPACT DATA**

Test Vehicle: 2012 Toyota RAV4 EV 5-Dr SUV

NHTSA No. CC5108

VOLTMETER INFORMATION

Make	Fluke
Model	11
Serial Number	68541895
Internal Impedance Value (MΩ)	> 10 MΩ < 100 pF
Nominal Propulsion Battery Voltage (Vb) (V)	380.2
Resolution (V)	0.001
NOTE: Record V1, V2, V1', V2' voltage measurements at a minimum of 5 seconds after impact.	

**ELECTRIC ENERGY STORAGE/CONVERSION SYSTEM
VOLTAGE LOCATION OF MEASUREMENT**

Measurement is made from the side of the automatic disconnect connected to the electric powertrain.

Vb (V)	4.2 V
--------	-------

ELECTRIC ENERGY STORAGE/CONVERSION SYSTEM VOLTAGE

V1 =	1.3	V	Impact Time	0	Minutes	36	s
V2 =	1.0	V	Impact Time	0	Minutes	41	s
V1' =	0.4	V	Impact Time	0	Minutes	50	s
V2' =	0.4	V	Impact Time	0	Minutes	59	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.

$R_{i1} = R_o (1 + V_2/V_1) [(V_1 - V_1')/V_1']$							
Ri1 =	784212	Ω	Impact Time	0	Minutes	36	s
$R_{i2} = R_o (1 + V_1/V_2) [(V_2 - V_2')/V_2']$							
Ri2 =	679650	Ω	Impact Time	0	Minutes	41	s
Ri = The lesser of Ri1 and Ri2							
Ri =	679650	Ω	Impact Time	0	Minutes	41	s
Ri/Vb = electrical Isolation Value/Nominal Battery Voltage							
Minimum Electrical Value is 500 Ω/V							
Ri/Vb =	1788	Ω/V	Impact Time	0	Minutes	41	s

Is the measured Electrical Isolation Value	Yes, Pass	No, Fail
≥500 Ω/V without electrical isolation monitoring	X	
≥100 Ω/V with electrical isolation monitoring		

DATA SHEET 4 (CONTINUED)

POST-IMPACT DATA

ELECTRIC ENERGY STORAGE/CONVERSION DEVICE

	Inside Passenger Compartment	Outside Passenger Compartment
Location of Electric Energy Storage/Conversion Device		X

	Yes, Pass	No, Fail
All Components of Electrical Energy Storage/Conversion Device remained attached to the vehicle with at least one mounting location?	X	

Describe Electric Energy Storage/Conversion Device movement within the passenger compartment [Supply photographs as appropriate]
Not Applicable

	Yes, Fail	No, Pass
Has the Electric Energy Storage/Conversion Device moved within the passenger compartment?		X

Describe intrusion of an outside Electric Energy Storage/Conversion Device into the passenger compartment [Supply photographs as appropriate]
No Movement

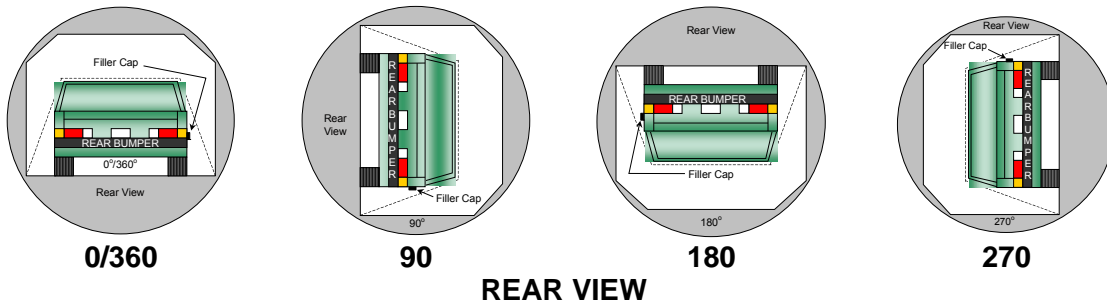
	Yes, Fail	No, Pass
Has an outside Electric Energy Storage/Conversion Device intruded into the passenger compartment?		X

	Yes, Fail	No, Pass
Is Electric Energy Storage/Conversion Device electrolyte spillage visible in the passenger compartment?		X

DATA SHEET 5
STATIC ROLLOVER TEST DATA

Test Vehicle: 2012 Toyota RAV4 EV 5-Dr SUV

NHTSA No. CC5108



**DETERMINATION OF ELECTRIC ENERGY STORAGE/CONVERSION DEVICE
ELECTROLYTE COLLECTION TIME PERIOD**

Rollover Stage	Rotation Time (spec. 1-3 min)				FMVSS 301 Hold Time		Total Time				Next Whole Minute Interval	
0° - 90°	1	minutes	53	seconds	5	minutes	6	minutes	53	seconds	7	minutes
90° - 180°	1	minutes	51	seconds	5	minutes	6	minutes	51	seconds	7	minutes
180° - 270°	1	minutes	47	seconds	5	minutes	6	minutes	47	seconds	7	minutes
270° - 360°	1	minutes	52	seconds	5	minutes	6	minutes	52	seconds	7	minutes

**ACTUAL TEST VEHICLE ELECTRIC ENERGY STORAGE/CONVERSION DEVICE
ELECTROLYTE SPILLAGE**

Rollover Stage	Electric Energy Storage/Conversion Device Electrolyte Spillage (L)	Spillage Location
0° to 90°	0	Not Applicable
90° to 180°	0	Not Applicable
180° to 270°	0	Not Applicable
270° to 360°	0	Not Applicable

Total Spillage: 0 L

	Yes, Fail	No, Pass
Is the total spillage of Electric Energy Storage/Conversion Device electrolyte greater than 5.0 Liters?		X
Is Electric Energy Storage/Conversion Device electrolyte spillage visible in the passenger compartment?		X

DATA SHEET 5 (CONTINUED)
STATIC ROLLOVER TEST DATA

Test Vehicle: 2012 Toyota RAV4 EV 5-Dr SUV

NHTSA No. CC5108

VOLTMETER INFORMATION

Make	Fluke
Model	11
Serial Number	68541895
Internal Impedance Value (MΩ)	> 10 MΩ < 100 pF
Nominal Electric Energy Storage/Conversion Device Voltage (Vb) (V)	366.7
Record V1, V2, V1', V2' voltage measurements at the start of each successive increment of 90°, 180°, 270°, and 360° of the static rollover test.	

ELECTRICAL ISOLATION MEASUREMENT

V1 =	0.0	V	0°	Time		Minutes		s
V1 =	0.0	V	90°	Time	2	Minutes	29	s
V1 =	0.0	V	180°	Time	2	Minutes	39	s
V1 =	0.0	V	270°	Time	2	Minutes	3	s
V1 =	0.0	V	360°	Time	2	Minutes	17	s
V2 =	0.0	V	0°	Time		Minutes		s
V2 =	0.0	V	90°	Time	2	Minutes	37	s
V2 =	0.0	V	180°	Time	2	Minutes	43	s
V2 =	0.0	V	270°	Time	2	Minutes	9	s
V2 =	0.0	V	360°	Time	2	Minutes	20	s
V1' =	0.0	V	0°	Time		Minutes		s
V1' =	0.0	V	90°	Time	2	Minutes	42	s
V1' =	0.0	V	180°	Time	2	Minutes	51	s
V1' =	0.0	V	270°	Time	2	Minutes	15	s
V1' =	0.0	V	360°	Time	2	Minutes	28	s
V2' =	0.0	V	0°	Time		Minutes		s
V2' =	0.0	V	90°	Time	2	Minutes	51	s
V2' =	0.0	V	180°	Time	3	Minutes	0	s
V2' =	0.0	V	270°	Time	2	Minutes	22	s
V2' =	0.0	V	360°	Time	2	Minutes	36	s
Vb =	0.0	V	0°	Time		Minutes		s
Vb =	0.0	V	90°	Time	2	Minutes	20	s
Vb =	0.0	V	180°	Time	2	Minutes	34	s
Vb =	0.0	V	270°	Time	1	Minutes	59	s
Vb =	0.0	V	360°	Time	2	Minutes	12	s

DATA SHEET 5 (CONTINUED)
STATIC ROLLOVER TEST DATA

Test Vehicle: 2012 Toyota RAV4 EV 5-Dr SUV

NHTSA No. CC5108

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.

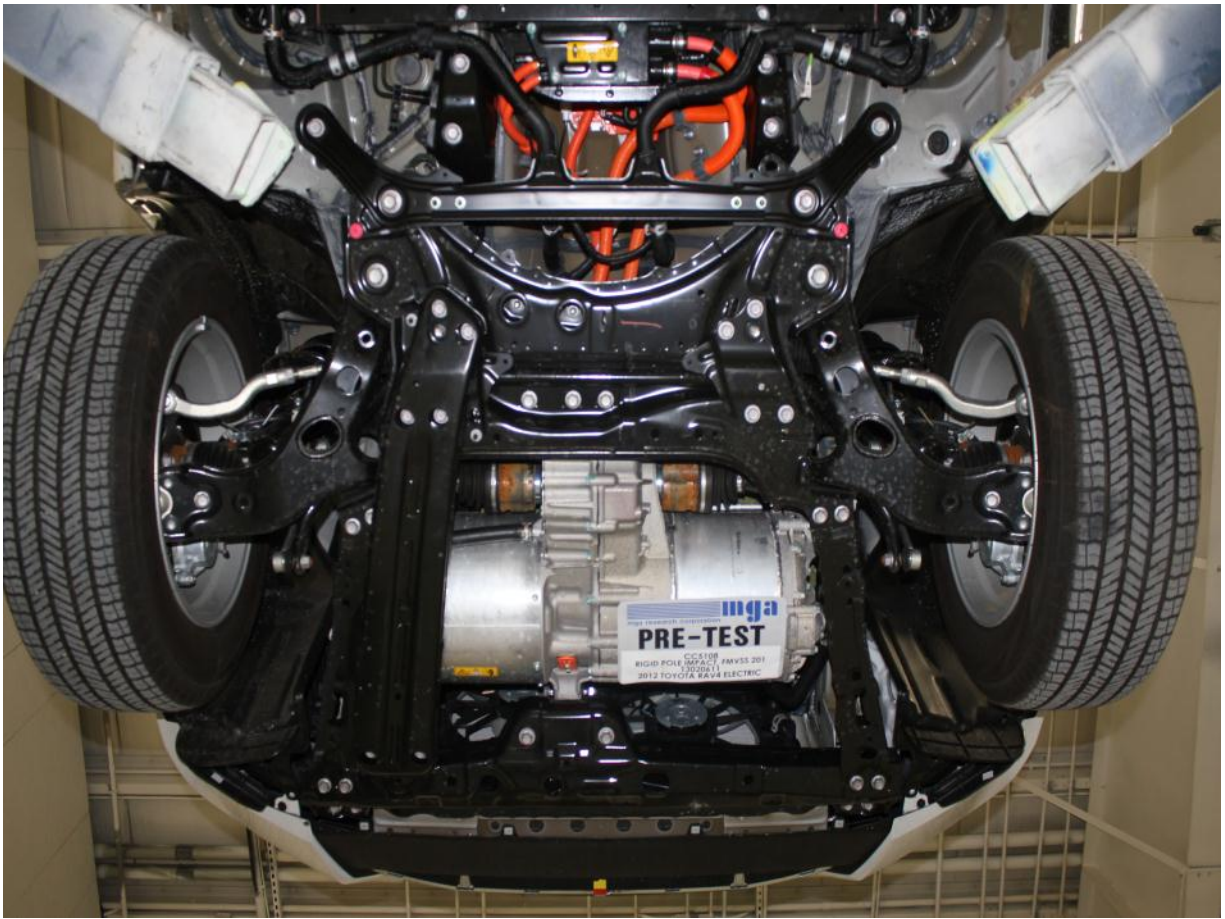
$R_{i1} = R_o (1 + V_2/V_1) [(V_1 - V_1')/V_1']$								
Ri1 =	Zero Volts	Ω	0°	Time		Minutes		s
Ri1 =	Zero Volts	Ω	90°	Time	2	Minutes	29	s
Ri1 =	Zero Volts	Ω	180°	Time	2	Minutes	39	s
Ri1 =	Zero Volts	Ω	270°	Time	2	Minutes	3	s
Ri1 =	Zero Volts	Ω	360°	Time	2	Minutes	17	s
$R_{i2} = R_o (1 + V_1/V_2) [(V_2 - V_2')/V_2']$								
Ri2 =	Zero Volts	Ω	0°	Time		Minutes		s
Ri2 =	Zero Volts	Ω	90°	Time	2	Minutes	37	s
Ri2 =	Zero Volts	Ω	180°	Time	2	Minutes	43	s
Ri2 =	Zero Volts	Ω	270°	Time	2	Minutes	9	s
Ri2 =	Zero Volts	Ω	360°	Time	2	Minutes	20	s
Ri = The lesser of Ri1 and Ri2								
Ri =	Zero Volts	Ω	0°	Time		Minutes		s
Ri =	Zero Volts	Ω	90°	Time	2	Minutes	29	s
Ri =	Zero Volts	Ω	180°	Time	2	Minutes	39	s
Ri =	Zero Volts	Ω	270°	Time	2	Minutes	3	s
Ri =	Zero Volts	Ω	360°	Time	2	Minutes	17	s
Ri/Vb = Electrical Isolation Value/Nominal Battery Voltage Minimum Electrical Isolation Value is 500 Ω/V								
Ri/Vb =	Zero Volts	Ω/V	0°	Time		Minutes		s
Ri/Vb =	Zero Volts	Ω/V	90°	Time	2	Minutes	29	s
Ri/Vb =	Zero Volts	Ω/V	180°	Time	2	Minutes	39	s
Ri/Vb =	Zero Volts	Ω/V	270°	Time	2	Minutes	3	s
Ri/Vb =	Zero Volts	Ω/V	360°	Time	2	Minutes	17	s

Is the measured Electrical Isolation Value	Yes, Pass	No, Fail
≥500 Ω/V without electrical isolation monitoring	X	
≥100 Ω/V with electrical isolation monitoring		

APPENDIX A
PHOTOGRAPHS

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Pre-Impact View of Electric Propulsion Drive



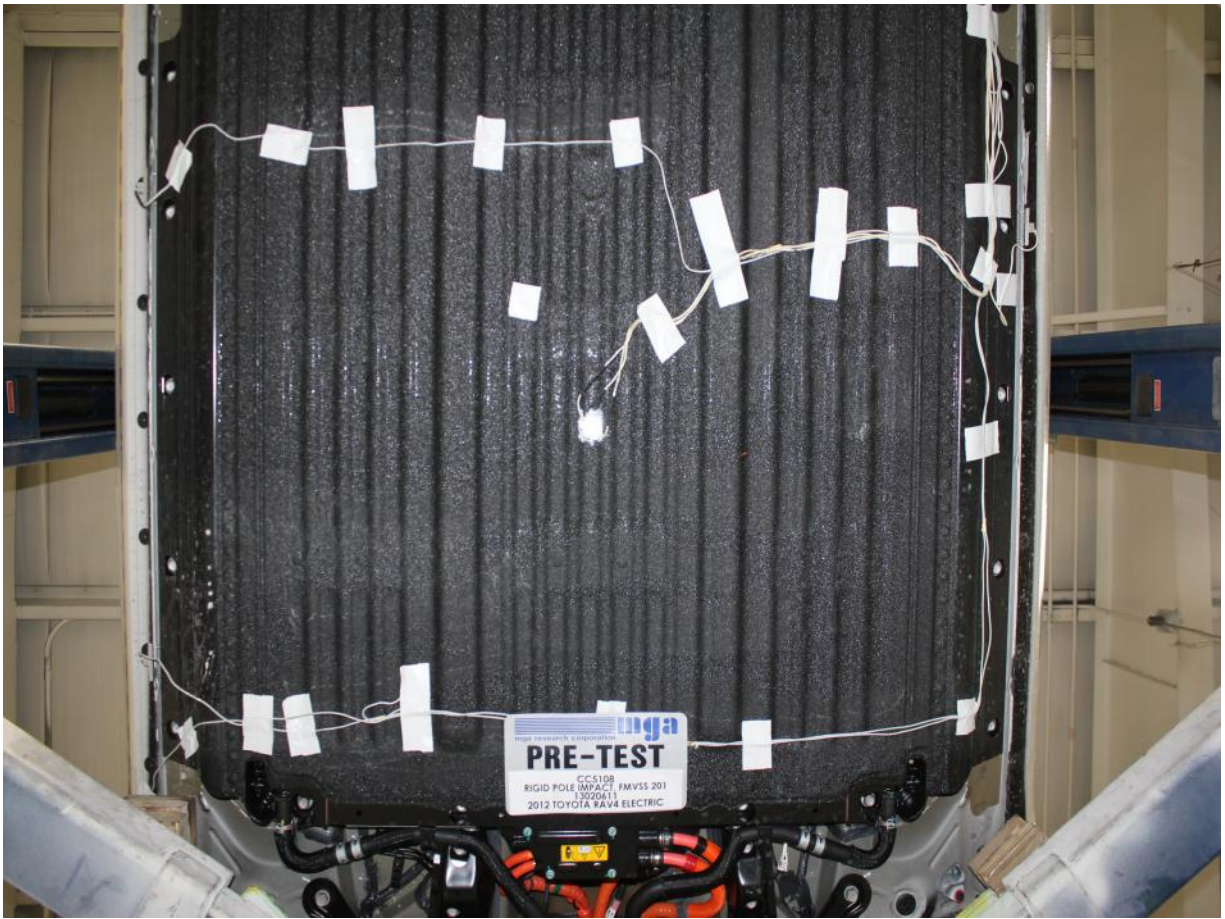
Pre-Impact View of Electric Propulsion Drive



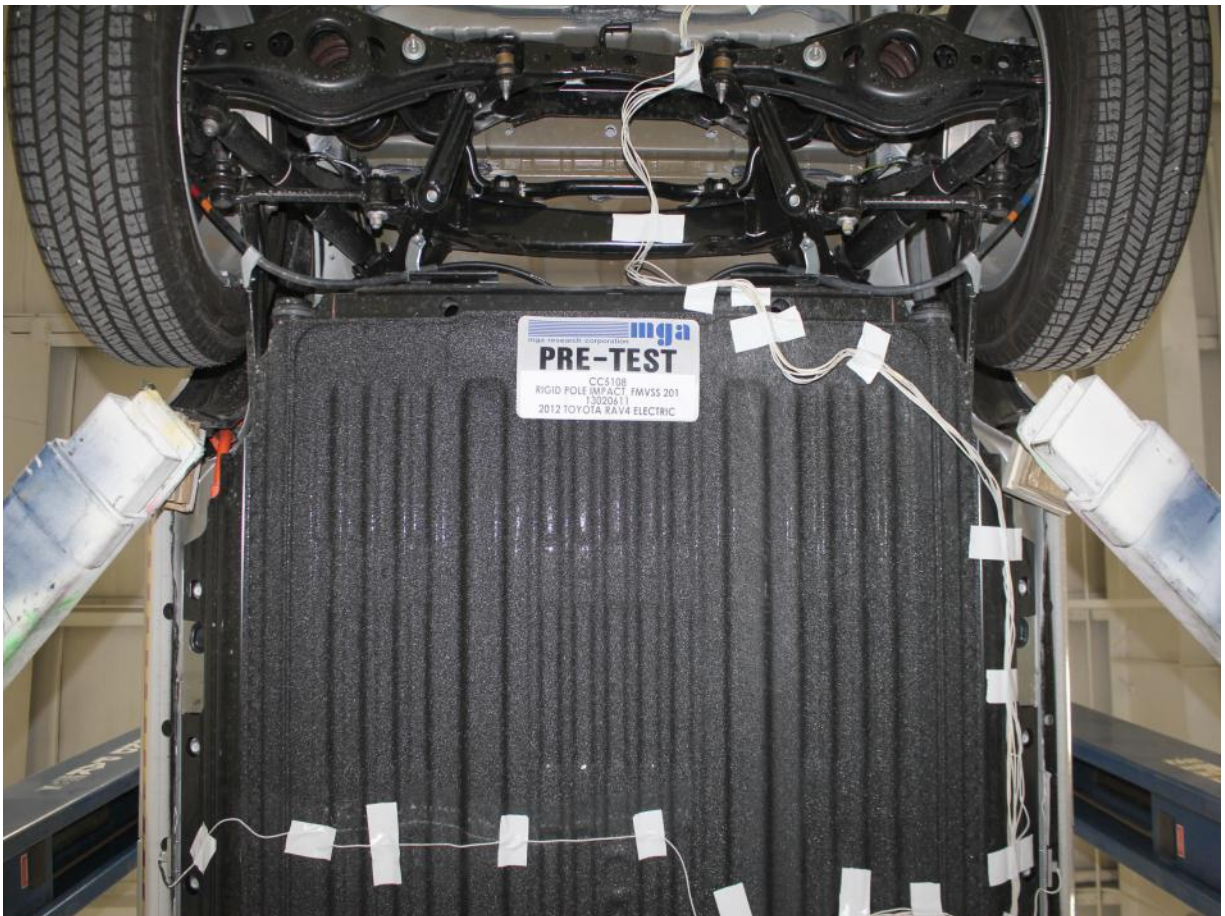
Post-Impact View of Electric Propulsion Drive



Post-Impact View of Electric Propulsion Drive



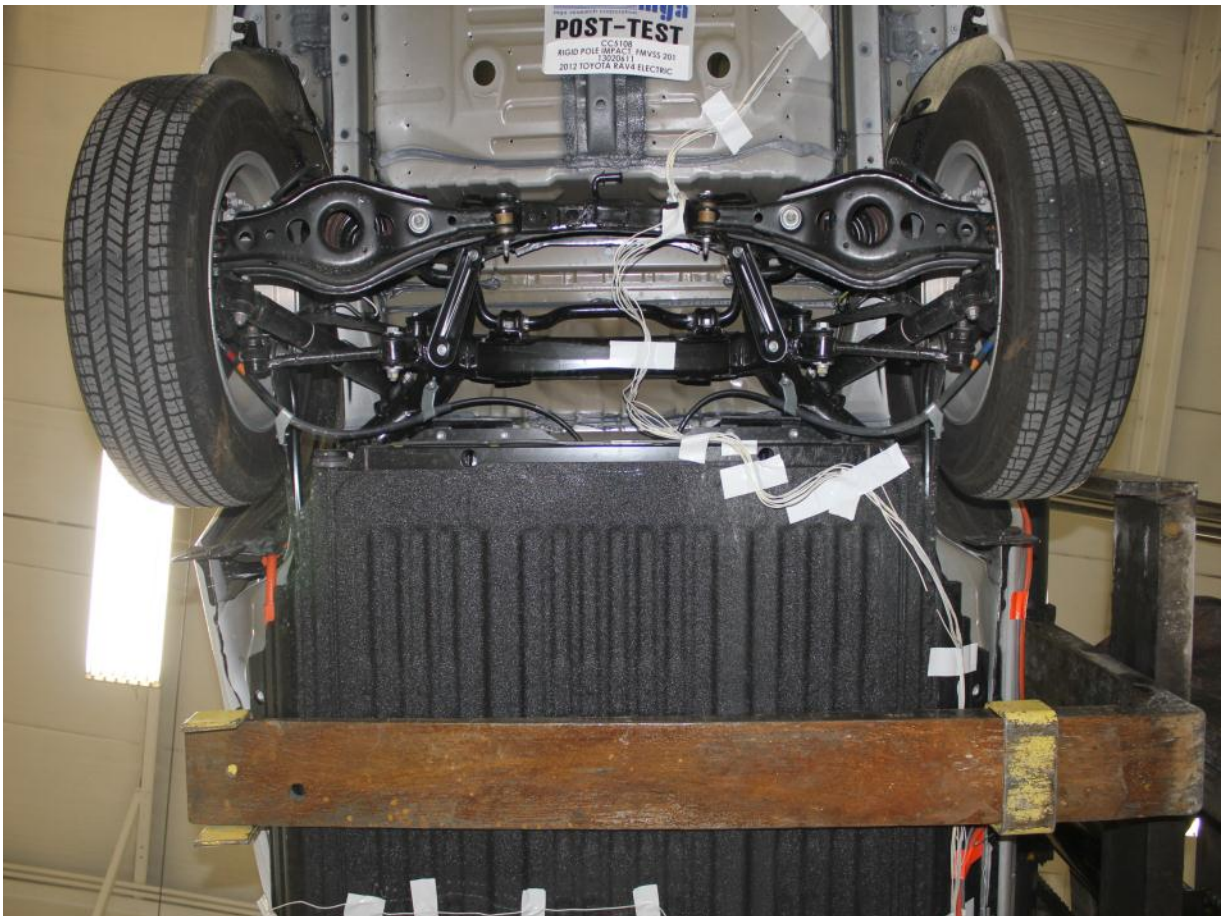
Pre-Impact View of Propulsion Battery



Pre-Impact View of Propulsion Battery



Post-Impact View of Propulsion Battery



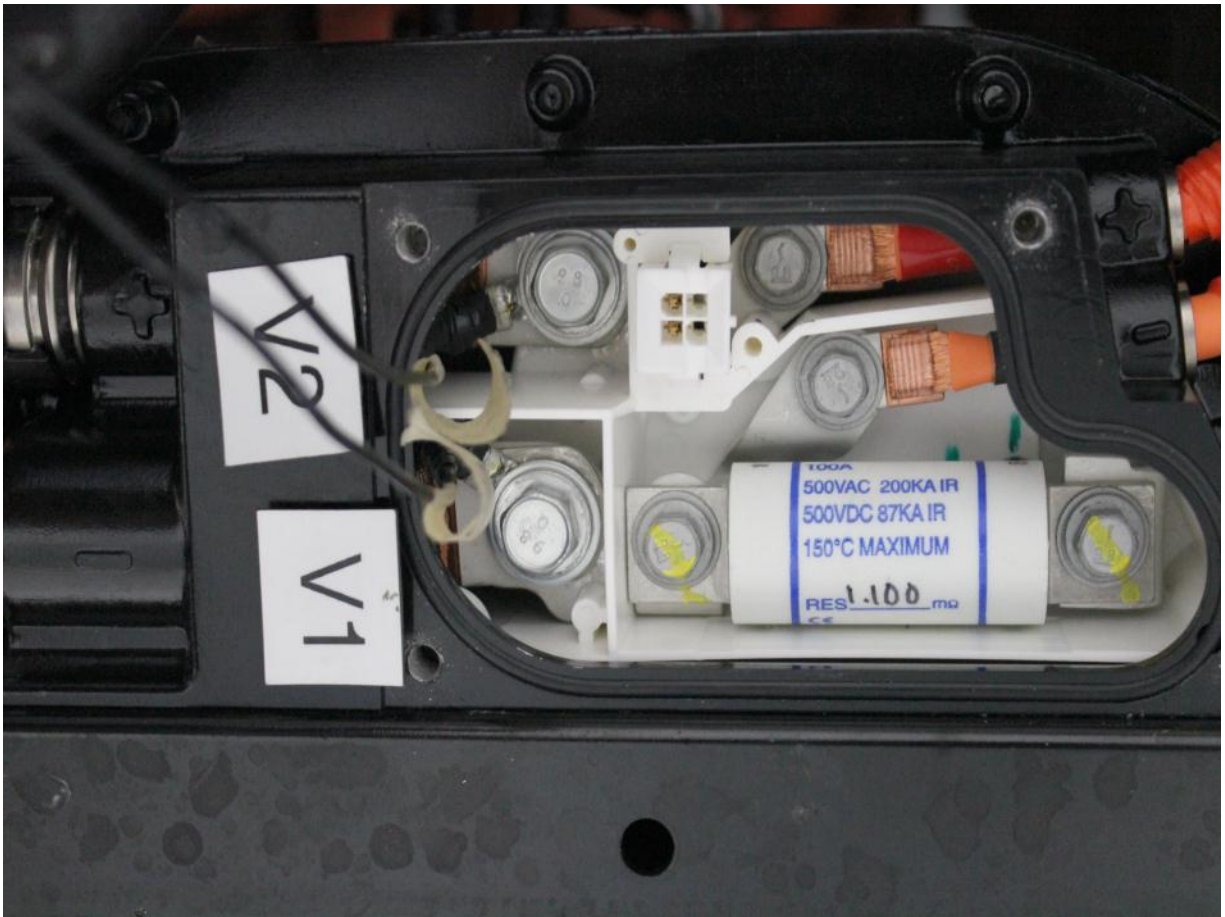
Post-Impact View of Propulsion Battery



Pre-Impact View of Passenger Compartment



Post-Impact View of Passenger Compartment



Pre-Impact View of High Voltage Lead Attached



Pre-Impact View of Ground Lead Attached



Pre-Impact View of Installed Impact Interface Port



Post-Impact View of Installed Impact Interface Port



FMVSS No. 305 Static Rollover at 90°



FMVSS No. 305 Static Rollover at 180°



FMVSS No. 305 Static Rollover at 270°



FMVSS No. 305 Static Rollover at 360°



As Delivered Right Front ¾ View of Impact Vehicle



As Delivered Left Rear ¾ View of Impact Vehicle



Vehicle's Certification Label



Vehicle's Tire Information Placard or Label



Load Carrying Capacity Reduced Label