REPORT NUMBER: 305-MGA-2013-003

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

TOYOTA MOTOR CORPORATION
2012 Toyota Prius Plug-In Hybrid 5-Dr Hatchback
NHTSA NUMBER: CC5105

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

Test Date: December 10, 2012

Report Date: December 31, 2012

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: _____
Joe Fleck, Project Engineer

Approved by: _____
David Winkelbauer, Project Manager

Approval Date: December 31, 2012

Accepted by: Edward E. Chan

Digitally signed by Edward E. Chan
DN: cn=Edward E. Chan, o=Office of Vehicle Safety Compliance, ou=National Highway Traffic Safety Administration, email=ed.chan@dot.gov, c=US
Date: 2012.12.31 09:34:12 -05'00'

Acceptance Date: _____

Technical Report Documentation Page

1. Report No. 305-MGA-2013-003	*2. Government Accession No.*	*3. Recipient's Catalog No.*
4. Title and Subtitle Final Report of FMVSS 305 Compliance Testing of 2012 Toyota Prius Plug-In Hybrid 5-Dr Hatchback; NHTSA No.: CC5105		*5. Report Date* December 31, 2012 *6. Performing Organization Code* MGA
7. Author(s) Joe Fleck, Project Engineer David Winkelbauer, Project Manager		*8. Performing Organization Report No.* 305-MGA-2013-003
9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105		*10. Work Unit No.* *11. Contract or Grant No.* DTNH22-12-D-00268
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Vehicle Safety Compliance (NVS-220) 1200 New Jersey Ave, SE Washington, DC 20590		*13. Type of Report and Period Covered:* Final Test Report December 10, 2012 to December 31, 2012 *14. Sponsoring Agency Code* NVS-220
15. Supplementary Notes		

16. Abstract

An indicant compliance test was conducted on the subject 2012 Toyota Prius Plug-In Hybrid 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 Compliance Testing Safety Engineering FMVSS 305		*18. Distribution Statement* Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services (TIS) Room E12-100 East Building 1200 New Jersey Ave. Washington, D.C. 20590 e-mail: tis@nhtsa.dot.gov Fax: 202-493-2833	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 28	22. Price

Form DOT F1700.7 (8-72)

TABLE OF CONTENTS

SECTION 1
PURPOSE OF COMPLIANCE TEST

This hybrid vehicle, a 2012 Toyota Prius Plug-In Hybrid 5-Dr Hatchback, (NHTSA No. CC5105), 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 Prius Plug-In Hybrid 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. DTNH22-12-D-00268.

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: 2012 Toyota Prius Plug-In Hybrid 5-Dr Hatchback NHTSA No. CC5105

TEST VEHICLE INFORMATION

Year/Make/Model/Body Style	2012 Toyota Prius Plug-In Hybrid 5-Dr
NHTSA No.	CC5105
Color	Winter Gray Metallic
Date Received	05/16/2012
Odometer Reading	13 km
Selling Dealer	Livermore Auto Group

DATA FROM CERTIFICATION LABEL

Manufactured By	TOYOTA MOTOR CORPORATION
Date of Manufacture	03/12
VIN:	JTDKN3DP3C3006140

GVWR (kg)	1842
GAWR Front (kg)	1030
GAWR Rear (kg)	987

DATA FROM VEHICLE'S TIRE PLACARD & SIDEWALL

Measured Parameter	Front	Rear
Location of Placard of Vehicle	Left Side B-Post	
Recommended Tire Size	P195/65R15	P195/65R15
Recommended Cold Tire Pressure	240 kPa	230 kPa
Size of Tires on Test Vehicle	P195/65R15	P195/65R15
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)				370
Number of Occupants x 68 kg				340
Cargo Weight (RCLW) (kg)				26

ELECTRIC VEHICLE PROPULSION SYSTEM

Type of Electric Vehicle (Electric/Hybrid):	Gas-Electric Hybrid
Electric Energy Storage/Device:	Lithium Ion
Nominal Voltage (V):	207.2 V
Physical Location of the High Voltage Source Automatic Disconnect:	Physically Contained Within the Energy Storage System
Auxiliary Battery Type:	12 V Lead-Acid Battery

DATA SHEET 2

PRE-TEST DATA

Test Vehicle: 2012 Toyota Prius Plug-In Hybrid 5-Dr Hatchback NHTSA No. CC5105

CALCULATION OF TARGET TEST WEIGHT (TTW)

Measured Parameter	Units	Value
Unloaded Vehicle Weight (UVW)	kg	1442.9
Rated Cargo & Luggage Weight (RCLW)	kg	26
Weight of 1 P572U ATD (SID H3) Dummy	kg	80.7
TARGET TEST WEIGHT	kg	1549.6

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

TEST VEHICLE WEIGHTS

		As Delivered			Fully Loaded			As Tested		
	Units	Front Axle	Rear Axle	Total	Front Axle	Rear Axle	Total	Front Axle	Rear Axle	Total
Left	kg	429.1	308.0		462.1	350.5		445.4	362.0	
Right	kg	415.5	290.3		423.0	315.1		421.8	315.7	
Ratio	%	58.5	41.5		57.1	42.9		56.1	43.9	
Totals	kg	844.6	598.3	1442.9	885.1	665.6	1550.7	867.2	677.7	1544.9

TIRE PRESSURES

	Units	LF	RF	RR	LR
As Delivered	kPa	240	240	230	230
As Tested	kPa	240	240	230	230

DATA SHEET 2 (CONTINUED)

PRE-TEST DATA

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

Electrolyte Fluid Type:	Organic Electrolyte	
Electrolyte Fluid Specific Gravity:	1.225 g/cm³	
Electrolyte Kinematic Viscosity (centistokes):	3.4 mPa·s (25° C)	
Electrolyte Fluid Color:	Clear	
Electric Energy Storage/Conversion System Coolant Type, Color, Specific Gravity (if applicable):	Air	
Location of Battery Modules:	X	Inside Passenger Compartment (Rack 1)
		Outside Passenger Compartment (Rack 2)
	Rear Cargo Area	
Electric Energy Storage/Conversion System State of Charge:		Maximum State of Charge
	X	Range of Normal Operating Voltage
Maximum State of Charge		
Test Voltage - No less than 95% of maximum State of Charge:	220.9 V	
Range of Normal Operating Voltage:	168.0 – 229.6 V	
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)	Ground stud located at right front corner of HV battery pack.

ELECTRIC ENERGY STORAGE/CONVERSION TEST POINTS

Details of Electric Energy Storage/Conversion System Test Points:	On the front side of the HV battery pack, which is located under the access panel, the test points are located on the traction side of the contactor.

DATA SHEET 3

PRE-IMPACT ELECTRIC ISOLATION MEASUREMENTS & CALCULATIONS

Test Vehicle: 2012 Toyota Prius Plug-In Hybrid 5-Dr Hatchback NHTSA No. CC5105

VOLTMETER INFORMATION

Make:	Fluke
Model:	177
Serial Number:	17210161
Internal Impedance Value (MΩ):	> 10 MΩ < 100 pF
Resolution (V):	.001 Volts
Last Calibration Date:	06/29/2012

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):	220.9

ELECTRIC ENERGY STORAGE/CONVERSION SYSTEM TO VEHICLE CHASSIS

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

V1 (V):	106.1
V2 (V):	105.3

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):	180100

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):	15.4
Ri1 = Ro (1 + V2/V1) [(V1-V1’)/V1’]	
Ri1 (Ω):	2113440
V2’ (V):	15.8
Ri2 = Ro (1 + V1/V2) [(V2-V2’)/V2’]	
Ri2 (Ω):	2048124
Ri = The lesser of Ri1 and Ri2	
Ri Pre-Test ((Ω):	2048124
Ri/Vb (Ω/V):	9272
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 Prius Plug-In Hybrid 5-Dr Hatchback NHTSA No. CC5105

VOLTMETER INFORMATION

Make:	Fluke
Model:	177
Serial Number:	17210161
Internal Impedance Value (MΩ):	> 10 MΩ < 100 pF
Nominal Propulsion Battery Voltage (Vb) (V):	220.9
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):	0.6 V

ELECTRIC ENERGY STORAGE/CONVERSION SYSTEM VOLTAGE

V1 =	0.20	V	Impact Time:	0	Minutes	46	s
V2 =	0.30	V	Impact Time:	0	Minutes	51	s
V1' =	0.02	V	Impact Time:	0	Minutes	58	s
V2' =	0.02	V	Impact Time:	1	Minutes	6	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 =	4052250	Ω	Impact Time:	0	Minutes	46	s
Ri2 = Ro (1 + V1/V2) [(V2-V2')/V2']							
Ri2 =	4202333	Ω	Impact Time:	0	Minutes	51	s
Ri = The lesser of Ri1 and Ri2							
Ri =	4052250	Ω	Impact Time:	0	Minutes	46	s
Ri/Vb = electrical Isolation Value/Nominal Battery Voltage							
Minimum Electrical Value is 500 Ω/V							
Ri/Vb =	18344	Ω/V	Impact Time:	0	Minutes	46	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

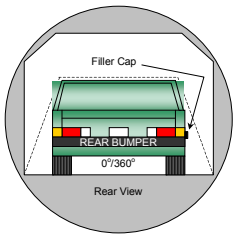
	Yes, Fail	No, Pass
Has an outside Electric Energy Storage/Conversion Device intruded into the passenger compartment?		X

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

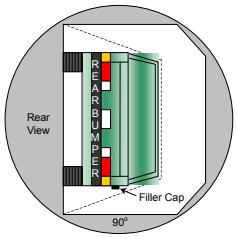
DATA SHEET 5

STATIC ROLLOVER TEST DATA

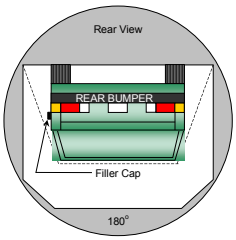
Test Vehicle: 2012 Toyota Prius Plug-In Hybrid 5-Dr Hatchback NHTSA No. CC5105



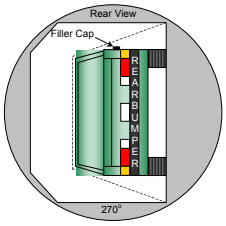
0/360



90



180



270

REAR VIEW

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	50	seconds	5	minutes	6	minutes	50	seconds	7	minutes
90° - 180°	1	minutes	49	seconds	5	minutes	6	minutes	49	seconds	7	minutes
180° - 270°	1	minutes	46	seconds	5	minutes	6	minutes	46	seconds	7	minutes
270° - 360°	1	minutes	53	seconds	5	minutes	6	minutes	53	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 Prius Plug-In Hybrid 5-Dr Hatchback NHTSA No. CC5105

VOLTMETER INFORMATION

Make:	Fluke
Model:	177
Serial Number:	17210161
Internal Impedance Value (MΩ):	> 10 MΩ < 100 pF
Nominal Electric Energy Storage/Conversion Device Voltage (Vb) (V):	220.9
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 =	0.00	V	0°	Time:		Minutes		s
V1 =	0.00	V	90°	Time:	2	Minutes	12	s
V1 =	0.00	V	180°	Time:	2	Minutes	15	s
V1 =	0.00	V	270°	Time:	2	Minutes	6	s
V1 =	0.00	V	360°	Time:	2	Minutes	4	s
V2 =	0.00	V	0°	Time:		Minutes		s
V2 =	0.00	V	90°	Time:	2	Minutes	22	s
V2 =	0.00	V	180°	Time:	2	Minutes	21	s
V2 =	0.00	V	270°	Time:	2	Minutes	13	s
V2 =	0.00	V	360°	Time:	2	Minutes	13	s
V1' =	0.00	V	0°	Time:		Minutes		s
V1' =	0.00	V	90°	Time:	3	Minutes	35	s
V1' =	0.00	V	180°	Time:	2	Minutes	32	s
V1' =	0.00	V	270°	Time:	2	Minutes	25	s
V1' =	0.00	V	360°	Time:	2	Minutes	30	s
V2' =	0.00	V	0°	Time:		Minutes		s
V2' =	0.00	V	90°	Time:	3	Minutes	47	s
V2' =	0.00	V	180°	Time:	2	Minutes	45	s
V2' =	0.00	V	270°	Time:	2	Minutes	42	s
V2' =	0.00	V	360°	Time:	2	Minutes	40	s
Vb =	0.10	V	0°	Time:		Minutes		s
Vb =	0.00	V	90°	Time:	2	Minutes	5	s
Vb =	0.00	V	180°	Time:	2	Minutes	10	s
Vb =	0.00	V	270°	Time:	1	Minutes	55	s
Vb =	0.00	V	360°	Time:	1	Minutes	57	s

DATA SHEET 5 (CONTINUED)

STATIC ROLLOVER TEST DATA

Test Vehicle: 2012 Toyota Prius Plug-In Hybrid 5-Dr Hatchback NHTSA No. CC5105

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	0°	Time:		Minutes		s
Ri1 =	Zero Volts	Ω	90°	Time:	2	Minutes	12	s
Ri1 =	Zero Volts	Ω	180°	Time:	2	Minutes	15	s
Ri1 =	Zero Volts	Ω	270°	Time:	2	Minutes	6	s
Ri1 =	Zero Volts	Ω	360°	Time:	2	Minutes	4	s
Ri2 = Ro (1 + V1/V2) [(V2-V2')/V2']								
Ri2 =	Zero Volts	Ω	0°	Time:		Minutes		s
Ri2 =	Zero Volts	Ω	90°	Time:	2	Minutes	22	s
Ri2 =	Zero Volts	Ω	180°	Time:	2	Minutes	21	s
Ri2 =	Zero Volts	Ω	270°	Time:	2	Minutes	13	s
Ri2 =	Zero Volts	Ω	360°	Time:	2	Minutes	13	s
Ri = The lesser of Ri1 and Ri2								
Ri =	Zero Volts	Ω	0°	Time:		Minutes		s
Ri =	Zero Volts	Ω	90°	Time:	2	Minutes	12	s
Ri =	Zero Volts	Ω	180°	Time:	2	Minutes	15	s
Ri =	Zero Volts	Ω	270°	Time:	2	Minutes	6	s
Ri =	Zero Volts	Ω	360°	Time:	2	Minutes	4	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	12	s
Ri/Vb =	Zero Volts	Ω/V	180°	Time:	2	Minutes	15	s
Ri/Vb =	Zero Volts	Ω/V	270°	Time:	2	Minutes	6	s
Ri/Vb =	Zero Volts	Ω/V	360°	Time:	2	Minutes	4	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		

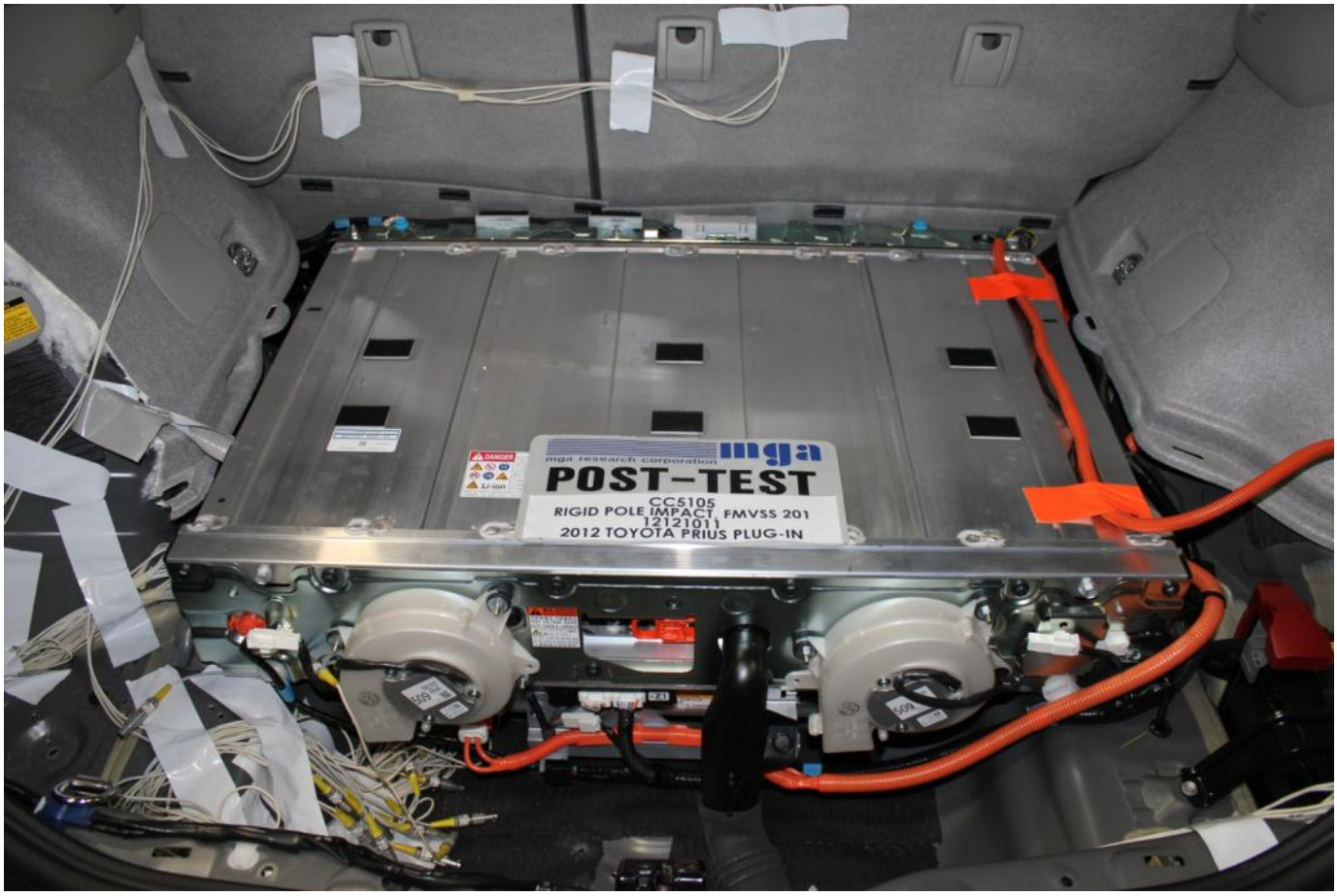
APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Pre-Impact View of Electric Propulsion Drive

Post-Impact View of Electric Propulsion Drive

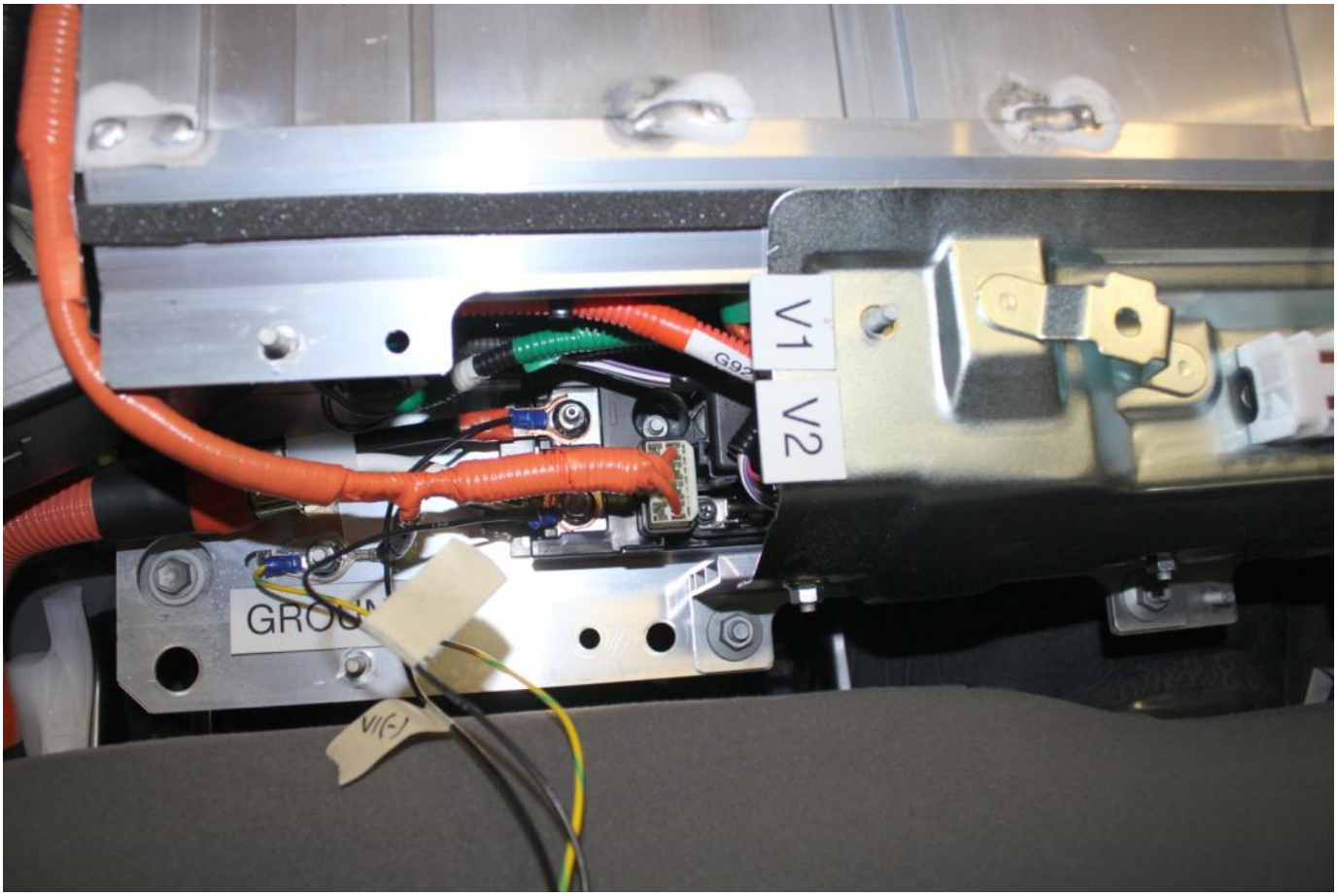
Pre-Impact View of Propulsion Battery



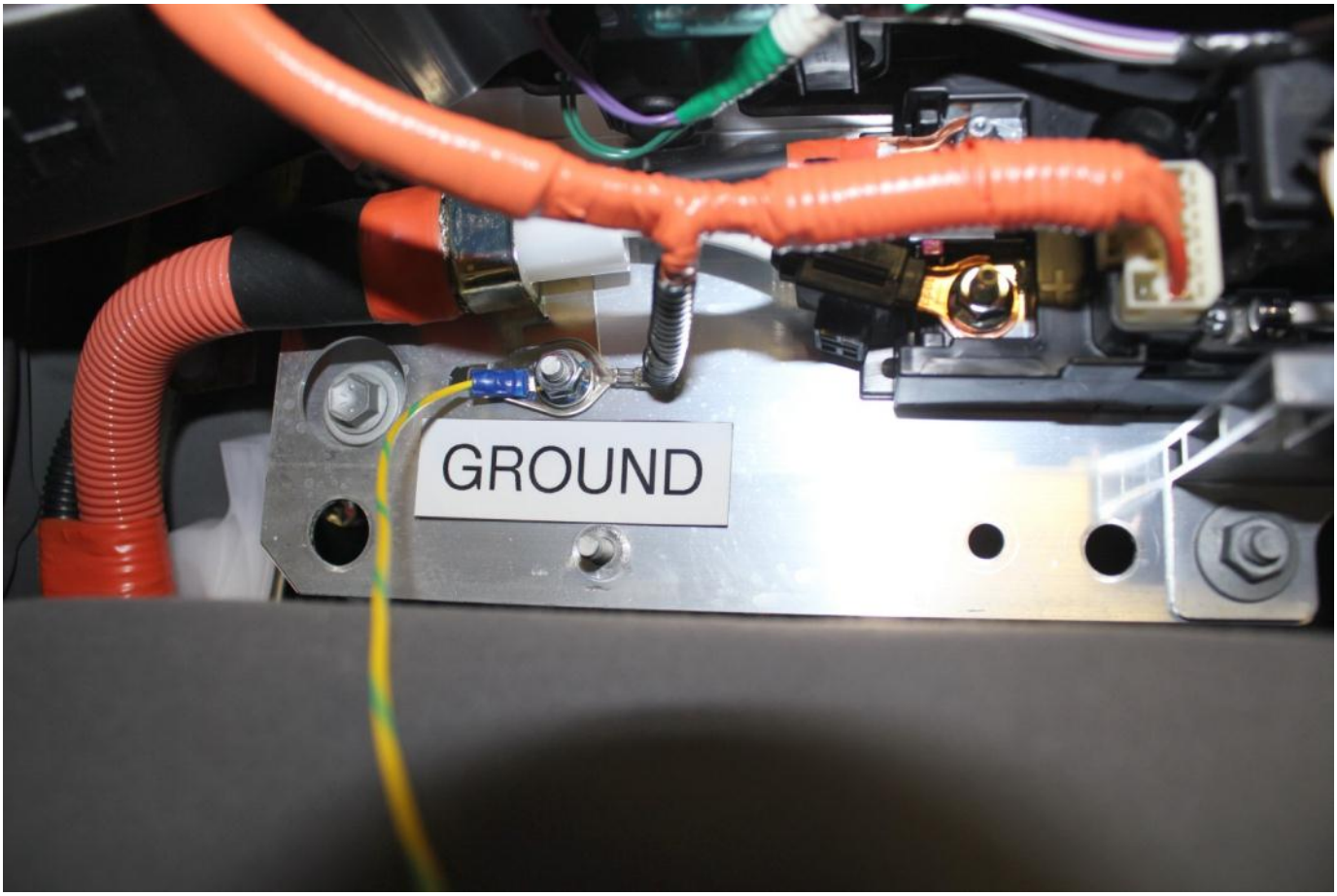
Post-Impact View of Propulsion Battery

Pre-Impact View of Passenger Compartment

Post-Impact View of Passenger Compartment

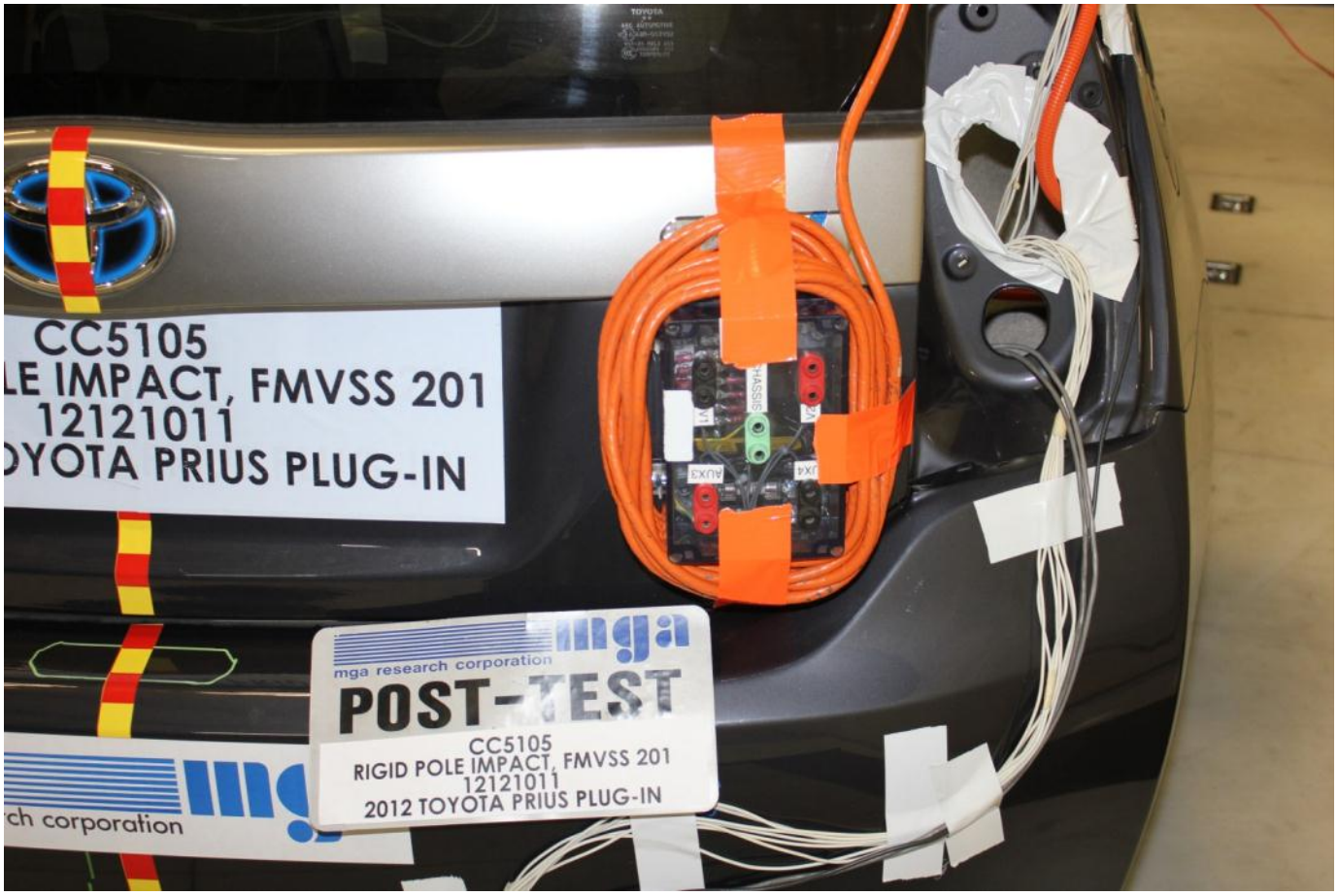


Pre-Impact View of High Voltage Lead Attached



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