

REPORT NUMBER: 305-MGA-2011-003

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

**GENERAL MOTORS LLC
2011 CHEVROLET VOLT 5-DR HATCHBACK
NHTSA NUMBER: CB0102**

**PREPARED BY:
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Test Date: September 21, 2011

Report Date: October 20, 2011

FINAL REPORT

**PREPARED FOR:
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NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
ENFORCEMENT
OFFICE OF VEHICLE SAFETY COMPLIANCE
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WASHINGTON, DC 20590**

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Technical Report Documentation Page

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16. Abstract An indicant compliance test was conducted on the subject 2011 Chevrolet Volt 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					
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SECTION 1
PURPOSE OF COMPLIANCE TEST

This electric vehicle, a 2011 Chevrolet Volt 5-Dr Hatchback, (NHTSA No. CB0102), 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 Chevrolet Volt 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

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: 2011 Chevrolet Volt 5-Dr Hatchback NHTSA No. CB0102

TEST VEHICLE INFORMATION

Year/Make/Model/Body Style	2011 Chevrolet Volt 5-Dr Hatchback
NHTSA No.	CB0102
Color	Silver
Date Received	5/18/2011
Odometer Reading	31 miles
Selling Dealer	Ken Dixon Chevrolet-Cadillac

DATA FROM CERTIFICATION LABEL

Manufactured By	General Motors LLC	GVWR (kg)	2062
Date of Manufacture	01/11	GAWR Front (kg)	1139
VIN:	1G1RC6E48BU101109	GAWR Rear (kg)	923

DATA FROM VEHICLE'S TIRE PLACARD & SIDEWALL

Measured Parameter	Front	Rear
Location of Placard of Vehicle	Left Side B-Post	
Recommended Tire Size	P215/55R17	P215/55R17
Recommended Cold Tire Pressure	240 kPa	240 kPa
Size of Tires on Test Vehicle	P215/55R17	P215/55R17
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	Bucket		
Number of Occupants	2	2		4
Capacity Weight (VCW) (kg)				340
Number of Occupants x 68 kg				272
Cargo Weight (RCLW) (kg)				68

ELECTRIC VEHICLE PROPULSION SYSTEM

Type of Electric Vehicle (Electric/Hybrid):	Electric
Propulsion Battery Type:	Lithium-Ion
Nominal Voltage (V):	370 V
Physical Location of Automatic Propulsion Battery Disconnect:	Accessed by Removing Lower Console Bin in Storage Area
Auxiliary Battery Type:	12V AGM (Absorbent Glass Mat)

DATA SHEET 2
PRE-TEST DATA

Test Vehicle: 2011 Chevrolet Volt 5-Dr Hatchback

NHTSA No. CB0102

CALCULATION OF TARGET TEST WEIGHT (TTW)

Measured Parameter	Units	Value
Unloaded Vehicle Weight (UVW)	kg	1702.4
Rated Cargo & Luggage Weight (RCLW)	kg	68
Weight of 1 P572U ATD (ES-2re) Dummy	kg	52.2
TARGET TEST WEIGHT	kg	1822.6

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	527.1	339.3		546.1	393.7		547.0	381.9	
Right	kg	511.7	324.3		514.4	368.3		524.8	363.4	
Ratio	%	61.0	39.0		58.2	41.8		59.0	41.0	
Totals	kg	1038.8	663.6	1702.4	1060.5	762.0	1822.5	1071.8	745.3	1817.1

TIRE PRESSURES

	Units	LF	RF	RR	LR
As Delivered	kPa	240	2240	240	240
As Tested	kPa	240	240	240	240

PROPULSION BATTERY SYSTEM DATA (COTR SUPPLIED DATA)

Electrolyte Fluid Type:	1 molar concentration of a lithium salt, lithium hexafluorophosphate (LiPF ₆) dissolved in a mixture of various organic carbonates that includes ethylene carbonate as the base solvent.	
Electrolyte Fluid Specific Gravity:	1.15 g/ml, estimated	
Electrolyte Kinematic Viscosity (centistokes):		
Electrolyte Fluid Color:	Clear, pale yellow, semi-sweet smelling solution	
Propulsion Battery Coolant Type, Color, Specific Gravity (if applicable):	DEX-COOL	
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:	390 V
X	Test Voltage ($\geq 95\%$ of Maximum State of Charge):	389.1
	Test Voltage (Within Normal Operating Voltage Range):	

VEHICLE CHASSIS GROUND POINT(S) LOCATION(S)

Details of Vehicle Chassis Ground Point(s) & Location(s)	Auxiliary Power Module (APM) Case Mounting Stud
Details of Vehicle High Voltage (HV) Location(s)	Inside APM Case Connected to High Voltage (HV) + and - Terminal

PROPULSION BATTERY SYSTEM

Details of Propulsion Battery Components	Amp Located in Rear Cargo Area Inverter Located Under Hood – Left Side of Vehicle
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DATA SHEET 3

PRE-IMPACT ELECTRIC ISOLATION MEASUREMENTS & CALCULATIONS

Test Vehicle: 2011 Chevrolet Volt 5-Dr Hatchback

NHTSA No. CB0102

VOLTMETER INFORMATION

Make:	Fluke
Model:	11
Serial Number:	68541895
Internal Impedance Value (M Ω):	> 10 M Ω < 100 pF
Resolution (V):	.001 Volts
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):	389.1
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PROPULSION BATTERY TO VEHICLE CHASSIS

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

V1 (V):	188.0
V2 (V):	191.1

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
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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):	35.7
$R_{i1} = R_o (1 + V_2/V_1) [(V_1 - V_1')/V_1']$	
Ri1 (Ω):	1722232.2
V2' (V):	36.5
$R_{i2} = R_o (1 + V_1/V_2) [(V_2 - V_2')/V_2']$	
Ri2 (Ω):	1682185.2
Ri = The lesser of Ri1 and Ri2	
Ri Pre-Test ((Ω):	1682185.2
Ri/Vb (Ω/V):	4323.2
Minimum Electrical Isolation Value is 500 Ω/V	

Note: Measured 7 minutes 15 seconds before impact.

	Yes	No, Fail
Is the measured Electrical Isolation Value $\geq$ 500 Ω/V?	X	

DATA SHEET 4
POST-IMPACT DATA

Test Vehicle: 2011 Chevrolet Volt 5-Dr Hatchback NHTSA No. CB0102

VOLTMETER INFORMATION

Make:	Fluke
Model:	11
Serial Number:	68541895
Internal Impedance Value (MΩ):	> 10 MΩ < 100 pF
Nominal Propulsion Battery Voltage (Vb) (V):	370

PROPULSION BATTERY VOLTAGE

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

V1 =	1.7	V	Impact Time:	0	Minutes	21	s
V2 =	1.3	V	Impact Time:	0	Minutes	33	s
V1' =	0.2	V	Impact Time:	0	Minutes	25	s
V2' =	0.2	V	Impact Time:	0	Minutes	53	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 =	2649K	Ω	Impact Time:	0	Minutes	33	s
$R_{i2} = R_o (1 + V_1/V_2) [(V_2 - V_2')/V_2']$							
Ri2 =	2451K	Ω	Impact Time:	0	Minutes	53	s
Ri = The lesser of Ri1 and Ri2							
Ri =	2451K	Ω	Impact Time:	0	Minutes	53	s
Ri/Vb = electrical Isolation Value/Nominal Battery Voltage							
Minimum Electrical Value is 500 Ω/V							
Ri/Vb =	6530	Ω/V	Impact Time:	0	Minutes	53	s

	Yes	No, Fail
Is the measured Electrical Isolation Value $\geq$ 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]:

No Movement

	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 4 (CONTINUED)

POST-IMPACT DATA

ADDITIONAL DATA CHANNELS

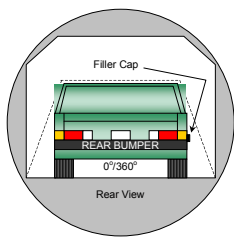
Loc. No.	Description	Peak Values			
		Max	Time (ms)	Min	Time (ms)
1	Rotation About X Axis (Deg/Sec)	423.6	52.0	-676.5	36.5
	Rotation About Y Axis (Deg/Sec)	388.1	40.4	-82.1	34.3
	Rotation About Z Axis (Deg/Sec)	373.8	44.3	-290.2	53.3
2	Left Front Seat Crossmember X (G)	8.2	59.2	-23.1	53.2
	Left Front Seat Crossmember Y (G)	39.0	28.0	-32.2	67.8
	Left Front Seat Crossmember Z (G)	22.2	21.5	-34.0	64.3
	Left Front Seat Crossmember Resultant (G)	45.2	63.6		
3	Vehicle Battery Bottom (X) (G)	(1)	(1)	(1)	(1)
	Vehicle Battery Bottom (Y) (G)	(1)	(1)	(1)	(1)
	Vehicle Battery Bottom (Z) (G)	(1)	(1)	(1)	(1)
	Resultant (G)	(1)	(1)		

⁽¹⁾ No valid data collected for Vehicle Battery Bottom X, Y, and Z after 20 msec.

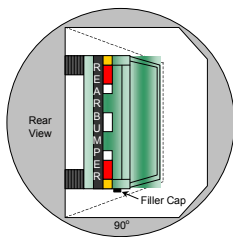
DATA SHEET 5

STATIC ROLLOVER TEST DATA

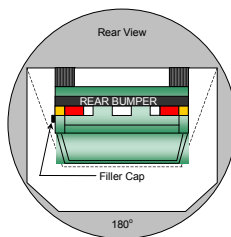
Test Vehicle: 2011 Chevrolet Volt 5-Dr Hatchback

NHTSA No. CB0102

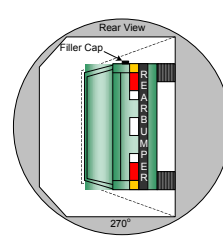
0/360



90



180



270

REAR VIEW

DETERMINATION OF PROPULSION BATTERY 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	59	seconds	5	minutes	6	minutes	59	seconds	7	minutes
90° - 180°	1	minutes	53	seconds	5	minutes	6	minutes	53	seconds	7	minutes
180° - 270°	1	minutes	49	seconds	5	minutes	6	minutes	49	seconds	7	minutes
270° - 360°	1	minutes	58	seconds	5	minutes	6	minutes	58	seconds	7	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 Chevrolet Volt 5-Dr Hatchback NHTSA No. CB0102

VOLTMETER INFORMATION

Make:	Fluke
Model:	11
Serial Number:	68541895
Internal Impedance Value (MΩ):	> 10 MΩ < 100 pF
Nominal Propulsion Battery Voltage (Vb) (V):	370

ELECTRICAL ISOLATION MEASUREMENT

V1 =	0.8	V	90°	Time:	2	Minutes	10	s
V1 =	0.8	V	180°	Time:	2	Minutes	05	s
V1 =	0.8	V	270°	Time:	1	Minutes	57	s
V1 =	0.8	V	360°	Time:	2	Minutes	01	s
V2 =	1.0	V	90°	Time:	2	Minutes	18	s
V2 =	1.0	V	180°	Time:	2	Minutes	15	s
V2 =	0.8	V	270°	Time:	2	Minutes	10	s
V2 =	0.7	V	360°	Time:	2	Minutes	20	s
V1' =	0.1	V	90°	Time:	2	Minutes	15	s
V1' =	0.1	V	180°	Time:	2	Minutes	10	s
V1' =	0.1	V	270°	Time:	1	Minutes	59	s
V1' =	0.1	V	360°	Time:	2	Minutes	10	s
V2' =	0.1	V	90°	Time:	2	Minutes	25	s
V2' =	0.1	V	180°	Time:	2	Minutes	20	s
V2' =	0.1	V	270°	Time:	2	Minutes	18	s
V2' =	0.1	V	360°	Time:	2	Minutes	23	s
Vb =	1.80	V	90°	Time:	2	Minutes	01	s
Vb =	1.80	V	180°	Time:	2	Minutes	00	s
Vb =	1.79	V	270°	Time:	1	Minutes	50	s
Vb =	1.78	V	360°	Time:	2	Minutes	00	s

DATA SHEET 5 (CONTINUED)
STATIC ROLLOVER TEST DATA

Test Vehicle: 2011 Chevrolet Volt 5-Dr Hatchback NHTSA No. CB0102

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 =	3153K	Ω	90°	Time:	2	Minutes	18	s
Ri1 =	3153K	Ω	180°	Time:	2	Minutes	15	s
Ri1 =	2802K	Ω	270°	Time:	2	Minutes	10	s
Ri1 =	2627K	Ω	360°	Time:	2	Minutes	20	s
$R_{i2} = R_o (1 + V_1/V_2) [(V_2 - V_2')/V_2']$								
Ri2 =	3243K	Ω	90°	Time:	2	Minutes	25	s
Ri2 =	3243K	Ω	180°	Time:	2	Minutes	20	s
Ri2 =	2802K	Ω	270°	Time:	2	Minutes	18	s
Ri2 =	2570K	Ω	360°	Time:	2	Minutes	23	s
Ri = The lesser of Ri1 and Ri2								
Ri =	3153K	Ω	90°	Time:	2	Minutes	18	s
Ri =	3153K	Ω	180°	Time:	2	Minutes	15	s
Ri =	2802K	Ω	270°	Time:	2	Minutes	10	s
Ri =	2570K	Ω	360°	Time:	2	Minutes	23	s
Ri/Vb = Electrical Isolation Value/Nominal Battery Voltage Minimum Electrical Isolation Value is 500 Ω/V								
Ri/Vb =	8103.7	Ω/V	90°	Time:	2	Minutes	18	s
Ri/Vb =	8103.7	Ω/V	180°	Time:	2	Minutes	15	s
Ri/Vb =	7203.2	Ω/V	270°	Time:	2	Minutes	10	s
Ri/Vb =	6615.2	Ω/V	360°	Time:	2	Minutes	23	s

	Yes	No, Fail
Is the measured Electrical Isolation Value $\geq$ 500 Ω/V?	X	

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

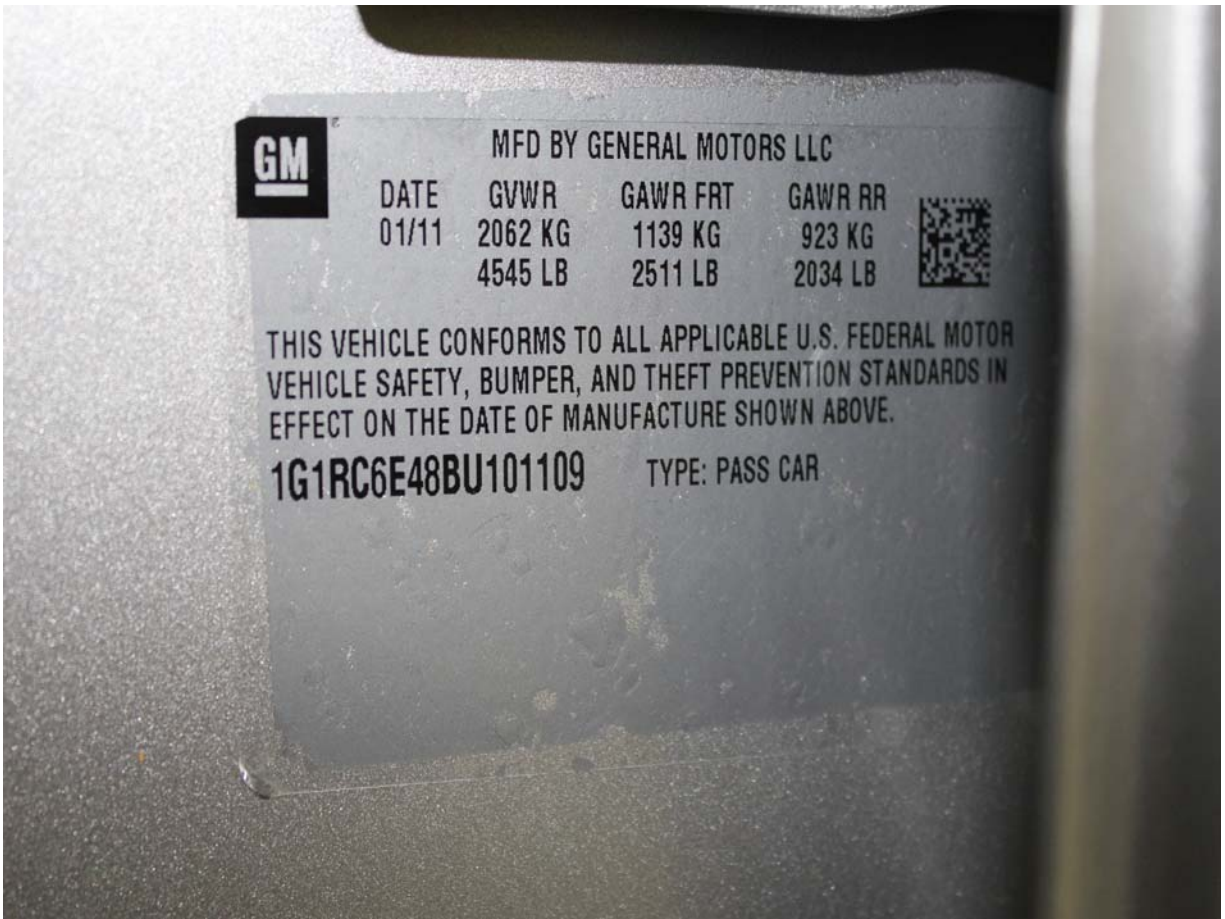
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As Delivered Right Front $\frac{3}{4}$ View of Test Vehicle



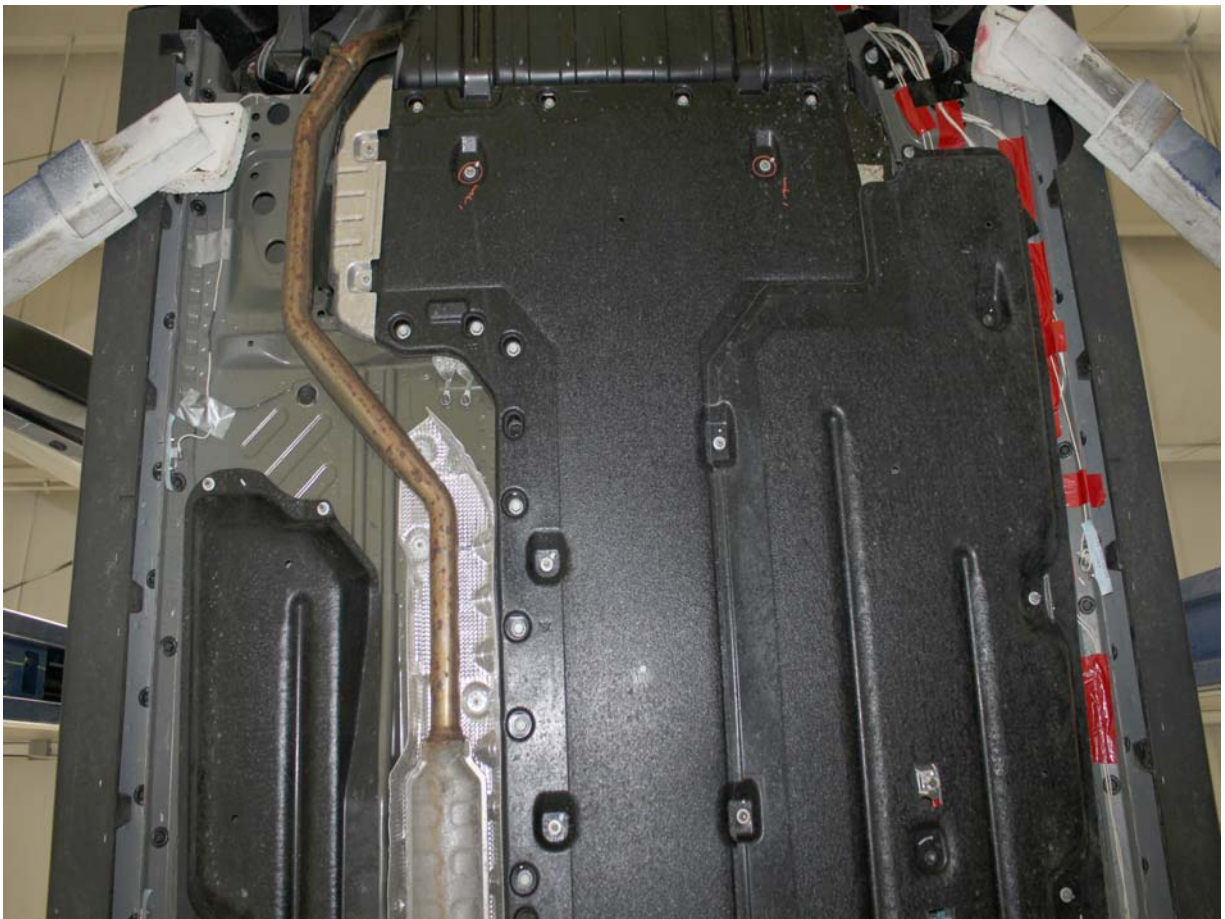
As Delivered Left Rear $\frac{3}{4}$ View of Test Vehicle



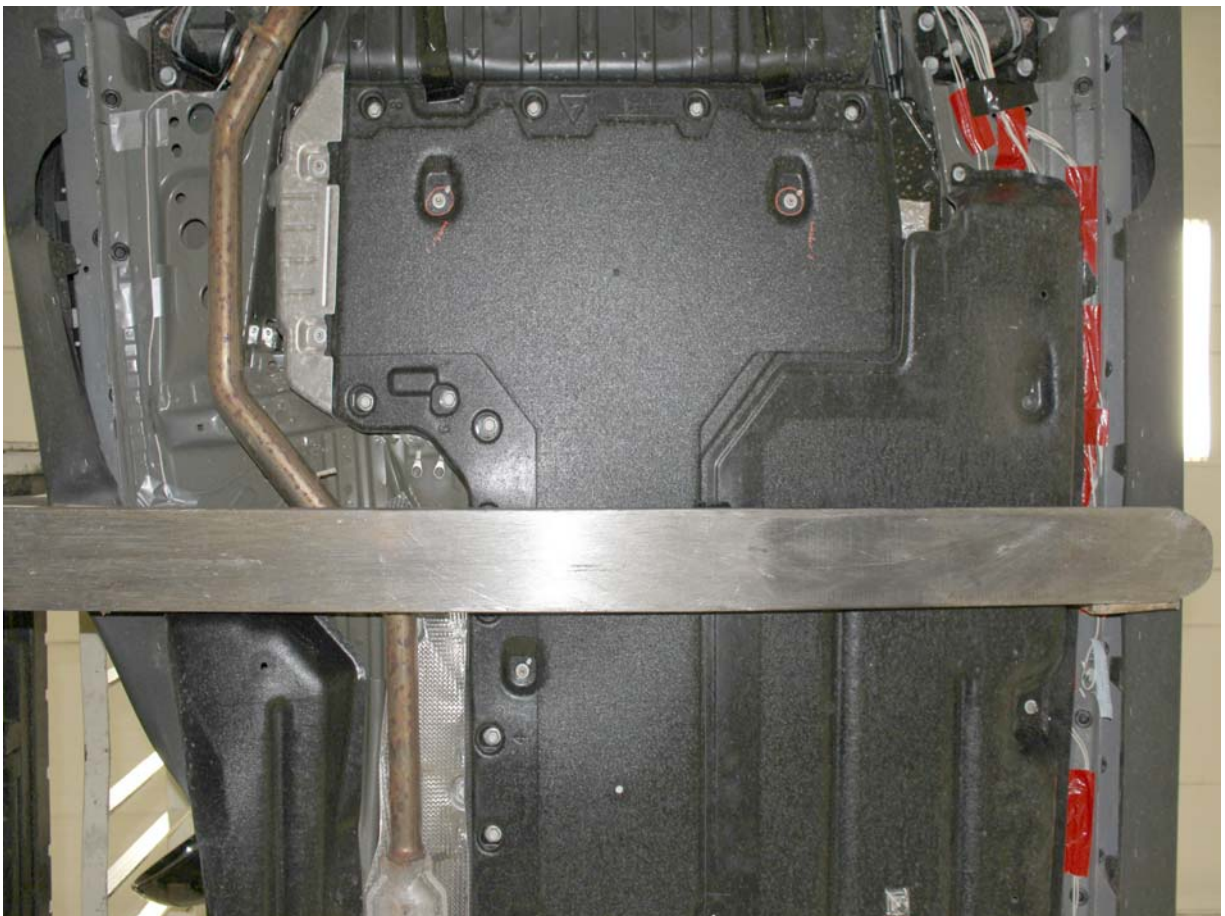
Vehicle's Certification Label



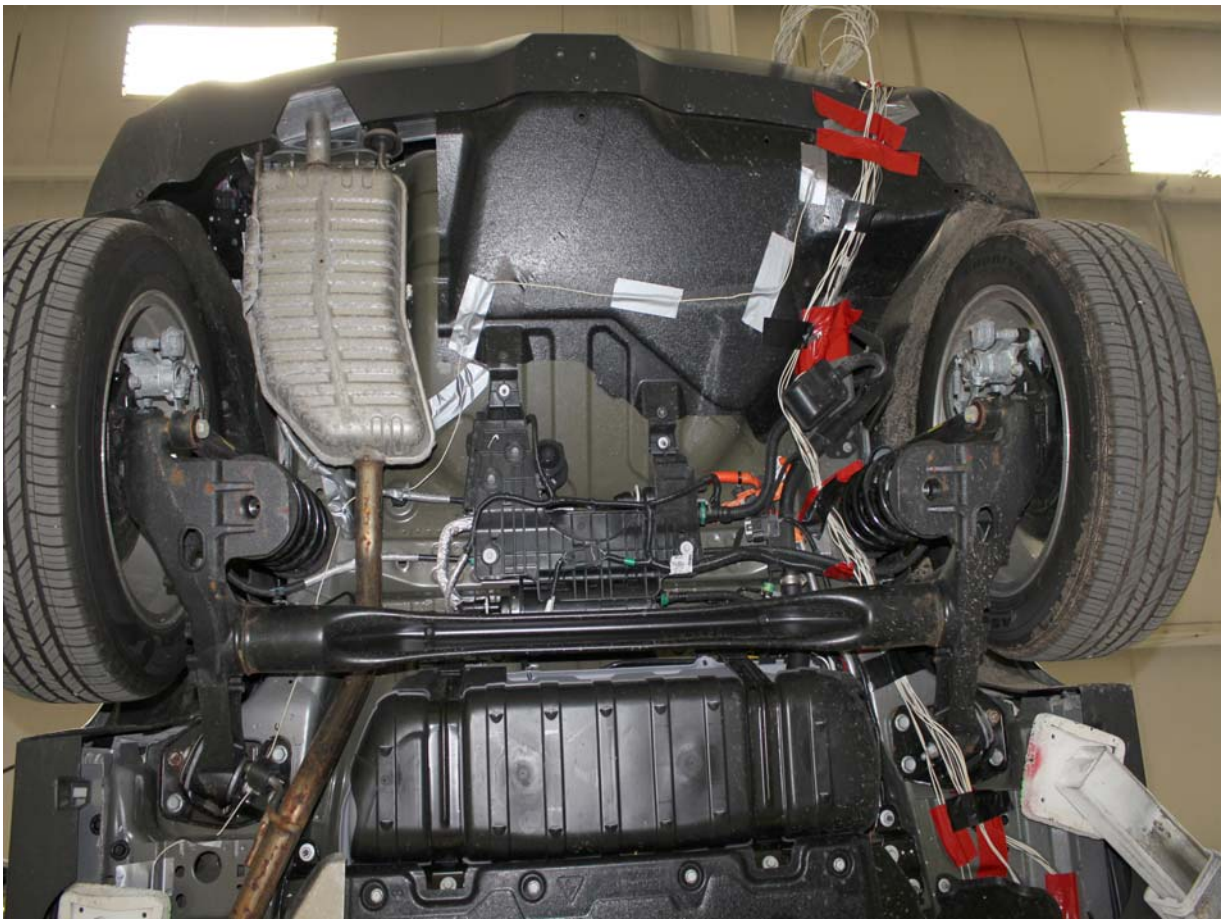
Vehicle's Tire Information Placard or Label



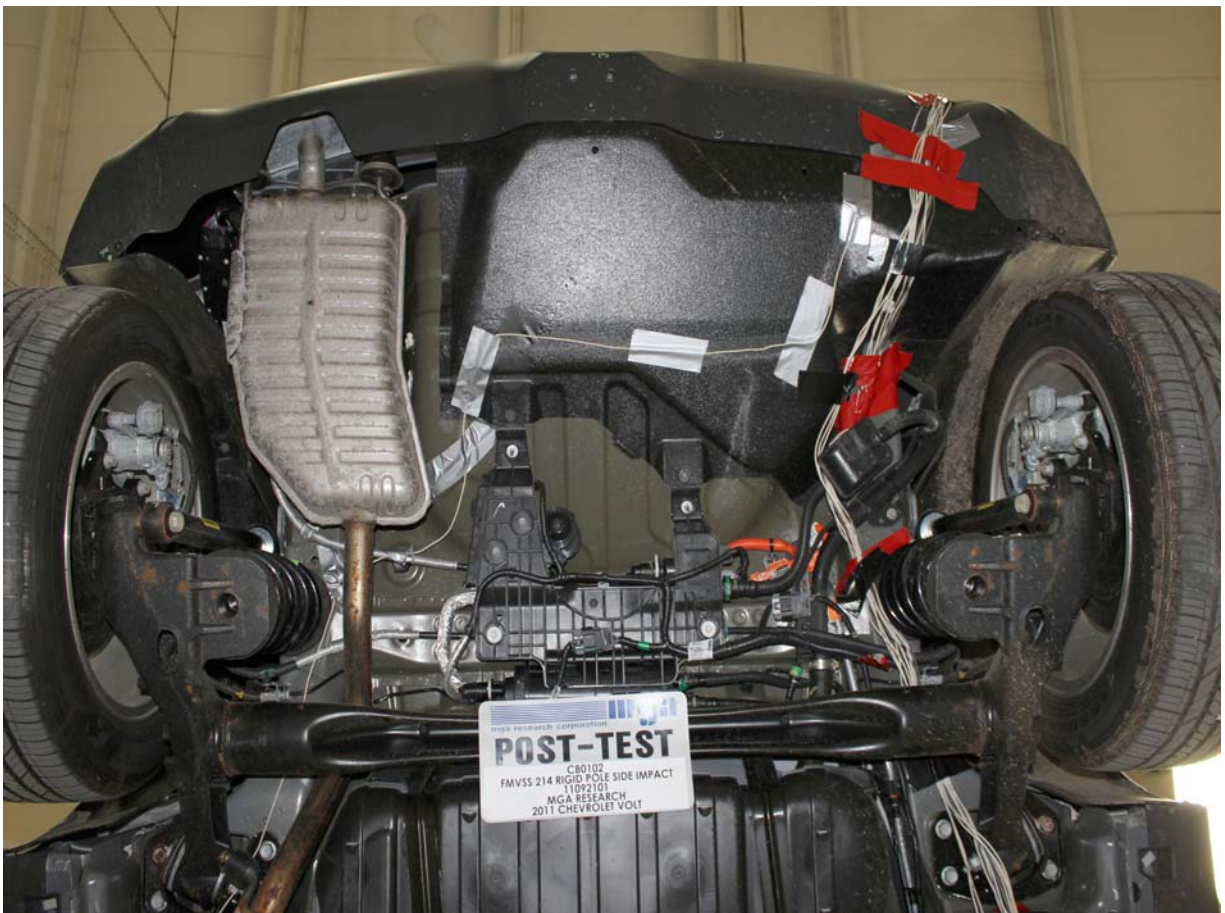
Pre-Test View of Propulsion Battery (Mid View)



Post-Test View of Propulsion Battery (Mid 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



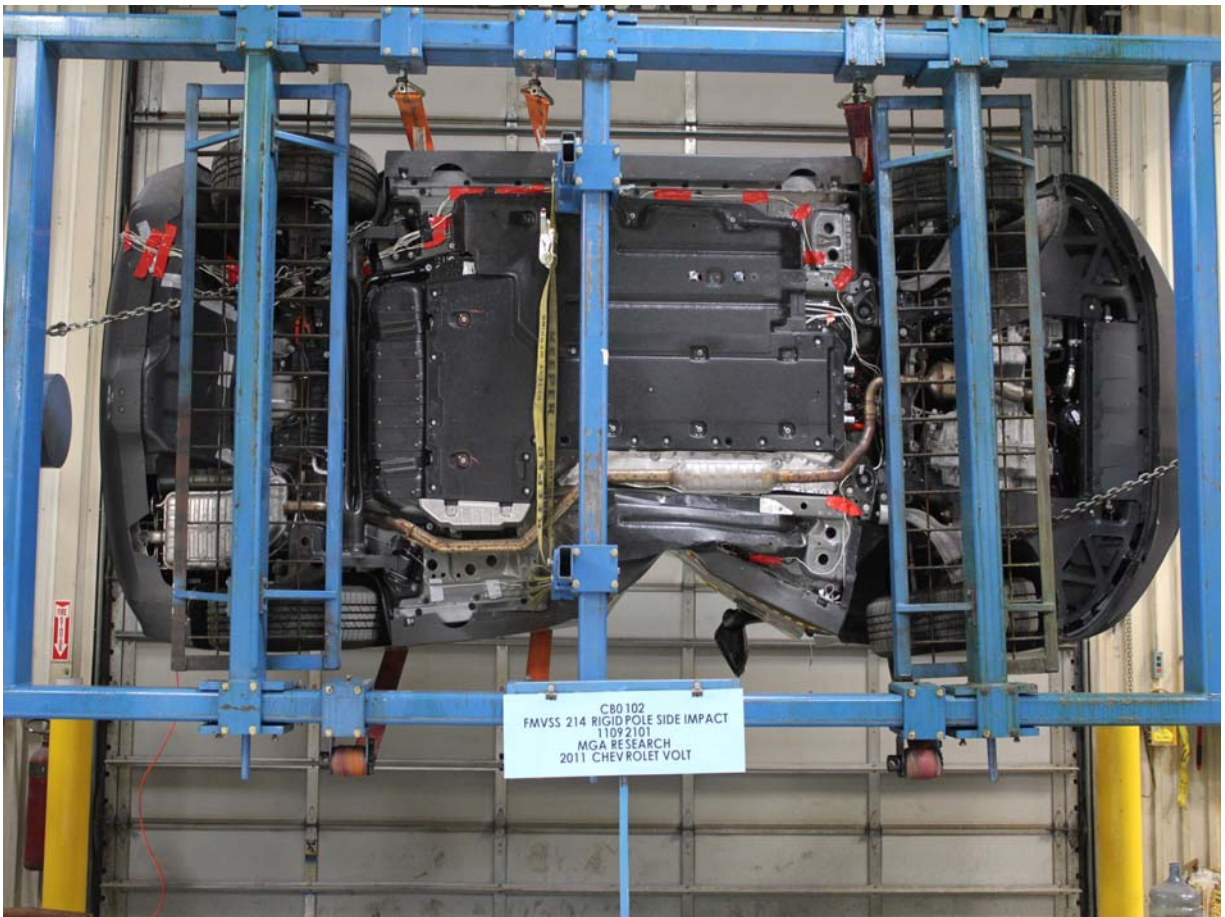
Post-Test View of Vehicle's Passenger Compartment Adjacent to Propulsion Battery



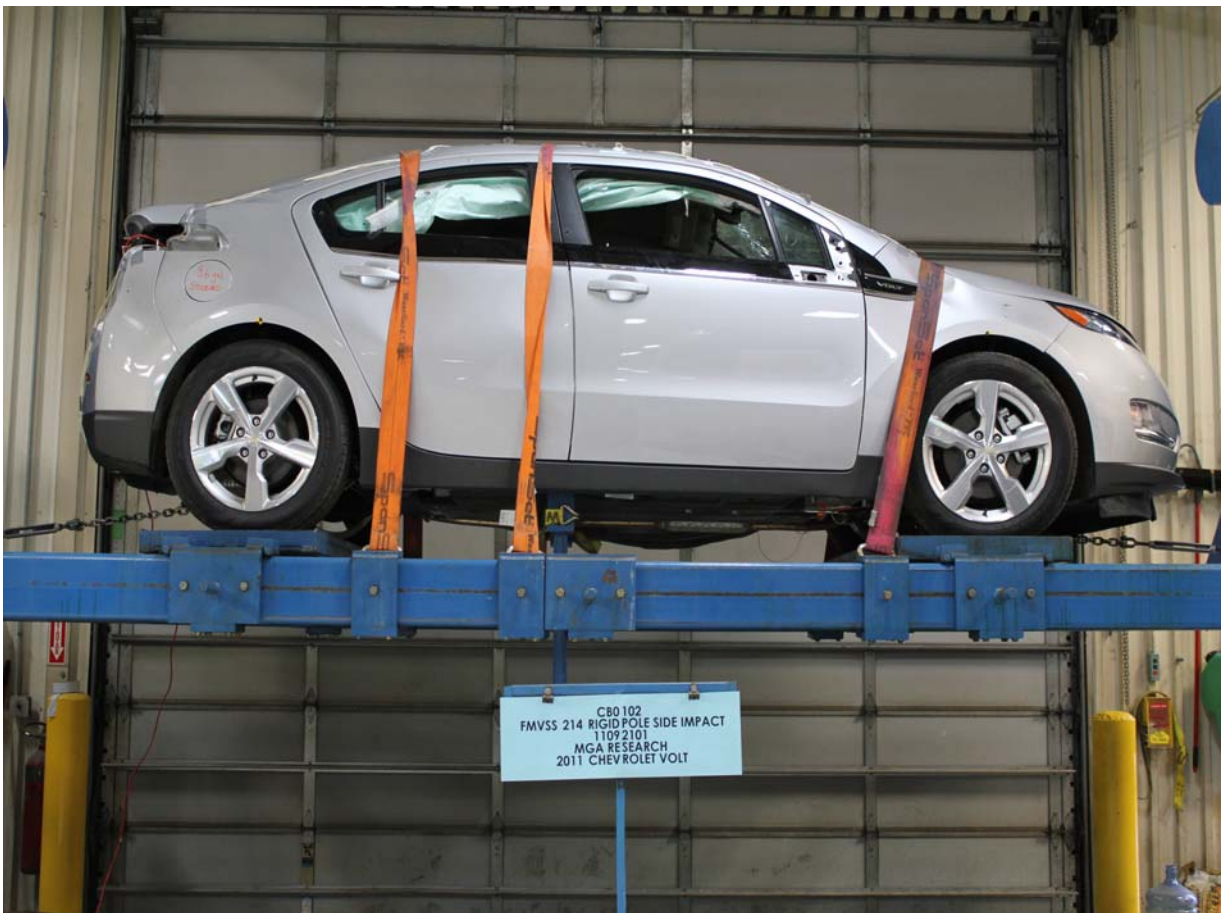
Vehicle at 90 Degrees on Static Rollover Device



Vehicle at 180 Degrees on Static Rollover Device



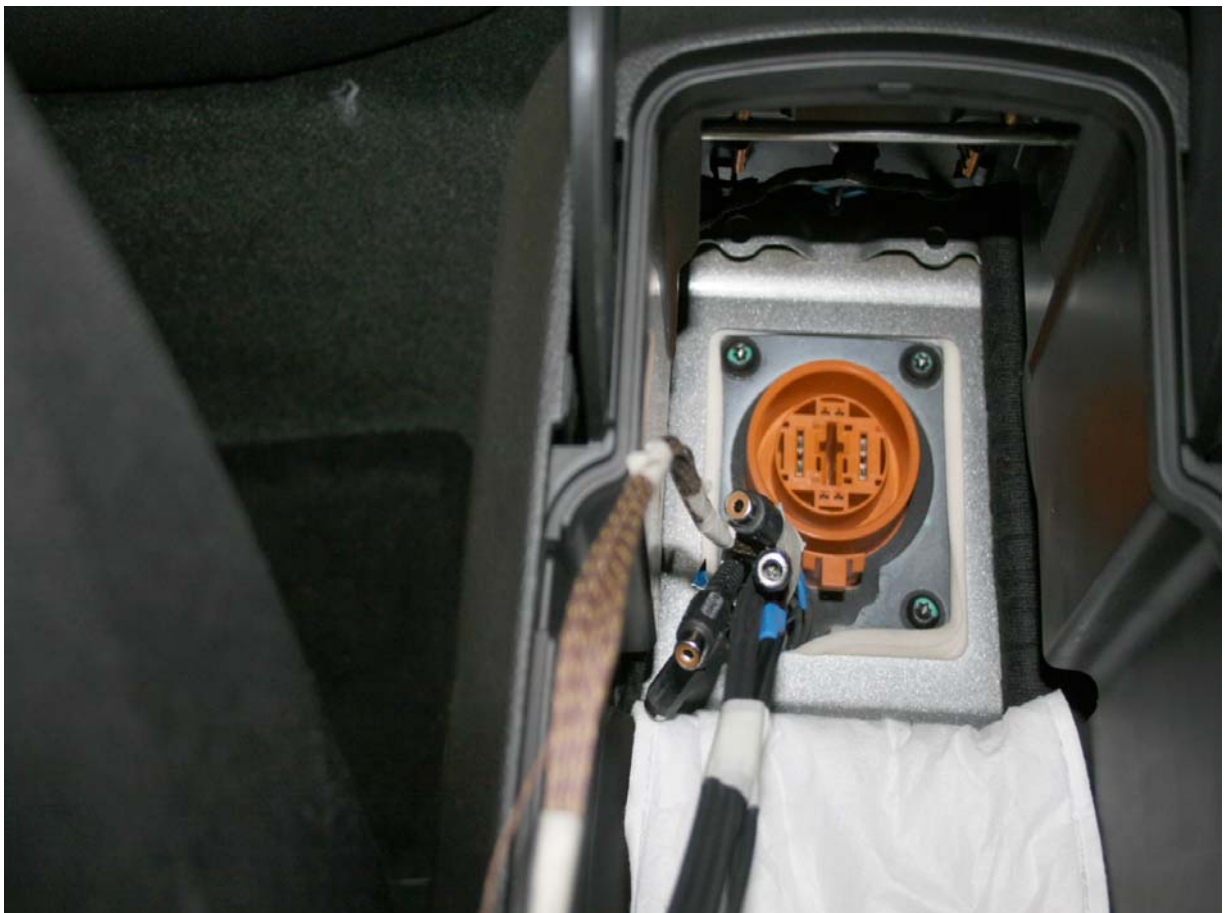
Vehicle at 270 Degrees on Static Rollover Device



Vehicle at 360 Degrees on Static Rollover Device



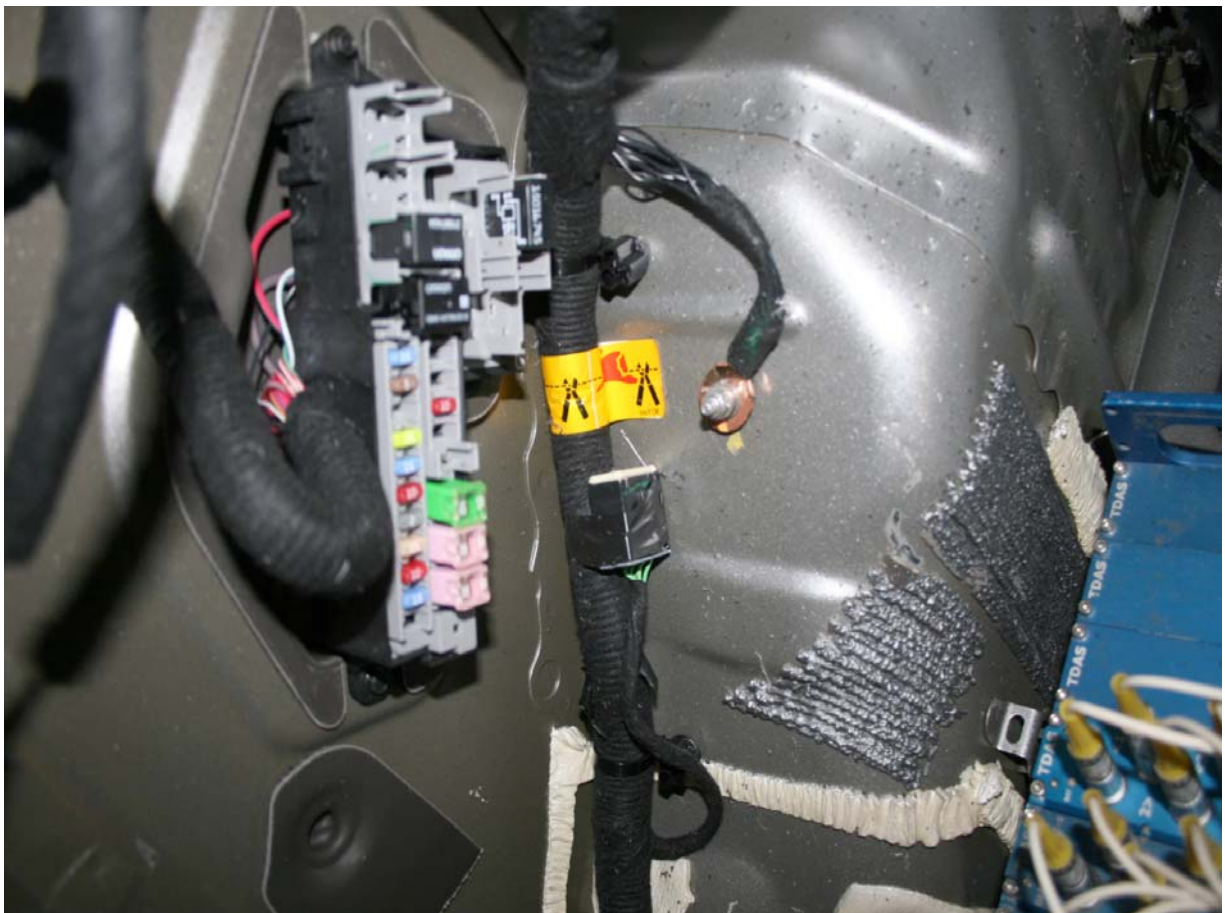
Manual High Voltage Service Disconnect



Manual High Voltage Service Disconnect



First Responder Warning/Location



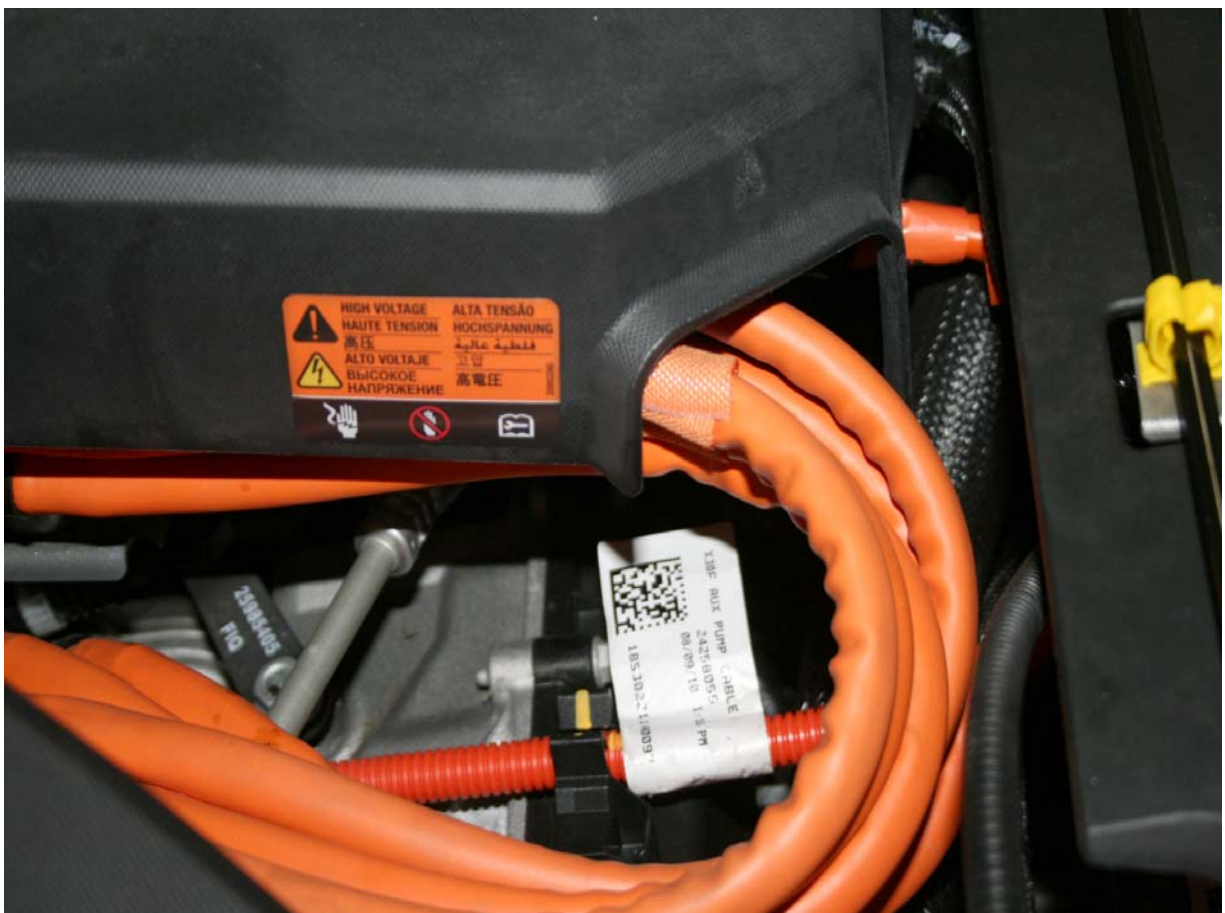
First Responder Warning/Location



Auxiliary Power Module Warning Label



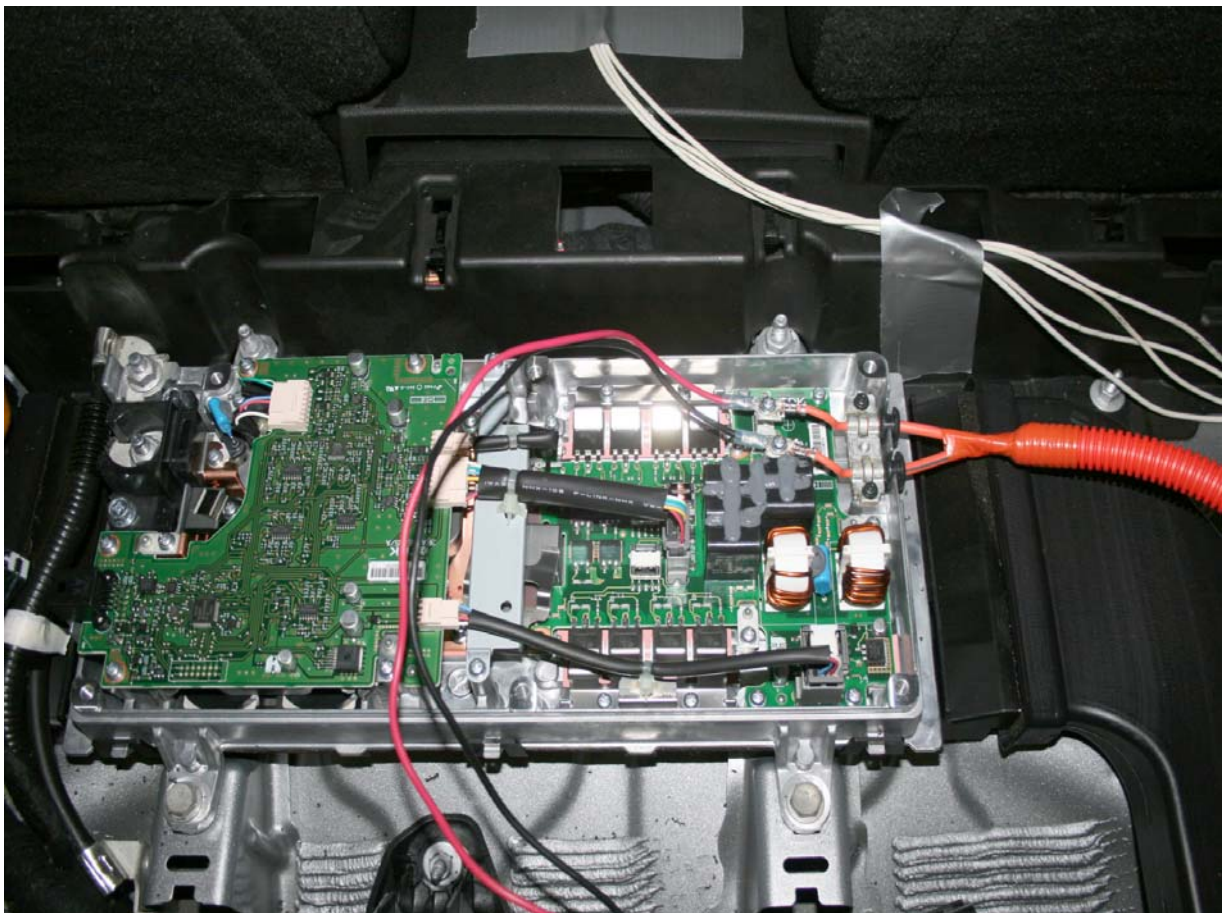
Power Inverter Warning Label/Location



Power Inverter Warning Label



Ground Location/Close-up of Leads Attached

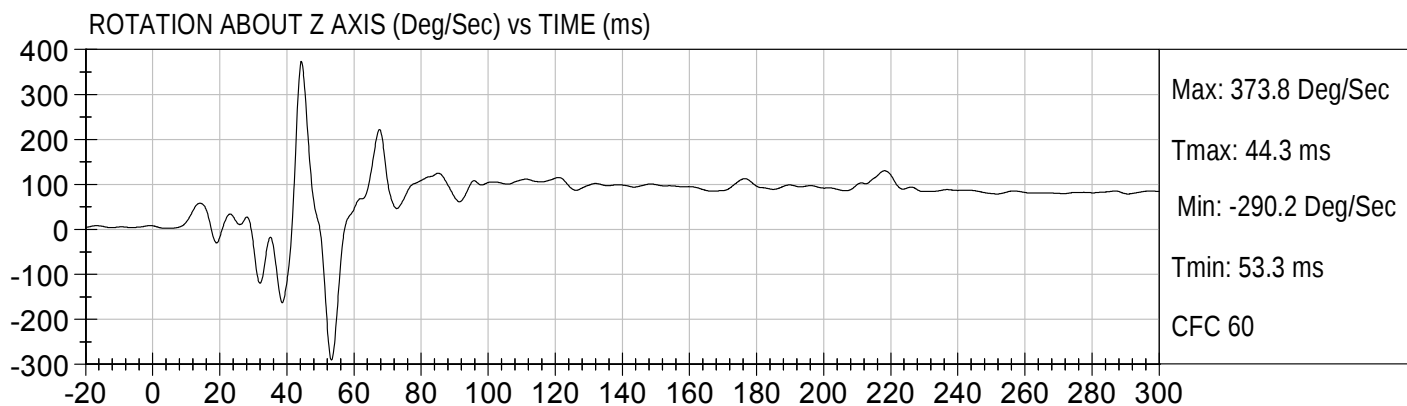
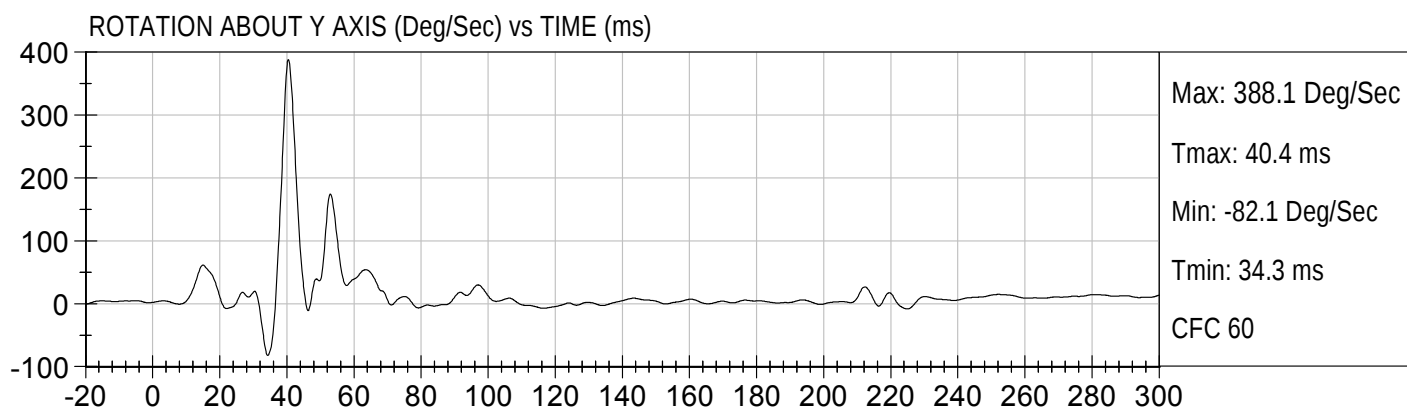
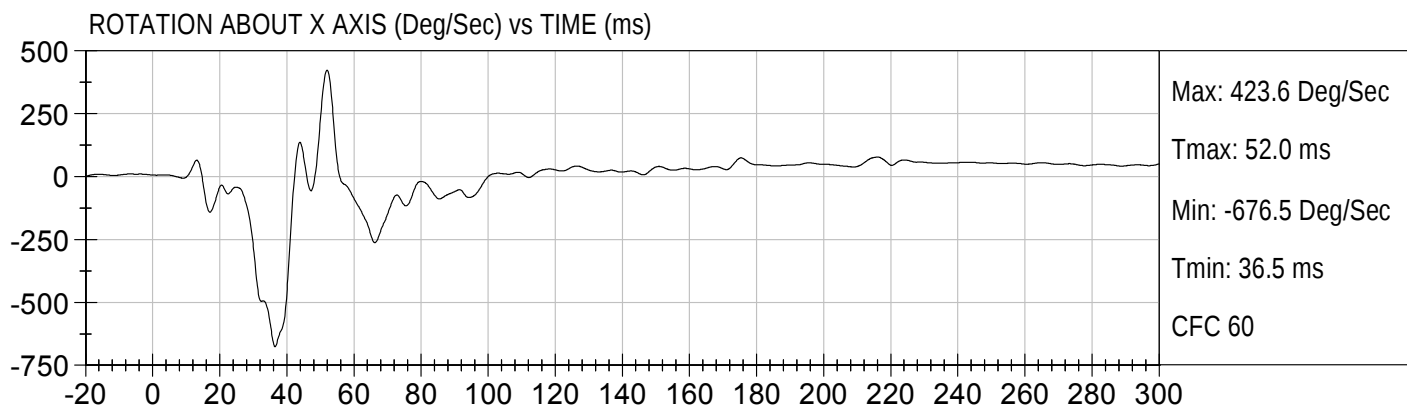


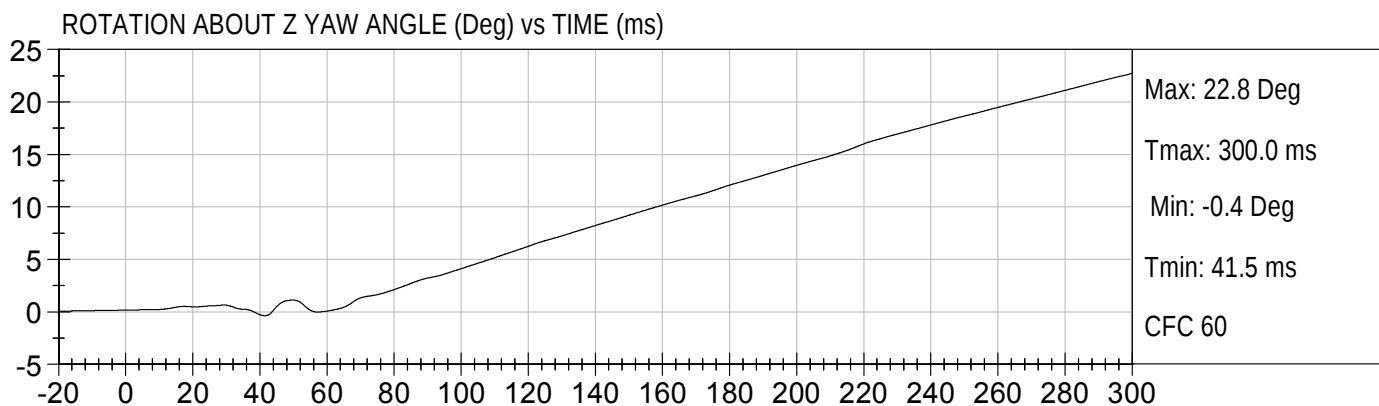
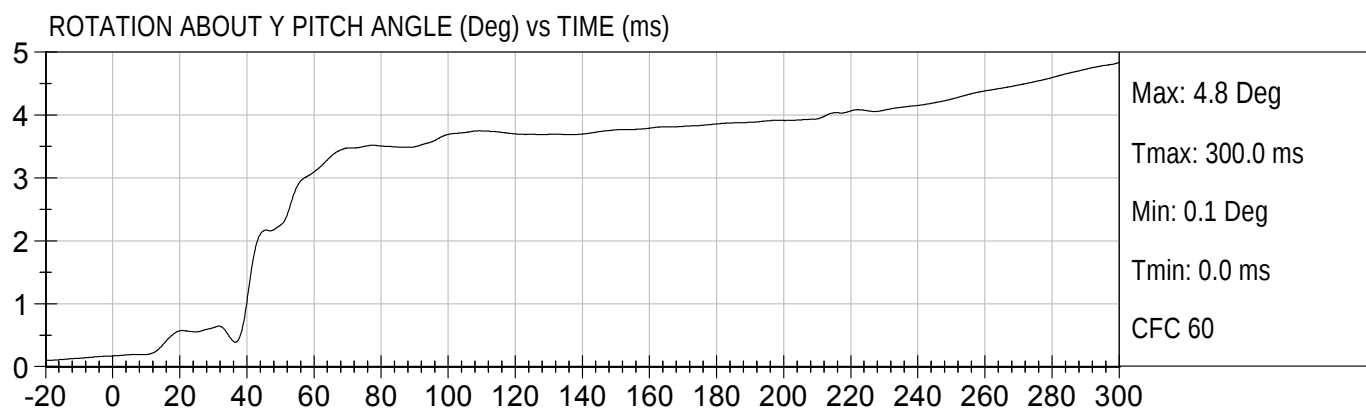
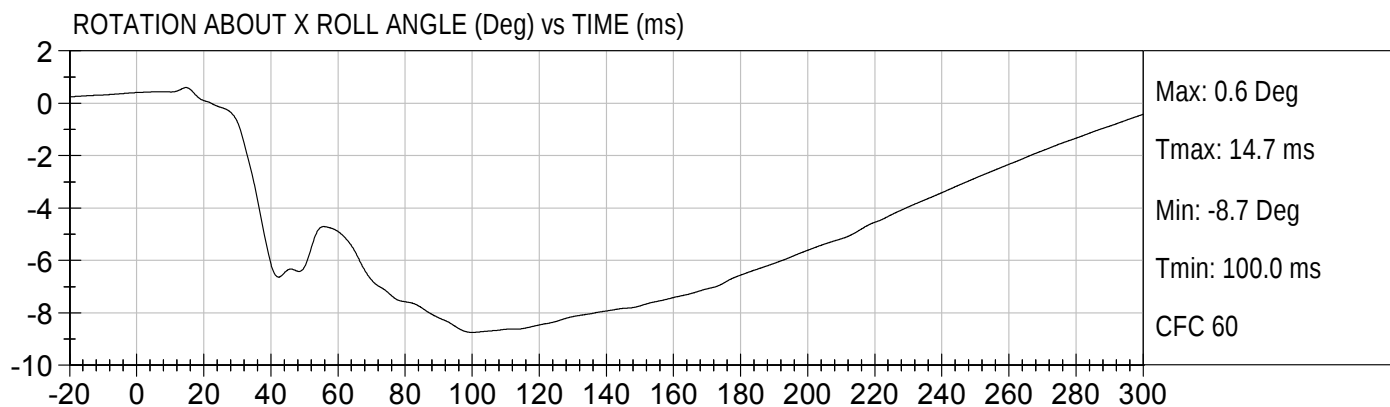
High Voltage/Close-up of Leads Attached

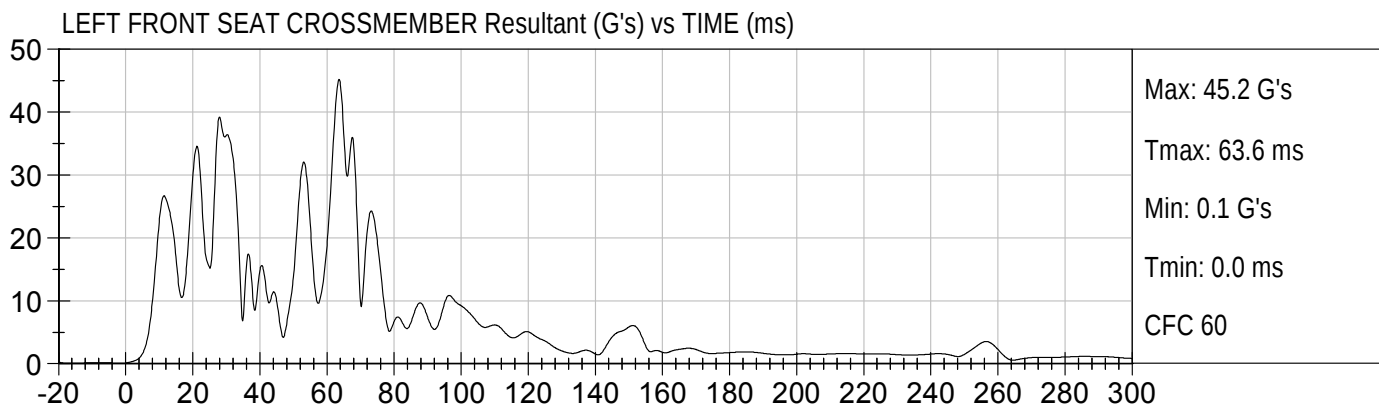
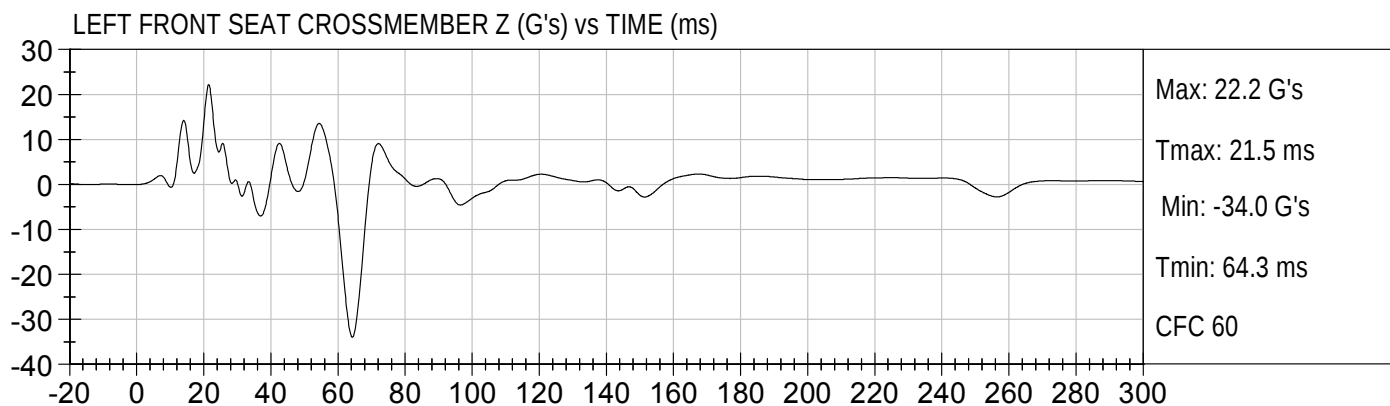
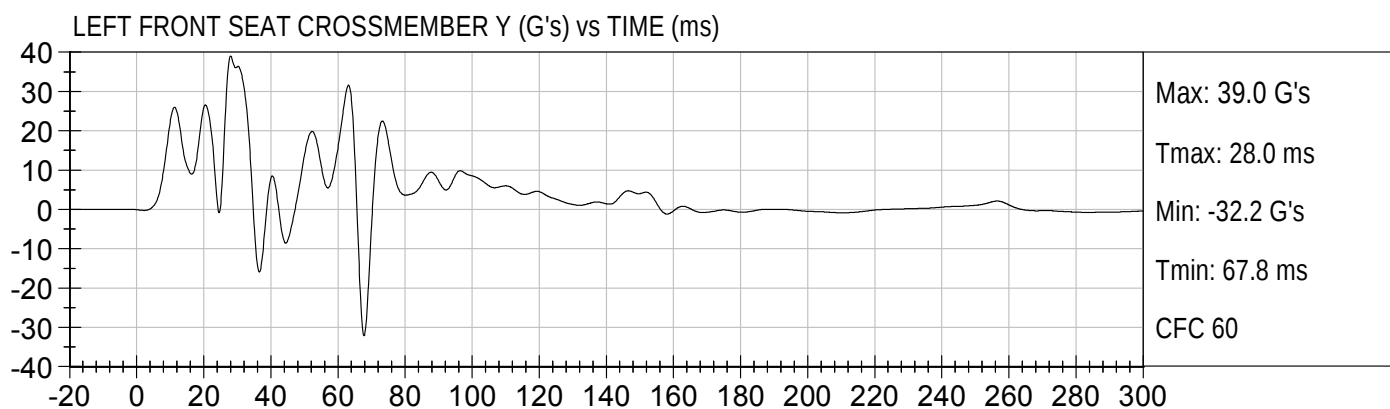
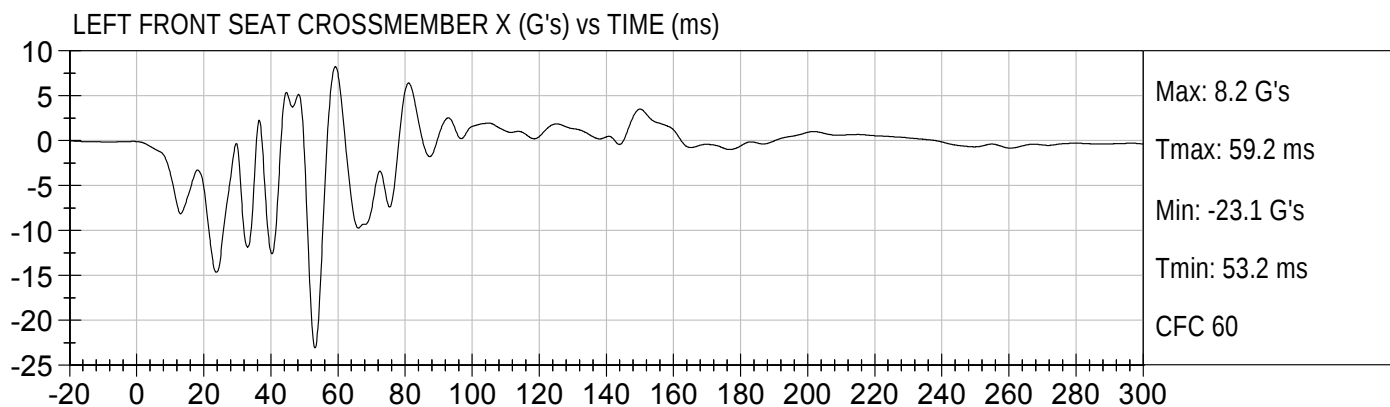
APPENDIX B
DATA PLOTS

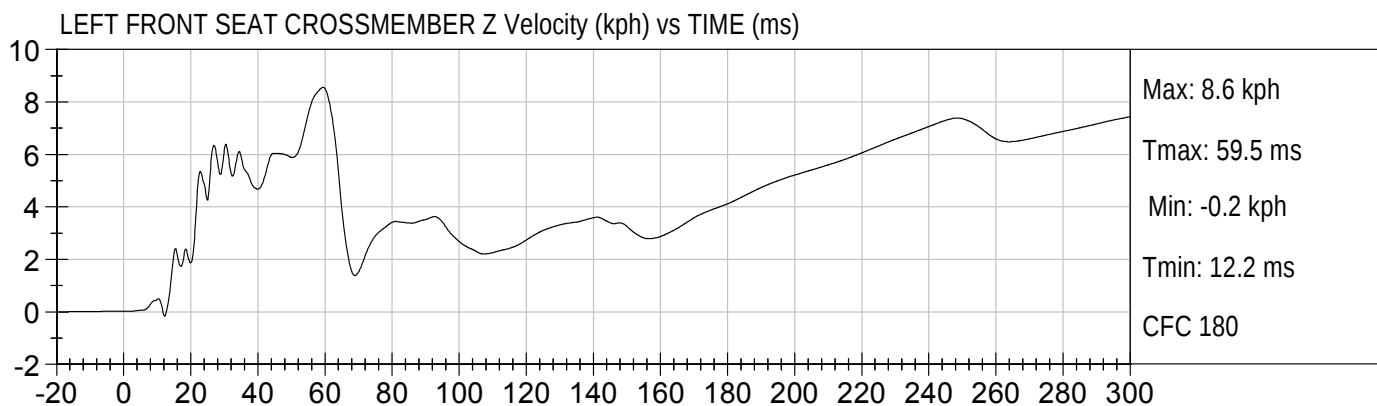
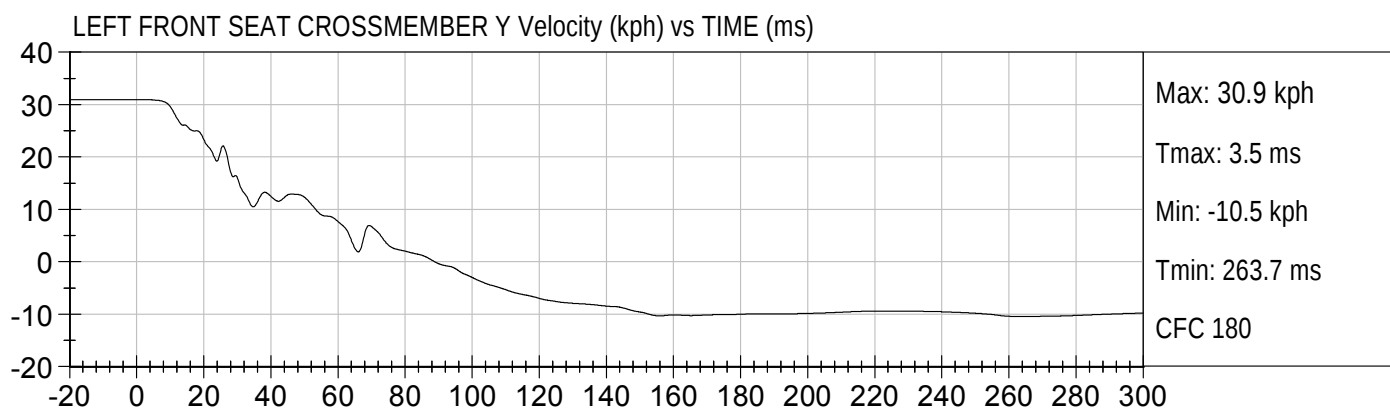
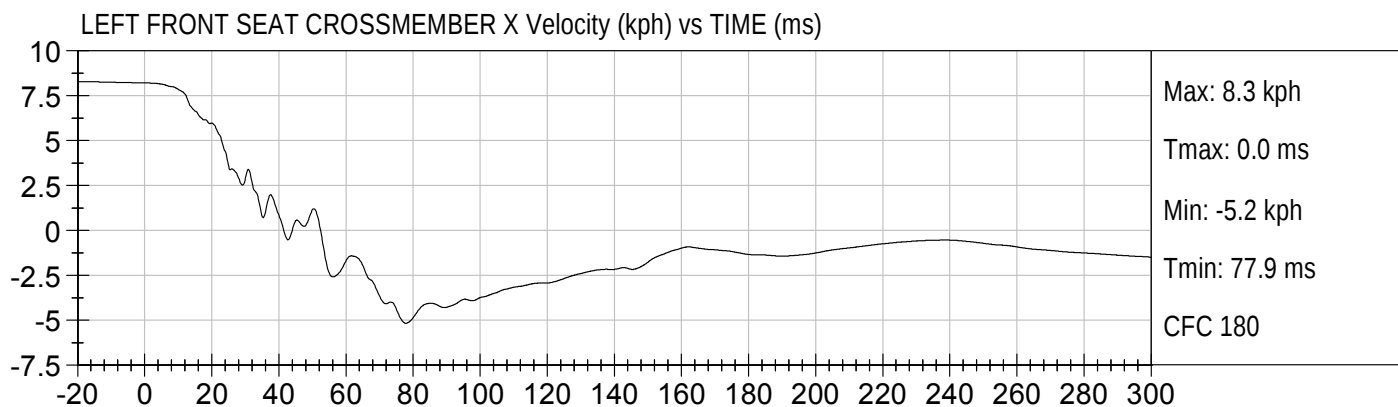
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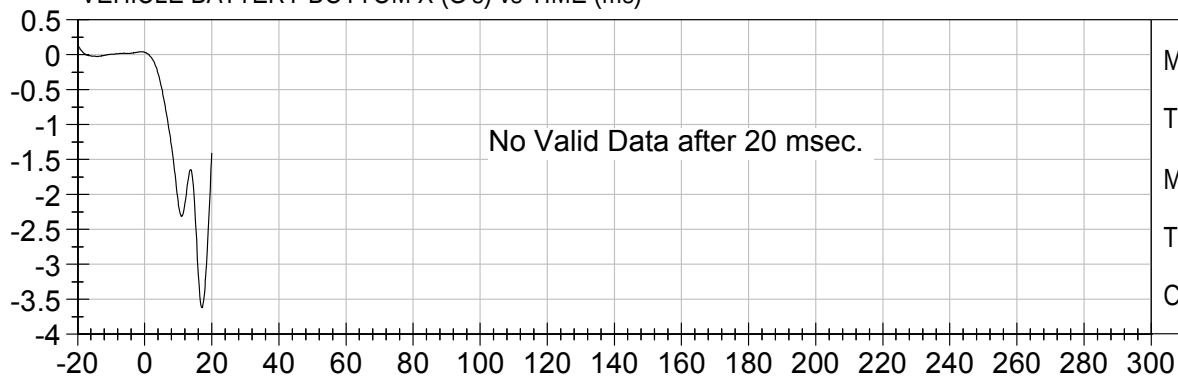






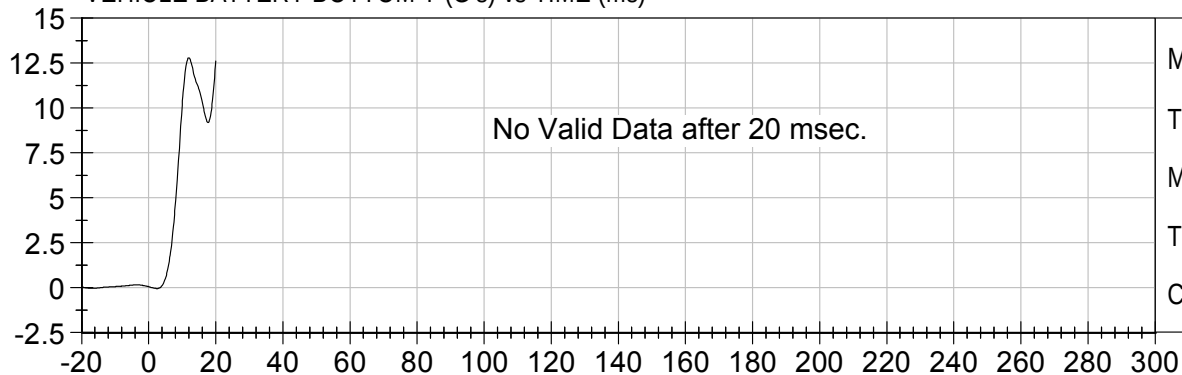


VEHICLE BATTERY BOTTOM X (G's) vs TIME (ms)



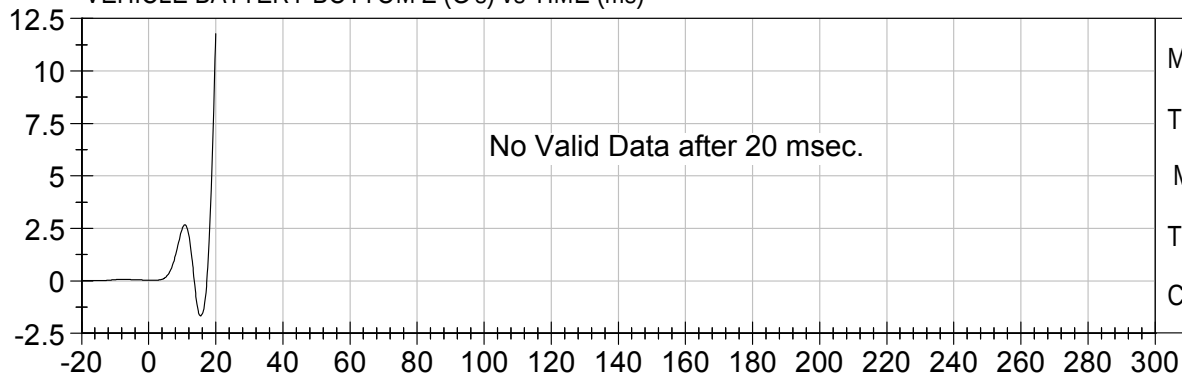
Max: 0.1 G's
Tmax: 0.0 ms
Min: -3.6 G's
Tmin: 17.1 ms
CFC 60

VEHICLE BATTERY BOTTOM Y (G's) vs TIME (ms)



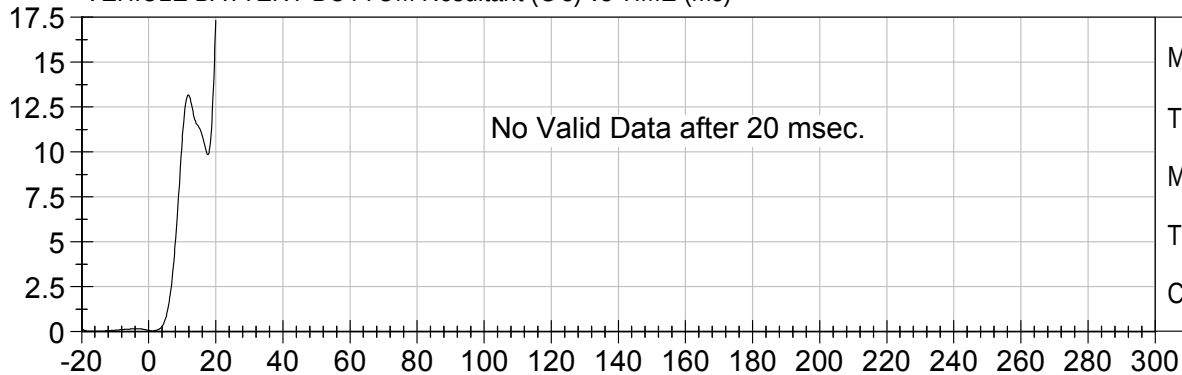
Max: 12.8 G's
Tmax: 12.0 ms
Min: -0.0 G's
Tmin: 2.5 ms
CFC 60

VEHICLE BATTERY BOTTOM Z (G's) vs TIME (ms)



Max: 11.8 G's
Tmax: 20.0 ms
Min: -1.7 G's
Tmin: 15.4 ms
CFC 60

VEHICLE BATTERY BOTTOM Resultant (G's) vs TIME (ms)



Max: 17.3 G's
Tmax: 20.0 ms
Min: 0.0 G's
Tmin: 0.0 ms
CFC 60

