REPORT NUMBER: NCAP305I-MGA-2016-007

NEW CAR ASSESSMENT PROGRAM (NCAP)
FMVSS No. 305 Indicant Test

VOLVO CAR CORPORATION
2016 Volvo XC90 T8 Inscription 5-Door SUV
NHTSA NUMBER: O20165905

MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105

Test Date: April 26, 2016

Report Date: June 14, 2016

FINAL REPORT

U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Office of Crashworthiness Standards
Mail Code: NRM-110
1200 New Jersey Ave, SE
Room W43-410
Washington, DC 20590

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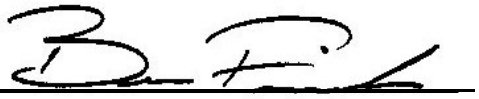
Prepared by: 
Ben Fischer, Project Engineer

Approved by: 
Joe Fleck, Project Engineer

Approval Date: June 14, 2016

FINAL REPORT ACCEPTANCE BY OVSC:

_____
Division Chief, New Car Assessment Program
NHTSA, Office of Crashworthiness Standards

Date: _____

_____
COTR, New Car Assessment Program
NHTSA, Office of Crashworthiness Standards

Date: _____

Technical Report Documentation Page

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4. Title and Subtitle Final Report of FMVSS 305 Compliance Testing of 2016 Volvo XC90 T8 Inscription 5-Door SUV, NHTSA No.: O20165905		*5. Report Date* June 14, 2016 *6. Performing Organization Code* MGA
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15. Supplementary Notes		

16. Abstract

An FMVSS No. 305 Indicant test, in conjunction with an NCAP side moving deformable barrier (MDB) impact test was conducted on the subject 2016 Volvo XC90 T8 Inscription 5-Door SUV in accordance with the specifications of the applicable Office of Crashworthiness Standards Test Procedures for the generation of consumer information for the New Car Assessment Program (NCAP). No test failures were reported.

17. Key Words New Car Assessment Program (NCAP) FMVSS 305 Indicant		*18. Distribution Statement* Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services Division, NPO-411 1200 New Jersey Ave, SE Washington, DC 20590 Email: tis@nhtsa.dot.gov FAX: 202-493-2833	
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SECTION 1
PURPOSE OF TEST

An FMVSS No. 305 Indicant test, in conjunction with an NCAP side moving deformable barrier (MDB) impact test was conducted on the subject 2016 Volvo XC90 T8 Inscription 5-Door SUV.

The Indicant test was conducted in accordance with the Office of Crashworthiness Standards Laboratory Test Procedure, dated January 31, 2012 to determine compliance to the requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 305, “Electric-Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection” for the purpose of providing consumer information.

This FMVSS No. 305 Indicant test is part of the MY 2016 New Car Assessment Program Test Program, sponsored by the National Highway Traffic Safety Administration (NHTSA), under contract DTNH22-14-D-00353.

SECTION 2
SUMMARY OF TEST RESULTS

A side moving deformable barrier (MDB) impact test was performed by MGA Research Corporation on a 2016 Volvo XC90 T8 Inscription 5-Door SUV on April 26, 2016. Electrical isolation measurements were taken immediately post-impact and observations were made related to electrolyte spillage and battery retention. A static rollover was subsequently performed on the subject vehicle and electrical isolation measurements were taken at each stage of the rollover.

Based on the test results, the 2016 Volvo XC90 T8 Inscription 5-Door SUV appears to meet the requirements for electrolyte spillage, electrical isolation, and battery retention during FMVSS No. 305 Indicant testing.

Data sheets, along with pre-test and post-test photographs of the test vehicle, are included in this report to document the test.

TEST NOTES

None

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

SECTION 3
DATA SHEETS

DATA SHEET NO. 1
TEST VEHICLE SPECIFICATIONS

Test Vehicle: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905

TEST VEHICLE INFORMATION

Year/Make/Model/Body Style	2016 Volvo XC90 T8 Inscription 5-Door SUV
NHTSA No.	O20165905
Color	Luminous Sand Metallic
Odometer Reading	19km / 12mi

DATA FROM CERTIFICATION LABEL

Manufactured By	VOLVO CAR CORPORATION
Date of Manufacture	01/16
VIN:	YV4BC0PL8G1066023

GVWR (kg)	3010
GAWR Front (kg)	1420
GAWR Rear (kg)	1628

ELECTRIC VEHICLE PROPULSION SYSTEM

Type of Electric Vehicle (Electric/Hybrid):	Gasoline-Electric Hybrid
Electric Energy Storage/Device:	Lithium-Ion (Li-Ion) Battery
Nominal Voltage (V):	355 V
Is this vehicle equipped with an Automatic Propulsion Battery Disconnect?	Yes
Physical Location of the Automatic Propulsion Battery Disconnect:	Physically contained within the Energy Storage System.
Auxiliary Battery Type:	12 V Lead-Acid Battery

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

Electrolyte Fluid Type:	LiPF6 in Organic Carbonate Solution	
Electrolyte Fluid Specific Gravity:	1.2 (g/cc)	
Electrolyte Kinematic Viscosity (centistokes):	3 (cP) @ 25° C	
Electrolyte Fluid Color:	Colorless or Pale Yellow Liquid	
Electric Energy Storage/Conversion System Coolant Type, Color, Specific Gravity (if applicable):	Water Glycol, Color: Green	
Location of Battery Modules:		Inside Passenger Compartment
	X	Outside Passenger Compartment
	The high-voltage battery is mounted under the center console.	

DATA SHEET NO. 1
TEST VEHICLE SPECIFICATIONS

Test Vehicle: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905

ELECTRIC ENERGY STORAGE CONVERSION/DEVICE STATE OF CHARGE

For all battery types:	
Voltage range corresponding to **useable energy** of the battery:	
Minimum State of Charge:	N/A
Maximum State of Charge:	398 V
95% of Maximum State of Charge:	378.1 V
Test Voltage - No less than 95% of maximum State of Charge:	387.1 V
For batteries that are rechargeable ONLY by an energy source on the vehicle:	
Voltage range corresponding to **useable energy** of the battery:	
Minimum State of Charge:	
Maximum State of Charge:	
Test Voltage – Maximum practicable State of Charge within Normal Operating Range:	

DATA SHEET 2
PRE-IMPACT DATA

Test Vehicle: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905

VEHICLE CHASSIS GROUND POINT(S) LOCATION(S)

Details of Vehicle Chassis Ground Point(s) & Location(s)	Mounting Bolt at Manual Service Disconnect Housing.

ELECTRIC ENERGY STORAGE/CONVERSION TEST POINTS

Details of Electric Energy Storage/Conversion System Test Points:	Manufacturer Supplied “Breakout Box”.

DATA SHEET 3
PRE-IMPACT ELECTRIC ISOLATION MEASUREMENTS & CALCULATIONS

Test Vehicle: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905

VOLTMETER INFORMATION

Make:	Fluke
Model:	177
Serial Number:	22600211
Internal Impedance Value (MΩ):	> 10 MΩ < 100 pF
Resolution (V):	.001 Volts
Last Calibration Date:	3/2/2016

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):	386.9

ELECTRIC ENERGY STORAGE/CONVERSION SYSTEM TO VEHICLE CHASSIS

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

V1 (V):	24.7
V2 (V):	362.0

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):	180,700

V1' (V) Pre-Impact:	9.4
V2' (V) Pre-Impact:	15.5

DATA SHEET 3 (CONTINUED)
PRE-IMPACT ELECTRICAL ISOLATION MEASUREMENTS & CALCULATIONS

Test Vehicle: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905

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):	9.4
Ri1 = Ro (1 + V2/V1) [(V1-V1')/V1']	
Ri1 (Ω):	4,604,675
V2' (V):	15.5
Ri2 = Ro (1 + V1/V2) [(V2-V2')/V2']	
Ri2 (Ω):	4,315,144
Ri = The lesser of Ri1 and Ri2	
Ri Pre-Test (Ω):	4,315,144
Ri/Vb (Ω/V):	11,153
Minimum Electrical Isolation Value is 500 Ω/V	

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

DATA SHEET 4
POST-IMPACT DATA

Test Vehicle: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905

VOLTMETER INFORMATION

Make:	Fluke
Model:	177
Serial Number:	22600211
Internal Impedance Value (MΩ):	> 10 MΩ < 100 pF
Nominal Propulsion Battery Voltage (Vb) (V):	355

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):	8.4

ELECTRIC ENERGY STORAGE/CONVERSION SYSTEM VOLTAGE

V1 =	50.9	V	Impact Time:	1	Minutes	5	s
V2 =	34.4	V	Impact Time:	1	Minutes	1	s
V1' =	2.7	V	Impact Time:	1	Minutes	14	s
V2' =	2.1	V	Impact Time:	1	Minutes	33	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 =	5,405,958	Ω	Impact Time:	1		5	s
Ri2 = Ro (1 + V1/V2) [(V2-V2')/V2']							
Ri2 =	6,891,789	Ω	Impact Time:	1	Minutes	1	s
Ri = The lesser of Ri1 and Ri2							
Ri =	5,405,958	Ω	Impact Time:	1	Minutes	5	s
Ri/Vb = electrical Isolation Value/Nominal Battery Voltage							
Minimum Electrical Value is 500 Ω/V							
Ri/Vb =	13,972	Ω/V	Impact Time:	1	Minutes	5	s

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

DATA SHEET 4 (CONTINUED)
POST-IMPACT DATA

Test Vehicle: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905

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

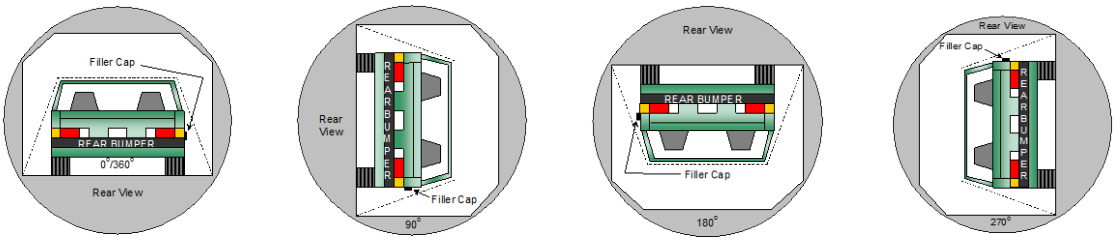
Describe intrusion of an outside Electric Energy Storage/Conversion Device into the passenger compartment [Supply photographs as appropriate]:
No Intrusion

	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: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905



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	52	seconds	5	minutes	6	minutes	52	seconds	7	minutes
90° - 180°	1	minutes	48	seconds	5	minutes	6	minutes	48	seconds	7	minutes
180° - 270°	1	minutes	48	seconds	5	minutes	6	minutes	48	seconds	7	minutes
270° - 360°	1	minutes	50	seconds	5	minutes	6	minutes	50	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: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905

VOLTMETER INFORMATION

Make:	Fluke
Model:	177
Serial Number:	22600211
Internal Impedance Value (MΩ):	> 10 MΩ < 100 pF
Nominal Electric Energy Storage/Conversion Device Voltage (Vb) (V):	355
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 =	4.1	V	0°	Time:		Minutes		s
V1 =	5.2	V	90°	Time:	1	Minutes	5	s
V1 =	4.3	V	180°	Time:	1	Minutes	1	s
V1 =	4.3	V	270°	Time:	1	Minutes	14	s
V1 =	4.3	V	360°	Time:	1	Minutes	33	s
V2 =	4.1	V	0°	Time:		Minutes		s
V2 =	3.3	V	90°	Time:	1	Minutes	12	s
V2 =	4.1	V	180°	Time:	1	Minutes	8	s
V2 =	4.0	V	270°	Time:	1	Minutes	18	s
V2 =	4.0	V	360°	Time:	1	Minutes	37	s
V1' =	0.2	V	0°	Time:		Minutes		s
V1' =	0.2	V	90°	Time:	1	Minutes	19	s
V1' =	0.2	V	180°	Time:	1	Minutes	15	s
V1' =	0.1	V	270°	Time:	1	Minutes	28	s
V1' =	0.2	V	360°	Time:	1	Minutes	42	s
V2' =	0.2	V	0°	Time:		Minutes		s
V2' =	0.1	V	90°	Time:	1	Minutes	25	s
V2' =	0.2	V	180°	Time:	1	Minutes	22	s
V2' =	0.2	V	270°	Time:	1	Minutes	35	s
V2' =	0.3	V	360°	Time:	1	Minutes	50	s
Vb =	8.5	V	0°	Time:		Minutes		s
Vb =	8.5	V	90°	Time:	1	Minutes	0	s
Vb =	8.5	V	180°	Time:	0	Minutes	56	s
Vb =	8.5	V	270°	Time:	1	Minutes	9	s
Vb =	8.5	V	360°	Time:	1	Minutes	28	s

DATA SHEET 5 (CONTINUED)
STATIC ROLLOVER TEST DATA

Test Vehicle: 2016 Volvo XC90 T8 Inscription 5-Door SUV NHTSA No. O20165905

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 =	7,047,300	Ω	0°	Time:		Minutes		s
Ri1 =	7,384,375	Ω	90°	Time:	1	Minutes	5	s
Ri1 =	7,236,405	Ω	180°	Time:	1	Minutes	1	s
Ri1 =	14,649,307	Ω	270°	Time:	1	Minutes	14	s
Ri1 =	7,150,257	Ω	360°	Time:	1	Minutes	33	s
Ri2 = Ro (1 + V1/V2) [(V2-V2')/V2']								
Ri2 =	7,047,300	Ω	0°	Time:		Minutes		s
Ri2 =	14,894,061	Ω	90°	Time:	1	Minutes	12	s
Ri2 =	7,219,185	Ω	180°	Time:	1	Minutes	8	s
Ri2 =	7,124,098	Ω	270°	Time:	1	Minutes	18	s
Ri2 =	4,624,414	Ω	360°	Time:	1	Minutes	37	s
Ri = The lesser of Ri1 and Ri2								
Ri =	7,047,300	Ω	0°	Time:		Minutes		s
Ri =	14,894,061	Ω	90°	Time:	1	Minutes	5	s
Ri =	7,219,185	Ω	180°	Time:	1	Minutes	1	s
Ri =	7,124,098	Ω	270°	Time:	1	Minutes	14	s
Ri =	4,624,414	Ω	360°	Time:	1	Minutes	33	s
Ri/Vb = Electrical Isolation Value/Nominal Battery Voltage Minimum Electrical Isolation Value is 500 Ω /V								
Ri/Vb =	18,215	Ω/V	0°	Time:		Minutes		s
Ri/Vb =	19,086	Ω/V	90°	Time:	1	Minutes	5	s
Ri/Vb =	18,659	Ω/V	180°	Time:	1	Minutes	1	s
Ri/Vb =	18,413	Ω/V	270°	Time:	1	Minutes	14	s
Ri/Vb =	11,952	Ω/V	360°	Time:	1	Minutes	33	s

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

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Photo No. 001 - Auxiliary Power Module Warning Label

Photo No. 002 - Power Inverter Warning Label

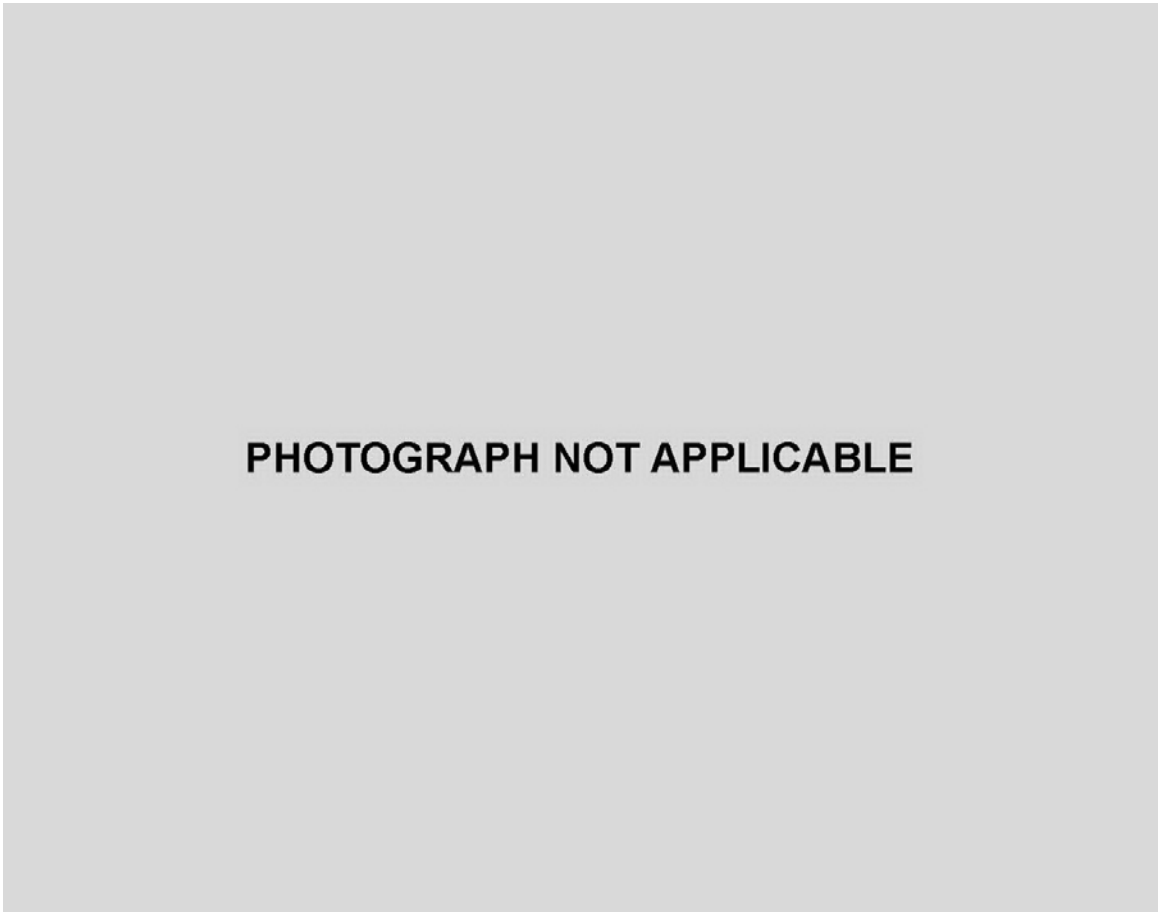


Photo No. 003 - First Responder Warning Label

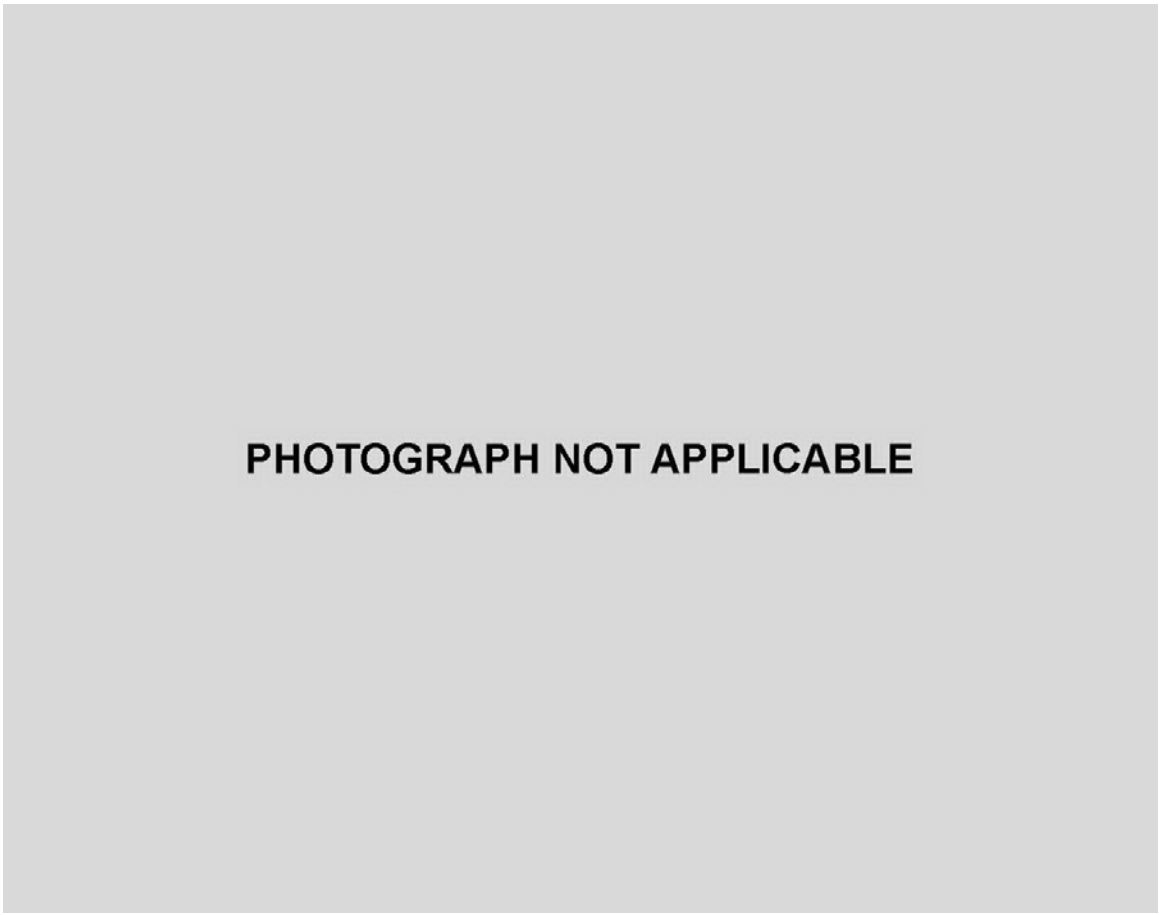


Photo No. 004 - First Responder Warning Location

PHOTOGRAPH NOT APPLICABLE

Photo No. 005 - Other Vehicle Label(s) Related to Electrical Propulsion System

Photo No. 006 - Manual High Voltage Service Disconnect in Place

Photo No. 007 - Manual High Voltage Service Disconnect Removed

Photo No. 007a - Manual High Voltage Service Disconnect Removed

Photo No. 008 - Pre-Impact View of Propulsion Battery

Photo No. 009 - Post-Impact Front View of Propulsion Battery

Photo No. 010 - Post-Impact Rear View of Propulsion Battery

PHOTOGRAPH NOT AVAILABLE

Photo No. 011 - Pre-Impact View of Battery Box(s) or Container(s) Which Holds Individual Battery Modules

Photo No. 012 - Post-Impact View of Battery Box(s) or Container(s) Which Holds Individual Battery Modules

PHOTOGRAPH NOT AVAILABLE

Photo No. 013 - Pre-Impact View of Propulsion Battery Module(s)

Photo No. 014 - Post-Impact View of Propulsion Battery Module(s)

Photo No. 015 - Pre-Impact View of Electric Propulsion Drive

PHOTOGRAPH NOT APPLICABLE

Photo No. 015a - Pre-Impact View of Electric Propulsion Drive

Photo No. 016 - Post-Impact View of Electric Propulsion Drive

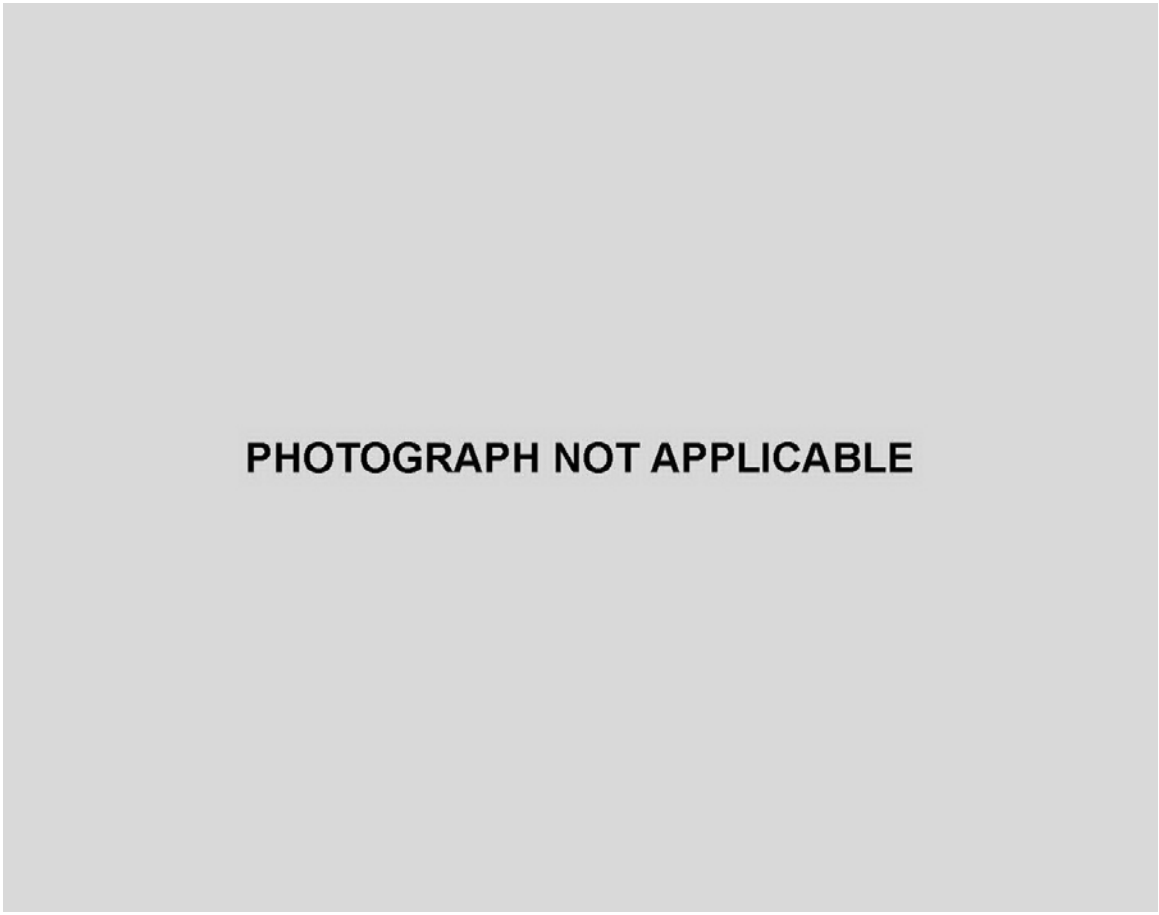


Photo No. 016a - Post-Impact View of Electric Propulsion Drive

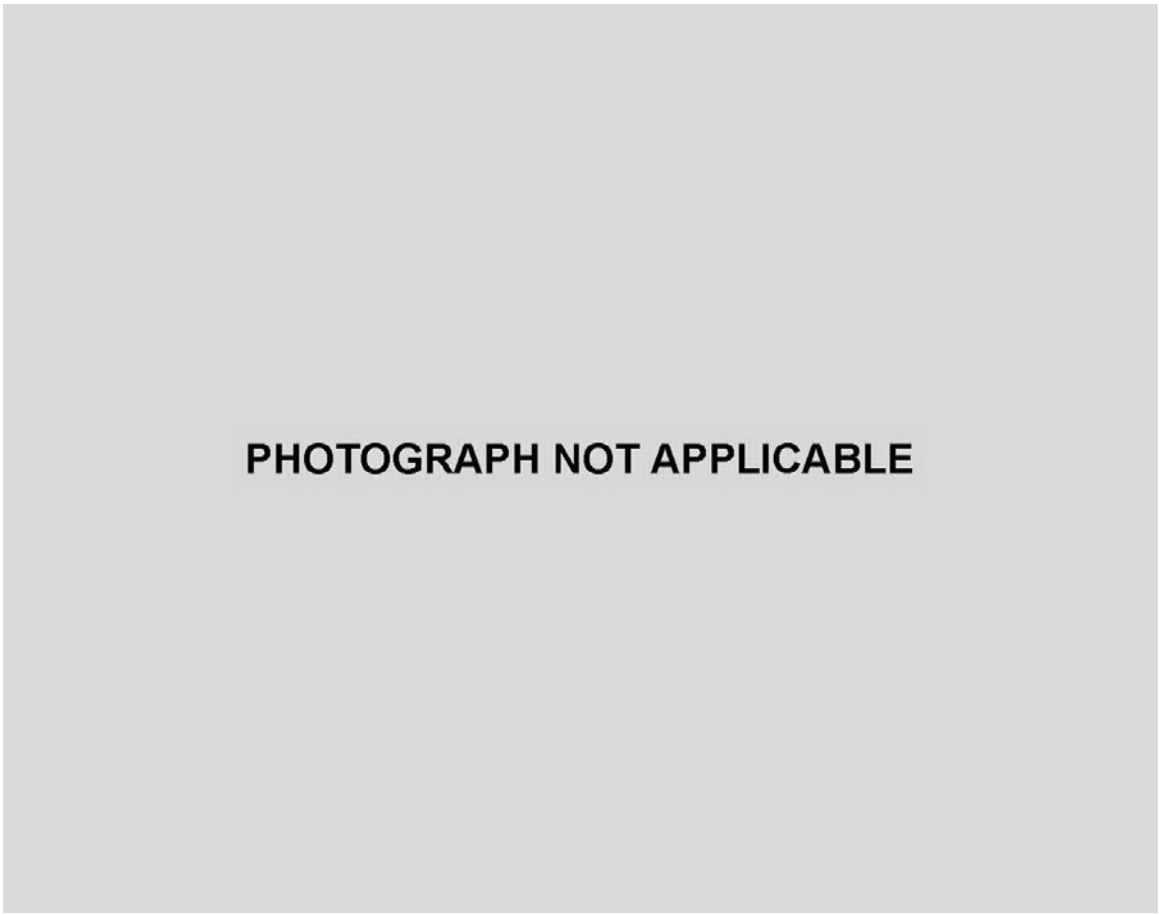


Photo No. 017 - Pre-Impact View of High Voltage Interconnect(s)

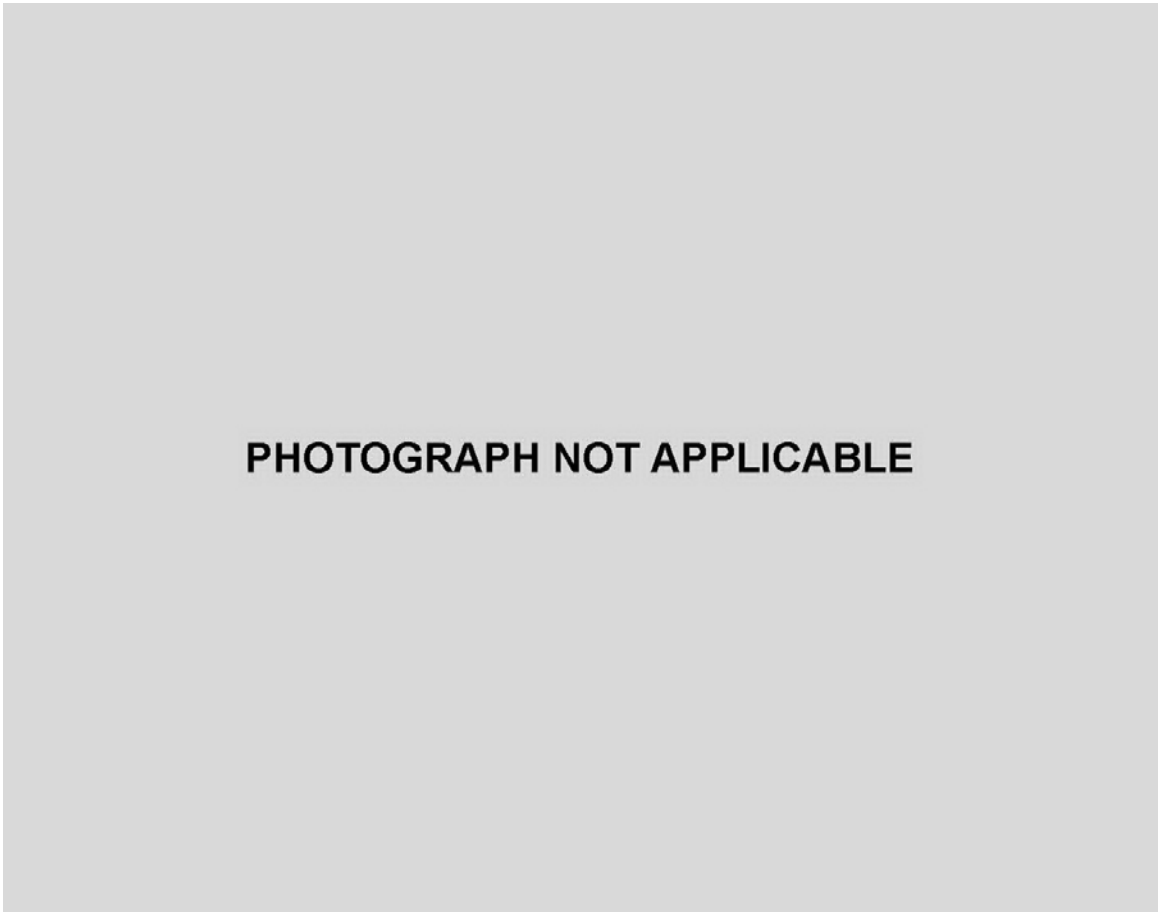


Photo No. 018 - Pre-Impact View Propulsion Battery Venting System(s)

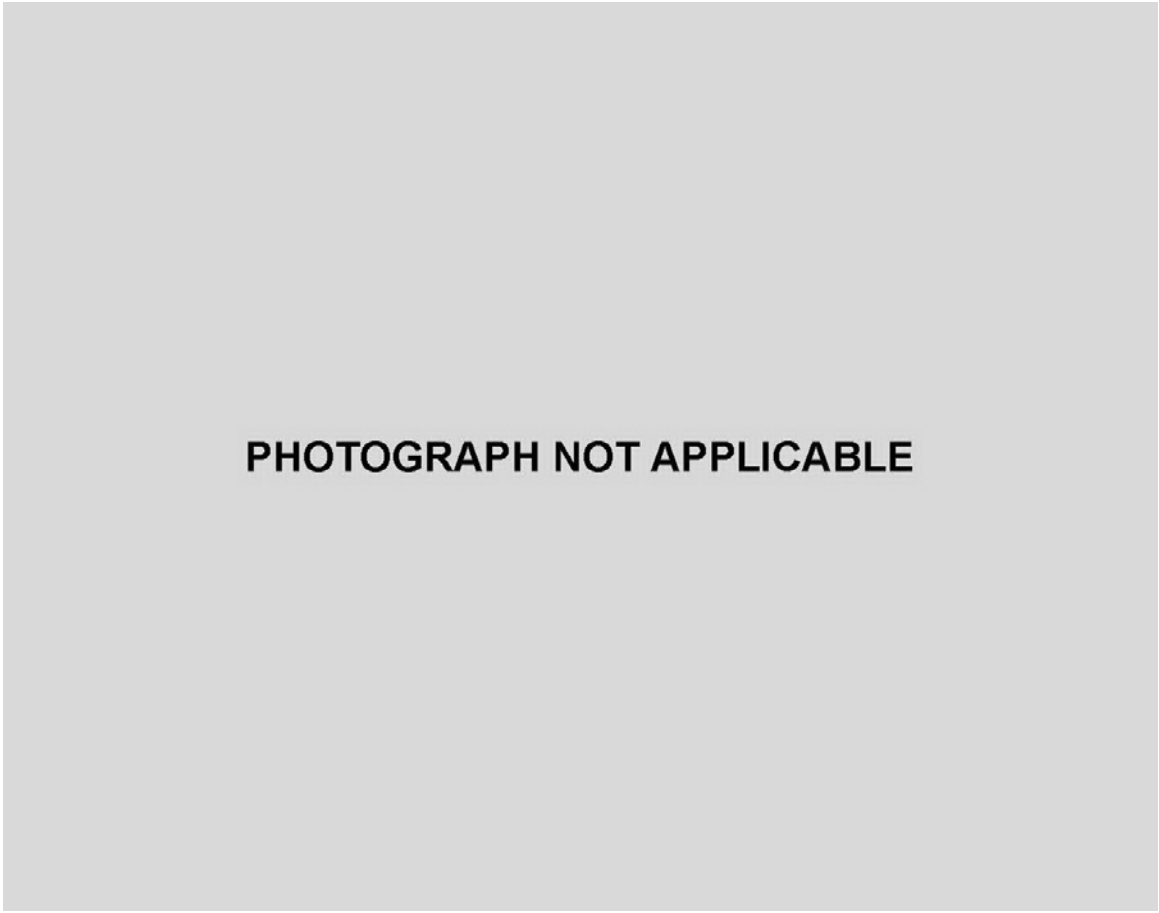


Photo No. 019 - Pre-Impact View of Other Visible Electric Propulsion Components

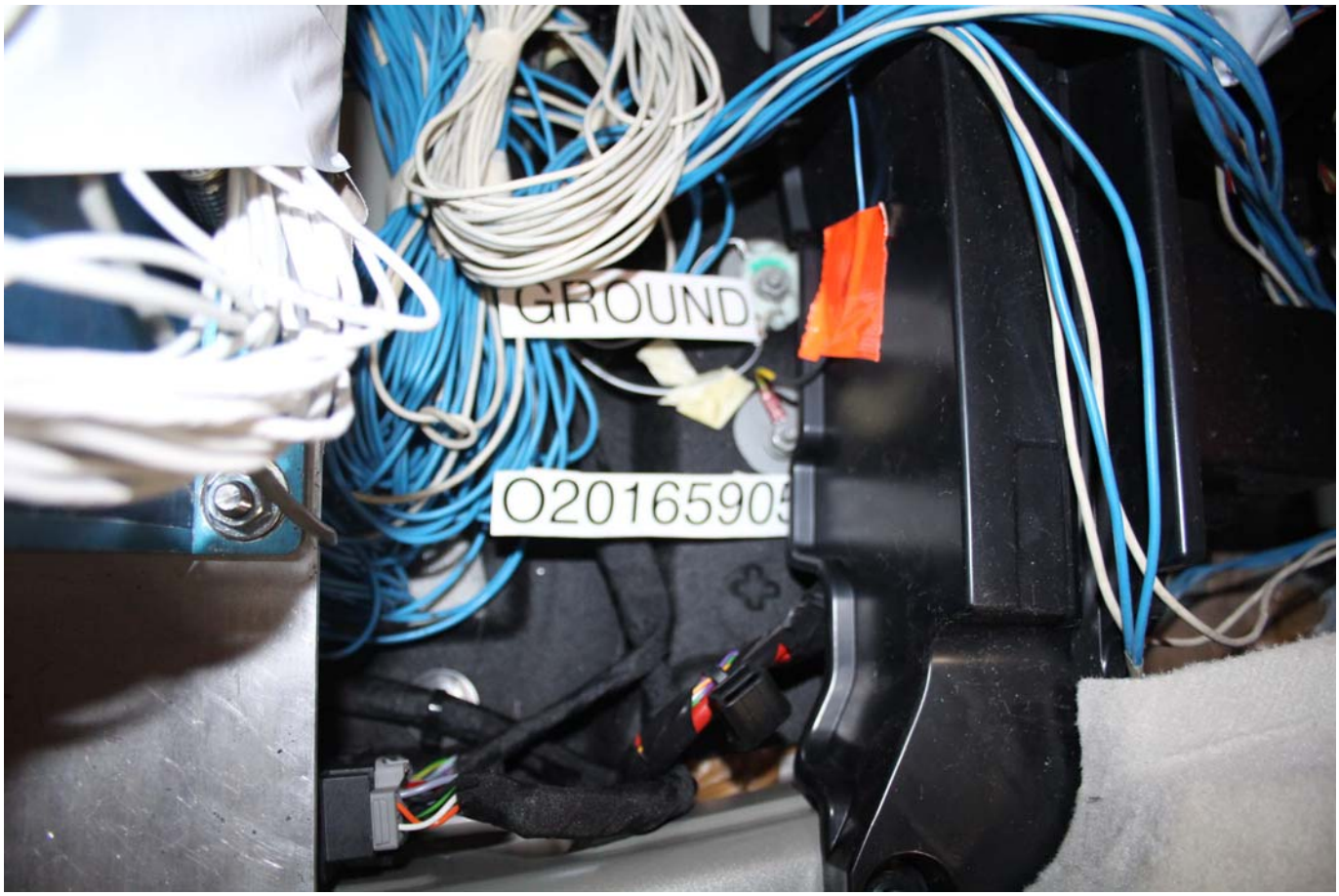


Photo No. 020 - Pre-Impact View of Ground Lead Attached

Photo No. 021 - Pre-Impact View of High Voltage Leads Attached

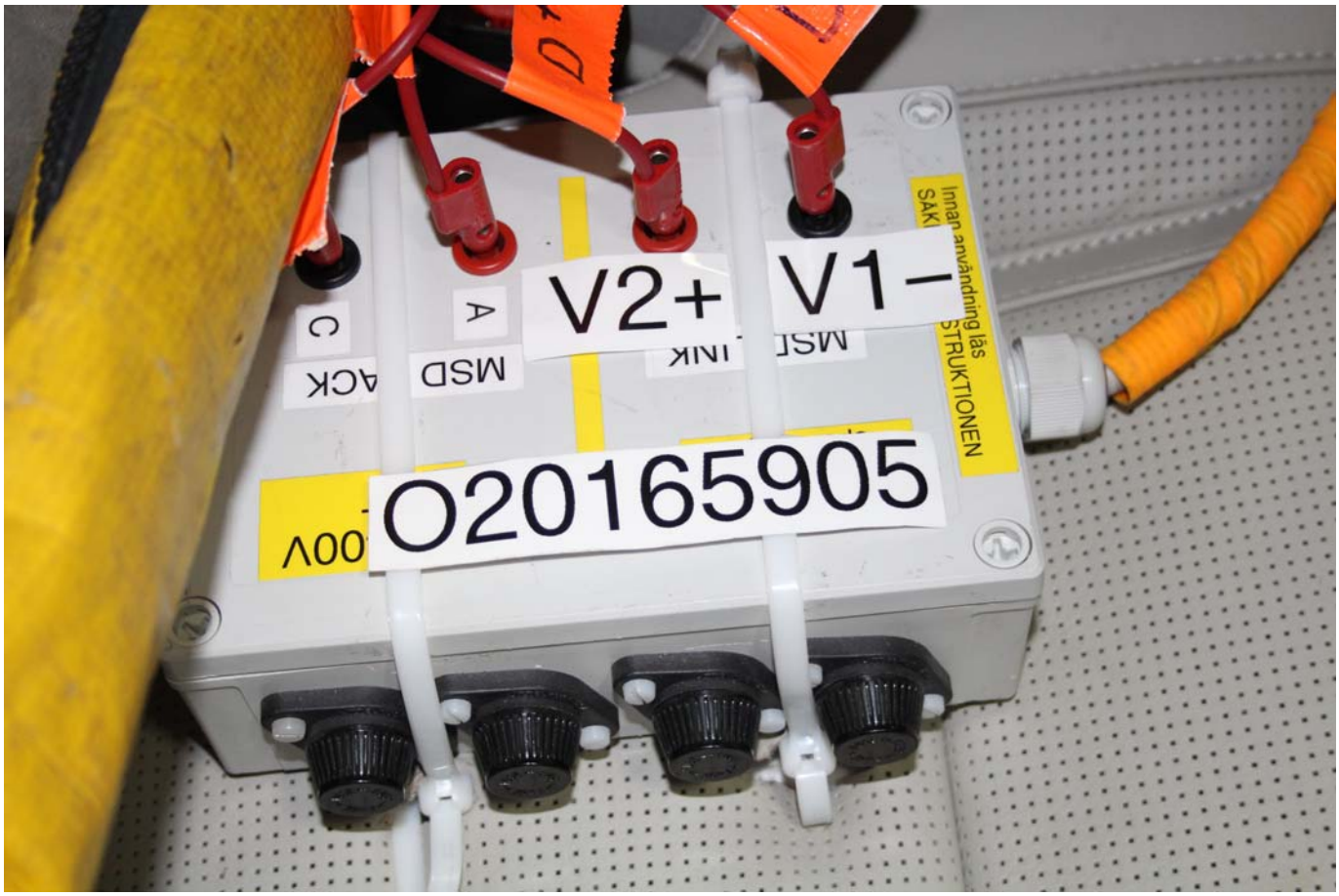


Photo No. 022 - Pre-Impact Close-Up View of High Voltage Leads Attached

Photo No. 023 - Pre-Impact View of Installed Impact Interface Port

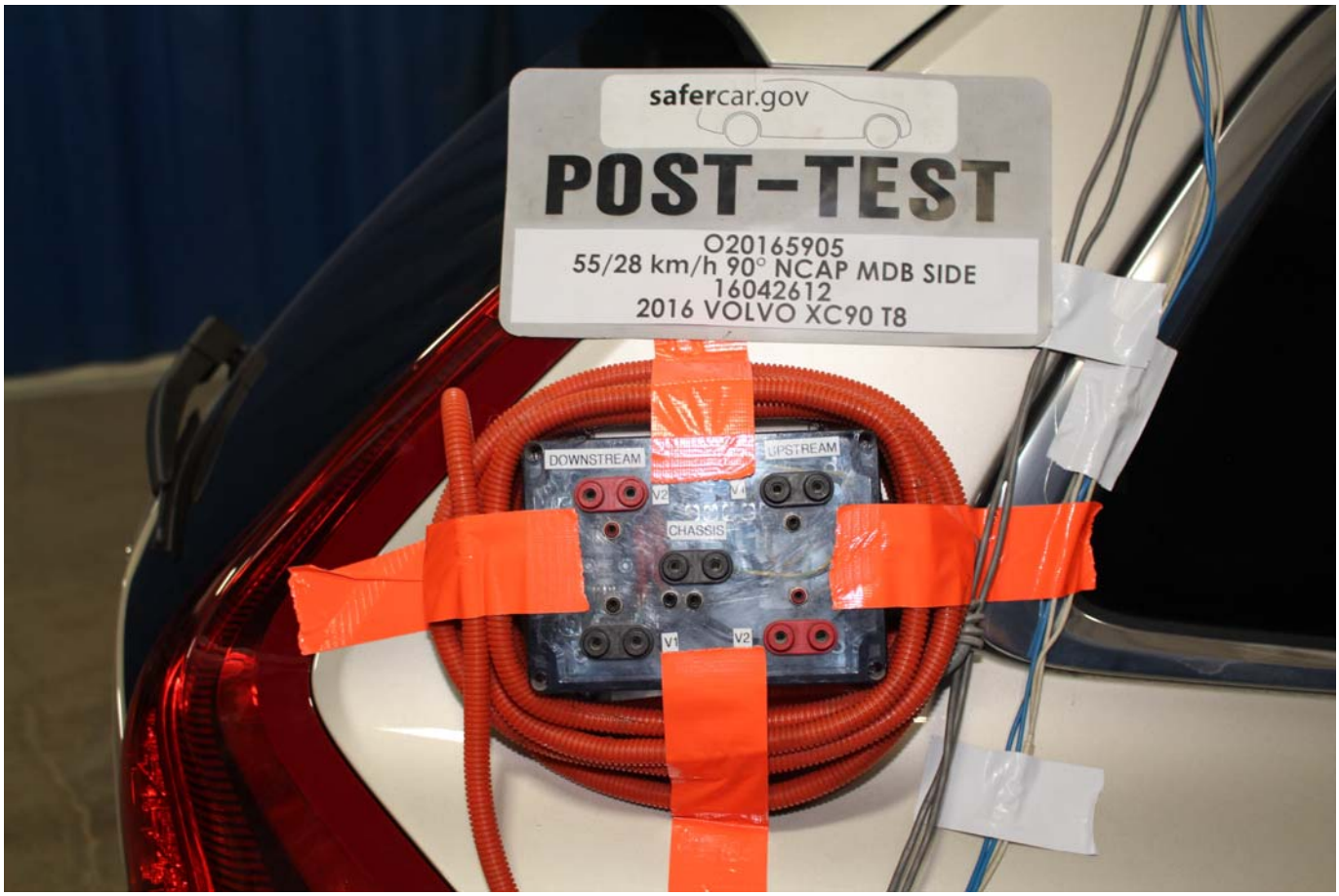


Photo No. 024 - Post-Impact View of Installed Impact Interface Port

PHOTOGRAPH NOT APPLICABLE

Photo No. 025 - Pre-Impact View of Other Test Devices

PHOTOGRAPH NOT APPLICABLE

Photo No. 026 - Post-Impact View of Other Test Devices

Photo No. 027 - FMVSS No. 305 Static Rollover at 90°

Photo No. 028 - FMVSS No. 305 Static Rollover at 180°

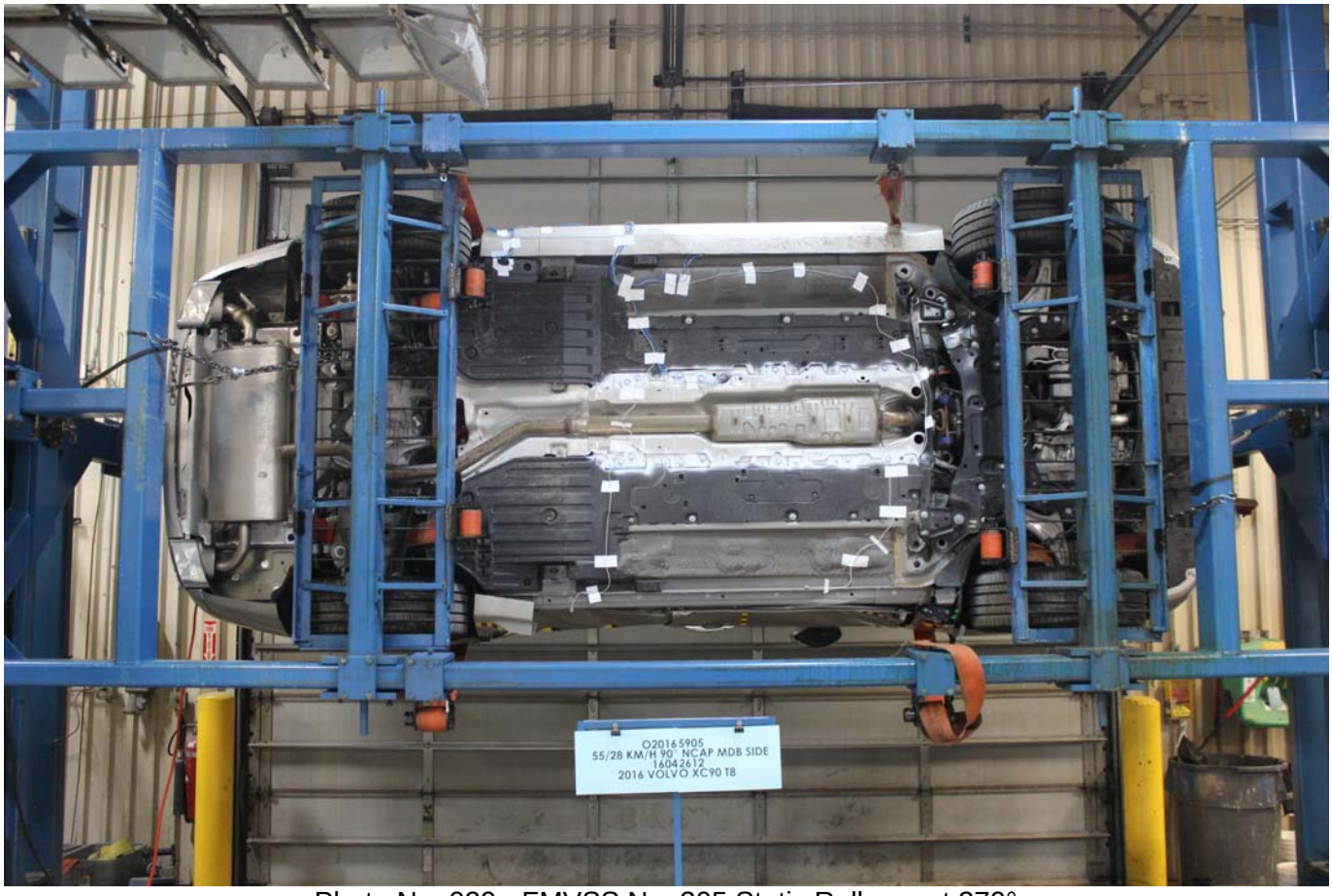


Photo No. 029 - FMVSS No. 305 Static Rollover at 270°

Photo No. 030 - FMVSS No. 305 Static Rollover at 360°

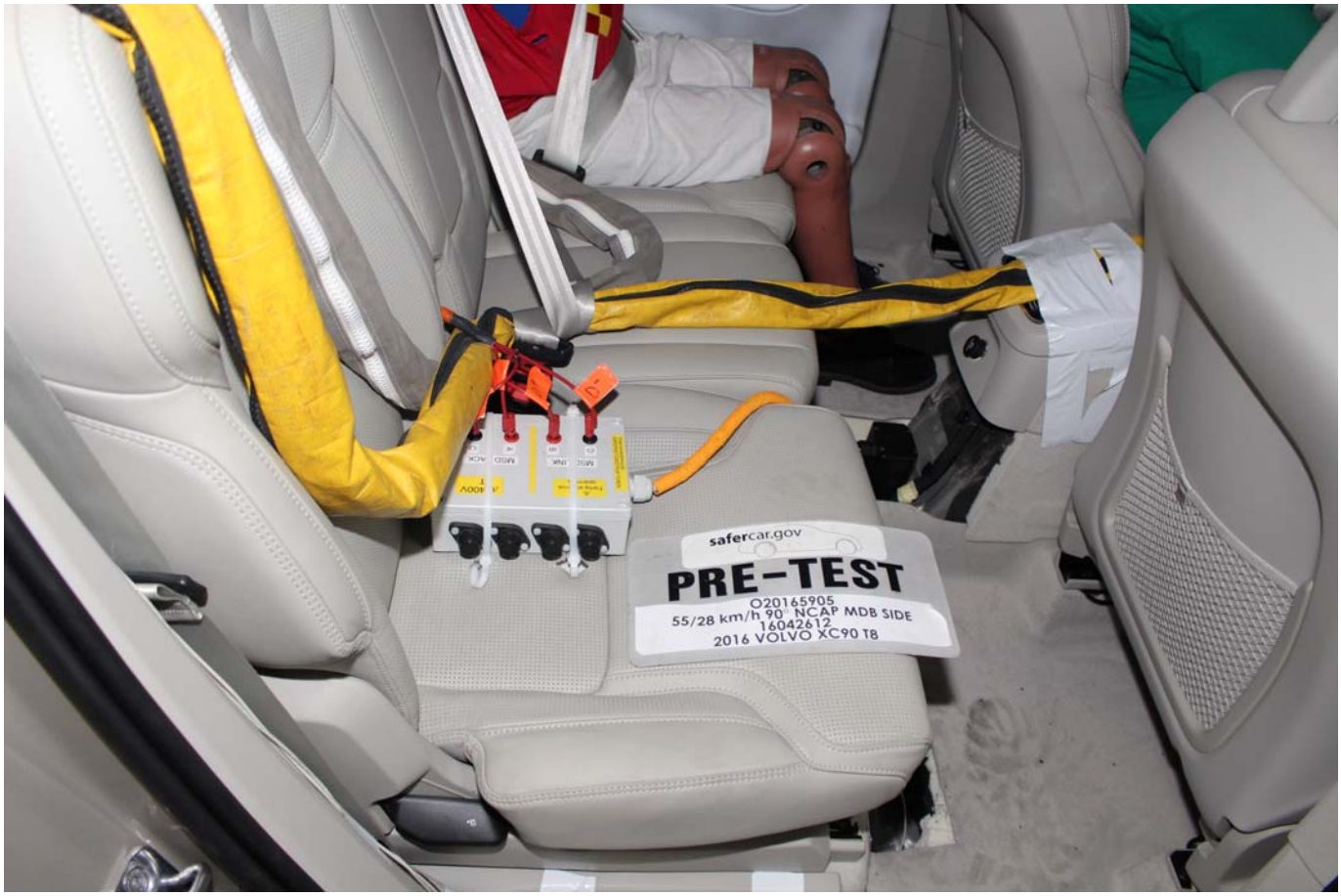


Photo No. 031 - Pre-Impact View of the Vehicle Passenger Compartment Adjacent to Propulsion Battery

Photo No. 032 - Post-Impact View of the Vehicle Passenger Compartment Adjacent to Propulsion Battery

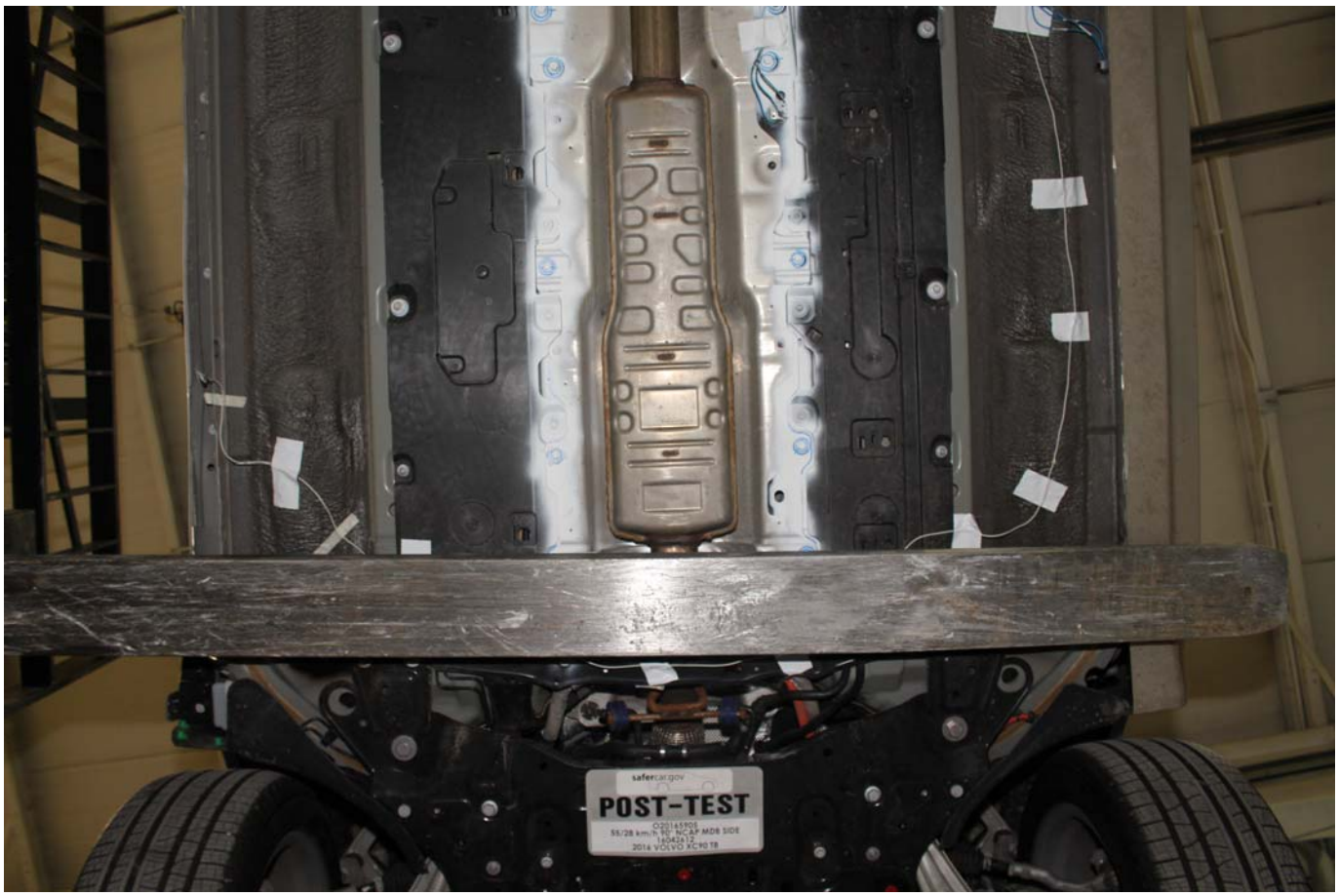


Photo No. 033 - Post-Impact Propulsion Battery System Mounting and-or Intrusion Failure(s)

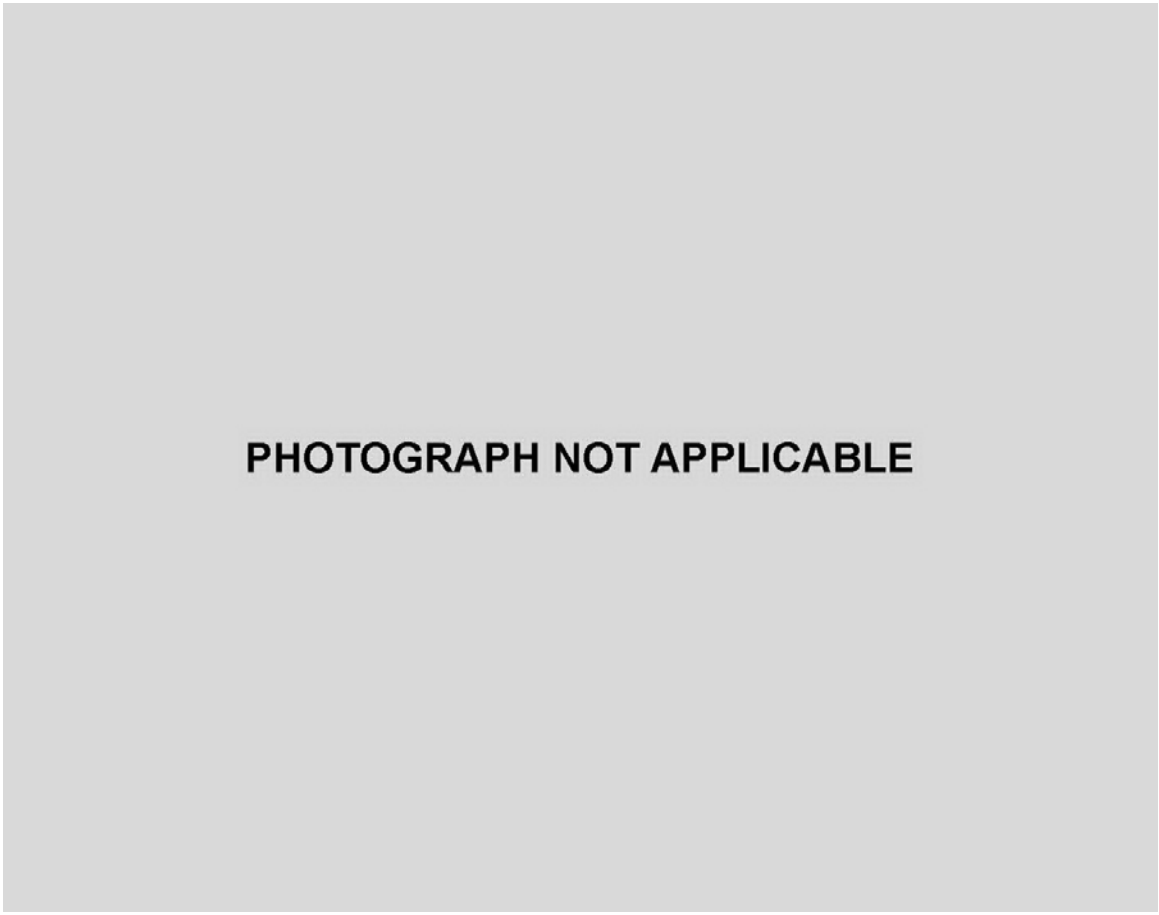


Photo No. 034 - Post-Impact View of Battery Component Intrusion

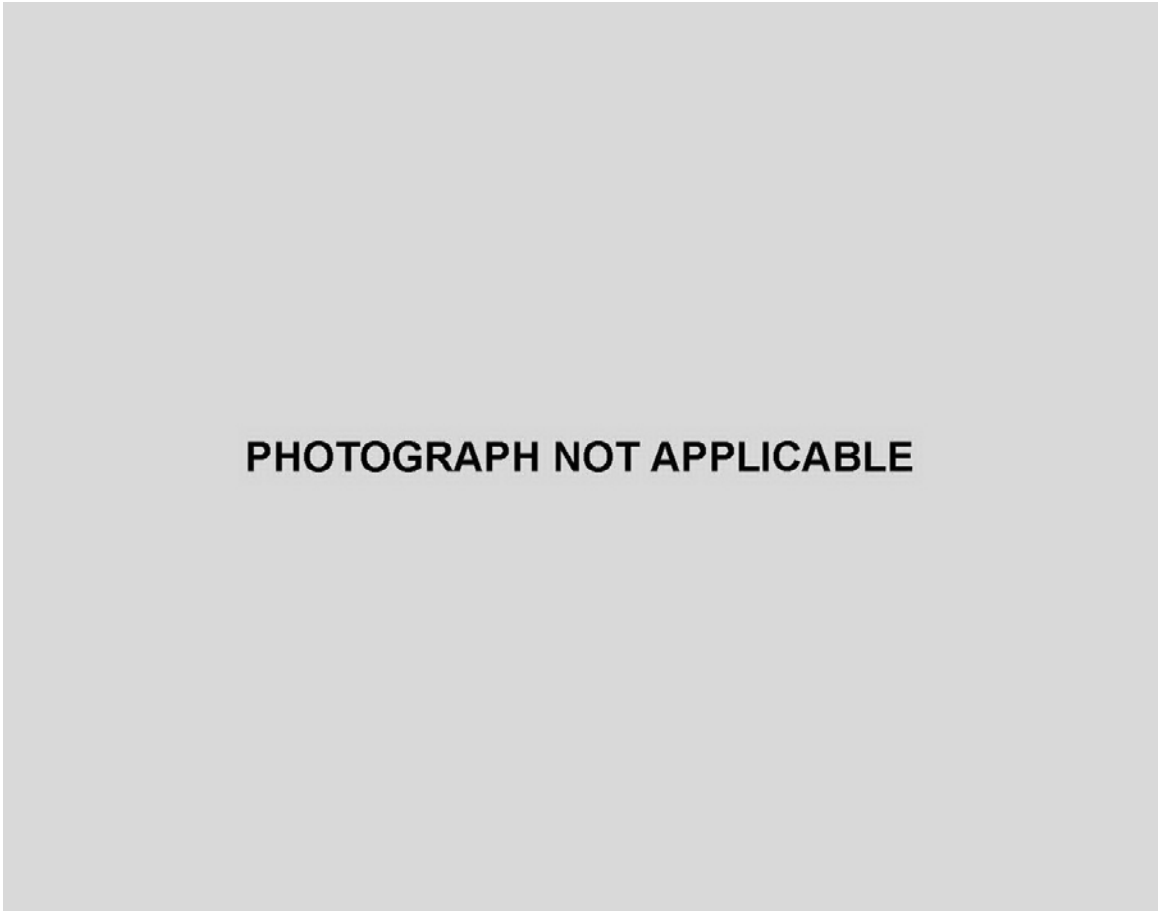


Photo No. 035 - Post-Impact View of Battery Module Movement or Retention Loss

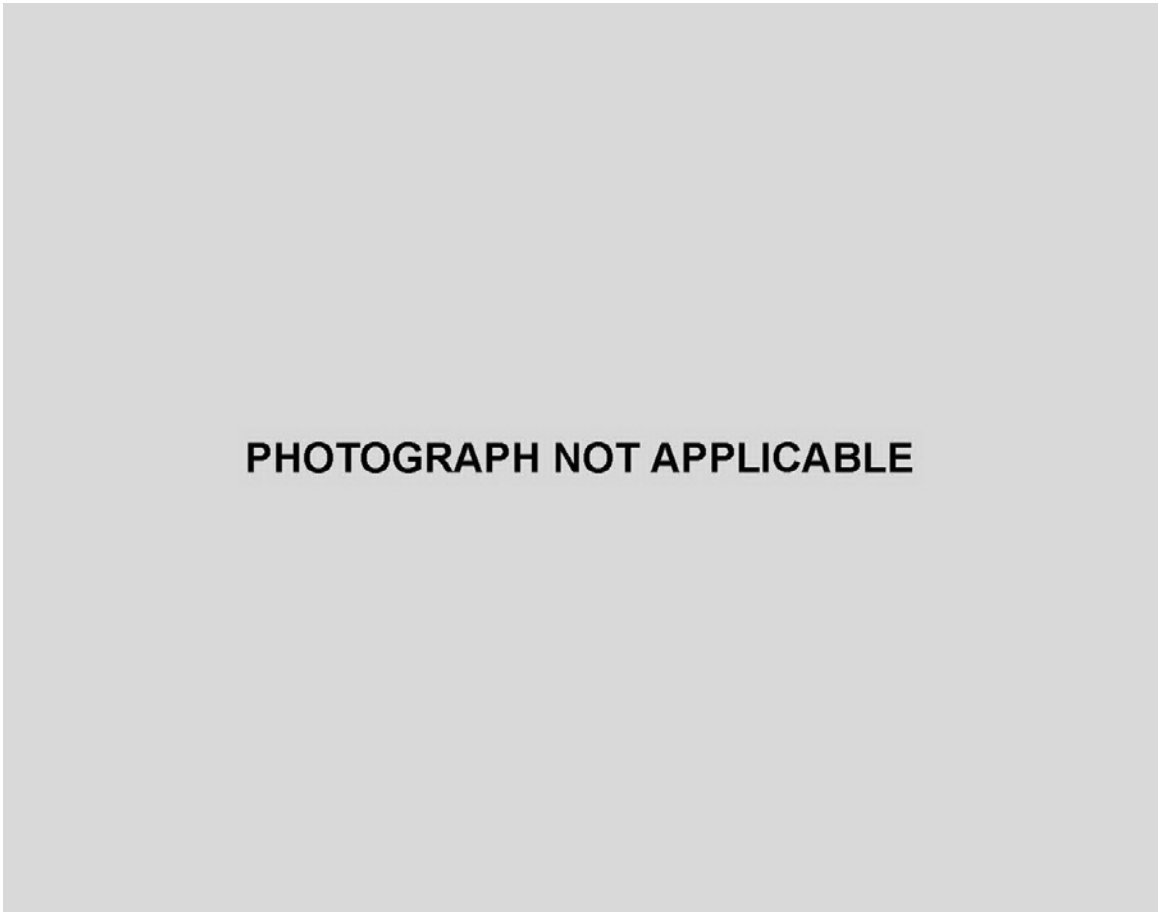


Photo No. 036 - Post-Impact View of Propulsion Battery Electrolyte Spillage Location

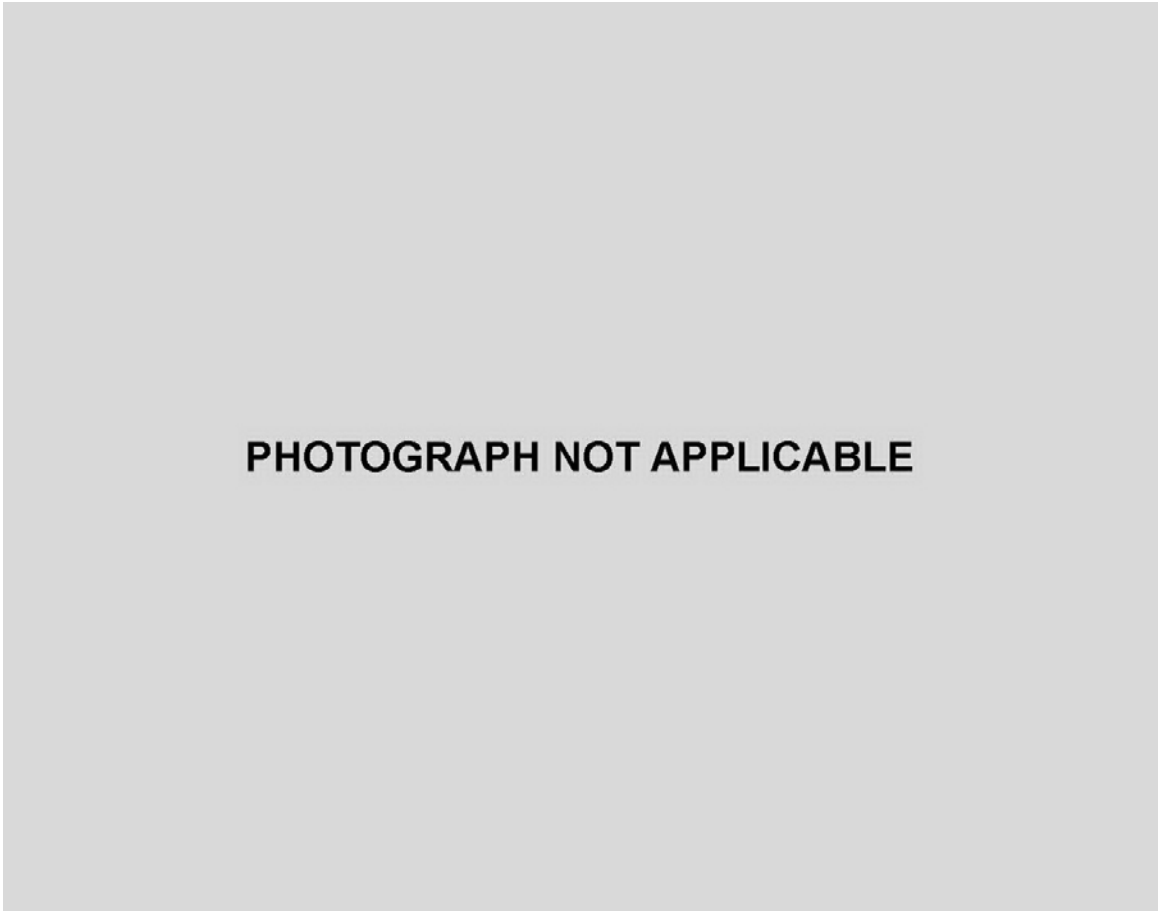


Photo No. 037 - Post-Test View of Propulsion Battery Electrolyte Spillage Location

Photo No. 038 - As Delivered Right Front ¾ View of Impact Vehicle

Photo No. 039 - As Delivered Left Rear ¾ View of Impact Vehicle

Photo No. 040 - Vehicle's Certification Label

Photo No. 041 - Vehicle's Tire Information Placard or Label