

REPORT NUMBER: NCAP305I-KAR-13-052

**NEW CAR ASSESSMENT PROGRAM (NCAP)
FMVSS NO. 305 INDICANT TEST**

**TESLA MOTORS, INC.
2013 TESLA MODEL S 5-DOOR HATCHBACK**

NHTSA NUMBER: MD5000

**PREPARED BY:
KARCO ENGINEERING, LLC.
9270 HOLLY ROAD
ADELANTO, CA 92301**



AUGUST 5, 2013

FINAL REPORT

**U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
OFFICE OF RULEMAKING
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Prepared By: AB
Mr. Balbino A. Beltran, Project Engineer
KARCO Engineering, LLC.

Reviewed By: WSP
Mr. Michael L. Dunlap, Director of Operations
KARCO Engineering, LLC.

Approved By: Frank D. Richardson
Mr. Frank D. Richardson, Program Manager
KARCO Engineering, LLC.

Approval Date: August 5, 2013

FINAL REPORT ACCEPTANCE BY OCWS:

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

Date: _____

COTR, New Car Assessment Program
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16. Abstract An FMVSS No. 305 Indicant test, in conjunction with an NCAP frontal barrier impact test was conducted on the subject 2013 Tesla Model S 5-door hatchback in accordance with the specifications of the applicable Office of Crashworthiness Standards Test Procedure for the generation of consumer information for the New Car Assessment Program (NCAP). No test failures were reported.					
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SECTION 1

TEST PURPOSE AND PROCEDURE

An FMVSS No. 305 Indicant test, in conjunction with an NCAP frontal barrier impact test was conducted on the subject 2013 Tesla Model S 5-door electric hatchback.

The indicant test was conducted in accordance with the Office of Crashworthiness Standards Laboratory Test Procedure, dated September, 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 2013 New Car Assessment Program Test Program, sponsored by the National Highway Traffic Safety Administration (NHTSA), under contract no. DTNH22-D-12-00259

SECTION 2

SUMMARY OF TEST RESULTS

A frontal barrier impact test was performed by KARCO Engineering, LLC. on a 2013 Tesla Model S 5-door electric hatchback on July 22, 2013. Electrical isolation measurements were taken immediately post-impact and observations were made relating 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 2013 Tesla Model S 5-door hatchback 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.

SECTION 3

DATA SHEETS

Test Vehicle: 2013 Tesla Model S 5-Door Hatchback

NHTSA No.: MD5000

Test Program: FMVSS No. 305 Indicant Test

Test Date: 07/22/13

CONVERSION FACTORS

Quantity	Typical Application	Std Units	Metric Unit	Multiply By
Mass	Vehicle Weight	lb	kg	0.4536
Linear Velocity	Impact Velocity	miles/hr	km/hr	1.609344
Length or Distance	Measurements	in	mm	25.4
Volume	Fuel Systems	gal	liter	3.785
Volume	Small Fluids	oz	mL	29.574
Pressure	Tire Pressures	lbf/in ²	kPa	6.895
Temperature	General Use	°F	°C	$=(T_f - 32)/1.8$
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf-ft	N•m	1.355

ELECTRICAL CODES

Code	Units	Description
V_b	V	Propulsion Battery Voltage
V_1	V	Propulsion Battery Negative to Chassis
V_2	V	Propulsion Battery Positive to Chassis
R_o	Ω	Resistance of Grounding Circuit
V_1'	V	Propulsion Battery Negative to Chassis with R_o installed
V_2'	V	Propulsion Battery Positive to Chassis with R_o installed
R_{i1}	Ω	Electrical Isolation Value of Propulsion Battery Negative to Chassis Ground
R_{i2}	Ω	Electrical Isolation Value of Propulsion Battery Positive to Chassis Ground
R_i	Ω	Electrical Isolation Value of Propulsion Battery - The Minimum of R_{i1} and R_{i2}
R_i/V_b	Ω/v	Electrical Isolation per Volt of Propulsion Battery

DATA SHEET NO. 1**TEST VEHICLE INFORMATION**

Test Vehicle: 2013 Tesla Model S 5-Door Hatchback NHTSA No.: MD5000
Test Program: FMVSS No. 305 Indicant Test Test Date: 07/22/13

TEST VEHICLE INFORMATION

NHTSA Number	MD5000
Model Year	2013
Make	Tesla
Model	Model S
Body Style	5-Door Hatchback
Body Color	Silver
Odometer Reading (km / mi)	37 / 23

DATA FROM VEHICLE'S CERTIFICATION LABEL

Manufactured By	Tesla Motors, Inc.
Date of Manufacture	May-13
VIN	5YJSA1AGXDFP11283
GVWR (kg)	2590

ELECTRIC VEHICLE PROPULSION SYSTEM

Type of Electrical Vehicle	Electric
Propulsion Battery Type	Li-Ion
Nominal Voltage (V)	300
Automatic Propulsion Battery Disconnect	Yes
Physical Location of Automatic Propulsion Battery Disconnect	Front compartment near 12 V Battery
Auxiliary Battery Type	12 Volt Lead Acid

PROPULSION BATTERY SYSTEM DATA

Electrolyte Fluid Type	EMC Solvent + LiPF ₆ Salt
Electrolyte Fluid Specific Gravity (g/cc)	1.2
Electrolyte Fluid Dynamic Viscosity (mPa s)	4.7
Electrolyte Fluid Color	Clear
Propulsion Battery Coolant Type	Ethylene Glycol / Water
Propulsion Battery Coolant Color	Blue Green
Propulsion Battery Coolant Specific Gravity	1.048 / 1.0

LOCATION OF BATTERY MODULES

Location	Beneath the occupant compartment underneath the vehicle
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DATA SHEET NO. 1 ... (CONTINUED)**TEST VEHICLE INFORMATION**Test Vehicle: 2013 Tesla Model S 5-Door HatchbackNHTSA No.: MD5000Test Program: FMVSS No. 305 Indicant TestTest Date: 07/22/13*For all battery types:*

Description	Volts
Minimum Operating Voltage	210
Maximum Operating Voltage	350
95% of Maximum Operating Voltage	333
Test Voltage (no less than 95% of Maximum)	349.4

For batteries that are rechargeable ONLY by an energy source on the vehicle:

Description	Volts
Minimum Operating Voltage	
Maximum Operating Voltage	
Test Voltage (Maximum practicable state of charge within normal operating range)	

DATA SHEET NO. 2

PRE-IMPACT DATA

Test Vehicle:	<u>2013 Tesla Model S 5-Door Hatchback</u>	NHTSA No.:	<u>MD5000</u>
Test Program:	<u>FMVSS No. 305 Indicant Test</u>	Test Date:	<u>07/22/13</u>

VEHICLE CHASSIS GROUND POINT(S) LOCATION(S)

DETAILS OF VEHICLE CHASSIS GROUND POINT(S) AND LOCATION(S):

The chassis ground used for the electrical isolation measurements was a pre-existing chassis ground point located in the rear trunk compartment near the right rear wheel well. A photograph of the location is included in Figure 21 of Appendix A.

PROPULSION BATTERY SYSTEM

DETAILS OF PROPULSION BATTERY COMPONENTS:

The electrical propulsion system utilizes one Lithium-Ion (Li-Ion) battery and a traction motor to propel the vehicle. The propulsion battery is located on the underside of the vehicle between the axles. The propulsion battery encompasses fourteen (14) battery modules, each of which consisted of six (6) cells. The battery is equipped with an automatic disconnect located in the front compartment near the 12 V battery. The first responder disconnect is located in the front trunk area, near the base of the windshield on the right side of the vehicle.

DATA SHEET NO. 3**PRE-IMPACT ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS**

Test Vehicle: 2013 Tesla Model S 5-Door Hatchback NHTSA No.: MD5000
Test Program: FMVSS No. 305 Indicant Test Test Date: 07/22/13

VOLTMETER INFORMATION

Make	Fluke
Model	16
Serial No.	82810107
Internal Impedance Value	10 MΩ
Resolution	0.001

DRIVE INVERTER ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

Code	Units	Threshold	Pre-Test
V_b	V		349.40
V_1	V		186.70
V_2	V		182.30
R_o	Ω		222400.00
V_1'	V		15.77
V_2'	V		26.29
R_{i1}	Ω		4,764,348
R_{i2}	Ω		2,671,384
R_i	Ω		2,671,384
R_i/V_b	Ω/V	500	8,905

Is the Measured Electrical Isolation Value ≥ 500 Ω/V?	Yes
---	-----

DATA SHEET NO. 3 ... (CONTINUED)**PRE-IMPACT ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS**

Test Vehicle: 2013 Tesla Model S 5-Door Hatchback NHTSA No.: MD5000
Test Program: FMVSS No. 305 Indicant Test Test Date: 07/22/13

ANCILLARY ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

Code	Units	Threshold	Pre-Test
V_b	V		349.40
V_1	V		185.90
V_2	V		147.30
R_o	Ω		219,500
V_1'	V		15.33
V_2'	V		15.57
R_{i1}	Ω		4,377,444
R_{i2}	Ω		4,200,808
R_i	Ω		4,200,808
R_i/V_b	Ω/V	500	14,003

Is the Measured Electrical Isolation Value $\geq$ 500 Ω/V ?	Yes
--	-----

DATA SHEET NO. 4**POST-IMPACT DATA**Test Vehicle: 2013 Tesla Model S 5-Door HatchbackNHTSA No.: MD5000Test Program: FMVSS No. 305 Indicant TestTest Date: 07/22/13**VOLTMETER INFORMATION**

Make	Fluke
Model	16
Serial No.	82810107
Internal Impedance Value	10 MΩ
Resolution	0.001

DRIVE INVERTER ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

Code	Units	Threshold	Post-Test
V_b	V		0.02
V_1	V		0.02
V_2	V		0.03
R_o	Ω		222,400
V_1'	V		0.00
V_2'	V		0.00
R_{i1}	Ω		Zero Volts*
R_{i2}	Ω		10,783,030
R_i	Ω		Zero Volts*
R_i/V_b	Ω/V	500	Zero Volts*

Is the Measured Electrical Isolation Value $\geq$ 500 Ω/V?	Yes
--	-----

*Zero Volts is considered to be compliant

DATA SHEET NO. 4 ... (CONTINUED)**POST-IMPACT DATA**

Test Vehicle: 2013 Tesla Model S 5-Door Hatchback NHTSA No.: MD5000
 Test Program: FMVSS No. 305 Indicant Test Test Date: 07/22/13

ANCILLARY ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

Code	Units	Threshold	Post-Test
V_b	V		0.02
V_1	V		0.03
V_2	V		0.45
R_o	Ω		219,500
V_1'	V		0.00
V_2'	V		0.00
R_{i1}	Ω		100,463,462
R_{i2}	Ω		52,008,818
R_i	Ω		52,008,818
R_i/V_b	Ω/V	500	173,363

Is the Measured Electrical Isolation Value $\geq$ 500 Ω/V ?	Yes
--	-----

PROPULSION BATTERY SYSTEM COMPONENTS

Has the propulsion battery module moved within the passenger compartment: No

Describe any movement: There was no movement of the propulsion battery.

Has an outside propulsion battery component intruded into the passenger compartment: No

Describe any intrusion: There was no intrusion of the propulsion battery into the occupant compartment.

Is there propulsion battery electrolyte spillage visible in the passenger compartment: No

DATA SHEET NO. 5

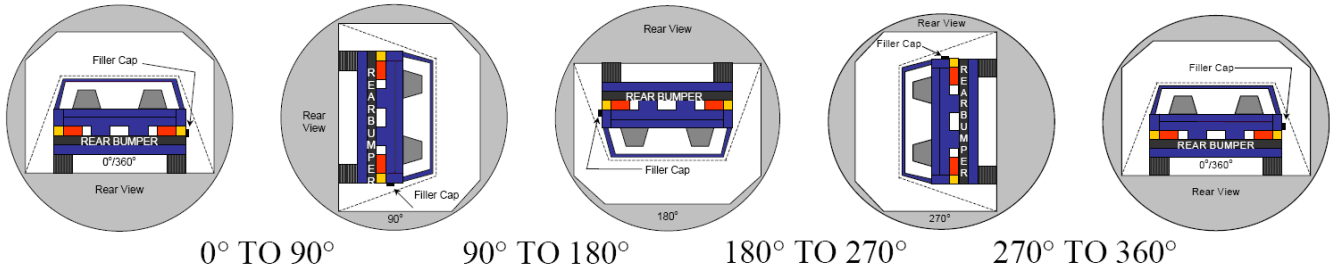
STATIC ROLLOVER TEST DATA

Test Vehicle: 2013 Tesla Model S 5-Door Hatchback

NHTSA No.: MD5000

Test Program: FMVSS No. 305 Indicant Test

Test Date: 07/22/13



PROPULSION BATTERY ELECTROLYTE COLLECTION TIME PERIOD

Test Phase	Rotation Time	Hold Time	Total Time
0° To 90°	82	300	382
90° To 180°	81	300	381
180° To 270°	78	300	378
270° To 360°	80	300	380

TEST VEHICLE PROPULSION BATTERY ELECTROLYTE SPILLAGE

Test Phase	Propulsion Battery Electrolyte Spillage (L)	Spillage Location
0° To 90°	0.0	N/A
90° To 180°	0.0	N/A
180° To 270°	0.0	N/A
270° To 360°	0.0	N/A

Is the Total Propulsion Battery Electrolyte Spillage Greater Than 5.0 Liters?	No spillage occurred
Is the Propulsion Battery Electrolyte Spillage Visible in the Passenger Compartment?	N/A

DATA SHEET NO. 5 ... (CONTINUED)

STATIC ROLLOVER TEST DATA

Test Vehicle: 2013 Tesla Model S 5-Door Hatchback NHTSA No.: MD5000
 Test Program: FMVSS No. 305 Indicant Test Test Date: 07/22/13

VOLTMETER INFORMATION

Make	Fluke
Model	16
Serial No.	82810107
Internal Impedance Value	10 MΩ
Resolution	0.001

DRIVE INVERTER ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

Code	Units	Threshold	90°	180°	270°	360°
V_b	V		0.000	0.000	0.000	0.000
V_1	V		0.006	0.008	0.008	0.009
V_2	V		0.007	0.009	0.008	0.009
R_o	Ω		222,400.000	222,400.000	222,400.000	222,400.000
V_1'	V		0.000	0.000	0.000	0.000
V_2'	V		0.000	0.000	0.001	0.000
R_{i1}	Ω		Zero Volts*	Zero Volts*	Zero Volts*	Zero Volts*
R_{i2}	Ω		Zero Volts*	Zero Volts*	3113600.000	Zero Volts*
R_i	Ω		Zero Volts*	Zero Volts*	Zero Volts*	Zero Volts*
R_i/V_b	Ω/V	500	Zero Volts*	Zero Volts*	Zero Volts*	Zero Volts*

Is the Measured Electrical Isolation Value ≥ 500 Ω/V?	Yes
---	-----

*Zero Volts is considered to be compliant

DATA SHEET NO. 5 ... (CONTINUED)

STATIC ROLLOVER TEST DATA

Test Vehicle: 2013 Tesla Model S 5-Door Hatchback

NHTSA No.: MD5000

Test Program: FMVSS No. 305 Indicant Test

Test Date: 07/22/13

ANCILLARY ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

Code	Units	Threshold	90°	180°	270°	360°
V_b	V		0.000	0.000	0.000	0.000
V_1	V		0.005	0.008	0.008	0.007
V_2	V		0.007	0.008	0.008	0.008
R_o	Ω		219,500	219,500	219,500	219,500
V_1'	V		0.000	0.000	0.000	0.000
V_2'	V		0.000	0.001	0.001	0.001
R_{i1}	Ω		Zero Volts*	Zero Volts*	Zero Volts*	Zero Volts*
R_{i2}	Ω		Zero Volts*	3,073,000	3,073,000	2,880,938
R_i	Ω		Zero Volts*	Zero Volts*	Zero Volts*	Zero Volts*
R_i/V_b	Ω/V	500	Zero Volts*	Zero Volts*	Zero Volts*	Zero Volts*

Is the Measured Electrical Isolation Value $\geq$ 500 Ω/V ?	Yes
--	-----

*Zero Volts is considered to be compliant

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PHOTOGRAPHS

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Photograph Not
Available

No Visible Auxiliary Power Module Warning Label

FIGURE 1. Auxiliary Power Module Warning Label



FIGURE 2. Power Inverter Warning Label

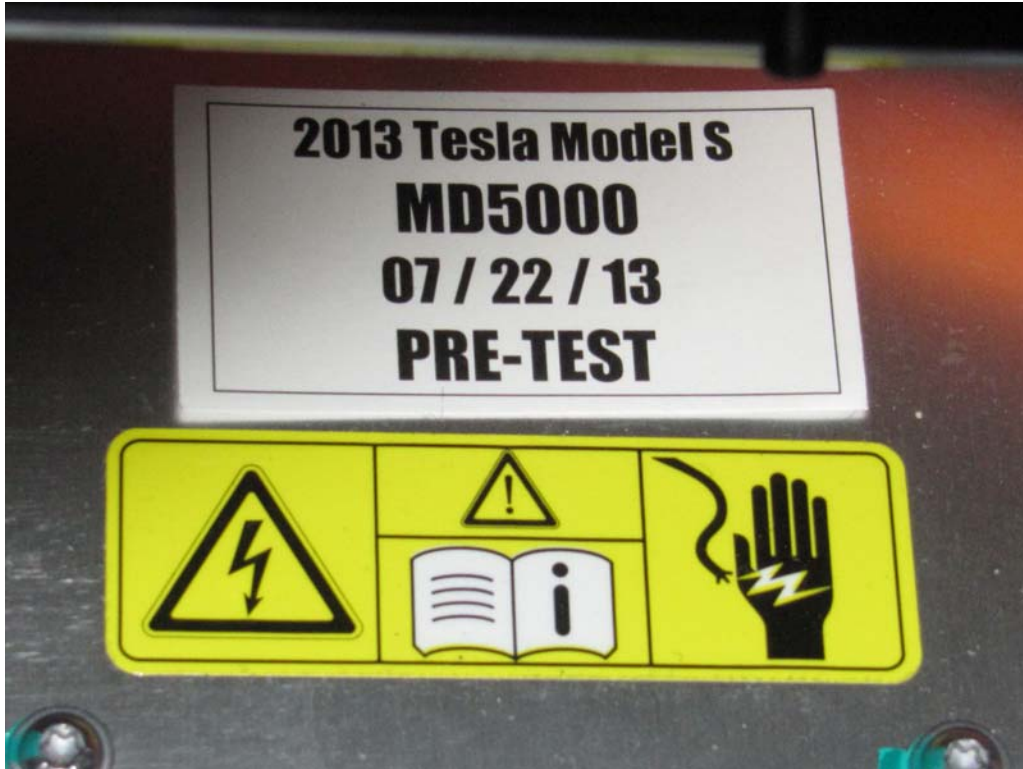


FIGURE 2a. Power Inverter Warning Label



FIGURE 3. First Responder Warning Label



FIGURE 3a. First Responder Warning Label



FIGURE 4. First Responder Warning Location

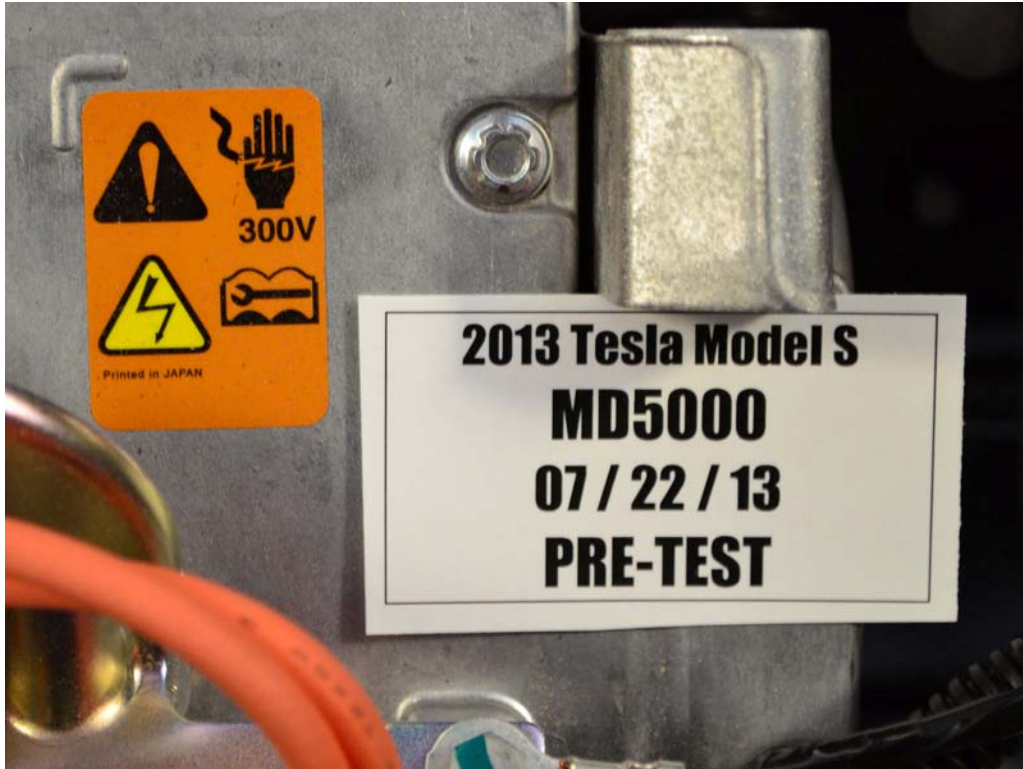


FIGURE 5. Other Vehicle Label(s) Related to Electrical Propulsion System



FIGURE 5a. Other Vehicle Label(s) Related to Electrical Propulsion System



FIGURE 5b. Other Vehicle Label(s) Related to Electrical Propulsion System



FIGURE 5c. Other Vehicle Label(s) Related to Electrical Propulsion System

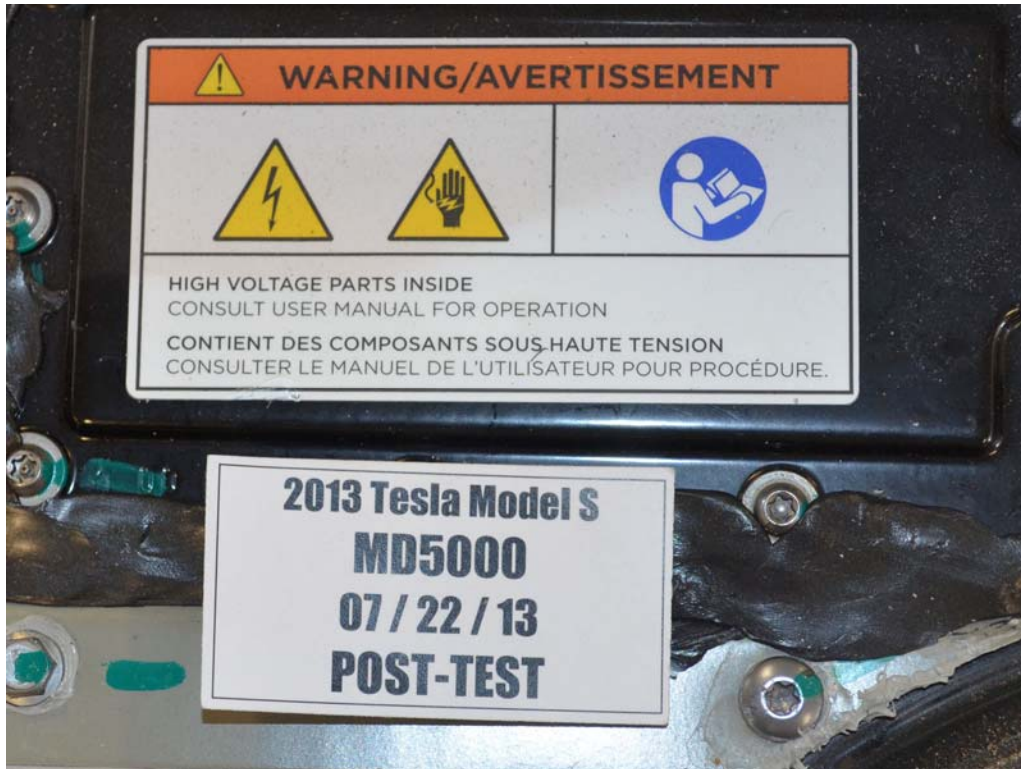


FIGURE 5d. Other Vehicle Label(s) Related to Electrical Propulsion System



FIGURE 5e. Other Vehicle Label(s) Related to Electrical Propulsion System

Photograph Not Applicable

Vehicle Not Equipped with
Manual High Voltage
Service Disconnect

FIGURE 6. Manual High Voltage Service Disconnect In Place

Photograph Not Applicable

Vehicle Not Equipped with
Manual High Voltage
Service Disconnect

FIGURE 7. Manual High Voltage Service Disconnect Removed

Photograph Not Applicable

Vehicle Not Equipped with Manual High Voltage Service Disconnect

FIGURE 8. Manual High Voltage Service Disconnect Removed



FIGURE 9. Pre-Impact View of Propulsion Battery



FIGURE 9a. Pre-Impact View of Propulsion Battery

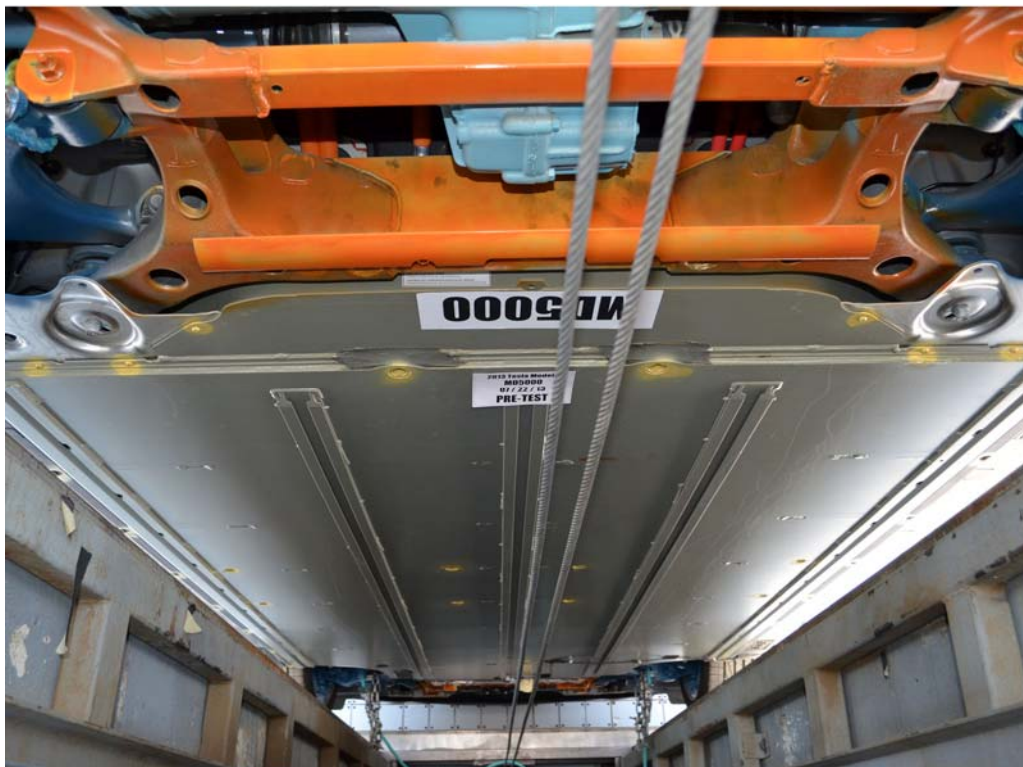


FIGURE 9b. Pre-Impact View of Propulsion Battery



FIGURE 10. Post-Impact Front View of Propulsion Battery



FIGURE 11. Post-Impact Rear View of Propulsion Battery



FIGURE 12. Pre-Impact View of Battery Box(s) or Container(s)
Which Holds Individual Battery Modules



FIGURE 13. Post-Impact View of Battery Box(s) or Container(s)
Which Holds Individual Battery Modules

Battery Cover Not Removed Pre-Test

[illegible]

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FIGURE 15a. Post-Impact View of Propulsion Battery Module(s)



FIGURE 16. Pre-Impact View of Electric Propulsion Drive



FIGURE 17. Post-Impact View of Electric Propulsion Drive



FIGURE 18. Pre-Impact View of High Voltage Interconnect(s)



FIGURE 18a. Pre-Impact View of High Voltage Interconnect(s)



FIGURE 18b. Pre-Impact View of High Voltage Interconnect(s)

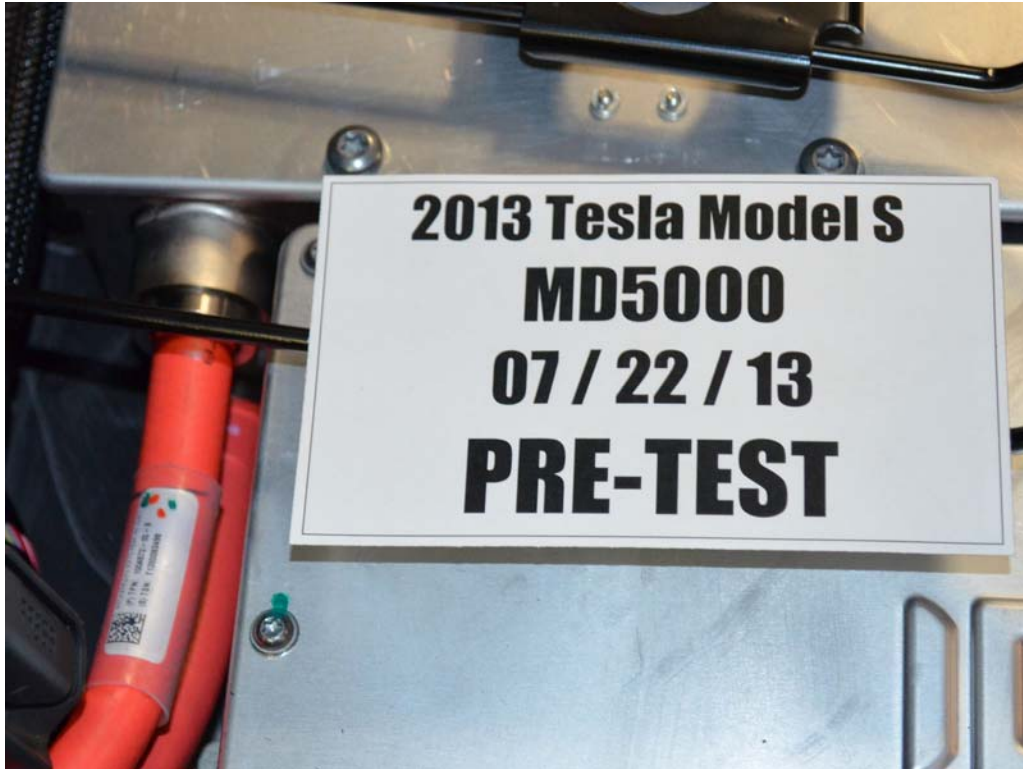


FIGURE 18c. Pre-Impact View of High Voltage Interconnect(s)

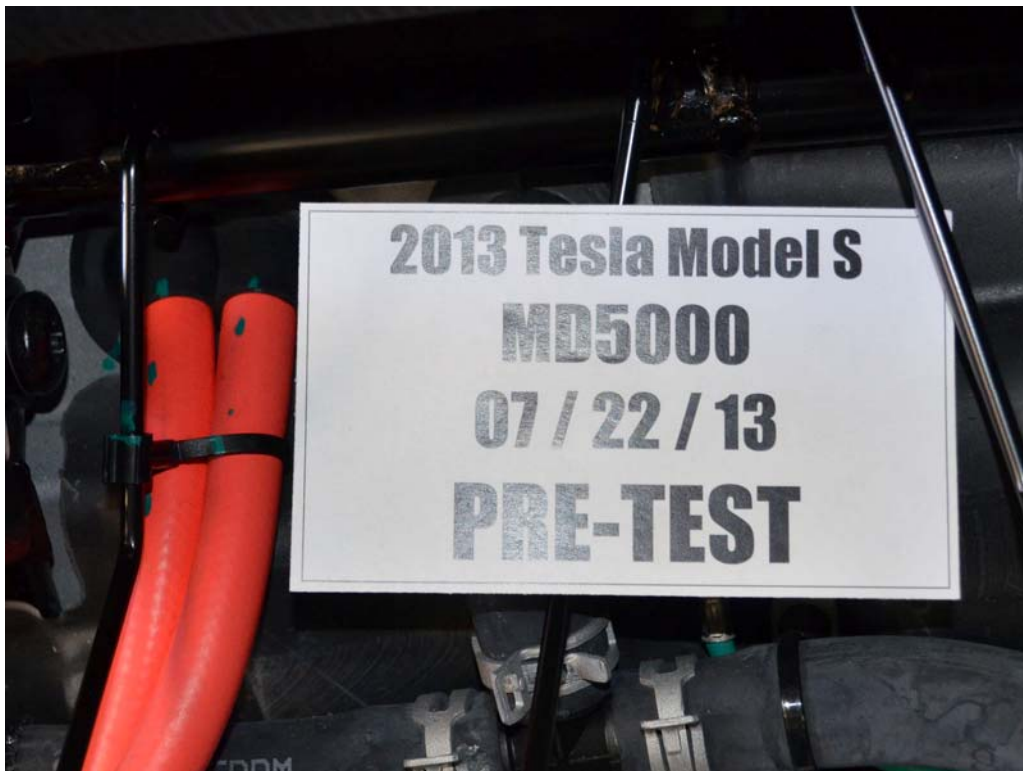


FIGURE 18d. Pre-Impact View of High Voltage Interconnect(s)

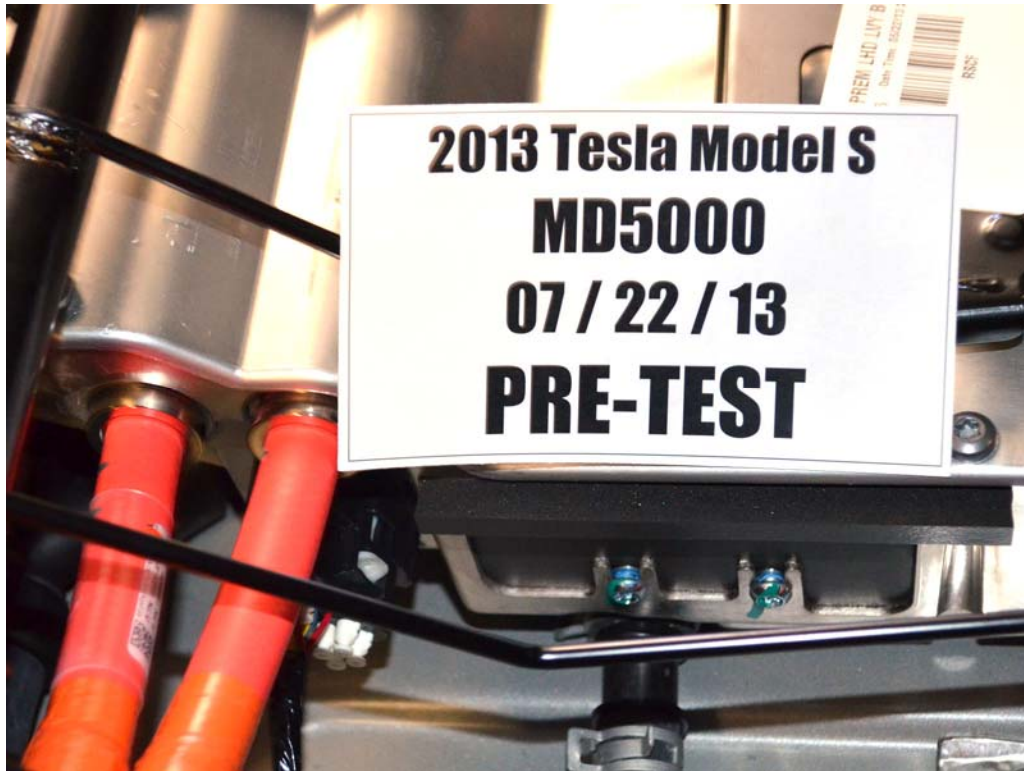


FIGURE 18e. Pre-Impact View of High Voltage Interconnect(s)



FIGURE 18f. Pre-Impact View of High Voltage Interconnect(s)



FIGURE 18g. Pre-Impact View of High Voltage Interconnect(s)



FIGURE 19. Pre-Impact View of Battery Venting System(s)



FIGURE 19a. Pre-Impact View of Battery Venting System(s)

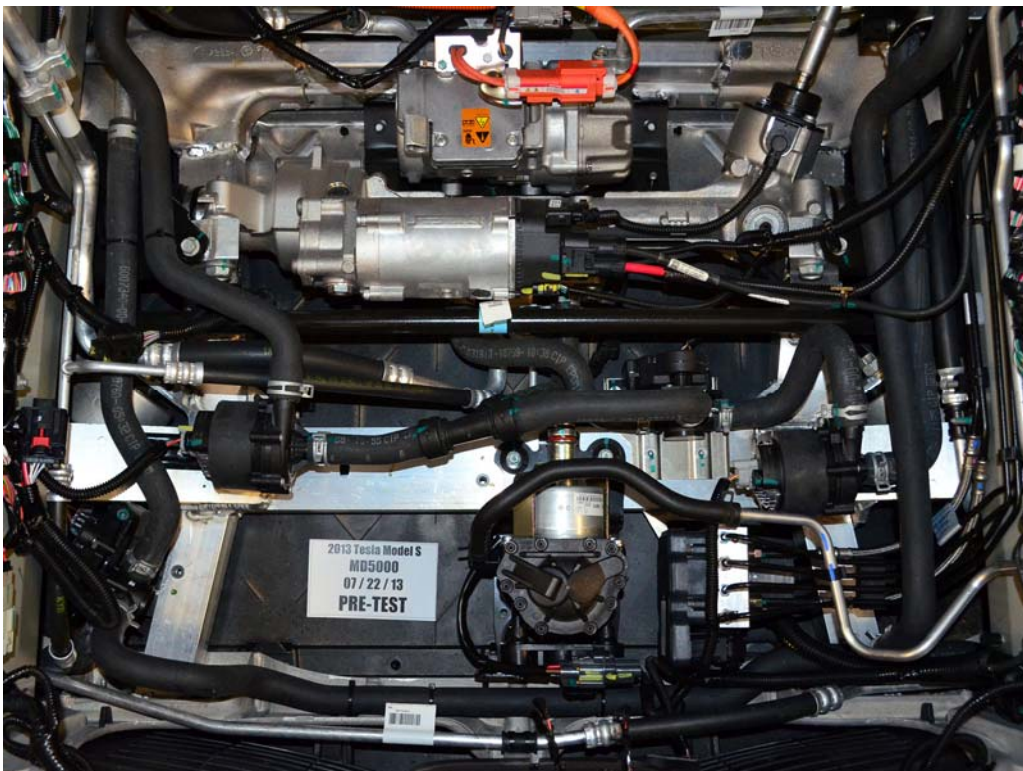


FIGURE 19b. Pre-Impact View of Battery Venting System(s)

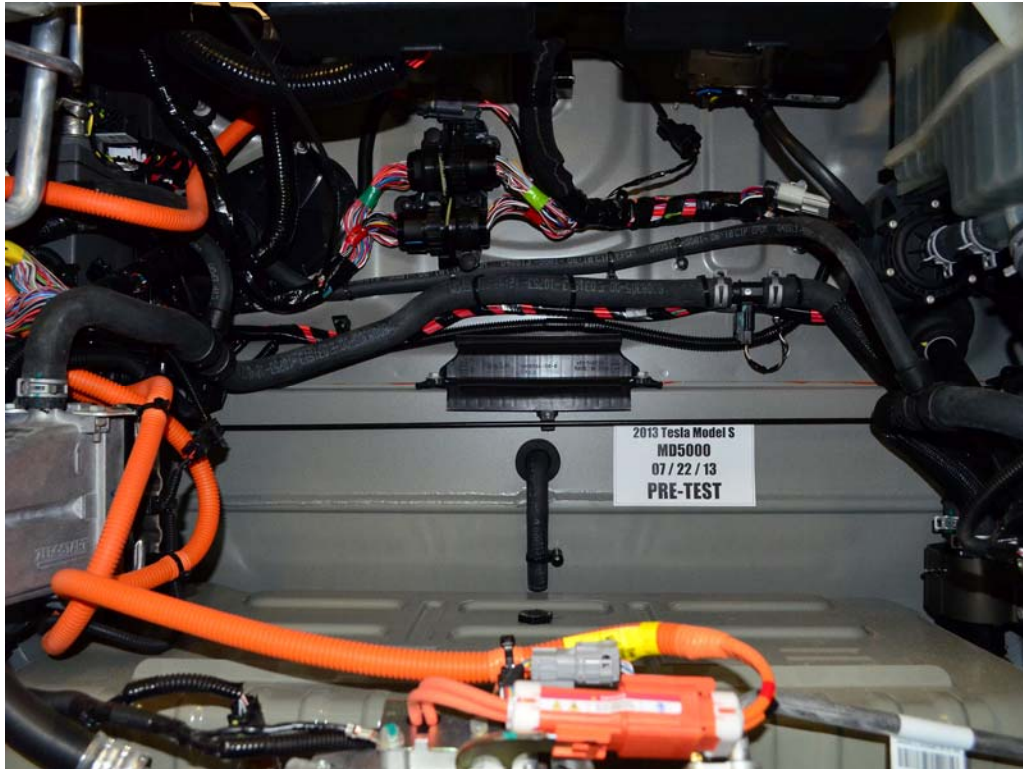


FIGURE19c. Pre-Impact View of Battery Venting System(s)

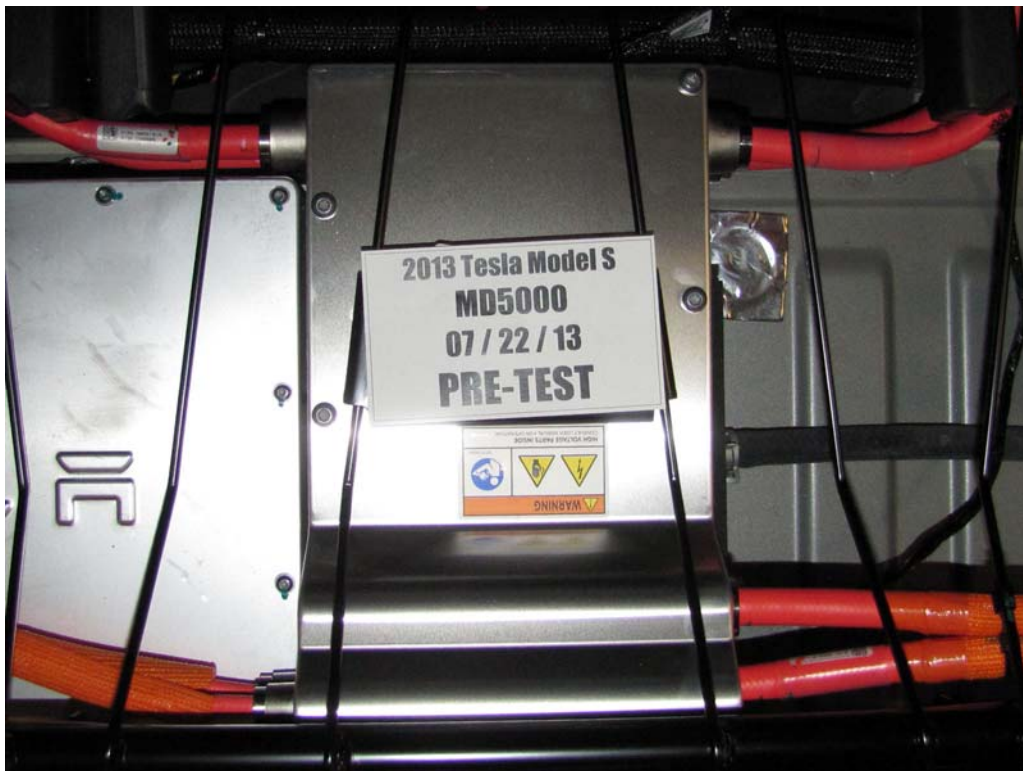


FIGURE 20. Pre-Impact View of Other Visible Electric Propulsion Components



FIGURE 20a. Pre-Impact View of Other Visible Electric Propulsion Components

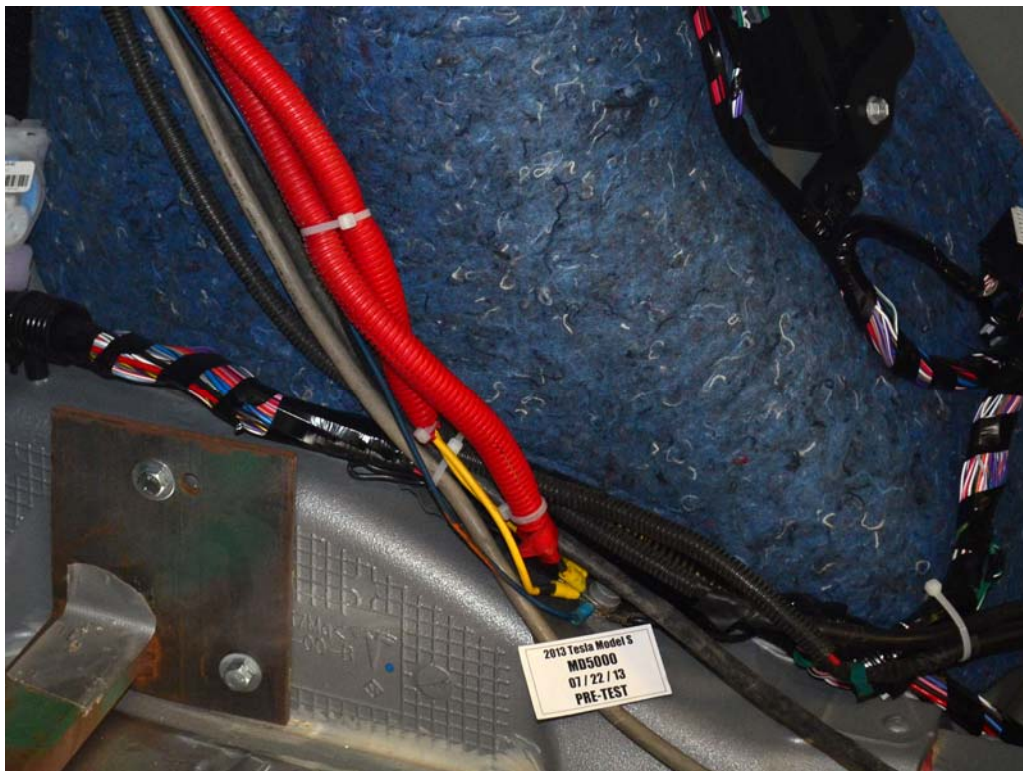


FIGURE 21. Pre-Impact View of Ground Lead Attached



FIGURE 22. Pre-Impact View of High Voltage Leads Attached

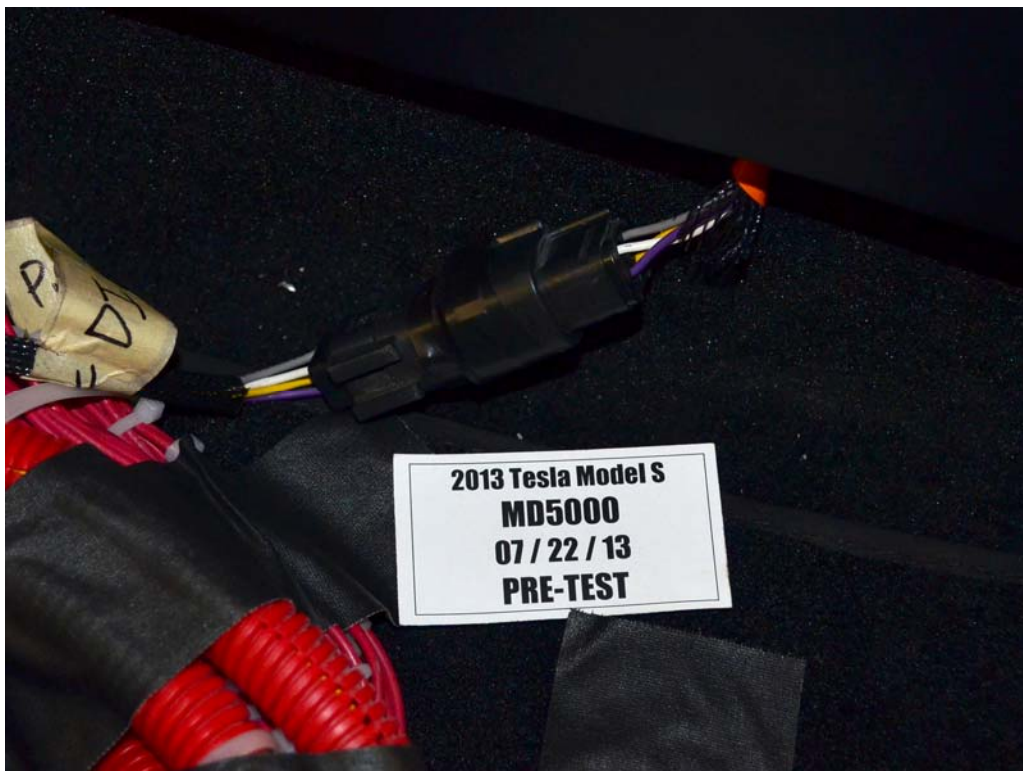


FIGURE 23. Pre-Impact Close-Up View of High Voltage Leads Attached



FIGURE 24. Pre-Impact View of Installed Test Interface Port

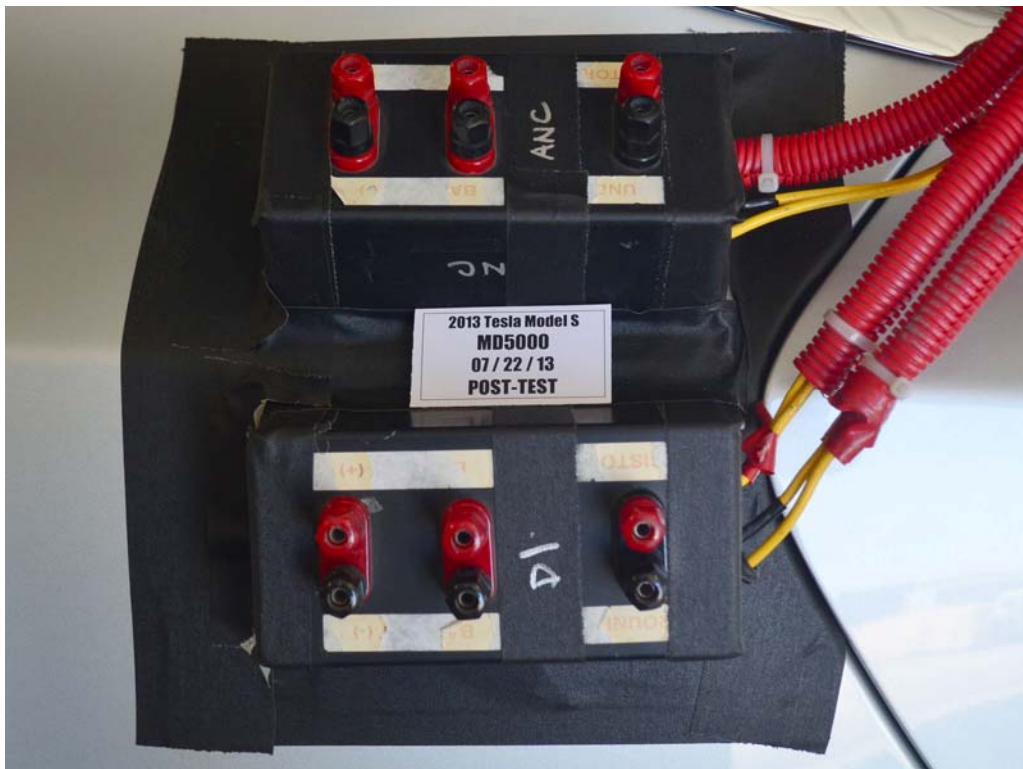


FIGURE 25. Post-Impact View of Installed Test Interface Port



FIGURE 26. Pre-Impact View of Other Test Devices

Photograph Not Available

FIGURE 27. Post-Impact View of Other Test Devices



FIGURE 28. FMVSS No. 305 Static Rollover at 0°



FIGURE 29. FMVSS No. 305 Static Rollover at 90°



FIGURE 30. FMVSS No. 305 Static Rollover at 180°



FIGURE 31. FMVSS No. 305 Static Rollover at 270°

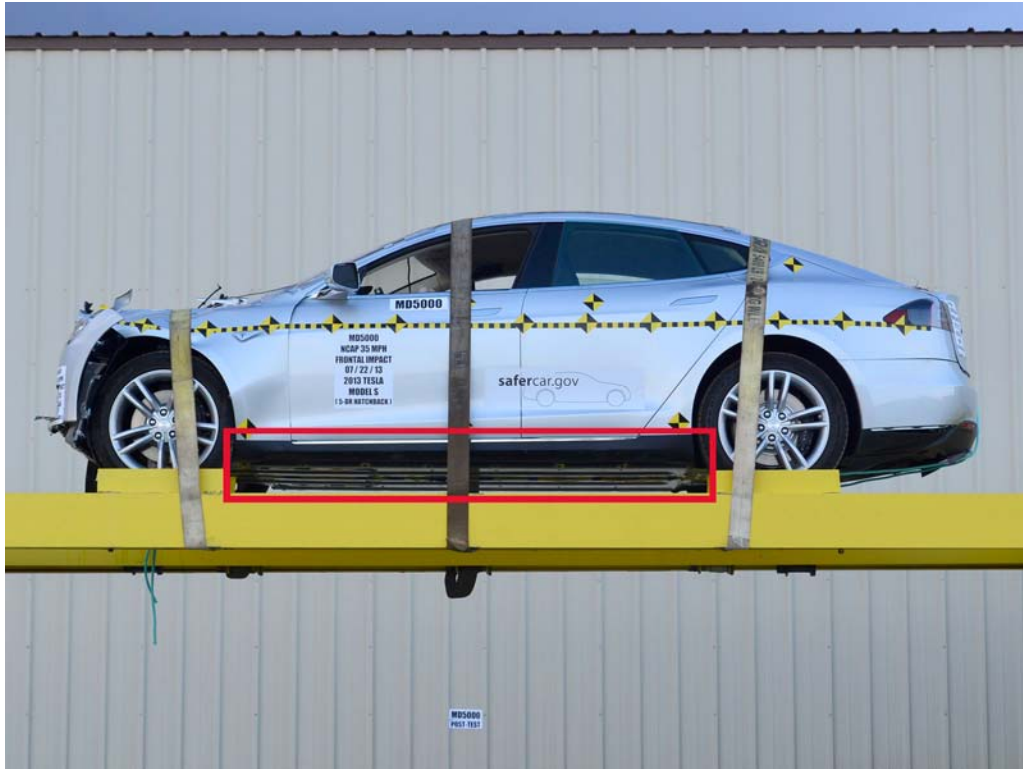


FIGURE 32. FMVSS No. 305 Static Rollover at 360°



FIGURE 33. Pre-Impact View of the Vehicle Passenger Compartment Adjacent to Propulsion Battery



FIGURE 34. Post-Impact View of the Vehicle Passenger Compartment
Adjacent to Propulsion Battery

Photograph Not Applicable

No Battery System
Mounting and/or Intrusion
Failure

FIGURE 35. Post-Impact View of Propulsion Battery System
Mounting and/or Intrusion Failure(s)

Photograph Not Applicable

**No Battery Component
Intrusion**

FIGURE 36. Post-Impact View of Propulsion Battery Component Intrusion

Photograph Not Applicable

**No Battery Module
Movement or Retention
Loss**

FIGURE 37. Post-Impact View of Propulsion Battery Module
Movement or Retention Loss

Photograph Not Applicable

**No Propulsion Battery
Electrolyte Spillage**

FIGURE 38. Post-Impact View of Propulsion Battery Electrolyte Spillage Location

Photograph Not Applicable

**No Propulsion Battery
Electrolyte Spillage**

FIGURE 39. Post-Test View of Propulsion Battery Electrolyte Spillage Location