REPORT NUMBER: NCAP305I-KAR-13-035

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

FORD MOTOR CO.

2013 FORD FOCUS ELECTRIC 5-DOOR HATCHBACK

NHTSA NUMBER: MD0216

PREPARED BY:

KARCO ENGINEERING, LLC.

9270 HOLLY ROAD

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JANUARY 3, 2013

FINAL REPORT

U.S. DEPARTMENT OF TRANSPORTATION

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

OFFICE OF RULEMAKING

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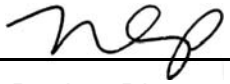
Reviewed By: 

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Approval Date: January 3, 2013

FINAL REPORT ACCEPTANCE BY OCWS:

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

Date:

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

Date:

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9. Performing Organization Name and Address KARCO Engineering, LLC. 9270 Holly Rd. Adelanto, CA 92301		**10. Work Unit No.** **11. Contract or Grant No.** DTNH22-09-D-00122	
12. Sponsoring Agency Name and Address U. S. Department of Transportation National Highway Traffic Safety Administration Office of Crashworthiness Standards Mail Code: NVS-111 1200 New Jersey Ave., SE, Room W43-410 Washington, D.C. 20590		**13. Type of Report and Period Covered** Final Test Report, Dec. 19, 2012 - Jan. 3, 2013 **14. Sponsoring Agency Code** NVS-111	
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 2013 Ford Focus Electric 5-door electric hatchback 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, Room E12-100 Washington, DC 20590 e-mail: tis@nhtsa.dot.gov FAX: 202-493-2833	
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SECTION 1
TEST PURPOSE AND PROCEDURE

An FMVSS No. 305 Indicant test, in conjunction with an NCAP side moving deformable barrier (MDB) impact test was conducted on the subject 2013 Ford Focus Electric 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-09-00122.

SECTION 2
SUMMARY OF TEST RESULTS

A side moving deformable barrier (MDB) impact test was performed by KARCO Engineering, LLC. on a 2013 Ford Focus Electric 5-door electric hatchback on December 19, 2012. 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 Ford Focus Electric 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 Ford Focus Electric 5-Door Hatchback NHTSA No.: MD0216

Test Program: FMVSS No. 305 Indicant Test Test Date: 12/19/12

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	^oF	^oC	=(Tf -32)/1.8
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf-ft	N•m	1.355

DATA SHEET NO. 1

TEST VEHICLE INFORMATION

Test Vehicle: 2013 Ford Focus Electric 5-Door Hatchback NHTSA No.: MD0216

Test Program: FMVSS No. 305 Indicant Test Test Date: 12/19/12

TEST VEHICLE INFORMATION

NHTSA Number	MD0216
Model Year	2013
Make	Ford
Model	Focus Electric
Body Style	5-Door Hatchback
Body Color	Ingot Silver Metallic
Odometer Reading (km / mi)	44 / 27

DATA FROM VEHICLE'S CERTIFICATION LABEL

Manufactured By	Ford Motor Co.
Date of Manufacture	Jul-12
VIN	1FADP3R44DL126036
GVWR	2085

ELECTRIC VEHICLE PROPULSION SYSTEM

Type of Electrical Vehicle	Electric
Propulsion Battery Type	Lithium Ion
Nominal Voltage (V)	350
Automatic Propulsion Battery Disconnect	Yes
Physical Location of Automatic Propulsion Battery Disconnect	Inside the Upper Propulsion Battery
Auxiliary Battery Type	12 Volt Lead Acid

PROPULSION BATTERY SYSTEM DATA

Electrolyte Fluid Type	Non-Aqueous
Electrolyte Fluid Specific Gravity (g/cc)	1.23
Electrolyte Fluid Kinematic Viscosity (cSt)	244
Electrolyte Fluid Color	n/a
Propulsion Battery Coolant Type	Ethylene Glycol
Propulsion Battery Coolant Color	Orange
Propulsion Battery Coolant Specific Gravity	Not Available

LOCATION OF BATTERY MODULES

Location	Upper Battery Module Behind the Rear Passenger Seat in the Occupant Compartment; Lower Battery Module Beneath the Rear Seat Area Under the Vehicle.

DATA SHEET NO. 1 … (CONTINUED)

TEST VEHICLE INFORMATION

Test Vehicle: 2013 Ford Focus Electric 5-Door Hatchback NHTSA No.: MD0216

Test Program: FMVSS No. 305 Indicant Test Test Date: 12/19/12

For all battery types:

Description	Volts
Minimum Operating Voltage	300
Maximum Operating Voltage	350
95% of Maximum Operating Voltage	333
Test Voltage (no less than 95% of Maximum)	339.5

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: 2013 Ford Focus Electric 5-Door Hatchback NHTSA No.: MD0216

Test Program: FMVSS No. 305 Indicant Test Test Date: 12/19/12

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 sanded portion of the right rear quarter panel. A self tapping screw was installed through the sanded area of the panel. 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 utilized two separate lithium ion battery modules and a traction motor to propel the vehicle. There is one battery located in the occupant compartment, behind the rear seats. The other battery is located beneath the vehicle, under the rear seats. The two batteries are wired in series to provide a nominal 350 V to the traction motor. Each battery has a separate service disconnect. The upper battery service disconnect is located on the front side of the battery, directly behind the rear seat back; the lower battery service disconnect is located in the right rear wheel well area.

DATA SHEET NO. 3

PRE-IMPACT ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

Test Vehicle: 2013 Ford Focus Electric 5-Door Hatchback NHTSA No.: MD0216

Test Program: FMVSS No. 305 Indicant Test Test Date: 12/19/12

VOLTMETER INFORMATION

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

ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

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

Code	Units	Threshold	Pre-Test
V_b	V		339.50
V_1	V		40.10
V_2	V		39.90
R_o	Ω		222,800
V_1'	V		9.89
V_2'	V		9.90
R_{i1}	Ω		1,357,736
R_{i2}	Ω		1,353,687
R_i	Ω		1,353,687
R_i/V_b	Ω/V	500	3,868

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

DATA SHEET NO. 4

POST-IMPACT DATA

Test Vehicle: 2013 Ford Focus Electric 5-Door Hatchback NHTSA No.: MD0216

Test Program: FMVSS No. 305 Indicant Test Test Date: 12/19/12

VOLTMETER INFORMATION

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

ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

Code	Units	Threshold	Post-Test
V_b	V		0.69
V_1	V		0.18
V_2	V		0.40
R_o	Ω		222,800
V_1'	V		0.02
V_2'	V		0.03
R_{i1}	Ω		4,666,422
R_{i2}	Ω		3,984,407
R_i	Ω		3,984,407
R_i/V_b	Ω/V	500	11,384

Is the Measured Electrical Isolation Value ≥ 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 batteries.

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

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

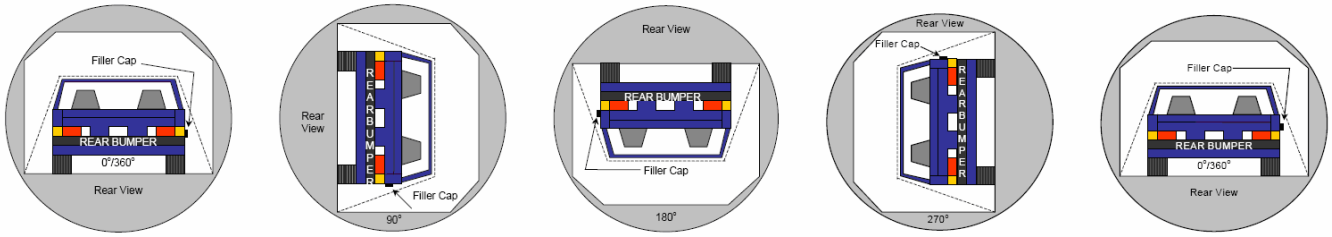
Is there propulsion battery electrolyte spillage visible in the passenger compartment: No

DATA SHEET NO. 5

STATIC ROLLOVER TEST DATA

Test Vehicle: 2013 Ford Focus Electric 5-Door Hatchback NHTSA No.: MD0216

Test Program: FMVSS No. 305 Indicant Test Test Date: 12/19/12



0° TO 90° 90° TO 180° 180° TO 270° 270° TO 360°

PROPULSION BATTERY ELECTROLYTE COLLECTION TIME PERIOD

Test Phase	Rotation Time	Hold Time	Total Time
0° To 90°	87	300	387
90° To 180°	86	300	386
180° To 270°	85	300	385
270° To 360°	87	300	387

TEST VEHICLE PROPULSION BATTERY ELECTROLYTE SPILLAGE

Test Phase	Propulsion Battery Electrolyte Spillage (L)	Spillage Location
0° To 90°	0.0	None
90° To 180°	0.0	None
180° To 270°	0.0	None
270° To 360°	0.0	None

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 Ford Focus Electric 5-Door Hatchback NHTSA No.: MD0216

Test Program: FMVSS No. 305 Indicant Test Test Date: 12/19/12

VOLTMETER INFORMATION

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

ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS

Code	Units	Threshold	90°	180°	270°	360°
V_b	V		0.00	0.00	0.00	0.00
V_1	V		0.04	0.00	0.00	0.00
V_2	V		0.01	0.00	0.00	0.00
R_o	Ω		222,800	222,800	222,800	222,800
V_1'	V		0.00	0.00	0.00	0.00
V_2'	V		0.00	0.00	0.00	0.00
R_{i1}	Ω		Zero Volts	Zero Volts	Zero Volts	Zero Volts
R_{i2}	Ω		Zero Volts	Zero Volts	Zero Volts	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?	Zero Volts is considered to be compliant

APPENDIX A

PHOTOGRAPHS

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TABLE OF PHOTOGRAPHS … (CONTINUED)

FIGURE 1. Auxiliary Power Module Warning Label

FIGURE 1a. Auxiliary Power Module Warning Label

FIGURE 1b. Auxiliary Power Module Warning Label

FIGURE 1c. Auxiliary Power Module Warning Label

FIGURE 2. Power Inverter Warning Label

Photograph Not Applicable

No First Responder Warning Label

FIGURE 3. First Responder Warning Label

Photograph Not Applicable

No First Responder Warning Label

FIGURE 4. First Responder Warning Location

FIGURE 5. Other Vehicle Label Related to Electrical Propulsion System

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

FIGURE5b. Manual High Voltage Disconnect In Place

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

FIGURE 6. Manual High Voltage Disconnect In Place

FIGURE 6a. Manual High Voltage Disconnect In Place

FIGURE 7. Manual High Voltage Disconnect Removed

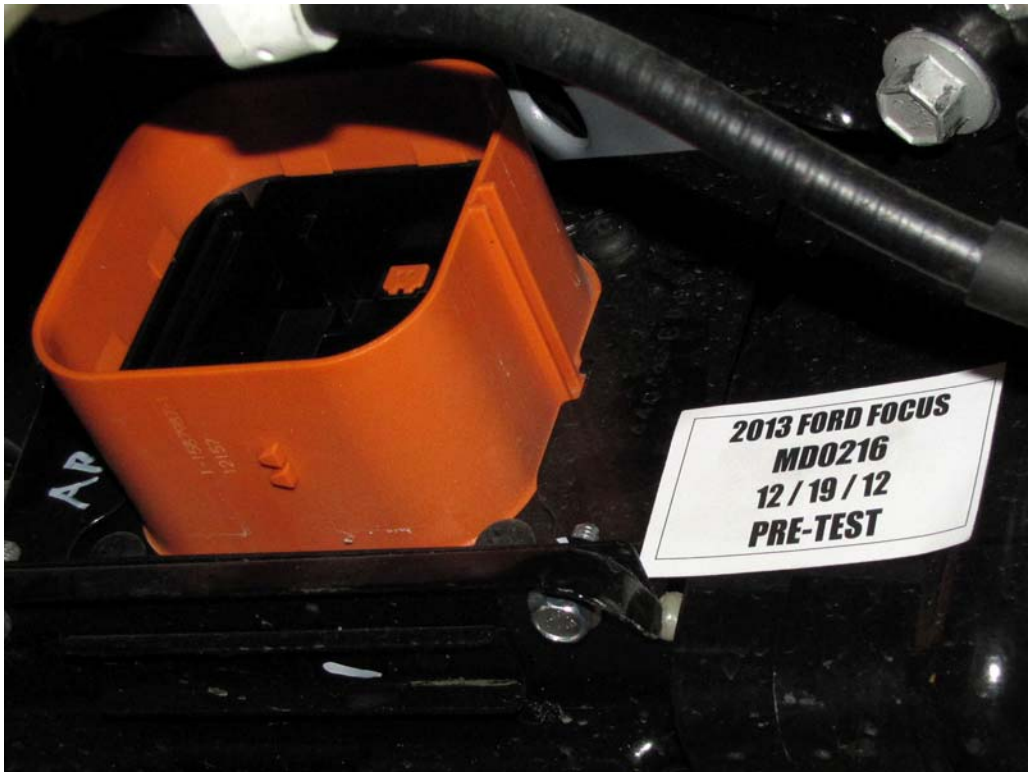

FIGURE 7a. Manual High Voltage Disconnect Removed

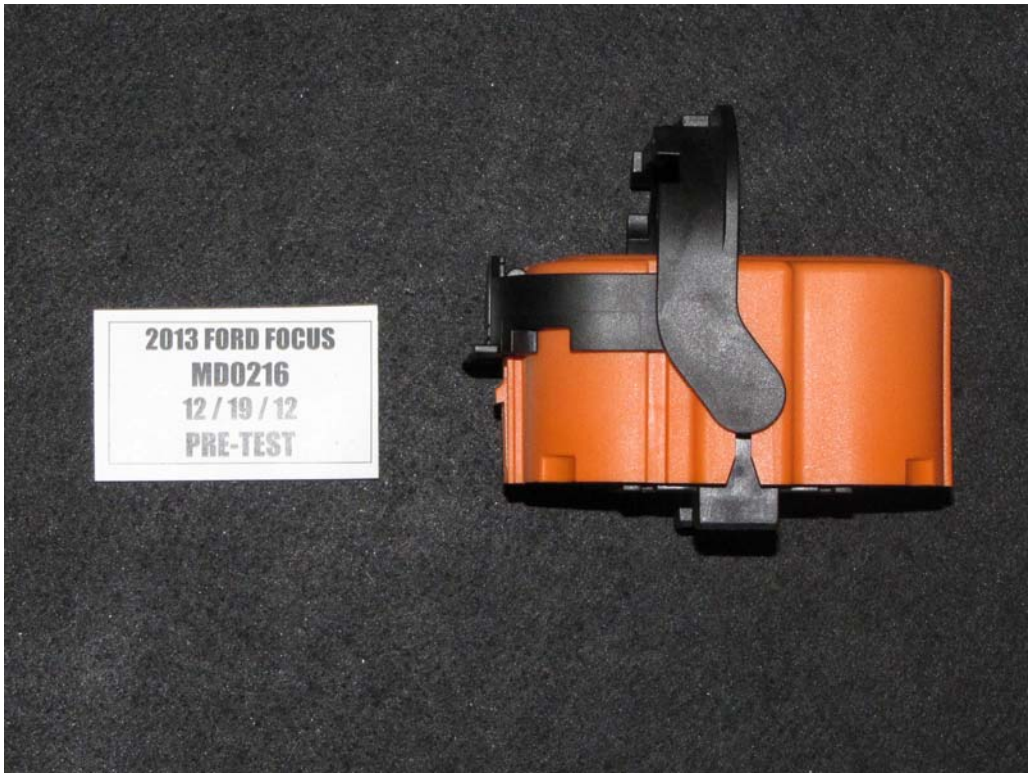

FIGURE 8. Manual High Voltage Disconnect Removed

FIGURE 8a. Manual High Voltage 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 9c. Pre-Impact View of Propulsion Battery

FIGURE 10. Post-Impact Front View of Propulsion Battery

FIGURE 10a. Post-Impact Front View of Propulsion Battery

FIGURE 11. Post-Impact Rear View of Propulsion Battery

FIGURE 11a. Post-Impact Rear View of Propulsion Battery

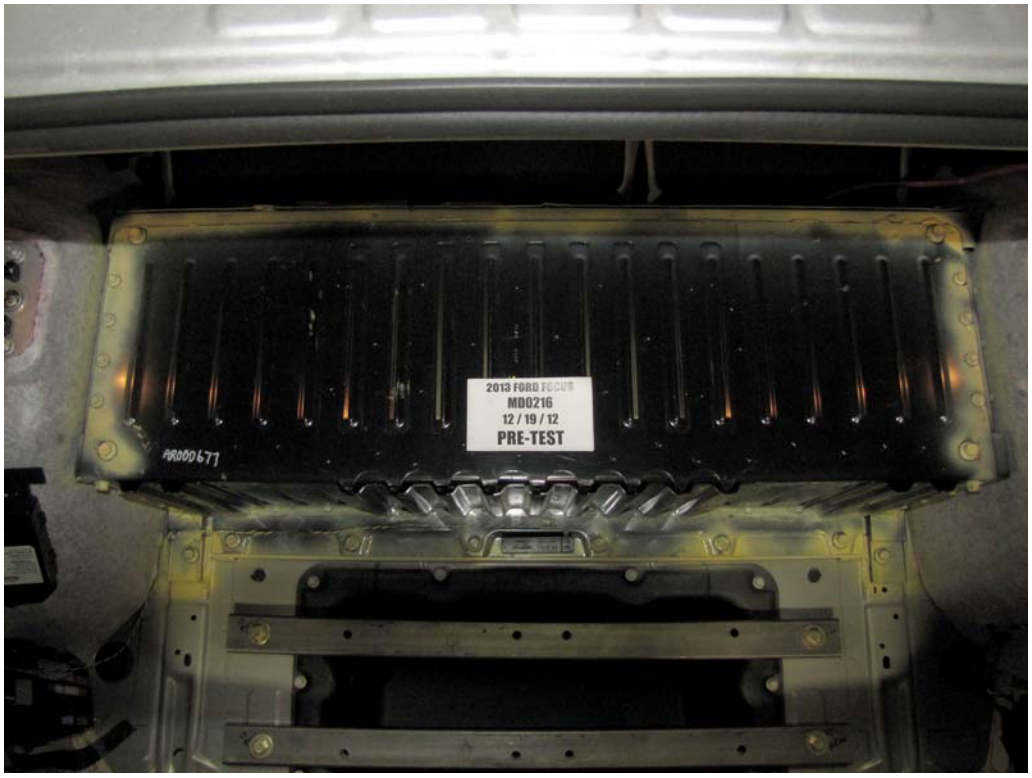

FIGURE 12. Pre-Impact View of Battery Box or Container
Which hold Individual Battery Modules

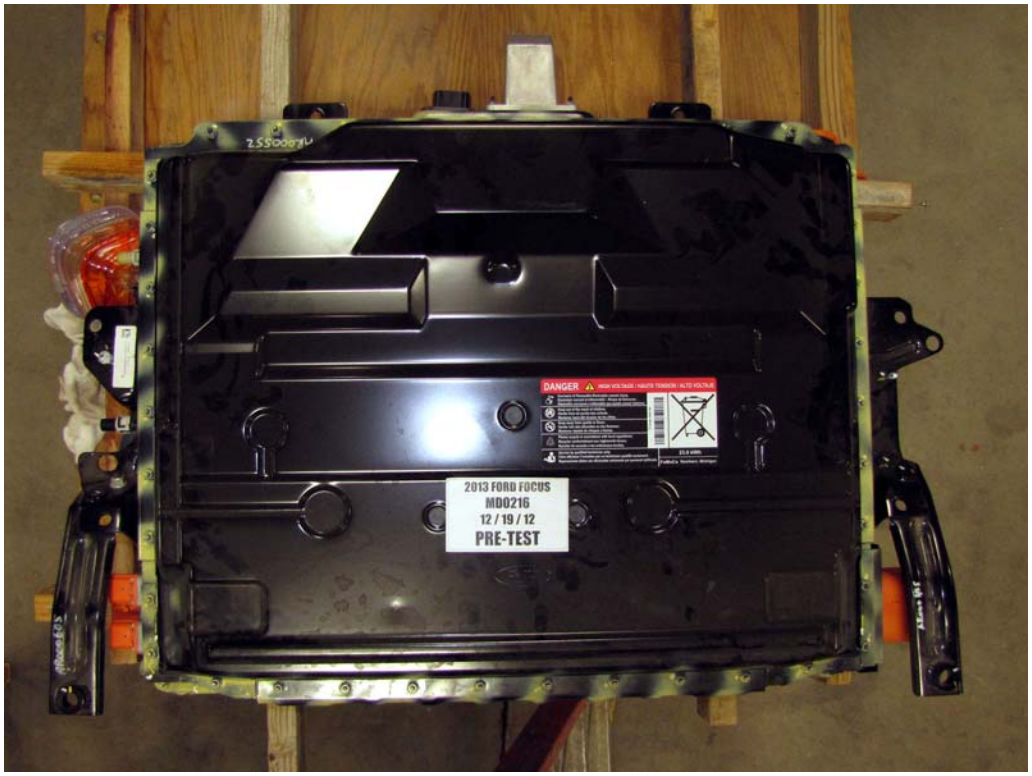

FIGURE 12a. Pre-Impact View of Battery Box or Container
Which hold Individual Battery Modules

FIGURE 12b. Pre-Impact View of Battery Box or Container
Which hold Individual Battery Modules

FIGURE 12c. Pre-Impact View of Battery Box or Container
Which hold Individual Battery Modules

FIGURE 12d. Pre-Impact View of Battery Box or Container
Which hold Individual Battery Modules

FIGURE 12e. Pre-Impact View of Battery Box or Container
Which hold Individual Battery Modules

FIGURE 12f. Pre-Impact View of Battery Box or Container
Which hold Individual Battery Modules

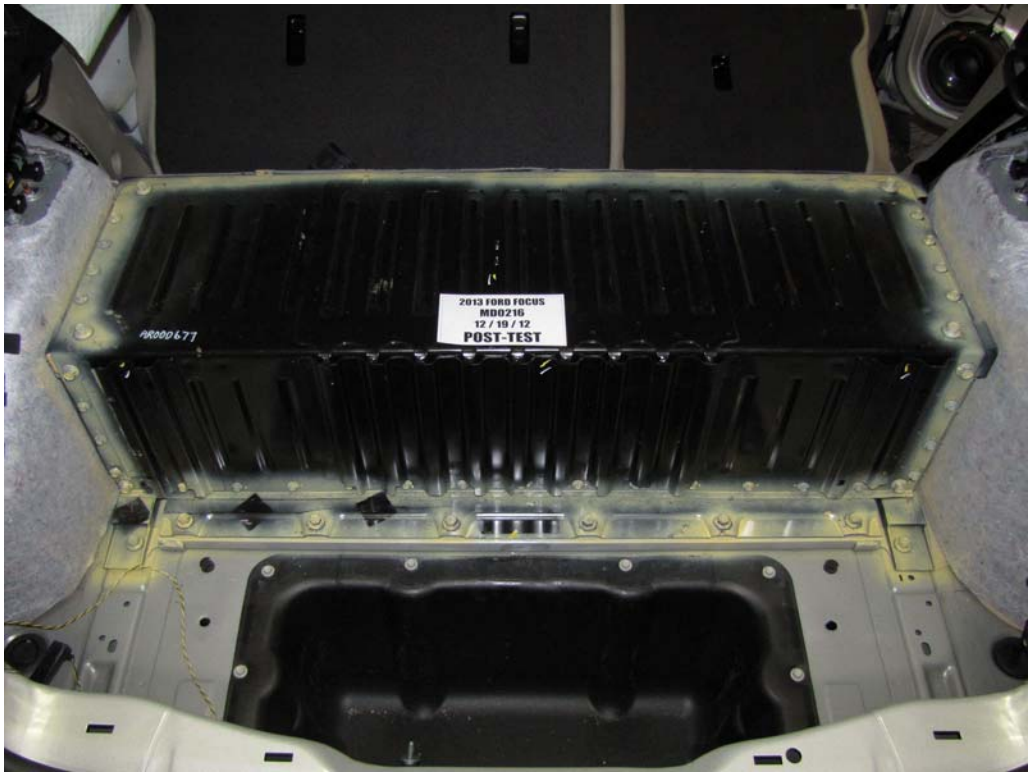

FIGURE 13. Post-Impact View of Battery Box or Container
Which hold Individual Battery Modules

FIGURE 13a. Post-Impact View of Battery Box or Container
Which hold Individual Battery Modules

FIGURE 13b. Post-Impact View of Battery Box or Container
Which hold Individual Battery Modules

FIGURE 13c. Post-Impact View of Battery Box or Container
Which hold Individual Battery Modules

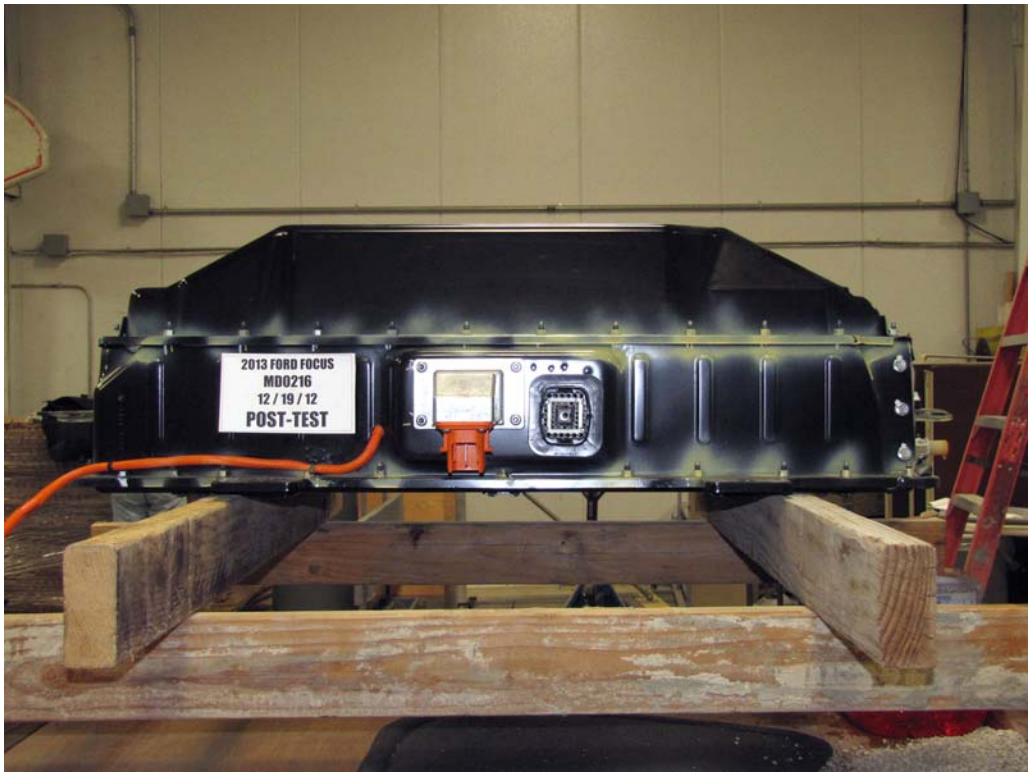

FIGURE 13d. Post-Impact View of Battery Box or Container
Which hold Individual Battery Modules

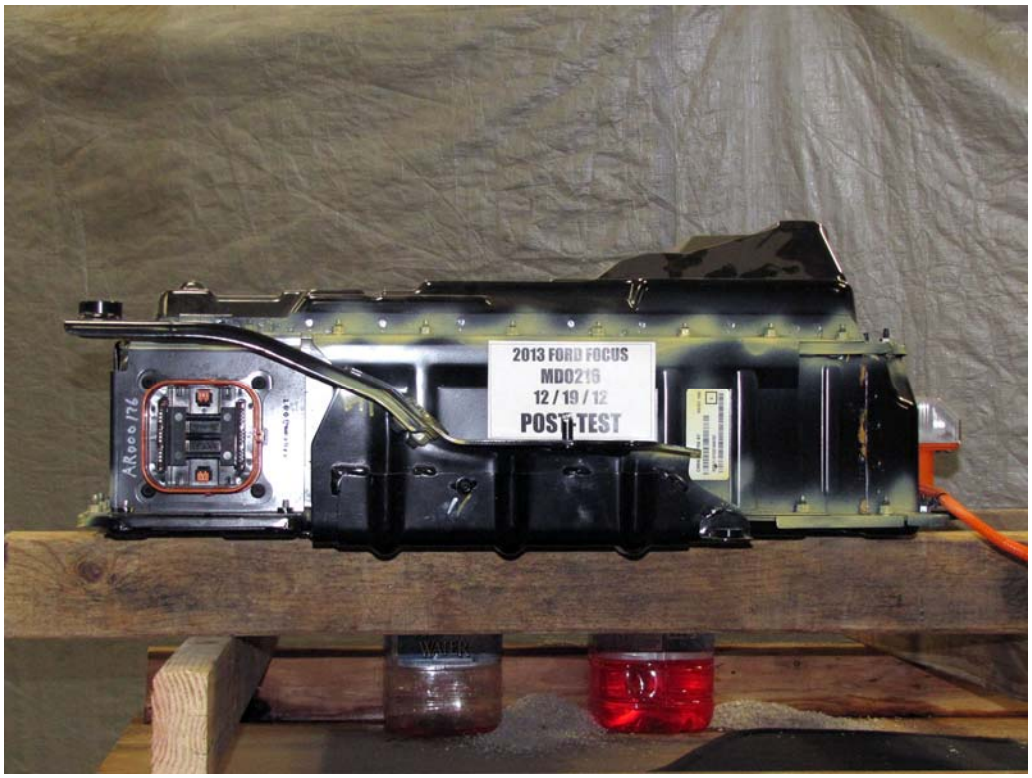

FIGURE 13e. Post-Impact View of Battery Box or Container
Which hold Individual Battery Modules

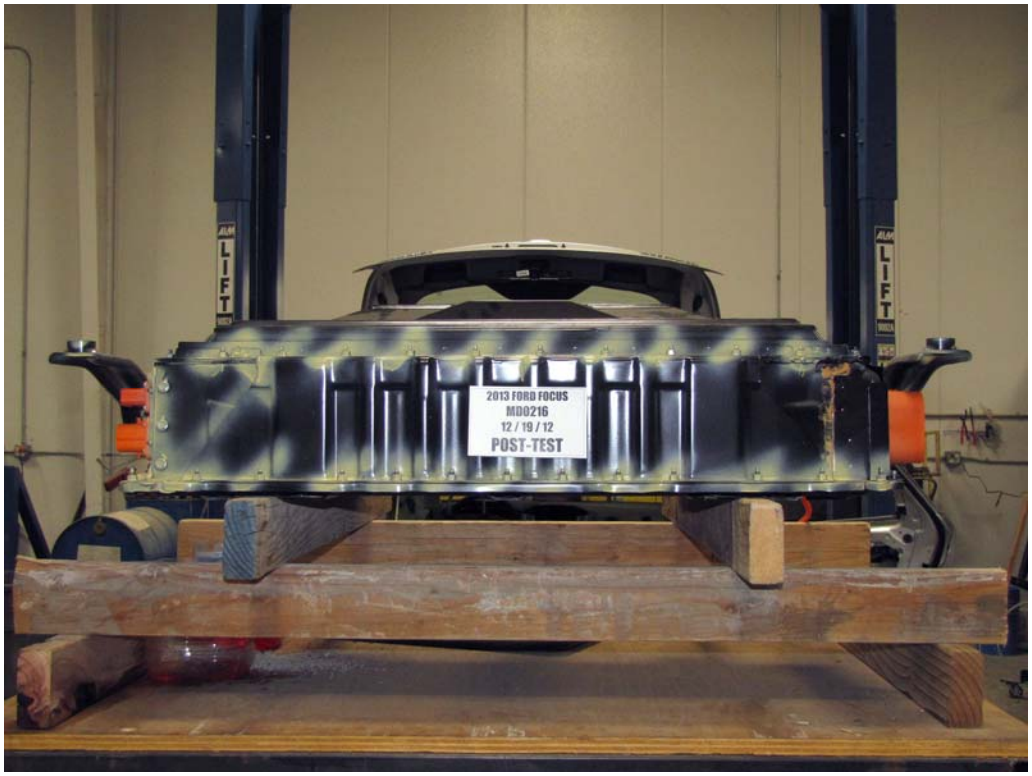

FIGURE 13f. Post-Impact View of Battery Box or Container
Which hold Individual Battery Modules

Photograph Not Available

Upper Cover Not Removed Pre-Test

FIGURE 14. Pre-Impact View of Battery Modules

FIGURE 14a. Pre-Impact View of Battery Modules

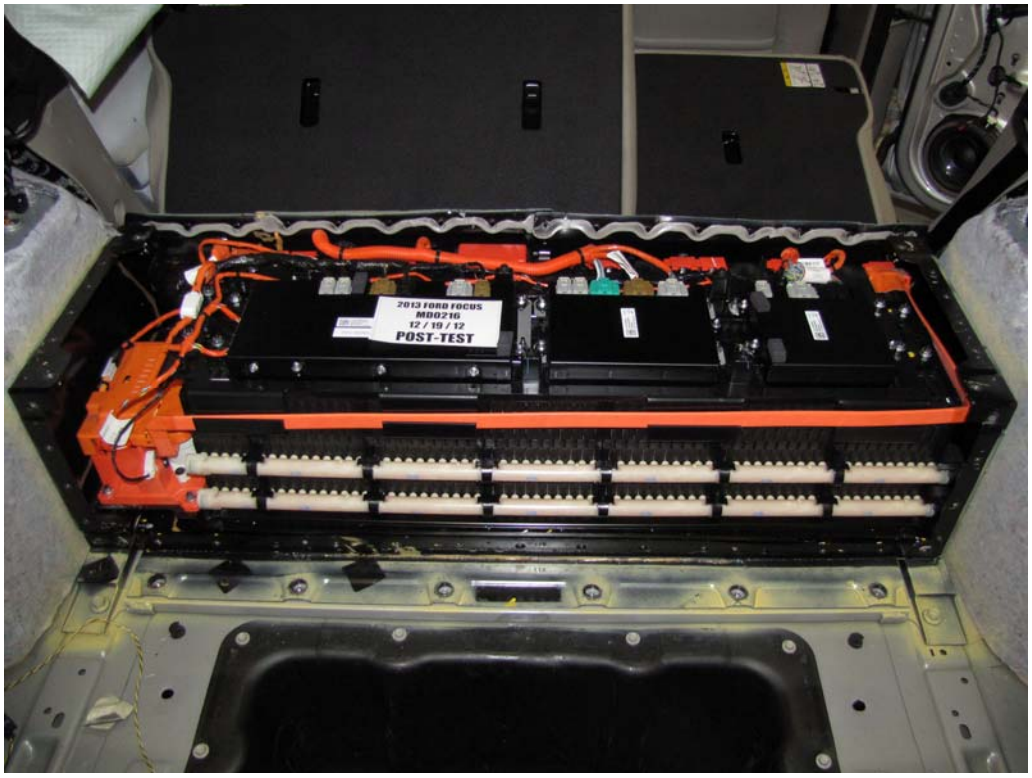

FIGURE 15. Post-Impact View of Battery Modules

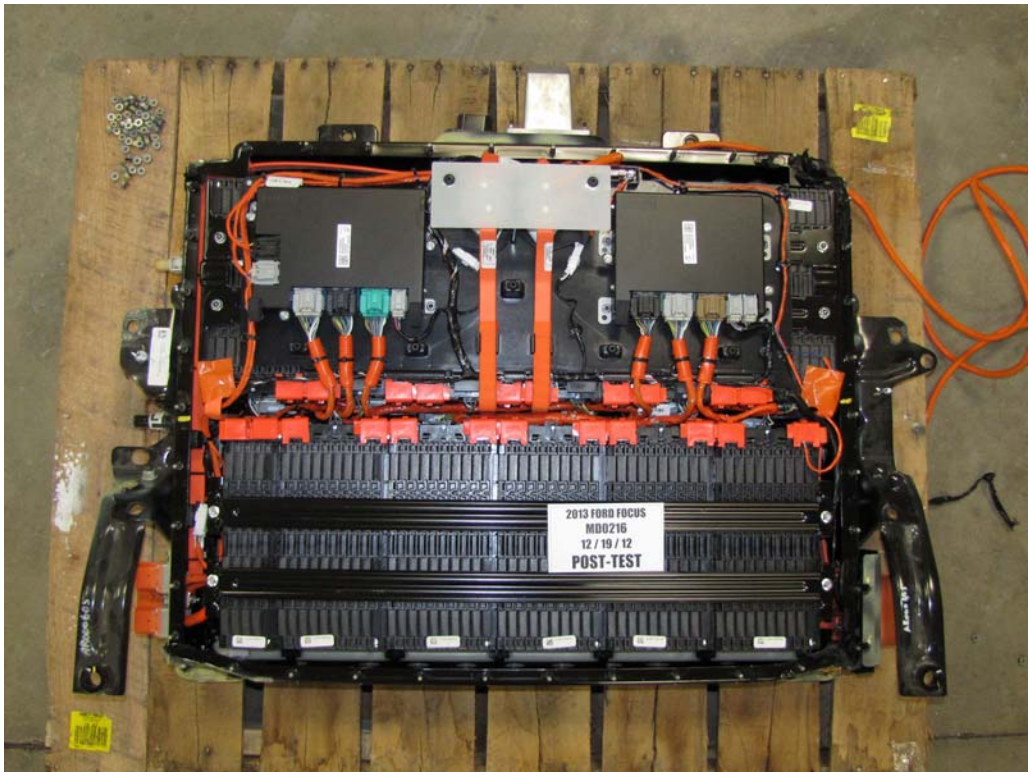

FIGURE 15a. Post-Impact View of Battery Modules

FIGURE 15b. Post-Impact View of Battery Modules

FIGURE 15c. Post-Impact View of Battery Modules

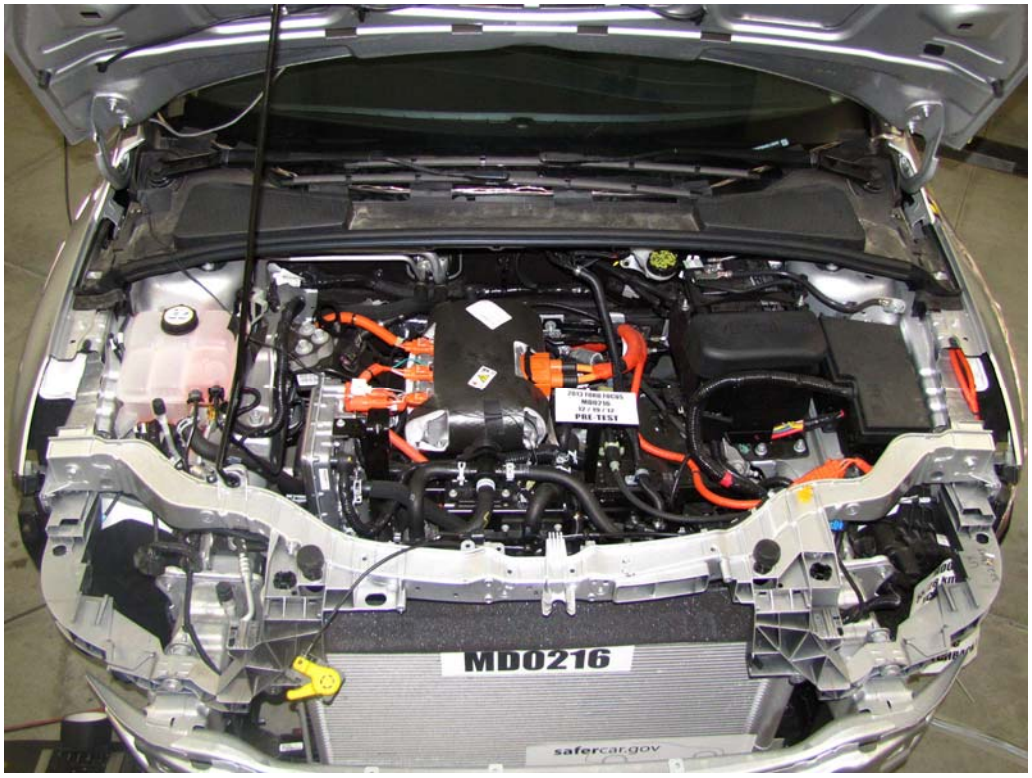

FIGURE 16. Pre-Impact View of Electric Propulsion Drive

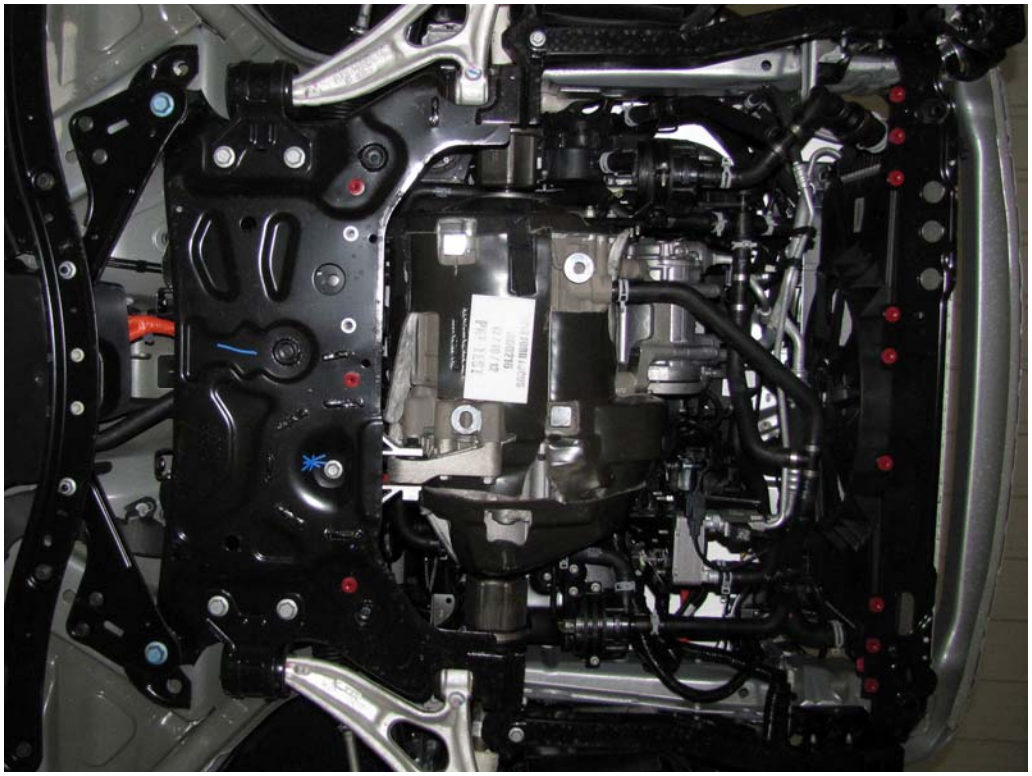

FIGURE 16a. Pre-Impact View of Electric Propulsion Drive

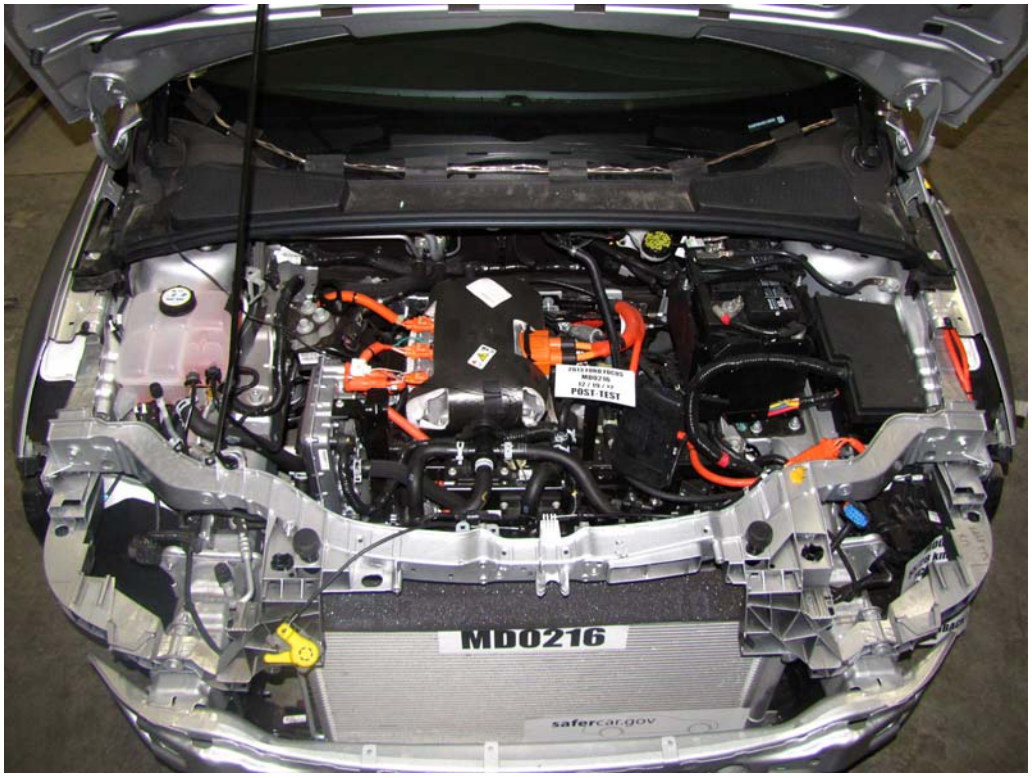

FIGURE 17. Post-Impact View of Electric Propulsion Drive

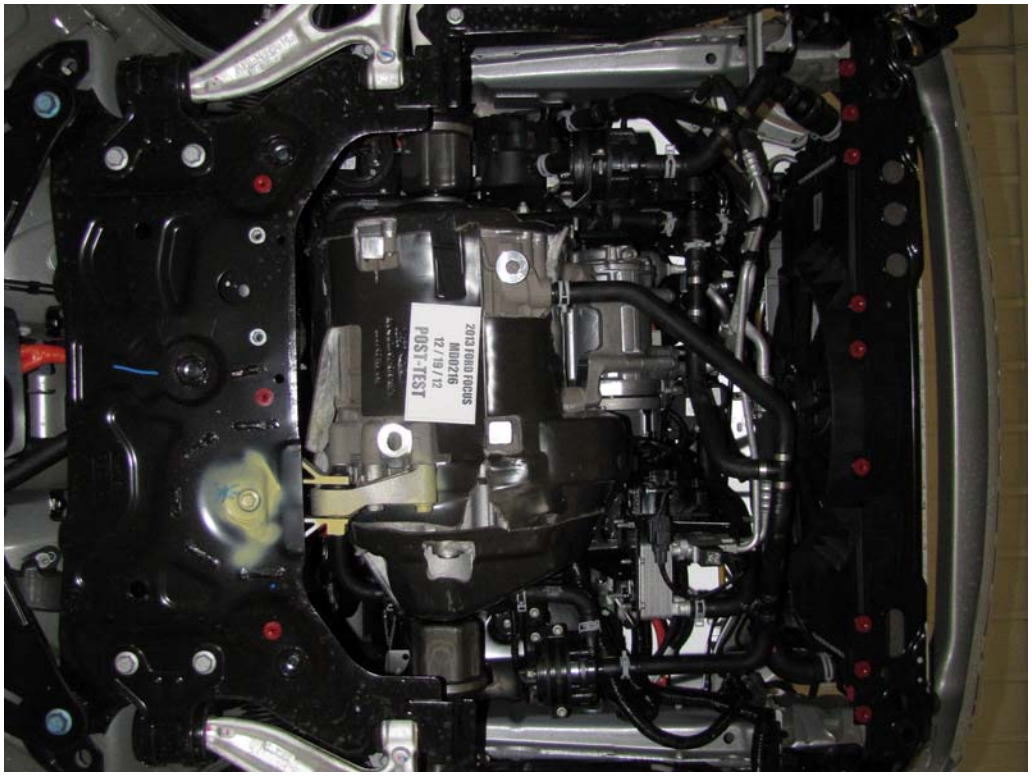

FIGURE 17a. Post-Impact View of Electric Propulsion Drive

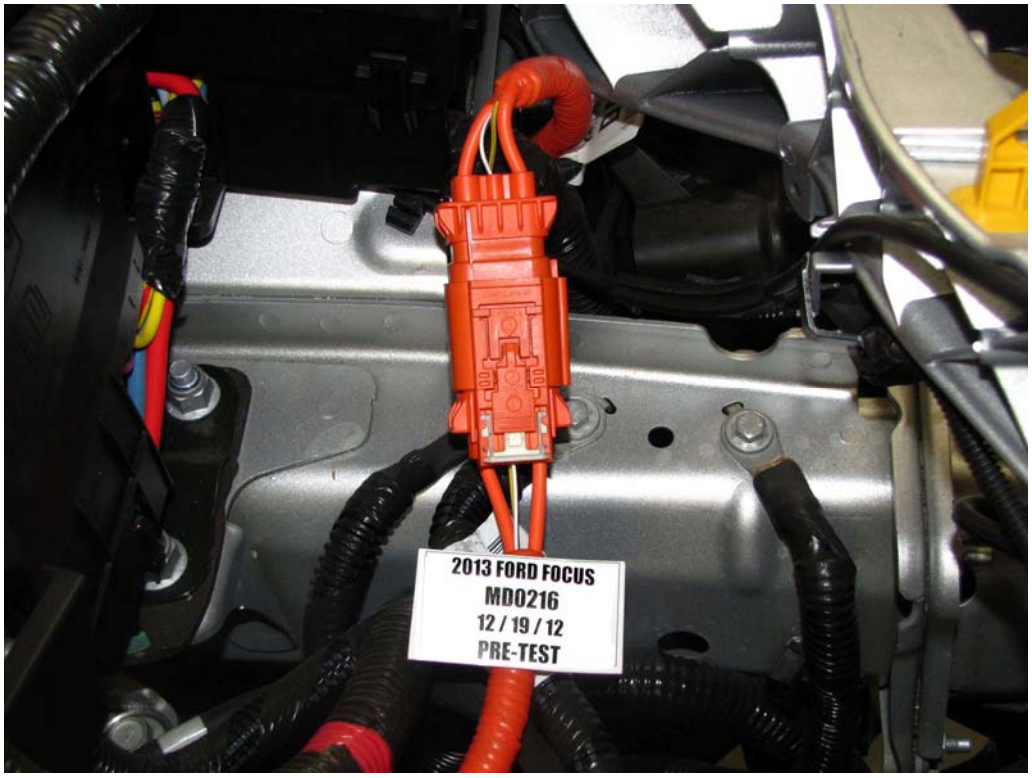

FIGURE 18. Pre-Impact View of High Voltage Interconnect(s)

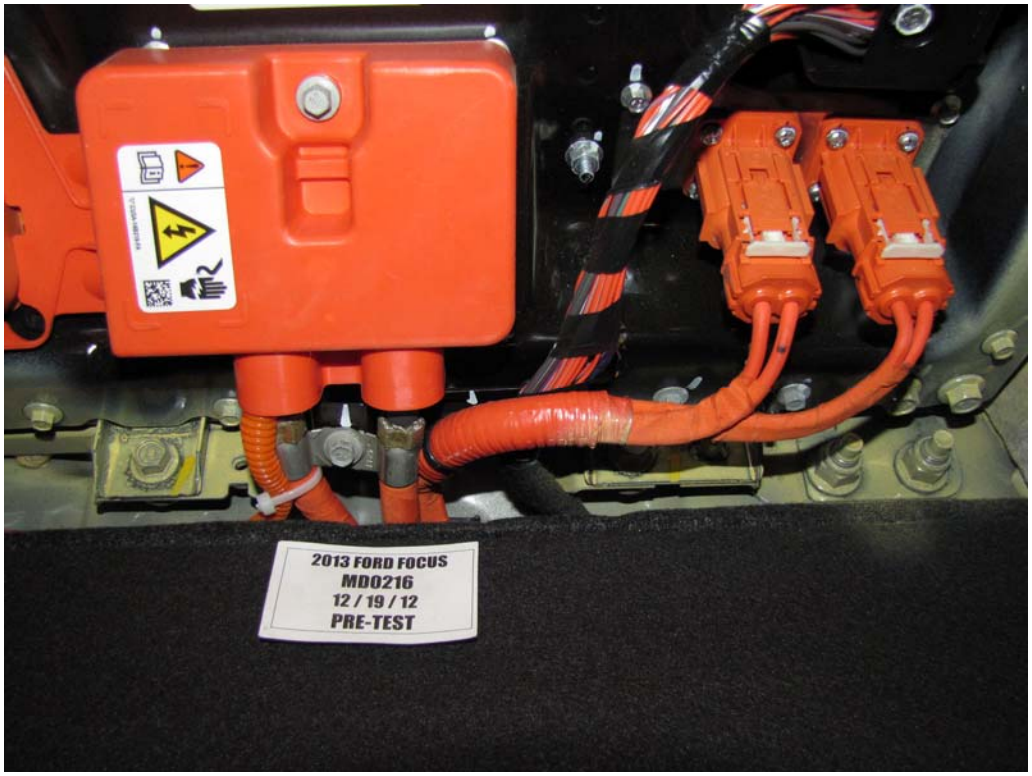

FIGURE 18a. Pre-Impact View of High Voltage Interconnect(s)

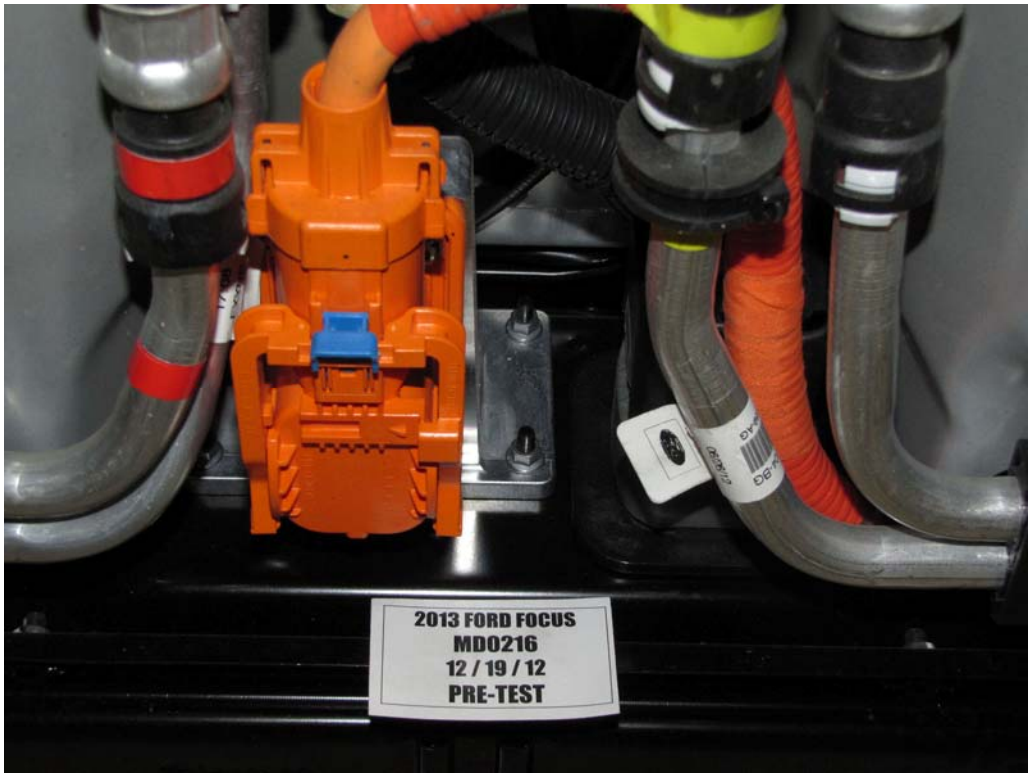

FIGURE 18b. Pre-Impact View of High Voltage Interconnect(s)

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

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

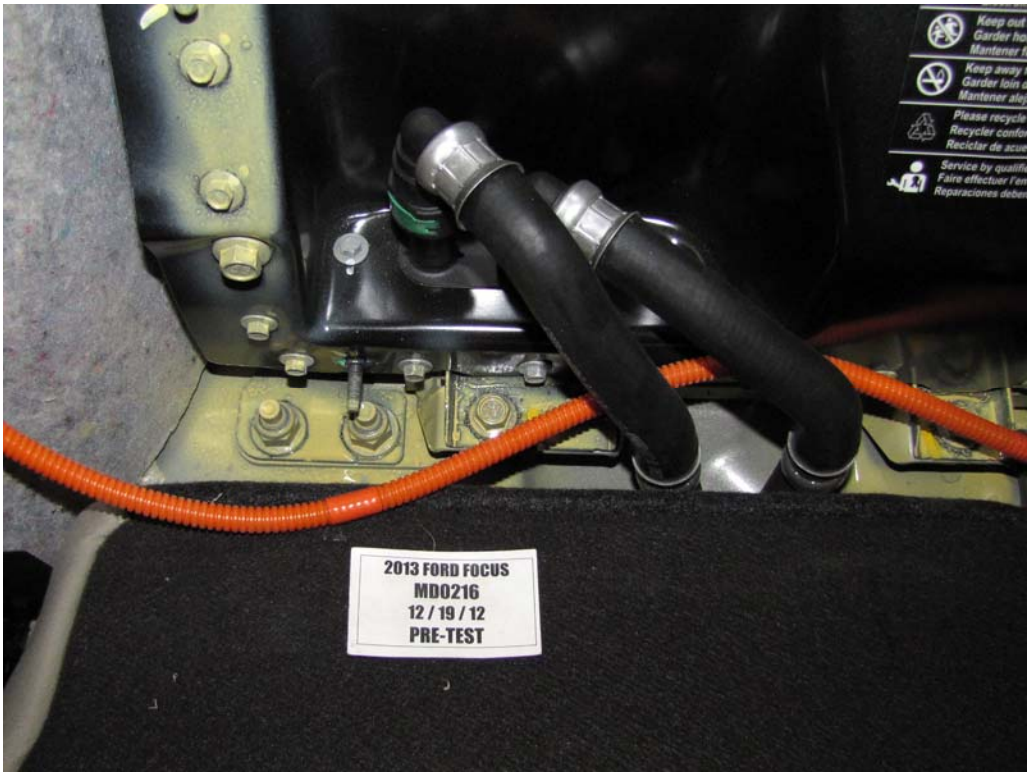

FIGURE 19a. Pre-Impact View of Propulsion Battery Venting System(s)

Photograph Not Applicable

FIGURE 20. 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 22a. Pre-Impact View of High Voltage Leads Attached

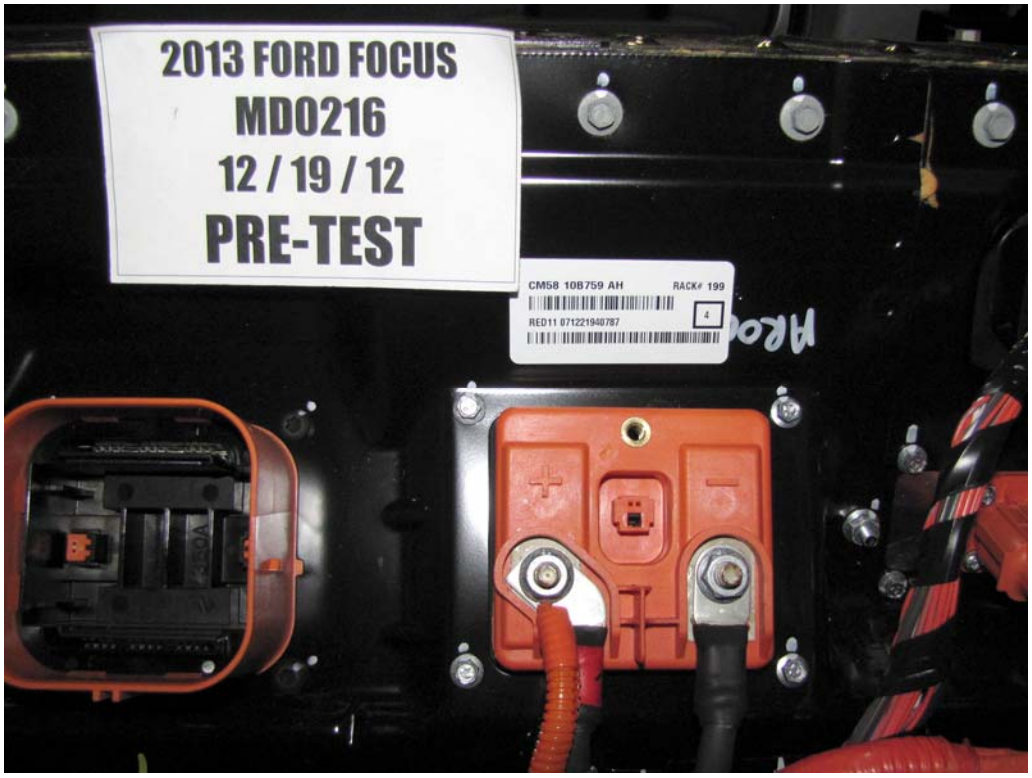

FIGURE 23. Pre-Impact Close-Up View of High Voltage Leads Attached

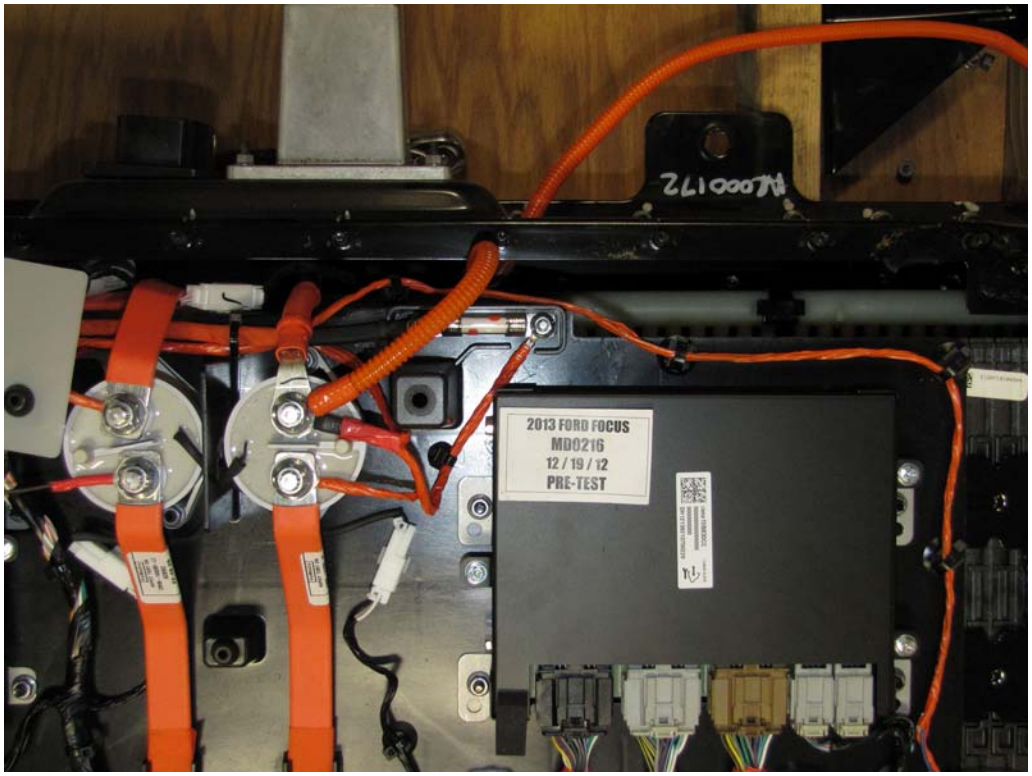

FIGURE 23a. Pre-Impact Close-Up View of High Voltage Leads Attached

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

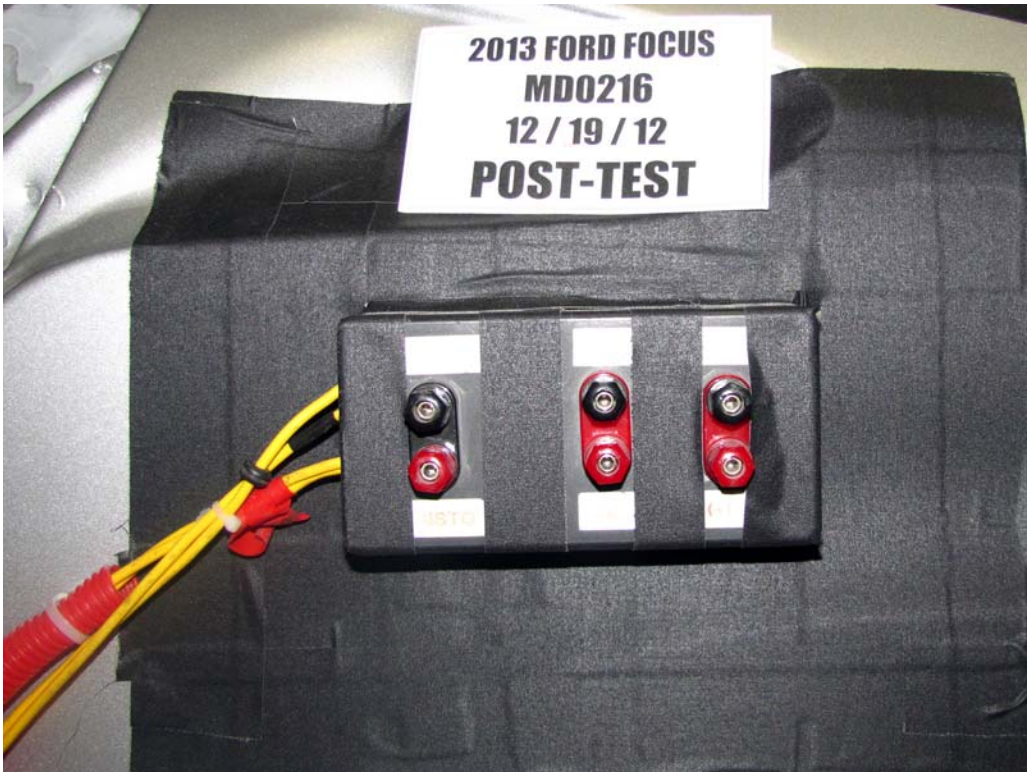

FIGURE 25. Post-Impact View of Installed Test Interface Port

Photograph Not Applicable

FIGURE 26. Pre-Impact View of Other test Devices

Photograph Not Applicable

FIGURE 27. Post-Impact View of Other test Devices

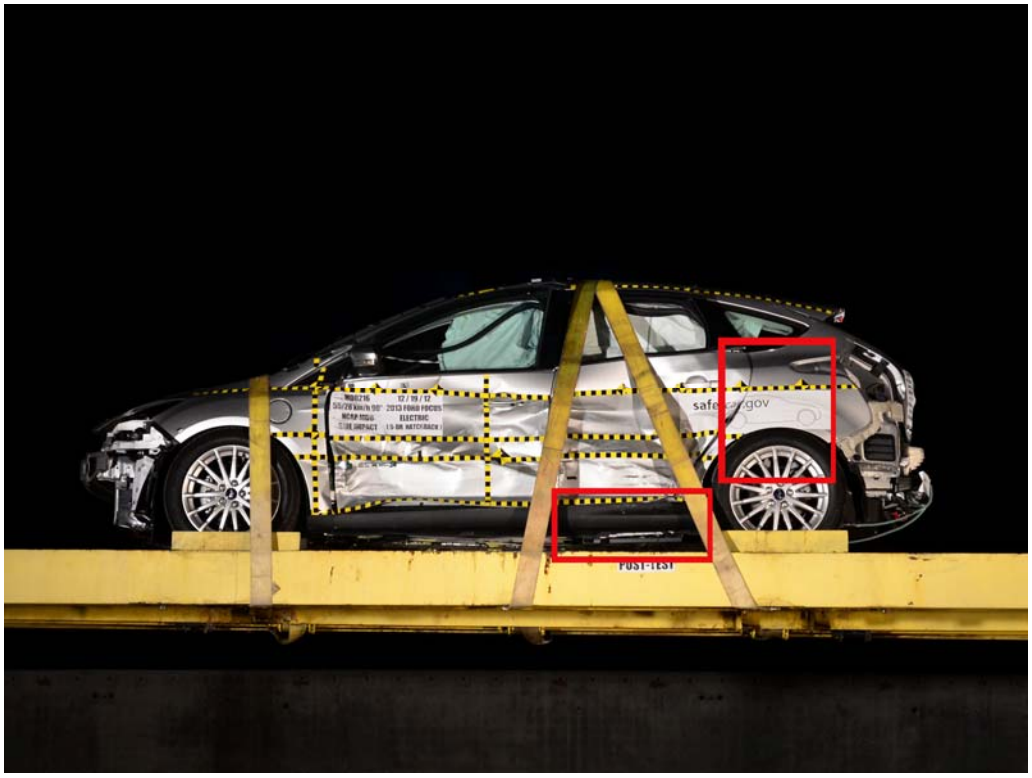

FIGURE 28. FMVSS No. 305 Static Rollover at 0°

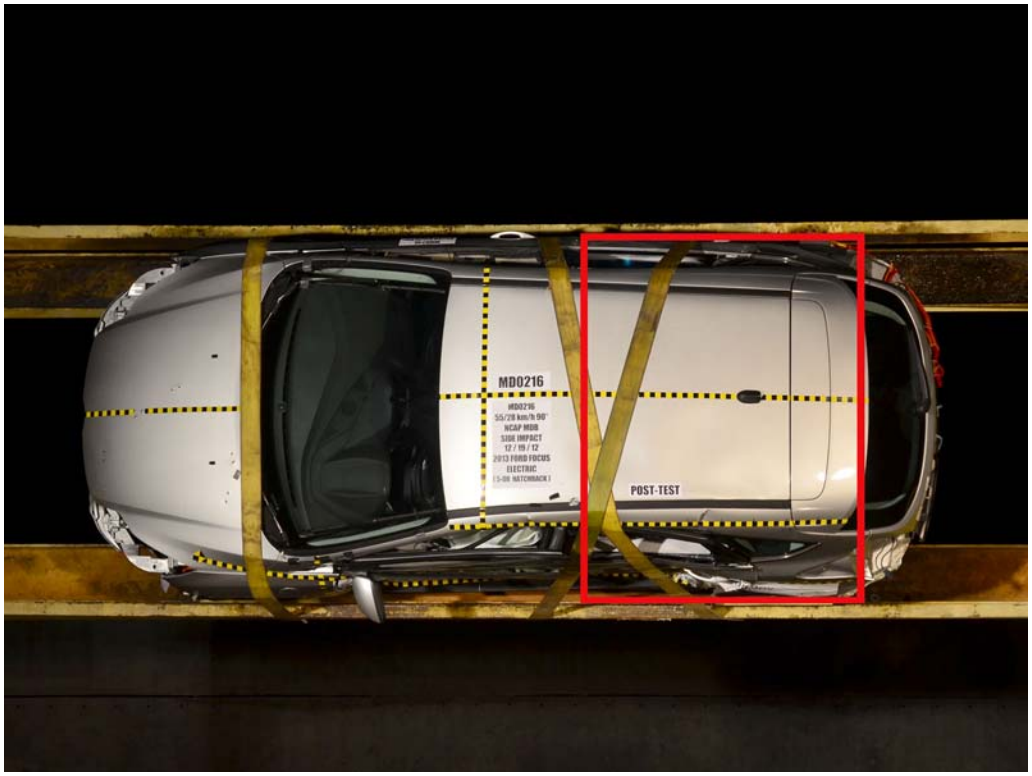

FIGURE 29. FMVSS No. 305 Static Rollover at 90°

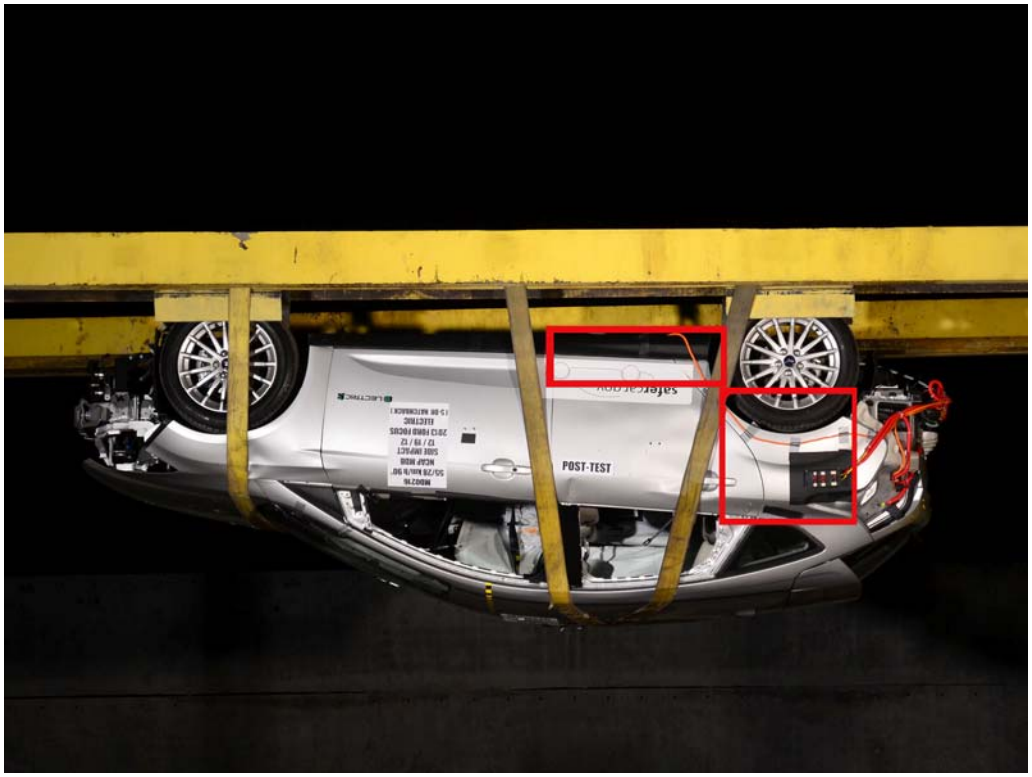

FIGURE 30. FMVSS No. 305 Static Rollover at 180°

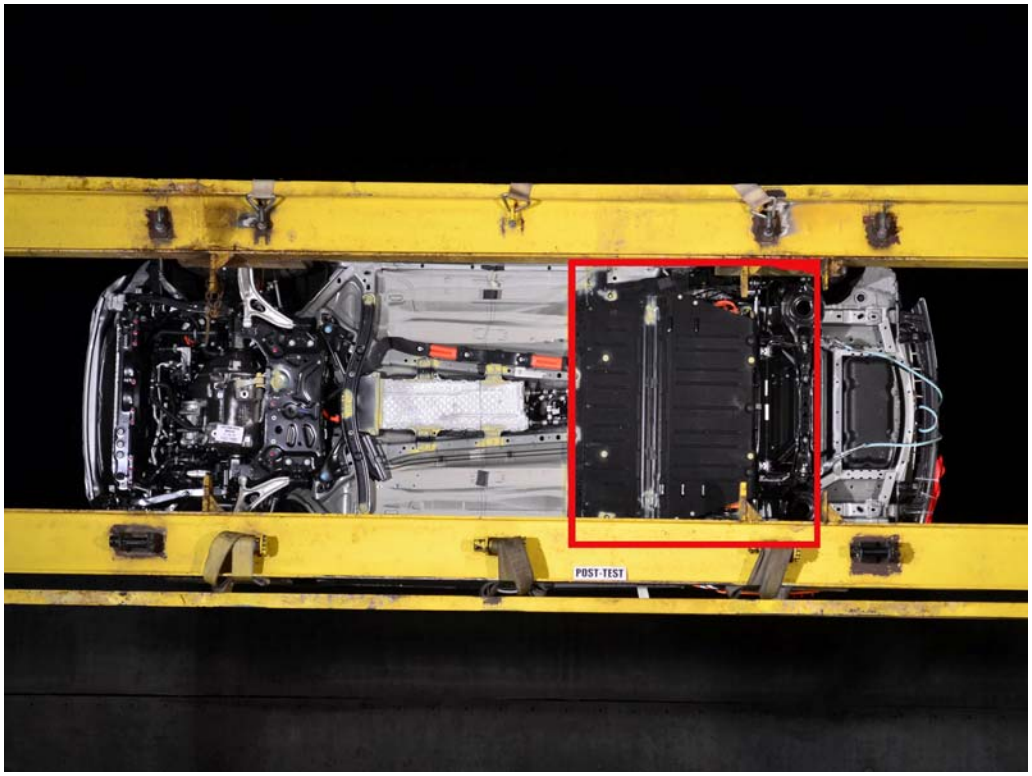

FIGURE 31. FMVSS No. 305 Static Rollover at 270°

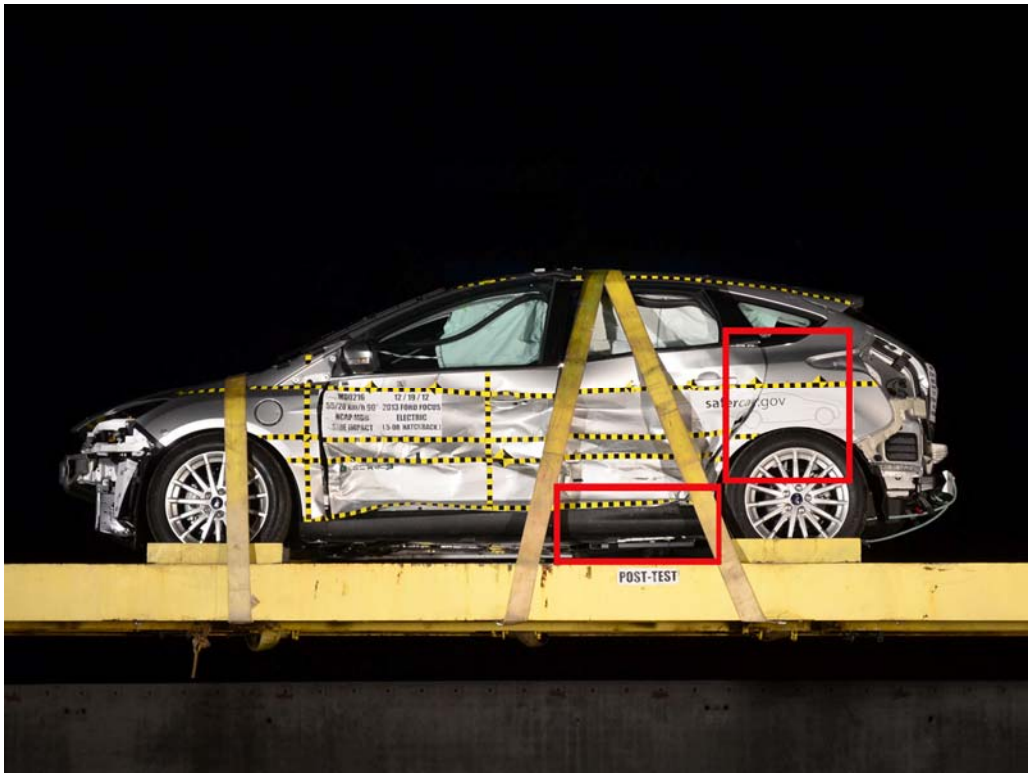

FIGURE 32. FMVSS No. 305 Static Rollover at 360°

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

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

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

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

FIGURE 35. Post-Impact Propulsion Battery System Mounting and/or Intrusion Failure

FIGURE 36. Post-Impact View of Battery Component Intrusion

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

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

Photograph Not Applicable

No Propulsion Battery
Electrolyte Spillage

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