REPORT NUMBER: NCAP305I-KAR-13-009

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

CODA AUTOMOTIVE

2012 CODA 4-DOOR SEDAN

NHTSA NUMBER: MC0533

PREPARED BY:

KARCO ENGINEERING, LLC.

9270 HOLLY ROAD

ADELANTO, CA 92301

AUGUST 16, 2012

FINAL REPORT

U.S. DEPARTMENT OF TRANSPORTATION

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

SAFETY PERFORMANCE STANDARDS

OFFICE OF CRASHWORTHINESS STANDARDS

1200 NEW JERSEY AVE, SE

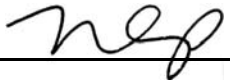
ROOM W43-410

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: 

Mr. Kelsey A. Chiu, Engineering Department Supervisor
KARCO Engineering, LLC.

Reviewed By: 

Mr. Michael L. Dunlap, Director of Operations
KARCO Engineering, LLC.

Approved By: 

Mr. Frank D. Richardson, Program Manager
KARCO Engineering, LLC.

Approval Date: August 16, 2012

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:

TECHNICAL REPORT DOCUMENTATON PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NCAP305I-KAR-13-009		

4. Title and Subtitle	5. Report Date
Final Report of New Car Assessment Program FMVSS 305 Indicant Testing of a 2012 CODA 4-Door Sedan NHTSA No. MC0533	August 16, 2012
	6. Performing Organization Code KAR
7. Authors Mr. Kelsey A. Chiu, Engineering Department Supervisor, KARCO Mr. Frank Richardson, Program Manager, KARCO	**8. Performing Organization Report No.** TR-P33001-01-NC
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 1200 New Jersey Ave., SE, Room W43-410 Washington, D.C. 20590	**13. Type of Report and Period Covered** Final Test Report, Aug. 2 - Aug. 16, 2012
	14. Sponsoring Agency Code NVS-111

15. Supplementary Notes

16. Abstract

An FMVSS No. 305 Indicant test, in conjunction with an NCAP frontal barrier impact test was conducted on the subject 2012 CODA 4-door electric sedan 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. The test was conducted at the KARCO Engineering, LLC. facility in Adelanto, California on August 2, 2012.

The maximum attainable voltage, as specified by the manufacturer, is 385 V. The actual maximum attainable voltage for this vehicle was 347 V. Based on this vehicle's maximum attainable voltage, the test was conducted with the vehicle's voltage below the standard's specification of 95% of the battery's capacity.

17. Key Words	18. Distribution Statement
New Car Assessment Program (NCAP) FMVSS 305 Indicant	Copies of this report are available from: National Highway Traffic Safety Admin. Technical Reference Division 1200 New Jersey Ave., SE Washington, DC 20590

19. Security Classification of this report	20. Security Classification of this page	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	43	

TABLE OF CONTENTS

SECTION 1
TEST PURPOSE AND PROCEDURE

PURPOSE

An FMVSS No. 305 Indicant test, in conjunction with an NCAP frontal barrier impact test was conducted on the subject 2012 CODA 4-door electric sedan.

The Indicant test was conducted in accordance with the Office of Crashworthiness Standards Laboratory Test Procedure, dated May 21, 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 number DTNH22-09-D-00122.

SECTION 2
SUMMARY OF TEST RESULTS

SUMMARY

A frontal barrier impact test was performed on a 2012 CODA 4-door electric sedan. The test was performed at KARCO Engineering, LLC. on August 2, 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 2012 CODA 4-door sedan 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: 2012 CODA 4-Door Sedan NHTSA No.: MC0533

Test Program: FMVSS No. 305 Indicant test Test Date: 08/02/12

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

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2012 CODA 4-Door Sedan NHTSA No.: MC0533

Test Program: FMVSS 305 – Frontal Impact Test Date: 08/02/12

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA Number	MC0533
Model Year	2012
Make	CODA
Model	CODA
Body Style	4-Door Sedan
VIN	53G1U4A47CB000048
Body Color	Perfect Storm
Odometer Reading (km / mi)	27 / 17
Type of Electrical Vehicle	Electric
Propulsion Battery Type	Lithium Ion
Nominal Voltage (V)	333
Automatic Propulsion Battery Disconnect	Yes
Location of Battery Disconnect	Internal to battery system
Auxiliary Battery Type	12 Volt Lead Acid
Electrolyte Fluid Type	EC/DEC/LiPF6
Electrolyte Fluid Specific Gravity	No Free Electrolyte
Electrolyte Fluid Kinematic Viscosity	No Free Electrolyte
Location of Battery Modules	Outside Passenger Compartment
Propulsion Battery Coolant Type	Air
Propulsion Battery Coolant Color	N/A
Propulsion Battery Coolant Specific Gravity	N/A

DATA FROM CERTIFICATION LABEL

Manufactured By	CODA Automotive
Date of Manufacture	Feb-12

GVWR (kg)	2045
GAWR Front (kg)	995
GAWR Rear (kg)	1050

DATA SHEET NO. 1 … (CONTINUED)

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2012 CODA 4-Door Sedan NHTSA No.: MC0533

Test Program: FMVSS 305 – Frontal Impact Test Date: 08/02/12

PROPULSION BATTERY STATE OF CHARGE

For all battery types:

Description	Volts
Minimum Operating Voltage	
Maximum Operating Voltage	385
95% of Maximum Operating Voltage	366
Test Voltage (no less than 95% of Maximum)	347*

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)	

*NOTE: The maximum attainable voltage, as specified by the manufacturer, is 385 V. The actual maximum attainable voltage for this vehicle was 347 V. Based on this vehicle's maximum attainable voltage, the test was conducted with the vehicle's voltage below the standard's specification of 95% of the battery's capacity.

DATA SHEET NO. 2

PRE-IMPACT DATA

Test Vehicle:	2012 CODA 4-Door Sedan	NHTSA No.:	MC0533
Test Program:	FMVSS 305 – Frontal Impact	Test Date:	08/02/12

PROPULSION BATTERY SYSTEM

The 2012 CODA 4-door sedan is a plug-in electric vehicle that uses two types of batteries: a high voltage traction battery and a low voltage accessory battery. The high voltage traction battery is a 333-volt lithium ion battery pack which powers the drive motor and other high voltage components. The battery pack is encased in an aluminum enclosure with a plastic cover and is mounted underneath the vehicle. The low voltage accessory battery is a standard 12-volt lead acid battery to power select vehicle electrical equipment. The 12-volt battery is mounted in the rear trunk area next to the right panel.

VEHICLE CHASSIS GROUND POINT(S) LOCATION(S):

The vehicle chassis ground point used for the high voltage 305 measurements was the same bolt used to ground the main 12 volt battery. The bolt is located in the passenger's side rear section of the trunk.

DATA SHEET NO. 3

POST-IMPACT ELECTRICAL ISOLATION MEASUREMENTS & CALCULATIONS

Test Vehicle: 2012 CODA 4-Door Sedan NHTSA No.: MC0533

Test Program: FMVSS 305 – Frontal Impact Test Date: 08/02/12

VOLT METER INFORMATION

Make	Fluke
Model	70 III
S/N	AA00042105
Internal Impedance Value (MΩ)	10
Resolution (V)	0.0001
Last Calibration Date	6/11/2012

MEASUREMENT DESCRIPTIONS

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

ELECTRICAL ISOLATION DATA

Code	Units	Threshold	Pre-Test	Post-Test
V_b	V		347.00	0.00
V_1	V		147.85	0.09
V_2	V		145.70	0.08
R_o	Ω		222,200	222,200
V_1'	V		6.80	0.00
V_2'	V		7.00	0.00
R_{i1}	Ω		9,151,009	36,690,463
R_{i2}	Ω		8,870,437	36,631,664
R_i	Ω		8,870,437	36,631,664
R_i/V_b	Ω/V	500	26,638	110,005

* - “Zero Volts” is considered as being compliant.

DATA SHEET NO. 3 … (CONTINUED)

POST-IMPACT ELECTRICAL ISOLATION MEASUREMENTS & CALCULATIONS

Has the Propulsion Battery Module moved within the passenger compartment? NA

Describe any movement: _____

Has an outside Propulsion Battery Component intruded into the passenger compartment? No

Describe any intrusion: There was no battery component intrusion

Is the Propulsion Battery Electrolyte Spillage visible in the passenger compartment? No

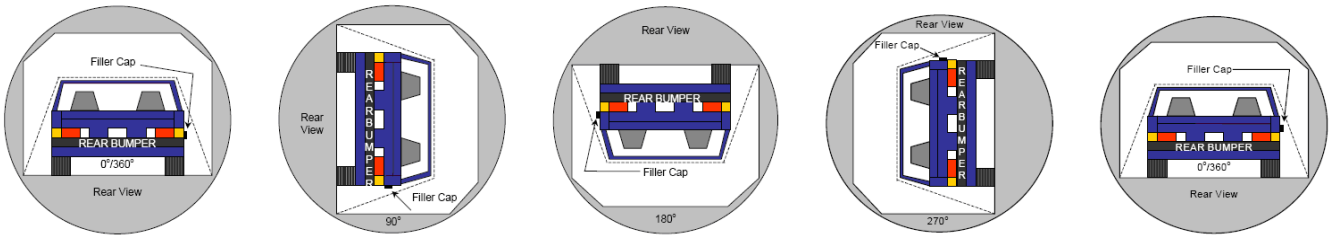
Describe any spillage: There was no electrolyte spillage

DATA SHEET NO. 4

STATIC ROLLOVER TEST DATA

Test Vehicle: 2012 CODA 4-Door Sedan NHTSA No.: MC0533

Test Program: FMVSS 305 – Frontal Impact Test Date: 08/02/12



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

1. The specified fixture rollover rate for each 90° of rotation is 60 to 180 seconds.
2. The position hold time at each position is 300 seconds (minimum).
3. Details of Electrolyte Spillage: There was no electrolyte spillage.

SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° To 90°	82	300	382
90° To 180°	91	300	391
180° To 270°	78	300	378
270° To 360°	77	300	377

TEST VEHICLE PROPULSION BATTERY ELECTROLYTE SPILLAGE

Maximum Allowable Spillage	5.0L throughout impact test and static rollover

Test Phase	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 (L)	0	

DATA SHEET NO. 4… (CONTINUED)

STATIC ROLLOVER TEST DATA

Test Vehicle: 2012 CODA 4-Door Sedan NHTSA No.: MC0533

Test Program: FMVSS 305 – Frontal Impact Test Date: 08/02/12

ELECTRICAL ISOLATION DATA

Code	Units	Threshold	0°	90°	180°	270°
V_b	V		0.00	0.00	0.00	0.00
V_1	V		0.00	0.00	0.00	0.00
V_2	V		0.00	0.00	0.00	0.00
R_o	Ω		222,200	222,200	222,200	222,200
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*

* - “Zero Volts” is considered as being compliant.

APPENDIX A

PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

TABLE OF PHOTOGRAPHS … (CONTINUED)

Photograph Not Applicable

No Auxiliary Power Module Label

FIGURE 1. Auxiliary Power Module Warning Label

FIGURE 2. Power Inverter Warning Label

FIGURE 2a. Power Inverter Warning Label

FIGURE 2b. Power Inverter Warning Label

FIGURE 3. First Responder Warning Label

FIGURE 3a. First Responder Warning Label

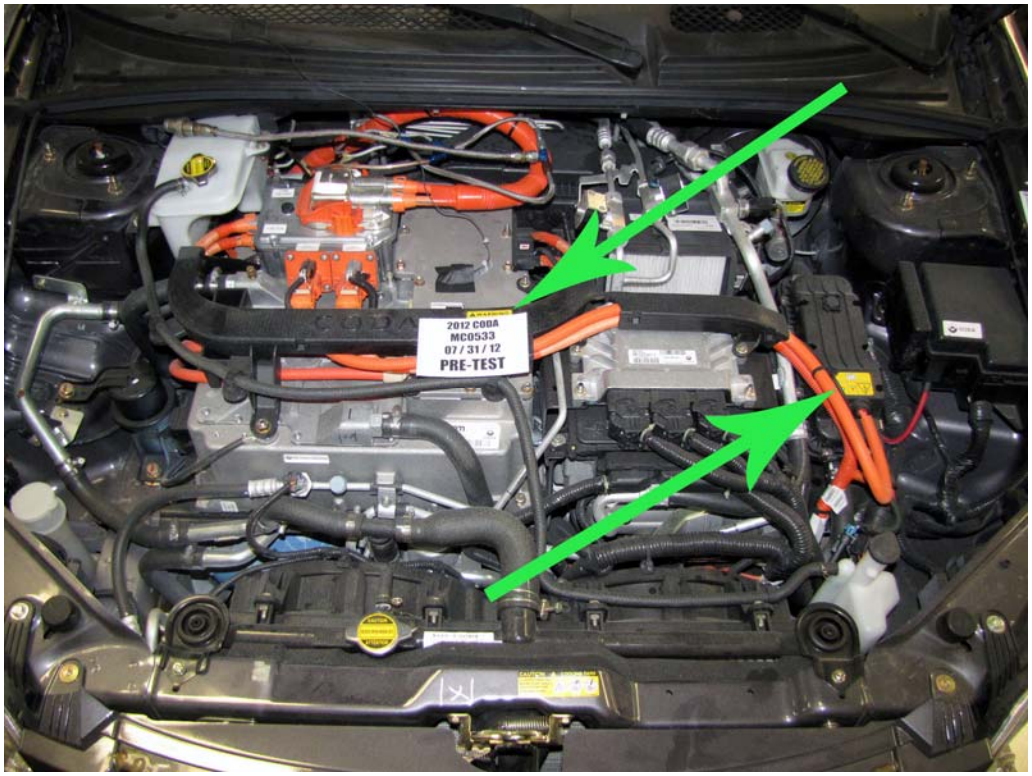


FIGURE 4. First Responder Warning Location

FIGURE 5. Other Vehicle Label Related to Electrical Propulsion System

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

FIGURE 6. Manual High Voltage Disconnect in Place

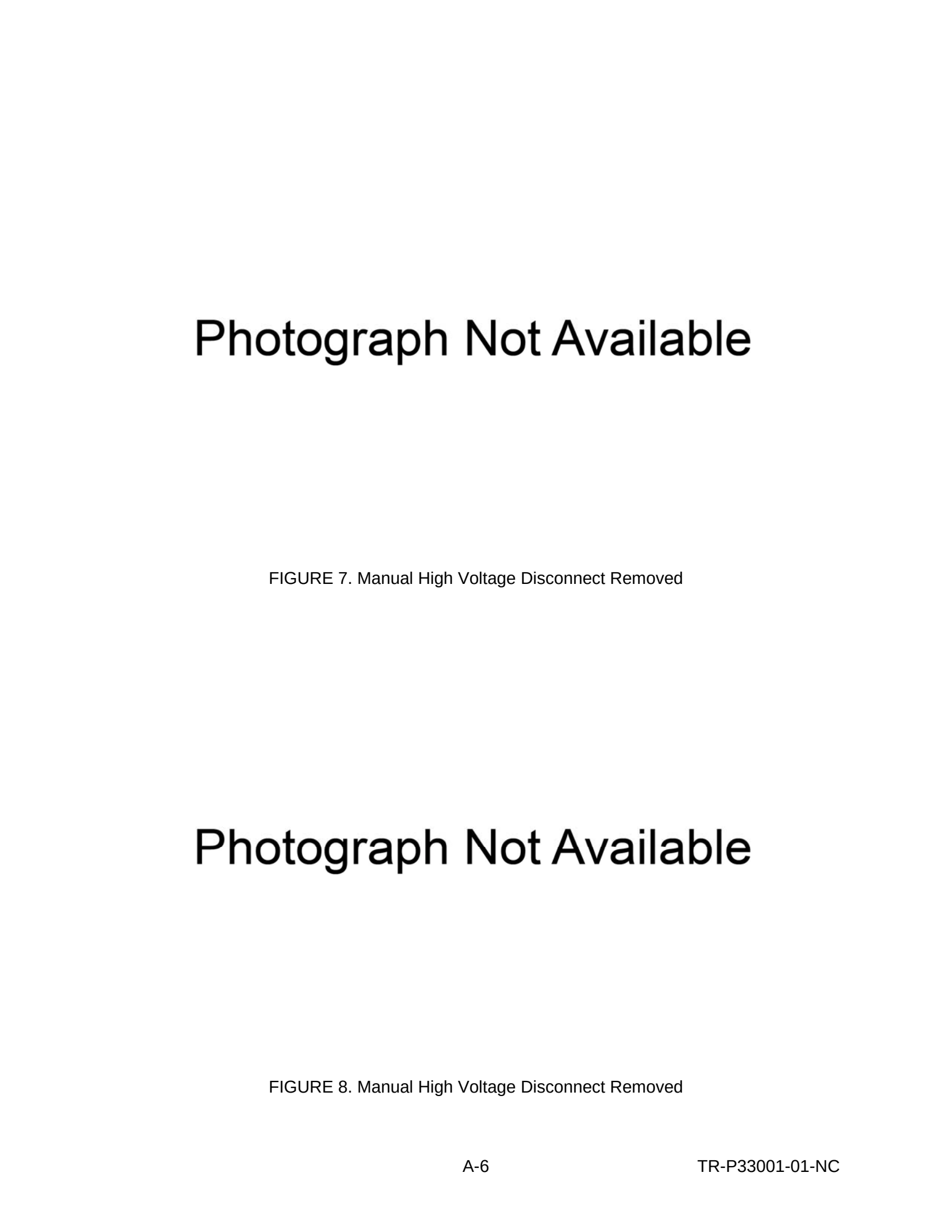


FIGURE 7. Manual High Voltage Disconnect Removed

FIGURE 8. Manual High Voltage Disconnect Removed

FIGURE 9. Pre-Impact View of Propulsion Battery

FIGURE 10. Post-Impact Front View of Propulsion Battery

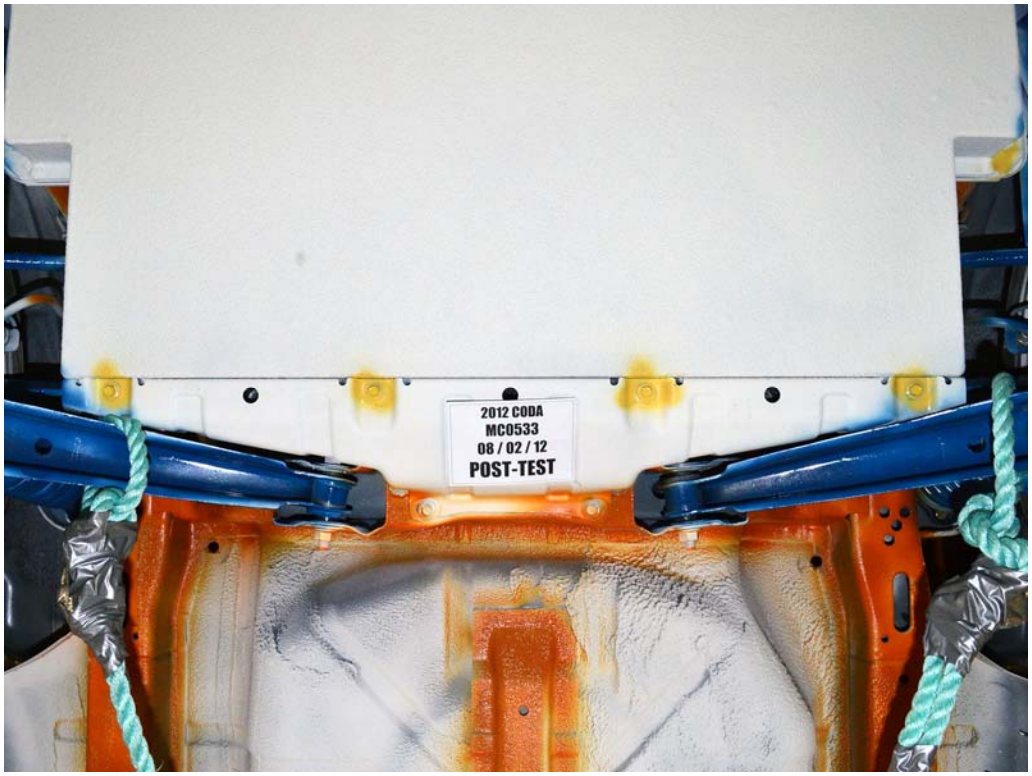


FIGURE 11. Post-Impact Rear View of Propulsion Battery

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

FIGURE 13. Post-Impact Front View of Propulsion Battery

FIGURE 14. Pre-Impact View of Propulsion Battery Module

FIGURE 15. Post-Impact View of Propulsion Battery Module

FIGURE 16. Pre-Impact View of Electric Propulsion Drive

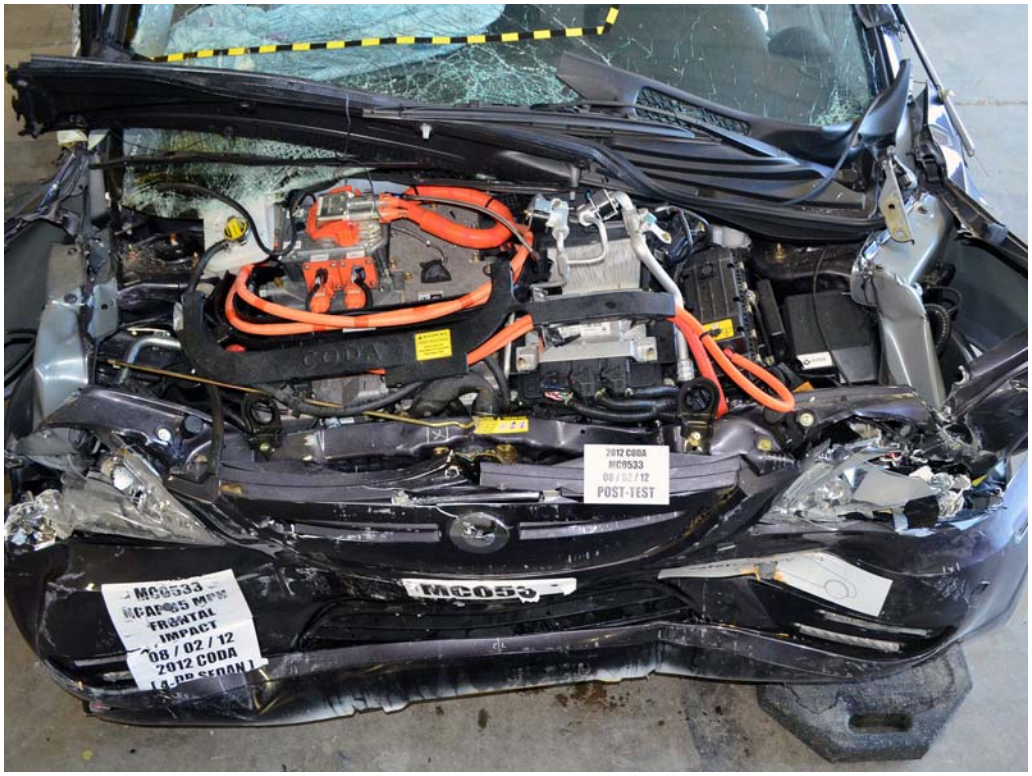


FIGURE 17. Post-Impact View of Electric Propulsion Drive

FIGURE 18. Pre-Impact View of High Voltage Interconnect

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

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

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

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

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

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

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

FIGURE 18h. Pre-Impact View of High Voltage Interconnect

FIGURE 18i. Pre-Impact View of High Voltage Interconnect

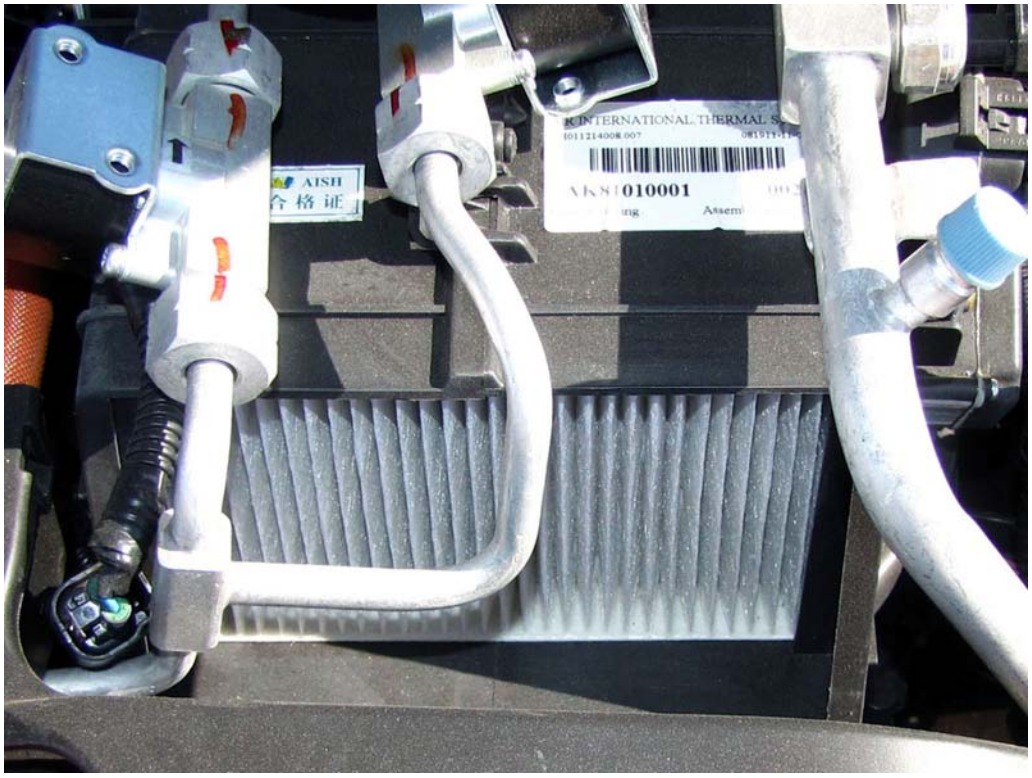


FIGURE 19. Pre-Impact View of Propulsion Battery Venting System

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

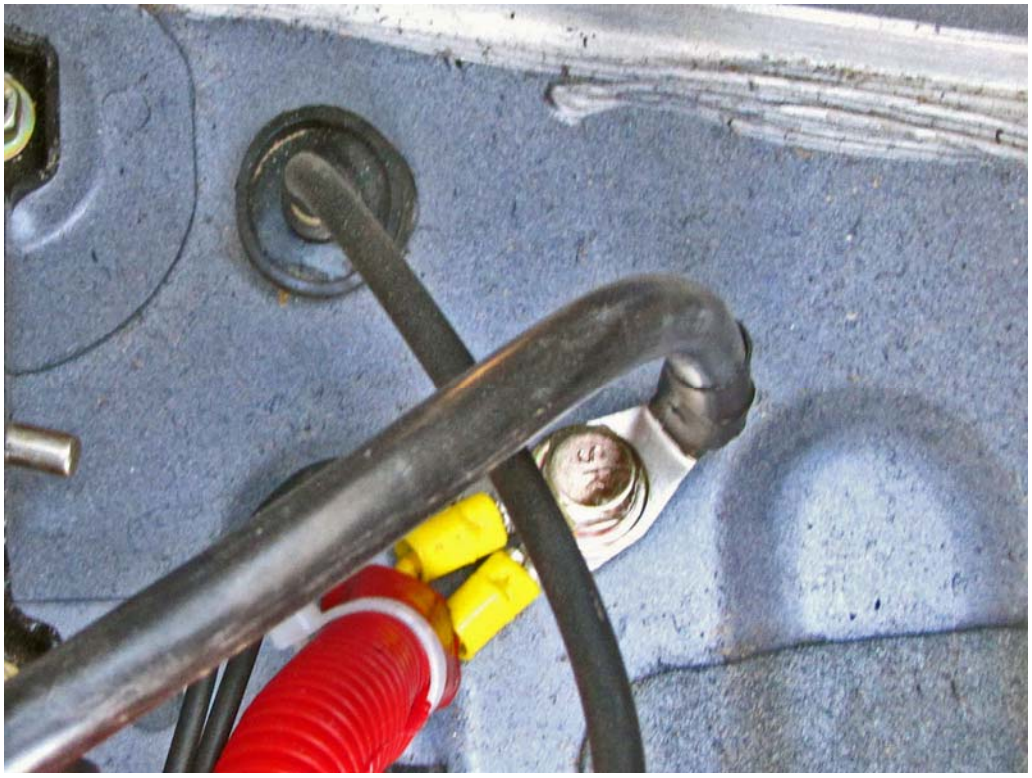


FIGURE 21. Pre-Impact View of Ground Lead Attached

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

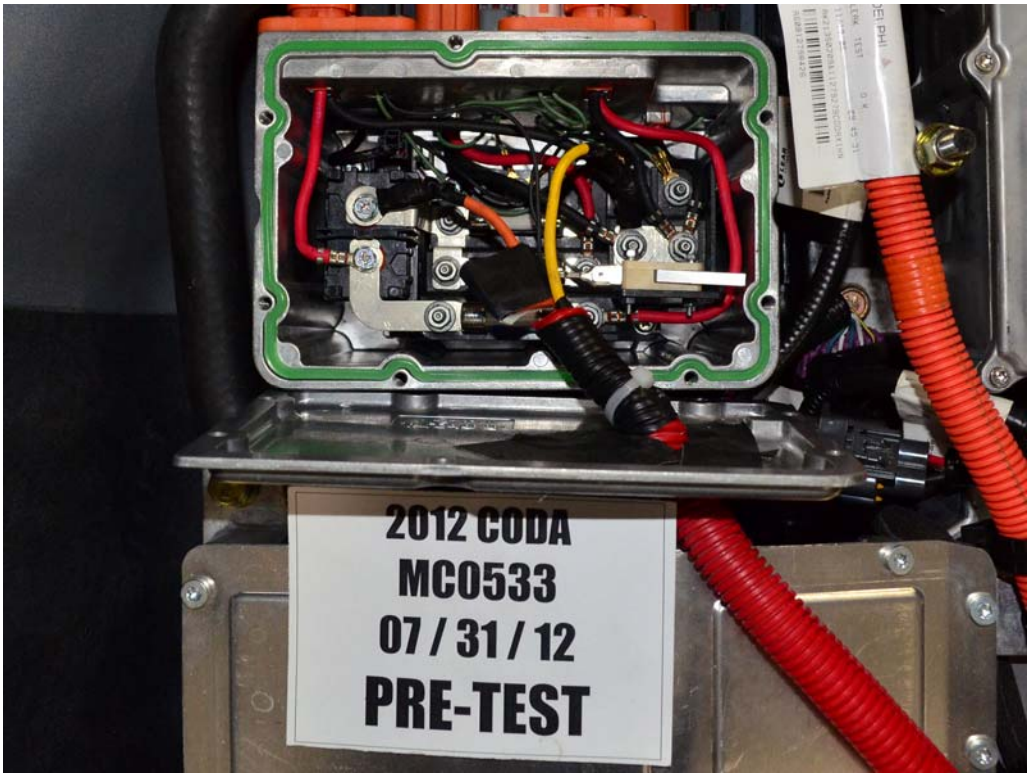


FIGURE 23. Pre-Impact Close-Up View of High Voltage Leads Attached

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

Photograph Not Available

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

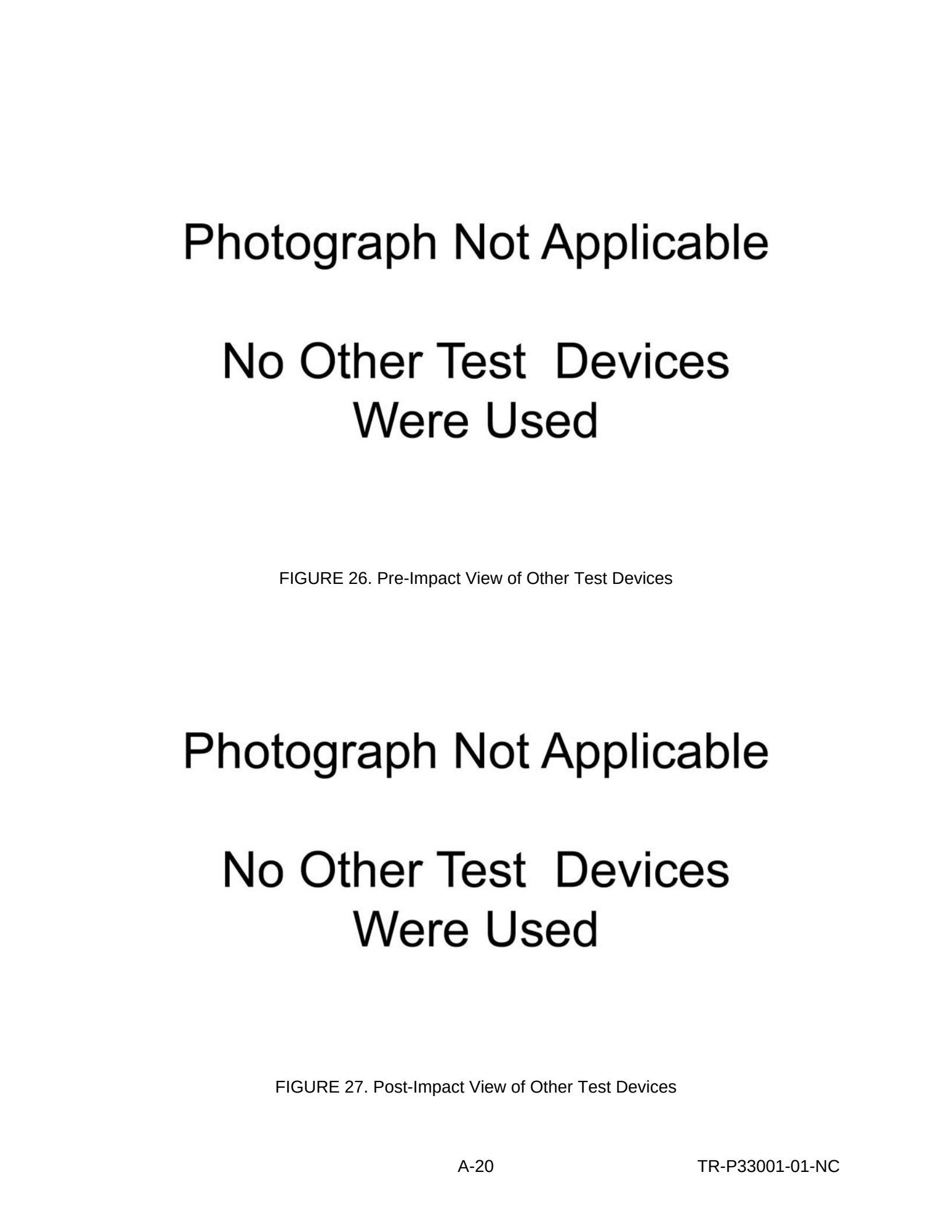


FIGURE 26. Pre-Impact View of Other Test Devices

FIGURE 27. Post-Impact View of Other Test Devices

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

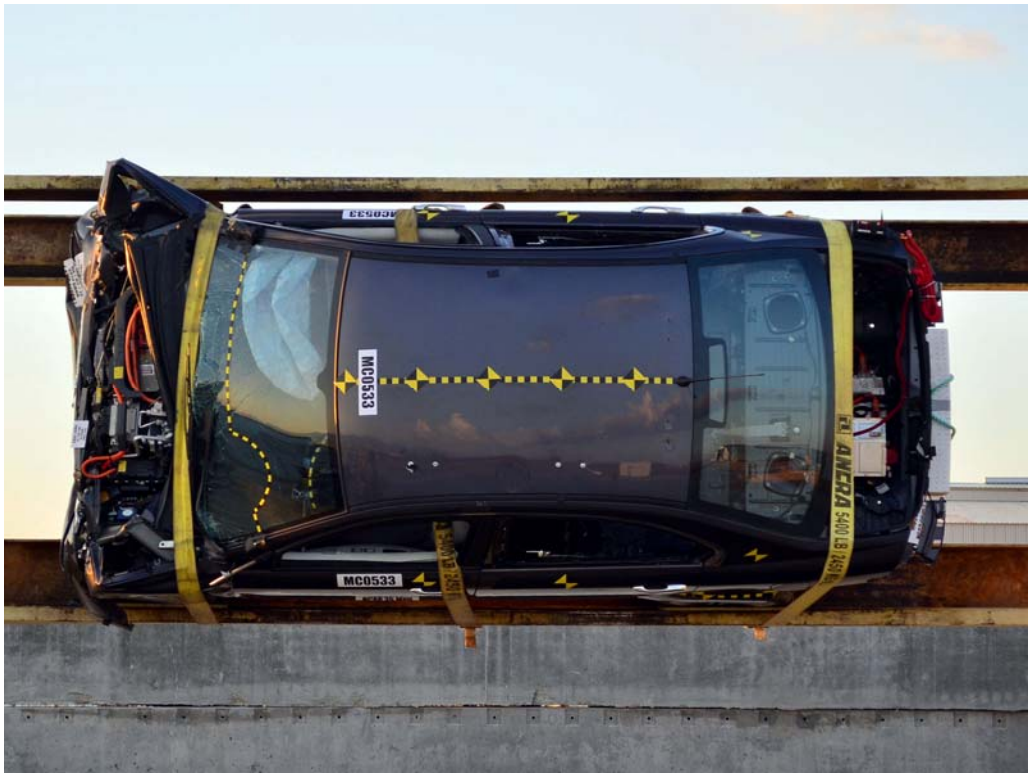


FIGURE 29. FMVSS No. 305 Static Rollover at 90 Degrees

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

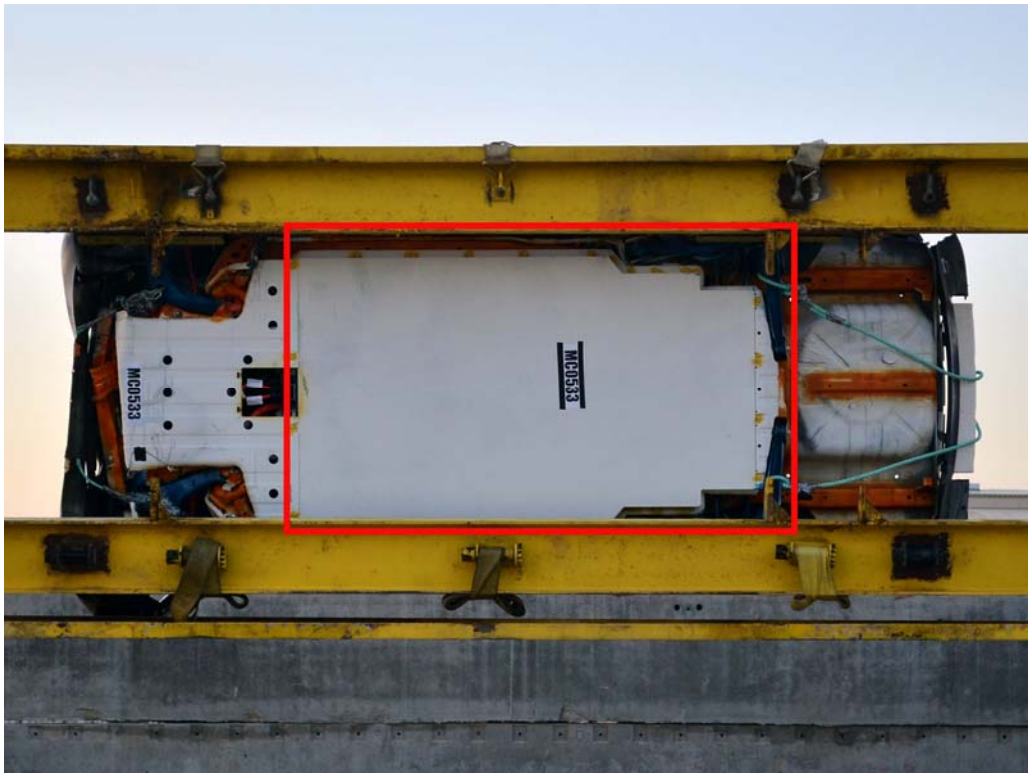


FIGURE 31. FMVSS No. 305 Static Rollover at 270 Degrees

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

Photograph Not Applicable

Battery Is Located
Underneath the Vehicle

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

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

Photograph Not Applicable

No Battery Component Intrusion

FIGURE 36. Post-Impact View of Battery Component Intrusion

Photograph Not Applicable

No Battery Movement or Retention Loss

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

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

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