REPORT NUMBER: 301-CAL-08-02

SAFETY COMPLIANCE TESTING FOR FMVSS 301
FUEL SYSTEM INTEGRITY – REAR IMPACT

TOYOTA MOTOR CORPORATION
2008 TOYOTA HIGHLANDER HYBRID
4-DOOR SUV

NHTSA NUMBER: C85106

CALSPAN
TRANSPORTATION SCIENCES CENTER
P.O. BOX 400
BUFFALO, NEW YORK 14225

July 23, 2008

FINAL REPORT

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance (NVS-224)
1200 New Jersey Avenue, SE
Washington, DC 20590

This Final Test Report was prepared for the U.S. Department of Transportation, National Highway Traffic Safety Administration, under Contract No. DTNH22-06-C-00031. 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 manufactures' 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: Vincent M. Paolini

Vincent M. Paolini, Project Engineer

Approved By: David Travale

David J. Travale, Program Manager
Transportation Sciences Center

Approval Date: Vincent M. Paolini Digitally signed by Vincent M. Paolini
DN: CN = Vincent M. Paolini, C = US, O = Calspan
Date: 2008.08.26 13:01:46 -04'00'

FINAL REPORT ACCEPTANCE BY:

Accepted By: Edward E. Chan Digitally signed by Edward E. Chan
DN: CN = Edward E. Chan, C = US, O = National Highway Traffic Safety Administration, OU = Office of Vehicle Safety Compliance
Date: 2008.08.28 10:16:23 -04'00'

Acceptance Date: _____

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. 301-CAL-08-02	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Final Report of FMVSS 301 Compliance Rear Impact Testing of a 2008 Toyota Highlander Hybrid 4-Door SUV NHTSA No.: C85106		5. Report Date July 23, 2008 6. Performing Organization Code CAL	
7. Author(s) Vincent M. Paolini, Project Engineer David J. Travale, Program Manager		8. Performing Organization Report No. 8860-F301-02	
9. Performing Organization Name and Address Calspan Transportation Sciences Center P.O. Box 400 Buffalo, New York 14225		10. Work Unit No. 11. Contract or Grant No. DTNH22-06-C-00031	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Vehicle Safety Compliance 1200 New Jersey Avenue, SE Washington, D.C. 20590		13. Type of Report and Period Covered Final Report, July 2008 14. Sponsoring Agency Code NVS-220	
15. Supplementary Notes			
16. Abstract Compliance tests were conducted on the subject 2008 Toyota Highlander Hybrid 4-Door SUV in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-301R-02 for the determination of FMVSS 301 compliance. Test failures identified were as follows: None The test vehicle appeared to comply with all requirements of FMVSS 301R-02 "Fuel System Integrity – Rear Impact."			
17. Key Words Compliance Testing Safety Engineering FMVSS 301		18. Distribution Statement Copies of this report are available from: National Highway Traffic Safety Administration Technical Reference Division (TIS) (NPO-230) 1200 New Jersey Avenue, SE Washington, D.C. 20590 Telephone No. (202) 366-4946	
19. Security Classification of Report UNCLASSIFIED	20. Security Classification of Page UNCLASSIFIED	21. No. of Pages 38	22. Price

TABLE OF CONTENTS

SECTION 1

PURPOSE AND TEST PROCEDURE

This rear impact test is part of the FMVSS 301 Compliance Test Program sponsored by the National Highway Traffic Safety Administration (NHTSA) under Contract No. DTNH22-06-C-00031. The purpose of this test was to determine if the subject vehicle, a 2008 Toyota Highlander Hybrid 4-Door SUV, meets the performance requirements of FMVSS No. 301R-02 "Fuel System Integrity – Rear Impact." The test was conducted in accordance with the Office of Vehicle Safety Compliance's Laboratory Test Procedure (TP-301R-02, dated January 17, 2007).

SECTION 2

COMPLIANCE TEST RESULTS SUMMARY

A 2347.0 kg 2008 Toyota Highlander Hybrid 4-Door SUV was impacted from the rear by an 1362.5 kg moving barrier at a velocity of 79.39 kph (79.39 mph). The test was performed by Calspan Corporation on July 23, 2008.

The test vehicle was equipped with a 65.1 liter fuel tank which was filled to 92 percent capacity with stoddard fluid prior to impact. Additional ballast (84 kg) was secured in the vehicle cargo area. Two ballast Part 572E 50th percentile male Anthropomorphic Test Device (ATD) were placed in the front occupant seating positions and.

The crash event was recorded by three high-speed cameras and one real-time camera. High-speed camera locations and other pertinent camera information are found on page 3-6 of this report. Pre- and post-test photographs of the vehicle can be found in Appendix A.

There was no fuel system fluid spillage following the impact or during any portion of the static rollover test. The average vehicle longitudinal crush was 253 millimeters. The vehicle appeared to comply with all the requirements of FMVSS No. 301 "Fuel System Integrity."

SECTION 3

SUMMARY OF TEST RESULTS

DATA SHEET 1

TEST VEHICLE SPECIFICATIONS

TEST VEHICLE INFORMATION:

Year/Make/Model/Body Style: 2008 Toyota Highlander Hybrid 4-Door SUV

Vehicle Body Color: Green NHTSA Number: C85106

Engine Data (Gasoline): 6 Cylinders; - CID; 3.5 Liters; _____ cc

Transmission: 5 Speed; - Manual; X Automatic; X Overdrive

Final Drive: - Rear Wheel Drive; - Front Wheel Drive; X Four Wheel Drive

MAJOR TEST VEHICLE OPTIONS:

X AC; X Pwr Steering; X Power Brakes; X Power Locks; X Power Seats

X ABS; X Tilt Wheel; X Stab Control ___ Traction Control X Anti-Theft

DEALER AND DELIVERY INFORMATION:

Date Received: 12/11/07 ; Odometer Reading 129 km

Selling Dealer: West-Herr Toyota/Scion

Dealer Address: 4141 Southwestern Blvd., Orchard Park, NY 14127

DATA FROM VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufacturer: Toyota Motor Corporation

Vehicle Build Date: 09/07

VIN:: JTEEW41A182001348

GVWR: 2785 kg; GAWR: 1340 kg FRONT; 1550 kg REAR

DATA FROM VEHICLE'S TIRE LABEL AND SIDEWALL:

Location of Tire Placard: Driver Side Door

Type of Spare Tire: Passenger Tire (P245/55R19)

	Front	Rear
Maximum Tire Pressure (sidewall - kPa)	300	300
Cold Pressure (tire placard - kPa) – test pressure	230	230
Recommended Tire Size (tire placard)	P245/55R19	P245/55R19
Vehicle Tire Size with load index & speed symbol	P245/55R19 103S	P245/55R19 103S
Tire Manufacturer	Toyo	Toyo
Tire Name	Open Country	Open Country
Treadwear, Traction, Temperature	300 AA	300 AA

VEHICLE CAPACITY DATA:

Type of Front Seats: - Bench; X Bucket; - Split Bench

Number of Occupants: 2 Front; 5 Rear; 7 Total

Vehicle Capacity Weight (VCW) = 544.0 Kg

No. of Occupants x 68.04 kg = 476.3 Kg

Rated Cargo/Luggage Weight (RCLW) = 67.7 Kg

DATA SHEET 2

PRE-TEST DATA

WEIGHT OF TEST VEHICLE AS RECEIVED FROM DEALER (with maximum fluids)= UDW:

	Left Side (kg)	Right Side (kg)	Ratio (%)	Total (kg)
Front =	594	572	54.6	1166.0
Rear =	493	478	45.4	971.0
			Total Delivered Weight (UDW) =	2137.0

CALCULATION OF VEHICLE'S TARGET TEST WEIGHT:

Total Delivered Weight (UDW) =	2137.0	kg
Rated Cargo/Luggage Weight (RCLW) =	67.7	kg
Weight of 2 p.572E Dummies @ 74 each =	148.0	kg
TARGET TEST WEIGHT =	2352.7	kg

WEIGHT OF TEST VEHICLE WITH TWO DUMMIES AND 54.0 KG OF CARGO WEIGHT:

	Left Side (kg)	Right Side (kg)	Ratio (%)	Total (kg)
Front =	642	624	53.9	1266.0
Rear =	548	533	46.1	1081.0
			Total Vehicle Test Weight (ATW) =	2347.0

Weight of Ballast Secured in Vehicle[1] = 59 kg Ballast Type 25 lb. Lead Shot Bags

Method of securing Ballast: Compartment

Components Removed for Weight Reduction: None

VEHICLE ATTITUDE (all dimension in millimeters):

	Left Front	Right Front	Left Rear	Right Rear	CG[2]
AS DELIVERED:	852	857	860	867	1265
AS TESTED:	841	847	852	855	1282

Vehicle's Wheel Base: 2785 mm

[1]Ballast weight does not include the weight of instrumentation, on-board cameras and data acquisition system

[2]Rearward of the front axle centerline.

VEHICLE PRE-TEST WIDTH AND IMPACT OFFSET MEASUREMENT:

Vehicle Width at Widest Point: 1937 mm Location: Rear Wheel well

Centerline offset for impact line: 387 mm

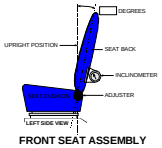
Filler neck side (left/right) Left

DATA SHEET 2 (continued)

PRE-TEST DATA

Vehicle: 2008 Toyota Highlander Hybrid 4-Door SUV NHTSA No. C85106

Nominal Design Riding Position for adjustable driver and passenger seat backs. Please describe how to position the inclinometer to measure the seat back angle. Include description of the location of the adjustment latch detent, if applicable.



FRONT SEAT ASSEMBLY

Seat back angle for driver's seat: 86.3

Measurement instructions: Recline seat back to the 6th detent from full upright position (Full upright Position = 0)

Seat back angle for passenger's seat: 87.0

Measurement instructions: Recline seat back to the 7th detent from full upright position (Full upright Position = 0)

2. SEAT FORE AND AFT POSITIONING:

Positioning of the driver's seat: Seat placed in mid-position from the most forward and most rearward Positions (Total travel of seat = 280 mm; Seat placed in 140 mm from most forward position)

Positioning of the passenger's seat: Seat placed in the closest rearward detent from mid position (Total number of detents = 16; Seat placed in the 9th detent)

3. FUEL TANK CAPACITY DATA:

3.1 A. "Usable Capacity" of the standard equipment fuel tank is 65.1 liters

B. "Usable Capacity" of the optional equipment fuel tank is -- liters

C. "Usable Capacity" of the vehicle(s) used for certification testing to requirements of FMVSS 301 = 59.9 to 61.2 liters

3.2 Actual Amount of Stoddard solvent added to vehicle for test = 60.5 liters

Stoddard Fluid: specific gravity: 0.764 ; kinematic viscosity: 0.96 centistokes; color: Red

3.3 Is vehicle equipped with electric fuel pump? Yes- X ; No- ____

If YES, explain the vehicle operating conditions under which the fuel pump will pump fuel.

Fuel pump will operate when vehicle in 'ON' position.

4. STEERING COLUMN ADJUSTMENTS:

Steering wheel and column adjustments are made so that the steering wheel hub is at the geometric center of the locus it describes when it is moved through its full range of driving positions. If the tested vehicle has any of these adjustments, does your company use any specific procedures to determine the geometric center.

Operational Instructions: Steering column tilt was set to 26.5 degrees (mid-position) Telescope was set at 20 mm rearward of foremost position

5. SEAT BELT UPPER ANCHORAGE:

Nominal design riding position: Placed in one detent downward from uppermost position.

6. COMMENTS:

None

DATA SHEET 3

MOVING DEFORMABLE BARRIER (MDB) DATA

Vehicle: 2008 Toyota Highlander Hybrid 4-Door SUV NHTSA No. C85106

MDB FACE MANUFACTURER AND SERIAL NUMBER:

Plascore 099B0508 019A0608

MDB DETAILS:

Overall Width of Framework Carriage	=	1250	Millimeters
Overall Length of MDB (incl. honeycomb impact face)	=	4120	Millimeters
Wheelbase of Framework Carriage	=	2591	Millimeters
Tread of Framework Carriage (Front & Rear)	=	1875	Millimeters
C.G. Location Rearward of Front Axle	=	1139	Millimeters

MDB WEIGHT:

Left Front	=	357.0	kg	Left Rear	=	323.0	kg
Right Front	=	404.0	kg	Right Rear	=	273.5	kg
TOTAL FRONT =		761.0	kg	TOTAL REAR	=	596.5	kg
TOTAL MDB WEIGHT =		1357.5	Kg				

Tires (Mfr, line, size): Dunlop A/T Radial Rover P205/75R15

TIRE PRESSURE:

Left Front	=	207	kPa	Left Rear	=	207	kPa
Right Front	=	207	kPa	Right Rear	=	207	kPa

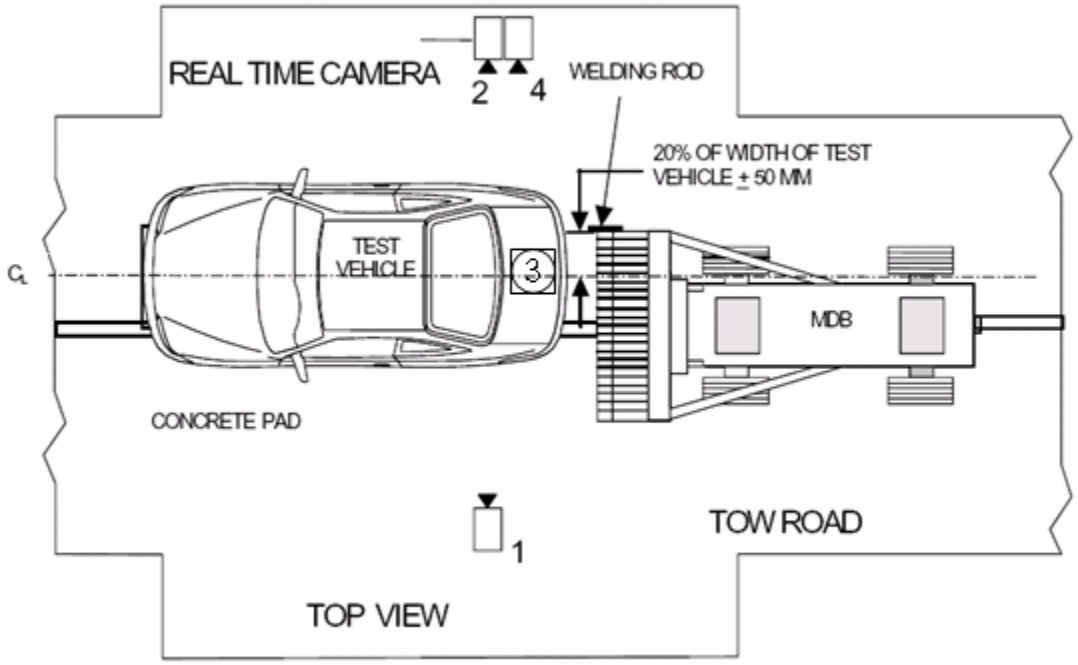
Brake Abort System? (Yes/No) Yes

Date of Last Calibration: 6/15/07

DATA SHEET 4

HIGH SPEED CAMERA LOCATIONS AND DATA SUMMARY

Vehicle: 2008 Toyota Highlander Hybrid 4-Door SUV NHTSA No. C85106



Camera No.	View	Coordinates (millimeters)			Angle (deg.)	Lens (mm)	Film Speed (fps)
		X*	Y*	Z*			
1	Left Side View	99	-9780	1200	-1.2	28	1000
2	Real-Time Camera	-	-	-	-	-	30
3	Overhead View	0	-100	4880	90	14	1000
4	Right Side View	103	9434	1135	-2.3	24	1000

* Reference (from point of impact); all measurements accurate to within ±6 mm.

X = (Impact Point) + Forward
Y = (Impact Point) + To Right
Z = (Ground Level) + Down

DATA SHEET 5

POST-TEST DATA

Vehicle: 2008 Toyota Highlander Hybrid 4-Door SUV NHTSA No. C85106

REQUIRED IMPACT VELOCITY RANGE:: 78.5 to 80.1 km/h

ACTUAL IMPACT VELOCITY WITHIN 1.5 M OF IMPACT PLANE:

Trap No. 1 = 79.39 km/h Trap No. 2 = 79.29 km/h

Average Impact Speed = 79.34 km/h

WELDING ROD IMPACT POINT:

10 mm Vertical distance from target center (+ is above) Tolerance: ±40 mm

-20 mm Horizontal distance from target center (+ is right) Tolerance: ±50 mm

STODDARD SOLVENT SPILLAGE MEASUREMENT:

A. Front impact until vehicle motion ceases -

Actual = 0 g Maximum Allowable = 28 g

B. For 5 minute period after vehicle motion ceases -

Actual = 0 g Maximum Allowable = 28 g

C. For next 25 minutes -

Actual = 0 g/minute Maximum Allowable = 28 g/minute

D. Provide Spillage Details: None

DATA SHEET 5

POST-TEST DATA (Continued)

Vehicle: 2008 Toyota Highlander Hybrid 4-Door SUV NHTSA No. C85106

POST TEST SEAT DATA

LOCATION	SEAT MOVEMENT (mm)	SEAT BACK FAILURE
P1 (Left Front)	None	Seat back reclined during impact
P2 (Right Front)	None	Seat back reclined during impact

POST TEST ATD CONTACT DATA

LOCATION	Position 1 (Driver)	Position 2 (Passenger)
Head	Back of Head into Head restraint	Back of Head into Head restraint
Chest	No Contact	No Contact
Abdomen	No Contact	No Contact
Left Knee	No Contact	No Contact
Right Knee	No Contact	No Contact

VEHICLE DIMENSIONS:

Vehicle length:

	Left Side	Centerline	Right Side
Pre-Test	4715	4782	4715
Post-Test	4405	4467	4582
Crush	310	315	133

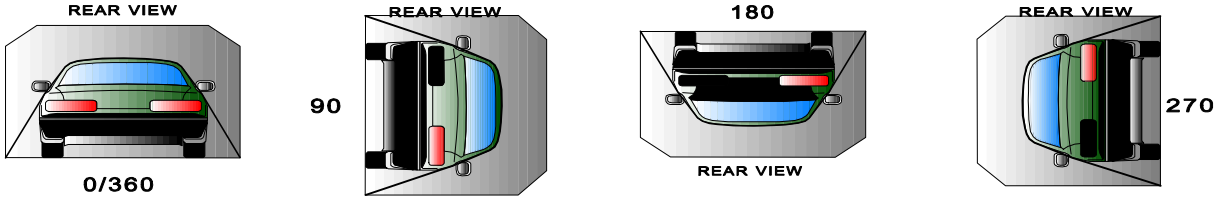
Vehicle Wheel Base:

	Left Side	Right Side
Pre-Test	2783	2786
Post-Test	2787	2775
Crush	-5	11

DATA SHEET 6

FMVSS 301 ROLLOVER DATA

Vehicle: 2008 Toyota Highlander Hybrid 4-Door SUV NHTSA No.: C85106



I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

Rollover Stage	Rotation Time (spec. 1 -3 min)				FMVSS 301 Hold Time		Total Time				Next Whole Minute Interval	
0º - 90º	1	minutes	01	seconds	5	minutes	6	minutes	1	seconds	7	minutes
90º - 180º	1	minutes	07	seconds	5	minutes	6	minutes	7	seconds	7	minutes
180º-270º	1	minutes	01	seconds	5	minutes	6	minutes	1	seconds	7	minutes
270º-360º	0	minutes	59	seconds	5	minutes	5	minutes	59	seconds	6	minutes

II. FMVSS 301 REQUIREMENTS: (Maximum allowable solvent spillage):

First 5 minutes from onset of rotation	6th min.	7th min.	8th min. (if required)
142 g	28 g	28 g	28 g

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

Rollover Stage	First 5 minutes from onset of rotation (g)	6th min. (g)	7th min. (g)	8th min. (if required) (g)
0º - 90º	0	0	0	N/A
90º - 180º	0	0	0	N/A
180º-270º	0	0	0	N/A
270º-360º	0	0	0	N/A

Note: Record spillage for whole minute intervals only as determined above.

IV. SOLVENT SPILLAGE LOCATION(S):

Rollover Stage	Spillage Location
0º - 90º	None
90º - 180º	None
180º-270º	None
270º-360º	None

APPENDIX A

PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Figure A-1: Vehicle Certification Placard

Figure A-2: Vehicle Tire Placard

Figure A-3: Pre-Test Front View

Figure A-4: Post-Test Front View

Figure A-5: Pre-Test Left Side View

Figure A-6: Post-Test Left Side View

Figure A-7: Pre-Test Right Side View

Figure A-8: Post-Test Right Side View

Figure A-9: Pre-Test Left Front Three-Quarter View

Figure A-10: Post-Test Left Front Three-Quarter View

Figure A-11: Pre-Test Right Front Three-Quarter View

Figure A-12: Post-Test Right Front Three-Quarter View

Figure A-13: Pre-Test Left Rear Three-Quarter View

Figure A-14: Post-Test Left Rear Three-Quarter View

Figure A-15: Pre-Test Right Rear Three-Quarter View

Figure A-16: Pre-Test Right Rear Three-Quarter View

Figure A-17: Pre-Test Rear View

Figure A-18: Post-Test Rear View

Figure A-19: Pre-Test MDB Front View

Figure A-20: Post-Test MDB Front View

Figure A-21: Pre-Test MDB Left Side View

Figure A-22: Post-Test MDB Left Side View

Figure A-23: Pre-Test MDB Right Side View

Figure A-24: Post-Test MDB Right Side View

Figure A-25: Pre-Test MDB Top View

Figure A-26: Post-Test MDB Top View

Figure A-27: Pre-Test Overhead Vehicle and MDB View

Figure A-28: Post-Test Impact Target View

Figure A-29: Pre-Test Front Underbody View

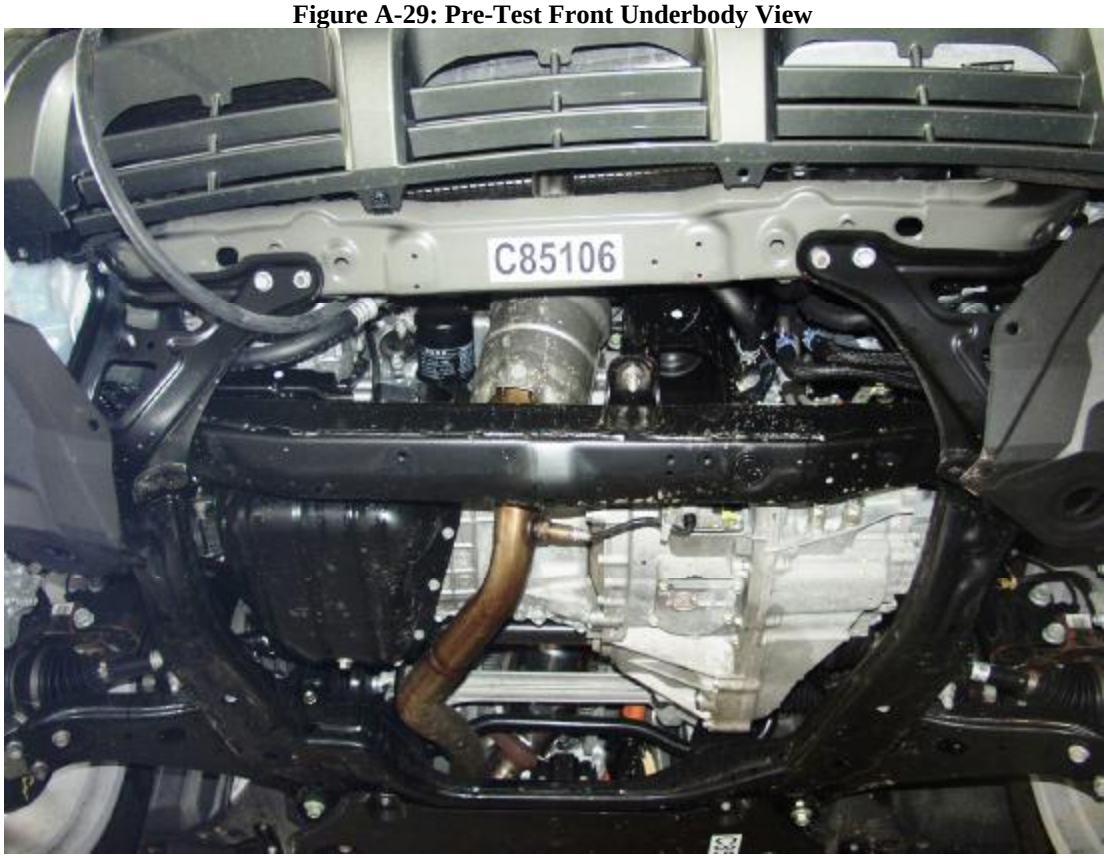


Figure A-30: Post-Test Front Underbody View

Figure A-31: Pre-Test Mid Underbody View

Figure A-32: Post-Test Mid Underbody View

Figure A-33:Pre-Test Rear Underbody View

Figure A-34: Post-Test Rear Underbody View

Figure A-35: Pre-Test Fuel Filler Cap View

Figure A-36: Post-Test Fuel Filler Cap View

Figure A-37: Impact View

Figure A-38: Rollover 90° View

Figure A-39: Rollover 180° View

Figure A-40: Rollover 270° View

Figure A-41: Rollover 360° View