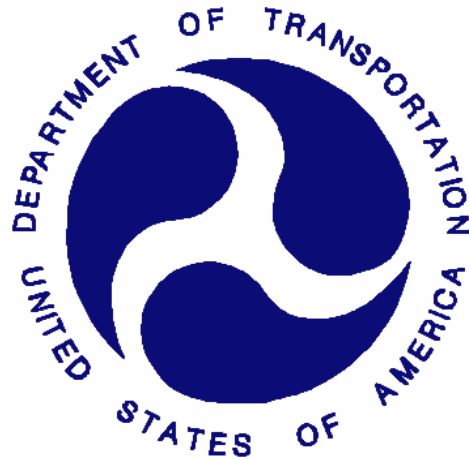


**REPORT NUMBER: 301-MGA-2010-004**

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

**FUJI HEAVY INDUSTRIES LTD.  
2010 SUBARU OUTBACK  
NHTSA NUMBER: CA5502**

**PREPARED BY:  
MGA RESEARCH CORPORATION  
5000 WARREN ROAD  
BURLINGTON, WI 53105**



**Test Date: July 9, 2010**


**Final Report Date: July 23, 2010**

**FINAL REPORT**

**PREPARED FOR:  
U.S. DEPARTMENT OF TRANSPORTATION  
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION  
ENFORCEMENT  
OFFICE OF VEHICLE SAFETY COMPLIANCE  
1200 NEW JERSEY AVENUE, S.E., NVS-220  
WASHINGTON, D.C. 20590**

This final test report was prepared for the U.S. Department of Transportation, National Highway Traffic Safety Administration, in response to Contract Number DTNH22-06-C-00030.

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Prepared by:  Date: 7/21/2010  
Joe Fleck, Project Engineer

Reviewed by:  Date: 7/21/2010  
David Winkelbauer, Facility Director

FINAL REPORT ACCEPTED BY:

Edward E. Chan

Digitally signed by Edward E. Chan  
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Safety Administration, ou=Office of Vehicle Safety  
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Date: 2010.07.23 15:10:56 -04'00'

COTR, Rear Impact

7/23/2010  
Date of Acceptance

**Technical Report Documentation Page**

1. Report No. 301-MGA-2010-004		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Final Report for Fuel System Integrity Test of a 2010 Subaru Outback NHTSA No.: CA5502				5. Report Date July 21, 2010	
				6. Performing Organization Code MGA	
7. Author(s) Joe Fleck, Project Engineer				8. Performing Organization Report No. 301-MGA-2010-004	
9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105				10. Work Unit No.	
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				14. Sponsoring Agency Code NVS-220	
15. Supplementary Notes					
16. Abstract A rear impact was conducted on a 2010 Subaru Outback at MGA Research Corporation on July 9, 2010. This test was conducted to obtain data indicant of FMVSS 301R. The impact velocity was 79.5 km/h. The ambient temperature at the time of impact was 28 degrees Celsius.					
17. Key Words  Fuel System Integrity Test 2010 Subaru Outback NHTSA No: CA5502				18. Distribution Statement Copies of this report are available from: National Highway Traffic Safety Admin., Technical Ref. Division, 1200 New Jersey Avenue, SE Washington, D.C. 20590	
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## SECTION 1

### PURPOSE AND SUMMARY OF TEST

#### PURPOSE

This rear impact test is sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number DTNH22-06-C-00030. The purpose of this test is to reduce deaths and injuries occurring from fires that result from fuel spillage during and after motor vehicle crashes and resulting from ingestion of fuels during siphoning.

#### SUMMARY

A 2010 Subaru Outback was impacted by a Moving Deformable Barrier (MDB) at a velocity of 79.5 km/h. The test was performed at MGA Research Corporation on July 9, 2010. Pre-and post-test photographs of the vehicle and dummies can be found in Appendix A.

One real-time camera and four high-speed cameras were used to document the impact event.

- Left Rear Half            1000 fps
- Right Rear Half         1000 fps
- Overhead Overall        1000 fps
- Right Overall            1000 fps
- Real Time Pan            30 fps

Two ballast Part 572E, 50<sup>th</sup> percentile male anthropomorphic test devices (ATDs) were placed in the driver and right-front passenger seating positions according to dummy placement instructions specified in the Laboratory Indicant Test Procedure.

There was no Stoddard Solvent leakage after the event or during any phase of the static rollover.

The vehicle appeared to comply with all the requirements of FMVSS No. 301 "Fuel System Integrity."

**SECTION 2  
DATA SHEETS**

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

Test Vehicle: 2010 Subaru Outback NHTSA No.: CA5502  
 Test Program: FMVSS 301 Fuel System Integrity Test Date: 7/9/2010

**TEST VEHICLE INFORMATION**

Manufacturer	Fuji Heavy Industries LTD.
Model	Subaru Outback
Body Style	Passenger Car
Major Options	None
NHTSA No.	CA5502
VIN	4S4BRCACXA1324198
Color	Cypress Green Pearl
Delivery Date	6/17/2010
Odometer Reading (mile)	239
Dealer	North Park Subaru
Transmission	Manual
Final Drive	Four Wheel Drive
Number of Cylinders	4
Engine Displacement (L)	2.5
Engine Placement	Lateral

**DATA FROM VEHICLE'S CERTIFICATION LABEL**

Manufactured By	Fuji Heavy Industries LTD.
Date of Manufacture	08/09

GVWR (kg)	2080
GAWR Front (kg)	1070
GAWR Rear (kg)	1060

**VEHICLE CAPACITY DATA**

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench		
Number of Occupants	2	3		5
Capacity Wt. (VCW) (kg)				408
Number of Occupants x 68 kg.				340
Cargo Wt. (RCLW) (kg)				68

**DATA SHEET NO. 1 (continued)**  
**TEST VEHICLE SPECIFICATIONS**

Test Vehicle: 2010 Subaru Outback                      NHTSA No.: CA5502  
 Test Program: FMVSS 301 Fuel System Integrity      Test Date: 7/9/2010

**DATA FROM VEHICLE'S TIRE PLACARD**

Measured Parameter	Front	Rear
Maximum Tire Pressure (kPa)	300	300
Cold Pressure (kPa)	220	210
Recommended Tire Size	P215/70R16	P215/70R16
Recommended Load Range	99S	99S
Tire Size on Vehicle	P215/70R16	P215/70R16
Tire Manufacturer	Continental	Continental
Location of Placard of Vehicle	Lower B-Post	
Type of Spare Tire (full size/space saver)	Space Saver	

**DATA SHEET NO. 2**

**PRE-TEST DATA**

Test Vehicle: 2010 Subaru Outback                      NHTSA No.: CA5502  
 Test Program: FMVSS 301 Fuel System Integrity      Test Date: 7/9/2010

**WEIGHT OF TEST VEHICLE**

	Units	As Delivered (UVW) (Axle)			As Tested (ATW) (Axle)		
		Front	Rear	Total	Front	Rear	Total
Left	kg	434.1	352.0		483.5	409.1	
Right	kg	417.3	337.9		464.5	393.3	
Ratio	%	55.2	44.8		54.2	45.8	
Totals	kg	851.4	689.9	1541.3	948.0	802.4	1750.4

**CALCULATION OF TARGET TEST WEIGHT (TTW)**

Measured Parameter	Units	Value
Total Delivered Weight (UVW)	kg	1541.3
Rated Cargo/Luggage Weight (RCLW)	kg	68
Weight of 2 P572E ATDs	kg	148
Calculated Vehicle Target Weight (TVTW)	kg	1757.3

Vehicle Wheelbase	2745 mm
Vehicle Width	1822 mm
Weight of Ballast Secured in Rear Seat	61.2 kg
Method of Securing Ballast	Ratchet Straps
Vehicle Components Removed for Weight Reduction	None

**VEHICLE ATTITUDES**

	Units	LF	RF	LR	RR
As Delivered	mm	790	797	804	818
As Tested	mm	773	784	788	792



**DATA SHEET NO. 2 (continued)**

**PRE-TEST DATA**

Test Vehicle: 2010 Subaru Outback NHTSA No.: CA5502  
Test Program: FMVSS 301 Fuel System Integrity Test Date: 7/9/2010

**FUEL SYSTEM DATA**

	Units: Liters
Usable Capacity of "Standard Tank" (Owner's Manual)	70.0
Usable Capacity Figure Furnished by COTR	70.0
Usable Capacity of "Optional" Tank	
92-94% of Usable Capacity	64.4 to 65.8
Actual Test Volume (entire fuel system filled)	65.1

Test Fluid Type	Stoddard Solvent
Test Fluid Kinematic Viscosity (centistokes)	2.1 cSt @ 20° C
Test Fluid Color	Purple
Type of Vehicle Fuel Pump	Electrical
Activate Electric Fuel Pump Operation with Ignition Switch ON, but Engine OFF	Yes

Comments (noticeable attributes of fuel system components, capacity, etc.)	None
--	------

**DATA SHEET NO. 3**  
**MOVING BARRIER DATA**

Test Vehicle: 2010 Subaru Outback                      NHTSA No.: CA5502  
 Test Program: FMVSS 301 Fuel System Integrity      Test Date: 7/9/2010

**MOVING BARRIER'S TEST WEIGHT**

	Units	Front	Rear	Total
Left	kg	374.2	308.8	
Right	kg	389.5	291.2	
Ratio	%	56.0	44.0	
Totals	kg	763.7	600.0	1363.7

Tires (Mfr, line, size)	Yokohama
Tire Pressure (kPa)	207
Brake Abort System (Yes/No)?	Yes
Date of Last Calibration	8/6/2008

**DATA SHEET NO. 4**

**POST-TEST DATA**

Test Vehicle: 2010 Subaru Outback

NHTSA No.: CA5502

Test Program: FMVSS 301 Fuel System Integrity

Test Date: 7/9/2010

**IMPACT VELOCITY**

	Units: km/h
Required Impact Velocity	80.0
Actual Impact Velocity (Trap No. 1)	79.5
Actual Impact Velocity (Trap No. 2)	79.5
Average Impact Speed	79.5

Temperature at Time of Impact (°C)	28
Test Time	12:15 pm

**WELDING ROD IMPACT POINT**

	Units: mm
Vertical distance from target center (+ above target / - below target)	3 down
Horizontal distance from target center (+ to the right / - to the left)	6 left

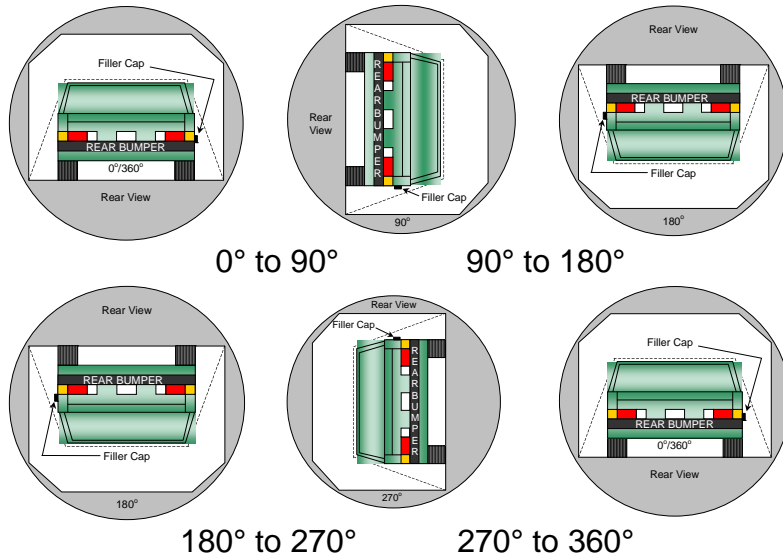
**DATA SHEET NO. 5**  
**STATIC ROLLOVER TEST DATA**

Test Vehicle: 2010 Subaru Outback                      NHTSA No.: CA5502  
 Test Program: FMVSS 301 Fuel System Integrity      Test Date: 7/9/2010

**STODDARD SOLVENT SPILLAGE MEASUREMENT**

- A. From impact until vehicle motion ceases:   0   g  
 (Maximum Allowable = 28 grams)
- B. For the 5 minute period after motion ceases:   0   g  
 (Maximum Allowable = 28 grams)
- C. For the following 25 minutes:   0   g  
 (Maximum Allowable = 28 grams/minute)
- D. Spillage:   None

**FMVSS 301 STATIC ROLLOVER DATA**



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 Stoddard Solvent spillage locations: **Not Applicable**

**DATA SHEET NO. 5 (continued)**  
**STATIC ROLLOVER TEST DATA**

Test Vehicle: 2010 Subaru Outback                      NHTSA No.: CA5502  
 Test Program: FMVSS 301 Fuel System Integrity      Test Date: 7/9/2010

**STODDARD SOLVENT SPILLAGE MEASUREMENT**  
**Hold Time = 5 minutes at all intervals**

**0° TO 90° Rotation Time (sec) =** 120 sec

Test Phase	Spillage (g)	Spillage Details
First 5 minutes from onset of rotation	0	
Sixth minute from onset of rotation	0	
Seventh minute from onset of rotation	0	
Eight minute if required	N/A	

**90° TO 180° Rotation Time (sec) =** 112 sec

Test Phase	Spillage (g)	Spillage Details
First 5 minutes from onset of rotation	0	
Sixth minute from onset of rotation	0	
Seventh minute from onset of rotation	0	
Eight minute if required	N/A	

**180° TO 270° Rotation Time (sec) =** 108 sec

Test Phase	Spillage (g)	Spillage Details
First 5 minutes from onset of rotation	0	
Sixth minute from onset of rotation	0	
Seventh minute from onset of rotation	0	
Eight minute if required	N/A	

**270° TO 360° Rotation Time (sec) =** 112 sec

Test Phase	Spillage (g)	Spillage Details
First 5 minutes from onset of rotation	0	
Sixth minute from onset of rotation	0	
Seventh minute from onset of rotation	0	
Eight minute if required	N/A	

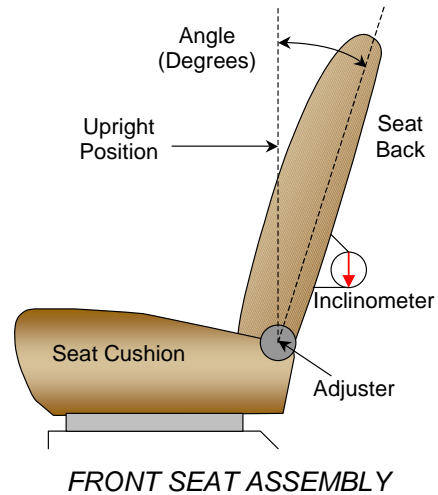
**FORM 1**  
**TEST VEHICLE INFORMATION**

Test Vehicle: 2010 Subaru Outback  
Test Program: FMVSS 301 Fuel System Integrity

NHTSA No.: CA5502  
Test Date: 7/9/2010

**NORMAL DESIGN RIDING POSITION**

With the seat in the mid fore-aft seat track position the angle of the driver's seat back when it is in the nominal riding position is set at 6 degrees on the headrest post.



Driver Seat Back Angle	6.4° at headrest post
Passenger Seat Back Angle	6.8° at headrest post

**SEAT FORE/AFT POSITIONING**

	Total Fore/Aft Travel	Placed in Position #
Driver Seat	296 mm	148 mm
Passenger Seat	250 mm	125 mm

**D-RING ADJUSTMENT**

The driver and passenger D-rings were placed in the 1<sup>st</sup> position of 5, top as 0.

**STEERING COLUMN ADJUSTMENT**

The steering column was placed in the mid position.

**APPENDIX A**  
**PHOTOGRAPHS**

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A-1.

MFD BY FUJI HEAVY INDUSTRIES LTD. DATE: 08/09


GVWR: 4585 LB ( 2080 KG)

GAWR:F 2360 LB ( 1070 KG) WITH P215/70R16 TIRES.  
16X6 1/2JJ RIMS. AT 220 KPA ( 32 PSI) COLD

GAWR:R 2340 LB ( 1060 KG) WITH P215/70R16 TIRES.  
16X6 1/2JJ RIMS. AT 210 KPA ( 30 PSI) COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR  
VEHICLE SAFETY AND THEFT PREVENTION STANDARDS  
IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

VIN: 4S4BRCACXA1324198 MPV



ASSEMBLED BY SIA INC. MADE IN U.S.A.

Vehicle's Certification Label



**TIRE AND LOADING INFORMATION**  
**RENSEIGNEMENTS SUR LES PNEUS ET LE CHARGEMENT**

SEATING CAPACITY | TOTAL 5 | FRONT 2 | REAR 3  
 NOMBRE DE PLACES | TOTAL 5 | AVANT 2 | ARRIÈRE 3

The combined weight of occupants and cargo should never exceed 408kg or 900 lbs.  
 Le poids total des occupants et du chargement ne doit jamais dépasser 408kg ou 900lb.

TIRE PNEU	SIZE DIMENSIONS	COLD TIRE PRESSURE PRESSION DES PNEUS À FROID
FRONT AVANT	P215/70R16	220 KPA, 32 PSI
REAR ARRIÈRE	P215/70R16	210 KPA, 30 PSI
SPARE DE SECOURS	T145/80R17	420 KPA, 60 PSI

**SEE OWNER'S  
 MANUAL FOR  
 ADDITIONAL  
 INFORMATION**  
**VOIR LE MANUEL  
 DE L'USAGER  
 POUR PLUS DE  
 RENSEIGNEMENTS**

4D

A-2.

Vehicle's Tire Placard

A-3.



Pre-Test Front View of Vehicle



A-4.

Post-Test Front View of Vehicle

A-5.



Pre-Test Left Side View of Vehicle

A-6.



Post-Test Left Side View of Vehicle

A-7.



Pre-Test Left Rear Close-up View of Vehicle



A-8.



Post-Test Left Rear Close-up View of Vehicle

A-9.



Pre-Test Right Side View of Vehicle

A-10.



Post-Test Right Side View of Vehicle



Pre-Test Right Rear Close-up View of Vehicle

A-12.



Post-Test Right Rear Close-up View of Vehicle



A-13.

Pre-Test Rear View of Vehicle



A-14.

Post-Test Rear View of Vehicle

A-15.



Pre-Test ¾ Frontal View From Right Side of Vehicle





A-16.

Post-Test  $\frac{3}{4}$  Frontal View From Right Side of Vehicle

A-17.



Pre-Test ¾ Rear View From Right Side of Vehicle

A-18.



Post-Test  $\frac{3}{4}$  Rear View From Right Side of Vehicle

A-19.

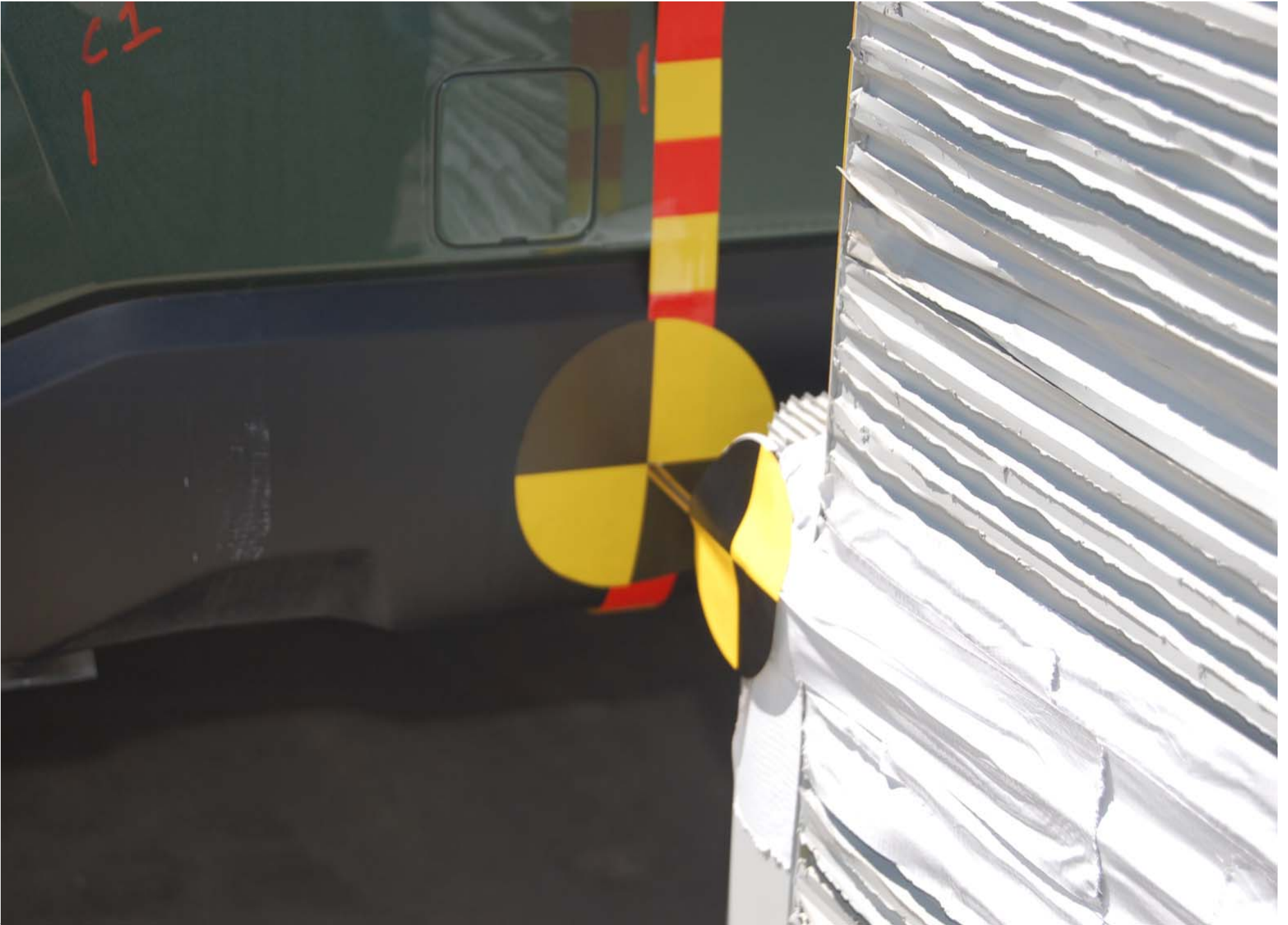


Pre-Test  $\frac{3}{4}$  Rear View From Left Side of Vehicle

A-20.



Post-Test  $\frac{3}{4}$  Rear View From Left Side of Vehicle



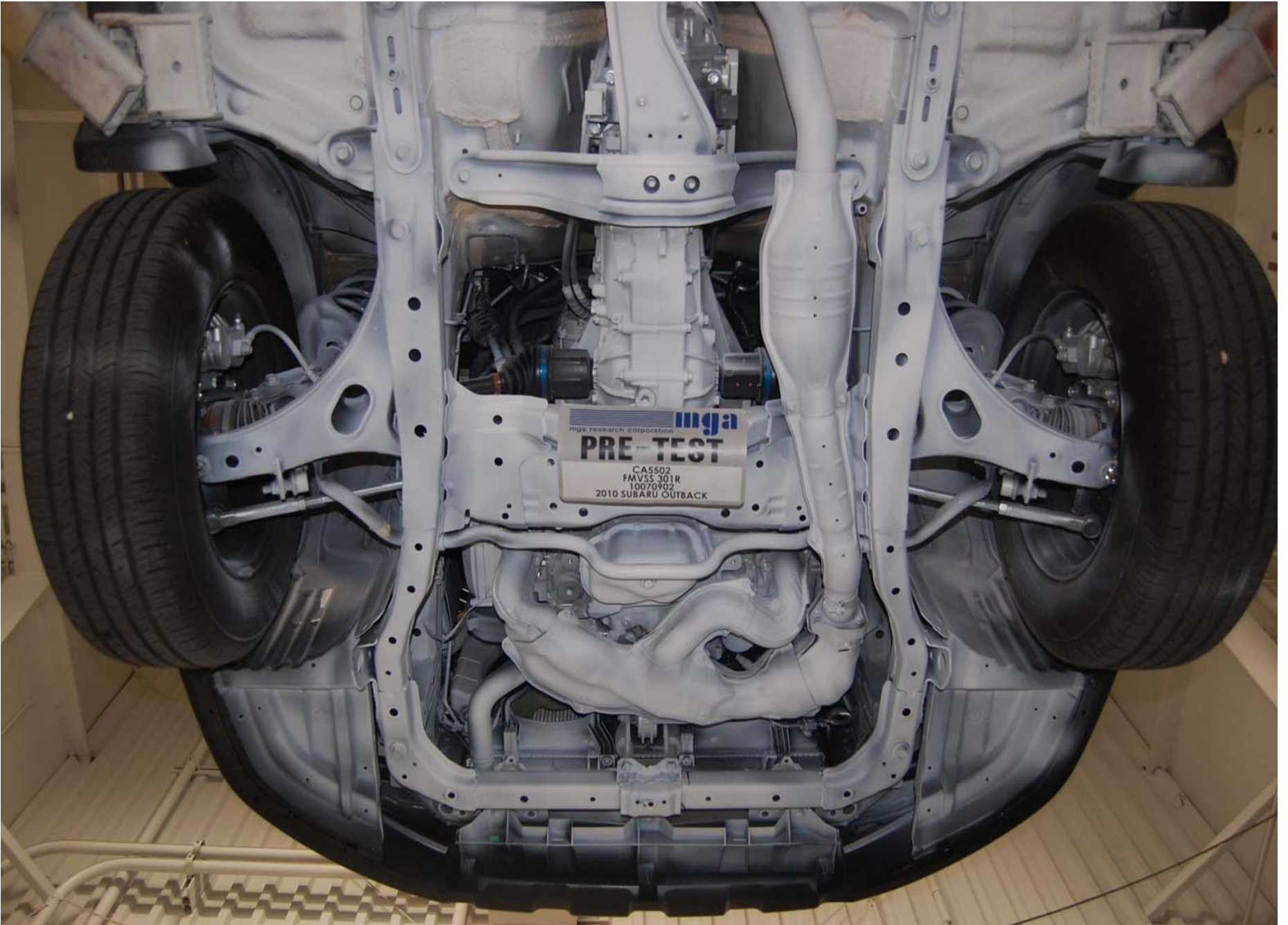
A-21.

Pre-Test Impact Point



A-22.

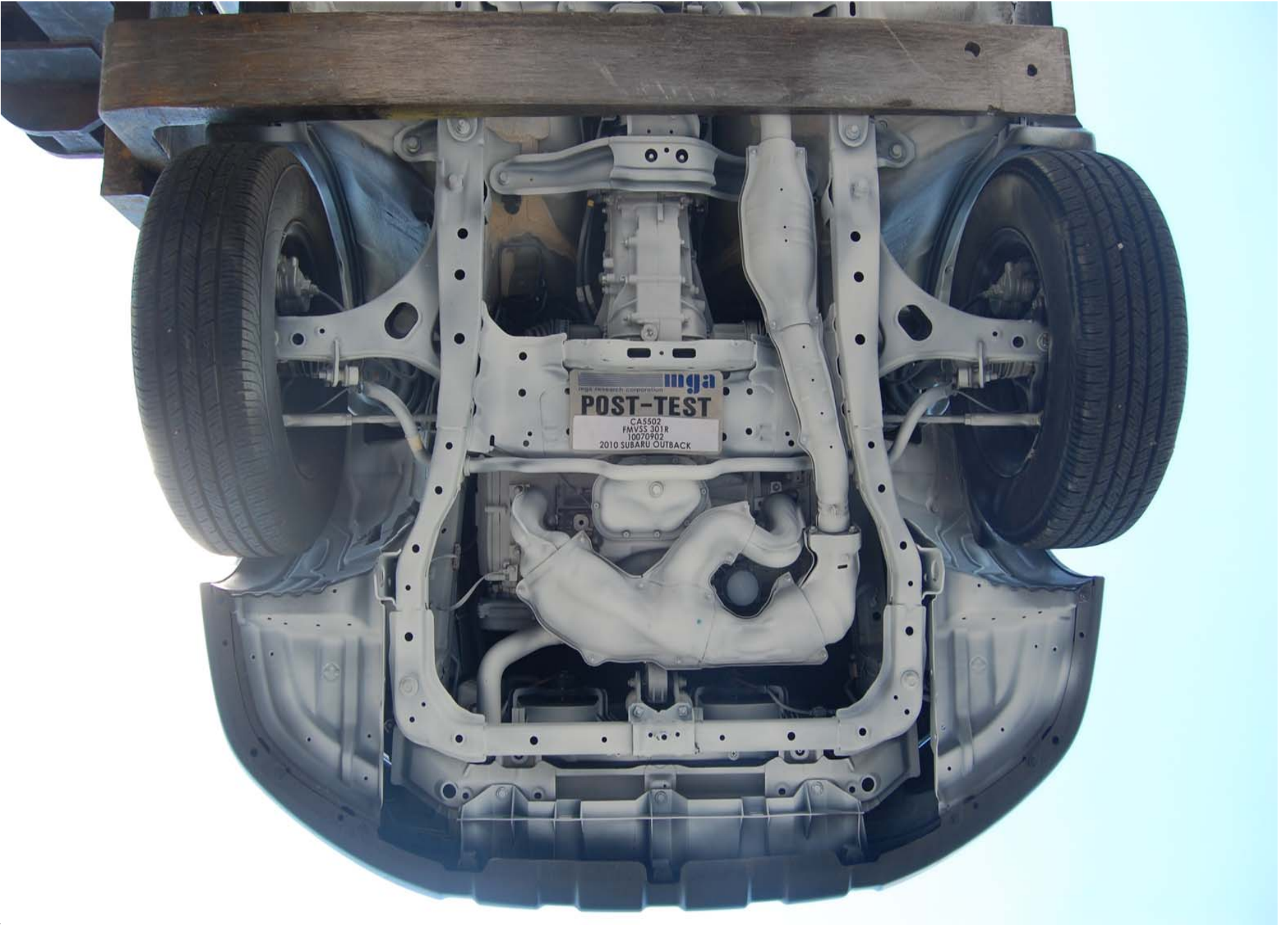
Post-Test Impact Point



A-23.

Pre-Test Underbody View 1

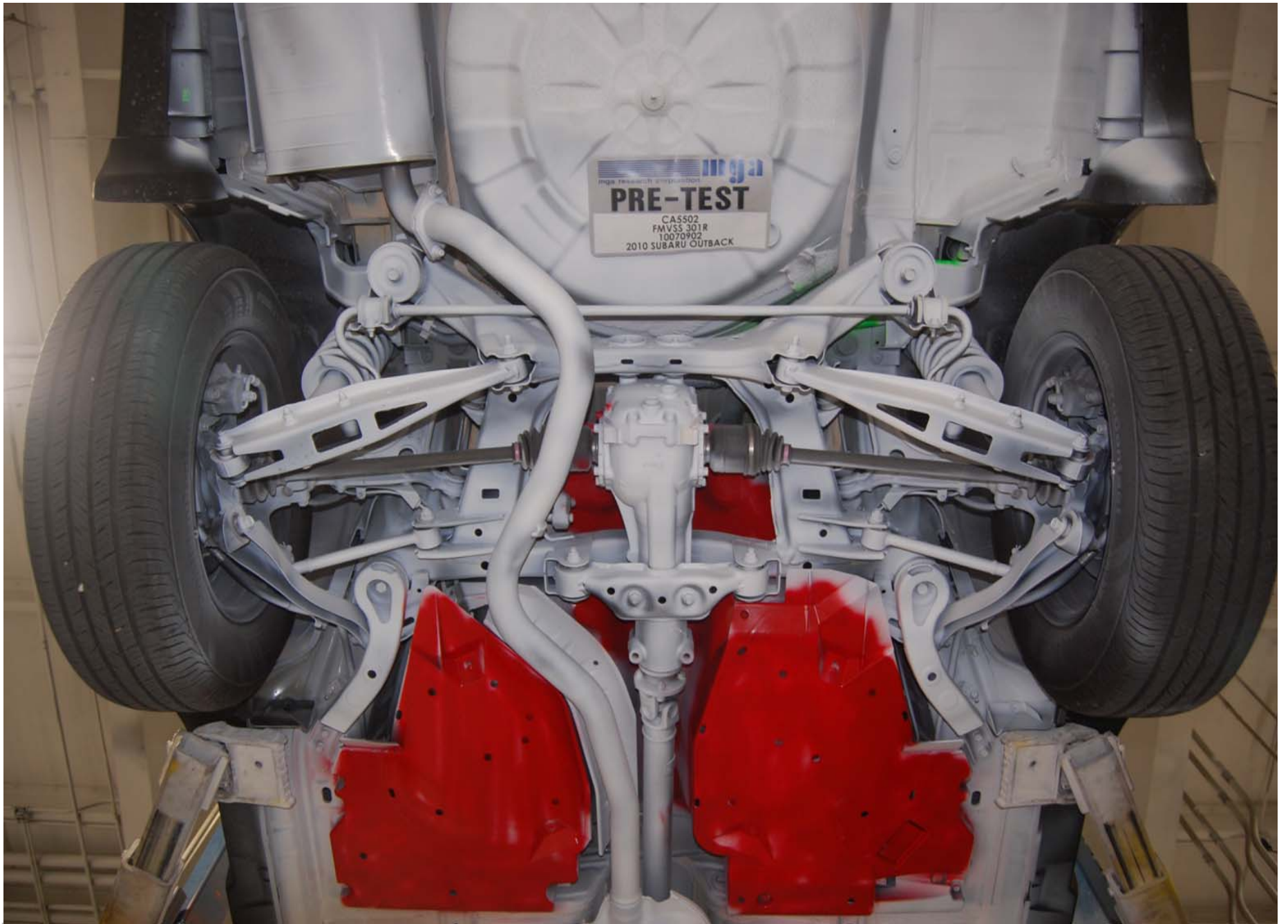




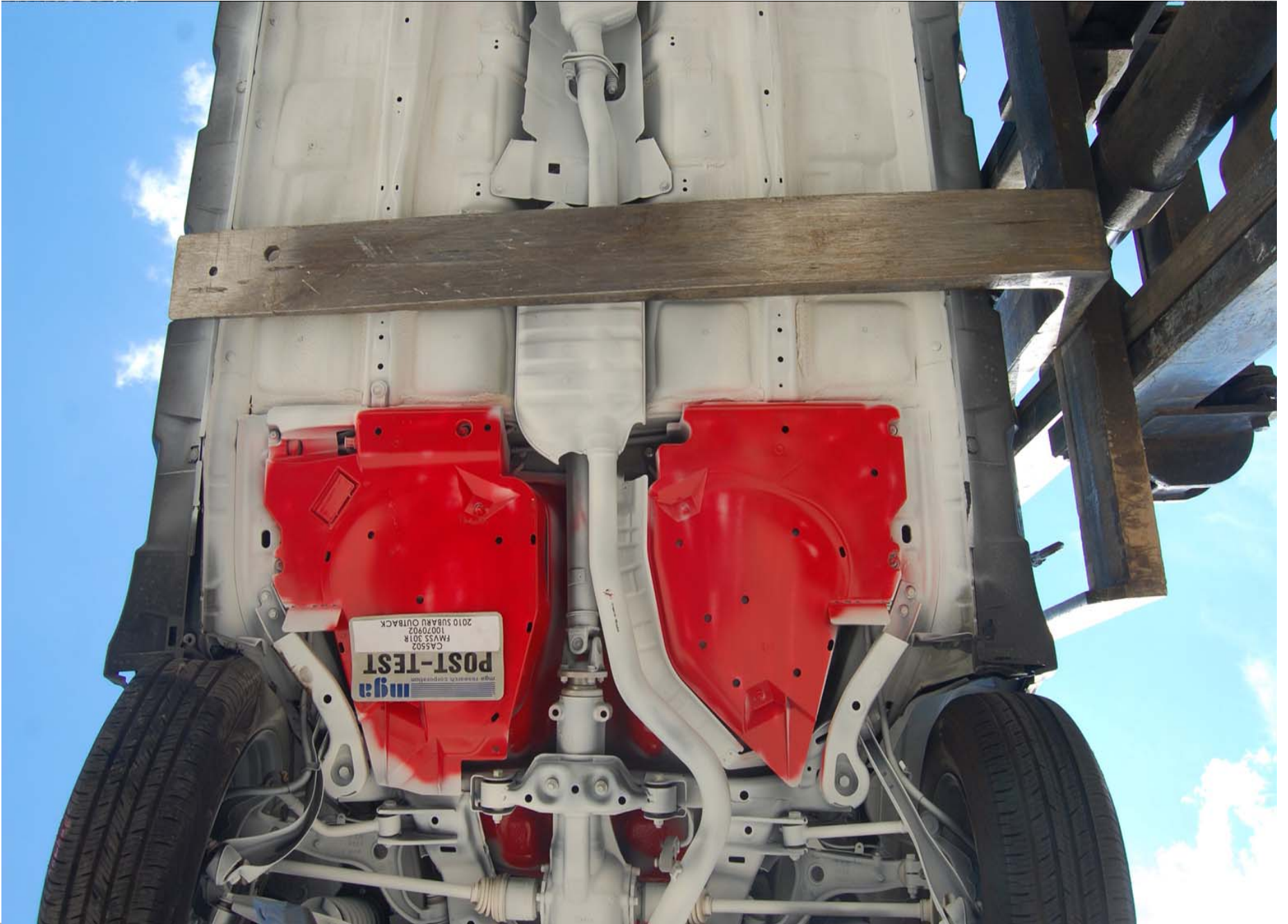
A-24.

Post-Test Underbody View 1

A-25.



Pre-Test Underbody View 2



Post-Test Underbody View 2

A-27.



Pre-Test Underbody View 3

A-28.



Post-Test Underbody View 3



Pre-Test Front View of MDB

A-30.



Post-Test Front View of MDB

A-31.



Pre-Test  $\frac{3}{4}$  Right Side View of MDB



A-32.



Post-Test ¾ Right Side View of MDB

A-33.

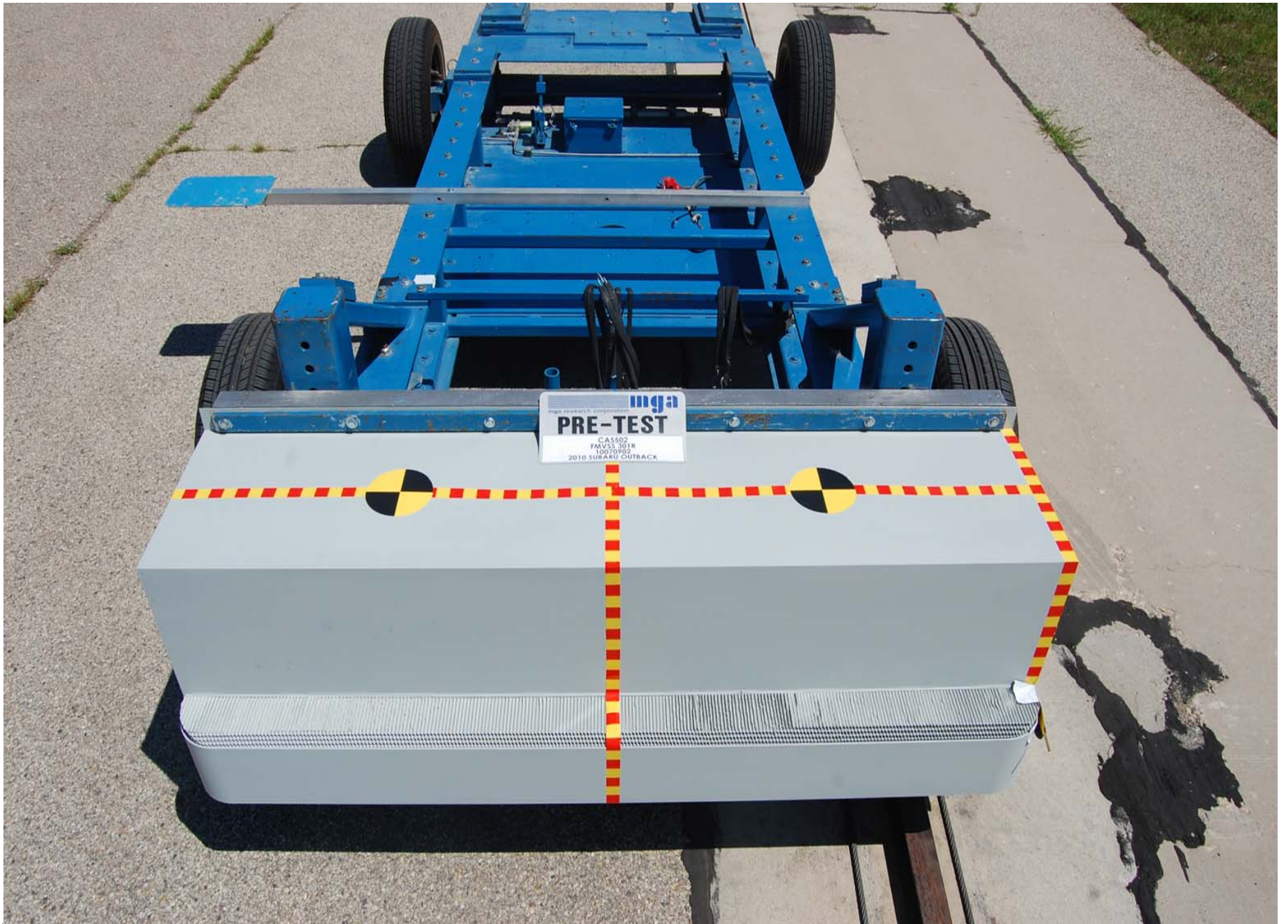


Pre-Test  $\frac{3}{4}$  Left Side View of MDB

A-34.



Post-Test  $\frac{3}{4}$  Left Side View of MDB



Pre-Test Top View of MDB

A-36.



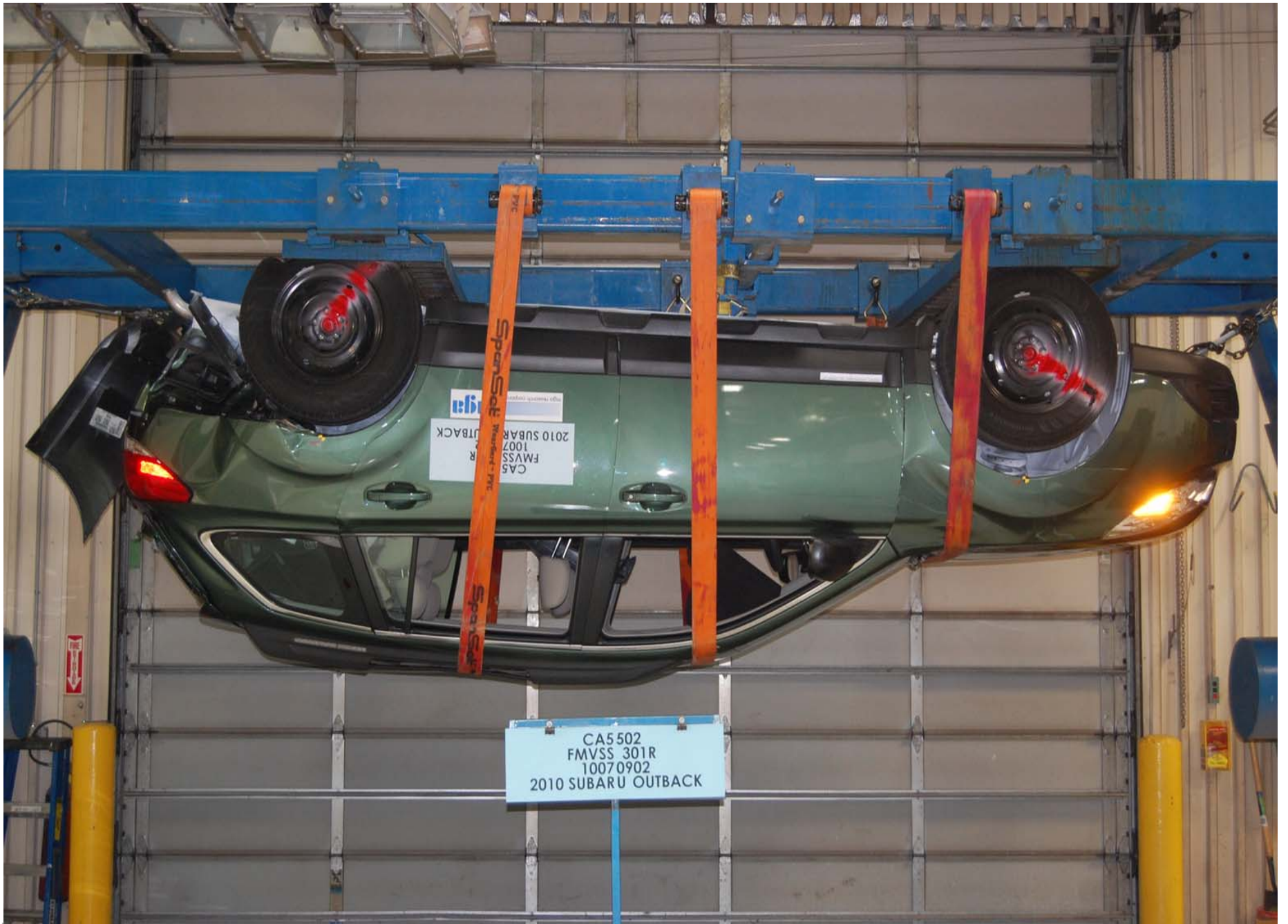
Post-Test Top View of MDB



A-37.

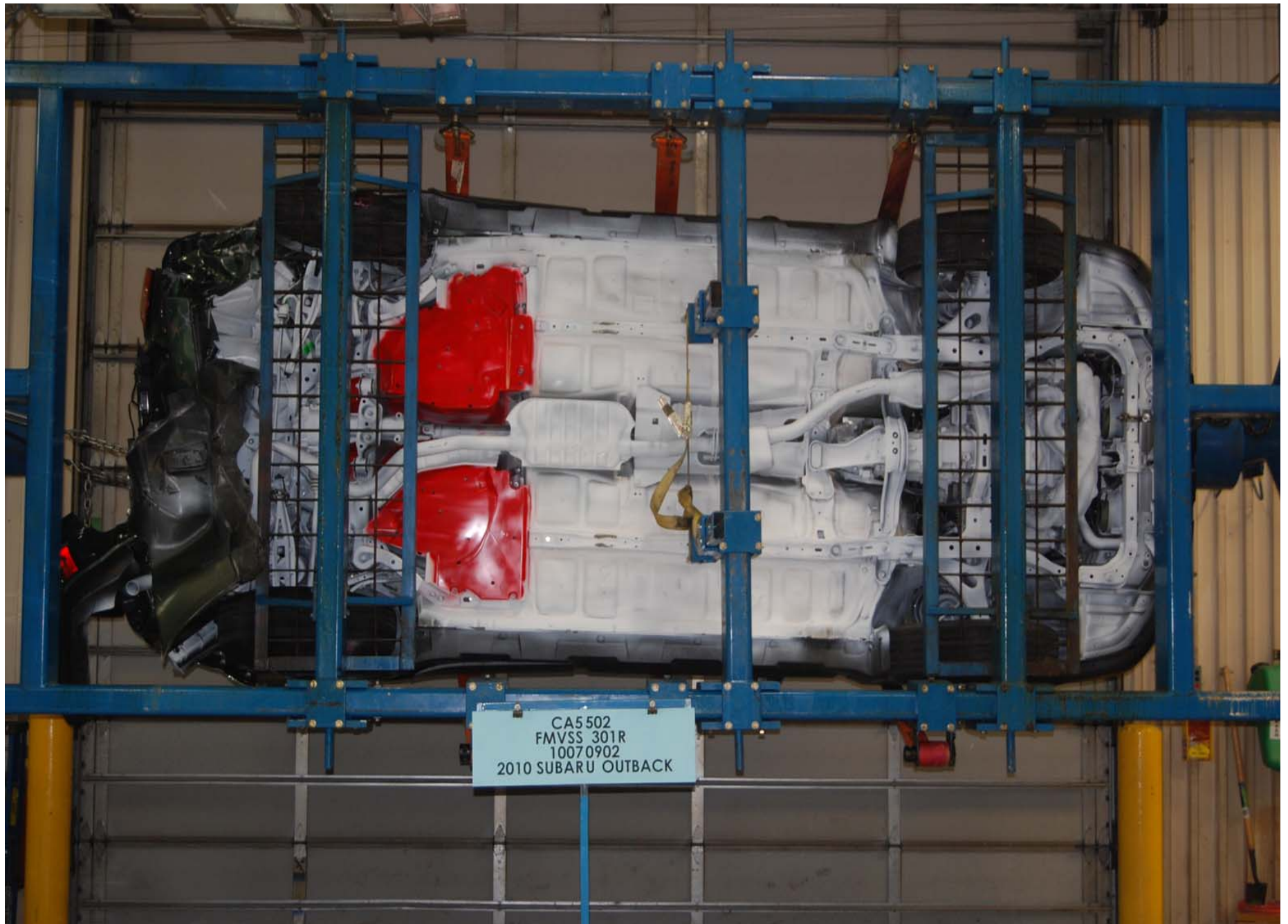
Static Rollover at 90 Degrees

A-38.



Static Rollover at 180 Degrees

A-39.



Static Rollover at 270 Degrees



A-40.



Static Rollover at 360 Degrees