

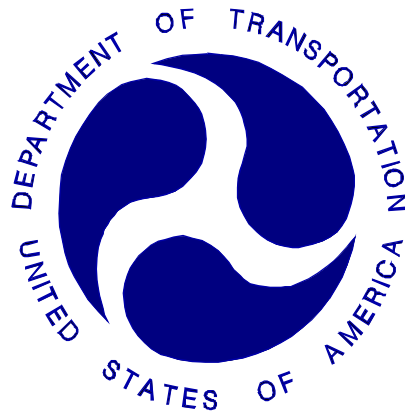
REPORT NUMBER: 301-CAL-09-02

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

**HYUNDAI MOTOR CO.  
2009 HYUNDAI ELANTRA  
4-DOOR SEDAN**

NHTSA NUMBER: C90506

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



April 10,2009

**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.



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Acceptance Date: \_\_\_\_\_

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## **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 2009 Hyundai Elantra 4-door Sedan, 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 1486 kg 2009 Hyundai Elantra 4-door Sedan was impacted from the rear by an 1362.5 kg moving barrier at a velocity of 78.63 kph (48.86 mph). The test was performed by Calspan Corporation on April 10,2009.

The test vehicle was equipped with a 45 liter fuel tank which was filled to 92 percent capacity with stoddard fluid prior to impact. Additional ballast (45 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.

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 748 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: 2009 Hyundai Elantra 4-door Sedan  
 Vehicle Body Color: Black NHTSA Number: C90506  
 Engine Data: 4 Cylinders; - CID; 2.0 Liters; - cc  
 Transmission: 5 Speed; x Manual; - Automatic; - Overdrive  
 Final Drive: - Rear Wheel Drive; x Front Wheel Drive; - 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 x Traction Control x Anti-Theft

**DEALER AND DELIVERY INFORMATION:**

Date Received: 2/25/09 ; Odometer Reading 121 km  
 Selling Dealer: Vision Hyundai  
 Dealer Address: 2525 W. Henrietta Rd. Rochester NY 14623

**DATA FROM VEHICLE'S CERTIFICATION LABEL:**

Vehicle Manufacturer: Hyundai Motor Co.  
 Vehicle Build Date: 11/08  
 VIN: KMHDU46DX9U626955  
 GVWR: 1755 kg; GAWR: 1010 kg FRONT; 950 kg REAR

**DATA FROM VEHICLE'S TIRE LABEL AND SIDEWALL:**

Location of Tire Placard: Rear Trunk  
 Type of Spare Tire: Temporary

	<u>Front</u>	<u>Rear</u>
Maximum Tire Pressure (sidewall - kPa)	300	300
Cold Pressure (tire placard - kPa) – test pressure	220	220
Recommended Tire Size (tire placard)	P195/65R15	P195/65R15
Vehicle Tire Size with load index & speed symbol	89T	89T
Tire Manufacturer	Kumho	Kumho
Tire Name	Solus	Solus
Treadwear, Traction, Temperature	440 AA A	440 AA A

**VEHICLE CAPACITY DATA:**

Type of Front Seats: - Bench; x Bucket; - Split Bench  
 Number of Occupants: 2 Front; 3 Rear; 5 Total  
 Vehicle Capacity Weight (VCW) = 385 kg  
 No. of Occupants x 68.04 kg = 340 kg  
 Rated Cargo/Luggage Weight (RCLW) = 45 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)
<b>Front</b> =	400.5	402.5	62.1	803.0
<b>Rear</b> =	256.5	234.0	37.9	490.5
<b>Total Delivered Weight (UDW) =</b>				1293.5

CALCULATION OF VEHICLE'S TARGET TEST WEIGHT:

Total Delivered Weight (UDW)	=	1293.5	kg
Rated Cargo/Luggage Weight (RCLW)	=	45.0	kg
Weight of 2 p.572E Dummies @ 78 each	=	156	kg
<b>TARGET TEST WEIGHT</b>	=	1494.5	kg

WEIGHT OF TEST VEHICLE WITH TWO DUMMIES AND 36.5 KG OF CARGO WEIGHT:

	Left Side (kg)	Right Side (kg)	Ratio (%)	Total (kg)
<b>Front</b> =	458.5	459.0	61.7	917.5
<b>Rear</b> =	290.0	278.5	38.3	568.5
<b>Total Vehicle Test Weight (ATW) =</b>				1486.0

Weight of Ballast Secured in Vehicle<sup>1</sup> = 45 kg Ballast Type Lead shot

Method of securing Ballast: Compartment placement

Components Removed for Weight Reduction: None

VEHICLE ATTITUDE (all dimension in millimeters):

	Left Front	Right Front	Left Rear	Right Rear	CG <sup>2</sup>
AS DELIVERED:	682	688	692	692	1005
AS TESTED:	661	665	675	678	1014

Vehicle's Wheel Base: 2650 mm

<sup>1</sup>Ballast weight does not include the weight of instrumentation, on-board cameras and data acquisition system

<sup>2</sup>Rearward of the front axle centerline.

VEHICLE PRE-TEST WIDTH AND IMPACT OFFSET MEASUREMENT:

Vehicle Width at Widest Point: 1776 mm Location: Front Axle

Centerline offset for impact line: 355 / 1421 mm

Filler neck side (left/right) Left

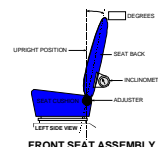
DATA SHEET 2 (continued)

PRE-TEST DATA

Vehicle: 2009 Hyundai Elantra 4-door Sedan

NHTSA No. C90506

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.



Seat back angle for driver's seat: N/A

Measurement instructions: Head restraint posts angle is 6.8 degrees

Seat back angle for passenger's seat: N/A

Measurement instructions: Head restraint posts angle is 6.8 degrees

2. SEAT FORE AND AFT POSITIONING:

Positioning of the driver's seat: Full forward to full rear – 272 mm , seat centered at notch 11

Positioning of the passenger's seat: Notches 0-24; seat centered at notch 12

3. FUEL TANK CAPACITY DATA:

- 3.1 A. "Usable Capacity" of the standard equipment fuel tank is 45.05 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 = 41.5 to 42.34 liters

3.2 Actual Amount of Stoddard solvent added to vehicle for test = 41.6 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.

With ignition turned "ON"

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 wheel was set to center of loci – 64.1 up to 68.4 down – center is 66.25 degrees

5. SEAT BELT UPPER ANCHORAGE:

Nominal design riding position:

4 positions 0 to 3 – Placed in detent 1 from 0

6. COMMENTS:

None

**DATA SHEET 3**

**MOVING DEFORMABLE BARRIER (MDB) DATA**

Vehicle: 2009 Hyundai Elantra 4-door Sedan

NHTSA No. C90506

MDB FACE MANUFACTURER AND SERIAL NUMBER:

N/A

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MDB DETAILS:

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

MDB WEIGHT:

Left Front	=	<u>357.0</u>	kg	Left Rear	=	<u>323.0</u>	kg
Right Front	=	<u>404.0</u>	kg	Right Rear	=	<u>273.5</u>	kg
TOTAL FRONT =		<u>761.0</u>	kg	TOTAL REAR =		<u>596.5</u>	kg
TOTAL MDB WEIGHT =		<u>1357.5</u>	kg				
Tires (Mfr, line, size):		<u>N/A</u>					

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TIRE PRESSURE:

Left Front	=	<u>207</u>	kPa	Left Rear	=	<u>207</u>	kPa
Right Front	=	<u>207</u>	kPa	Right Rear	=	<u>207</u>	kPa

Brake Abort System? (Yes/No) Yes

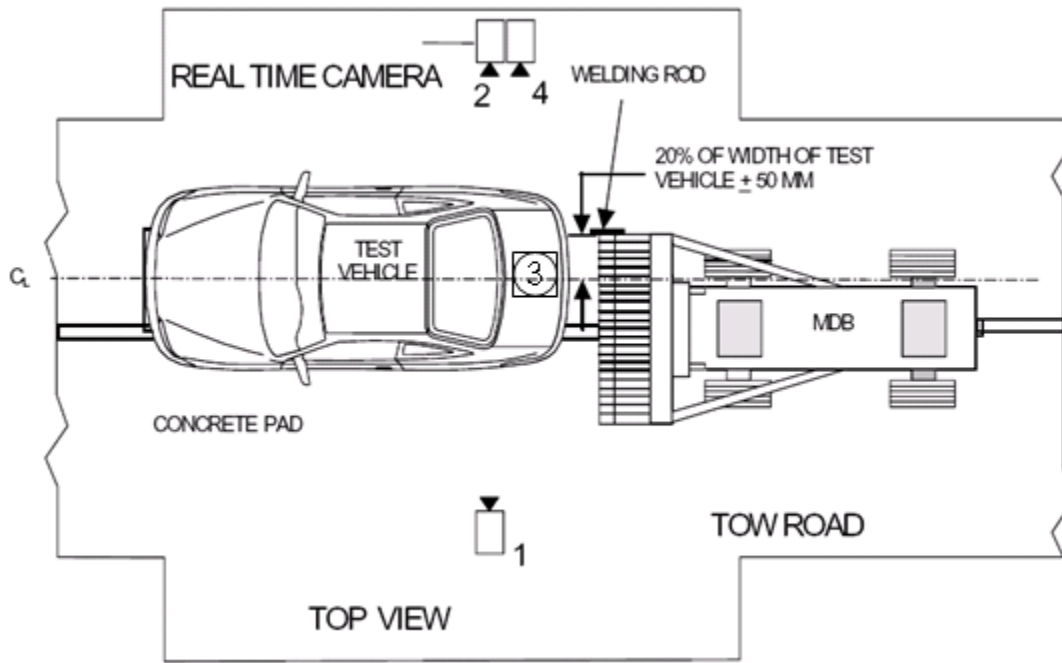
Date of Last Calibration: 06/07

**DATA SHEET 4**

**HIGH SPEED CAMERA LOCATIONS AND DATA SUMMARY**

Vehicle: 2009 Hyundai Elantra 4-door Sedan

NHTSA No. C90506



Camera No.	View	Coordinates (millimeters)			Angle (deg.)	Lens (mm)	Film Speed (fps)
		X*	Y*	Z*			
1	Left Side View	7117	1805	1094	3.6	25	1000
2	Real-Time Camera	-	-	-	-	-	30
3	Overhead View	0	0	4880	90	12.5	1000
4	Right Side View	7764	1423	954	1.1	25	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: 2009 Hyundai Elantra 4-door Sedan

NHTSA No. C90506

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

ACTUAL IMPACT VELOCITY WITHIN 1.5 M OF IMPACT PLANE:

Trap No. 1 = 78.63 km/h                      Trap No. 2 = 78.63 km/h

Average Impact Speed = 78.63 km/h

WELDING ROD IMPACT POINT:

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

6    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

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**DATA SHEET 5**

**POST-TEST DATA (Continued)**

Vehicle: 2009 Hyundai Elantra 4-door Sedan

NHTSA No. C90506

POST TEST SEAT DATA

LOCATION	SEAT MOVEMENT (mm)	SEAT BACK FAILURE
<b>P1 (Left Front)</b>	None	Reclined
<b>P2 (Right Front)</b>	None	Reclined

POST TEST ATD CONTACT DATA

LOCATION	Position 1 (Driver)	Position 2 (Passenger)
<b>Head</b>	Back of head to head restraint	Back of head to head restraint
<b>Chest</b>	None	None
<b>Abdomen</b>	None	None
<b>Left Knee</b>	None	None
<b>Right Knee</b>	None	None

**VEHICLE DIMENSIONS:**

Vehicle length:

	Left Side	Centerline	Right Side
Pre-Test	4402	4500	4402
Post-Test	3725	3752	3814
Crush	677	748	588

Vehicle Wheel Base:

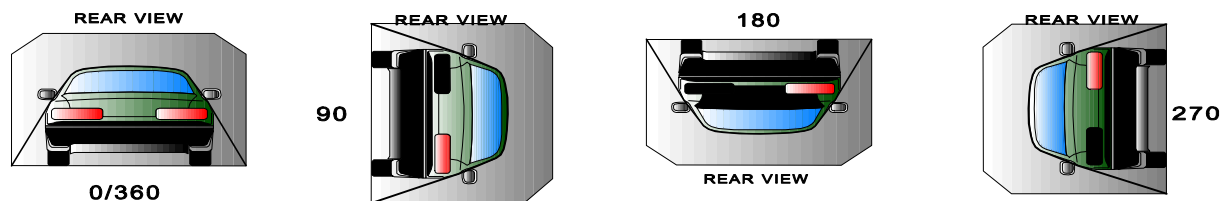
	Left Side	Right Side
Pre-Test	2655	2645
Post-Test	2492	2619
Crush	163	26

## DATA SHEET 6

### FMVSS 301 ROLLOVER DATA

Vehicle: 2009 Hyundai Elantra 4-door Sedan

NHTSA No.: C90506



#### 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	
	1	minutes	03	seconds	5	minutes	6	minutes	3	seconds	7	minutes
0° - 90°	1	minutes	03	seconds	5	minutes	6	minutes	3	seconds	7	minutes
90° - 180°	1	minutes	01	seconds	5	minutes	6	minutes	1	seconds	7	minutes
180°-270°	1	minutes	04	seconds	5	minutes	6	minutes	4	seconds	7	minutes
270°-360°	1	minutes	11	seconds	5	minutes	6	minutes	11	seconds	7	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)
0° - 90°	0	0	0	N/A
90° - 180°	0	0	0	N/A
180°-270°	0	0	0	N/A
270°-360°	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
0° - 90°	None
90° - 180°	None
180°-270°	None
270°-360°	None

**APPENDIX A**

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**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-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**



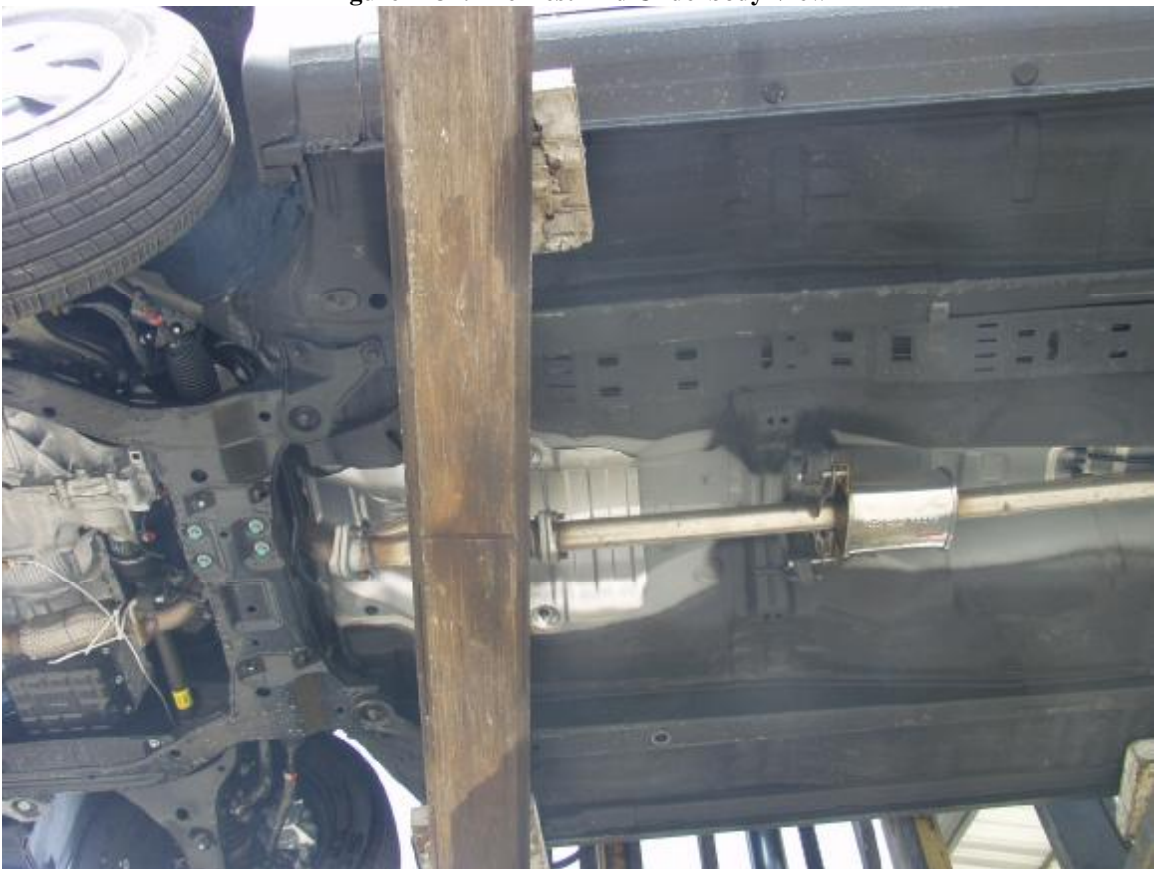
**Figure A-29: Pre-Test Front Underbody View**



**Figure A-30: Post-Test Front Underbody View**



**Figure A-31: Pre-Test Mid Underbody View**



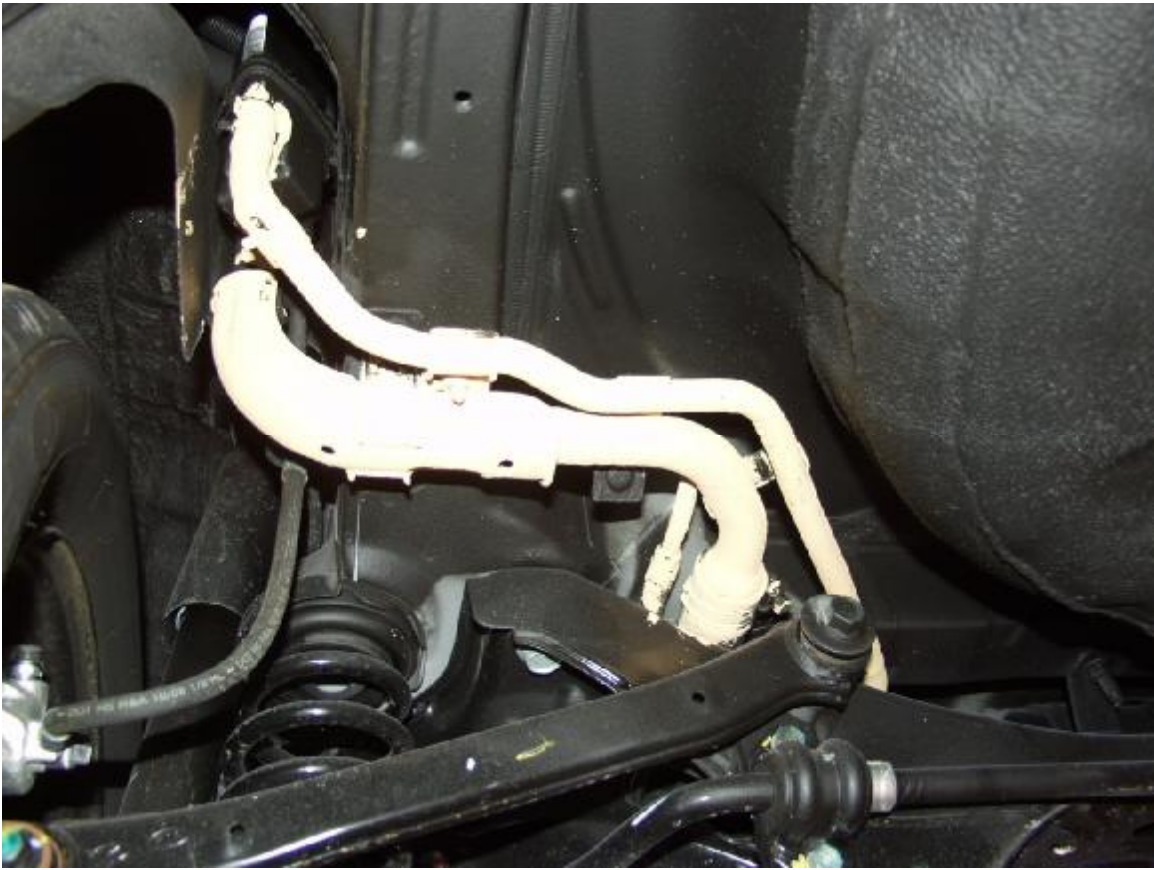
**Figure A-32: Post-Test Mid Underbody View**



**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**