

REPORT NUMBER: TR-P32096-04-NC

**RESEARCH AND DEVELOPMENT
80 KM/H 70% OVERLAP REAR IMPACT**

**SATURN CORPORATION
1996 SATURN SL1 4-DOOR SEDAN**

NHTSA NUMBER: PT0102

**PREPARED BY:
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**TEST DATE:
AUGUST 16, 2012**


**REPORT DATE:
AUGUST 30, 2012
FINAL REPORT**

**U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
NATIONAL CENTER FOR STATISTICS AND ANALYSIS
OFFICE OF REGULATORY ANALYSIS AND EVALUATION
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16. Abstract A 80 km/h 70% overlap rear impact test was conducted on the subject 1996 Saturn SL1 4-door sedan in accordance with the specifications of the Office of Vehicle Compliance Laboratory Test Procedure for FMVSS 301R. The test was conducted at the KARCO Engineering, LLC. facility in Adelanto, California on August 16, 2012. The impact velocity was 79.84 km/h and the outside ambient temperature at the struck (driver's) side of the vehicle was 41.0 deg. C. The vehicle's doors remained closed throughout the event. The left front, right front and right rear doors remained operational after the event. The left rear door and hatch were jammed shut. Stoddard solvent leaked from the underside of the vehicle immediately after the test. Solvent was observed leaking from the front and rear of the fuel tank. Actual leakage location is in an unidentified region of the fuel tank. The solvent continued to leak throughout the static rollover at every position from 0°-360°.			
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SECTION 1 SUMMARY OF TEST

SUMMARY

The purpose of this rear impact test series is to measure the performance of the subject vehicle, a 1996 Saturn SL1 4-door sedan, for FMVSS 301R *'Fuel System Integrity – Rear Impact'*.

This 80 km/h 70% Overlap Rear Impact is sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number DTNH22-11-D-00245. It was conducted in accordance with the Office of Vehicle Compliance Laboratory Test Procedure for FMVSS 301R *'Fuel System Integrity – Rear Impact'*, dated January, 2007.

A 1996 Saturn SL1 4-door sedan was impacted by a moving deformable barrier at a velocity of 79.84 km/h. The test was performed at KARCO Engineering, LLC. on August 16, 2012. Pre- and post-test photographs of the vehicle and dummies can be found in Appendix A of this report.

Two (2) real-time cameras and three (3) high-speed cameras were used to document the rear impact event.

Two Part 572E 50th percentile male anthropomorphic test devices (ATD) were placed in the driver and right front passenger seating positions. Both ATD's were un-instrumented for this test.

Both the driver and passenger side doors remained closed during the impact event. The left front, right front and right rear doors remained operational after the event. The left rear door and hatch were jammed shut.

Stoddard solvent leaked from the underside of the vehicle immediately after the test. Solvent was observed leaking from the front and rear of the fuel tank. Actual leakage location is in an unidentified region of the fuel tank. The solvent continued to leak throughout the static rollover at every position from 0°-360°. Solvent leakage is summarized in Data Sheets 5 and 6. Photographs of the damaged area are presented in Appendix A.

SECTION 2
DATA SHEETS

Test Vehicle: 1996 Saturn SL1 4-Door Sedan NHTSA No.: PT0102
 Test Program: 70% Overlap Rear Impact Test Date: 08/16/12

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	°F	°C	$=(T_f - 32)/1.8$
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf-ft	N•m	1.355

DATA SHEET NO. 1

TEST VEHICLE SPECIFICATIONS

Test Vehicle: 1996 Saturn SL1 4-Door Sedan NHTSA No.: PT0102
 Test Program: 70% Overlap Rear Impact Test Date: 08/16/12

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA Number	PT0102
Model Year	1996
Make	Saturn
Model	SL1
Body Style	4-Door Sedan
VIN	1G8ZG5281TZ3
Date Received	7/13/2012
Body Color	Gold
Odometer Reading (km / mi)	246354 / 153077
Engine Displacement (L)	1.9
Engine Placement	Transverse
Transmission Type	Manual
Transmission Speeds	5
Overdrive	Yes
Final Drive	Front
Roof Rack	No
Sunroof / T-Top	No
Tinted Glass	No
Traction Control	No
Power Brakes	Yes
Front Disc Brakes	Yes
Rear Disc Brakes	Yes
Anti-Lock Brakes (ABS)	No

All Wheel Drive	No
Power Steering	Yes
Driver Front Airbag	Yes
Driver Side Airbag	No
Driver Head Airbag	No
Driver Curtain Airbag	No
Driver Combo Airbag	No
Driver Knee Airbag	No
Passenger Front Airbag	Yes
Passenger Side Airbag	No
Passenger Head Airbag	No
Passenger Curtain Airbag	No
Passenger Combo Airbag	No
Passenger Knee Airbag	No
Seat Belt Pre-Tensioners	No
Load Limiters	No
Bucket Seats	Yes
Air Conditioning	Yes
AM/FM TAPE	Yes
Tilt Steering	Yes
Automatic Door Locks	No
Power Windows	No
Power Seats	No

Does Owner's Manual provide instructions to turn off automatic door locks?

DATA FROM CERTIFICATION LABEL

Manufactured By	Saturn Corporation
Date of Manufacture	Jun-96

GVWR (kg)	1477
GAWR Front (kg)	752
GAWR Rear (kg)	725

VEHICLE SEATING AND CAPACITY WEIGHT INFORMATION

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench		
Designated Seating Capacity	2	3		5
Capacity Weight (VCW) (kg)				392.0
DSC x 68.04 (kg)				340.0
Cargo Weight (RCLW) (kg)				52.0

A
B
A-B

DATA SHEET NO. 2
PRE-TEST INSPECTION

Test Vehicle: 1996 Saturn SL1 4-Door Sedan

NHTSA No.: PT0102

Test Program: 70% Overlap Rear Impact

Test Date: 08/16/12

Feature	Yes	No	Comments
Is the vehicle totally complete?	X		None
Does the vehicle run and drive?	X		None
Is there any sign that the vehicle has ever been in a crash?		X	None
Are the bumpers damaged?		X	None
Do the doors open and close properly?	X		None
Are the doors properly aligned so that there are no gaps when closed?	X		None
Does the battery hold a charge so that electrical accessories in the vehicle may be operated without starting the engine?	X		None
Does the vehicle sag or have a raised or lowered suspension?		X	None
Are any of the control arms or other suspension components damaged or distorted?		X	None
Do the tires have some usable tread remaining and hold pressure?	X		None
Are the radiator and/or its supporting cross members damaged?		X	None
Is the cooling system able to retain its coolant and are the proper fluid levels maintained?	X		None
Does the fuel tank leak?		X	None
Does the fuel tank have any damages or dents that would reduce its internal capacity?		X	None
Is the fuel tank located behind the rear axle?		X	None
Is the fuel tank located between the front and rear axle?	X		None
Is the vehicle attitude "as tested" between "as delivered" and "fully loaded" before running the test?	X		None

Equipment	Present		Proper Place		Operate Properly	
	Yes	No	Yes	No	Yes	No
Engine	X		X		X	
Transmission	X		X		X	
Drive Axles	X		X		X	
Battery	X		X		X	
Alternator	X		X		X	
Radiator	X		X		X	

DATA SHEET NO. 3

PRE-TEST DATA

Test Vehicle: 1996 Saturn SL1 4-Door Sedan

NHTSA No.: PT0102

Test Program: 70% Overlap Rear Impact

Test Date: 08/16/12

TEST VEHICLE AXLE WEIGHTS

	Units	As Delivered (UVW)			As Tested (ATW)			Fully Loaded		
		Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Left	kg	328.5	212.5		377.5	263.0		369.0	278.0	
Right	kg	322.5	209.5		370.5	255.5		357.0	269.0	
Ratio	%	60.7%	39.3%	100.0%	59.1%	40.9%	100.0%	57.0%	43.0%	100.0%
Total	kg	651.0	422.0	1073.0	748.0	518.5	1266.5	726.0	547.0	1273.0

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value	
Total Delivered Weight (UVW)	kg	1073.0	A
Actual Weight of 2 P572 ATDs Used	kg	148.0	B
Rated Cargo/Luggage Wt (RCLW)	kg	52.0	C
Calculated Vehicle Target Wt (TVT _W)	kg	1273.0	A+B+C

TEST VEHICLE ATTITUDES

Condition	Units	LF	RF	LR	RR	CG Aft of Front Axle
As Delivered	mm	677	682	667	661	1021
As Tested	mm	654	654	646	647	1062
Fully Loaded	mm	650	652	633	638	1115
Post-Test	mm	700	786		643	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	2595
Total Vehicle Length	mm	4470
Amount of Stoddard Solvent in Fuel Tank	L	45.06

DATA SHEET NO. 3 ... (CONTINUED)

PRE-TEST DATA

Test Vehicle: 1996 Saturn SL1 4-Door Sedan NHTSA No.: PT0102
 Test Program: 70% Overlap Rear Impact Test Date: 08/16/12

BALLAST DATA

Description	Value
Type of Ballast	Ballast Dummy
Method of Securing Ballast	Seat Belt
Weight of Ballast in Cargo Area	28.0 kg
Weight of Vehicle Components Removed	0.0 kg

VEHICLE COMPONENTS REMOVED TO MEET TEST WEIGHT:

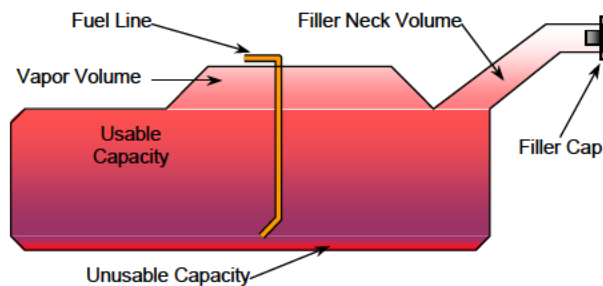
No vehicle components were removed

FUEL TANK CAPACITY

Description	Liters
Fuel System Capacity Listed in Owners Manual	48.45
Usable Capacity of "Standard Tank"	48.45
91 - 94% of Usable Capacity	44.09 - 45.54
Actual Amount of Stoddard Solvent Used	45.06

FUEL PUMP

The vehicle is equipped with an electric fuel pump. The fuel pump is activated when the ignition is turned on.



VEHICLE FUEL TANK ASSEMBLY

TEST FLUID

Description	Value
Test Fluid Type	Stoddard Solvent
Test Fluid Specific Gravity	0.97
Test Fluid Kinematic Viscosity	
Test Fluid Color	Purple

DATA SHEET NO. 3 ... (CONTINUED)

PRE-TEST DATA

Test Vehicle: 1996 Saturn SL1 4-Door Sedan

NHTSA No.: PT0102

Test Program: 70% Overlap Rear Impact

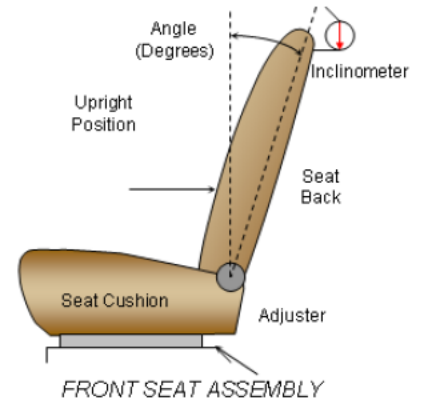
Test Date: 08/16/12

NOMINAL DESIGN RIDING POSITION

Seat back angle is measured at the headrest back using a digital inclinometer.

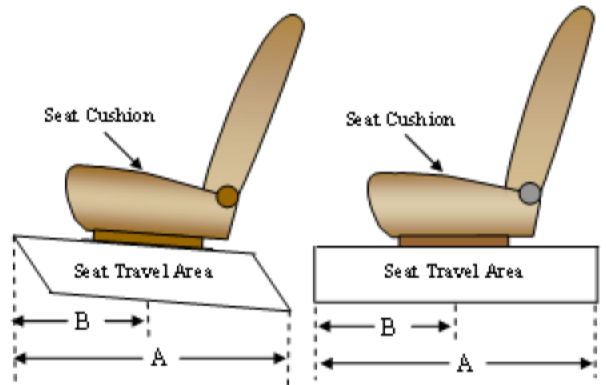
SEAT BACK ANGLE

Seating Position	Degrees
Driver Seat Back Angle	4.3
Passenger Seat Back Angle	4.5



SEAT FORE / AFT POSITIONING

The total seat travel is measured from the forward most possible position to the rear most possible position. The driver's seat is set to the middle of the fore-aft travel. The passenger's seat is set to the middle of the fore-aft travel.



SEAT FORE/AFT POSITIONS

Seating Position	Total Fore-Aft Travel	Placed in Position
Driver Seat	200 mm	100 mm
Passenger Seat	200 mm	100 mm

DATA SHEET NO. 3 ... (CONTINUED)

PRE-TEST DATA

Test Vehicle: 1996 Saturn SL1 4-Door Sedan

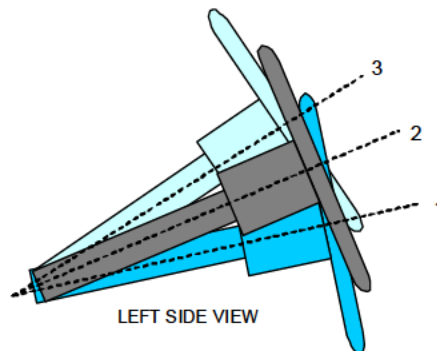
NHTSA No.: PT0102

Test Program: 70% Overlap Rear Impact

Test Date: 08/16/12

STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the geometric center of the locus it describes when moved through its full range of motion. A digital inclinometer is used to measure a plate which is placed across the rim of the steering wheel for angular measurements. A tape measure is used to measure telescoping steering wheel travel.



LEFT SIDE VIEW
STEERING COLUMN ASSEMBLY

STEERING COLUMN POSITIONING

	Degrees	Fore-Aft Position (mm)
Lowermost Position, No. 1	17.0	
Geometric Center Position, No. 2	18.5	
Uppermost Position, No. 3	20.0	
Telescoping Steering Wheel Travel		
Test Position	18.5	

DATA SHEET NO. 4
MOVING BARRIER DATA

Test Vehicle: 1996 Saturn SL1 4-Door Sedan NHTSA No.: PT0102
 Test Program: 70% Overlap Rear Impact Test Date: 08/16/12

MOVING BARRIER TEST WEIGHT

	Units	As Tested Weights		
		Front Axle	Rear Axle	Total
Left	kg	401.8	298.0	699.8
Right	kg	376.9	291.6	668.5
Ratio	%	56.9%	43.1%	100.0%
Total	kg	778.7	589.6	1368.3

MOVING BARRIER TIRE INFORMATION

Measured Parameter	Front	Rear
Recommended Tire Size	205/75R15	205/75R15
Tire Size on Vehicle	205/75R15	205/75R15
Tire Manufacturer	Pacemark	Pacemark
Tire Model	All Weather	All Weather
Treadwear	420	420
Traction	A	A
Temperature Grades	B	B
Tire Pressure - Front	220	220
Tire Pressure - Rear	220	220

MOVING BARRIER DIMENSIONS

Measurement Description	Length (mm)
Overall Width	1676
Overall Height	559
Honeycomb Depth	381
Overall Depth	483
Bottom Honeycomb to Bottom Bumper	51
Bumper Height	203
Ground to Top of MDB	788
Ground to Bottom of MDB	229
Ground to Bottom of Bumper	280
Ground to Top of Bumper	483

DATA SHEET NO. 5

POST TEST DATA

Test Vehicle: 1996 Saturn SL1 4-Door Sedan NHTSA No.: PT0102

Test Program: 70% Overlap Rear Impact Test Date: 08/16/12

Temperature at Time of Impact: 41°C Test Time: 3:34 PM

VIN: 1G8ZG52811Z3

IMPACT VELOCITY DATA

Measured Parameter	Units	Value
Trap No. 1 Velocity (Primary)	km/h	79.84
Trap No. 2 Velocity (Redundant)	km/h	79.79

IMPACT POINT LOCATION DATA

Measured Parameter	Units	Tolerance	Value
Vehicle Width	mm		1685
Vertical Impact Reference Line (Left of Vehicle Center Line)	mm		337
Actual Impact Point (Left of Vehicle Center Line)	mm		321
Horizontal Offset (+ right / - left)	mm	± 50 of Intended Impact Point	-16
Vertical Offset (+ down / - up)	mm	± 20 of Intended Impact Point	-3

TARGET VEHICLE PRE- AND POST- TEST STRUCTURAL MEASUREMENTS

No.	Description	Pre-Test	Post-Test	Difference
1	Total Length at Centerline	4470	4002	-468
2	Total Length	4470	4286	-184
3	Total Width	1685	1810	125
4	Left Side Wheelbase	2595	2280	-315
5	Right Side Wheelbase	2595	2565	-30

MAXIMUM STATIC CRUSH OF HONEYCOMB FACE

Row	Vertical Location		From Centerline		Max. Crush (mm)
	Description	Height (mm)	Distance (mm)	Direction	
A	Center of Bumper	432	800	Right	155
B	Top of Bumper	533	800	Right	161
C	Mid Level	686	800	Right	94
D	Top of Stack	813	100	Left	39

DATA SHEET NO. 5 ... (CONTINUED)

POST-TEST DATA

Test Vehicle: 1996 Saturn SL1 4-Door Sedan NHTSA No.: PT0102
Test Program: 70% Overlap Rear Impact Test Date: 08/16/12

DOOR OPENING AND SEAT TRACK INFORMATION

Description	Driver	Passenger
Front Door Opening	Remained closed and latched	Remained closed and latched
Rear Door Opening	Jammed Shut	Remained closed and latched
Hatch and Other Doors	Jammed Shut	

DATA SHEET NO. 6

FMVSS 301 DATA

Test Vehicle: 1996 Saturn SL1 4-Door Sedan NHTSA No.: PT0102
Test Program: 70% Overlap Rear Impact Test Date: 08/16/12

FMVSS 301 FUEL SYSTEM INTEGRITY POST-IMPACT DATA

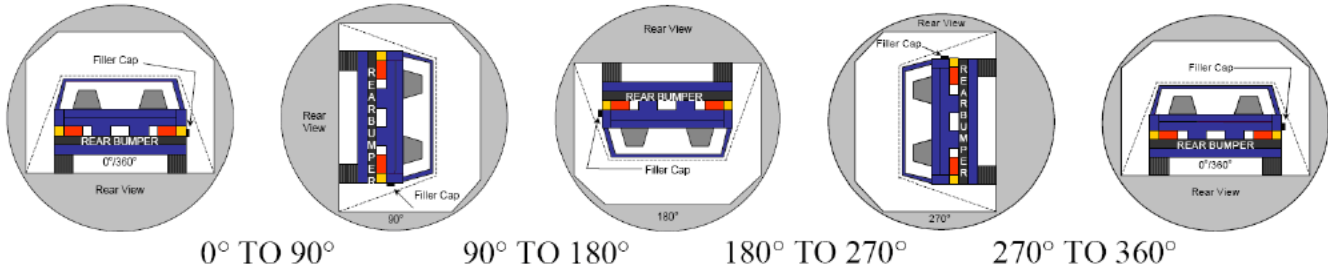
Stoddard Solvent Spillage Measurements

- A. From impact until vehicle motion ceases: 0 g
(Maximum allowable = 28 g)
- B. For the 5 minute period after motion ceases: 573.7 g
(Maximum allowable = 28 g)
- C. For the following 25 minutes: 387.2 g
(Maximum allowable = 28 g/minute)
- D. Spillage: Solvent was observed leaking from the front and rear of the fuel tank. Actual leakage location is in an unidentified region of the fuel tank.

DATA SHEET NO. 7
STATIC ROLLOVER TEST DATA

Test Vehicle: 1996 Saturn SL1 4-Door Sedan
Test Program: 70% Overlap Rear Impact

NHTSA No.: PT0102
Test Date: 08/16/12



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).

Details of Stoddard solvent spillage: Solvent was observed leaking from the front and rear of the fuel tank. Actual leakage location is in an unidentified region of the fuel tank.

SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° To 90°	82	300	382
90° To 180°	81	300	381
180° To 270°	79	300	379
270° To 360°	79	300	379

FMVSS 301 SPILLAGE TABLE

Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eighth Minute
0° To 90°	1721 g	918 g	688 g	
90° To 180°	1922 g	57 g		
180° To 270°	115 g	57 g		
270° To 360°	688 g			

SOLVENT SPILLAGE LOCATION TABLE

Test Phase	Spillage Location
0° To 90°	Fuel Tank
90° To 180°	Fuel Tank
180° To 270°	Fuel Tank
270° To 360°	Fuel Tank

SECTION 3
LABORATORY NOTICE OF APPARENT TEST FAILURE

TEST INFORMATION:

Test Date	8/16/2012
Laboratory	KARCO Engineering, LLC.
Contract No.	DTNH22-11-D-00245
Delivery Order No.	
Lab Project Engineer's Name	Steven Matsusaka
NHTSA No.	PT0102
Test Vehicle	
Year	1996
Make	Saturn
Model	SL1
Body Style	4-Door Sedan
VIN	1G8ZG5281TZ3
Manufacturer	Saturn Corporation

TEST FAILURE DESCRIPTION:

Stoddard solvent leaked from the underside of the vehicle immediately after the test. Solvent was observed leaking from the front and rear of the fuel tank. Actual leakage location is in an unidentified region of the fuel tank.

FMVSS REQUIREMENT, PARAGRAPHS:

5.2 Collection of Stoddard Spillage

NOTIFICATION TO NHTSA

Date: 8/24/12 By: Kelsey Chiu

REMARKS:

None.

**APPENDIX A
PHOTOGRAPHS**

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FIGURE 1. Vehicle Certification Label



FIGURE 2. Vehicle Tire Placard



FIGURE 3. Pre-Test Front of Test Vehicle



FIGURE 4. Post-Test Front of Test Vehicle



FIGURE 5. Pre-Test Left Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 6. Post-Test Left Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 7. Pre-Test Left View of Test Vehicle



FIGURE 8. Post-Test Left View of Test Vehicle



FIGURE 9. Pre-Test Left Rear $\frac{3}{4}$ View of Test Vehicle



FIGURE 10. Post-Test Left Rear $\frac{3}{4}$ View of Test Vehicle



FIGURE 11. Pre-Test Rear View of Test Vehicle



FIGURE 12. Post-Test Rear View of Test Vehicle



FIGURE 13. Pre-Test Right Rear $\frac{3}{4}$ View of Test Vehicle



FIGURE 14. Post-Test Right Rear $\frac{3}{4}$ View of Test Vehicle



FIGURE 15. Pre-Test Right View of Test Vehicle



FIGURE 16. Post-Test Right View of Test Vehicle



FIGURE 17. Pre-Test Right Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 18. Post-Test Right Front $\frac{3}{4}$ View of Test Vehicle

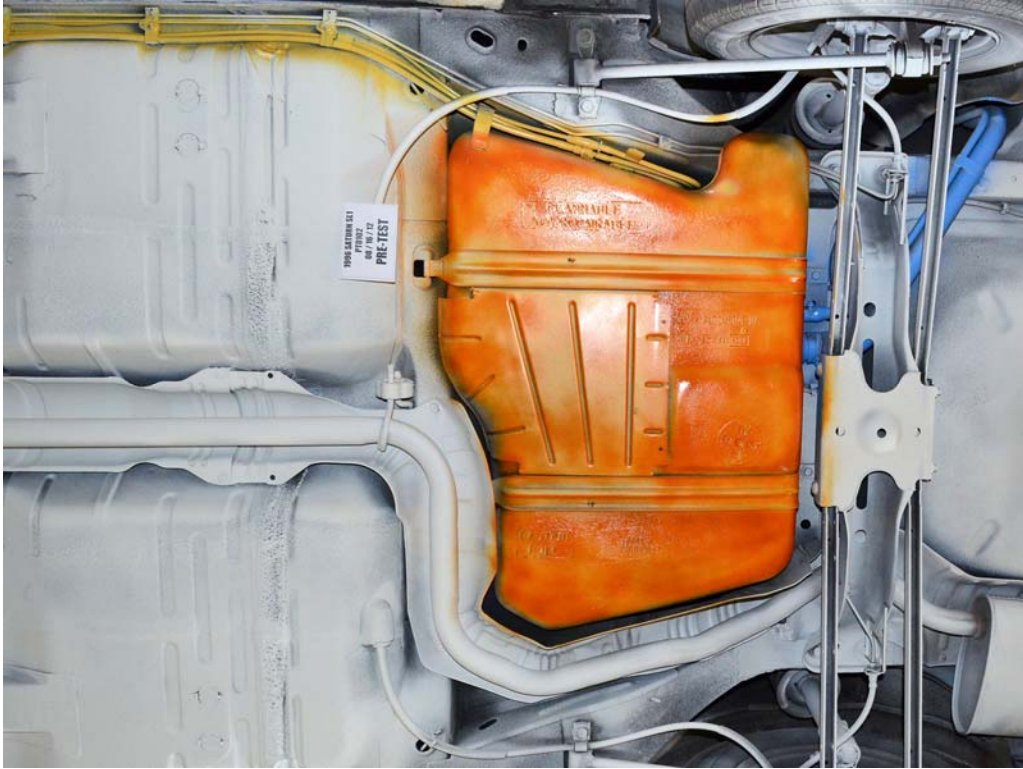


FIGURE 19. Pre-Test Underbody, Fuel Tank Location

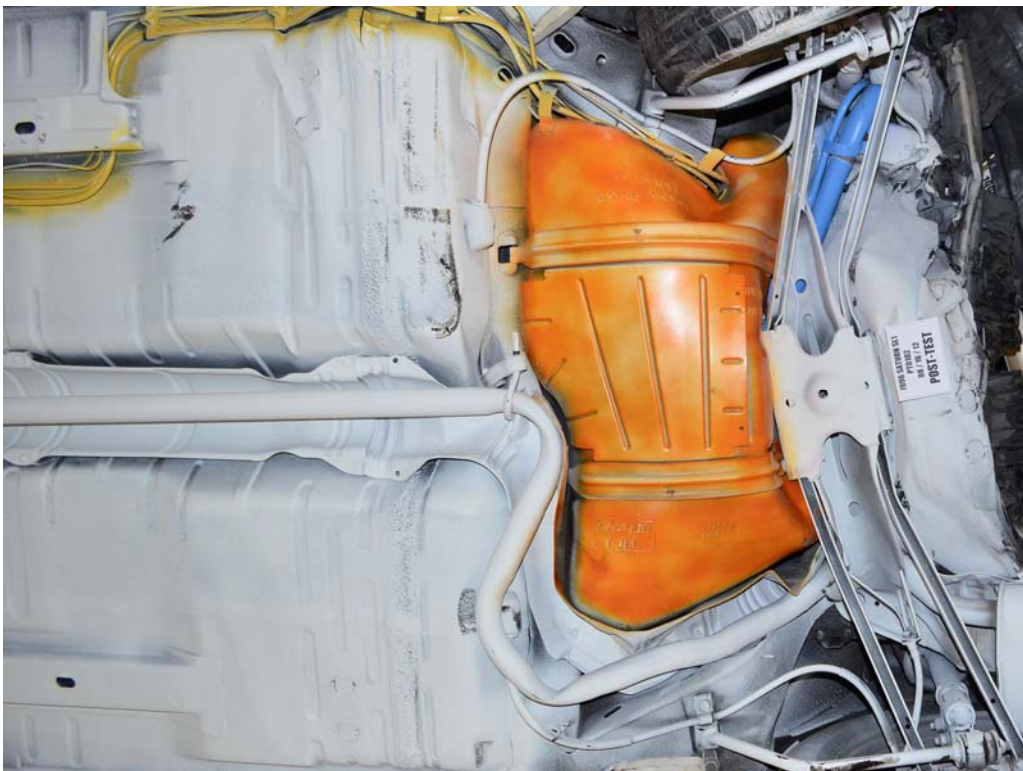


FIGURE 20. Post-Test Underbody, Fuel Tank Location



FIGURE 21. Pre-Test Underbody, Fuel Filler Neck Location



FIGURE 22. Post-Test Underbody, Fuel Filler Neck Location



FIGURE 23. Pre-Test Underbody, Fuel Line Location



FIGURE 24. Post-Test Underbody, Fuel Line Location



FIGURE 25. Vehicle at 0° on Static Rollover Device



FIGURE 26. Vehicle at 90° on Static Rollover Device



FIGURE 27. Vehicle at 180° on Static Rollover Device



FIGURE 28. Vehicle at 270° on Static Rollover Device



FIGURE 29. Vehicle at 360° on Static Rollover Device



FIGURE 30. Post-Test Stoddard Solvent Spillage Location View