REPORT NUMBER: 301-CAL-03-05

SAFETY COMPLIANCE TESTING FOR FMVSS 301
FUEL SYSTEM INTEGRITY

SATURN CORPORATION
2003 SATURN ION
4-DOOR SEDAN

NHTSA NUMBER: C30112

VERIDIAN TEST NUMBER: 8635-301-14

August 4, 2003

VERIDIAN ENGINEERING
P.O. BOX 400
BUFFALO, NEW YORK 14225

FINAL REPORT

PREPARED FOR:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Safety Assurance
Office of Vehicle Safety Compliance
400 Seventh Street, S.W.
Room No. 6115 (NV-220)
Washington, DC 20590
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Prepared By: 

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Approved By: 

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Transportation Sciences Center

Approval Date: 

August 12, 2003

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted By: 

[Signature]

Acceptance Date: 

[Signature]

[Date]
Compliance tests were conducted on the subject 2003 Saturn Ion 4-Door Sedan in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-301-03 for the determination of FMVSS 301 compliance. For the purpose of acquiring information for applied research, two instrumented Anthropomorphic Test Devices (ATDs) were placed in the front occupant seating positions and various instrumentation was added to the test vehicle. Test failures identified were as follows:

The test vehicle appeared to comply with all requirements of FMVSS 301 "Fuel System Integrity."
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<th>Title</th>
<th>Page No.</th>
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SECTION 1
PURPOSE OF COMPLIANCE TEST

This 30 mph rear moving barrier impact test is part of the Federal Motor Vehicle Safety Standard (FMVSS) 301
Compliance Test Program conducted for the National Highway Traffic Safety Administration (NHTSA) by Veridian
Engineering under Contract No. D7NH22-01-C-01025. The purpose of this test was to determine if the subject vehicle, a
2003 Saturn Ion 4 Door Sedan, meets the performance requirements of FMVSS No. 301, "Fuel System Integrity." This
compliance test was conducted using the requirements found in the OVSC Laboratory Test Procedure No. TP-301-03, dated
SECTION 2

COMPLIANCE TEST RESULTS SUMMARY

A 1431.5 kg 2003 Saturn Ion 4-Door Sedan was impacted from the rear by an 1797 pound moving barrier at a velocity of 48.1 kph (29.9 mph). The test was performed by Veridian Engineering on August 4, 2003.

The test vehicle was equipped with a 51.5 liter fuel tank which was filled to 92 percent capacity with standard fluid prior to impact. Additional ballast was not required to achieve vehicle test weight. For the purpose of acquiring information for applied research, one instrumented Part 572 C 50th percentile male Anthropomorphic Test Device (ATD) and one instrumented Part 572 O 5th percentile female ATD were placed in the front occupant seating positions and various instrumented were added to the test vehicle. Research data is presented in a separate report.

The crash event was recorded by ten high speed cameras and one real-time camera. Camera locations and other pertinent camera information are found on pages 3-9 and 3-10 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 403 millimeters. The vehicle appeared to comply with all the requirements of FMVSS No. 301 "Fuel System Integrity."
SECTION 3

COMPLIANCE TEST DATA
TEST VEHICLE INFORMATION:

Year/Make/Model/Body Style: 2003 Saturn Ion 4 Door Sedan

NHTSA No.: C30112; Color: Silver

Engine Data: 4 Cylinders; CID: 2.2 Liters

Transmission Data: 5 Speeds; X Manual; Automatic: Overdrive

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

Major Options: A/C; Power Steering; Power Brakes

- Power Windows; Power Door Locks; Tilt Wheel

Date Received: 04/19/03; Odometer Reading 187 km

Selling Dealer: Saturn of Orchard Park, 3559 Southwestern Blvd., Orchard Park, NY 14127

DATA FROM VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufactured by: Saturn Corporation

Date of Manufacture: 01/03

VIN: 1GGA552603Z1358200

GVWR: 1644 kg; GAWR-FRONT: 833 kg; GAWR-REAR: 811 kg

DATA FROM VEHICLE'S TIRE LABEL:

Location of Placement on Vehicle: Glove compartment door

Recommended Tire Size: P185/70R14 S

*Recommended Cold Tire Pressure: FRONT: 210 kPa; REAR: 210 kPa

DATA FROM TIRE SIDEWALL:

Size of Tires on Test Vehicle: P185/70R14 87S

Tire Pressure with Maximum Capacity Vehicle Load: FRONT: 300 kPa; REAR: 300 kPa

Type of Spare Tire: Temporary TL155/70R14

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) = 408 kg

No. of Occupants x 68.04 kg = 340.2 kg

Rated Cargo/Luggage Weight (RCLW) = 87.8 kg

* Tire pressure used for test
WEIGHT OF TEST VEHICLE AS RECEIVED FROM DEALER (with maximum fluids) = UDW:

Right Front = 359.5 kg  
Left Front = 364.5 kg  
TOTAL FRONT = 724.0 kg

Right Rear = 247.0 kg  
Left Rear = 249.0 kg  
TOTAL REAR = 496.0 kg

TOTAL DELIVERED WEIGHT = 1220.0 kg

% of Total Front of Vehicle Weight = 59.3%  
% of Total Rear Weight = 40.7%

CALCULATION OF VEHICLE'S TARGET TEST WEIGHT:

Total Delivered Weight = 1220.0 kg
Rated Cargo/Luggage Weight (RCLW) = 67.8 kg
Weight of 2 p.572 Dummies, 74.4 kg

TARGET TEST WEIGHT = 1436.6 kg

WEIGHT OF TEST VEHICLE WITH TWO DUMMIES AND 62.7 KG OF CARGO WEIGHT:

Right Front = 430.5 kg  
Left Front = 449.5 kg  
TOTAL FRONT = 880.0 kg

Right Rear = 267.5 kg  
Left Rear = 284.0 kg  
TOTAL REAR = 551.5 kg

TOTAL TEST WEIGHT = 1436.5 kg

% of Total Front of Vehicle Weight = 61.5%  
% of Total Rear Weight = 38.5%

* Weight of Ballast Secured in Vehicle Trunk Area = 0 kg

Type of Ballast: None

Method of Securing Ballast: None

Vehicle Components Removed for Weight Reduction: Bumper cover, front door glass, rear door trim and glass, engine air intake ducts.

VEHICLE ATTITUDE (all dimension in millimeters):

AS DELIVERED: RF 715  LI 714  RR 714  LR 711

AS TESTED: RF 673  LI 663  RR 709  LR 698

Vehicle's Wheel Base: 2622 mm

Location of Vehicle's C.G.: 1010 millimeters rearward of front wheel center.

FUEL SYSTEM DATA:

Fuel System Capacity From Owner's Manual = 51.1 liters
Usable Capacity Figure Furnished by COITR = 51.5 liters
Test Volume Range (91 to 94% of Usable Capacity) = 46.87 to 48.41 liters

ACTUAL TEST VOLUME = 47.3 liters (with entire fuel system filled)

* Ballast weight includes the RCLW, the weight of drained vehicle fluids and the weight of any removed vehicle components less the weight of onboard instrumentation, cameras, and hardware.
**DATA SHEET 2 (continued)**

**PRE-TEST DATA**

**FULL SYSTEM DATA (continued):**

<table>
<thead>
<tr>
<th>Test Fluid Type:</th>
<th>Stoddard Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Fluid Specific Gravity:</td>
<td>0.764</td>
</tr>
<tr>
<td>Test Fluid Kinematic Viscosity:</td>
<td>0.96 centistokes</td>
</tr>
<tr>
<td>Test Fluid Color:</td>
<td>Orange (&quot;red&quot; is preferred)</td>
</tr>
<tr>
<td>Type of Vehicle Fuel Pump:</td>
<td>Electric</td>
</tr>
</tbody>
</table>

**Electric Fuel Pump Operation with Ignition Switch ON and Engine OFF -**

When ignition is switched on without starting the engine, the fuel pump operates for several seconds then shuts off.

**Details of Fuel System:** Fuel filler is located on the left rear quarter panel aft of the rear axle; Fuel tank is located on the vehicle underbody beneath the rear seat and forward of the rear axle. Fuel lines are routed along the left side of the vehicle underbody.

**Comments:** None

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DATA SHEET 3
MOVING BARRIER DATA

WEIGHT OF MOVING BARRIER:

Right Front  = 504.9 kg
Left Front   = 499.9 kg
TOTAL FRONT = 1004.8 kg

Right Rear  = 393.7 kg
Left Rear   = 398.3 kg
TOTAL REAR = 792.0 kg

TOTAL BARRIER WEIGHT = 1796.8 kg

MOVING BARRIER DIMENSIONS:

Barrier Face Height: 1524 mm
Barrier Face Width: 1981 mm
Barrier Face Ground Clearance: 127 mm
Tread Width: 1511 mm
Wheel Base: 3048 mm

Location of C.G.:
X: 1344 mm rearward of front wheel center.
Y: 0 mm from longitudinal-vertical plane of symmetry.
Z: 414 mm above ground.

MOVING BARRIER TIRES:

Manufacturer: Classic
Model: Poly IV
Size: 215/75R15
Recommended Max Pressure: 240 kPa.

MOVING BARRIER ABORT SYSTEM:

Type: Trailing cable
DATA SHEET 4
POST TEST DATA

TYPE OF TEST:

<table>
<thead>
<tr>
<th>Type of Test:</th>
<th>Rear Barrier</th>
<th>Impact Angle:</th>
<th>0°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Date:</td>
<td>August 4, 2003</td>
<td>Time:</td>
<td>11:58</td>
</tr>
<tr>
<td>Vehicle NHTSA No.:</td>
<td>C30112</td>
<td>VIN:</td>
<td>1G6AF52F03Z138200</td>
</tr>
<tr>
<td>Required Impact Velocity Range:</td>
<td>46.51 to 48.12 kph</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BARRIER IMPACT VELOCITY: (Speed traps within 5 feet of impact plane.)

<table>
<thead>
<tr>
<th>Trap No. 1</th>
<th>Trap No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>48.1 kph</td>
<td>48.1 kph</td>
</tr>
</tbody>
</table>

Average Impact Speed = 48.1 kph

VEHICLE STATIC CRUSH:

<table>
<thead>
<tr>
<th>Vehicle Length:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test Left = 4523; CL = 4683; Right = 4525</td>
</tr>
<tr>
<td>Post-Test Left = 4112; CL = 4212; Right = 4198</td>
</tr>
<tr>
<td>Crush Left = 411; CL = 471; Right = 327</td>
</tr>
<tr>
<td>AVERAGE = 403 millimeters</td>
</tr>
</tbody>
</table>
DATA SHEET 4 (continued)

POST TEST DATA

TEST VEHICLE NHTSA NO.: C30112  TEST DATE: August 4, 2003
Vehicle Mfr./Make/Model: 2003 Saturn Ion 4-Door Sedan
Test vehicle fuel tank filled to 91% to 94% of manufacturer's "usable" capacity and with electric fuel pump operating (if it will operate without engine operation). Part 572 test dummies located at each front designated seating position.

*******************************
TEST VEHICLE IMPACT TYPE:

- Frontal (42.28 kph target velocity)
- Oblique (42.28 kph target velocity) with ______ barrier face first contacting _______ (driver/passenger) side
- X Rear Moving Barrier (42.28 kph target velocity)
- Lateral Moving Barrier (32.19 kph target velocity)

FUEL SPILLAGE MEASUREMENT:

1. From impact until vehicle motion ceases
   ACTUAL MAX ALLOWED
   0  28 g

2. For five minute period after vehicle motion ceases
   0  28 g

3. For next 25 minutes
   0  28 g/min

SOLVENT SPILLAGE DETAILS:
None
DATA SHEET 5

STATIC ROLLOVER TEST DATA

Table 7: FMVSS NO. 301 - STATIC ROLLOVER DATA SHEET

Vehicle: 2003 Saturn Ion 4-Door Sedan

NHTSA No.: C30112

I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

<table>
<thead>
<tr>
<th>Rollover Stage</th>
<th>Rotation Time (spec. 1-3 min)</th>
<th>FMVSS 301 Hold Time</th>
<th>Total Time</th>
<th>Next Whole Minute Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>0° - 90°</td>
<td>1 minutes 14 seconds</td>
<td>5 minutes</td>
<td>6 minutes</td>
<td>14 seconds 7 minutes</td>
</tr>
<tr>
<td>90° - 180°</td>
<td>1 minutes 4 seconds</td>
<td>5 minutes</td>
<td>6 minutes</td>
<td>4 seconds 7 minutes</td>
</tr>
<tr>
<td>180° - 270°</td>
<td>1 minutes 2 seconds</td>
<td>5 minutes</td>
<td>6 minutes</td>
<td>2 seconds 7 minutes</td>
</tr>
<tr>
<td>270° - 360°</td>
<td>1 minutes 10 seconds</td>
<td>5 minutes</td>
<td>6 minutes</td>
<td>10 seconds 7 minutes</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>First 5 minutes from onset of rotation</th>
<th>6th min.</th>
<th>7th min.</th>
<th>8th min. (if required)</th>
</tr>
</thead>
<tbody>
<tr>
<td>142 g</td>
<td>28 g</td>
<td>28 g</td>
<td>28 g</td>
</tr>
</tbody>
</table>

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

<table>
<thead>
<tr>
<th>Rollover Stage</th>
<th>First 5 minutes from onset of rotation (g)</th>
<th>6th min. (g)</th>
<th>7th min. (g)</th>
<th>8th min. (if required) (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0° - 90°</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>90° - 180°</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>180° - 270°</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>270° - 360°</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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

IV. SOLVENT SPILLAGE LOCATION(S):

<table>
<thead>
<tr>
<th>Rollover Stage</th>
<th>Spillage Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>0° - 90°</td>
<td>None</td>
</tr>
<tr>
<td>90° - 180°</td>
<td>None</td>
</tr>
<tr>
<td>180° - 270°</td>
<td>None</td>
</tr>
<tr>
<td>270° - 360°</td>
<td>None</td>
</tr>
</tbody>
</table>
DATA SHEET 6
HIGH SPEED CAMERA LOCATIONS

REAL TIME CAMERA →

NO STEEL GRATING ALLOWED OVER PHOTO PIT

CONCRETE PAD

TOP VIEW

MOVING BARRIER

PHOTO PIT

LEFT SIDE VIEW
### DATA SHEET 6 (continued)

**HIGH SPEED CAMERA LOCATIONS**

**NIITSA No.: C30112**  
**Vehicle:** 2003 Saturn Ion 4-Door Sedan

<table>
<thead>
<tr>
<th>CAMERA NO.</th>
<th>VIEW</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>ANGLE**</th>
<th>LENS (mm)</th>
<th>SPEED (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Real-Time Camera</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Right Side View</td>
<td>140</td>
<td>1690</td>
<td>1695</td>
<td>-1</td>
<td>35</td>
<td>1000</td>
</tr>
<tr>
<td>3</td>
<td>Left Side View</td>
<td>165</td>
<td>2078</td>
<td>1600</td>
<td>1</td>
<td>35</td>
<td>1000</td>
</tr>
<tr>
<td>4</td>
<td>Vehicle front Underbody View</td>
<td>0</td>
<td>3380</td>
<td>-1956</td>
<td>90</td>
<td>13</td>
<td>995</td>
</tr>
<tr>
<td>5</td>
<td>Vehicle Mid Section</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Underbody View</td>
<td>0</td>
<td>1938</td>
<td>-1956</td>
<td>90</td>
<td>13</td>
<td>1005</td>
</tr>
<tr>
<td>6</td>
<td>Vehicle Rear Underbody View</td>
<td>0</td>
<td>992</td>
<td>1956</td>
<td>90</td>
<td>13</td>
<td>1030</td>
</tr>
<tr>
<td>7</td>
<td>Moving Barrier View</td>
<td>0</td>
<td>0</td>
<td>2515</td>
<td>-105</td>
<td>13</td>
<td>1000</td>
</tr>
<tr>
<td>8</td>
<td>Overhead Overall View</td>
<td>-508</td>
<td>0</td>
<td>9804</td>
<td>.90</td>
<td>13</td>
<td>1000</td>
</tr>
<tr>
<td>9†</td>
<td>Onboard Driver View</td>
<td>855</td>
<td>2715</td>
<td>970</td>
<td>.6</td>
<td>8</td>
<td>1000</td>
</tr>
<tr>
<td>10†</td>
<td>Onboard Passenger View</td>
<td>855</td>
<td>2702</td>
<td>970</td>
<td>.5</td>
<td>8</td>
<td>1000</td>
</tr>
</tbody>
</table>

* X = film plane to monorail centerline (+ to left of rail)  
Y = film plane to impact location (+ ahead of impact location)  
Z = film plane to ground (+ above ground)  
** = referenced to horizontal plane

† Research cameras.
Appendix A

PHOTOGRAPHS
<table>
<thead>
<tr>
<th>Figure</th>
<th>Photograph Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>PRE-TEST FRONT VIEW</td>
<td>A-3</td>
</tr>
<tr>
<td>A-2</td>
<td>POST-TEST FRONT VIEW</td>
<td>A-4</td>
</tr>
<tr>
<td>A-3</td>
<td>PRE-TEST LEFT SIDE VIEW</td>
<td>A-5</td>
</tr>
<tr>
<td>A-4</td>
<td>POST-TEST LEFT SIDE VIEW</td>
<td>A-6</td>
</tr>
<tr>
<td>A-5</td>
<td>PRE-TEST RIGHT SIDE VIEW</td>
<td>A-7</td>
</tr>
<tr>
<td>A-6</td>
<td>POST-TEST RIGHT SIDE VIEW</td>
<td>A-8</td>
</tr>
<tr>
<td>A-7</td>
<td>PRE TEST REAR VIEW</td>
<td>A-9</td>
</tr>
<tr>
<td>A-8</td>
<td>POST TEST REAR VIEW</td>
<td>A-10</td>
</tr>
<tr>
<td>A-9</td>
<td>PRE-TEST LEFT FRONT THREE-QUARTER VIEW</td>
<td>A-11</td>
</tr>
<tr>
<td>A-10</td>
<td>POST-TEST LEFT FRONT THREE QUARTER VIEW</td>
<td>A-12</td>
</tr>
<tr>
<td>A-11</td>
<td>PRE-TEST RIGHT REAR THREE-QUARTER VIEW</td>
<td>A-13</td>
</tr>
<tr>
<td>A-12</td>
<td>POST-TEST RIGHT REAR THREE-QUARTER VIEW</td>
<td>A-14</td>
</tr>
<tr>
<td>A-13</td>
<td>PRE-TEST FRONT UNDERBODY VIEW</td>
<td>A-15</td>
</tr>
<tr>
<td>A-14</td>
<td>POST-TEST FRONT UNDERBODY VIEW</td>
<td>A-16</td>
</tr>
<tr>
<td>A-15</td>
<td>PRE-TEST REAR UNDERBODY VIEW</td>
<td>A-17</td>
</tr>
<tr>
<td>A-16</td>
<td>POST-TEST REAR UNDERBODY VIEW</td>
<td>A-18</td>
</tr>
<tr>
<td>A-17</td>
<td>CERTIFICATION PLACARD</td>
<td>A-19</td>
</tr>
<tr>
<td>A-18</td>
<td>TIRE PLACARD</td>
<td>A-20</td>
</tr>
<tr>
<td>A-19</td>
<td>ROLLOVER 90°</td>
<td>A-21</td>
</tr>
<tr>
<td>A-20</td>
<td>ROLLOVER 180°</td>
<td>A-22</td>
</tr>
<tr>
<td>A-21</td>
<td>ROLLOVER 270°</td>
<td>A-23</td>
</tr>
<tr>
<td>A-22</td>
<td>ROLLOVER 360°</td>
<td>A-24</td>
</tr>
</tbody>
</table>
TIRE-LOADING INFORMATION

OCCUPANTS: VEHICLE CAPACITY
FR. CTR. RR. TOTAL
9 3 5

MAXIMUM LOADING AT GVWR:
SAME AS VEHICLE CAPACITY WEIGHT.

2262
COLD TIRE PRESSURE:

TIRE SIZE: SPEED RATING: PSI:
FRONT: P135/70R14 9 60
REAR: P155/70R14 H 60

LOAD:
FRONT: 115/70R14
REAR: 115/70R14

IF TIRES ARE HOT, ADD 4 PSI (28 XPS).

SEE OWNER'S MANUAL FOR ADDITIONAL INFORMATION.

Figure A-18: TIRE-PLACARD