

Report Number 301-DYS-78-040

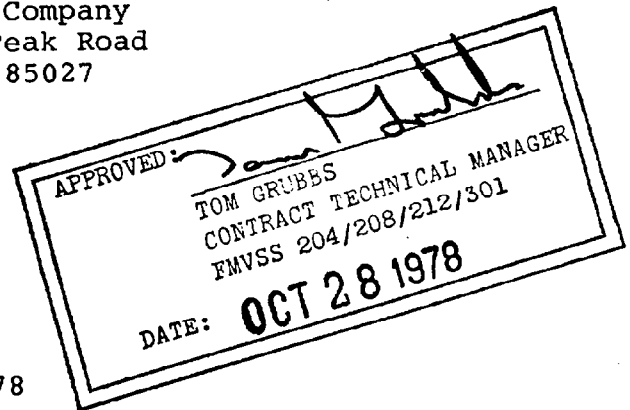
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DOT 0106

FMVSS 301 STANDARDS ENFORCEMENT TESTING
OF FUEL SYSTEM INTEGRITY

General Motors Corporation
1978 Chevrolet Malibu Classic Four-Door Sedan
NHTSA 780101

Dynamic Science, Inc.
A Talley Industries Company
1850 West Pinnacle Peak Road
Phoenix, Arizona 85027



September 1978

FINAL REPORT

Prepared for:

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
Office of Vehicle Safety Compliance
2100 Second Street, S.W.
Washington, D.C. 20590

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dsi Dynamic Science Inc.

a TALLEY INDUSTRIES Company

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Final Report Accepted by:

TOM GRUBBS

Contract Technical Manager

OCT 28 1978

Date

TECHNICAL REPORT STANDARD TITLE PAGE

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16. Abstract FMVSS 301 Standards Enforcement Test of a 1978 Chevrolet Malibu Classic Four-Door Sedan, NHTSA 780101, VIN 1W19U8K426501, was conducted at the Dynamic Science, Inc. Deer Valley facility in Phoenix, Arizona, to determine compliance with the requirements of Standard 301. The moving barrier impacted the rear of the vehicle at a speed of 29.83 mph. The test date was September 13, 1978 and the ambient temperature was 90°F. The vehicle appeared to comply with the requirements of FMVSS 301 as specified for the vehicle manufacture date. CTM's COPY					
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METRIC CONVERSION FACTORS

Approximate Conversions
from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares	2.5	acres	
(10 000 m ²)				
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric ton	1.1	short tons	
(1000 kg)				
VOLUME				
mL	milliliters	0.03	fluid ounces	fl oz
mL	milliliters	0.06	cubic inches	in ³
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m ³	cubic meters	35	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³
TEMPERATURE (exact)				
°C	degrees Celsius	9/5 (then add 32)	degrees Fahrenheit	°F

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
acres	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons	0.9	metric ton	t
(2000 lb)				
VOLUME				
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
in ³	cubic inches	16	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³
TEMPERATURE (exact)				
°F	degrees Fahrenheit	5/9 (after subtracting 32)	degrees Celsius	°C

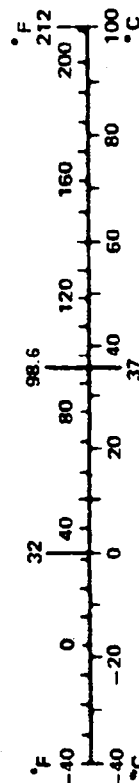


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1.0 PURPOSE AND TEST PROCEDURE

1.1 PURPOSE

The purpose of the test was to evaluate the integrity of the vehicle fuel system in accordance with the requirements of Federal Motor Vehicle Safety Standard (FMVSS) 301 entitled "Fuel System Integrity."

1.2 TEST PROCEDURE

The Dynamic Science, Inc. Test Procedure for FMVSS 301 submitted to and approved by the Contract Technical Monitor (CTM) contains the specific procedures used to conduct this test.

2.0 SUMMARY OF VEHICLE PERFORMANCE

1978 Chevrolet Malibu Classic Four-Door Sedan, NHTSA 780101.

2.1 PRIMARY RESULTS

The impact velocity was 29.83 mph.

No fuel spillage occurred during and following barrier impact or the static rollover.

The vehicle therefore appeared to comply with the requirements of FMVSS 301 as specified for the vehicle manufacture date.

2.2 SECONDARY RESULTS

The vehicle average static crush was 15.15 inches.

The ambient temperature at the time of the test was 90°F and the vehicle had been in that environment for several hours prior to the test.

The door locks were set in the unlocked position prior to the test and they remained unlocked during the test. Following the test, both front doors opened easily. Both rear doors required tools to open.

3.0 TEST RESULTS AND IMPACT EFFECTS

The following data sheets report:

- Test conditions (pages 3-2 and 3-3)
- Post-impact data (page 3-4)
- Fuel system leakage data (pages 3-5 through 3-8).

A description of the impact effects follows the data sheets (page 3-9).

SUMMARY OF TEST CONDITIONS
1978 Chevrolet Malibu Classic Four-Door Sedan, NHTSA 780101

TEST VEHICLE IDENTIFICATION

Manufacturer: General Motors Corporation
Make/Model: Chevrolet Malibu
Body Style: Four-Door Sedan Model Year: 1978
VIN: 1W19U8K426501 ; Build Date: 10/77
NHTSA No.: 780101 ; Color: Brown
Engine Data: 8 cylinders; 305 c.i.d.
Transmission Data: - speed
☐ Manual ☒ Automatic
Major Options: Power Brakes, Tinted Glass, Radio, Power
Steering, Air Conditioning

TEST CONDITIONS

Date of Test: September 13, 1978 ; Time of Test: 1434
Ambient Temperature 90 °F at impact area

TEST VEHICLE WEIGHT (data taken from tire pressure placard)

Vehicle Capacity Weight: 1060 lb
Designated Seating Capacity: Front 3
Rear 3
Total 6

GVWR (taken from Certification Label): 4515 lb
GAWR Front: 2195 lb
GAWR Rear: 2320 lb

Vehicle Delivered Weight Front: 1899 lb
(fluids to capacity) Rear: 1423 lb
Total: 3322 lb

Calculated Vehicle Test Weight: 3810 lb

Actual Vehicle Test Weight Front: 1970 lb
Rear: 1831 lb
Total: 3801 lb

REMARKS: _____

1978 CHEV. MALIBU
#780101

SUMMARY OF TEST CONDITIONS (CONTD)
1978 Chevrolet Malibu Classic Four-Door Sedan, NHTSA 780101

VEHICLE ATTITUDE: (all dimensions in inches)

Delivered Attitude: RF 31.0 LF 31.0 RR 31.0 LR 31.0
Test Attitude: RF 29.1 LF 30.6 RR 31.0 LR 28.9

VEHICLE TIRE DATA

Recommended Cold Tire Pressure: Front 26 psi
Rear 29 psi
Recommended Tire Size: P195/75R14
Load Range: B
Tires on Vehicle: P195/75R14
Is Spare Tire a "Space Saver": Yes (yes/no)

TEST FLUID DATA

Stoddard Solvent

Test Fluid Type: No. 2; Spec. Grav.: 0.764
Spill Point Volume: 17.9 gallons
Test Volume: 16.7 gallons
Fuel System Capacity
(data from Owner's Manual): 17.5 gallons
Details of fuel system: _____

POST-IMPACT DATA SHEET
1978 Chevrolet Malibu Classic Four-Door Sedan, NHTSA 780101

TYPE OF TEST: Rear IMPACT

DATE OF TEST: September 13, 1978

REQUIRED VELOCITY RANGE (mph): 28.9 to 29.9

IMPACT VELOCITY (mph):

Primary 29.83, Secondary 29.90

VEHICLE STATIC CRUSH (in.):

1.* Driver Side: 16.3 Passenger Side: 14.0

Average: 15.15

Detail: _____

2.** Amount of Crush: _____ on _____ side

Detail: _____

VEHICLE REBOUND*** (in.):

Driver Side: _____, Passenger Side: _____

Average: _____

REMARKS: _____

*For frontal and rear impacts only.

**For side impacts only.

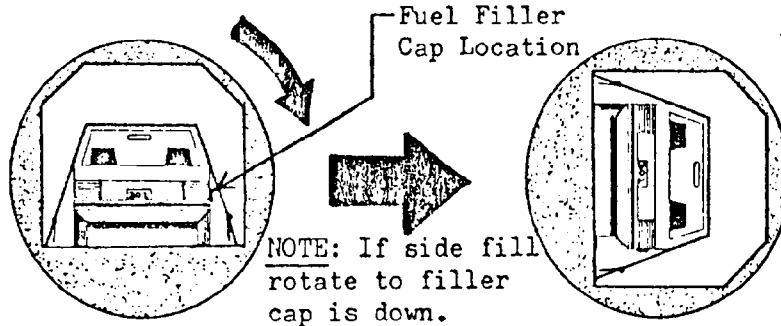
***For rigid barrier only.

FMVSS NO. 301-75 STATIC ROLLOVER DATA SHEET

TEST PHASE:

0°

90°



I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

Rollover Fixture 90° Rotation Time - - = minutes, seconds
(Spec. Range = 1 to 3 minutes)

FMVSS 301-75 Position Hold Time - - - = minutes, seconds

TOTAL - - - - - = minutes, seconds

Next Whole Minute Interval - - - - - = minutes

II. FMVSS 301-75 REQUIREMENTS:

(1) Time Period--

First 5 min. FROM onset of rotation	6th. min.	7th. min.	8th. min. if reqd.
-------------------------------------	-----------	-----------	-----------------------

(2) Maximum Allowable Solvent Spillage--

5 ounces	1 ounce	1 ounce	1 ounce
----------	---------	---------	---------

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

0	0	0	
---	---	---	--

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

IV. SOLVENT SPILLAGE LOCATION(S):

VEH. NHTSA ID NO.:

7	8	0	1	0	1
---	---	---	---	---	---

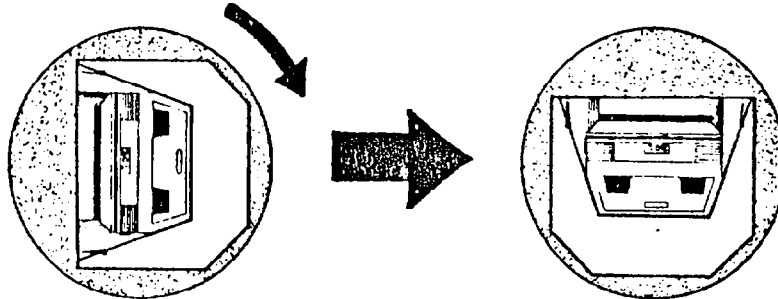
(PAGE 2 OF 4)

FMVSS NO. 301-75 STATIC ROLLOVER DATA SHEET

TEST PHASE:

90 °

180 °



I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

Rollover Fixture 90° Rotation Time - - = minutes, seconds
(Spec. Range = 1 to 3 minutes)

FMVSS 301-75 Position Hold Time - - - = minutes, seconds

TOTAL - - - - - = minutes, seconds

Next Whole Minute Interval - - - - - = minutes

II. FMVSS 301-75 REQUIREMENTS:

(1) Time Period--

First 5 min. FROM onset of rotation	6th. min.	7th. min.	8th. min. if reqd.
-------------------------------------	-----------	-----------	-----------------------

(2) Maximum Allowable Solvent Spillage--

5 ounces	1 ounce	1 ounce	1 ounce
----------	---------	---------	---------

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

0	0	0	0
---	---	---	---

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

IV. SOLVENT SPILLAGE LOCATION(S):

VEH. NHTSA ID NO.:

7	8	0	1	0	1
---	---	---	---	---	---

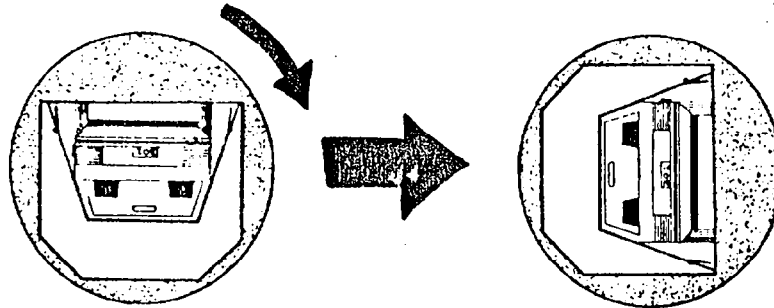
(PAGE 3 OF 4)

FMVSS NO. 301-75 STATIC ROLLOVER DATA SHEET

TEST PHASE:

180 °

270 °



I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

Rollover Fixture 90° Rotation Time - - = minutes, seconds
(Spec. Range = 1 to 3 minutes)

FMVSS 301-75 Position Hold Time - - - = minutes, seconds

TOTAL - - - - - = minutes, seconds

Next Whole Minute Interval - - - - - = minutes

II. FMVSS 301-75 REQUIREMENTS:

(1) Time Period--

First 5 min. FROM onset of rotation	6th. min.	7th. min.	8th. min. if reqd.
-------------------------------------	-----------	-----------	-----------------------

(2) Maximum Allowable Solvent Spillage--

5 ounces	1 ounce	1 ounce	1 ounce
----------	---------	---------	---------

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

0	0	0	
---	---	---	--

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

IV. SOLVENT SPILLAGE LOCATION(S):

VEH. NHTSA ID NO.:

7	8	0	1	0	1
---	---	---	---	---	---

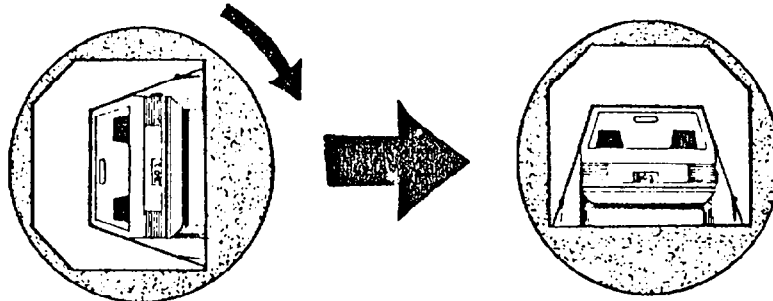
(PAGE 4 OF 4)

FMVSS NO. 301-75 STATIC ROLLOVER DATA SHEET

TEST PHASE:

270°

360°



I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

Rollover Fixture 90° Rotation Time - - = minutes, seconds
(Spec. Range = 1 to 3 minutes)

FMVSS 301-75 Position Hold Time - - - = minutes, seconds

TOTAL - - - - - = minutes, seconds

Next Whole Minute Interval - - - - - = minutes

II. FMVSS 301-75 REQUIREMENTS:

(1) Time Period--

First 5 min. FROM onset of rotation	6th. min.	7th. min.	8th. min. if reqd.
-------------------------------------	-----------	-----------	-----------------------

(2) Maximum Allowable Solvent Spillage--

5 ounces	1 ounce	1 ounce	1 ounce
----------	---------	---------	---------

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

0	0	0	
---	---	---	--

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

IV. SOLVENT SPILLAGE LOCATION(S):

IMPACT EFFECTS

1978 Chevrolet Malibu Classic Four-Door Sedan, NHTSA 780101

VISIBLE DUMMY CONTACT POINTS

	<u>Driver</u>	<u>Passenger</u>
Head	<u>None</u>	<u>None</u>
Chest	<u>None</u>	<u>None</u>
Abdomen	<u>None</u>	<u>None</u>
Left Knee	<u>None</u>	<u>None</u>
Right Knee	<u>None</u>	<u>None</u>

	<u>Front</u>		<u>Rear</u>	
	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
<u>DOOR OPENING</u>				
Easy	<u>X</u>	<u>X</u>	<u></u>	<u></u>
Difficult	<u></u>	<u></u>	<u></u>	<u></u>
Tools Required	<u></u>	<u></u>	<u>X</u>	<u>X</u>

SEAT BACK

Failure Yes

GLAZING DAMAGE

Windshield	<u>None</u>		
Backlight			<u>None</u>
Others	<u>None</u>	<u>None</u>	<u>None</u> <u>None</u>

OTHER NOTABLE IMPACT EFFECTS:

Left rear tire flattened by impact with crushing sheet metal.

Seat moved 1 inch in track.

4.0 PHOTOGRAPHIC COVERAGE

This section consists of pre-test and post-test photographs of the vehicle and fuel system.

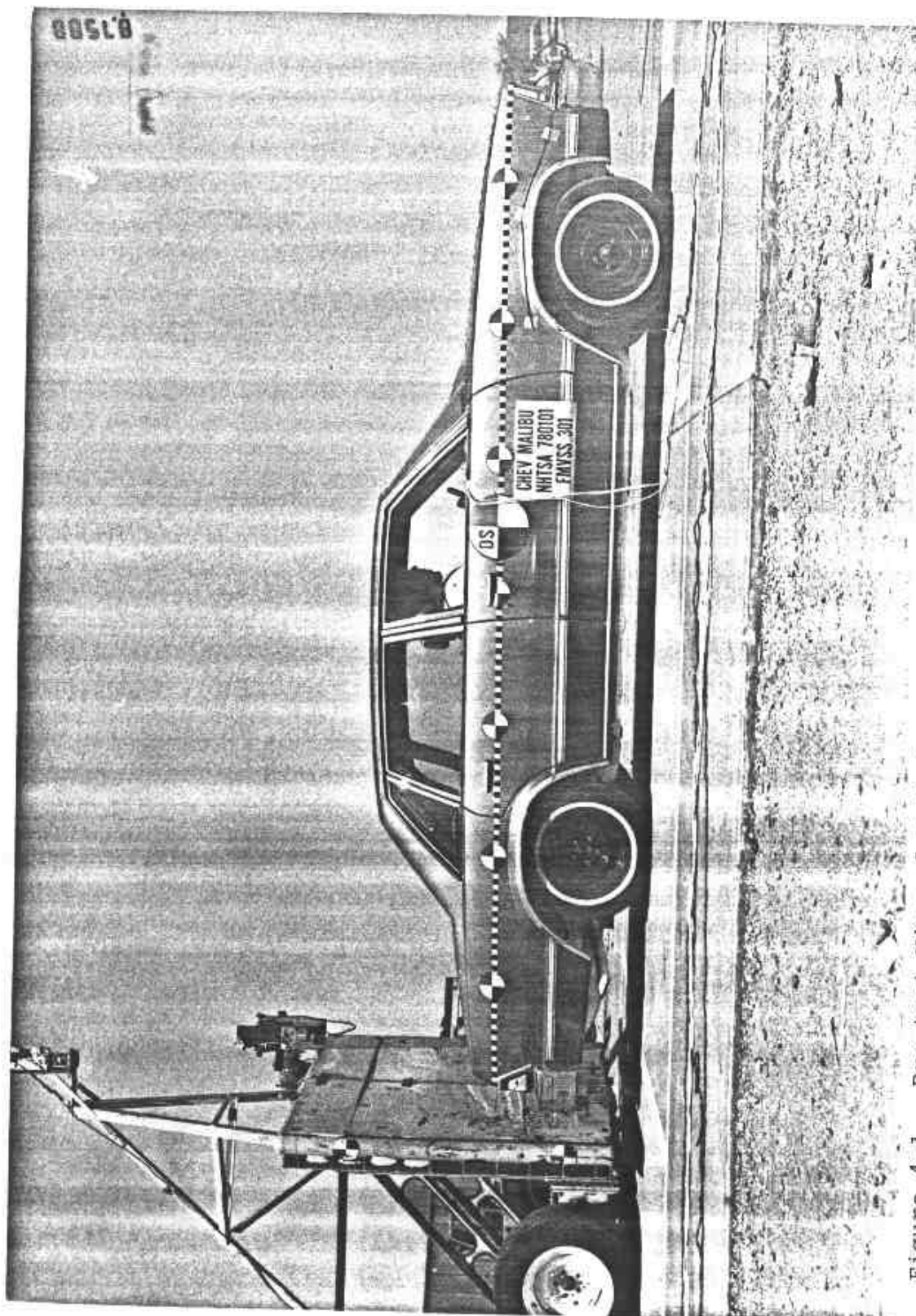


Figure 4-1. Pre-test View of Vehicle-to-Barrier Configuration - 1978 Chevrolet Malibu Classic Four-Door Sedan - NHTSA 780101.

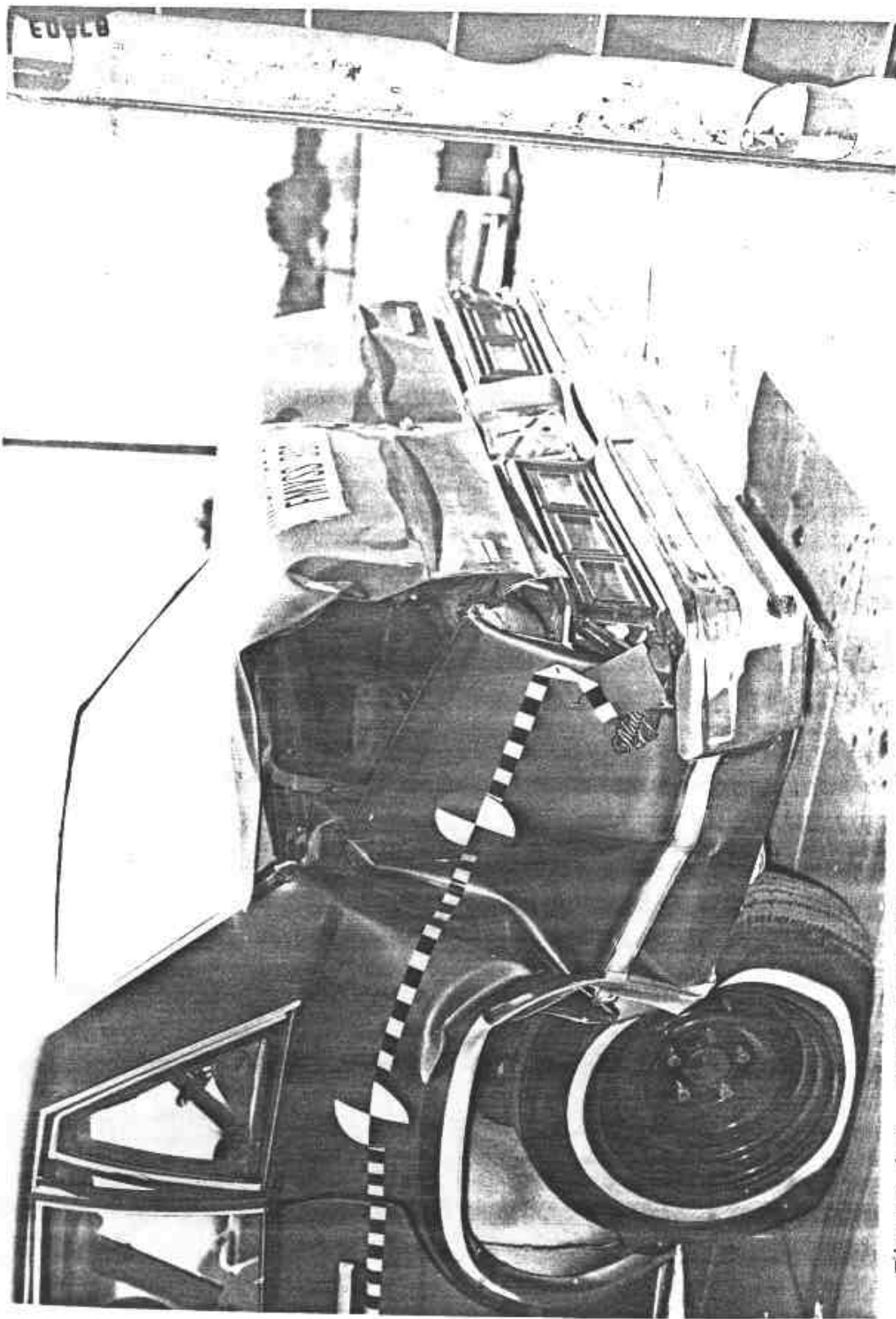


Figure 4-2. Post-test Close-up of Damage to Rear of 1978 Chevrolet Malibu Classic Four-Door Sedan - NHTSA 780101.

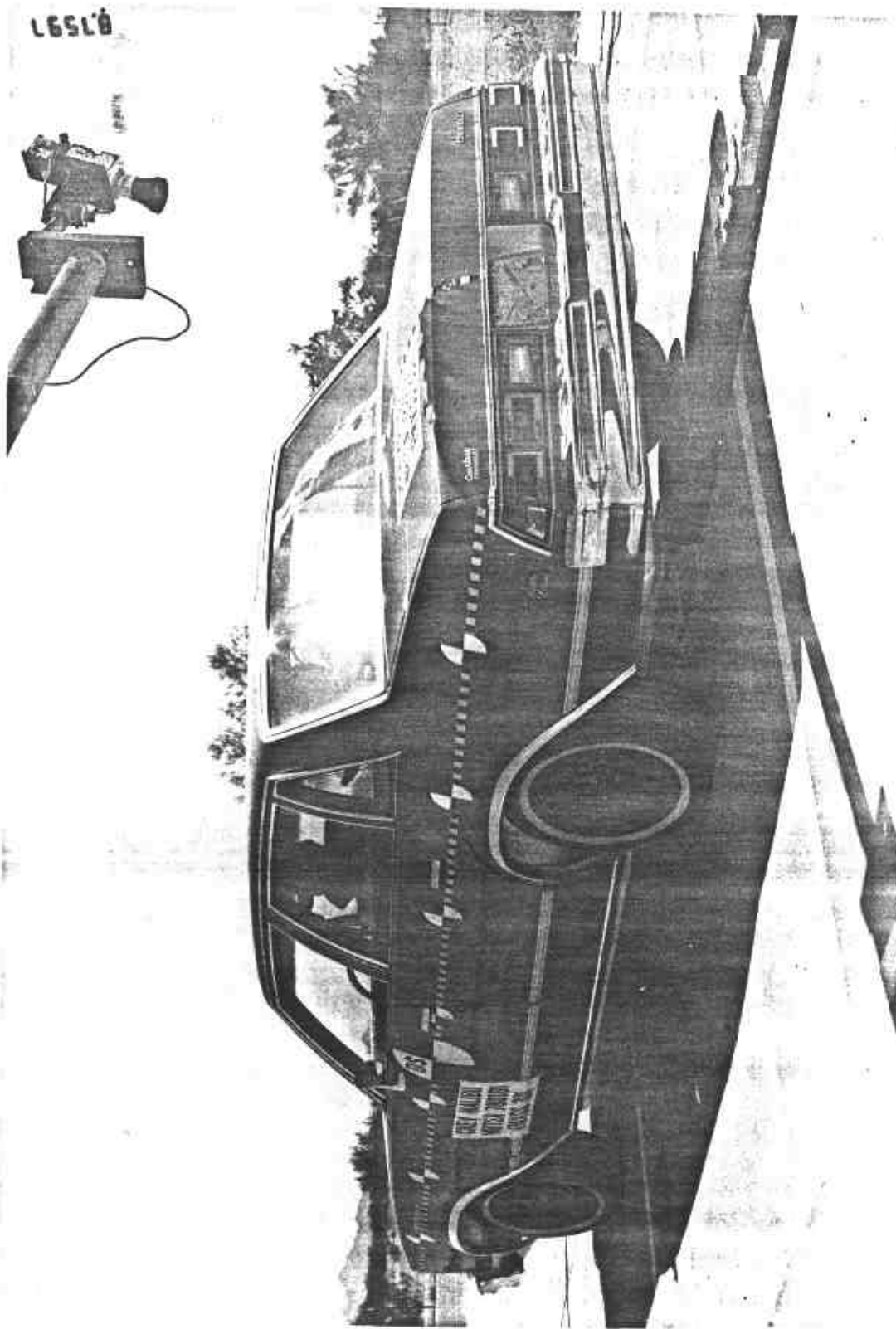


Figure 4-3. Pre-test View of Rear of 1978 Chevrolet Malibu Classic Four-Door Sedan - NHTSA 780101.

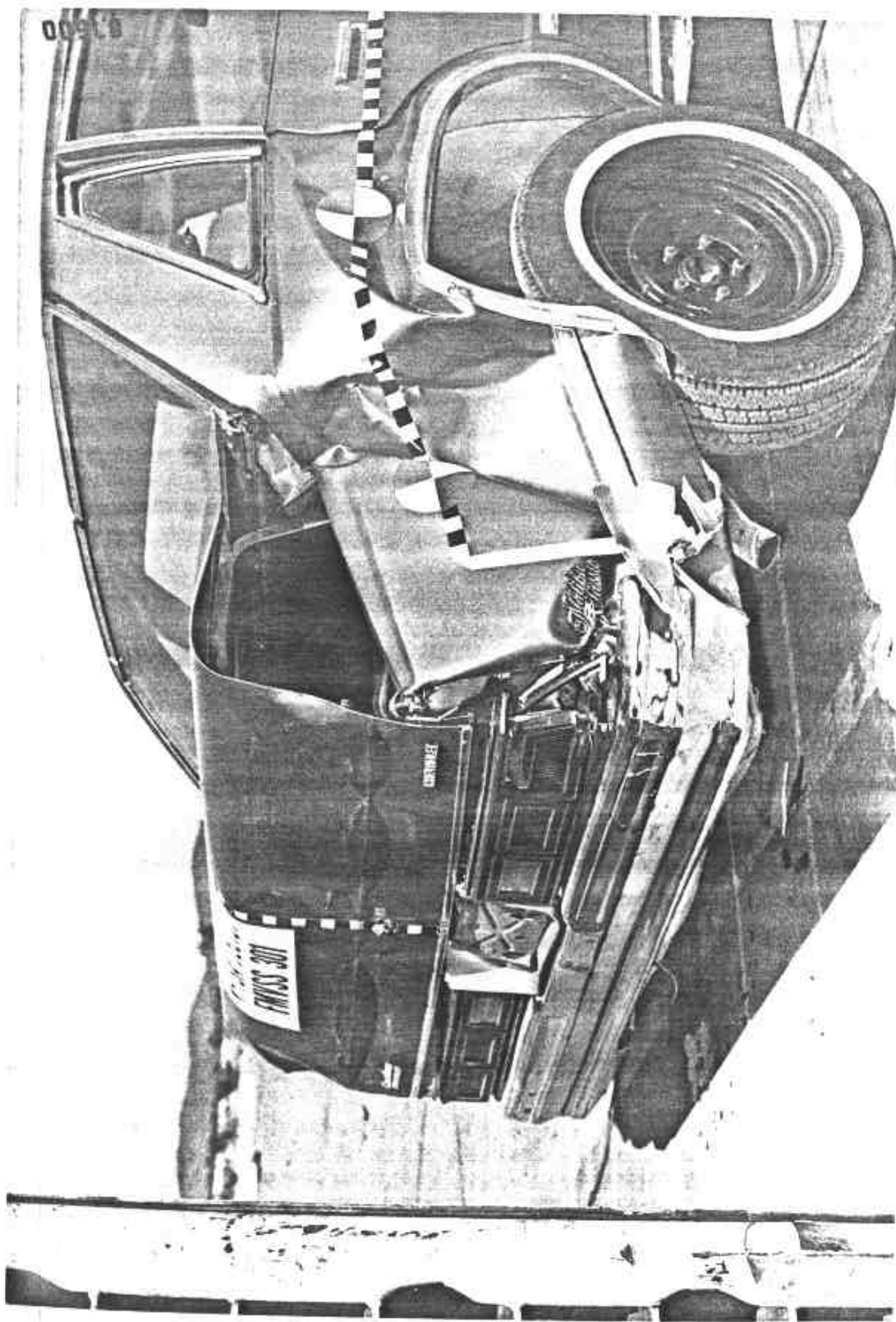


Figure 4-4. Post-test View of Rear of 1978 Chevrolet Malibu Classic Four-Door Sedan - NHTSA 780101.

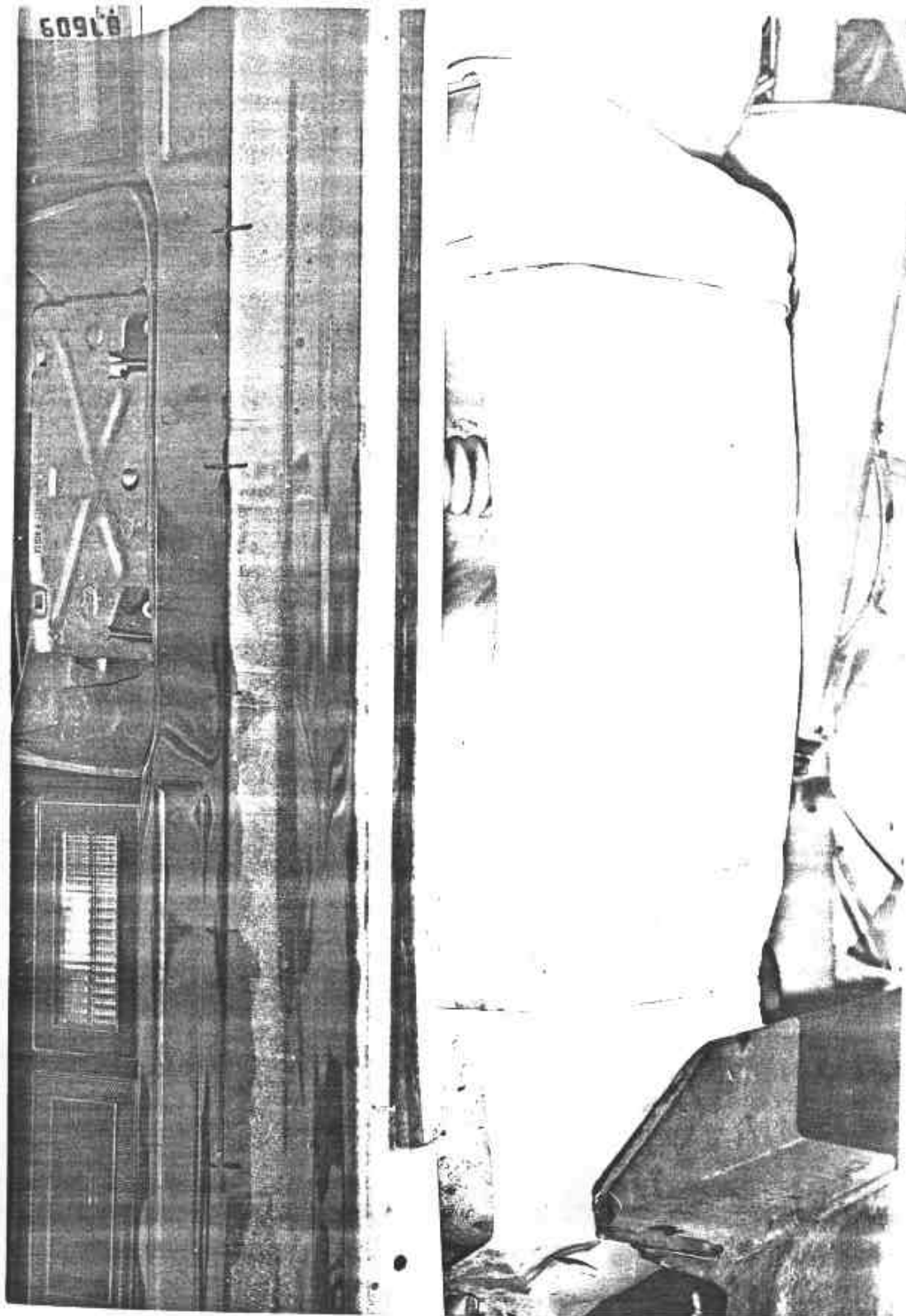


Figure 4-5. Post-test View of Fuel Tank - 1978 Chevrolet Malibu Classic Four-Door Sedan - NHTSA 780101.



Figure 4-6. Post-test View of Occupant Compartment -
1978 Chevrolet Malibu Classic Four-Door
Sedan - NHTSA 780101.

5.0 TEST FACILITY AND EQUIPMENT FOR FMVSS 301 (REAR) IMPACT TESTS

General Test Facility Description

FMVSS 301 impact tests are conducted at the Dynamic Science, Inc. Deer Valley Facility in Phoenix, Arizona. Figure 5-1 is an overall aerial view of that facility.

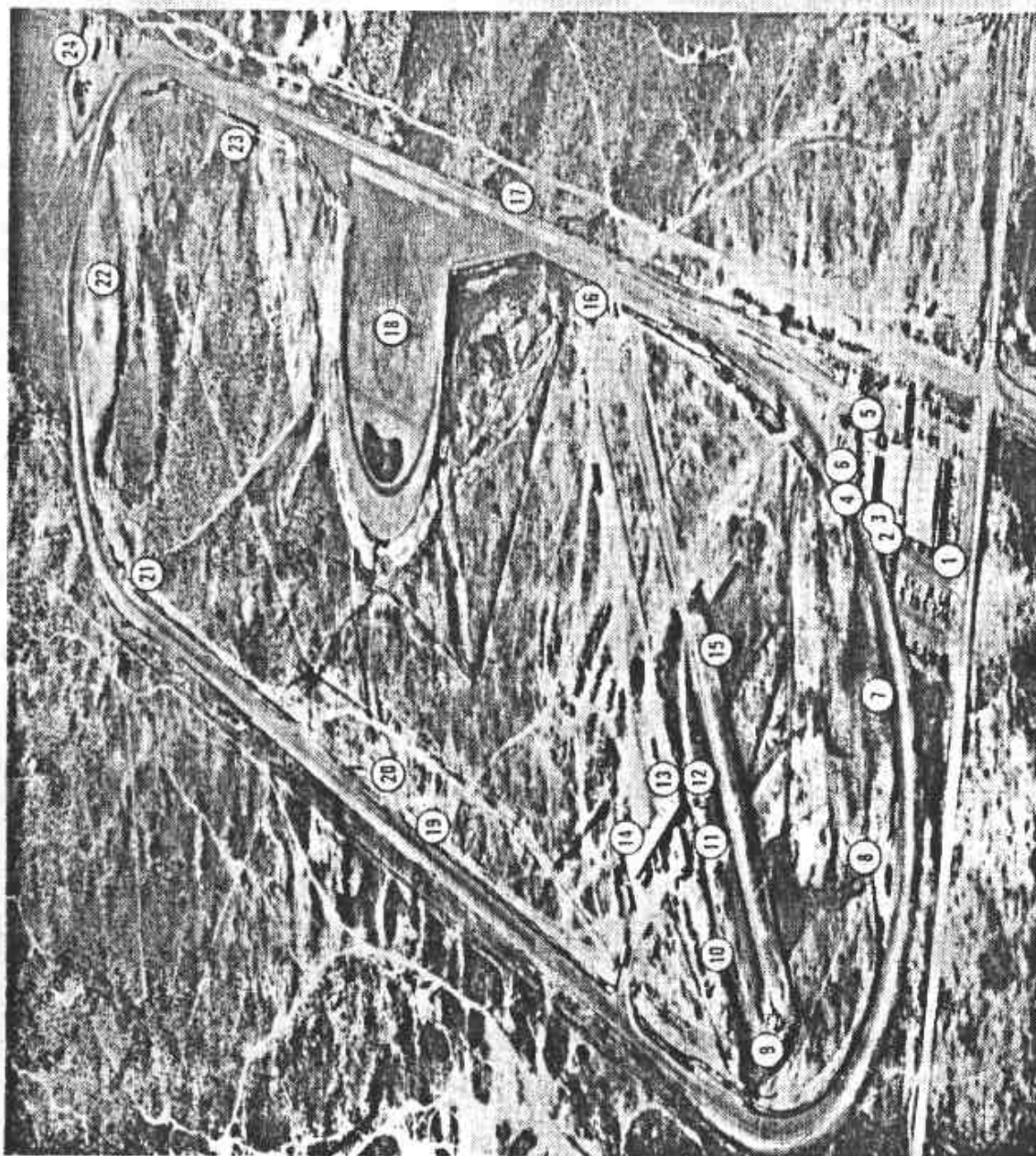
More specifically, the Monorail Impact Facility shown schematically in Figure 5-2 is used. As indicated in Figure 5-2, the Monorail Impact Facility accommodates a variety of test modes and configurations.

Test Track and Guidance System

The test track consists of 1,200 feet of asphalt pavement (SN = 75 $\pm$ 5), 14 feet in width. The length allows sufficient acceleration distance to accommodate impact speeds in excess of 60 mph with sufficient distance remaining to abort the test if necessary. Guidance for the test vehicle is provided by a sliding shoe attached to the vehicle. The sliding shoe rides on the monorail embedded in the test track. Prior to impact, the shoe is mechanically released from the test vehicle.

Tow System and Velocity Control

The tow system consists of a drum-driven endless cable powered by a pair of 390-cubic-inch engines driven in tandem driving a modified three-speed C-6 automatic truck transmission. The tow system can propel a 6,000-pound vehicle into the fixed barrier at 75 mph. Velocity control is achieved through a manually controlled throttle system. A visual readout of speed versus distance is provided and compared with the "ideal curve." Velocity control under ± 0.5 mph is realizable down to 20 mph and ± 2.0 percent down to zero mph.



1. ENGINEERING/ADMINISTRATION CENTER
2. MECHANICAL/INSTRUMENTATION SHOPS
3. DUMMY CALIBRATION LABORATORY
4. GARAGE/MAINTENANCE SHOP
5. ENVIRONMENTAL CHAMBER
6. STATIC CRUSH FACILITY
7. TWO-MILE OVAL TURNAROUND (TYPICAL OF TWO)
8. BARRIER IMPACT FACILITY
9. DROP TOWER/SLID TEST FACILITY
10. CENTRAL DATA ACQUISITION AND CONTROL STATION
11. PENDULUM FACILITY
12. NONMETALLICS LABORATORY
13. TEST SERVICE FACILITY
14. VEHICLE-TO-VEHICLE TEST FACILITY
15. ROLLOVER TEST FACILITY
16. RIDE QUALITY COURSE
17. SKID PAD
18. HIGH AND LOW SKID NUMBER BRAKING LANES
19. SALT WATER TROUGH
20. BELGIAN BLOCK PARKING BRAKE TEST RAMP
21. PULL-OFF AREA (TYPICAL OF THIRTEEN)
22. BALLISTIC TEST RANGE

Figure 5-1. The Dynamic Science, Inc. Deer Valley Facility.

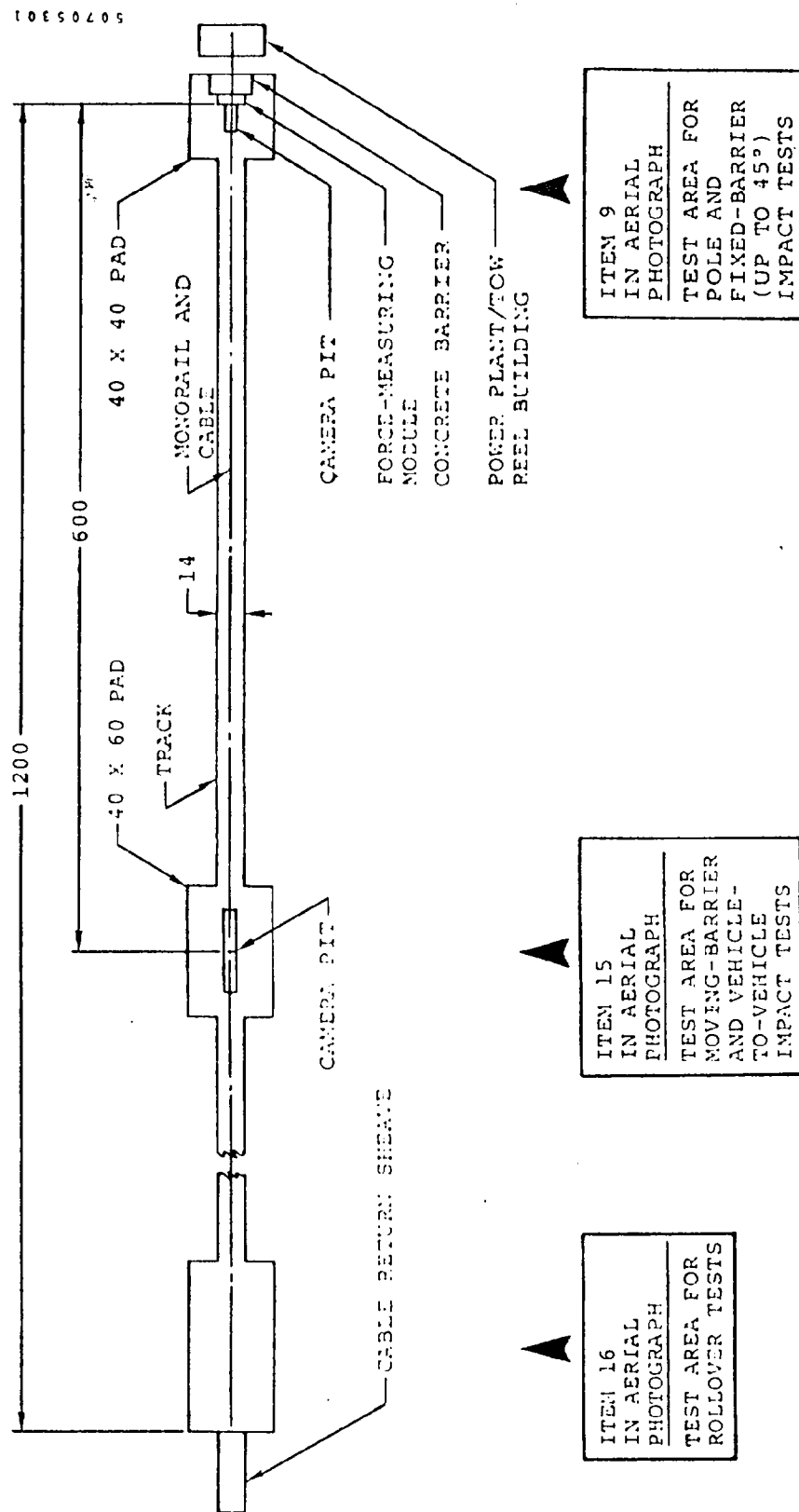


Figure 5-2. Monorail Impact Facility.

Automatic abort capability is provided through the vehicle service brakes which are actuated by releasing high-pressure air into the hydraulic system. Abort criteria consist of vehicle speed, data acquisition and instrumentation system readiness, and stability of the vehicle on the test track. The first two criteria are automatically monitored by the test control system while the third criterion is visually monitored by the test conductor. Manual abort provisions are available to the test conductor. Upon verifying vehicle speed, the test control system automatically deactivates the abort system to preclude inadvertent test abort immediately prior to impact.

Control System

The master control system used for impact tests controls and monitors all primary system functions that must operate throughout a predetermined interval during a test. This includes the starting and stopping of the tape recorder, high-speed cameras, and oscillograph, and the control of the power winch which propels the test vehicle. The operation of the various devices is confirmed, including vehicle velocity and tape recorder speed synchronization, before it passes through a "commit" window. When the vehicle is committed, the abort system is disarmed, preventing an accidental abort after the point of no return is reached.

Any system malfunction, including improper vehicle velocity up to the commit window, generates an abort. The control system uses the pulse output from the IRIG time base generator as a clock with a manual push button defining time zero. The logic circuits compare pulse counts from time zero to preset values dialed in at the control panel. As each control circuit gets an equal comparison, that circuit is turned on. If the self-test circuit does not verify, the abort system is automatically activated. After successful vehicle test, the last control circuit shuts the entire system down. The manual backup control system provides the test conductor the option for manually aborting the test if the need arises.

Moving Barrier

The moving barrier used by Dynamic Science conforms to all the requirements of paragraph S8.2 of FMVSS 208, "Occupant Crash Protection." It is rigid and has a solid suspension so it undergoes no significant amount of dynamic or static deformation and absorbs no significant portion of the energy dissipated in the impact.

The impact surface is a vertical, rigid, flat rectangle, 78 inches wide and 60 inches high, perpendicular to the barrier's direction of travel. The lower edge of the barrier face is horizontal and 5 inches above the ground surface.

The nominal weight of the moving barrier is 4,000 pounds. The actual measured weight of the barrier is 3,996 pounds distributed as follows:

LF 1536 lb	RF 1415 lb
LR 427 lb	RR 618 lb

The tires are size J60-15, inflated to 24 psi in the front and 10 psi in the rear.

A guide at the back of the moving barrier which rides along the monorail ensures that the barrier travels in a straight line with no significant lateral, vertical, or rotational movement.

Fuel Simulation

As prescribed in the FMVSS 301 Laboratory Procedure, the vehicle fuel system is filled to 90 to 95 percent of capacity with Stoddard Solvent.

The fuel is pumped out of the fuel tank, and the residual fuel in the fuel lines and the carburetor is burned by operating the vehicle engine. The fuel system is filled with Stoddard Solvent No. 2. Stoddard Solvent is then pumped into the fuel lines, up to the carburetor. The weight of the Stoddard Solvent added and removed is determined with two Western Beam Scales (Model No. WP 2000).

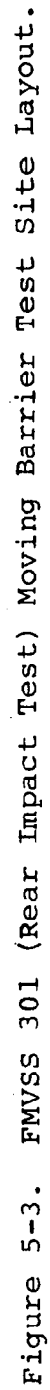
The solvent used, Stoddard Solvent No. 2, has a specific gravity of 0.764 at 72°F and a viscosity of 0.99 centistokes.

High-Speed Motion Photography

Five high-speed (1,000 frames per second) motion cameras with 100 Hz timing marks are used for photographic test documentation. The general location of the cameras is diagrammed in Figure 5-3. Precise positioning is accomplished through bore sighting with the vehicle at the impact point prior to the test.

Test Equipment List and Function

<u>Item</u>	<u>Manufacturer</u>	<u>Model</u>	<u>Purpose</u>
Timing Trap	Dynamic Science	None	Determine impact speed by furnishing a start and stop signal to recording oscillograph.
Oscillograph	Bell and Howell	5-134	Records timing start and stop signals from timing traps, cable drum drive rpm, and impact switch.
Speed Control	Dynamic Science	None	Precision control of cable drive drum rpm.
Beam Scales	Western	WP 2000	Used to determine vehicle test weights.
High-Speed Motion Picture Cameras	Photosonics	16-1B	Used for side, overhead, and underside film coverage.



<u>Item</u>	<u>Manufacturer</u>	<u>Model</u>	<u>Purpose</u>
Motion Picture Camera	Bolex	H-16	Panning and documentation.
Still Camera	Kowa	6	Documentary photo coverage.
100 and 1000 Hz Time Code Generators	Dynamic Science	None	Furnish timing signal for high-speed cameras and a 1 second timing for velocity determination.
Stop Watch	Brietling	None	Time for collection of fuel leak samples.
Containers	-	-	Collection for fuel leak samples.
Graduated Cylinder	Pyrex	3022	Fuel volume measurement.
Graduated Cylinder	Kimax	-	Fuel volume measurement,
Calibrated Steel Rule	Starret	48 in.	Precision measurement of velocity trap spacing.
Anthropomorphic Dummies	Sierra Engineering Company	292-1050	To ballast the vehicle and to gather occupant response data.