

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: 8655-1/301-14

August 4, 2003

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



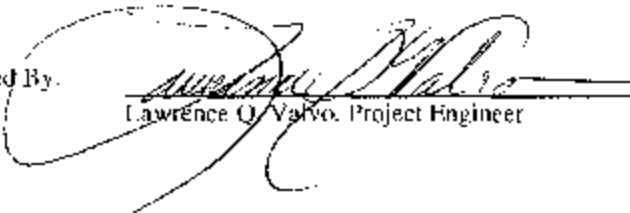
FINAL REPORT

PREPARED FOR:

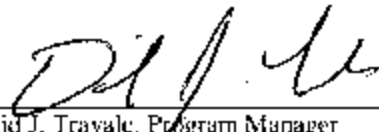
U. S. Department of Transportation
National Highway Traffic Safety Administration
Safety Assurance
Office of Vehicle Safety Compliance
400 Seventh Street, S. W.
Room No. 6115 (NVS-220)
Washington, DC 20590

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 manufacturers' 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.

Prepared By:


Lawrence Q. Valvo, Project Engineer

Approved By:

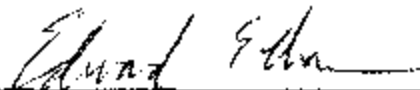

David J. Travale, Program Manager
Transportation Sciences Center

Approval Date:

August 12, 2003

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted By:



Acceptance Date:

9/11/03

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. 301-CAL-03-05	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Final Report of FMVSS 301 Compliance Testing of a 2003 Saturn Ion 4-Door Sedan NHTSA No. C30112		5. Report Date August 4, 2003	
		6. Performing Organization Code CAL	
7. Author(s) Lawrence Q. Valvo, Project Engineer David J. Travale, Program Manager		8. Performing Organization Report No. 8655-1301-14	
9. Performing Organization Name and Address Veridian Engineering 4455 Genesee Street Buffalo, New York 14225		10. Work Unit No.	
		11. Contract or Grant No. DTNH22-01-C-01025	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Vehicle Safety Compliance (NVS-220) 400 Seventh St., S.W., Rm. 6115, Washington, D.C. 20590		13. Type of Report and Period Covered Final Test Report	
		14. Sponsoring Agency Code NVS-220	
15. Supplementary Notes			
16. Abstract 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."			
17. Key Words Compliance Testing Safety Engineering FMVSS 301		18. Distribution Statement Copies of this report are available from: NHTSA Technical Reference Division Room 5108 (NPO-230), 400 Seventh, S.W., Washington, D.C. 20590 Telephone No. (202) 366-4946	
19. Security Classif. (of this report) UNCLASSIFIED	20. Security Classif. (of this page) UNCLASSIFIED	21. No. of Pages 40	22. Price

TABLE OF CONTENTS

<u>Section</u>		<u>Page No.</u>
1	PURPOSE OF COMPLIANCE TEST	1-1
2	COMPLIANCE TEST RESULTS SUMMARY	2-1
3	COMPLIANCE TEST DATA	3-1
	Data Sheet 1 - Test Vehicle Specifications	3-2
	Data Sheet 2 - Pre-Test Data	3-3
	Data Sheet 3 - Moving Barrier Data	3-5
	Data Sheet 4 - Post Test Data	3-6
	Data Sheet 5 - Static Rollover Test Data	3-8
	Data Sheet 6 - High Speed Camera Locations	3-9
APPENDIX A	PHOTOGRAPHS	A-1

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. DTNH22-01-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 February 28, 2003.

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 stoddard 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 E 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 instruments 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

DATA SHEET 1

TEST VEHICLE SPECIFICATIONS

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; - cc

Placement: - Longitudinal or In-Line; X Transverse or Lateral

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

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

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

- Power Windows; - Power Door Locks; X Tilt Wheel

Date Received: 04/10/03; Odometer Reading 187 km

Selling Dealer: Saturn of Orchard Park

& Address: 3559 Southwestern Blvd., Orchard Park, NY 14127

DATA FROM VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufactured by: Saturn Corporation

Date of Manufacture: 01/03

VIN: 1G8AF52F03Z138200

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

DATA FROM VEHICLE'S TIRE LABEL:

Location of Placard 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 Manufacturer:

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

Type of Spare Tire: Temporary T115/70R14

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) = 67.8 kg

*Tire pressure used for test

DATA SHEET 2

PRE-TEST DATA

WEIGHT OF TEST VEHICLE AS RECEIVED FROM DEALER (with maximum fluids)= UDW:

Right Front = <u>359.5</u> kg	Right Rear = <u>247.0</u> kg
Left Front = <u>364.5</u> kg	Left Rear = <u>249.0</u> kg
TOTAL FRONT = <u>724.0</u> kg	TOTAL REAR = <u>496.0</u> kg
TOTAL DELIVERED WEIGHT = <u>1220.0</u> kg	
% of Total Front of Vehicle Weight = <u>59.3%</u>	of Total Rear Weight = <u>40.7%</u>

CALCULATION OF VEHICLE'S TARGET TEST WEIGHT:

Total Delivered Weight	=	<u>1220.0</u> kg
Rated Cargo/Luggage Weight (RCLW)	=	<u>67.8</u> kg
Weight of 2 p.572 Dummies, 71.4 kg	=	<u>148.8</u> kg
TARGET TEST WEIGHT	=	<u>1436.6</u> kg

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

Right Front = <u>430.5</u> kg	Right Rear = <u>267.5</u> kg
Left Front = <u>449.5</u> kg	Left Rear = <u>284.0</u> kg
TOTAL FRONT = <u>880.0</u> kg	TOTAL REAR = <u>551.5</u> kg
TOTAL TEST WEIGHT = <u>1431.5</u> kg	
% of Total Front of Vehicle Weight = <u>61.5%</u>	of Total Rear Weight = <u>38.5%</u>

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

Type of Ballast: None

Method of Securing Ballast: -

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 <u>715</u>	LF <u>714</u>	RR <u>714</u>	LR <u>711</u>
AS TESTED:	RF <u>673</u>	LF <u>663</u>	RR <u>700</u>	LR <u>698</u>
Vehicle's Wheel Base:	<u>2622</u> mm			
Location of Vehicle's C.G.:	<u>1010</u> millimeters rearward of front wheel center.			

FUEL SYSTEM DATA:

Fuel System Capacity From Owner's Manual =	<u>51.1</u> liters
Usable Capacity Figure Furnished by COTR =	<u>51.5</u> liters
Test Volume Range (91 to 94% of Usable Capacity) =	<u>46.87</u> to <u>48.41</u> liters
ACTUAL TEST VOLUME —	<u>47.3</u> 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

FUEL SYSTEM DATA (continued):

Test Fluid Type: Stoddard Solution

Test Fluid Specific Gravity: 0.764

Test Fluid Kinematic Viscosity: 0.96 centistokes

Test Fluid Color: Orange ("red" is preferred)

Type of Vehicle Fuel Pump: Electric

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

DATA SHEET 3

MOVING BARRIER DATA

WEIGHT OF MOVING BARRIER:

Right Front	=	<u>504.9</u>	kg	Right Rear	=	<u>393.7</u>	kg
Left Front	=	<u>499.9</u>	kg	Left Rear	=	<u>398.3</u>	kg
TOTAL FRONT	=	<u>1004.8</u>	kg	TOTAL REAR	=	<u>792.0</u>	kg
TOTAL BARRIER WEIGHT	=	<u>1796.8</u>	kg				

MOVING BARRIER DIMENSIONS:

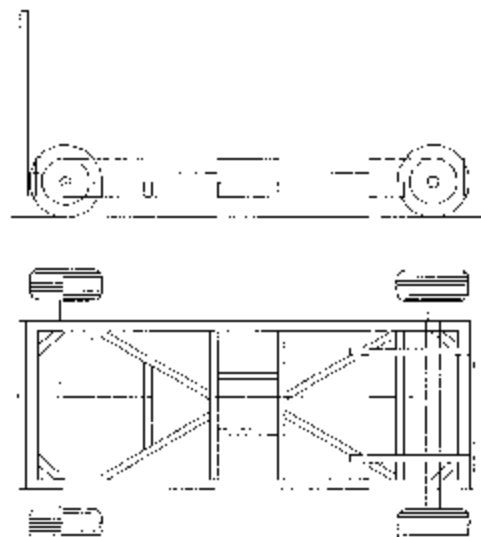
Barrier Face Height:	<u>1524</u>	mm
Barrier Face Width:	<u>1981</u>	mm
Barrier Face Ground Clearance:	<u>127</u>	mm
Tread Width:	<u>1511</u>	mm
Wheel Base:	<u>3048</u>	mm
Location of C.G.:	X: <u>1344</u> mm rearward of front wheel center.	
	Y: <u>0</u> mm from longitudinal-vertical plane of symmetry.	
	Z: <u>414</u> mm above ground.	

MOVING BARRIER TIRES:

Manufacturer:	<u>Classic</u>
Model:	<u>Poly IV</u>
Size:	<u>215/75D15</u>
Recommended Max Pressure:	<u>240</u> kPa:

MOVING BARRIER ABORT SYSTEM:

Type:	<u>Trailing cable</u>
-------	-----------------------



DATA SHEET 4

POST TEST DATA

TYPE OF TEST:

Type of Test: Rear Barrier Impact Angle: 0°
 Test Date: August 4, 2003 Time: 11:58 Temperature: 26.1 °C
 Vehicle NHTSA No.: C30112 VIN: 1G8AF52F03Z138200
 Required Impact Velocity Range: 46.51 to 48.12 kph

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

Trap No. 1 = 48.1 kph; Trap No. 2 = 48.1 kph
 Average Impact Speed = 48.1 kph

VEHICLE STATIC CRUSH:

Vehicle Length:

Pre-Test	Left =	<u>4523</u>	; C/L =	<u>4683</u>	Right =	<u>4525</u>
Post-Test	Left =	<u>4112</u>	; C/L =	<u>4212</u>	Right =	<u>4198</u>
Crush	Left =	<u>411</u>	; C/L =	<u>471</u>	Right =	<u>327</u>
AVERAGE	=	<u>403</u>	millimeters			

DATA SHEET 4 (continued)

POST TEST DATA

TEST VEHICLE NHTSA NO.: C30112 TEST DATE: August 4, 2003

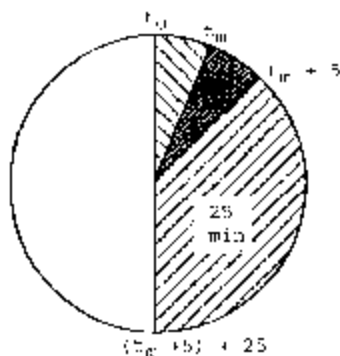
Vehicle Mfg./Make/Model: 2003 Saturn Ion 4-Door Sedan

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
☒ 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
2. For five minute period after vehicle motion ceases
3. For next 25 minutes

ACTUAL	MAX ALLOWED
0	28 g
0	28 g.
0	28 g/min.

SOLVENT SPILLAGE DETAILS:

None

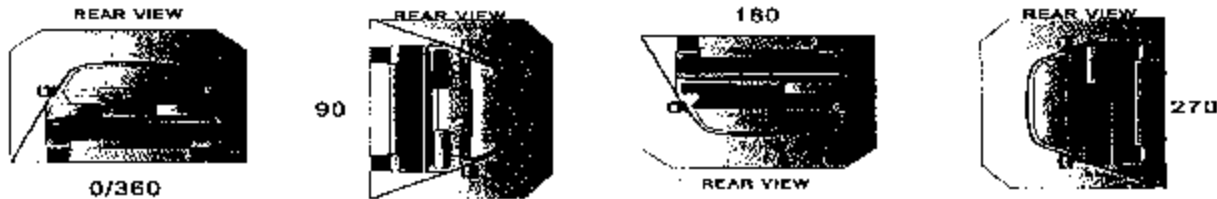
DATA SHEET 5

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:

Rollover Stage	Rotation Time (spec. 1-3 min)				FMVSS 301 Hold Time		Total Time				Next Whole Minute Interval	
0° - 90°	1	minutes	14	seconds	5	minutes	6	minutes	14	seconds	7	minutes
90° - 180°	1	minutes	4	seconds	5	minutes	6	minutes	4	seconds	7	minutes
180° - 270°	1	minutes	2	seconds	5	minutes	6	minutes	2	seconds	7	minutes
270° - 360°	1	minutes	10	seconds	5	minutes	6	minutes	10	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	-
90° - 180°	0	0	0	-
180° - 270°	0	0	0	-
270° - 360°	0	0	0	-

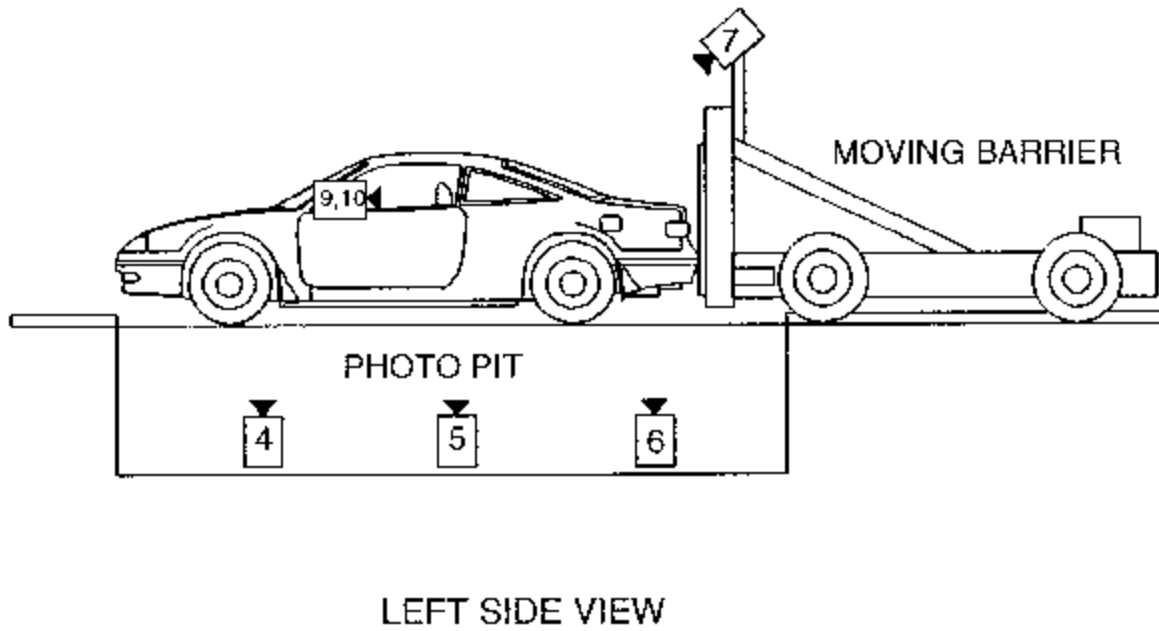
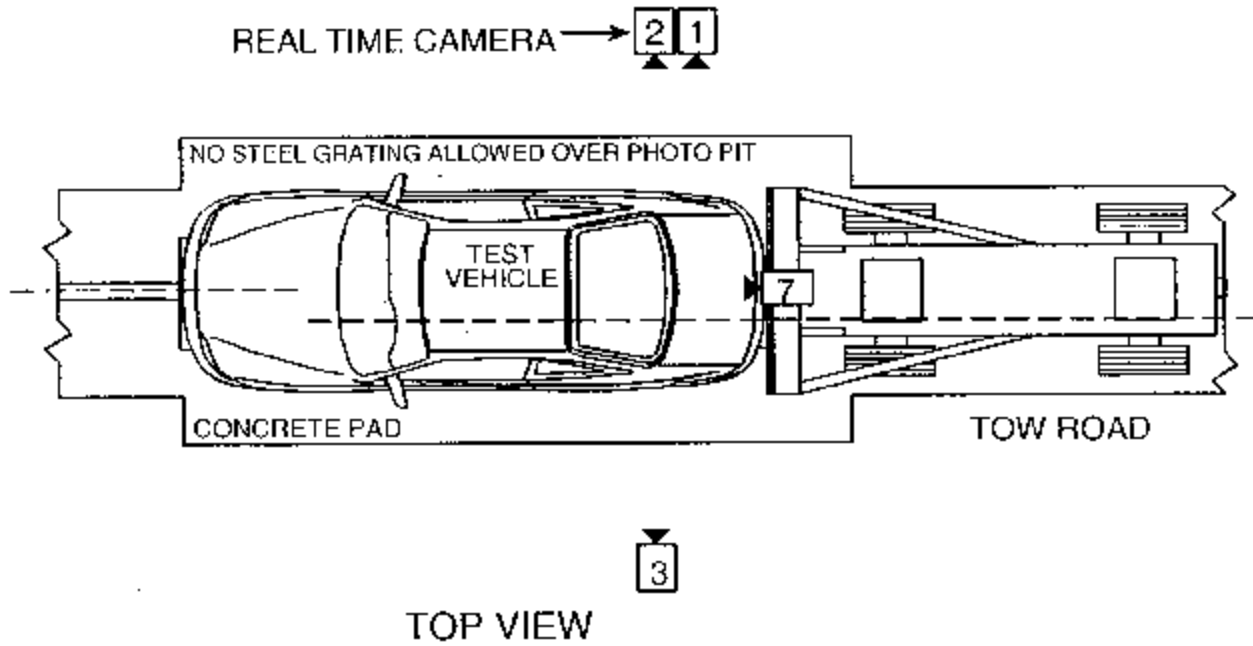
Note: Record spillage for whole minute intervals only as determined above.

IV. SOLVENT SPILLAGE LOCATION(S):

Rollover Stage	Spillage Location
0° - 90°	None
90° - 180°	None
180° - 270°	None
270° - 360°	None

DATA SHEET 6

HIGH SPEED CAMERA LOCATIONS



DATA SHEET 6 (continued)
HIGH SPEED CAMERA LOCATIONS

NIJTS No. : C30112

Vehicle : 2003 Saturn Ion 4-Door Sedan

CAMERA NO.	VIEW	CAMERA POSITIONS (mm)*			ANGLE** (degrees)	LENS (mm)	SPEED (fps)
		X	Y	Z			
1	Real-Time Camera	-	-	-	-	-	24
2	Right Side View	15480	1690	1095	-1	35	1000
3	Left Side View	16512	2078	1000	1	35	1000
4	Vehicle Front Underbody View	0	3380	-1956	90	13	995
5	Vehicle Mid Section Underbody View	0	1938	-1956	90	13	1005
6	Vehicle Rear Underbody View	0	992	1956	90	13	1030
7	Moving Barrier View	0	0	2515	-105	13	1000
8	Overhead Overall View	-508	0	9804	-90	13	1000
9†	Onboard Driver View	855	2715	970	-6	8	1000
10†	Onboard Passenger View	855	2702	975	-5	8	1000

* 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

LIST OF PHOTOGRAPHS

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

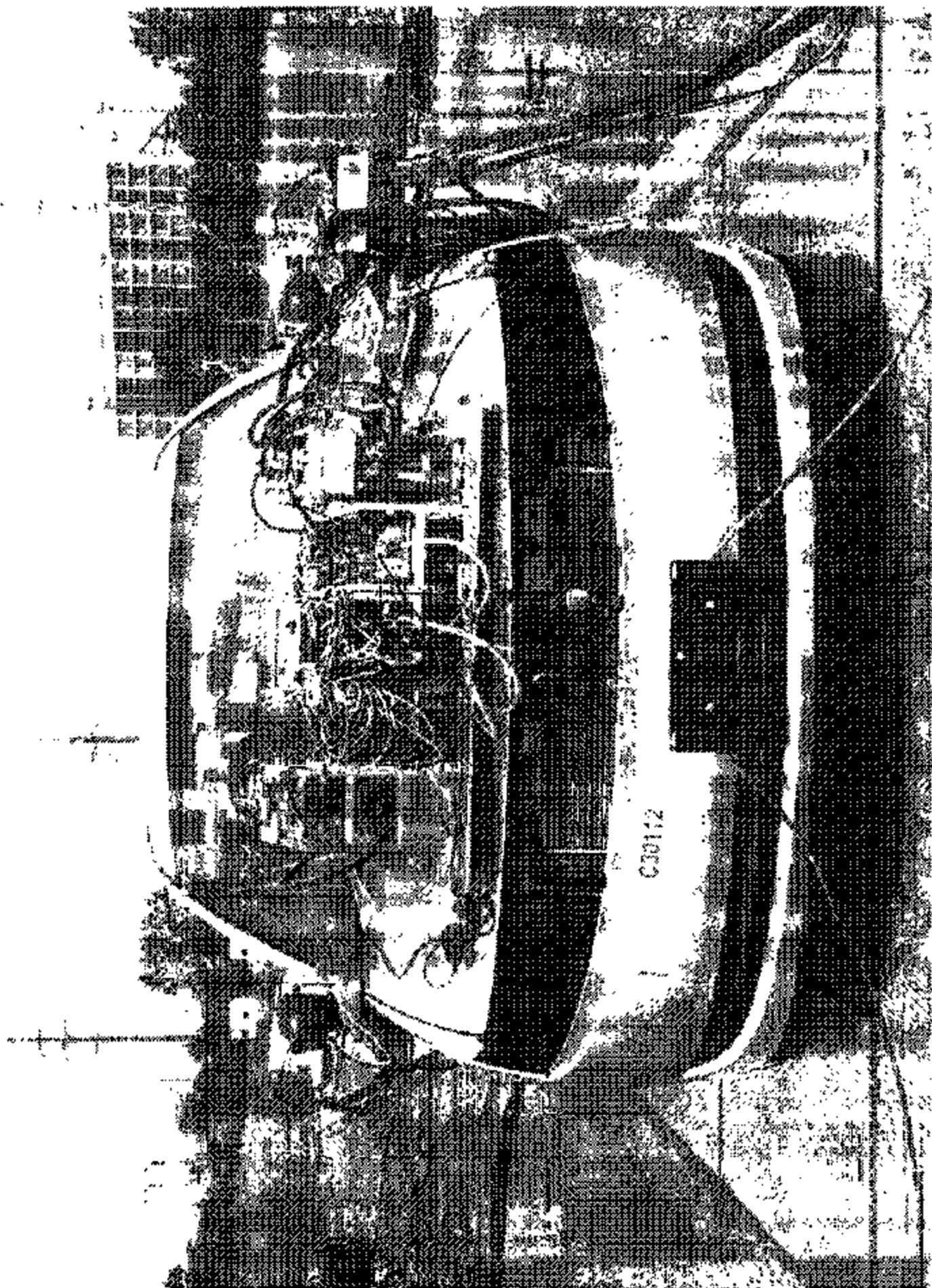
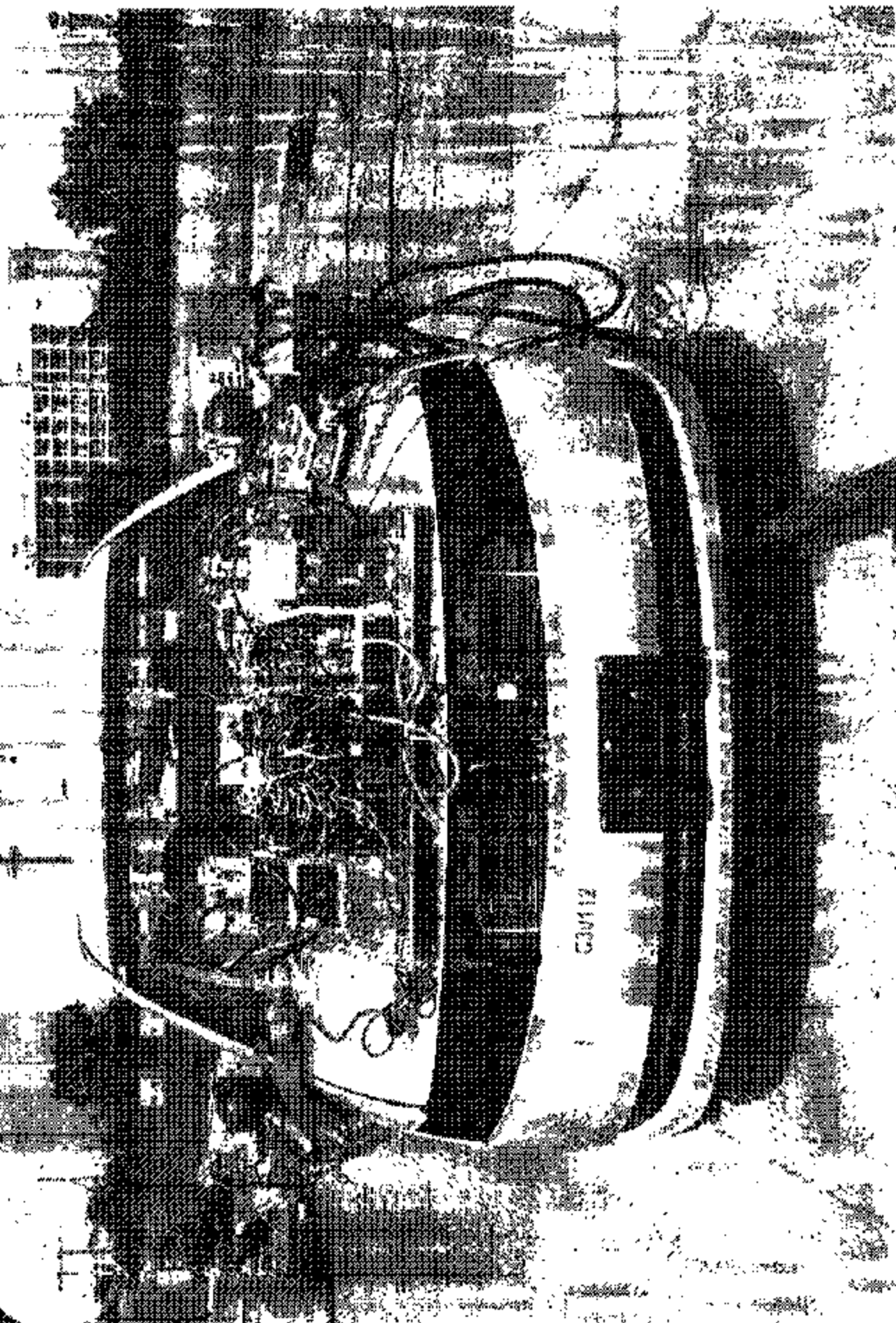


Figure A-1 PREL-1151 FRONT VIEW



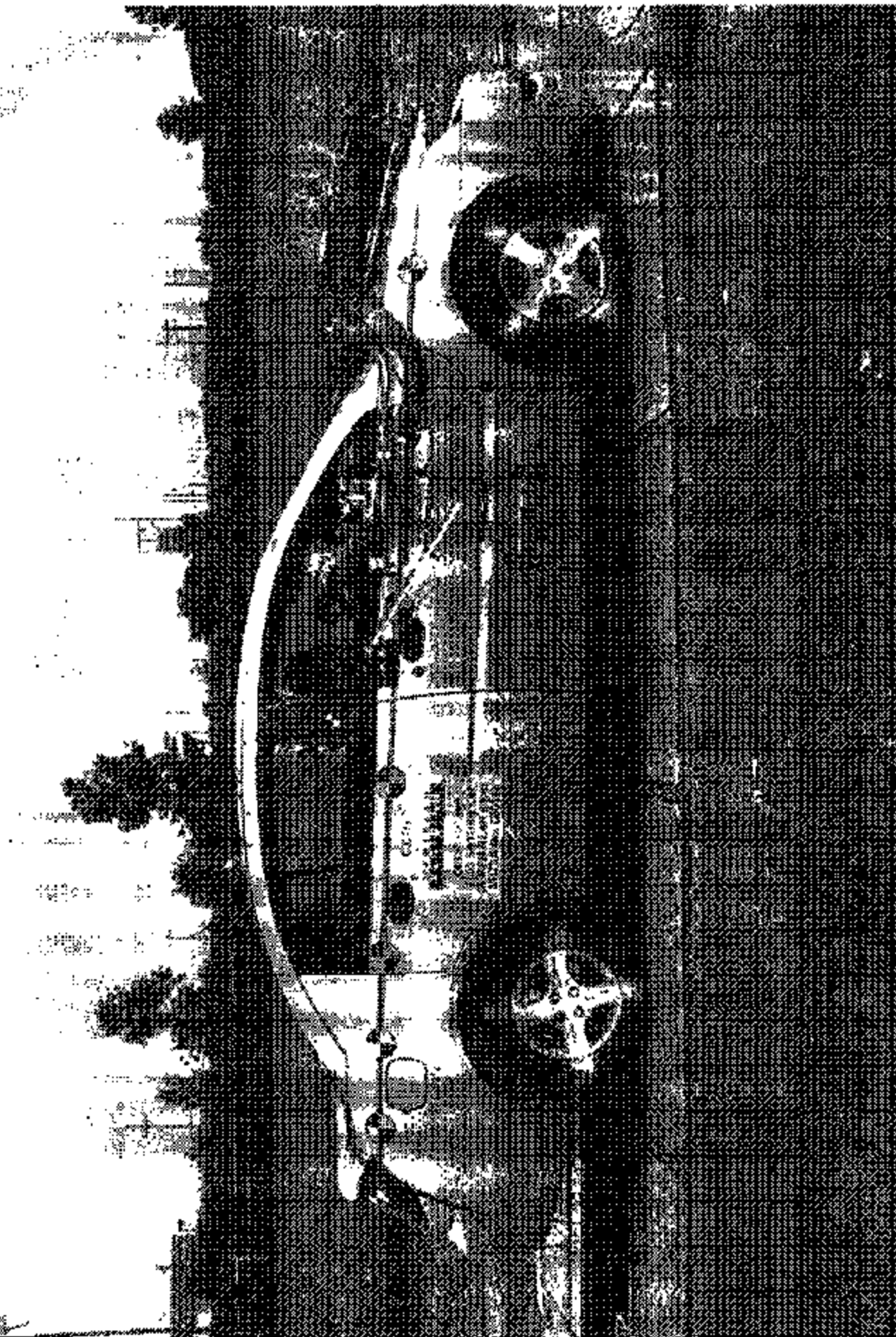


FIGURE 4-5 PRE-TEST RIGHT SIDE VIEW

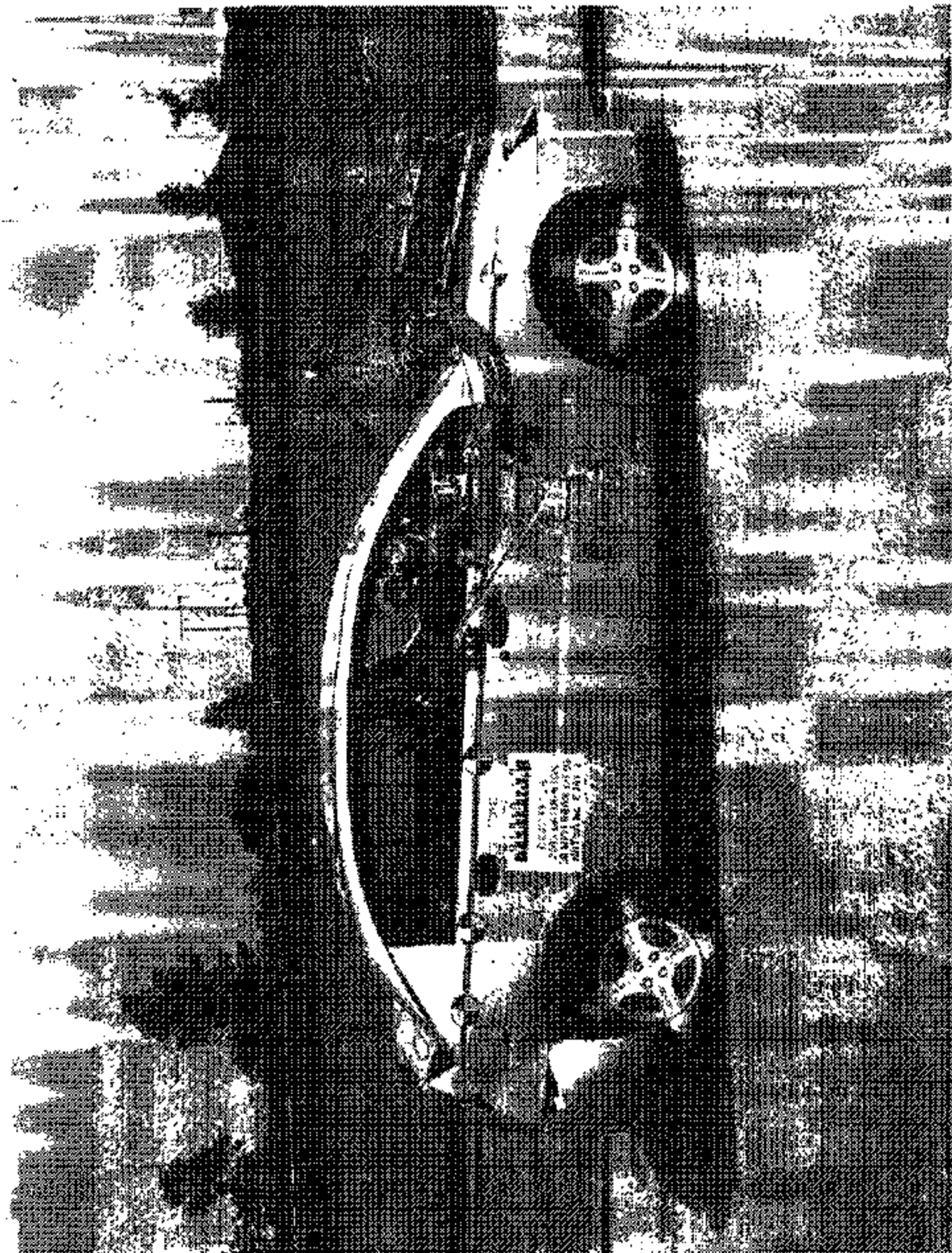


Figure A-9 POST-TENSION RIGHT SIDE VIEW

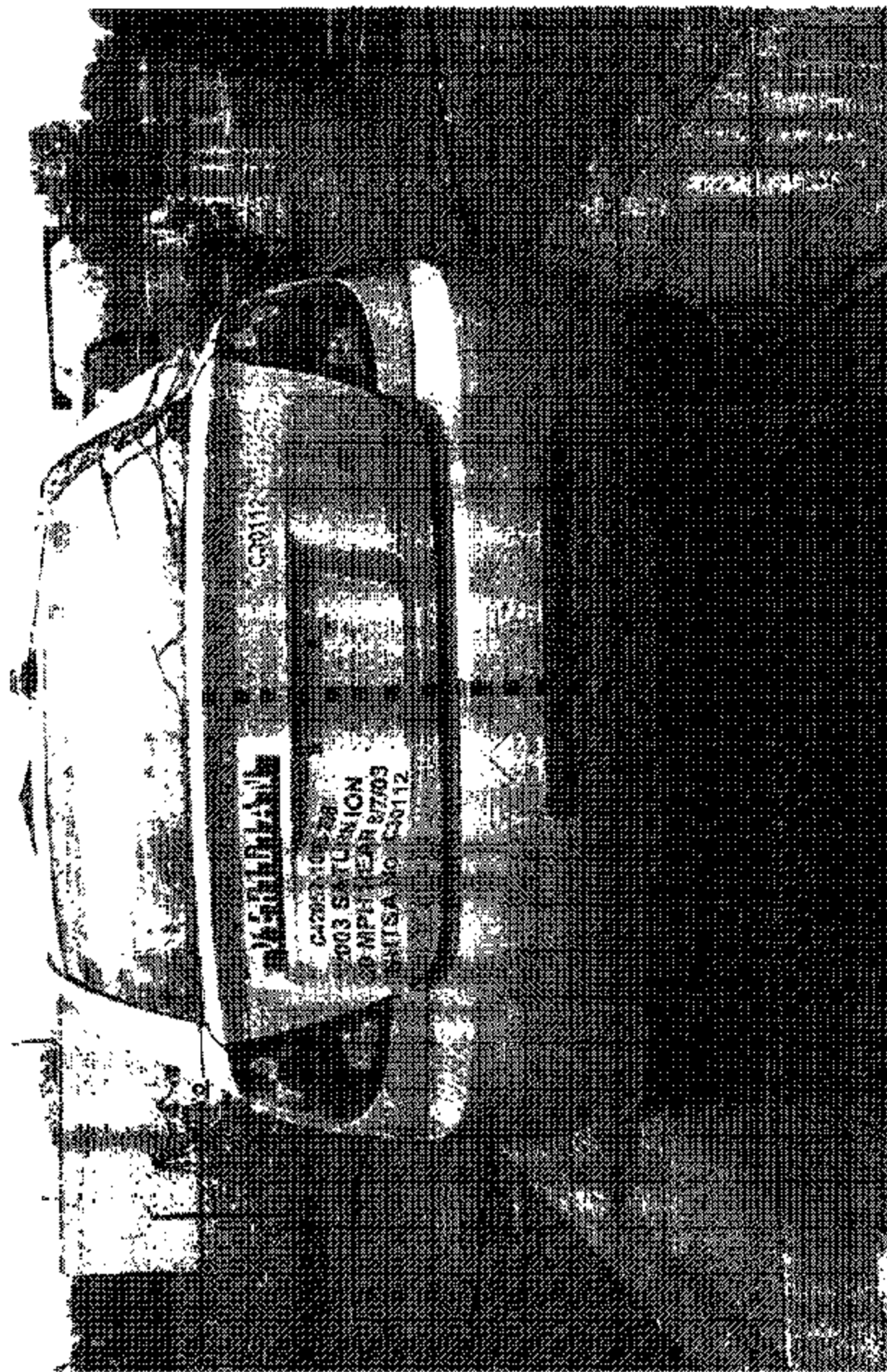


Figure A-7 PRELIMINARY REAR VIEW

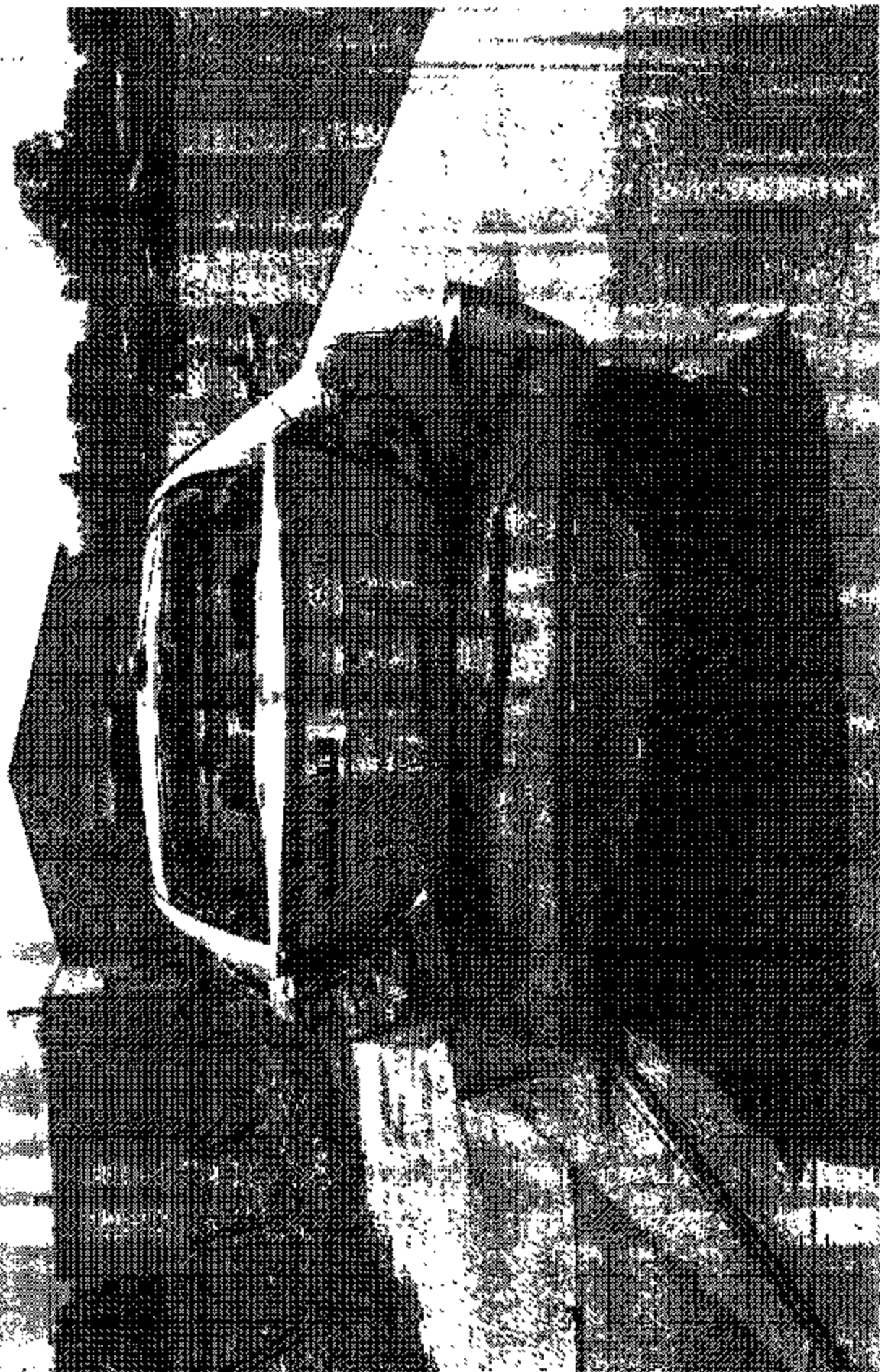


FIGURE 1-10 POST-TEST REAR VIEW

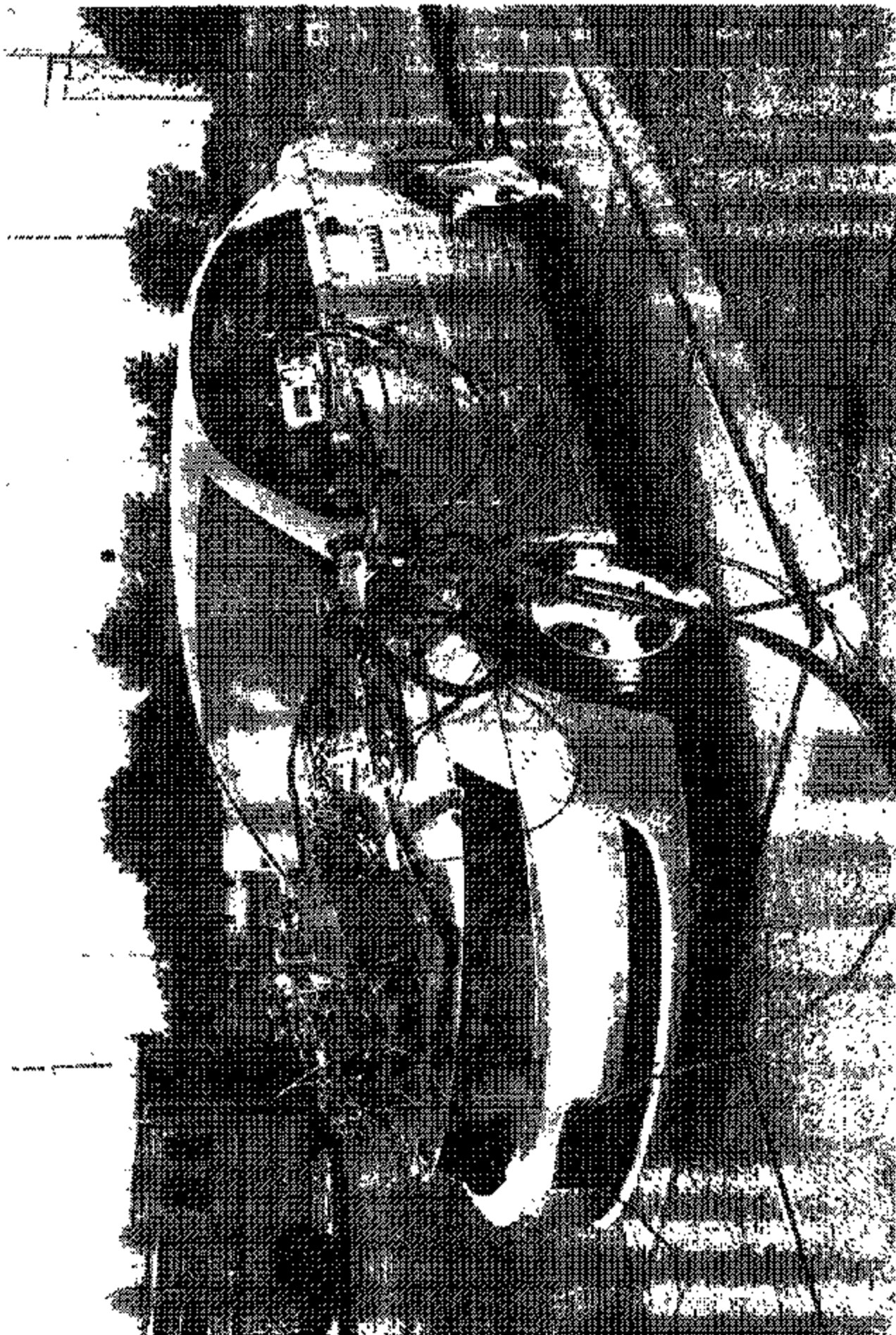


Figure A-9 PRE-TEXT LIFT FROM THREE-QUARTER VIEW

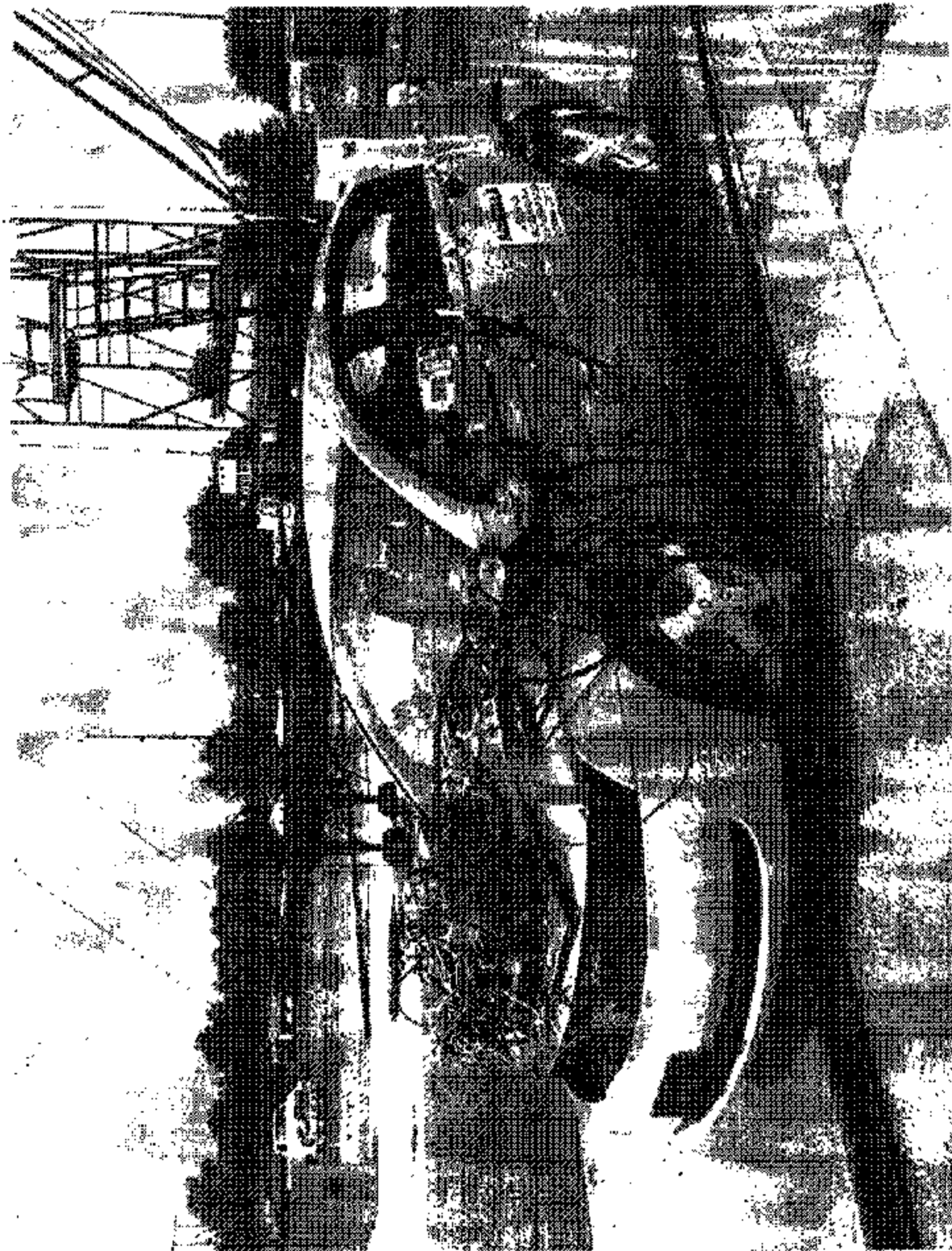


Figure A-10: JET-100 FRONT THREE-QUARTER VIEW



FIGURE 8-11 PRE-FLY RIGHT-OF-WAY FORTY-FOUR VIEW

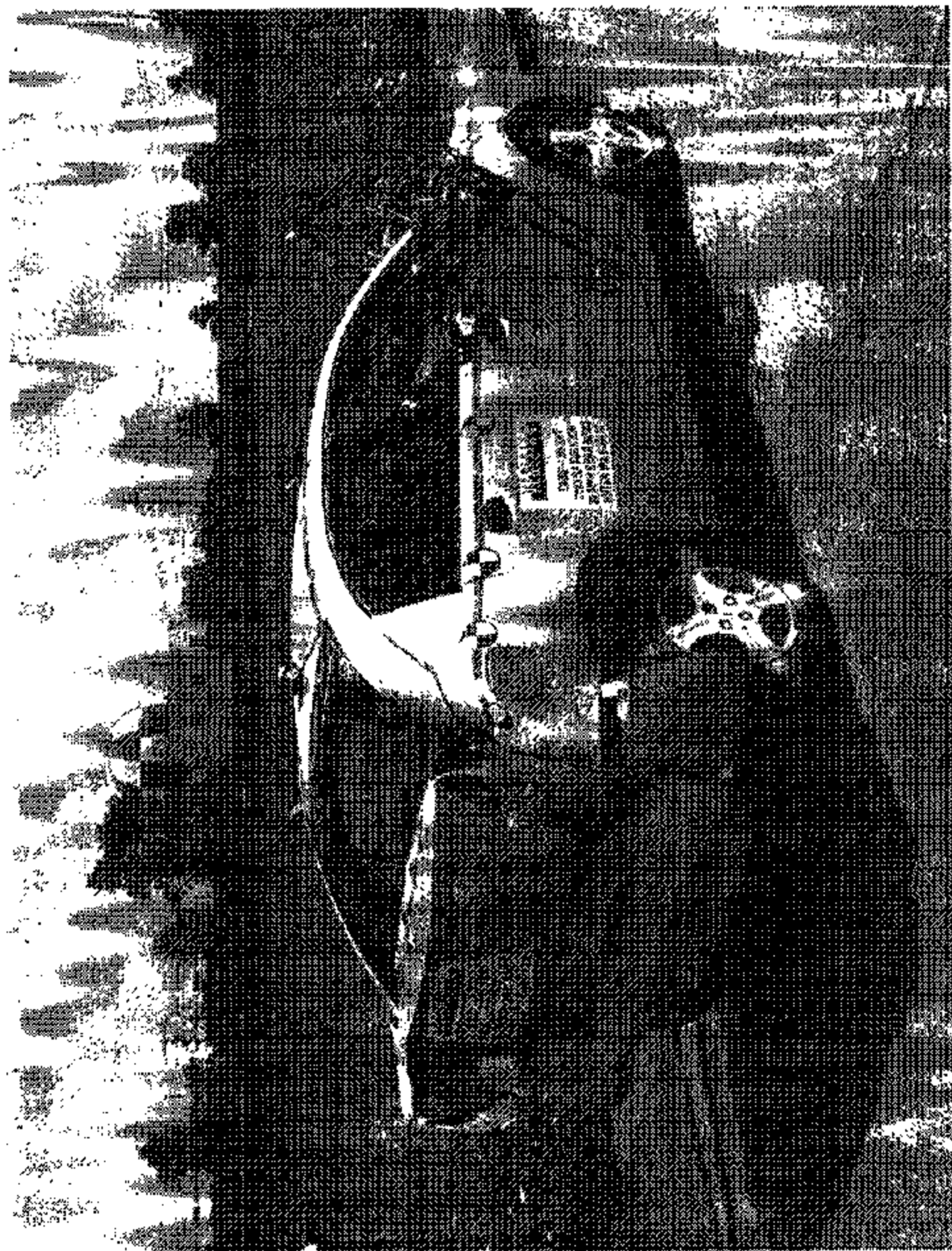


Figure A-12 POST-TEST RIGHT REAR THREE-QUARTER VIEW



FIGURE 13 PRE-TEST FROM UNDERBODY VIEW

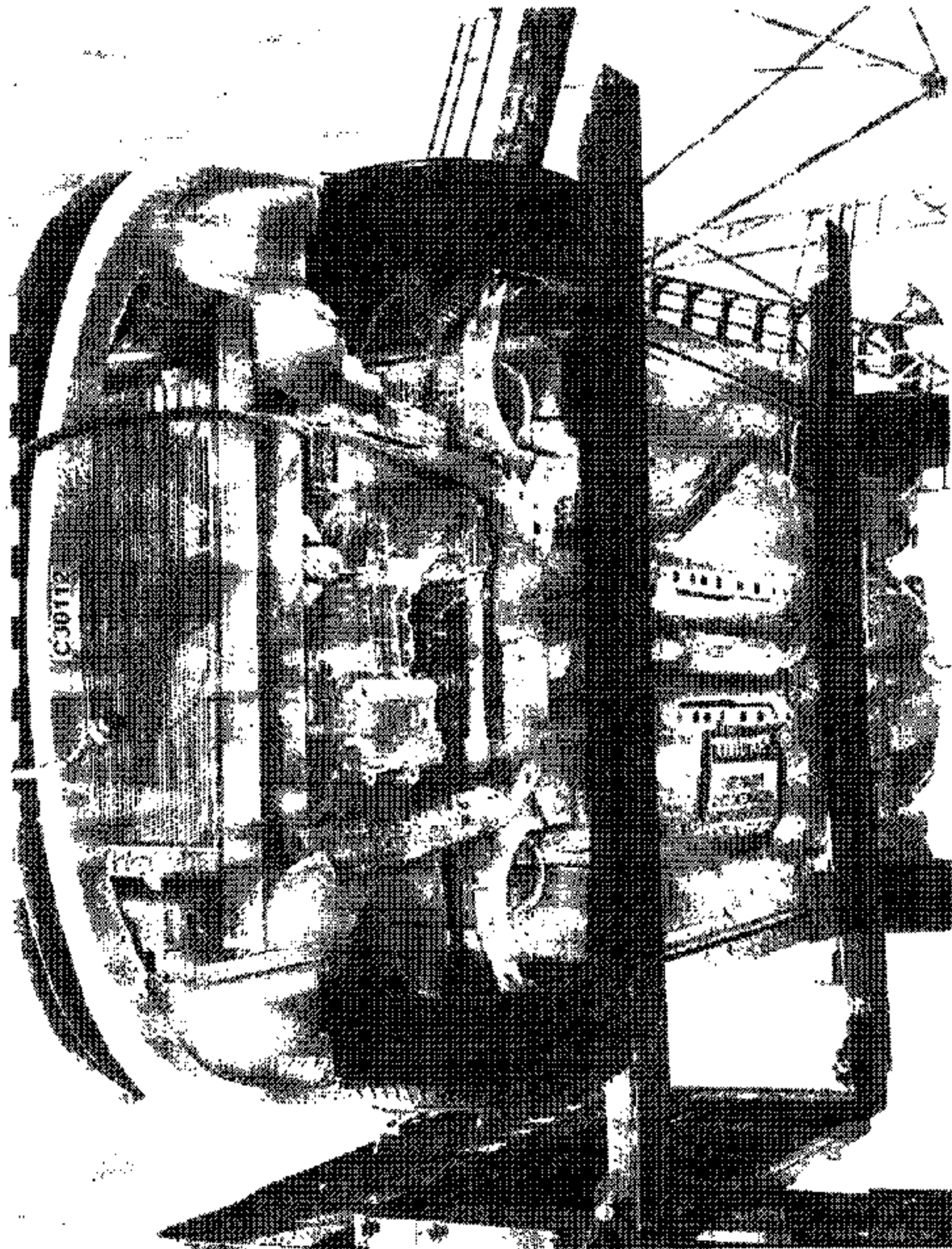


Figure A-14 POST-TEST FRONT UNDERBODY VIEW



FIGURE A-13 PRELIMINARY REAR UNDERBODY VIEW

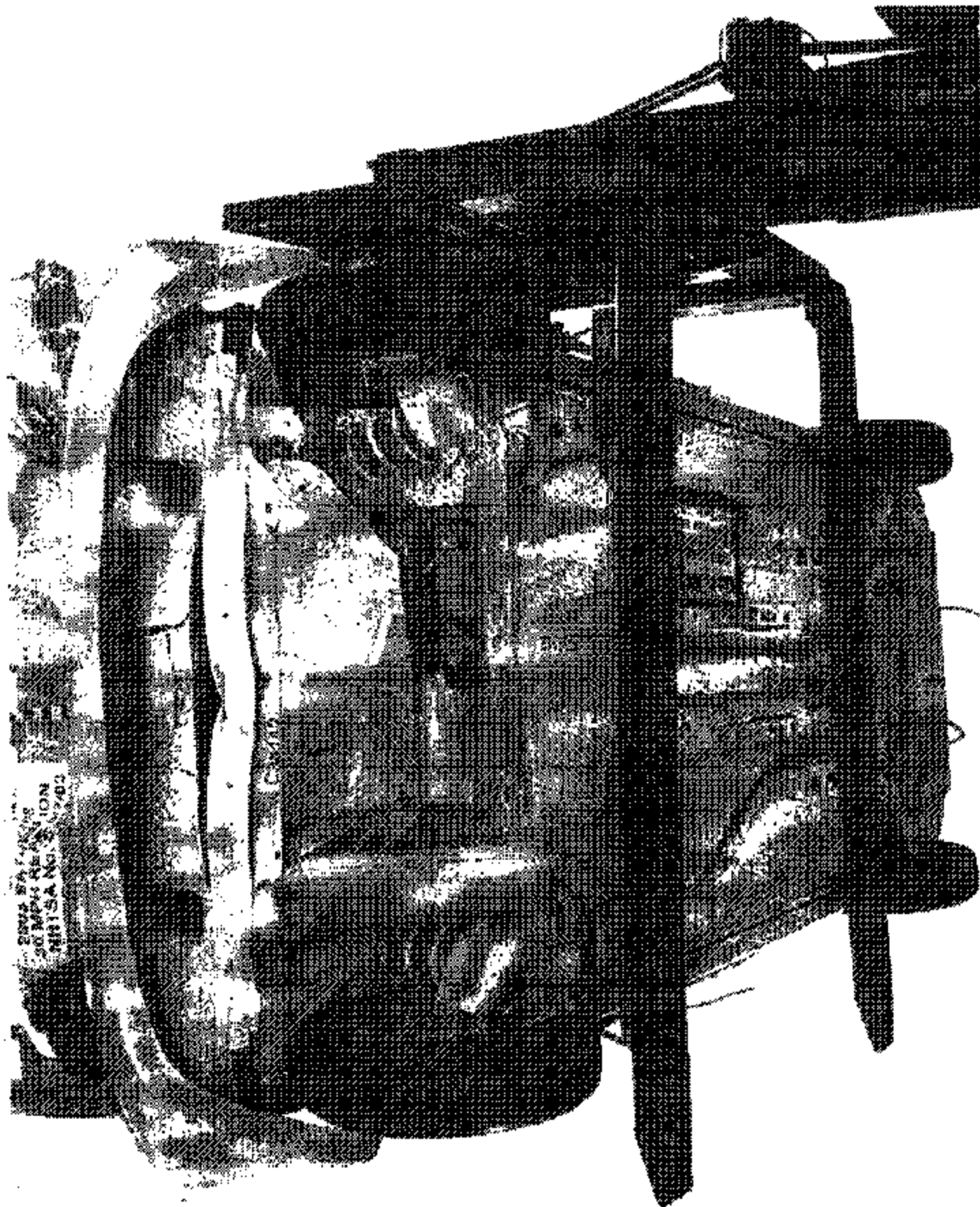


Figure A-16 POST-TEST REAR CRASH/IMPACT VIEW

REC'D BY SATURN CORPORATION

DATE 01/03 362513 164-113

THIS VEHICLE CONFORMS TO ALL
FEDERAL MOTOR VEHICLE
SAFETY STANDARDS AND THE
EFFECT OF THE BATTLE OF
MANUFACTURERS SHOWN ABOVE.

100455270373200

Figure A-17 CERTIFICATION PLACARD

TIRE-LOADING INFORMATION

OCCUPANTS VEHICLE CAPACITY

CTR. DR. TOTAL LBS 899

LOADING AT GWR: 400

VEHICLE CAPACITY WEIGHT

ZZHB COLD TIRE PRESSURE

SIZE SPEED RATING

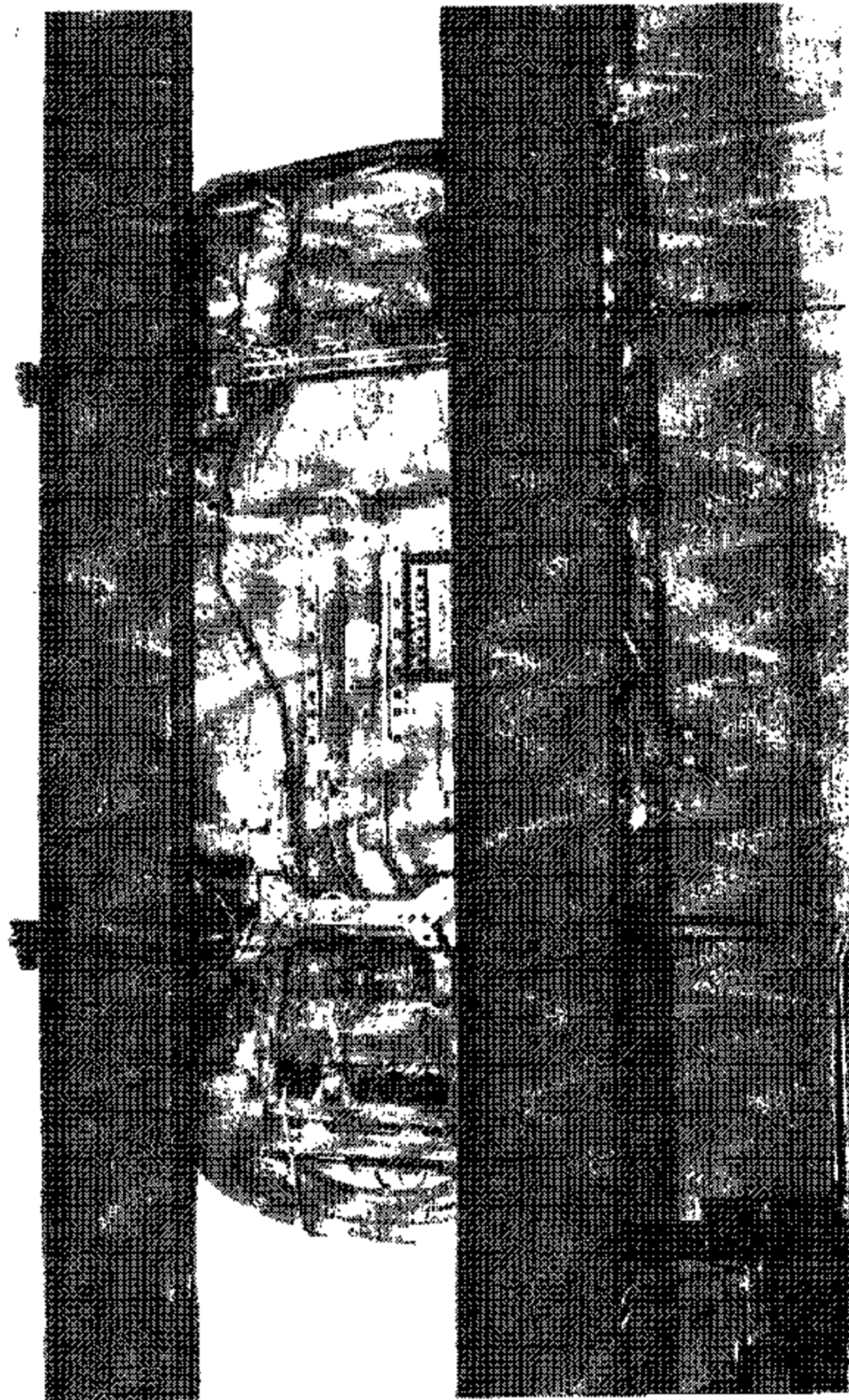
110R14 85H
110R14 85H
110R14 85H

IF TIRES ARE HOT, ADD 4 PSI (20 PSI)

SEE OWNER'S MANUAL FOR ADDITIONAL

INFORMATION

Figure A-18 TIRE PLACARD



06 214 1102 674 1102 1

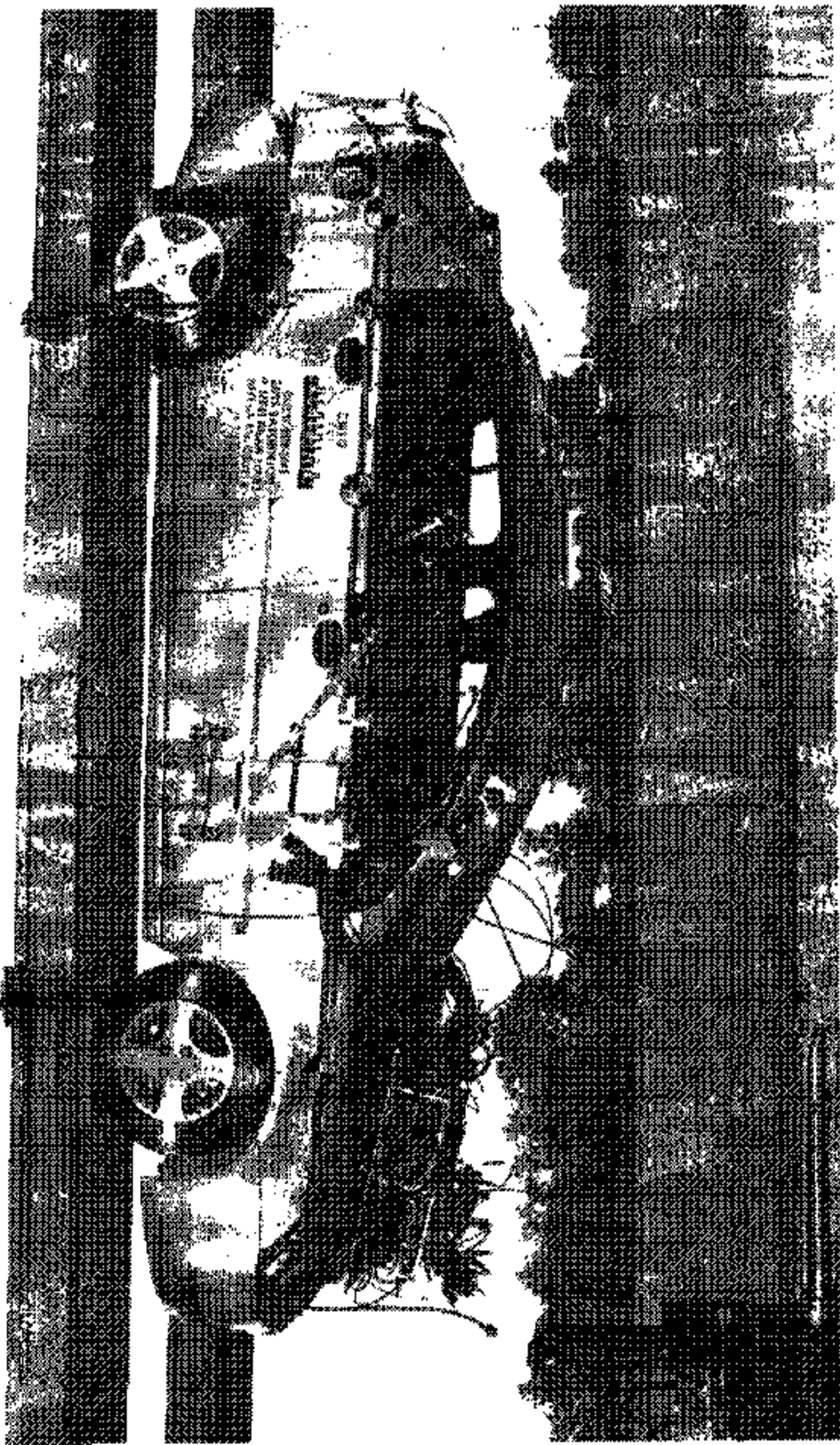


Figure A-20 ROT LOVER INP

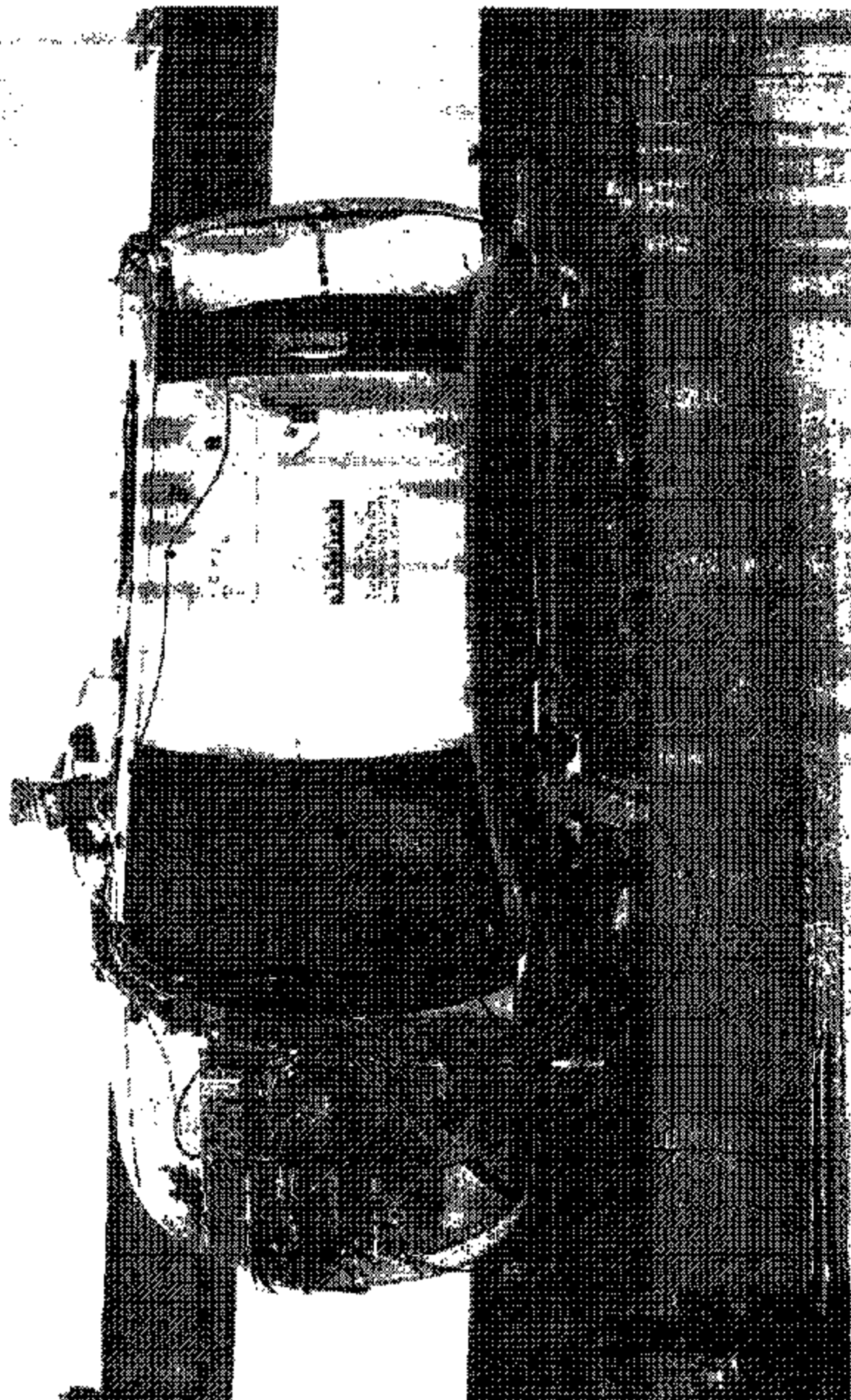


Figure A-21 RICHKOTR 27F

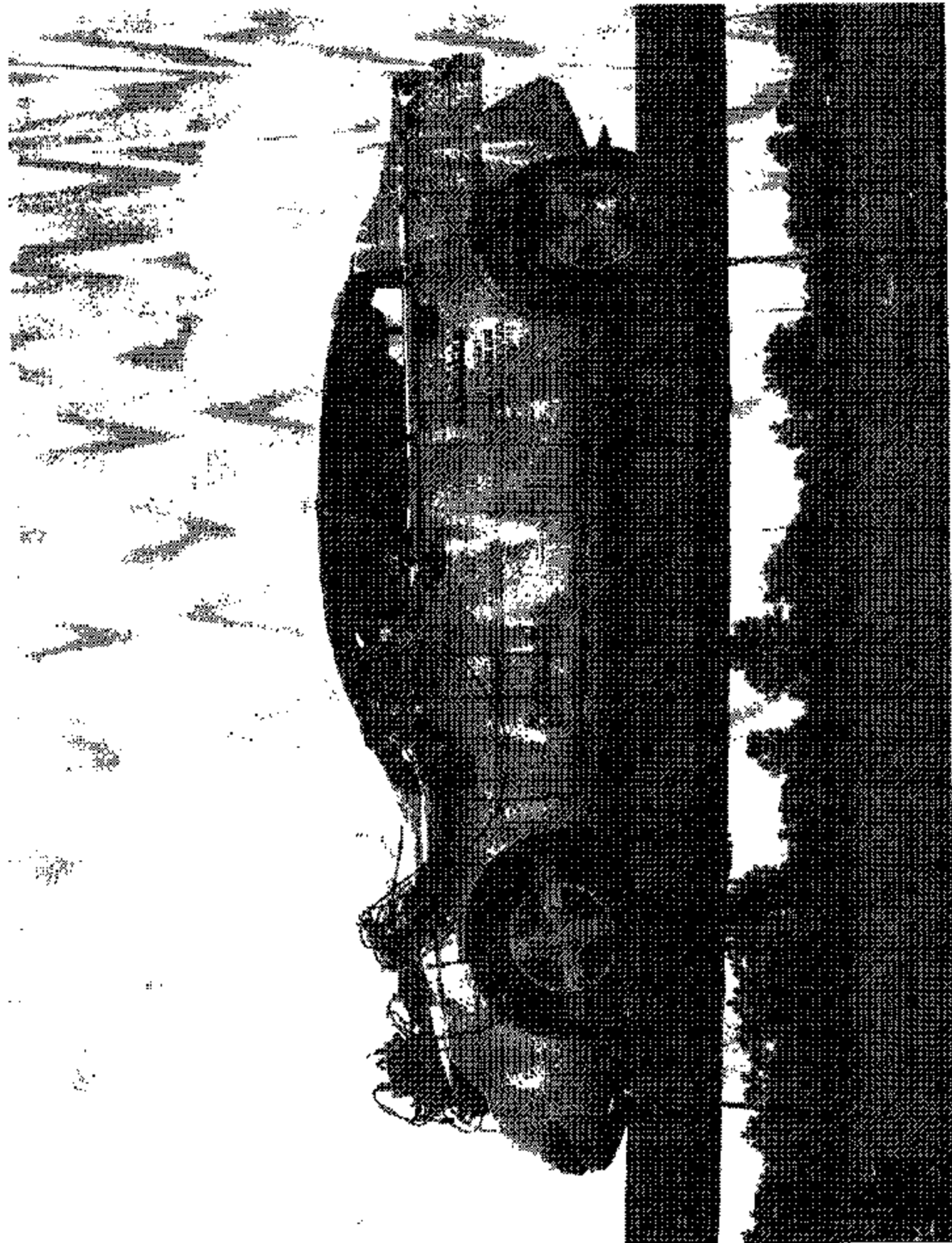


Figure A-22 ROLL OVER 360°