

REPORT NUMBER 216-GTL-03-003

SAFETY COMPLIANCE TESTING FOR FMVSS NO. 216 ROOF CRUSH RESISTANCE

KIA MOTORS CORPORATION
2003 KIA SORENTO, MPV
NHTSA NO. C30505

GENERAL TESTING LABORATORIES, INC.
1623 LEEDSTOWN ROAD
COLONIAL BEACH, VIRGINIA 22443



AUGUST 4, 2003

FINAL REPORT

PREPARED FOR

U. S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
SAFETY ENFORCEMENT
OFFICE OF VEHICLE SAFETY COMPLIANCE
400 SEVENTH STREET, SW
ROOM 6111 (NVS-220)
WASHINGTON, D.C. 20590

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Approved By: Shanté Bernard
Approval Date: 8/4/03

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted By: _____

Acceptance Date: _____

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SECTION 1

PURPOSE OF COMPLIANCE TEST

1.0 PURPOSE OF COMPLIANCE TEST

A 2003 Kia Sorento MPV was subjected to Federal Motor Vehicle Safety Standard (FMVSS) No. 216 testing to determine if the vehicle was in compliance with the requirements of the standard. The purpose of this standard is to reduce deaths and injuries due to the crushing of the roof into the occupant compartment in rollover crashes.

1.1 The test vehicle was a 2003 Kia Sorento MPV. Nomenclature applicable to the test vehicle are:

A. Vehicle Identification Number: KNDJD733635081536

B. NHTSA No.: C30505

C. Manufacturer: KIA MOTORS CORPORATION

D. Manufacture Date: 11/25/02

1.2 TEST DATE

The test vehicle was subjected to FMVSS No. 216 testing on July 18, 2003.

SECTION 2

COMPLIANCE TEST RESULTS SUMMARY

2.0 TEST RESULTS

All tests were conducted in accordance with NHTSA, Office of Vehicle Safety Compliance (OVSC) Laboratory Procedure, TP-216-05 and General Testing Laboratories Procedure, TP-216-05B with the following modifications requested by the COTR:

- 1) The vehicle was rigidly mounted in the test fixture by welding vertical supports to the vehicle jack points to prevent any vehicle movement. Chains were not used in an effort to reduce and/or eliminate "pre-stressing" of the vehicle due to the tightening of chains.
- 2) Dial gauges were placed at the vehicle corners and at the passenger door to track overall vehicle motion and the ability of the alternate tie-down procedure to restrict motion of the vehicle.
- 3) String potentiometers were placed at the driver's designated seat position and attached to the interior surface of the roof above a normally positioned 50th percentile Hybrid III ATD head. The string potentiometers tracked the interior motion of the roof.
- 4) Performed the roof crush test to a loading ram displacement of 127 mm or 44,482 N force, whichever comes first.

The data for this portion of the test can be found on Data Sheets 6 and 7.

Based on the test performed, the 2003 Kia Sorento appears to meet the requirements of FMVSS 216 testing.

SECTION 3

COMPLIANCE TEST DATA

3.0 TEST RESULTS

The following data sheets document the results of testing on the 2003 Kia Sorento.

DATA SHEET 1
FMVSS 216
SUMMARY OF RESULTS

VEH. MOD YR/MAKE/MODEL/BODY: 2003 KIA SORENTO MPV

VEH. NHTSA NO: C30505; VIN: KNDJD733635081536

VEH. BUILD DATE: 11/25/02; TEST DATE: JULY 18, 2003

TEST LABORATORY: GENERAL TESTING LABORATORIES

OBSERVERS: GRANT FARRAND, JIMMY LATANE, AMANDA PRESCOTT

A. VISUAL INSPECTION OF TEST VEHICLE

Upon receipt, inspect vehicle for completeness, function, and discrepancies or damage which might influence the testing.

RESULTS:

B. VEHICLE DATA

- (1) Vehicle type as shown on certification label: MPV
 (2) Vehicle UVW as recorded on Data Table 2: 1906 kg

C. STATIC LOAD TEST OF DRIVER SIDE OF ROOF

Minimum roof crush resistance required by FMVSS 216 for the vehicle tested:

MCCR as recorded on Data Table 2: 28,018 N

Maximum roof crush resistance measured during test was
36,878 N at 69 mm

PASS FAIL

X _____

D. POST TEST VISUAL INSPECTION

Roof pushed down on driver's side from "A" pillar to "C" pillar. Roof is pushed down approximately 5" and "B" pillar is pushed in approximately 4" toward the passenger side. Windshield, driver's window and driver side rear passenger windows are shattered.

RESULTS:

REMARKS:

RECORDED BY: [Signature]
 APPROVED BY: D. M. [Signature]

DATE: 07/18/03

DATA SHEET 2
FMVSS 216
RECEIVING INSPECTION

VEH. MOD YR/MAKE/MODEL/BODY: 2003 KIA SORENTO MPV

VEH. NHTSA NO: C30505; VIN: KNDJD733635081536

VEH. BUILD DATE: 11/25/02; TEST DATE: JULY 18, 2003

TEST LABORATORY: GENERAL TESTING LABORATORIES

OBSERVERS: GRANT FARRAND, JIMMY LATANE, AMANDA PRESCOTT

Upon receipt, the vehicle will be examined visually for completeness, function, and damage. The roof and supporting structures such as the doors and windows should be checked for proper operation and any discrepancies which may influence the testing. The vehicle will be weighed and the minimum roof crush resistance determined.

RESULTS:

(1) Unloaded Vehicle Weight (UVW)

Left Front	<u>508</u>	kg	Left Rear	<u>437</u>	kg
Right Front	<u>528</u>	kg	Right Rear	<u>433</u>	kg
Front Axle	<u>1036</u>	kg	Rear Axle	<u>870</u>	kg

TOTAL UVW 1906 kg

(2) Vehicle type as shown on vehicle certification label: MPV

(3) Minimum Roof Crush Resistance (MCRR):

Passenger Car:

UVW x 1.5 x 9.8 = N/A N

MCRR = N/A N (UVW x 1.5 x 9.8 or 22,241 N whichever is less)

MPV, Truck or Bus:

MCRR = UVW x 1.5 x 9.8 = 28,018 N

(4) Other Comments: _____

REMARKS:

RECORDED BY: [Signature]

APPROVED BY: [Signature]

DATE: 07/18/03

DATA SHEET 3
FMVSS 216
PRE-TEST PREPARATION

VEH. MOD YR/MAKE/MODEL/BODY: 2003 KIA SORENTO MPV

VEH. NHTSA NO: C30505; VIN: KNDJD733635081536

VEH. BUILD DATE: 11/25/02; TEST DATE: JULY 18, 2003

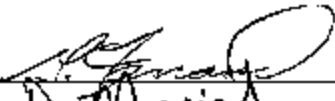
TEST LABORATORY: GENERAL TESTING LABORATORIES

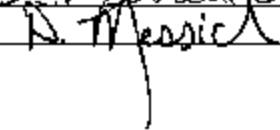
OBSERVERS: GRANT FARRAND, JIMMY LATANE, AMANDA PRESCOTT

Prior to testing, the following will be accomplished:

- A. Secure any convertible top, movable or removable roof structure in their weather tight positions OK
- B. Close all windows OK
- C. Close and lock all doors OK
- D. State Side of Roof Tested Driver
- E. Measure the lateral angle of the test device at sufficient points to determine that it has a 25 degree (plus zero degree, minus one degree) angle 25°
- F. Measure the longitudinal angle of the loading device at sufficient points to determine that it has a 5 degree (plus zero minutes, minus 20 minutes) 5°
- G. The test device will initially contact the roof at 330 mm aft of windshield
- H. If the test device was relocated based on the requirements of Chapter 12.3 paragraph F, describe where the test device will initially contact the roof as relocated N/A
- I. Ambient temperature 51 mm from the vehicle roof in the immediate area of the test device: 28.3 degrees C.

REMARKS:

RECORDED BY: 

APPROVED BY: 

DATE: 07/18/03

DATA SHEET 4
FMVSS 216

VEH. MOD YR/MAKE/MODEL/BODY: 2003 KIA SORENTO MPV

VEH. NHTSA NO: C30505; VIN: KNDJD733635081536

VEH. BUILD DATE: 11/25/02; TEST DATE: JULY 18, 2003

TEST LABORATORY: GENERAL TESTING LABORATORIES

OBSERVERS: GRANT FARRAND, JIMMY LATANE, AMANDA PRESCOTT

RESULTS: Plots of load versus displacement and time versus displacement showed that:

- (1) The maximum roof crush resistance was 36,878 N at 69 mm
- (2) The rate of loading was 5.08 mm/sec (.2 in/sec)
- (3) The required roof crush resistance of 28,018 N was at 42 mm

REMARKS:

RECORDED BY: *G. Farrand*

APPROVED BY: *D. Musick*

DATE: 07/18/03

DATA SHEET 5
FMVSS 216
POST TEST VISUAL INSPECTION

VEH. MOD YR/MAKE/MODEL/BODY: 2003 KIA SORENTO MPV

VEH. NHTSA NO: C30505; VIN: KNDJD733635081536

VEH. BUILD DATE: 11/25/02; TEST DATE: JULY 18, 2003

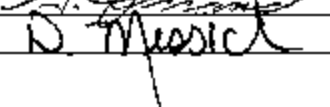
TEST LABORATORY: GENERAL TESTING LABORATORIES

OBSERVERS: GRANT FARRAND, JIMMY LATANE, AMANDA PRESCOTT

Upon completion of testing, a detailed visual inspection of the vehicle shall be made. Describe all damage and deformation that occurred during the test.

RESULTS: Roof pushed down on driver's side from "A" pillar to "C" pillar. Roof is pushed down approximately 5" and "B" pillar is pushed in approximately 4" toward the passenger side. Windshield, driver's window and driver side rear passenger windows are shattered.

RECORDED BY: 

APPROVED BY: 

DATE: 07/18/03

DATA SHEET 6
FMVSS 216 MODIFIED PORTION PRE-TEST

VEH. MOD YR/MAKE/MODEL/BODY: 2003 KIA SORENTO MPV

VEH. NHTSA NO: C30505; VIN: KNDJD733635081536

VEH. BUILD DATE: 11/25/02; TEST DATE: JULY 18, 2003

TEST LABORATORY: GENERAL TESTING LABORATORIES

OBSERVERS: GRANT FARRAND, JIMMY LATANE, AMANDA PRESCOTT

Driver Seat Torso Angle: 23°

Driver Seat "H" Point Location at Mid Travel:

X= 205 mm aft from centerline of front outboard seat mounting bolt

Y= 245 mm inboard from centerline of front outboard seat mounting bolt

Z= 280 mm up from centerline of front outboard seat mounting bolt

Point VRL (Vertical Measurement from H-Point to Headliner): 861 mm

Point VRI (Vertical Measurement from H-Point to Structure Above Headliner): 907 mm

Point RE (Distance from H-Point to a point 112mm behind point VRI): 925 mm

#1 LVDT (R.F.) Length: 920 mm

#2 LVDT (R.R.) Length: 890 mm

#3 LVDT (L.R.) Length: 890 mm

Distance from LVDT #1 (R.F.) to LVDT #2 (R.R.) = 270 mm

Distance from LVDT #2 (R.R.) to LVDT #3 (L.R.) = 250 mm

Distance from LVDT #1 (R.F.) to LVDT #3 (L.R.) = 370 mm

All LVDT's are located on a 185 mm radius from a vertical line passing through the seat "H" point. Using the forward direction as 0° reference and measuring clockwise, LVDT #1 is located at 43°, LVDT #2 is located at 137° and LVDT #3 is located at 222°.

NOTES:

RECORDED BY: [Signature]
APPROVED BY: D. Thumick

DATE: 07/18/03

DATA SHEET 7
FMVSS 216 MODIFIED PORTION POST TEST

VEH. MOD YR/MAKE/MODEL/BODY: 2003 KIA SORENTO MPV

VEH. NHTSA NO: C30505; VIN: KNDJD733635081536

VEH. BUILD DATE: 11/25/02; TEST DATE: JULY 18, 2003

TEST LABORATORY: GENERAL TESTING LABORATORIES

OBSERVERS: GRANT FARRAND, JIMMY LATANE, AMANDA PRESCOTT

Maximum Load Applied = 36,878 N @ 69.0 mm
Maximum Displacement = 137.0 mm @ 29,223 N

#1 LVDT (RF) Displacement = 39.8 mm

#2 LVDT (RR) Displacement = 47.0 mm

#3 LVDT (LR) Displacement = 34.3 mm

Left Front Dial Indicator Displacement = 4.7 mm

Right Front Dial Indicator Displacement = 4.6 mm

Left Rear Dial Indicator Displacement = 29.8 mm

Right Rear Dial Indicator Displacement = 23.5 mm

Right Door Sill Dial Indicator Displacement = 1.9 mm

NOTES:

RECORDED BY: [Signature]

APPROVED BY: [Signature]

DATE: 07/18/03

SECTION 4
INSTRUMENTATION AND EQUIPMENT LIST

TABLE 1 - INSTRUMENTATION & EQUIPMENT LIST

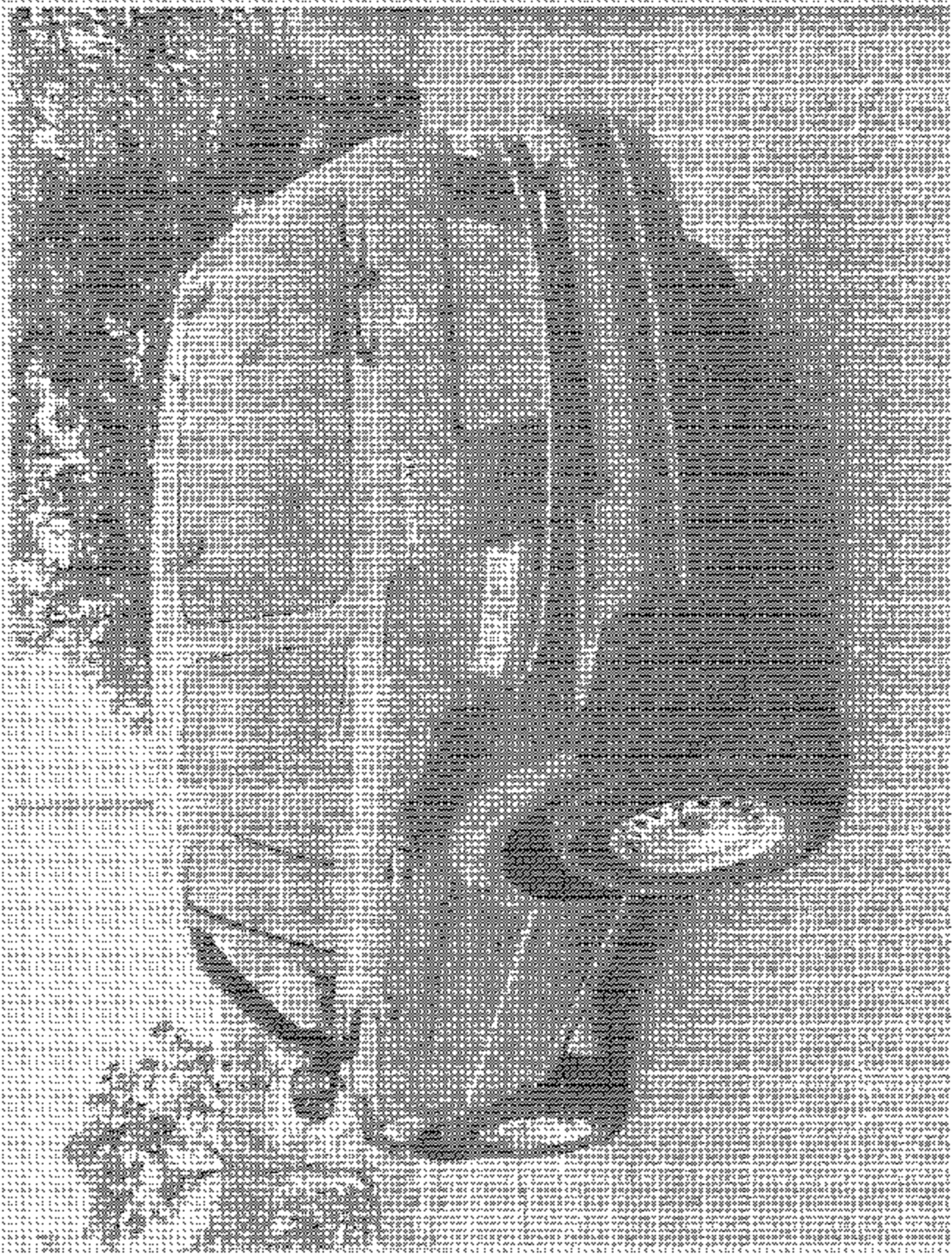
EQUIPMENT	DESCRIPTION	MODEL/ SERIAL NO.	CAL. DATE	NEXT CAL. DATE
COMPUTER	AT&T	486D66	BEFORE USE	BEFORE USE
TEST FIXTURE	GTL	N/A	N/A	N/A
A/D INTERFACE	METRABYTE	DAS-16(F)	BEFORE USE	BEFORE USE
SIGNAL CONDITIONER	METRABYTE	EXP-RES	BEFORE USE	BEFORE USE
LOAD CELL	REVERE	USP2/46024	06/03	06/04
DIAL INDICATOR	MITUTOYO	2424-10	BEFORE USE	BEFORE USE
LINEAR POTENTIOMETER	SERVO SYSTEMS	20/69	BEFORE USE	BEFORE USE
LINEAR POTENTIOMETER	SERVO SYSTEMS	20/70	BEFORE USE	BEFORE USE
LINEAR POTENTIOMETER	SERVO SYSTEMS	20/72	BEFORE USE	BEFORE USE
LINEAR POTENTIOMETER	ELECTRIC ASSOC. INC.	11A4A6	BEFORE USE	BEFORE USE

SECTION 5
PHOTOGRAPHS



ZIGLKA SORU NTO
NHTSA NO. 50160X
FAY 65 NC 216

FIGURE 3
3. FORWARD VIEW OF VEHICLE ON TESTED
SIDE BEFORE TESTING



2003 KIA SORENTO
MITSUBISHI OUTLANDER
FINISS NO. 215

FIGURE 32
MINIATURAL PHOTO MIRROR CHARTERED
FOR SERVICE TESTING

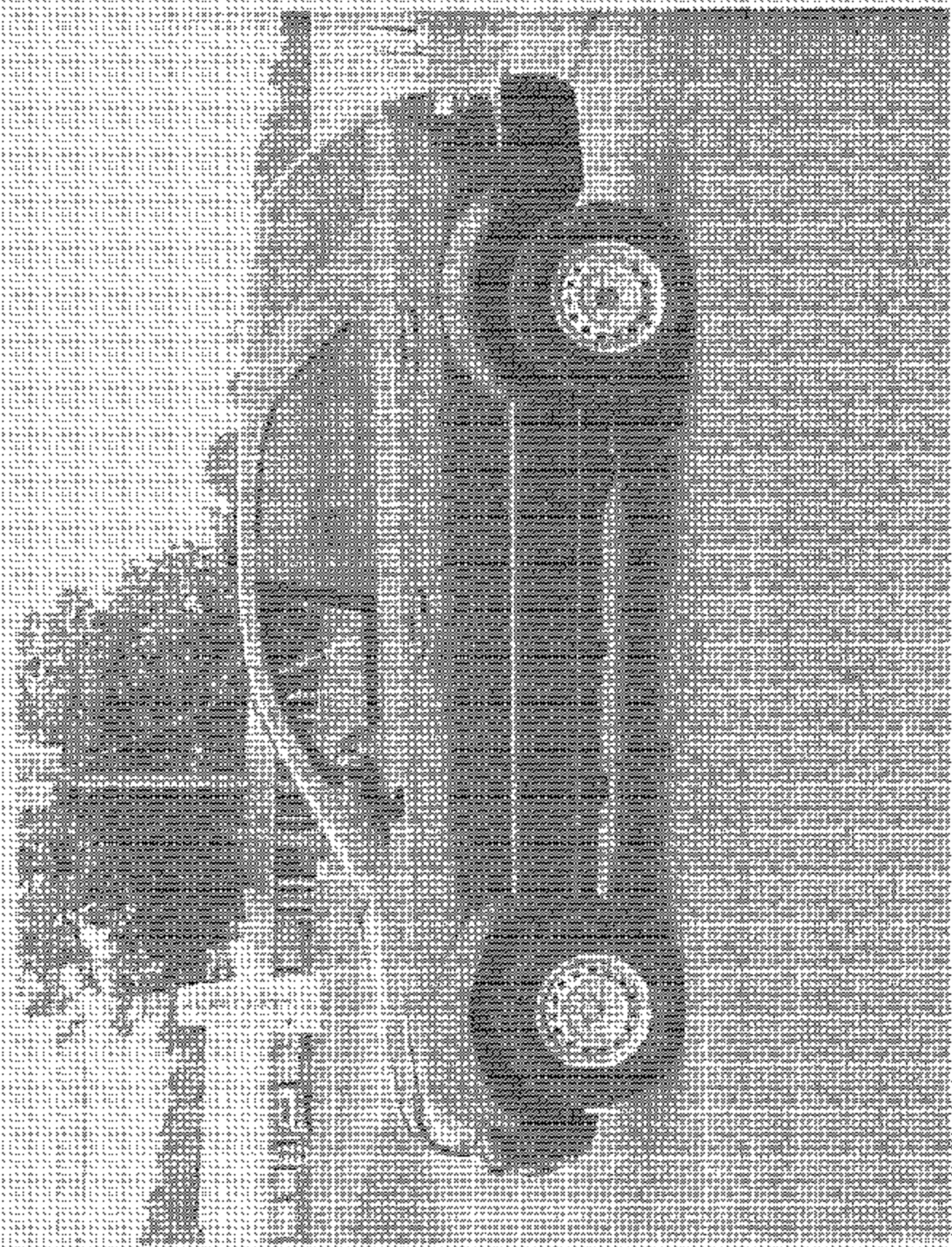


FIGURE 53
LEFT SIDE VIEW OF VEHICLE BEFORE
TESTING

2005 KIA SORENTO
NHISA NO. QAD-405
PASSNO. 216

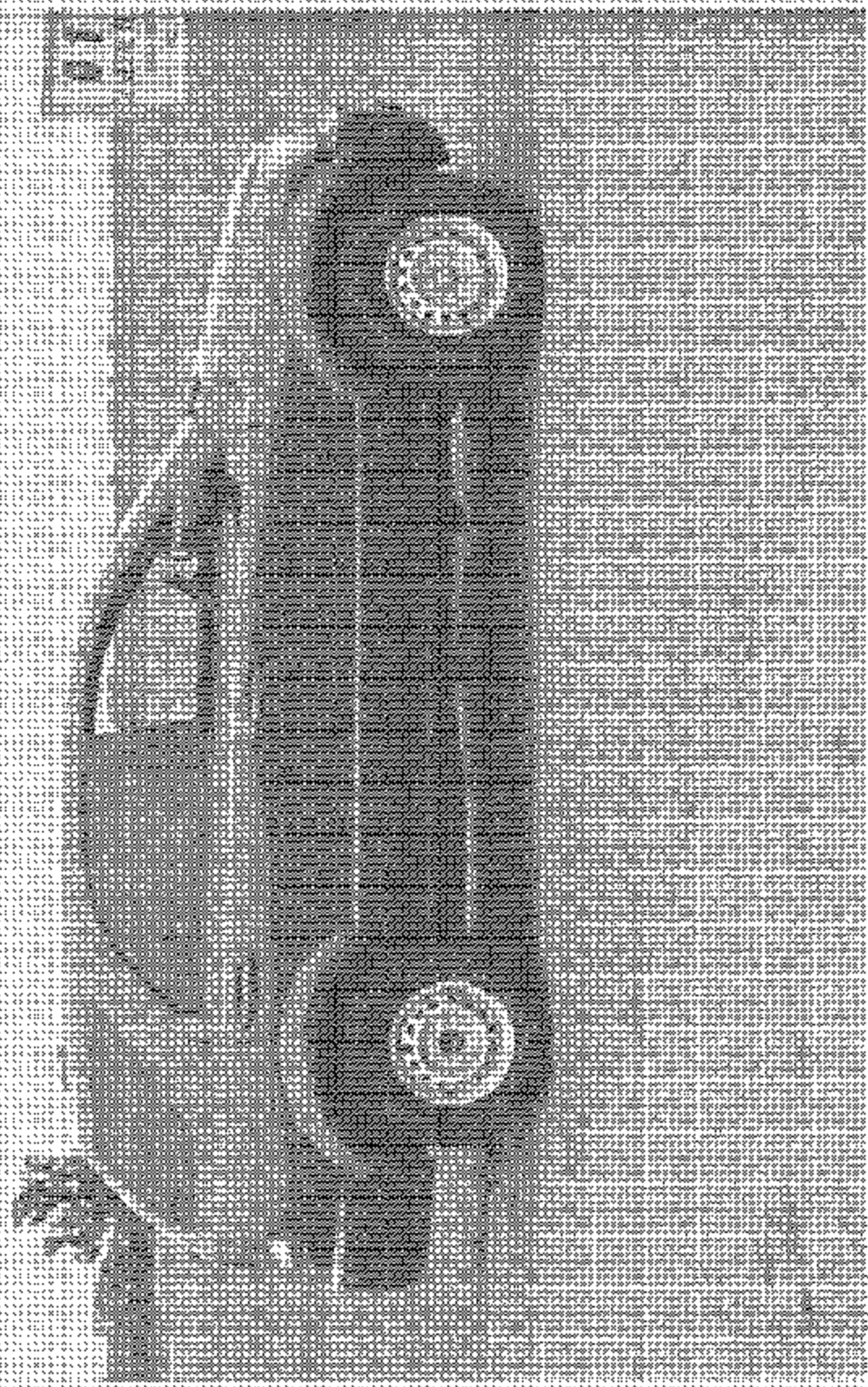


FIGURE 1-4
RIGHT SIDE VIEW OF VEHICLE BEFORE
TESTING

2003 KIA SORENTO
NHTSA NO. 060606
CMVSS NO. 216

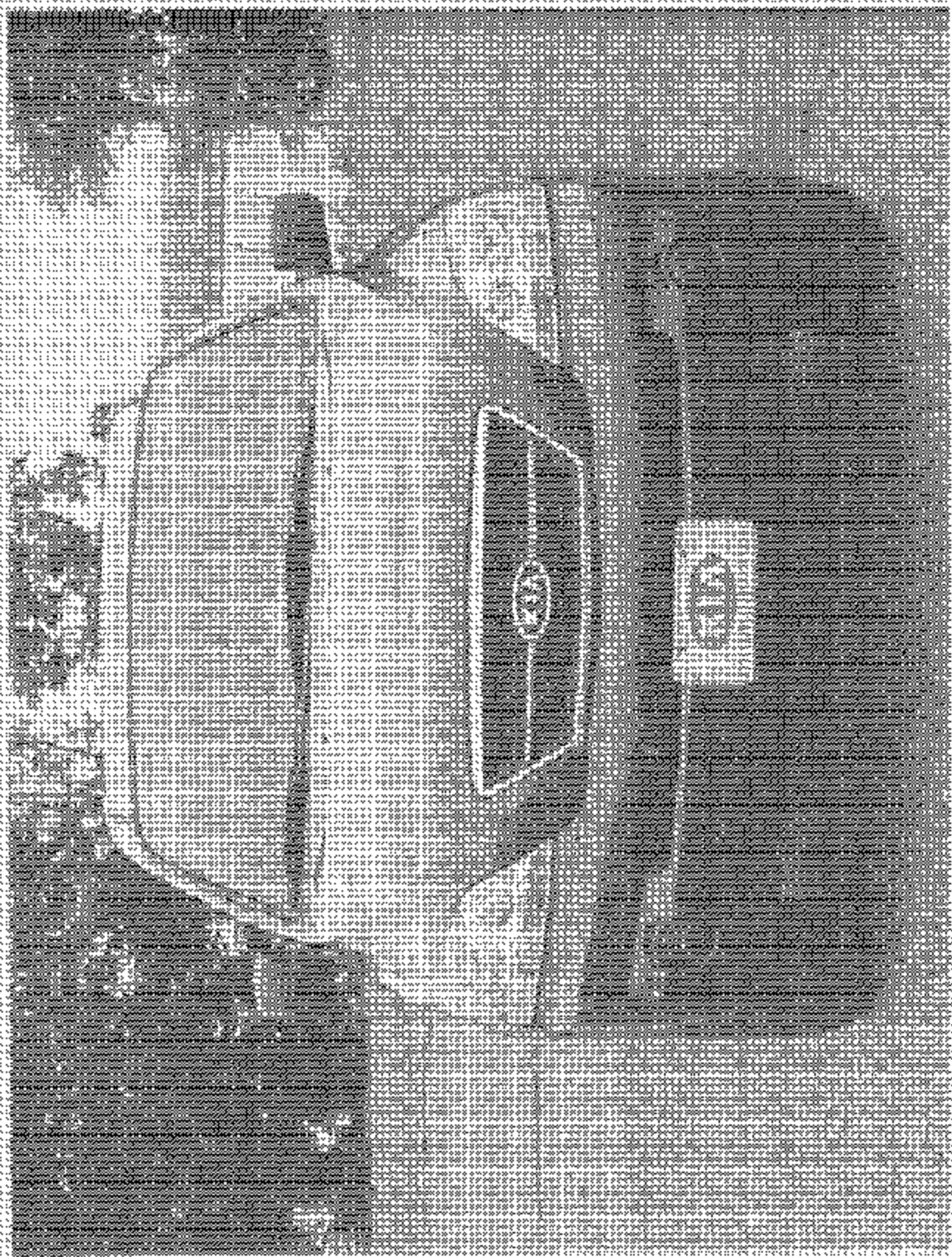
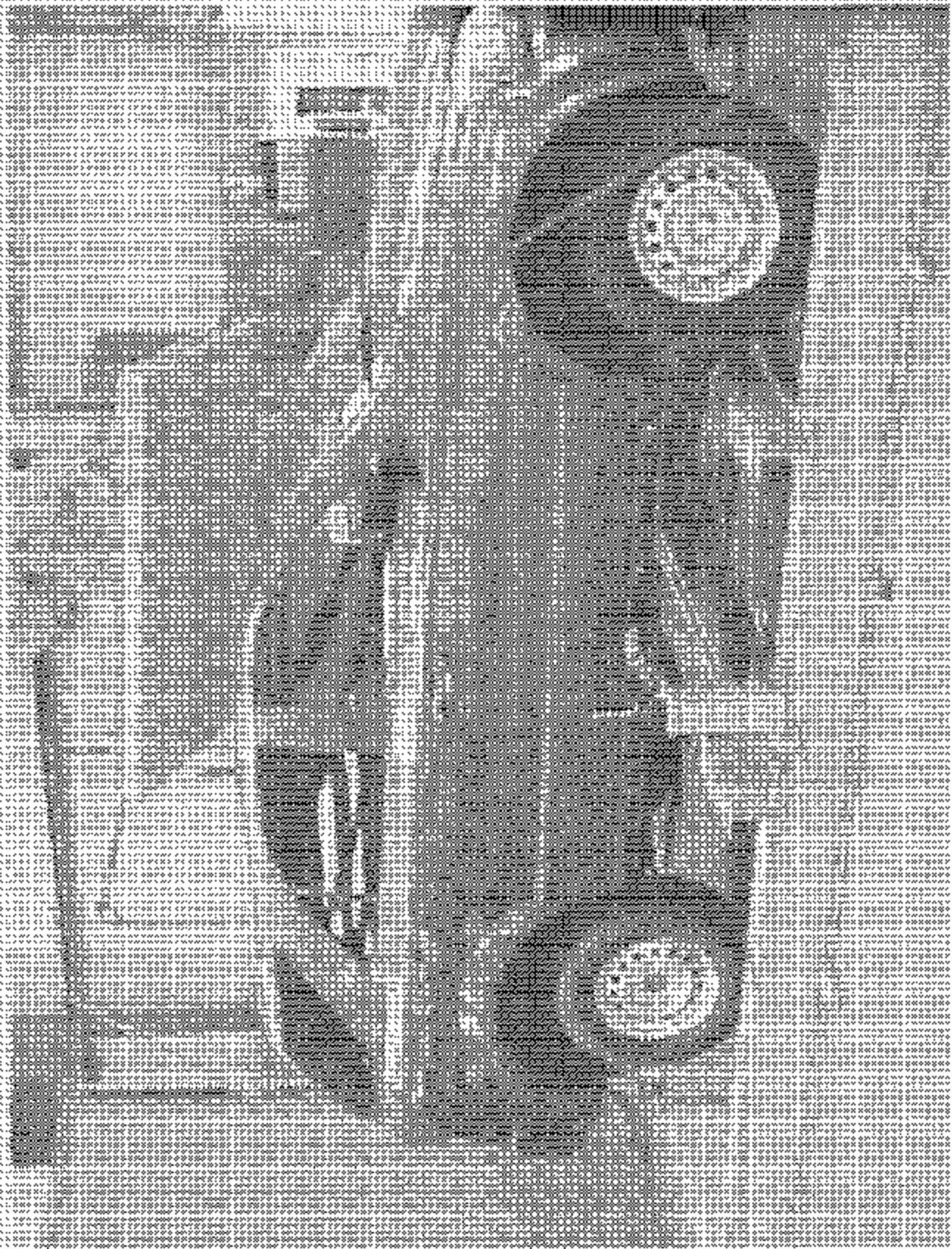


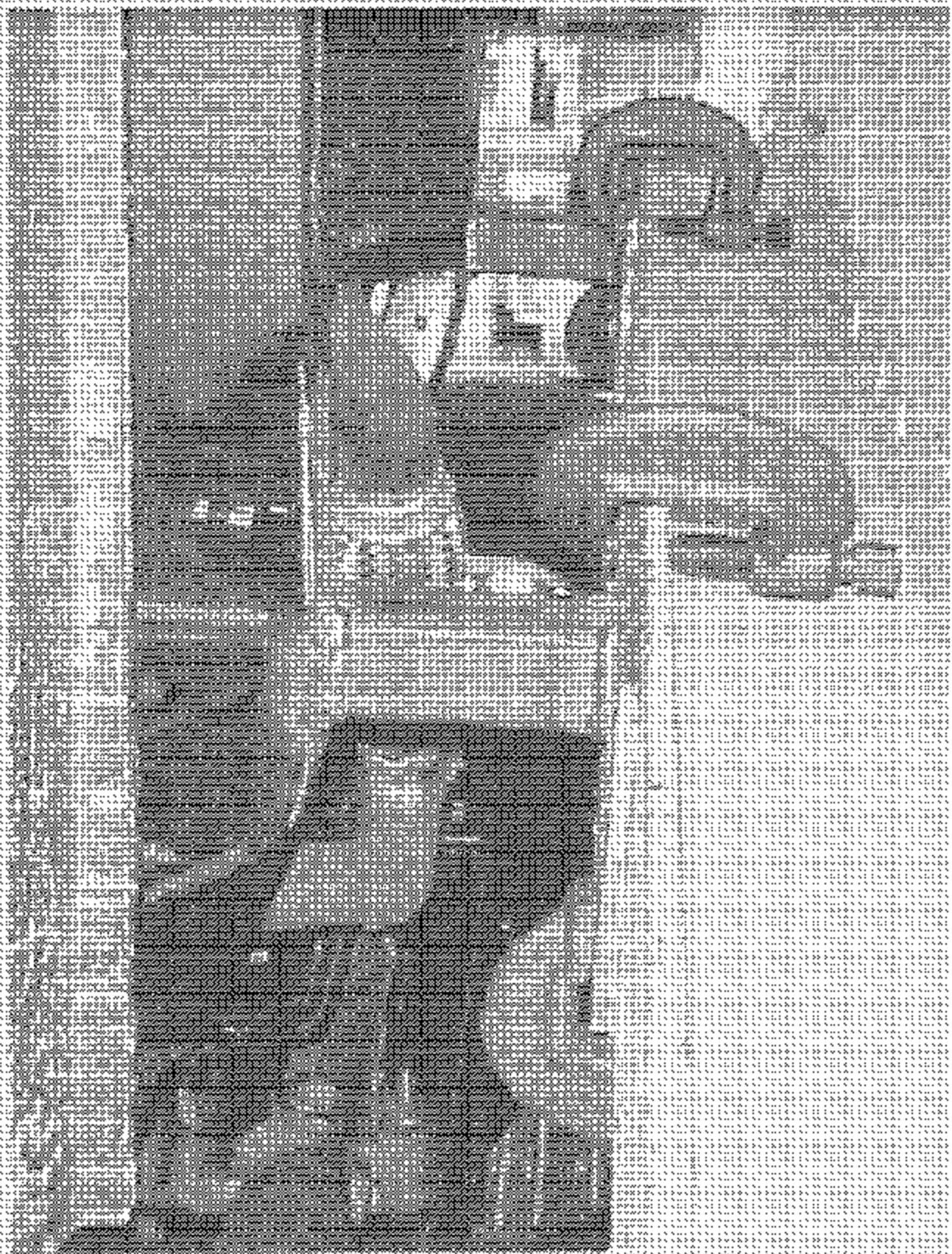
FIGURE 4-5
FRONT VIEW OF VEHICLE UNDER TESTING

ZUCERLA/ARRETO
PHISA NO. 000805
CN 55AM
CNVSS NO. 216



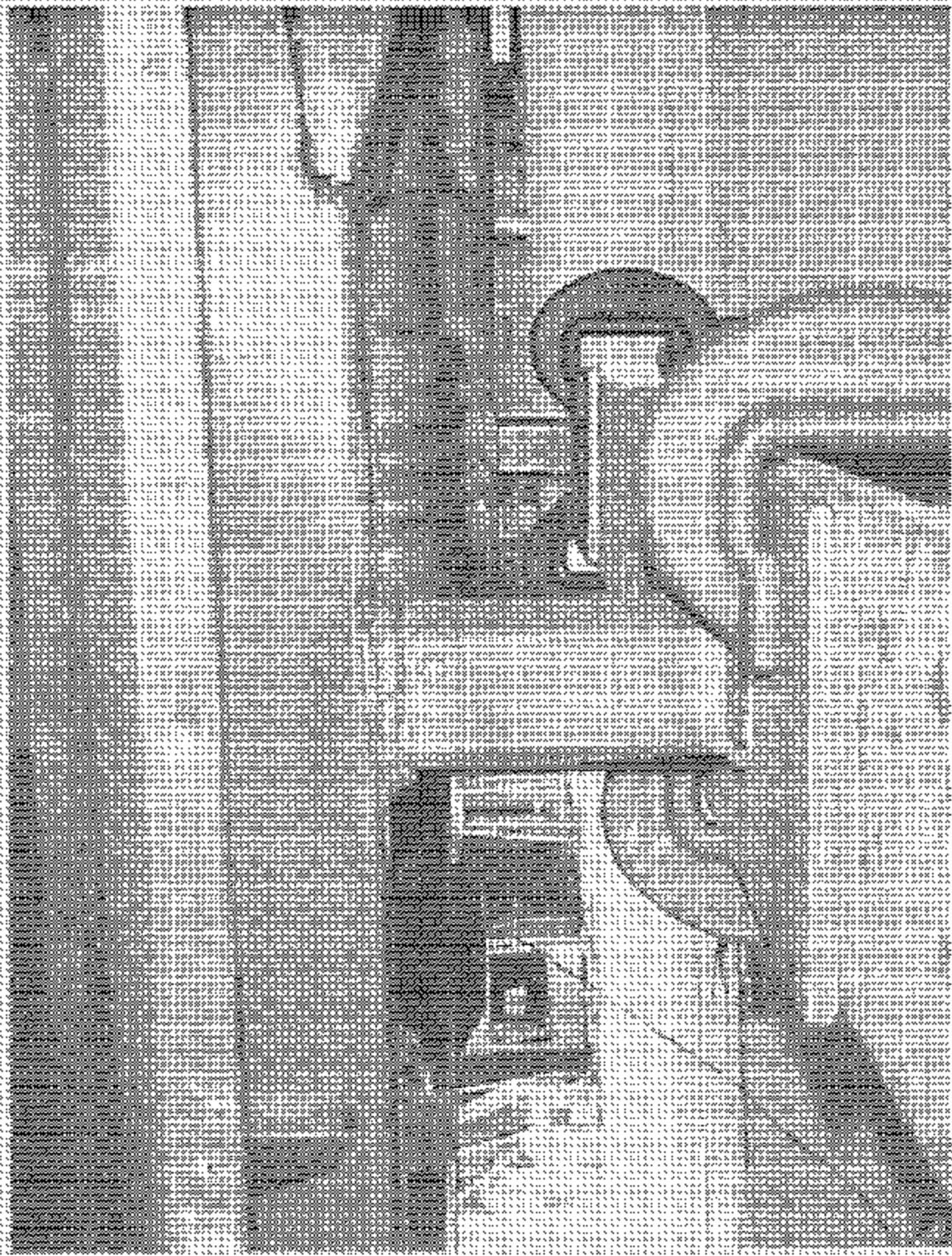
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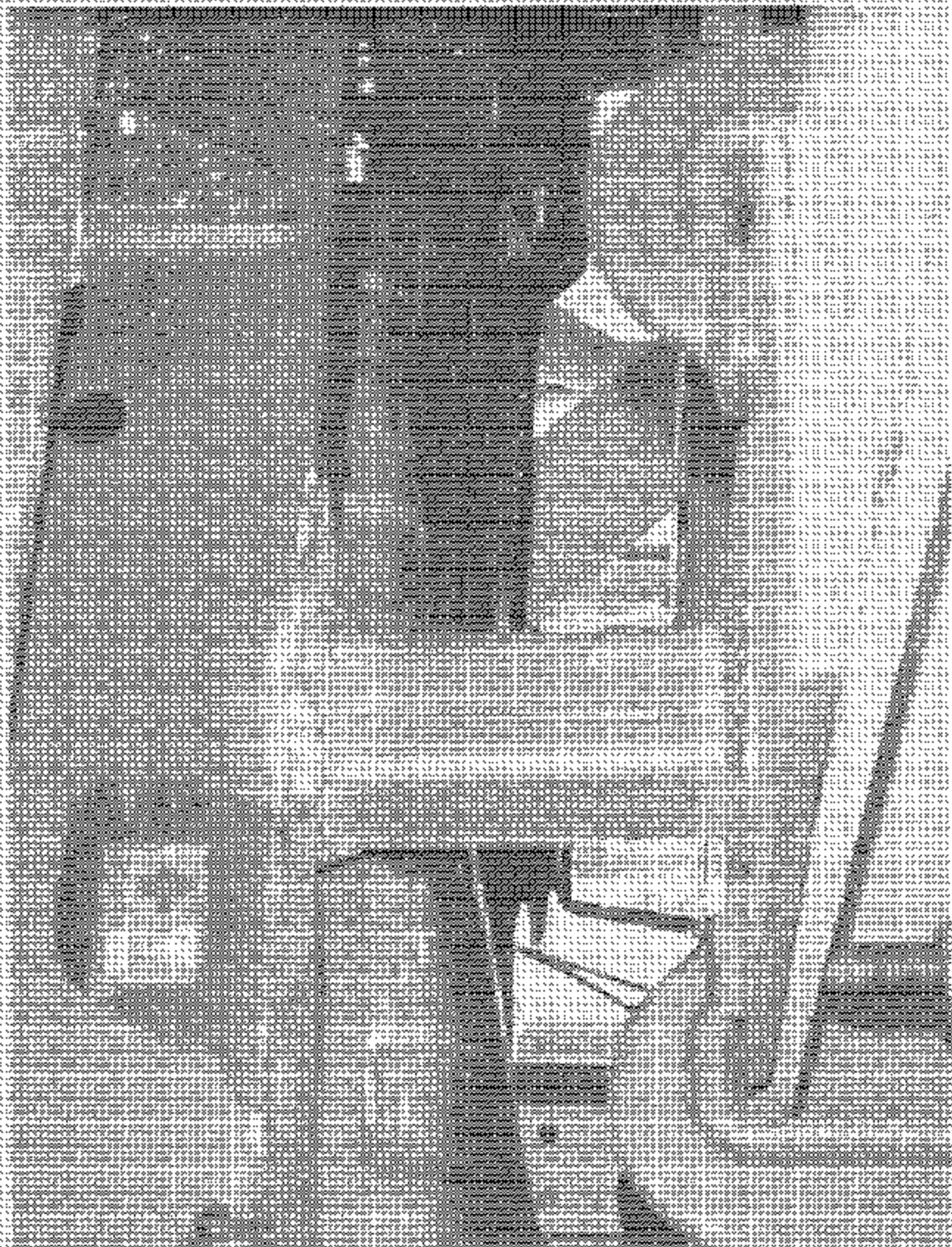
CHENKAI SONGPAI AND JIANG
XIAO WANG

9-2 ON SSAME
SOSOCI CAN ABILIN
EJNENON VOENOT



20030104 MOHENTD
NHTSA NO. 000505
FINVSS NO. 2-3

MOHENTD NO. 000505
FINVSS NO. 2-3



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TEHRAN, IRAN

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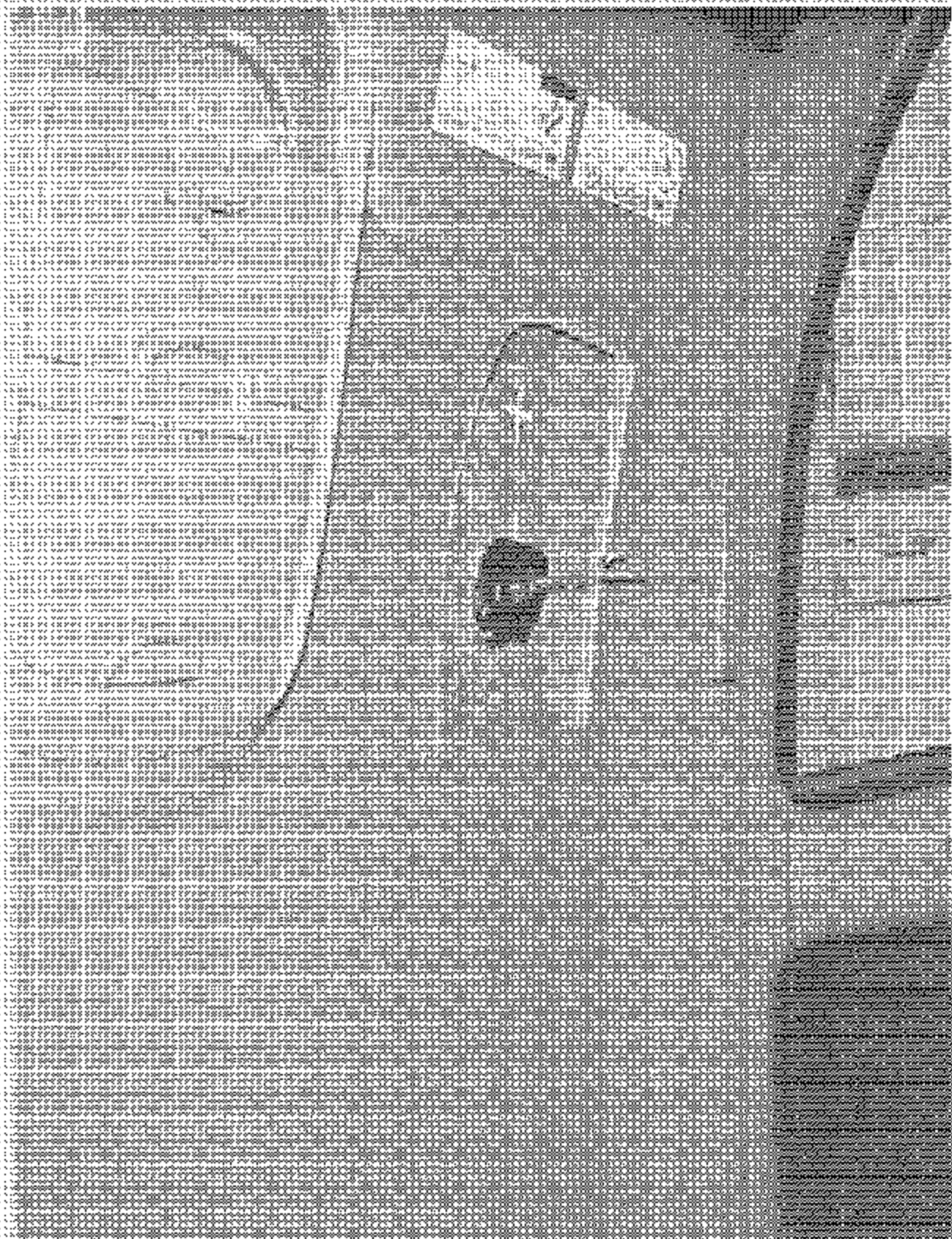
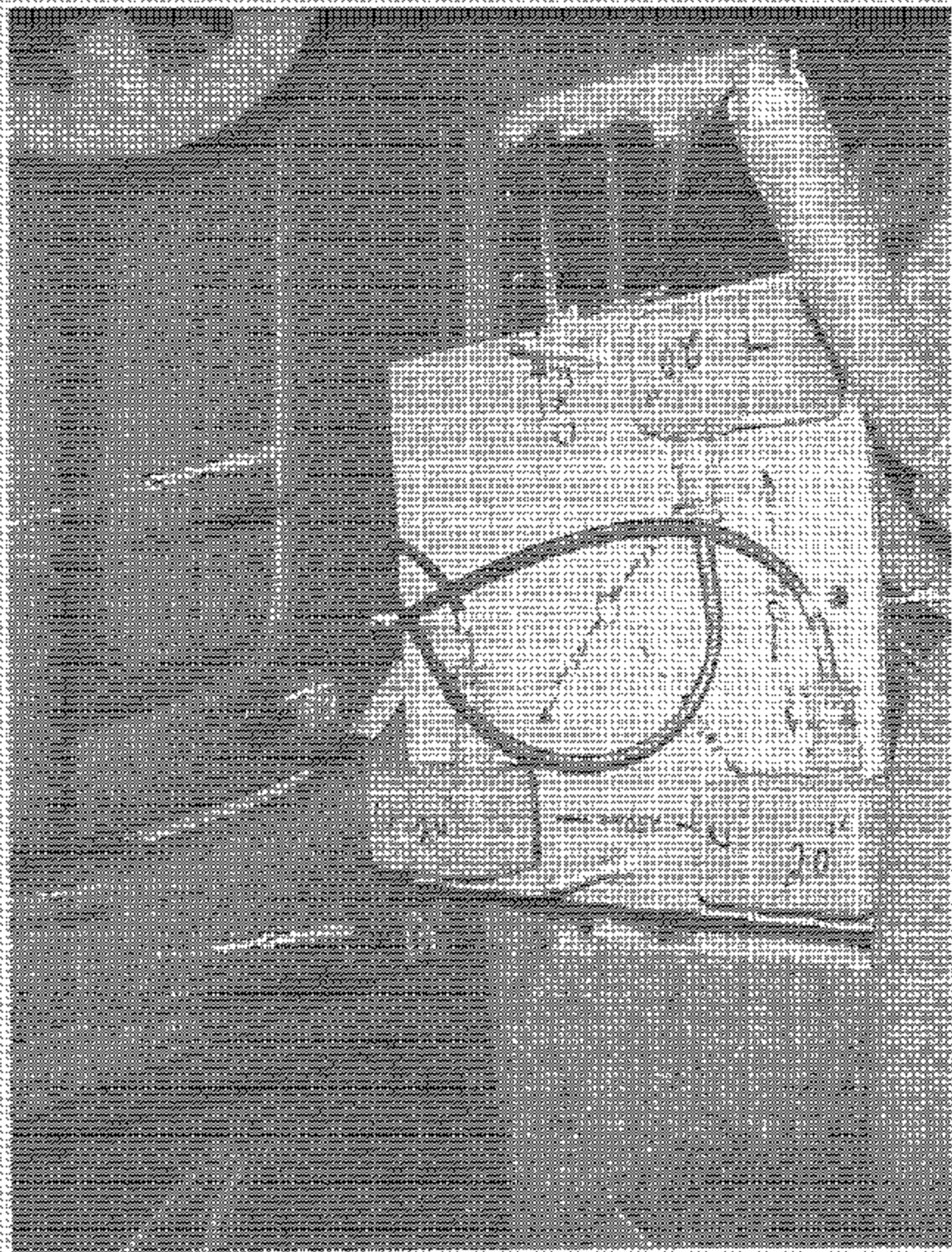


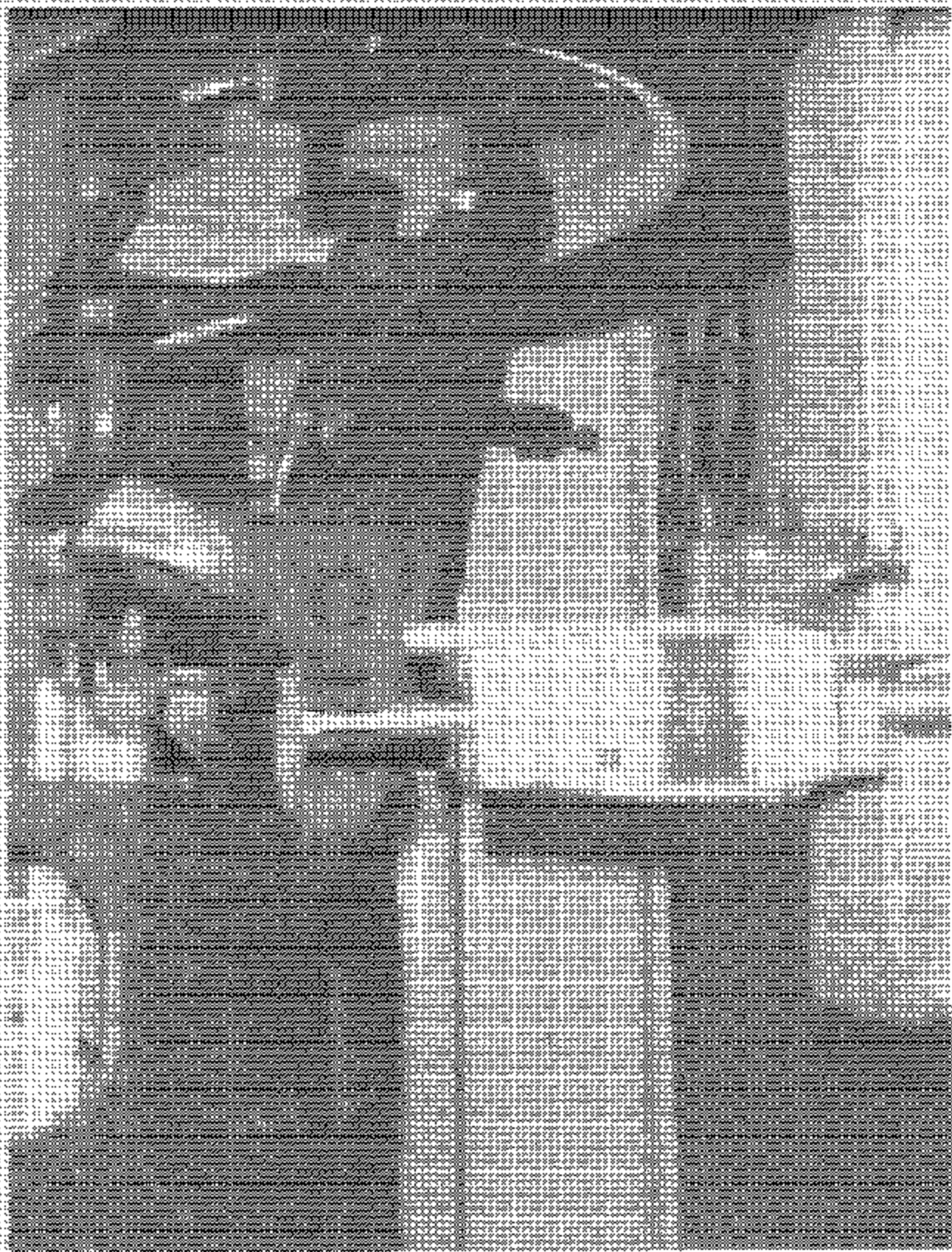
FIGURE A-1
LEFT DISPLACEMENT MOUNTING TO ROOF

ENCLOSURE
EHTSA MC 08-006
EHTSA MC 08-006



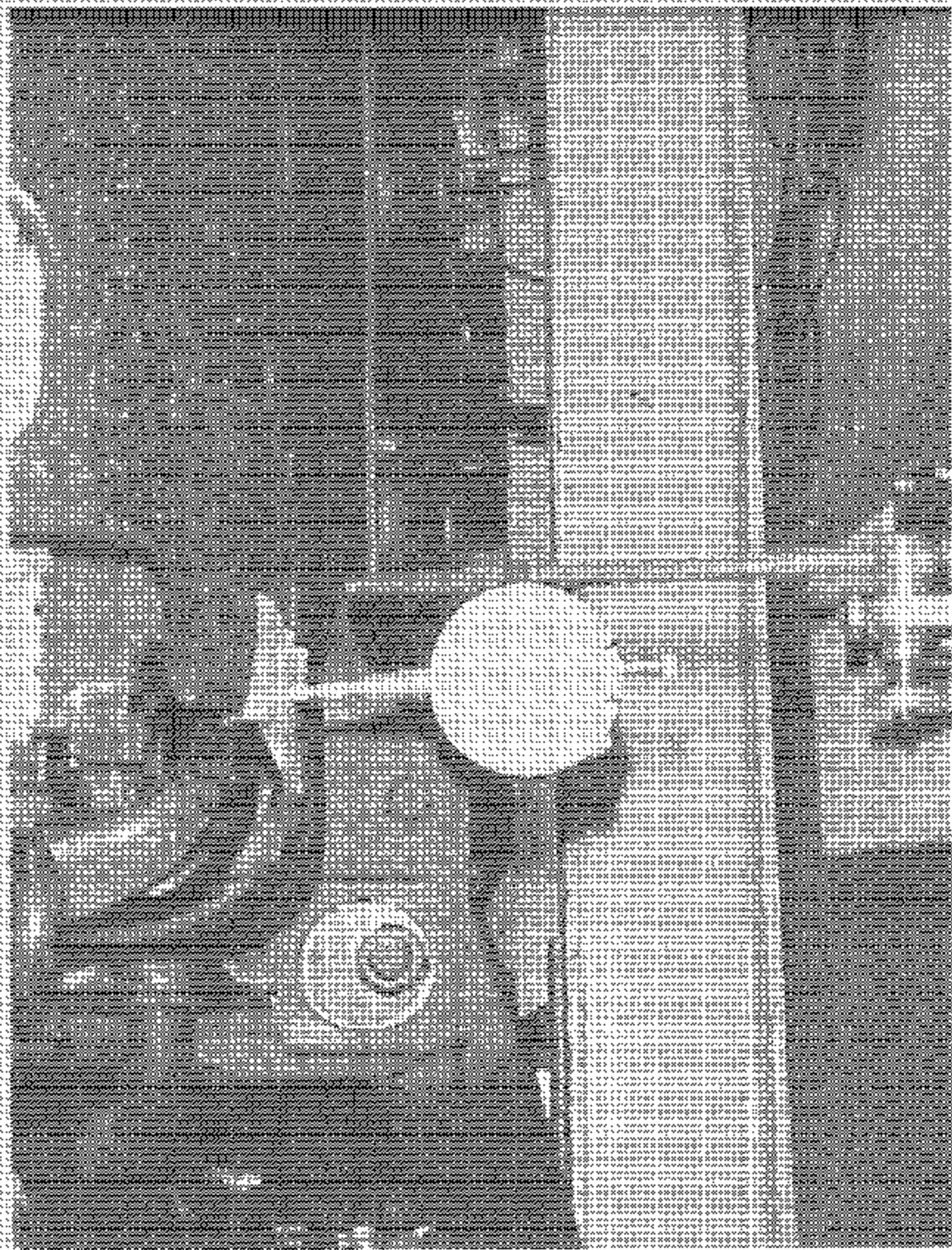
TAYLOR & SHERIDAN
 1111 S. 10th St.
 SALT LAKE CITY, UT 84143

FIGURE 1
 LAMP TRANSDUCER MOUNTING AT 100W



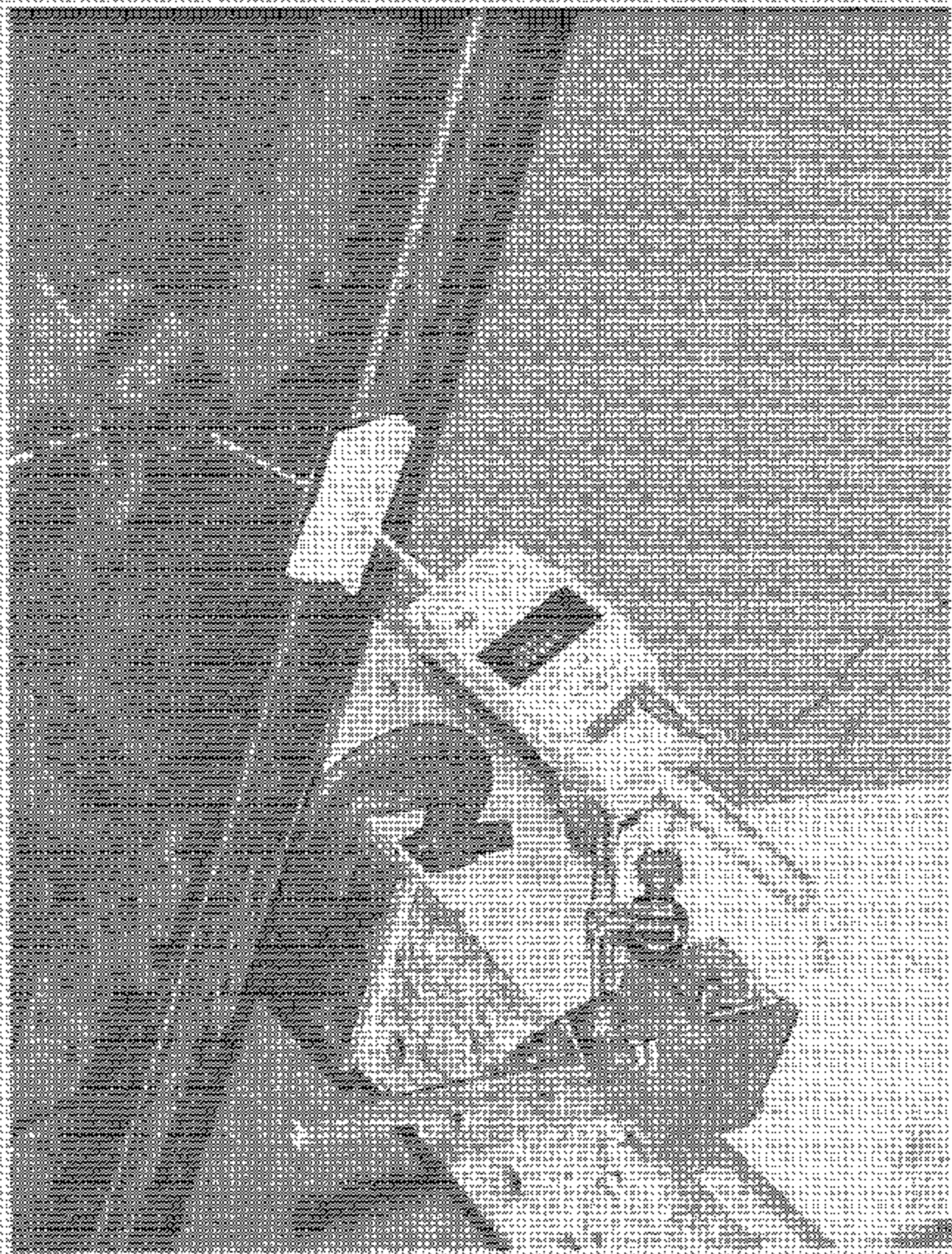
2003-04-05 10:00:00
 41155A.MX 000000
 11/15/03 10:00:00

FIGURE 1
 DISPLACEMENT INDICATOR AT LEFT FRONT OF
 VEHICLE



2003 KIA SILVERADO
NHTSA NO. 03-056
FNUSS NO. 216

FIGURE 2-14
DISMACHETTI INDICATOR AT REAR VIEW
OF VEHICLE



RECEIVED
DISPATCHED NOV 10 1964
BY VICTOR

2003-CA-FORENTD
RUFF SA NO CACSOX
PLAYSS NC 2-3

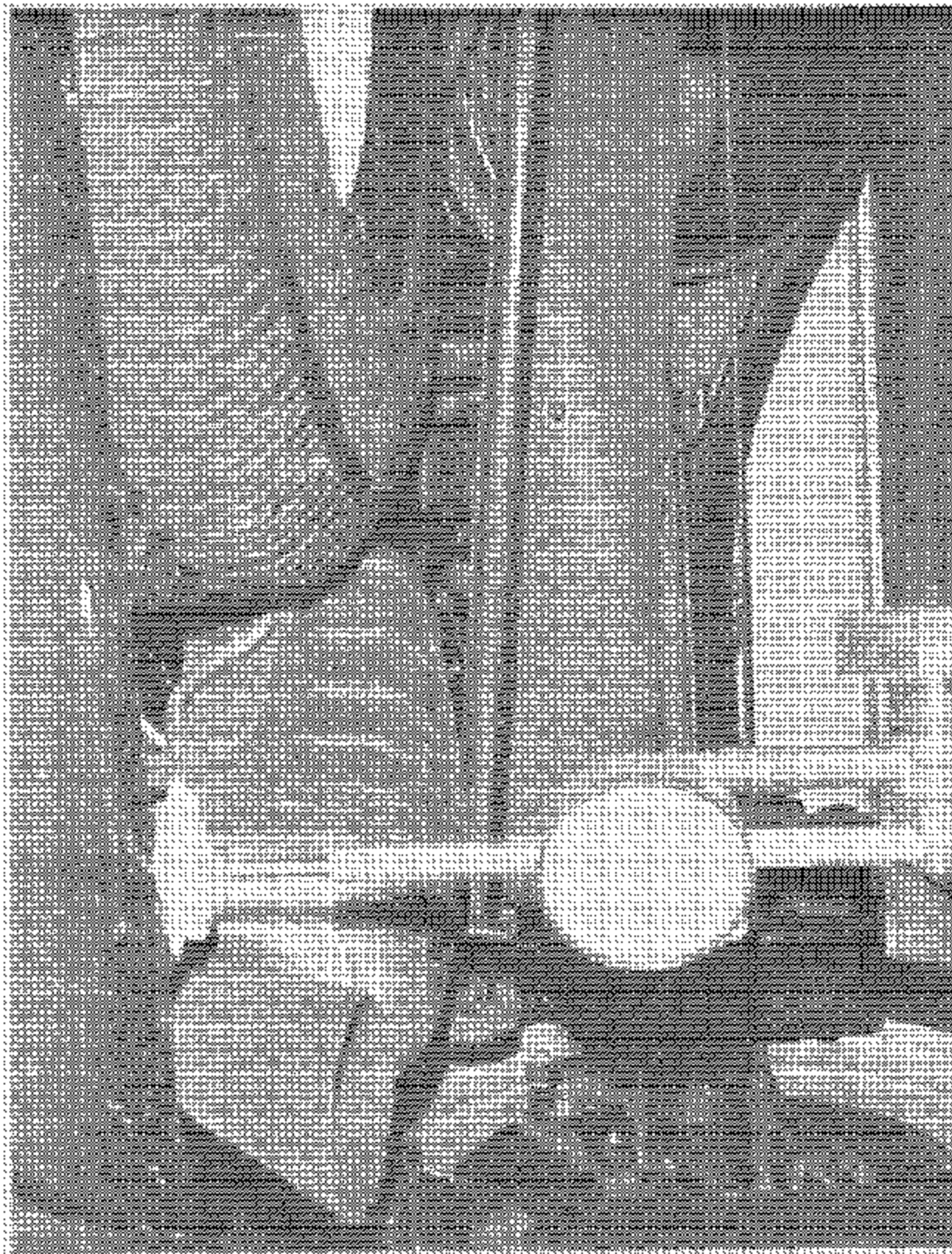


FIGURE 5-18
DISPLACEMENT INDICATOR AT REAR
OF VEHICLE

FOOTER: A-2000-000000
PMTSA NO. 000000
PMVSS NO. 000000

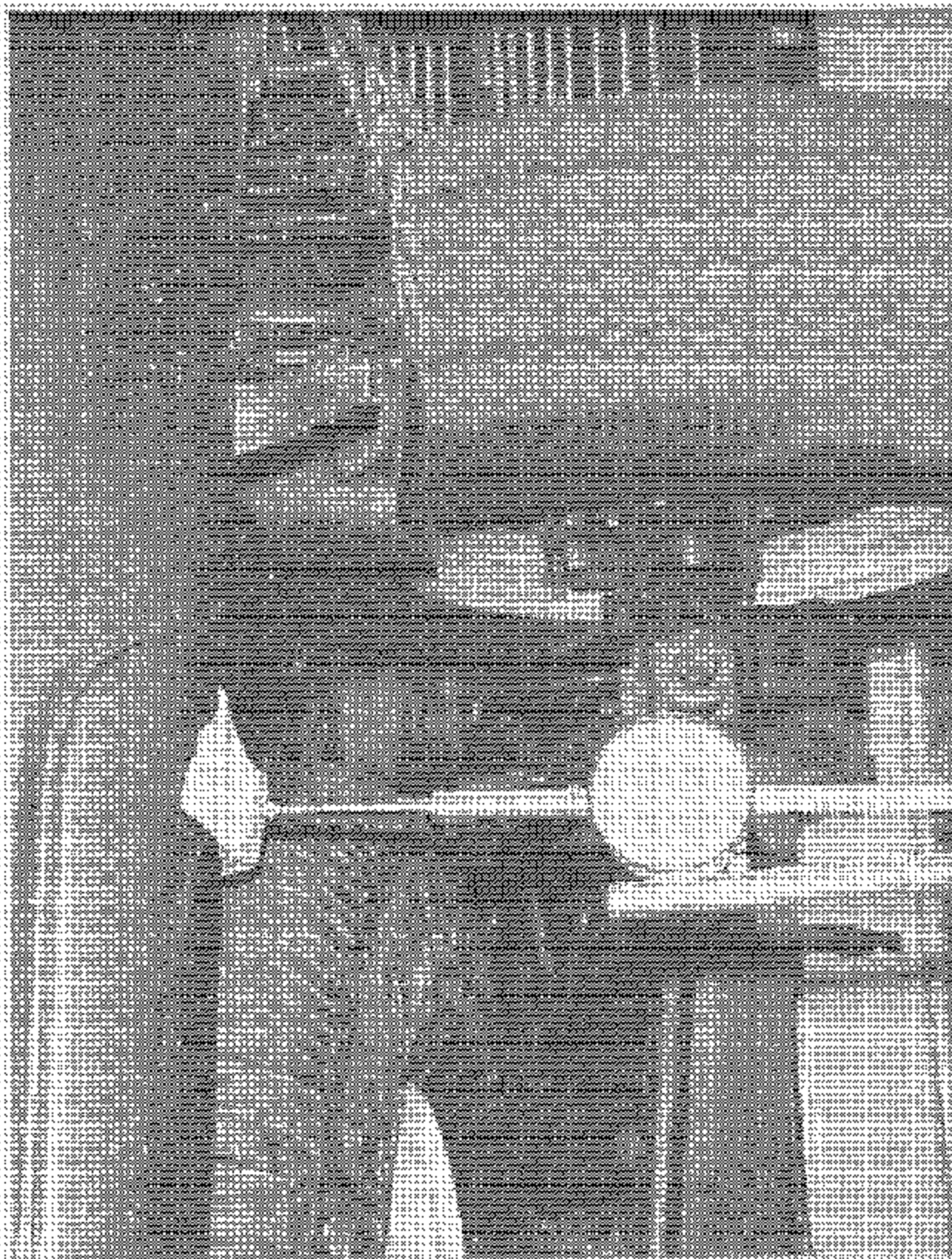


FIGURE 5.17
DISPLACEMENT INDICATOR AT RIGHT REAR
OF VEHICLE

2003 KIA XIENTO
PMTSA NO. 70565
PMTSS NO. 826



FIGURE 5-15
FRONT VIEW OF LOADING DEVICE PLACED
AGAINST VEHICLE ROOF

FIGURE 5-15
FRONT VIEW OF LOADING DEVICE PLACED
AGAINST VEHICLE ROOF



FIGURE 3-19
REAR VIEW OF LOADING DEVICE PLACED
AGAINST HOLE ROOF

FORNIA WILSON
NHTSA NO. 100016
INVEST. NO. 754



FIGURE 3-20
FRONT VIEW OF LOADING DEVICE PLACED
AGAINST WHOLE ROOF AT FULL LOAD

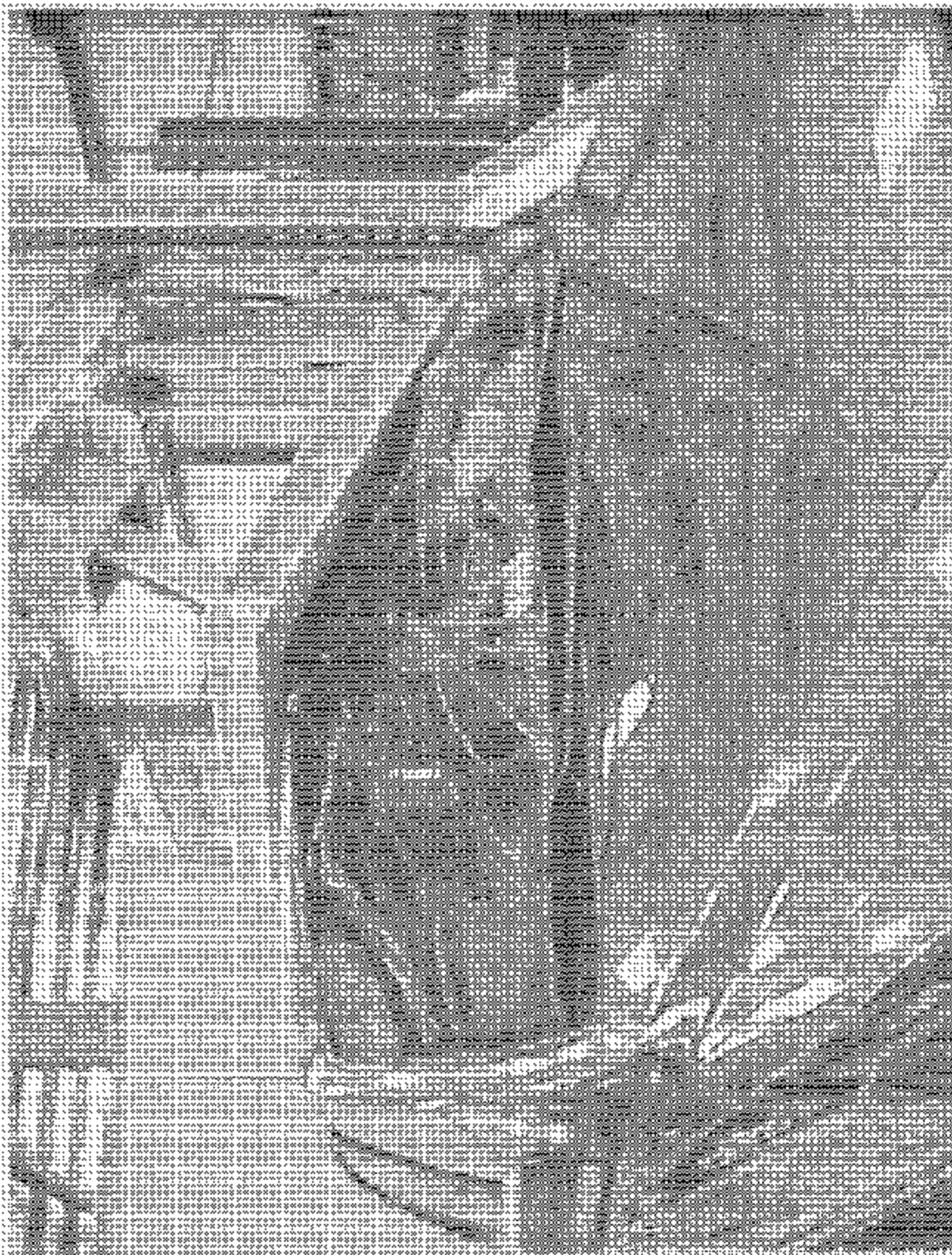


FIGURE 5-21
FRONT VIEW OF LOADING DEVICE PLACED
AGAINST VEHICLE ROOF AT FULL LOAD

AMERICAN INSTITUTE
OF SAFETY ENGINEERS
AMERICAN INSTITUTE



FIGURE 5.22
REAR VIEW OF LOADING DEVICE PLACED
AGAINST VEHICLE ROOF AT FULL LOAD

PHOTO BY K. J. GILBERT
PHOTO NO. 530945
INVEST NO. 816

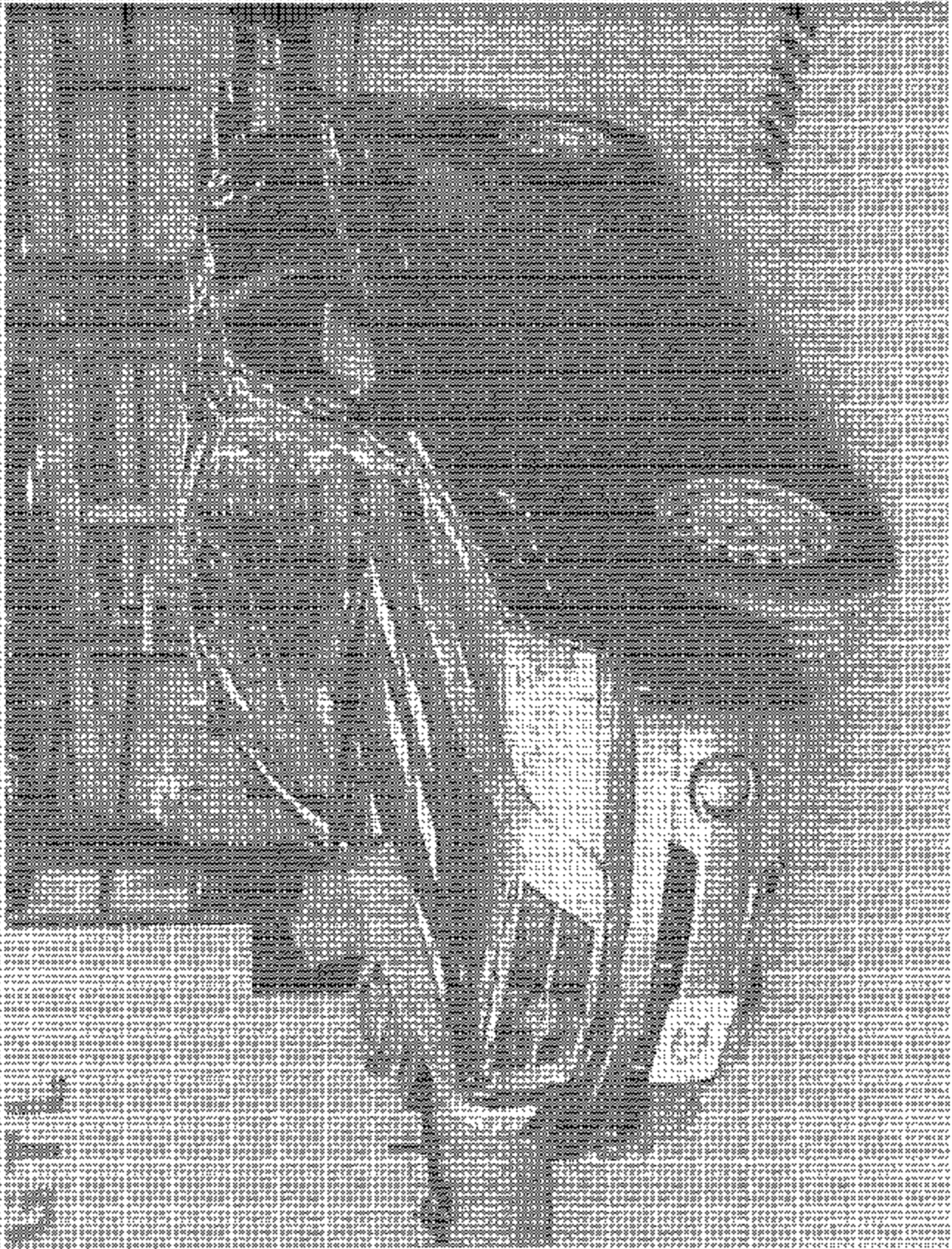


FIGURE 200
PERMANENT DEFORMATION OF VEHICLE ON TESTED
SIDE AFTER TESTING

SAFARI COMPANY
PITTSBURGH, PA.
PITTSBURGH, PA.

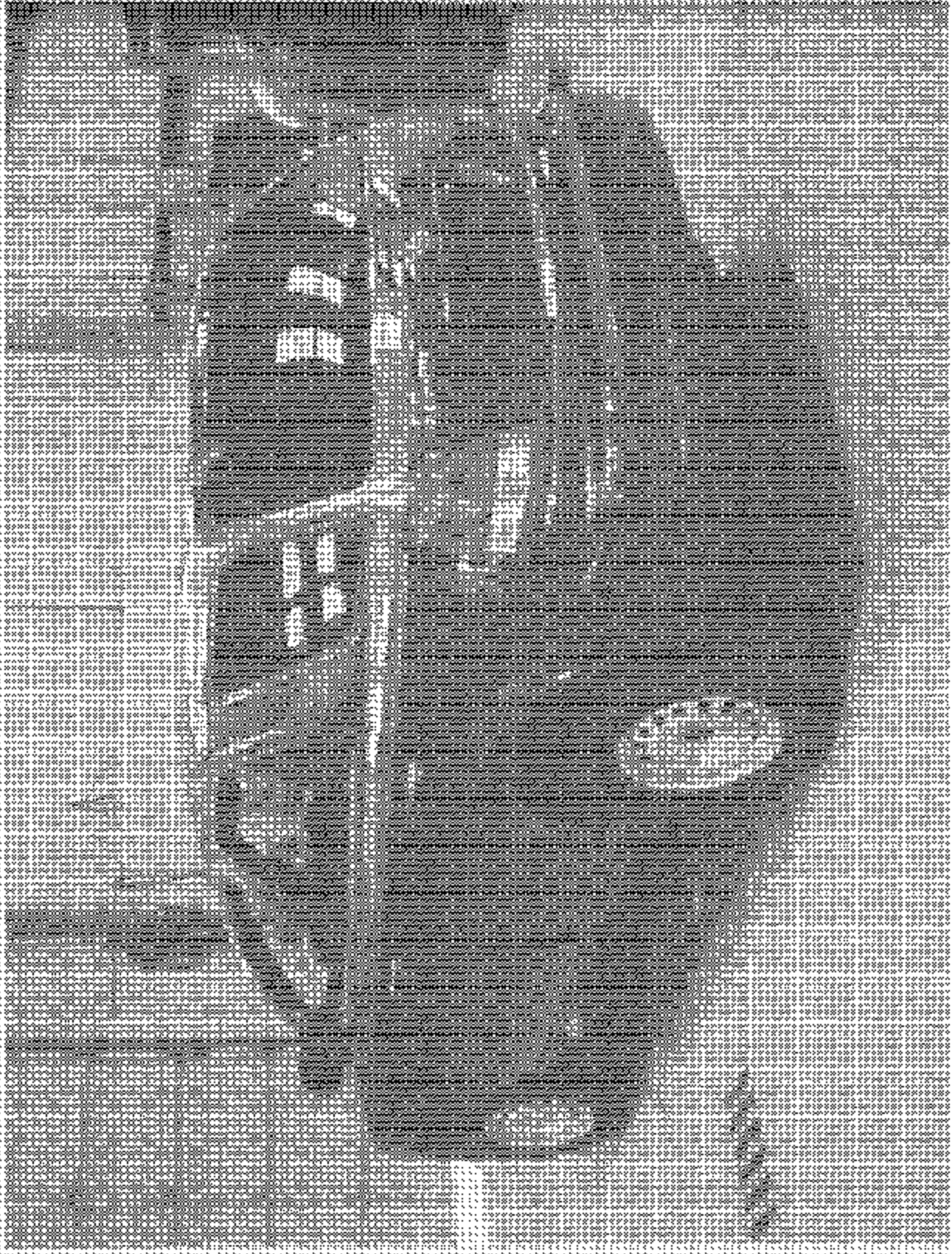
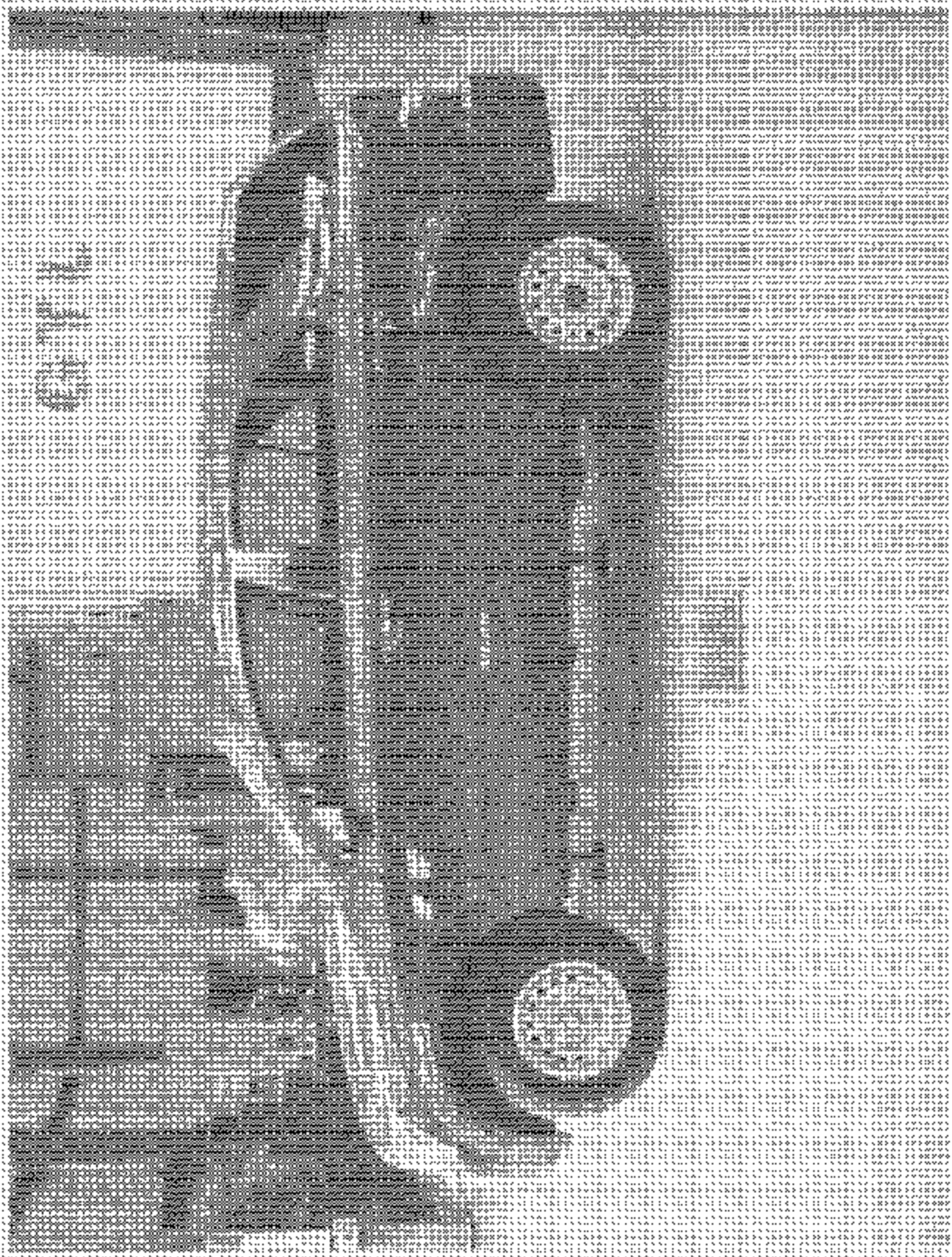


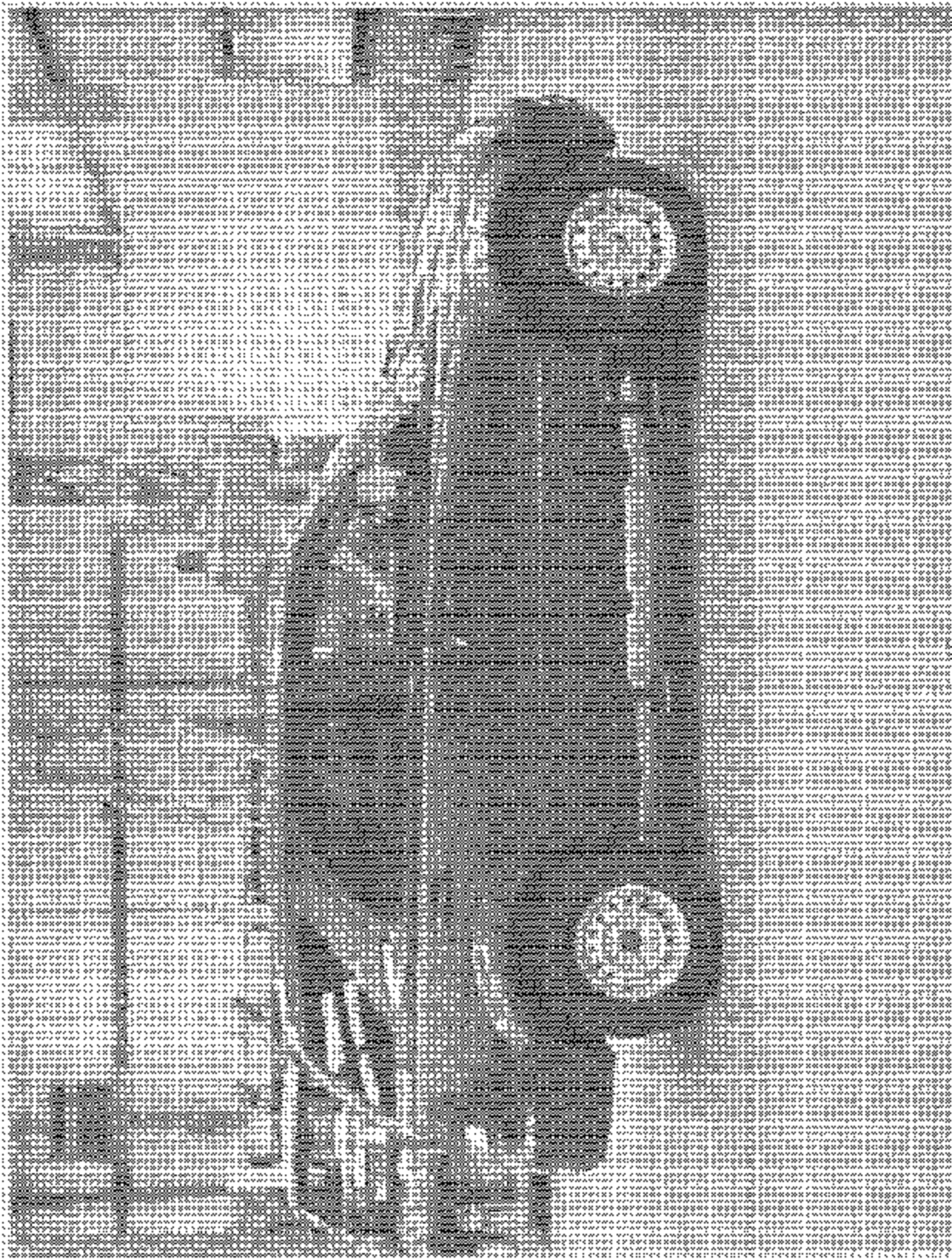
FIGURE 324
WRECKAGE VIEW OF VEHICLE ON TESTED
SIDE AFTER TESTING

AMERICAN SAFETY
NHTSA NO. 100615
THYSE INC. 734



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DATE 08-14-2013 BY 60322

FIGURE 3-25
LEFT SIDE VIEW OF VEHICLE AFTER TESTS



FOUR 5-55
RIGHT SIDE VIEW OF VEHICLE AFTER TESTING

PROBIA 10100010
NHSA-NO 50065
INVEST NO 816

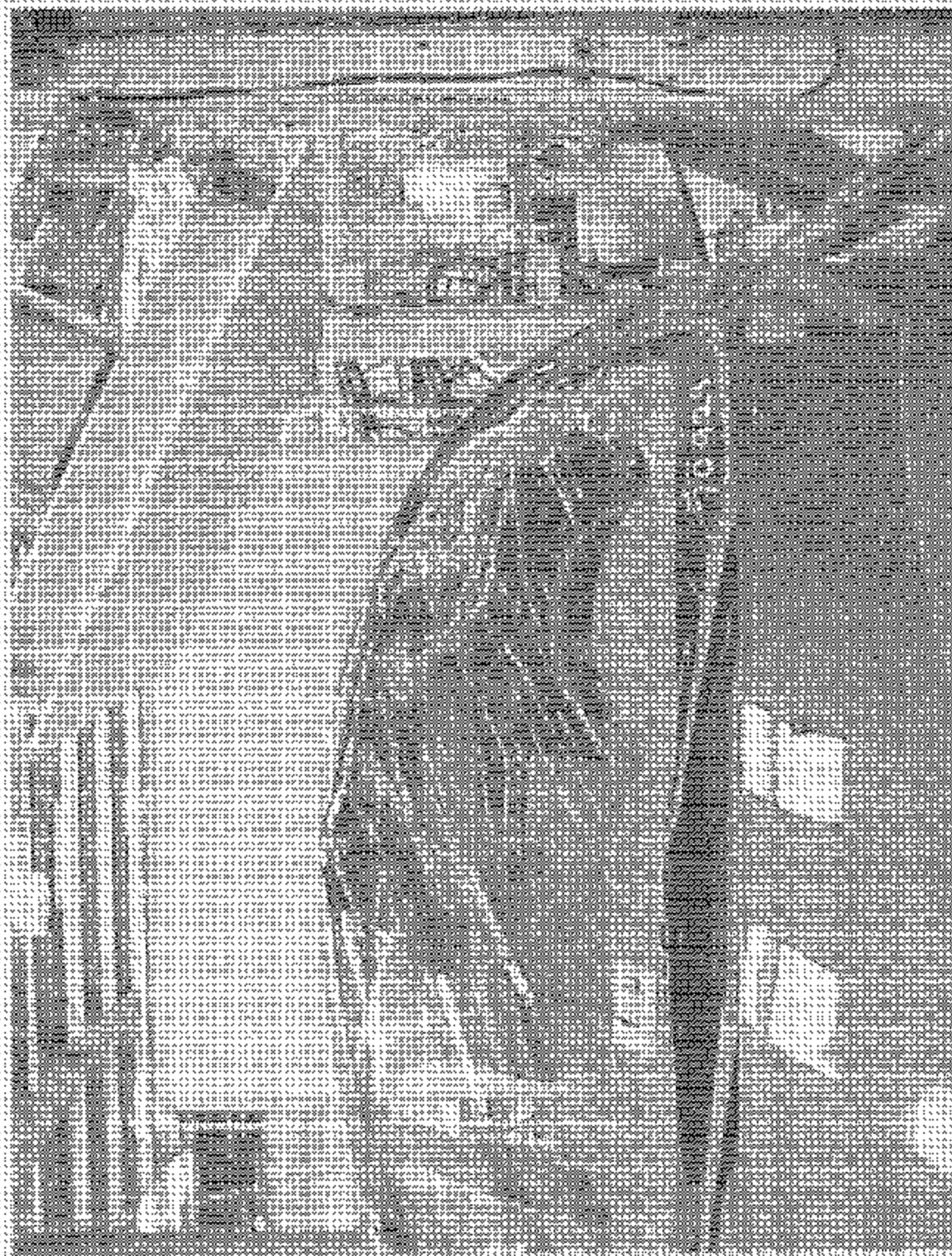


FIGURE 5-27
FRONT VIEW OF VEHICLE ROOF AFTER
REMOVAL OF FLOATING DEVICE

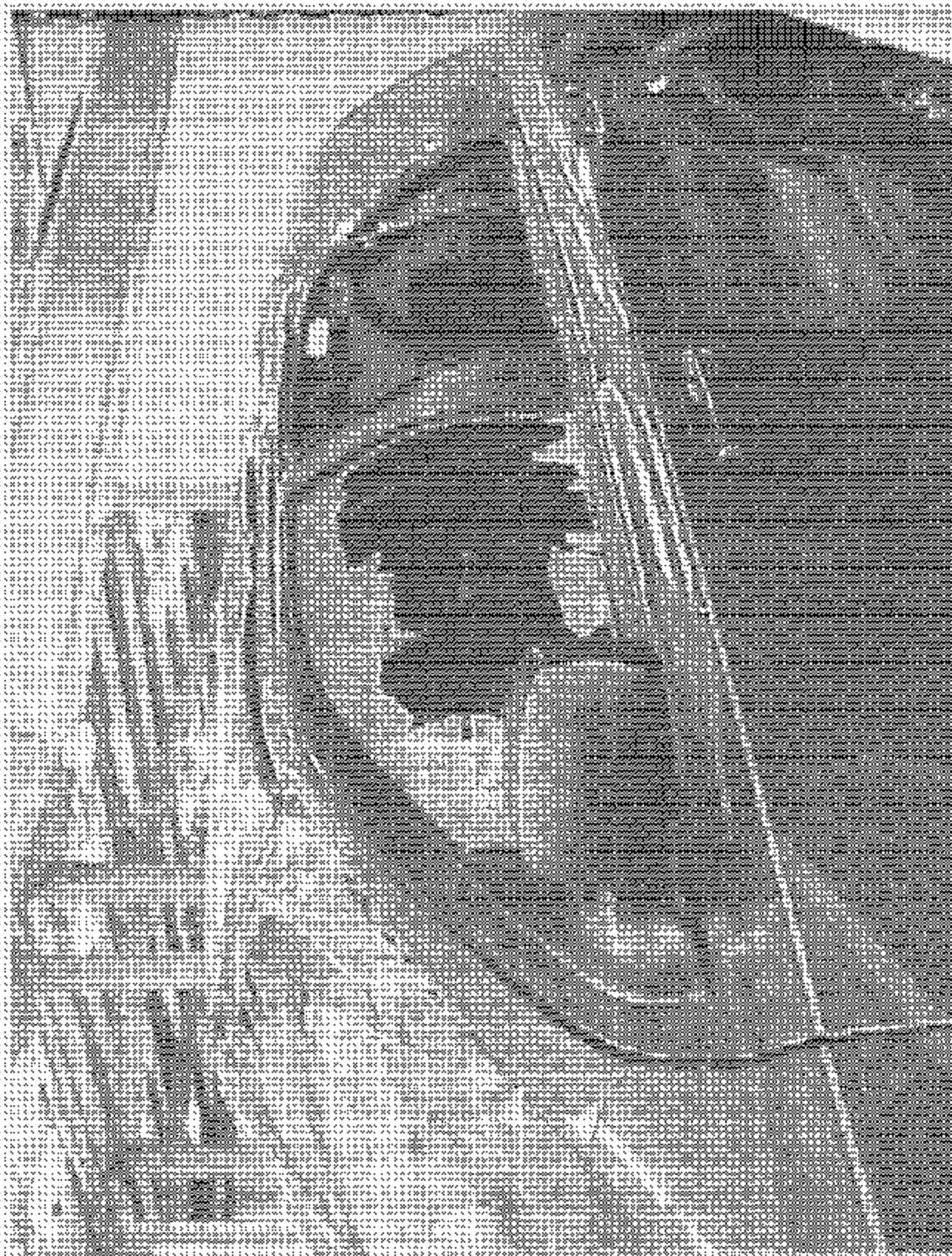


FIGURE 5-27
FRONT VIEW OF VEHICLE ROOF AFTER
REMOVAL OF LOADING DEVICE

PHOTO BY J. J. J. J. J.
PHOTO NO. 00000
PHOTO NO. 00000



FIGURE 329
A REAR VIEW OF VEHICLE ROOF AFTER
REMOVAL OF LOADING DEVICE

UNITED STATES
PATENT AND
TRADE MARK
OFFICE

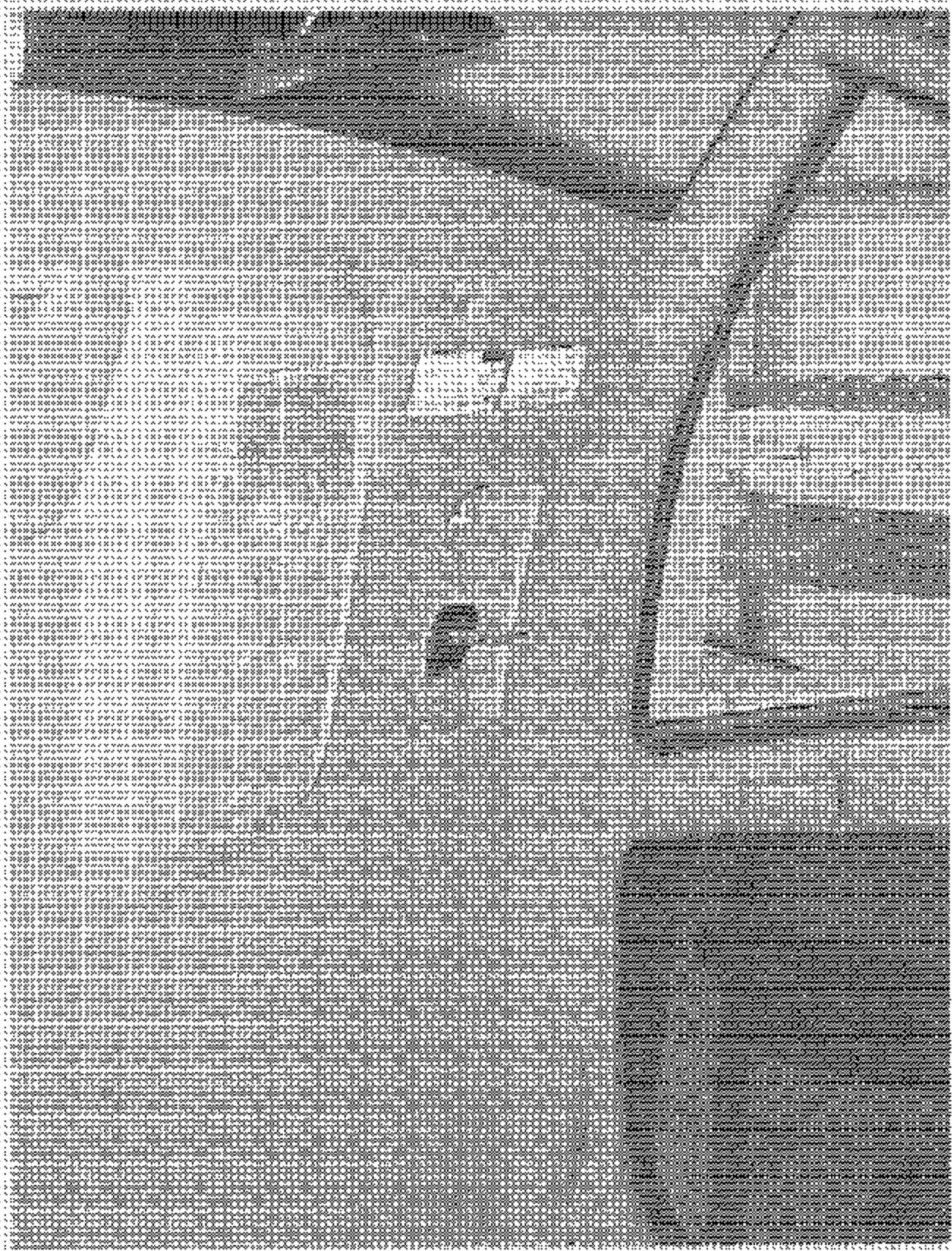


FIGURE 5-30
INTERIOR VIEW OF ROOM PRE-TEST

PER ON BOARD
EQUIPMENT
EXAMINER

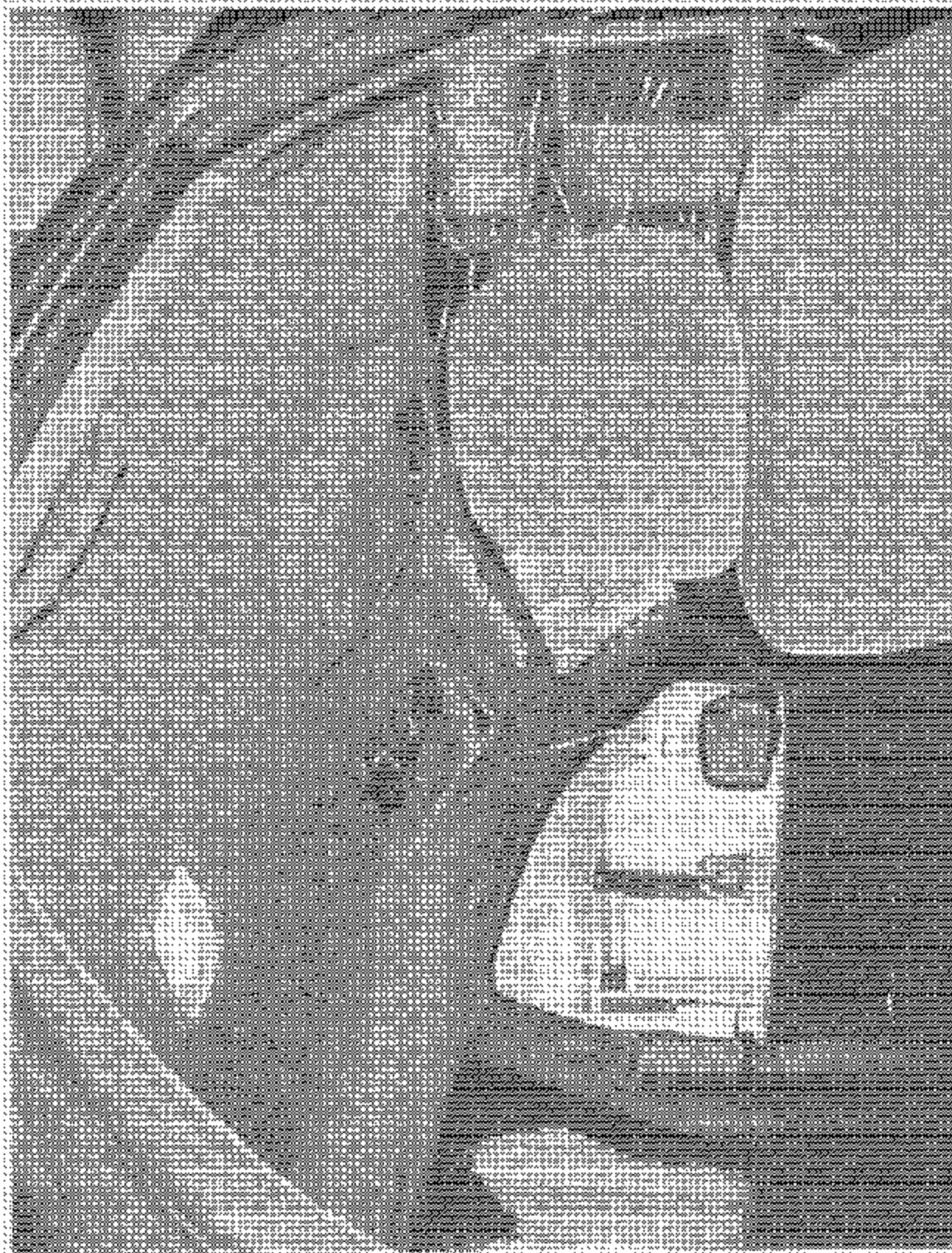
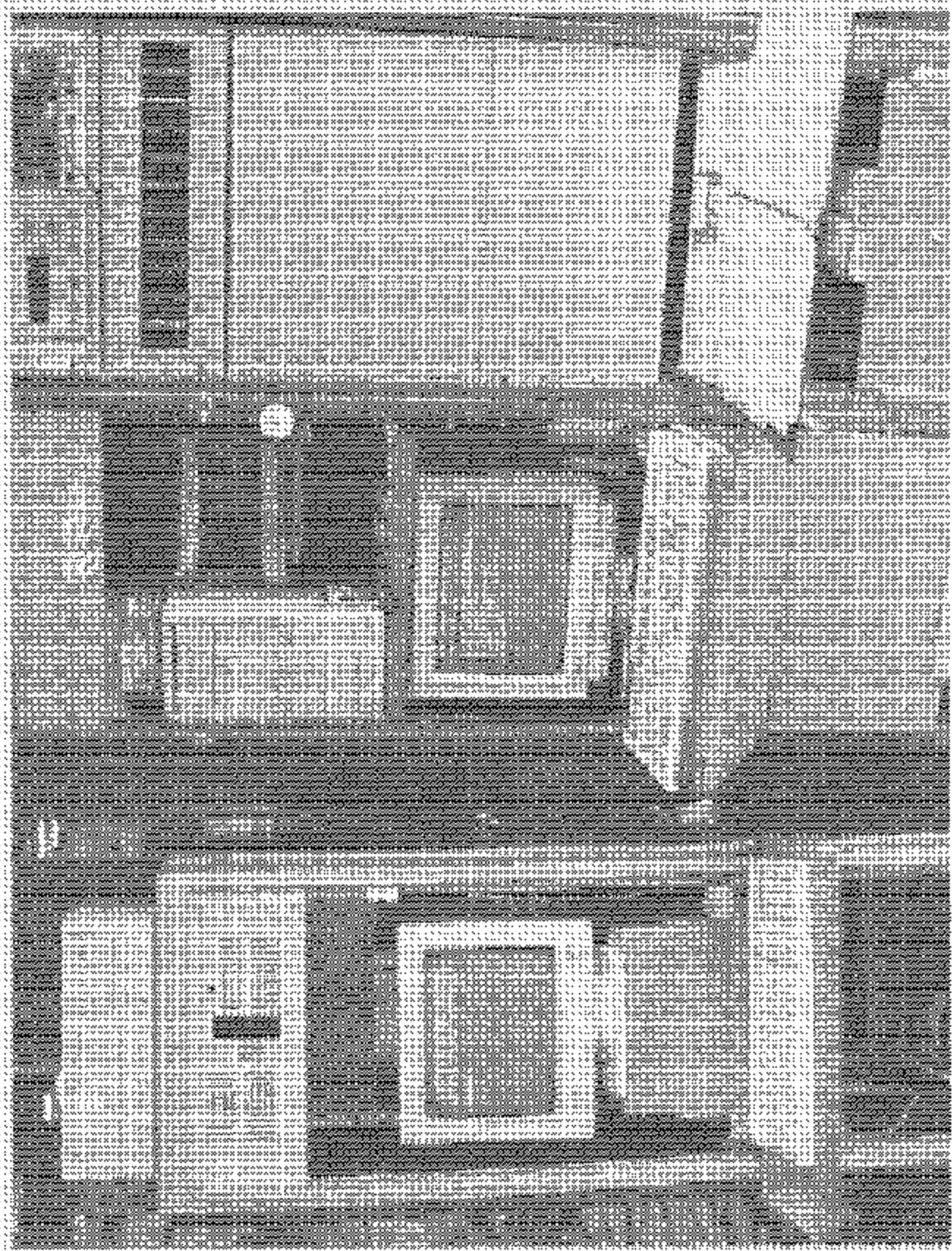


FIGURE 3.5:
INTERIOR VIEW OF ROOF POST TEST

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AMTSA 100-000000
AMTSA 100-000000



POLICE 532
IDENTIFICATION SET-UP

FOR THE
FEDERAL BUREAU OF INVESTIGATION
WASHINGTON, D.C. 20535

THE

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100

Figure 1

FIGURE 1
The effect of the
rate of change of
the parameters of
the model on the
rate of change of
the solution.

THE UNIVERSITY OF CHICAGO

16
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THE
NEW
YORK
PUBLIC
LIBRARY



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[illegible]

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PG. 14-552
CLOSED VIEW OF VEHICLE SELECTION
L3581

SORENTO

2WD

GWR 2480KG (M57LB) MAXIMUM GROSS WEIGHT

4WD

GWR 2700KG (M57LB) MAXIMUM GROSS WEIGHT

GAWR FRONT

1280KG (3822LB) USING P245/50R17 Tires

ON 16X7J RIMS W/ LATE 10 2100KG (4620LB)

GAWR REAR

1500KG (3307LB) USING P245/50R17 Tires

ON 16X7J RIMS W/ LATE 10 2100KG (4620LB)

EXPERIMENTAL

P245/50R17 Tires ON EX 17 RIM

INFLATE TO 2100KG (4620LB)

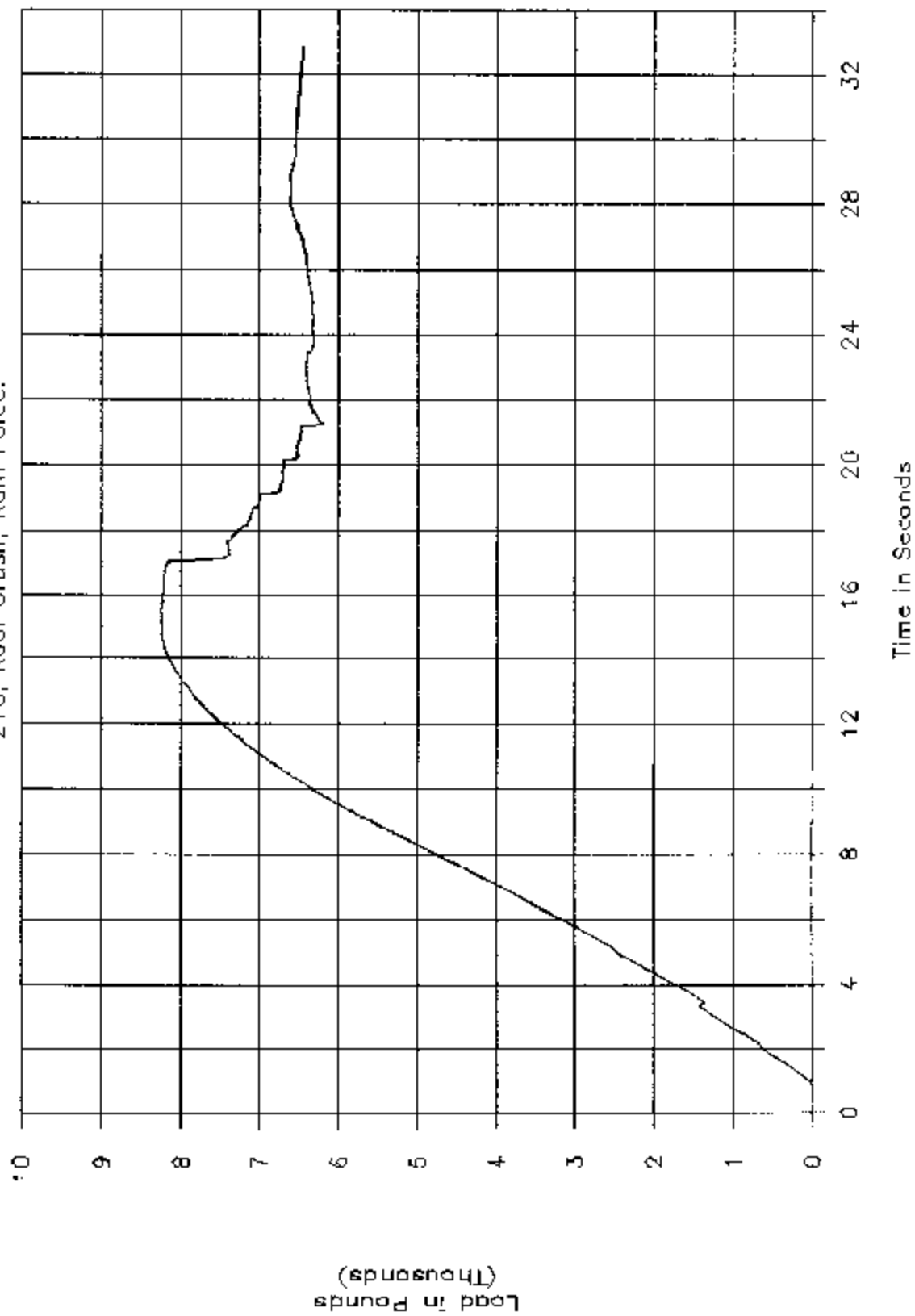
2014 KIA SORENTO
NHTSA NO. 20140605
PAGE 20 OF 21

English 300
CLOSE UP VIEW OF VEHICLE TIRE
INFORMATION LABEL

SECTION 6
TEST PLOTS

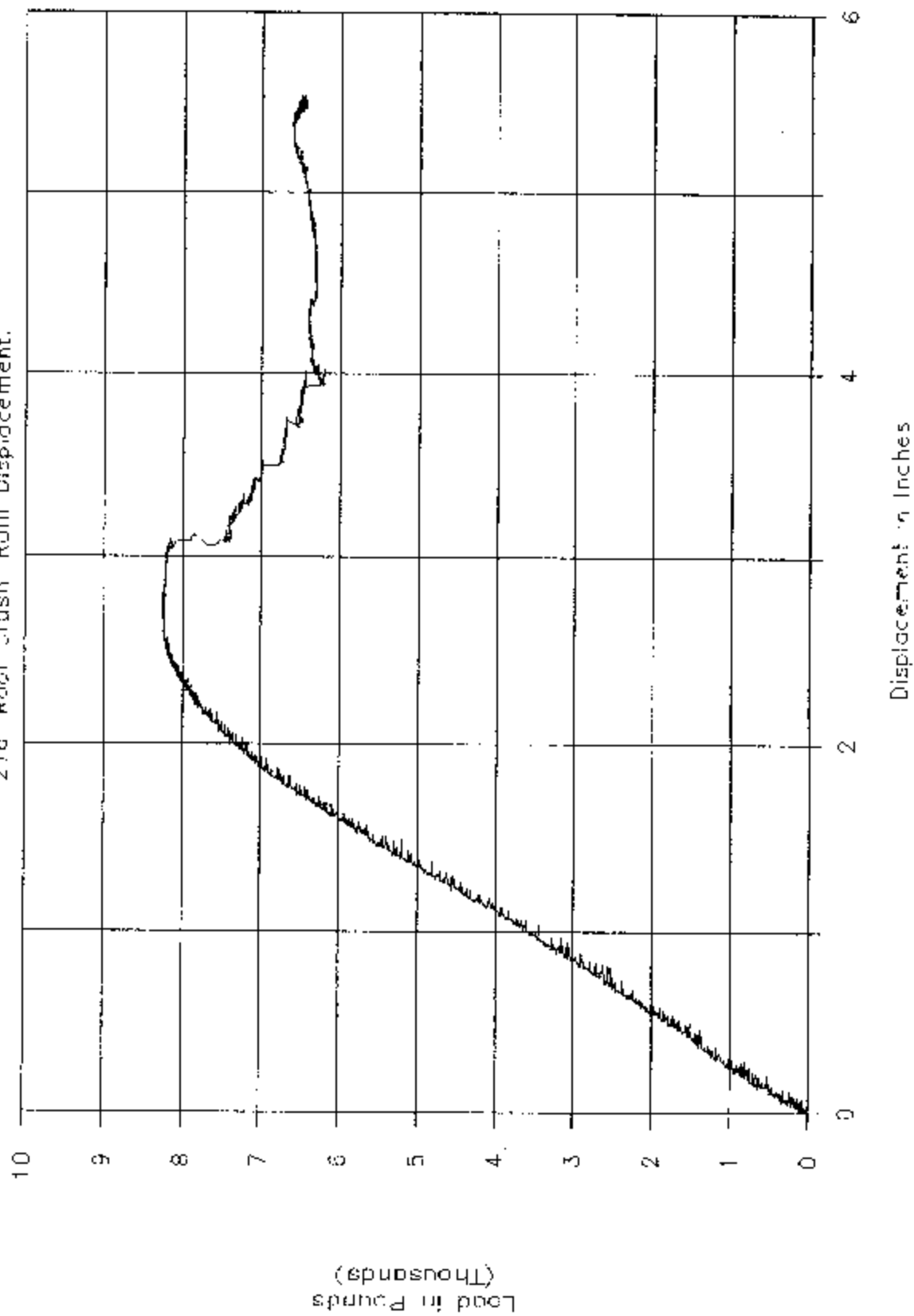
GTL 5079

216, Roof Crush, Ram Force.



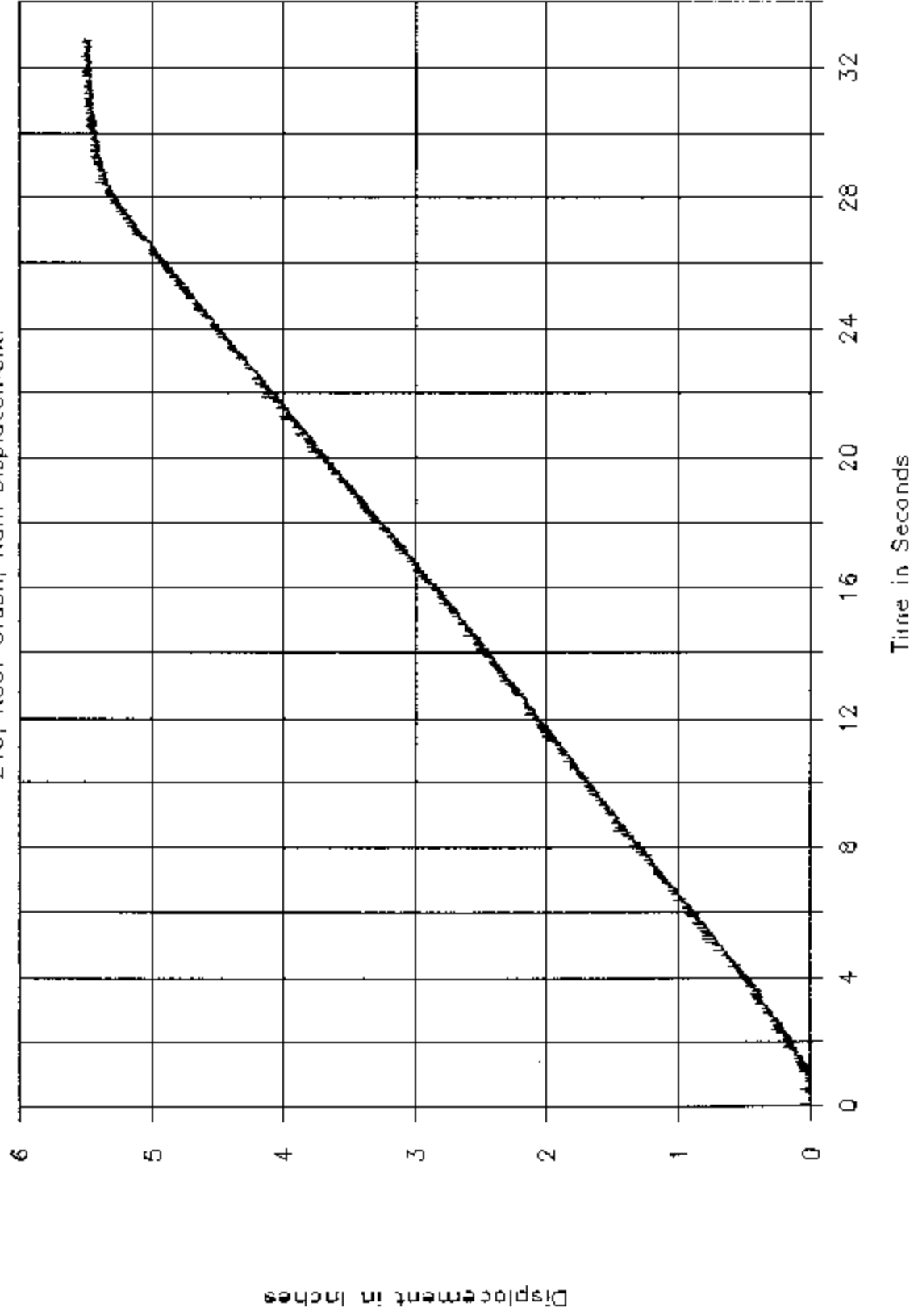
GTL 5079

216 Roof Crush Rom Displacement.



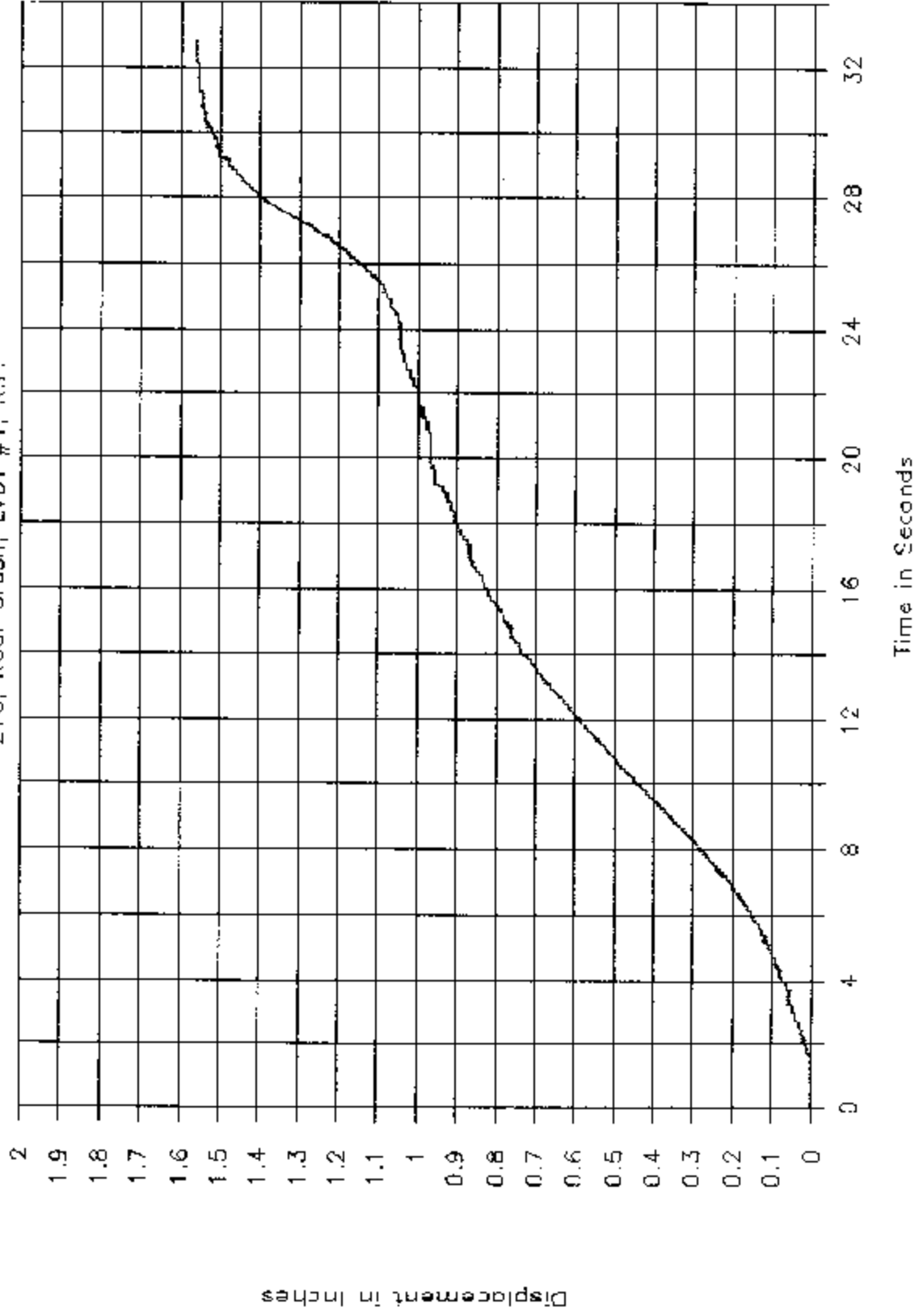
GTL 5079

216, Roof Crush, Ram Displacement.



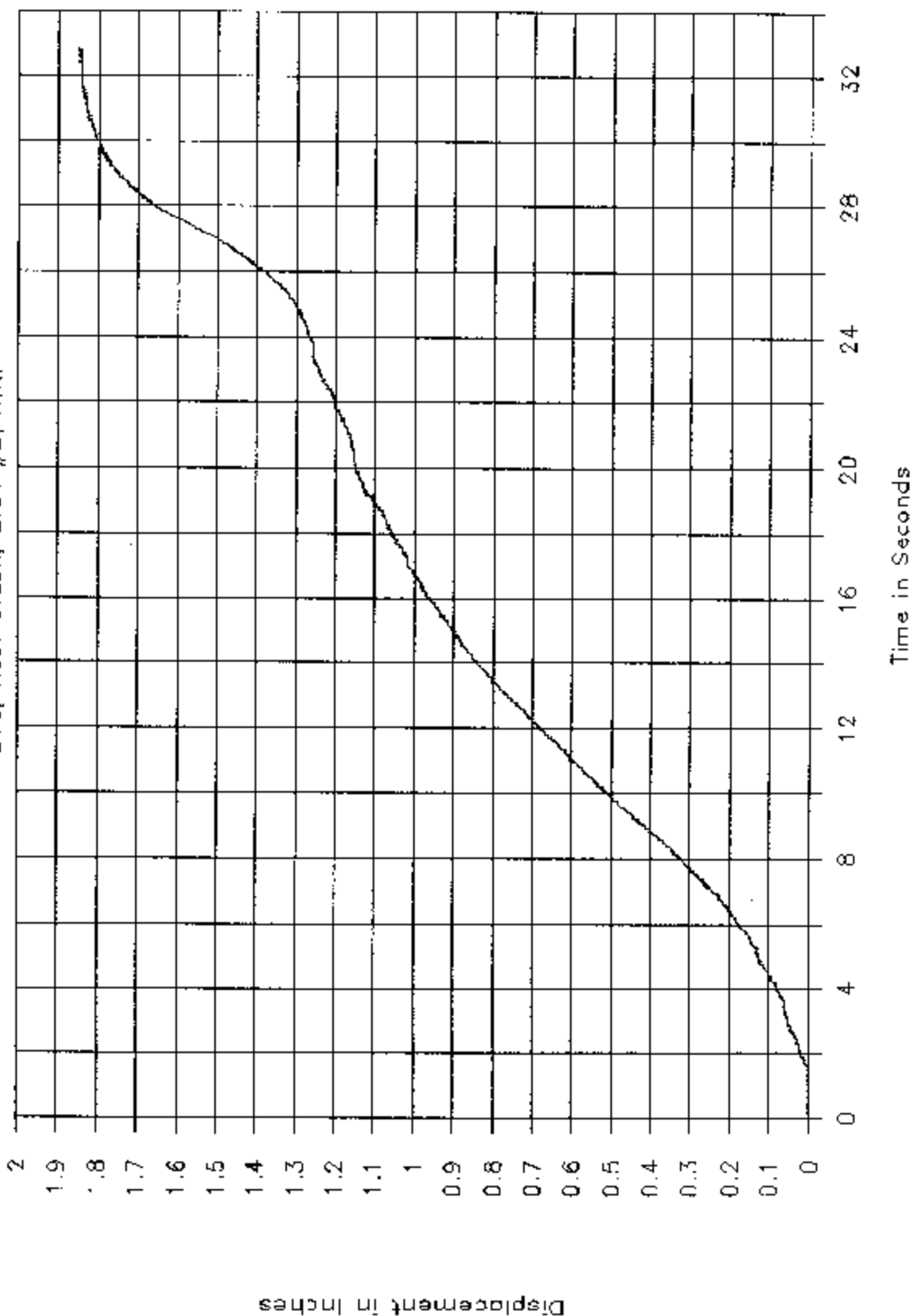
GTL 5079

216, Roof Crush, LVDT #1, R.F.



GTL 5079

216, Roof Crush, LVDT #2, R.R.



GTL 5079

216, Roof Crush, LVDT #3, L.R.

