HS636817

REPORT NUMBER: 201-CAL-03-03

SAFETY COMPLIANCE TESTING FOR FMVSS 201 OCCUPANT PROTECTION IN INTERIOR IMPACT

TOYOTA MOTOR MANUFACTURING, CALIFORNIA INC.
2003 TOYOTA TACOMA PICK-UP

NHTSA NUMBER: C35102

VERIDIAN TEST NUMBER: 8655-03

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

Test Date: March 31, 2003

FINAL REPORT

PREPARED FOR:

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
Mail Code: NVS-220, Room 6117
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Washington, DC 20590

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Approval Date: August 12, 2003

FINAL REPORT ACCEPTANCE BY NHTSA:

Office of Vehicle Safety Compliance

9.24.2003

Date of Report Acceptance

TECHNICAL REPORT STANDARD TITLE PAGE

1. *Report No.* CAL-03-03	2. *Government Accession No.*	3. *Recipient's Catalog No.*
4. *Title and Subtitle* Final Report of FMVSS 201 Compliance Testing of a 2003 Toyota Tacoma Pick-up NHTSA No C35102		5. *Report Date* March 31, 2003
		6. *Performing Organization Code* CAL
7. *Author(s)* David J. Travale, Program Manager James Czarnecki, Project Engineer		8. *Performing Organization Report No.* 8655-03
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 Mail Code: NVS-220 400 Seventh, SW, Room 6111 Washington, D.C. 20590		13. *Type of Report and Period Covered* Final Report March 2003
		14. *Sponsoring Agency Code* NVS-220
15. *Supplementary Notes*		

16. *Abstract*

Compliance tests were conducted on the subject vehicle a 2003 Toyota Tacoma Pick-up in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure TP-201-02 for determination of FMVSS 201 compliance. Test failures identified were as follows: None

17. *Key Words* Compliance Testing Safety Engineering FMVSS 201		18. *Distribution Statement* Copies of this report are available from: NHTSA Technical Reference Division National Highway Traffic Safety Admin. 400 Seventh St., SW, Room 5108 Washington, DC 20590	
19. *Security Classif. (of this report)* UNCLASSIFIED	20. *Security Classif. (of this page)* UNCLASSIFIED	21. *No. of Pages*	22. *Price*

Form DOT F1700.7 (8-69)

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LIST OF DATA SHEETS

SECTION 1

PURPOSE AND TEST PROCEDURE

This head impact compliance test is part of the FMVSS 201, Occupant Protection in Interior Impact Test Program sponsored by the National Highway Traffic Safety Administration (NHTSA) under Contract No. DTNH22-01-C-01025. The purpose of the compliance test was to determine whether the subject vehicle, a 2003 Toyota Tacoma Pick-up, NHTSA No. C35102, meets the performance requirements of FMVSS 201, Occupant Protection in Interior Impact. The compliance test was conducted using the requirements found in the OVSC Laboratory Test Procedure No. TP-201-02 dated March 3, 1989.

SECTION 2

SUMMARY OF OCCUPANT PROTECTION IN INTERIOR IMPACTS

A 2003 Toyota Tacoma Pick-up, NHTSA No. C35102, was impacted at various locations throughout its instrument cluster/dash panel and seat back area by a 15 lb, 6.5 inch diameter steel headform. A total of three (3) impacts were performed in this test series. The target area impacts were chosen by the NHTSA Contracting Officer's Technical Representative (COTR). The three (3) chosen impact points were:

Instrument Panel Cluster Area

Airbag Cover / Dash Panel Area (2 impacts)

The selected impact areas on the test vehicle appeared to comply with the performance requirements of FMVSS 201.

The 6.5 inch diameter steel headform weighed 15 lb and had an accelerometer mounted along the centerline of the head.

One (1) channel of data for each target impact test was recorded on a Keyser Threde data acquisition system. Data plots can be found in Appendix C along with still photographs can be found in Appendix A of this report.

To document each target area impact test, one digital photo was taken pre- and post-test at various locations to view the headform contact with the selected target areas

DATA SHEET 2-1

TEST VEHICLE RECEIVING INSPECTION DATA SHEET

VEHICLE YEAR/MAKE/MODEL/STYLE:	2003 Toyota Tacoma Pick-up
NHTSA NO.:	C35102
VIN:	5TENL42N63Z1574'9
DATE OF MANUFACTURE:	09/02 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	14
LABORATORY:	Veridian Engineering
TEST DATE:	March 31, 2003

NUMBER OF SEATING POSITIONS:

FRONT: 2 REAR: 0

INSTRUMENT PANEL:

NOTE UNUSUAL FEATURES: None

TYPE OF FRONT SEATS:

BENCH: X BUCKET: - SPLIT BACKS: -

TYPE OF HEAD RESTRAINTS:

FIXED: X ADJUSTABLE: -

VEHICLE EQUIPPED WITH ARMRESTS?

NO: - YES: X NUMBER: 2

LOCATION: Front door panels

VEHICLE EQUIPPED WITH SUN VISORS?

NO: - YES: X

VEHICLE EQUIPPED WITH INTERIOR DOOR LATCHES?

NO: - YES: X NUMBER: 1

LOCATION: Glove Box

DATA SHEET 2-2

HEADFORM IMPACT TEST RESULTS
INSTRUMENT PANEL

VEHICLE YEAR/MAKE/MODEL/STYLE:	2003 Toyota Tacoma Pick-up
NHTSA NO.:	C35102
VIN:	5TENL42N63Z157419
DATE OF MANUFACTURE:	09/02 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	14
LABORATORY:	Veridian Engineering
TEST DATE:	March 31, 2003

IMPACT LOCATION AND NUMBER				VELOCITY (mph)	PEAK ACCELERATION (3 ms Clip) Gs
NUMBER	X (inches)	Y (inches)	ANGLE (degrees)		
1 IP VENT	23.4	0	-23	11.55	32.36
2 IP LEFT AIRBAG	25.4	7.75	-45	11.43	59.50
3 IP RIGHT AIRBAG	25.5	19.0	-49	11.38	61.18

REFERENCE POINT: Seating Reference Position (SGRP) on front passenger side is the reference point (x=0 positive forward from SGRP and y=0 positive to the right of the vehicle centerline).

REMARKS:

DATA SHEET 2-3

HEADFORM IMPACT TEST RESULTS
SEAT BACKS

VEHICLE YEAR/MAKE/MODEL/STYLE:	2003 Toyota Tacoma Pick-up
NHTSA NO.:	C35102
VIN:	5TENL42N63Z157419
DATE OF MANUFACTURE:	09/02 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING.	14
LABORATORY:	Veridian Engineering
TEST DATE:	March 31, 2003

IMPACT LOCATION AND NUMBER				VELOCITY (mph)	PEAK ACCELERATION (3 ms Clip) Gs
NUMBER	X (inches)	Y (inches)	ANGLE (degrees)		
NONE	-	-	-	-	-

* FRONT SEAT IS ONLY SEAT IN VEHICLE

REFERENCE POINT: SGRP on rear passenger side is the reference point (x=0 positive forward from SGRP and y=0 positive to the right of the SGRP).

DATA SHEET 2-4

SUNVISOR AND ARMREST EVALUATION

VEHICLE YEAR/MAKE/MODEL/STYLE:	2003 Toyota Tacoma Pick-up
NHTSA NO.:	C35102
VIN:	5TENL42N63Z157419
DATE OF MANUFACTURE:	09/02 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	14
LABORATORY:	Veridian Engineering
TEST DATE:	March 31, 2003

SUNVISOR INFORMATION:

1. Are sunvisors constructed of or covered with energy absorbing material?

   YES (PASS): X NO (FAIL): -

2. Are any edges statically contactable by a spherical 6.5 inch diameter headform of radius less than 0.125 inch?

   YES (FAIL): - NO (PASS): X

ARMREST INFORMATION:

A. FIXED ARMREST

1. Is it constructed of energy absorbing material with the capability of laterally deflecting 2 inches without contacting any underlying rigid material?

   YES: N/A NO: N/A

2. Is it constructed of energy absorbing material that deflects or collapses within 1.25 inches of the rigid test panel surface without contacting underlying rigid material between 0.50 and 1.25 inches from the panel which has a vertical height of less than 1 inch?

   YES: N/A NO: N/A

3. Does it provide adequate pelvic area impact protection?

   YES: X NO: -

4. Does it meet at least one of the criteria No. 1 to 3?

   YES (PASS): X NO (FAIL): -

B. FOLDING ARMREST

Is it made of or covered with energy absorbing material? Or does it meet at least one of the criteria No. 1 to 3?

YES (PASS): X NO (FAIL): -

DATA SHEET 2-5

DOOR LATCH EVALUATION

VEHICLE YEAR/MAKE/MODEL/STYLE:	2003 Toyota Tacoma Pick-up
NHTSA NO.:	C35102
VIN:	5TENL42N63Z157419
DATE OF MANUFACTURE:	09/02 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	14
LABORATORY:	Veridian Engineering
TEST DATE:	March 31, 2003

LATCH ENGAGEMENT INTERFERENCE

DESCRIPTION OF LATCH LOCATION	NO LOAD	10G HORIZONTAL TRANSVERSE	10G VERTICAL	30G HORIZONTAL LONGITUDINAL
Glove Box	YES	YES	YES	YES

(APPENDIX B CONTAINS CALCULATION SHEETS WHICH ARE BASED ON MANUFACTURER'S DATA)

DATA SHEET 2-6

SUMMARY OF RESULTS

VEHICLE YEAR/MAKE/MODEL/STYLE:	2003 Toyota Tacoma Pick-up
NHTSA NO.:	C35102
VIN:	5TENL42N63Z157419
DATE OF MANUFACTURE:	09/02 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	14
LABORATORY:	Veridian Engineering
TEST DATE:	March 31, 2003

	NUMBER OF IMPACTS	PASS/FAIL
INSTRUMENT PANEL	3	PASS
SEAT BACK	0	N/A
SUNVISORS	N/A	PASS
ARMRESTS	N/A	PASS
INTERIOR COMPARTMENT DOORS	N/A	PASS

REMARKS:

APPENDIX A

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PHOTOGRAPHS

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A-16	INSTRUMENT PANEL VENT IMPACT #3 PRE-TEST
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Figure A-1 : LEFT SIDE VIEW OF VEHICLE

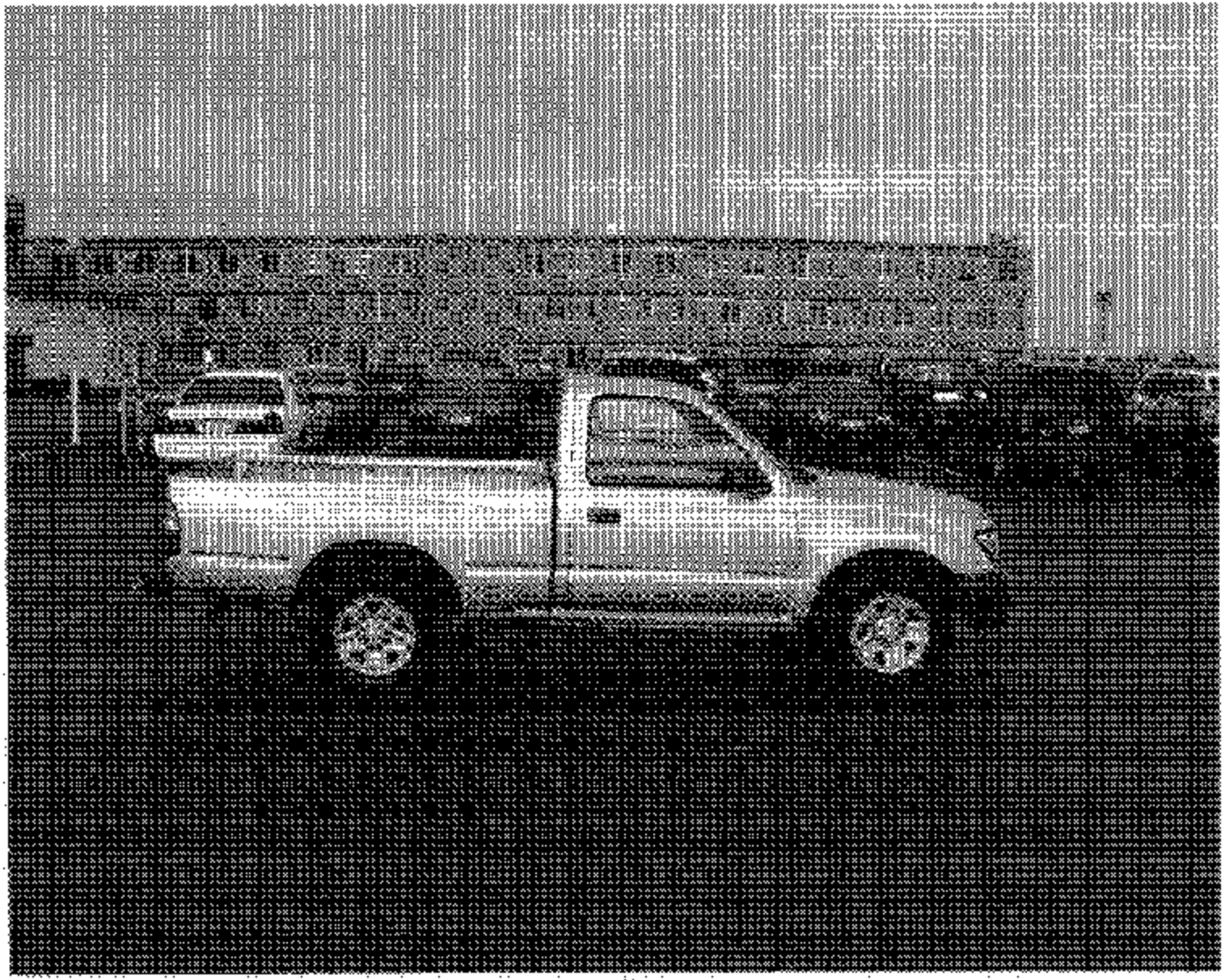


Figure A-2 : RIGHT SIDE VIEW OF VEHICLE

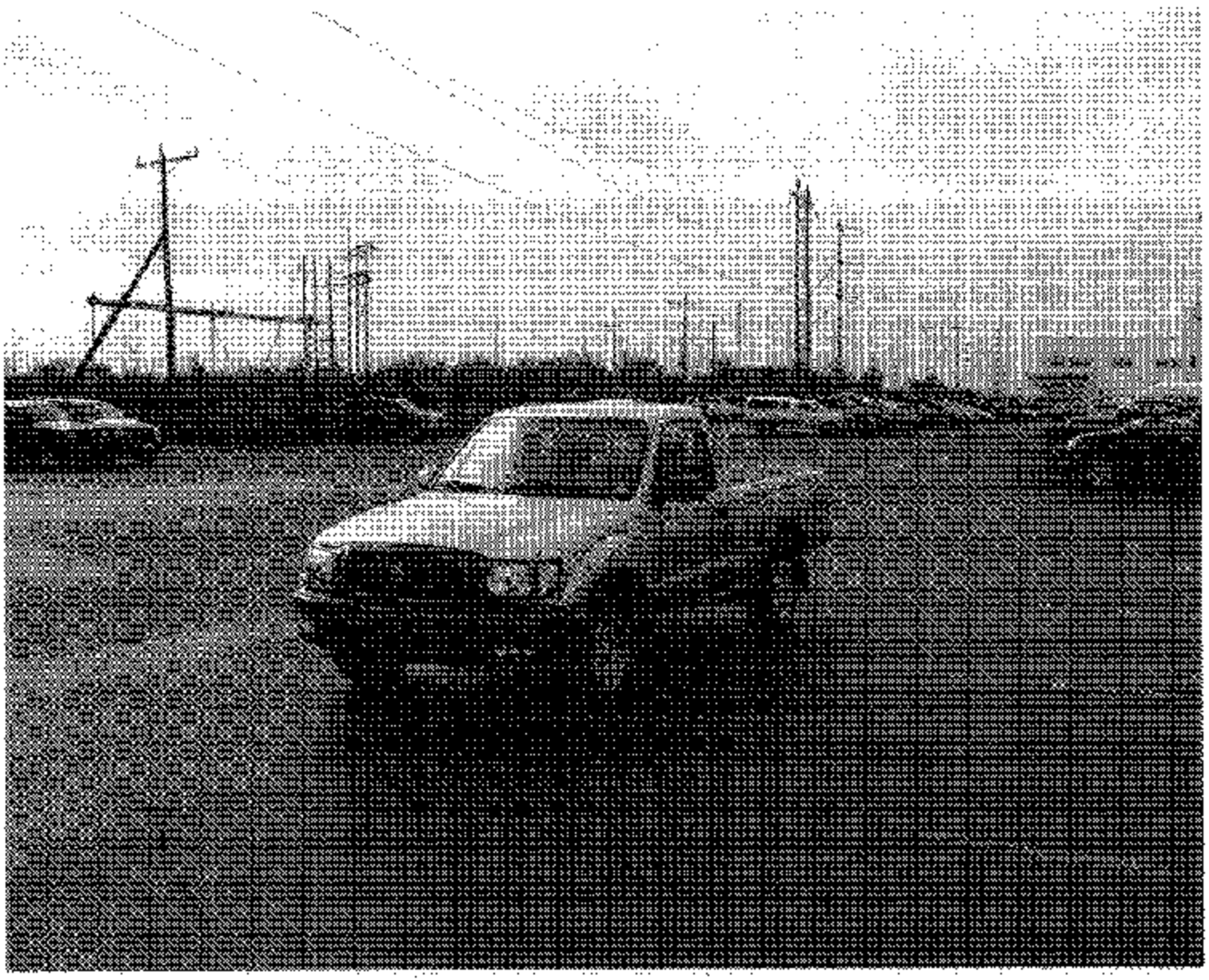


Figure A-3 : 3/4 FRONTAL VIEW FROM LEFT SIDE OF VEHICLE

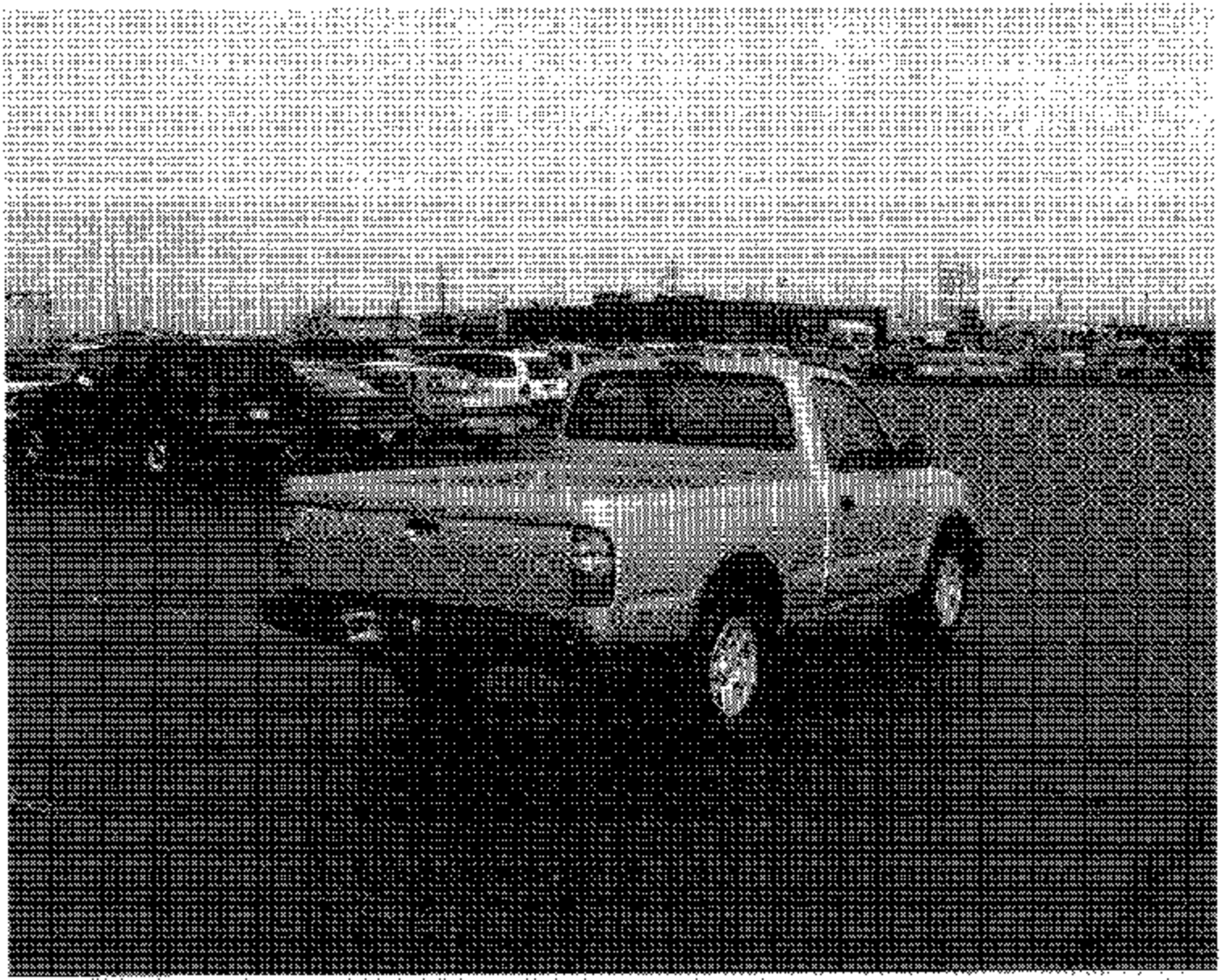


Figure A-4 : 3/4 REAR VIEW FROM RIGHT SIDE OF VEHICLE

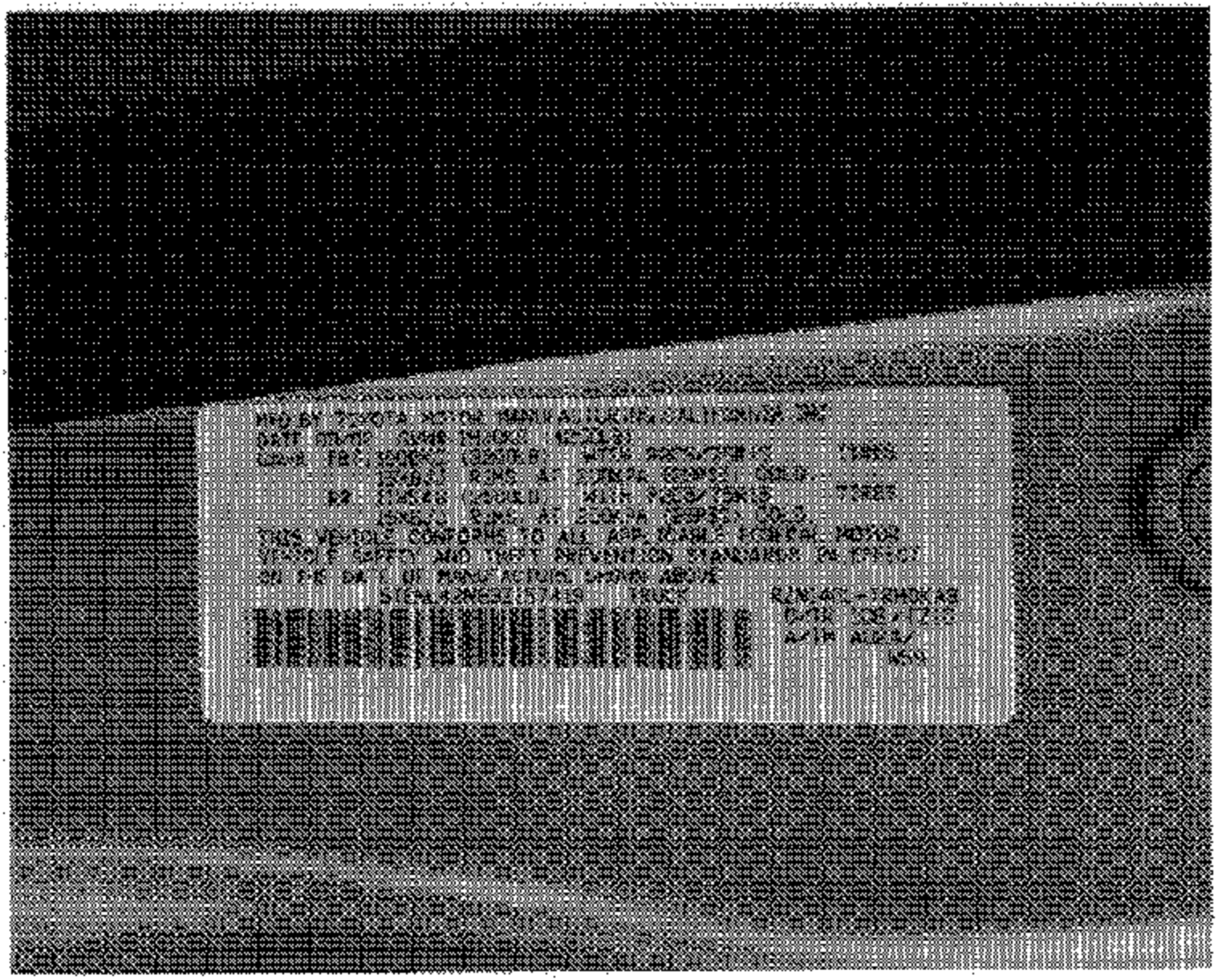


Figure A-3 . VEHICLES CERTIFICATION LABEL

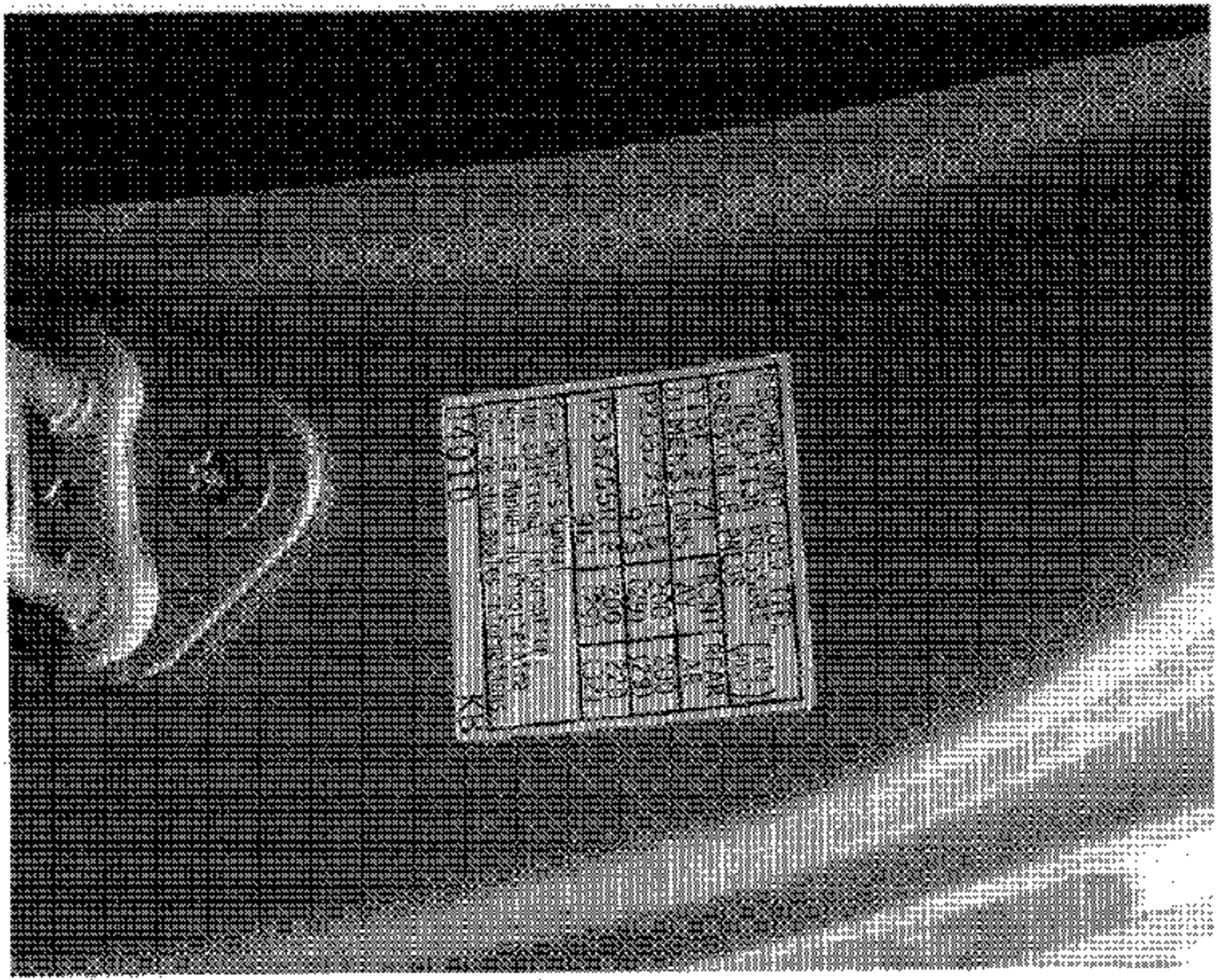


Figure A-6 : VEHICLE'S TIRE INFORMATION LABEL

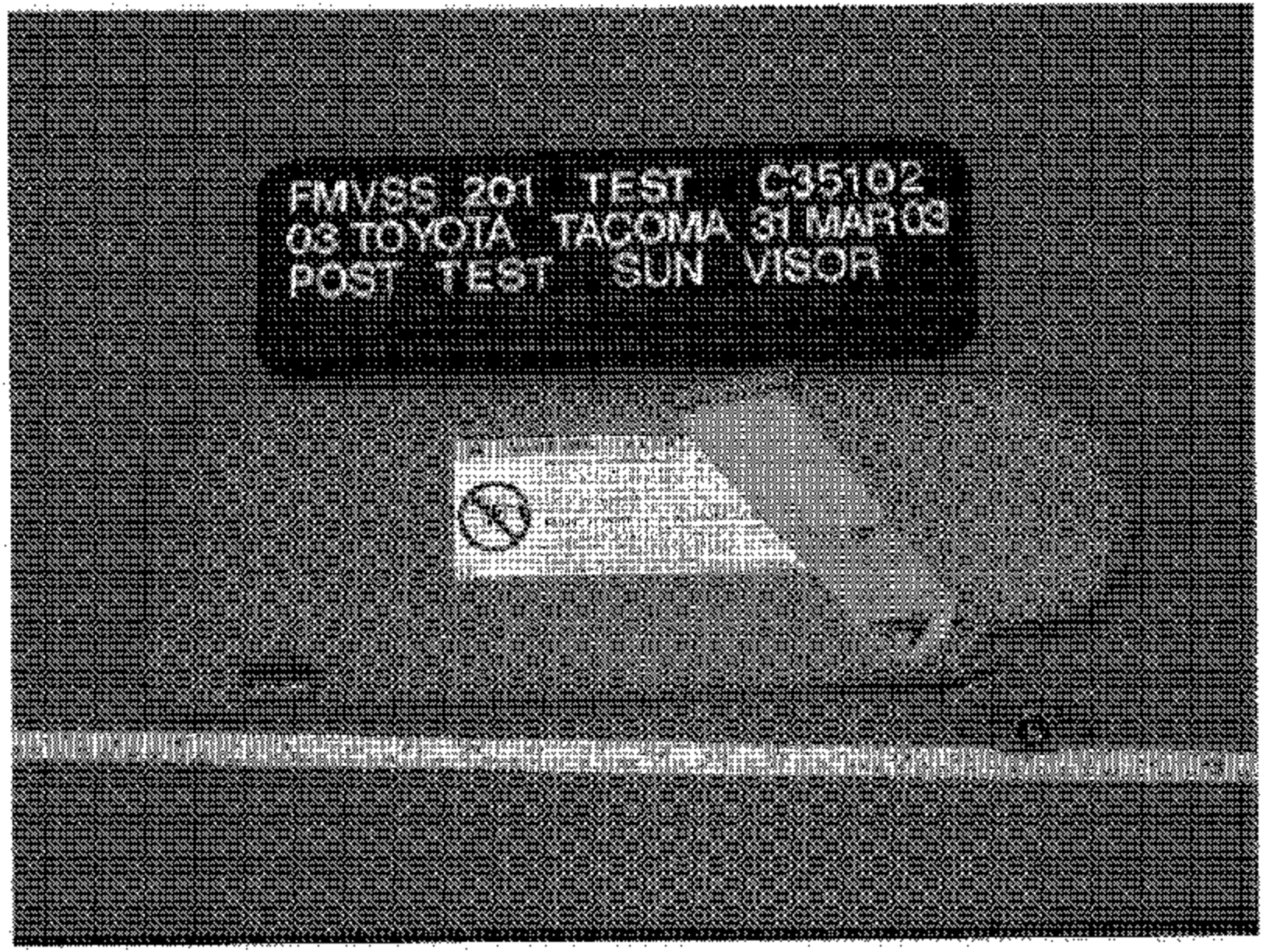


Figure A-7 : SUNVISOR CONSTRUCTION

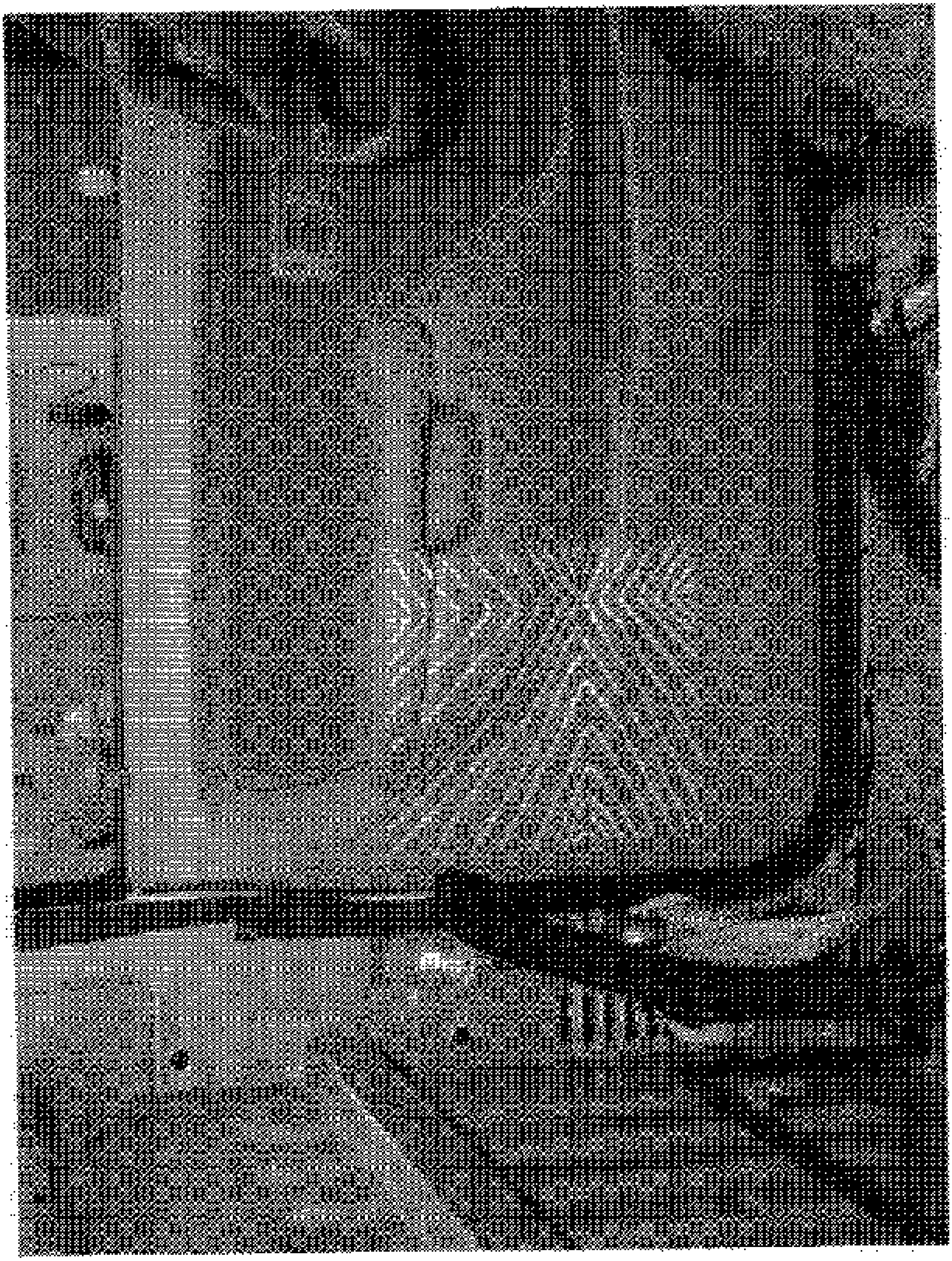


Figure A-8 · ARMREST LEFT FRONT DOOR

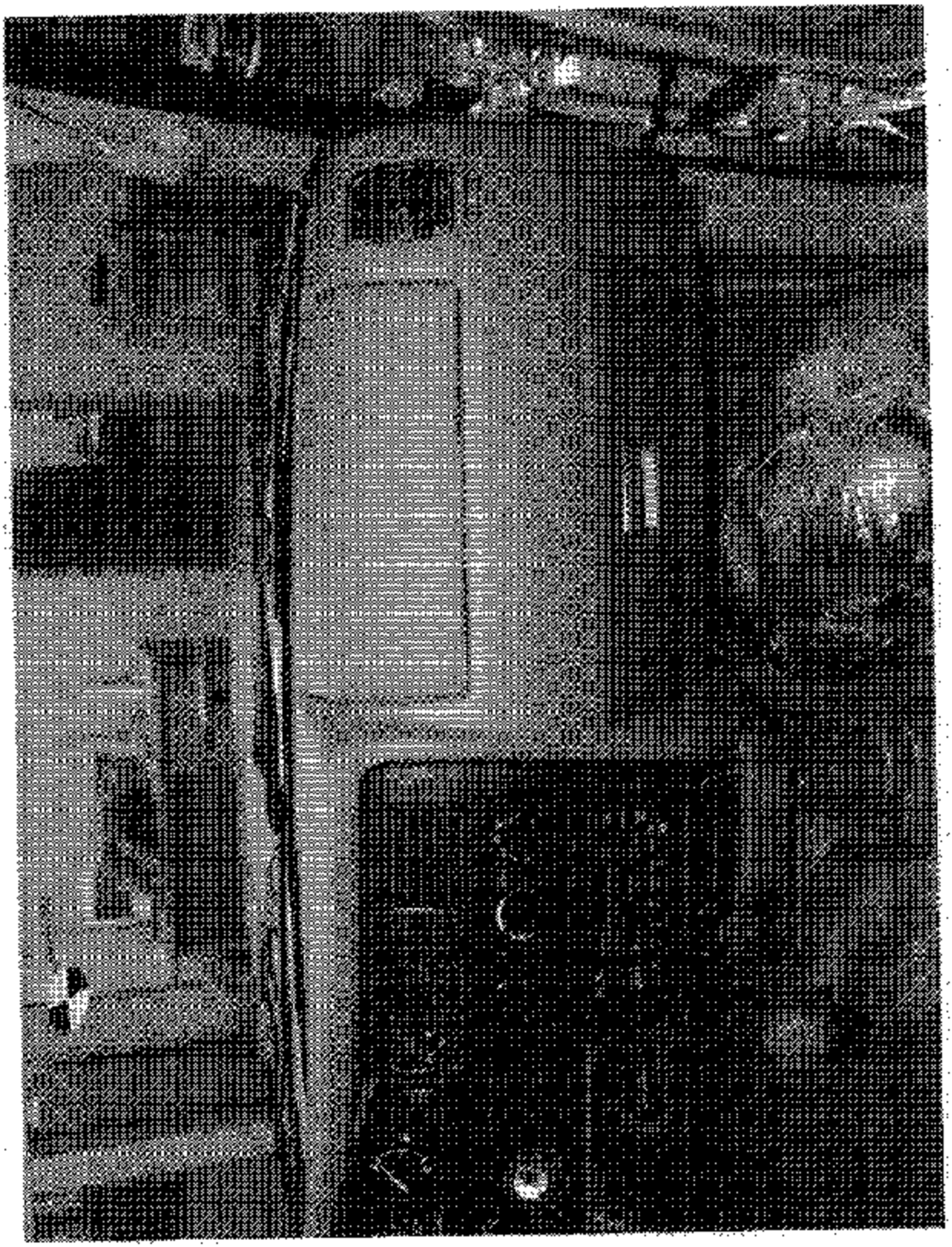


Figure A-9: INSTRUMENT PANEL

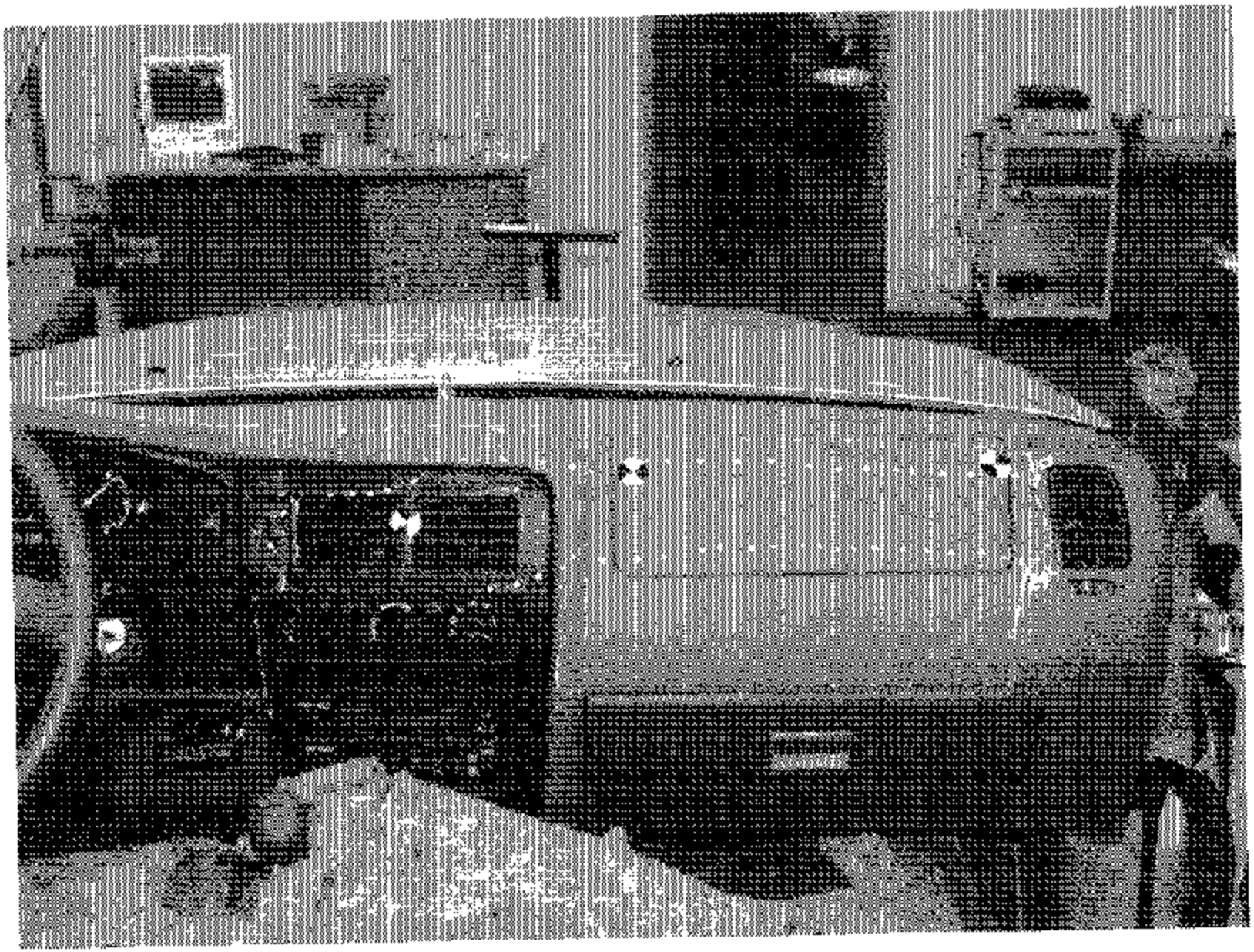


Figure A-10 DELINEATED INSTRUMENT PANEL IMPACT ZONE PRE-TEST

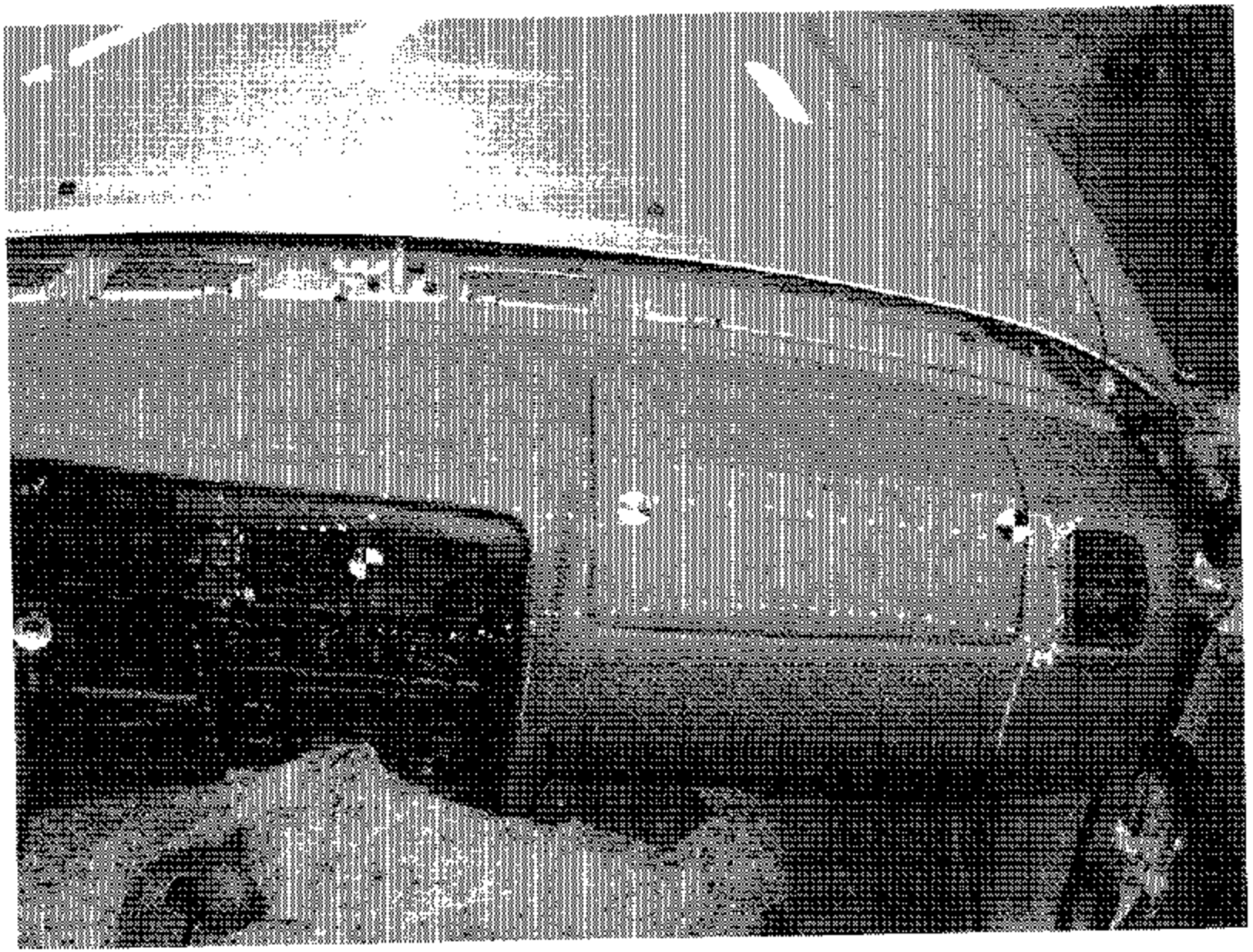


Figure A-11 : DELINEATED INSTRUMENT PANEL IMPACT ZONE POST-TEST

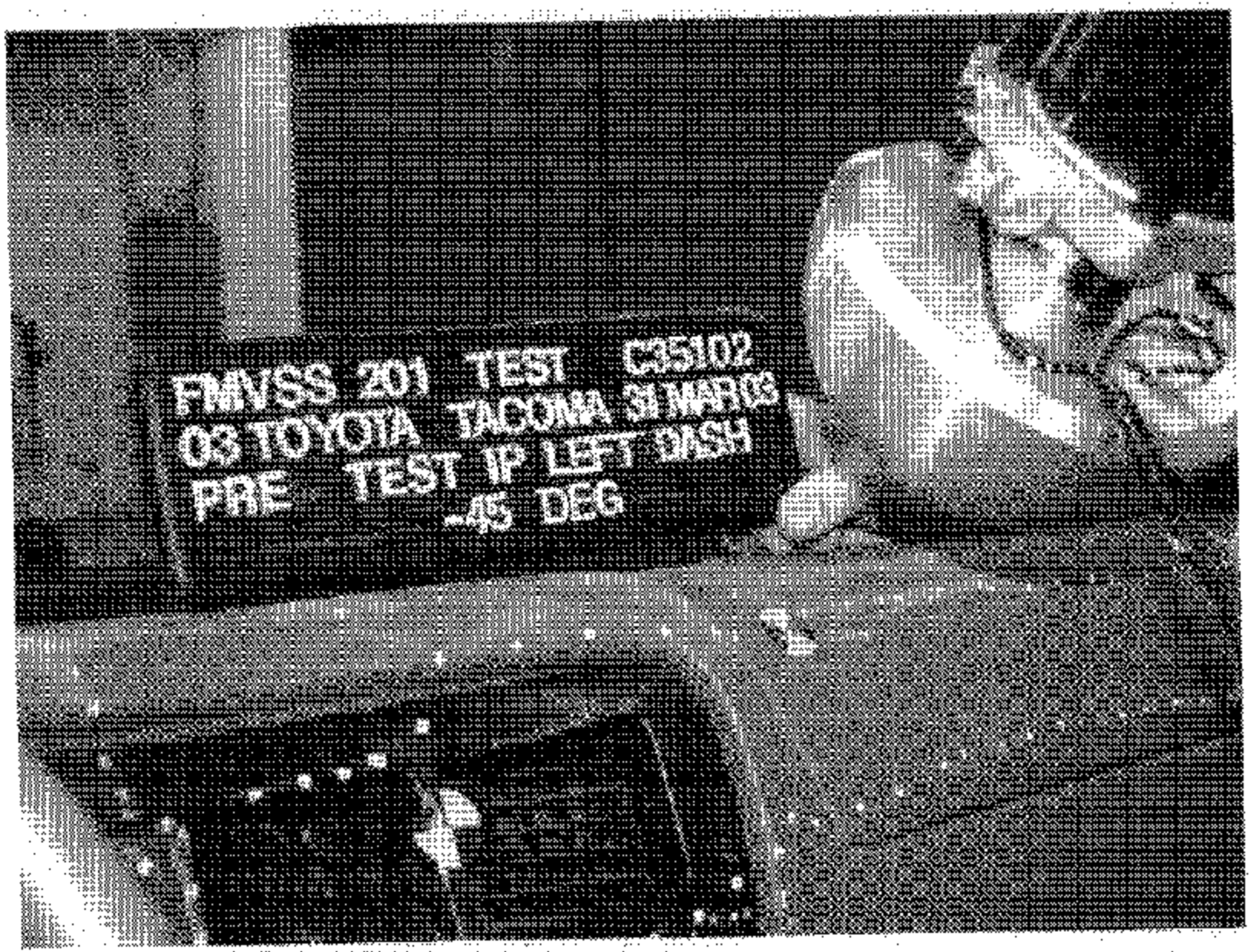


Figure A-12. INSTRUMENT PANEL AIRBAG LEFT IMPACT PRE-TEST

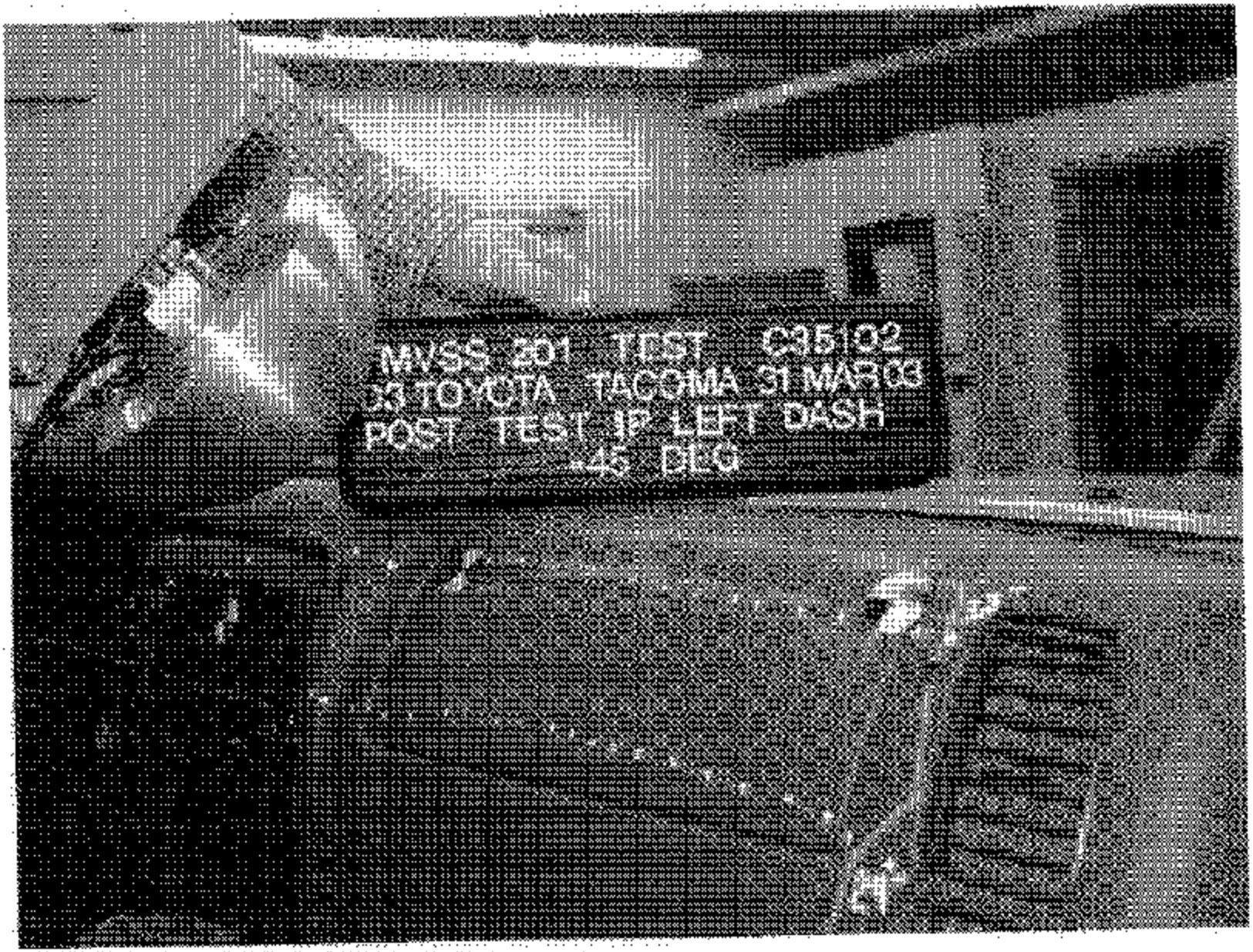


Figure A-13 INSTRUMENT PANEL AIRBAG LEFT IMPACT POST-TEST

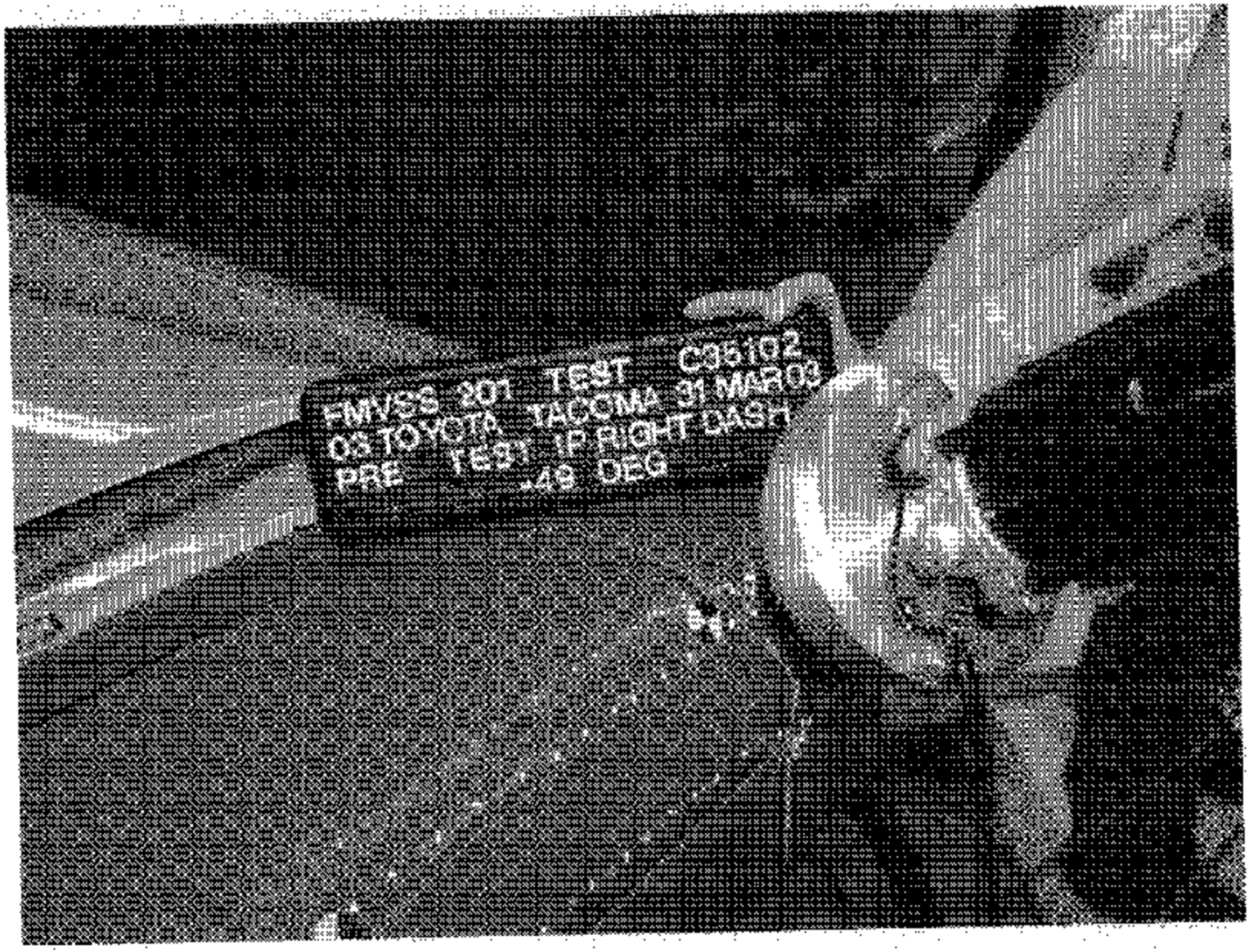


Figure A-14 : INSTRUMENT PANEL AIRBAG RIGHT IMPACT PRE-TEST

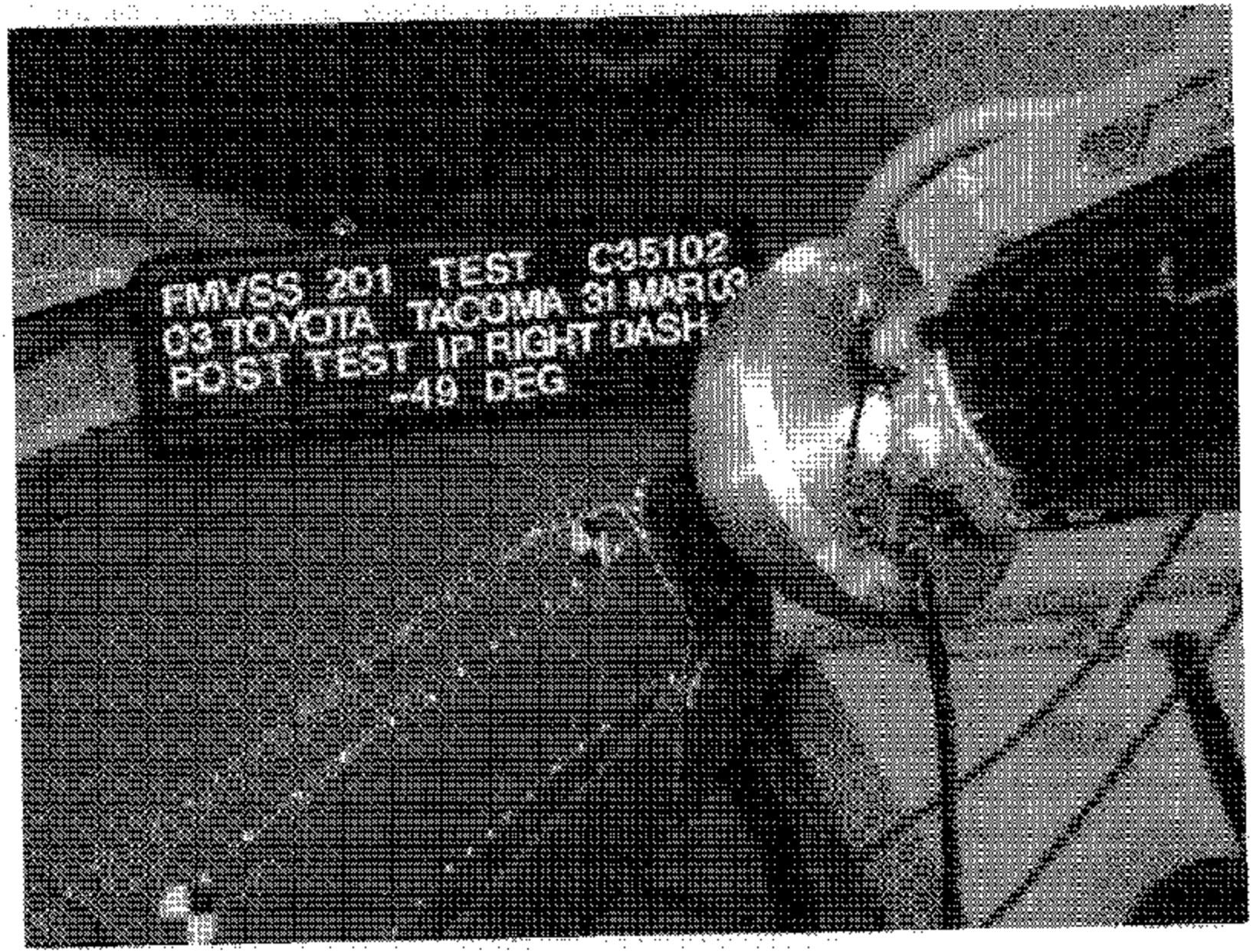


Figure A-15 : INSTRUMENT PANEL AIRBAG RIGHT IMPACT POST-TEST

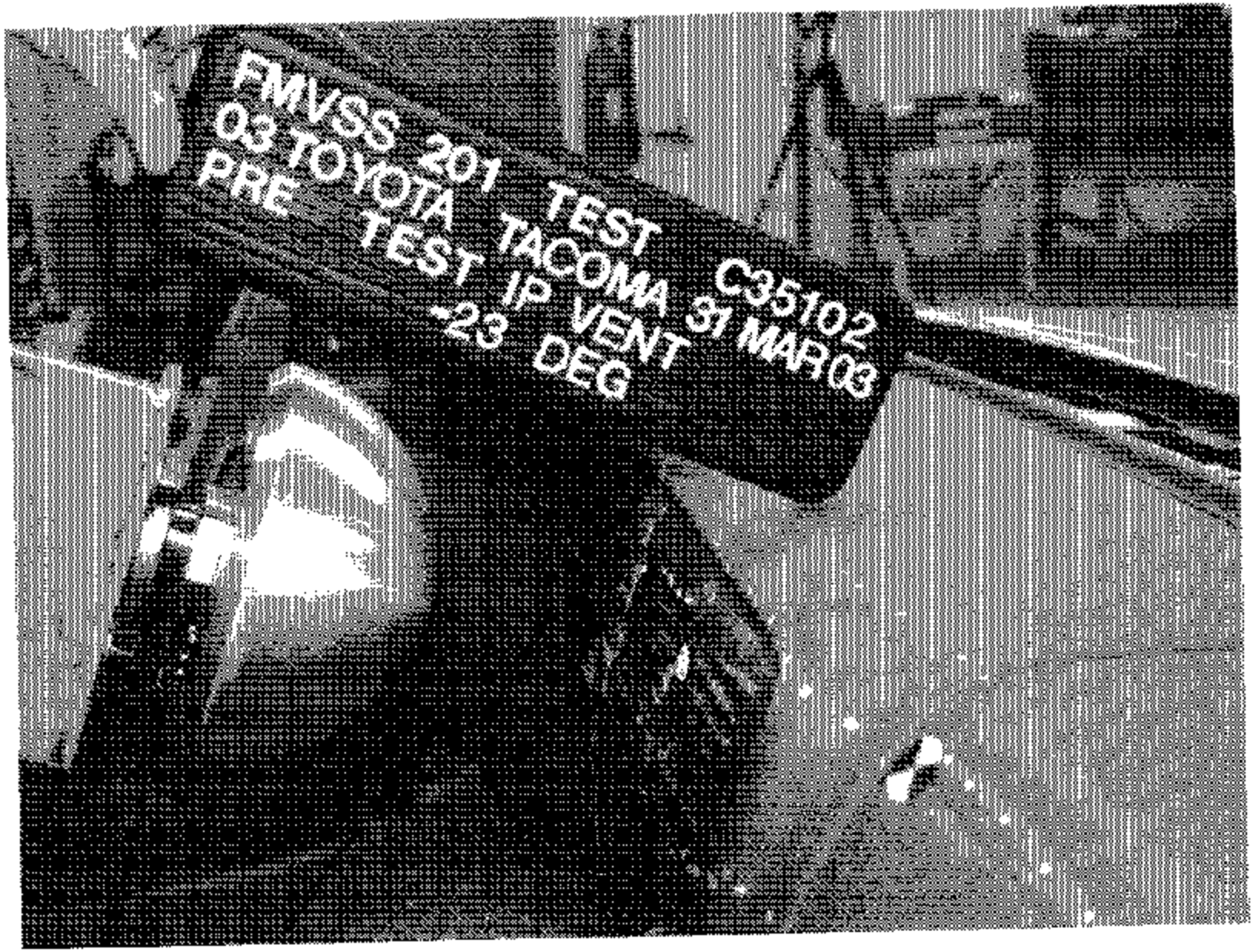


Figure A-16 INSTRUMENT PANEL CONSOLE VENT IMPACT PRE-TEST

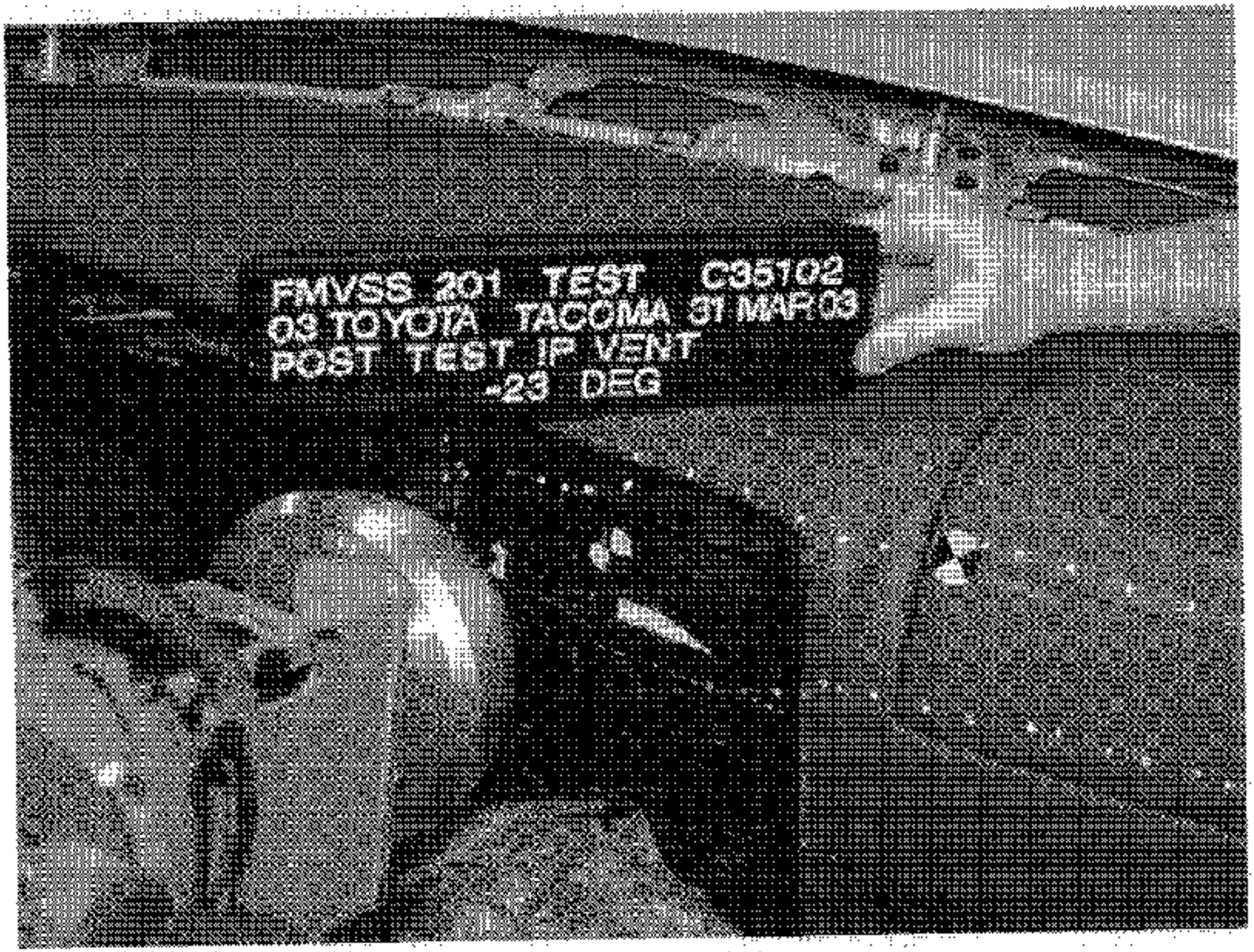


Figure A-17 : INSTRUMENT PANEL CONSOLE VENT IMPACT POST-TEST

APPENDIX B

INTERIOR COMPARTMENT DOOR CALCULATIONS

FMVSS No. 201
Latch Component Analysis Information

Latch component inertial analysis information for each interior compartment door assembly located in an instrument panel, console assembly, seat back, or side panel adjacent to a designated seating position in accordance with the procedure described in section 5 of SAE Recommended Practice J839b, "Passenger Car Side Door Latch Systems."

Such data shall include:

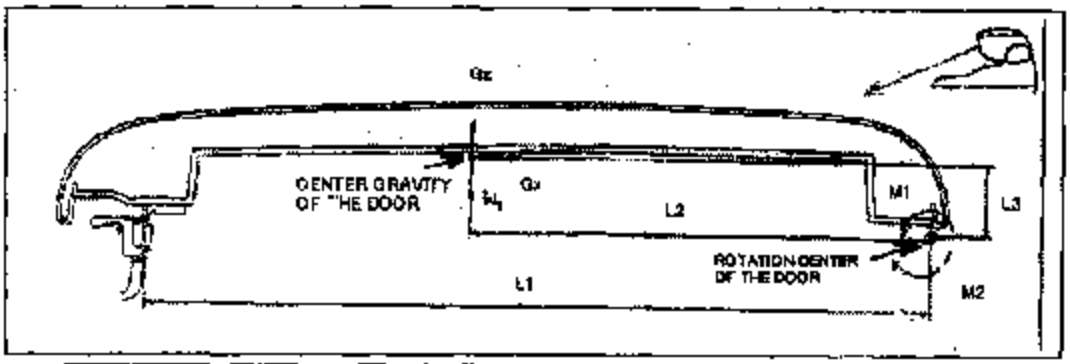
2003 model TOYOTA TACOMA

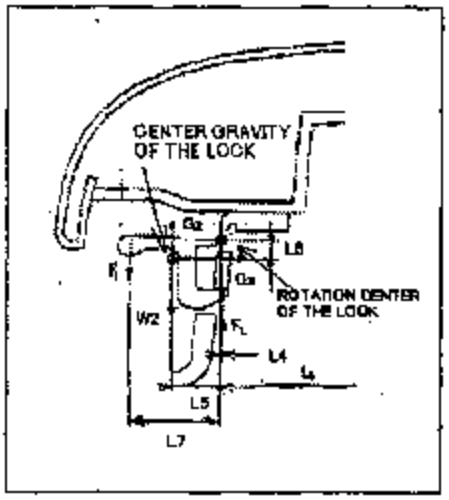
FMVSS No.201 Occupant Protection in Interior Impact "Console Door"

A. ARMREST ASSY IN DESIGN (DOWN POSITION)

Part name: DOOR S/A CONSOLE COMPARTMENT
PART NO: 58905-AD010

1. Geometric details of the latch/lock configuration;





2. Mass data for each element in the linkage.

MARK	DATA	UNIT	REMARK
W1	$536*10^{-3}$	Kg	Static load of the console door
W2	$5.6*10^{-3}$	Kg	Static load of the lock
L1	$297*10^{-3}$	m	Longitudinal distance between deflection load point of the door and its rotation center
L2	$175*10^{-3}$	m	Longitudinal distance between center gravity of the door and its rotation center
L3	$28*10^{-3}$	m	Vertical distance between center gravity of the door and its rotation center
L4	$1.5*10^{-3}$	m	Longitudinal distance between latch deflection force point of the lock and its rotation center
L5	$10*10^{-3}$	m	Longitudinal distance between center gravity of the lock and its rotation center
L6	$4*10^{-3}$	m	Vertical distance between center gravity of the lock and its rotation center
L7	$18*10^{-3}$	m	Longitudinal distance between opposite force point of the lock and its rotation center
F1	14.67	N	Latch operation load

3. Calculation results on "console box door"

3-1.When subjected to a vertical inertia load of 10G

M2=Gz * W1 * L2
=10 * 9.8 * $536*10^{-3}$* $175*10^{-3}$
=9.19 Nm

M1= (W1 * g * L2)+L1/L4 (F1 * L7 -Gz *W2 *L5)
=$536*10^{-3}$* 9.8* $175*10^{-3}$) + $297*10^{-3}$ / $1.5*10^{-3}$ (14.67*$18*10^{-3}$- 10 *9.8 * $5.6*10^{-3}$ * $10*10^{-3}$)
=52.11 Nm

M1/M2 = 52.11 /9.19 = 5.67 >1..... **LID WILL REMAIN CLOSED**

3-2 When subjected to a transverse inertia load of 10G

A transverse inertial load will not cause the lid to open because of the fore/aft location of the latch and hinge.

3-3 When subjected to a longitudinal inertia load of 30G

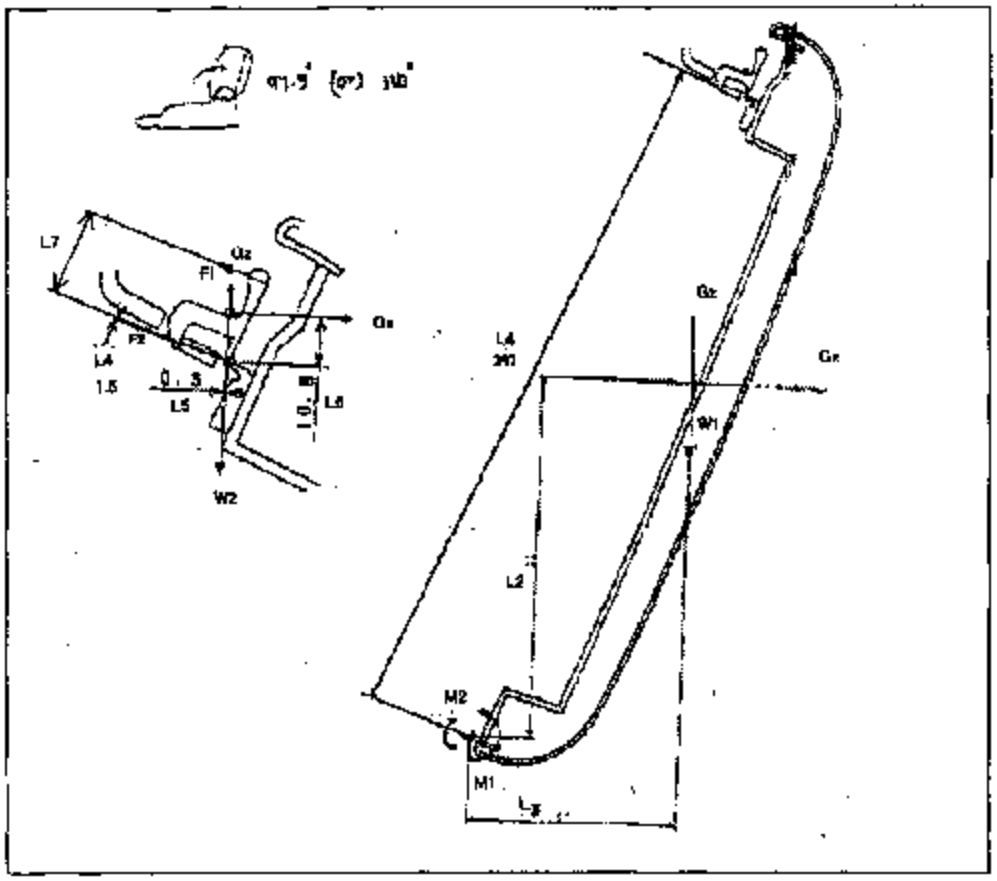
M2= Gx * W1 * L3
= 30 * 9.8 * $536*10^{-3}$* $28*10^{-3}$
=4.41 Nm

M1= L1/L4 (F1 * L7 + Gx * W2 * L6)+(W1 * g * L2)
=$297*10^{-3}$ / $1.5*10^{-3}$ (14.67 * $18*10^{-3}$ + 30*9.8 * $5.6*10^{-3}$ * $4*10^{-3}$)+ ($536*10^{-3}$* 9.8 * $175*10^{-3}$)
= 54.5 Nm

M1 / M2 = 54.5 / 4.41 = 12.35 > 1..... **LID WILL REMAIN CLOSED**

B. ARM REST ASSY IN FULLY ROTATED (97.5 deg AND 110 deg)

1. Geometric details of the latch/lock configuration;



2. Mass data for each element in the linkage.

MARK	DATA	UNIT	REMARK
W1	$536*10^{-3}$	Kg	Static load of the console door
W2	$5.6*10^{-3}$	Kg	Static load of the lock
L1	$297*10^{-3}$	m	Longitudinal distance between deflection load point of the door and its rotation center in down position
L2	$183.2*10^{-3}$ (97.5deg) $155*10^{-3}$ (110 deg)	m	Vertical distance between center gravity of the door and its rotation center
L3	$62.1*10^{-3}$ (97.5 deg) $86.5*10^{-3}$ (110 deg)	m	longitudinal distance between center gravity of the door and its rotation center
L4	$1.5*10^{-3}$	m	Longitudinal distance between latch deflection load point of the lock and its rotation center in down position
L5	$0.3*10^{-3}$	m	Longitudinal distance between center gravity of the lock and its rotation center

L6	$10.8*10^{-3}$	m	Vertical distance between center gravity of the lock and its rotation center
L7	$18*10^{-3}$	m	Longitudinal distance between opposite force point of the lock and its rotation center in down position
F1	14.67	N	Latch operation load

3. Calculation results on "console box door"

3-1.When subjected to a vertical inertia load of 10G (ROTATED 110 deg)

DOWNWARD

$M2= W1 * g * L3 + Gz * W1 * L3$
$=536*10^{-3} * 9.8 * 86.5*10^{-3} + 10 * 9.8 * 536*10^{-3} * 86.5*10^{-3}$
$= 4.99$ Nm

$M1 = L1 / L4 (F1 * L7 - Gz * W2 * L5)$
$= 297*10^{-3} / 1.5*10^{-3} (14.67 * 18*10^{-3} - 10 * 9.8 * 5.6*10^{-3} * 0.3*10^{-3})$
$= 52.3$ Nm

M1 / M2 = 52.3/ 4.99 =10.47 > 1..... **LID WILL REMAIN CLOSED**

3-2 When subjected to a transverse inertia load of 10G

A transverse inertial load will not cause the lid to open because of the fore/aft location of the latch and hinge.

3-3. When subjected to a longitudinal inertia load of 30G (A/R ASSY ROTATED 97.5 deg)

REARWARD

$M2= W1 * g * L3 + Gx * W1 * L2$
$=536*10^{-3} * 9.8 * 82.1*10^{-3} + 30 * 9.8 * 536*10^{-3} * 183.2*10^{-3}$
$= 29.16$ Nm

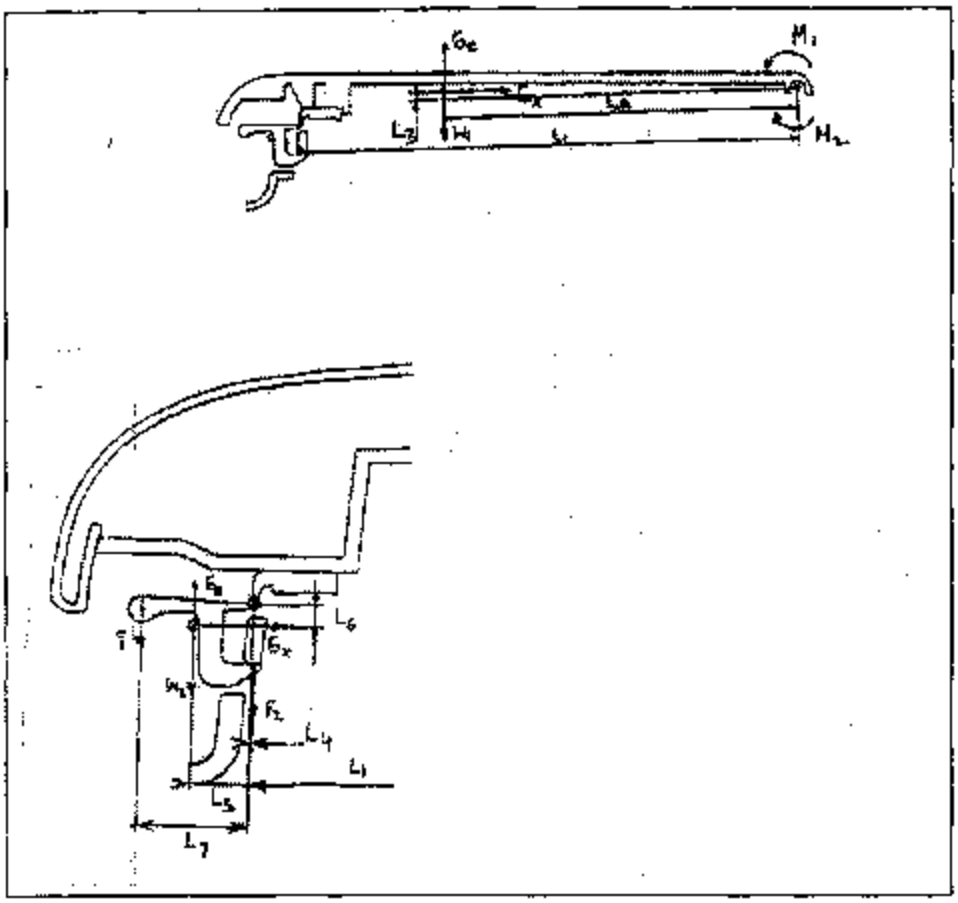
$M1 = L1 / L4 (F1 * L7 - Gx * W2 * L6)$
$= 297*10^{-3} / 1.5*10^{-3} (14.67 * 18*10^{-3} - 30 * 9.8 * 5.6*10^{-3} * 10.8*10^{-3})$
$= 48.76$ Nm

M1 / M2 = 48.76 / 29.16 =1.67 > 1 ..... **LID WILL REMAIN CLOSED**

C. LOWER LID

Part name: DOOR CONSOLE COMPARTMENT
PART NO: 58951-AD010

1. Geometric details of the latch/lock configuration;



2. Mass data for each element in the linkage.

MARK	DATA	UNIT	REMARK
W1	$87*10^{-3}$	Kg	Static load of the console door
W2	$5.6*10^{-3}$	Kg	Static load of the lock
L1	$168*10^{-3}$	m	Longitudinal distance between deflection load point of the door and its rotation center
L2	$120*10^{-3}$	m	Longitudinal distance between center gravity of the door and its rotation center
L3	$2.6*10^{-3}$	m	Vertical distance between center gravity of the door and its rotation center
L4	$1*10^{-3}$	m	Longitudinal distance between latch deflection load point of the lock and its rotation center

L5	$10*10^{-3}$	m	Longitudinal distance between center gravity of the lock and its rotation center
L6	$4*10^{-2}$	m	Vertical distance between center gravity of the lock and its rotation center
L7	$18*10^{-3}$	m	Longitudinal distance between opposite force point of the lock and its rotation center
F1	14.67	N	Latch operation load

3. Calculation results on "console box door"

3-1.When subjected to a vertical inertia load of 10G

M1/M2 >1

$M2=Gz * W1 * L2$

$=10 * 9.8 * 87*10^{-3} * 120*10^{-3}$

=1.02 Nm

$M1= (W1 * g * L2)+L1/L4 (F1 * L7 -Gz *W2 *L5)$

$=87*10^{-3} * 9.8* 120*10^{-3}) + 168*10^{-3}/ 1*10^{-3} (14.67*18*10^{-3} - 10 *9.8 * 5.6*10^{-3} *10*10^{-3})$

=43.54 Nm

M1/M2 = 43.54/1.02 = 42.69 >1 **LID WILL REMAIN CLOSED**

3-2 When subjected to a transverse inertia load of 10G

A transverse inertial load will not cause the lid to open because of the fore/aft location of the latch and hinge.

3-3 When subjected to a longitudinal Inertia load of 30G

$M2= Gx * W1 * L3$

$= 30 * 9.8 * 87*10^{-3} * 2.6*10^{-3}$

=0.066 Nm

$M1= (W1 * g * L2) + L1/L4 (F1 * L7 + Gx * W2 * L6)$

$=(87*10^{-3} * 9.8 * 120*10^{-3}) +168*10^{-3}/ 1*10^{-3} \quad (14.67 * 18*10^{-3} + \ 30*9.8 * 5.6*10^{-3} * 4*10^{-3})$

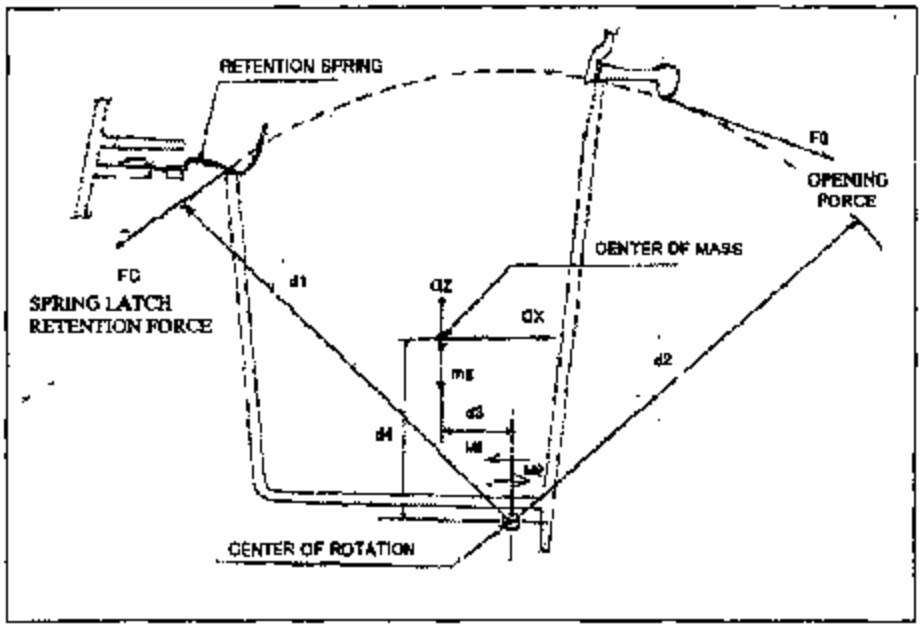
= 45.55 Nm

M1 / M2 = 45.55/ 0.066 = 690.2 > 1 ..... **LID WILL REMAIN CLOSED**

D. REAR STORAGE BIN

Part name: PANEL,CONSOLE RR END
PART NO: 58923-AD010

1. Geometric details of the latch/lock configuration;



2. Mass data for each element in the linkage

MARK	DATA	UNIT	REMARK
m	0.105	Kg	MASS OF BIN BOX
F0	19.6	N	Minimum design allowed opening force
FC	15.63	N	Spring latch retention force
Gx	30	G	Longitudinal inertia load
Gz	10	G	Vertical inertia load
d1	$107*10^{-3}$	m	
d2	$107*10^{-3}$	m	
d3	$17*10^{-3}$	m	
d4	$42*10^{-3}$	m	

3. Calculation results on "storage bin box "

3-1.When subjected to a vertical inertia load of 10G

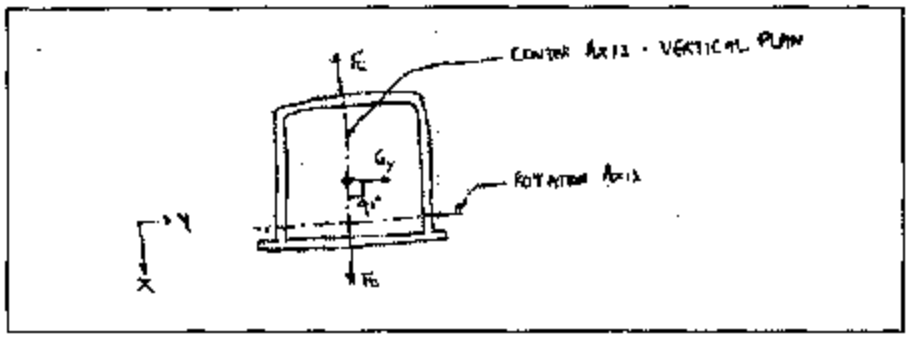
$M1 = (Fc * d1) + (m * g * d3)$
$= (15.63 * 107*10^{-3}) + (0.105 * 9.8 * 17*10^{-3})$
$= 1.69$ Nm

$M2 = Gz * m * d3$
$= 10 * 9.8 * 0.105 * 17*10^{-3}$
$= 0.175$ Nm

M1 > M2 ..... LID WILL REMAIN CLOSED

3-2 When subjected to a transverse inertia load of 10G

PLAN VIEW



SINCE STORAGE BIN IS SYMMETRICAL ABOUT THE VERTICAL CENTER PLANE,TRANSVERSE INERTIAL LOAD Gy WILL NOT HAVE A COMPONENT IN THE X-DIRECTION OR Z - DIRECTION.

$M1 = (Fc * d1) + (m * g * d3)$
$= 1.69$ Nm

$M2 = Gy \cos 90_{(deg)} * m * d3$
$= 0.0$ Nm

M1 > M2 ... STORAGE BIN WILL REMAIN CLOSED

3-3 When subjected to a longitudinal inertia load of 30G

M1= (Fc * d1) + (m * g * d3)
= 1.69 Nm

M2= Gx * m * d4
=30 * 9.8 * 0.105 * 42*10^{-3}
= 1.29 Nm

M1 > M2 .....**STORAGE BIN WILL REMAIN CLOSED**

Appendix : calculation of Fc

Fc: the spring latch retention load

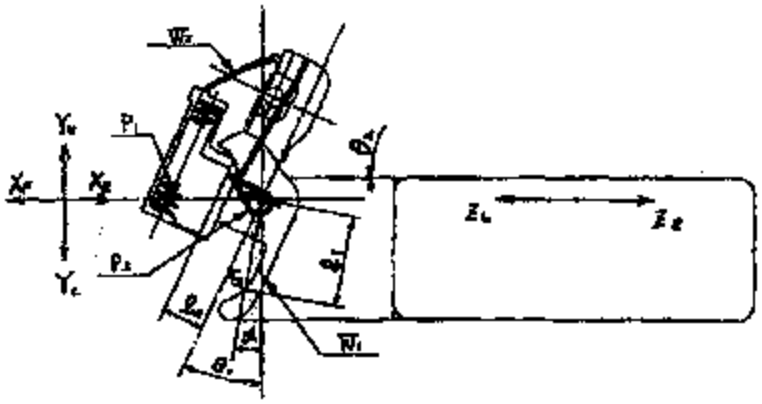
M1= (Fc * d1) + (m * g * d3) = M2
= 1.69

M2= F0 * d2
(F0 is the minimum design allowed opening force: 15.87 N)

M1=M2
(Fc * 107*10^{-3}) + (0.105 * 9.8 * 17*10^{-3}) =15.87 * 107*10^{-3}
FC = (1.69 - 17*10^{-3}) / 107*10^{-3}
= 15.63 N

E. Glove Compartment

1. Geometric details of the latch/lock configuration:



2. Dimensions & the meaning of the marks:

Mark	Data	Unit	Meaning of the mark
W_1	13.0×10^{-3}	Kg	Weight of the handle
W_2	2.00×10^{-3}	Kg	Weight of the locking bar
P_1	4.51	N	Installation force of the compression spring
P_2	3.82×10^{-2}	Nm	Installation moment of the torsion spring
l_1	1.10×10^{-2}	m	Distance between rotation center of the handle and center gravity of the handle
l_2	8.80×10^{-3}	m	Distance between rotation center of the handle and the locking bar
θ_1	25.2	degree	Installation angle of the handle
θ_2	0	degree	Installation angle of the lock assembly
α	10.1	degree	Angle of the center gravity of the handle from the vertical line
M(+)	-	Nm	Moment rotating the handle
M(-)	-	Nm	Moment which is not rotating the handle
F(+)	-	N	Force moving the locking bar
F(-)	-	N	Force which is not moving the locking bar

3. Calculation Results on "Glove Compartment"
(The direction releasing the lock is considered as a "+(plus)" axis)

3-1. When subjected to an inertia load of 30G along the X_F axis:

(1) Concerning the moment around the rotation center of the Handle
$M(+) = W_1 \times \sin\alpha \times l_1 \times 9.8 = 2.46 \times 10^{-4}$ (Nm)
$M(-) = -(W_1 \times 30 \times \cos\alpha \times l_1 \times \cos\theta_2 \times 9.8) - P_2 = -7.95 \times 10^{-2}$ (Nm)
$M = M(+) + M(-) = -7.92 \times 10^{-2}$ (Nm)
Total moment of the handle "M (+) + M (–)" is -7.92×10^{-2} (Nm).
Since the sign is "– (minus)", the handle can not rotate to open the door.

(2) Concerning an inertia load onto the locking bar
$F(+) = (W_2 \times 30 \times \sin\theta_1 \times \cos\theta_2 + W_2 \times \cos\theta_1) \times 9.8 = 2.69 \times 10^{-1}$ (N)
$F(-) = -P_1 = -4.51$ (N)
$F = F(+) + F(-) = -4.24$ (N)
Total force onto the Locking bar "F (+) + F (-)" is – 4.24 (N).
Since the sign is "– (minus)", the locking bar can not move downward to open the door.

Therefore, the lock can not release, even if an inertia load of 30G is applied along the FRONT direction.

3-2. When subjected to an inertia load of 30G along the X_R axis:

(1) Concerning the moment around the rotation center of the handle
$M(+) = (W_1 \times 30 \times \cos\alpha \times l_1 \times \cos\theta_2 + W_1 \times \sin\alpha \times l_1) \times 9.8 = 4.17 \times 10^{-2}$ (Nm)
$M(-) = -P_2 = -3.82 \times 10^{-2}$ (Nm)
$M = M(+) + M(-) = 3.50 \times 10^{-3}$ (Nm)
Total moment of the handle "M (+) + M (–)" is 3.50×10^{-3} (Nm).
Since the sign is "+(plus)", the handle can rotate to open the door.
(2) Concerning an inertia load onto the locking bar
$F(+) = W_2 \times \cos\theta_1 \times 9.8 = 1.76 \times 10^{-2}$ (N)
$F(-) = -(W_2 \times 30 \times \sin\theta_1 \times \cos\theta_2 \times 9.8) - P_1 = -4.76$ (N)
$F = F(+) + F(-) = -4.74$ (N)
Total force onto the locking bar "F (+) + F (–)" is – 4.74 (N).
Additionally, from the calculation result of above (1), the force, which acted the locking bar by the moment of the handle, shall be considered.
Total force onto the locking bar is
$F' = M/l_2 + F = -4.34$ (N).
Since the sign is "– (minus)", the locking bar can not move downward to open the door

Therefore, the lock can not release, even if an inertia load of 30G is applied along the REAR direction.

3-3. When subjected to an inertia load of 10G along the Y_U axis:

(1) Concerning the moment around the rotaion center of the handle
$M(+) = W_1 \times \sin\alpha \times l_1 \times 9.8 = 2.46 \times 10^{-4}$ (Nm)
$M(-) = -(W_1 \times 10 \times \sin\alpha \times l_1 \times 9.8) - P^2 = -4.06 \times 10^{-2}$ (Nm)
$M = M(+) + M(-) = -4.03 \times 10^{-2}$ (Nm)
Total moment of the handle "M (+) + M (–)" is -4.03×10^{-2} (Nm)
Since the sign is "– (minus)", the handle can not rotate to open the door.

(2) Concerning an inertia load onto the locking bar
$F(+) = W_2 \times \cos\theta_1 \times 9.8 = 1.76 \times 10^{-2}$ (N)
$F(-) = -(W_2 \times 10 \times \cos\theta_1 \times 9.8) - P_1 = -4.66$
$F = F(+) + F(-) = -4.66$ (N)
Total force onto the locking bar "F (+) + F (–)" is – 4.66 (N).
Since the sign is "– (minus)", the locking bar can not move downward to open the door.

Therefore, the lock can not release, even if an inertia load of 10G is applied along the UPPER direction.

3-4. When sujected to an inertia load of 10G along the Y_L axis:

(1) Concerning the moment around the rotation center of the handle.
$M(+) = (W_1 \times \sin\alpha \times l_1 + W_1 \times 10 \times \sin\alpha \times l_1) \times 9.8 = 2.71 \times 10^{-3}$ (Nm)
$M(-) = -P_2 = -3.82 \times 10^{-2}$ (Nm)
$M = M(+) + M(-) = -3.54 \times 10^{-2}$ (Nm)
Total moment of the handle "M (+) + M (–)" is -3.54×10^{-2} (N)
Since the sign is "– (minus)", the handle can not rotate to open the door.

(2) Concerning an inertia load onto the locking bar
$F(+) = (W_2 \times 10 \times \cos\theta_1 + W_2 \times \cos\theta_1) \times 9.8 = 1.96 \times 10^{-1}$ (N)
$F(-) = -P_1 = -4.51$ (N)
$F = F(+) + F(-) = -4.31$ (N)
Total force onto the locking bar "F (+) + F (–)" is – 4.31 (N).
Since the sign is "– (minus)", the locking bar can not move downward to open the door.

Therefore, the lock can not release, even if an inertia load of 10G is applied along the LOWER direction.

3-5. When subjected to an inertia load of 10G along the Z_R axis:

(1) Concerning the moment around the rotation center of the handle
$M(+) = W_1 \times \sin\alpha \times l_1 \times 9.8 = 2.46 \times 10^{-5}$ (N)
$M(-) = -(10 \times W_1 \times \sin\theta_2 \times l_1 \times \cos\alpha \times 9.8) - P_2 = -3.82 \times 10^{-2}$ (N)
$M = M(+) + M(-) = -3.79 \times 10^{-2}$ (Nm)
Total moment of the handle "M (+) + M (–)" is -3.79×10^{-2} (N).
Since the sign is "– (minus)", the handle can not rotate to open the door.

(2) Concerning an inertia load onto the locking bar
$F(+) = (10 \times W_2 \times \sin\theta_2 \times \sin\theta_1 + W_2 \times \cos\theta_1) \times 9.8 = 1.81 \times 10^{-2}$ (N)
$F(-) = -P_1 = -4.51$ (N)
$F = F(+) + F(-) = -4.50$ (N)
Total force onto locking bar "F (+) + F (–)" is – 4.50 (N).
Since the sign is "– (minus)", the locking bar can not move downward to open the door.

Therefore, the lock can not release, even if an inertia load of 10G is applied along the RIGHT direction.

3-6. When subjected to an inertia load of 10G along the Z_L axis:

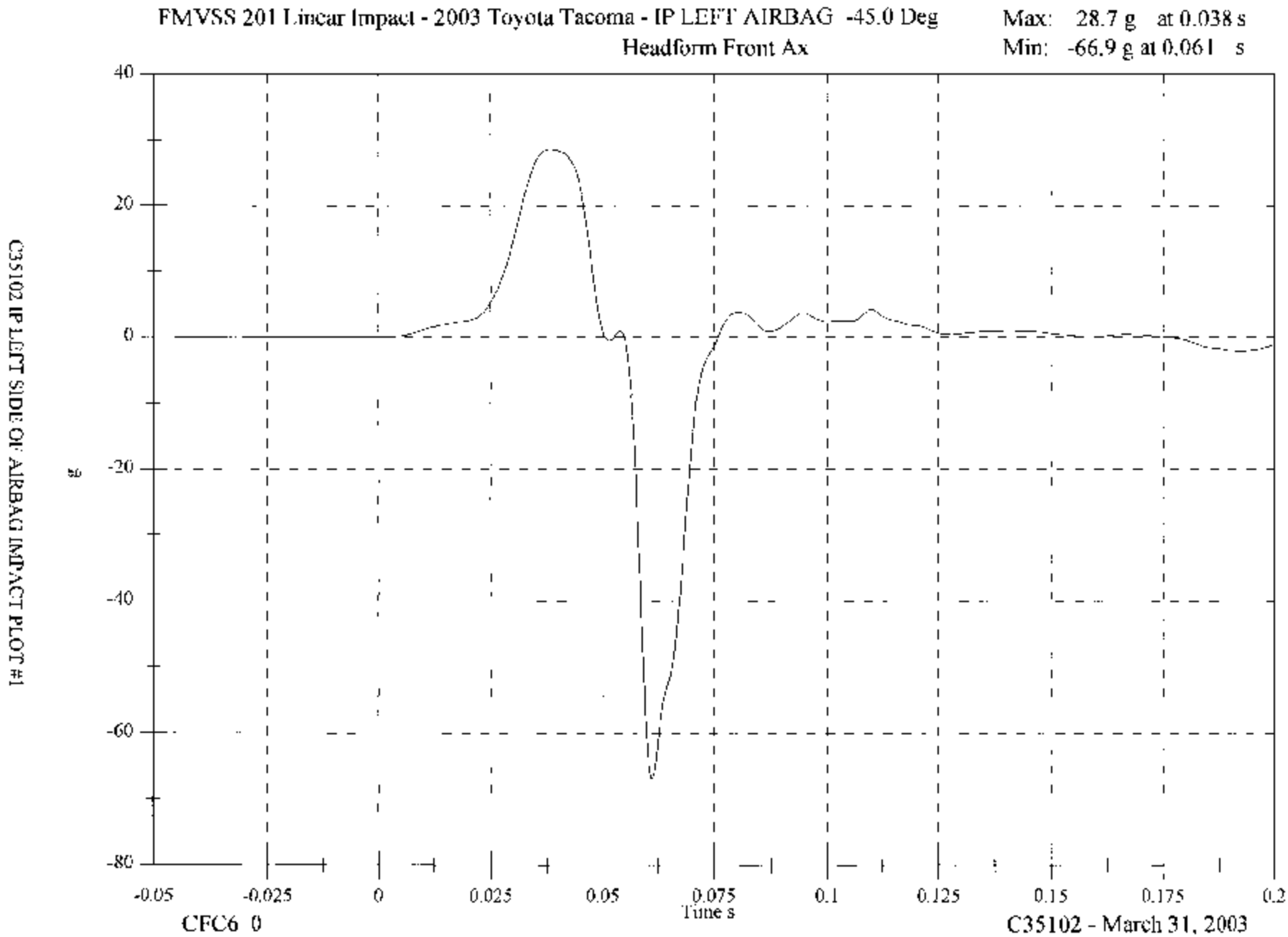
(1) Concerning the moment around the rotation center of the handle
$M(+) = (W_1 \times \sin\alpha \times l_1 + 10 \times W_1 \times \sin\theta_2 \times l_1 \times \cos\alpha) \times 9.8 = 2.46 \times 10^{-4}$ (Nm)
$M(-) = -P_2 = -3.82 \times 10^{-2}$ (Nm)
$M = M(+) + M(-) = -3.79 \times 10^{-2}$ (Nm)
Total moment of the handle "M (+) + M (–)" is -3.79×10^{-2} (Nm)
Since the sign is "– (minus)", the handle can not rotate to open the door.

(2) Concerning an inertia load onto the locking bar
$F(+) = W_2 \times \cos\theta_1 \times 9.8 = 1.78 \times 10^{-2}$ (N)
$F(-) = -(10 \times W_2 \times \sin\theta_2 \times \sin\theta_1 \times 9.8) - P_1 = -4.51$ (N)
$F = F(+) + F(-) = -4.49$ (N)
Total force onto the locking bar "F (+) + F (–)" is – 4.49 (N).
Since the sign is "– (minus)", the locking bar can not move downward to open the door.

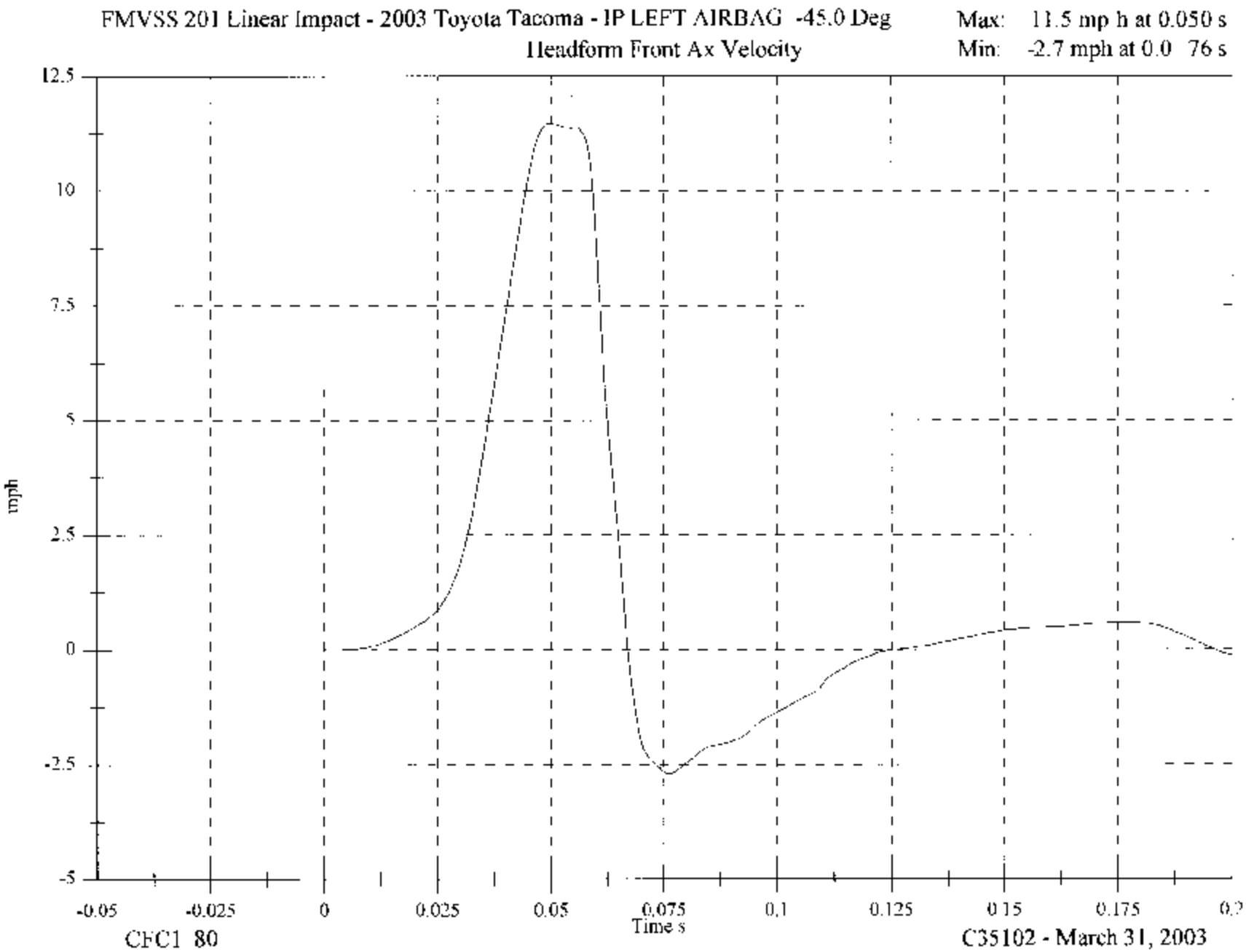
Therefore, the lock can not release, even if an inertia load of 10G is applied along the LEFT direction.

APPENDIX C

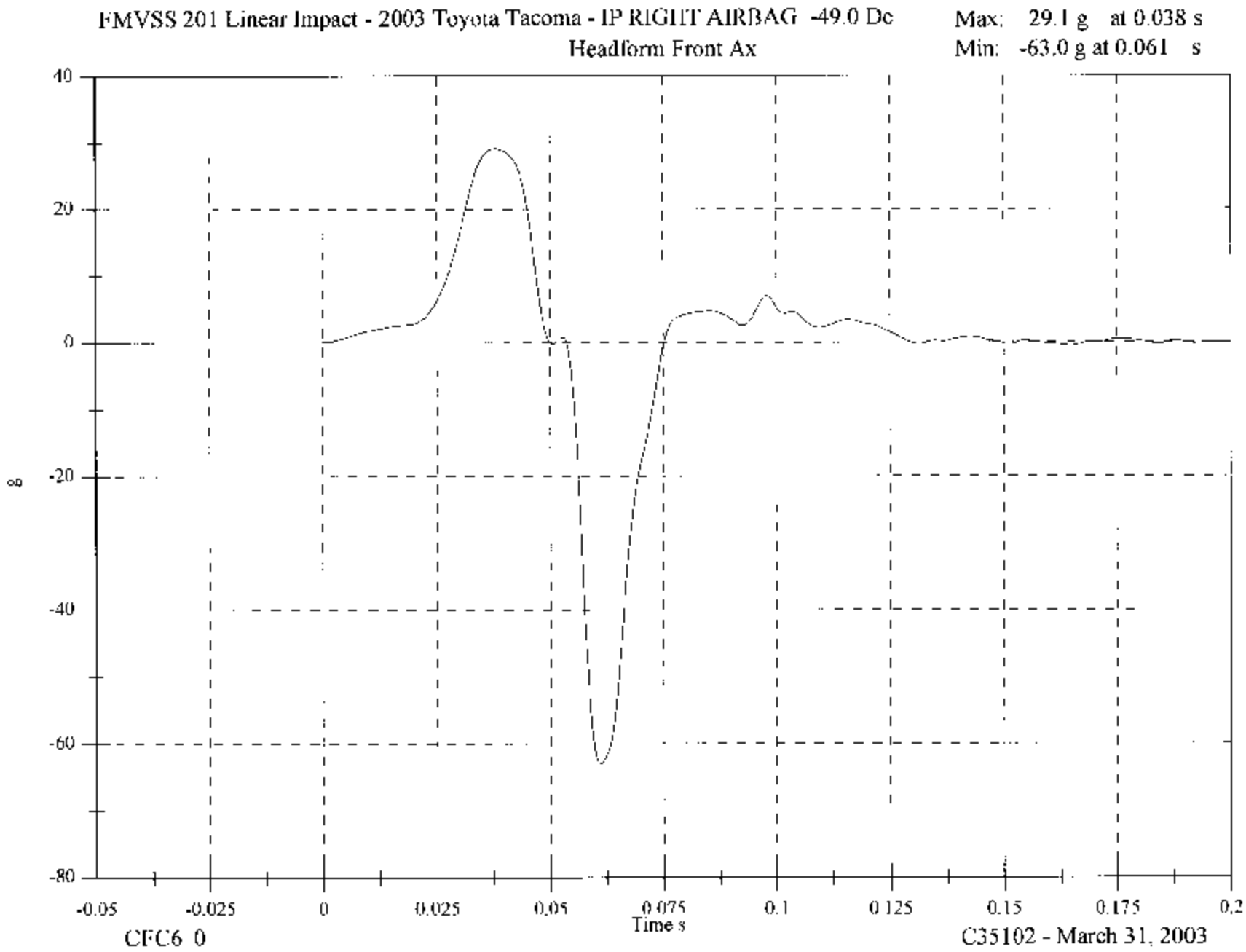
DATA PLOTS


FMVSS 201 Linear Impact - 2003 Toyota Tacoma - IP LEFT AIRBAG -45.0 Deg
Headform Front Ax
Max: 28.7 g at 0.038 s
Min: -66.9 g at 0.061 s
C35102 IP LEFT SIDE OF AIRBAG IMPACT PLOT #1
g
40
20
0
-20
-40
-60
-80
-0.05
-0.025
0
0.025
0.05
0.075
0.1
0.125
0.15
0.175
0.2
Time s
CFC6 0
C35102 - March 31, 2003

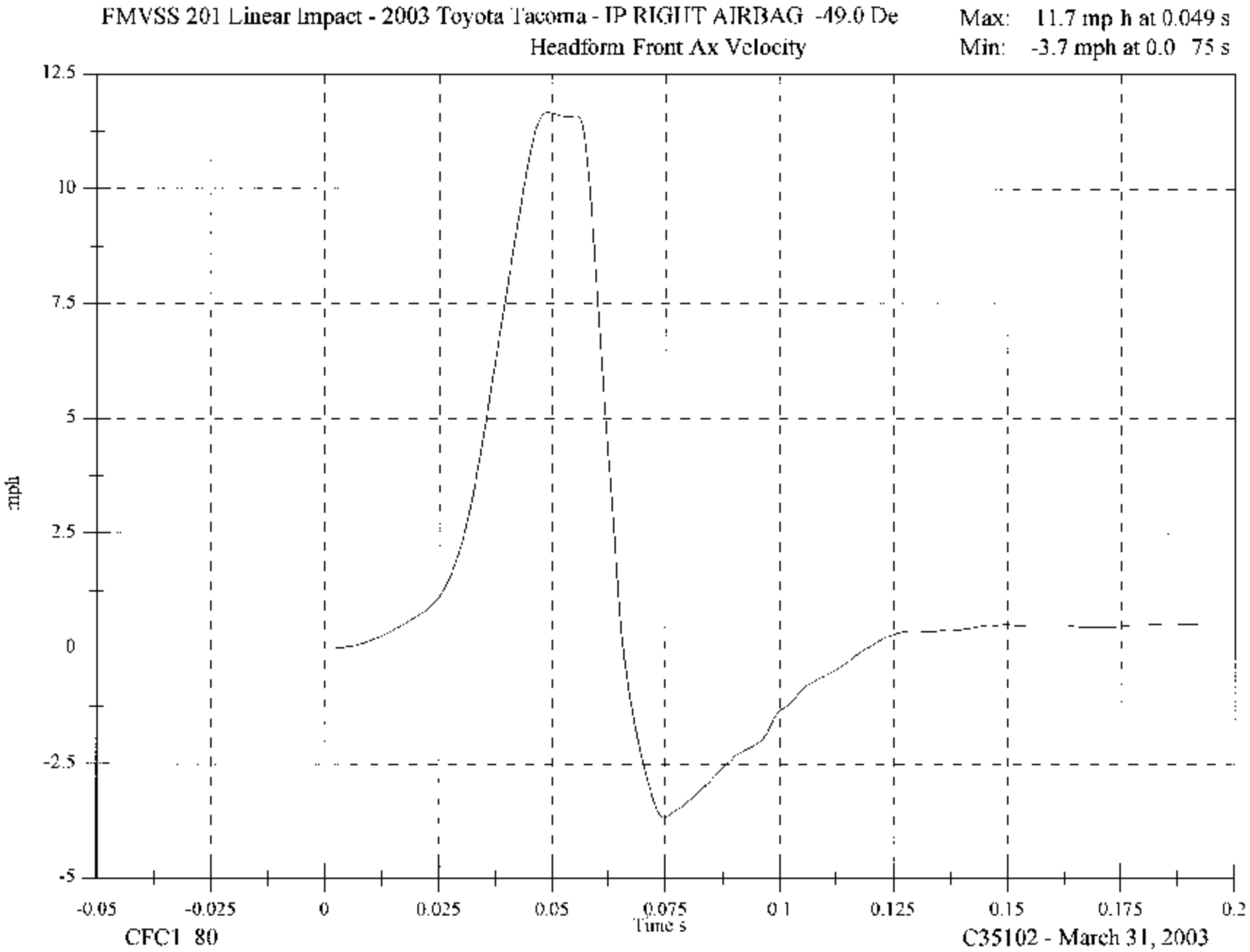
C35102 IP LEFT SIDE OF AIRBAG IMPACT PLOT #2

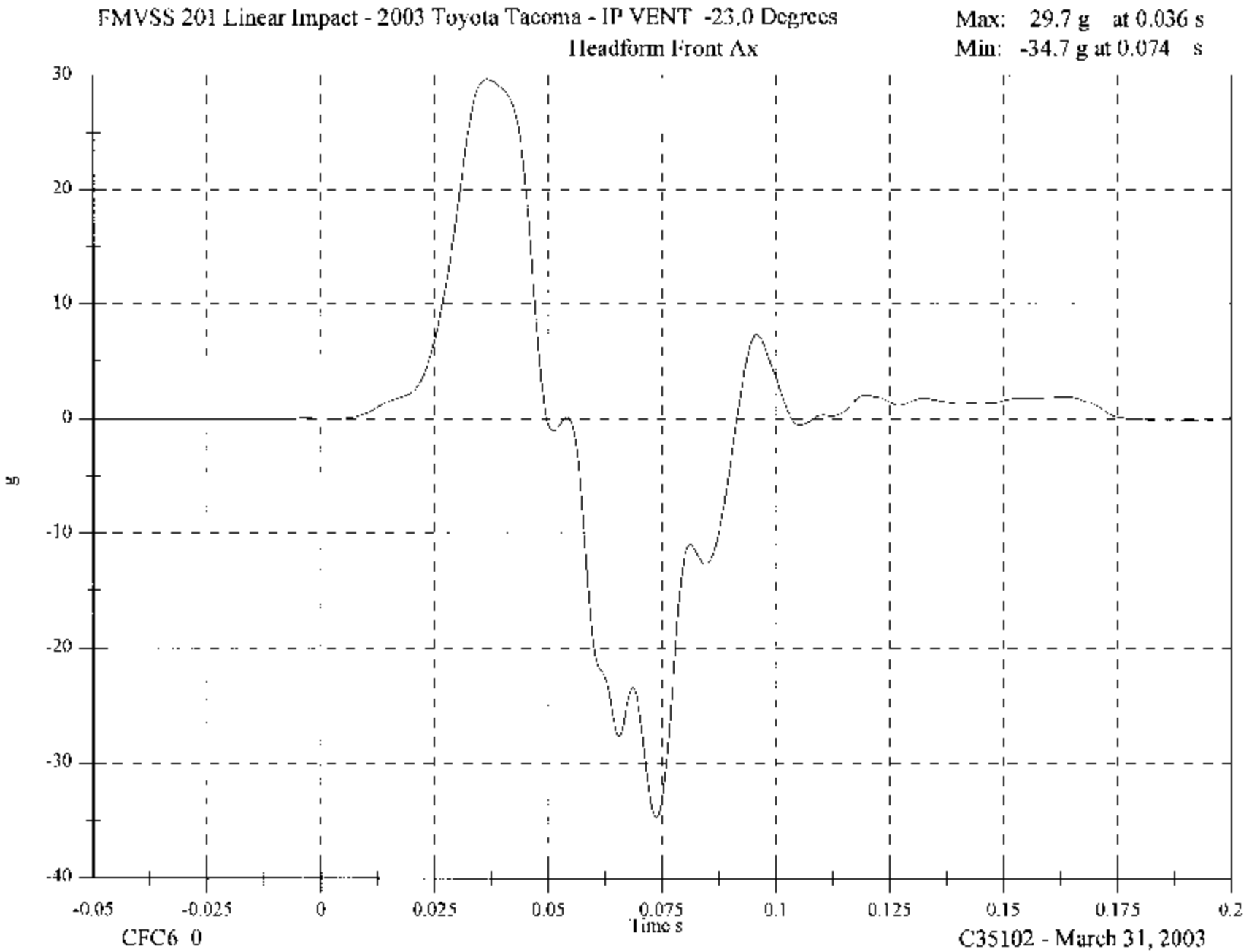


C35102 IP RIGHT SIDE OF AIRBAG IMPACT PLOT #1



C35102 IP RIGHT SIDE OF AIRBAG IMPACT PLOT #2





C35102 IP VENT IMPACT PLOT #1

C35102 IP VENT IMPACT PLOT #2