HS 637297

REPORT NUMBER: 201-VER-04-05

SAFETY COMPLIANCE TESTING FOR FMVSS 201
OCCUPANT PROTECTION IN INTERIOR IMPACT

TOYOTA MOTOR MANUFACTURING INDIANA, INC.
2004 TOYOTA SIENNA

NHTSA NUMBER: C45103

GD TEST NUMBER: 8655-F201-28

ADVANCED INFORMATION ENGINEERING SERVICES
A GENERAL DYNAMICS COMPANY
TRANSPORTATION SCIENCES CENTER
P.O. BOX 400
BUFFALO, NEW YORK 14225

Test Date: July 21, 2004

FINAL REPORT

PREPARED FOR:

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
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Prepared by: ______________________
James Czarnecki, Project Engineer

Approved by: ______________________
David J. Travale, Program Manager
Transportation Science Center

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15. *Supplementary Notes*		

16. *Abstract*

Compliance tests were conducted on the subject vehicle, a 2004 Toyota Sienna, 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* <u>Copies of this report are available from:</u> NHTSA Technical Reference Division National Highway Traffic Safety Admin. 400 Seventh St., SW Washington, DC 20590	
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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 this impact compliance test was to determine whether the subject vehicle, a 2004 Toyota Sienna, NHTSA No. C45103, 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 2004 Toyota Sienna, NHTSA No. C45103, 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 five (5) impacts were performed in this test series. The five (5) chosen impact points were:

Seat Back / Head Restraint Area (2 impacts)

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 its centerline.

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. Still photographs can be found in Appendix A of this report.

TEST VEHICLE RECEIVING INSPECTION DATA SHEET

VEHICLE YEAR/MAKE/MODEL/STYLE:	2004 Toyota Sienna
NHTSA NO.:	C45103
VIN:	5TDZA23C34S070133
DATE OF MANUFACTURE:	09/03 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	111 miles
LABORATORY:	GD Engineering
TEST DATE:	July 21, 2004

NUMBER OF SEATING POSITIONS:

FRONT: 2 REAR: 3

INSTRUMENT PANEL:

NOTE UNUSUAL FEATURES: None

TYPE OF FRONT SEATS:

BENCH: - BUCKET: X SPLIT BACKS: -

TYPE OF HEAD RESTRAINTS:

FIXED: - ADJUSTABLE: X

VEHICLE EQUIPPED WITH ARMRESTS?

NO: - YES: X NUMBER: 6

LOCATION: Front and rear door panels with seat fold down arm rests

VEHICLE EQUIPPED WITH SUN VISORS?

NO: - YES: X

VEHICLE EQUIPPED WITH INTERIOR DOOR LATCHES?

NO: - YES: X NUMBER: 1

LOCATION: Glove Box

HEADFORM IMPACT TEST RESULTS
INSTRUMENT PANEL

VEHICLE YEAR/MAKE/MODEL/STYLE:	2004 Toyota Sienna
NHTSA NO.:	C45103
VIN:	5TDZA23C34S070133
DATE OF MANUFACTURE:	09/03 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	111 miles
LABORATORY:	GD Engineering
TEST DATE:	July 21, 2004

IMPACT LOCATION AND NUMBER					VELOCITY (mph)	PEAK ACCELERATION (3 ms Clip) Gs
NUMBER		X (inches)	Y (inches)	ANGLE (degrees)		
1	Dash Cluster	24.25	0.0	-27	11.4	49.92
2	Left Side of Airbag Cover	28.75	12.5	-45	11.4	47.22
3	Right Side of Airbag Cover	27.75	22.3	-54	11.5	49.22

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

REMARKS:

HEADFORM IMPACT TEST RESULTS
SEAT BACKS

VEHICLE YEAR/MAKE/MODEL/STYLE:	2004 Toyota Sienna
NHTSA NO.:	C45103
VIN:	5TDZA23C34S070133
DATE OF MANUFACTURE:	09/03 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	111 miles
LABORATORY:	GD Engineering
TEST DATE:	June 9, 2004

IMPACT LOCATION AND NUMBER				VELOCITY (mph)	PEAK ACCELERATION (3 ms Clip) Gs
NUMBER	X (inches)	Y (inches)	ANGLE (degrees)		
Front Seat Back	-10.3	0.0	-17	14.6	41.07
2^{ND} Row Seat Back	-53.9	0.0	-17	14.9	51.17

REFERENCE POINT: <u>SGRP on rear passenger side is the reference point (x positive forward from SGRP and y positive to the right of the seat centerline).</u>

SUN VISOR AND ARMREST EVALUATION

VEHICLE YEAR/MAKE/MODEL/STYLE:	2004 Toyota Sienna
NHTSA NO.:	C45103
VIN:	5TDZA23C34S070133
DATE OF MANUFACTURE:	09/03 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	111 miles
LABORATORY:	GD Engineering
TEST DATE:	July 21, 2004

SUN VISOR INFORMATION:

1. Are sun visors 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): -

DOOR LATCH EVALUATION

VEHICLE YEAR/MAKE/MODEL/STYLE:	2004 Toyota Sienna
NHTSA NO.:	C45103
VIN:	5TDZA23C34S070133
DATE OF MANUFACTURE:	09/03 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	111 miles
LABORATORY:	GD Engineering
TEST DATE:	July 21, 2004

LATCH ENGAGEMENT INTERFERENCE

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

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

SUMMARY OF RESULTS

VEHICLE YEAR/MAKE/MODEL/STYLE:	2004 Toyota Sienna
NHTSA NO.:	C45103
VIN:	5TDZA23C34S070133
DATE OF MANUFACTURE:	09/03 (SEE CERTIFICATION LABEL)
COLOR:	Silver
ODOMETER READING:	111 miles
LABORATORY:	GD Engineering
TEST DATE:	July 21, 2004

	NUMBER OF IMPACTS	PASS/FAIL
INSTRUMENT PANEL	3	Pass
SEAT BACK	2	Pass
SUN VISORS	n/a	Pass
ARMRESTS	n/a	Pass
INTERIOR COMPARTMENT DOORS	n/a	Pass

REMARKS:

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PHOTOGRAPHS

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Figure A-1 : LEFT SIDE VIEW OF VEHICLE

Figure A-2 : RIGHT SIDE VIEW OF VEHICLE

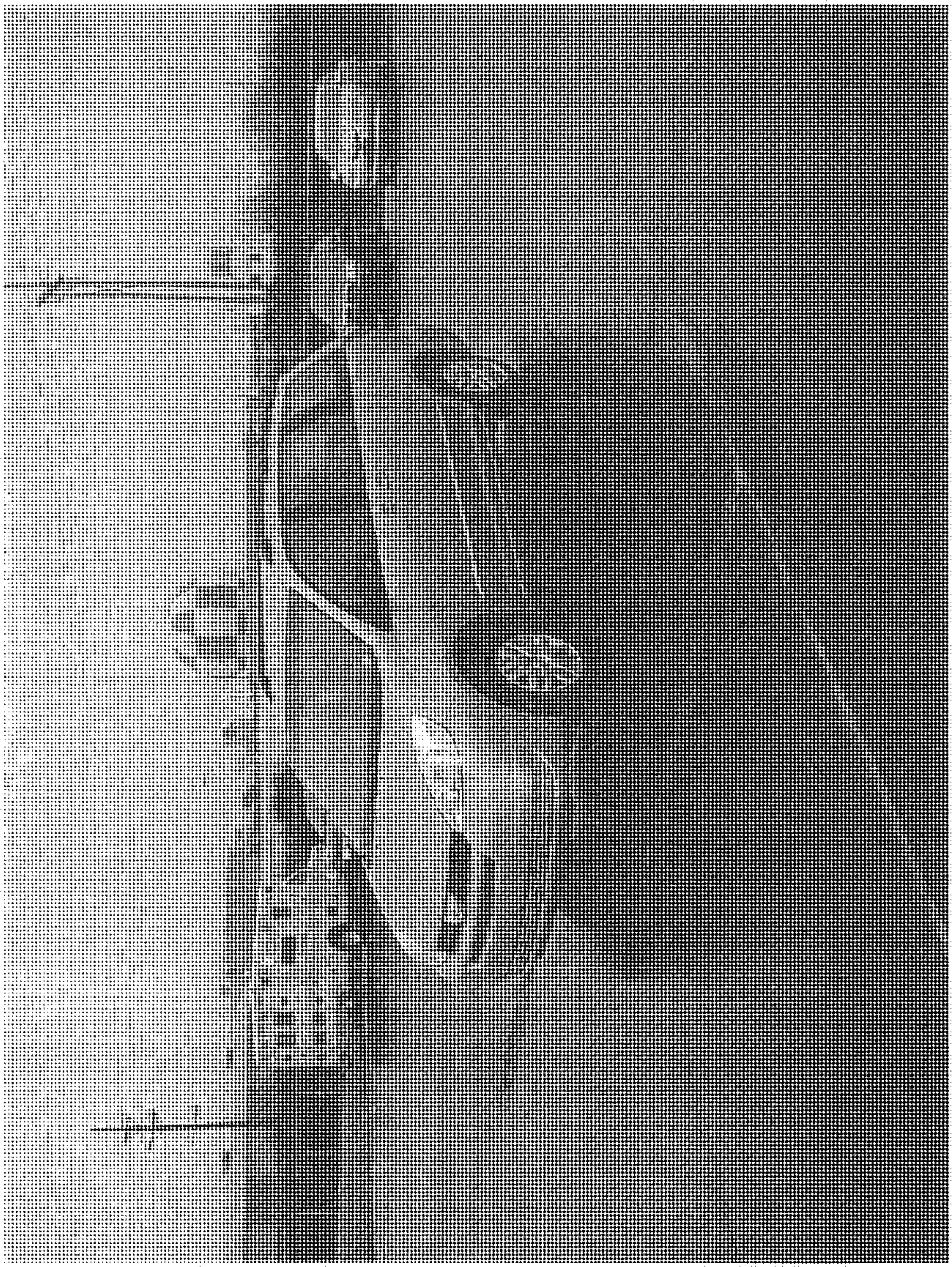


Figure A-3 : 3/4 FRONTAL VIEW FROM LEFT SIDE OF VEHICLE

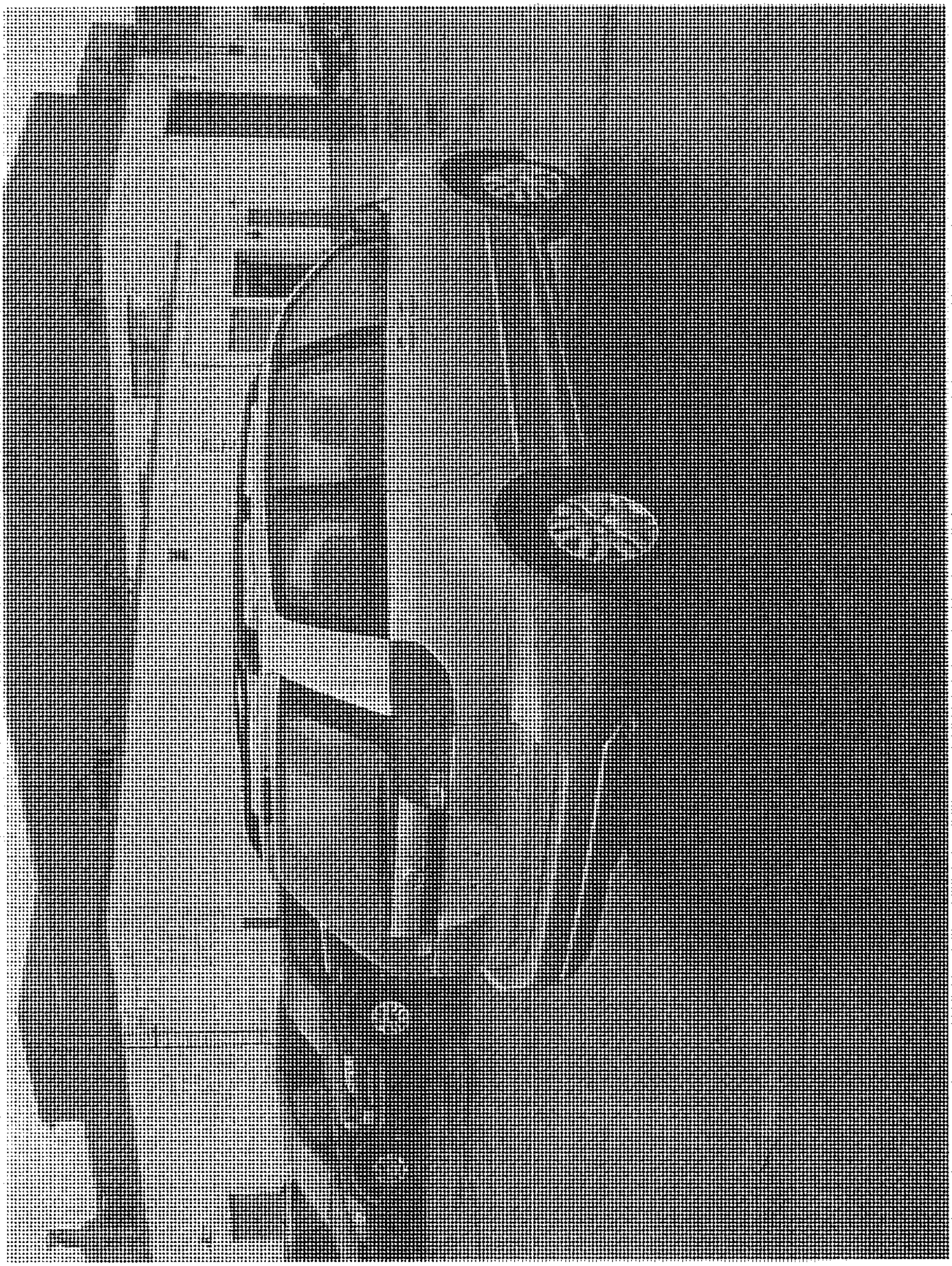


Figure A-4 : 3/4 REAR VIEW FROM RIGHT SIDE OF VEHICLE

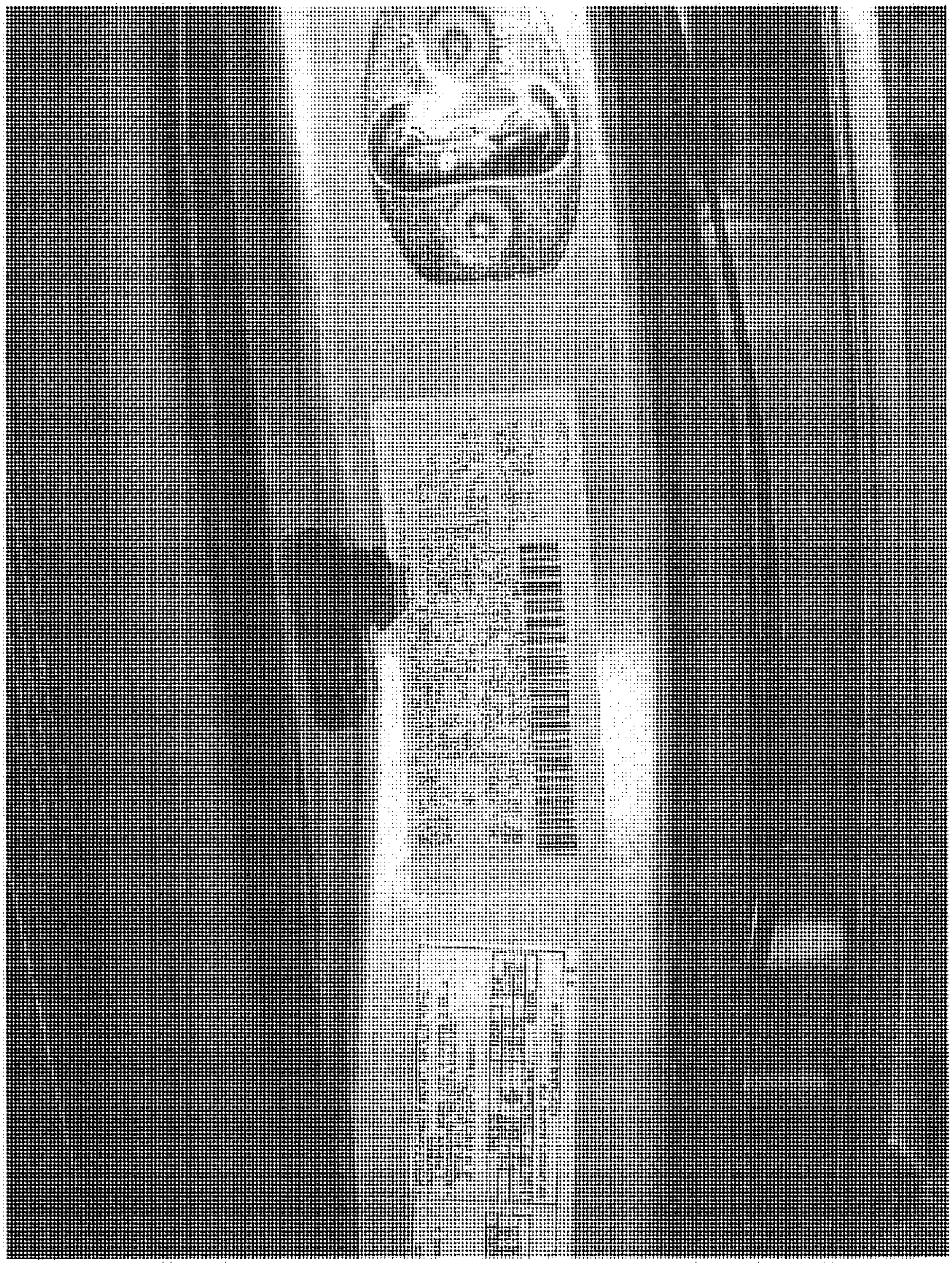


Figure A-5 : VEHICLE'S CERTIFICATION LABEL

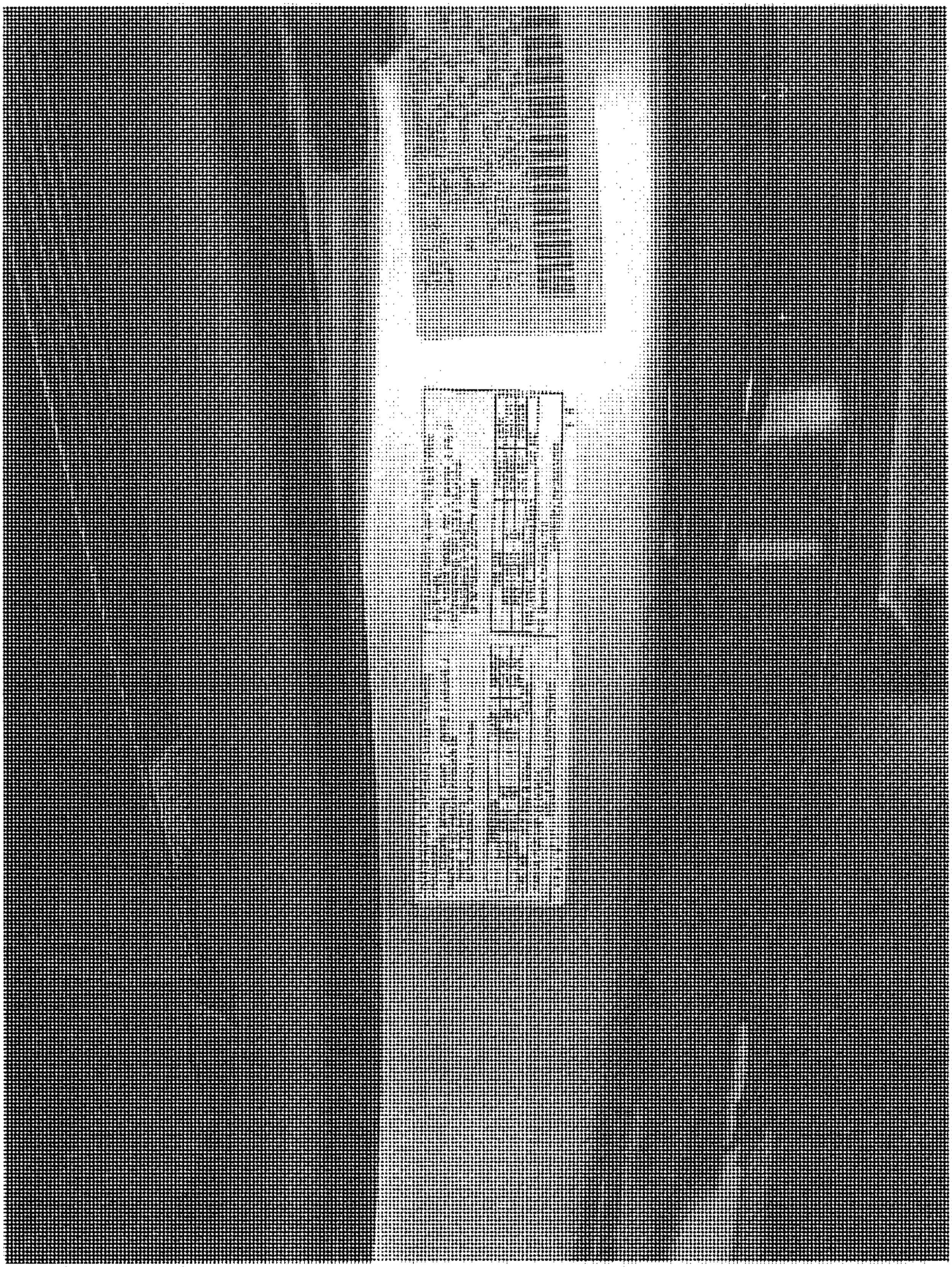


Figure A-5 - VEHICLE'S TIRE INFORMATION LABEL

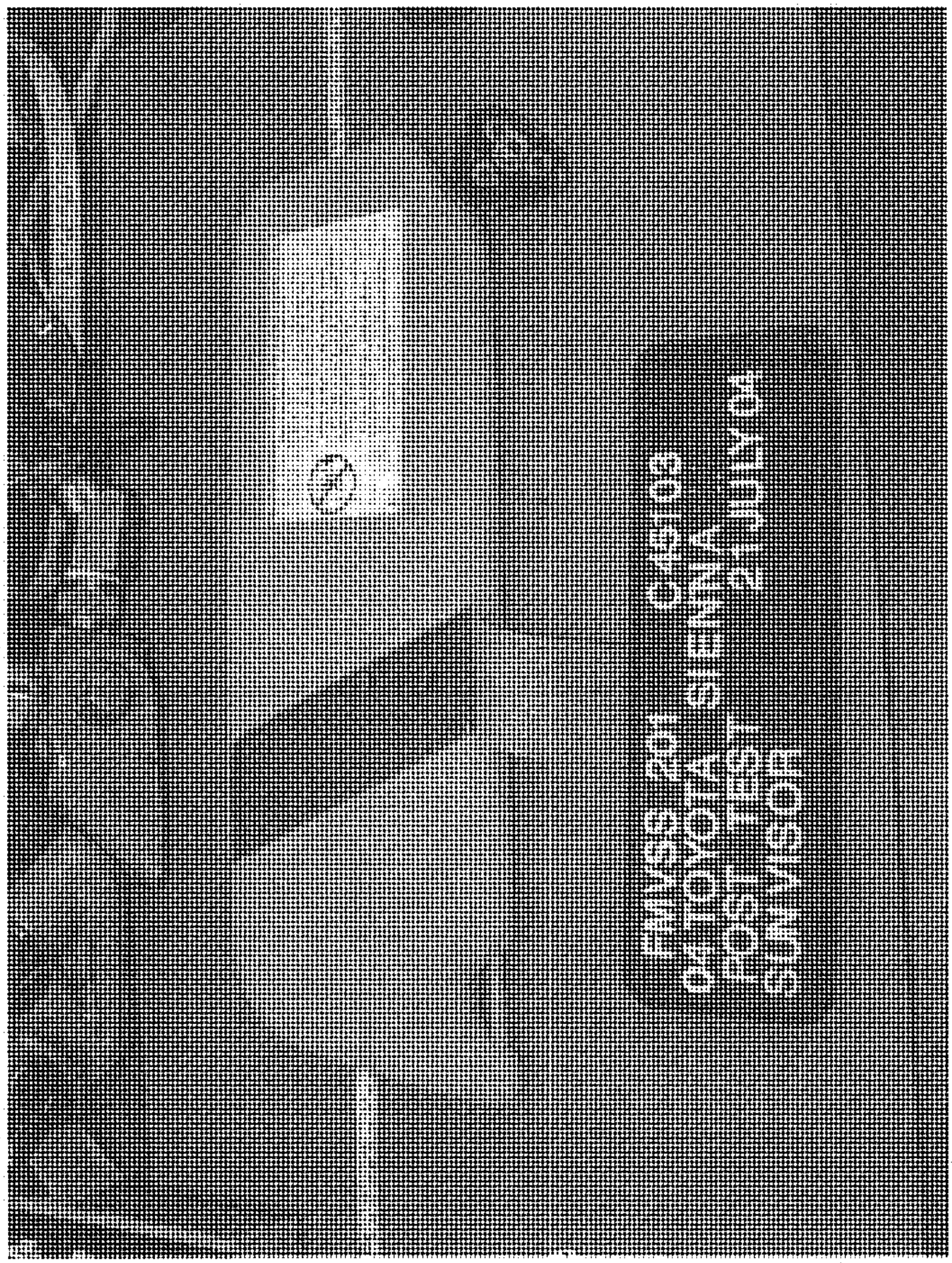


Figure A-7 : SUNVISOR CONSTRUCTION

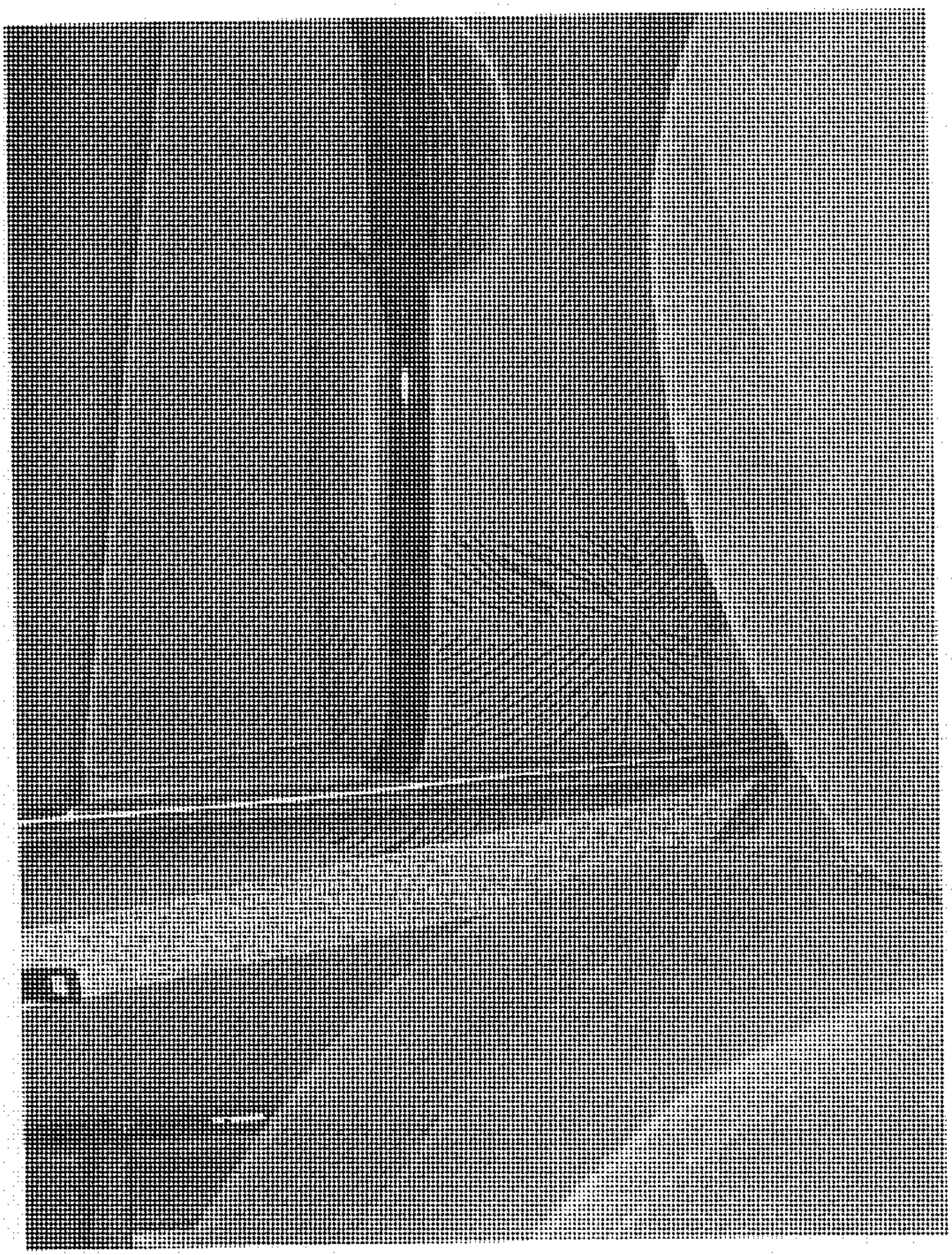


Figure A-8 : ARMREST LEFT FRONT DOOR

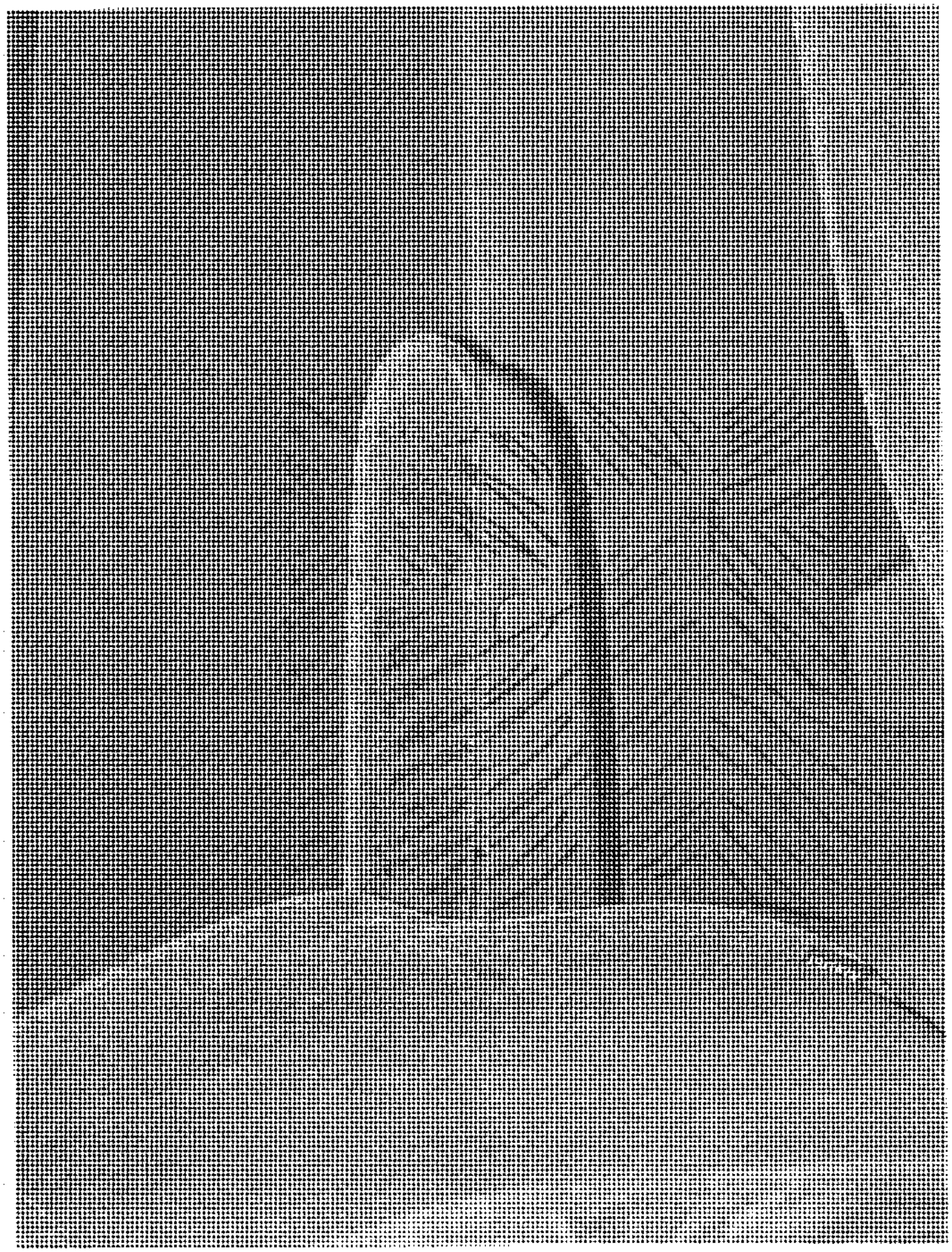


Figure A-9 : ARMREST LEFT 2ND ROW DOOR

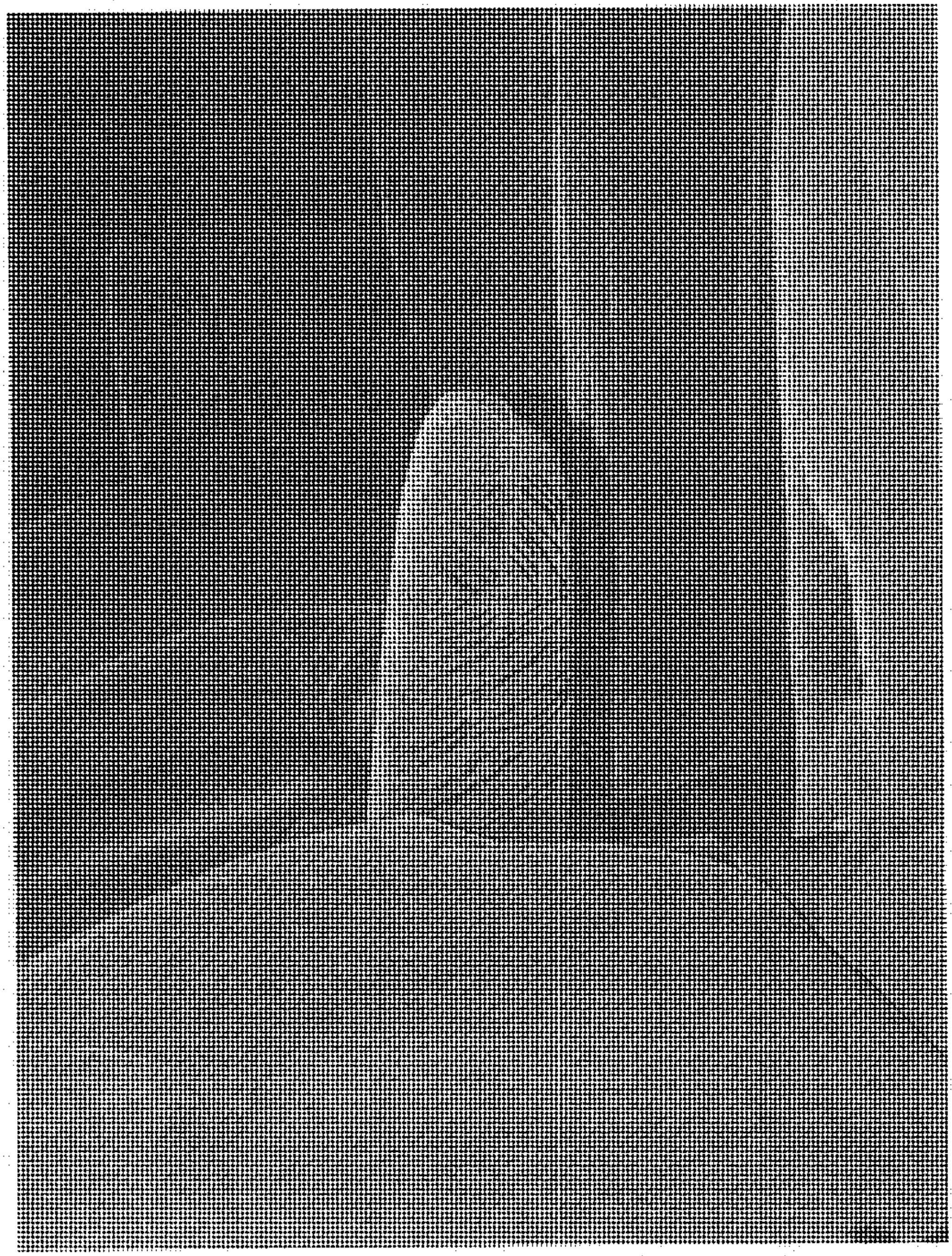


Figure A-10 : ARMREST FOR 2ND SEATING ROW

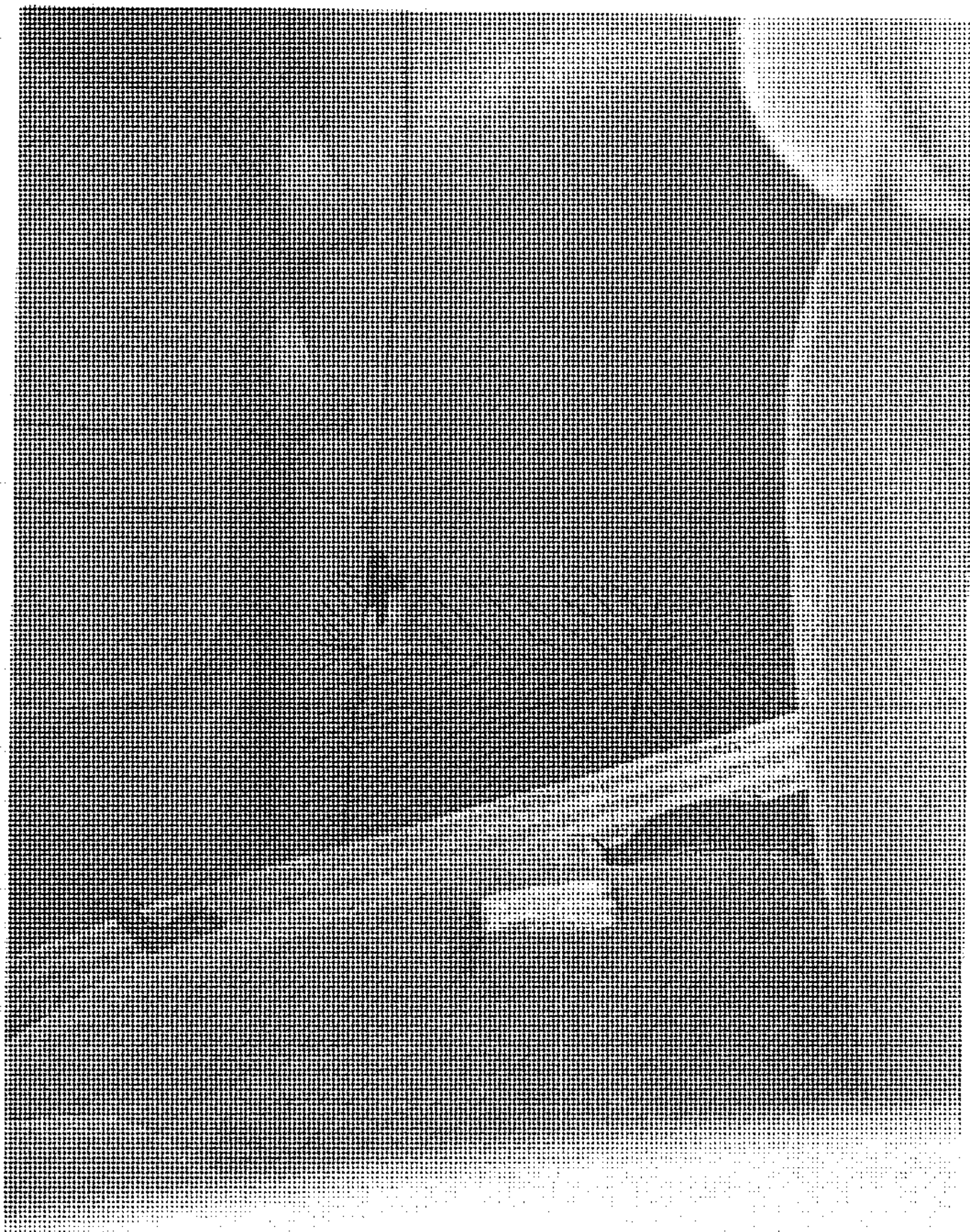


Figure A-11 : ARMREST REAR SEAT LEFT TRIM PANEL

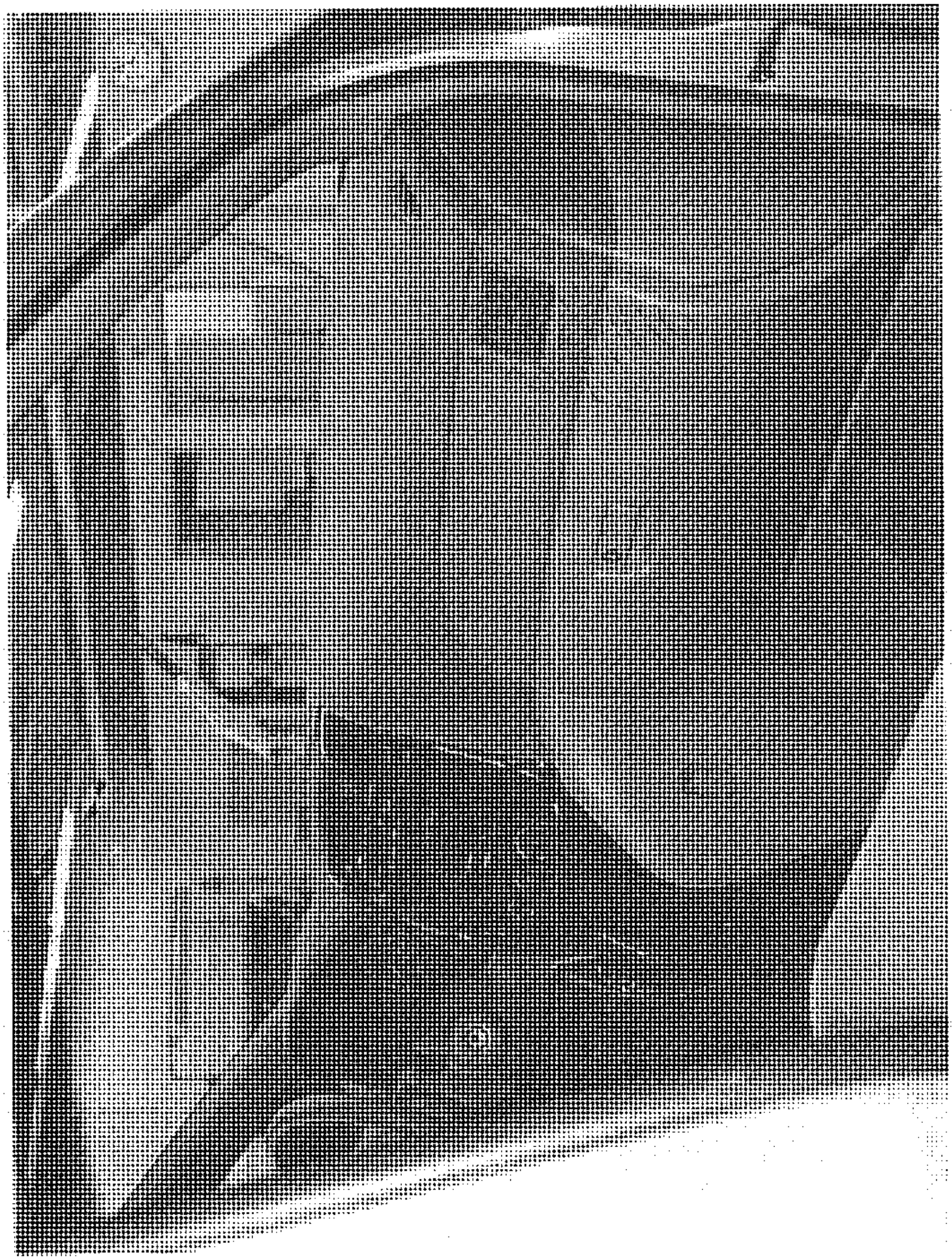


Figure A-12 : INSTRUMENT PANEL

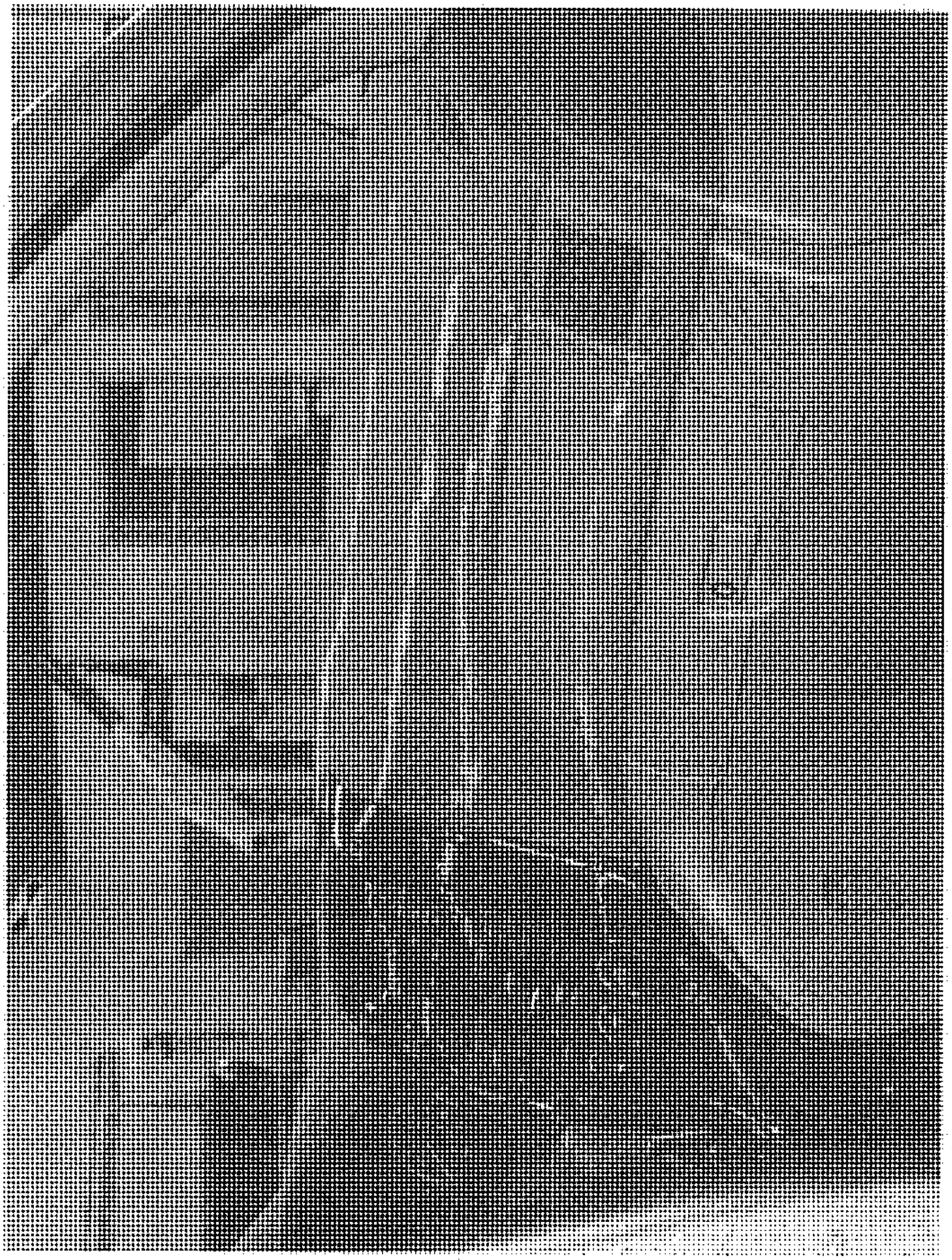


Figure A-13 : DELINEATED INSTRUMENT PANEL IMPACT ZONE PRE-TEST

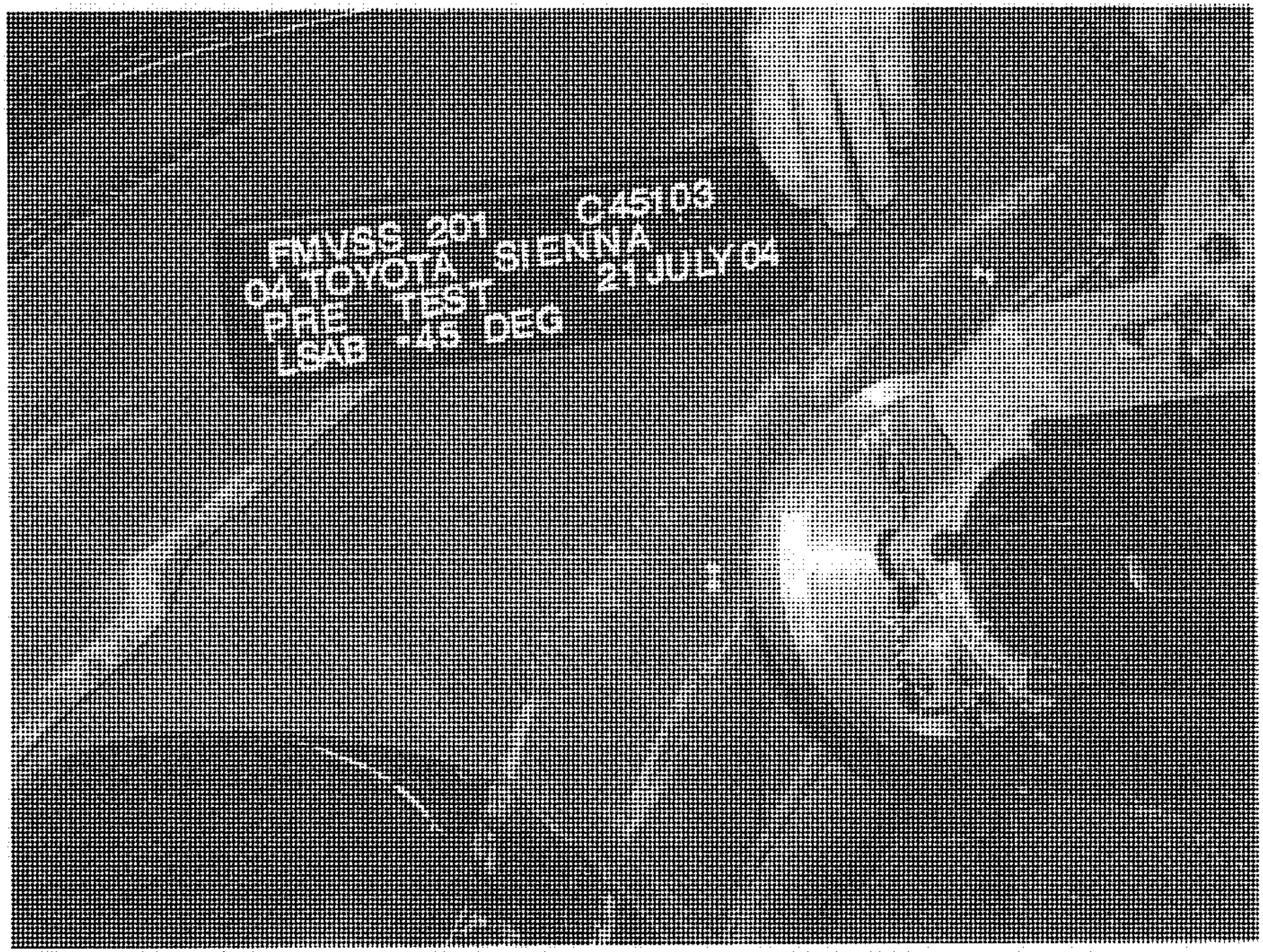


Figure A-14 : INSTRUMENT PANEL LEFT SIDE AIRBAG COVER IMPACT PRE-TEST

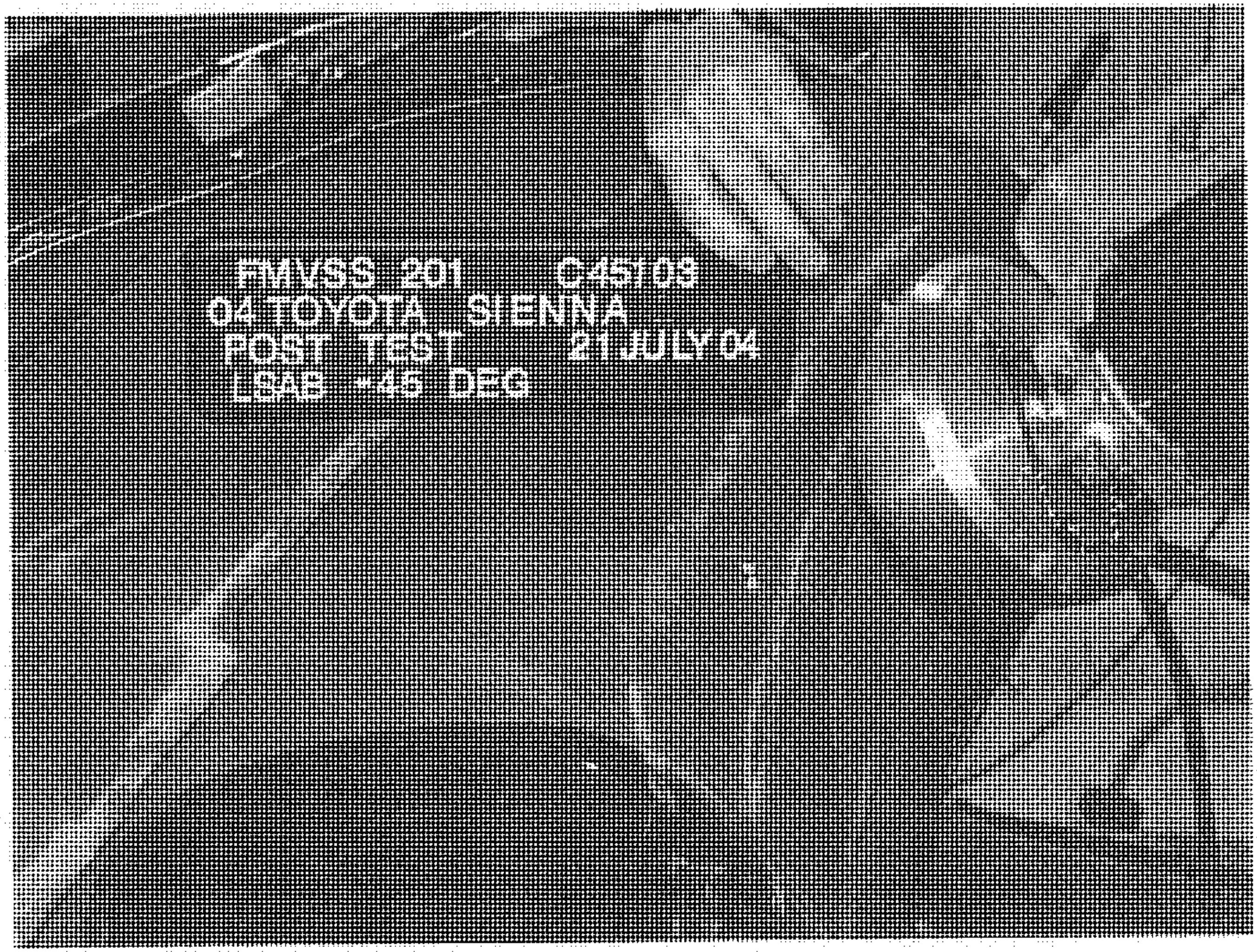


Figure A-15 : INSTRUMENT PANEL LEFT SIDE AIRBAG COVER IMPACT POST-TEST

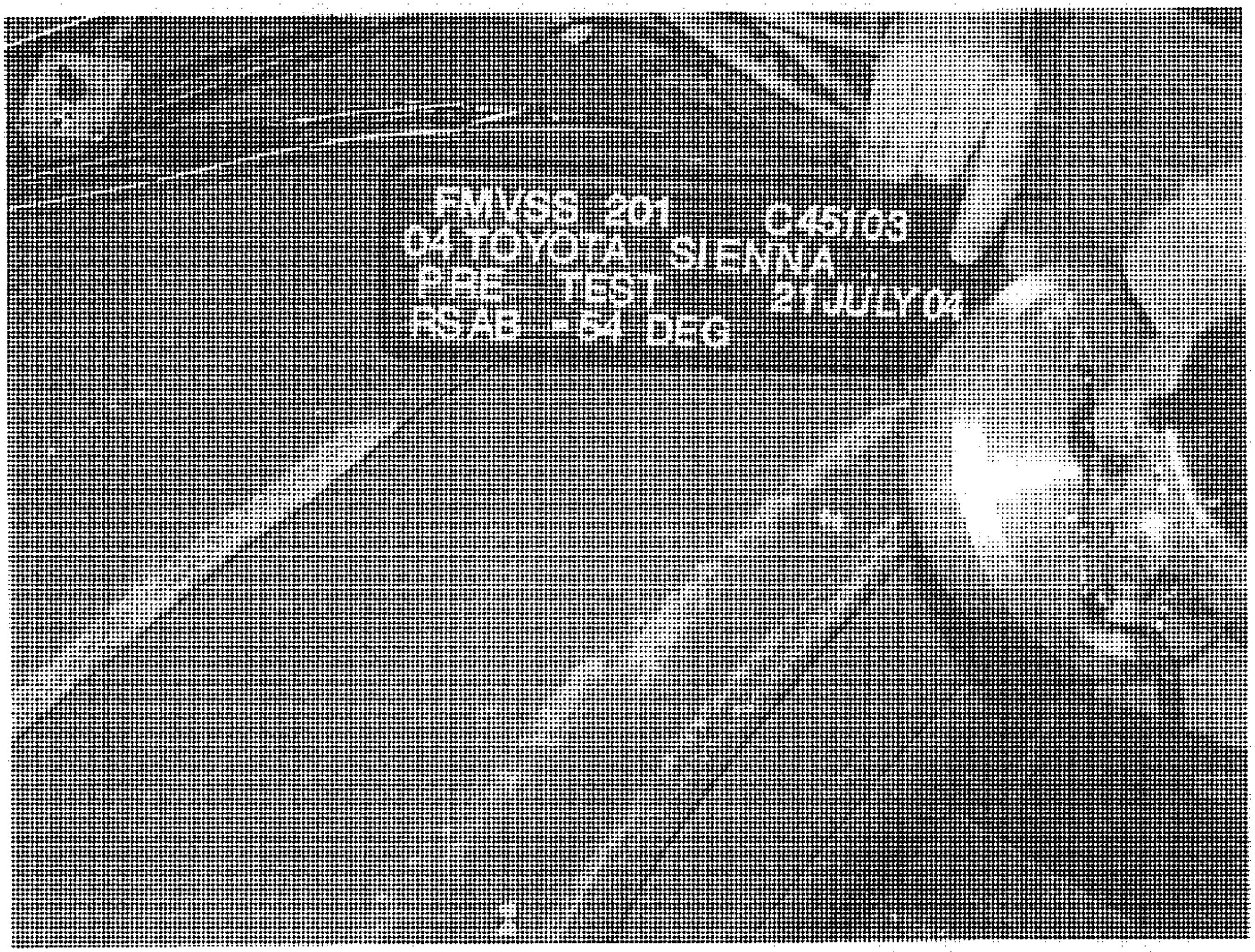


Figure A-16 : INSTRUMENT PANEL RIGHT SIDE AIRBAG COVER IMPACT PRE-TEST

Figure A-17 : INSTRUMENT PANEL RIGHT SIDE AIRBAG COVER IMPACT POST-TEST

Figure A-18 : INSTRUMENT PANEL CONSOLE VENT IMPACT PRE-TEST

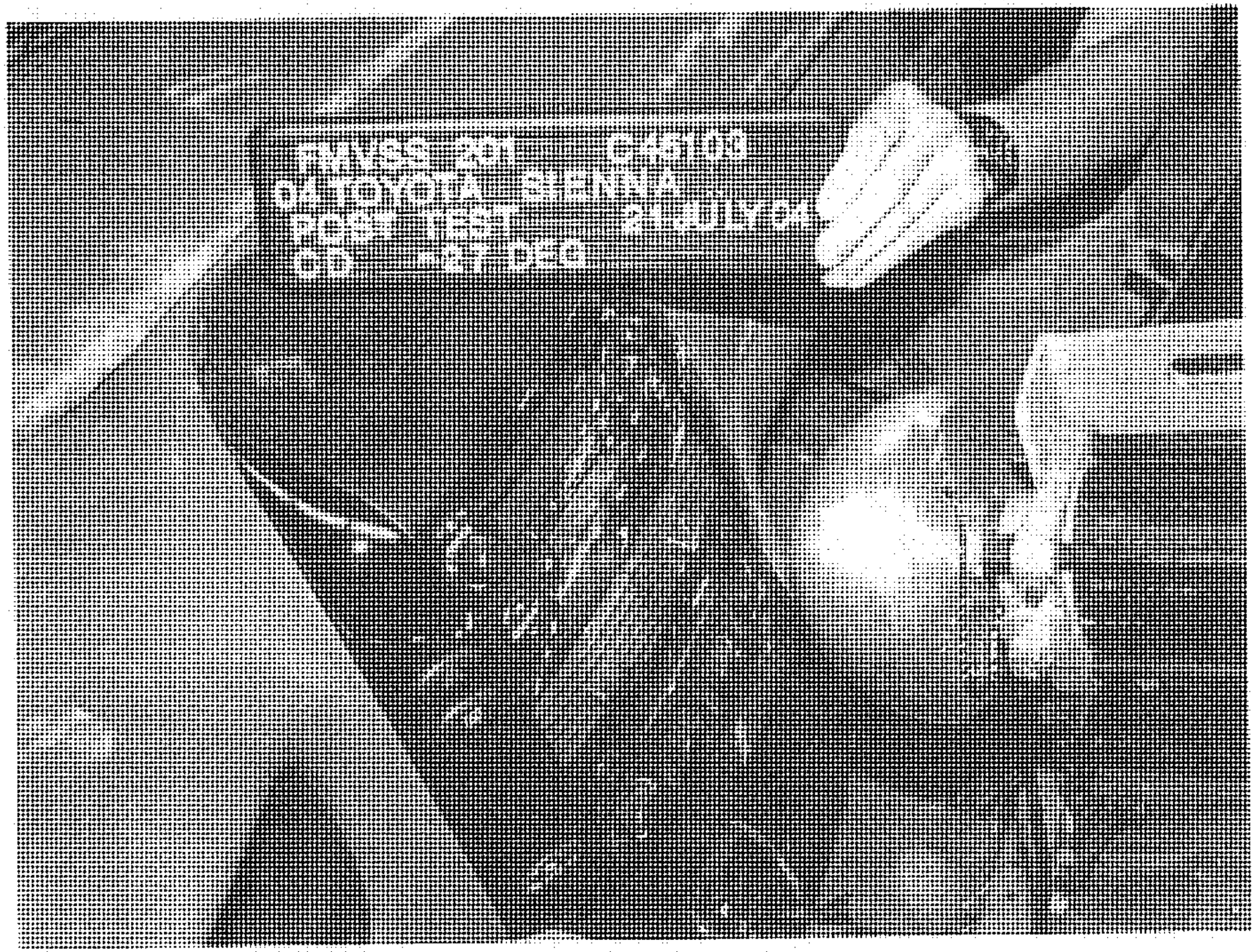


Figure A-19 : INSTRUMENT PANEL CONSOLE VENT IMPACT POST-TEST

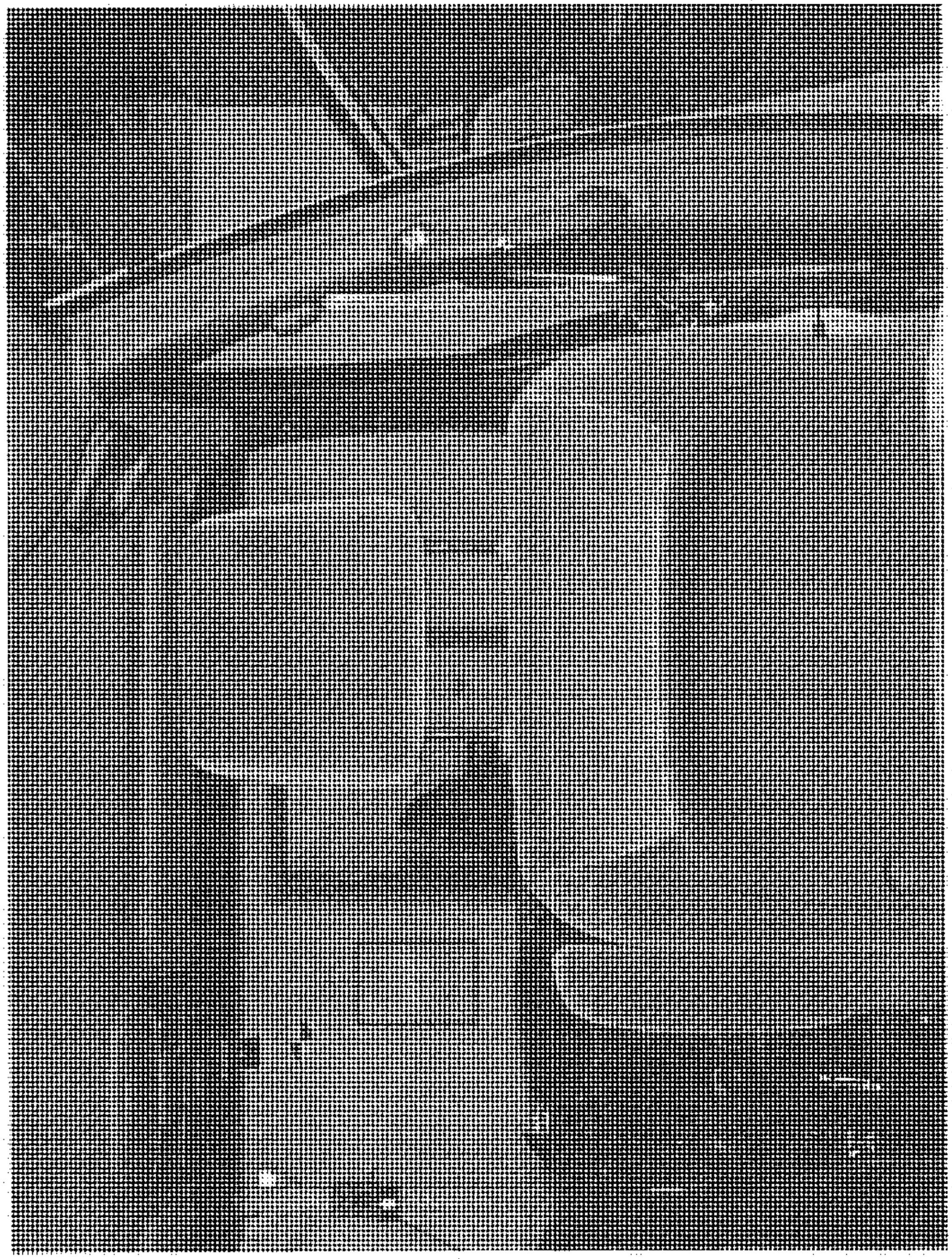


Figure A-20 : FRONT SEAT HEAD RESTRAINT

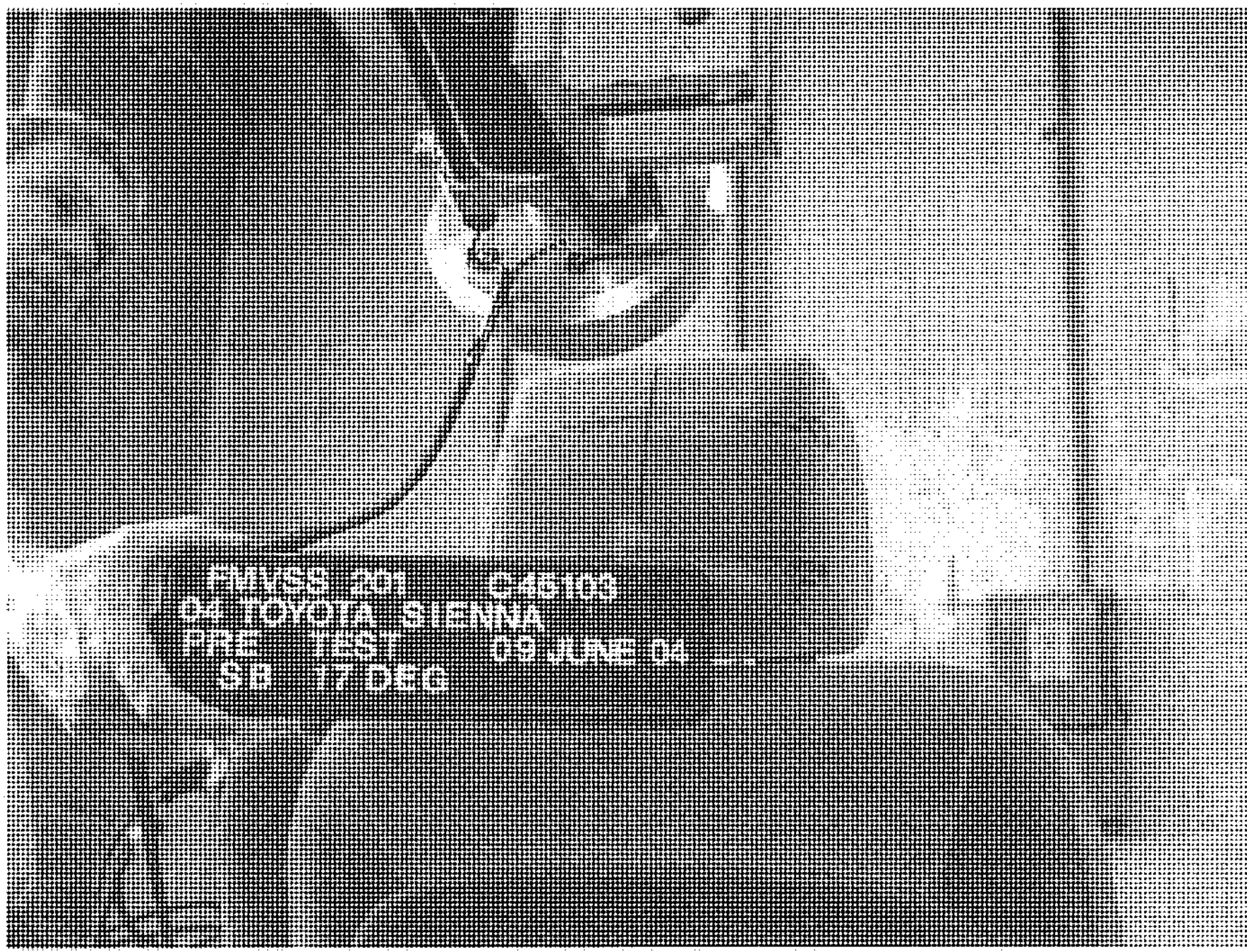


Figure A-21 : FRONT SEAT HEAD RESTRAINT IMPACT AREA PRE-TEST

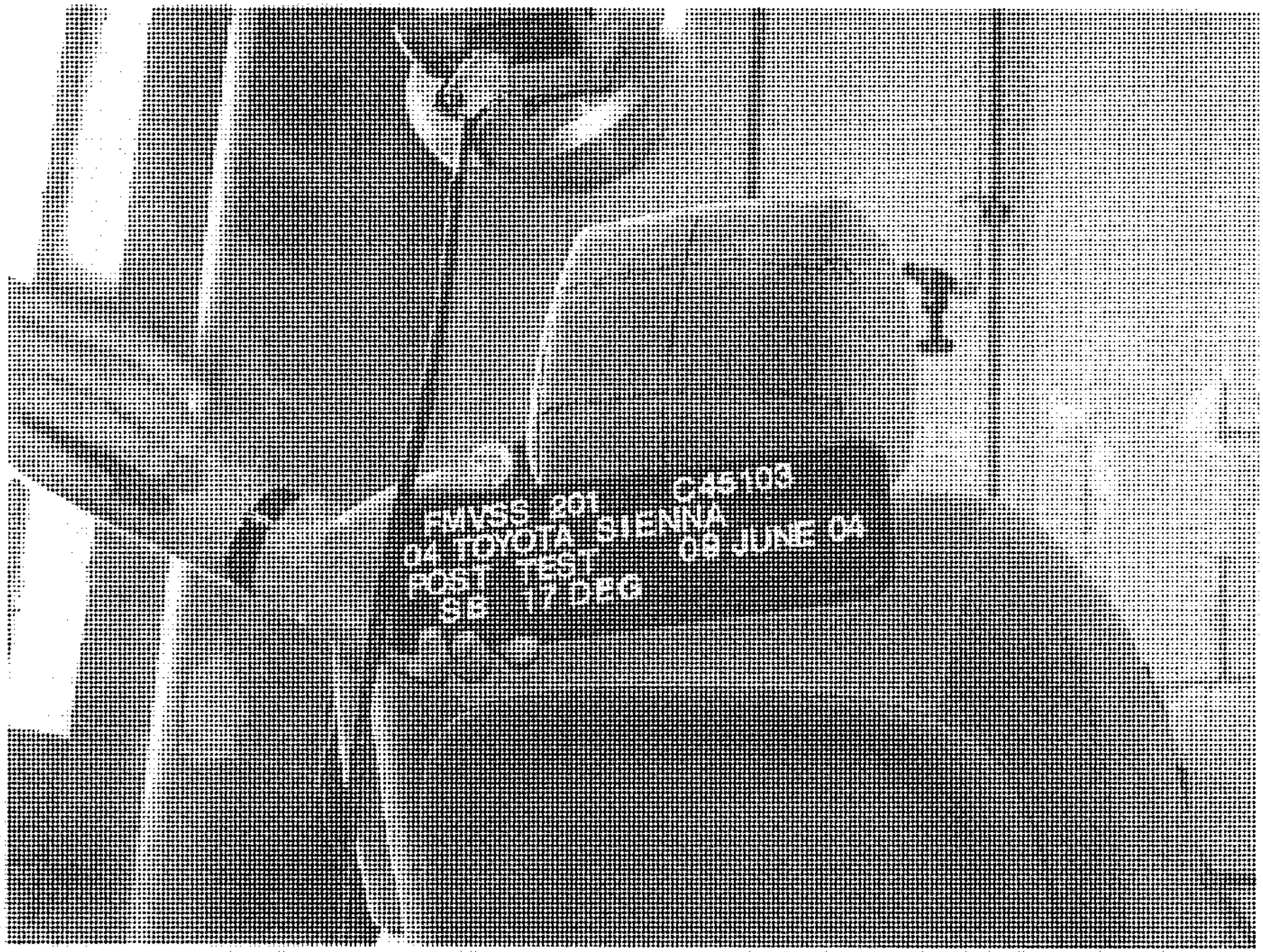


Figure A-22 : FRONT SEAT HEAD RESTRAINT IMPACT AREA POST-TEST

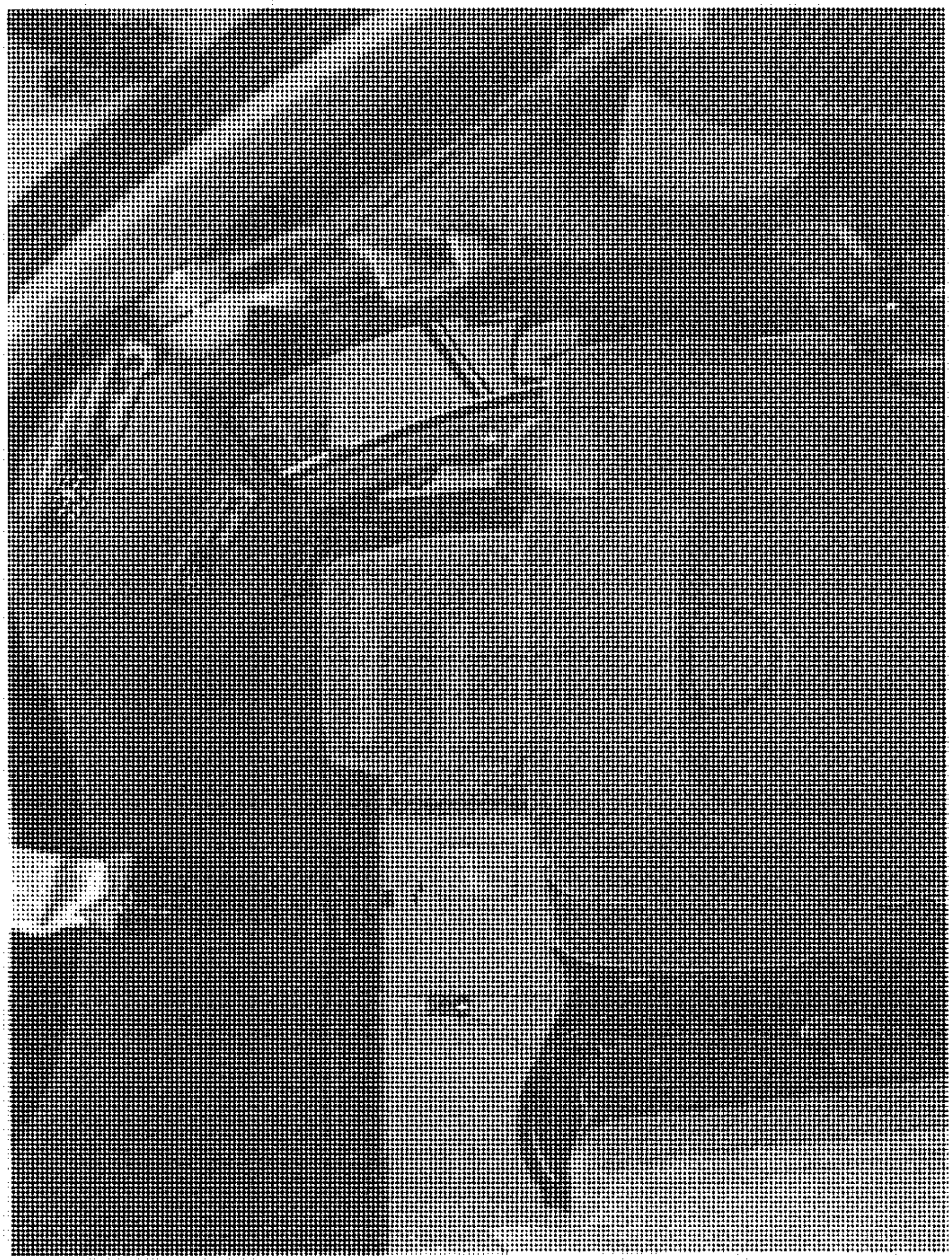


Figure A-23 : SECOND ROW SEAT HEAD RESTRAINT

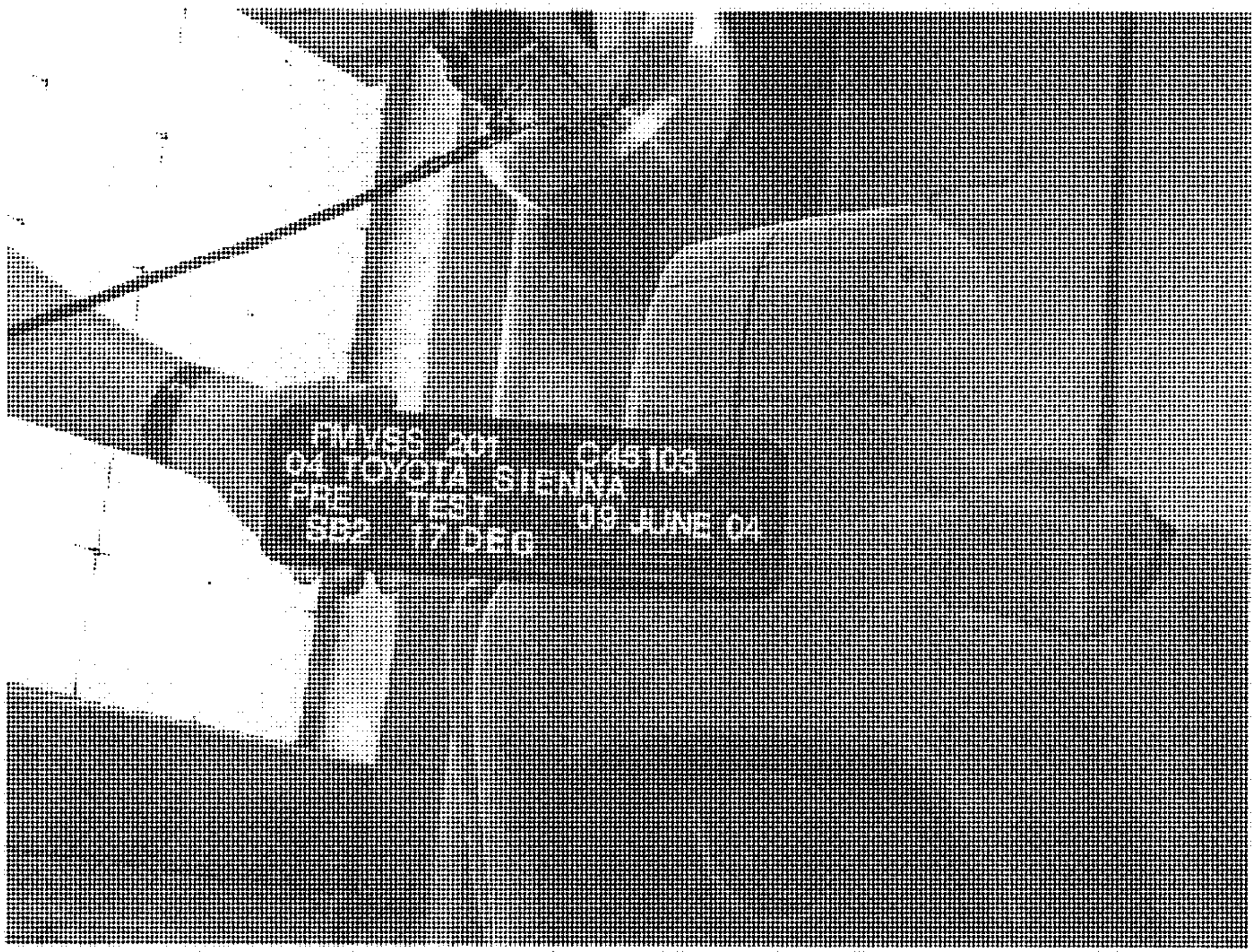


Figure A-24 : SECOND ROW SEAT HEAD RESTRAINT IMPACT AREA PRE-TEST

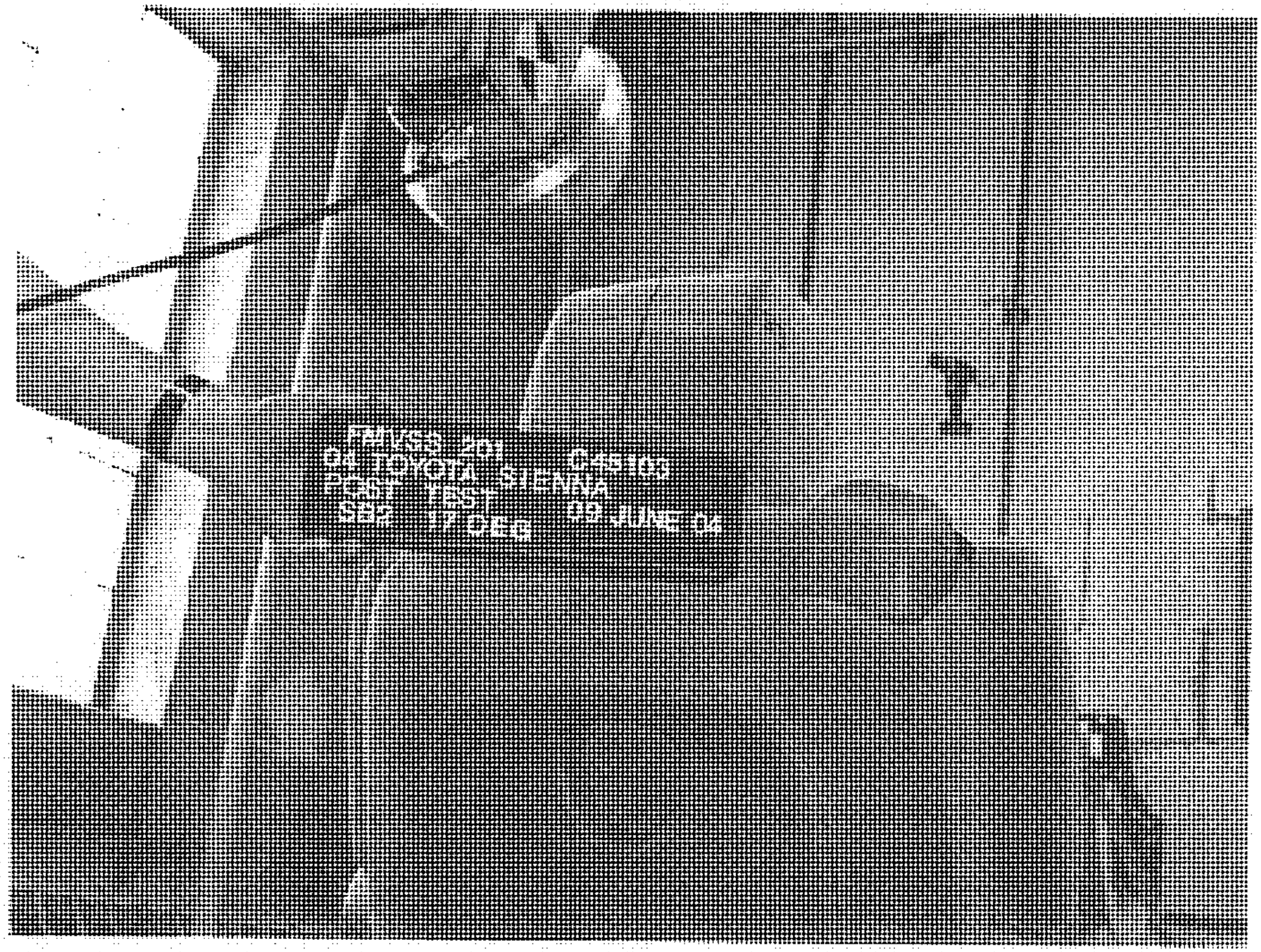


Figure A-25 : SECOND ROW SEAT HEAD RESTRAINT IMPACT AREA POST-TEST

APPENDIX B

INTERIOR COMPARTMENT DOOR CALCULATIONS

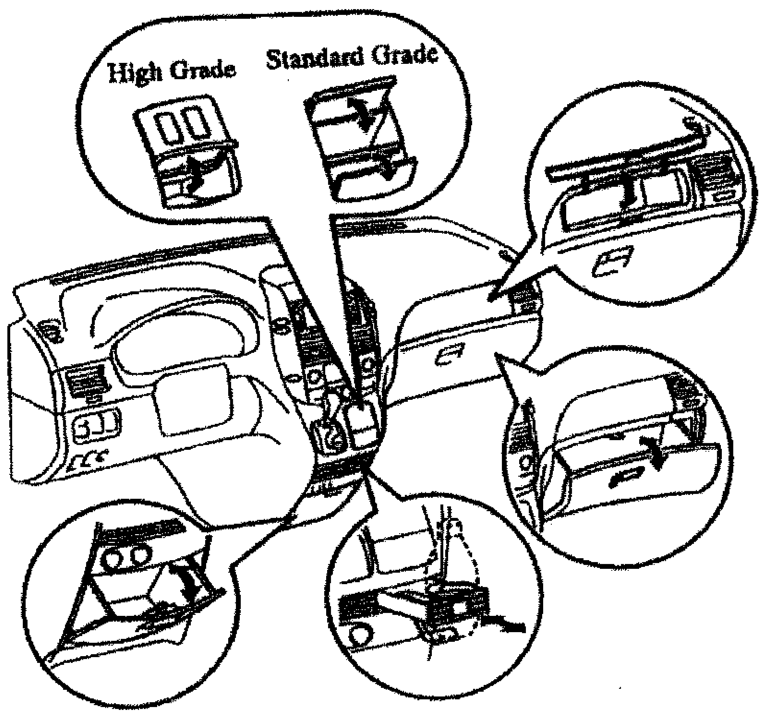
FMVSS No. 201
Latch Component Analysis Information

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

Such data shall include:

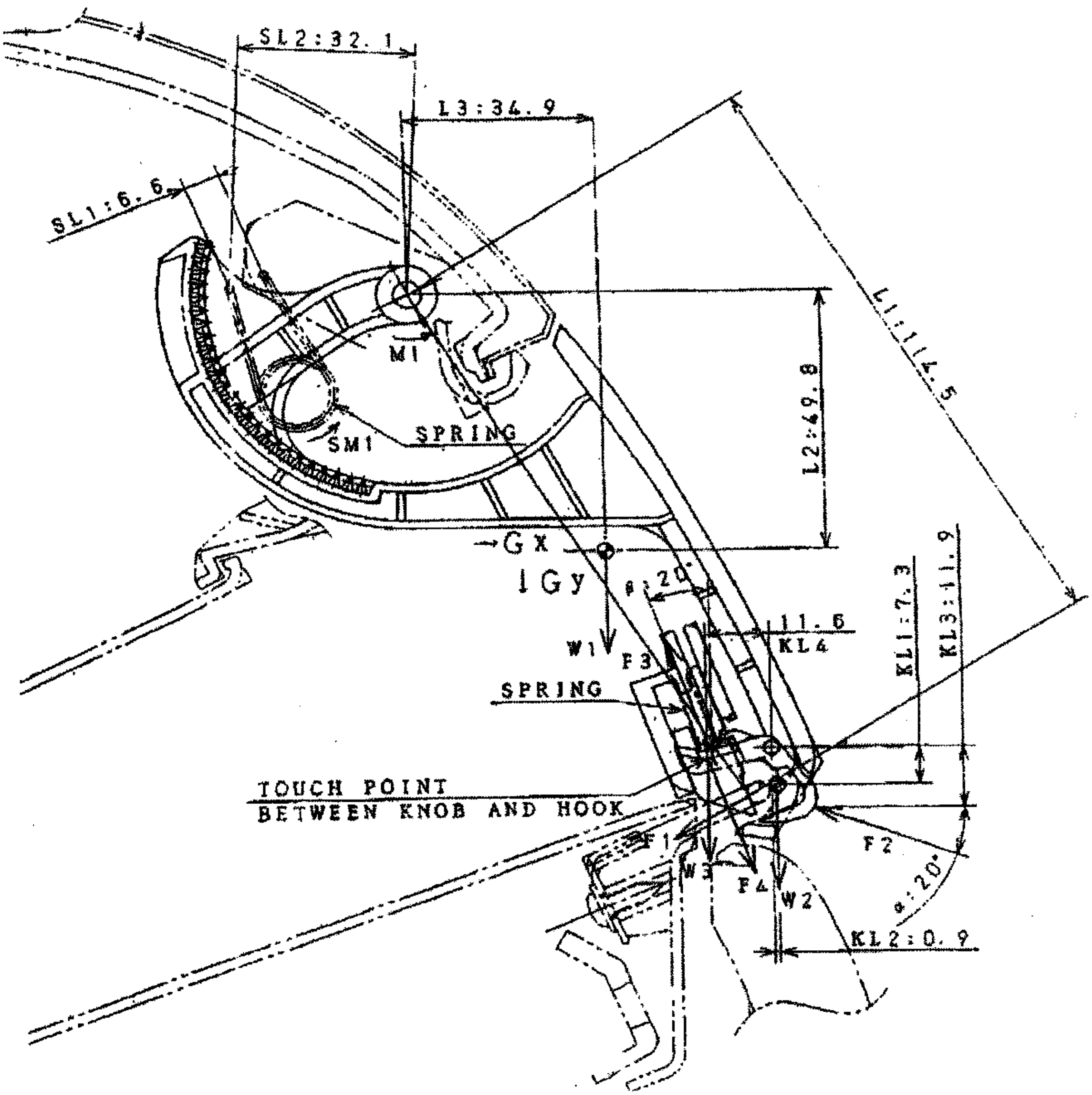
2004 model TOYOTA SIENNA

Instrument Panel Assembly



PASSENGER UPPER DOOR
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

1. Geometric details of the latch/lock configuration.



2. Mass data for each element in the linkage.

1. SM1: Max Moment of the two spring to open direction
   SM1 =0.109 Nm (Maximum Torque on drawing spec.)

2. W1: Weight of the Door assy = 2.35 N
   Mass of the Door assy = 239.5 g

3. W2: Weight of the lock knob = 0.0164 N
   Mass of the lock knob = 1.67 g

4. W3: Weight of the lock hook = 0.0231 N
   Mass of the lock hook = 2.36 g

5. Fs: Operation force to release knob = 4.12 N

6. F2: Operation force to the lock knob open = 3 N
   (Minimum force on drawing spec.)

7. Dimensions (mm)
   L1 = 114.5
   L2 = 49.8
   L3 = 34.9
   SL1 = 6.6
   SL2 = 32.1
   KL1 = 7.3
   KL2 = 0.9
   KL3 = 11.9
   KL4 = 11.6

3. Calculation results on "passenger upper door"

M1 : Moment of the Door received to open direction.
SM1:Max Moment of the two spring to open direction.
M2 : Moment of the lock knob received to open direction.
W1 : Weight of the Door assy.
W2 : Weight of the lock knob.
W3 : Weight of the lock hook.
F1 : Force of the lock hook receive.
F2 : Operation force to the lock knob open.
F3 : Force of the lock hook receive force to up.
F4 : Force of the lock hook receive force to close.
Fs : Operation force to release knob.

1)30G Rear Direction

M1 = Gx x W1 x L2 - W1 x L3 + Fs x L1
= 30 x 2.35 x 49.8/1000 - 2.35 x 34.9/1000 + 4.12 x 114.5/1000
= 3.90 (Nm)

The Lock knob & The lock hook do not receive force to open.
F1 = M1 / L1 = 3.90 / (114.5/1000) = 34.07 (N)

So, when the lock hook will not have failure by F1, the door will not open.

Physical Failure test

Test method : Pull the this door by 51.1 N force. (= F1 x 150 %) = FF1
<Test> #1: No failure, #2: No failure, #3: No failure, #4: No failure, #5: No failure

So, this parts do not have failure by 51.1N force (> F1)

FF1 > F1 (51.11 > 34.07), so the door does not open.

Result : The Door will remain closed.

2)30G Front Direction

The door assy does not receive force to open.
The lock knob receives moment to open.
M2 = Gx x W2 x KL1 + W2 x KL2
= 30 x 0.0164 x (7.3/1000) + 0.0164 x (0.9/1000)
= 0.0036 (Nm)

The lock hook receive force to up
F3 = M2 / KL4 x cos20 - W3 x cos20 + W3 x sin20 x 30G
= (0.0036/11.6/1000) x cos20 - 0.023 x cos20 + 0.0231 x sin20 x 30
= 0.545 (N)

The lock hook force to close
F4 = F2 x cos20 x KL3 / KL4 x cos20
= 3 x cos20 x (11.9/1000) / (11.6/1000) x cos20
= 2.72 (N)

Result : F3 < F4 (0.545 < 2.72) So the lock knob will not released.

3)10G Down Direction

The door assy does not receive force to open.

The lock knob receives moment to open.

M2 = Gy x W2 x KL2 + W2 x KL2.
= 10 x 0.0164 x (0.9/1000) + 0.0164 x (0.9/1000)
= 0.000165 (Nm)

The lock hook receives force to up

F3 = M2 / KL4 x cos20 - Gy x W3 x cos20 - W3 x cos20
= 0.000165 / (11.6/1000) x cos20 - 10 x 0.023 x cos20 - 0.023 x cos20
= - 0.22 (N)

The lock hook force to close (down)

F4 = F2 x cos20 x KL3 / KL4 x cos20
= 2.72 (N)

Result : F3 < F4 (- 0.22 < 2.72) So, the lock hook will not released.

4)10G Up Direction

A) To confirm failure due to force on hook

M1 = Gy x W1 x L3 - W1 x L3 + Fs x L1
= 10 x 2.35 x (34.9/1000) + 2.35 x (34.9/1000) + 4.12 x (114.5/1000)
= 1.37 (Nm)

So, when the lock hook does not have failure by F1, the door will not open.

F1 = M1 / L1
= 1.37 / (114.5/1000)
= 11.9 (N)

The lock does not open due to force because : FF1 > F1 (52 > 11.9)

B) To confirm lock failure due to force on hook

The Lock knob does not receive force to open.

F3 = Gy x W3 x cos20 - 0.0231 x cos20
= 10 x 0.0231 x cos20 - 0.0231 x cos20
= 0.198 (N)

The lock hook force to close

F4 = 2.72 (N)

F3 < F4 (0.198 < 2.72) So, the lock hook will not move to open direction (UP).

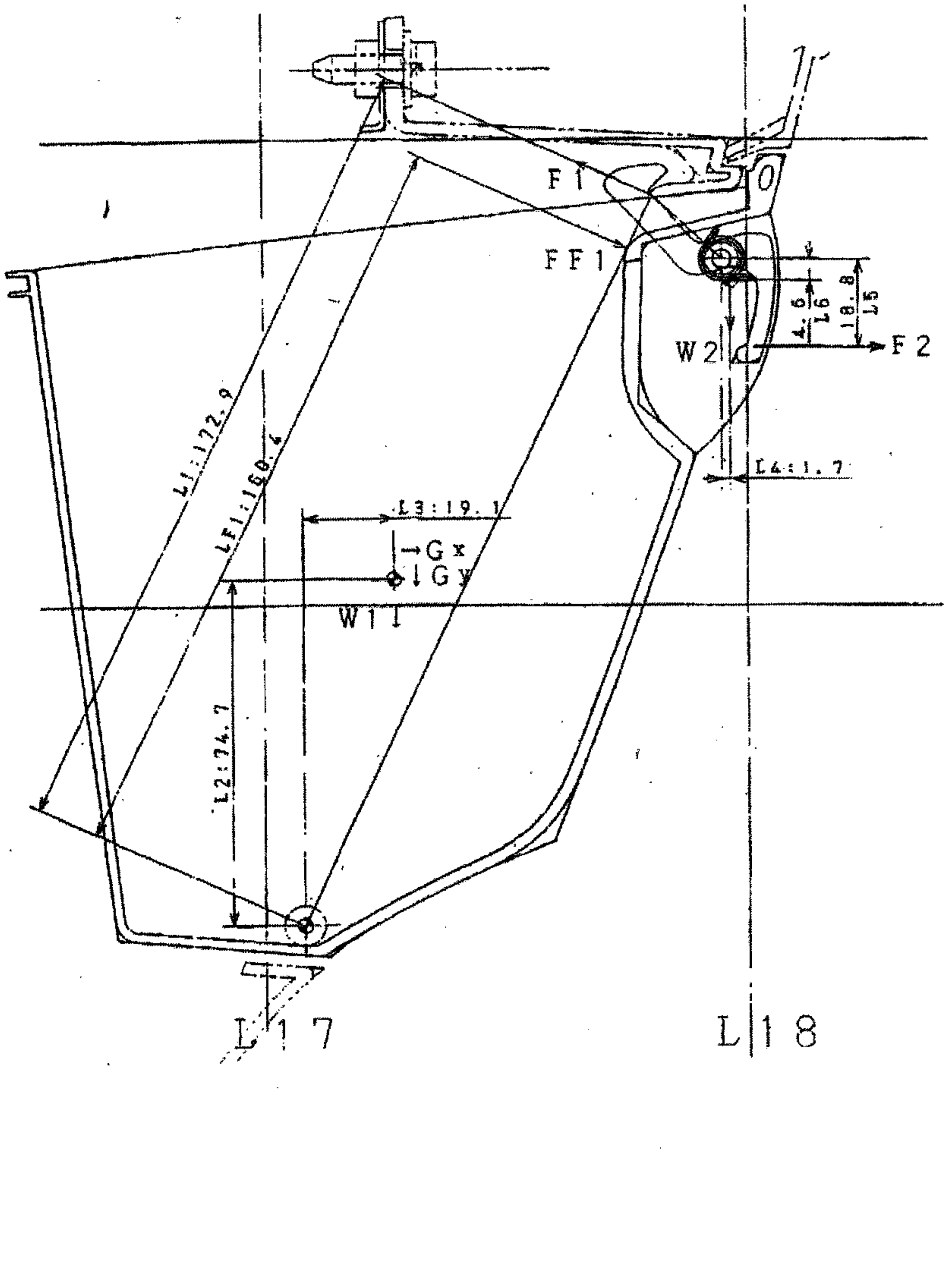
Result: The Door will remain closed.

5)Right & Left Direction

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

CENTER LOWER BOX
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

1. Geometric details of the latch/lock configuration.



2. Mass data for each element in the linkage.

1. W1 : Weight of the Box assy = 2.98 N
Mass of the Box assy = 304 g

2. W2 : Weight of the lock knob = 0.1 N
Mass of the lock knob = 10.7 g

3. F2 : Operation force to the lock knob open = 10.8 N

4. Dimension (mm)
L1 = 172.9
L2 = 74.7
L3 = 19.1
L4 = 1.7
L5 = 18.8
L6 = 4.6
LF1 = 160.4

3. Calculation results on "center lower box"

M1 : Moment of the Box received to open box.
M2 : Moment of the lock knob received to open .
M3 : Moment of the lock knob received to close knob by spring.
W1 : Weight of the Box assy.
W2 : Weight of the lock knob
F1 : Force of the lock knob received by M1.
F2 : Operation force to the lock knob open.
FF1: Push force of failure test.

1)30G Rear Direction

A) To confirm failure due to force on hook

M1 = W1 x L3 + Gx x W1 x L2
= 2.98 x 19.1/1000 + 30 x 2.98 x 74.7/1000
= 6.74 (Nm)

F1 = M1 / L1 = 6.74 / (172.9/1000)
= 39.0 (N)

Physical Failure Test
Test method : Push this box by FF1 force. (FF1 = M1 / LF1 x 150 % = 6.71 / (160.4/1000) x 1.5 = 63 (N) <Test> #1: No failure, #2: No failure, #3: No failure, #4: No failure, #5: No failure So, this box does not open (failure) due to FF1 force.

The lock does not open due to linear force because : FF1 > F1 (63 > 39.0)

B) To confirm no lock rotation

M2 = Gx x W2 x L6 - W2 x L4
= 30 x 0.1 x 4.6/1000 - 0.1 x 1.7/1000
= 0.0137 (Nm)

M3 = F2 x L5
= 10.8 x 18.8/1000
= 0.203 (Nm)

M2 < M3 (0.0137 < 0.203), The lock knob and lock hook will not rotate to open.
The Box will not open.

Result : Because of items A) and B) the box will remain closed.

2)30G Front Direction

The Box & lock knob will not receive force to open.
Result: The Box will remain closed.

3)10G Down Direction

A) To confirm failure due to force on hook

$$M1 = W1 \times L3 + Gy \times W1 \times L3$$
$$= 2.98 \times 19.1/1000 + 10 \times 2.98 \times 19.1/1000$$
$$= 0.626 \text{ (Nm)}$$

$$F1 = M1 / L1 = 0.626 / (172.9/1000)$$
$$= 3.62 \text{ (N)}$$

The lock does not open due to force because : $FF1 > F1$ $(63 > 3.62)$

B) To confirm no/lock rotation

The lock knob will not receive a force to rotate open.

Result : Because of items A) and B) the box will remain closed.

4)10G Up Direction

A) To confirm lock failure due to force on hook

The Box will not receive force to open.

B) To confirm no lock rotation

$$M2 = Gy \times W2 \times L4 - W2 \times L4$$
$$= 10 \times 0.1 \times 1.7/1000 - 0.1 \times 1.7/1000$$
$$= 0.0015 \text{ (Nm)}$$

$$M3 = F2 \times L5 = 0.203 \text{ (Nm)}$$

$M2 < M3$ $(0.0015 < 0.203)$, The lock knob and lock hook will not rotate to open.
The Box will not open.

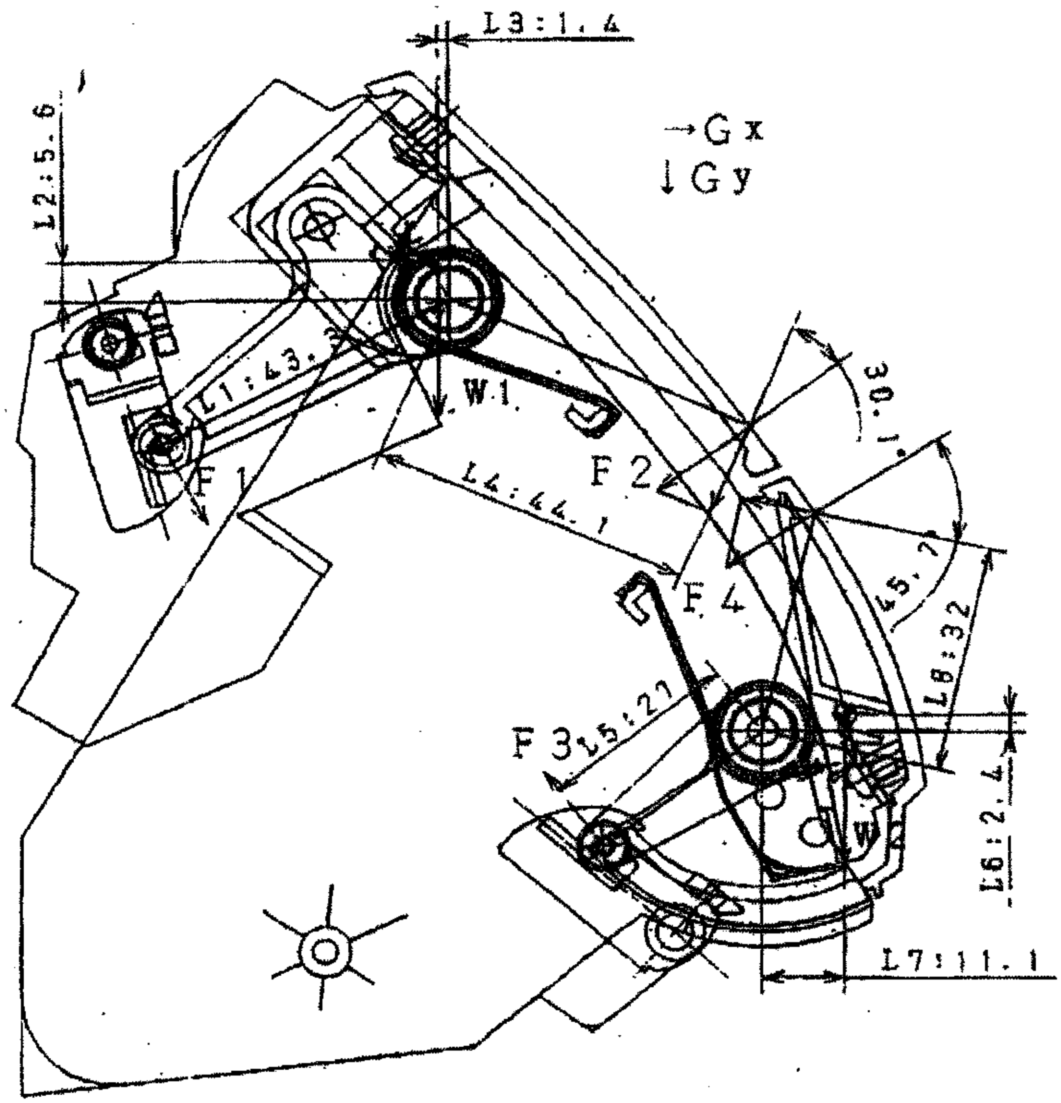
Result : Because of items A) and B) the box will remain closed.

5)Right & Left Direction

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

CENTER STORAGE BOX (STD)
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

1. Geometric details of the latch/lock configuration.



2. Mass data for each element in the linkage.

1. W1: Weight of the upper Door assy = 0.833 N
   Mass of the upper Door assy = 85.1 g

2. W2 : Weight of the lower Door assy = 0.51 N
   Mass of the lower Door assy = 52.2 g

3. F2 : Operation force of the upper door push open
   F2 = 4 N (Minimum force on drawing spec.)

4. F4 : Operation force of the lower door push open
   F4 = 4 N (Minimum force on drawing spec.)

5. Dimension (mm)
   L1 = 43.3
   L2 = 5.6
   L3 = 1.4
   L4 = 44.1
   L5 = 27
   L6 = 2.4
   L7 = 11.1
   L8 = 32

3. Calculation results on "center storage box (STD)"

M1 : Moment of the upper Door received to open direction.
Mc1: Moment of the upper Door having to close.
M2 : Moment of the lower Door received to open direction.
Mc2 : Moment of the lower Door having to close.
W1 : Weight of the upper Door assy.
W2 : Weight of the lower Door assy.
F1 : Force of the upper door lock hook receive
F2 : Operation force of the upper door push open
F3 : Force of the lower door lock hook receive
F4 : Operation force of the lower door push open

UPPER DOOR
1)30G Rear Direction

Door Open moment
M1 = Gx x W1 x L2 - W1 x L3
= 30 x 0.833 x 5.6/1000 - 0.833 x 1.4/1000
= 0.139 (Nm)
Door Close moment
(Force of close is as same as the operation force to open.)
Mc1 = F2 x cos30.1 x L4 = 4 x cos30.1 x 44.1/1000
= 0.153 (Nm)

Result : M1 < Mc1 (0.139 < 0.153). So the upper door will remain closed.

)G Front Direction
The upper Door is not received force to open direction.
So, when the door does not have failure by F1, the door will not open.

Mc1 = Gx x W1 x L2 + W1 x L3 + F2 X cos30 x L4
= 30 x 0.833 x 5.6/1000 + 0.833 x (1.4/1000) + 4 x cos30 x (44.1/1000)
= 0.293 (Nm)

F1 = Mc1 / L1 =0.293 / (43.3/1000) = 6.77 (N)

Physical Failure test
Test method : Pull the this door by 10.0 N force. (=F1 x 150 %) = FF3 (Pull force direction & point is as same as F1) <Test> #1: No failure, #2: No failure, #3: No failure, #4: No failure, #5: No failure
So, this parts do not have failure by 10.0 N force (> F1)

FF3 > F1 (10 > 6.77), so the door does not open.

Result : The Door will remain closed.

3)10G Down Direction

The upper Door is not received force to open direction.
So, when the door does not have failure by F1, the door will not open.

$Mc1 = Gy \times W1 \times L3 + W1 \times L3 + F2 \times \cos30 \times L4.$
$= 10 \times 0.833 \times 1.4/1000 + 0.833 \times 1.4/1000 + 4 \times \cos30 \times (44.1/1000)$
$= 0.166$ (Nm)

$F1 = Mc1 / L1 = 0.166 / (43.3/1000)$
$= 3.83$ (N)

FF3 > FF1 (10.0 > 3.83) so, the door does not open.

Result : The box will remain closed.

4)10G Up Direction

Door Open moment
$M1 = Gy \times W1 \times L3 - W1 \times L3$
$= 10 \times 0.833 \times 1.4/1000 - 0.833 \times (1.4/1000)$
$= 0.0105$ (Nm)

Door Close moment
(Force of close is as same as the operation force to open.)
$Mc1 = F2 \times \cos30.1 \times L4 = 4 \times \cos30.1 \times (44.1/1000)$
$= 0.153$ (Nm)
Result : M1 < Mc1 (0.0105 < 0.153) So,the upper door will remain closed.

ight & Left Direction

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

LOWER DOOR

1)30G Rear Direction

The lower Door does not receive force to open direction.
So, when the door does not have failure by F3, the door will not open.

$Mc2 = Gx \times W2 \times L6 + W2 \times L7 + F4 \times \cos45.7 \times L8$
$= 30 \times 0.51 \times 2.4/1000 + 0.51 \times 11.1/1000 + 4 \times \cos45.7 \times 32/1000$
$= 0.132$ (Nm)

$F3 = Mc2 / L5 = 0.132 / (27/1000)$
$= 4.89$ (N)

Physical Failure test

Test method : Pull the this door by 7.3 N force.(= F3 x 150 %) = FFL
(Pull force direction & point is as same as F3.)
<Test> #1: No failure, #2: No failure, #3: No failure, #4: No failure, #5: No failure

So, this parts do not have failure by 7.3 N force (> F3)

FFL > F3 (7.3 > 4.89), so the door does not open.

Result : The Door will not open by 30G rear direction.

2)30G Front Direction

Door Open moment

M2 = Gx x W2 x L6 - W2 x L7

= 30 x 0.51 x 2.4/1000 - 0.51 x (11.1/1000)

= 0.031 (Nm)

Door Close moment

(Force of close is as same as the operation force to open.)

Mc2 = F4 x cos45.7 x L8

= 4 x cos45.7 x 32/1000

= 0.0894 (Nm)

Result : M2 < Mc2 (0.031 < 0.0894) So, the lower door will remain closed.

3)10G Down Direction

The lower Door do not receive force to open direction.

So, the lower door will not open.

Mc2 = Gy x W2 x L7 + W2 x L7 + +F4 x cos45.7 x L8

= 10 x 0.51 x 11.1/1000 + 0.51 x 11.1/1000 + 4 x cos45.7 x 32/1000

= 0.152 (Nm)

F3 = Mc2 / L5 = 0.152 / (27/1000) = 5.62 (N)

Physical Failure test
Test method : Pull the this door by 8.43 N force. (= F3 x 150 %) = FFA (Pull force direction & point is as same as F3.) <Test> #1: No failure, #2: No failure, #3: No failure, #4: No failure, #5: No failure So, this parts do not have failure by 8.43 N force (> F3)

FFA > F3 (8.43 > 5.62), so the door does not open.

Result : The Door will remain closed.

4)10G Up Direction

Door Open moment

M2 = Gy x W2 x L7 - W2 x L7

= 10 x 0.51 x 11.1/1000 - 0.51 x 11.1/1000

= 0.051 (Nm)

Door Close moment

(Force of close is as same as the operation force to open.)

Mc2 = F4 x cos45.7 x L8 = 4 x cos45.7 x 32/1000

= 0.0894 (Nm)

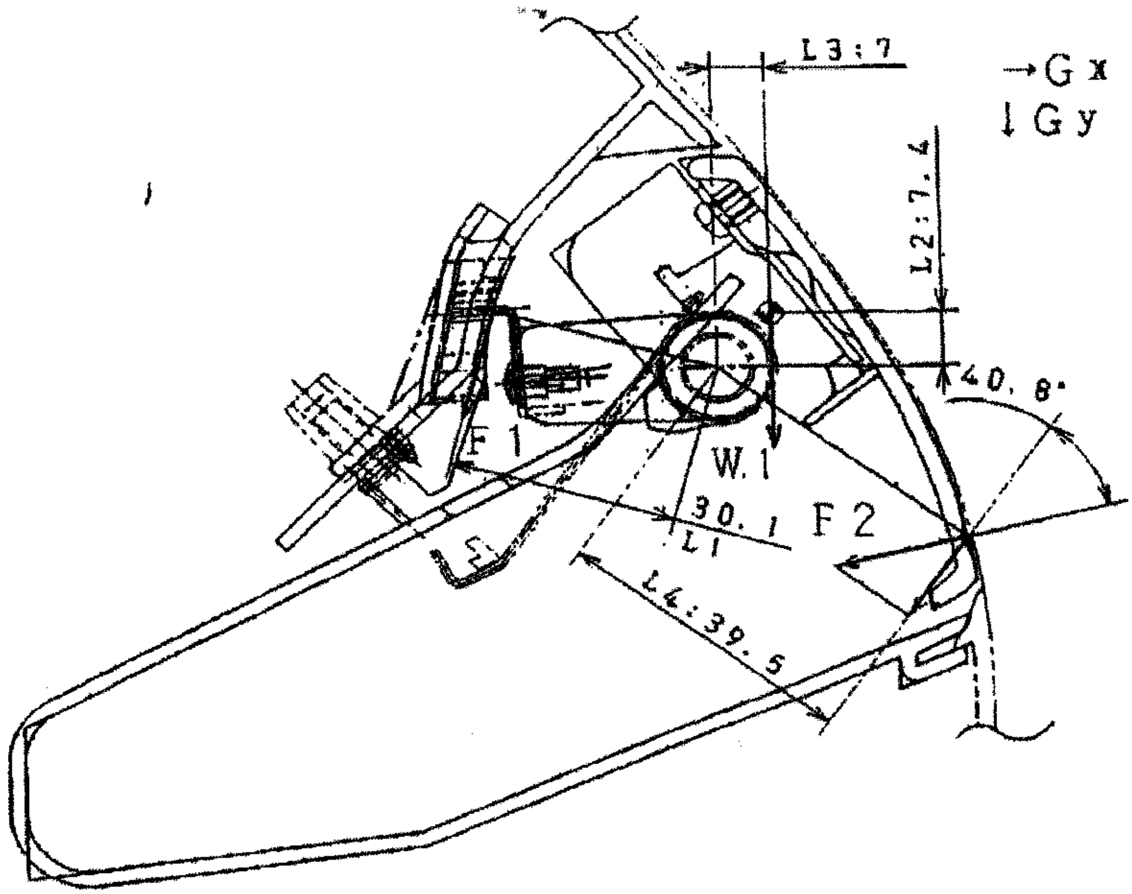
Result : M2 < Mc2 (0.051 < 0.0894) The lower door will remain closed.

'Right & Left Direction

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

CENTER STORAGE BOX (HIGH GRADE)
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

1. Geometric details of the latch/lock configuration.



. Mass data for each element in the linkage.

1. W1: Weight of the Door assy = 0.52 N
   Mass of the Door assy = 53.06 g

2. F2 : Operation force of the door push open = 4 N

3. Dimension (mm)
   L1 = 30.1
   L2 = 7.4
   L3 = 7.0
   L4 = 39.5

Calculation results on "center storage box (High grade)"

M1 : Moment of the Door received to open door.
Mc1: Moment of the Door having to close door.
W1 : Weight of the Door assy.
F1 : Force of the door lock hook receive
F2 : Operation force of the door push open.

1)30G Rear Direction

A) To confirm moment

Door Open moment
M1 = Gx x W1 x L2 + W1 x L3
= 30 x 0.52 x 7.4/1000 + 0.52 x 7.0/1000
= 0.119 (Nm)
Door Close moment
(Force to close is same as the operation force to open.)
Mc1 = F2 x cos40.8 x L4 = 4 x cos40.8 x 39.5/1000
= 0.120 (Nm)

M1 < Mc1 (0.119 < 0.120). So, the door will not open.

<u>Result: The door will remain closed.</u>

2)30G Front Direction
The Door will not receive force to open.
So, the door does not have failure by F1, the door will not open.

Mc1 = Gx x W1 x L2 - W1 x L3 + F2 x cos40.8 x L4
= 30 x 0.52 x 7.4/1000 + 0.52 x 7.0/1000 + 4 x cos40.8 x 39.5/1000
= 0.24 (Nm)
F1 = Mc1 / L1
= 0.24 / (30.1/1000)
= 7.97 (N)

Physical Failure test
Test method : Pull the this door by 11.0 N force. (= F1 x 150 %) = Fp (Pull force direction & point is as same as F1.) <Test> #1: No failure, #2: No failure, #3: No failure, #4: No failure, #5: No failure So, this door does not have failure at 11.0N force (> F1)

The door does not open due to force: Fp > F1 (11.0 > 7.97)

<u>Result : The Door will remain closed.</u>

3)10G Down Direction

The Door does not receive force in open direction.
So, the door will not have failure by F1, the door will not open.

$$Mc1 = Gy \times W1 \times L3 - W1 \times L3 + F2 \times \cos 40.8 \times L4$$
$$= 10 \times 0.52 \times 7/1000 - 0.52 \times 7/1000 + 4 \times \cos 40.8 \times 39.5/1000$$
$$= 0.15 \text{ (Nm)}$$

$$F1 = Mc1 / L1$$
$$= 0.15 / (30.1/1000)$$
$$= 4.98 \text{ (N)}$$

The door does not open due to force: $Fp > F1$ $(11.0 > 4.98)$

<u>Result: The door will remain closed.</u>

4)10G Up Direction

A) To confirm moment

Door Open moment

$$M1 = Gy \times W1 \times L3 + W1 \times L3$$
$$= 10 \times 0.52 \times 7/1000 + 0.52 \times 7.0/1000$$
$$= 0.04 \text{ (Nm)}$$

Door Close moment
(Force of close is as same as the operation force to open.)
$$Mc1 = F2 \times \cos 40.8 \times L4 = 4 \times \cos 40.8 \times 39.5/1000$$
$$= 0.120 \text{ (Nm)}$$

$M1 < Mc1$ $(0.04 < 0.120)$ So, the door will not move to open.

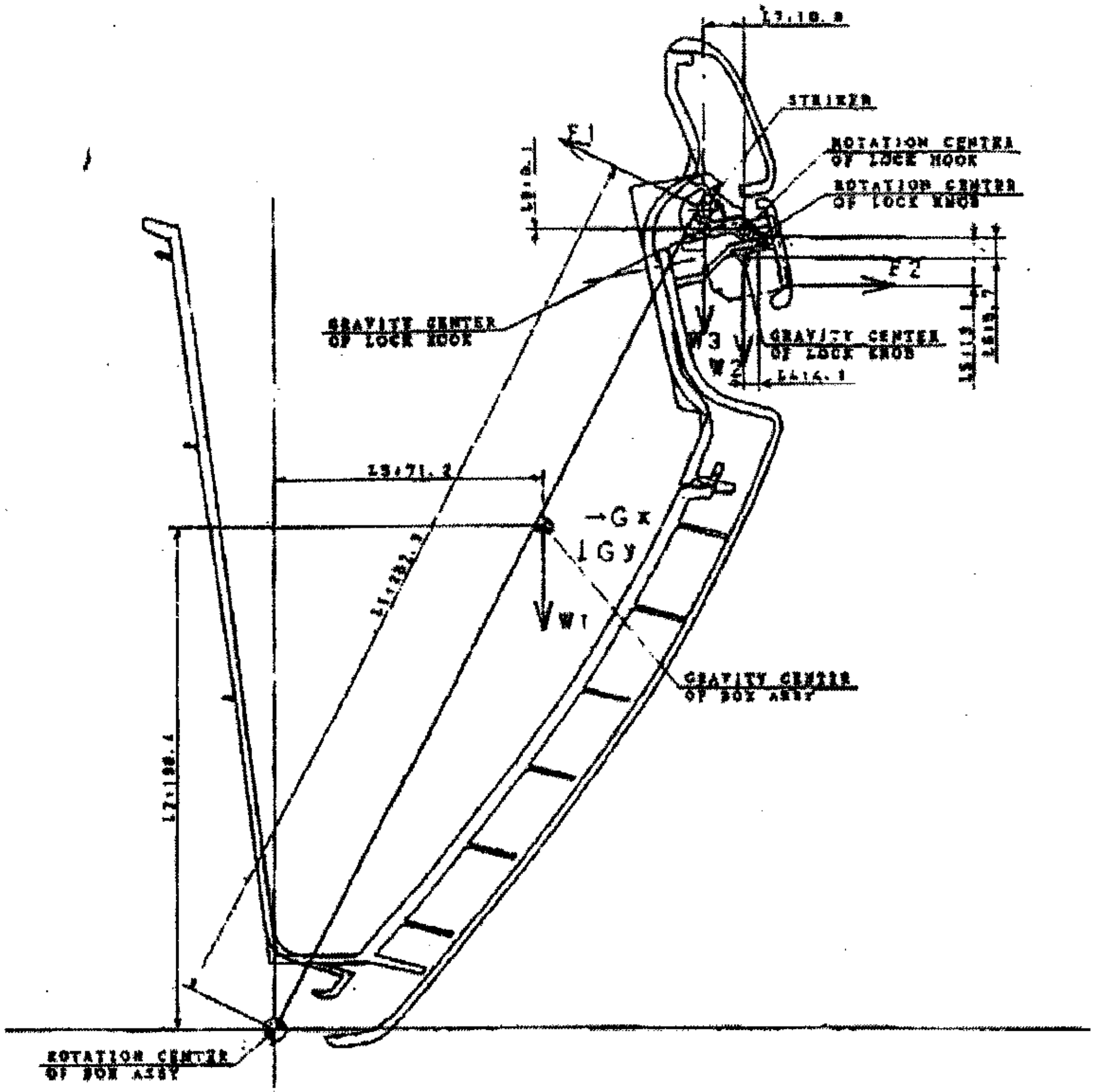
<u>Result: The door will remain closed.</u>

5)Right & Left Direction

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

GLOVE BOX
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

Geometric details of the latch/lock configuration.



2. Mass data for each element in the linkage.

1. W1 : Weight of the Box assy = 15 N
   Mass of the Box assy = 1534 g

2. W2 : Weight of the lock knob = 0.38 N
   Mass of the lock knob = 39.2 g

3. W3 : Weight of the lock hook = 0.03 N
   Mass of the lock hook = 3.0 g

4. F2 : Operation force to the lock knob open = 22 N

6. Dimension (mm)
   L1 = 252.3
   L2 = 138.4
   L3 = 71.2
   L4 = 4.1
   L5 = 13.1
   L6 = 5.7
   L7 = 10.8
   L8 = 0.1

3. Calculation results on "glove box"

M1 : Moment of the Box received to open direction
M2 : Moment of the lock knob received to open dir
M3 : Moment of the lock hook received to open direction.
M4 : Moment of the lock knob having to close direction by spring force.
W1 : Weight of the Box assy.
W2 : Weight of the lock knob.
W3 : Weight of the lock hook.
F1 : Force of the lock knob received by M1
F2 : Operation force to the lock knob open.

1)30G Rear Direction

A) To confirm failure due to force on hook

$M1 = W1 \times L3 + Gx \times W1 \times L2$
$= 15.0 \times 71.2/1000 + 30 \times 15.0 \times 138.4/1000$
$= 63.4$ (Nm)

$F1 = M1 / L1 = 63.4 / (252.3/1000) = 251.3$ (N)

Physical Failure test
Test method : Pull the this door by 377 N force. (= F1 x 150 %) = FL (Pull force direction & point is as same F1.) <Test> #1:No failure, #2:No failure, #3:No failure, #4:No failure,#5:No failure So, this box does not open (failure) due to FL force.

The lock does not open due to force because : FL > F1 (377 > 251.3)

B) To confirm no lock rotation

$M2 = Gx \times W2 \times L6 + W2 \times L4$
$= 30 \times 0.38 \times 5.7/1000 + 38.5 \times 4.1/1000$
$= 0.067$ (Nm)

$M3 = Gx \times W3 \times L8 + W3 \times L7$
$= 30 \times 0.03 \times 0.1/1000 + 0.03 \times 10.8/1000$
$= 0.0042$ (Nm)

$M2 + M3 = 0.0712$ (Nm)

$M4 = F2 \times L5 = 22 \times 13.1/1000$
$= 0.29$ (Nm)

$M2 + M3 < M4$ $(0.0712 < 0.29)$, So, the lock knob and lock hook will not rotate to open.

The Box will not open.

Result : Because of items A) and B) the box will remain closed.

2)30G Front Direction

The Box, lock knob and lock hook do not receive force to open direction.
So, the Box will not open.

3)10G Down Direction

A) To confirm failure due to force on hook

$$\begin{aligned} M1 &= W1 \times L3 + Gy \times W1 \times L3 \\ &= 15.0 \times 71.2/1000 + 10 \times 15.0 \times 71.2/1000 \\ &= 11.75\ (Nm) \end{aligned}$$

$$F1 = M1 / L1 = 11.75 / (252.3/1000) = 46.6\ (N)$$

The lock does not open due to linear force because : $FL > F1$ $(377 > 46.6)$

B) To confirm no lock rotation

$$\begin{aligned} M2 &= Gy \times W2 \times L4 + W2 \times L4 \\ &= 10 \times 0.38 \times 4.1/1000 + 0.38 \times 4.1/1000 \\ &= 0.018\ (Nm) \end{aligned}$$

$$\begin{aligned} M3 &= Gy \times W3 \times L7 + W3 \times L7 \\ &= 10 \times 0.03 \times 10.8/1000 + 0.03 \times 10.8/1000 \\ &= 0.00356\ (Nm) \end{aligned}$$

$$M2 + M3 = 0.022\ (Nm)$$

$$\begin{aligned} M4 &= F2 \times L5 = 22 \times 13.1/1000 \\ &= 0.29\ (Nm) \end{aligned}$$

$M2 + M3 < M4$, $(0.022 < 0.29)$ So, the lock knob and lock hook will not rotate to open.
The Box will not open.

<u>Result : the Box will remain closed.</u>

4)10G Up Direction

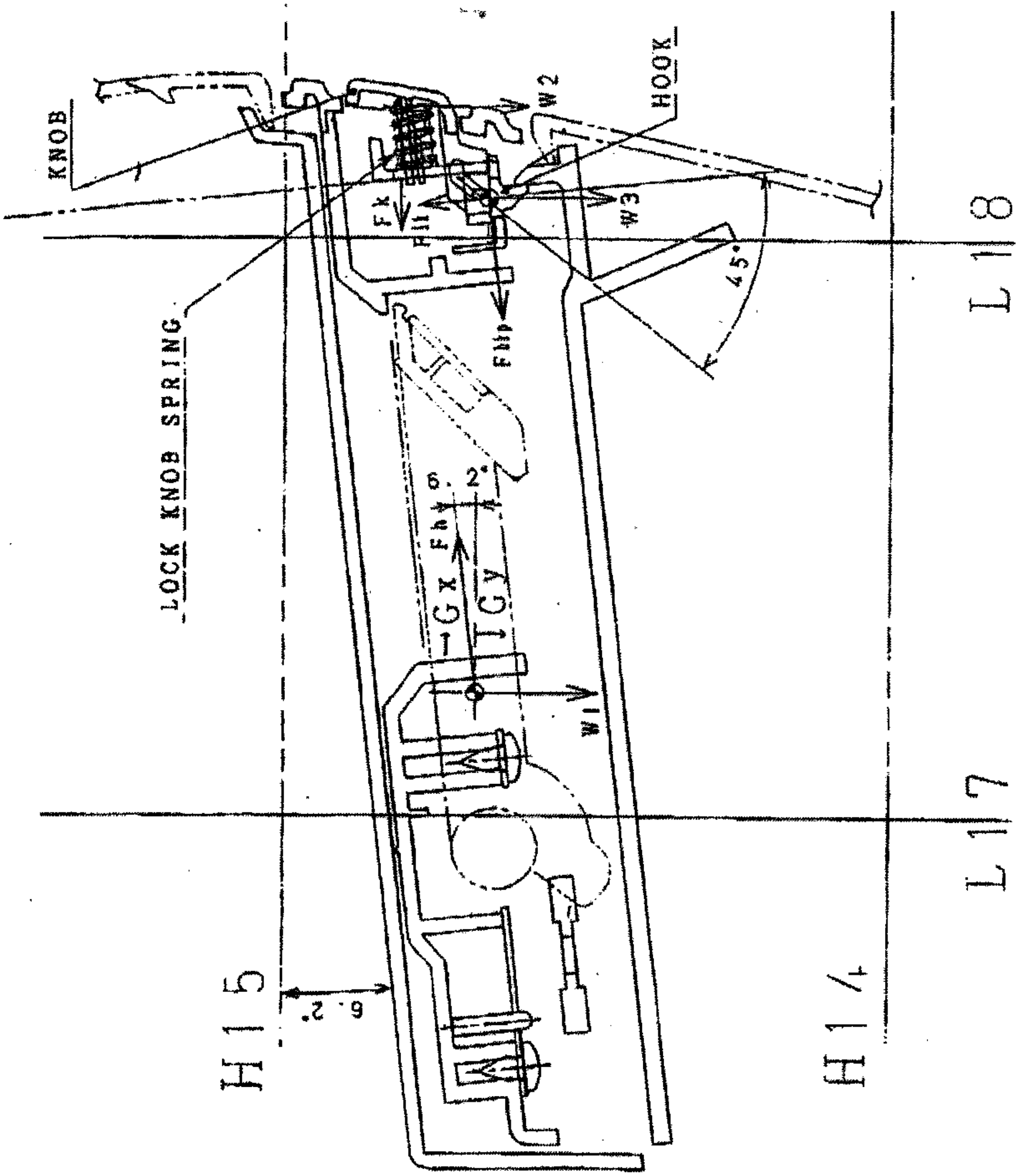
The Box, the lock knob and lock hook are not received force to open direction.
So, the Box will not open.

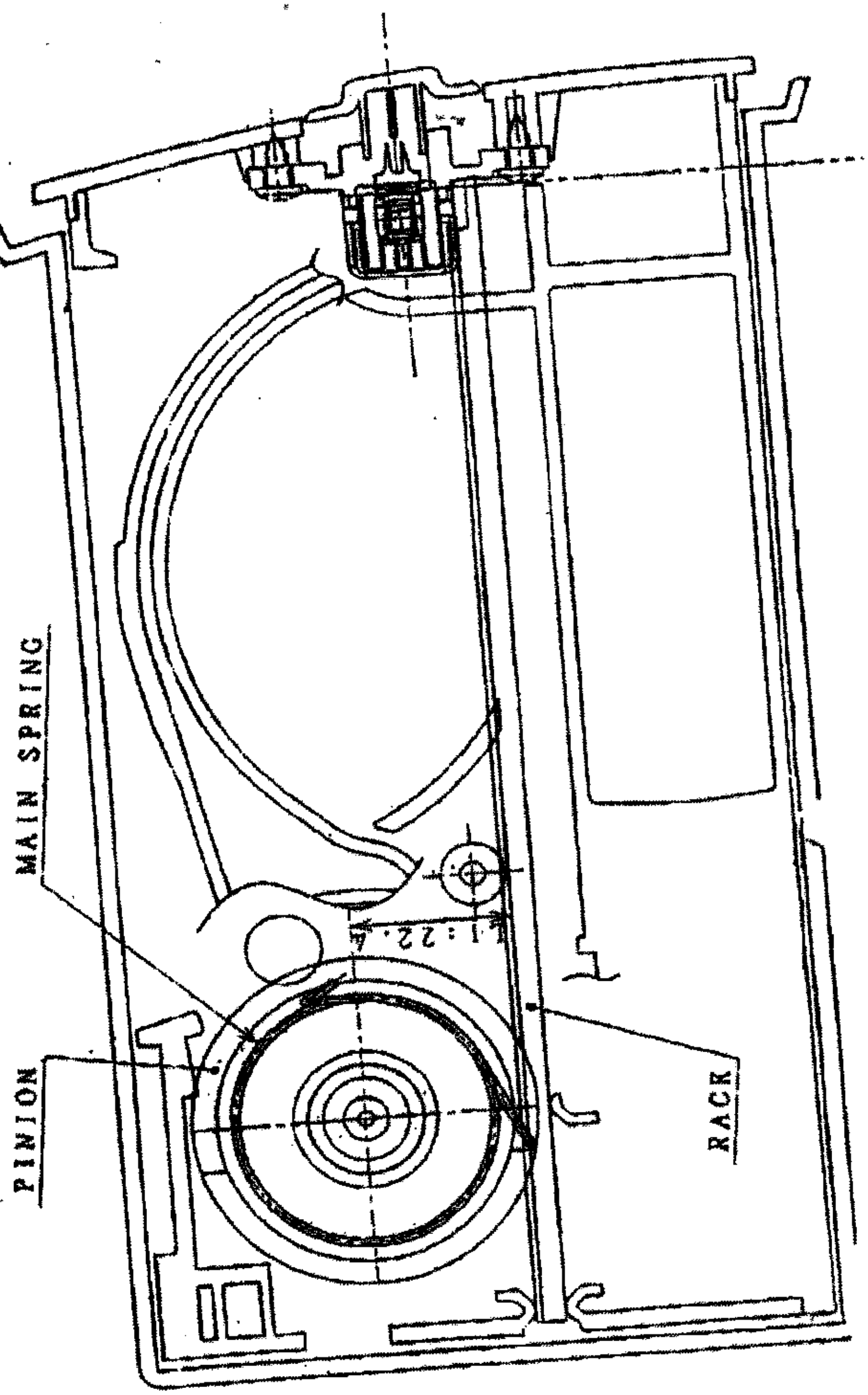
5)Right & Left Direction

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

CUP & COIN HOLDER
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

Geometric details of the latch/lock configuration.




MAIN SPRING
PINION
RACK
1:22.4

2. Mass data for each element in the linkage.

1. W1 : Weight of the cup&coin holder = 2.72 N
   Mass of the cup & coin holder = 277 g

2. W2 : Weight of the push knob = 0.0166 N
   Mass of the push knob = 1.698 g

3. W3 : Weight of the lock hook = 0.00344 N
   Mass of the lock hook = 0.351 g

4. Tms : Max Torque of main spring
   Tms = 0.213 Nm (Maximum Torque on drawing spec.)

5. Fls : Force of lock knob spring
   Fls = 3 N (Minimum operation force on drawing spec.)

6. Dimension (mm)

   L1 = 22.4

3. Calculation results on "cup and coin box"

Fh : Force of cup&coin holder open
Fk : Force of push knob movement (Release holder)
Fhk : Force of lock hook movement.
Fhkp : Force of pulling the lock knob to push position
W1 : Weight of the cup&coin holder
W2 : Weight of the push knob
W3 : Weight of the lock hook
L1 : Length between the main spring center and rack

Tms : Max Torque of main spring
Fls : Force of lock knob spring

1)30G Rear Direction

A) Compare the force to open cup holder to force at 30G

The force to open cup&coin holder (not effect by lock hook).
Fh = Tms / L1 + 30 x W1 x cos6.2 - W1 x sin6.2
= 0.213/0.0224 + 30 x 2.72 x cos 6.2 - 2.72 x sin6.2
= 90.0 (N)

Physical Failure test
Test method : Pull this cup&coin holder, and measure the force at failure. <Test > #1: 119N, #2: 112N, #3: 120N, #4: 115N, #5: 112N x = 115.6 (NF) x = 115.6 (g) σ =4.0(g) x-3 = 103.6 (N) Result: The cup holder will have failure (<u>the lock hook move to open position</u>) over 103.6N.

Fh < Ff (90.0 < 103.6), So the cup holder (the lock hook will not move to open position) will not open.

<u>Result: So, the cup&coin holder will remain closed.</u>

2)30G Front Direction

For the cup&coin holder, this direction is close direction.
Force to push the lock knob to push :
Fk = 30 x W2 x cos6.2+ W2 x sin6.2
= 30 x 0.0166 x cos6.2 + 0.0166 x sin6.2
= 0.497 (N)

Force of lock knob spring : Fls = 3 (N)

Force of lock hook to move up:
Fhk = W3 x 30G x sin6.2+ W3 x cos6.2
= 0.0034 x 30 x 0.108 - 0.0034 x 0.99
= 0.00768 (N)

Force to pull the knob to push position
Fhkp = cos45 x cos45 x Fhk
= cos45 x cos45 x 0.00768
= 0.0038 (N)

Fls > Fk + Fhkp (3 > 0.500), so the lock hook does mot move

Fk < Fls (0.497 < 3.0), so the lock knob will not open by 30G front direction.

<u>Result: The cup&coin holder will remain closed.</u>

3)10G Down Direction

For the cup&coin holder and lock hook, this direction is close direction.

Force of lock knob push :

$Fk = 10G \times W2 \times \sin6.2 + W2 \times \sin6.2$

$= 10 \times 0.0166 \times \sin6.2 + W2 \times \sin6.2$

$= 0.0197$ (N)

Force of lock knob spring : $Fls = 3$ (N)

$Fk < Fls$ $(0.0197 < 3.0)$ so the lock knob will not move to open direction by 10G front direction.
And the cup&coin holder will not open.

Result: The cup&coin holder will remain closed.

4)10G Up Direction

Force of pulling the lock hook to push position

$Fhkp = Fhk \times \cos45 \times \cos45$

$= (10\ G \times W3 \times \cos6.2 - W3 \times \cos6.2) \times \cos45 \times \cos45$

$= (\ 0\ G \times 0.0034 \times \cos6.2 - 0.0034 \times \cos6.2) \times \cos45 \times \cos45$

$= 0.0159$ (N)

$Fhkp < Fls$ $(0.0159 < 3.0)$, so the lock knob will not move to open direction by 10G front direction.
And the cup&coin holder will not open.

Result: The cup&coin holder will remain closed.

5)Right & Left Direction

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

Attachment 2-2
1/15

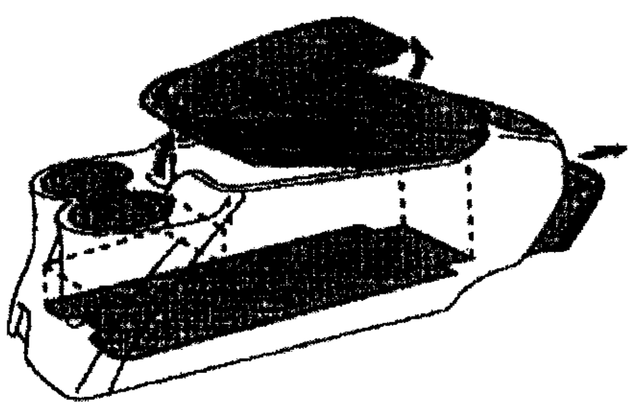
FMVSS No. 201
Latch Component Analysis Information

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:

2004 model TOYOTA SIENNA

Console Assembly



RELEASE HANDLE
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

1. Geometric details of the latch/lock configuration.

SEE FIGURE 1: Page 12

2. Mass data for each element in the linkage.

RELEASE HANDLE = 0.0393kg
RELEASE HANDLE SPRING TORQUE = 359 N mm

3. Calculation results on "release handle"

Inertial load and Direction	Calculation needed?	M1	M2
+30g L	Yes	1.7	619.2
-30g L	Yes	262	359
+10g W	No opening Moment in this direction		
-10g W	No opening Moment in this direction		
+10g H	Yes	1.7	376.3
-10g H	Yes	19.0	359

RELEASE HANDLE ONLY -30g L: (Show M1<M2 about Pivot Point A)

Opening Moment; M1
M1: 30 (9.81) (0.0393) 22.5 + (9.81) (0.0393)(4.5)
260.2 + 1.73
262

Retaining Moment; M2
M2: 359

The Release Handle will not release because M1<M2(262<359)

RELEASE HANDLE ONLY +30g L: (Show M1<M2 about Pivot Point A)

Opening Moment; M1
M1: (9.81) (0.0393)(4.5)
1.73
1.7

Retaining Moment; M2
M2: 359 + 30 (9.81) (0.0393) 22.5
359 + 260.2
619.2

The Release Handle will not release because M1<M2(1.7<619)

RELEASE HANDLE ONLY 10g -H: (Show M1<M2 about Pivot point A)

Opening Moment; M1
M1: 10 (9.81) (0.0393) (4.5)+9.81(0.0393)(4.5)
17.3+1.73
19

Retaining Moment; M2
M2: 359

The Release Handle will not release because M1<M2(19<359)

RELEASE HANDLE ONLY 10g +H: (Show M1<M2 about Pivot point A)

Opening Moment; M1
M1: 9.81(0.0393)(4.5)
1.73
1.7

Retaining Moment; M2
M2: 359 + 10 (9.81) (0.0393) (4.5)
359 + 17.3
376.3

The Release Handle will not release because M1<M2(1.7<376.3)

RR STORAGE BOX
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

1. Geometric details of the latch/lock configuration.

   SEE FIGURE 3: Page 14

2. Mass data for each element in the linkage.

   Latch Mass= 0.0278kg
   Spring force = 4.2 N Min.
   Spring Force is the Retaining Force; Fr.

3. Calculation results on "RR storage box"

Inertial load and Direction	Calculation needed?	Fo	Fr
30g, +L	Yes	3.2	4.2
30g, -L	Yes	0.3	7.2
10g, +W	No opening Force in this direction		
10g, -W	No opening Force in this direction		
10g, +H	Yes	0.3	6.7
10g, -H	Yes	3.0	4.2

Show that Fr is greater than Fo for following inertial loading scenario's: 30g, +L, 30g, -L, 10g, +H, 10g, -H.

<u>(STORAGE BOX) 30g, +L: (Show Fr>Fo)</u>

Only the inertial forces and spring force acting on the latch need to be considered:

Opening Force Fo:
Fo: 30 (9.81)(0.0278) sin21.1 + (9.81)(0.0278) cos21.1
2.96 + 0.25
3.2

Retaining Force Fr:
Fr: 4.2

<u>The RR Storage Box will remain closed because Fr>Fo(4.2>3.2)</u>

<u>(STORAGE BOX) 10g, -H:(Show Fr>Fo)</u>

Only the latch and latch spring need to be considered:

Opening Force; Fo
Fo: (10 (9.81) (0.0278) +(9.81) (0.0278))cos21.1
2.72+0.25
3.0

Retaining Force; Fr
Fr: 4.2

<u>The RR Storage Box will remain closed because Fr>Fo(4.2>3.0)</u>

<u>(STORAGE BOX) 30g, -L:(Show Fr>Fo)</u>

Only the latch and latch spring need to be considered:

Opening Force; Fo
Fo: (9.81)(0.0278)cos21.2
0.25
0.3

Retaining Force: Fr
Fr: 4.2 + 30 (9.81) (0.0278) sin21.1
4.2 + 2.96
7.2

<u>The RR Storage Box will remain closed because Fr>Fo(7.2>0.3)</u>

(STORAGE BOX) 10g, +H: (Show Fr>Fo)

Only the latch and latch spring need to be considered:

Opening Force; Fo

Fo: (9.81) (0.0278)cos(21.2)

0.25

0.3

Retaining Force; Fr

Fr: 4.2 + 10 (9.81) (0.0278)cos(21.2)

4.2 + 2.54

6.7

The RR Storage Box will remain closed because Fr>Fo(6.7>0.3)

MAIN LID
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

1. Geometric details of the latch/lock configuration.

SEE FIGURE 1 & 2: Page Page 12 & 13

2. Mass data for each element in the linkage.

MAIN LID LATCH MASS = 0.0077kg
MAIN LID LATCH MEASURED SPRING TORQUE = 17.5mm x 4.9N=85.75 N mm
MAIN LID MASS = 1.05 kg
MAIN LID SPRING TORQUE MINIMUM = 3,248 N mm
F = FORCE ON THE MAIN LID LATCH
F2 = FORCE ON THE MAIN LID LATCH
F3= force on the Lid cushions when ther is no force on the latch
(Note: cushions not shown in Figures)

3. Calculation results on "main lid"

Inertial load and Direction	Calculation needed?	M1 '	M2 '
+30g L	Yes	9.5	226
-30g L	Yes	0	235.6
+10g W	No opening Moment in this direction		
-10g W	No opening Moment in this direction		
+10g H	Yes	3.3	418.1
-10g H	Yes	0	89.4

(Main Lid) +30g L: (Show M1 '<M2 ' about Pivot Point B)

First find the force on the Main Lid ; Latch:

Opening moment; M1

M1: Main Lid Spring Torque + 30 (9.81) (1.05) (20)
3,248 + 30 (9.81) (1.05) (20)
3,248 + 6,180.30

Retaining moment; M2

M2: F (277.2) + (9.81) (1.05) (163.5)
F (277.2) + 1,684.13

F = (3,248 +6,180.3 -1,684.13)/277.2
F= 28 N

Next find the Moments on the Main Lid; Latch about Pivot Point D.

Opening moment; M1 '

M1 ': 30(9.81)(0.0077) (4.2)
9.52
9.5

Retaining moment; M2 '

M2 ': (9.81)(0.0077)(4.4) + F(5) + 85.75
0.33 + 140 + 85.75
226

Thus the only way for the lid to open is for the latch to break at or below 28N.
Through physical testing the minimum strength of the latch is greater than 350 N. Therefore, the lid will remain closed.

(Main Lid) +10g H: (Show M1 '<M2 ' about Pivot Point B)

First find the force on the Main Lid; Latch:

Opening moment; M1		Retaining moment; M2
10(9.81)(1.05)(163.5) + 3,248	M2:	F (277.2) + (9.81) (1.05) (163.5)
16,841 + 3,248		F (277.2) + 1,684
20,089		
		F = (20,089 - 1,684)/277.2
		F= 66.4N

Next find the Moments on the Main Lid , Latch about Pivot Point D.

	Opening moment; M1 '		Retaining moment; M2 '
M1 ':	10 (9.81)(0.0077) (4.4)	M2 ':	9.81 (0.0077)(4.4) + F (5)+85.75+(3.248/277.2)(5)
	3.3		0.33 +66.4(5) + 85.75+ 0.059
			418.1

Thus the only way for the lid to open is for the latch to break at or below 66.4N.
Through physical testing the minimum strength of the latch is greater than 350 N. Therefore, the lid will remain closed.

(Main Lid) -30g L: (Show M1 '<M2 ' about Pivot Point B)

1st find the force on the Main Lid; Latch:

	Opening moment; M1		Retaining moment; M2
M1:	Spring Torque	M2:	F3 (277.2) + (9.81) (1.05) (163.5) + 30 (9.81) (1.05) (20)
	3,248		F3 (277.2) + 1,684.1 +6,180.3
	3,248		
			F3 = (3,248 - 6,180.3 -1,684.1)/277.2
			F3= -71 N

F3 represents the additional retaining force, or (compression force on the lids rubber cushions). Therefore, there is no force acting to open the lid.

Next find the Moments on the Main Lid; Latch about Pivot Point D)

Opening moment; M1 '	Retaining moment; M2 '
M1 0	M2 (9.81)(0.0077)(4.4) + (28)(5) + 85.75 + 30(9.81)(0.0077) (4.2)
	0.33 + 140 + 85.75 + 9.52
	235.6

Thus there is no moment acting to open the latch. Therefore, the lid will remain closed.

(Main Lid) -10g H: (Show M1 '<M2 ' about Pivot Point B)

1st find the force on the Main Lid; Latch:

Opening moment; M1

M1: 3248

Retaining moment; M2

M2: F3 (277.2) + (9.81) (1.05) (163.5) + 10(9.81)(1.05)(163.5)

F3 (277.2) + 1,684 +16,841

F3 = (3,248 - 1,588 -15,879)/277.2

F3 = -55.1N

F3 represents the additional retaining force, or (compression force on the lids rubber cushions). Therefore, there is no force acting to open the lid.

Next find the Moments on the Main Lid, Latch about Pivot Point D)

Opening moment; M1 '

M1 0

Retaining moment; M2 '

M2 ': 9.81 (0.0077)(4.4) + 10 (9.81)(0.0077) (4.4)+85.75

0.33 + 3.3+85.75

89.4

Thus there is no moment acting to open the latch. Therefore, the lid will remain closed.

MEMO LID
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

1. Geometric details of the latch/lock configuration.

SEE FIGURE 1: Page 12

2. Mass data for each element in the linkage.

Memo Lid Mass=0.395kg
Latch Force F1=20.6 N
Note: Frictional torque in the hinge is ignored.

3. Calculation results on "memo lid"

Inertial load and Direction	Calculation needed?	M1	M2
30g, +L	Yes	721	4,141
30g, -L	Yes	0	4,862
10g, +W	No opening Moment in this direction		
10g, -W	No opening Moment in this direction		
10g, +H	Yes	2,662	4,141
10g, -H	Yes	0	6,803

(Memo Lid) 30g, +L: (Show M2 > M1 about Pivot Point C)

Opening moment; M1
M1: 30 (9.81) (0.395) (6.2)
720.74
721

Retaining monent; M2
M2: F1 (188.1) + (9.81) (0.395)(68.7)
20.6 (188.1) + 266.21
3,874.86 + 266.21
4,141

The memo lid will remain closed because M2>M1(4141>721)

(Memo Lid) 10g, +H: (Show M2 > M1 about Pivot Point C)

Opening moment; M1
M1: 10 (9.81) (0.395) (68.7)
2,662.1
2,662

Retaining monent; M2
M2: F1 (188.1) + 9.81 (0.395) (68.7)
(20.6) (188.1) + 266.21
3,874.86 + 266.21
4,141

The memo lid will remain closed because M2>M1(4141>2662)

(Memo Lid) 30g, -L: (Show M2 > M1 about Pivot Point C)

Opening moment; M1
M1: 0

Retaining monent; M2
M2: F1 (188.1) + (9.81) (0.395)(68.7) + 30 (9.81) (0.395) (6.2)
20.6 (188.1) + 266.21 + 720.7
3,874.86 + 266.21 + 720.7
4,862

The memo lid will remain closed because M2>M1(4862>0)

(Memo Lid) 10g, -H: (Show M2 > M1 about Pivot Point C)

	Opening moment; M1		Retaining monent; M2
M1:	0	M2:	F1 (188.1) + 9.81 (0.395) (68.7) + 10 (9.81) (0.395) (68.7)
			(20.6) (188.1) + 266.21 + 2,662.09
			3,874.86 + 266.21 + 2,622
			6,803

The memo lid will remain closed because M2>M1(6803>0)

MAIN LOCK TO FLOOR STRIKER
FMVSS201 INTERIOR COMPARTMENT DOOR CALCULATION

1. Geometric details of the latch/lock configuration.

See Figure 4: Page 15

2. Mass data for each element in the linkage.

Ratchet Mass=0.0493 kg
FS=Spring Force = 16.3 N Min.

3. Calculation results on "main lock to floor striker"

Inertial load and Direction	Calculation needed?	M1	M2
30g, +L	Yes	17.2	1,088.4
30g, -L	Yes	440.9	664.7
10g, +W	No opening Moment in this direction		
10g, -W	No opening Moment in this direction		
10g, +H	Yes	58.3	664.4
10g, -H	Yes	17.2	705.8

(Main Lock) 30g, -L: (Show M2 > M1 about Pivot Point E)

(Note: Need only consider the inertial loading affect on the Ratchet and Spring)

Opening moment; M1
M1: 30 mg(29.2) + FSsin21.3 (2.9)
30 (0.0493) (9.81) (29.2) + 16.3sin21.3 (2.9)
423.66 + 17.2
440.9

Retaining monent; M2
M2: Spring Force (43.5)cos21.3 + mg(8.5)
16.3 (43.5)cos21.3 + (0.0493) (9.81) (8.5)
660.62 + 4.11
664.7

The main lock will not release because M2>M1(665>441)

(Main Lock) 30g, +L: (Show M2 > M1 about Pivot Point E)

(Note: Need only consider the inertial loading affect on the Ratchet and Spring)

Opening moment; M1
M1: FSsin21.3 (2.9)
16.3sin21.3 (2.9)
17.2

Retaining monent; M2
M2: Spring Force (43.5)cos21.3 + mg(8.5) + 30 mg(29.2)
16.3 (43.5)cos21.3 + (0.0493) (9.81) (8.5) + 30 (0.0493) (9.81) (29.2
660.62 + 4.11 + 423.66
1,088.4

The main lock will not release because M2>M1(1088>17)

(Main Lock) 10g, +H: (Show M2 > M1 about Pivot Point E)

(Note: Need only consider the inertial loading affect on the Ratchet and Spring)

Opening moment; M1
M1: 10 (mg) (8.5) + FSsin21.3 (2.9)
10 (0.0493) (9.81) (8.5) + 16.3sin21.3 (2.9)
41.1 + 17.2
58.3

Retaining monent; M2
M2: Spring Force (43.5)cos21.3 + mg(8.5)
16.3 (43.5)cos21.3 + (0.0493) (9.81) (8.5)
660.62 + 4.11
664.7

The main lock will not release because M2>M1(665>58)

(Main Lock) 10g, -H: (Show M2 > M1 about Pivot Point E)

(Note: Need only consider the inertial loading affect on the Ratchet and Spring)

Opening moment; M1

M1: FSsin21.3 (2.9)

16.3sin21.3 (2.9)

17.2

Retaining monent; M2

M2: Spring Force (43.5)cos21.3 + mg(8.5) + 10 (mg)

16.3 (43.5)cos21.3 + (0.0493) (9.81) (8.5) + 10 (0.0493) (9.81) (8.5)

660.62 + 4.11 + 41.1

705.8

The main lock will not release because M2>M1(706>17)

FIGURE 1

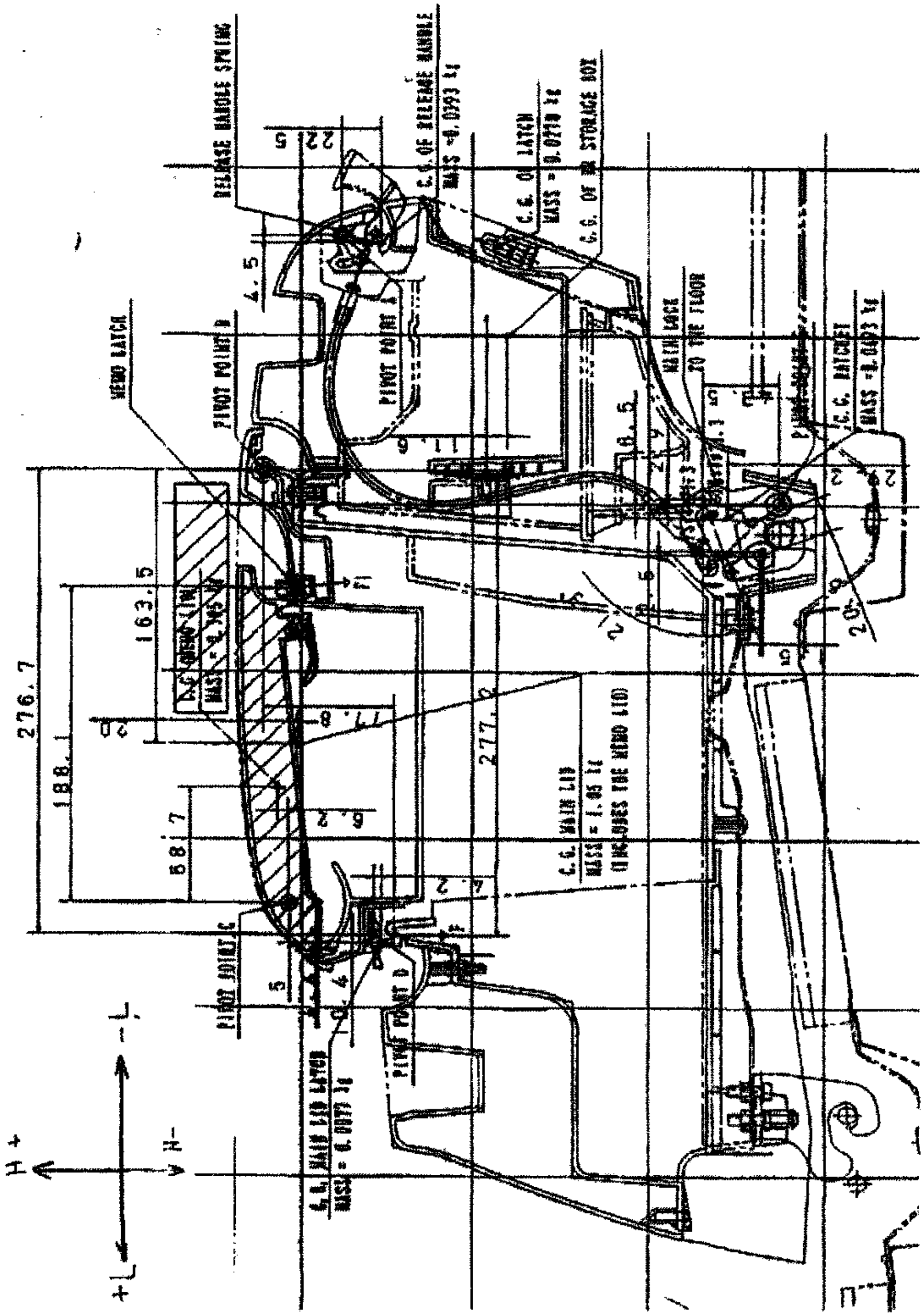

RELEASE HANDLE SPRING
C.G. OF RELEASE HANDLE
C.G. OF LATCH
MEMO LATCH
PIVOT POINT B
PIVOT POINT A
MAIN LOCK
TO THE FLOOR
C.G. RATCHET
C.G. MAIN LID
(INCLUDES THE MEMO LID)
PIVOT POINT C
PIVOT POINT D
C.G. MAIN LID LATCH
276.7
163.5
188.1
277.2
H+
H-
+L
-L

FIGURE 2

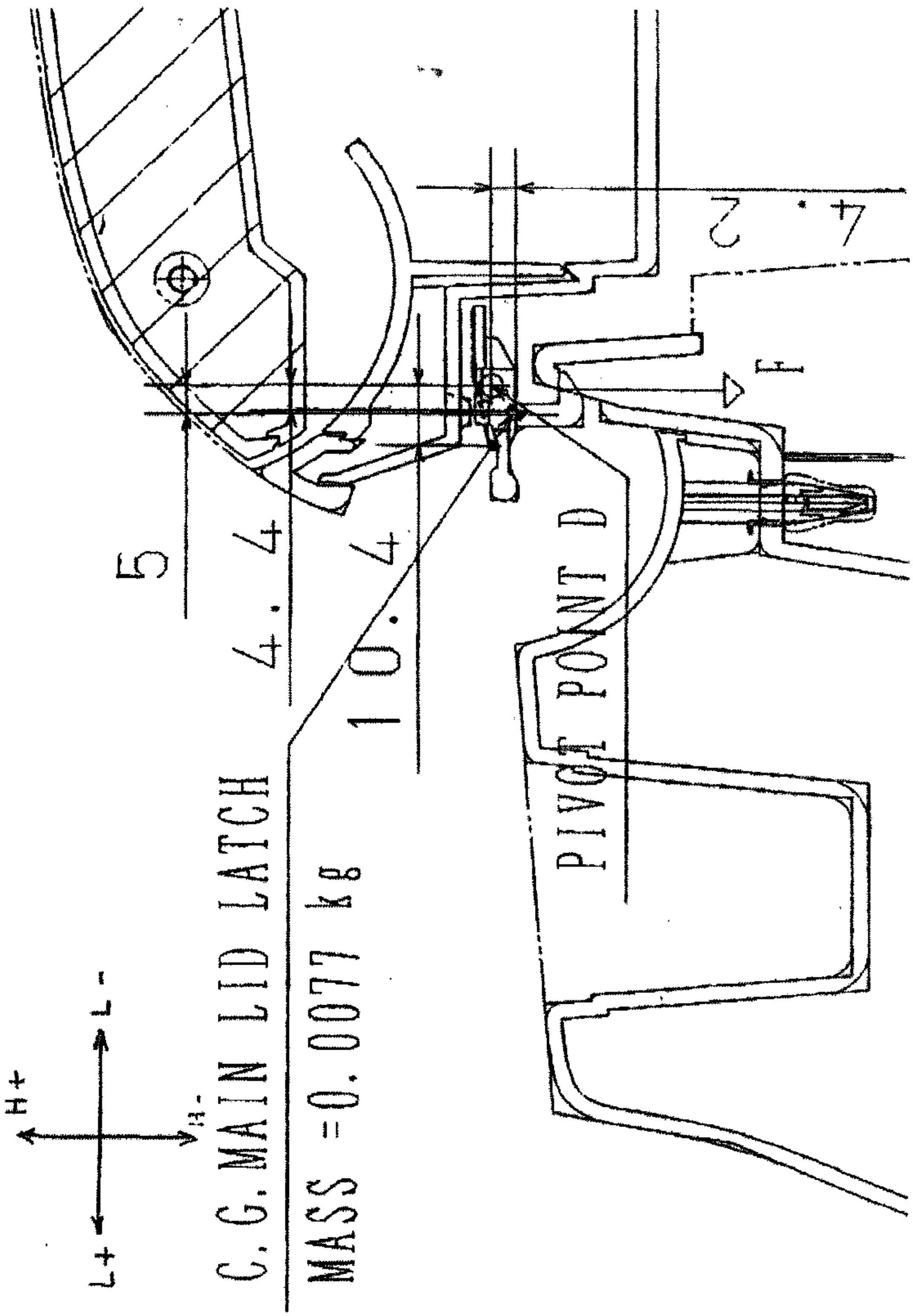


FIGURE 3

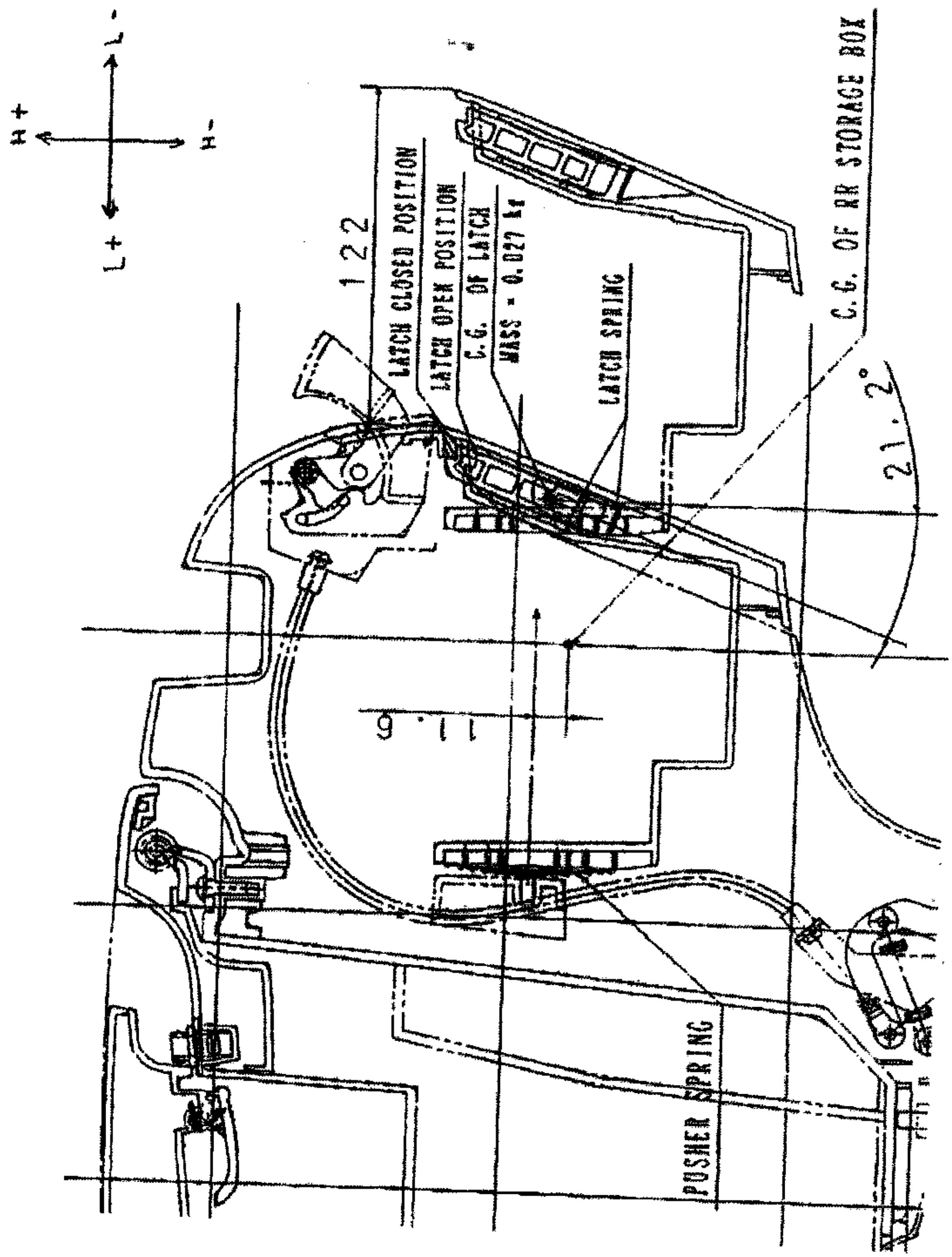
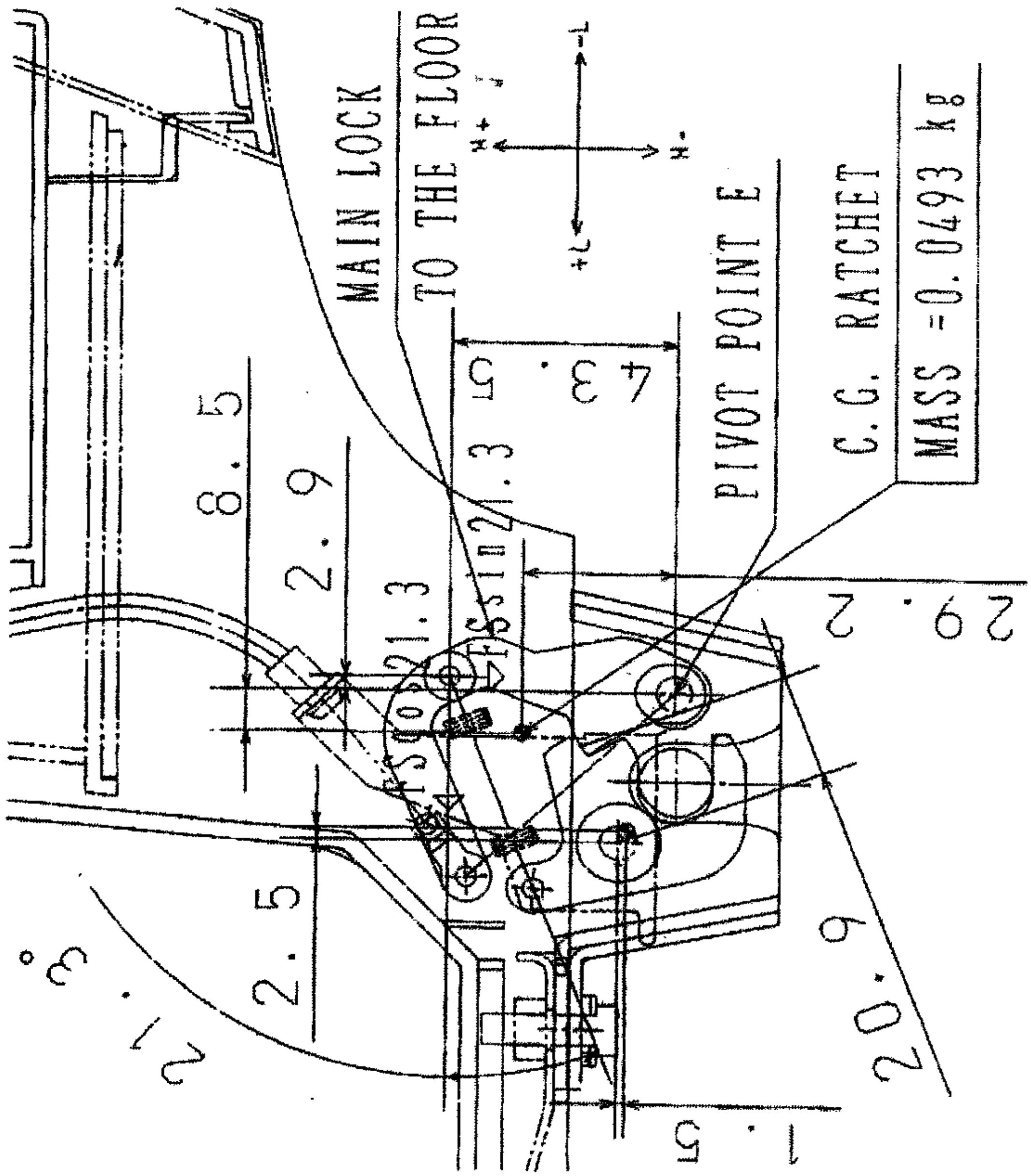
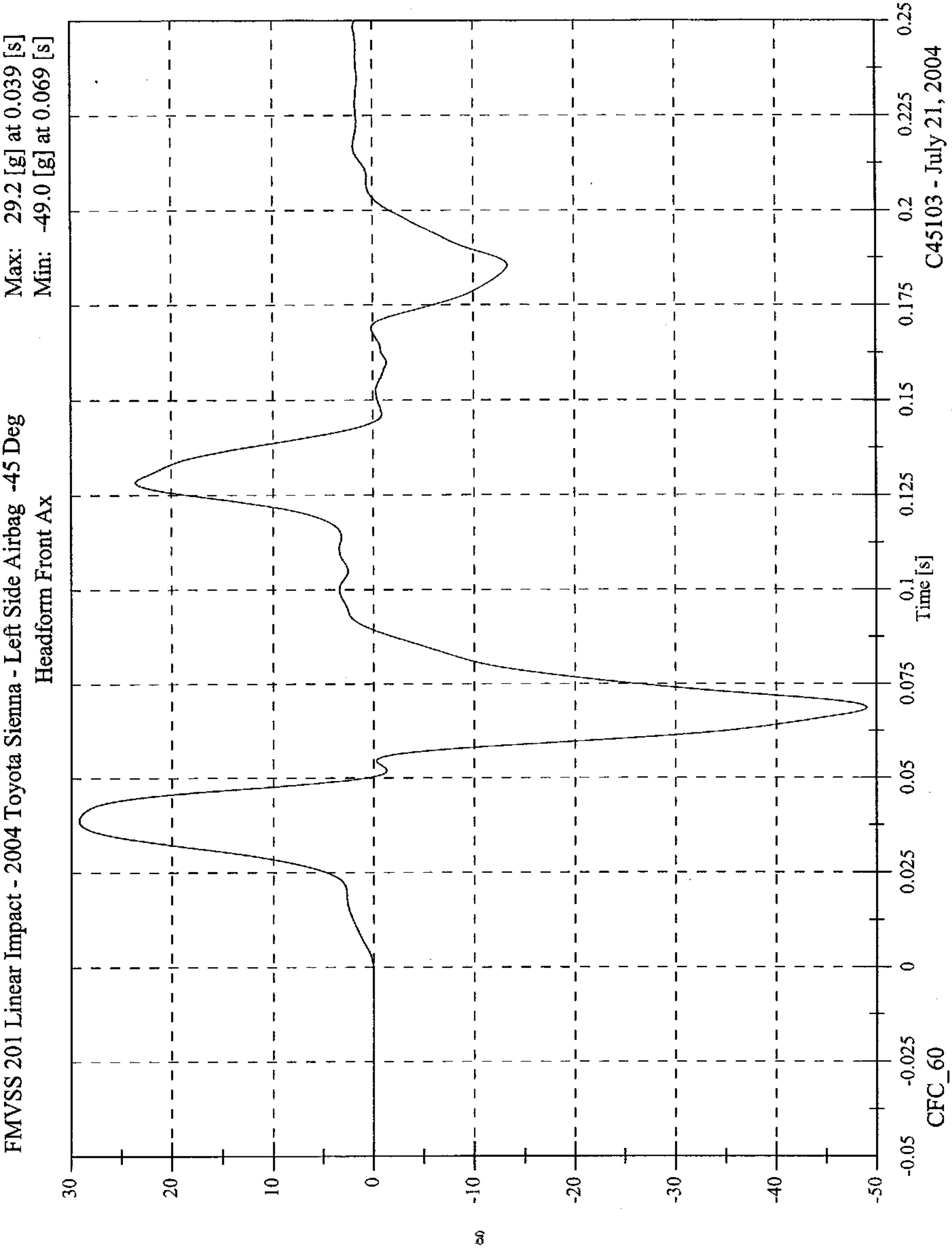

L-
L+
H+
H-
122
LATCH CLOSED POSITION
LATCH OPEN POSITION
C.G. OF LATCH
MASS = 0.027 kg
LATCH SPRING
C.G. OF RR STORAGE BOX
21.2°
11.6
PUSHER SPRING

FIGURE 4 15/15

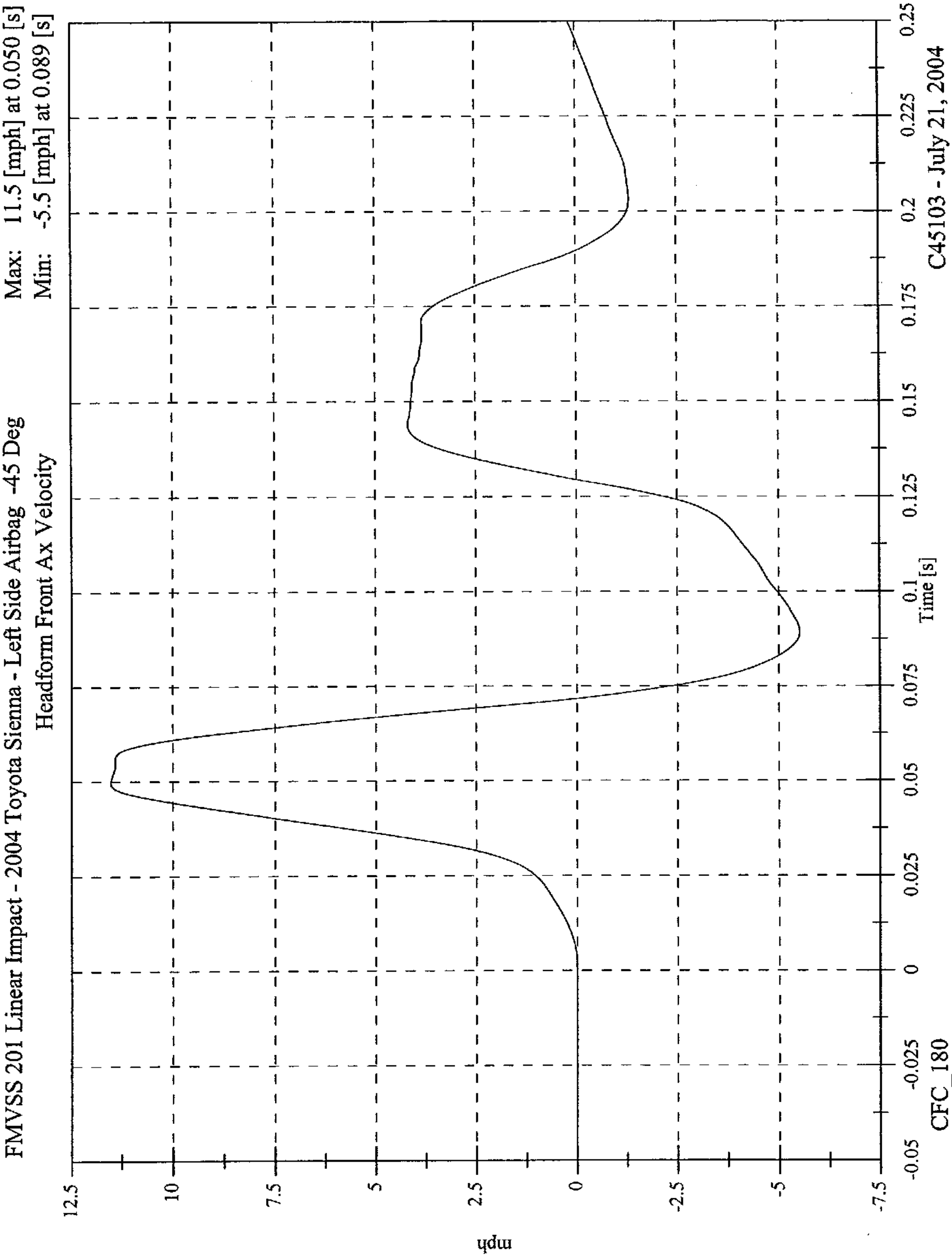


APPENDIX C

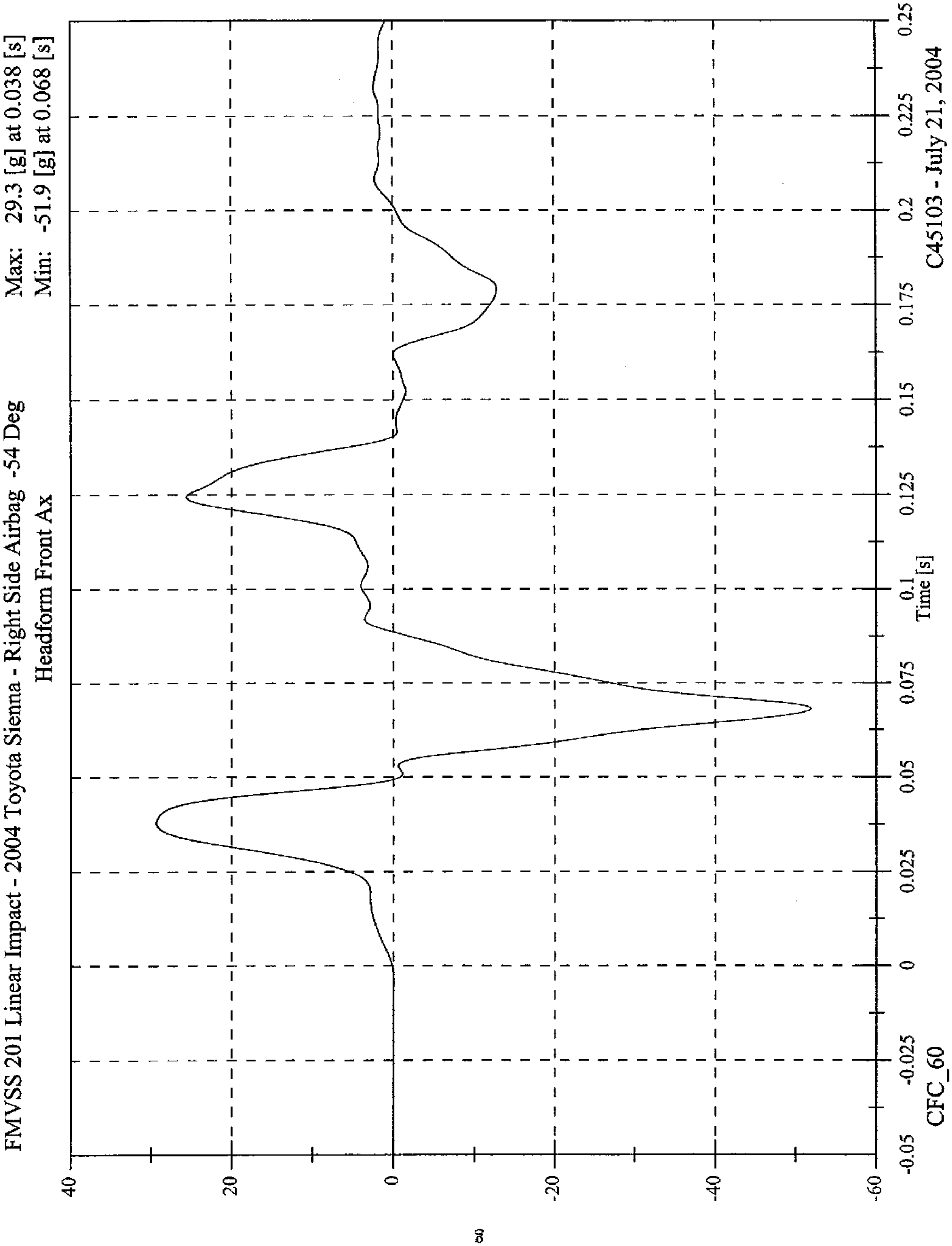
DATA PLOTS



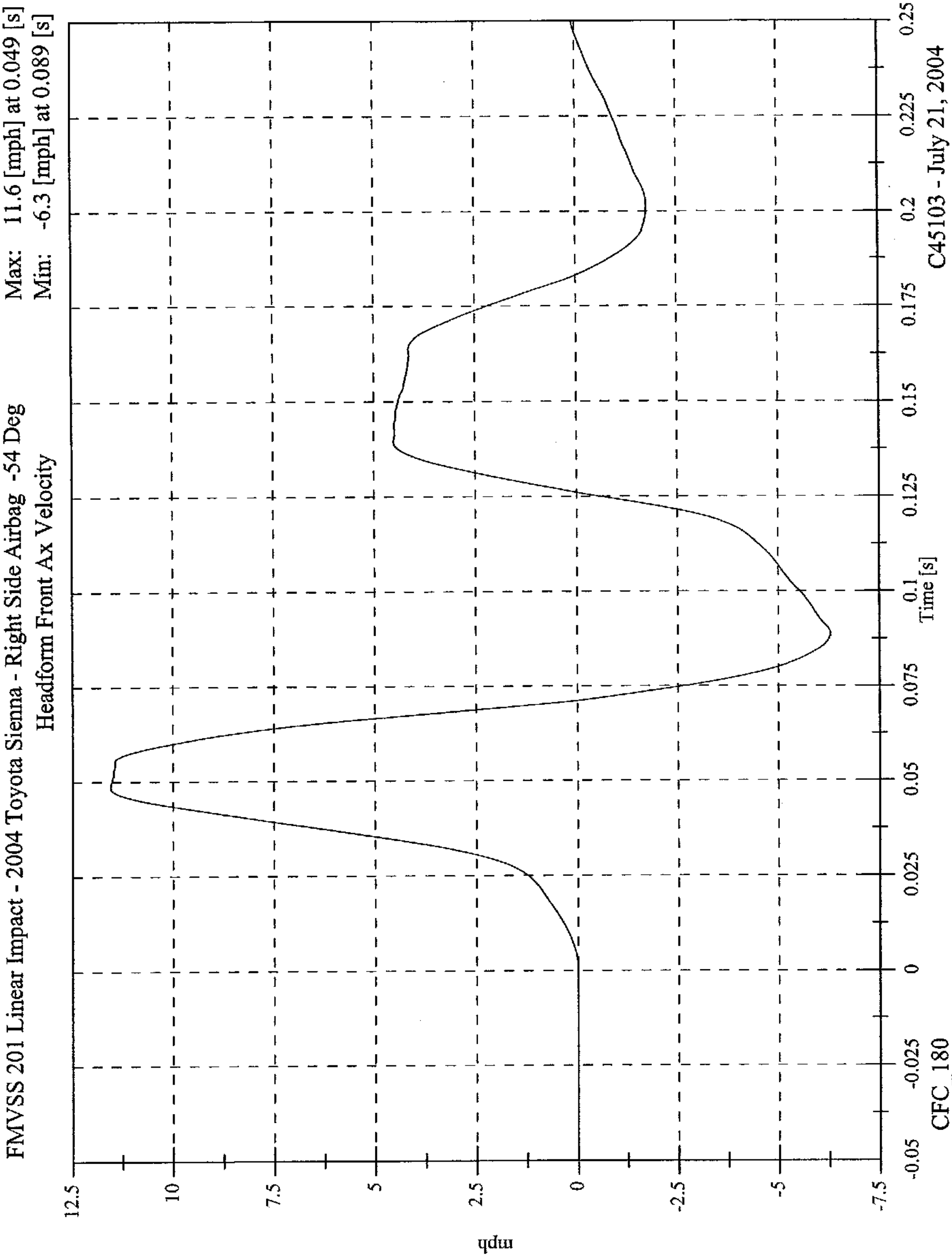
C45103 Left Side of Airbag Cover Impact Plot #1



C45103 Left Side of Airbag Cover Impact Plot #2

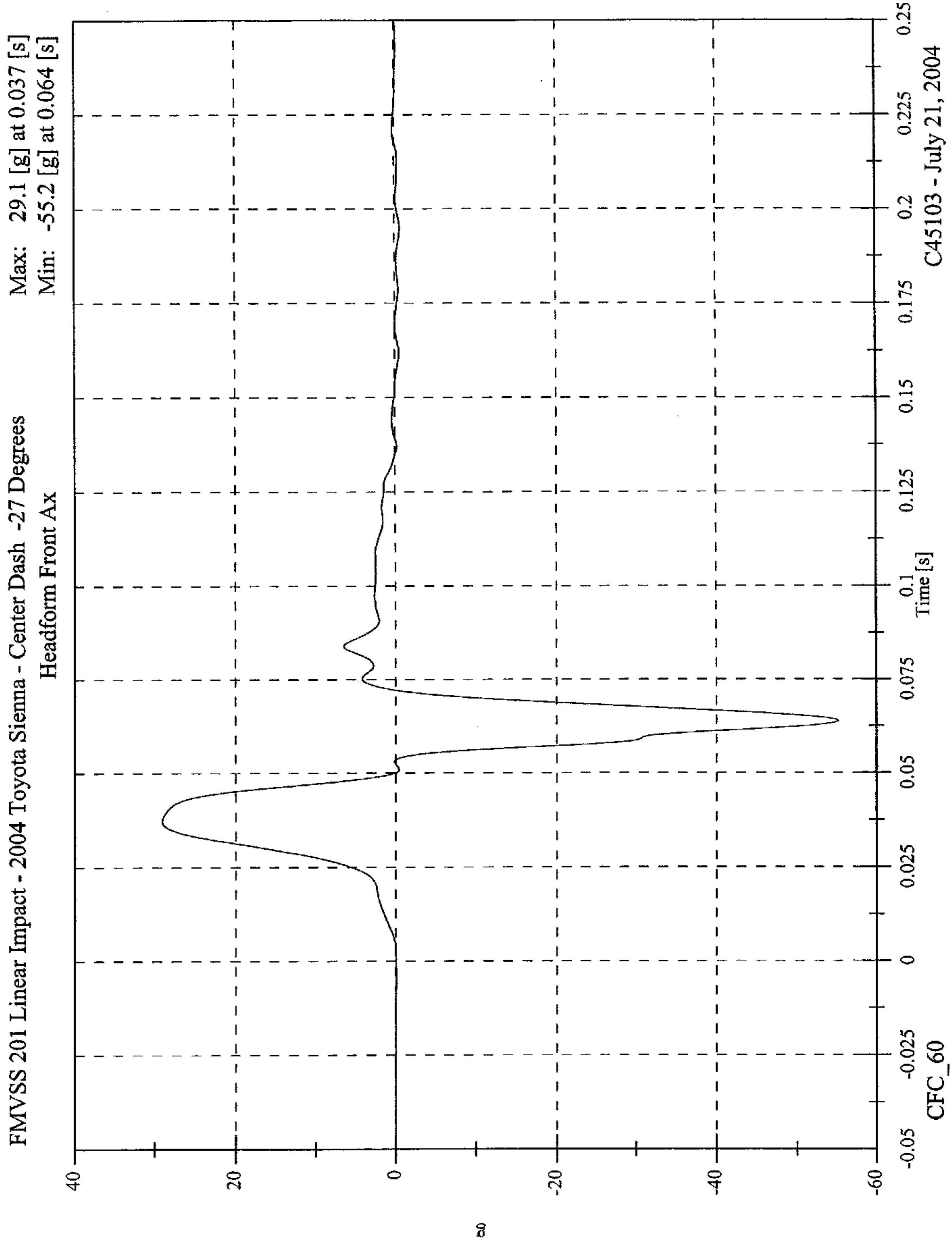


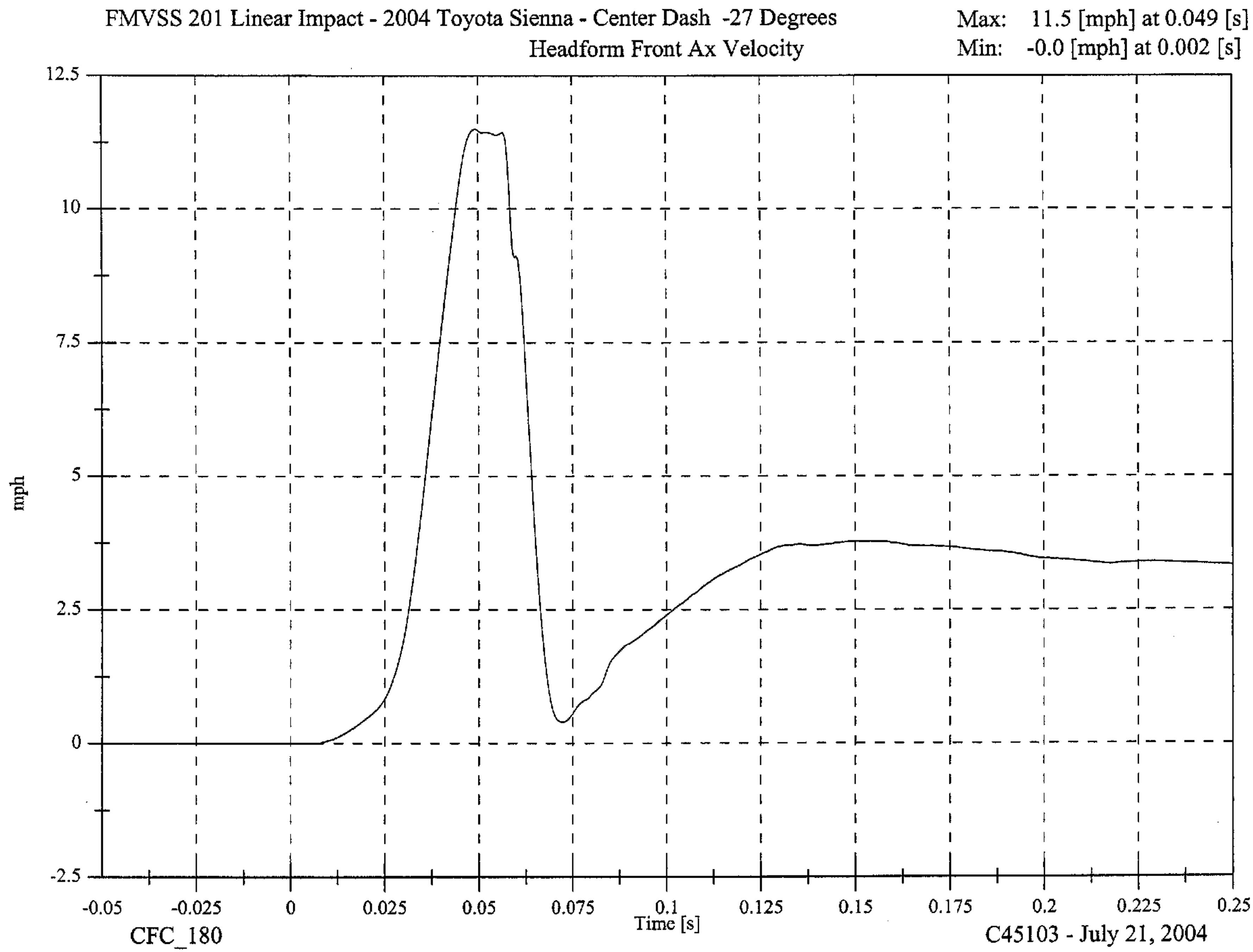
C45103 Right Side of Airbag Cover Impact Plot #1

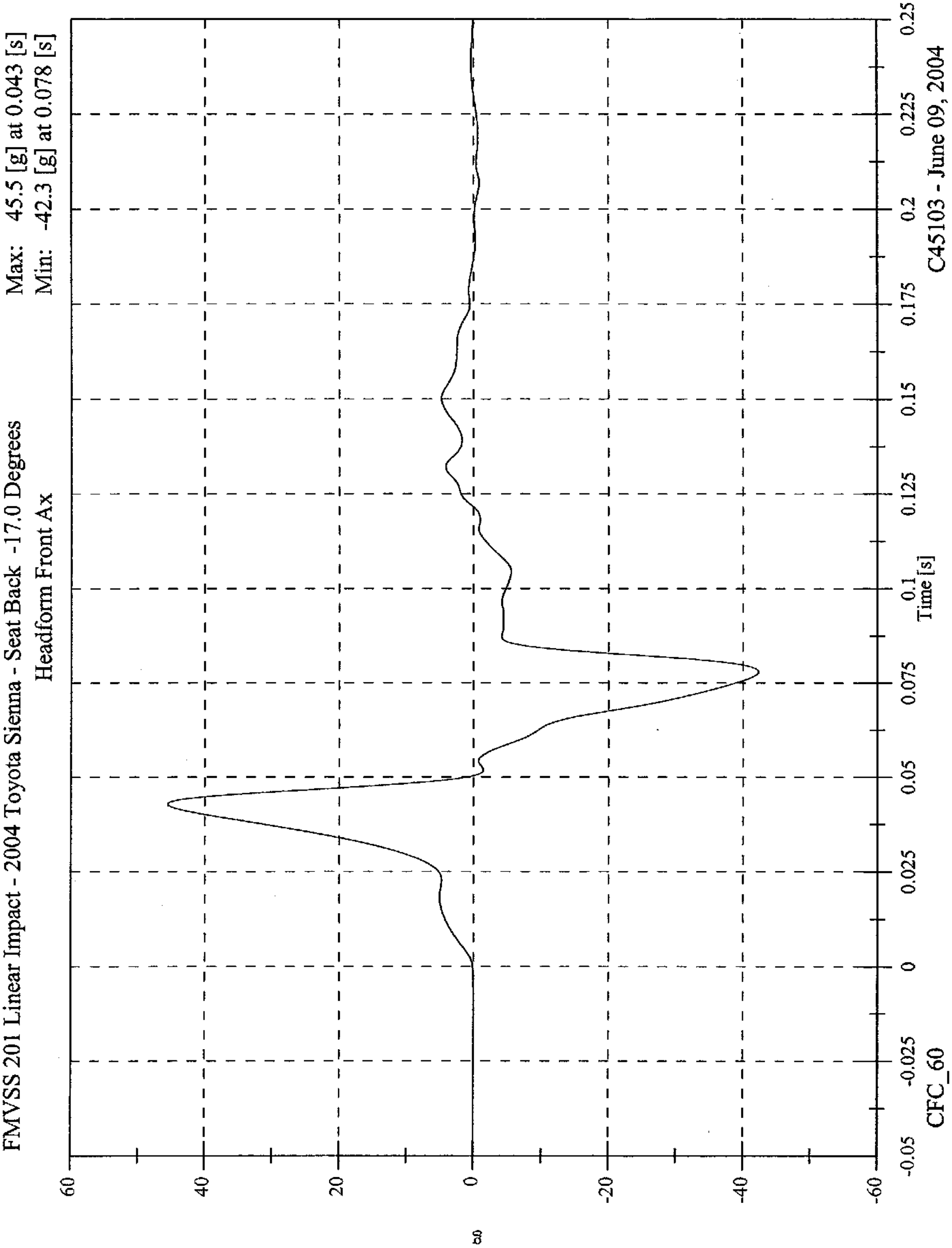


C45103 Right Side of Airbag Cover Impact Plot #2

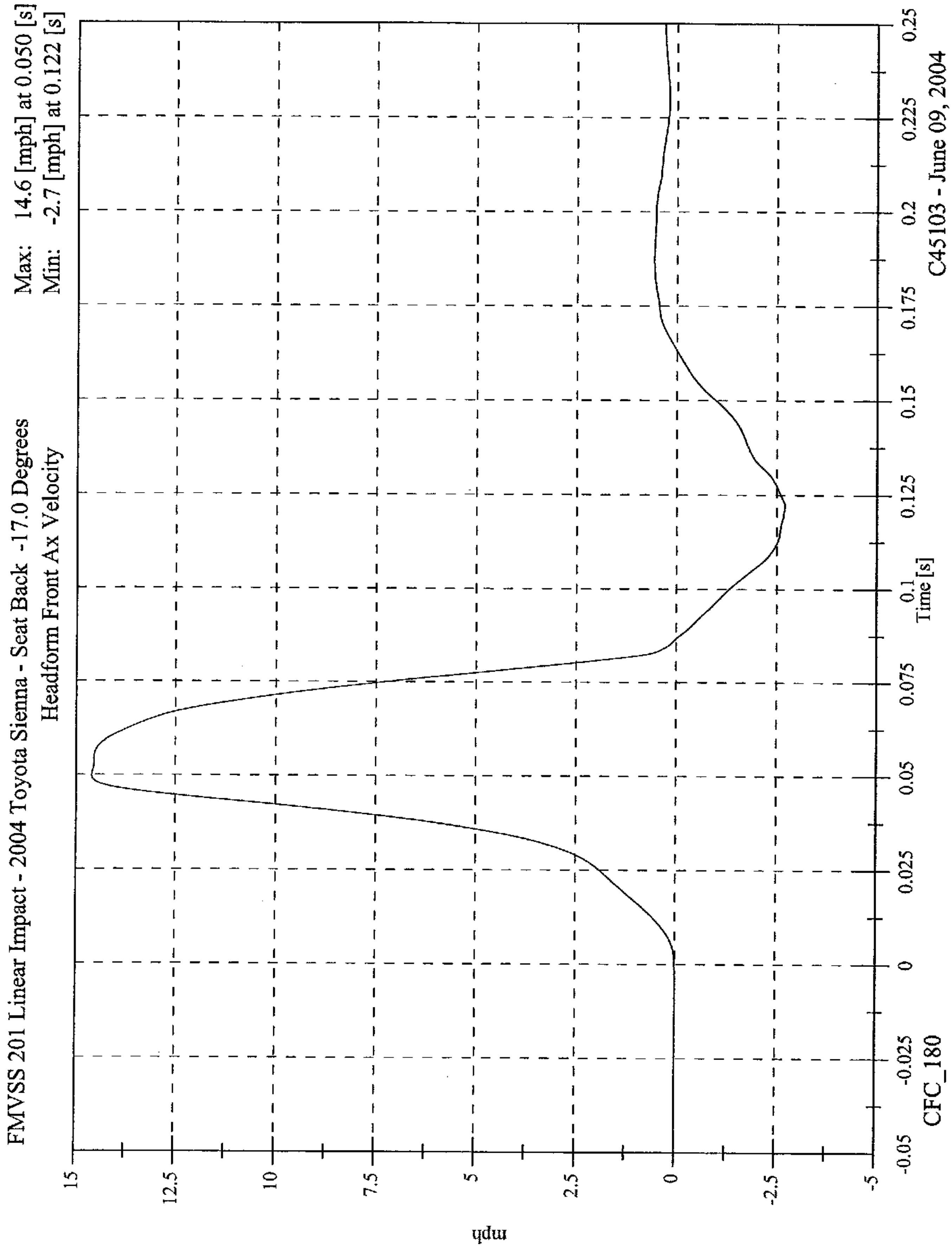
8655-F201-28


FMVSS 201 Linear Impact - 2004 Toyota Sienna - Center Dash -27 Degrees
Headform Front Ax
Max: 29.1 [g] at 0.037 [s]
Min: -55.2 [g] at 0.064 [s]
C45103 - July 21, 2004
CFC_60
Time [s]
g
-0.05
-0.025
0
0.025
0.05
0.075
0.1
0.125
0.15
0.175
0.2
0.225
0.25
40
20
0
-20
-40
-60

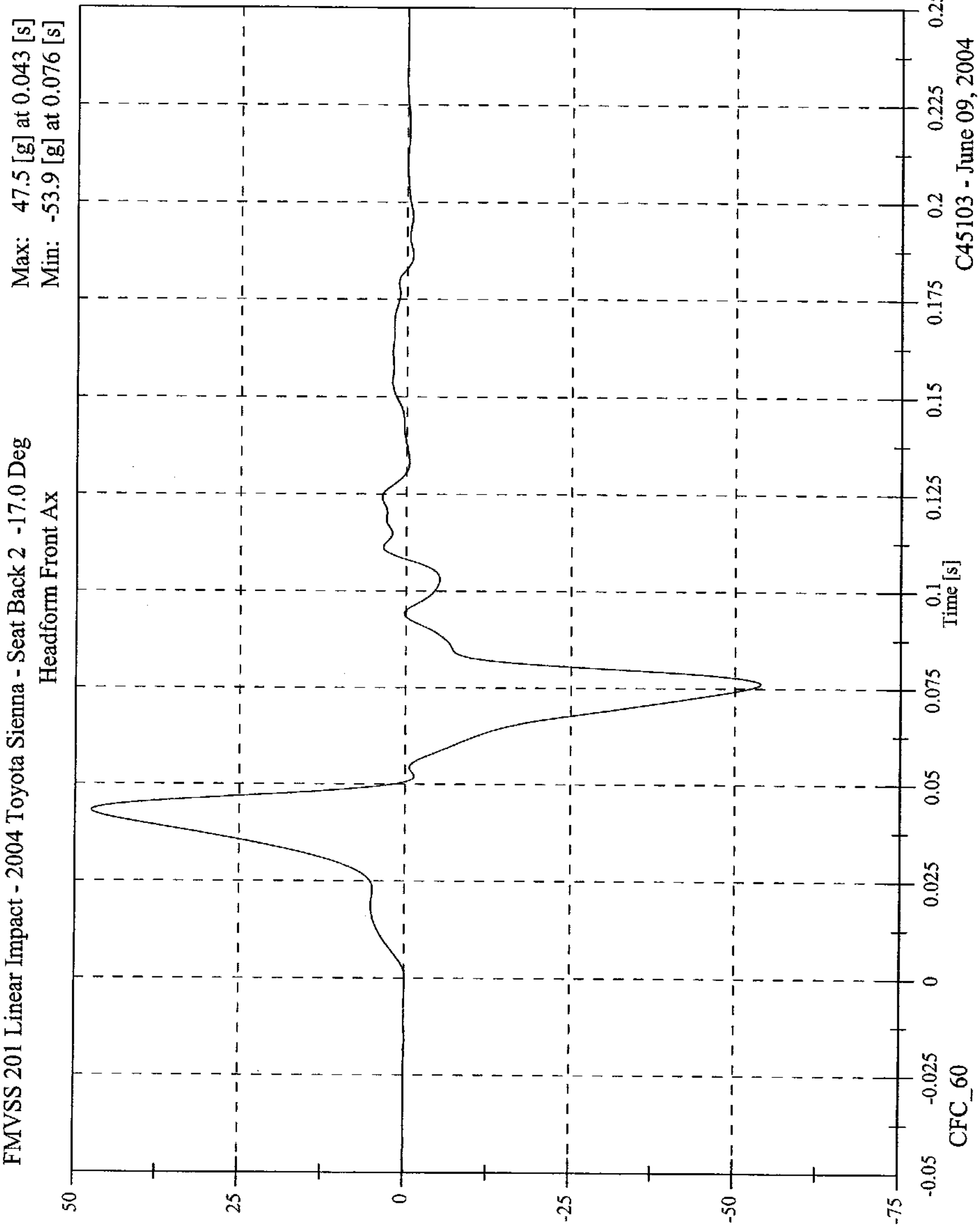

FMVSS 201 Linear Impact - 2004 Toyota Sienna - Center Dash -27 Degrees
Headform Front Ax Velocity
Max: 11.5 [mph] at 0.049 [s]
Min: -0.0 [mph] at 0.002 [s]
mph
12.5
10
7.5
5
2.5
0
-2.5
-0.05
-0.025
0
0.025
0.05
0.075
0.1
0.125
0.15
0.175
0.2
0.225
0.25
Time [s]
CFC_180
C45103 - July 21, 2004

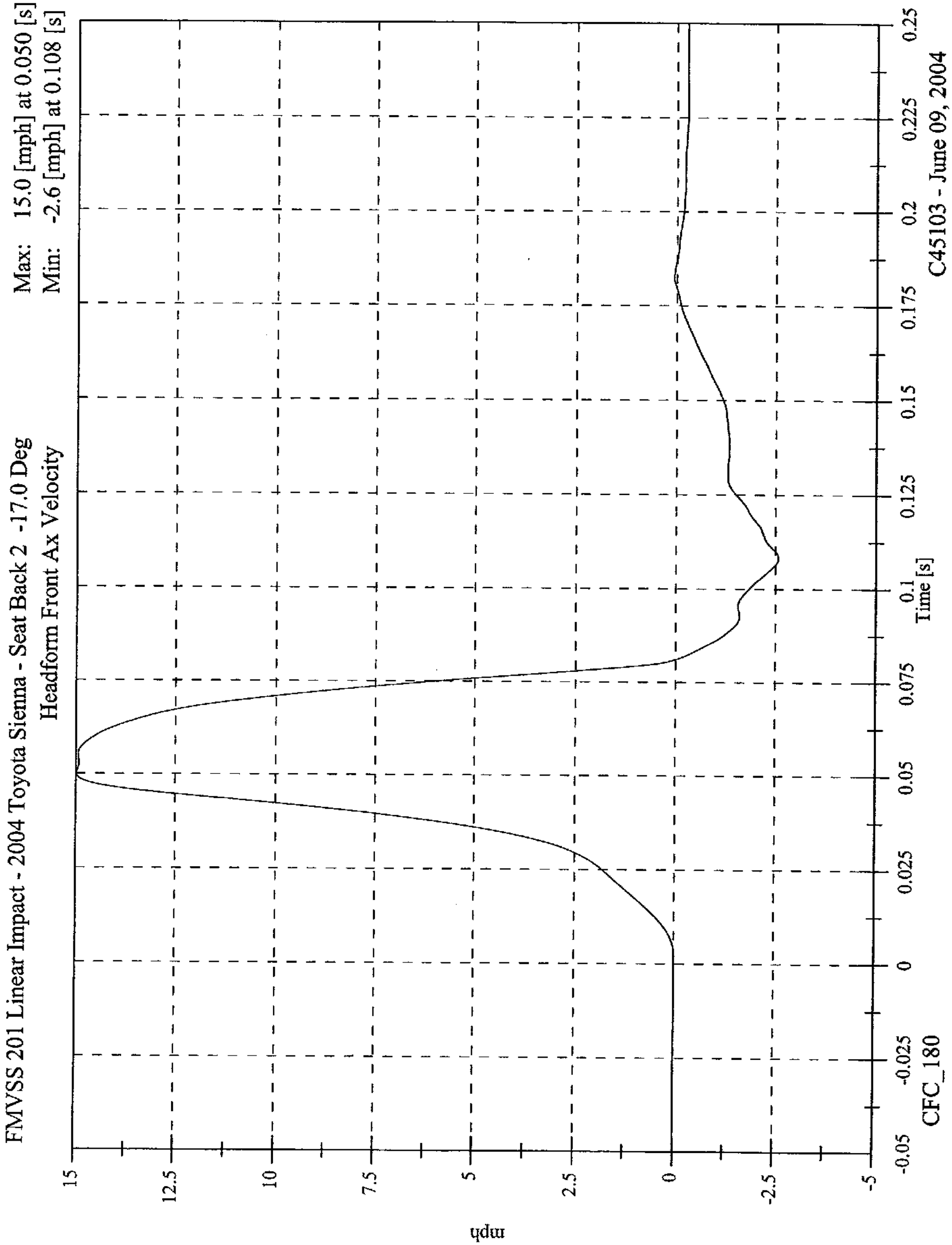


C45103 Front Row Seat Back Impact Plot #1



C45103 Front Row Seat Back Impact Plot #2


FMVSS 201 Linear Impact - 2004 Toyota Sienna - Seat Back 2 -17.0 Deg
Headform Front Ax
Max: 47.5 [g] at 0.043 [s]
Min: -53.9 [g] at 0.076 [s]
C45103 - June 09, 2004
CFC_60
Time [s]
g
50
25
0
-25
-50
-75
-0.05
-0.025
0
0.025
0.05
0.075
0.1
0.125
0.15
0.175
0.2
0.225
0.25



C45103 2nd Row Seat Back Impact Plot #2

8655-F201-28