HS 638091

REPORT NUMBER: 201-CAL-05-02

SAFETY COMPLIANCE TESTING FOR FMVSS 201
OCCUPANT PROTECTION IN INTERIOR IMPACT

FORD MOTOR COMPANY
2005 FORD FREESTYLE

NHTSA NUMBER: C50205

CALSPAN TEST NUMBER: 8655-F201-30

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

Test Date: June 16, 2005

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 6111
400 Seventh Street, SW
Washington, DC 20590

Prepared by: James Czarnecki, Project Engineer

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

Approval Date: Nov 15 2005

FINAL REPORT ACCEPTANCE BY:

NHTSA, Office of Vehicle Safety Compliance

12/5/2005

Date of Report Acceptance

TECHNICAL REPORT STANDARD TITLE PAGE

1. *Report No.* 201-CAL-05-02	2. *Government Accession No.*	3. *Recipient's Catalog No.*
4. *Title and Subtitle* Final Report of FMVSS 201 Compliance Testing of a 2005 Ford Freestyle NHTSA No. C50205		5. *Report Date* June 28, 2005
		6. *Performing Organization Code* CAL
7. *Author(s)* David J. Travale, Program Manager; James Czarnecki, Project Engineer		8. *Performing Organization Report No.* 8655-F201-30
9. *Performing Organization Name and Address* Calspan, 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 JUNE – JULY 2005
		14. *Sponsoring Agency Code* NVS-220
15. *Supplementary Notes*		

16. Abstract

Compliance tests were conducted on the subject vehicle, a 2005 Ford Freestyle, 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, 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)

TABLE OF CONTENTS

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 this impact compliance test was to determine whether the subject vehicle, a 2005 Ford Freestyle, NHTSA No. C50205, 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 2005 Ford Freestyle, NHTSA No. C50205, 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 four (4) impacts were performed in this test series. The target area impacts were chosen by the NHTSA Contracting Officer's Technical Representative (COTR). The four (4) chosen impact points were:

Seat Back / Head Restraint Area

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, a digital picture was taken pre- and post-test at various locations to view the headform contact with the selected target areas.

TEST VEHICLE RECEIVING INSPECTION DATA SHEET

VEHICLE YEAR/MAKE/MODEL/STYLE:	2005 Ford Freestyle
NHTSA NO.:	C50205
VIN:	1FMZK01115GA30899
DATE OF MANUFACTURE:	01/05 (SEE CERTIFICATION LABEL)
COLOR:	Red
ODOMETER READING:	25
LABORATORY:	Calspan
TEST DATE:	June 16, 2005

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: 3

LOCATION: Front and rear door panels and center console arm rest

VEHICLE EQUIPPED WITH SUN VISORS?

NO: - YES: X

VEHICLE EQUIPPED WITH INTERIOR DOOR LATCHES?

NO: - YES: X NUMBER: 5

LOCATION: Glove Box, Top Center Storage Bin, Front Seat Overhead Console, Front Seat Floor Console, and Rear (2nd Row) Seat Floor Console

HEADFORM IMPACT TEST RESULTS
INSTRUMENT PANEL

VEHICLE YEAR/MAKE/MODEL/STYLE:	2005 Ford Freestyle
NHTSA NO.:	C50205
VIN:	1FMZK01115GA30899
DATE OF MANUFACTURE:	01/05 (SEE CERTIFICATION LABEL)
COLOR:	Red
ODOMETER READING:	25
LABORATORY:	Calspan
TEST DATE:	June 16, 2005

IMPACT LOCATION AND NUMBER				VELOCITY (mph)	PEAK ACCELERATION (3 ms Clip) Gs
NUMBER	X (inches)	Y (inches)	ANGLE (degrees)		
IP1 Center cluster air vent	24.25	12.75	-12	11.70	40.62
IP2 Airbag Seam, Left Side, Bottom	26.50	4.25	-68	11.41	51.40
IP3 Airbag Seam, Right Side, Bottom	26.25	4.25	-68	11.58	55.28

REFERENCE POINT: Seating Reference Position (SgRP) on front outboard passenger designated seating position is the reference point (x positive forward of SgRP and y positive right of SgRP).
REMARKS: None

HEADFORM IMPACT TEST RESULTS
SEAT BACKS

VEHICLE YEAR/MAKE/MODEL/STYLE:	2005 Ford Freestyle
NHTSA NO.:	C50205
VIN:	1FMZK01115GA30899
DATE OF MANUFACTURE:	01/05 (SEE CERTIFICATION LABEL)
COLOR:	Red
ODOMETER READING:	25
LABORATORY:	Calspan
TEST DATE:	June 16, 2005

IMPACT LOCATION AND NUMBER				VELOCITY (mph)	PEAK ACCELERATION (3 ms Clip) Gs
NUMBER	X (inches)	Y (inches)	ANGLE (degrees)		
SB1 Seat Back	15.5	0	-37	14.77	42.20

REFERENCE POINT: SgRP on rear outboard passenger designated seating position is the reference point
(x positive forward of SgRP and y positive right of SgRP).

SUN VISOR AND ARMREST EVALUATION

VEHICLE YEAR/MAKE/MODEL/STYLE:	2005 Ford Freestyle
NHTSA NO.:	C50205
VIN:	1FMZK01115GA30899
DATE OF MANUFACTURE:	01/05 (SEE CERTIFICATION LABEL)
COLOR:	Red
ODOMETER READING:	25
LABORATORY:	Calspan
TEST DATE:	June 16, 2005

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:	2005 Ford Freestyle
NHTSA NO.:	C50205
VIN:	1FMZK01115GA30899
DATE OF MANUFACTURE:	01/05 (SEE CERTIFICATION LABEL)
COLOR:	Red
ODOMETER READING:	25
LABORATORY:	Calspan
TEST DATE:	June 16, 2005

LATCH ENGAGEMENT INTERFERENCE

DESCRIPTION OF LATCH LOCATION	NO LOAD	10G HORIZONTAL TRANSVERSE	10G VERTICAL	30G HORIZONTAL LONGITUDINAL
Glove Box	PASS	PASS	PASS	PASS
Top Center Storage Bin	PASS	PASS	PASS	PASS
Front Seat Overhead Console	PASS	PASS	PASS	PASS
Front Seat Floor Console	PASS	PASS	PASS	PASS
Rear (2nd Row) Seat Floor Console	PASS	PASS	PASS	PASS

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

SUMMARY OF RESULTS

VEHICLE YEAR/MAKE/MODEL/STYLE:	2005 Ford Freestyle
NHTSA NO.:	C50205
VIN:	1FMZK01115GA30899
DATE OF MANUFACTURE:	01/05 (SEE CERTIFICATION LABEL)
COLOR:	Red
ODOMETER READING:	25
LABORATORY:	Calspan
TEST DATE:	June 16, 2005

	NUMBER OF IMPACTS	PASS/FAIL
INSTRUMENT PANEL	3	PASS
SEAT BACK	1	PASS
SUN VISORS	N/A	PASS
ARMRESTS	N/A	PASS
INTERIOR COMPARTMENT DOORS	N/A	PASS

REMARKS:

APPENDIX A

PHOTOGRAPHS

PHOTOGRAPHS

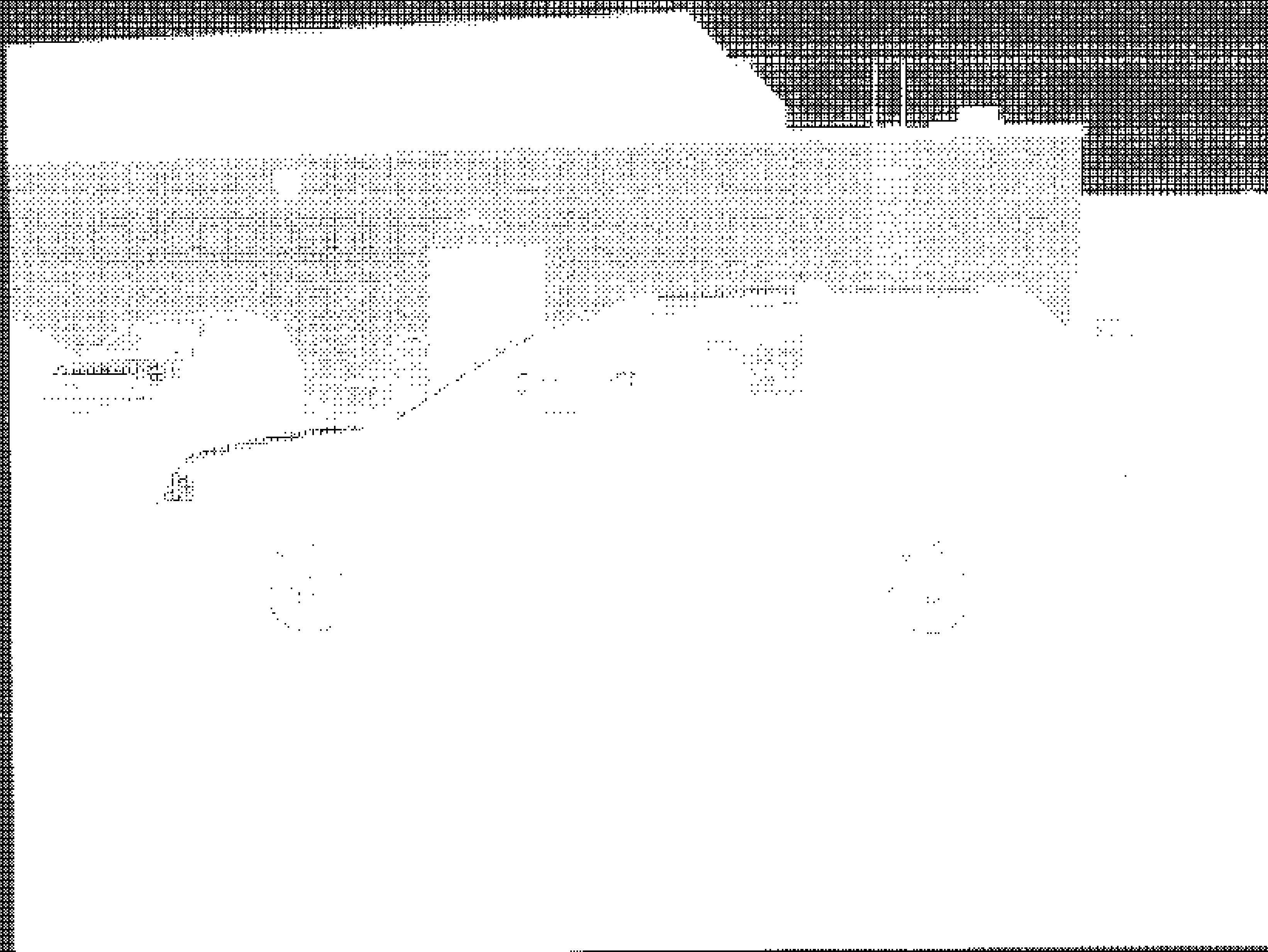


Figure A-1 : LEFT SIDE VIEW OF VEHICLE

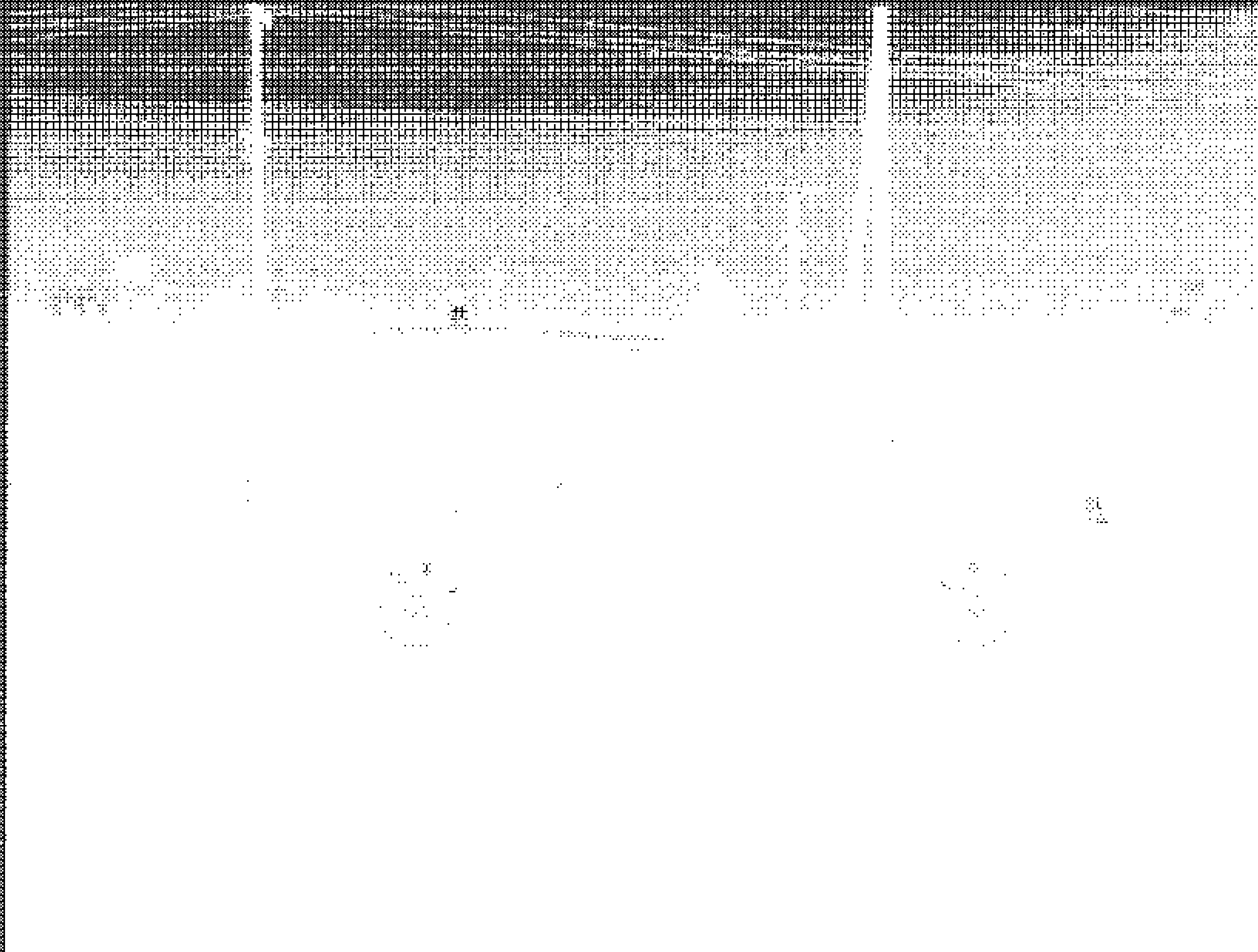


Figure A-2: RIGHT SIDE VIEW OF VEHICLE

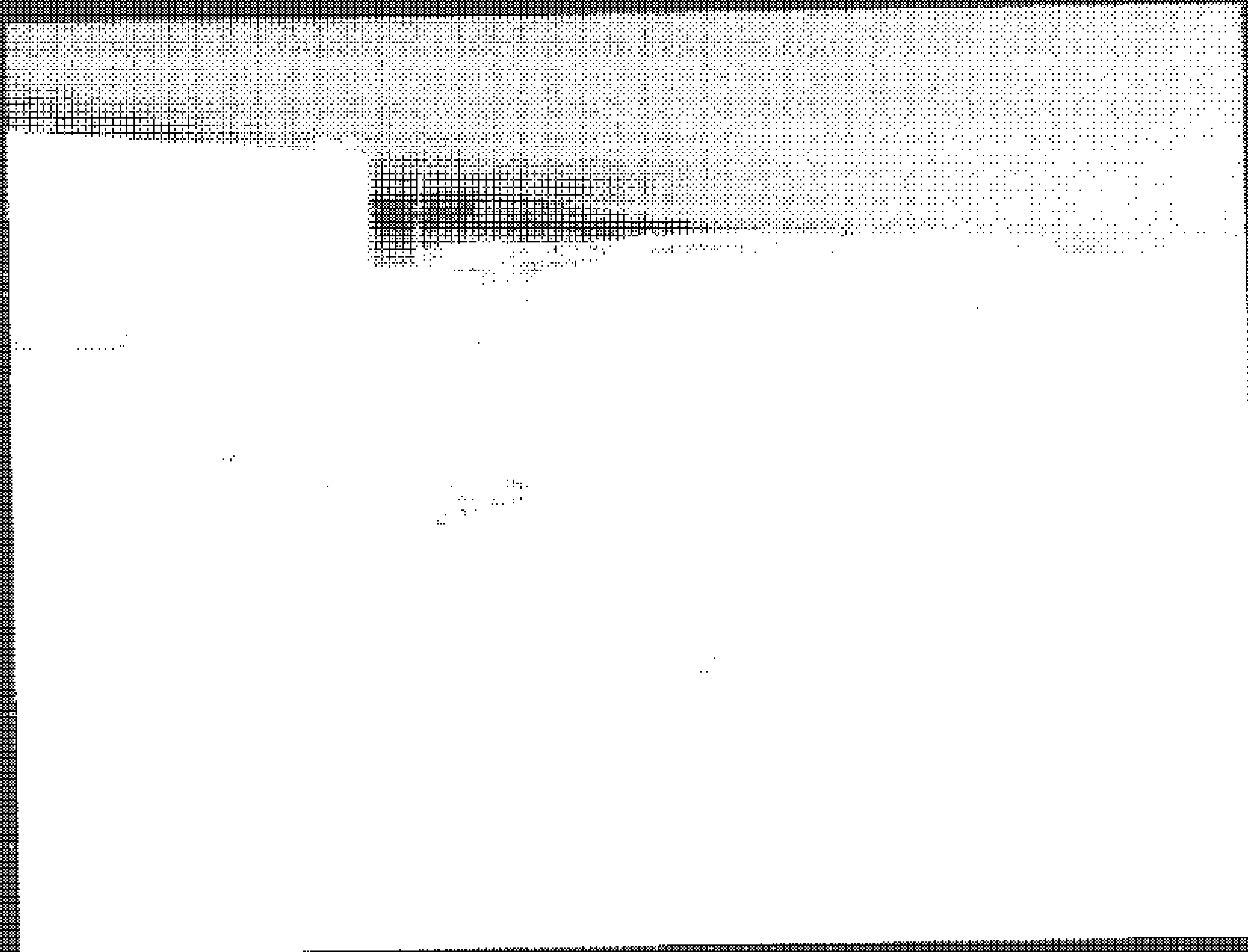


Figure A-3 : 3/4 FRONTAL VIEW FROM LEFT SIDE OF VEHICLE

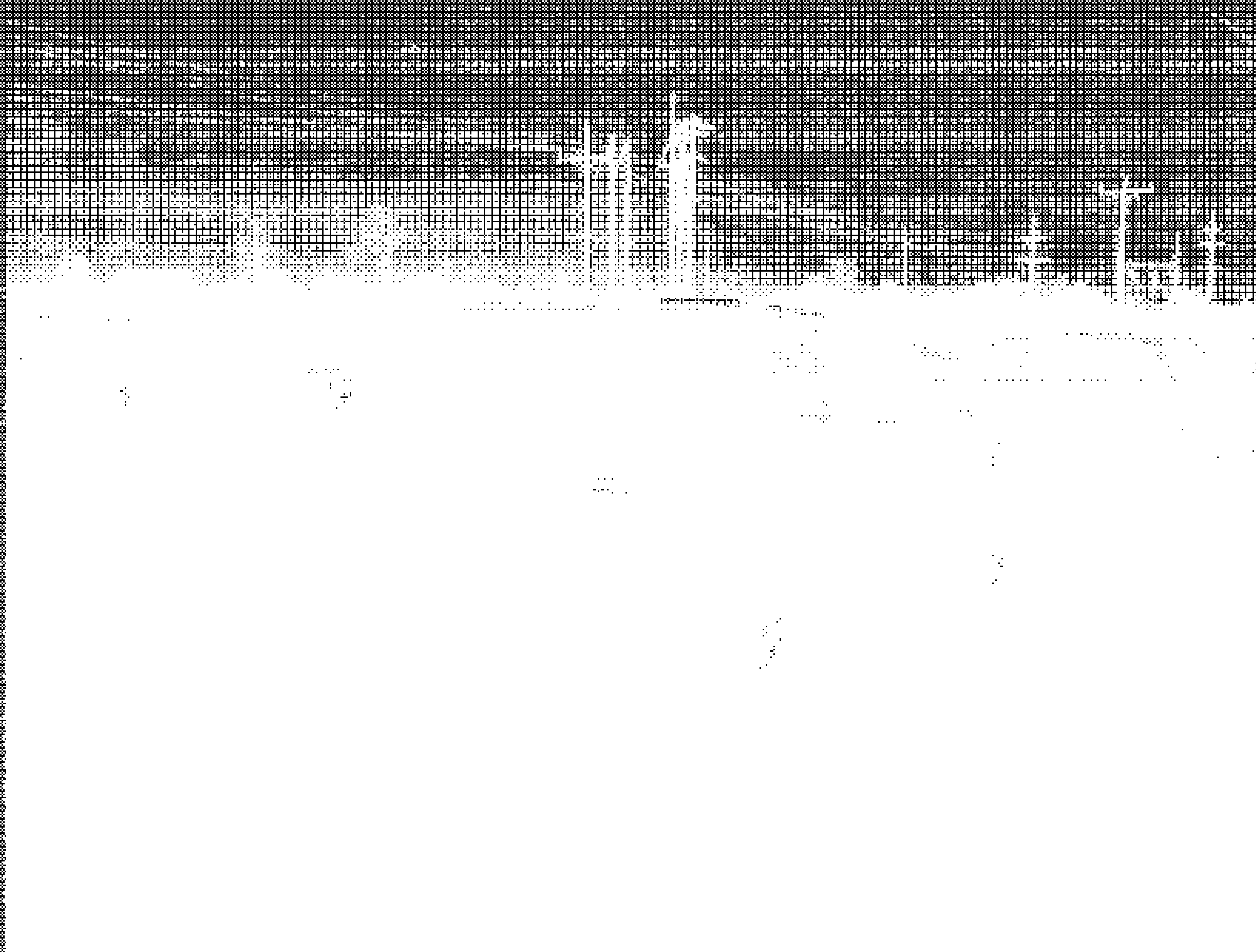


Figure A-4 : 3/4 REAR VIEW FROM RIGHT SIDE OF VEHICLE

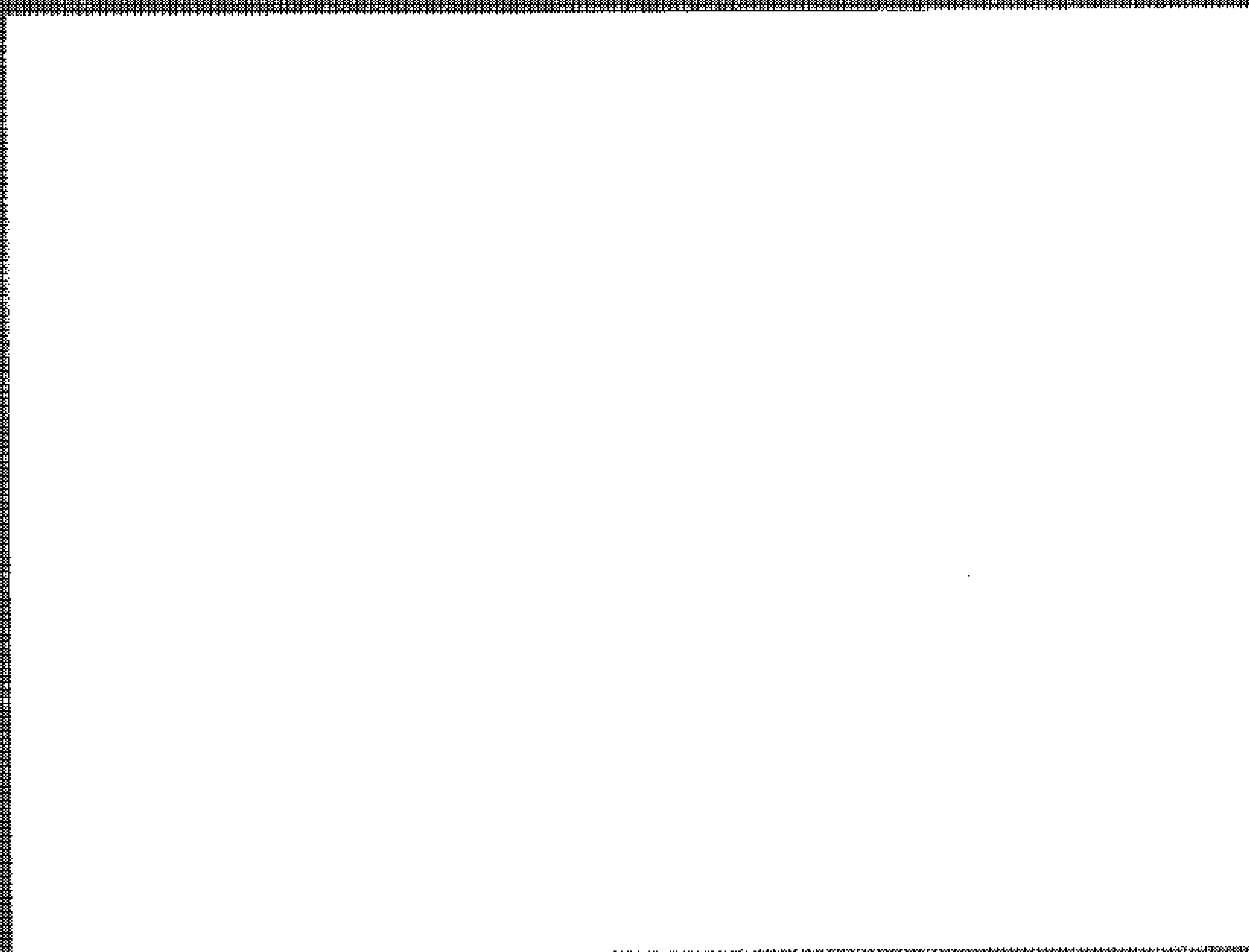


Figure A-5 : VEHICLE'S CERTIFICATION LABEL

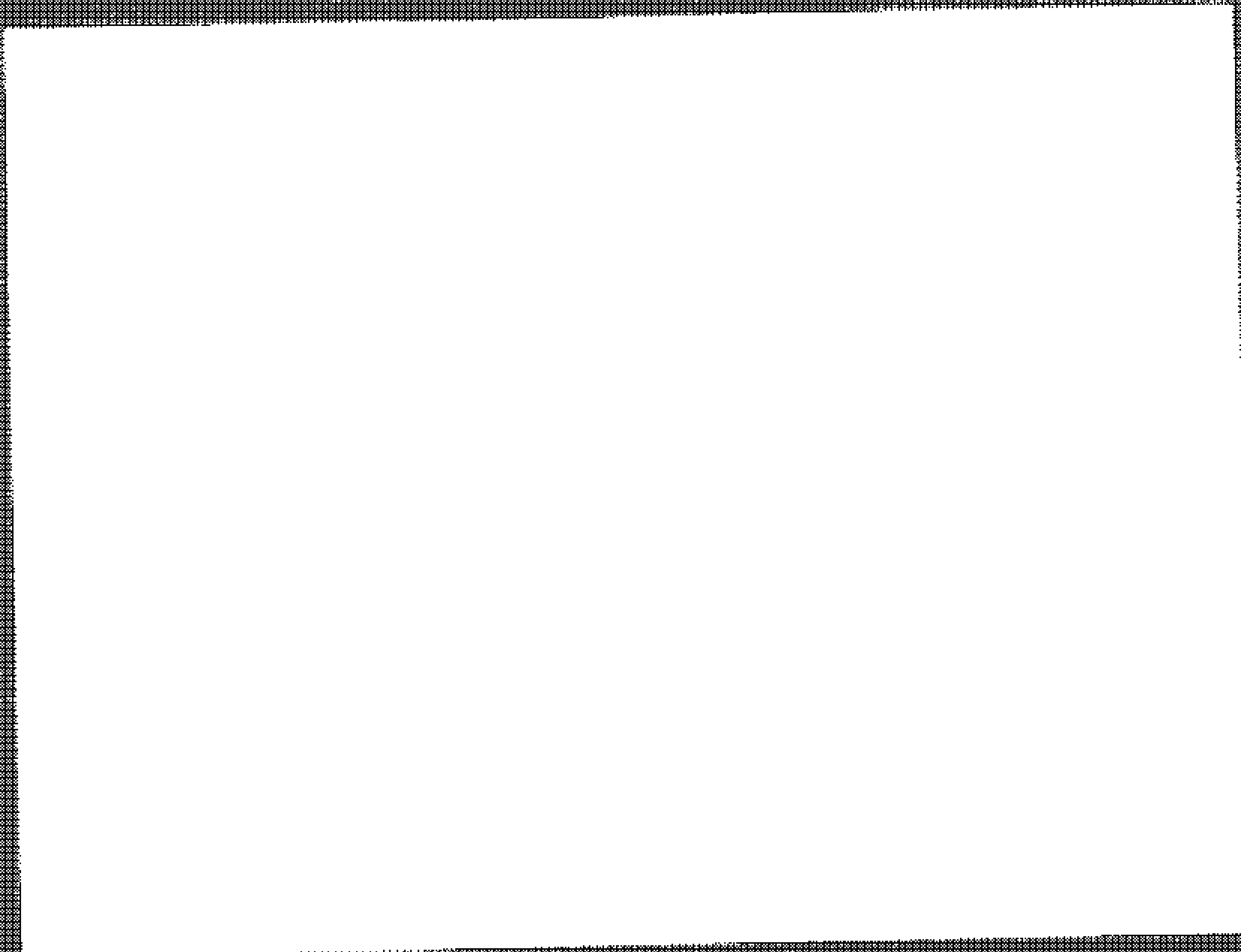


Figure A-6: VEHICLE'S TIRE INFORMATION LABEL

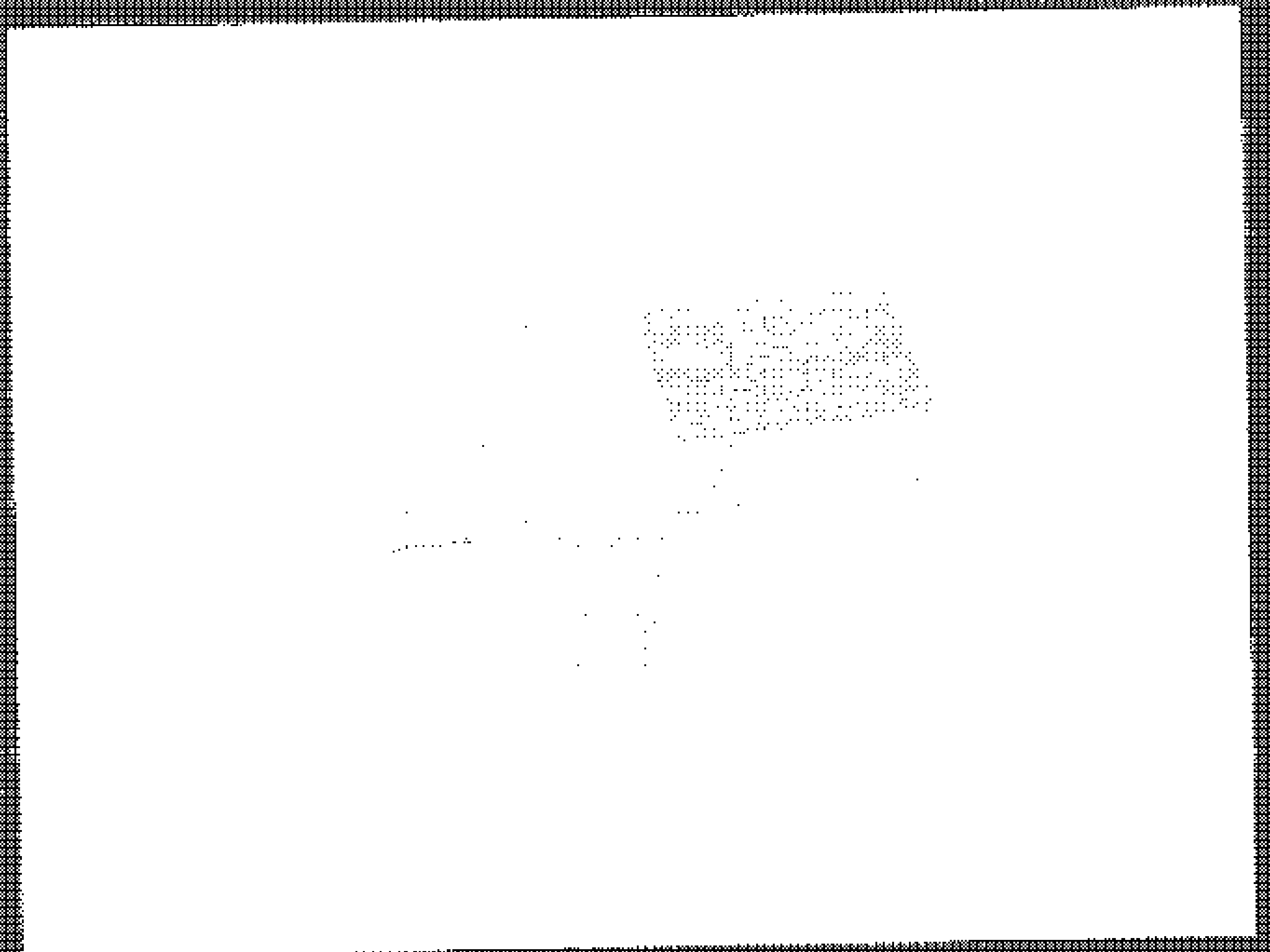


Figure A-7: SUN VISOR CONSTRUCTION

Figure A-8 : ARMREST LEFT FRONT DOOR

Figure A-9: ARMREST FRONT CONSOLE

Figure A-10: ARMREST LEFT REAR DOOR

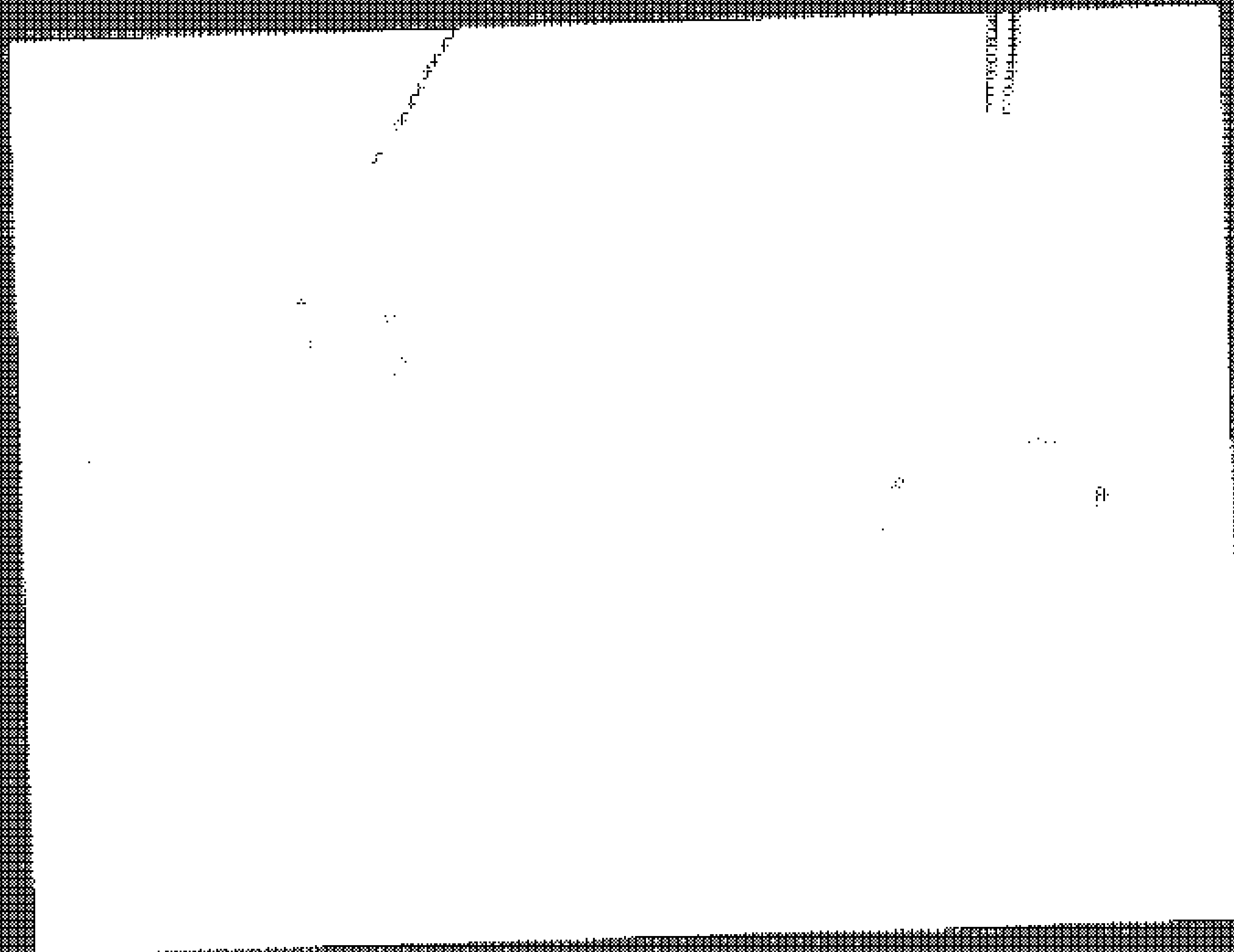


Figure A-11. INSTRUMENT PANEL

PHOTO NOT AVAILABLE

Figure A-12 INSTRUMENT PANEL IMPACT ZONE PRE-TEST

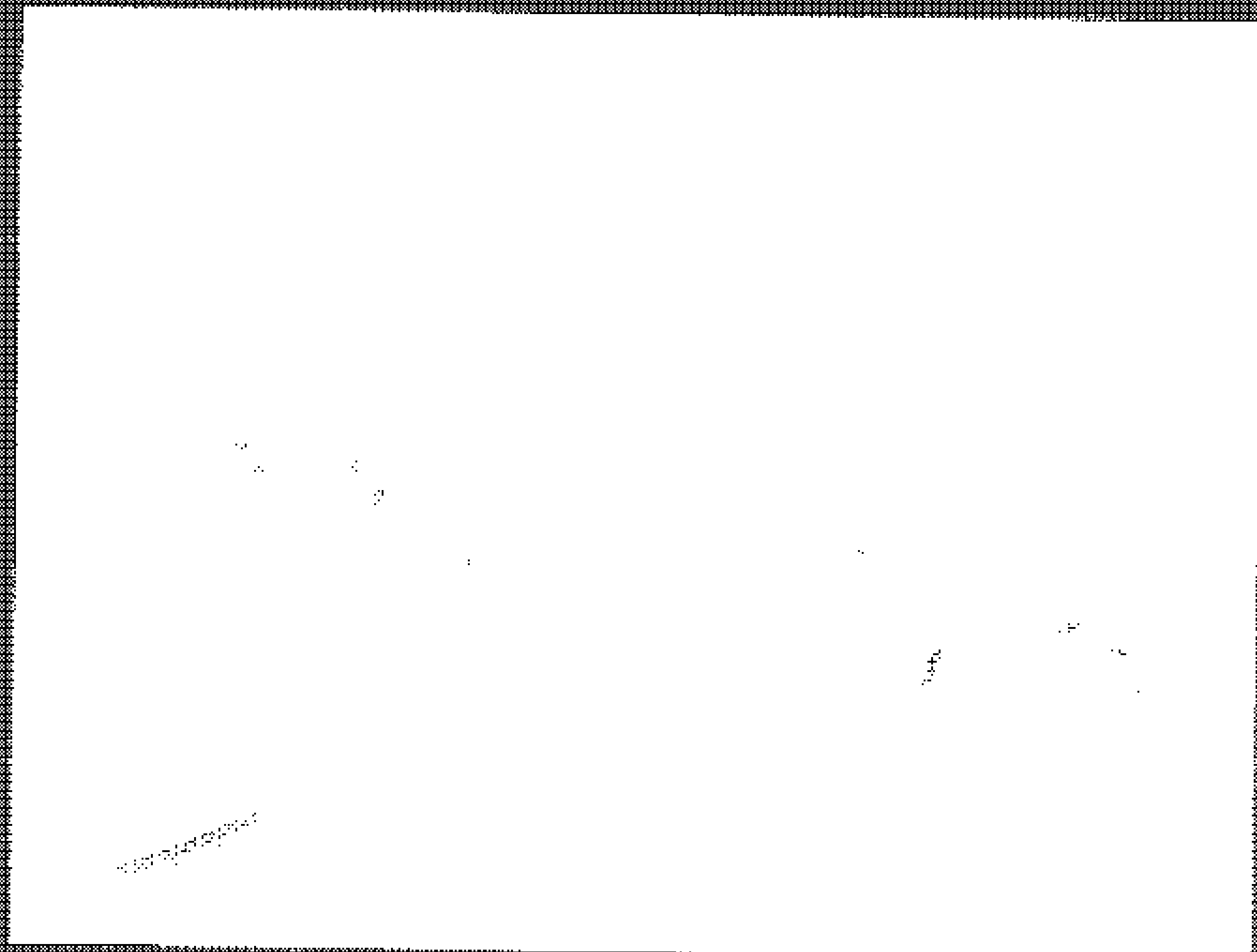


Figure A-13 : INSTRUMENT PANEL IMPACT ZONE POST-TEST

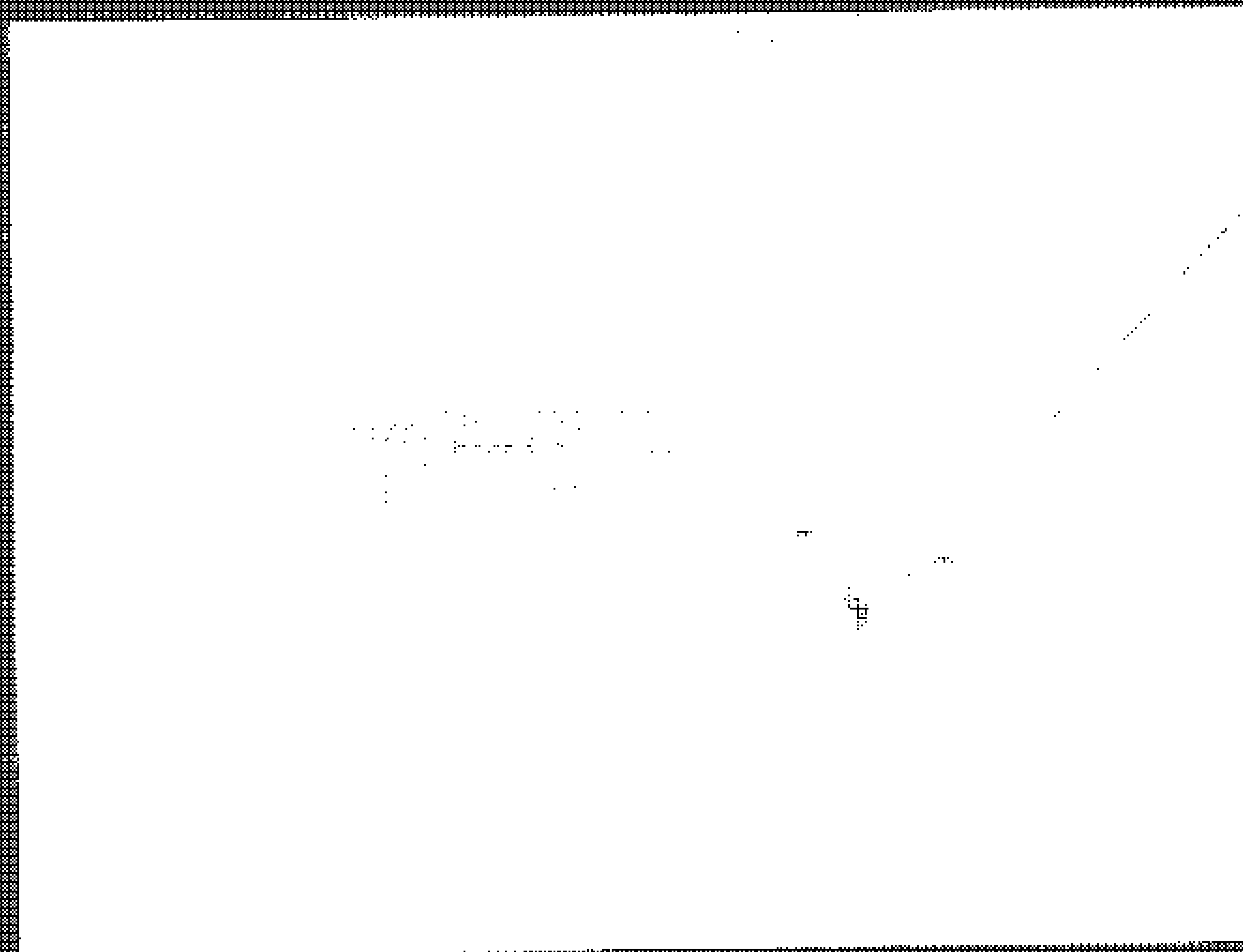


Figure A-14 : INSTRUMENT PANEL LEFT SIDE AIRBAG COVER IMPACT PRE-TEST

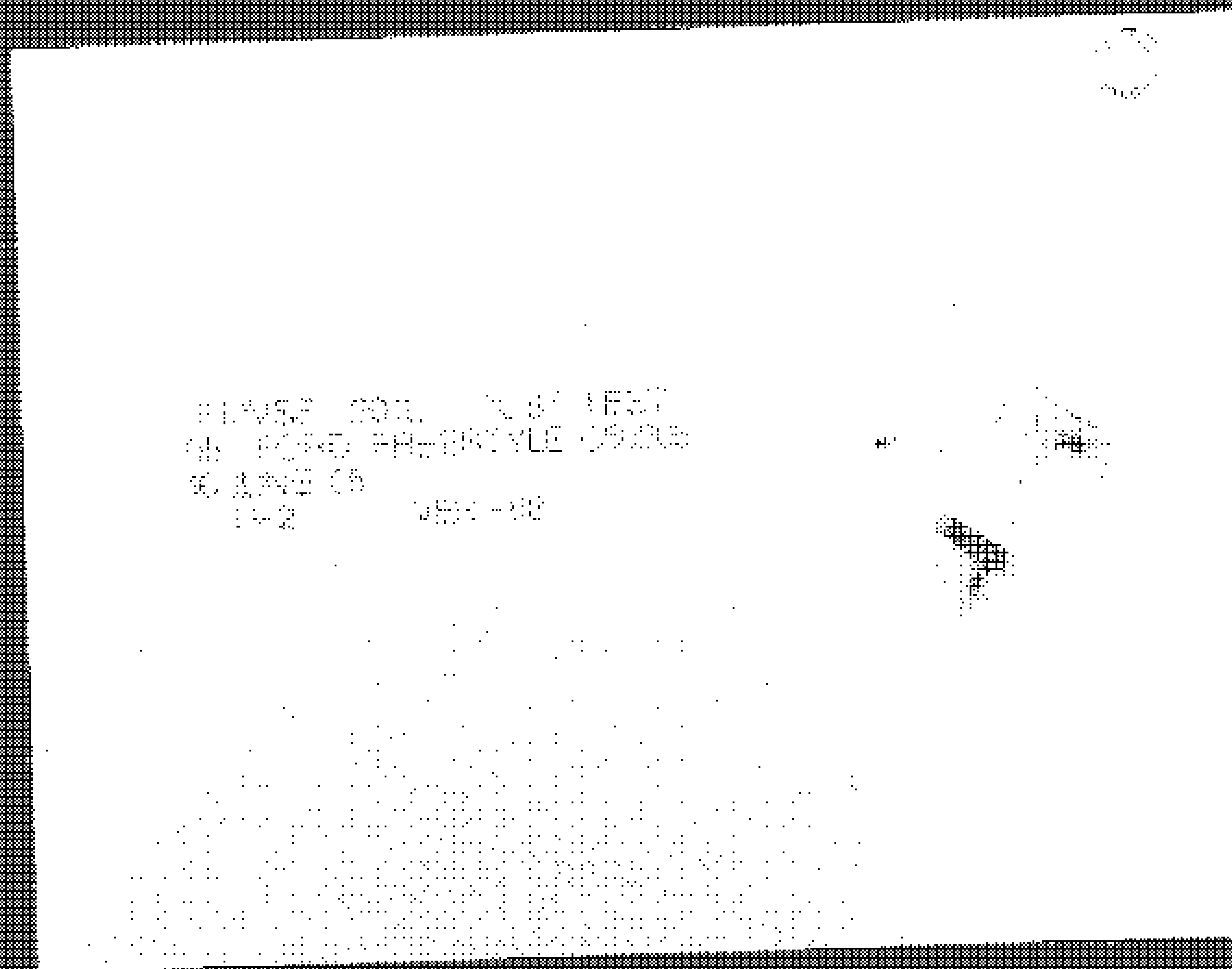


Figure A-15 : INSTRUMENT PANEL LEFT SIDE AIRBAG COVER IMPACT POST-TEST

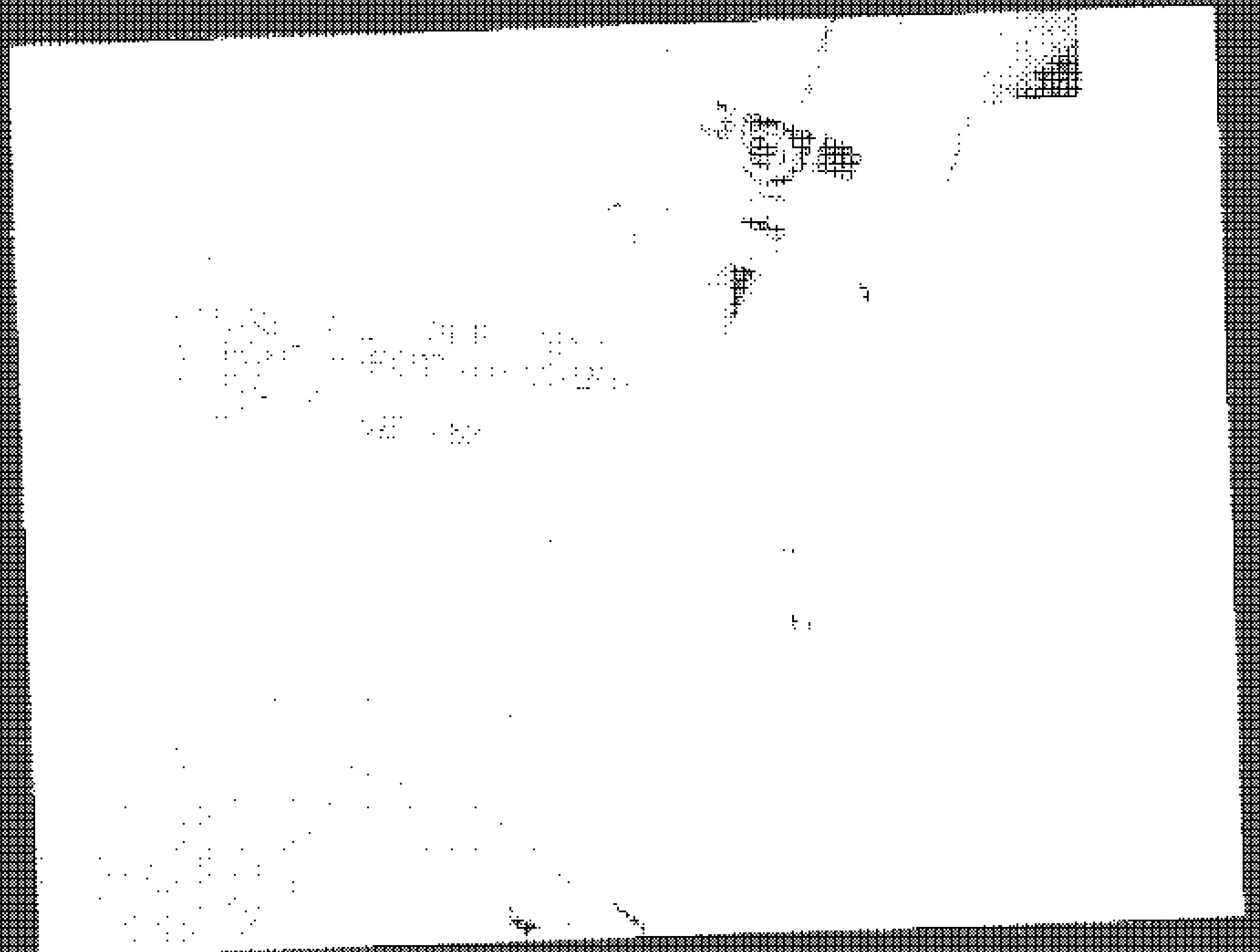


Figure A-16 : INSTRUMENT PANEL RIGHT SIDE AIRBAG COVER IMPACT PRE-TEST

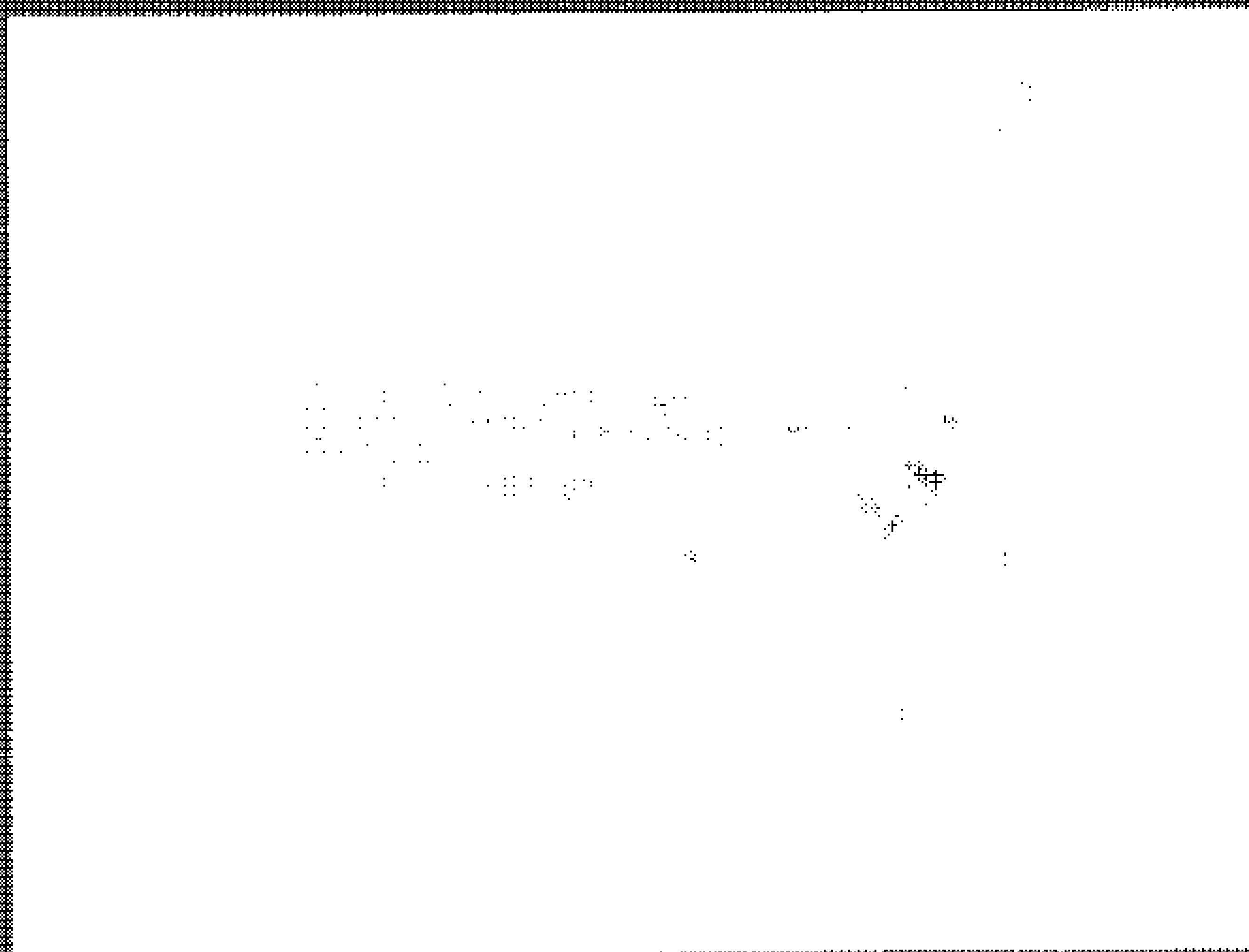


Figure A-17 : INSTRUMENT PANEL RIGHT SIDE AIRBAG COVER IMPACT POST-TEST

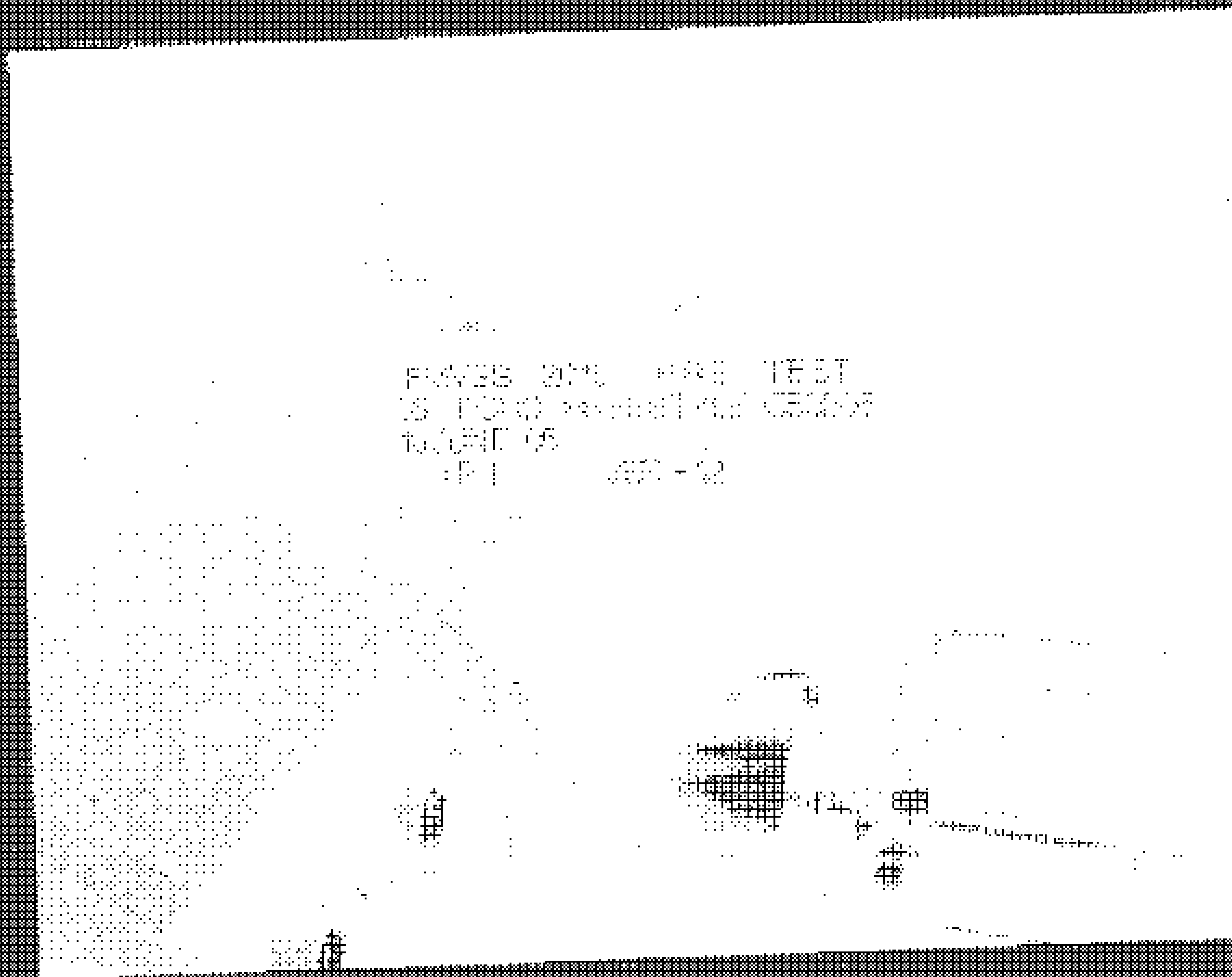


Figure A-18 : INSTRUMENT PANEL ABOVE CENTER CLUSTER VENT IMPACT PRE-TEST

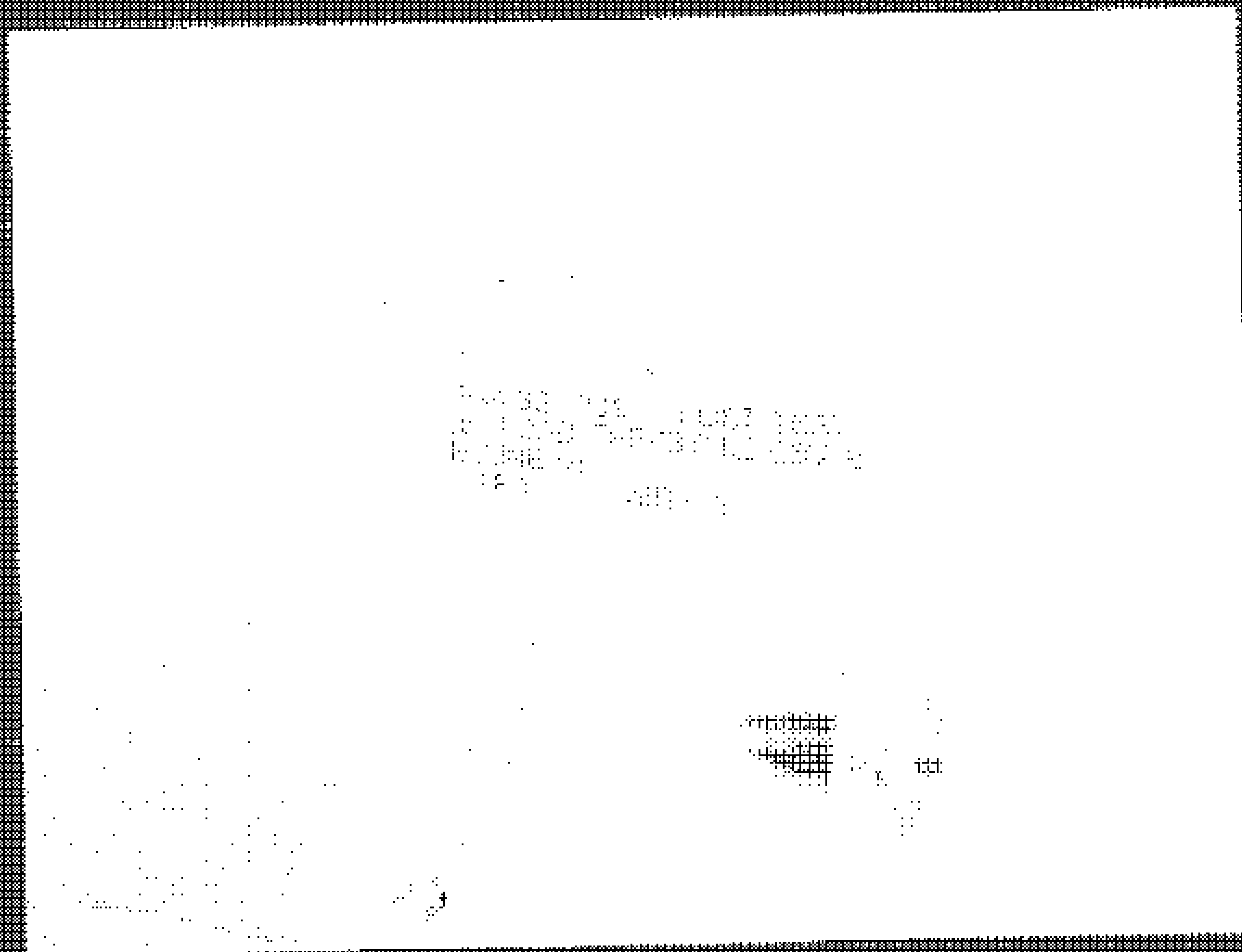


Figure A-19 : INSTRUMENT PANEL ABOVE CENTER CLUSTER VENT IMPACT POST-TEST

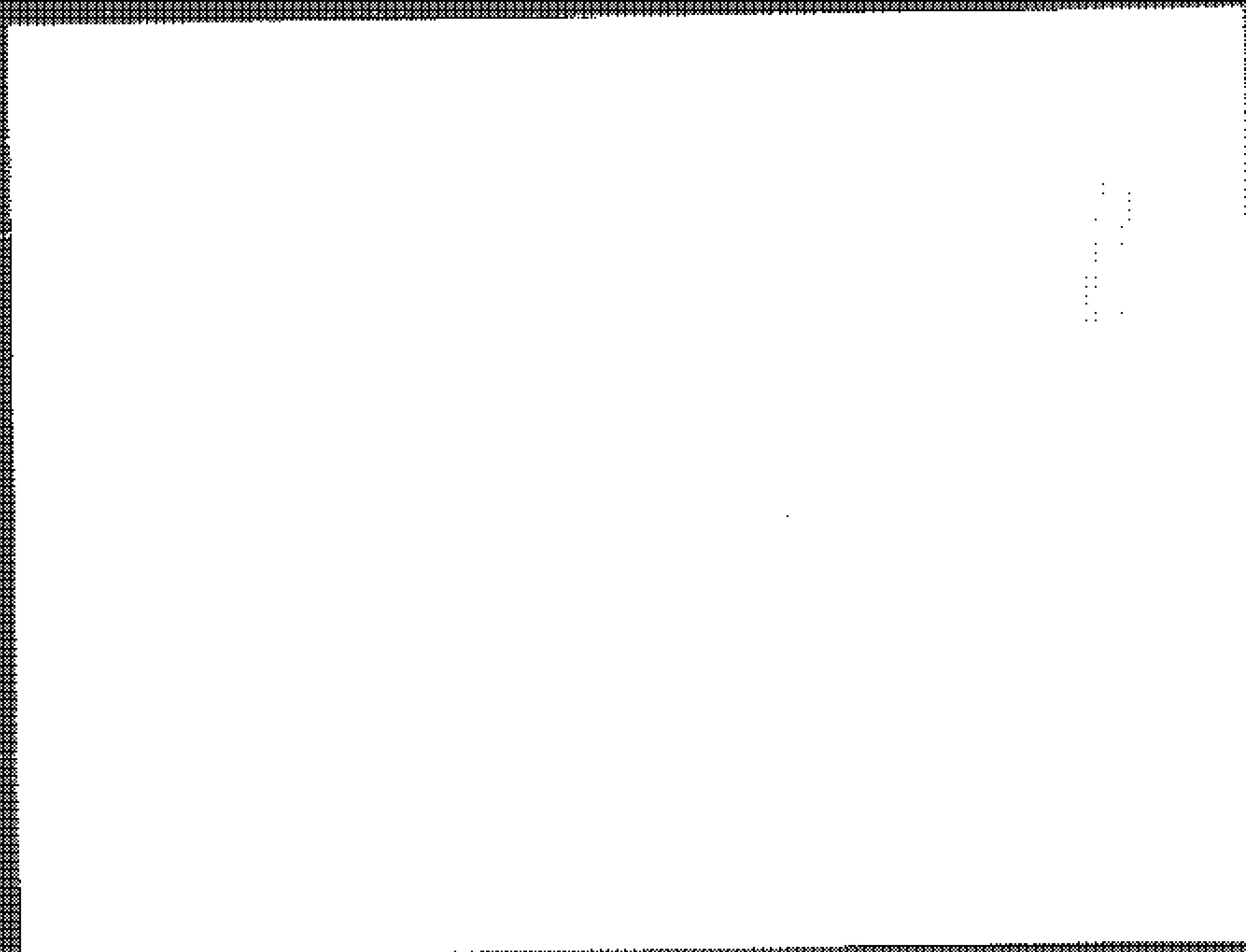


Figure A-70 : HEAD RESTRAINT

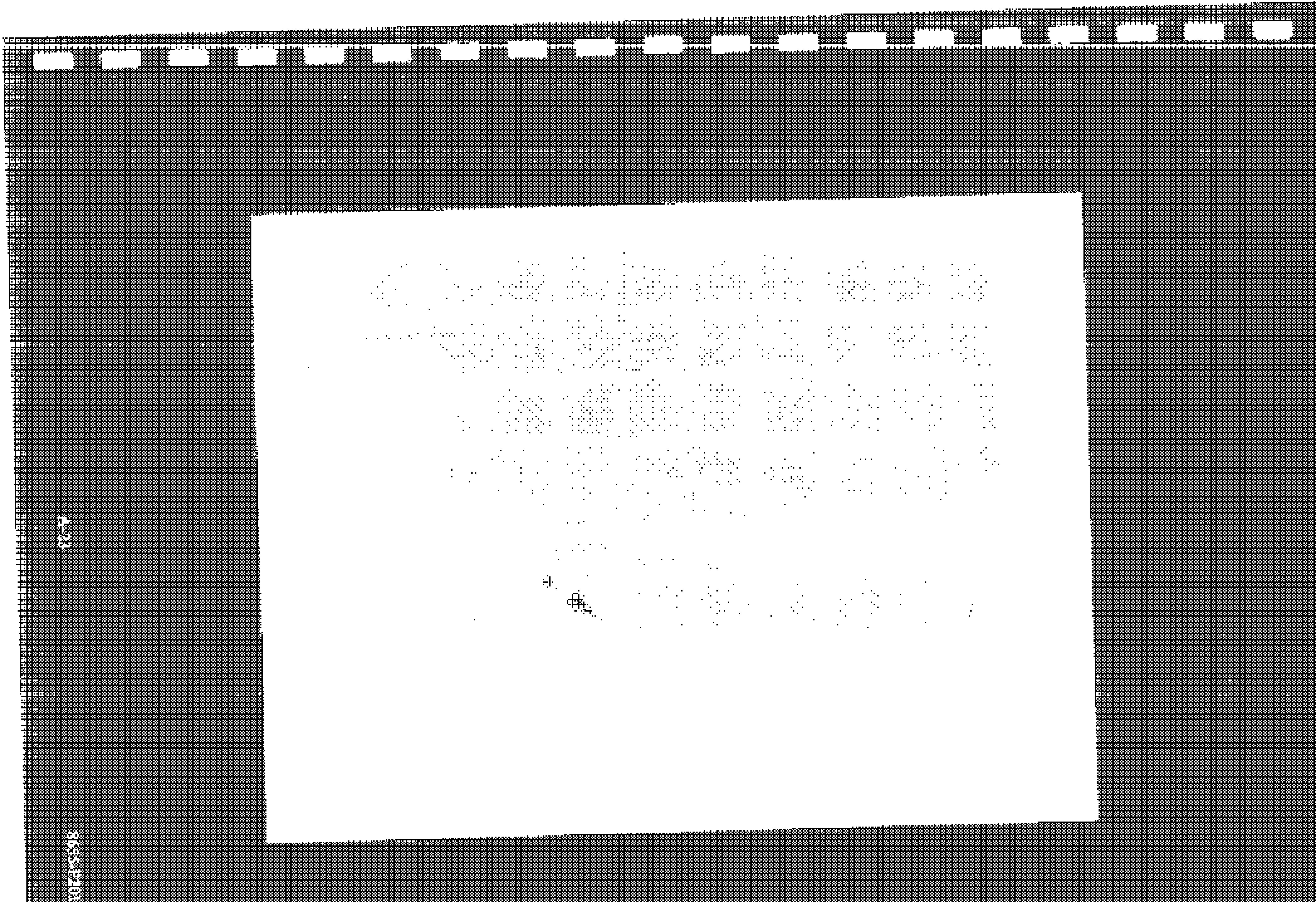


Figure A-21 : HEAD RESTRAINT IMPACT AREA PRE-TEST

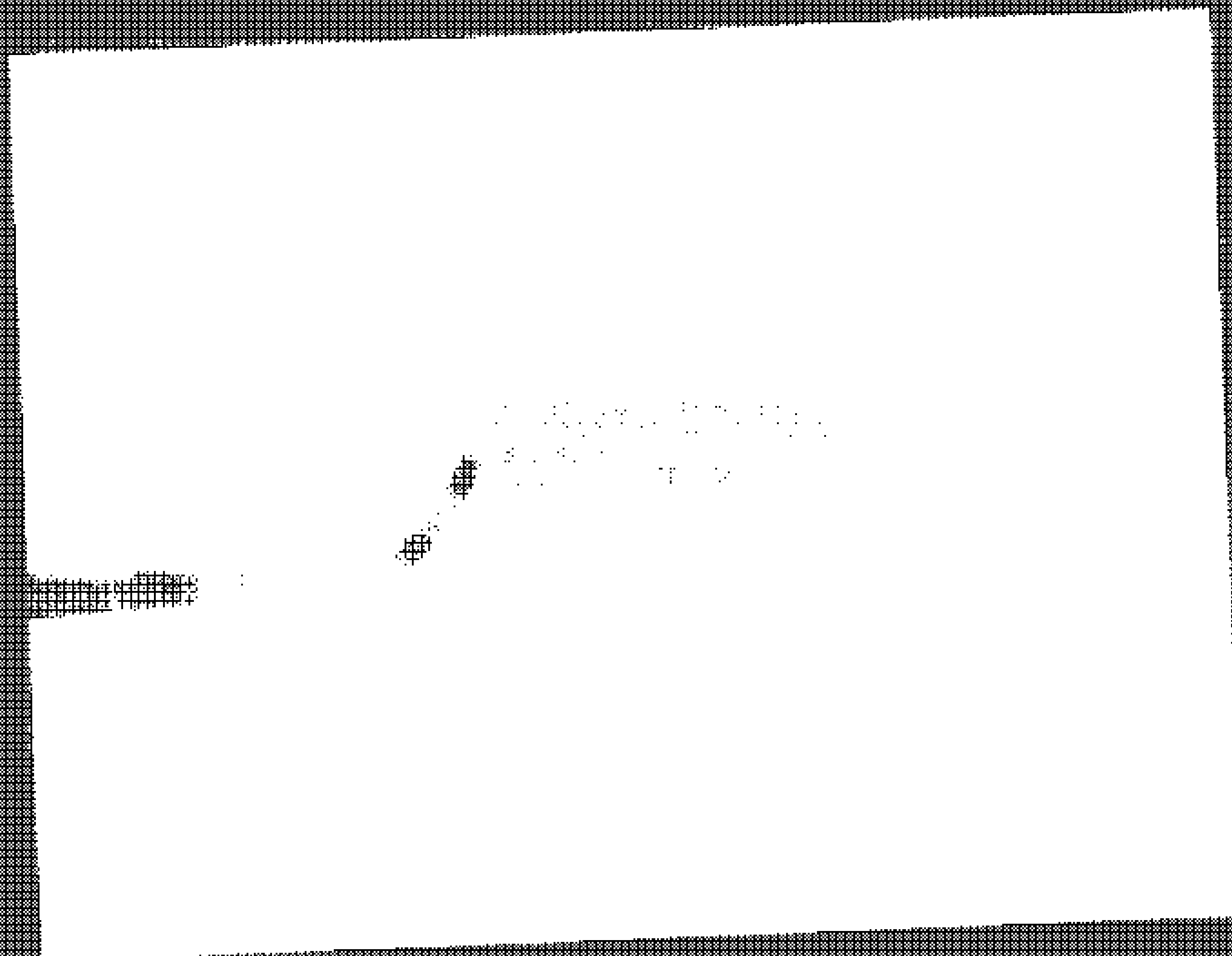


Figure A-22 : HEAD RESTRAINT IMPACT AREA PRE-TEST

8635-F301-30

APPENDIX B

INTERIOR COMPARTMENT DOOR CALCULATIONS

FORM 5

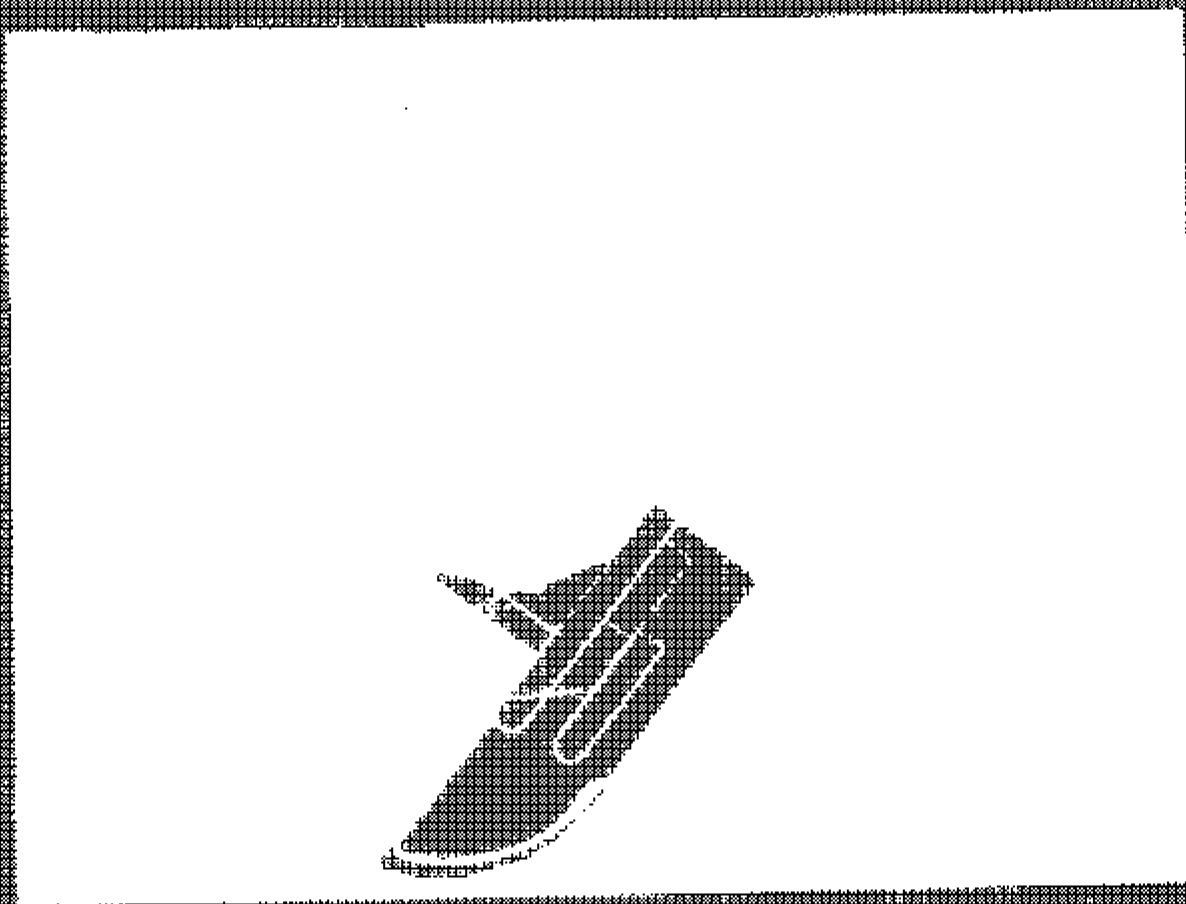
D219 / D258 Glove Box Latch
FMVSS No. 201
Latch Component Analysis Information

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 J839, "Passenger Car Side Door Latch Systems."

Such data shall include:

1. Geometric details of the latch/lock configuration.

In Vehicle Position of Glove Box Latch – Left Side View



2. Mass data for each element in the linkage.

Latch Handle: 0.039 kg

Latch Pawl: 0.008 kg

Mass of spring: 0.000637 kg

3. Spring rates for each spring element in the configuration.

Spring Rate: 1.377 N/mm (note: this is the only spring in this latch)
Free spring length: 34.9 mm
Installed spring length: 30.0 mm
Compressed spring length: 17.5 mm

4. Any additional details unique to the design yet necessary for the calculations.

None

2006 – D219 / D258
Glove compartment latch strength verification – F/CMVSS 201

Introduction:

Interior compartment doors and latches are required to stay closed/latched when subjected to 10G vertical, 10G transverse and 30G longitudinal loads (Paragraphs (a) and (c) of FMVSS 201, S5.3.1 Interior Compartment Doors). There are two parts to the analysis of an interior compartment door assembly. Part 1) analysis of the latch separately, and Part 2) analysis of the entire interior compartment door system. In the first part the latch is examined by itself to see whether the inertial loads will cause sufficient opening moments about the latch's pivot point due to the forces of its own inertia, to cause unlatching. The second part is an examination of the ultimate strength of the latch in its environment, i.e. the inertial effects on the interior compartment door cause opening moments about point H (the hinge pivot), and opening forces at the latch. Pull tests are done and compared to the forces generated at the latch by the inertial loads. If the latch withstands a greater laboratory static load than is generated by the inertial loads, the latch and interior compartment door system comply with the requirements of the regulation.

Objective:

Verify that the glove compartment door and its latch meet the requirements of F/CMVSS 201.

Definitions:

W	=	weight of the compartment door or latch.
m	=	mass of the compartment door or latch.
CG	=	center of gravity of the moving door or latch.
$\sum M_H$	=	summation of moments about the compartment door hinge point or latch pivot point.
F_{10G}	=	vertical 10G inertial load acting on the CG of the compartment door or latch.
F_{30G}	=	longitudinal 30G inertial load acting on the CG of the compartment door or latch.
F_1	=	calculated force at the pull test location that generates the equivalent opening moment about the latch pivot point due to the inertial loads in Part 1.
F_2	=	calculated force at the pull test location that generates the equivalent opening moment about the compartment door hinge point due to the inertial loads in Part 2.
F_{ult}	=	ultimate force that holds the compartment door closed.
F_{op}	=	minimum force that opens the latch, opening effort.
L_{CG}	=	moment arm of the weight of the compartment door or latch measured from the door hinge point or the latch pivot point respectively.
L_{10G}	=	moment arm of the vertical 10G inertial load measured from the door hinge point or the latch pivot point.
L_{30G}	=	moment arm of the longitudinal 30G inertial load measured from the door hinge point or the latch pivot point.
L_1	=	moment arm of the force, F_1, measured from the latch pivot point.
L_2	=	moment arm of the force, F_2, measured from the door hinge point.

Part 1: Analysis of latch by itself

The D219 and D258 have the same glove box and latch system. The latch is supplied by NYX, Inc. and is carry-over from the U222. Reference the attached inertial analysis done by NYX, Inc. on the glove compartment latch for the 2003 MY U222.

Part 2: Analysis of entire interior compartment door system

For Part 2, both the 10G vertical load and 30G longitudinal load will cause opening moments about the hinge pivot point. The 10G transverse load does not cause any opening moments in this case. The 30G longitudinal load is the worst case in this instance and is the only scenario examined in this package. Refer to the illustration on page 4 throughout this analysis.

Calculations:

W = 2.77 lbs (12.32 N)
Mass = 1.255 kg

30G longitudinal load:

Opening moments due to inertia through the CG about Point H.

$$\sum M_H = F_{30G} L_{30G} + WL_{CG}$$
$$\sum M_H = mass \cdot (30g) \cdot L_{30G} + WL_{CG}$$
$$\sum M_H = (1.255\,kg)(30)(9.81)(76.92\,mm) + (12.32\,N)(24.0\,mm)$$
$$\sum M_H = 28705.8\,N - mm$$

10G vertical load:

The 30G longitudinal load case above is the worst case for this analysis (causes the highest opening moments about the hinge pivot) and is the only case examined in this evaluation.

M_H is the total opening moment that would be generated at Point H by an applied 30G longitudinal load.

A single force is assumed acting through the pull test location that generates the equivalent opening moment due to the 30G longitudinal load acting through the CG of the assembly, the worst case. This force will be the minimum force (adjusted from the center of gravity up to the pull location) that the latch must be designed to withstand in order to prevent the opening event due to the inertial load.

Summing the moments about the hinge point

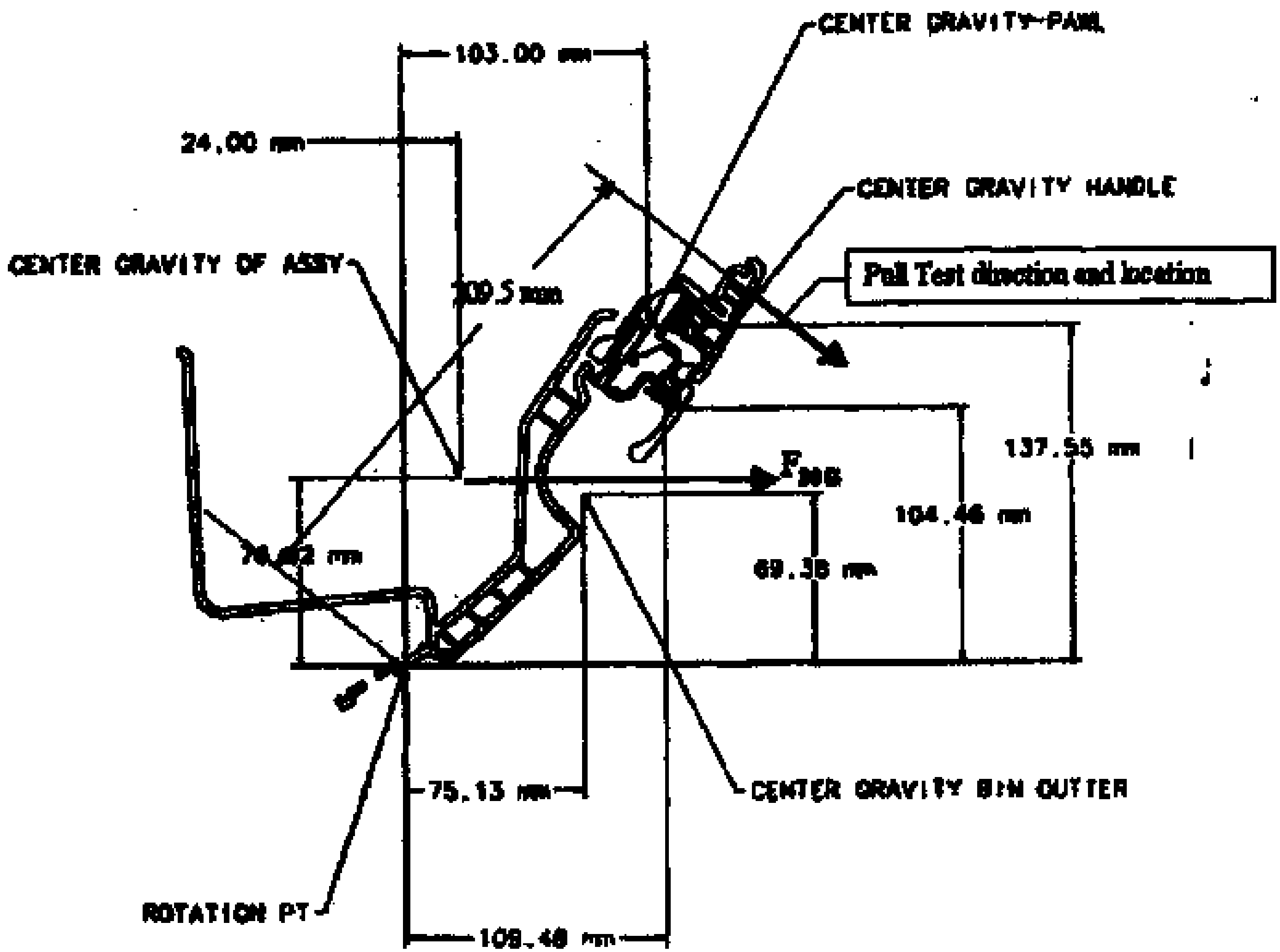
$$\sum M_H = F_2 L_2$$
$$F_2 L_2 = \sum M_H$$
$$F_2 L_2 = 28705.8N - m$$
$$F_2 = \frac{28705.8N - m}{209.5mm}$$
$$F_2 = 137.0N$$
$$F_2 \approx 30.8lbs$$

Conclusion:

F_2, the calculated force acting at the designated test location, that generates the equivalent opening moments as a 30 G longitudinal load, is 137.0 N. Therefore, the latch must be designed so that F_{ult} is greater than F_2.

Test verification:

A pull test on the U222 system (same latch) resulted in an ultimate load of 680 N at which point the striker wire-form pulled free of the glove box latch. There was no apparent damage to the latch, and it still functioned properly. This ultimate load results in a **Design factor of 680 / 137.0 = 4.96.**


CENTER GRAVITY-PAWL
103.00 mm
24.00 mm
CENTER GRAVITY HANDLE
CENTER GRAVITY OF ASSY
109.5 mm
Pull Test direction and location
137.55 mm
F_{300}
104.46 mm
76.62 mm
69.38 mm
75.13 mm
CENTER GRAVITY BIN OUTTER
ROTATION PT
109.48 mm

FORM 5

D219 and D258 Top Center Storage Bin Latch
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:

1. Geometric details of the latch/lock configuration.

In Vehicle Position of Center Storage Bin Latch – Left Side View

2. Mass data for each element in the linkage.

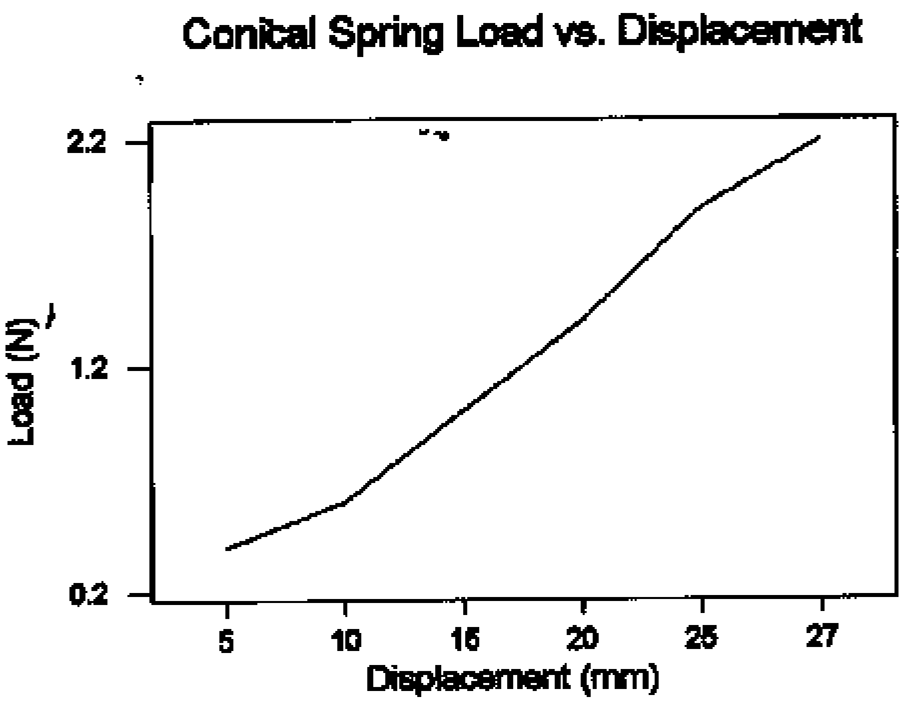
Push button: 0.001 kg

Latch hook: 0.003 kg

3. Spring rates for each spring element in the configuration.

Conical Compression Spring: (see load-displacement curve on next page)

Free length: 28.5 mm
Installed length: 8.5 mm (0.45 N preload at installed length)
Wire diameter: 0.89 mm
Top coil diameter: 17.0 mm
Bottom coil diameter: 21.0 mm



Torsion Spring:

Spring rate: 0.05 kgf/millimeter per degree

4. Any additional details unique to the design yet necessary for the calculations.

None

2006 – D219
Instrument Panel Storage Bin Lid Latch Strength and Latch Inertial Analysis

Introduction:

Interior compartment doors and latches are required to stay closed/latched when subjected to 10G vertical, 10G transverse and 30G longitudinal loads (Paragraphs (a) and (c) of FMVSS 201, S5.3.1 Interior Compartment Doors). There are two parts to the analysis of an interior compartment door assembly. Part 1) analysis of the latch separately, and Part 2) analysis of the entire interior compartment door system. In the first part the latch is examined by itself to see whether the inertial loads will cause opening moments about the latch's pivot point due to the forces of its own inertia. The second part is an examination of the ultimate strength of the latch in its environment, i.e. the inertial effects on the interior compartment door cause opening moments about point H (the hinge pivot), and opening forces at the latch. Pull tests are done and compared to the forces generated at the latch by the inertial loads. If the latch withstands a greater laboratory static load than is generated by the inertial loads, the latch and interior compartment door system comply with the requirements of the regulation.

Objective:

Verify that the storage bin lid and its latch meet the requirements of F/CMVSS 201.

Definitions:

W	=	weight of the compartment door or latch.
m	=	mass of the compartment door or latch.
CG	=	center of gravity of the moving door or latch.
$\sum M_H$	=	summation of moments about the compartment door hinge point or latch pivot point in the clockwise direction.
F_{100}	=	vertical 10G inertial load acting on the CG of the compartment door or latch.
F_{300}	=	longitudinal 30G inertial load acting on the CG of the compartment door or latch.
F_1	=	calculated force at the test location that generates the equivalent opening moment about the latch pivot point due to the inertial loads in Part 1.
F_2	=	calculated force at the pull test location that generates the equivalent opening moment about the compartment door hinge point due to the inertial loads in Part 2.
F_{ult}	=	ultimate force that holds the compartment door closed.
F_{op}	=	minimum force that opens the latch, opening effort.
L_{CG}	=	moment arm of the weight of the compartment door or latch measured from the door hinge point or the latch pivot point respectively.
L_{100}	=	moment arm of the vertical 10G inertial load measured from the door hinge point or the latch pivot point.
L_{300}	=	moment arm of the longitudinal 30G inertial load measured from the door hinge point or the latch pivot point.
L_1	=	moment arm of the force, F_1, measured from the latch pivot point.
L_2	=	moment arm of the force, F_2, measured from the door hinge point.

Part 1: Analysis of latch by itself

Piolax supplies the latch being used for the 2005 MY D219 and D258 storage bin. For this part of the analysis, refer to the figure of the latch on page 5.

10G transverse loads:

The transverse load condition will not cause any opening moments about the latch hooks pivot.

10G vertical load upward:

The button would tend to move upward, and the moment generated about the latch hook pivot would act in a CW direction keeping the latch closed.

10G vertical load downward:

The button would tend to move down putting a force into the hook generating an opening moment, and the inertia of the hook would tend to rotate it CCW in the direction of opening.

$$\sum M_{total} = M_{button} + M_{hook}$$
$$M_{button} = F_{10G\_button} * L_{10G\_button}$$
$$M_{button} = (0.001kg)(10)(9.81)(\cos 20)(9.762mm) = 0.9N-mm$$
$$M_{hook} = F_{10G\_hook} * L_{10G\_hook}$$
$$M_{hook} = (0.003kg)(10)(9.81)(2.52mm) = 0.742N-mm$$
$$\sum M_{total} = 0.9N-mm + 0.742N-mm = 1.64N-mm$$

A 10G vertical load generates 1.64 N-mm of opening moment about the latch hook pivot. The minimum opening effort required to actuate the latch is 4 N. A 4 N force on the button would generate a moment of: 4 N * 9.762 mm = 39.0 N-mm about the latch hook pivot. This means that 39.0 N-mm of moment is needed to open the latch. The latch will not open due to the inertia generated by a 10G downward vertical load, with a design factor of 39.0/1.64 = 23.8.

30G longitudinal load forward:

The button would tend to move downward, but the hook, which weighs 3 times more than the button would tend to rotate CW keeping the system latched. The bin would not open.

30G longitudinal load rearward:

The button would tend to move upward, but the hook would tend to rotate CCW in the opening direction.

$$M_{hook} = F_{30G\_hook} * L_{30G\_hook}$$
$$M_{hook} = (0.003kg)(30)(9.81)(6.95mm)$$
$$M_{hook} = 6.136N-mm$$

The 30G rearward longitudinal load would generate an opening moment about the latch pivot of 6.136 N-mm. The minimum opening effort required to actuate the latch is 4 N. A 4 N force on the button would generate a moment of 39.0 N-mm about the latch hook pivot. This means that 39.0 N-mm of moment is needed to open the latch. The latch will not open due to the inertia generated by a 30G rearward longitudinal load, with a design factor of 39.0/6.136 = 6.36.

The latch will not open by its own inertia under any of the loading conditions called out in S5.3.1 (a) and (c) of FMVSS 201.

Part 2: Analysis of entire interior compartment door system

For Part 2, the 10G transverse loads do not cause any opening moments about the lid pivot and are not considered in this analysis. Both the 10G vertical load upward and 30G longitudinal loads will cause opening moments about the hinge pivot point. But the moment arm of the 10G vertical load is >> 3 times the length of the 30G longitudinal loads moment arm, so the 10G vertical load upward is the worst case and will be the only condition examined in this analysis. Refer to the illustration on page 6 of the lid and latch system throughout this analysis.

Calculations:

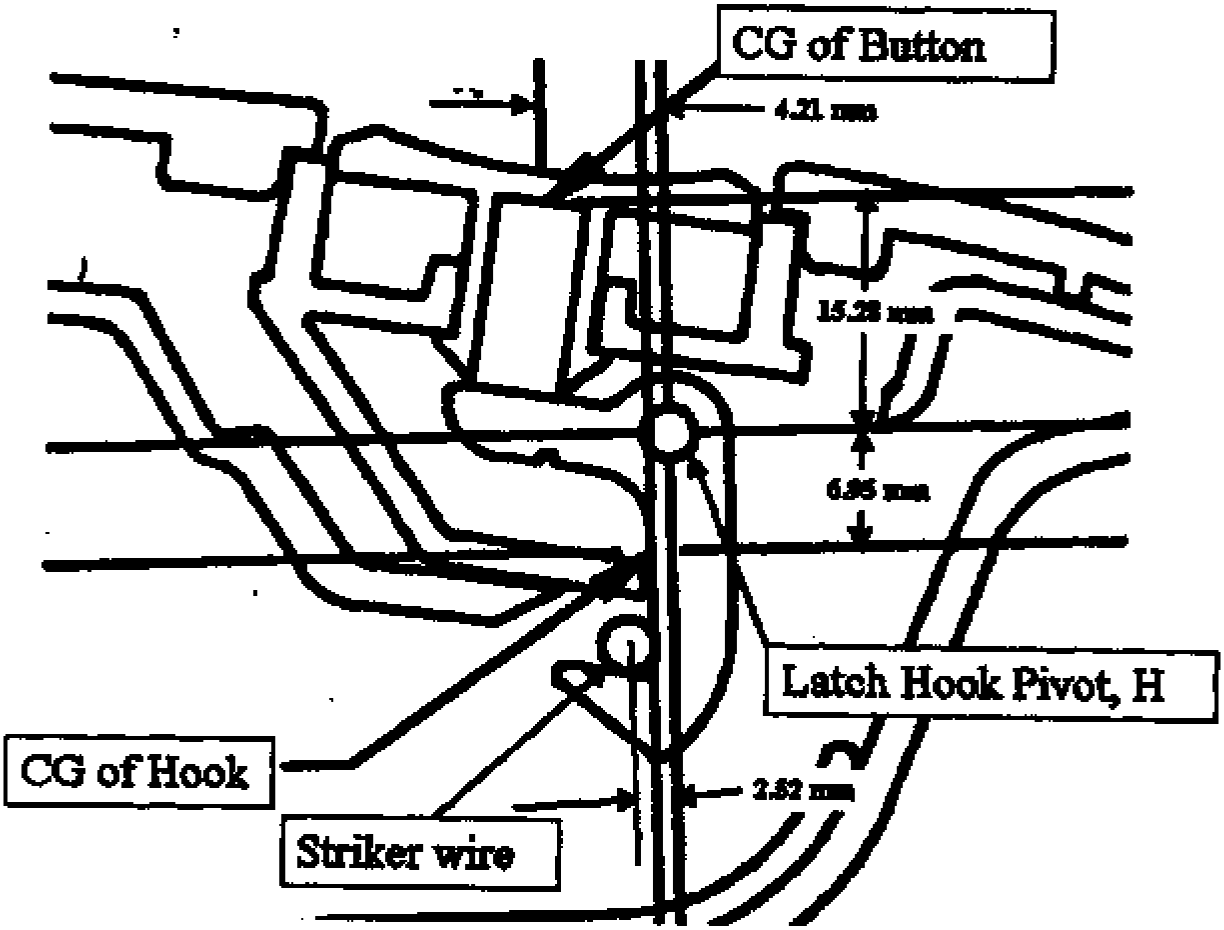
W = 0.86 lbs (3.83 N)
Mass = 0.39 kg

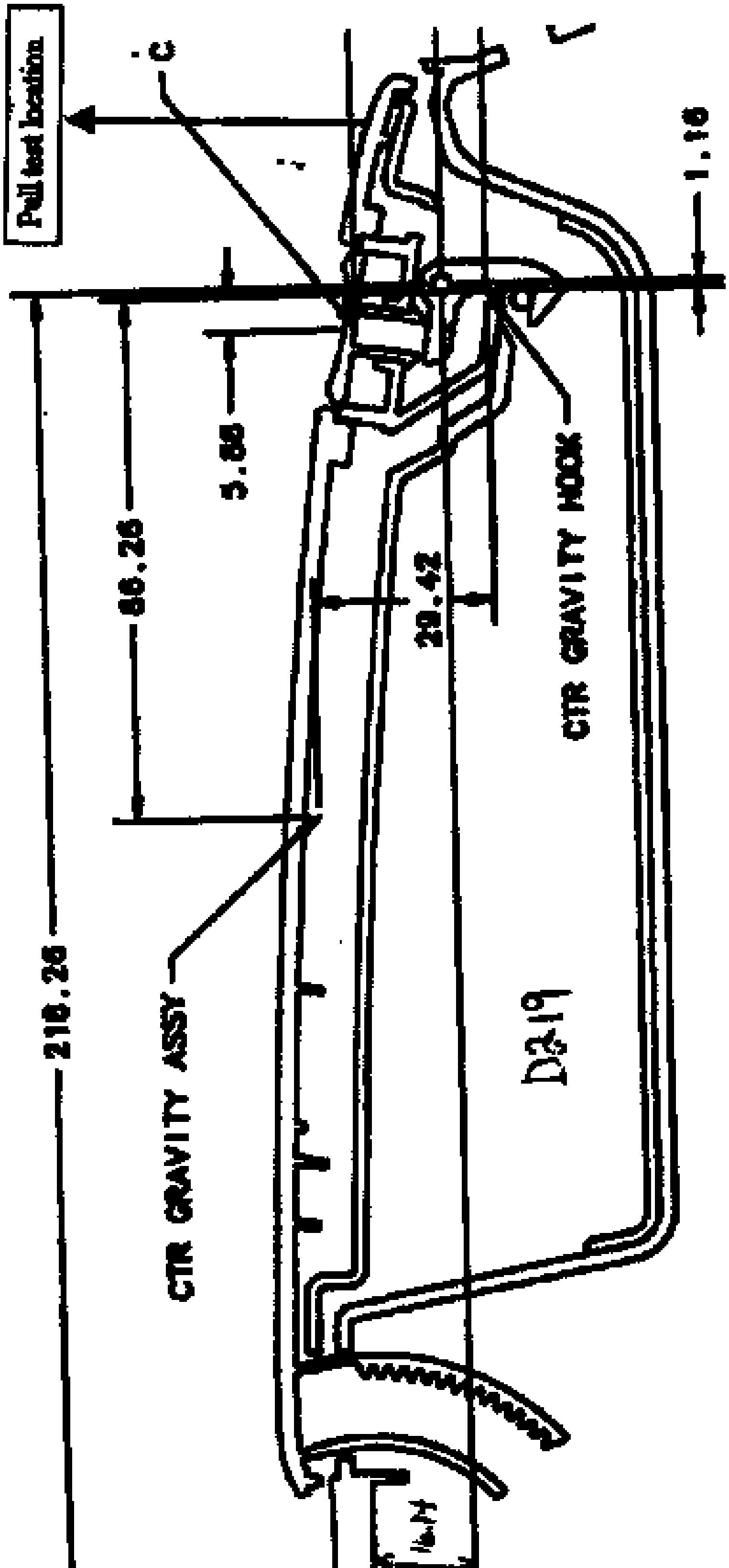
<u>10G vertical load upward</u>:

The moment generated about the hinge point H by the 10G load, neglecting the moment due to the weight of the assembly (worst case) is:

$$\sum M_H = F_{10G} * L_{10G}$$
$$\sum M_H = m \cdot (10G) \cdot L_{10G}$$
$$\sum M_H = (0.39kg)(10)(9.81)(130.84mm)$$
$$\sum M_H = 5005.81N - mm$$

A pull test was done on physical parts. The force was applied at the rearward in vehicle edge of the lid. The result was 320 N. A 320 N force at this location would generate, 320 N * 245 mm = 78400 N-mm of moment about the hinge pivot. This means that 78400 N-mm of moment is needed to overcome the strength of the latch, and the 10G vertical load only generated 5005.8 N-mm of moment. The latch will not open due to the inertia generated by a 10G vertical load, with a design factor of 78400 / 5005.8 = 15.6.


CG of Button
4.21 mm
15.28 mm
6.86 mm
Latch Hook Pivot, H
CG of Hook
2.52 mm
Striker wire



Pull test location
C
1.16
5.55
86.26
29.42
CTR GRAVITY HOOK
218.26
CTR GRAVITY ASSY
D219

FORM 5

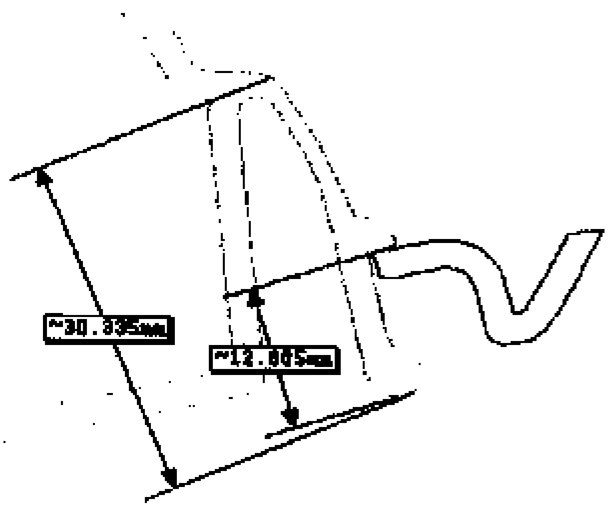
FMVSS No. 201
Latch Component Analysis Information

D219/D258 Overhead Console Latch

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:

1. Geometric details of the latch/lock configuration.



2. Mass data for each element in the linkage.

Mass of the latch: 1 g.

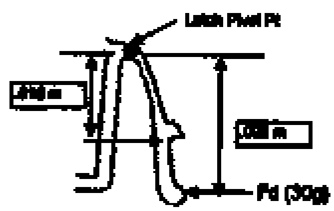
3. **Spring rates for each spring element in the configuration.**

F = K * x => Linear approximation for calculating spring constant
F average = 7.5 N
x = 3.5 mm
F = K * x
K = F / x = 7.5 N / (3.5 mm)
K = 2.14 N/mm

4. **Any additional details unique to the design yet necessary for the calculations.**

There are no unique design features. The latch is a standard off the shelf "living hinge" design.

Latch 30g Deceleration



Latch Efforts
7.0
7.5
7.0
7.0
7.2

m	Mass =	0.001 Kg
Fd	Force of Deceleration (m)(g)(D) = (0.001)(9.81)(30) =	0.29 N
F_L	Spring force of Latch (measured)	7 N
F_{LC}	Calculated Min retention force of Latch	

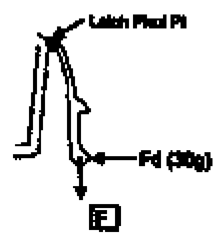
$\Sigma M_o = (F_{LC} * 0.018) - (Fd * .028) = 0$

$F_{LC} = \frac{(0.29 * .028)}{.018}$

F_{LC} = 0.45 N

Factor of Safety = F_L / F_{LC} = 15.6

Latch Shear (30g Decel) & Axial Loads (10g Rollover) Calcs



Fx = Axial load on latch (10g rollover) = (10)(0.001)(9.81) =	0.10 N
Fd = Shear load on latch (30g decel) = (30)(0.001)(9.81) =	0.29 N
A = Area of latch @ Latch Pivot point = (19 x 1.75 mm^2) =	33.25 mm^2
Yield Modulus (PC-ABS)	57 Mpa

Shear Calcs		Axial Load Calcs	
τ = Fd/A	0.01 Mpa	σ = Fx/A	0.003 Mpa
FS =	5700	FS =	19000

FMVSS 201 COMPLIANCE REPORT AND CALCULATIONS

D219 MODEL YEAR 2005

CONSOLE ASSEMBLY ROOF

STANDARD

ASSEMBLY NO.: 5F93-74519A58-A/B
5G13-54519A58-A

MOONROOF

JANUARY 29, 2003

TABLE OF CONTENTS

REVISION LOG

1 Original Completion.. 1-Jul-2003

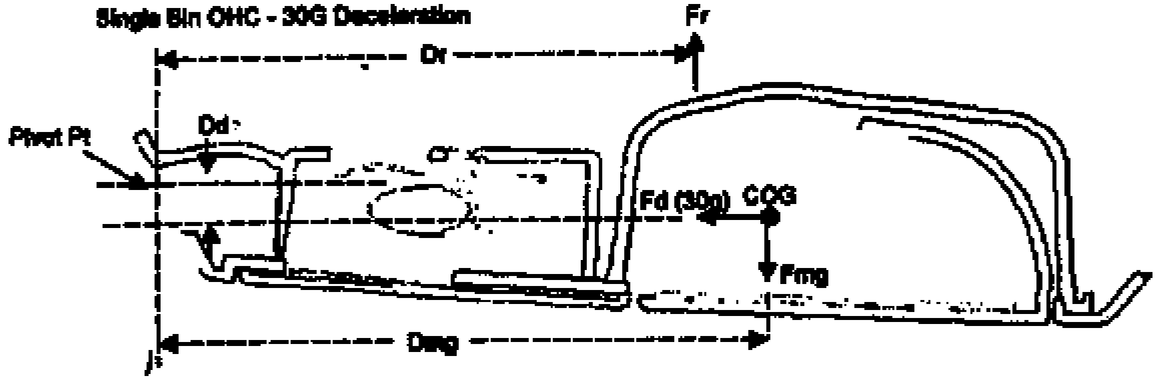
2 Revised to include 1PP changes... 28-Jan-2004

FMVSS 201 REQUIREMENTS

FMVSS 201 requires all interior compartment doors remained closed when subjected to:

1. An inertial load of 30G in the +/- X Direction (Vehicle forward/rearward)
2. An inertial load of 10G in the +/- Z Direction (Vehicle up/down)
3. An inertial load of 10G in the +/- Y Direction (Vehicle inboard/outboard)

Single Bin OHC - 30G Deceleration



m	Mass =	0.42 Kg
Fmg	Force of Gravity (m)(g) = (0.42)(9.81)=	4.1 N
Fr	Calc. for retention of clip (N) =	Solve N
Fd	Force of Deceleration (m)(g)(D) = (0.42)(9.81)(30) =	123.6 N
Dd	Radial arm of Deceleration =	0.017 M
Dr	Radial arm of clip=	0.102 M
Dmg	Distance radial arm of Fmg =	0.102 M
FS	Factor of Safety =	19.7

#	LB	N
[illegible]	[illegible]	[illegible]
2	130	
3	128	
4	131	
5	135	

$\Sigma Mo = (Fr)(Dr) - [(Fmg)(Dmg) + (Fd)(Dd)] = 0$

$Fr = [(Fmg)(Dmg) + (Fd)(Dd)] / Dr$

$Fr = [(4.1)(0.102) + (123.6)(0.017)] / 0.102$

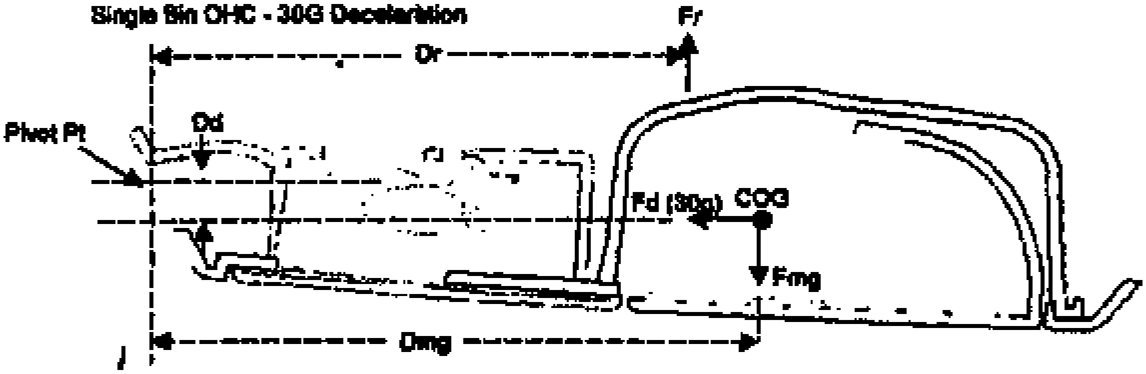
$Fr = (0.42 + 2.10) / 0.102$

$Fr = 2.52 / 0.102$

$Fr = 24.7$ N

Factor of Safety ⟶ 486.2 / 24.7 = 19.7

Single Sin OHC - 30G Deceleration



m	Mass =	0.42 Kg
Fmg	Force of Gravity (m)(g) = (0.42)(9.81)=	4.1 N
Fr	Calc. for retention of clip (N) =	Solve N
Fd	Force of Deceleration (m)(g)(D) = (0.42)(9.81)(30) =	123.6 N
Dd	Radial arm of Deceleration =	0.017 M
Dr	Radial arm of clip=	0.102 M
Dmg	Distance radial arm of Fmg =	0.102 M
FS	Factor of Safety =	19.7

S	LB	N
[illegible]	[illegible]	[illegible]
2	130	
3	128	
4	131	
6	135	

Σ Mo = (Fr)(Dr) -[(Fmg)(Dmg) + (Fd)(Dd)] = 0

Fr = [(Fmg)(Dmg) + (Fd)(Dd)] / Dr

Fr = [(4.1)(0.102) +(123.6)(0.017)] / 0.102

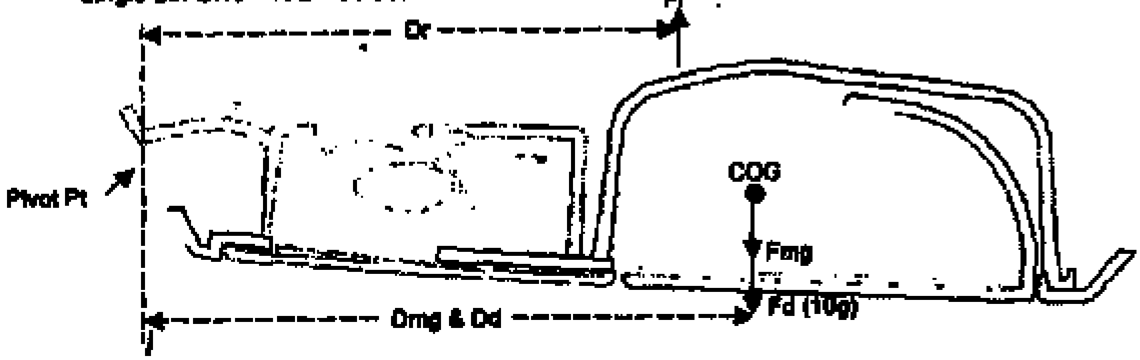
Fr = (0.42 + 2.10) / 0.102

Fr = 2.52 / 0.102

Fr = 24.7 N

Factor of Safety ⟶ 486.2 / 24.7 = 19.7

Single Bin OHC - 10G Roll Over



m	Mass =	0.42 Kg
Fmg	Force of Gravity (m)(g) = (0.42)(9.81)=	4.1 N
Fr	Calc. for retention of clip (N) =	Solve N
Fd	Force of Deceleration (m)(g)(D) = (0.42)(9.81)(10) =	41.2 N
Dd	Radial arm of Deceleration =	0.102 M
Dr	Radial arm of clip=	0.102 M
Dmg	Distance radial arm of Fmg =	0.102 M
FS	Factor of Safety =	10.7

[illegible]	LB	N
[illegible]	[illegible]	[illegible]
2	130	
3	128	
4	131	
5	135	

$\Sigma Mo = (Fr)(Dr) - [(Fmg)(Dmg) + (Fd)(Dd)] = 0$

$Fr = [(Fmg)(Dmg) + (Fd)(Dd)] / Dr$

$Fr = [(4.1)(0.102) + (42.1)(0.102)] / 0.102$

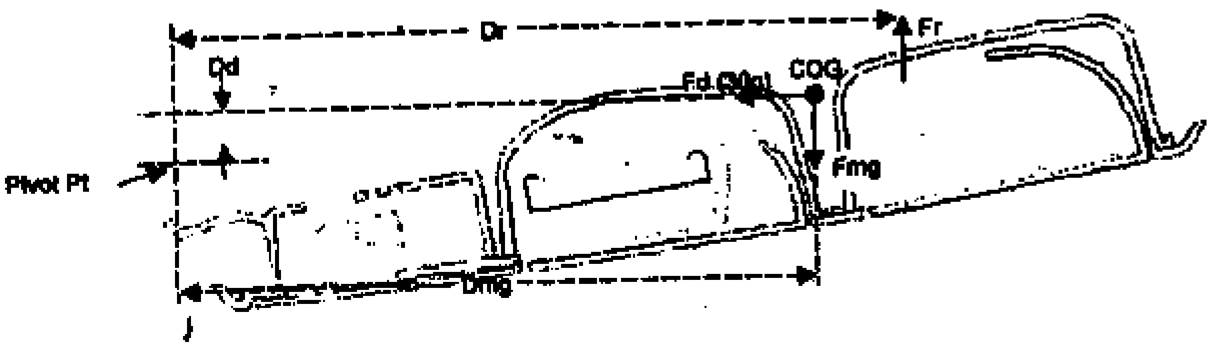
$Fr = (0.42 + 4.2) / 0.102$

$Fr = 4.6 / 0.102$

$Fr = 45.3\ N$

Factor of Safety ⟶ 486.2 / 45.3 = 10.7

Dual Bin OHC - 30G Deceleration



m	Mass =	0.64 Kg
Fmg	Force of Gravity (m)(g) = (0.64)(9.81)=	6.28 N
Fr	Calc. for retention of clip (N) =	Solve N
Fd	Force of Deceleration (m)(g)(D) = (0.64)(9.81)(30) =	188.352 N
Dd	Radial arm of Deceleration =	0.0108 M
Dr	Radial arm of clip=	0.214 M
Dmg	Distance radial arm of Fmg =	0.1467 M

S	LB	N
[illegible]	[illegible]	[illegible]
2	130	
3	128	
4	131	
5	135	

$\sum Mo = (Fr)(Dr) - [(Fmg)(Dmg) - (Fd)(Dd)] = 0$

$Fr = [(Fmg)(Dmg) - (Fd)(Dd)] / Dr$

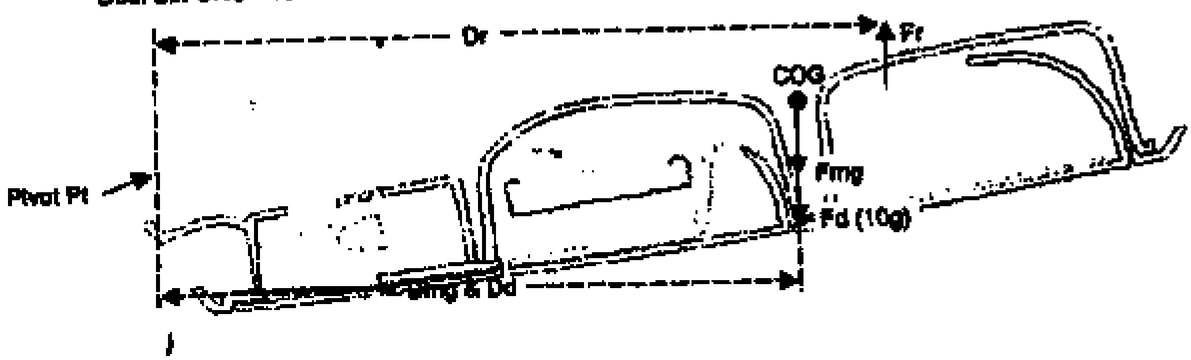
$Fr = [(6.28)(0.1467) - (188.352)(0.0108)] / 0.214$

$Fr = (0.94 - 2.03) / 0.214$

$Fr = -1.09 / 0.214$

$Fr = -5.1$ N Calc. suggest OHC will pivot up in headliner.

Dual Bin OHC - 10G Roll Over



m	Mass =	0.64 Kg
Fmg	Force of Gravity (m)(g) = (0.64)(9.81)=	6.28 N
Fr	Calc. for retention of clip (N) =	Solve N
Fd	Force of Deceleration (m)(g)(D) = (0.64)(9.81)(10) =	62.8 N
Dd	Radial arm of Deceleration =	0.1487 M
Dr	Radial arm of clip=	0.214 M
Dmg	Distance radial arm of Fmg =	0.1487 M
FS	Factor of Safety =	10

S	LB	N
1	140	[illegible]
2	130	
3	128	
4	131	
5	136	

$$\Sigma M_o = (Fr)(Dr) - [(Fmg)(Dmg) + (Fd)(Dd)] = 0$$

$$Fr = [(Fmg)(Dmg) + (Fd)(Dd)] / Dr$$

$$Fr = [(6.28)(0.1487) + (62.8)(0.01487)] / 0.214$$

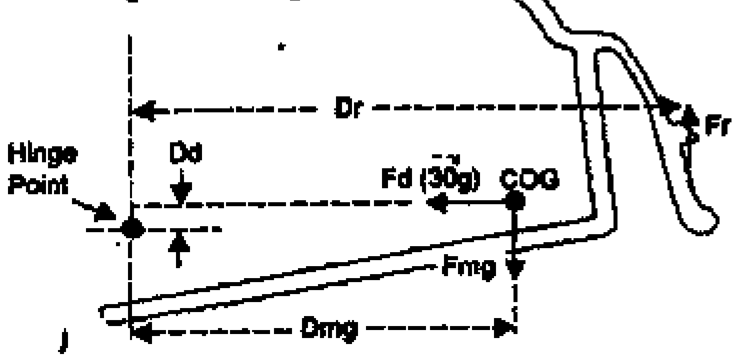
$$Fr = (0.93 - 9.3) / 0.214$$

$$Fr = 10.23 / 0.214$$

$$Fr = 47.8 \text{ N}$$

Factor of Safety ⟶ 496.2 / 47.8 = 10

Sunglass Door 30g Deceleration



m	Mass =	0.08 Kg
Fmg	Force of Gravity (m)(g) = (0.08)(9.81)=	0.78 N
Fr	Calc. for retention of latch (N) =	Solve N
Fd	Force of Deceleration (m)(g)(D) = (0.08)(9.81)(30) =	23.4 N
Dd	Radial arm of Deceleration =	0.003 M
Dr	Radial arm of latch=	0.052 M
Dmg	Distance radial arm of Fmg =	0.022 M

Pull Force on Latch		
S	LB	N
1	50	
[redacted]		
3	55	
4	50	
5	50	

Σ Mo = (Fr)(Dr) -[(Fmg)(Dmg) - (Fd)(Dd)] = 0

Fr = [(Fmg)(Dmg) - (Fd)(Dd)] / Dr

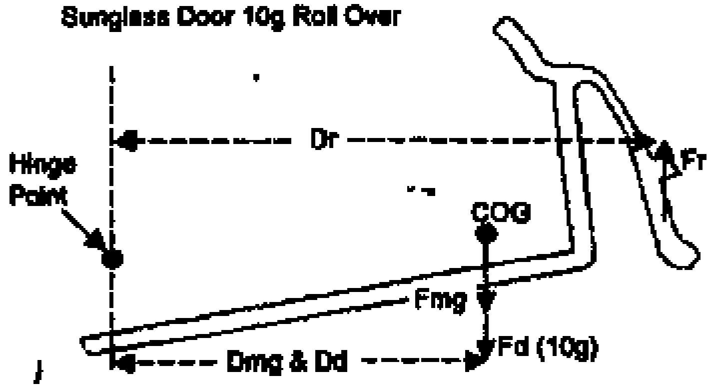
Fr = [(0.78)(0.022) - (23.4)(0.003)] / 0.052

Fr = (0.017 - 0.07) / 0.052

Fr = 0.053/0.052

Fr = -1.02 N   **Calculation suggest door will pivot upward in the OHC.**

Sunglass Door 10g Roll Over



m	Mass =	0.08 Kg
Fmg	Force of Gravity (m)(g) = (0.08)(9.81)=	0.78 N
Fr	Calc. for retention of latch (N) =	Solve N
Fd	Force of Deceleration (m)(g)(D) = (0.08)(9.81)(10) =	7.8 N
Dd	Radial arm of Deceleration =	0.022 M
Dr	Radial arm of latch=	0.052 M
Dmg	Distance radial arm of Fmg =	0.022 M
FS	Factor of Safety =	55

Pull Force on Latch		
S	LB	N
1	50	
[illegible]	[illegible]	[illegible]
3	55	
4	50	
5	50	

$$\Sigma Mo = (Fr)(Dr) - [(Fmg)(Dmg) + (Fd)(Dd)] = 0$$

$$Fr = [(Fmg)(Dmg) + (Fd)(Dd)] / Dr$$

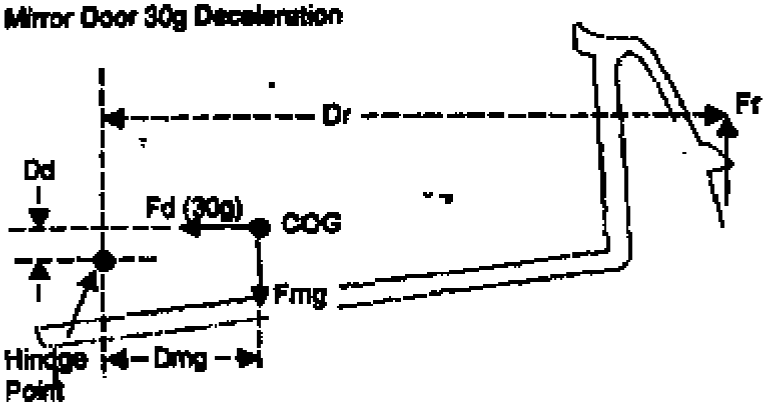
$$Fr = [(0.78)(0.022) + (7.8)(0.022)] / 0.052$$

$$Fr = 0.19 / 0.052$$

$$Fr = 3.63 \text{ N}$$

Factor of Safety ⟶ 196 / 3.63 = 56

Mirror Door 30g Deceleration



m	Mass =	0.14 Kg
Fmg	Force of Gravity (m)(g) = (0.14)(9.81)=	1.37 N
Fr	Calc. for retention of latch (N) =	Solve N
Fd	Force of Deceleration (m)(g)(D) = (0.14)(9.81)(30) =	41.1 N
Dd	Radial arm of Deceleration =	0.0065 M
Dr	Radial arm of latch=	0.052 M
Dmg	Distance radial arm of Fmg =	0.0095 M

Pull Force on Latch		
S	LB	N
1	50	
[illegible]	[illegible]	[illegible]
3	55	
4	50	
5	50	

$$\Sigma M_o = (Fr)(Dr) - [(Fmg)(Dmg) - (Fd)(Dd)] = 0$$

$$Fr = [(Fmg)(Dmg) - (Fd)(Dd)] / Dr$$

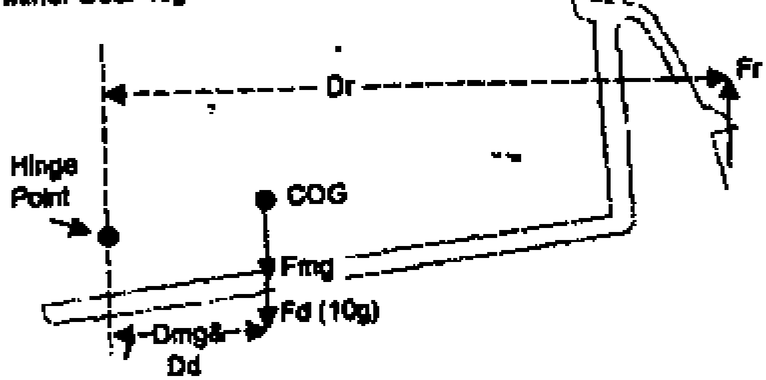
$$Fr = [(1.37)(0.0095) - (41.4)(0.0065)] / 0.052$$

$$Fr = (0.013 - 0.27) / 0.052$$

$$Fr = -0.26 / 0.052$$

$Fr = -4.9$ N **Calculation suggest door will pivot upward in the OHC.**

Mirror Door 10g Roll Over



m	Mass =	0.14 Kg
Fmg	Force of Gravity (m)(g) = (0.14)(9.81)=	1.37 N
Fr	Calc. for retention of latch (N) =	Solve N
Fd	Force of Deceleration (m)(g)(D) = (0.14)(9.81)(10) =	13.7 N
Dd	Radial arm of Deceleration =	0.0095 M
Dr	Radial arm of latch=	0.052 M
Dmg	Distance radial arm of Fmg =	0.0095 M
FS	Factor of Safety =	72

Pull Force on Latch		
S	LB	N
1	50	
[illegible]	[illegible]	[illegible]
3	55	
4	50	
5	50	

$$\Sigma M_o = (Fr)(Dr) - [(Fmg)(Dmg) + (Fd)(Dd)] = 0$$

$$Fr = [(Fmg)(Dmg) + (Fd)(Dd)] / Dr$$

$$Fr = [(1.37)(0.0095) + (13.7)(0.0095)] / 0.052$$

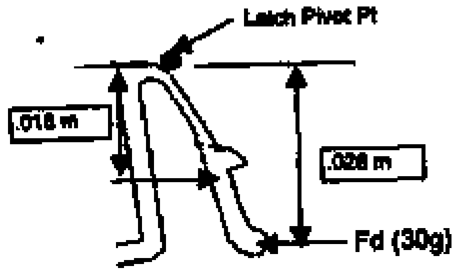
$$Fr = (0.013 + 0.13) / 0.052$$

$$Fr = 0.143 / 0.052$$

$$Fr = 2.75\ N$$

Factor of Safety ⟶ 198 / 2.75 = 72

Latch 30g Deceleration



Latch Efforts
7.0
7.5
7.0
7.0
7.2

m	Mass =	0.001 Kg
Fd	Force of Deceleration (m)(g)(D) = (0.001)(9.81)(30) =	0.29 N
F_L	Spring force of Latch (measured)	7 N
F_{LC}	Calculated Min retention force of Latch	

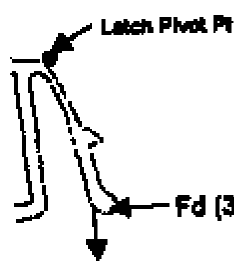
$\Sigma Mo = (F_{LC} * 0.018) - (Fd * .028) = 0$

$F_{LC} = \frac{(0.29 * .028)}{.018}$

$F_{LC} =$ 0.45 N

Factor of Safety = F_L / F_{LC} = 16.6

Latch Shear (30g Decel) & Axial Loads (10g Rollover) Calcs



F_A = Axial load on latch (10g rollover) = (10)(0.001)(9.81) =	0.10 N
Fd = Shear load on latch (30g decel) = (30)(0.001)(9.81) =	0.29 N
A = Area of latch @ Latch Pivot point = (19 x 1.75 mm**2) =	33.25 mm^2
Yield Modulus (PC-ABS)	57 Mpa

Shear Calcs

τ = Fd/A 0.01 Mpa

FS = 5700

Axial Load Calcs

σ = FA/A 0.003 Mpa

FS = 19000

FORM 5

FMVSS No. 201
Latch Component Analysis Information for:
2005 D219/258/333 Front Floor Console
P/N's 5F93-74045A06, 5G13-54045A06 & 5T53-54045A06

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:

1. Geometric details of the latch/lock configuration.

   See Attachment 1

2. Mass data for each element in the linkage.

   1) Latch = 14.2 Grams
   2) Armrest w/Latch = 1.259 Kg

3. Spring rates for each spring element in the configuration.

   - Linear Approximation for calculating Spring Constant for System (Latch and Bumper)
     - F=kx where F= Force, k = Spring Constant, x = Distance
       k = F / x → k = 24.1N / 0.82cm = 29.39 N/cm

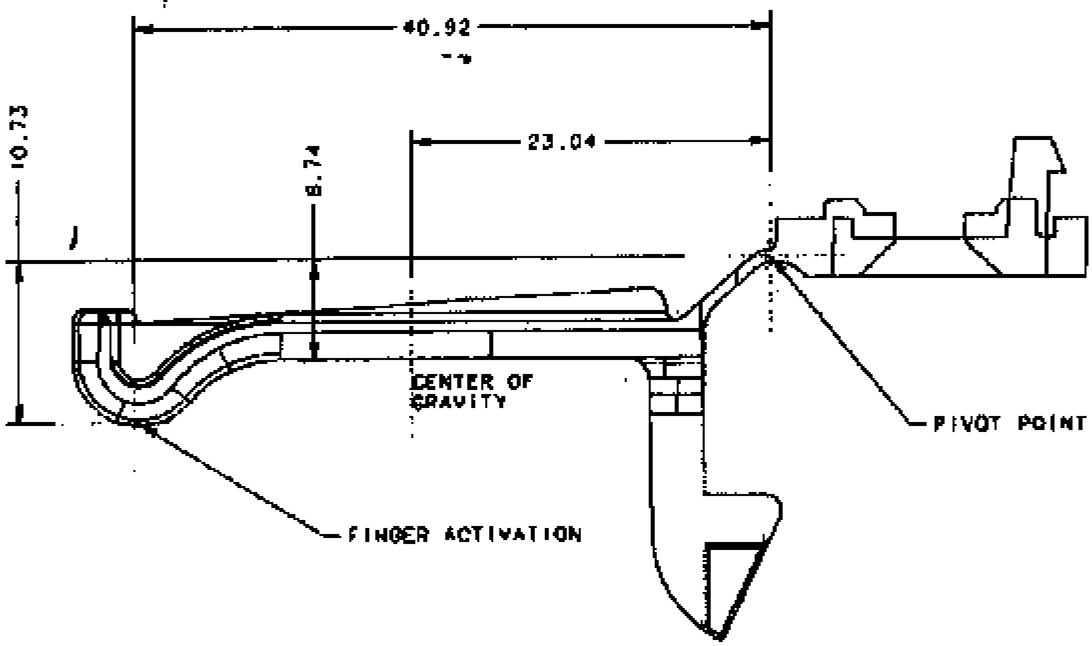
   > Note: Lowest Tested Effort = 24.1 Newtons (used in calculations)
   > Average = 28.0 Newtons

   See Attachment 2

4. Any additional details unique to the design yet necessary for the calculations.

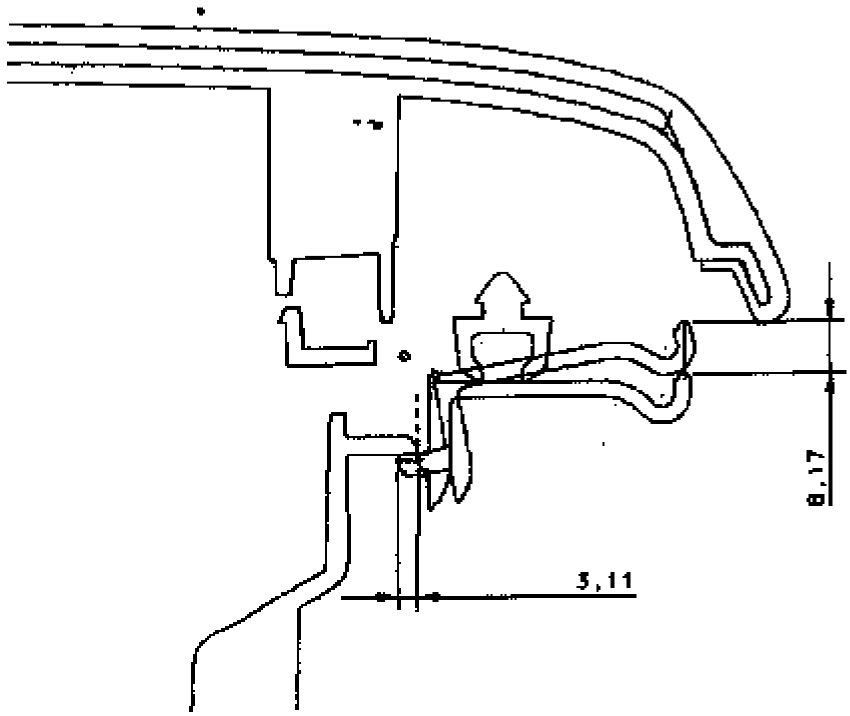
   See Attachment 3

Attachment 1

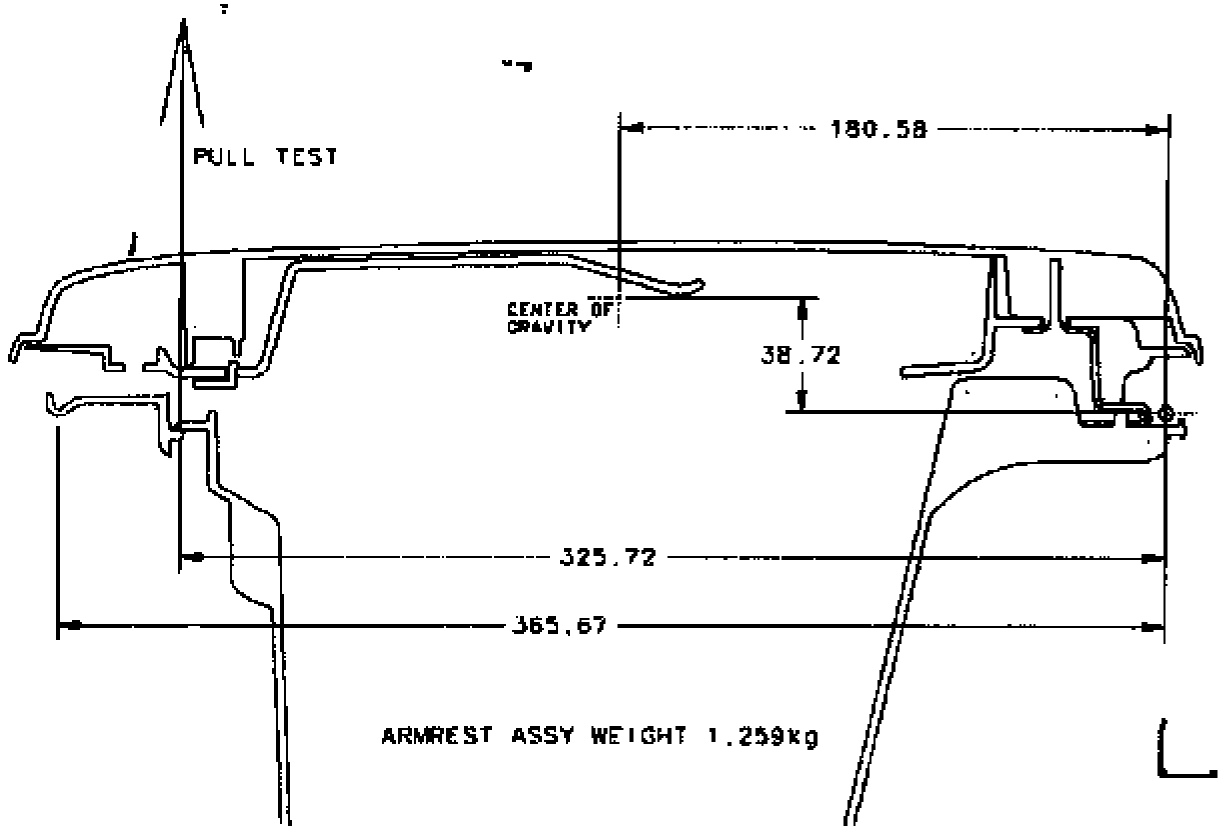


LATCH WEIGHT (MOVING SIDE) 14.2g

Attachment 2



Attachment 3



2005 – D219/D258
Front Floor Console Lid Latch Strength and Latch Inertial Analysis

Introduction:

Interior compartment doors and latches are required to stay closed/latched when subjected to 10G vertical, 10G transverse and 30G longitudinal loads (Paragraphs (a) and (c) of FMVSS 201, S5.3.1 Interior Compartment Doors). There are two parts to the analysis of an interior compartment door assembly. Part 1) analysis of the latch separately, and Part 2) analysis of the entire interior compartment door system. In the first part the latch is examined by itself to see whether the inertial loads will cause opening moments about the latch's pivot point due to the forces of its own inertia. The second part is an examination of the ultimate strength of the latch in its environment, i.e. the inertial effects on the interior compartment door cause opening moments about point H (the hinge pivot), and opening forces at the latch. Pull tests are done and compared to the forces generated at the latch by the inertial loads. If the latch withstands a greater laboratory static load than is generated by the inertial loads, the latch and interior compartment door system comply with the requirements of the regulation.

Objective:

Verify that the floor console lid and its latch meet the requirements of F/CMVSS 201.

Definitions: (If used in this analysis)

W	=	weight of the compartment door or latch.
m	=	mass of the compartment door or latch.
CG	=	center of gravity of the moving door or latch.
ΣM_H	=	summation of moments about the compartment door hinge point or latch pivot point in the clockwise direction.
F_{10G}	=	vertical 10G inertial load acting on the CG of the compartment door or latch.
F_{30G}	=	longitudinal 30G inertial load acting on the CG of the compartment door or latch.
F_1	=	calculated force at the test location that generates the equivalent opening moment about the latch pivot point due to the inertial loads in Part 1.
F_2	=	calculated force at the pull test location that generates the equivalent opening moment about the compartment door hinge point due to the inertial loads in Part 2.
F_{ult}	=	ultimate force that holds the compartment door closed.
F_{op}	=	minimum force that opens the latch, opening effort.
L_{CG}	=	moment arm of the weight of the compartment door or latch measured from the door hinge point or the latch pivot point respectively.
L_{10G}	=	moment arm of the vertical 10G inertial load measured from the door hinge point or the latch pivot point.
L_{30G}	=	moment arm of the longitudinal 30G inertial load measured from the door hinge point or the latch pivot point.
L_1	=	moment arm of the force, F_1, measured from the latch pivot point.
L_2	=	moment arm of the force, F_2, measured from the door hinge point.

[handwritten initials/signature] 1/4/04

[redacted]

For this part of the analysis, refer to the figure of the latch on page 5.

10G transverse loads:

The transverse load condition will not cause any opening moments about the latch pivot.

10G vertical load downward:

The moments generated about the latch pivot would act in a direction keeping the latch closed.

10G vertical load upward:

There would be opening moments generated about the latch pivot by a 10G vertical load upward.

$$Mpivot = F_{10G\_latch} * L_{10G\_latch}$$
$$Mpivot = m_{latch}(10)(9.81m/s^2)(23.04mm)$$
$$Mpivot = 0.0142kg(10)(9.81)(23.04)$$
$$Mpivot = 32.1N - mm$$

A 10G vertical load upward would generate 32.1 N-mm of moment about the latch pivot point. The latch will withstand at least a 14.0N load at the finger activation point of the latch, as measured in laboratory testing (lowest load experienced out of 3 samples). This 14.0N load results in (14.0N)(40.92mm) = 572.9 N-mm of moment about the latch pivot. This means that the latch will withstand 572.9 N-mm of moment. The latch will stay closed, with a design factor of 572.9/32.1 = 17.8.

30G longitudinal load forward:

There would be opening moments generated about the latch pivot by a 30G forward inertia load.

$$Mpivot = F_{30G\_latch} * L_{30G\_latch}$$
$$Mpivot = m_{latch}(30)(9.81m/s^2)(6.74mm)$$
$$Mpivot = 0.0142kg(30)(9.81)(6.74)$$
$$Mpivot = 28.17N - mm$$

A 30G longitudinal load forward would generate 28.17 N-mm of moment about the latch pivot point. The latch will withstand at least a 14.0N load at the finger activation point of the latch, as measured in laboratory testing (lowest load experienced out of 3 samples). This 14.0N load results in (14.0N)(40.92mm) = 572.9 N-mm of moment about the latch pivot. This means that the latch will withstand 572.9 N-mm of moment. The latch will stay closed, with a design factor of 572.9/28.17 = 20.3.

30G longitudinal load rearward:

The moments generated about the latch pivot would act in a direction keeping the latch closed.

Part 2: Analysis of entire interior compartment door system

For Part 2, the 10G transverse loads do not cause any opening moments about the lid pivot and are not considered in this analysis. Both the 10G vertical load upward and 30G longitudinal load rearward will cause opening moments about the hinge pivot point. Refer to the illustration on page 6 of the lid and latch system throughout this analysis.

Calculations:

Mass = 1.259 kg

<u>30G longitudinal load rearward:</u>

The moment generated about the hinge point by the 30G load, neglecting the moment due to the weight of the assembly (worst case) is:

$$\sum M_H = F_{30G} * L_{30G}$$
$$\sum M_H = m \cdot (30G) \cdot L_{30G}$$
$$\sum M_H = (1.259kg)(30)(9.81)(38.72mm)$$
$$\sum M_H = 14346.7N - mm$$

A pull test was done on physical parts. The force was applied at the latch area, 325.72 mm from the hinge pivot. The lowest result experienced out of 3 tests was 245 N. A 245 N force at this location would generate, 245 N * 325.72 mm = 79801.4 N-mm of moment about the hinge pivot. This means that 79801.4 N-mm of moment is needed to overcome the strength of the latch, and the 30G load only generated 14346.7 N-mm of moment. The latch will not open due to the inertia generated by a 30G load, with a design factor of 79801.4 / 14346.7 = 5.56.

<u>42G longitudinal load rearward (this calculation done at request of customer):</u>

The moment generated about the hinge point by a 42G load, neglecting the moment due to the weight of the assembly (worst case) is:

$$\sum M_H = F_{42G} * L_{42G}$$
$$\sum M_H = m \cdot (42G) \cdot L_{42G}$$
$$\sum M_H = (1.259kg)(42)(9.81)(38.72mm)$$
$$\sum M_H = 20085.3N - mm$$

A pull test was done on physical parts. The force was applied at the latch area, 325.72 mm from the hinge pivot. The lowest result experienced out of 3 tests was 245 N. A 245 N force at this location would generate, 245 N * 325.72 mm = 79801.4 N-mm of moment about the hinge pivot. This means that 79801.4 N-mm of moment is needed to overcome the strength of the latch, and a 42G load only generated 20085.3

N-mm of moment. The latch will not open due to the inertia generated by a 42G load, with a design factor of 79801.4 / 20085.3 = 3.97.

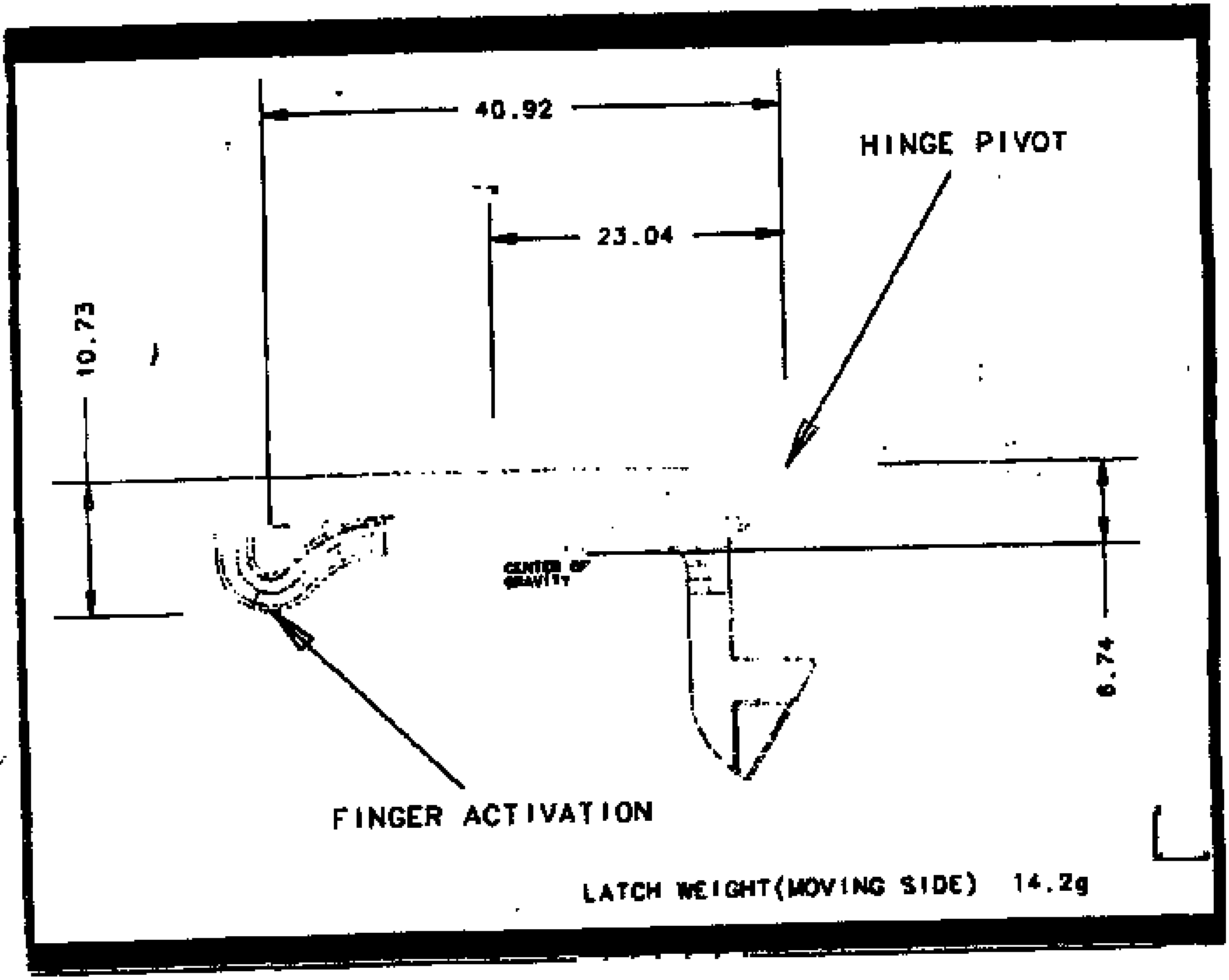
10G vertical load upward:

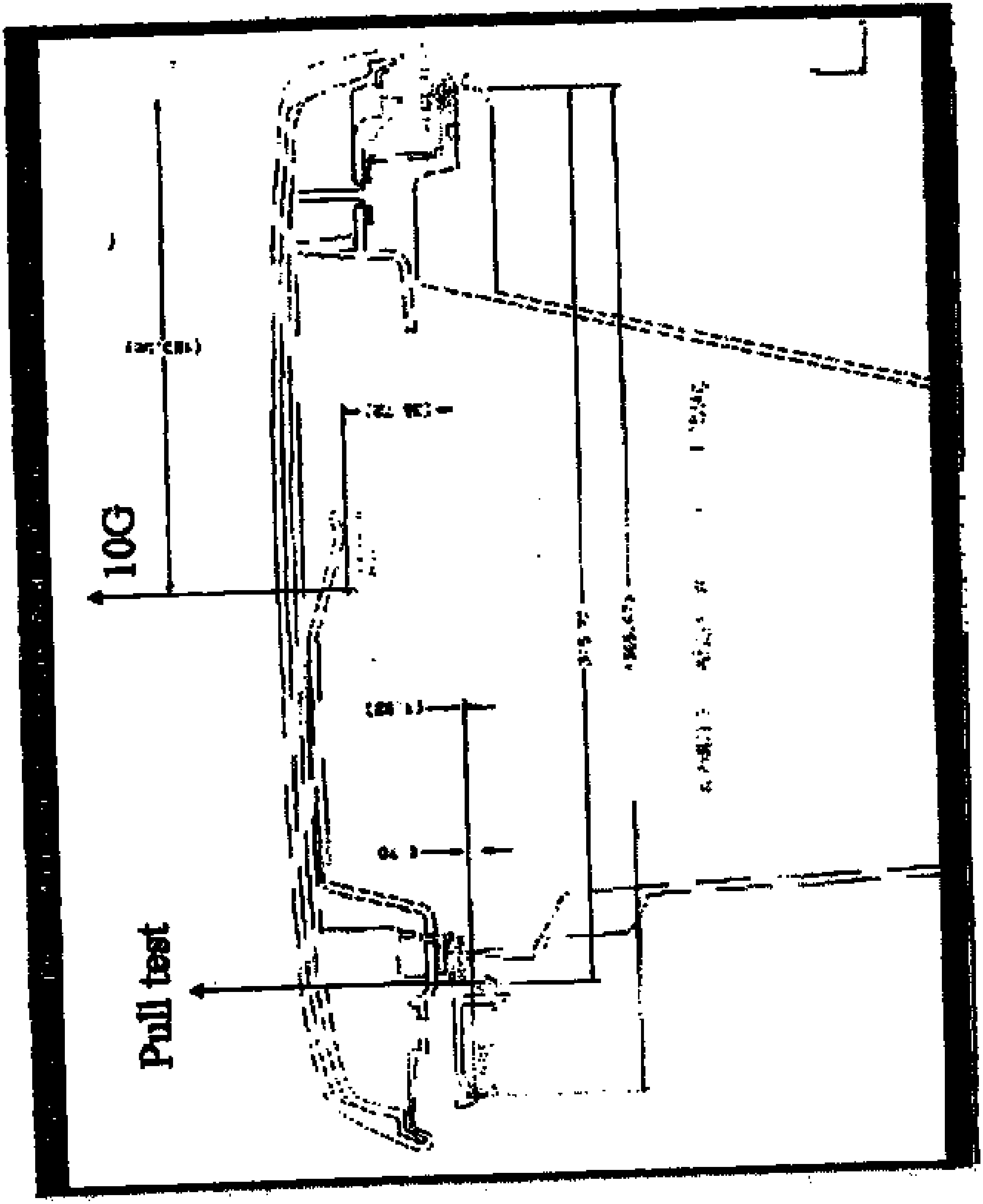
The moment generated about the hinge point by the 10G load, neglecting the moment due to the weight of the assembly (worst case) is:

$$\sum M_H = F_{10G} * L_{10G}$$
$$\sum M_H = m \cdot (10G) \cdot L_{10G}$$
$$\sum M_H = (1.259\,kg)(10)(9.81)(180.58\,mm)$$
$$\sum M_H = 22303.1\,N-mm$$

A pull test was done on physical parts. The force was applied at the latch area, 325.72 mm from the hinge pivot. The lowest result experienced out of 3 tests was 245 N. A 245 N force at this location would generate, 245 N * 325.72 mm = 79801.4 N-mm of moment about the hinge pivot. This means that 79801.4 N-mm of moment is needed to overcome the strength of the latch, and the 10G vertical load only generated 22303.1 N-mm of moment. The latch will not open due to the inertia generated by a 10G vertical load, with a design factor of 79801.4 / 22303.1 = 3.57.

The latch and lid will not open by their own inertia under any of the loading conditions called out in S5.3.1 (a) and (c) of FMVSS 201.


40.92
HINGE PIVOT
23.04
10.73
CENTER OF GRAVITY
6.74
FINGER ACTIVATION
LATCH WEIGHT(MOVING SIDE) 14.2g


10G
Pull test

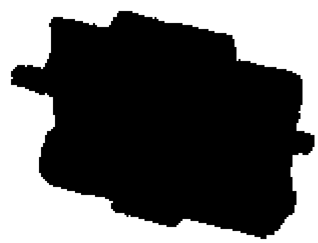
FMVSS No. 201
Latch Component Analysis Information

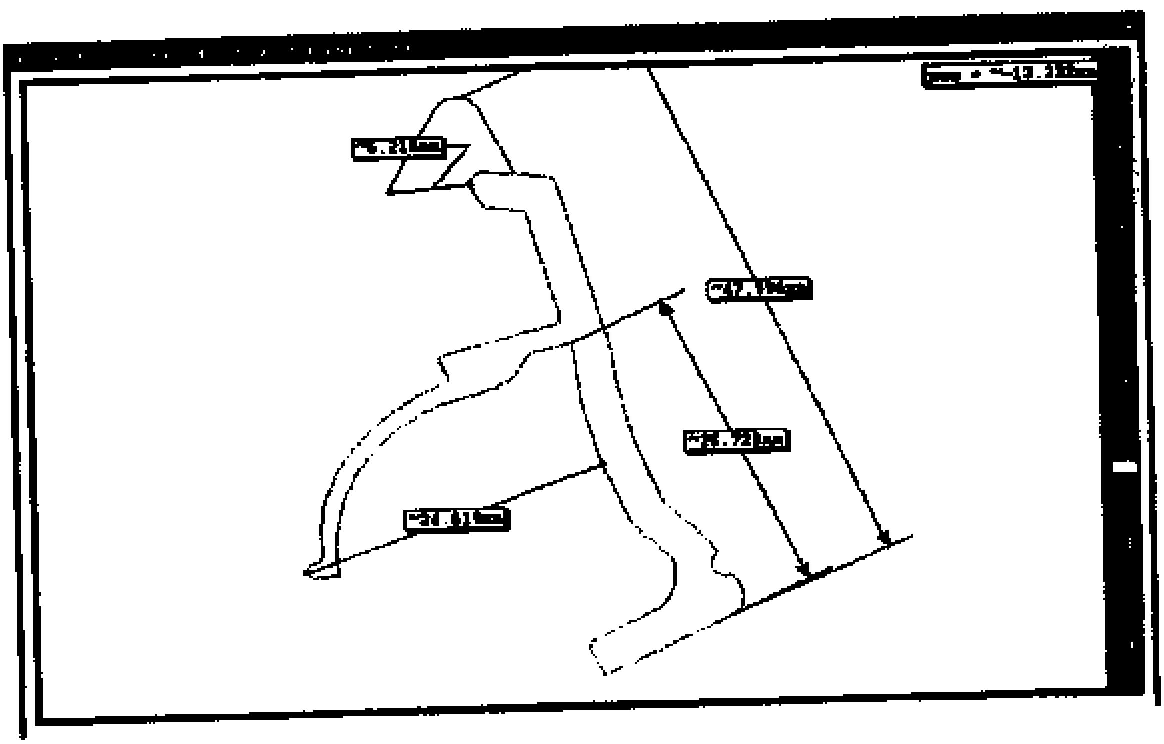
D219 Second Row Console Storage Lid Latch

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:

1. Geometric details of the latch/lock configuration.





2. **Mass data for each element in the linkage.**

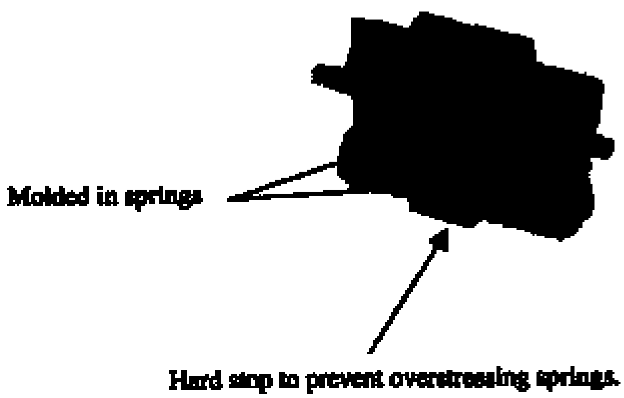
Mass of the latch: 18 g.

3. **Spring rates for each spring element in the configuration.**

$F = K * x$ => Linear approximation for calculating spring constant
F average = 19 N
$x = 3.1$ mm
$F = K * x$
$K = F / x = 19$ N / (3.1 mm)
$K = 6.13$ N/mm

4. **Any additional details unique to the design yet necessary for the calculations.**

The latch has a maximum throw of 8.5 mm as there is a hard stop that would prevent overstressing the molded in springs.



FORM 5

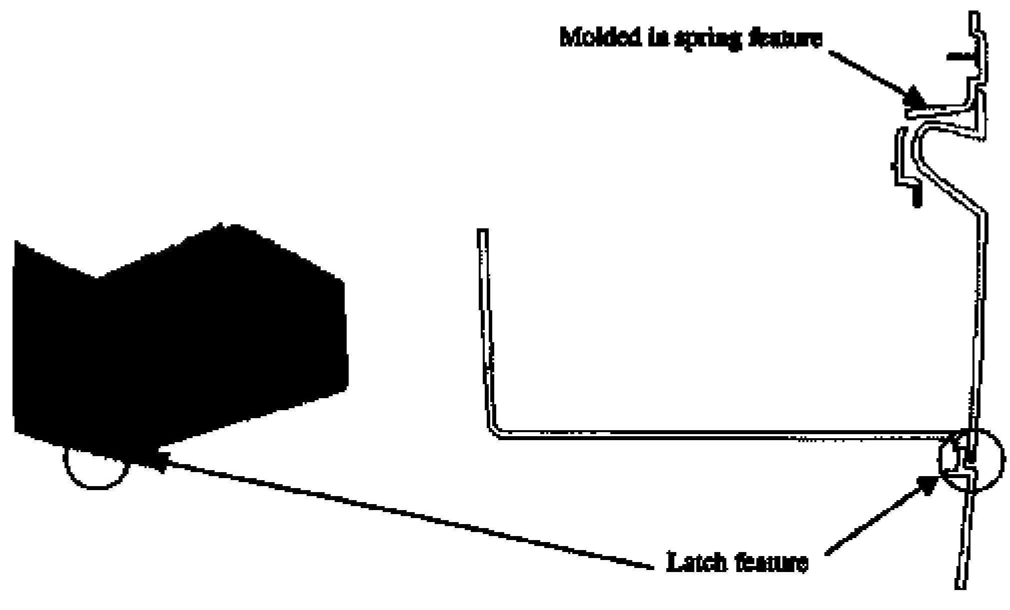
FMVSS No. 201
Latch Component Analysis Information

D219 Second Row Console - Storage Tray Latch

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:

1. Geometric details of the latch/lock configuration.



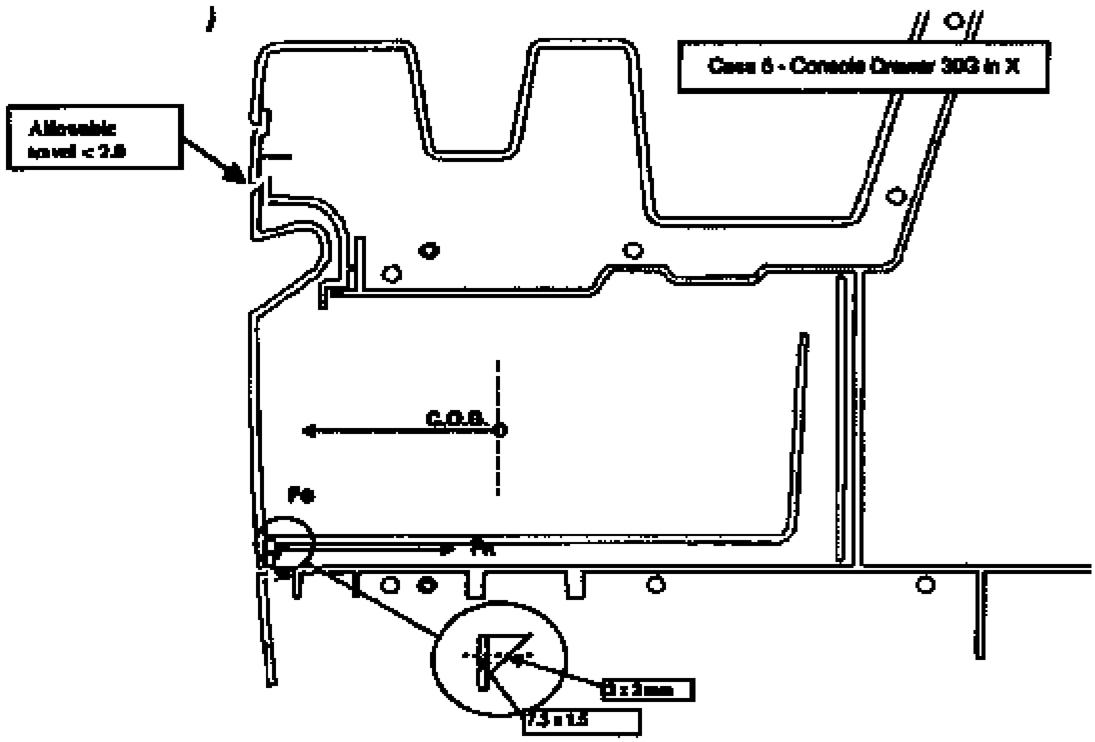
2. Mass data for each element in the linkage.

The latch is not a seperate assembly, but is molded into the storage tray as shown above.
Mass of tray – 0.25 kg

3. **Spring rates for each spring element in the configuration.**

$F = K * x$ => Linear approximation for calculating spring constant
F average = 19.8 N
$x = 0.80$ mm
$F = K * x$
$K = F / x = 19.8 \text{ N} / (0.8 \text{ mm})$
$K = 24.75$ N/mm

4. **Any additional details unique to the design yet necessary for the calculations.**



C.O.G.	center of gravity	=	X = 3906, Y = 0, Z = 1217
F_G	acceleration of lid at 30G (F=MA)	=	(30) (9.81) (0.25) = 73.58
F_{RM}	measured retention force of tray	=	119.7 N
F_R	required retention force of tray	=	73.6 N
M	mass of tray	=	0.25 Kg
AL	Area of Latch	=	16.96 mm^2
	Material Strength	=	21 Mpa

$\Sigma F_x = 0 = F_G - F_R = 0$

$F_R = F_G = 73.6$N

$F_R = 73.6$ N

$F_{RM} = 119.7 > 73.6$ N

$\boxed{FS = 1.6}$

$\tau = F_R/A$ = 4.34 MPa

$\boxed{FS = \text{Mat}/\tau = 4.8 \quad \text{(Mat'l break point of latch)}}$

$\boxed{\text{Tray Stop Retention Force (Measured) } 119.7 - 158.0 \text{ N}}$

FMVSS 201 COMPLIANCE REPORT AND CALCULATIONS

D219 MODEL YEAR 2006

CONSOLE ASSEMBLY 2ND ROW SEAT

ASSEMBLY NO.: 6F93-7467442-AKW

JANUARY 29, 2003

Originated by: Mangesh Soman
Original - April 7, 2003
Revised - Jan 29, 2003

TABLE OF CONTENTS

REVISION LOG

FMVSS 201 REQUIREMENTS

FMVSS 201 requires all interior compartment doors remained closed when subjected to:

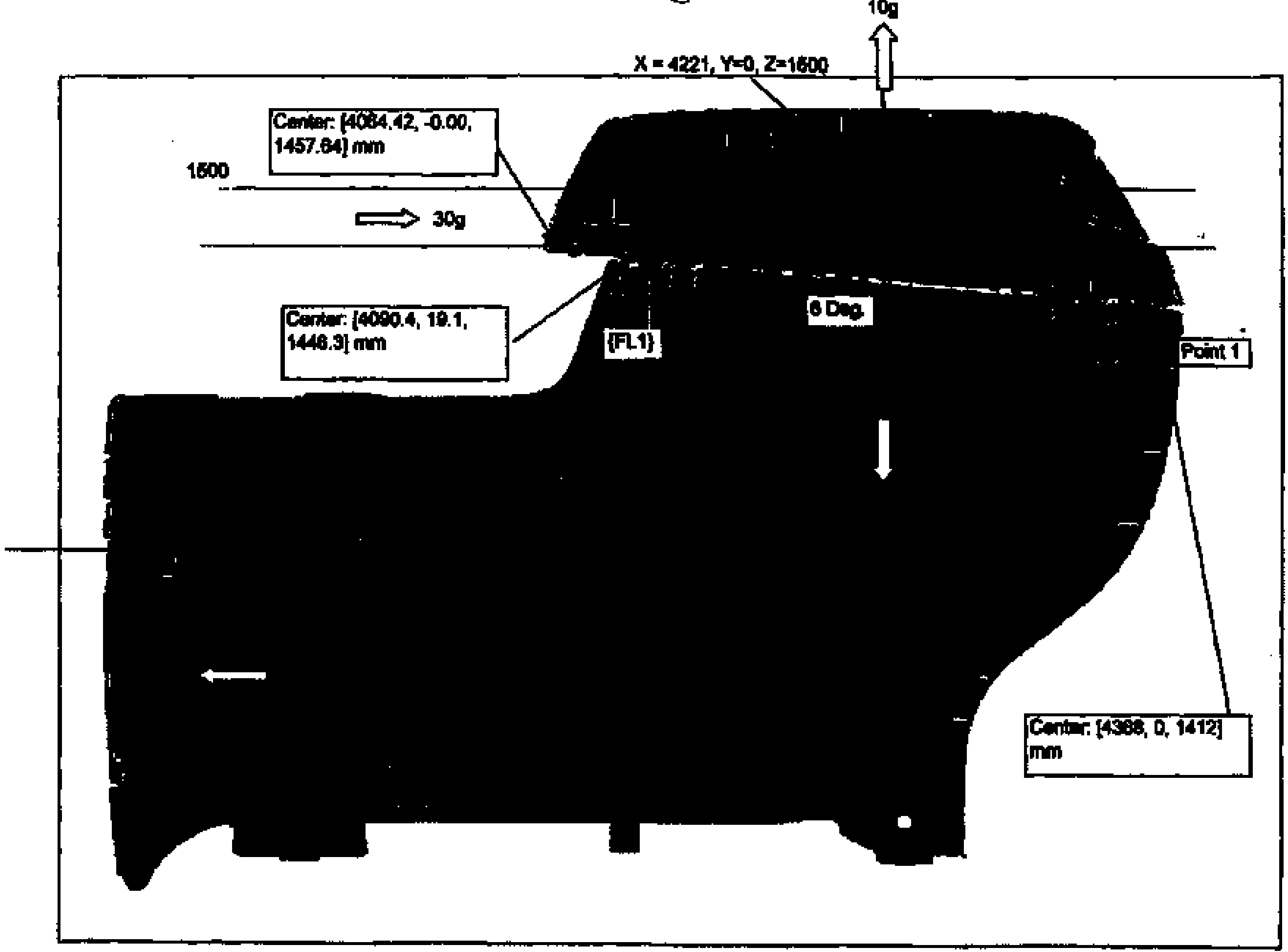
1. An inertial load of 30G in the +/- X Direction (Vehicle forward/rearward)
2. An inertial load of 10G in the +/- Z Direction (Vehicle up/down)
3. An inertial load of 10G in the +/- Y Direction (Vehicle inboard/outboard)

The requirement applies to all stowage compartment doors of which the D219 Rear Console has two (2):

1. Console Armrest opening rear ward to allow access to console bin
2. Console Sliding Tray which allows access to a small stowage bin at the front of the console

The D219 Rear Console has a portion of the armrest that folds forward to become a part of the load floor. This 'Load *Floor panel*' is not considered a stowage compartment door and, therefore, is not subjected to FMVSS 201.

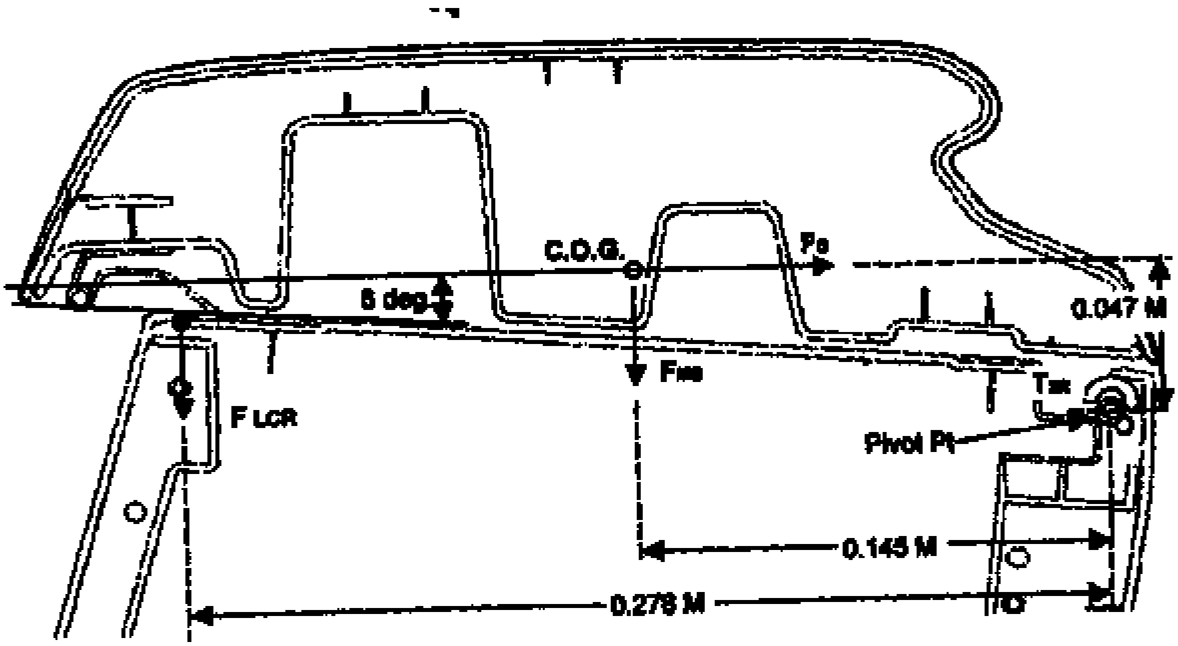
FREE B(... DIAGRAM



FREE BODY DIAGRAM

30G Rear Open - Rear Impact
(Rear Hinge Cycle)
Calculated without breaking down into Z and X components

Case 1 - Console Armrest 30G in X



Components:

C.O.G.	center of gravity	=	X = 4222.6, Y = 0, Z = 1467.7
M L	mass of lid	=	1.25 Kg
F G	acceleration of lid at 30G (F=MA)	=	(30) (1.25) (9.81) = 367.9 N
F LCR	calculated retention force of latch	=	(solve for)
F LR	measured min retention force of latch	=	156.1 N
T SR	spring torque of hinge (measured)	=	2.82 NM
F MG	effect of gravity on lid (F=MG)	=	12.3 N

$$\Sigma M_O = 0 = [(F_{LCR})(0.278) + (F_{MG})(0.145) - T_{SR}] - [(F_{GX})(0.047)]$$

$$F_{LCR} = \frac{[(F_G)(0.047) + T_{SR}] - [(F_{MG})(0.145)]}{0.278}$$

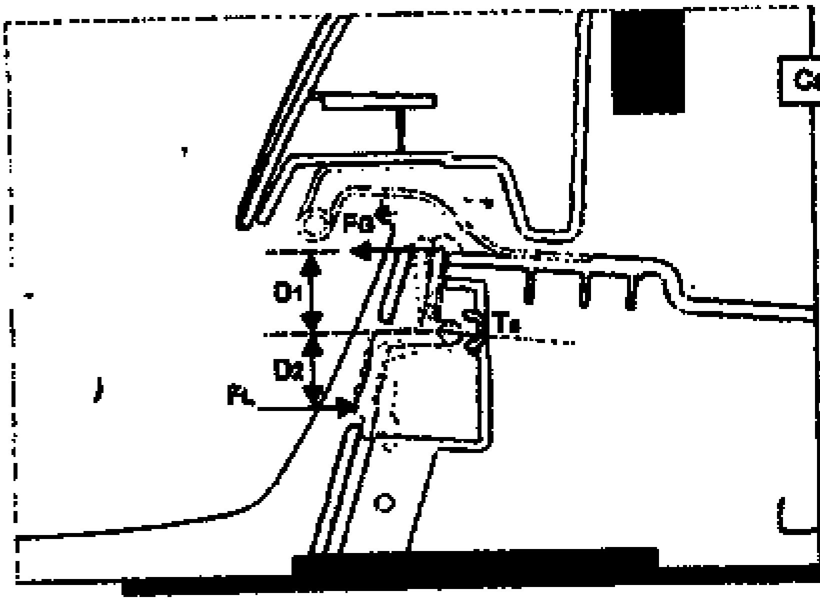
$$F_{LCR} = \frac{[(367.9)(0.047) + 2.82] - [1.78]}{0.278}$$

$$F_{LCR} = 65.9\ N$$

$F_{LR} = 156.1\ N > 65.9\ N = F_{LCR}$

$\boxed{FS = F_{LR}/F_L = 2.4}$

30G Rear Open - Latch Movement
(Rear Hinge Cycle)



Case 2 - Latch 30G in X

Latch Push Force (Measured)
(Newtons)
17.1 - 19.7 N

Components:

M L	mass of Latch	=		0.02 Kg
F G	acceleration of latch at 30G (*)	=	(30) (0.02) (9.81) =	5.89 N
FL	Latch push Force (measured)	=		17.1 N
Ts	Resistant Torque of latch spring	=	(FL) (D2) = (17.1*.024)	0.41 NM
Tsc	Calculated Torque of latch	=		(Solve for) NM
D1	Radial Arm (1)	=		0.023 M
D2	Radial Arm (2)	=		0.024 M

$\Sigma M_O = 0 = T_{sc} - (F_G)(D_1)$

$T_{sc} = (F_G)(D_1)$
$= \quad 0.14$ NM

$T_s = 17.1N * 0.024m =$ 0.41 Nm

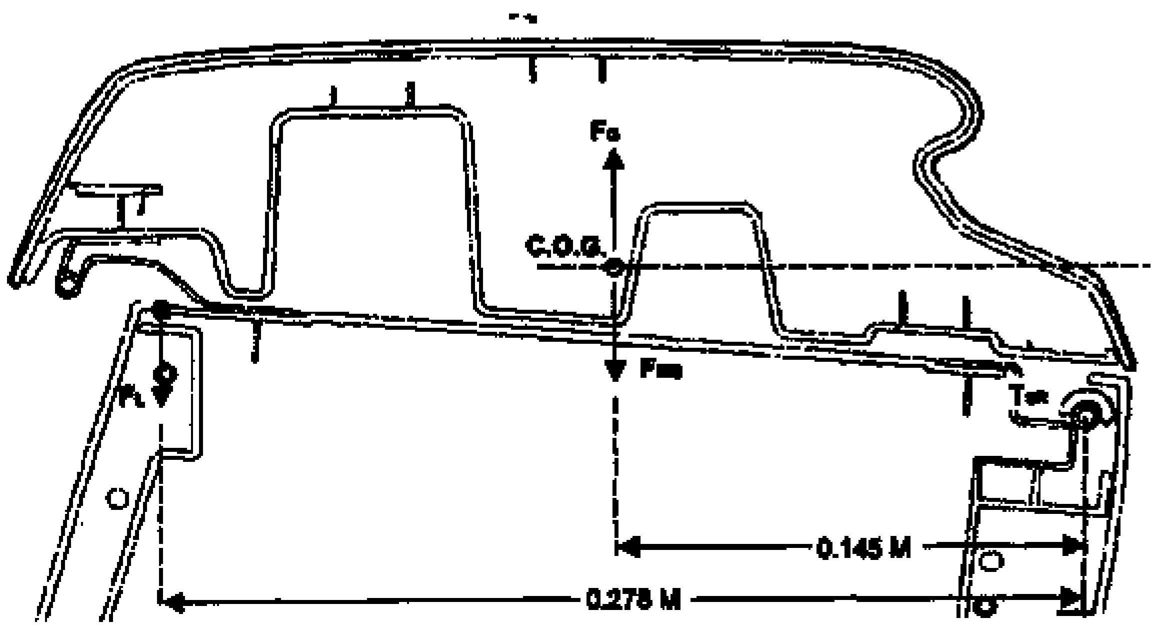
$T_s = .48$ NM > 0.14 NM $= T_{sc}$

$\boxed{\text{Factor of Safety} = \quad T_s/T_{sc} = \quad 3.03}$

* Worst case scenario - applied decel loads (30G) at catch area instead of center of gravity

10G Front Open - CNSL Opening (Rollover Load)
(Rear Hinge Cycle)

Case 3 - Console Armrest 10G in Rollover (-Z)



Components:

C.O.G.	center of gravity	=	X = 4222.8, Y = 0, Z = 1467.7	
M_L	mass of lid	=		1.25 Kg
F_G	acceleration of lid at 10G	=	(10) (1.25) (9.81) =	122.6 N
F_L	calculated retention force of latch	=		(solve for)
F_{MG}	effect of gravity on lid	=		12.3 N
T_{SR}	spring torque of hinge (measured)	=		2.82 NM
F_{LM}	retention force of latch (measured)	=		156.1 N

$$\Sigma M_O = 0 = [\,(F_L)\,(0.278) + (F_{MG})(0.145)\,] - [(F_G)(0.145) + T_{SR}\,] = 0$$

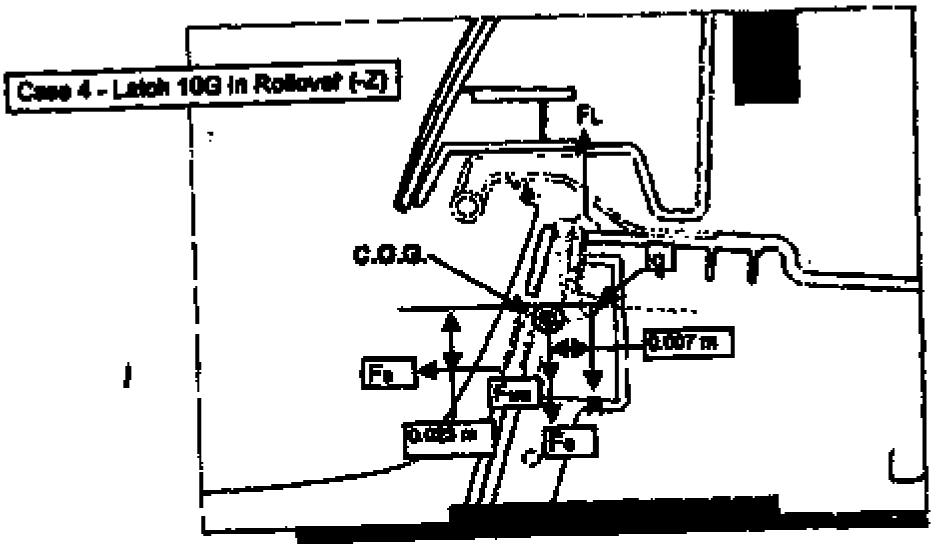
$$F_L = \frac{[\,(F_G)\,(0.145) + 2.82] - [\,(F_{MG})\,(0.145)\,]}{0.278}$$

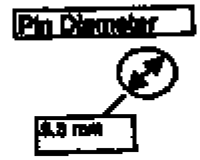
$$F_L = \frac{[(17.8 + 2.82 - (1.78\,)]}{0.278}$$

$$F_L = 67.8$$

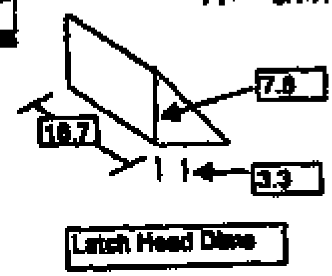
FS =	F_{LM}/F_L =	2.30

10G Front Open - Latch Failure (Rollover Load) (FACTOR OF SAFETY) CALCULATION
(Rear Hinge Cycle)





PI = 3.141593



F_L	Force of lid applied to latch	=	50.65 N	
R	Resultant Force at Pin	=	50.65 N	
A_P	Area of Pin	=	22.05	mm^2
A_H	Area of latch head (1/2b*h)	=	12.87	mm^2
A	Area of latch arm	=	42	mm^2
	Material Strength	=	66 Mpa	
F_{MG}	effect of gravity on lid (F=MG)	=	0.49	N
F_R	effect of Rollover on Latch (F=MA)	=	4.91	N
F_S	Min Req'd force of molded in spring	=	Calc	
F_{MS}	Measured force of molded in spring	=	17.1	N

$$\Sigma M_O = 0 = [(F_S*.023)]-[(F_R*.007)+(F_{MG}*.007)]$$

$$F_S = \frac{[(4.91*.007)+(.49*.007)]}{\boxed{.023}}$$

Latch Push Force (Measured) (Newtons) 17.1 - 19.7 N

F_S = 1.64 N

Factor of Safety = F_{MS}/F_S = 17.1/1.64 =	10.4

Shear Force at Pin

τ = R/A_P = 50.65/22.05
= 2.29 Mpa

Factor of Safety (FS)	=	66/2.29	=	28.8

Shear Force at latch head

τ = F_L/A_H = 50.65/12.87
= 3.9 Mpa

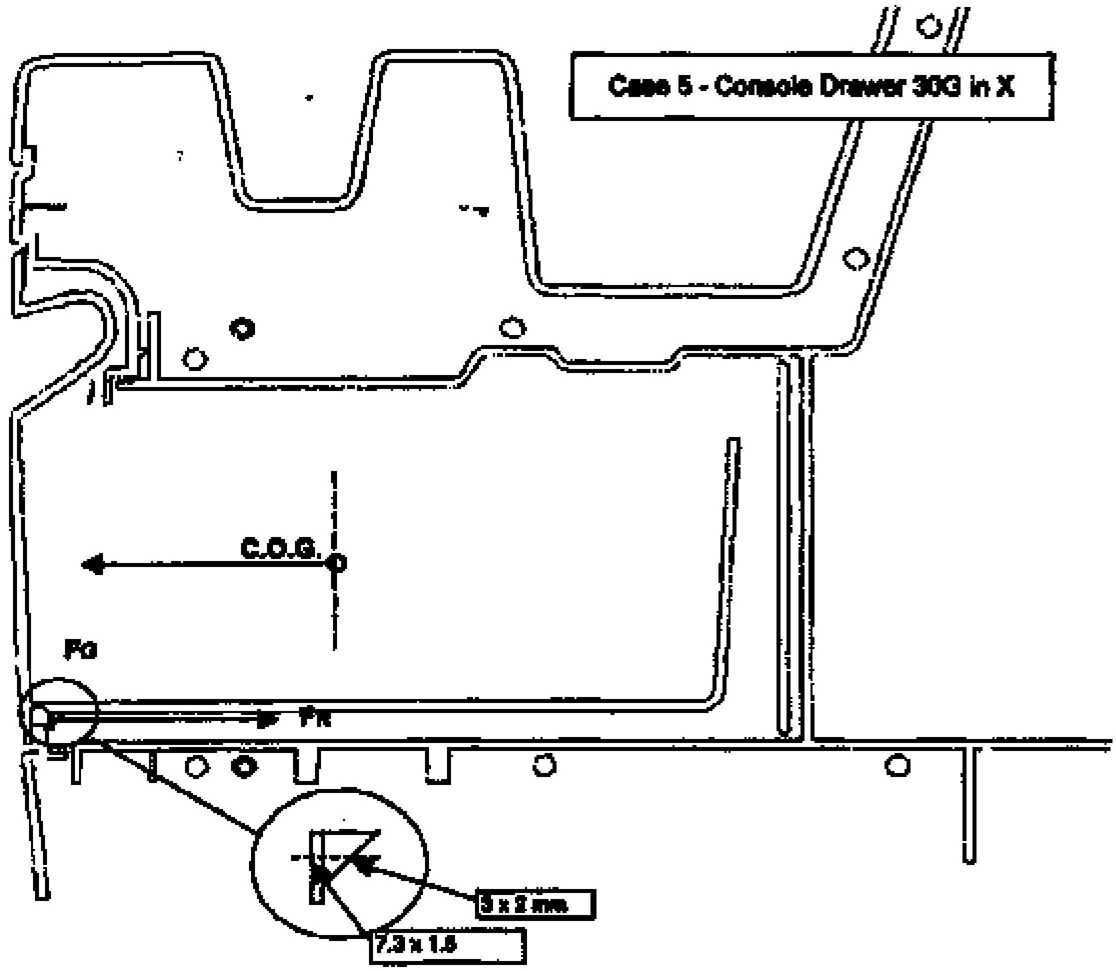
Factor of Safety (FS)	=	66/3.9	=	16.9

Axial Load (Tensile) on Latch arm

σ = F_L/A = 50.65/42
= 1.2 Mpa

Factor of Safety (FS)	=	66/1.2	=	55

30G - Tray Latch Failure (FACTOR OF SAFETY CALCULATION)



C.O.G.	center of gravity	=	X = 3906, Y = 0, Z = 1217
F_G	acceleration of lid at 30G (F=MA)	=	(30) (9.81) (0.25) = 73.58
F_{RM}	measured retention force of tray	=	119.7 N
F_R	required retention force of tray	=	73.6 N
M	mass of tray	=	0.25 Kg
AL	Area of Latch	=	16.95 mm^2
	Material Strength	=	21 Mpa

$\Sigma F_x = 0 = F_G - F_R = 0$

$\tau = F_R/A$ = 4.34 MPa

$F_R = F_G = 73.6$ N

$\boxed{FS = \text{Mat'l}/\tau = 4.8 \quad \text{(Mat'l failure of latch)}}$

(FACTOR OF SAFETY)

$F_R = 73.6$ N

$F_{RM} = 119.7 > 73.6$ N

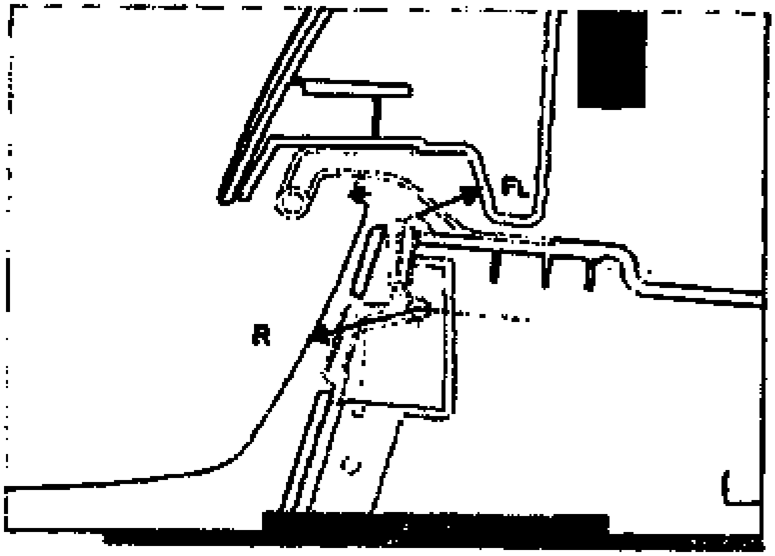
$\boxed{FS = 1.6}$

Tray Stop Retention Force (Measured)
119.7 - 158.0 N

Case 6 - Cross Car 10G Loads

Console Latch & Hinges are aligned with centerline of vehicle (Y0 Axis) The latch and hinge mechanisms, along with the sliding tray were shown to sustain a 30G vehicle fore/aft load. Therefore, neither the tray, hinges or the latch should fail under a 10G cross car load.

Latch Shear and tensile strength calcs reshown below



FL	Force of lid applied to latch	=	50.65 N
R	Resultant Force at Pin	=	50.65 N
AP	Area of Pin	=	19.63 mm^2
AH	Area of latch head	=	12.36 mm^2
A	Area of latch arm	=	42 mm^2
	Material Strength	=	66 Mpa

Shear Force at Pin

τ = R/AP = 50.65/19.63
= 2.58 Mpa

Factor of Safety (FS)	=	66/2.58	=	25.6

Shear Force at latch head

τ = FL/AH = 50.65/12.36
= 4.1 Mpa

Factor of Safety (FS)	=	66/4.1	=	16.1

Axial Load (Tensile) on Latch arm

σ = FL/A = 50.65/42
= 1.2 Mpa

Factor of Safety (FS)	=	66/1.2	=	55

SUMMARY

Case 1 - Console Armrest 30G in X

The armrest will remain closed during a 30G longitudinal load with a factor of safety of 2.4.

Case 2 - Latch 30G in X

The latch will remain closed (therby not allowing the armrest to open) during a 30G longitudinal load with a factor of safety of 3.03.

Case 3 - Console Armrest 10G in Rollover (-Z)

The armrest will remain closed during a 10G vertical load with a factor of safety of 2.30.

Case 4 - Latch 10G in Rollover (-Z)

The latch will remain closed (therby not allowing the armrest to open) during a 10G vertical load with a factor of safety of 28.8 for shear at latch pin, 16.1 for shear at latch head and 55 for tensile loads and 10.4 for latch inertial loads.

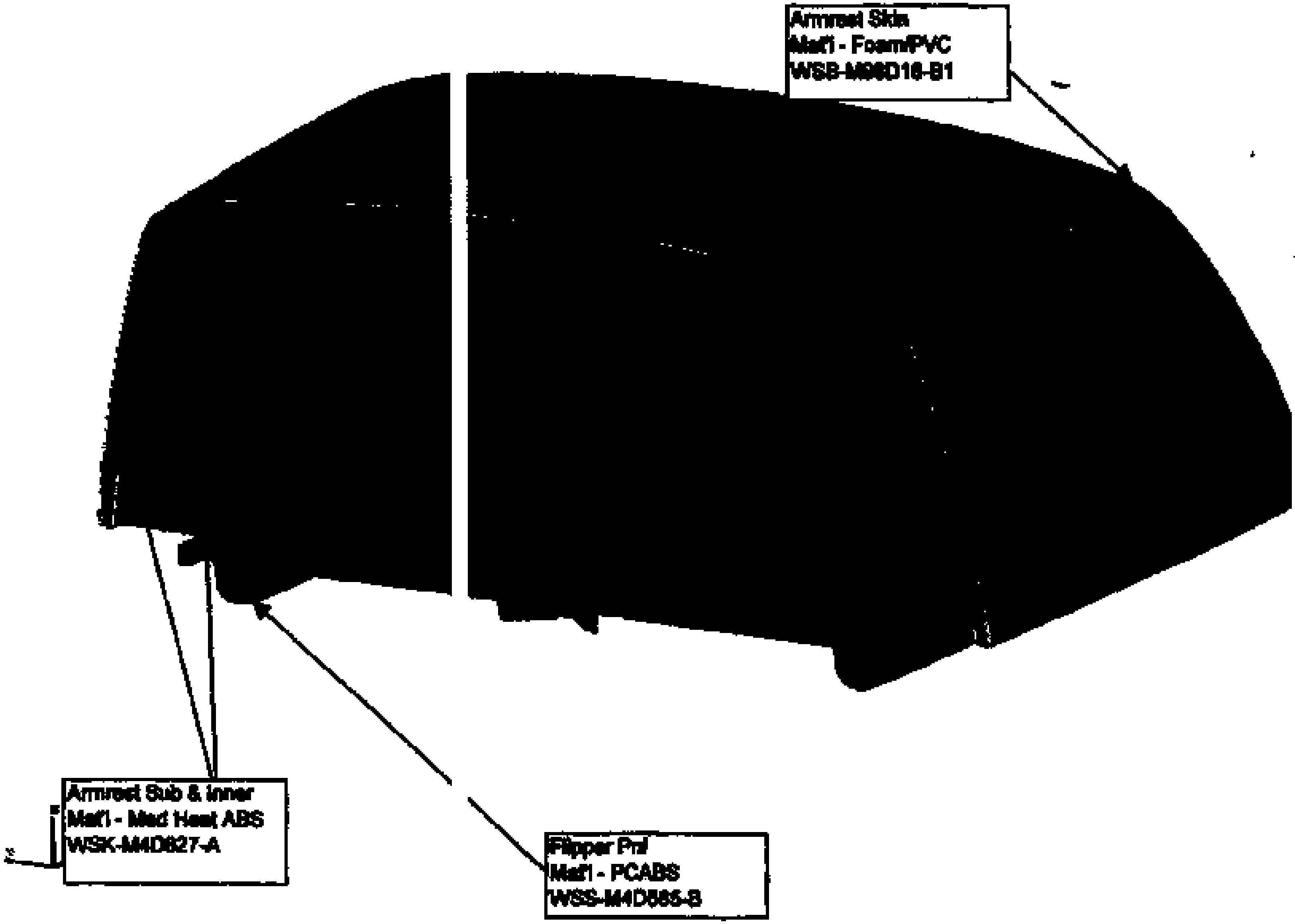
Case 5 - Console Drawer 30G in X

The console drawer will remain closed during a 30G longitudinal load with a factor of safety of 1.6 for the latch failure and 4.9 for the latch material yield failure

Case 6 - Console Armrest in 10g (+/-Y)

The console armrest will remain closed during a 10G cross car load with a factor of safety of 1.64 for the armrest and 25.6 for shear at latch pin, 15.9 for shear at latch head and 55 for tensile loads.

NOTES



January 29th 2004

APPENDIX C

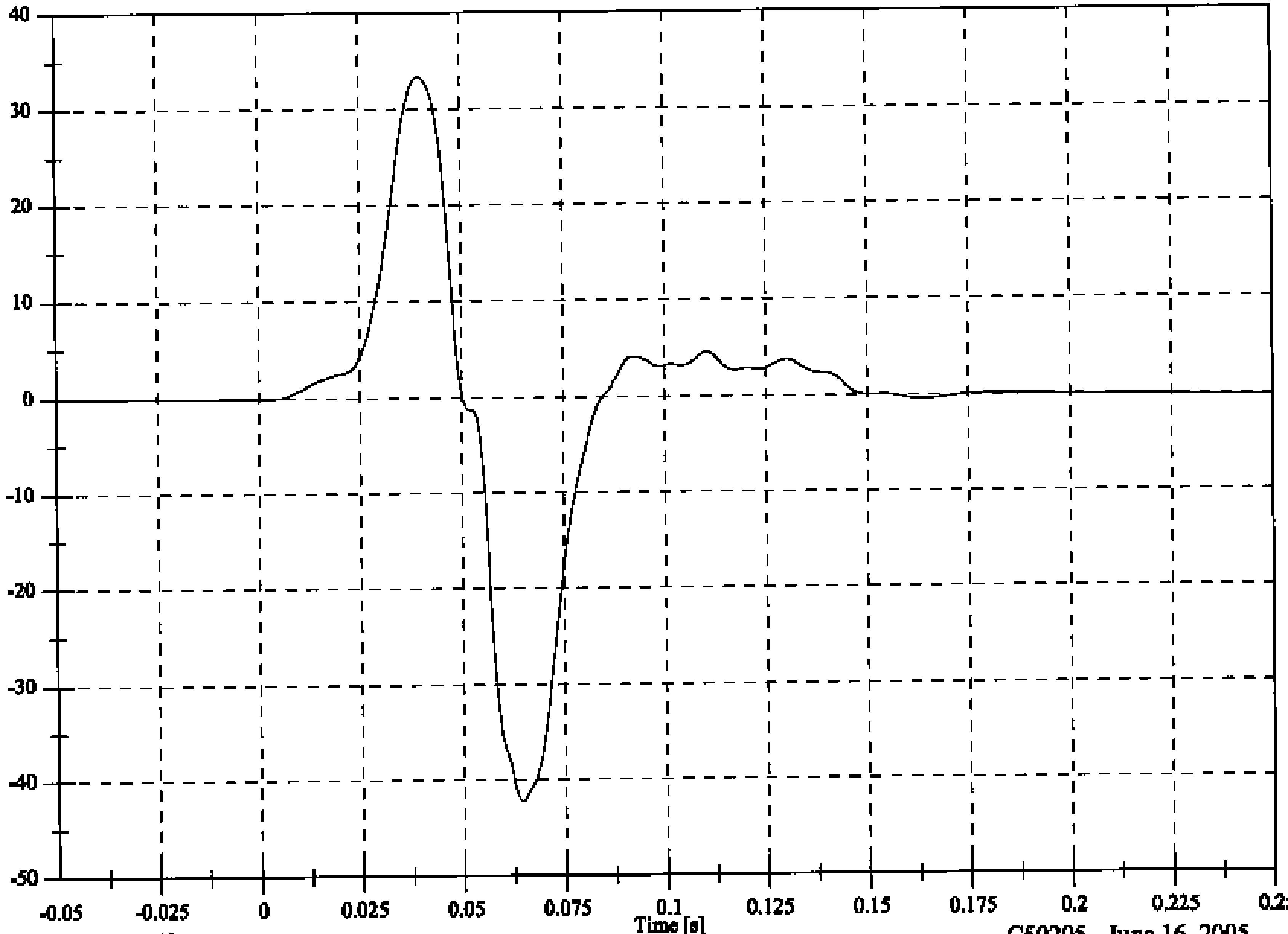
DATA PLOTS

FMVSS 201 Linear Impact - 2005 Ford Freestyle - IP1 -12 Degrees

Impactor Headform Ax

Max: 33.4 [g] at 0.040 [s]

Min: -42.2 [g] at 0.064 [s]



C50205 IP1 IMPACT PLOT # 1

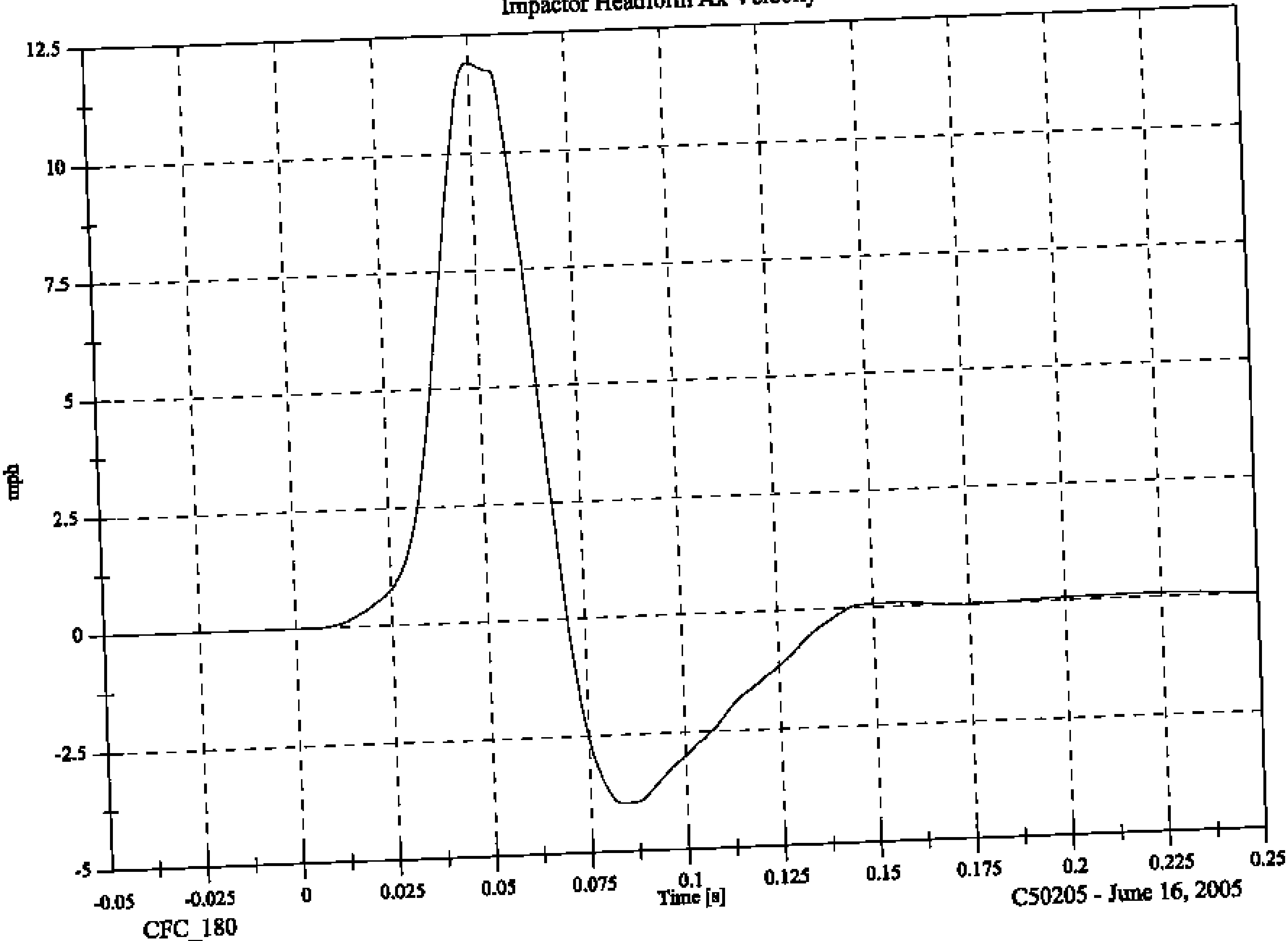
8655-F201-30

FMVSS 201 Linear Impact - 2005 Ford Freestyle - IP1 -12 Degrees

Impactor Headform Ax Velocity

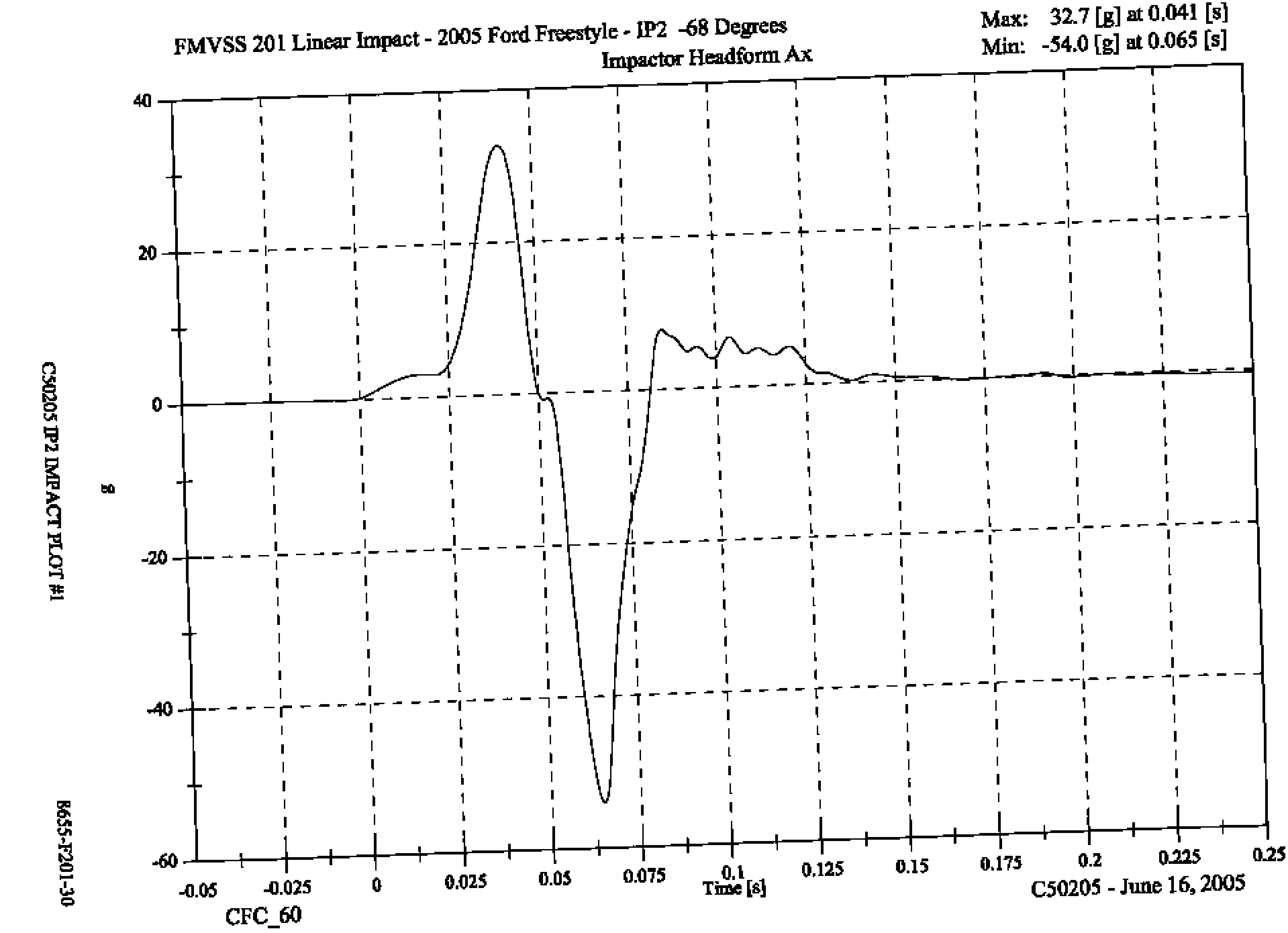
Max: 11.9 [mph] at 0.049 [s]

Min: -4.0 [mph] at 0.086 [s]



C50205 IP1 IMPACT PLOT # 2

8655-F201-30



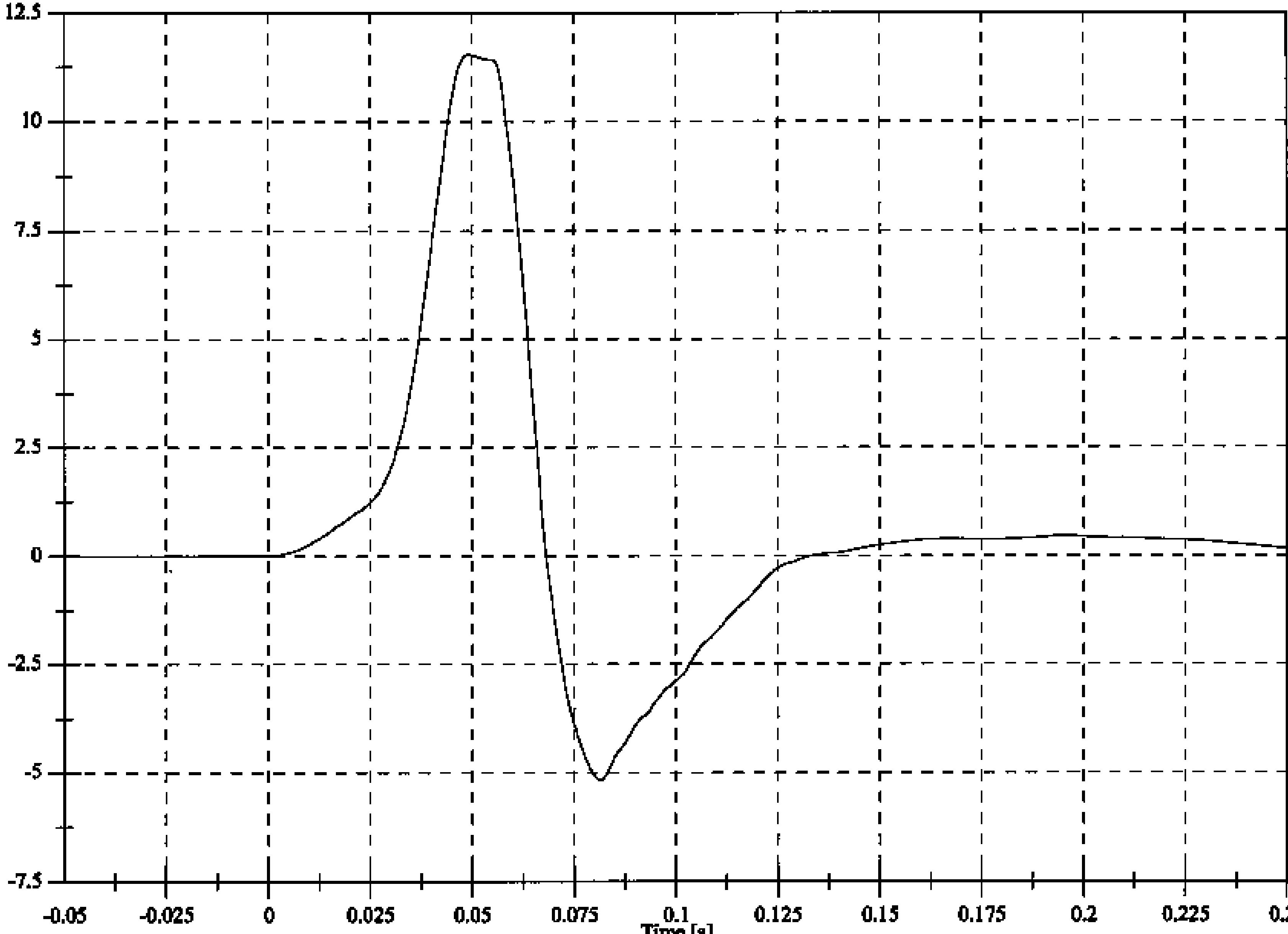
FMVSS 201 Linear Impact - 2005 Ford Freestyle - IP2 -68 Degrees
Impactor Headform Ax
Max: 32.7 [g] at 0.041 [s]
Min: -54.0 [g] at 0.065 [s]
40
20
0
-20
-40
-60
g
-0.05
-0.025
0
0.025
0.05
0.075
0.1
0.125
0.15
0.175
0.2
0.225
0.25
Time [s]
CFC_60
C50205 - June 16, 2005
C50205 IP2 IMPACT PLOT #1
B655-F201-30

FMVSS 201 Linear Impact - 2005 Ford Freestyle - IP2 -68 Degrees

Impactor Headform Ax Velocity

Max: 11.5 [mph] at 0.049 [s]

Min: -5.2 [mph] at 0.081 [s]



CFC_180

C50205 - June 16, 2005

C50205 IP2 IMPACT PLOT #2

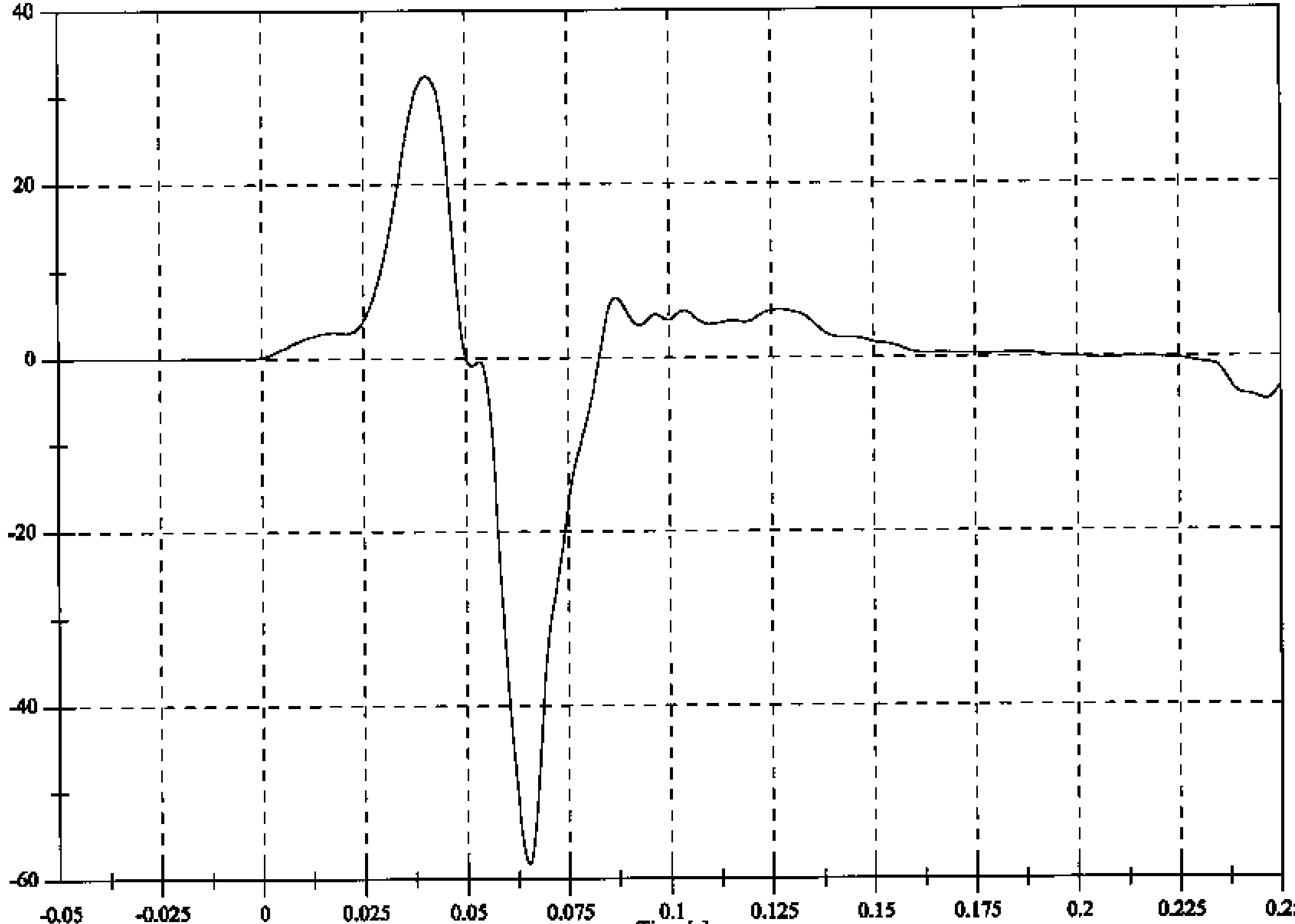
8655-F201-30

FMVSS 201 Linear Impact - 2005 Ford Freestyle - IP3 -68 Degrees

Impactor Headform Ax

Max: 32.4 [g] at 0.040 [s]

Min: -58.3 [g] at 0.065 [s]

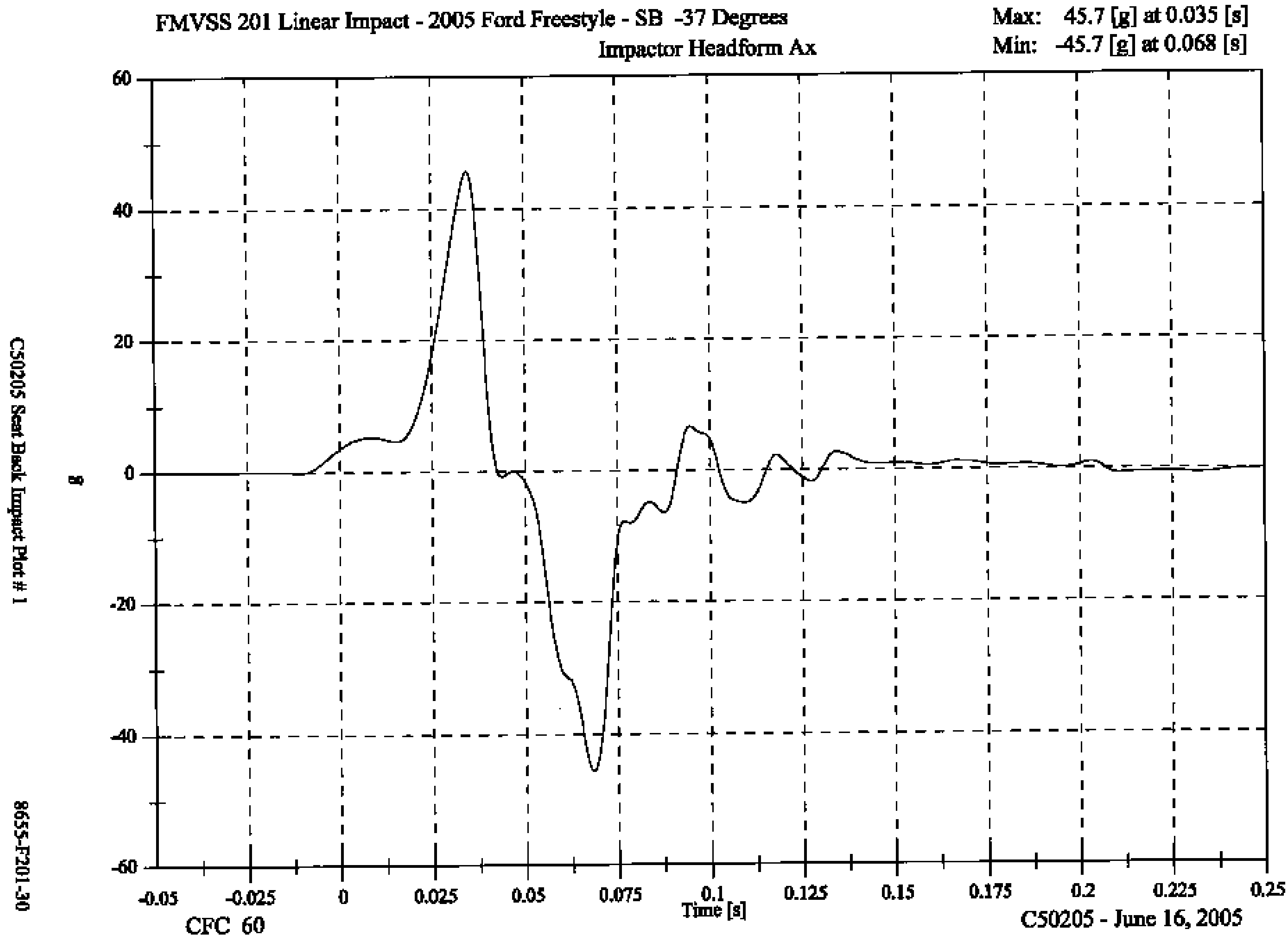


CFC_60

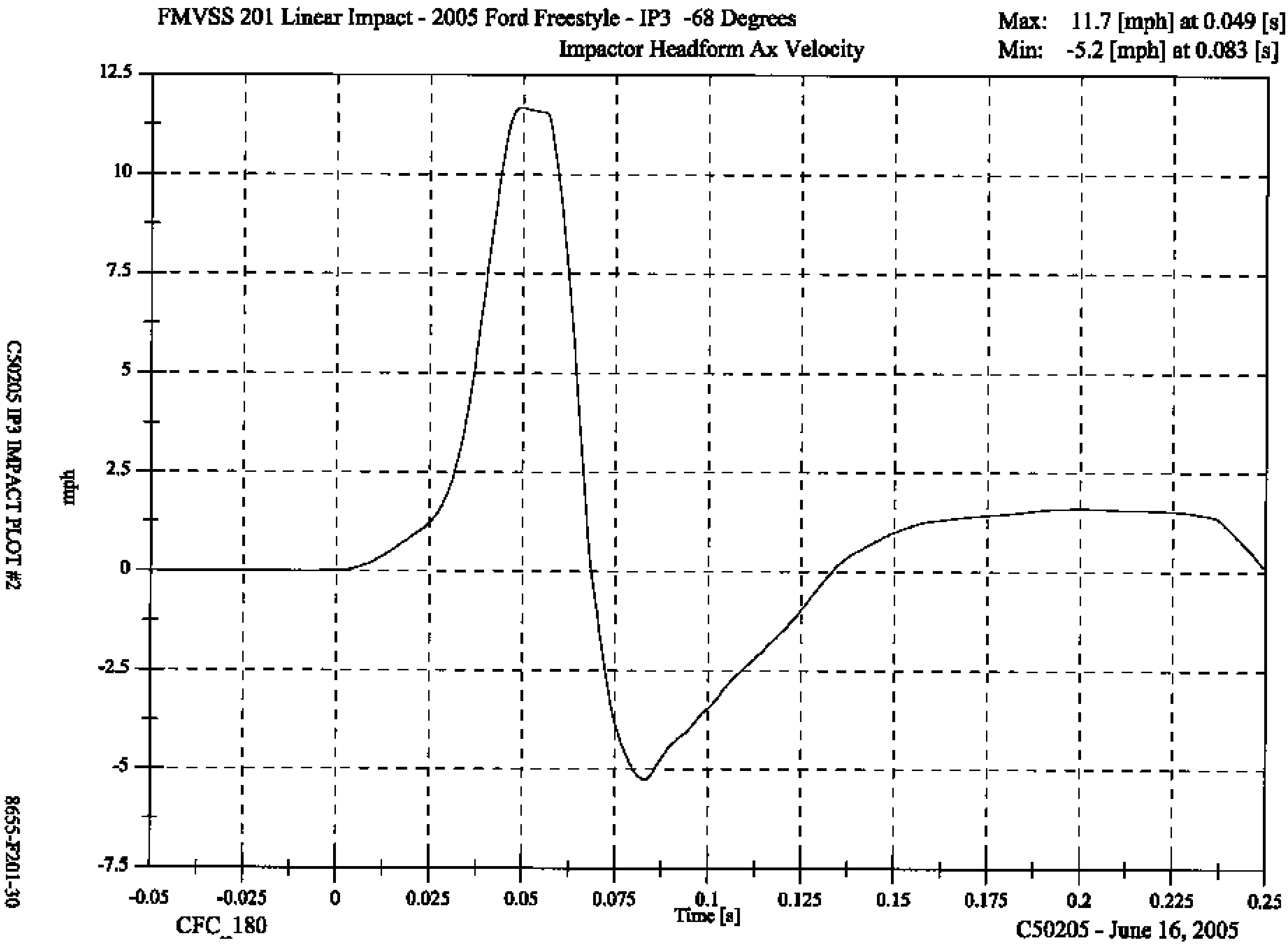
C50205 - June 16, 2005

C50205 IP3 IMPACT PLOT #1

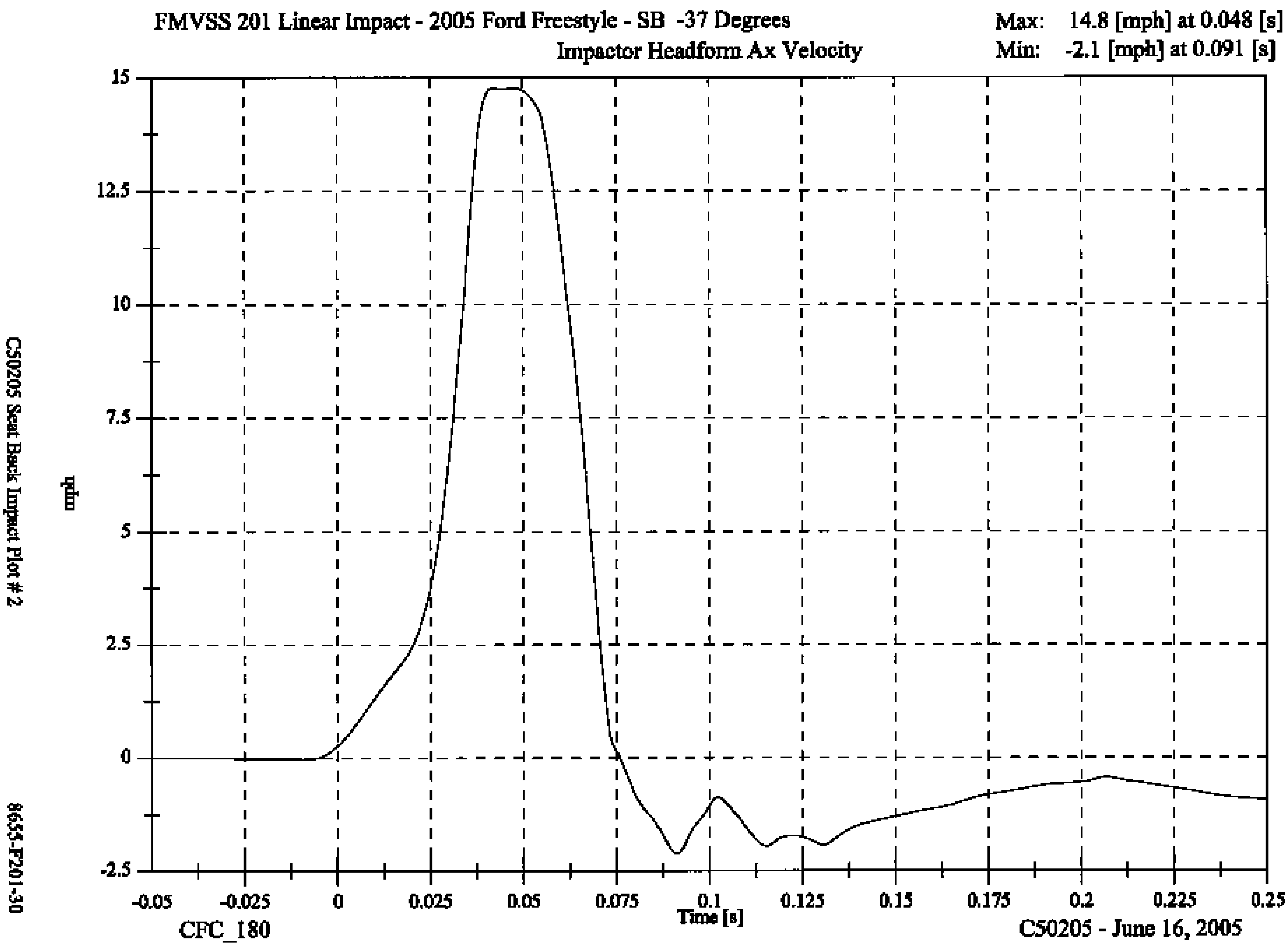
8655-F201-30



FMVSS 201 Linear Impact - 2005 Ford Freestyle - SB -37 Degrees
Impactor Headform Ax
Max: 45.7 [g] at 0.035 [s]
Min: -45.7 [g] at 0.068 [s]
60
40
20
0
-20
-40
-60
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
Time [s]
CFC_60
C50205 - June 16, 2005
C50205 Seat Back Impact Plot # 1
8655-F201-30



FMVSS 201 Linear Impact - 2005 Ford Freestyle - IP3 -68 Degrees
Impactor Headform Ax Velocity
Max: 11.7 [mph] at 0.049 [s]
Min: -5.2 [mph] at 0.083 [s]
C50205 IP3 IMPACT PLOT #2
mph
12.5
10
7.5
5
2.5
0
-2.5
-5
-7.5
-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
C50205 - June 16, 2005
8655-F201-30



FMVSS 201 Linear Impact - 2005 Ford Freestyle - SB -37 Degrees
Impactor Headform Ax Velocity
Max: 14.8 [mph] at 0.048 [s]
Min: -2.1 [mph] at 0.091 [s]
mph
Time [s]
15
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
CFC_180
C50205 - June 16, 2005
C50205 Seat Back Impact Plot # 2
8655-F201-30