

# 1904

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MOVING BARRIER REAR IMPACT TEST  
FOR FUEL SYSTEM INTEGRITY

FORD MOTOR CORPORATION  
1993 FORD ESCORT  
3-DOOR HATCHBACK

CALSPAN TEST NUMBER: Y47-020-1278

APRIL 23, 1993

CALSPAN CORPORATION  
ADVANCED TECHNOLOGY CENTER  
P.O. BOX 400  
BUFFALO, NEW YORK 14225



FINAL REPORT

Prepared For:  
U.S. Department of Transportation  
Research and Special Programs Administration  
Transportation Systems Center  
Kendall Square  
Cambridge, MA 02142

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(COTR), NHTSA, Office of Vehicle Safety Compliance

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Date of Report Acceptance

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| 15. Supplementary Notes  |  |  |           |
| 16. Abstract<br><br>A Moving Barrier Rear Impact test of a 1993 Ford Escort 3-Door Hatchback was performed at the Calspan Corporation Advanced Technology Center Crash Test Facility on April 23, 1993.<br><br>The impact velocity was 35.2 MPH and the ambient temperature at the time of impact was 65°F. There was no fuel leakage detected after the test. |  |  |           |
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Section 1

PURPOSE AND TEST PROCEDURE

This 35 mph rear moving barrier impact test is part of a test program conducted for the National Highway Traffic Safety Administration (NHTSA) by Calspan Advanced Technology Center under contract No. DTRS57-90-C-00104.

The purpose of this test was to generate vehicle and occupant data with regard to the test vehicle, a 1993 Ford Escort 3-Door Hatchback. This test was conducted using the requirements found in the OVSC Laboratory Test Procedure No. TP-301-00, dated April 26, 1989.

Section 2  
SUMMARY OF TEST

A rear moving barrier impacted a 1993 Ford Escort 3-Door Hatchback at a velocity of 35.2 mph. The test was performed at the Calspan Advanced Technology Center on April 23, 1993. Pre- and Post-test photographs can be found in Appendix A of this report.

The test was documented by one real time camera and 5 high-speed cameras. Camera locations and other pertinent data can be found in Figure 6 and Table 4.

The test vehicle contained two Hybrid III 50th percentile male anthropomorphic test devices (ATDs) in the driver and right front passenger positions. Both ATDs were restrained with the vehicles automatic torso and manual lap belts. Both ATDs were instrumented with head and chest accelerometers, chest potentiometers, left/right femur load cells, neck transducers and tibial transducers. The ATDs were placed in the vehicle following the dummy placement instructions specified in the Laboratory Indicant Test Procedure.

The 56 channels of data were recorded on a P.C. based data acquisition system. Appendix B contains the vehicle and dummy response data traces. The vehicle accelerometers on the barriers left and right rail contained questionable data at 47 and 65 milliseconds and from 125 to 130 milliseconds.

The drivers HIC was 217.2. The maximum chest deceleration over 3 milliseconds was 14.5 gs. The left femur load was -332.2 pounds and the right femur load was 165.0 pounds.

The right-front passenger sustained a HIC value of 351.4. The maximum chest deceleration over 3 milliseconds was 14.3 gs. The left femur load was 145.1 pounds and 143.6 pounds on the right femur.

Post test analysis showed no fuel leakage during the FMVSS 301 static and rollover tests.

Section 3  
VEHICLE AND TEST INFORMATION

Figure 1

GENERAL TEST AND VEHICLE PARAMETER DATA

TEST VEHICLE INFORMATION:

Year/Make/Model/Body Style: 1993 Ford Escort 3-Door Hatchback  
Run No.: 1278; VIN: 1FAPP10J8PW258210; Color: White  
Engine Data: 4 cylinders; - CID; 1.9 Liters; - cc  
Placement: - Longitudinal or In-Line; ✓ Transverse or Lateral  
Transmission Data: 5 speeds; ✓ Manual; - Automatic; - Overdrive  
Final Drive: - Rear Wheel Drive; ✓ Front Wheel Drive; - Four Wheel Drive  
Major Options: - A/C; - Pwr.Strg.; ✓ Pwr.Brakes  
- Pwr.Windows; - Pwr.Door Locks  
Date Received: 4-12-93; Odometer Reading 25 miles  
Selling Dealer: West Herr Ford  
& Address 5025 Camp Rd. Hamburg, NY

DATA FROM VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufactured by: Ford Motor Corporation  
Date of Manufacture: 1/93  
GVWR: 3430 lbs.; GAWR: 1840 lbs. FRONT; 1664 lbs. REAR

DATA FROM TIRE PLACARD:

Tire Pressure with Maximum Capacity Vehicle Load: 35 psi FRONT  
35 psi REAR  
Recommended Tire Size: P175/70R13 Load Range: STD  
Recommended Cold Tire Pressure: 32 psi FRONT; 32 psi REAR  
Size of Tires on Test Vehicle: P175/70R13; Manufacturer: Goodyear

Vehicle Capacity Data:

Type of Front Seats: - Bench; ✓ Bucket; - Split Bench  
Number of Occupants: 2 Front; 3 Rear; 5 Total  
Vehicle Capacity Weight (VCW) = 830 lbs.  
No. of Occupants x 150 lbs. = 750 lbs.  
Rated Cargo/Luggage Weight (RCLW) = 80 lbs. (Difference)

Table 1

GENERAL TEST AND VEHICLE PARAMETER DATA (cont'd)

WEIGHT OF TEST VEHICLE AS RECEIVED FROM DEALER (WITH MAXIMUM FLUIDS) = UDW:

Right Front = 690 lbs.      Right Rear = 430 lbs.  
 Left Front = 700 lbs.      Left Rear = 450 lbs.  
 TOTAL FRONT = 1390 lbs.      TOTAL REAR = 880 lbs.  
 % of Total Vehicle Weight = 61.2 % of Total Weight = 38.8 %  
 TOTAL DELIVERED WEIGHT = 2270 lbs.

WEIGHT OF TEST VEHICLE WITH TWO DUMMIES AND 216 POUNDS OF CARGO WEIGHT:

Right Front = 850 lbs.      Right Rear = 490 lbs.  
 Left Front = 900 lbs.      Left Rear = 580 lbs.  
 TOTAL FRONT = 1750 lbs.      TOTAL REAR = 1070 lbs.  
 % of Total Weight = 62.1 %      % of Total Weight = 37.9 %  
 TOTAL TEST WEIGHT = 2820 lbs.

Weight of Ballast Secured in Vehicle Trunk Area = 0 lbs.

VEHICLE ATTITUDE (all dimensions in inches):

AS DELIVERED:    RF 25.2      LF 25.1      RR 24.6      LR 24.5  
 AS TESTED:      RF 24.1      LF 23.8      RR 24.2      LR 23.7  
 Vehicle's Wheel Base: 98.4 in.  
 Location of Vehicle's C.G.: 37.3 inches rearward of front wheel center

FUEL SYSTEM DATA:

Fuel System Capacity From Owner's Manual = 13.2 gallons  
 Usable Capacity Figure Furnished by COTR = 13.2 gallons  
 Test Volume Range (92 to 94% of Usable Capacity) = 12.1 to 12.4 gallons  
 ACTUAL TEST VOLUME = 12.3 gallons (with entire fuel system filled)  
 Test Fluid Type: Stoddard Solution;      Spec. Grav. 0.764  
 Kinematic Viscosity = 0.96 centistokes; Color = Purple

DETAILS OF FUEL SYSTEM:

12.3 gallons of stoddard solution was placed in the fuel tank.



Figure 2  
POST-TEST IMPACT DATA  
SUMMARY OF RESULTS (cont'd)

CONTACT PTS.:

|            | <u>Driver</u>                          | <u>Passenger</u>                       |
|------------|--|--|
| Head       | <u>Rear of head contacted headrest</u> | <u>Rear of head contacted headrest</u> |
| Chest      | <u>No Comments</u>                     | <u>No Comments</u>                     |
| Abdomen    | <u>No Comments</u>                     | <u>No Comments</u>                     |
| Left Knee  | <u>No Comments</u>                     | <u>No Comments</u>                     |
| Right Knee | <u>No Comments</u>                     | <u>No Comments</u>                     |

STODDARD SPILLAGE: None  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

GLAZING DAMAGE: None  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

OTHER NOTABLE IMPACT FEATURES: None  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Table 1

DUMMY INJURY CRITERIA VALUES

Test No.: Y47-020-1278 Vehicle: 1993 Ford Escort 3-Door Hatchback

|           | MAXIMUM ACCELERATION (g's) |       |      |      |       |      |     |      |
|-----------|----------------------------|-------|------|------|-------|------|-----|------|
|           | HEAD                       |       |      |      | CHEST |      |     |      |
|           | X                          | Y     | Z    | R    | X     | Y    | Z   | R*   |
| Dummy (1) | 34.1                       | -10.8 | 28.5 | 41.6 | 12.6  | -3.4 | 7.7 | 14.5 |
| Dummy (2) | 53.5                       | 16.7  | 30.2 | 60.6 | 13.2  | 4.4  | 8.0 | 14.3 |

|           | MAXIMUM FORCE - FEMUR LOAD (lbs.) |             |
|-----------|-----------------------------------|-------------|
|           | LEFT FEMUR                        | RIGHT FEMUR |
| Dummy (1) | -332.2                            | 165.0       |
| Dummy (2) | 145.1                             | 143.6       |

|           | HEAD INJURY CRITERIA** |                        |                       |   |
|-----------|------------------------|------------------------|-----------------------|---|
|           | HIC                    | 36 millisecond Maximum |                       | Avg. Acc. (g)<br>t <sub>1</sub> TO t <sub>2</sub> |
|           |                        | t <sub>1</sub> (msec)  | t <sub>2</sub> (msec) |   |
| Dummy (1) | 217.2                  | 133.800                | 169.680               | 32.57   |
| Dummy (2) | 351.4                  | 128.280                | 159.960               | 41.49   |

\* Defined as exceeding 0.003 sec. duration

\*\*As defined in FMVSS No. 208

Table 2  
HYBRID III NECK AND CHEST DATA SHEET

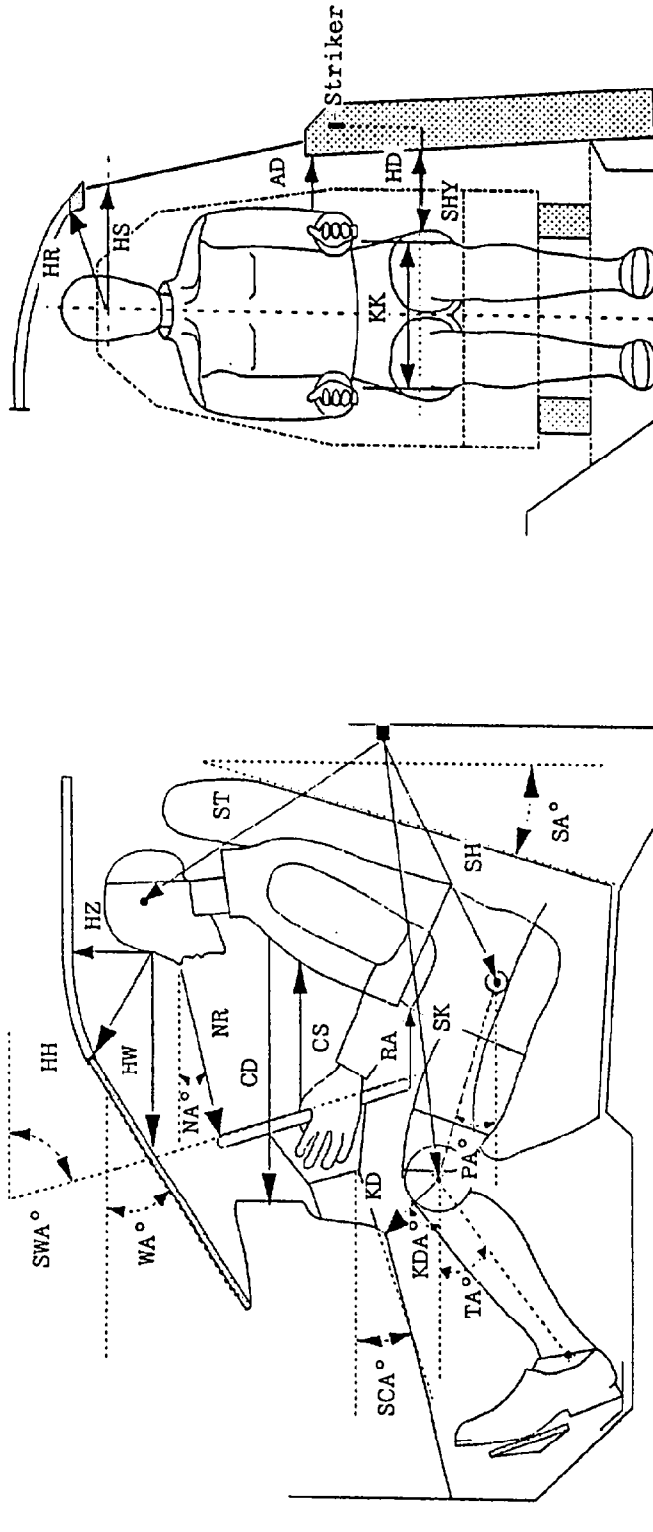
Vehicle Year/Make/Model/Body Style: 1993 Ford Escort 3-Door Hatchback

Test No.: Y47-020-1278 Test Date: April 23, 1993

| MAXIMUM<br>VALUES        | DRIVER DUMMY<br>ID # <u>171</u> | PASSENGER DUMMY<br>ID # <u>186</u> |
|--------------------------|---------------------------------|------------------------------------|
| Neck Load X (lbs)        | -44.1                           | -104.5                             |
| Neck Load Y (lbs)        | -35.0                           | 31.5                               |
| Neck Load Z (lbs)        | 271.1                           | 278.5                              |
| Neck Moment X (ft-lbs)   | 8.5                             | 10.7                               |
| Neck Moment Y (ft-lbs)   | -23.3                           | -21.4                              |
| Neck Moment Z (ft-lbs)   | -3.3                            | 3.6                                |
| Chest Deflection X (in.) | -0.1                            | .02                                |
| Time of Max. Occurance   | 76.6 msec                       | 71.5 msec                          |

NOTE: All values listed must be occurring during primary impact event.

Figure 3  
DUMMY MEASUREMENTS FOR FRONT SEAT PASSENGERS



- HH - Head to Header
- HW - Head to Windshield
- HZ - Head to Roof
- NR - Nose to Rim
- CS - Steering Wheel to Chest
- CD - Chest to Dash
- RA - Rime to Abdomen
- KDL/KDR - Knee to Dash
- KDA - Knee to Dash Angle
- SH - Striker to H-Point
- SK - Striker to Knee
- ST - Striker to Head
- NA - Nose to Rim Angle
- TA - Tibial Angle
- PA - Pelvic Angle
- SA - Seat Back Angle
- SCA - Steering Column Angle
- SWA - Steering Wheel Angle
- WA - Windshield Angle

- HR - Head to Side Header
- HS - Head to Side Window
- AD - Arm to Door
- HD - H-Point to Door
- SHY - Striker to H-Point (Y Dir.)
- KK - Knee to Knee

Vertical Longitudinal Planes

Vertical Transverse Plane

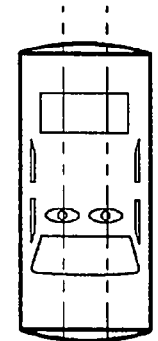
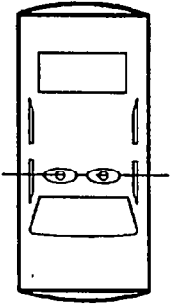


Table 3

FRONT SEAT OCCUPANT MEASUREMENTS

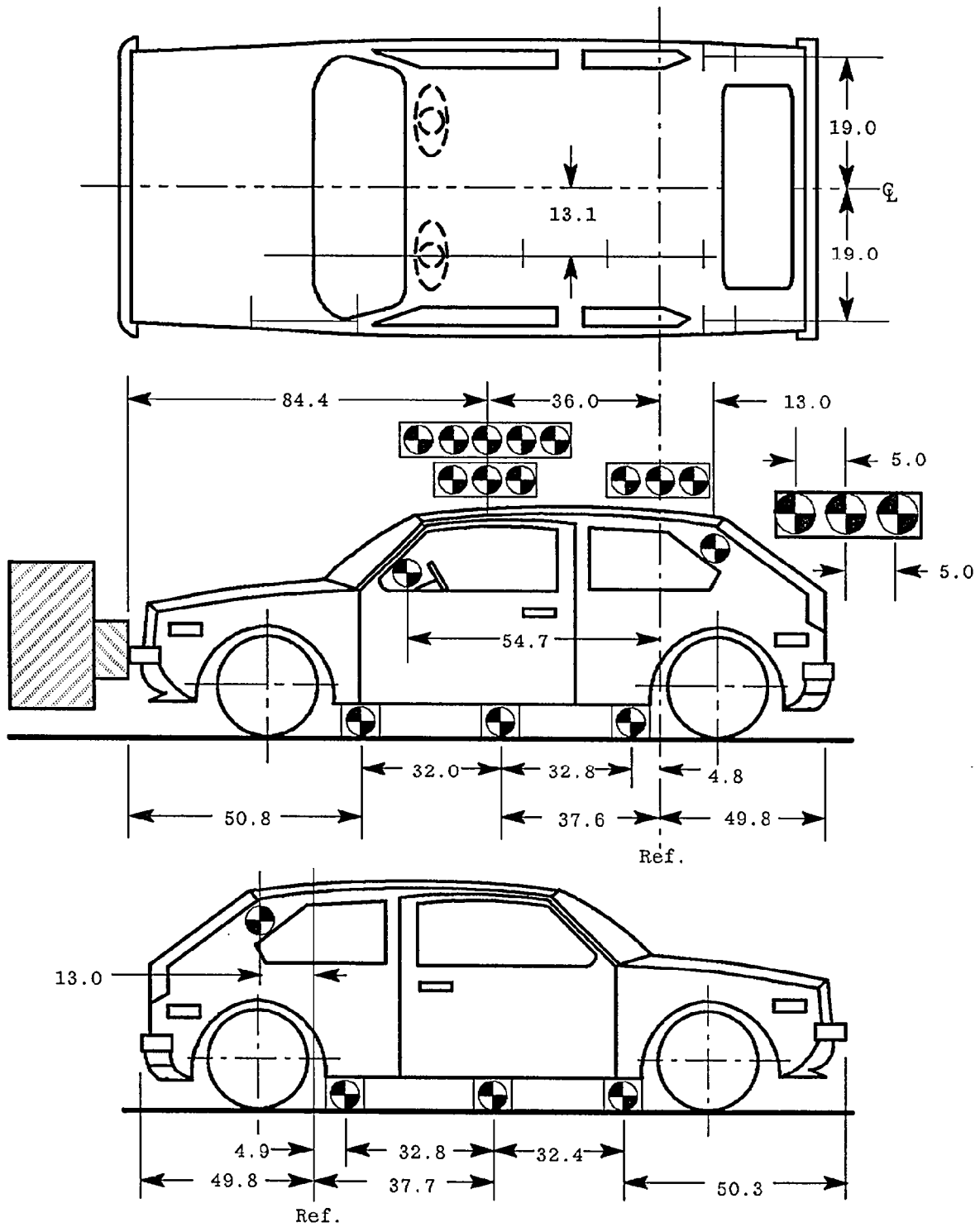
(all dimensions in inches unless otherwise specified)

|      | DRIVER (Serial #171)    | PASS (Serial #186)      |
|------|-------------------------|-------------------------|
| WA°  | 33°                     | -                       |
| SWA° | -63°                    | -                       |
| SCA° | 27°                     | -                       |
| SA°  | See Note                | See Note                |
| HZ   | 8.5 in.                 | 8.3 in.                 |
| HH   | 14.3 in.                | 14.4 in.                |
| HW   | 21.8 in.                | 21.1 in.                |
| HR   | 8.6 in.                 | 8.4 in.                 |
| NR   | 15.4 in Angle (NA) 4°   | -                       |
| CD   | 20.3 in.                | 19.1 in.                |
| CS   | 10.9 in.                | -                       |
| RA   | 6.3 in.                 | -                       |
| KDL  | 5.3 in. Angle (KDA) 30° | 5.2 in.                 |
| KDR  | 5.4 in.                 | 6.0 in. Angle (KDA) 34° |
| PA°  | 25°                     | 25°                     |
| TA°  | 45°                     | 45°                     |
| KK   | 10.5 in.                | 9                       |
| ST   | 22.6 in. Angle 40°      | 22.8 in. Angle 46°      |
| SK   | 33.6 in. Angle 94°      | 33.7° in. Angle 95°     |
| SH   | 18.2 in. Angle 112°     | 18.8 in. Angle 112°     |
| SHY  | 8.2 in.                 | 8.6 in.                 |
| HS   | 9.0 in.                 | 9.3 in.                 |
| HD   | 7.8 in.                 | 7.3 in.                 |
| AD   | 3.8 in.                 | 5.1 in.                 |

Note: Seat back was positioned according to manufacturer specifications.

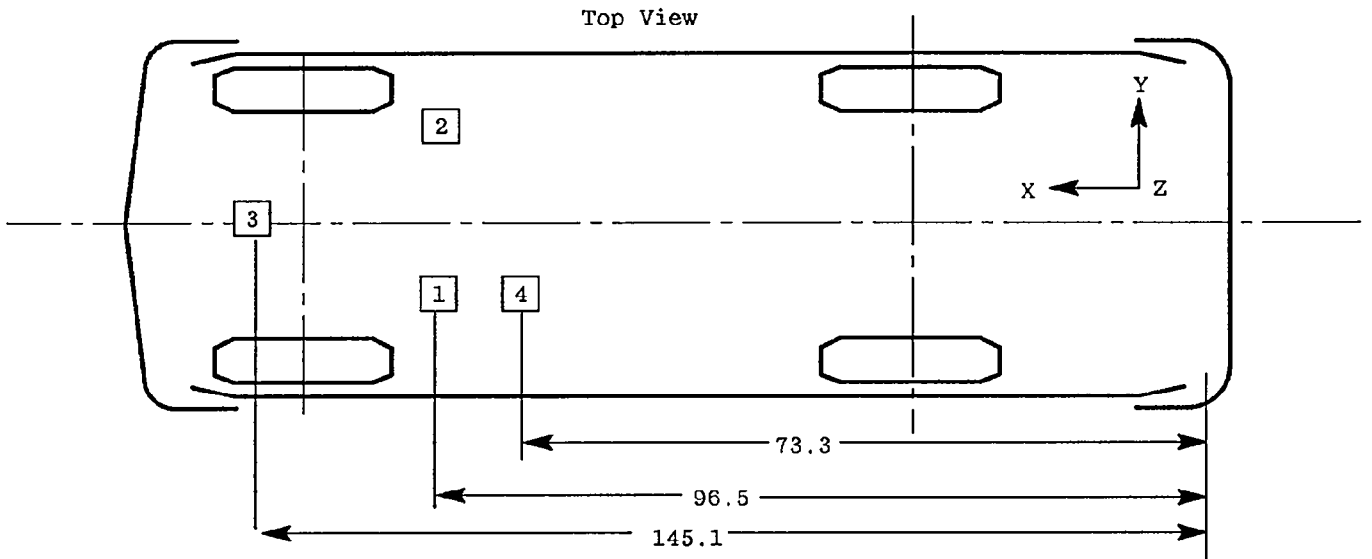
Figure 4

VEHICLE TARGET LOCATIONS



(Dimensions in inches)

Figure 5  
 VEHICLE ACCELEROMETER LOCATIONS



| ACCELEROMETER<br>NUMBER* | ACCELEROMETER LOCATION | DIRECTION |   |   |
|--------------------------|------------------------|-----------|---|---|
|                          |                        | X         | Y | Z |
| 1                        | Left Seat              | ✓         |   |   |
| 2                        | Right Seat             | ✓         |   |   |
| 3                        | Engine Top             | ✓         |   |   |
| 4                        | Left Rear Seat         | ✓         |   |   |

\*The accelerometer pack number can be correlated with the vehicle response data traces found in Appendix B.

Figure 6  
CAMERA POSITIONS FOR FRONTAL IMPACTS

NOTE: Camera Information Shown on Table 4

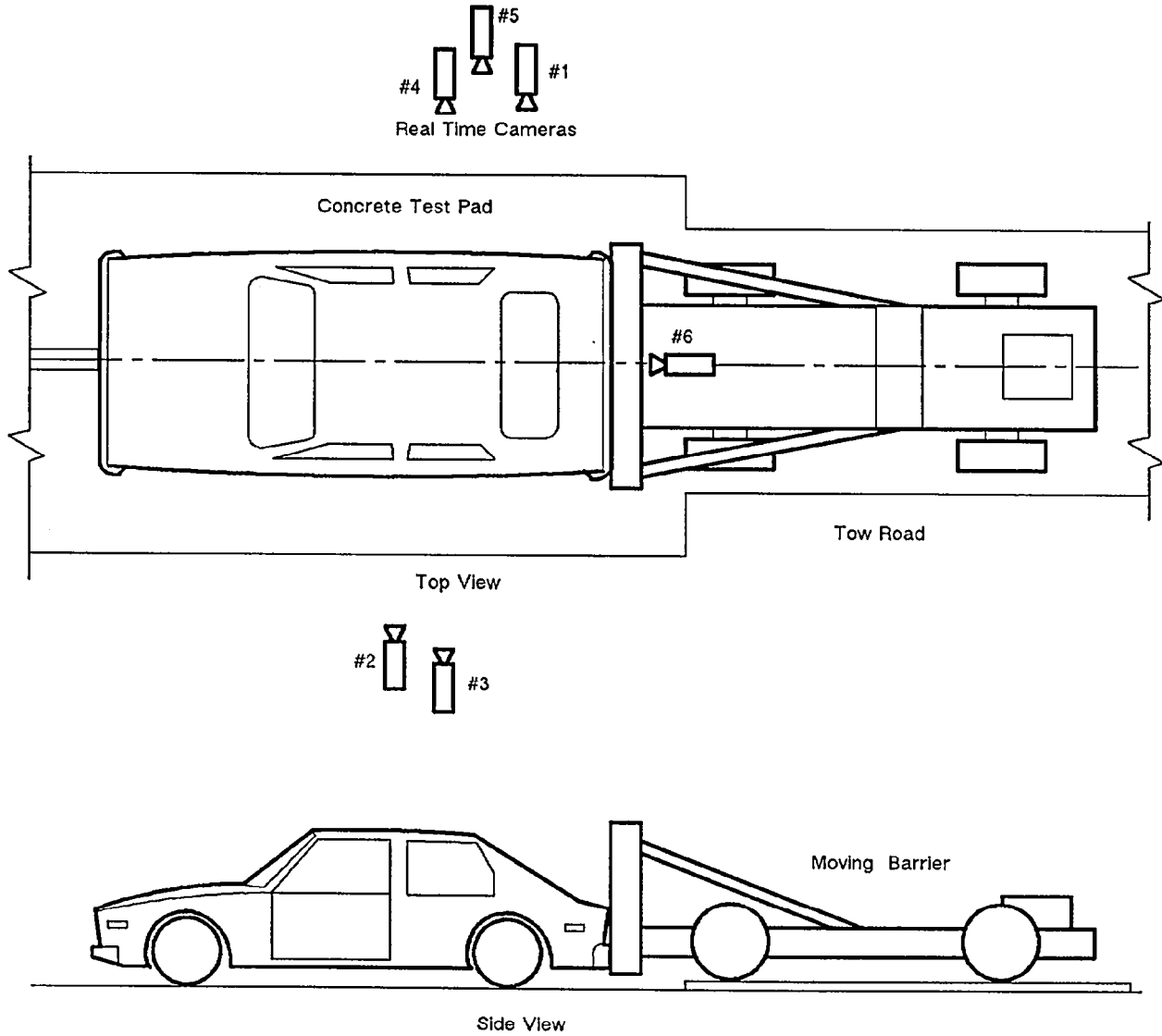


Table 4

HIGH-SPEED CAMERA LOCATIONS

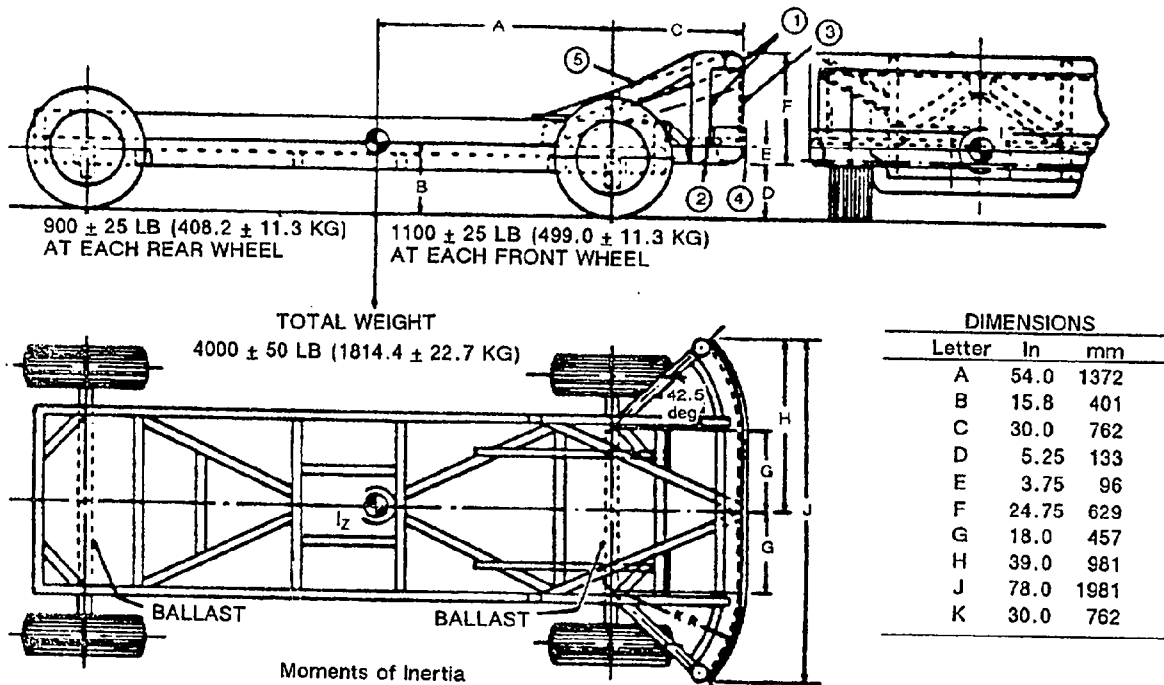
Test No. Y47-020-1278 Vehicle: 1993 Ford Escort 3-Door Hatchback

| CAMERA NO. | VIEW               | CAMERA POSITIONS (in)* |    |    | ANGLE** (deg) | LENS (mm) | SPEED (fps) |
|------------|--------------------|------------------------|----|----|---------------|-----------|-------------|
|            |                    | X                      | Y  | Z  |               |           |             |
| 1          | Real-Time          | -                      | -  | -  | -             | 24        |             |
| 2          | Right Side View    | 332                    | 59 | 41 | -3°           | 570       |             |
| 3          | Right Closeup View | 416                    | 32 | 42 | -3            | 760       |             |
| 4          | Left Side View     | 332                    | 88 | 39 | 0             | 600       |             |
| 5          | Left Closeup View  | 415                    | 64 | 40 | -1°           | 770       |             |
| 6          | Overhead View      | 4                      | 15 | -  | 90            | 600       |             |

\*X = film plane to monorail centerline  
 Y = film plane to impact location  
 Z = film plan to ground  
 \*\* = referenced to horizontal plane

Figure 6a

COMMON CARRIAGE WITH CONTOURED IMPACT SURFACE ATTACHED



Moments of Inertia  
 $I_z = 271 \pm 13.6 \text{ SLUG} \cdot \text{FT}^2 \text{ (} 367 \pm 18.4 \text{ kg} \cdot \text{m}^2 \text{)}$   
 $I_z = 3475 \pm 13.6 \text{ SLUG} \cdot \text{FT}^2 \text{ (} 367 \pm 18.4 \text{ kg} \cdot \text{m}^2 \text{)}$

NOTES:

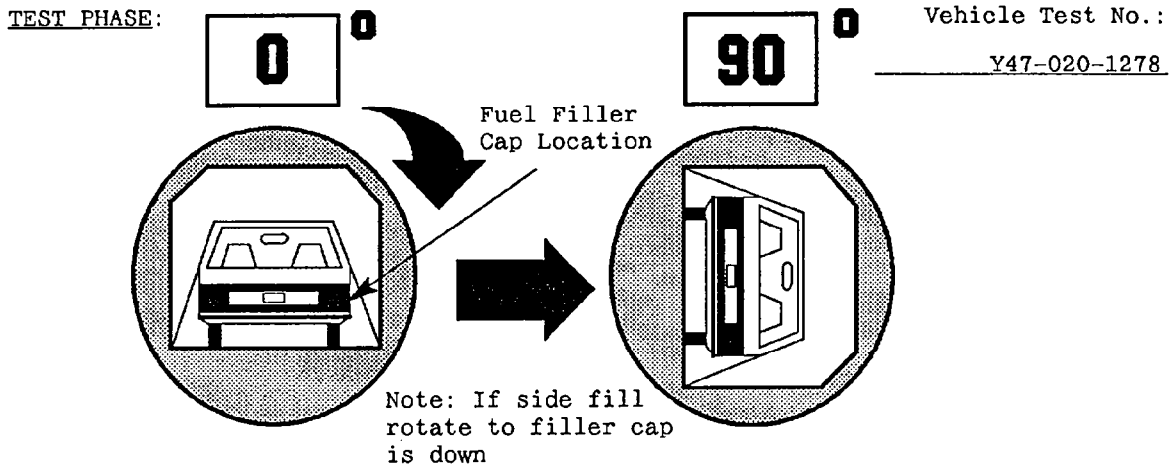
1. Upper frame 4.0 in dia x 0.25 in wall (102 mm dia x 6 mm wall) steel tubing (three sides).
2. Lower frame 6.0 in dia x 0.50 in wall (152 mm dia x 13 mm wall) steel tubing.
3. Face plate 0.75 in (19 mm) thick cold rolled steel.
4. Leading edge 1.0 x 4.0 in (25 x 102 mm) steel band, sharp edges broken
5. All inner reinforcements 4.0 x 2.0 x 0.19 in (102 x 51 x 5 mm) steel tubing.

Section 4

SUMMARY OF RESULTS FOR FUEL SYSTEM INTEGRITY



Figure 8  
 "STATIC ROLLOVER DATA"



I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

Rollover Fixture 90° Rotation Time \_\_\_\_\_ 3 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds  
 (Spec. Range = 1 to 3 minutes)

FMVSS 301 Position Hold Time + \_\_\_\_\_ 5 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds

TOTAL \_\_\_\_\_ 8 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds

Next whole minute interval \_\_\_\_\_ 8 \_\_\_\_\_ minutes

II. FMVSS 301 REQUIREMENTS:

(1) Time Period

|                                    |          |          |                      |
|------------------------------------|----------|----------|----------------------|
| First 5 min FROM onset of rotation | 6th min. | 7th min. | 8th min.<br>if reqd. |
|------------------------------------|----------|----------|----------------------|

(2) Maximum Allowable Solvent Spillage

|          |         |         |         |
|----------|---------|---------|---------|
| 5 ounces | 1 ounce | 1 ounce | 1 ounce |
|----------|---------|---------|---------|

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

|   |   |   |   |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
|---|---|---|---|

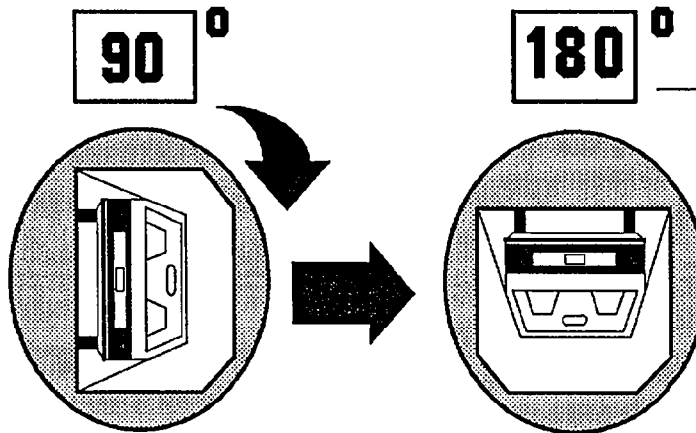
Note: Record spillage for whole minute intervals only as determined above.

IV. SOLVENT SPILLAGE LOCATION(S):

None

Figure 8  
 "STATIC ROLLOVER DATA" (cont.)

TEST PHASE:



Vehicle Test No.:

Y47-020-1278

I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

Rollover Fixture 90° Rotation Time \_\_\_\_\_ 3 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds  
 (Spec. Range = 1 to 3 minutes)

FMVSS 301 Position Hold Time + \_\_\_\_\_ 5 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds

TOTAL \_\_\_\_\_ 8 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds

Next whole minute interval \_\_\_\_\_ 8 \_\_\_\_\_ minutes

II. FMVSS 301 REQUIREMENTS:

(1) Time Period

|                                    |          |          |                      |
|------------------------------------|----------|----------|----------------------|
| First 5 min FROM onset of rotation | 6th min. | 7th min. | 8th min.<br>if reqd. |
|------------------------------------|----------|----------|----------------------|

(2) Maximum Allowable Solvent Spillage

|          |         |         |         |
|----------|---------|---------|---------|
| 5 ounces | 1 ounce | 1 ounce | 1 ounce |
|----------|---------|---------|---------|

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

|   |   |   |   |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
|---|---|---|---|

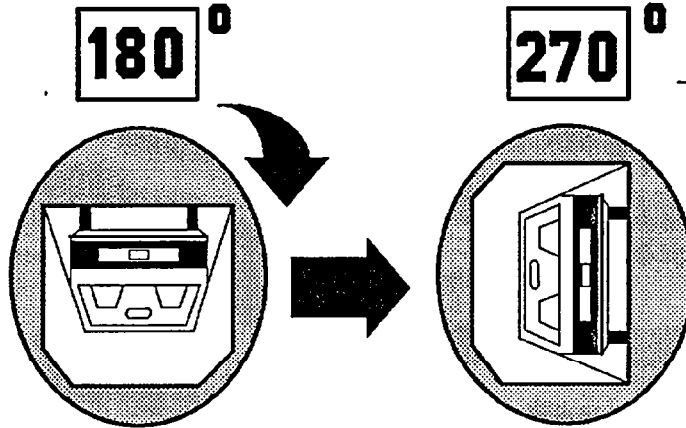
Note: Record spillage for whole minute intervals only as determined above.

IV. SOLVENT SPILLAGE LOCATION(S):

None

Figure 8  
 "STATIC ROLLOVER DATA" (cont.)

TEST PHASE:



Vehicle Test No.:  
 Y47-020-1278

I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

Rollover Fixture 90° Rotation Time \_\_\_\_\_ 3 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds  
 (Spec. Range = 1 to 3 minutes)

FMVSS 301 Position Hold Time + \_\_\_\_\_ 5 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds

TOTAL \_\_\_\_\_ 8 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds

Next whole minute interval \_\_\_\_\_ 8 \_\_\_\_\_ minutes

II. FMVSS 301 REQUIREMENTS:

(1) Time Period

|                                    |          |          |                      |
|------------------------------------|----------|----------|----------------------|
| First 5 min FROM onset of rotation | 6th min. | 7th min. | 8th min.<br>if reqd. |
|------------------------------------|----------|----------|----------------------|

(2) Maximum Allowable Solvent Spillage

|          |         |         |         |
|----------|---------|---------|---------|
| 5 ounces | 1 ounce | 1 ounce | 1 ounce |
|----------|---------|---------|---------|

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

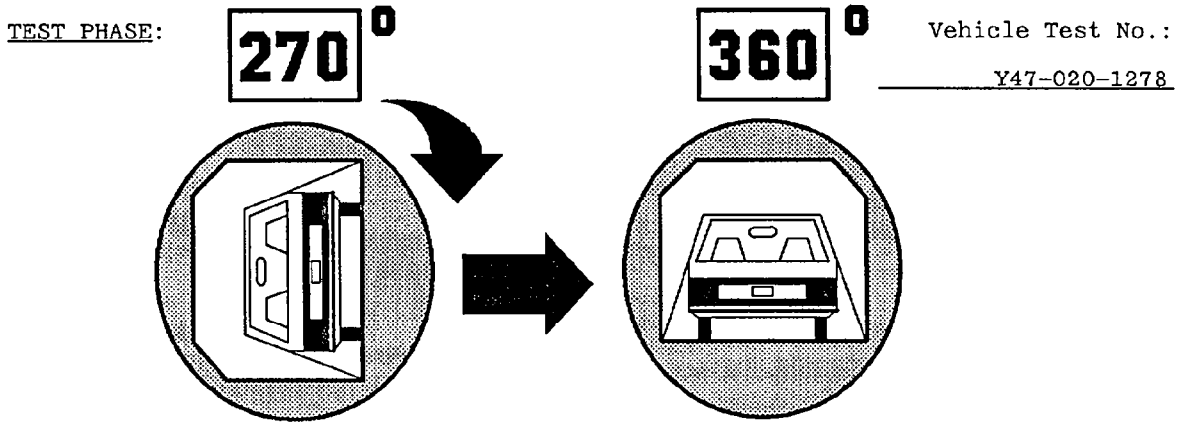
|   |   |   |   |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
|---|---|---|---|

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

IV. SOLVENT SPILLAGE LOCATION(S):

None

Figure 8  
 "STATIC ROLLOVER DATA" (cont.)



I. DETERMINATION OF SOLVENT COLLECTION TIME PERIOD:

Rollover Fixture 90° Rotation Time (Spec. Range = 1 to 3 minutes) \_\_\_\_\_ 3 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds

FMVSS 301 Position Hold Time + \_\_\_\_\_ 5 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds

TOTAL \_\_\_\_\_ 8 \_\_\_\_\_ minutes \_\_\_\_\_ 00 \_\_\_\_\_ seconds

Next whole minute interval \_\_\_\_\_ 8 \_\_\_\_\_ minutes

II. FMVSS 301 REQUIREMENTS:

(1) Time Period

|                                    |          |          |                      |
|------------------------------------|----------|----------|----------------------|
| First 5 min FROM onset of rotation | 6th min. | 7th min. | 8th min.<br>if reqd. |
|------------------------------------|----------|----------|----------------------|

(2) Maximum Allowable Solvent Spillage

|          |         |         |         |
|----------|---------|---------|---------|
| 5 ounces | 1 ounce | 1 ounce | 1 ounce |
|----------|---------|---------|---------|

III. ACTUAL TEST VEHICLE SOLVENT SPILLAGE:

|   |   |   |   |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
|---|---|---|---|

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

IV. SOLVENT SPILLAGE LOCATION(S):

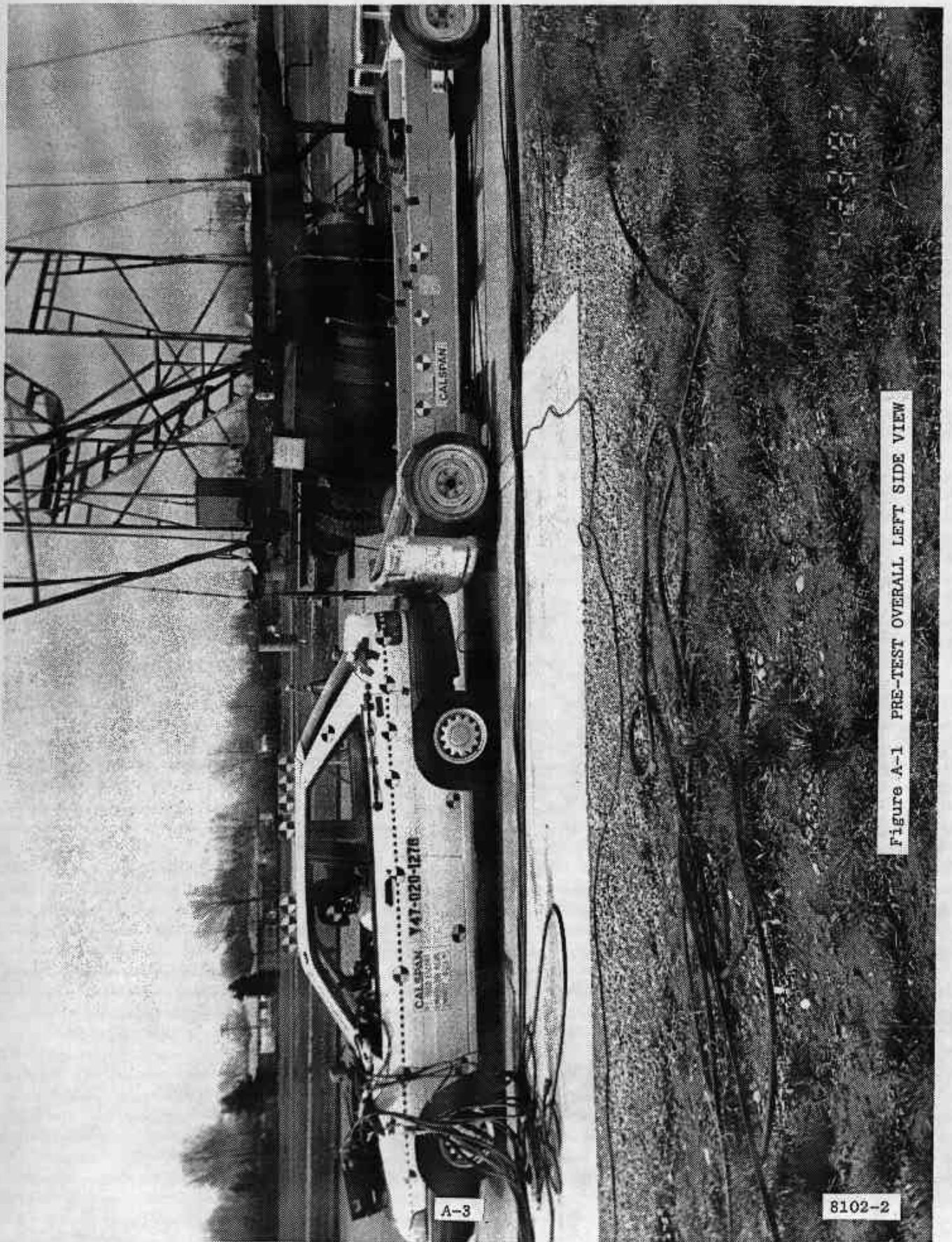
None

Appendix A

PHOTOGRAPHS

PHOTOGRAPHS

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A-3

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Figure A-1 PRE-TEST OVERALL LEFT SIDE VIEW

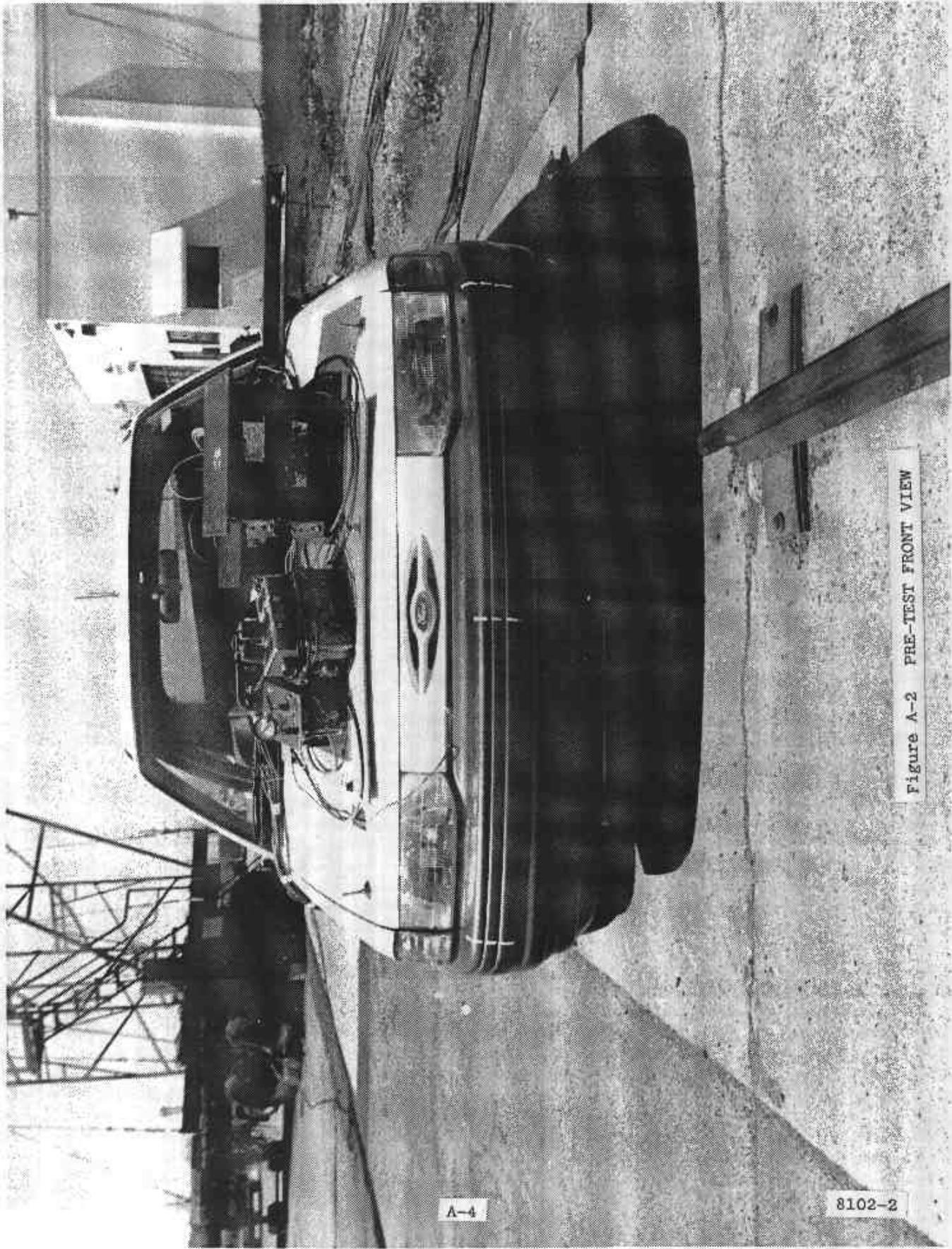


Figure A-2 PRE-TEST FRONT VIEW

A-4

8102-2



Figure A-3 POST-TEST FRONT VIEW

A-5

8102-2

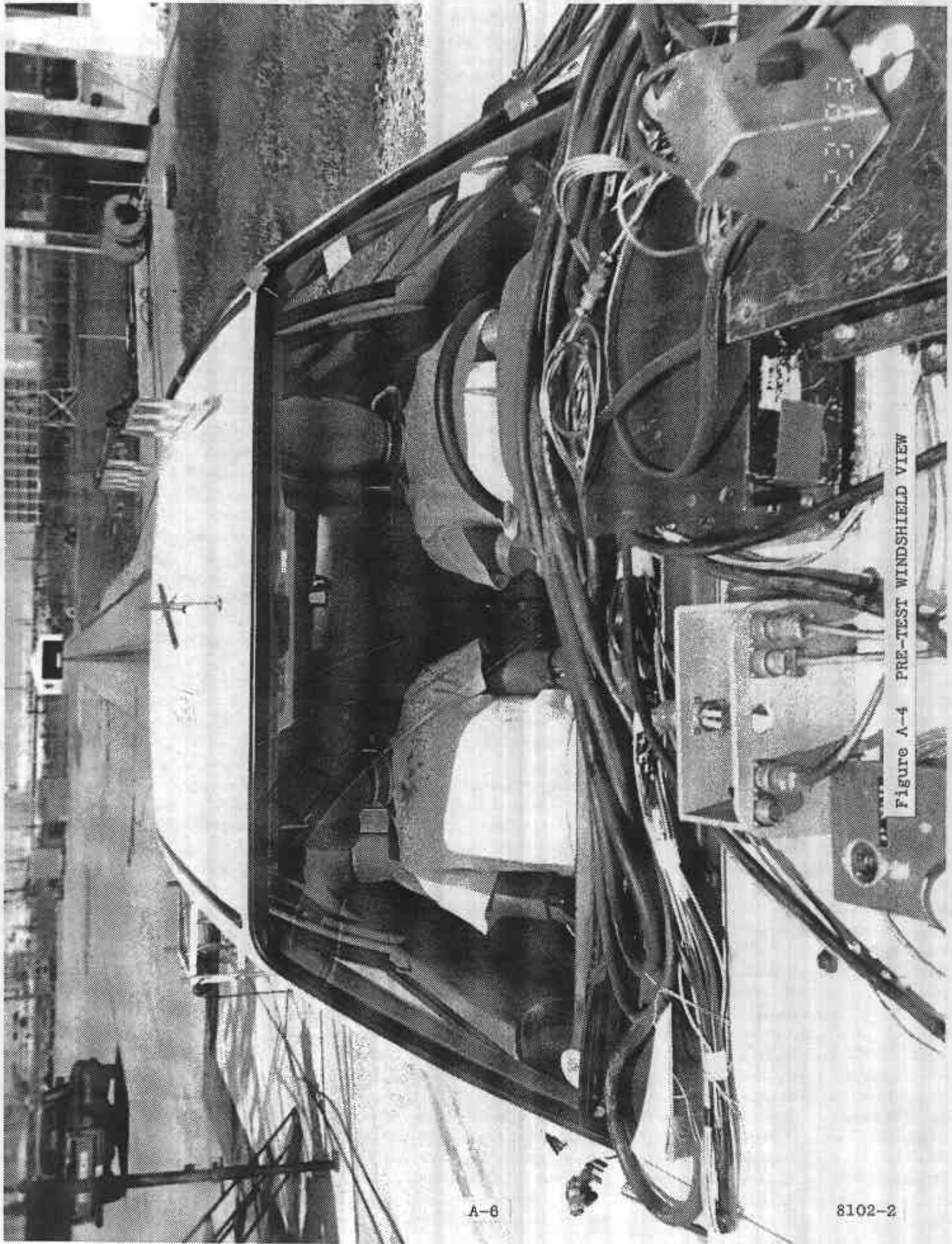


Figure A-4 PRE-TEST WINDSHIELD VIEW

A-8

8102-2

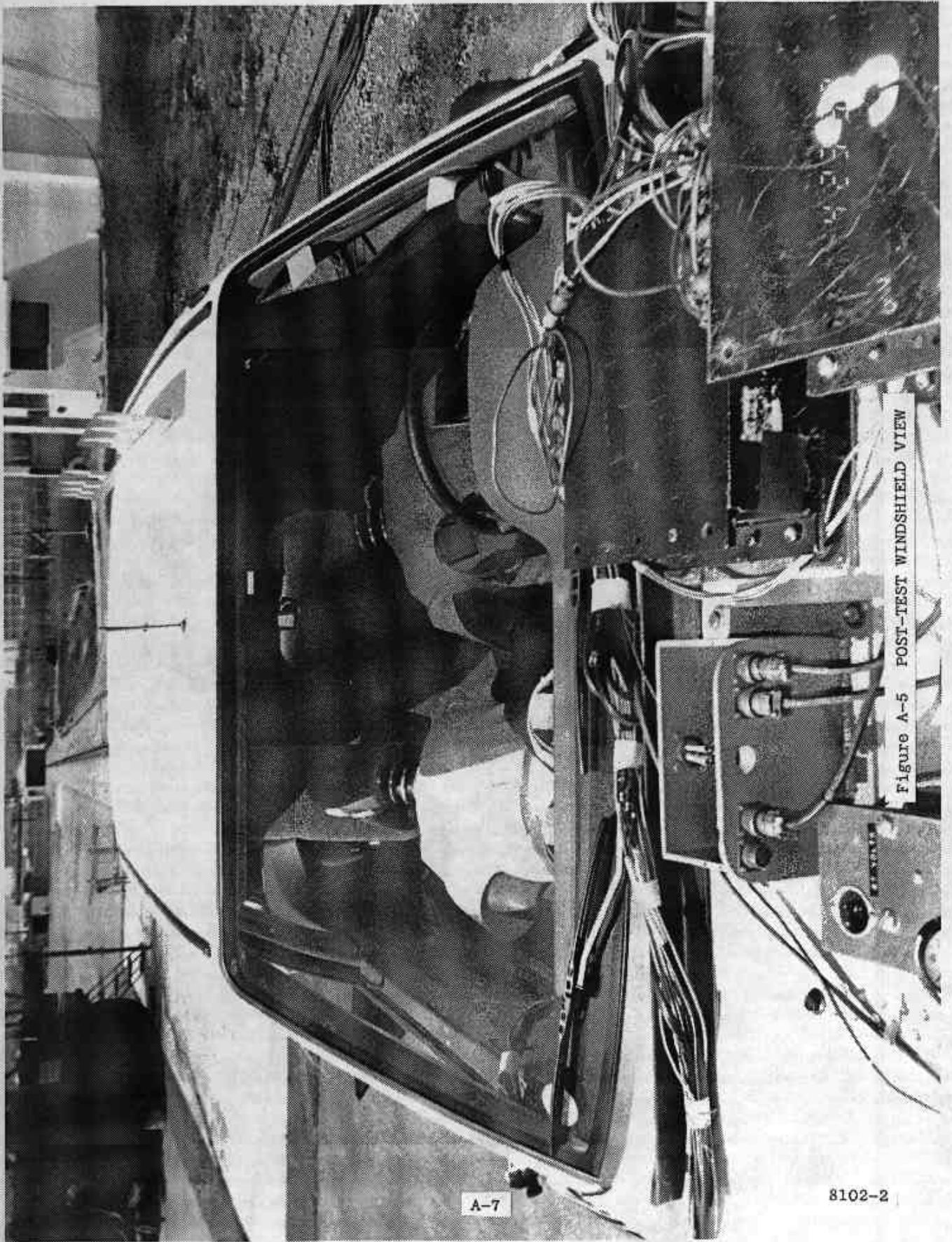
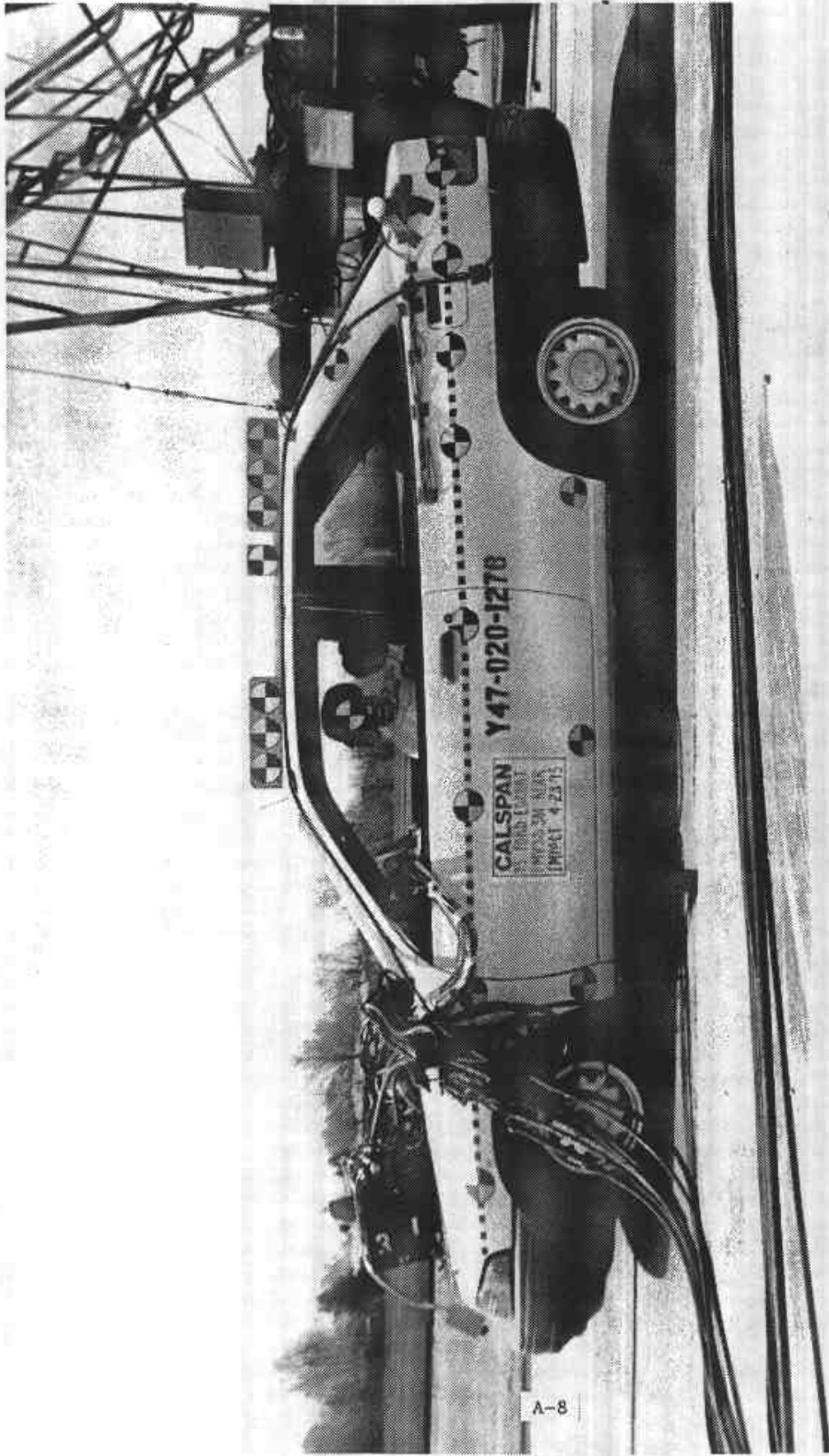


Figure A-5 POST-TEST WINDSHIELD VIEW

A-7

8102-2



A-8

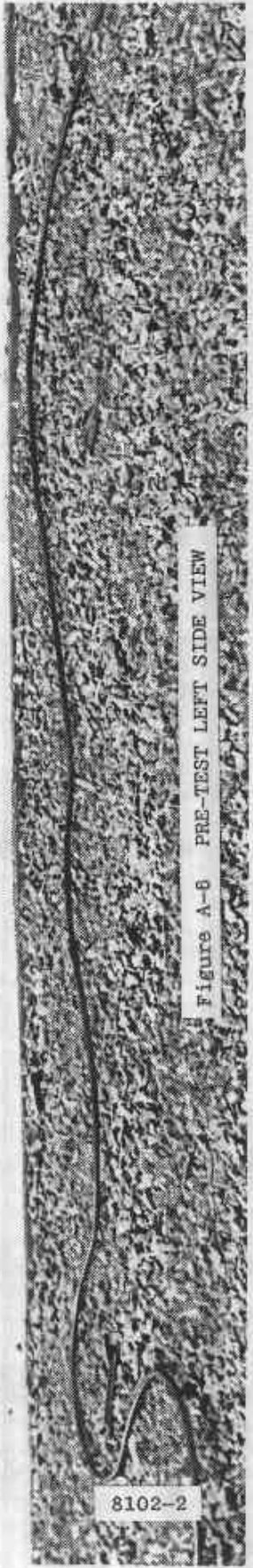


Figure A-6 PRE-TEST LEFT SIDE VIEW

8102-2

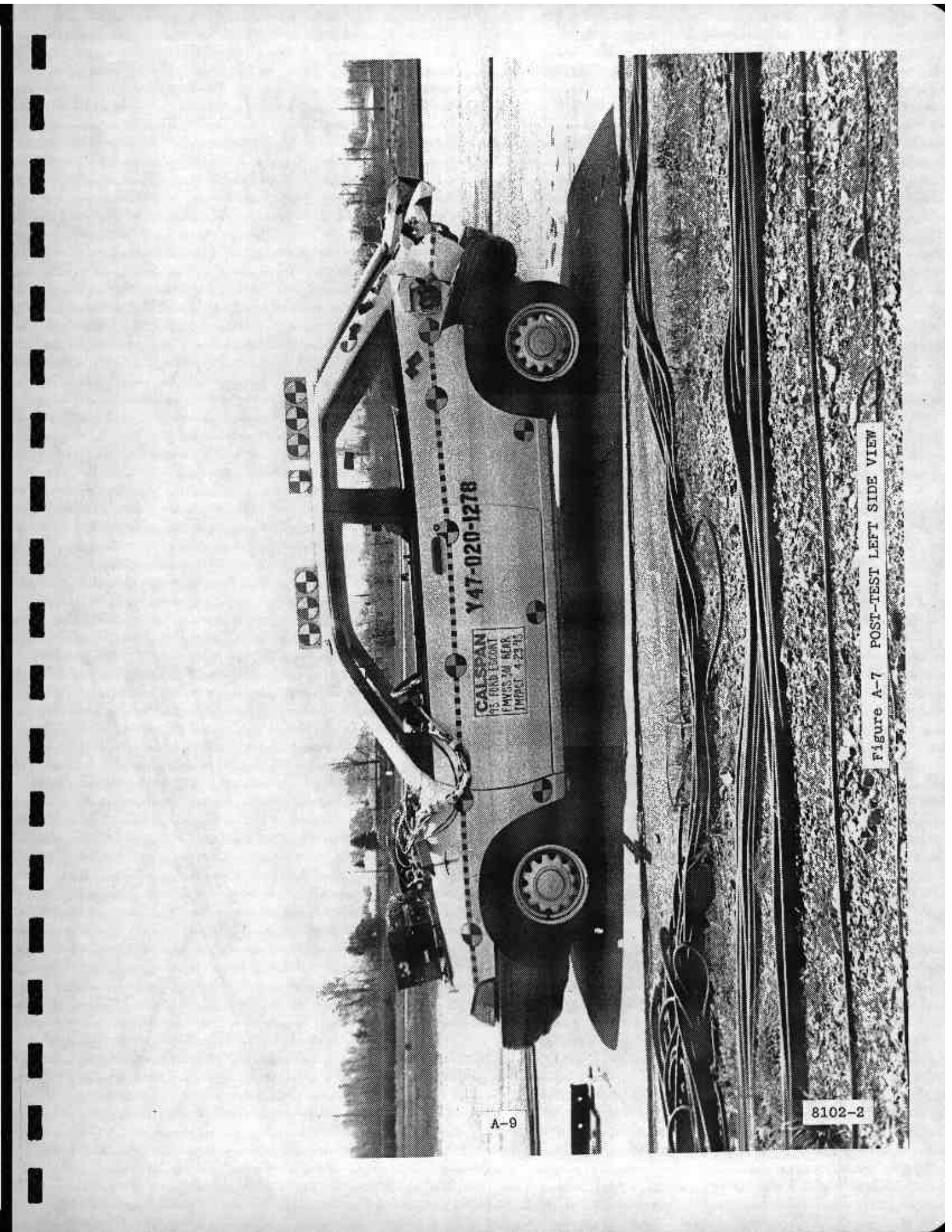


Figure A-7 POST-TEST LEFT SIDE VIEW

A-9

8102-2



A-10

8102-2

Figure A-8 PRE-TEST LEFT REAR THREE-QUARTER VIEW

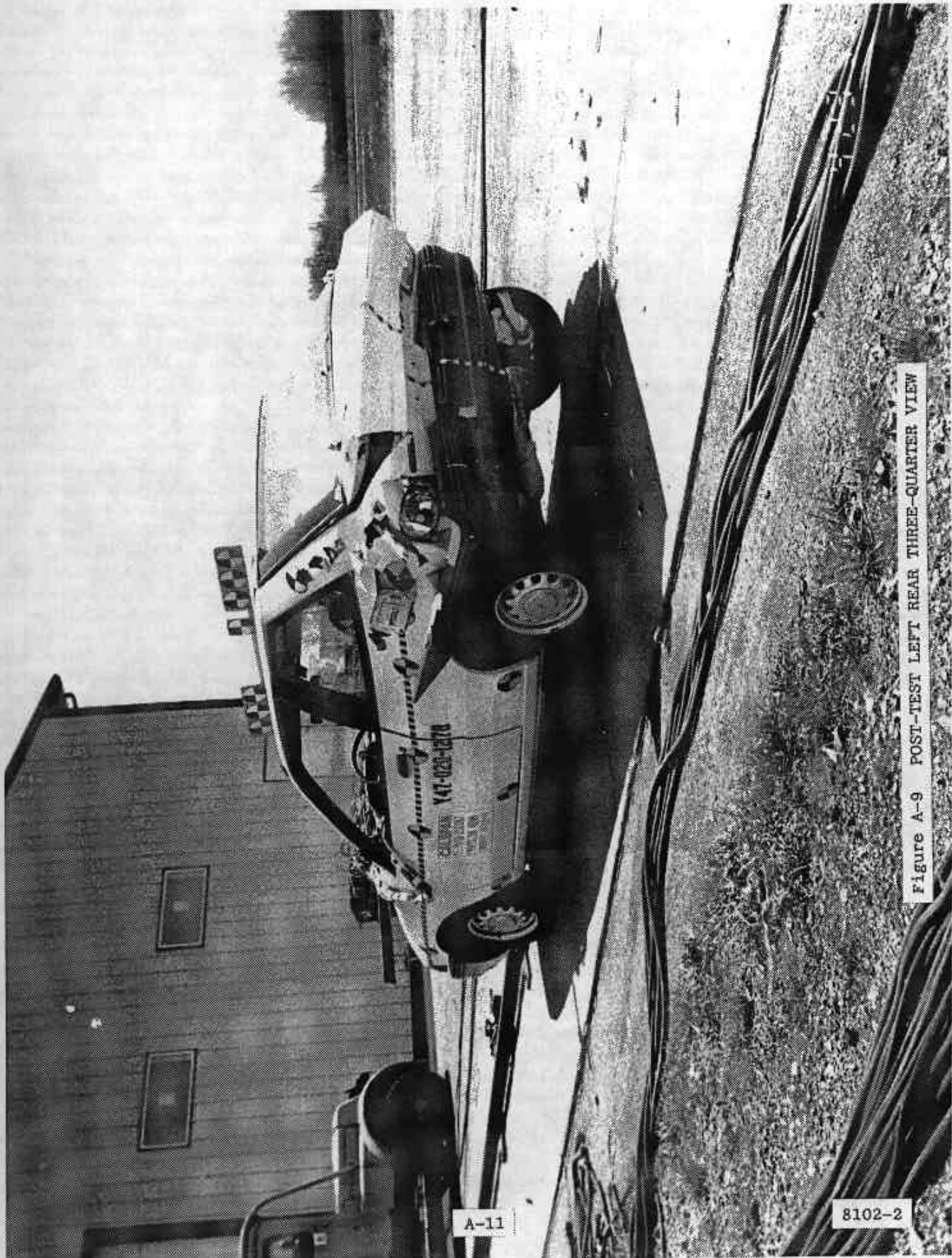


Figure A-9 POST-TEST LEFT REAR THREE-QUARTER VIEW

A-11

8102-2

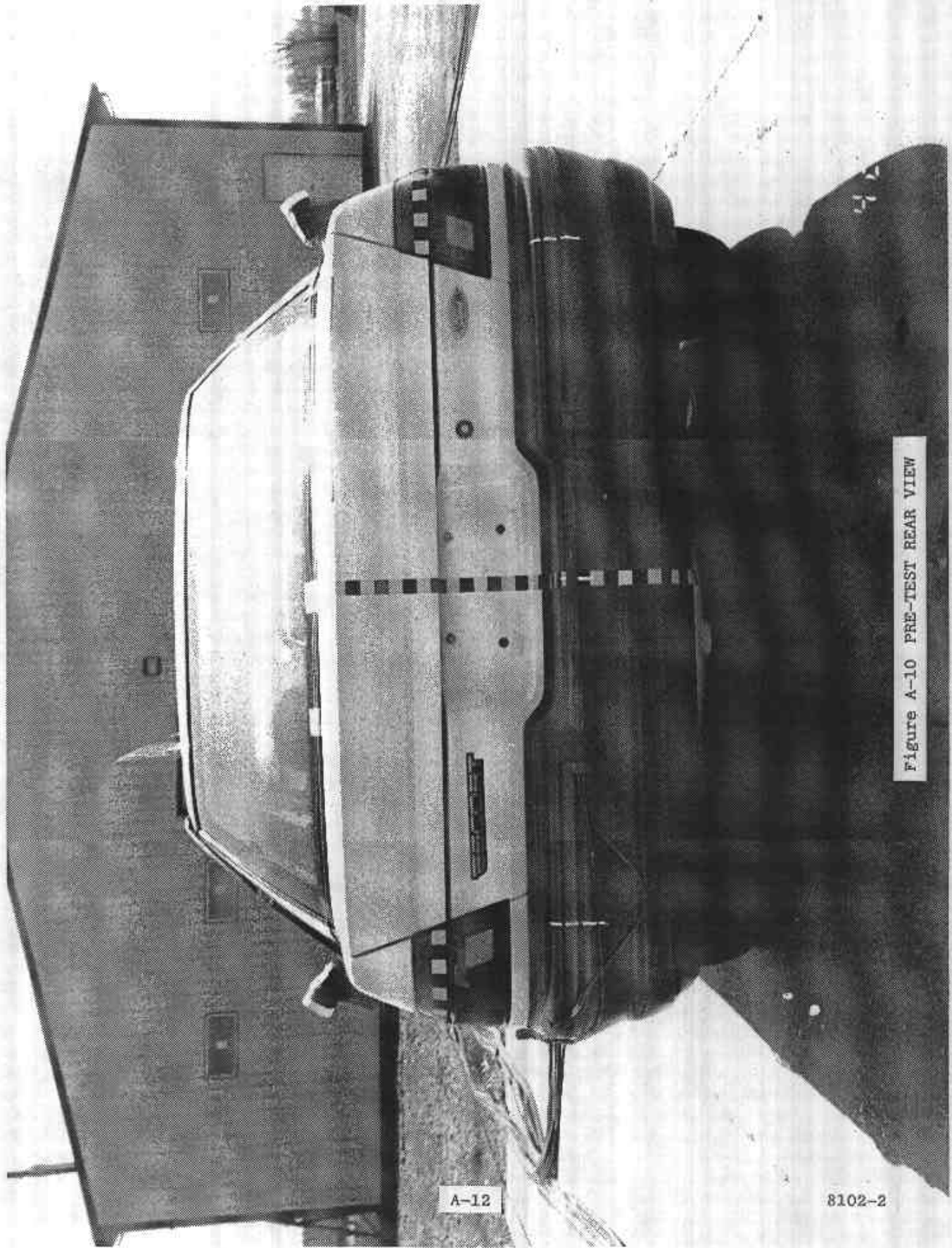


Figure A-10 PRE-TEST REAR VIEW

A-12

8102-2

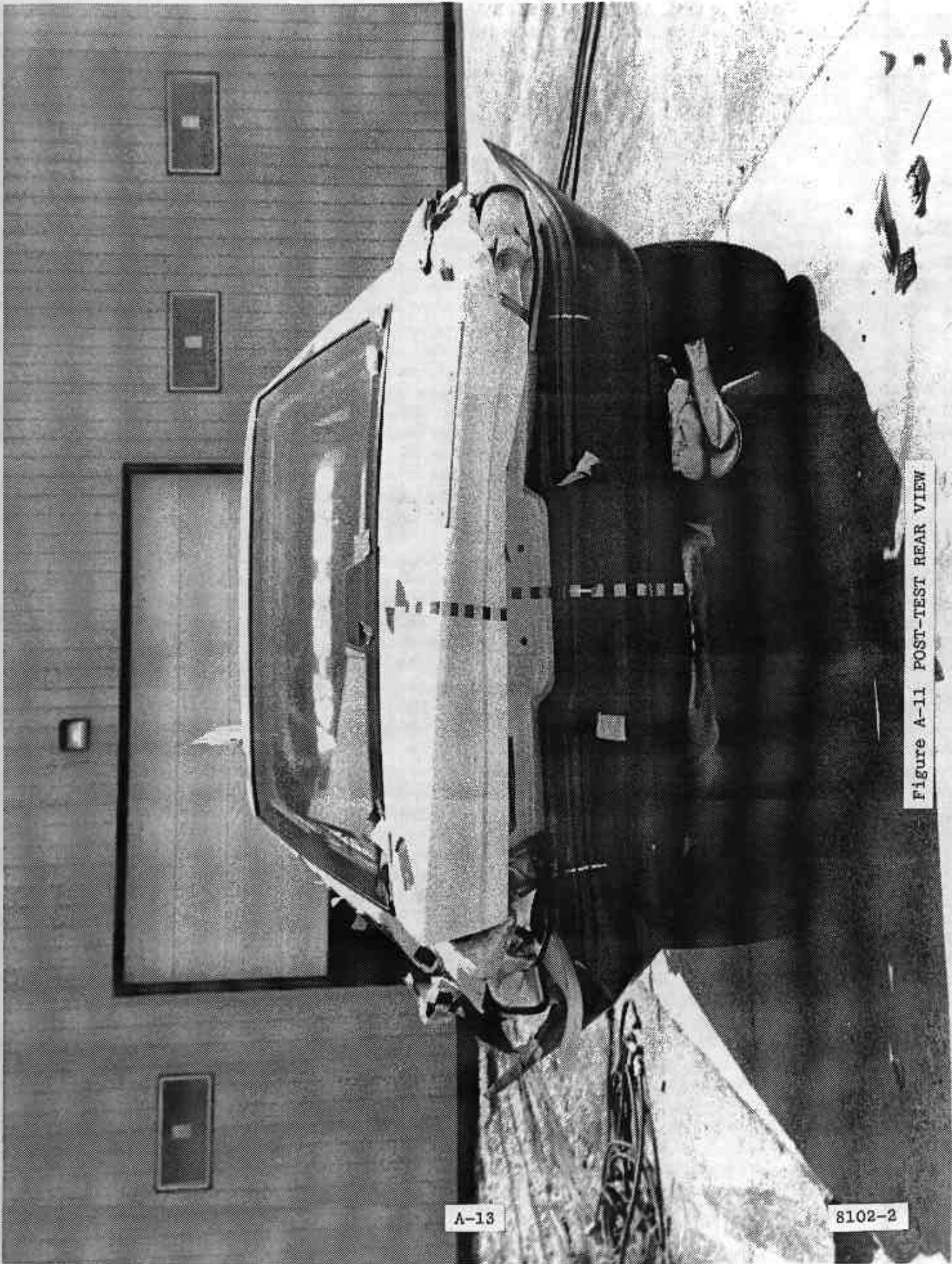
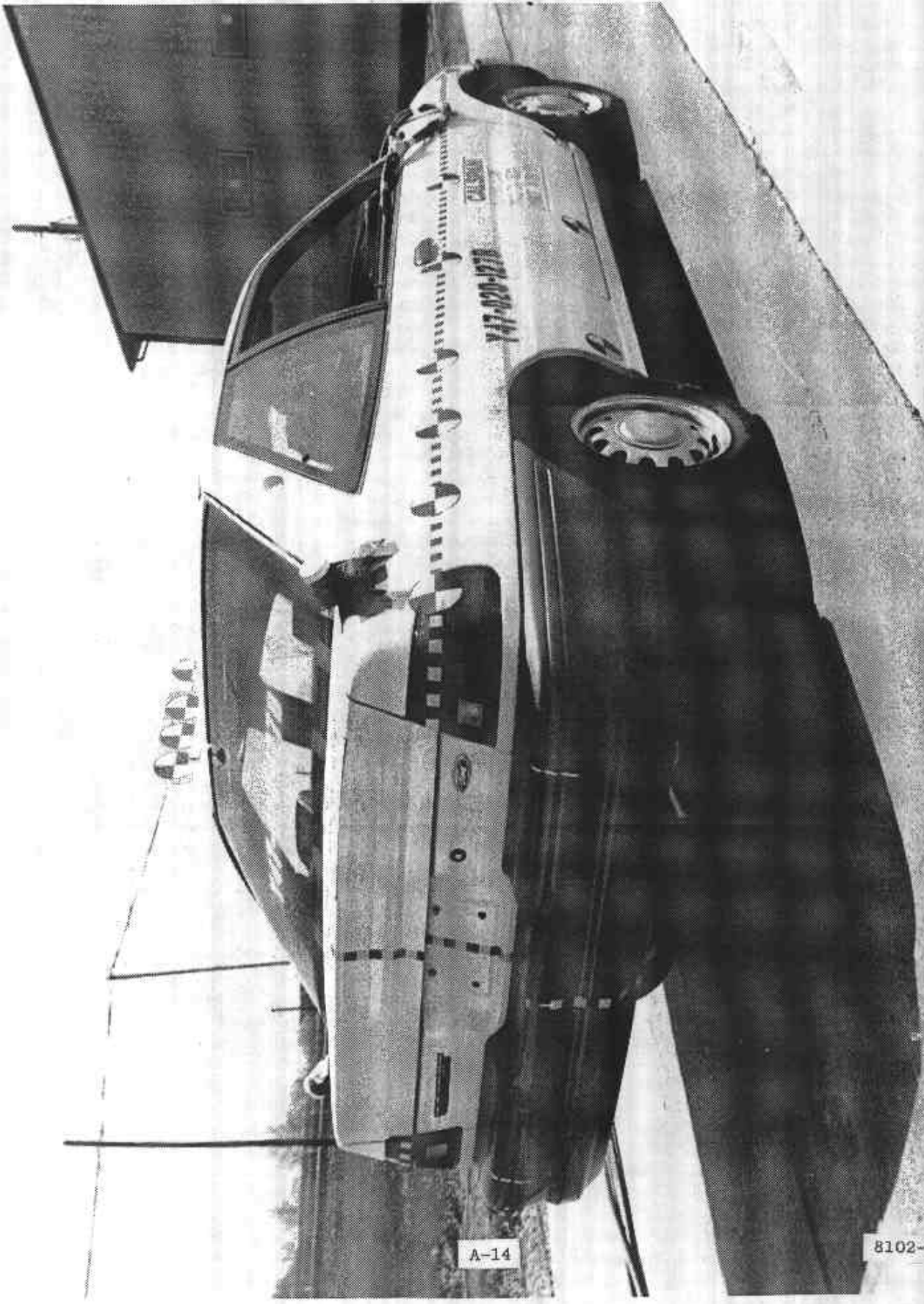


Figure A-11 POST-TEST REAR VIEW

A-13

8102-2



A-14

8102-2

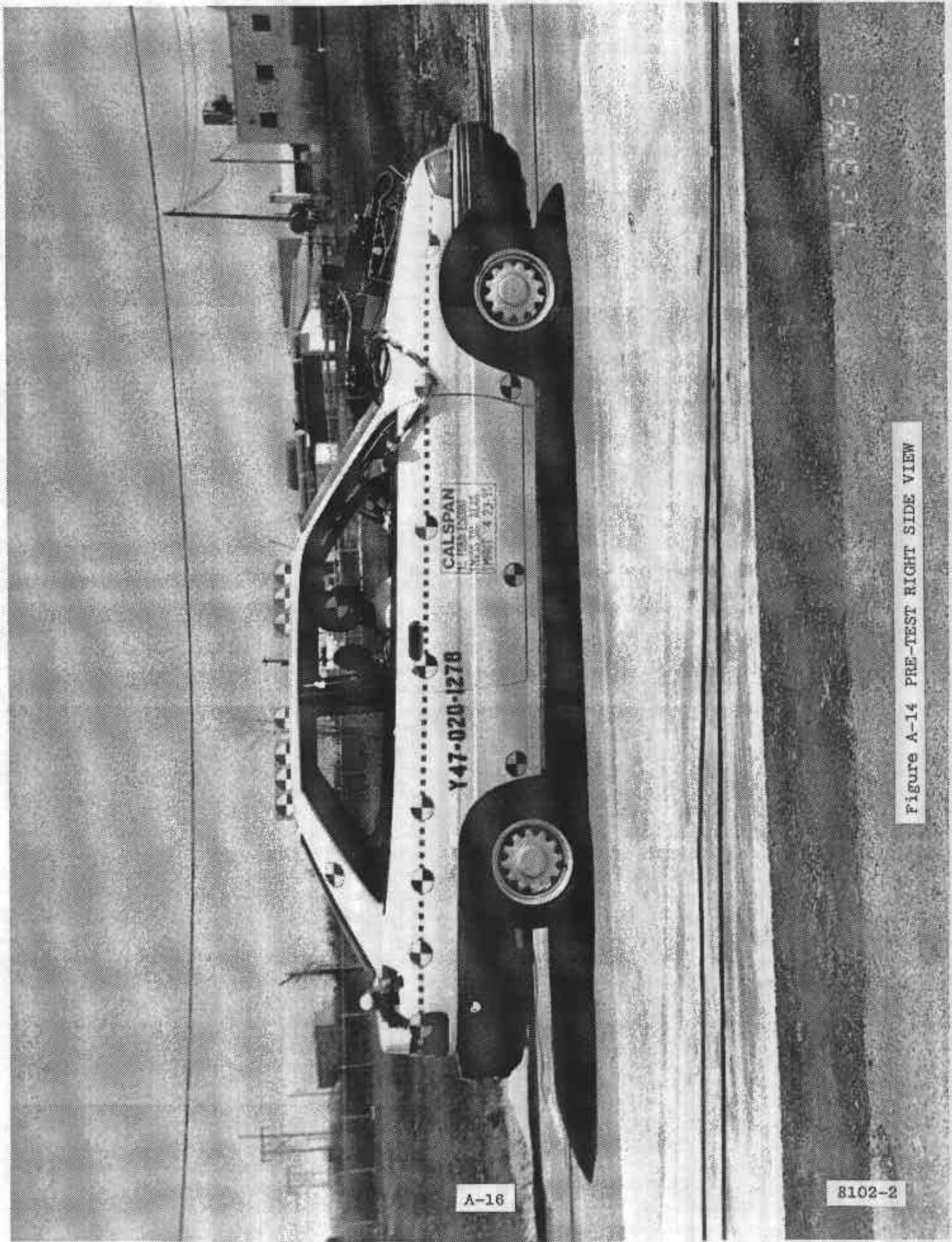
Figure A-12 PRE-TEST RIGHT REAR THREE-QUARTER VIEW



A-15

8102-2

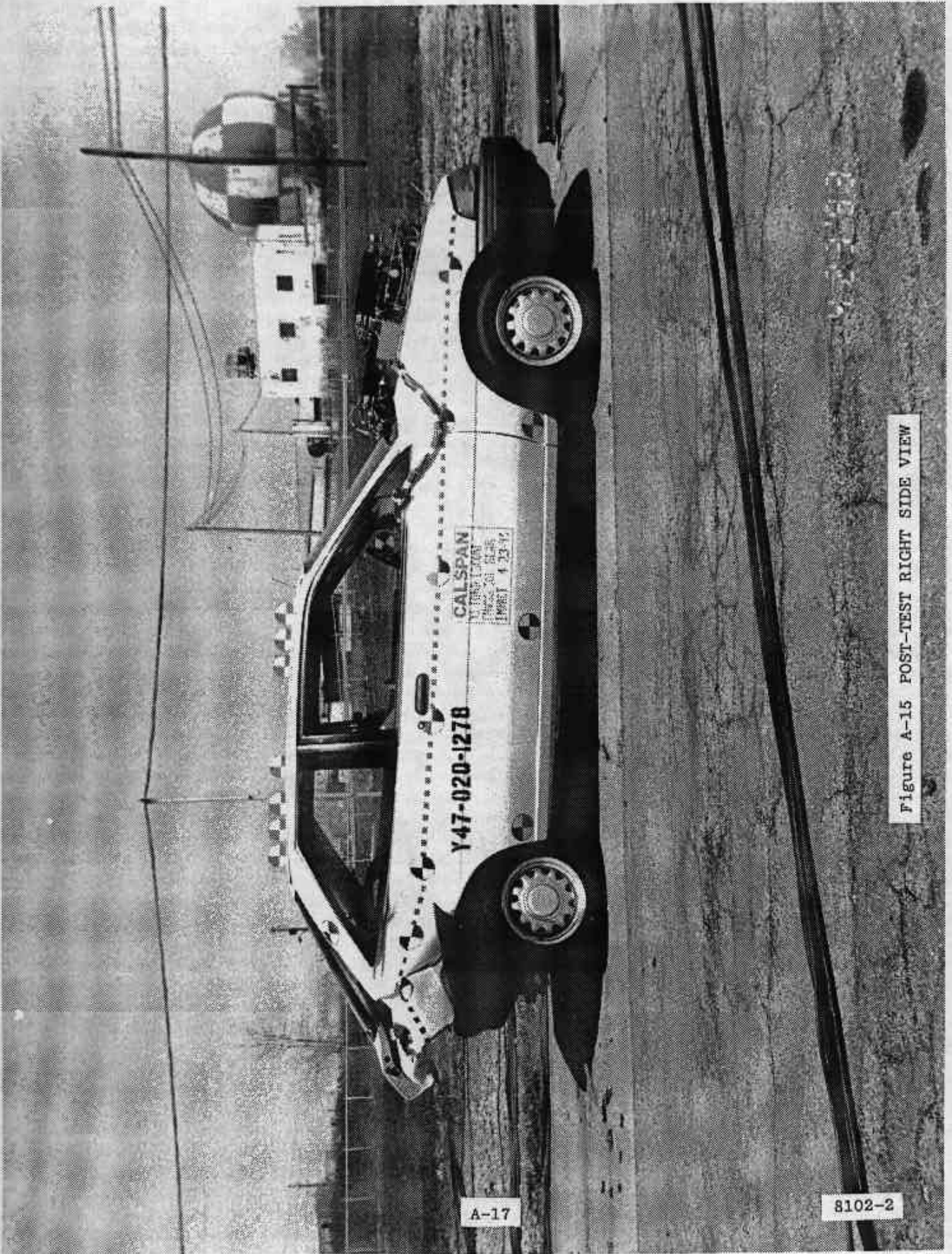
Figure A-13 POST-TEST RIGHT REAR THREE-QUARTER VIEW



A-16

8102-2

Figure A-14 PRE-TEST RIGHT SIDE VIEW



A-17

8102-2

Figure A-15 POST-TEST RIGHT SIDE VIEW



Figure A-16 PRE-TEST RIGHT FRONT THREE-QUARTER VIEW

A-18

8102-2



Figure A-17 POST-TEST RIGHT FRONT THREE-QUARTER VIEW

A-19

8102-2

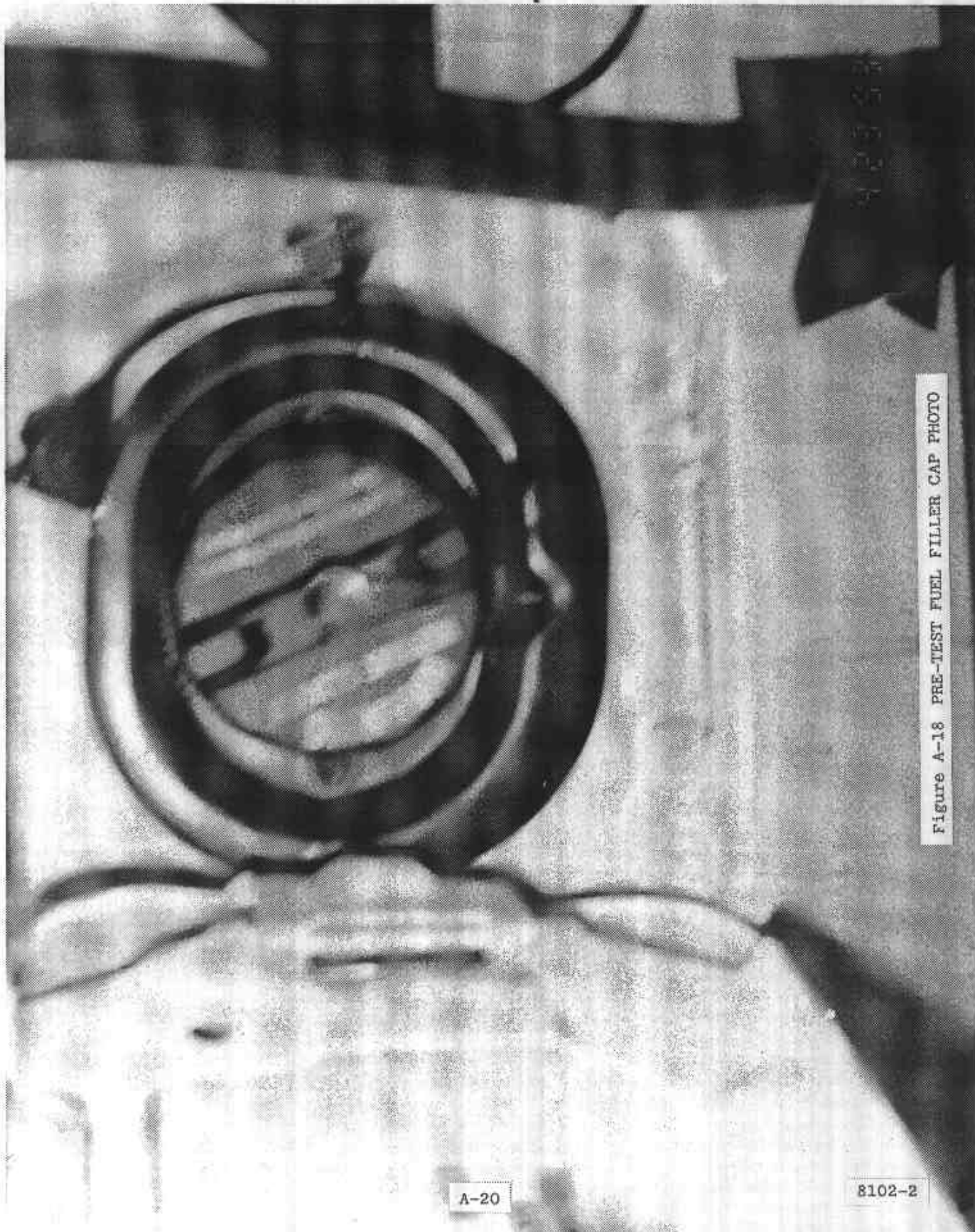
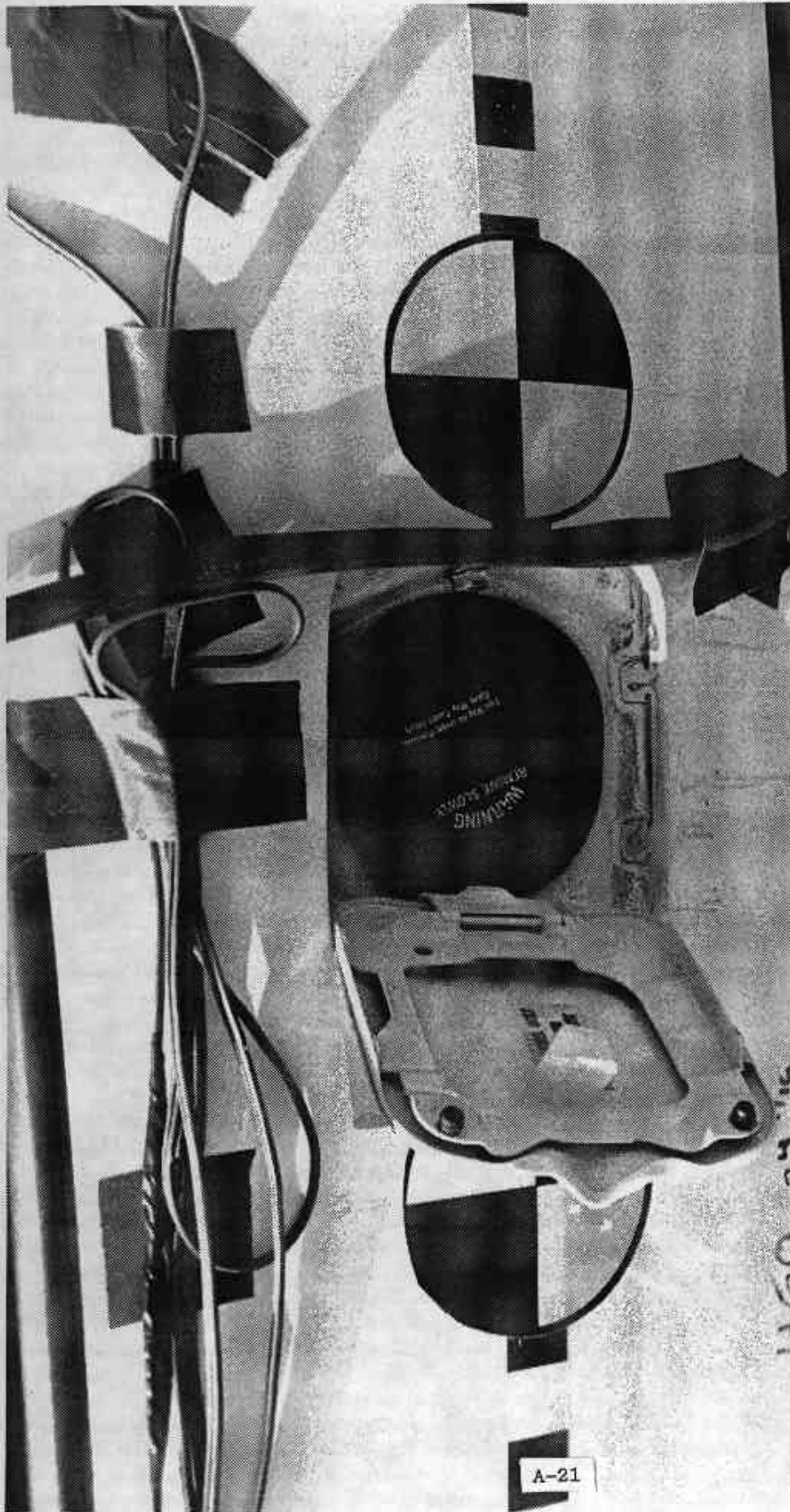


Figure A-18 PRE-TEST FUEL FILLER CAP PHOTO

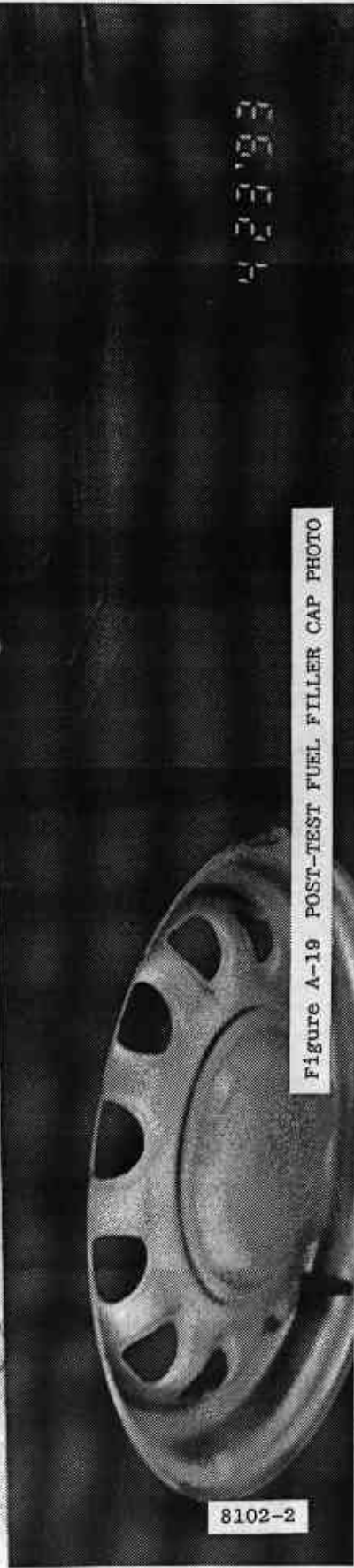
A-20

8102-2



A-21

450 24 116



8102-2

Figure A-19 POST-TEST FUEL FILLER CAP PHOTO

42393

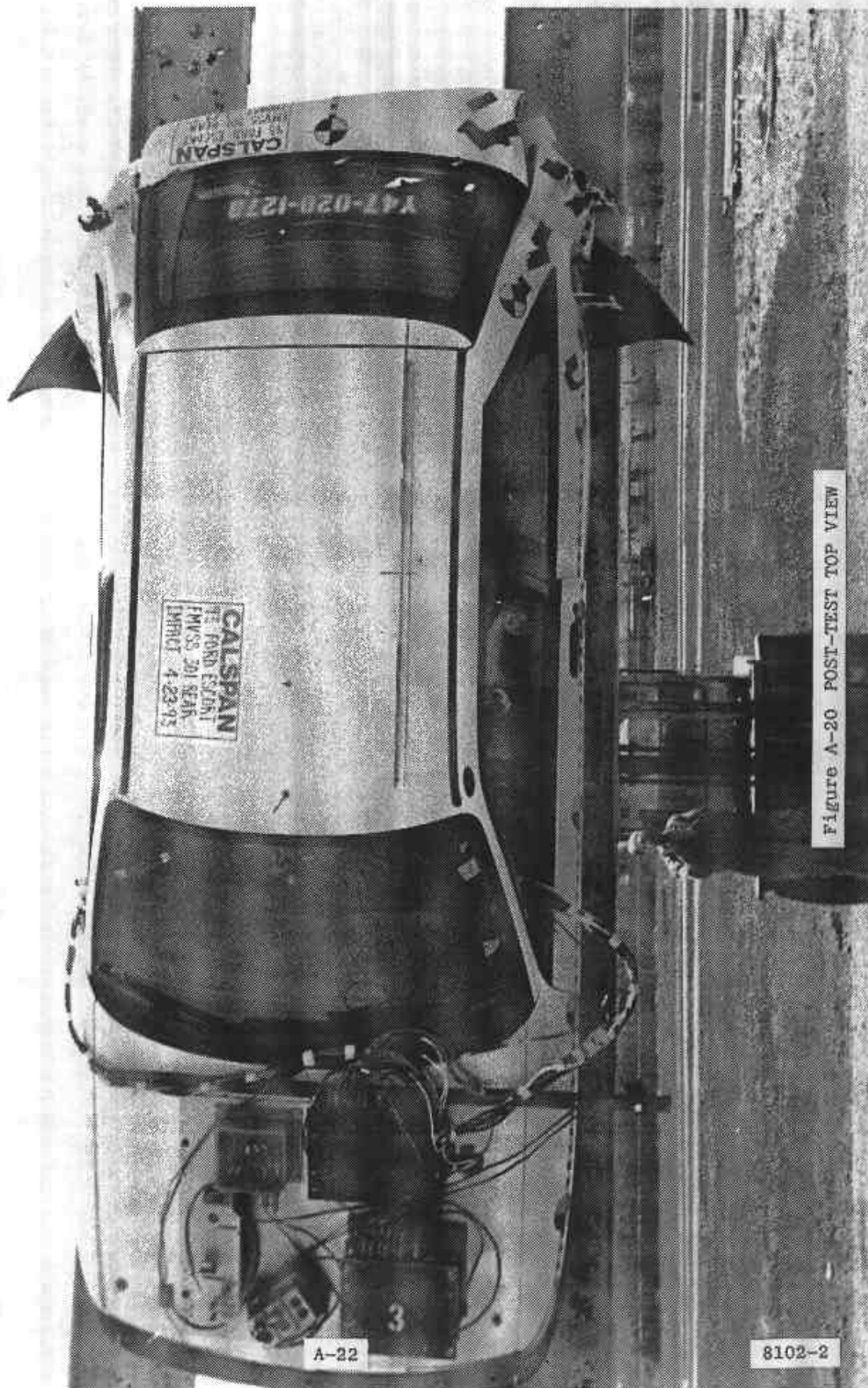


Figure A-20 POST-TEST TOP VIEW

A-22

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Figure A-21 POST-TEST DRIVER DUMMY AND INTERIOR VIEW

A-23

8102-2



Figure A-22 POST-TEST DRIVER DUMMY POSITION VIEW

A-24

8102-2



Figure A-23 POST-TEST PASSENGER DUMMY AND INTERIOR VIEW

A-25

8102-2



Figure A-24 POST-TEST PASSENGER DUMMY POSITION VIEW

A-26

8102-2

Appendix B

VEHICLE AND DUMMY RESPONSE DATA

TEST VEHICLE AND MOVING BARRIER DATA

VEHICLE DATA

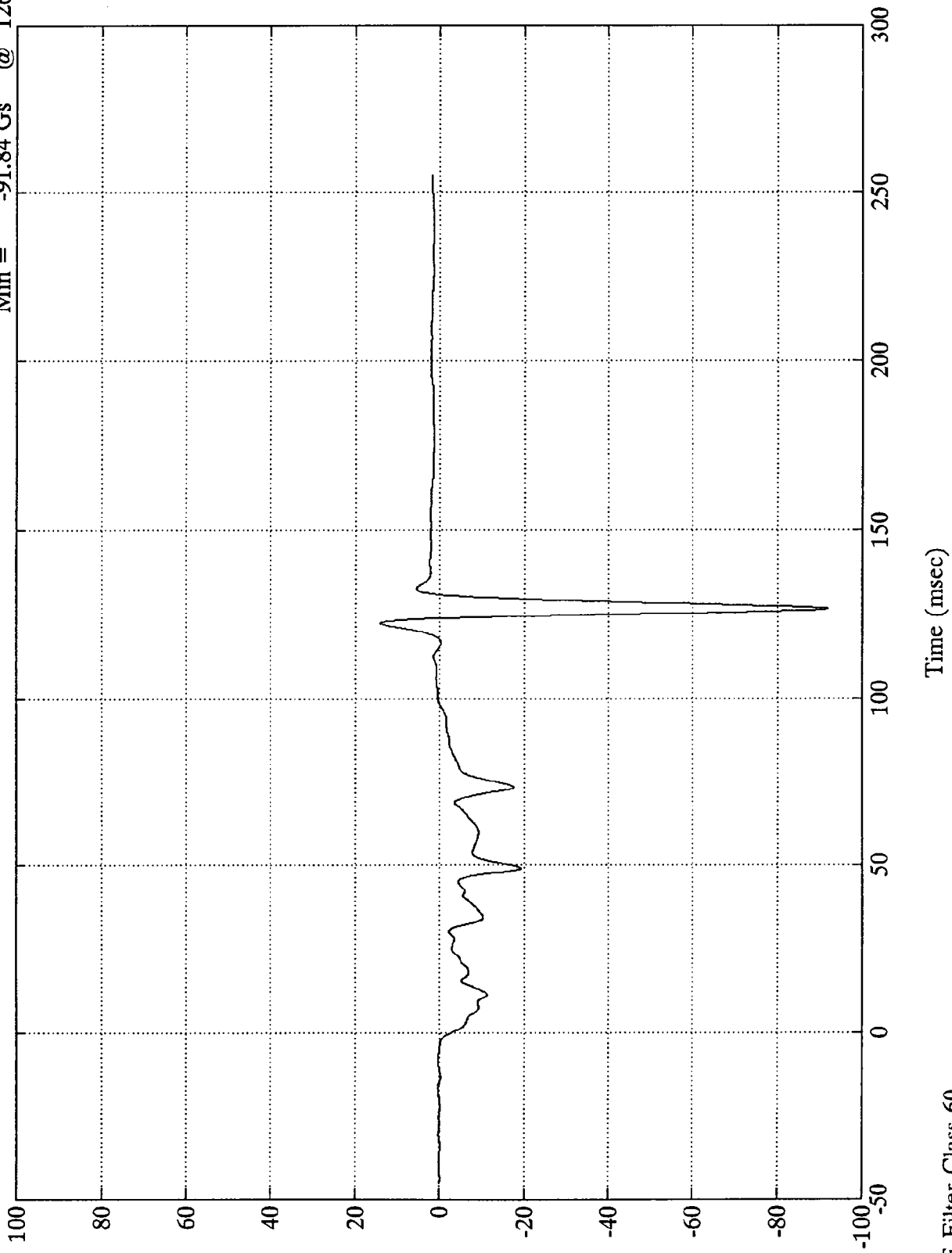
FILTER CHANNEL CLASS

60

TSC 301 TEST 2 - REAR IMPACT

Barrier Left Rail (X)

Max = 14.20 Gs @ 122.51 msec  
Min = -91.84 Gs @ 126.84 msec



B-3

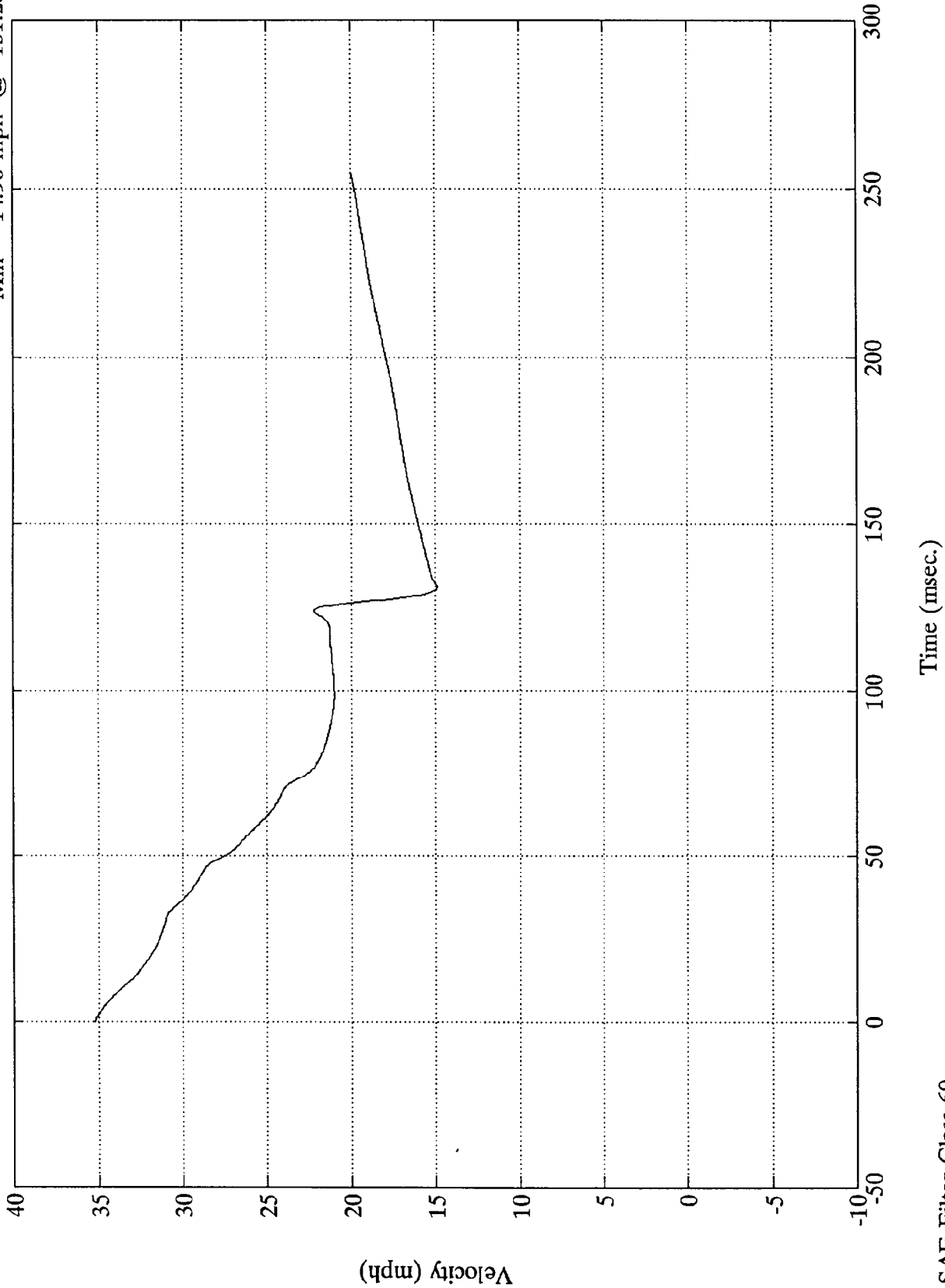
8102-2

SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Barrier Left Rail (X)

Max = 35.20 mph @ -0.00 msec  
Min = 14.90 mph @ 131.28 msec

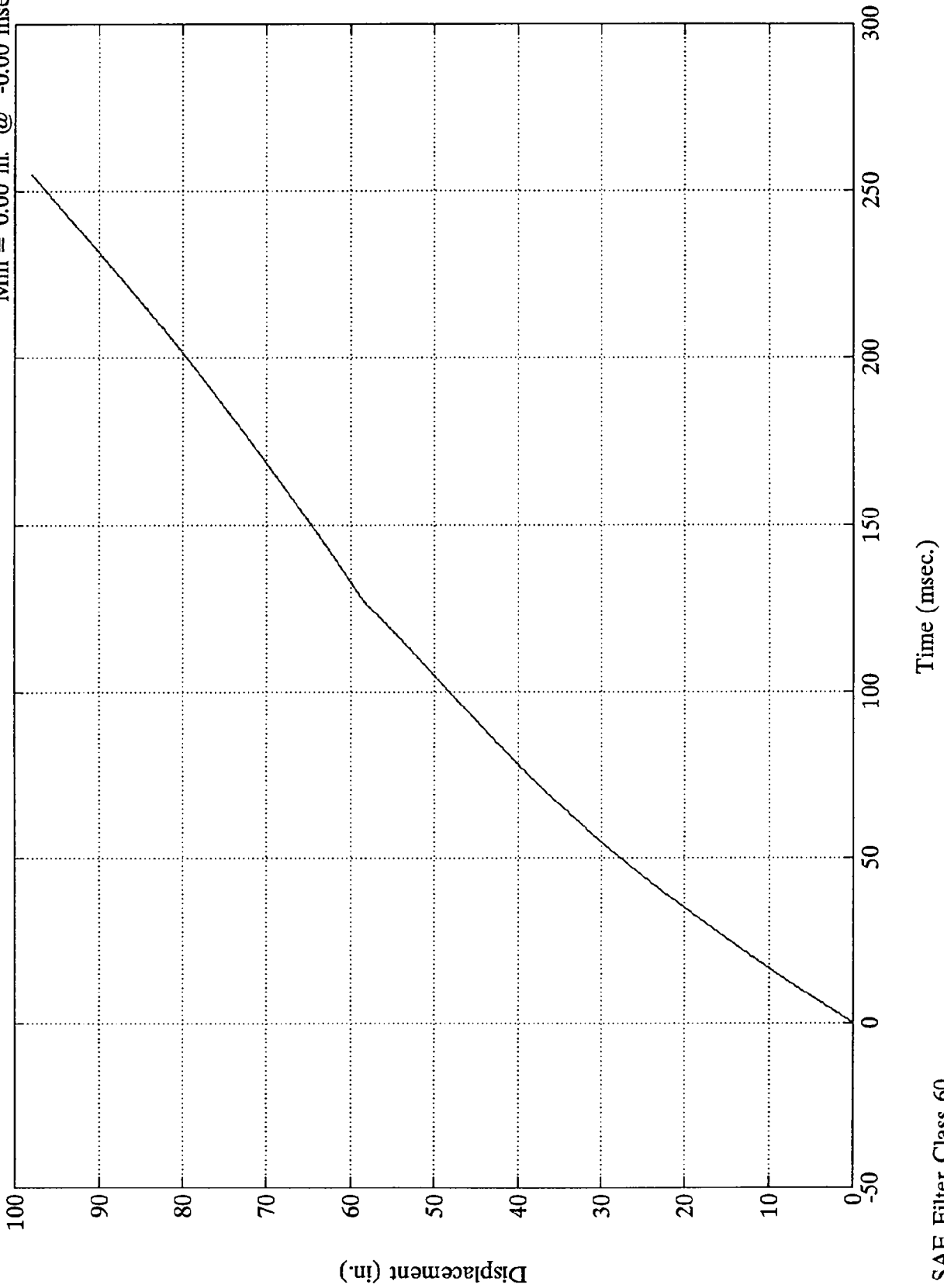


SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Barrier Left Rail (X)

Max = 97.95 in. @ 254.88 msec  
Min = 0.00 in. @ -0.00 msec

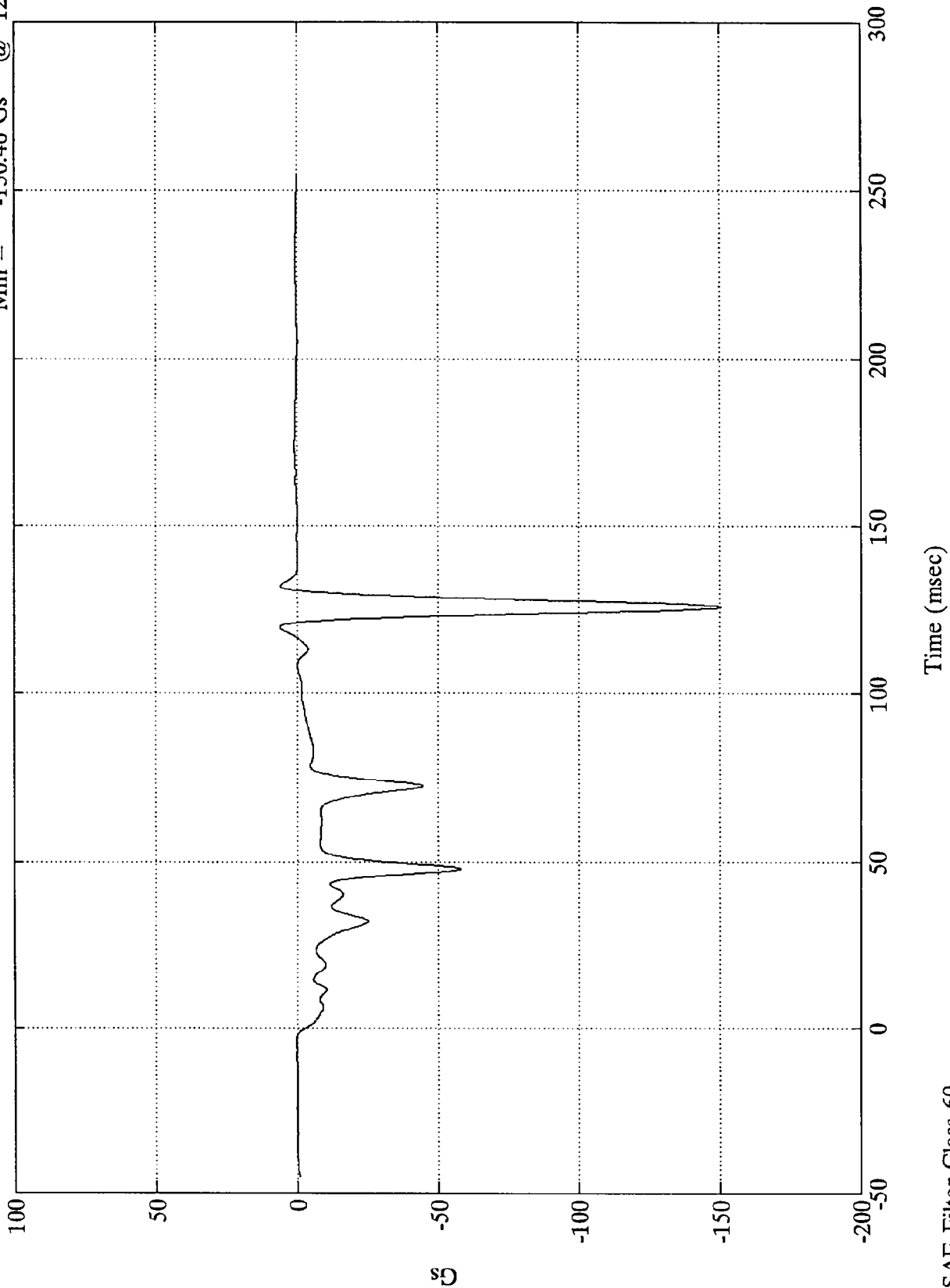


SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Max = 6.17 Gs @ 119.63 msec  
Min = -150.46 Gs @ 125.88 msec

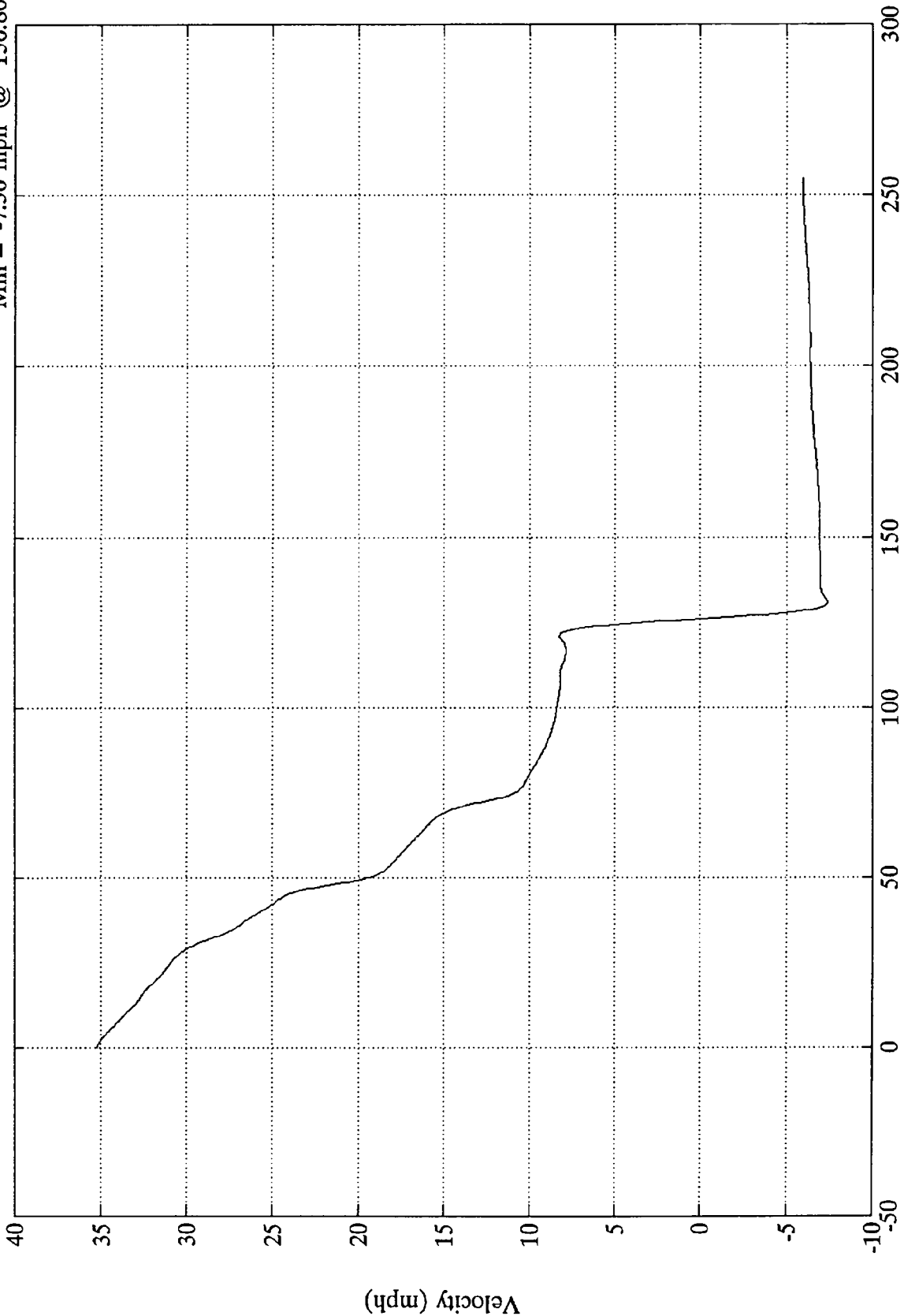
Barrier Right Rail (X)



TSC 301 TEST 2 - REAR IMPACT

Max = 35.20 mph @ -0.00 msec  
Min = -7.36 mph @ 130.80 msec

Barrier Right Rail (X)



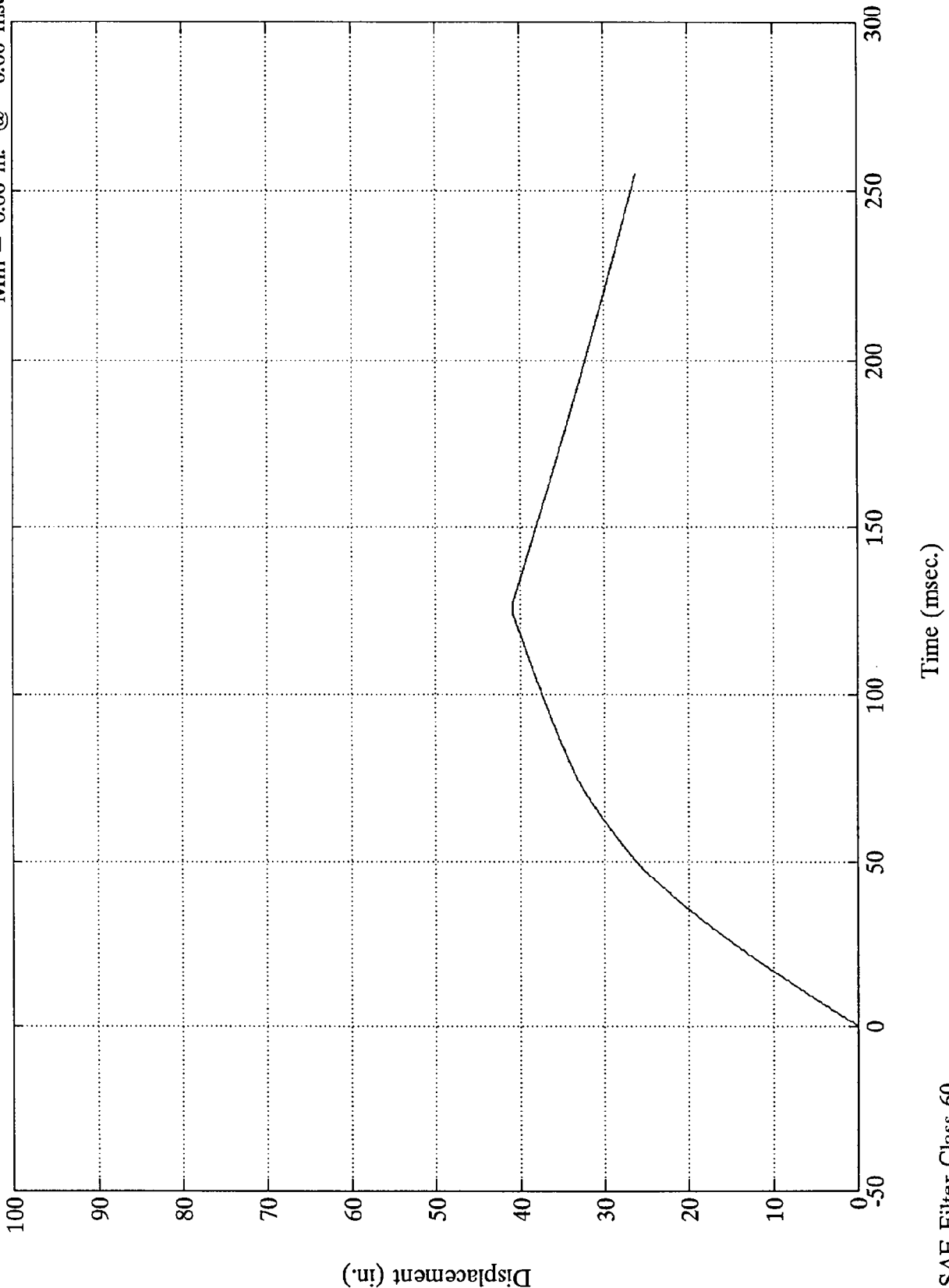
Time (msec.)

SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Barrier Right Rail (X)

Max = 40.89 in. @ 126.24 msec  
Min = 0.00 in. @ -0.00 msec

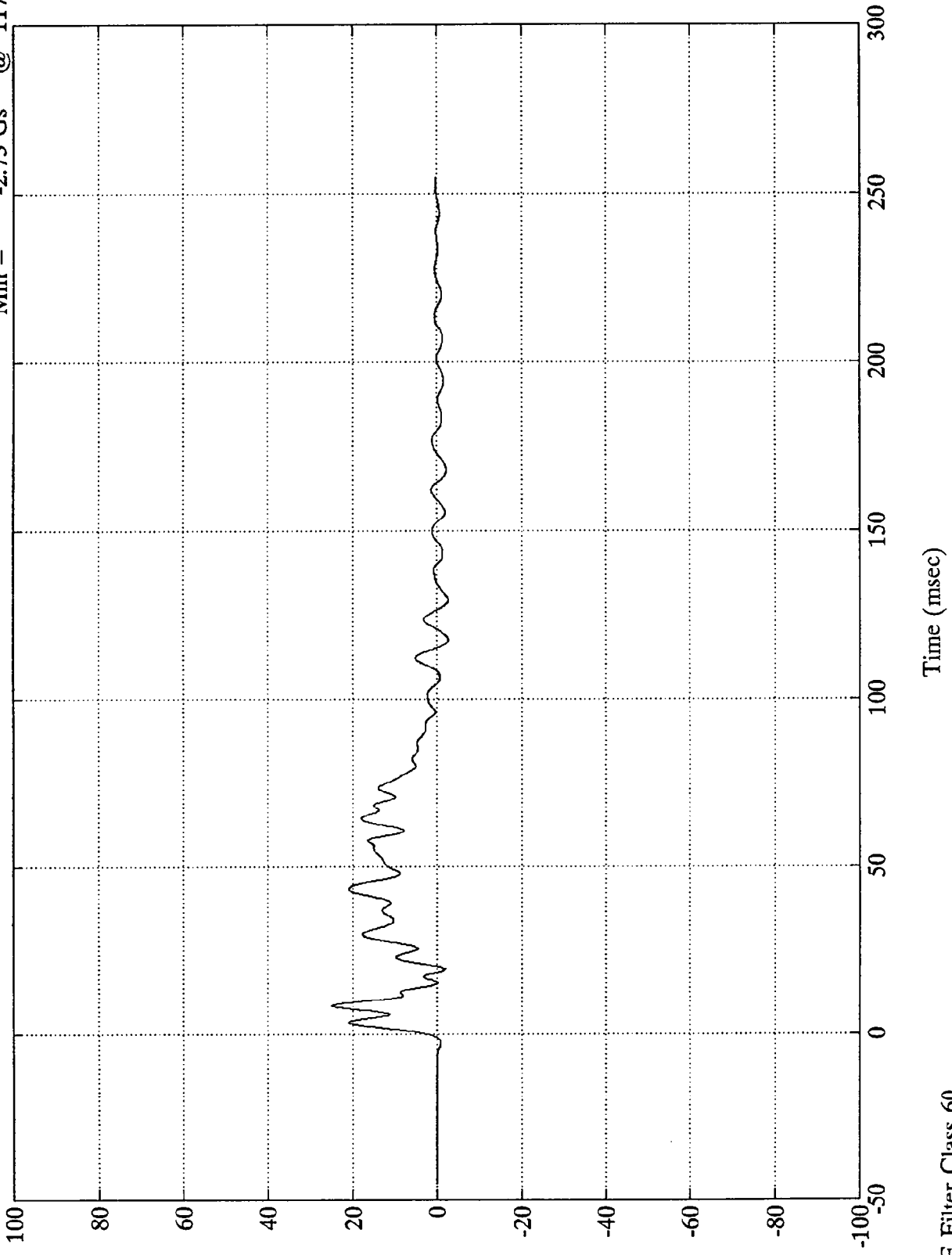


SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Acc. #1 Left Seat

Max = 25.01 Gs @ 8.39 msec  
Min = -2.73 Gs @ 117.24 msec



B-9

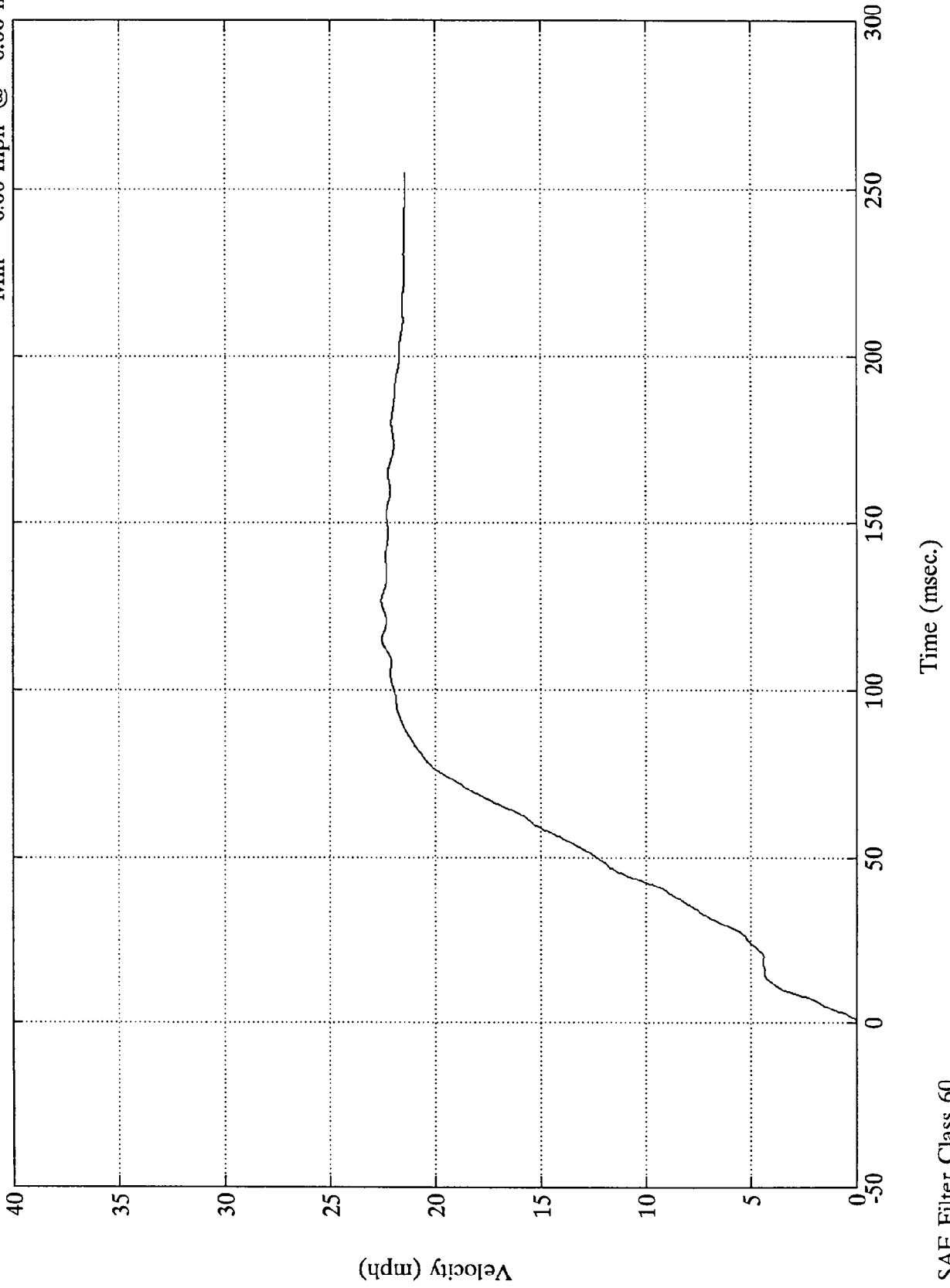
8102-2

SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Max = 22.58 mph @ 126.72 msec  
Min = 0.00 mph @ -0.00 msec

Acc. #1 Left Seat

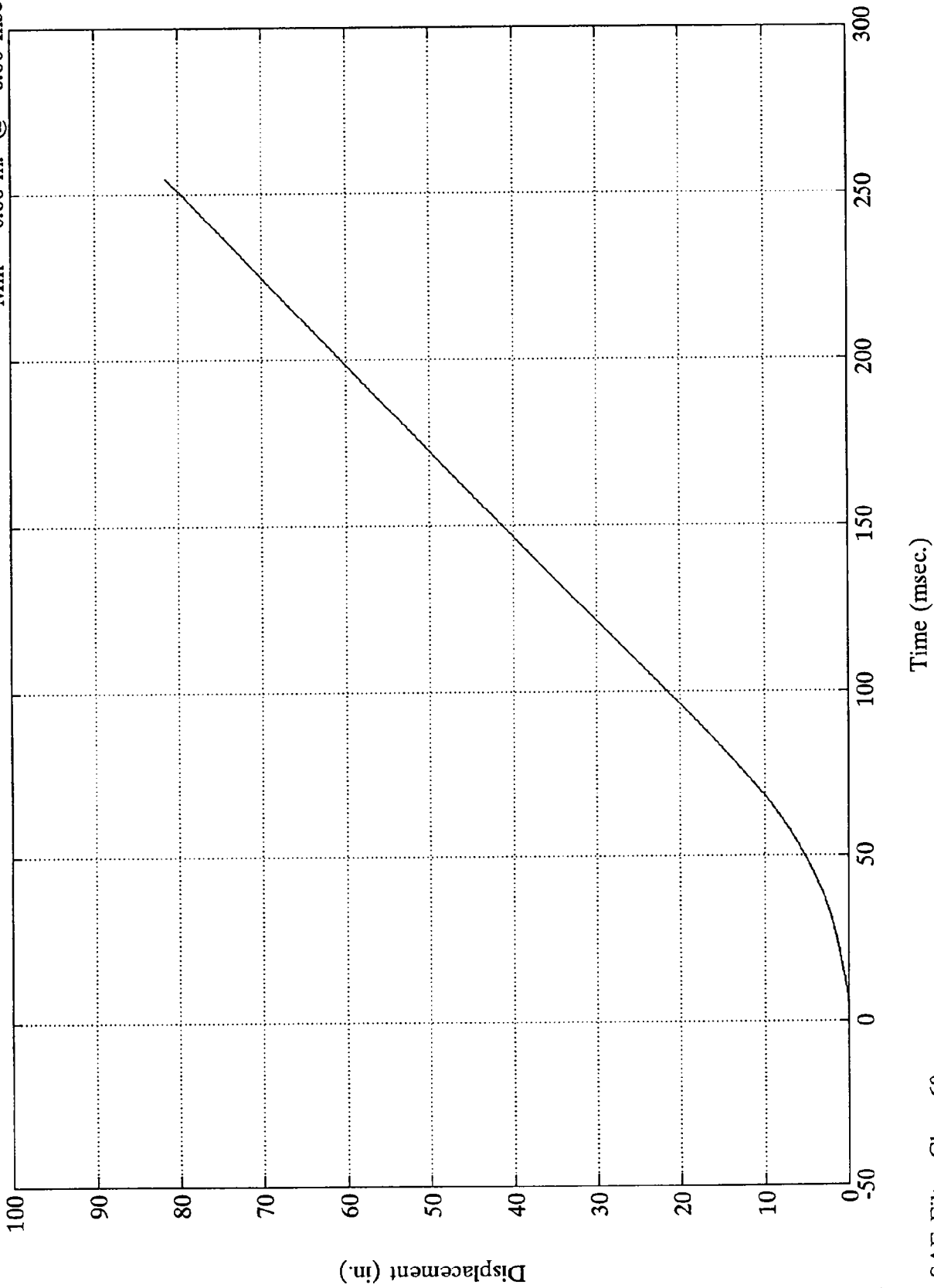


SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Acc. #1 Left Seat

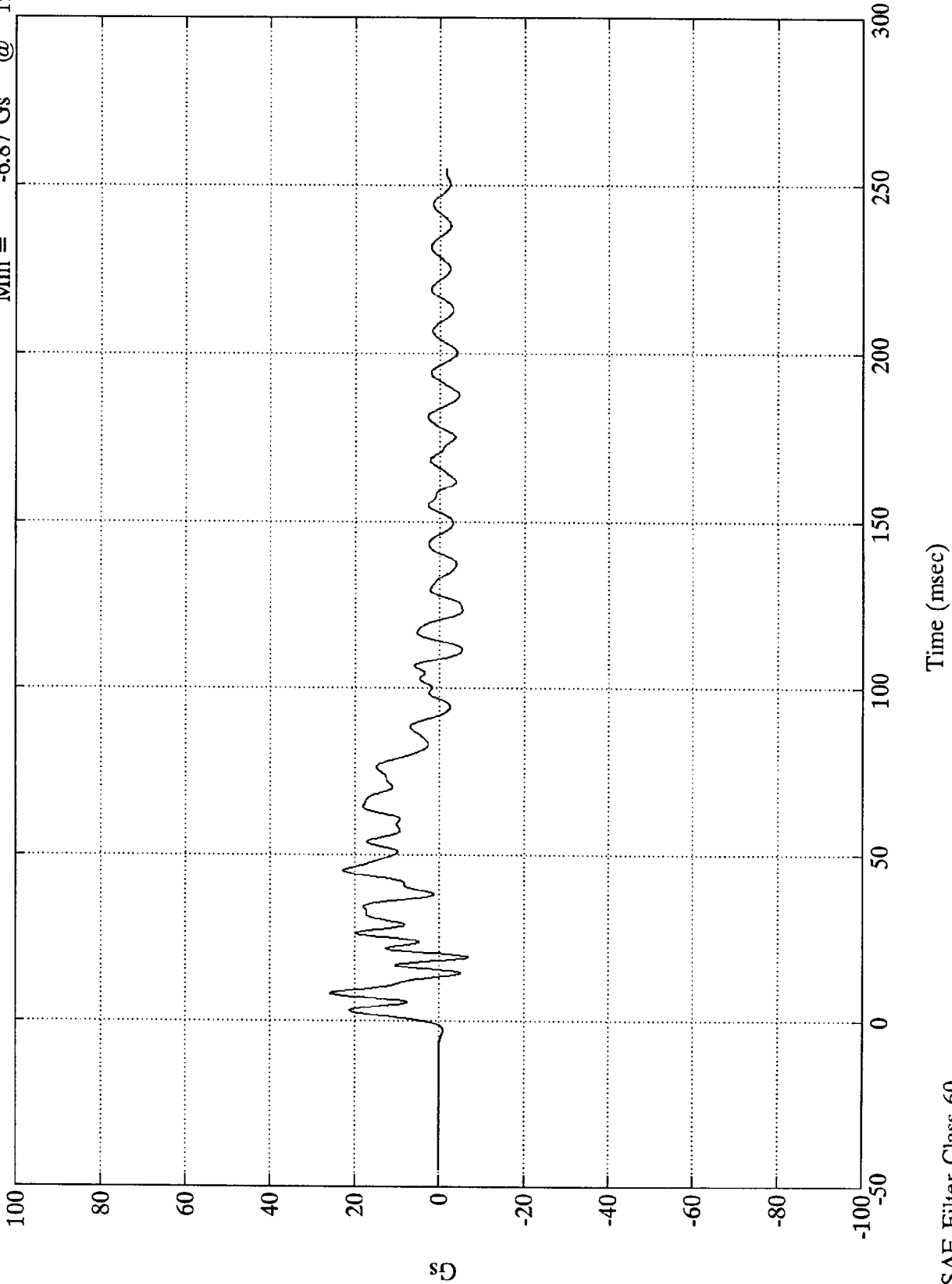
Max = 81.44 in. @ 254.88 msec  
Min = 0.00 in. @ -0.00 msec



TSC 301 TEST 2 - REAR IMPACT

Acc. #2 Right Seat

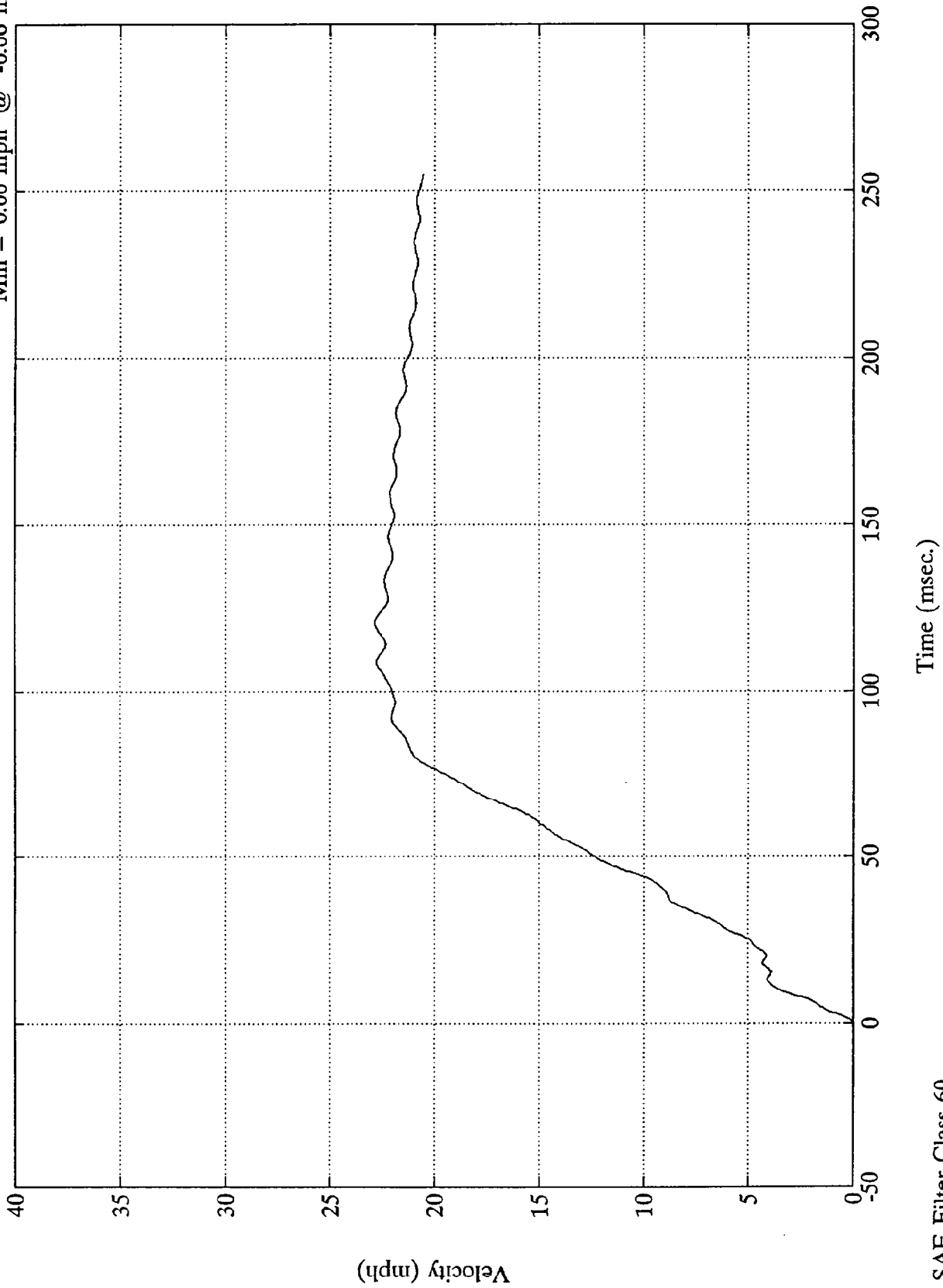
Max = 25.80 Gs @ 8.03 msec  
Min = -6.87 Gs @ 19.07 msec



TSC 301 TEST 2 - REAR IMPACT

Acc. #2 Right Seat

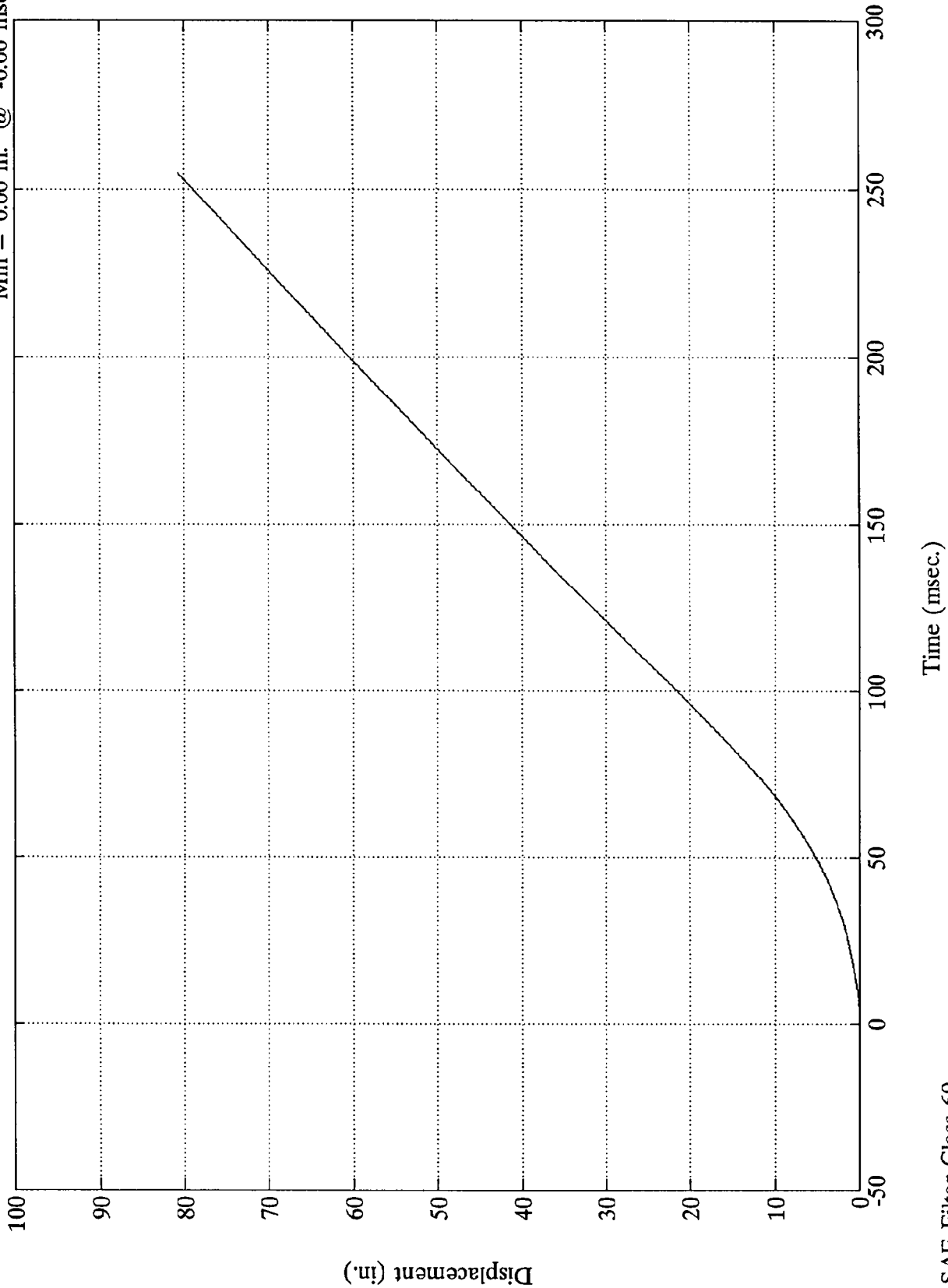
Max = 22.85 mph @ 120.96 msec  
Min = 0.00 mph @ -0.00 msec



TSC 301 TEST 2 - REAR IMPACT

Acc. #1 Right Seat

Max = 80.67 in. @ 254.88 msec  
Min = 0.00 in. @ -0.00 msec

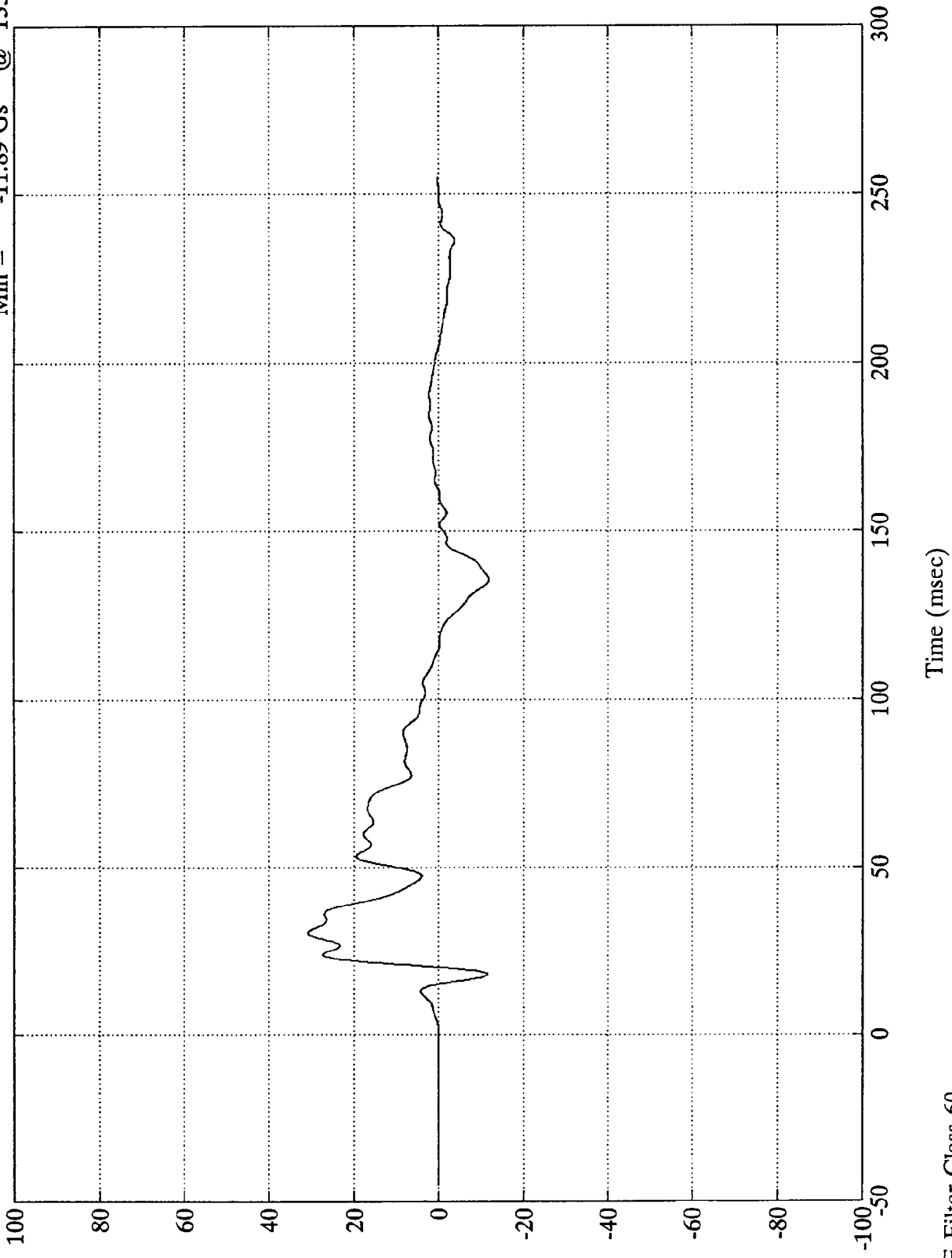


SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Acc. #3 Engine Top

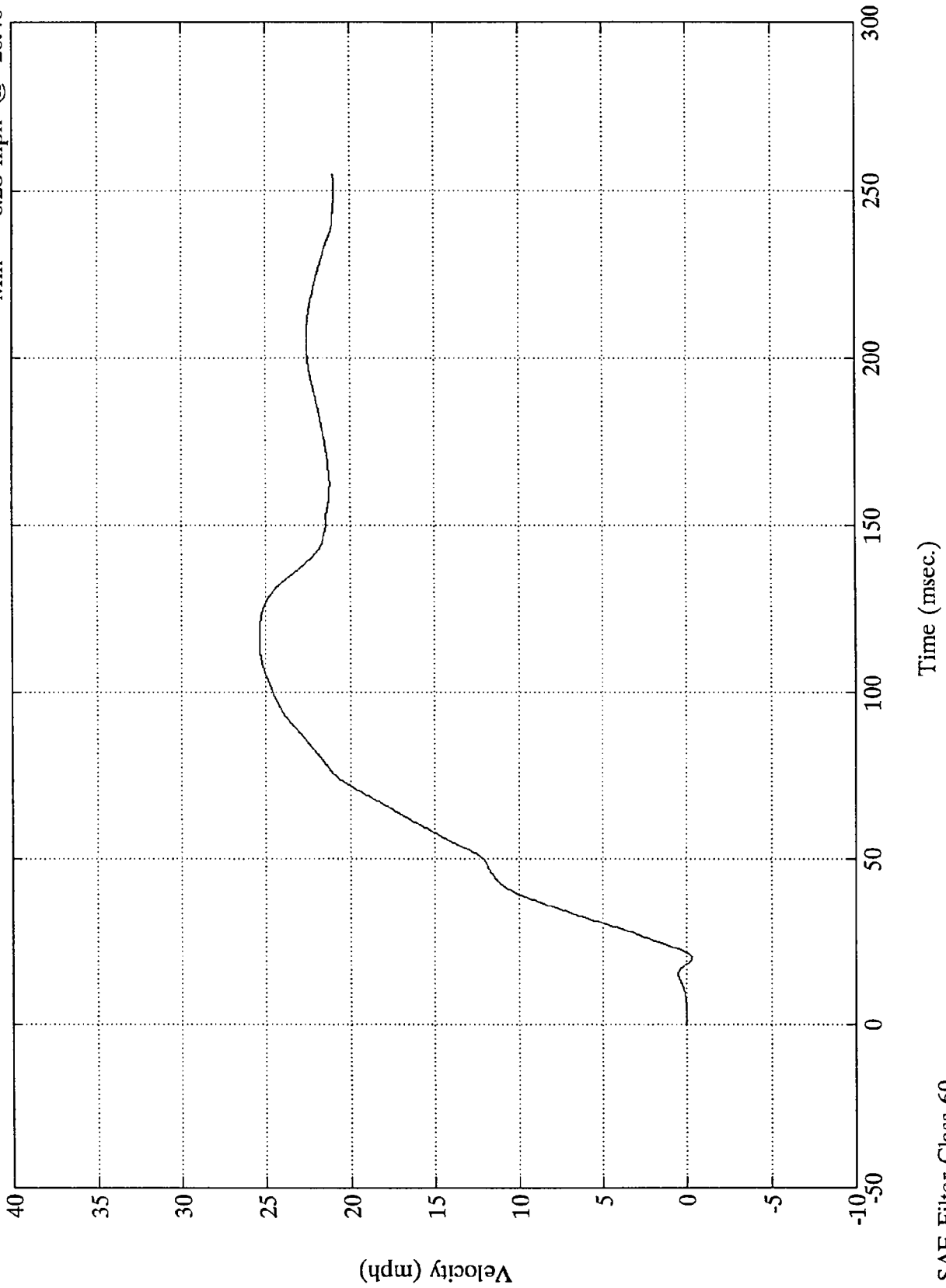
Max = 30.88 Gs @ 30.47 msec  
Min = -11.89 Gs @ 135.60 msec



TSC 301 TEST 2 - REAR IMPACT

Acc. #3 Engine Top

Max = 25.38 mph @ 115.20 msec  
Min = -0.28 mph @ 20.40 msec

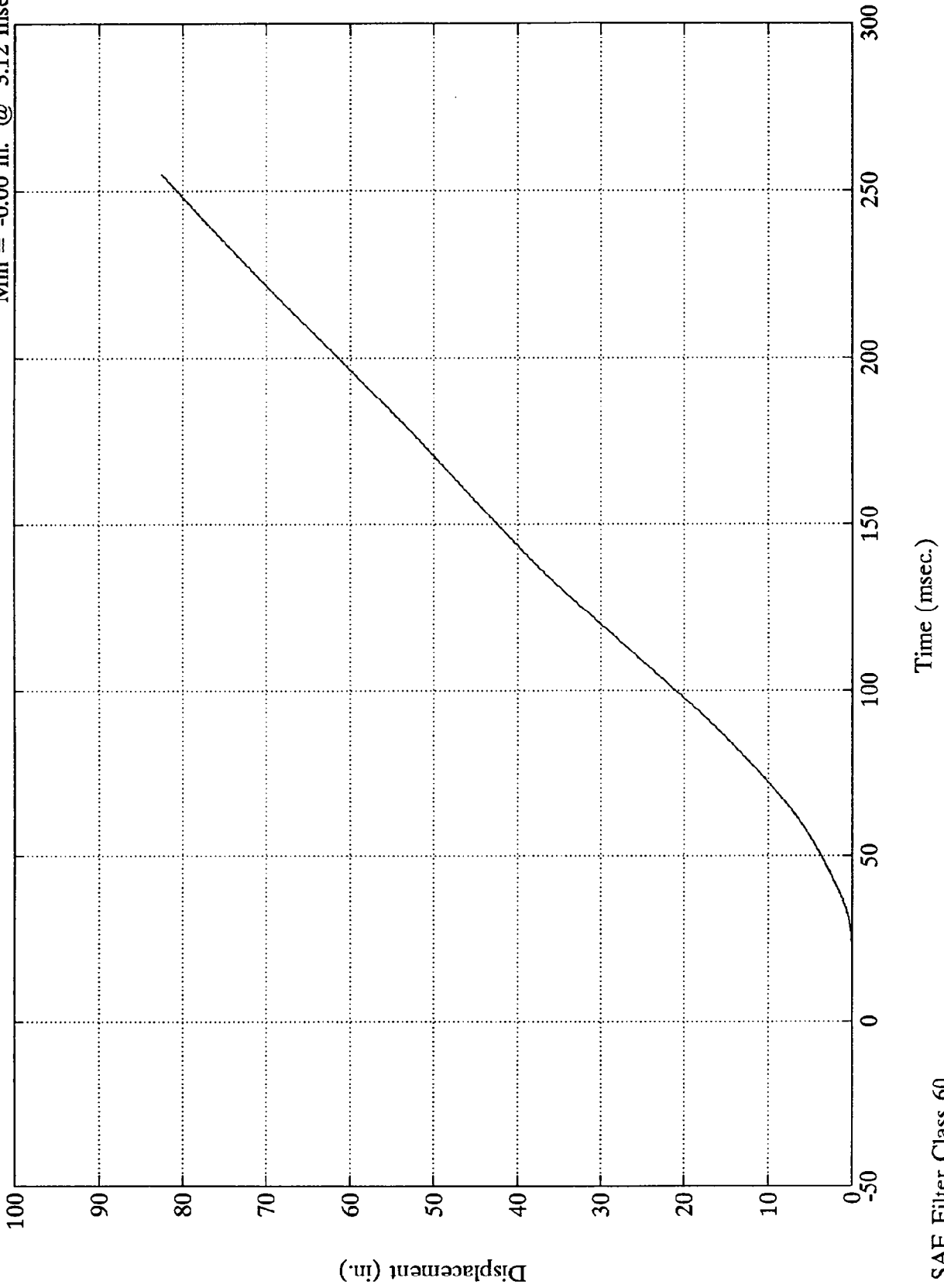


SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Acc. #3 Engine Top

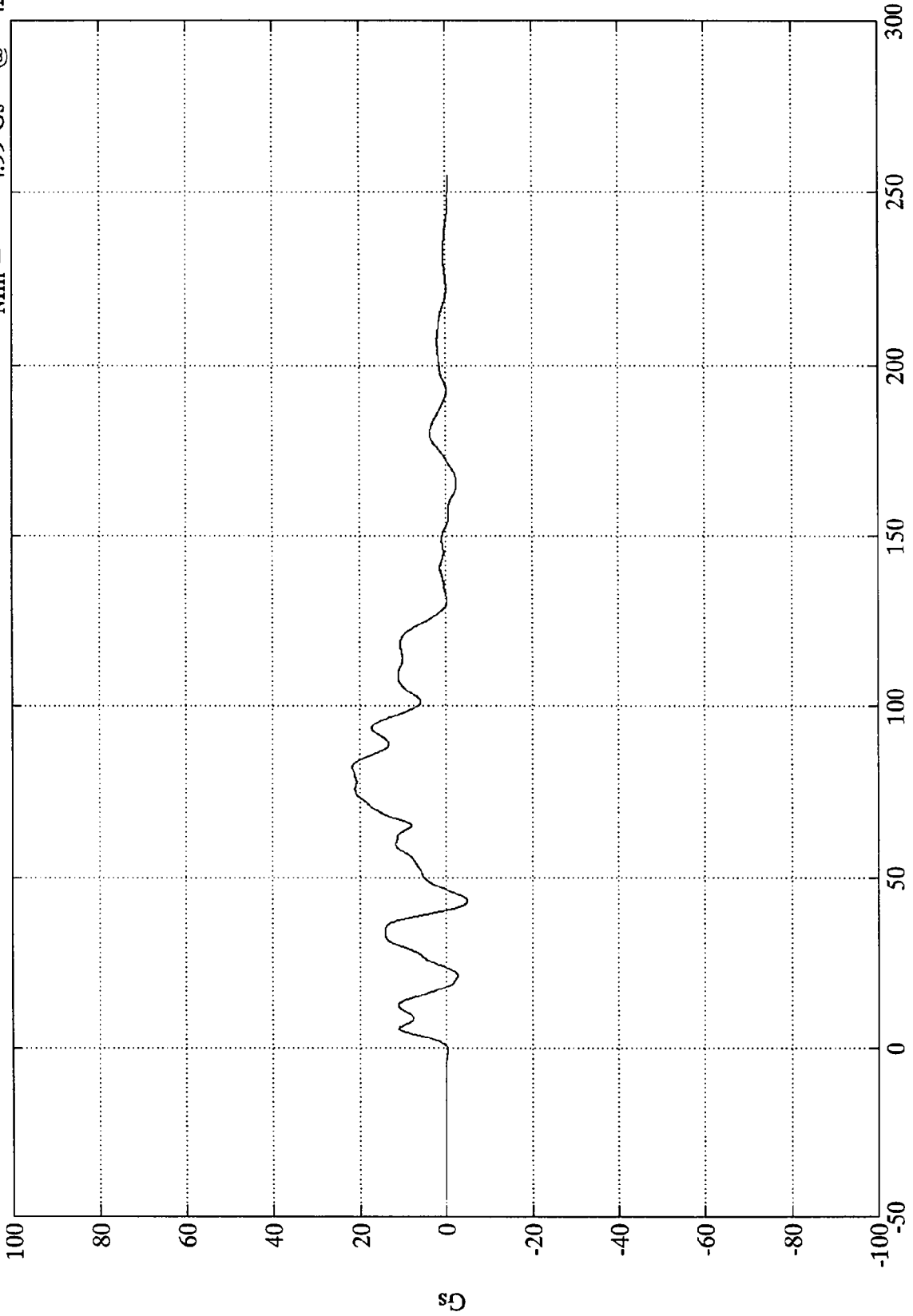
Max = 82.48 in. @ 254.88 msec  
Min = -0.00 in. @ 3.12 msec



TSC 301 TEST 2 - REAR IMPACT

Max = 21.69 Gs @ 82.19 msec  
Min = -4.99 Gs @ 42.84 msec

Acc. #4 Left Rear Seat



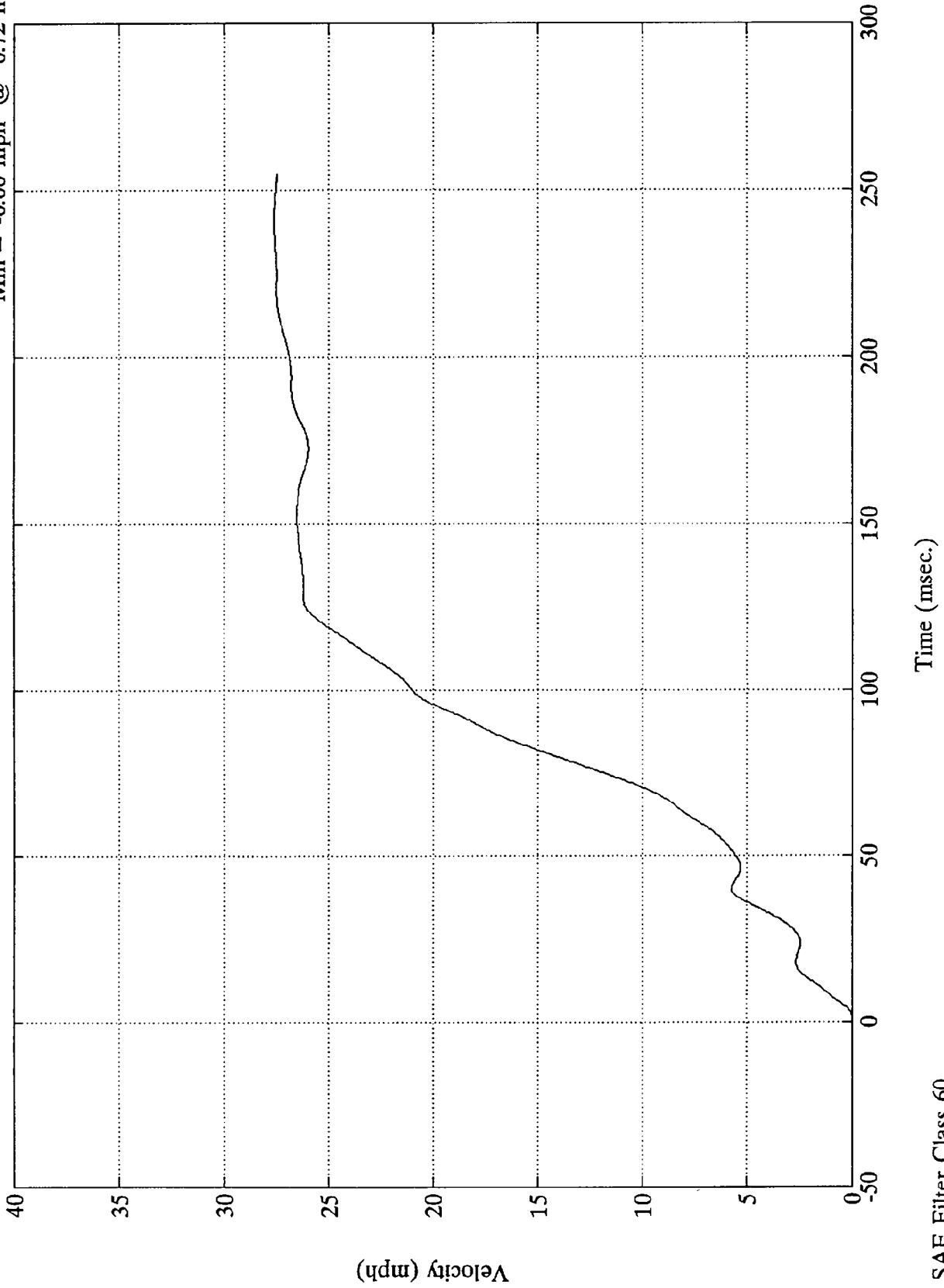
Time (msec)

SAE Filter Class 60

TSC 301 TEST 2 - REAR IMPACT

Acc. #4 Left Rear Seat

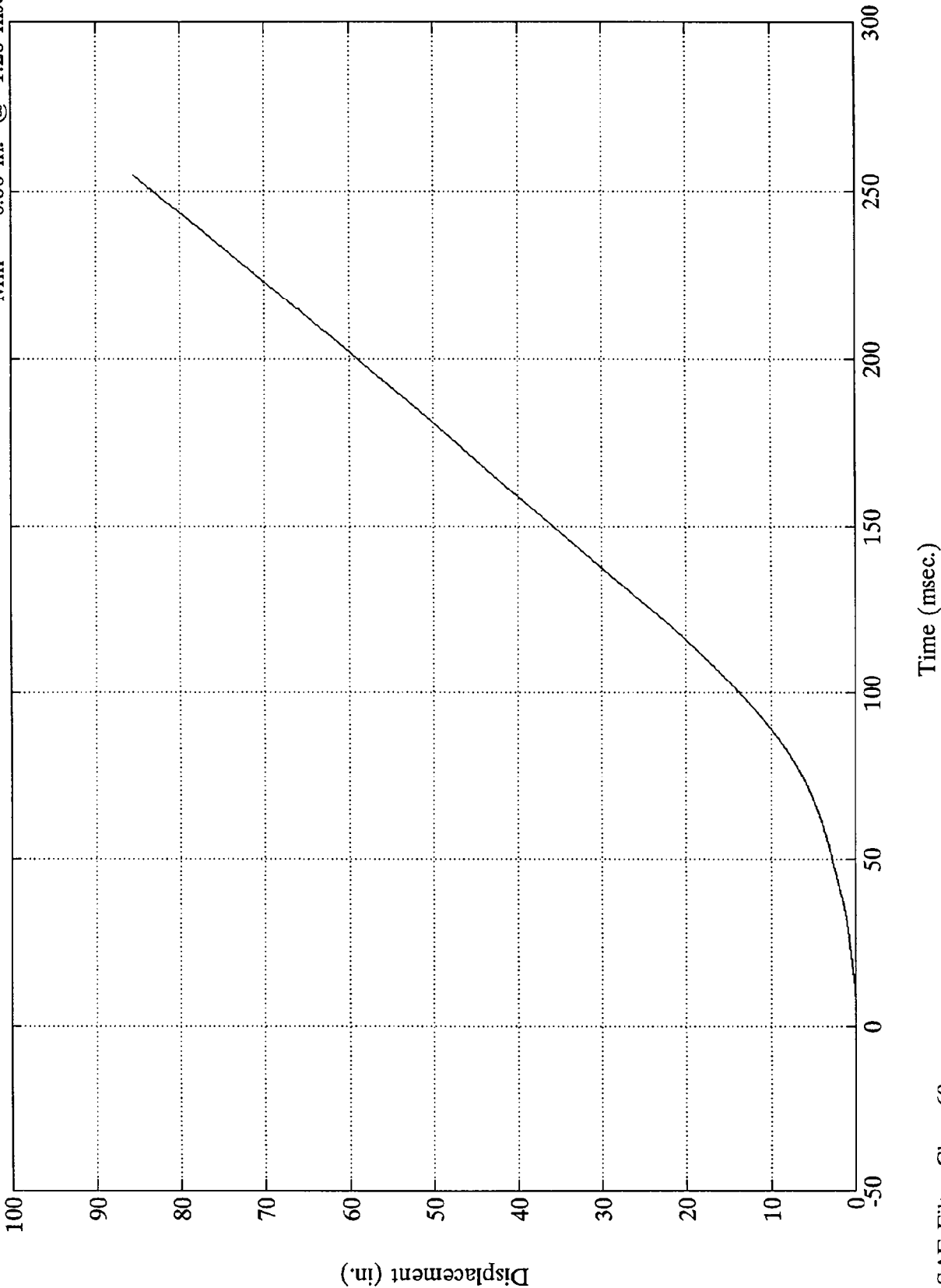
Max = 27.61 mph @ 242.64 msec  
Min = -0.00 mph @ 0.72 msec



TSC 301 TEST 2 - REAR IMPACT

Acc. #4 Left Rear Seat

Max = 85.49 in. @ 254.88 msec  
Min = -0.00 in. @ 1.20 msec



SAE Filter Class 60

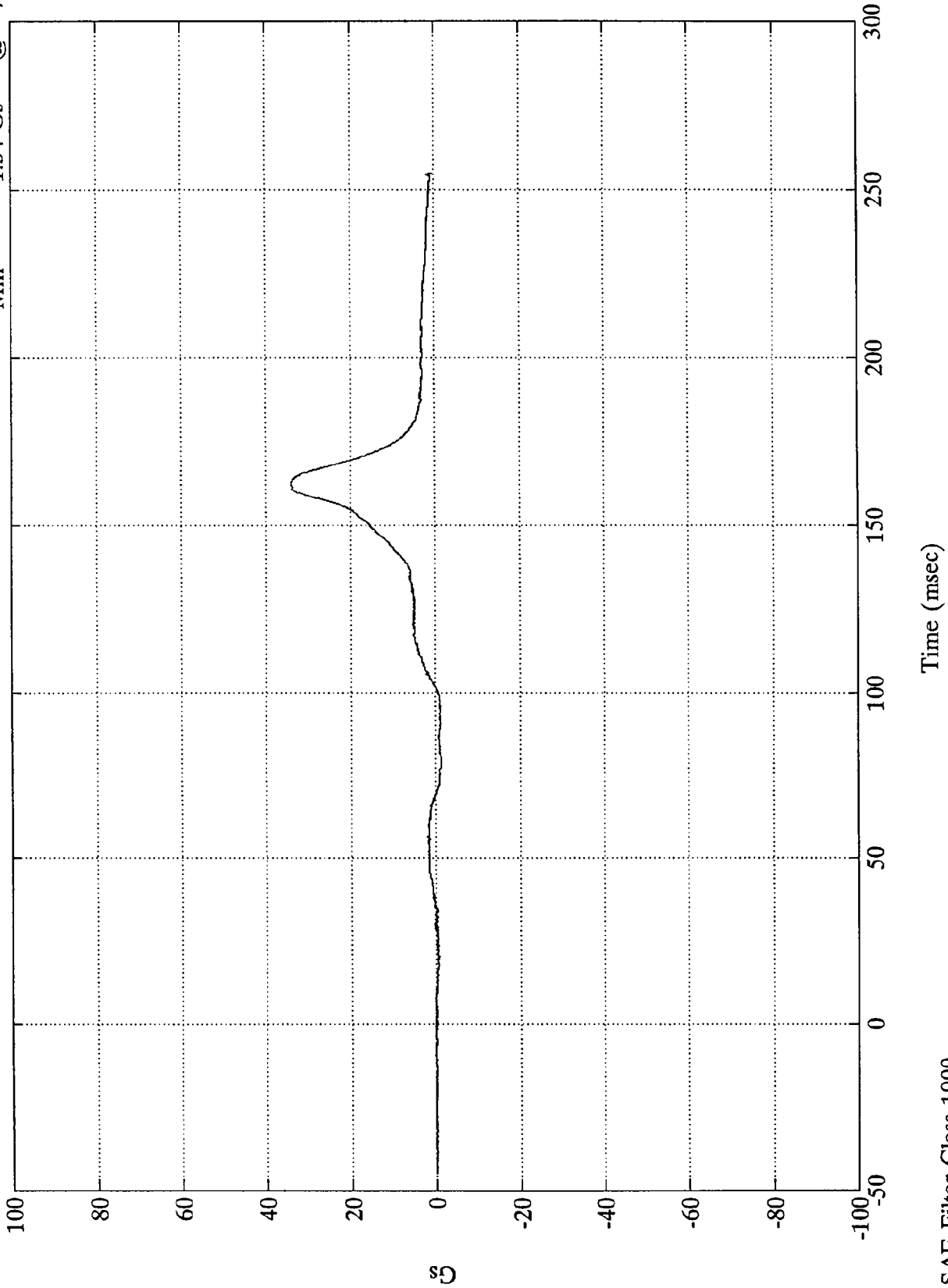
TEST NO. Y47-020-1278

| DUMMY DATA                  | SAE FILTER CHANNEL CLASS |
|-----------------------------|--------------------------|
| Head Accelerations          | 1000                     |
| Chest Accelerations         | 180                      |
| Femur Forces                | 600                      |
| Chest Deflection            | 180                      |
| Upper Neck Forces           | 1000                     |
| Upper Neck Moment           | 600                      |
| Upper Tibia Forces, Moments | 600                      |

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Head X

Max = 34.09 Gs @ 163.08 msec  
Min = -1.34 Gs @ 79.80 msec

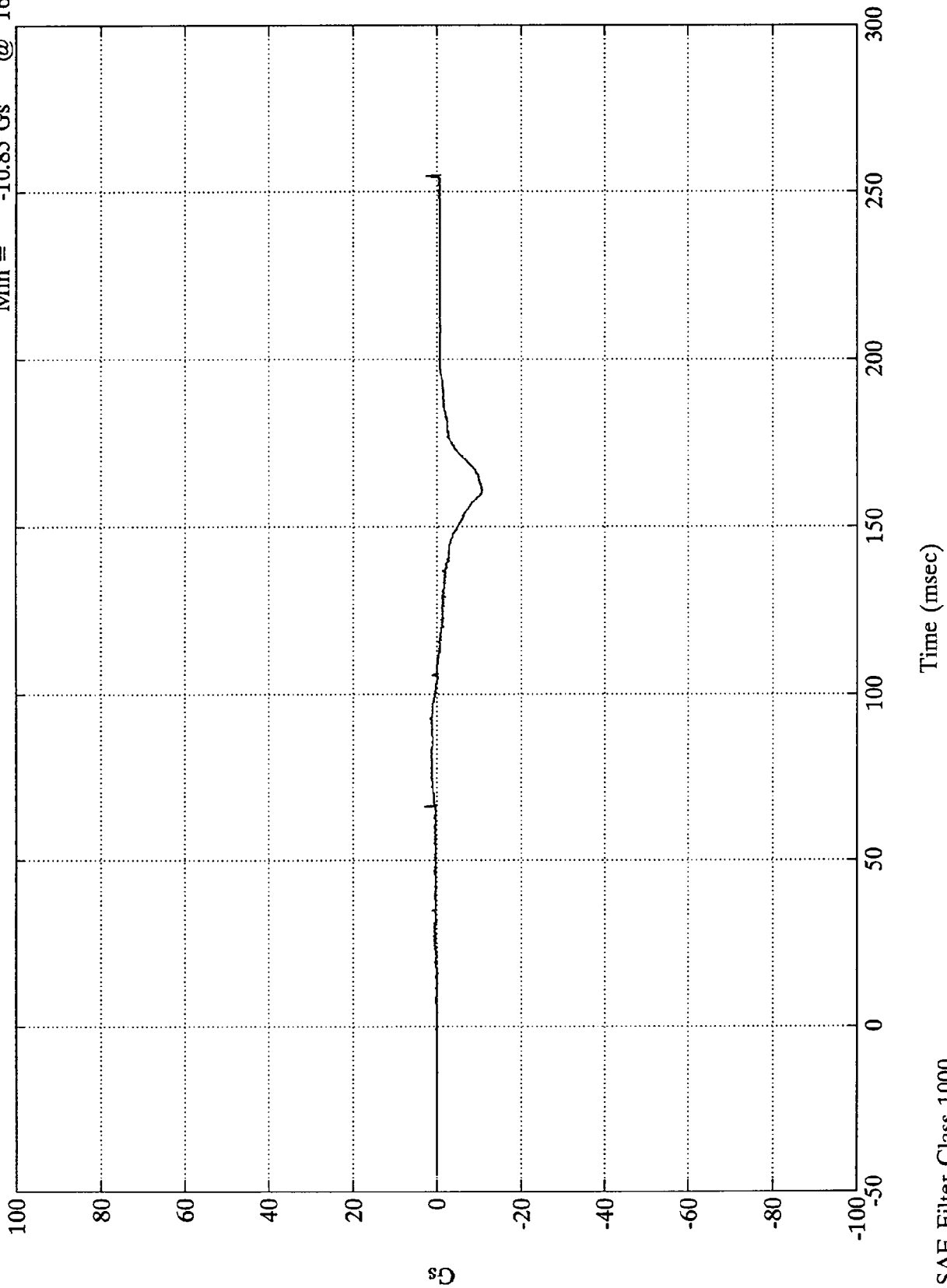


SAE Filter Class 1000

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Head Y

Max = 2.93 Gs @ 66.00 msec  
Min = -10.85 Gs @ 161.04 msec



50

B-23

8102-2

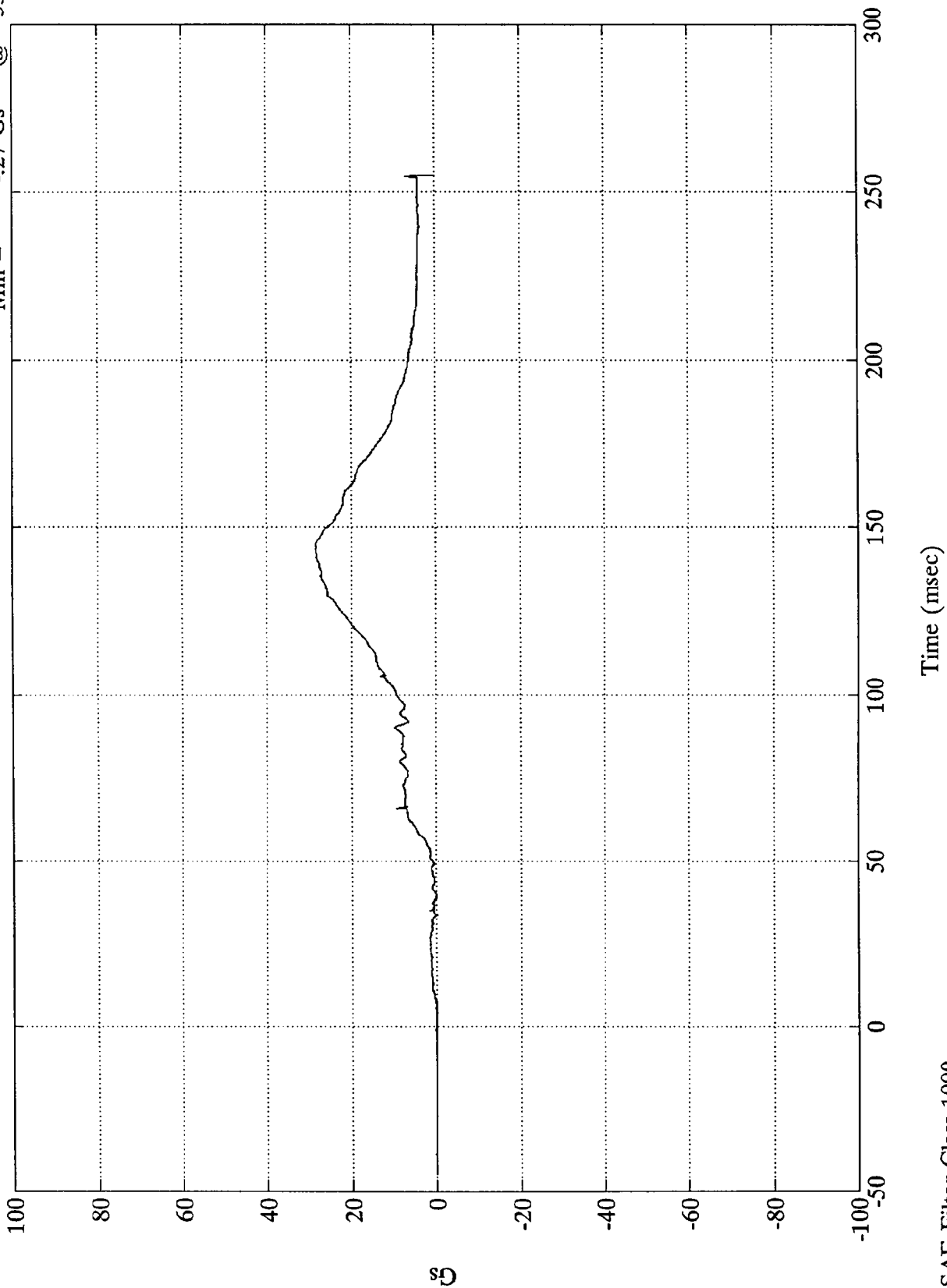
SAE Filter Class 1000

Time (msec)

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Head Z

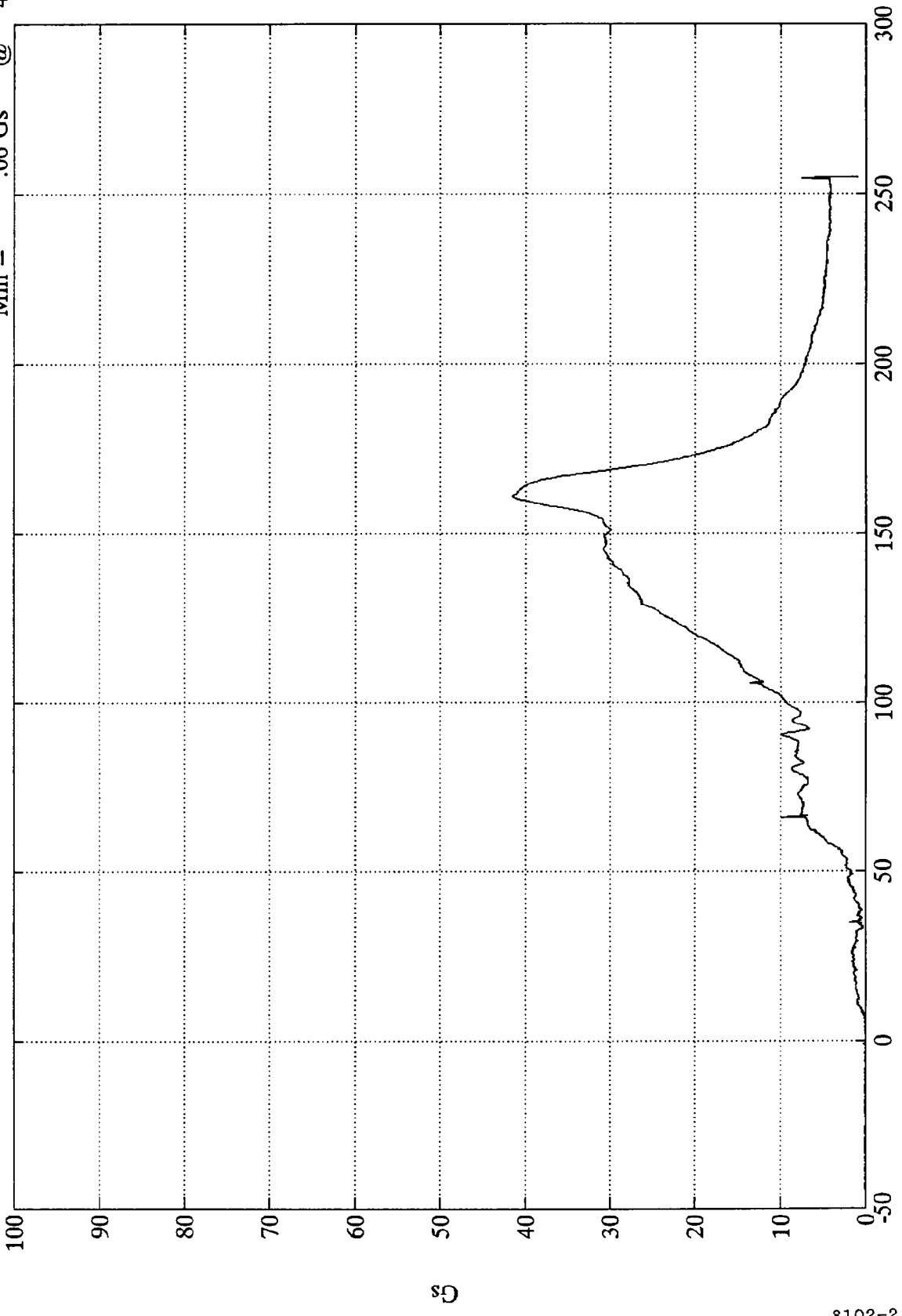
Max = 28.49 Gs @ 142.91 msec  
Min = -2.27 Gs @ 33.47 msec



TSC 301 TEST 2 - REAR IMPACT

Max = 41.56 Gs @ 161.04 msec  
Min = .06 Gs @ 4.79 msec

Pos. 1 Head Resultant



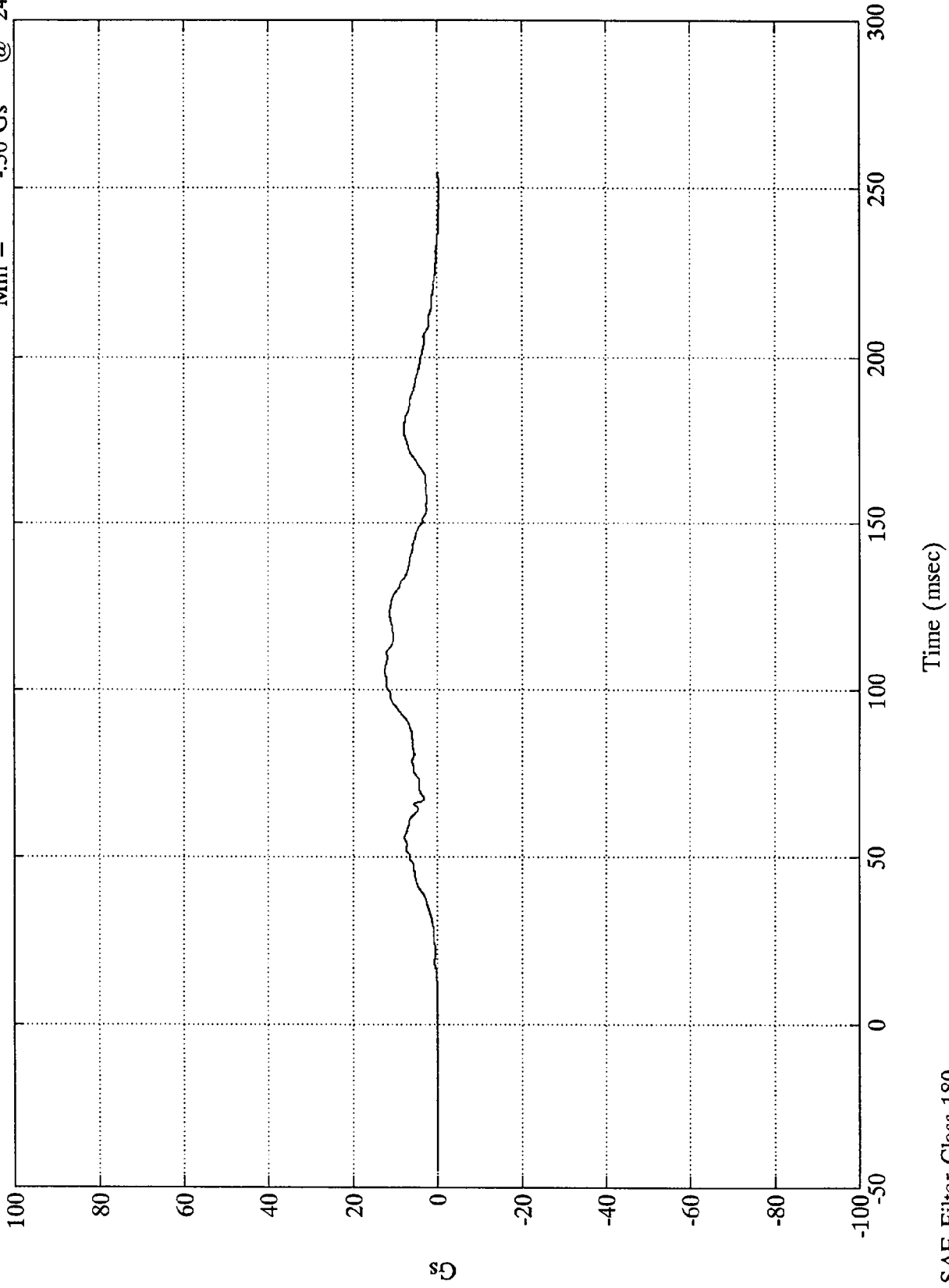
Time (msec)

SAE Filter Class 1000

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Chest X

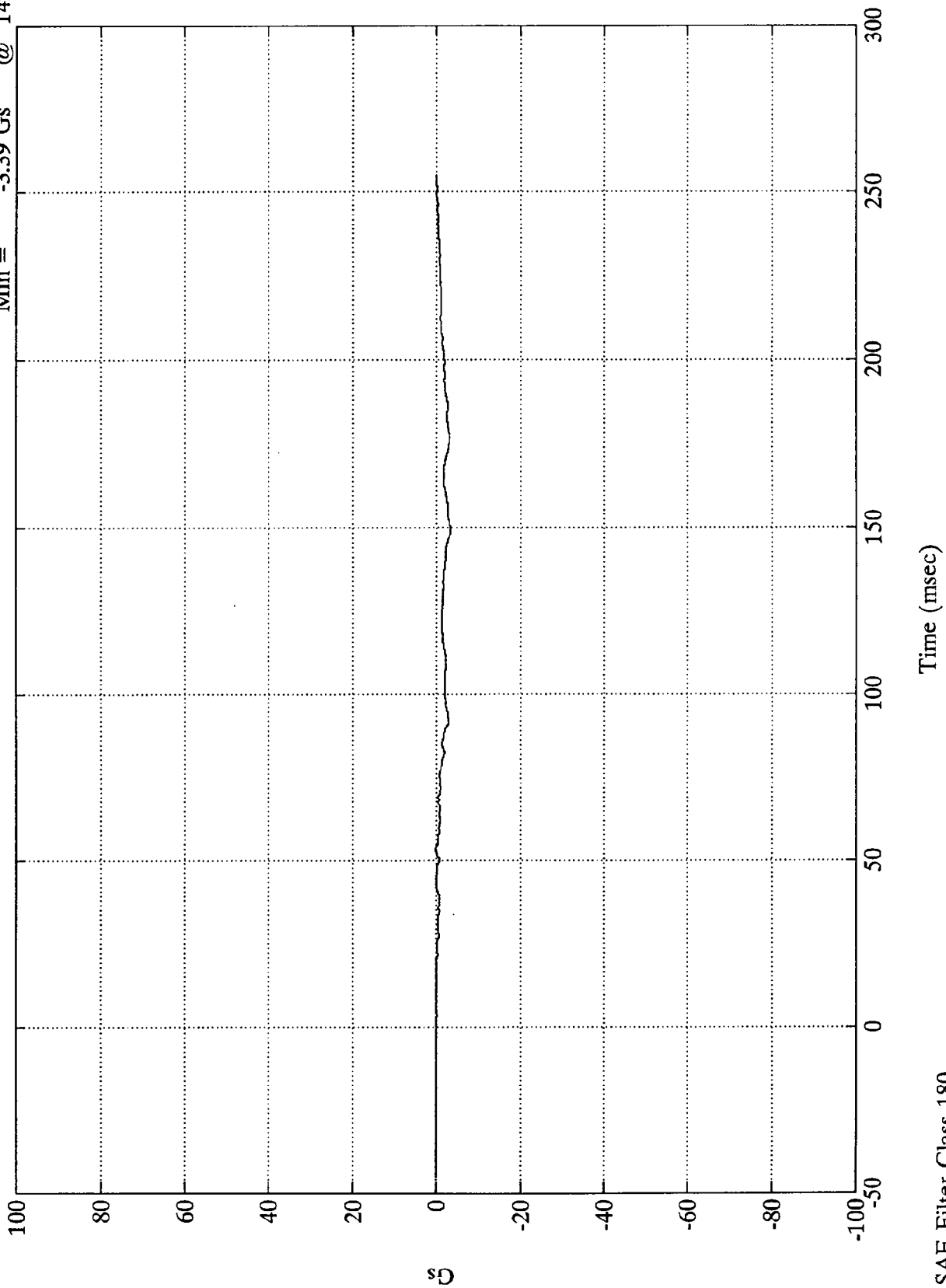
Max = 12.55 Gs @ 105.59 msec  
Min = -5.50 Gs @ 249.12 msec



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Chest Y

Max = .18 Gs @ 53.40 msec  
Min = -3.39 Gs @ 149.64 msec



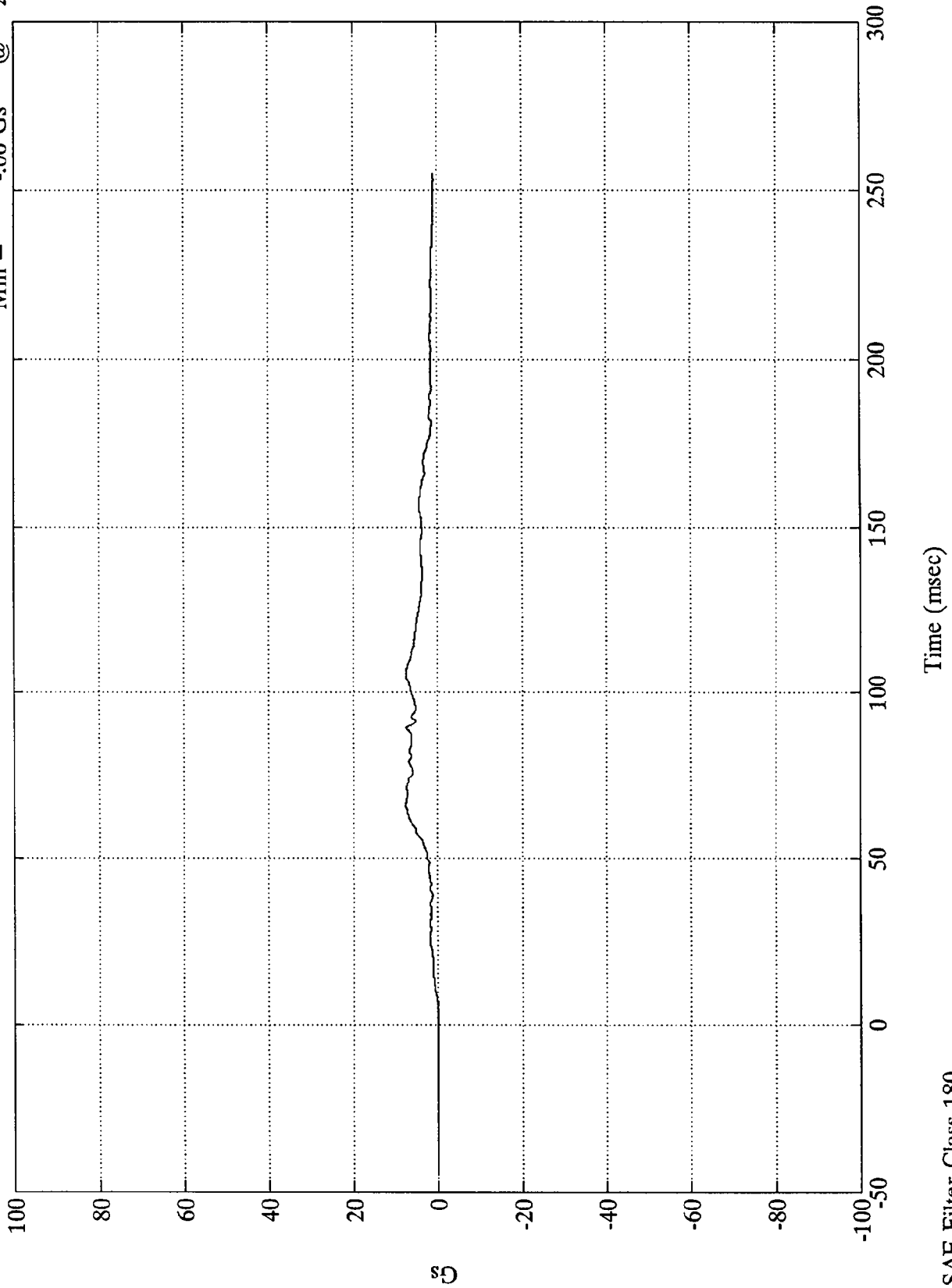
8102-2  
B-27

SAE Filter Class 180

TSC 301 TEST 2 - REAR IMPACT

Max = 7.67 Gs @ 66.00 msec  
Min = -0.06 Gs @ 2.63 msec

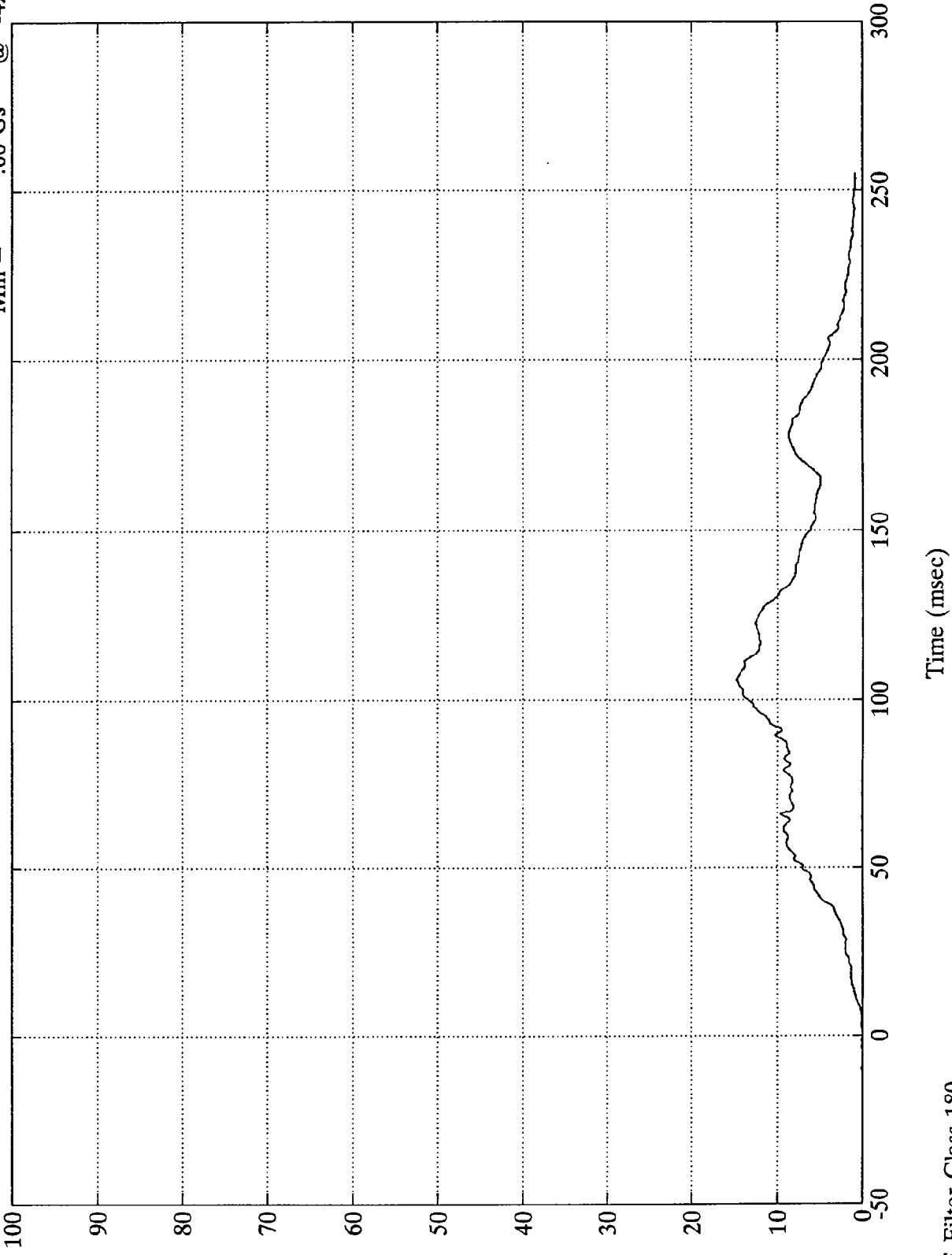
Pos. 1 Chest Z



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Chest Resultant

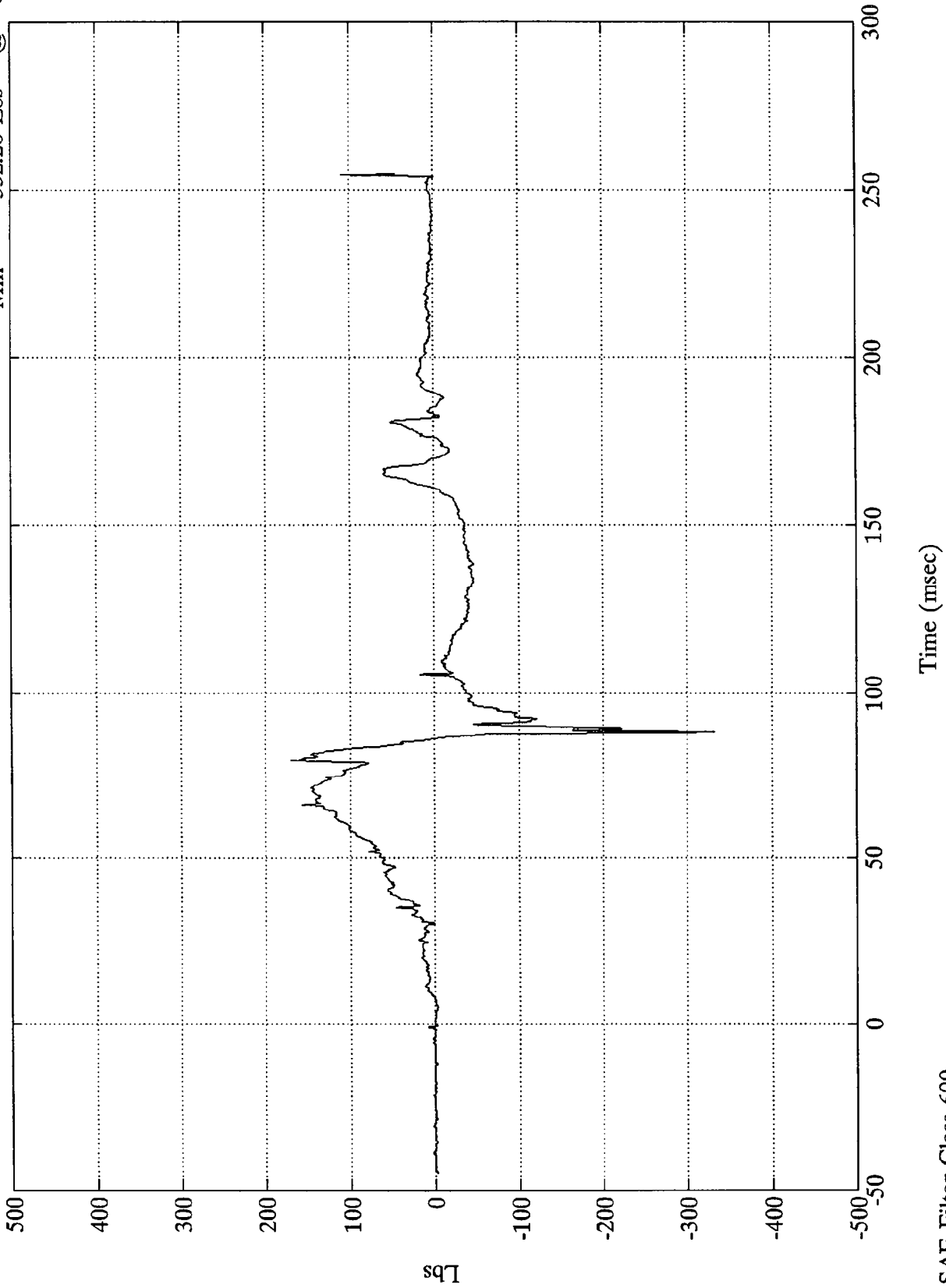
Max = 14.73 Gs @ 105.59 msec  
Min = .00 Gs @ -42.48 msec



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Left Femur

Max = 169.91 Lbs @ 79.80 msec  
Min = -332.20 Lbs @ 88.20 msec

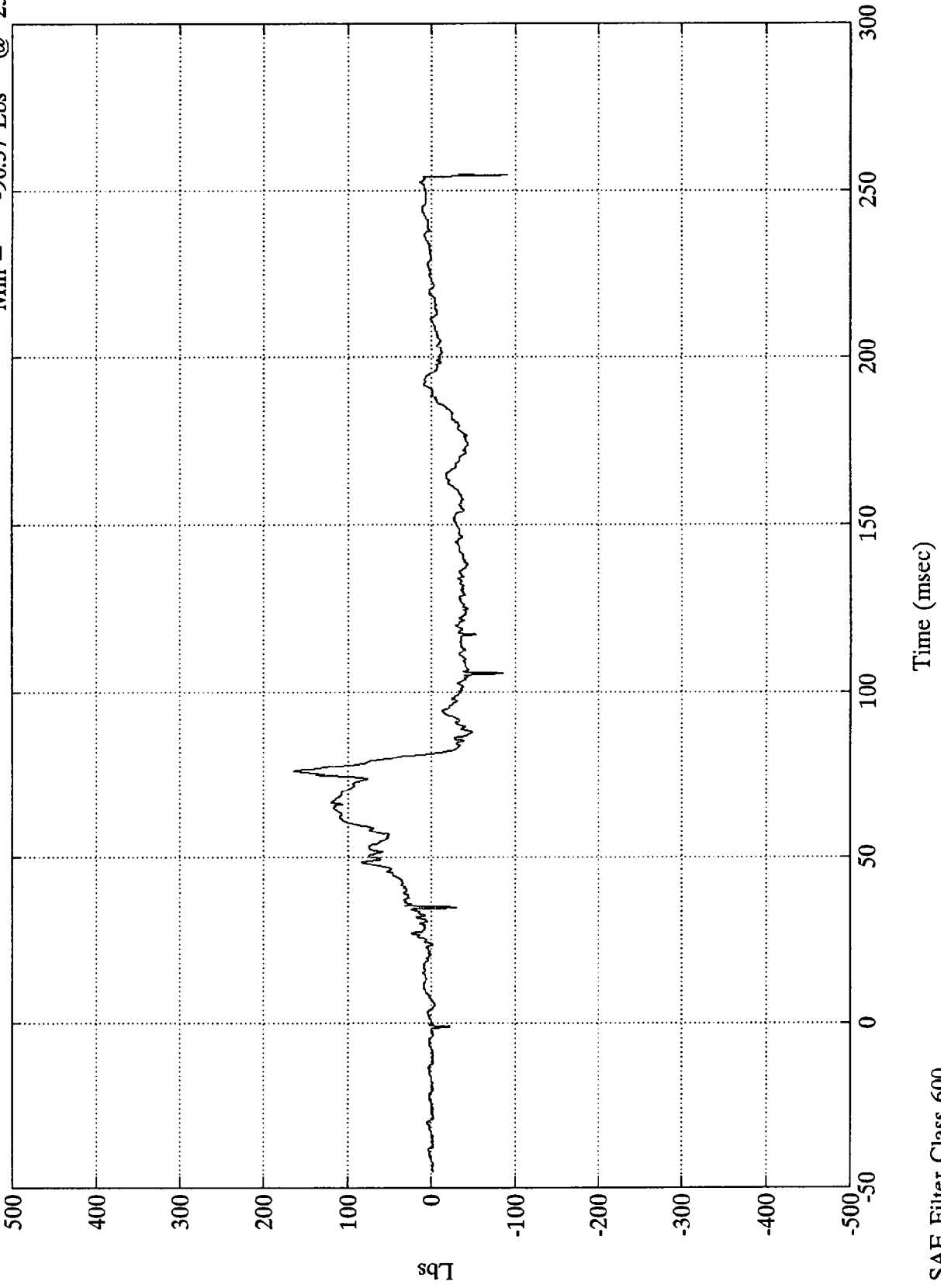


SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Right Femur

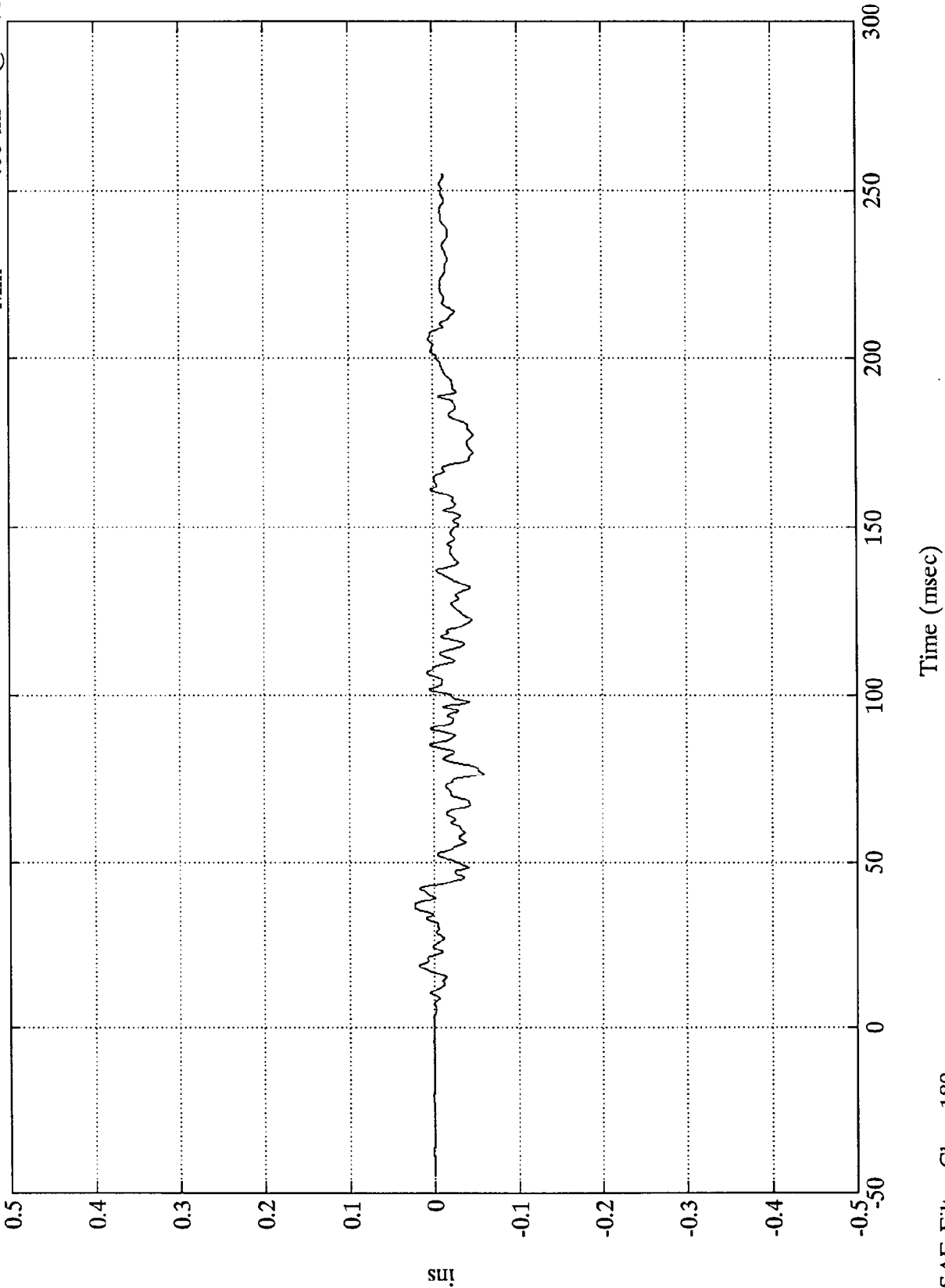
Max = 165.02 Lbs @ 76.20 msec  
Min = -90.37 Lbs @ 254.52 msec



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Chest Deflection

Max = .02 ins @ 36.24 msec  
Min = -.06 ins @ 76.55 msec



in  
B-32

8102-2

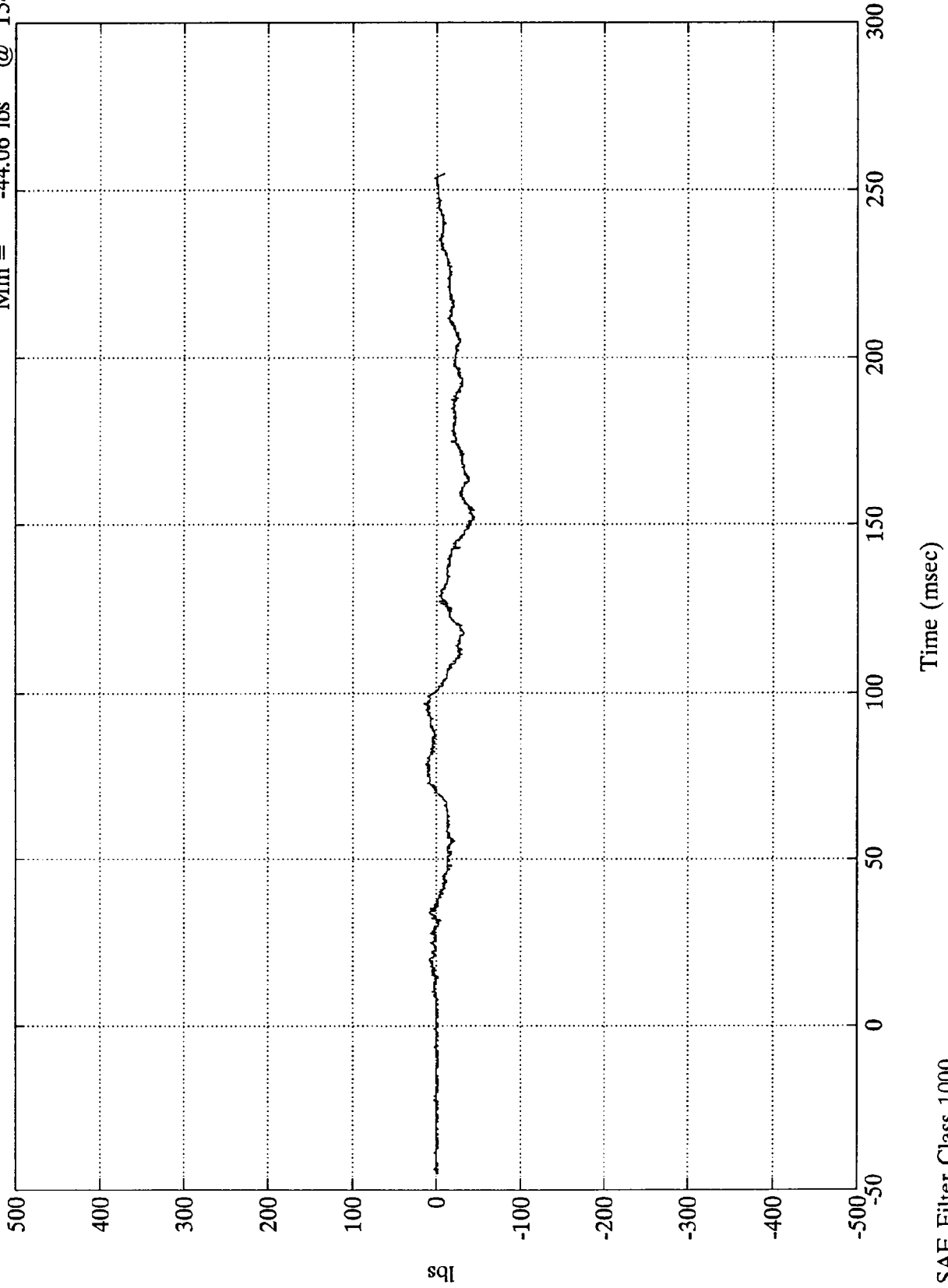
SAE Filter Class 180



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Upper Neck Fx

Max = 14.57 lbs @ 96.36 msec  
Min = -44.06 lbs @ 154.32 msec



B-33

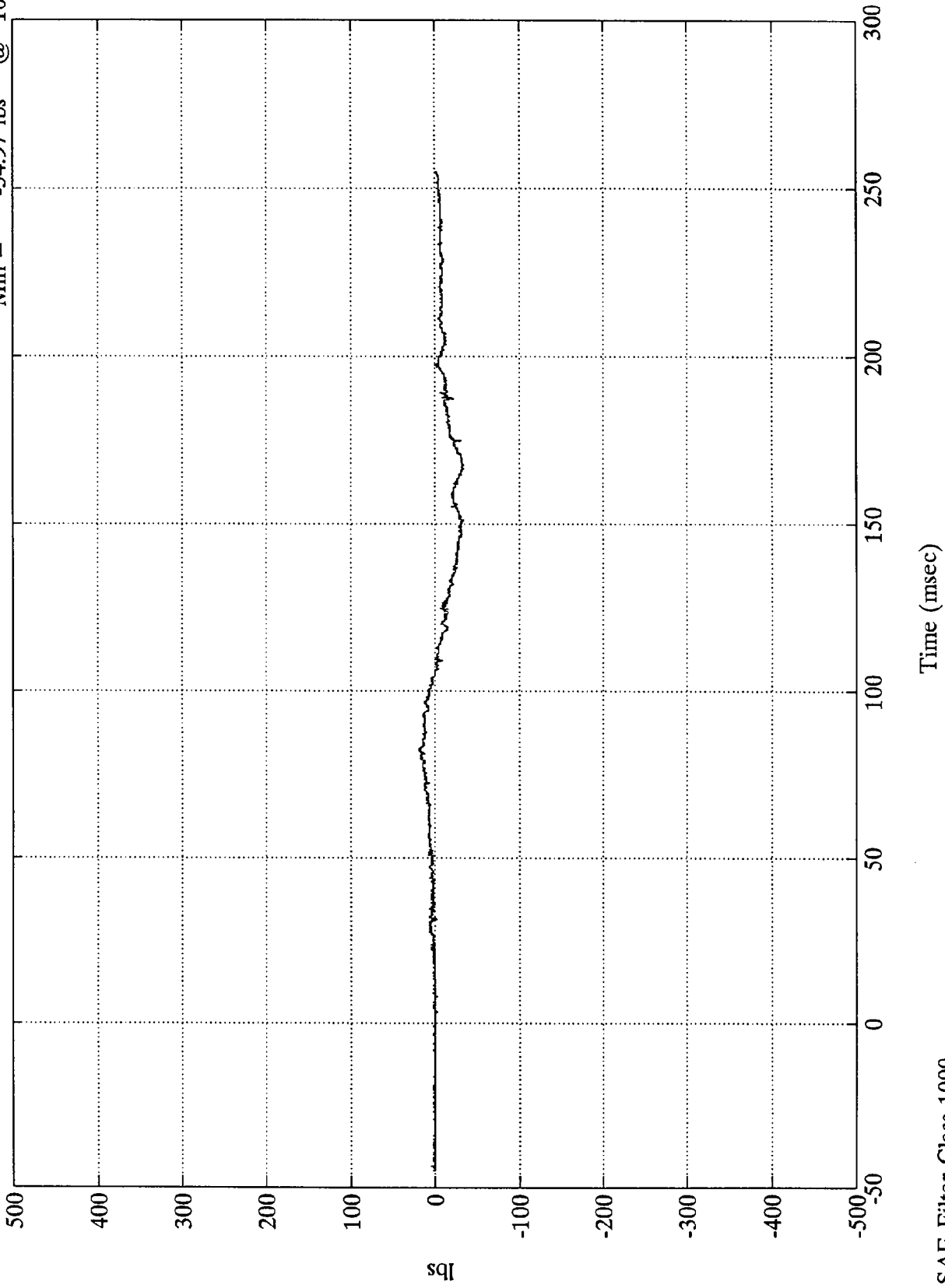
8102-2

SAE Filter Class 1000

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Upper Neck Fy

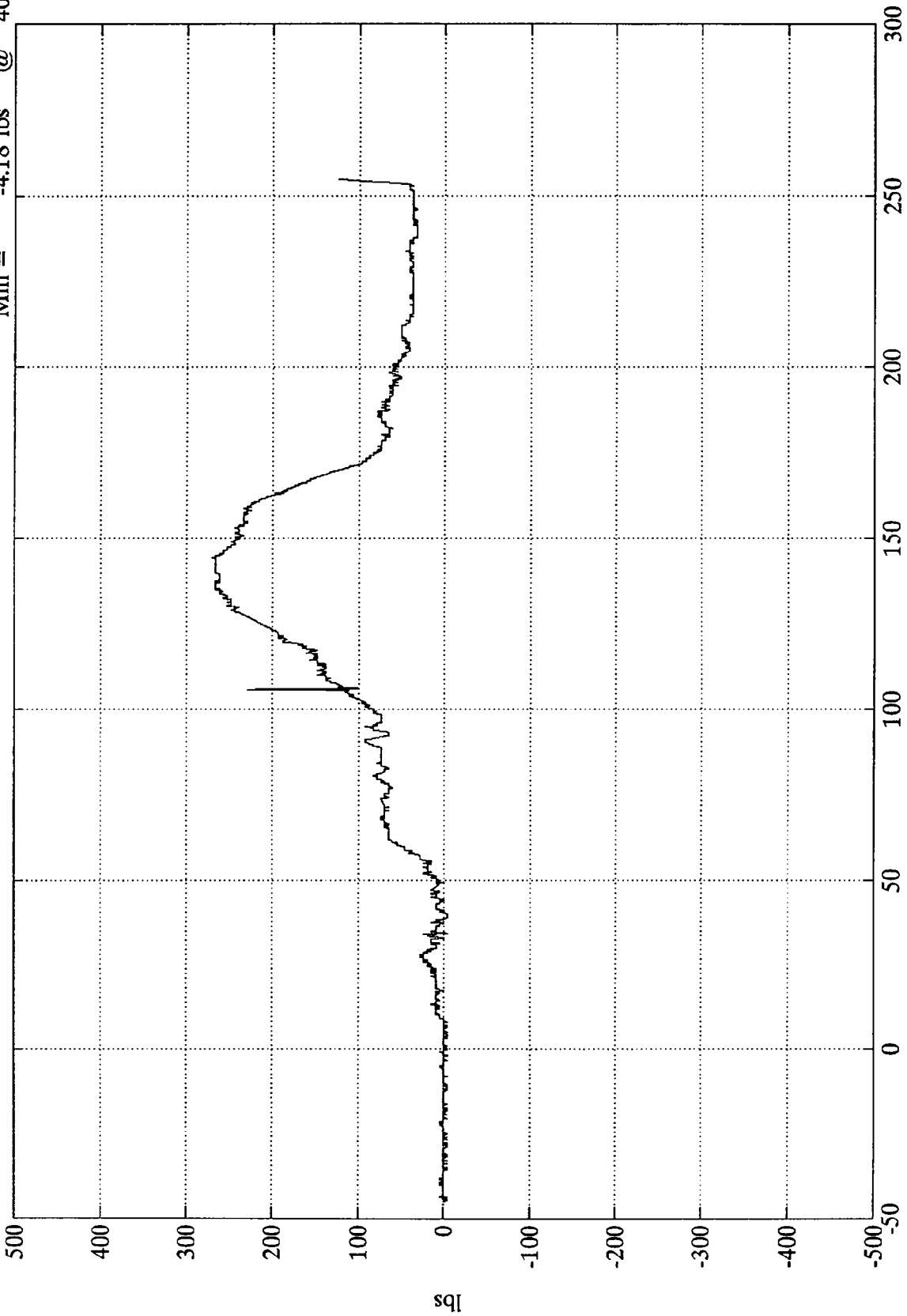
Max = 19.33 lbs @ 82.56 msec  
Min = -34.97 lbs @ 167.63 msec



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Upper Neck Fz

Max = 271.13 lbs @ 144.36 msec  
Min = -4.18 lbs @ 40.19 msec



B-35

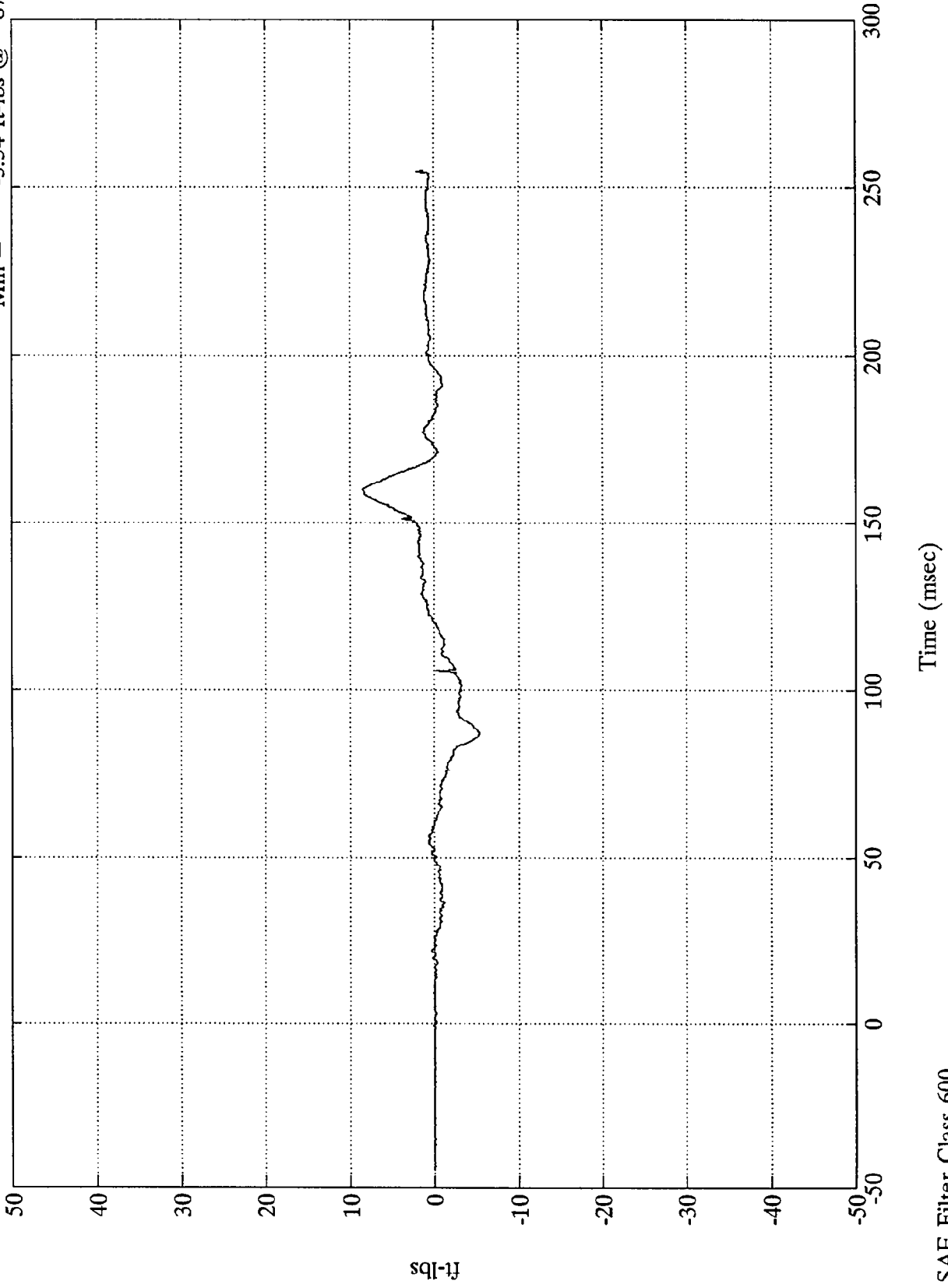
8102-2

SAE Filter Class 1000

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Upper Neck Mx

Max = 8.49 ft-lbs @ 159.83 msec  
Min = -5.34 ft-lbs @ 87.24 msec



B-36

8102-2

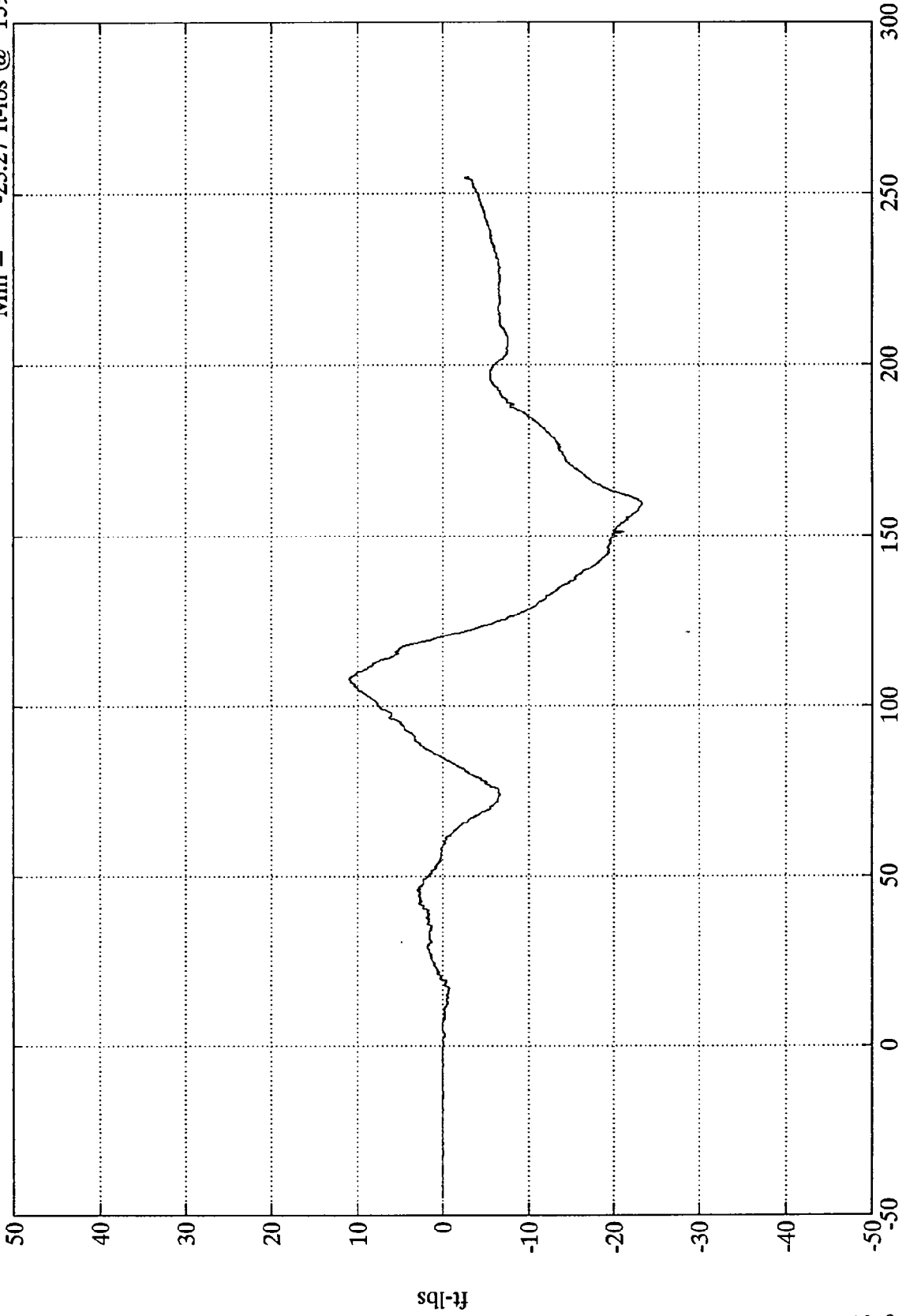
SAE Filter Class 600



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Upper Neck My

Max = 10.88 ft-lbs @ 107.76 msec  
Min = -23.27 ft-lbs @ 159.24 msec



sq|-tj  
B-37

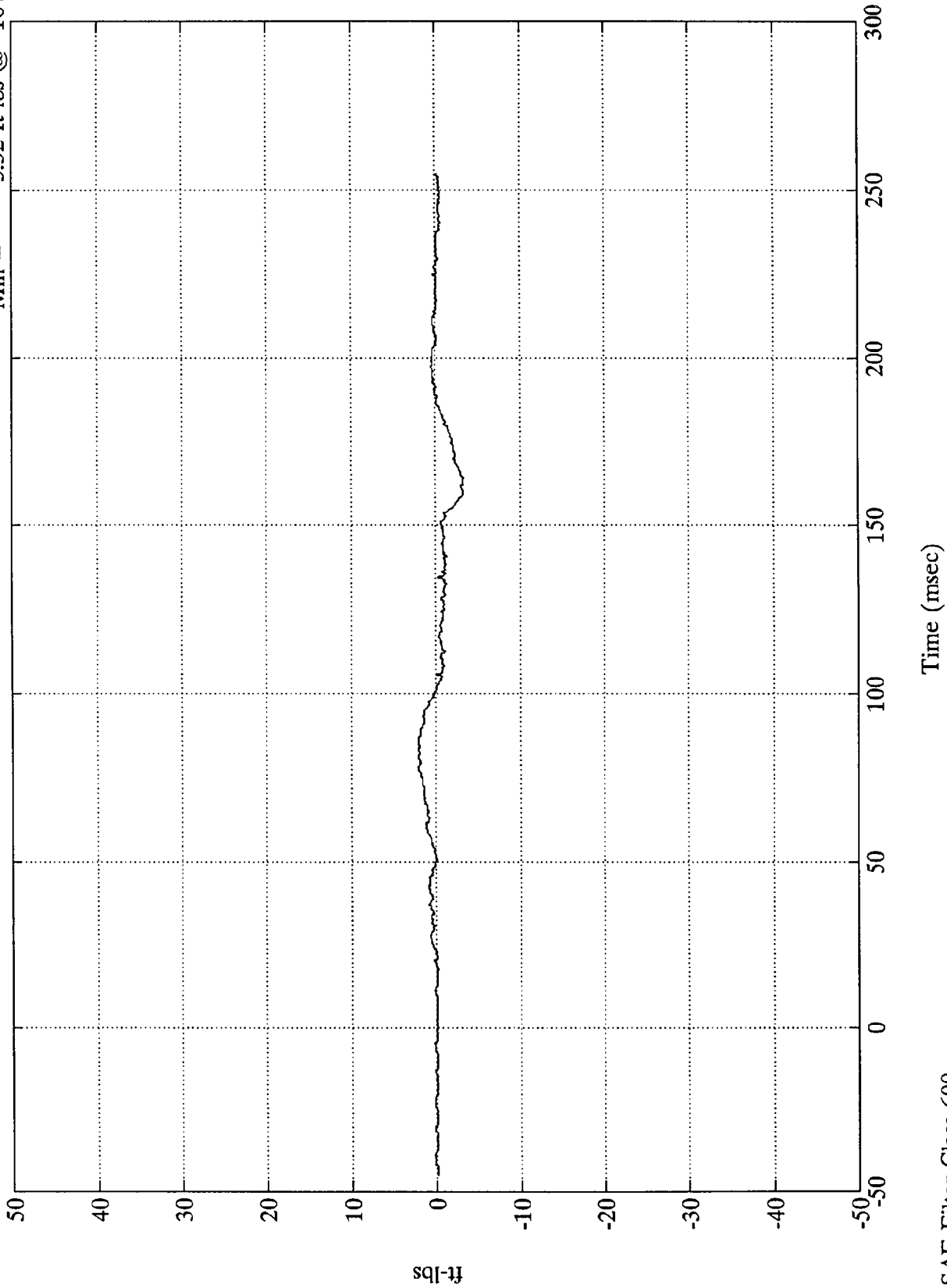
8102-2

SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Upper Neck Mz

Max = 2.09 ft-lbs @ 78.48 msec  
Min = -3.32 ft-lbs @ 164.27 msec



ft-lbs

Time (msec)

SAE Filter Class 600

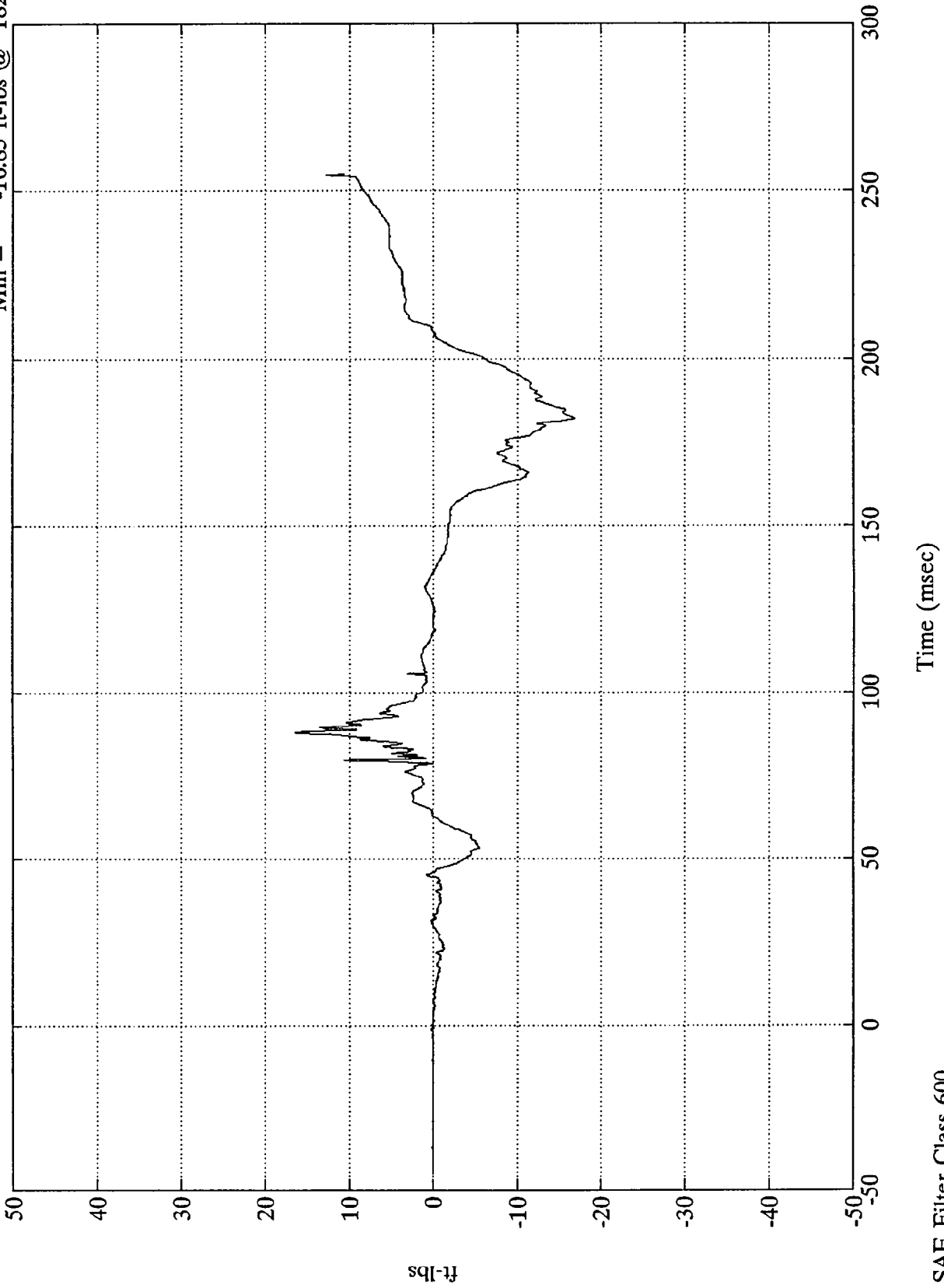
8102-2

B-38

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Lt Upper Tibia Mx

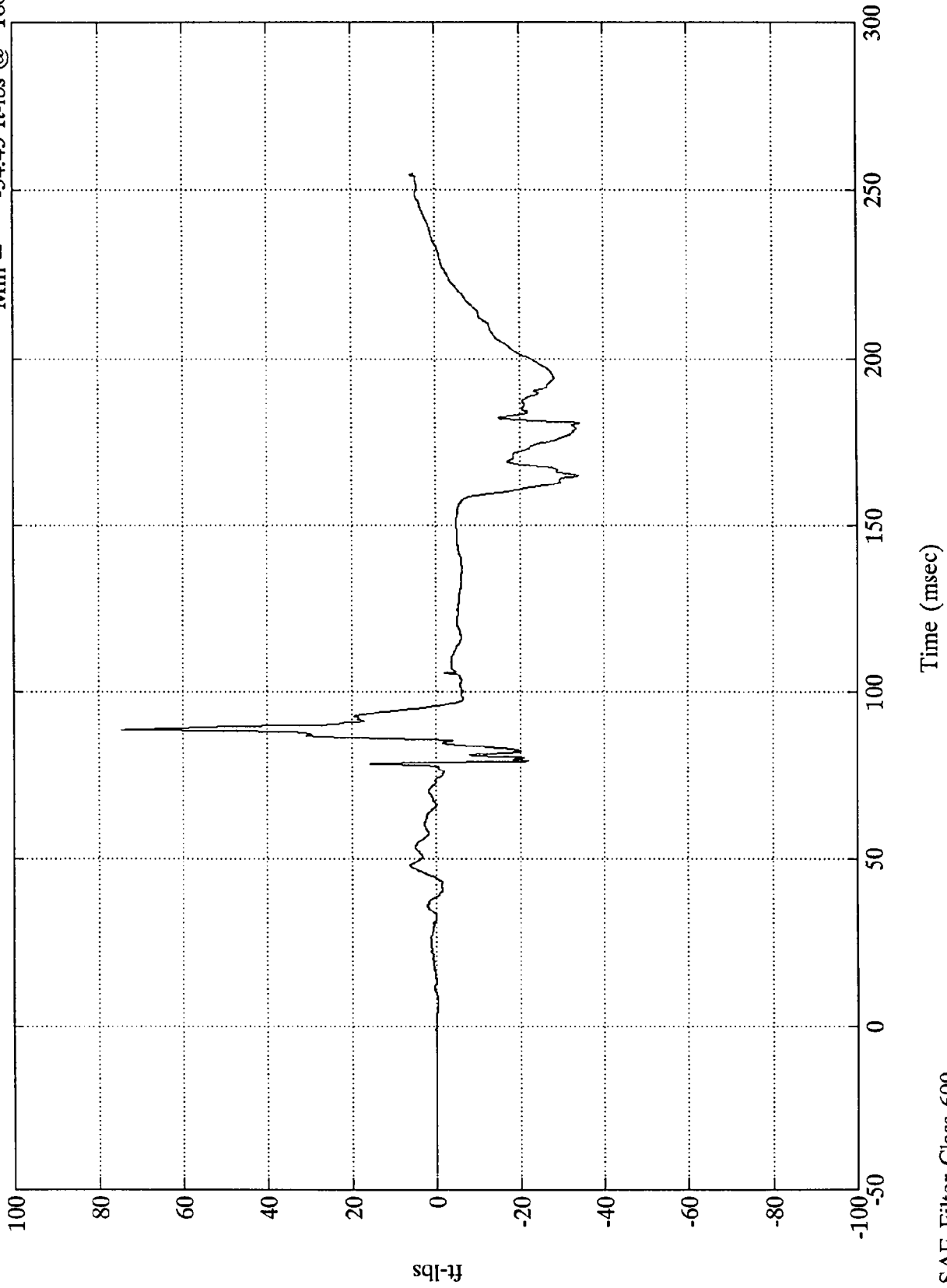
Max = 16.43 ft-lbs @ 87.96 msec  
Min = -16.85 ft-lbs @ 182.16 msec



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Lt Upper Tibia My

Max = 74.55 ft-lbs @ 88.68 msec  
Min = -34.43 ft-lbs @ 180.83 msec



ft-lbs  
B-40

8102-2

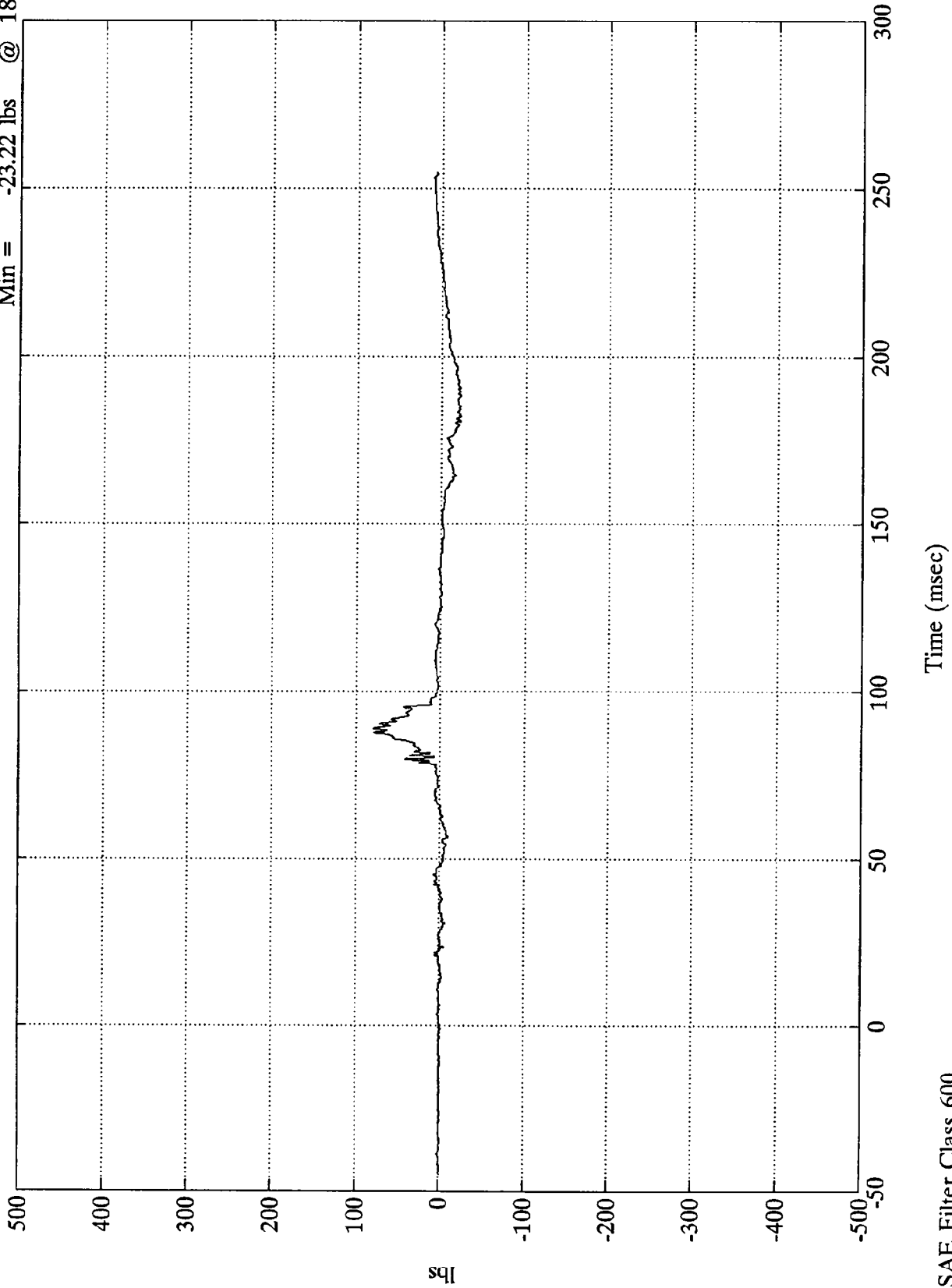
SAE Filter Class 600

Time (msec)

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Lt Lower Tibia Fy

Max = 79.55 lbs @ 88.68 msec  
Min = -23.22 lbs @ 188.39 msec



sq|  
B-41

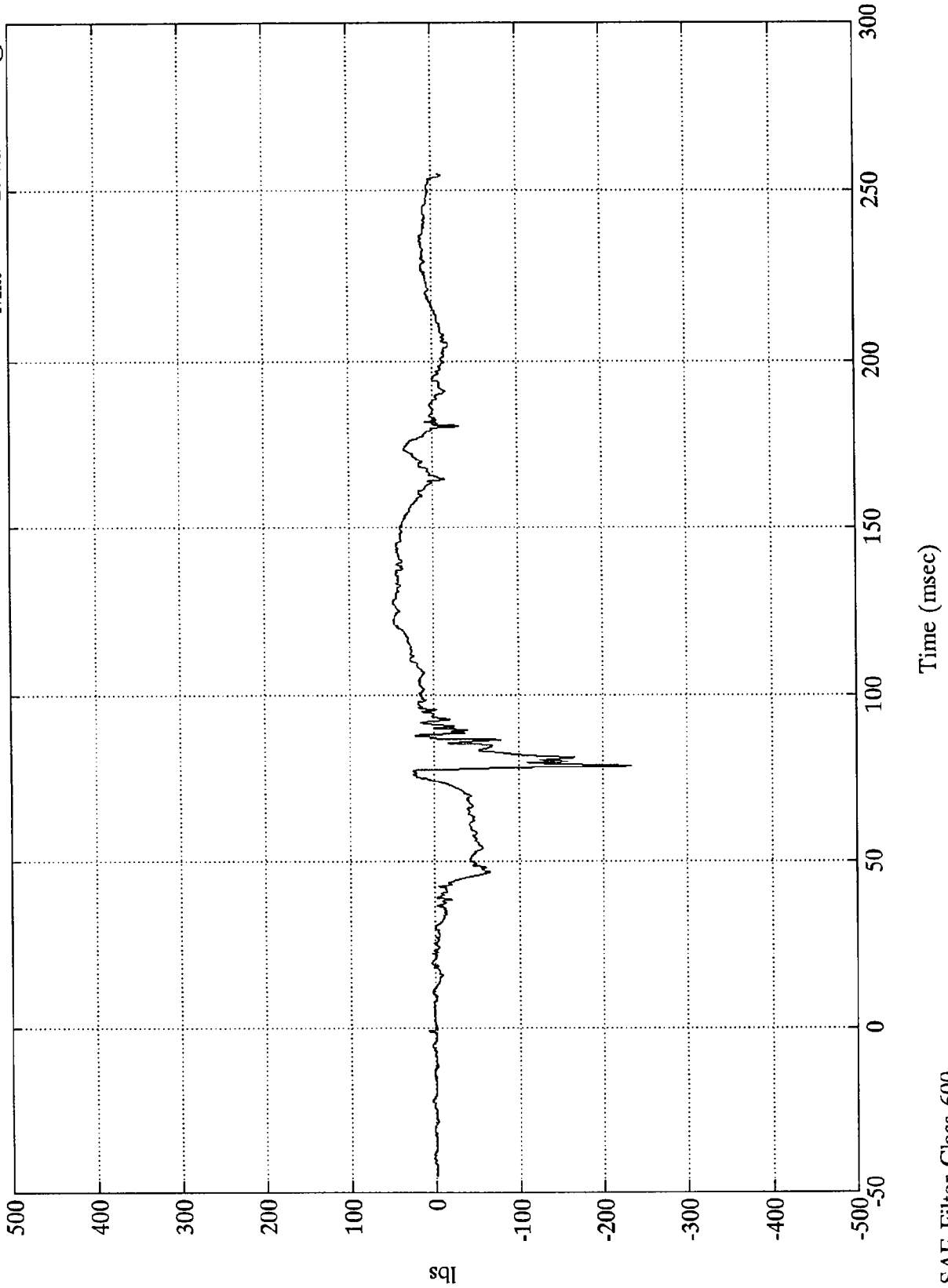
8102-2

SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Lt Lower Tibia Fz

Max = 48.38 lbs @ 127.44 msec  
Min = -234.11 lbs @ 78.60 msec



sqi  
B-42

8102-2

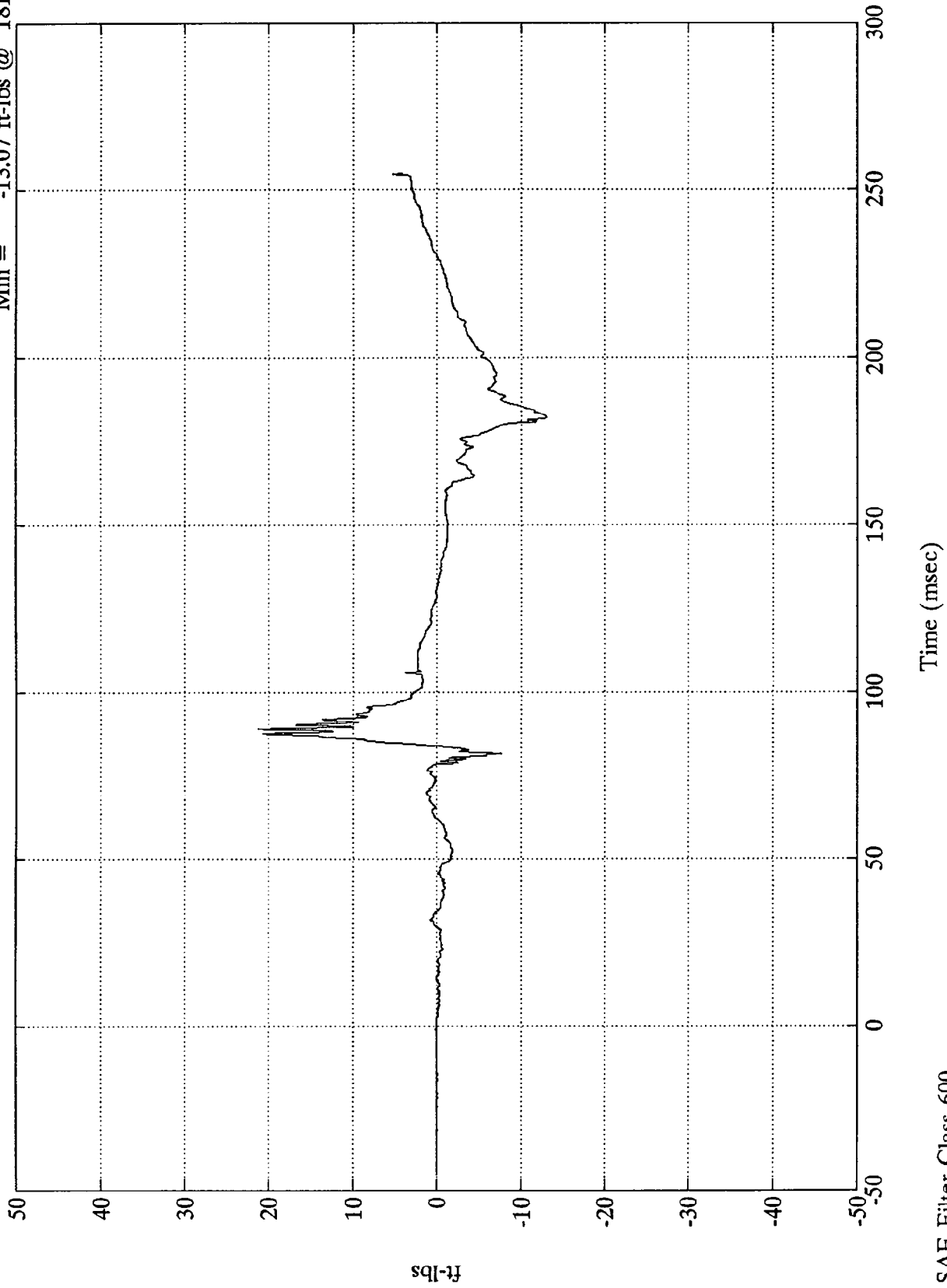
SAE Filter Class 600

Time (msec)

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Lt Lower Tibia Mx

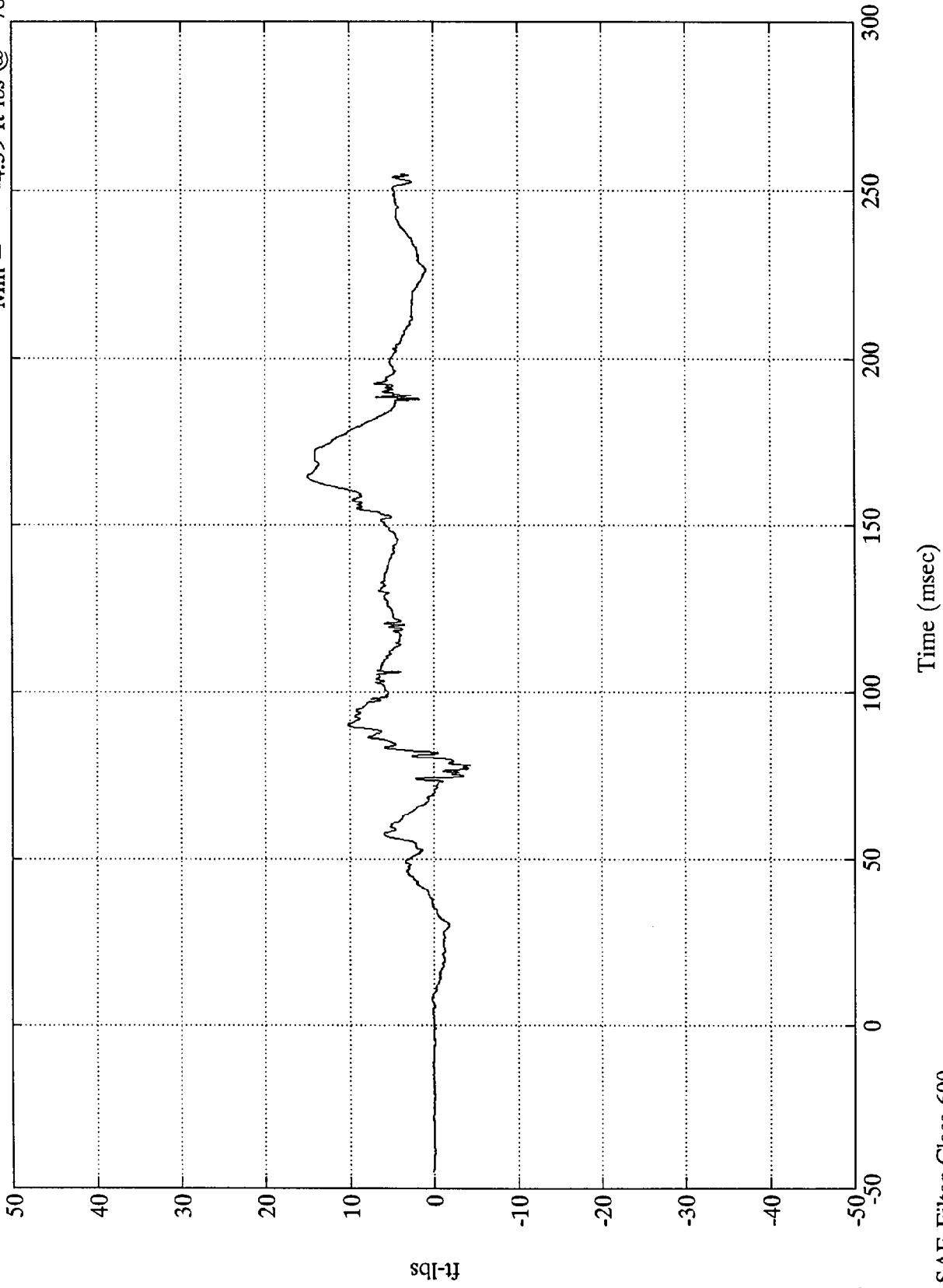
Max = 21.30 ft-lbs @ 88.80 msec  
Min = -13.07 ft-lbs @ 181.80 msec



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Rt Upper Tibia Mx

Max = 14.97 ft-lbs @ 164.64 msec  
Min = -4.39 ft-lbs @ 78.12 msec



sqj-tj  
B-44

8102-2

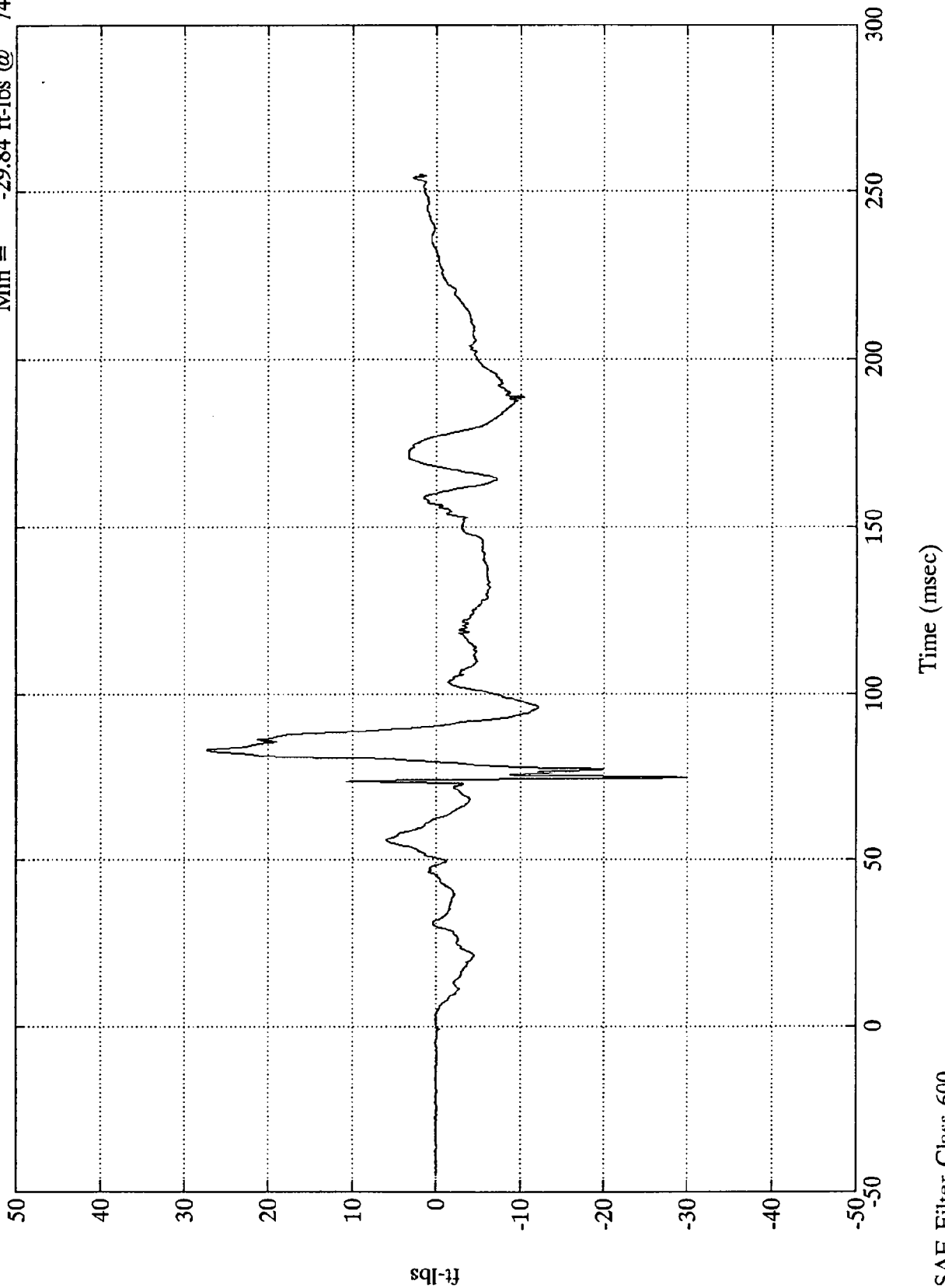
SAE Filter Class 600



TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Rt Upper Tibia My

Max = 27.35 ft-lbs @ 83.04 msec  
Min = -29.84 ft-lbs @ 74.76 msec



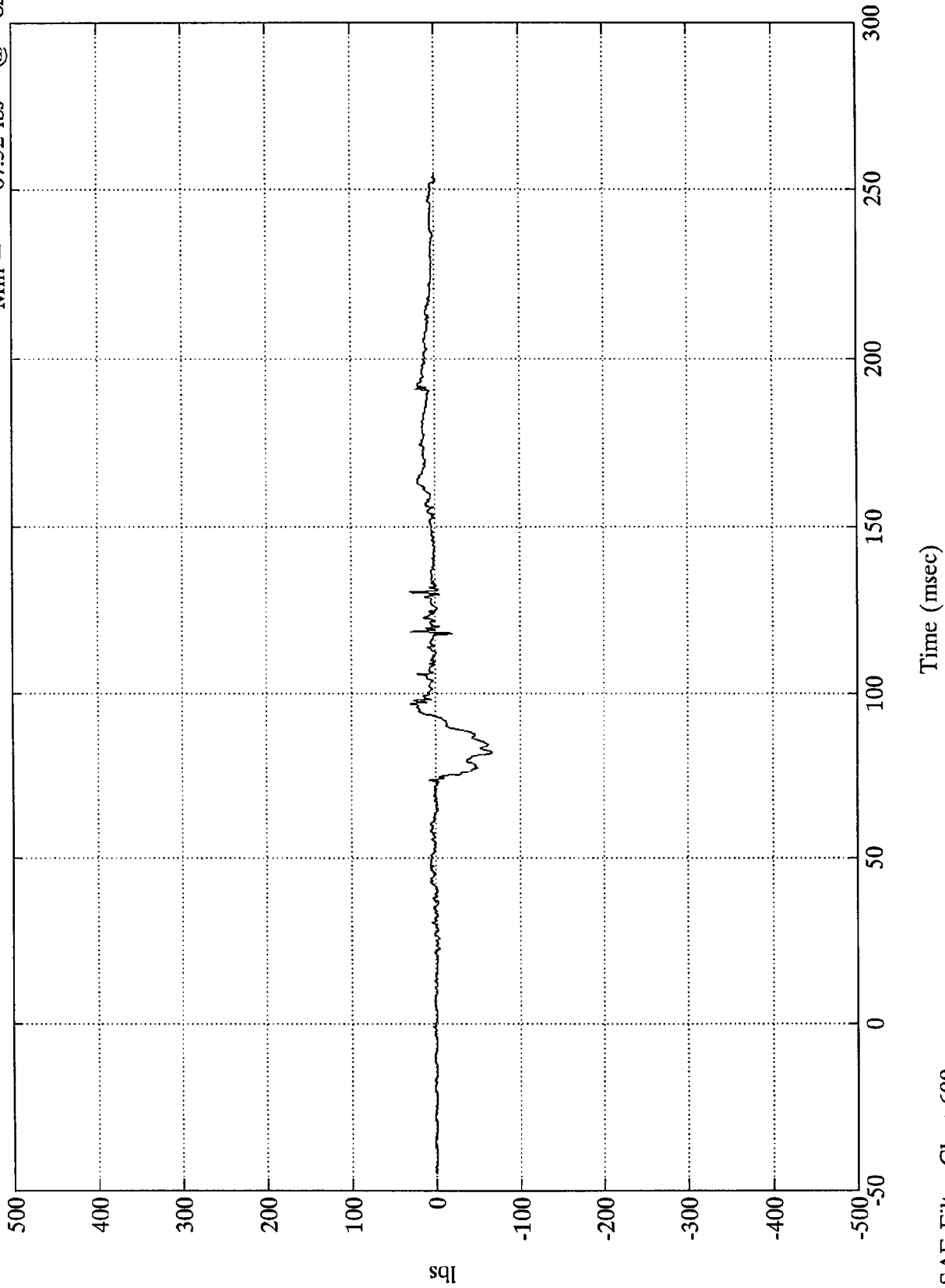
B-45

8102-2

SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

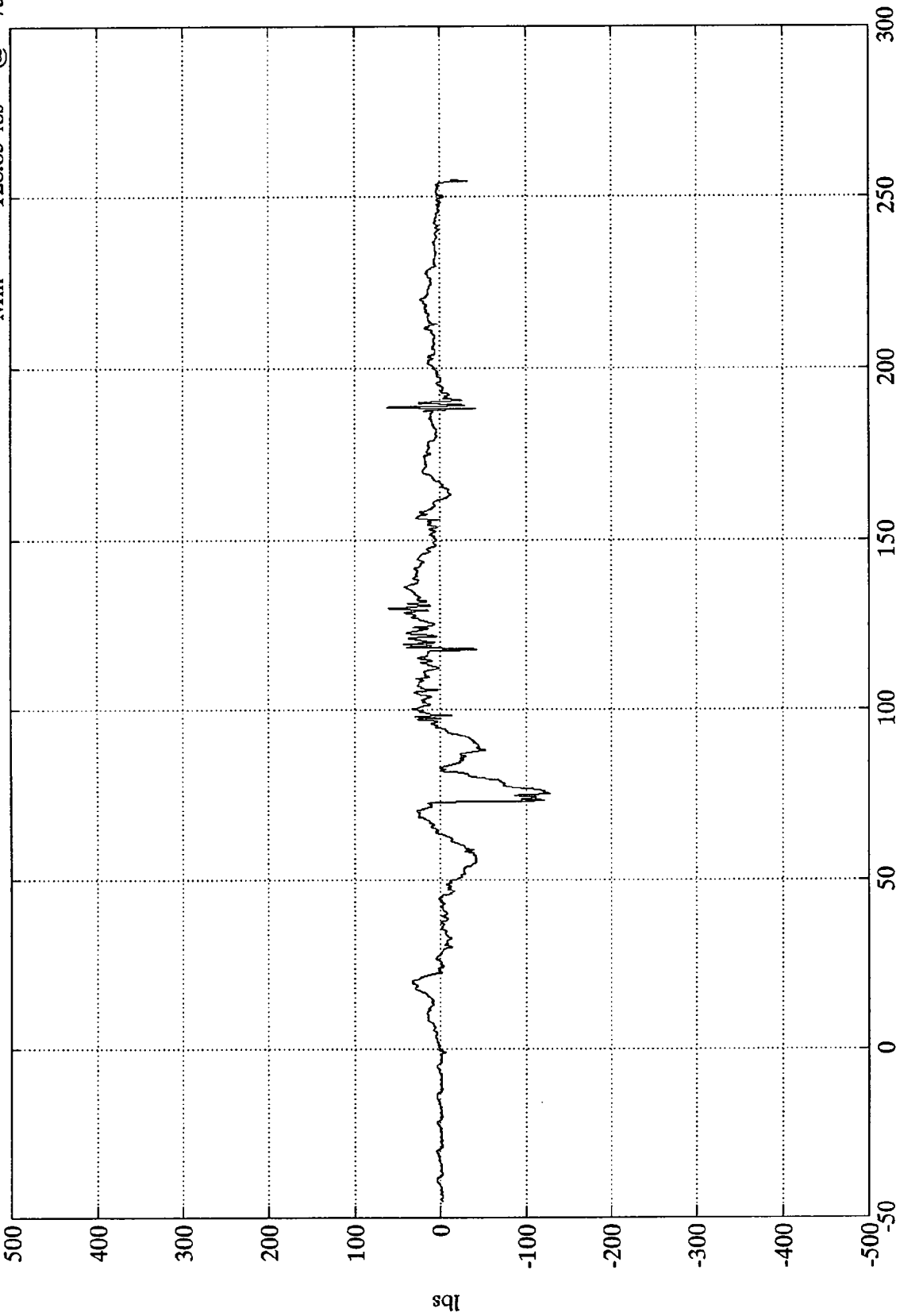
Pos. 1 Rt Lower Tibia Fy  
Max = 30.34 lbs @ 130.08 msec  
Min = -67.52 lbs @ 82.19 msec



TSC 301 TEST 2 - REAR IMPACT

Max = 61.51 lbs @ 188.63 msec  
Min = -128.85 lbs @ 75.23 msec

Pos. 1 Rt Lower Tibia Fz



sq1  
B-47

8102-2

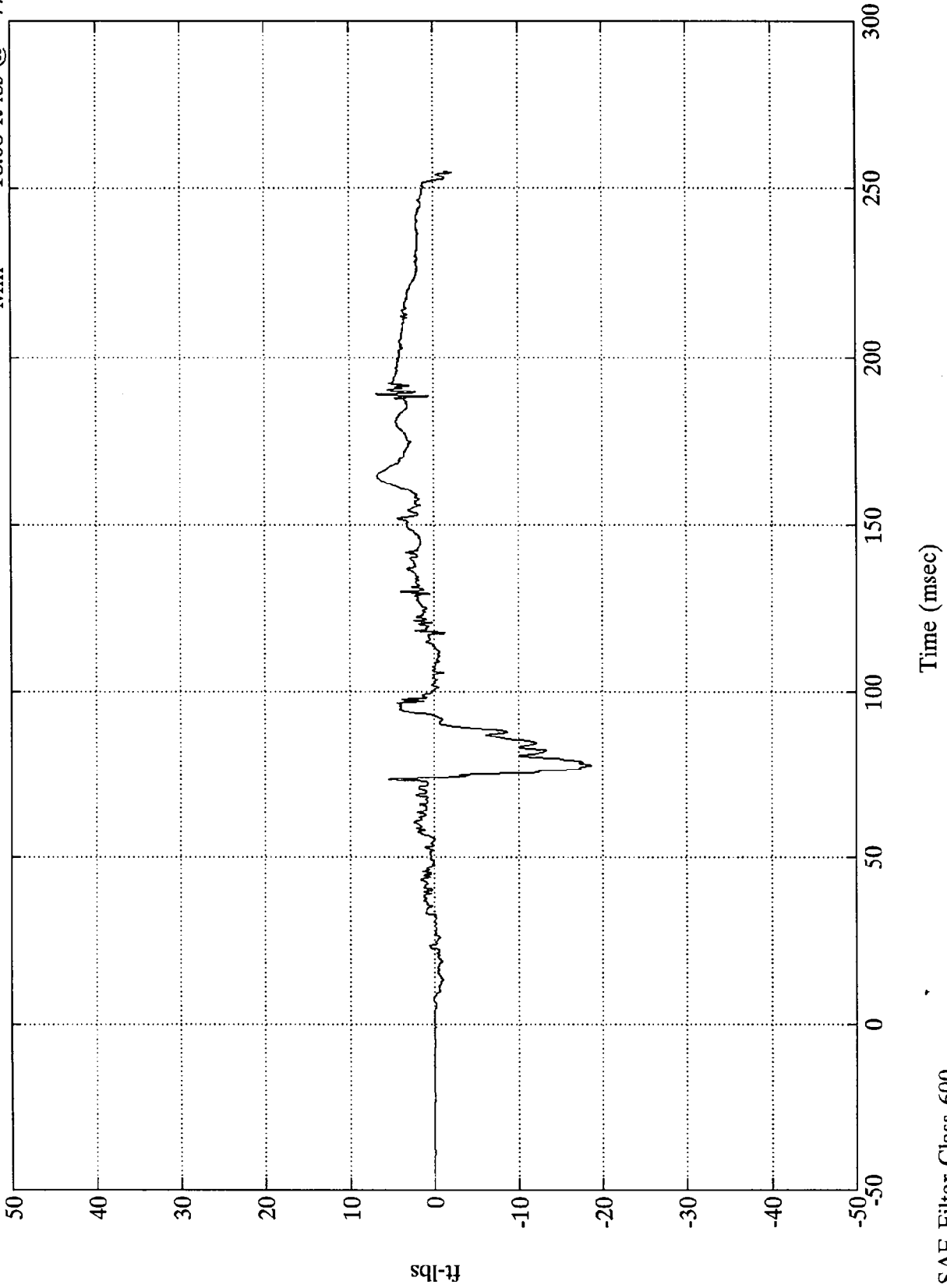
SAE Filter Class 600

Time (msec)

TSC 301 TEST 2 - REAR IMPACT

Pos. 1 Rt Lower Tibia Mx

Max = 6.88 ft-lbs @ 188.76 msec  
Min = -18.68 ft-lbs @ 77.64 msec



B-48

8102-2

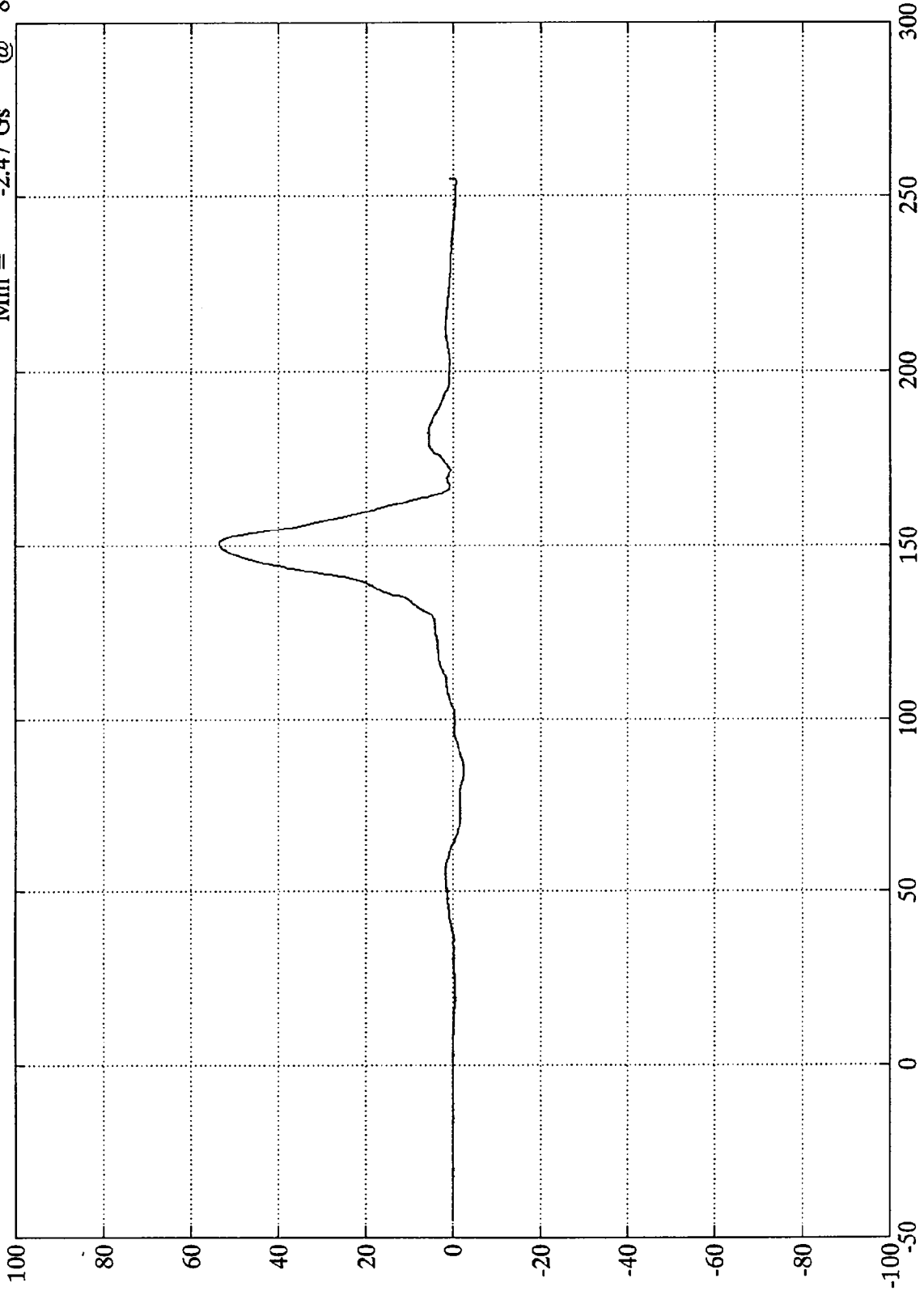
SAE Filter Class 600



TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Head X

Max = 53.49 Gs @ 151.08 msec  
Min = -2.47 Gs @ 85.56 msec



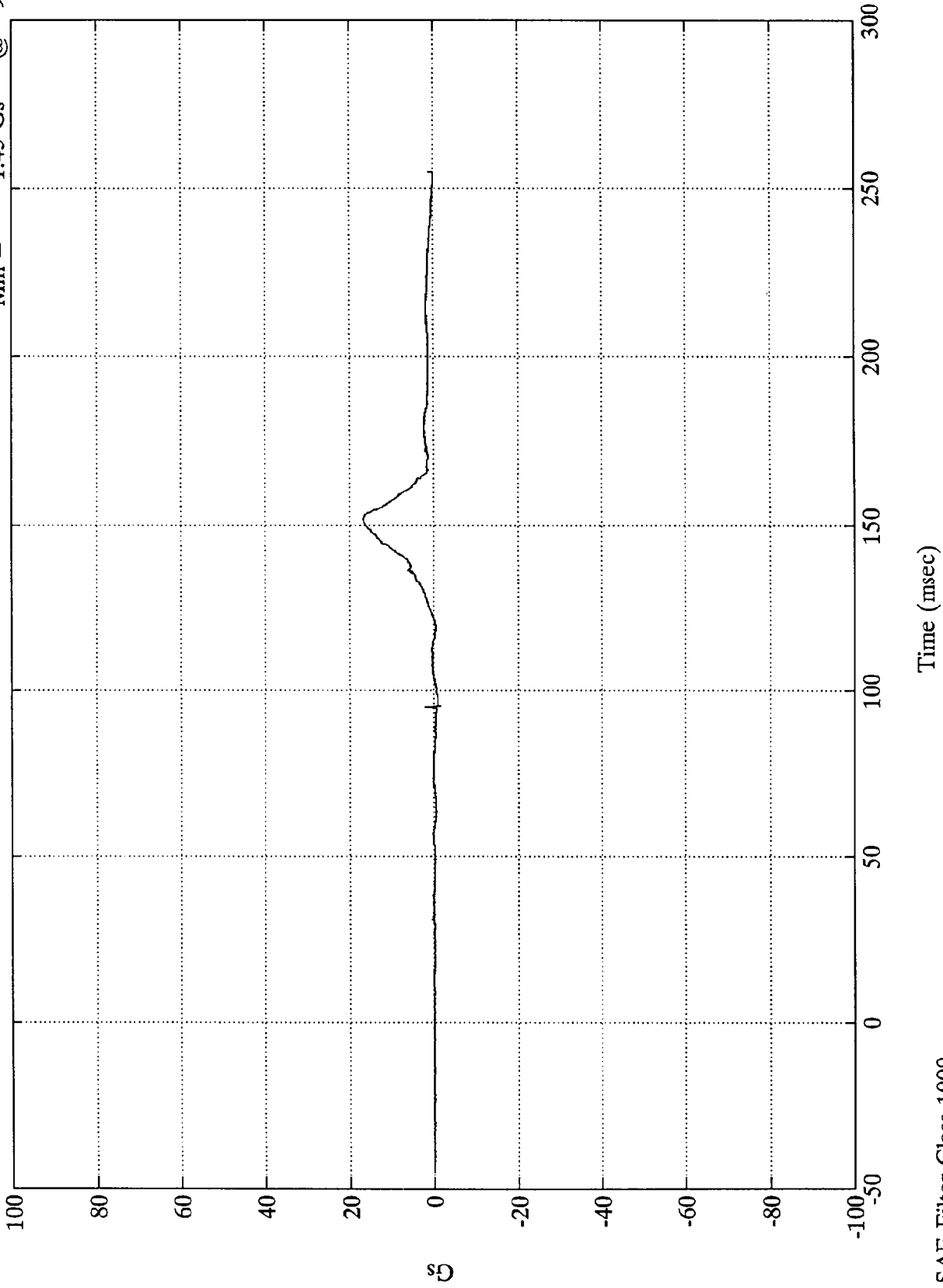
Time (msec)

SAE Filter Class 1000

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Head Y

Max = 16.75 Gs @ 152.04 msec  
Min = -1.45 Gs @ 95.16 msec



B-50

8102-2

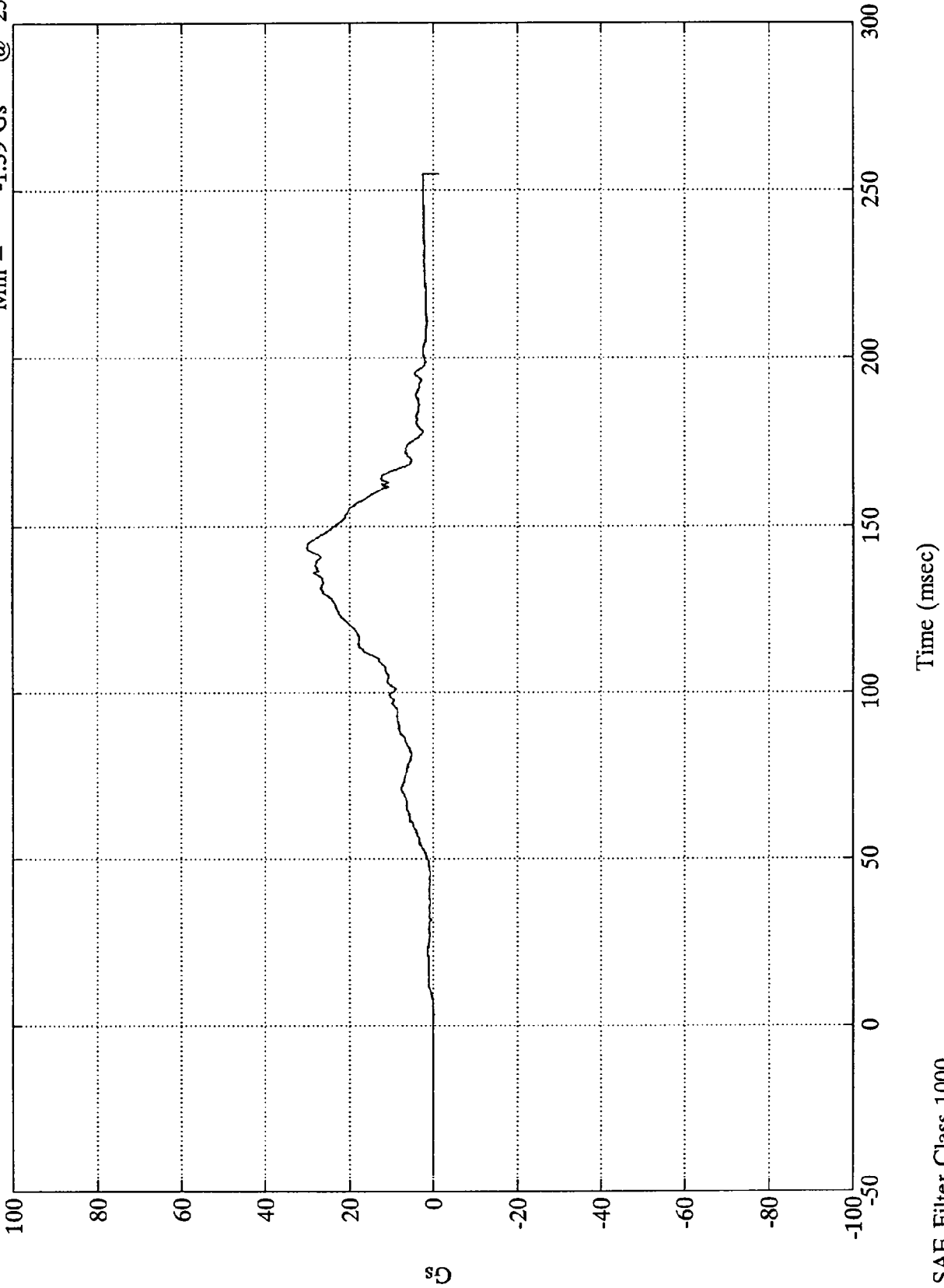
SAE Filter Class 1000



TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Head Z

Max = 30.21 Gs @ 143.76 msec  
Min = -1.39 Gs @ 254.88 msec



B-51

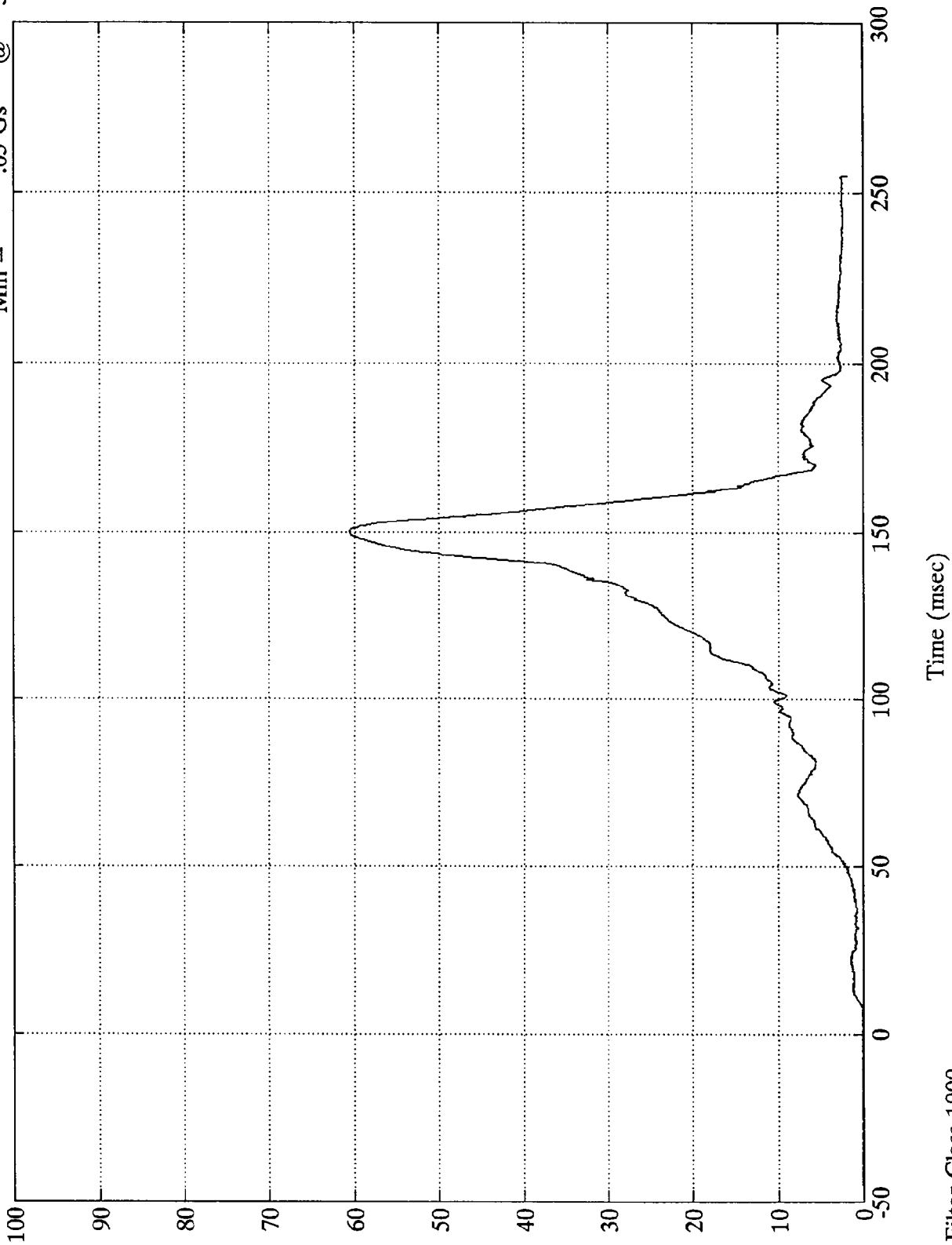
8102-2

SAE Filter Class 1000

TSC 301 TEST 2 - REAR IMPACT

Max = 60.61 Gs @ 150.36 msec  
Min = .03 Gs @ 5.27 msec

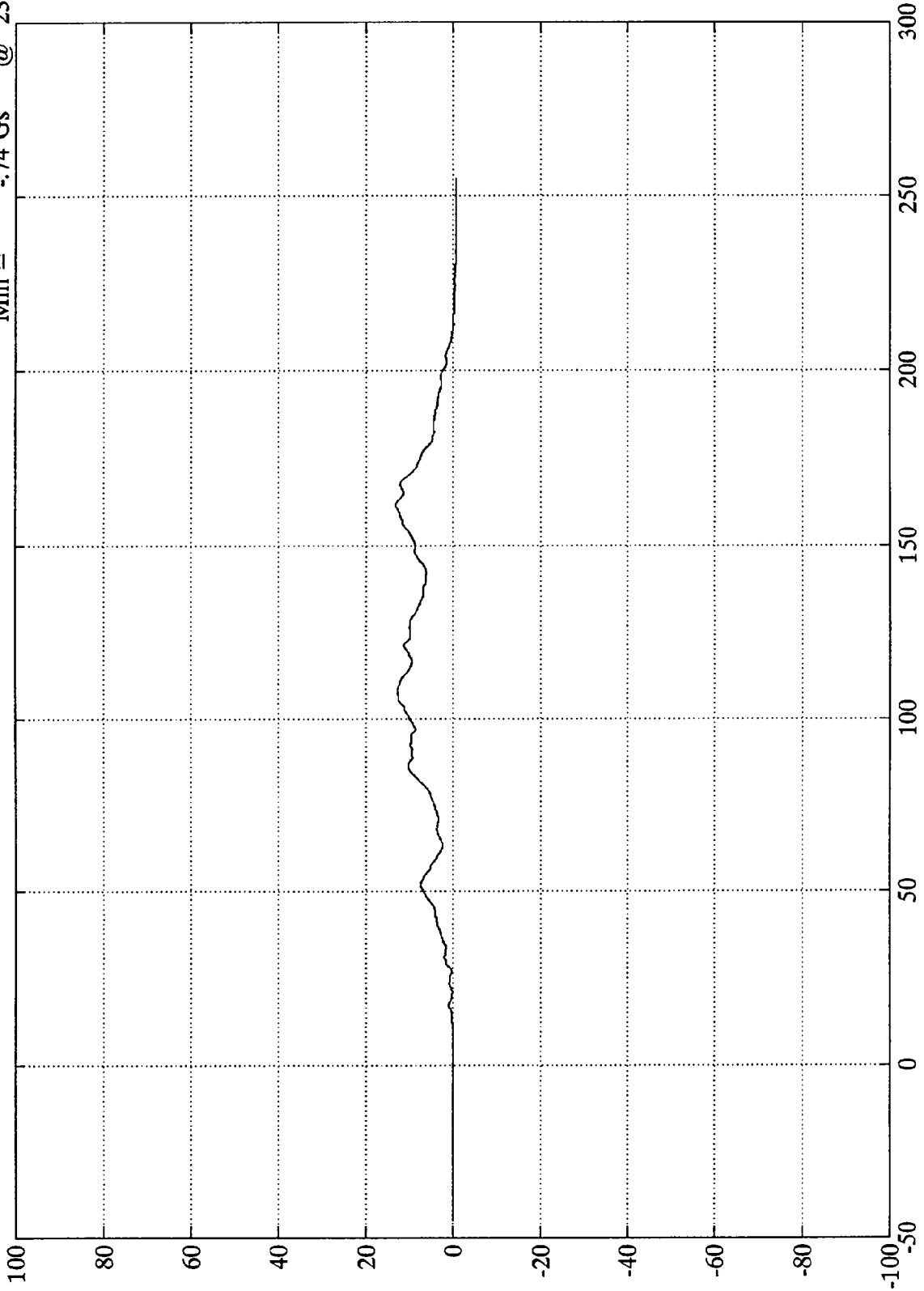
Pos. 2 Head Resultant



TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Chest X

Max = 13.23 Gs @ 161.88 msec  
Min = -7.74 Gs @ 236.52 msec



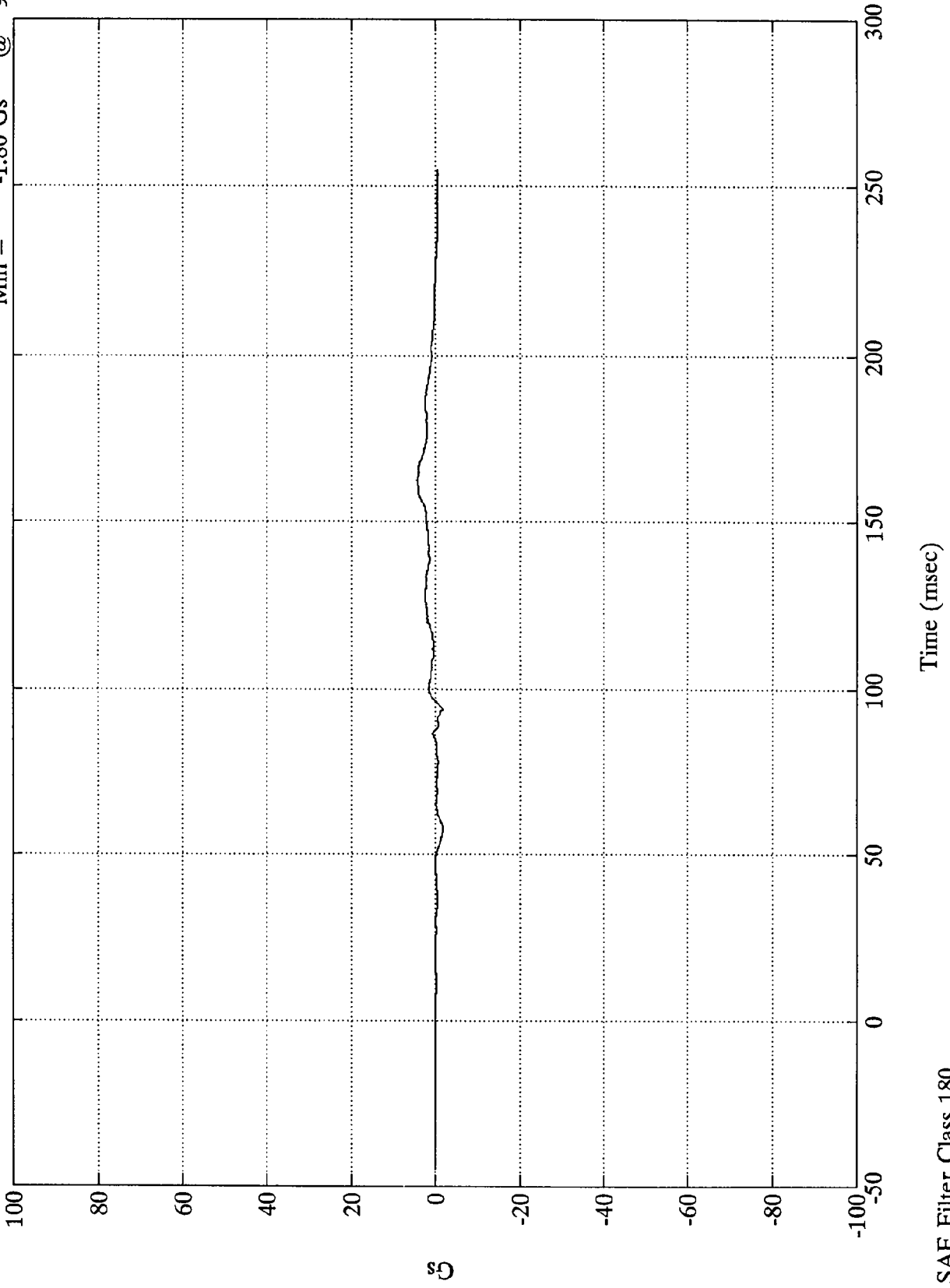
Time (msec)

SAE Filter Class 180

TSC 301 TEST 2 - REAR IMPACT

Max = 4.39 Gs @ 162.48 msec  
Min = -1.80 Gs @ 93.84 msec

Pos. 2 Chest Y



B-54

8102-2

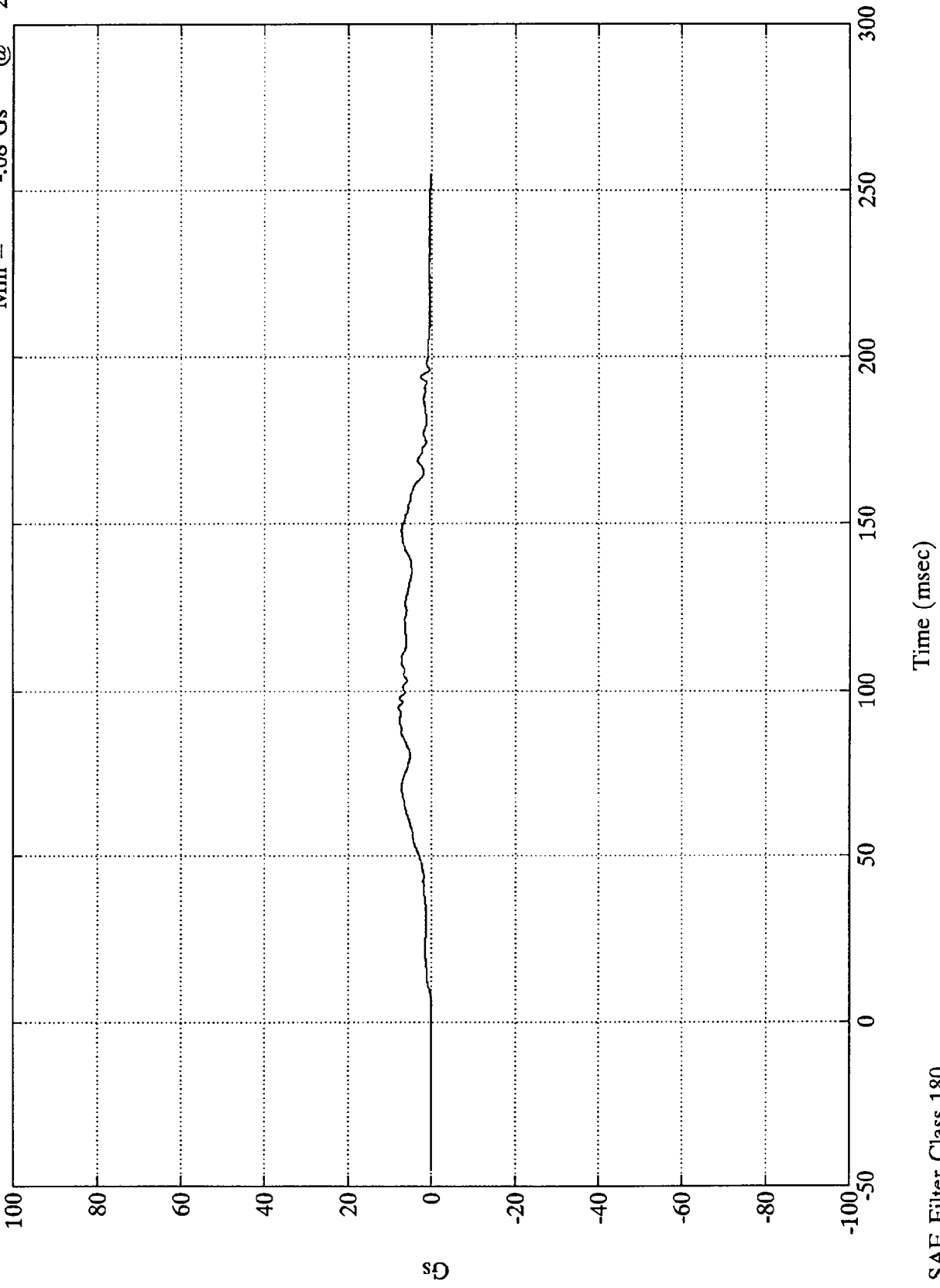
SAE Filter Class 180

Time (msec)

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Chest Z

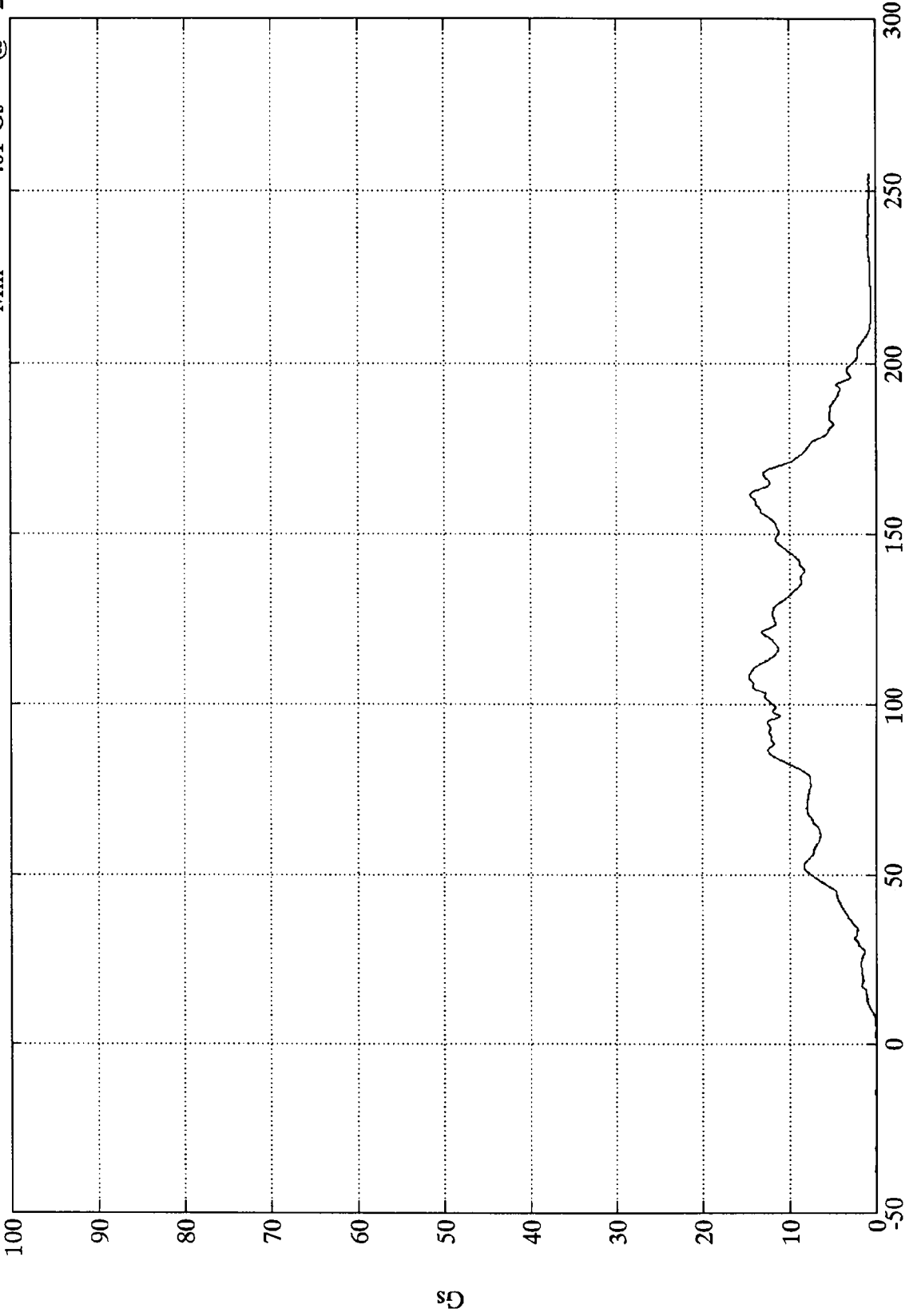
Max = 8.01 Gs @ 94.80 msec  
Min = -0.08 Gs @ 2.51 msec



TSC 301 TEST 2 - REAR IMPACT

Max = 14.70 Gs @ 108.23 msec  
Min = .01 Gs @ -23.16 msec

Pos. 2 Chest Resultant



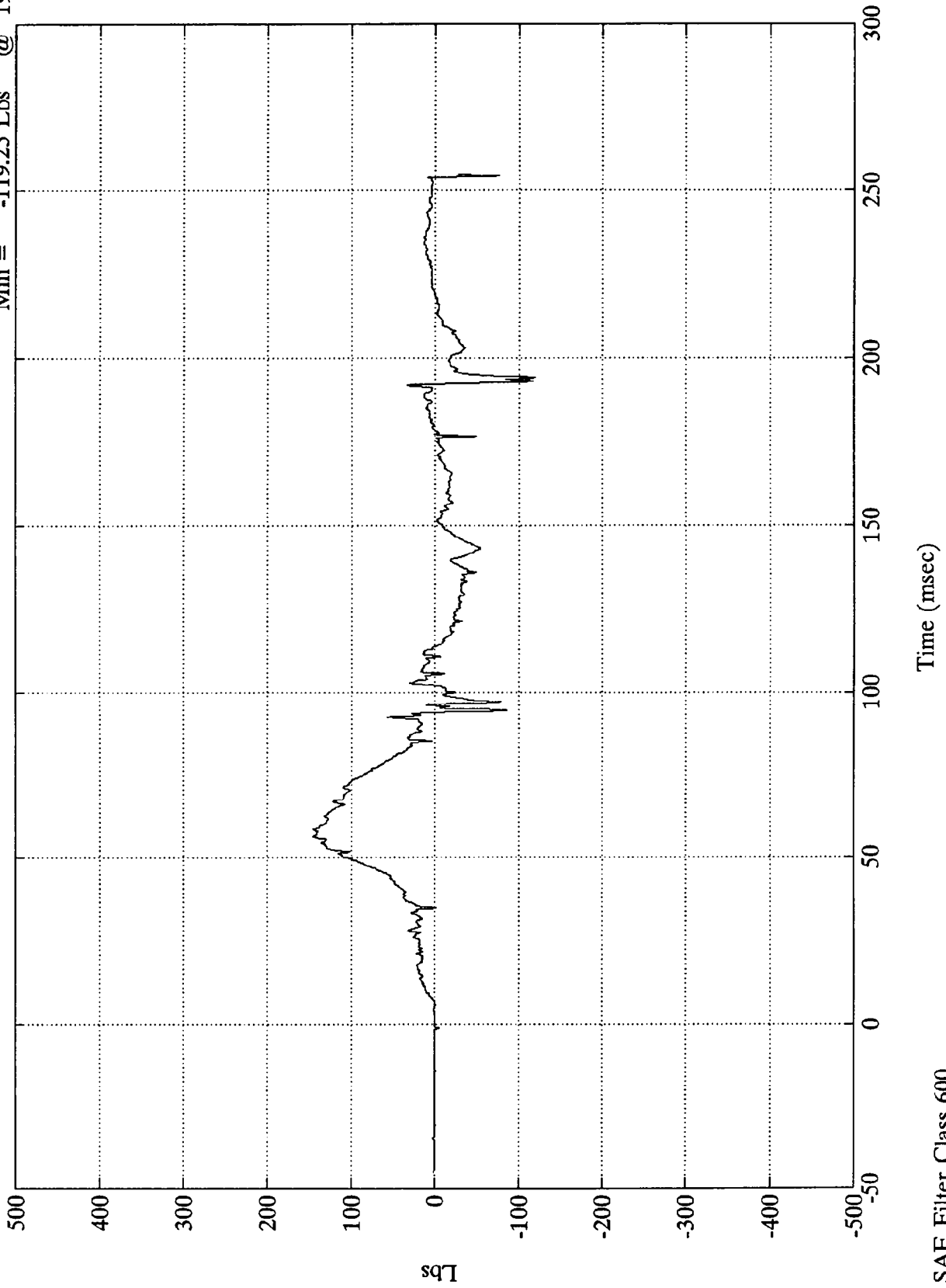
Time (msec)

SAE Filter Class 180

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Left Femur

Max = 145.09 Lbs @ 58.43 msec  
Min = -119.25 Lbs @ 194.16 msec



B-57

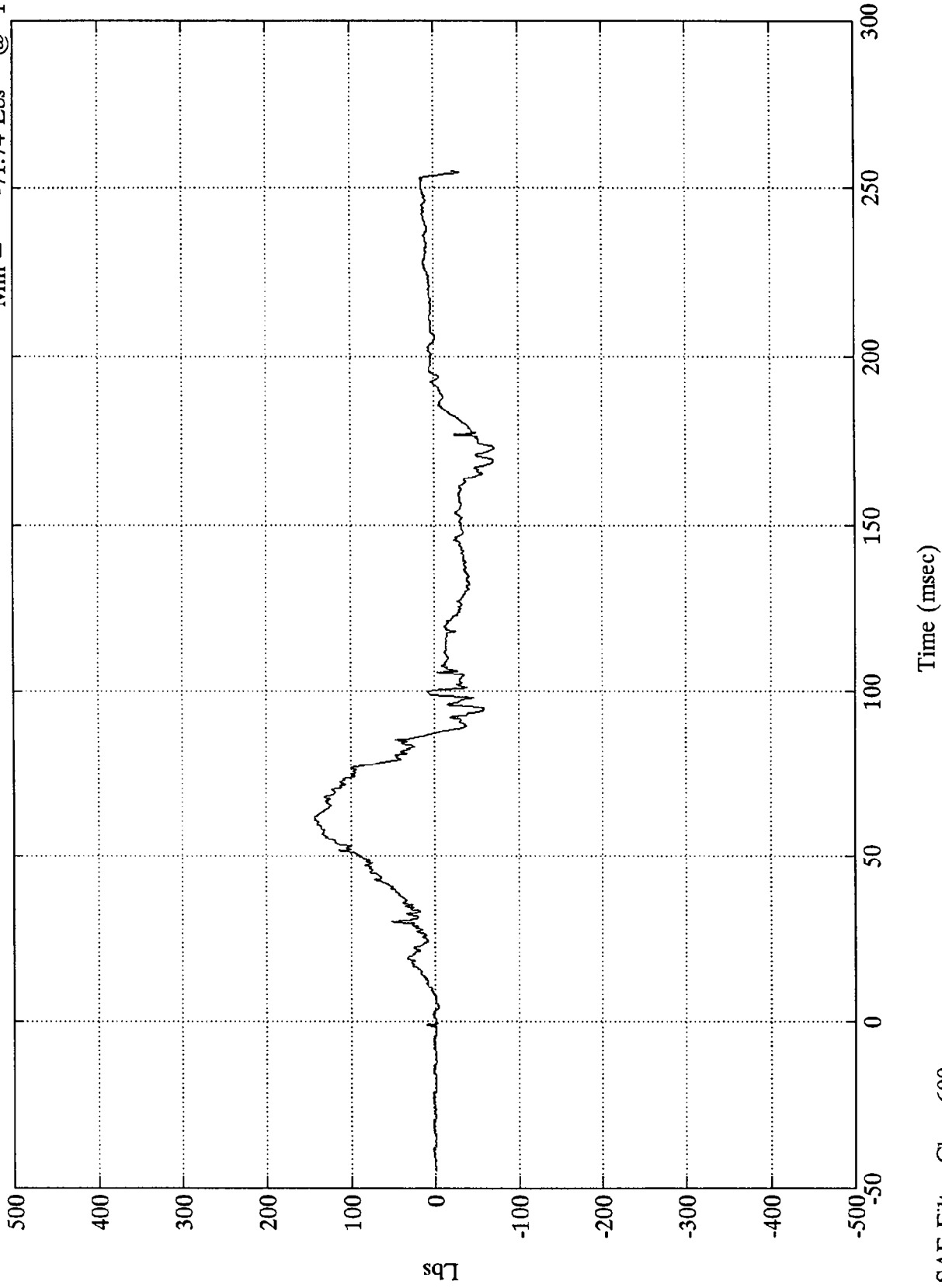
8102-2

SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Right Femur

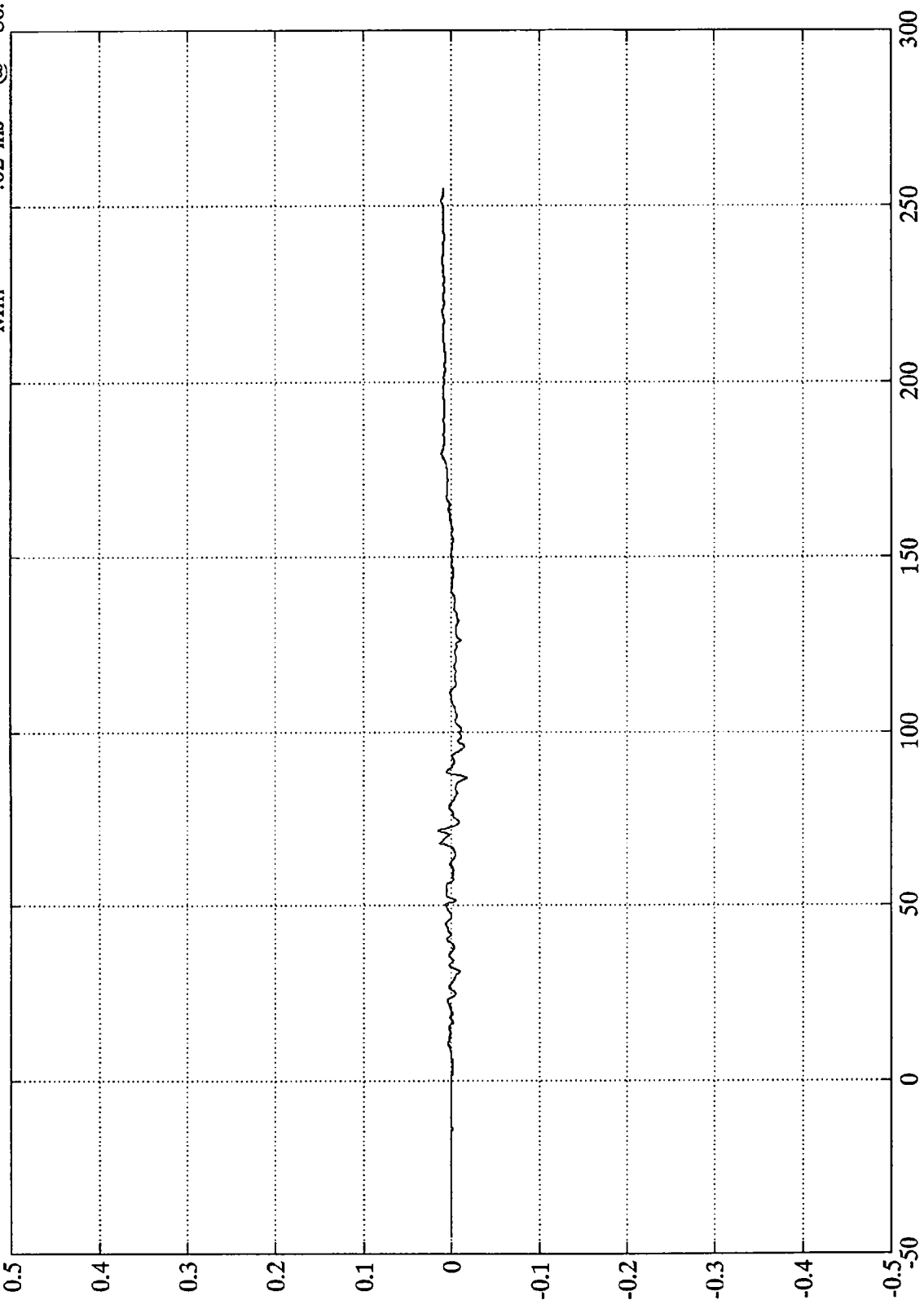
Max = 143.56 Lbs @ 61.56 msec  
Min = -71.74 Lbs @ 172.68 msec



TSC 301 TEST 2 - REAR IMPACT

Max = .02 ins @ 71.52 msec  
Min = -.02 ins @ 86.76 msec

Pos. 2 Chest Deflection



in  
B-59

8102-2

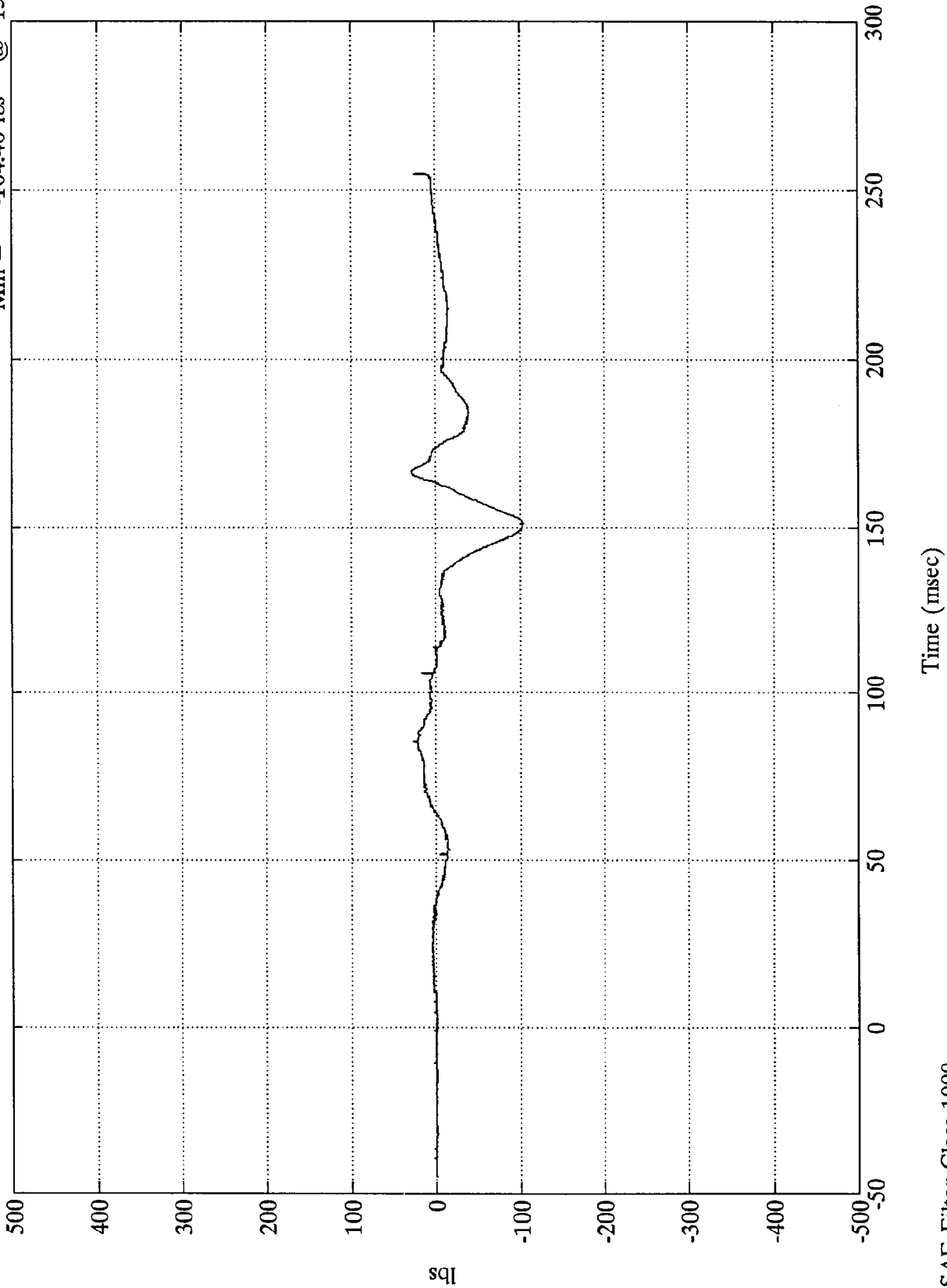
SAE Filter Class 180

Time (msec)

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Upper Neck Fx

Max = 28.07 lbs @ 167.16 msec  
Min = -104.46 lbs @ 151.20 msec



B-60

8102-2

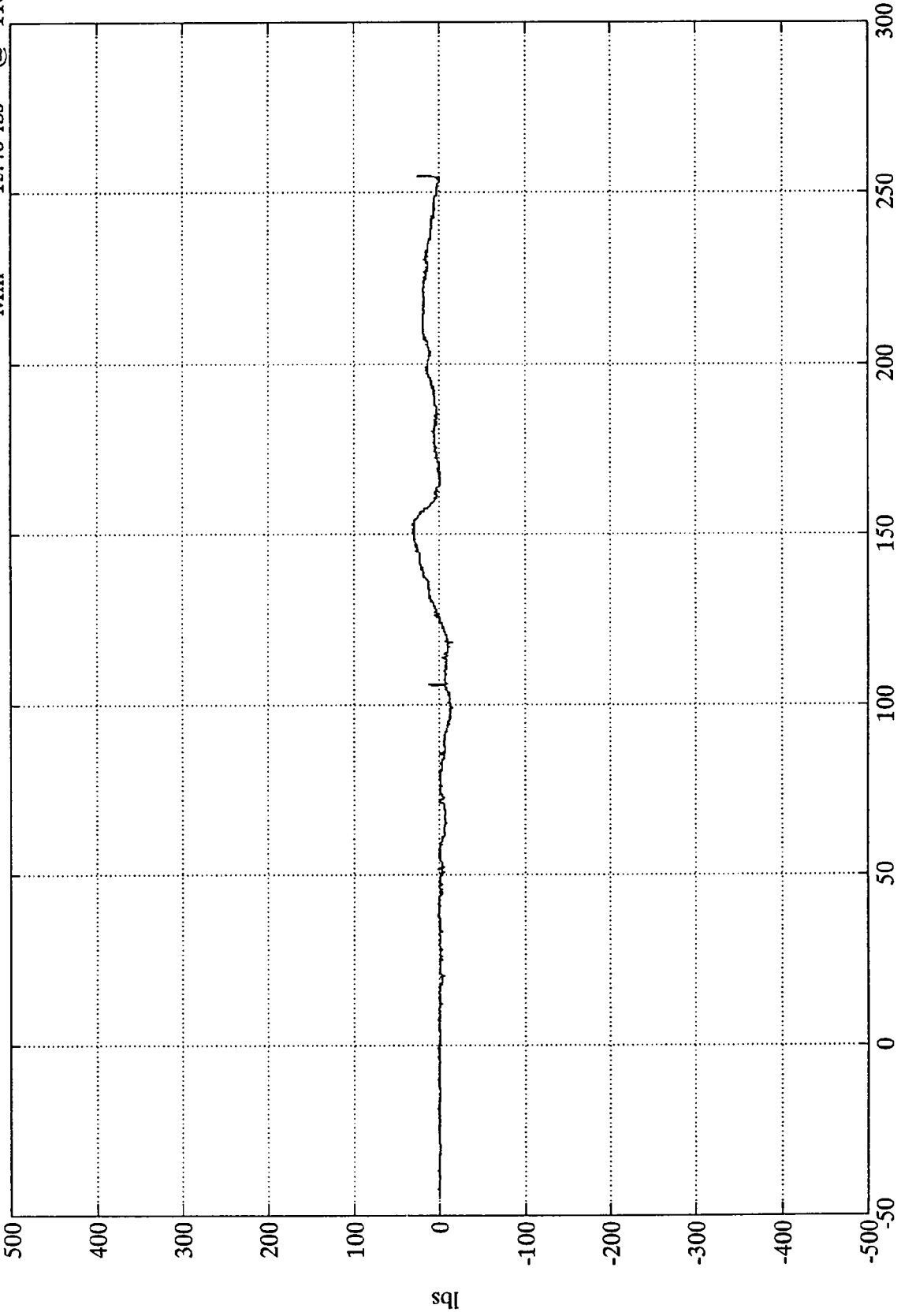
SAE Filter Class 1000



TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Upper Neck Fy

Max = 31.47 lbs @ 153.48 msec  
Min = -15.40 lbs @ 118.20 msec



sqi  
B-61

8102-2

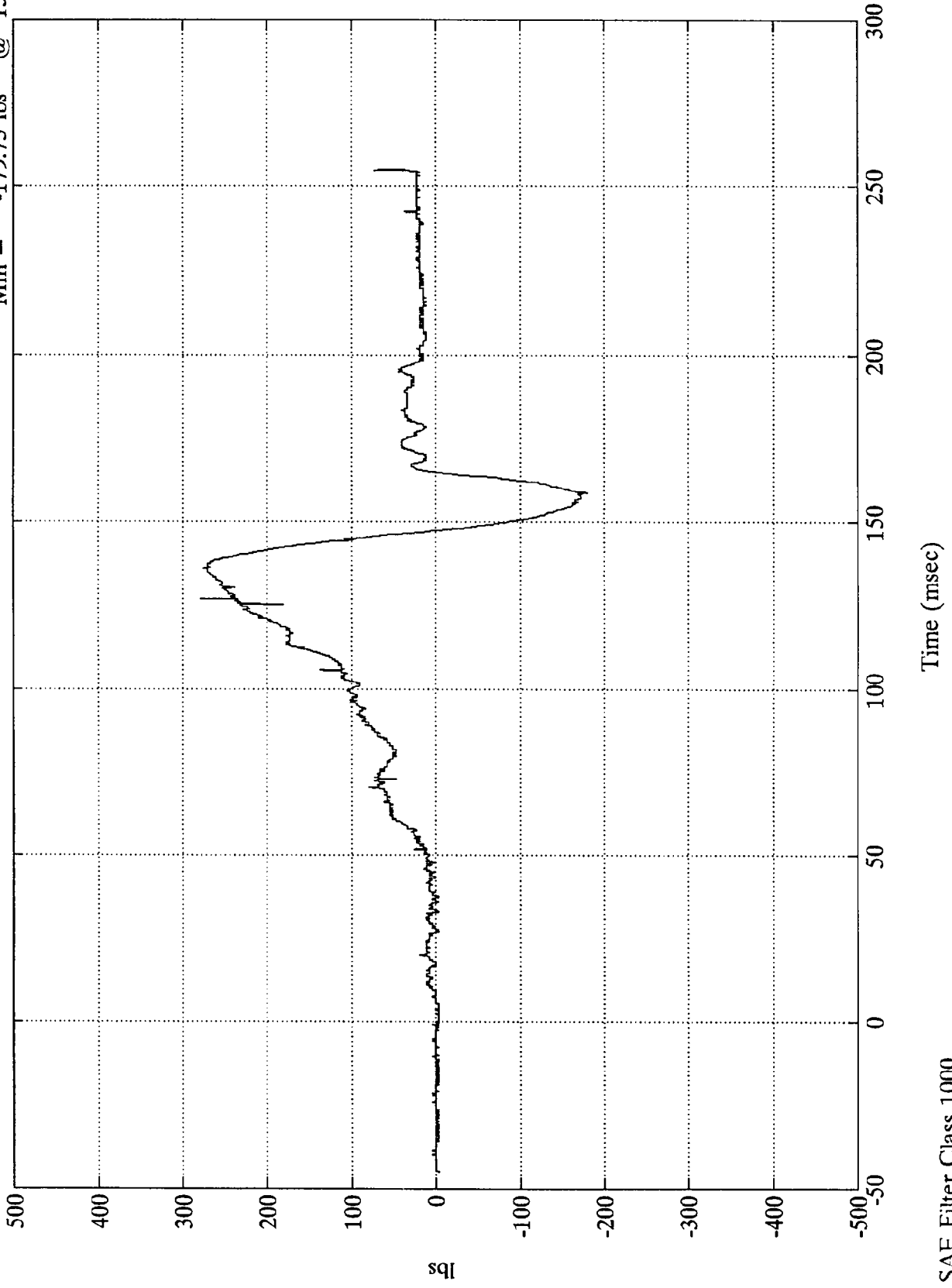
SAE Filter Class 1000

Time (msec)

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Upper Neck Fz

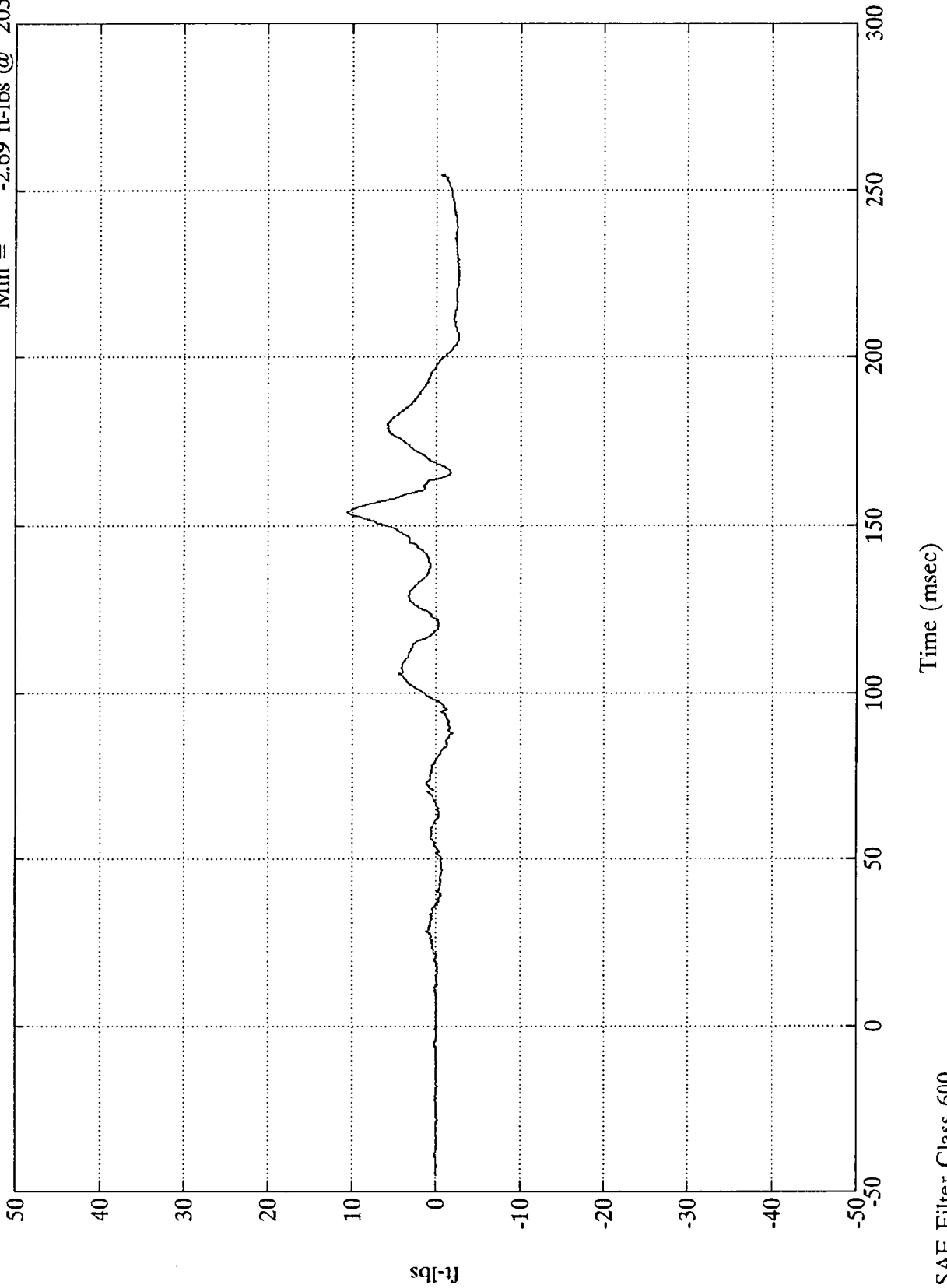
Max = 278.48 lbs @ 127.08 msec  
Min = -179.73 lbs @ 158.88 msec



TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Upper Neck Mx

Max = 10.68 ft-lbs @ 154.19 msec  
Min = -2.69 ft-lbs @ 205.80 msec



sq[-1]

B-63

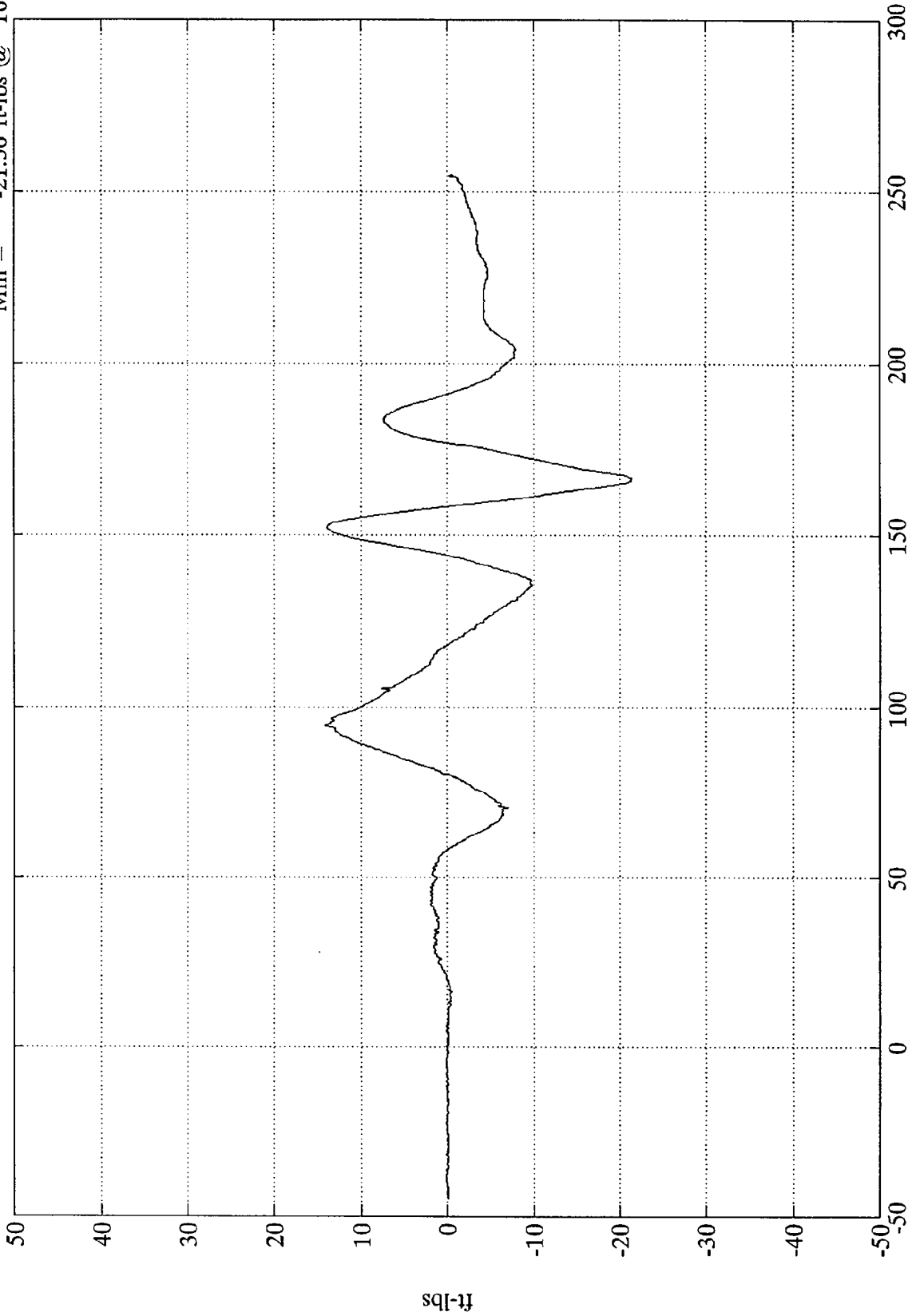
8102-2

SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Upper Neck My

Max = 14.15 ft-lbs @ 94.68 msec  
Min = -21.36 ft-lbs @ 166.80 msec



B-64

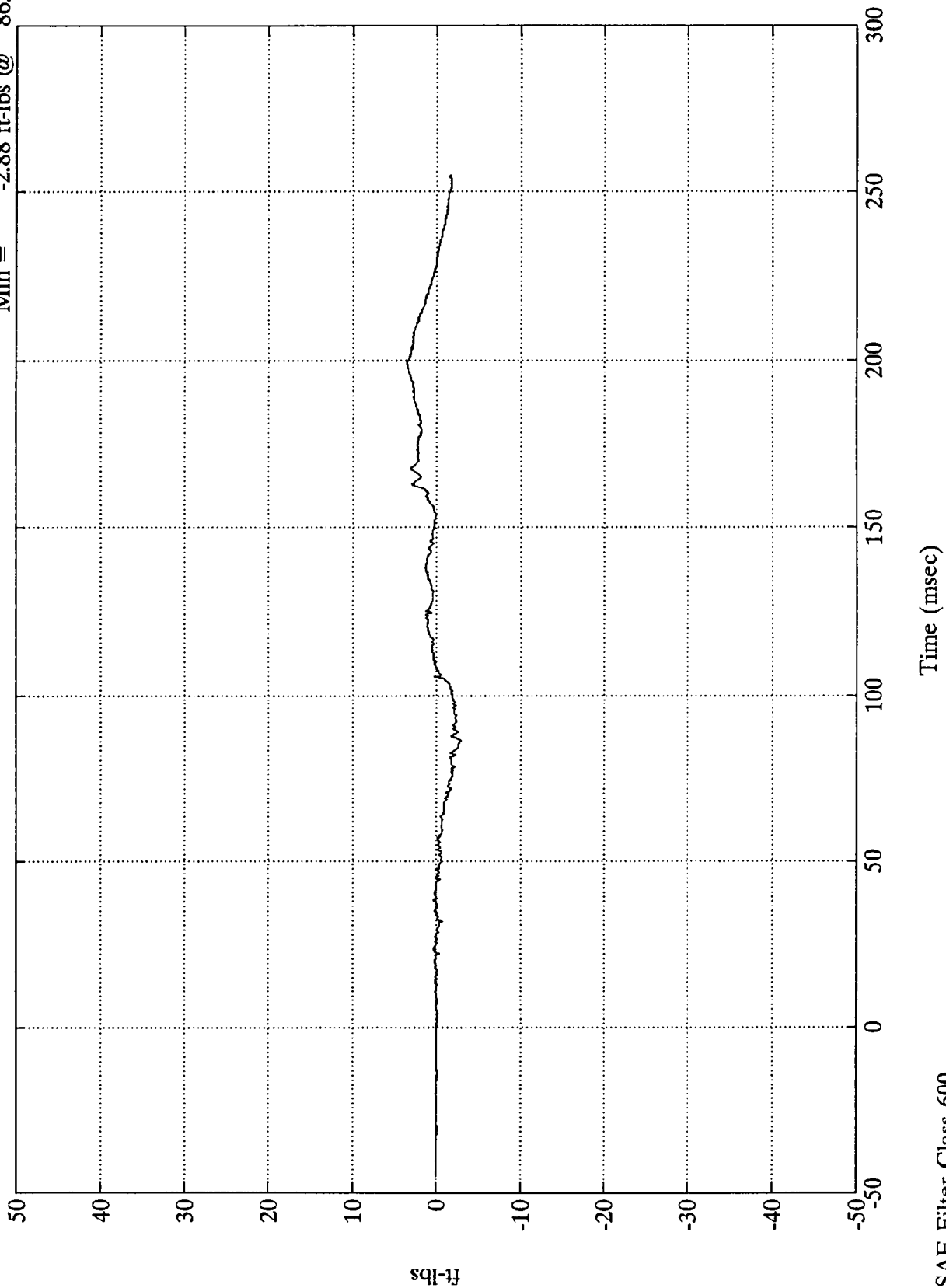
8102-2

SAF. Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Upper Neck Mz

Max = 3.59 ft-lbs @ 199.19 msec  
Min = -2.88 ft-lbs @ 86.28 msec



B-65

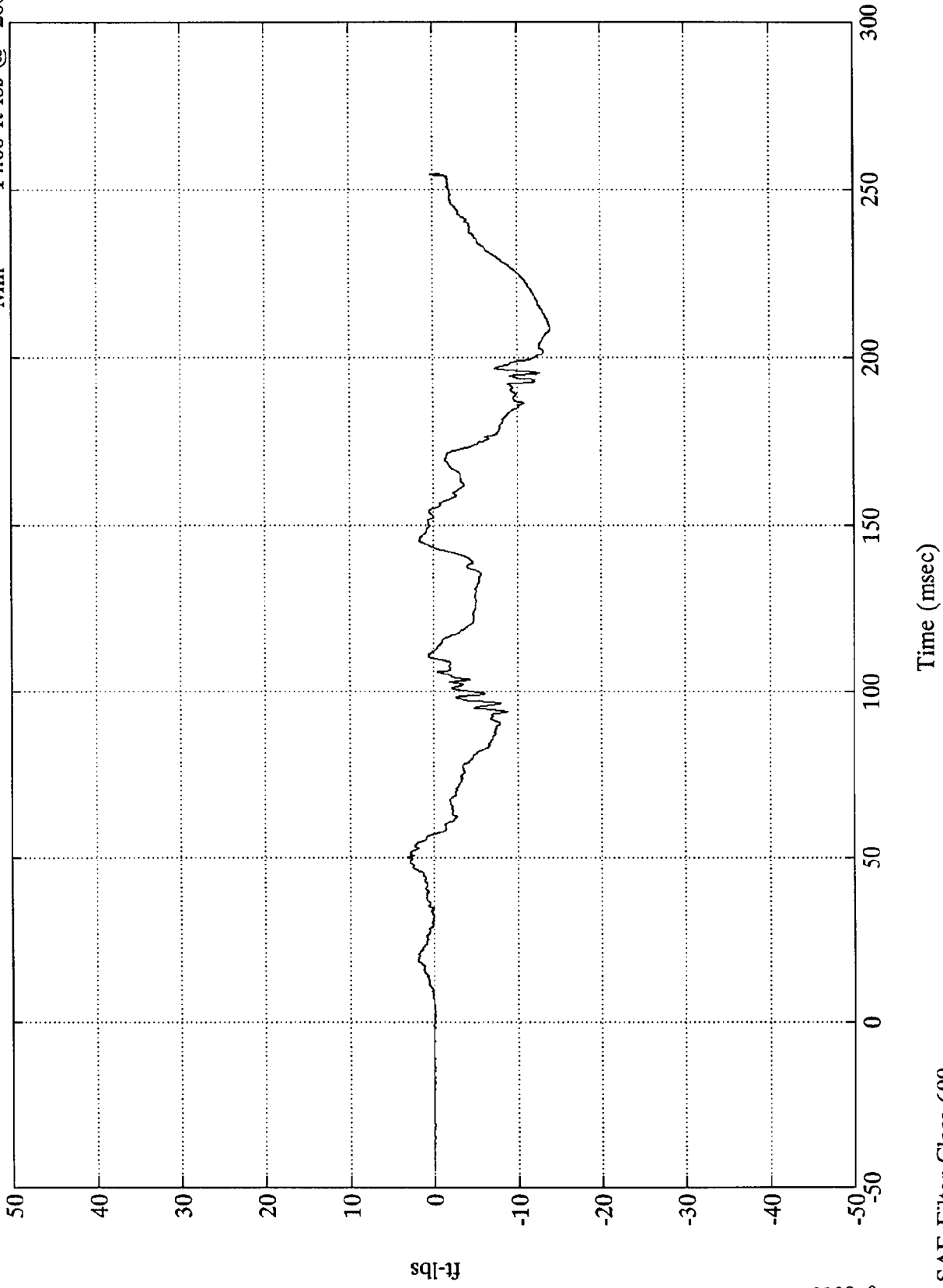
8102-2

SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Lt Upper Tibia Mx

Max = 3.12 ft-lbs @ 50.28 msec  
Min = -14.00 ft-lbs @ 208.32 msec



ft-lbs  
B-66

8102-2

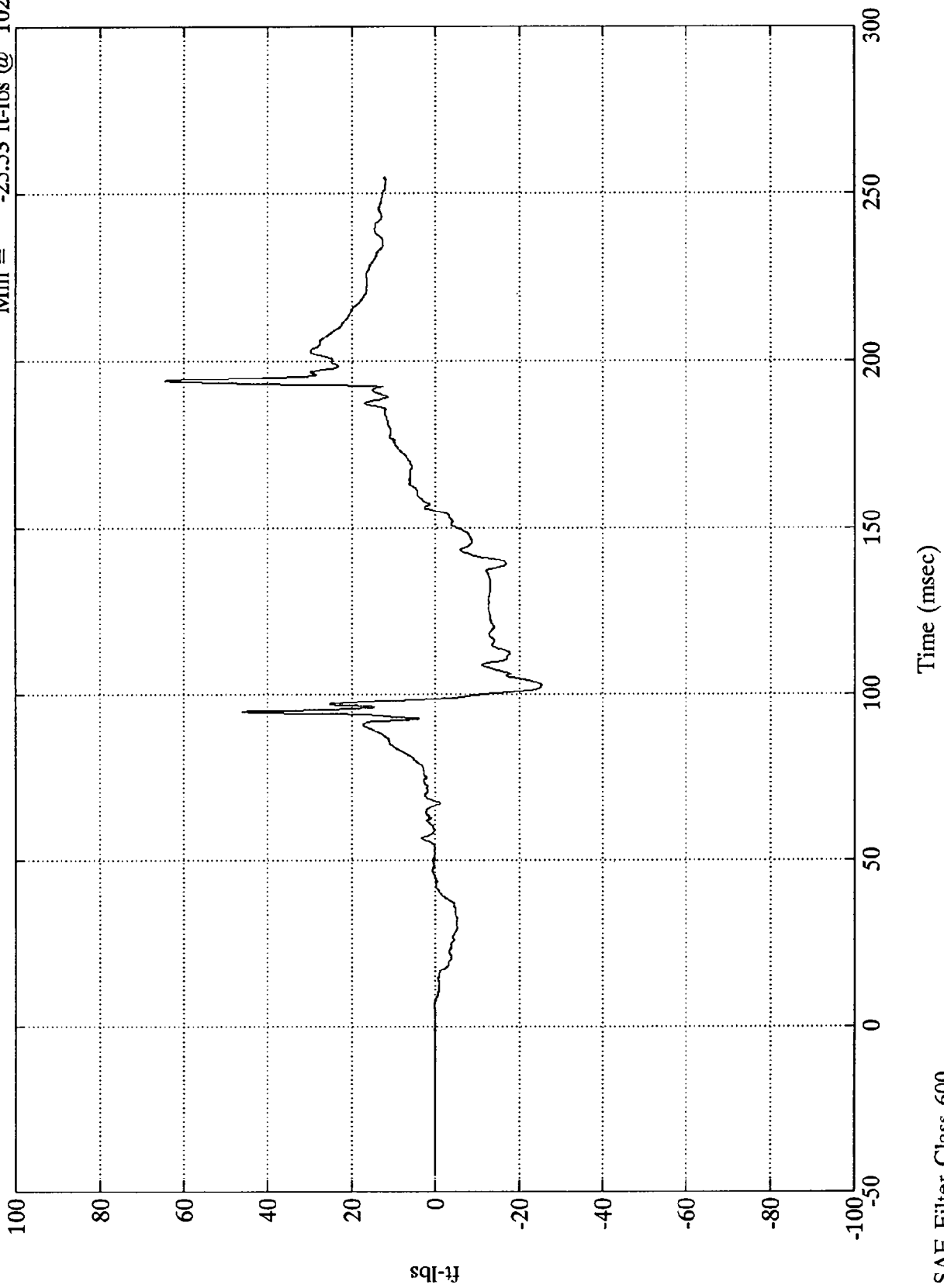
SAE Filter Class 600

Time (msec)

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Lt Upper Tibia My

Max = 64.50 ft-lbs @ 194.03 msec  
Min = -25.53 ft-lbs @ 102.72 msec



B-67

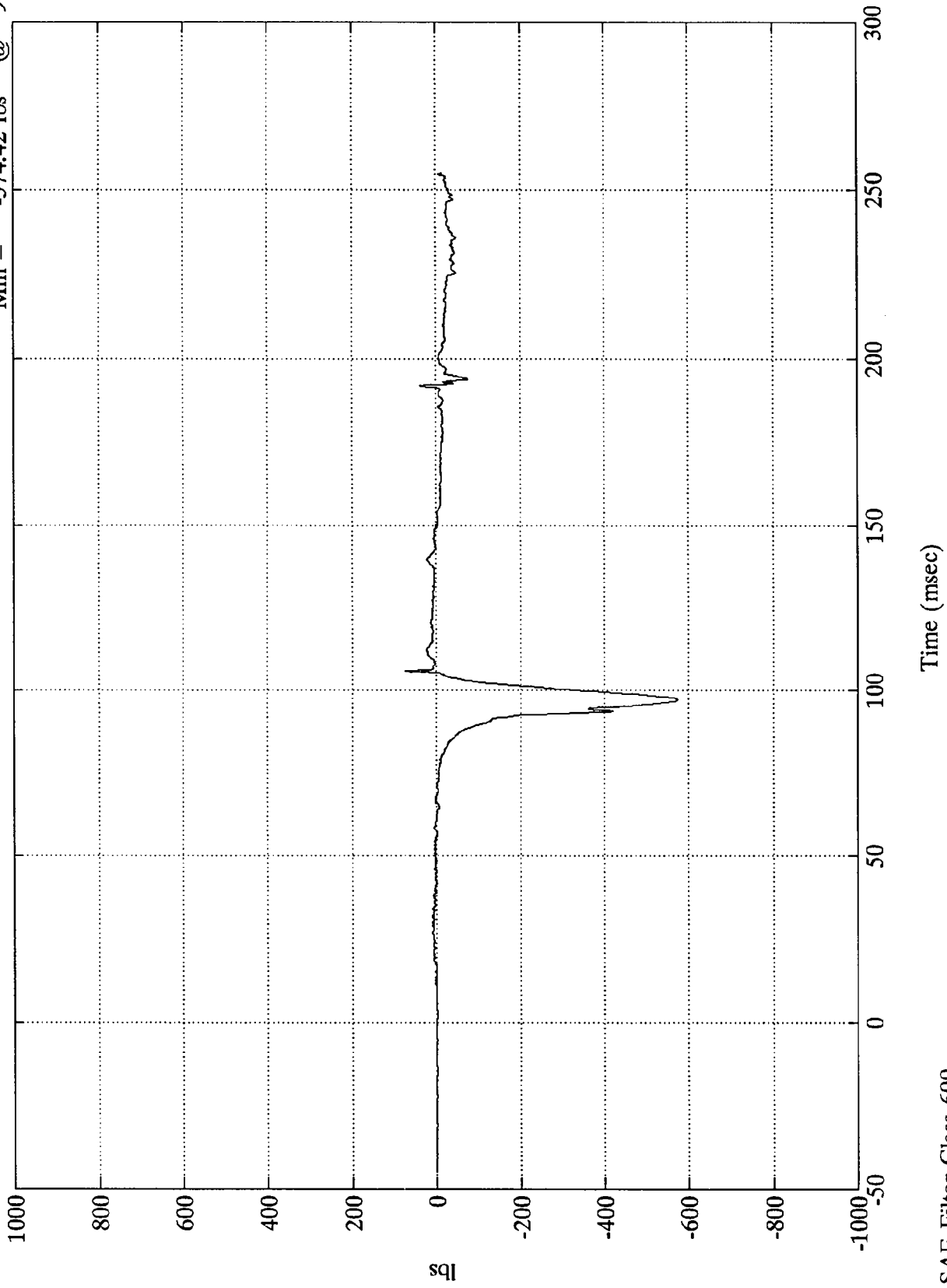
8102-2

SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Lt Lower Tibia Fy

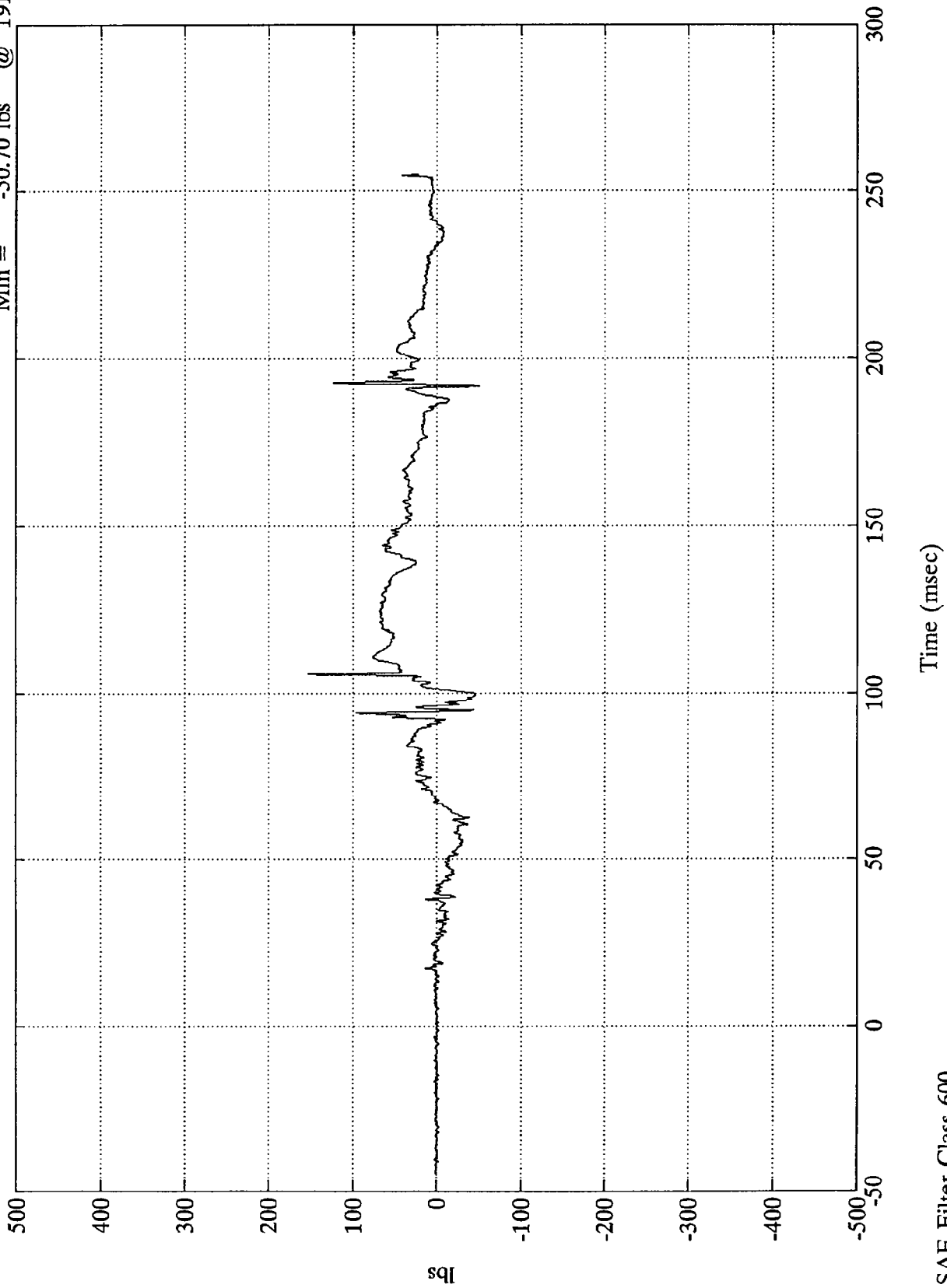
Max = 74.43 lbs @ 105.72 msec  
Min = -574.42 lbs @ 97.08 msec



TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Lt Lower Tibia Fz

Max = 153.16 lbs @ 105.72 msec  
Min = -50.70 lbs @ 191.76 msec



B-69

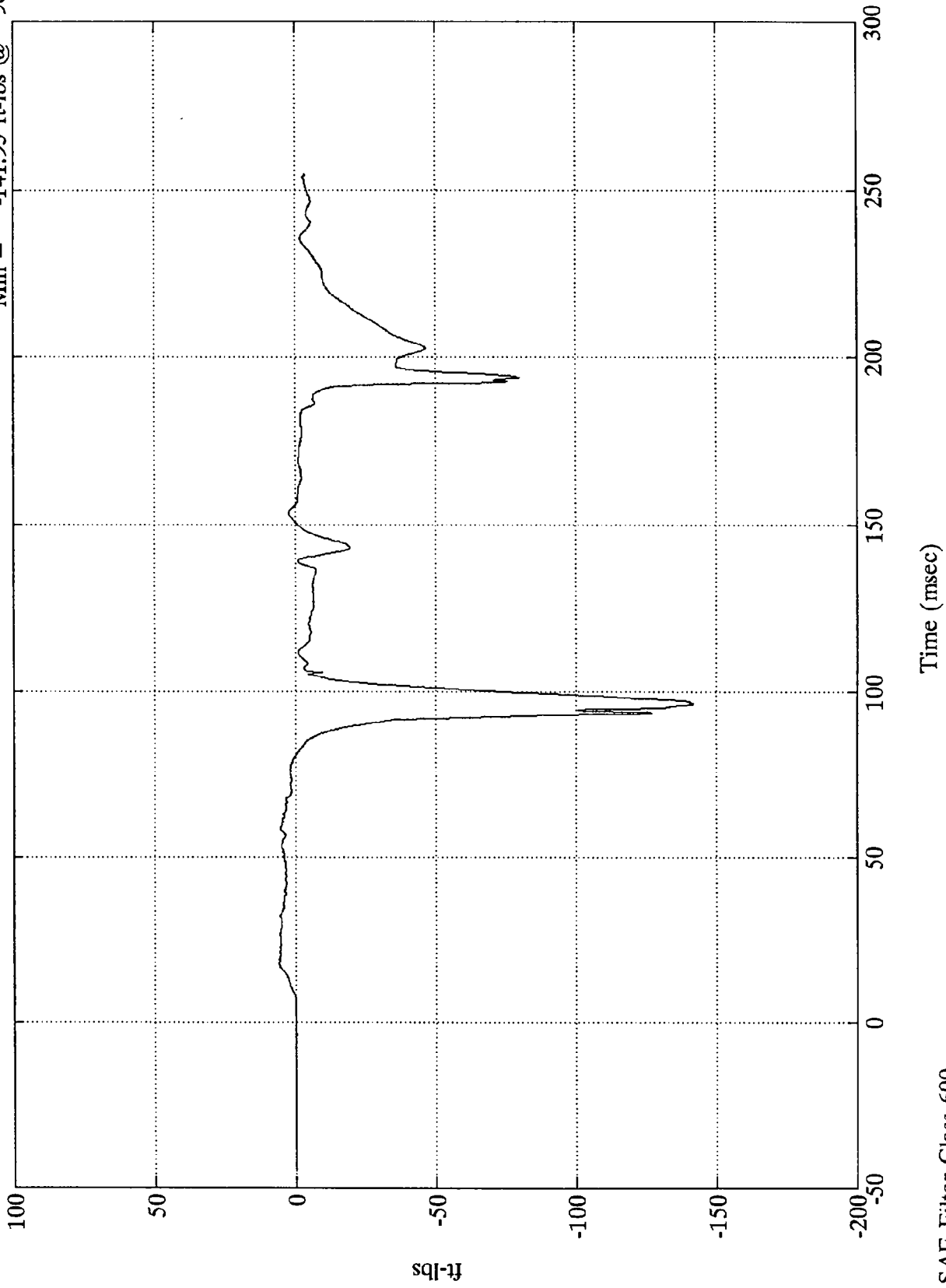
8102-2

SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Max = 6.08 ft-lbs @ 17.27 msec  
Min = -141.95 ft-lbs @ 96.36 msec

Pos. 2 Lt Lower Tibia Mx



B-70

8102-2

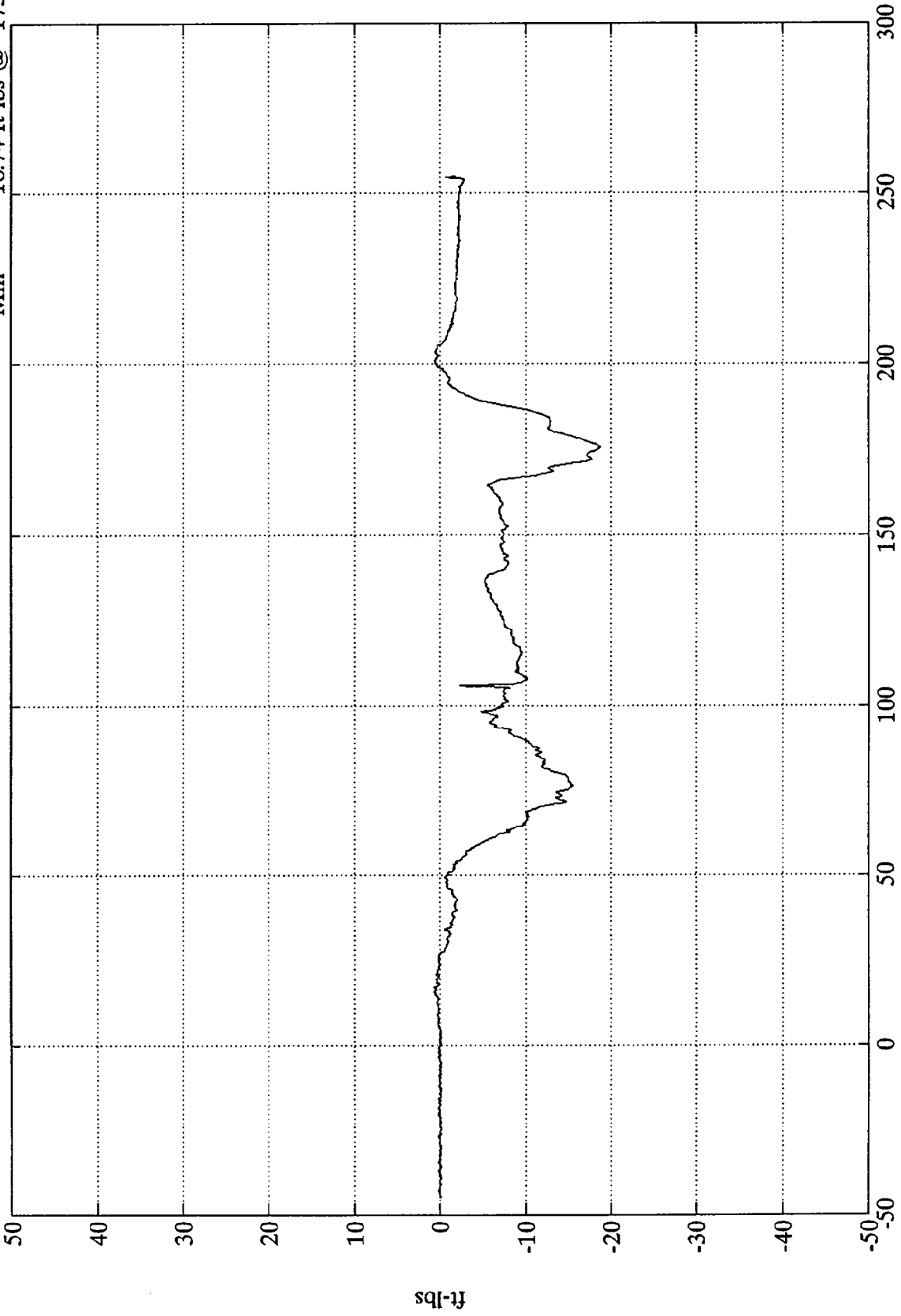
SAE Filter Class 600



TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Rt Upper Tibia Mx

Max = .73 ft-lbs @ 17.03 msec  
Min = -18.74 ft-lbs @ 175.44 msec



ft-lbs  
B-71

8102-2

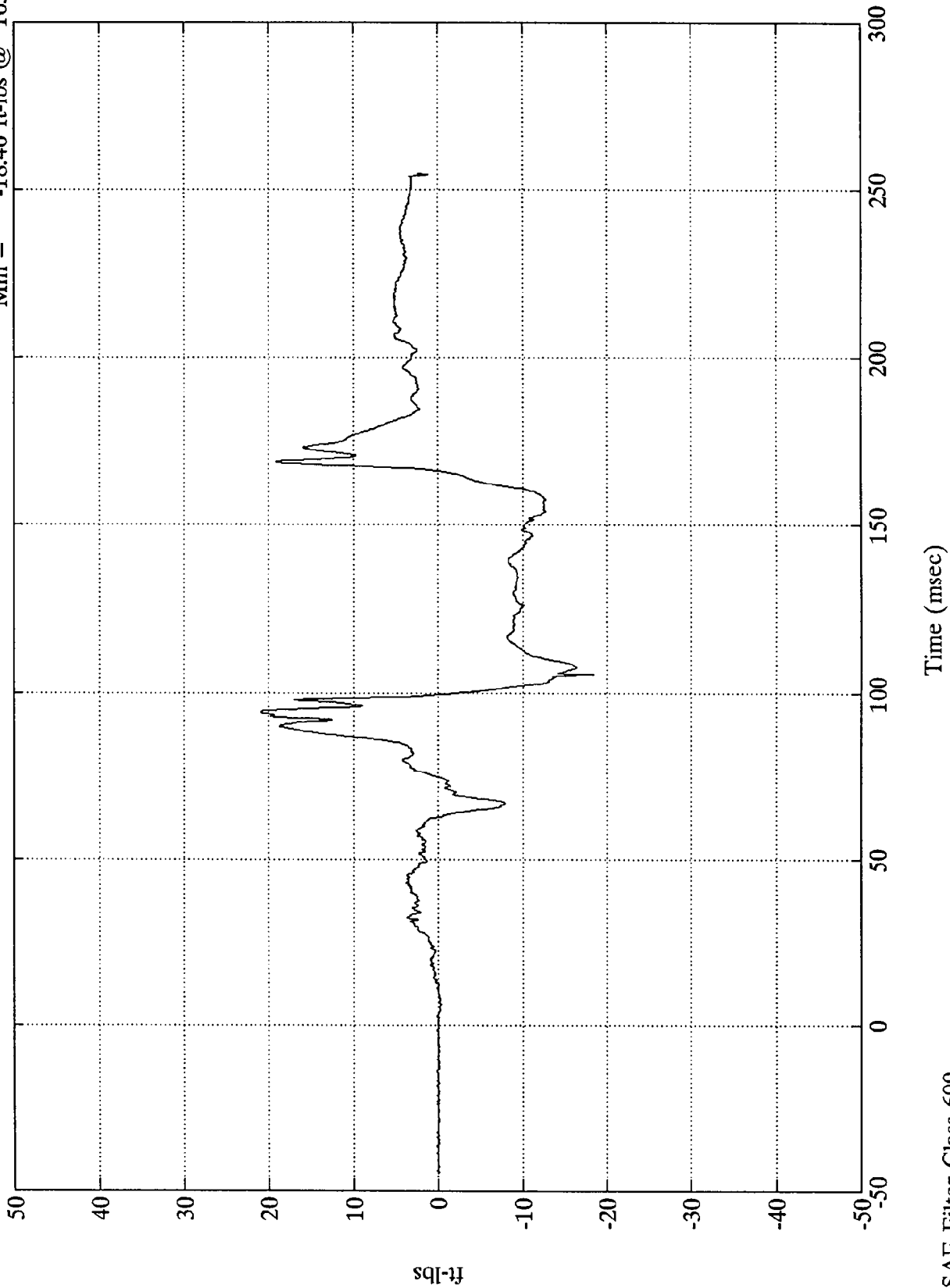
SAE Filter Class 600

Time (msec)

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Rt Upper Tibia My

Max = 20.91 ft-lbs @ 94.44 msec  
Min = -18.46 ft-lbs @ 105.59 msec



B-72

8102-2

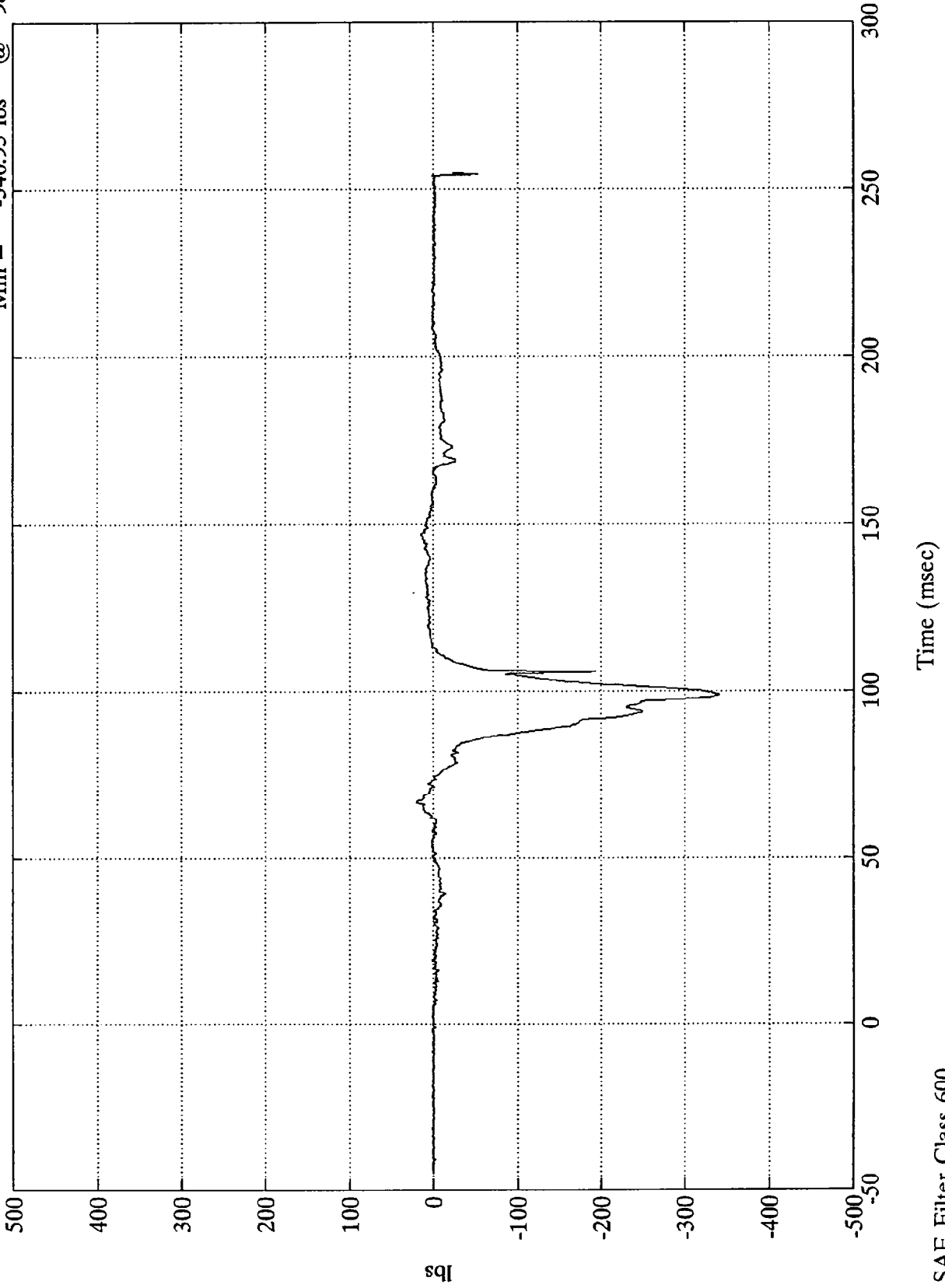
SAE Filter Class 600



TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Rt Lower Tibia Fy

Max = 20.12 lbs @ 66.48 msec  
Min = -340.95 lbs @ 98.76 msec



B-73

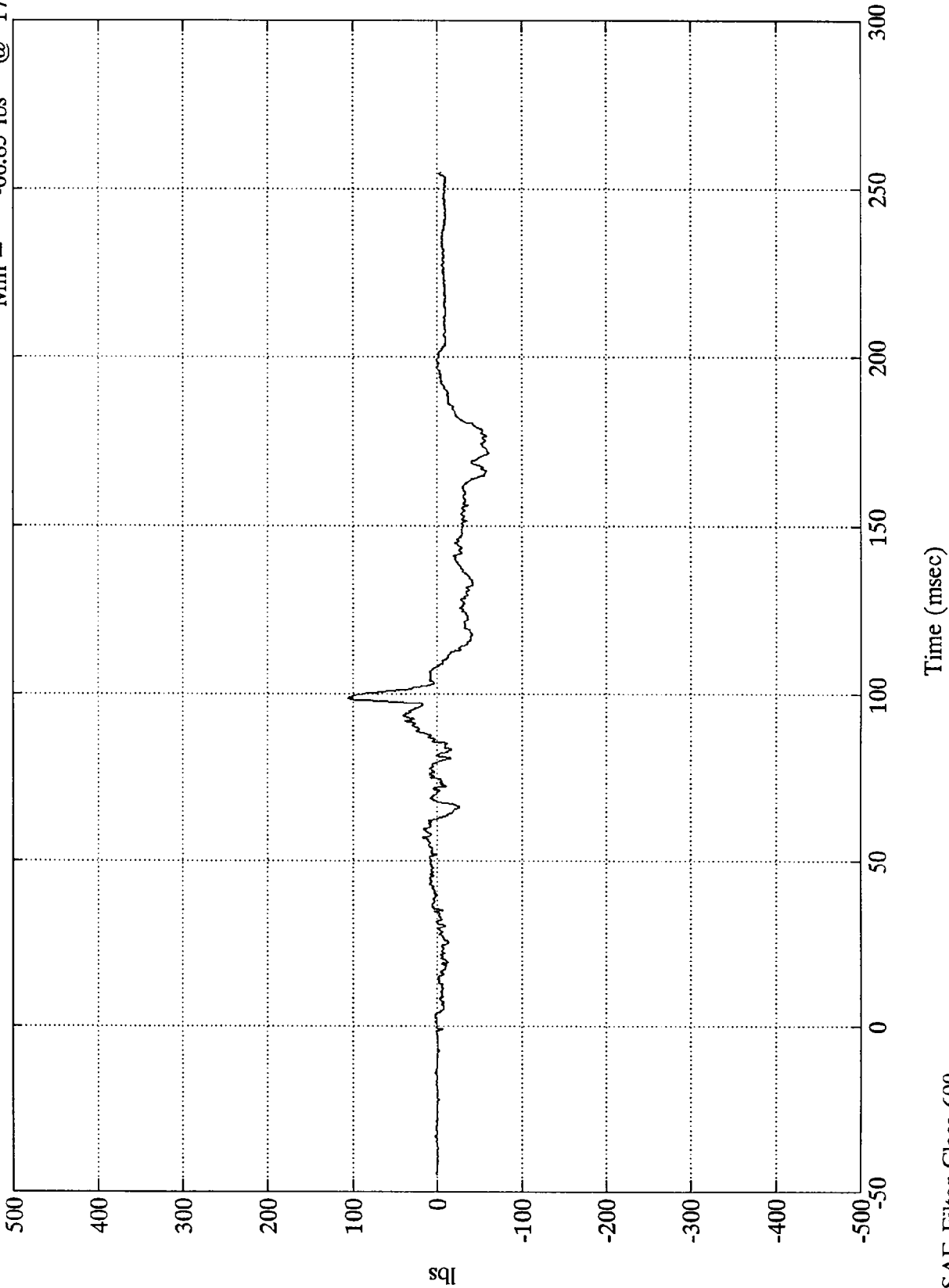
8102-2

SAE Filter Class 600

TSC 301 TEST 2 - REAR IMPACT

Pos. 2 Rt Lower Tibia Fz

Max = 105.07 lbs @ 98.52 msec  
Min = -60.85 lbs @ 171.47 msec



B-74

8102-2

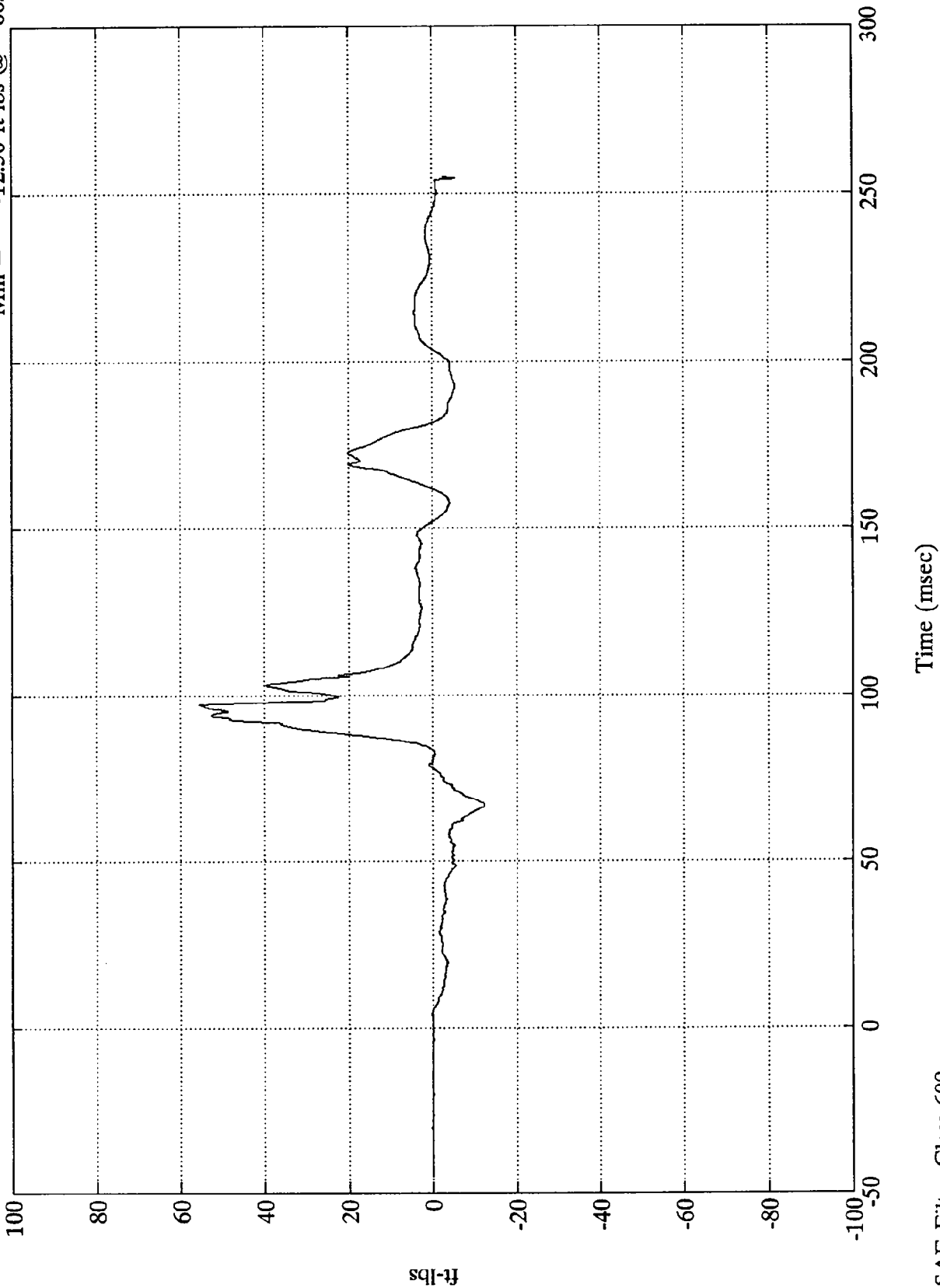
SAE Filter Class 600



TSC 301 TEST 2 - REAR IMPACT

Max = 55.47 ft-lbs @ 96.95 msec  
Min = -12.30 ft-lbs @ 66.36 msec

Pos. 2 Rt Lower Tibia Mx



B-75

8102-2

SAE Filter Class 600