

TEST REPORT

CONTRACT NAME: MODIFIED INTEGRATED VEHICLE (MIV)  
CONTRACT NUMBER: DTNH22-81-C-07085  
TEST DESCRIPTION: MOVING BARRIER SIDE IMPACTOR  
(MBSI) INTO CITATION DOOR  
WITH MODIFIED SIDE STRUCTURE  
AND GTR PADDING (46.45 MPH;  
DRIVER SIDE OCCUPANT, 60 DEGREE  
IMPACT)  
MIV TEST NUMBER: 4  
MCR TEST NUMBER: 2600  
TEST DATE: APRIL 27, 1983  
REPORT DATE: MAY 1982

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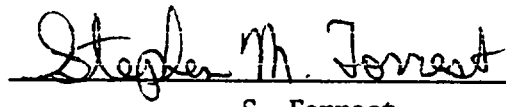
MIV TEST NUMBER: 4

MCR TECHNOLOGY, INC.  
TEST NUMBER: 2600

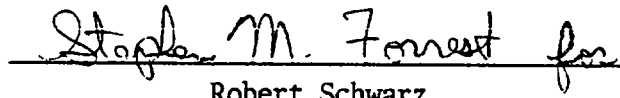
TEST DATE: April 27, 1983

REPORT DATE: May 1983

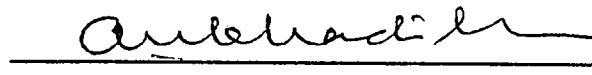
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# METRIC CONVERSION FACTORS

| Approximate Conversions to Metric Measures |                        |                            |                 | Approximate Conversions from Metric Measures |                     |                   |               |
|--------------------------------------------|------------------------|----------------------------|-----------------|----------------------------------------------|---------------------|-------------------|---------------|
| Symbol                                     | When You Know          | Multiply by                | To Find         | Symbol                                       | When You Know       | Multiply by       | To Find       |
| <b>LENGTH</b>                              |                        |                            |                 | <b>LENGTH</b>                                |                     |                   |               |
| in                                         | inches                 | 2.5                        | cm              | mm                                           | millimeters         | 0.04              | inches        |
| ft                                         | feet                   | 30                         | cm              | cm                                           | centimeters         | 0.4               | inches        |
| yd                                         | yards                  | 0.9                        | m               | m                                            | meters              | 3.3               | feet          |
| mi                                         | miles                  | 1.6                        | km              | km                                           | kilometers          | 1.1               | yards         |
|                                            |                        |                            |                 |                                              |                     | 0.5               | miles         |
| <b>AREA</b>                                |                        |                            |                 | <b>AREA</b>                                  |                     |                   |               |
| in <sup>2</sup>                            | square inches          | 6.5                        | cm <sup>2</sup> | square centimeters                           | 0.16                |                   | square inches |
| ft <sup>2</sup>                            | square feet            | 0.09                       | m <sup>2</sup>  | square meters                                | 1.2                 |                   | square yards  |
| yd <sup>2</sup>                            | square yards           | 0.8                        | m <sup>2</sup>  | square kilometers                            | 0.4                 |                   | square miles  |
| mi <sup>2</sup>                            | square miles           | 2.6                        | km <sup>2</sup> | hectares (10,000 m <sup>2</sup> )            | 2.5                 |                   | acres         |
|                                            | acres                  | 0.4                        | ha              |                                              |                     |                   |               |
| <b>MASS (weight)</b>                       |                        |                            |                 | <b>MASS (weight)</b>                         |                     |                   |               |
| oz                                         | ounces                 | 28                         | g               | grams                                        | 0.035               |                   | ounces        |
| lb                                         | pounds                 | 0.45                       | kg              | kilograms                                    | 2.2                 |                   | pounds        |
|                                            | short tons (2000 lb)   | 0.9                        | t               | tonnes (1000 kg)                             | 1.1                 |                   | short tons    |
| <b>VOLUME</b>                              |                        |                            |                 | <b>VOLUME</b>                                |                     |                   |               |
| teaspoon                                   | teaspoons              | 5                          | ml              | milliliters                                  | 0.03                |                   | fluid ounces  |
| fluid ounce                                | fluid ounces           | 16                         | ml              | liters                                       | 2.1                 |                   | pints         |
| cup                                        | cups                   | 30                         | ml              | liters                                       | 1.06                |                   | quarts        |
| pt                                         | pints                  | 0.24                       | l               | liters                                       | 0.26                |                   | gallons       |
| qt                                         | quarts                 | 0.47                       | l               | liters                                       | 35                  |                   | cubic feet    |
| gal                                        | gallons                | 0.95                       | l               | liters                                       | 1.3                 |                   | cubic yards   |
| ft <sup>3</sup>                            | cubic feet             | 3.8                        | m <sup>3</sup>  | cubic meters                                 |                     |                   |               |
| yd <sup>3</sup>                            | cubic yards            | 0.03                       | m <sup>3</sup>  | cubic meters                                 |                     |                   |               |
|                                            |                        | 0.76                       | m <sup>3</sup>  |                                              |                     |                   |               |
| <b>TEMPERATURE (exact)</b>                 |                        |                            |                 | <b>TEMPERATURE (exact)</b>                   |                     |                   |               |
| °F                                         | Fahrenheit temperature | 5/9 (after subtracting 32) | °C              | °C                                           | Celsius temperature | 9/5 (then add 32) | °F            |

\*1 in. = 2.54 exactly. For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weight and Measures, Price \$2.25, SD Catalog No. C13.10.286.



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## SECTION 1

### TEST OBJECTIVES AND SPECIAL PROCEDURES

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## OBJECTIVES:

As part of the Modified Integrated Vehicle (MIV) project, side structures improvements subtask, this test was conducted to obtain data for the door response, with nearside occupant, of a side impacted Chevrolet Citation containing lightweight structural modifications and GTR padding. The data will be used to assess the benefits of the side structure modifications combined with padding.

## SPECIAL PROCEDURES:

A moving barrier side impactor (MBSI) was used as the impacting vehicle. The MBSI, previously developed under NHTSA Contract DOT-HS-8-01933, consists of a rolling chassis and a deformable nose. The nose section, which is replaceable, is constructed of aluminum sheet and honeycomb and is representative of the front end structure of an automobile. The angle of tow was 41 degrees relative to the longitudinal centerline of the impacted vehicle, with the MBSI at a "crab" angle of 19 degrees. A single HSRI side impact dummy (SID) occupied the nearside position and was unrestrained. The SID utilized the "ACE" brand chest damper set to Position Number 9 as well as the modifications to the chest area as instructed by NHTSA.



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## SECTION 2

### TEST CONDITIONS

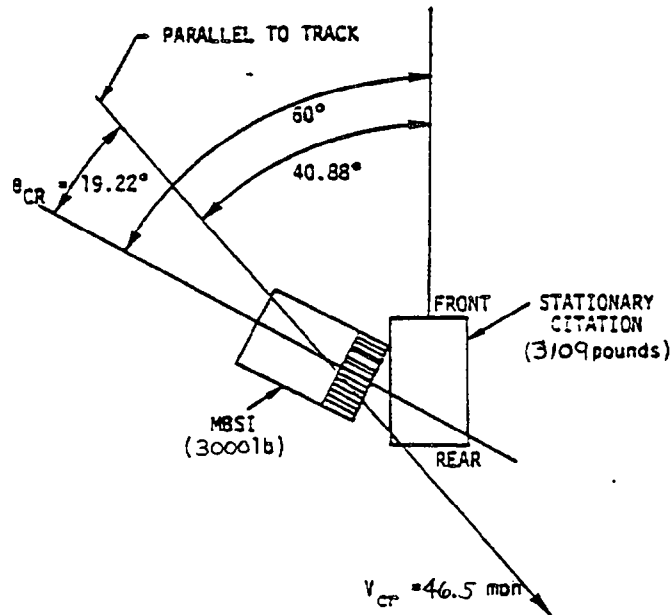
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## TEST CONDITIONS:

The MBSI was towed into the stationary Citation at an angle 41 degrees relative to the Citation longitudinal centerline (see diagram below). The MBSI nose was oriented to strike at an angle of 60 degrees relative to the Citation centerline. Thus it simulated a 60 degree side impact with a crabbing angle of 19 degrees. The crabbing velocity ( $V_{CR}$ ) was 46.45 mph. This condition is representative of a 90 degree impact in which the impacting and impacted vehicles are moving forward at 35.07 and 17.53 mph, respectively.

The first point of contact was intended to be 89.5 inches forward of the rear axle centerline.\* The actual point of impact was approximately  $\frac{1}{2}$  inch ahead of that point. The Citation rocker panel to ground distances were: LF = 8.12 inches; RF = 7.87 inches; LR = 7.5 inches; RR = 7.75 inches.

The front seat was adjusted to the mid-track position. The windshield and driver side glass were removed, the rear hatch window was removed for improved camera coverage, and the fuel system was drained and filled with Stoddard solution.



VEHICLE ORIENTATION DIAGRAM

\* Wheelbase  $\div 2 = 89.5''$

## RECEIVING INSPECTION OF VEHICLES

Contractor: MCR Technology, Inc. Contract No.: DTNH22-81-C-07085  
VIN No. 1X685A6156337  
Make: Chevrolet Model: Citation  
Year: 1981 Color: Red  
Mfgr Date: October 1980 Odometer: 11590  
Shipping Weight: 2645 lbs

### Accessories

|                |     |                            |     |
|----------------|-----|----------------------------|-----|
| Power steering | yes | Automatic transmission     | yes |
| Power brakes   | yes | Automatic speed control    | no  |
| Power seats    | no  | Tilting steering wheel     | no  |
| Power windows  | no  | Telescoping steering wheel | no  |
| Tinted glass   | no  | Air conditioning           | yes |
| Radio          | yes | Anti-skid brake            | no  |
| Clock          | no  | Rear window defroster      | no  |

Seats (front): bench

### Brakes

Front: disc  
Rear: drum

### Tires

Size: P185/80R13 Mfgr & Line: Goodyear Fastrak  
Ply Rating: 3 Ply Tread/1 Ply Radial: Yes  
Sidewall  
"Space Saver" spare tire: Yes

### Engine

Type: Gas V-6 Cylinders: 4  
Transmission, Frwd Speeds: Auto-3 Total Displacement: 2.5 liters

Fuel Capacity: 14 gallons

Restraint System: 3-point belts

### Remarks

1. Is the vehicle stock throughout? Yes.
2. Does vehicle show evidence of prior accident history? No.
3. Does vehicle show any significant corrosion? No.
4. Condition of the front bumper and frame: Very good.

## SUMMARY OF CRASH TEST CONDITIONS

### Test Vehicle Information

|               |                      |               |                    |
|---------------|----------------------|---------------|--------------------|
| Manufacturer: | General Motors Corp. | Make & Model: | Chevrolet Citation |
| VIN Number:   | 1X685A6156337        | Build Date:   | October 1980       |
| Model Year:   | 1981                 | Color:        | Red                |
| Transmission: | Automatic            |               |                    |
| Body Style:   | 4-door Hatchback     |               |                    |

### Engine Data

Type: Gasoline L-4  
Cylinders: 4  
Displacement: 2.5 liters

### Data from Certification Label on Left Door Rear Face or B-Post

Vehicle Mfgr: General Motors Corp. VIN: 1X685A6156337  
Date of Mfgr: October 1980  
GVWR: 3540 lbs GAWR: Front, 1929 lbs; Rear, 1,611 lbs

### Data from "Recommended Tire Pressure" Label on Door, Post, Glovebox, Etc.

|                             |                                   |
|-----------------------------|-----------------------------------|
| Vehicle Load Up to Capacity | Recommended Tire Size: P185/80R13 |
| Front: 26 psi               | Load Range: B                     |
| Rear: 26 psi                |                                   |

### Vehicle Capacity

Type of Seats: bench  
No. of Occupants (designated seating capacity): Front, 2; Rear, 3; Total, 5  
Cargo Load: 895 lbs

### Weight of Test Vehicle as Received from Dealer (with maximum fluids)

Total Front Weight: 1719 lbs (65% of total vehicle weight)  
Total Rear Weight: 926 lbs (35% of total vehicle weight)  
Total Delivered Weight: 2645 lbs

### Weight of Test Vehicle with Required Dummies and -0- Pounds of Cargo

Total Front Weight: 1865 lbs (60% of total vehicle weight)  
Total Rear Weight: 1244 lbs (40% of total vehicle weight)  
Total Test Weight: 3109 lbs  
Weight of Ballast Secured in Vehicle: 150 lbs

### Test Conditions

|               |                |                        |
|---------------|----------------|------------------------|
| Date of Test: | April 27, 1983 | Ambient Temperature at |
| Time of Test: | 12:30 p.m.     | Impact Area: 70 °F     |
|               |                | Wind Velocity: 0-5 mph |

SUMMARY OF CRASH TEST CONDITIONS (cont'd)

Test No.: 2600 Project Title: MIV Side Impact Test 4  
 Date: 4/27/83 Time: 12:30 pm Temp: 70°F  
 Wind Velocity: 0-5 mph

Subject Vehicle Data

Description: 4-door, 4 cylinder Chevrolet Citation; MIV X-9;  
 Lightweight Modifications

|                               | <u>Actual</u> | <u>Intended</u> |
|-------------------------------|---------------|-----------------|
| Test weight (lbs)             | 3109          | 3100*           |
| Vehicle orientation (degrees) | 0             | 0               |
| Vehicle velocity (mph)        | 0             | 0               |
| Maximum crush (inches)        |               |                 |
| Static                        | 16.5          | N.A.            |
| Dynamic                       | N/A           | N.A.            |
| Maximum intrusion (inches)    | 15.0          | N.A.            |

Dummies

|                  | Driver | Middle Passenger | Rt. Front Passenger | Left Rear Passenger | Rt. Rear Passenger |
|------------------|--------|------------------|---------------------|---------------------|--------------------|
| Type             | SID    |                  |                     |                     |                    |
| Serial no.       | HSRI   |                  |                     |                     |                    |
| Instrumentation  |        |                  |                     |                     |                    |
| Head accel.      | Triax  |                  |                     |                     |                    |
| Chest accel.     | See    |                  |                     |                     |                    |
| Remarks          |        |                  |                     |                     |                    |
| Femur L.C.'s     | No     |                  |                     |                     |                    |
| Other            | Yes    |                  |                     |                     |                    |
| Restraint system | None   |                  |                     |                     |                    |

Remarks: Dummy Instrumentation: upper spine triaxial; lower spine triaxial; left ribs (upper and lower) R-L; right ribs (upper and lower) R-L; pelvic triaxial; upper sternum A-P; lower sternum A-P; chest deflection R-L; strip switches at hip and shoulder areas. Dummy uses an "ACE" brand damper.

The vehicle includes the structural modifications and weights shown on the following page. The vehicle also includes the "best" padding on the driver door, as determined by sled testing. This pad is the General Tire and Rubber Company (GTR) molded foam, 1-piece hip and shoulder pad.

\*Including occupant and Stoddard solution.

## SUMMARY OF CRASH TEST CONDITIONS (cont'd)

### Impacting Vehicle/Object Data

Description: Moving Barrier Side Impactor (MBSI)

|                               | <u>Actual</u>       | <u>Intended</u> |
|-------------------------------|---------------------|-----------------|
| Test weight (lbs)             | 3000                | 3000            |
| Vehicle orientation (degrees) | See Test Conditions |                 |
| Vehicle velocity (mph)        | 46.45               | 46.3            |
| Maximum crush (inches)        |                     |                 |
| Static                        | 12.25               |                 |
| Dynamic                       | N/A                 |                 |

Remarks: MBSI bumper centerline to ground distance equals 18 inches. The MBSI was towed through its center of gravity.

### Side Structure Weight Estimate

|                                                   |     |
|---------------------------------------------------|-----|
| 1. Sill override stops 2 @ 1.55 pounds            | 3.1 |
| 2. Lower seat back reinforcement 1 @ 3.3pounds    | 3.3 |
| 3. Upper seat back reinforcement 1 @ 4.7pounds    | 4.7 |
| 4. B-pillar spacers 2 @ 0.75 pounds               | 1.5 |
| 5. B-pillar reinforcements and additional welding | 2.5 |
| 6. Welded lower hinge and fixed pin bolt          | 0.2 |

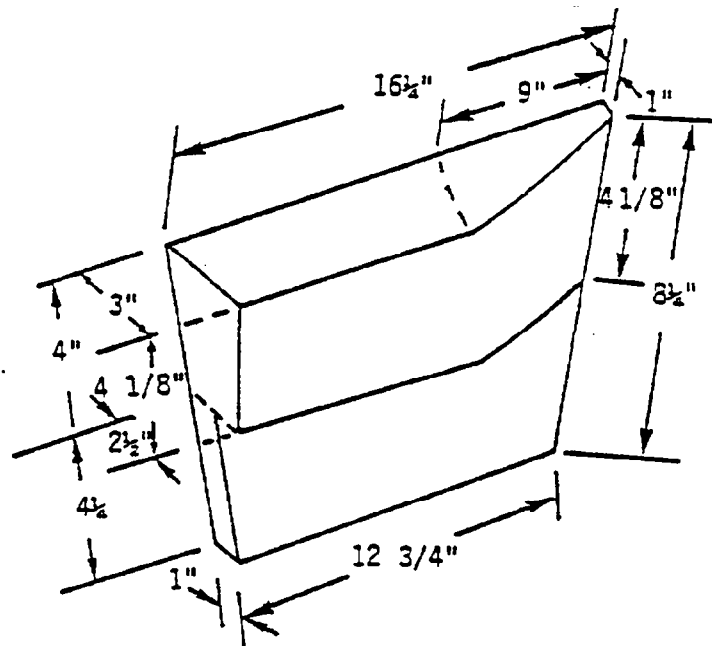
Impact absorbing door padding

General Tire and Rubber (GTR) molded pad 2.0\*

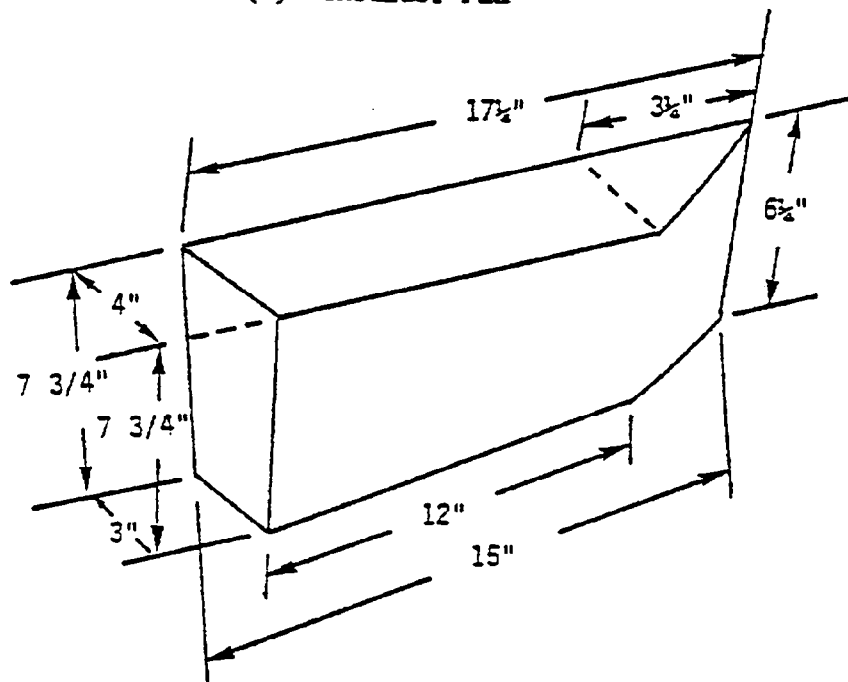
TOTAL 17.3

\*Driver's side only. Weight for system 4.0 making total weight 19.3 lb.



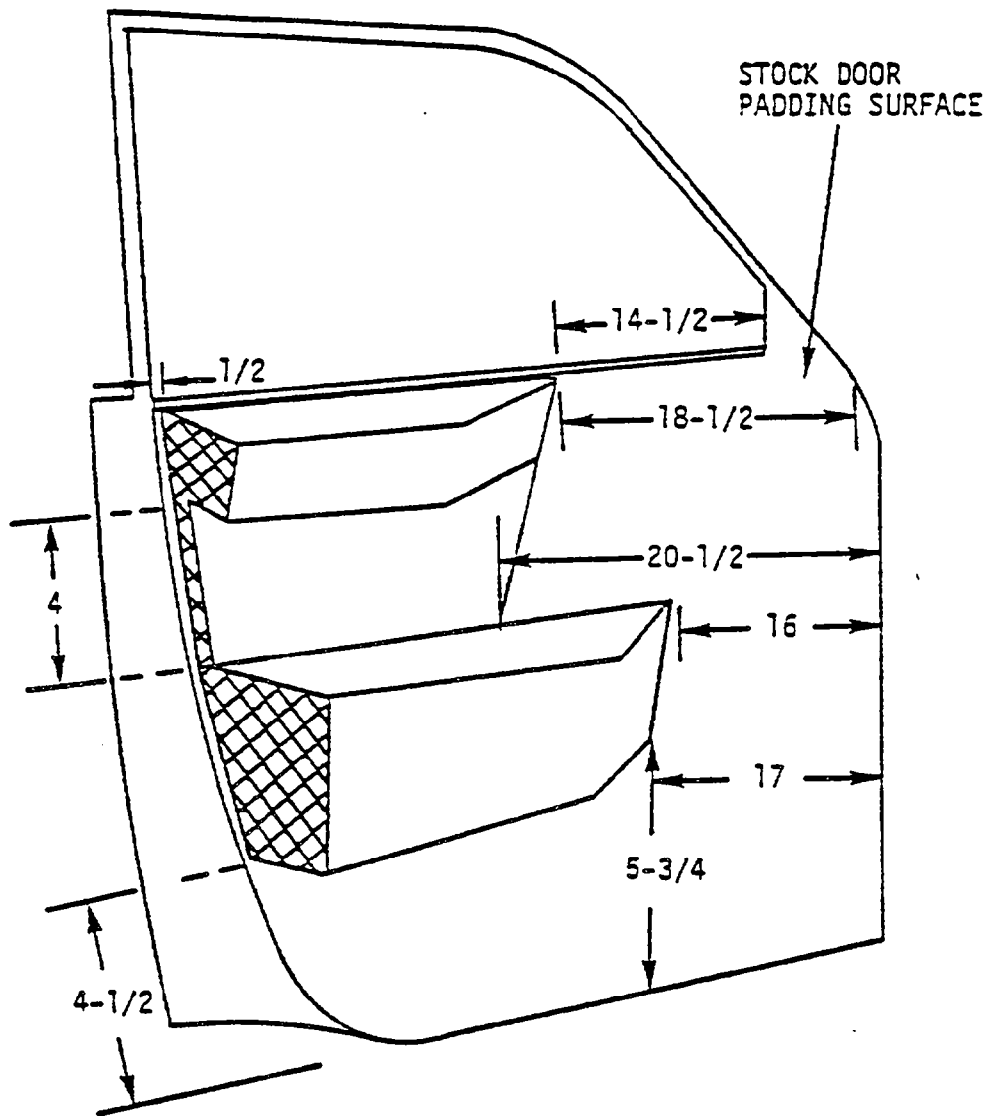


(a) Shoulder Pad

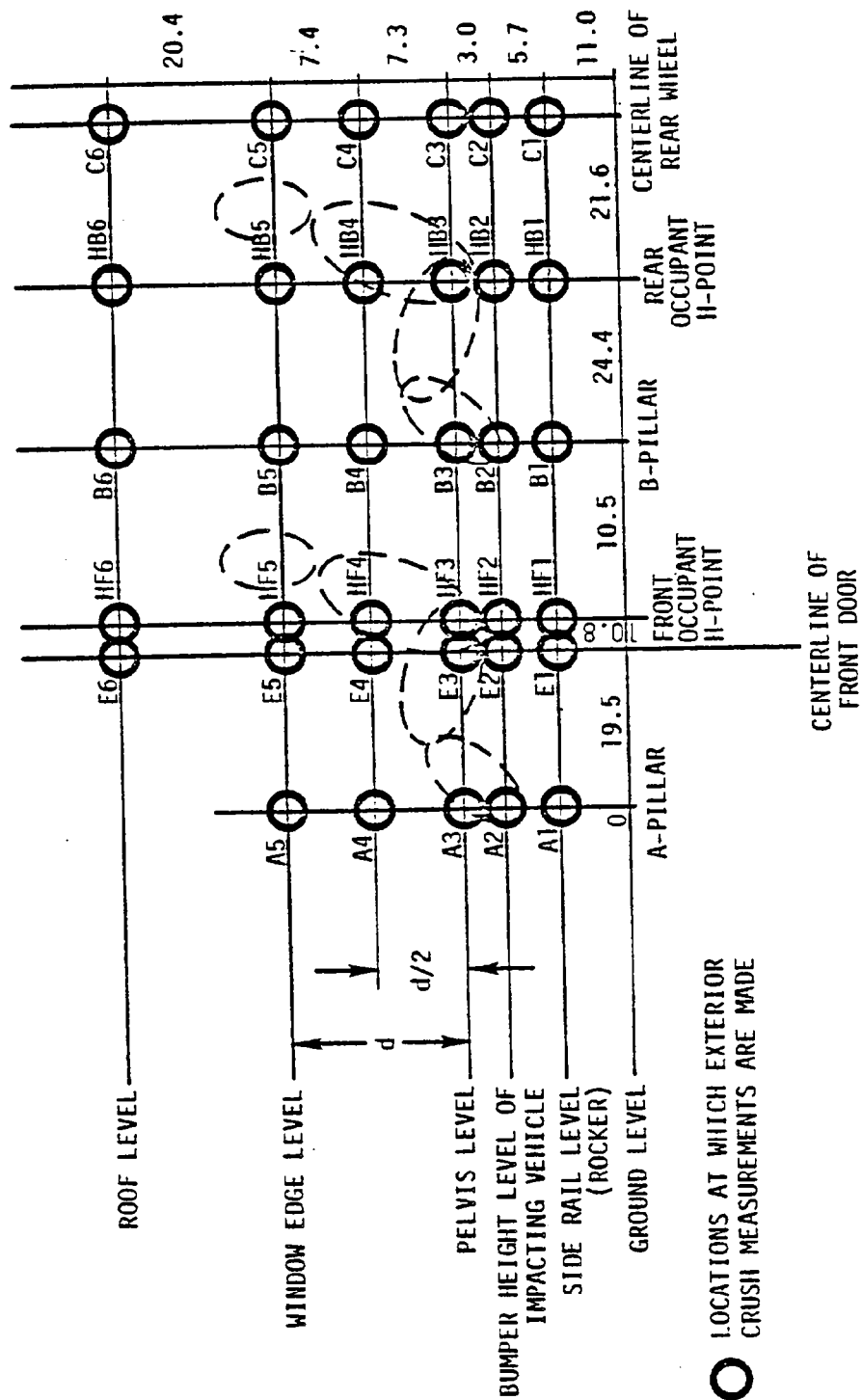


(b) Hip Pad

MIV MODERATE DOOR PADDING DIMENSIONS  
(MEASURED OVER STOCK DOOR PADDING)



MIV DRIVER DOOR PADDING LOCATIONS

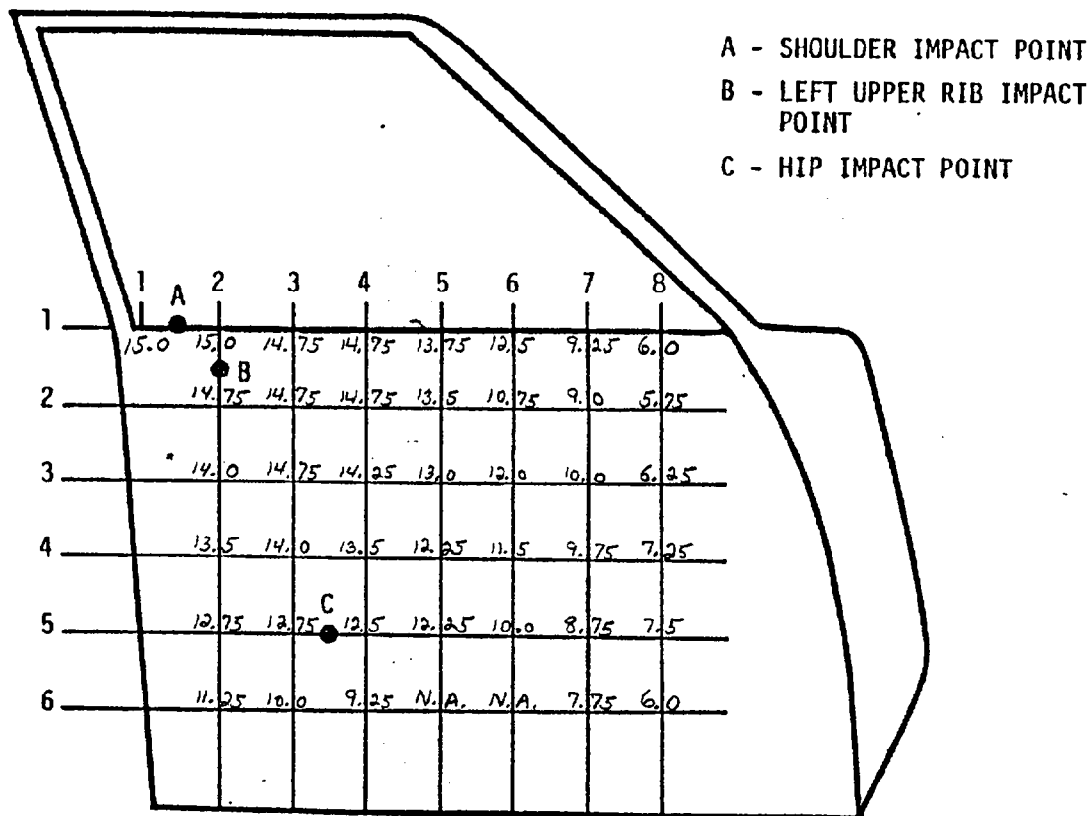


EXTERIOR CRUSH MEASUREMENTS LOCATIONS

CRUSH MEASUREMENTS\*  
(all measurements in inches)

| Location (see<br>previous page) | Pre-Test | Post-Test | Crush |
|---------------------------------|----------|-----------|-------|
| A1                              | 7.75     | 7         | -0.75 |
| A2                              | 4.62     | 4.62      | 0.0   |
| A3                              | 4.0      | 7.0       | 3.0   |
| A4                              | 3.87     | 6.12      | 2.25  |
| A5                              | 5.12     | 5.0       | -0.12 |
| E1                              | 7.75     | 12.5      | 4.75  |
| E2                              | 4.5      | 17.5      | 13.0  |
| E3                              | 3.75     | 19.0      | 15.25 |
| E4                              | 3.37     | 17.25     | 13.88 |
| E5                              | 4.75     | 18.75     | 14.0  |
| E6                              | 11.75    | 14.25     | 2.5   |
| HF1                             | 7.5      | 15.25     | 7.75  |
| HF2                             | 4.5      | 19.0      | 14.5  |
| HF3                             | 3.5      | 20.0      | 16.5  |
| HF4                             | 3.25     | 19.0      | 15.75 |
| HF5                             | 4.75     | 21.25     | 16.5  |
| HF6                             | 11.75    | 14.25     | 2.5   |
| B1                              | 7.5      | 16.25     | 8.75  |
| B2                              | 4.5      | 15.5      | 11.0  |
| B3                              | 3.5      | 17.75     | 14.25 |
| B4                              | 3.37     | 17.5      | 14.13 |
| B5                              | 4.75     | 18.0      | 13.25 |
| B6                              | 11.87    | 16.5      | 4.63  |
| HB1                             | 7.25     | 6.5       | -0.75 |
| HB2                             | 4.12     | 9.5       | 5.38  |
| HB3                             | 3.25     | 11.75     | 8.5   |
| HB4                             | 3.25     | 11.25     | 8.0   |
| HB5                             | 4.62     | 11.0      | 6.38  |
| HB6                             | 11.5     | 13.0      | 1.5   |
| C1                              | 6.75     | 4.5       | -2.25 |
| C2                              | 5.25     | 3.5       | -1.75 |
| C3                              | 4.5      | 1.75      | -2.75 |
| C4                              | 2.0      | 3.75      | 1.75  |
| C5                              | 4.5      | 5.0       | 0.5   |
| C6                              | 7.0      | 8.75      | 1.75  |

\*The car centerline is 36.25 inches from the template face (car side).  
Measurements taken from the marked side of the template (not the car side).



(GRID REFERENCE POINT: 1,1 AT LOWER REAR EDGE OF GLASS)

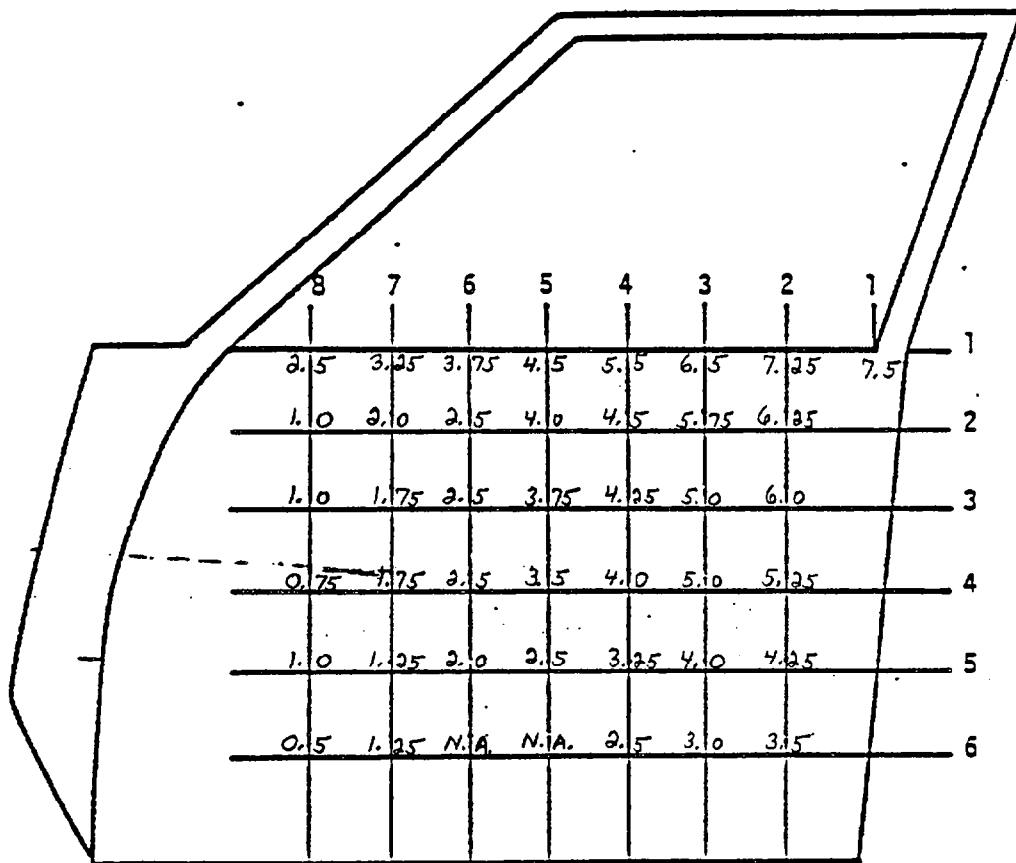
CITATION DOOR 4 INCH BY 4 INCH INTRUSION GRID  
(WITHOUT DOOR PAD; DRIVER SIDE)

PRE- AND POST-TEST MEASUREMENTS  
CITATION DOOR GRID WITHOUT DOOR PAD  
(DRIVERS SIDE)

| Column/Row | Pre<br>(inches) | Post<br>(inches) | Delta<br>(inches) | Column/Row | Pre<br>(inches) | Post<br>(inches) | Delta<br>(inches) |
|------------|-----------------|------------------|-------------------|------------|-----------------|------------------|-------------------|
| 1/1        | 29.0            | 14.0             | 15.0              | 5/4        | 29.0            | 16.75            | 12.25             |
| 2/1        | 29.0            | 14.0             | 15.0              | 5/5        | 28.5            | 16.25            | 12.25             |
| 2/2        | 29.25           | 14.5             | 14.75             | 5/6        | 28.0            | N/A              | N/A               |
| 2/3        | 29.0            | 15.0             | 14.0              | 6/1        | 29.0            | 16.5             | 12.5              |
| 2/4        | 28.5            | 15.0             | 13.5              | 6/2        | 28.75           | 18.0             | 10.75             |
| 2/5        | 28.25           | 15.5             | 12.75             | 6/3        | 29.0            | 17.0             | 12.0              |
| 2/6        | 28.0            | 16.75            | 11.25             | 6/4        | 28.5            | 17.0             | 11.5              |
| 3/1        | 29.0            | 14.25            | 14.75             | 6/5        | 28.25           | 18.25            | 10.0              |
| 3/2        | 29.0            | 14.25            | 14.75             | 6/6        | 28.0            | N/A              | N/A               |
| 3/3        | 29.0            | 14.25            | 14.75             | 7/1        | 29.0            | 19.75            | 9.25              |
| 3/4        | 29.0            | 15.0             | 14.0              | 7/2        | 28.25           | 19.25            | 9.0               |
| 3/5        | 28.5            | 15.75            | 12.75             | 7/3        | 28.75           | 18.75            | 10.0              |
| 3/6        | 28.0            | 18.0             | 10.0              | 7/4        | 28.75           | 19.0             | 9.75              |
| 4/1        | 29.0            | 14.25            | 14.75             | 7/5        | 28.25           | 19.5             | 8.75              |
| 4/2        | 29.25           | 14.5             | 14.75             | 7/6        | 28.0            | 20.75            | 7.25              |
| 4/3        | 29.25           | 15.0             | 14.25             | 8/1        | 28.0            | 22.0             | 6.0               |
| 4/4        | 29.0            | 15.5             | 13.5              | 8/2        | 27.75           | 22.0             | 5.75              |
| 4/5        | 28.5            | 16.0             | 12.5              | 8/3        | 27.5            | 21.25            | 6.25              |
| 4/6        | 28.0            | 18.75            | 9.25              | 8/4        | 28.25           | 21.0             | 7.25              |
| 5/1        | 29.0            | 15.25            | 13.75             | 8/5        | 28.5            | 21.0             | 7.5               |
| 5/2        | 29.0            | 15.5             | 13.5              | 8/6        | 28.0            | 22.0             | 6.0               |
| 5/3        | 29.0            | 16.0             | 13.0              |            |                 |                  |                   |

PRE- AND POST-TEST MEASUREMENTS  
CITATION DOOR GRID WITH DOOR PAD  
(DRIVER'S SIDE)

| Column/Row | Pre<br>(inches) | Post<br>(inches) | Delta<br>(inches) | Column/Row | Pre<br>(inches) | Post<br>(inches) | Delta<br>(inches) |
|------------|-----------------|------------------|-------------------|------------|-----------------|------------------|-------------------|
| 1/1        | 25.5            | 13.5             | 12.0              | 5/4        | 25.5            | 11.75            | 13.75             |
| 2/1        | 25.5            | 14.25            | 11.25             | 5/5        | 28.0            | 15.0             | 13.0              |
| 2/2        | 25.75           | 11.0             | 14.75             | 5/6        | 27.5            | 13.0             | 14.5              |
| 2/3        | 27.0            | 12.75            | 14.25             | 6/1        | 28.5            | 16.0             | 12.5              |
| 2/4        | 24.5            | 10.5             | 14.0              | 6/2        | 28.0            | 15.25            | 12.75             |
| 2/5        | 27.75           | 15.0             | 12.75             | 6/3        | 28.0            | 15.25            | 12.75             |
| 2/6        | 27.5            | 15.25            | 12.25             | 6/4        | 28.0            | 15.5             | 12.5              |
| 3/1        | 25.75           | 14.25            | 11.5              | 6/5        | 27.75           | 17.0             | 10.75             |
| 3/2        | 26.0            | 11.5             | 14.5              | 6/6        | 27.5            | 17.5             | 10.0              |
| 3/3        | 27.25           | 13.75            | 13.5              | 7/1        | 27.5            | 20.0             | 7.5               |
| 3/4        | 24.5            | 10.75            | 13.75             | 7/2        | 27.5            | 19.0             | 8.5               |
| 3/5        | 27.75           | 15.0             | 12.75             | 7/3        | 27.25           | 17.75            | 9.5               |
| 3/6        | 27.50           | 15.25            | 12.25             | 7/4        | 27.0            | 17.25            | 9.75              |
| 4/1        | 26.5            | 14.75            | 11.75             | 7/5        | 27.5            | 18.0             | 9.5               |
| 4/2        | 26.75           | 12.25            | 14.5              | 7/6        | 27.5            | 18.5             | 9.0               |
| 4/3        | 27.25           | 13.0             | 14.25             | 8/1        | 27.5            | 22.5             | 5.0               |
| 4/4        | 24.5            | 11.0             | 13.5              | 8/2        | 27.5            | 21.5             | 6.0               |
| 4/5        | 27.75           | 15.0             | 12.75             | 8/3        | 27.0            | 20.75            | 6.25              |
| 4/6        | 27.5            | 15.25            | 12.25             | 8/4        | 27.0            | 20.0             | 7.0               |
| 5/1        | 28.5            | 15.75            | 12.75             | 8/5        | 27.25           | 20.0             | 7.25              |
| 5/2        | 28.5            | 14.75            | 13.75             | 8/6        | 27.5            | 20.0             | 7.5               |
| 5/3        | 28.5            | 14.75            | 13.75             |            |                 |                  |                   |



(GRID REFERENCE POINT: 1,1 AT LOWER REAR EDGE OF GLASS)

CITATION DOOR 4 INCH BY 4 INCH INTRUSION GRID  
(WITHOUT DOOR PAD; PASSENGER SIDE)

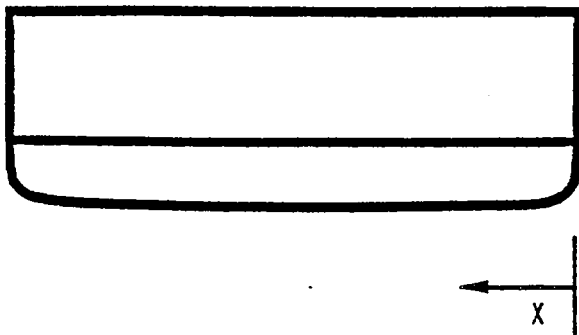


PRE- AND POST-TEST MEASUREMENTS  
CITATION DOOR GRID WITHOUT DOOR PAD

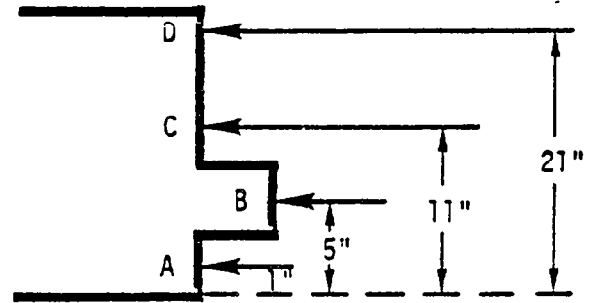
PASSENGER SIDE

| Column/Row | Pre<br>(inches) | Post<br>(inches) | Delta<br>(inches) | Column/Row | Pre<br>(inches) | Post<br>(inches) | Delta<br>(inches) |
|------------|-----------------|------------------|-------------------|------------|-----------------|------------------|-------------------|
| 1/1        | 28.0            | 35.5             | 7.5               | 5/4        | 28.5            | 32.0             | 3.5               |
| 2/1        | 28.0            | 35.25            | 7.25              | 5/5        | 28.0            | 30.5             | 2.5               |
| 2/2        | 28.25           | 34.5             | 6.25              | 5/6        | 27.5            | N/A              | N/A               |
| 2/3        | 28.0            | 34.0             | 6.0               | 6/1        | 28.0            | 31.75            | 3.75              |
| 2/4        | 27.75           | 33.0             | 5.25              | 6/2        | 28.5            | 31.0             | 2.5               |
| 2/5        | 27.75           | 32.0             | 4.25              | 6/3        | 28.5            | 31.0             | 2.5               |
| 2/6        | 27.5            | 31.0             | 3.5               | 6/4        | 28.0            | 30.5             | 2.5               |
| 3/1        | 27.75           | 34.25            | 6.5               | 6/5        | 28.0            | 30.0             | 2.0               |
| 3/2        | 28.0            | 33.75            | 5.75              | 6/6        | 27.5            | N/A              | N/A               |
| 3/3        | 28.0            | 33.0             | 5.0               | 7/1        | 27.75           | 31.0             | 3.25              |
| 3/4        | 28.0            | 33.0             | 5.0               | 7/2        | 27.75           | 29.75            | 2.0               |
| 3/5        | 27.75           | 31.75            | 4.0               | 7/3        | 28.5            | 30.25            | 1.75              |
| 3/6        | 27.5            | 30.5             | 3.0               | 7/4        | 28.25           | 30.0             | 1.75              |
| 4/1        | 28.0            | 33.5             | 5.5               | 7/5        | 28.0            | 29.25            | 1.25              |
| 4/2        | 28.25           | 32.75            | 4.5               | 7/6        | 27.5            | 28.75            | 1.25              |
| 4/3        | 28.25           | 32.5             | 4.25              | 8/1        | 27.5            | 30.0             | 2.5               |
| 4/4        | 28.0            | 32.0             | 4.0               | 8/2        | 27.5            | 28.5             | 1.0               |
| 4/5        | 27.75           | 31.0             | 3.25              | 8/3        | 27.5            | 28.5             | 1.0               |
| 4/6        | 27.5            | 30.0             | 2.5               | 8/4        | 28.25           | 29.0             | 0.75              |
| 5/1        | 28.0            | 32.5             | 4.5               | 8/5        | 28.25           | 29.25            | 1.0               |
| 5/2        | 28.0            | 32.0             | 4.0               | 8/6        | 27.5            | 28.0             | 0.5               |
| 5/3        | 28.25           | 32.0             | 3.75              |            |                 |                  |                   |

# MBSI CRUSH - TEST D6



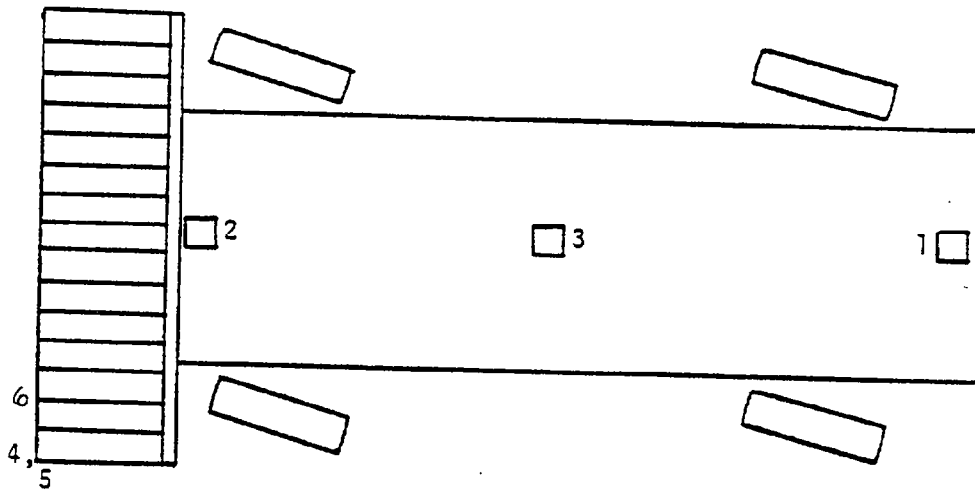
MBSI TOP VIEW



MBSI SIDE VIEW

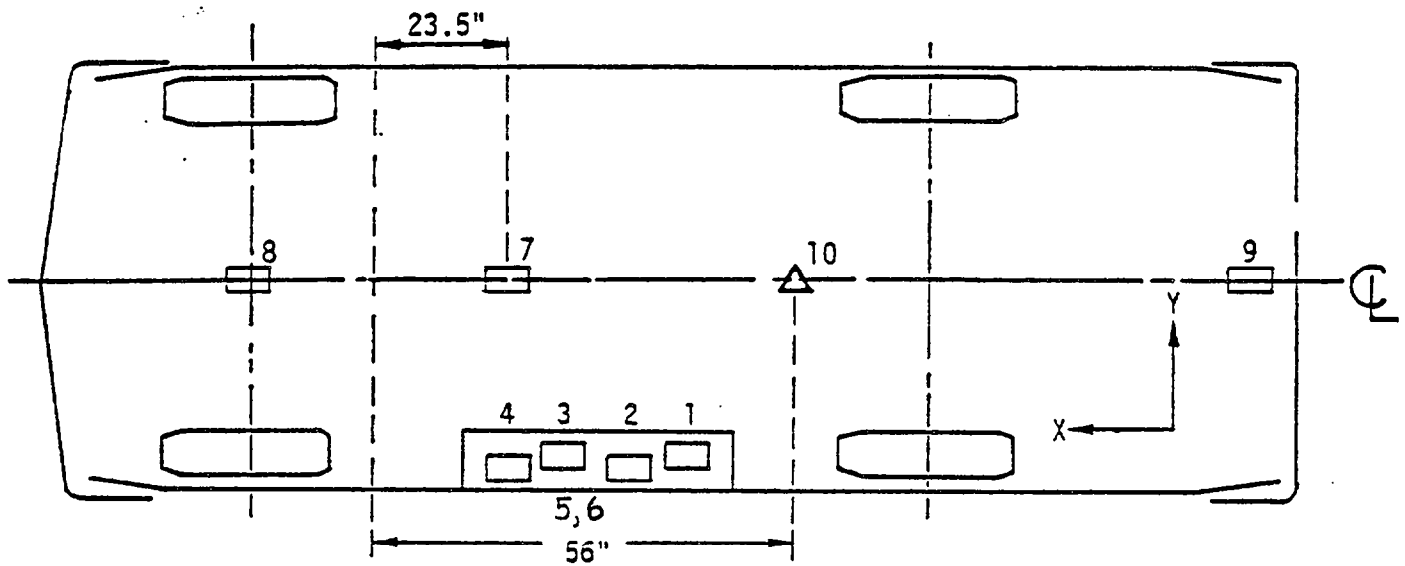
| X<br>(inches) | A     | B     | C    | D    |
|---------------|-------|-------|------|------|
| 0             | 12.25 | 11.25 | 8.75 | 3.75 |
| 1             | 10.75 | 10.75 | 8.00 | 2.75 |
| 2             | 9.75  | 10.00 | 7.75 | 2.50 |
| 3             | 9.75  | 9.25  | 6.50 | 2.00 |
| 4             | 9.75  | 8.50  | 5.75 | 1.75 |
| 5             | 8.75  | 8.00  | 4.75 | 1.50 |
| 6             | 8.25  | 7.50  | 4.25 | 1.50 |
| 7             | 8.00  | 7.25  | 3.75 | 1.50 |
| 8             | 7.50  | 7.25  | 3.50 | 1.50 |
| 9             | 7.25  | 6.75  | 3.38 | 1.38 |
| 10            | 6.75  | 6.50  | 3.25 | 1.25 |
| 11            | 6.25  | 6.25  | 3.25 | 1.25 |
| 16            | 5.25  | 5.50  | 3.00 | 1.50 |
| 21            | 3.75  | 5.00  | 2.50 | 1.50 |
| 26            | 1.75  | 4.00  | 1.75 | 0.63 |
| 31            | 2.25  | 2.50  | 0.75 | 0.50 |
| 36            | 2.50  | 1.25  | 0.50 | 0.50 |
| 41            | 0.75  | 0.88  | 0.38 | 0.38 |
| 46            | 0.25  | 0.75  | 0.25 | 0.38 |
| 51            | 2.25  | 0.63  | 0.38 | 0.25 |
| 56            | 0.25  | 0.50  | 0.25 | 0.25 |
| 61            | 0.25  | 0.25  | 0.13 | 0.13 |
| 66            | 0.00  | 1.25  | 0.00 | 0.00 |

TRANSDUCER DESCRIPTION/LOCATION

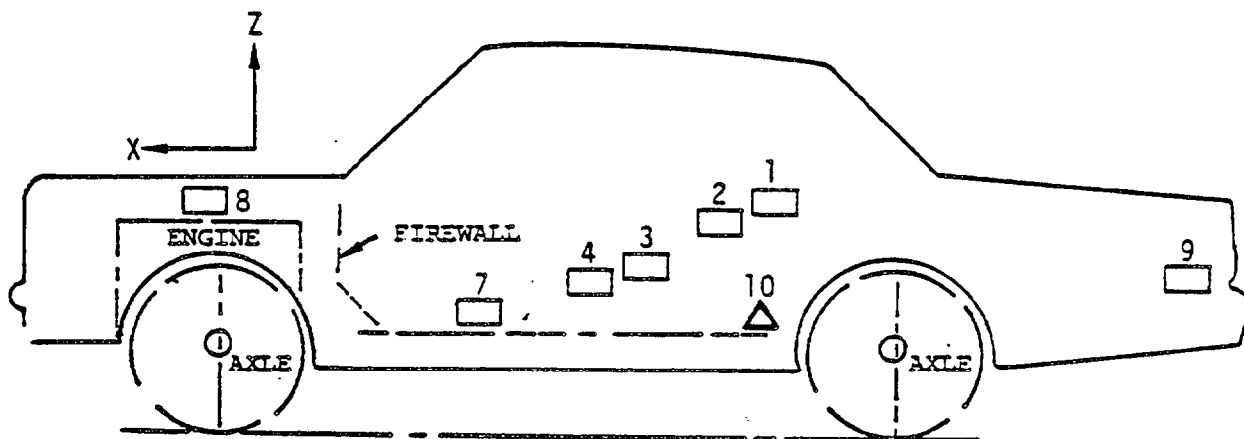


- 1 BIAX ON CENTERLINE AT REAR
- 2 TRIAX ON CENTERLINE BEHIND ALUMINUM
- 3 300<sup>0</sup>/s RATE GYRO (YAW)
- 4 ZERO EVENT STRIP SWITCH ON LOWER STRUCTURE
- 5 IMPACT STRIP SWITCH ON UPPER STRUCTURE
- 6 BUMPER CRUSH GAGE

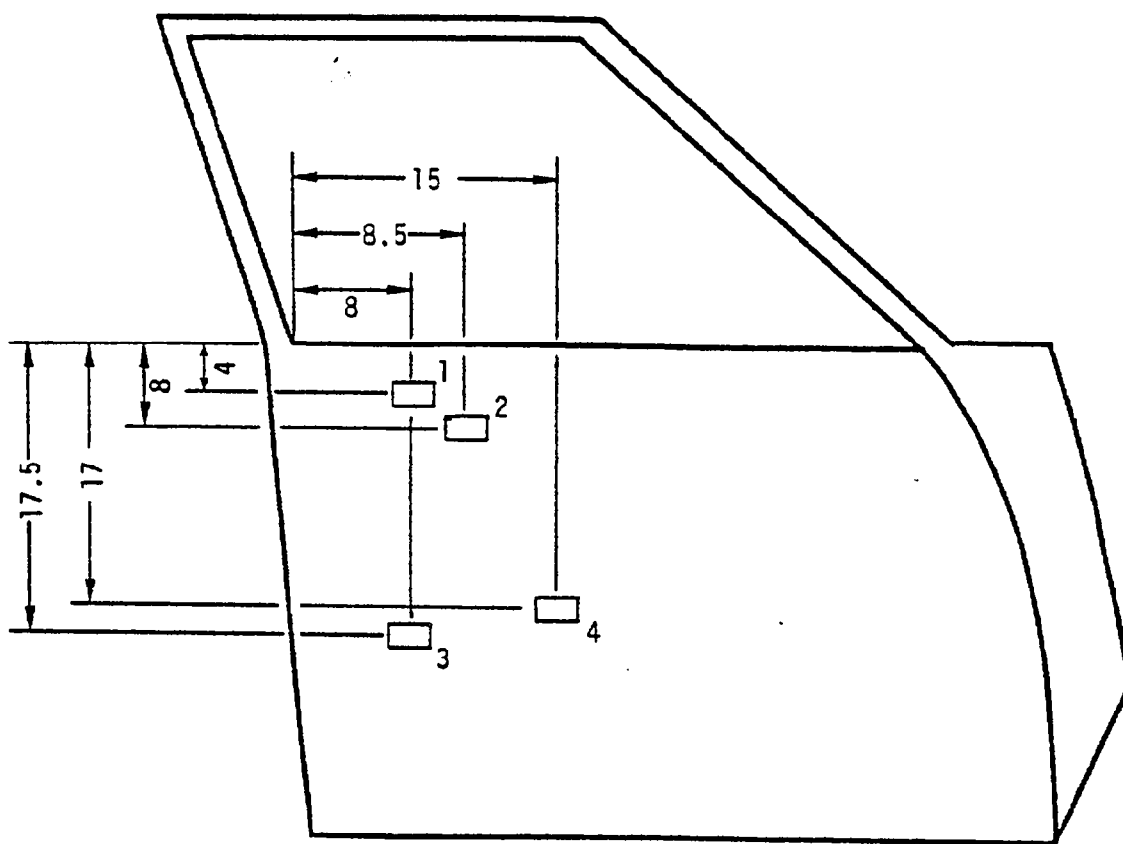
BULLET VEHICLE - MBSI



▲ GYRO  
 □ ACCELEROMETER



TARGET VEHICLE TRANSDUCER LOCATIONS



□ UNIAXIAL ACCELEROMETER

ALL DIMENSIONS IN INCHES

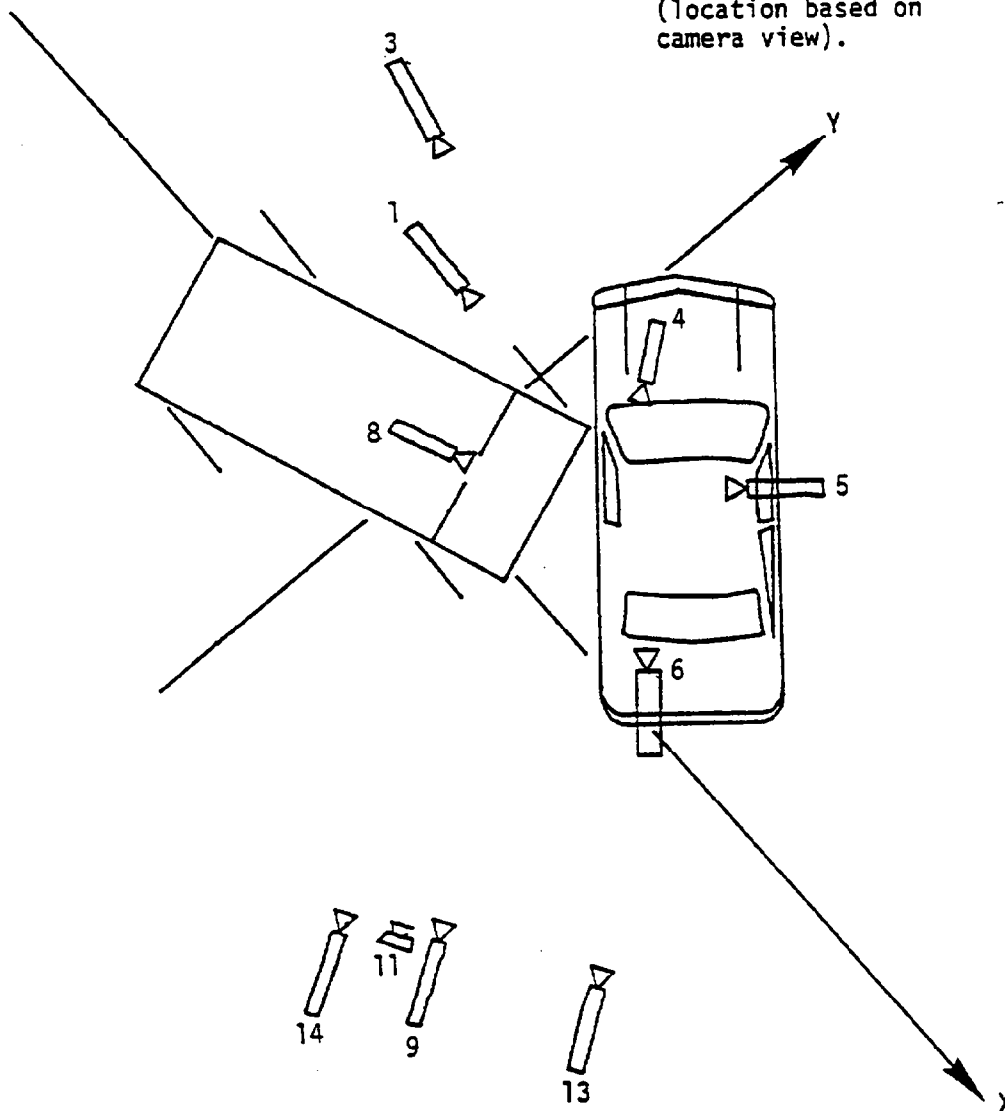
DOOR INSTRUMENTATION  
(INSIDE VIEW DRIVER DOOR)

# INSTRUMENTATION DESCRIPTION AND LOCATION

| INSTRUMENT #             | LOCATION                                                                         | TYPE              | ORIENTATION | RANGE        | SERIAL #                         |
|--------------------------|----------------------------------------------------------------------------------|-------------------|-------------|--------------|----------------------------------|
| 1-4                      | Inner Door Panel (See Previous Page)                                             | Uniaxial          | Y           | 0-200G       | 25797<br>25789<br>19431<br>21041 |
| 5&6                      | Strip switches on door exterior at hip & shoulder impact locations (18" & (29")) | Strip Switches    | N.A.        | N.A.         | N.A.                             |
| 7                        | 23.5" Aft of firewall (CG)                                                       | Triaxial          | X,Y,Z       | 250G's       | 1634 Triax                       |
| 8                        | Engine                                                                           | Biaxial           | X,Y         | 250G's       | 19428, 19430                     |
| 9                        | Trunk area (rear bumper)                                                         | Biaxial           | X,Y         | 250G's       | 20839, 20840                     |
| 10                       | 56" Aft of firewall - mid-compartment                                            | Yaw Rate Gyro     | YAW         | 300 deg/sec. | 371                              |
| <u>IMPACTING VEHICLE</u> |                                                                                  |                   |             |              |                                  |
| 1                        | Centerline at Rear                                                               | Biax              | X,Y         | 250G         | 1680 X,Y                         |
| 2                        | Centerline at Front                                                              | Triax             | X,Y,Z       | 100G         | 1709 Triax                       |
| 3                        | 46" Aft of Front Wheel L(CG)                                                     | Rate Gyro         | YAW         | 300 deg/sec. | G5923                            |
| 4                        | Zero event strip switch on bumper                                                | Strip Switch      | N.A.        | N.A.         | N.A.                             |
| 5                        | Impact strip switch on upper structure                                           | Strip Switch      | N.A.        | N.A.         | N.A.                             |
| 6                        | Behind alum. nose near impact point                                              | Linear Transducer | Y           | N.A.         | N.A.                             |

NOTES:

1. Cameras 15, 16 & 17 are not shown, but are mounted to the overhead tower.
2. Two zero event strobes (inside & outside the Citation) are required (location based on camera view).



CAMERA POSITION DIAGRAM

## CAMERA POSITIONS

| Camera<br>Number | Camera/Magazine    | X    | Y    | Z<br>(Height) |
|------------------|--------------------|------|------|---------------|
| 1                | Photosonic<br>19/6 | -18" | +10' | 29"           |
| 3                | Photosonic<br>4/8  | -24' | +19' | 44"           |
| 9                | Photosonic<br>3/12 | +10' | -21' | 44"           |
| 11               | Nikon              | +8'  | -26' | 54"           |
| 13               | Photosonic<br>16/7 | +18' | -25' | 44"           |
| 14               | Arriflex 16        | +5'  | -36' | 56"           |

See Camera Position Diagram for orientation and zero position.

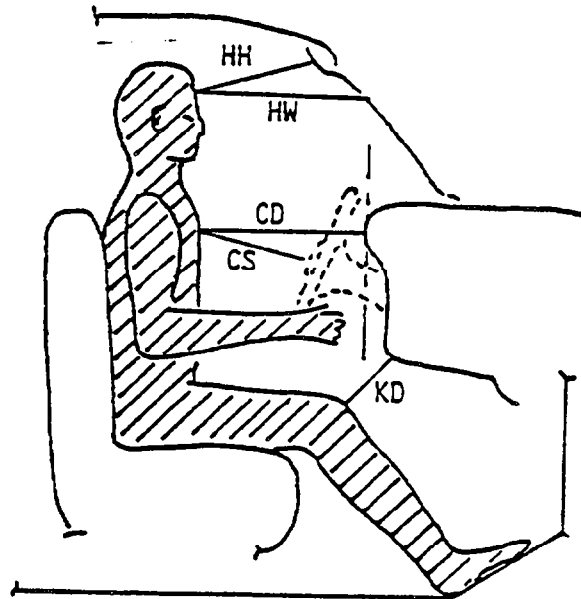


# PHOTOGRAPHIC COVERAGE

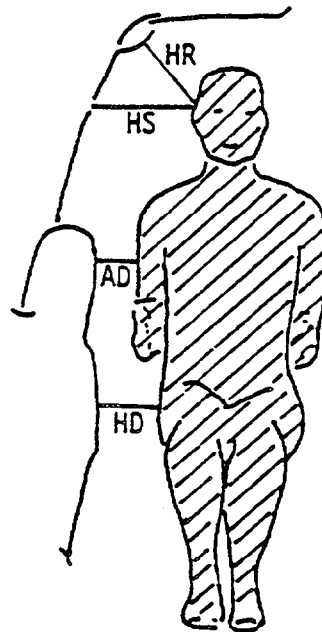
| Camera Number | Location              | Type        | Lens (mm)   | Speed (fps) | Purpose of Camera Data  |
|---------------|-----------------------|-------------|-------------|-------------|-------------------------|
| 1             | Offboard              | Photosonic  | 13          | 1000        | Closeup of impact       |
| 3             | Offboard              | Photosonic  | 13          | 1000        | Closeup of impact       |
| 4             | Onboard hood          | Photosonic  | 8           | 1000        | Occupant kinematics     |
| 5             | Onboard driver window | Photosonic  | 8           | 1000        | Occupant kinematics     |
| 6             | Onboard rear (window) | Photosonic  | 8           | 1000        | Occupant kinematics     |
| 8             | Onboard MBSI          | Photosonic  | 8           | 1000        | Occupant kinematics     |
| 9             | Offboard              | Photosonic  | 13          | 1000        | Closeup of impact       |
| 11            | Offboard              | Nikon FM    | 50          | Motor       | 35 mm sequence of event |
| 13            | Offboard              | Photosonic  | 13          | 1000        | Closeup of impact       |
| 14            | Offboard              | Arriflex 16 | 10-120 Zoom | 24          | Documentary             |
| 16            | Tower                 | Photosonic  | 13          | 1000        | Closeup of impact       |
| 17            | Tower                 | Photosonic  | 8           | 1000        | Overall view            |

# OCCUPANT CLEARANCE DIMENSIONS

|     | ACTUAL | TARGET |
|-----|--------|--------|
| HH  | 13.5   | 13.5   |
| HW  | N/A    | N/A    |
| CD  | 22.0   | 22.0   |
| CS  | 12.5   | 12.5   |
| KDL | 5.5    | 5.5    |
| KDR | 5.25   | 5.5    |



|    | ACTUAL | TARGET |
|----|--------|--------|
| HR | 6.5    | 6.5    |
| HS | N/A    | N/A    |
| AD | 5.25   | 5.25   |
| HD | 6.5    | 6.5    |



NOTE: ALL DIMENSIONS IN INCHES

PRE-TEST POSITION OF THE CITATION

Left Front

X 78"  
Y 70"

Right Front

X -35"  
Y 117"

Left Rear

X 0"  
Y 0"

Right Rear

X 42"  
Y 46"

POST-TEST FINAL RESTING POSITIONS OF BOTH VEHICLES

Citation

Left Front

X 486"  
Y 346"

Right Front

X 426"  
Y 380"

Left Rear

X 538"  
Y 432"

Right Rear

X 488"  
Y 460"

MBSI

Left Front

X 882"  
Y -190"

Right Front

X 884"  
Y -111"

Left Rear

X 977"  
Y 192"

Right Rear

X 986"  
Y -111"

See Camera Position Diagram for orientation.

## COMMENTS ON TEST 2600 INSTRUMENTATION

1. The head I.S. data channel contains noise spikes at approximately 70 ms. The reason for this noise is not known, however, it does not appear to significantly affect the H.I.C. By plotting the head resultant we can calculate the HIC over the time frame of  $2.054 - .08$  ms with the noise removed by the equation  $H.I.C. = (t_2 - t_1) \bar{a}^{2.5}$ . This gives an approximate H.I.C. of 3079 vs. 3498 for the trace including the noise. For the purposes of this report we will use the corrected H.I.C. value because we feel it more accurately portrays reality.
2. Door accelerometer #2 is questionable after the initial peak due to the fact that first integral Vs drops down to approximately -10 ft/sec. where approximately 25-30 ft/sec. is reasonable and evident in the other three door accelerometers. It is believed that this is caused by the rotation of the accelerometer due to the crush and distortion of the door inner panel.

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### SECTION 3

#### TEST RESULTS

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# SUMMARY OF RESULTS

Test Number: 2600

Project Title: MIV Side Impact

Date: 4/27/83

Time: 12:30 pm Temperature: 70°F

|                               | <u>Subject Vehicle</u>       | <u>Impacting Vehicle/Object</u> |
|-------------------------------|------------------------------|---------------------------------|
| <u>General</u>                |                              |                                 |
| Vehicle/object description    | 4-door Chevrolet Citation    | MBSI                            |
| Test weight (lbs)             | 3109                         | 3000                            |
| Test velocity (mph)           | 0                            | 46.45                           |
| <u>Vehicle Response Data</u>  |                              |                                 |
| Maximum crush (inches)        |                              |                                 |
| Static                        | 16.5                         | 12.25                           |
| Dynamic                       | N/A                          | N/A                             |
| Maximum intrusion (inches)    | 15.0                         | N/A                             |
| <u>Occupant Response</u>      |                              |                                 |
| HIC                           | 3079 from .054 to .08 sec.** |                                 |
| Head SI                       | N/A                          |                                 |
| Max. resultant head Gs        | 238.3 (peak)                 | 195.6 (3 msec)                  |
| Max. A-P head Gs              | 154.5 (peak)                 | 104.7 (3 msec)                  |
| Max. S-I head Gs              | 218.9* (peak)                | 101.8 (3 msec)                  |
| Max. R-L head Gs              | 190.2 (peak)                 | 97.1 (3 msec)                   |
| Chest SI                      | 2775 upper                   | 1388 lower                      |
| Chest R-L deflection (inches) | 1.86 (peak)                  | 1.86 (3 msec)                   |
| Max. resultant chest Gs       | 171.7 upper (peak)           | 161.2 upper (3 msec)            |
|                               | 109.0 lower (peak)           | 105.0 lower (3 msec)            |
| Max. A-P chest Gs             | 35.4 upper (peak)            | 33.0 upper (3 msec)             |
|                               | 31.9 lower (peak)            | 30.2 lower (3 msec)             |
| Max. S-I chest Gs             | 26.2 upper (peak)            | 24.5 upper (3 msec)             |
|                               | 12.2 lower (peak)            | 10.5 lower (3 msec)             |
| Max. R-L chest Gs             | 168.0 upper (peak)           | 159.2 upper (3 msec)            |
|                               | 104.8 lower (peak)           | 100.5 lower (3 msec)            |
| Max. resultant pelvic Gs      | 90.8 (peak)                  | 81.2 (3 msec)                   |
| Max. A-P pelvic Gs            | 16.8 (peak)                  | 13.9 (3 msec)                   |
| Max. S-I pelvic Gs            | 26.9 (peak)                  | 15.9 (3 msec)                   |
| Max. R-L pelvic Gs            | 89.5 (peak)                  | 80.4 (3 msec)                   |
| Max. femur load - right (lbs) | N/A                          | N/A                             |
| Max. femur load - left (lbs)  | N/A                          | N/A                             |

\*Noisy Data

\*\*Head I.S. noise removed



# SUMMARY OF RESULTS (cont'd)

## Occupant Response (cont'd)

|                             |                           |                                |
|-----------------------------|---------------------------|--------------------------------|
| Max. R-L left upper rib Gs  | 102.9 (peak)              | 89.6 (3 msec)                  |
| Max. R-L right upper rib Gs | 107.1 (peak)              | 103.9 (3 msec)                 |
| Max. R-L left lower rib Gs  | 100.9 (peak)              | 88.1 (3 msec)                  |
| Max. R-L right lower rib Gs | 117.9 (peak)              | 112.9 (3 msec)                 |
| Max. A-P upper sternum Gs   | 90.2 (peak)               | 84.0 (3 msec)                  |
| Max. A-P lower sternum Gs   | 79.5 (peak)               | 69.2 (3 msec)                  |
| B(LUR) 7.1254               | PAP(LUR) 3714.99 WATTS/KG | FROM .034375 TO .05625 SECONDS |
| B(LLR) 7.09841              | PAP(LLR) 3726.61 WATTS/KG | FROM .035 TO .058125 SECONDS   |

|                              |                                         |
|------------------------------|-----------------------------------------|
| Peak power (T1) (lat.)       | 211,913 ft <sup>2</sup> /s <sup>3</sup> |
| Peak power (T1) (res.)       | 230,180 ft <sup>2</sup> /s <sup>3</sup> |
| Peak power (T12) (lat.)      | 119,235 ft <sup>2</sup> /s <sup>3</sup> |
| Peak power (T12) (res.)      | 126,277 ft <sup>2</sup> /s <sup>3</sup> |
| Peak lat. acceleration (T1)  | 168.0 Gs (peak) 159.2 Gs (3 msec)       |
| Peak res. acceleration (T1)  | 171.7 Gs (peak) 161.2 Gs (3 msec)       |
| Peak lat. acceleration (T12) | 104.8 Gs (peak) 100.5 Gs (3 msec)       |
| Peak res. acceleration (T12) | 109.0 Gs (peak) 105.0 Gs (3 msec)       |

PAP(T1) 8924.74 Watts/Kg. from .04625 to .058125 seconds  
PAP(T12) 5849.27 Watts/Kg. from .038125 to .05875 seconds

## PHOTOGRAPHS

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PRE-TEST PHOTOGRAPHS



FIGURE 1. CRASH CONFIGURATION - DRIVERS SIDE FRONT



FIGURE 2. CRASH CONFIGURATION - DRIVERS SIDE REAR

PRE-TEST PHOTOGRAPHS



FIGURE 3. SUBJECT VEHICLE - PASSENGER SIDE



FIGURE 4. SUBJECT VEHICLE- DRIVERS SIDE

PRE-TEST PHOTOGRAPHS

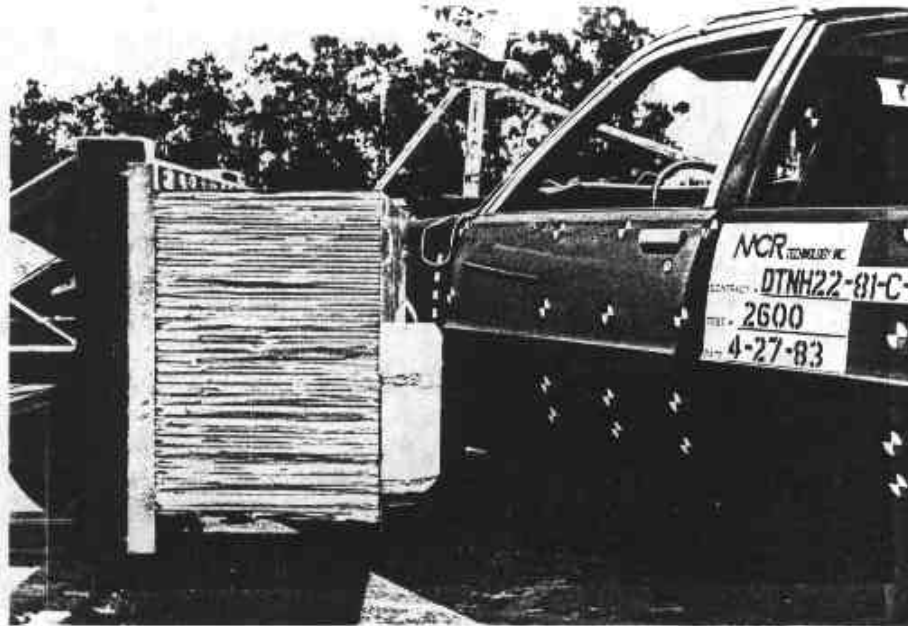


FIGURE 5. CLOSE-UP OF DRIVERS SIDE DOOR IMPACT AREA



Figure 6. ALIGNMENT OF MBSI TO CITATION

PRE-TEST PHOTOGRAPHS

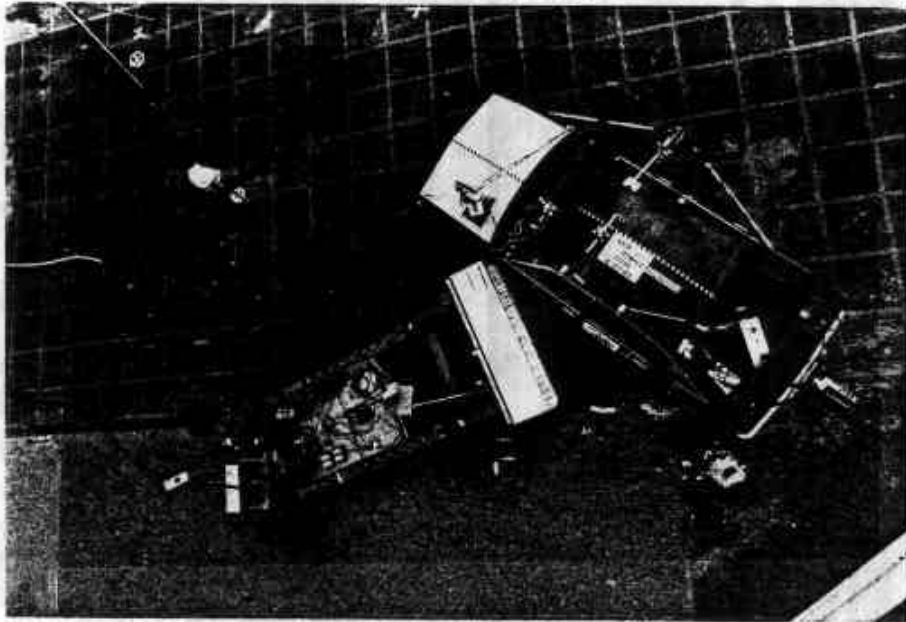


FIGURE 7. CRASH CONFIGURATION - OVERHEAD

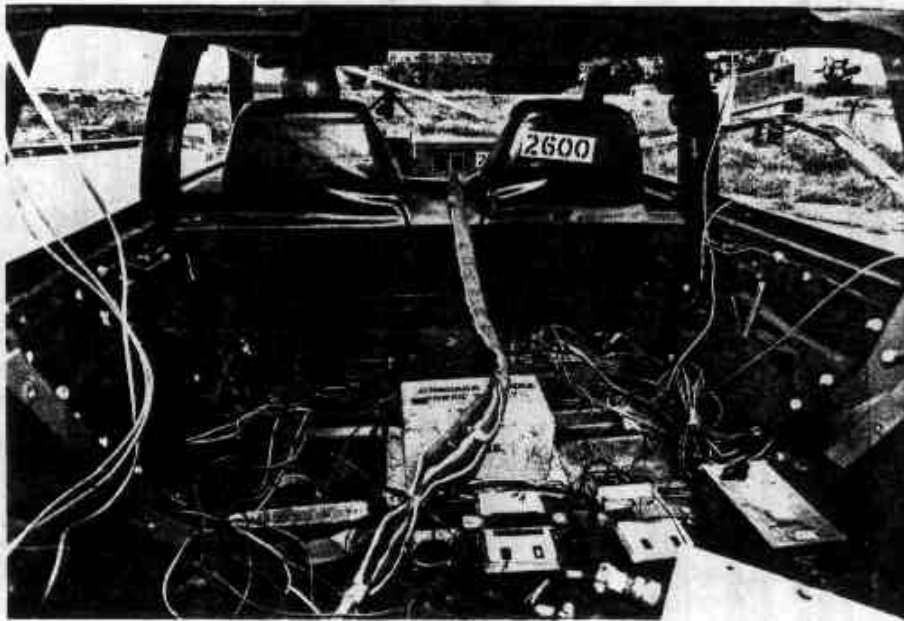


FIGURE 8. SUBJECT VEHICLE - REAR INTERIOR VIEW

PRE-TEST PHOTOGRAPHS



FIGURE 9. OCCUPANT POSITION FROM DRIVERS SIDE



FIGURE 10. OCCUPANT POSITION FROM PASSENGER SIDE



POST-TEST PHOTOGRAPHS



FIGURE 11. FINAL RESTING POSITION



FIGURE 12. VEHICLE DAMAGE - DRIVERS SIDE

POST-TEST PHOTOGRAPHS



FIGURE 13. CLOSE UP OF VEHICLE DAMAGE - DRIVERS SIDE

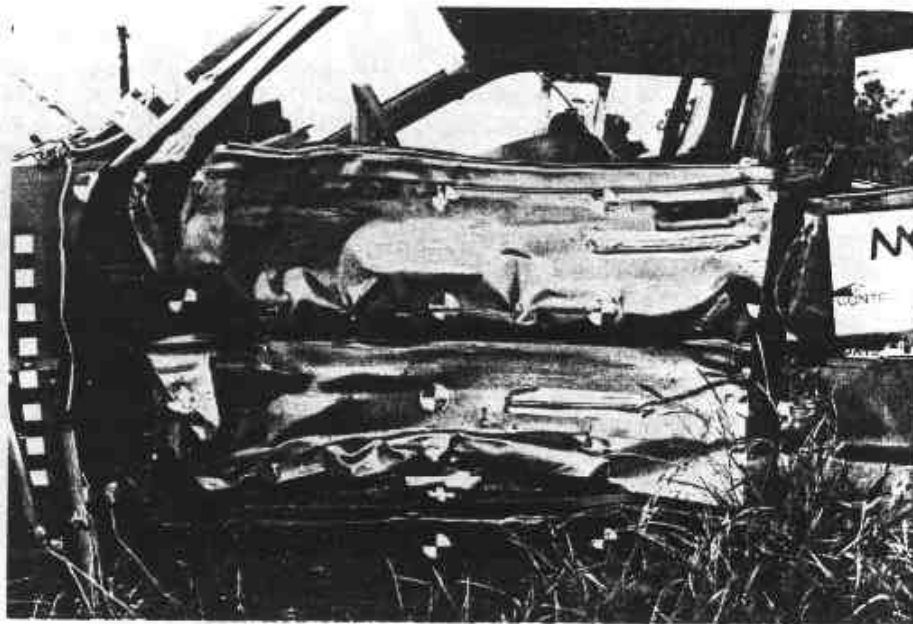


FIGURE 14. DAMAGE TO VEHICLE DRIVER SIDE FRONT DOOR AREA

POST-TEST PHOTOGRAPHS



FIGURE 15. DAMAGE TO VEHICLE DRIVER SIDE REAR DOOR AREA



FIGURE 16. VEHICLE DAMAGE - PASSENGER SIDE

POST-TEST PHOTOGRAPHS

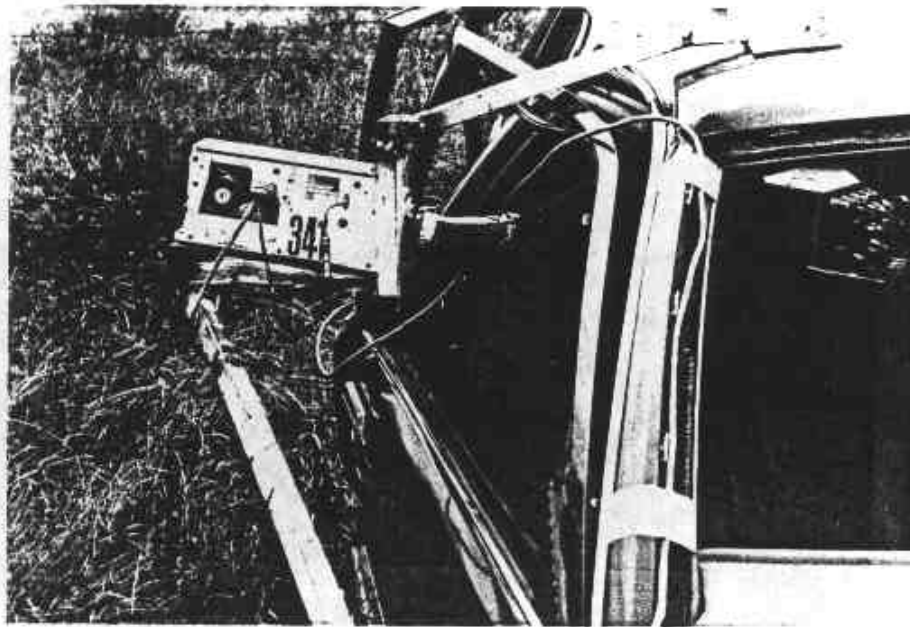


FIGURE 17. CLOSE UP OF VEHICLE DAMAGE - PASSENGER SIDE



FIGURE 18. INTERIOR DAMAGE - REAR VIEW

POST-TEST PHOTOGRAPHS



FIGURE 19. OCCUPANT POSITION FROM DRIVERS SIDE



FIGURE 20. OCCUPANT POSITION FROM PASSENGER SIDE





FIGURE 21. OCCUPANT POSITION FRONT VIEW

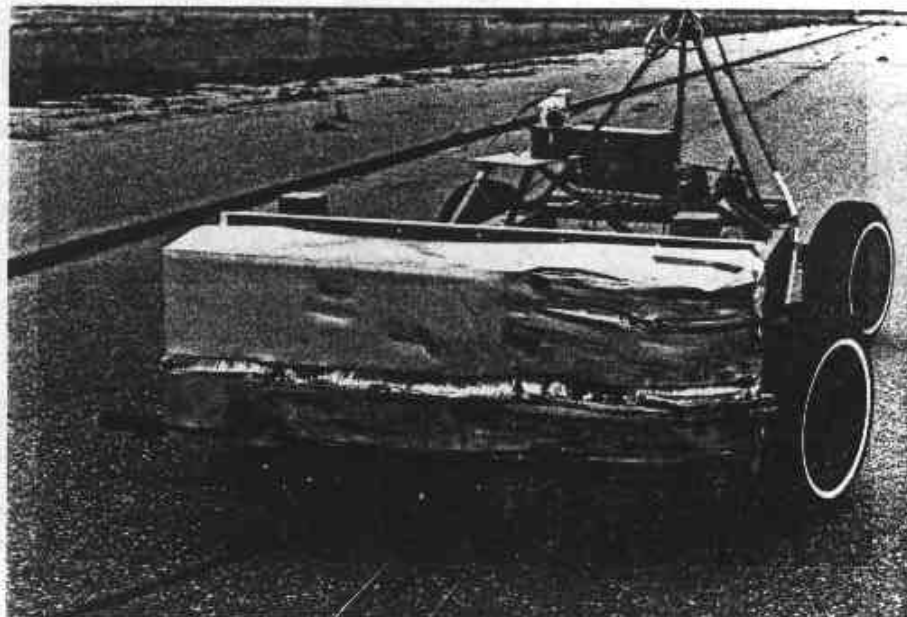


FIGURE 22. MBSI DAMAGE

Intentionally Blank

DATA TRACES



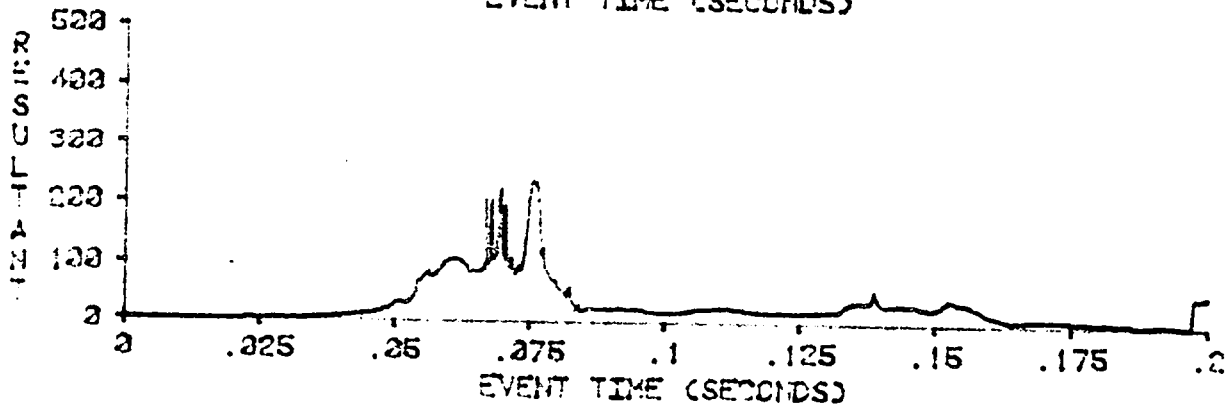
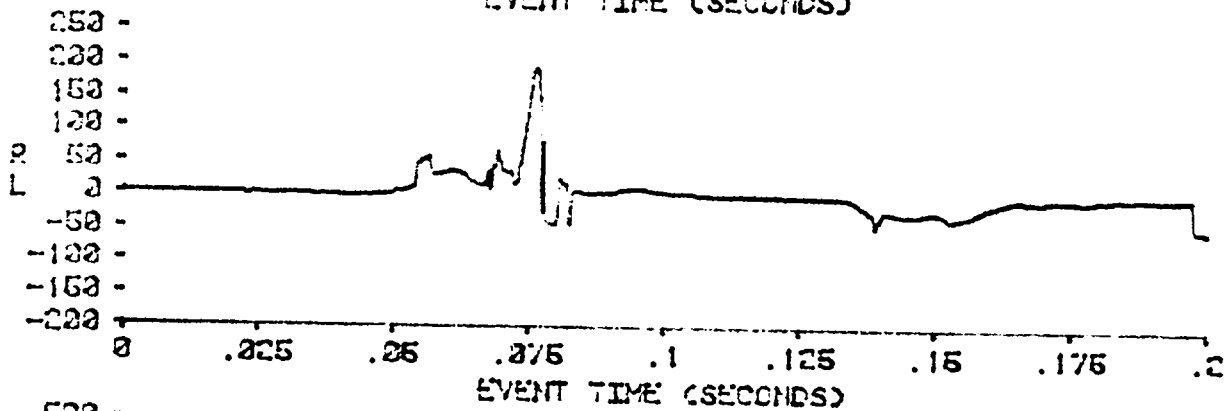
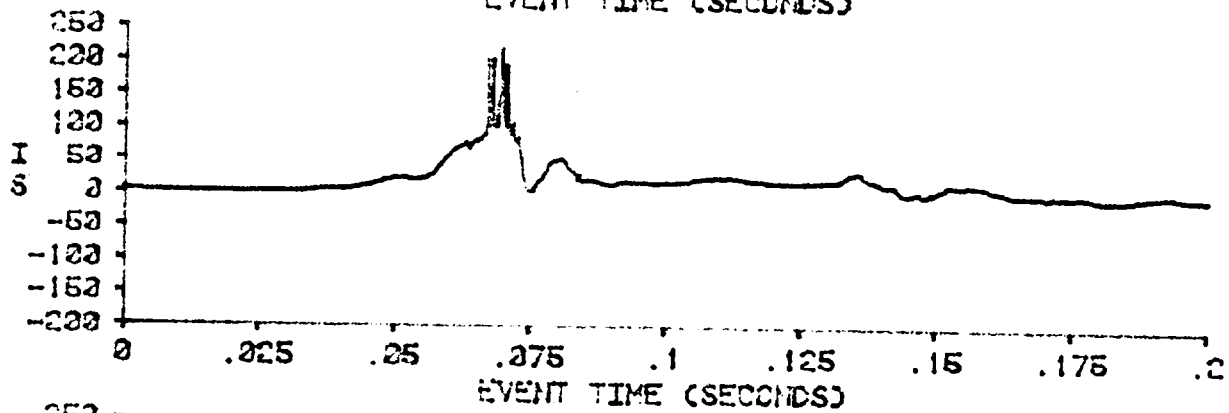
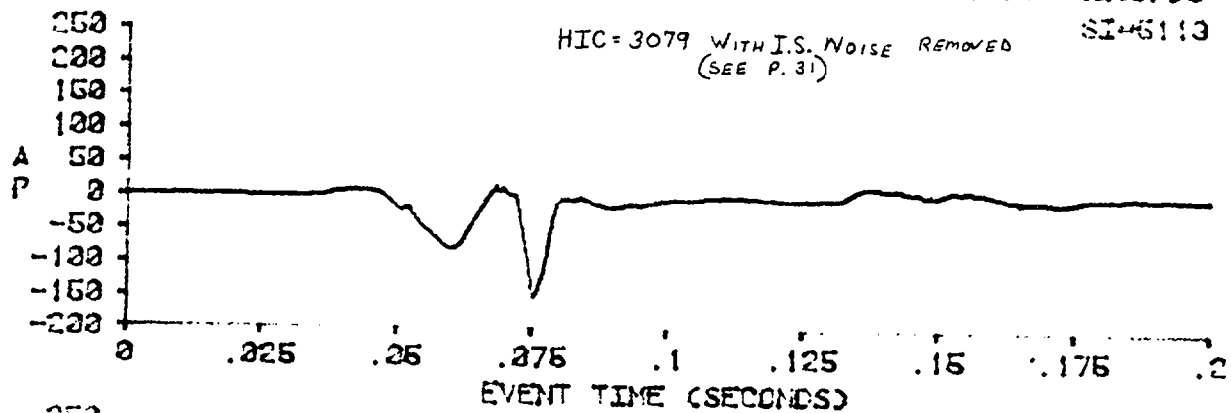
Intentionally Blank

VEHICLE 1 - CITATION - 0 MPH  
DUMMY HEAD G'S  
FILTER CLASS 1000

TEST 2600  
4/27/83  
SIM#113

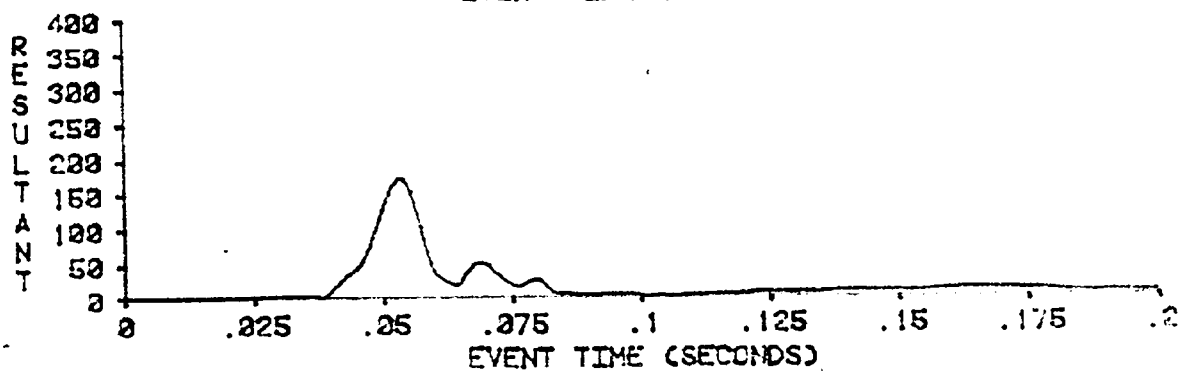
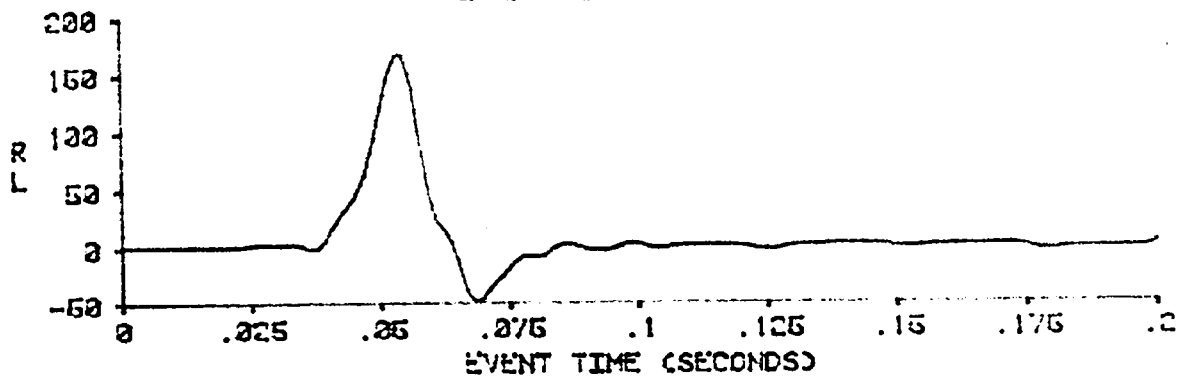
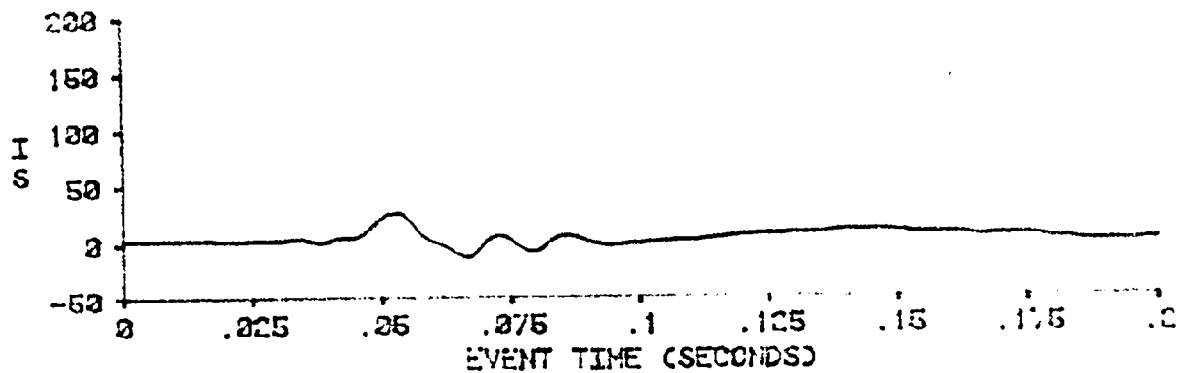
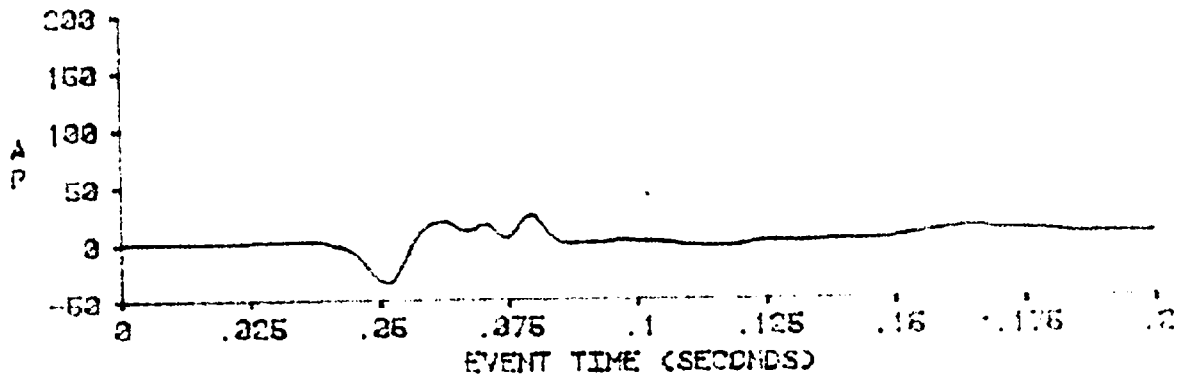
HIC=3438 FROM .064 TO .0798 SECONDS

HIC=3079 WITH I.S. NOISE REMOVED  
(SEE P. 31)



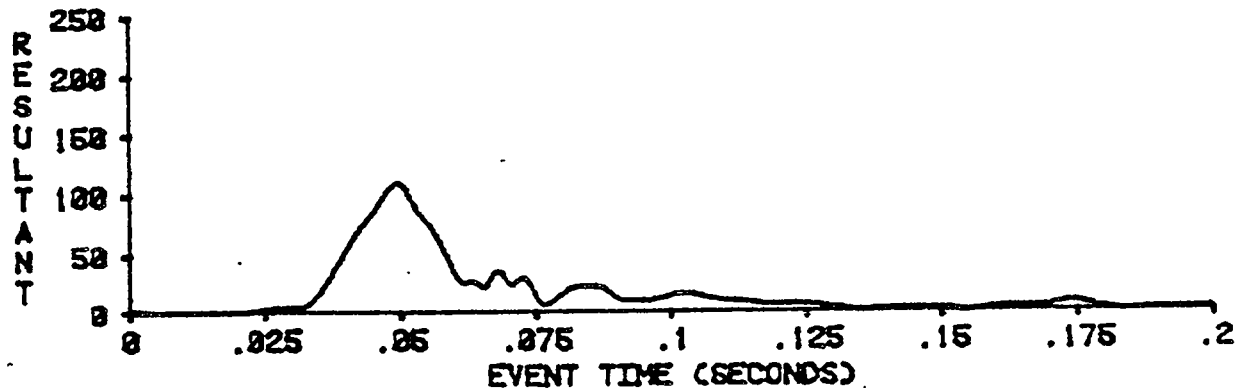
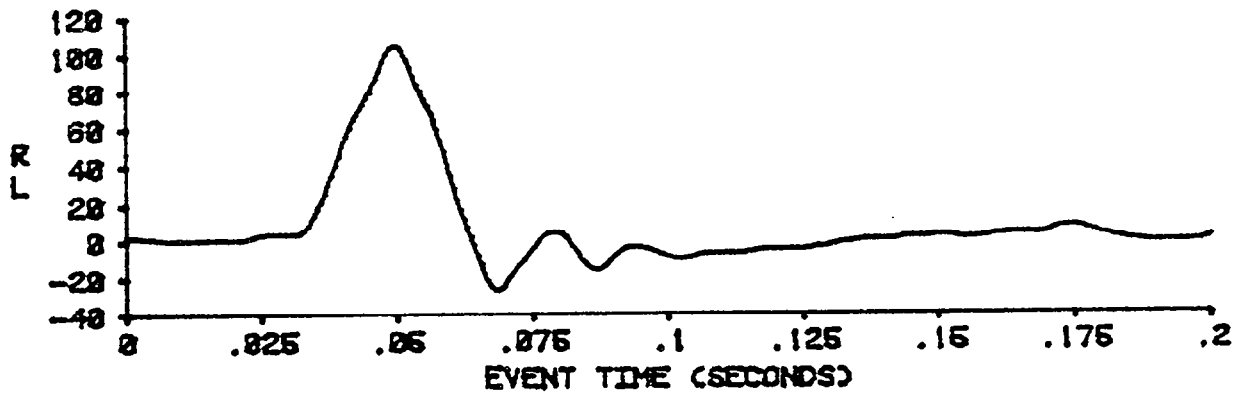
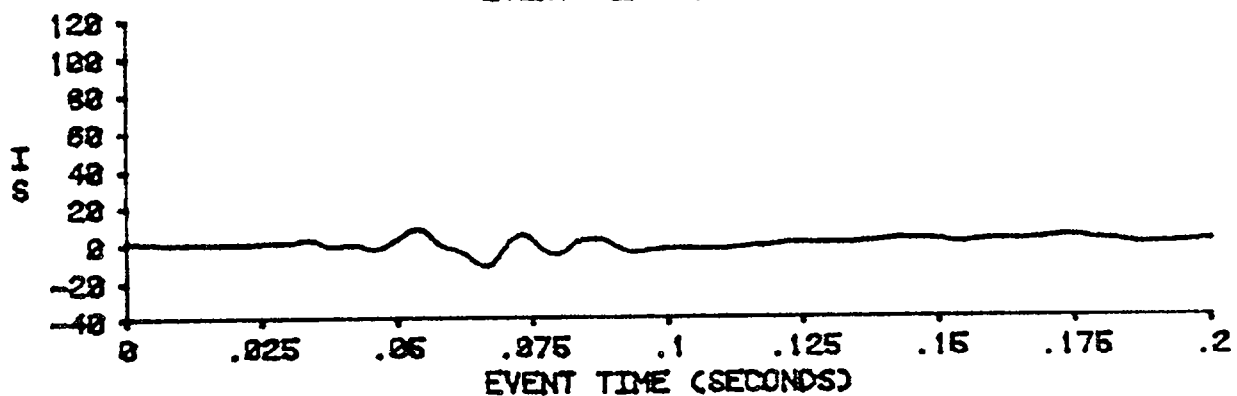
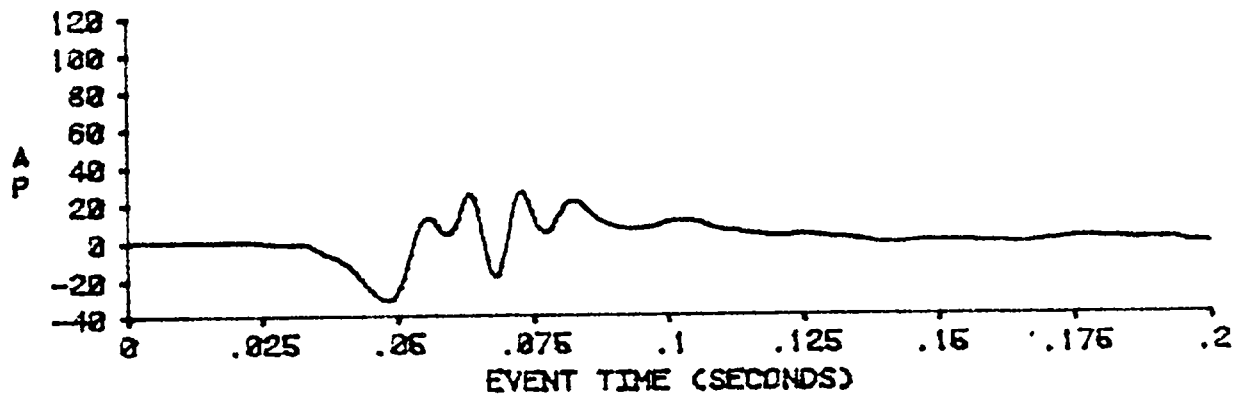
VEHICLE 1 - CITATION - 2 MPH  
DUMMY UPPER SPINE G'S  
FILTER: FIR

TEST 2600  
4/27/83  
SINCE 1975



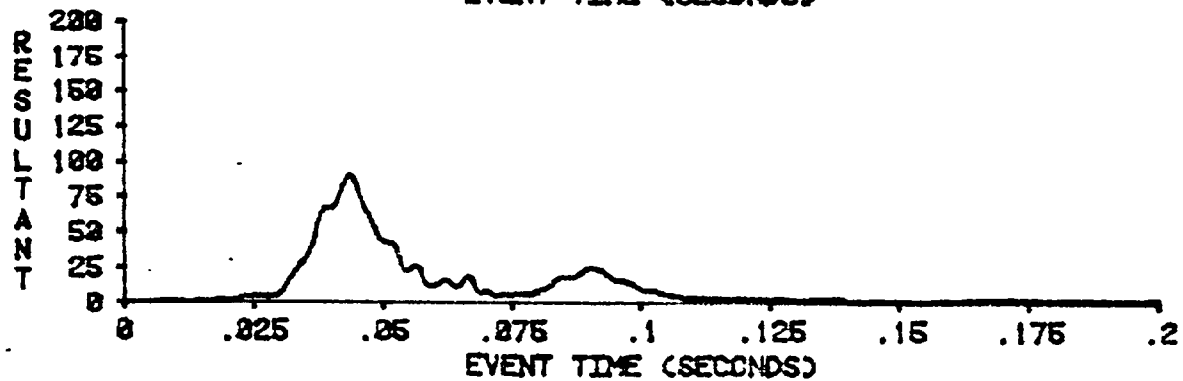
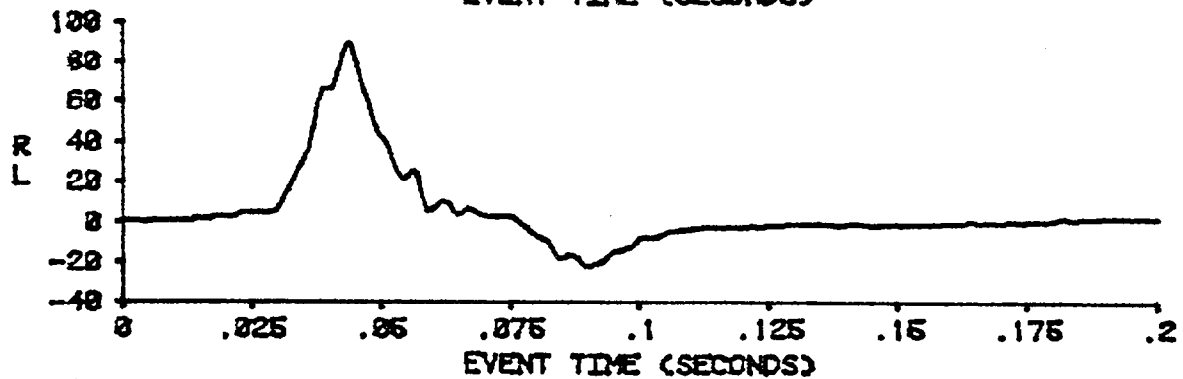
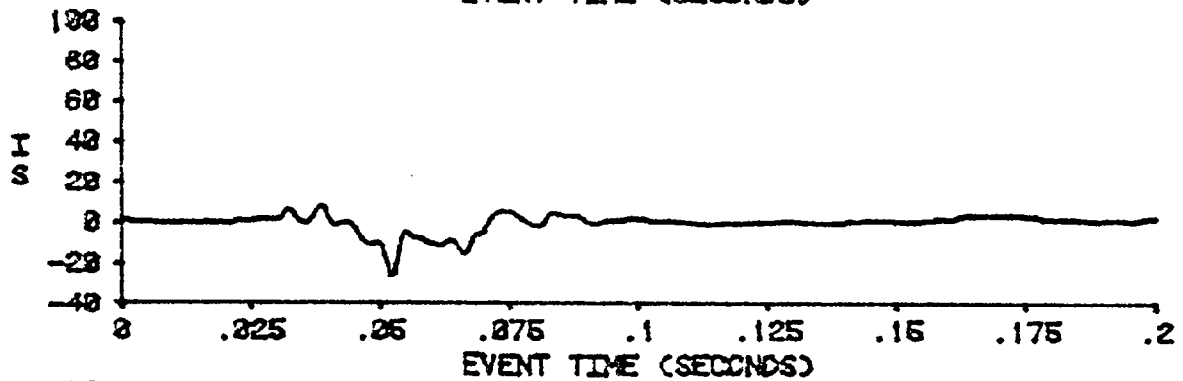
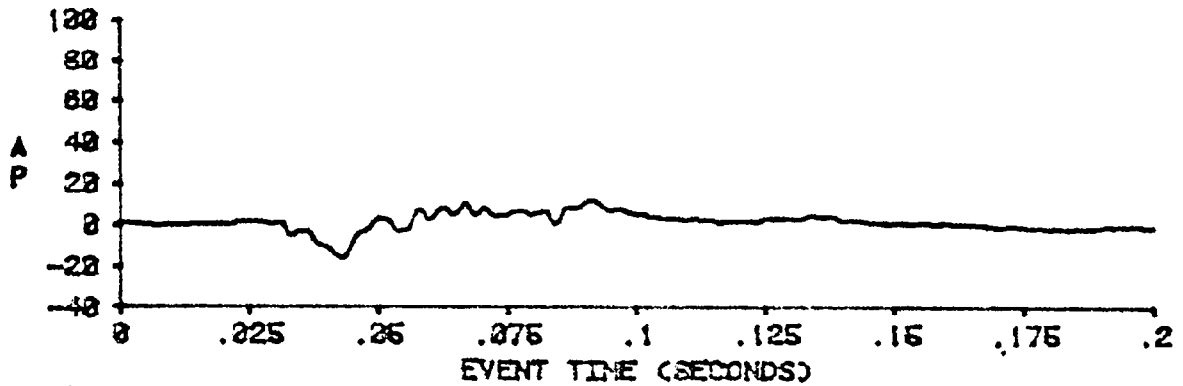
VEHICLE 1 - CITATION - 0 MPH  
DUMMY LOWER SPINE G'S  
FILTER: FIR

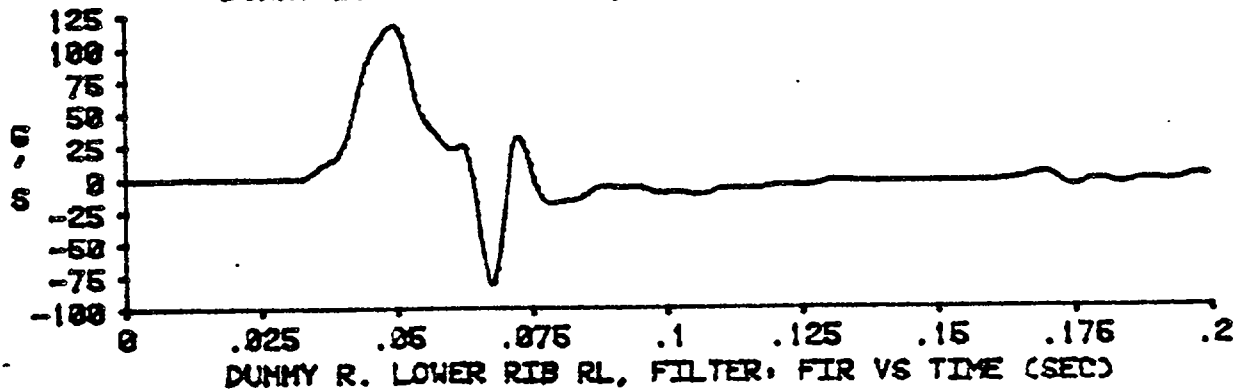
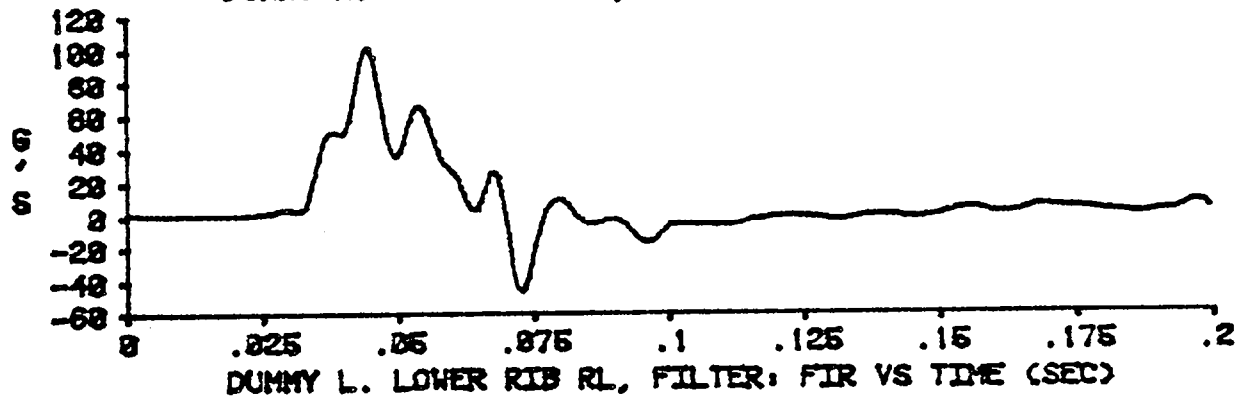
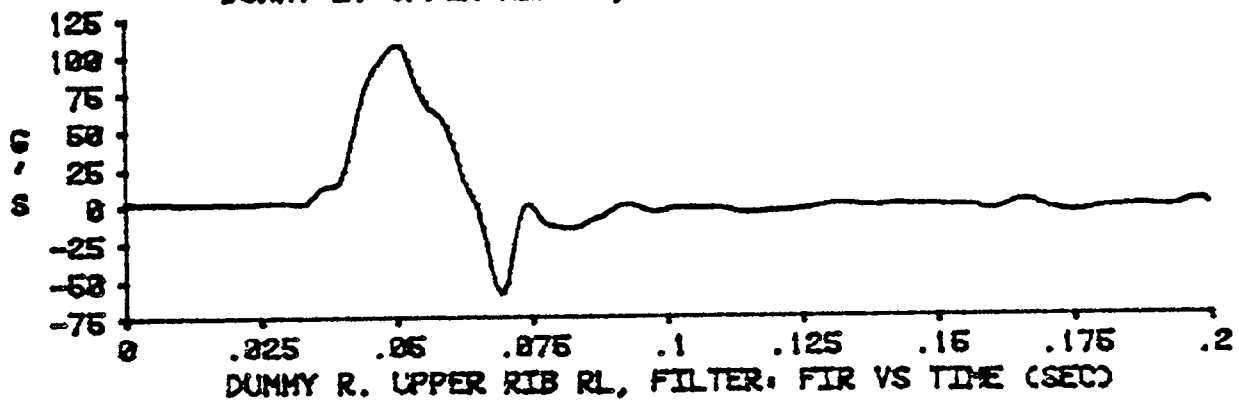
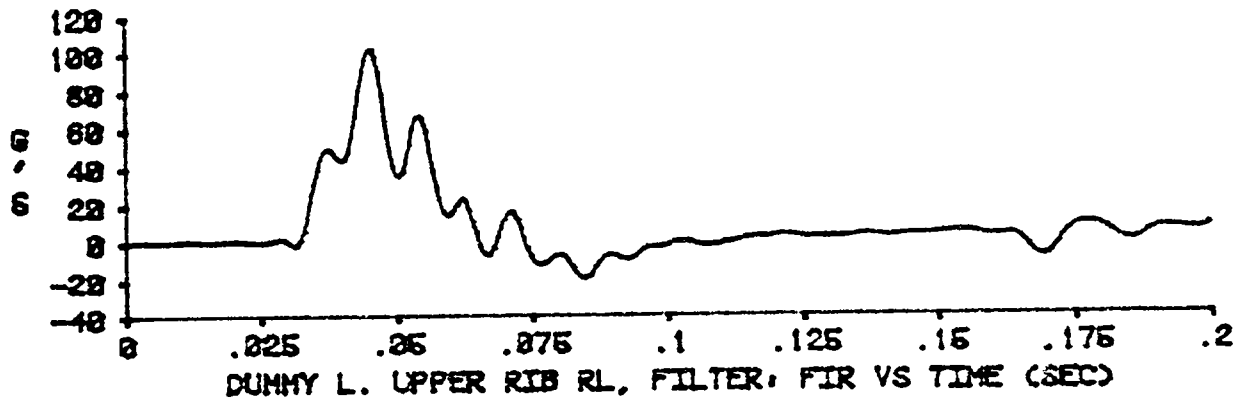
TEST 2600  
4/27/83  
SI=1388



VEHICLE 1 - CITATION - 3 MPH  
DUMMY PELVIS G'S  
FILTER CLASS 180

TEST 2600  
4/27/83

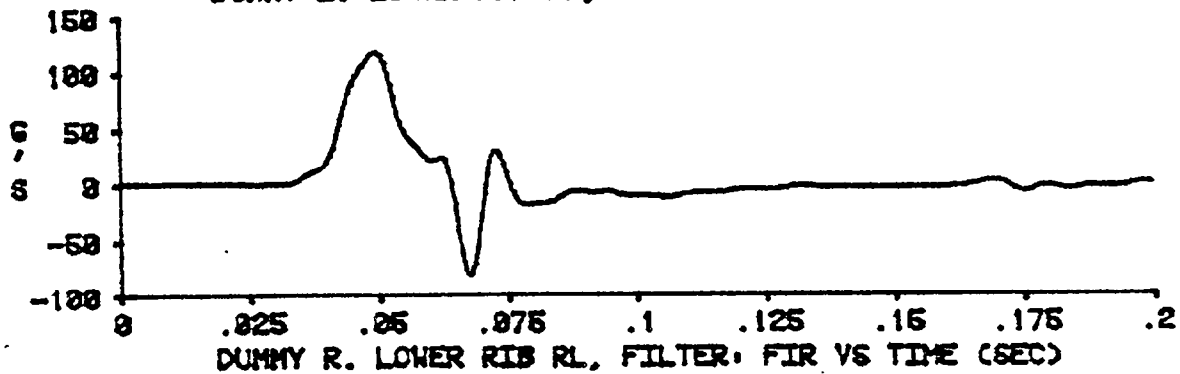
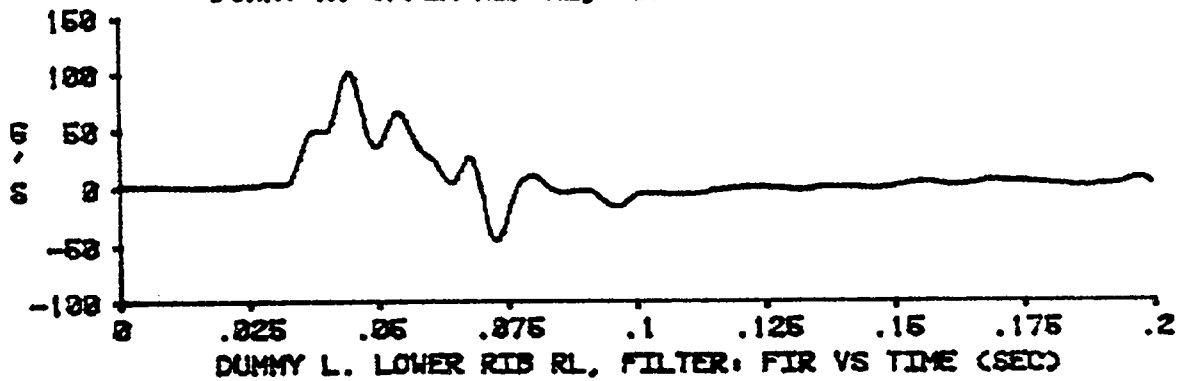
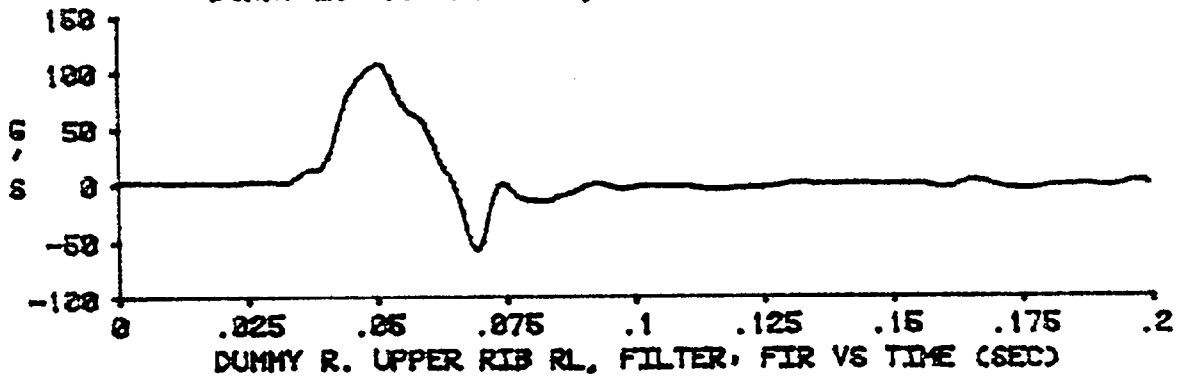
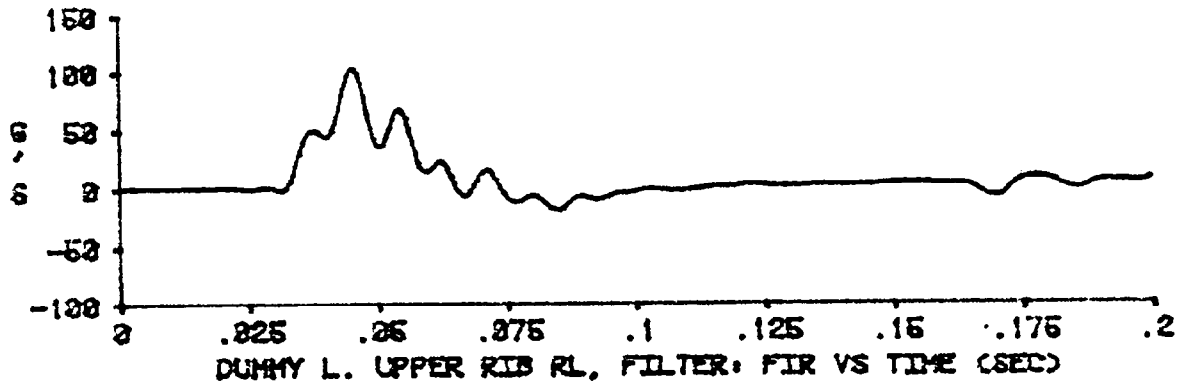


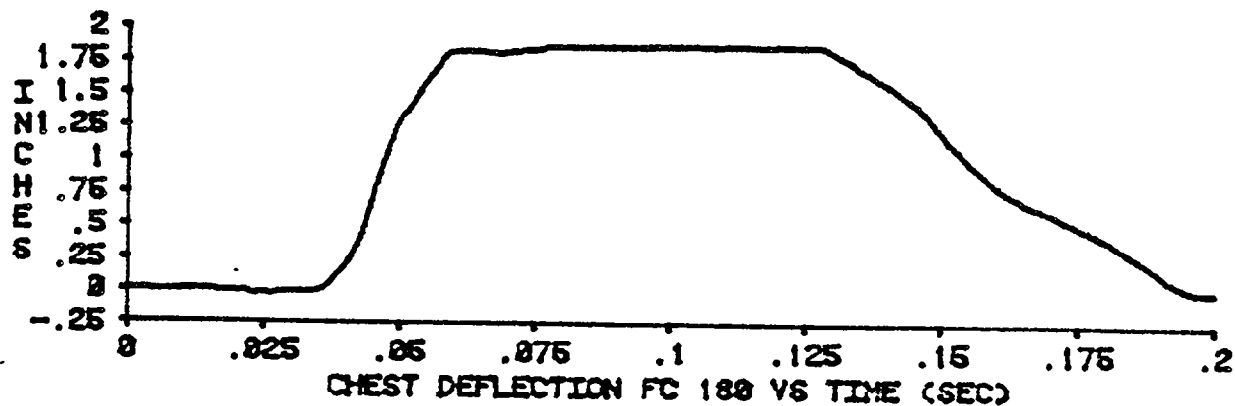
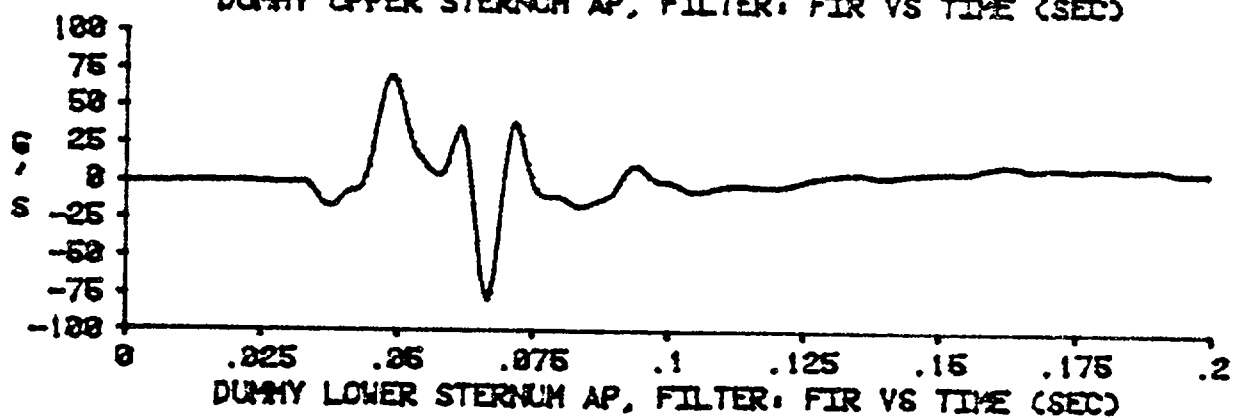
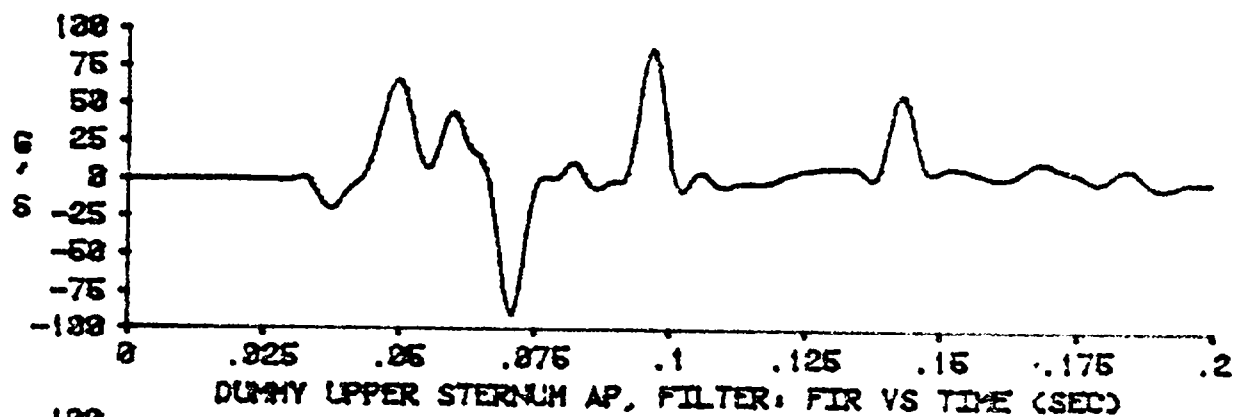


VEHICLE 1 - CITATION - 8 MPH

TEST 2600

4/27/83



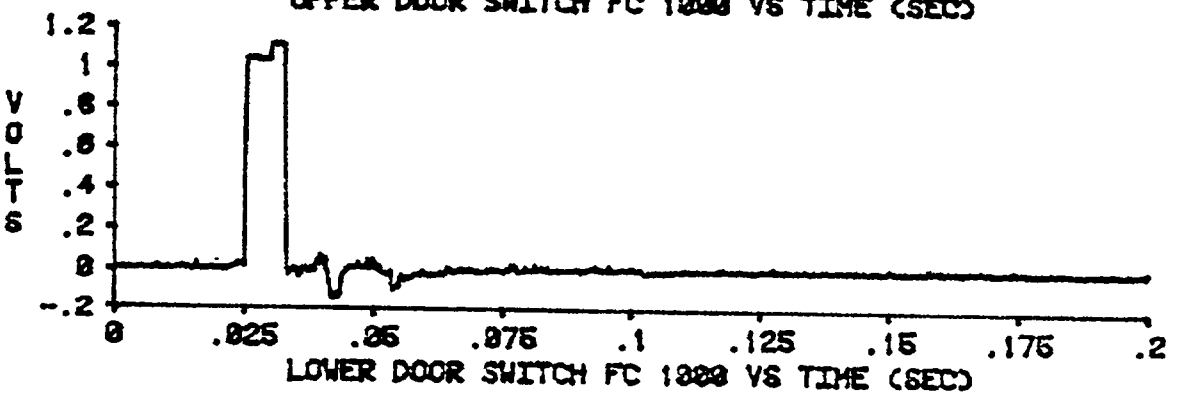
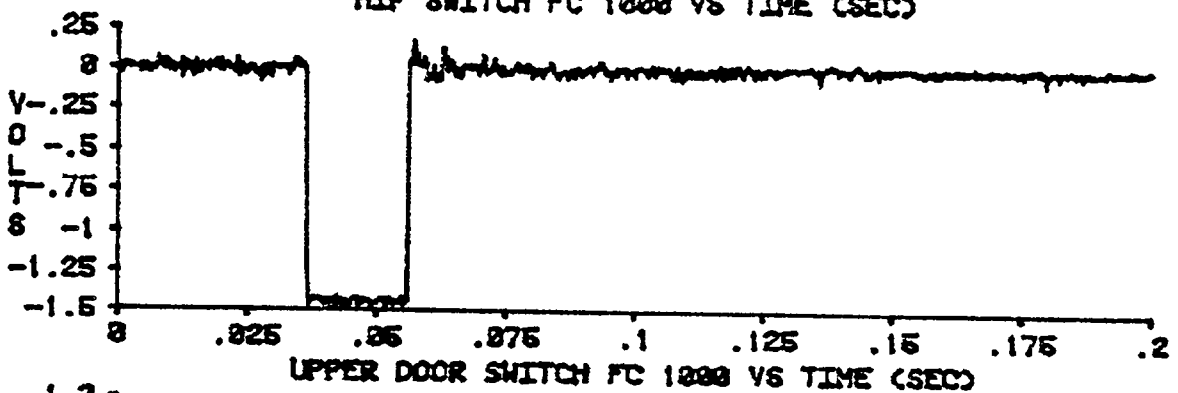
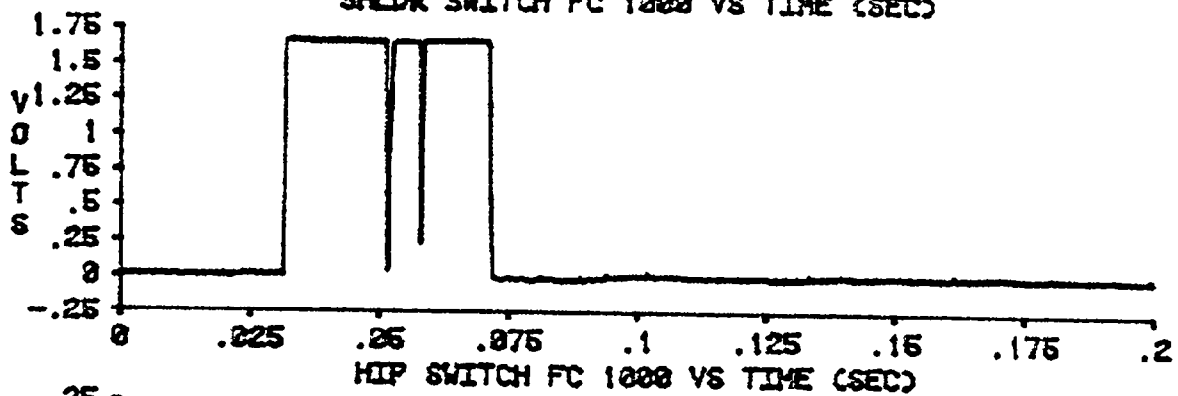
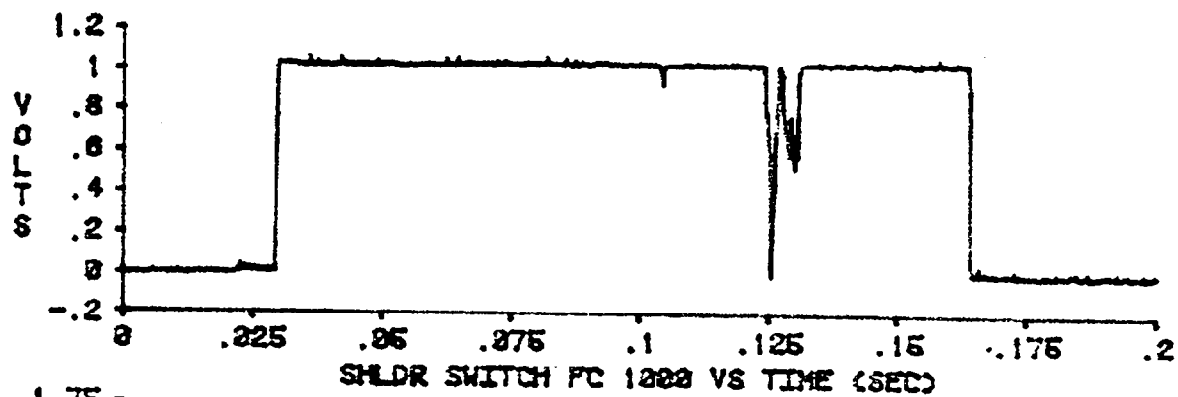




VEHICLE 1 - CITATION - 8 MPH

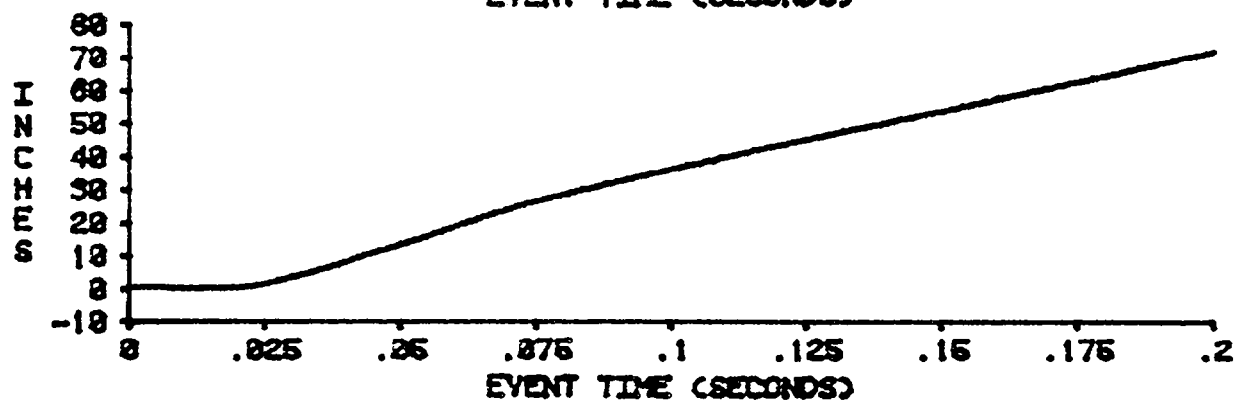
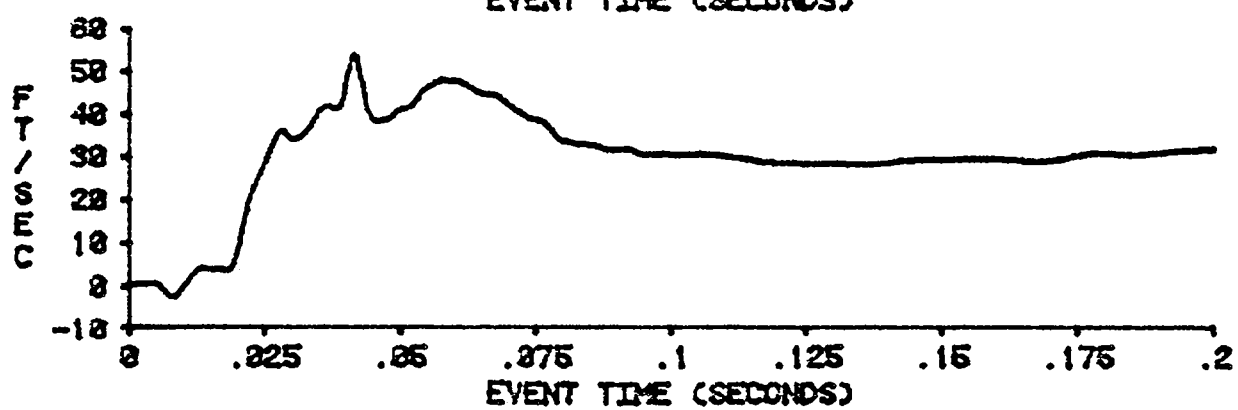
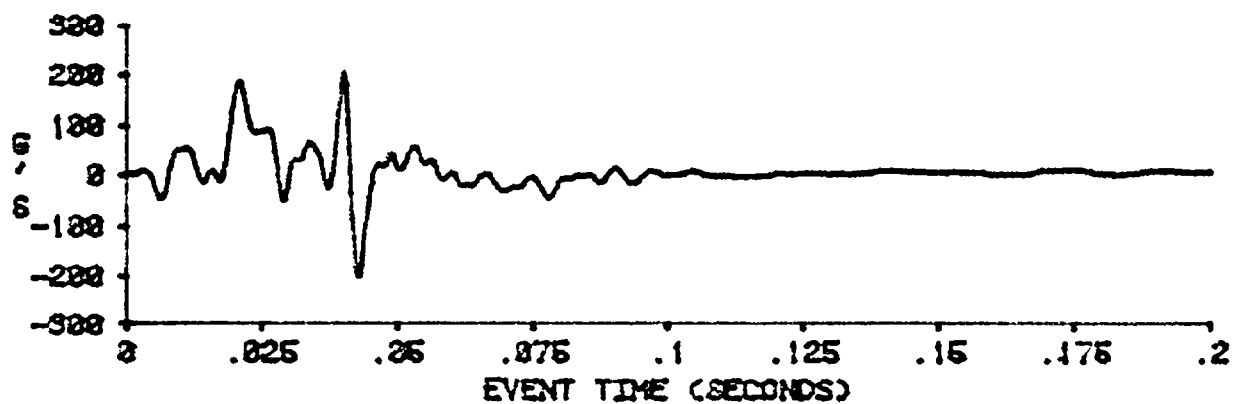
TEST 2600

4/27/83



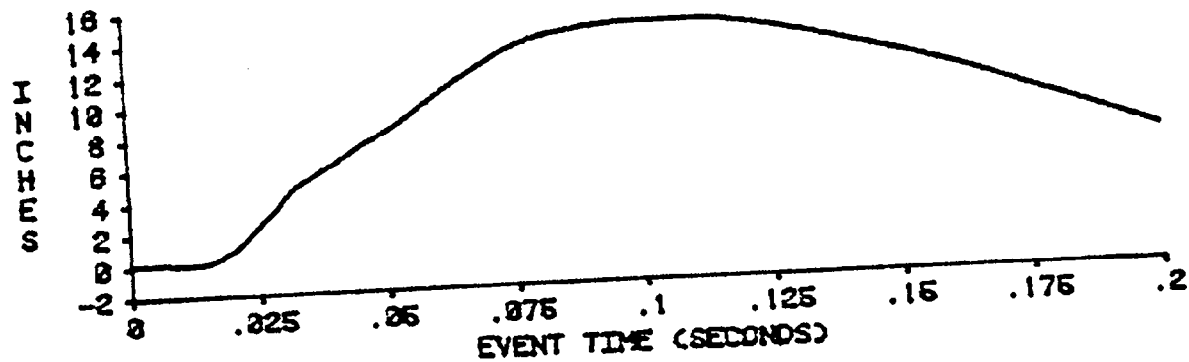
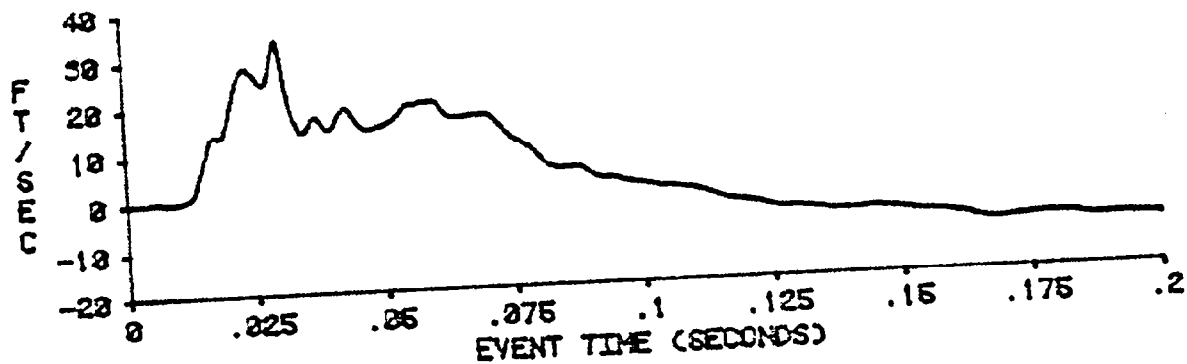
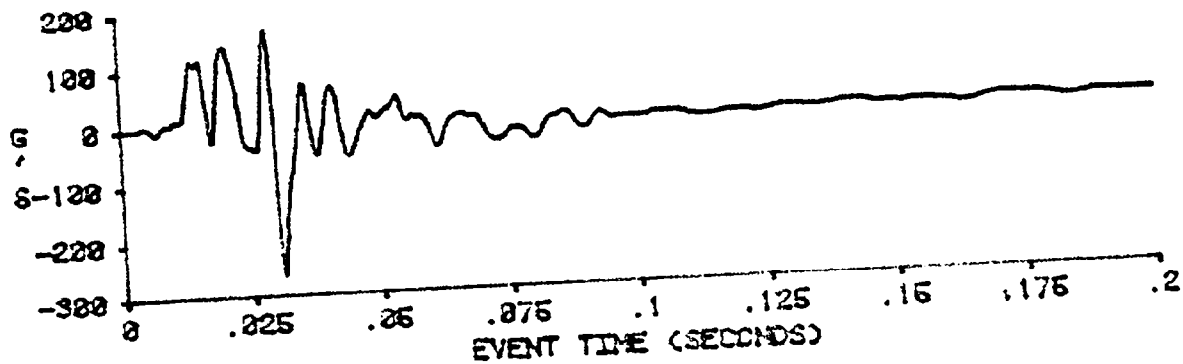
VEHICLE 1 - CITATION - 3 MPH  
DOOR 1 RL  
FILTER CLASS 180

TEST 2600  
4/27/83



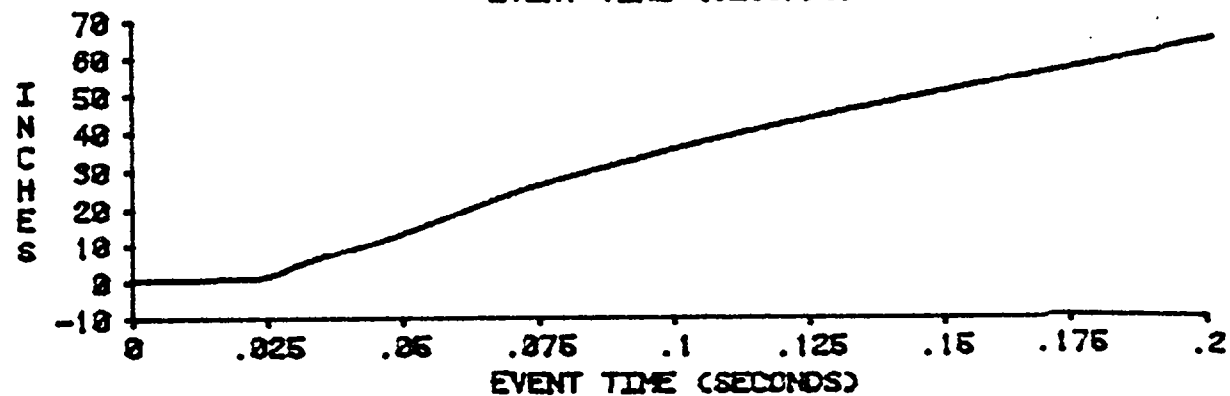
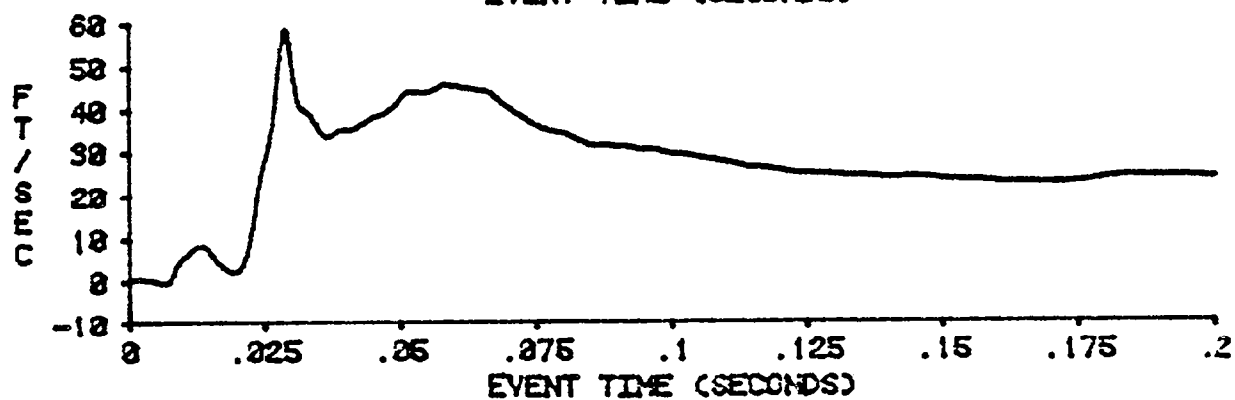
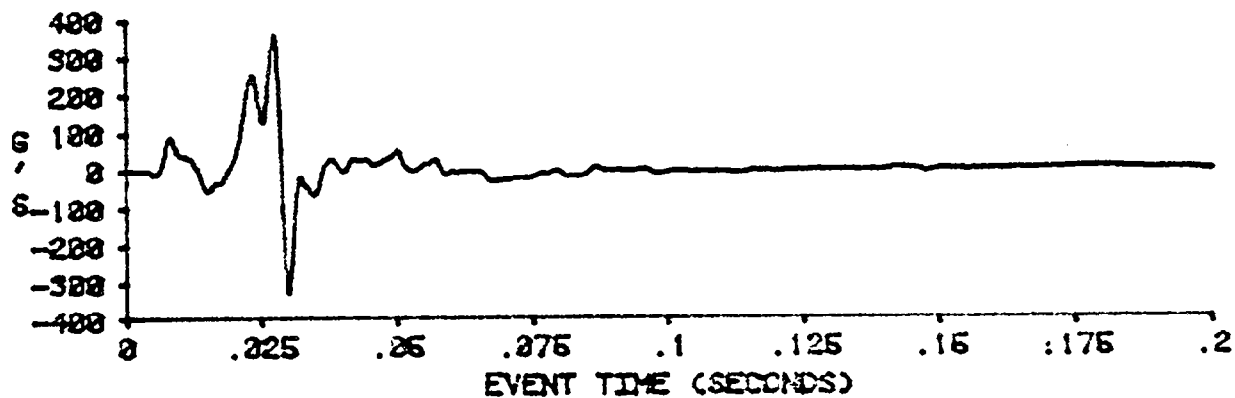
VEHICLE 1 - CITATION - 3 MPH  
DOOR 2 RL  
FILTER CLASS 138

TEST 2600  
4/27/89



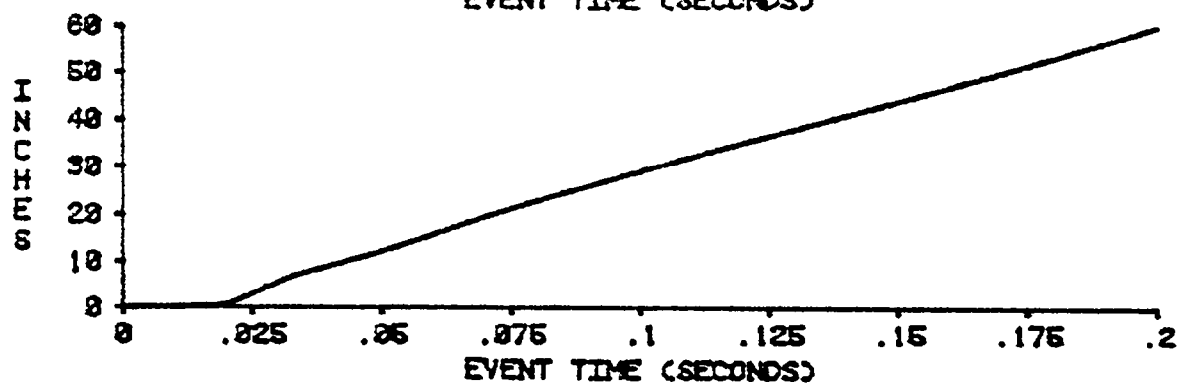
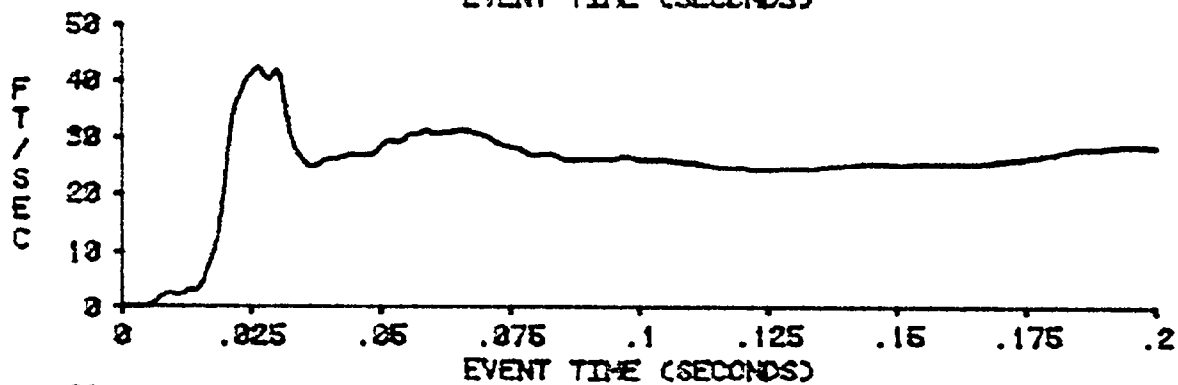
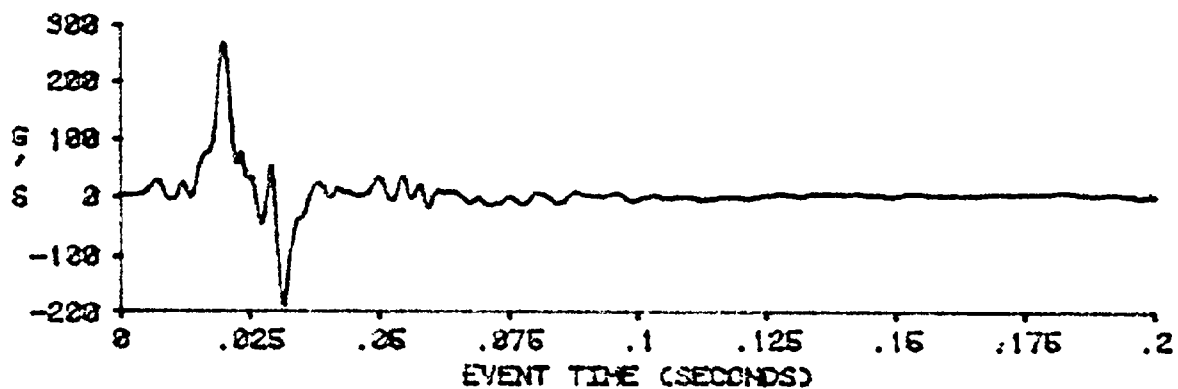
VEHICLE 1 - CITATION - 2 MPH  
DOOR 3 RL  
FILTER CLASS 188

TEST 2600  
4/27/83



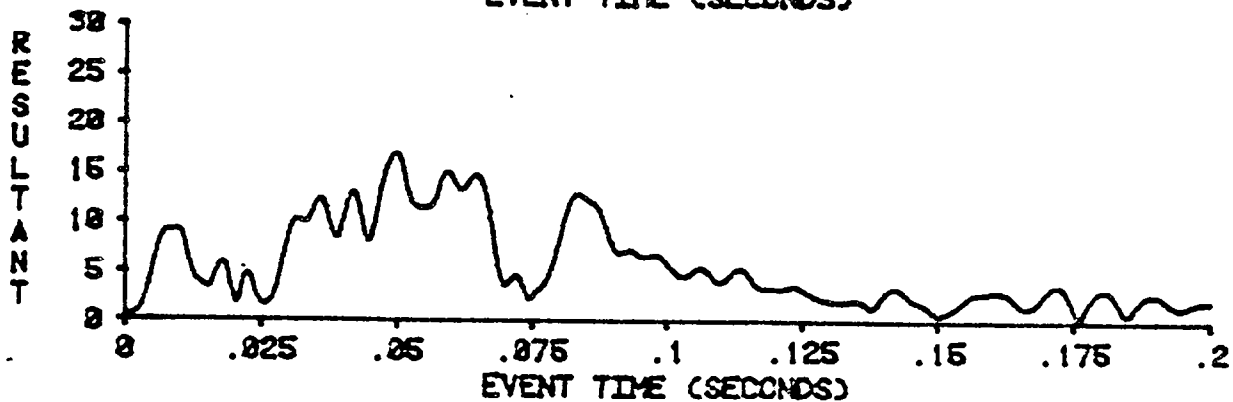
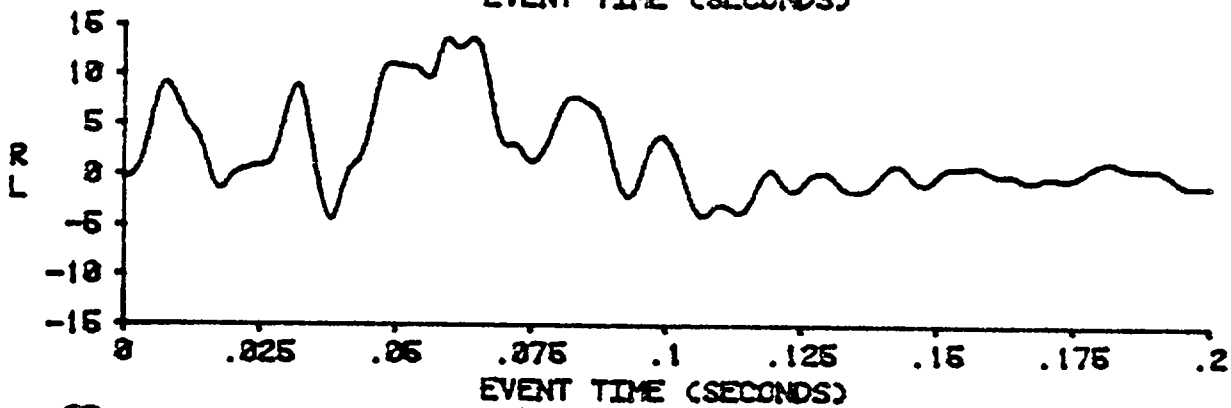
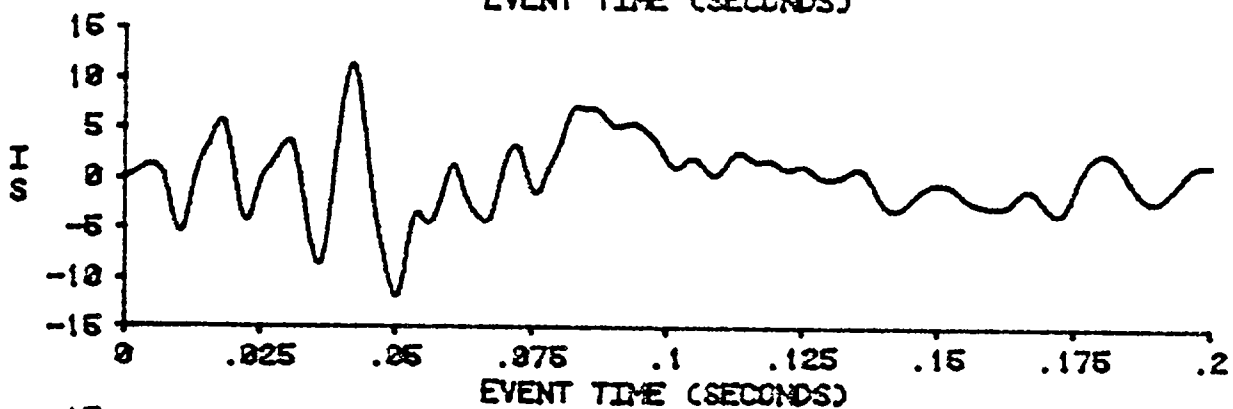
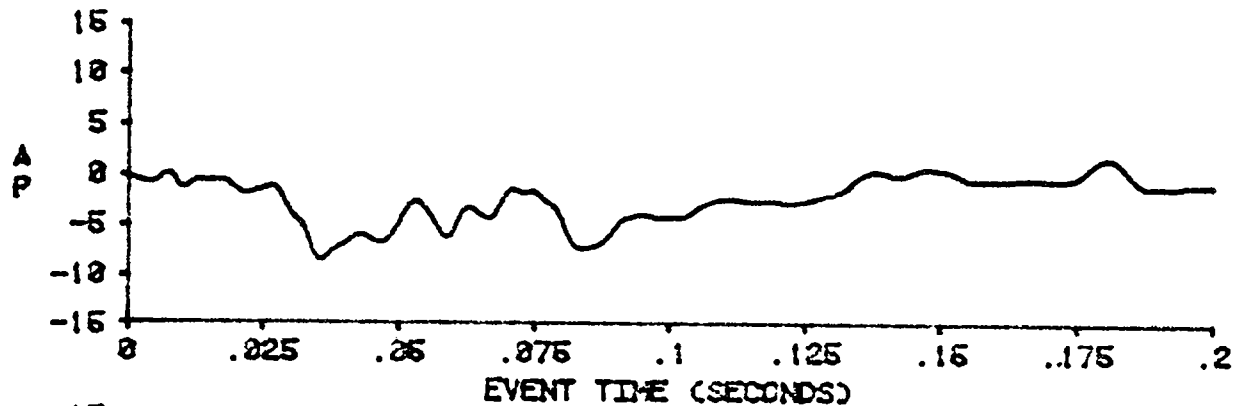
VEHICLE 1 - CITATION - 3 MPH  
DCOR 4 RL  
FILTER CLASS 133

TEST 2600  
4/27/83



VEHICLE 1 - CITATION - 0 MPH  
MID-MID COMPARTMENT G'S  
FILTER CLASS 60

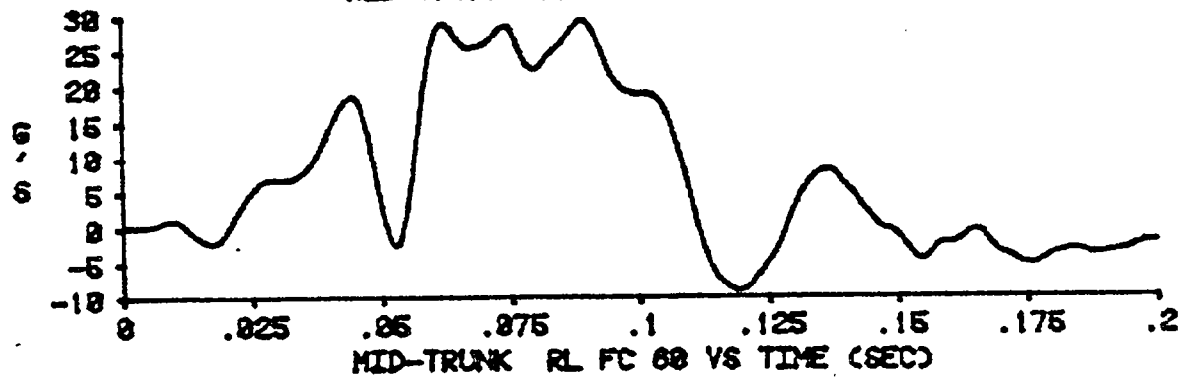
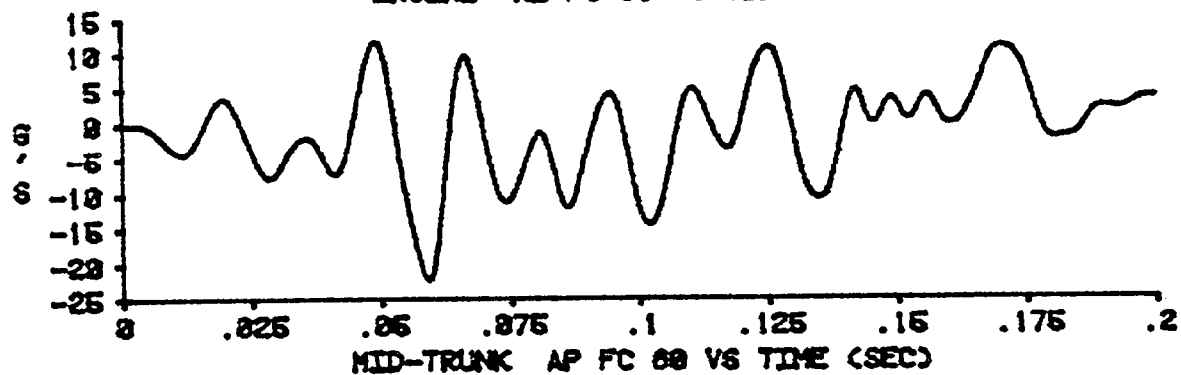
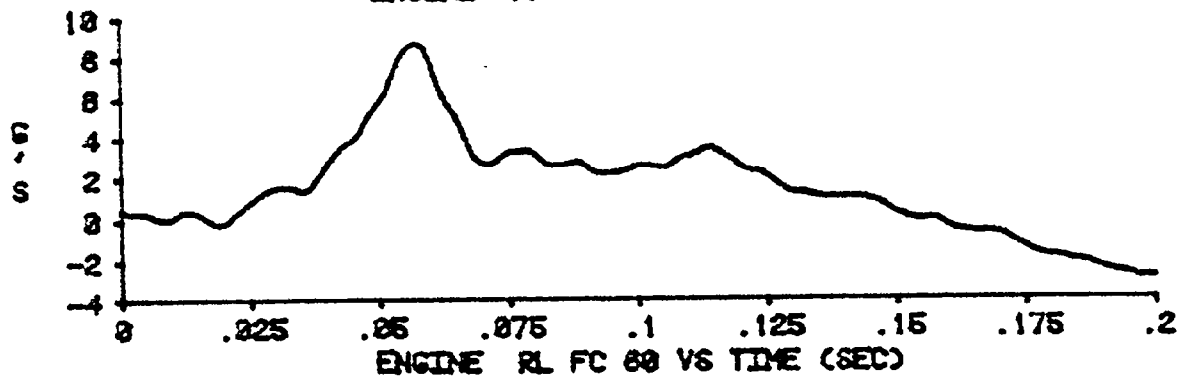
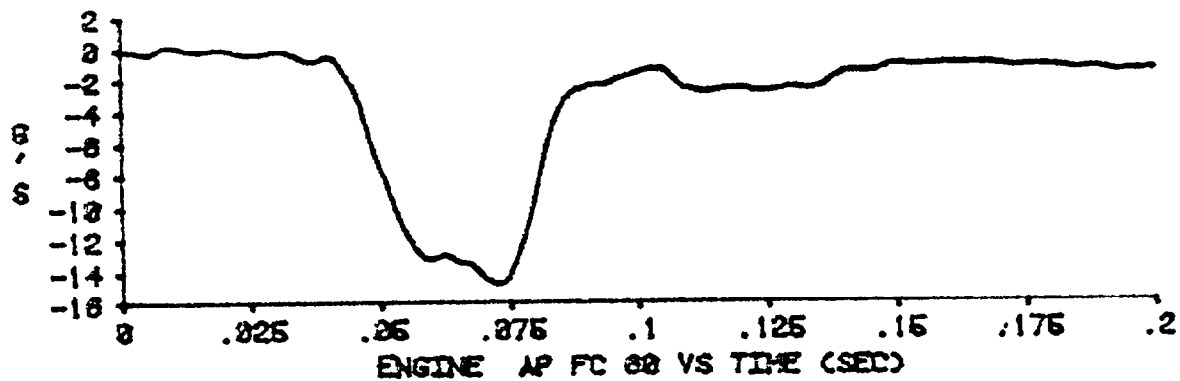
TEST 2600  
4/27/83



VEHICLE 1 - CITATION - 3 MPH

TEST 2600

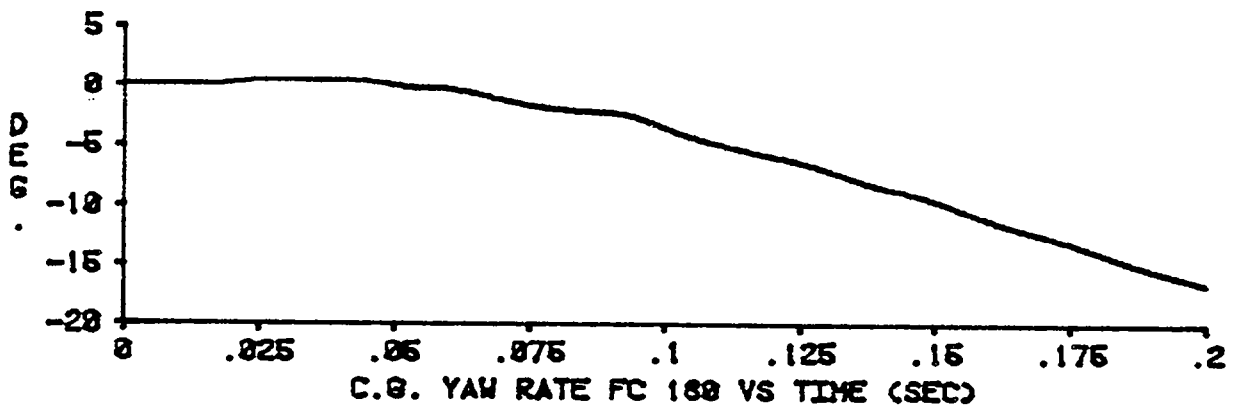
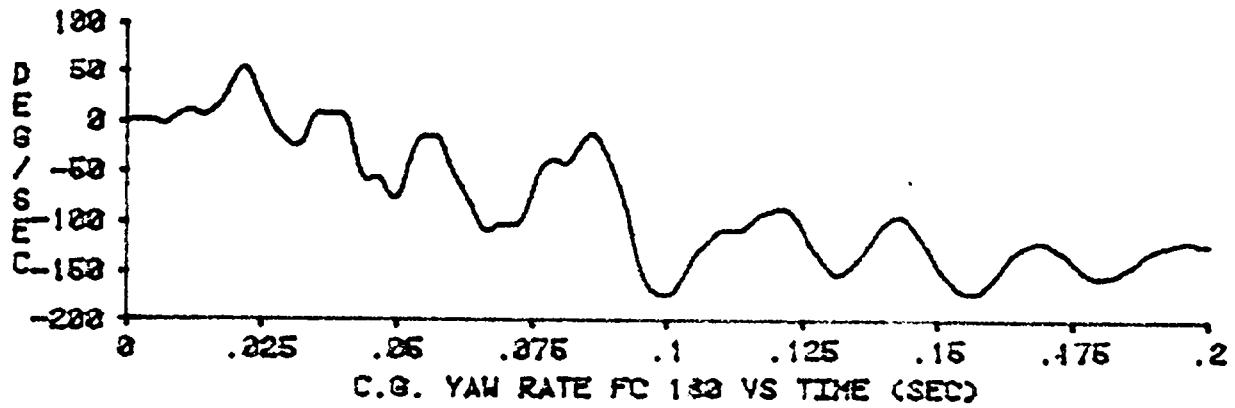
4/27/83



VEHICLE 1 - CITATION - 2 MPH

TEST 2600

4/27/83

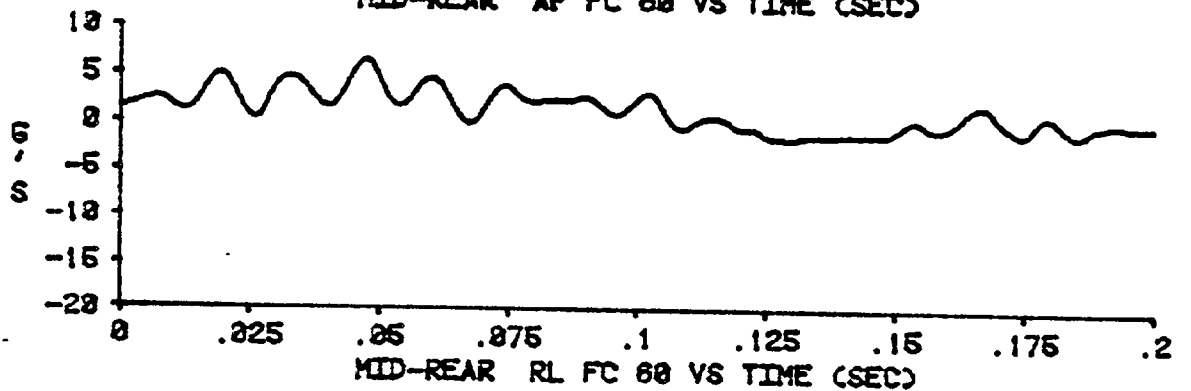
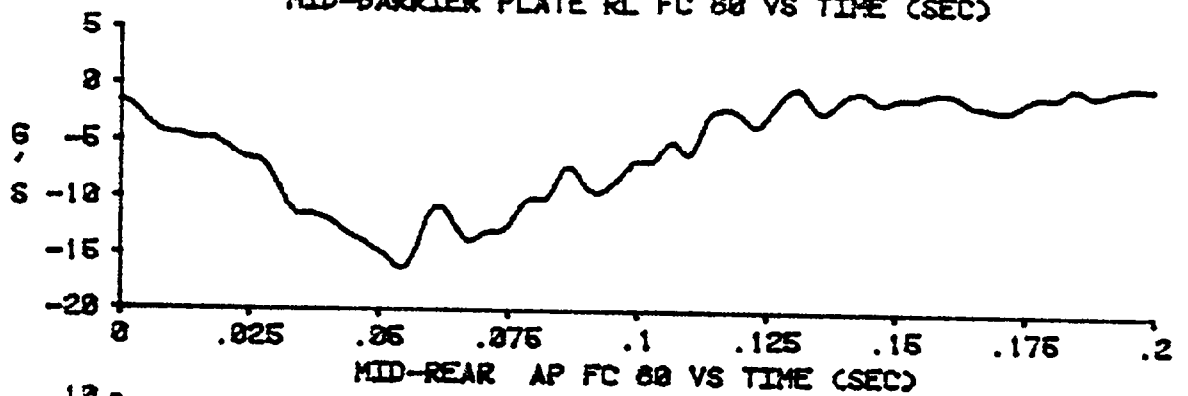
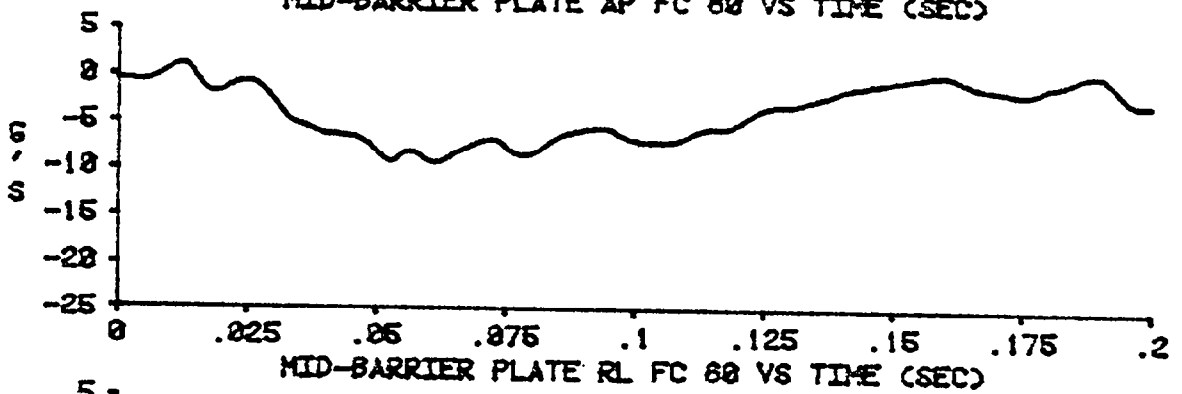
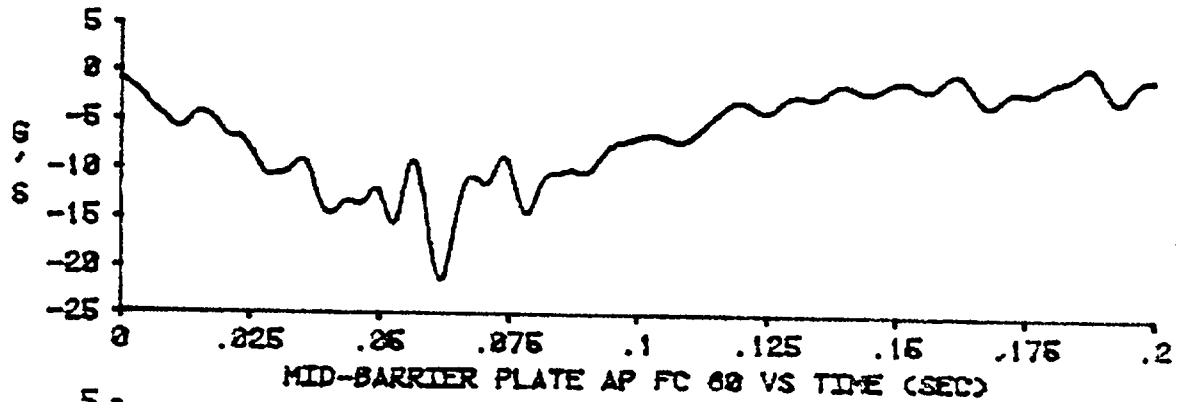


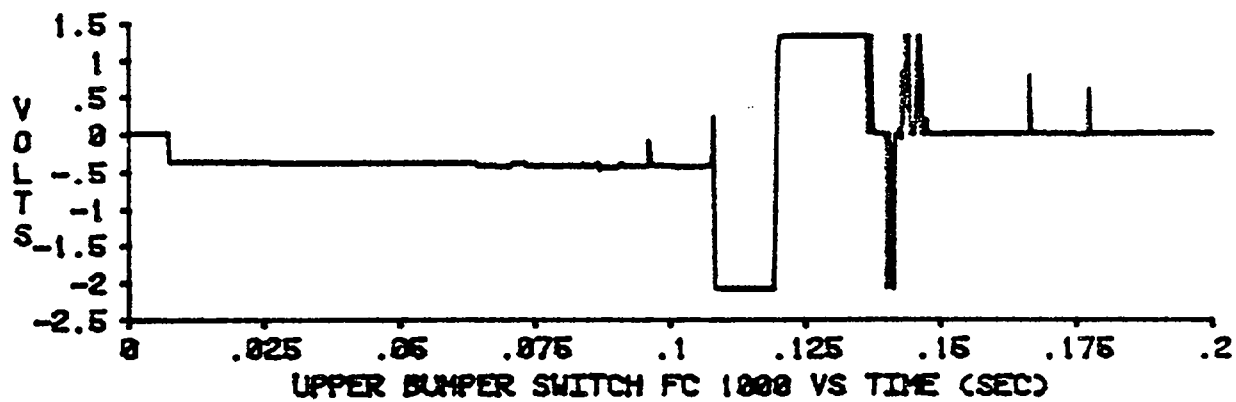
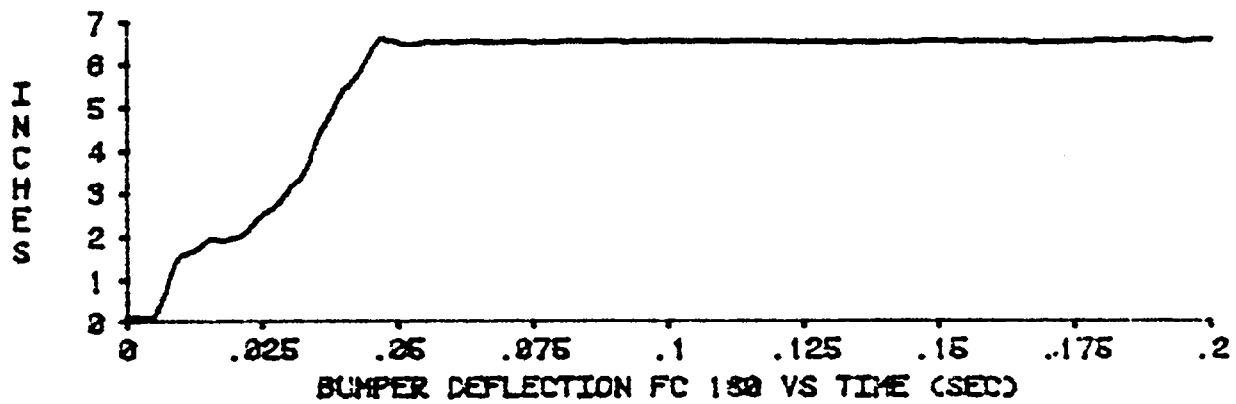


VEHICLE 2 - MBSI - 48.5 MPH

TEST 2600

4/27/83





VEHICLE 2 - MBSI - 46.5 MPH

TEST 2600  
4/27/83

