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L. Robert Shelton,
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SAFETY ADMINISTRATION
400 Seventh Street, S.W., Room 5220
Washington, DC 20590

Dear Mr. Shelton:

Re: **Settlement Agreement**
Section B. Fire Safety Research

Enclosed is a final report prepared by Jack L. Jensen and Jeffrey Santrock of General Motors Corporation, entitled, "Evaluation of Motor Vehicle Fire Initiation and Propagation/Part 11: Crash Tests on a Front-Wheel Drive Passenger Vehicle."

This final report relates to Project B.3 (Fire Initiation and Propagation Tests).

Yours truly,

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Evaluation of Motor Vehicle Fire Initiation and Propagation
Part 11: Crash Tests on a Front-Wheel Drive Passenger Vehicle

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General Motors Corporation

Abstract

This report describes the test conditions and presents the results of three crash tests, each of a front-wheel drive, mid-sized, four-door passenger vehicle, to study post-collision fire potential. Specialized instrumentation was used to help identify potential ignition and fuel sources during the crash. These tests were part of a series of crash and fire propagation tests which General Motors Corporation conducted pursuant to an agreement between GM and the U.S. Department of Transportation (Project B.3).

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1. Introduction

Three crash tests were conducted on front-wheel-drive passenger vehicles (1998 Honda Accords) to study post-collision fire potential. These tests were part of a series of crash and fire propagation tests that General Motors Corporation conducted pursuant to an agreement between GM and the U.S. Department of Transportation. An earlier report, "Vehicle Crash and Fire Propagation Test Program" [1] documented the overall strategies and test methodologies for this project. Part 2 of this report "Crash Tests on a Passenger Van" [2] presented the results of a series of tests similar to those presented here on a front-wheel-drive passenger van (1996 Dodge Caravan). Part 5 of this report "Crash Tests on a Rear Wheel Drive Passenger Car" [3] presented the results of tests on a 1997 Chevrolet Camaro. Part 8 of this report "Crash Tests on a Sport Utility Vehicle" [4] presented the results of tests on a 1997 Ford Explorer.

The series of crash tests described in this report consisted of three tests each on a new 1998 Honda Accord. The three crash conditions were an 85 km/h (53 mph) offset moving deformable barrier rear impact, a 55 km/h (34 mph) offset pole frontal impact, and a 105 km/h (65 mph) oblique moving deformable barrier frontal impact. The three test conditions used for the front-wheel-drive passenger vehicle were the same as for the test series on the rear-wheel-drive passenger vehicle (1997 Chevrolet Camaro) and the sport utility vehicle (1997 Ford Explorer). This combination of tests, however, was slightly different than the combination used for the initial series on the passenger van, which was the first series conducted. The reasons for the differences were described in Parts 1 and 2. [1],[2]

The three front-wheel-drive passenger vehicles tested were newly purchased 1998 Honda Accords. All three vehicles were equipped with a 2.3-liter 4-cylinder engine, air conditioning, 4-speed automatic transmission. As in previous test series [1],[2],[3],[4] the best selling engine, transmission and air conditioning options were selected. 1997 Accord sales data was used to select the options for the 1998 Accords as it was the latest available data at the time of purchase. Of the 1997 Accords sold, 93% were sold with the 2.2-liter 4-cylinder engine and 7% were sold with the 2.7-liter V-6 [5]. (The 2.3 liter engine was not available until 1998 model year, but similar sales trends were anticipated.) 70% were sold with air conditioning and 88% with automatic transmission [5]. Sales figures were not used to select any other options. All three Accords were identically equipped with Michelin 195/65 R15 tires, standard driver and passenger airbag systems and adjustable height 3 point frontal seat belt systems.

2. Front-Wheel-Drive Passenger Vehicle Offset Moving Deformable Barrier Rear Impact, Test C11990

An offset moving deformable barrier rear impact was conducted indoors at the GM Milford Proving Ground on May 13, 1998. A total of 70 data channels were recorded for this test, which includes channels on the test vehicle, the impacting barrier, and the Anthropomorphic Test Devices (ATDs). Fewer channels were recorded for this test than for the subsequent frontal impact tests. Fewer injury measurements were recorded from the 50th percentile Hybrid III ATDs (located in the two front seating positions) because many of the injury measurements available with the Hybrid III dummy are more meaningful for frontal impacts (such as leg injury measurements.) In addition, it should be noted that the Injury Assessment Reference Values (IARVs) for the recorded injury measurements were developed primarily for frontal impacts, and may not be appropriate for rear loading. Also, unlike the subsequent frontal impact tests, the rear impact was conducted without the engine running; thus no instrumentation was required to monitor the engine. Similarly, hydrocarbon vapor measurements, which were recorded in the engine compartment for frontal tests were not included in this test. The purpose of the hydrocarbon vapor measurements for the frontal tests was to identify the presence of vapors resulting from gasoline or leaks of other engine compartment fluids. However, for the rear impacts, the fuel system contained Stoddard Solvent, not gasoline, and no other engine compartment fluids were used.

2.1. *Test Conditions*

2.1.1. Impact Conditions

This test was an offset moving deformable barrier rear impact as depicted in Figure 1 and Figure 2. The test vehicle was parked and impacted with a deformable moving barrier similar to what is specified in FMVSS214 [6]. The impact velocity, measured with radar, was 84.7 km/h (52.6 mph). The moving barrier impacted the test vehicle in the rear on the filler neck side (left side) with a 70% overlap. The overlap was computed by measuring the widest part of the vehicle body vertically in line with the rear axle and multiplying this width by 0.70. For this particular test, the vehicle width vertically in line with the rear wheel centerline was measured to be 1782 mm, resulting in a desired overlap of 1247 mm, as shown in Figure 3. The actual impacted overlap for this test was within 15 mm of the desired.

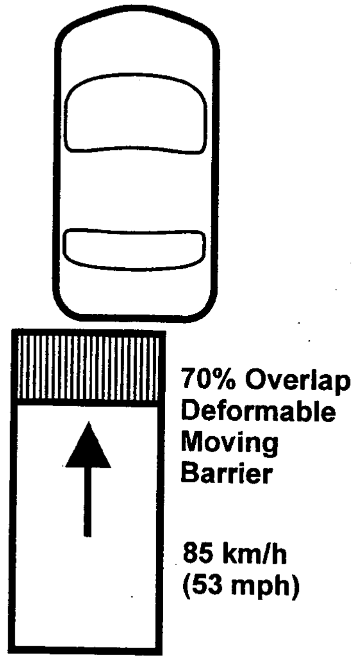

Figure 1
Crash Test Configuration for Test C11990

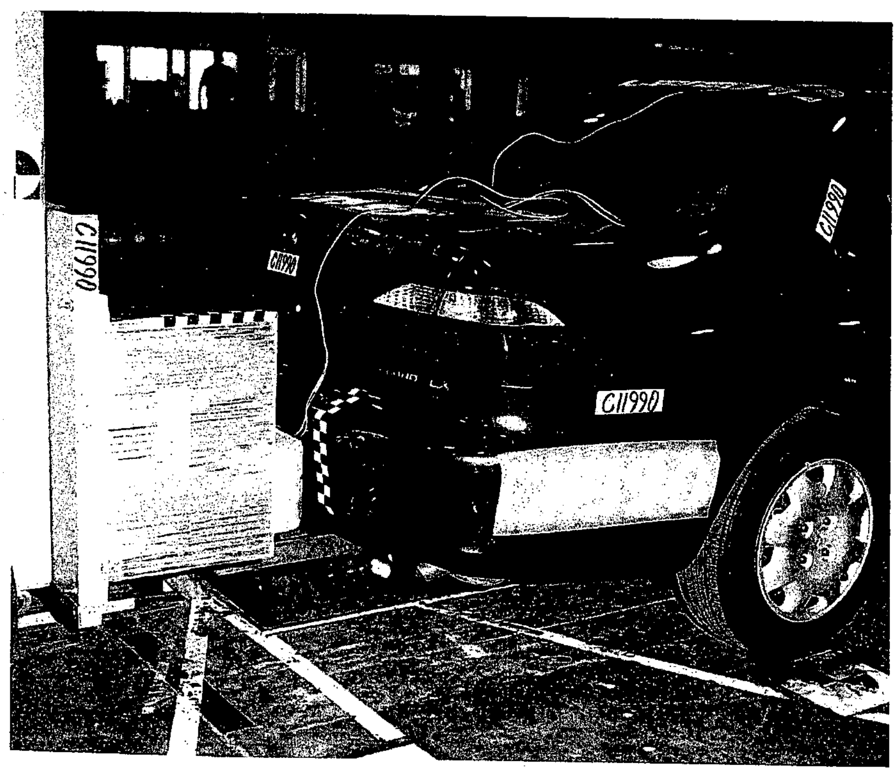

Figure 2
Pre-Test Photograph of Test C11990

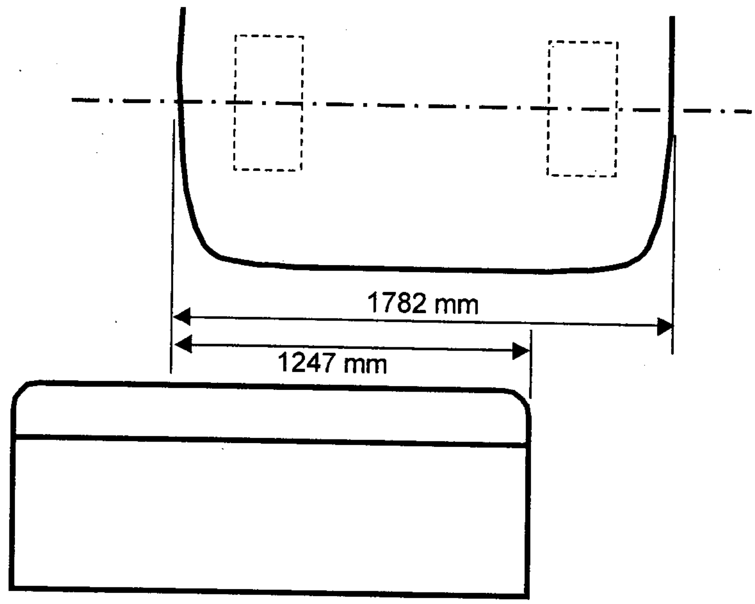

Figure 3
Schematic of Intended Vehicle Overlap
Test C11990

The moving barrier's total mass was 1371 kg (3022 lbs.); its frontal axle mass was 779 kg (1717 lbs.); and its rear axle mass was 592 kg (1305 lbs.) The center of gravity was measured to be 526 mm (20.7 inches) above grade, 1118 mm (44 inches) rearward of the front axle and laterally in the center of the barrier. Its wheels were aligned with the longitudinal axis of the moving barrier as shown in Figure 1. (unlike FMVSS 214 testing, in which the wheels are set at an angle.) The aluminum honeycomb barrier face was similar to that specified in FMVSS 214 and the center of the bumper form was measured to be 444 mm (17.5 inches) above grade. The brakes on the moving barrier were activated at time zero (impact). However a mechanical delay in the pressurization of the brake lines resulted in an effective brake activation time of approximately 80-150 msec after impact. The barrier was also stopped following the impact using a cable attached to the barrier. This cable ("snubber" cable) was restrained with a remote brake system which was also activated at time zero, but had an effective activation time of about 100 – 150 msec.

2.1.2. Vehicle Description

The test vehicle was a 1998 Honda Accord (VIN: 1HGCG5646WA018992) which had a test mass of 1648.5 kg (1043 kg front, 605.5 kg rear) which included the two ATDs, crash test instrumentation, and Stoddard Solvent in the production fuel tank. First, the fuel tank's unusable capacity was established (filled) with Stoddard Solvent, then 61.1 liters of Stoddard were added to the unusable capacity of the tank. (61.1 liters represents 95% of the usable capacity of 64.5 liters.) The headlights, ignition, hazard lights, and rear defroster were all on for the test. The transmission selector was placed in reverse for the test. The engine was not operating for the test.

2.1.3. Modifications to Production Vehicle

Because the objective of this test was to conduct basic research on crash conditions that might result in post-collision fire and not to test a production vehicle for compliance with any performance standard, some modifications to the production vehicle were made to facilitate the test objectives. A description of some of the modifications follows.

The test vehicle's front brakes were isolated from the brake system and connected to an auxiliary brake machine which charged the lines at about 150 msec after impact. There was also a mechanical delay of 80 – 150 msec from the time the auxiliary brake machine was activated until the lines were pressurized, resulting in an effective delay of 230 – 300 msec. The purpose of using the brake machine was to help control vehicle kinematics after the impact. The test vehicle's rear brakes were isolated from the rest of the braking system by cutting and capping the rear brake lines. The rear brakes were isolated to retain the functionality of the front brakes if the rear brake lines were damaged during the impact. The rear brakes were not activated during the test.

The vehicle's hood was removed to facilitate the installation of the crash test instrumentation above the engine compartment. In addition, a pressure transducer was installed in the fuel return line.

Electrical measurements, such as currents and voltages, of the rear brake and turn lights were made. Every reasonable attempt was made to locate this instrumentation in locations that would not affect the outcome of the test.

For all of the tests conducted for this project, the test vehicles were loaded with all required instrumentation for the test objective, independent of a target test mass. Thus, the test masses for different tests on the same vehicle model are likely different, and also different than the test mass required by FMVSS 208 [7].

2.1.4. Vehicle Measurements

Measurements listed here are the ones taken to measure the standard vehicle properties typically measured during crash tests and not necessarily to identify fire ignition potential. (As compared to Section 2.1.9 which lists electrical voltages and currents used to identify potential shorts, and Section 2.1.8 that lists fluid pressures used to identify fluid leaks.)

- Front left rocker panel acceleration (longitudinal, lateral, and vertical)
- Front right rocker panel acceleration (longitudinal, lateral, and vertical)
- Rear left rocker panel acceleration (longitudinal, lateral, and vertical)

- Rear right rocker panel acceleration (longitudinal, lateral, and vertical)
- Rear left frame acceleration (longitudinal, lateral, and vertical)
- Rear right frame acceleration (longitudinal, lateral, and vertical)
- Driver's and passenger's air bag current (using non-intrusive clamp-on current transducers)

In addition, one electrical contact measurement between the rear crossmember and the fuel tank cradle was used to identify contact between them.

2.1.5. Photographic Coverage

High-speed 16-mm movie cameras were used to film the crash test. All cameras were located off-board of the vehicle. Cameras were located at various locations around the impact including above, below, and to both sides of the vehicle. In addition, video cameras were located at two off-board locations.

2.1.6. Moving Barrier Measurements

The following acceleration measurements were measured on the deformable moving barrier:

- Moving deformable barrier at Center of Gravity (CG) acceleration (longitudinal, lateral, and vertical)
- Moving deformable barrier at rear crossmember acceleration (longitudinal, lateral, and vertical)

2.1.7. Anthropomorphic Test Device (ATD) Measurements

Two 50th percentile male Hybrid III ATDs (FMVSS reference part 572, Subpart E) [8] were located in the front outboard seating positions. The seats were located in the fore-aft mid position and the ATDs were positioned similar to as described in FMVSS 208 [7]. The ATDs were restrained using the vehicle's lap / shoulder belts with the adjustable guide loop set in the third position from the top. The pelvic angle was 23.0 degrees for the left front occupant and 21.7 degrees for the right front. The head target angle was at 0 degrees from horizontal for both ATDs. The following measurements were recorded for each ATD:

- Head triaxial acceleration
- Head/ neck interface (upper neck) longitudinal shear force (Fx)
- Head/neck interface (upper neck) lateral shear force(Fy)
- Head/neck interface (upper neck) axial force (Fz)
- Head/neck interface (upper neck) moments about longitudinal, lateral and vertical axis (Mx, My, Mz)
- Chest triaxial acceleration

Appendix A includes the Injury Assessment Reference Values (IARV) [9] used for the analysis of the recorded ATD measurements.

2.1.8. Fluid Pressure Measurements

The fuel line pressure and the fuel return line pressures were recorded. Unlike the subsequent frontal impacts in which the engine was operating, no other fluid pressure measurements were made.

2.1.9. Additional Electrical Measurements

Electrical events such as shorts, arcs or overheated circuits are sometimes suspected as possible ignition sources for post-collision fires. Therefore, in addition to standard crash test electrical measurements (such as the air bag currents), electrical measurements were also made on some electrical circuits anticipated to be in the area of vehicle crush. Due to instrumentation limitations, only selected and not all electrical circuits in the area of anticipated crush were monitored.

Clamp - on current monitoring transducers were used to measure the following currents:

- Rear window defroster (measured behind the instrument panel, right side)
- CHMSL (Center High Mounted Stop Light)/ rear brake light (measured under left side of Instrument Panel (IP), near the fuse panel)
- Rear backup lights (measured under left side of the IP near the fuse panel)
- Rear tail lights (measured under left side of the IP near the fuse panel)
- Rear left turn signal (measured under left side of the IP near the fuse panel)
- Battery (main B+ cable from battery, transducer located near the battery)
- Ignition (measured under IP, near the steering column)

Direct voltage measurements (not requiring transducers) were made of the following circuits:

- Ignition (measured under IP, near steering column)
- CHMSL / rear brake light (measured under left side of the IP near the fuse panel)
- Rear window defroster (measured behind the instrument panel, right side)
- Rear backup light (measured under left side of the IP near the fuse panel)
- Rear tail light (measured under left side of the IP near the fuse panel)
- Rear turn signal (measured under left side of the IP near the fuse panel)
- Battery (measured at the battery terminals)

2.1.10. Evaluation of the Crashworthiness of Potential Fire Detection or Suppression Technologies

An experimental fire detection device was evaluated for its crashworthiness during this test. This thermal wire device was supplied by Dual Spectrum Santa Barbara and was similar to those evaluated in previous tests in this series [2],[3],[4]. It consists of two wires separated by an insulating material designed to melt when exposed to flames. The completion of the electrical circuit could be used to activate a fire suppression system. For test C11990, the thermal wire was attached in a U-shape under the fuel tank. The wire was attached to the fuel tank cradle assembly just below the front edge and two side edges of the tank. A photograph of the thermal wire installation is shown in Figure 4.

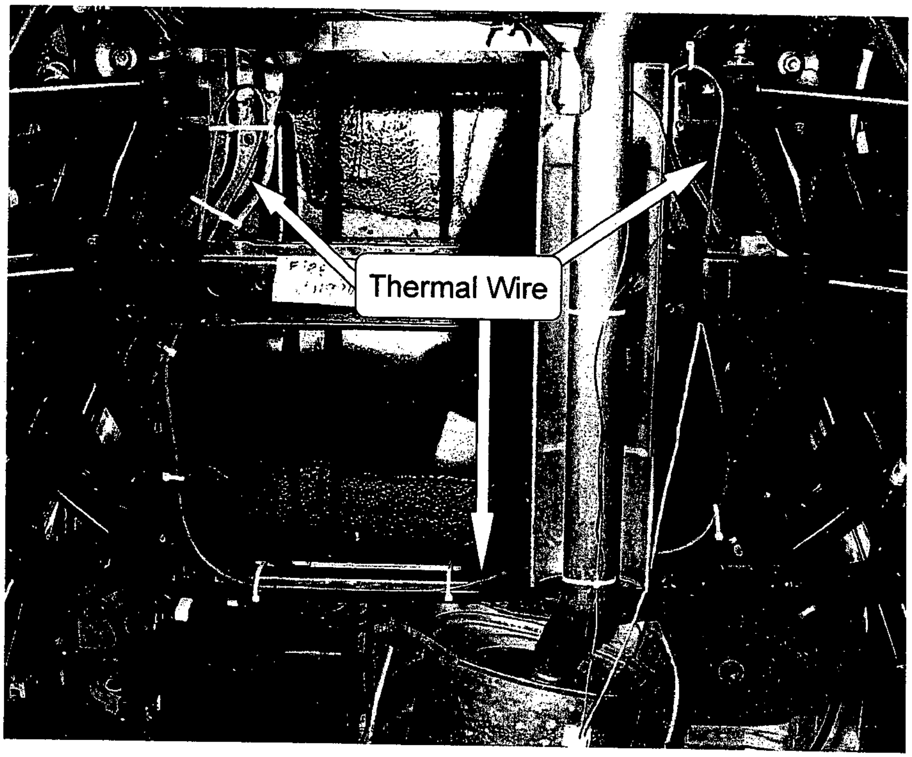

Figure 4
Location of Thermal Wire Fire Detector
Test C11990

2.2. *Summary of Test Results*

Post-test photographs of the vehicle are shown in Figure 5 and Figure 6.

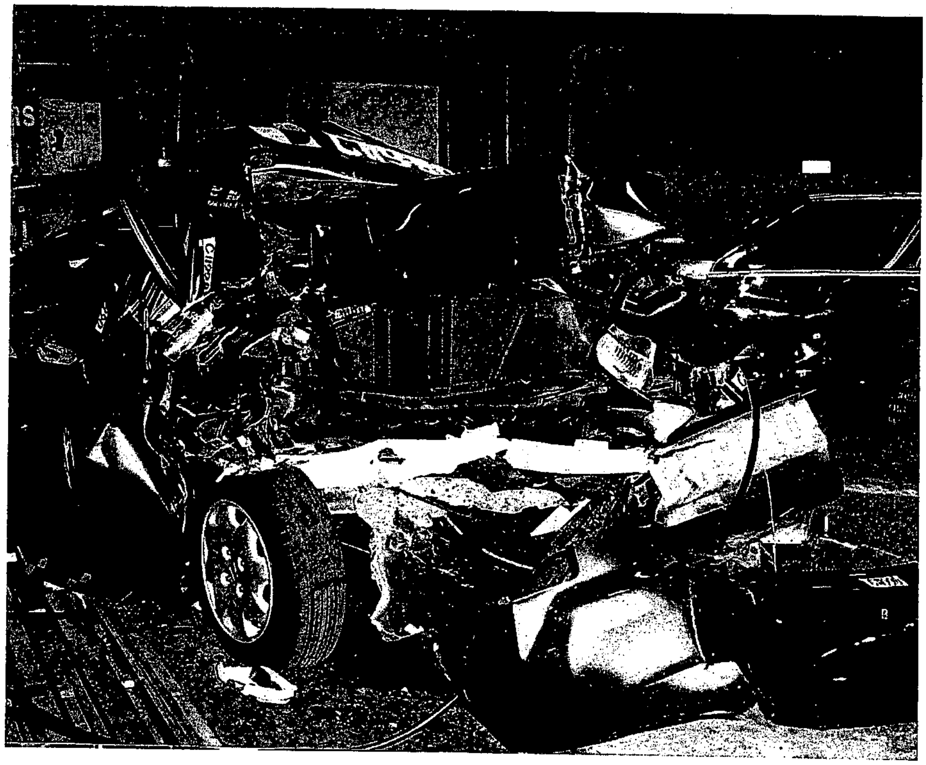

Figure 5
Post-Test Photograph of Test C11990, Left-Rear View

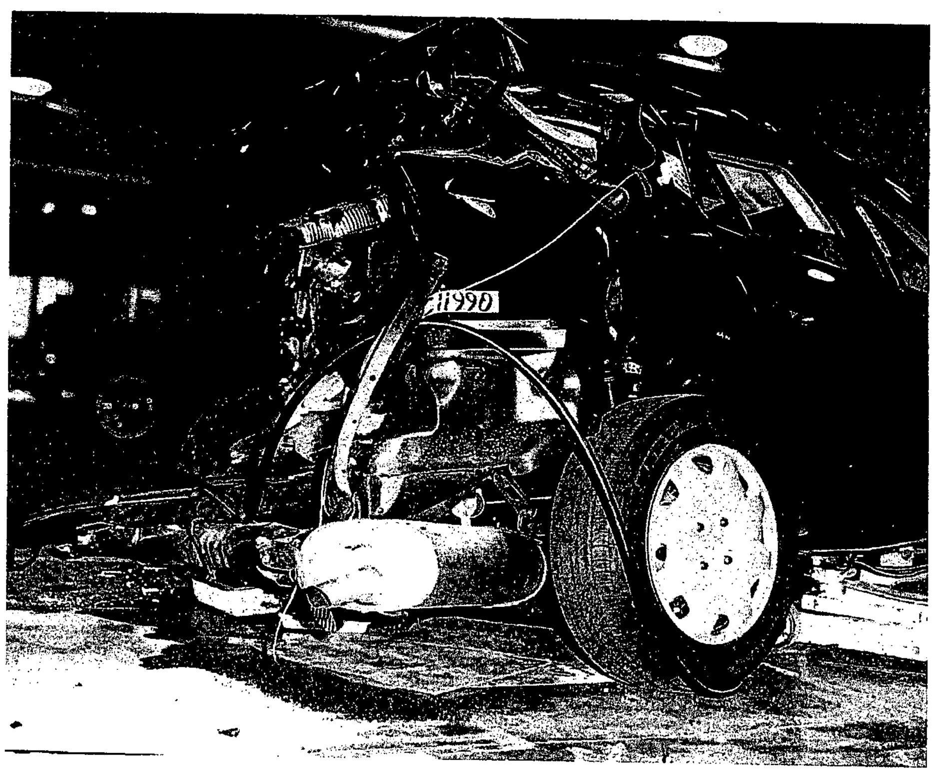

Figure 6
Post-Test Photograph of Test C11990, Right-Rear View

2.2.1. Summary of Standard Vehicle Crash Test Measurements

The complete set of recorded and computed vehicle measurements is included in Appendix B (Plots 19 through 36, 44, 45, and 54.)

The average of the two front rocker panel longitudinal acceleration measurements (Figure 7) was integrated to compute the change in vehicle longitudinal velocity (Figure 8). The peak vehicle longitudinal acceleration (after filtering at SAE class 60 [10]), was 16.75 g and the maximum longitudinal change in vehicle velocity was 41.9 km/h (26.0 mph).

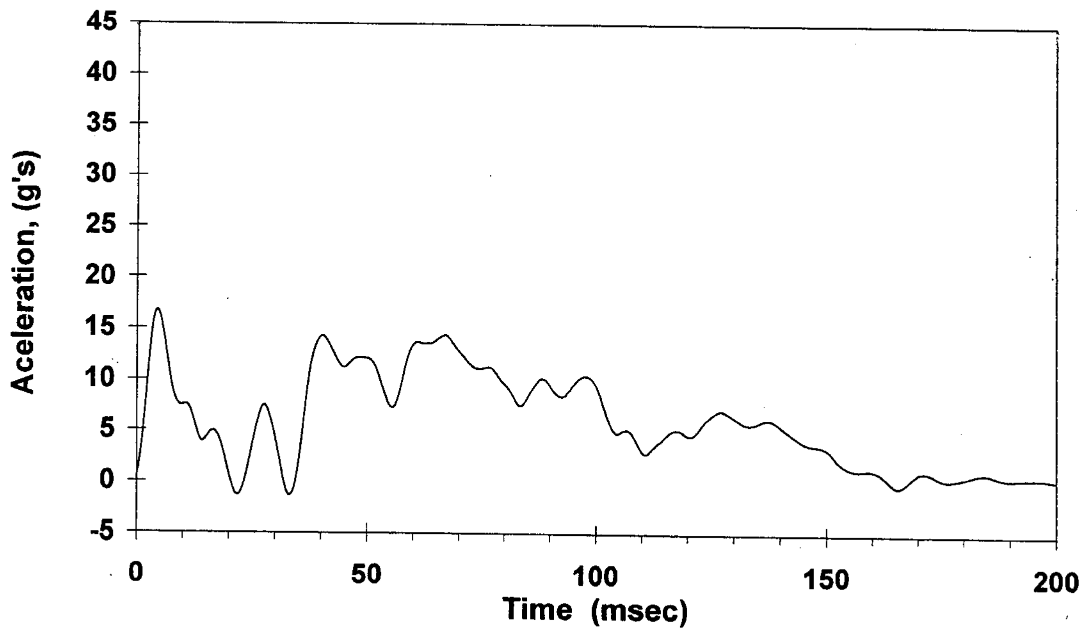

Figure 7
Averaged (Left & Right) Front Rocker Panel Longitudinal Acceleration
Test C11990, filtered at SAE class 60 [10]

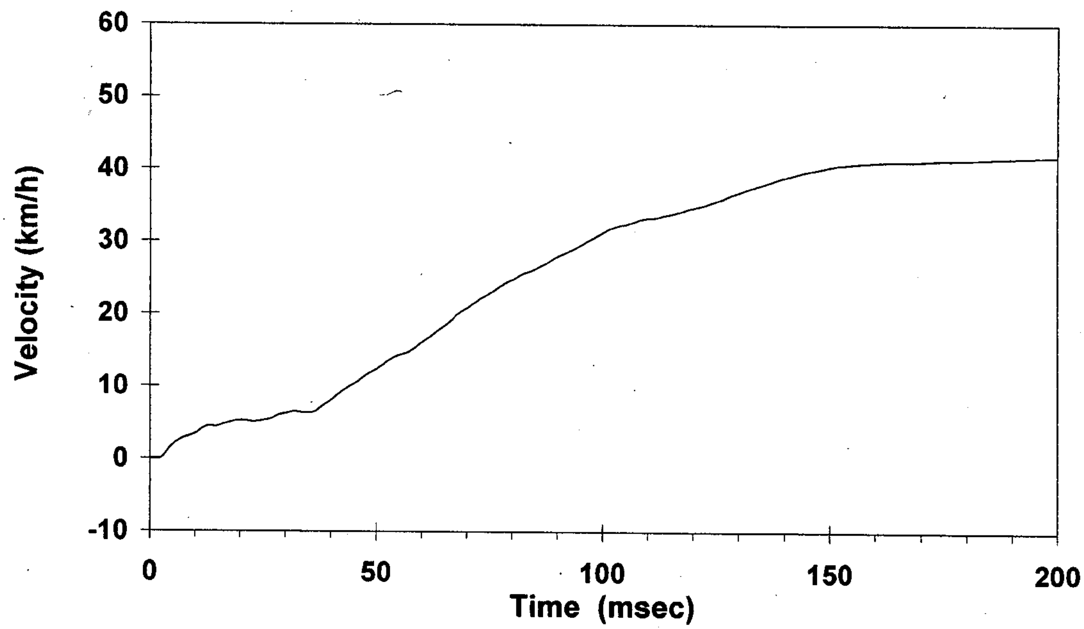

Figure 8
Averaged (Left & Right) Rear Rocker Panel Longitudinal Velocity
Test C11990, filtered at SAE class 180 [10]

The result of the vehicle contact measurement is shown in Appendix B, Plots 54. The rear crossmember first contacted the fuel tank cradle assembly at 32 msec.

The frontal air bags did not deploy in this rear impact crash test (Appendix B, plots 44 and 45).

2.2.2. Summary of Recorded Barrier Measurements

The acceleration measurements and related computed values from the moving barrier are included in Appendix B (Plots 55 through 61).

The longitudinal velocity of the barrier's CG is shown in plot 55 and re-created here as Figure 9. The barrier sustained a velocity change of 50.8 km/h (31.5 mph).

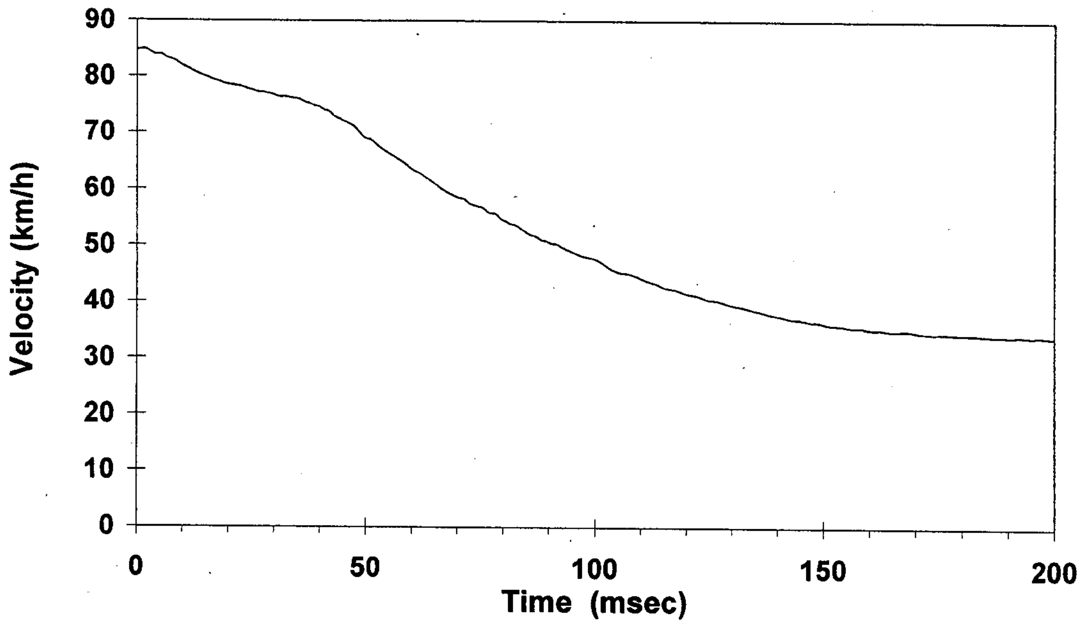

Figure 9
Moving Deformable Barrier Longitudinal Velocity at CG
Test C11990

2.2.3. Summary of Recorded ATD Measurements

The recorded and computed ATD measurements are included in Appendix B (pages i and ii, and Plots 1 through 18).

All recorded injury measurements were below their respective IARVs.

2.2.4. Summary of Hydrocarbon Vapor Measurements

Unlike the frontal impacts, there were no hydrocarbon vapor measurements taken for this test .

2.2.5. Summary of Fluid Pressure Measurements

The dynamic pressure of the fuel supply line is shown in Appendix B, Plot 62. Although this pressure measurement fluctuates during the test, the fluctuation is consistent with similar measurements on other vehicles tested for the project. There is not an overall drop in supply line pressure indicating there was likely no leak in the pressurized fuel system during the impact. The fuel supply line was pressurized but the engine was not operating for the test.

2.2.6. Summary of Fuel System Integrity

Stoddard Solvent leaked from the fuel tank immediately after the test at the crash test site. (The fuel tank is not pressurized thus this leak is not indicated in the pressurized fuel supply pressure measurement in section 2.2.5) The leak rate was not measured at the crash test site, however, it clearly exceed 141.75 grams (5 oz.) for the first five minutes after the impact.

During the post–test vehicle inspection, several possible sources of the Stoddard leak were identified. There was a small rip in the top surface of the fuel tank to the right of and just slightly rear of the fuel pump assembly. The rip was less than 15 mm long and less than 3 mm wide. A photograph of the rip is shown in Figure 10. The rip appeared to be caused by the fuel tank material buckling over on itself while the fuel tank was crushed during the impact. In addition to the rip in the fuel tank wall material, the nylon top of the fuel pump assembly was cracked and broken pieces were missing during the inspection. The missing pieces resulted in an opening approximately 50 square mm. The rip in the upper surface of the tank, however, was lower than the opening in the nylon cap of the fuel pump assembly, so it was likely the primary source of the Stoddard leak. Although the leak rate through the rip was not measured at the crash test site, it was later measured during laboratory experiments on the fuel tank. The measured leak rate of Stoddard Solvent was approximately 400 cc/min for the first minute and 200 cc/min for the fifth minute.

Figure 10
Post-Test Photograph of Rip in Top Surface of Fuel Tank
Test C11990

2.2.7. Summary of Additional Electrical Measurements

The results of the additional electrical measurements made on some of the rear electrical circuits are shown in Appendix B, Plots 37 to 43 and 46 to 52.

The battery voltage, ignition voltage, rear taillight voltage, and rear window defroster voltage are shown in Appendix B, plots 43,37,41, and 39 respectively. The results of these four measurements are very similar. As an example, the ignition voltage is recreated here as Figure 11. This signal can be considered a good indication of the status of the overall vehicle electrical voltage available during the crash. That is, the overall voltage was maintained during and after the impact however, there were small discrete drops in available voltage from 53 msec to 86 msec, from 110 msec to 135 msec, and again from 138 msec to 151 msec. These small drops in available current were likely caused by circuits intermittently shorting to ground during the impact, putting additional load on the battery for discrete periods of time.

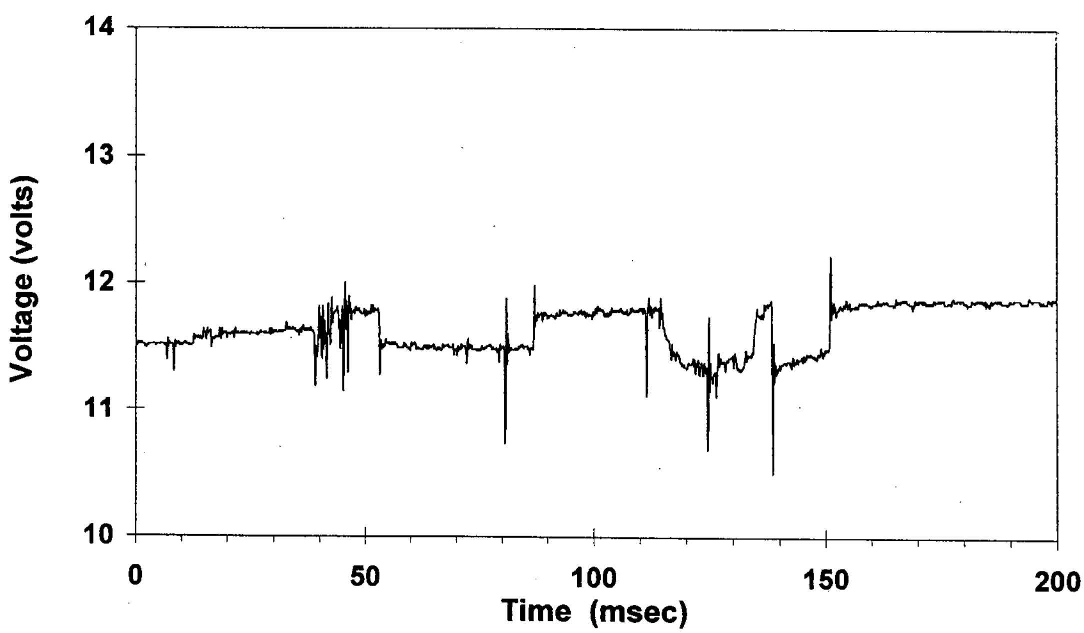

Figure 11
Ignition Voltage
Test C11990

This is supported by the battery current (Figure 12 and Plot 51) which indicates an increase in overall current leaving the battery from about 53 msec to 86 msec, again from 110 msec to 135 msec, and again from 138 msec to 151 msec. The specific circuits shorted during the test were not identified and were likely not one of the circuits monitored during the test. However the ignition current (Appendix B, Plot 52 indicates an increase in current from 110 msec to 135 msec, indicating that one of the three shorts was on a circuit controlled through the ignition.

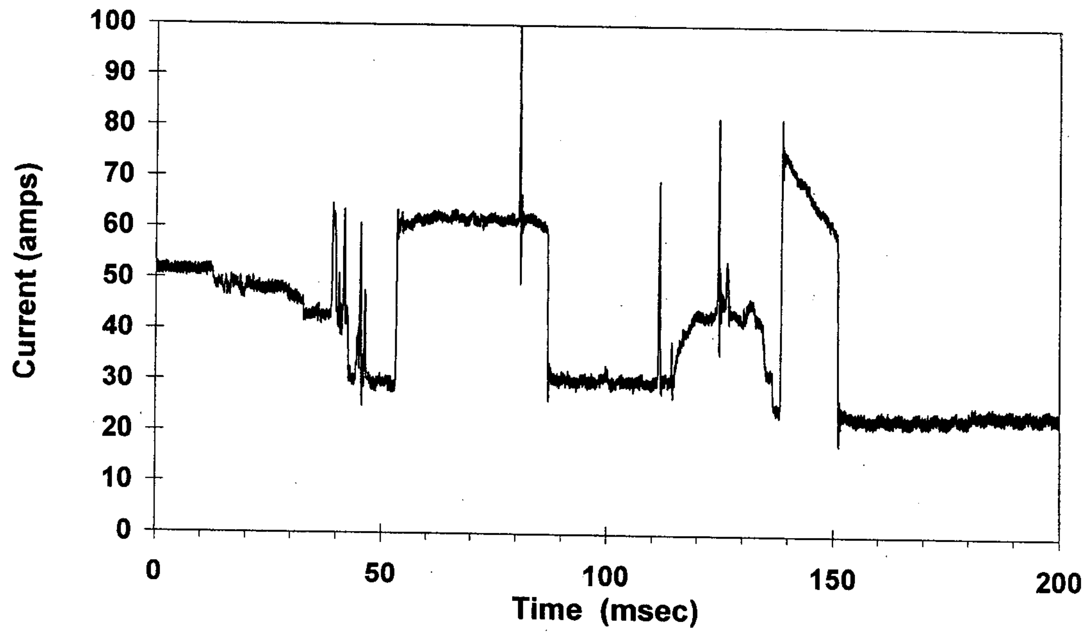

Figure 12
Battery Current
Test C11990

Intermittent drops in system voltage due to shorts during the impact were observed during other vehicle crash tests for this project [2],[3],[4]. In fact, nearly all of the crash tests conducted exhibited behaviors of this type on the overall vehicle system voltage. The 2 discrete shorts identified here for test C11990 were likely caused by shorts of small gage wires as indicated by the relatively small drop in voltage (less than 0.5 volts) and the relatively small increase in battery current (about 30 amps.) Larger voltage drops and current increases have been identified in previous tests, particularly with frontal impacts where large gauge cables such as the battery or starter cables were shorted.

The rear backup light voltage and current (Appendix B, Plots 40 and 48) indicate a loss of voltage and current at around 20 msec likely due to the circuit opening during the vehicle crush.

Similarly, the CHMSL / brake light voltage and current (Appendix B, Plots 38 and 46) both drop to zero at around 30 msec. This was likely either to an open in the circuit caused by the vehicle crush or possibly the release of the brake pedal by the crash dummy's foot during the impact.

The rear window defroster current (Appendix B, Plot 47) dropped to zero around 45 msec also likely due to an open circuit. The defroster voltage measurement remained at near 12 volts through to the end of the test (Appendix B, Plot 39) indicating that the open occurred on the load side of the measurement location.

The left rear turn signal current (Appendix B, Plot 50) indicated a drop in current to zero at around 13 msec indicating a possible open in the circuit. The left rear turn signal voltage (Appendix B, Plot 42) indicated a partial drop in voltage available from 53 msec to 86 msec, coinciding with one of the three previously mentioned shorts. This drop of 6 volts, indicates the circuit which shorted could have been closely associated (electrically) with the turn signal circuit. At 138 msec the turn signal voltage drops to zero most likely caused by an open circuit or possibly by the turn signal timing out during its normal operation. This drop to zero volts is not likely a short on the turn signal circuit because there is no increase in current identified (Appendix B, Plot 50).

2.2.8. Summary of Numerical Film Analysis

The numeric film analysis plots are included in Appendix C (Plots 1 through 6).

The crush of the vehicle on the right side is represented here as the longitudinal displacement of the moving barrier relative to the vehicle as numerically measured from film. This measurement is shown in Plot 1. Approximately 1299 mm of displacement occurred on the right side of the vehicle and represents the combined crush of the deformable barrier face and the vehicle. The targets on the left side of the vehicle became obscured during the impact, and thus this measurement (Plot 4) was not read throughout the event.

2.2.9. Results of Post-test Static Rollover

Because there was a fuel system leak at the crash test sight, the vehicle was not rolled statically following the test. (Post–test static rollovers were conducted on other rear-impacted vehicles to determine the presence of fuel system leaks.)

2.2.10. Results of the Evaluation of the Crashworthiness of Potential Fire Detection or Suppression Technologies

The electrical contact measurement used to monitor the thermal wire fire detector is shown in Appendix B, Plot 53. This plot indicates two electrical closures the first occurring at 84 msec. This indicates that this specific mounting location for this device would not be crashworthy for this impact type. (The intent of the evaluation of the experimental fire detectors was to establish whether they would survive the crash and therefore remain functional to activate a fire suppression system following the impact.)

2.2.11. Summary of Post-test Vehicle Inspection

The vehicle was disassembled and inspected for any structural openings from the exterior into the passenger compartment, the locations of any fluid leaks that occurred during the crash test, the locations of any electrical shorts that occurred during the crash test, and any contact between potentially combustible materials and normally hot surfaces. As with any severe crash test, the vehicle residual crush makes the inspection of every component difficult if not impossible. Many components became buried and impossible to inspect without further damage. Some occurrences or events may not have been identified and noted. However, a reasonable effort was made to complete as thorough an inspection as possible.

Consistent with the crash tests on other vehicle types in this project, openings from the exterior to the interior of the passenger compartment caused by the crash were identified. These openings were not evaluated for their potential contribution to fire propagation, instead all openings identified were noted. The presence of interior components, such as interior trim or carpeting, in many cases, would prohibit the free flow of air through the structural openings. Later fire propagation tests were conducted on some of the crash-tested vehicles to better characterize propagation characteristics, and are reported separately. Those openings (excluding glass breakage) identified for this test, follow:

- A hole in the left rear floor pan above the rear suspension approximately 400 mm long by 400 mm wide.

- A deformation of the left rear outer door skin combined with a deformation of the inner door frame and panel resulting in a opening into the passenger compartment approximately 370 mm long by 150 mm wide.

Other than the previously mentioned Stoddard Solvent leak in the fuel tank, there were no additional fluid leaks identified during the post-test vehicle inspection.

There were no specific electrical shorts visibly identified during the post-test vehicle inspection, although the electrical measurements during the crash indicated there were likely some shorts (See section 2.2.7).

There was no contact between any potentially combustible material and a normally hot surface identified.

2.3. *Conclusions*

1. There were no post-collision fires identified during this crash test.

2. The peak vehicle longitudinal acceleration (after filtering at SAE class 60 [10]), was 16.75 g and the maximum longitudinal change in vehicle velocity was 41.9 km/h (26.0 mph).

3. Stoddard Solvent leaked out of the fuel tank immediately after the impact. The leak rate was not measured at the crash test site. The source of the leak was later identified as a rip in the upper surface of the fuel tank. The leak rate was later measured in laboratory experiments on the tank after it was removed from the vehicle. The measured leak rate was approximately 400 cc/min during the first minute and slowed to 200 cc/min by 5 minutes.

4. Other than the Stoddard Solvent leak, there were no other fluid leaks identified.

5. All of the measurements from the front seated ATDs were below their respective Injury Assessment Reference Values (IARVs).

6. Consistent with tests of other vehicle models in this series, the main system vehicle voltage fluctuated during the impact. There were three discrete partial drops in the main system voltage that was apparent on all of the voltages recorded. It is likely that intermittent shorts to ground putting additional load on the battery caused these drops. However, the specific circuits that were shorted were not identified.

7. An experimental thermal wire fire detector was mounted in the underbody crossmember to evaluate its crashworthiness. The electrical monitoring of the device did indicate a closure (activation) during the impact due to the vehicle crush, not due to heat or fire.

8. Consistent with other vehicles tested in this series, crash-induced structural openings from outside to inside of the passenger compartment were identified. These openings were noted independent of their possible contribution to fire propagation. For this test, two separate openings were identified: one on the left rear floorpan and one due to deformation of the left rear door.

9. There was no evidence of any potentially combustible materials contacting normally hot surfaces.

3. Front-Wheel Drive Passenger Vehicle Oblique Moving Barrier Frontal Impact, Test C12127

A front-wheel-drive passenger vehicle oblique moving barrier frontal impact crash test was conducted at the General Motors Proving Ground on August 12, 1998. A total of 142 data channels were recorded for this test, including 136 on the test vehicle and ATDs and 6 on the moving barrier. Similar to the other 105 km/h oblique moving deformable barrier frontal impacts, this test was conducted outdoors.

3.1. *Test Conditions*

3.1.1. Impact Conditions

This test was a frontal oblique moving deformable barrier frontal impact as depicted in Figure 13. The impact configuration was nearly identical to the two previous oblique moving barrier tests. However, the relative angle between the vehicle and moving barrier was set at 21 degrees, which is vehicle specific. This angle was set so the center of the moving barrier face impacted the front left corner of the test vehicle and its velocity vector passed through the CG of the test vehicle. The CG of the test vehicle was approximately 1198 mm rearward of the front wheel centerline and laterally in the center of the vehicle. Similar to the previous oblique moving barrier tests, the front left corner was defined as the intersection of two lines. The first line was tangent to the most forward part of the vehicle bumper and perpendicular to the vehicle longitudinal centerline. The other line was tangent to the widest part of the vehicle body (excluding mirrors) and parallel to the vehicle longitudinal centerline. This intersection represents a virtual corner of the vehicle, which was not on the vehicle body due to the contours of the body styling. This resulted in a theoretical overlap of 50% based on the barrier width of 1676 mm and a vehicle width of 1782 mm. ([(1676 / 2) / cos (21 °)] / 1782 = 0.503.)

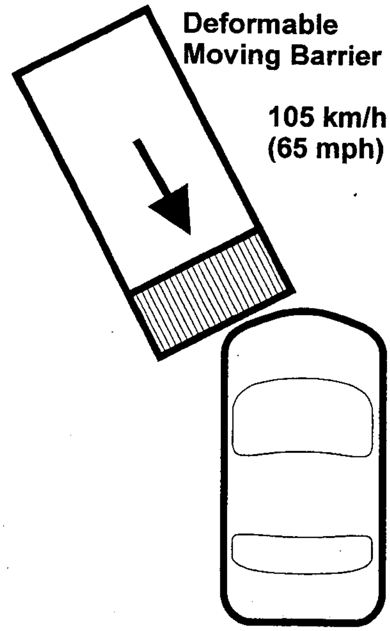

Figure 13
Crash Test Configuration for Test C12127

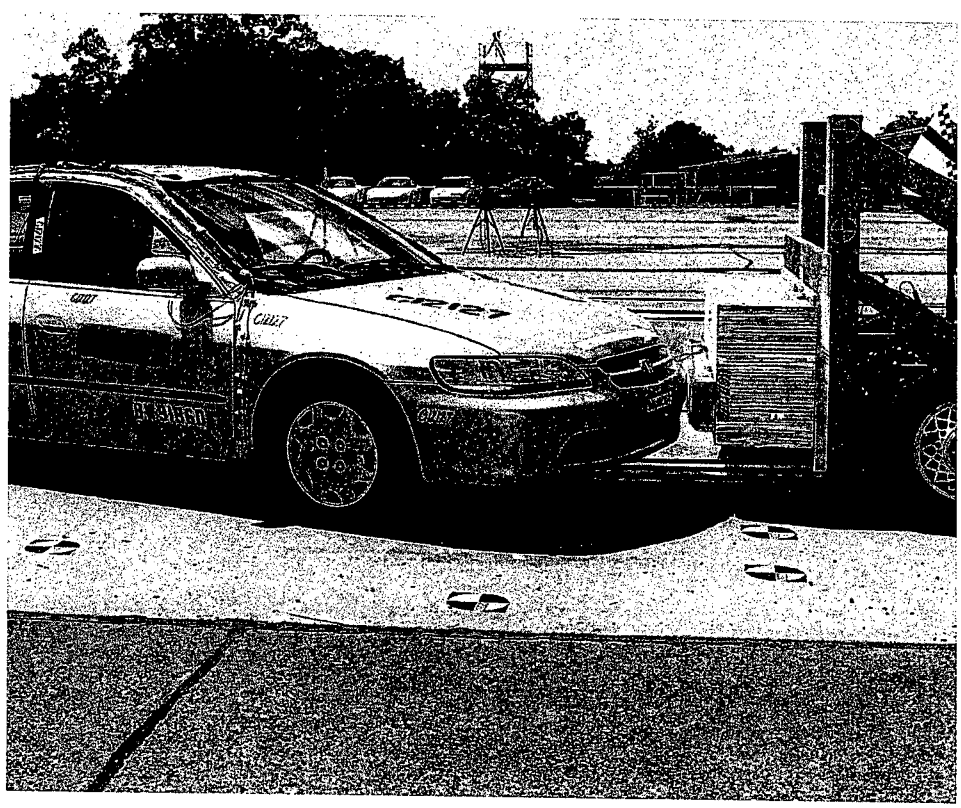

Figure 14
Pre-Test Photograph of Test C12127

The mass of the deformable barrier was 1639 kg (3613 lbs.). This mass was greater than what is used for FMVSS214 [6] tests (1367 kg or 3015 lb.) The height of the center of the simulated bumper form was 432 mm (17 in.) above grade (which is the same as specified in FMVSS214 [6].) The wheels of the moving barrier were oriented in the same direction of the barrier longitudinal axis. The wheelbase, trackwidth, center of gravity, and aluminum honeycomb barrier face of the moving barrier were all similar to what is specified for FMVSS214 [6] testing. The brakes of the moving barrier were activated at impact, resulting in an effective brake activation time of about 150 msec after impact. The test vehicle's brakes were on during the impact.

The impact velocity was measured with radar and was 104.1 km/h (64.7 mph).

3.1.2. Vehicle Description

The test vehicle was a 1998 Honda Accord (VIN: 1HGCG5642WA003857) which had a test mass of 1738 kg (966 kg front, 772 kg rear) which included the two ATDs, crash test instrumentation, and Stoddard Solvent in the gasoline tank. Similar to test C11990, 61.3 liters of Stoddard Solvent were added to the unusable capacity of the tank. (61.3 liters represents 95% of the usable capacity of 64.5 liters.) The engine was operating at impact with complete engine compartment fluids, including battery electrolyte. The radio, high beam headlights, and air conditioning were all operating at impact. The transmission was in neutral for the test.

3.1.3. Pre-test Engine Warm-up Procedure

The engine was started approximately 55 minutes before impact as outlined in Table 1.

Table 1.
Engine Warm-up Procedure for Test C12127

	Time after initial engine start, (min)	Duration, (min)
Engine started (idle approximately 900 rpm)	0	14
Engine speed increased to 1300 rpm	14	11
Engine turned off for instrumentation set-up	25	13
Engine restarted, set to 1400 rpm	38	17
Impact	55	

The surface temperature of the left exhaust manifold was measured using a non-contact infrared meter during the engine warm-up period. The manifold temperature was measured both on the surface of the manifold heat shield and also on the surface of the manifold itself through the vent hole in the shield. The shield temperature was 68°C and the manifold temperature was 239°C. Both measurements were taken about 23 minutes after the initial engine start and were not corrected for the emissivity of the materials.

3.1.4. Modifications to Production Vehicle

Gasoline was supplied to the engine from an auxiliary tank mounted in the rear cargo area (trunk), as the production fuel tank contained Stoddard Solvent. The production fuel supply and return lines were disconnected from the production fuel pump and connected to auxiliary fuel lines which were routed to the auxiliary fuel tank in the trunk. These auxiliary lines were routed through the fuel pump access hole in the floor of the trunk. The production fuel supply and return lines were not moved, just disconnected from the production pump and attached to the auxiliary lines. The remaining supply and return ports at the production fuel pump unit were connected to each other, to prevent the leakage of Stoddard Solvent.

The vehicle's rear brake lines were cut forward of the rear wheels and an auxiliary brake machine was installed to charge the rear brake lines. The purpose of using the brake machine was to help control vehicle kinematics after the impact by isolating the rear brakes to ensure the rear wheels would be locked even if the brake lines were severed towards the front of the vehicle. The front brakes were pre-charged by mechanically locking down the brake pedal, so the front brake fluid pressure would be at a steady state charged condition to enable easy identification of fluid leaks. Unlike the pole impacts, no modifications were made to the front wheel brake calipers or pads.

Similar to previous tests, every reasonable attempt was made to make the added instrumentation in the engine compartment as non-intrusive as possible so as not to affect the outcome of the test.

3.1.5. Vehicle Measurements

Measurements listed here are ones taken to measure the vehicle properties during the crash.

- Front left rocker panel acceleration (longitudinal, lateral, and vertical)
- Front right rocker panel acceleration (longitudinal, lateral, and vertical)
- Rear left rocker panel acceleration (longitudinal, lateral, and vertical)
- Rear right rocker panel acceleration (longitudinal, lateral, and vertical)
- Left floorpan acceleration (longitudinal)
- Right floorpan acceleration (longitudinal)
- Center console acceleration (longitudinal, lateral, & vertical, measured on the airbag sensing module)
- Left toepan longitudinal displacement (relative to floorpan, using string potentiometer)
- Driver's and passenger's air bag current (using non-intrusive clamp on current transducers)
- Engine motion (rotation of crankshaft using an auxiliary magnetic pickup transducer) (labeled "engine rpm" in Appendix D)

- Fuel pump current (measured at auxiliary fuel tank)
- Fuel pump voltage (measured at auxiliary fuel tank)
- Vehicle yaw angular velocity (measured using rate gyroscope located on the floorpan near the CG)

3.1.6. Photographic Coverage

High-speed 16-mm movie cameras were used to film the crash test. Cameras were located above, in front of, and to both sides of the test vehicle.

3.1.7. Moving Barrier Measurements

The following accelerations were measured on the deformable moving barrier:

- Moving deformable barrier at CG acceleration (longitudinal, lateral, and vertical)
- Moving deformable barrier at rear crossmember acceleration (longitudinal, lateral, and vertical)

3.1.8. Anthropomorphic Test Device (ATD) Measurements

Two 50^{th} percentile male Hybrid III ATDs [8] were located in the front outboard seating positions. The seats were located in the fore-aft mid position, and the seat backs were at 10.0 degrees relative to vertical, (measured at the head restraint.) The ATDs were restrained using the vehicle's lap / shoulder belts with the adjustable guide loop set in the third position from the top. In addition, the ATDs were restrained by the vehicle's frontal air bags. The ATDs were positioned per FMVSS 208 [7] guidelines and the pelvic angles were measured to be 21.1 degrees from horizontal for the left front ATD and 22.2 degrees for the right front ATD. The head target angle was at 0 degrees from horizontal for both ATDs. The following channels were measured for each ATD.

- Head triaxial acceleration
- Head/ neck interface (upper neck) longitudinal shear force (Fx)
- Head/neck interface (upper neck) lateral shear force(Fy)
- Head/neck interface (upper neck) axial force (Fz)
- Head/neck interface (upper neck) moments about longitudinal, lateral and vertical axis (Mx, My, Mz)
- Chest triaxial acceleration
- Sternal deflection
- Pelvic triaxial acceleration
- Femur axial loads, left and right femurs
- Knee clevis loads, left and right, inner and outer
- Upper tibia bending moment, (Mx, right - left), left and right legs
- Upper tibia bending moment, (My, anterior - posterior), left and right legs

- Lower tibia bending moment, (My, anterior - posterior), left and right legs
- Lower tibia shear load, (Fx, anterior - posterior), left and right legs
- Lower tibia axial load, (Fz, vertical), left and right legs
- Tibia/femur displacement, left and right legs
- Lumbar moment (My, anterior - posterior)
- Lumbar shear load (Fx, anterior - posterior)
- Lumbar axial load (Fz, vertical)

The left front (driver) ATD only was instrumented to make the following additional measurements on the lower leg:

- Upper tibia shear load (Fx, anterior – posterior), left and right legs
- Lower tibia shear load (Fy, right - left), left and right legs
- Lower tibia bending moment (Mx, right – left), left and right legs

3.1.9. <u>Hydrocarbon Vapor Measurements</u>

The concentration of hydrocarbon vapor was measured at the five following locations in the engine compartment:

- Left fuel rail (location #1)
- Right fuel rail (location #2)
- Left manifold shield (location #3)
- Right manifold shield (location #4)
- Near the catalytic converter (location #5)

The concentration of hydrocarbon vapors was measured using tin oxide sensors at each location [1]. Co-located with the tin oxide sensors at locations #1,#2,#3, and #5 were sample tubes that drew gas into collection tubes for subsequent analysis by gas chromatography/ mass spectrometry (GC/MS) [1]. The sample tube for vapor collection at location #4 was not co-located with the vapor sensor. For this location only, the vapor sensor was located above the right manifold shield but the vapor collection tube was placed through the hole in the manifold shield to collect gas from under the shield. The tin oxide sensor could not be located under the shield because of the sensor's temperature sensitivity.

3.1.10. <u>Fluid Pressure Measurements</u>

Pressures in several of the vehicle's fluid systems were measured to help identify fluid leaks and the time during the impact when they occurred. Pressure measurements included:

- Left front brake pressure (line tapped near the master cylinder)
- Right front brake pressure (line tapped on right side of engine compartment near the shock tower)
- Power steering system pressure (measured at power steering pump)
- Cooling system pressure (measured at coolant output neck on the engine block)
- Auxiliary fuel supply line pressure (measured near the auxiliary fuel tank in the rear cargo area)
- Engine oil pressure (measured at the oil pressure sending unit near the oil filter)
- Transmission fluid pressure (tapped into transmission fluid cooler line exit port on the transmission housing)

3.1.11. Additional Electrical Measurements

Additional electrical measurements were made to identify possible shorts, arcing or overheated circuits.

Hall – effect clamp - on current monitoring transducers were used to measure the following currents:

- Alternator cable (measured between the alternator and battery)
- A/C clutch (measured in right rear engine compartment near the power distribution center)
- Left condenser fan (measured in right rear engine compartment near the power distribution center)
- Right radiator fan (measured in right rear engine compartment near the power distribution center)
- Starter cable (measured on starter cable near the battery)
- Battery (measured between battery and power distribution center near the right shock tower)
- HVAC blower (measured under the instrument panel)
- Left front headlight high beam (measured in right rear engine compartment near the power distribution center)
- Right front headlight high beam (measured in right rear engine compartment near the power distribution center)
- Ignition (measured under instrument panel near the steering column)

Voltages were measured on the following circuits:

- Ignition (measured under the instrument panel near the steering column)
- Left front headlight high beam – ground side (measured at driver's side fuse panel behind the IP)
- Starter (measured at terminals at starter)
- Battery (measured at terminal on battery)

3.1.12. Evaluation of the Crashworthiness of Potential Fire Detection or Suppression Technologies

Devices representing two different fire detection technologies were included on this test: optical sensors, and thermal wires.

The thermal wire device was similar to the one referenced in Section 2.1.10. For test C12127, the thermal wire was located on the underside of the hood liner as shown in Figure 15.

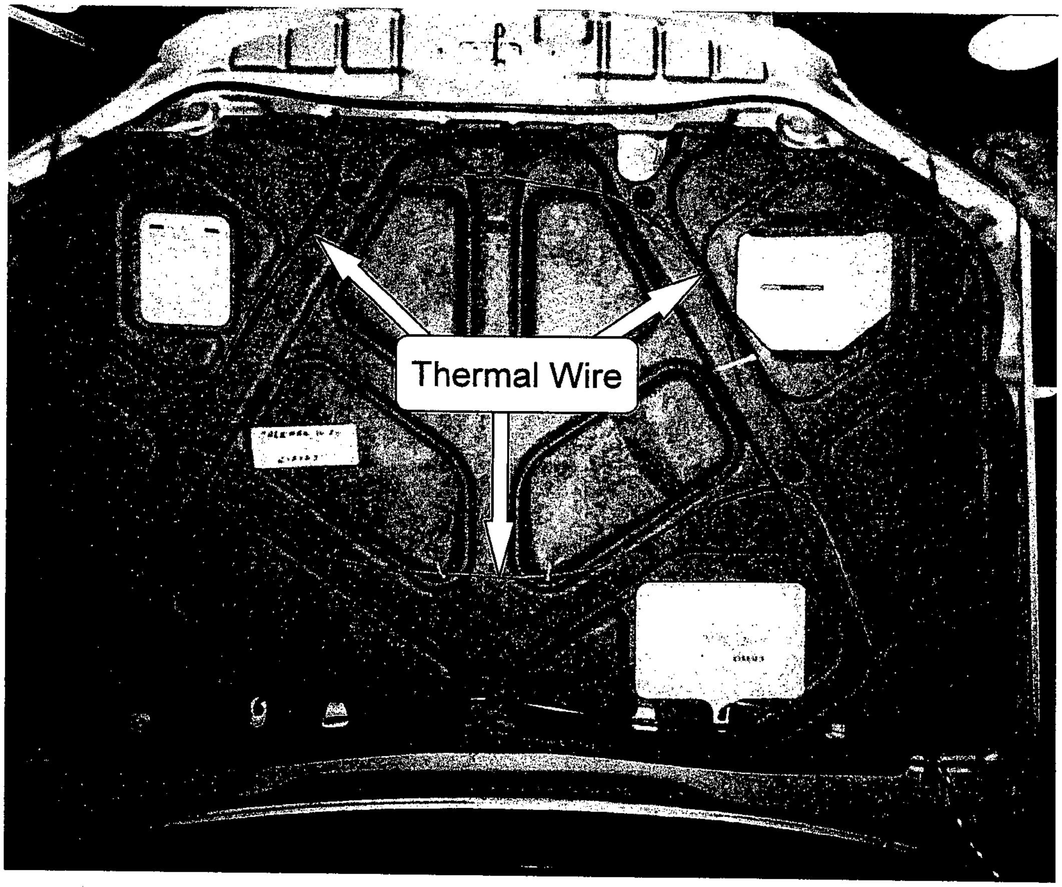

Figure 15
Thermal Wire Fire Detector
Test C12127

Two Dual Spectrum PM-5V optical sensors were mounted in the rear portion of the engine compartment. The optical sensors used were similar to those used in previous tests [2],[3].[4] and are designed to sense infrared energy to detect a fire. One was located in the left rear portion of the engine compartment and was oriented (aimed) forward and inboard towards the center of the engine. The other was symmetrically located on the right side of the engine compartment and was also oriented forward and inboard. One activation channel was recorded for each sensor.

3.2. *Summary of Test Results*

Post-test photographs of the vehicle are shown in Figure 16 and Figure 17.

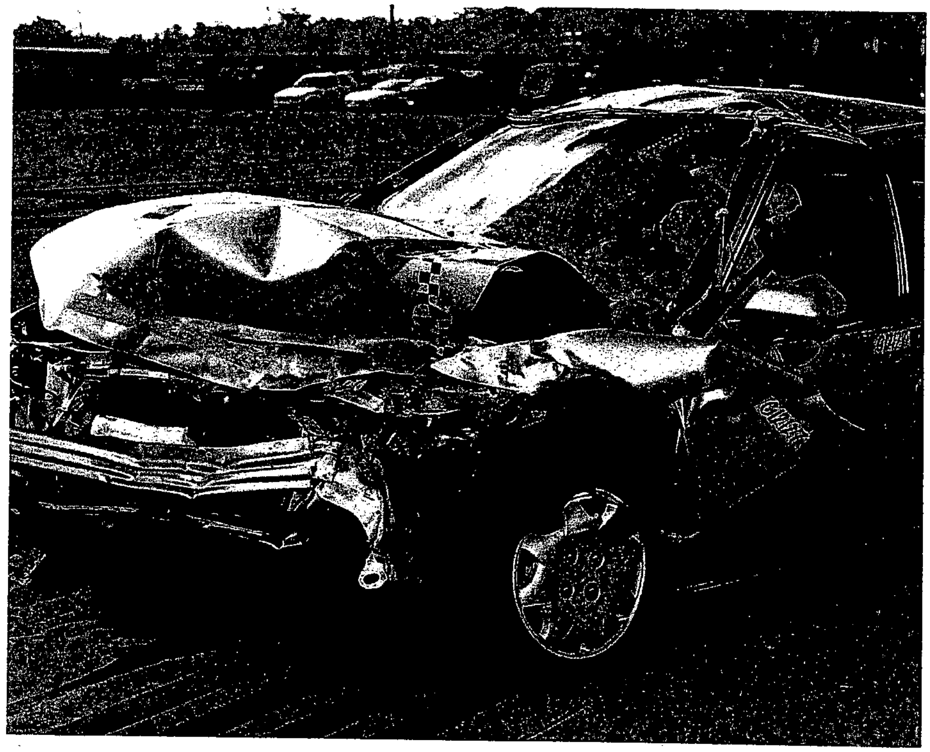

Figure 16
Post-Test Photograph of Test C12127, Front Left View

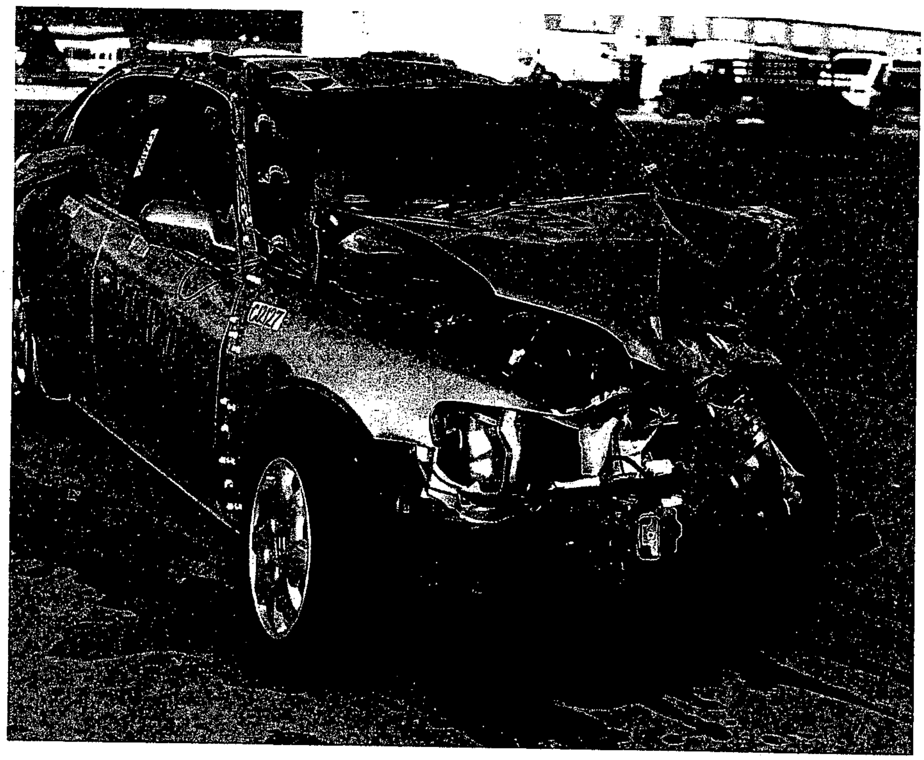

Figure 17
Post-Test Photograph of Test C12127, Front Right View

3.2.1. Summary of Vehicle Crash Test Measurements

The complete set of recorded and computed vehicle measurements are included in Appendix D (Plots 61 through 78, 83, 84, 92, 93, 95, and 106).

Because this vehicle was impacted at a 21 degree angle, it experienced both longitudinal (relative to the vehicle) and lateral accelerations early during the crash event. Similar to the other oblique moving barrier tests conducted for this project [2],[3],[4] the accelerations and velocity changes of the vehicle's rocker panels were translated to a new coordinate system that is aligned with the initial motion of the moving barrier. This measurement could be compared to the vehicle's longitudinal acceleration and change in velocity in pure longitudinal crashes, such as the pole impacts, in which vehicle yaw is minimal. The axis of the vehicle and barrier are shown in Figure 18, a_o is the acceleration in the vehicle's longitudinal direction, a_a is the acceleration in the vehicle's lateral direction, and a_b is the acceleration in the barrier's initial longitudinal direction.

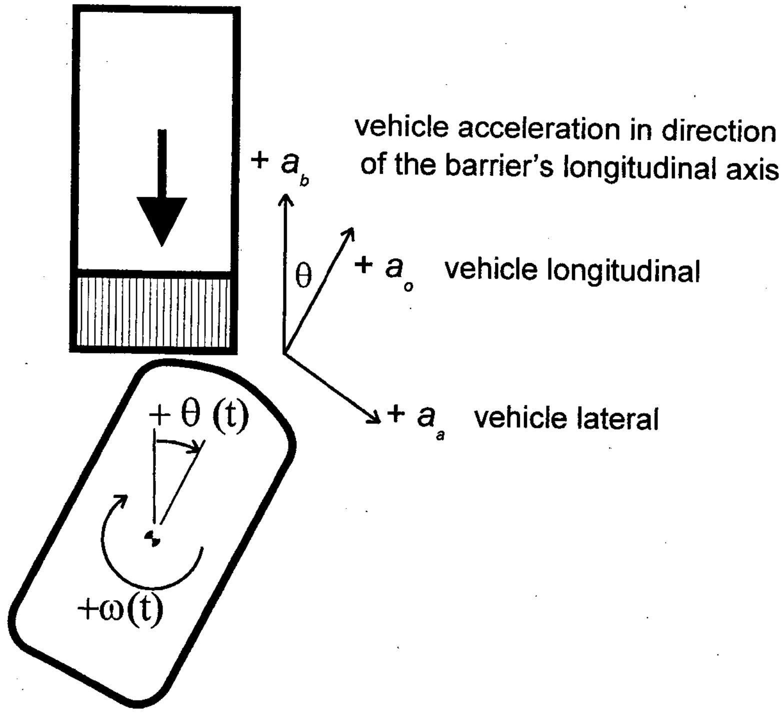

Figure 18
Vehicle and Barrier Axis
Test C12127

The translated measurement was calculated using the following steps:

The yaw velocity rate, $\omega(t)$ (which was measured and is shown in Plot 106, Appendix D) was integrated using a constant of 21° to yield the vehicle's angle $\theta(t)$. Plot 106 has reversed polarity as compared to previous tests [2],[3],[4]. Thus, the signal was multiplied by −1 during the integration to match the sign convention of previous tests as well as the sign convention of Figure 18. This angle, $\theta(t)$, is relative to the barrier's initial longitudinal axis and is shown in Figure 19.

$$\theta(t) = \int \omega(t)\, \delta t + 21^\circ$$

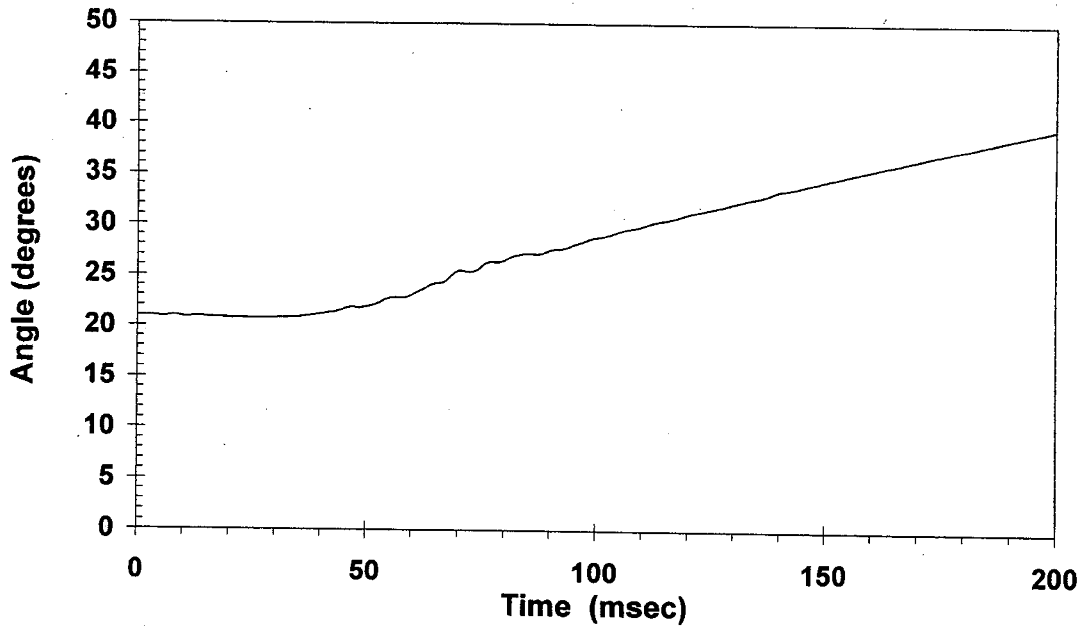

Figure 19
Vehicle's Yaw Angle, θ(*t*)
Test C12127

Next, the following data channels were filtered at SAE class 60 [10] :

Right front rocker panel longitudinal acceleration, $a_{rfo}(t)$, (Plot 67, Appendix D)

Right front rocker panel lateral acceleration, $a_{rfa}(t)$, (Plot 68, Appendix D)

Left rear rocker panel longitudinal acceleration, $a_{lro}(t)$, (Plot 72, Appendix D)

Left rear rocker panel lateral acceleration, $a_{lra}(t)$, (Plot 73, Appendix D)

Next, the right front rocker resultant acceleration in the direction of the barrier's initial longitudinal axis, $a_{rfb}(t)$, was calculated using the following formula (see Figure 20):

$$a_{rfb}(t) = a_{rfo}(t)\cos\theta(t) - a_{rfa}(t)\cos(90° - \theta(t))$$

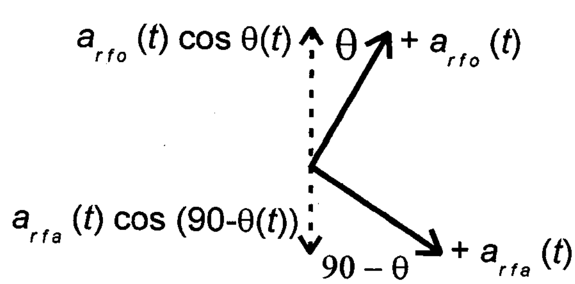

Figure 20
Translation of Accelerations to the Barrier's Initial Axes

In a similar fashion, the left rear rocker resultant acceleration in the direction of the barrier's initial longitudinal axis, $a_{lrb}(t)$, was calculated using the following formula:

$$a_{lrb}(t) = a_{lro}(t)\cos\theta(t) - a_{lra}(t)\cos(90° - \theta(t))$$

The two locations were averaged to yield $a_{avgb}(t)$, the averaged vehicle acceleration in the direction of the barrier's initial longitudinal axis, which is shown in Figure 21.

$$a_{avgb}(t) = [a_{rrb}(t) + a_{lrb}(t)] / 2$$

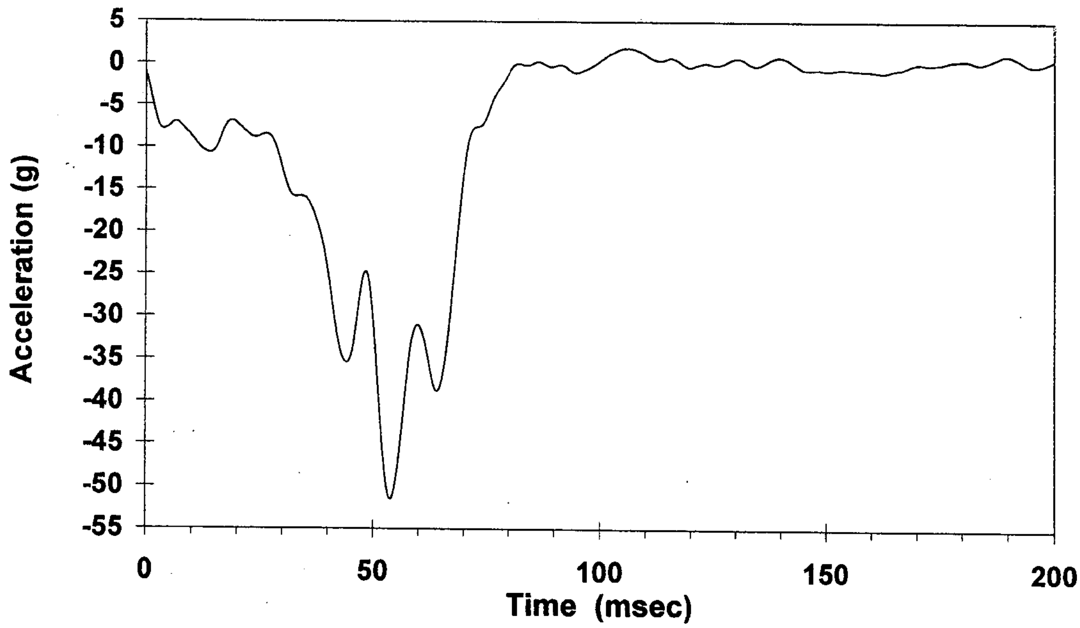

Figure 21
Vehicle's Averaged Acceleration In The Direction Of The Barrier's Longitudinal Axis, $A_{avgb}(T)$
Test C12127

This averaged acceleration was integrated to give $v_{avgb}(t)$, the vehicle's velocity in the direction of the barrier's initial longitudinal axis, which is shown in Figure 22. The vehicle experienced a change in velocity of 53 km/h in the direction of the barrier's initial longitudinal axis.

$v_{avgb}(t) = \int a_{avgb}(t)\,dt + 0$ (the vehicle's initial velocity was 0)

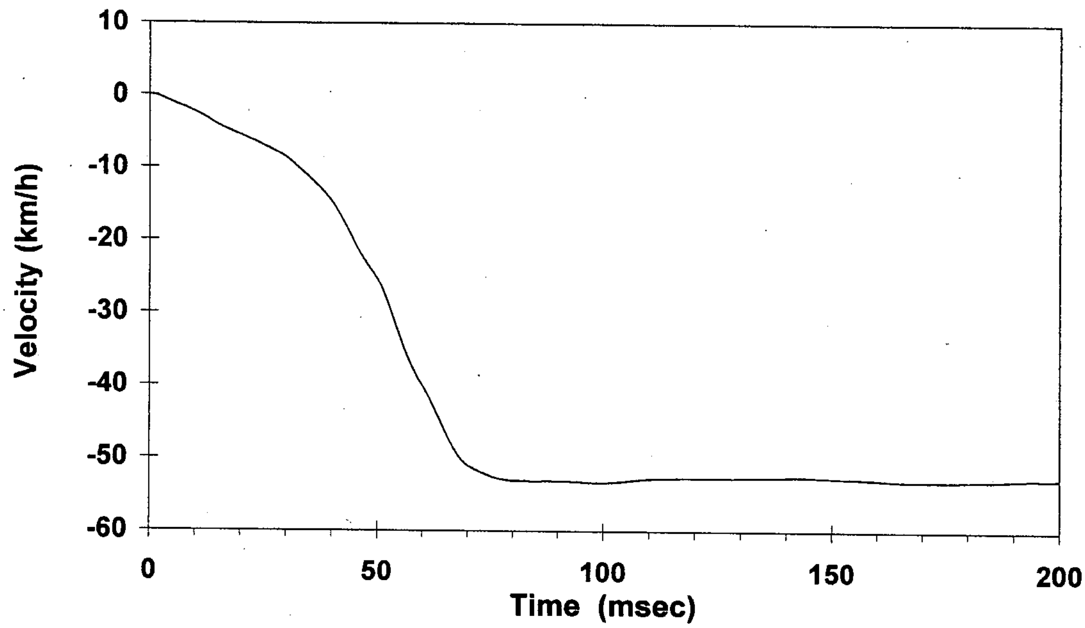

Figure 22
Vehicle's Averaged Velocity in the Direction of the Barrier's Longitudinal Axis, $V_{avgb}(T)$
Test C12127

The displacement of the driver's side toe pan relative to the vehicle was approximately 165 mm as shown in Figure 23 and Plot 78 Appendix D.

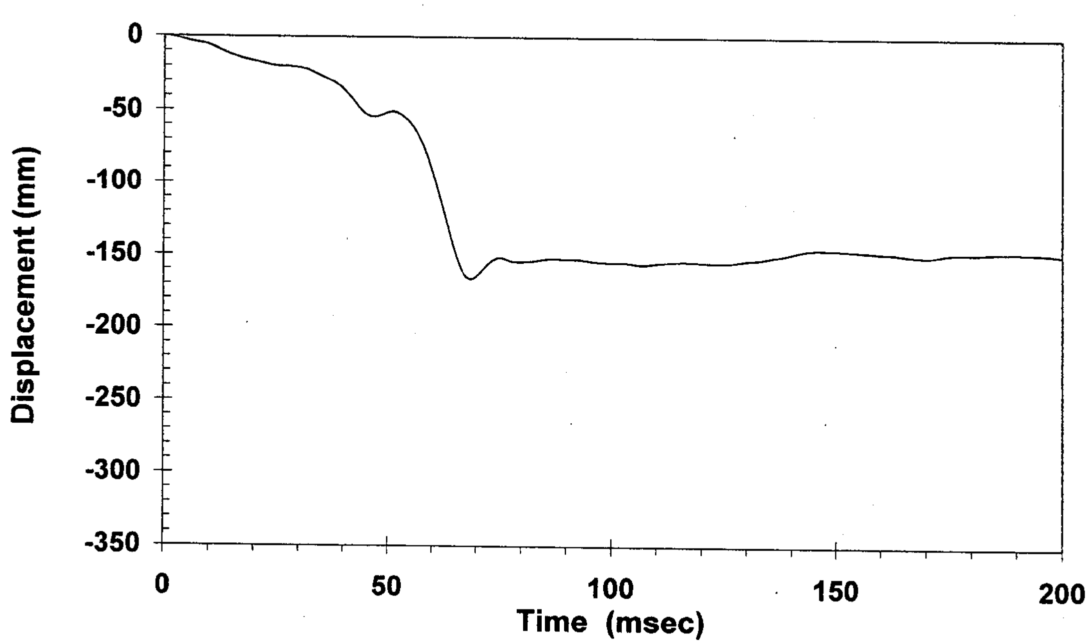

Figure 23
Left Toepan Displacement, Relative to Floorpan
Test C12127, filtered at SAE class 60 [10]

The current measurements of the driver and passenger air bag circuits indicated that both air bags deployed at 11 msec (Appendix D, Plots 92 and 93.)

No reliable information was collected from the engine motion transducer due to an instrumentation malfunction (Appendix D, Plot 84.) Although this transducer provided useful engine measurements on previous tests it malfunctioned or was damaged during this test.

Figure 24 and plot 95 in Appendix D show the fuel pump current draw during the impact. The fuel pump was drawing about 4 amps while it was operating at impact. The current dropped to zero at about 20 msec after impact indicating the pump was off. This is consistent with the other frontal tests of this series in that, the fuel pumps have lost electrical power early (before 100 msec) in every test conducted. The fuel pump was likely stopped due to the drop in main vehicle voltage.

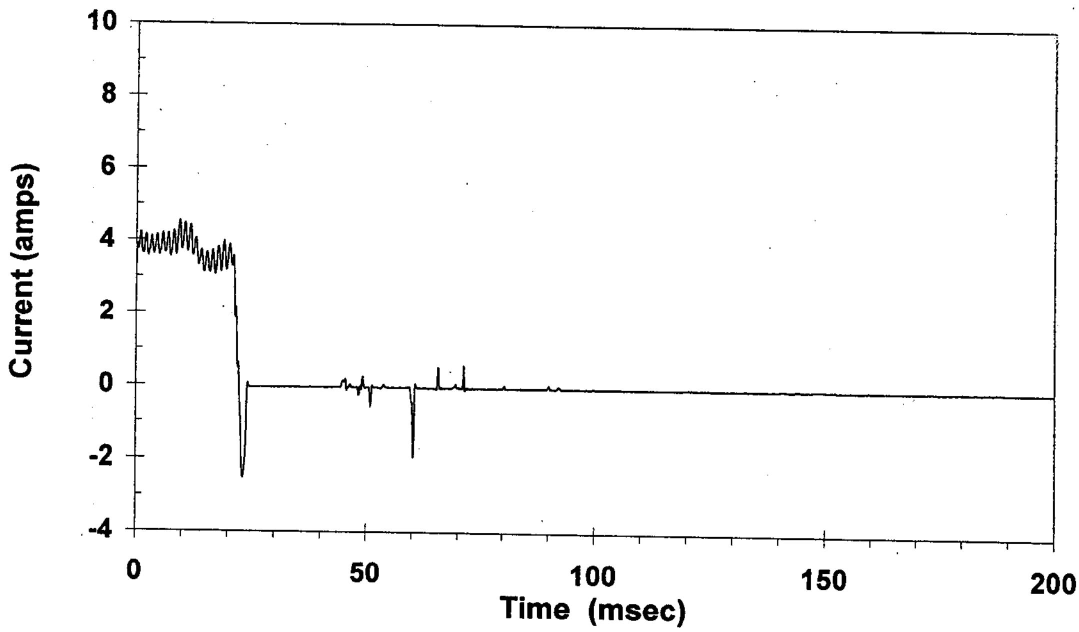

Figure 24
Fuel Pump Current
Test C12127

The ignition feed voltage, battery voltage and starter voltage all indicated intermittent drops from the nominal 13 volts throughout the impact. These voltages are shown in Figure 25 (plot 79), plot 80 and plot 81 respectively. The first drop in system voltage however, occurred at 20 msec coinciding with the loss in current to the fuel pump. Consistent with other frontal tests in this series, the fuel pump shut down at the first drop, albeit partial drop, in system voltage. The fuel pump voltage decayed from 12 volts to near zero from about 20 msec to 200 msec as shown in Figure 26 and Plot 83 (Appendix D), due to the loss of supplied voltage at 20 msec. Bench-tests on fuel pumps for other vehicles in this project [2] also indicated a gradual decay in voltage (lasting 40-150 msec) when current flow was stopped to the motor. This is likely due to the windings of the motor producing a voltage drop as the motor stops. The decay shown in Figure 26 is consistent with the observations from other tests.

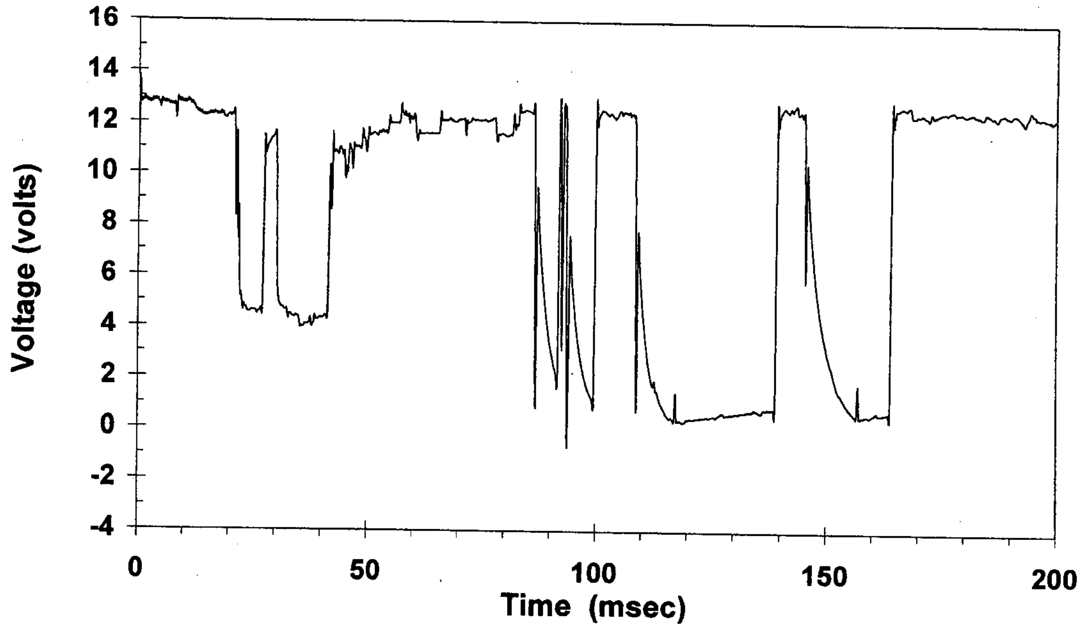

Figure 25
Ignition Voltage
Test C12127

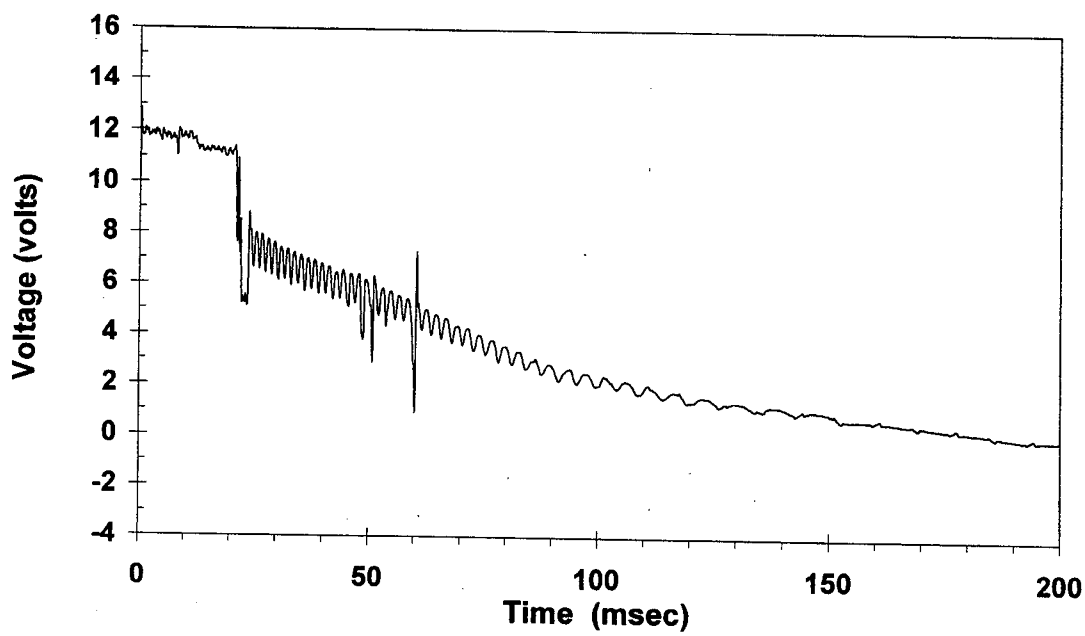

Figure 26
Fuel Pump Voltage
Test C12127

3.2.2. Summary of Recorded Barrier Measurements

The acceleration measurements and related computed values from the moving barrier are included in Appendix D (Plots 107 through 113).

The longitudinal velocity of the barrier's CG is re-created here as Figure 27. The barrier sustained a velocity change of about 60.0 km/h (37 mph) in 150 msec.

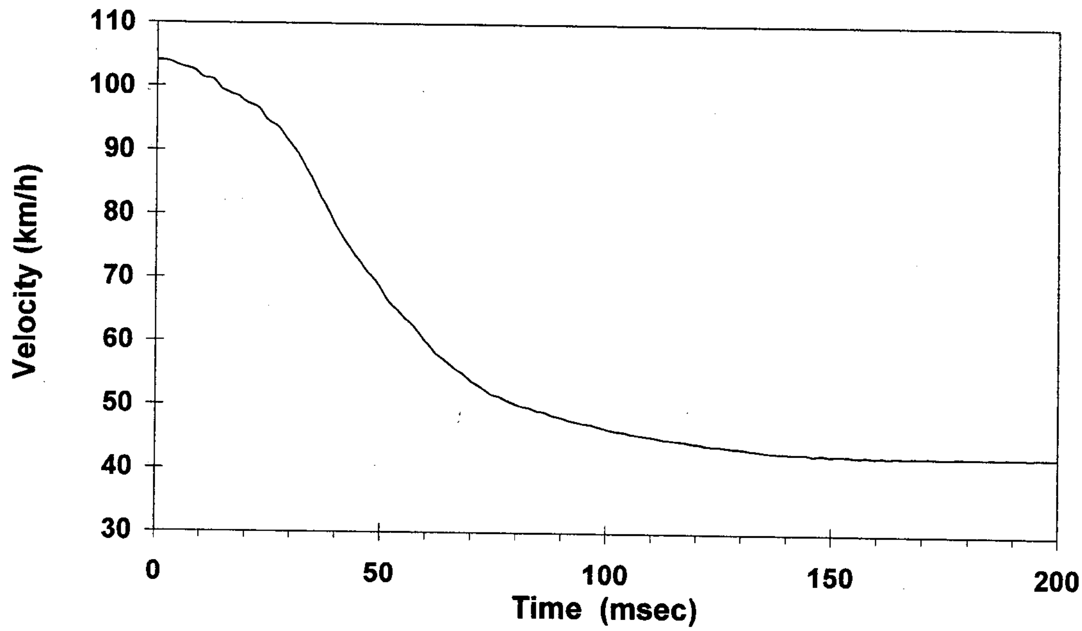

Figure 27
Moving Deformable Barrier Longitudinal Velocity at CG
Test C12127

3.2.3. Summary of Recorded ATD Measurements

The complete set of recorded and computed ATD measurements are included in Appendix D (pages i and ii, and Plots 1 through 60).

For the left front ATD, the upper right tibia moment (Mx, My resultant) exceeded its Injury Assessment Reference Value (IARV). Its peak value was 254 Nm (Plot 21) which was 113% of the IARV of 225 Nm [9]. The computed leg index for the right leg (upper tibia, Plot 23) which uses the upper tibia bending moment also exceeded its IARV. The leg index was 1.21 compared to its IARV of 1.00.

Also for the left front ATD, the upper left tibia index was 1.02 compared to its IARV of 1.00.

Also for the left front ATD, the 3 msec consecutive acceleration peak was 65 g's exceeding its IARV of 60 g. (Appendix D, Plot 3)

For the right front ATD, the upper right tibia moment (Mx, My resultant) exceeded its IARV. Its peak value was 253 Nm (Plot 45) which was 112% of the IARV of 225 Nm [9]. The computed leg index for the right leg (upper tibia index, Plot 47) which uses the upper tibia bending moment also exceeded its IARV. The leg index was 1.15 compared to its IARV of 1.00.

All other recorded and computed ATD measurements were below their respective IARVs.

3.2.4. Summary of Hydrocarbon Vapor Measurement

A complete set of the recorded measurements is included in Appendix E, Figures E1 through EE5, and Appendix D, Plots 85 through 89. The signal cables from all of the vapor sensors shorted to ground from 194 to 254 msec; outside of this time frame, however, all of the data was valid. The vapor sensor at location #5 (catalytic converter) indicated vapor concentrations significantly lower than the other locations near the engine. The vapor sensors at locations #1, #2, #3, and #4 (left and right fuel rails, left and right manifold shields) all indicated the hydrocarbon vapor concentration exceeded 4% within the first 30 seconds after impact. Of those 4 locations, the sensor at location #4 (right manifold shield) indicated the longest duration concentration as it exceeded 2 % until about 100 seconds after impact as shown in Figure E4 in Appendix E. However, these signals may have been caused by exposure of the gas sensors to flames in the engine compartment during the impact, which were observed in the high-speed films. (A description of the engine compartment fire is included in Section 3.2.5.) Rapid changes in the temperature of the sensing elements in these sensors will cause the resistance of the sensing element to change. In turn, this would result in a change in the voltage-drop across the load resistor in series with the gas sensor, which is the output signal used to estimate the hydrocarbon vapor concentrations in Figures E1 through E5.

The GC/MS analysis was completed on the vapors collected from all 5 locations [1], and the results are shown in Appendix E Figures EE1 through EE5. Samples from locations 1 through 5 contained trace amounts of aromatic hydrocarbons (substituted benzenes and substituted naphthalenes) that can be produced during combustion of petroleum products as shown in Figures EE1 through EE5. Samples from locations 3 and 4 (above left and below right manifold shield) also contained relatively large amounts of mixtures of aliphatic hydrocarbons in the range of C12 to C26. These chromatagrams are shown in Figures EE3 and EE4 in Appendix E. Figure EE4 is recreated here as Figure 28.

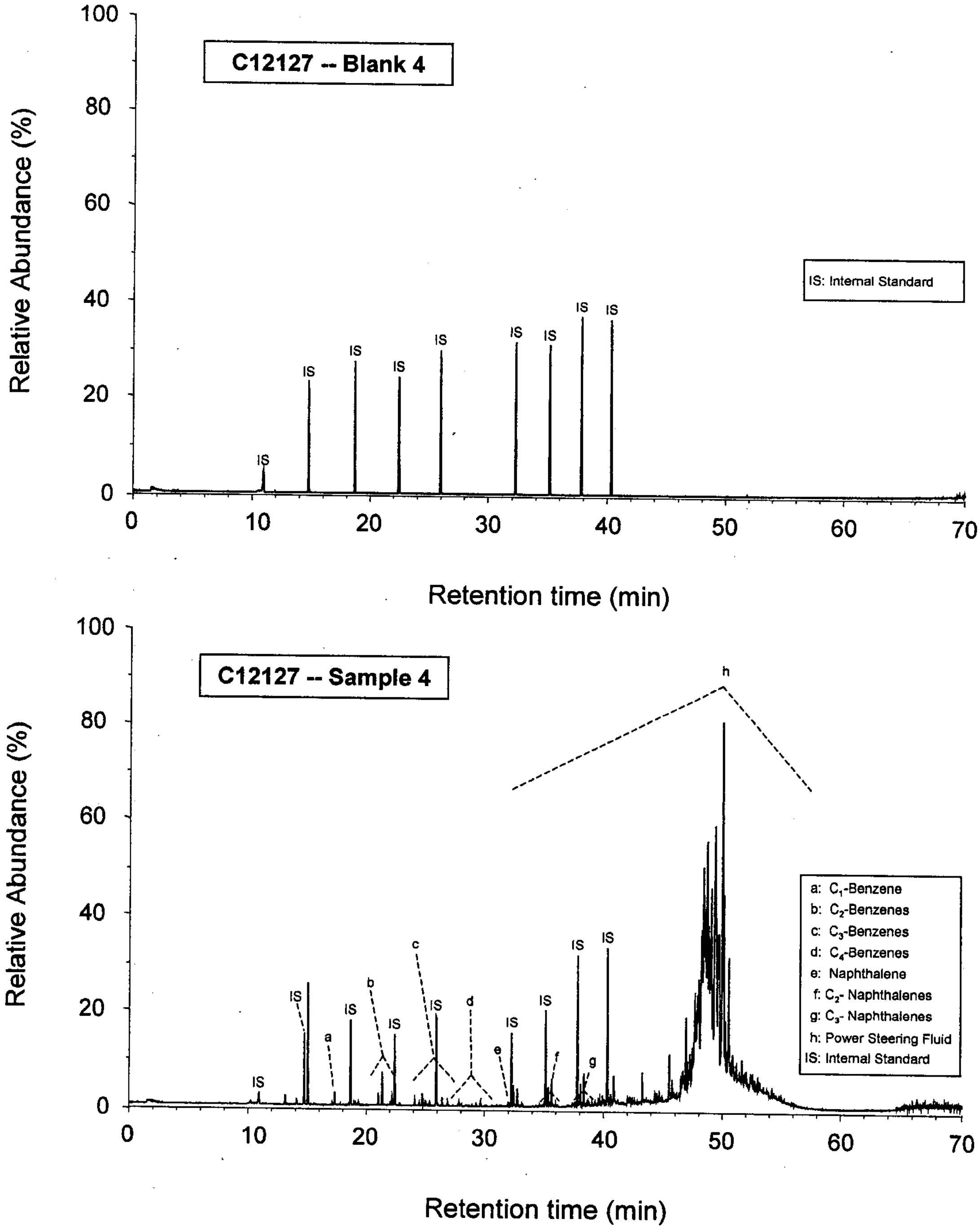

Figure 28

GC/MS analysis of hydrocarbon vapor sample from near the right manifold shield (location #4) during Crash Test C12127. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

Additional fluid headspace vapors were analyzed to identify the sources of the vapors sampled during the crash test. In a series of laboratory tests, Honda factory-fill engine coolant, Honda factory-fill brake fluid, and Honda factory-fill power steering fluid were heated to approximately 300°C. The vapors above these heated fluids were sampled for a GC/MS analysis (Appendix E, Figures EE6 through EE8.) The vapor above liquid gasoline at room temperature was also sampled for GC/MS analysis (Figure EE9). The vapor above the engine coolant heated to 300°C was predominantly ethylene glycol (Figure EE8). The vapor above the brake fluid was a mixture of poly (ethylene glycol) ethers (Figure EE6). The vapor above the power steering fluid heated to 300°C was a mixture of aliphatic hydrocarbons in the range of C12 to C26 . The GC/MS chromatogram from the heated power steering fluid is shown in Appendix E, Figure EE7 and recreated here as Figure 29. The vapor above liquid gasoline at room temperature was a mixture of aliphatic and aromatic hydrocarbons in the range of C5 to C10 (Figure EE9). The distribution of aliphatic hydrocarbons from locations 3 and 4 was the same as the distribution of aliphatic hydrocarbons vaporizing from the Honda factory-fill power steering fluid heated to 300°C in the laboratory experiment. Thus, the source of the Hydrocarbon vapors measured during the crash test was power steering fluid.

None of the vapor samples collected from the engine compartment of the test vehicle during this test contained gasoline, brake fluid, or engine coolant. The test vehicle did not leak motor oil and only a very small amount of transmission fluid during this test as described in Section 3.2.12. Thus, neither motor oil or transmission fluid was tested in these laboratory tests.

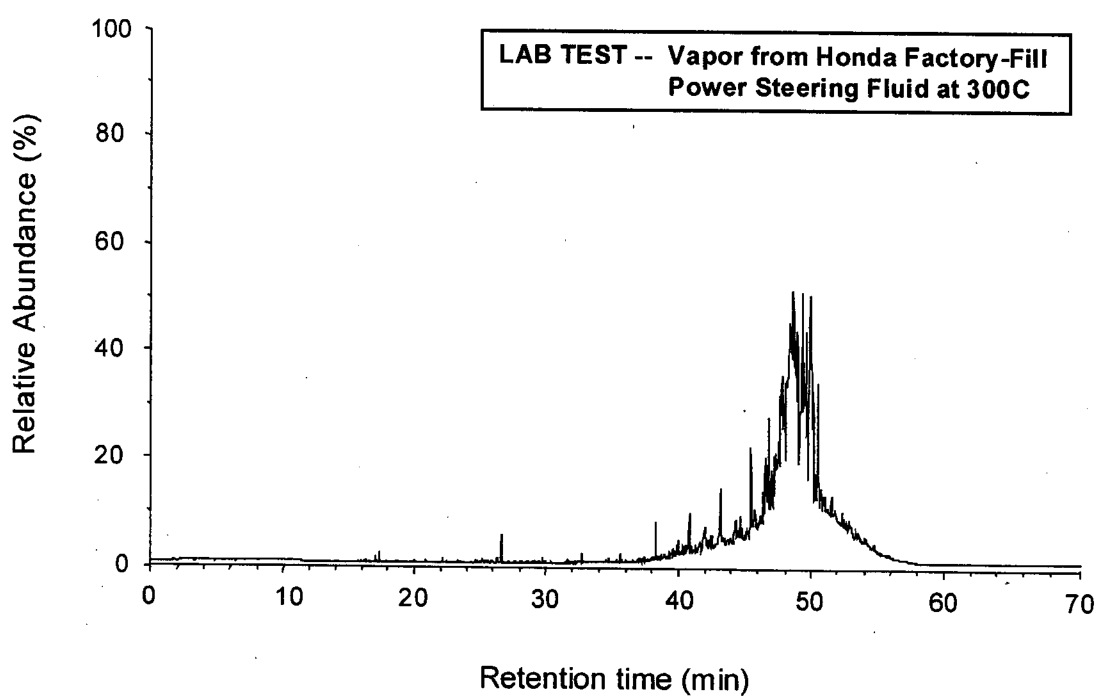

Figure 29
Chromatogram of vapor from Honda factory-fill power steering fluid heated to 300°C in a laboratory test

3.2.5. Summary of Engine Compartment Fire

There were two separate but related fires observed during and after the impact in the engine compartment. First, a flame flash was observed above the engine during the impact in the high-speed films. The flash was first observed at about 42 msec after time zero and lasted at least 400 msec. (See Figure 30.) In addition, visible flames were observed in and around the washer solvent reservoir bottle approximately 5 minutes after impact. The fire at the washer solvent bottle was allowed to burn for an additional 5 minutes before it was extinguished.

Figure 30
Consecutive frames from the high-speed film recorded during this test showing the front of the test vehicle at 42 and 44 milliseconds, Test C12127.

High-speed film of this crash test showed that the flame flash appeared as a burning aerosol/vapor as shown in Figure 31.

Figure 31
Frame of high-speed film recorded during this test viewing into the engine compartment under the deformed hood of the test vehicle at 134 milliseconds, Test C12127.

Results of the GC/MS analyses indicate that hydrocarbons produced by vaporizing power steering fluid on a heated surface were present around the exhaust manifold of the test vehicle during this crash test, suggesting that power steering fluid was involved in this fire. (See Section 3.2.4.) The power steering fluid reservoir was located in the left front quadrant of the engine compartment of the test vehicle. Components in this area were displaced rearward and to the right, along the approximate trajectory of the moving barrier (Figure 32). The power steering fluid reservoir was crushed against the alternator. The top of the power steering fluid reservoir was disconnected from the body of the reservoir, and power steering fluid had been expelled from the reservoir when it was crushed. These observations suggest that the flames in the front of the engine compartment at 44 milliseconds resulted from power steering fluid that had vaporized and ignited by contact with the exhaust manifold and ignited.

Figure 32
Photograph of the left side of the engine compartment in the test vehicle after test #C12127.

An oily liquid was observed pooled in the web-pockets of the exhaust manifold, and an oily residue was observed on a number of components in and around the engine compartment of the test vehicle after this test. A sample of the liquid in the exhaust manifold web-pocket was obtained for GC/MS analysis using a clean glass pipette. Samples of the oily residue on a number of components were obtained using either clean glass fiber filters or clean cotton swabs. The areas sampled included: the collector on the exhaust manifold, the exhaust manifold heat shield (2 samples), the valve cover on the engine, the subframe left strut mounting, the lens from the left head light assembly, and the reflector in the left head lamp assembly. The residue was extracted from the glass filter or cotton swabs into a mixture of analytical grade solvents (1:1 hexane-tetrahydrofuran). In cases where there did not appear to be sufficient residue to obtain an amount of the residue adequate for GC/MS analysis, a few drops of the extracting solvent mixture were applied to the glass filter or cotton swab to dissolve the residue and wick it into the fibers. Figures EE10 through EE17 in Appendix E show results from the GC/MS analysis of the residue samples from the test vehicle after this test. Figure EE10 from Appendix E is recreated here as Figure 34. These analyses indicated that the oily residue in the engine compartment of the test vehicle was a mixture of aliphatic hydrocarbons in the range to C_{15} to C_{30}. In addition, each of the chromatograms in Figures EE10 through EE17 contained three distinct peaks, centered at approximately C_{17}, C_{20}, and C_{26}.

Additional laboratory tests were performed to determine the source of the oily residue in the engine compartment of the test vehicle used in C12127 and the ignition characteristics of Honda/Acura underhood fluids on the exhaust manifold in an exemplar vehicle. In these tests, Honda underhood fluids were poured onto the exhaust manifold of an exemplar vehicle under conditions similar to those in C12127 to determine the ignition characteristics of these fluids on the exhaust manifold. Samples of the residual fluids on the exhaust manifold were acquired for GC/MS analysis. Chromatograms from the GC/MS analysis of residual fluids on the exhaust manifold of the test vehicle were compared to the chromatograms in Figures EE10 through EE17 to determine the source of the oily residue sampled from the engine compartment of the test vehicle used in C12127 after the crash test.

In these laboratory tests, the exemplar vehicle was a 1998 Honda Accord with a 2.3L/L4 engine and options similar to the test vehicle used in C12127. The fluids used in these tests included: Honda/Acura All Season Antifreeze/Coolant, Honda/Acura Premium Formula Automatic Transmission Fluid, Honda/Acura Power Steering Fluid, Honda/Acura DOT 3 Heavy Duty Brake Fluid, and Honda Factory-Fill Windshield Washer Fluid. The engine was turned on and the engine speed was set to 1500 rpm. The radio, low-beam head lights, and fog lights were turned on. The HVAC system was set to the AC/RECIRC mode with the fan on HIGH. The engine was allowed to run with the exemplar vehicle in this condition for approximately one hour before conducting a test. The electrical power to the radiator fans was disconnected just before performing each test. The exhaust manifold and exhaust manifold heat shield were cleaned in between tests.

Exhaust manifold surface temperatures in the exemplary vehicle during these tests were similar to exhaust manifold surface temperatures in the test vehicle in C12127. An infrared thermogram of the exhaust manifold indicates that the temperature of the front surface of the exhaust manifold collector before the test was conducted was approximately 375 – 380°C (Figure 33). This compares to a temperature of 239°C (corrected for the emissivity of the iron manifold) that was measured by inserting single wavelength infrared thermometer through one of the holes in the exhaust manifold heat shield at the end of the engine warm-up period in C12127 (See Section 3.1.3). The holes in the exhaust manifold heat shield were above the runners in the exhaust manifold. The infrared thermogram in Figure 33 indicated that the temperatures of the surfaces of the exhaust manifold runners were between 250 and 300°C.

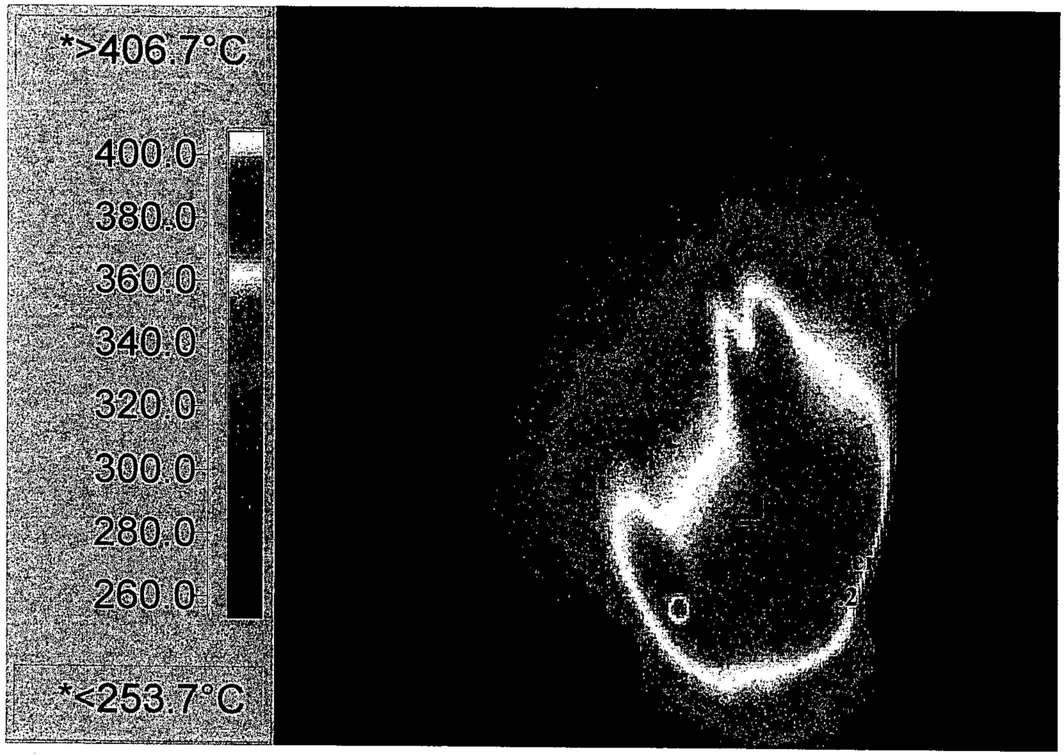

Figure 33
Infrared thermogram of the exhaust manifold in the vehicle used for the laboratory tests immediately after the heat shield was removed

In the first series of these tests, approximately 250 cm^3 of each fluid was poured onto the exhaust manifold with the heat shield removed. In the second series of tests, approximately 250 cm^3 of each of the fluids was poured onto the top of the exhaust manifold heat shield where it attached to the engine. Fluid flowed onto the manifold through the gap at the rear of the heat shield and through two holes in the heat shield. The results of these two series of tests are summarized in the third column of Table 2.

The open-cup flash points of these fluids were determined by using procedures described in ASTM D 92-98a. Five-replicate measurements of flash point were performed on each fluid. The results of these determinations are summarized in the fourth column of Table 2.

Table 2.
Manifold Ignition Behaviors and Flash Points of
Honda Motor Vehicle Fluids

Fluid	Ignition on Manifold without Heat Shield	Ignition on Manifold with Heat Shield	Flash Point
Honda/Accura All Season Antifreeze/Coolant	NO	NO	117 to 130°C
Honda/Accura Premium Formula Automatic Transmission Fluid	NO	NO	157 to 160°C
Honda/Accura DOT3 Heavy Duty Brake Fluid	NO	NO	123 to 125°C
Honda/Accura Power Steering Fluid	NO	YES	170 to 175°C
Honda Factory-Fill Windshield Washer Fluid	NO	NO	34 to 39°C

Samples of liquid residue remaining in the exhaust manifold web-pockets after these tests were retained for GC/MS analysis. Figures EE18 through EE20 in Appendix E show results of the GC/MS analyses of the remaining liquid residue. Each of these samples was a mixture of aliphatic hydrocarbons in the range of range of C_{15} to C_{30} with distinct peaks at approximately C_{17}, C_{20}, and C_{26}. The distribution of hydrocarbons in the oily residue sampled from the engine compartment of the test vehicle after this crash test (Figure 34 and Appendix E, Figures EE10 through EE17) matched the distribution of hydrocarbons in the residue from power steering fluid on the exhaust manifold of the exemplar vehicle (Appendix E, Figures EE18 through EE20). Figure EE18, a chromatogram from the residue from the exemplary vehicle is recreated here as Figure 35 for comparison to Figure 34, a chromatogram from the residue of the crash tested vehicle.

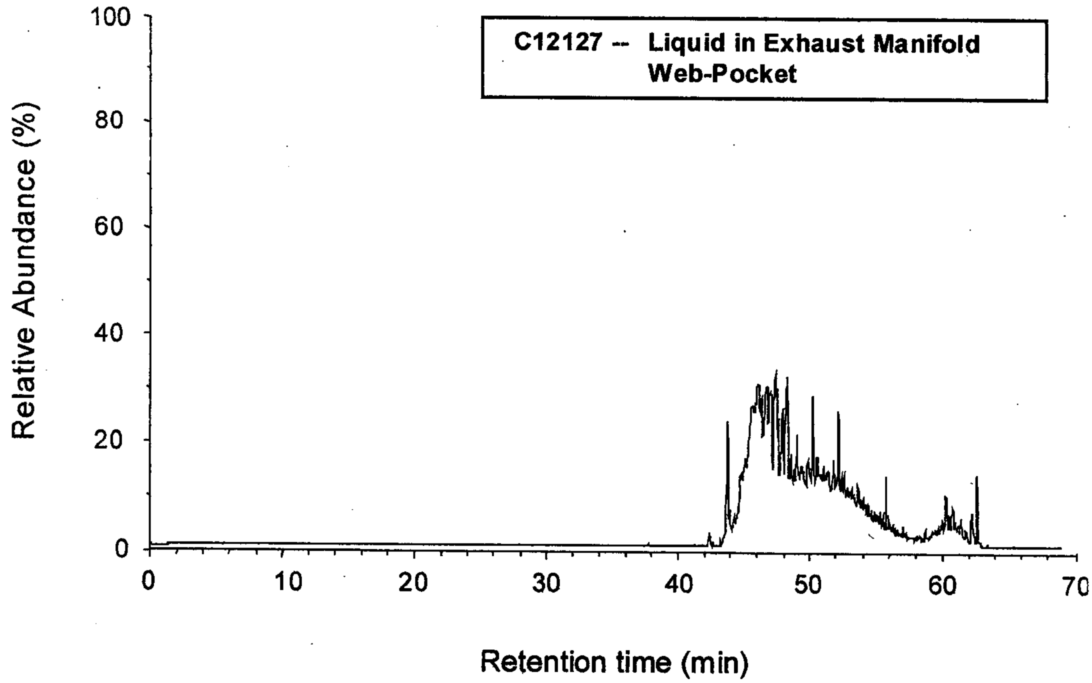

Figure 34
Chromatogram of liquid residue pooled in the left exhaust manifold web-pocket from crash tested vehicle Test C12127

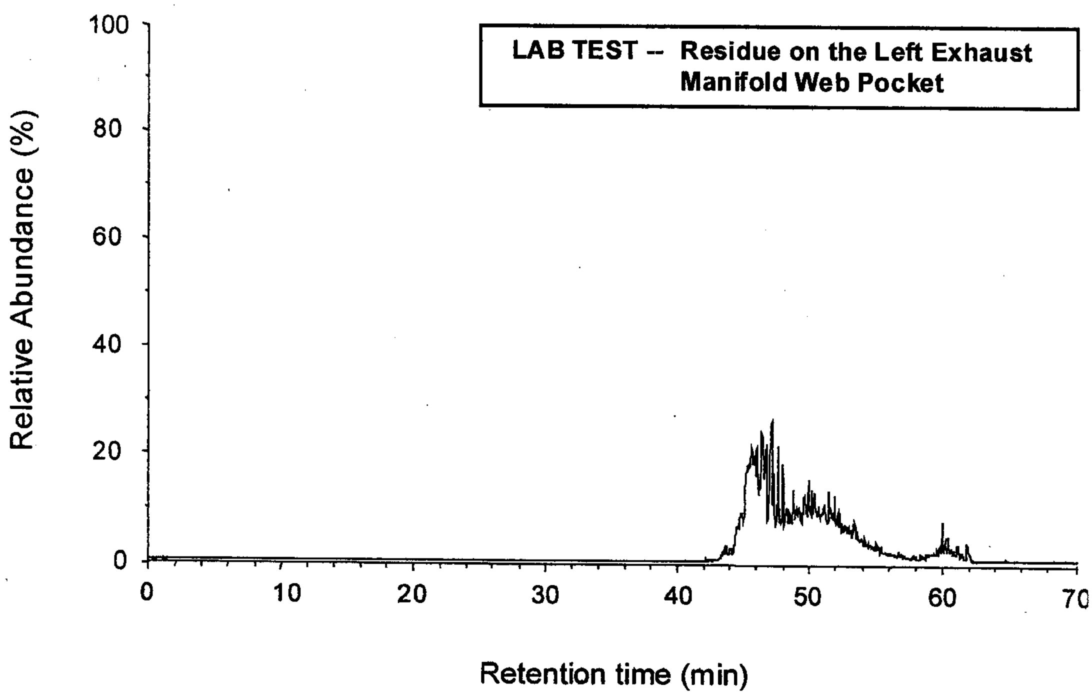

Figure 35
Chromatogram of the liquid residue from Honda power steering fluid in left exhaust manifold web-pocket of the exemplar vehicle

These results suggest that power steering fluid was the fuel and the exhaust manifold was the ignition source for the fire observed in the engine compartment of the test vehicle during this crash test. The GC/MS analyses of the oily residue in the engine compartment (Figures EE10 to EE17) confirm that power steering fluid was expelled from the power steering fluid reservoir, and sprayed onto components in the upper part of the engine compartment. Hydrocarbon vapor from power steering fluid was detected in gas samples collected from above and below the exhaust manifold heat shield (Figures EE3 and EE4 in Appendix E, and Figure 28). Of the fluids in the test vehicle released during this crash test, only power steering fluid ignited when poured onto the exhaust manifold of the exemplar vehicle when it was operated under conditions similar to the test vehicle at the time of this crash test (Table 2). As no other flammable vapors were detected in the gas samples from the test vehicle, the flames observed in the upper part of the engine compartment appear to have been burning power steering fluid aerosol/vapor.

Approximately 5 minutes after impact, a fire was noticed in the windshield washer fluid reservoir. A section of the outer wall of the reservoir had just started to burn with a luminescent orange flame at this time. A blue liquid was observed in the bottom of the reservoir, and blue flames were observed above this liquid indicating that methanol vapor from the residual windshield washer fluid in the reservoir was burning. Between 5 and 10 minutes after impact, flames spread on the windshield washer fluid reservoir (Figure 36). The fire was extinguished about 5 minutes after it was first noticed, about 10 minutes after impact.

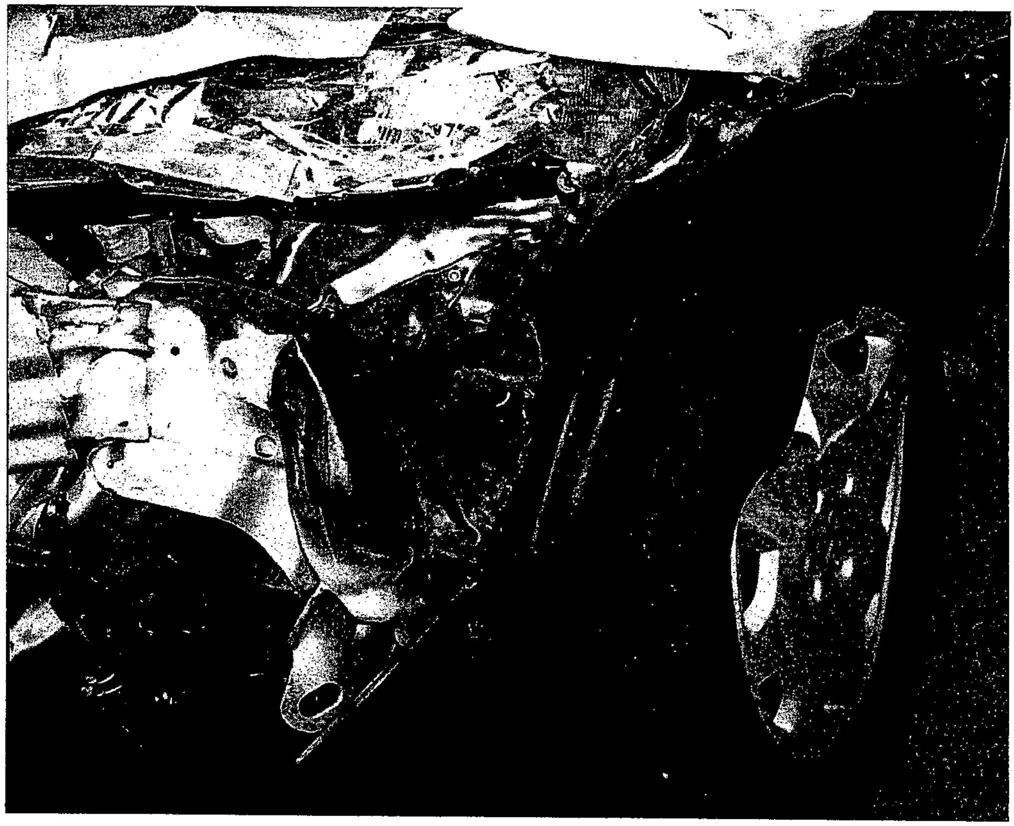

Figure 36
Photograph of the front left corner of the test vehicle between about 5 and 10 minutes after impact
Test C12127

The windshield washer fluid reservoir was located in the front left corner of the test vehicle, outside the inner fender panel behind the front bumper fascia. The reservoir was compressed during the crash test. Two tears developed in the side of the reservoir, the filler tube was sheered-off by a section of the crushed inner fender panel, and the pump was dislodged from its fitting at the bottom of the reservoir. The windshield washer fluid reservoir contained a full charge of fluid before this crash test. Most of the fluid was expelled from the reservoir during this crash test. A small amount of windshield washer fluid (blue liquid) was noted in the bottom of the reservoir after the fire was extinguished.

The flash point of the windshield washer fluid in the test vehicle was between 34 and 39°C (Table 2). The temperature of the windshield washer fluid in the test vehicle was not measured during this crash test. This test was conducted on a hot summer day with little cloud cover. The ambient air temperature was approximately 26°C (78°F) at the time of this test. In an exemplar vehicle operated under similar conditions similar to the test vehicle (engine on at approximately 1500 rpm for 1 hour), the air temperature in the upper part of the engine compartment exceeded 93°C, and the temperature of the windshield washer fluid reached about 41°C. These results indicate that the temperature of the windshield washer fluid in the test vehicle was probably greater than its flash point at the time of this test.

Analysis of the high-speed film from this crash test showed that the burning power steering fluid aerosol moved towards the front of the test vehicle as it translated rearward and rotated away from the barrier (Figure 37). Laboratory tests were conducted to determine (1) if methanol vapor above windshield washer fluid at a temperature greater than its flash point and contained in an exemplar windshield washer fluid reservoir would ignite when exposed to a burning aerosol of power steering fluid, and (2) if flames would spread to the exemplar windshield washer fluid reservoir.

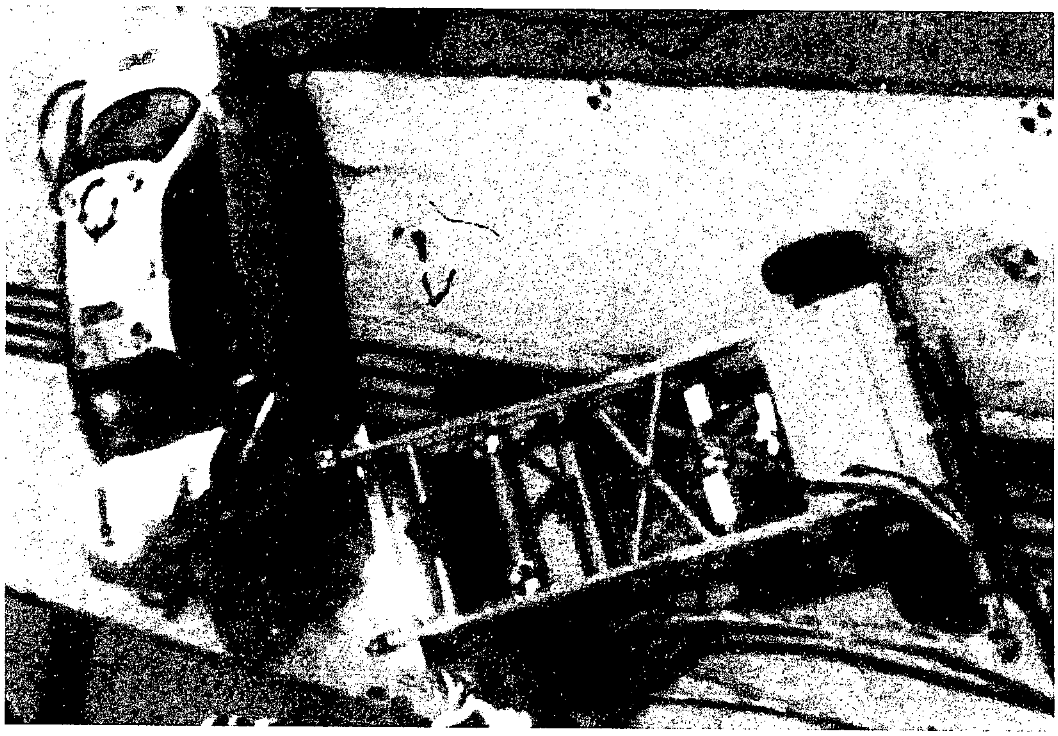

Figure 37
Frame from high-speed film recorded during this test showing the test vehicle and barrier at 464 milliseconds, Test C12127

An exemplar Honda Accord windshield washer fluid reservoir was deformed and two holes were cut into its side to approximate the condition of the windshield washer fluid reservoir in the test vehicle after this crash test. The exemplar windshield washer fluid reservoir was heated to between 38 and 43°C with an electrical heat gun. Honda factory-fill windshield washer fluid heated to approximately 41°C was added to the exemplar reservoir. A thermocouple probe was inserted into the reservoir so that the thermocouple tip was a few inches above the fluid surface. Power steering fluid heated to 82°C (approximate operating temperature) was added to an insulated hand-pump oilcan with a misting nozzle. With a single pump of the oilcan, a power steering fluid aerosol was sprayed through the flame from a propane torch into the holes in the exemplar windshield fluid reservoir. No flames were initially visible inside the exemplar windshield washer fluid reservoir. The temperature of the thermocouple in the reservoir increased to between 100-200°C, indicating that the methanol vapor was burning with a non-luminous flame. After about 5 minutes, sections of the reservoir started to soften, melt, and burn. This analysis indicated that the fire was caused by ignition of methanol vapor from the windshield washer fluid by burning power steering fluid aerosol.

3.2.6. Summary of Fluid Pressure Measurements

The dynamic pressure measurements of the engine compartment fluids are shown in Appendix D, Plots 114 through 122.

Plots 114 and 115 are the left and right brake system pressures respectively. The left front brake pressure measurement (Plot 114) is inconclusive due to a malfunction. The right front brake pressure measurement (Plot 115) exceeded its full-scale calibration; other than the time of overload, it is generally valid data and does not indicate a leak. The post test inspection (see Section 3.2.12) confirmed that there was no leak in the pressurized brake fluid system; however, the non-pressurized fluid reservoir was damaged.

The power steering pressure measurement (Plot 116) is also inconclusive due to a malfunction. However the release of power steering fluid due to the reservoir being crushed is discussed in both Sections 3.2.5 and 3.2.12.

The engine coolant system pressure (Plot 118) indicates a rise in pressure followed by a drop to near zero after 100 msec. This is consistent with the post-test inspection that revealed a crushed and leaking radiator. Similar to previous tests, the engine cooling system maintained a steady state pressure while the engine was off during the set up of the instrumentation just prior to the test. An artifact of the data acquisition system forced some channels to zero, thus, this measurement was biased back to the true steady state beginning pressure. Plot 117 is the unbiased data and Plot 118 shows the corrected (biased) data.

The fuel supply pressure (Plot 120) indicated some fluctuations in fuel pressure during the impact, but did not indicate a complete loss in pressure. These fluctuations in fuel pressure are consistent with other tests conducted in which there was not a leak in the pressurized fuel system. This was also supported by the post-test vehicle inspection which did not reveal any leaks in the fuel system. Similar to the engine coolant, the fuel system maintains a pressure when the engine is off, thus both an unbiased (Plot 119) and a biased (corrected, Plot 120) trace are included.

The pressure of the engine oil is shown in Plot 121, and does not indicate any leaks. This was confirmed during the post-test vehicle inspection.

The transmission cooler pressure (Plot 122) does not indicate a rapid drop in pressure. However, the post-test inspection did indicate the presence of transmission fluid near the cooling line. It is possible that the leak was slow and was not readily apparent on the 240 msec plot of pressure measurement.

3.2.7. Summary of Fuel System Integrity

There were no apparent leaks to the pressurized (Section 0) or non-pressurized fuel systems.

3.2.8. Summary of Additional Electrical Measurements

The results of the electrical measurements made in the engine compartment are shown in Appendix D (Plots 79 through 82, 94, and 96 through 104).

The ignition voltage, battery voltage, and starter voltage (Plots 79, 80, and 81, and Figure 25) all exhibited temporary and sometimes partial drops in system voltage during the impact as described in Section 3.2.1. These intermittent drops continued until about 2200 msec (2.2 seconds) after impact before the voltage settled at near zero. (The plots in Appendix D only display the first 240 msec of data, however, the data was inspected through about 20000 msec or 20 seconds). Because these three waveforms are nearly identical, this waveform is the characteristic waveform of the overall system voltage during the crash. That is, these voltage drops limited the supply voltages to all circuits on the vehicle. Temporary voltage drops during the crush were observed in nearly every frontal impact test of this project [2],[3],[4]. The cause of the voltage drops could be temporary shorts to ground providing additional loading on the battery or possible internal opens or shorts in the battery as the vehicle is crushed. With some of the previous testing on other vehicles, the specific shorts responsible for the additional loading on the battery were identified. In this test, no specific shorts to ground were identified which coincided with the times of voltage drops; however, not every circuit on the vehicle was monitored.

The battery current measurement (Plot 104) indicates that a short to ground likely occurred between 20 and 40 msec due to the increase in current flow in the main battery cable. Current supplying nearly all circuits on the vehicle, except the alternator and the starter, flows through the main battery cable, thus high current flow here indicates the presence of, but not the location of, a short. The full-scale range of this transducer (500 amps) was exceeded. This was also not uncommon in other tests of this project. Space restrictions limited the capacity of the current transducers that could be used, so these transducers frequently overloaded (although capable of identifying the times of high current flow but not the absolute magnitude of the flow.) This current measurement appears valid and remains relatively low after the time of overload. Thus there is no indication of shorts coinciding with the main voltage drops identified on the voltage circuits after 80 msec. The starter cable current (Plot 102) also appears valid and does not indicate the presence of a short during the impact.

The air conditioning clutch current (Plot 96), the right front headlight high-beam current (Plot 98), the condenser fan current (Plot 100), the radiator fan current (Plot 101) and the HVAC blower current (Plot 103) all exhibited normal operating current draw at the time of impact but all dropped to zero early during the impact. All of these measurements appear valid, thus current likely stopped flowing to these circuits during the impact, most likely due to electrical opens or physical damage to the loading devices themselves. None of these four measurements indicated a short to ground that would appear as a rise in current from normal operating levels.

The left front high-beam ground side voltage indicates rises in the ground side voltage for very short durations. These could be due to instrumentation malfunctions or shorts on the circuit caused by the crush of the vehicle near the left front headlight. The post-test inspection did indicate that the left headlight fuse (#45) was open after the test; which indicates the likelihood that the short rise in voltage was due to a short to ground and that the fuse protected the circuit from overload.

The ignition feed current (Plot 94) and the left headlight current measurements (Plot 97) are generally inconclusive and may all be effected by instrumentation malfunctions. It was not uncommon in previous tests for damage to occur to the current transducers themselves during the impact.

The alternator current (Plot 99) indicates a waveform uncharacteristic of a current measurement and is likely inconclusive due to instrumentation malfunctions. However the post-test inspection (Section 3.2.12) did not reveal any shorts in the alternator cable.

3.2.9. Summary of Numerical Film Analysis

No numeric film analysis was done for this test.

3.2.10. Results of Post-test Static Rollover

No static rollover was conducted on this vehicle following the crash test. Previous crash-tested vehicles with full engine compartment fluids had been rolled and the engine compartment fluids flowed into the passenger compartment during the roll, contaminating the interior trim materials. Since some of these vehicles were to be burned, and fluid contamination was undesirable, no further rolls were conducted on the frontal impact test vehicles. [2]

3.2.11. Results of the Evaluation of the Crashworthiness of Potential Fire Detection or Suppression Technologies

The results of the electrical measurements of the experimental fire detectors are shown in Appendix D (Plots 90,91, and 105).

Plot 90 is the optical fire sensor #1 located in the engine compartment. The sensor did not activate during the impact, although there was a fire flash in the engine compartment (Section 3.2.5). The lack of activation of the sensor was not investigated further, however, it is possible the flash was not in the field of view of the sensors for a long enough time to activate the sensors. The fire flash exceeded 400 msec in duration but it was not a sustained flame after that. The subsequent smaller but longer fire near the washer solvent reservoir bottle was not in the field of view of the optical sensors. The washer solvent bottle was low in the front left corner of the engine compartment, while the optical sensors were mounted at the rear of the engine compartment above the engine as described in Section 3.1.12.

The other optical fire sensor output is shown in Plot 91. This signal dropped to zero intermittently during the impact. A post-test inspection of this sensor by the manufacturer indicated this was due to the internal battery of the sensor not being fully charged.

The thermal wire fire sensor output is shown in Plot 105. This sensor temporarily closed at 70 msec and again several times during the event through 1500 msec. The circuit then remained open until 3000 msec (3 seconds) when it closed and remained closed until about 85000 msec (85 seconds) after impact. It then re-opened until measurements were stopped. Plot 105 only displays the first 240 msec of data, but the raw data was inspected through 600,000 msec (10 minutes) after impact. This sensor wire did not appear to be burned or melted following the crash test so it is likely the closures were due to the wire being pinched during the crush. The initial flash was of a short duration and left no indication of heat damage to the wire or the hood insulation. The subsequent longer fire at the washer solvent reservoir was not close enough to the fire wire to cause activation.

3.2.12. Summary of Post-test Vehicle Inspection

As with the previous tests, the vehicle was disassembled and inspected to identify openings into the passenger compartment, the locations of any fluid leaks, the locations of any electrical shorts identified during the crash test, and any contact between combustible materials and hot surfaces.

The following crash-induced structural openings into the passenger compartment (excluding glass breakage) were identified during the post-test inspection:

- A triangular opening hear the bottom of the driver side hinge pillar approximately 30 mm long by 10 mm wide (approximately 150 mm^2).

- A rectangular opening under the steering column pass-through approximately 90 mm by 20 mm.

- A split of a metal seam running laterally across the upper cowl. The split was approximately 450 mm long by 20 mm wide at its widest point. However, nearly this entire split was covered with stretched adhesive, so it was not open for free airflow.

- A small circular hole in the driver floor pan near the toe pan approximately 7 mm in diameter.

The following fluid leaks were identified during the post-test inspection:

- Transmission fluid: small leak in cooling line, transmission housing was intact
- Engine coolant: radiator crushed, coolant lost
- Power steering fluid: pump cracked, fluid lost
- Brake fluid: reservoir broken, fluid released
- Washer solvent: reservoir broken, fluid released
- Battery electrolyte, battery housing pinched but intact, electrolyte expelled through vent hole

There were no leaks found in the fuel lines or the engine oil system.

There were no specific electrical shorts identified during the post-test vehicle inspection. However, two fuses were identified which were open following the test: fuse #45 in the engine compartment fuse relay box (see Section 3.2.8), and fuse #10 in the passenger side instrument panel fuse panel.

The only observed contact between a possible combustible solid and a normally hot surface was contact between the exhaust manifold and the radiator fan shroud, however there was no indication of any heat damage to the fan shroud.

3.3. *Conclusions*

1. There was a short duration fire flash above the engine during the impact as well a self sustaining fire in and around the washer solvent reservoir which was noticed 5 minutes after impact. Crash test measurements and subsequent laboratory testing indicated that the initial fire flash was caused by power steering fluid contacting the exhaust manifold during the impact. The subsequent fire in the washer solvent reservoir was caused by ignition of methanol vapor from the windshield washer fluid by burning power steering fluid aerosol that entered the crushed reservoir during the impact.

2. The electric fuel pump began stopping at 20 msec after impact due to the temporary loss of main vehicle system voltage. The fuel pump did not recover when the main electrical voltage temporarily returned at 50 msec.

3. There was no liquid Stoddard Solvent leaks off of the vehicle.

4. The vehicle's acceleration measurements were translated to a new coordinate system in line with the longitudinal axis of the moving barrier. The peak acceleration of the vehicle along this axis was 52 g (filtered at 60 Hz). The change of velocity of the passenger compartment along this same axis was 53 km/h (33 mph).

5. The moving deformable barrier sustained a longitudinal velocity change of about 60.0 km/h (37 mph) in 150 msec.

6. Both air bags deployed at 11 msec past time zero.

7. For the left front ATD, the upper tibia resultant moment and the corresponding tibia index exceeded their IARVs for the right leg. The upper tibia index only exceeded its IARV for the left leg. Also for the left front ATD the chest acceleration measurement exceeded its IARV.

8. For the right front ATD only the right upper tibia index exceeded its IARV.

9. There was approximately 165 mm toe pan intrusion on the driver's side.

10. The engine speed measurement was inconclusive due to an instrumentation malfunction.

11. The vapor sensors at four locations in the engine compartment (left and right fuel rails, left and right manifold shields) all indicated that hydrocarbon vapor concentrations exceeded 4% within the first 30 seconds after impact. Vapor sampling and subsequent GC/MS analysis indicated the sampled vapors at some of the locations were vaporized power steering fluid.

12. Transmission fluid, engine coolant, power steering fluid, battery electrolyte, brake fluid and washer solvent all leaked during the test. There was no fluid leak in the engine oil or fuel systems.

13. The main vehicle electrical voltage dropped from its normal 13 volts intermittently during the impact and until 2.2 seconds after the impact before stabilizing at near zero. Intermittent drops in vehicle voltage have been observed in most frontal tests conducted for this project, and usually were caused by temporary shorts drawing the battery voltage down. In this case, an increase in current draw current was measured on the main battery cable which coincided with some but not all of the voltage drops. This indicated that some of the voltage drops were likely caused by additional loading on the battery due to circuit shorts to ground. However, the specific locations of these shorts were not all identified.

14. The electrical monitoring of the experimental thermal wire fire detector attached to the underside of the hood did show evidence of temporary electrical closures during and immediately after the test.

However, there was not evidence of any heat damage on or around the sensor and the closure was likely caused by the wire being pinched during the vehicle crush.

15. Monitoring of the experimental optical fire detectors indicated that one malfunctioned due to an insufficient internal battery and the other did not activate during the test. The subsequent washer bottle reservoir fire was out of the field of view of the optical sensors.

16. Four crash-induced openings into the passenger compartment were identified.

17. There was only one observed occurrence of contact between a solid combustible and a normally hot surface which was contact between the exhaust manifold and the radiator fan shroud. There was no indication of heat damage to the shroud.

4. Front-Wheel Drive Passenger Vehicle Offset Pole Frontal Impact, Test C12174

The front-wheel drive passenger vehicle offset pole frontal impact crash test (Test #C12174) was conducted on September 16, 1998 at the GM Proving Ground in Milford, Michigan. A total of 132 channels of data were recorded during the test.

4.1. *Test Conditions*

4.1.1. Impact Conditions

This test was an offset pole frontal impact as depicted in Figure 38 and Figure 39. The test vehicle was towed into a 355 mm (14 inch) diameter steel pole. The lateral offset between the vehicle longitudinal centerline and the pole centerline was 305 mm (12 inches), with the impact occurring on the right side of the vehicle centerline (passenger's side). The impact velocity was measured with radar, and was 55.4 km/h (34.4 mph).

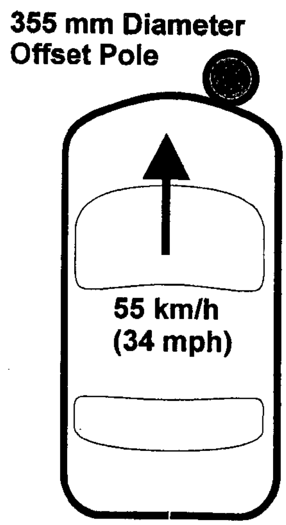

Figure 38
Crash Test Configuration for Test C12174

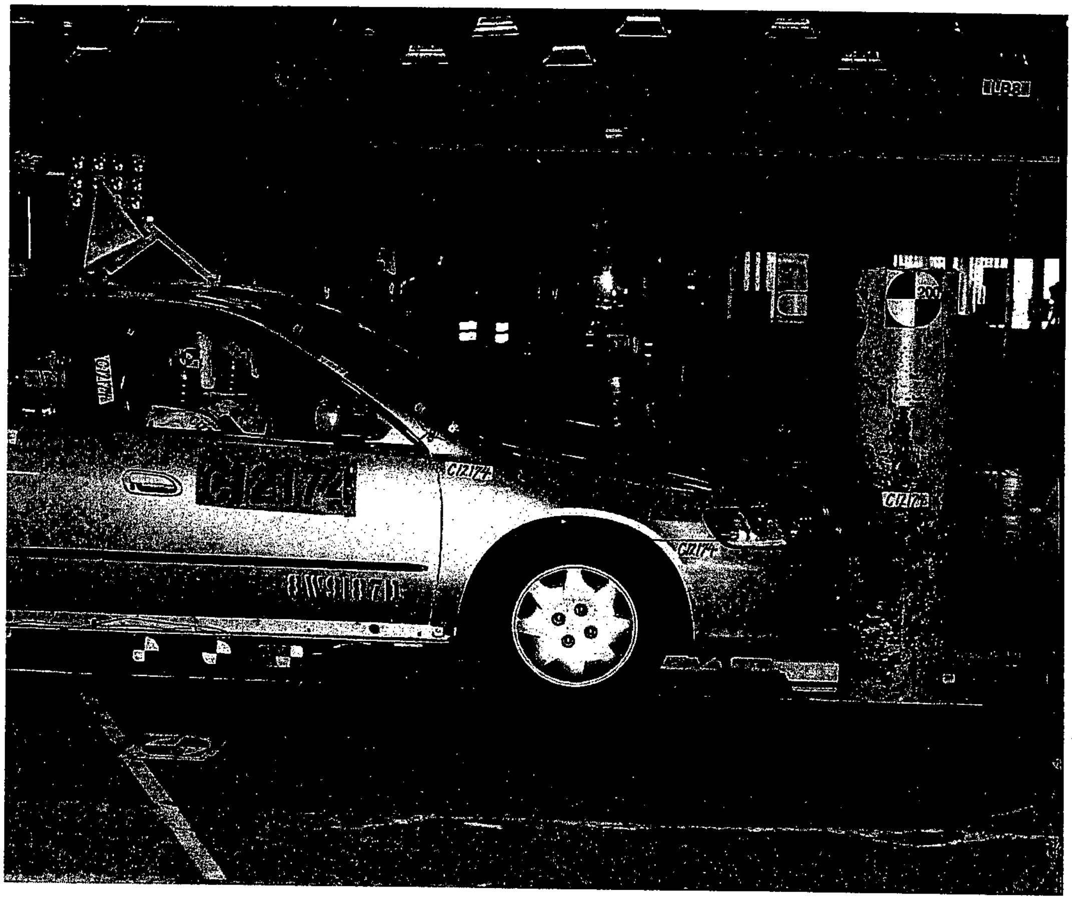

Figure 39
Pre-test Photograph of Test C12174

4.1.2. Vehicle Description

The test vehicle was a 1998 Honda Accord (VIN: 1HGCG5647WA027927) which had a test mass of 1708 kg (960 kg front, 748 kg rear) which included the two ATDs, crash test instrumentation, and Stoddard Solvent in the gasoline tank. Similar to the previous two tests, 61.3 liters of Stoddard Solvent were added to the unusable capacity of the tank. (61.3 liters represents 95% of the usable capacity of 64.5 liters.) The radio, high beam headlights, and air conditioning were all operating at impact. The transmission was in neutral for the test.

4.1.3. Pre-test Engine Warm-up Procedure

The engine was started approximately 50 minutes before impact as outlined in Table 3.

Table 3.
Engine Warm-up Procedure for Test C12174

	Time after initial engine start, (min)	Duration, (min)
Engine started (idle approximately 900 rpm)	0	3
Engine speed increased to 1300 rpm	3	22
Engine turned off for instrumentation set-up	25	7
Engine restarted, set to 1400 rpm	32	18
Impact	50	

Similar to test C12127, the surface temperature of the left exhaust manifold was measured on the surface of the manifold heat shield and also on the surface of the manifold itself through the vent hole in the shield. At 24 minutes after the initial engine start, the shield temperature was 71°C and the manifold temperature was 262°C. At 42 minutes after engine start, the shield was 77°C and the manifold was 232°C.

4.1.4. Modifications to Production Vehicle

The same modifications were made to the production vehicle as with test C12127 (Section 3) with the exception of the brakes. The vehicle's rear brake lines were cut and an auxiliary brake machine was installed to abort the test during the tow, if necessary. The pistons were removed from the front calipers and the brake fluid inlet port was welded shut. This was done in an attempt to pre-charge the front brake lines prior to the test, while still allowing the front wheels to rotate during tow. However, for this test only, the fabricated brake pedal lockdown mechanism did not hold the brake down, thus the brake lines were not pre-charged as with other pole impacts conducted for this project.

4.1.5. Vehicle Measurements

The vehicle measurements were the same as for test C12127 (see Section 3.1.5) except the vehicle yaw was not measured and the toepan displacement measurement was on the right side rather than the left.

4.1.6. Photographic Coverage

High-speed 16 mm movie cameras were used to film the crash test. Cameras were located at various locations around the impact including above, in front of, below and to both sides of the vehicle.

4.1.7. Anthropomorphic Test Device (ATD) Measurements

Two 50th percentile male Hybrid III ATDs [8] were located in the front outboard seating positions. The ATDs were positioned similar to test C12127. The pelvic angle was 21.5 degrees for the left front occupant and 20.8 degrees for the right front occupant. The head target angle was at 0 degrees from horizontal for both ATDs.

The ATDs were both instrumented to make the same measurements as test C12127 (Section 3.1.8) except the six additional tibia measurements were recorded on the right front occupant rather than the left front occupant. (The six additional measurements were upper tibia Fx shear load: left and right legs, lower tibia Fy shear load: left and right legs, and lower tibia bending moment Mx: left and right legs).

4.1.8. Hydrocarbon Vapor Measurements

The concentration hydrocarbon vapor was measured at the same five locations as with test C12127. Namely:

- Left fuel rail (location #1)
- Right fuel rail (location #2)
- Left manifold shield (location #3)
- Right manifold shield (location #4)
- Near the catalytic converter (location #5)

Similar to test C12127, vapor sample tubes were co-located with the concentration sensors for locations #1, #2, #3, and #5 only. For location #4, the vapor collection tube was located underneath the manifold heat shield as described in Section 3.1.9.

4.1.9. Fluid Pressure Measurements

Pressures in several of the vehicle's fluid systems were measured to help identify fluid leaks and the time during the impact when they occurred. Pressures measured were the same as for test C12127 (Section 3.1.10).

4.1.10. Additional Electrical Measurements

The currents measured for test C12174 were the same as for test C12127 except the starter cable current was not measured.

The voltage measurements for test C12174 were the same as for test C12127 except the ground voltage for the right front headlight was measured rather than for the left front headlight.

4.1.11. Evaluation of the Crashworthiness of Potential Fire Detection or Suppression Technologies

Both the experimental thermal wire and optical sensor fire detectors (as described in Section 3.1.12) were evaluated on test C12174. The mounting locations for the optical sensors were the same as for test C12127. The underhood mounting location of the thermal wire was similar to but slightly more rearward than the location for test C12127, as shown in Figure 40.

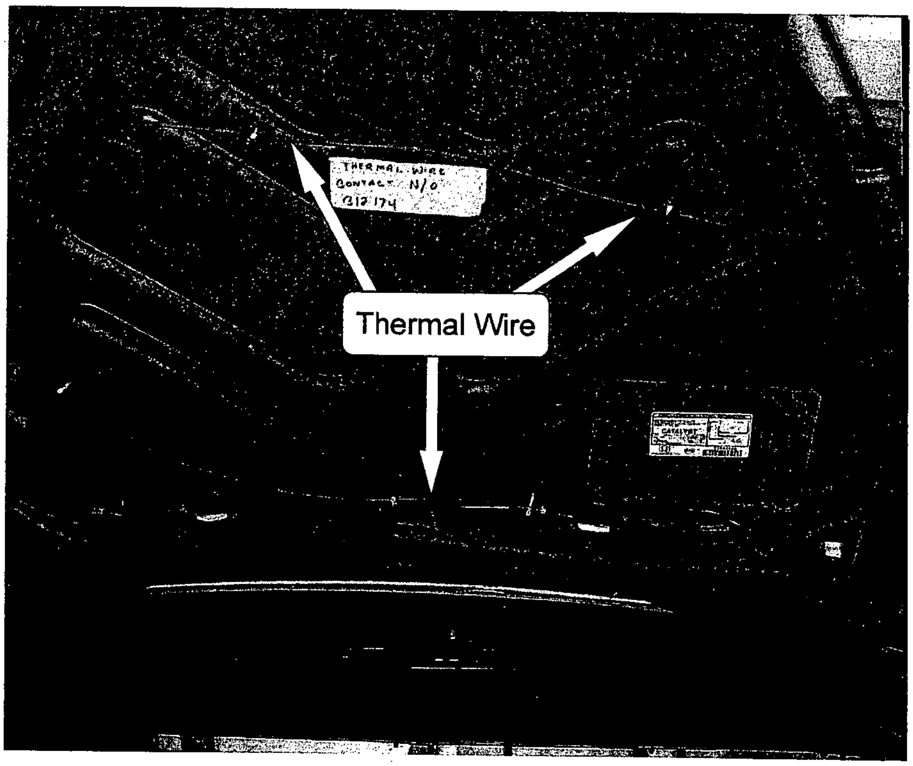

Figure 40
Thermal Wire Fire Detector
Test C12174

4.2. *Summary of Test Results*

Post-test photographs of the vehicle are shown in Figure 41 and Figure 42.

Figure 41
Post-Test Photograph of Test C12174, Front-Right View

Figure 42
Post-Test Photograph of Test C12174, Front-Left View

4.2.1. Summary of Standard Vehicle Crash Test Measurements

The complete set of recorded and computed vehicle measurements are included in Appendix F (Plots 61 through 80, 84, 88, 94, 95, and 97).

The two rear rocker panel longitudinal acceleration measurements were averaged and integrated to compute the change in vehicle velocity, and integrated again to compute vehicle displacement. The peak vehicle longitudinal acceleration (after filtering at SAE class 60 [10]), was 31 g. The maximum longitudinal change in vehicle velocity was 59.5 km/h (37.0 mph), with the velocity crossing zero at 110 msec past time zero (impact.) The averaged rear rocker longitudinal acceleration and velocity are shown in Plot 78 and in Figure 43 and Figure 44.

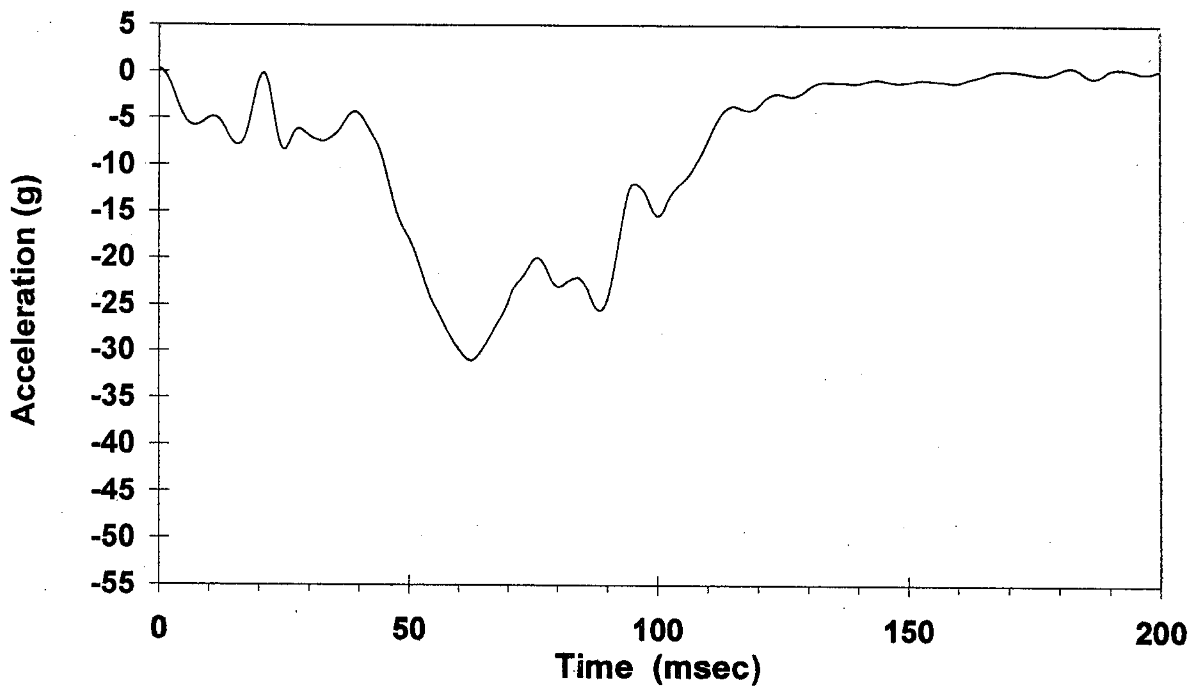

Figure 43
Averaged (Left & Right) Rear Rocker Panel Longitudinal Acceleration
Test C12174, filtered at SAE class 60 [10]

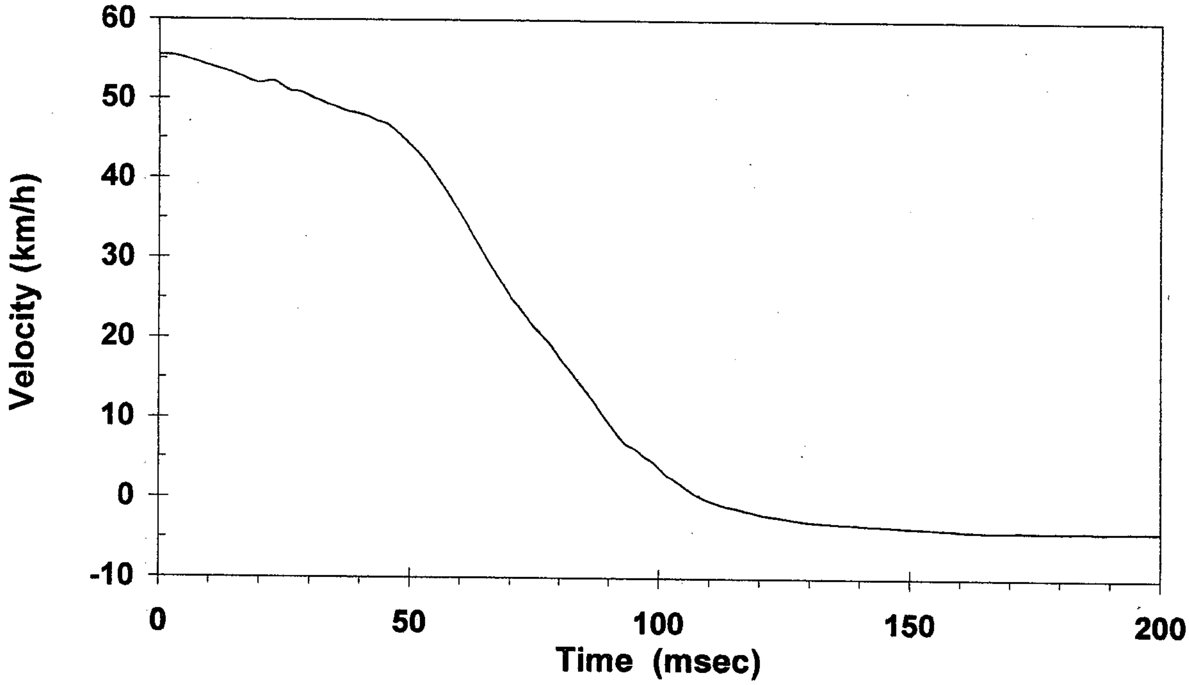

Figure 44
Averaged (Left & Right) Rear Rocker Panel Longitudinal Velocity
Test C12174

The displacement of the right toe pan, relative to the passenger compartment, was approximately 215 mm and is shown in Figure 45 and also Plot 80, Appendix F.

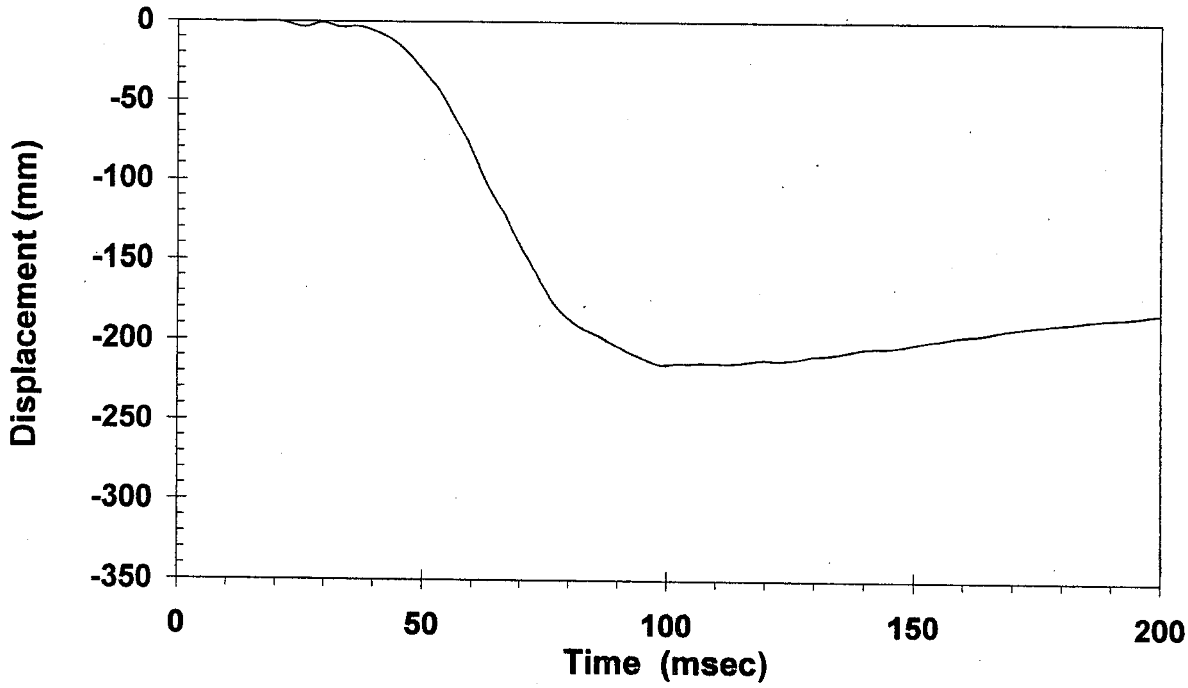

Figure 45
Right Toepan Displacement, Relative to Floorpan
Test C12174, filtered at SAE class 60 [10]

The engine motion stopped at 72 msec after time zero as shown in Figure 46 and Plot 88 in Appendix F. This transducer was mounted such that it outputs a voltage peak each time a flywheel tooth passes by. Thus, the cyclic voltage waveform indicates engine motion and the lack of the cyclic signal indicates engine stoppage. (Note the time scale in Figure 46 has been expanded to show greater time resolution.)

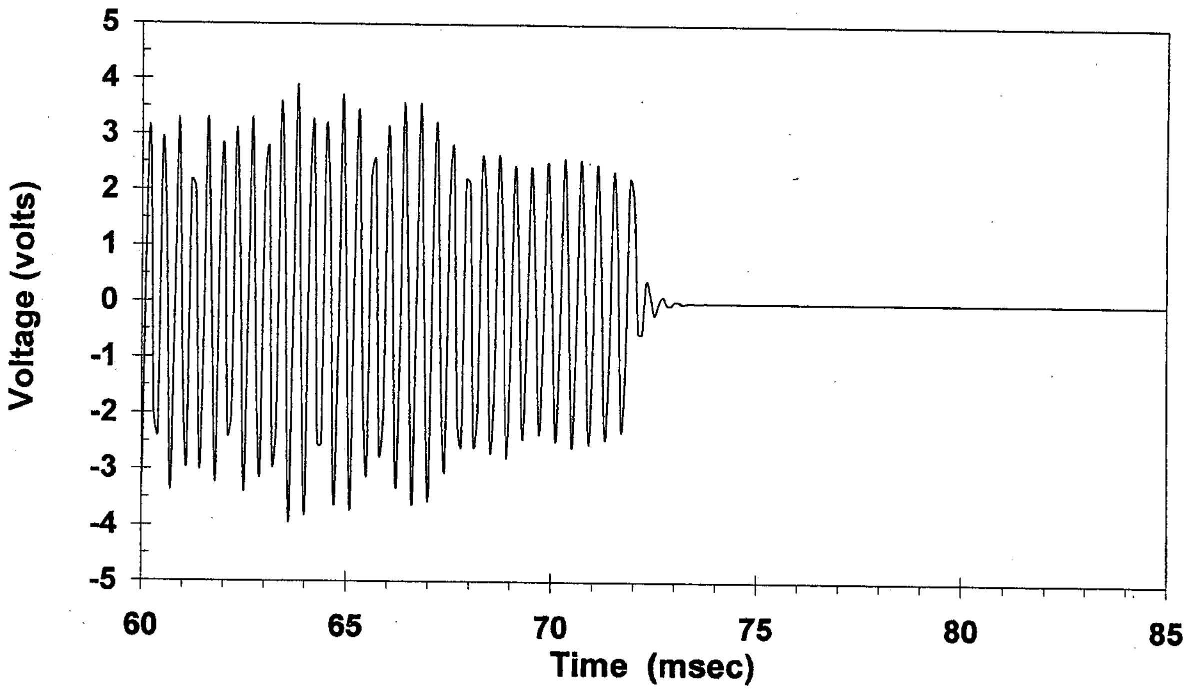

Figure 46
Engine Motion
Measured using Auxiliary Magnetic Pickup Transducer, Test C12174

The current measurements of the driver and passenger air bag circuits indicated that both air bags deployed at about 18 msec (Appendix F, Plots 94 and 95.)

Figure 47 and Plot 97 in Appendix F show the fuel pump current draw during the impact. Similar to test C12127, the fuel pump was drawing about 4 amps at impact. The current began to drop at 30 msec and stopped flowing by about 35 msec. The fuel pump was likely stopped due to the drop in main vehicle voltage, as shown by the battery voltage in Figure 48 and Plot 81. The battery voltage dropped from 13 volts to 11 volts at 30 msec and indicated intermittent and partial drops in voltage throughout the impact. The starter cable voltage (Plot 82) and ignition voltage (Plot 85) indicated nearly identical time histories as the battery voltage, indicating that all circuits on the vehicle were likely limited to voltages indicated in Figure 48.

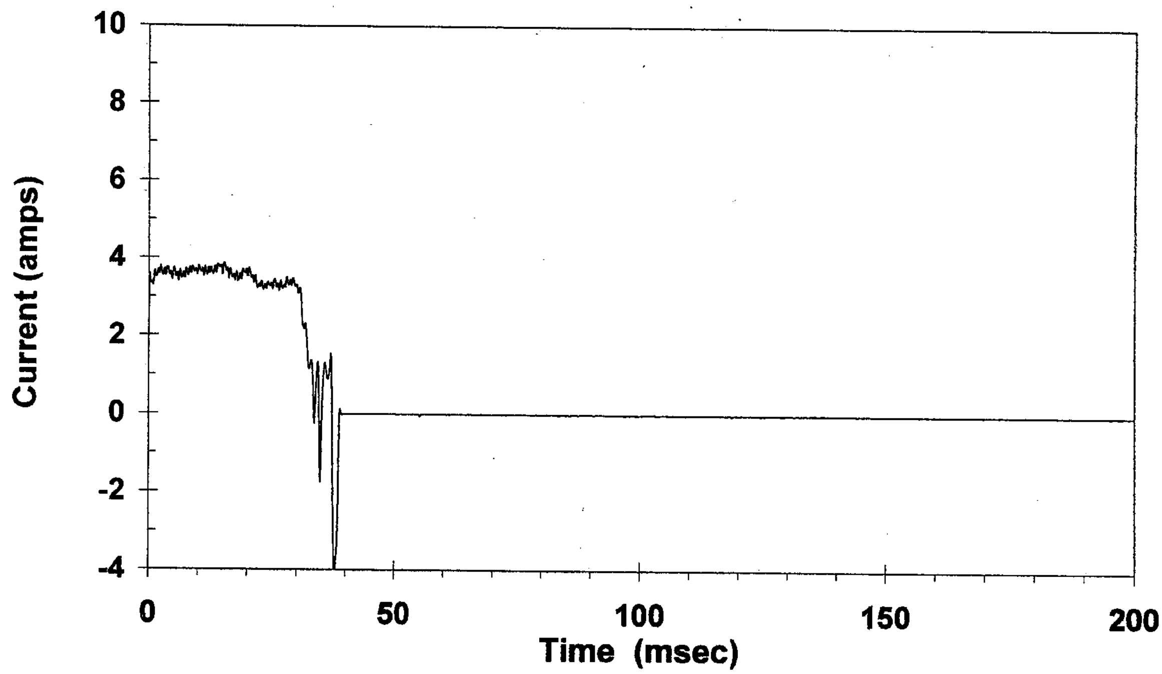

Figure 47
Fuel Pump Current
Test C12174

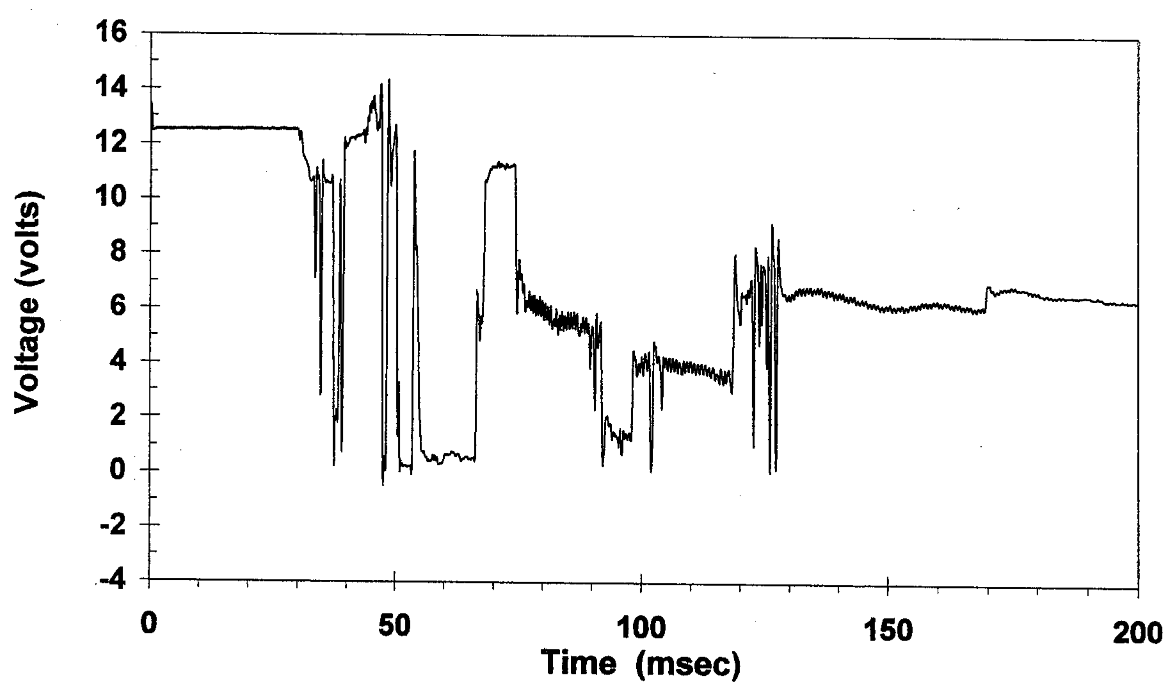

Figure 48
Battery Voltage
Test C12174

The fuel pump voltage decayed from 12 volts to near zero from about 30 msec to 200 msec as shown in Figure 49 and Plot 84 (Appendix F), consistent with the behavior observed in test C12127.

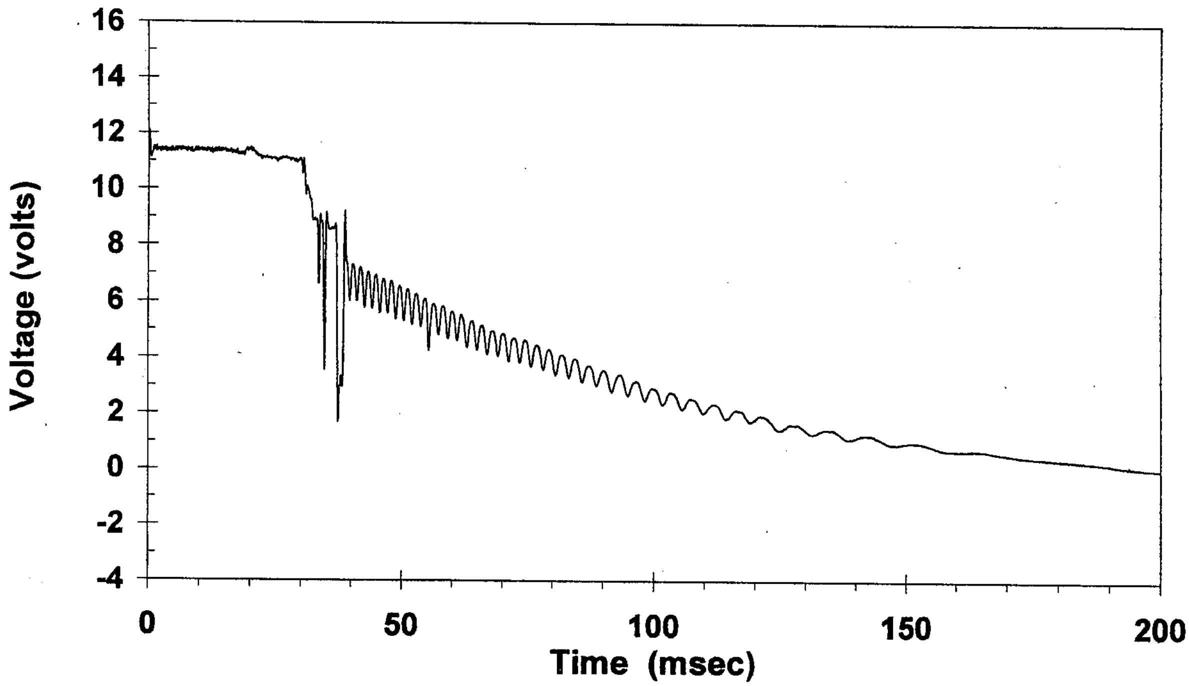

Figure 49
Fuel Pump Voltage
Test C12174

4.2.2. Summary of Recorded ATD Measurements

The complete set of recorded and computed ATD measurements is included in Appendix F (pages i and ii, and Plots 1 through 60).

For the left front ATD, the lower right tibia moment (My) which had a peak value of 498 Nm exceeded its IARV of 225 Nm (Plot 22) [9]. This measurement is also used to compute the lower right leg index (Plot 23) which was 2.28 exceeding its IARV of 1.0.

For the right front ATD, both the lower left and lower right tibia moments exceeded their IARV of 225 Nm. The lower right tibia moment reached 366 Nm and the lower left moment was 460 Nm; both are shown in Plot 46. The left and right lower leg indices were 2.08 and 1.68 respectively, as shown in Plot 47.

Also on the right front ATD, the upper left tibia index reached 1.01 exceeding its IARV of 1.0 as shown in Plot 47. The upper left tibia moment alone did not exceed its IARV.

All other recorded injury measurements were below their respective IARVs for each dummy.

4.2.3. Summary of Hydrocarbon Vapor Measurements

A complete set of the recorded measurements is included in Appendix F, Plots 89 through 93, and also Appendix G, Figures G1 through GG5.

The vapor sensors at locations #1, #2, and #5 (left and right fuel rails, catalytic converter) all indicated negligible concentrations of hydrocarbon vapors during and after the impact as shown in Appendix G, Figures G1, G2, and G5. The vapor sensor at location #3 (left exhaust manifold) indicated a concentration of hydrocarbon vapor exceeding 1% for about 1 minute after the impact as shown in Figure G3. The highest concentration of hydrocarbon vapors was monitored at location #4 (right exhaust manifold) which exceeded 4% for 200 seconds after impact as shown in Figure G4.

The GC/MS analysis was completed on the vapors collected from all 5 locations [1]; the results are shown in Appendix G Figures GG1 through GG5. The GC/MS analysis of samples collected from locations #3 and #4 did not indicate the presence of a vapor unique to those locations. Thus, it is possible the high concentration measurements from locations #3 and #4 (Figures G3 and G4) are suspect measurements. These types of tin oxide sensors no longer function properly when doused with liquids, which may have happened during the crash. The results of the GC/MS analysis for location #2, however, did identify the presence of vaporized engine coolant and is recreated here as Figure 50. Ethylene glycol (coolant) is shown as a peak number 2 in Figure 50.

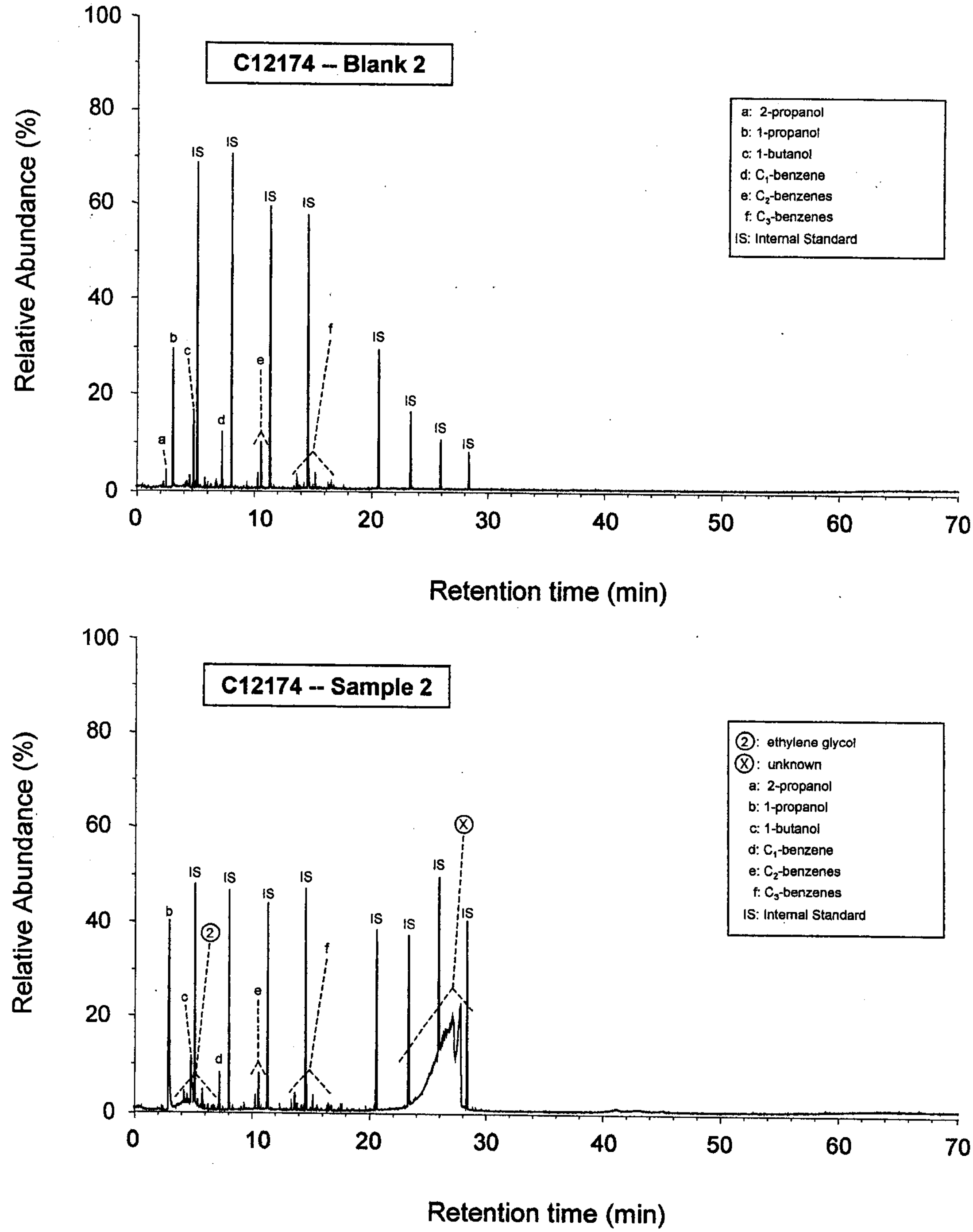

Figure 50
GC/MS analysis of hydrocarbon vapor sample from near the right fuel rail (location #2) during Crash Test C12174. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

4.2.4. Summary of Fluid Pressure Measurements

The dynamic pressure measurements of the engine compartment fluids are shown in Appendix F, Plots 106 through 113.

The power steering fluid pressure is shown in Plot 106 and does not indicate any leaks in the pressurized power steering fluid system. The pressure returns to zero late in the event due to the engine stoppage.

The engine oil pressure is shown in Plot 107 and also does not indicate the presence of a leak, as there is no rapid drop in pressure.

Similar to test C12127, the cooling system pressure had to be biased post-test as the pressure was maintained during the instrumentation set up period which artificially forced this measurement to zero. The unbiased pressure is shown in Plot 108 and the biased (corrected) pressure is in Plot 109. The post-test inspection clearly indicated a crushed radiator and a loss of coolant consistent with all of the frontal crash tests conducted for this project. The pressure did not rapidly drop to zero because the measurement was taken at the thermostat housing and not at the radiator. It is possible a restriction in the cooling line during the crush delayed the drop in pressure at the transducer.

Similar to the coolant, the pressure of the fuel supply line had to be biased post-test. The un-biased measurement is shown in Plot 110 and the biased (corrected) measurement is shown in Plot 111. There was no leak in the fuel system.

The left and right front brake system pressures are shown in Plots 112 and 113. The front brakes were not pre-charged as intended due to a problem pre-test with the fabricated brake pedal locking device. The brake pedal was not engaged, thus the lines were not pre-charged. The left front brake pressure did not indicate a leak in the pressurized system which was confirmed with the post test inspection (Section 4.2.9) which revealed leaks only in the non-pressurized brake reservoir. The right front brake pressure measurement is inconclusive.

4.2.5. Summary of Additional Electrical Measurements

The results of the additional electrical measurements are shown in Appendix F (Plots 81 through 83, 85, 96 through 104).

The battery voltage, starter cable voltage, and ignition voltage (Figure 48, Plot 81, Plot 82 and Plot 85), all exhibited temporary and sometimes partial drops in system voltage during the impact as described in Section 4.2.1. Temporary voltage drops during the crush were observed in test C12127 as well as other frontal crash tests for this project. [2],[3],[4]. A significant increase in current was observed on two monitored channels: the radiator fan (Plot 102 and Figure 51) and the A/C clutch (Plot 98). The rise in current occured from about 30 to 40 msec coinciding with the drop in voltage as shown in Figure 48. Thus, this voltage drop from 30 – 40 msec was likely due to a short to ground affecting both the radiator fan and A/C clutch current flow. An increase in current flow was also measured on the battery cable (Plot 96), which would be expected as the battery cable supplies the other two circuits. The current transducer on the battery cable was a larger transducer capable of measuring more current (500 amps) than the transducers used on individual circuits. Thus, this measurement did not overload its full scale range from 30 to 40 msec and indicated a current flow of about 300 amps . The causes of the other voltage drops after 40 msec (Figure 48) were not positively identified, and could possibly be due to the physical crushing of the battery.

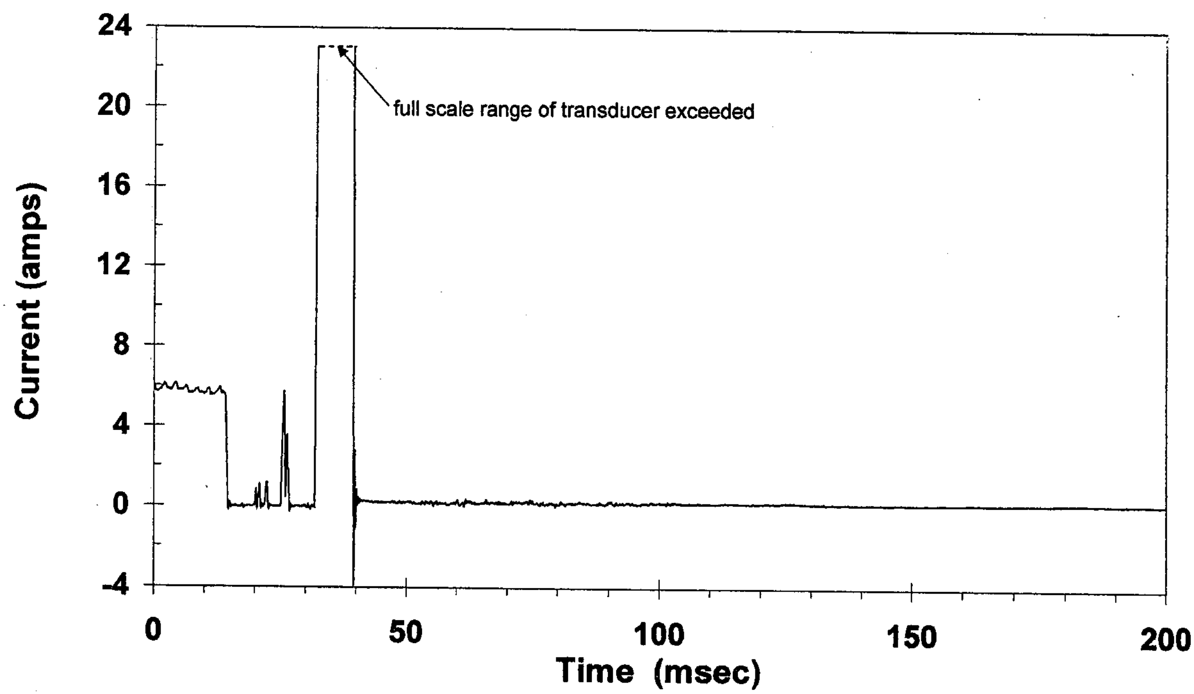

Figure 51
Radiator Fan Current
Test C12174

The right front headlight ground voltage (Plot 83) drops from a low voltage to zero as would be expected if the circuit were open or the bulb filament broken during the impact.

The alternator current, HVAC blower current, condenser fan current, and left front headlight current (Plots 100, 99, 103, and 101) all indicate normal current draw at the time of impact followed by a drop to zero as the vehicle was crushed and the engine stops. None of these three measurements showed a short to ground (indicated by a significant rise in current draw.) Plot 99 showed negative current flow at impact that simply means that the physical orientation of the current transducer relative to the cable was reversed.

The battery current and ignition current malfunctioned because the transducers were damaged in the impact (Plots 96 and 104). The early measurements are likely valid (such as the battery current rise from 30 to 40 msec) but later on they are generally inconclusive due to the malfunction.

4.2.6. Summary of Numerical Film Analysis

The numerical film analysis plots are included in Appendix H (plots 1 through 8).

The numerical analysis of the overhead film indicated that the dynamic pole penetration into the engine compartment was approximately 1030 mm at 138 msec after time zero, as shown in Plot 8.

4.2.7. Results of Post-test Static Rollover

No static rollover was conducted on this vehicle following the crash test for reasons described in the results of the first offset frontal pole impact on the passenger van. [2]

4.2.8. Results of the Evaluation of the Crashworthiness of Potential Fire Detection or Suppression Technologies

The results of the electrical measurements of the experimental fire detectors are shown in Appendix F, (Plots 86, 87 and 105).

Neither of the two optical fire sensors indicated an activation (Plot 86 and 87). The left optical sensor measurement is invalid after 122 msec due to an instrumentation malfunction.

The thermal wire fire detector did not activate during the impact (Plot 105).

4.2.9. Summary of Post-test Vehicle Inspection

As with the previous tests, the vehicle was disassembled and inspected to identify structural openings air passages from the engine compartment into the passenger compartment, the locations of any fluid leaks, the locations of any electrical shorts identified during the crash test, and any contact between possible combustible solids and hot surfaces.

The following openings into the passenger compartment were identified during the post-test inspection:

- A separation on the floor pan near the right frame rail and right toe pan. The separation was approximately 10 cm long by 6 mm wide.

- There were two small openings in the sheet metal adhesive used to bond panels together in the forward bulkhead. Both of these were near the top of the forward bulkhead and oriented vertically. One was on the driver's side near the steering column mounting brackets and was 25 mm long by 5 mm wide. The other was on the passenger side and was 37 mm long by 12 mm wide.

The following fluid leaks were identified during the post-test inspection:

- Engine coolant: radiator crushed, coolant lost
- Battery electrolyte: housing cracked, electrolyte lost
- Brake fluid reservoir knocked off of master cylinder, brake fluid lost

The fuel filler tube pulled out of the fender and remained intact with the filler cap in place.

There were no leaks found in the transmission fluid system, fuel lines, engine oil system, washer solvent reservoir, or power steering system.

There was no contact between a normally hot surface and a combustible solid identified.

4.3. *Conclusions*

1. There were no fires observed during or after this crash test.

2. The electric fuel pump began stopping at 30 msec after impact due to a temporary drop in the main vehicle system voltage.

3. The peak longitudinal acceleration of the passenger compartment was approximately 31 g (filtered at 60 Hz). The maximum longitudinal change in vehicle velocity was 59.5 km/h (37.0 mph), with the velocity crossing zero at 110 after impact.

4. Both air bags deployed at 18 msec past time zero.

5. For the left front ATD, the lower right tibia moment (My) and the lower right leg index exceeded their respective IARVs. For the right front ATD, both the lower left and lower right tibia moments and the lower left and lower right leg indices exceeded their respective IARVs. In addition, the upper left tibia index for the right front ATD exceeded its IARV. All other ATD measurements were below their respective IARVs.

6. There was approximately 215 mm of toe pan intrusion on the passenger's side.

7. The engine rotation stopped by 72 msec after time zero.

8. There was no spillage of gasoline or Stoddard Solvent off of the vehicle during or immediately after the crash test.

9. The numerical analysis of the overhead film indicated that the maximum dynamic pole penetration into the engine compartment was approximately 1030 mm at 138 msec after time zero.

10. The concentration of hydrocarbon vapors at three of the five measured locations was negligible. Of the two locations in which appreciable concentrations were measured, the highest concentration was at the right exhaust manifold. This concentration exceeded 4% for about 200 seconds after impact. However there was no vapor identified from the GC/MS analysis for this location, thus it is possible that the sensors malfunctioned due to exposure to liquids during the impact. The GCMS analysis on the vapor sample collected from near the right fuel rail identified the vapor source as vaporized engine coolant.

11. Brake fluid, engine coolant, and battery electrolyte all leaked during the test. No other engine compartment fluids were released.

12. The main system voltage indicated temporary and partial drops in system voltage beginning at 30 msec and lasting throughout the impact. At least one short was identified which caused one of the drops due to additional loading on the battery. The other drops in system voltage were likely due to unidentified shorts to ground or internal damage to the battery as it was crushed.

13. The electrical monitoring of the experimental thermal wire fire detector attached to the underside of the hood did not show evidence of any electrical closures throughout the test, demonstrating crashworthiness for its given mounting location and this crash configuration.

14. Neither of the experimental optical fire detectors mounted in the engine compartment indicated activations, although the data from one was invalid after 122 msec due to an instrumentation problem.

15. Three crash induced structural openings into the passenger compartment were identified: one on the floor pan near the right frame rail and two small openings in the adhesive attaching the vertical panels of the forward bulkhead.

16. There was no contact between a normally hot surface and a combustible solid.

5. Conclusions Of The Front-Wheel-Drive Passenger-Vehicle Crash Test Series

From the data collected on this series of crash tests, several conclusions and observations can be made concerning post-collision fire potential. It is important to note that the intent of the crash tests was not to determine if a production vehicle met a crash test performance standard. Instead, the intent was to study how post-collision fires might start under a range of crash conditions.

The 105 km/h oblique moving barrier frontal impact test resulted in a fire. The ignition source was the exhaust manifold and the fuel was power steering fluid. This resulted in a fire flash above the engine compartment during the impact and it also ignited methanol vapor in the windshield washer fluid and started a subsequent self-sustaining fire in and around the washer solvent reservoir. There were no other fires on the other two crash tests conducted. The only other fire occurring during a crash test on any of the other vehicles tested also occurred during a 105 km/hr oblique moving barrier test on a passenger van [2]. However, that fire was electrical in nature.

For the two frontal tests, the fuel pump began to stop by 30 msec after impact in both tests. This observation is consistent with the crash tests conducted on other vehicles for this project [2],[3],[4]; that is, the fuel pumps shut down early during the impact likely due to drops in the main vehicle voltage. The drops in vehicle voltage were caused by the crash and although the drops were sometimes partial and intermittent, the fuel pumps shut down permanently at the first occurrence of voltage loss. Typically, these voltage drops were likely caused by circuits shorting to ground imposing additional loading on the battery or due to internal damage to the battery caused by the vehicle crush. In the two frontal crash tests reported here, only one short was specifically located corresponding to a measured drop in system voltage; the specific causes of the other drops in system voltage remained unidentified.

For the frontal offset pole impact, the motion of the engine was monitored and indicated the engine stopped by 72 msec after impact. For the oblique moving barrier frontal impact, this measurement was inconclusive.

Three different experimental fire-sensing technologies were evaluated for their crashworthiness. The thermal wire fire detectors proved crashworthy, that is it did not activate due the vehicle crush during the offset pole impact. However, for the other 2 tests the thermal wire did indicate an electrical closure due to the vehicle crush and not due to heat exposure. Experimental optical fire detectors were included only on the two frontal crash tests. These did not activate during the tests, demonstrating crashworthiness to survive the impact. However, during the oblique moving barrier frontal impact the sensors did not activate when exposed to the engine compartment fire. It is unknown whether the fire flash in the engine compartment was of sufficient duration to activate the sensors.

Consistent with the tests on other vehicles, crash-induced openings into the passenger compartment (as defined in section 2.2.11) were identified (see sections 2.2.11, 3.2.12, and 4.2.9). Their possible contribution to fire propagation was evaluated in fire propagation tests and reported separately.

There was no liquid Stoddard spillage off of the vehicle on the two frontal crash tests. For the offset deformable barrier rear impact, Stoddard Solvent leaked out of a rip in the top surface of the fuel tank. The leak rate was not measured at the crash test site but during subsequent laboratory experiments the leak rate was estimated to be 400 cc/min during the first minute and slowed considerably thereafter.

Of the non-fuel fluids, brake fluid, battery electrolyte, and engine coolant was released in both of the frontal impact tests. In addition, power steering fluid, transmission fluid, and washer solvent was released in the oblique moving barrier frontal impact. No fluids besides Stoddard Solvent were released during the rear impact test.

During the two frontal crash tests, sensors were used to measure the concentration of hydrocarbon vapors in the engine compartment and subsequent GC/MS analyses were conducted to identify the vapors. Vaporized engine coolant was identified in the offset pole frontal impact and vaporized power steering fluid was identified in the oblique moving barrier frontal impact.

The vehicles were inspected for contact between potentially hot surfaces and combustible materials after all three tests. The only occurrence noted was for the oblique moving barrier frontal impact; the exhaust manifold contacted the radiator fan shroud. There was no indication of thermal damage to the radiator shroud, however.

In general, most of the recorded injury measurements for the ATDs were below their respective IARVs. Only a few exceptions were noted. For the offset pole impact, measurements on the lower right leg of the left front ATD exceeded their IARVs as did measurements on both lower legs on the right front ATD. For the oblique moving barrier frontal impact, measurements on both lower legs and the chest acceleration of the left front ATD exceeded their IARVs.

REFERENCES

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2. Jensen J.L.; and Santrock J., "Evaluation of Motor Vehicle Fire Initiation and Propagation, Part 2: Crash Tests on a Passenger Van", Technical report submitted to the National Highway Traffic Safety Administration, Washington D.C., August 25, 1998

3. Jensen J.L.; and Santrock J., "Evaluation of Motor Vehicle Fire Initiation and Propagation, Part 5: Crash Tests on a Rear Wheel Drive Passenger Car", Technical report submitted to the National Highway Traffic Safety Administration, Washington D.C.

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5. Ward's 1998 Automotive Yearbook, Sixtieth Edition, pages 291-299, Ward's Communications, Southfield, MI, 1998

6. Federal Safety Standards. Motor Vehicle Safety Standard No. 214 Side Impact Protection - Passenger Cars, Trucks, Buses & Multipurpose Passenger Vehicles with GVWR of 10,000 Pounds or Less. 60FR57838-39 (November 22, 1995).

7. Federal Safety Standards. Motor Vehicle Safety Standard No. 208 Occupant Crash Protection - Passenger Cars, Multipurpose Passenger Vehicles, Trucks, Buses. 61FR26845-46 (May 29, 1996).

8. Federal Safety Standards. Motor Vehicle Regulation No. 572, Test Dummies Specificatinos-Anthropomorphic Test Dummy for Applicable Test Procedures, Subpart E. October 23, 1986.

9. AGARD Report AR-330, "Anthropomorphic Dummies for Crash and Escape System Testing", Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France, July 1996.

10. SAE J211 MAR 95, Instrumentation for Impact Test, SAE Recommended Practice, SAE Handbook, Vol. 3, 1996.

Appendix A: Anthropomorphic Test Device (ATD) Injury Assessment Reference Values (IARV)

Appendix A:
Anthropomorphic Test Device (ATD) Injury Assessment Reference Values (IARV)

The Injury Assessment Reference Values (IARV) used for the mid-sized male Hybrid III ATD are recreated here from the Advisory Group for Aerospace Research & Development, Report 330, "Anthropomorphic Dummies for Crash and Escape System Testing" [9].

Body Region Injury Assessment Criteria	Injury Assessment Reference Value for the mid sized male Hybrid III
Head	
HIC; $(t_2 - t_1) \leq 15$ msec*	1000
Head/Neck Interface	
Upper neck longitudinal shear force, +Fx and –Fx	Figure A1
Upper neck axial force, compression, -Fz	Figure A2
Upper neck axial force, tension, +Fz	Figure A3
Upper neck longitudinal moment, flexion, +My	190 Nm
Upper neck longitudinal moment, extension, -My	57 Nm
Chest	
Resultant spinal acceleration	60 g
Sternal deflection due to:	
Shoulder belt	50 mm
Air bag (no belt)	65 mm
Viscous Criterion (V*C)	1 m/s
Femur	
Axial compression	Figure A4
Knee	
Tibia-to-femur displacement	15 mm
Knee clevis loads (med./lat. Compression)	4000 N
Tibia	
Axial load, compression, Fz	8000 N
Tibia index, TI = M/Mc + Fz/Fc	1.0
Where,	
M = resultant moment, (of Mx & My), for upper index	225 Nm
M = anterior/posterior moment, My, for lower index	225 Nm
Mc = critical bending moment	225 Nm
Fc = critical compersive force	35,900 N

*: The Head Injury Criteria (HIC) is defined as: HIC = $(Aavg)^{2.5}(t_2 - t_1)$, where Aavg is the average resultant acceleration of the center of mass of the head (expressed in G) for the time interval $t_2 - t_1$ (expressed in seconds).

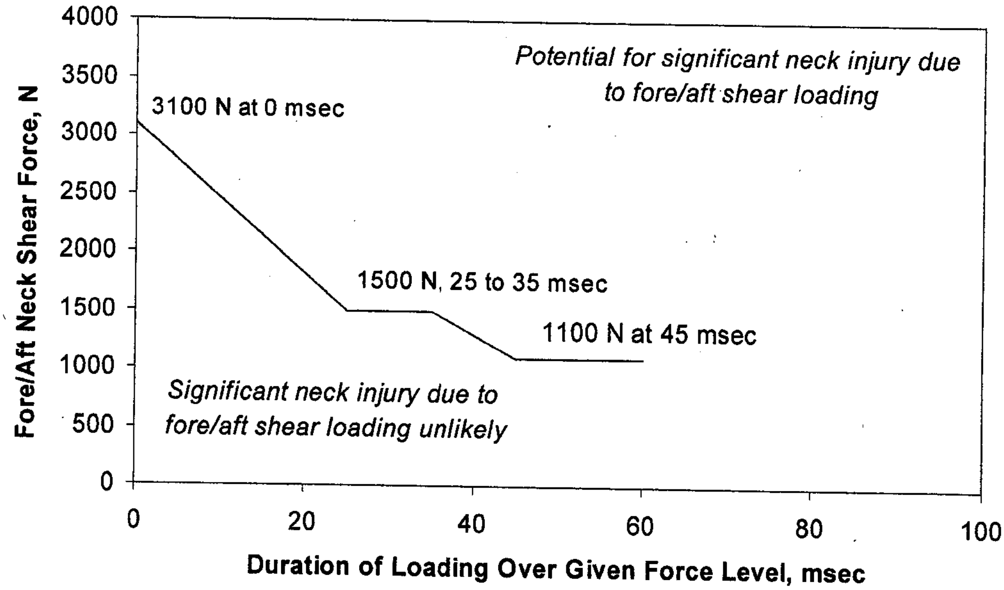


Figure A1
Injury Assessment Curves for Fore-and-Aft Sheer Forces Measured with Hybrid III Mid-sized Adult Male ATD [9]

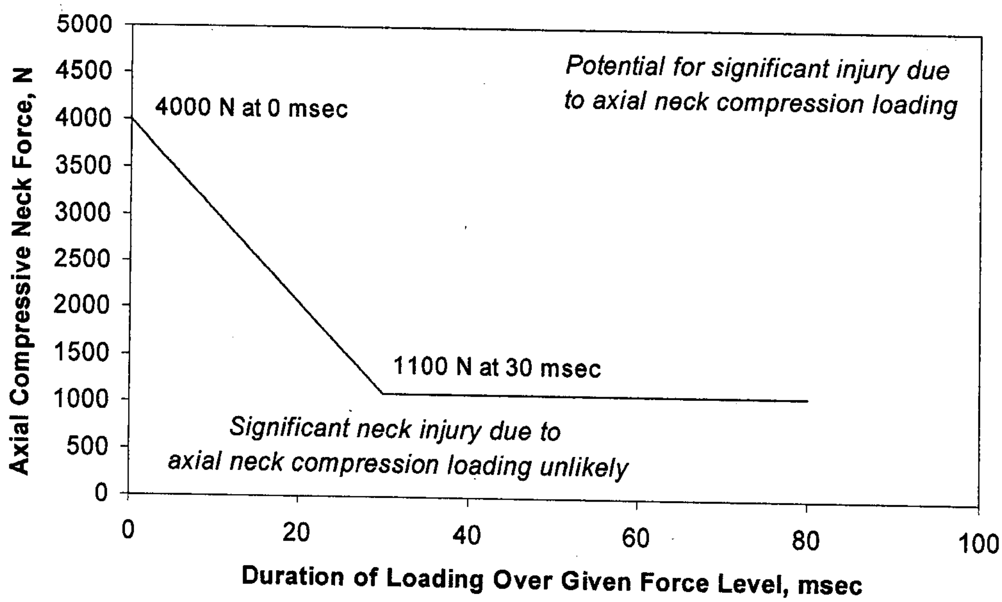


Figure A2
Injury Assessment Curves for Axial Neck Compression Measured with Hybrid III Mid-sized Adult Male ATD [9]

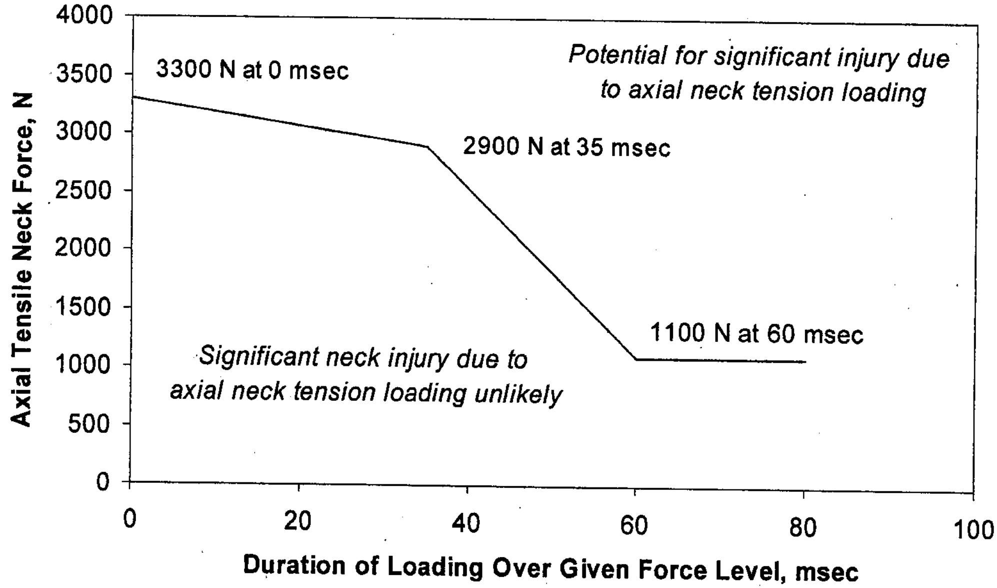


Figure A3
Injury Assessment Curves for Axial Neck Tension Measured with Hybrid III Mid-sized Adult Male ATD [9]

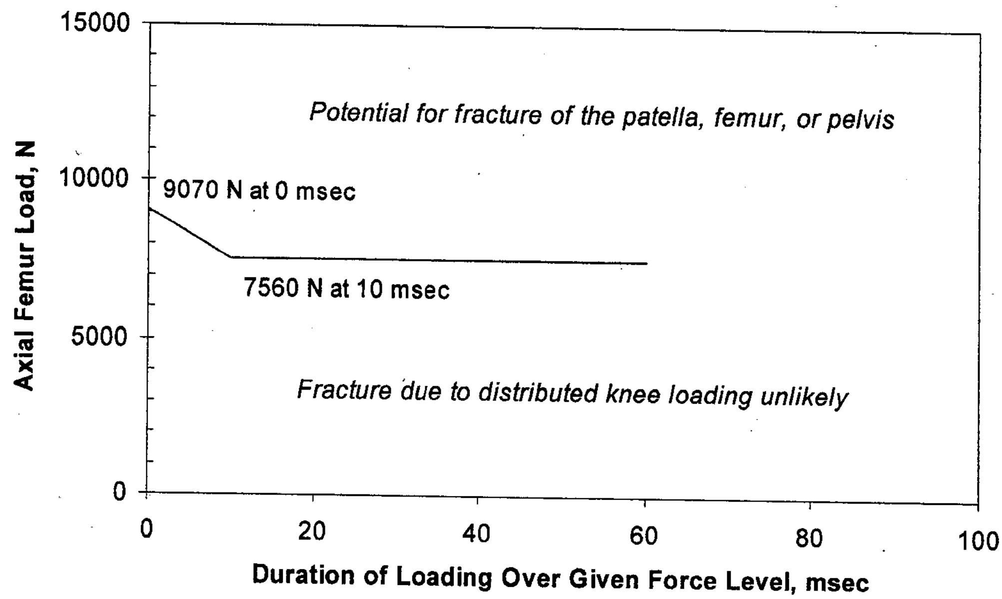


Figure A4
Injury Assessment Curves for Axial Compressive Femur Force Measured with Hybrid III Mid-sized Adult Male ATD [9]

Appendix B: C11990 data plots

LEFT FRONT

ANTHROPOMORPHIC TEST DEVICE SUMMARY DATA

LTV MDB TO STATIONARY VEHICLE 84.7KM/H

C11990 L.REAR IMP 70% OVERLAP

R & D CTR 8W9188 4 DOOR

ATD TYPE: GM50H

TEST DATE: 05/13/1998

MEASURED QUANTITY	100% OF IARV	150% OF IARV	IAV VALUE	IARV	
HIC, LIMITED TO 15 MS			550	1000	
HIC, LIMITED TO 36 MS			550	1000	
NECK FLEXION			67NM	190NM	
NECK EXTENSION			3NM	57NM	
NECK TENSION			601N	3300N	
NECK COMPRESSION			468N	4000N	
NECK SHEAR FORWARD			220N	3100N	
NECK SHEAR REARWARD			590N	3100N	
NECK TENSION DUR ASSESS			0.18	1.00	
NECK COMPRESSION DUR ASSESS			0.12	1.00	
NECK SHEAR FWD DUR ASSESS			0.07	1.00	
NECK SHEAR RWD DUR ASSESS			0.27	1.00	
CHEST ACCEL			15G	60G	
CHEST COMPRESSION W/O SH BELT			*	65.0MM	!
CHEST COMPRESSION W/ SH BELT			*	50.0MM	!
CHEST VISCOUS CRITERIA			*	1.00M/SEC	
FEMUR COMP, LEFT			*	10000N	
FEMUR COMP, RIGHT			*	10000N	
FEMUR DURATION ASSESS, LEFT			*	1.00	
FEMUR DURATION ASSESS, RIGHT			*	1.00	
TIBIA/FEMUR DISP, LEFT			*	15.0MM	
TIBIA/FEMUR DISP, RIGHT			*	15.0MM	
KNEE CLEVIS, LEFT INSIDE			*	4000N	
KNEE CLEVIS, LEFT OUTSIDE			*	4000N	
KNEE CLEVIS, RIGHT INSIDE			*	4000N	
KNEE CLEVIS, RIGHT OUTSIDE			*	4000N	
TIBIA COMP, LEFT			*	8000N	
TIBIA COMP, RIGHT			*	8000N	
TIBIA MOM, UPPER, LEFT			*	225NM	
TIBIA MOM, UPPER, RIGHT			*	225NM	
TIBIA MOM, LOWER, LEFT			*	225NM	
TIBIA MOM, LOWER, RIGHT			*	225NM	
LEG INDEX, UPPER LEFT			*	1.00	
LEG INDEX, UPPER RIGHT			*	1.00	
LEG INDEX, LOWER LEFT			*	1.00	
LEG INDEX, LOWER RIGHT			*	1.00	

IAV - INJURY ASSESSMENT VALUE

IARV - INJURY ASSESSMENT REFERENCE VALUE

* NOT MEASURED, THIS TEST

! RESTRAINT SYSTEM DEPENDENT. CHOOSE VALUE THAT APPLIES TO THIS TEST.

PROCESSED 05/14/1998 10:14 V2.09

RIGHT FRONT

ANTHROPOMORPHIC TEST DEVICE SUMMARY DATA

LTV MDB TO STATIONARY VEHICLE 84.7KM/H

C11990 L.REAR IMP 70% OVERLAP

R & D CTR 8W9188 4 DOOR

ATD TYPE: GM50H

TEST DATE: 05/13/1998

MEASURED QUANTITY	100% OF IARV	150% OF IARV	IAV VALUE	IARV	
HIC, LIMITED TO 15 MS			70	1000	
HIC, LIMITED TO 36 MS			130	1000	
NECK FLEXION			73NM	190NM	
NECK EXTENSION			10 NM	57NM	
NECK TENSION			606N	3300N	
NECK COMPRESSION			214N	4000N	
NECK SHEAR FORWARD			122N	3100N	
NECK SHEAR REARWARD			262N	3100N	
NECK TENSION DUR ASSESS			0.37	1.00	
NECK COMPRESSION DUR ASSESS			0.06	1.00	
NECK SHEAR FWD DUR ASSESS			0.05	1.00	
NECK SHEAR RWD DUR ASSESS			0.10	1.00	
CHEST ACCEL			16G	60G	
CHEST COMPRESSION W/O SH BELT			*	65.0MM	‡
CHEST COMPRESSION W/ SH BELT			*	50.0MM	‡
CHEST VISCOUS CRITERIA			*	1.00M/SEC	
FEMUR COMP, LEFT			*	10000N	
FEMUR COMP, RIGHT			*	10000N	
FEMUR DURATION ASSESS, LEFT			*	1.00	
FEMUR DURATION ASSESS, RIGHT			*	1.00	
TIBIA/FEMUR DISP, LEFT			*	15.0MM	
TIBIA/FEMUR DISP, RIGHT			*	15.0MM	
KNEE CLEVIS, LEFT INSIDE			*	4000N	
KNEE CLEVIS, LEFT OUTSIDE			*	4000N	
KNEE CLEVIS, RIGHT INSIDE			*	4000N	
KNEE CLEVIS, RIGHT OUTSIDE			*	4000N	
TIBIA COMP, LEFT			*	8000N	
TIBIA COMP, RIGHT			*	8000N	
TIBIA MOM, UPPER, LEFT			*	225NM	
TIBIA MOM, UPPER, RIGHT			*	225NM	
TIBIA MOM, LOWER, LEFT			*	225NM	
TIBIA MOM, LOWER, RIGHT			*	225NM	
LEG INDEX, UPPER LEFT			*	1.00	
LEG INDEX, UPPER RIGHT			*	1.00	
LEG INDEX, LOWER LEFT			*	1.00	
LEG INDEX, LOWER RIGHT			*	1.00	

IAV - INJURY ASSESSMENT VALUE

IARV - INJURY ASSESSMENT REFERENCE VALUE

* NOT MEASURED; THIS TEST

‡ RESTRAINT SYSTEM DEPENDENT. CHOOSE VALUE THAT APPLIES TO THIS TEST.

PROCESSED 05/14/1998 10:14 V2.09

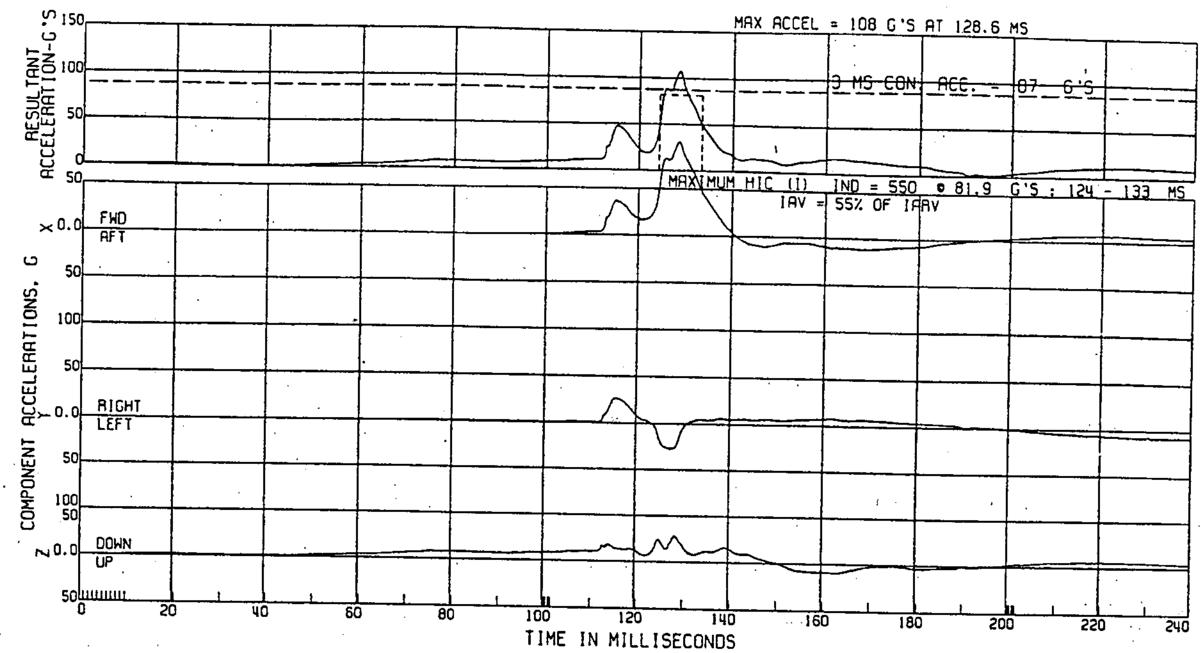
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

L. FRT HEAD ACCEL.

(HIC I LIMITED TO 15MS)

ATD TYPE: GM50H
TEST DATE:05/13/1998



Appendix B, plot # 1

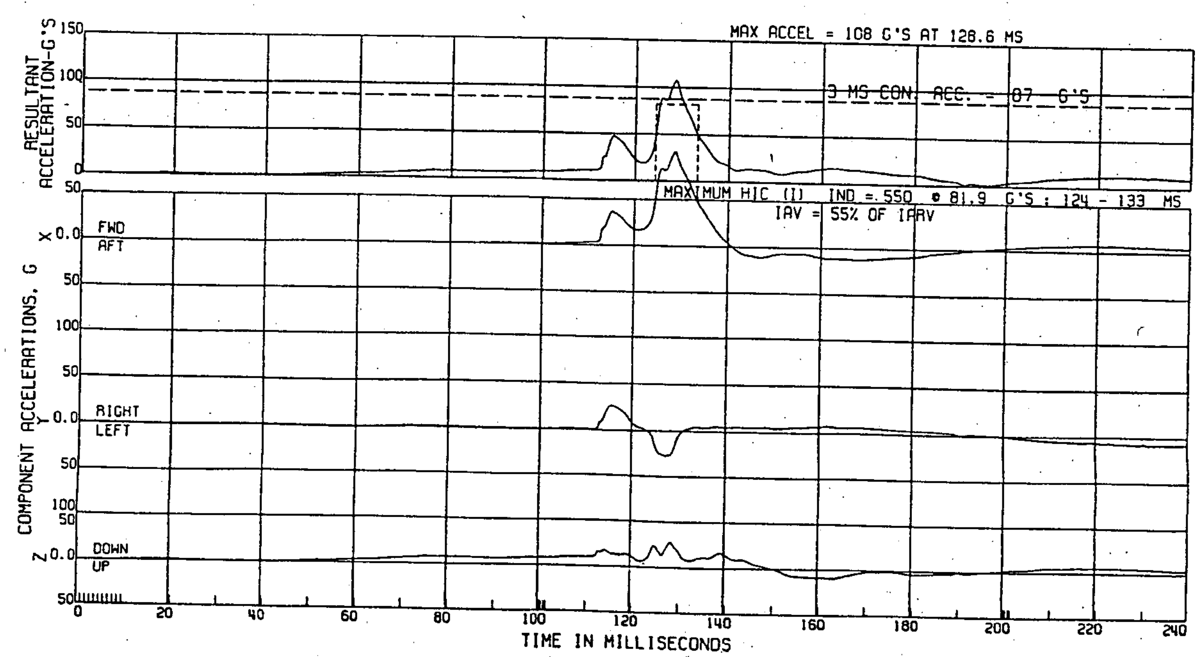
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

L. FRT HEAD ACCEL.

(HIC I LIMITED TO 36MS)

ATD TYPE: GM50H
TEST DATE:05/13/1998



Appendix B, plot # 2

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

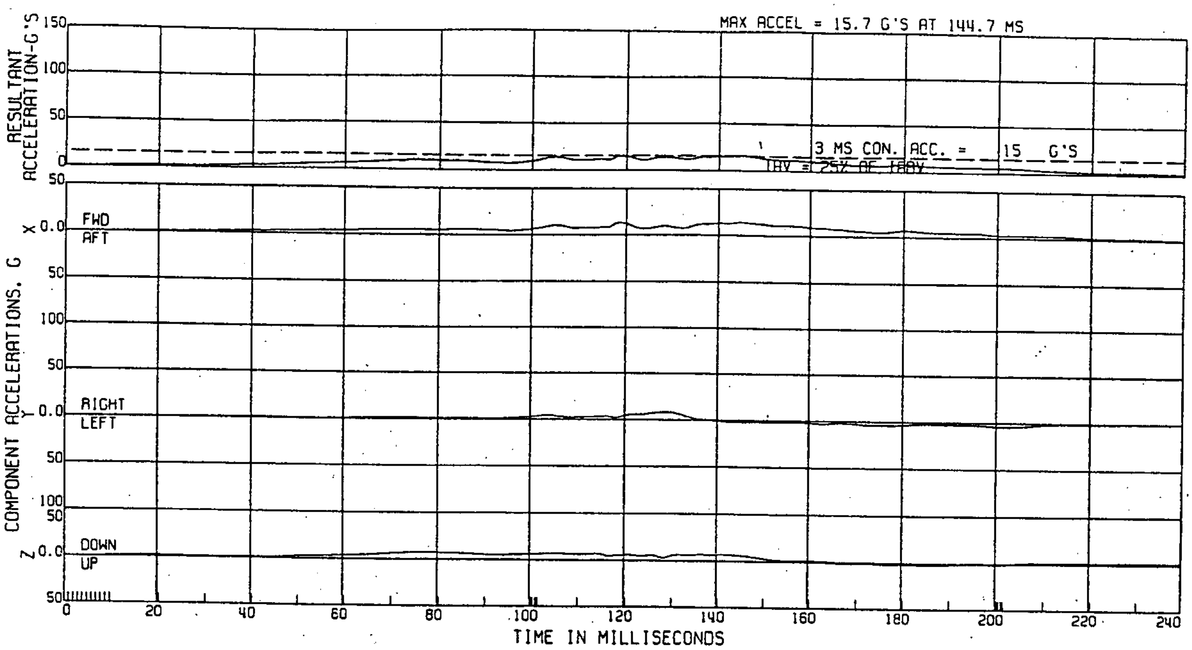
R & D CTR 8W9188 4 DOOR

ELEC DATA, SAE CLASS 180

L. FRT CHEST ACCEL.

ATD TYPE: GM50H

TEST DATE:05/13/1998



Appendix B, plot # 3

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

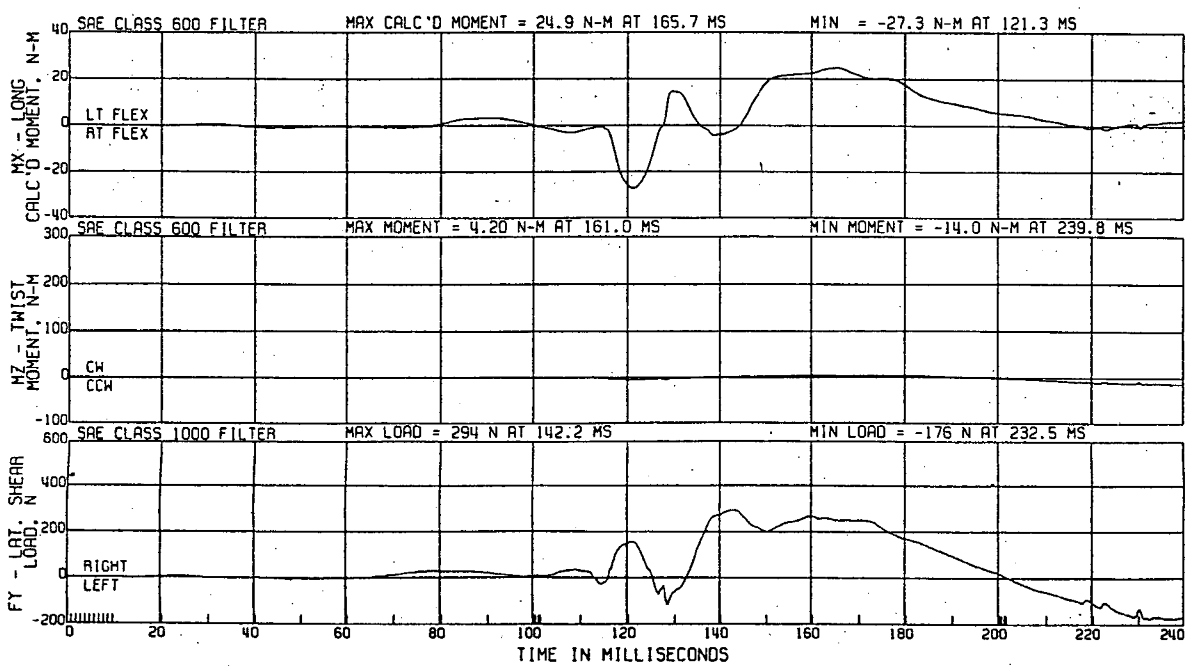
ELEC DATA

L. FRT NECK LOADING ON HEAD, UPPER LOAD

L. FRT NECK LOADING ON HEAD

ATD TYPE: GM50H

TEST DATE:05/13/1998



Appendix B, plot # 4

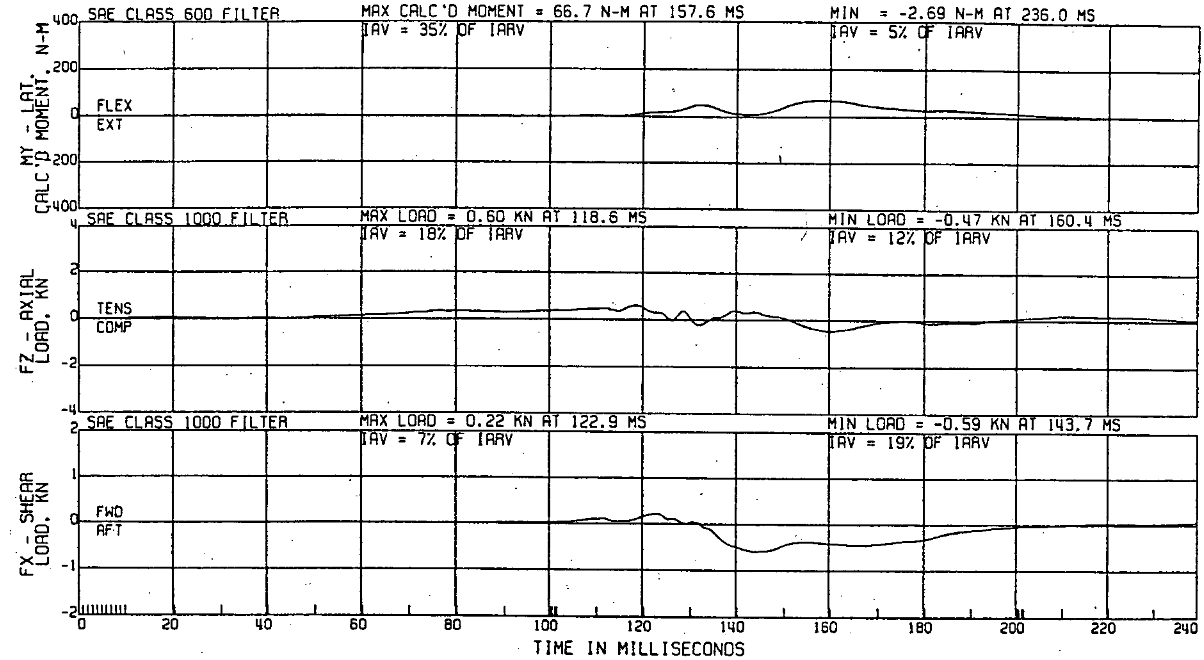
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA

NECK LOADING ON HEAD

L. FRT NECK LOADING ON HEAD

ATD TYPE: GM50H
TEST DATE:05/13/1998



Appendix B, plot # 5

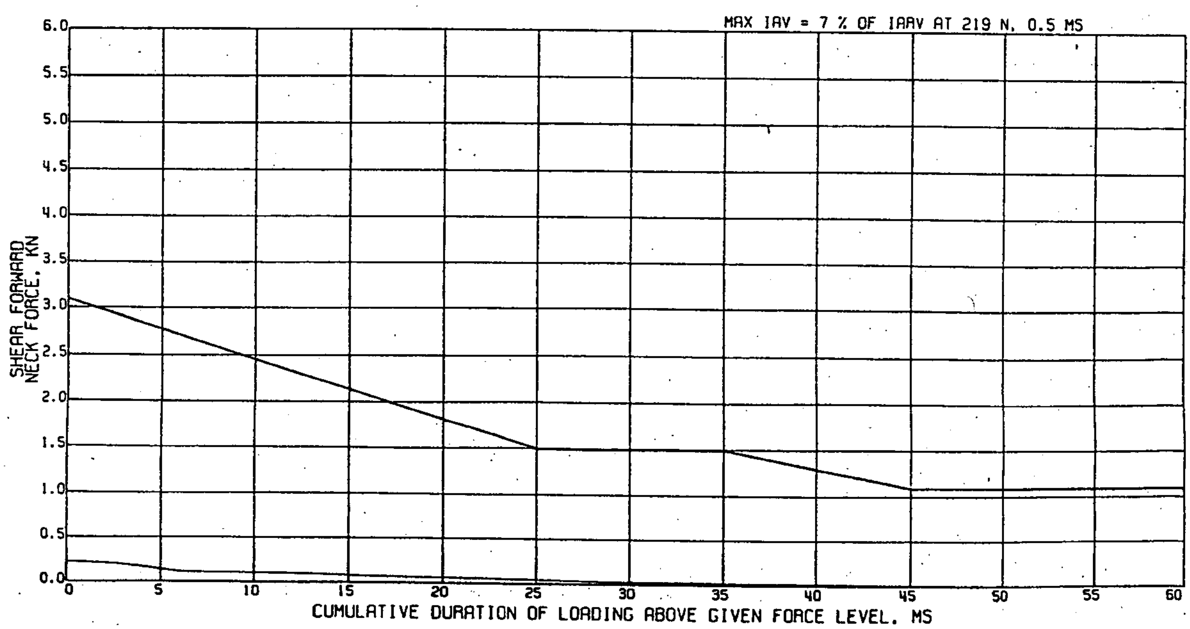
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

FORWARD NECK SHEAR ON HEAD,

L. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:05/13/1998

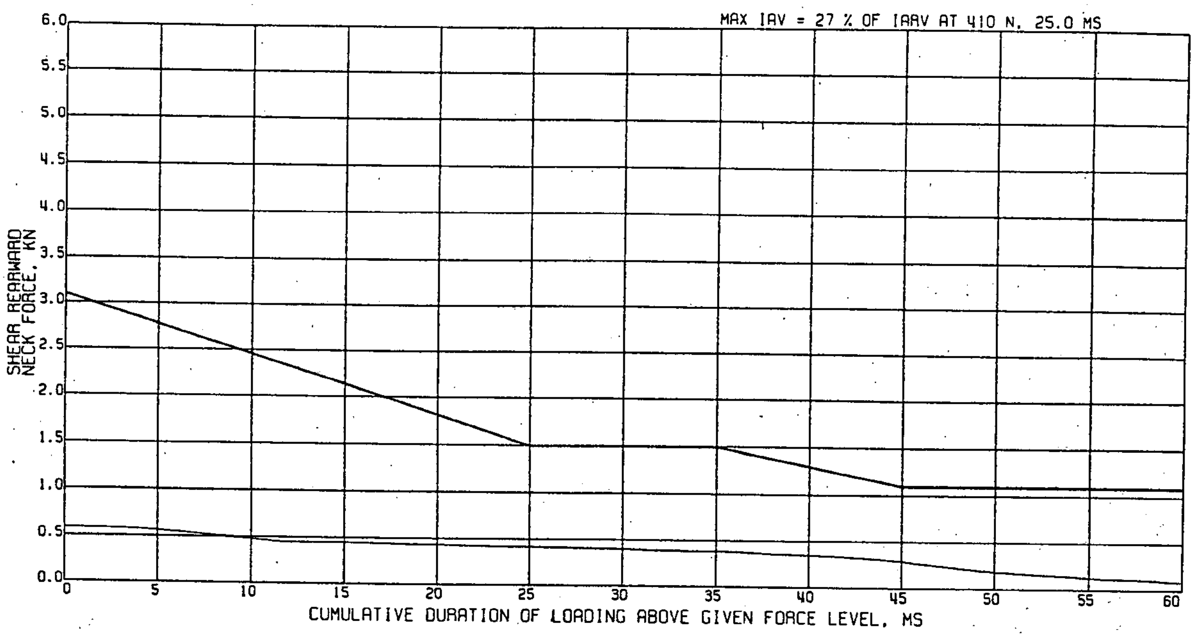


C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

REARWARD NECK SHEAR ON HEAD,
L. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:05/13/1998



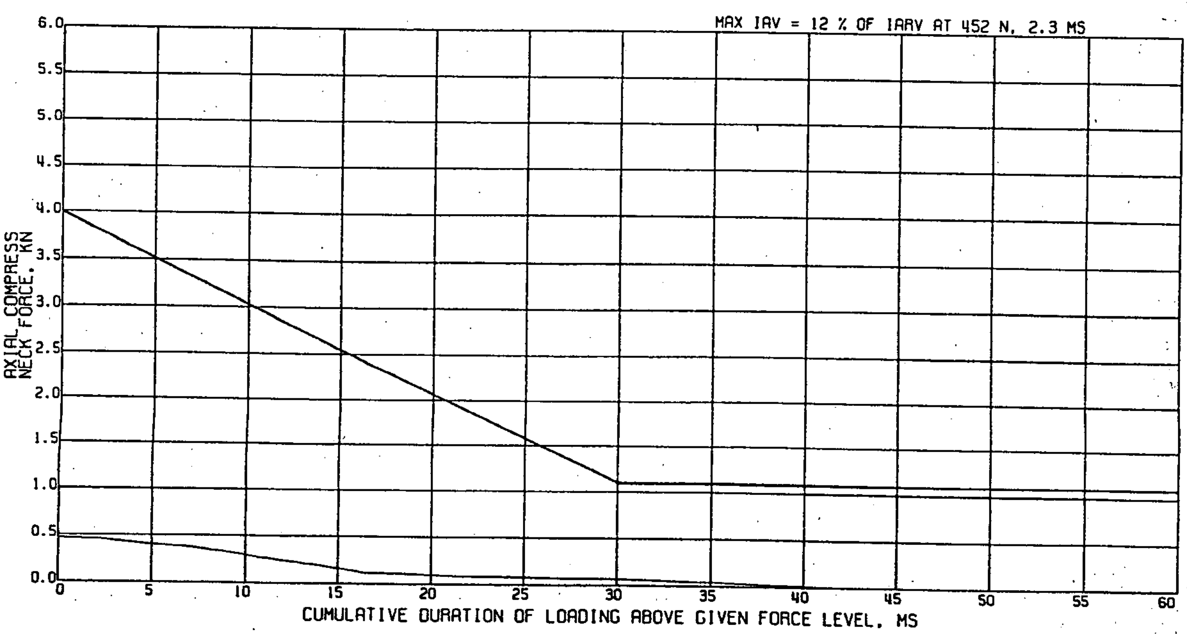
Appendix B, plot # 7

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

AXIAL COMPRESSION ON HEAD,
L. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:05/13/1998



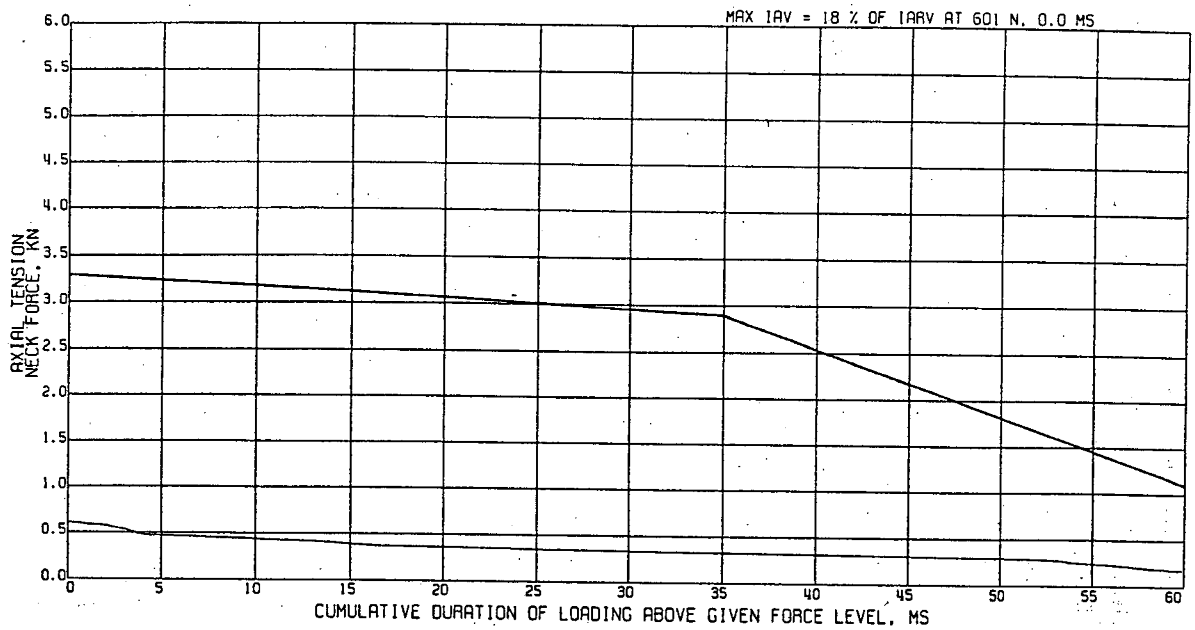
Appendix B, plot # 8

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

AXIAL TENSION ON HEAD,
L. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:05/13/1998



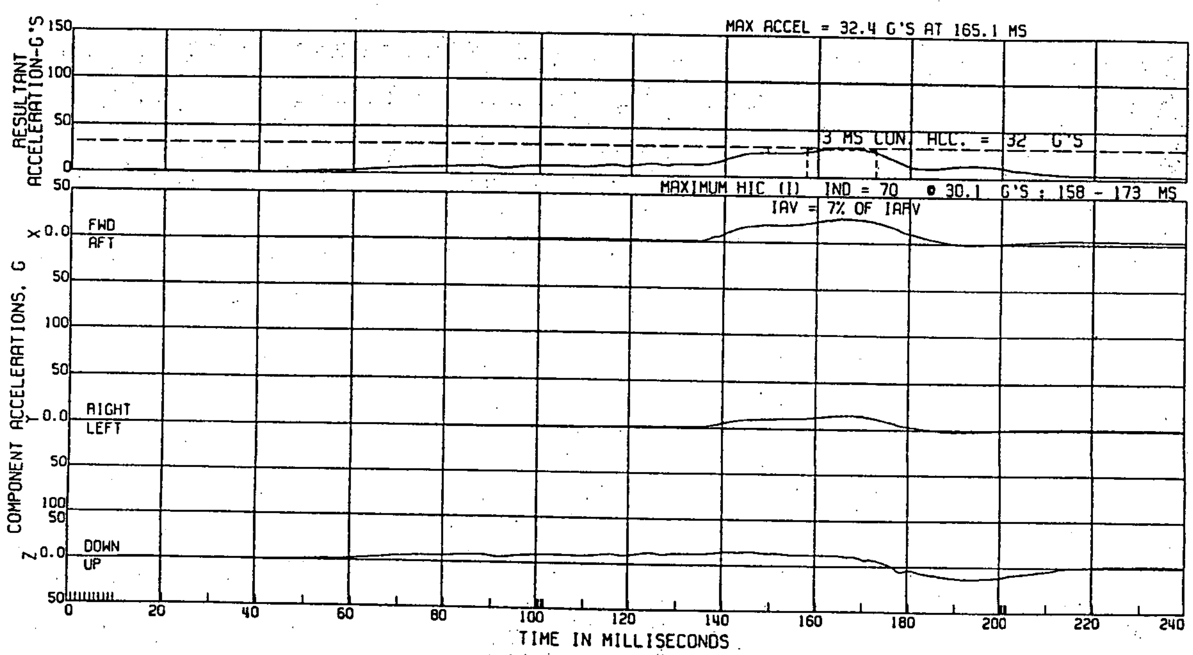
Appendix B, plot # 9

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

R. FRT HEAD ACCEL.
(HIC I LIMITED TO 15MS)

ATD TYPE: GM50H
TEST DATE:05/13/1998



Appendix B, plot # 10

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

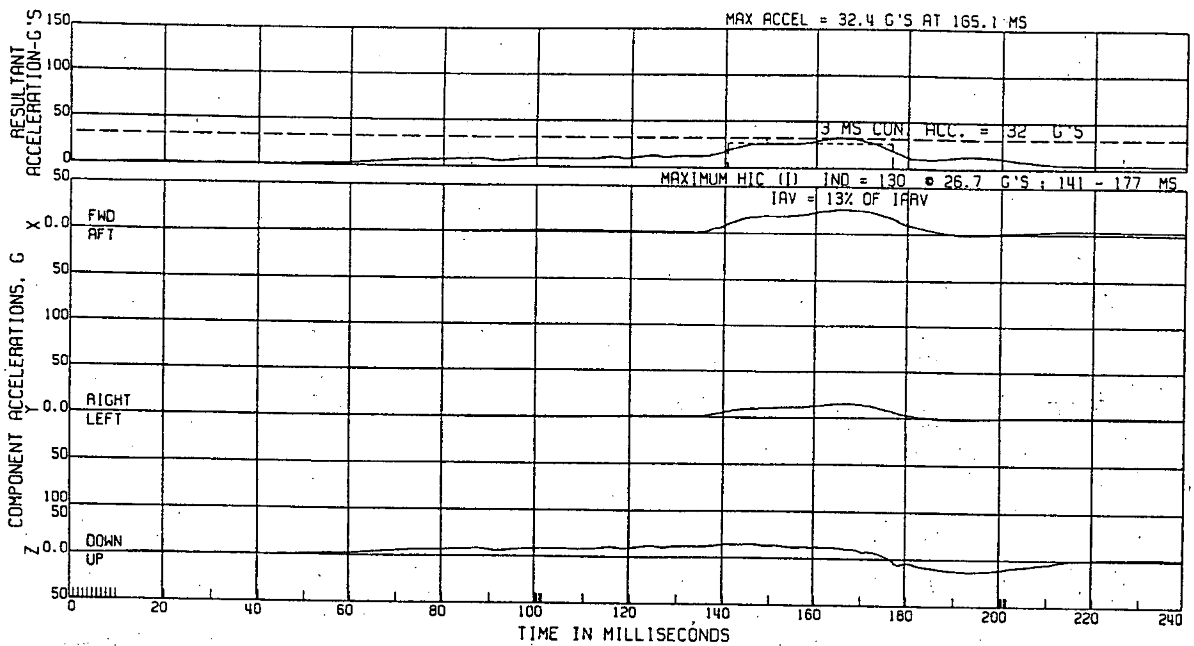
ELEC DATA, SAE CLASS 1000

R. FRT HEAD ACCEL.

(HIC I LIMITED TO 36MS)

ATD TYPE: GM50H

TEST DATE:05/13/1998



Appendix B, plot # 11

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

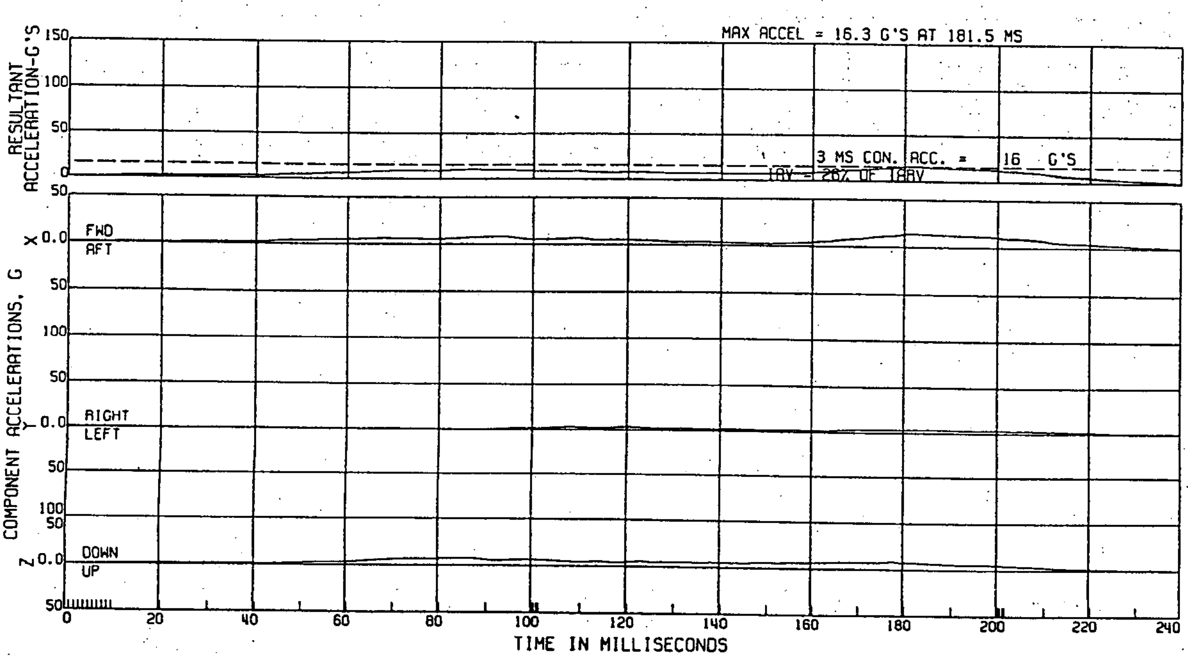
R & D CTR 8W9188 4 DOOR

ELEC DATA, SAE CLASS 180

R. FRT CHEST ACCEL.

ATD TYPE: GM50H

TEST DATE:05/13/1998



Appendix B, plot # 12

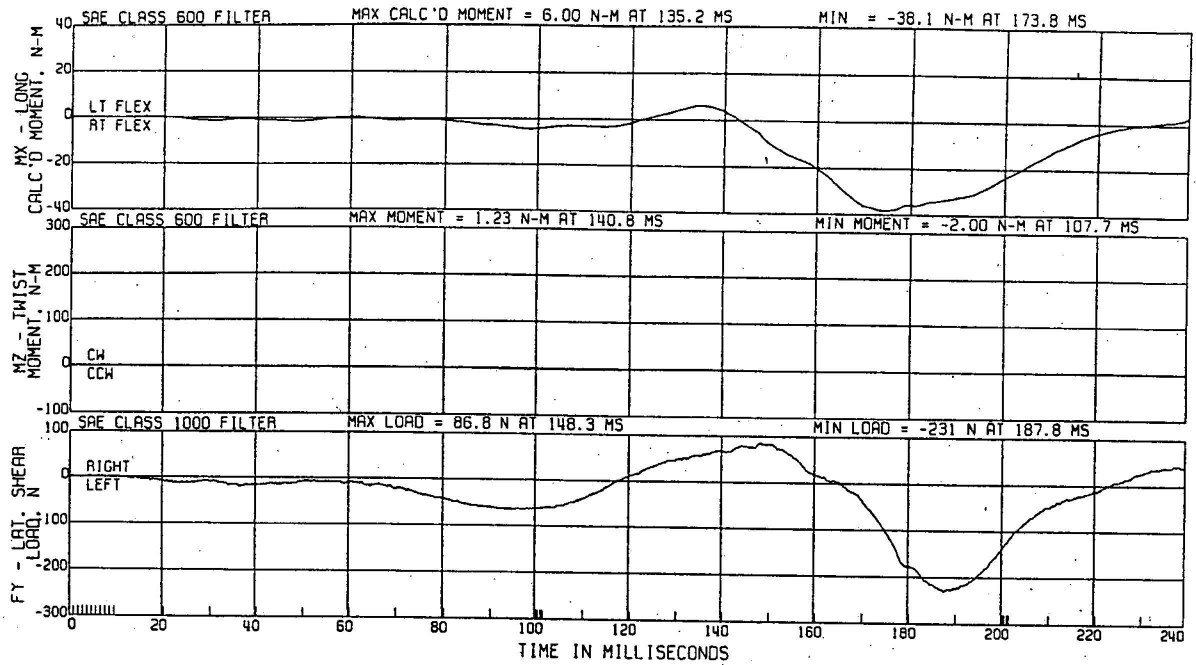
C11990 L.REAR IMP 70% OVERLAP LTV MOB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR R. FRT NECK LOADING ON HEAD, UPPER LOAD ATD TYPE: GM50H

TEST DATE:05/13/1998

ELEC DATA

R. FRT NECK LOADING ON HEAD



Appendix B, plot # 13

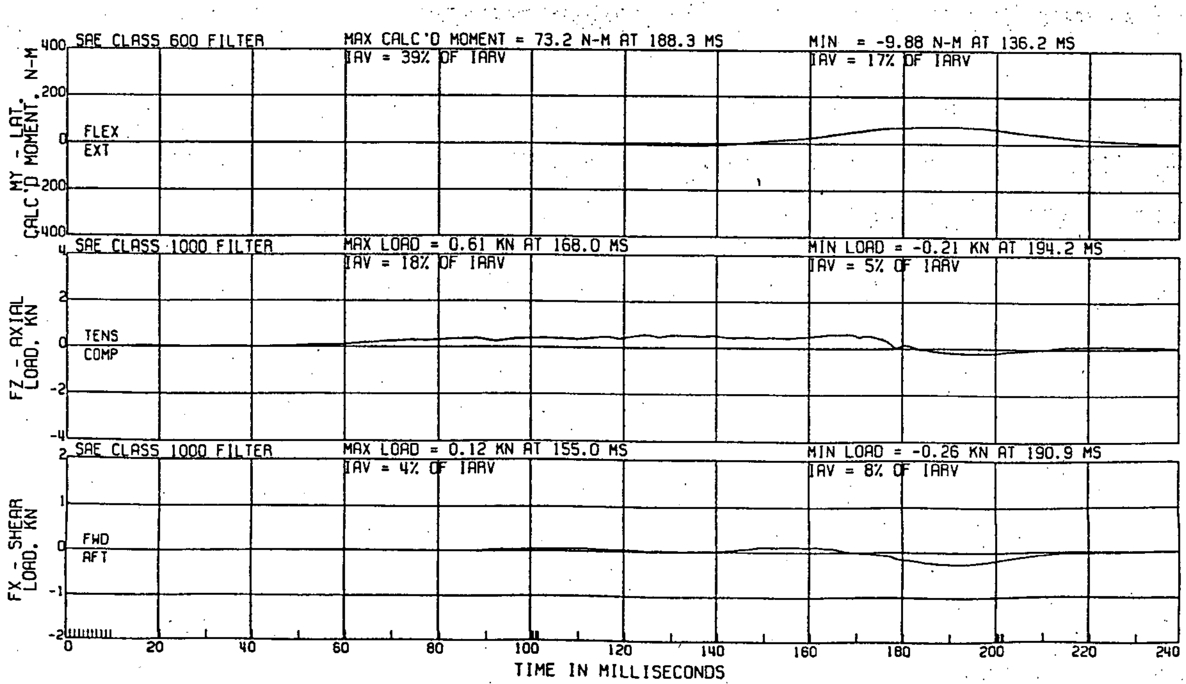
C11990 L.REAR IMP 70% OVERLAP LTV MOB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR NECK LOADING ON HEAD ATD TYPE: GM50H

TEST DATE:05/13/1998

ELEC DATA

R. FRT NECK LOADING ON HEAD



Appendix B, plot # 14

11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

& D CTR 8W9188 4 DOOR

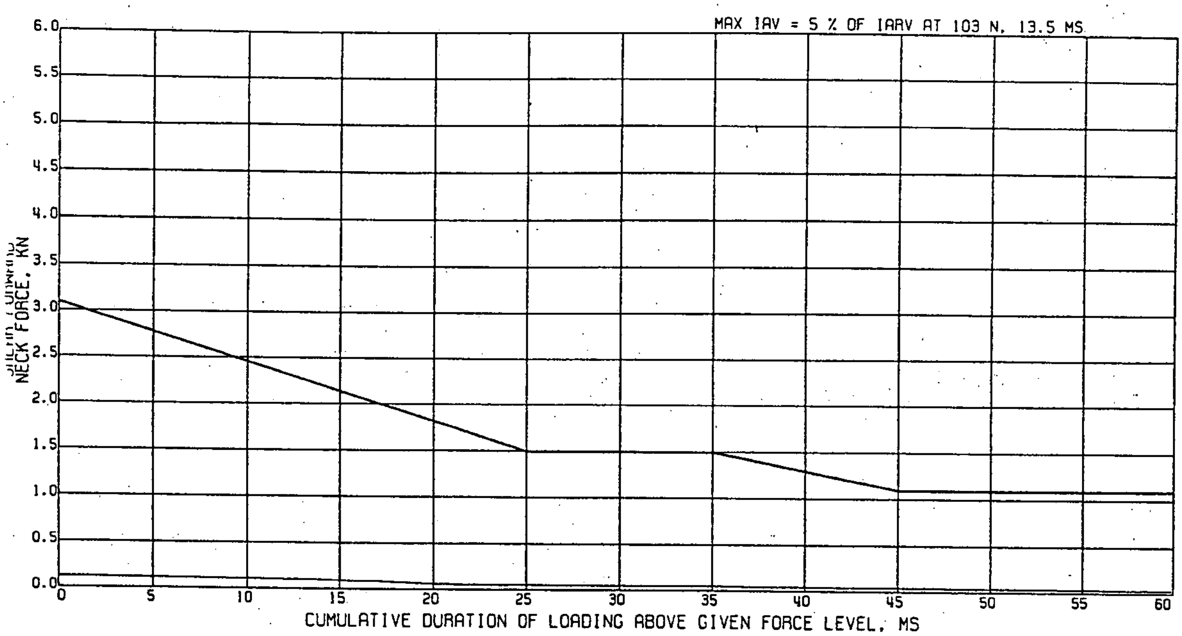
EC DATA, SAE CLASS 1000

FORWARD NECK SHEAR ON HEAD,

R. FRT INJURY REFERENCE

ATD TYPE: GM50H

TEST DATE:05/13/1998



Appendix B, plot **# 15**

11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

& D CTR 8W9188 4 DOOR

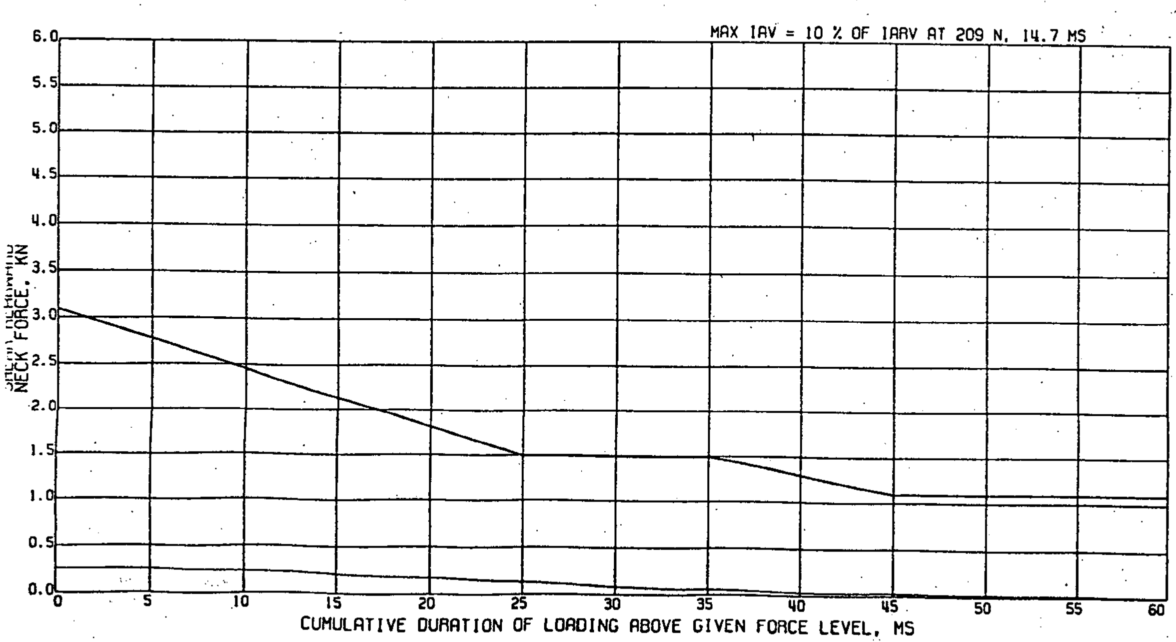
EC DATA, SAE CLASS 1000

REARWARD NECK SHEAR ON HEAD,

R. FRT INJURY REFERENCE

ATD TYPE: GM50H

TEST DATE:05/13/1998

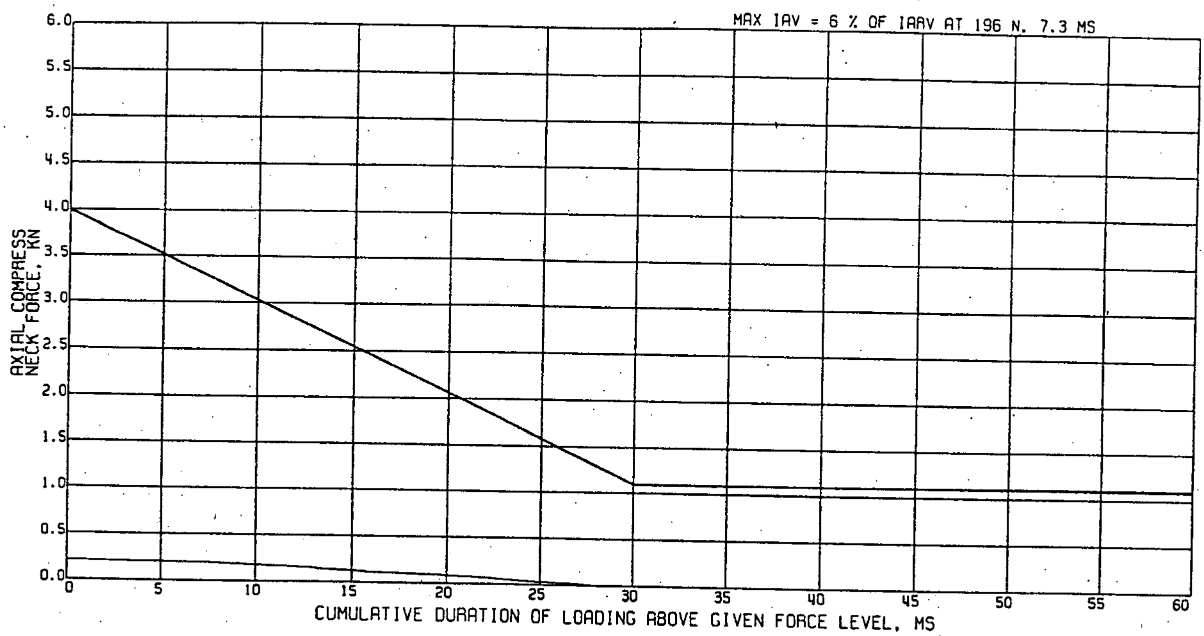


C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

AXIAL COMPRESSION ON HEAD,
R. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:05/13/1998



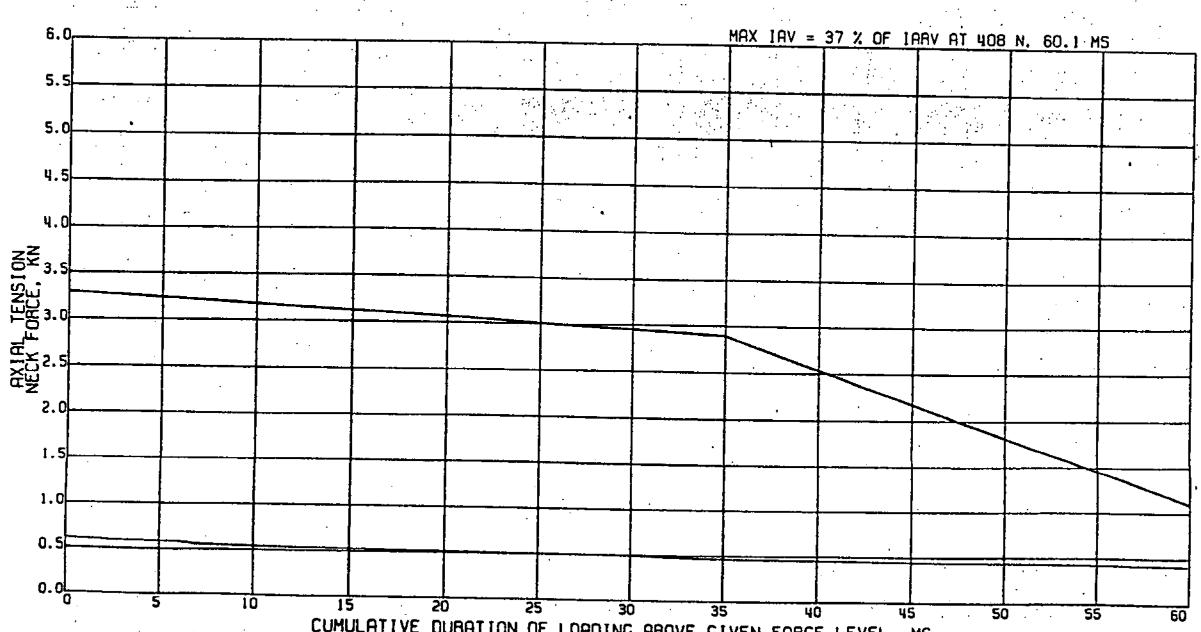
Appendix B, plot # **17**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

AXIAL TENSION ON HEAD,
R. FRT INJURY REFERENCE

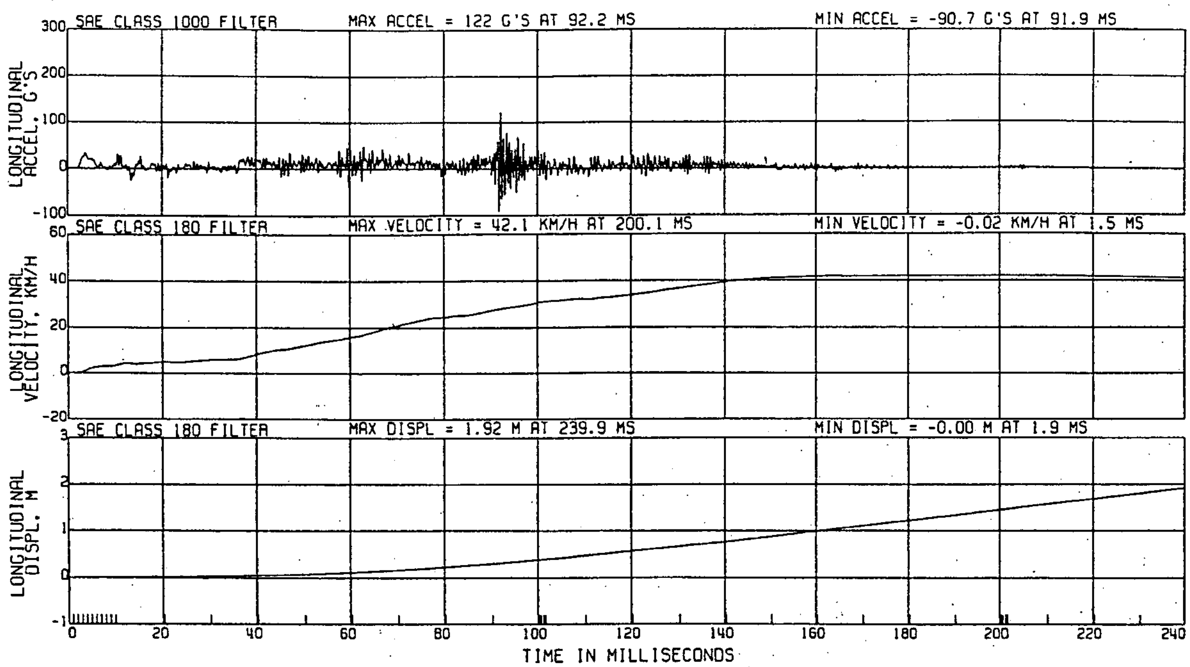
ATD TYPE: GM50H
TEST DATE:05/13/1998



Appendix B, plot # **18**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

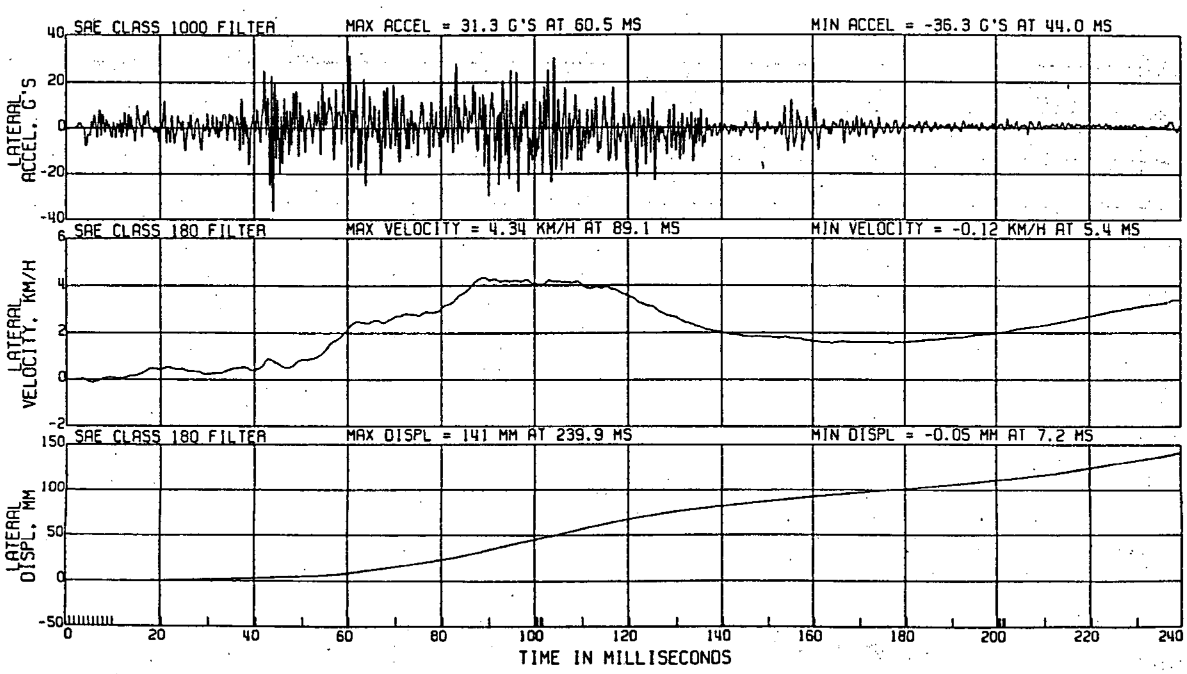
R & D CTR 8W9188 4 DOOR L. FRT ROCKER TEST DATE:05/13/1998
ELEC DATA



Appendix B, plot # **19**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR L. FRT ROCKER TEST DATE:05/13/1998
ELEC DATA



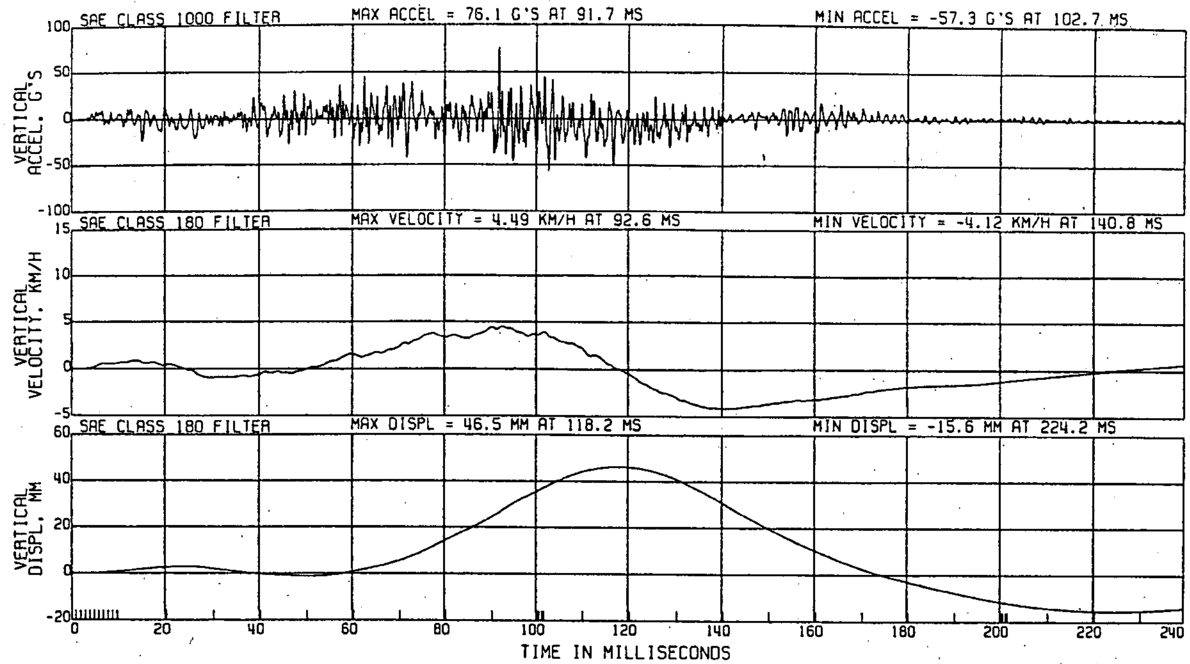
Appendix B, plot # **20**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

L. FRT ROCKER

R & D CTR 8W9188 4 DOOR TEST DATE:05/13/1998

ELEC DATA



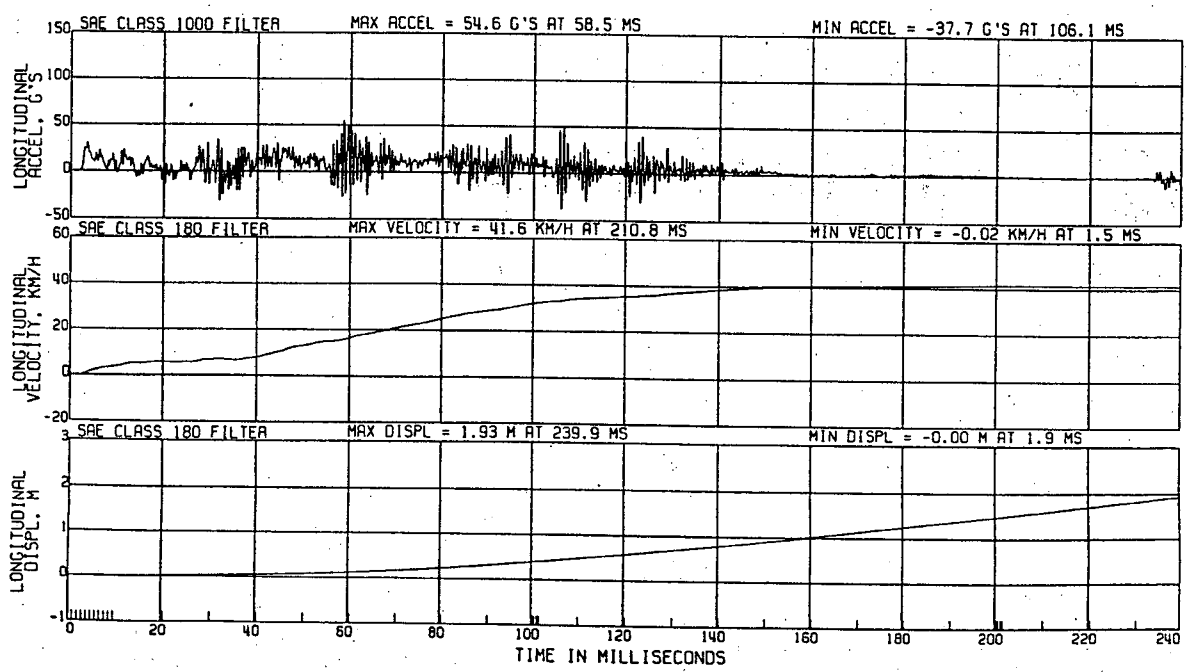
Appendix B, plot # **21**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R. FRT ROCKER

R & D CTR 8W9188 4 DOOR TEST DATE:05/13/1998

ELEC DATA



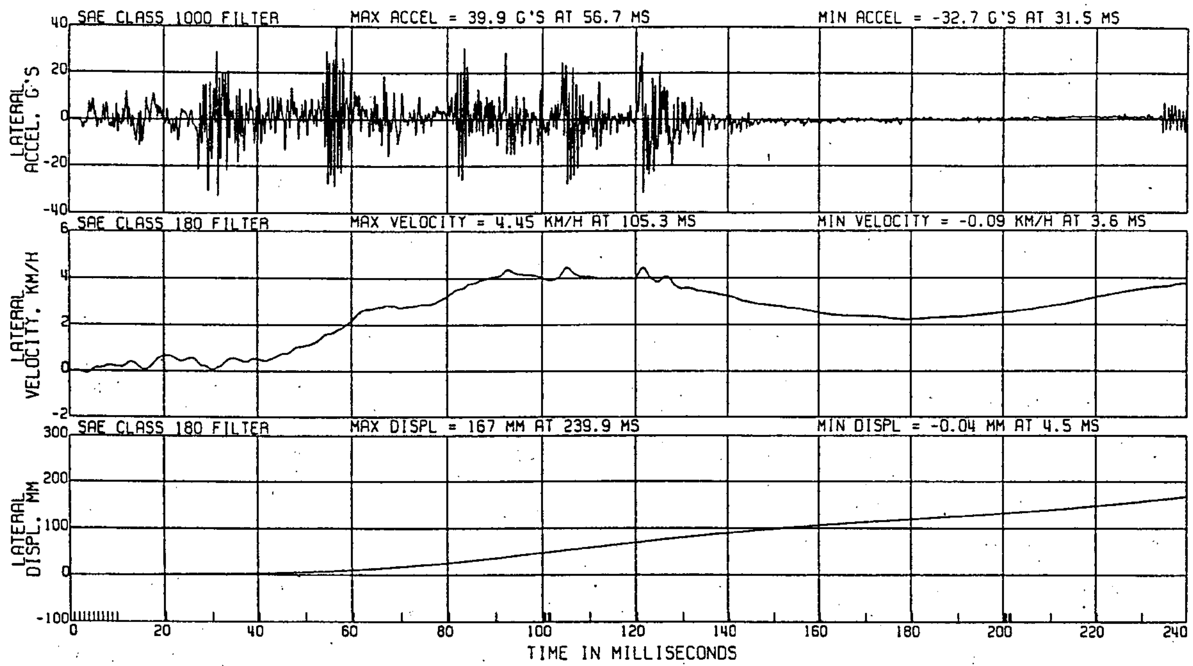
Appendix B, plot # **22**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA

R. FRT ROCKER

TEST DATE:05/13/1998



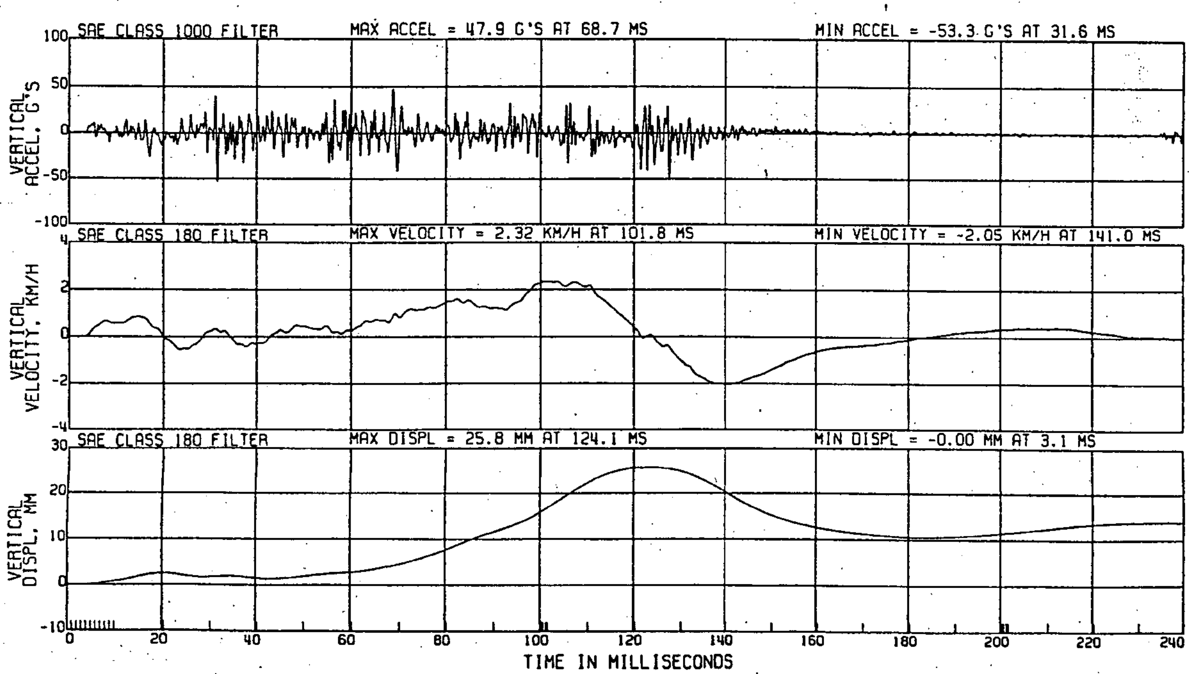
Appendix B, plot # **23**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA

R. FRT ROCKER

TEST DATE:05/13/1998

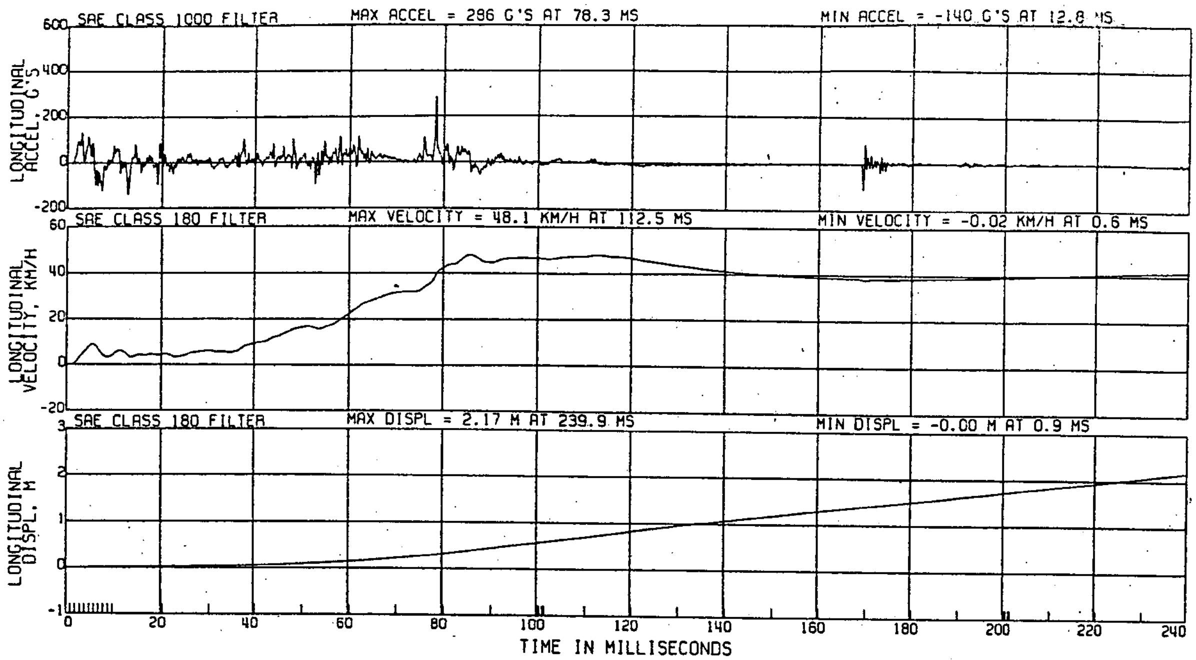


Appendix B, plot # **24**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR L.REAR FRAME TEST DATE:05/13/1998

ELEC DATA

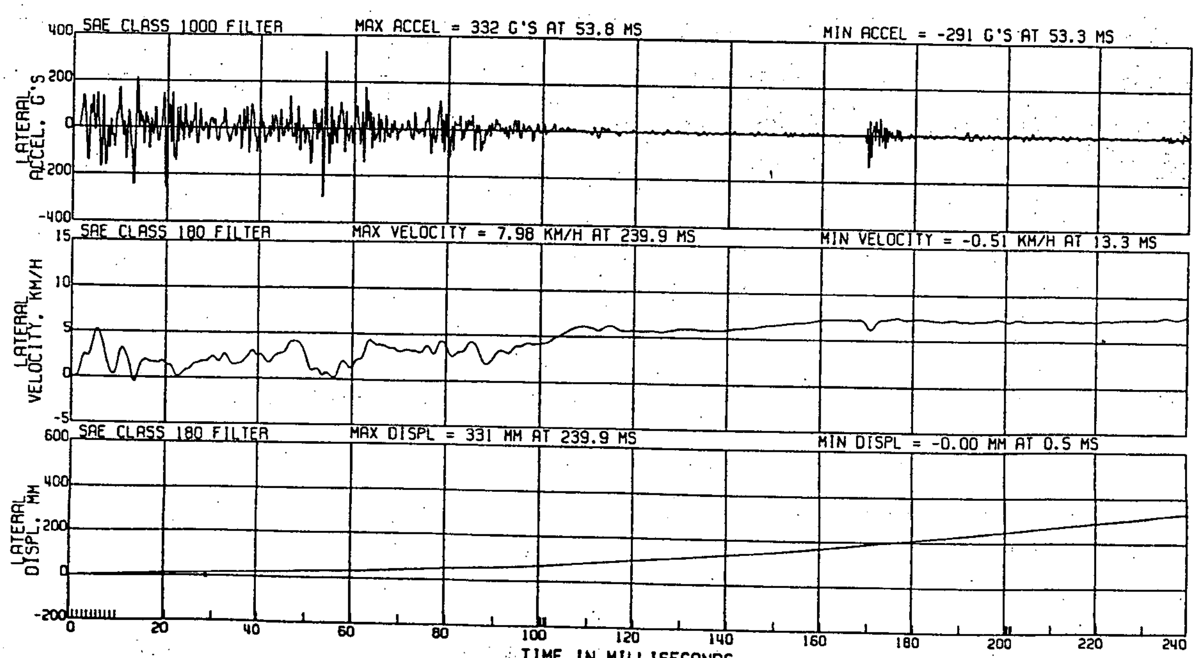


Appendix B, plot # **25**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR L.REAR FRAME TEST DATE:05/13/1998

ELEC DATA



Appendix B, plot # **26**

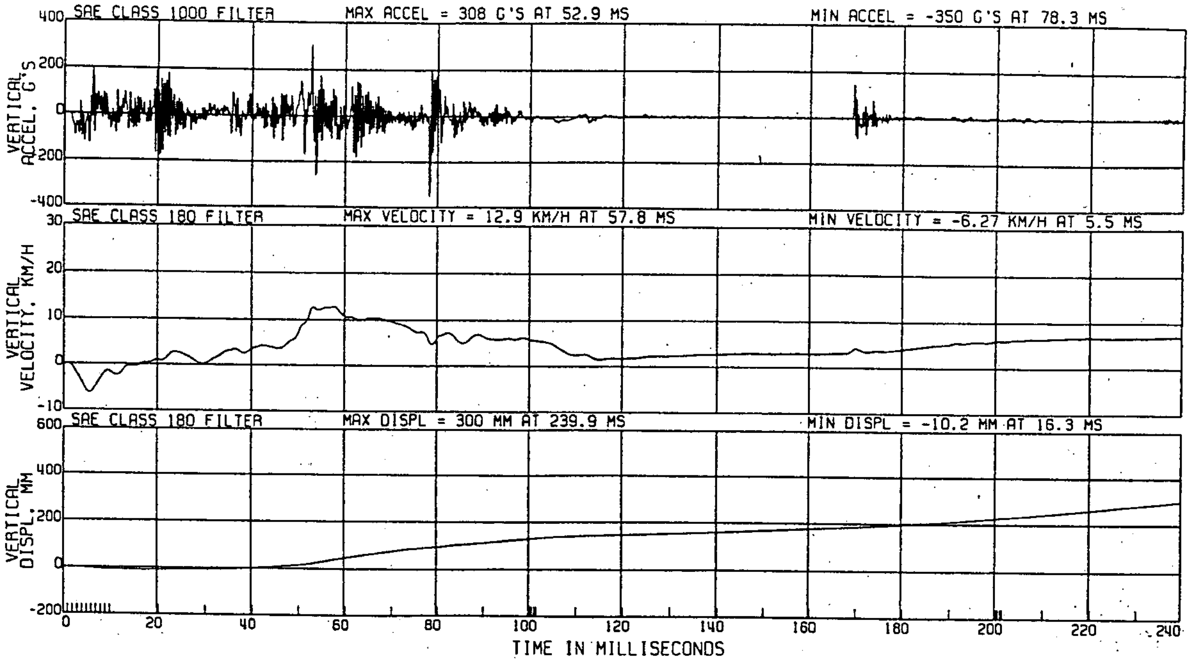
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

L.REAR FRAME

TEST DATE:05/13/1998

ELEC DATA



Appendix B, plot # **27**

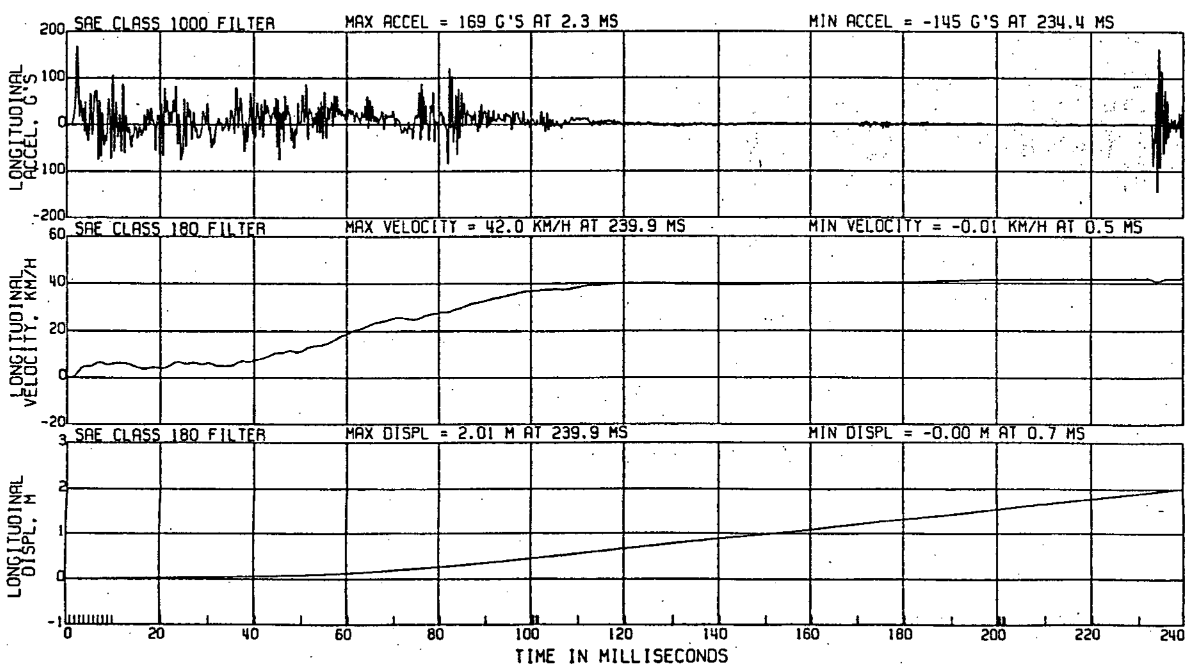
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

R.REAR FRAME

TEST DATE:05/13/1998

ELEC DATA

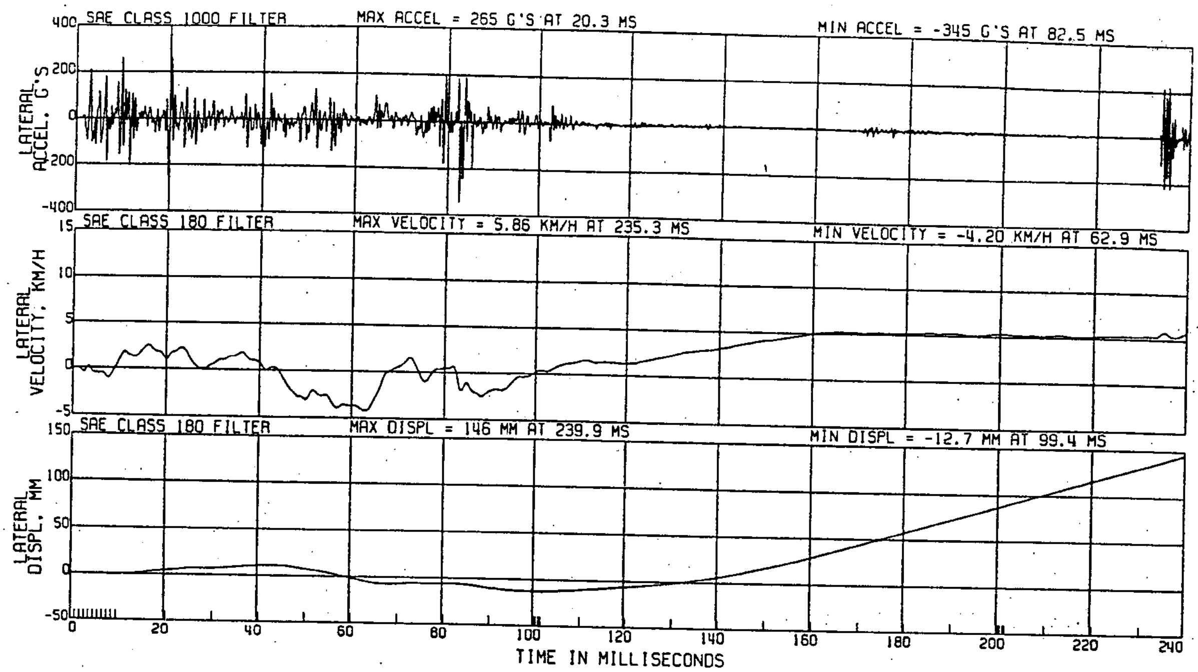


Appendix B, plot # **28**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR R.REAR FRAME

ELEC DATA TEST DATE:05/13/1998

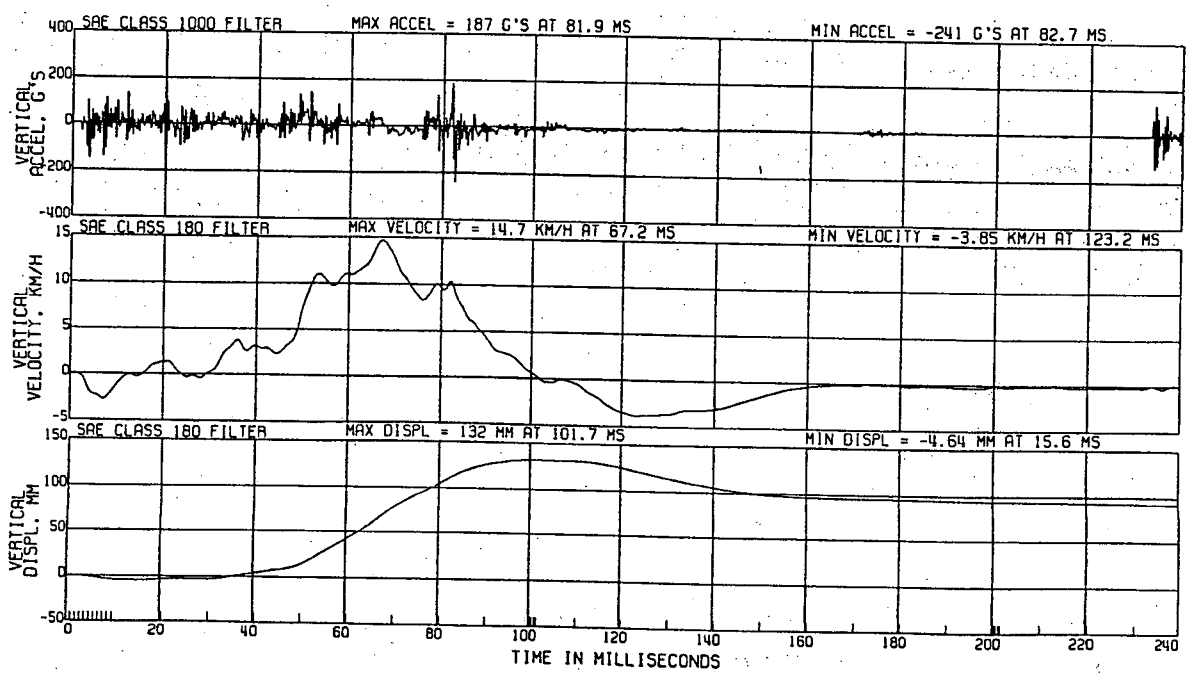


Appendix B, plot # **29**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR R.REAR FRAME

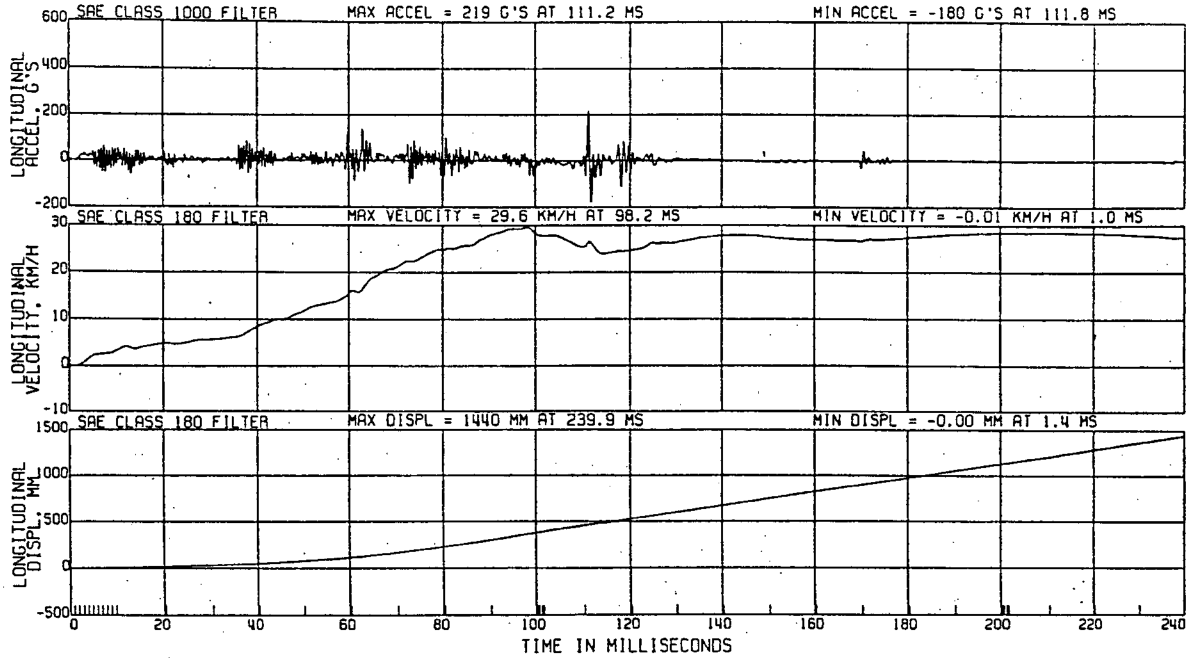
ELEC DATA TEST DATE:05/13/1998



Appendix B, plot # **30**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

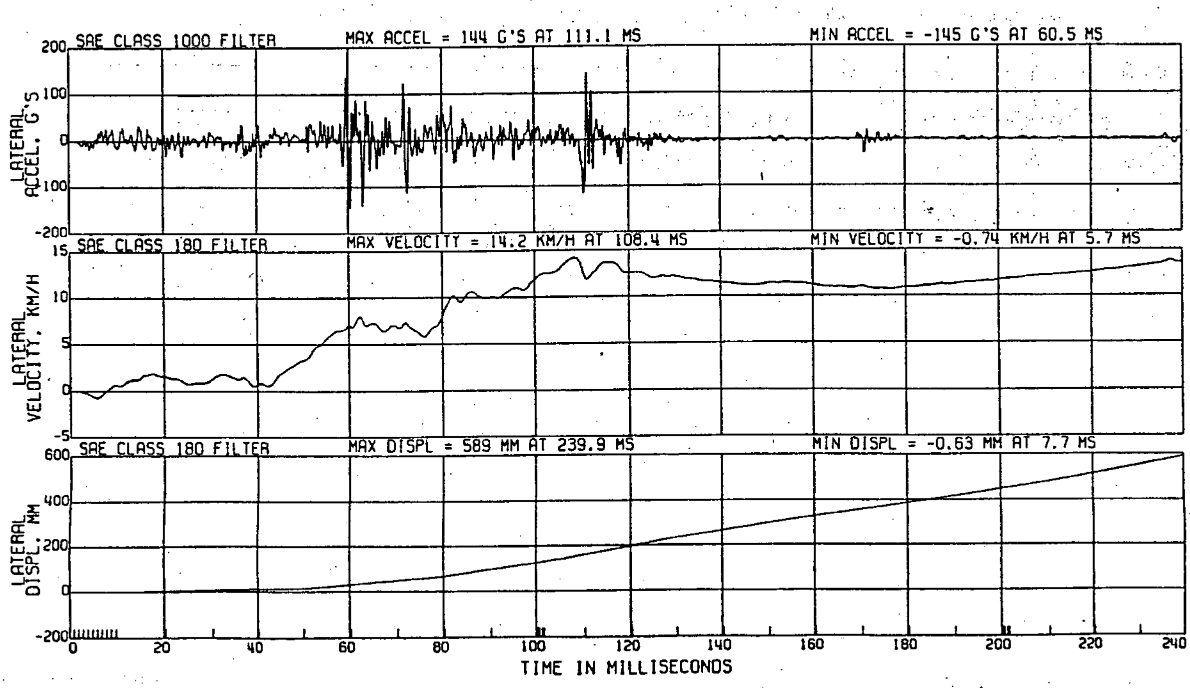
R & D CTR 8W9188 4 DOOR L.REAR ROCKER TEST DATE:05/13/1998
ELEC DATA



Appendix B, plot # **31**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR L.REAR ROCKER TEST DATE:05/13/1998
ELEC DATA

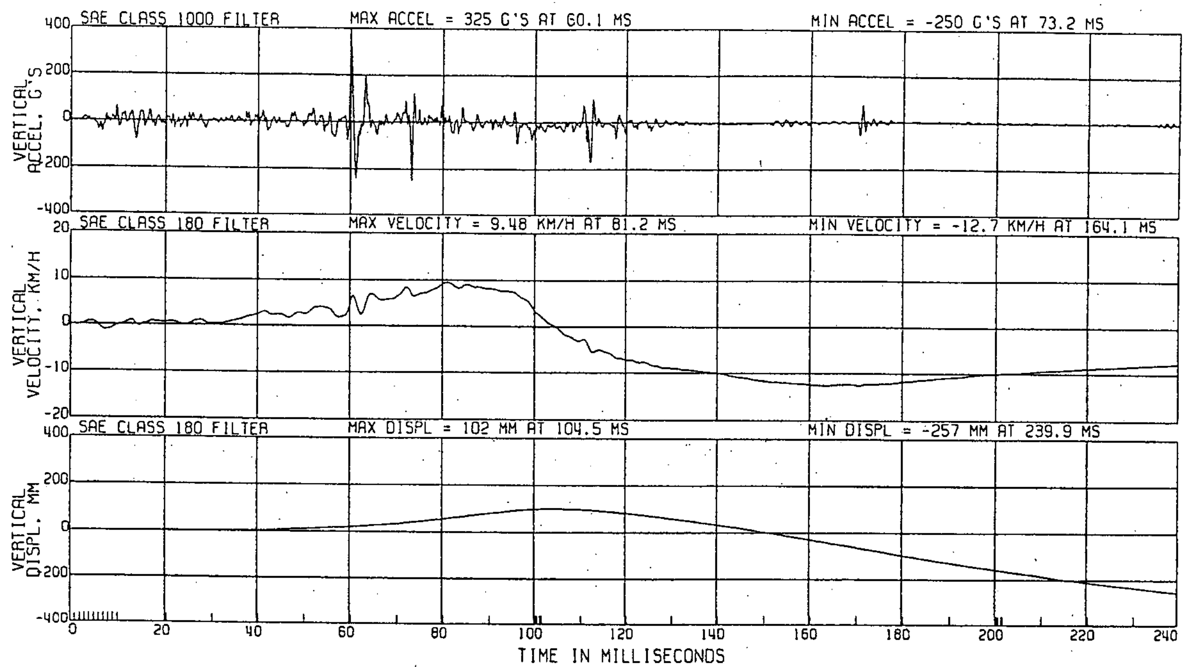


Appendix B, plot # **32**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR L.REAR ROCKER TEST DATE:05/13/1998

ELEC DATA

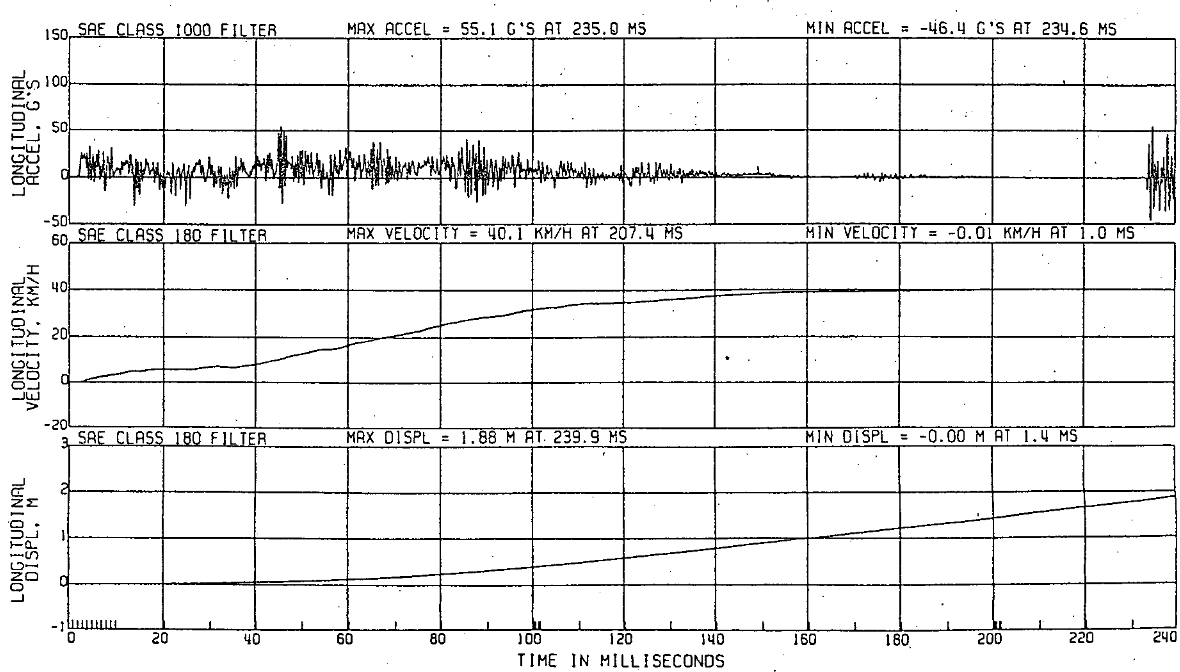


Appendix B, plot # **33**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR R.REAR ROCKER TEST DATE:05/13/1998

ELEC DATA

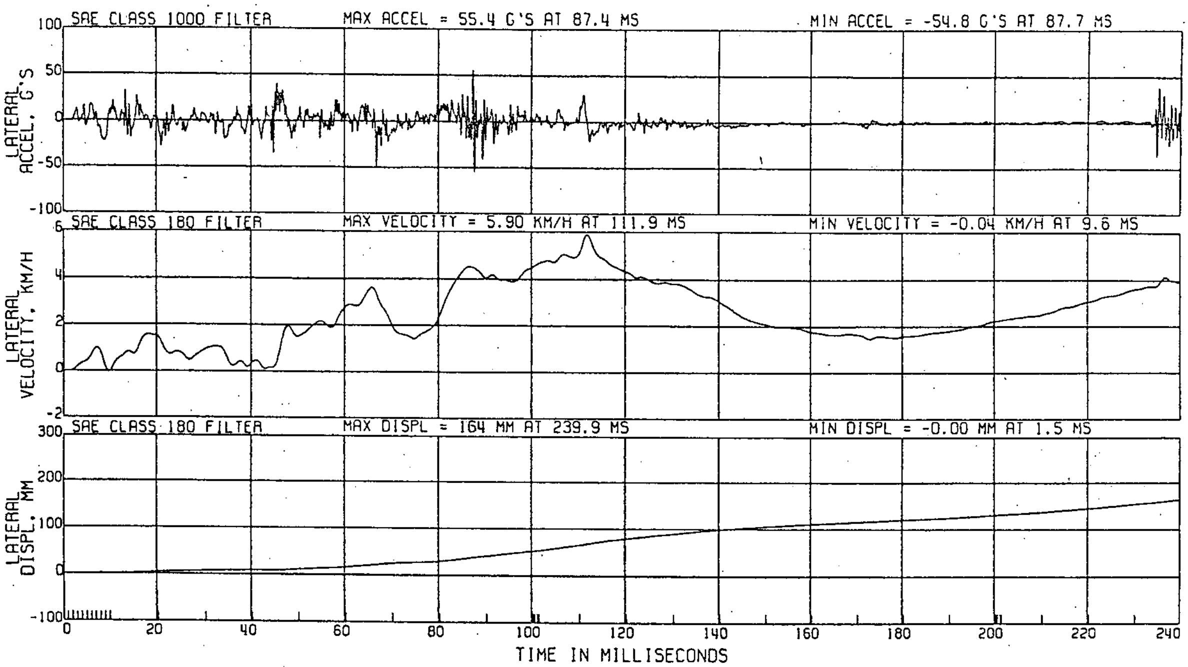


Appendix B, plot # **34**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR R.REAR ROCKER TEST DATE:05/13/1998

ELEC DATA

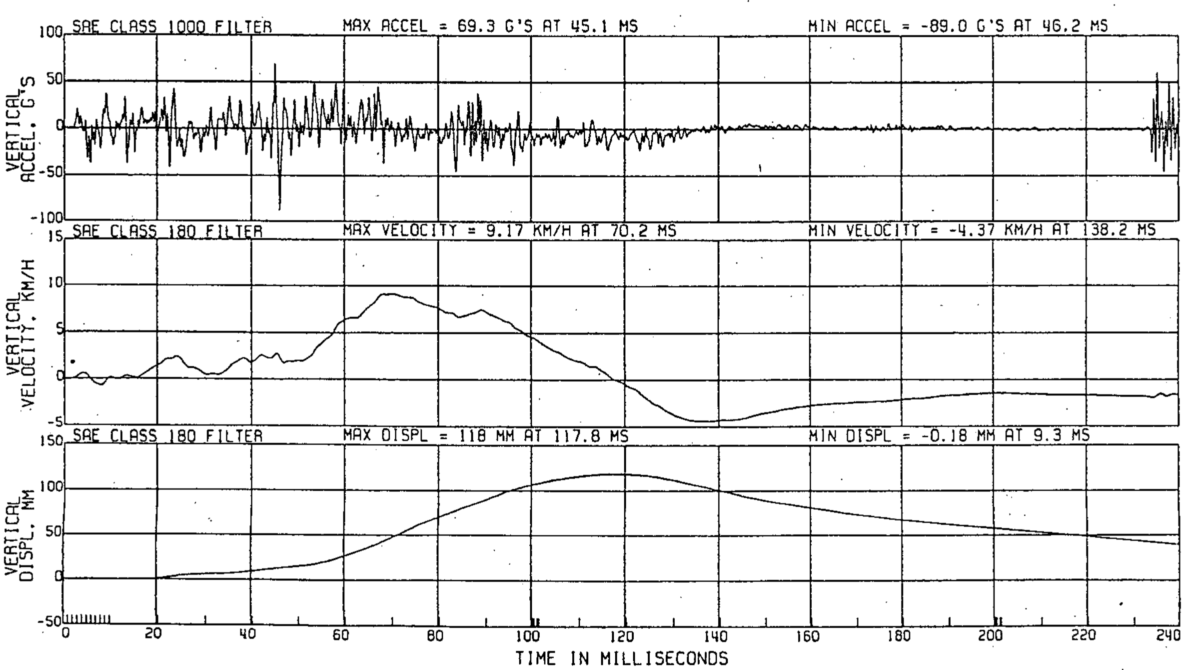


Appendix B, plot # **35**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR R.REAR ROCKER TEST DATE:05/13/1998

ELEC DATA



Appendix B, plot # **36**

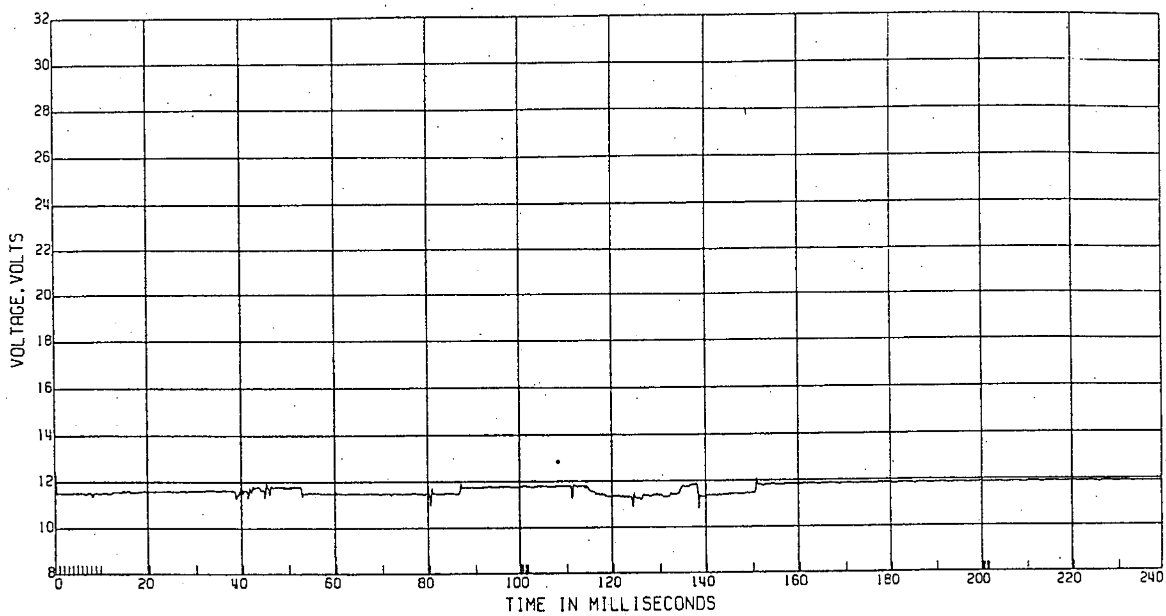
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

ELEC DATA, SAE CLASS 1000

IGNITION VOLTAGE

TEST DATE:05/13/1998



Appendix B, plot # 37

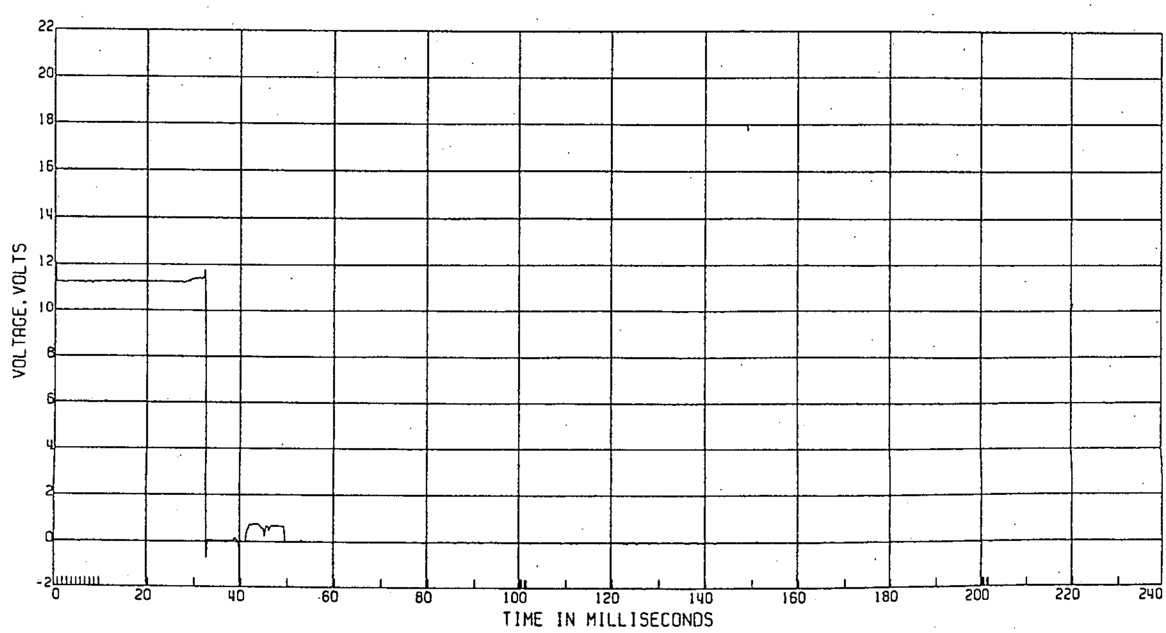
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

ELEC DATA, SAE CLASS 1000

CHMSL/BRAKE LIGHT VOLTAGE

TEST DATE:05/13/1998

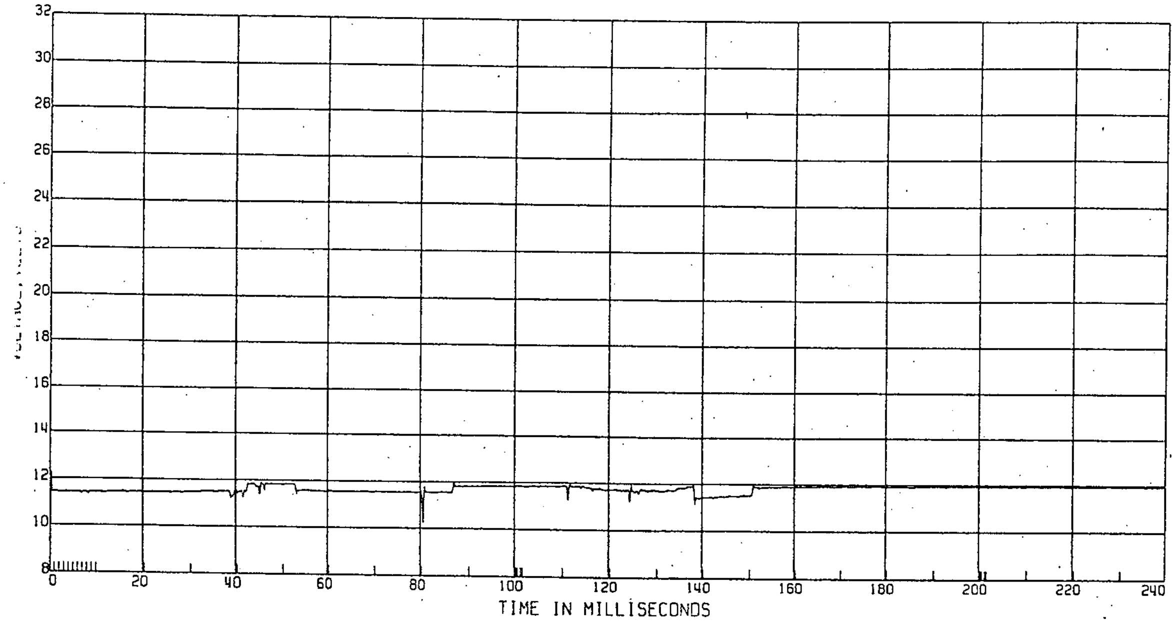


Appendix B, plot # 38

990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

: D CTR 8W9188 4 DOOR REAR WINDOW DEFROSTER VOLTAGE TEST DATE:05/13/1998

:C DATA, SAE CLASS 1000

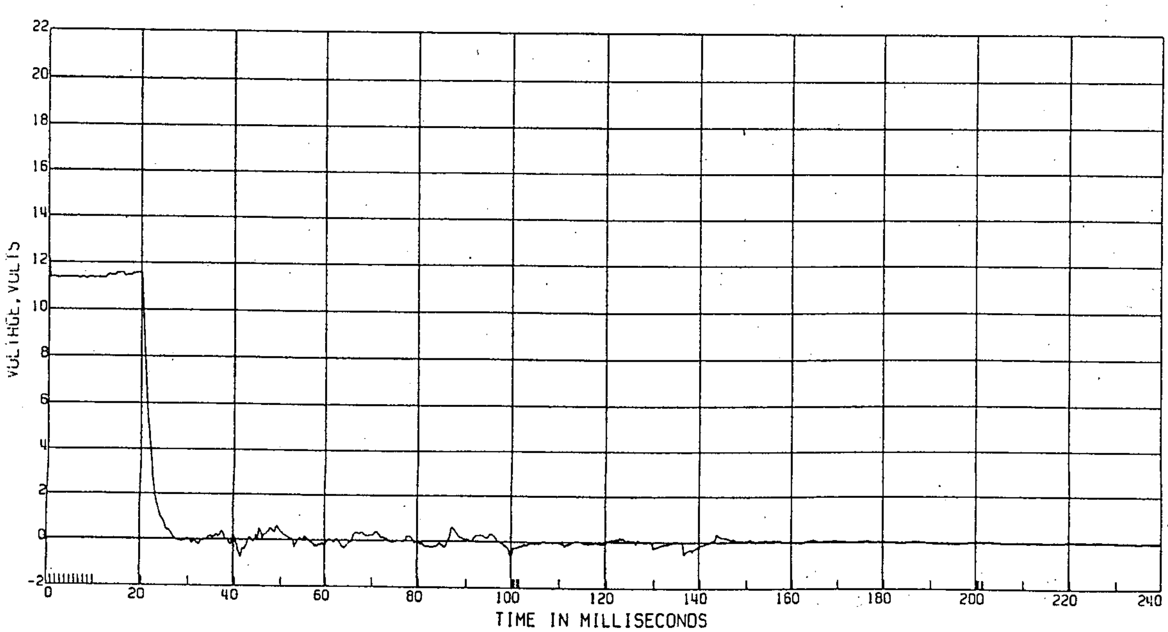


Appendix B, plot # **39**

1990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

& D CTR 8W9188 4 DOOR L.REAR BACKUP LIGHT VOLTAGE TEST DATE:05/13/1998

EC DATA, SAE CLASS 1000



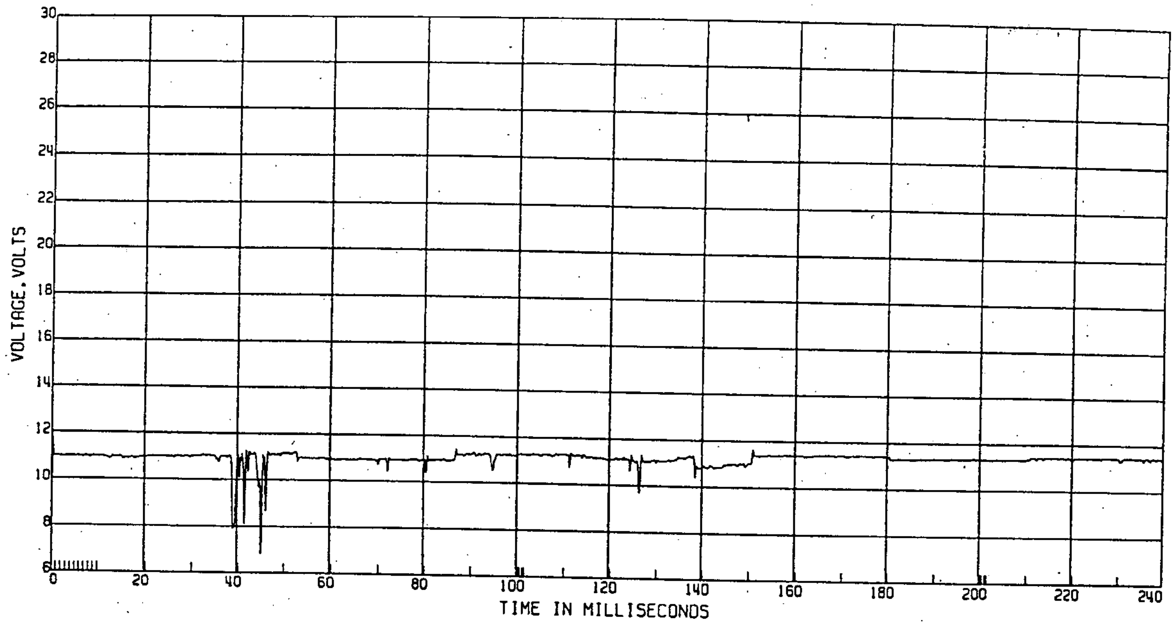
Appendix B, plot # **40**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

REAR TAIL LIGHTS VOLTAGE

TEST DATE:05/13/1998



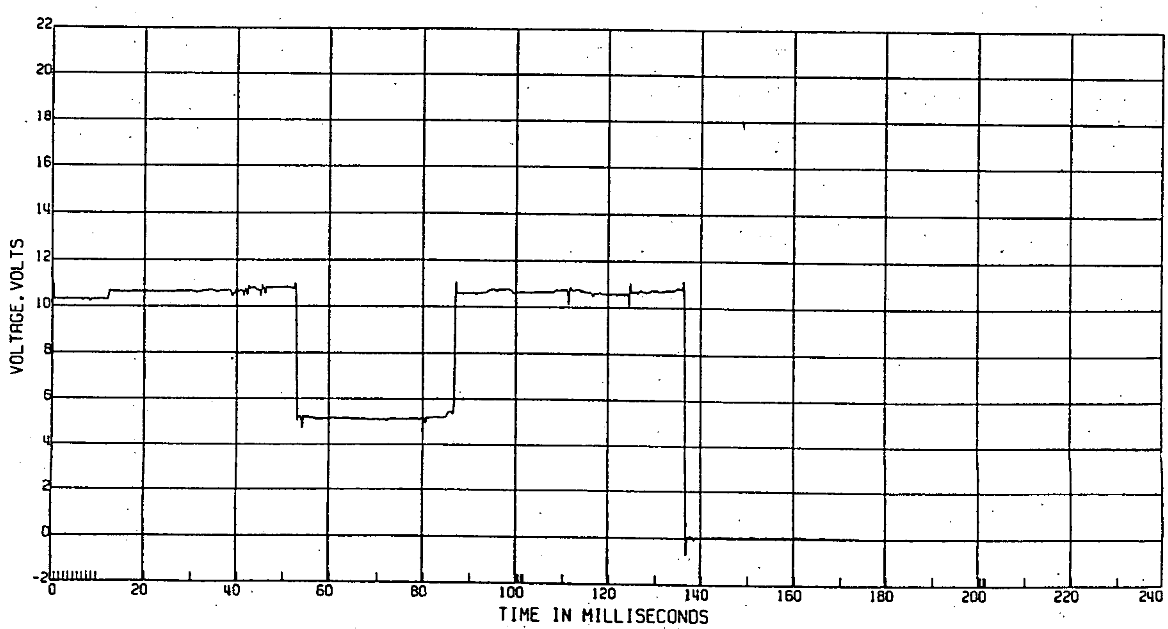
Appendix B, plot # **41**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

L.REAR TURN SIGNAL VOLTAGE

TEST DATE:05/13/1998



Appendix B, plot # **42**

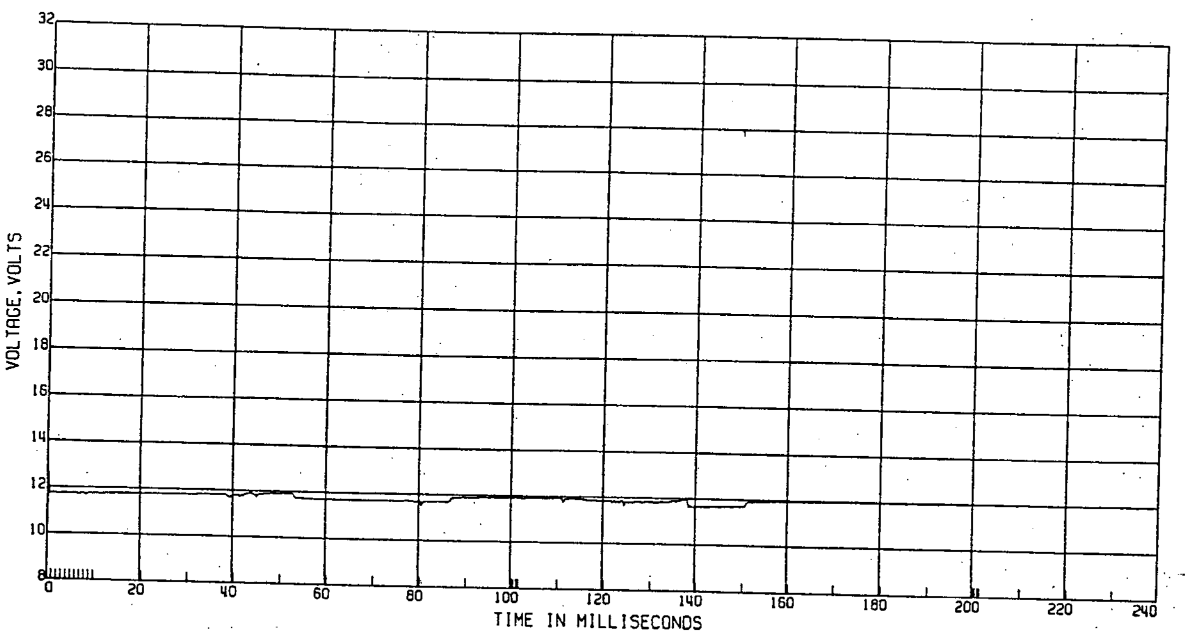
:11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

1 & D CTR 8W9188 4 DOOR

LEC DATA, SAE CLASS 1000

BATTERY VOLTAGE

TEST DATE:05/13/1998



Appendix B, plot # 43

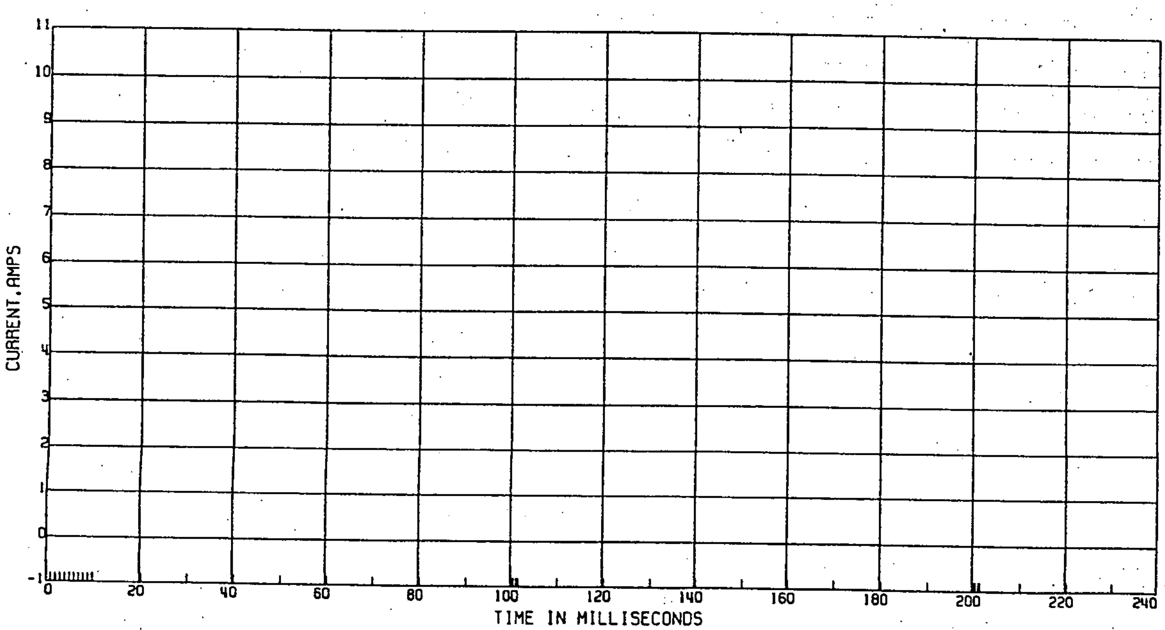
11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

& D CTR 8W9188 4 DOOR

LEC DATA, SAE CLASS 1000

L. WHEEL BAG CURRENT

TEST DATE:05/13/1998



Appendix B, plot # 44

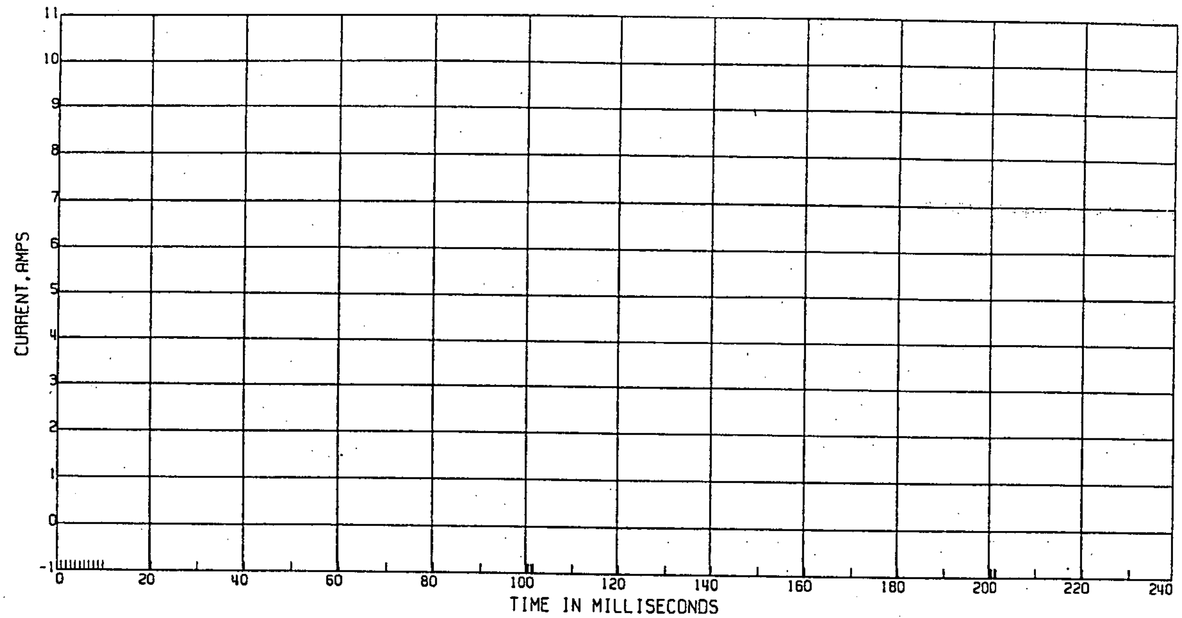
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

ELEC DATA, SAE CLASS 1000

R. I/P BAG CURRENT

TEST DATE:05/13/1998



Appendix B, plot # 45

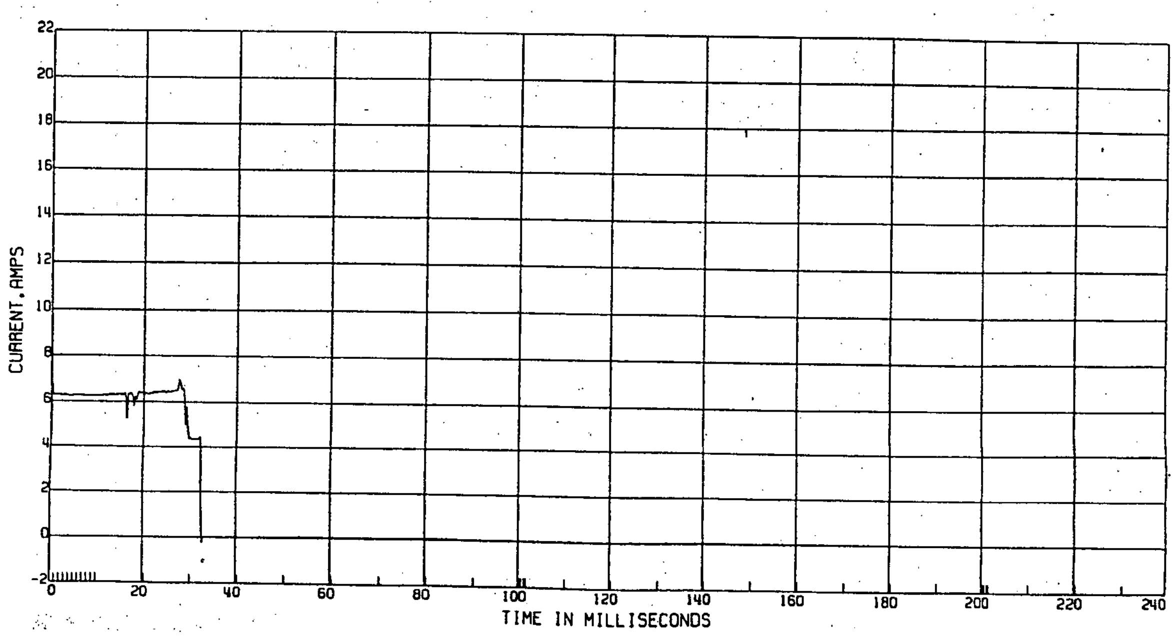
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

ELEC DATA, SAE CLASS 1000

CHMSL/BRAKE LIGHT CURRENT

TEST DATE:05/13/1998



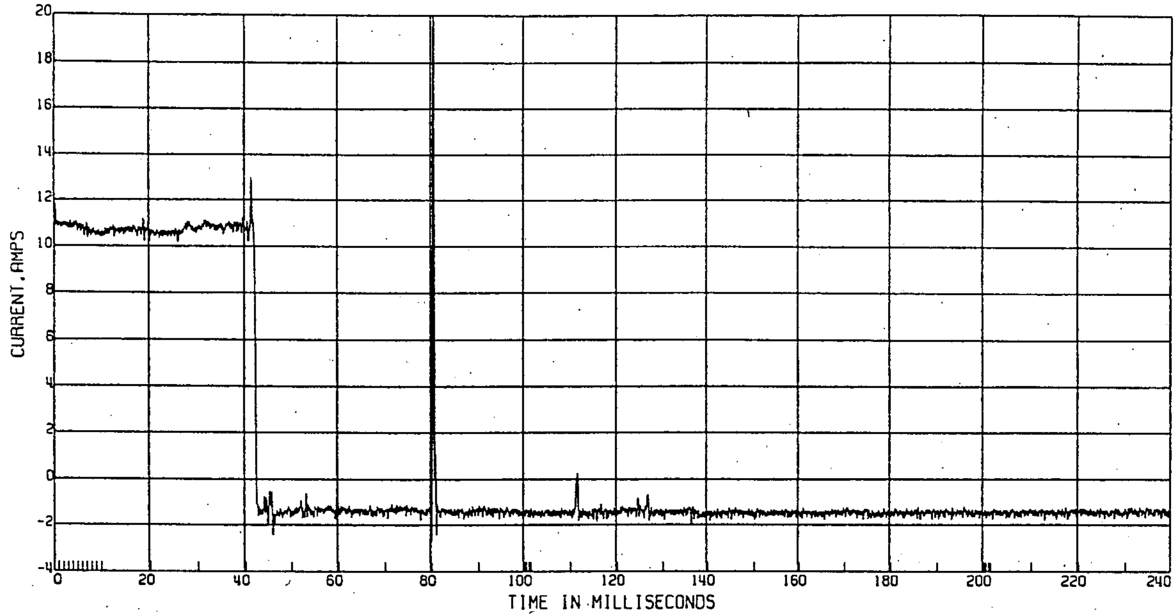
Appendix B, plot # 46

1990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

& D CTR 8W9188 4 DOOR
.EC DATA, SAE CLASS 1000

REAR WINDOW DEFROSTER CURRENT

TEST DATE:05/13/1998



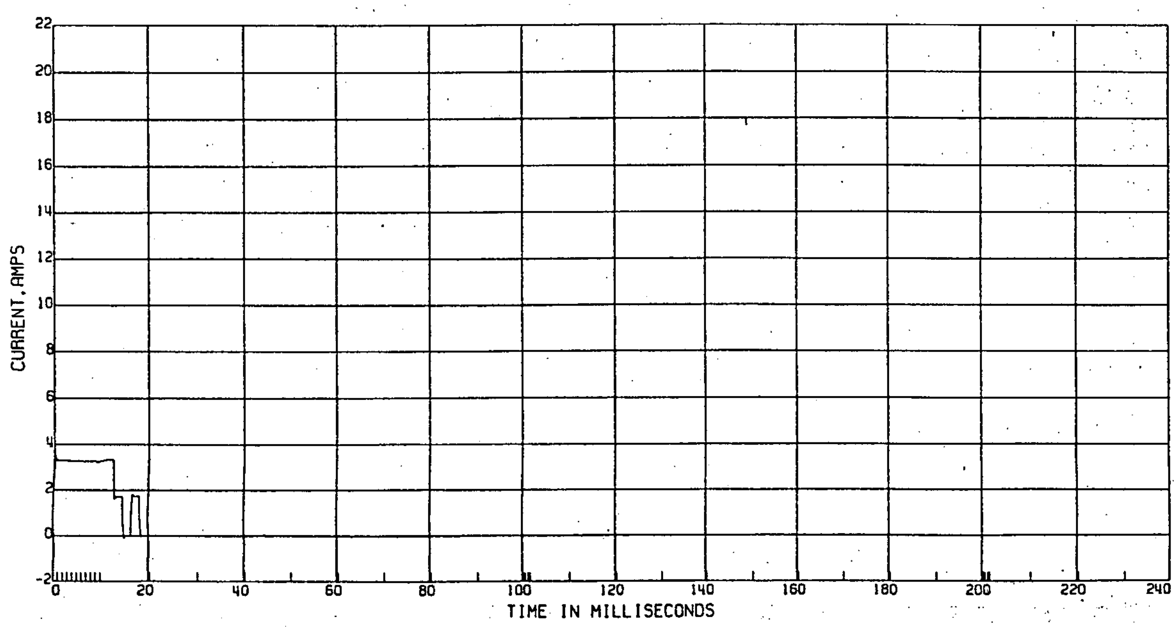
Appendix B, plot # 47

1990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

& D CTR 8W9188 4 DOOR
.EC DATA, SAE CLASS 1000

REAR BACKUP LIGHTS CURRENT

TEST DATE:05/13/1998



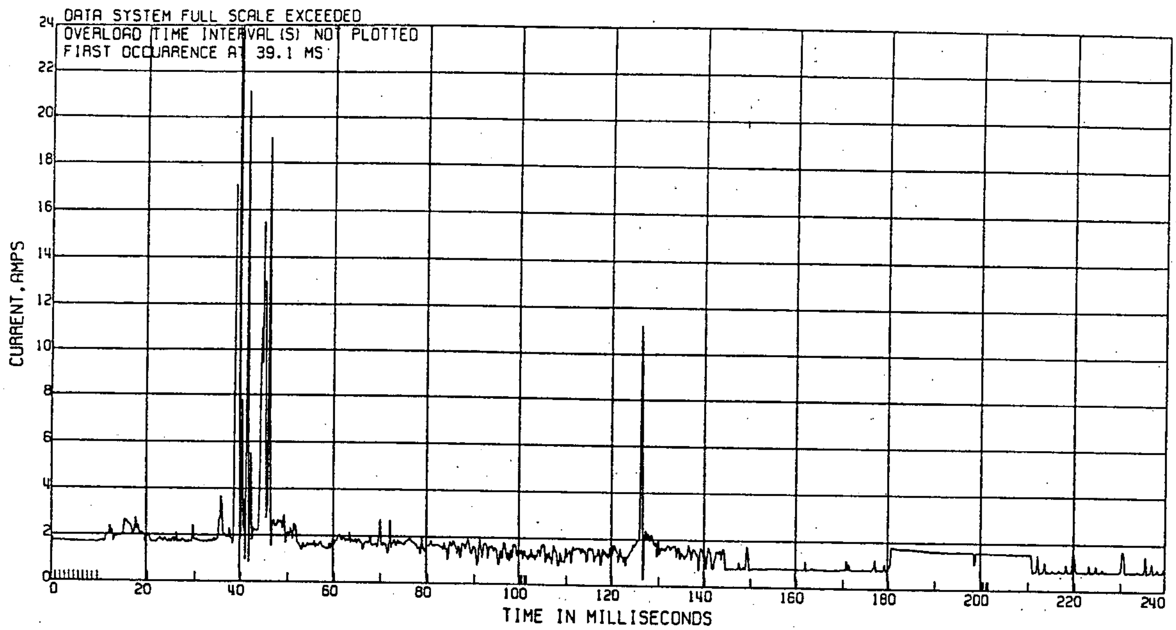
Appendix B, plot # 48

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

REAR TAIL LIGHTS CURRENT

TEST DATE:05/13/1998



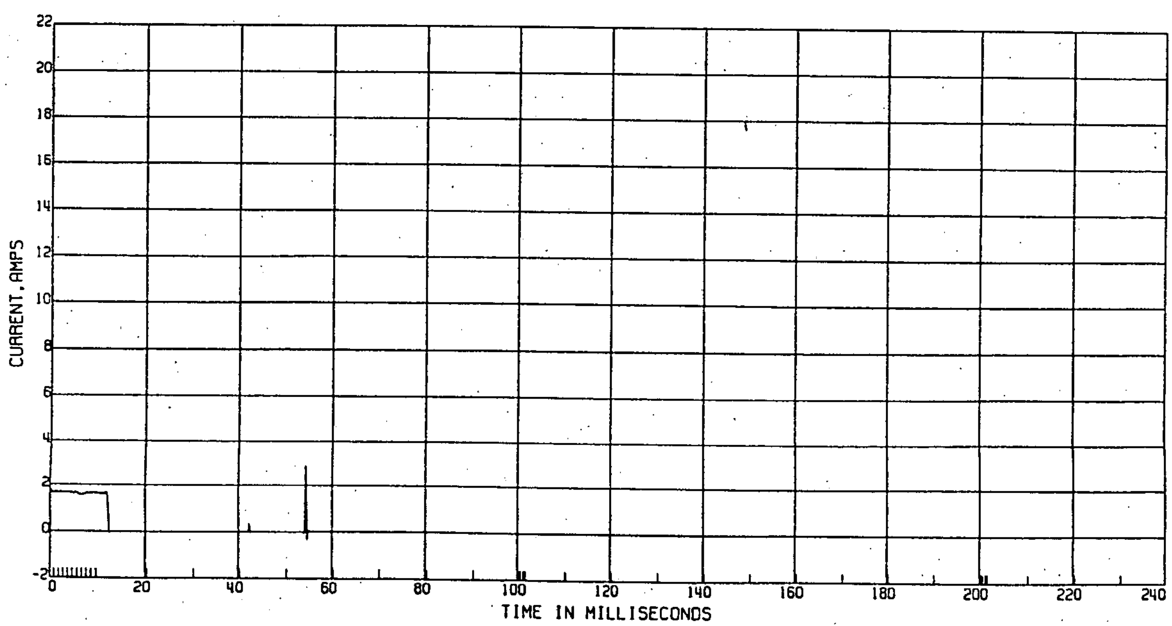
Appendix B, plot # **49**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

L.REAR TURN SIGNAL CURRENT

TEST DATE:05/13/1998



Appendix B, plot # **50**

.11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

. & D CTR 8W9188 4 DOOR

.LEC DATA, SAE CLASS 1000

BATTERY CURRENT

TEST DATE:05/13/1998

Appendix B, plot # **51**

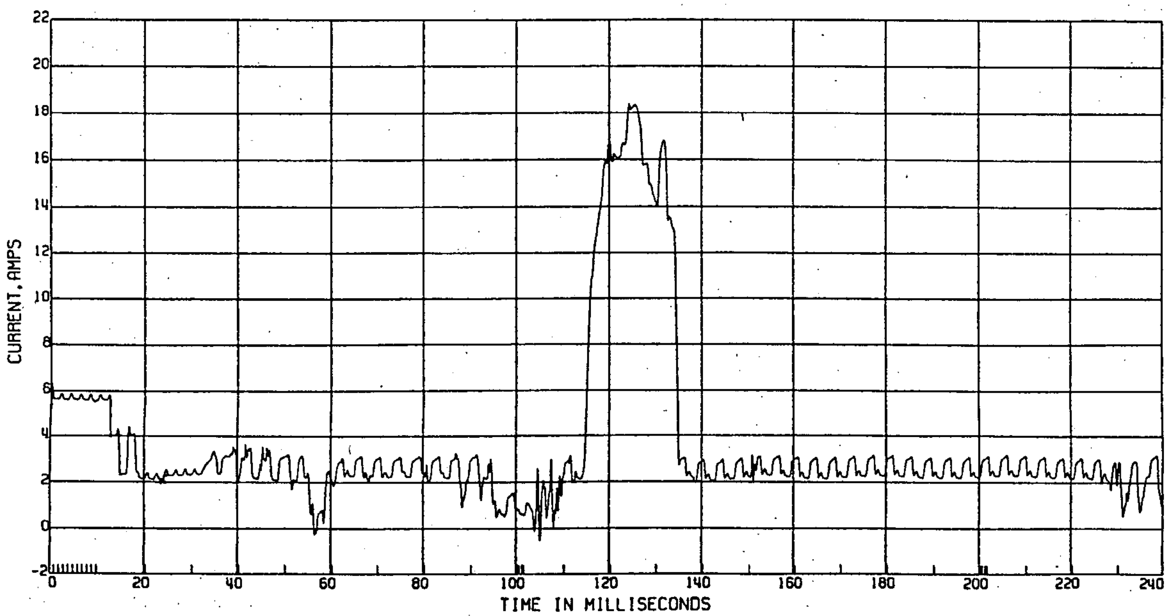
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

ELEC DATA, SAE CLASS 1000

IGNITION CURRENT

TEST DATE:05/13/1998



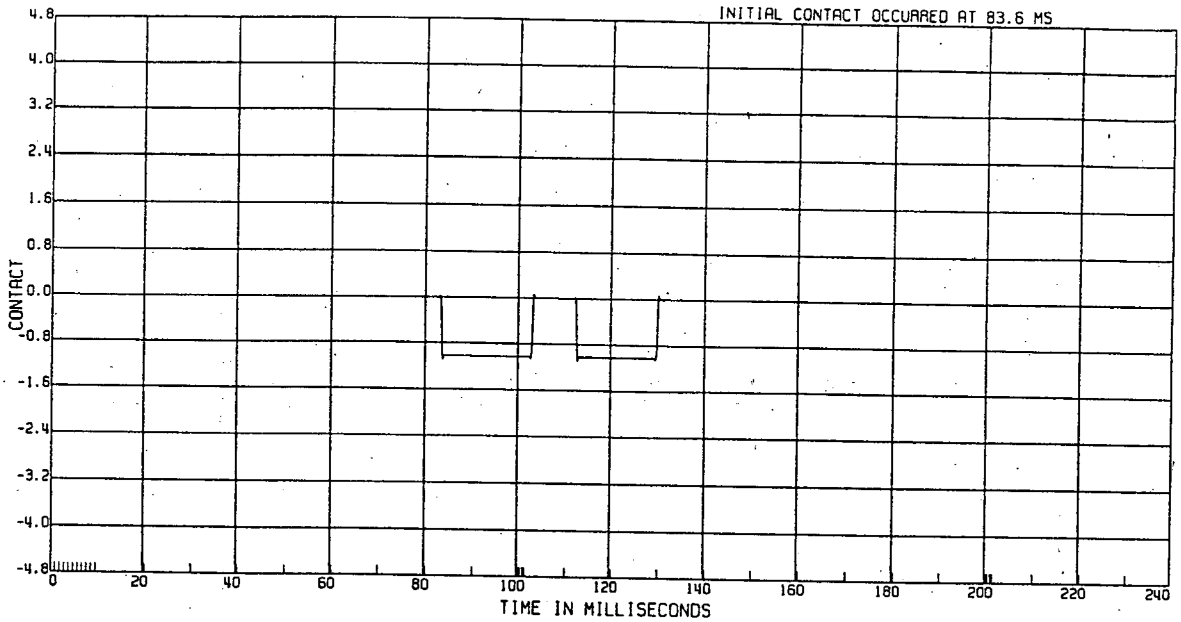
Appendix B, plot # **52**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

THERMAL WIRE-XMBR CONTACT

TEST DATE:05/13/1998



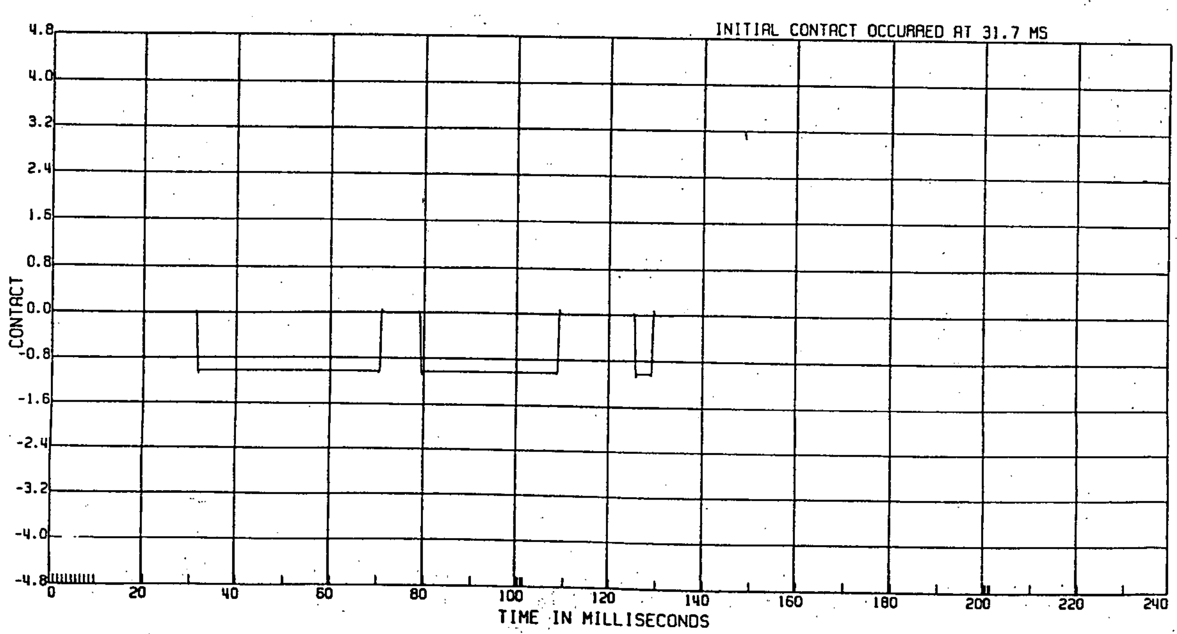
Appendix B, plot # 53

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR
ELEC DATA, SAE CLASS 1000

REAR XMBR TO FUEL CRADLE CONTACT

TEST DATE:05/13/1998



Appendix B, plot # 54

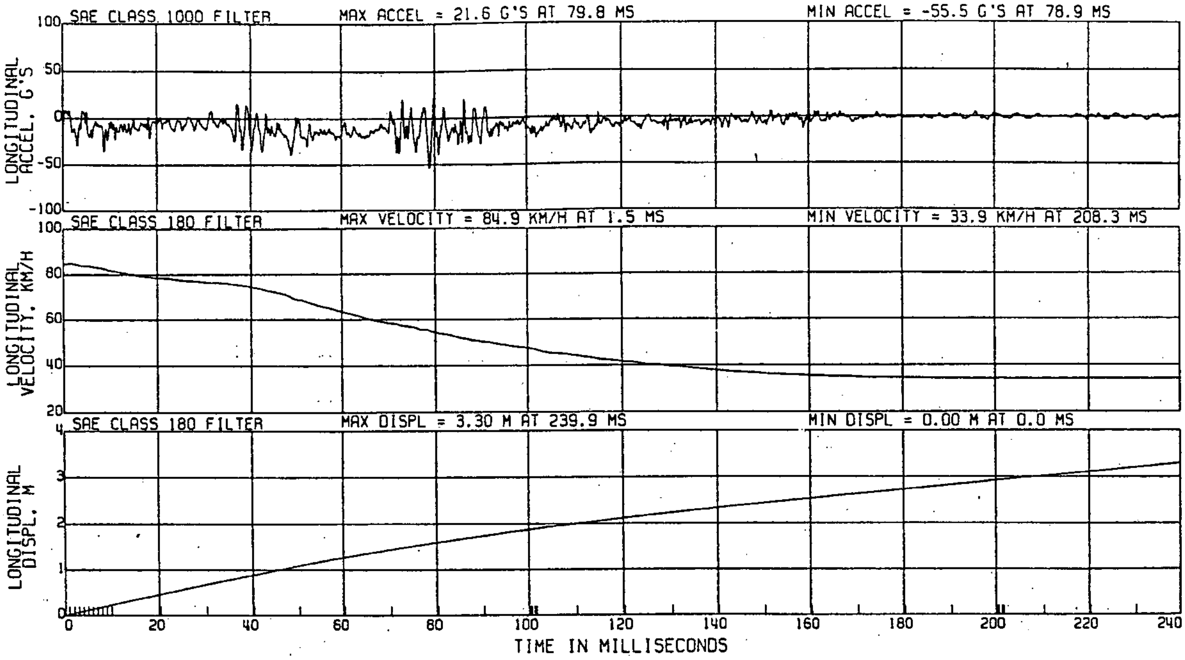
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR

ELEC DATA

LTV MDB AT C.G.

TEST DATE:05/13/1998



Appendix B, plot # **55**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

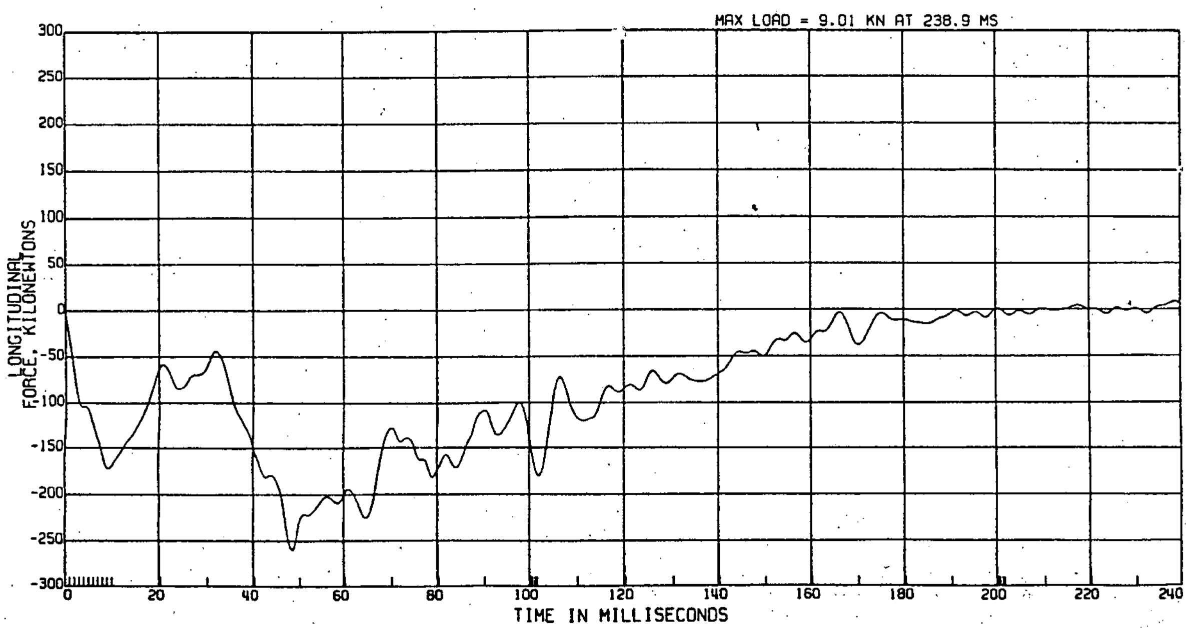
R & D CTR 8W9188 4 DOOR

ELEC DATA, SAE CLASS 60

LTV MDB LONG. FORCE AT C.G.

(1371.0 KG) (9.807) (LONG.ACCEL)

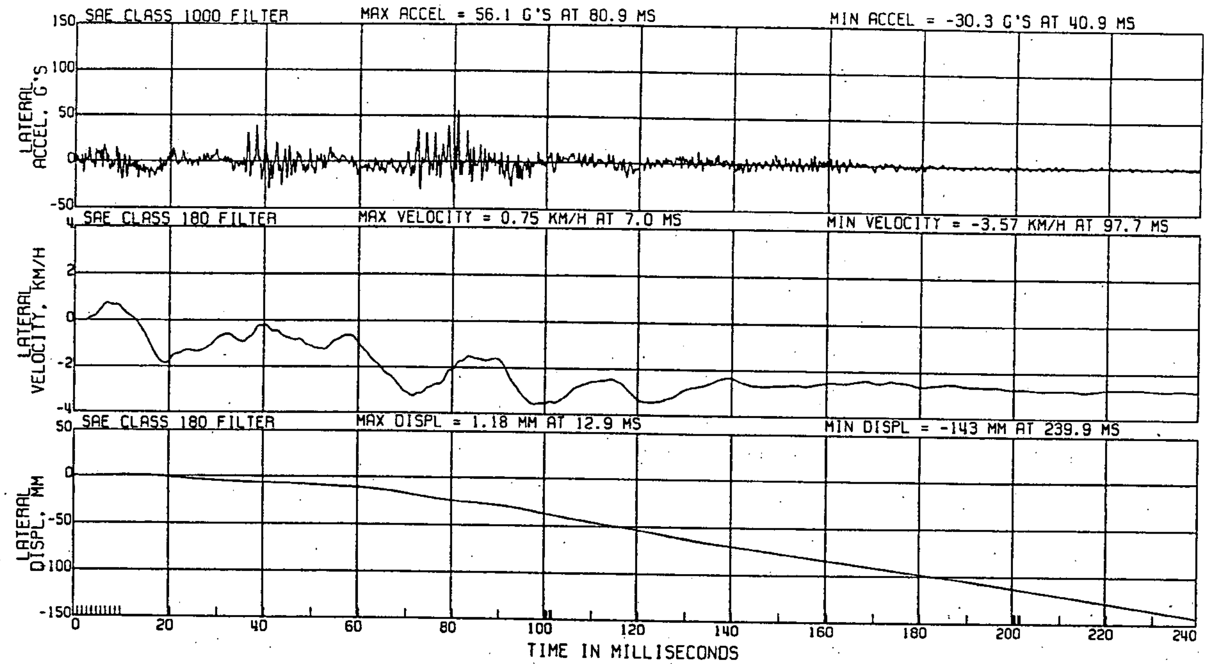
TEST DATE:05/13/1998



Appendix B, plot # **56**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

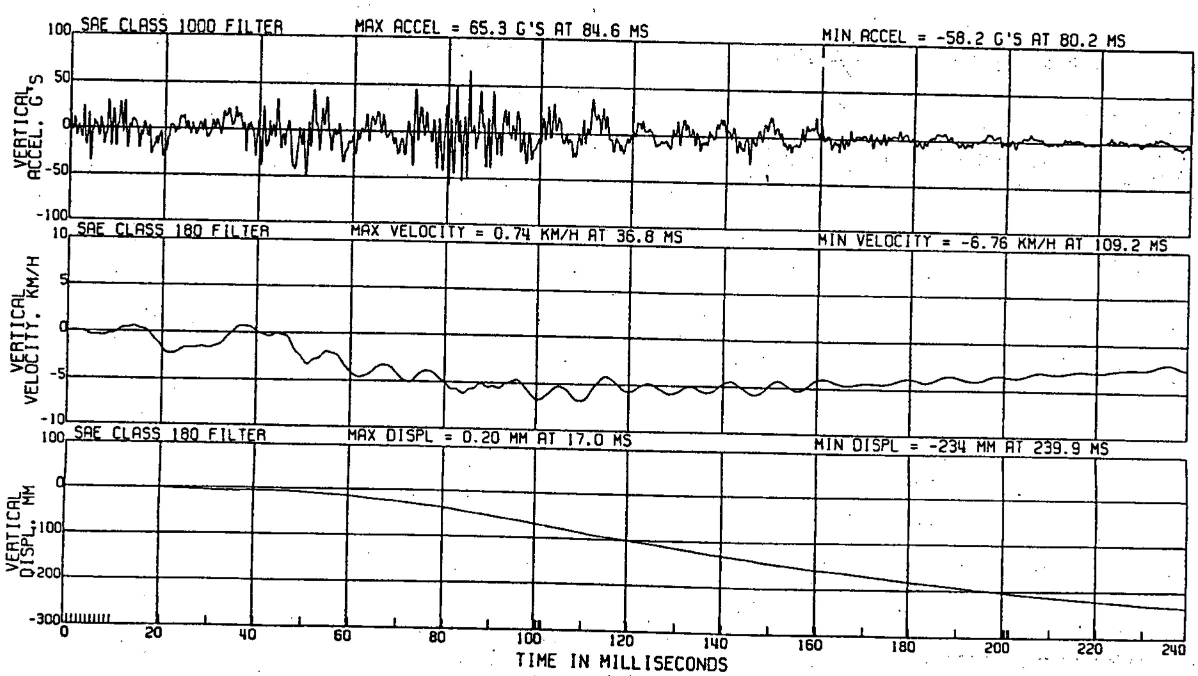
R & D CTR 8W9188 4 DOOR LTV MDB AT C.G. TEST DATE:05/13/1998
ELEC DATA



Appendix B, plot # 57

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

R & D CTR 8W9188 4 DOOR LTV MDB AT C.G. TEST DATE:05/13/1998
ELEC DATA



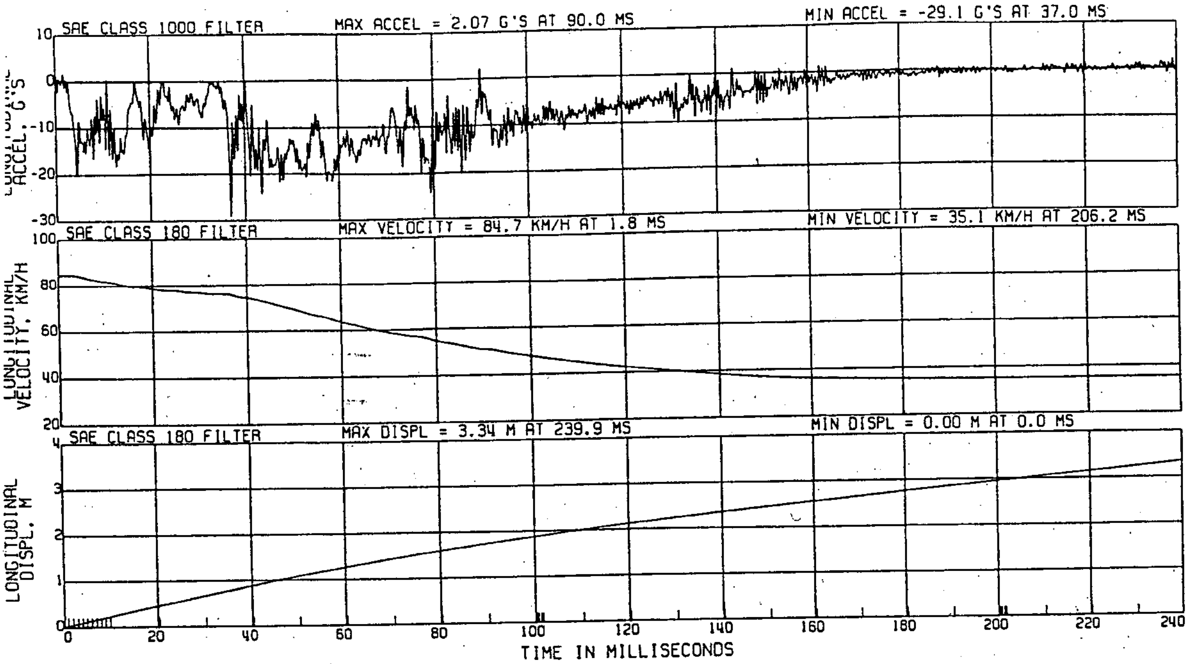
Appendix B, plot # 58

1990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

LTV MDB AT REAR C/MBR TEST DATE:05/13/1998

& D CTR 8W9188 4 DOOR

.EC DATA



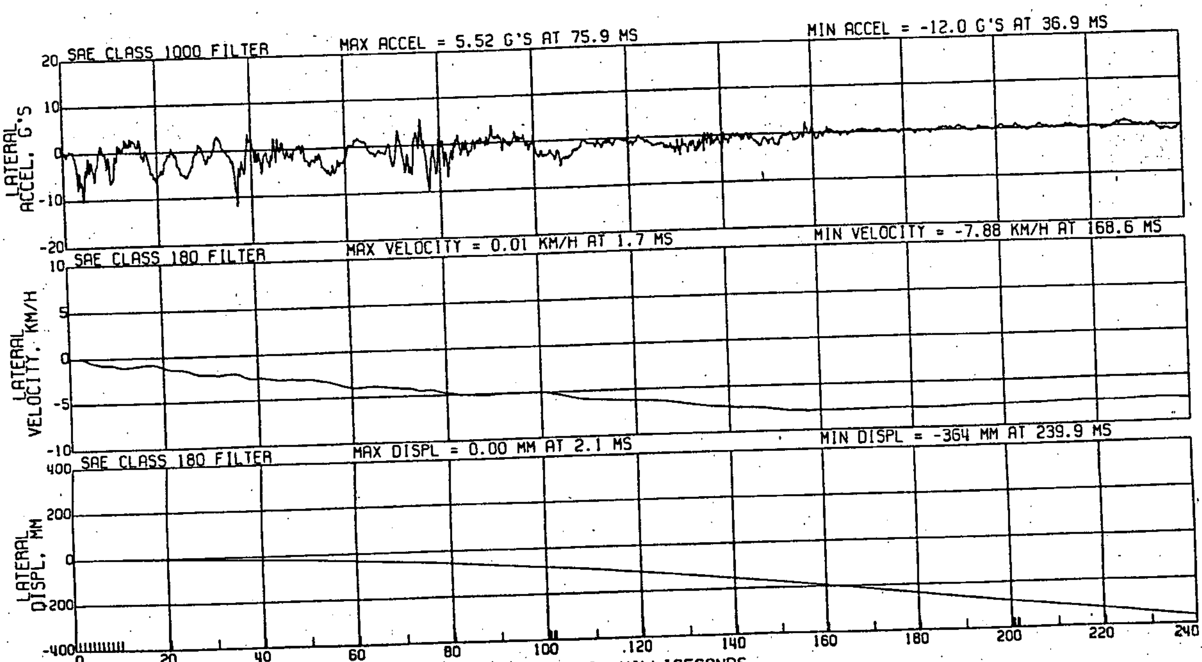
Appendix B, plot # **59**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

LTV MDB AT REAR C/MBR TEST DATE:05/13/1998

R & D CTR 8W9188 4 DOOR

ELEC DATA



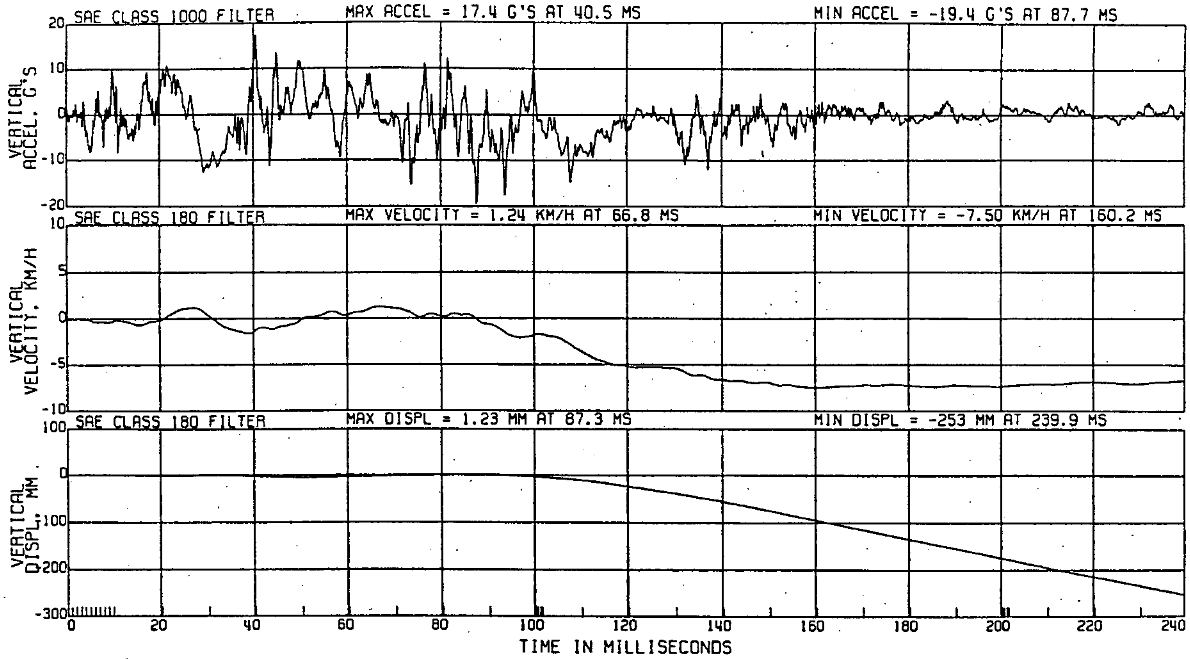
Appendix B, plot # **60**

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

LTV MDB AT REAR C/MBR

R & D CTR 8W9188 4 DOOR TEST DATE:05/13/1998

ELEC DATA



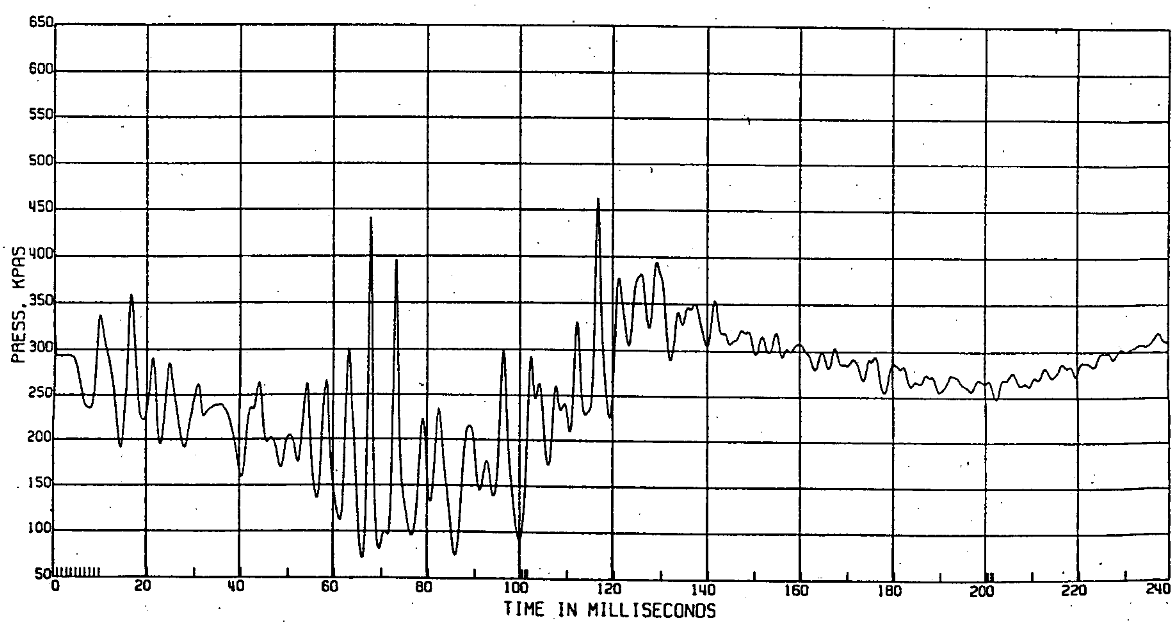
Appendix B, plot # 61

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

FUEL LINE PRESSURE

R & D CTR 8W9188 4 DOOR TEST DATE:05/13/1998

ELEC DATA, SAE CLASS 1000



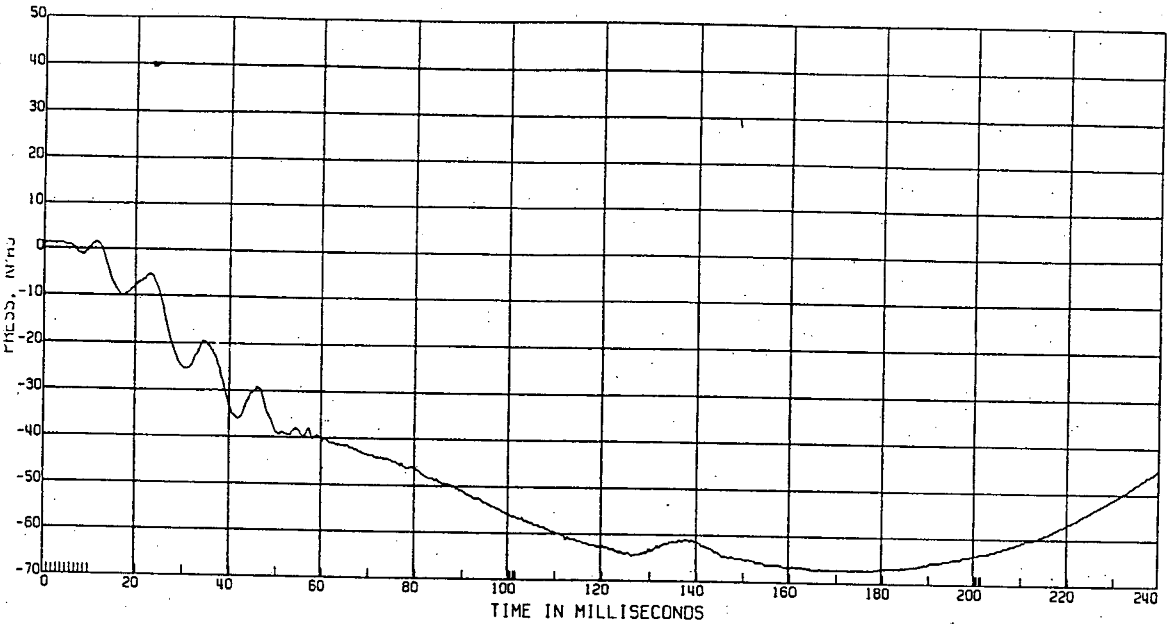
1990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H

& D CTR 8W9188 4 DOOR

EC DATA, SAE CLASS 1000

RETURN FUEL LINE PRESSURE

TEST DATE:05/13/1998



Appendix B, plot # 63

Appendix C: C11990 numeric film plots

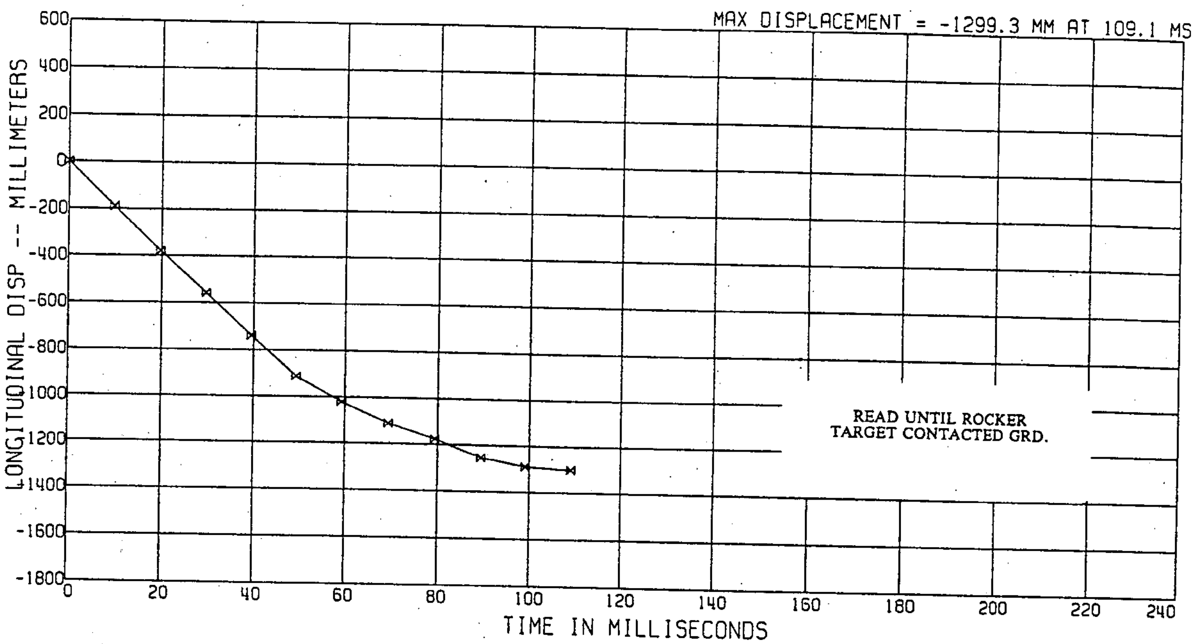
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H FIGURE

R & D CTR 8W9188 4 DOOR
FILM DATA

RIGHT SIDE

TEST DATE:05/13/98

STRUCK VEH DISPL RELATIVE TO MOVING BARRIER



Appendix C, Plot #1

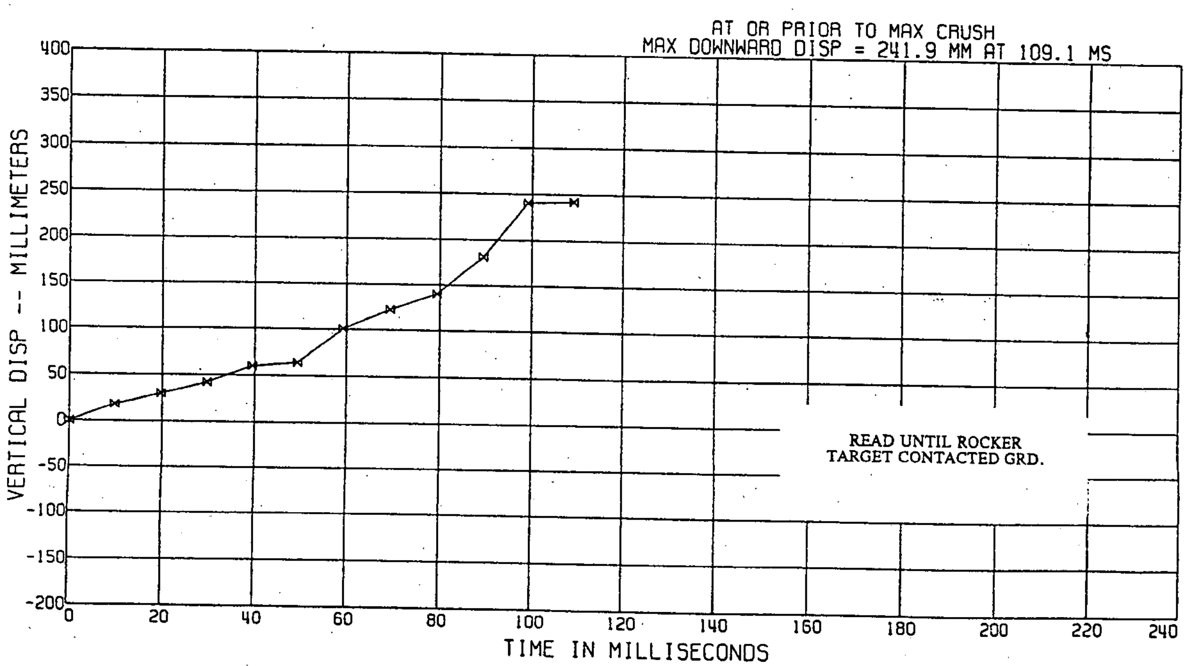
C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H FIGURE

R & D CTR 8W9188 4 DOOR
FILM DATA

RIGHT SIDE

TEST DATE:05/13/98

STRUCK VEH DISPL RELATIVE TO MOVING BARRIER



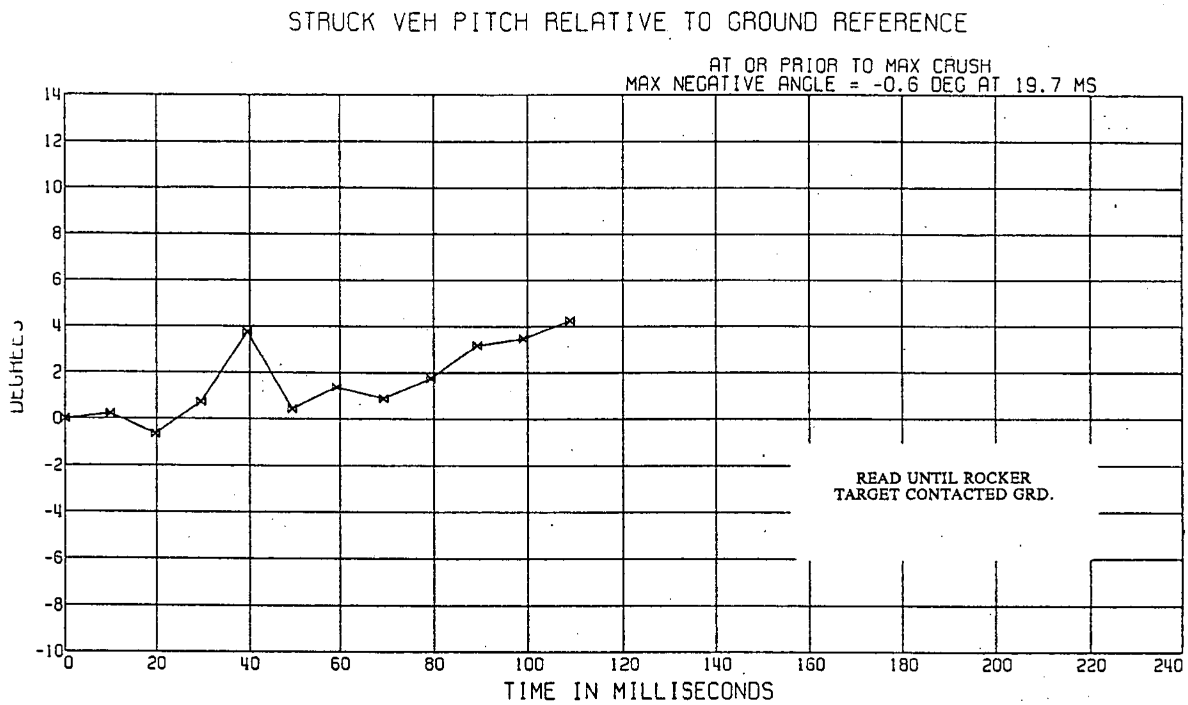
Appendix C, Plot #2

:11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H FIGURE

1 & D CTR 8W9188 4 DOOR
ILM DATA

RIGHT SIDE

TEST DATE:05/13/98



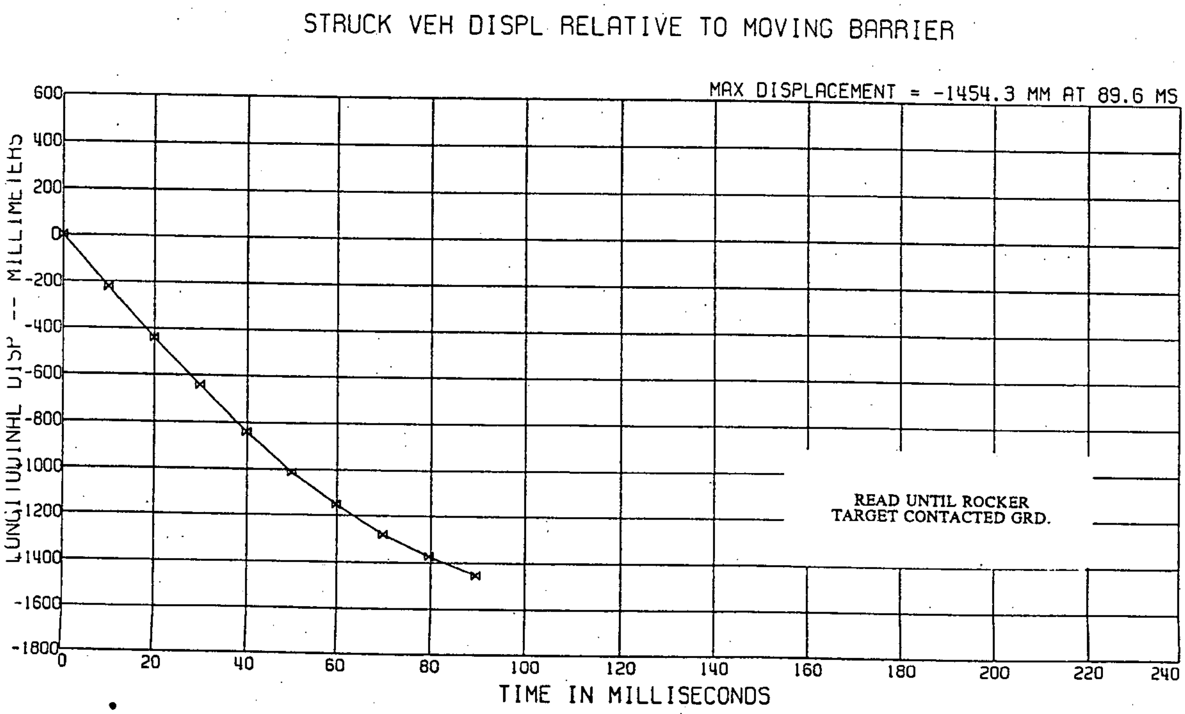
Appendix C, Plot #3

C11990 L.REAR IMP 70% OVERLAP LTV MDB TO STATIONARY VEHICLE 84.7KM/H FIGURE

R & D CTR 8W9188 4 DOOR
FILM DATA

LEFT SIDE

TEST DATE:05/13/98



Appendix C, Plot #4

C11990 L.REAR IMP 70% OVERLAP   LTV MDB TO STATIONARY VEHICLE 84.7KM/H   FIGURE

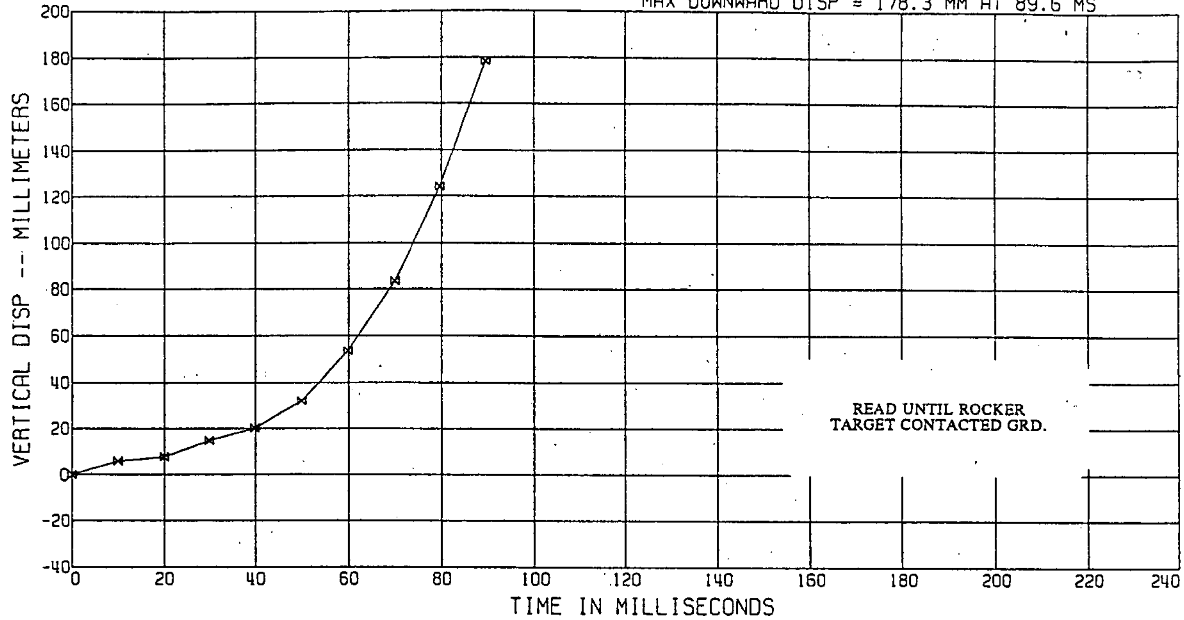
R & D CTR 8W9188 4 DOOR
FILM DATA

LEFT SIDE

TEST DATE:05/13/98

STRUCK VEH DISPL RELATIVE TO MOVING BARRIER

AT OR PRIOR TO MAX CRUSH
MAX DOWNWARD DISP = 178.3 MM AT 89.6 MS



Appendix C, Plot #5

C11990 L.REAR IMP 70% OVERLAP   LTV MDB TO STATIONARY VEHICLE 84.7KM/H   FIGURE

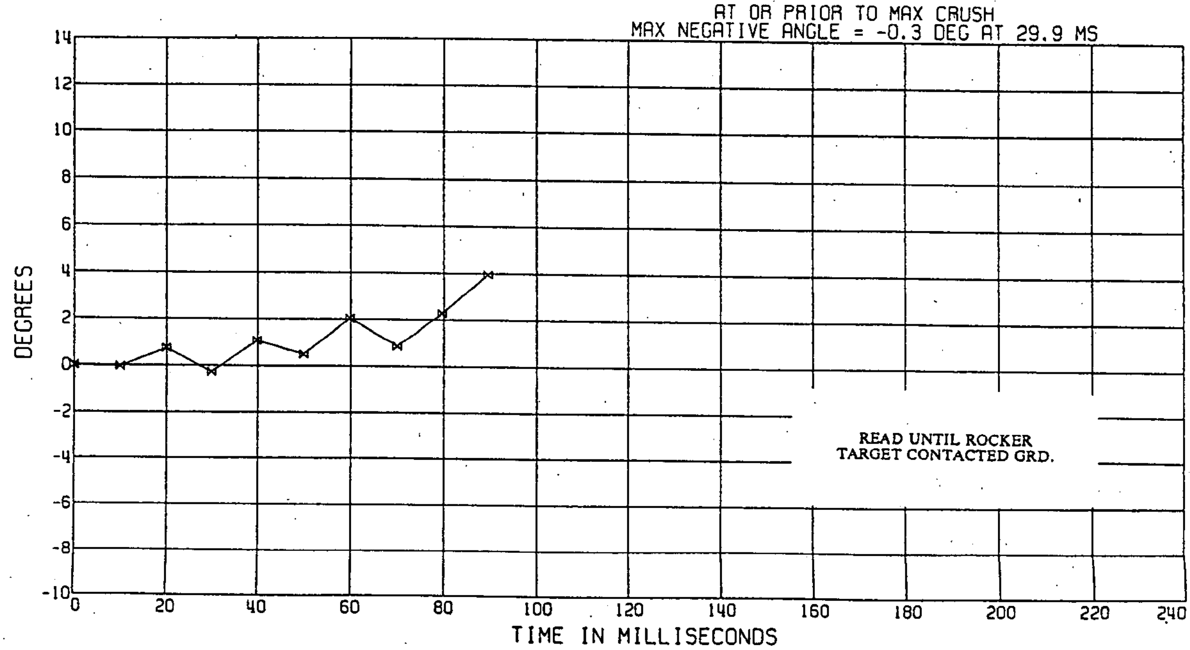
R & D CTR 8W9188 4 DOOR
FILM DATA

LEFT SIDE

TEST DATE:05/13/98

STRUCK VEH PITCH RELATIVE TO GROUND REFERENCE

AT OR PRIOR TO MAX CRUSH
MAX NEGATIVE ANGLE = -0.3 DEG AT 29.9 MS



Appendix C, Plot #6

Appendix D: C12127 data plots

LEFT FRONT
ANTHROPOMORPHIC TEST DEVICE SUMMARY DATA
LTV MDB TO STATIONARY VEHICLE 104.1KM/H

C12127 L. SIDE IMPACT-339 DEG
R & D CTR 8W9186D HONDA

ATD TYPE: GM50H
TEST DATE: 08/12/1998

MEASURED QUANTITY	100% OF IARV / 150% OF IARV	IAV VALUE	IARV
HIC, LIMITED TO 15 MS		250	1000
HIC, LIMITED TO 36 MS		300	1000
NECK FLEXION		82NM	190NM
NECK EXTENSION		44NM	57NM
NECK TENSION		2206N	3300N
NECK COMPRESSION		24N	4000N
NECK SHEAR FORWARD		114N	3100N
NECK SHEAR REARWARD		762N	3100N
NECK TENSION DUR ASSESS		0.67	1.00
NECK COMPRESSION DUR ASSESS		0.01	1.00
NECK SHEAR FWD DUR ASSESS		0.05	1.00
NECK SHEAR RWD DUR ASSESS		0.48	1.00
CHEST ACCEL		65G	60G
‡ CHEST COMPRESSION W/O SH BELT		42.8MM	65.0MM ‡
CHEST COMPRESSION W/ SH BELT		42.8MM	50.0MM ‡
CHEST VISCOUS CRITERIA		0.50M/SEC	1.00M/SEC
FEMUR COMP, LEFT		6061N	10000N
FEMUR COMP, RIGHT		4061N	10000N
FEMUR DURATION ASSESS, LEFT		0.67	1.00
FEMUR DURATION ASSESS, RIGHT		0.45	1.00
TIBIA/FEMUR DISP, LEFT		6.9MM	15.0MM
TIBIA/FEMUR DISP, RIGHT		0.3MM	15.0MM
KNEE CLEVIS, LEFT INSIDE		2485N	4000N
KNEE CLEVIS, LEFT OUTSIDE		1261N	4000N
KNEE CLEVIS, RIGHT INSIDE		1698N	4000N
KNEE CLEVIS, RIGHT OUTSIDE		3077N	4000N
TIBIA COMP, LEFT		1336N	8000N
TIBIA COMP, RIGHT		3753N	8000N
TIBIA MOM, UPPER, LEFT		222NM	225NM
TIBIA MOM, UPPER, RIGHT		254NM	225NM
TIBIA MOM, LOWER, LEFT		147NM	225NM
TIBIA MOM, LOWER, RIGHT		165NM	225NM
LEG INDEX, UPPER LEFT		1.02	1.00
LEG INDEX, UPPER RIGHT		1.21	1.00
LEG INDEX, LOWER LEFT		0.67	1.00
LEG INDEX, LOWER RIGHT		0.83	1.00

IAV - INJURY ASSESSMENT VALUE
IARV - INJURY ASSESSMENT REFERENCE VALUE

‡ RESTRAINT SYSTEM DEPENDENT. CHOOSE VALUE THAT APPLIES TO THIS TEST.

RIGHT FRONT

ANTHROPOMORPHIC TEST DEVICE SUMMARY DATA

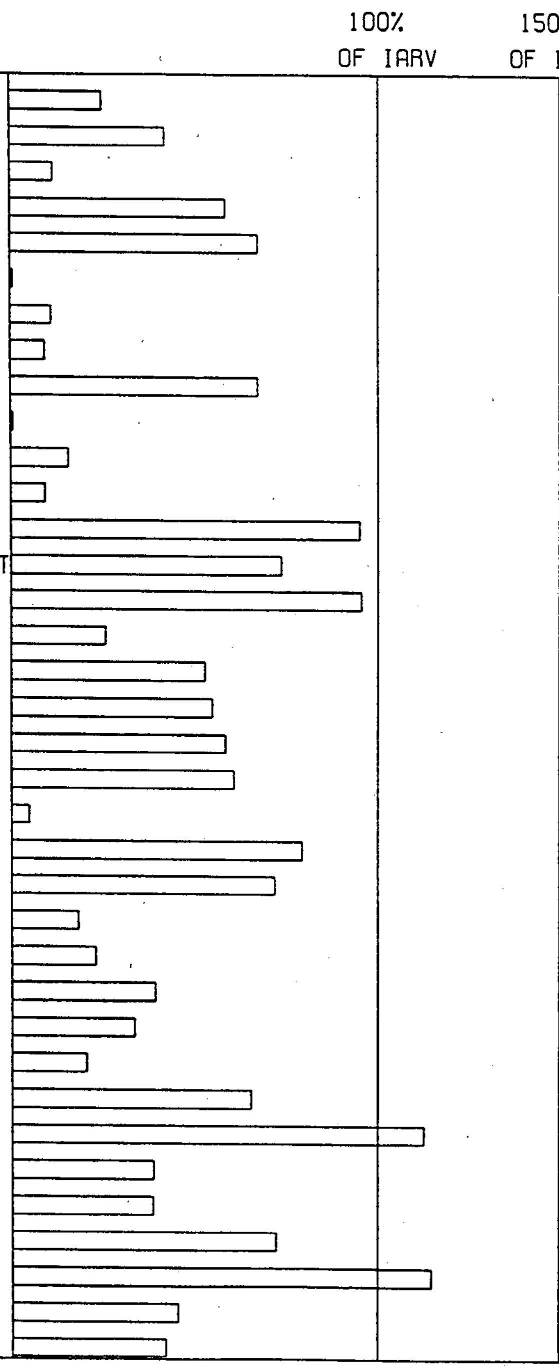
LTV MDB TO STATIONARY VEHICLE 104.1KM/H

C12127 L. SIDE IMPACT-339 DEG

R & D CTR 8W9186D HONDA

ATD TYPE: GM50H

TEST DATE: 08/12/1998



MEASURED QUANTITY	IAV VALUE	IARV
HIC, LIMITED TO 15 MS	250	1000
HIC, LIMITED TO 36 MS	420	1000
NECK FLEXION	22NM	190NM
NECK EXTENSION	33NM	57NM
NECK TENSION	2213N	3300N
NECK COMPRESSION	27N	4000N
NECK SHEAR FORWARD	351N	3100N
NECK SHEAR REARWARD	294N	3100N
NECK TENSION DUR ASSESS	0.67	1.00
NECK COMPRESSION DUR ASSESS	0.01	1.00
NECK SHEAR FWD DUR ASSESS	0.16	1.00
NECK SHEAR RWD DUR ASSESS	0.10	1.00
CHEST ACCEL	57G	60G
‡ CHEST COMPRESSION W/O SH BELT	47.8MM	65.0MM ‡
CHEST COMPRESSION W/ SH BELT	47.8MM	50.0MM ‡
CHEST VISCOUS CRITERIA	0.26M/SEC	1.00M/SEC
FEMUR COMP, LEFT	5282N	10000N
FEMUR COMP, RIGHT	5480N	10000N
FEMUR DURATION ASSESS, LEFT	0.58	1.00
FEMUR DURATION ASSESS, RIGHT	0.60	1.00
TIBIA/FEMUR DISP, LEFT	0.7MM	15.0MM
TIBIA/FEMUR DISP, RIGHT	11.9MM	15.0MM
KNEE CLEVIS, LEFT INSIDE	2867N	4000N
KNEE CLEVIS, LEFT OUTSIDE	729N	4000N
KNEE CLEVIS, RIGHT INSIDE	917N	4000N
KNEE CLEVIS, RIGHT OUTSIDE	1567N	4000N
TIBIA COMP, LEFT	2672N	8000N
TIBIA COMP, RIGHT	1634N	8000N
TIBIA MOM, UPPER, LEFT	147NM	225NM
TIBIA MOM, UPPER, RIGHT	253NM	225NM
TIBIA MOM, LOWER, LEFT	87NM	225NM
TIBIA MOM, LOWER, RIGHT	87NM	225NM
LEG INDEX, UPPER LEFT	0.72	1.00
LEG INDEX, UPPER RIGHT	1.15	1.00
LEG INDEX, LOWER LEFT	0.45	1.00
LEG INDEX, LOWER RIGHT	0.42	1.00

IAV - INJURY ASSESSMENT VALUE

IARV - INJURY ASSESSMENT REFERENCE VALUE

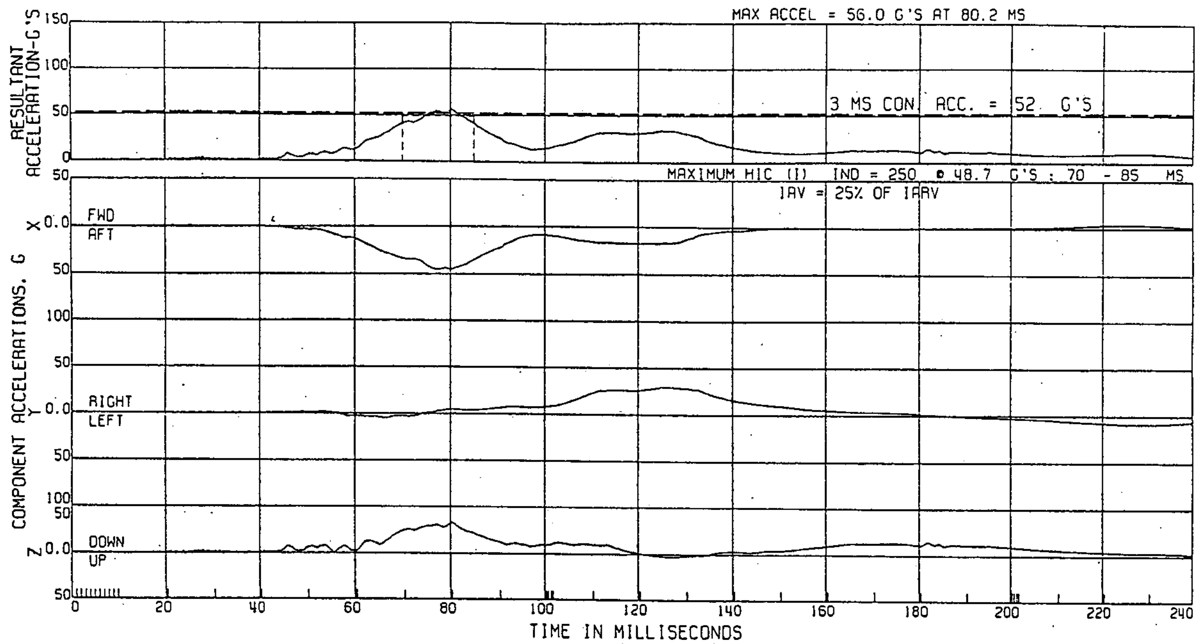
‡ RESTRAINT SYSTEM DEPENDENT. CHOOSE VALUE THAT APPLIES TO THIS TEST.

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

L. FRT HEAD ACCEL.
(HIC I LIMITED TO 15MS)

ATD TYPE: GM50H
TEST DATE:08/12/1998



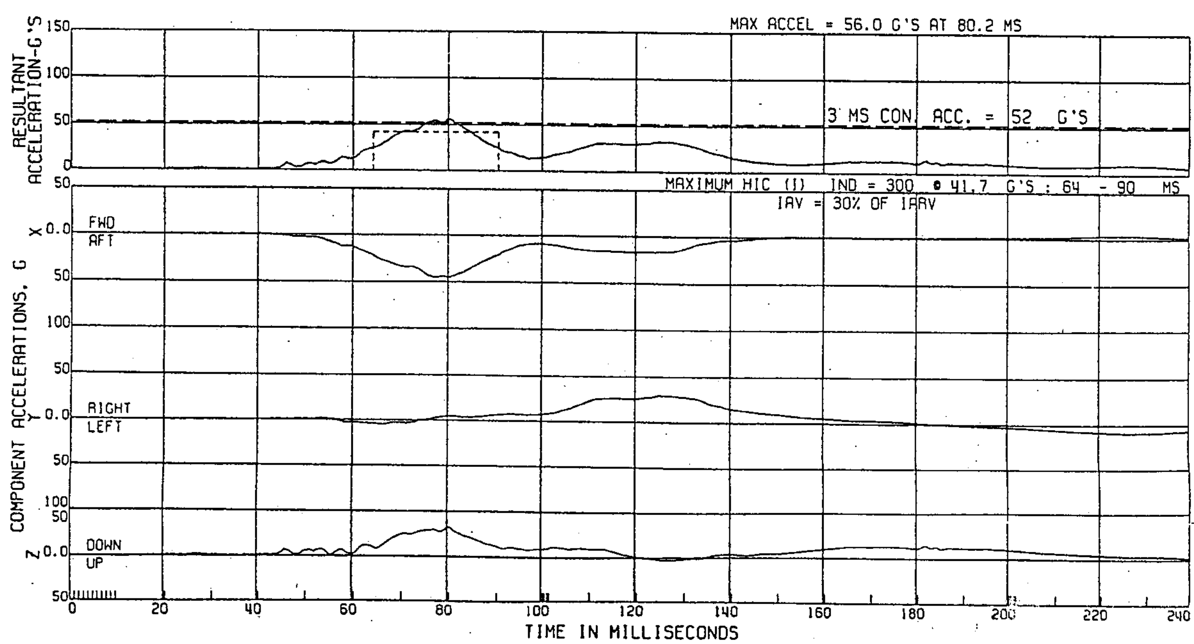
Appendix D, plot # 1

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

L. FRT HEAD ACCEL.
(HIC I LIMITED TO 36MS)

ATD TYPE: GM50H
TEST DATE:08/12/1998



Appendix D, plot # 2

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

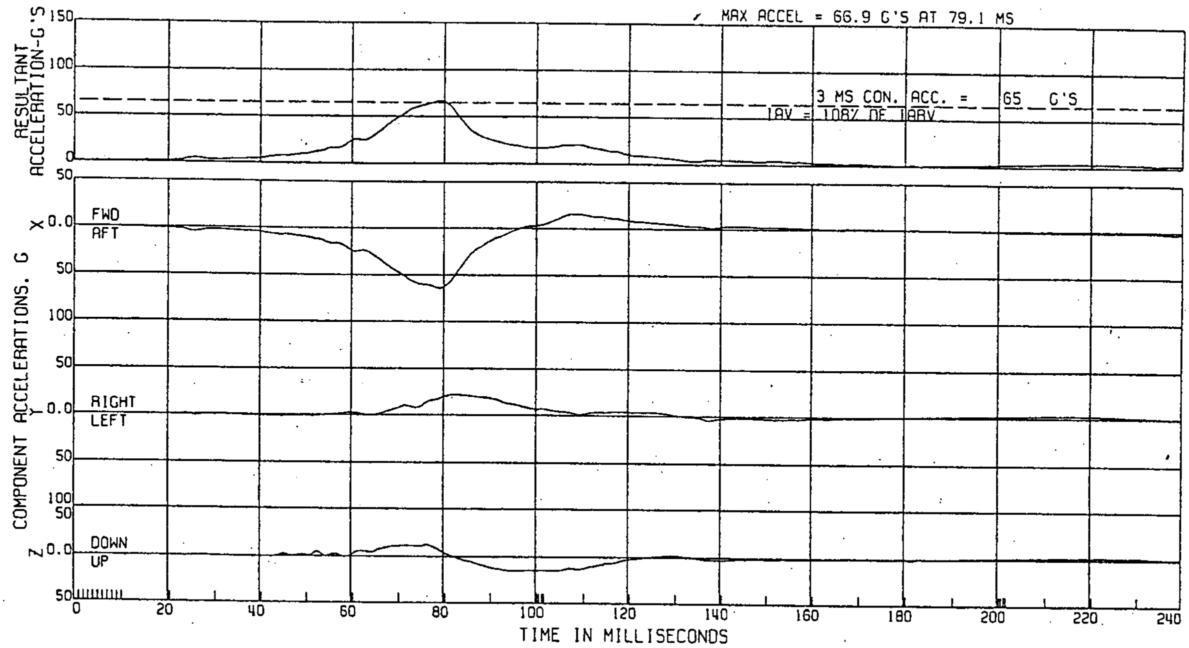
R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 180

L. FRT CHEST ACCEL.

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **3**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

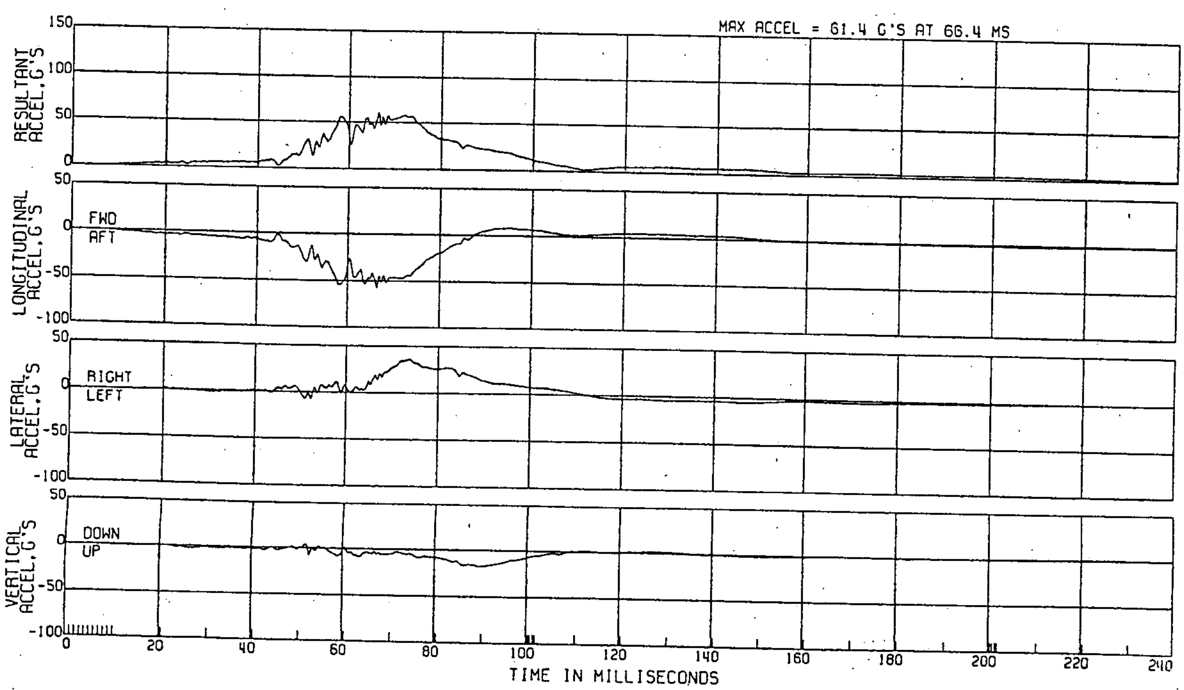
R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

L. FRT PELVIC ACCEL.

ATD TYPE: GM50H

TEST DATE:08/12/1998



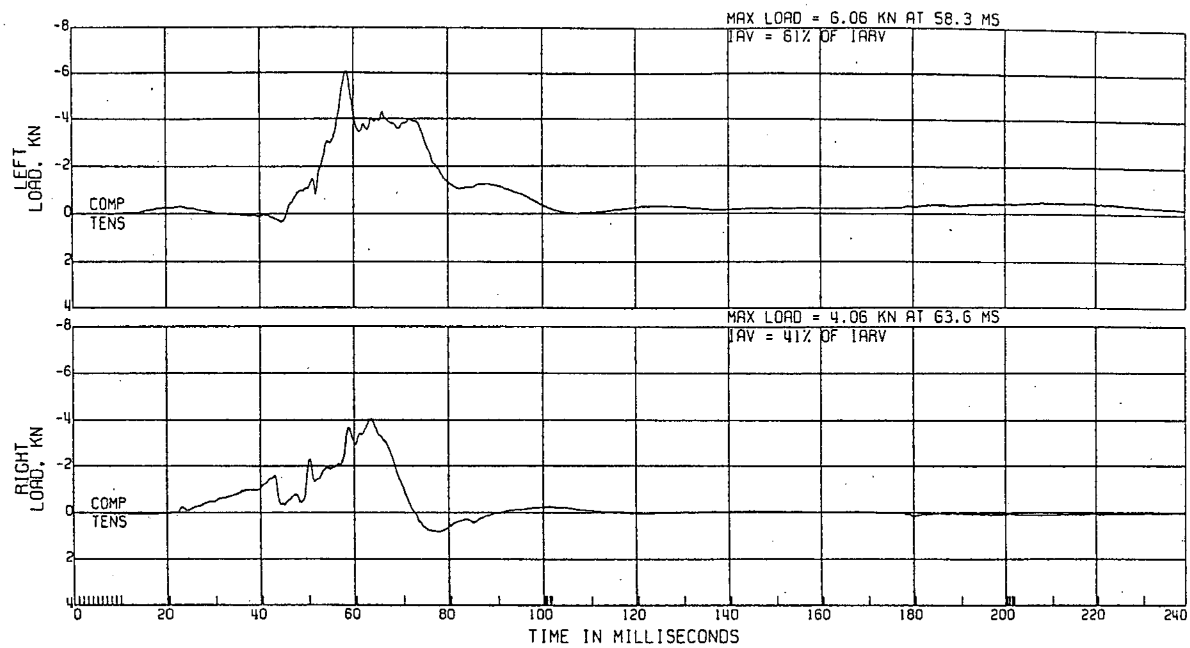
Appendix D, plot # **4**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 600

L. FRT FEMUR LOAD

ATD TYPE: GM50H
TEST DATE:08/12/1998



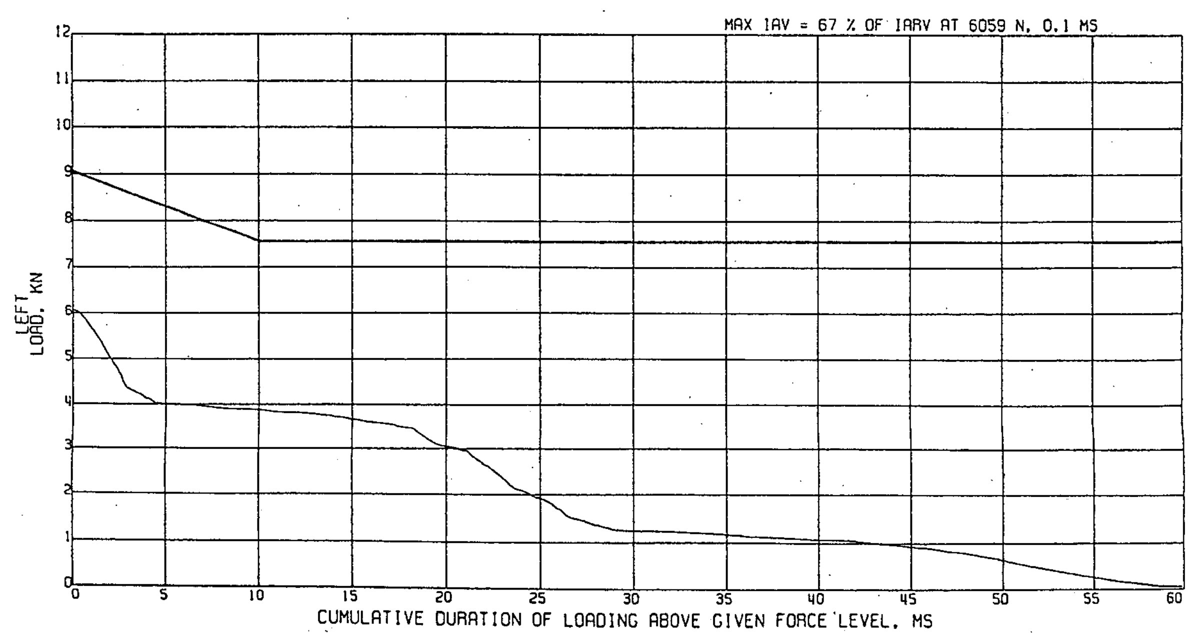
Appendix D, plot # 5

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 600

L. FRT FEMUR LOAD
DURATION ASSESSMENT

ATD TYPE: GM50H
TEST DATE:08/12/1998



6 Appendix D, plot # 6

:127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

ATD TYPE: GM50H

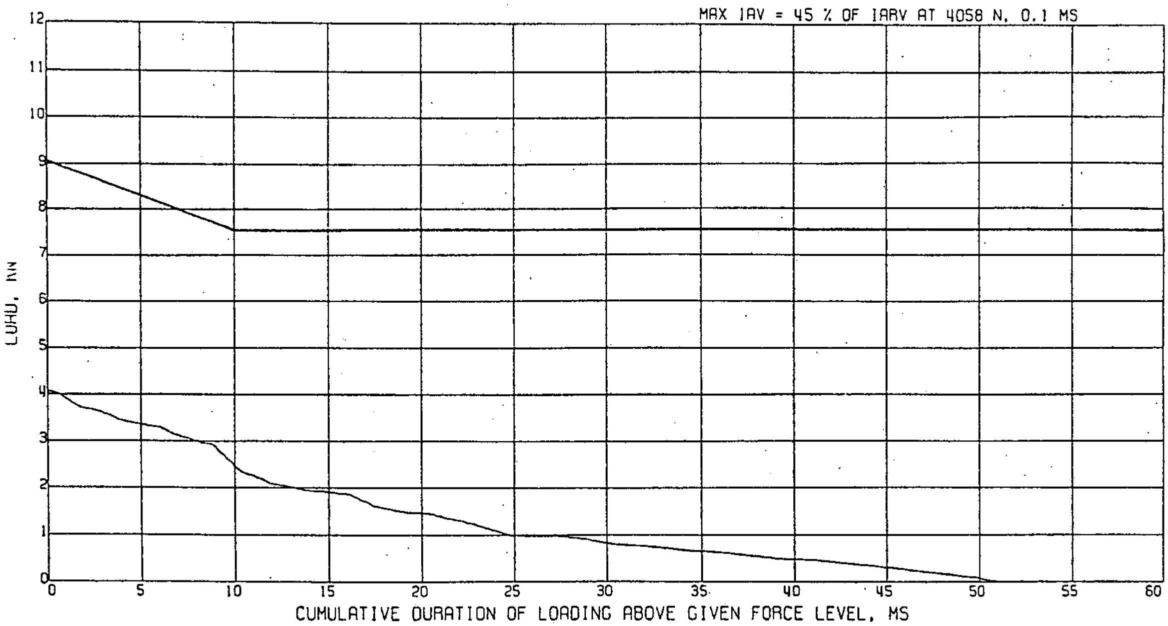
: D CTR 8W91860 HONDA

L. FRT FEMUR LOAD

TEST DATE:08/12/1998

:C DATA, SAE CLASS 600

DURATION ASSESSMENT



Appendix D, plot # **7**

:127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

ATD TYPE: GM50H

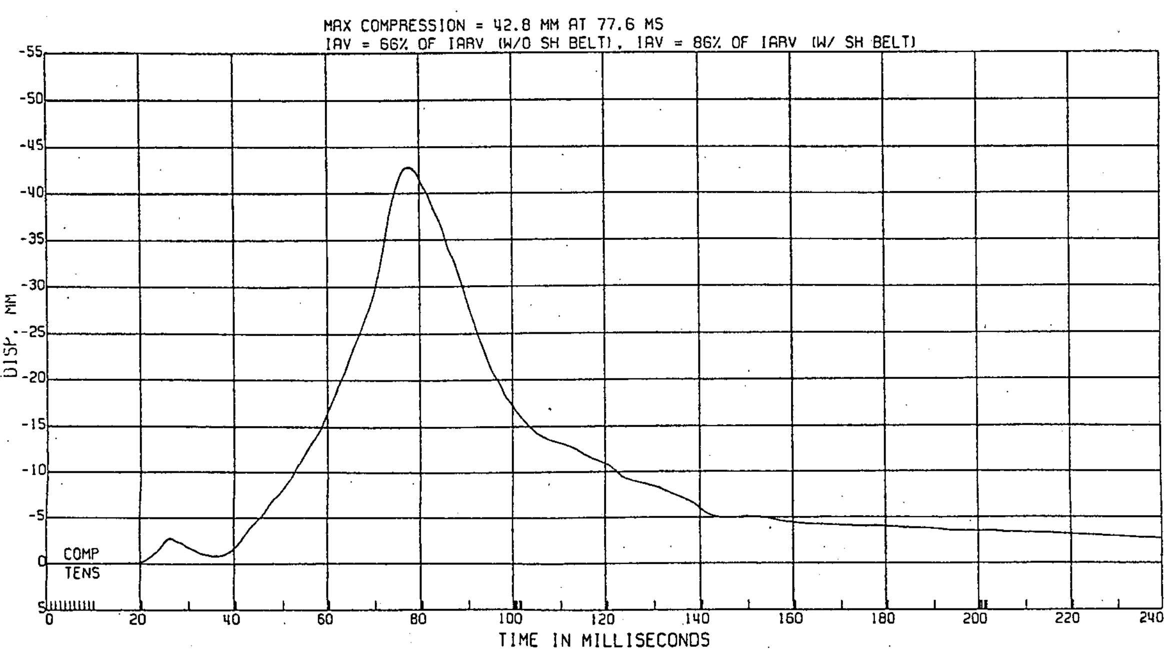
: D CTR 8W91860 HONDA

L. FRT CHEST DISP, TEMP AT 76.8'F

TEST DATE:08/12/1998

:C DATA, SAE CLASS 180

NORMALIZED TO 70.7'F & PART 572 CORRIDOR



Appendix D, plot # **8**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

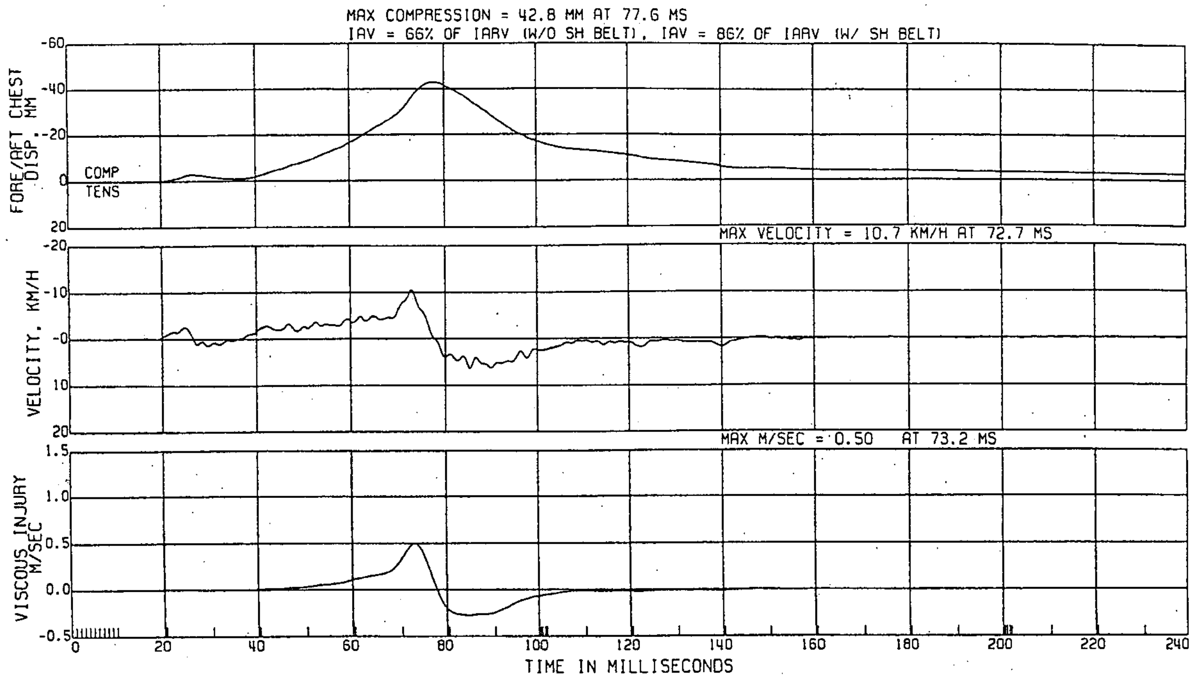
ELEC DATA, SAE CLASS 180

ATD TYPE: GM50H

TEST DATE:08/12/1998

L. FRT CHEST COMPRESSIVE DISP.

NORMALIZED, W/CALC VEL & VISCOUS INJURY



Appendix D, plot # 9

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

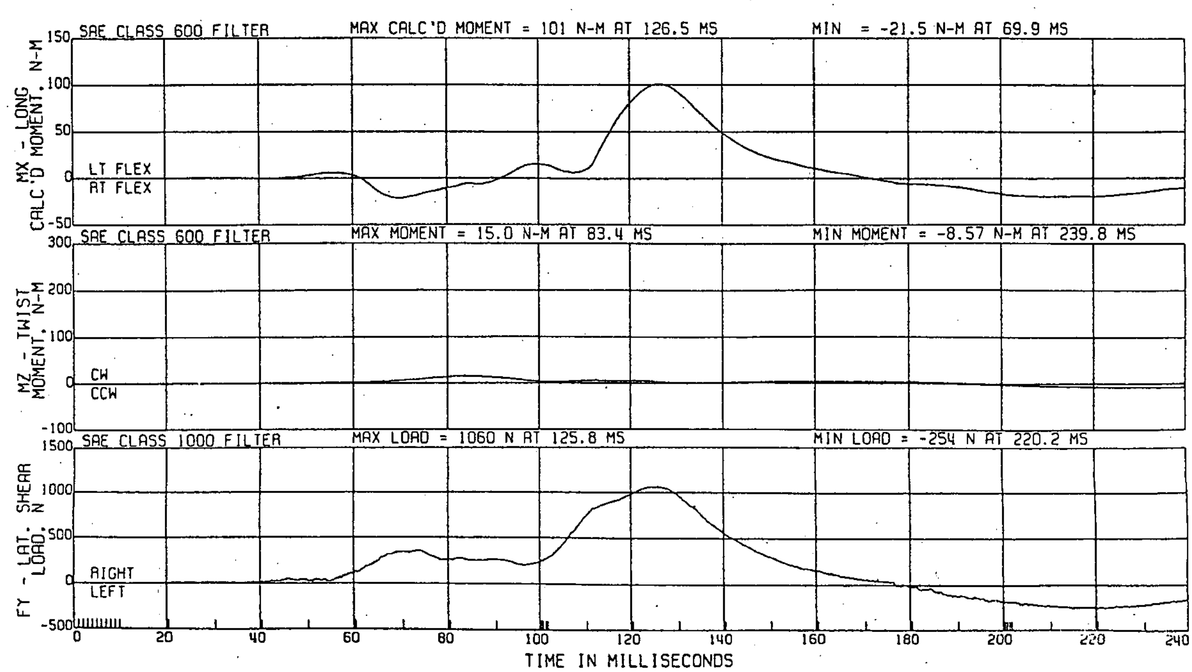
ELEC DATA

ATD TYPE: GM50H

TEST DATE:08/12/1998

L. FRT NECK LOADING ON HEAD, UPPER LOAD

L. FRT NECK LOADING ON HEAD

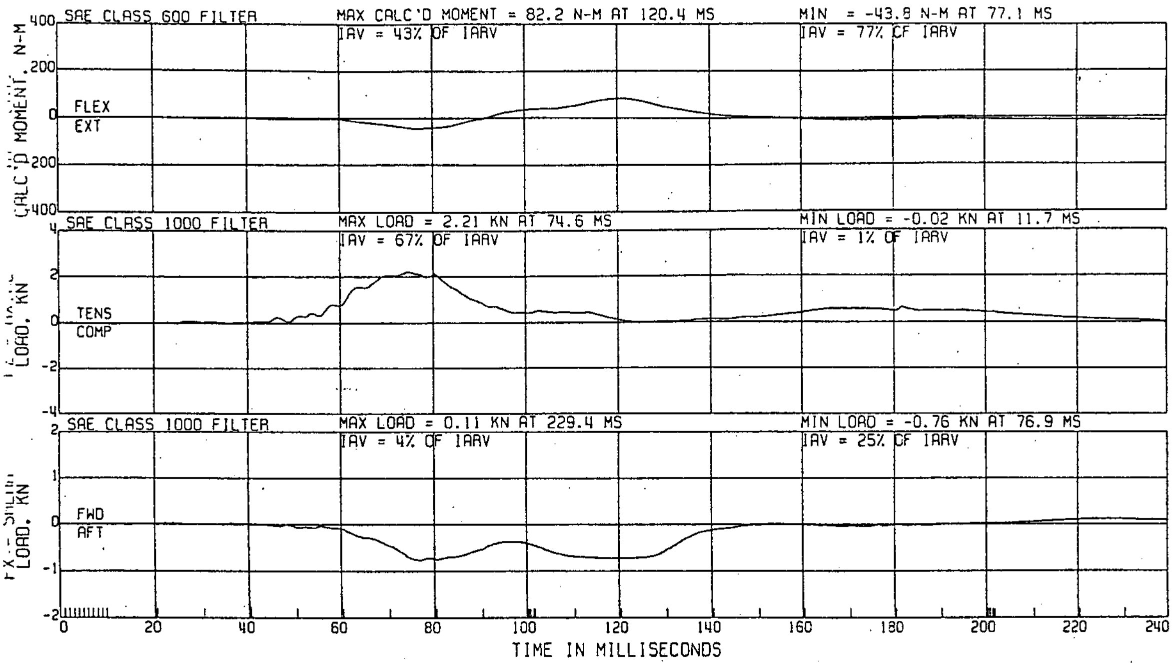


Appendix D, plot # 10

2127 L. SIDE IMPACT-339 DEG LTV MOB TO STATIONARY VEHICLE 104.1KM/H
ATD TYPE: GM50H
& D CTR 8W9186D HONDA
TEST DATE:08/12/1998
.EC DATA

NECK LOADING ON HEAD

L. FRT NECK LOADING ON HEAD

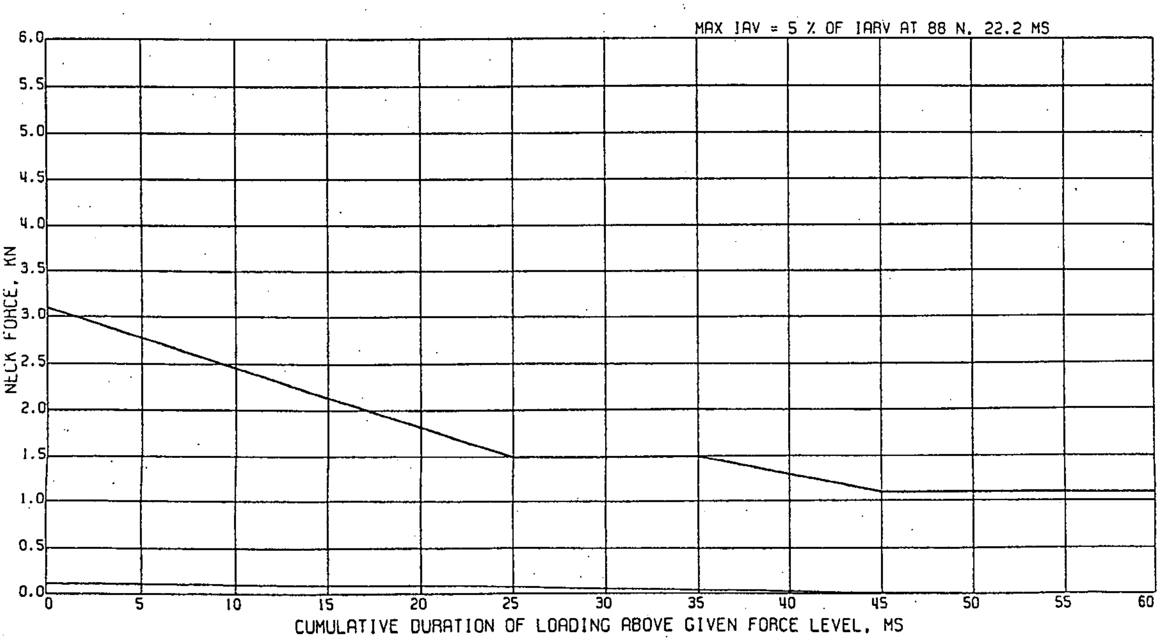


Appendix D, plot # **11**

2127 L. SIDE IMPACT-339 DEG LTV MOB TO STATIONARY VEHICLE 104.1KM/H
ATD TYPE: GM50H
& D CTR 8W9186D HONDA
TEST DATE:08/12/1998
EC DATA, SAE CLASS 1000

FORWARD NECK SHEAR ON HEAD,

L. FRT INJURY REFERENCE



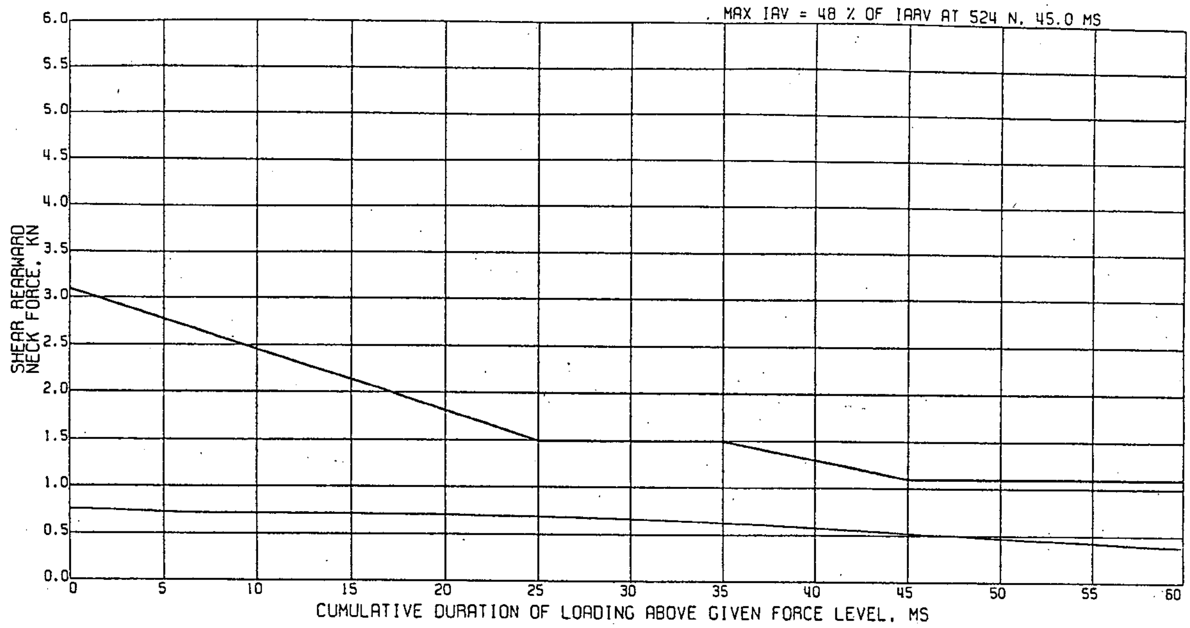
Appendix D, plot # **12**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

REARWARD NECK SHEAR ON HEAD,
L. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:08/12/1998



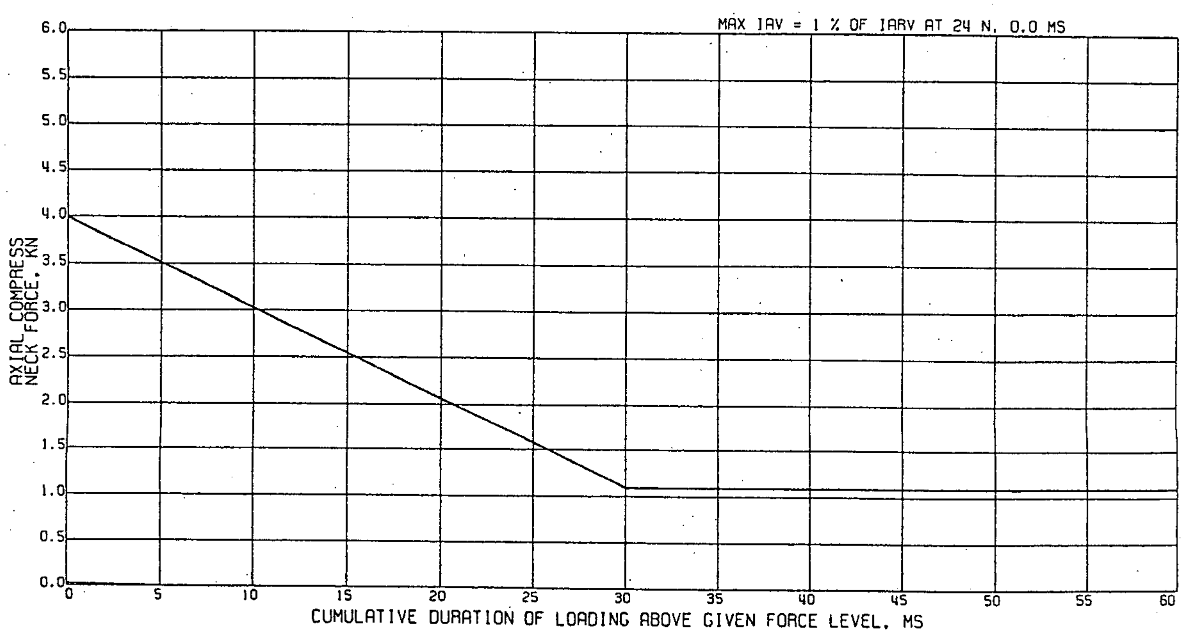
Appendix D, plot # **13**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

AXIAL COMPRESSION ON HEAD,
L. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:08/12/1998



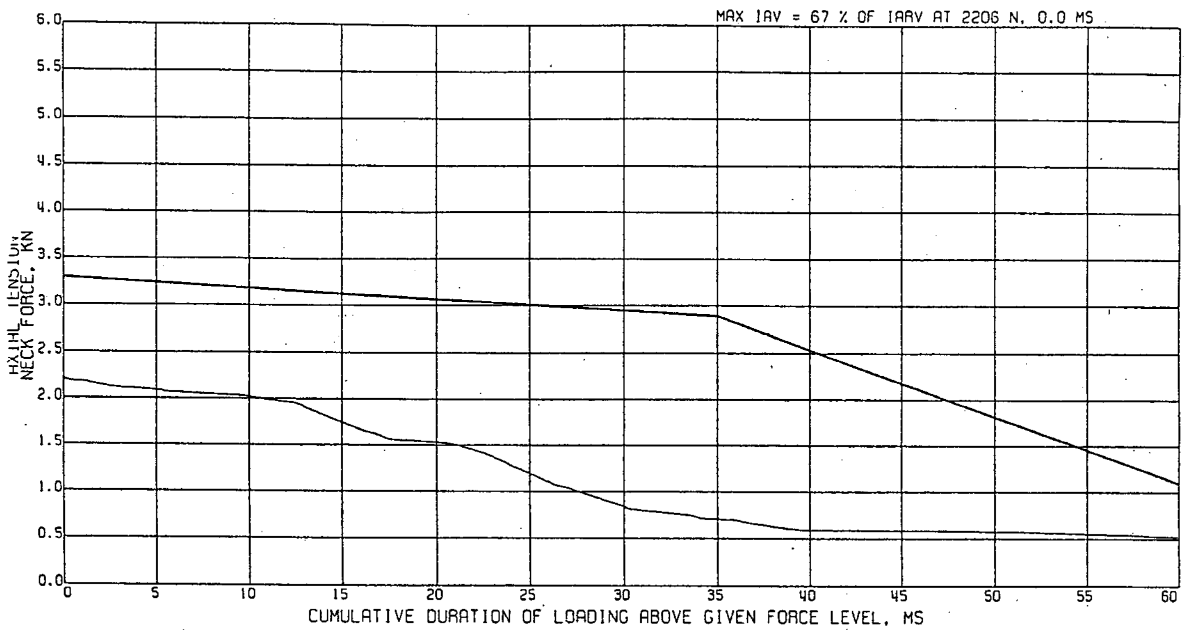
Appendix D, plot # **14**

:2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA
.EC DATA, SAE CLASS 1000

AXIAL TENSION ON HEAD,
L. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:08/12/1998



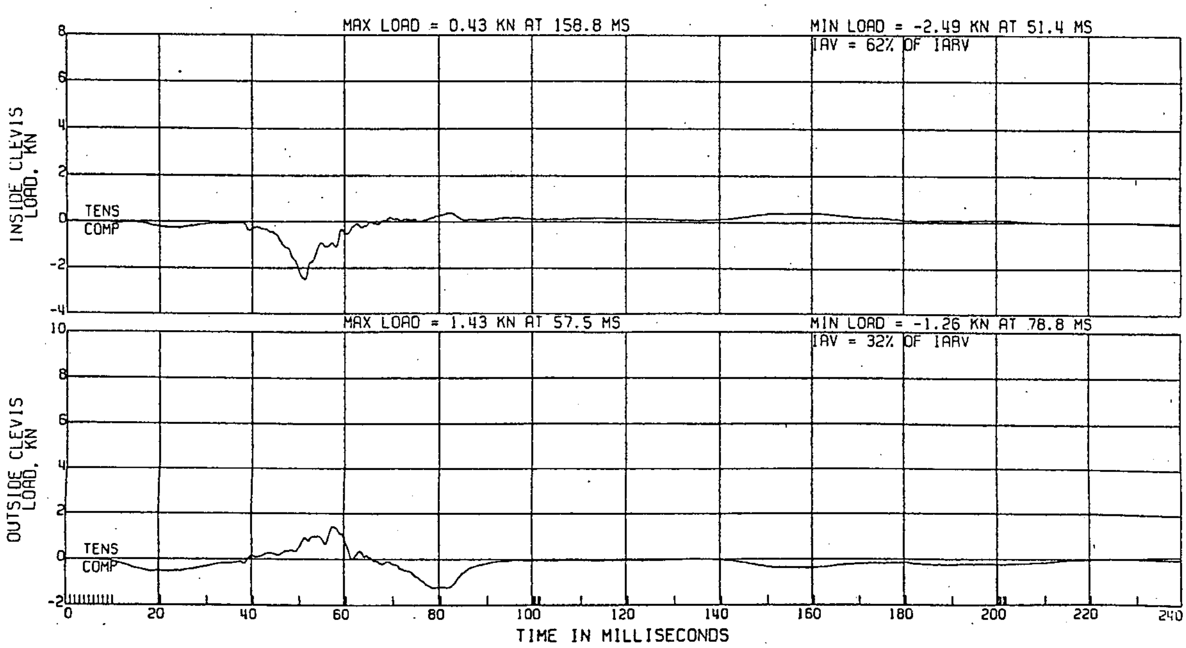
Appendix D, plot # **15**

:12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

: & D CTR 8W9186D HONDA
'LEC DATA, SAE CLASS 600

L. FRT LEFT KNEE CLEVIS LOAD

ATD TYPE: GM50H
TEST DATE:08/12/1998



Appendix D, plot # **16**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

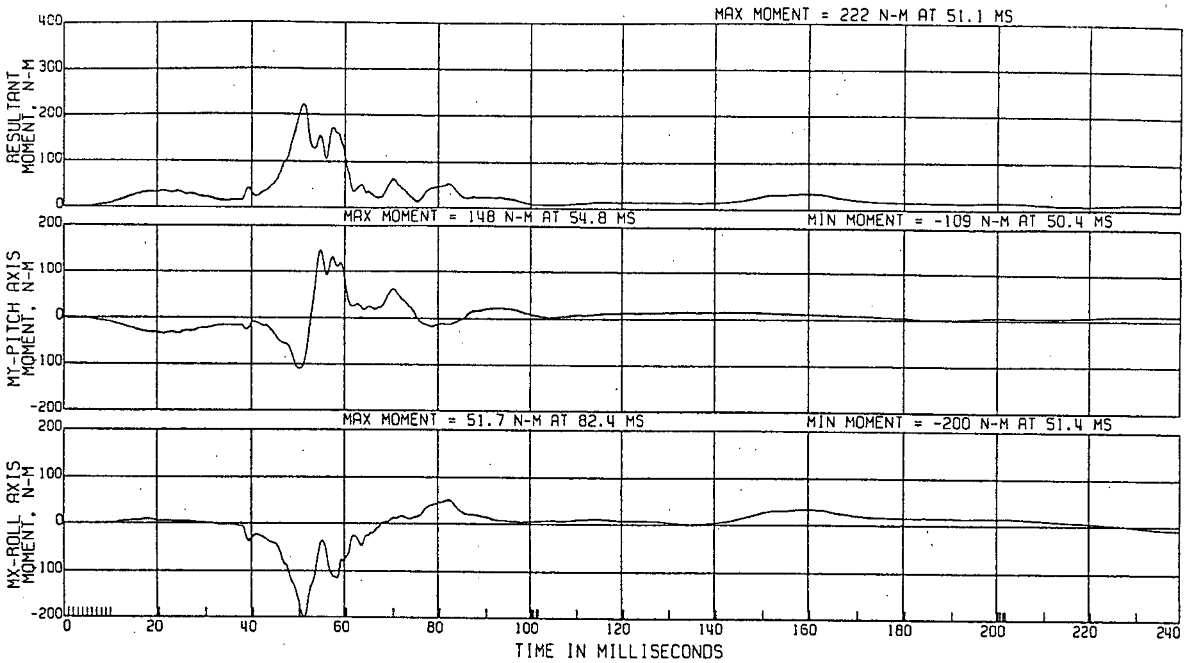
R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 600

L. FRT LEFT TIBIA UPPER MOMENT

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # 17

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

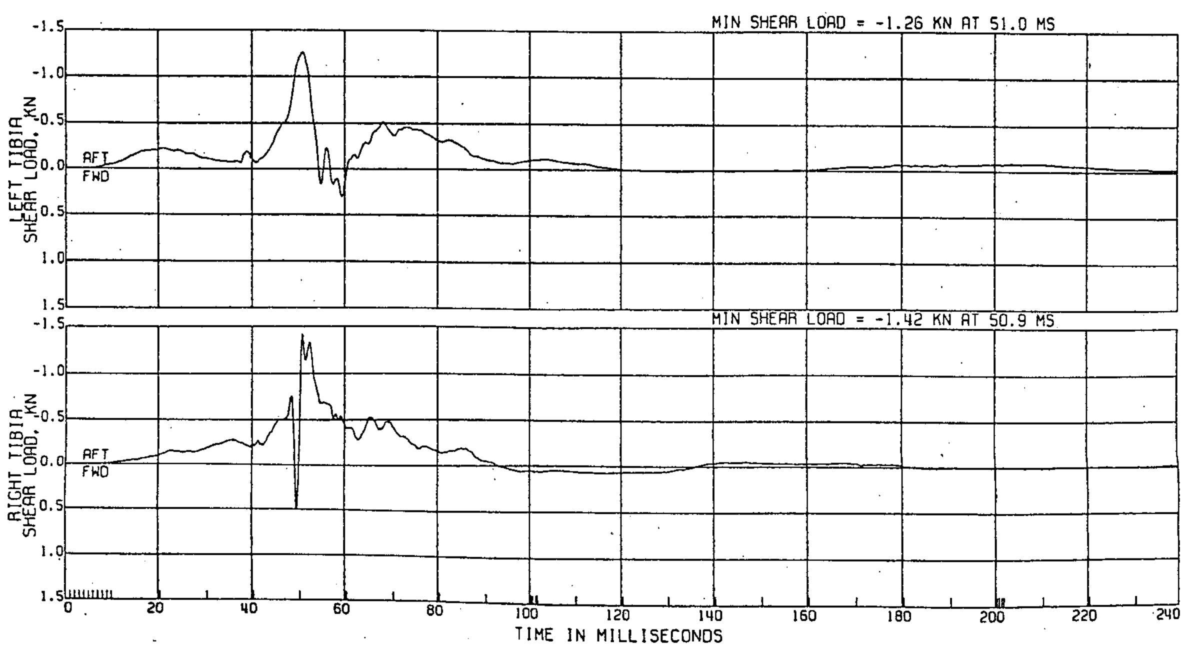
ATD TYPE: GM50H

R & D CTR 8W9186D HONDA

TEST DATE:08/12/1998

ELEC DATA, SAE CLASS 600

L. FRT TIBIA LOWER SHEAR LOAD



Appendix D, plot # 18

.127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

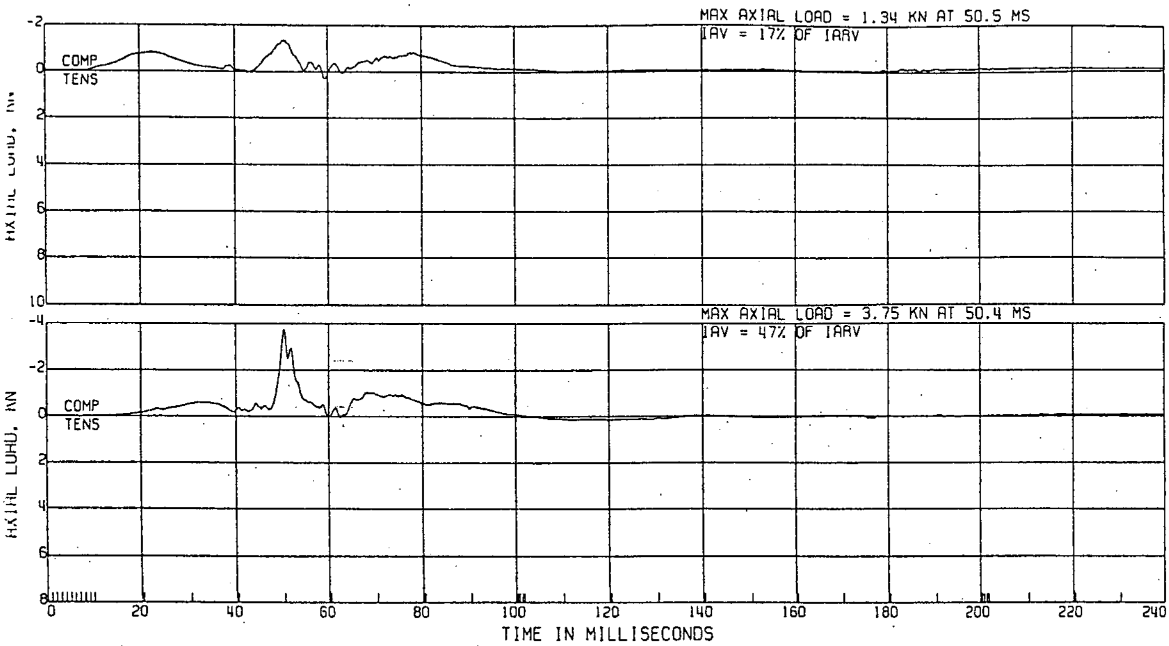
ATD TYPE: GM50H

. D CTR 8W9186D HONDA

TEST DATE:08/12/1998

:C DATA, SAE CLASS 600

L. FRT TIBIA LOWER AXIAL LOAD



Appendix D, plot # **19**

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

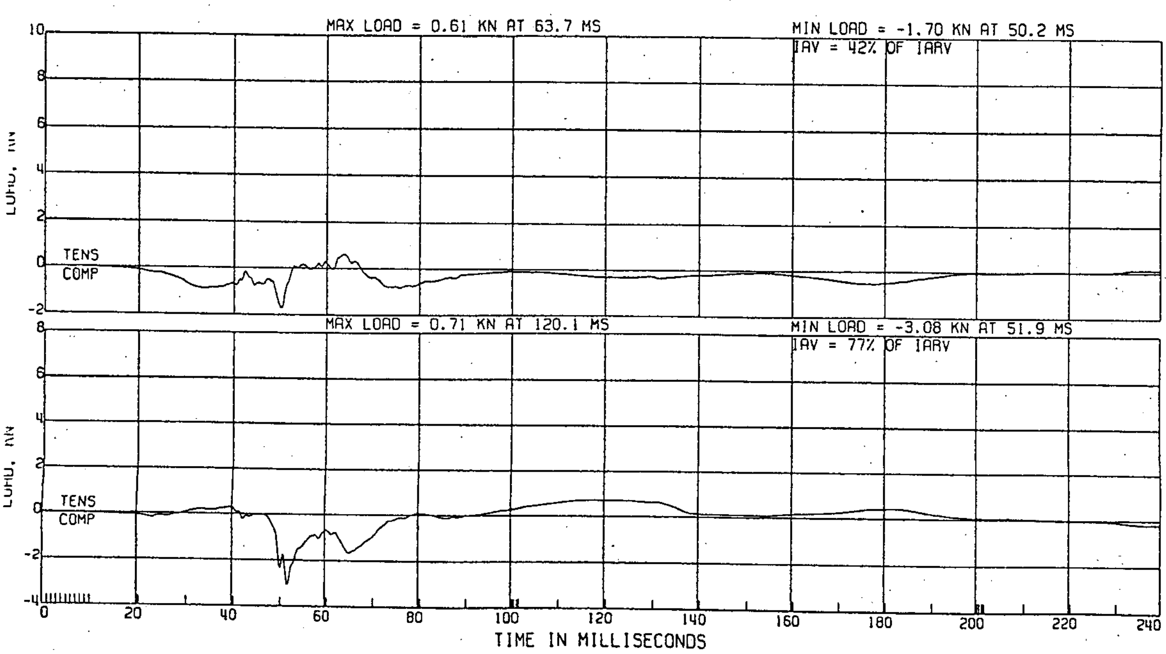
ATD TYPE: GM50H

: D CTR 8W9186D HONDA

L. FRT RIGHT KNEE CLEVIS LOAD

TEST DATE:08/12/1998

:C DATA, SAE CLASS 600



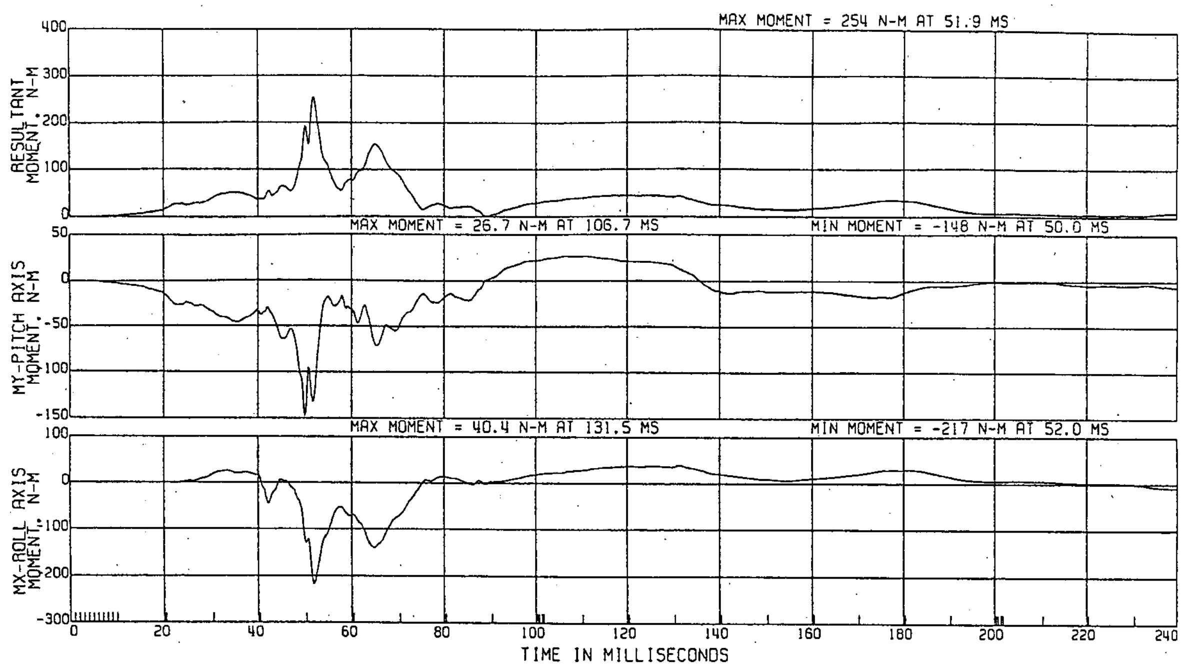
Appendix D, plot # **20**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 600

L. FRT RIGHT TIBIA UPPER MOMENT

ATD TYPE: GM50H
TEST DATE:08/12/1998



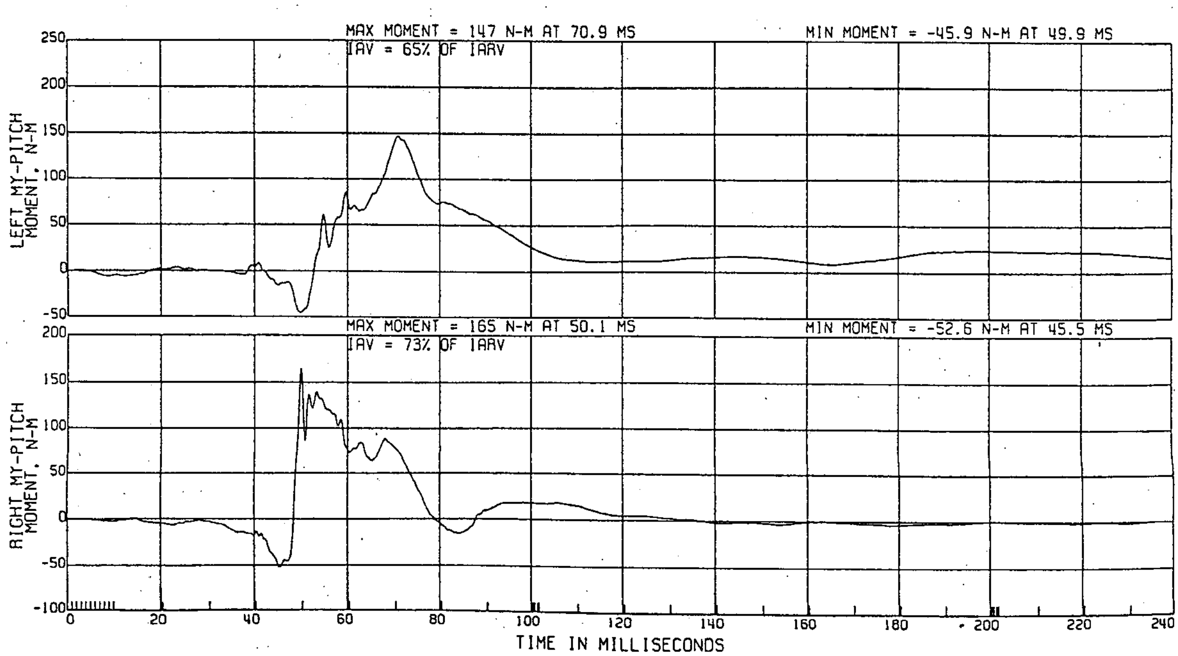
Appendix D, plot # **21**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

ATD TYPE: GM50H
TEST DATE:08/12/1998

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 600

L. FRT TIBIA LOWER BENDING MOMENTS



Appendix D, plot # **22**

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

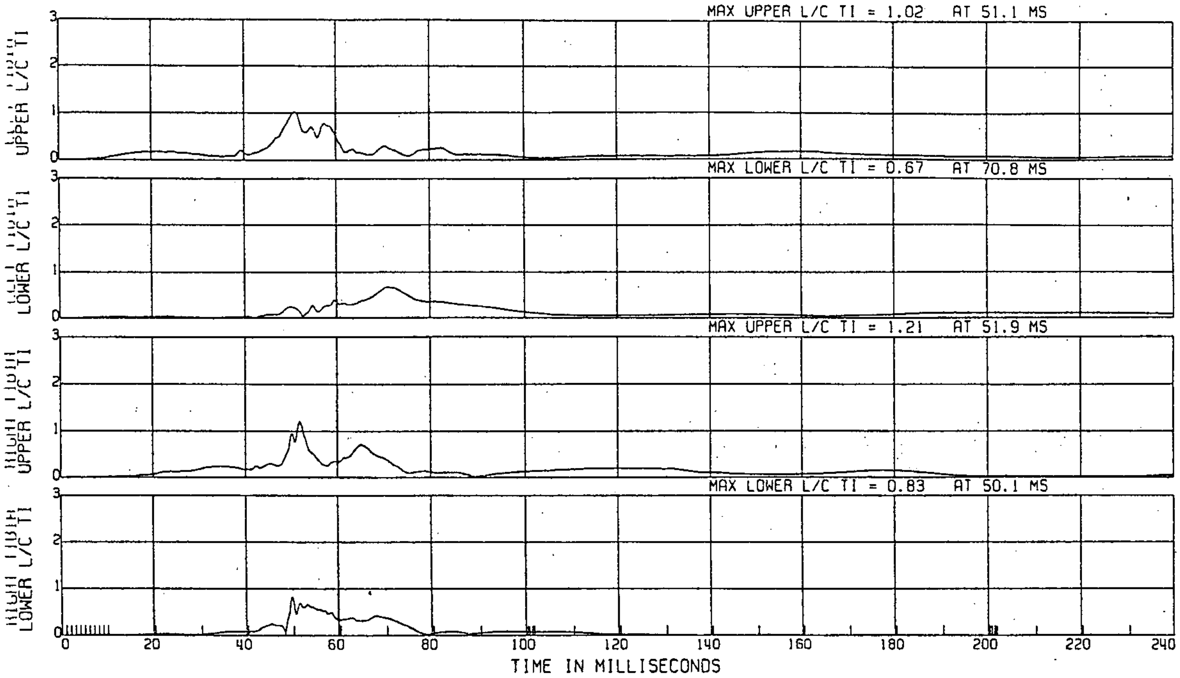
EC DATA, SAE CLASS 600

L. FRT TIBIA INDICES

TI = (RES MOM/225 NM) + (AXIAL/35900 N)

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **23**

12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

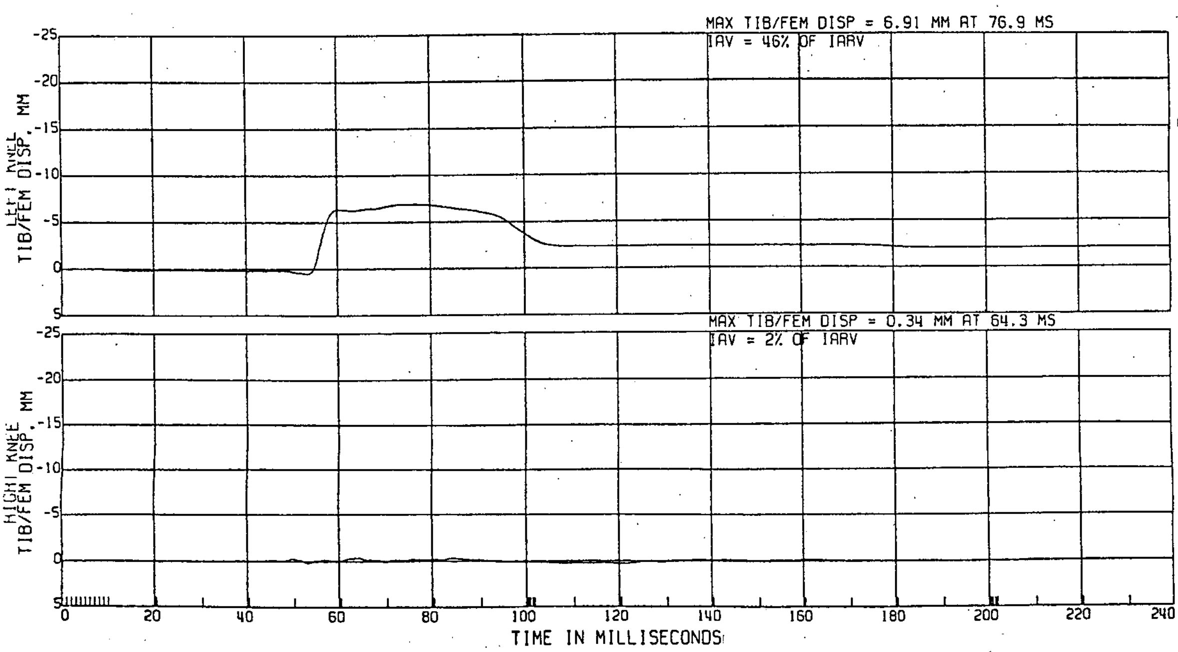
& D CTR 8W9186D HONDA

EC DATA, SAE CLASS 180

L. FRT TIBIA/FEMUR DISPLACEMENT

ATD TYPE: GM50H

TEST DATE:08/12/1998



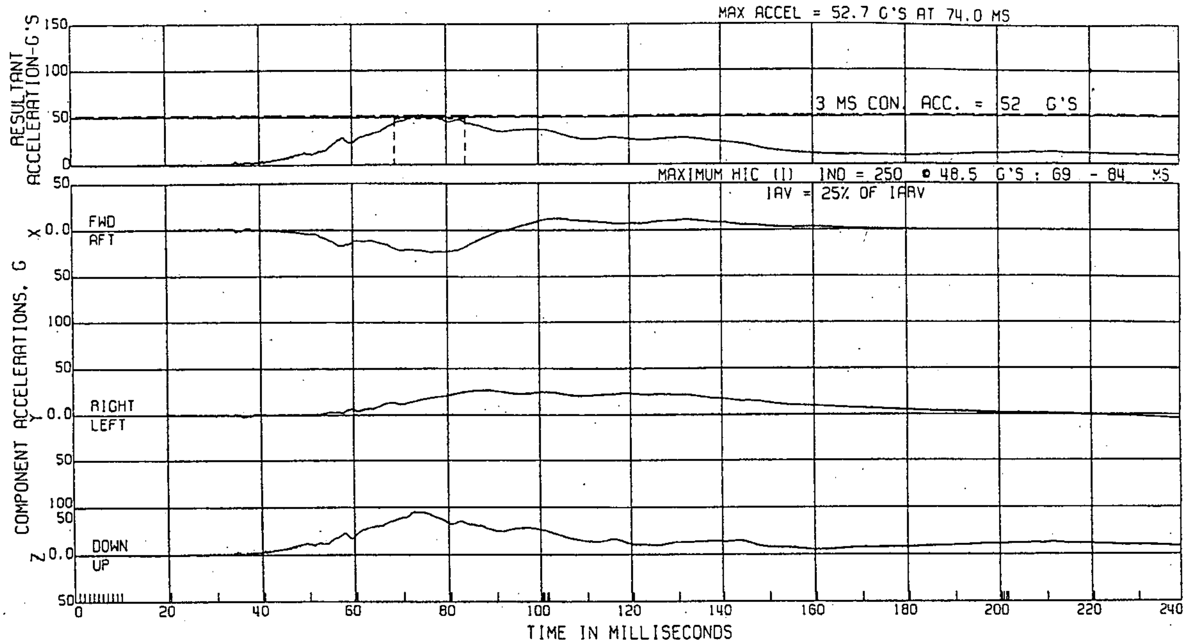
Appendix D, plot # **24**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

R. FRT HEAD ACCEL.
(HIC I LIMITED TO 15MS)

ATD TYPE: GM50H
TEST DATE:08/12/1998



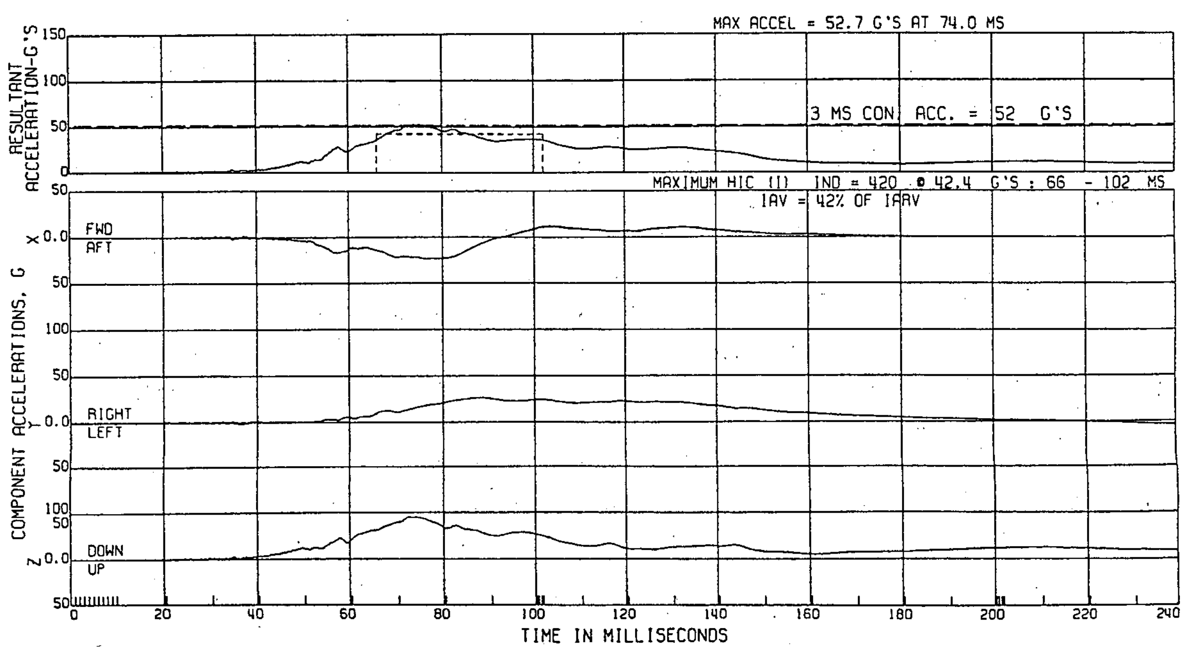
Appendix D, plot # 25

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

R. FRT HEAD ACCEL.
(HIC I LIMITED TO 36MS)

ATD TYPE: GM50H
TEST DATE:08/12/1998



Appendix D, plot # 26

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

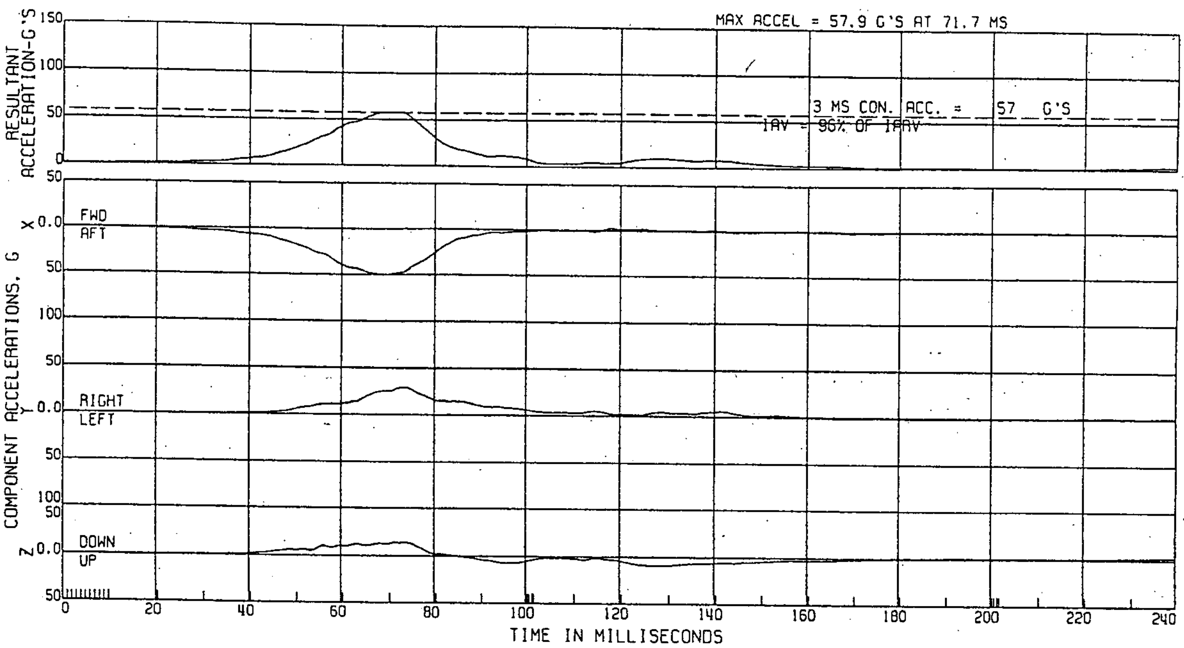
R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 180

R. FRT CHEST ACCEL.

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **27**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

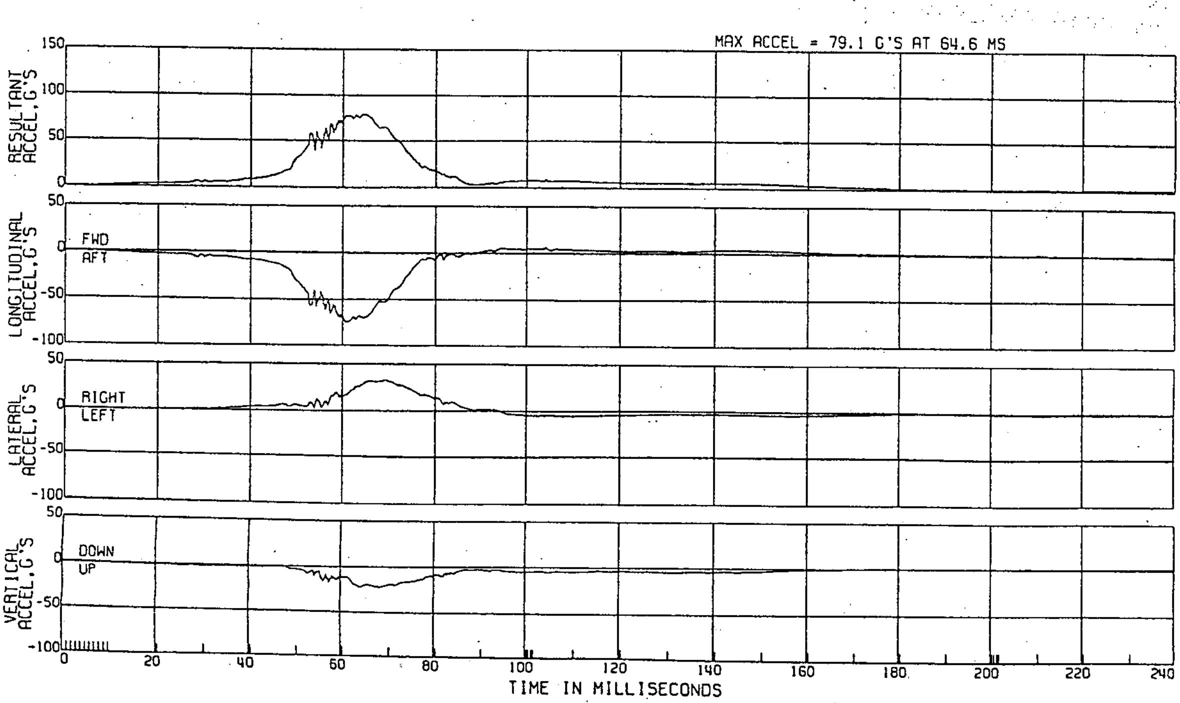
R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

R. FRT PELVIC ACCEL.

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **28**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

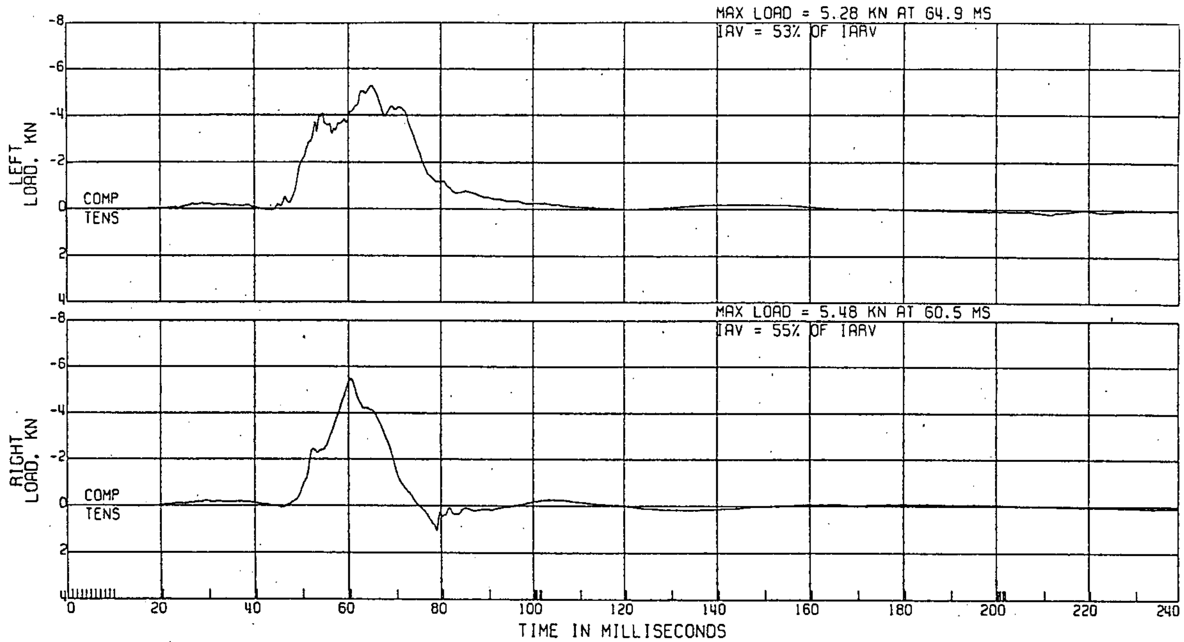
R & D CTR 8W91860 HONDA

ELEC DATA, SAE CLASS 600

R. FRT FEMUR LOAD

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **29**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W91860 HONDA

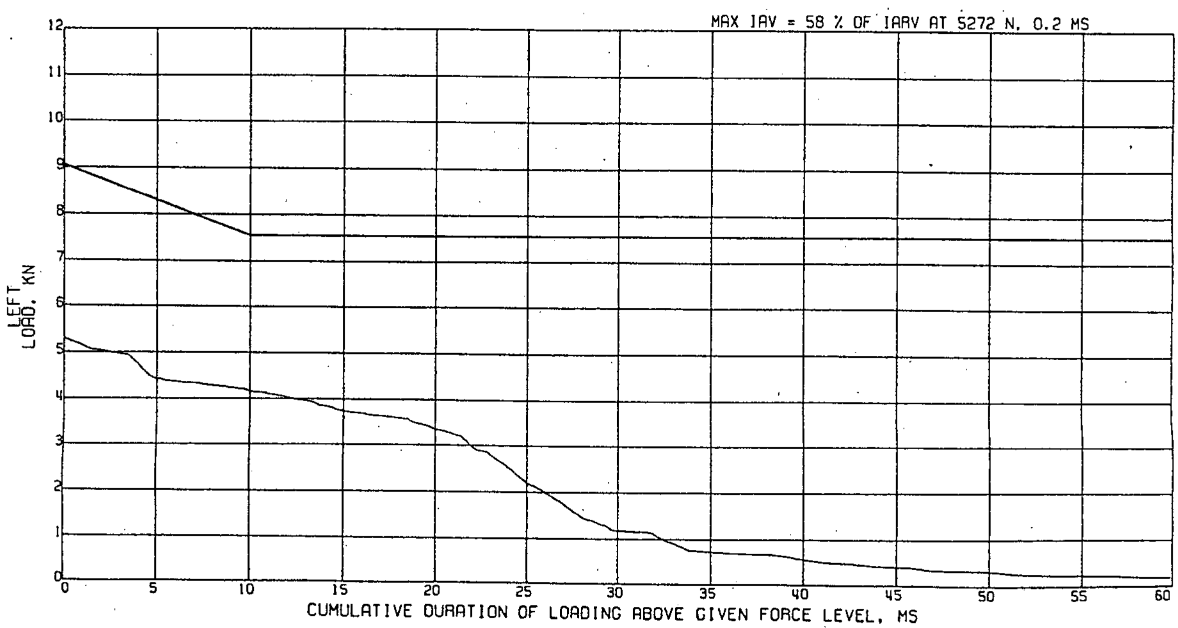
ELEC DATA, SAE CLASS 600

R. FRT FEMUR LOAD

DURATION ASSESSMENT

ATD TYPE: GM50H

TEST DATE:08/12/1998



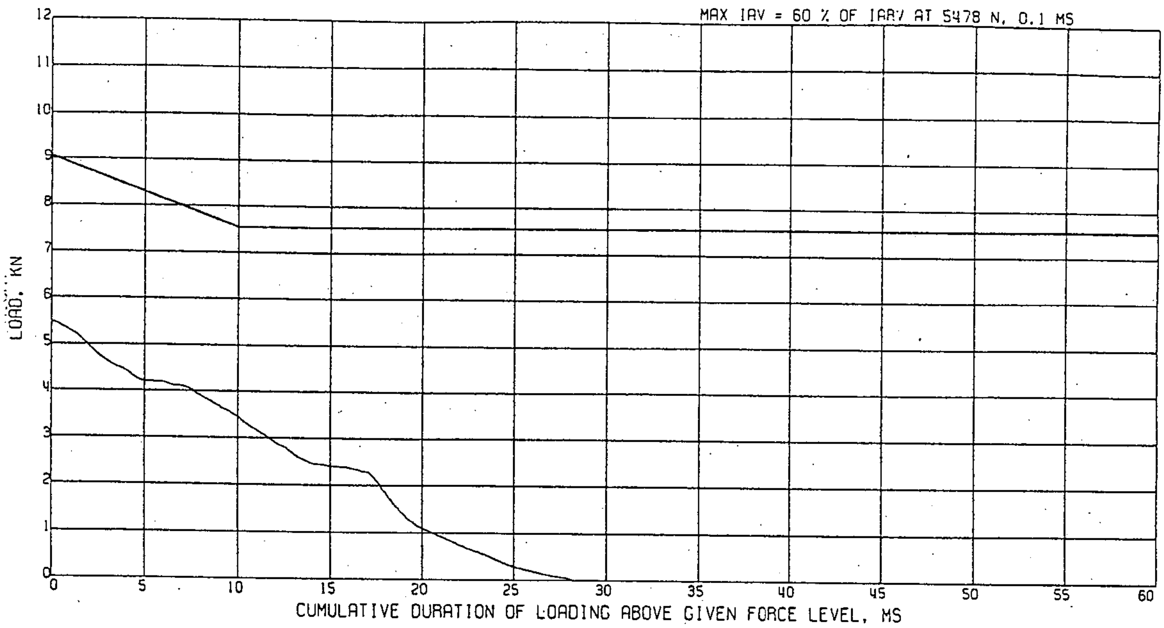
Appendix D, plot # **30**

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA
EC DATA, SAE CLASS 600

R. FRT FEMUR LOAD
DURATION ASSESSMENT

ATD TYPE: GM50H
TEST DATE:08/12/1998



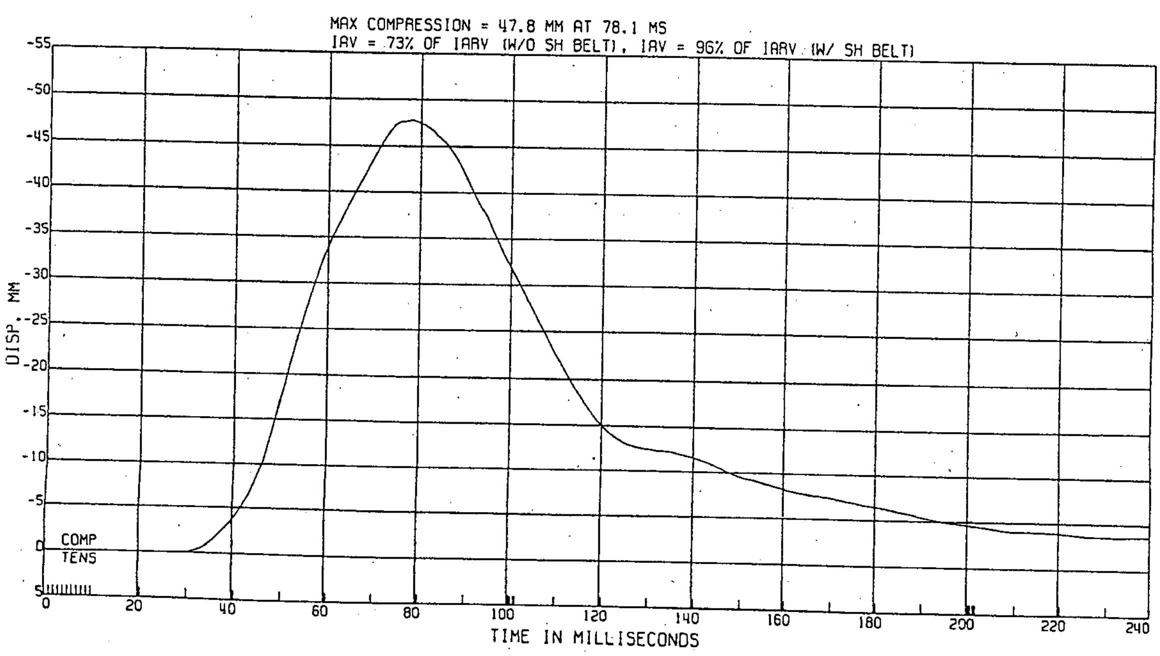
Appendix D, plot # **31**

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA
EC DATA, SAE CLASS 180

R. FRT CHEST DISP, TEMP AT 76.8'F
NORMALIZED TO 70.7'F & PART 572 CORRIDOR

ATD TYPE: GM50H
TEST DATE:08/12/1998



Appendix D, plot # **32**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

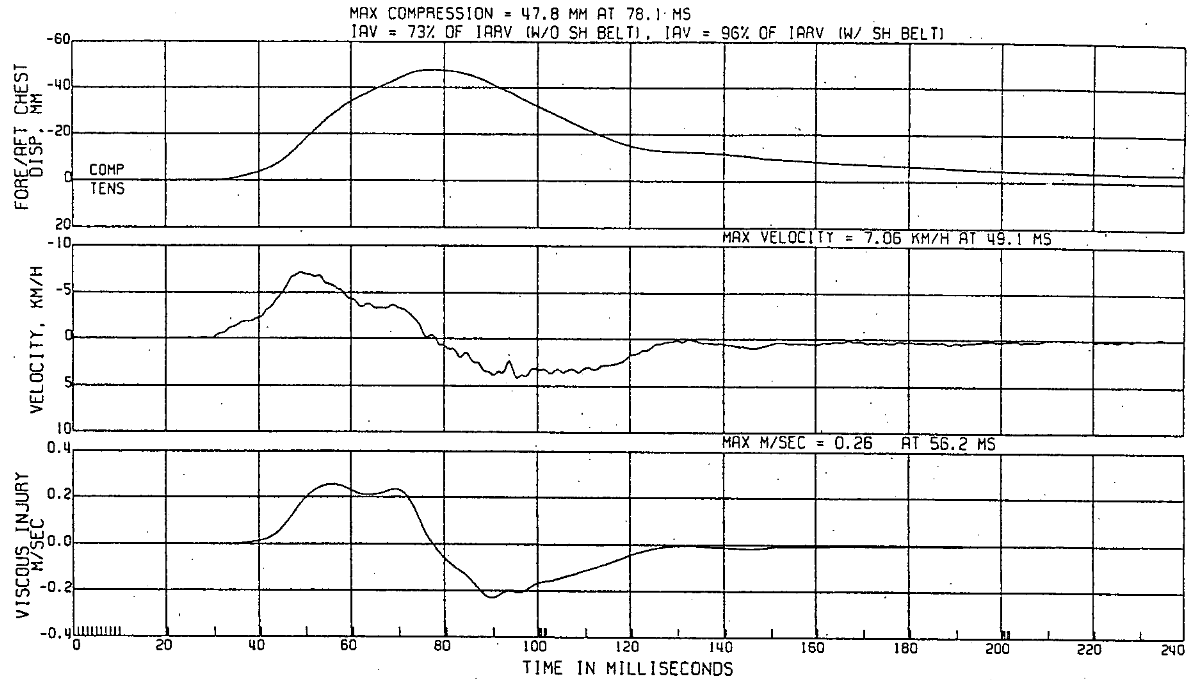
ELEC DATA, SAE CLASS 180

R. FRT CHEST COMPRESSIVE DISP.

NORMALIZED, W/CALC VEL & VISCOUS INJURY

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **33**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

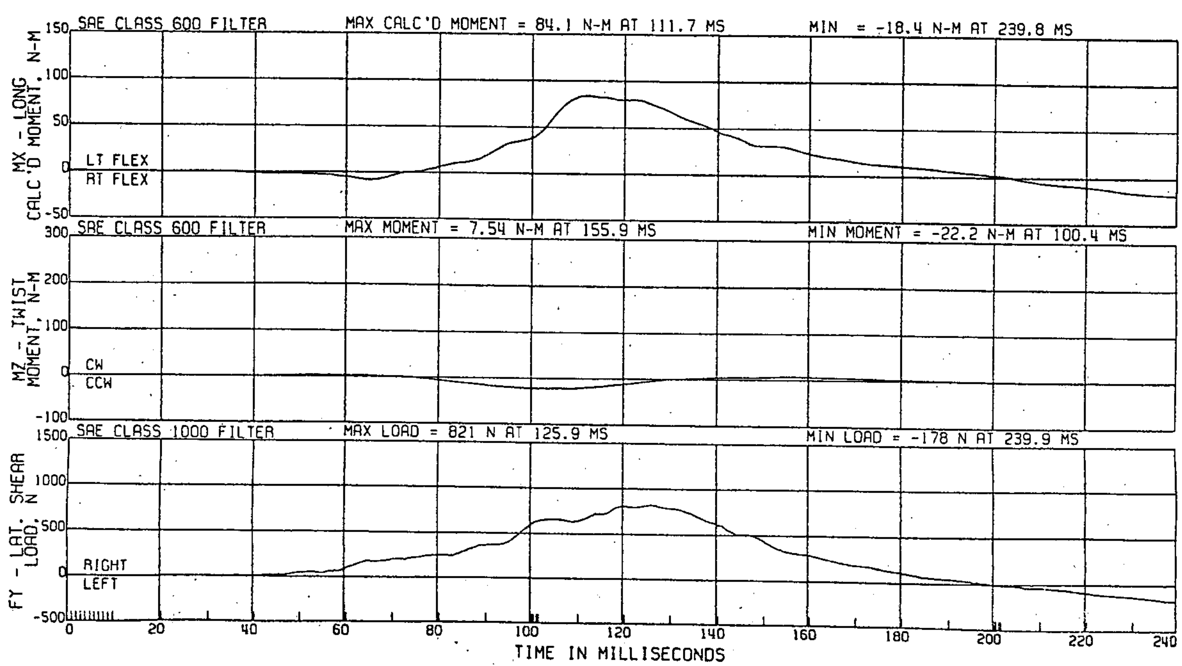
ELEC DATA

R. FRT NECK LOADING ON HEAD, UPPER LOAD

R. FRT NECK LOADING ON HEAD

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **34**

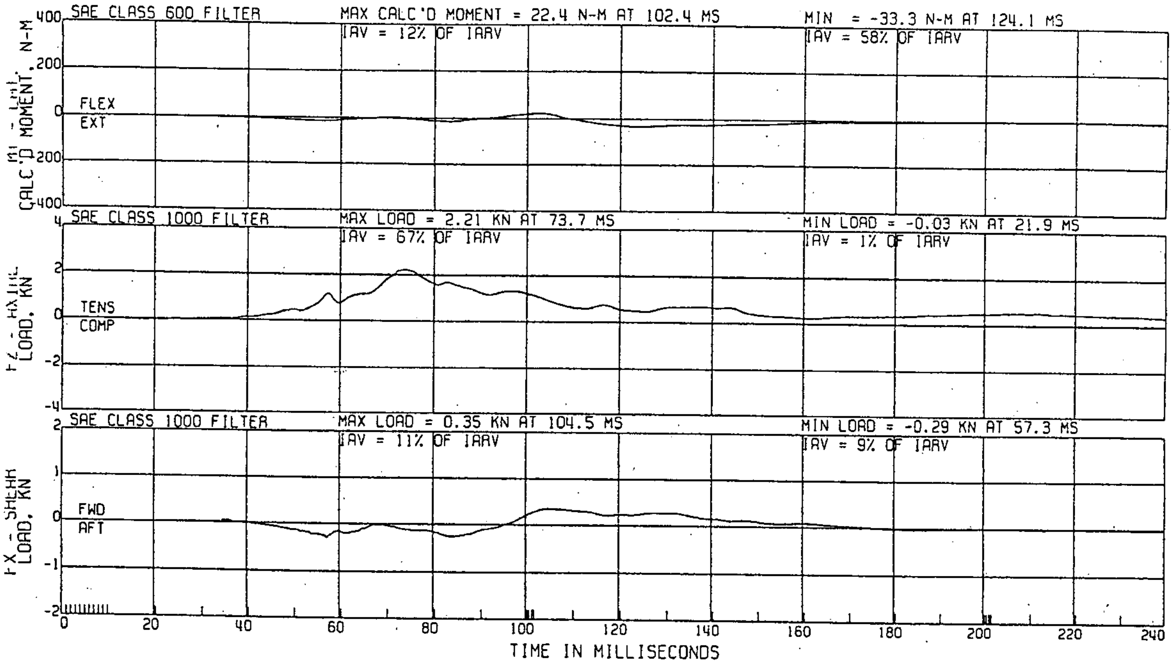
12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA
LEC DATA

NECK LOADING ON HEAD

R. FRT NECK LOADING ON HEAD

ATD TYPE: GM50H
TEST DATE:08/12/1998



Appendix D, plot # 35

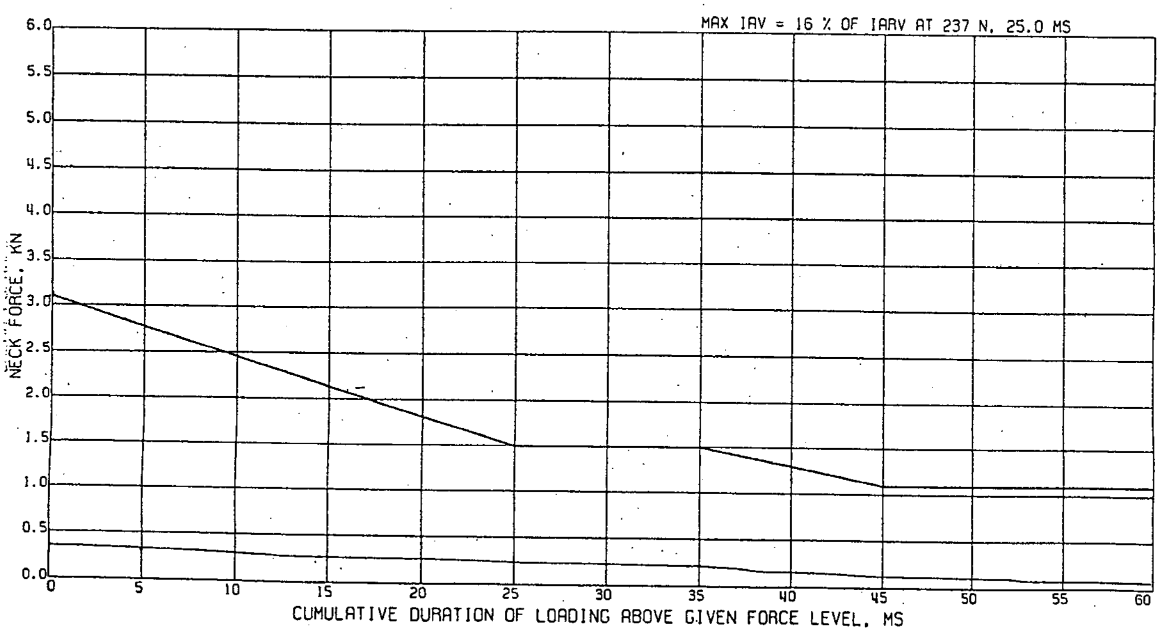
.2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA
.EC DATA, SAE CLASS 1000

FORWARD NECK SHEAR ON HEAD,

R. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:08/12/1998



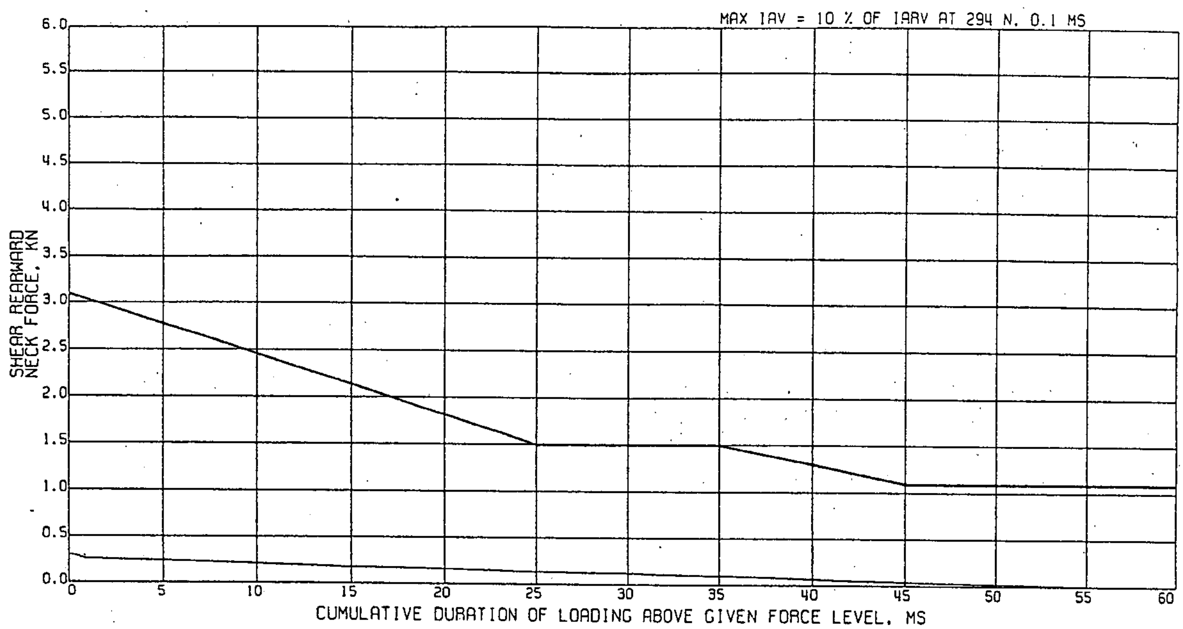
Appendix D, plot # 36

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

REARWARD NECK SHEAR ON HEAD,
R. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:08/12/1998



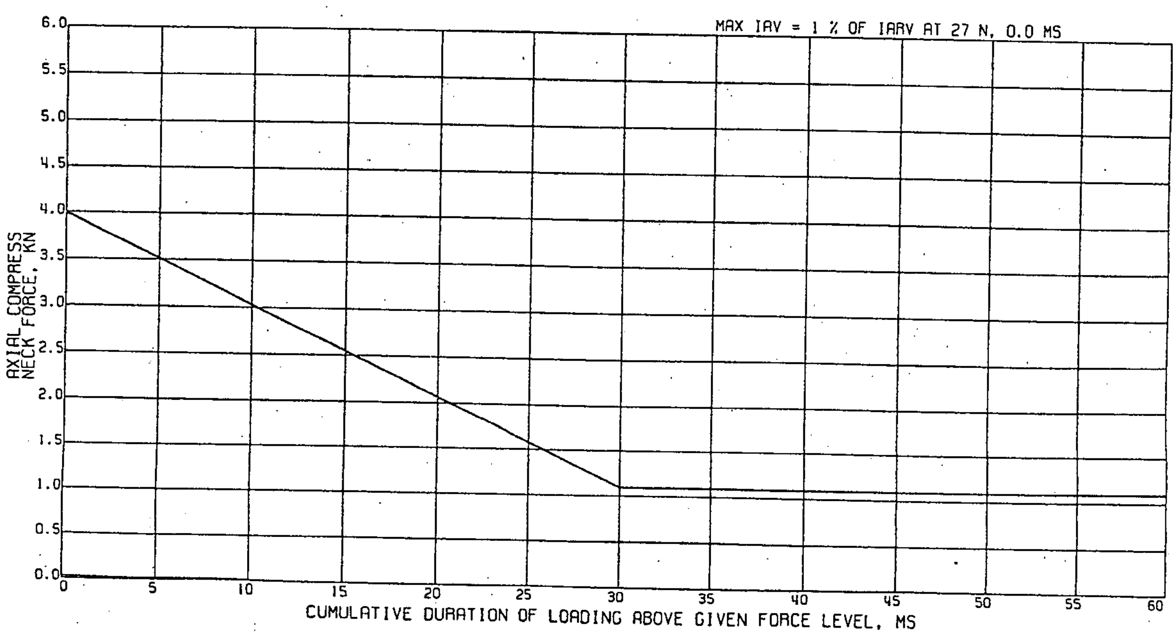
Appendix D, plot # 37

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

AXIAL COMPRESSION ON HEAD,
R. FRT INJURY REFERENCE

ATD TYPE: GM50H
TEST DATE:08/12/1998



Appendix D, plot # 38

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

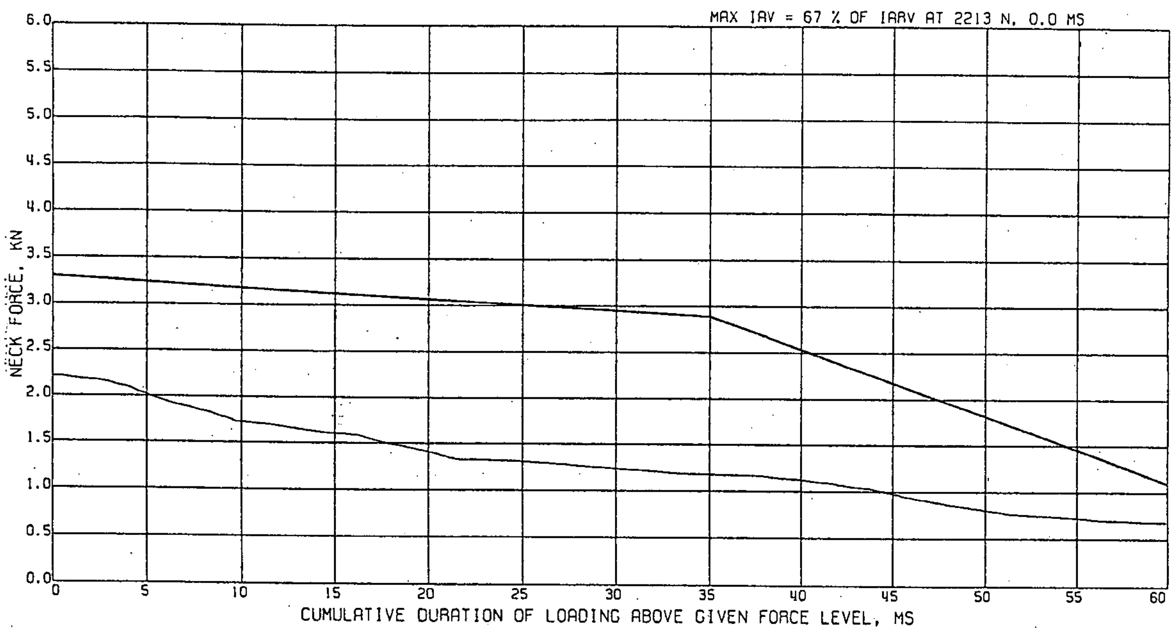
.EC DATA, SAE CLASS 1000

AXIAL TENSION ON HEAD,

R. FRT INJURY REFERENCE

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **39**

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

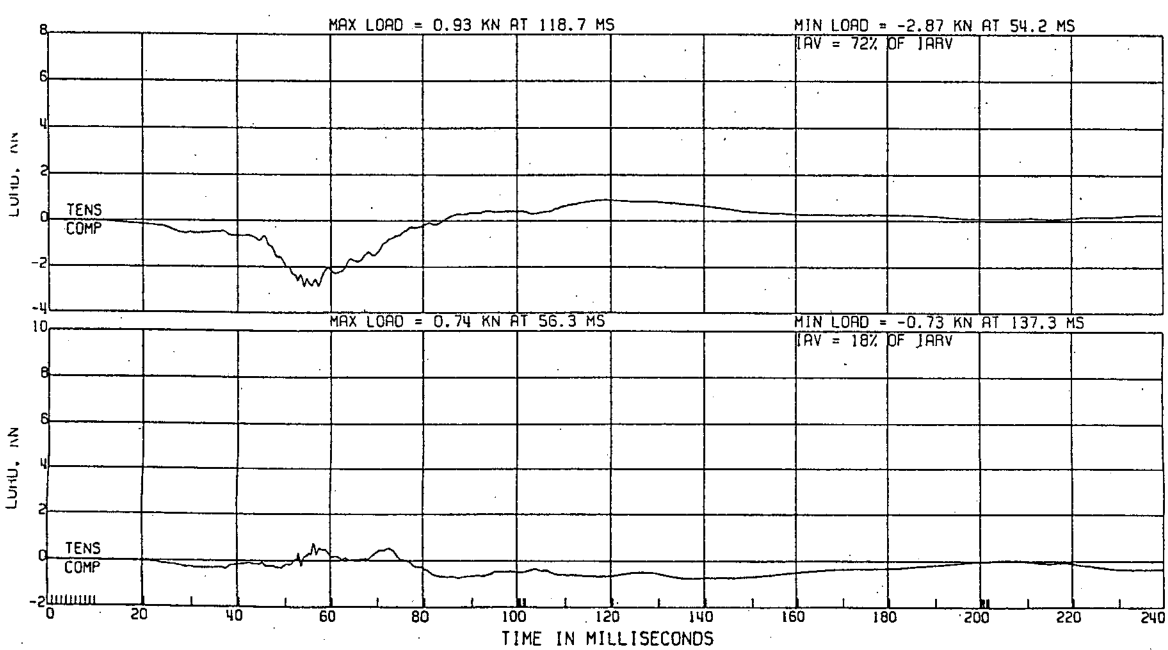
D CTR 8W9186D HONDA

C DATA, SAE CLASS 600

R. FRT LEFT KNEE CLEVIS LOAD

ATD TYPE: GM50H

TEST DATE:08/12/1998



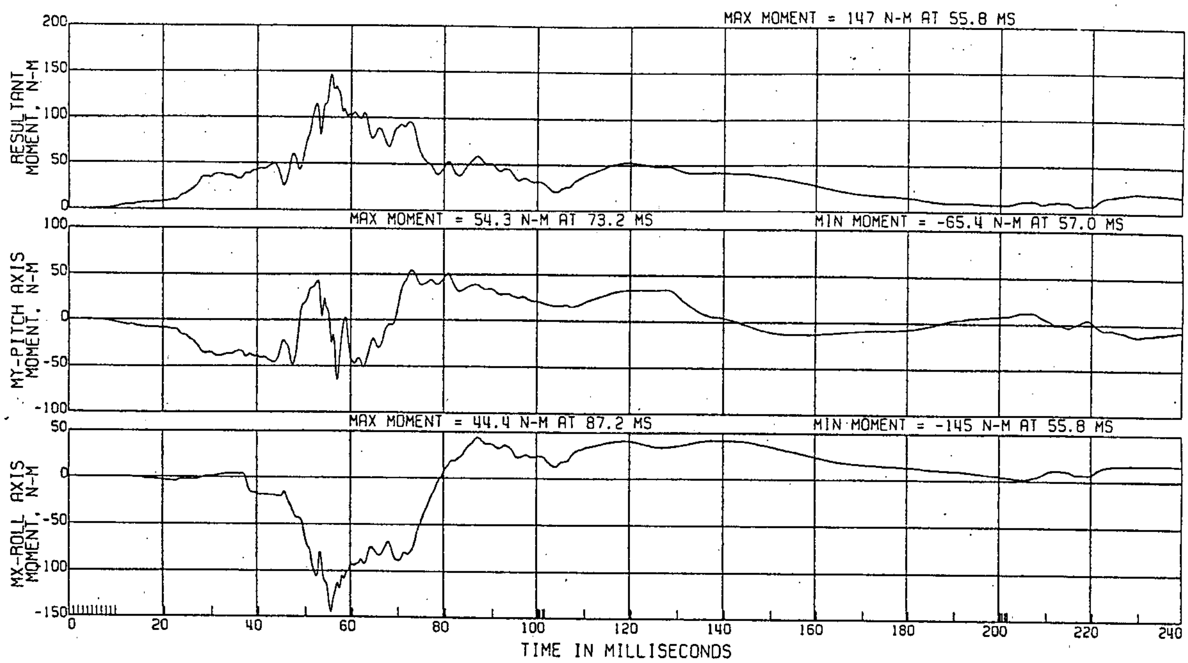
Appendix D, plot # **40**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 600

R. FRT LEFT TIBIA UPPER MOMENT

ATD TYPE: GM50H
TEST DATE:08/12/1998



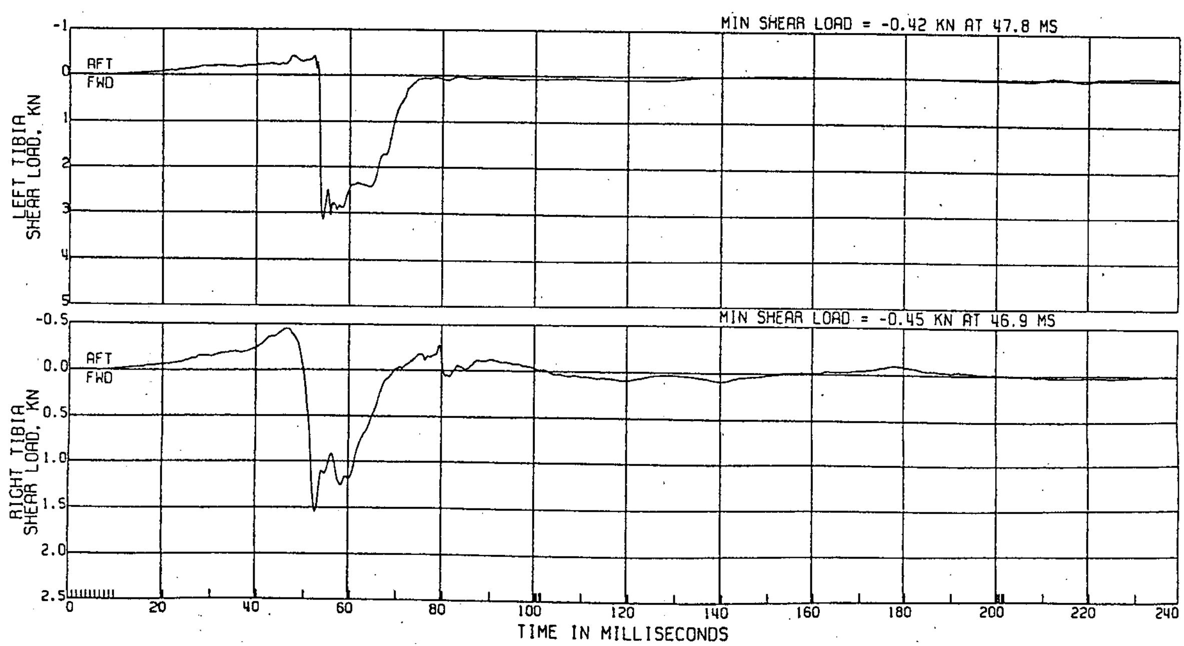
Appendix D, plot # 41

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 600

R. FRT TIBIA LOWER SHEAR LOAD

ATD TYPE: GM50H
TEST DATE:08/12/1998



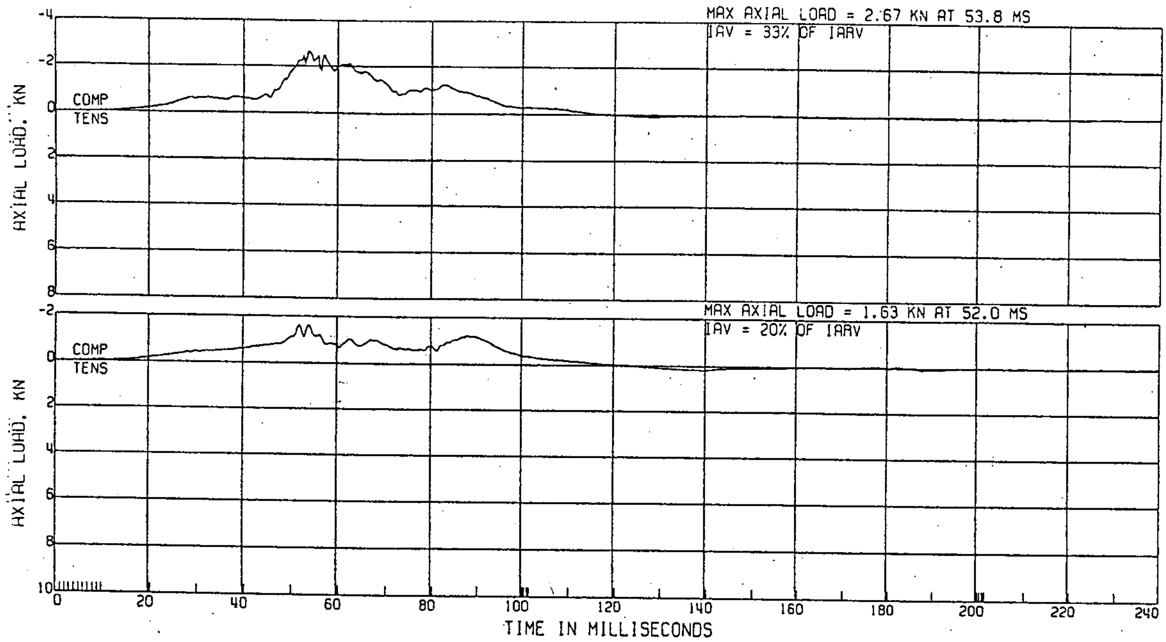
Appendix D, plot # 42

.2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA
.EC DATA, SAE CLASS 600

ATD TYPE: GM50H
TEST DATE:08/12/1998

R. FRT TIBIA LOWER AXIAL LOAD



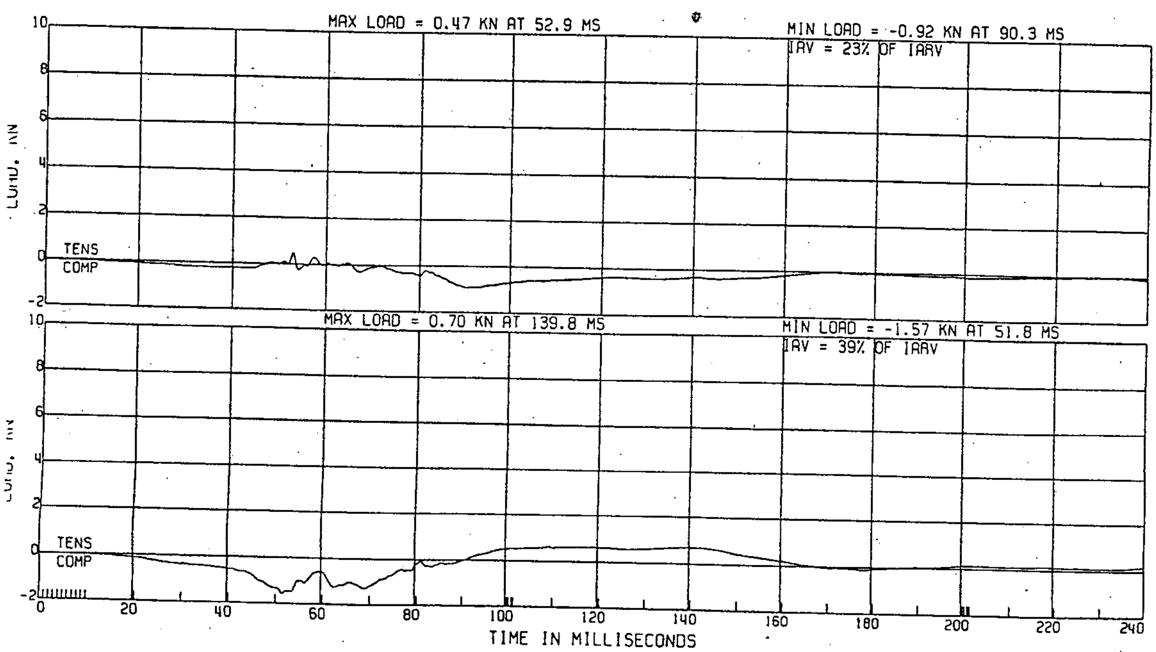
Appendix D, plot # **43**

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA
EC DATA, SAE CLASS 600

R. FRT RIGHT KNEE CLEVIS LOAD

ATD TYPE: GM50H
TEST DATE:08/12/1998



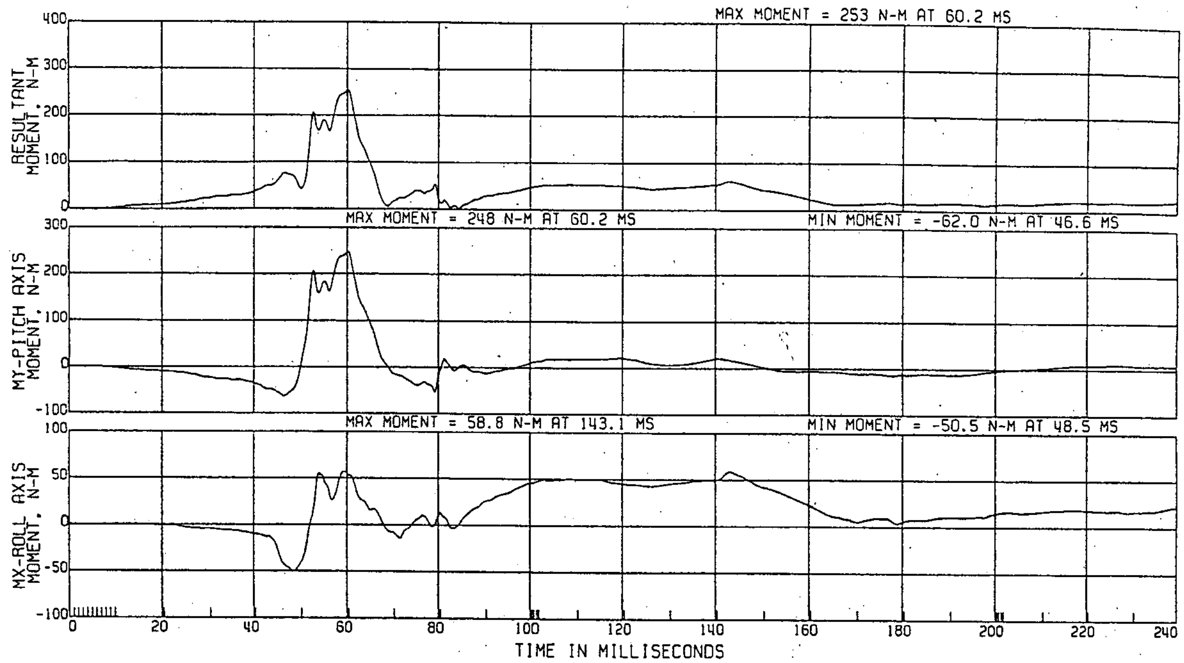
Appendix D, plot # **44**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 600

R. FRT RIGHT TIBIA UPPER MOMENT

ATD TYPE: GM50H
TEST DATE:08/12/1998



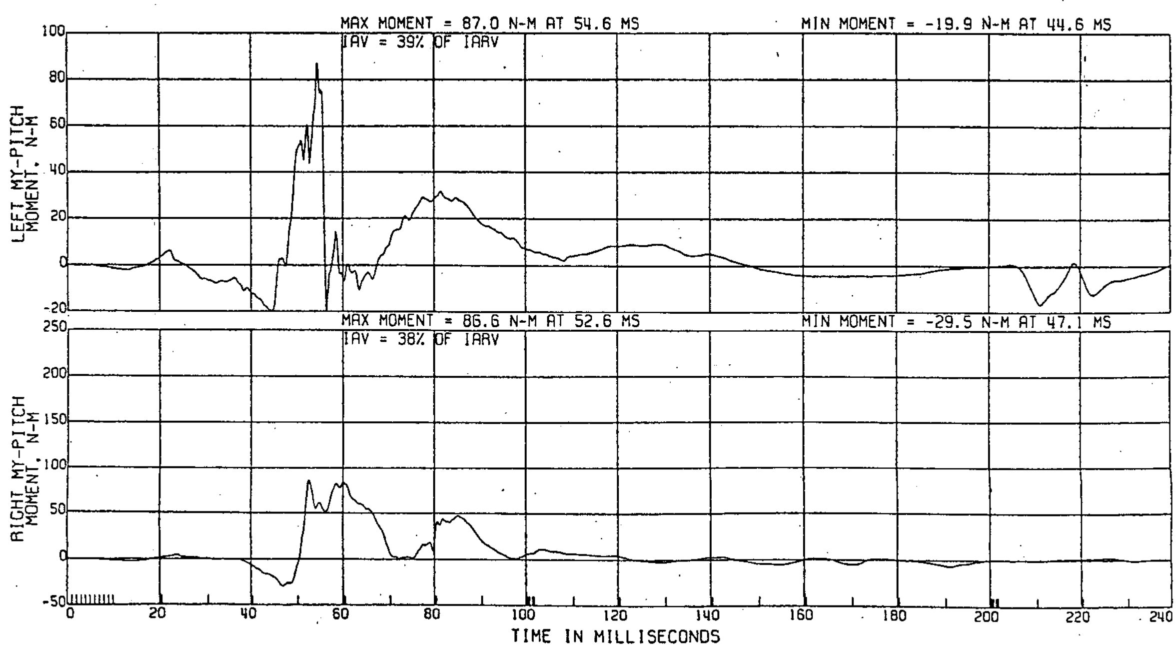
Appendix D, plot # **45**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

ATD TYPE: GM50H
TEST DATE:08/12/1998

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 600

R. FRT TIBIA LOWER BENDING MOMENTS



Appendix D, plot # **46**

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R D CTR 8W9186D HONDA

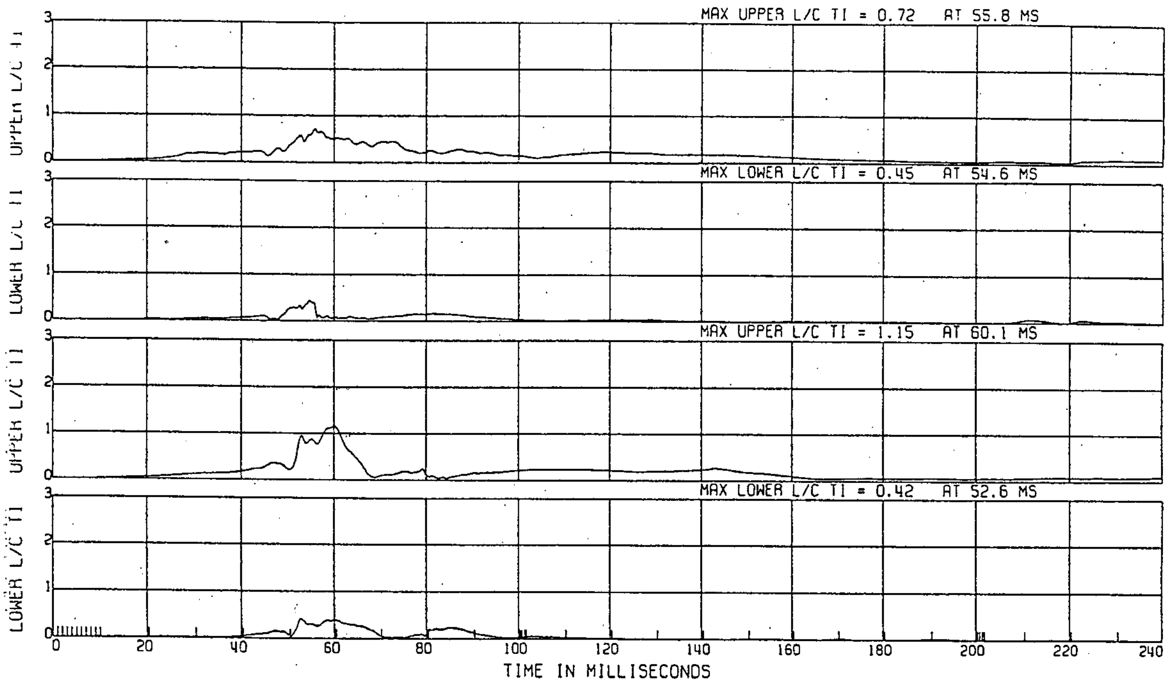
EC DATA, SAE CLASS 600

R. FRT TIBIA INDICES

TI = (RES MOM/225 NM) + (AXIAL/35900 N)

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **47**

127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

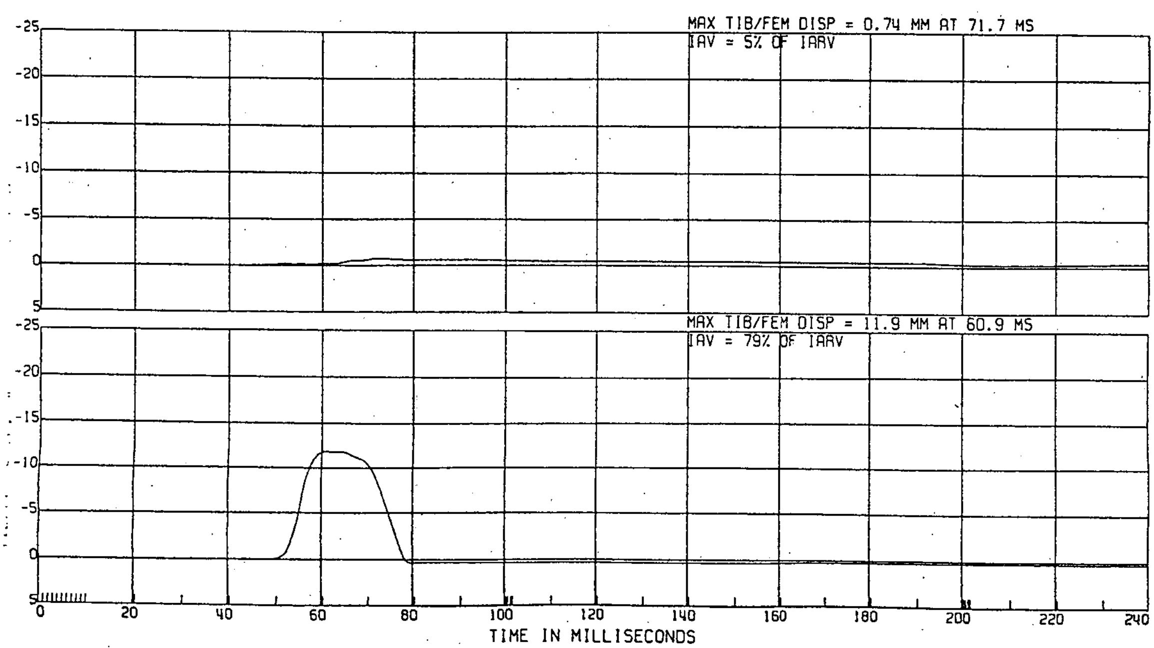
D CTR 8W9186D HONDA

C DATA, SAE CLASS 180

R. FRT TIBIA/FEMUR DISPLACEMENT

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **48**

C12127 L. SIDE IMPACT-339 DEG. LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

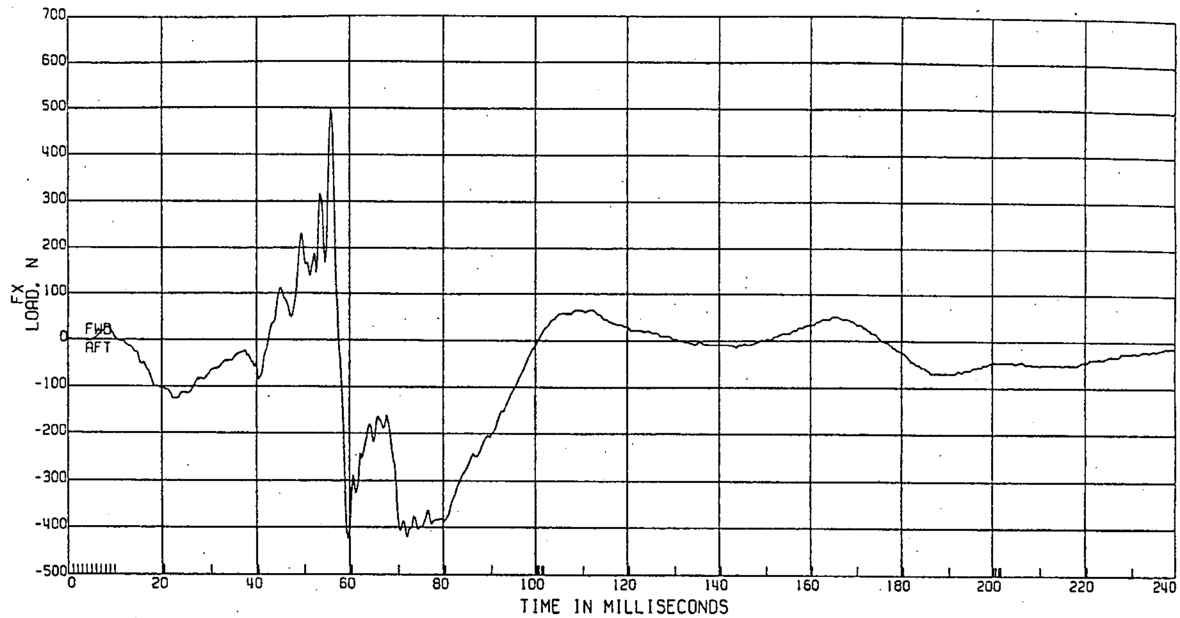
ELEC DATA, SAE CLASS 600

L. FRT TIBIA LEFT UPPER LOAD

(ENHANCED LOWER LEG)

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **49**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

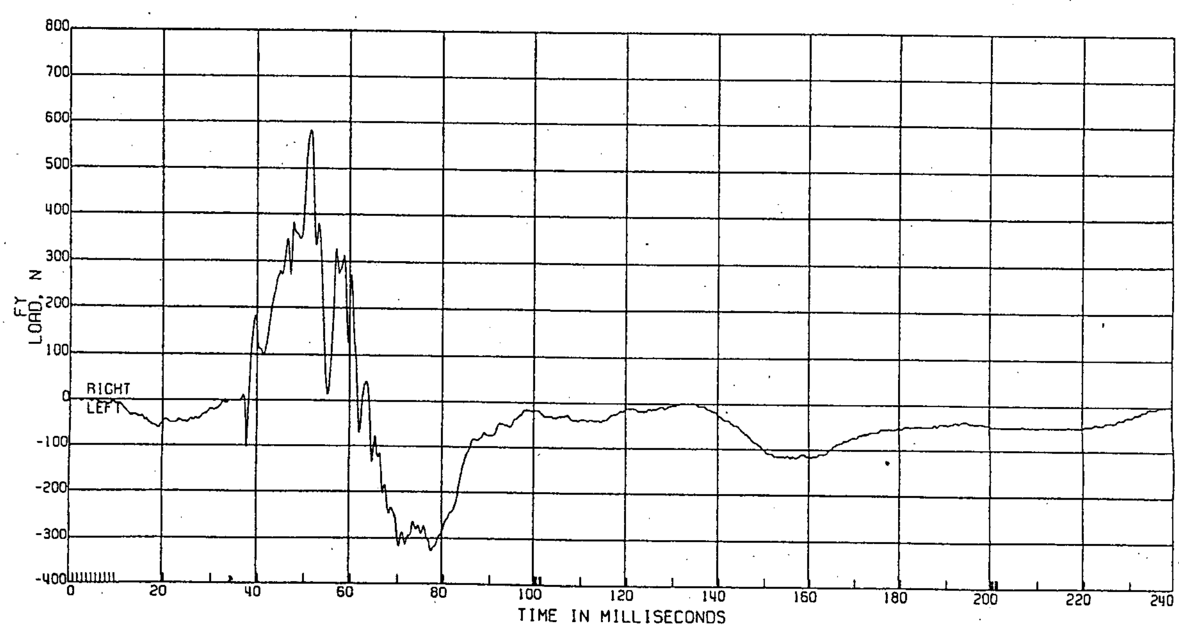
ELEC DATA, SAE CLASS 600

L. FRT TIBIA LEFT LOWER LOAD

(ENHANCED LOWER LEG)

ATD TYPE: GM50H

TEST DATE:08/12/1998

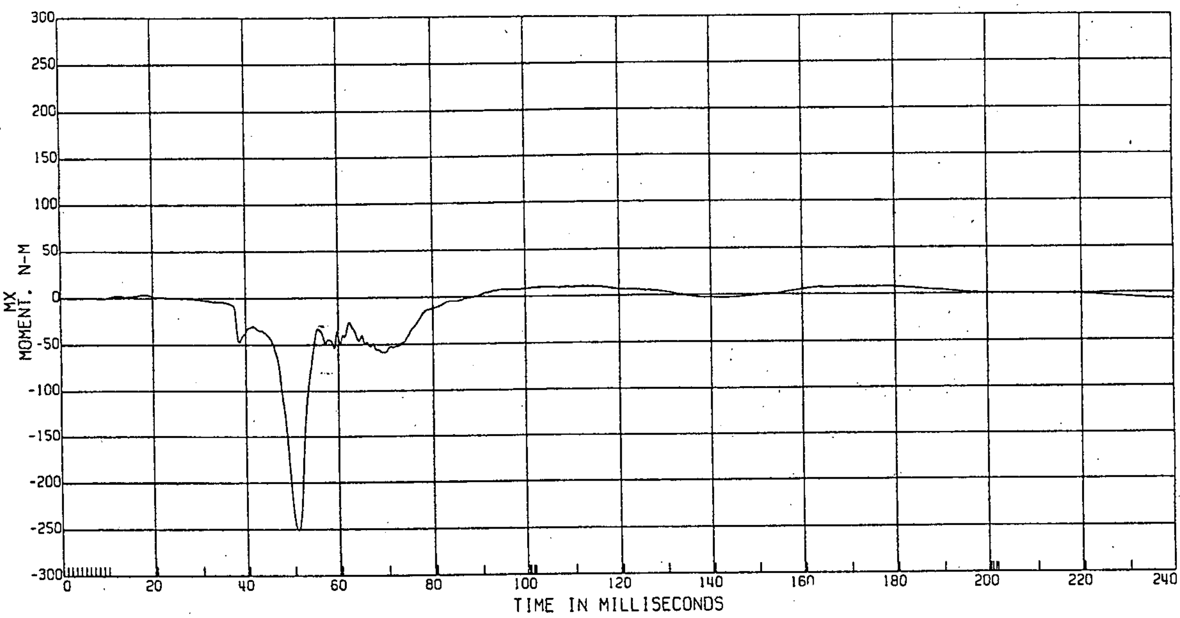


Appendix D, plot # **50**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H
R & D CTR 8W91860 HONDA
ELEC DATA, SAE CLASS 600

L. FRT TIBIA LEFT LOWER MOMENT
(ENHANCED LOWER LEG)

ATD TYPE: GM50H
TEST DATE:08/12/1998

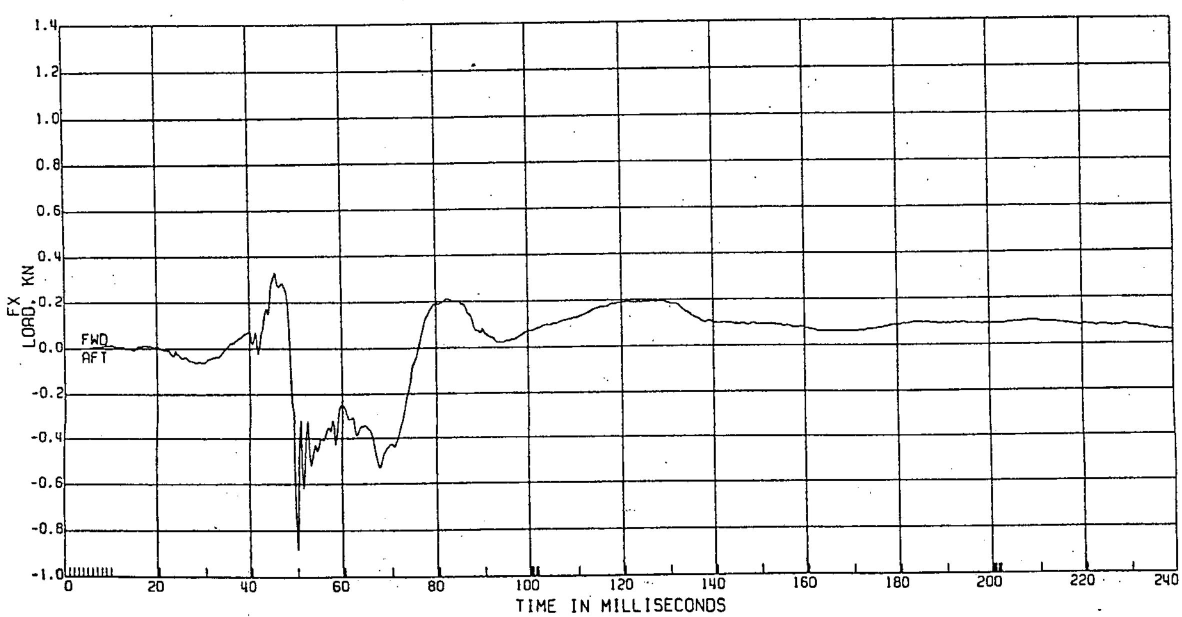


Appendix D, plot # **51**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H
R & D CTR 8W91860 HONDA
ELEC DATA, SAE CLASS 600

L. FRT TIBIA RIGHT UPPER LOAD
(ENHANCED LOWER LEG)

ATD TYPE: GM50H
TEST DATE:08/12/1998



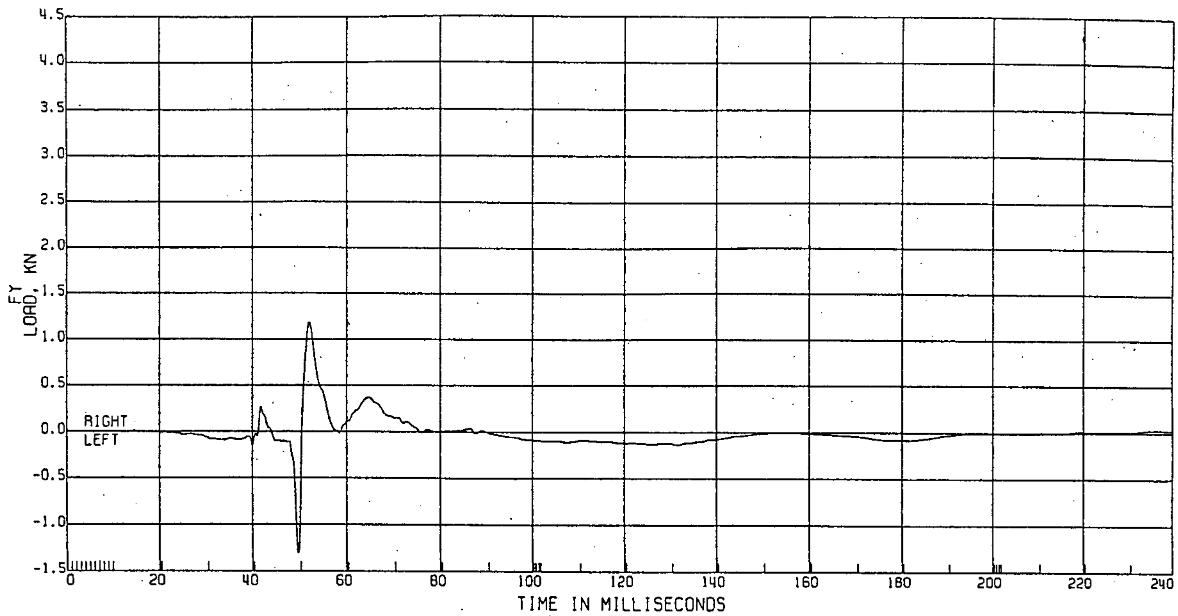
Appendix D, plot # **52**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W91860 HONDA
ELEC DATA, SAE CLASS 600

L. FRT TIBIA RIGHT LOWER LOAD
(ENHANCED LOWER LEG)

ATD TYPE: GM50H
TEST DATE:08/12/1998



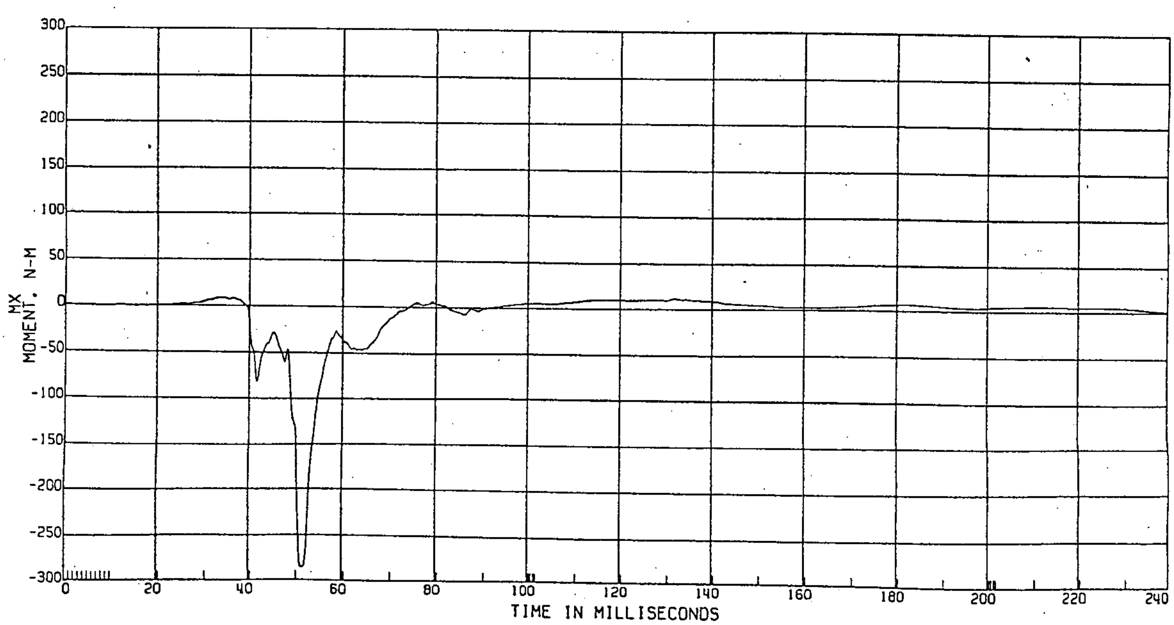
Appendix D, plot # 53

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W91860 HONDA
ELEC DATA, SAE CLASS 600

L. FRT TIBIA RIGHT LOWER MOMENT
(ENHANCED LOWER LEG)

ATD TYPE: GM50H
TEST DATE:08/12/1998



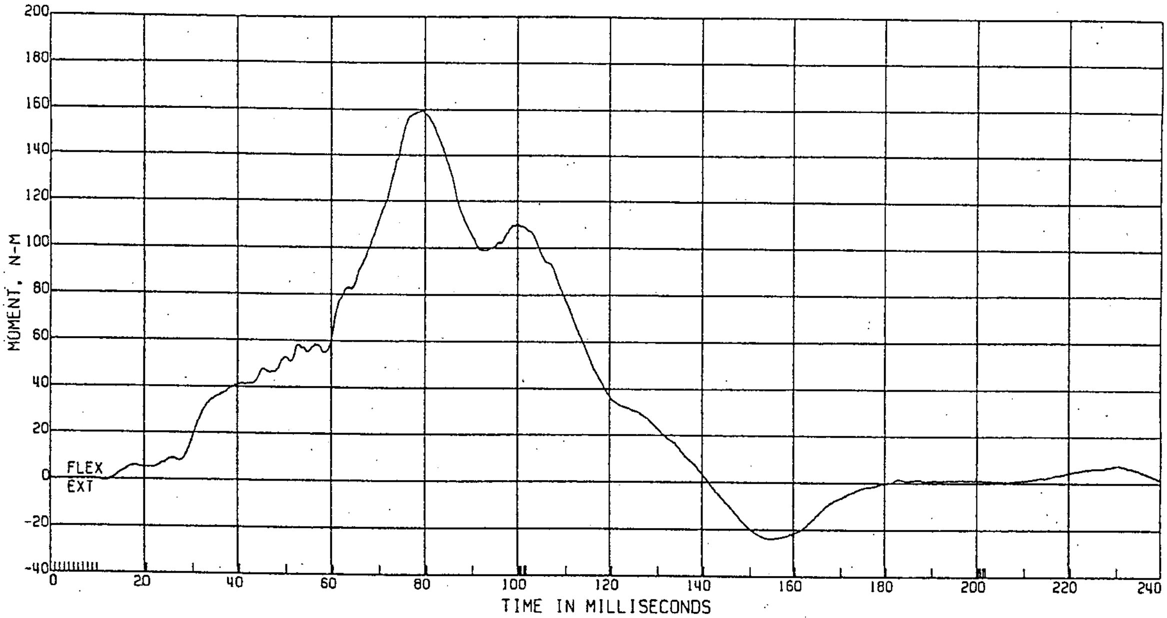
Appendix D, plot # 54

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

ATD TYPE: GM50H
TEST DATE:08/12/1998

& D CTR 8W91860 HONDA
EC DATA, SAE CLASS 1000

L. FRT LOWER LUMBAR MOMENT



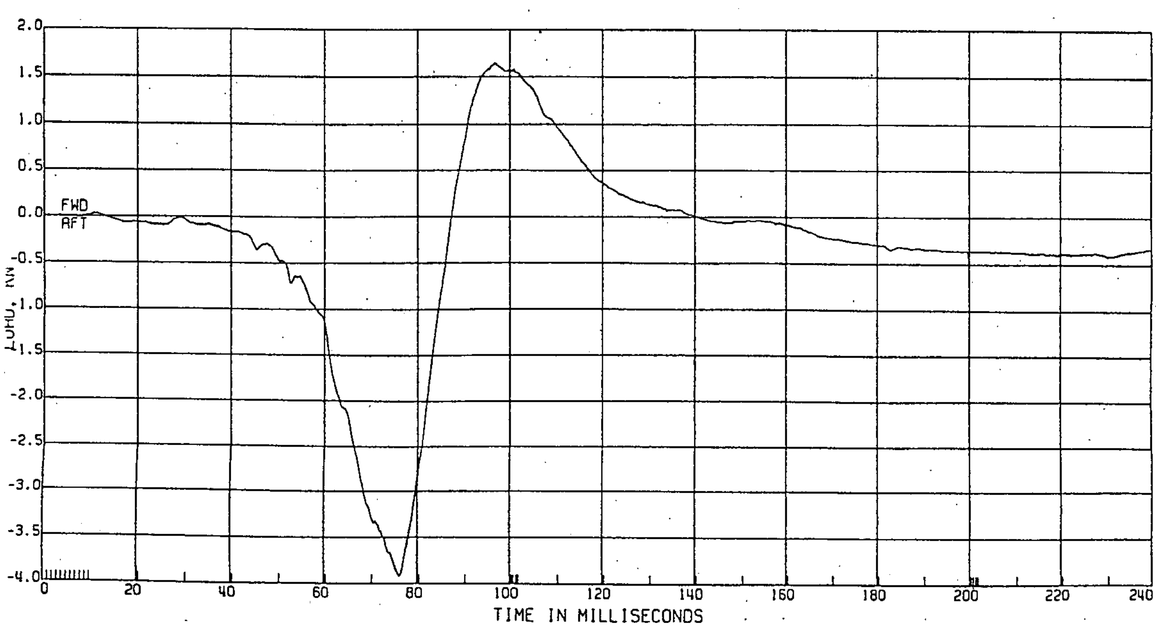
Appendix D, plot # **55**

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

ATD TYPE: GM50H
TEST DATE:08/12/1998

& D CTR 8W91860 HONDA
EC DATA, SAE CLASS 1000

L. FRT LOWER LUMBAR LOAD



Appendix D, plot # **56**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

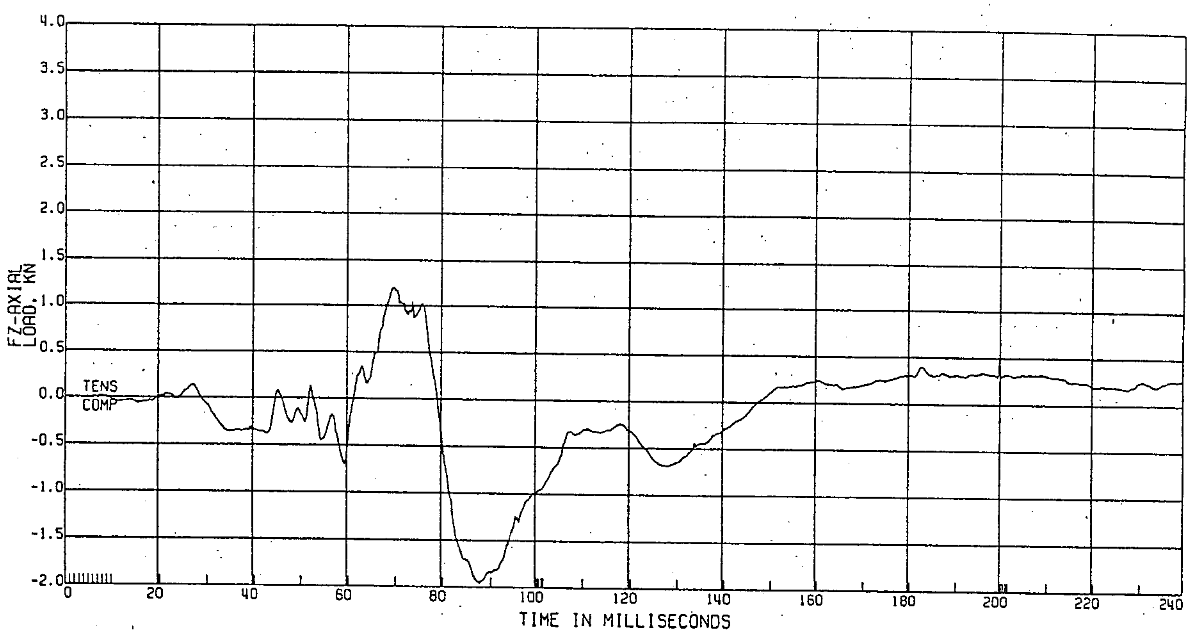
R & D CTR 8W9186D HONDA

L. FRT LOWER LUMBAR LOAD

ATD TYPE: GM50H

TEST DATE:08/12/1998

ELEC DATA, SAE CLASS 1000



Appendix D, plot # **57**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

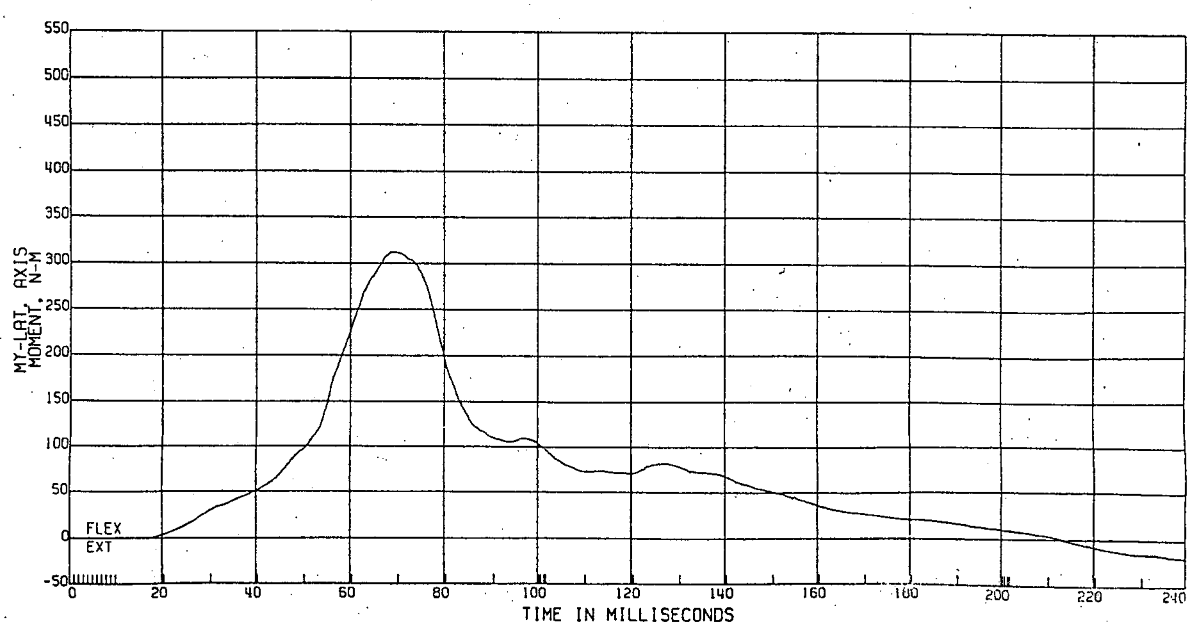
R & D CTR 8W9186D HONDA

R. FRT LOWER LUMBAR MOMENT

ATD TYPE: GM50H

TEST DATE:08/12/1998

ELEC DATA, SAE CLASS 1000



Appendix D, plot # **58**

12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1 KM/H

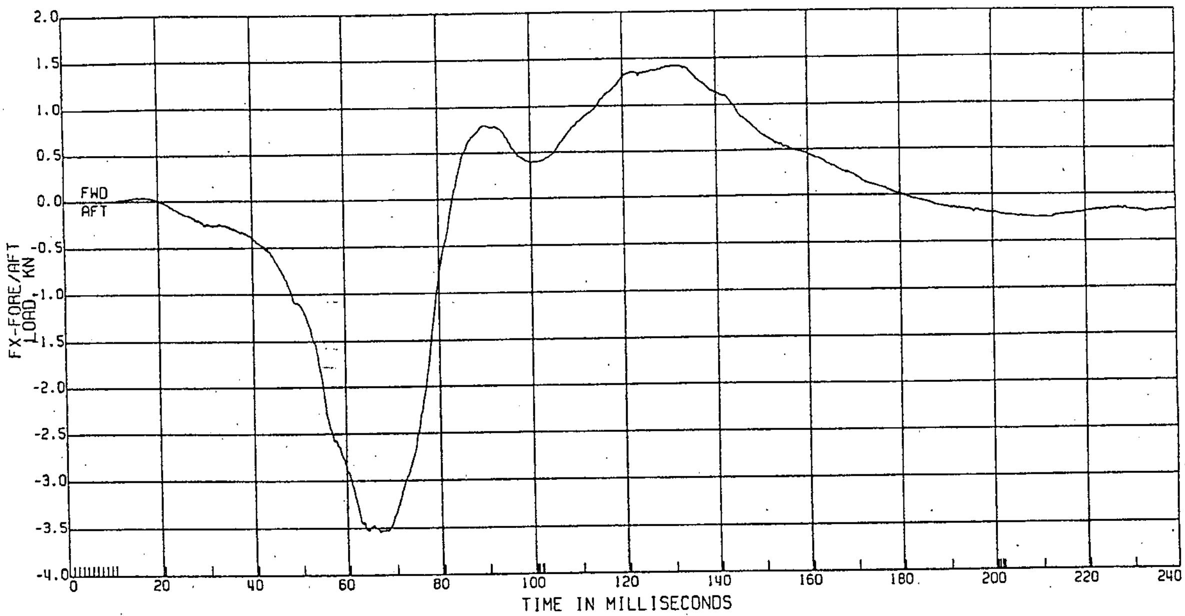
& D CTR 8W91860 HONDA

ELEC DATA, SAE CLASS 1000

R. FRT LOWER LUMBAR LOAD

ATD TYPE: GM50H

TEST DATE:08/12/1998



Appendix D, plot # **59**

12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1 KM/H

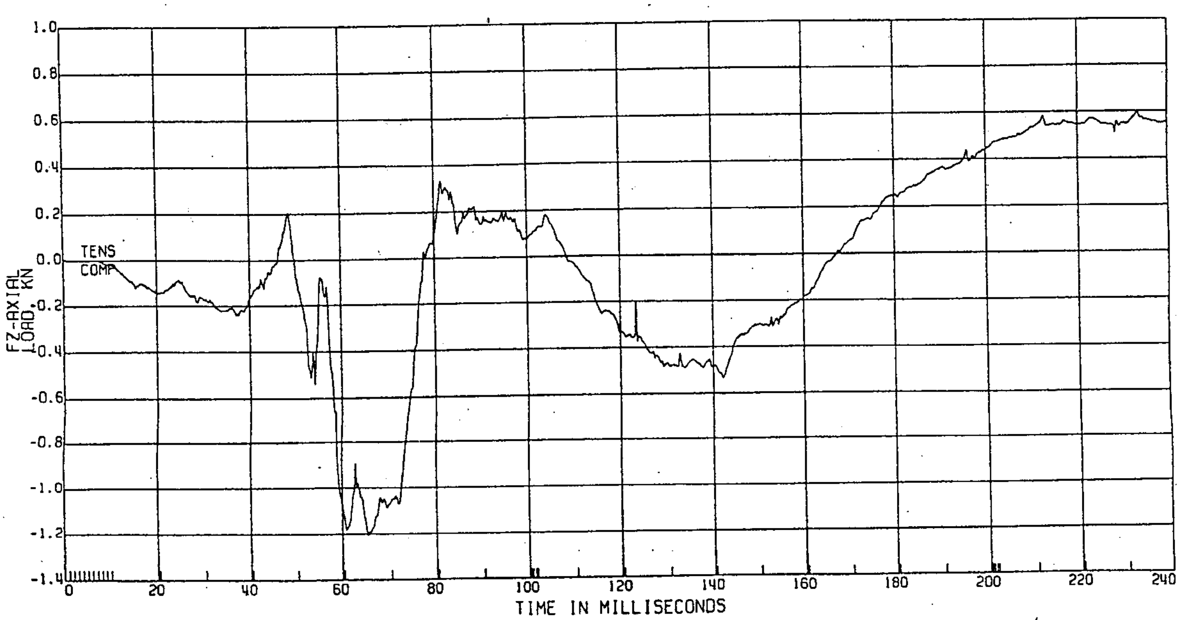
R & D CTR 8W91860 HONDA

ELEC DATA, SAE CLASS 1000

R. FRT LOWER LUMBAR LOAD

ATD TYPE: GM50H

TEST DATE:08/12/1998

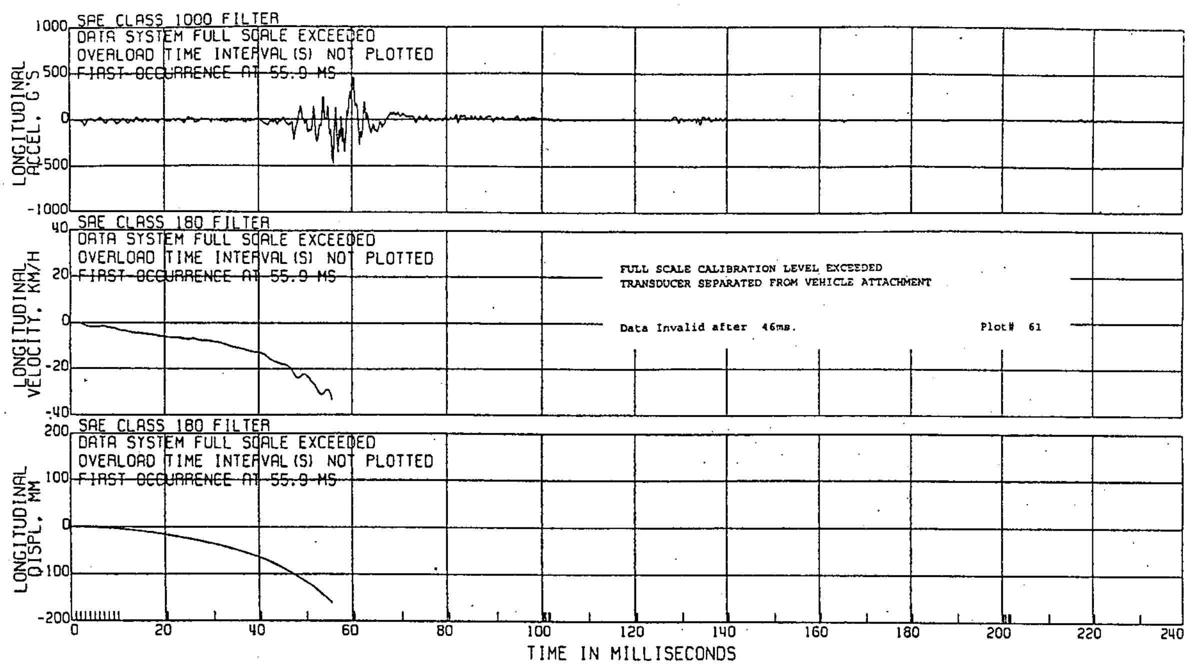


Appendix D, plot # **60**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA CTR CONSOLE ON SIR MODULE TEST DATE:08/12/1998

ELEC DATA

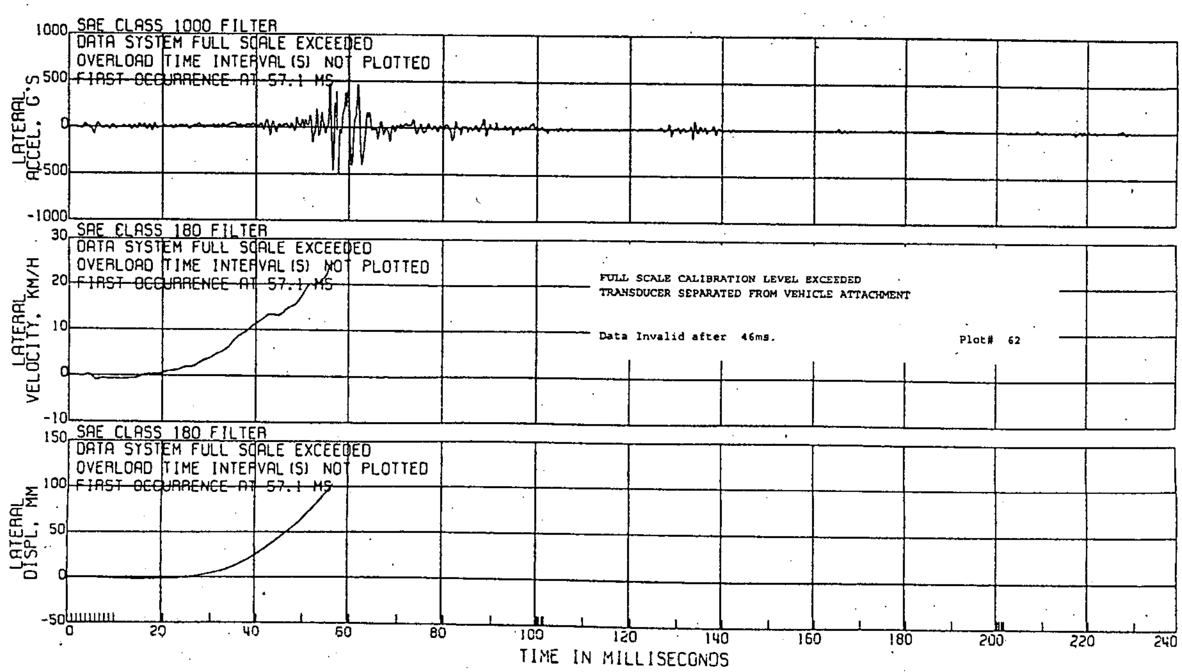


Appendix D, plot # **61**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA CTR CONSOLE ON SIR MODULE TEST DATE:08/12/1998

ELEC DATA

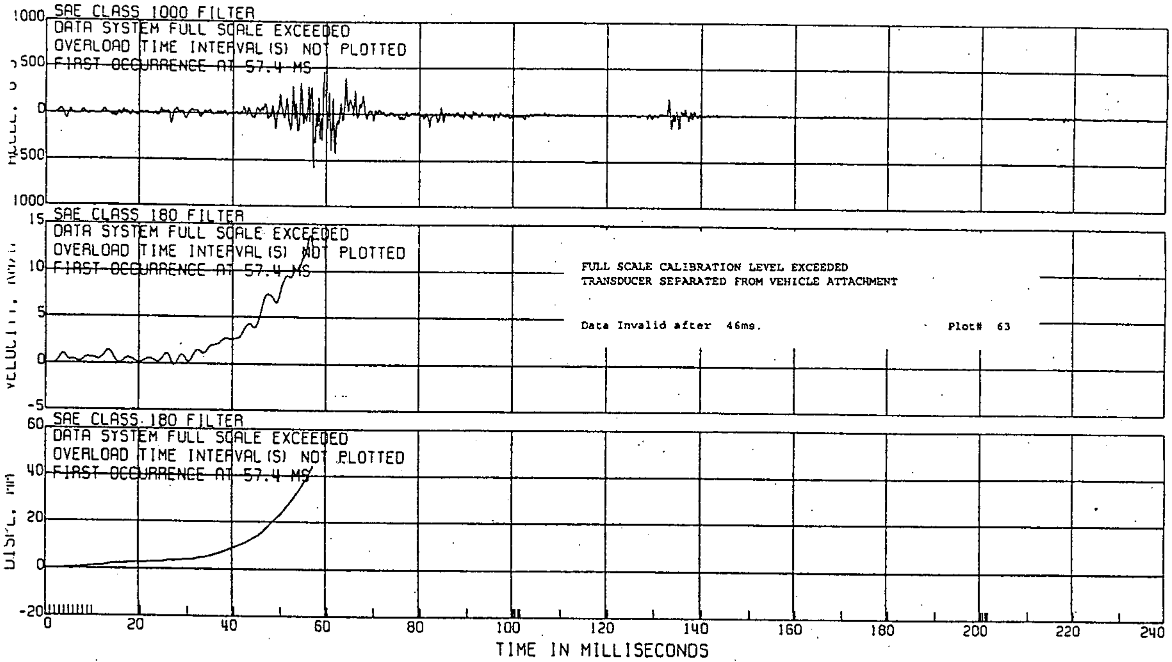


Appendix D, plot # **62**

127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

D CTR 8W9186D HONDA CTR CONSOLE ON SIR MODULE TEST DATE:08/12/1998

C DATA

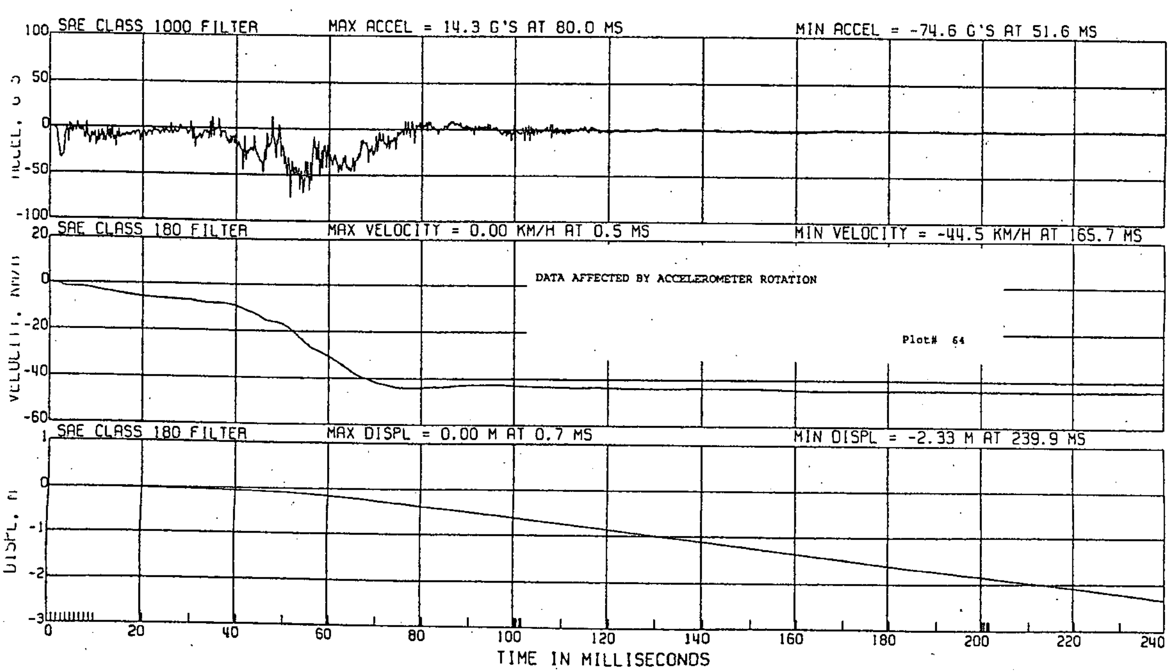


Appendix D, plot # **63**

2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

D CTR 8W9186D HONDA L. FRT ROCKER TEST DATE:08/12/1998

C DATA

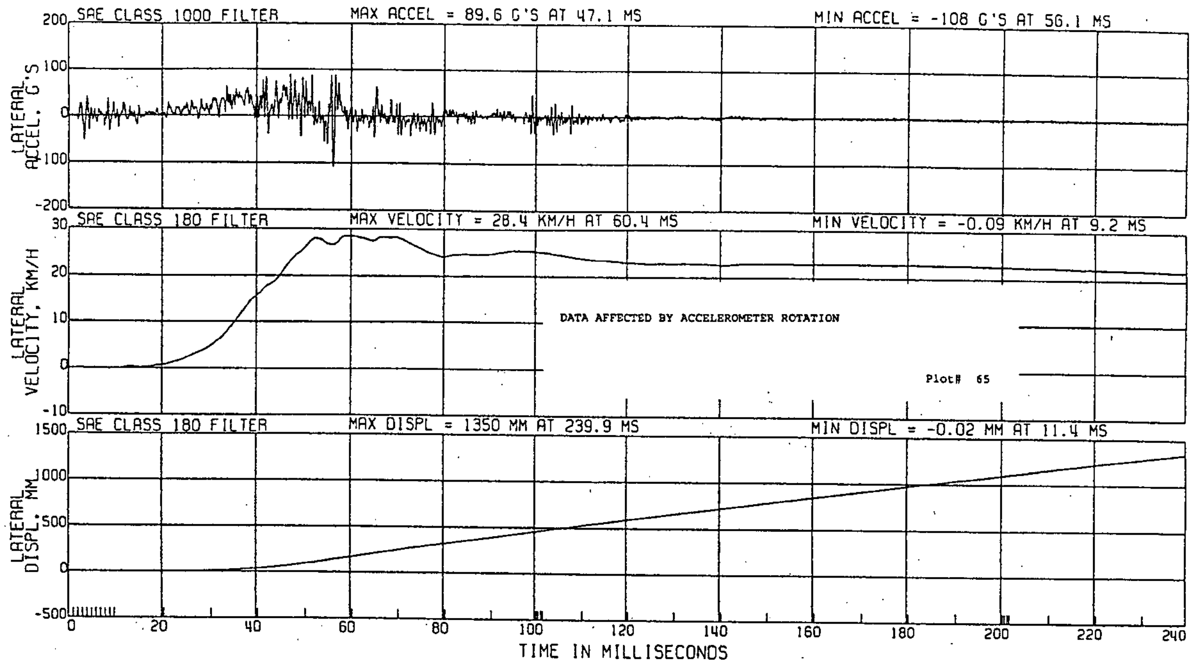


Appendix D, plot # **64**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA L. FRT ROCKER TEST DATE:08/12/1998

ELEC DATA

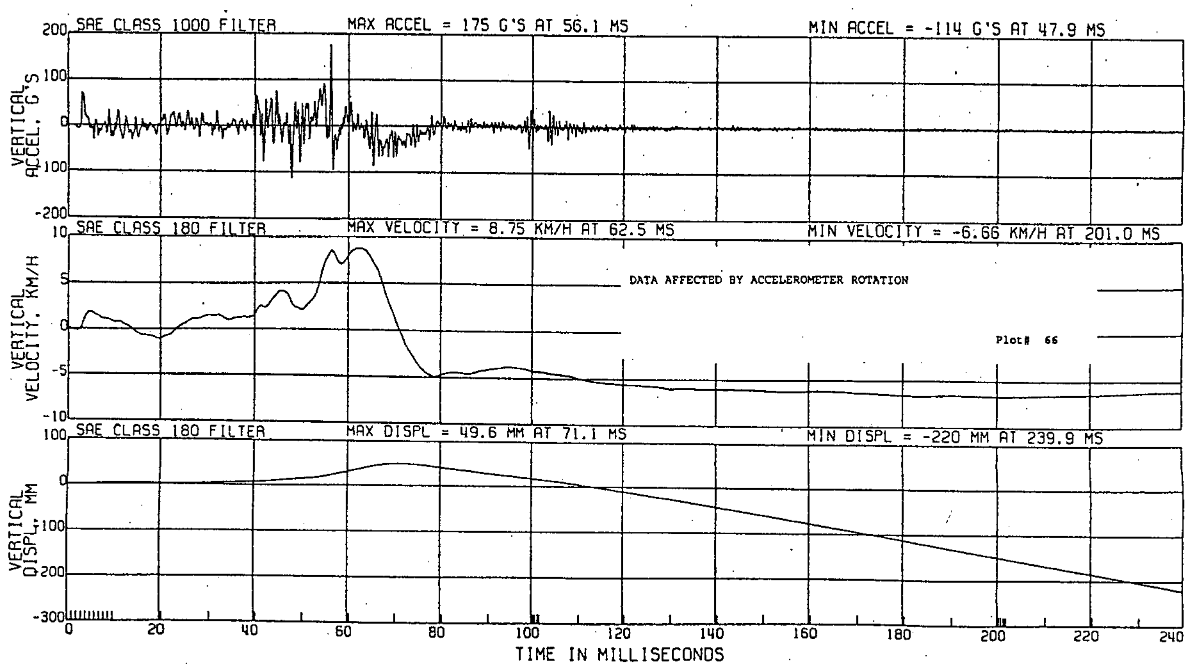


Appendix D, plot # **65**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA L. FRT ROCKER TEST DATE:08/12/1998

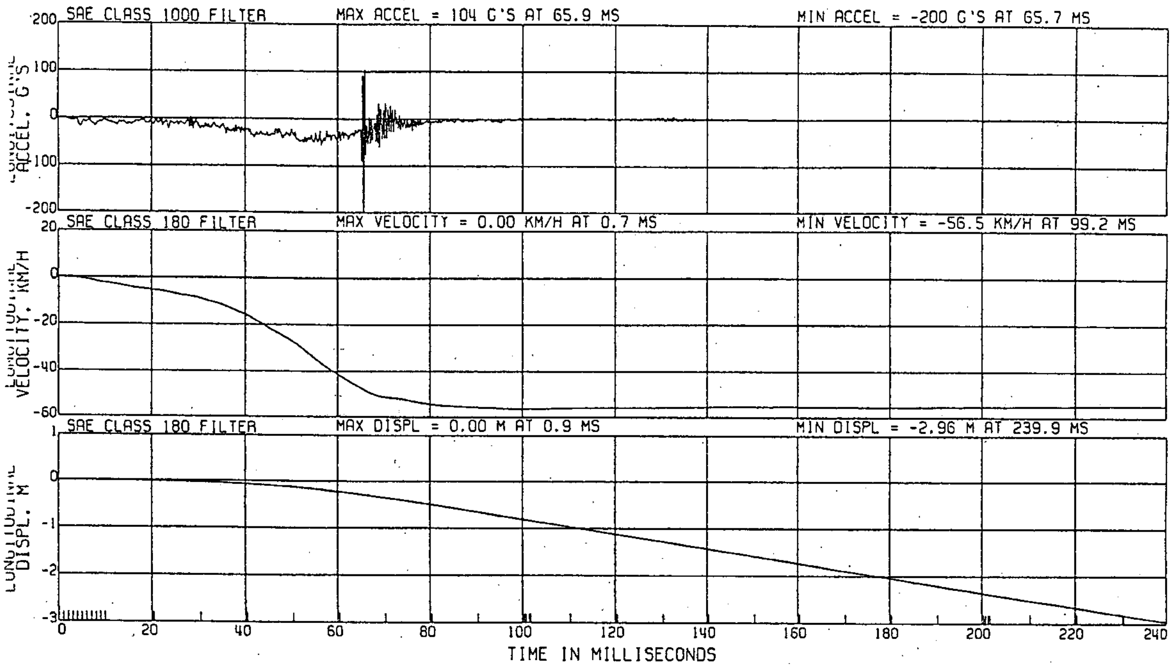
ELEC DATA



Appendix D, plot # **66**

.2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

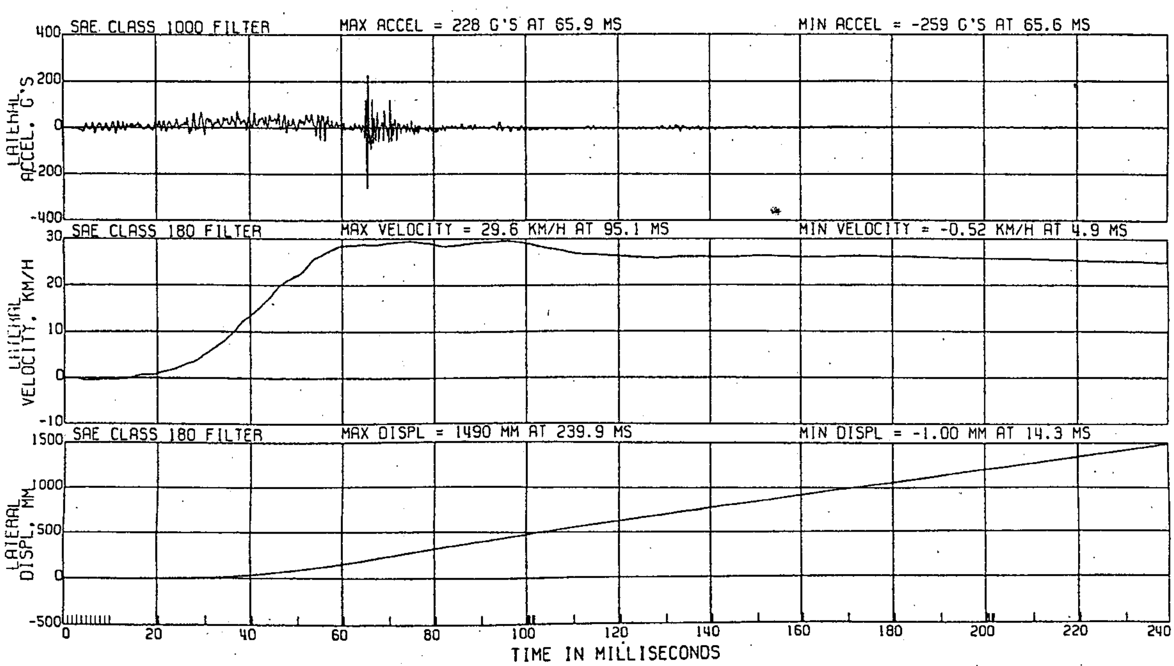
& D CTR 8W9186D HONDA R. FRT ROCKER TEST DATE:08/12/1998
.EC DATA



Appendix D, plot # **67**

:12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

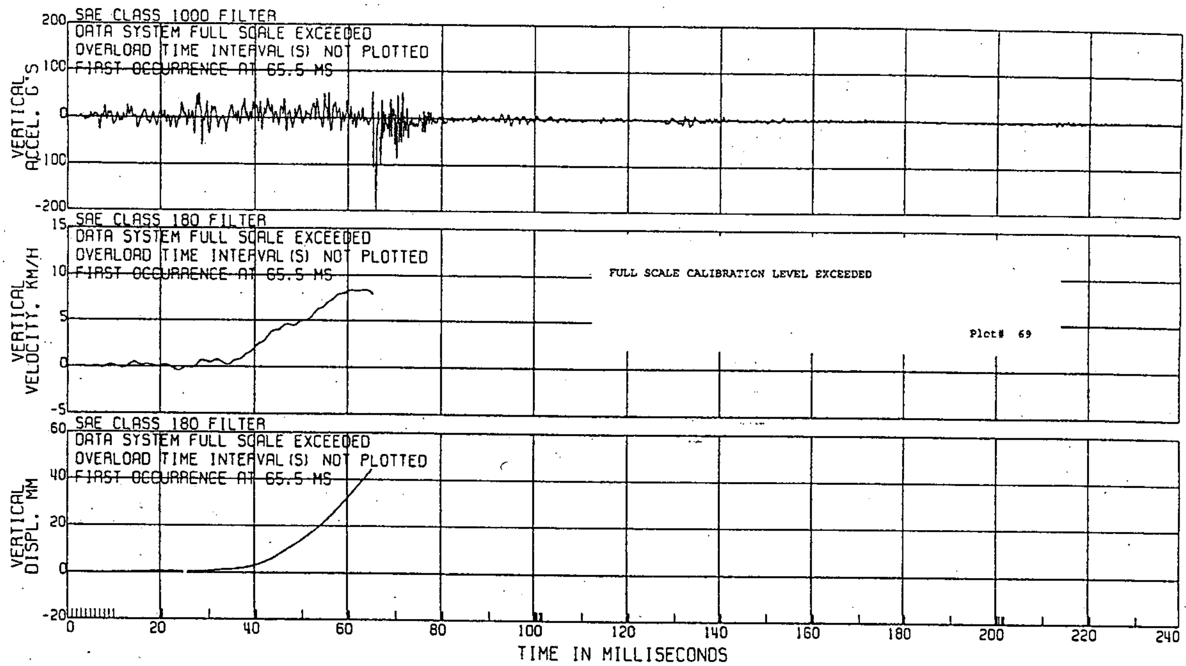
} & D CTR 8W9186D HONDA R. FRT ROCKER TEST DATE:08/12/1998
:LEC DATA



Appendix D, plot # **68**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

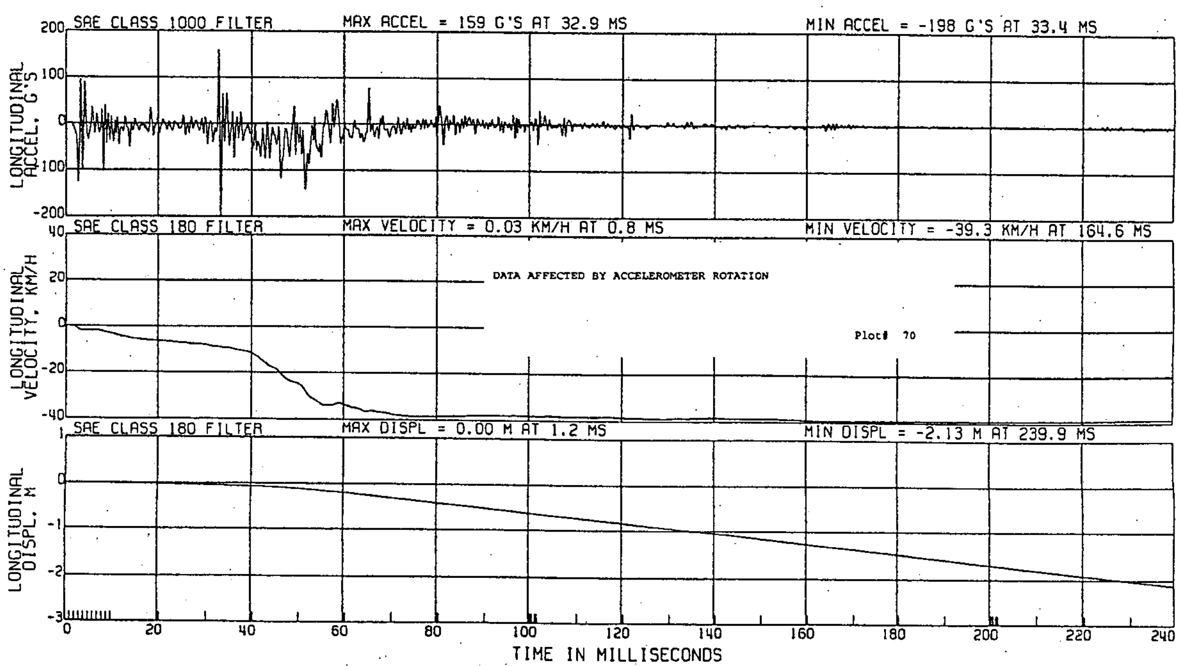
R & D CTR 8W9186D HONDA R. FRT ROCKER TEST DATE:08/12/1998
ELEC DATA



Appendix D, plot # **69**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

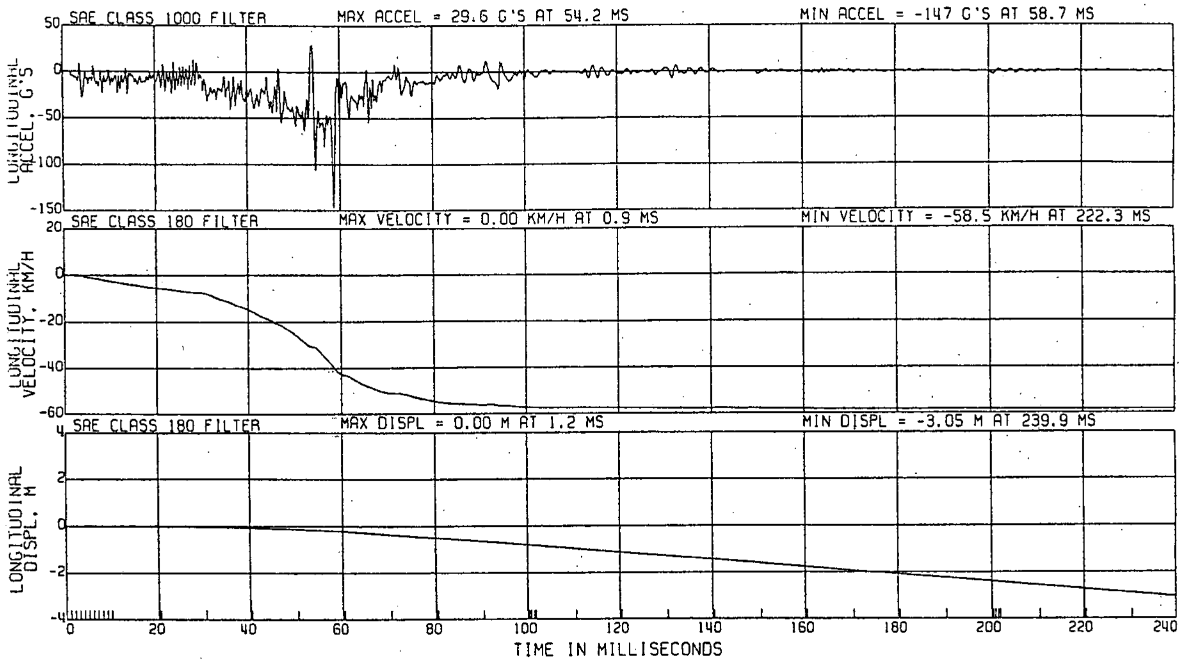
R & D CTR 8W9186D HONDA L. FLOORPAN TEST DATE:08/12/1998
ELEC DATA



Appendix D, plot # **70**

12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

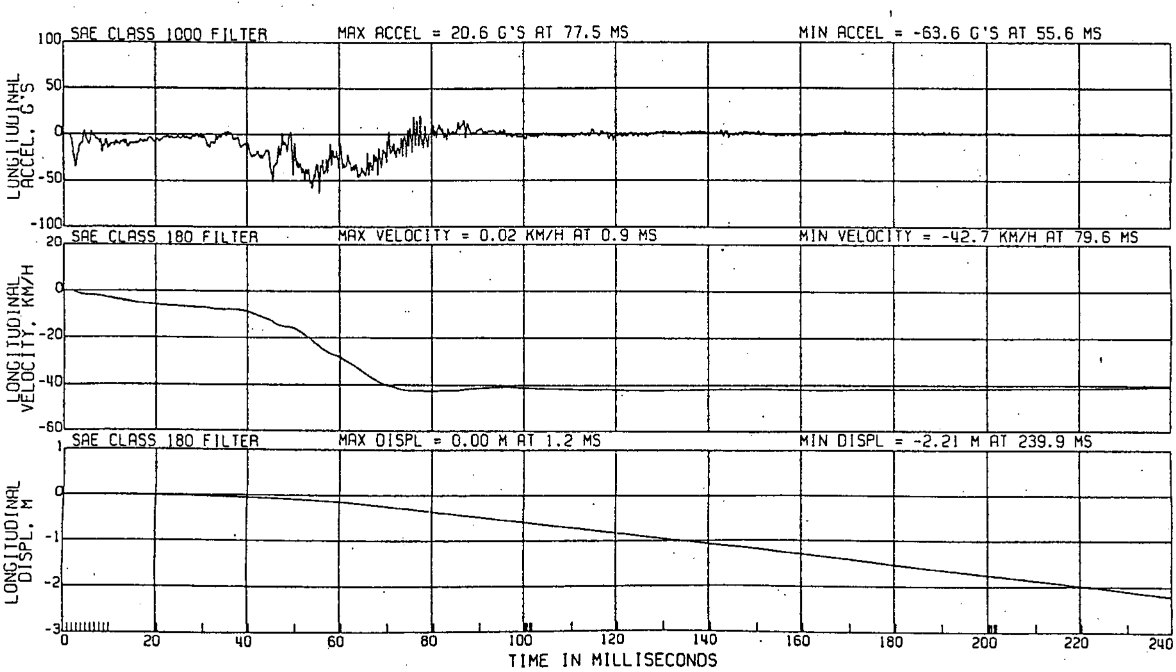
& D CTR 8W9186D HONDA R. FLOORPAN TEST DATE:08/12/1998
LEC DATA



Appendix D, plot # **71**

12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

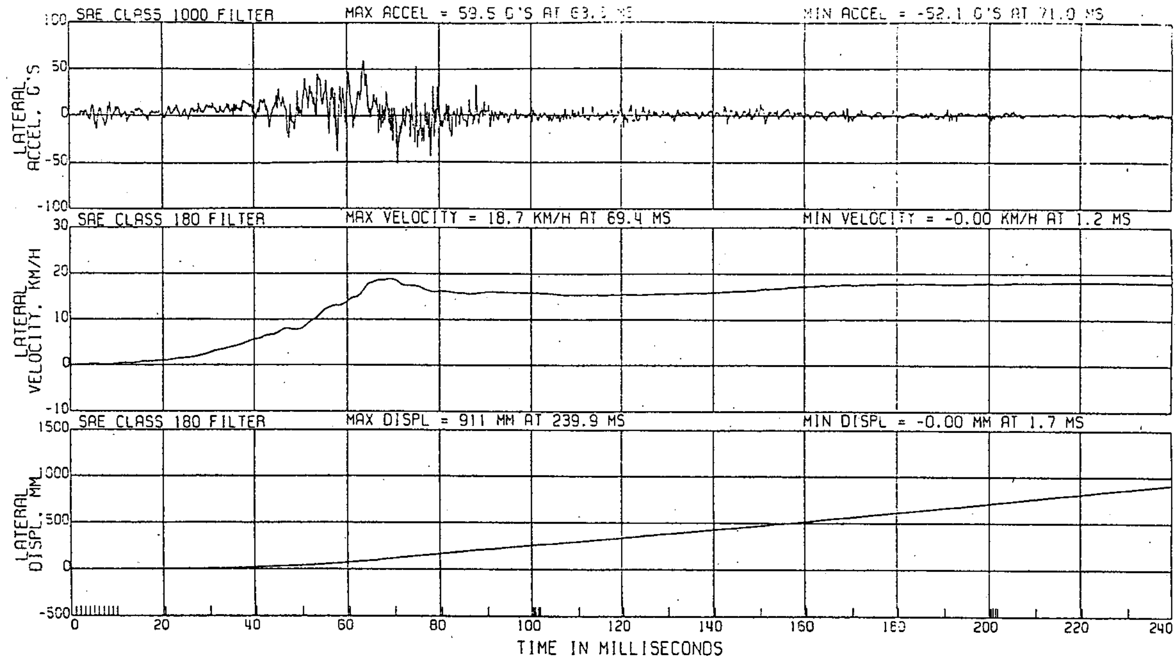
& D CTR 8W9186D HONDA L.REAR ROCKER TEST DATE:08/12/1998
LEC DATA



Appendix D, plot # **72**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

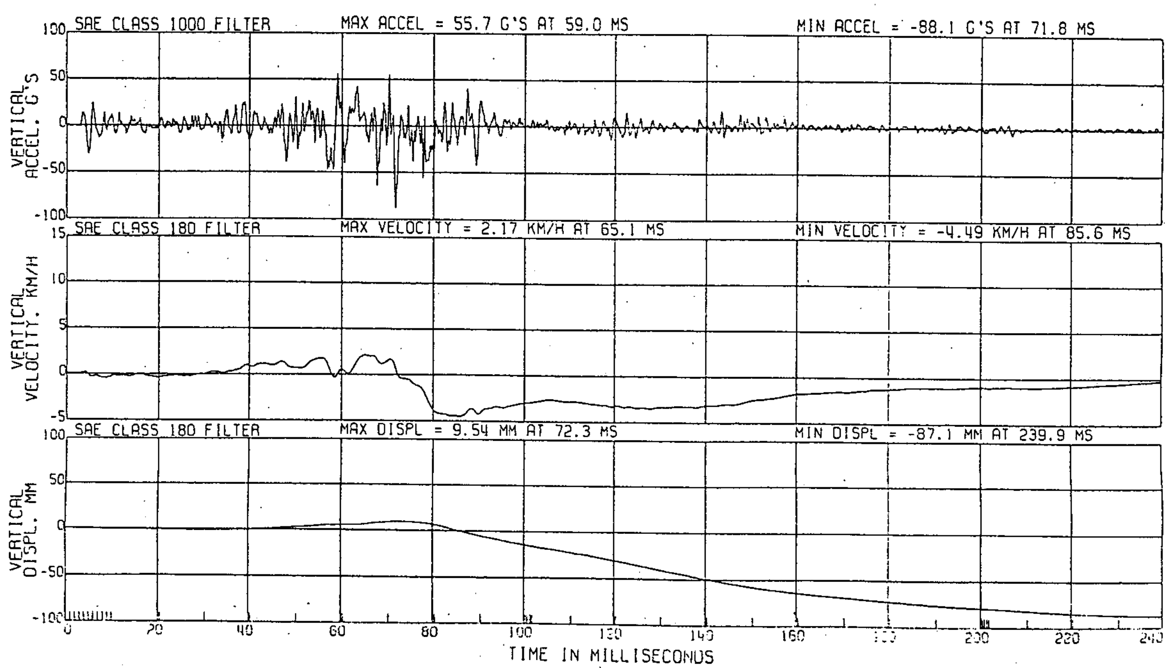
R & D CTR 8W9186D HONDA L.REAR ROCKER TEST DATE:08/12/1998
ELEC DATA



Appendix D, plot # **73**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA L.REAR ROCKER TEST DATE:08/12/1998
ELEC DATA

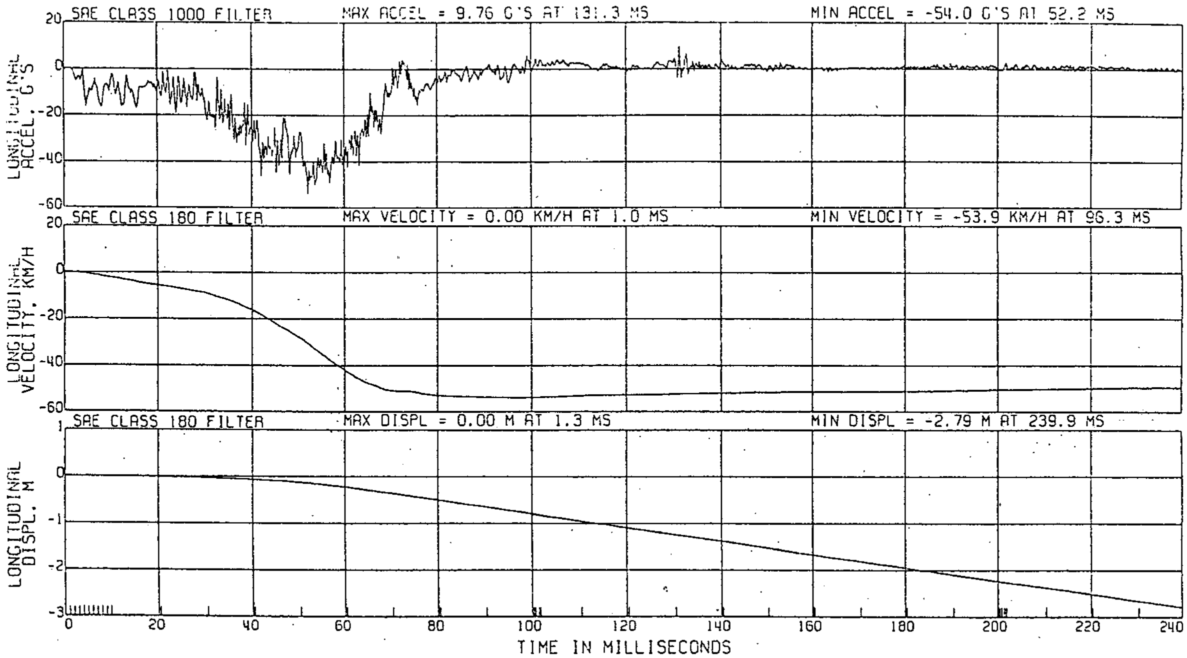


Appendix D, plot # **74**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA R.REAR ROCKER TEST DATE:08/12/1998

ELEC DATA

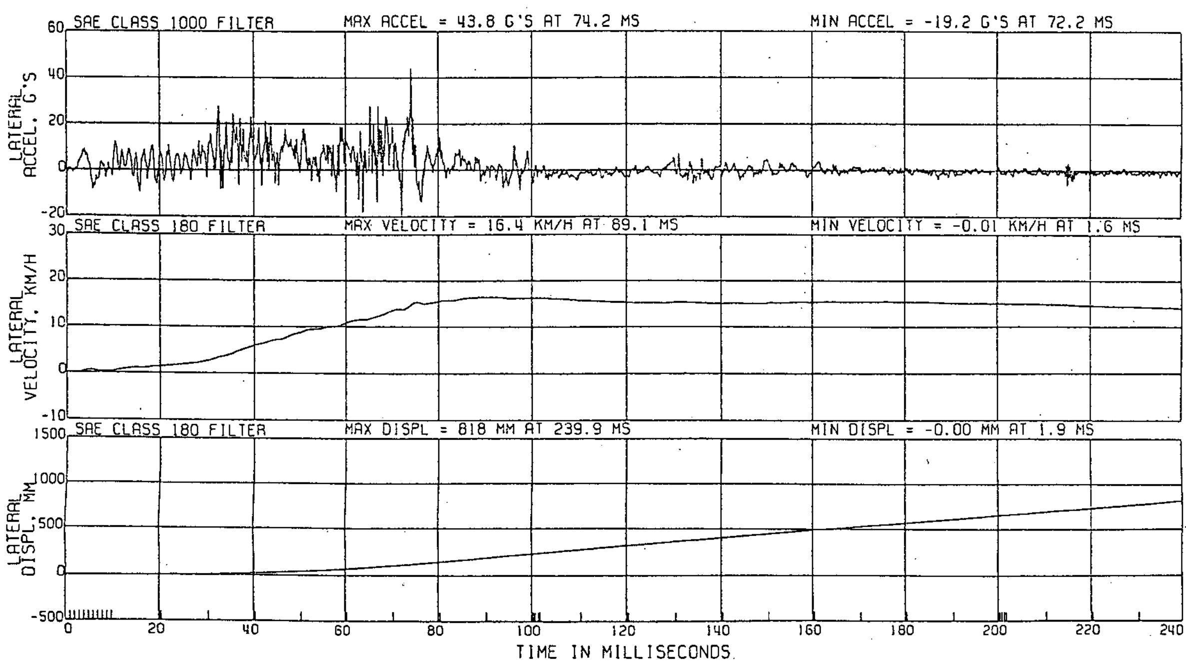


Appendix D, plot # **75**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA R.REAR ROCKER TEST DATE:08/12/1998

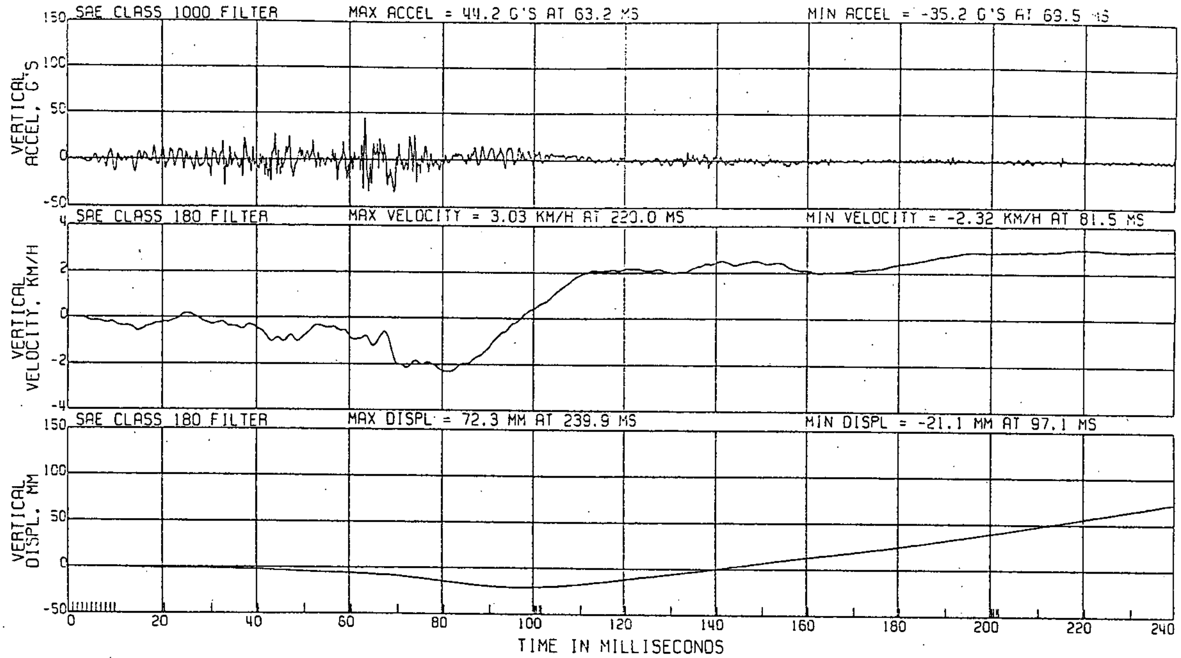
ELEC DATA



Appendix D, plot # **76**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

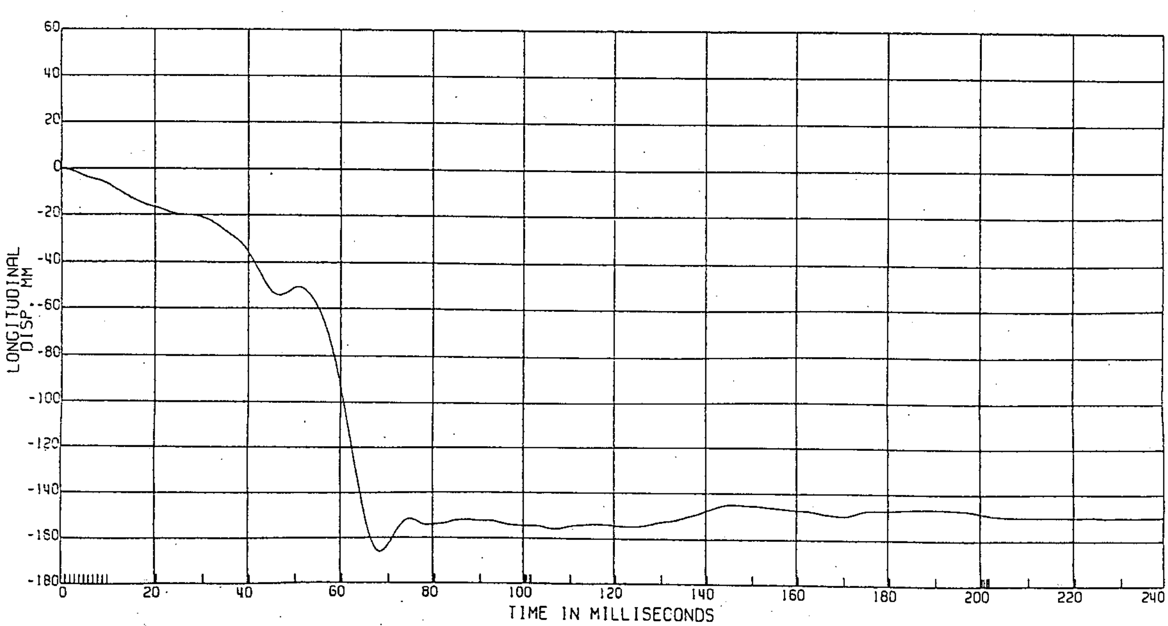
R & D CTR 8W9186D HONDA R.REAR ROCKER TEST DATE:08/12/1998
ELEC DATA



Appendix D, plot # **77**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA L. TOE PAN DISPL TEST DATE:08/12/1998
ELEC DATA, SAE CLASS 60



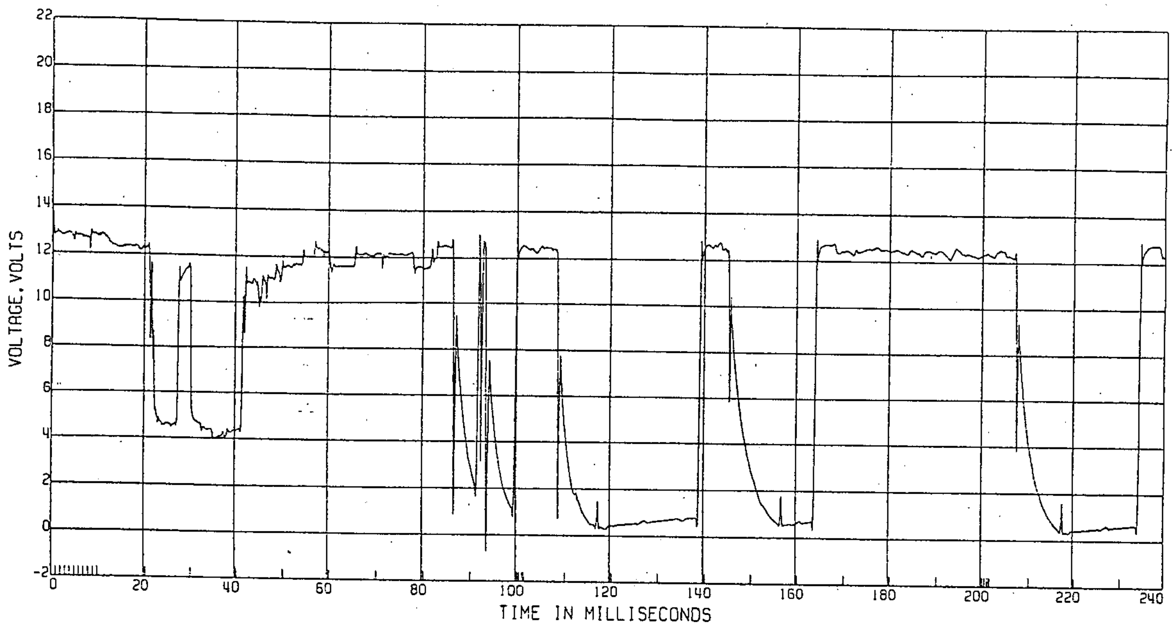
Appendix D, plot # 78

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

IGNITION FEED VOLTAGE

TEST DATE:08/12/1998



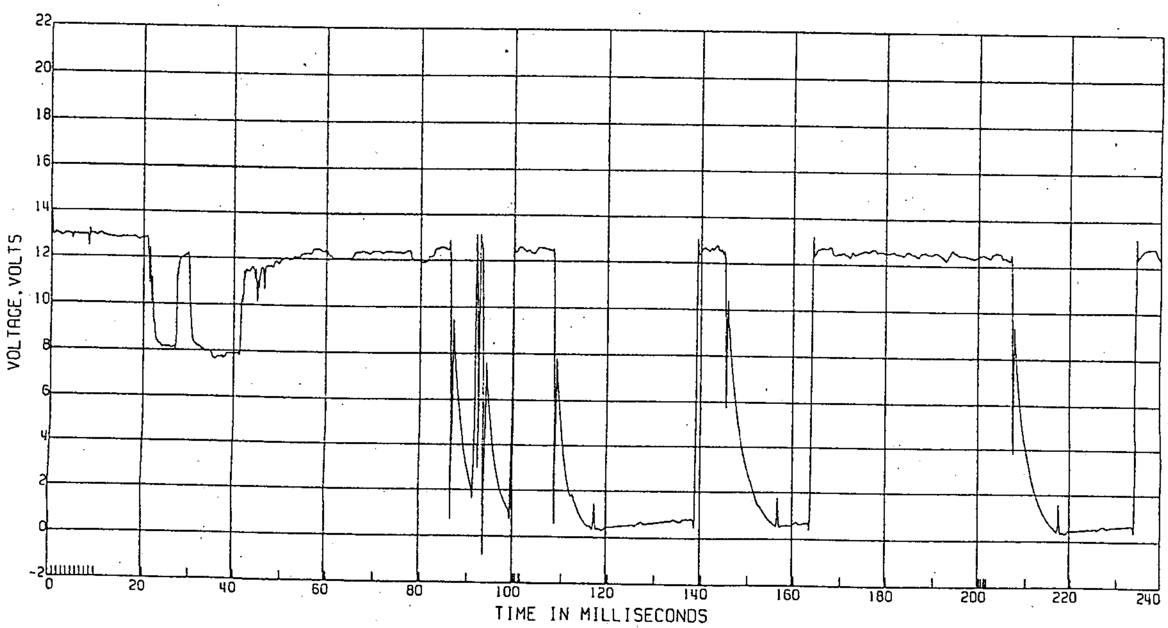
Appendix D, plot # **79**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

R. BATTERY VOLTAGE

TEST DATE:08/12/1998



Appendix D, plot # **80**

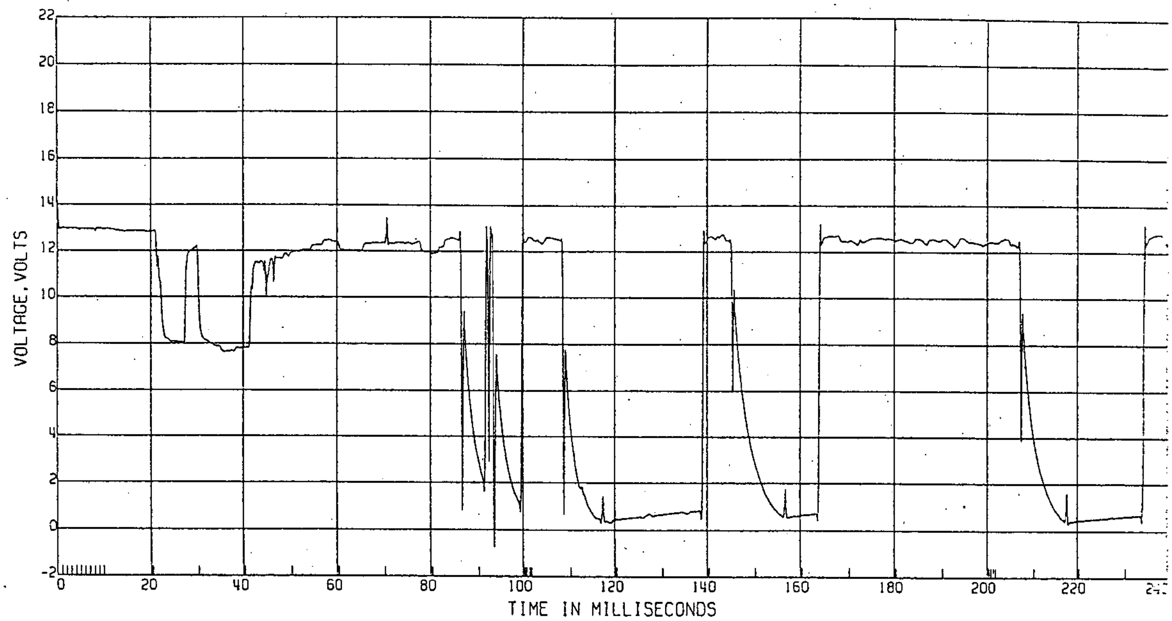
C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

STARTER VOLTAGE

TEST DATE:08/12/1998



Appendix D, plot # 81

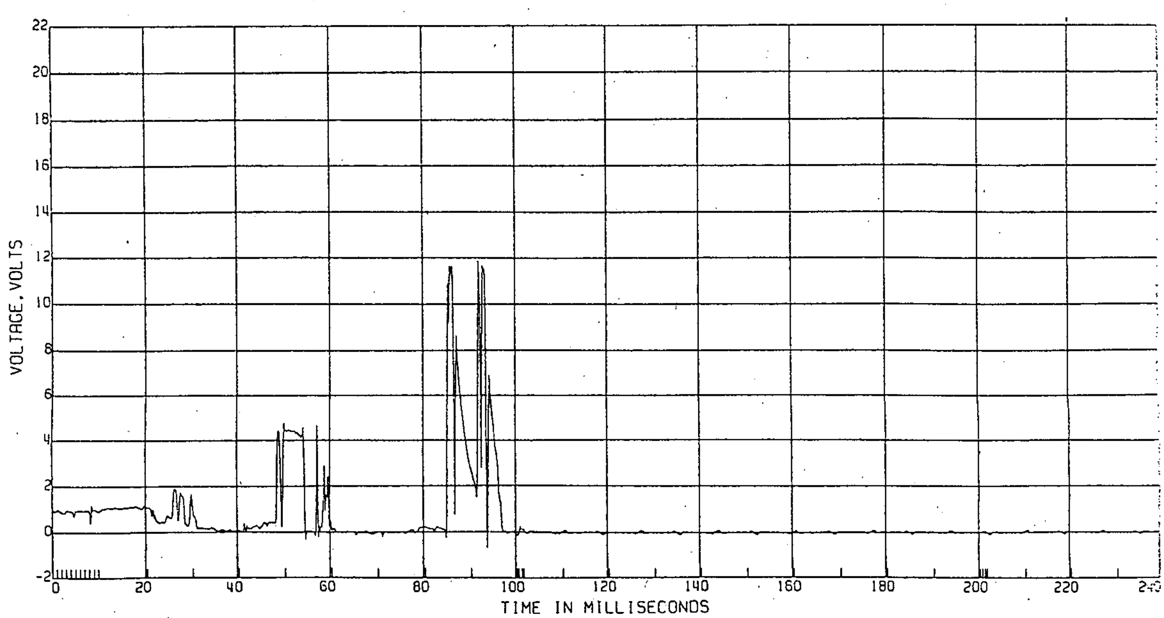
C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

L. FRT HI BEAM-GROUND VOLTAGE

TEST DATE:08/12/1998



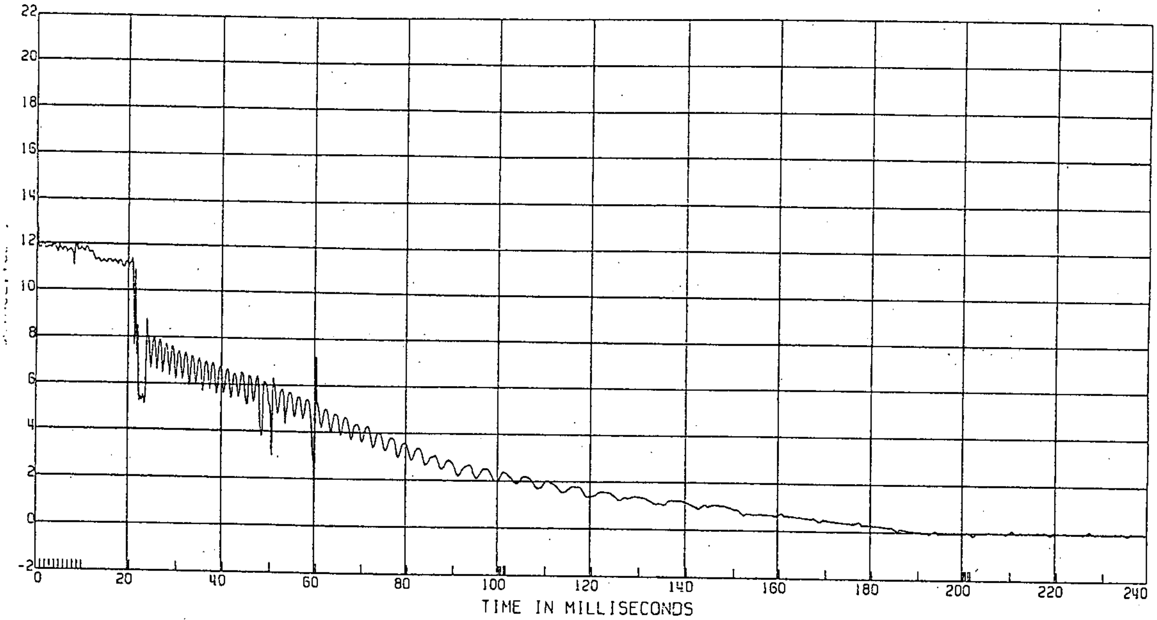
127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

D CTR 8W91860 HONDA

FUEL PUMP VOLTAGE

TEST DATE:08/12/1998

C DATA, SAE CLASS 1000



Appendix D, plot # **83**

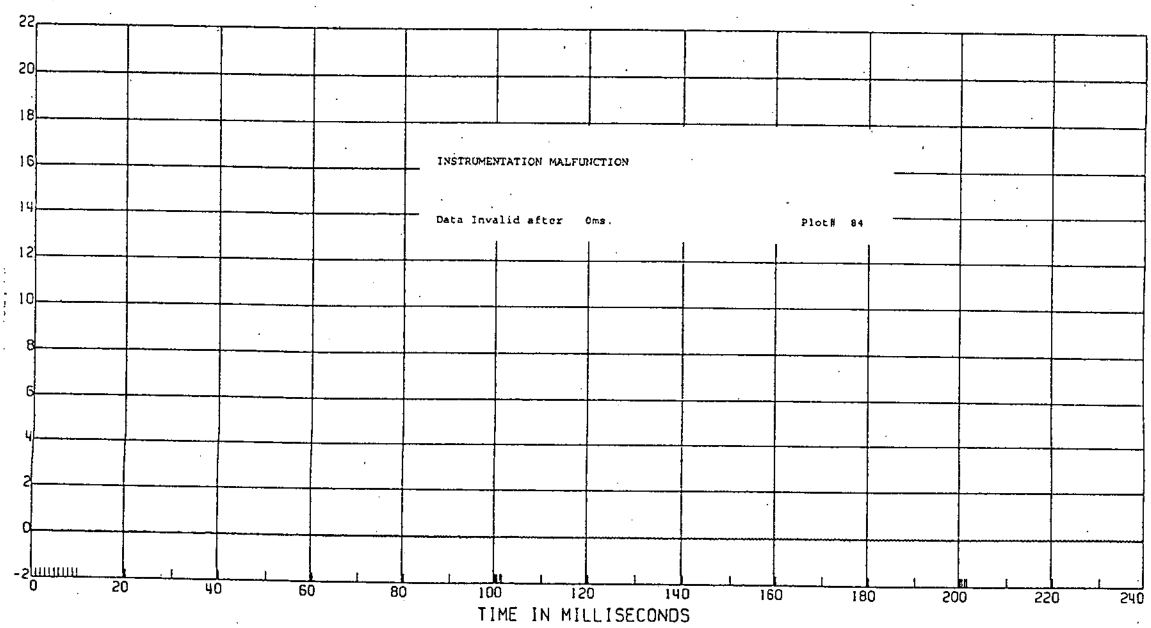
127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

D CTR 8W91860 HONDA

ENGINE RPM VOLTAGE

TEST DATE:08/12/1998

C DATA, SAE CLASS 1000



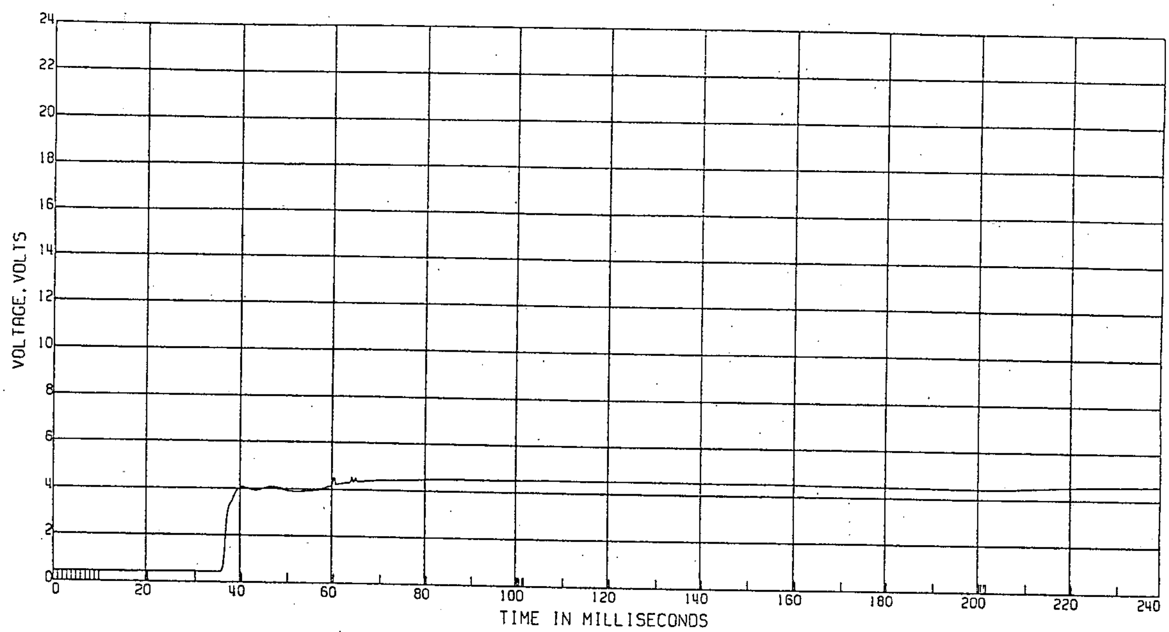
Appendix D, plot # **84**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

L. FUEL RAIL SENSOR #1 VOLTAGE

TEST DATE:08/12/1998



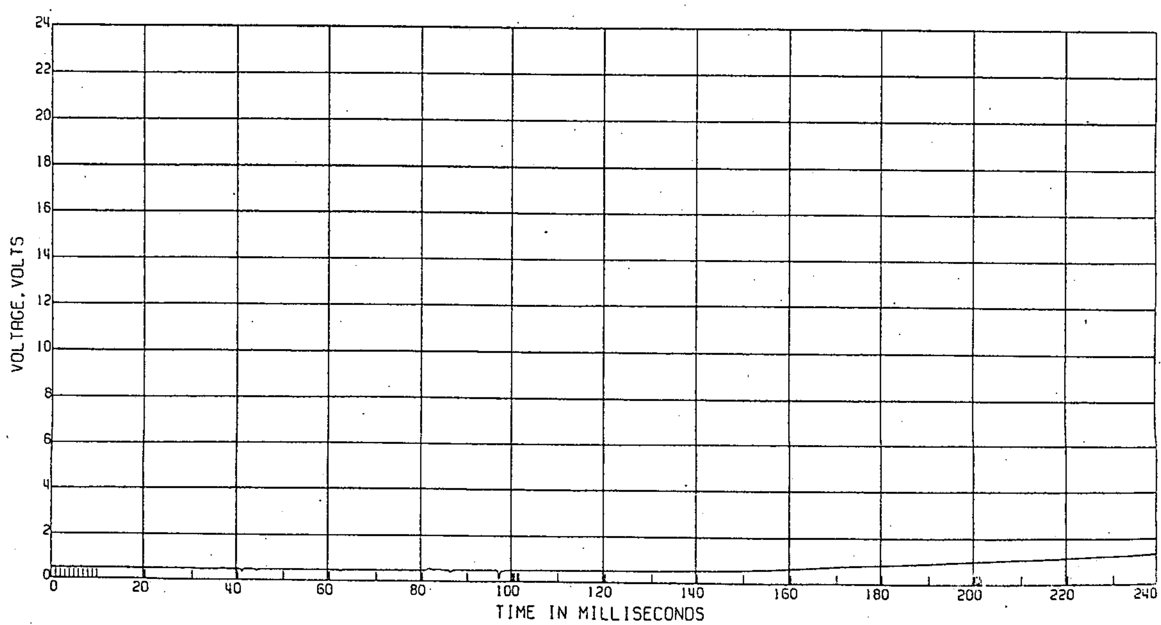
Appendix D, plot # 85

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

R. FUEL RAIL SENSOR #2 VOLTAGE

TEST DATE:08/12/1998



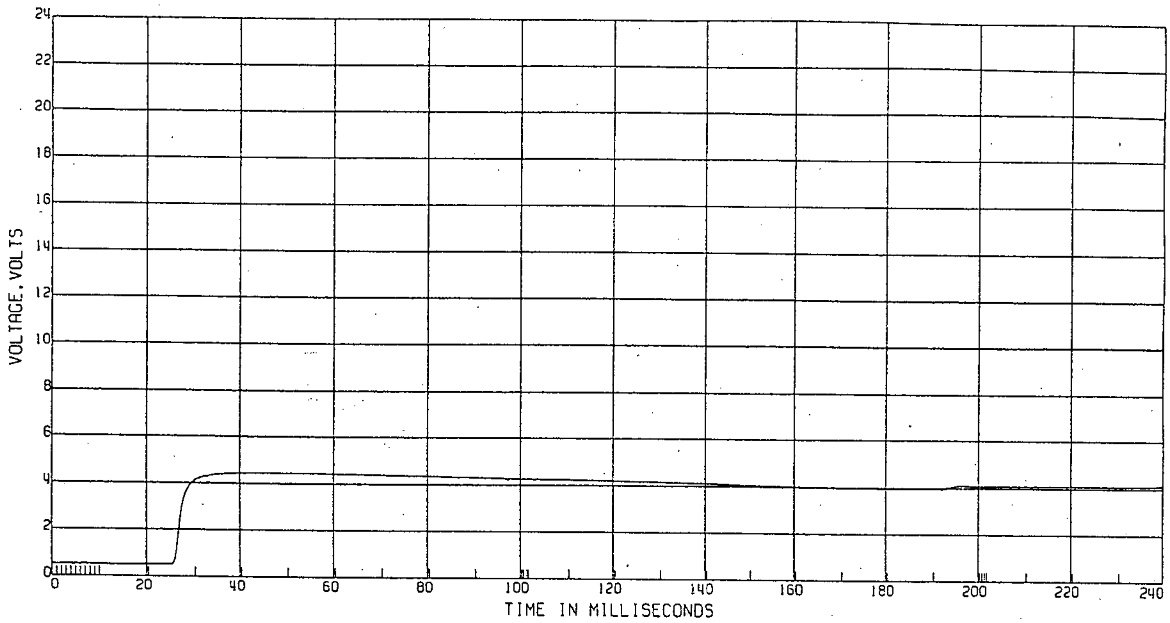
Appendix D, plot # 86

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W91860 HONDA
ELEC DATA, SAE CLASS 1000

L. MANIFOLD SHIELD SENSOR #3 VOLTAGE

TEST DATE:08/12/1998



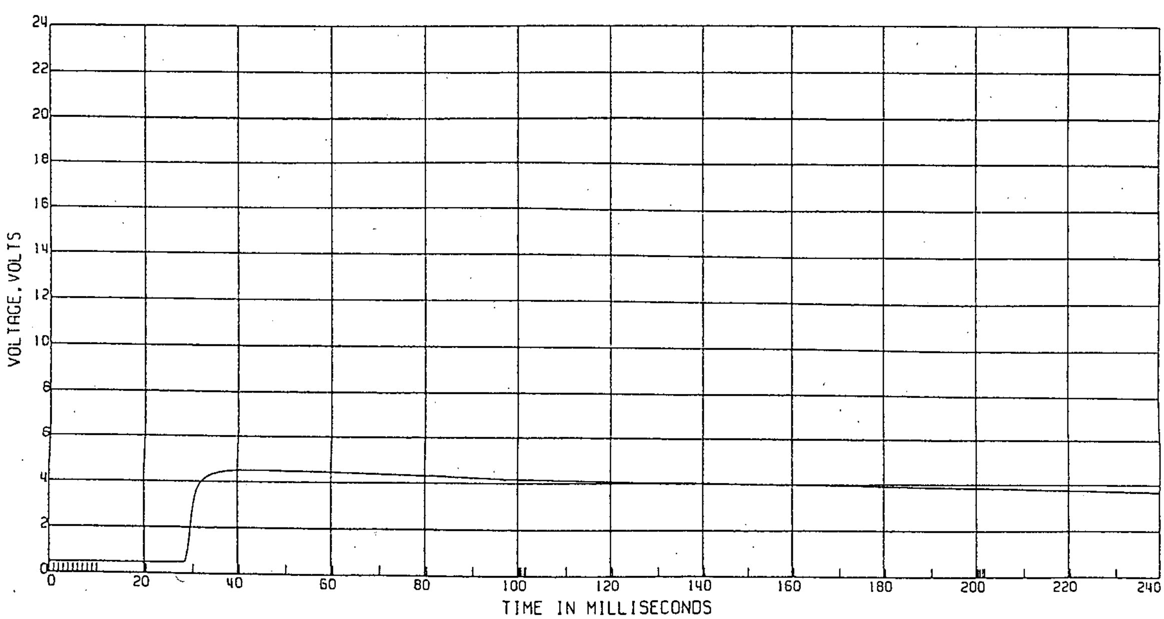
Appendix D, plot # **87**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W91860 HONDA
ELEC DATA, SAE CLASS 1000

R. MANIFOLD SHIELD SENSOR #4 VOLTAGE

TEST DATE:08/12/1998



Appendix D, plot # **88**

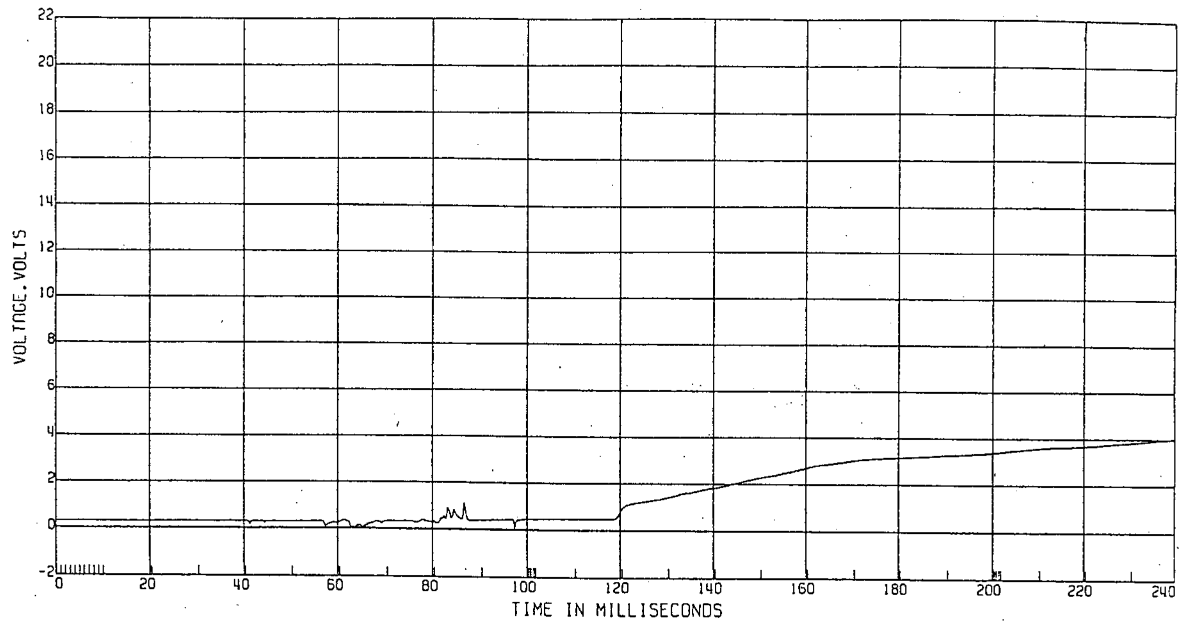
C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

CATALYTIC CONVERTER SENSOR #5 VOLTAGE

TEST DATE:08/12/1998

ELEC DATA, SAE CLASS 1000



Appendix D, plot # **89**

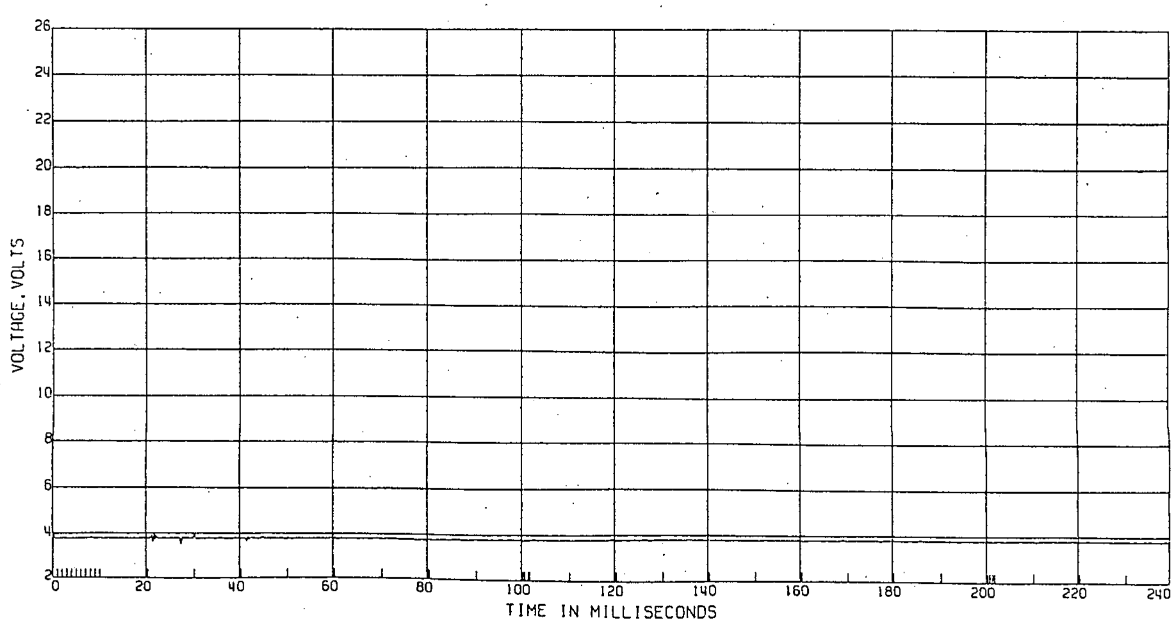
C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

OPTICAL DISC SENSOR #1 VOLTAGE

TEST DATE:08/12/1998

ELEC DATA, SAE CLASS 1000



Appendix D, plot # **90**

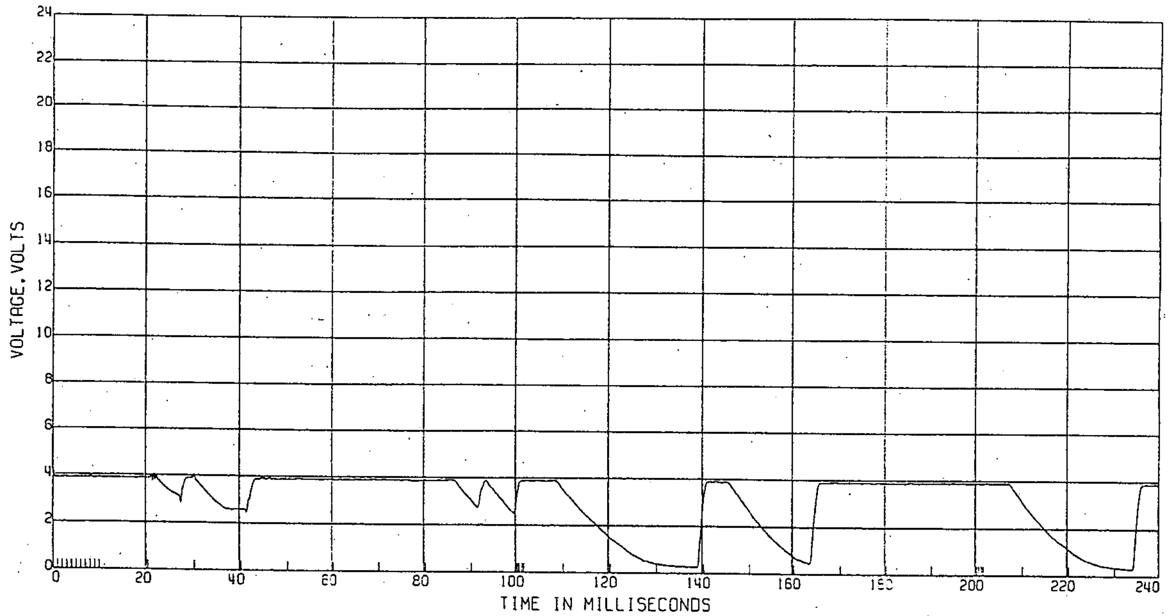
12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

OPTICAL DISC SENSOR #2 VOLTAGE

TEST DATE:08/12/1998

LEC DATA, SAE CLASS 1000



Appendix D, plot # 91

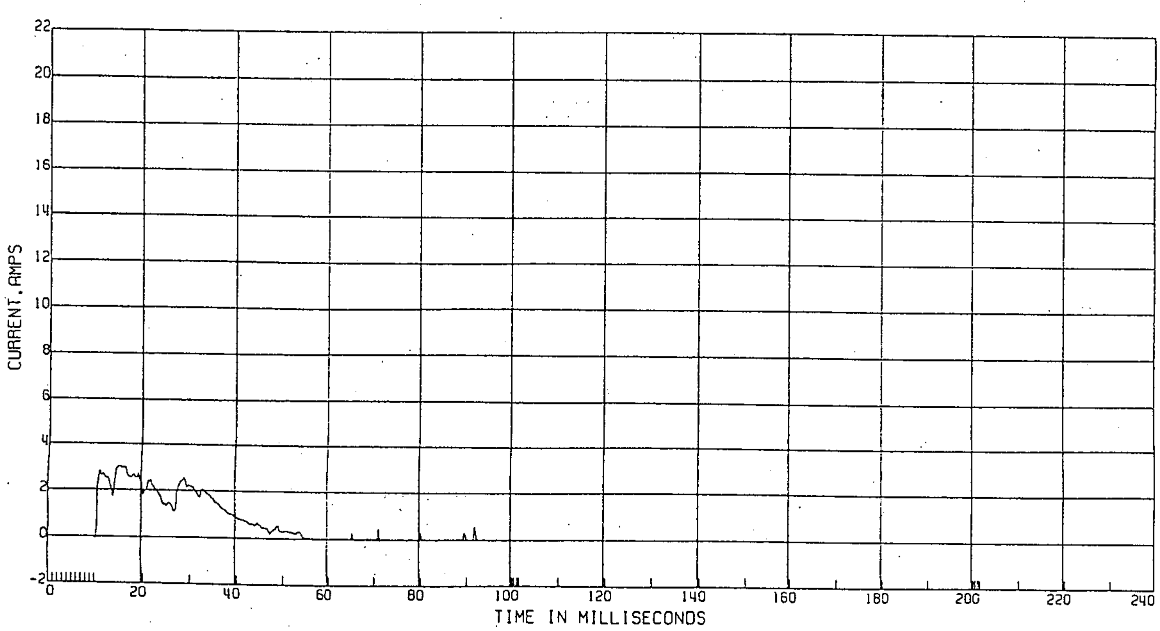
12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

WHEEL BAG CURRENT

TEST DATE:08/12/1998

LEC DATA, SAE CLASS 1000



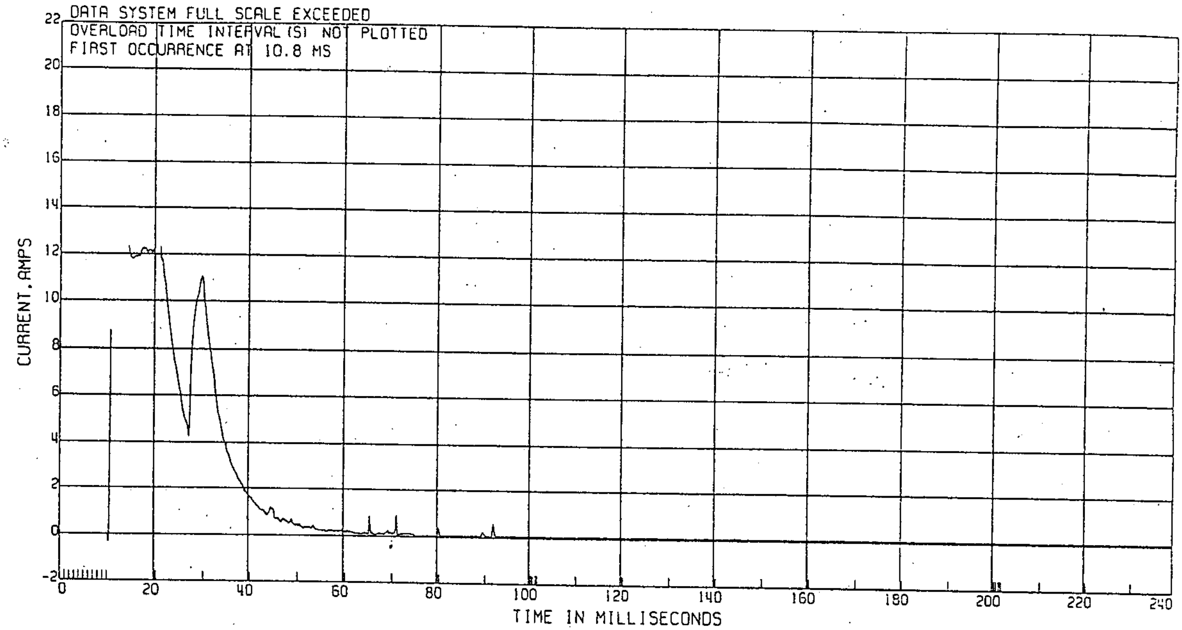
Appendix D, plot # 92

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

I/P BAG CURRENT

TEST DATE:08/12/1998



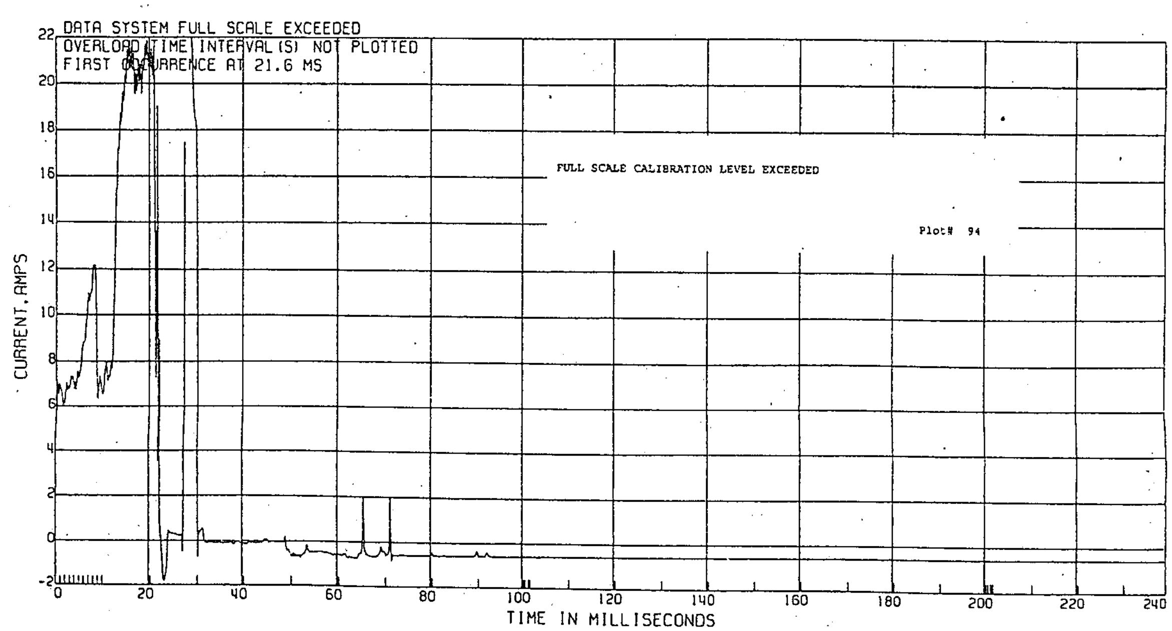
Appendix D, plot # 93

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA
ELEC DATA, SAE CLASS 1000

IGNITION FEED CURRENT

TEST DATE:08/12/1998



Appendix D, plot # 94

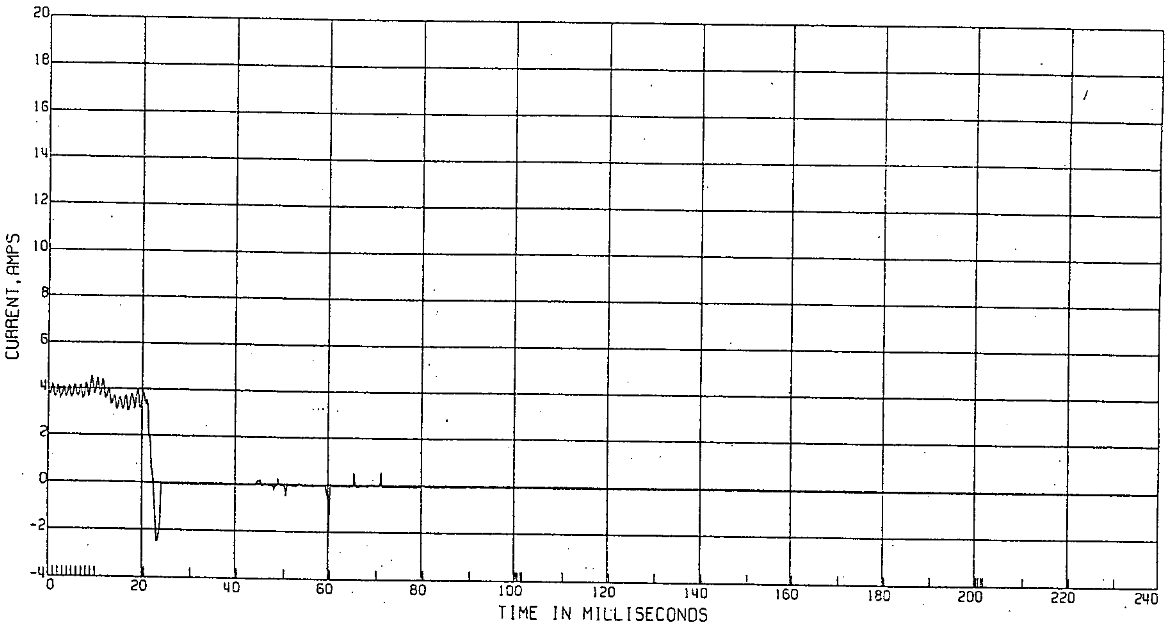
12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

FUEL PUMP CURRENT

EC DATA, SAE CLASS 1000

TEST DATE:08/12/1998



Appendix D, plot # **95**

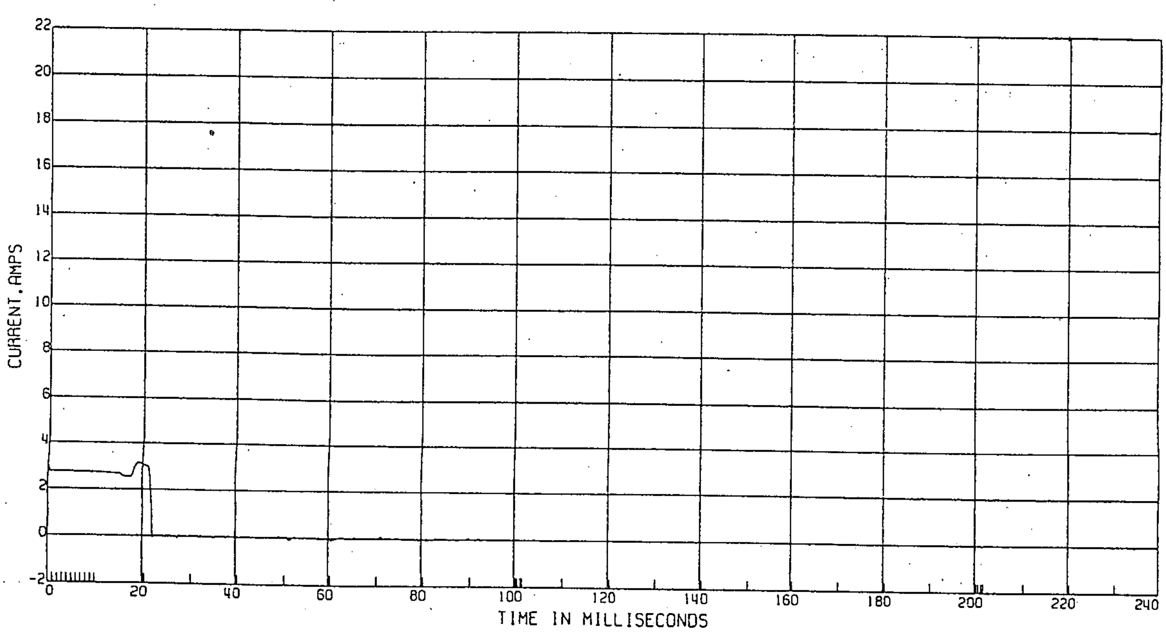
12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

AC CLUTCH CURRENT

EC DATA, SAE CLASS 1000

TEST DATE:08/12/1998



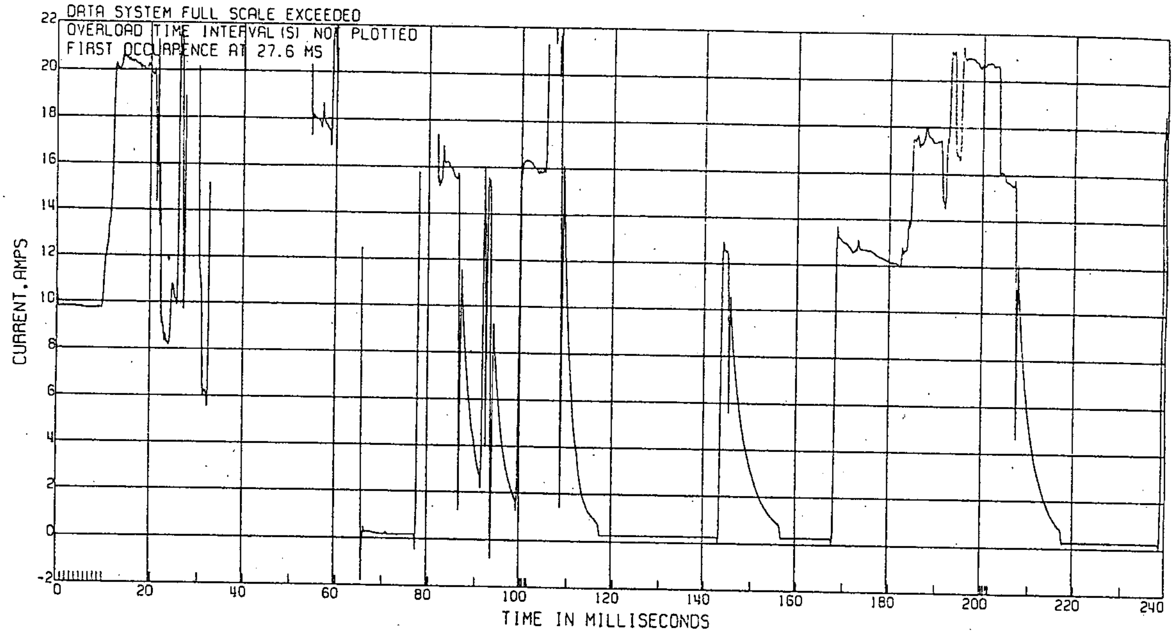
Appendix D, plot # **96**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W91860 HONDA L. FRT HEADLIGHT HI&LOW BEAM CURRENT TEST DATE:08/12/1998
ELEC DATA, SAE CLASS 1000

FULL SCALE CALIBRATION LEVEL EXCEEDED

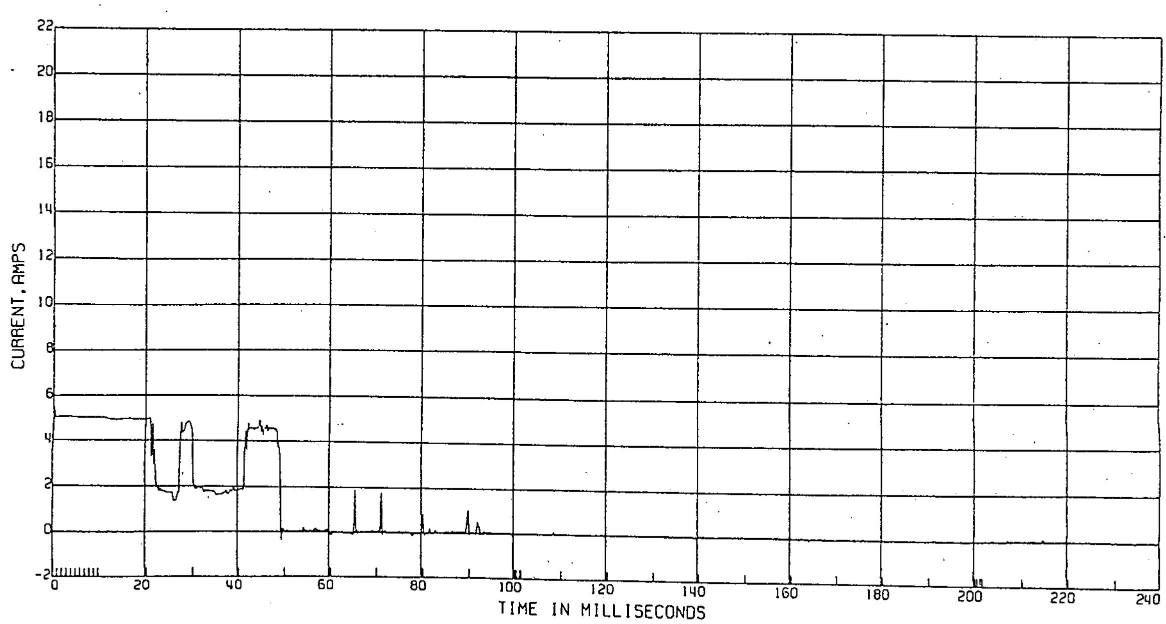
Plot# 97



Appendix D, plot # **97**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W91860 HONDA R. FRT HEADLIGHT HI-BEAM CURRENT TEST DATE:08/12/1998
ELEC DATA, SAE CLASS 1000



Appendix D, plot # **98**

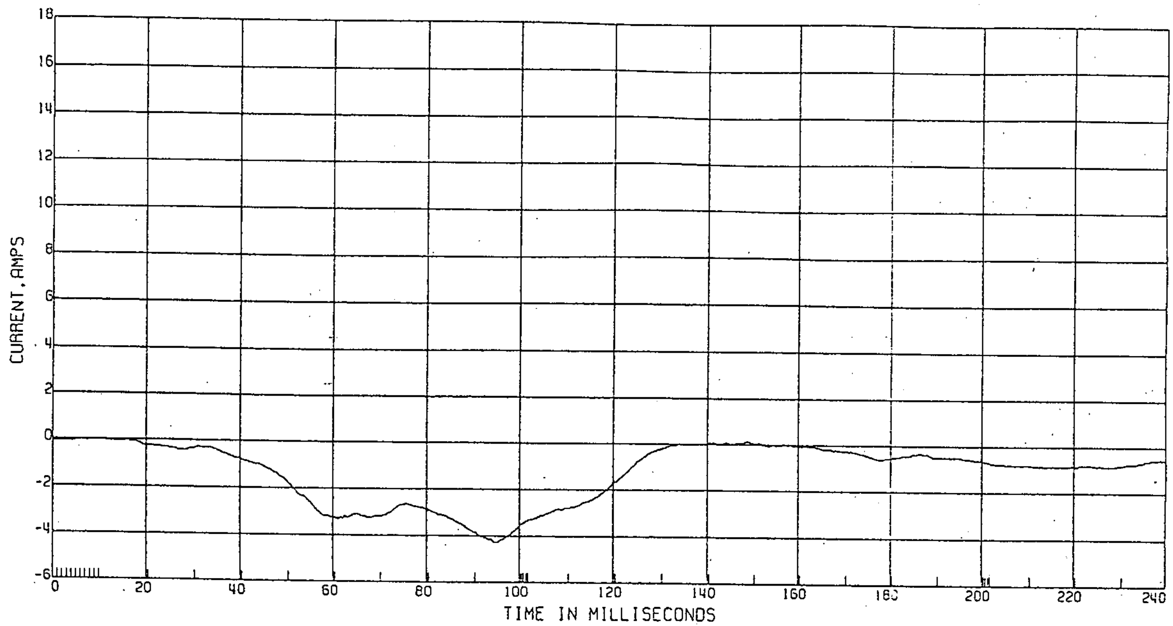
2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

.EC DATA, SAE CLASS 1000

ALTERNATOR CABLE CURRENT

TEST DATE:08/12/1998



Appendix D, plot # **99**

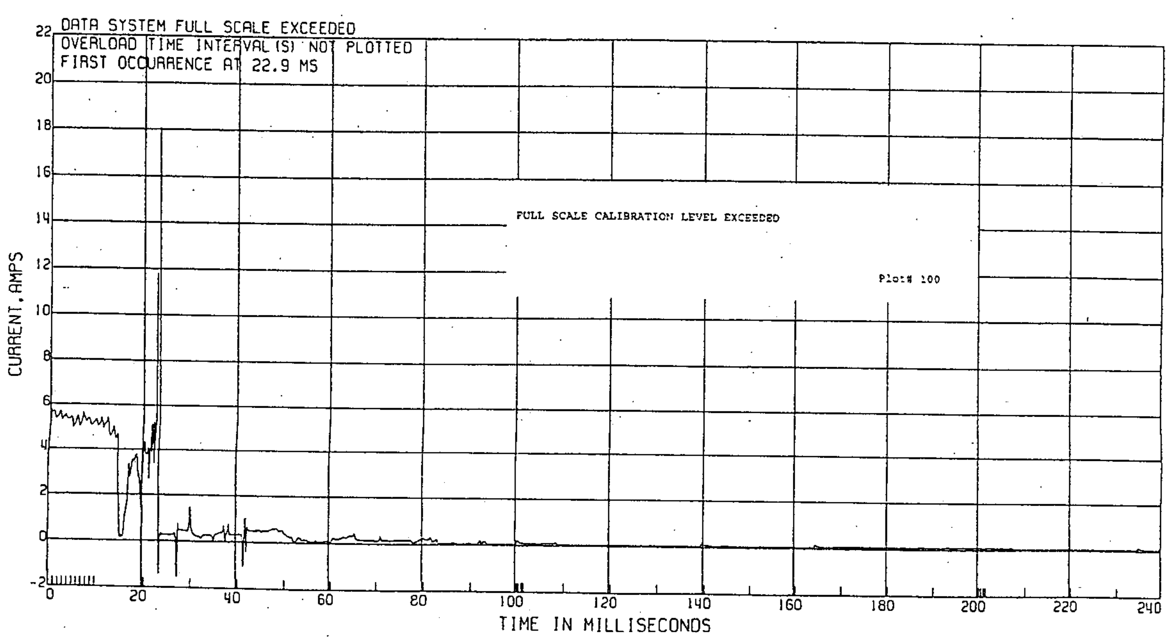
12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

.EC DATA, SAE CLASS 1000

L. CONDENSER FAN CURRENT

TEST DATE:08/12/1998



Appendix D, plot # **100**

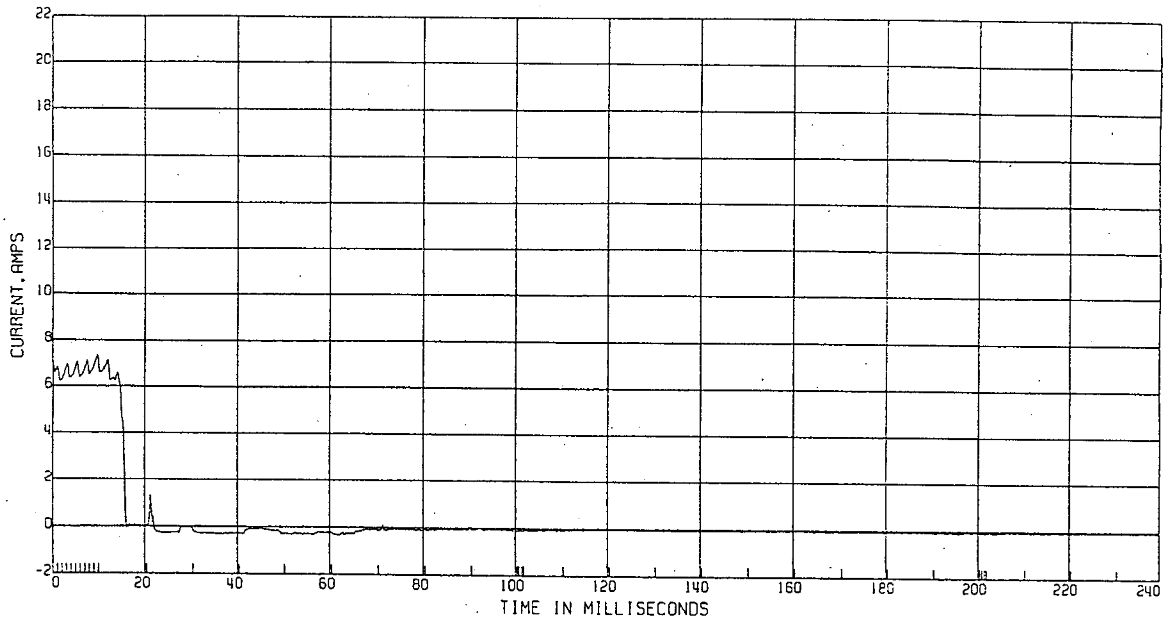
C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

R. RADIATOR FAN CURRENT

TEST DATE:08/12/1998



Appendix D, plot # **101**

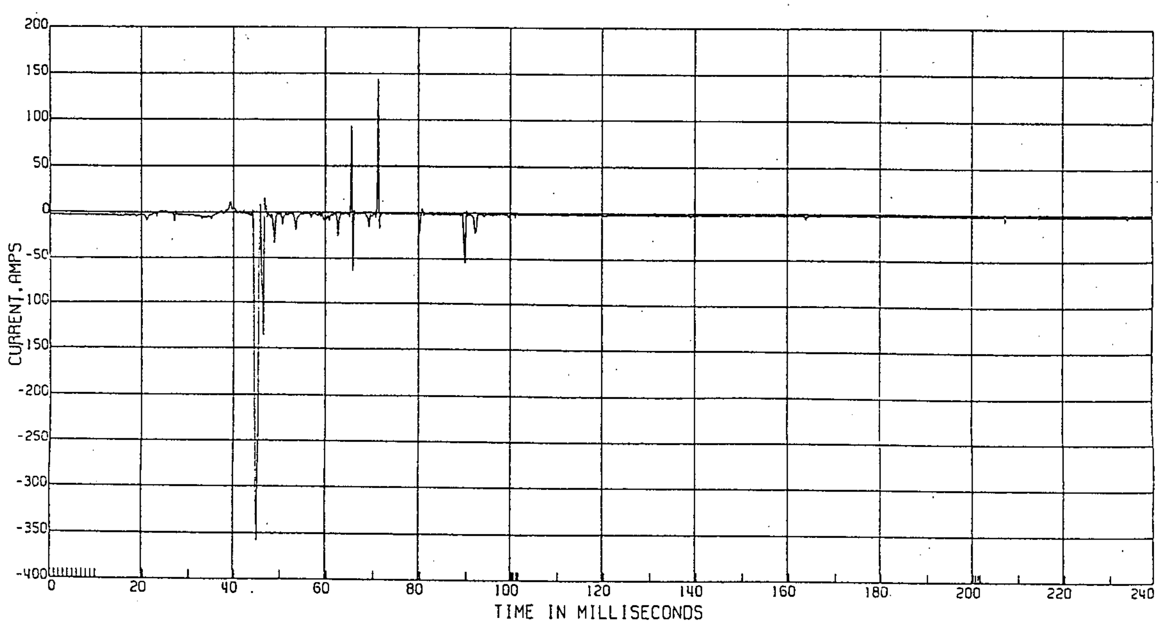
C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

STARTER CABLE CURRENT

TEST DATE:08/12/1998



Appendix D, plot # **102**

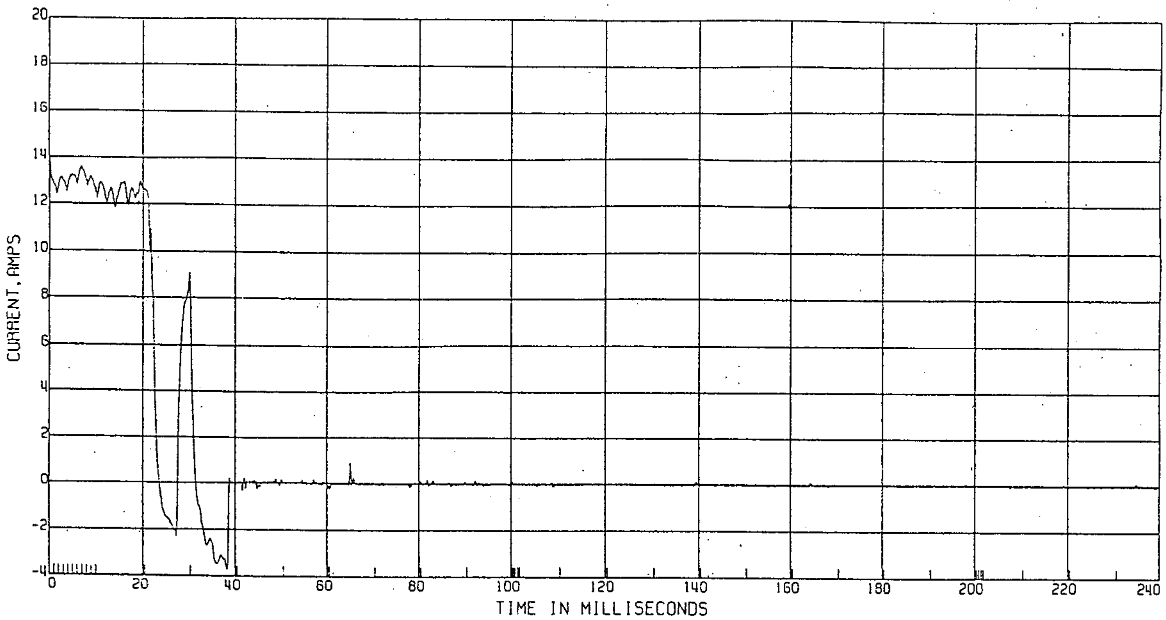
2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

HVAC BLOWER CURRENT

TEST DATE:08/12/1998

EC DATA, SAE CLASS 1000



Appendix D, plot # **103**

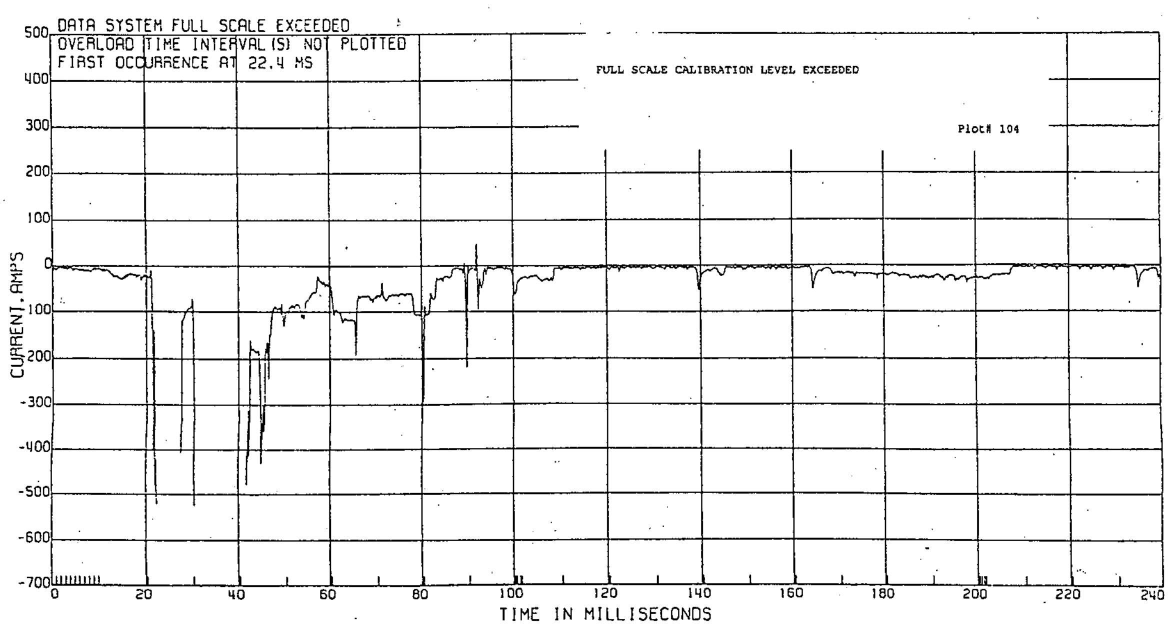
2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA

BATTERY CURRENT

TEST DATE:08/12/1998

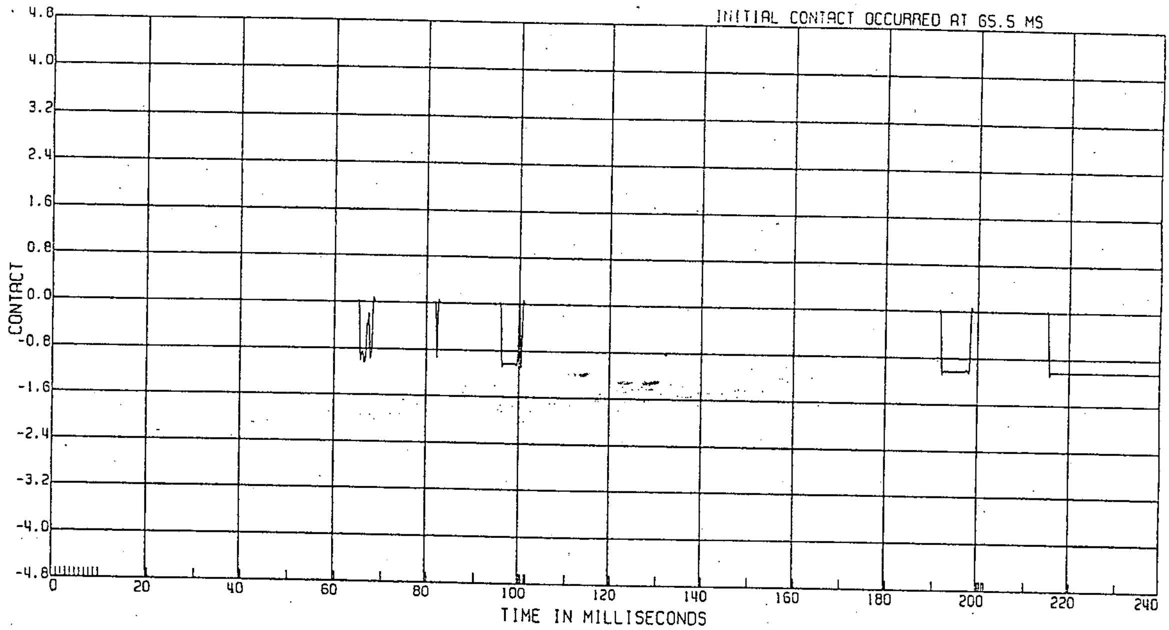
EC DATA, SAE CLASS 1000



Appendix D, plot # **104**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

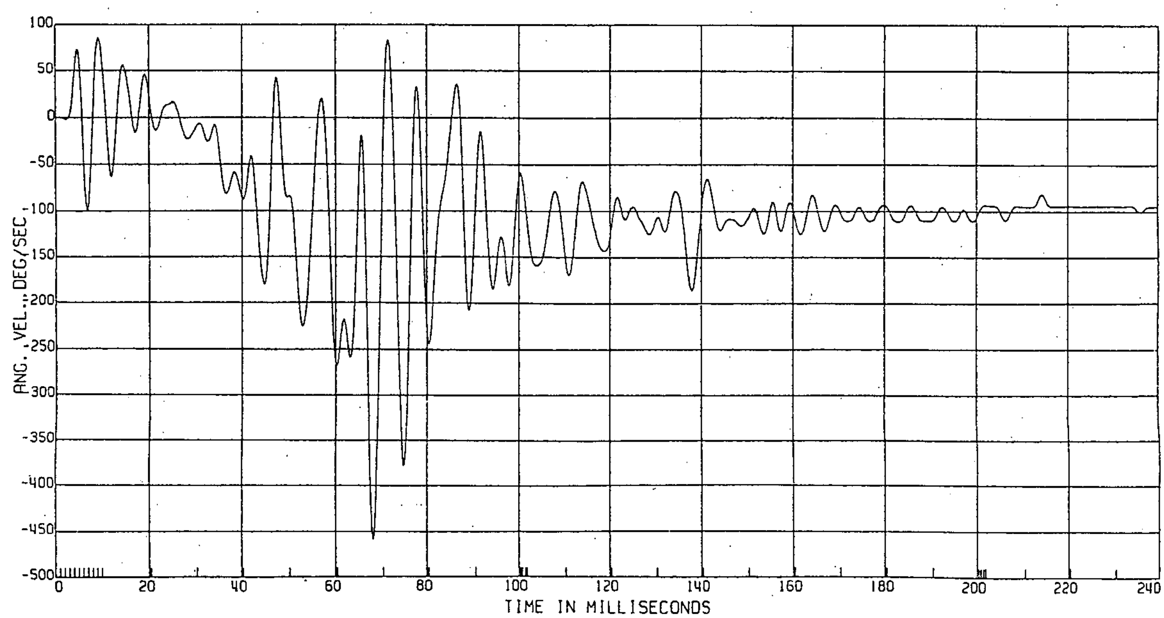
R & D CTR 8W91860 HONDA THERMAL WIRE CONTACT TEST DATE:08/12/1998
ELEC DATA, SAE CLASS 1000



Appendix D, plot # **105**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

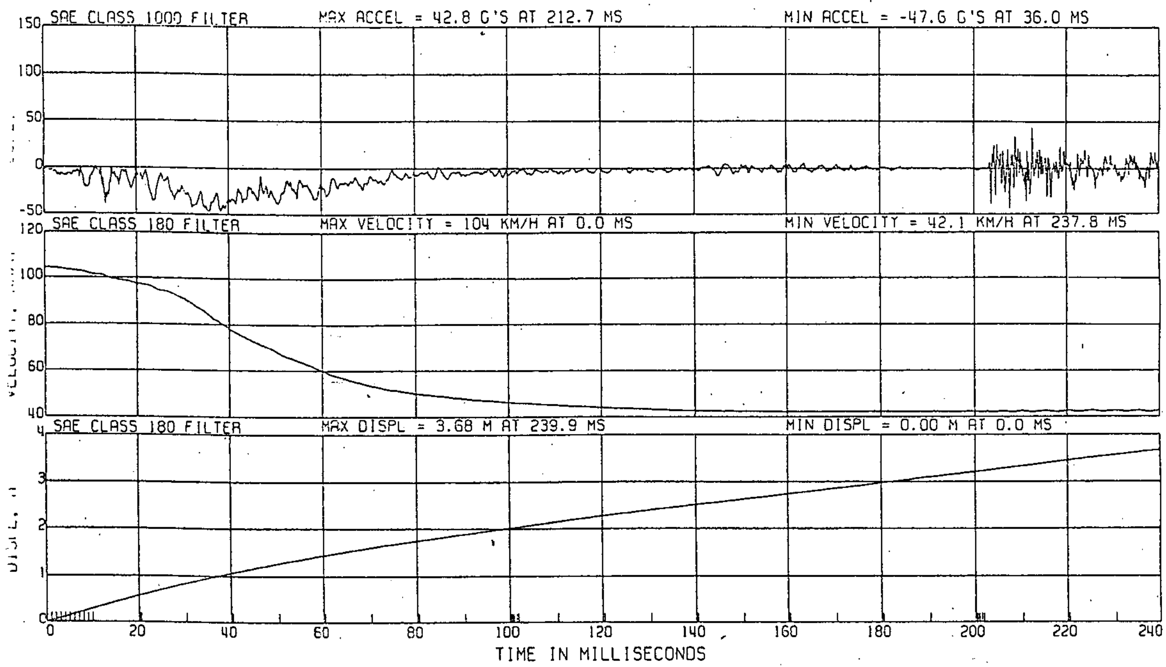
R & D CTR 8W91860 HONDA CTR RATE GYROSCOPE ANG. VEL. TEST DATE:08/12/1998
ELEC DATA, SAE CLASS 180



Appendix D, plot # **106**

.27 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

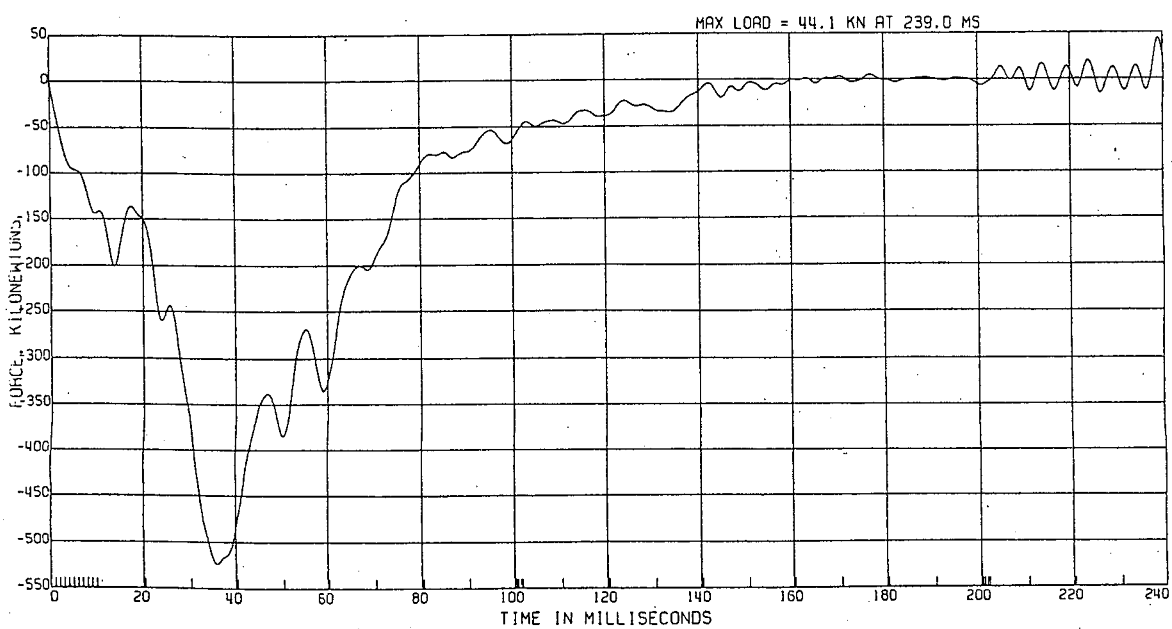
D CTR 8W9186D HONDA LTV MDB AT C.G. TEST DATE:08/12/1998
: DATA



Appendix D, plot # **107**

?127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

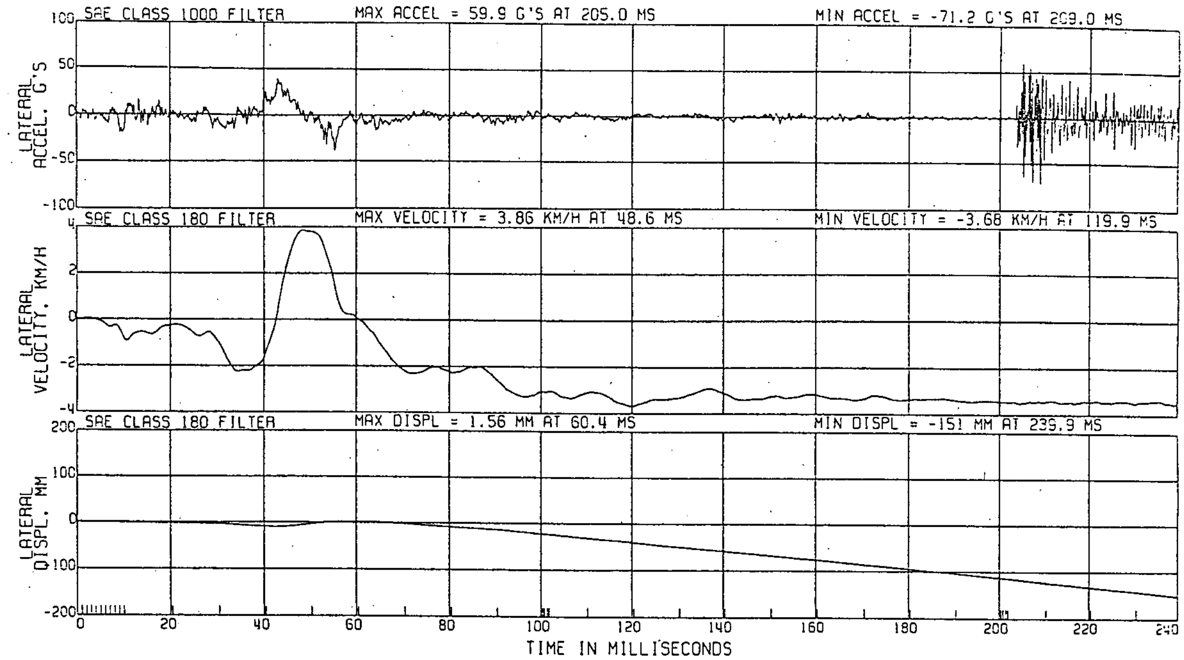
D CTR 8W9186D HONDA LTV MDB LONG. FORCE AT C.G. TEST DATE:08/12/1998
:C DATA, SAE CLASS 60 (1371.0 KG) (9.807) (LONG.ACCEL)



Appendix D, plot # **108**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

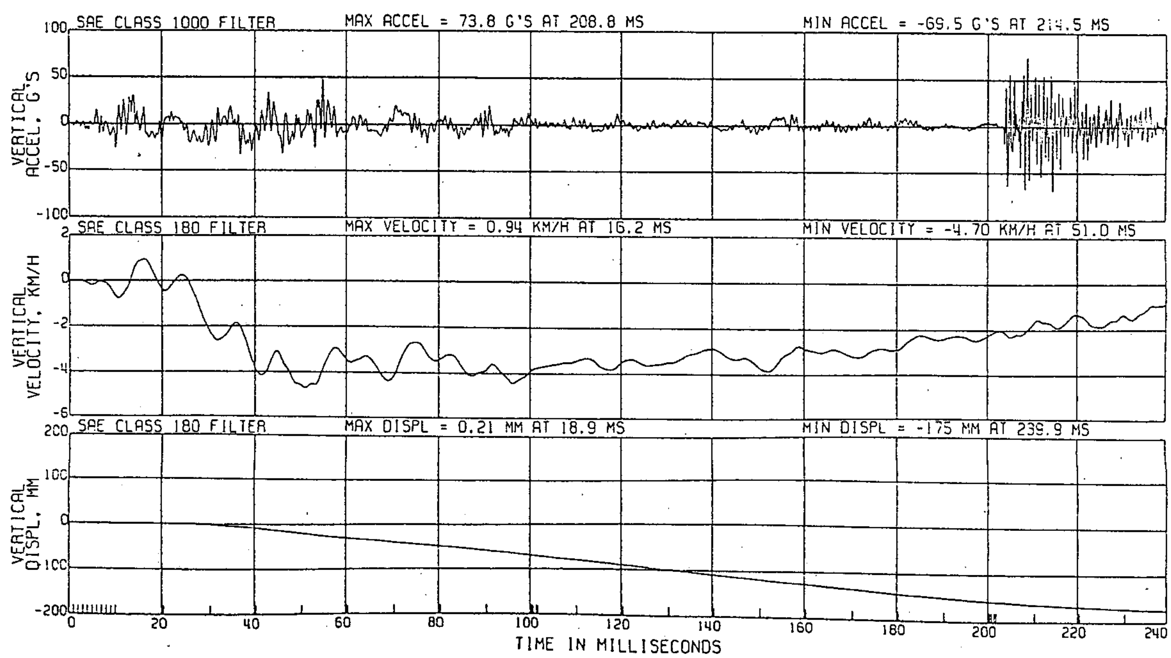
R & D CTR 8W9186D HONDA LTV MDB AT C.G. TEST DATE:08/12/1998
ELEC DATA



Appendix D, plot # **109**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA LTV MDB AT C.G. TEST DATE:08/12/1998
ELEC DATA

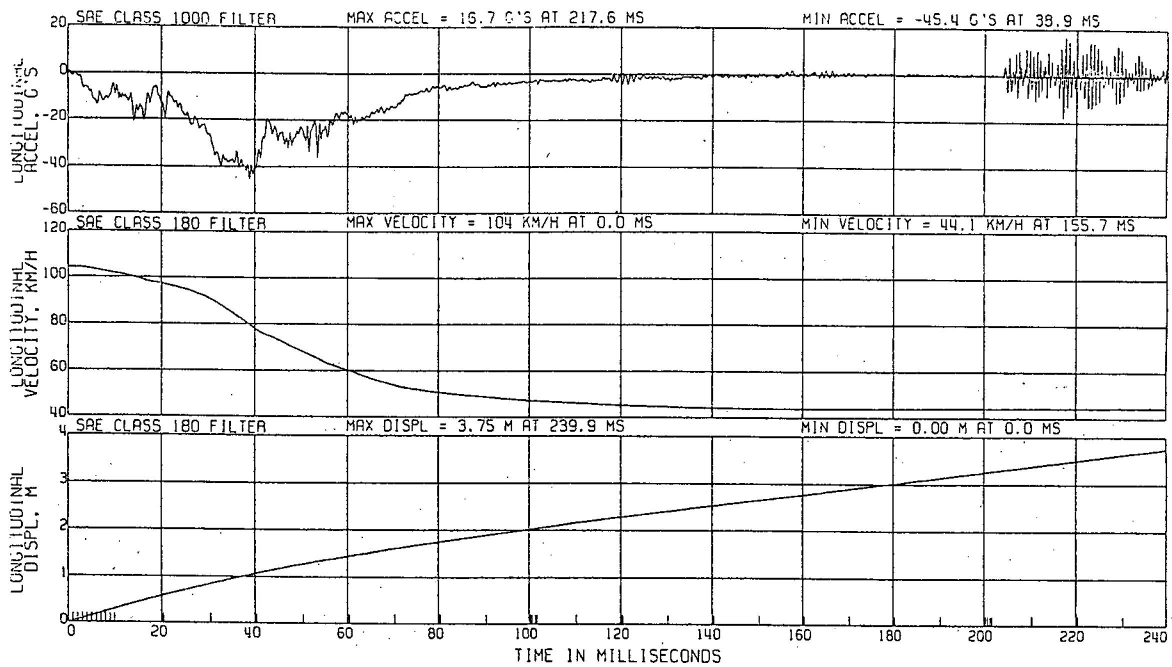


Appendix D, plot # **110**

:2127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA LTV MDB AT REAR C/MBR TEST DATE:08/12/1998

.EC DATA

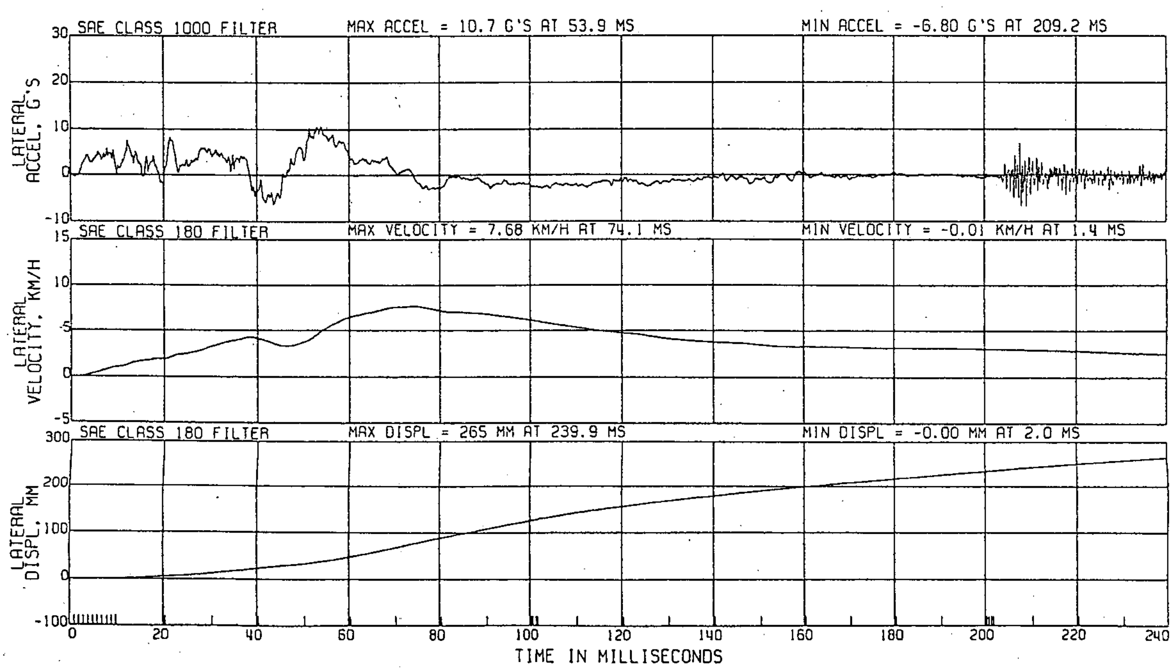


Appendix D, plot # **111**

:12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

& D CTR 8W9186D HONDA LTV MDB AT REAR C/MBR TEST DATE:08/12/1998

:LEC DATA

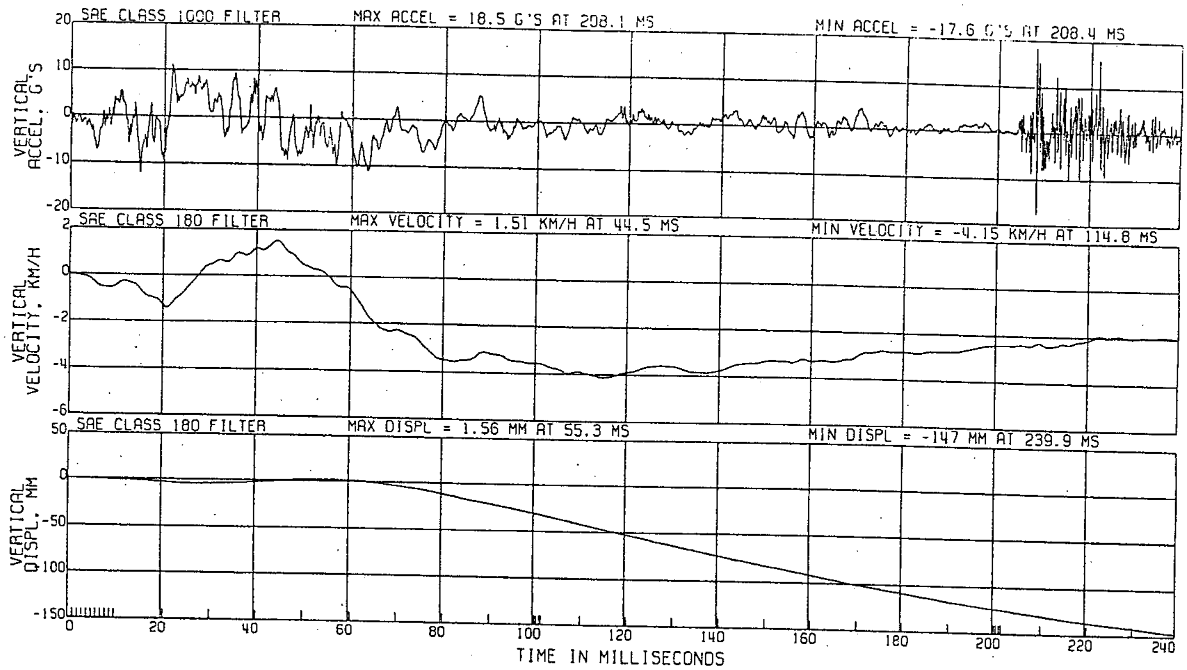


Appendix D, plot # **112**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W91860 HONDA LTV MDB AT REAR C/MBR

ELEC DATA TEST DATE:08/12/1998

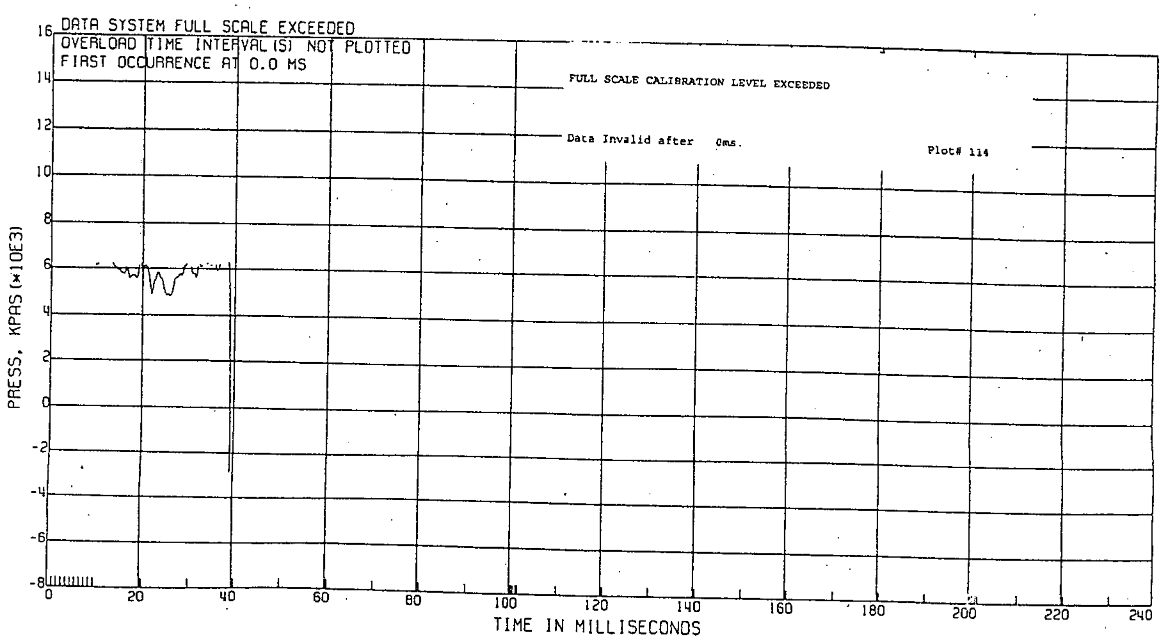


Appendix D, plot # **113**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W91860 HONDA L. FRT BRAKE SYSTEM PRESSURE

ELEC DATA, SAE CLASS 1000 TEST DATE:08/12/1998



Appendix D, plot # **114**

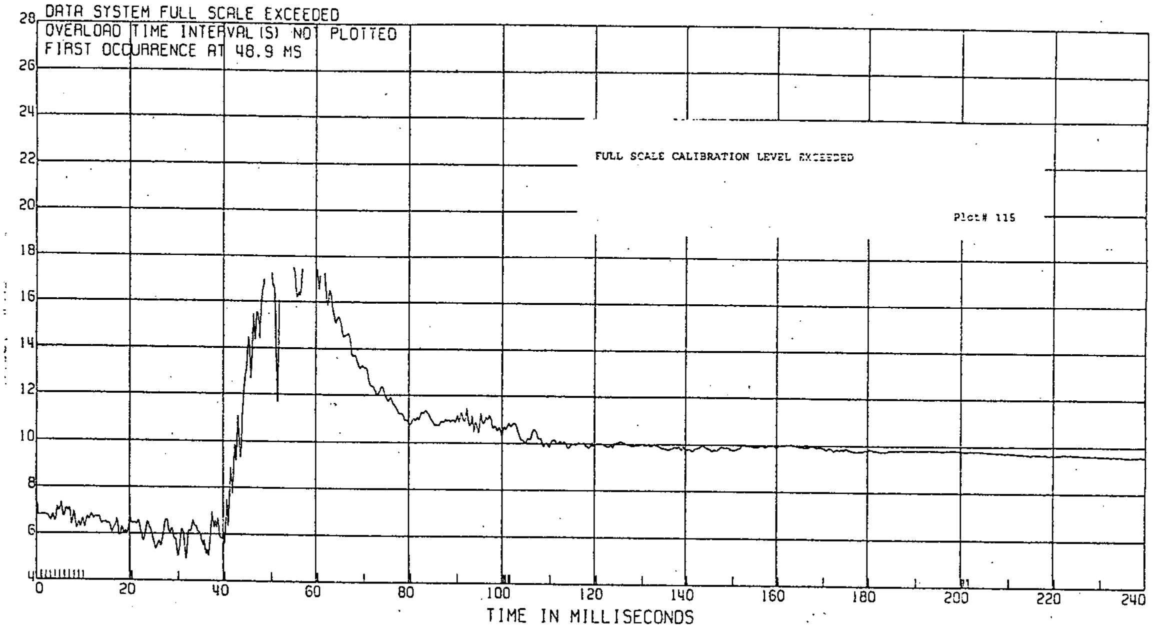
127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

D CTR 8W9186D HONDA

R. FRT BRAKE SYSTEM PRESSURE

TEST DATE:08/12/1998

C DATA, SAE CLASS 1000



Appendix D, plot # **115**

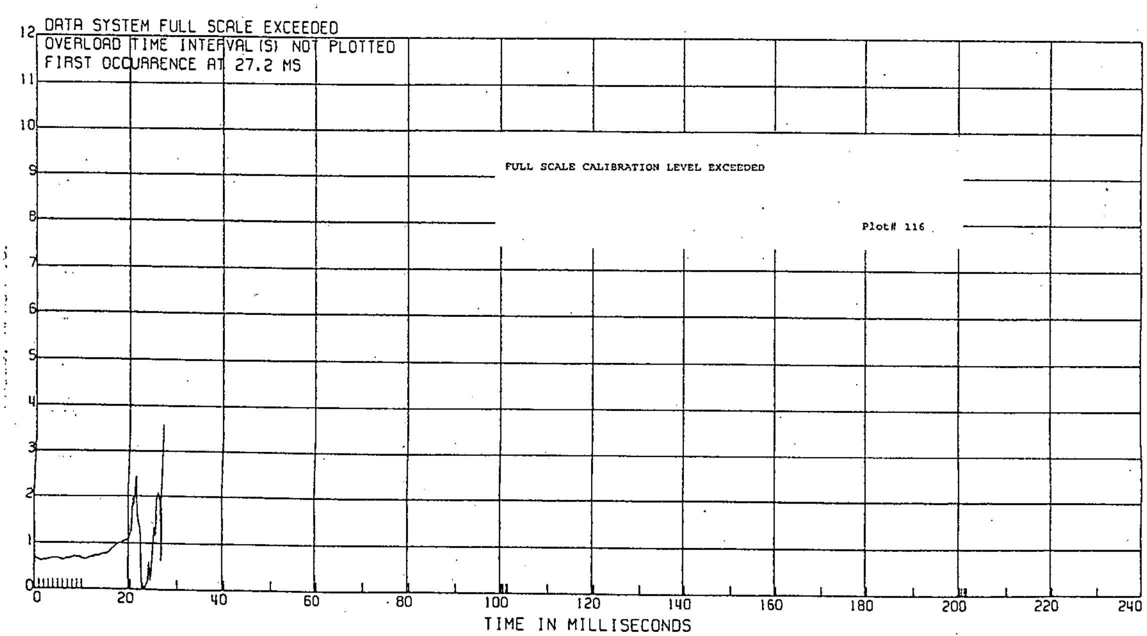
127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

D CTR 8W9186D HONDA

POWER STEERING SYSTEM PRESSURE

TEST DATE:08/12/1998

C DATA, SAE CLASS 1000



Appendix D, plot # **116**

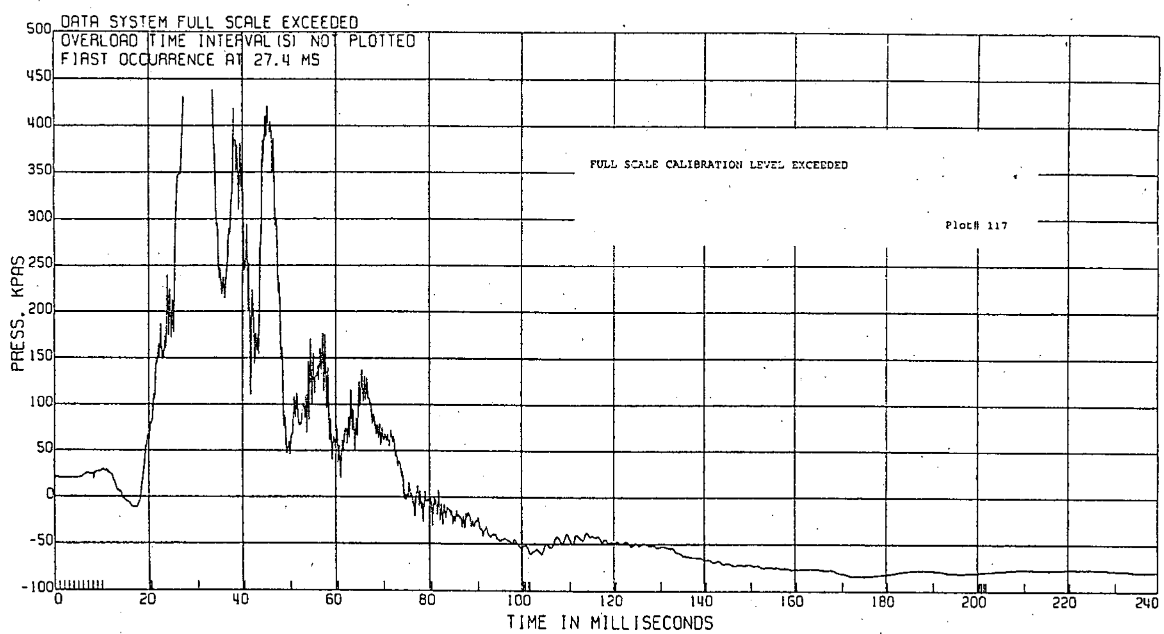
C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

COOLING SYSTEM PRESSURE

TEST DATE:08/12/1998



Appendix D, plot # **117**

C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

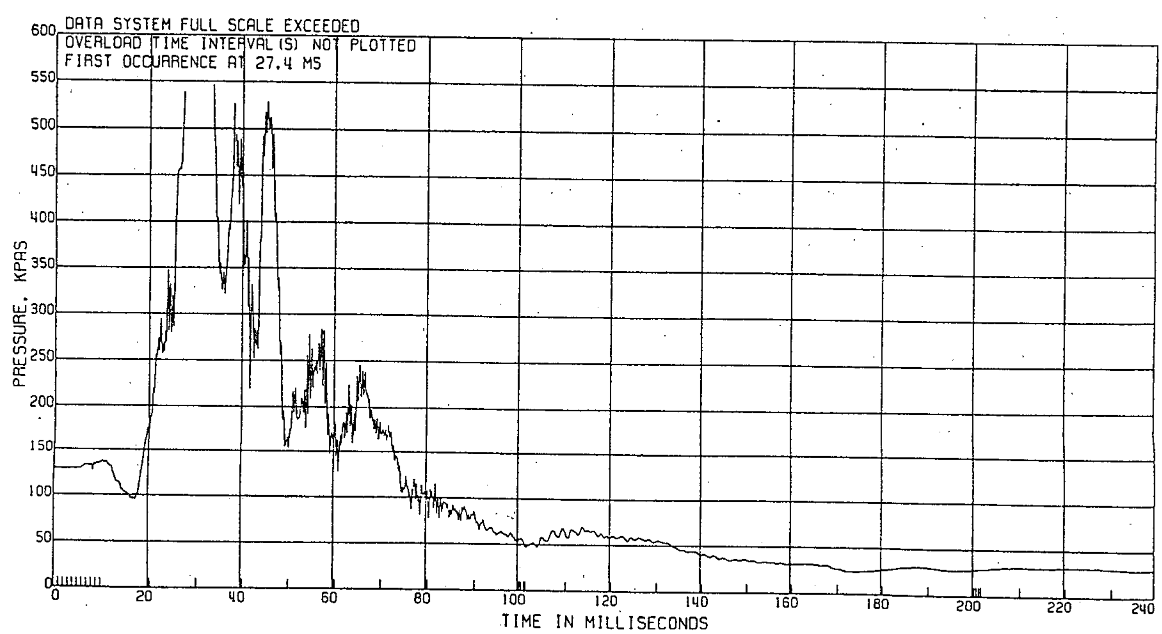
R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

COOLING SYSTEM PRESSURE

(BIASED DATA BY 108.0KPAS)

TEST DATE:08/12/1998



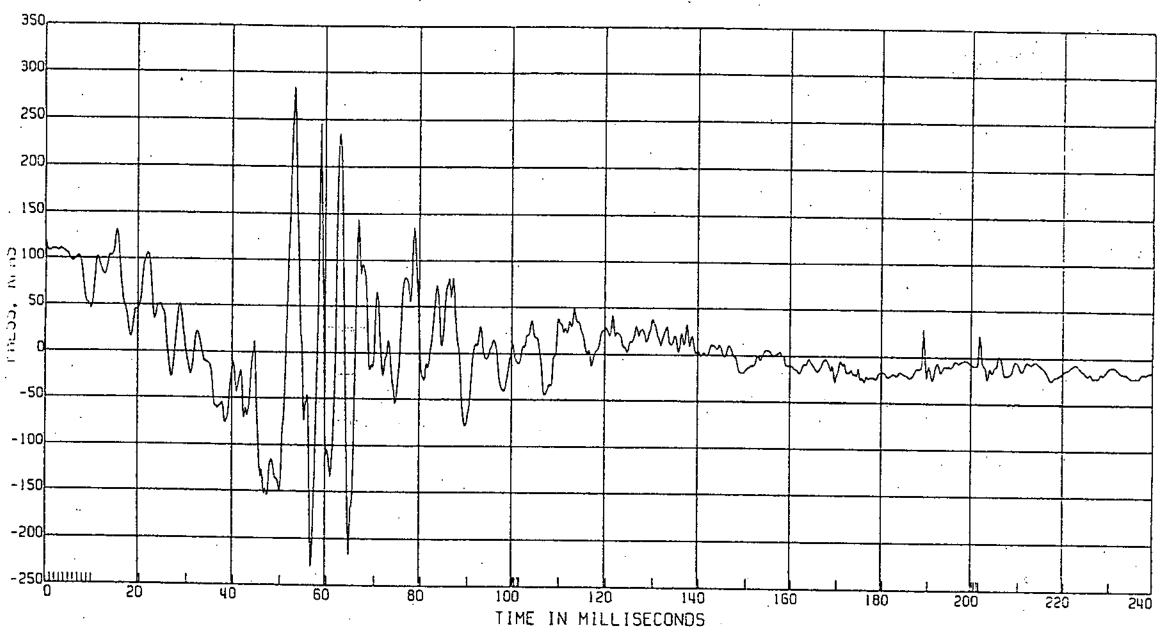
Appendix D, plot # **118**

127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1 KM/H

D CTR 8W9186D HONDA
C DATA, SAE CLASS 1000

AUXILIARY FUEL LINE PRESSURE

TEST DATE:08/12/1998



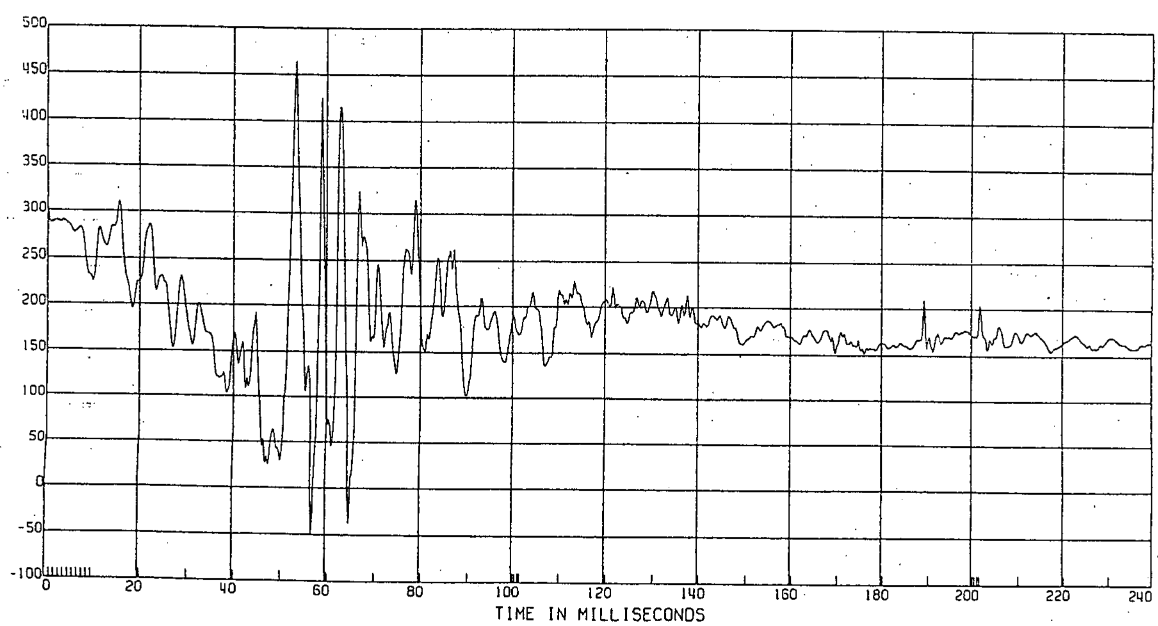
Appendix D, plot # **119**

127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1 KM/H

D CTR 8W9186D HONDA
C DATA, SAE CLASS 1000

AUXILIARY FUEL LINE PRESSURE
(BIASED DATA BY 180.0KPAS)

TEST DATE:08/12/1998



Appendix D, plot # **120**

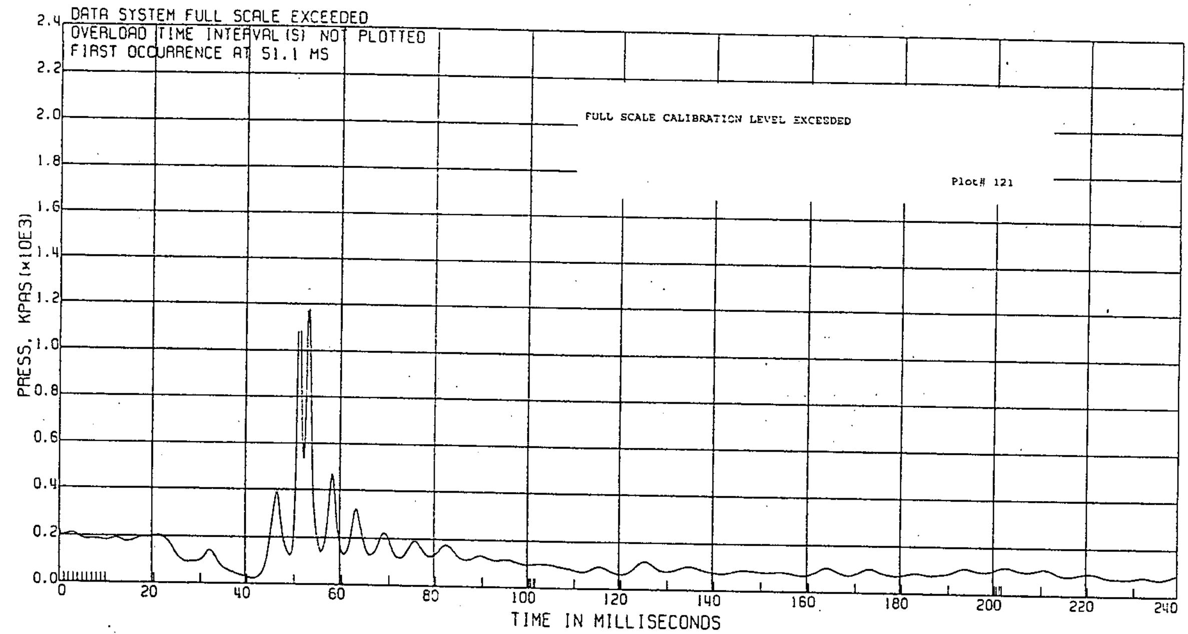
C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

ENGINE OIL PRESSURE

TEST DATE:08/12/1998



Appendix D, plot # **121**

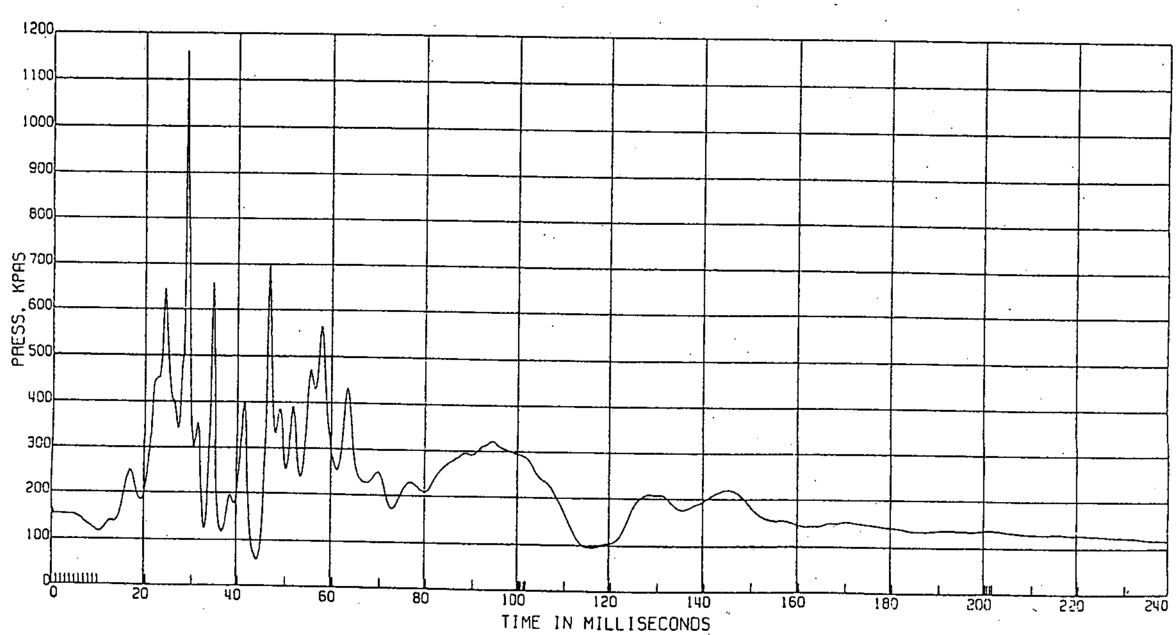
C12127 L. SIDE IMPACT-339 DEG LTV MDB TO STATIONARY VEHICLE 104.1KM/H

R & D CTR 8W9186D HONDA

ELEC DATA, SAE CLASS 1000

TRANSMISSION COOLER PRESSURE

TEST DATE:08/12/1998



Appendix D, plot # **122**

Appendix E: C12127 hydrocarbon vapor measurement plots

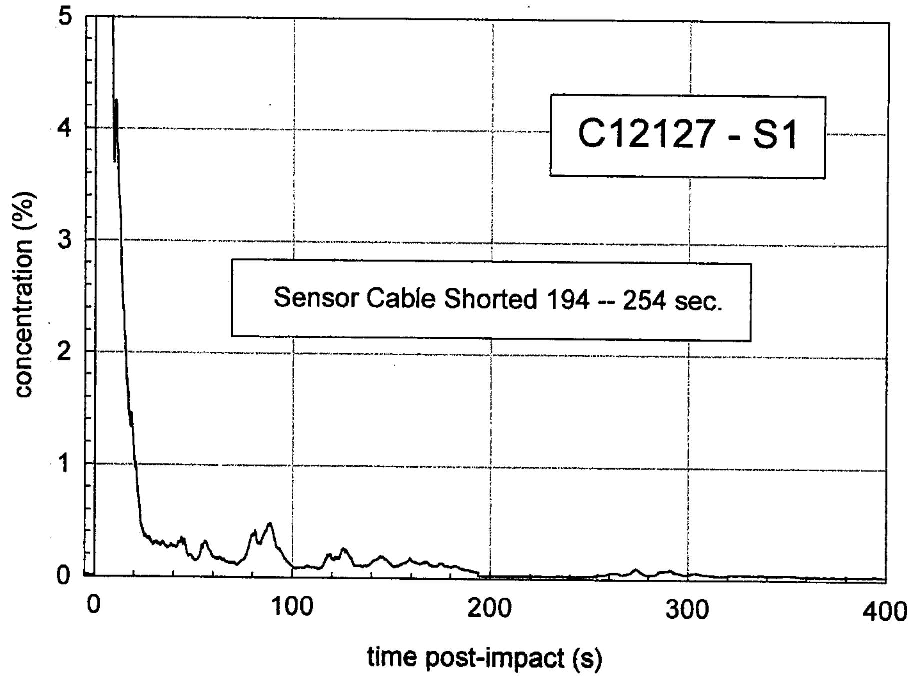


Figure E1
Concentration of Hydrocarbon Vapor Above the Left Fuel Rail (location #1)
Test C12127

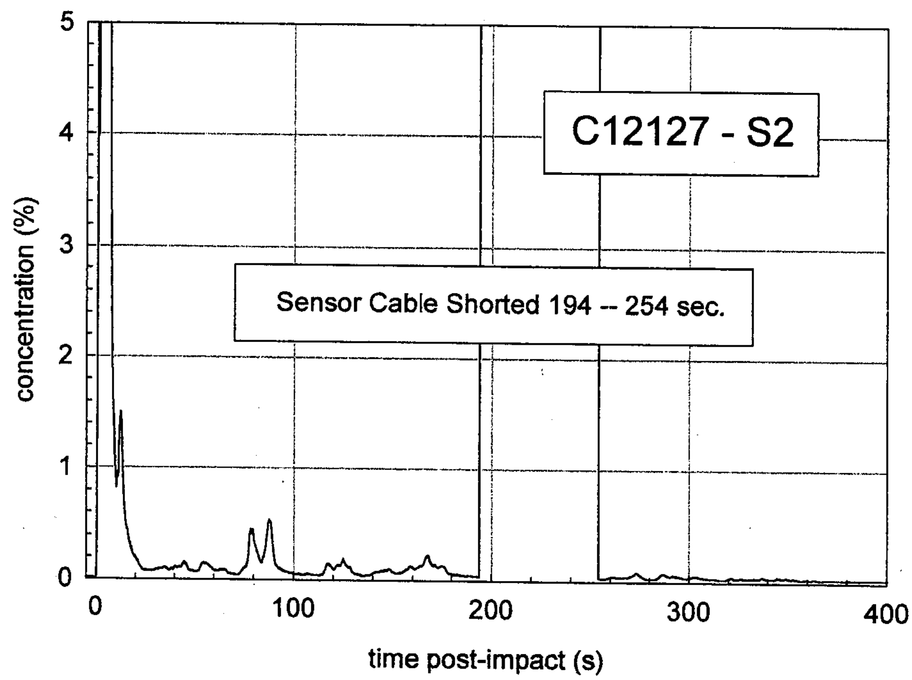


Figure E2
Concentration of Hydrocarbon Vapor Measured Near the Right Fuel Rail (location #2)
Test C12127

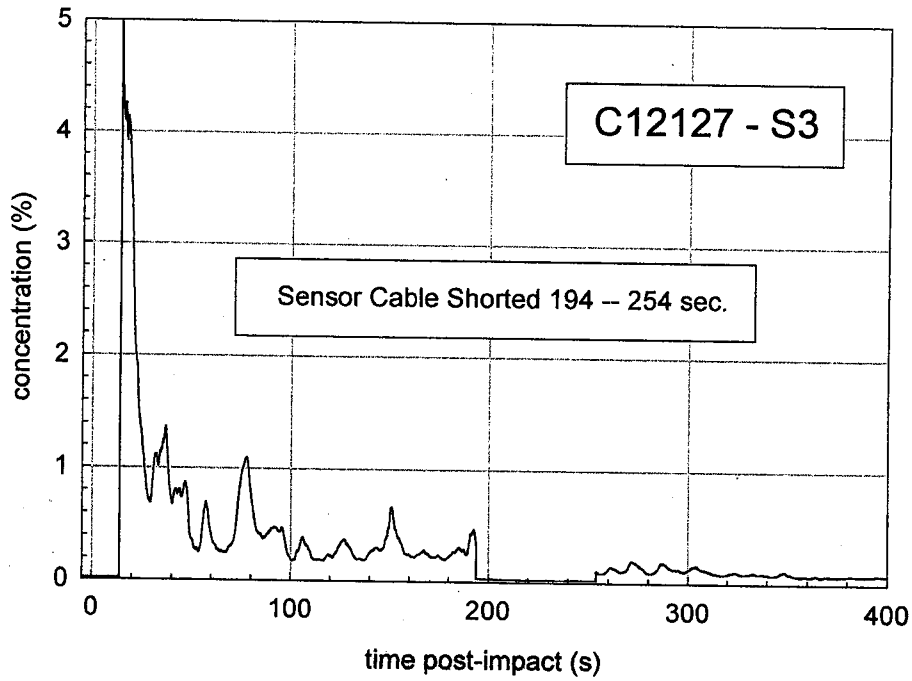


Figure E3
Concentration of Hydrocarbon Vapor Measured Near the Left Manifold Shield (location #3)
Test C12127

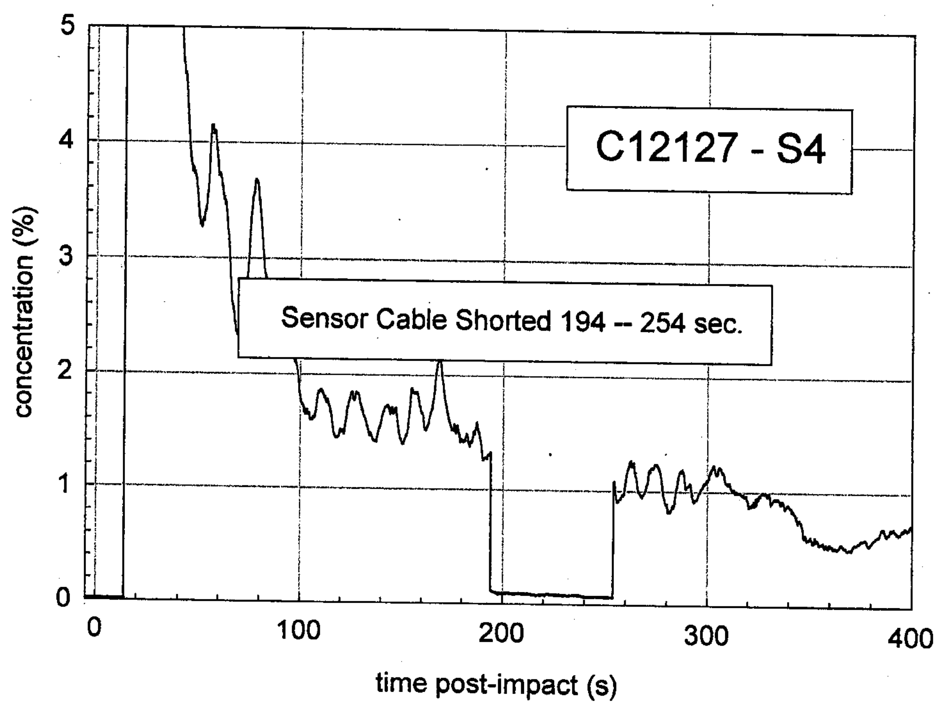


Figure E4
Concentration of Hydrocarbon Vapor Measured Near the Right Manifold Shield (location #4)
Test C12127

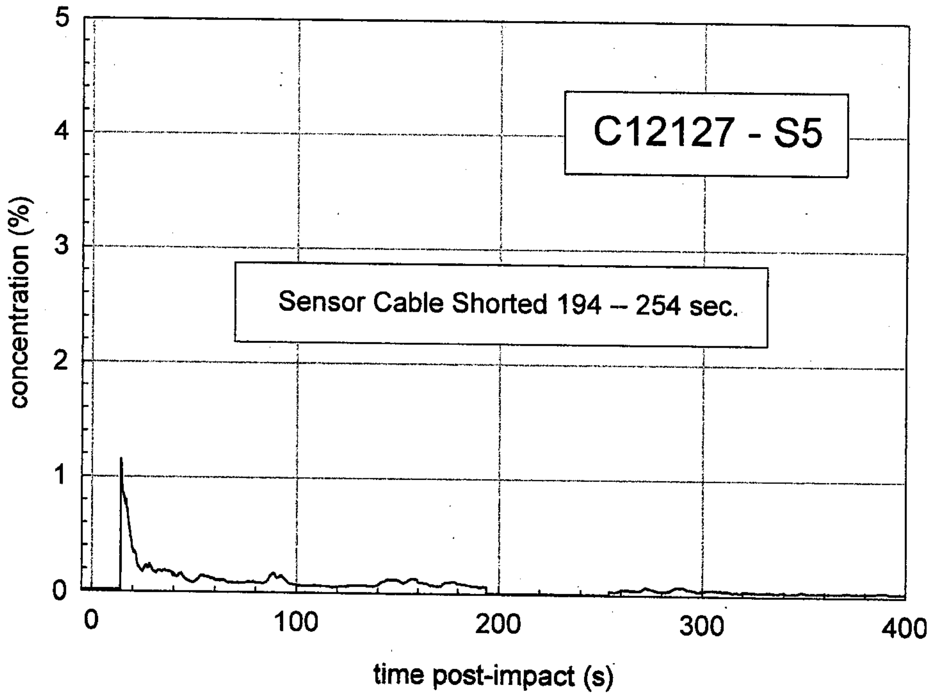
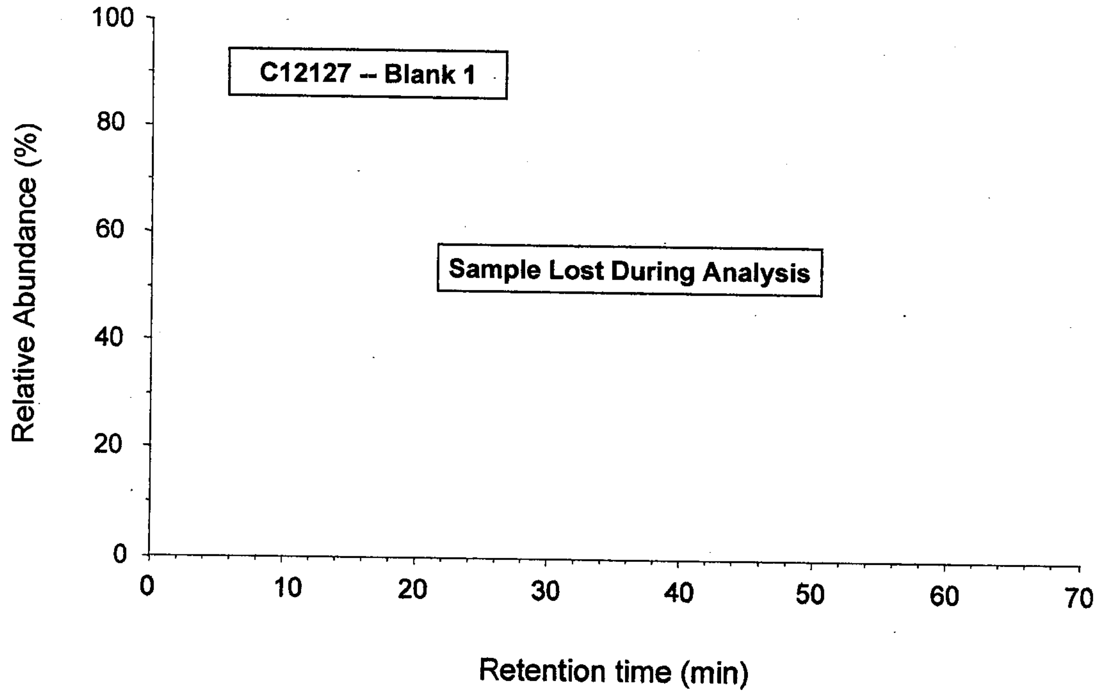


Figure E5
Concentration of Hydrocarbon Vapor Measured Near the Catalytic Converter (location #5)
Test C12127



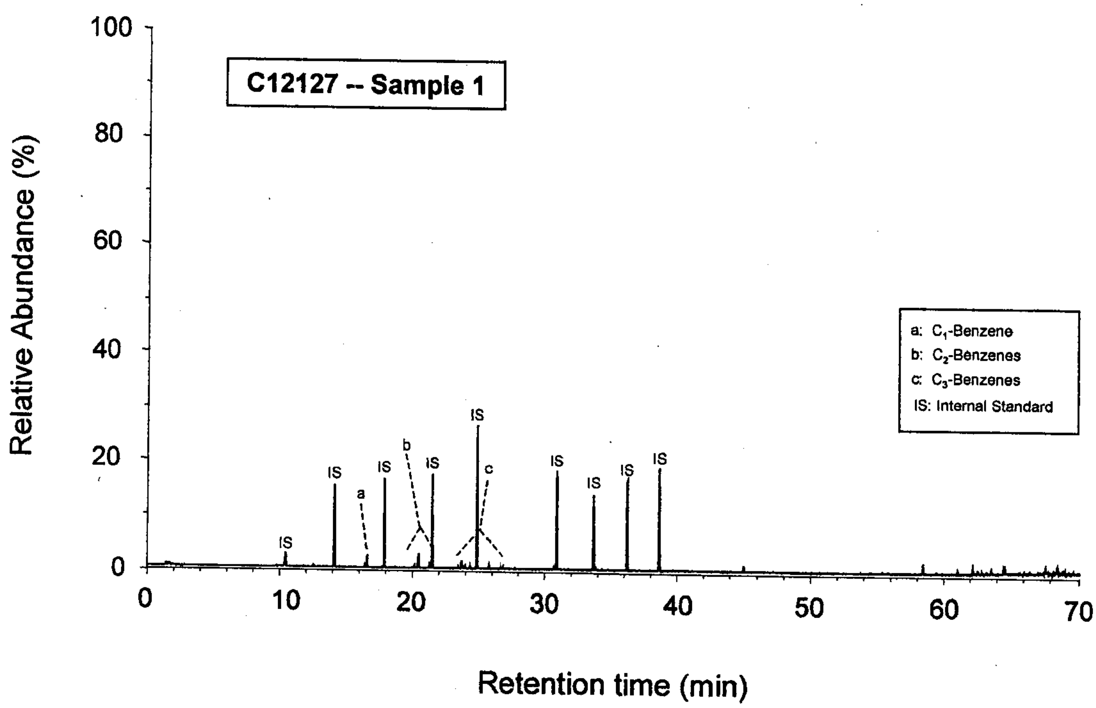


Figure EE1
GC/MS analysis of hydrocarbon vapor sample from above the left fuel rail (location #1) during Crash Test C12127. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

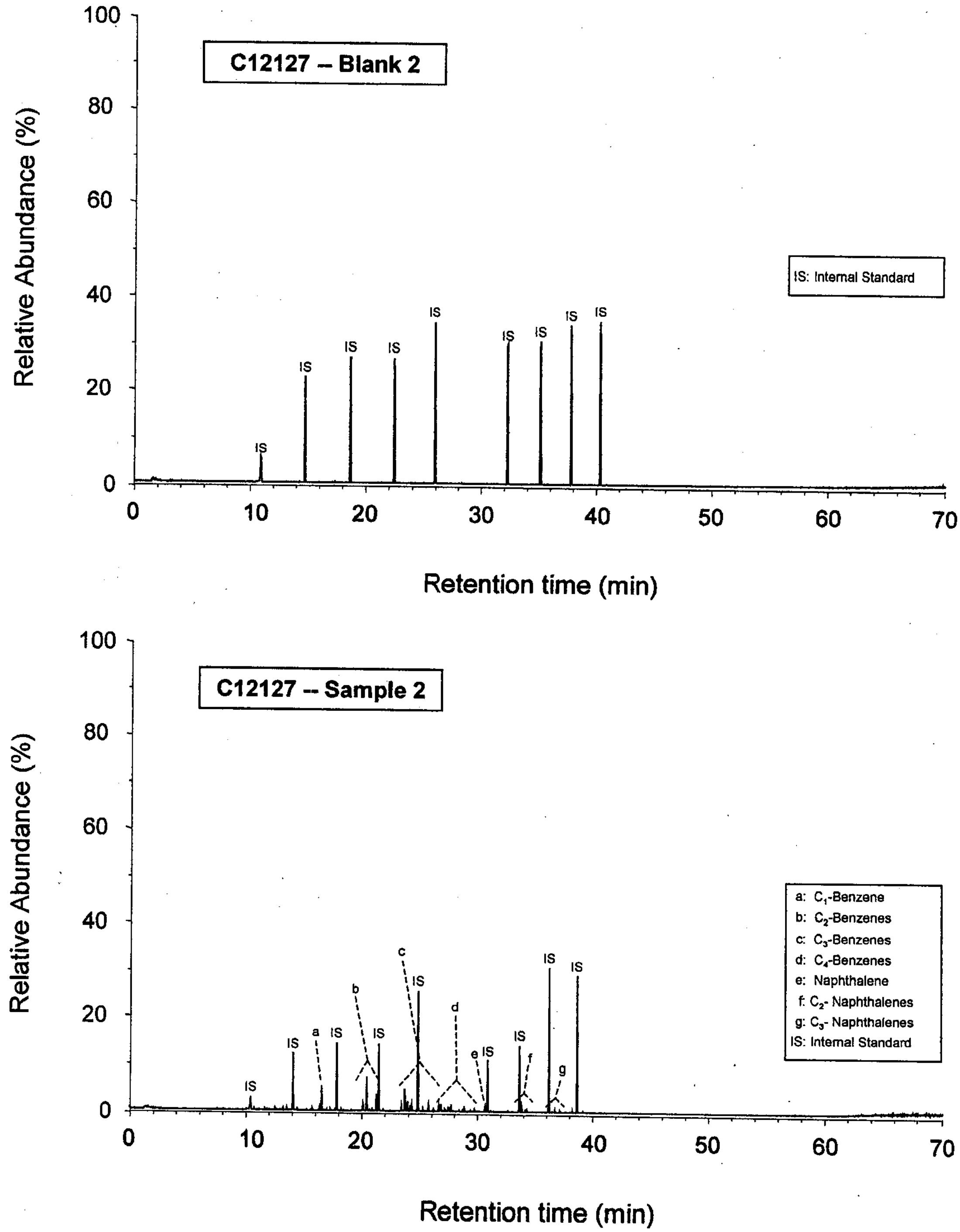


Figure EE2
GC/MS analysis of hydrocarbon vapor sample from near the right fuel rail (location #2) during Crash Test C12127. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

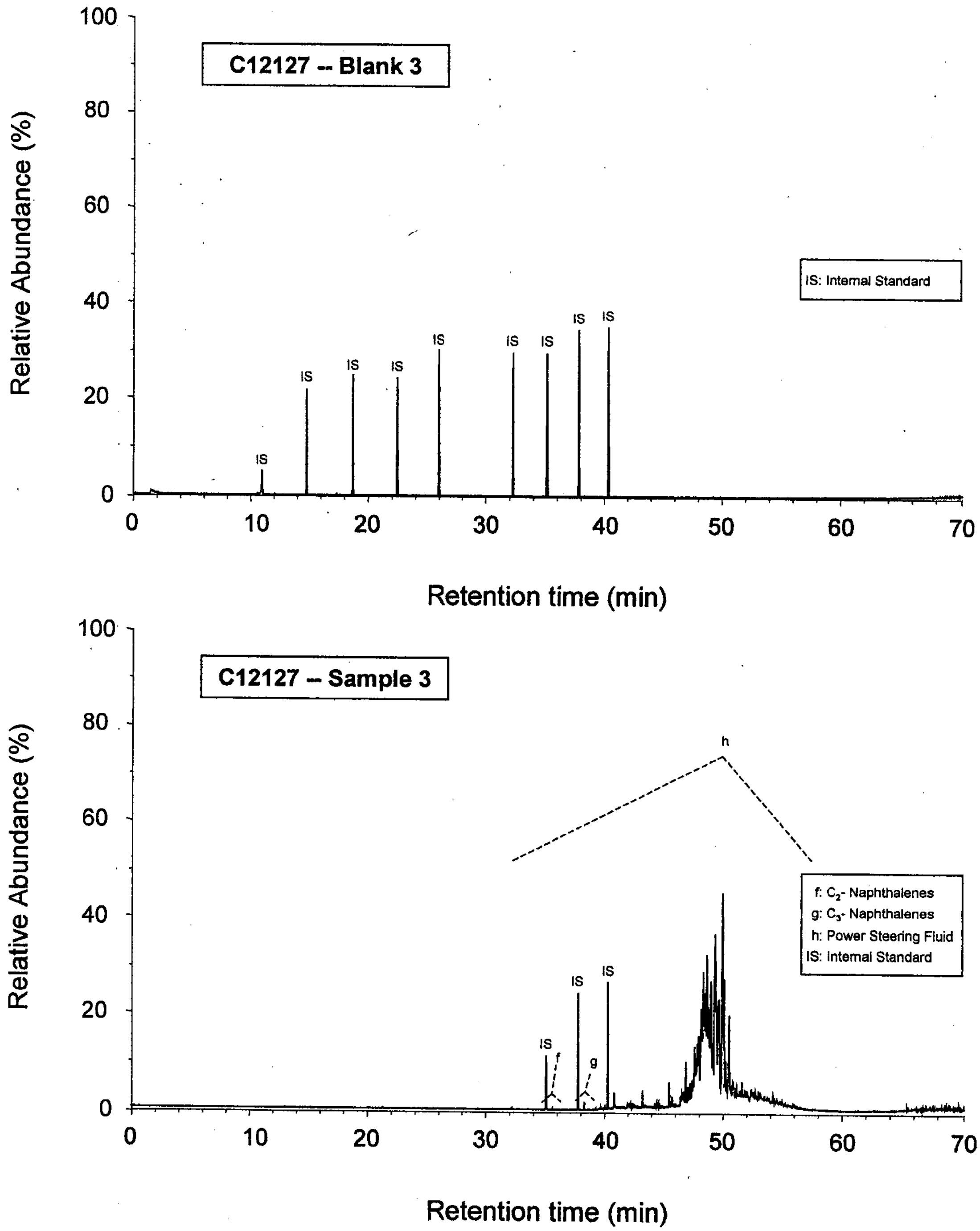


Figure EE3

GC/MS analysis of hydrocarbon vapor sample from near the left the left manifold shield (location #3) during Crash Test C12127. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

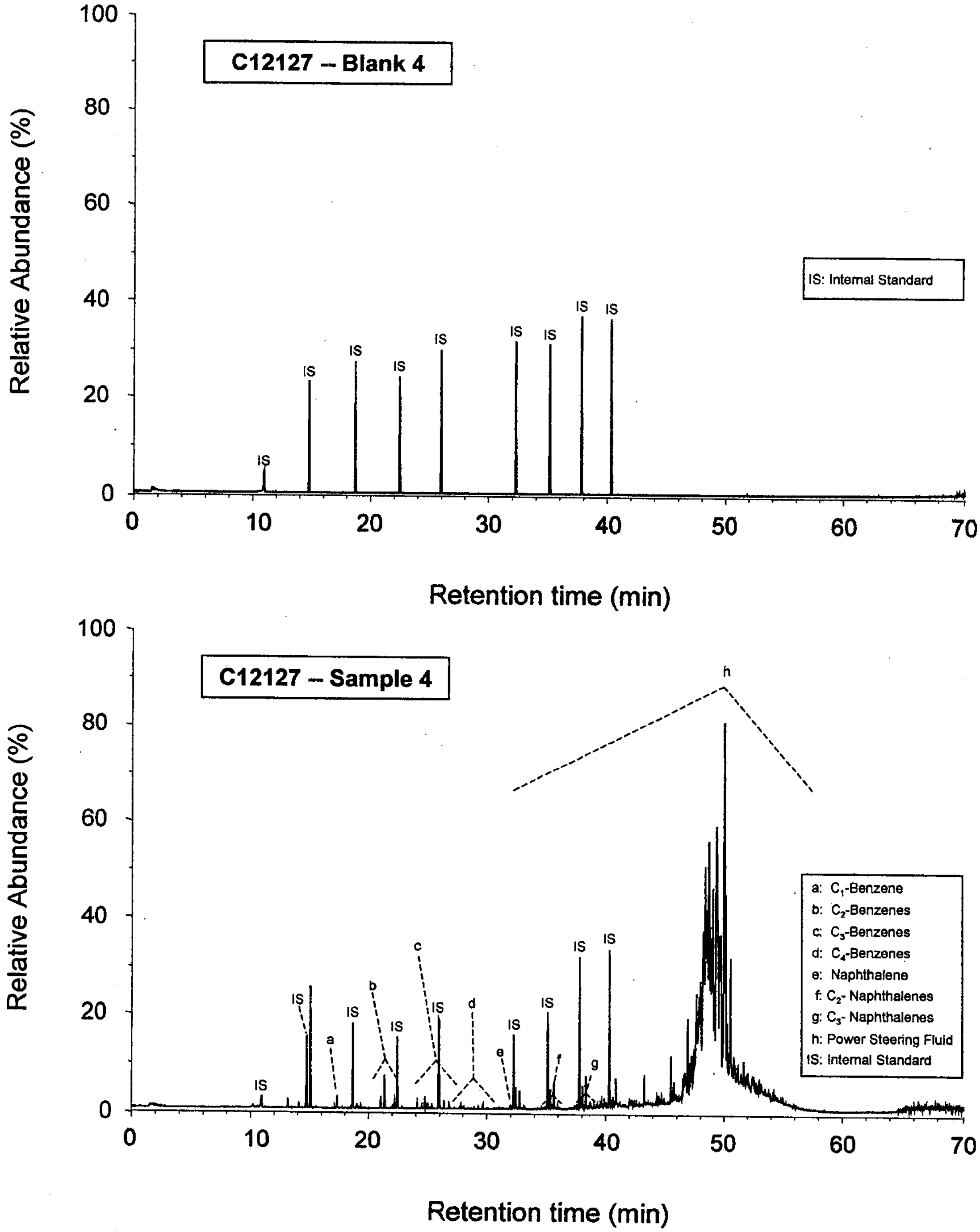


Figure EE4

GC/MS analysis of hydrocarbon vapor sample from near the right manifold shield (location #4) during Crash Test C12127. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

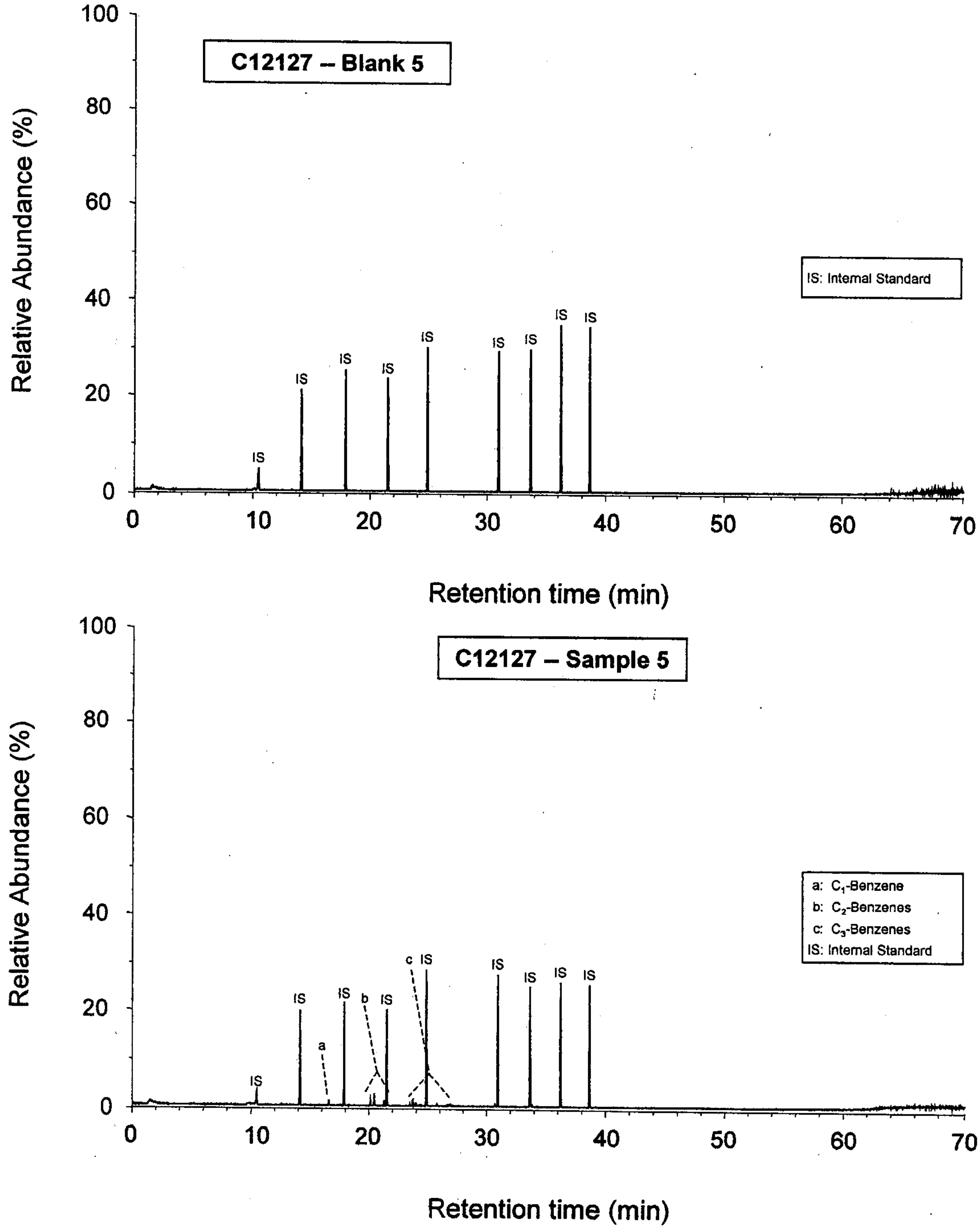


Figure EE5

GC/MS analysis of hydrocarbon vapor sample from near the Catalytic Converter (Location #5). during Crash Test C12127. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

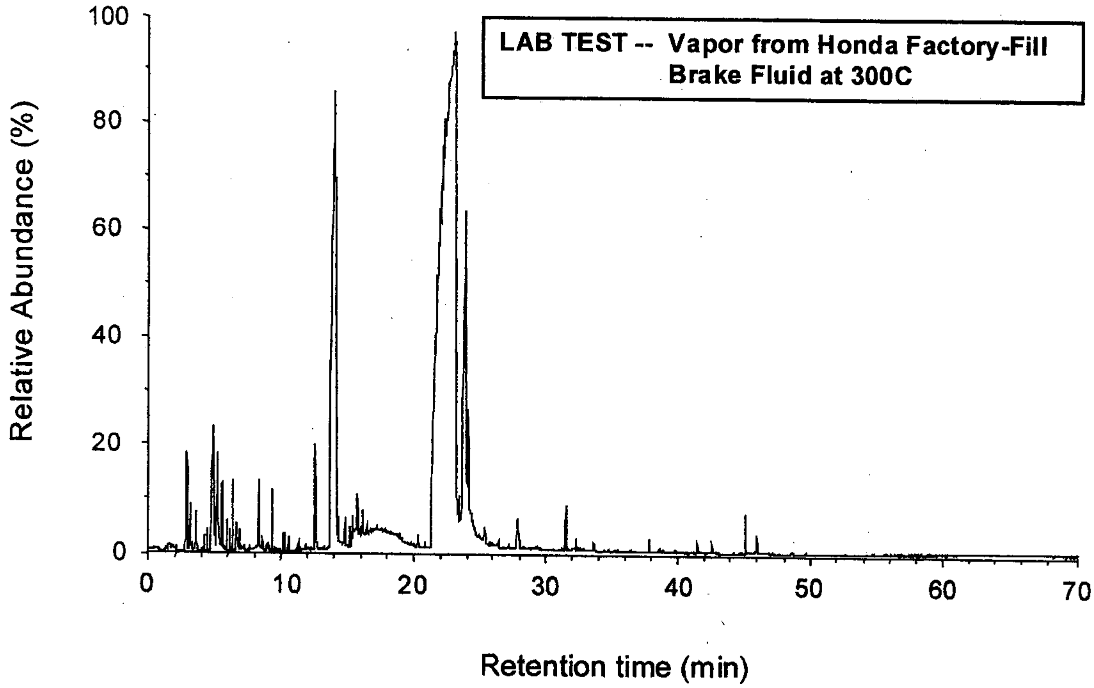


Figure EE6

Chromatogram of vapor from Honda factory-fill brake fluid heated to 300°C in a laboratory test

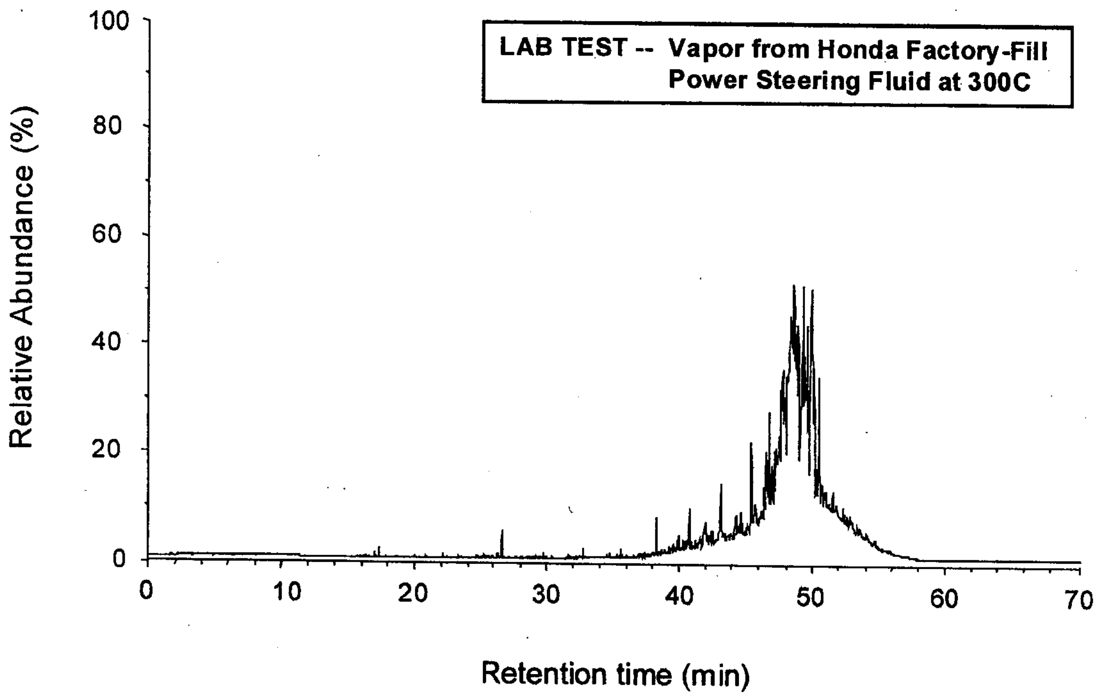


Figure EE7

Chromatogram of vapor from Honda factory-fill power steering fluid heated to 300°C in a laboratory test

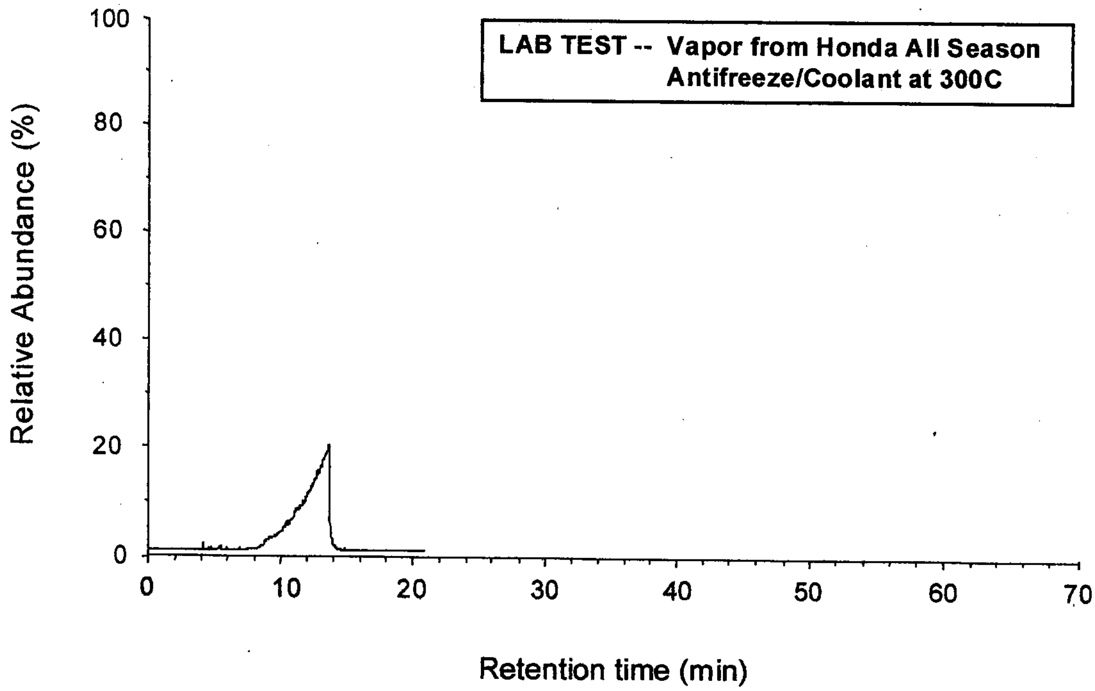


Figure EE8
Chromatogram of vapor from Honda All Season Antifreeze/Coolant heated to 300°C in a laboratory test

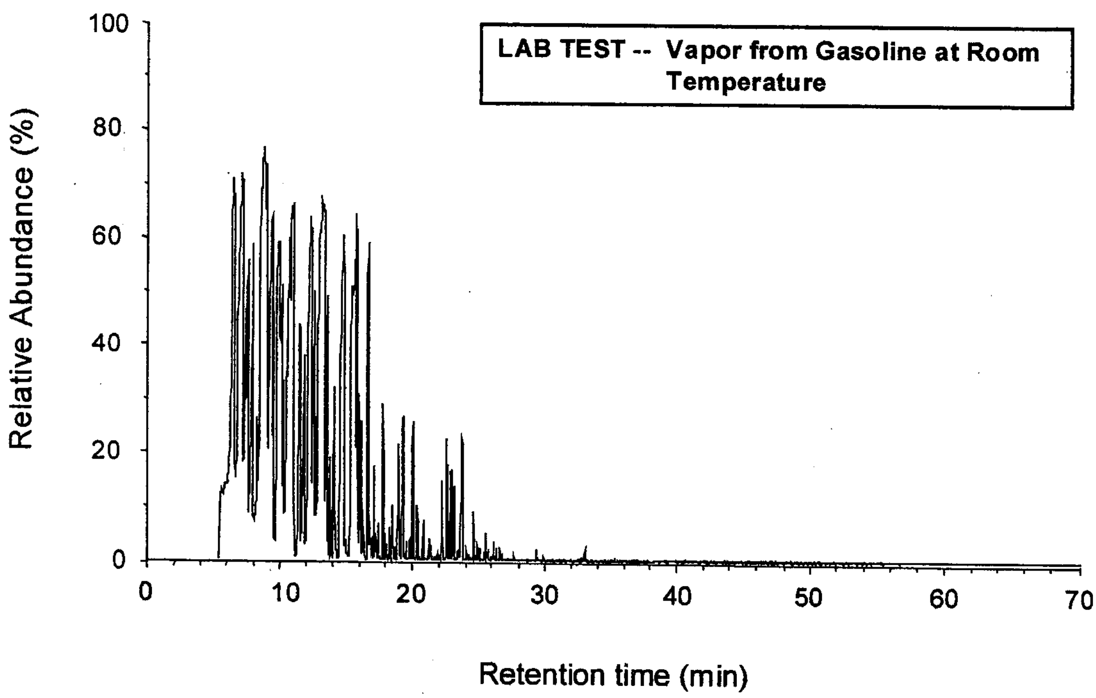


Figure EE9
Chromatogram of vapor from liquid gasoline at room temperature

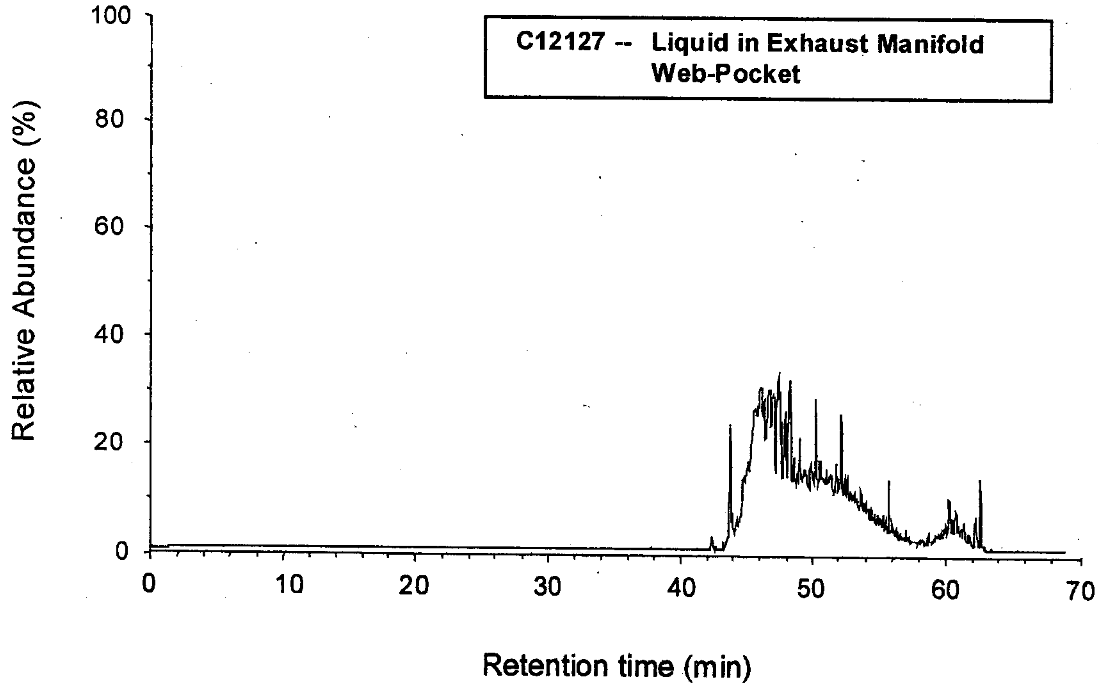


Figure EE10
Chromatogram of liquid residue pooled in the left exhaust manifold web-pocket

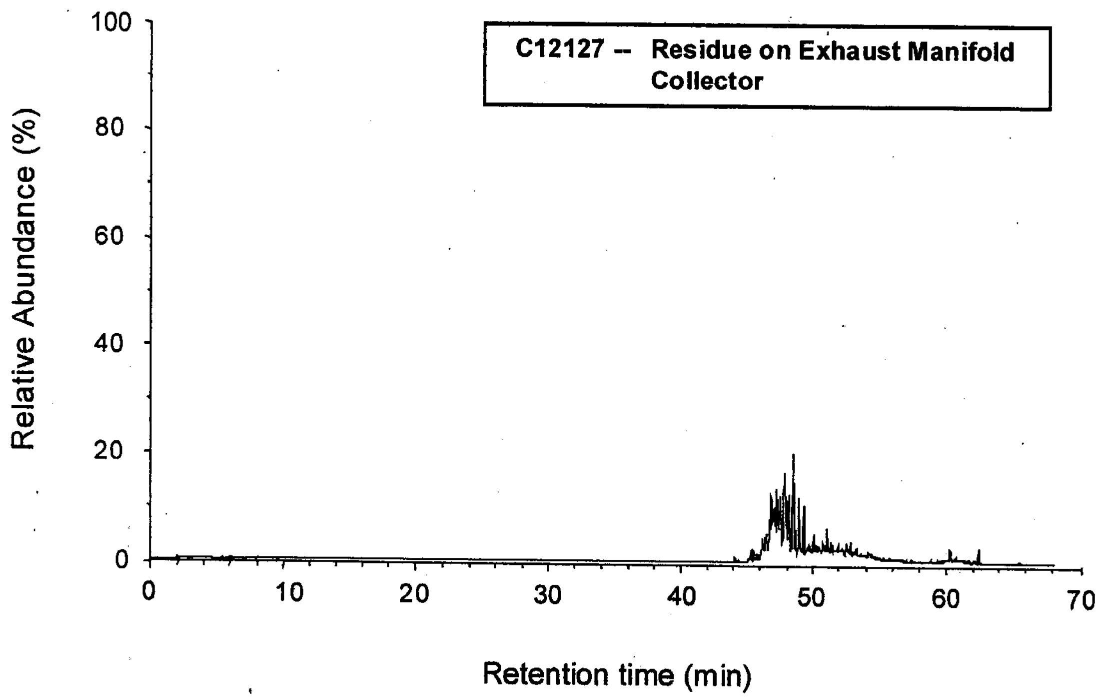


Figure EE11
Chromatogram of residue on the exhaust manifold collector

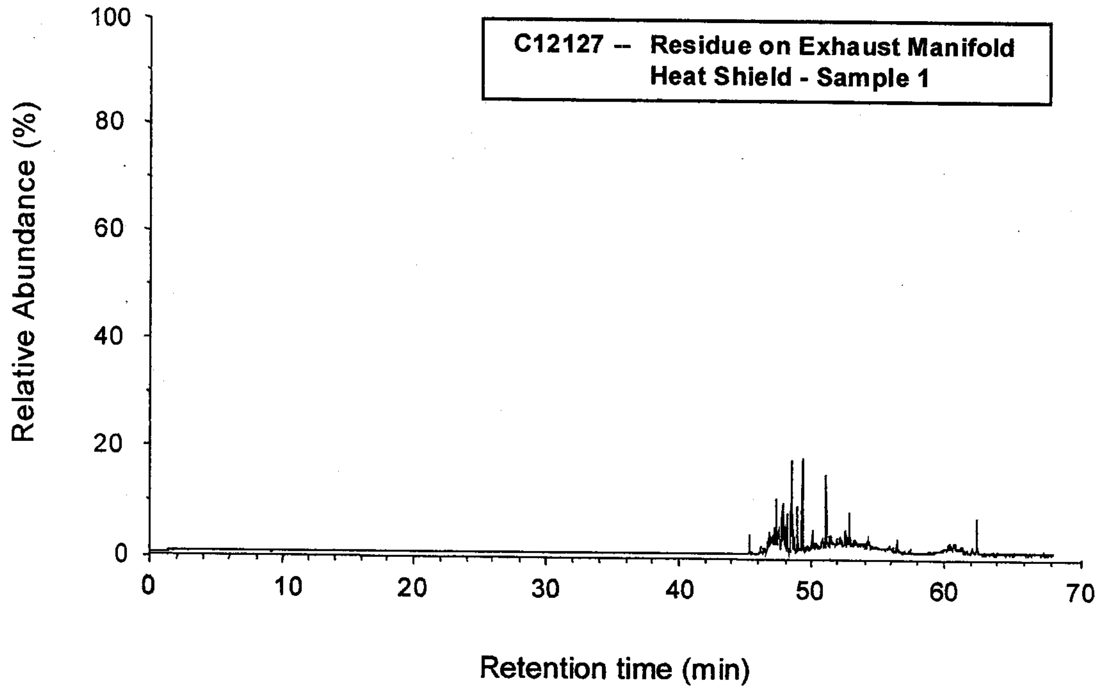


Figure EE12
Chromatogram of residue on the exhaust manifold heat shield Sample 1

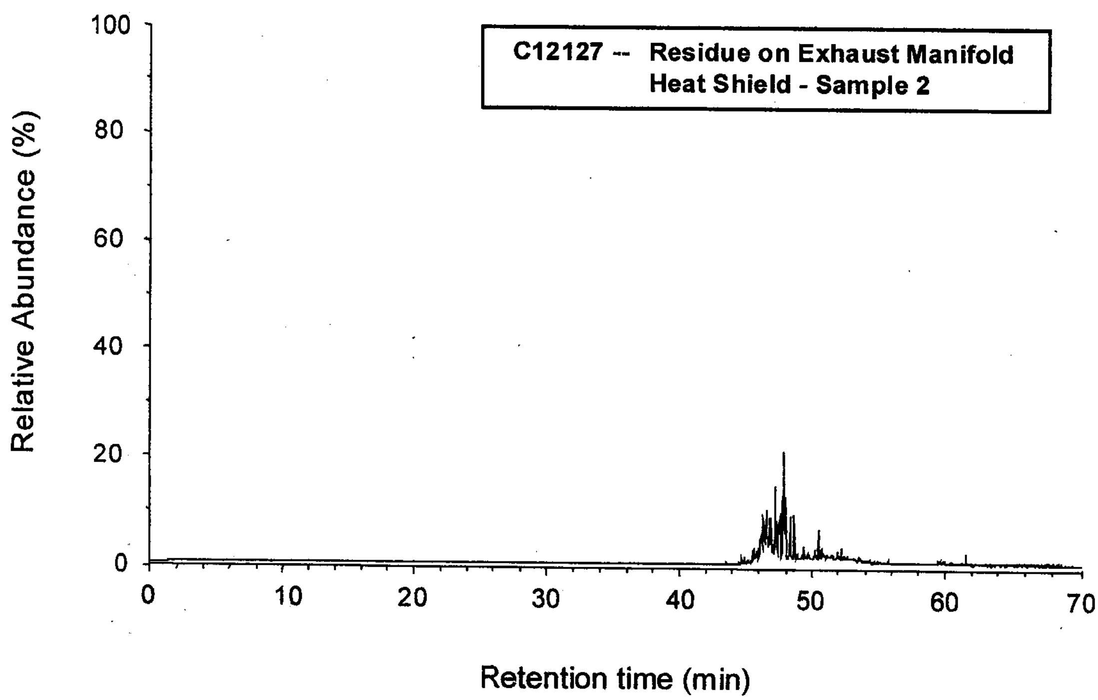


Figure EE13
Chromatogram of residue on the exhaust manifold heat shield Sample 2

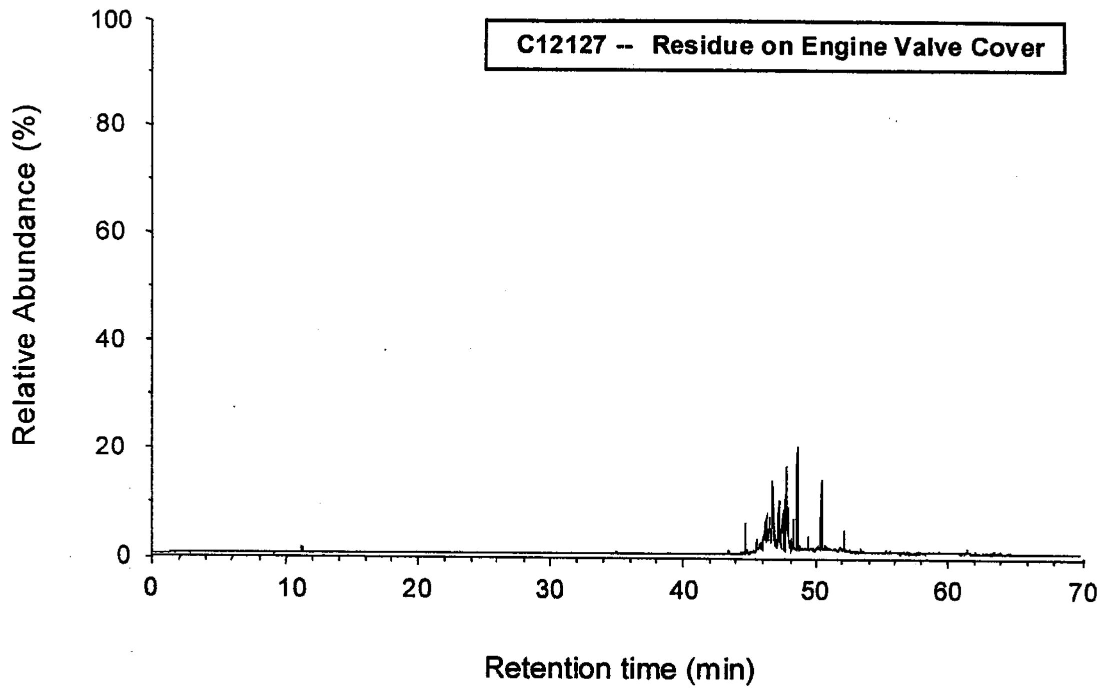


Figure EE14
Chromatogram of residue on the engine valve cover

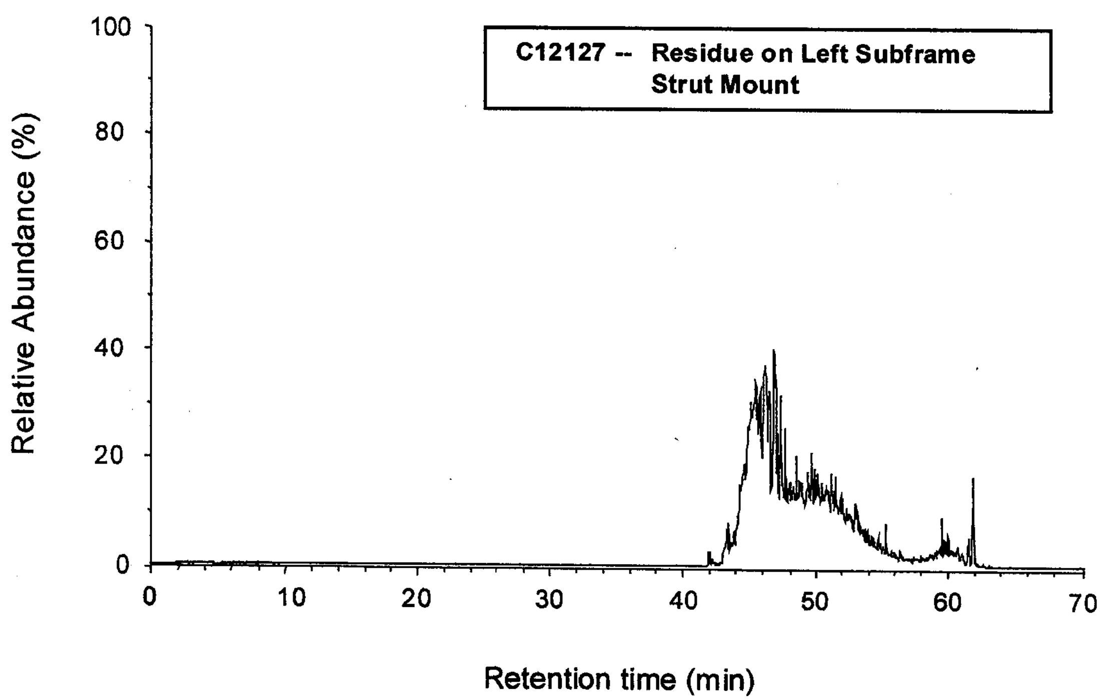


Figure EE15
Chromatogram of residue on the left subframe strut mount

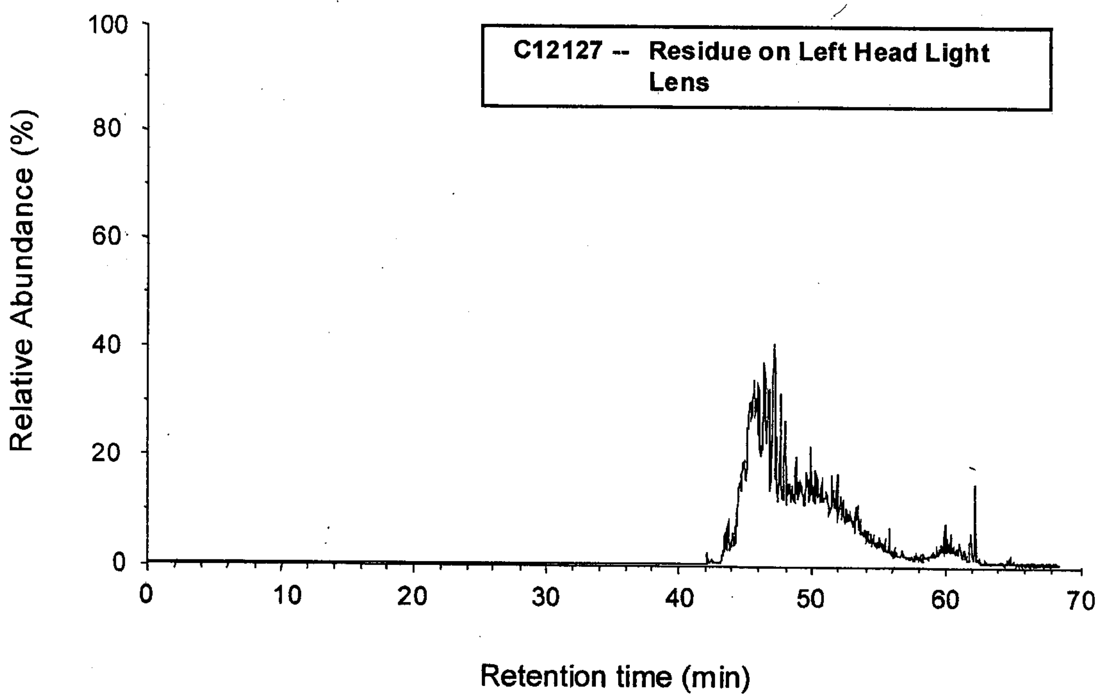


Figure EE16
Chromatogram of residue on the left head light lens

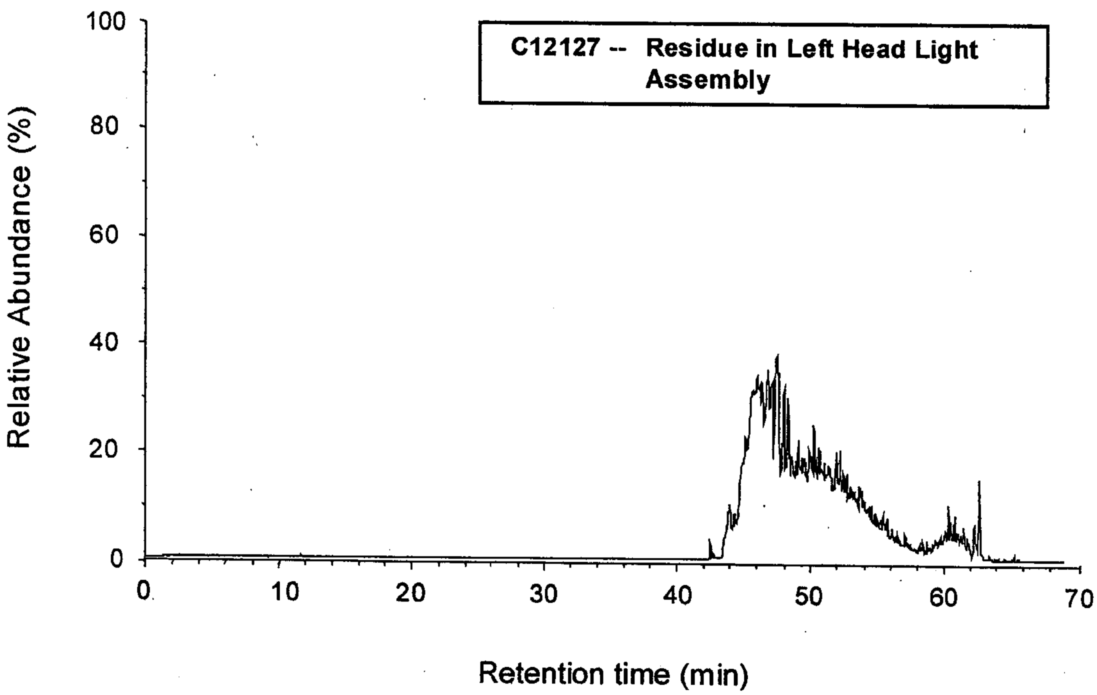


Figure EE17
Chromatogram of residue on the left head light assembly

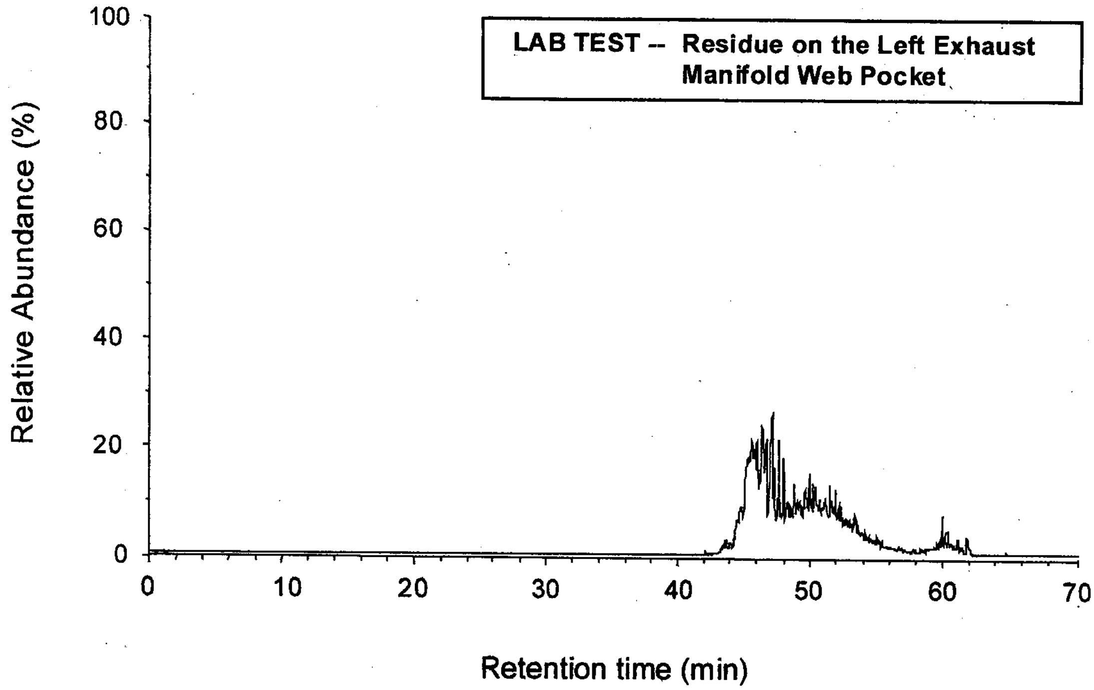


Figure EE18
Chromatogram of the liquid residue from Honda power steering fluid in left exhaust manifold web-pocket of the exemplar vehicle

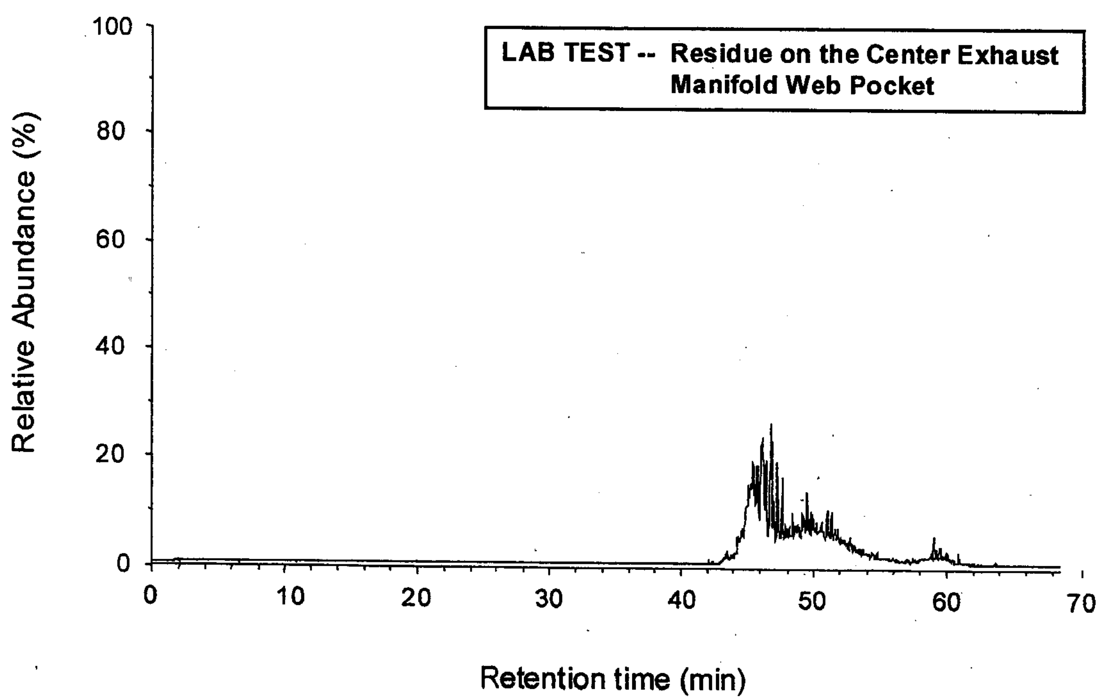


Figure EE19
Chromatogram of the liquid residue from Honda power steering fluid in center exhaust manifold web-pocket of the exemplar vehicle

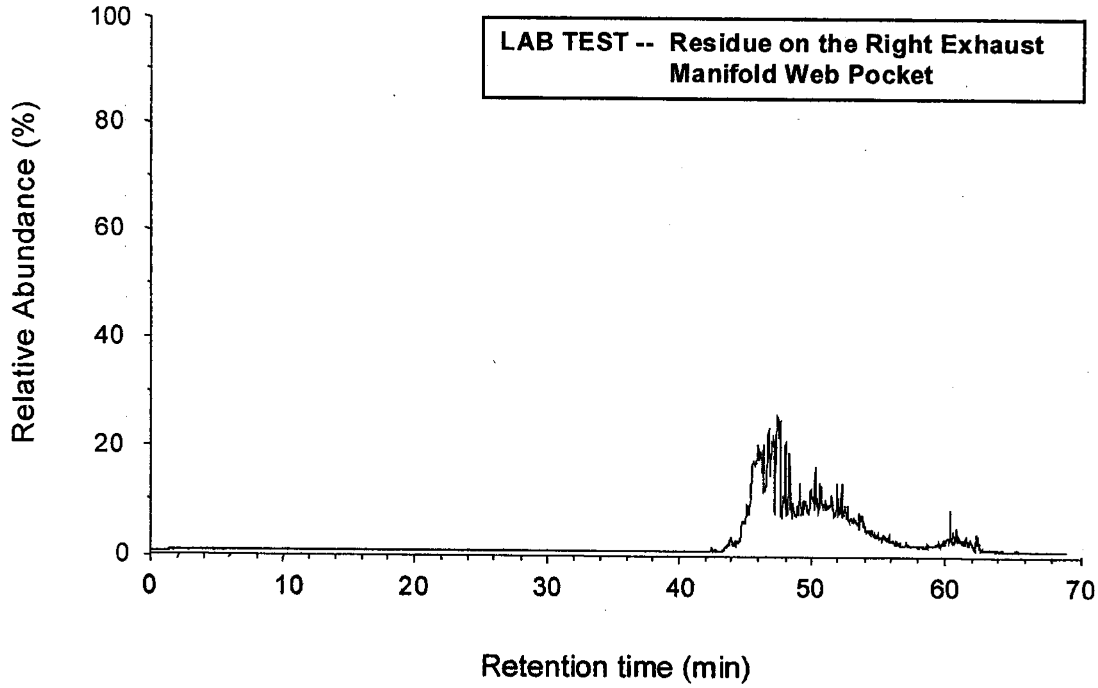


Figure EE20
Chromatogram of the liquid residue from Honda power steering fluid in right exhaust manifold web-pocket of the exemplar vehicle

Appendix F: C12174 data plots

LEFT FRONT
ANTHROPOMORPHIC TEST DEVICE SUMMARY DATA
MOVING VEHICLE TO FIXED POLE 55.4 KM/H

C12174 FRONT IMPACT

R & D CTR 8W9187D HONDA

ATD TYPE: GM50H

TEST DATE: 09/16/1998

MEASURED QUANTITY	100% OF IARV	150% OF IARV	IAV VALUE	IARV
HIC, LIMITED TO 15 MS			220	1000
HIC, LIMITED TO 36 MS			340	1000
NECK FLEXION			33NM	190NM
NECK EXTENSION			16NM	57NM
NECK TENSION			1853N	3300N
NECK COMPRESSION			54N	4000N
NECK SHEAR FORWARD			224N	3100N
NECK SHEAR REARWARD			439N	3100N
NECK TENSION DUR ASSESS			0.56	1.00
NECK COMPRESSION DUR ASSESS			0.01	1.00
NECK SHEAR FWD DUR ASSESS			0.07	1.00
NECK SHEAR RWD DUR ASSESS			0.23	1.00
CHEST ACCEL			50G	60G
! CHEST COMPRESSION W/O SH BELT			46.4MM	65.0MM !
CHEST COMPRESSION W/ SH BELT			46.4MM	50.0MM !
CHEST VISCOUS CRITERIA			0.34M/SEC	1.00M/SEC
FEMUR COMP, LEFT			1966N	10000N
FEMUR COMP, RIGHT			1732N	10000N
FEMUR DURATION ASSESS, LEFT			0.22	1.00
FEMUR DURATION ASSESS, RIGHT			0.19	1.00
TIBIA/FEMUR DISP, LEFT			0.1MM	15.0MM
TIBIA/FEMUR DISP, RIGHT			0.3MM	15.0MM
KNEE CLEVIS, LEFT INSIDE			733N	4000N
KNEE CLEVIS, LEFT OUTSIDE			1484N	4000N
KNEE CLEVIS, RIGHT INSIDE			2109N	4000N
KNEE CLEVIS, RIGHT OUTSIDE			1516N	4000N
TIBIA COMP, LEFT			1149N	8000N
TIBIA COMP, RIGHT			2922N	8000N
TIBIA MOM, UPPER, LEFT			124NM	225NM
TIBIA MOM, UPPER, RIGHT			176NM	225NM
TIBIA MOM, LOWER, LEFT			38NM	225NM
TIBIA MOM, LOWER, RIGHT		***	498NM	225NM
LEG INDEX, UPPER LEFT			0.58	1.00
LEG INDEX, UPPER RIGHT			0.85	1.00
LEG INDEX, LOWER LEFT			0.19	1.00
LEG INDEX, LOWER RIGHT		***	2.28	1.00

IAV - INJURY ASSESSMENT VALUE

IARV - INJURY ASSESSMENT REFERENCE VALUE

! RESTRAINT SYSTEM DEPENDENT. CHOOSE VALUE THAT APPLIES TO THIS TEST.

*** VALUE GREATER THAN 150% OF IAV

RIGHT FRONT
ANTHROPOMORPHIC TEST DEVICE SUMMARY DATA
MOVING VEHICLE TO FIXED POLE 55.4 KM/H

C12174 FRONT IMPACT

R & D CTR 8W9187D HONDA

ATD TYPE: GM50H
TEST DATE: 09/16/1998

MEASURED QUANTITY	100% OF IARV	150% OF IARV	IAV VALUE	IARV
HIC, LIMITED TO 15 MS			260	1000
HIC, LIMITED TO 36 MS			410	1000
NECK FLEXION			7NM	190NM
NECK EXTENSION			22NM	57NM
NECK TENSION			1223N	3300N
NECK COMPRESSION			23N	4000N
NECK SHEAR FORWARD			75N	3100N
NECK SHEAR REARWARD			113N	3100N
NECK TENSION DUR ASSESS			0.37	1.00
NECK COMPRESSION DUR ASSESS			0.01	1.00
NECK SHEAR FWD DUR ASSESS			0.02	1.00
NECK SHEAR RWD DUR ASSESS			0.04	1.00
CHEST ACCEL			44G	60G
! CHEST COMPRESSION W/O SH BELT			34.2MM	65.0MM !
! CHEST COMPRESSION W/ SH BELT			34.2MM	50.0MM !
CHEST VISCOUS CRITERIA			0.22M/SEC	1.00M/SEC
FEMUR COMP, LEFT			3199N	10000N
FEMUR COMP, RIGHT			2716N	10000N
FEMUR DURATION ASSESS, LEFT			0.35	1.00
FEMUR DURATION ASSESS, RIGHT			0.30	1.00
TIBIA/FEMUR DISP, LEFT			10.7MM	15.0MM
TIBIA/FEMUR DISP, RIGHT			0.2MM	15.0MM
KNEE CLEVIS, LEFT INSIDE			1197N	4000N
KNEE CLEVIS, LEFT OUTSIDE			1277N	4000N
KNEE CLEVIS, RIGHT INSIDE			1006N	4000N
KNEE CLEVIS, RIGHT OUTSIDE			1137N	4000N
TIBIA COMP, LEFT			2445N	8000N
TIBIA COMP, RIGHT			1781N	8000N
TIBIA MOM, UPPER, LEFT			218NM	225NM
TIBIA MOM, UPPER, RIGHT			108NM	225NM
TIBIA MOM, LOWER, LEFT		***	460NM	225NM
TIBIA MOM, LOWER, RIGHT		***	366NM	225NM
LEG INDEX, UPPER LEFT			1.01	1.00
LEG INDEX, UPPER RIGHT			0.53	1.00
LEG INDEX, LOWER LEFT		***	2.08	1.00
LEG INDEX, LOWER RIGHT		***	1.68	1.00

IAV - INJURY ASSESSMENT VALUE
IARV - INJURY ASSESSMENT REFERENCE VALUE

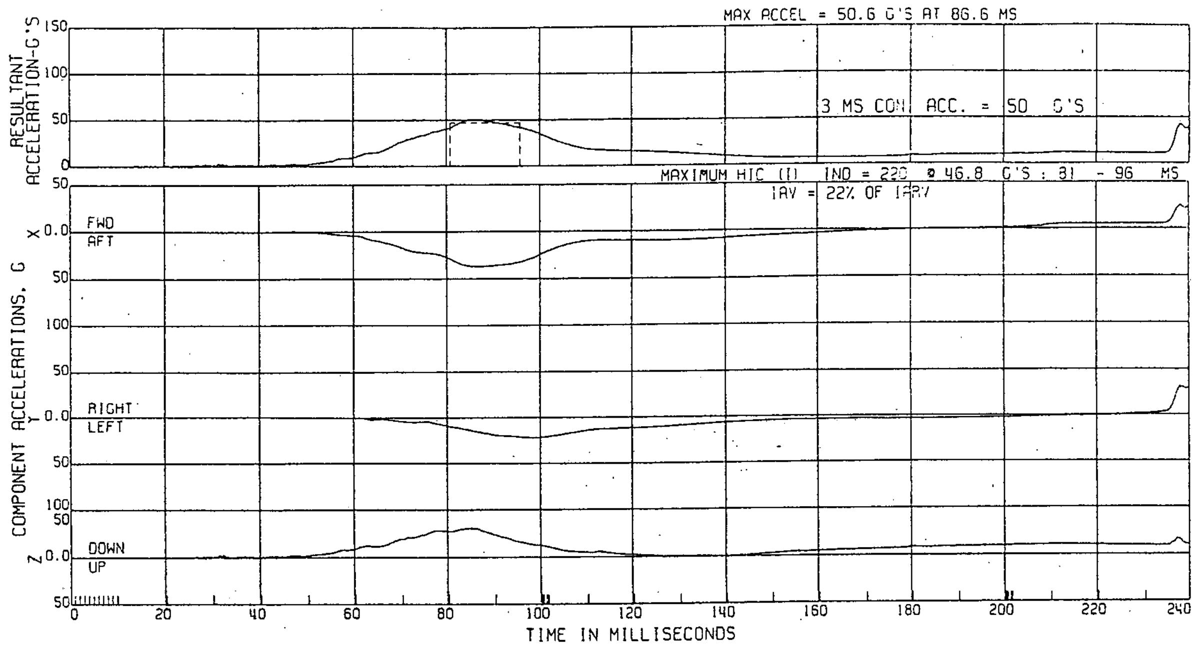
! RESTRAINT SYSTEM DEPENDENT. CHOOSE VALUE THAT APPLIES TO THIS TEST.

*** VALUE GREATER THAN 150% OF IAV

C12174 FRONT IMPACT
R & D CTR 8W91870 HONDA
ELEC DATA, SAE CLASS 1000

MOVING VEHICLE TO FIXED POLE 55.4 KM/H
L. FRT HEAD ACCEL.
(HIC I LIMITED TO 15MS)

ATD TYPE: GM50H
TEST DATE:09/16/1998

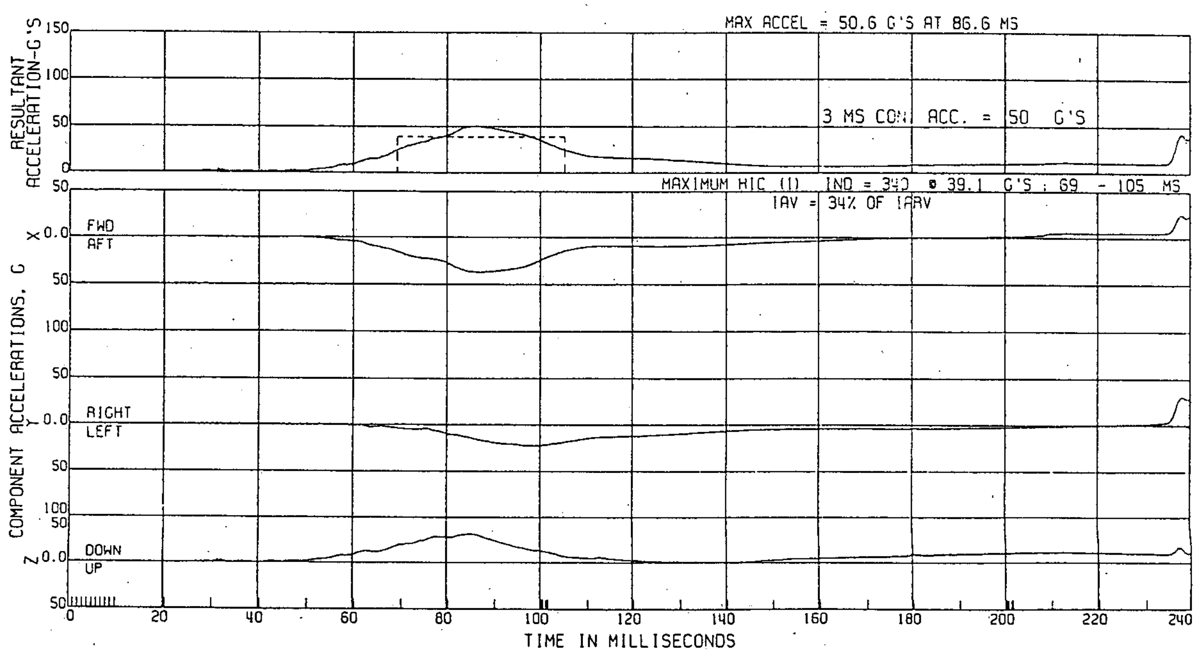


Appendix F, plot # 1

C12174 FRONT IMPACT
R & D CTR 8W91870 HONDA
ELEC DATA, SAE CLASS 1000

MOVING VEHICLE TO FIXED POLE 55.4 KM/H
L. FRT HEAD ACCEL.
(HIC I LIMITED TO 36MS)

ATD TYPE: GM50H
TEST DATE:09/16/1998



Appendix F, plot # 2

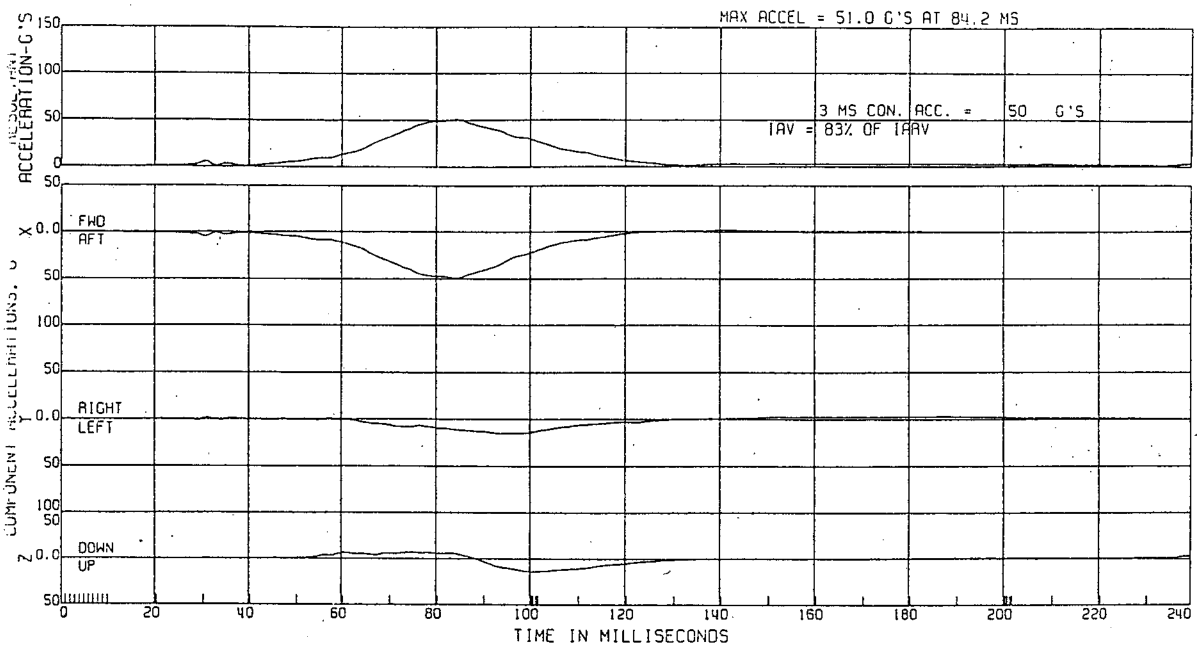
2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

L. FRT CHEST ACCEL.

ATD TYPE: GM50H
TEST DATE:09/16/1998

EC DATA, SAE CLASS 180



Appendix F, plot # 3

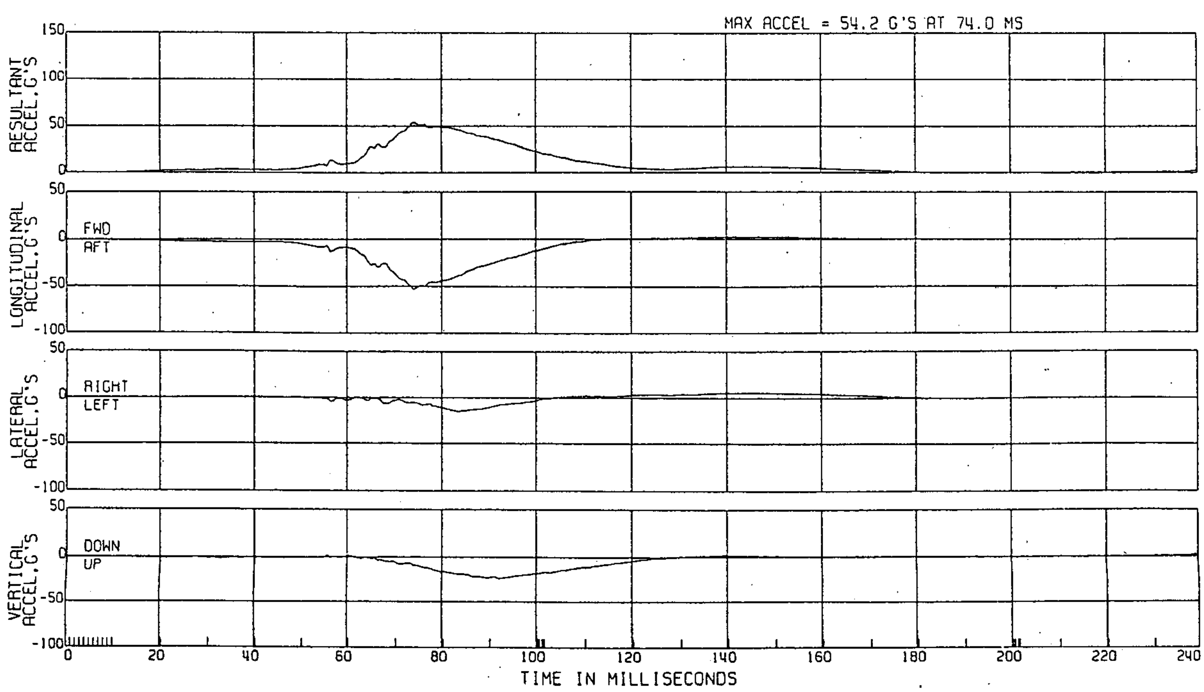
C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

L. FRT PELVIC ACCEL.

ATD TYPE: GM50H
TEST DATE:09/16/1998

ELEC DATA, SAE CLASS 1000



Appendix F, plot # 4

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

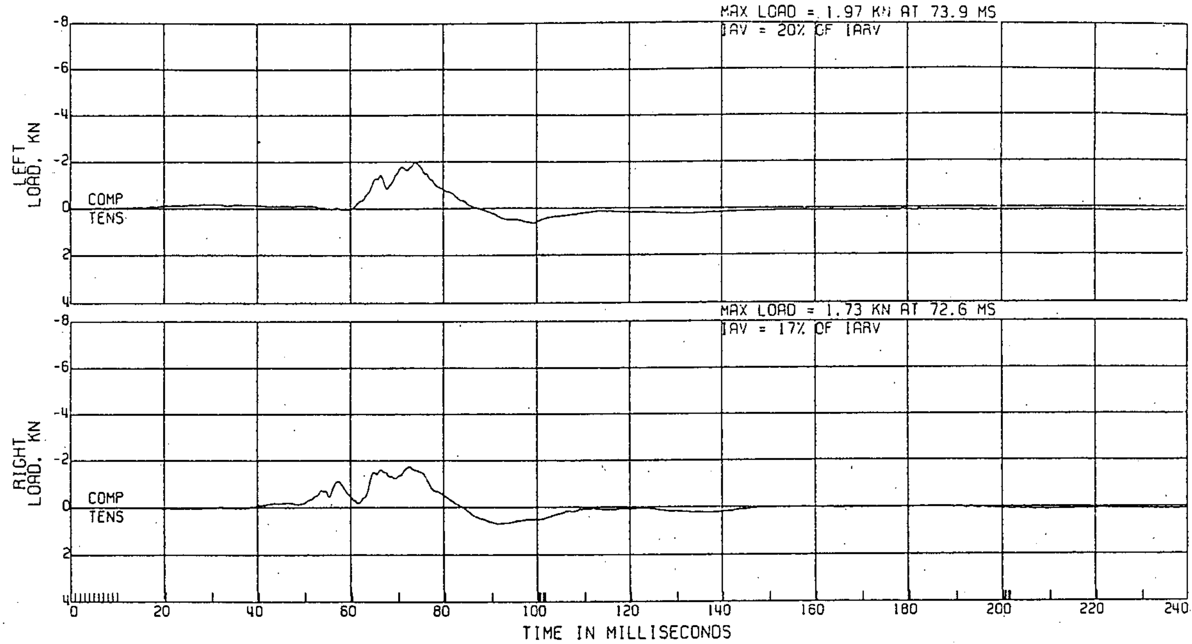
R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 600

L. FRT FEMUR LOAD

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **5**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

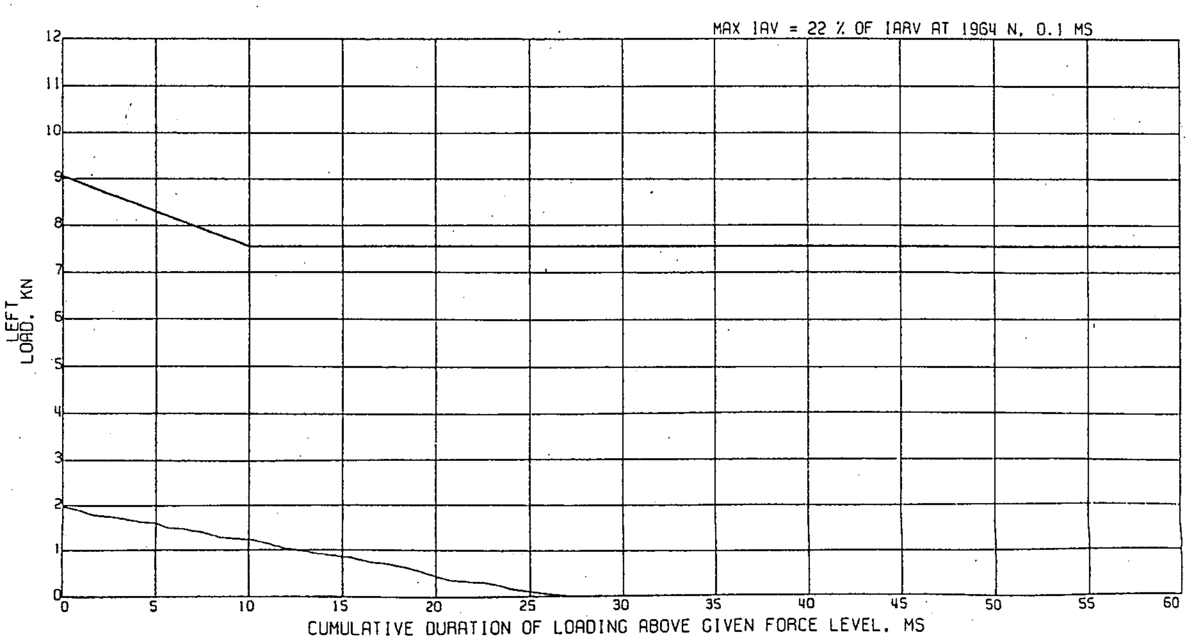
ELEC DATA, SAE CLASS 600

L. FRT FEMUR LOAD

DURATION ASSESSMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **6**

12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

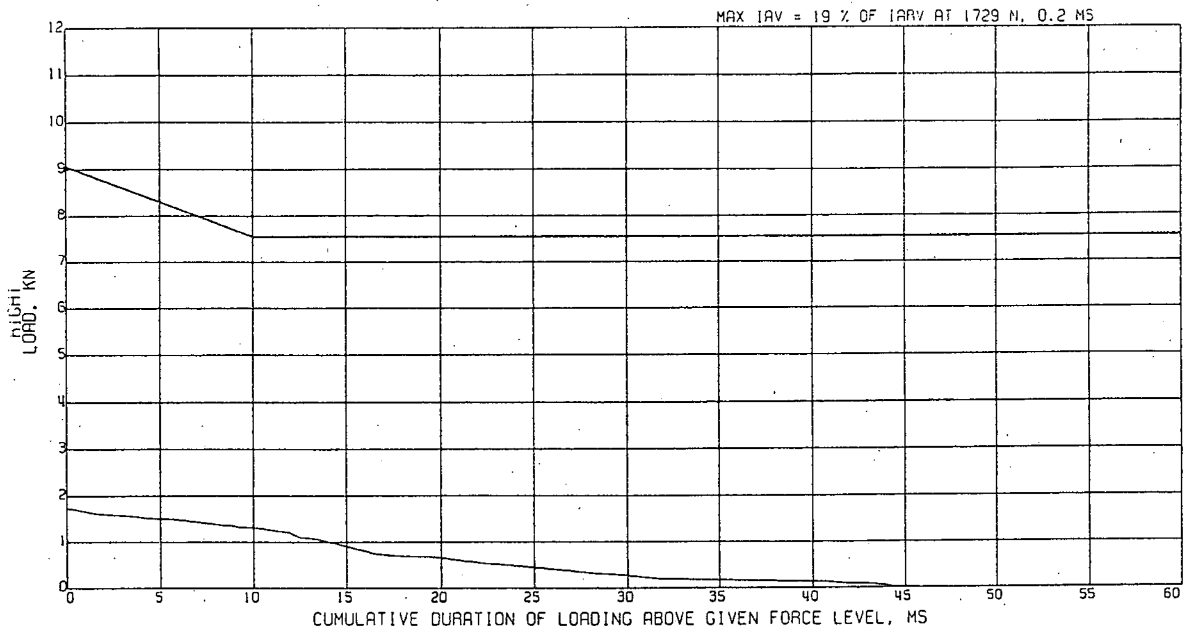
EC DATA, SAE CLASS 600

L. FRT FEMUR LOAD

DURATION ASSESSMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 7

12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

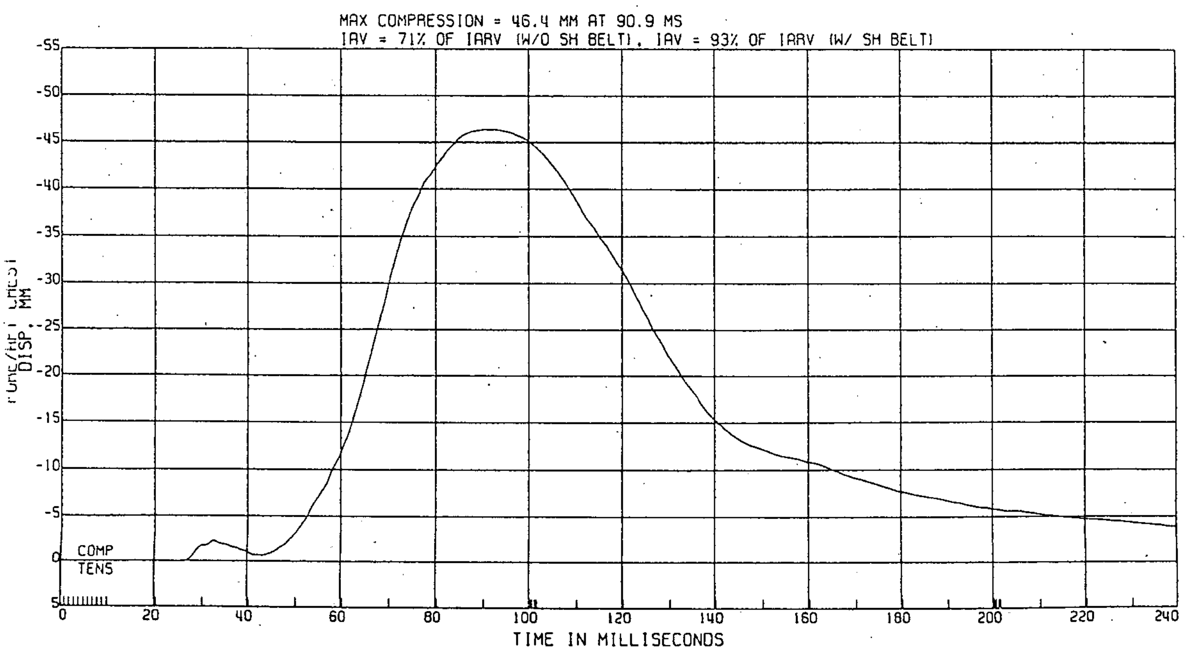
LEC DATA, SAE CLASS 180

L. FRT CHEST DISP, TEMP AT 71.2'F

NORMALIZED TO 70.7'F & PART 572 CORRIDOR

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 8

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

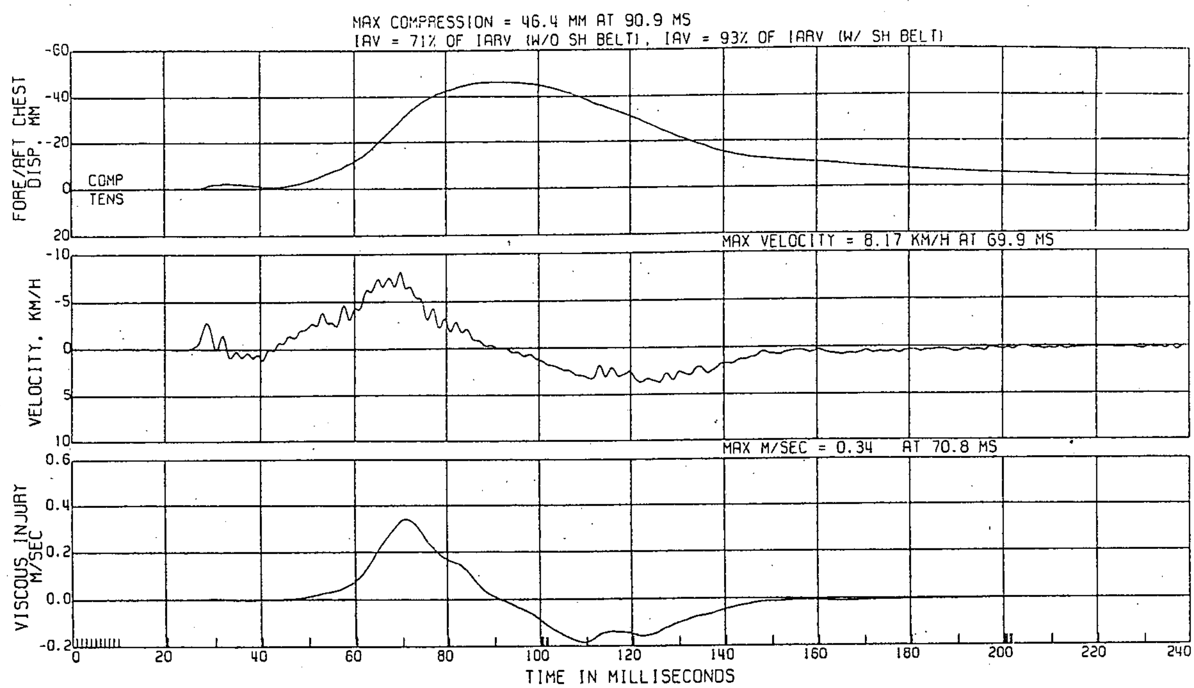
ELEC DATA, SAE CLASS 180

L. FRT CHEST COMPRESSIVE DISP.

NORMALIZED, W/CALC VEL & VISCOUS INJURY

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 9

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

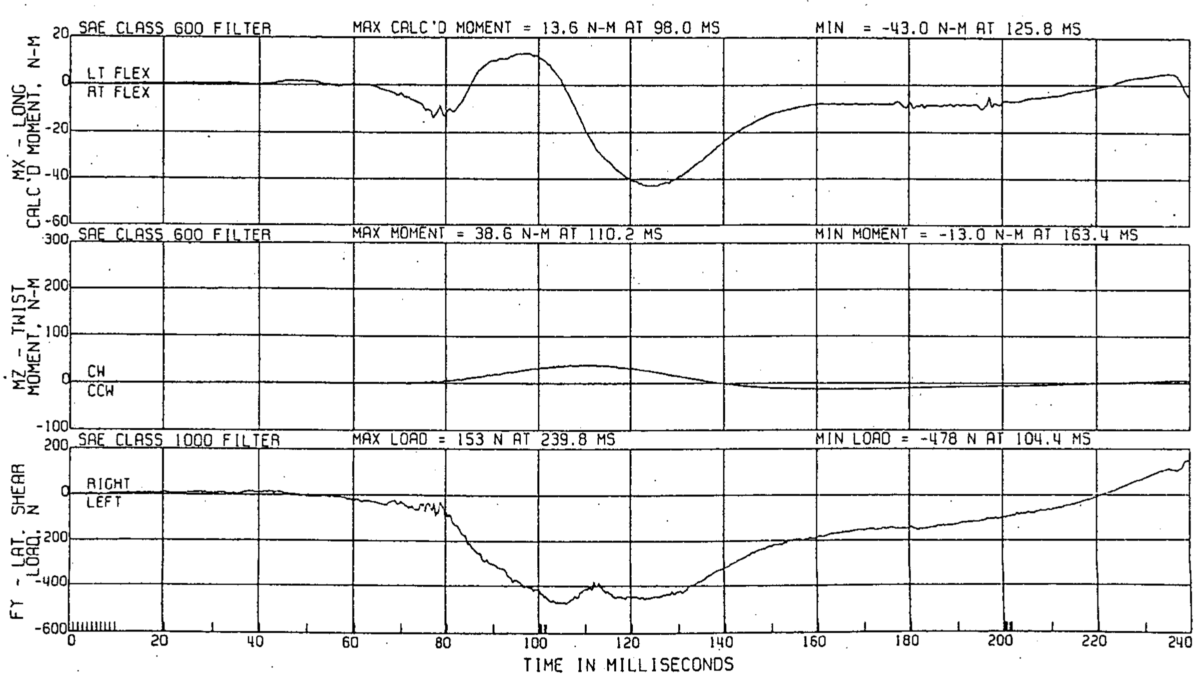
ELEC DATA

L. FRT NECK LOADING ON HEAD, UPPER LOAD

L. FRT NECK LOADING ON HEAD

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 10

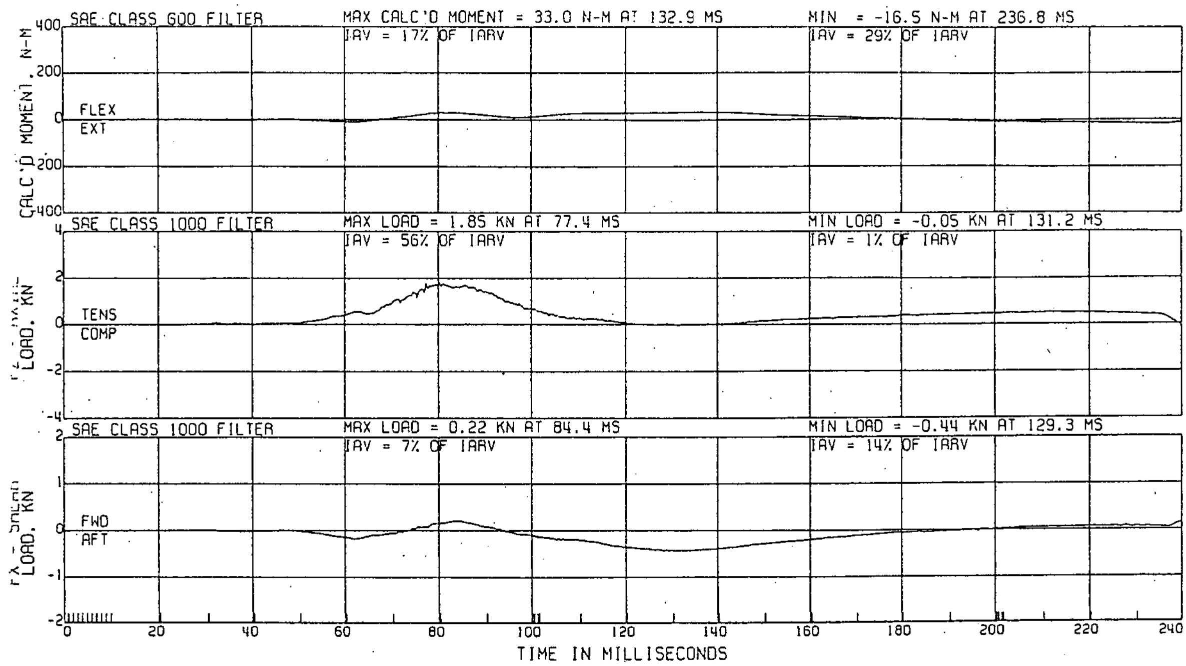
2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

ATD TYPE: GM50H

& D CTR 8W9187D HONDA NECK LOADING ON HEAD TEST DATE:09/16/1998

EC DATA

L. FRT NECK LOADING ON HEAD



Appendix F, plot # **11**

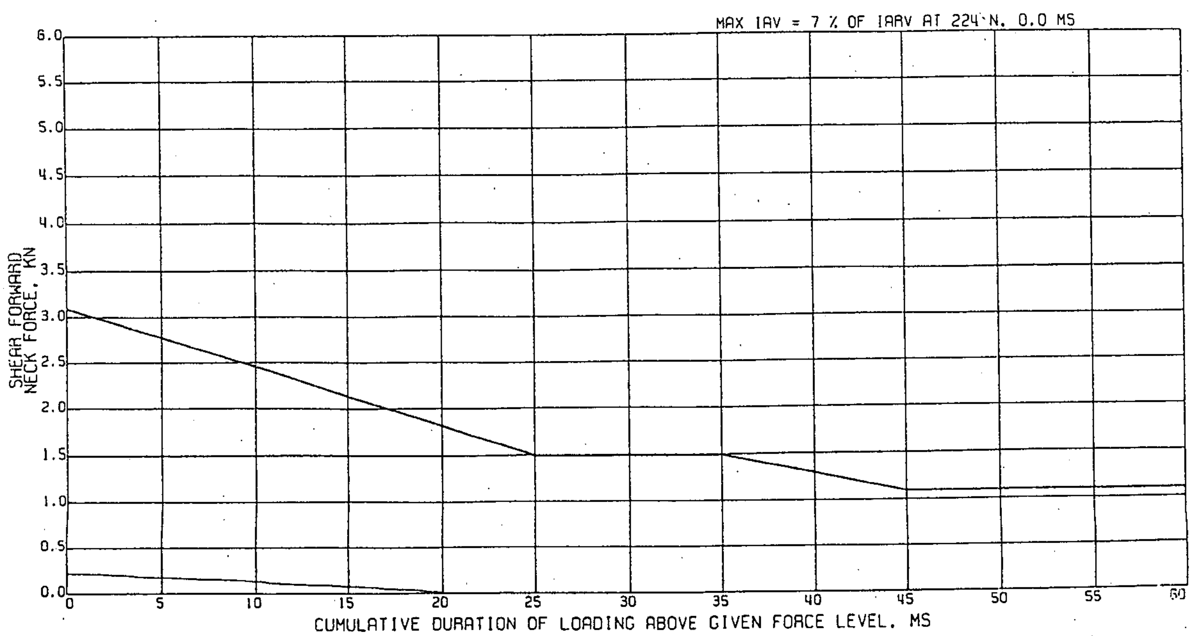
12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

ATD TYPE: GM50H

& D CTR 8W9187D HONDA FORWARD NECK SHEAR ON HEAD, TEST DATE:09/16/1998

LEC DATA, SAE CLASS 1000

L. FRT INJURY REFERENCE



Appendix F, plot # **12**

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W9187D HONDA

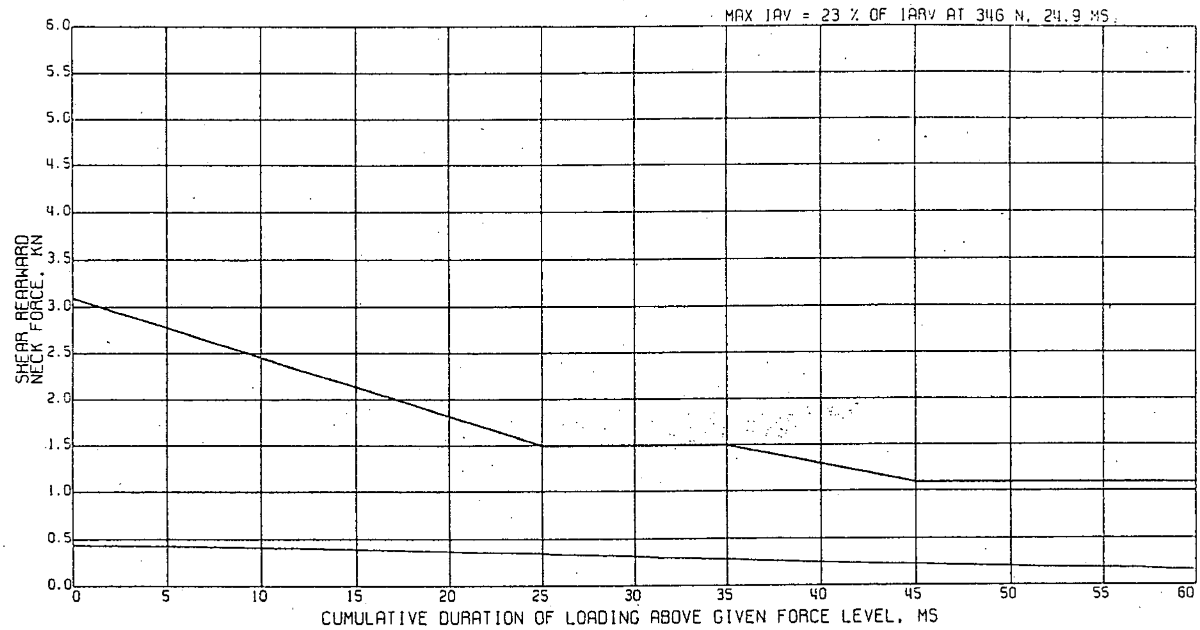
ELEC DATA, SAE CLASS 1000

REARWARD NECK SHEAR ON HEAD,

L. FRT INJURY REFERENCE

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 13

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W9187D HONDA

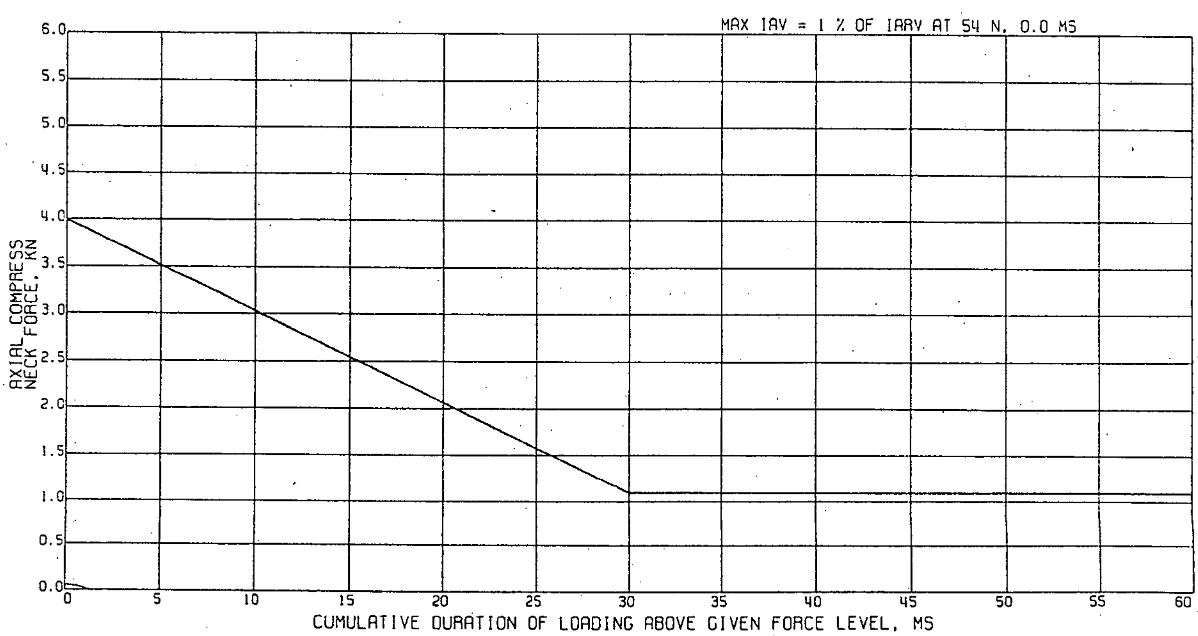
ELEC DATA, SAE CLASS 1000

AXIAL COMPRESSION ON HEAD,

L. FRT INJURY REFERENCE

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 14

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

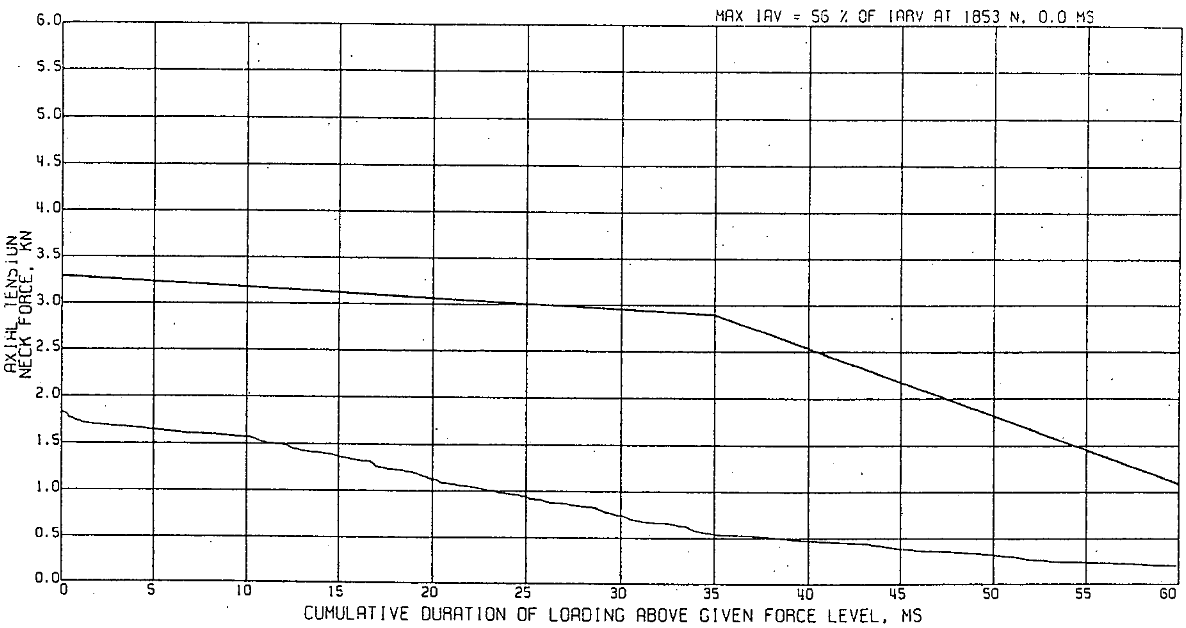
LEC DATA, SAE CLASS 1000

ATD TYPE: GM50H

TEST DATE:09/16/1998

AXIAL TENSION ON HEAD,

L. FRT INJURY REFERENCE



Appendix F, plot # **15**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

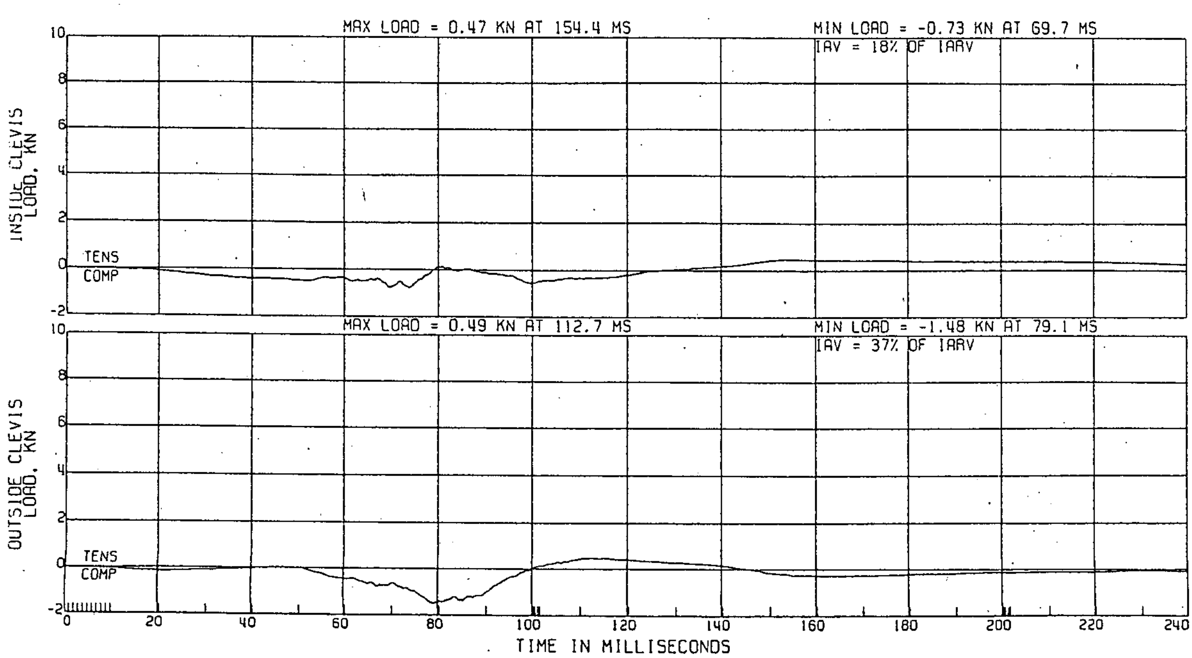
& D CTR 8W91870 HONDA

LEC DATA, SAE CLASS 600

ATD TYPE: GM50H

TEST DATE:09/16/1998

L. FRT LEFT KNEE CLEVIS LOAD



Appendix F, plot # **16**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

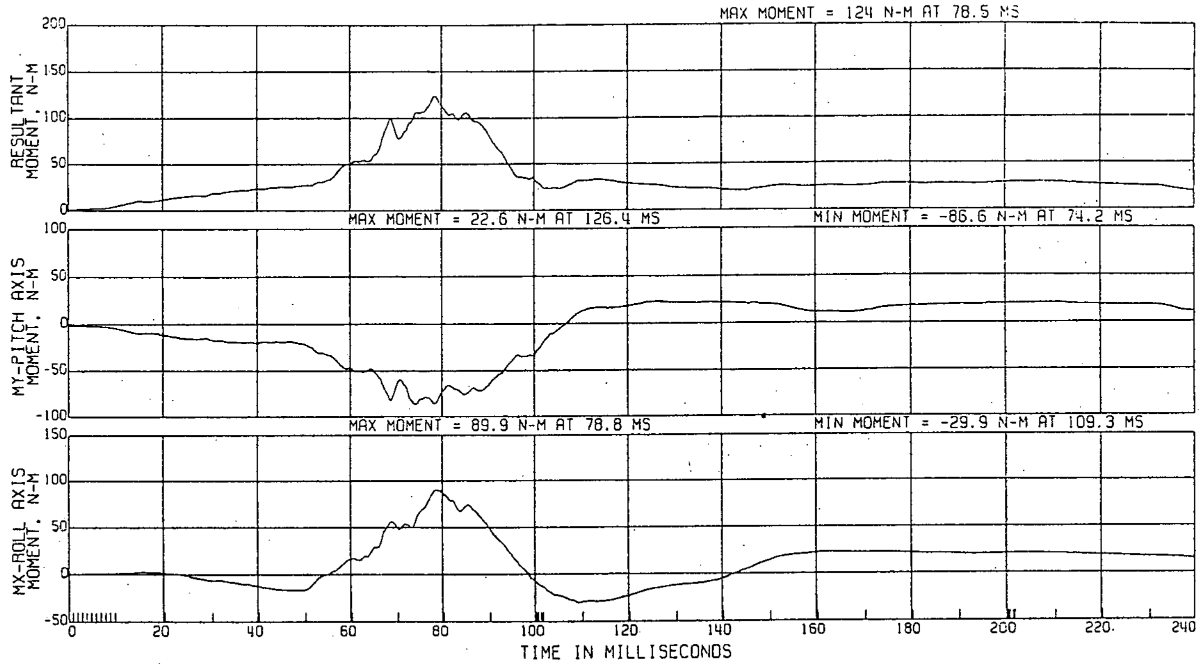
R & D CTR 8W9187D HONDA

ELEC DATA, SAE CLASS 600

L. FRT LEFT TIBIA UPPER MOMENT

ATD TYPE: GM50M

TEST DATE:09/16/1998



Appendix F, plot # **17**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

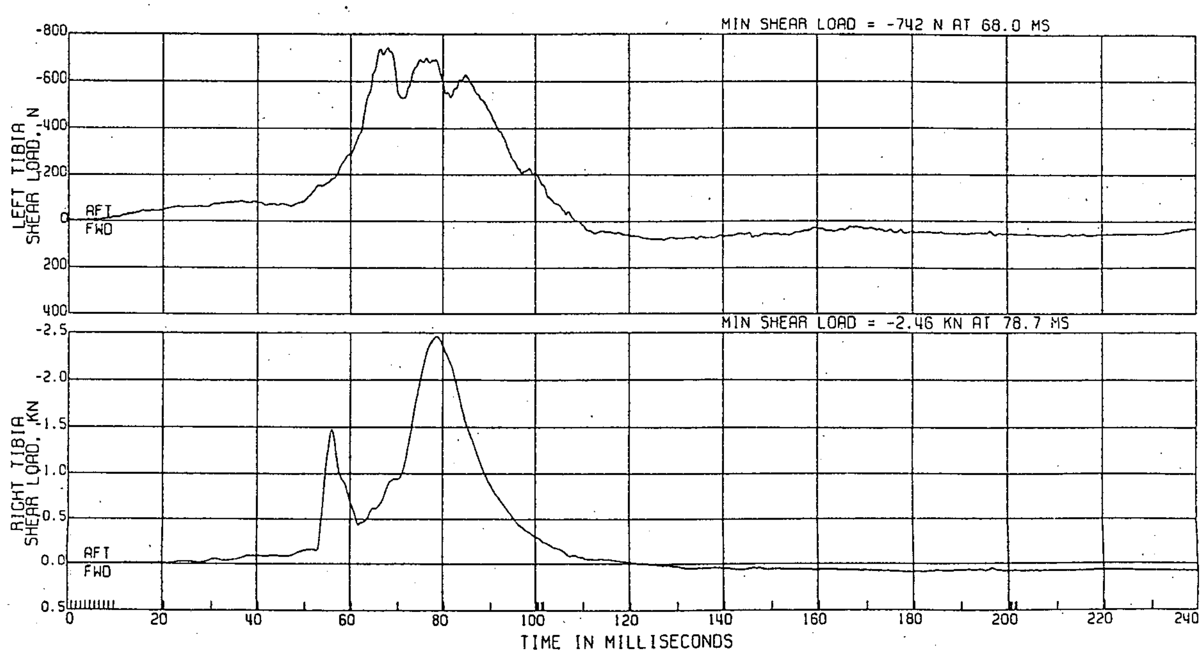
ATD TYPE: GM50M

R & D CTR 8W9187D HONDA

TEST DATE:09/16/1998

ELEC DATA, SAE CLASS 600

L. FRT TIBIA LOWER SHEAR LOAD



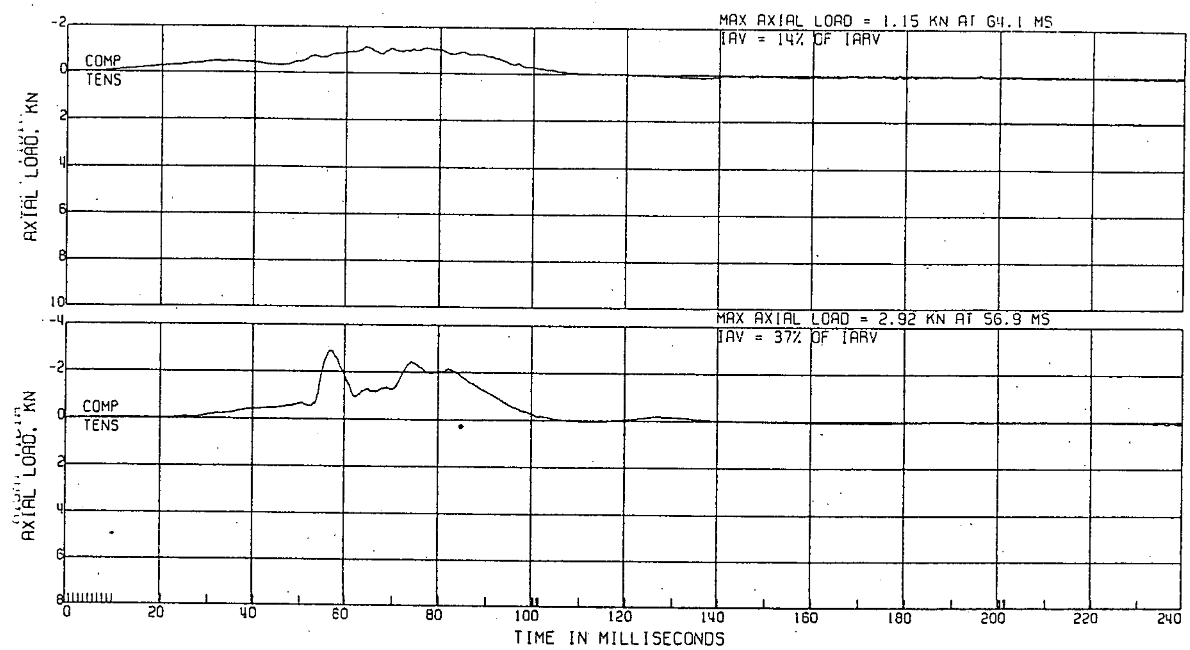
Appendix F, plot # **18**

2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA
EC DATA, SAE CLASS 600

ATD TYPE: GM50H
TEST DATE:09/16/1998

L. FRT TIBIA LOWER AXIAL LOAD



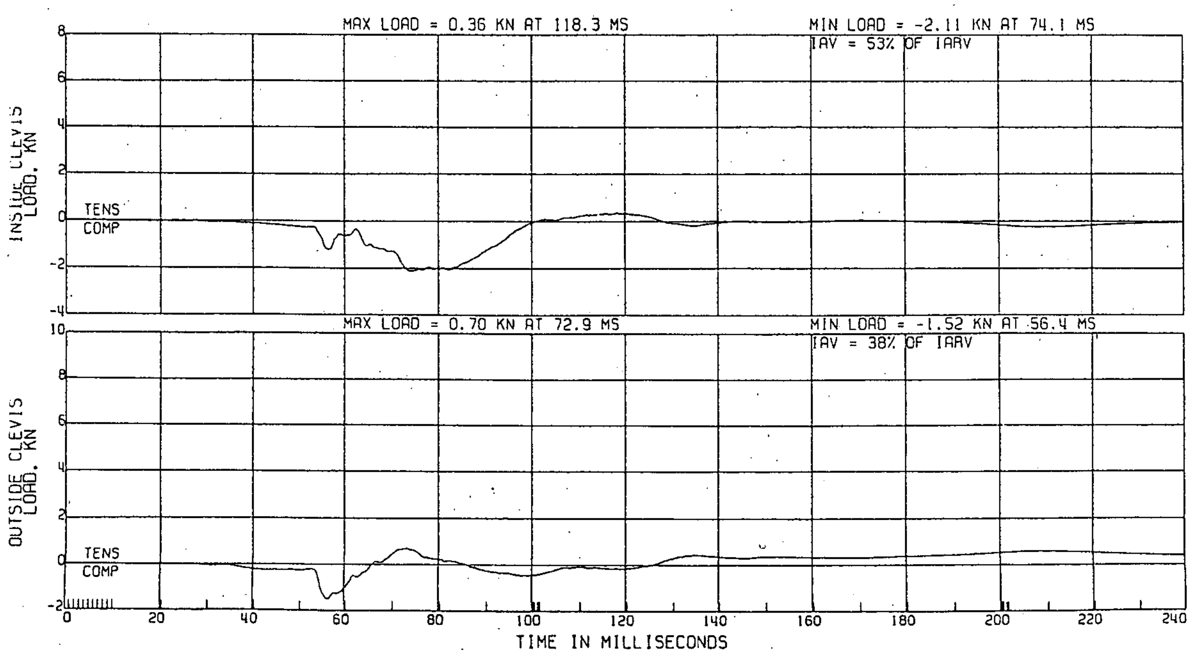
Appendix F, plot # 19

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

ATD TYPE: GM50H
TEST DATE:09/16/1998

& D CTR 8W91870 HONDA
LEC DATA, SAE CLASS 600

L. FRT RIGHT KNEE CLEVIS LOAD



Appendix F, plot # 20

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

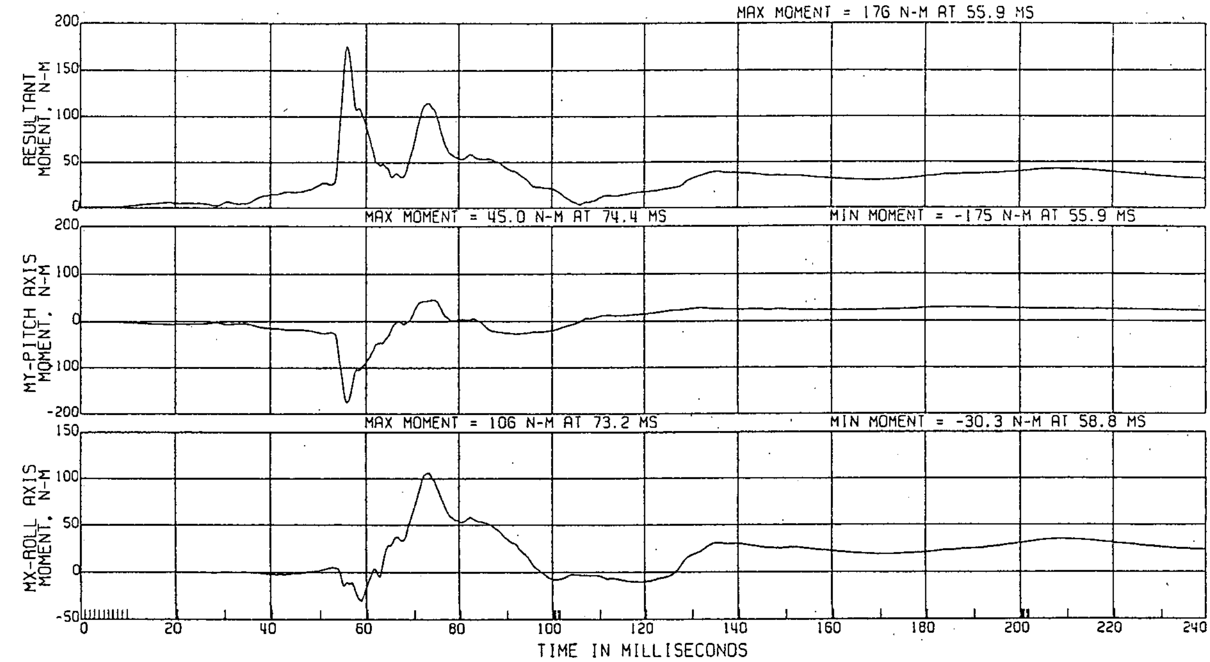
R & D CTR 8W9187D HONDA

ELEC DATA, SAE CLASS 600

L. FRT RIGHT TIBIA UPPER MOMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **21**

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

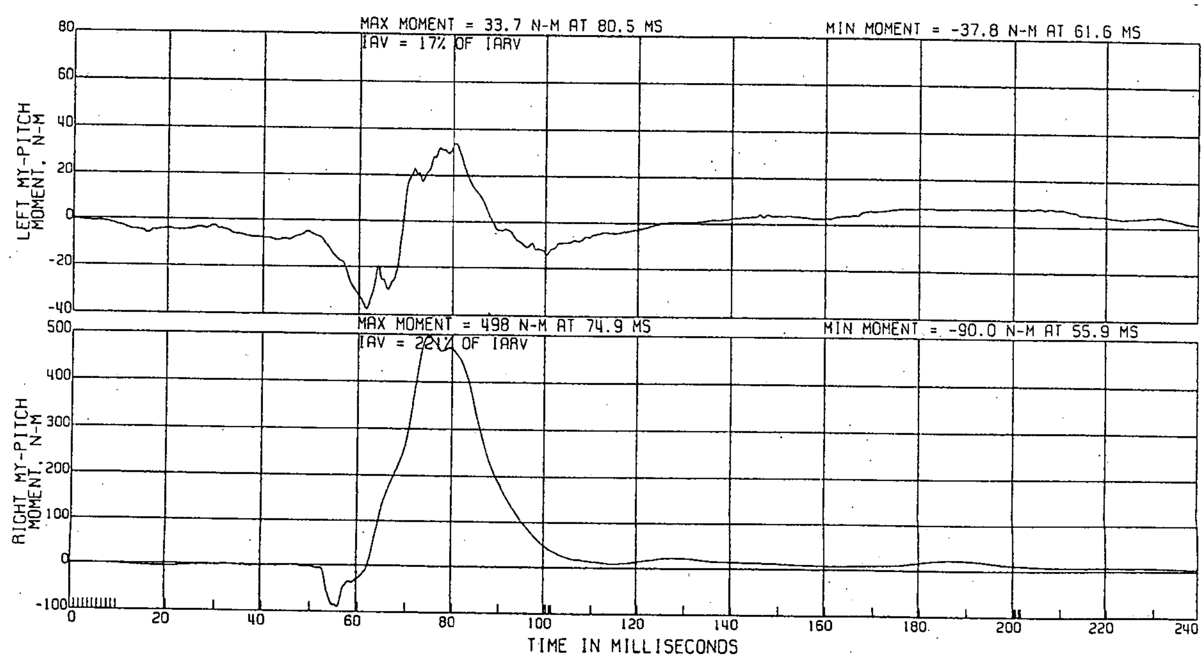
R & D CTR 8W9187D HONDA

ELEC DATA, SAE CLASS 600

ATD TYPE: GM50H

TEST DATE:09/16/1998

L. FRT TIBIA LOWER BENDING MOMENTS



2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

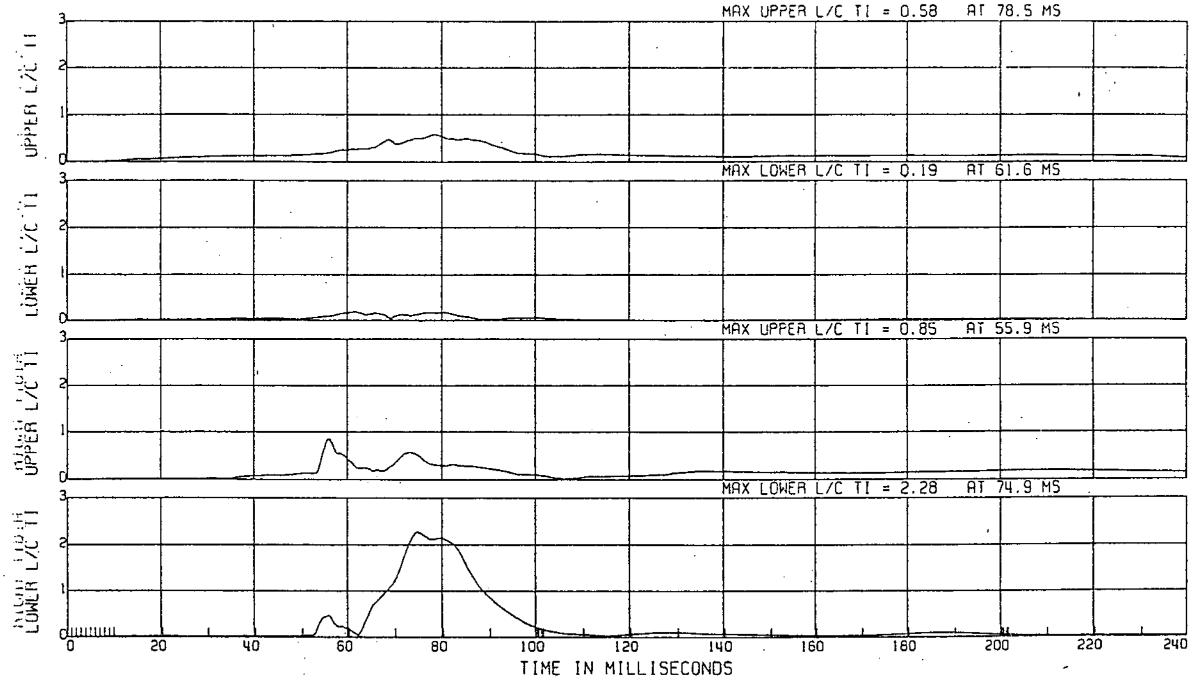
EC DATA, SAE CLASS 600

L. FRT TIBIA INDICES

TI = (RES MOM/225 NM) + (AXIAL/35900 N)

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **23**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

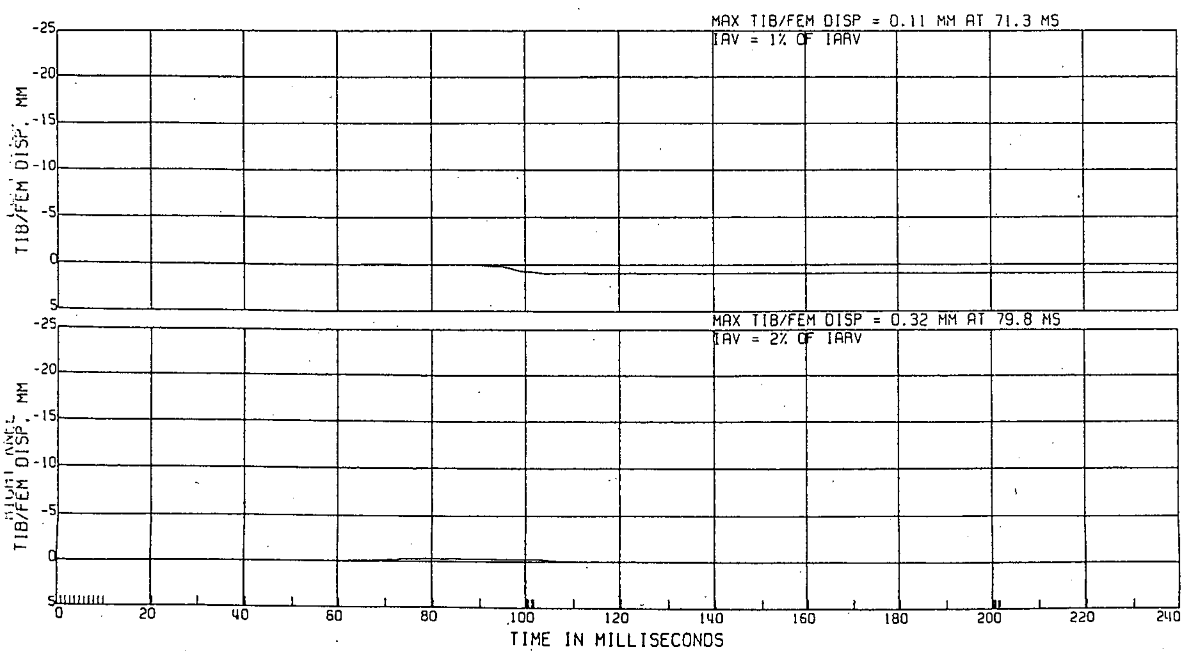
& D CTR 8W9187D HONDA

EC DATA, SAE CLASS 180

L. FRT TIBIA/FEMUR DISPLACEMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 24

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

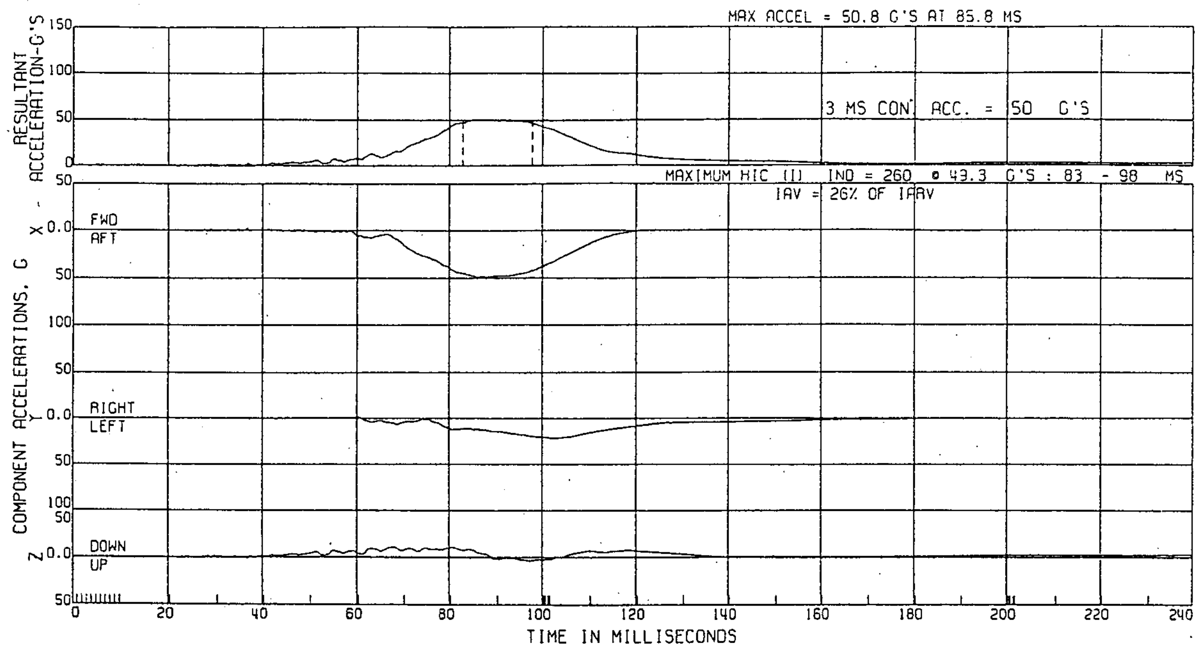
ELEC DATA, SAE CLASS 1000

R. FRT HEAD ACCEL.

(HIC I LIMITED TO 15MS)

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 25

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

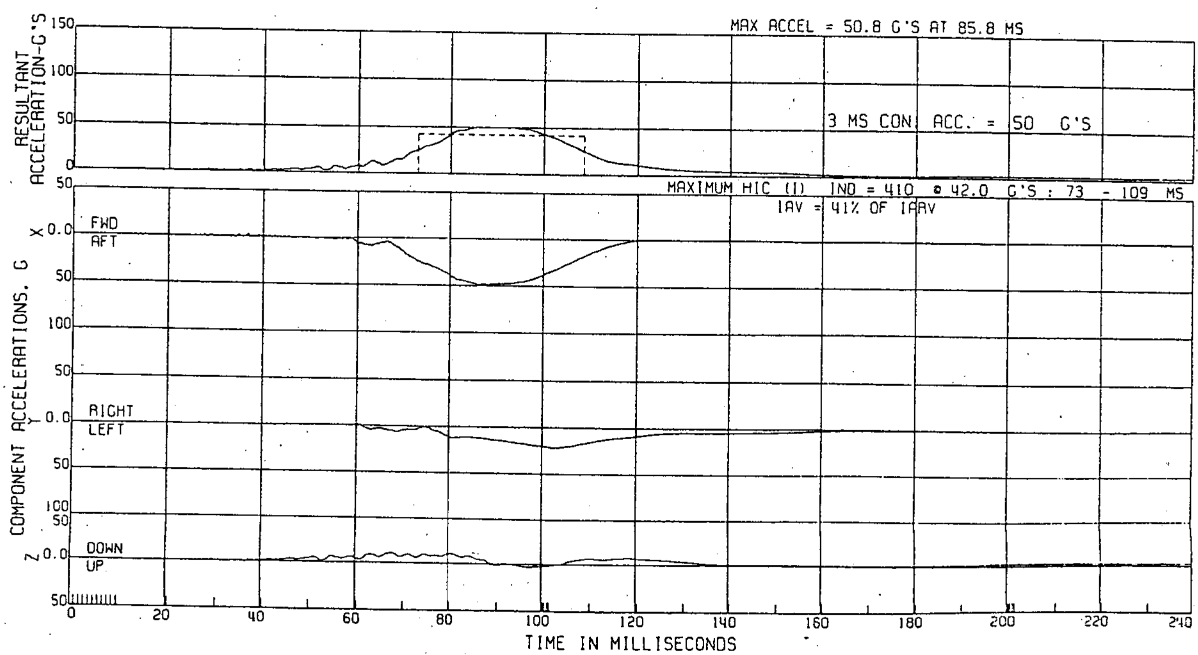
ELEC DATA, SAE CLASS 1000

R. FRT HEAD ACCEL.

(HIC I LIMITED TO 36MS)

ATD TYPE: GM50H

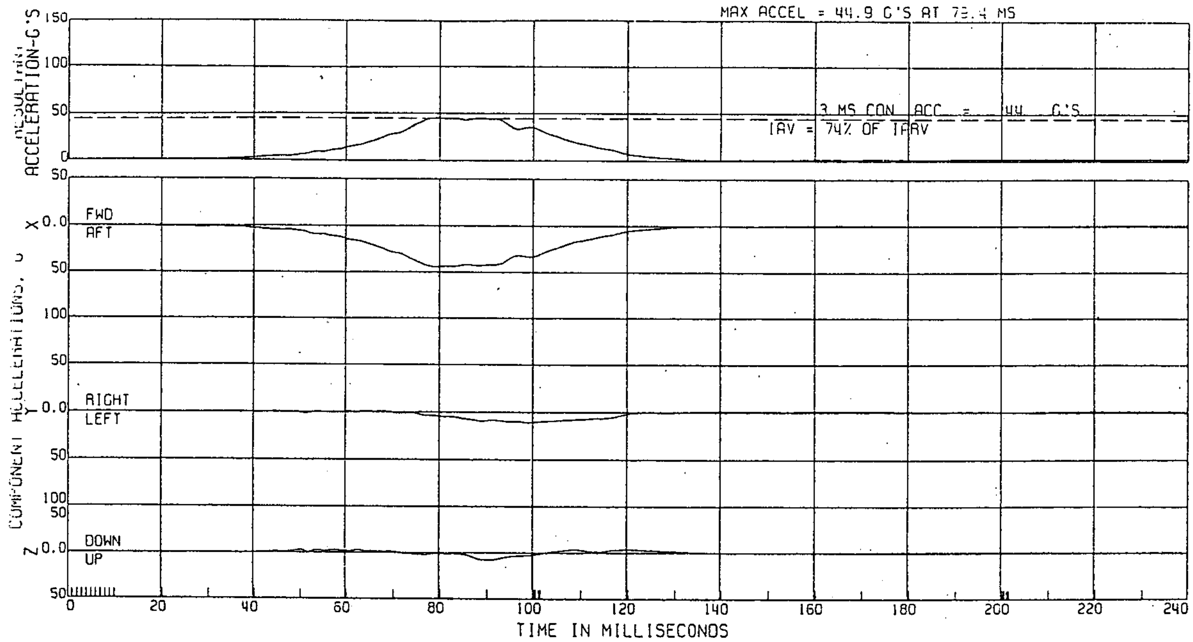
TEST DATE:09/16/1998



Appendix F, plot # 26

12174 FRONT IMPACT | MOVING VEHICLE TO FIXED POLE | 55.4 KM/H

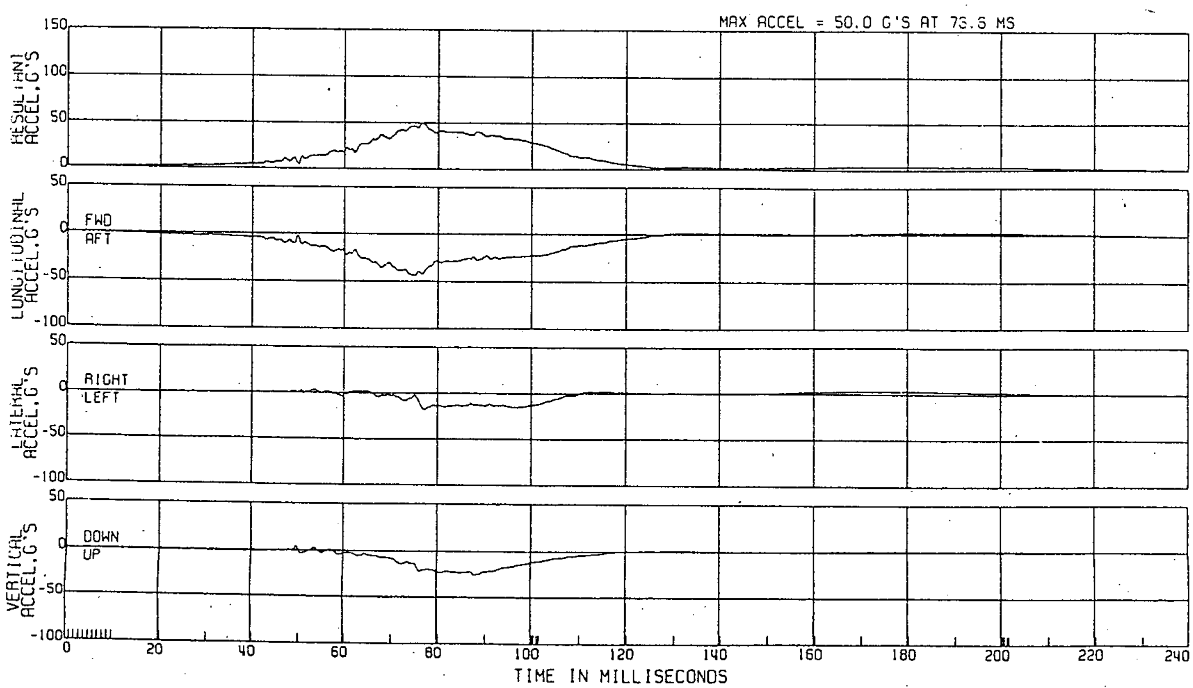
& D CTR 8W91870 HONDA | R. FRT CHEST ACCEL. | ATD TYPE: GM50H
TEST DATE:09/16/1998
LEC DATA, SAE CLASS 180



Appendix F, plot # **27**

12174 FRONT IMPACT | MOVING VEHICLE TO FIXED POLE | 55.4 KM/H

& D CTR 8W91870 HONDA | R. FRT PELVIC ACCEL. | ATD TYPE: GM50H
TEST DATE:09/16/1998
LEC DATA, SAE CLASS 1000



C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

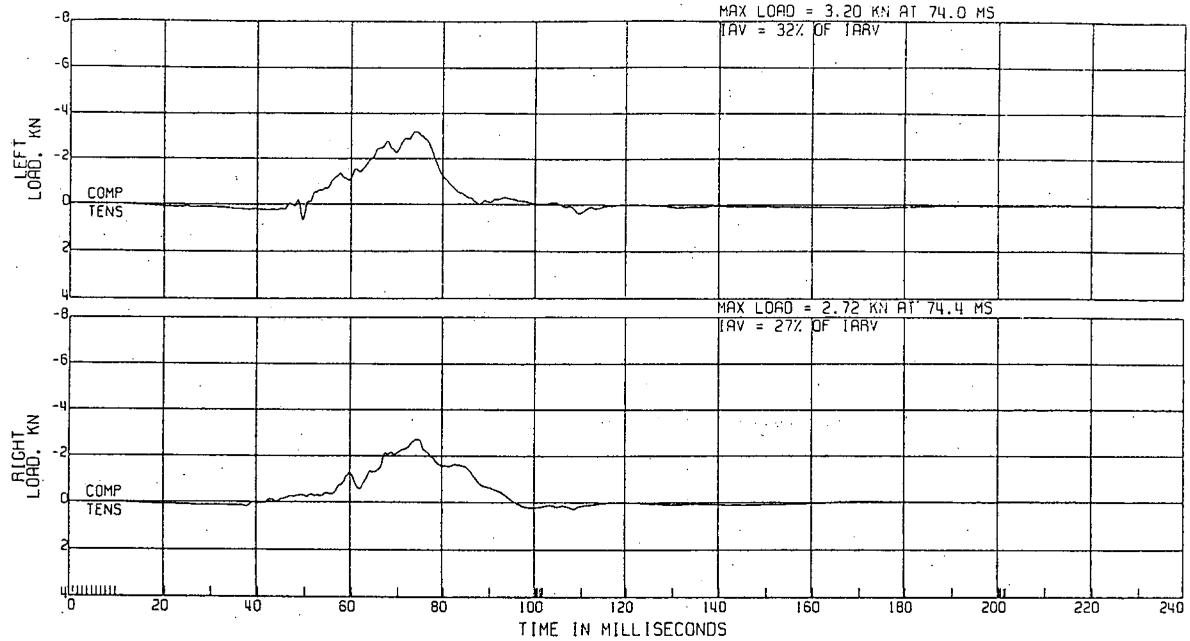
R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 600

R. FRT FEMUR LOAD

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 29

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

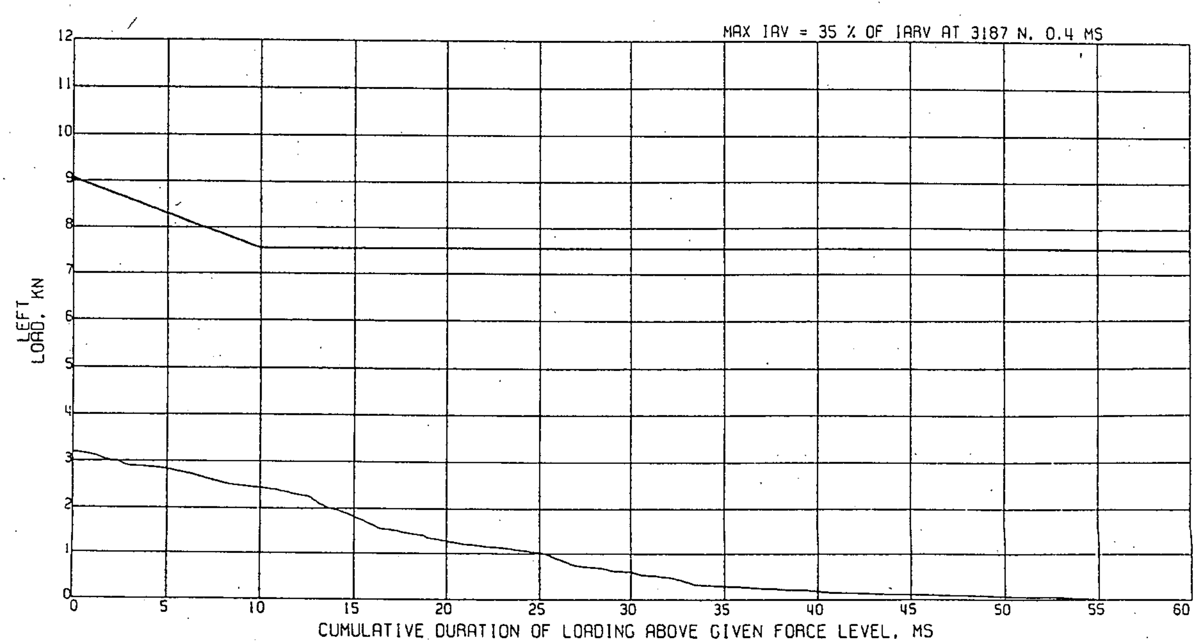
ELEC DATA, SAE CLASS 600

R. FRT FEMUR LOAD

DURATION ASSESSMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 30

.1174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

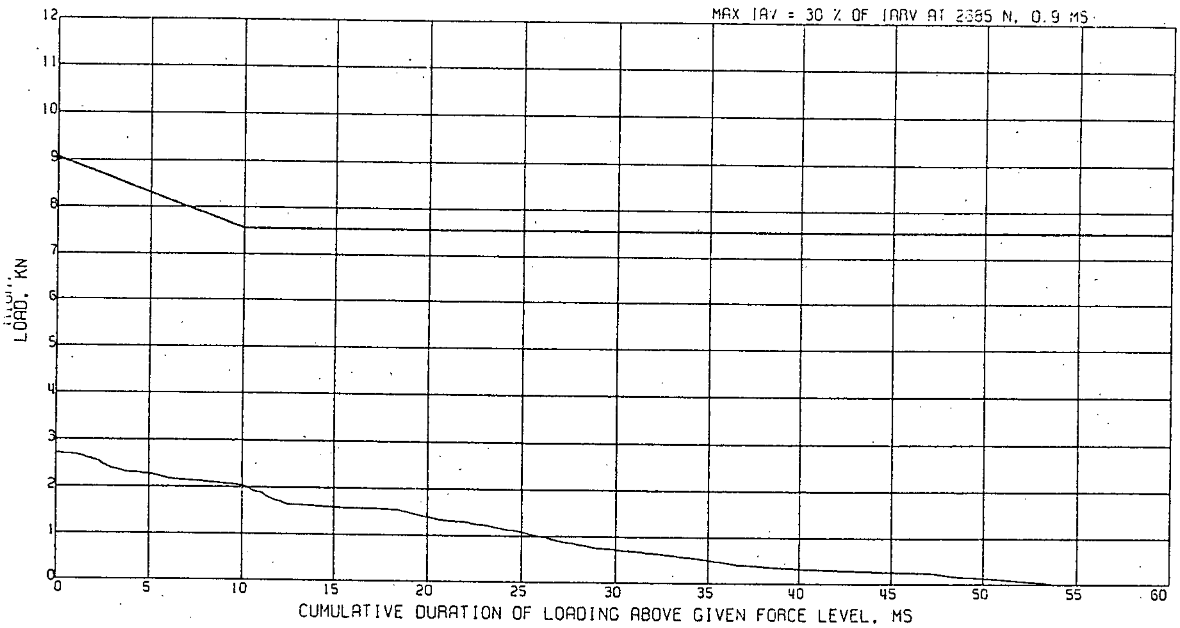
.LEC DATA, SAE CLASS 600

R. FRT FEMUR LOAD

DURATION ASSESSMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **31**

:12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

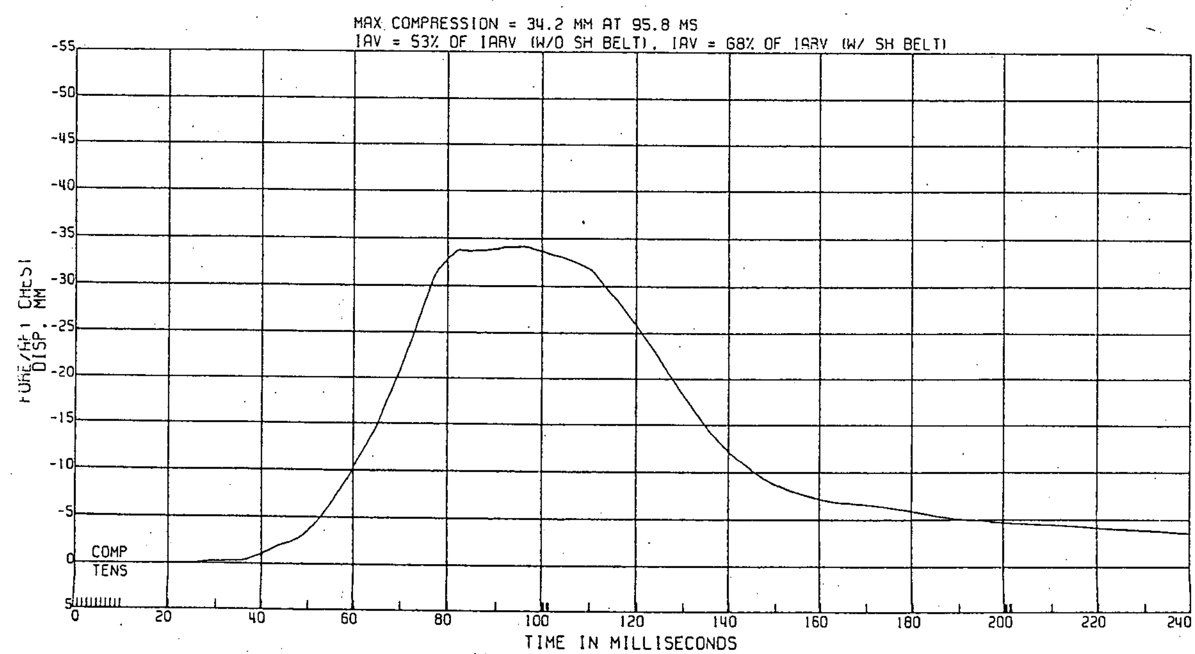
.LEC DATA, SAE CLASS 180

R. FRT CHEST DISP, TEMP AT 71.1'F

NORMALIZED TO 70.7'F & PART 572 CORRIDOR

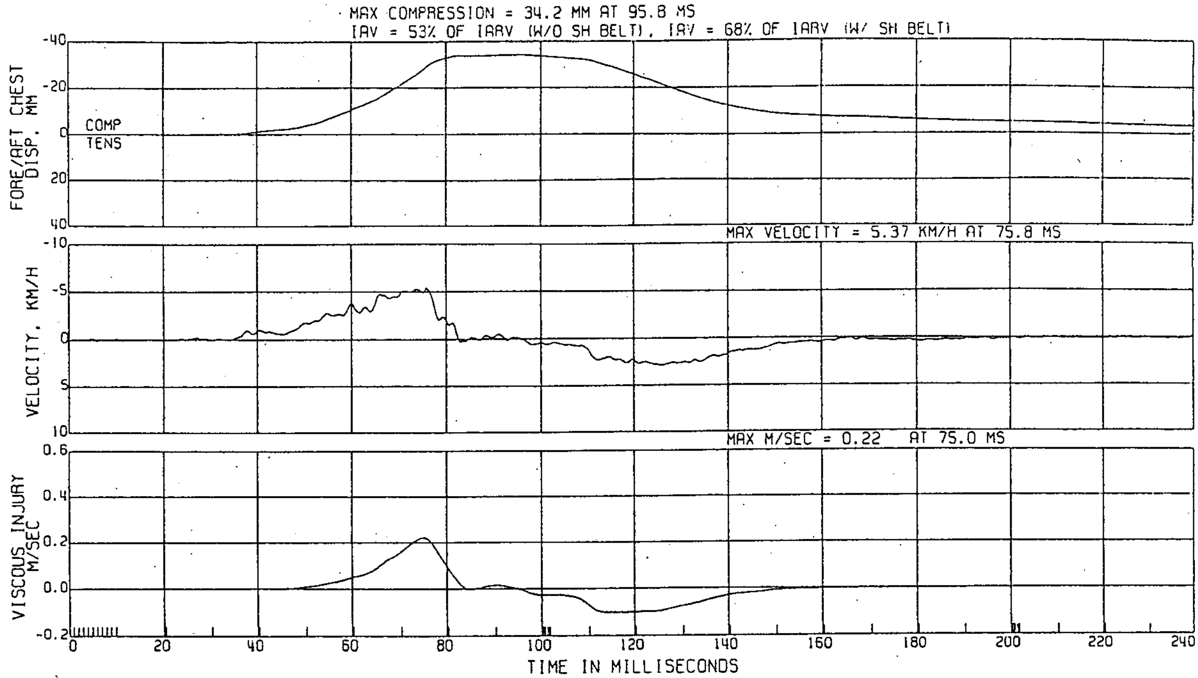
ATD TYPE: GM50H

TEST DATE:09/16/1998



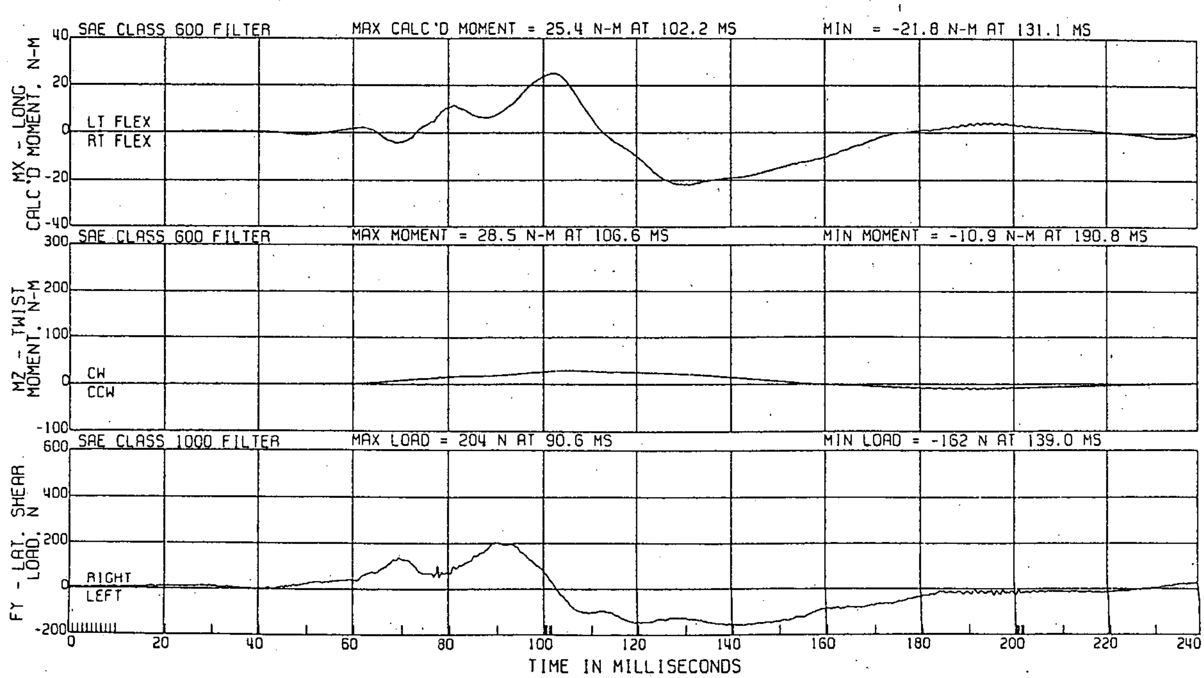
Appendix F, plot # **32**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H
ATD TYPE: GM50H
R & D CTR 8W91870 HONDA R. FRT CHEST COMPRESSIVE DISP. TEST DATE:09/16/1998
ELEC DATA, SAE CLASS 180 NORMALIZED, W/CALC VEL & VISCOUS INJURY



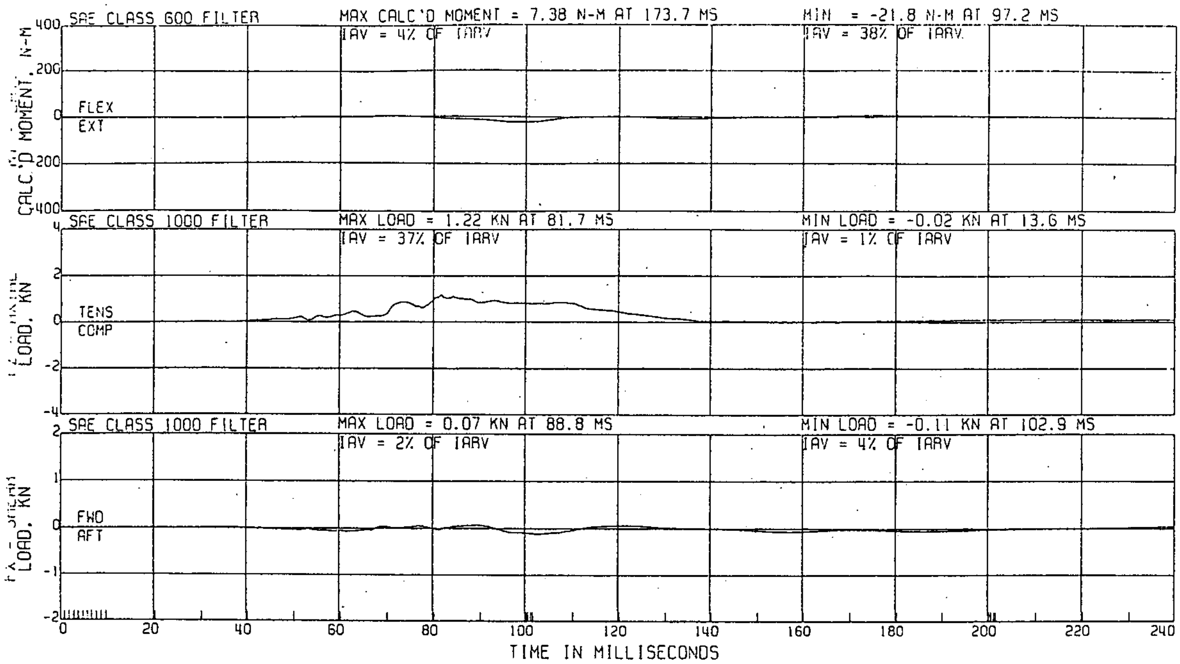
Appendix F, plot # 33

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H
ATD TYPE: GM50H
R & D CTR 8W91870 HONDA R. FRT NECK LOADING ON HEAD, UPPER LOAD TEST DATE:09/16/1998
ELEC DATA R. FRT NECK LOADING ON HEAD



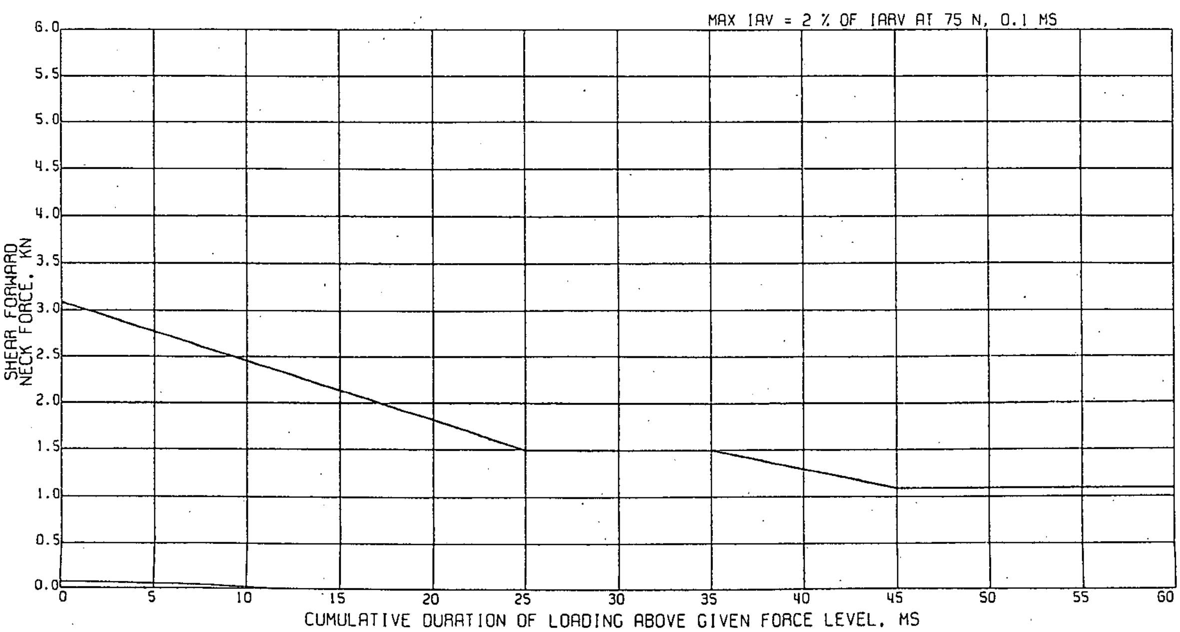
Appendix F, plot # 34

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H
ATD TYPE: GM50H
& D CTR 8W91870 HONDA NECK LOADING ON HEAD TEST DATE:09/16/1998
LEC DATA
R. FRT NECK LOADING ON HEAD



Appendix F, plot # **35**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H
ATD TYPE: GM50H
R & D CTR 8W91870 HONDA FORWARD NECK SHEAR ON HEAD, TEST DATE:09/16/1998
ELEC DATA, SAE CLASS 1000
R. FRT INJURY REFERENCE



Appendix F, plot # **36**

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

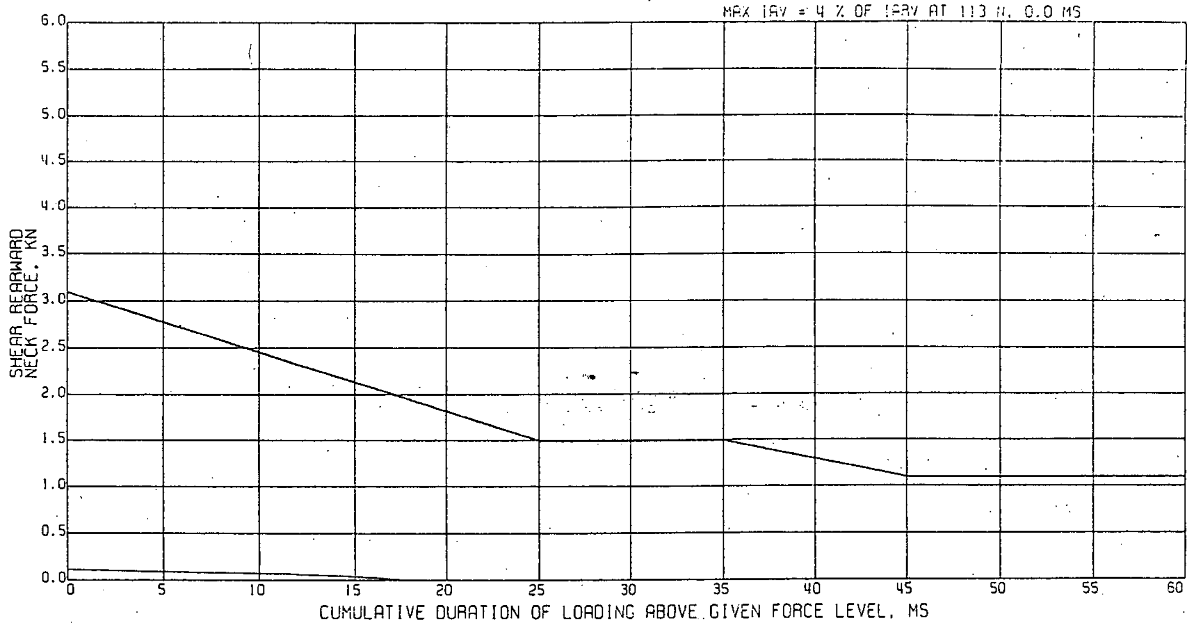
ELEC DATA, SAE CLASS 1000

REARWARD NECK SHEAR ON HEAD,

R. FRT INJURY REFERENCE

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 37

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

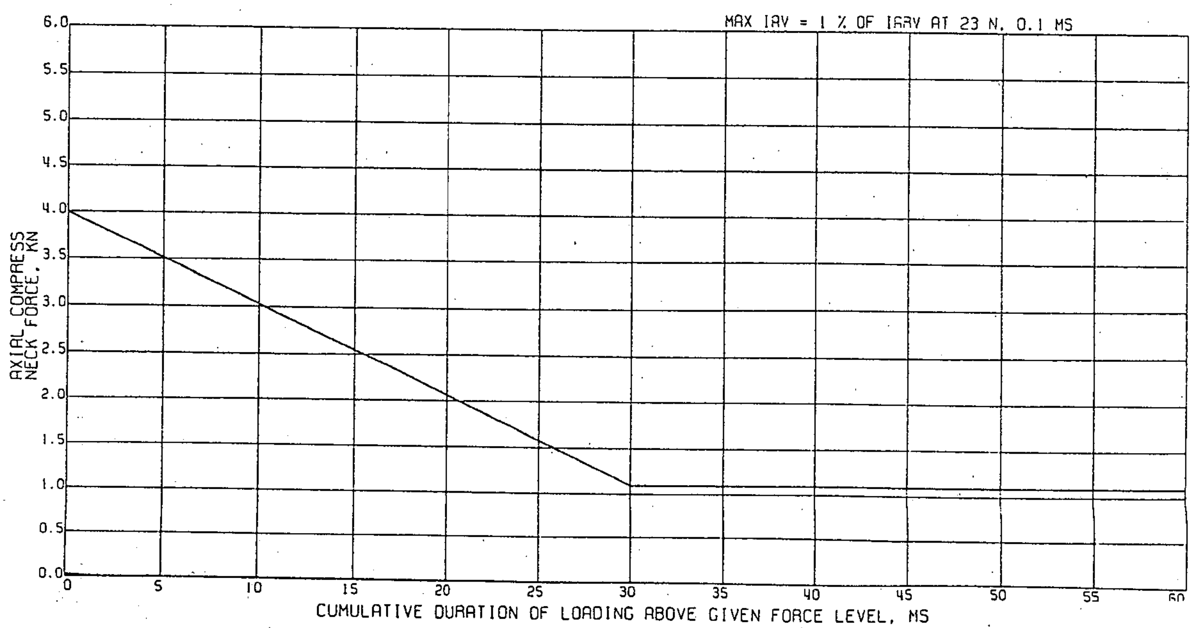
ELEC DATA, SAE CLASS 1000

AXIAL COMPRESSION ON HEAD,

R. FRT INJURY REFERENCE

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 38

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

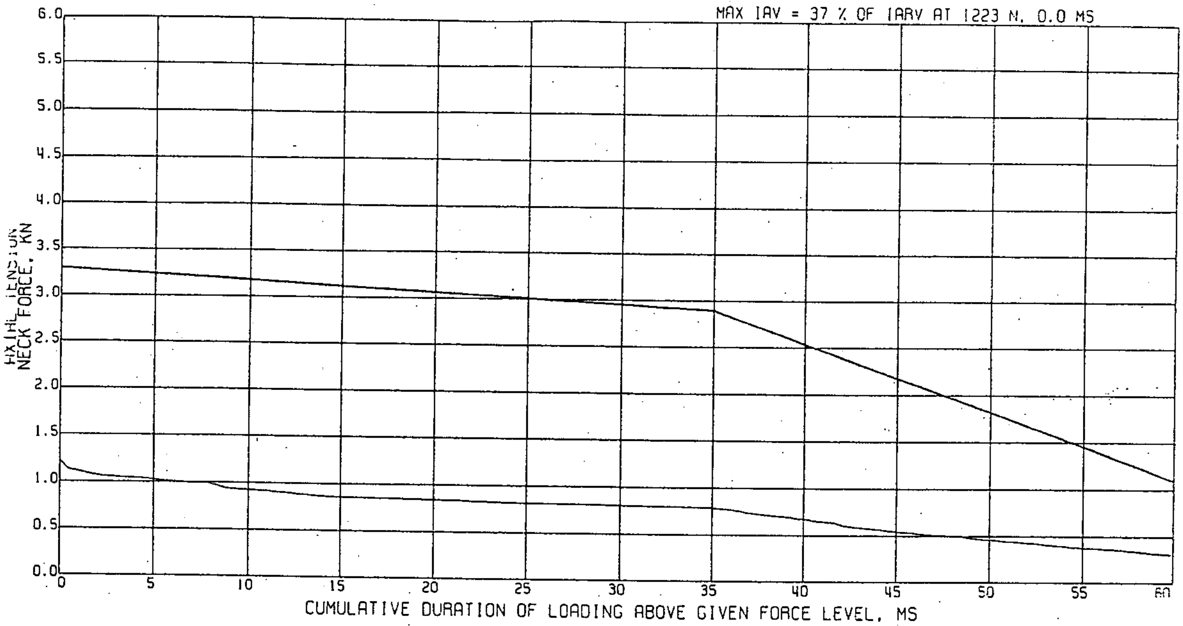
& D CTR 8W9187D HONDA

LEC DATA, SAE CLASS 1000

AXIAL TENSION ON HEAD, R. FRT INJURY REFERENCE

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 39

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

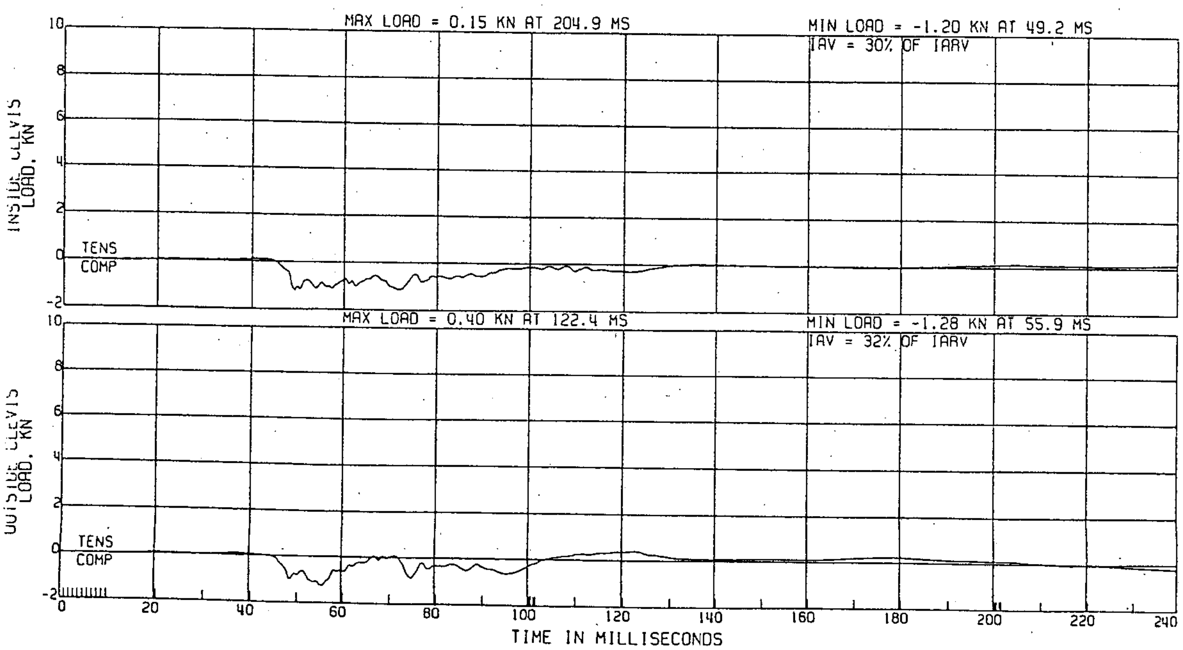
& D CTR 8W9187D HONDA

LEC DATA, SAE CLASS 600

R. FRT LEFT KNEE CLEVIS LOAD

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 40

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

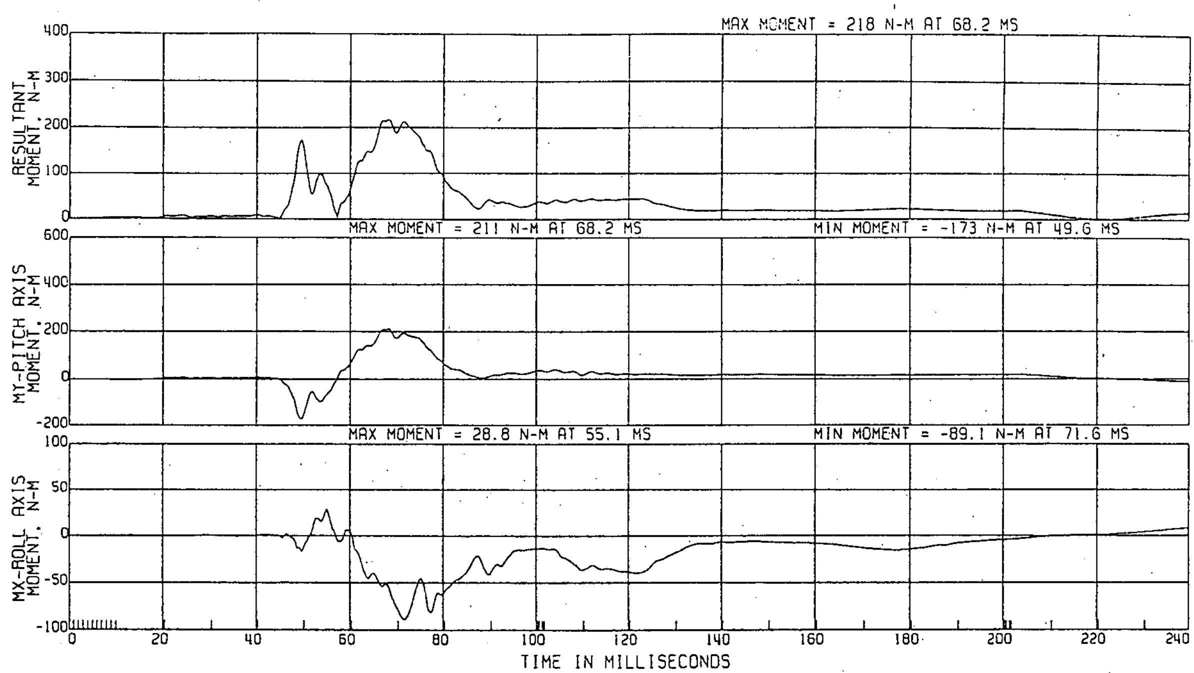
R & D CTR 8W9187D HONDA

ELEC DATA, SAE CLASS 600

R. FRT LEFT TIBIA UPPER MOMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **41**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

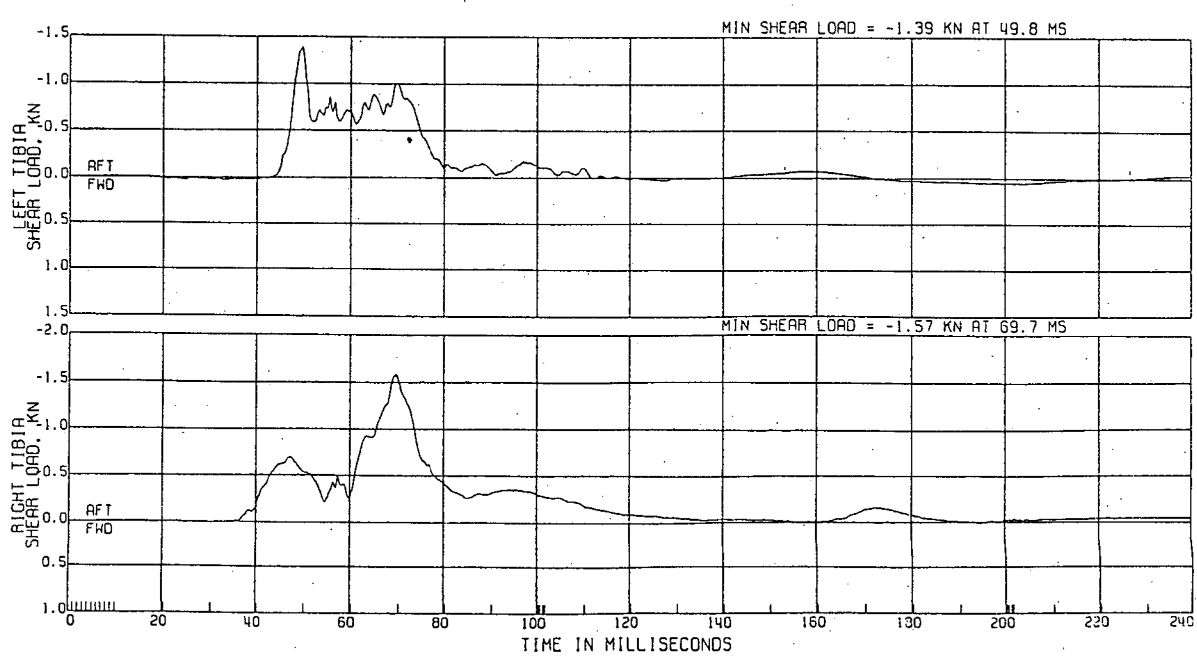
ATD TYPE: GM50H

R & D CTR 8W9187D HONDA

TEST DATE:09/16/1998

ELEC DATA, SAE CLASS 600

R. FRT TIBIA LOWER SHEAR LOAD



Appendix F, plot # **42**

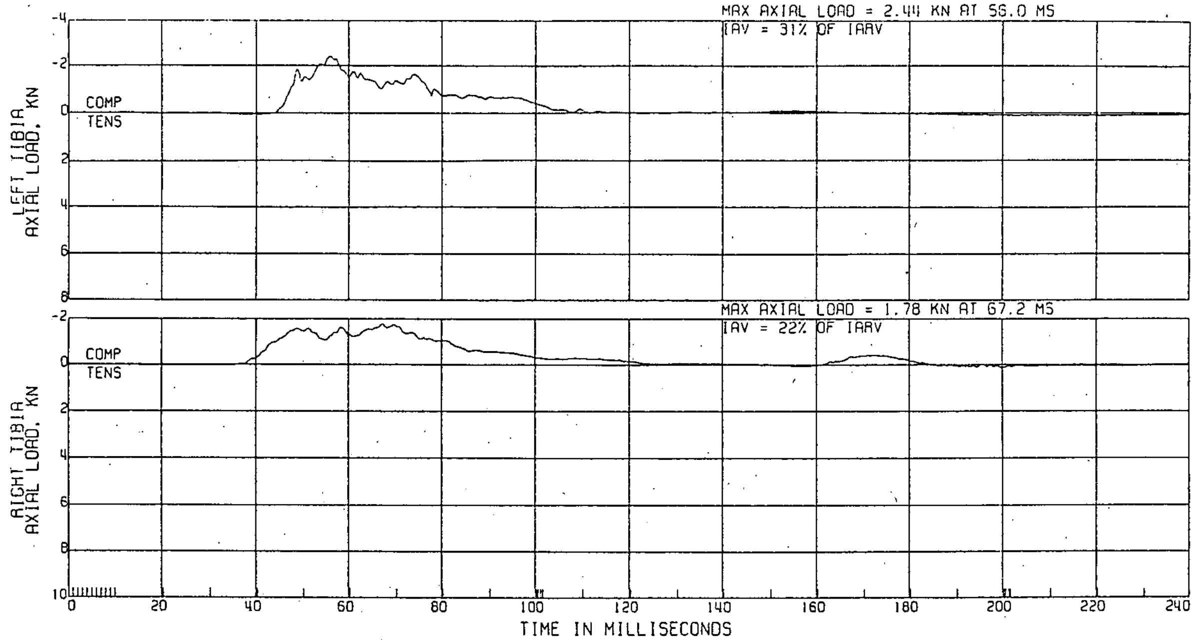
12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

ATD TYPE: GM50H

R & D CTR 8W91870 HONDA TEST DATE:09/16/1998

ELEC DATA, SAE CLASS 600

R. FRT TIBIA LOWER AXIAL LOAD



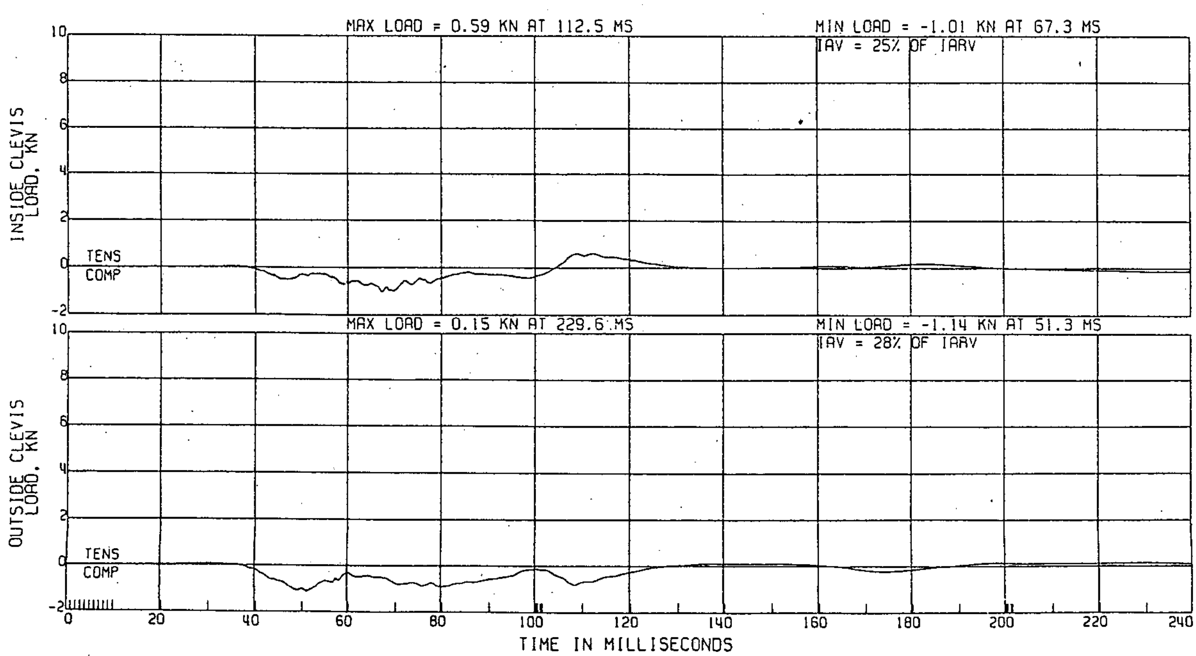
Appendix F, plot # 43

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

ATD TYPE: GM50H

R & D CTR 8W91870 HONDA R. FRT RIGHT KNEE CLEVIS LOAD TEST DATE:09/16/1998

ELEC DATA, SAE CLASS 600



Appendix F, plot # 44

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

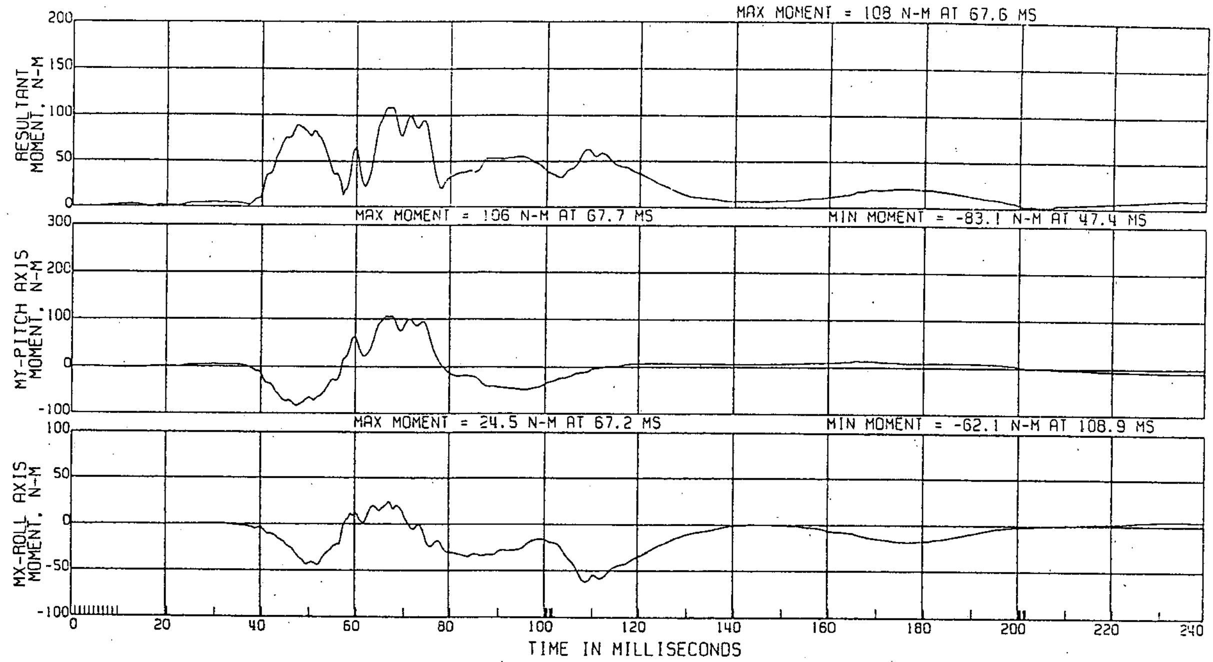
R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 600

R. FRT RIGHT TIBIA UPPER MOMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 45

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

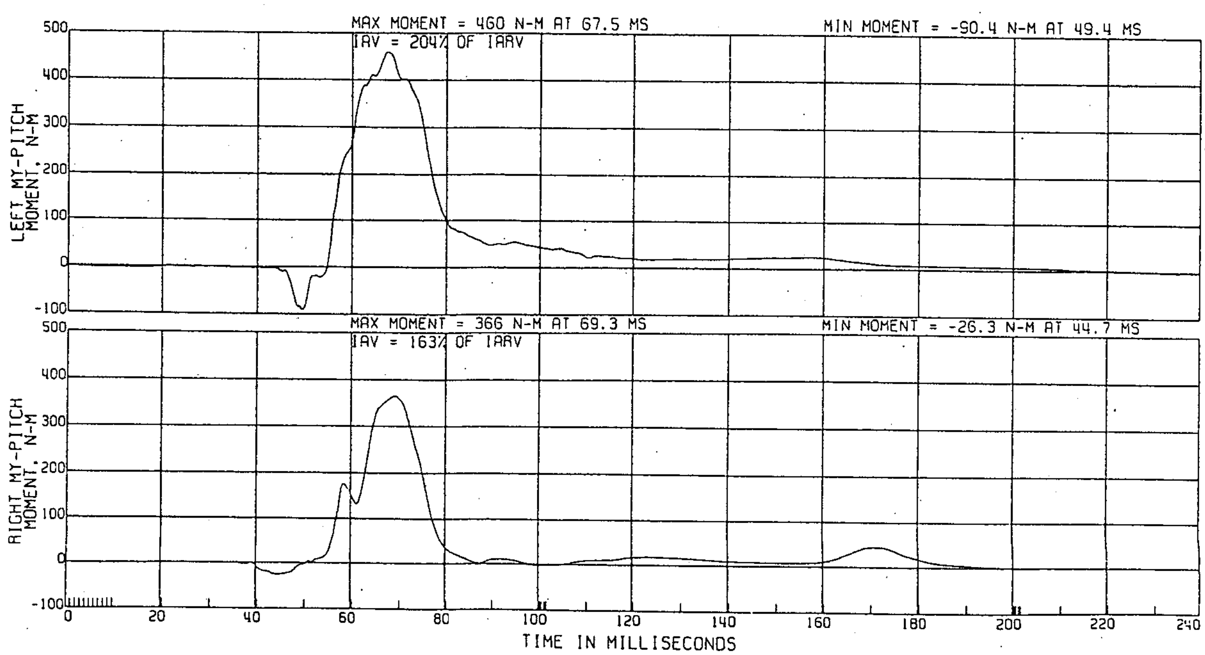
ATD TYPE: GM50H

TEST DATE:09/16/1998

R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 600

R. FRT TIBIA LOWER BENDING MOMENTS



Appendix F, plot # 46

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

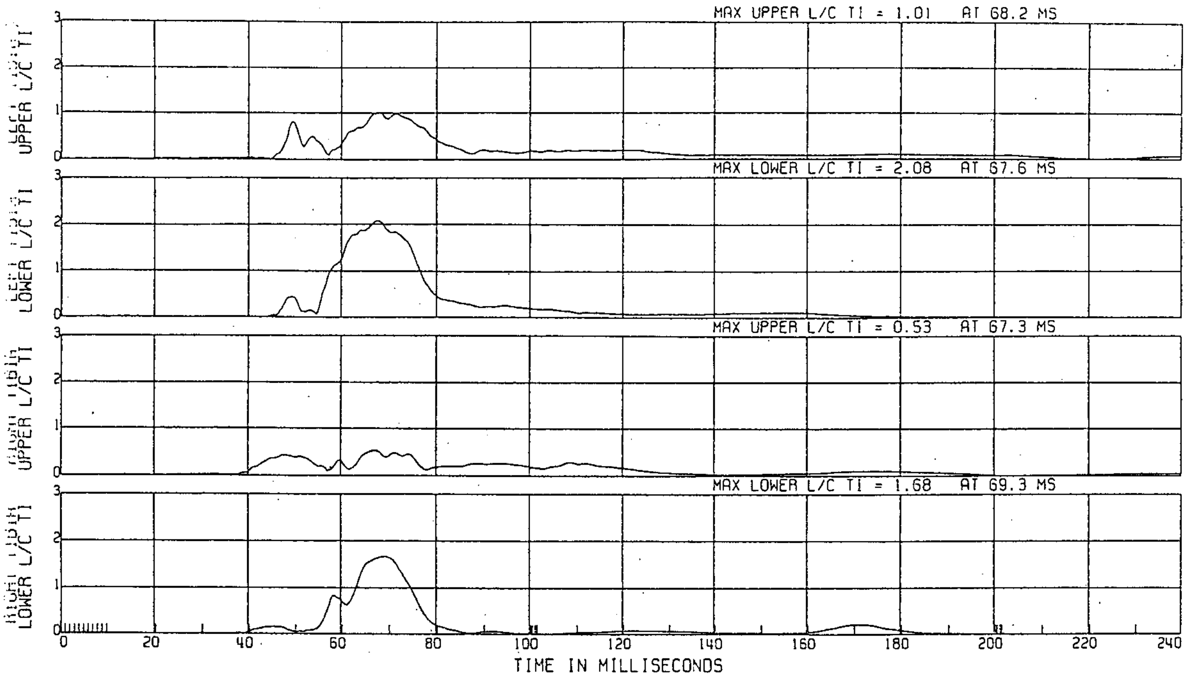
LEC DATA, SAE CLASS 600

R. FRT TIBIA INDICES

TI = (RES MOM/225 NM) + (AXIAL/35900 N)

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 47

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

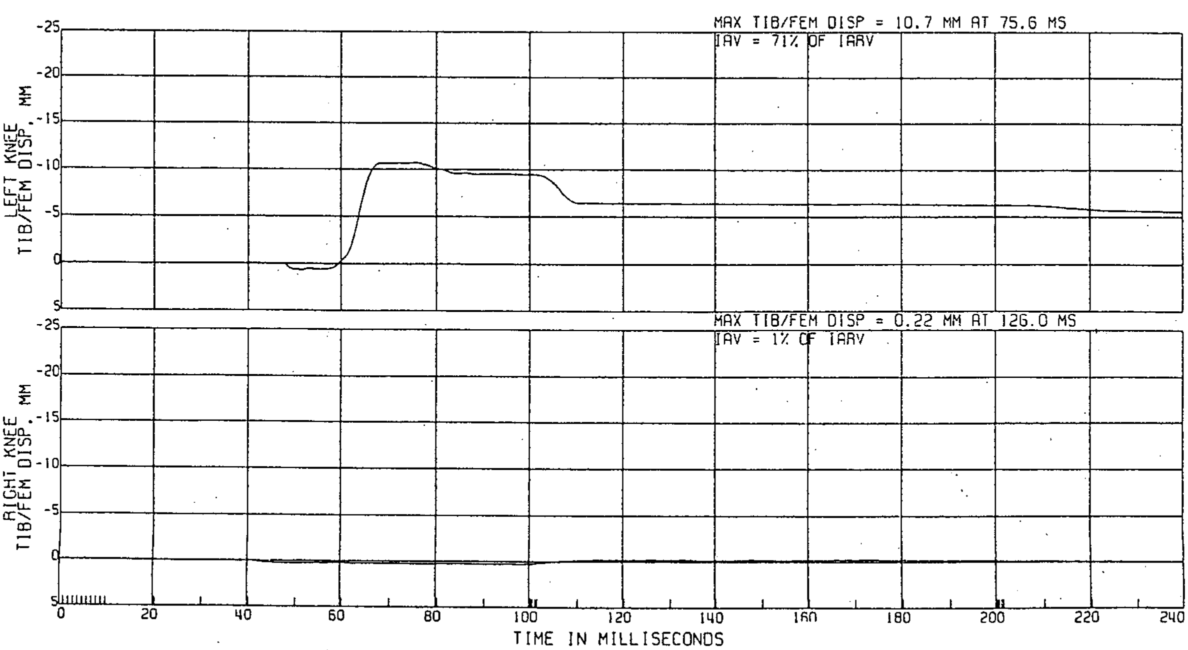
R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 180

R. FRT TIBIA/FEMUR DISPLACEMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998

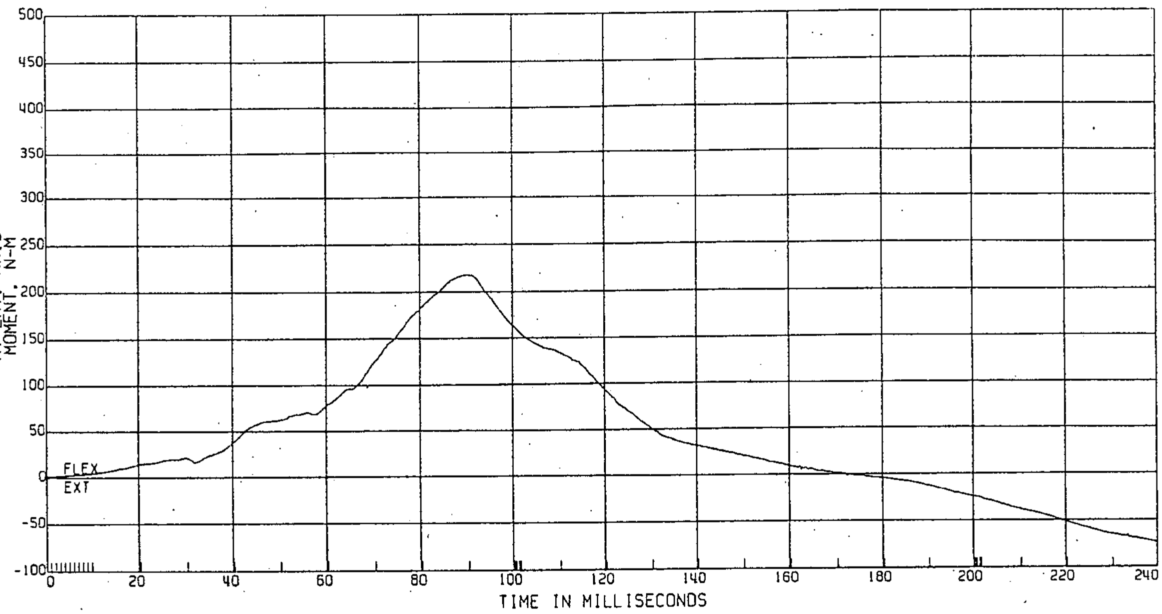


Appendix F, plot # 48

C12174 FRONT IMPACT   MOVING VEHICLE TO FIXED POLE   55.4 KM/H

R & D CTR   8W9187D HONDA   L. FRT LOWER LUMBAR MOMENT   ATD TYPE: GM50H

ELEC DATA, SAE CLASS 1000   TEST DATE:09/16/1998

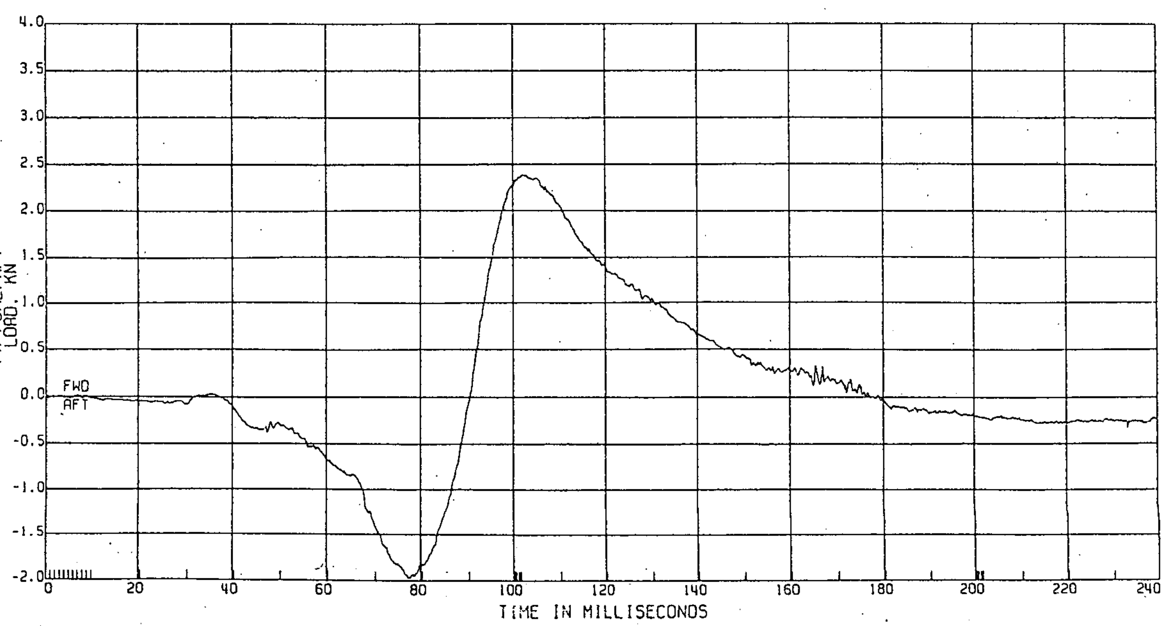


Appendix F, plot # 49

C12174 FRONT IMPACT   MOVING VEHICLE TO FIXED POLE   55.4 KM/H

R & D CTR   8W9187D HONDA   L. FRT LOWER LUMBAR LOAD   ATD TYPE: GM50H

ELEC DATA, SAE CLASS 1000   TEST DATE:09/16/1998



Appendix F, plot # 50

:2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

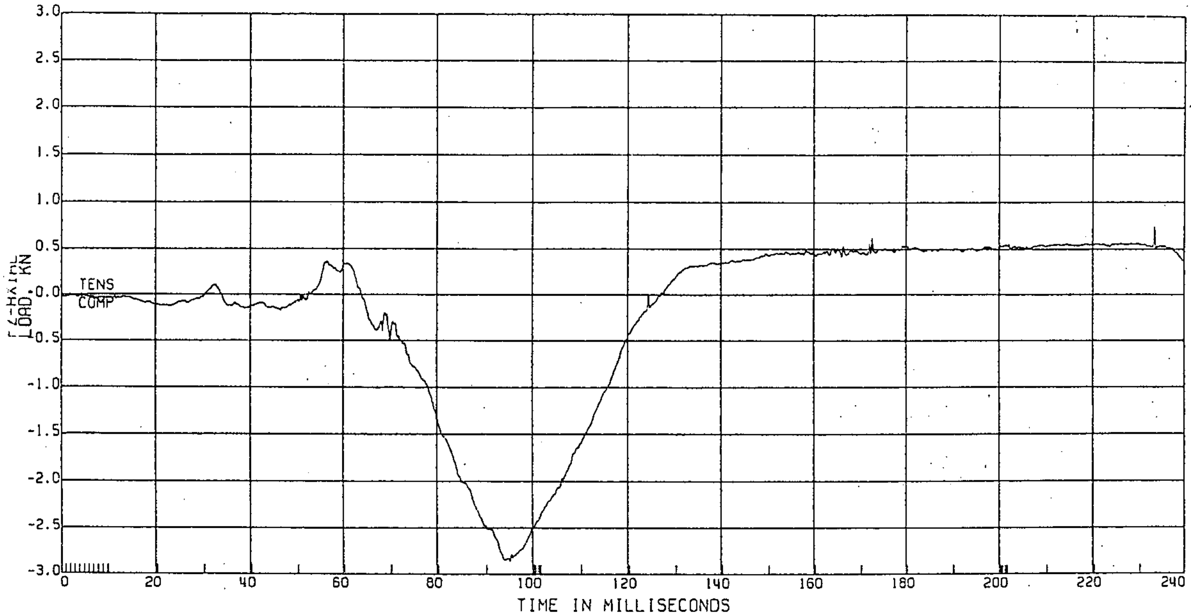
& D CTR 8W91870 HONDA

-EC DATA, SAE CLASS 1000

L. FRT LOWER LUMBAR LOAD

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **51**

:12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

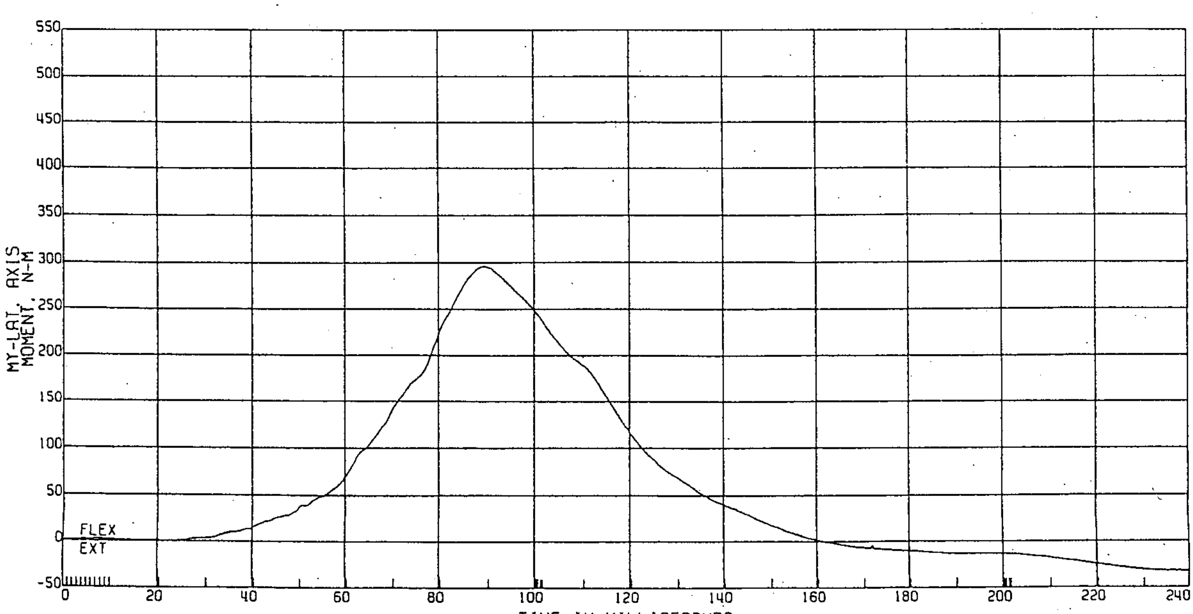
R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 1000

R. FRT LOWER LUMBAR MOMENT

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **52**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

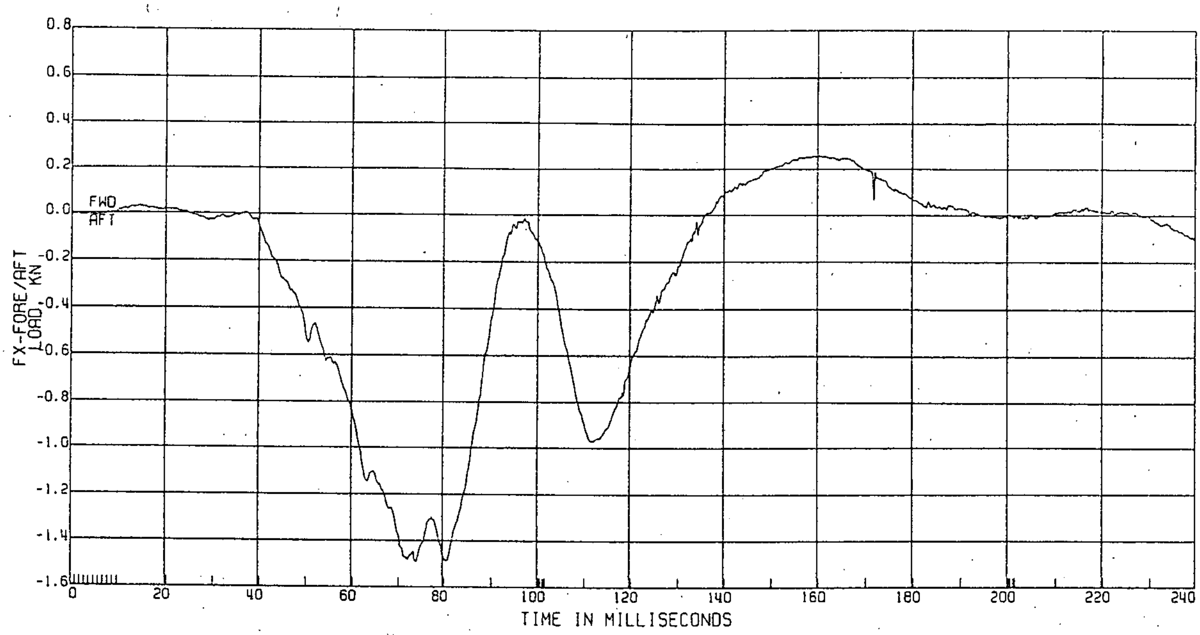
R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 1000

R. FRT LOWER LUMBAR LOAD

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 53

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

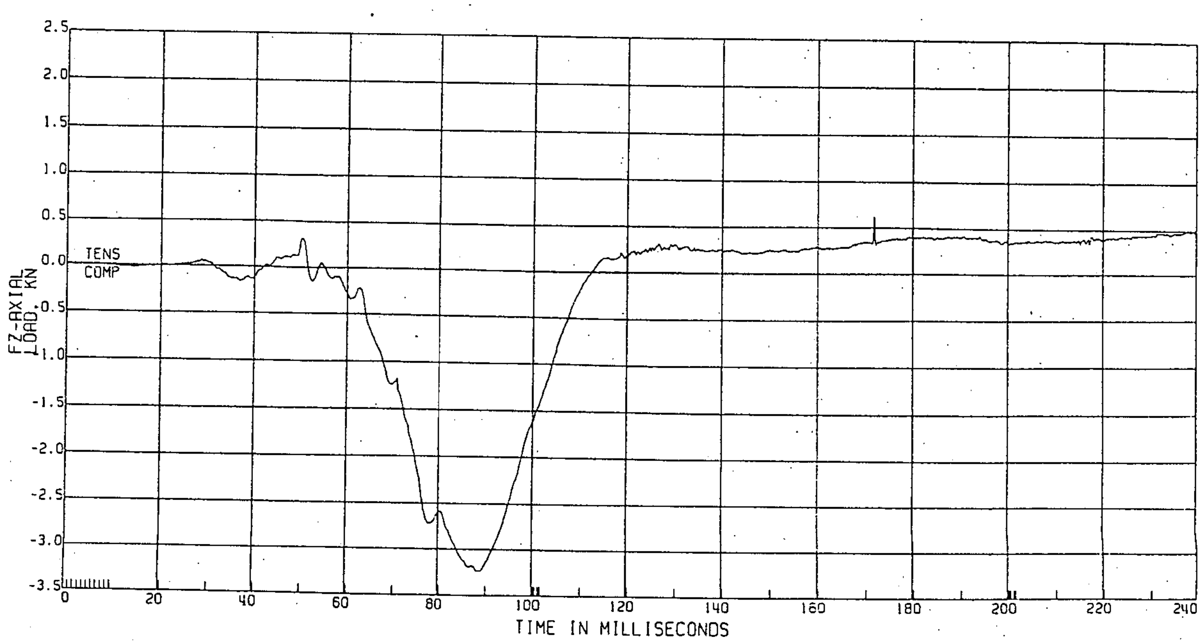
R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 1000

R. FRT LOWER LUMBAR LOAD

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 54

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

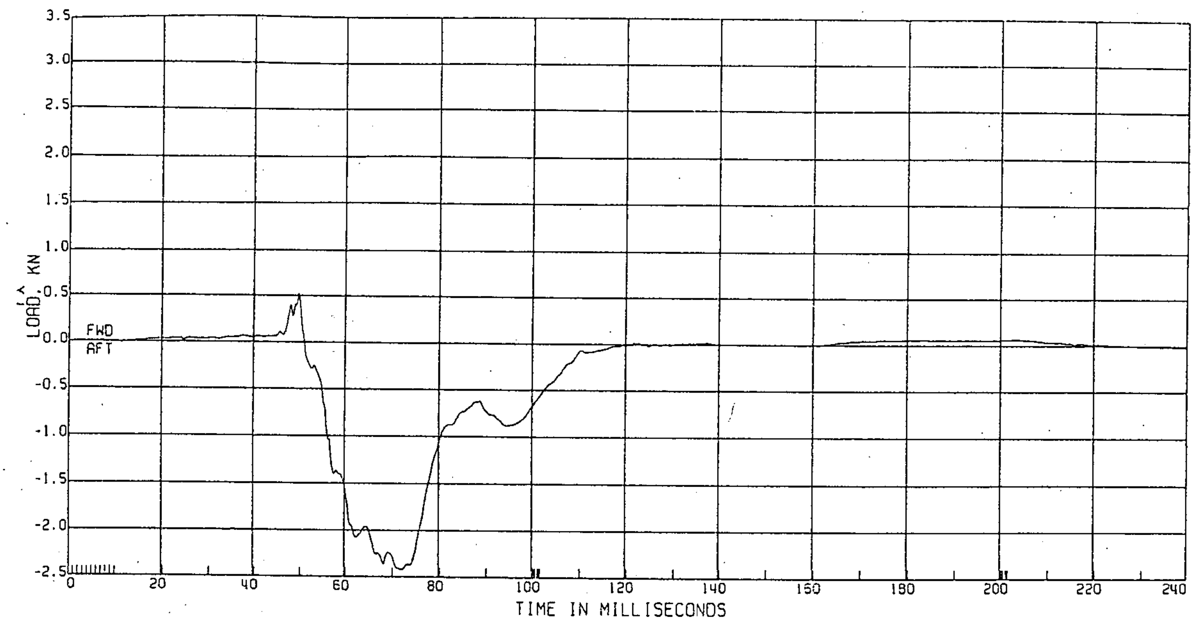
LEC DATA, SAE CLASS 600

R. FRT TIBIA LEFT UPPER LOAD

(ENHANCED LOWER LEG)

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **55**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

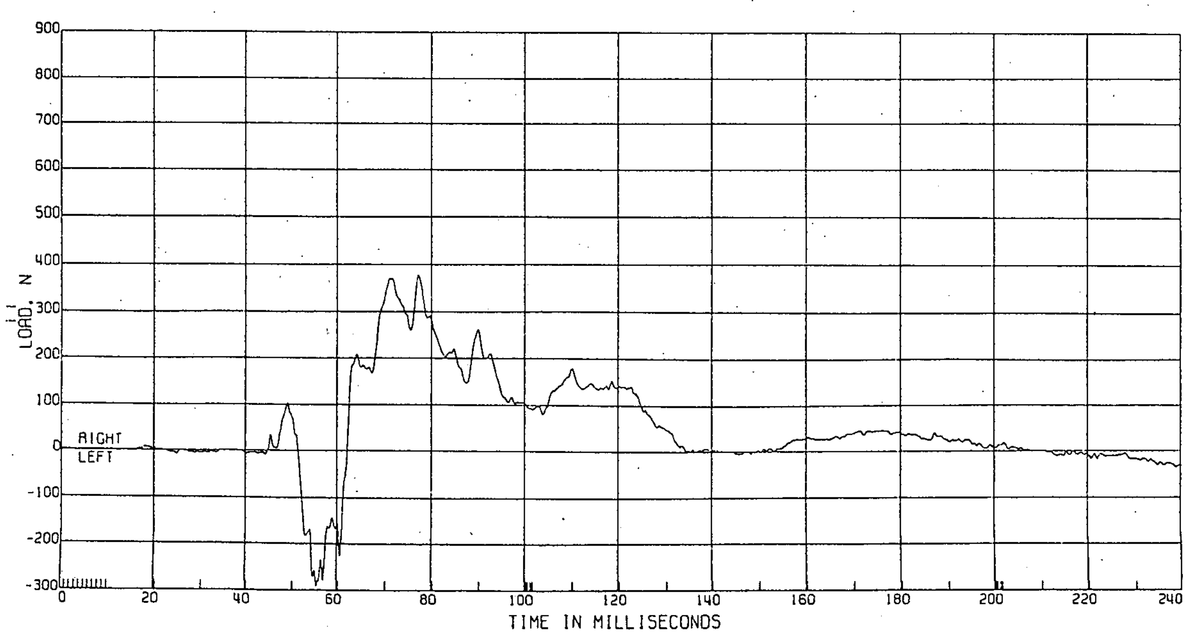
LEC DATA, SAE CLASS 600

R. FRT TIBIA LEFT LOWER LOAD

(ENHANCED LOWER LEG)

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # **56**

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

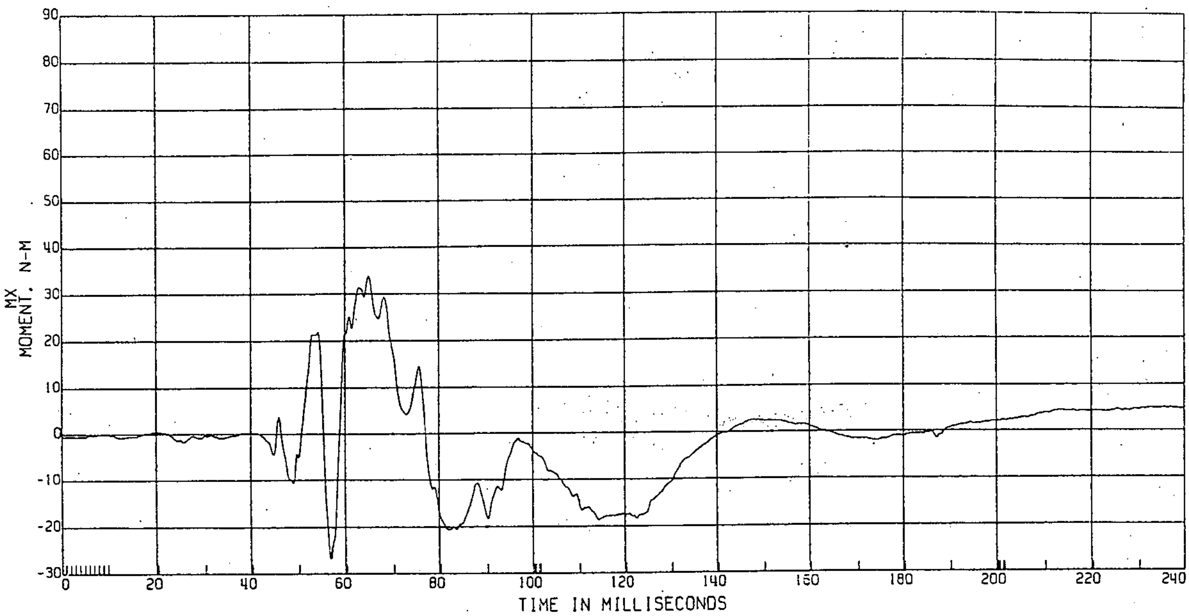
ELEC DATA, SAE CLASS 600

R. FRT TIBIA LEFT LOWER MOMENT

(ENHANCED LOWER LEG)

ATD TYPE: GM50H

TEST DATE:09/16/1998



Appendix F, plot # 57

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

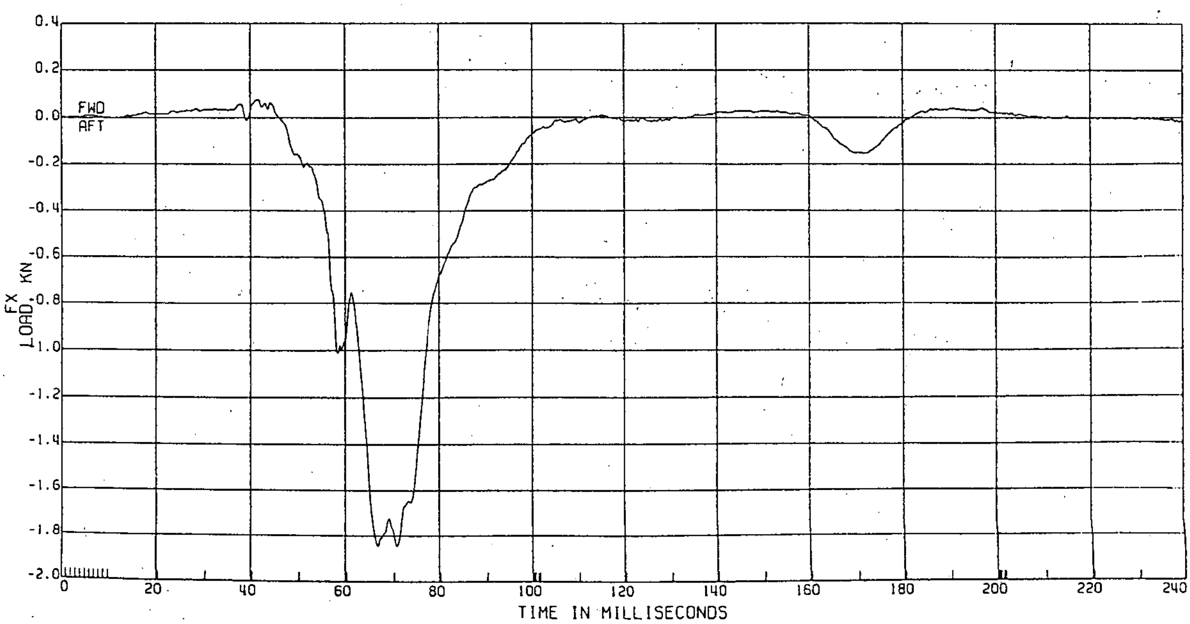
ELEC DATA, SAE CLASS 600

R. FRT TIBIA RIGHT UPPER LOAD

(ENHANCED LOWER LEG)

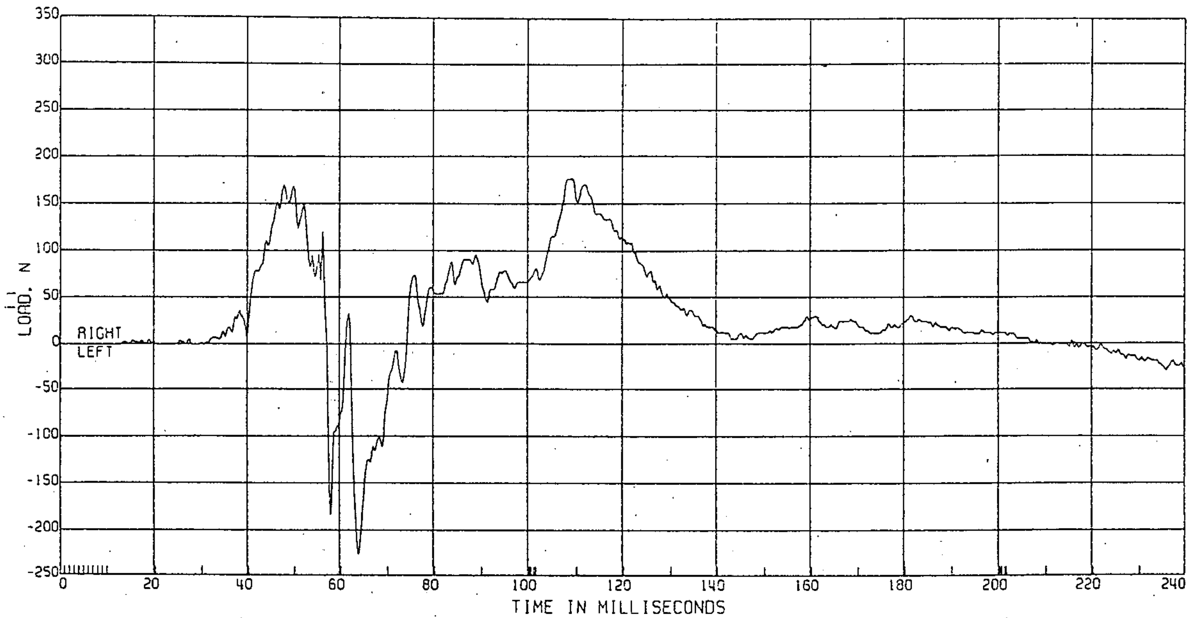
ATD TYPE: GM50H

TEST DATE:09/16/1998



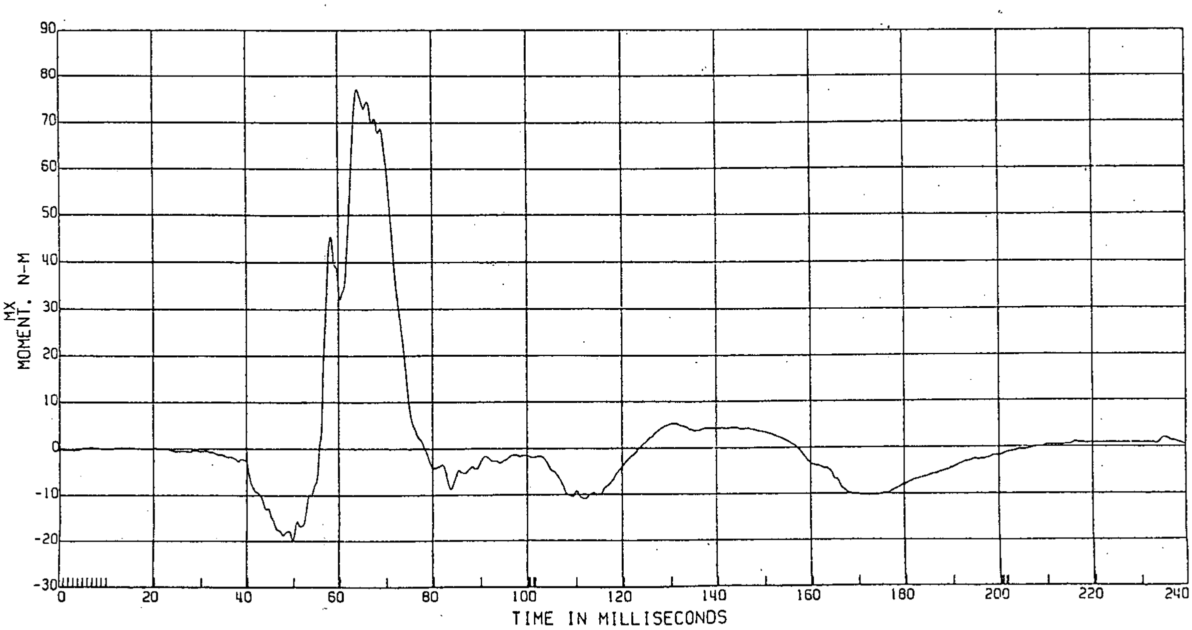
Appendix F, plot # 58

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H
ATD TYPE: GM50H
& D CTR 8W9187D HONDA R. FRT TIBIA RIGHT LOWER LOAD TEST DATE:09/16/1998
LEC DATA, SAE CLASS 600 (ENHANCED LOWER LEG)



Appendix F, plot # **59**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H
ATD TYPE: GM50H
& D CTR 8W9187D HONDA R. FRT TIBIA RIGHT LOWER MOMENT TEST DATE:09/16/1998
LEC DATA, SAE CLASS 600 (ENHANCED LOWER LEG)

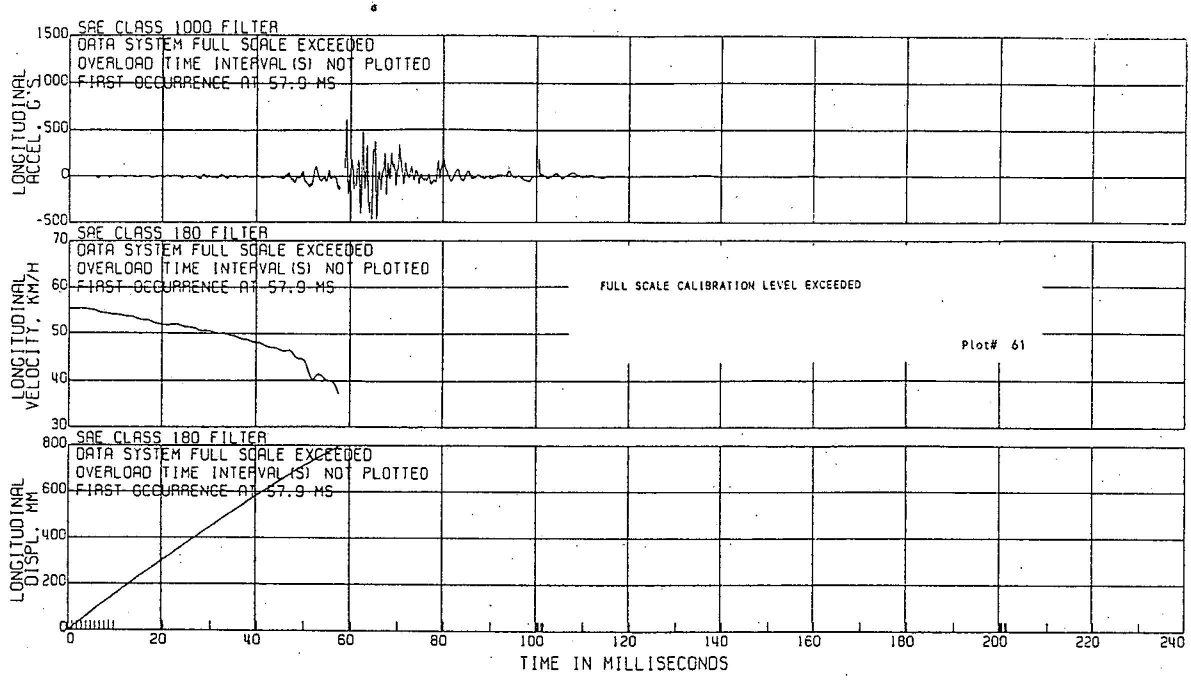


Appendix F, plot # **60**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA CTR TUNNEL AT SDM TEST DATE:09/16/1998

ELEC DATA

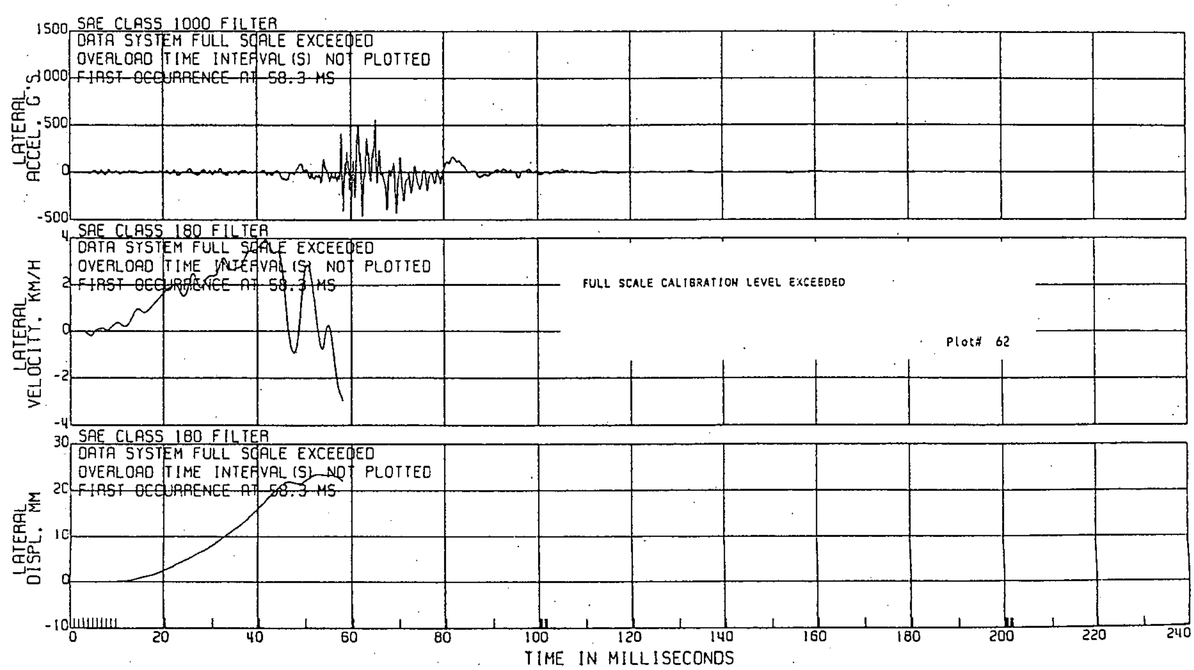


Appendix F, plot # **61**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA CTR TUNNEL AT SDM TEST DATE:09/16/1998

ELEC DATA

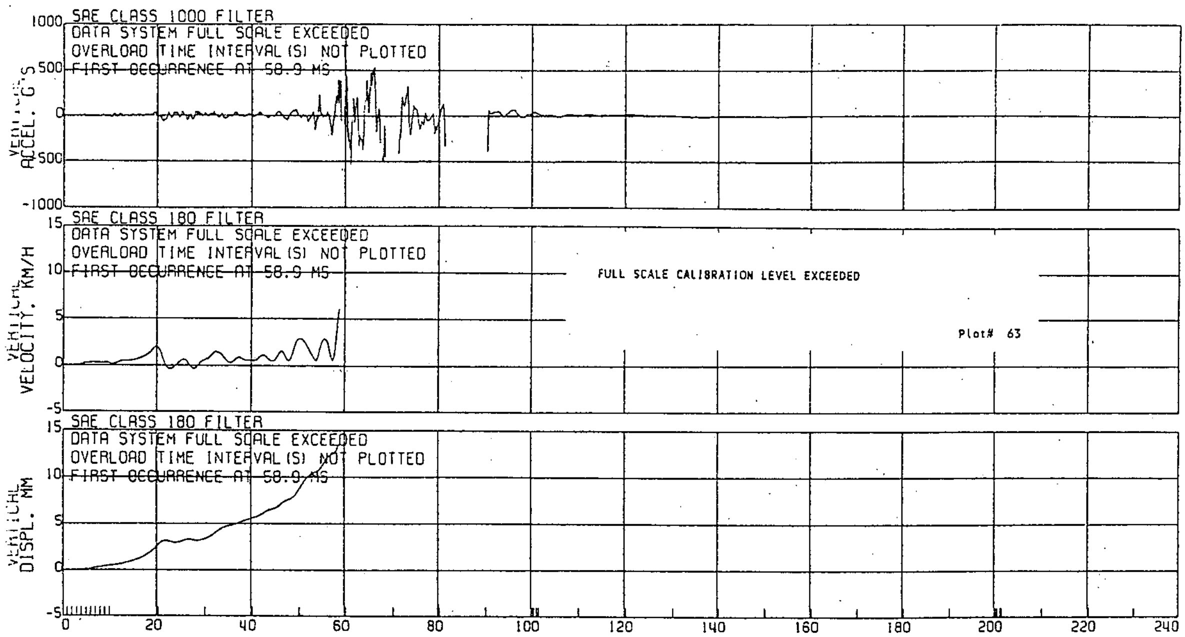


Appendix F, plot # **62**

:2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA CTR TUNNEL AT SDM TEST DATE:09/16/1998

LEC DATA

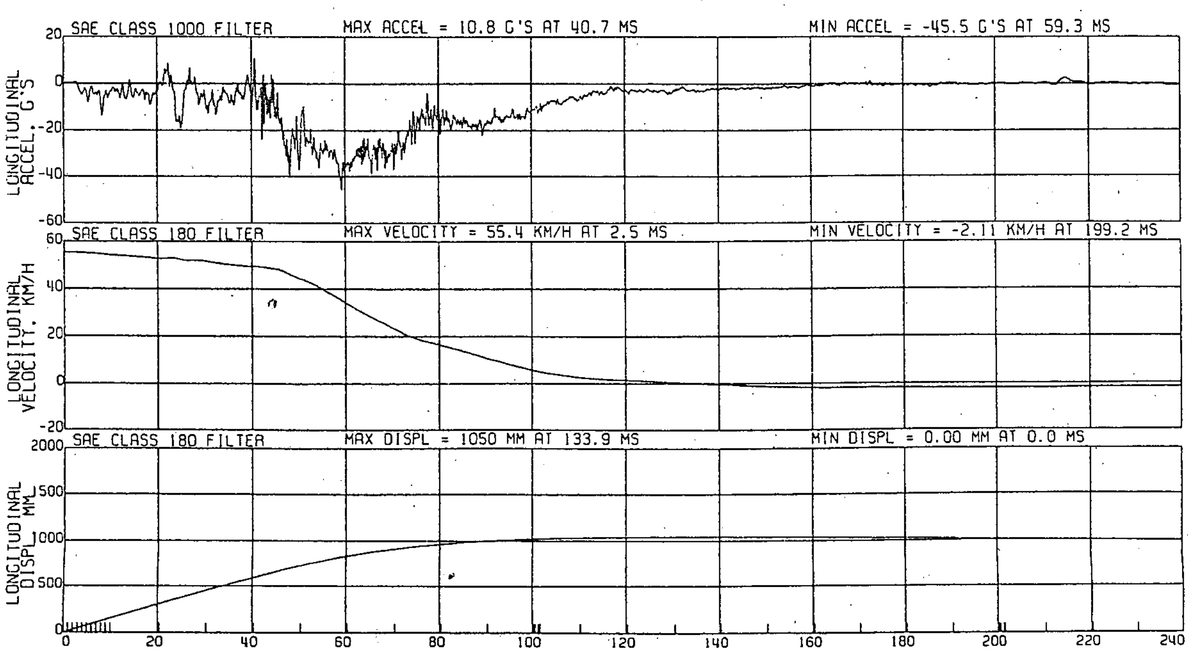


Appendix F, plot # **63**

:12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA L. FRT ROCKER TEST DATE:09/16/1998

:LEC DATA

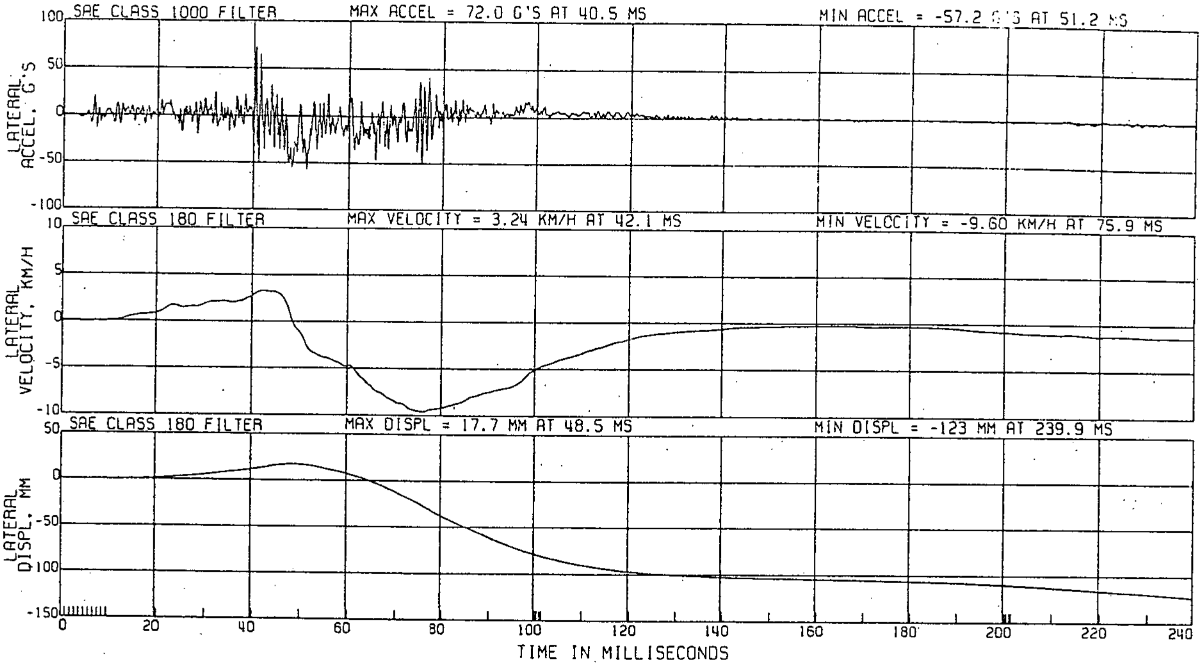


Appendix F, plot # **64**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA L. FRT ROCKER TEST DATE:09/16/1998

ELEC DATA

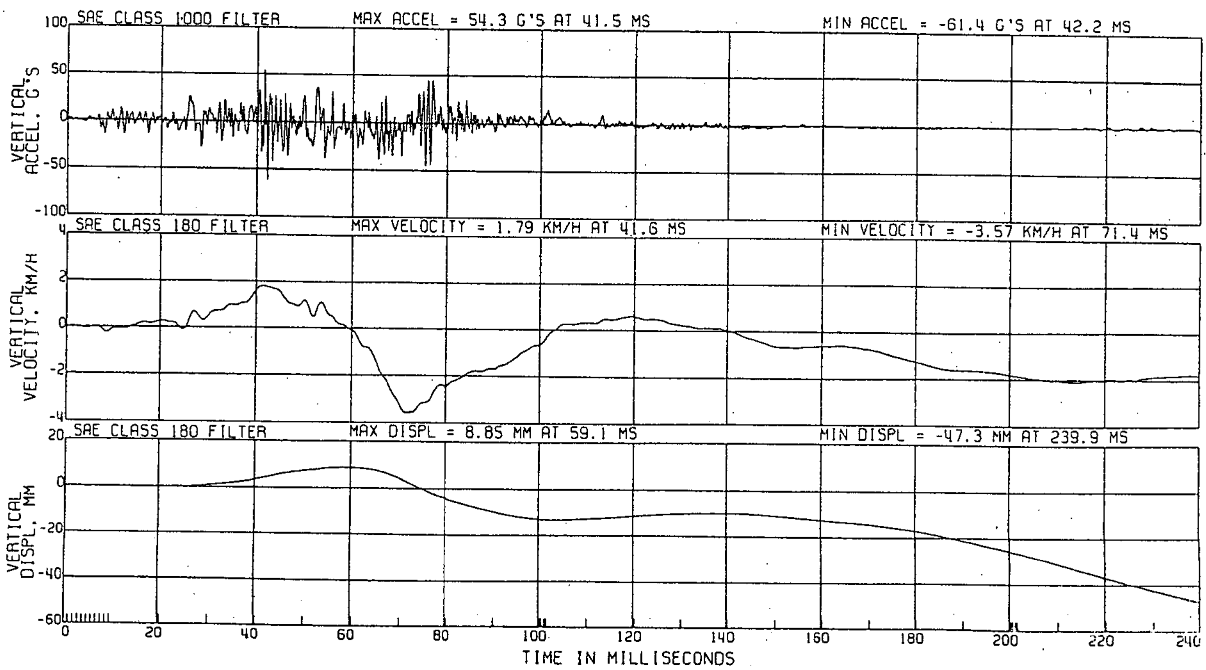


Appendix F, plot # **65**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA L. FRT ROCKER TEST DATE:09/16/1998

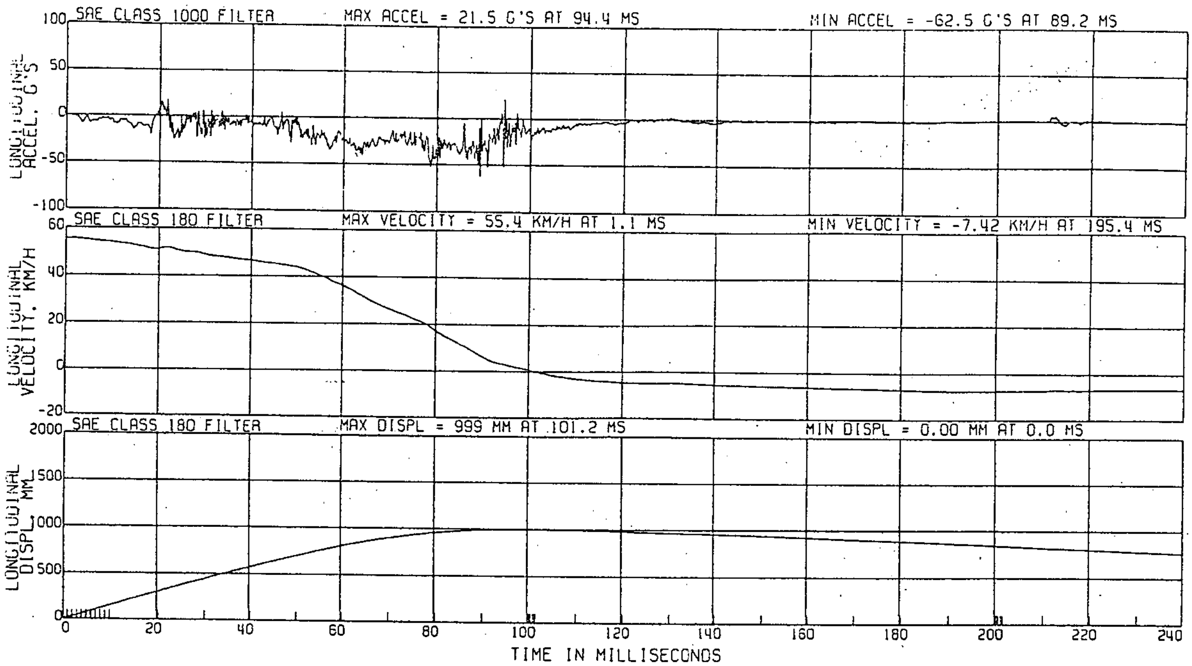
ELEC DATA



12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA R. FRT ROCKER TEST DATE:09/16/1998

LEC DATA

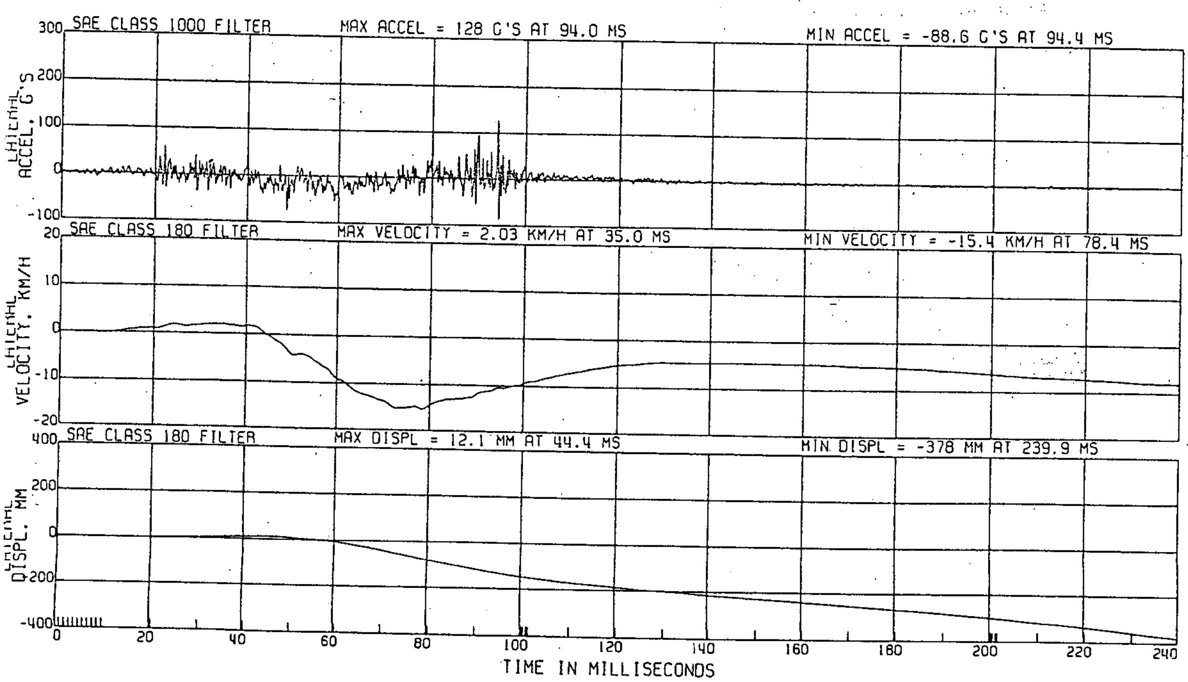


Appendix F, plot # **67**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA R. FRT ROCKER TEST DATE:09/16/1998

LEC DATA

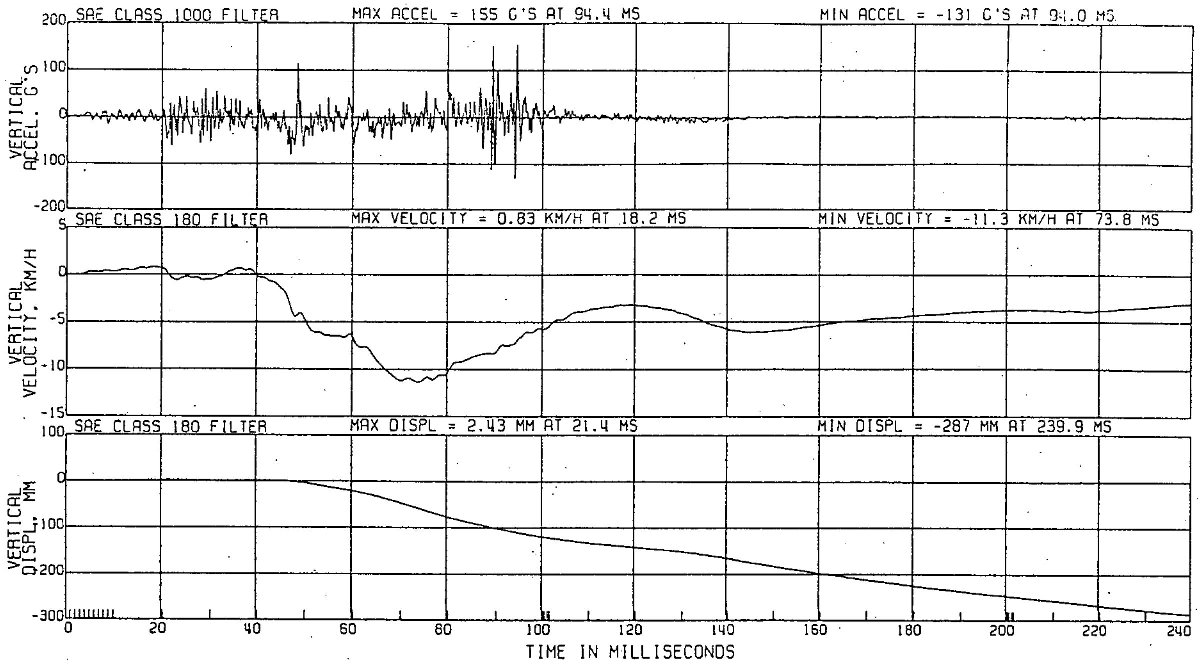


Appendix F, plot # **68**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R. FRT ROCKER

R & D CTR 8W9187D HONDA TEST DATE:09/16/1998
ELEC DATA

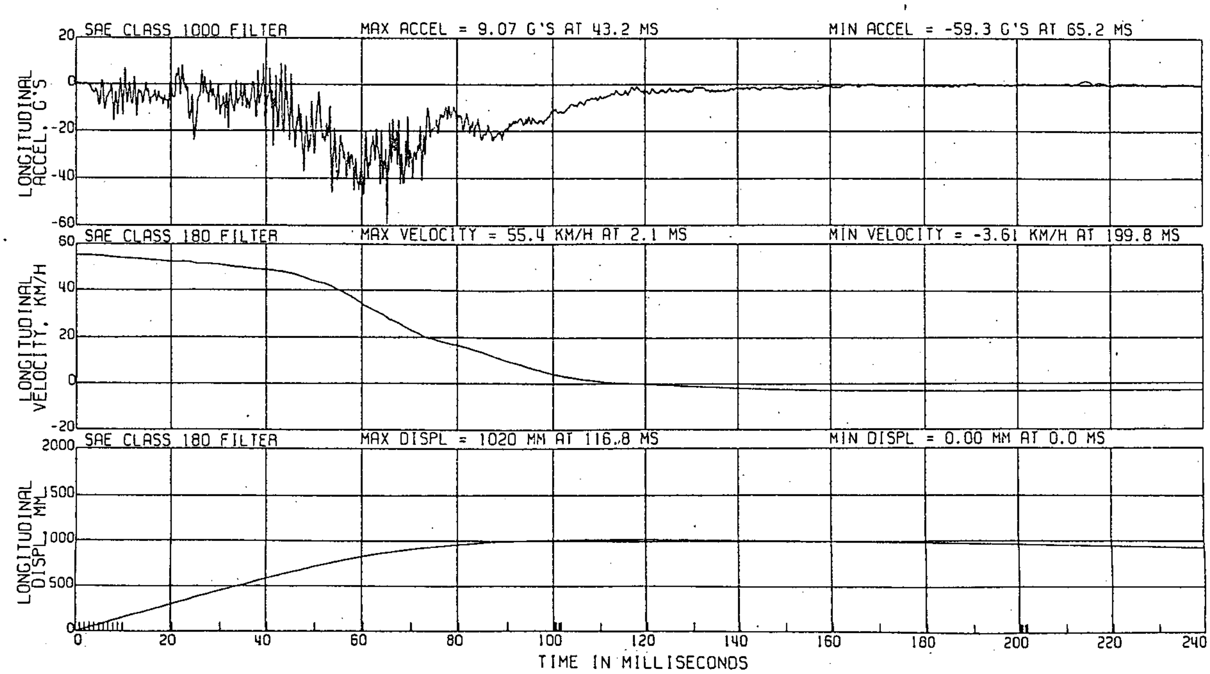


Appendix F, plot # 69

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

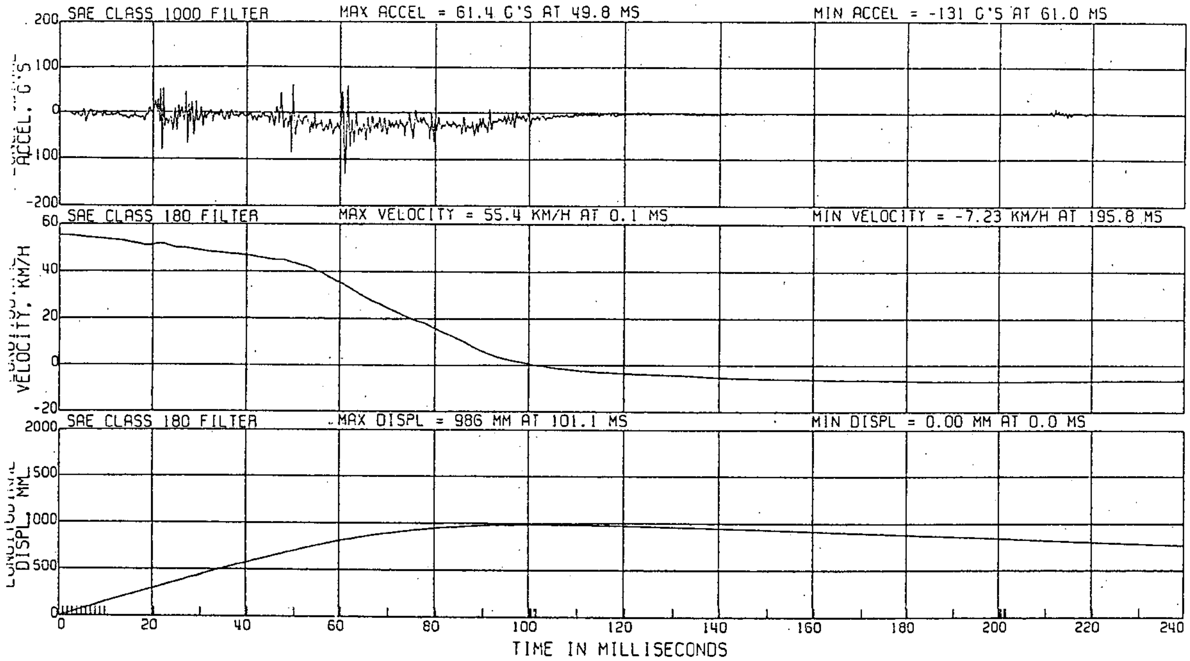
L. FLOORPAN

R & D CTR 8W9187D HONDA TEST DATE:09/16/1998
ELEC DATA



2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

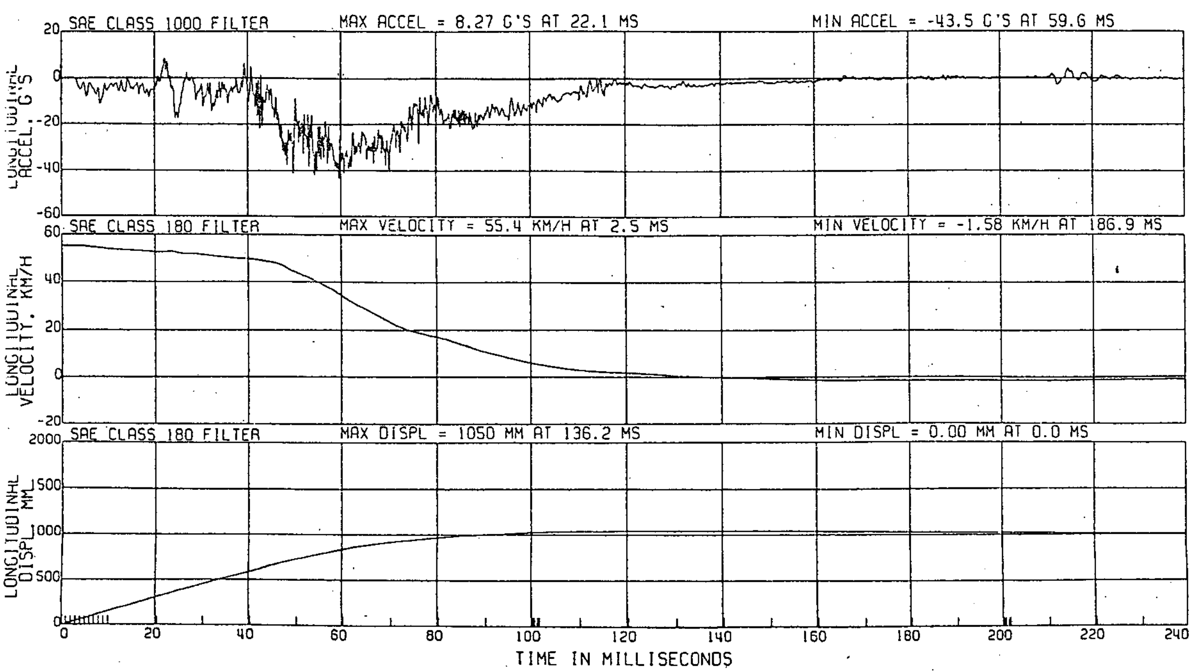
& D CTR 8W91870 HONDA R. FLOORPAN TEST DATE:09/16/1998
EC DATA



Appendix F, plot # 71

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

'& D CTR 8W91870 HONDA L.REAR ROCKER TEST DATE:09/16/1998
LEC DATA

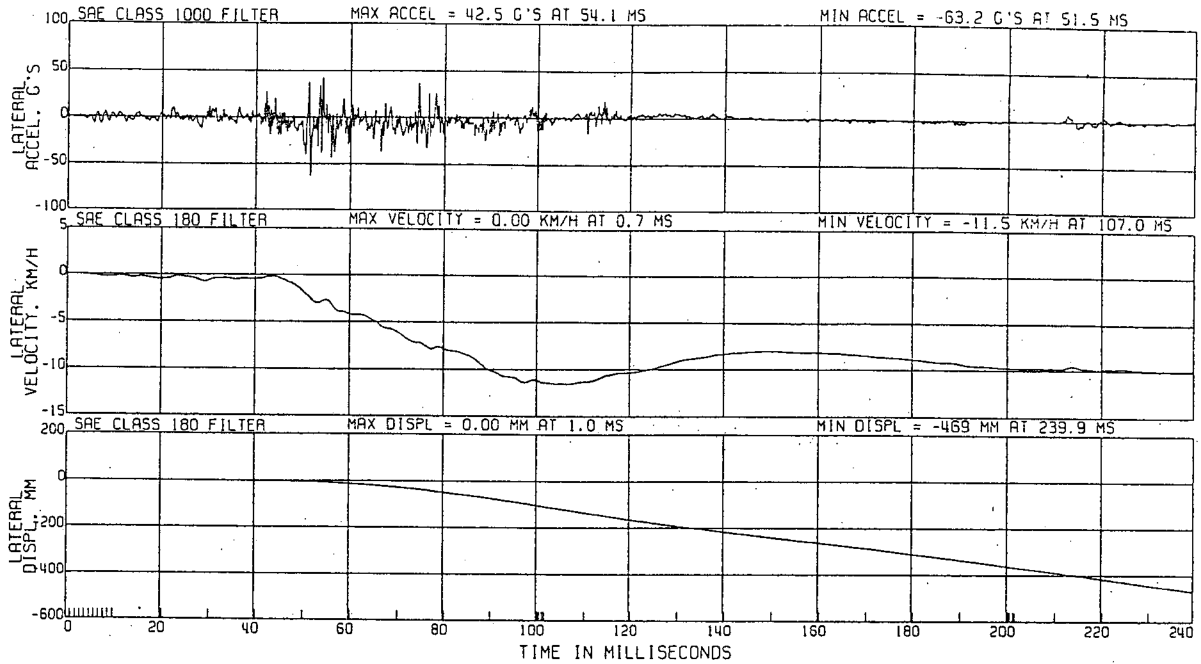


Appendix F, plot # 72

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA L.REAR ROCKER TEST DATE:09/16/1998

ELEC DATA

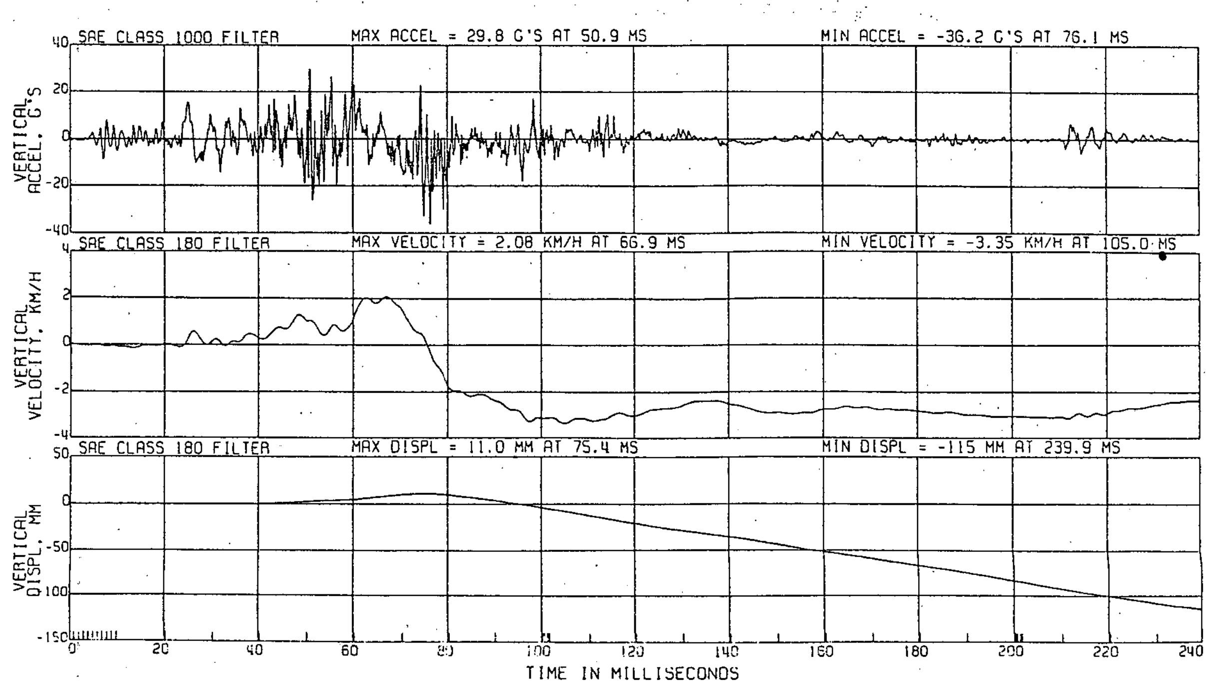


Appendix F, plot # 73

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA L.REAR ROCKER TEST DATE:09/16/1998

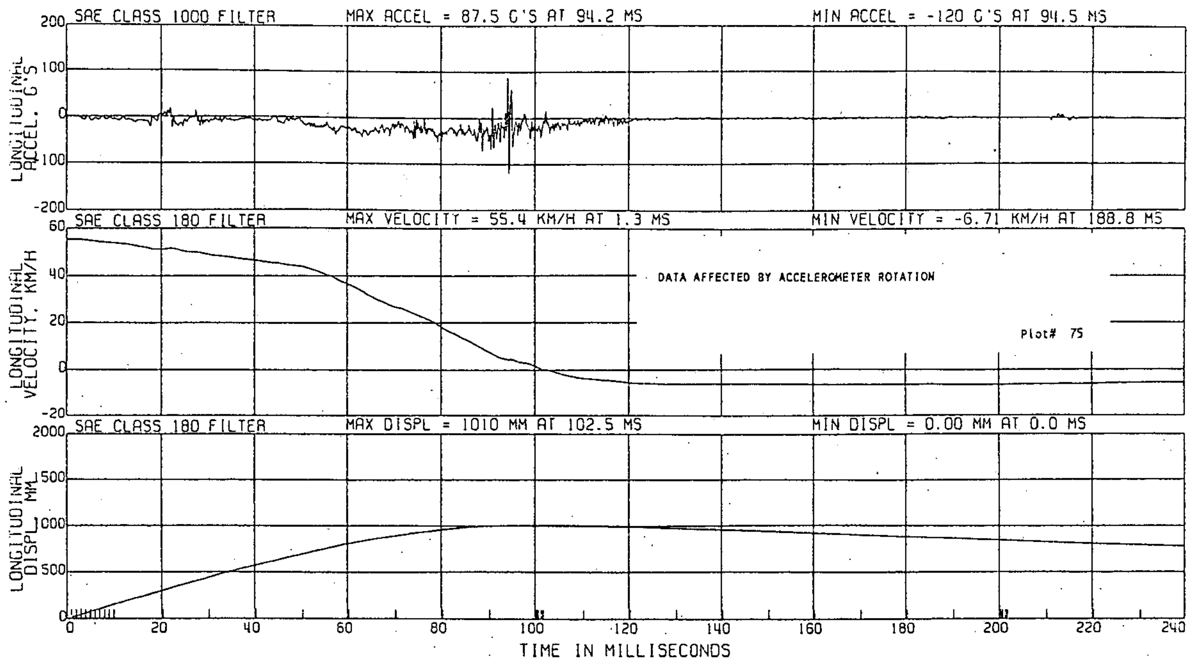
ELEC DATA



Appendix F, plot # 74

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

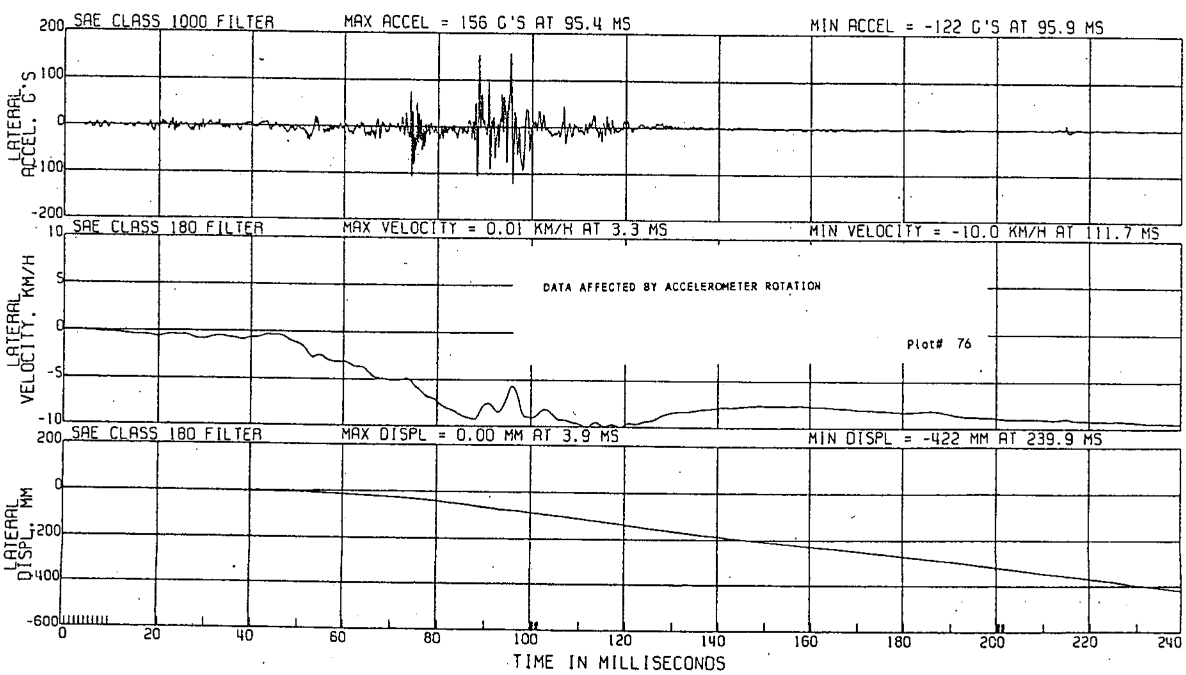
& D CTR 8W9187D HONDA R.REAR ROCKER TEST DATE:09/16/1998
LEC DATA



Appendix F, plot # 75

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W9187D HONDA R.REAR ROCKER TEST DATE:09/16/1998
ELEC DATA

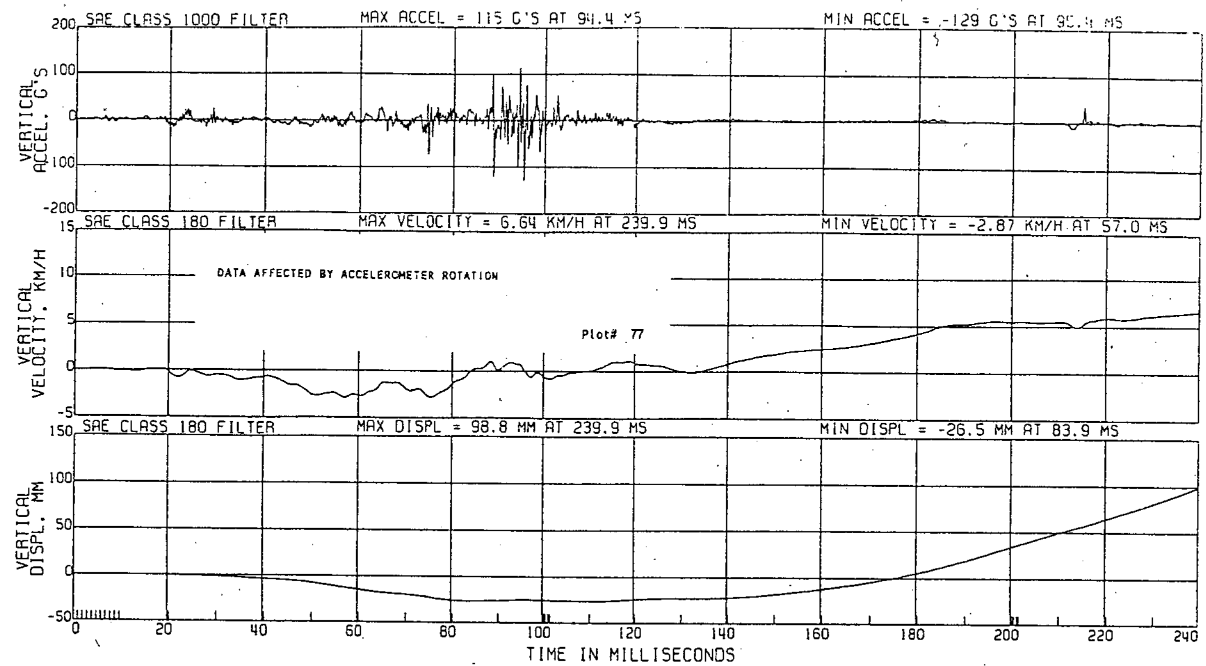


Appendix F, plot # 76

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W9187D HONDA R.REAR ROCKER TEST DATE:09/16/1998

ELEC DATA

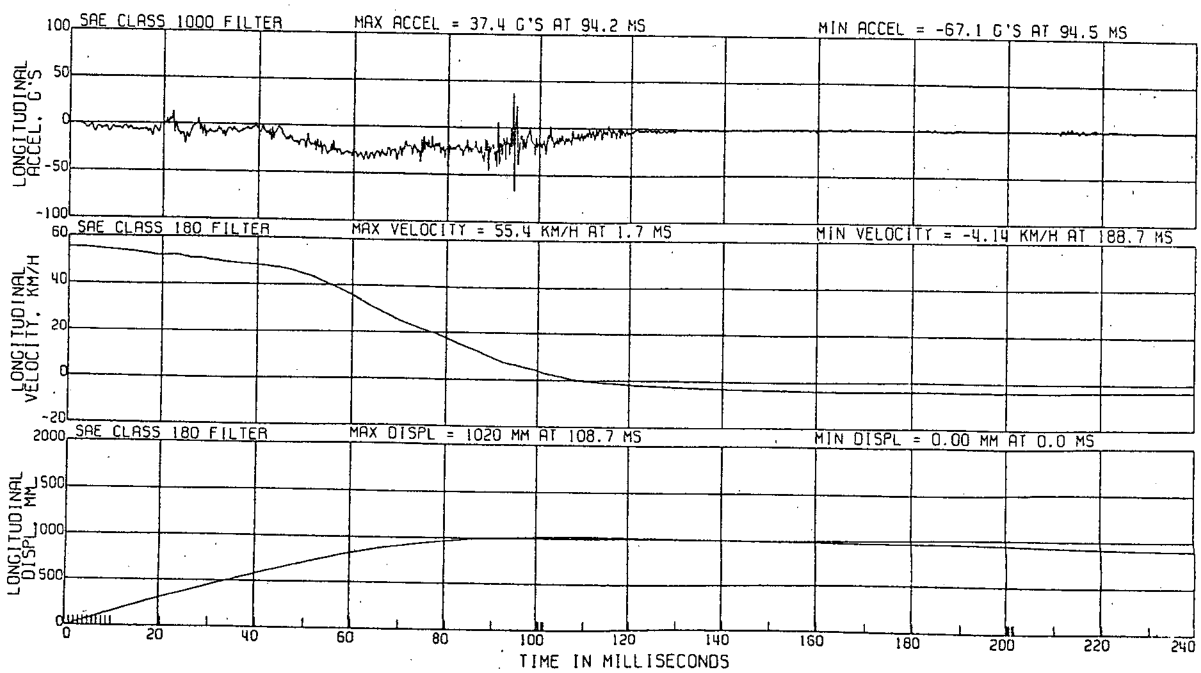


Appendix F, plot # 77

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W9187D HONDA AVERAGED REAR ROCKER TEST DATE:09/16/1998

ELEC DATA



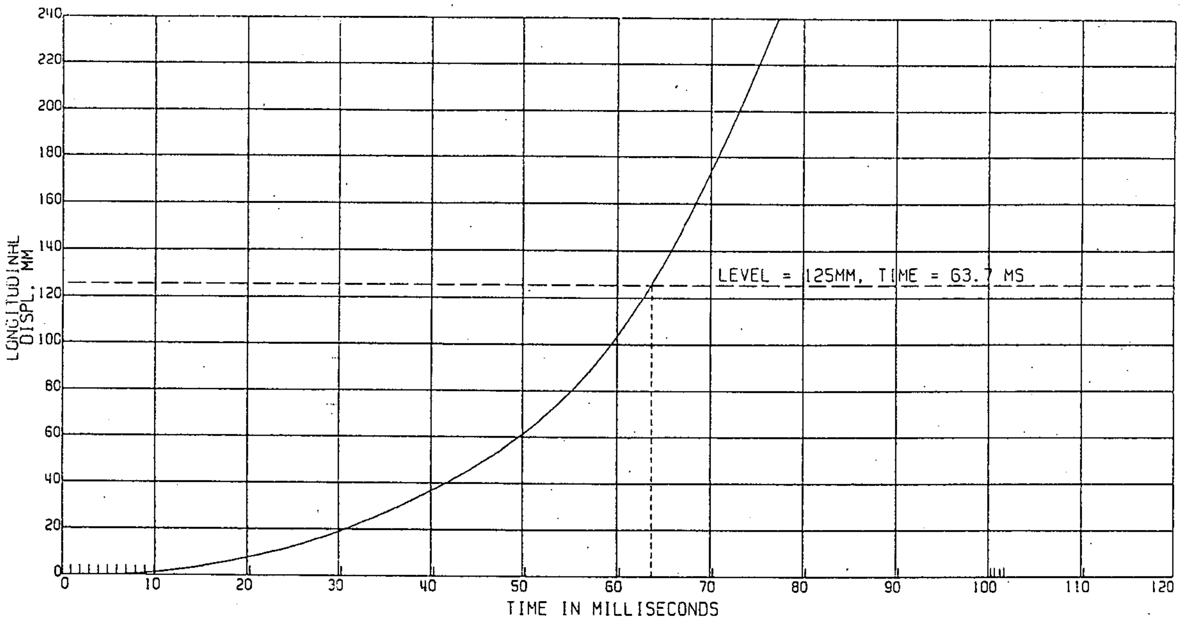
12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

COMP. FREE MASS DISP. REL. TO VEHICLE

TEST DATE:09/16/1998

LEC DATA, SAE CLASS 180



Appendix F, plot # 79

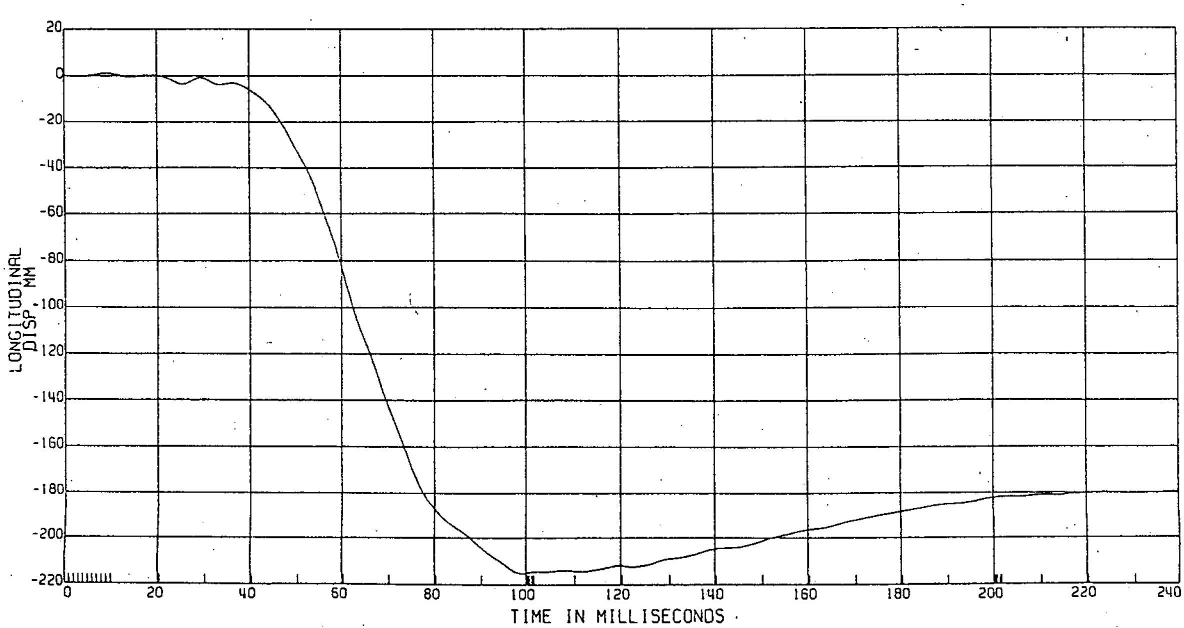
12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

R. TOE PAN DISPL

TEST DATE:09/16/1998

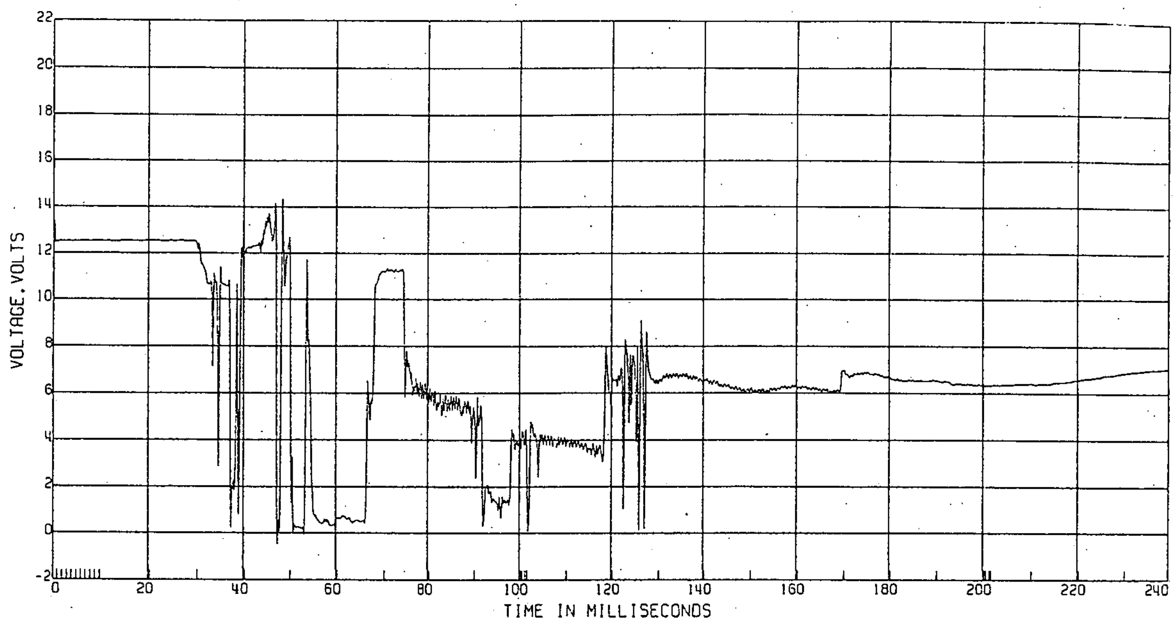
ELEC DATA, SAE CLASS 60



Appendix F, plot # 80

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

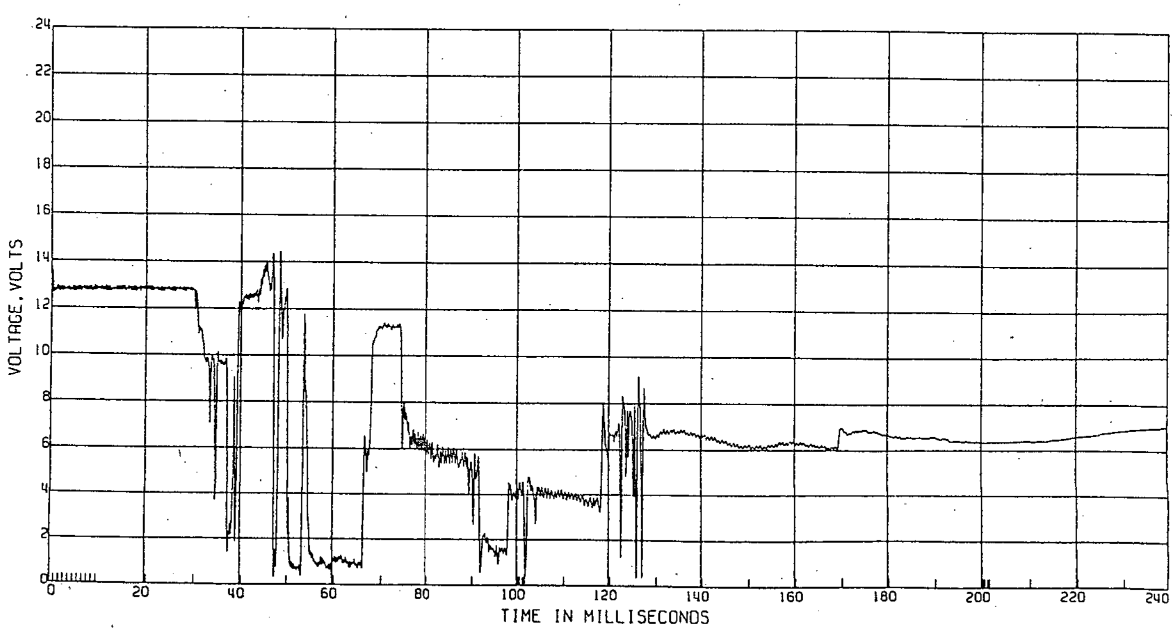
R & D CTR 8W91870 HONDA BATTERY AT PDC VOLTAGE TEST DATE:09/16/1998
ELEC DATA, SAE CLASS 1000



Appendix F, plot # 81

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA STARTER CABLE VOLTAGE TEST DATE:09/16/1998
ELEC DATA, SAE CLASS 1000



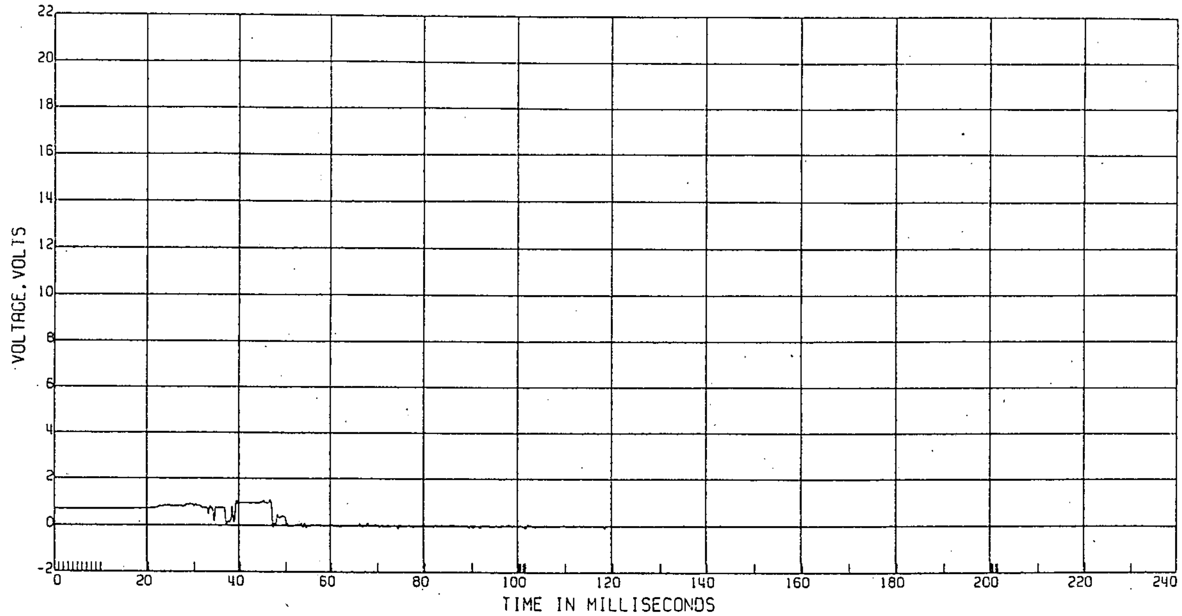
2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W9187D HONDA

R. FRT HEADLIGHT GROUND VOLTAGE

TEST DATE:09/16/1998

EC DATA, SAE CLASS 1000



Appendix F, plot # **83**

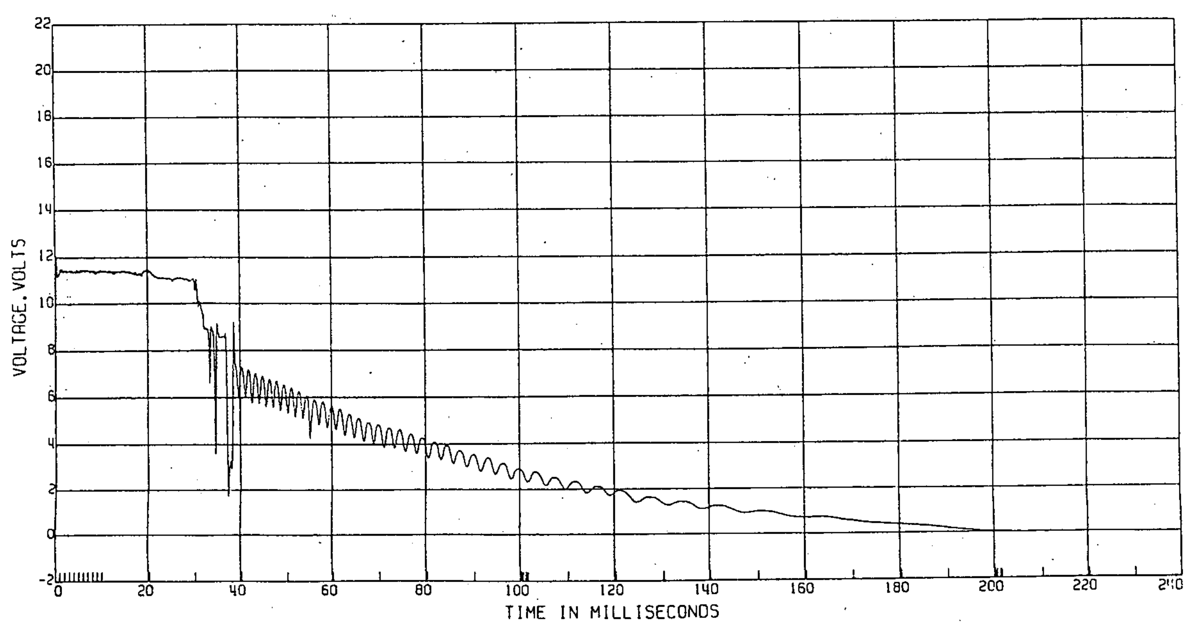
12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W9187D HONDA

FUEL PUMP VOLTAGE

TEST DATE:09/16/1998

LEC DATA, SAE CLASS 1000



Appendix F, plot # 84

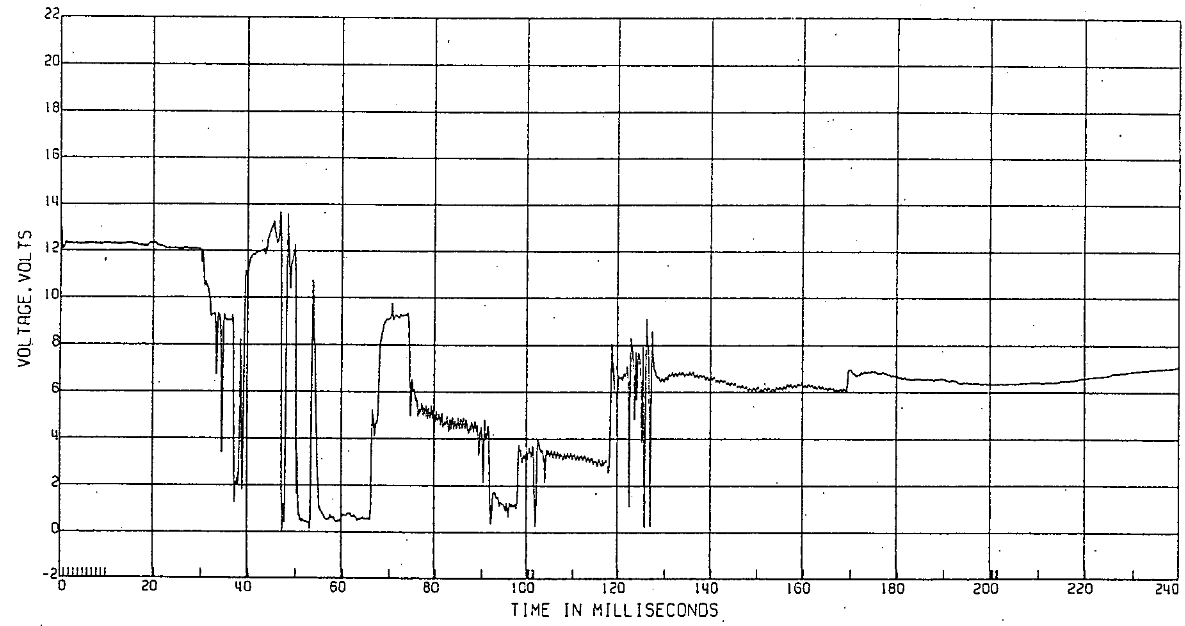
C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 1000

IGNITION FEED VOLTAGE

TEST DATE:09/16/1998



Appendix F, plot # 85

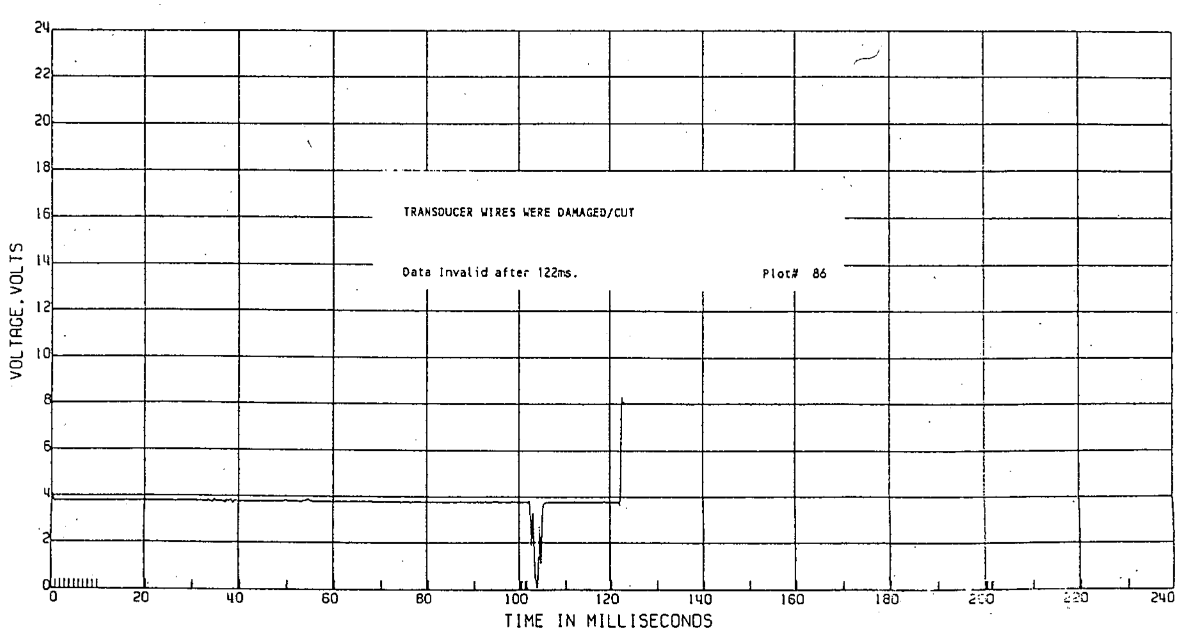
C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 1000

L. OPTICAL FIRE DETECTOR VOLTAGE

TEST DATE:09/16/1998



Appendix F, plot # 86

12174 FRONT IMPACT

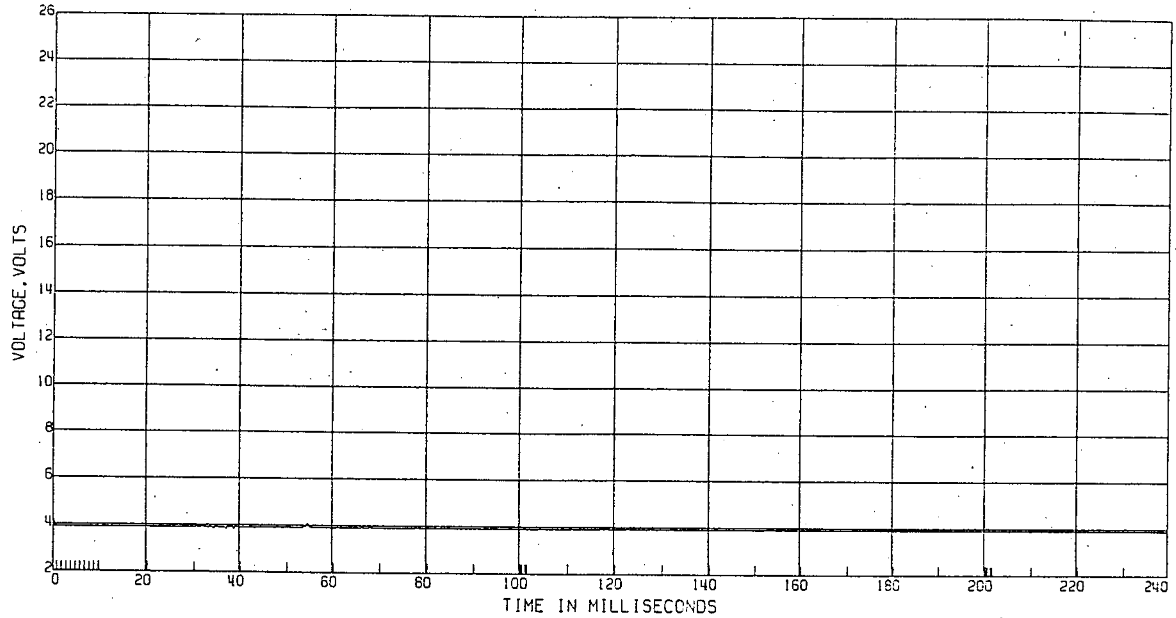
MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R. OPTICAL FIRE DETECTOR VOLTAGE

& D CTR 8W9187D HONDA

LEC DATA, SAE CLASS 1000

TEST DATE:09/16/1998



Appendix F, plot # 87

12174 FRONT IMPACT

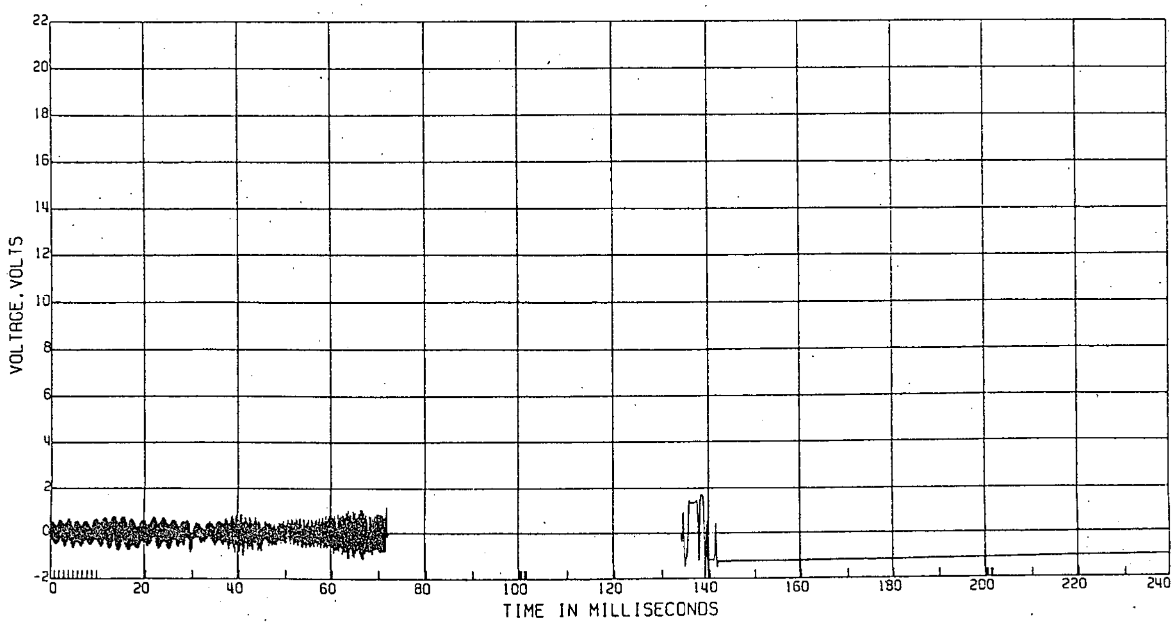
MOVING VEHICLE TO FIXED POLE 55.4 KM/H

ENG SPEED-(MP1A) VOLTAGE

& D CTR 8W9187D HONDA

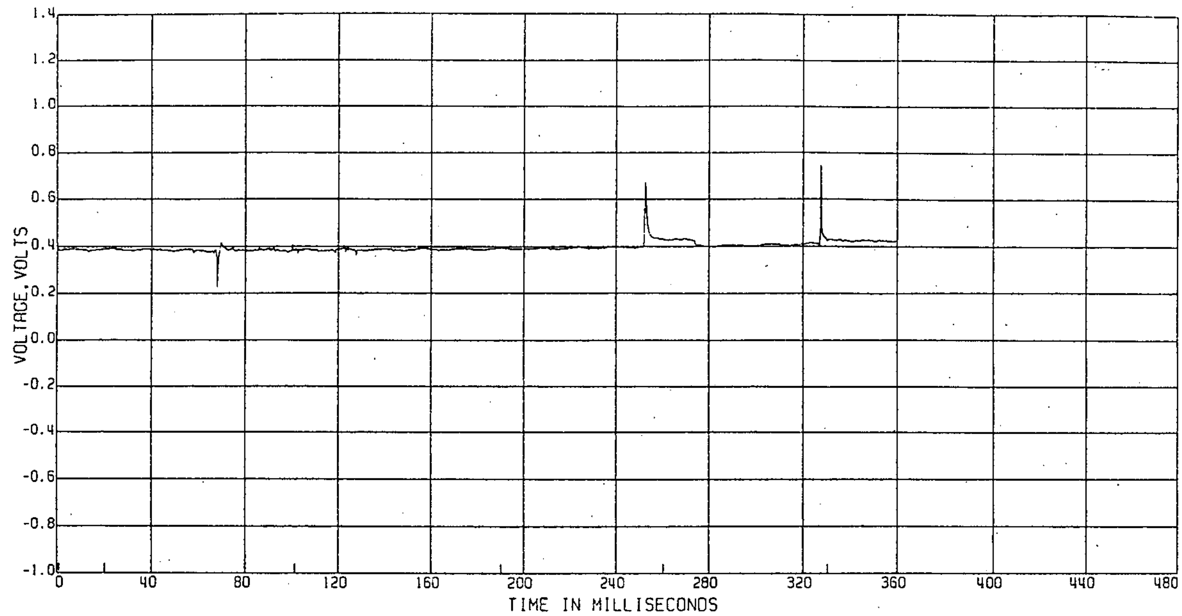
LEC DATA, SAE CLASS 1000

TEST DATE:09/16/1998



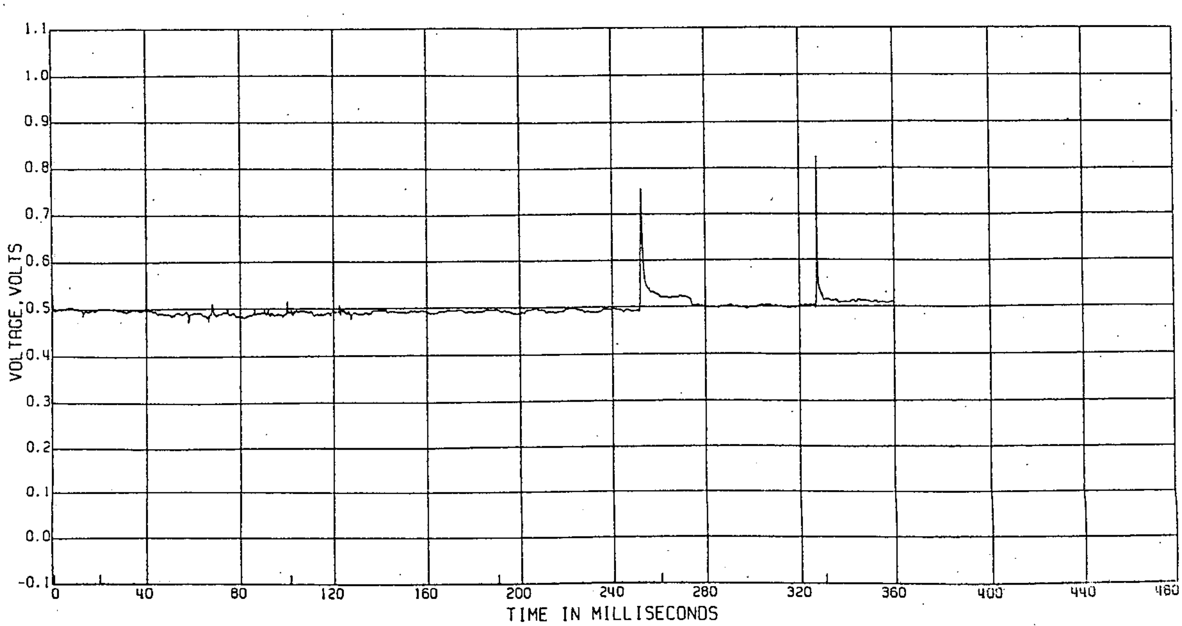
Appendix F, plot # 88

C12174 FRONT IMPACT
MOVING VEHICLE TO FIXED POLE 55.4 KM/H
R & D CTR 8W91870 HONDA
L. FUEL RAIL SENSOR (S1) VOLTAGE
TEST DATE:09/16/1998
ELEC DATA, SAE CLASS 1000



Appendix F, plot # 89

C12174 FRONT IMPACT
MOVING VEHICLE TO FIXED POLE 55.4 KM/H
R & D CTR 8W91870 HONDA
R. FUEL RAIL SENSOR (S2) VOLTAGE
TEST DATE:09/16/1998
ELEC DATA, SAE CLASS 1000

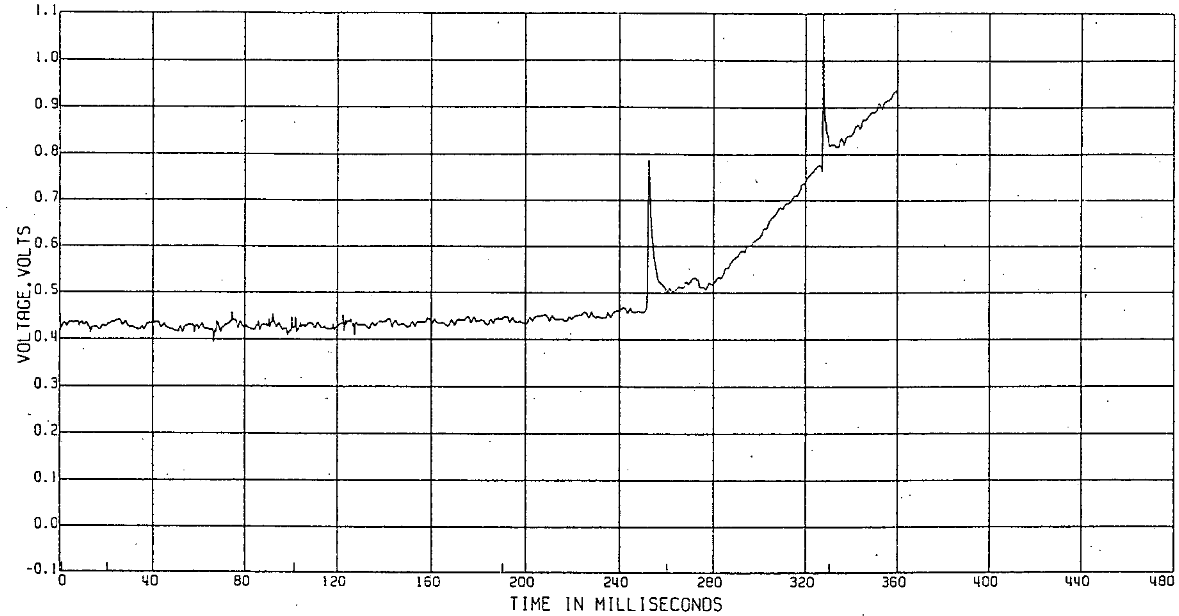


Appendix F, plot # 90

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W9187D HONDA L. MANIFOLD SHIELD (S3) VOLTAGE TEST DATE:09/16/1998

EC DATA, SAE CLASS 1000

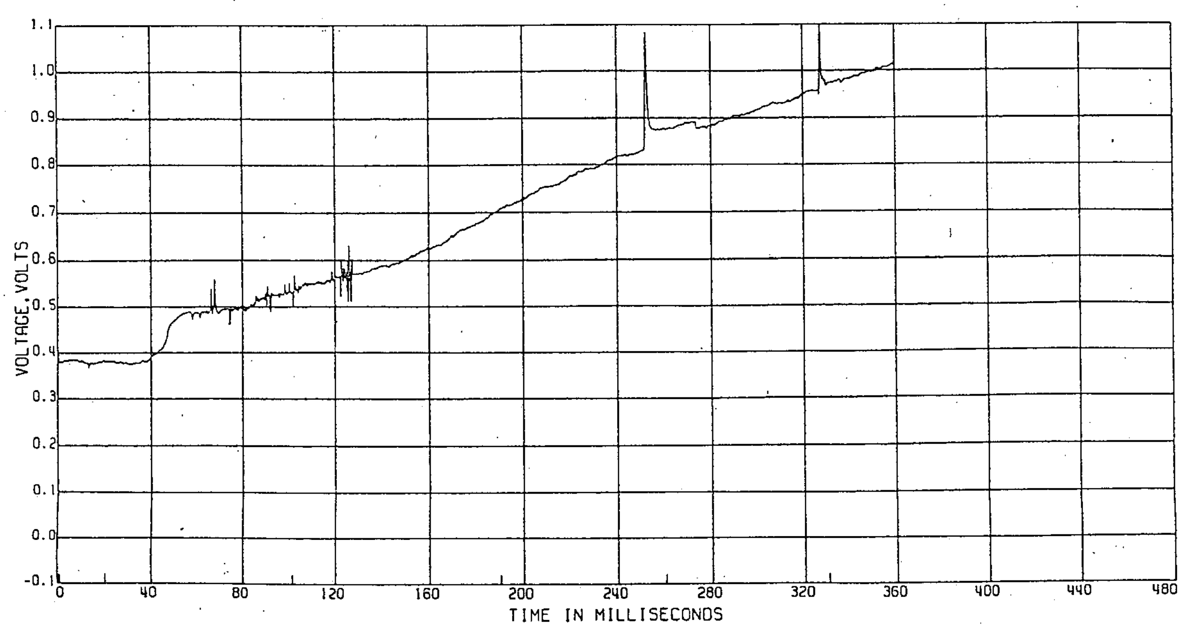


Appendix F, plot # **91**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W9187D HONDA R. MANIFOLD SHIELD (S4) VOLTAGE TEST DATE:09/16/1998

LEC DATA, SAE CLASS 1000



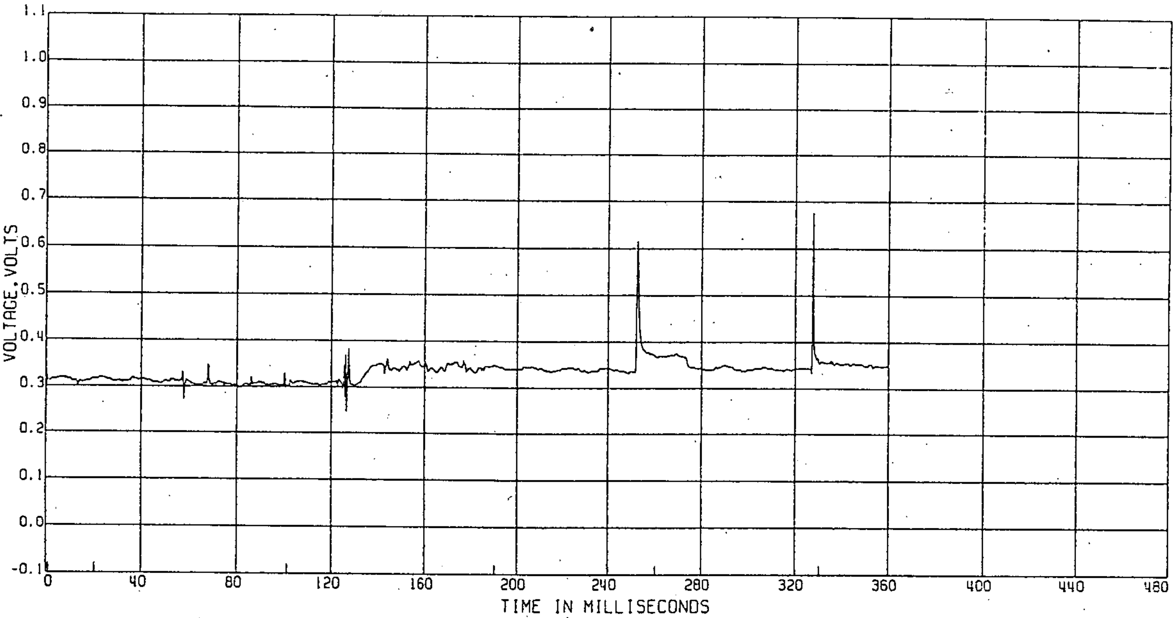
Appendix F, plot # **92**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA
ELEC DATA, SAE CLASS 1000

CATALYTIC CONVERTER VOLTAGE

TEST DATE:09/16/1998



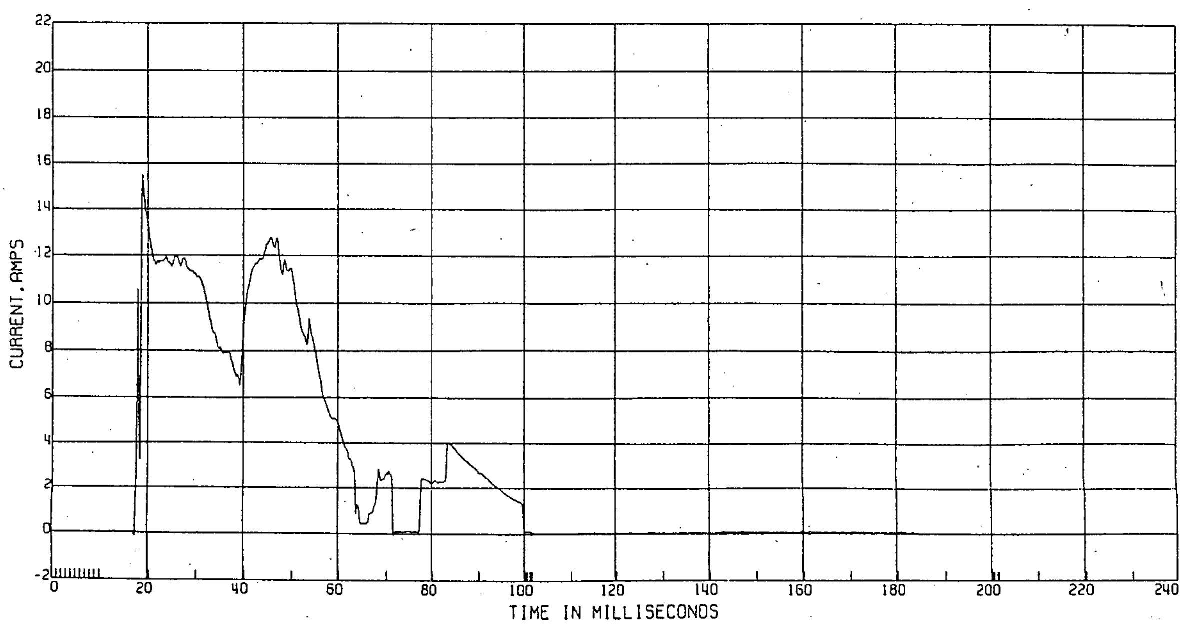
Appendix F, plot # 93

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA
ELEC DATA, SAE CLASS 1000

WHEEL BAG CURRENT

TEST DATE:09/16/1998



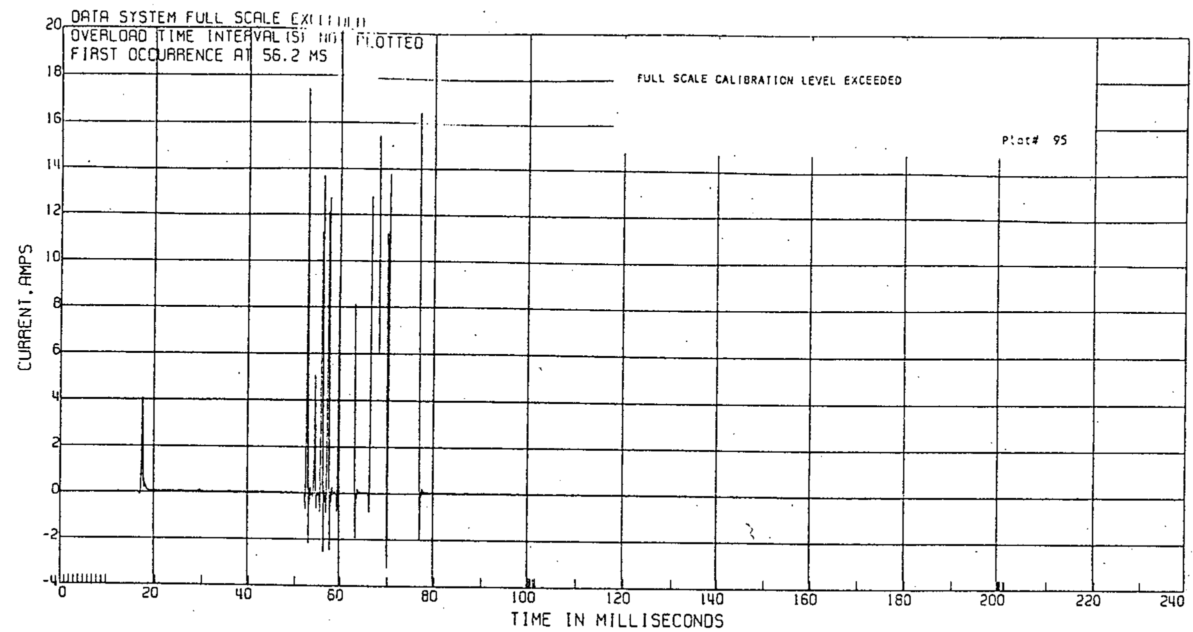
:2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W9187D HONDA

.EC DATA, SAE CLASS 1000

I/P BAG CURRENT

TEST DATE:09/16/1998



Appendix F, plot # **95**

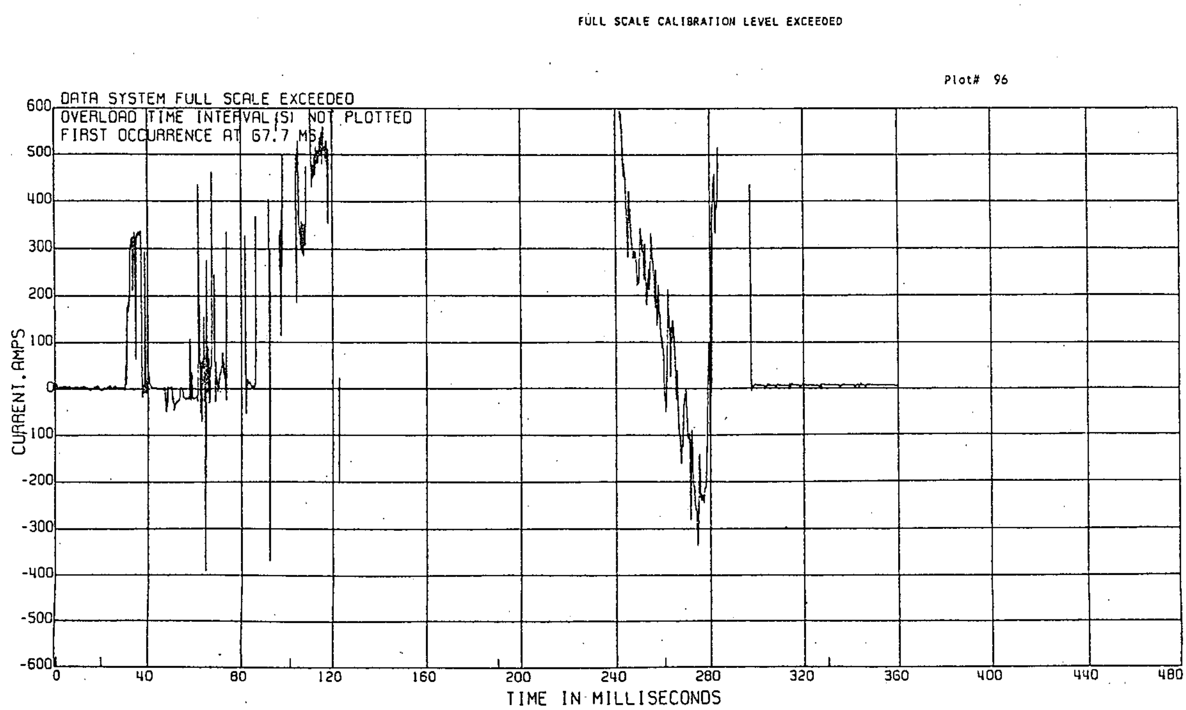
:2174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W9187D HONDA

.EC DATA, SAE CLASS 1000

BATTERY CURRENT

TEST DATE:09/16/1998



Appendix F, plot # **96**

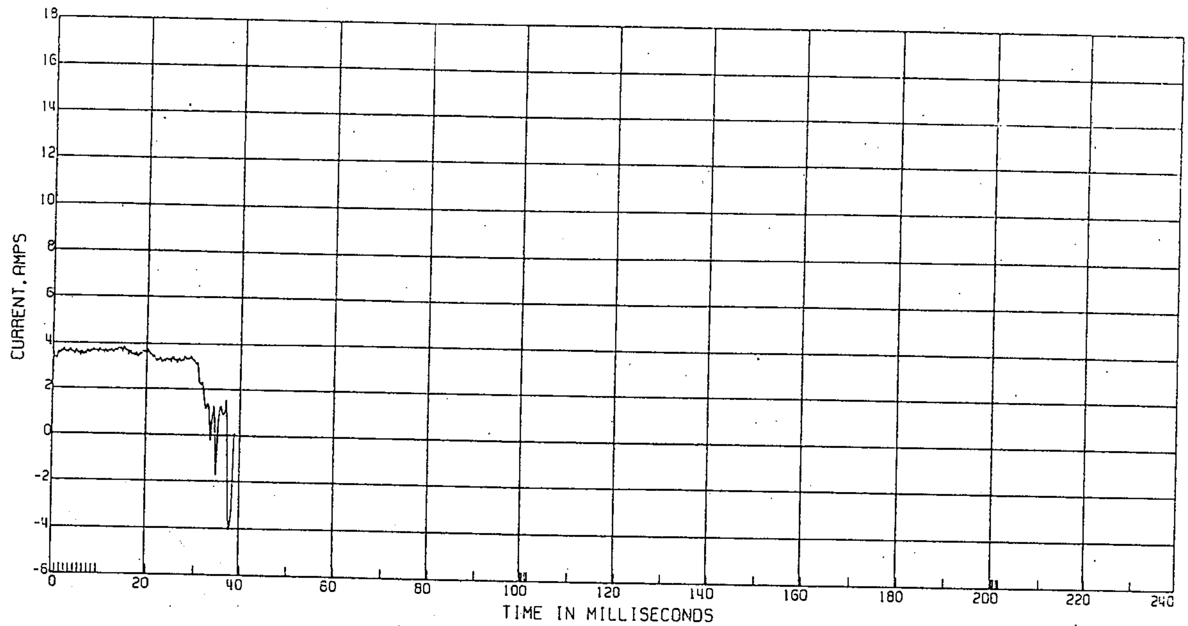
C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 1000

FUEL PUMP CURRENT

TEST DATE:09/16/1998



Appendix F, plot # 97

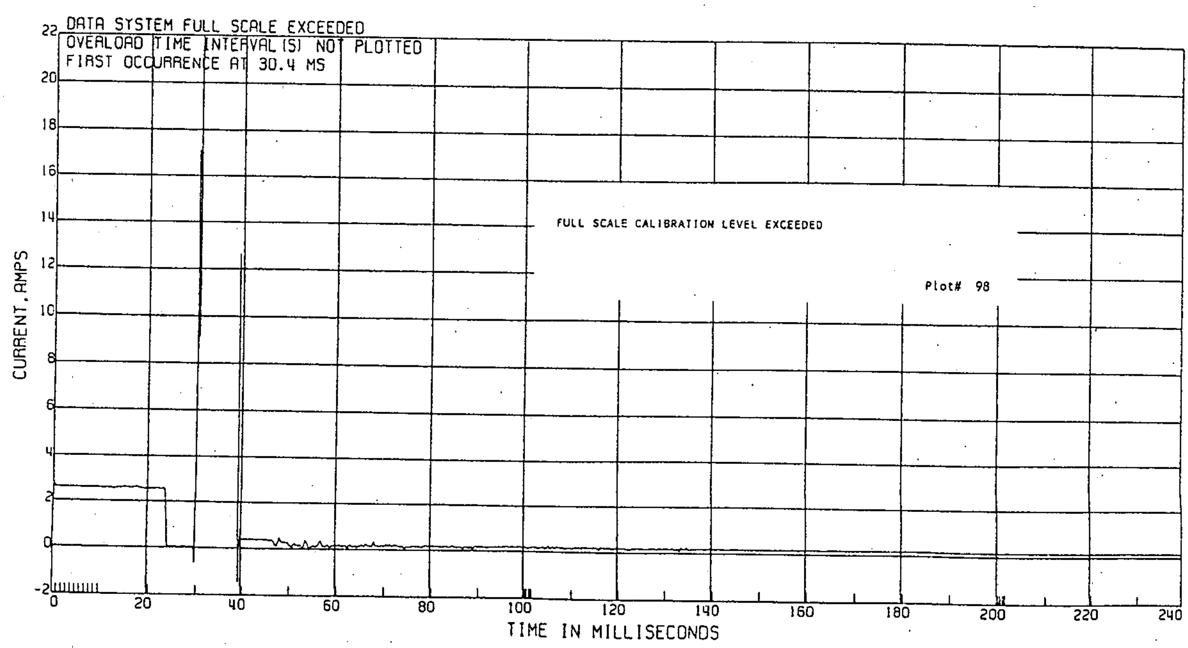
C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 1000

AC CLUTCH CURRENT

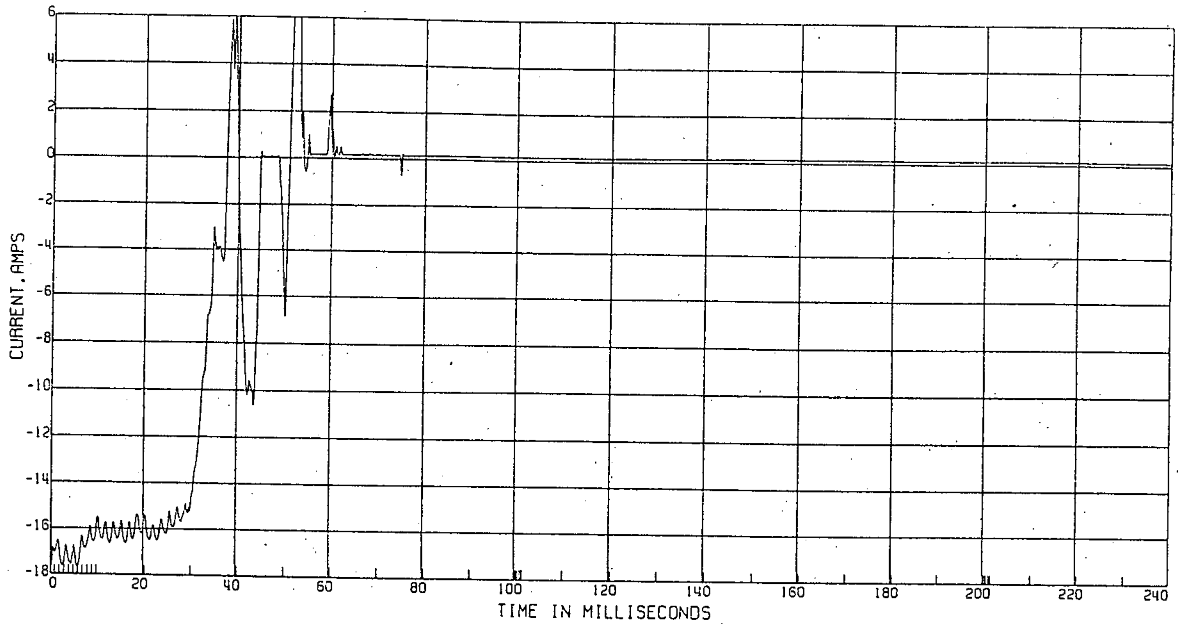
TEST DATE:09/16/1998



12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

? & D CTR 8W91870 HONDA HVAC BLOWER CURRENT TEST DATE:09/16/1998

LEC DATA, SAE CLASS 1000

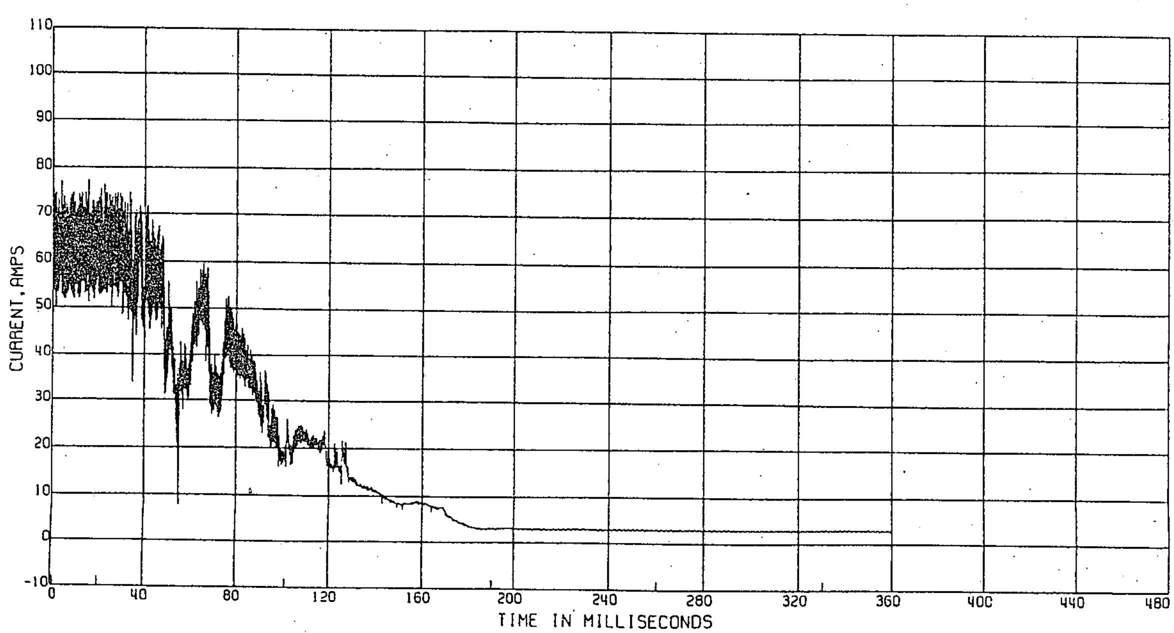


Appendix F, plot # **99**

?12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

? & D CTR 8W91870 HONDA ALTERNATOR CABLE CURRENT TEST DATE:09/16/1998

LEC DATA, SAE CLASS 1000

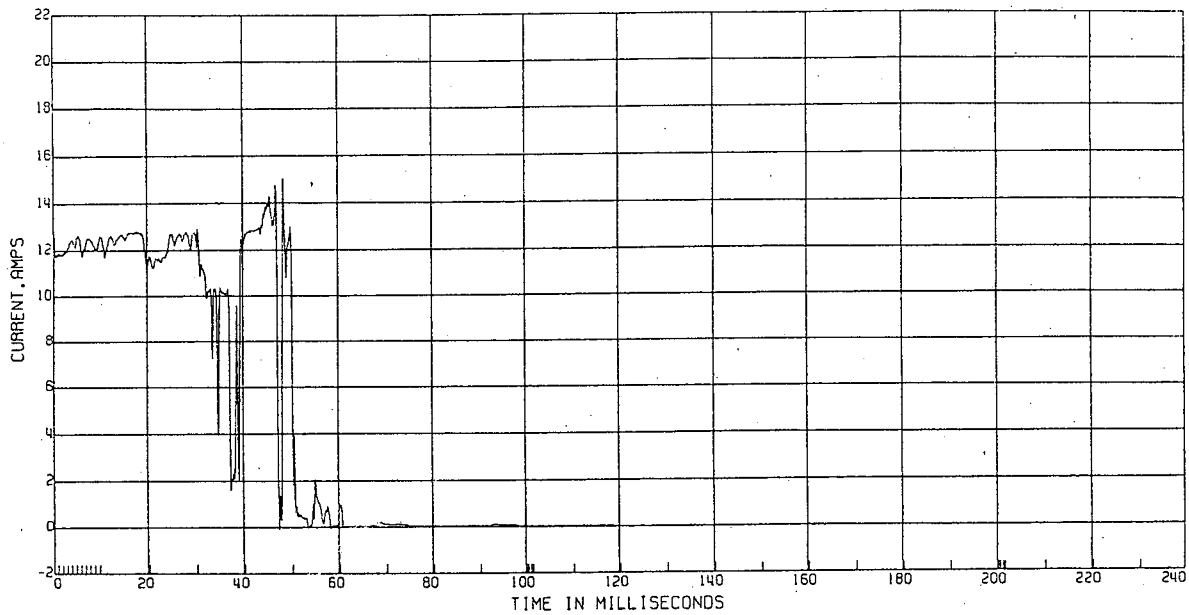


Appendix F, plot # **100**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W9187D HONDA L. FRT HEADLIGHT HI-LOW-BEAM CURRENT TEST DATE:09/16/1998

ELEC DATA, SAE CLASS 1000

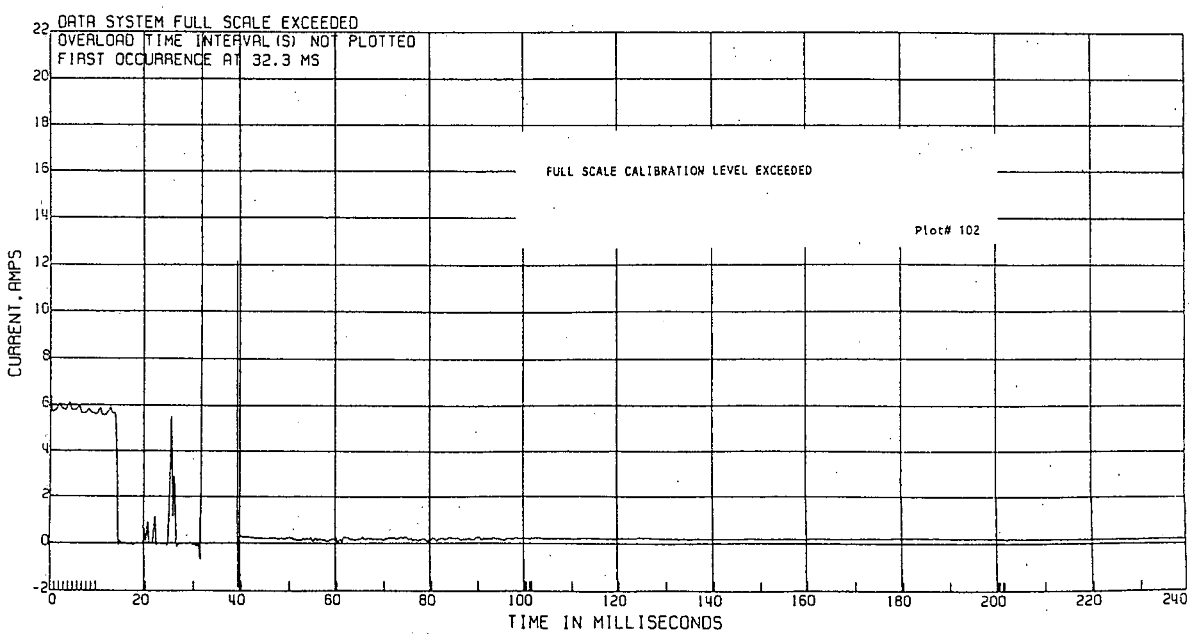


Appendix F, plot # **101**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W9187D HONDA RADIATOR FAN CURRENT TEST DATE:09/16/1998

ELEC DATA, SAE CLASS 1000



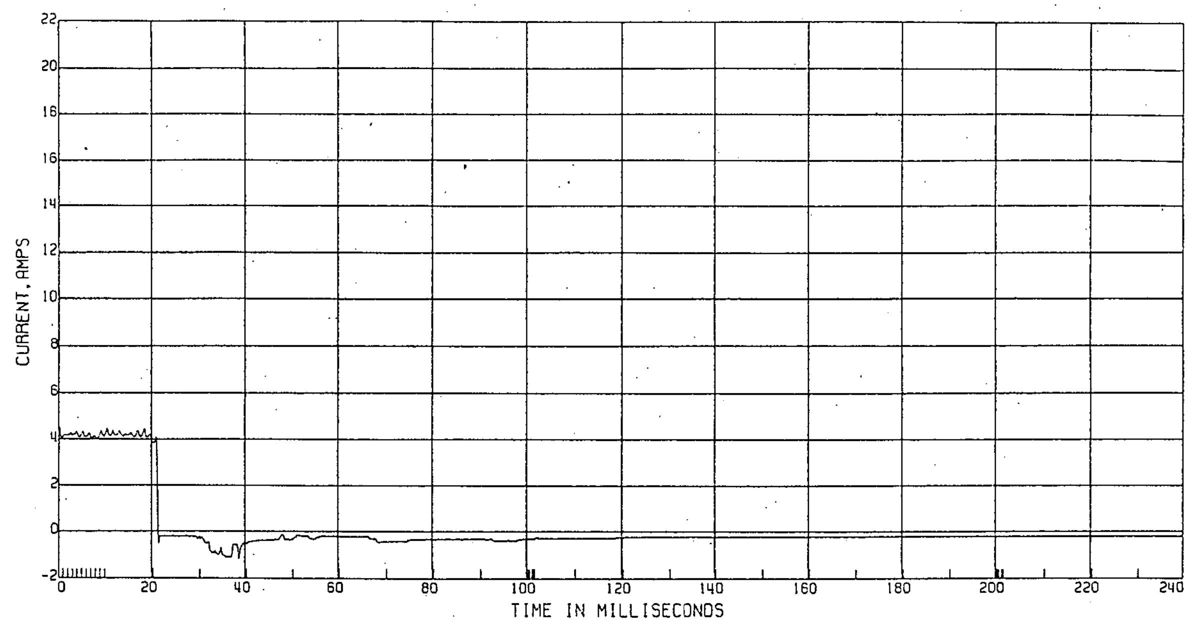
12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

LEC DATA, SAE CLASS 1000

CONDENSER FAN CURRENT

TEST DATE:09/16/1998



Appendix F, plot # **103**

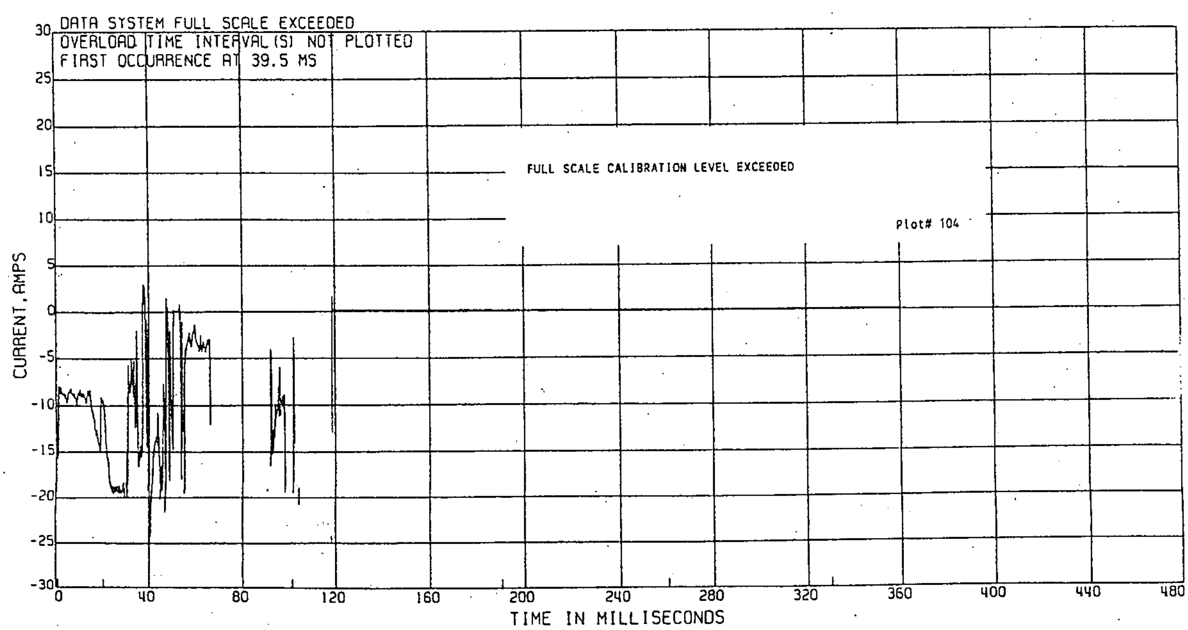
12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W91870 HONDA

LEC DATA, SAE CLASS 1000

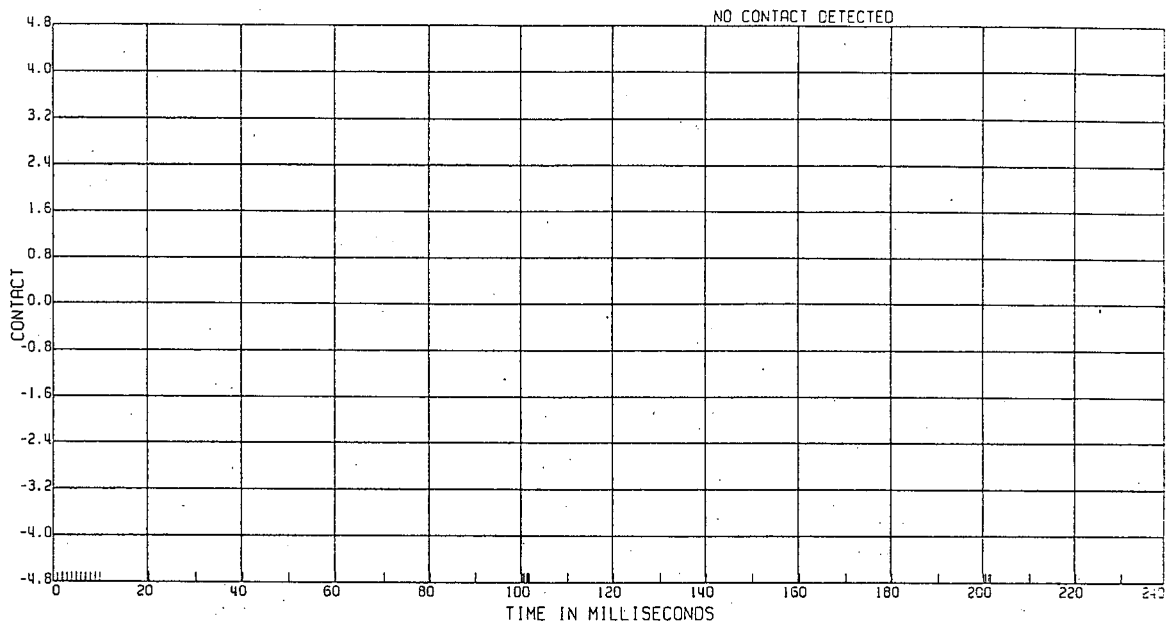
IGNITION FEED CURRENT

TEST DATE:09/16/1998



C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

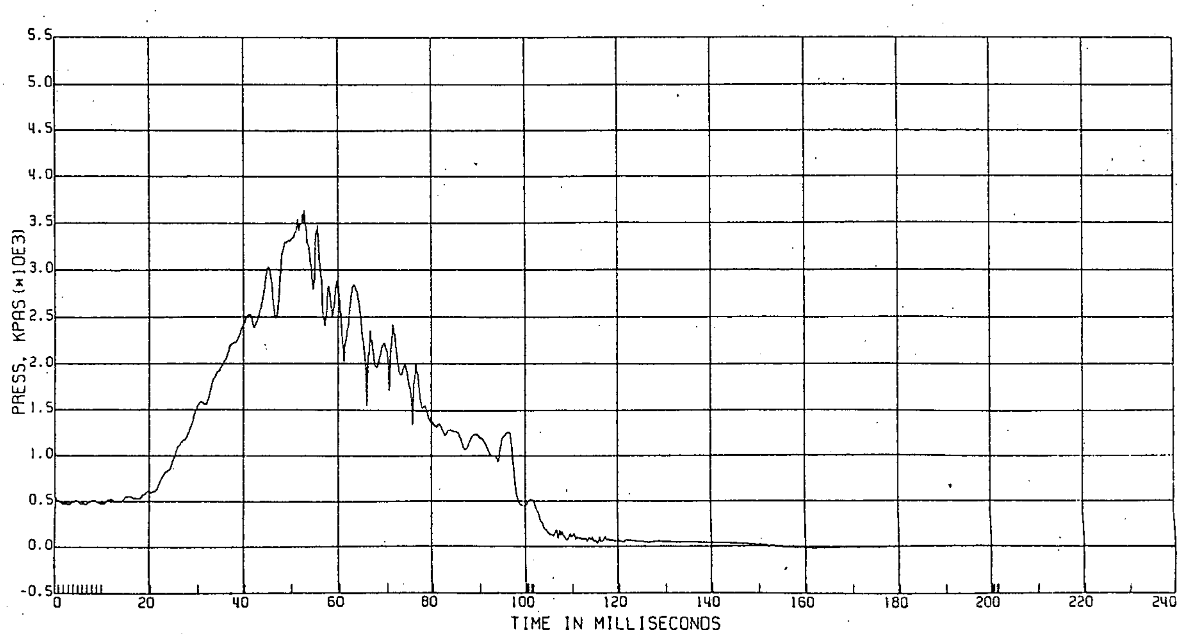
R & D CTR 8W91870 HONDA THERMAL WIRE CONTACT TEST DATE:09/16/1998
ELEC DATA, SAE CLASS 1000



Appendix F, plot # 105

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA POWER STEERING SYSTEM PRESSURE TEST DATE:09/16/1998
ELEC DATA, SAE CLASS 1000

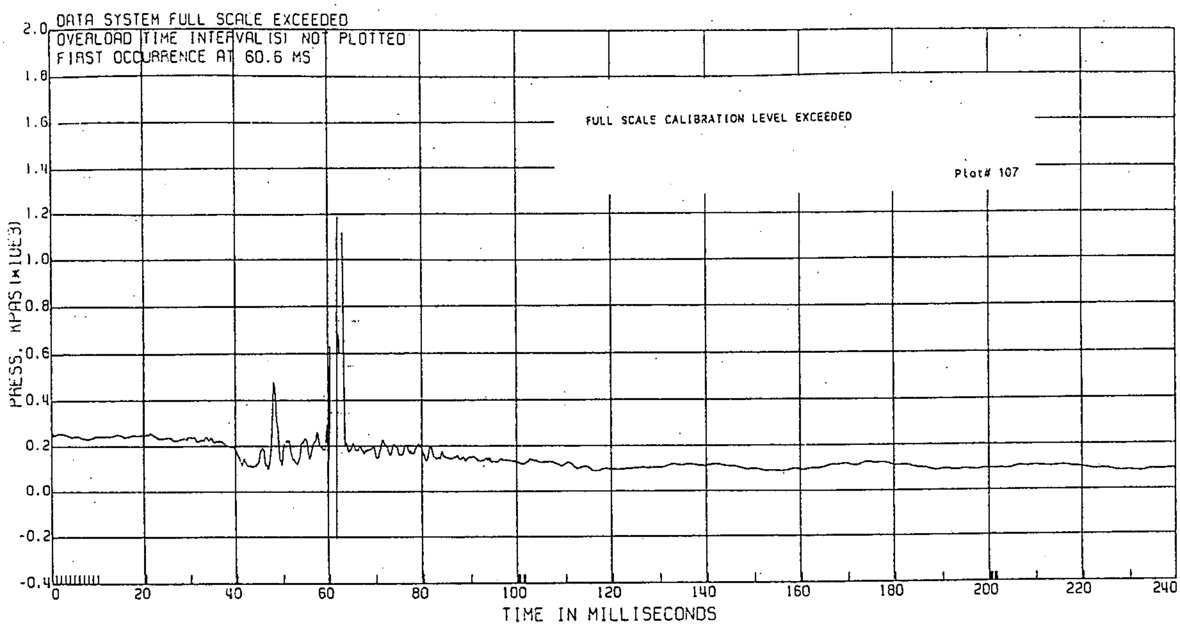


Appendix F, plot # 106

:174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

ENGINE OIL PRESSURE

: D CTR 8W91870 HONDA TEST DATE:09/16/1998
'C DATA, SAE CLASS 1000

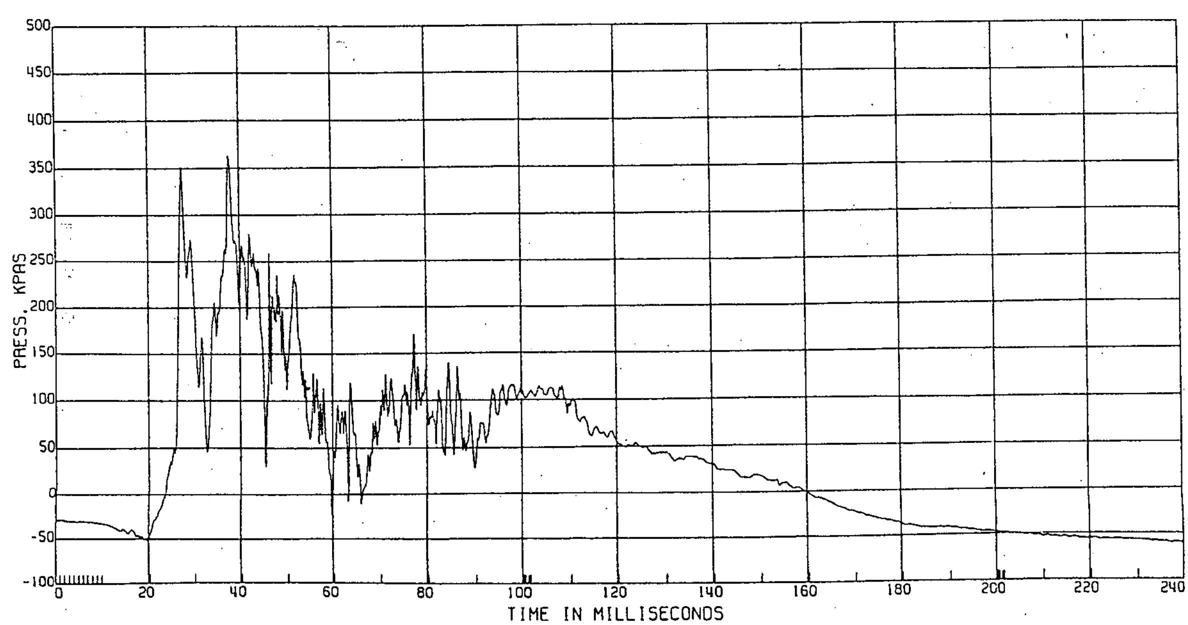


Appendix F, plot # **107**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

COOLING SYSTEM PRESSURE

& D CTR 8W91870 HONDA TEST DATE:09/16/1998
.EC DATA, SAE CLASS 1000



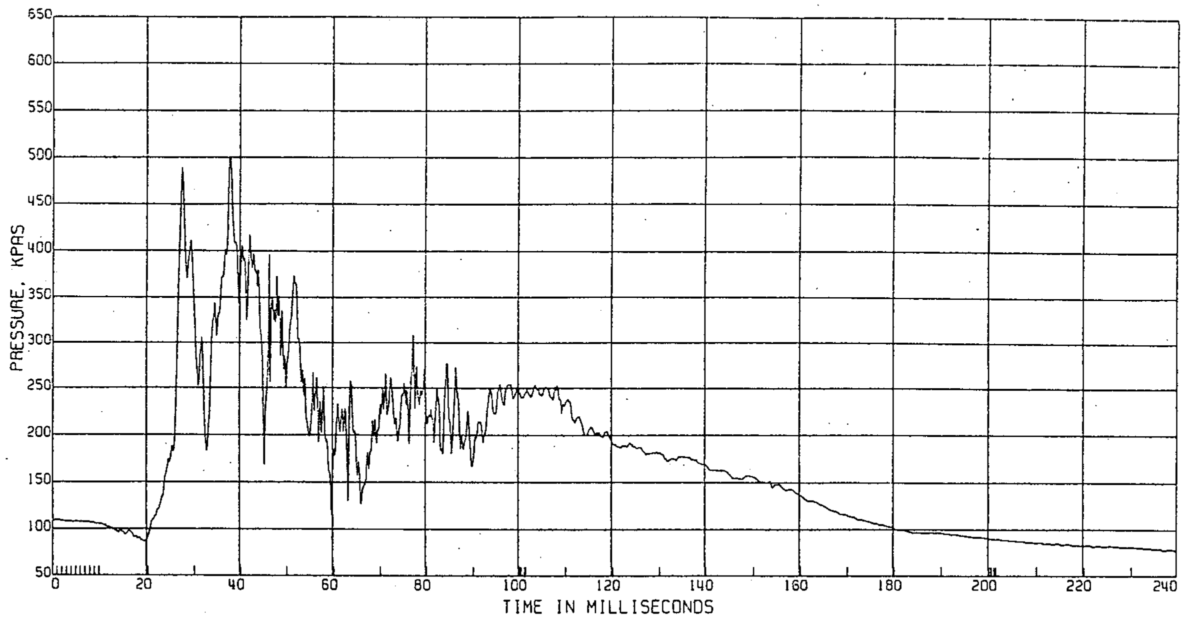
Appendix F, plot # **108**

C12174. FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA
ELEC DATA, SAE CLASS 1000

COOLING SYSTEM PRESSURE
(BIASED DATA BY 138.0KPAS)

TEST DATE:09/16/1998



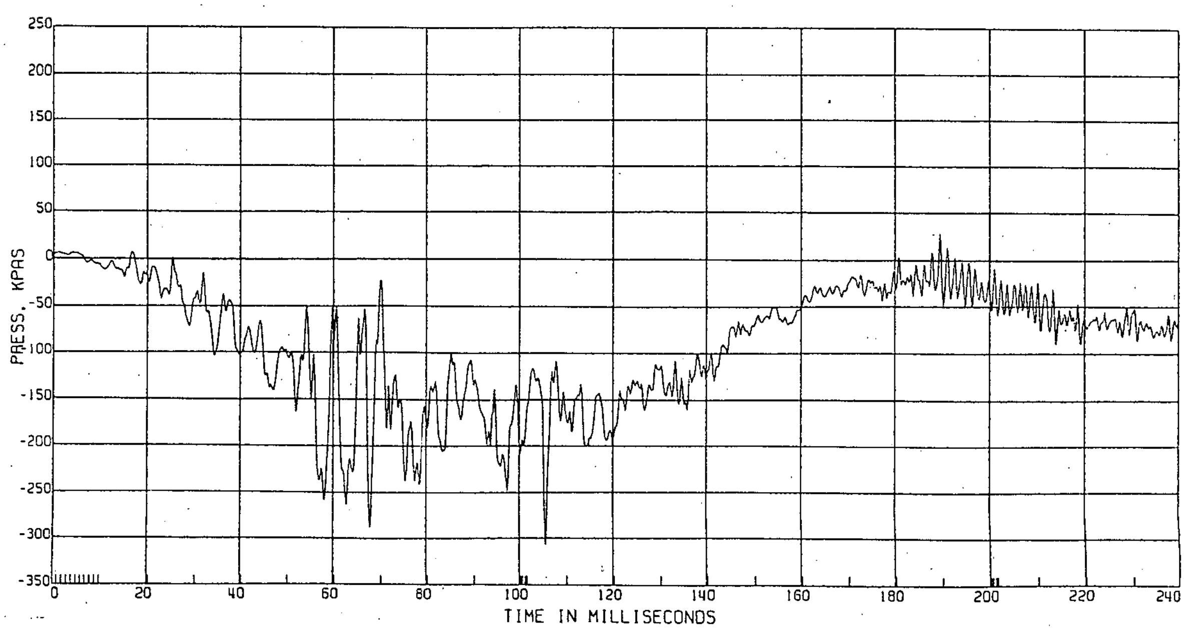
Appendix F, plot # **109**

C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA
ELEC DATA, SAE CLASS 1000

FUEL SUPPLY LINE PRESSURE

TEST DATE:09/16/1998



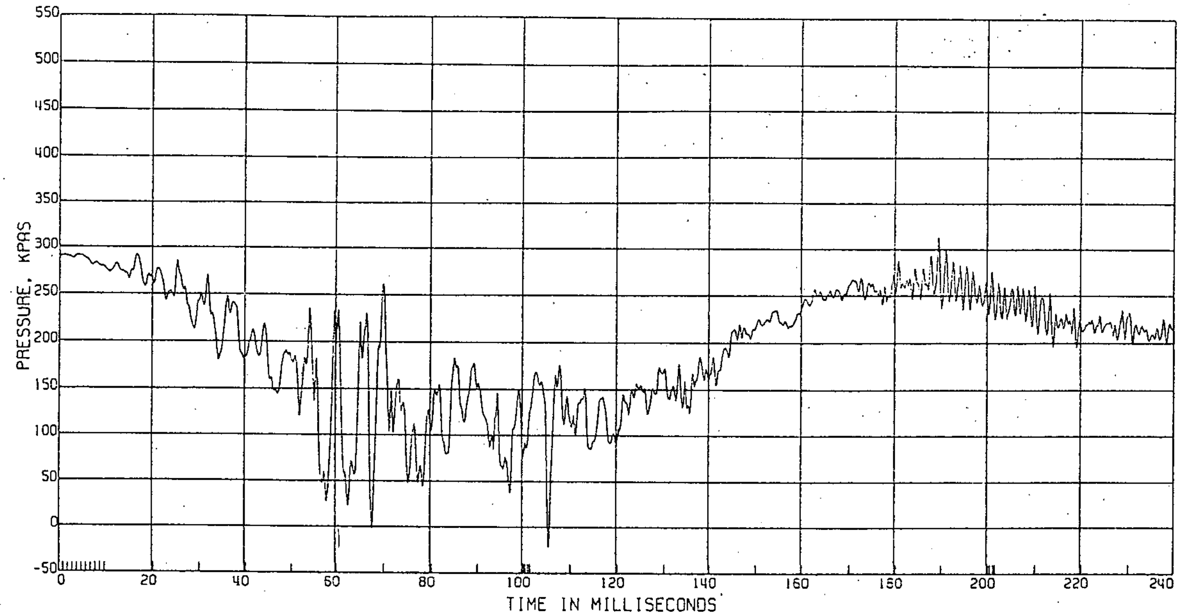
Appendix F, plot # **110**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W9187D HONDA
LEC DATA, SAE CLASS 1000

FUEL SUPPLY LINE PRESSURE
(BIASED DATA BY 285.0KPAS)

TEST DATE:09/16/1998



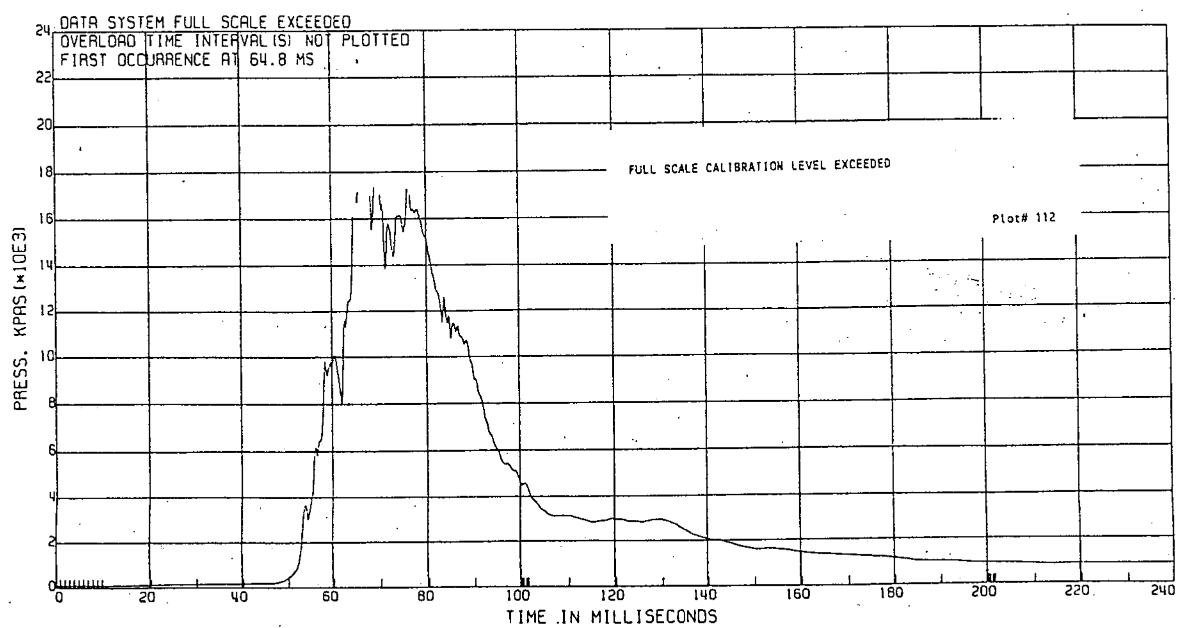
Appendix F, plot # **111**

12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

& D CTR 8W9187D HONDA
LEC DATA, SAE CLASS 1000

L. FRT BRAKE SYSTEM PRESSURE

TEST DATE:09/16/1998



Appendix F, plot # 112

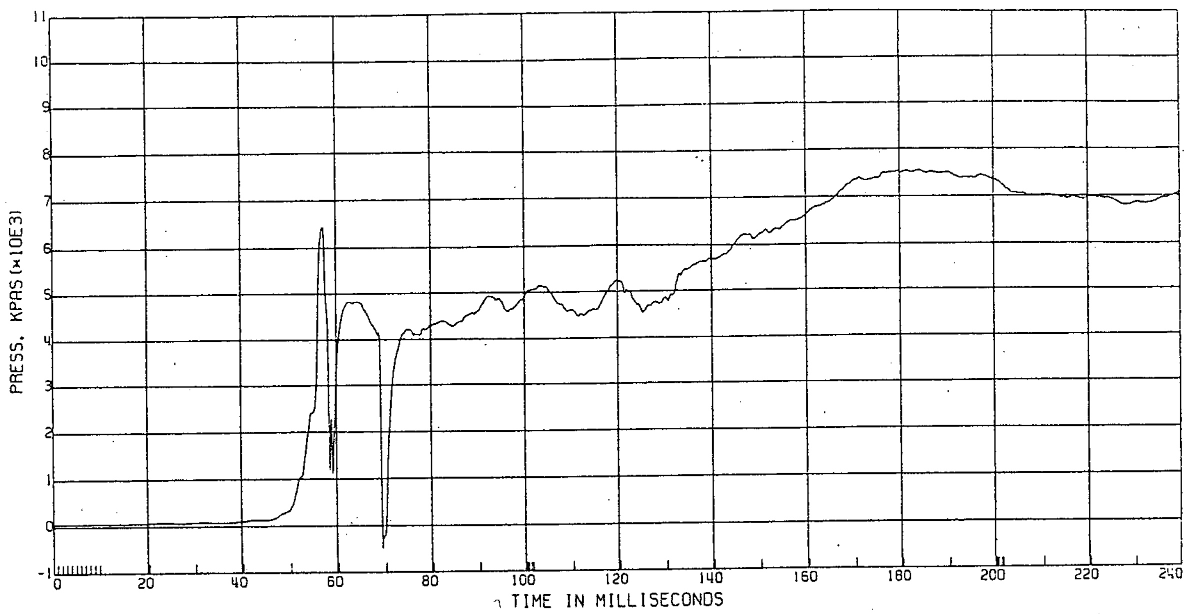
C12174 FRONT IMPACT MOVING VEHICLE TO FIXED POLE 55.4 KM/H

R & D CTR 8W91870 HONDA

ELEC DATA, SAE CLASS 1000

R. FRT BRAKE SYSTEM PRESSURE

TEST DATE:09/16/1998



Appendix F, plot # 113

Appendix G: C12174 hydrocarbon vapor measurement plots

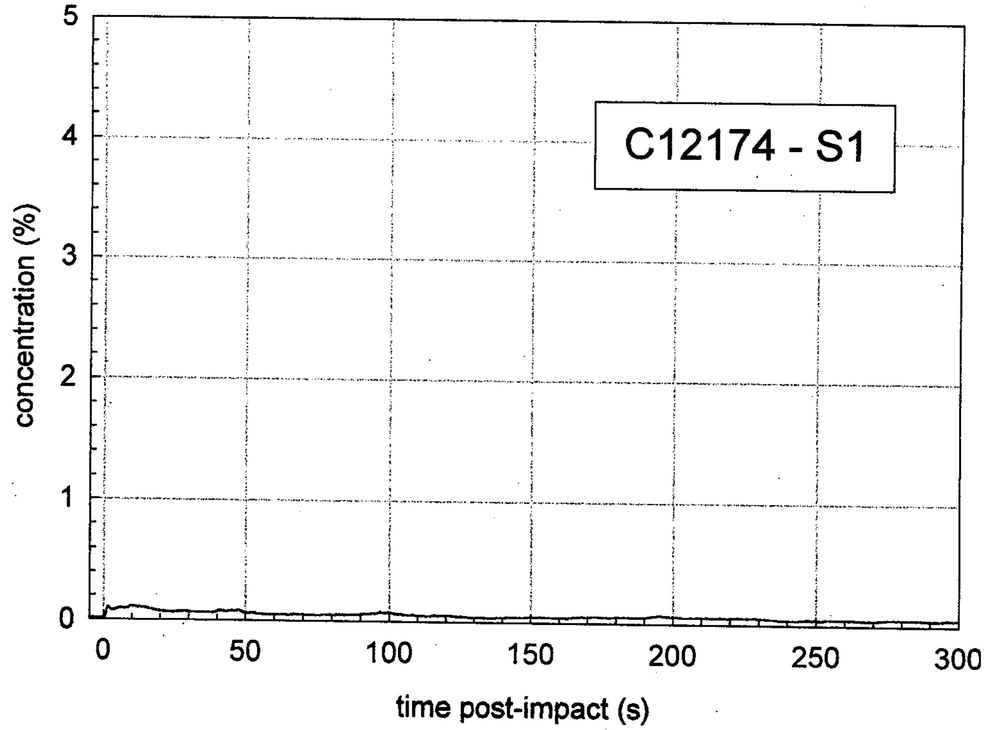


Figure G1
Concentration of Hydrocarbon Vapor Above the Left Fuel Rail (location #1)
Test C12174

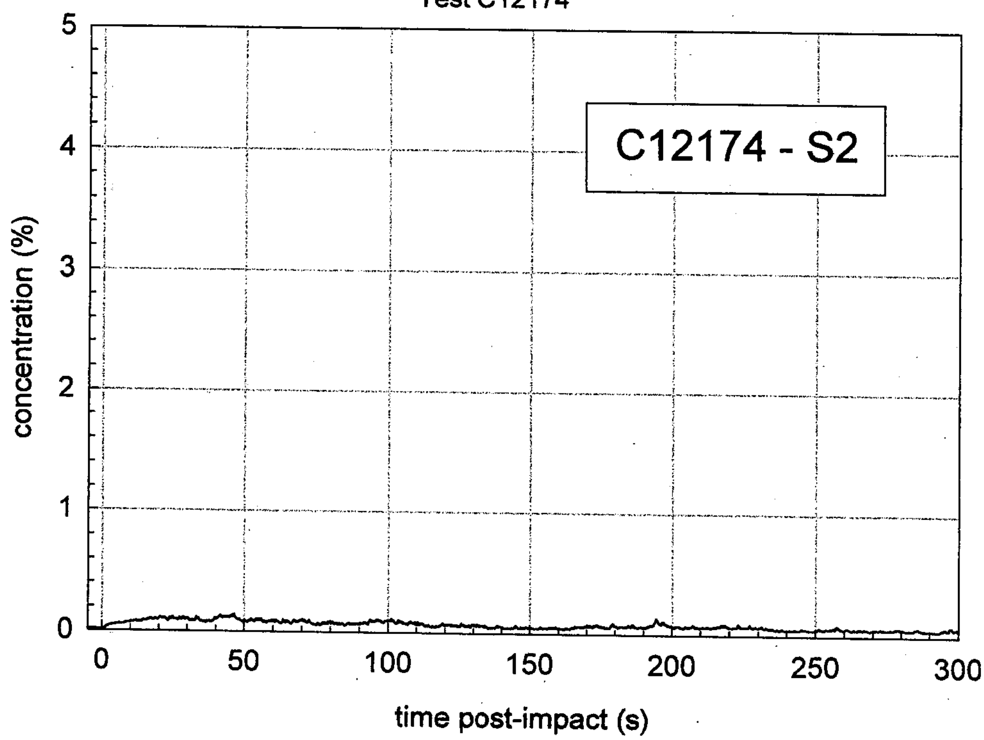


Figure G2
Concentration of Hydrocarbon Vapor Measured Near the Right Fuel Rail (location #2)
Test C12174

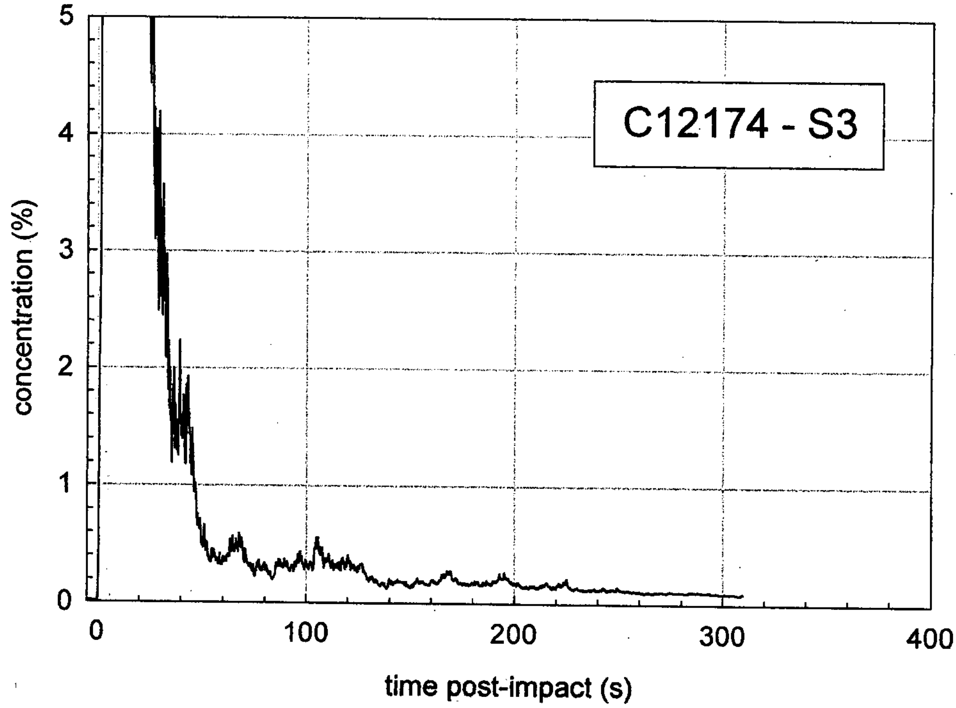


Figure G3
Concentration of Hydrocarbon Vapor Measured Near the Left Manifold Shield (location #3)
Test C12174

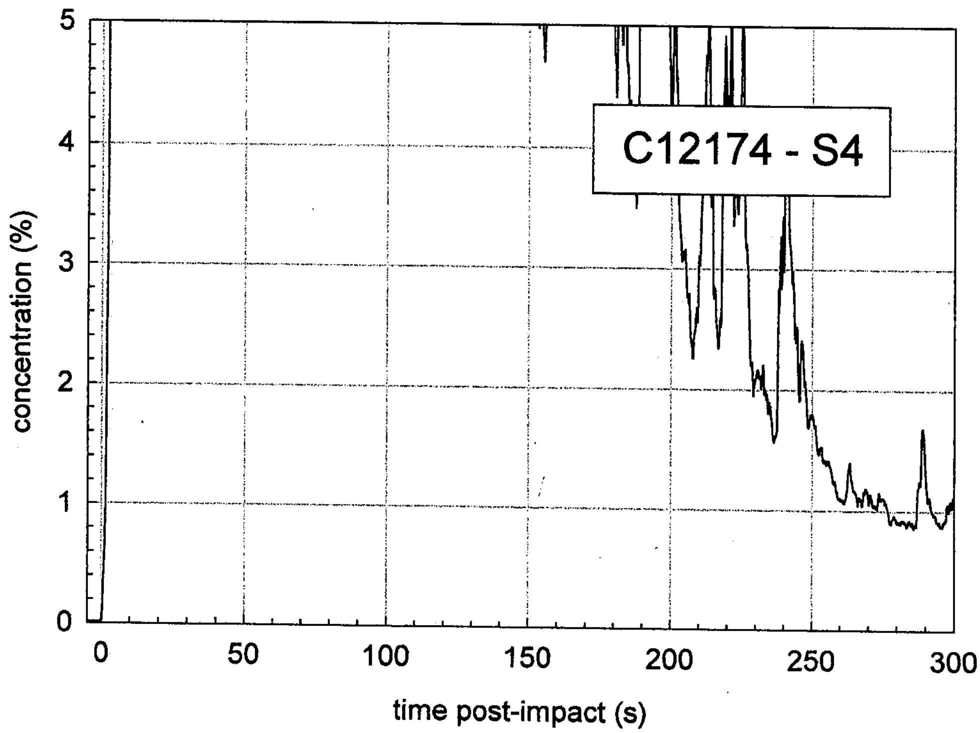


Figure G4
Concentration of Hydrocarbon Vapor Measured Near the Right Manifold Shield (location #4)
Test C12174

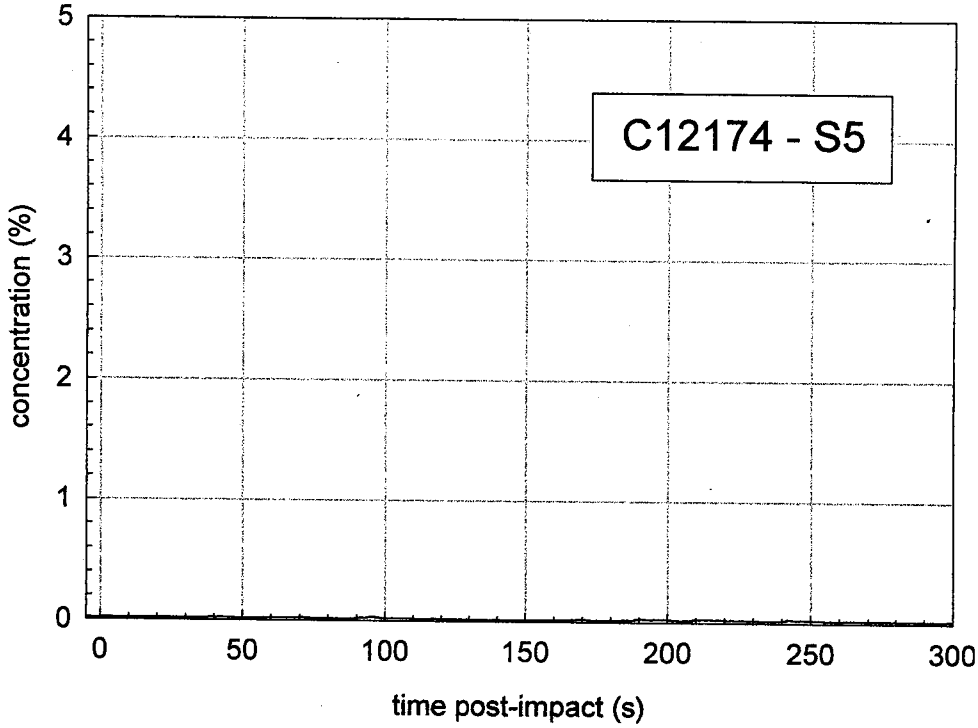


Figure G5
Concentration of Hydrocarbon Vapor Measured Near the Catalytic Converter (location #5)
Test C12174

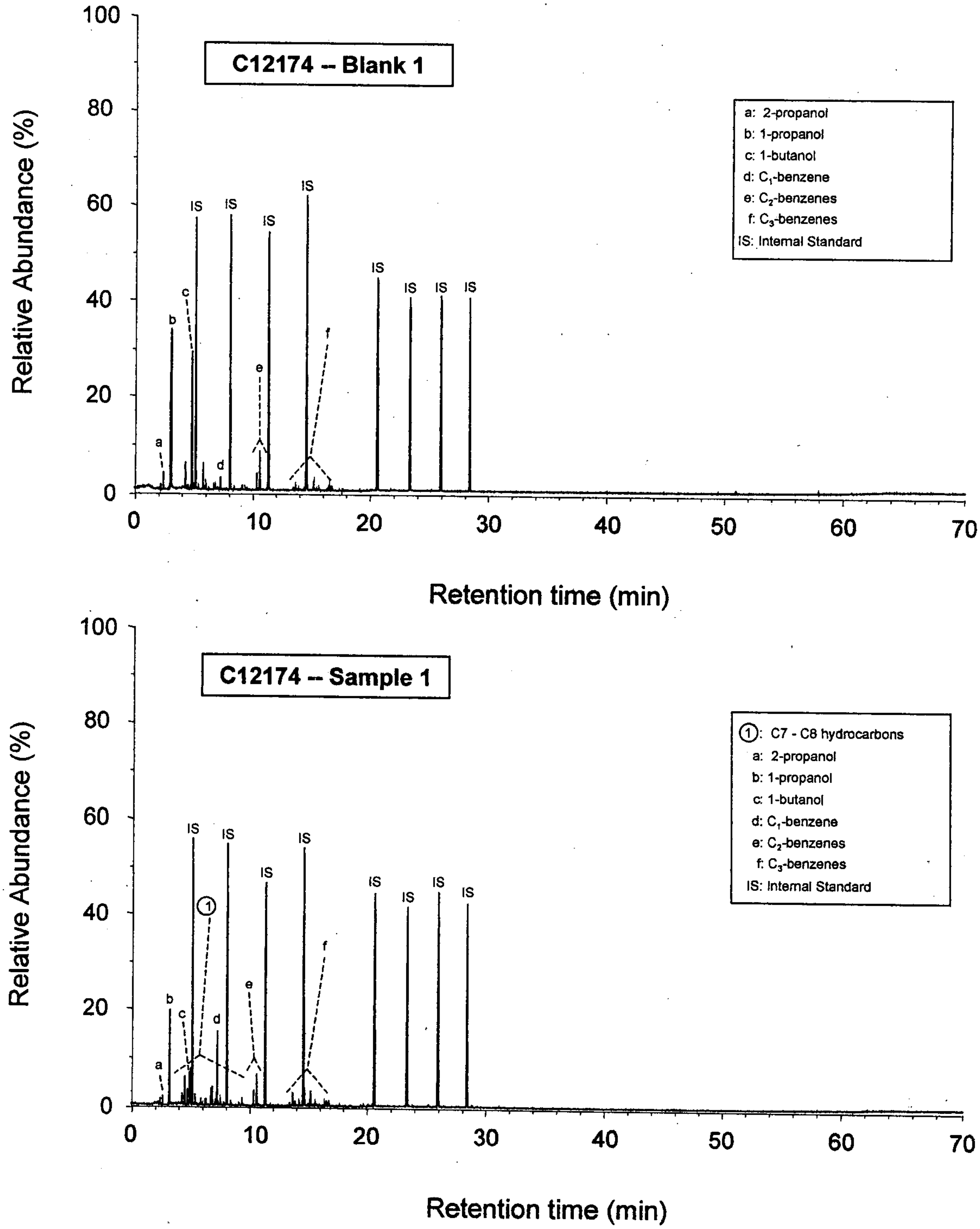


Figure GG1

GC/MS analysis of hydrocarbon vapor sample from above the left fuel rail (location #1) during Crash Test C12174. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

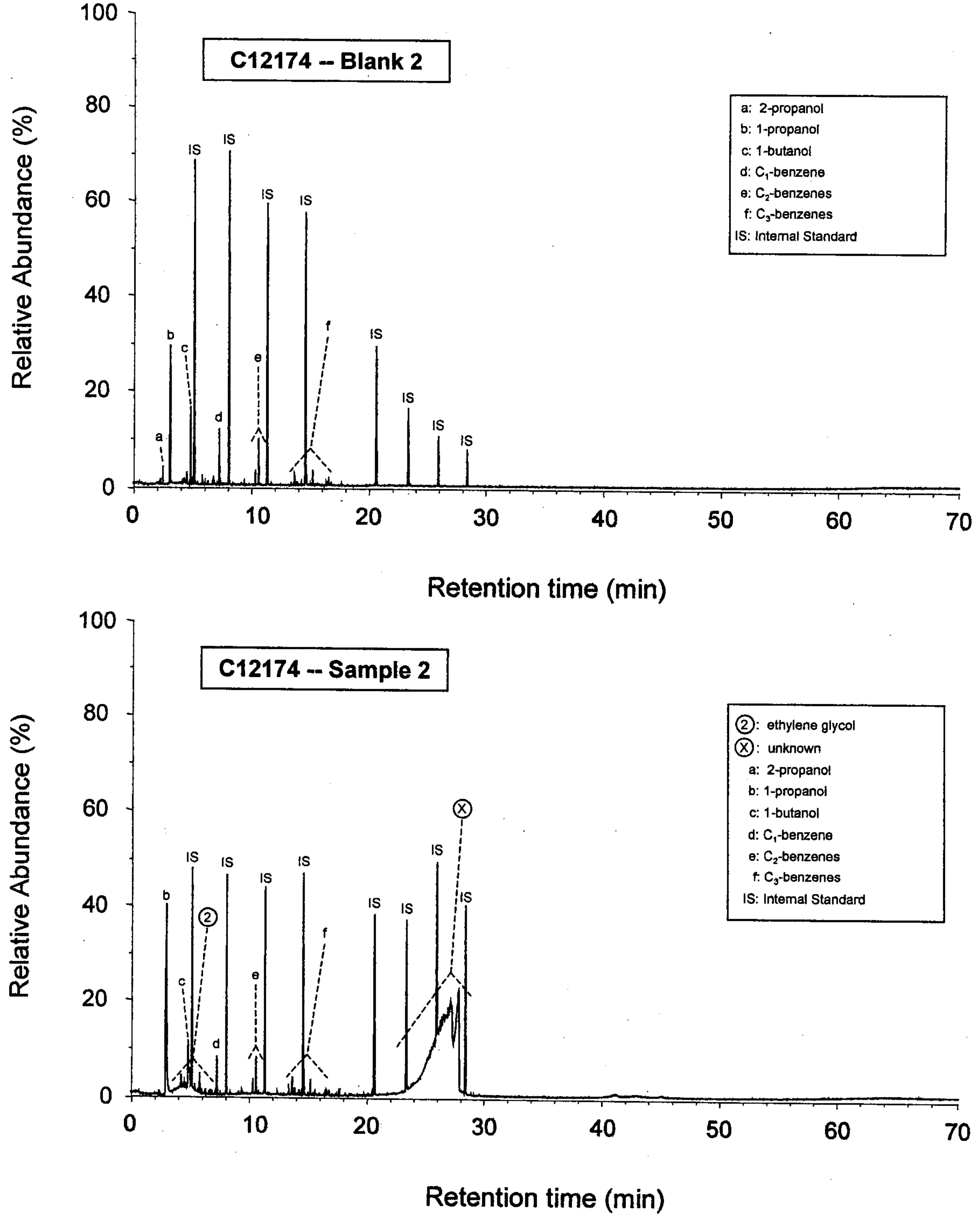


Figure GG2

GC/MS analysis of hydrocarbon vapor sample from near the right fuel rail (location #2) during Crash Test C12174. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

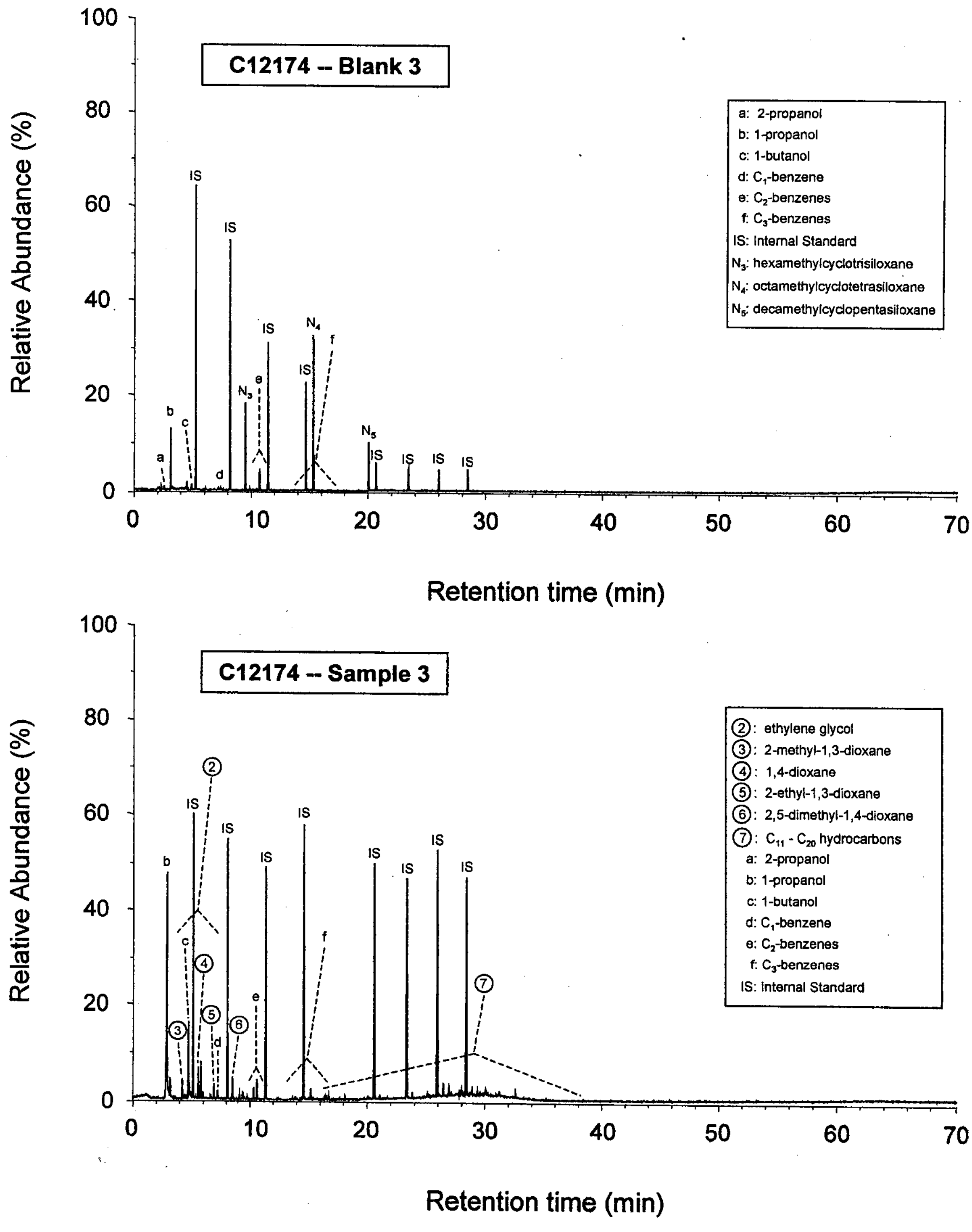


Figure GG3

GC/MS analysis of hydrocarbon vapor sample from near the left the left manifold shield (location #3) during Crash Test C12174. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

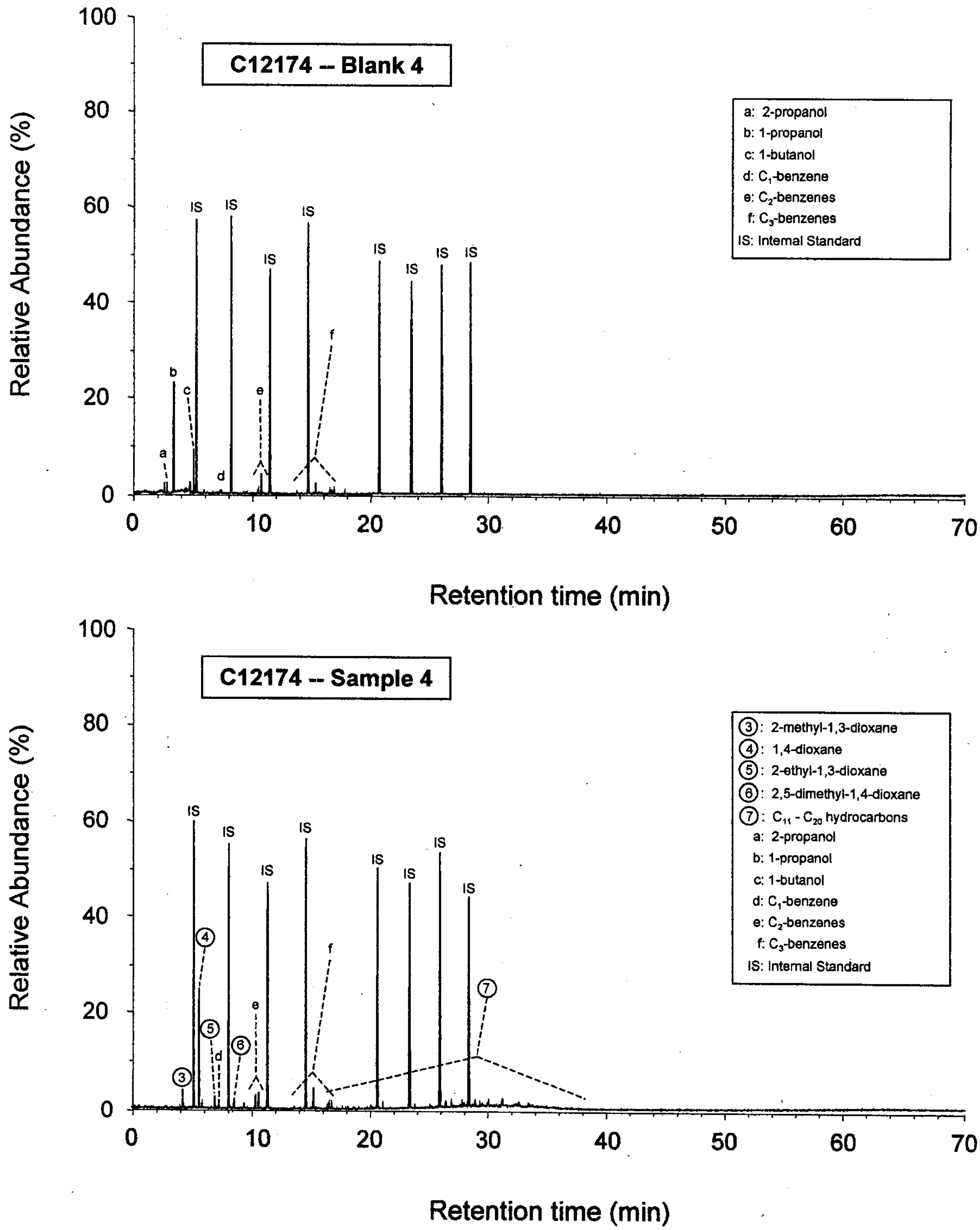
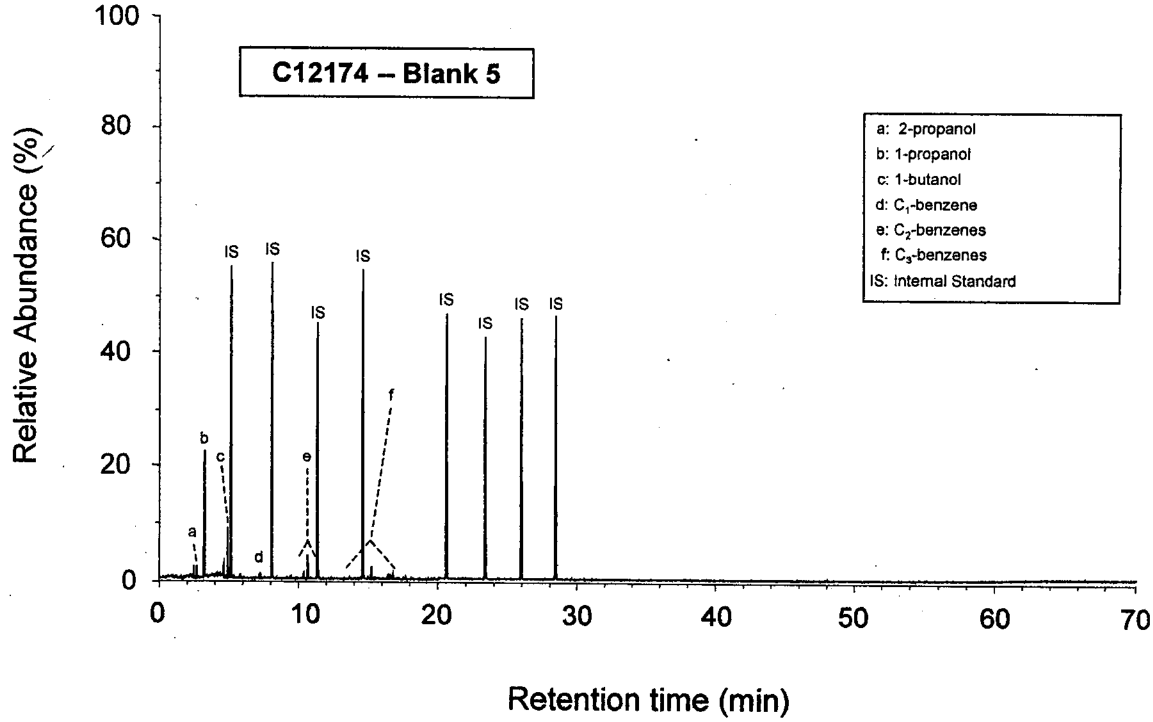


Figure GG4

GC/MS analysis of hydrocarbon vapor sample from near the right manifold shield (location #4) during Crash Test C12174. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.



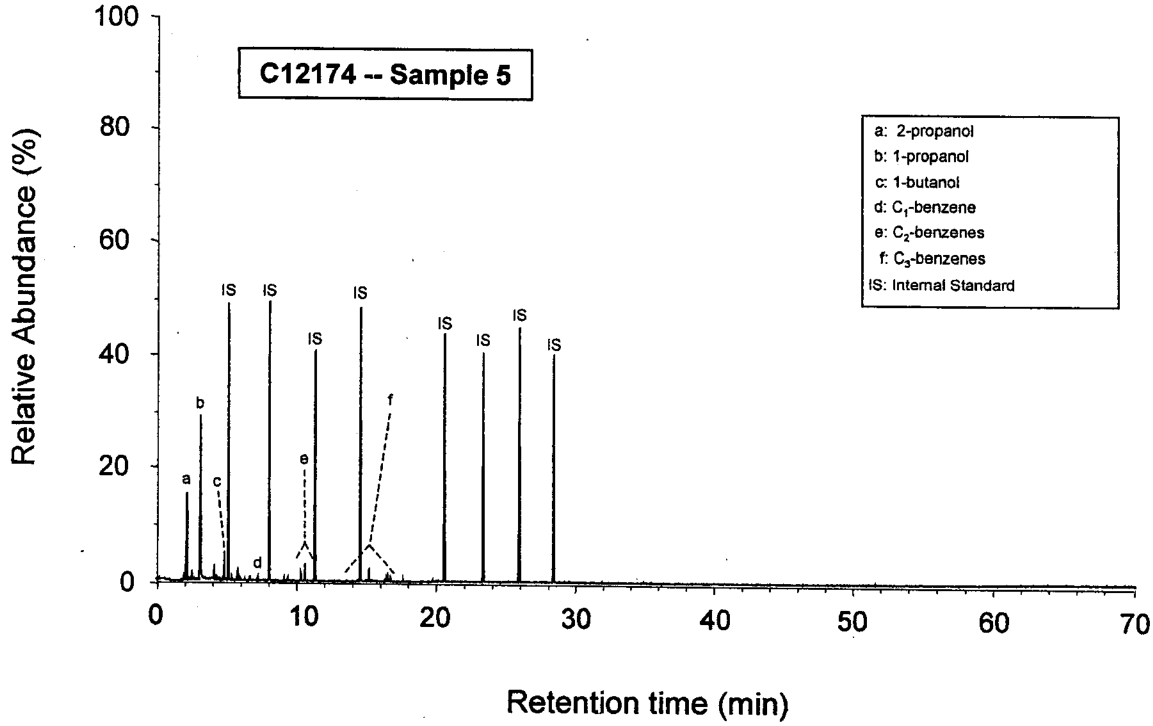


Figure GG5

GC/MS analysis of hydrocarbon vapor sample from near the Catalytic Converter (Location #5). during Crash Test C12174. The top panel is the chromatogram of background sample and the bottom panel is the chromatogram of the post-crash sample.

Appendix H: C12174 Numeric Film Plots

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4KM/H

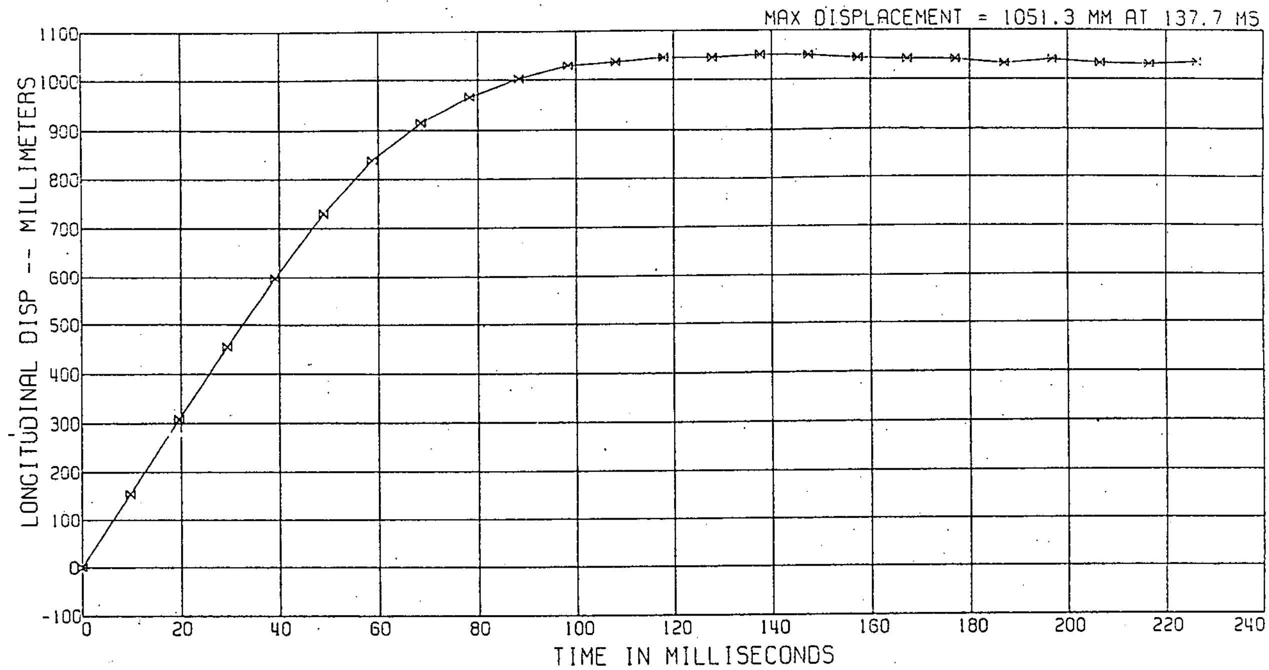
FIGURE

R&D CTR 8W9187D HONDA
FILM DATA

LEFT SIDE

TEST DATE:09/16/98

VEHICLE DISPL RELATIVE TO GROUND REFERENCE



Appendix H, Plot #1

C12174 FRONT IMPACT

MOVING VEHICLE TO FIXED POLE 55.4KM/H

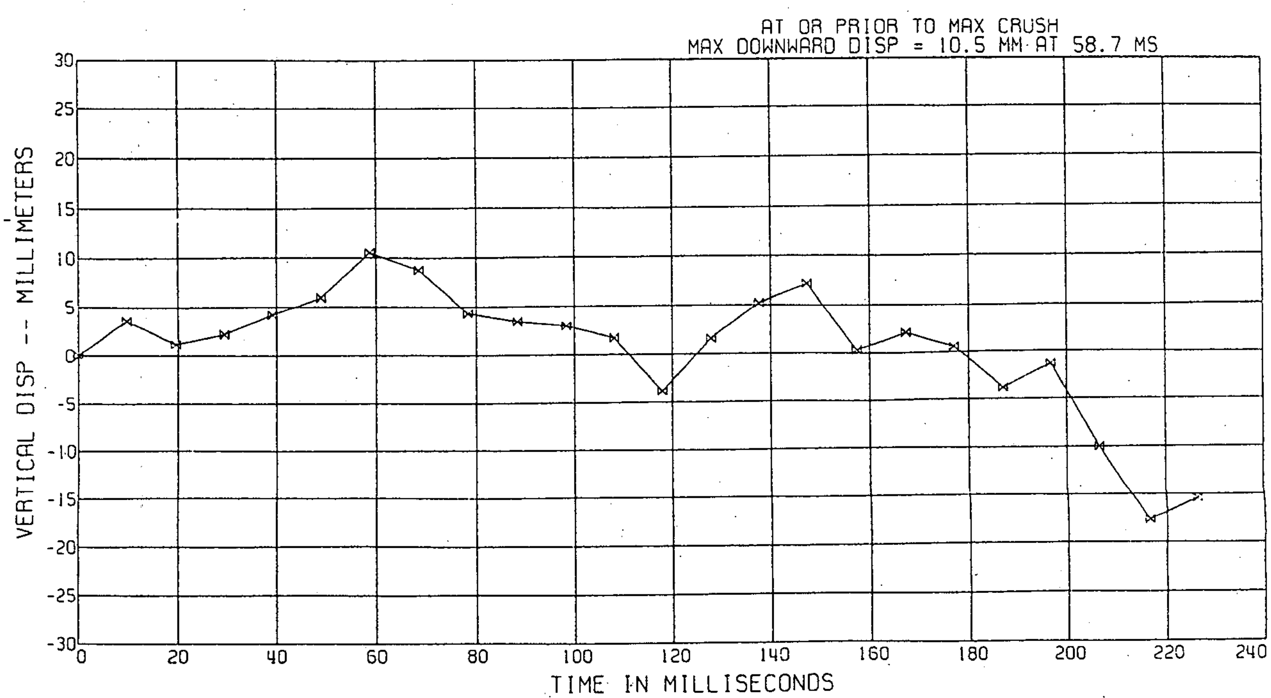
FIGURE

R&D CTR 8W9187D HONDA
FILM DATA

LEFT SIDE

TEST DATE:09/16/98

VEHICLE DISPL RELATIVE TO GROUND REFERENCE



Appendix H, Plot #2

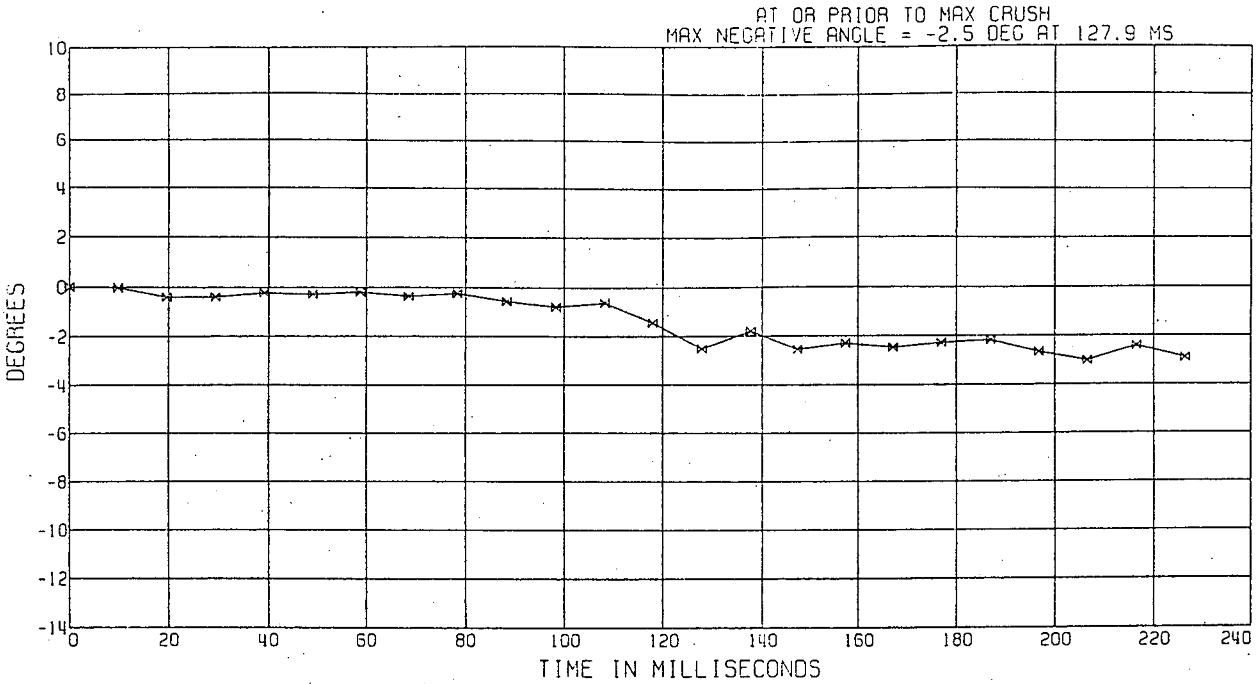
C12174 FRONT IMPACT | MOVING VEHICLE TO FIXED POLE 55.4KM/H | FIGURE

R&D CTR 8W91870 HONDA
FILM DATA

LEFT SIDE

TEST DATE:09/16/98

VEHICLE PITCH RELATIVE TO GROUND REFERENCE



Appendix H, Plot **#3**

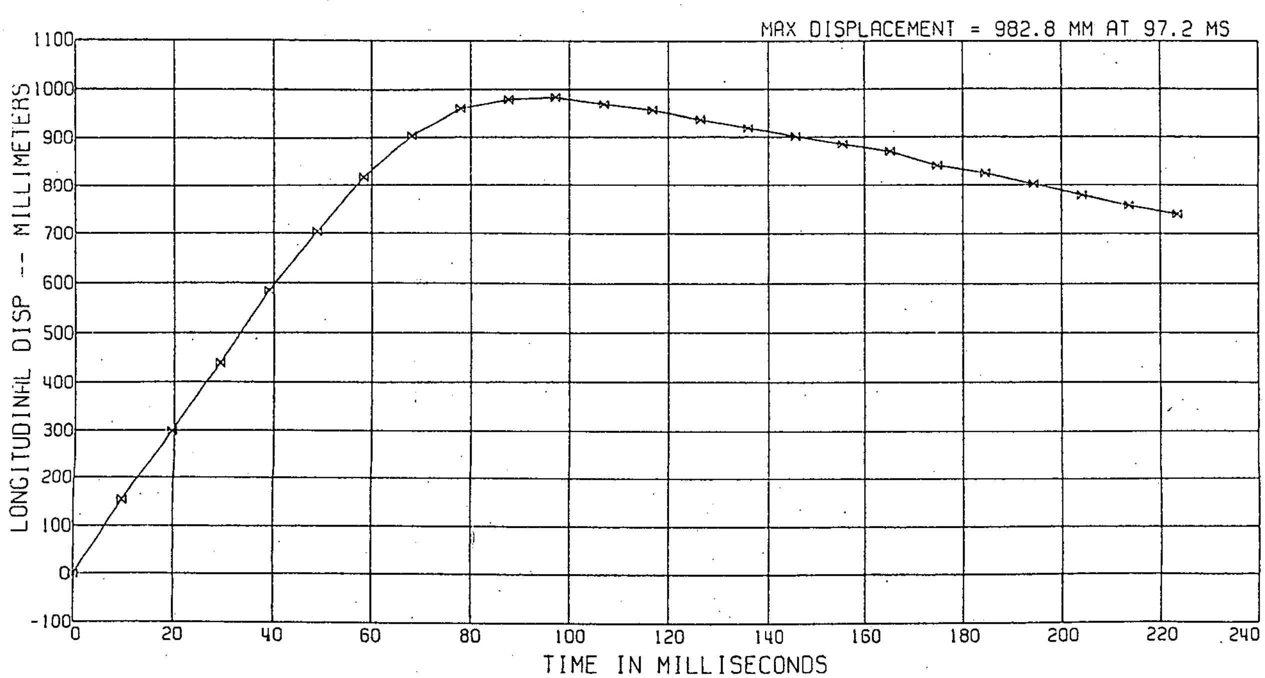
C12174 FRONT IMPACT | MOVING VEHICLE TO FIXED POLE 55.4KM/H | FIGURE

R&D CTR 8W91870 HONDA
FILM DATA

RIGHT SIDE

TEST DATE:09/16/98

VEHICLE DISPL RELATIVE TO GROUND REFERENCE



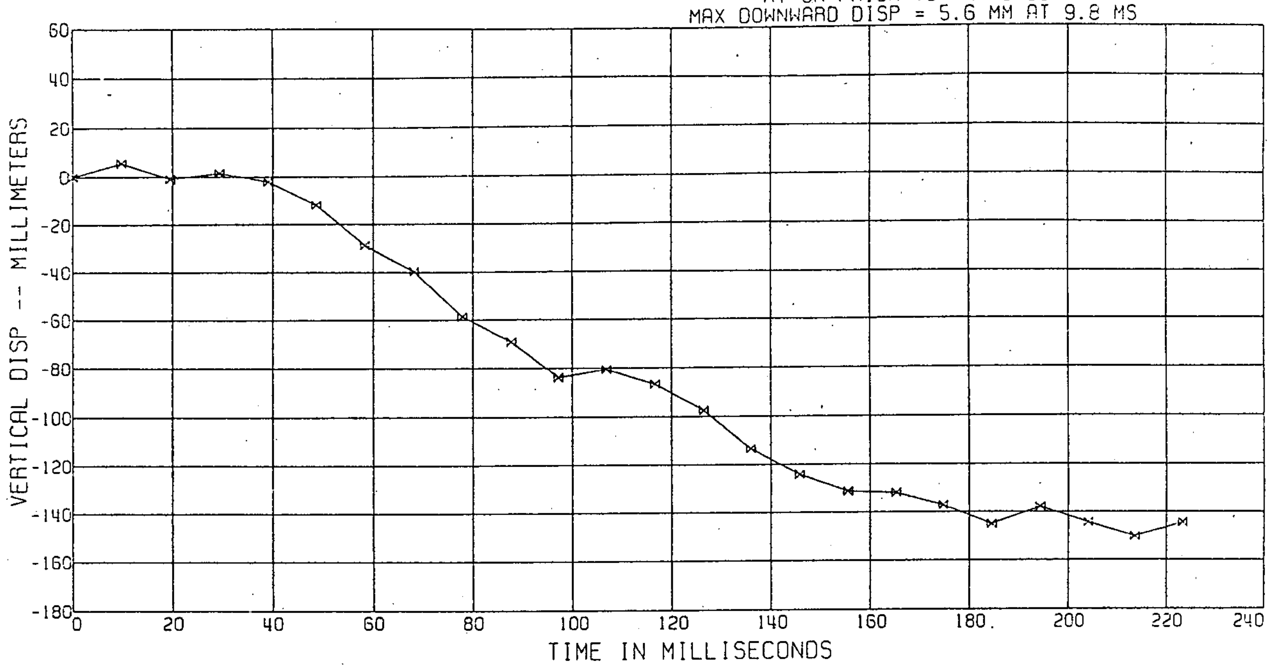
Appendix H, Plot **#4**

C12174 FRONT IMPACT
MOVING VEHICLE TO FIXED POLE 55.4KM/H
FIGURE

R&D CTR 8W91870 HONDA
FILM DATA
RIGHT SIDE
TEST DATE:09/16/98

VEHICLE DISPL RELATIVE TO GROUND REFERENCE

AT OR PRIOR TO MAX CRUSH
MAX DOWNWARD DISP = 5.6 MM AT 9.8 MS



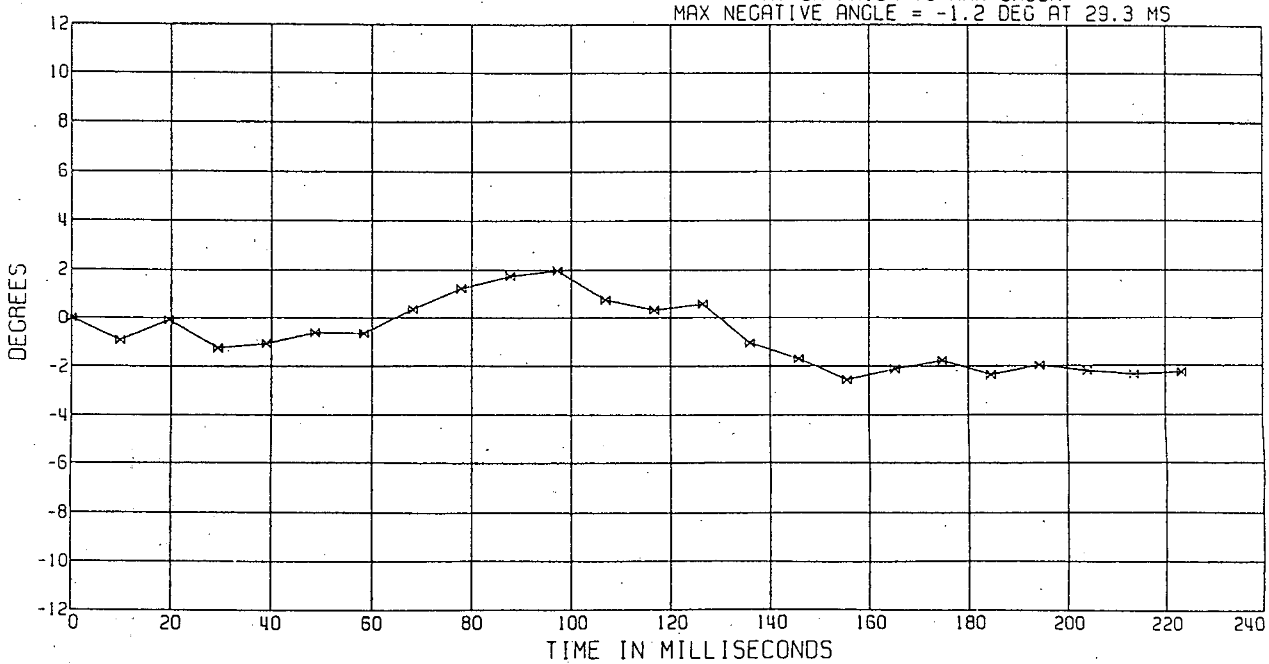
Appendix H, Plot #5

C12174 FRONT IMPACT
MOVING VEHICLE TO FIXED POLE 55.4KM/H
FIGURE

R&D CTR 8W91870 HONDA
FILM DATA
RIGHT SIDE
TEST DATE:09/16/98

VEHICLE PITCH RELATIVE TO GROUND REFERENCE

AT OR PRIOR TO MAX CRUSH
MAX NEGATIVE ANGLE = -1.2 DEG AT 29.3 MS



C12174 FRONT IMPACT — MOVING VEHICLE TO FIXED POLE 55.4KM/H — FIGURE

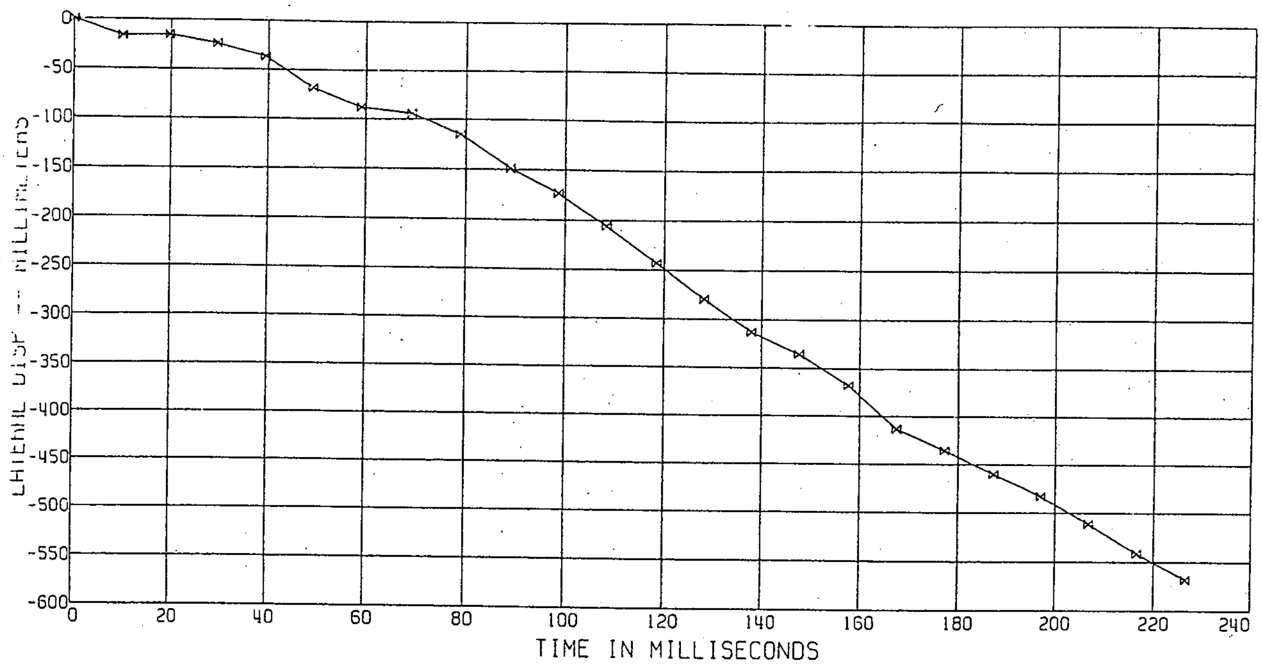
R&D CTR 8W91870 HONDA

FILM DATA

OVERHEAD VIEW

TEST DATE:09/16/98

VEHICLE DISPL RELATIVE TO POLE REFERENCE



Appendix H, Plot **#7**

C12174 FRONT IMPACT — MOVING VEHICLE TO FIXED POLE 55.4KM/H — FIGURE

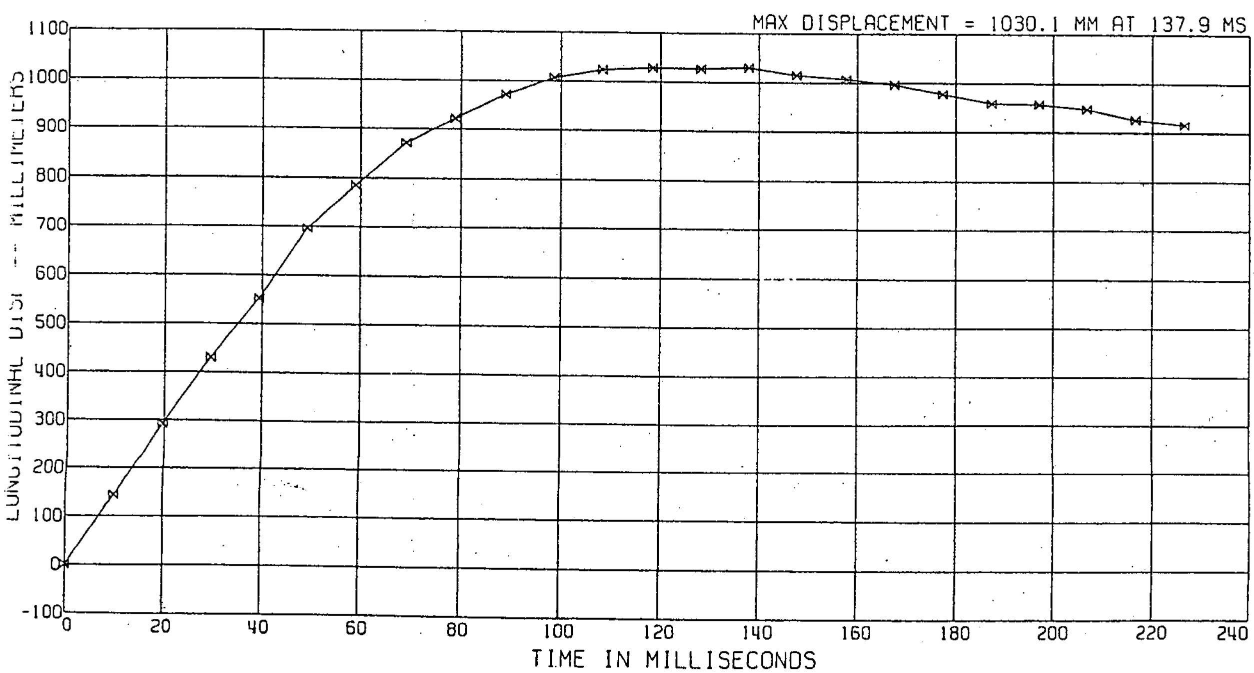
R&D CTR 8W91870 HONDA

FILM DATA

OVERHEAD VIEW

TEST DATE:09/16/98

VEHICLE DISPL RELATIVE TO POLE REFERENCE



Appendix H, Plot **#8**

Appendix I: Instrumentation Summaries

Standard ISF Printout

ISF as Tested

Test Number : C11990
Test Type : REAR IMPACT
Division :
Divisional Engineer :
Test Engineer :
Instrument Technician:
Test Technician :

ATD Usage:

Position	ID Number

Ref	DAS	Tran ID#	Req FS	P	Units	Position	Location	Component	Units	PrCd
1	G15	VOLTAGE.1	5	N	V	TIME ZERO			VOLTAGE, VOLTS	0011
2	G16	VOLTAGE.1	5	N	V	PHOTO TIMING			VOLTAGE, VOLTS	0021
3	D01	CJ50.1	200	N	G	L. FRT	HEAD	LONGITUDINAL	ACCEL, G'S	0031
4	D02	DA19.1	200	N	G	L. FRT	HEAD	LATERAL	ACCEL, G'S	0041
5	D03	CM80.1	200	N	G	L. FRT	HEAD	VERTICAL	ACCEL, G'S	0051
6	D04	CB16.1	200	R	G	L. FRT	CHEST	LONGITUDINAL	ACCEL, G'S	0062
7	D05	CB17.1	200	N	G	L. FRT	CHEST	LATERAL	ACCEL, G'S	0071
8	D06	CB18.1	200	R	G	L. FRT	CHEST	VERTICAL	ACCEL, G'S	0082
9	D10	P04N.1	6000	N	N	L. FRT	NECK	UAP SHEAR	LOAD, N'S	0091
10	D11	P04N.2	6000	N	N	L. FRT	NECK	URL SHEAR	LOAD, N'S	0101
11	D12	P04N.3	6000	N	N	L. FRT	NECK	UPPER AXIAL	LOAD, N'S	0111
12	D13	P04N.4	400	N	N-M	L. FRT	NECK	URL MOMENT	MOMENT, NM'S	0121
13	D14	P04N.5	400	N	N-M	L. FRT	NECK	UAP MOMENT	MOMENT, NM'S	0131
14	D15	P04N.6	400	N	N-M	L. FRT	NECK	ROT MOMENT	MOMENT, NM'S	0141
15	C01	CU98.1	200	N	G	R. FRT	HEAD	LONGITUDINAL	ACCEL, G'S	0151
16	C02	CT31.1	200	N	G	R. FRT	HEAD	LATERAL	ACCEL, G'S	0161
17	C03	CS92.1	200	N	G	R. FRT	HEAD	VERTICAL	ACCEL, G'S	0171
18	C04	FM76.1	200	R	G	R. FRT	CHEST	LONGITUDINAL	ACCEL, G'S	0182
19	C05	CF87.1	200	N	G	R. FRT	CHEST	LATERAL	ACCEL, G'S	0191
20	C06	AD339.1	200	R	G	R. FRT	CHEST	VERTICAL	ACCEL, G'S	0202
21	C10	P33N.1	6000	N	N	R. FRT	NECK	UAP SHEAR	LOAD, N'S	0211
22	C11	P33N.2	6000	N	N	R. FRT	NECK	URL SHEAR	LOAD, N'S	0221
23	C12	P33N.3	6000	N	N	R. FRT	NECK	UPPER AXIAL	LOAD, N'S	0231
24	C13	P33N.4	400	N	N-M	R. FRT	NECK	URL MOMENT	MOMENT, NM'S	0241
25	C14	P33N.5	400	N	N-M	R. FRT	NECK	UAP MOMENT	MOMENT, NM'S	0251
26	C15	P33N.6	400	N	N-M	R. FRT	NECK	ROT MOMENT	MOMENT, NM'S	0261
27	A01	J21211.1	450	R	G	L. FRT	ROCKER	LONGITUDINAL	ACCEL, G'S	0272
28	A02	J21210.1	450	N	G	L. FRT	ROCKER	LATERAL	ACCEL, G'S	0281
29	A03	J21212.1	450	R	G	L. FRT	ROCKER	VERTICAL	ACCEL, G'S	0292
30	A04	J20995.1	450	R	G	R. FRT	ROCKER	LONGITUDINAL	ACCEL, G'S	0302
31	A05	J20991.1	450	N	G	R. FRT	ROCKER	LATERAL	ACCEL, G'S	0311
32	A06	J20992.1	450	R	G	R. FRT	ROCKER	VERTICAL	ACCEL, G'S	0322

Date: 08-20-1998 Time: 14:19:45

Standard ISF Printout

ISF as tested

Test Number : C11990
Test Type : REAR IMPACT
Division :
Divisional Engineer :
Test Engineer :
Instrument Technician:
Test Technician :

Ref	DAS	Tran ID#	Req FS	P	Units	Position	Location	Component	Units	PrCd
65	E01	A98C.1	450	N	G		LTV MDB AT C.G.	LONGITUDINAL	ACCEL,G'S	0651
66	E02	AN3P2.1	450	R	G		LTV MDB AT C.G.	LATERAL	ACCEL,G'S	0662
67	E03	A58A.1	450	N	G		LTV MDB AT C.G.	VERTICAL	ACCEL,G'S	0671
68	E04	J12804.1	450	N	G		LTV MDB AT REAR C/MBR	LONGITUDINAL	ACCEL,G'S	0681
69	E05	J12812.1	450	R	G		LTV MDB AT REAR C/MBR	LATERAL	ACCEL,G'S	0692
70	E06	J12759.1	450	N	G		LTV MDB AT REAR C/MBR	VERTICAL	ACCEL,G'S	0701

Date: 08-20-1998 Time: 14:19:46

Standard ISF Printout

Test Number : C12127
Test Type : L. FRT IMPACT-240 DEG
Division J00131
Divisional Engineer
Test Engineer
Instrument Technici
Test Technician

ISF as tested

Ref	DAS	Tran ID#	Req FS	P	Units	Position	Location	Component	Units	PrCd
33	F18	P05KNR.1	7000	N	N	L. FRT	RIGHT KNEE	L. CLEVIS	LOAD,N'S	0331
34	F19	P05KNR.2	7000	N	N	L. FRT	RIGHT KNEE	R. CLEVIS	LOAD,N'S	0341
35	C01	P05STL.1	24	N	MM	L. FRT	TIBIA/FEMUR LEFT		DISP,MM'S	0351
36	C02	P05STR.1	24	N	MM	L. FRT	TIBIA/FEMUR RIGHT		DISP,MM'S	0361
37	E01	CM61.1	200	N	G	R. FRT	HEAD	LONGITUDINAL	ACCEL,G'S	0371
38	E02	CR33.1	200	N	G	R. FRT	HEAD	LATERAL	ACCEL,G'S	0381
39	E03	CX56.1	200	N	G	R. FRT	HEAD	VERTICAL	ACCEL,G'S	0391
40	E04	CR16.1	200	R	G	R. FRT	CHEST	LONGITUDINAL	ACCEL,G'S	0402
41	E05	CR99.1	200	N	G	R. FRT	CHEST	LATERAL	ACCEL,G'S	0411
42	E06	CT22.1	200	R	G	R. FRT	CHEST	VERTICAL	ACCEL,G'S	0422
43	E07	A46A.1	200	N	G	R. FRT	PELVIC	LONGITUDINAL	ACCEL,G'S	0431
44	E08	CT26.1	200	N	G	R. FRT	PELVIC	LATERAL	ACCEL,G'S	0441
45	E09	CV46.1	200	N	G	R. FRT	PELVIC	VERTICAL	ACCEL,G'S	0451
46	E20	P51L.1	14000	N	N	R. FRT	FEMUR	LEFT	LOAD,N'S	0461
47	E21	P51R.1	14000	N	N	R. FRT	FEMUR	RIGHT	LOAD,N'S	0471
48	E22	P51D.1	80	N	MM	R. FRT	CHEST	LONGITUDINAL	DISPL,MM'S	0481
49	E10	P51N.1	6000	N	N	R. FRT	NECK	UAP SHEAR	LOAD,N'S	0491
50	E11	P51N.2	6000	N	N	R. FRT	NECK	URL SHEAR	LOAD,N'S	0501
51	E12	P51N.3	6000	N	N	R. FRT	NECK	UPPER AXIAL	LOAD,N'S	0511
52	E13	P51N.4	400	N	N-M	R. FRT	NECK	URL MOMENT	MOMENT,NM'S	0521
53	E14	P51N.5	400	N	N-M	R. FRT	NECK	UAP MOMENT	MOMENT,NM'S	0531
54	E15	P51N.6	400	N	N-M	R. FRT	NECK	ROT MOMENT	MOMENT,NM'S	0541
55	E23	P51TUL.1	400	N	N-M	R. FRT	LEFT TIBIA	URL MOMENT	MOMENT,NM'S	0551
56	E24	P51TUL.2	400	N	N-M	R. FRT	LEFT TIBIA	UAP MOMENT	MOMENT,NM'S	0561
57	E25	P51TLL.1	400	N	N-M	R. FRT	LEFT TIBIA	LAP MOMENT	MOMENT,NM'S	0571
58	E26	P51TLL.2	10000	N	N	R. FRT	LEFT TIBIA	LAP SHEAR	LOAD,N'S	0581
59	E27	P51TUL.3	8000	N	N	R. FRT	LEFT TIBIA	LOWER AXIAL	LOAD,N'S	0591
60	E16	P51KNL.1	7000	N	N	R. FRT	LEFT KNEE	L. CLEVIS	LOAD,N'S	0601
61	E17	P51KNL.2	7000	N	N	R. FRT	LEFT KNEE	R. CLEVIS	LOAD,N'S	0611
62	E28	P51TUR.1	400	N	N-M	R. FRT	RIGHT TIBIA	URL MOMENT	MOMENT,NM'S	0621
63	E29	P51TUR.2	400	N	N-M	R. FRT	RIGHT TIBIA	UAP MOMENT	MOMENT,NM'S	0631
64	E30	P51TLR.1	400	N	N-M	R. FRT	RIGHT TIBIA	LAP MOMENT	MOMENT,NM'S	0641

Date: 08-20-1998 Time: 14:16:22

Standard ISF Printout

Test Number : C12127
Test Type : L. FRT IMPACT-240 DEG
Division 0131
Divisional Engineer
Test Engineer
Instrument Technician
Test Technician

ISF as tested

Ref	DAS	Tran ID#	Req FS	P	Units	Position	Location	Component	Units	PrCd
97	C26	J17396.1	450	R	G	R. REAR	ROCKER	LONGITUDINAL	ACCEL,G'S	0972
98	C27	J18311.1	450	R	G	R. REAR	ROCKER	LATERAL	ACCEL,G'S	0982
99	C28	J18319.1	450	N	G	R. REAR	ROCKER	VERTICAL	ACCEL,G'S	0991
100	C29	SR65.1	350	N	MM	L.	TOE PAN	LONGITUDINAL	DISPL,MM'S	1001
101	B01	VOLTCOND.1	20	N	V		IGNITION FEED		VOLTAGE,VOLTS	1011
102	B02	VOLTCOND.1	20	N	V	R.	BATTERY		VOLTAGE,VOLTS	1021
103	B03	VOLTCOND.1	20	N	V		STARTER		VOLTAGE,VOLTS	1031
104	B04	VOLTCOND.1	20	N	V	L. FRT	HI BEAM-GROUND		VOLTAGE,VOLTS	1041
105	B05	VOLTCOND.1	20	N	V		FUEL PUMP		VOLTAGE,VOLTS	1051
106	B06	VOLTAGE.1	8	N	V		ENGINE RPM		VOLTAGE,VOLTS	1061
107	B07	VOLTAGE.1	8	N	V	L.	FUEL RAIL SENSOR #1		VOLTAGE,VOLTS	1071
108	B08	VOLTAGE.1	8	N	V	R.	FUEL RAIL SENSOR #2		VOLTAGE,VOLTS	1081
109	B09	VOLTAGE.1	8	N	V	L.	MANIFOLD SHIELD SENSOR #3		VOLTAGE,VOLTS	1091
110	B10	VOLTAGE.1	8	N	V	R.	MANIFOLD SHIELD SENSOR #4		VOLTAGE,VOLTS	1101
111	B11	VOLTAGE.1	8	N	V	CATALYTIC CONVE	SENSOR #5		VOLTAGE,VOLTS	1111
112	B12	VOLTAGE.1	8	N	V	MANIFOLD	DROPPED FROM TEST PER CUST REQUEST	07-28-98	VOLTAGE,VOLTS	1121
113	B13	VOLTAGE.1	8	N	V		OPTICAL DISC SENSOR # 1		VOLTAGE,VOLTS	1131
114	B14	VOLTAGE.1	8	N	V		OPTICAL DISC SENSOR # 2		VOLTAGE,VOLTS	1141
115	B15	CP119.1	10	N	A		WHEEL BAG		CURRENT,AMPS	1151
116	B16	CP191.1	10	N	A		I/P BAG		CURRENT,AMPS	1161
117	B17	CP150.1	20	N	A		IGNITION FEED		CURRENT,AMPS	1171
118	B18	CP108.1	20	N	A		FUEL PUMP		CURRENT,AMPS	1181
119	B19	CP185.1	10	N	A		AC CLUTCH		CURRENT,AMPS	1191
120	B20	CP180.1	20	N	A	L. FRT	HEADLIGHT HI BEAM		CURRENT,AMPS	1201
121	B21	CP240.1	20	N	A	R. FRT	HEADLIGHT HI BEAM		CURRENT,AMPS	1211
122	C30	CG104.1	100	N	A		ALTERNATOR CABLE		CURRENT,AMPS	1221
123	B23	CP109.1	20	N	A	L.	CONDENSOR FAN		CURRENT,AMPS	1231
124	B24	CP190.1	20	N	A	R.	RADIATOR FAN		CURRENT,AMPS	1241
125	B25	CG202.1	500	N	A		STARTER CABLE		CURRENT,AMPS	1251
126	B26	CP110.1	20	N	A		HVAC BLOWER		CURRENT,AMPS	1261
127	B27	CG201.1	500	N	A		BATTERY		CURRENT,AMPS	1271
128	B28	10407.1	5000	N	KPA	L. FRT	BRAKE SYSTEM		PRESSURE,KPA'S	1281

Date: 08-20-1998 Time: 14:16:25

Standard ISF Printout

Test Number : C12174
Test Type : CENTER HIGH POLE
Division :
Divisional Engineer :
Test Engineer :
Instrument Technician:
Test Technician :

ISF as Tested

ATD Usage:

Position	ID Number

Ref	DAS	Tran ID#	Req FS	P	Units	Position	Location	Component	Units	PrCd
1	G15	VOLTAGE.1	5	N	V	TIME ZERO			VOLTAGE,VOLTS	0011
2	G16	VOLTAGE.1	5	N	V	PHOTO TIMING			VOLTAGE,VOLTS	0021
3	D01	CM07.1	200	N	G	L. FRT	HEAD	LONGITUDINAL	ACCEL,G'S	0031
4	D02	CR81.1	200	N	G	L. FRT	HEAD	LATERAL	ACCEL,G'S	0041
5	D03	CR45.1	200	N	G	L. FRT	HEAD	VERTICAL	ACCEL,G'S	0051
6	D04	AA23.1	200	R	G	L. FRT	CHEST	LONGITUDINAL	ACCEL,G'S	0062
7	D05	AA34.1	200	N	G	L. FRT	CHEST	LATERAL	ACCEL,G'S	0071
8	D06	AA63.1	200	R	G	L. FRT	CHEST	VERTICAL	ACCEL,G'S	0082
9	D07	CF70.1	400	N	G	L. FRT	PELVIC	LONGITUDINAL	ACCEL,G'S	0091
10	D08	CE63.1	400	N	G	L. FRT	PELVIC	LATERAL	ACCEL,G'S	0101
11	D09	CE38.1	400	N	G	L. FRT	PELVIC	VERTICAL	ACCEL,G'S	0111
12	D20	P09L.1	14000	N	N	L. FRT	FEMUR	LEFT	LOAD,N'S	0121
13	D21	P09R.1	14000	N	N	L. FRT	FEMUR	RIGHT	LOAD,N'S	0131
14	D22	P09D.1	80	N	MM	L. FRT	CHEST	LONGITUDINAL	DISPL,MM'S	0141
15	D10	P09N.1	6000	N	N	L. FRT	NECK	UAP SHEAR	LOAD,N'S	0151
16	D11	P09N.2	6000	N	N	L. FRT	NECK	URL SHEAR	LOAD,N'S	0161
17	D12	P09N.3	6000	N	N	L. FRT	NECK	UPPER AXIAL	LOAD,N'S	0171
18	D13	P09N.4	400	N	N-M	L. FRT	NECK	URL MOMENT	MOMENT,NM'S	0181
19	D14	P09N.5	400	N	N-M	L. FRT	NECK	UAP MOMENT	MOMENT,NM'S	0191
20	D15	P09N.6	400	N	N-M	L. FRT	NECK	ROT MOMENT	MOMENT,NM'S	0201
21	D23	P09TUL.1	400	N	N-M	L. FRT	LEFT TIBIA	URL MOMENT	MOMENT,NM'S	0211
22	D24	P09TUL.2	400	N	N-M	L. FRT	LEFT TIBIA	UAP MOMENT	MOMENT,NM'S	0221
23	D25	P09TLL.1	400	N	N-M	L. FRT	LEFT TIBIA	LAP MOMENT	MOMENT,NM'S	0231
24	D26	P09TLL.2	10000	N	N	L. FRT	LEFT TIBIA	LAP SHEAR	LOAD,N'S	0241
25	D27	P09TLL.3	8000	N	N	L. FRT	LEFT TIBIA	LOWER AXIAL	LOAD,N'S	0251
26	D16	P09KNL.1	7000	N	N	L. FRT	LEFT KNEE	L. CLEVIS	LOAD,N'S	0261
27	D17	P09KNL.2	7000	N	N	L. FRT	LEFT KNEE	R. CLEVIS	LOAD,N'S	0271
28	D28	P09TUR.1	400	N	N-M	L. FRT	RIGHT TIBIA	URL MOMENT	MOMENT,NM'S	0281
29	D29	P09TUR.2	400	N	N-M	L. FRT	RIGHT TIBIA	UAP MOMENT	MOMENT,NM'S	0291
30	D30	P09TLR.1	400	N	N-M	L. FRT	RIGHT TIBIA	LAP MOMENT	MOMENT,NM'S	0301
31	D31	P09TLR.2	10000	N	N	L. FRT	RIGHT TIBIA	LAP SHEAR	LOAD,N'S	0311
32	D32	P09TLR.3	8000	N	N	L. FRT	RIGHT TIBIA	LOWER AXIAL	LOAD,N'S	0321

Date: 09-18-2000 Time: 15:24:00

Standard ISF Printout

Test Number : C12174
Test Type : CENTER HIGH POLE
Division
Divisional Engineer
Test Engineer
Instrument Technicia
Test Technician

ISF as Tested

Ref	DAS	Tran ID#	Req FS	P	Units	Position	Location	Component	Units	PrCd
65	E31	P40TLR.2	10000	N	N	R. FRT	RIGHT TIBIA	LAP SHEAR	LOAD,N'S	0651
66	E32	P40TUR.3	8000	N	N	R. FRT	RIGHT TIBIA	LOWER AXIAL	LOAD,N'S	0661
67	E18	P40KNR.1	7000	N	N	R. FRT	RIGHT KNEE	L. CLEVIS	LOAD,N'S	0671
68	E19	P40KNR.2	7000	N	N	R. FRT	RIGHT KNEE	R. CLEVIS	LOAD,N'S	0681
69	C01	P40STL.1	24	N	MM	R. FRT	TIBIA/FEMUR LEFT		DISP,MM'S	0691
70	C02	P40STR.1	24	N	MM	R. FRT	TIBIA/FEMUR RIGHT		DISP,MM'S	0701
71	A03	P09LS.1	700	N	N-M	L. FRT	LOWER LUMBAR	MY-LAT. AXIS	MOMENT,NM'S	0711
72	A04	P09LS.2	10000	N	N	L. FRT	LOWER LUMBAR	FX-FORE/AFT	LOAD,N'S	0721
73	A05	P09LS.3	6000	N	N	L. FRT	LOWER LUMBAR	FZ-AXIAL	LOAD,N'S	0731
74	C03	P40LS.1	700	N	N-M	R. FRT	LOWER LUMBAR	MY-LAT. AXIS	MOMENT,NM'S	0741
75	C04	P40LS.2	10000	N	N	R. FRT	LOWER LUMBAR	FX-FORE/AFT	LOAD,N'S	0751
76	C05	P40LS.3	6000	N	N	R. FRT	LOWER LUMBAR	FZ-AXIAL	LOAD,N'S	0761
77	C06	P40TUL.4	10000	N	N	R. FRT	LEFT TIBIA	TUL FX	LOAD,N'S	0771
78	C07	P40TLL.3	10000	N	N	R. FRT	LEFT TIBIA	TLL FY	LOAD,N'S	0781
79	C08	P40TLL.4	400	N	N-M	R. FRT	LEFT TIBIA	TLL MX	MOMENT,NM'S	0791
80	C09	P40TUR.4	10000	N	N	R. FRT	RIGHT TIBIA	TUR FX	LOAD,N'S	0801
81	C10	P40TLR.3	10000	N	N	R. FRT	RIGHT TIBIA	TLR FY	LOAD,N'S	0811
82	C11	P40TLR.4	400	N	N-M	R. FRT	RIGHT TIBIA	TLR MX	MOMENT,NM'S	0821
83	A06	APA95.1	500	R	G	CTR	TUNNEL AT SDM	LONGITUDINAL	ACCEL,G'S	0832
84	A07	APAT1.1	500	N	G	CTR	TUNNEL AT SDM	LATERAL	ACCEL,G'S	0841
85	A08	J13536.1	500	N	G	CTR	TUNNEL AT SDM	VERTICAL	ACCEL,G'S	0851
86	A09	J22644.1	750	R	G	L. FRT	ROCKER	LONGITUDINAL	ACCEL,G'S	0862
87	A10	J22643.1	750	R	G	L. FRT	ROCKER	LATERAL	ACCEL,G'S	0872
88	A11	J22645.1	750	R	G	L. FRT	ROCKER	VERTICAL	ACCEL,G'S	0882
89	A12	J22691.1	750	R	G	R. FRT	ROCKER	LONGITUDINAL	ACCEL,G'S	0892
90	A13	J22693.1	750	R	G	R. FRT	ROCKER	LATERAL	ACCEL,G'S	0902
91	A14	J22692.1	750	R	G	R. FRT	ROCKER	VERTICAL	ACCEL,G'S	0912
92	A15	J18421.1	750	R	G	L.	FLOORPAN	LONGITUDINAL	ACCEL,G'S	0922
93	A16	J20333.1	750	R	G	R.	FLOORPAN	LONGITUDINAL	ACCEL,G'S	0932
94	A17	J22726.1	750	R	G	L. REAR	ROCKER	LONGITUDINAL	ACCEL,G'S	0942
95	A18	J22714.1	750	R	G	L. REAR	ROCKER	LATERAL	ACCEL,G'S	0952
96	A19	J22801.1	750	R	G	L. REAR	ROCKER	VERTICAL	ACCEL,G'S	0962

Date: 09-18-2000 Time: 15:24:00

Standard ISF Printout

Test Number : C12174
Test Type : CENTER HIGH POLE
Division :
Divisional Engineer :
Test Engineer :
Instrument Technician:
Test Technician :

ISF as Tested

Ref	DAS	Tran ID#	Req FS	P	Units	Position	Location	Component	Units	PrCd
129	C20	10165.1	500	N	KPA		FUEL SUPPLY LINE		PRESSURE,KPA'S	1291
130	C21	10481.1	14000	N	KPA	L. FRT	BRAKE		PRESSURE,KPA'S	1301
131	C22	AJ3G6.1	14000	N	KPA	R. FRT	BRAKE		PRESSURE,KPA'S	1311
132	C23	CONTACT.1	8	N	V		THERMAL WIRE		CONTACT,N/O	1321

Date: 09-18-2000 Time: 15:24:01