5.1 - D0T00158
5.2 - D0T00159
5.3 - D0T00041

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TASK 5 REPORT OF TESTS 5.1, 5.2, AND 5.3 FOR DEVELOPMENT OF COMPLIANCE TEST FOR TRUCK REAR UNDERRIDE PROTECTION

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November 1978

INTERIM REPORT

Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

Prepared for:

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
WASHINGTON, D.C. 20590

Prepared for the Department of Transportation, National Highway Traffic Safety Administration under Contract No. DOT-HS-8-01905. The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
TASK 5 REPORT OF TESTS 5.1, 5.2, AND 5.3 FOR DEVELOPMENT OF COMPLIANCE TEST FOR TRUCK REAR UNDERRIDE PROTECTION	November 1978
	6. Performing Orgn Code
7. Author(s) Baczynski, R., Davis, S., Cropper R.	8. Performing Orgn Rpt No. 8319-78-193A
9. Performing Organization Name and Address Dynamic Science, Inc. A Talley Industries Company 1850 West Pinnacle Peak Road Phoenix, Arizona 85027	10. Work Unit No. 11. Contract or Grant No. DOT-HS-8-01905
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590	13. Type of Report and Period Covered INTERIM REPORT Oct. - Nov. 1978 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report presents the results of the first three of eight passenger car-to-rear underride crash tests conducted in accordance with the requirements of Task 5 of the "Development of Compliance Test for Truck Rear Underride Protection" program. The test vehicles selected for these tests were 1978 VW Rabbits and a 1978 Ford Fiesta. These vehicles were impacted into bolt-on, rigid, cantilevered guards mounted to a truck/trailer body simulator at selected heights above ground level. The trailer body simulator used for the tests is a modified, 1977 Fruehauf, 40-foot, heavy duty platform trailer with Select-A-Point tandem rear wheels. For these three tests, two instrumented 50th percentile Part 572 anthropomorphic dummies were placed in the driver and front passenger positions in the car. The occupants were restrained with the vehicle's restraint system. The seat tracks were welded in the midposition to prevent breakaway and/or rotation.

17. Key Words	18. Distribution Statement
Underride Guard, Crash Tests	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. Pages	22. Price
Unclassified	Unclassified	159	

Form DOT F 1700.7 (8-69)

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1.0 INTRODUCTION

This report presents the results of the first three passenger car-to-rear truck underride guard crash tests conducted in accordance with the requirements of Task 5 of the "Development of Compliance Test for Truck Rear Underride Protection" program. This program is conducted for the Department of Transportation, National Highway Traffic Safety Administration, under Contract No. DOT-HS-01905. The test vehicles for tests 5.1 and 5.3 were 1978 Volkswagen Rabbit four-door sedans. For test 5.2, a 1978 Ford Fiesta two-door sedan was used. These vehicles were impacted into a bolt-on, rigid, cantilevered underride guard mounted to a truck/trailer body simulator. The test matrix and summary of the test conditions for the tests in Task 5 are summarized in Table 1-1. The trailer body simulator used for these tests is a modified, 1977 Fruehauf, 40-foot, heavy duty platform with Select-A-Point tandem rear wheels.

For these tests, two Part 572 instrumented dummies (GFE) were positioned in the left and right front occupant positions in the car. Each occupant was properly restrained with the vehicle's restraint system. The seat tracks were welded in their mid-position to prevent breakaway and/or rotation.

1.1 TEST OBJECTIVES

The object of these tests was to obtain the necessary data for establishing appropriate criteria for development of compliance test parameters and procedures for truck-trailer rear underride protection. The specific object in Task 5 is to test selected new guard designs as to their effectiveness in rear underride collisions with current production full- and small-size passenger cars, and to provide a basis for selecting the best underride guard with regard to critical parameters (geometric design, strength, energy absorbing capabilities, economic and environmental factors).

TABLE 1-1. TASK 5 CRASH TEST MATRIX

Test No.	Test Date	Struck Object	Bullet Vehicle	Impact Velocity (mph)	Engagement With Guard
5.1	9/07/78	Guard B* 24" Height	1978 Volkswagen Rabbit 4-Door Sedan	40.43	Symmetric
5.2	10/03/78	Guard B* 22" Height	1978 Ford Fiesta 2-Door Sedan	40.64	Symmetric
5.3	10/26/78	DSI T-1(A) Guard 20" Height	1978 Volkswagen Rabbit 4-Door Sedan	40.44	Symmetric
5.4		DSI T-1 Guard 24" Height	1978 Chevrolet Impala 4-Door Sedan	40	Symmetric
5.5		DSI T-1 Guard 24" Height	1978 Chevrolet Impala 4-Door Sedan	40	Offset
5.6		DSI T-1 Guard 22" Height	1978 Chevrolet Impala 4-Door Sedan	40	Symmetric
5.7		DSI T-1 Guard 22" Height	1978 Chevrolet Impala 4-Door Sedan	40	Offset
5.8		DSI T-1 Guard 22" Height	1978 Volkswagen Rabbit 2-Door Sedan	40	Offset

*Guard B is the Fruehauf Guard, used for Task 3 and Task 4, modified to provide greater rigidity and proper height.

11/01/78

2.0 TEST METHODOLOGY

Three vehicle-to-truck rear underride guard tests were conducted at the barrier impact facility. The trailer body simulator developed in Task 3 was utilized for mounting of the selected underride guard in these tests (see Figure 2-1). For all tests, the selected test underride guard was mounted to the trailer body simulator. The layout drawing of the test vehicle and trailer simulator arrangement for these tests is shown in Figure 2-2.

The three tests were conducted with symmetric engagement between the vehicle and guard, i.e., with the trailer and vehicle longitudinal centerline coincident (see Figure 2-3).

To prevent damage to the trailer undercarriage in the event of excessive underride by the test vehicle, a steel plate was mounted just aft of the rear wheels, supported on pivot pins from the trailer main I-beams. The plate was backed up by the tandem wheel tires. The face of the impact plate was covered with honeycomb material to absorb the energy of the vehicle impact.

The vehicle impact velocity (see Table 1-1) was controlled to within ± 1 mph. The test vehicle was prepared in accordance with the requirements of the test plan. It was then placed at the head of the test track facing the barrier where it was attached to the tow and guidance system. The trailer body simulator was prepared in accordance with the requirements of the test plan. Upon completion of the pre-crash checkout of the instrumentation, the vehicle was towed to the specified test speed and released from the tow system just prior to impact. The data from the test vehicle was transmitted to the data acquisition center via umbilical cable with telemetry as a backup. The data from the trailer body simulator was transmitted by umbilical cable only (see Figure 2-4).

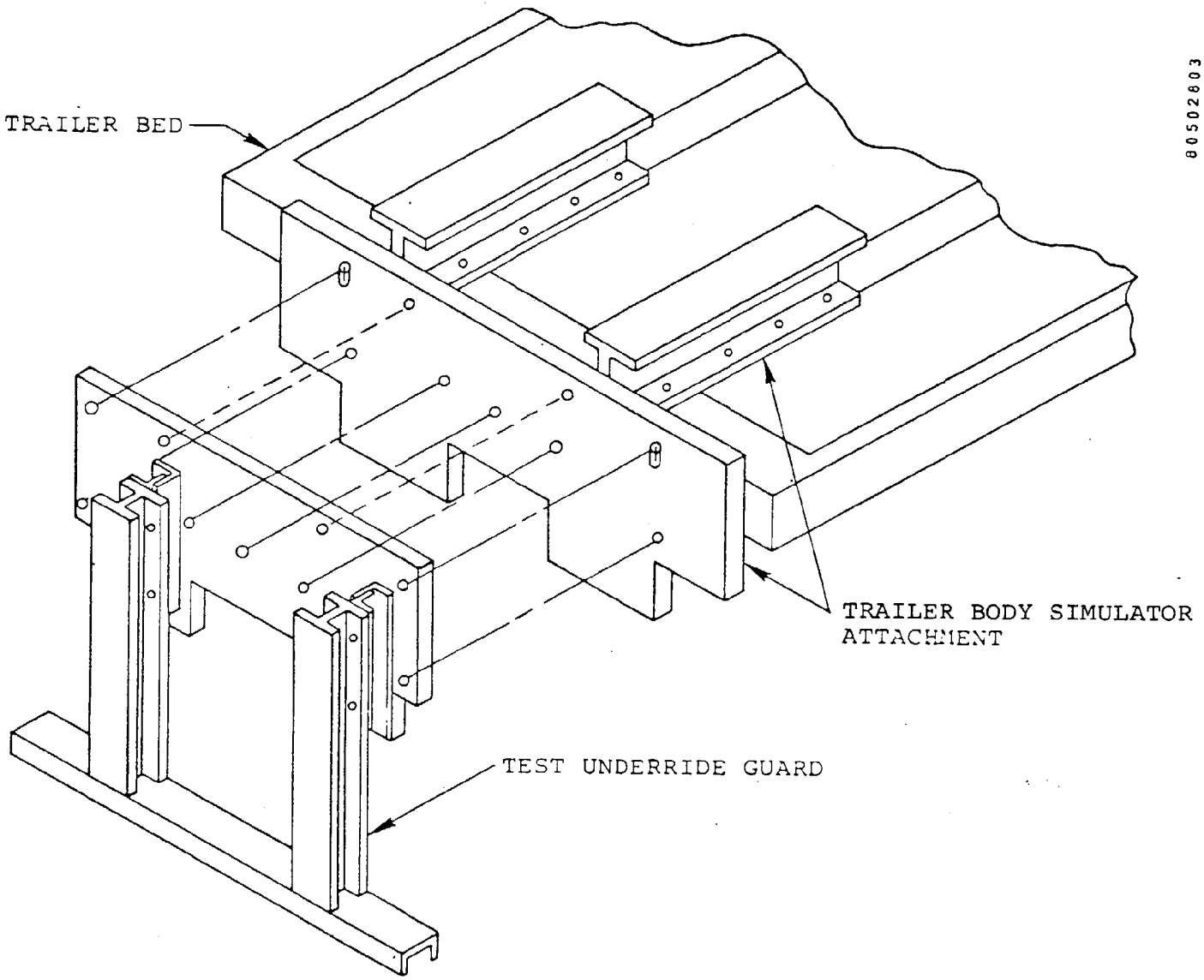


Figure 2-1. Trailer Body Simulator Interface for Guard B.

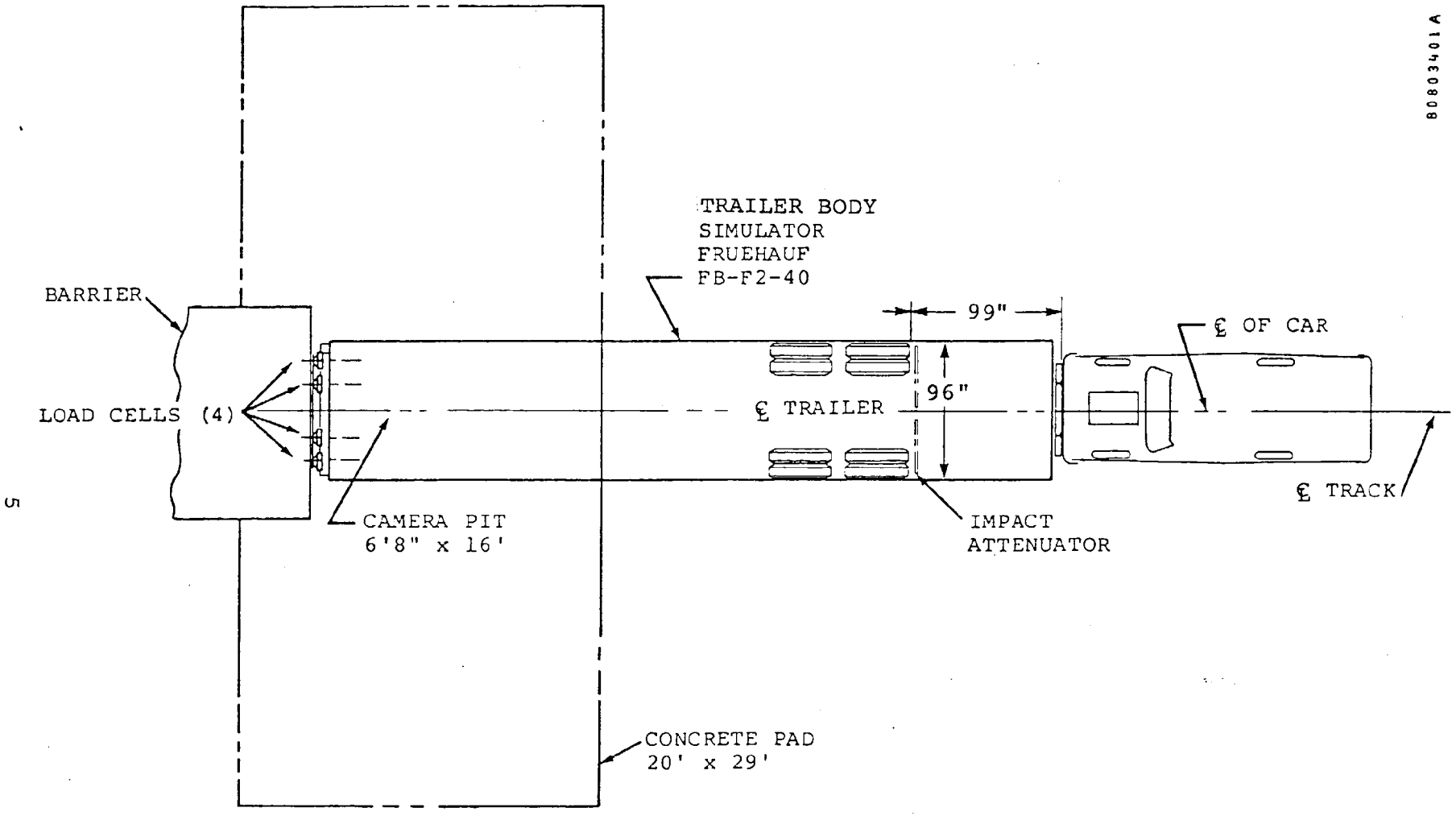


Figure 2-2. Symmetric Underride Guard Test Site.

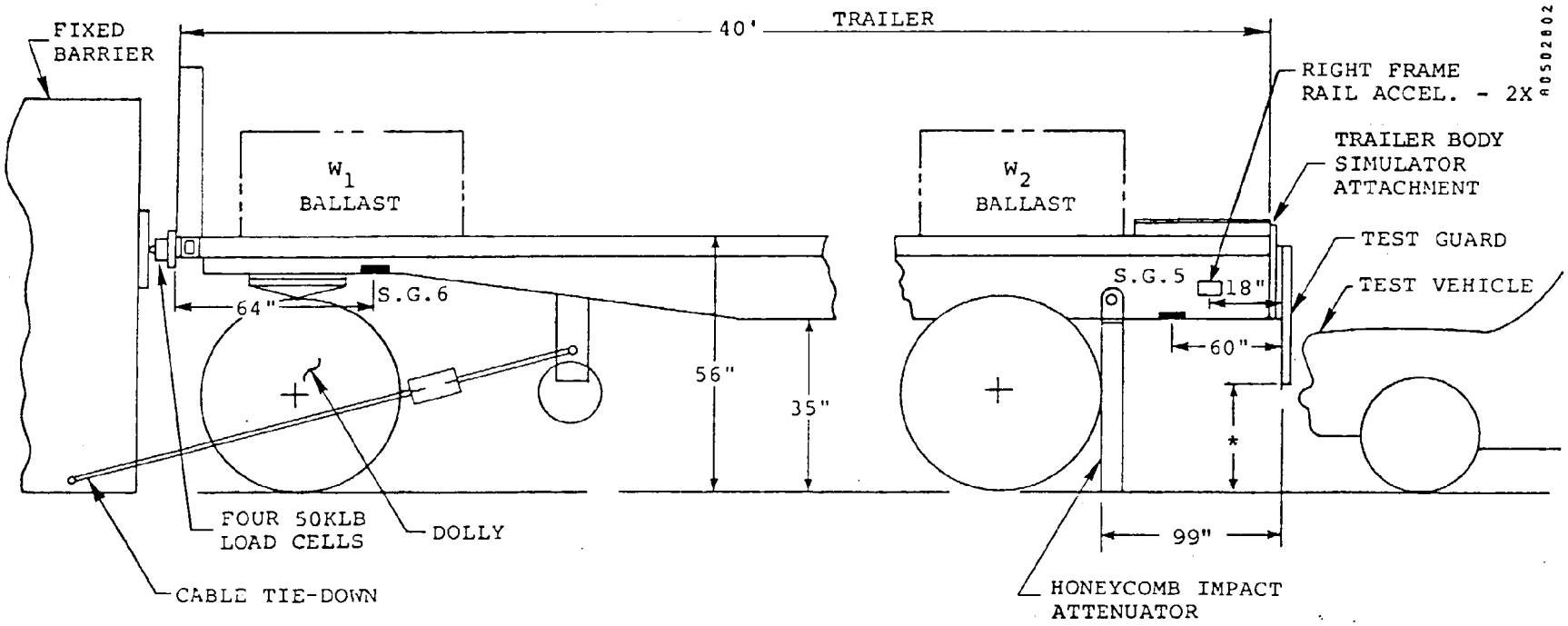


Figure 2-3. Task 5 Trailer Body Simulator Test Site Layout.

*See Table 1-1, Test Matrix.

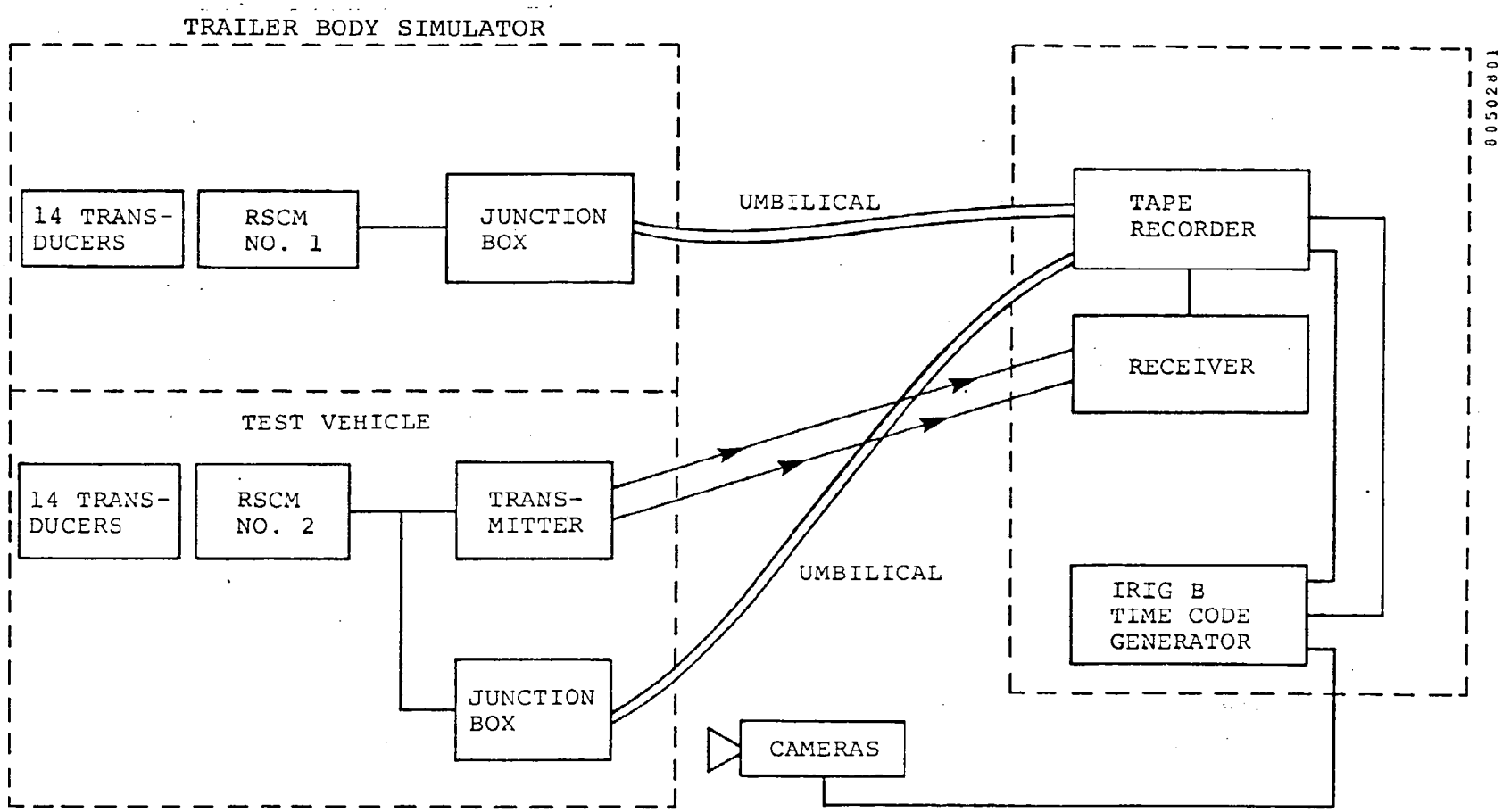


Figure 2-4. Data Acquisition - Vehicle-to-Truck Underride Simulator.

2.1 DATA ACQUISITION METHODS

The overall plan for obtaining the necessary data is outlined in Table 2-1. The table defines the test parameter, measurement method, and recording method used during conduct of these tests.

TABLE 2-1. DATA REQUIREMENTS

Test Parameter	Measurement Method	Magnetic Tape	Written Log	Photographic Analysis
Impact Time	Contact switch signal impressed on millisecond time base	X		
Approach Velocity	Tow cable velocity sensor	X		
Impact Velocity	Speed trap entrance and exit signals from speed trap	X*		
Rebound Velocity	Calculated from high-speed film analysis	X		X
Vehicle Acceleration Measurements	Accelerometers, unbound strain gauge type	X		
Underride Guard Structural Deformation	String potentiometer and direct linear measurement	X	X	
Stress in Underride Guard	Strain gauges	X		
Forces on Struck Body Simulator - Fixed Barrier Interface	Load cells	X		
Vehicle Structural Deformation	Direct linear measurement		X	
Vehicle Static Crush	Direct linear measurements		X	
Vehicle Dynamic Crush	Film analysis			X
Vehicle Underride Distance	Direct linear measurement and high-speed film analysis		X	X

*Velocity is also measured by electronic counter.

TABLE 2-1. DATA REQUIREMENTS (CONTD)

Test Parameter	Measurement Method	Magnetic Tape	Written Log	Photographic Analysis
Occupant Compartment Intrusion	Direct linear measurement and high-speed film analysis		X	X
Occupant Dynamic Displacement	High-speed film analysis			X
Vehicle Weight by Wheel	Direct pre-test measurement using balance scales		X	
Ballast Weight	Balance scale		X	

3.0 DATA ACQUISITION

3.1 INSTRUMENTATION

3.1.1 Test Vehicle Instrumentation

The test vehicle has a 50th percentile restrained dummy positioned in the driver and front passenger location. Twelve structural accelerometers were installed on the vehicle and consisted of the following (see Figure 3-1):

1. A biaxial (X, Y) mount located on the left rocker panel near the "B" pillar to measure accelerations of the occupant compartment.

2. A single (X) mount similar to No. 1, but on the right side of the vehicle.

3. A biaxial mount (X, Y) located on the rear floor structure over the rear axle.

4. A biaxial mount (X, Y) located on the upper centerline of the firewall in the engine compartment to measure acceleration of the forward section of the passenger compartment.

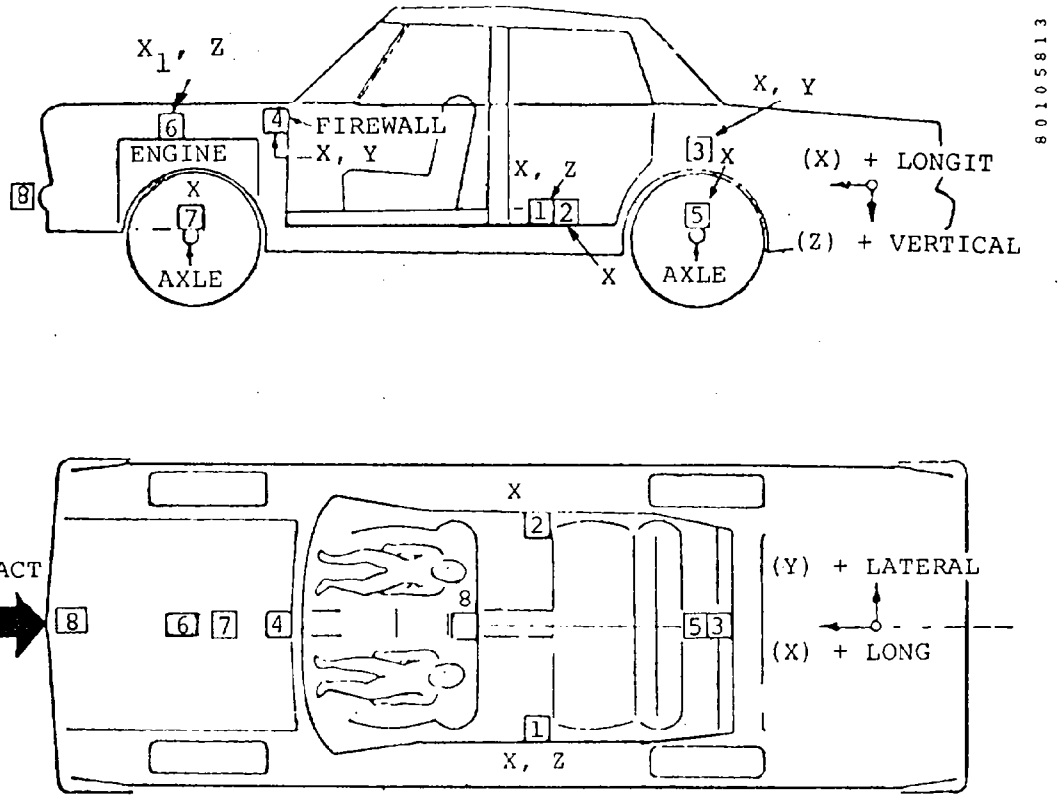
5. A single mount (X) located on the centerline of the rear axle to measure acceleration of the rear drive train and rear suspension assembly.

6. A biaxial mount (X, Y) located on the top of the engine block in a protective case to measure acceleration of the engine.

7. A single mount (X) located on the front frame cross-member in a protective case to measure axial acceleration of the front frame.

8. Two tape switches were mounted on the initial contact point of the car to record impact. The tape switches were installed in parallel, to provide redundancy of data.

The instrumentation requirements for the test vehicle are given in Figure 3-1.



NO.	VEHICLE ACCELEROMETER LOCATIONS AND PHYSICAL COORDINATES DESCRIPTION OF LOCATION	X**	Y**	Z**	MAXIMUM EXPECTED READINGS LONG*	LAT*	VERT*
1	Rocker panel near B-pillar behind driver's seat	92.5	22.5	-3.5	50	50	
2	Rocker panel near B-pillar behind passenger's seat	92.5	22.5	-3.5	50		
3	℄ of rear deck above rear axle	123.5	15.5	9.0	50	50	
4	℄ of firewall at A-pillar inside passenger compartment	40.5	9.5	10.5	100	100	
5	℄ of rear axle	114.0	4.0	-1.0	100		
6	Engine block (Top ℄) - longitudinal and vertical	32.5	2.0	-2.5	200		200
7	Front crossmember	13.0	13.0	8.0	200		
8	2 impact switches						

*G

**Reference points (for 1978 VW Rabbit):
X - Direction - Centerline of front bumper
Y - Direction - Centerline of vehicle
Z - Direction - Top of driver rocker sill.

Figure 3-1. Accelerometer Locations.

3.1.2 Trailer Body Simulator Instrumentation

The instrumentation on the trailer body simulator was the same for three tests. Figures 2-2 and 3-2 show the location of the instrumentation on the trailer body simulator and on the guard for symmetric engagement of underride guard. The instrumentation purposes and locations were as follows:

1. Three strain gauges on Tests 5.1 through 5.3 were mounted on selected points of interest of the underride guard to measure strains developed in the structure due to the impact forces.
2. Three string potentiometer displacement transducers mounted on the trailer simulator structure to measure relative displacement of the lower section of the underride guard.
3. Four load cells mounted on the front face of the trailer platform in contact with the face of the fixed barrier to measure dynamic impact forces of the test.
4. One longitudinal accelerometer mounted on the web of the right main frame I-beams of the trailer to measure acceleration of the trailer.
5. On Tests 5.1 through 5.3, two strain gauges were mounted on the lower flange of the right main frame rail of the trailer (fore and aft) to measure strains at various points in the truck body simulator during the crash.
6. Two tape contact switches mounted on the initial contact points of the impact. The switches were connected in parallel to provide redundancy of data.

3.2 PHOTOGRAPHY REQUIREMENTS

3.2.1 Vehicle-to-Trailer Body Simulator Test Photography

Six high-speed cameras (four 1000 fps and two 400 fps) and one panning (24 fps) camera were used, as shown in Table 3-1, for the vehicle-to-truck underride guard tests. Table 3-2 describes the still camera (B/W and color) photographic fields of view.

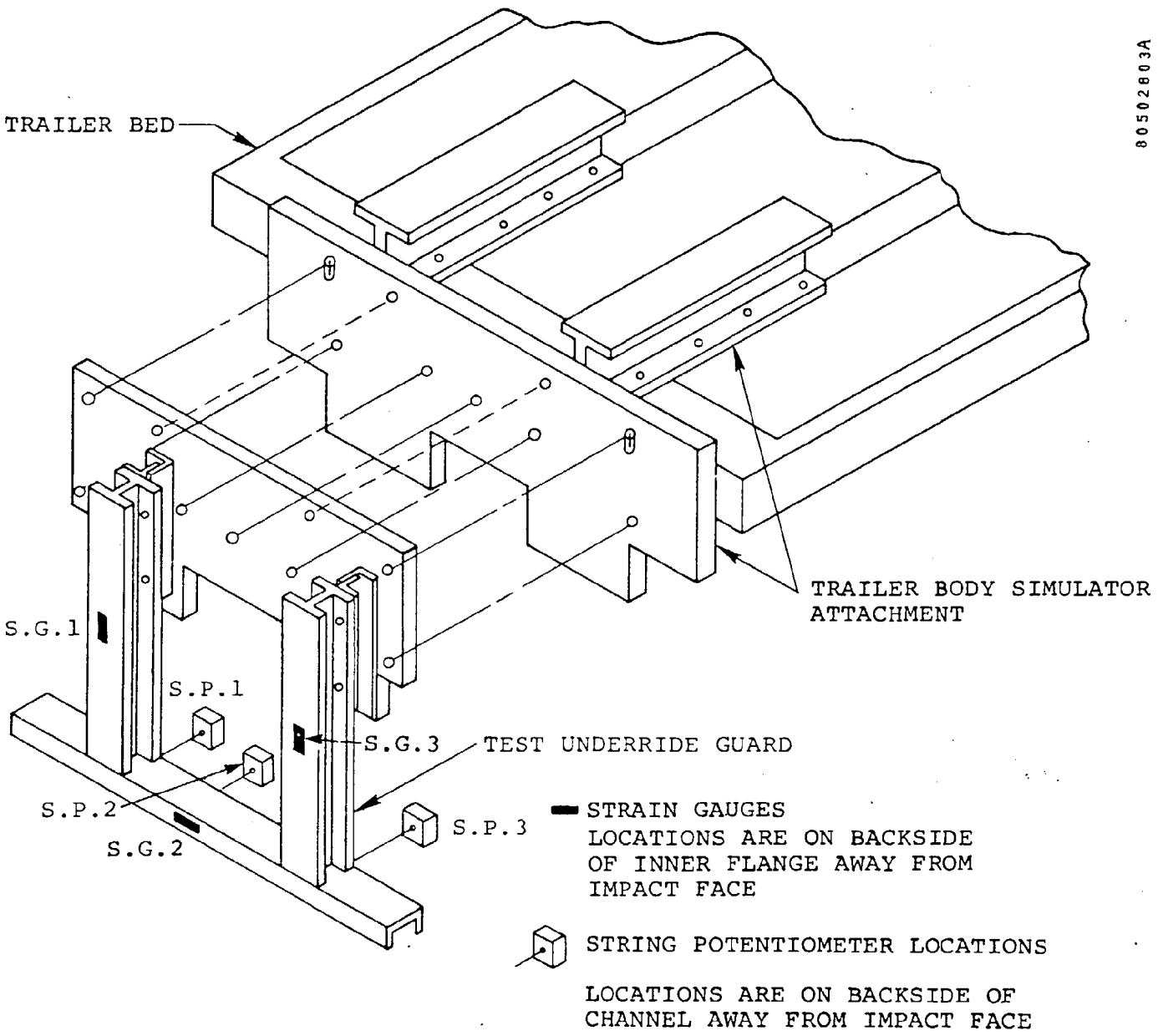


Figure 3-2. Tests No. 5.1 Through 5.3 Underride Guard Instrumentation.

TABLE 3-1. CAMERA LOCATIONS

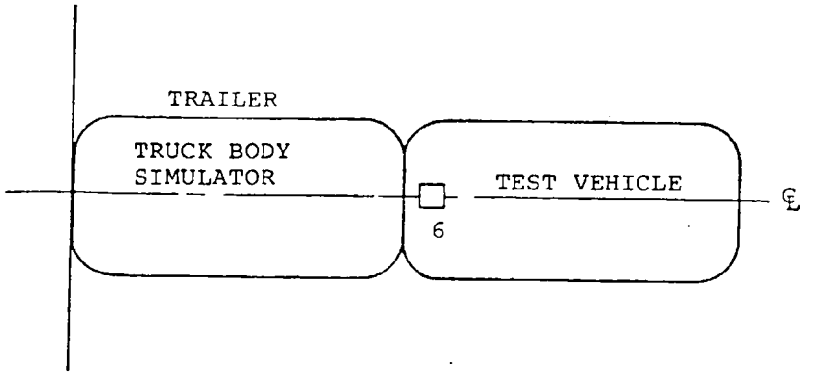
8319 Tests 5.1
Test No: through 5.8 Test Date: _____

Test Type: Car-to-Stationary Trailer Body Simulator

Vehicle A (Away): 1978 Chevrolet / 1978 VW Rabbit

Vehicle B (Barrier): _____

Comments: Camera locations are approximate and may be moved at discretion of test engineer.



CAMERA	YES
STILLS	X
SLIDES	X
MOVIE	X
POLAROID	

CAMERA SYMBOLS

- PIT
- GROUND
- BARRIER
- OVERHEAD
- ON-BOARD

FRAME RATE

1. 1000 fr/sec
2. 200 fr/sec
3. Other 24 fr/sec
4. 400 fr/sec
5. 500 fr/sec

TIMING LIGHT SPEED

1. 100 Hz (10 msec/light)
2. 200 Hz (5 msec/light)
3. Other _____

Loc. No.	Location	Field of View	Lens Size	Frm Rate	Tmng Spd	Ser No	Impact Dist-X	C.L. Dist-Y	CAM Hght-Z
1	Left Side	Overall of vehicle and trailer body	25mm	4	1				
2	Right Side	2/3 of vehicle to rear wheel of trailer body	25mm	4	1				
3	Left Side	2/3 of vehicle to rear wheel of trailer body	50mm	1	1				
4	Left Side	Close-up - front wheel of vehicle to rear wheel of trailer body	25mm	1	1				
5	Left Side	Angled close-up of impact area	13mm	1	1				
6	Rear of trailer body	Overhead view of impact area	13mm	1	1				
7	Left Side	Panning test and overall results	Zoom	3					

The panning camera documented the instrumentation, pre-test and post-test vehicle configurations, pre-test and post-test dummy positions, and the underride guard and test vehicle crush profiles.

3.3 VEHICLE STRUCTURAL DEFORMATION DATA

3.3.1 Data Acquisition

Pre-test and post-test measurements of the test vehicle and underride guard were made under the direction of the Test Engineer and were taken at the appropriate stage of vehicle testing.

TABLE 3-2. CAR-TO-TRUCK BODY SIMULATOR TESTS PHOTOGRAPHIC REQUIREMENTS AND CHECKLIST

Color Negatives (6cm x 7cm)	Color Slides (35mm)	Black and White	Field of View	Pre-Test	Post-Test
	X	X	Front View of Car	____	____
		X	Left Front Three-Quarter View of Car	____	____
	X	X	Left Side View of Car	____	____
		X	Right Front Three-Quarter View of Car	____	____
	X	X	Right Side View of Car	____	____
	X	X	Front View of Underride Guard	____	____
X	X	X	Overall View of Car/Trailer Body Interface - Left Side	____	____
X		X	Overall View of Car/Trailer Body Interface - Right Side	____	____
	X	X	Document Photos (2) of Trailer Body Simulator	____	____
	X	X	Close-up of Bumper/Underride Guard Match-up	____	____
		X	Close-up of Dummy Contact Points	____	____
		X	Overall Forward Occupant Compartment With Dummy	____	____
		X	Document Photos (3) of Trailer Body/Fixed Barrier Interface	____	____
X			Time of Typical Structural Collapse (100 ms)	____	____

4.0 SUMMARY OF TEST RESULTS

This section of the report presents the discussion of the test conditions and test results of the three Task 5 vehicle-to-underride guard tests (Test 5.1, 5.2, and 5.3). The data summary tables and data plots, along with photographs of the pre- and post-test documentation for Tests 5.1, 5.2, and 5.3 are provided in Appendices A, B, and C, respectively.

A summary of the pertinent crash data for the three tests is presented in subsection 4.4.

4.1 TEST 5.1

4.1.1 Test Conditions

The test vehicle longitudinal centerline was aligned with the longitudinal centerline of the trailer body simulator. The impacting vehicle test weight was a summation of the curb weight with all fluids removed except for water in the radiator plus the weight of the on-board instrumentation and the instrumented dummies in the driver and front passenger positions. The dummies were restrained by the vehicle passive restraint system.

The trailer body simulator was ballasted with concrete blocks totaling 9,250 pounds over the front dolly wheel centerline and 9,250 pounds over the rear tandem wheels centerline. The front ballast was added to prevent lifting of the front of the trailer during impact and maintain continuous contact of the load cells with the fixed barrier. (The rear ballast was used to level the

trailer fore and aft for proper orientation of the underride guard prior to test.) Through angled cable tie-down of the forward section of the trailer, the load cells were pre-loaded to approximately 2,000 pounds each. This pre-load was electrically set to zero during calibration setup to provide zero reference impact loads during the test.

The modified Fruehauf underride guard (Guard B) was assembled and installed on the rear of the platform trailer. The guard height level from the ground was set at 24.0 inches. Ground level was established from the contact points of the test vehicle front tires. The length of the horizontal member of the guard (4 x 4-inch tubing) was 72 inches to provide enlargement of the full width of the vehicle.

4.1.2 Test Results

In Test 5.1, the 1978 Volkswagen Rabbit weighing 2,491 pounds impacted the guard symmetrically at 40.43 mph. The underride guard overrode the car bumper by 4.4 inches. The maximum dynamic vehicle underride from the face of the front bumper, obtained from high-speed film analysis, was 63 inches (see Figure A-1 in Appendix A); vehicle rebound was 1.5 inches. The measured static collapse of the vehicle was 61.7 inches on the left side and 61 inches on the right side. It should be noted in Figure A-1, that vehicle underride and crush are different because initial guard/vehicle contact was at the vehicle grille 6.1 inches aft of the front bumper. Time zero for the data plots and displacement plots, obtained from film analysis, is at grille contact. The time differential between bumper and grille contact is 8.7 msec.

There was no permanent deformation of the vertical or horizontal members of the underride guard. However, there was slight deformation of both guard-to-trailer mounting brackets at the bolt holes. Solid guard contact was made with the air conditioning compressor. The transverse mounted engine was rotated 90 degrees rearward. Solid contact was made with the left and right shock towers. The left shock tower was pushed back to the firewall, and the right shock tower was rotated rearward. The shock tower movement in turn caused the front frame rails to rotate upwards until the bumper contacted the main frame rails of the trailer. The guard collapsed the hood and windshield into the occupant compartment. Both dummies struck the windshield and the vertical beams of the underride guard. Static deformation of the pertinent areas of the vehicle (including steering wheel movement), and photographs of the pre- and post-test damage are shown in Appendix A.

4.2 TEST 5.2

4.2.1 Test Conditions

The test vehicle and trailer body simulator was prepared and aligned at the test site in the same manner as in Test 5.1.

The underride guard used in Test 5.2 was identical to that used in Test 5.1, except for the addition of a two-by-four inch tubular section welded to the bottom of the guard. The guard was assembled to the trailer body simulator, and the height was set at 22.0 inches. Ground level was established from the contact points of the test vehicle front tires.

4.2.2 Test Results

In Test 5.2, the 1978 Ford Fiesta weighing 2,216 pounds impacted the guard symmetrically at 40.64 mph. The underride guard overrode the car bumper by 1.5 inches. At 19 msec after impact, the force generated by engine contact with the guard was sufficient to cause failure of the nut threads used for securing the guard to the simulator. The vehicle underrode the trailer simulator and firmly contacted the metal plate and honeycomb used to prevent damage to the rear wheel undercarriage, resulting in maximum dynamic vehicle underride of 118.9 inches. The vehicle rebound obtained from film analysis was 4.6 inches. As in Test 5.1, the initial guard/vehicle contact was at the grille 4.4 inches aft of the front bumper shown in Figure B-1, Appendix B. Time zero for the data plots and displacement plot obtained from film analysis is at grille contact. The time differential between bumper and grille contact is 6.3 msec.

There was no significant damage to the guard itself except for slight deformation at the lower left bolt hole. The guard-to-trailer mounting brackets were slightly deformed; however, there was no fracturing of the metal or the welds. The guard and car made solid contact at the headlight level of the car with the entire horizontal member making contact with the grille. The grille and radiator were pushed into the engine with the lower part of the guard striking the engine cylinder head. The engine was pushed back 5.5 inches toward the firewall. After the underride guard broke away from the trailer body, the roof of the car struck the back of the trailer body simulator. The car underrode the trailer body simulator back to the C pillar.

As the vehicle underrode the rear of the trailer body simulator, the driver head passed under the rear of the trailer without contact, which accounts for the low acceleration and injury criteria. The passenger head, however, impacted the rear structure of the trailer body simulator, resulting in injury criteria in excess of the allowable requirements of FMVSS 208.

Static deformation of the pertinent areas of the vehicle (including steering wheel movements), and photographs of the pre- and post-test damage crash documentation are shown in Appendix B.

4.3 TEST 5.3

4.3.1 Test Conditions

The test vehicle and truck/trailer simulator were prepared and aligned at the test site in the same manner as those used in the first two tests in Task 5.

The DSI T-1(A) steel guard was used in Test 5.3. The design is of similar configuration to the cantilevered Fruehauf guard, except that 100K psi yield strength was used to allow for greater load expected at the lower guard height. In addition, the guard width was increased to 84 inches. The guard height was set at 20.0 inches from ground level. Ground level was established from the contact points of the test vehicle front tires.

4.3.2 Test Results

In Test 5.3, the 1978 Volkswagen Rabbit weighing 2,459 pounds impacted the guard symmetrically at 40.44 mph. The underride guard barely contacted the upper front corner of the bumper on impact with the vehicle. The maximum vehicle underride from the front bumper, obtained from high-speed film analysis, was 39.5 inches (see Figure A-1 in Appendix A); the measured static

collapse of the vehicle was 29.0 inches on the left side and 30.5 inches on the right side. The vehicle rebound after the impact was 6.1 inches. It should be noted that time zero for the data plots and displacement plot obtained from film analysis is at bumper contact.

There was no permanent deformation of the underride guard, the mounting brackets, or the nuts and bolts. Solid contact was made with the horizontal member of the underride guard and the car grille area at the car headlight level. The guard firmly impacted the shock towers causing upward rotation of the forward frame structure. The radiator and condenser were pushed against the engine cylinder head, and the underride guard hit the air conditioning compressor. This rotated the transverse mounted engine rearward about 45 degrees. Also, the engine was pushed back into the firewall, causing significant firewall intrusion into the passenger compartment.

The steering wheel moved rearward in the occupant compartment and rotated upward so that it made an angle of approximately 90 degrees with the ground. The driver dummy hit the steering wheel with his head and chest. The passenger dummy hit the dash board above the glove compartment. Both dummies hit the knee bolsters causing the knee bolster on the driver's side to break away from the dash panel. Static deformation of the pertinent areas of the vehicle (including steering wheel movement), and photographs of the pre- and post-test vehicle conditions are shown in Appendix C.

4.4 TEST RESULTS SUMMARY

This section presents an easy access summary of the pertinent data for Tests 5.1, 5.2, and 5.3 of Task 5. Table 4-1 includes the vehicle description, test conditions, vehicle underride, and

TABLE 4-1. SUMMARY OF UNDERRIDE GUARD TEST RESULTS

Test No.	Test Vehicle	Test Weight (lb)	Guard Height (in.)	Impact Velocity (mph)	Maximum Truck Underride (in.)*	Maximum Force Load (lb)**
5.1	1978 VW Rabbit	2491	24	40.43	64.0 (44.4)***	69,843
5.2	1978 Ford Fiesta	2216	22	40.64	118.9**** (37.4)***	70,017
5.3	1978 VW Rabbit	2459	20	40.44	39.5 (44.4)***	91,444

*Based on high-speed film analysis.

**Sum of four load cells on time basis.

***Front Bumper to centerline of windshield at hood level.

****Guard mounting fastener failure.

maximum loads. Table 4-2 provides the critical parameters for defining occupant injury criteria. Table 4-3 presents the list of pertinent static deformation at various areas of the vehicle. Figure 4-1 presents a graphical representation of the driver side occupant compartment intrusion from the lower firewall to the top of the windshield for Tests 5.1 and 5.3.

TABLE 4-2. SUMMARY OF UNDERRIDE TEST OCCUPANT RESPONSE DATA - TASK 5

Parameter	Test 5.1	Test 5.2	Test 5.3	Injury Criteria*
Driver HIC	2218*	233	2401*	1000
Driver SI/G**	2801*/126	397/49	3108*/131	1000/None
Passenger HIC	725	1732*	2577*	1000
Passenger SI/G**	1162*/77	3349*/143	3270*/125	1000/None
Driver Chest SI/G	405/46	168/30	802/63*	1000/60**
Passenger Chest SI/G	370/41	281/41	717/62*	1000/60**
Driver Left Femur	1264	1065	1944	2250 lb
Driver Right Femur	1527	2185	2298*	2250 lb
Passenger Left Femur	1728	578	2893*	2250 lb
Passenger Right Femur	2190	390	2365*	2250 lb

*Failure - Exceeds Injury Criteria defined in FMVSS 208.

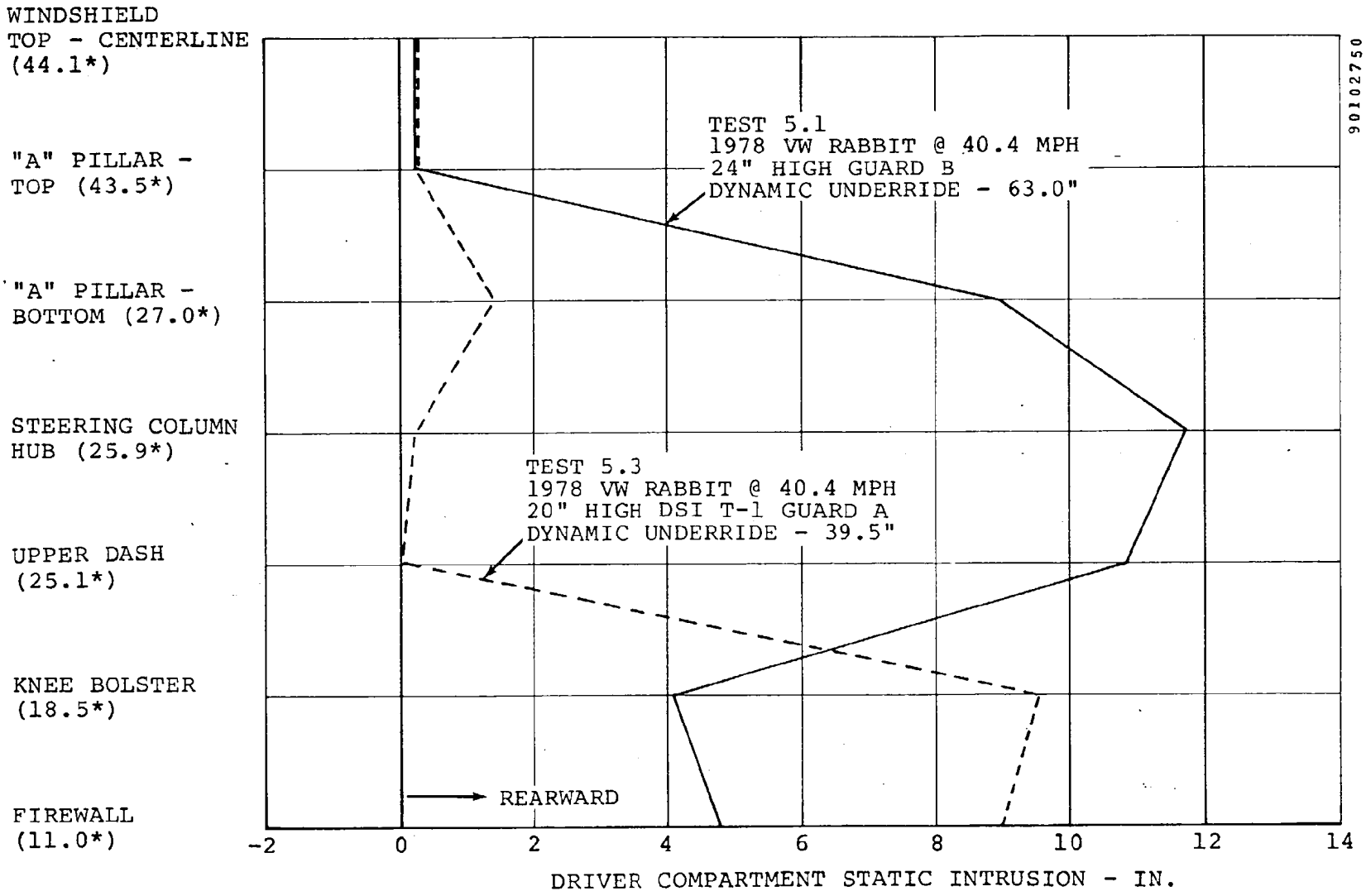
**G level defined as value for a cumulative duration of at least 3 msec.

TABLE 4-3. SUMMARY OF TEST VEHICLE STATIC DEFORMATION

Vehicle Location	Static Change Test 5.1	Test 5.2	Test 5.3
Centerline Windshield Opening (top)	0.2	44.6	0.2
Top of "A" Pillar (left)	0.2	38.9	0.2
Top of "A" Pillar (right)	0.9	33.4	0.9
Bottom of "A" Pillar (left)	8.9	-0.7	1.4
Bottom of "A" Pillar (right)	8.8	0.4	2.6
Rear Edge Dash Panel (left)	10.8	1.3	0.0
Rear Edge Dash Panel (right)	13.7	2.6	2.3
Steering Column Hub (horizontal)	11.7	0.7	0.2
Steering Column Lower Rim (horizontal)	9.0	-2.9	-1.5
Steering Column Hub (vertical)	5.9	6.0	-9.2
Steering Column Lower Rim (vertical)	1.5	2.1	-12.4
Knee Bolster* (left)	4.1	N/A	9.5
Knee Bolster* (right)	3.8	2.0	1.5
Firewall, Driver Centerline	4.8	1.1	9.0
Firewall, Passenger Centerline	6.7	0.7	8.7
Firewall, Vehicle Centerline	7.5	0.9	8.6
A/C Compressor or Water Pump	26.8	5.0	20.0
Front Engine Block (valve cover)	19.6	5.0	10.3
Front Edge Shock/Strut Tower (left)	23.4	5.3	13.3
Vehicle Maximum Underride	63.0	118.9	39.5

*No knee bolster in Ford Fiesta (5.2). Use Dash at knee level.

NOTES: Minus sign indicates forward or upward movement from original position. All dimensions are changes in longitudinal direction unless noted.



*VERTICAL HEIGHT ABOVE FLOOR PAN LEVEL (IN.)

Figure 4-1. Post-test Static Driver-side Compartment Intrusion.

5.0 TEST FACILITIES AND EQUIPMENT

5.1 GENERAL

The impact tests in this program were conducted at the Monorail Impact Facility, shown in Figure 5-1. The fixed barrier impact site were used for the vehicle-to-trailer body simulator tests.

Table 5-1 describes the test equipment and its function as it applies to the test parameters.

5.2 FACILITY AND EQUIPMENT DESCRIPTION

The following paragraphs briefly describe the track facility and equipment, their function, and mode of operation.

5.2.1 Test Track and Guidance System

The test track consists of 1,200 feet of asphalt pavement (SN = 75 $\pm$5), 14 feet in width. The length allows sufficient acceleration distance to accommodate impact speeds in excess of 60 mph with sufficient distance remaining to abort the test if necessary. Guidance for the test vehicle is provided by a sliding shoe attached to the vehicle. The sliding shoe rides on the monorail embedded in the test track. Prior to impact, the shoe is mechanically released from the test vehicle.

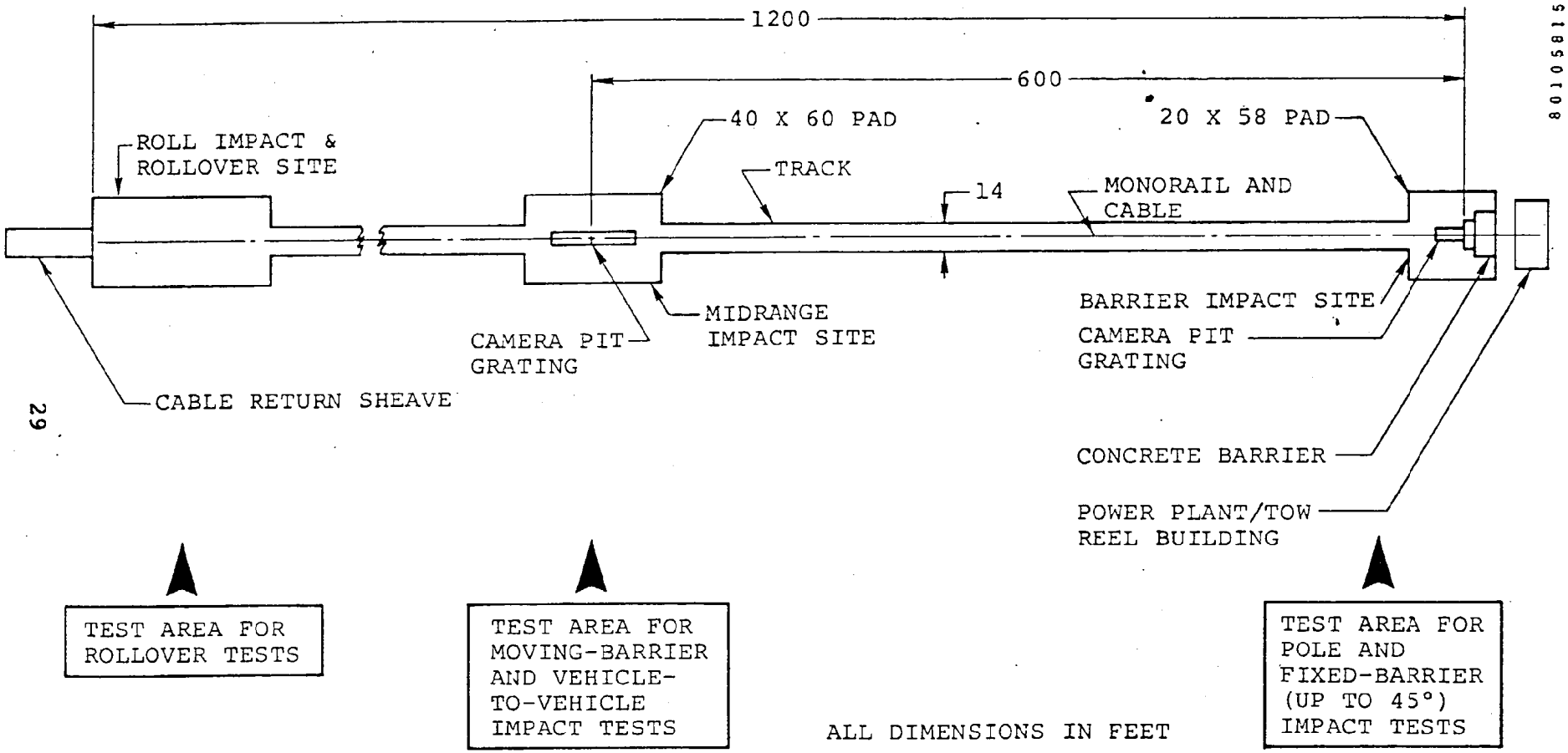


Figure 5-1. Monorail Impact Facility.

TABLE 5-1. TEST EQUIPMENT LIST AND FUNCTION

Item	Manufacturer	Model	Purpose
Timing Trap	Dynamic Science	None	Determine impact speed by furnishing a start and stop signal to recording oscillograph.
Oscillograph	Bell and Howell	5-134	Records timing start and stop signals from timing traps, cable drum drive rpm, and impact switch.
Speed Control	Dynamic Science	None	Precision control of cable drive drum rpm.
Beam Scales	Western	WP2000	Used to determine vehicle test weights.
High-speed Motion Picture Cameras	Photosonics, Milliken, Fairchild	16-1B DBM-5A HS-100	Used for side, overhead, and on-board film coverage as required.
Motion Picture Camera	Bolex	H-16	Panning and documentation.
Still Camera	Kowa	6	Documentary photo coverage.
100 and 1000 Hz Time Code Generators	Dynamic Science	None	Furnish timing signal for high-speed cameras and a 1-millisecond timing for velocity determination.
Calibrated Steel Rule	Starret	48 in.	Precision measurement of velocity trap spacing.
Anthropomorphic Dummies		Part 572	To ballast the vehicle and to observe occupant dynamic movement.
Vehicle Accelerometers	Statham	A69TC-200	Measures acceleration.
Strain Gauges	BLH	FAE-25-35-P	Measure underride guard component strain.
String Potentiometers	Celesco	PT-101-30	Measures displacement.
50 Klb Load Cells	Interface	1320AF	Force on trailer body simulator-fixed barrier interface.
Tape Recorder	Sangamo	Sabre III	Records instrumentation signals.
Oscillograph	Bell and Howell	5-134	Records real-time quick-look data.
Signal Conditioner	Ectron	M140	Conditions instrument output signal for recording.

5.2.2 Tow System and Velocity Control

The tow system consists of a drum-driven endless cable powered by a pair of 390-cubic-inch engines driven in tandem driving a modified three-speed C-6 automatic truck transmission. The tow system can propel a 6,000-pound vehicle into the fixed barrier at 75 mph or two 4,000-pound vehicles into each other at a closing speed of 90 mph. Velocity control is achieved through a manually controlled throttle system. A visual readout of speed versus distance is provided and compared with the "ideal curve." Velocity control under $\pm$0.5 mph is realizable down to 20 mph and $\pm$2.0 percent down to zero mph.

5.2.3 Abort System

Automatic abort capability is provided through the vehicle service brakes which are actuated by releasing high-pressure air into the hydraulic system. Abort criteria consists of vehicle speed, data acquisition and instrumentation system readiness, and stability of the vehicle on the test track. The first two criteria are automatically monitored by the test control system while the third criterion is visually monitored by the test conductor. Manual abort provisions are available to the test conductor. Upon verifying vehicle speed, the test control system automatically deactivates the abort system to preclude an inadvertent test abort immediately prior to impact.

5.2.4 Master Control System

The master control system used for impact tests controls and monitors all primary system functions that must operate throughout a predetermined interval during a test. This includes the starting and stopping of the tape recorder, high-speed cameras, and oscillograph, and the control of the power winch which propels the test vehicle. The operation of the various devices is confirmed, including vehicle velocity and tape recorder speed synchronization, before it passes through a "commit" window. When the vehicle is committed, the abort system is disarmed, preventing an accidental abort after the point of no return is reached.

Any system malfunction, including improper vehicle velocity up to the commit window, generates an abort. The control system uses the pulse output from the IRIG time base generator as a clock with a manual push button defining time zero. The logic circuits compare pulse counts from time zero to preset values dialed in at the control panel. As each control circuit gets an equal comparison, that circuit is turned on. If the self-test circuit does not verify, the abort system is automatically activated. After a successful vehicle test, the last control circuit shuts the entire system down. The manual backup control system provides the test conductor with the option of manually aborting the test if the need arises.

5.2.5 High-Speed Photography

Six high-speed (four 1000 and two 400 frames/second) motion 16mm cameras with 100 Hz timing marks were used for photographic test documentation. Precise field of view monitoring is accomplished by bore sighting with the vehicle at the impact site prior to the test.

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APPENDIX A

TEST 5.1 TEST DATA SUMMARY

1978 VW RABBIT

SYMMETRIC IMPACT @ 40 MPH

TABLE A-1. RECEIVING INSPECTION OF VEHICLES

Contractor: Dynamic Science, Inc. Contract No.: DOT-HS-8-01905

VIN NO.: 1783391361 Make: Volkswagen

NHTSA No.: R. & D.

Year: 1978 Color: Brown Model: Rabbit 4-Door

Auto Trans: [yes] no Pwr Steering: yes [no] Seats: (front) Bench: ____

Pwr Brakes: [yes] no Auto Speed Cont: yes [no] Bucket: X

Pwr Seats: yes [no] Anti Skid Brake: yes [no] Split Bench: ____

Pwr Windows: yes [no] Air Conditioning: [yes] no Split Back Bench: ____

Tinted Glass: yes [no] Rear Window Def.: [yes] no

Radio: yes [no] Brakes: drum: R disc: F

Clock: [yes] no

Tire Size: 155 SR-13 Ply Rating: 4 Mfg. & Line: UNIROYAL

Bias Ply: ____ Belted: ____ Radial X /Eng.HP: ____ Cylinders: 4 Total Displ: 89 CID

Trans, # Fwd. Speeds: 3 Shipping Weight: 2822 GVWR Odometer: 57.0

Dealer (name, address, and phone number) 602-264-0811

AZTEC VOLKSWAGEN
2020 E. Indian School Road
Phoenix, Arizona 85016

Remarks (list additional accessories not listed above)

Date of Manufacture: 3-78 Dynamic Science No.: 713 Date Received: 5-31-78

Tilting Steering Wheel: yes [no] Telescoping Steering Wheel: yes [no]

Fuel Capacity: ____ (from owner's manual) "Space Saver" Spare Tire yes [no]

Restraint System: Passive Belt

1. Is the vehicle stock throughout? Describe: Yes, New Production Vehicle

2. Does vehicle show evidence of prior accident history? Describe: None

3. Does vehicle show any significant corrosion? Describe: None

4. Check condition of the front bumper and frame: Satisfactory

TABLE A-2. SUMMARY OF VEHICLE ENGINE/BUMPER/FIREWALL CHARACTERISTICS

Test No. 5.1 Type Symmetric

Car Model 1978 VW Rabbit Dynamic Science No. 713

Engine Size	89 CID
Engine Height/Width (in.)	28/31*
Bumper to Engine (in.)	26
Engine Length (in.)	15
Engine to Firewall (in.)	5.5
Bumper to Firewall (in.)	41.5
Bumper to "Hard Point" (A/C Comp.) (in.)	17
Initial Impact Point to Front Bumper (in.)	6.1
Height From Top of Front Bumper to Lowest Point of Underride Guard (in.)	4.4
Horizontal Dimension From Centerline of Vehicle to Extreme Left Edge of Guard (in.)	36 in.
Horizontal Dimension From Centerline of Vehicle to Extreme Right Edge of Guard (in.)	36 in.

*Transverse mounted engine.

TABLE A-3. SUMMARY OF CAR ACCELEROMETER DATA

Accelerometer Number	Plot Location Number	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)
1X	101	-31.5	30
1Y	101	-25.7	30
2X	102	-27.6	31
3X	103	-29.1	35
3Y	103	-20.5	35
4X	104	-126.1	30
4Y	104	-33.6	31
5X	105	-33.5	37
$6X_1$	106	-48.7	81
$6X_2$	-	N/A	-
6Z	106	-63.4	49
7X	107	-103.7	26

TABLE A-4. SUMMARY OF TRAILER ACCELEROMETER DATA

Accelerometer Number	Plot Location Number	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)
2X	202	9.1	37

TABLE A-5. SUMMARY OF COMPARTMENT AND ENGINE ACCELEROMETER DATA

Accelerometer Number	Plot Location Number	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)
Average of 1X and 2X	412	-28.8	30
$6X_1$	106	-48.7	81

TABLE A-6. SUMMARY OF UNDERRIDE GUARD STRING POTENTIOMETER DATA

Displacement Potentiometer (Number)	Displacement Potentiometer (Location)	Plot Location Number	Maximum Dynamic Displacement D (in.)	Maximum Dynamic Displacement Time (msec)
SP1	left	4001	-.55	29
SP2	Center	4002	-.49	25
SP3	Right	4003	-.54	26

TABLE A-7. COMPARISON OF TOTAL INTERFACE FORCE FROM LOAD CELL AND ACCELEROMETER DATA

Parameter	Trailer Force Data*	Car Acceleration Data**
Force (lb)	69,843	55,577
Time (msec)	28	30

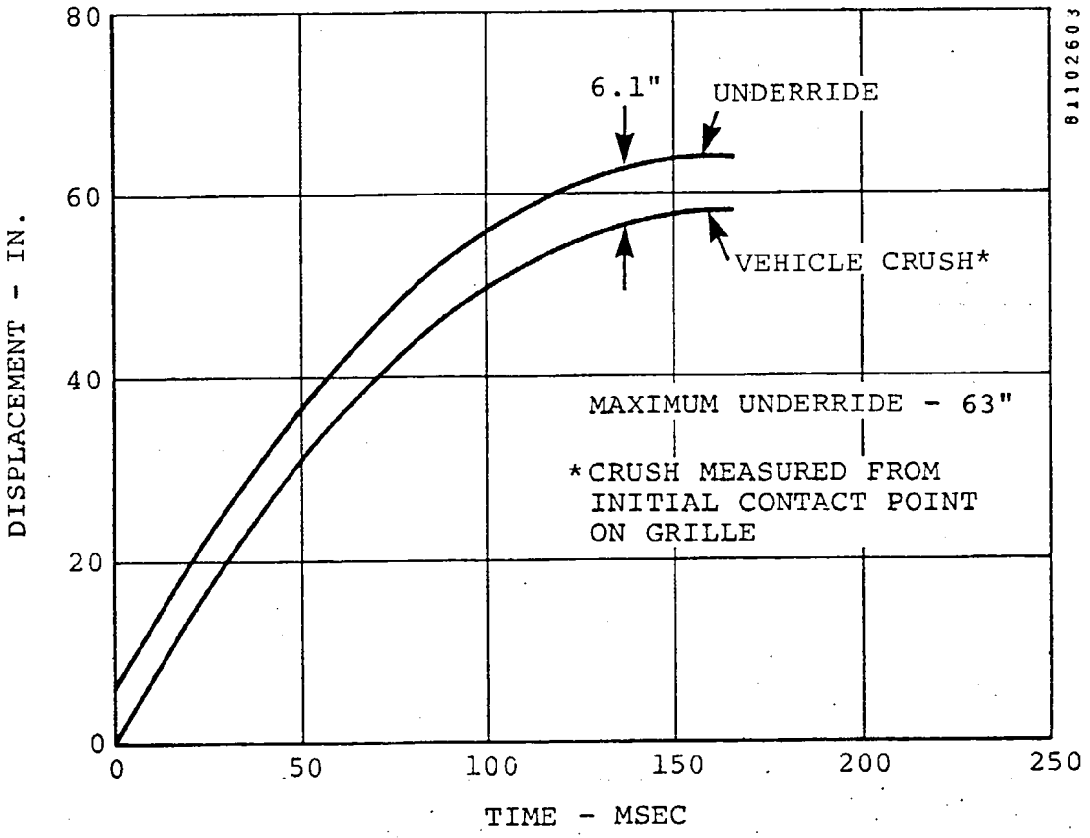
*Sum of 4 load cells.
**Average of car accelerometers 1 and 2 x (vehicle minus engine weight) + engine acceleration x (engine weight).

TABLE A-8. SUMMARY OF UNDERRIDE GUARD AND TRAILER STRAIN GAUGE DATA

Strain Gauge Number	Plot Location Number*	Maximum Strain** (μin./in.)	Maximum Time (msec)
SG1	4213	244	23
SG2	4213	-963	24
SG3	4213	462	22
SG4	Not Used	-	-
SG5	4256	282	24
SG6	4256	145	25

*For location of strain gauges 1-3, see Figure 3-2.
For location of strain gauges 5-6, see Figure 2-3.

**Stress = strain (in./in.) x E (30 x 10^6 lb/in. for steel), tensile strain and stress are negative values.



Test 5.1 Vehicle Underride Versus Time - 1978 Volkswagen Rabbit - Symmetric Impact @ 40.43 mph.

TABLE A-9. SUMMARY OF PRE-TEST AND POST-TEST VEHICLE STATIC MEASUREMENTS

TEST NO.: 5.1 VEHICLE: 1978 VW Rabbit

Location	Dimension Pre	Dimension Post	Reference	Difference
Front of Engine block at valve cover	118.3	98.7	Target 144	19.6
Front edge of A/C compressor	127.0	100.2	Target 144	26.8
Front edge of shock/ strut tower (Left)	113.6	90.2	Target 144	23.4
Bottom of "A" pillar (left)	92.9	84.0	Target 144	8.9
Bottom of "A" pillar (right)	92.5	83.7	Target 144	8.8
Rear edge of dash panel (left)	86.8	76.0	Target 144	10.8
Rear edge of dash panel (right)	87.2	73.5	Target 144	13.7
Steering column hub (horizontal)	77.2	65.5	Target 144	11.7
Steering column lower rim (horizontal)	73.0	64.0	Target 144	9.0
Steering column hub (vertical	21.9	16.0	Rocker Sill	5.9
Steering column lower rim (vertical)	13.0	11.5	Rocker Sill	1.5
Top of "A" pillar (left)	77.5	77.3	Target 144	0.2
Top of "A" Pillar (right)	77.5	76.6	Target 144	0.9
Centerline of wind-shield opening (top)	80.5	80.3	Target 144	0.2
Knee bolster (left)	84.5	80.4	Target 144	4.1
Knee bolster (right)	84.7	80.9	Target 144	3.8
Firewall, driver centerline	103.4	98.6	Target 144	4.8
Firewall, passenger centerline	102.5	95.8	Target 144	6.7
Firewall, centerline of vehicle	102.5	95.0	Target 144	7.5

TABLE A-10. SUMMARY OF PRE-TEST DUMMY POSITION DATA CHARACTERISTICS

Test No. 5.1 Type Symmetric

Car Model 1978 VW Rabbit Dynamic Science No. 713

	Left Front Occupant	Right Front Occupant
Seat Range (in.)	6.3	6.3
Seat Position* (in.)	3.0	3.0
Front Seat to Firewall (in.)	24.5	24.5
Forehead to Windshield (in.)	24.5	24.3
Torso to Steering Wheel** (in.)	13.5	23.3
Left/Right Knee to Dash Panel (in.)	2.5/2.3	3.0/3.3

Dummy Type Alderson Part 572

Locations: Left Front Occupant - No. 759

Right Front Occupant - No. 760

Restraint Type: LF Passive Shoulder Belt and Knee Bolster

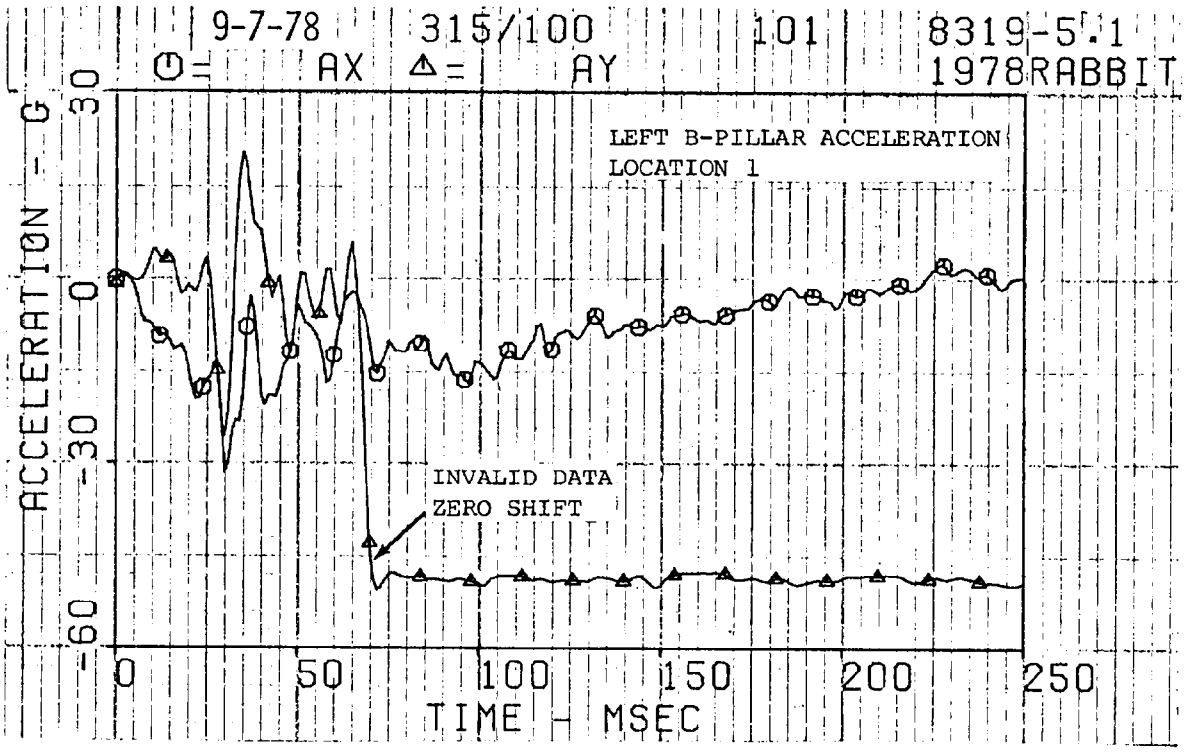
RF Passive Shoulder Belt and Knee Bolster

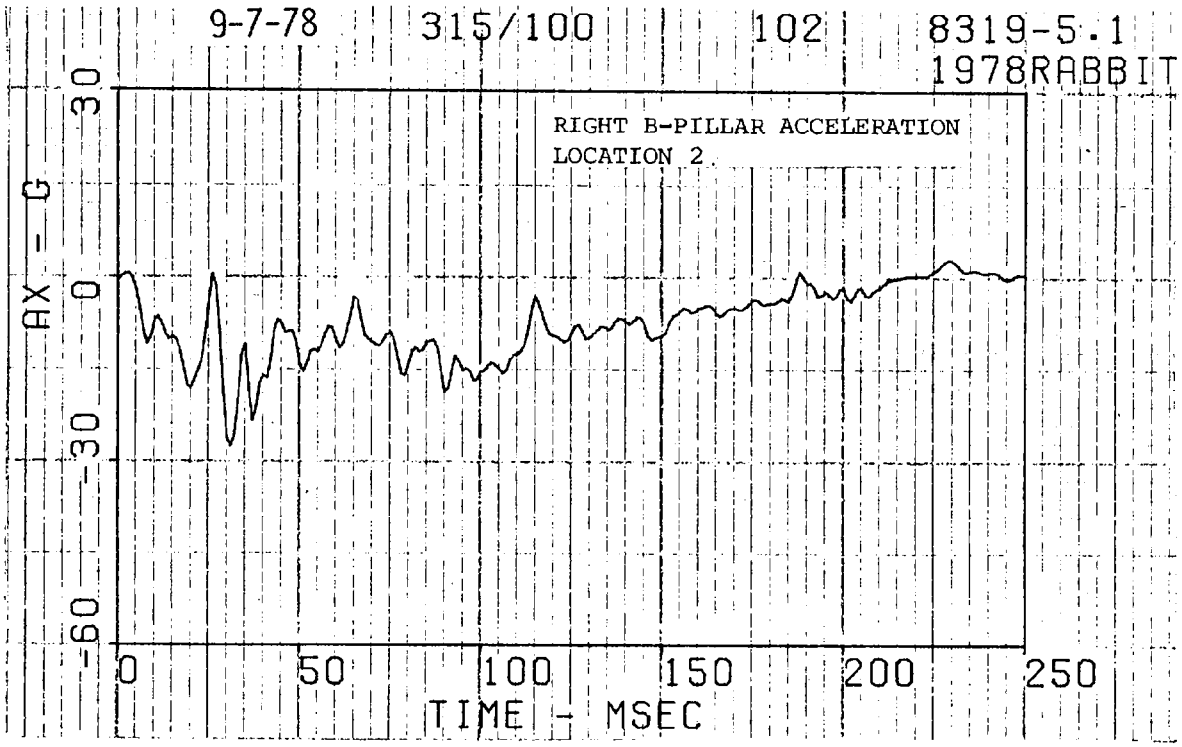
*From rearmost position to midpoint seat position.
**To dash panel for right front occupant.

TABLE A-11. SUMMARY OF OCCUPANT RESPONSE DATA FOR TEST 5.1

Response Parameter		Filter (Hz)	Left Front Dummy (Driver) Maximum Value A (G)	Left Front Dummy (Driver) Maximum Value T (msec)	Right Front Dummy (Passenger) Maximum Value A (G)	Right Front Dummy (Passenger) Maximum Value T (msec)
Head	X	1600	-124.6	107	-80.4	113
	Y	1600	-69.9	115	63.8	113
	Z	1600	126.9	107	55.4	113
	R	1600	187.2	107	116.7	113
SI/Time			2801 @ 200		1162 @ 200	
HIC/Time			2218 (105 to 118 msec)		725 (111 to 131 msec)	
Head Acceleration*	R	1600	126*		77*	
Chest	X	315	-45.5	126	-40.6	87
	Y	315	-23.6	102	21.9	141
	Z	315	40.8	116	19.2	74
	R	315	47.3	126	44.7	142
SI/Time			405 @ 200 msec		370 @ 200 msec	
Chest Acceleration*			46*		41*	
Femur Loads** (lb)	L	1000	-1264 @ 60		-1728 @ 66	
	R	1000	-1527 @ 40		-2190 @ 65	

*G values defined as value for a cumulative duration of at least 3 msec.
**Negative loads are compression; positive loads are tension.


9-7-78
315/100
101
8319-5.1
1978RABBIT
□= AX △= AY
LEFT B-PILLAR ACCELERATION
LOCATION 1
INVALID DATA
ZERO SHIFT
ACCELERATION - G
30
0
-30
-60
0
50
100
150
200
250
TIME - MSEC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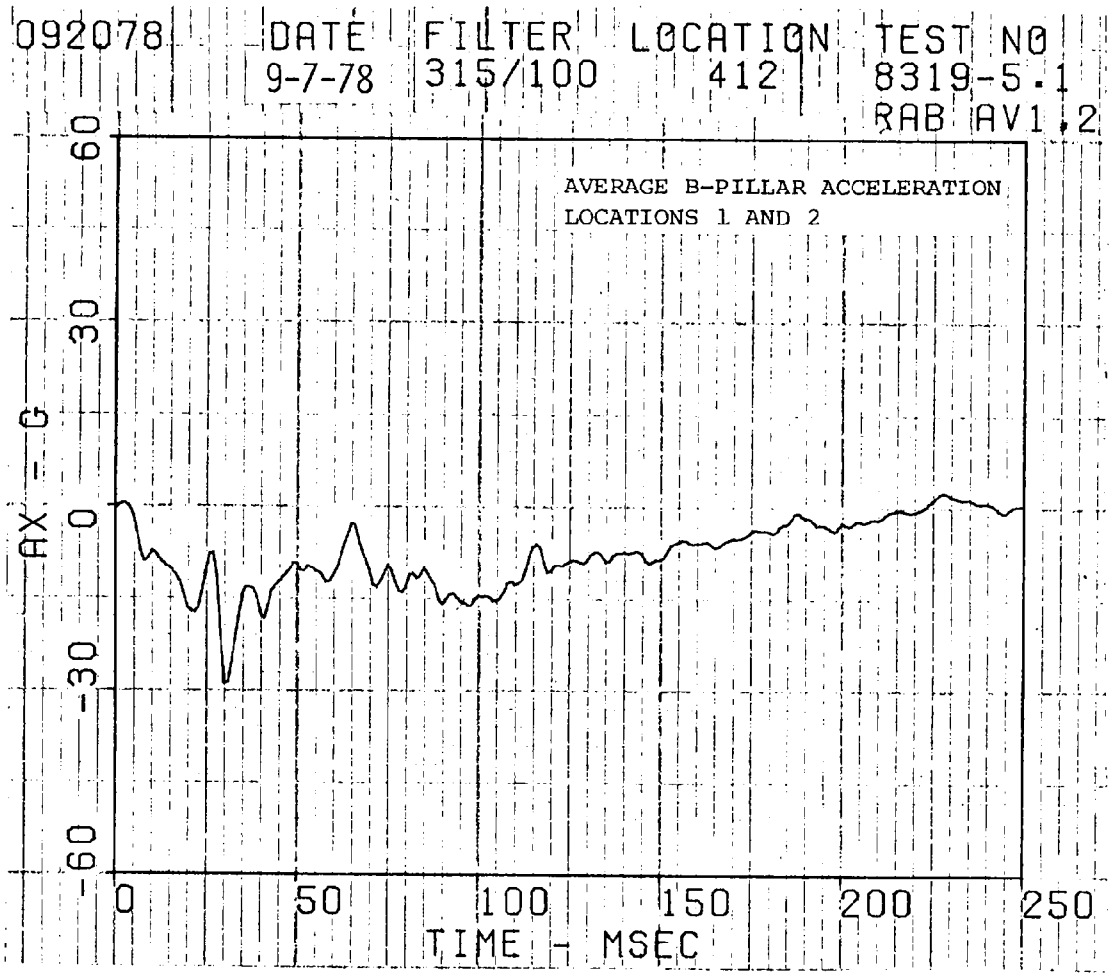
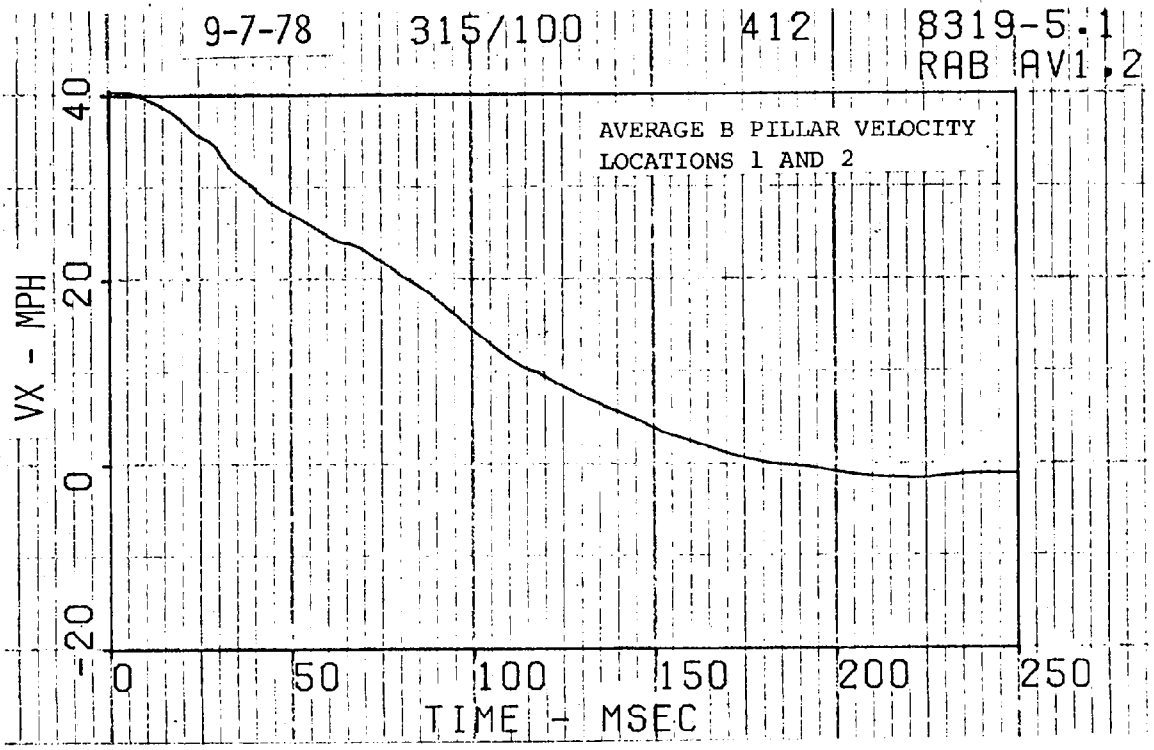
315/100
102
8319-5.1
1978RABBIT
RIGHT B-PILLAR ACCELERATION
LOCATION 2
AX - G
30
0
-30
-60
0
50
100
150
200
250
TIME - MSEC


092078
DATE
9-7-78
FILTER
315/100
LOCATION
412
TEST NO
8319-5.1
RAB AV1,2
AVERAGE B-PILLAR ACCELERATION
LOCATIONS 1 AND 2
AX - G
60
30
0
-30
-60
0
50
100
150
200
250
TIME - MSEC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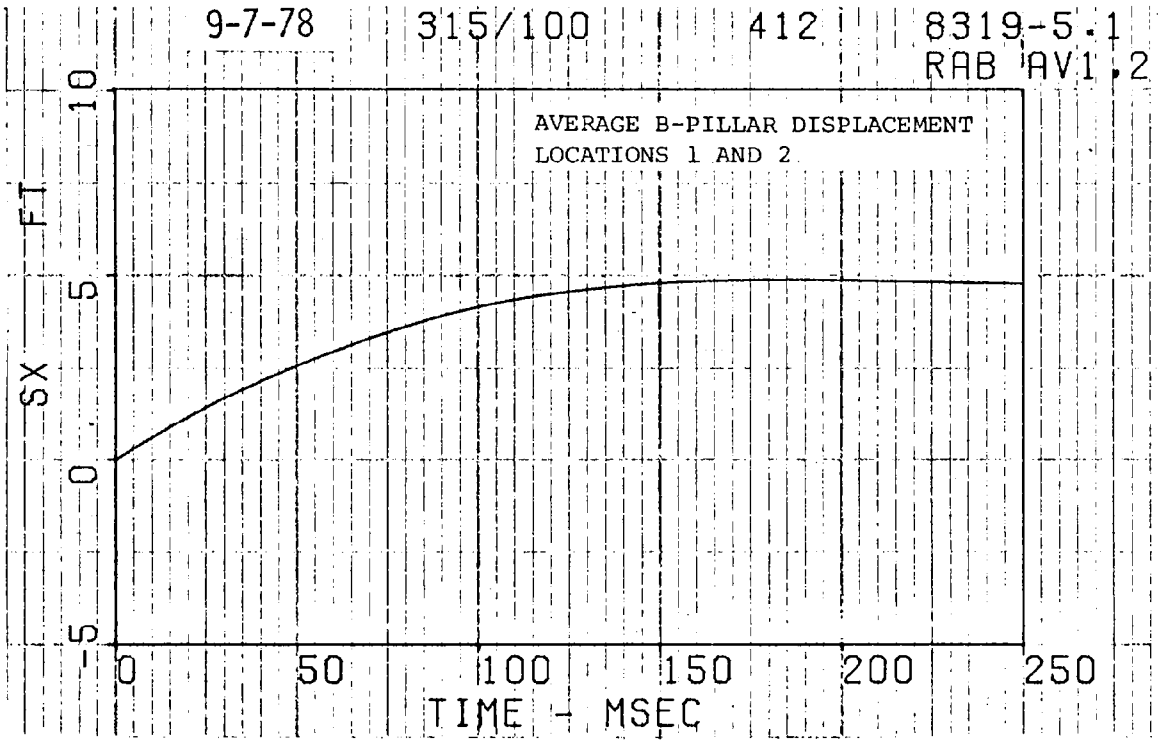
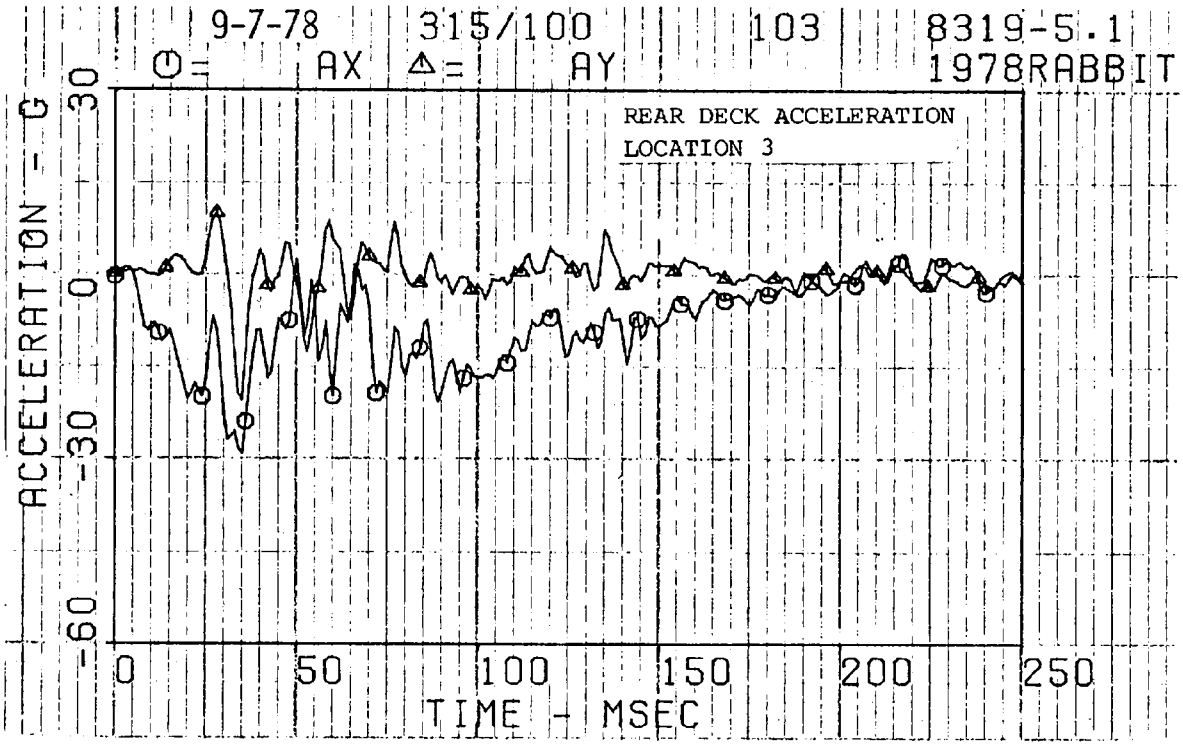
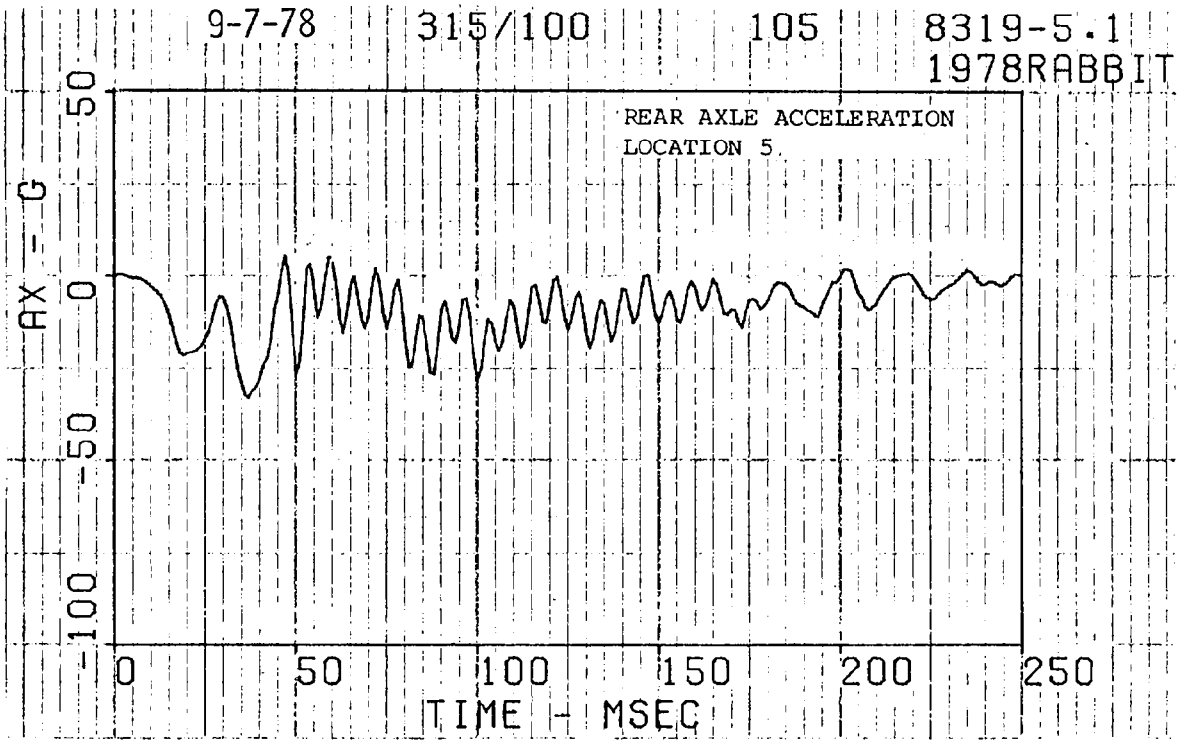
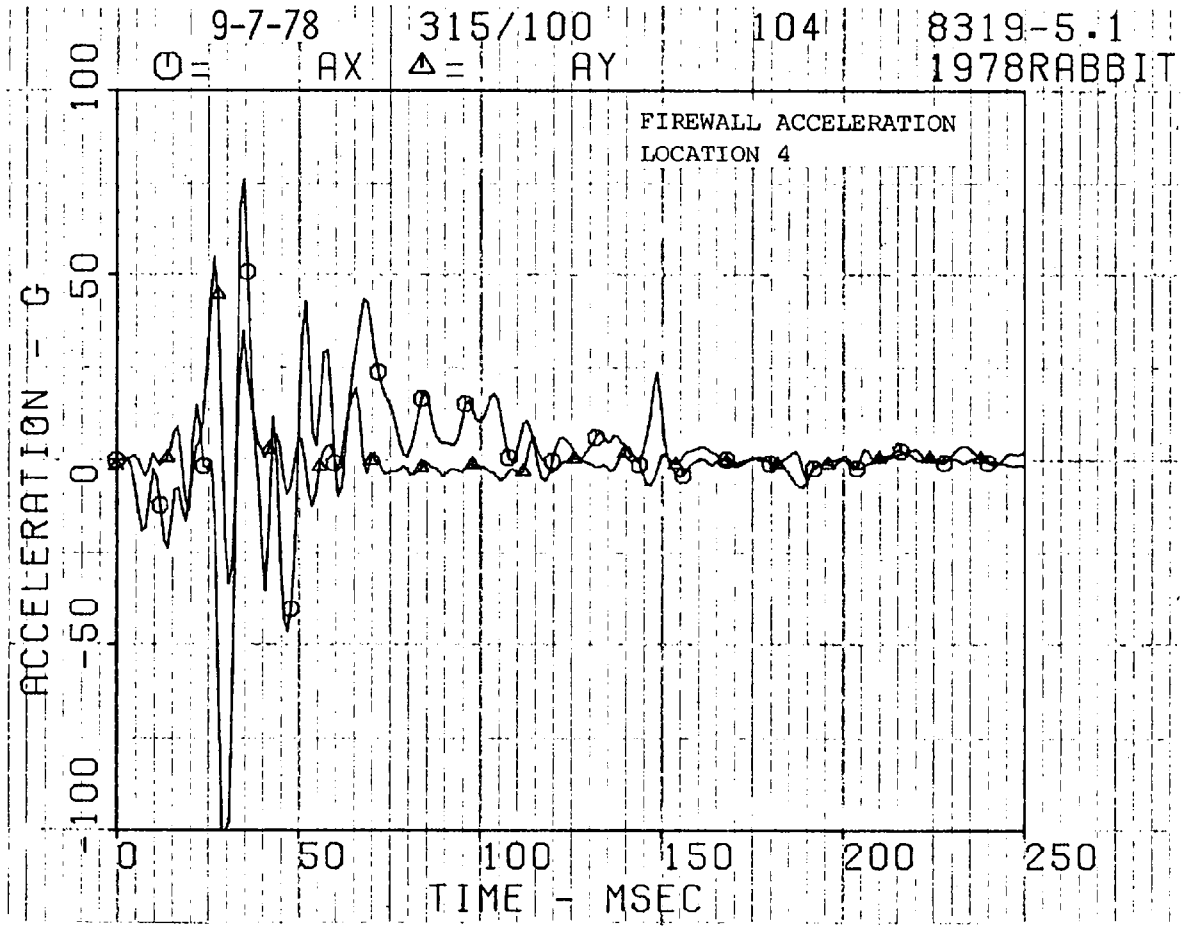
315/100
412
8319-5.1
RAB AV1,2
AVERAGE B PILLAR VELOCITY
LOCATIONS 1 AND 2
VX - MPH
40
20
0
-20
0
50
100
150
200
250
TIME - MSEC


9-7-78
315/100
412
8319-5.1
RAB AV1,2
AVERAGE B-PILLAR DISPLACEMENT
LOCATIONS 1 AND 2
SX - FT
10
5
0
-5
0
50
100
150
200
250
TIME - MSEC


9-7-78
315/100
103
8319-5.1
1978RABBIT
○= AX △= AY
REAR DECK ACCELERATION
LOCATION 3
ACCELERATION = G
30
0
-30
-60
0
50
100
150
200
250
TIME - MSEC


9-7-78
315/100
105
8319-5.1
1978RABBIT
REAR AXLE ACCELERATION
LOCATION 5
AX = G
50
0
-50
-100
0
50
100
150
200
250
TIME - MSEC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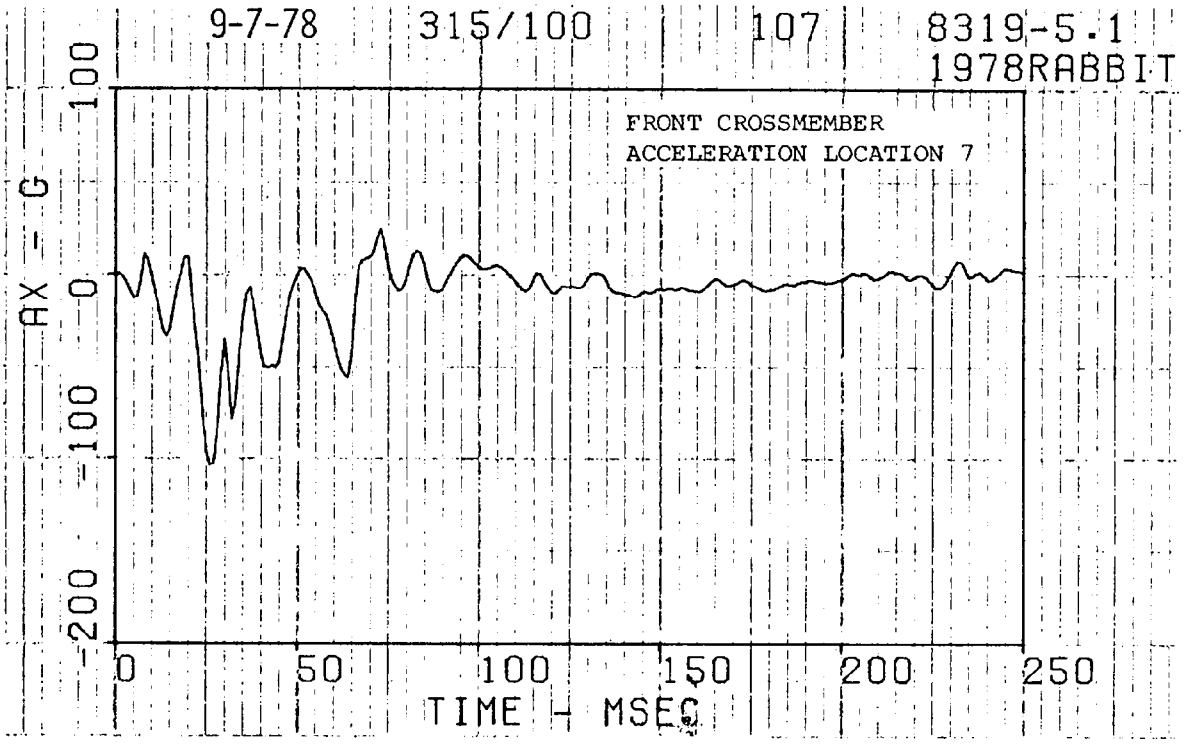
315/100
104
8319-5.1
1978RABBIT
○ = AX
△ = AY
FIREWALL ACCELERATION
LOCATION 4
ACCELERATION - G
100
50
0
-50
-100
0
50
100
150
200
250
TIME - MSEC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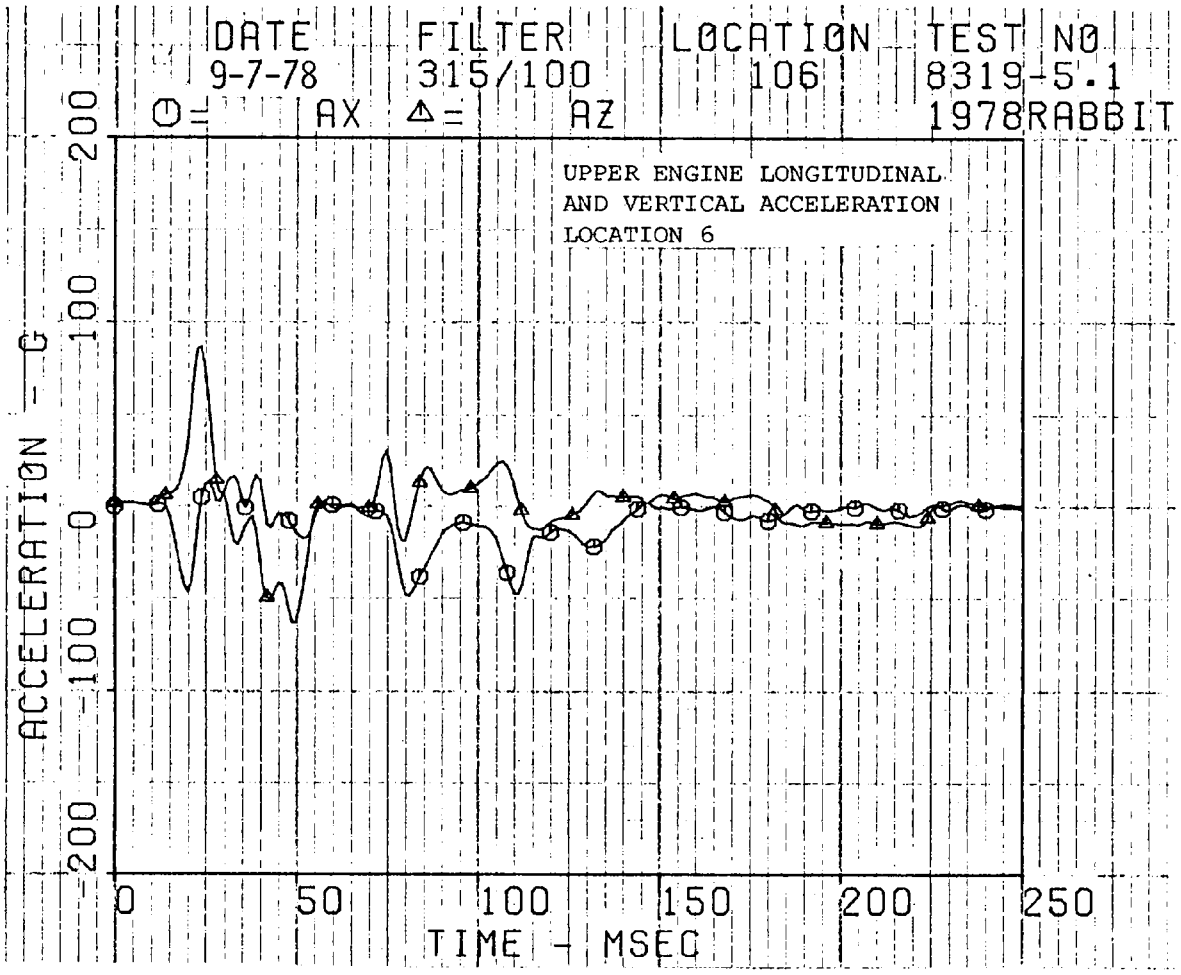
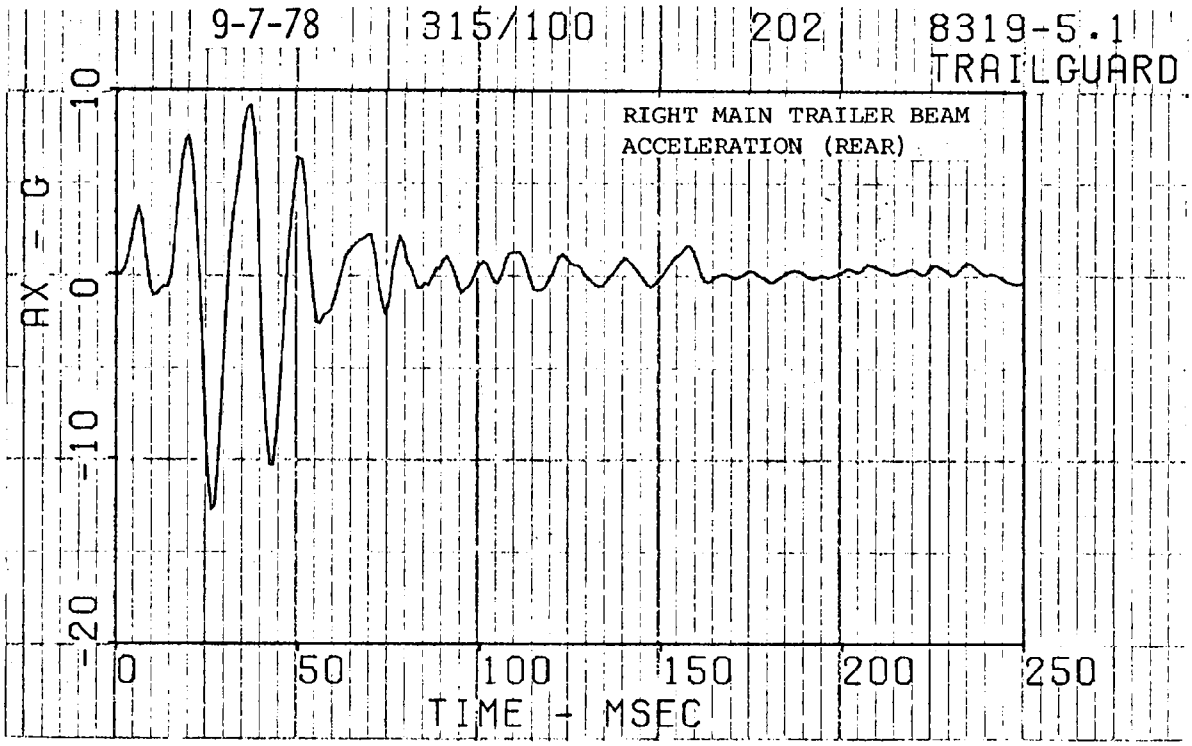
315/100
107
8319-5.1
1978RABBIT
FRONT CROSSMEMBER
ACCELERATION LOCATION 7
AX - G
100
0
-100
-200
0
50
100
150
200
250
TIME - MSEC


DATE
9-7-78
FILTER
315/100
LOCATION
106
TEST NO
8319-5.1
1978RABBIT
○= AX △= AZ
UPPER ENGINE LONGITUDINAL
AND VERTICAL ACCELERATION
LOCATION 6
ACCELERATION - G
200
100
0
-100
-200
0
50
100
150
200
250
TIME - MSEC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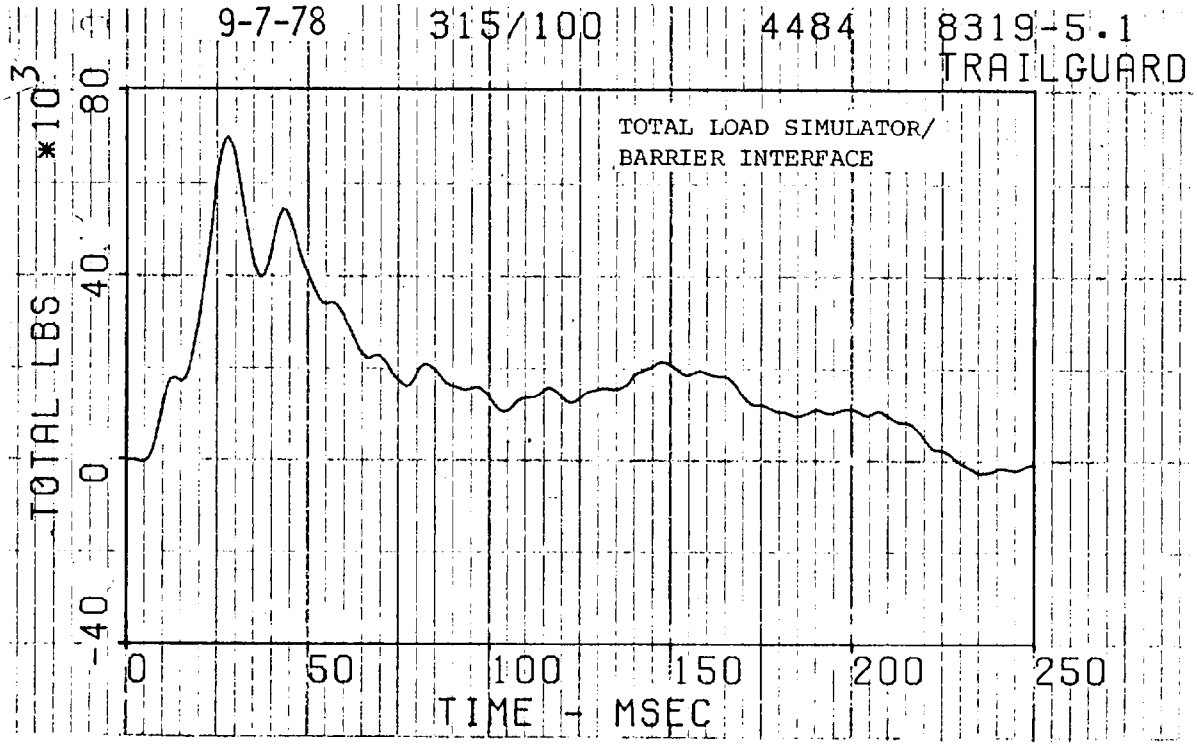
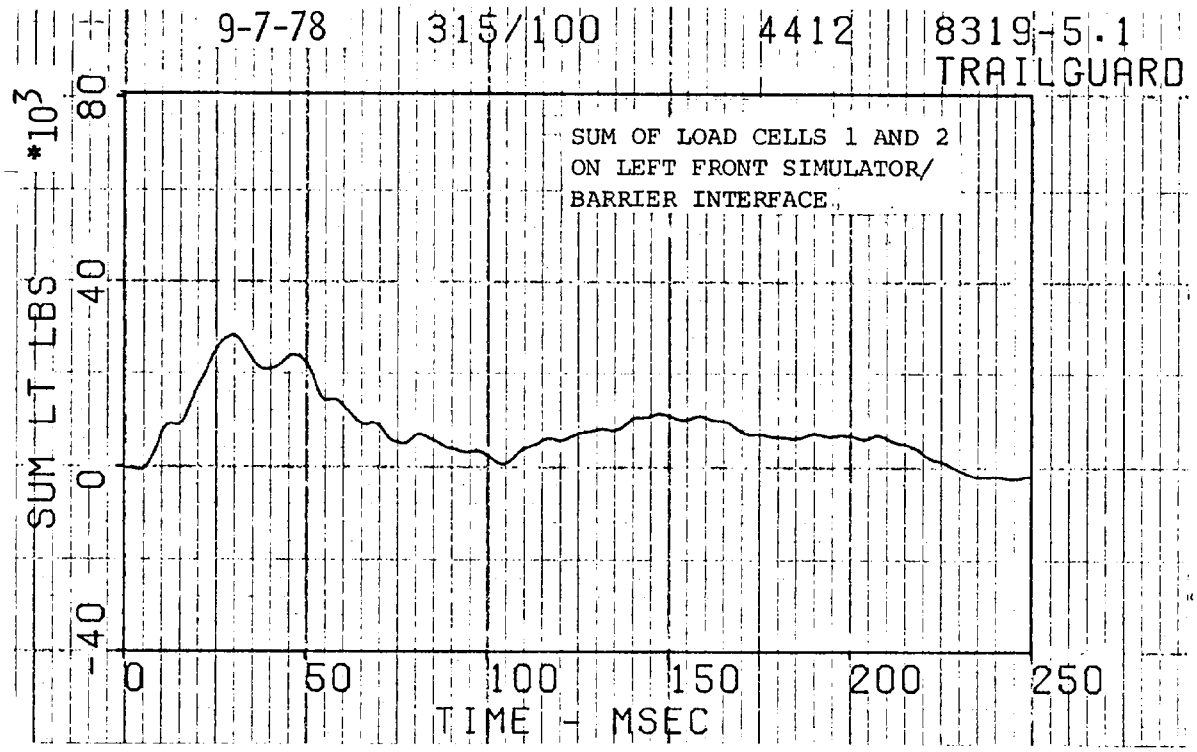
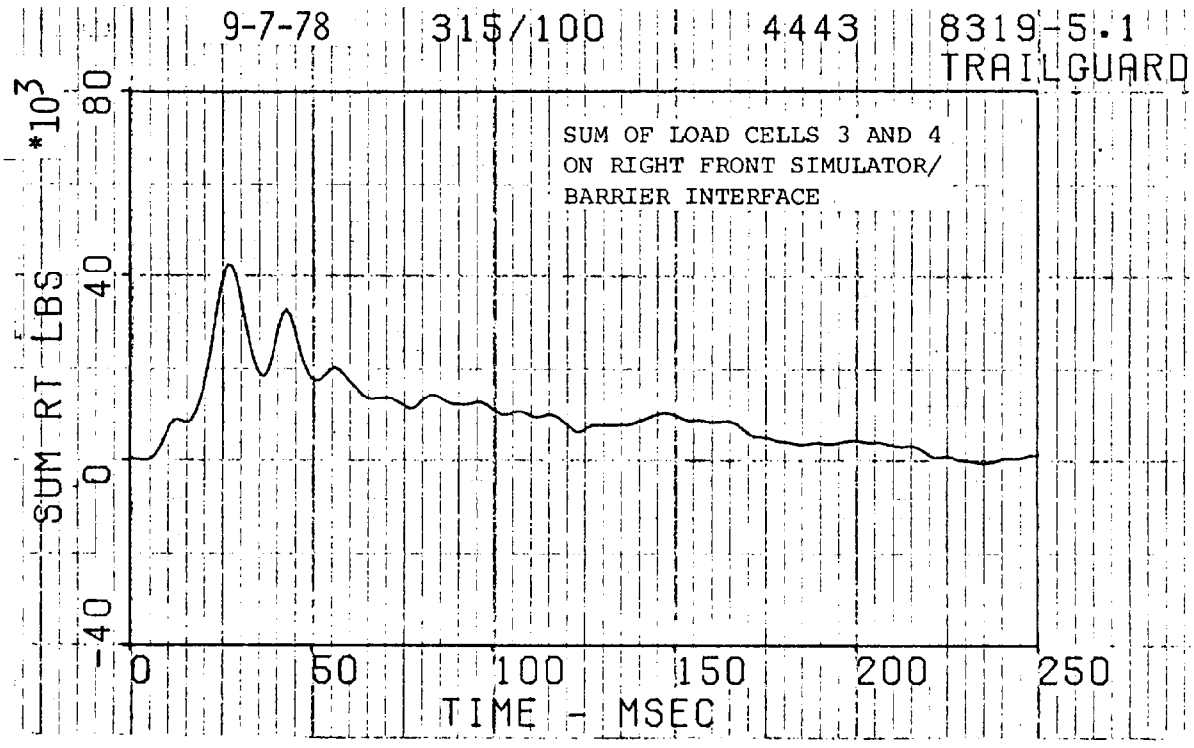
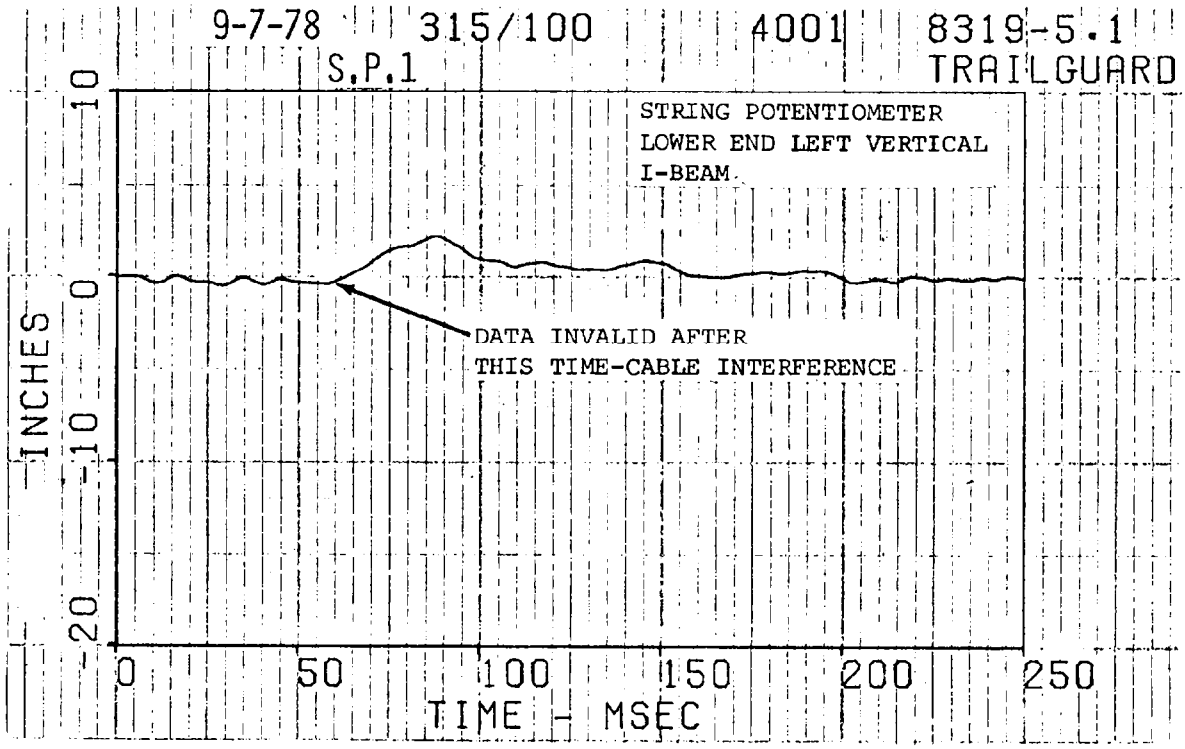
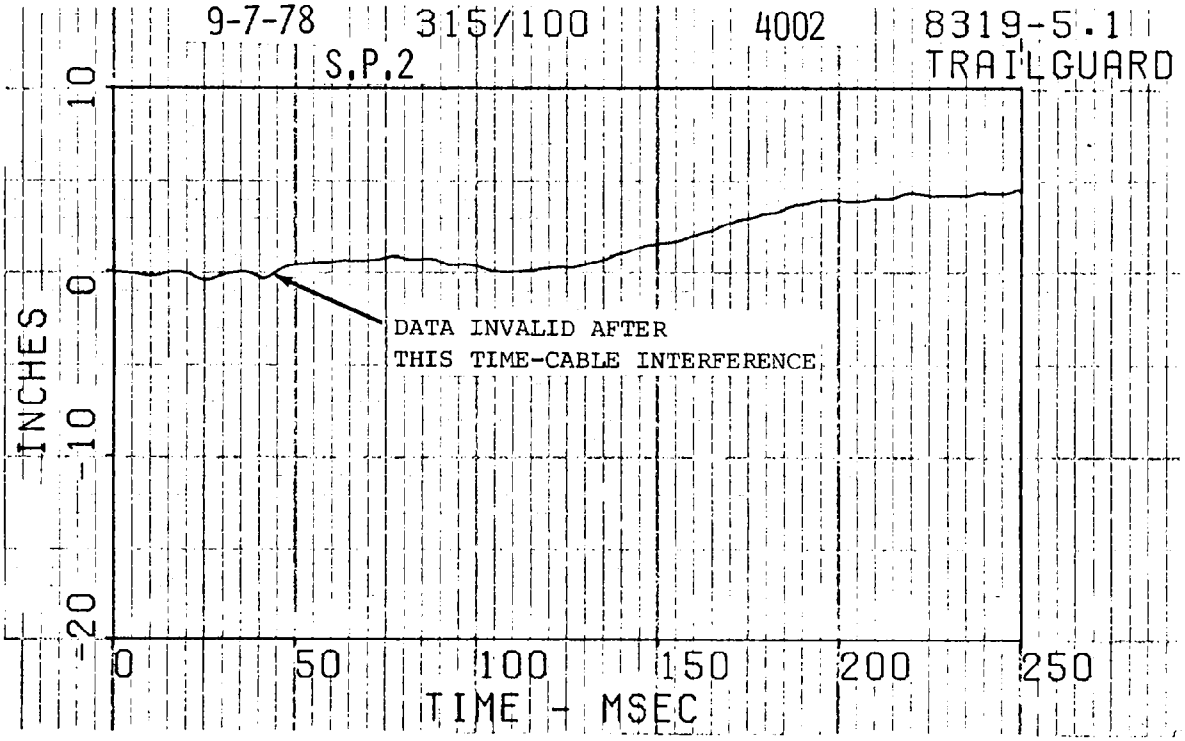
315/100
202
8319-5.1
TRAILGUARD
RIGHT MAIN TRAILER BEAM
ACCELERATION (REAR)
AX = G
10
0
-10
-20
0
50
100
150
200
250
TIME → MSEC

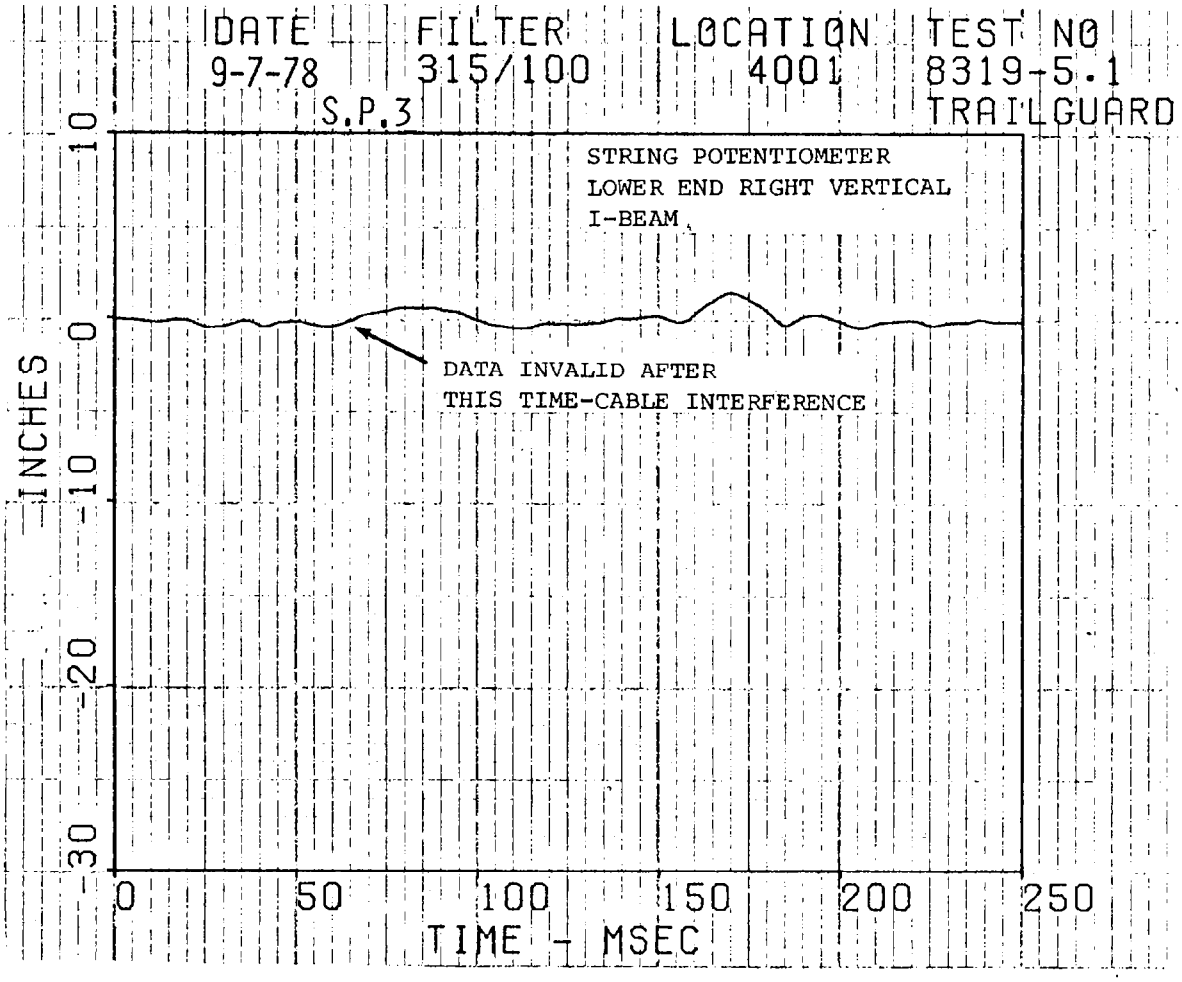

9-7-78
315/100
4484
8319-5.1
TRAILGUARD
TOTAL LOAD SIMULATOR/
BARRIER INTERFACE
TOTAL LBS *10^3
80
40
0
-40
0
50
100
150
200
250
TIME → MSEC

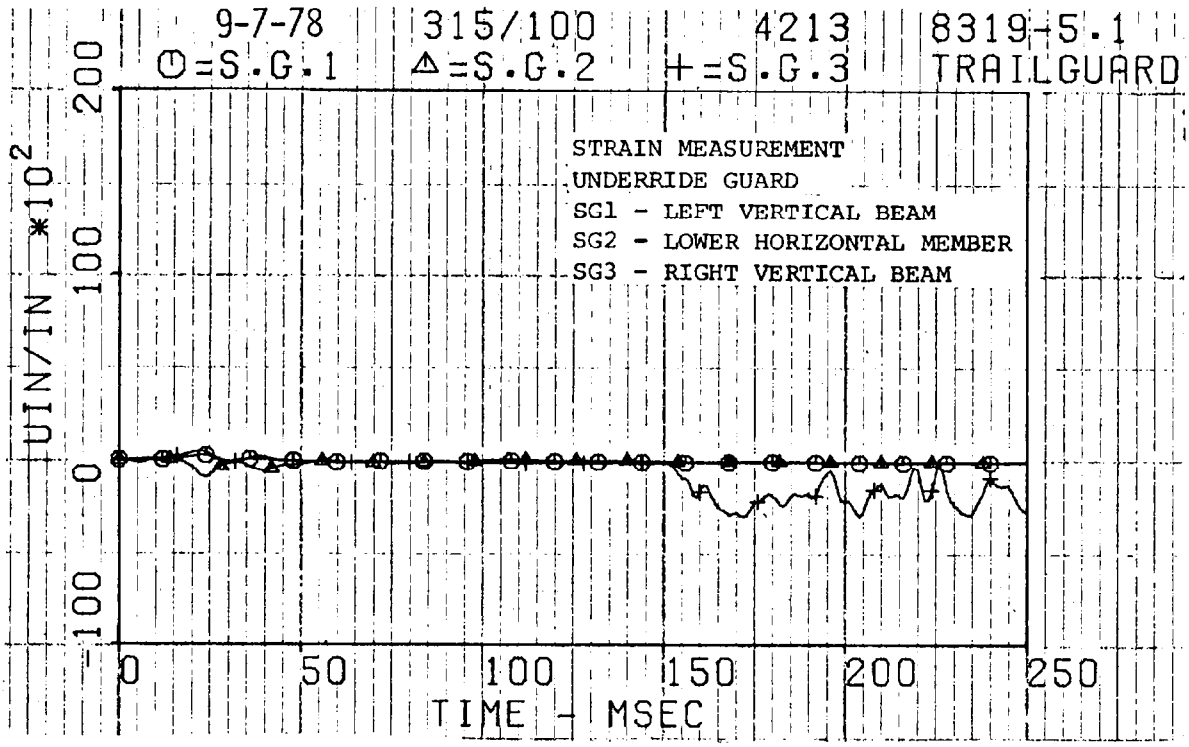

9-7-78
315/100
4412
8319-5.1
TRAILGUARD
SUM OF LOAD CELLS 1 AND 2
ON LEFT FRONT SIMULATOR/
BARRIER INTERFACE
SUM LT LBS *10^3
80
40
0
-40
0
50
100
150
200
250
TIME - MSEC

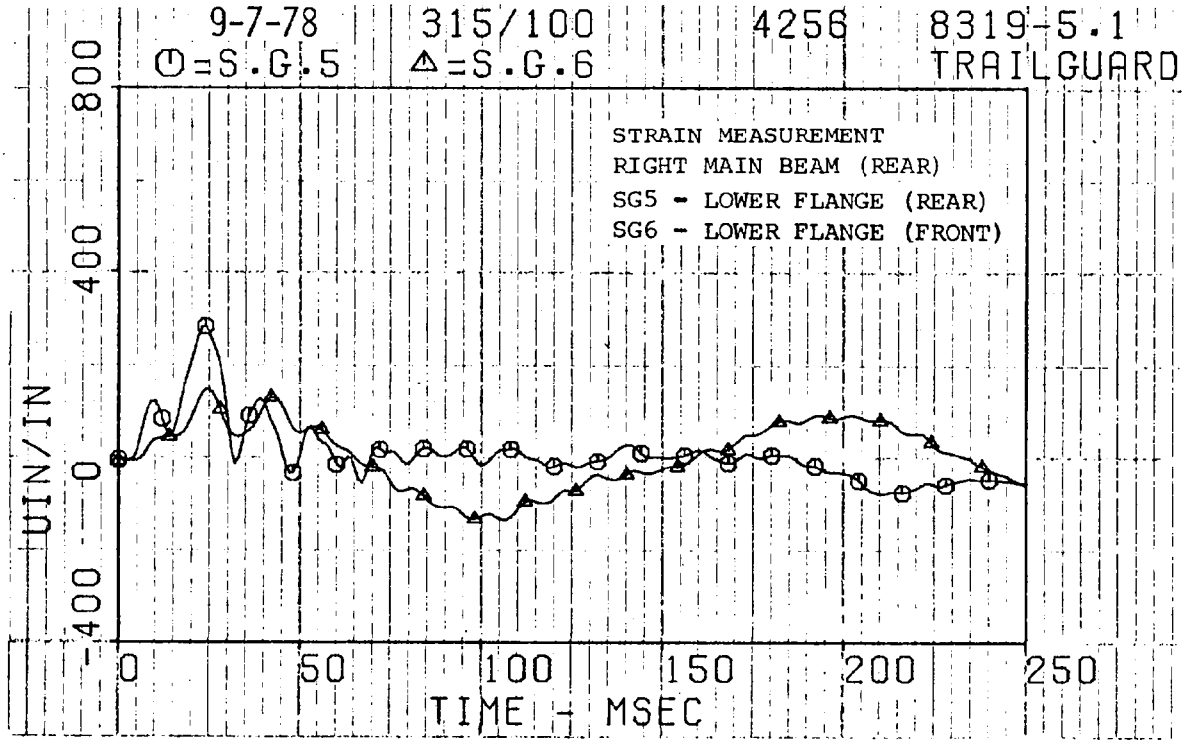

9-7-78
315/100
4443
8319-5.1
TRAILGUARD
SUM OF LOAD CELLS 3 AND 4
ON RIGHT FRONT SIMULATOR/
BARRIER INTERFACE
SUM RT LBS *10^3
80
40
0
-40
0
50
100
150
200
250
TIME - MSEC

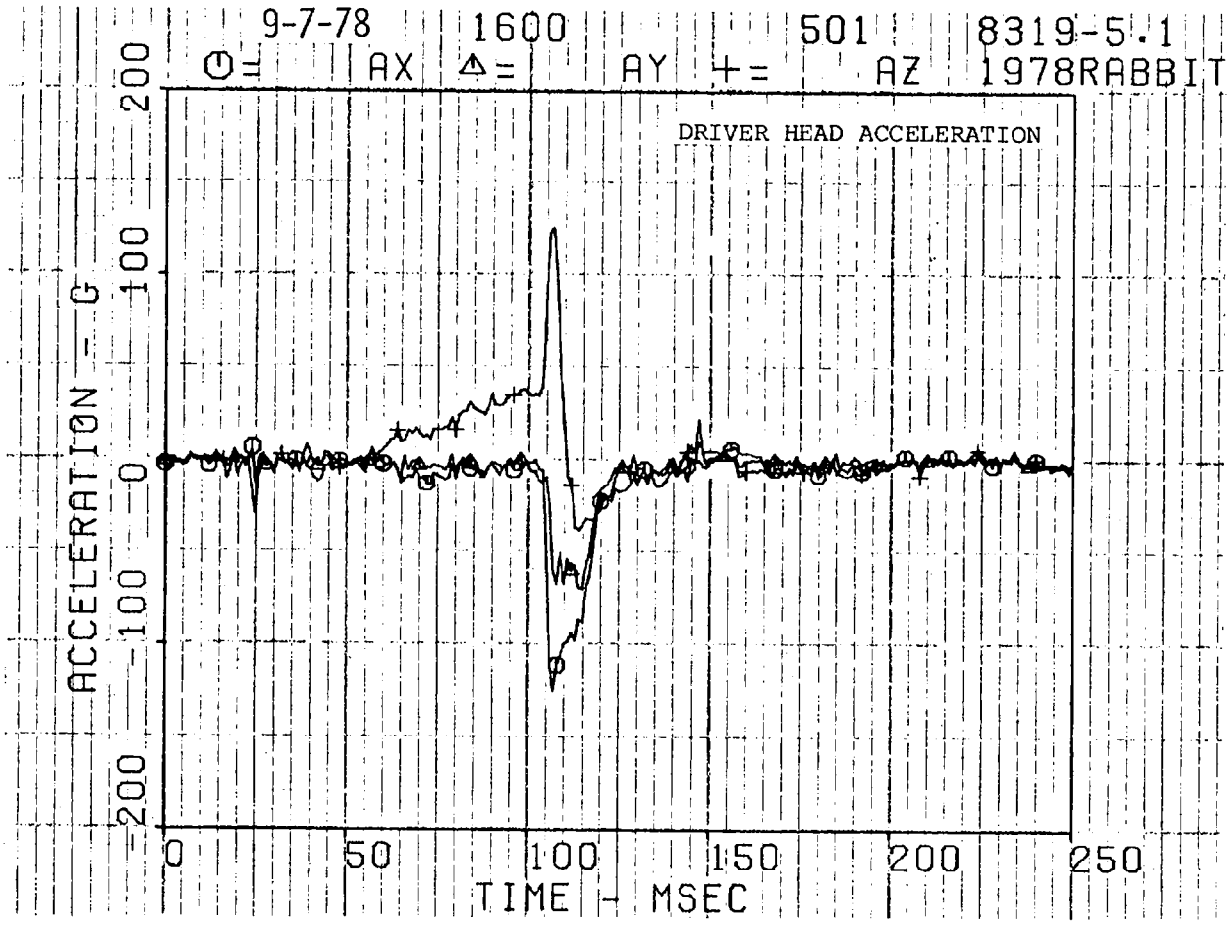

9-7-78
315/100
4001
8319-5.1
S.P.1
TRAILGUARD
STRING POTENTIOMETER
LOWER END LEFT VERTICAL
I-BEAM
DATA INVALID AFTER
THIS TIME-CABLE INTERFERENCE
INCHES
10
0
-10
-20
0
50
100
150
200
250
TIME - MSEC

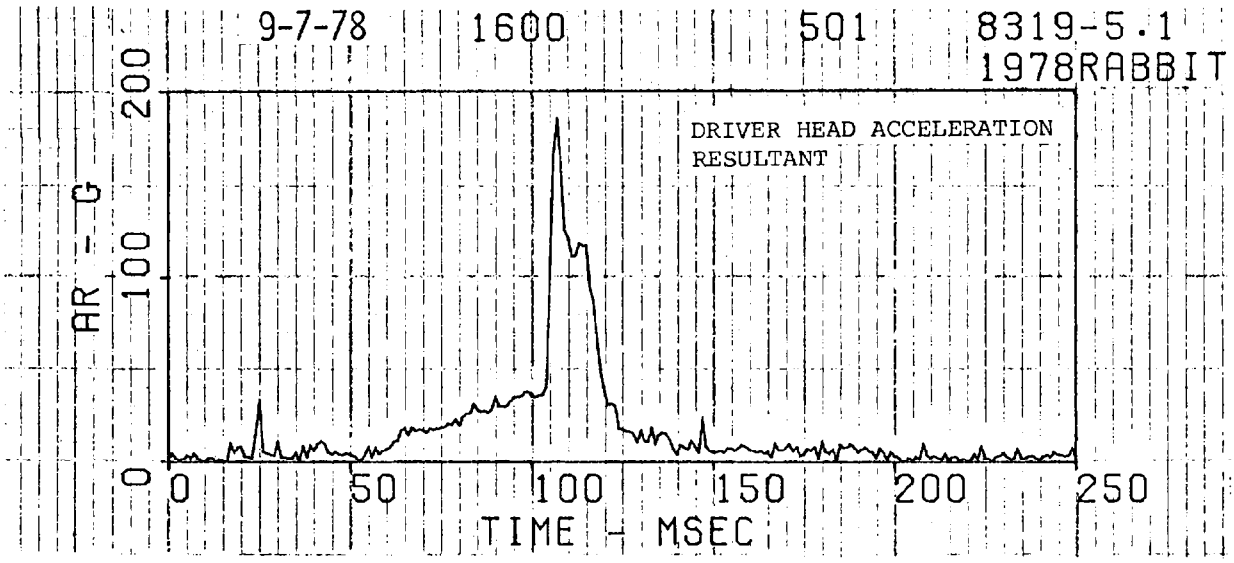

9-7-78
315/100
4002
8319-5.1
S.P.2
TRAILGUARD
DATA INVALID AFTER
THIS TIME-CABLE INTERFERENCE
INCHES
10
0
-10
-20
0
50
100
150
200
250
TIME - MSEC

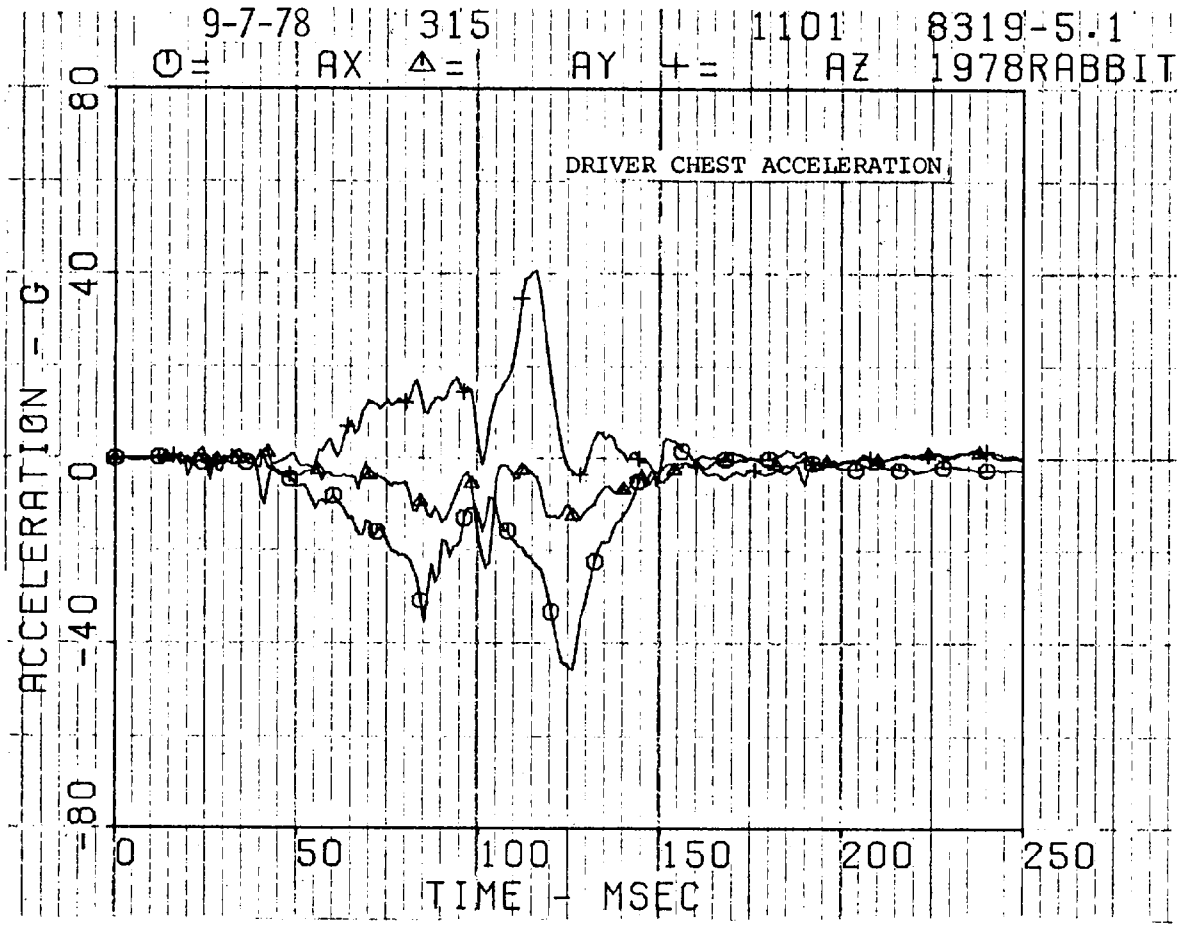

DATE
9-7-78
FILTER
315/100
LOCATION
4001
TEST NO
8319-5.1
S.P.3
TRAILGUARD
STRING POTENTIOMETER
LOWER END RIGHT VERTICAL
I-BEAM
DATA INVALID AFTER
THIS TIME-CABLE INTERFERENCE
INCHES
10
0
-10
-20
-30
0
50
100
150
200
250
TIME - MSEC

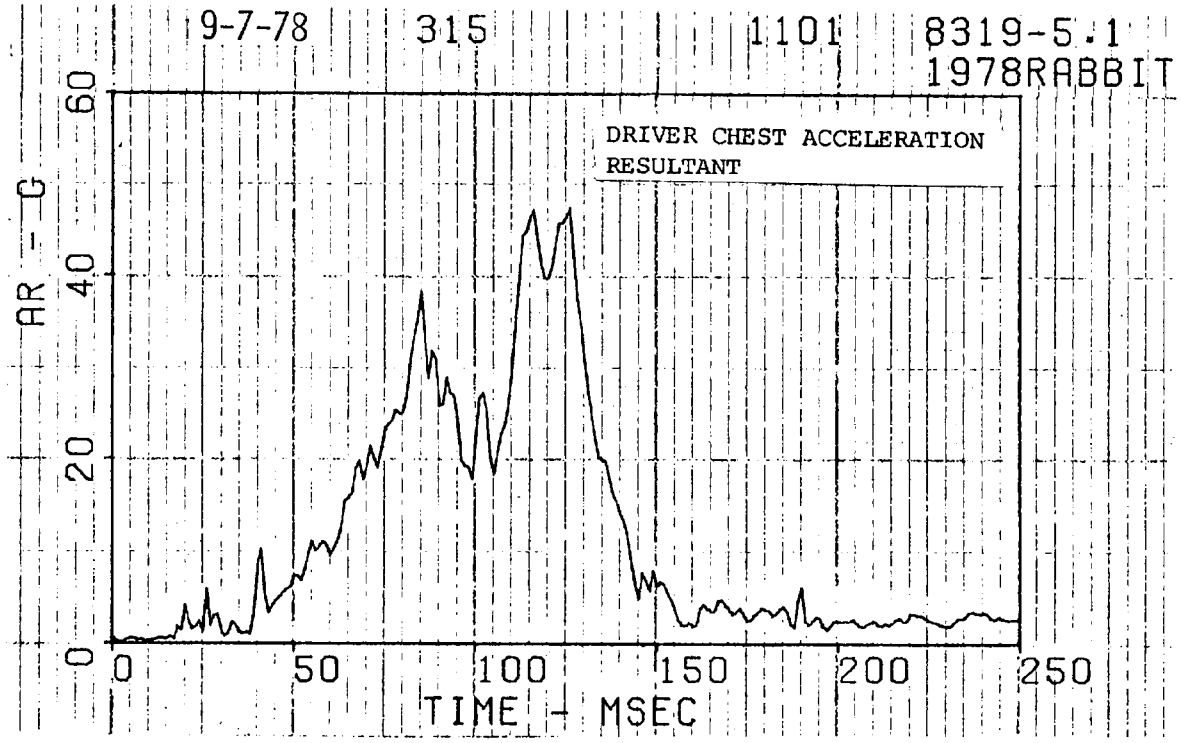

9-7-78
315/100
4213
8319-5.1
TRAILGUARD
⏲=S.G.1
△=S.G.2
+=S.G.3
STRAIN MEASUREMENT
UNDERRIDE GUARD
SG1 - LEFT VERTICAL BEAM
SG2 - LOWER HORIZONTAL MEMBER
SG3 - RIGHT VERTICAL BEAM
UIN/IN *10^2
200
100
0
-100
0
50
100
150
200
250
TIME - MSEC

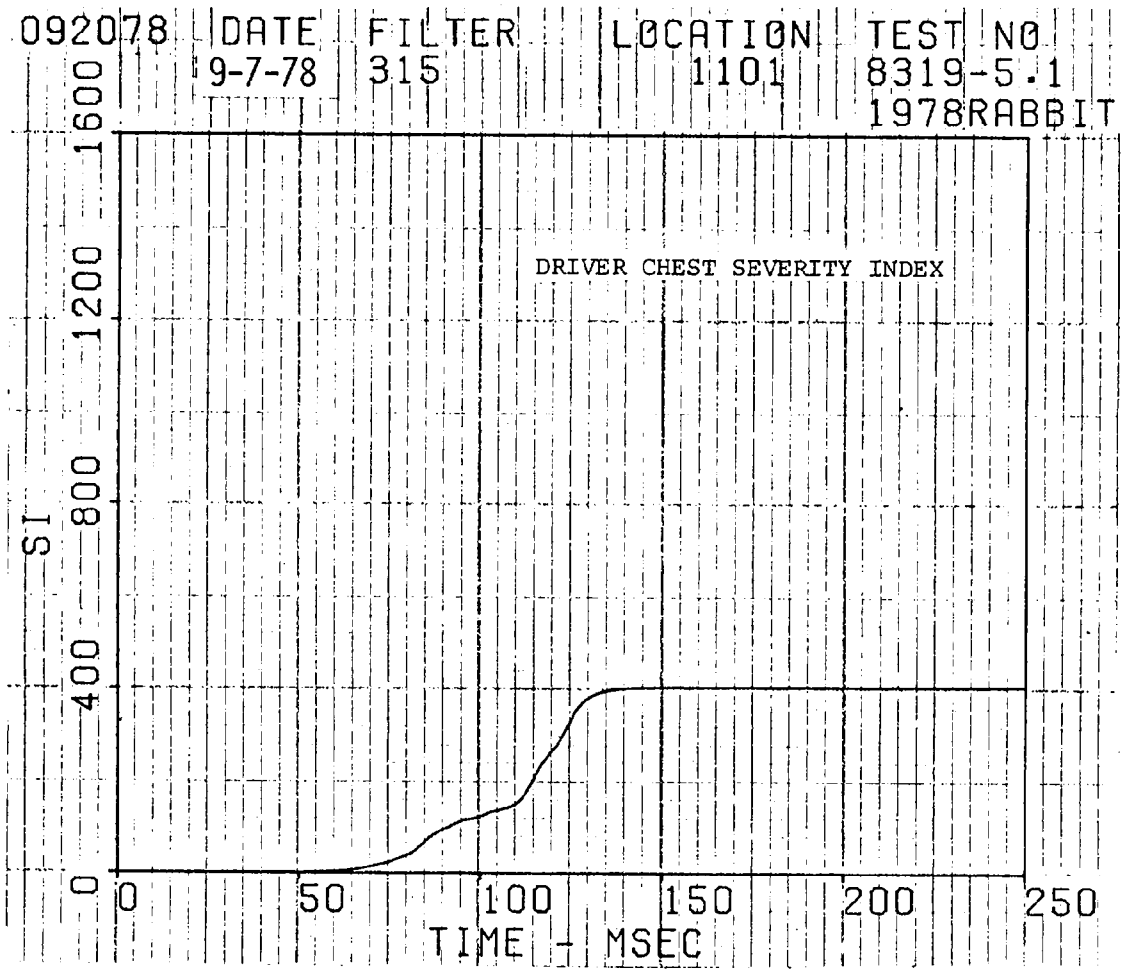

9-7-78
315/100
4256
8319-5.1
TRAILGUARD
⏲=S.G.5
△=S.G.6
STRAIN MEASUREMENT
RIGHT MAIN BEAM (REAR)
SG5 - LOWER FLANGE (REAR)
SG6 - LOWER FLANGE (FRONT)
UIN/IN
800
400
0
-400
0
50
100
150
200
250
TIME - MSEC

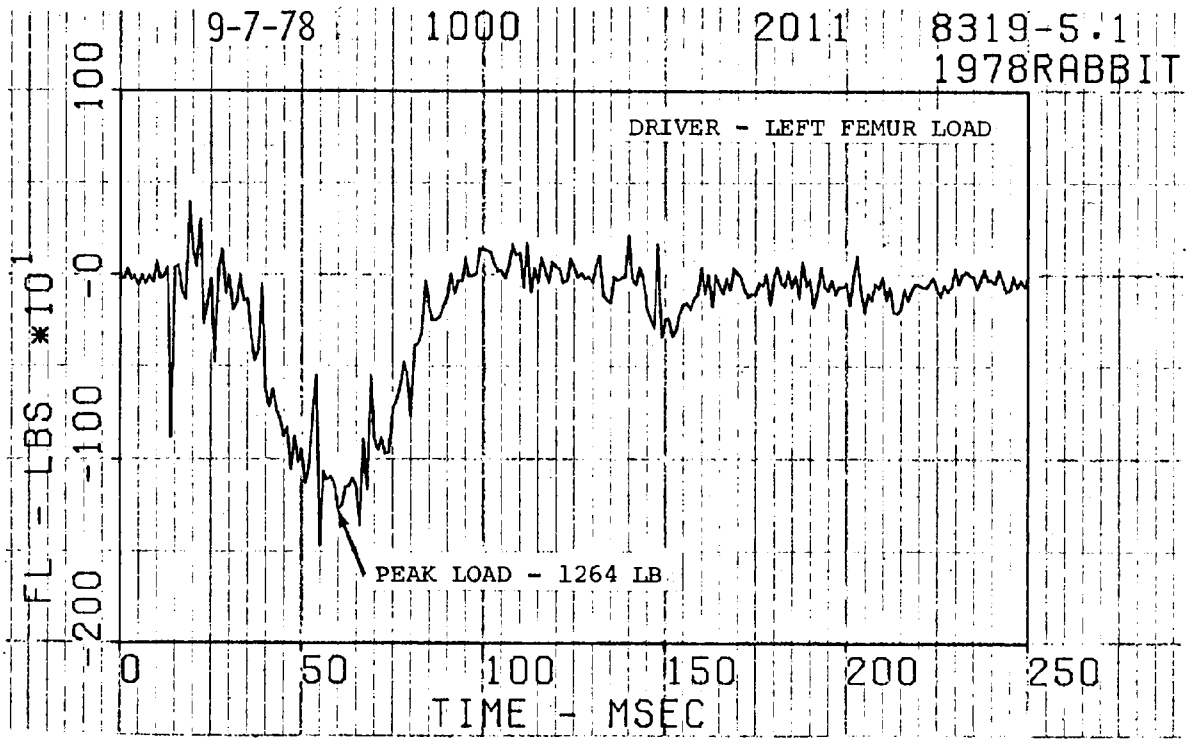

9-7-78
1600
501
8319-5.1
1978RABBIT
AX
AY
AZ
DRIVER HEAD ACCELERATION
ACCELERATION - G
200
100
0
-100
-200
0
50
100
150
200
250
TIME - MSEC

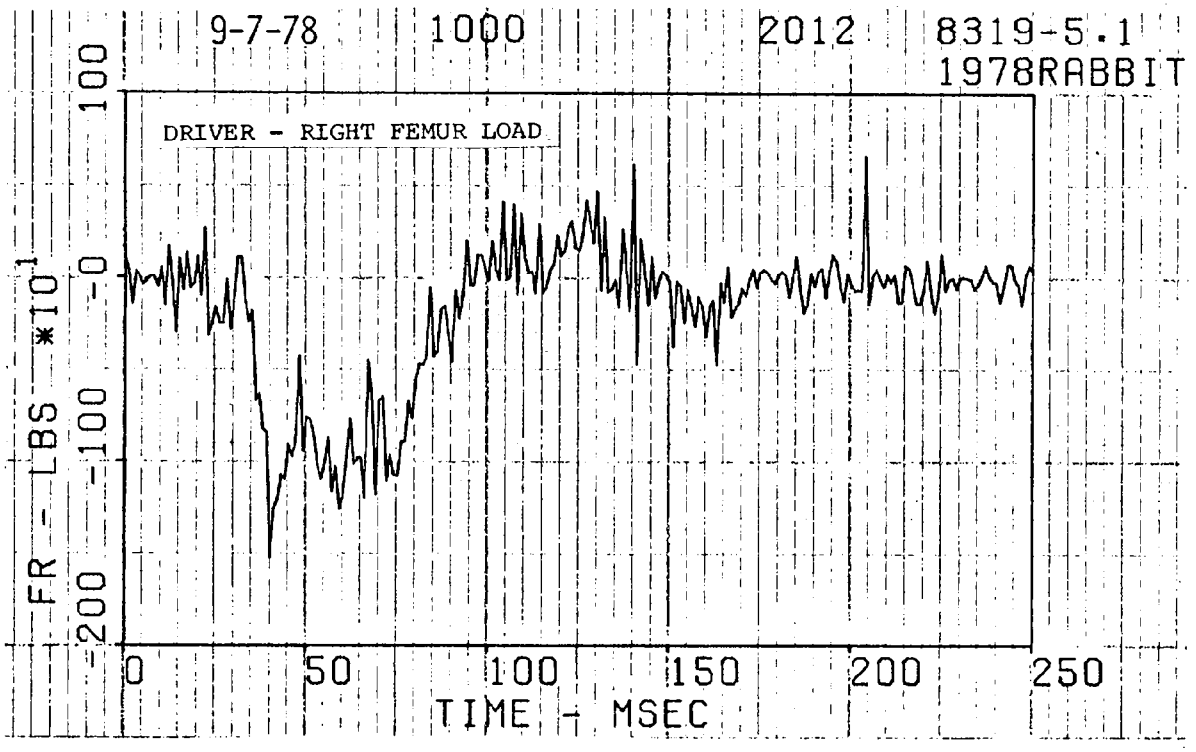

9-7-78
1600
501
8319-5.1
1978RABBIT
DRIVER HEAD ACCELERATION
RESULTANT
AR - G
200
100
0
0
50
100
150
200
250
TIME - MSEC

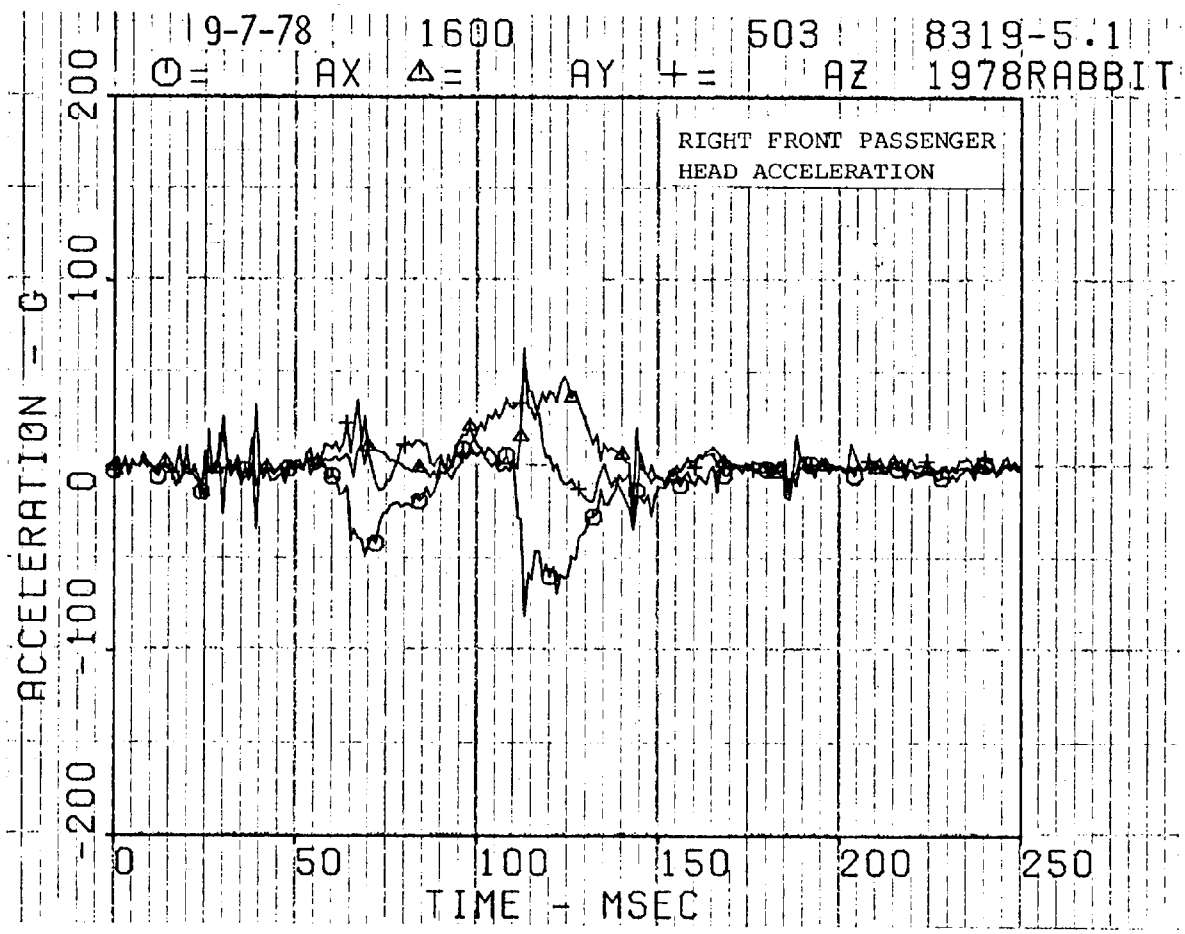

9-7-78
315
1101
8319-5.1
AX
AY
AZ
1978RABBIT
DRIVER CHEST ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
50
100
150
200
250
TIME - MSEC

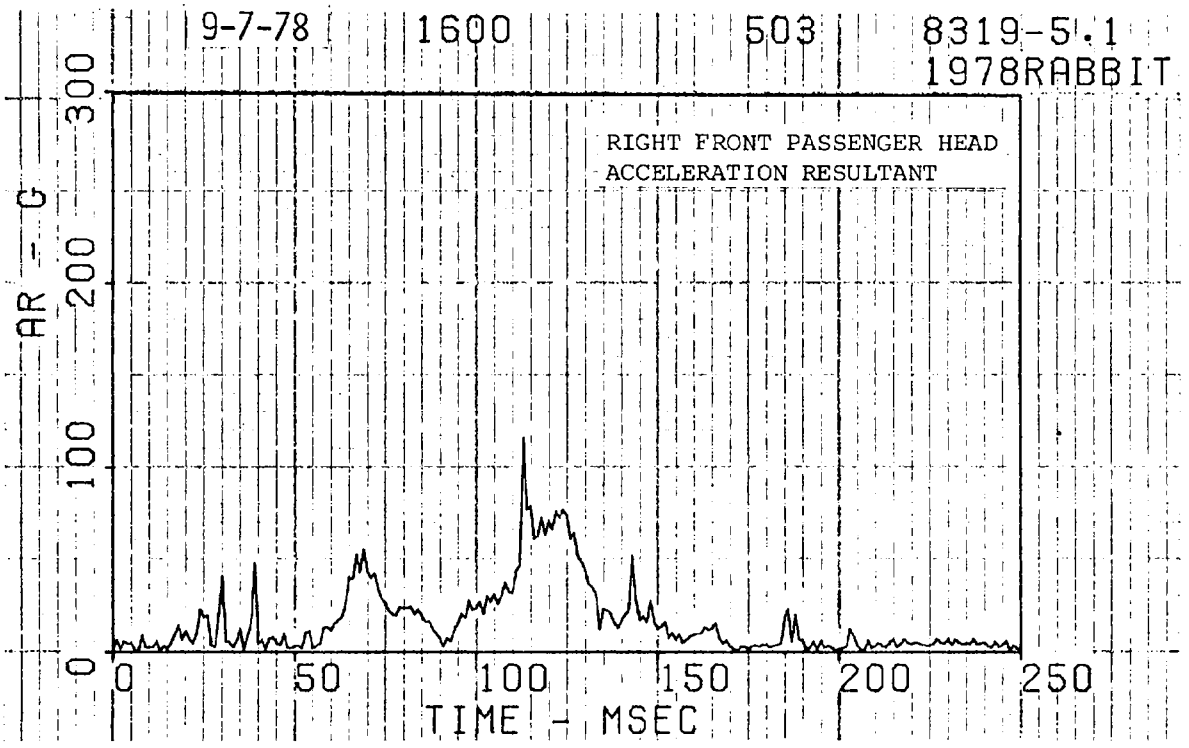

9-7-78
315
1101
8319-5.1
1978RABBIT
DRIVER CHEST ACCELERATION
RESULTANT
AR - G
60
40
20
0
0
50
100
150
200
250
TIME - MSEC

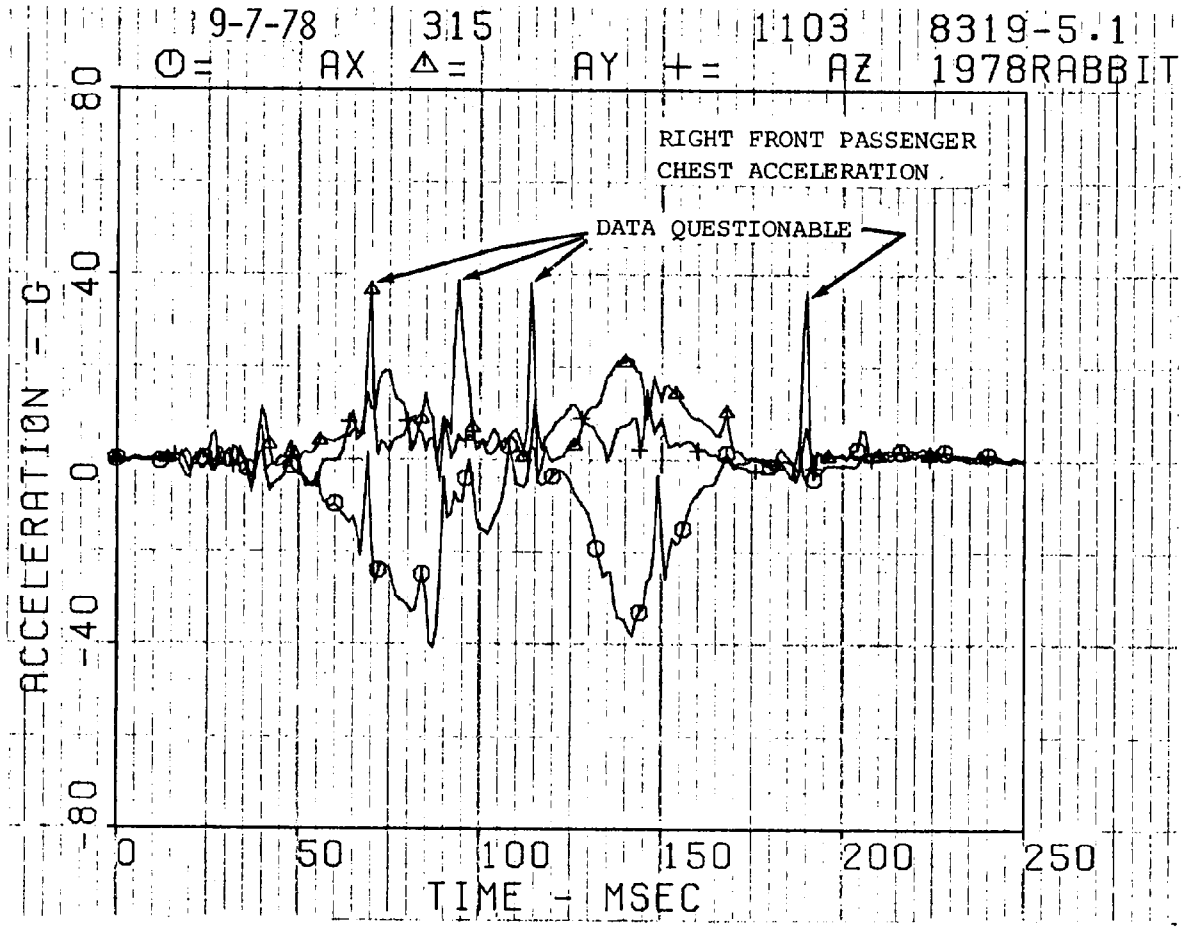

092078
DATE
9-7-78
FILTER
315
LOCATION
1101
TEST NO
8319-5.1
1978RABBIT
DRIVER CHEST SEVERITY INDEX
SI
1600
1200
800
400
0
0
50
100
150
200
250
TIME - MSEC

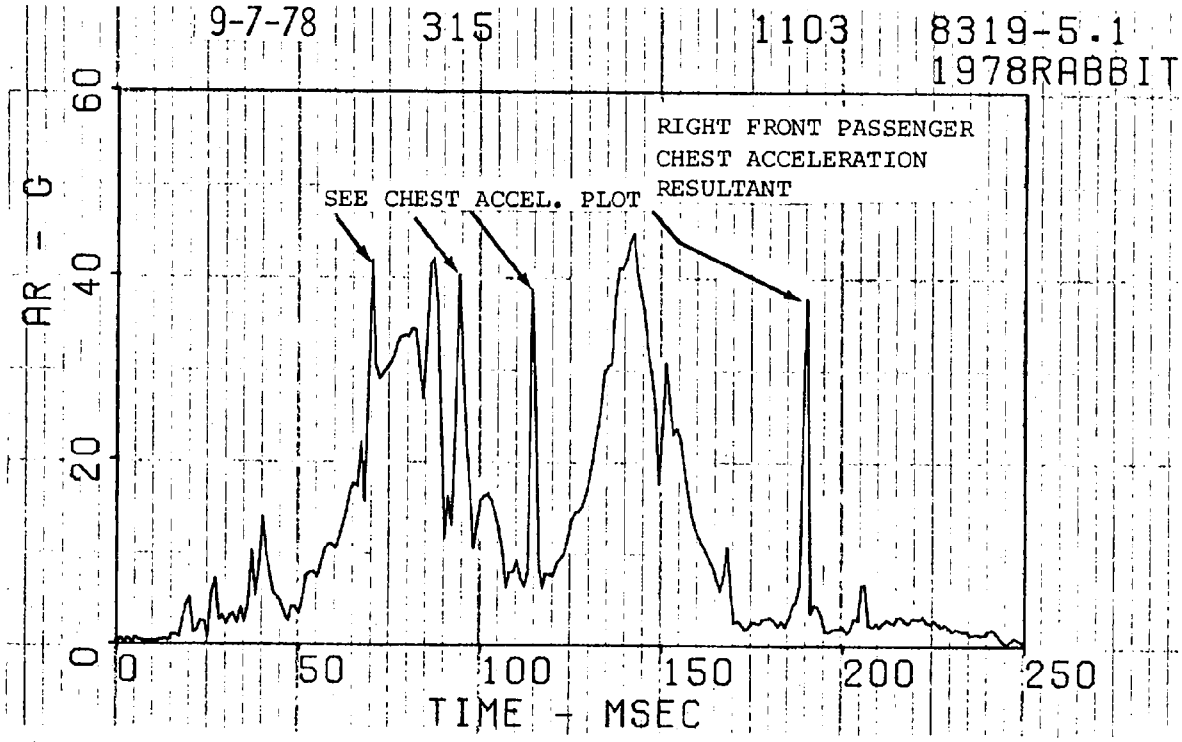

9-7-78
1000
2011
8319-5.1
1978RABBIT
DRIVER - LEFT FEMUR LOAD
PEAK LOAD - 1264 LB
FL - LBS *10^1
100
-0
-100
-200
0
50
100
150
200
250
TIME - MSEC

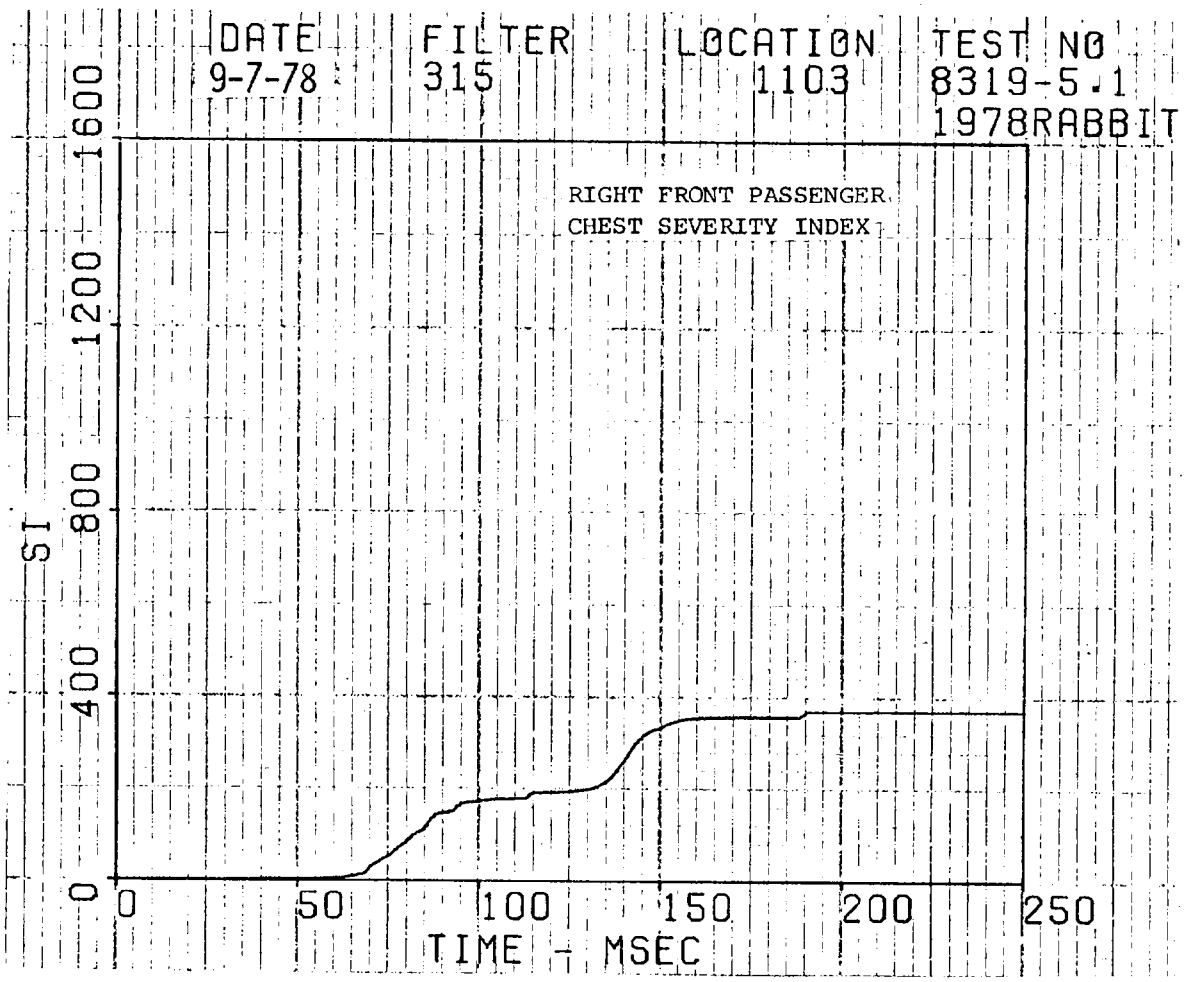

9-7-78
1000
2012
8319-5.1
1978RABBIT
DRIVER - RIGHT FEMUR LOAD
FR - LBS *10^1
100
-0
-100
-200
0
50
100
150
200
250
TIME - MSEC

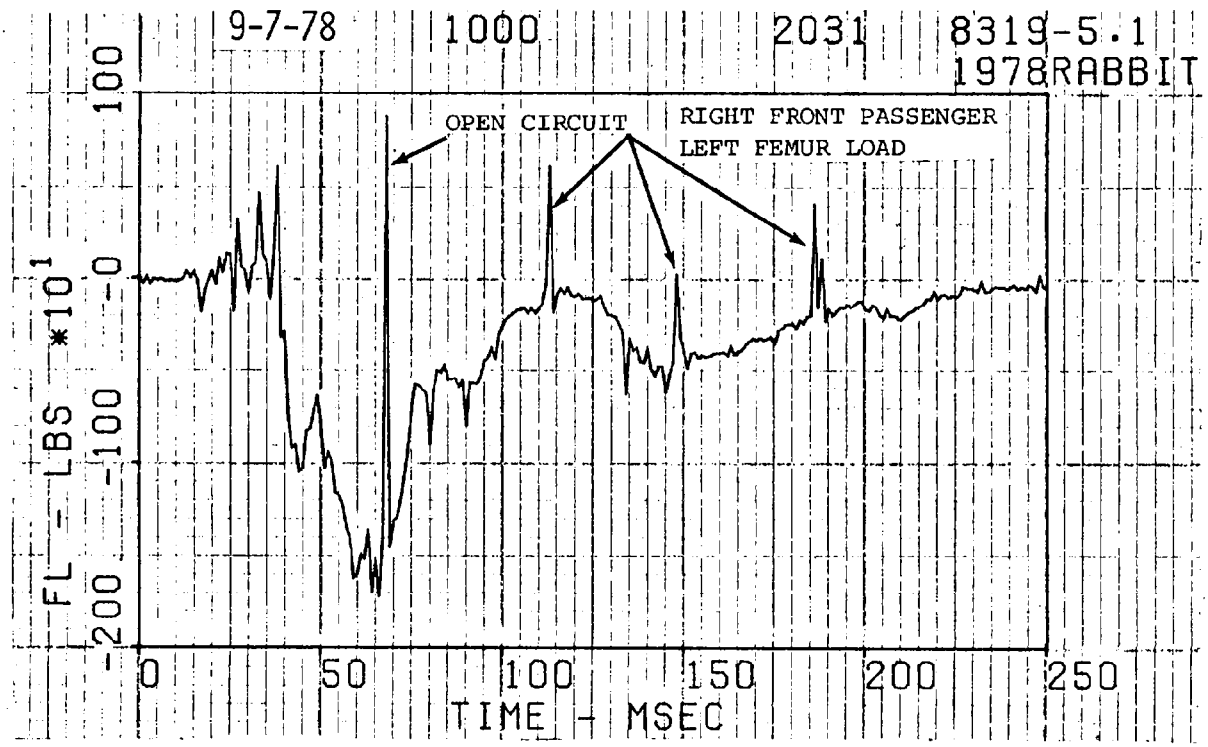

9-7-78
1600
503
8319-5.1
⊖= AX △= AY +=
AZ
1978RABBIT
RIGHT FRONT PASSENGER HEAD ACCELERATION
ACCELERATION - G
200
100
0
-100
-200
0
50
100
150
200
250
TIME - MSEC

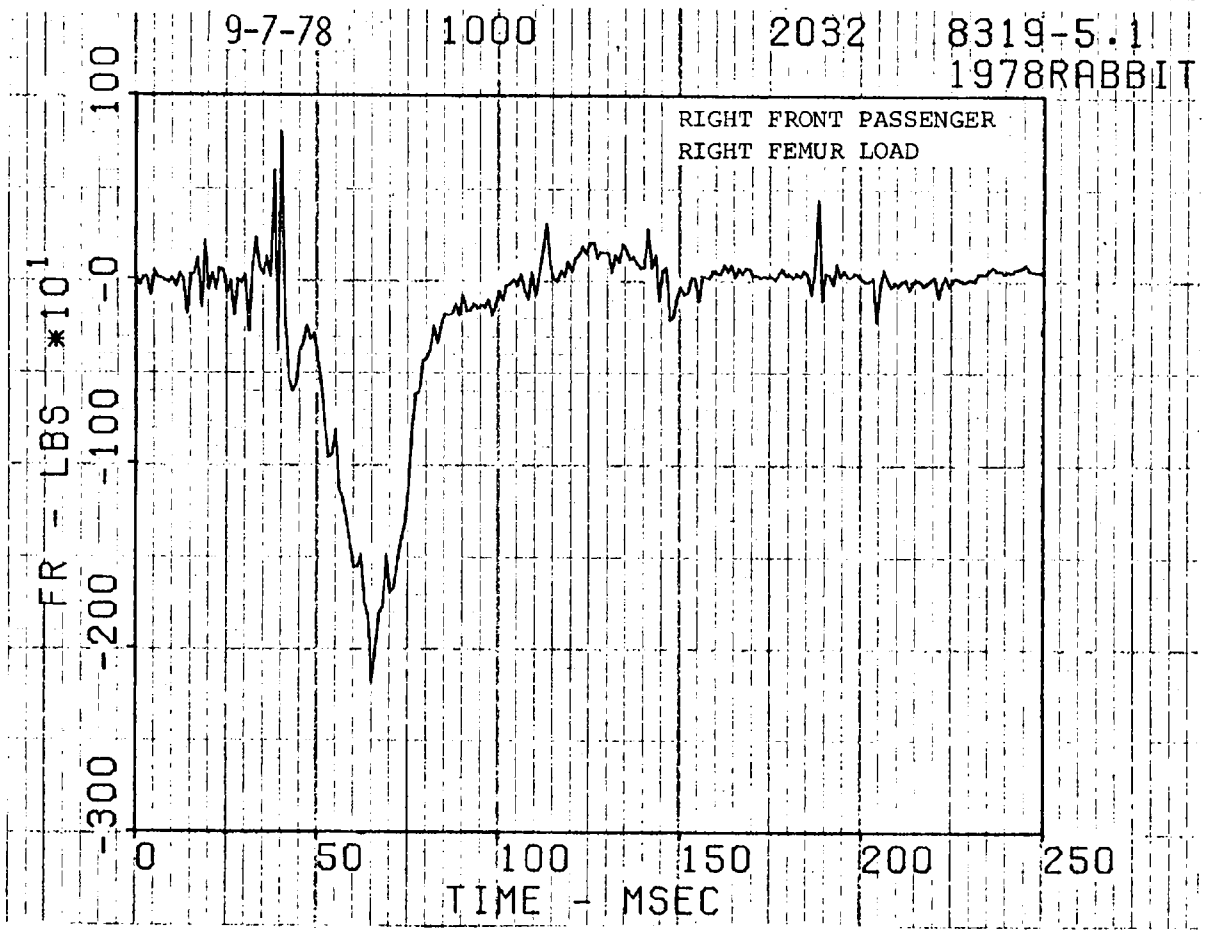

9-7-78
1600
503
8319-5.1
1978RABBIT
RIGHT FRONT PASSENGER HEAD ACCELERATION RESULTANT
AR - G
300
200
100
0
0
50
100
150
200
250
TIME - MSEC

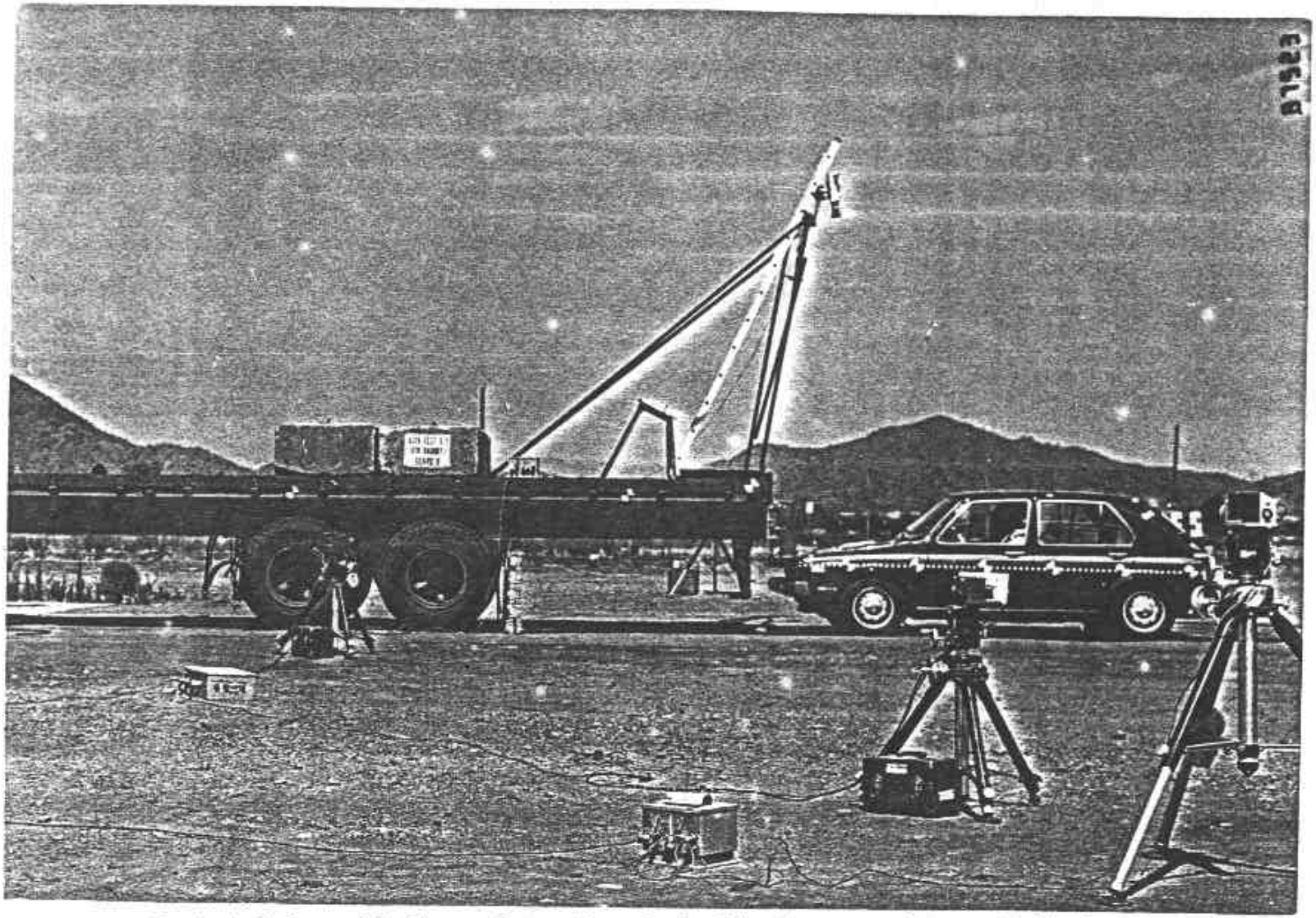

9-7-78 315 1103 8319-5.1
⊙= AX △= AY += AZ 1978RABBIT
RIGHT FRONT PASSENGER
CHEST ACCELERATION
DATA QUESTIONABLE
ACCELERATION - G
80
40
0
-40
-80
0
50
100
150
200
250
TIME - MSEC


9-7-78 315 1103 8319-5.1
1978RABBIT
RIGHT FRONT PASSENGER
CHEST ACCELERATION
RESULTANT
SEE CHEST ACCEL. PLOT
AR - G
60
40
20
0
0
50
100
150
200
250
TIME - MSEC


DATE
9-7-78
FILTER
315
LOCATION
1103
TEST NO
8319-5.1
1978RABBIT
RIGHT FRONT PASSENGER
CHEST SEVERITY INDEX
SI
0
400
800
1200
1600
0
50
100
150
200
250
TIME - MSEC

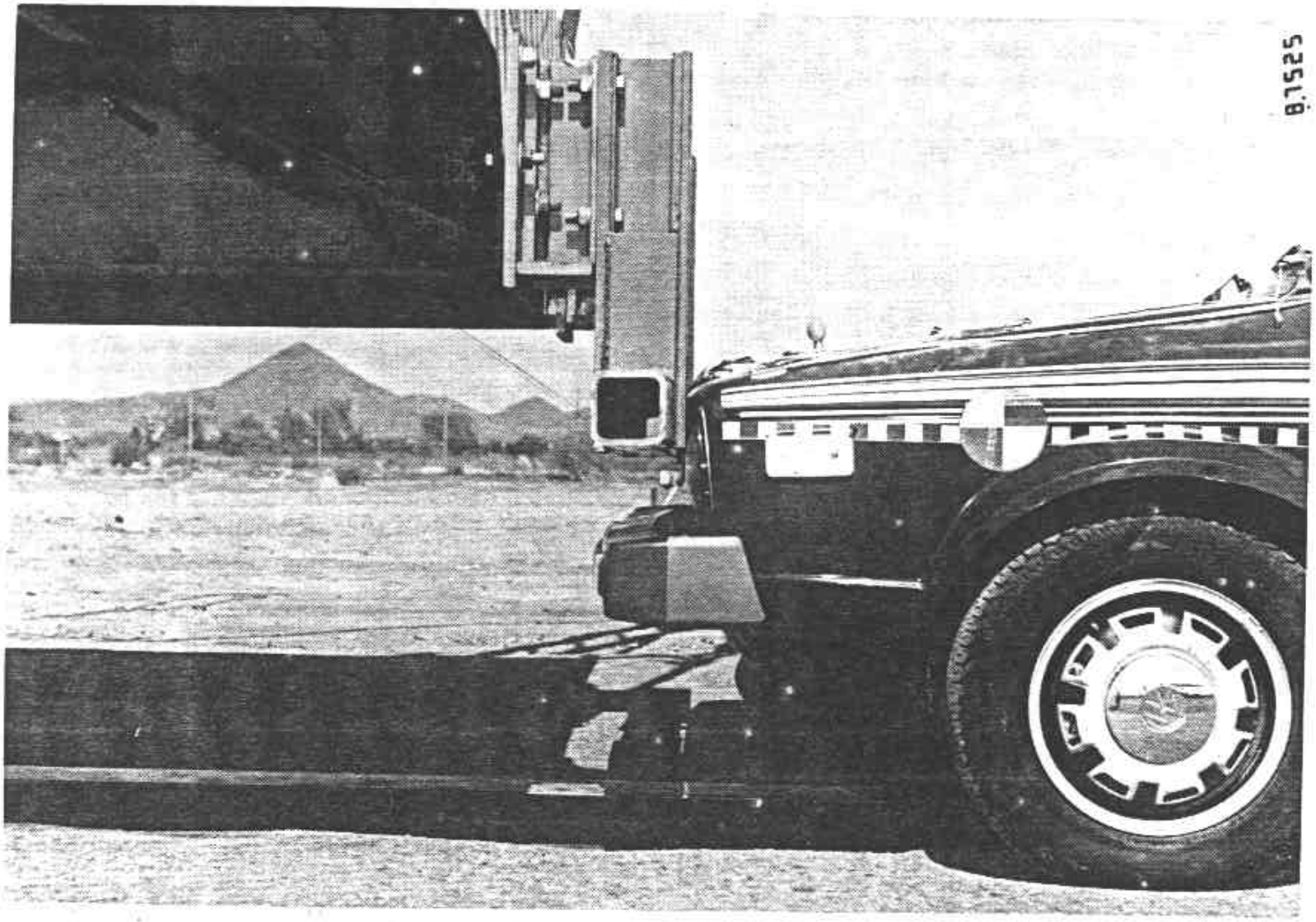

9-7-78
1000
2031
8319-5.1
1978RABBIT
OPEN CIRCUIT
RIGHT FRONT PASSENGER
LEFT FEMUR LOAD
FL = LBS *10^1
100
-0
-100
-200
0
50
100
150
200
250
TIME - MSEC


9-7-78
1000
2032
8319-5.1
1978RABBIT
RIGHT FRONT PASSENGER
RIGHT FEMUR LOAD
FR = LBS *10^1
100
-0
-100
-200
-300
0
50
100
150
200
250
TIME - MSEC



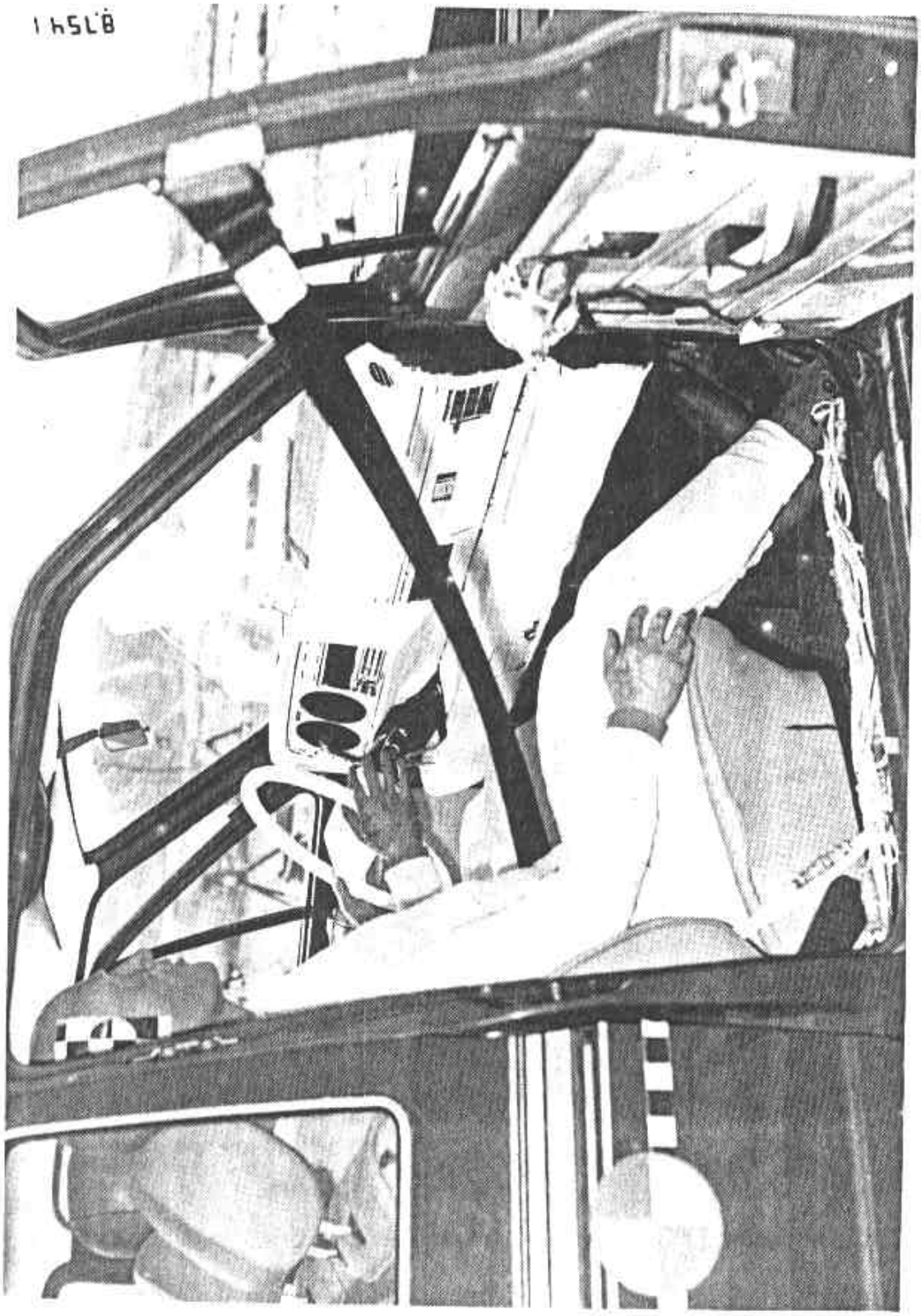
Test 5.1 Overall View of Trailer Body Simulator and Test Vehicle.

Test 5.1 Overall Pre-test View of Test Configuration.

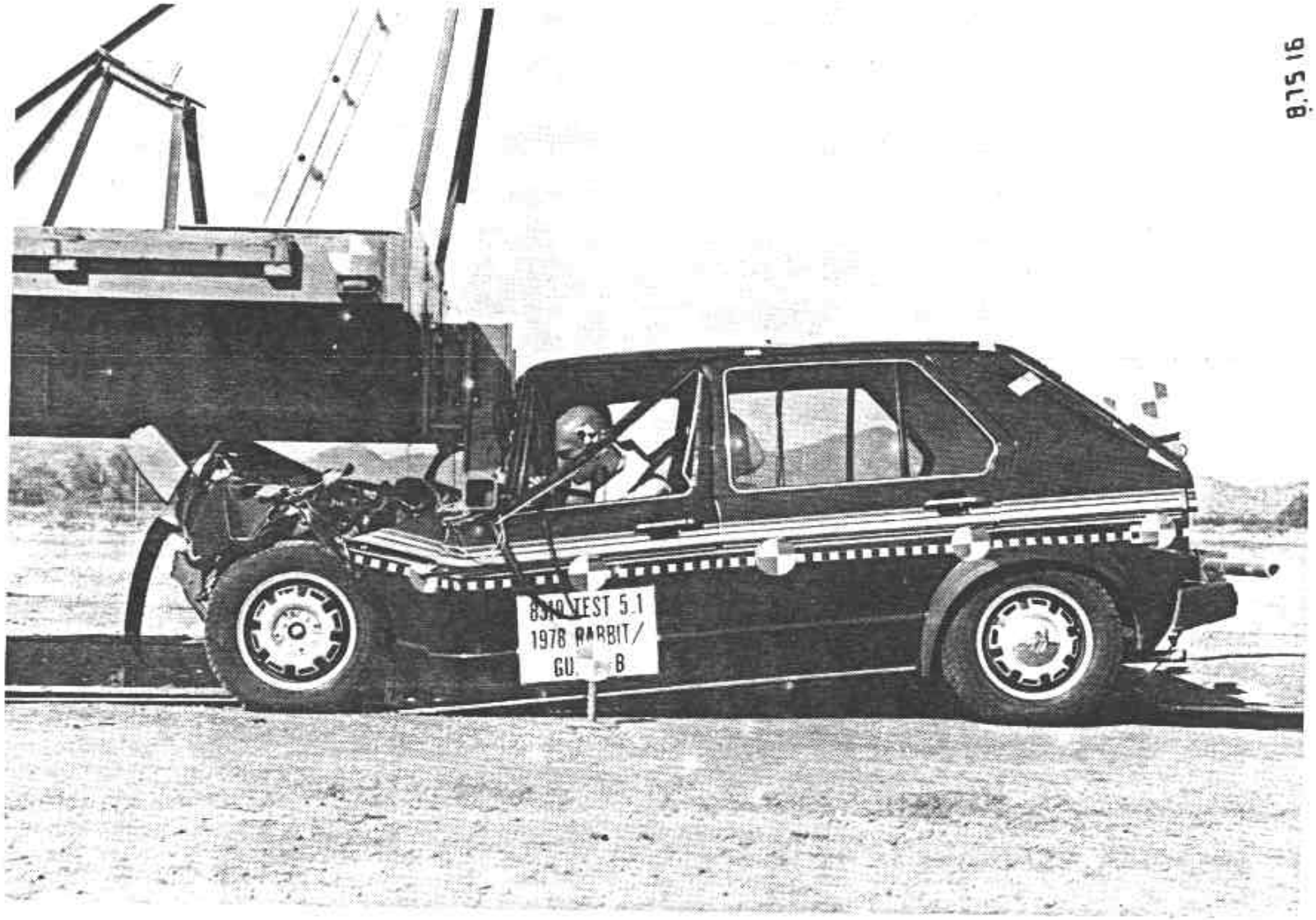


Test 5.1 Pre-test Close-up View of Vehicle/Guard Engagement.

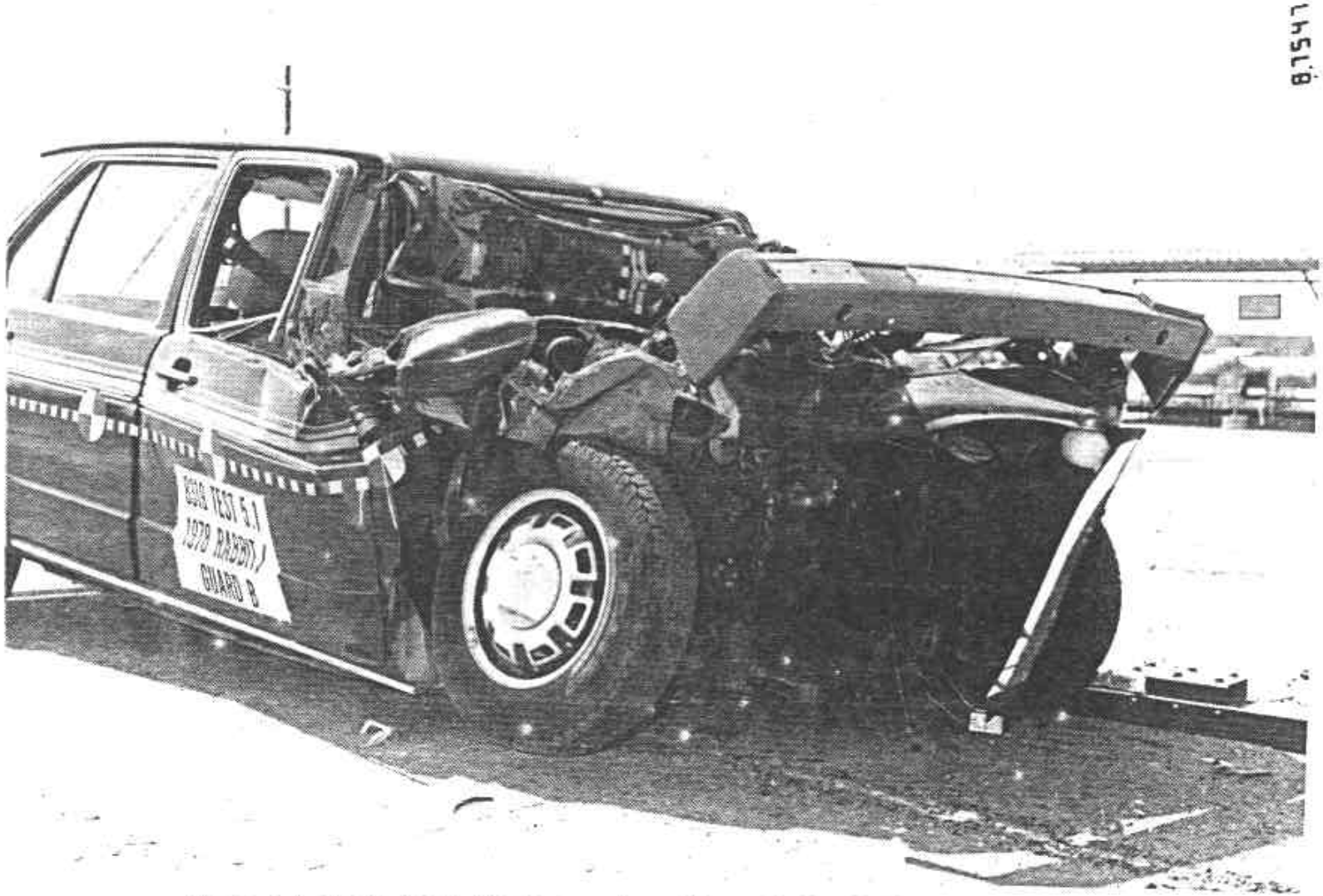
Test 5.1 Pre-test View of Driver Compartment.



Test 5.1 Pre-test View of Passenger Compartment.

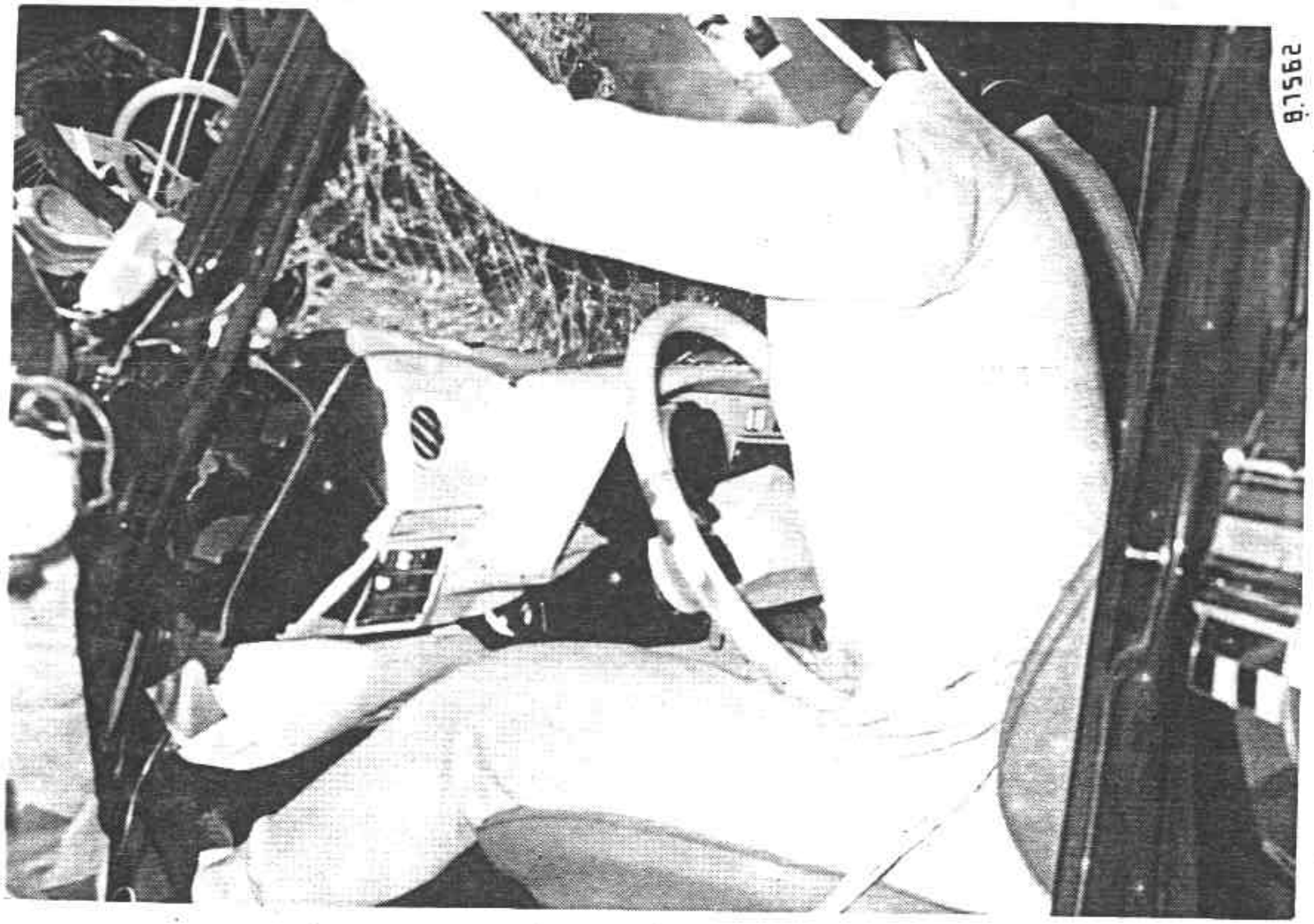


Test 5.1 Overall Post-test View of 1978 VW Rabbit/24" High Modified Guard A Crash.



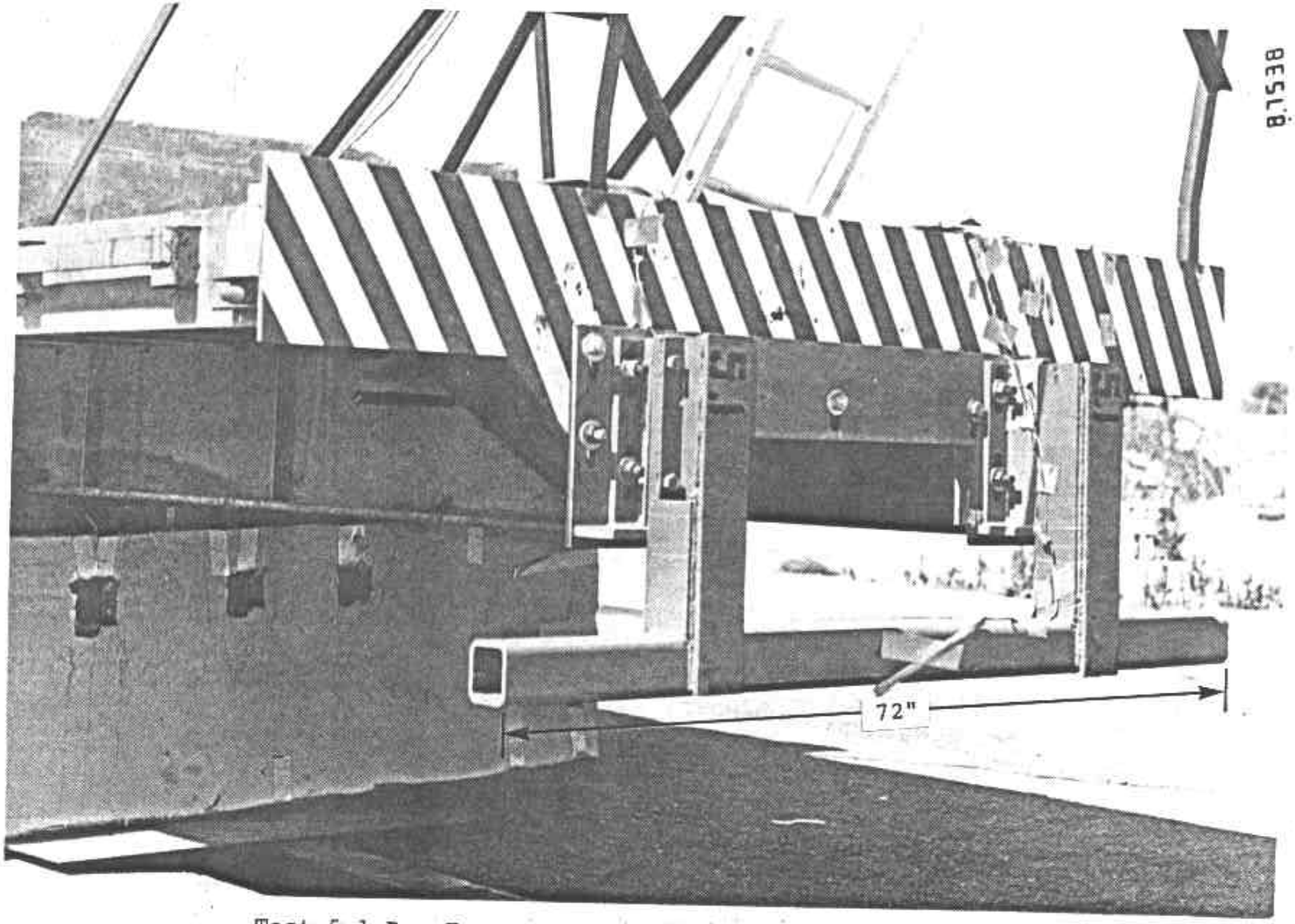
87548

Test 5.1 Post-test Three-quarter View of Frontal Damage.

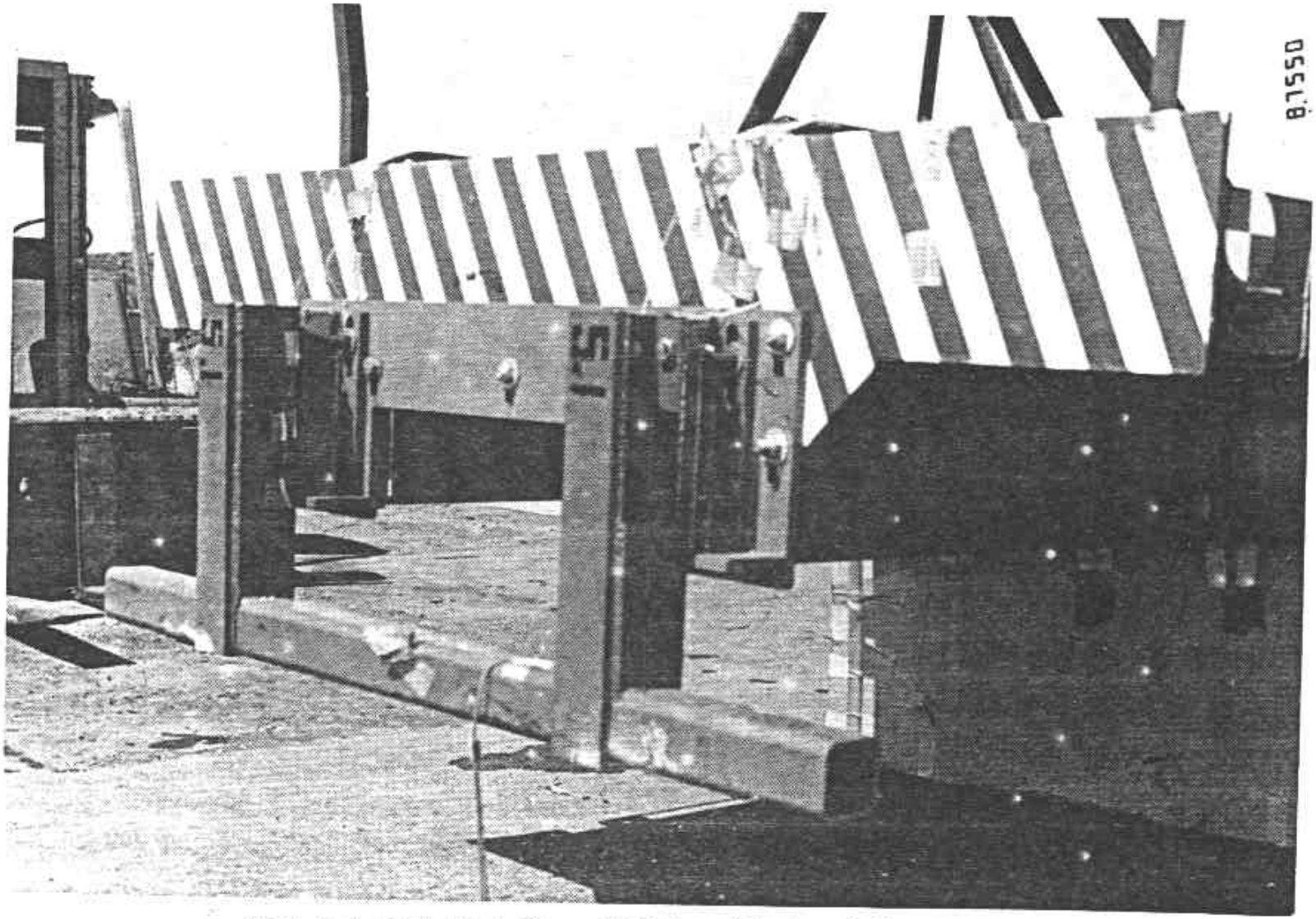


Test 5.1 Post-test View of Driver Compartment Damage.

Test 5.1 Post-test View of Passenger Compartment Damage.



Test 5.1 Pre-Test Overall View of Underride Guard.



Test 5.1 Post-test View of Underride Guard Damage.

0159

SAME

AS

0158

159

APPENDIX B

TEST 5.2 TEST DATA SUMMARY

1978 FORD FIESTA

SYMMETRIC IMPACT @ 40 MPH

TABLE B-1. RECEIVING INSPECTION OF VEHICLES

Contractor: Dynamic Science Contract No.: DOT-HS-8-01905

VIN NO.: GCFBTK24496 Make: Ford

NHTSA No.: R&D

Year: 1978 Color: Yellow Model: Fiesta 2-door Sedan

Auto Trans:	yes	(no)	Pwr Steering:	yes	(no)	Seats: (front) Bench:	
Pwr Brakes:	(yes)	no	Auto Speed Cont:	yes	(no)	Bucket:	X
Pwr Seats:	yes	(no)	Anti Skid Brake:	yes	(no)	Split Bench:	
Pwr Windows:	yes	(no)	Air Conditioning:	yes	(no)		
Tinted Glass:	(yes)	no	Rear Window Def.:	(yes)	no	Split Back Bench:	
Radio:	yes	(no)	Brakes: drum:		disc: F & R		
Clock:	yes	(no)					

Tire Size: 155SR12 Ply Rating: 4 Mfg. & Line: Michelin XZX

Bias Ply: ____ Belted: X Radial X /Eng.HP: ____ Cylinders: 4 Total Displ: 98 CID

Trans, # Fwd. Speeds: 4 Shipping Weight: 1840 Odometer: 145

Dealer (name, address, and phone number)

Art Butler
4817 N. 14th Place
Phoenix, Arizona 85016 (602)-279-0133

Remarks (list additional accessories not listed above)

Date of Manufacture: 10-77 Dynamic Science No.: 751 Date Received: 9-25-78

Tilting Steering Wheel: yes (no) Telescoping Steering Wheel: yes (no)

Fuel Capacity: _____ (from owner's manual) "Space Saver" Spare Tire yes (no)

Restraint System: Std. 3 Pt. Belt Sys.

1. Is the vehicle stock throughout? Describe: Yes. New Production Vehicle

2. Does vehicle show evidence of prior accident history? Describe: None

3. Does vehicle show any significant corrosion? Describe: None

4. Check condition of the front bumper and frame: Satisfactory

TABLE B-2. SUMMARY OF VEHICLE ENGINE/BUMPER/FIREWALL CHARACTERISTICS

Test No. 5.2 Type Symmetric

Car Model 1978 Ford Fiesta Dynamic Science No. 751

Engine Size	98 CID
Engine Height/Width (in.)	26.5/28*
Bumper to Engine (in.)	18.1
Engine Length (in.)	6.5
Engine to Firewall (in.)	10.5
Bumper to Firewall (in.)	35.1
Bumper to "Hard Point" (Engine) (in.)	18.1
Initial Impact Point to Front Bumper (in.)	4.4
Height From Top of Front Bumper to Lowest Point of Underride Guard (in.)	1.5
Horizontal Dimension From Centerline of Vehicle to Extreme Left Edge of Guard (in.)	36
Horizontal Dimension From Centerline of Vehicle to Extreme Right Edge of Guard (in.)	36

*Transverse mounted engine.

TABLE B-3. SUMMARY OF CAR ACCELEROMETER DATA

Accelerometer Number	Plot Location Number	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)
1X	101	-30.5	10
1Y	101	-8.6	28
2X	102	-29.1	9
3X	103	-37.7	20
3Y	103	-4.4	20
4X	104	-36.3	30
4Y	104	-7.7	22
5X	105	-42.1	16
$6X_1$	106	-89.0	23
$6X_2$	N/A	N/A	
6Z	106	-129.9	17
7X	107	-127.4	27

TABLE B-4. SUMMARY OF CAR ACCELEROMETER DATA

Accelerometer Number	Plot Location Number	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)
2X	202	-9.3	27

TABLE B-5. SUMMARY OF COMPARTMENT AND ENGINE ACCELEROMETER DATA

Accelerometer Number	Plot Location Number	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)
Average of 1X and 2X	401	-29.4	9
$6X_1$	106	-89.0	23

TABLE B-6. SUMMARY OF UNDERRIDE GUARD STRING POTENTIOMETER DATA

Displacement Potentiometer (Number)	Displacement Potentiometer (Location)	Plot Location Number	Maximum Dynamic Displacement D (in.)	Maximum Dynamic Displacement Time (msec)
SP1	Left	4001	-9.2*	59
SP2	Center	4002	-9.4*	60
SP3	Right	4003	-8.9*	58

*Guard broke away at mounting bolts to simulator at 23 msec.

TABLE B-7. COMPARISON OF TOTAL INTERFACE FORCE FROM LOAD CELL AND ACCELEROMETER DATA

Parameter	Trailer Force Data*	Car Acceleration Data**
Force (lb)	70,018	75,338
Time (msec)	22	24

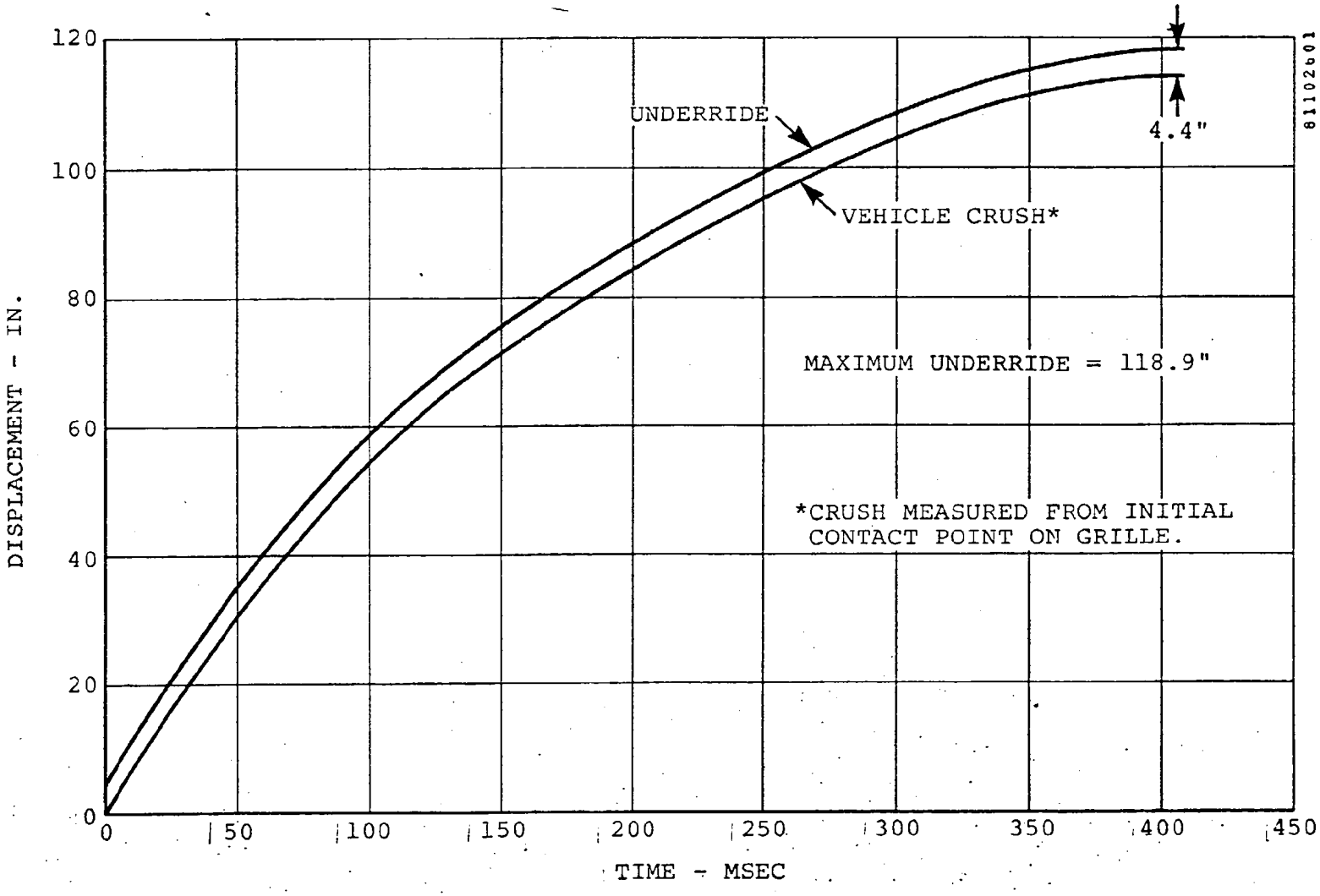
*Sum of 4 load cells.
**Average of car accelerometers 1 and 2 x (vehicle minus engine weight) + engine acceleration x (engine weight).

TABLE B-8. SUMMARY OF UNDERRIDE GUARD AND TRAILER STRAIN GAUGE DATA

Strain Gauge Number	Plot Location Number*	Maximum Strain** (μin./in.)	Maximum Time (msec)
SG1	4201	659	19
SG2	4201	-829	18
SG3		Failed	
SG4	Not Used		
SG5	4400	177	19
SG6	4400	392	18

*For location of strain gauges 1-3, see Figure 3-2.
For location of strain gauges 5-6, see Figure 2-3.

**Stress = strain (in./in.) x E (30 x 10^6 lb/in. for steel), tensile strain and stress are negative values.



Test 5.2 Vehicle Underride and Crush Versus Time - 1978 Ford Fiesta - Symmetric Impact @ 40.64 mph.

TABLE B-9. SUMMARY OF PRE-TEST AND POST-TEST VEHICLE STATIC MEASUREMENTS

TEST NO.: 5.2 VEHICLE: 1978 Ford Fiesta

Location	Dimension Pre	Dimension Post	Reference	Difference
Front edge of water pump casting	102	97	Target 120	5.0
Bottom of "A" pillar (left)	72.4	73.1	Target 120	-0.7
Bottom of "A" piller (right)	72.3	71.9	Target 120	0.4
Rear top edge of panel (left	67.3	66.0	Target 120	1.3
Rear top edge of panel (right)	67.0	64.4	Target 120	2.6
Steering column hub (horizontal)	58.4	57.7	Target 120	0.7
Steering column lower rim (horizontal)	54.2	57.1	Target 120	-2.9
Steering column hub (vertical)	21.3	15.3	Rocker Sill	6.0
Steering column lower rim (vertical)	12.2	10.1	Rocker Sill	2.1
Centerline windshield opening (top)	57.8	13.2	Target 120	44.6
Top of "A" pillar (left)	52.9	14.0	Target 120	38.9
Top of "A" pillar (right)	52.8	19.4	Target 120	33.4
Dash panel at knee height (left)	N/A	N/A	Target 120	N/A
Dash panel at knee height (right)	69.0	67.0	Target 120	2.0
Firewall, driver centerline	83.5	82.4	Target 120	1.1
Firewall, passenger centerline	83.0	82.3	Target 120	0.7
Firewall, vehicle centerline	83.0	82.1	Target 120	0.9
Shock tower (left)	95.7	90.4	Target 120	5.3
Shock tower (right)	95.5	89.3	Target 120	6.2

TABLE B-10. SUMMARY OF PRE-TEST DUMMY POSITION DATA CHARACTERISTICS

Test No. 5.2 Type Symmetric

Car Model 1978 Ford Fiesta Dynamic Science No. 751

	Left Front Occupant	Right Front Occupant
Seat Range (in.)	4.7	4.6
Seat Position* (in.)	2.5	2.4
Front Seat to Firewall (in.)	26.3	25.4
Forehead to Windshield (in.)	18.8	18.9
Torso to Steering Wheel** (in.)	14.2	23.6
Left/Right Knee to Dash Panel (in.)	12.5/6.7	5.6/6.0

Dummy Type Alderson Part 572

Locations: Left Front Occupant - No. 759

Right Front Occupant - No. 760

Restraint Type: LF Belts w/ELR***

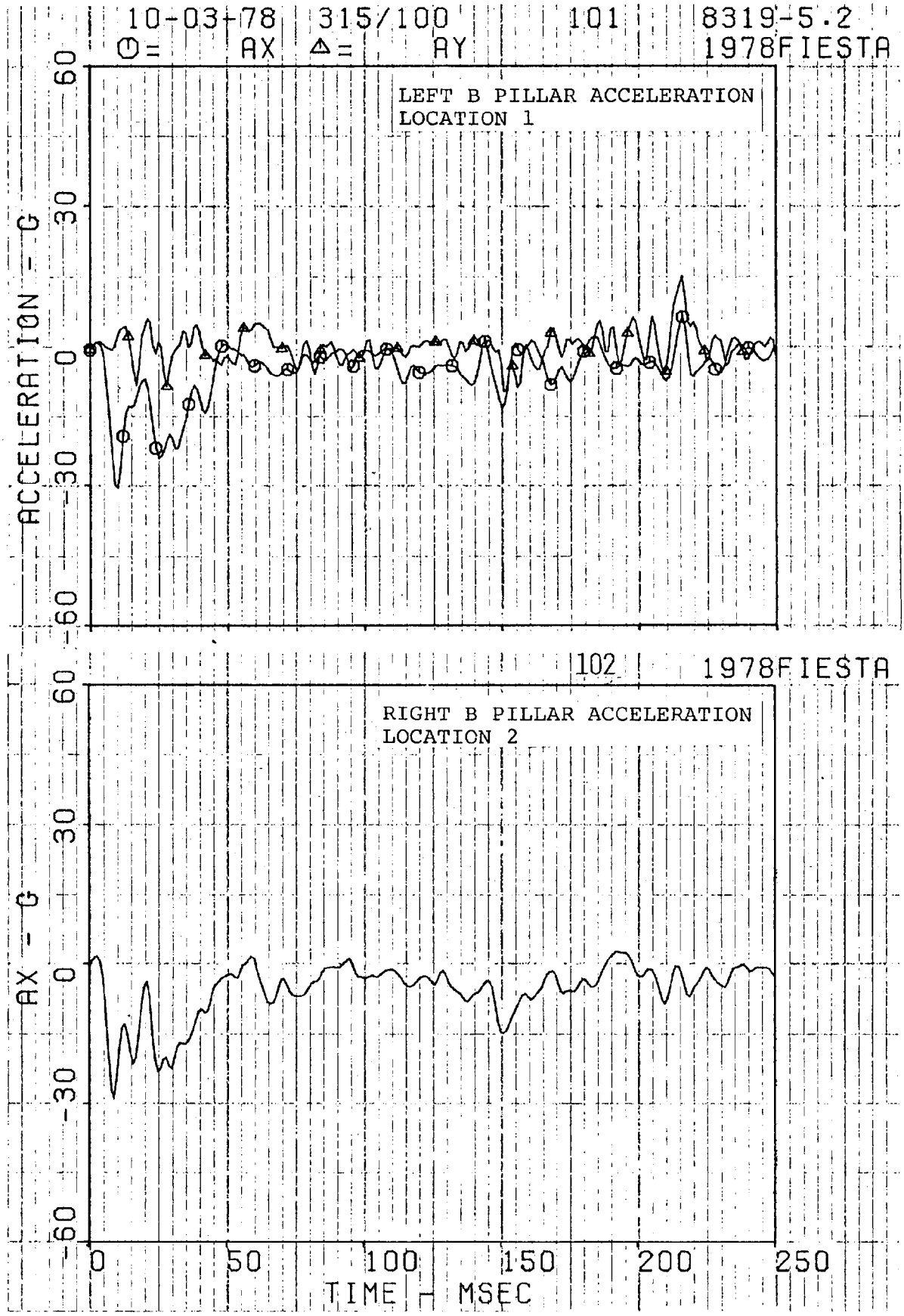
RF Belts w/ELR

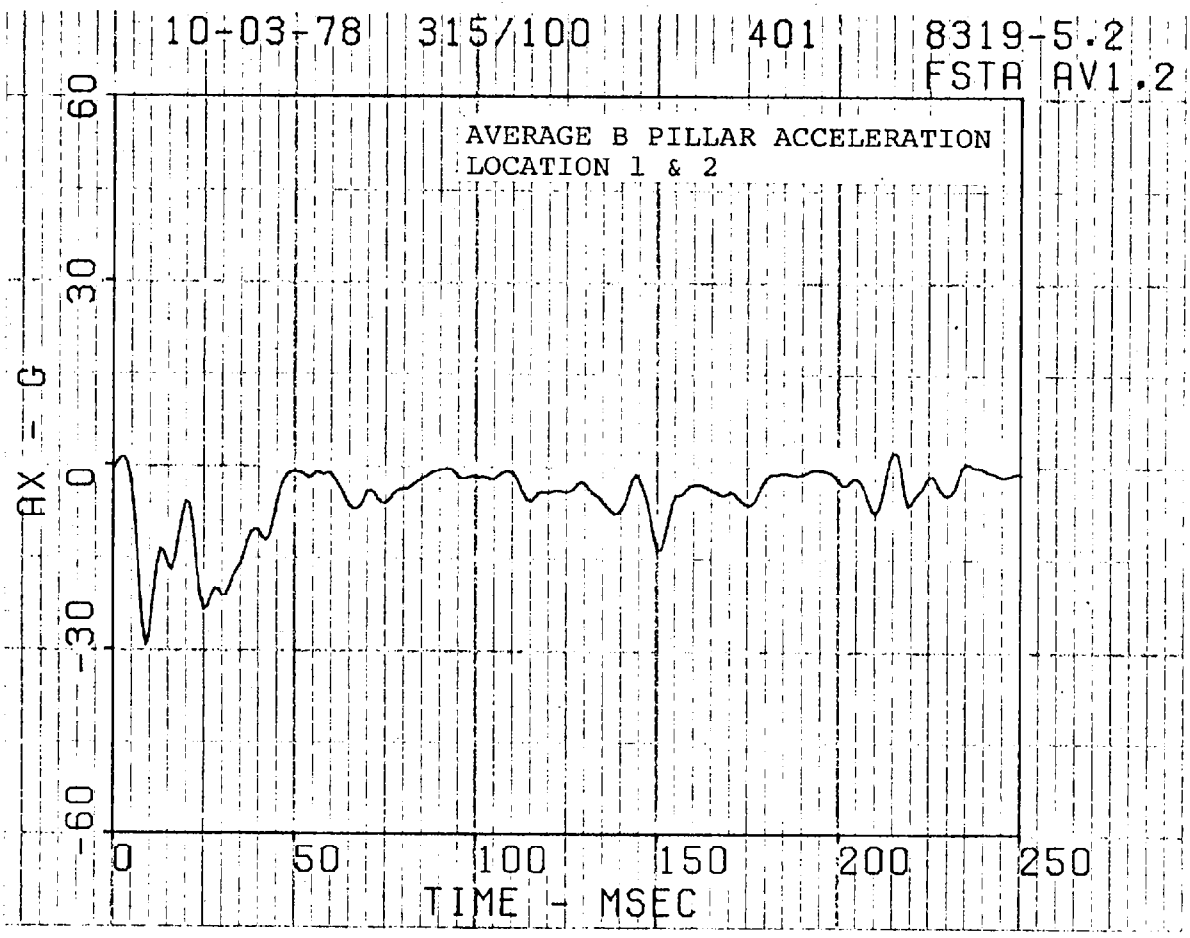
*From rearmost position to midpoint seat position.
**To dash panel for right front occupant.
**ELR = Emergency Locking Retractor.

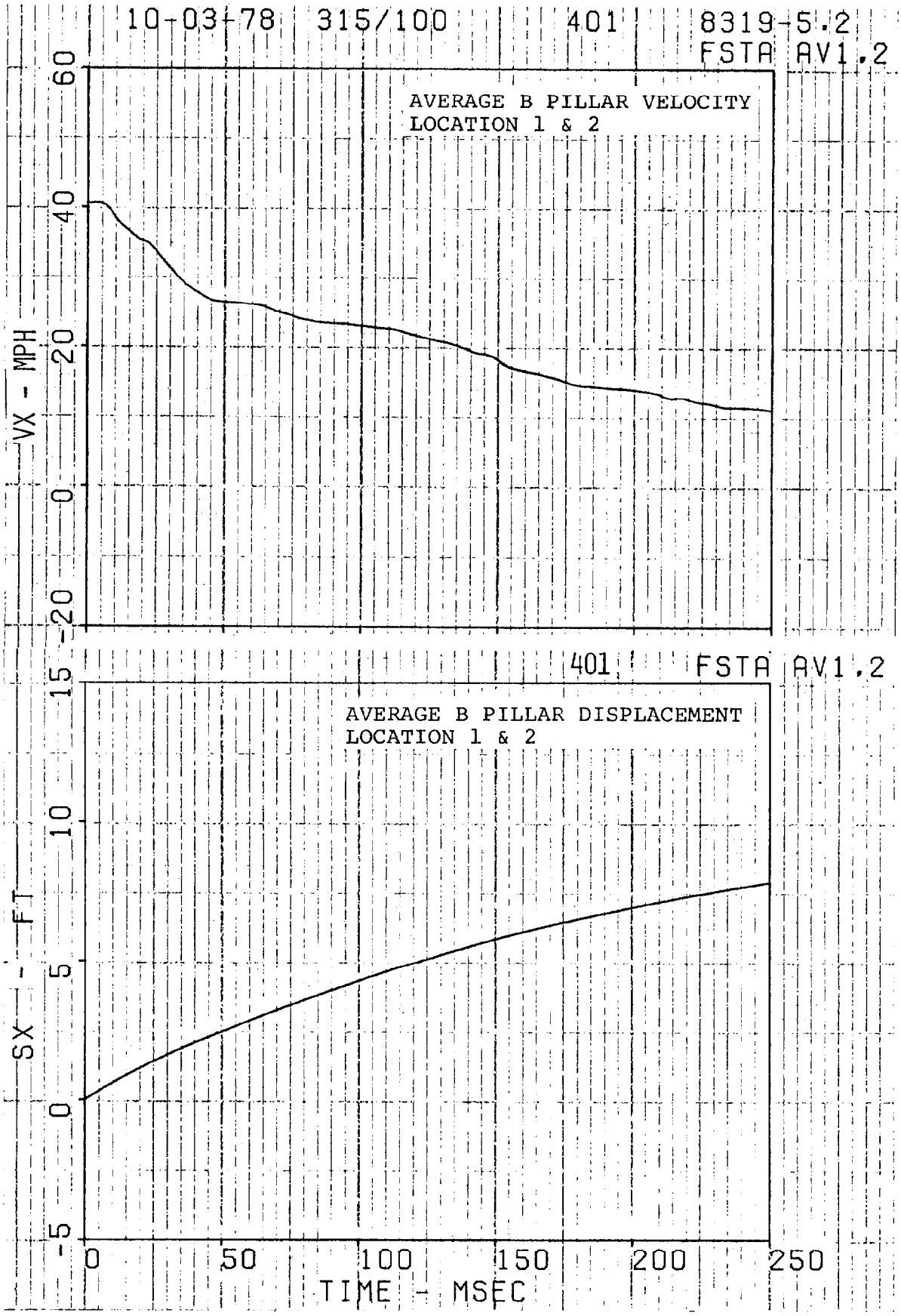
TABLE B-11. SUMMARY OF OCCUPANT RESPONSE DATA FOR TEST 5.2

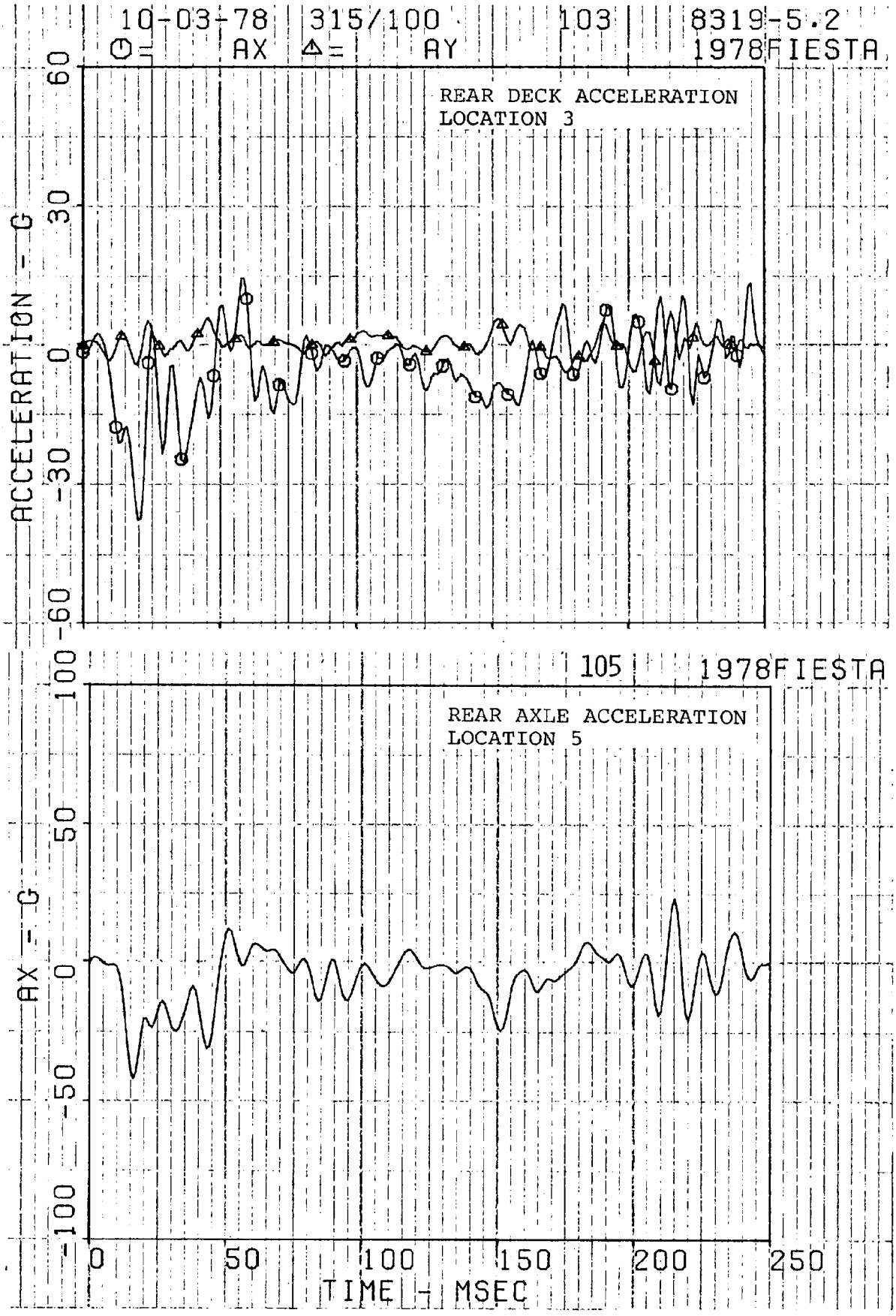
Response Parameter		Filer (Hz)	Left Front Dummy (Driver) Maximum Value A (G)	Left Front Dummy (Driver) Maximum Value T (msec)	Right Front Dummy (Passenger) Maximum Value A (G)	Right Front Dummy (Passenger) Maximum Value T (msec)
Head	X	1600	-43.2	147	-151.7	121
	Y	1600	17.9	207	-45.6	137
	Z	1600	53.2	216	195.0	121
	R	1600	64.0	147	248.5	121
SI/Time			352	200	3319	200
HIC/Time			233	130-168	1732	120-139
Head Acceleration*	R	1600	49*		143*	
Chest	X	315	-23.0	153	-51.9	127
	Y	315	13.3	217	18.9	130
	Z	315	-38.1	217	38.1	141
	R	315	43.6	217	56.5	127
SI/Time			142	200	279	200
Chest Acceleration*			30*		41*	
Femur Loads** (lb)	L	1000	-1066	215	-578	91
	R	1000	-2185	44	-390	96

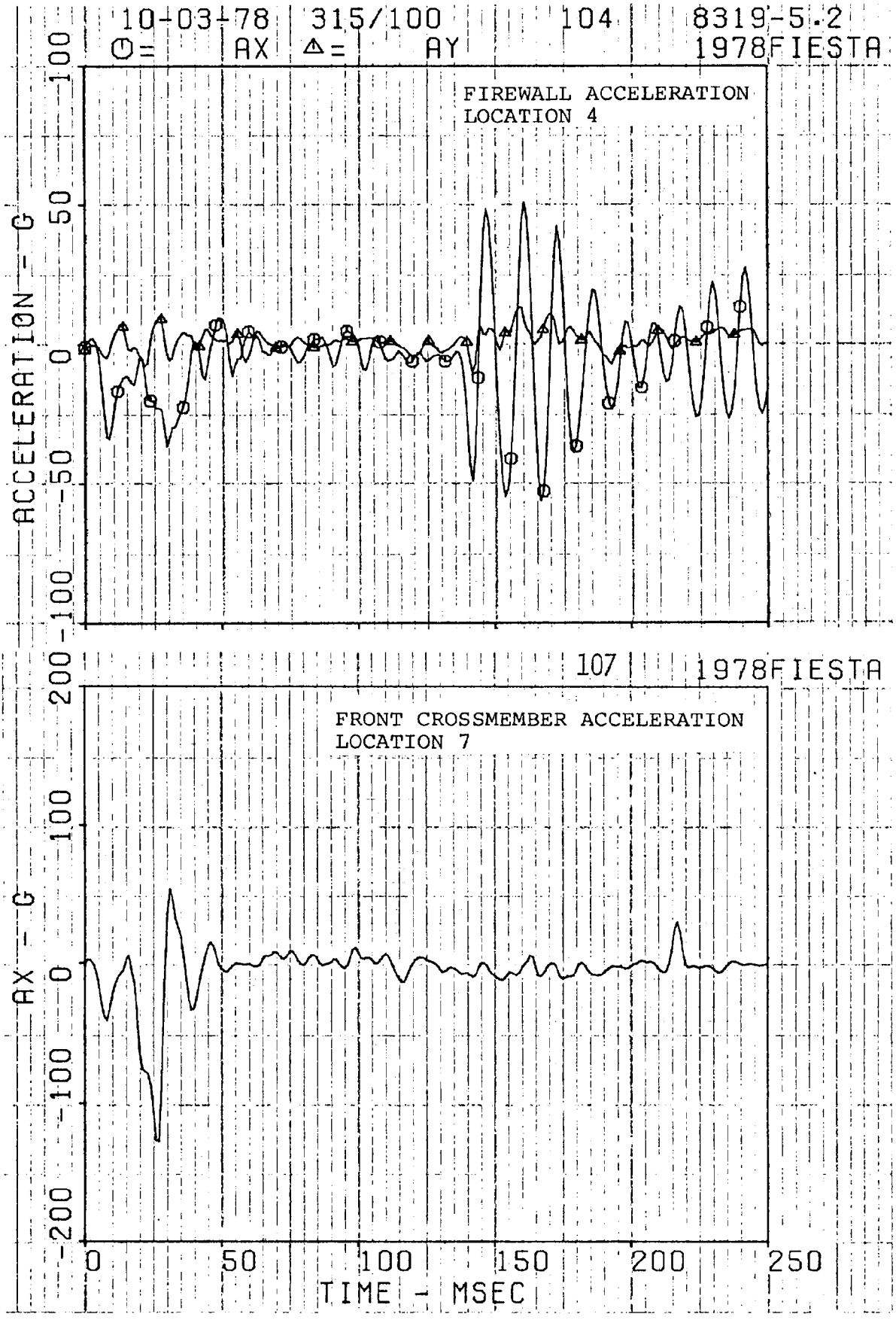
*G Values defined as value for a cumulative duration of at least 3 msec.
**Negative loads are compression; positive loads are tension.

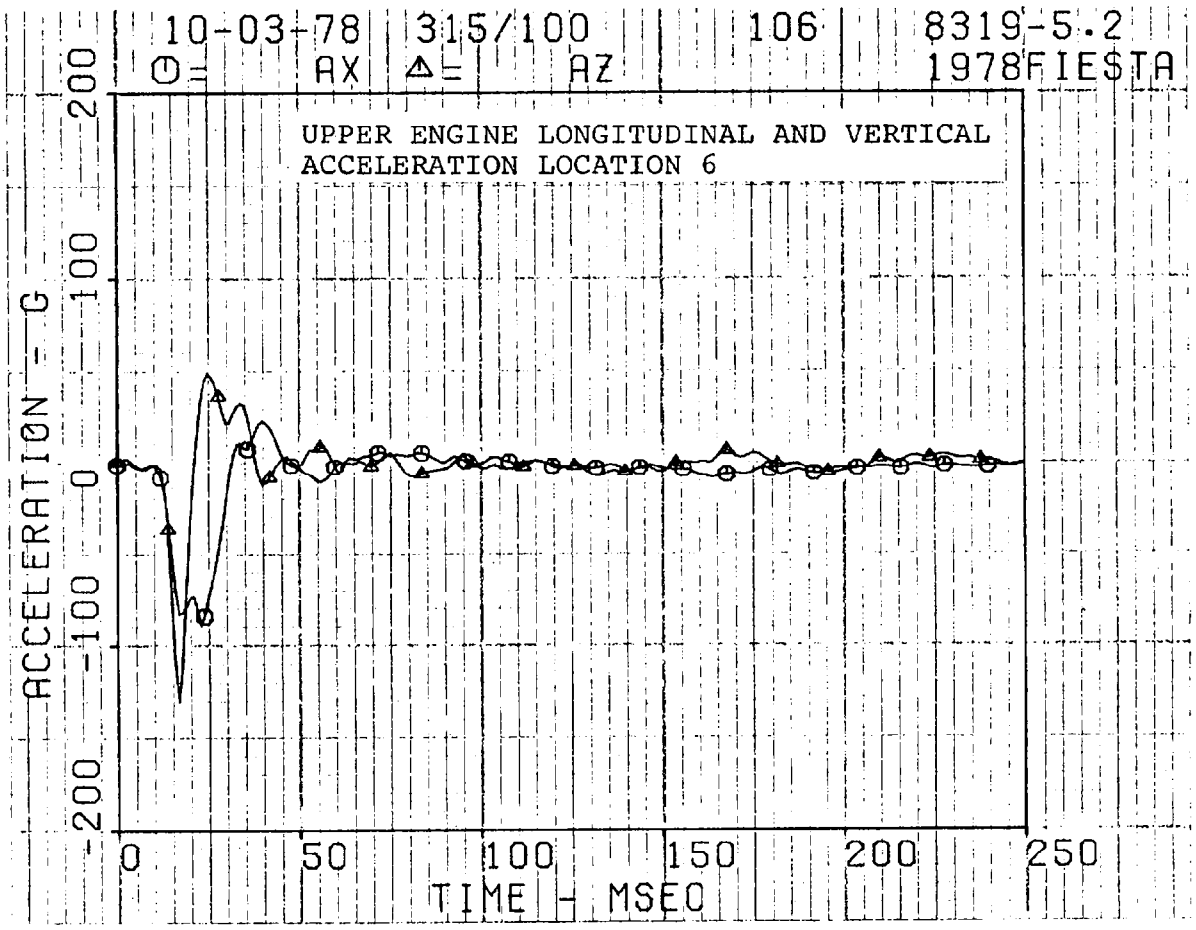

10-03-78 315/100 101 8319-5.2
○= AX △= AY 1978FIESTA
LEFT B PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
60
30
0
-30
-60
102 1978FIESTA
RIGHT B PILLAR ACCELERATION
LOCATION 2
AX - G
60
30
0
-30
-60
0
50
100
150
200
250
TIME - MSEC

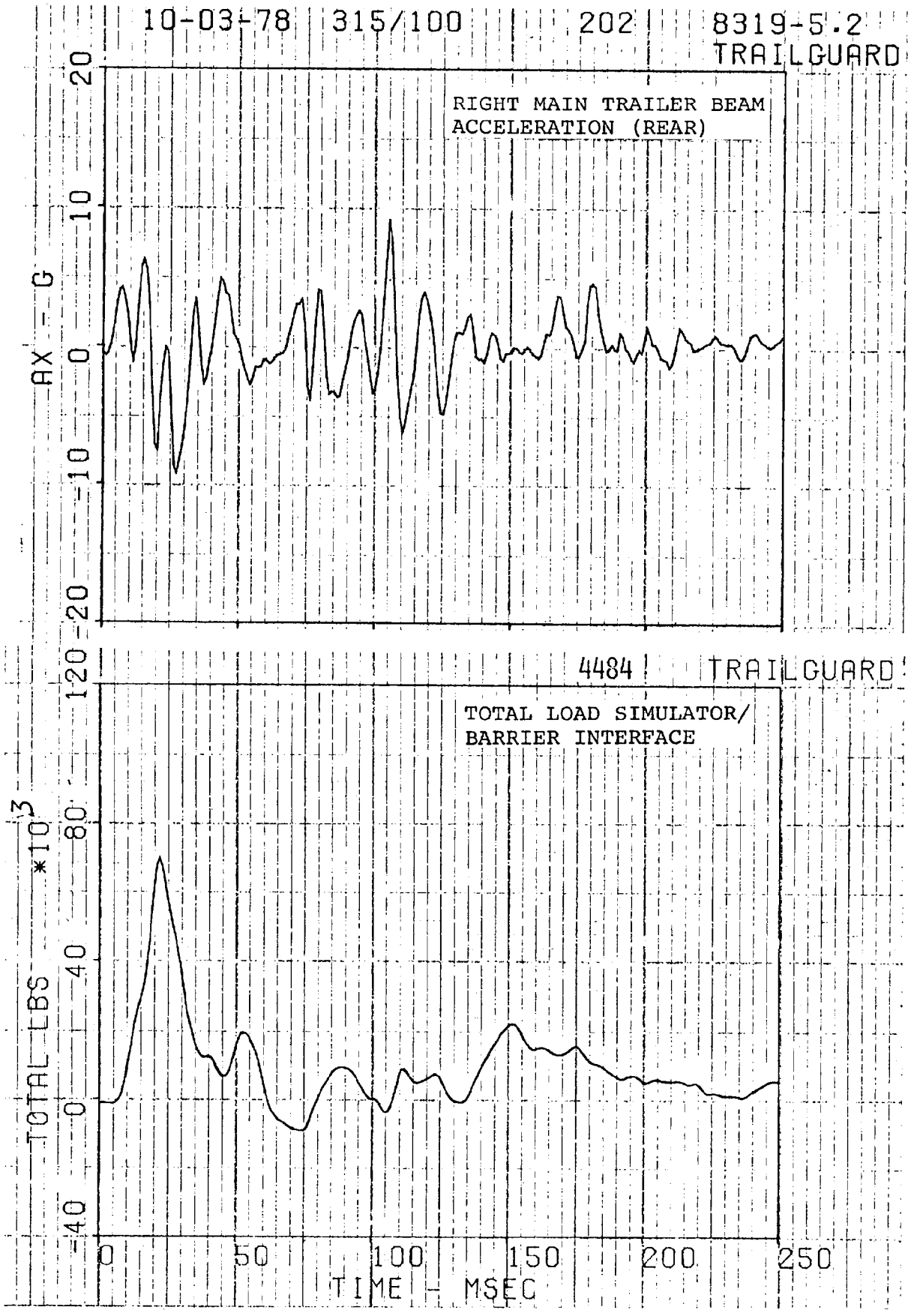

10-03-78 315/100 401 8319-5.2
FSTA AV1.2
AVERAGE B PILLAR ACCELERATION
LOCATION 1 & 2
AX = G
60
30
0
-30
-60
0
50
100
150
200
250
TIME - MSEC

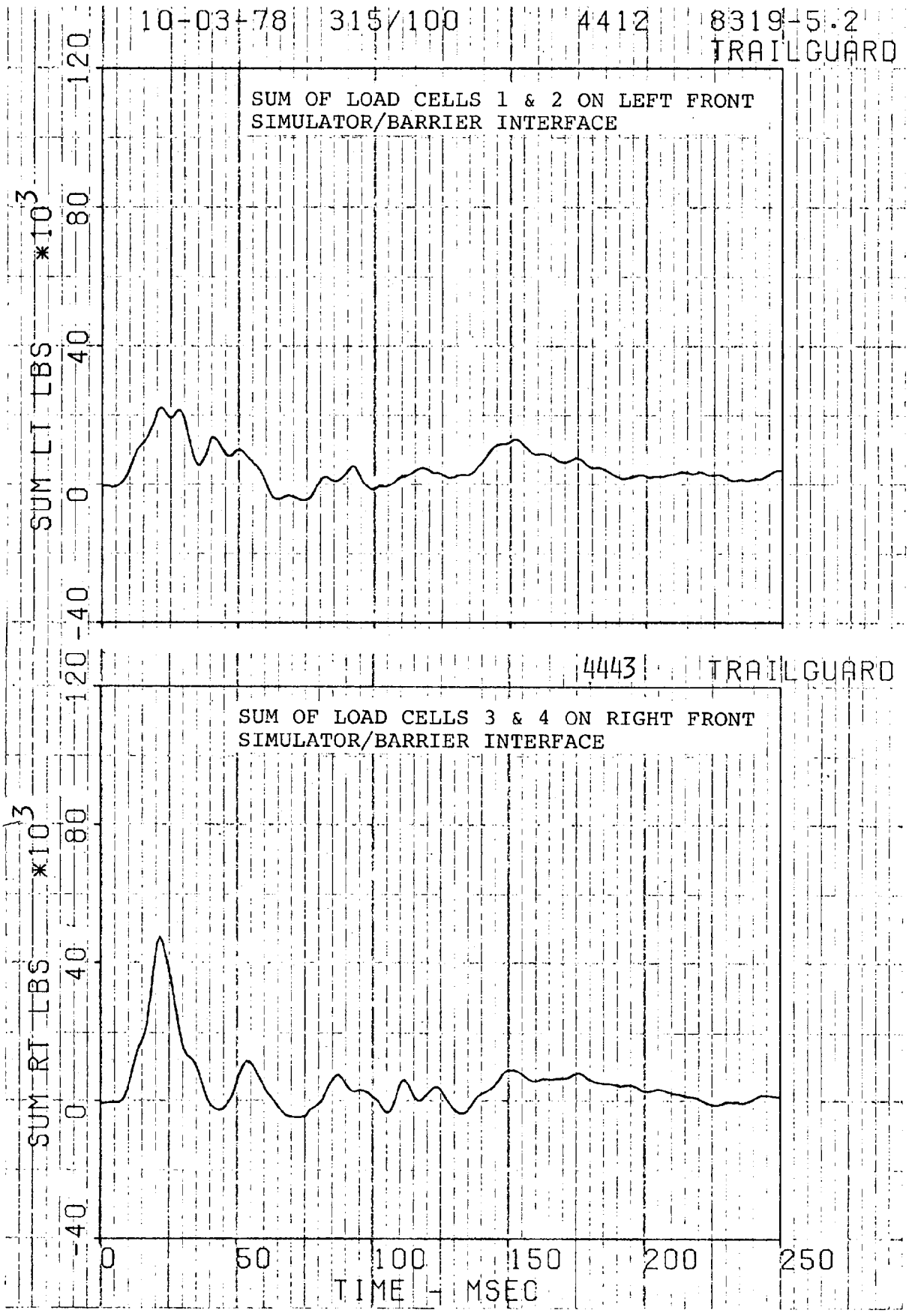

10-03-78 315/100 401 8319-5.2
FSTA AV1.2
AVERAGE B PILLAR VELOCITY
LOCATION 1 & 2
VX - MPH
60
40
20
0
-20
401 FSTA AV1.2
AVERAGE B PILLAR DISPLACEMENT
LOCATION 1 & 2
SX - FT
15
10
5
0
-5
0
50
100
150
200
250
TIME - MSEC

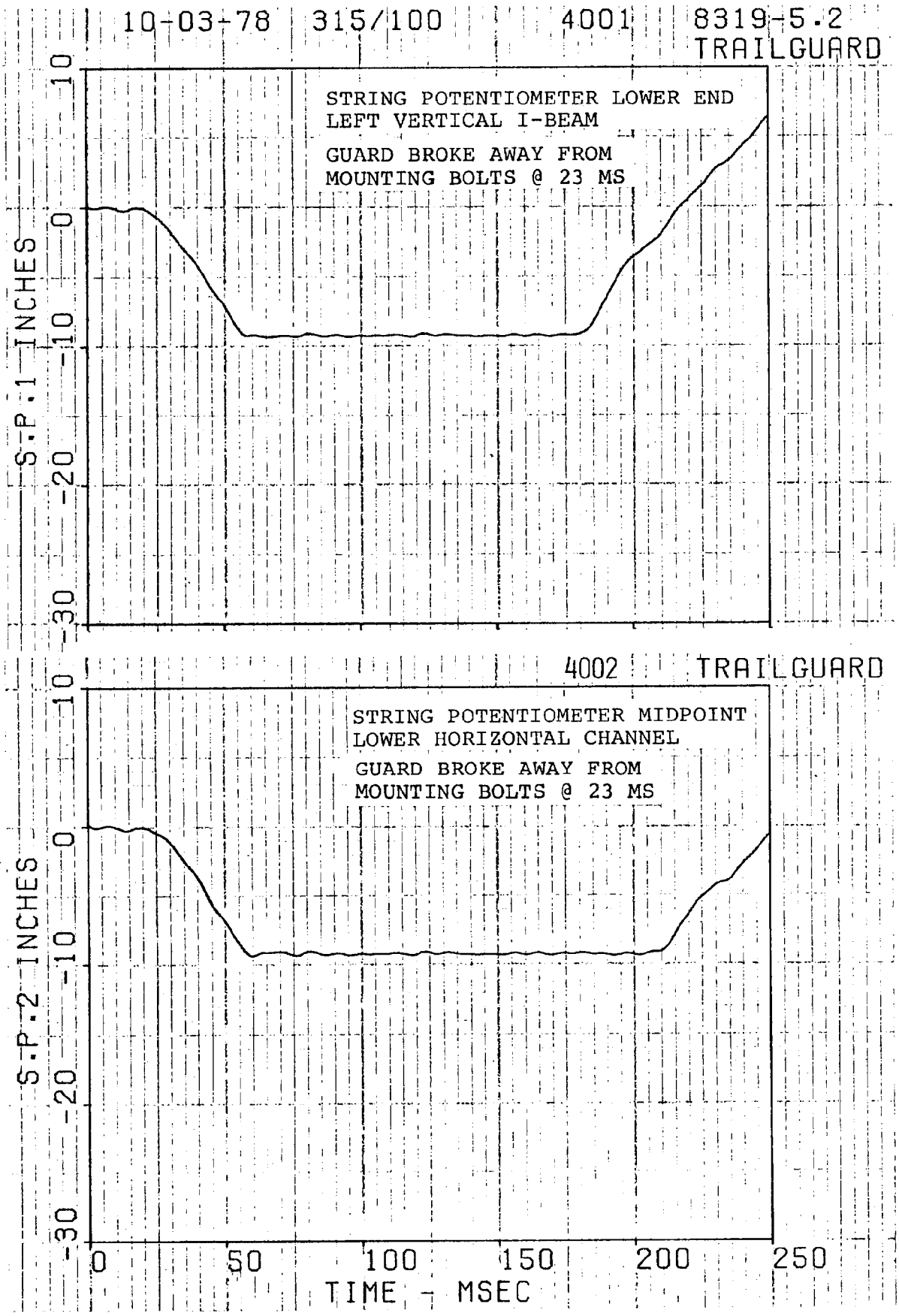

10-03-78 315/100 103 8319-5.2
AX AY 1978FIESTA
REAR DECK ACCELERATION
LOCATION 3
ACCELERATION - G
60
30
0
-30
-60
105 1978FIESTA
REAR AXLE ACCELERATION
LOCATION 5
AX - G
100
50
0
-50
-100
0
50
100
150
200
250
TIME - MSEC

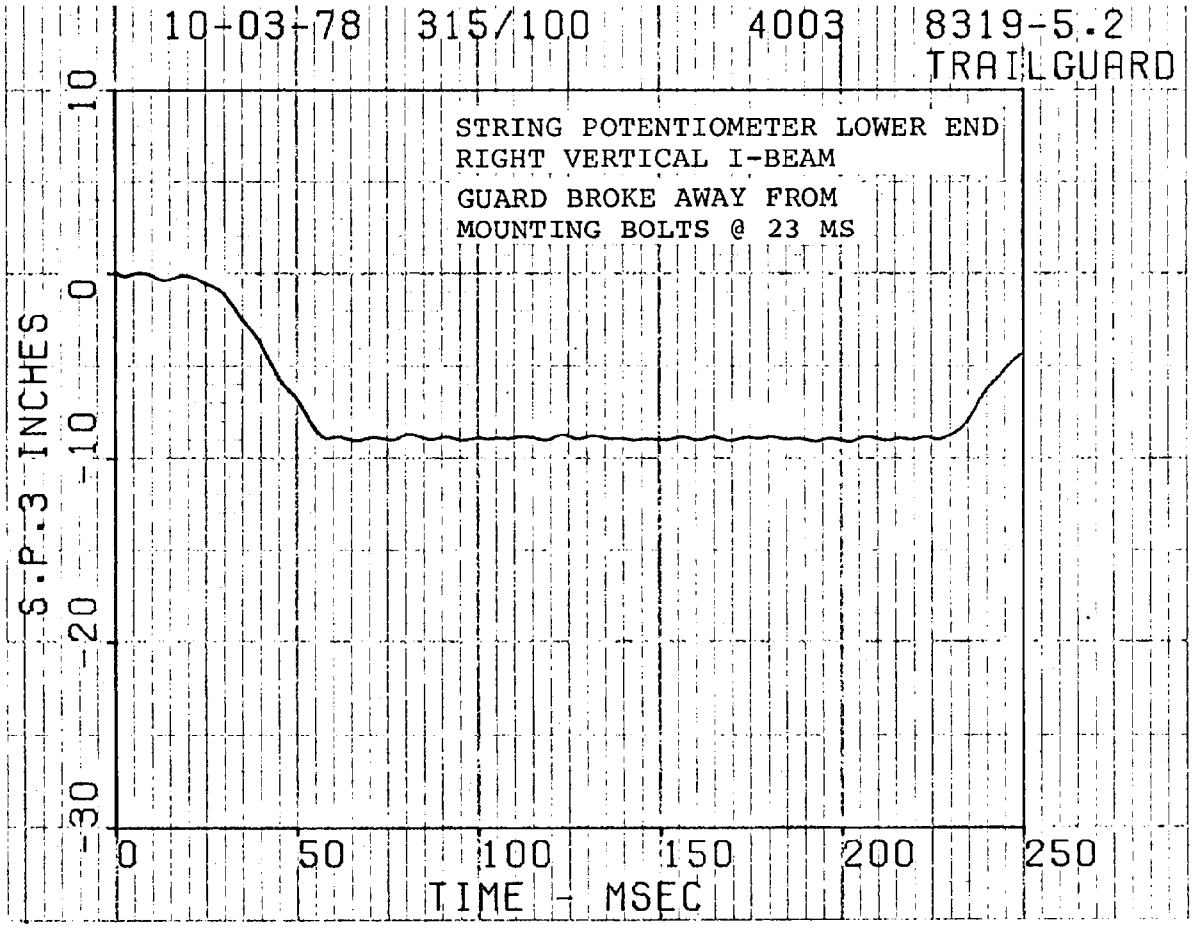

10-03-78 315/100 104 8319-5.2
⏱= AX △= AY 1978FIESTA
FIREWALL ACCELERATION
LOCATION 4
ACCELERATION - G
100
50
0
-50
-100
107 1978FIESTA
FRONT CROSSMEMBER ACCELERATION
LOCATION 7
AX - G
200
100
0
-100
-200
0
50
100
150
200
250
TIME - MSEC

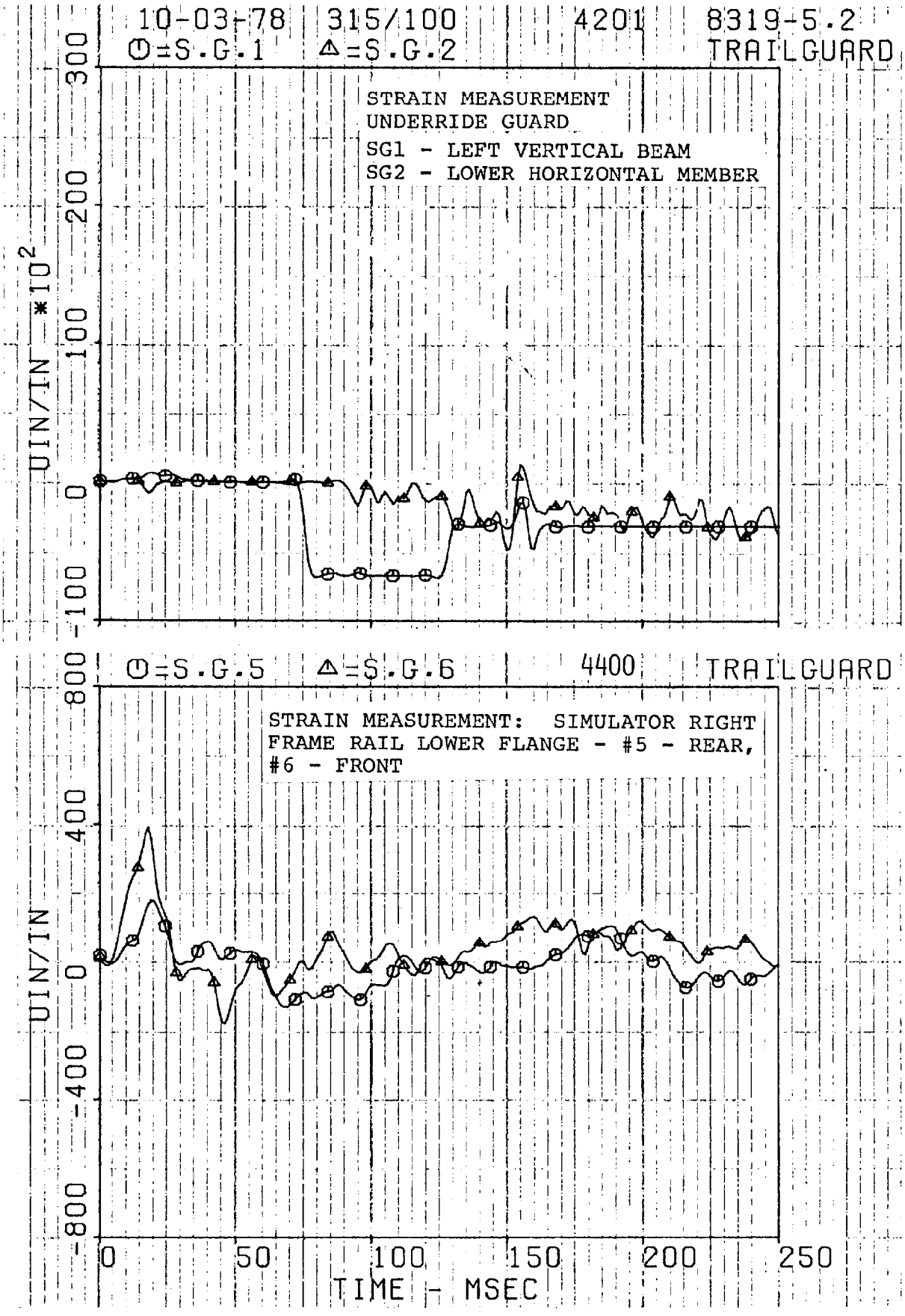

10-03-78 315/100 106 8319-5.2
⊖= AX △= AZ 1978FIESTA
UPPER ENGINE LONGITUDINAL AND VERTICAL
ACCELERATION LOCATION 6
ACCELERATION = G
200
100
0
-100
-200
0
50
100
150
200
250
TIME - MSEC

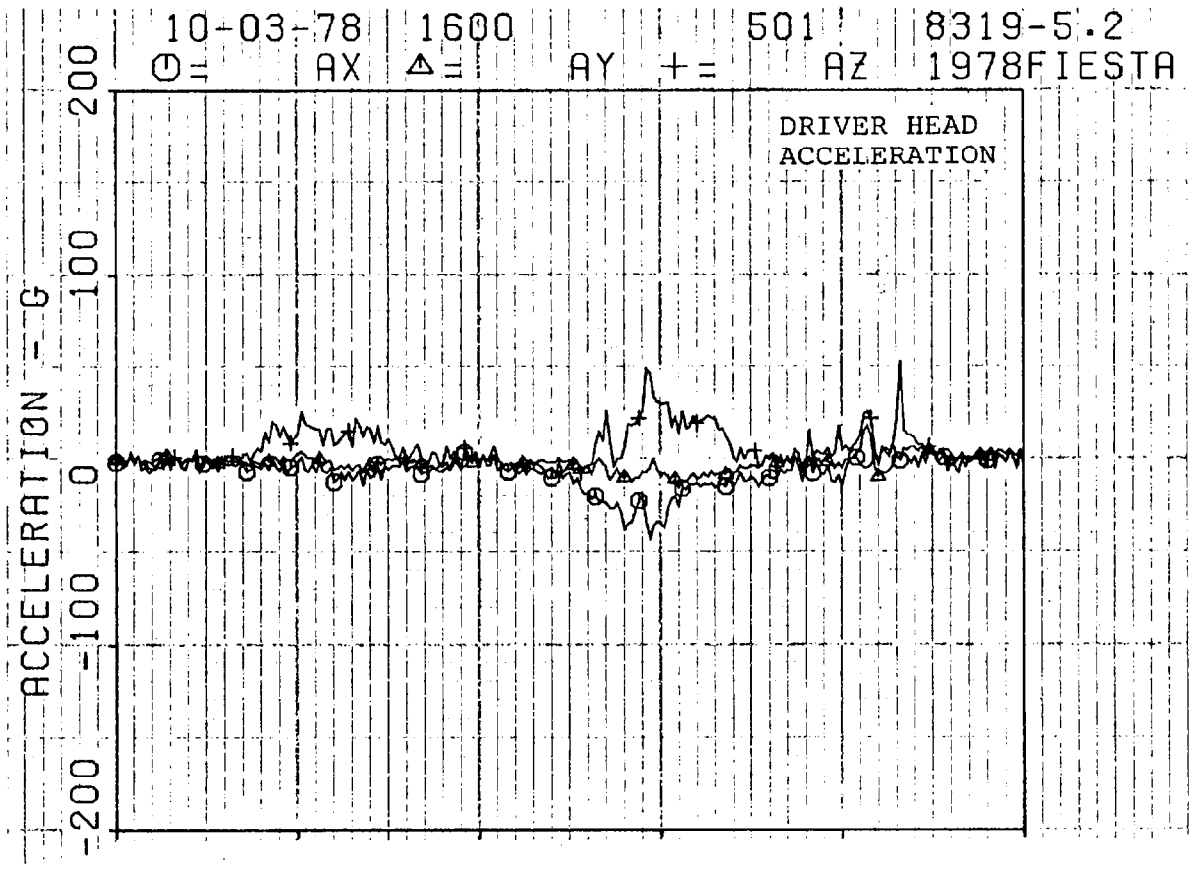

10-03-78 315/100 202 8319-5.2
TRAILGUARD
RIGHT MAIN TRAILER BEAM
ACCELERATION (REAR)
AX - G
20
10
0
-10
-20
4484 TRAILGUARD
TOTAL LOAD SIMULATOR/
BARRIER INTERFACE
TOTAL LBS *10^3
120
80
40
0
-40
0
50
100
150
200
250
TIME - MSEC

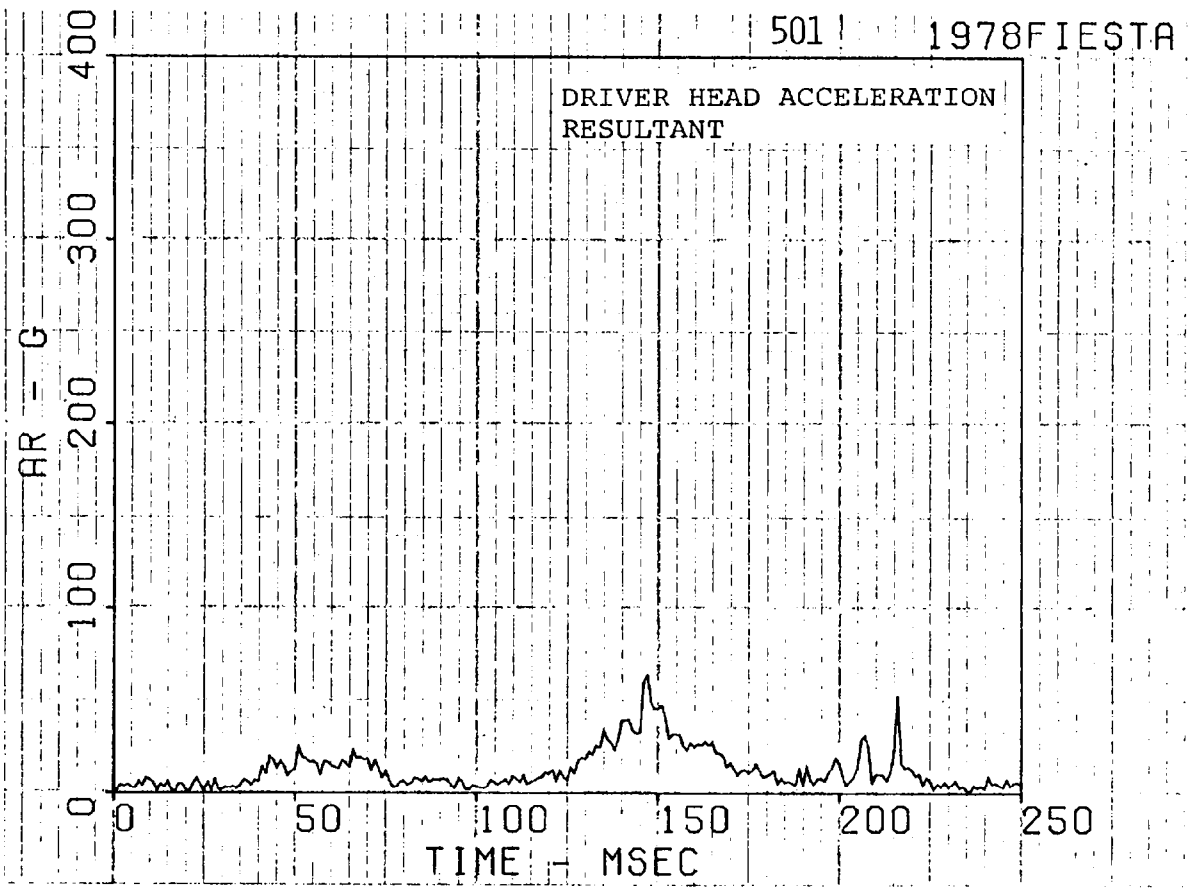

10-03-78 315/100 4412 8319-5.2
TRAILGUARD
SUM OF LOAD CELLS 1 & 2 ON LEFT FRONT
SIMULATOR/BARRIER INTERFACE
SUM LT LBS *10^3
120
80
40
0
-40
4443 TRAILGUARD
SUM OF LOAD CELLS 3 & 4 ON RIGHT FRONT
SIMULATOR/BARRIER INTERFACE
SUM RT LBS *10^3
120
80
40
0
-40
0
50
100
150
200
250
TIME - MSEC

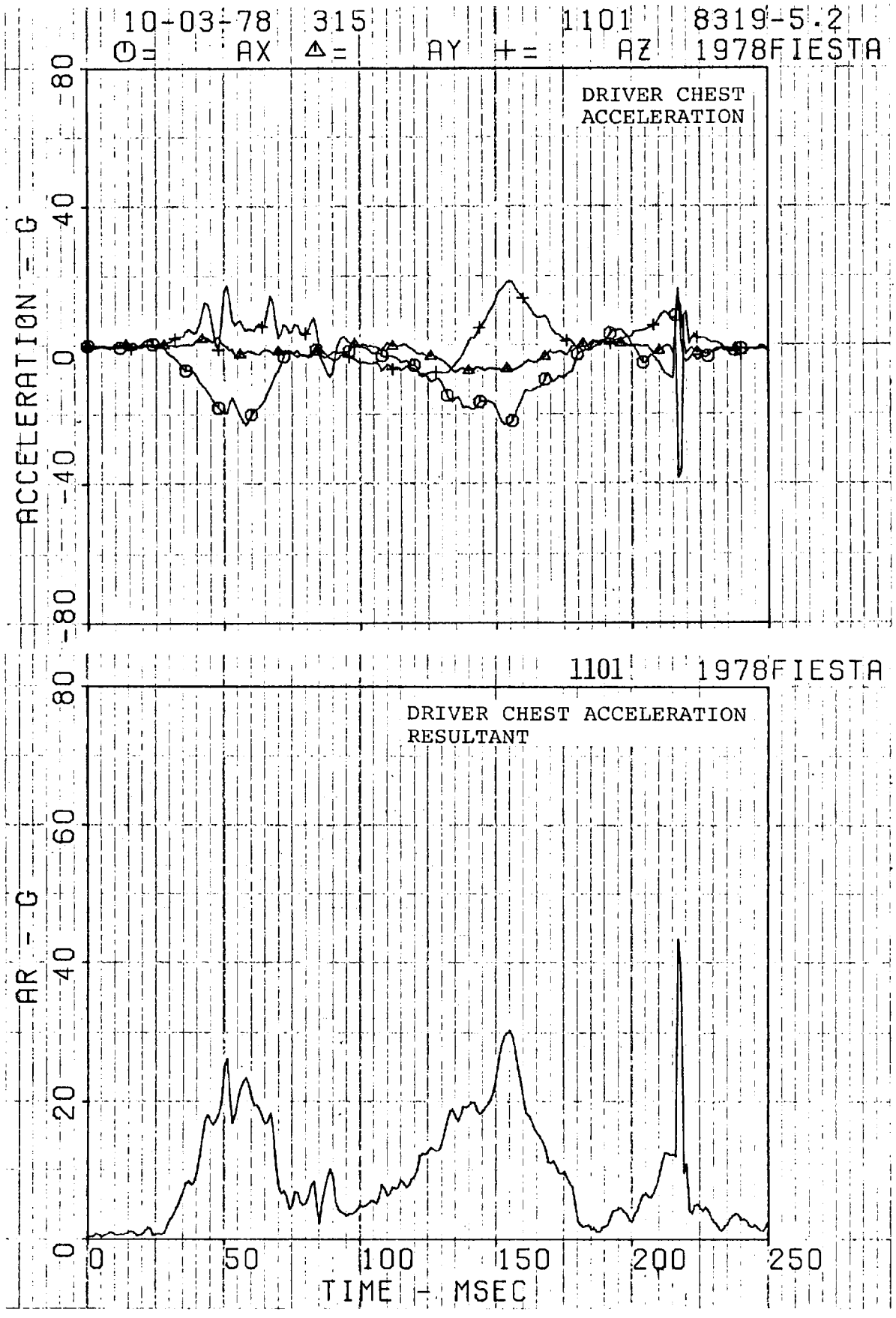

10-03-78 315/100 4001 8319-5.2
TRAILGUARD
STRING POTENTIOMETER LOWER END
LEFT VERTICAL I-BEAM
GUARD BROKE AWAY FROM
MOUNTING BOLTS @ 23 MS
S.P.1 INCHES
10
0
-10
-20
-30
4002 TRAILGUARD
STRING POTENTIOMETER MIDPOINT
LOWER HORIZONTAL CHANNEL
GUARD BROKE AWAY FROM
MOUNTING BOLTS @ 23 MS
S.P.2 INCHES
0
50
100
150
200
250
TIME - MSEC

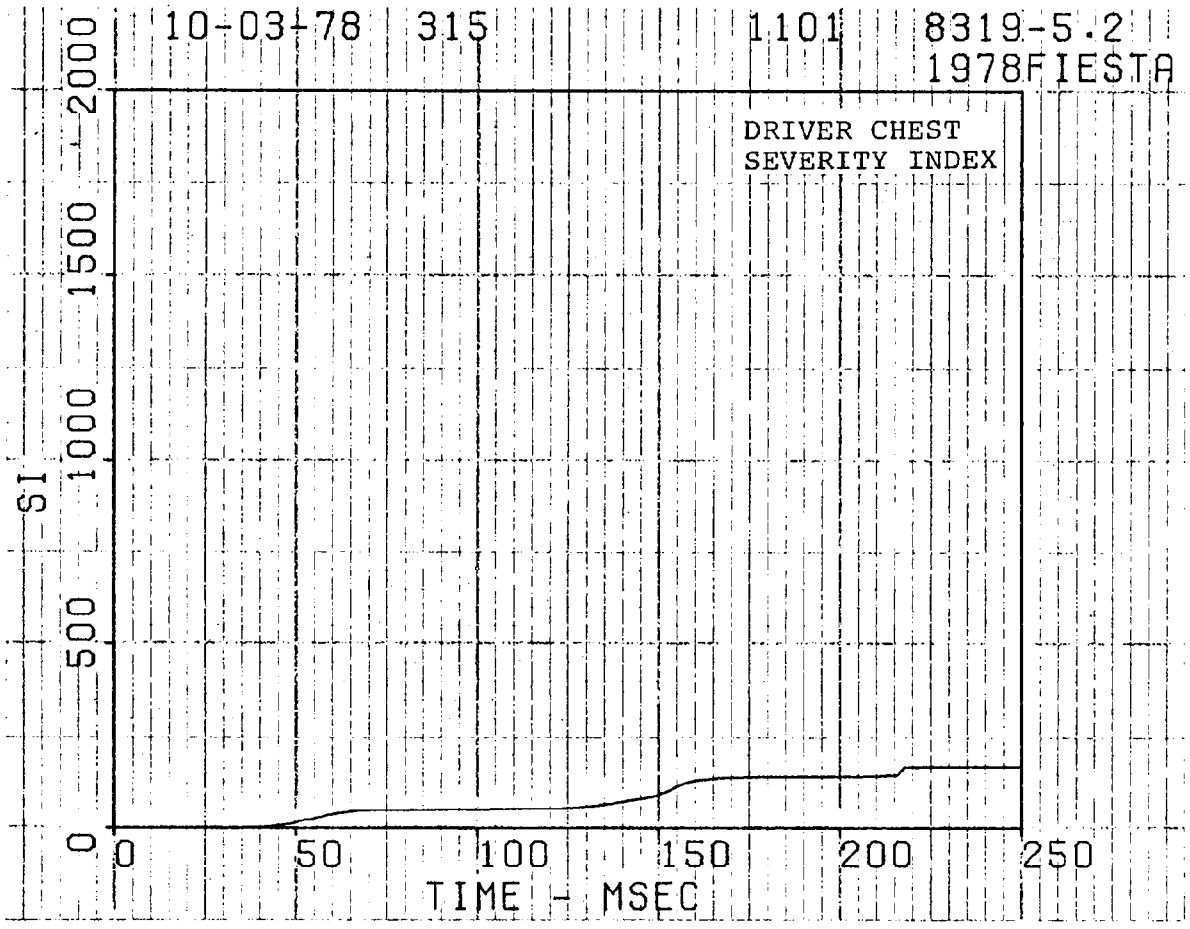

10-03-78 315/100 4003 8319-5.2
TRAILGUARD
STRING POTENTIOMETER LOWER END
RIGHT VERTICAL I-BEAM
GUARD BROKE AWAY FROM
MOUNTING BOLTS @ 23 MS
S.P.3 INCHES
10
0
-10
-20
-30
0
50
100
150
200
250
TIME - MSEC

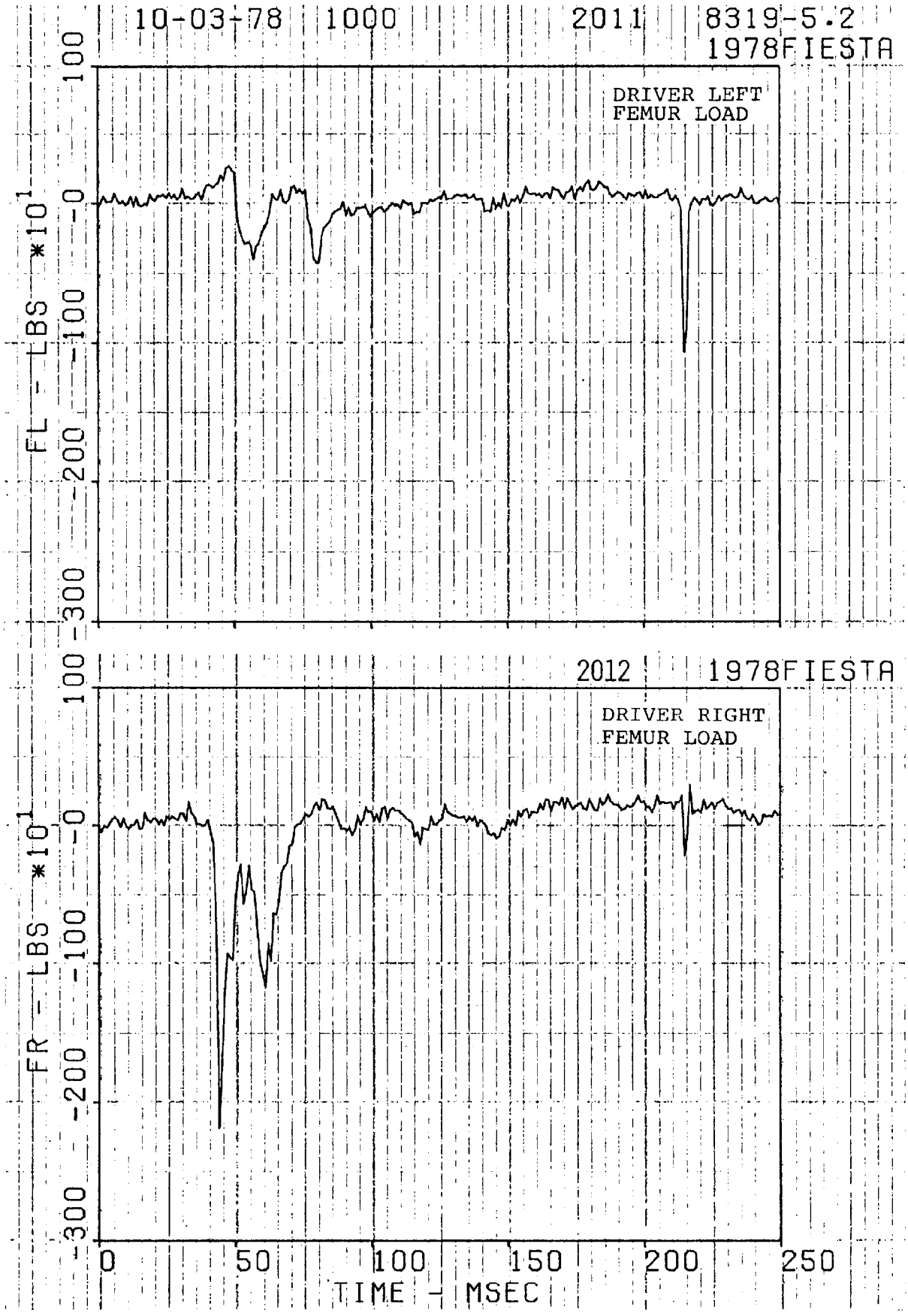

10-03-78 315/100 4201 8319-5.2
⏀=S.G.1 △=S.G.2 TRAILGUARD
STRAIN MEASUREMENT
UNDERRIDE GUARD
SG1 - LEFT VERTICAL BEAM
SG2 - LOWER HORIZONTAL MEMBER
UIN/IN *10²
300
200
100
0
-100
⏀=S.G.5 △=S.G.6 4400 TRAILGUARD
STRAIN MEASUREMENT: SIMULATOR RIGHT
FRAME RAIL LOWER FLANGE - #5 - REAR,
#6 - FRONT
UIN/IN
800
400
0
-400
-800
0
50
100
150
200
250
TIME - MSEC

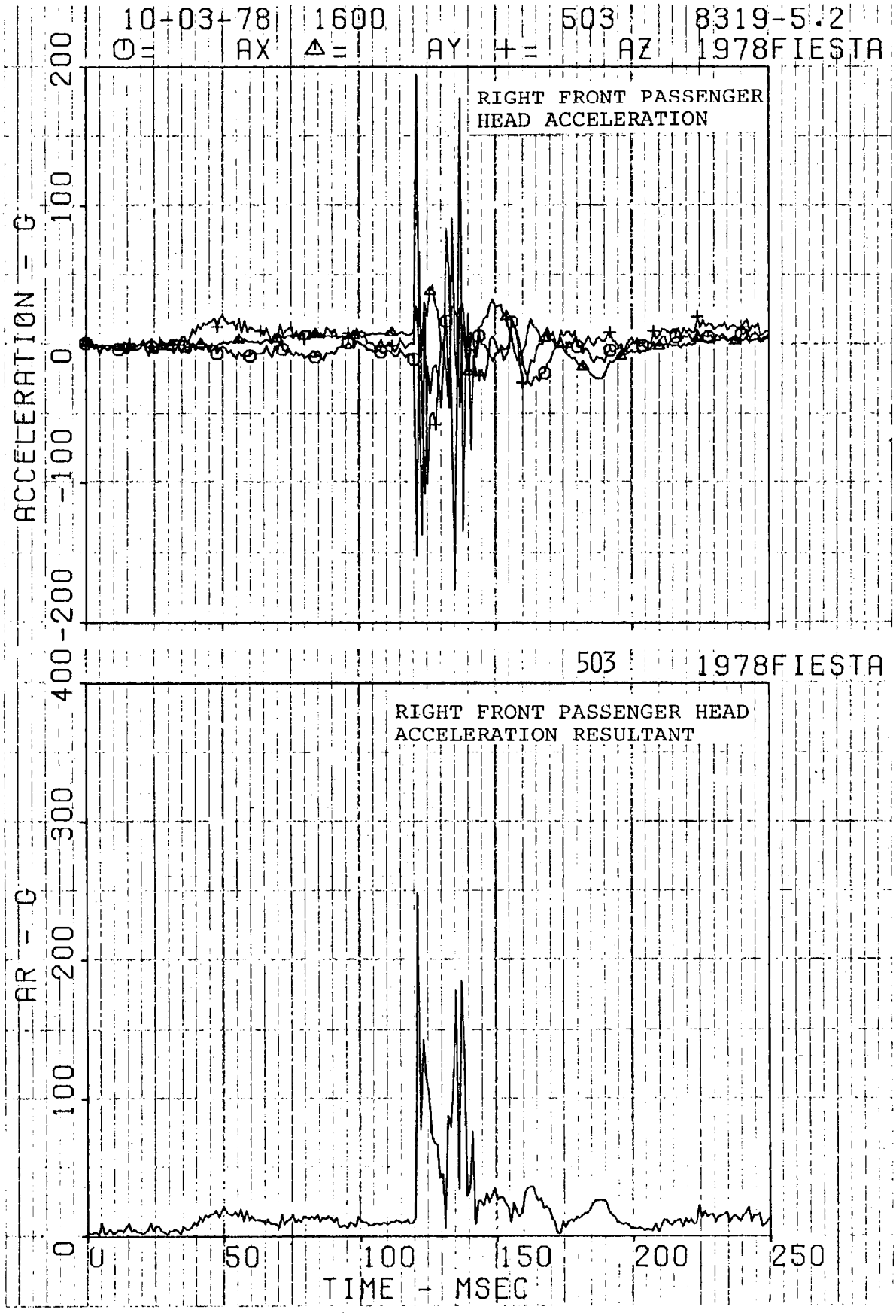

10-03-78 1600 501 8319-5.2
⏲= AX △= AY += AZ 1978FIESTA
DRIVER HEAD ACCELERATION
ACCELERATION = G
200
100
0
-100
-200

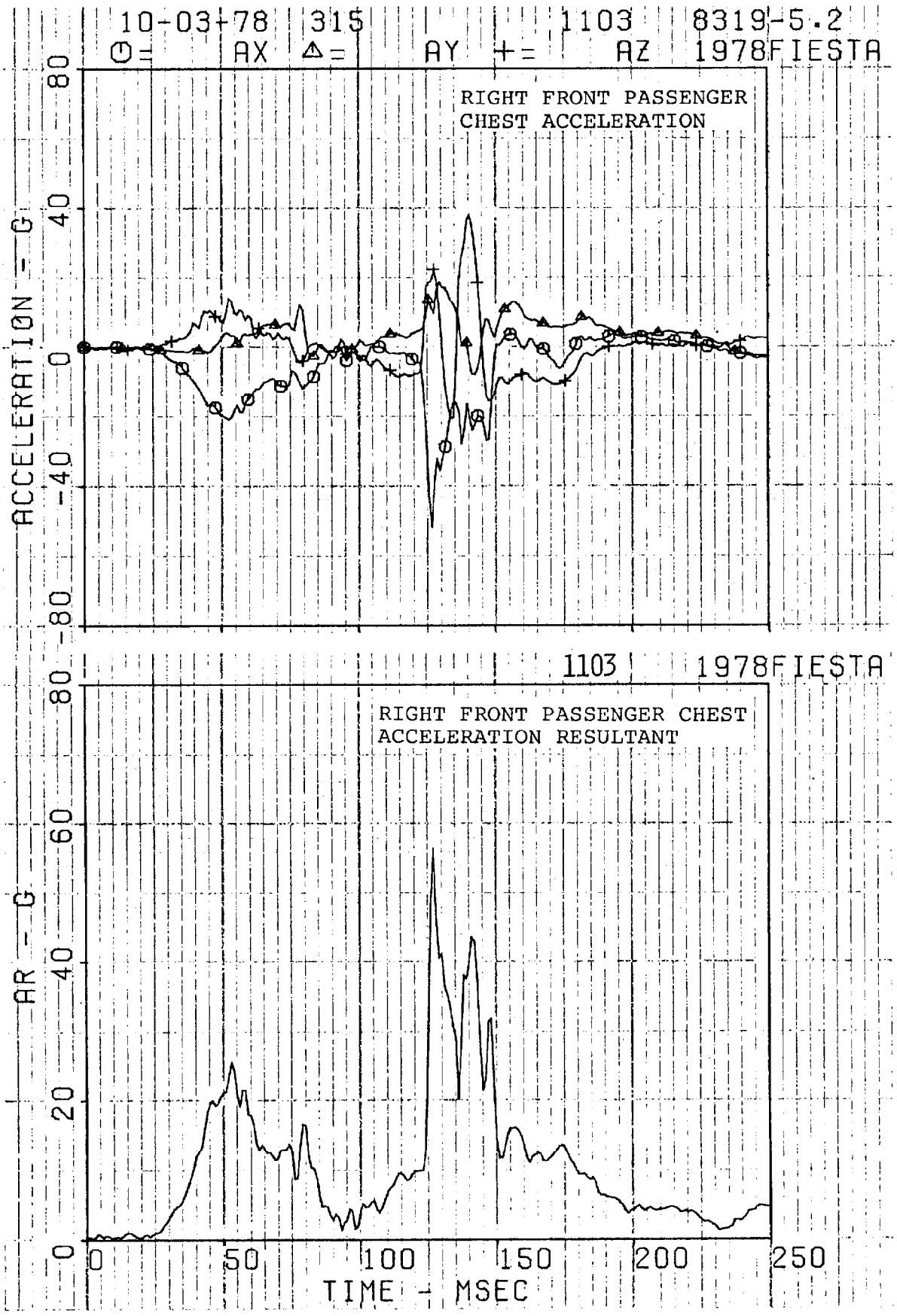

501 1978FIESTA
DRIVER HEAD ACCELERATION RESULTANT
AR = G
400
300
200
100
0
0
50
100
150
200
250
TIME - MSEC

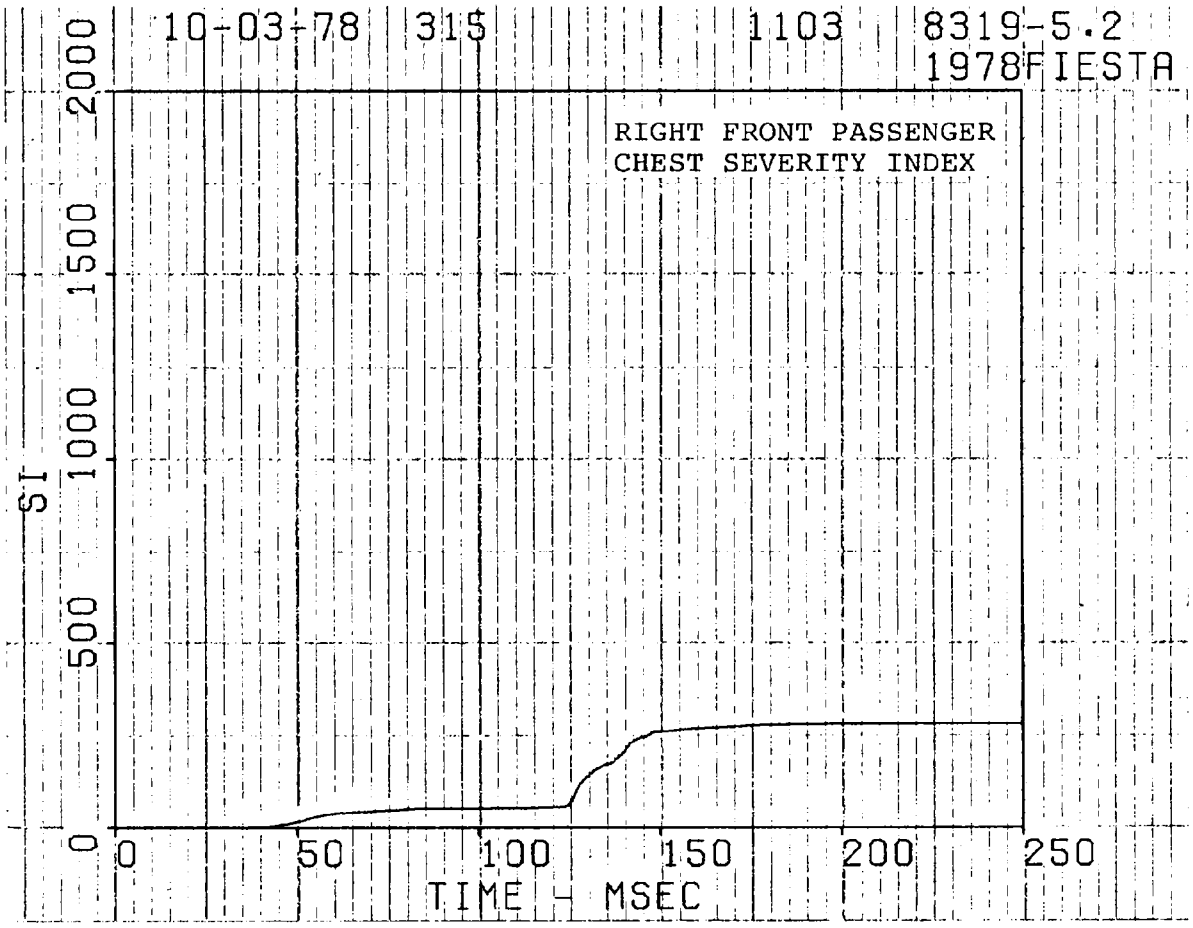

10-03-78 315 1101 8319-5.2
○= AX △= AY += AZ 1978FIESTA
DRIVER CHEST ACCELERATION
ACCELERATION = G
80
40
0
-40
-80
1101 1978FIESTA
DRIVER CHEST ACCELERATION RESULTANT
AR = G
80
60
40
20
0
0
50
100
150
200
250
TIME - MSEC

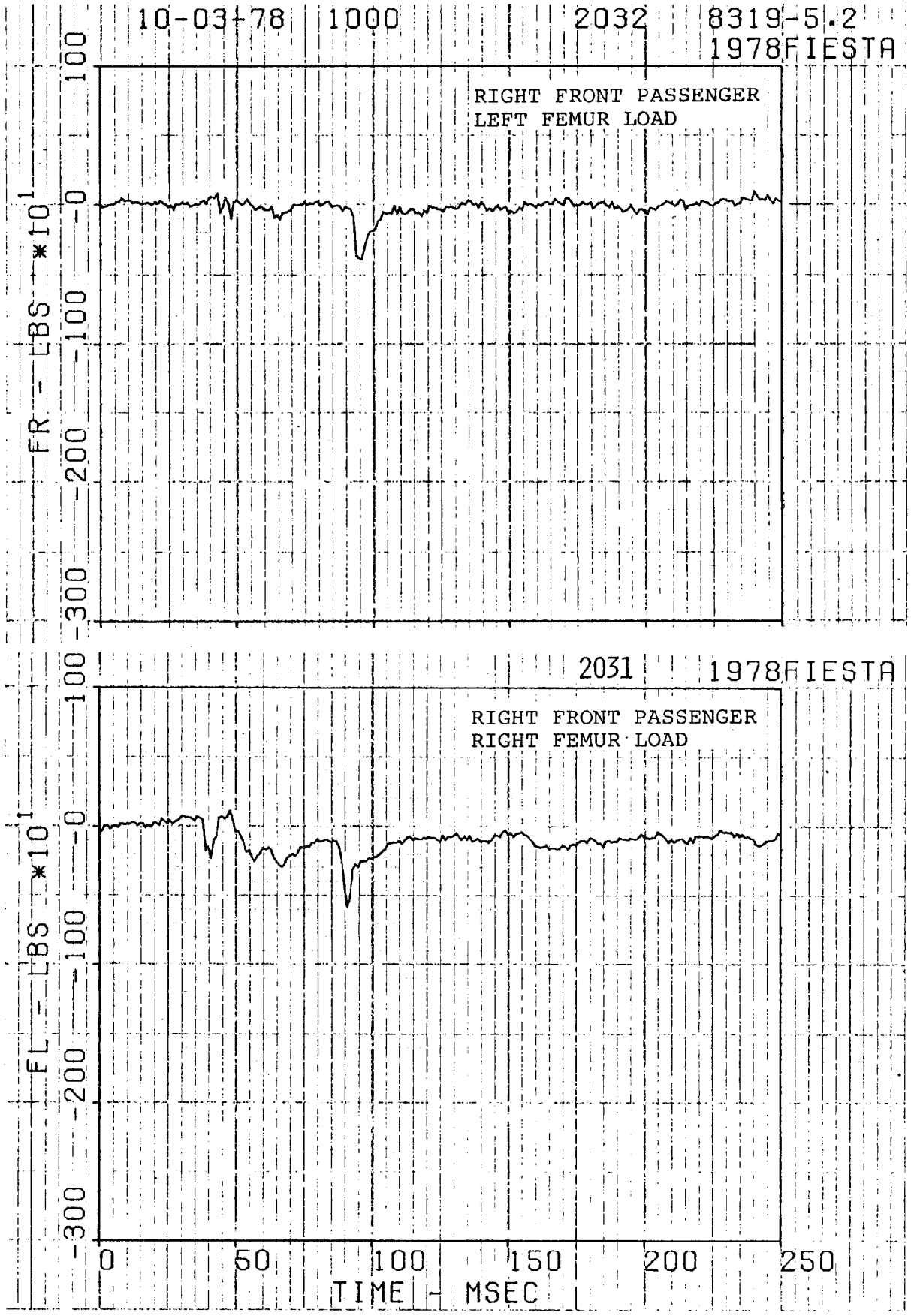

10-03-78 315 1101 8319-5.2
1978 FIESTA
DRIVER CHEST
SEVERITY INDEX
SI
0
500
1000
1500
2000
0
50
100
150
200
250
TIME - MSEC


10-03-78 1000
2011
8319-5.2
1978FIESTA
DRIVER LEFT
FEMUR LOAD
FL - LBS *10^1
100
-0
-100
-200
-300
2012
1978FIESTA
DRIVER RIGHT
FEMUR LOAD
FR - LBS *10^1
100
-0
-100
-200
-300
0
50
100
150
200
250
TIME - MSEC

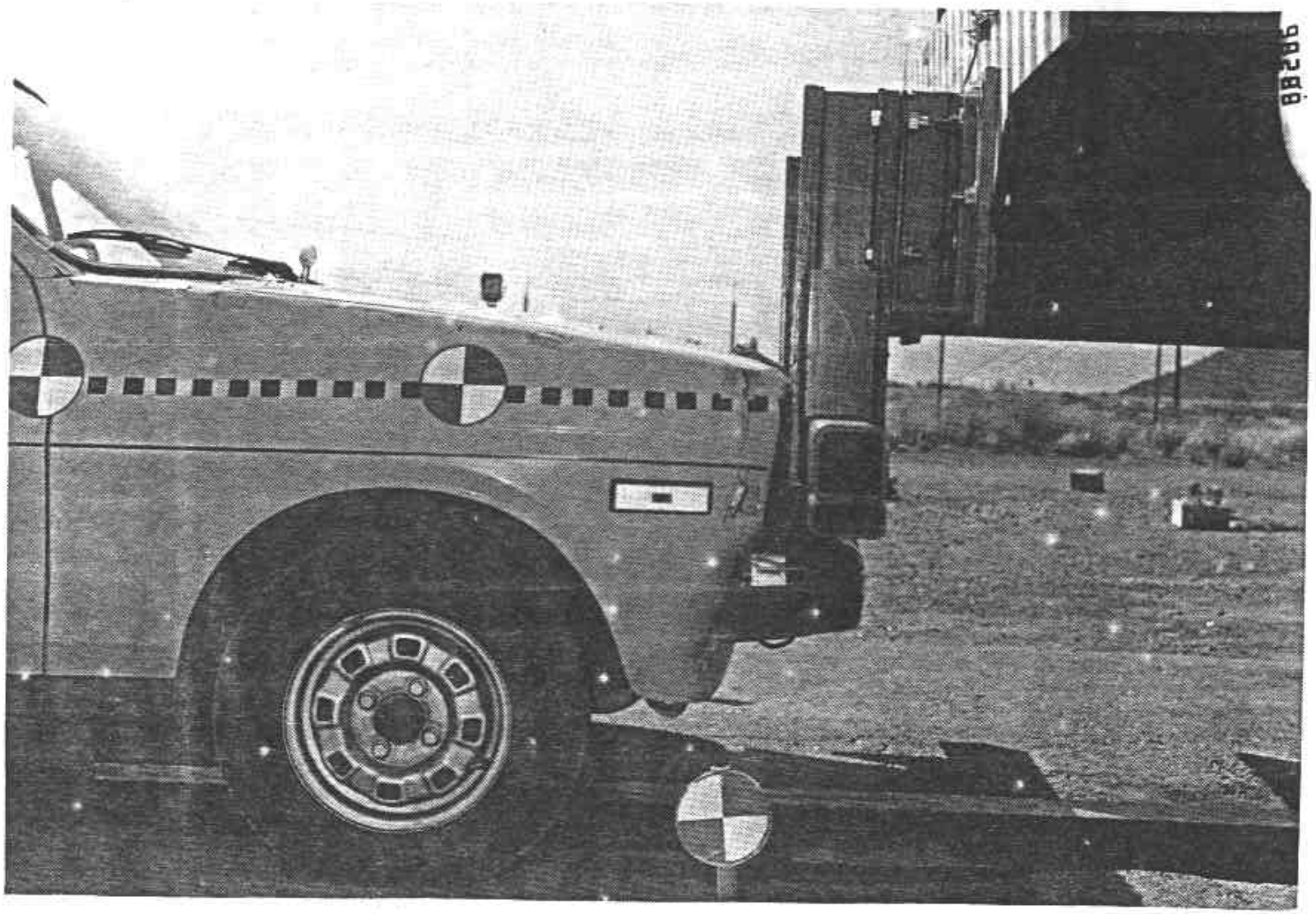

10-03-78 1600 503 8319-5.2
○= AX △= AY + = AZ 1978FIESTA
RIGHT FRONT PASSENGER HEAD ACCELERATION
ACCELERATION = G
200
100
0
-100
-200
503 1978FIESTA
RIGHT FRONT PASSENGER HEAD ACCELERATION RESULTANT
AR = G
400
300
200
100
0
0
50
100
150
200
250
TIME - MSEC


10-03-78 315
AX
AY
AZ
1103
8319-5.2
1978FIESTA
RIGHT FRONT PASSENGER CHEST ACCELERATION
ACCELERATION = G
80
40
0
-40
-80
1103
1978FIESTA
RIGHT FRONT PASSENGER CHEST ACCELERATION RESULTANT
AR = G
80
60
40
20
0
0
50
100
150
200
250
TIME - MSEC


10-03-78 315 1103 8319-5.2
1978FIESTA
RIGHT FRONT PASSENGER
CHEST SEVERITY INDEX
SI
0
500
1000
1500
2000
0
50
100
150
200
250
TIME - MSEC

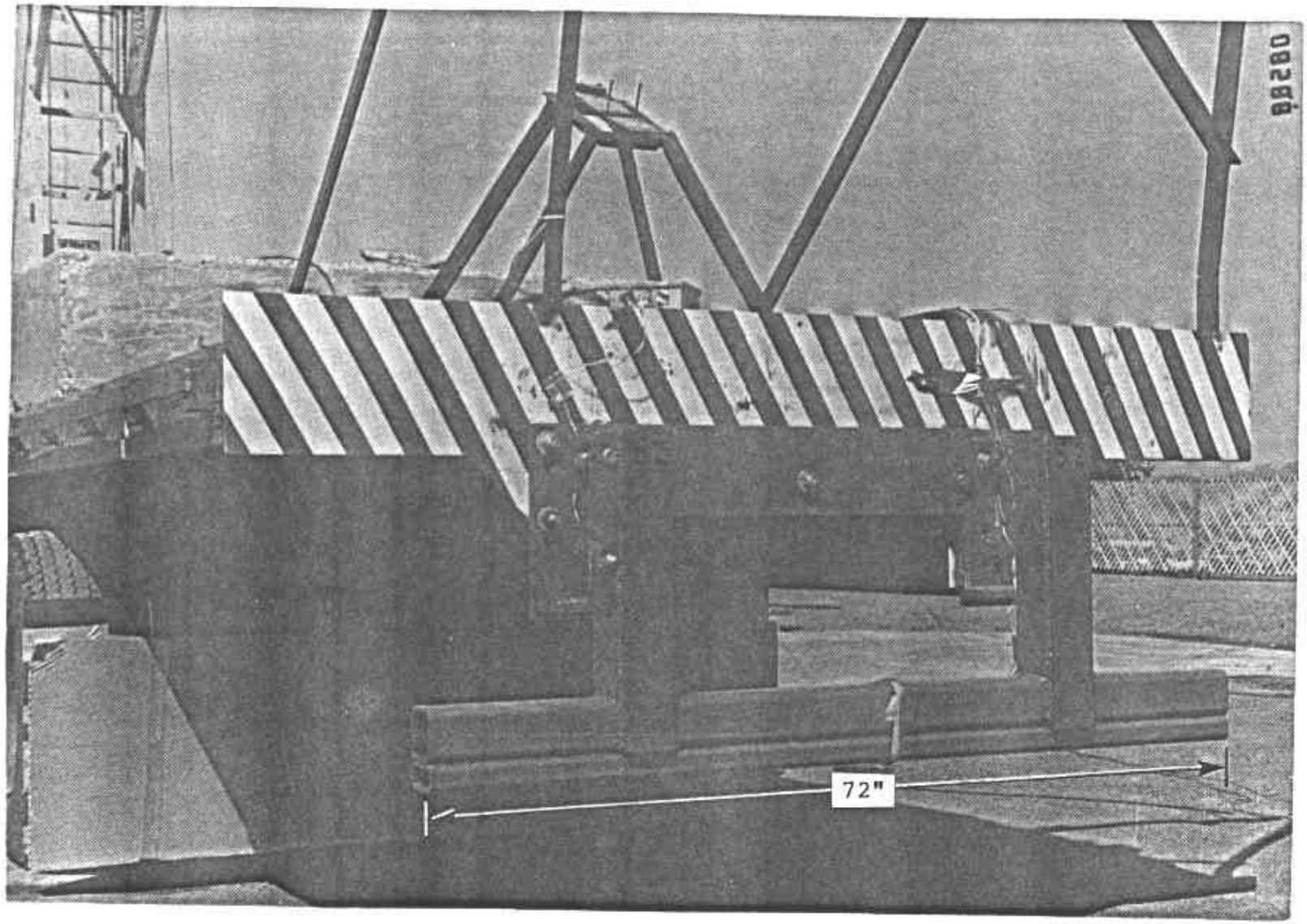

10-03-78 1000 2032 8319-5.2
1978FIESTA
RIGHT FRONT PASSENGER
LEFT FEMUR LOAD
FR - LBS *10¹
100
-0
-100
-200
-300
2031 1978FIESTA
RIGHT FRONT PASSENGER
RIGHT FEMUR LOAD
FL - LBS *10¹
100
-0
-100
-200
-300
0
50
100
150
200
250
TIME - MSEC

Test 5.2 Overall Pre-test View of Test Configuration.

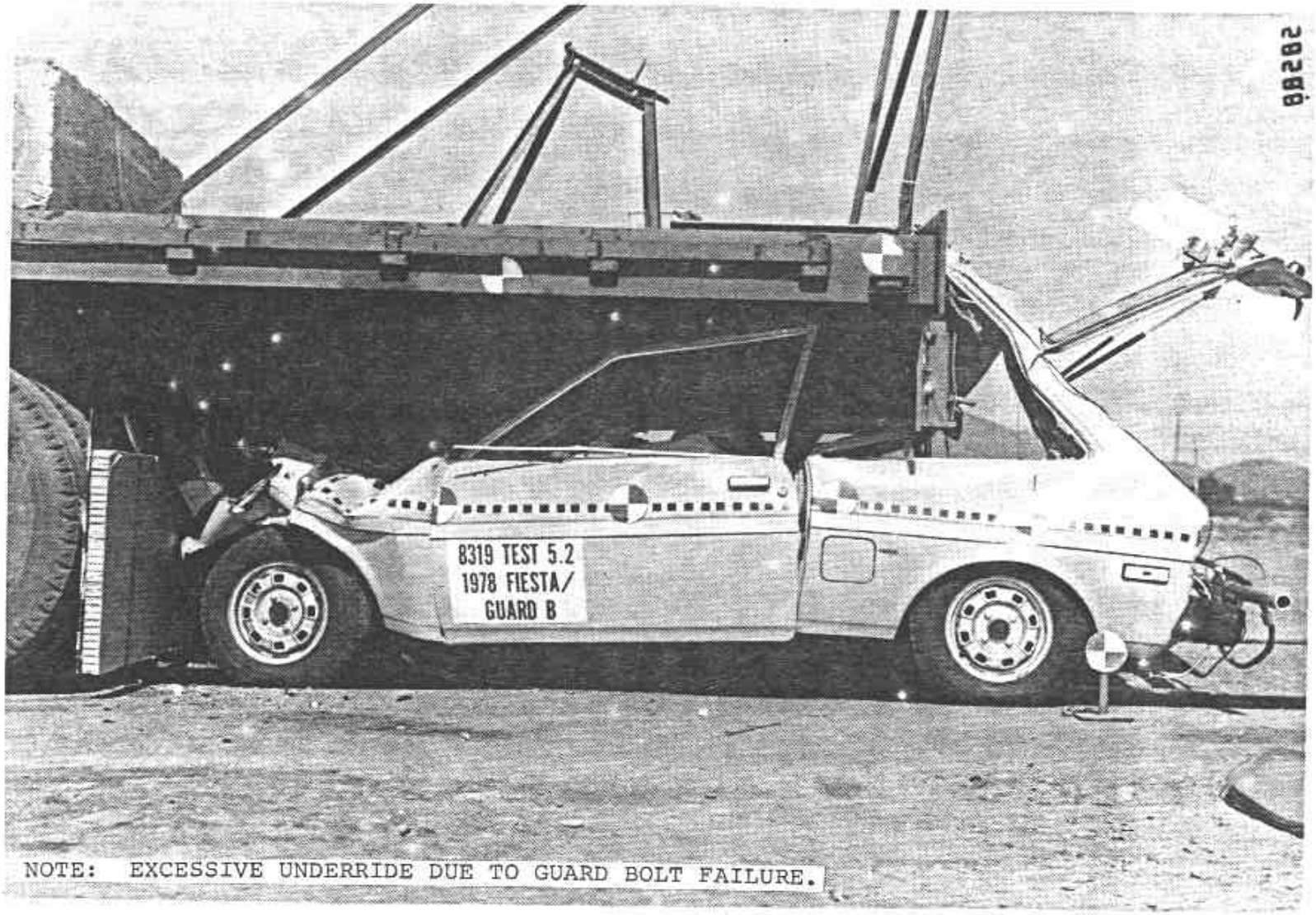


Test 5.2 Pre-test Close-up View of Vehicle/Guard Engagement.

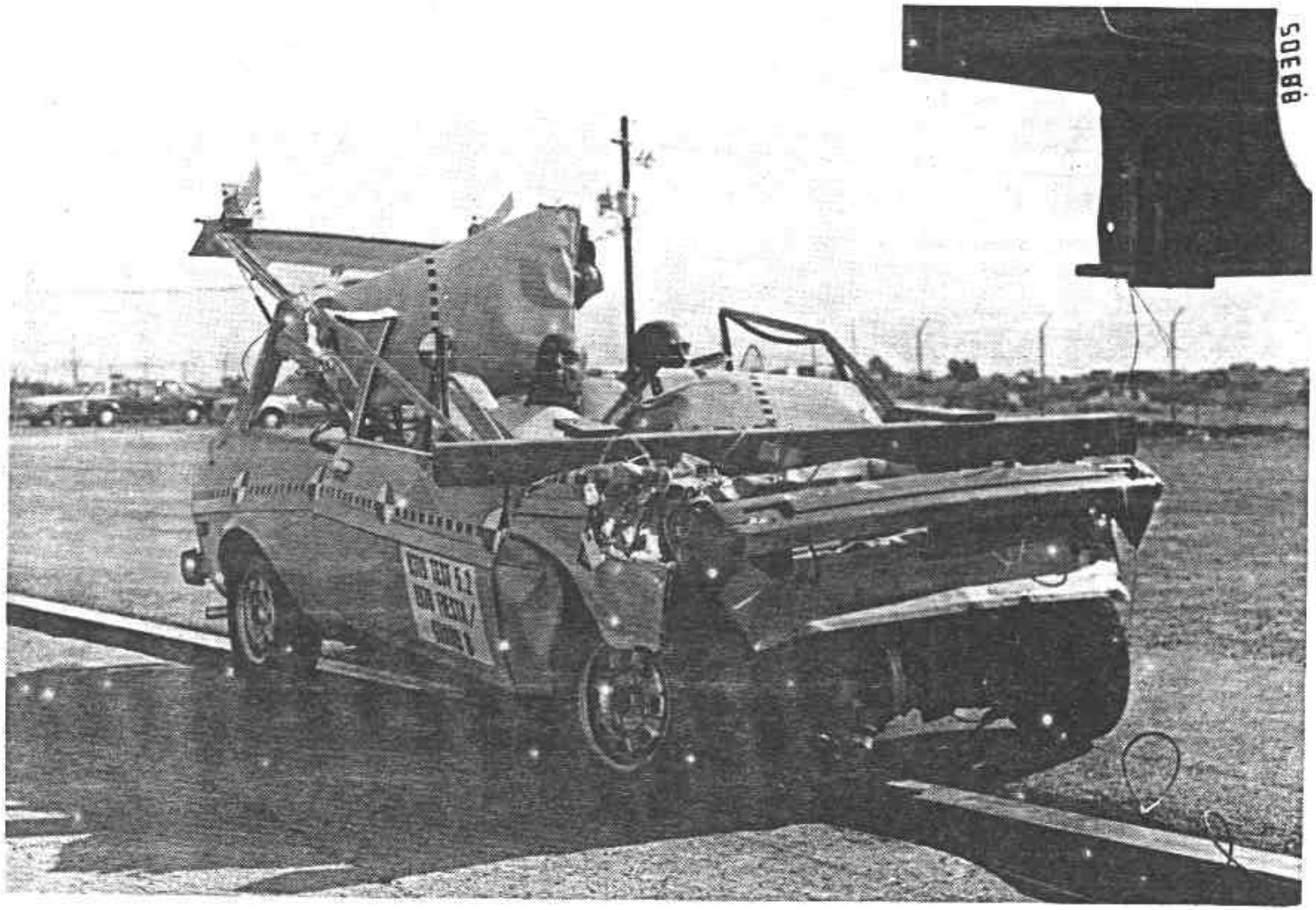
Test 5.2 Pre-test View of Test Configuration.



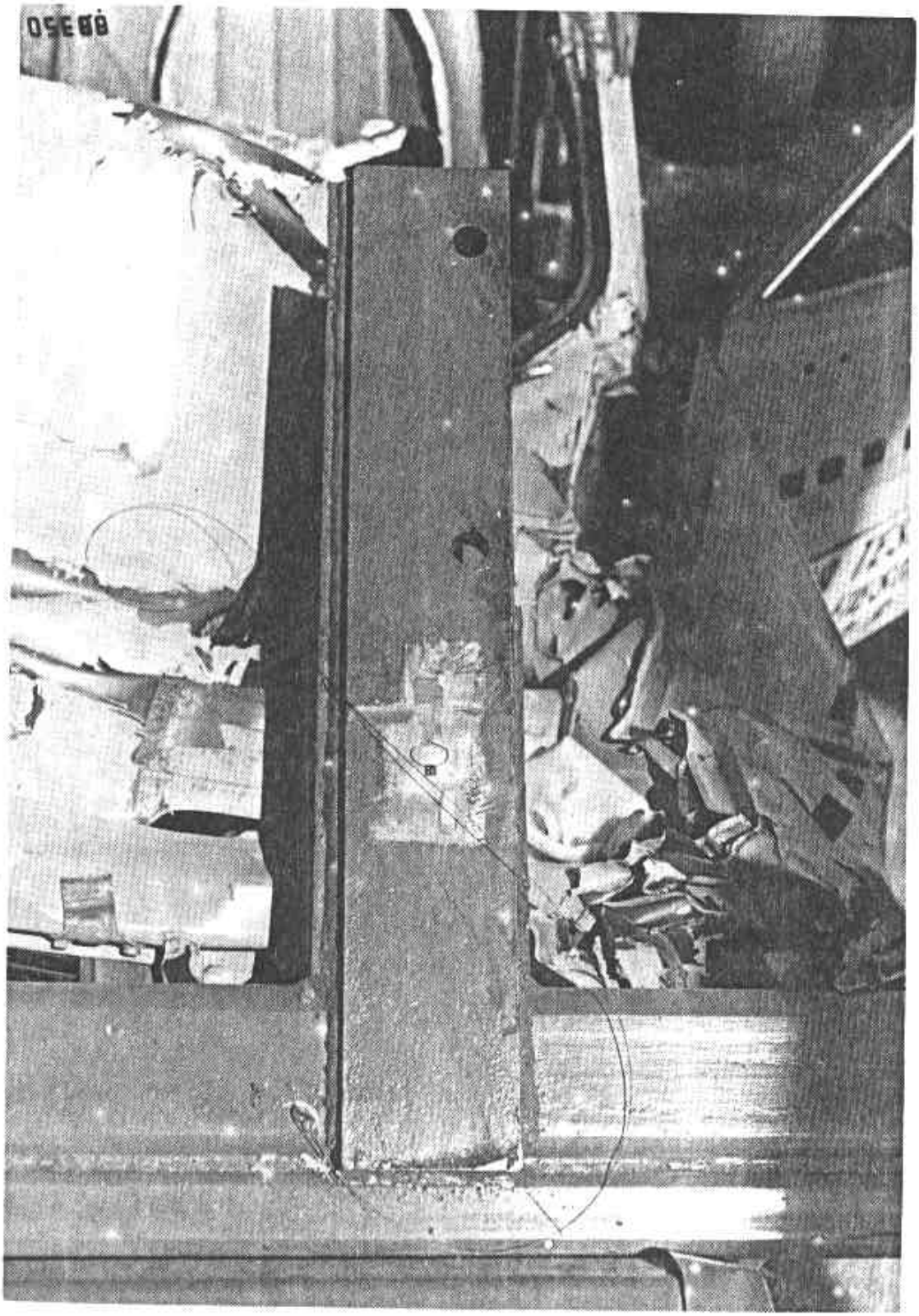
Test 5.2 Pre-test Overall View of Underride Guard.



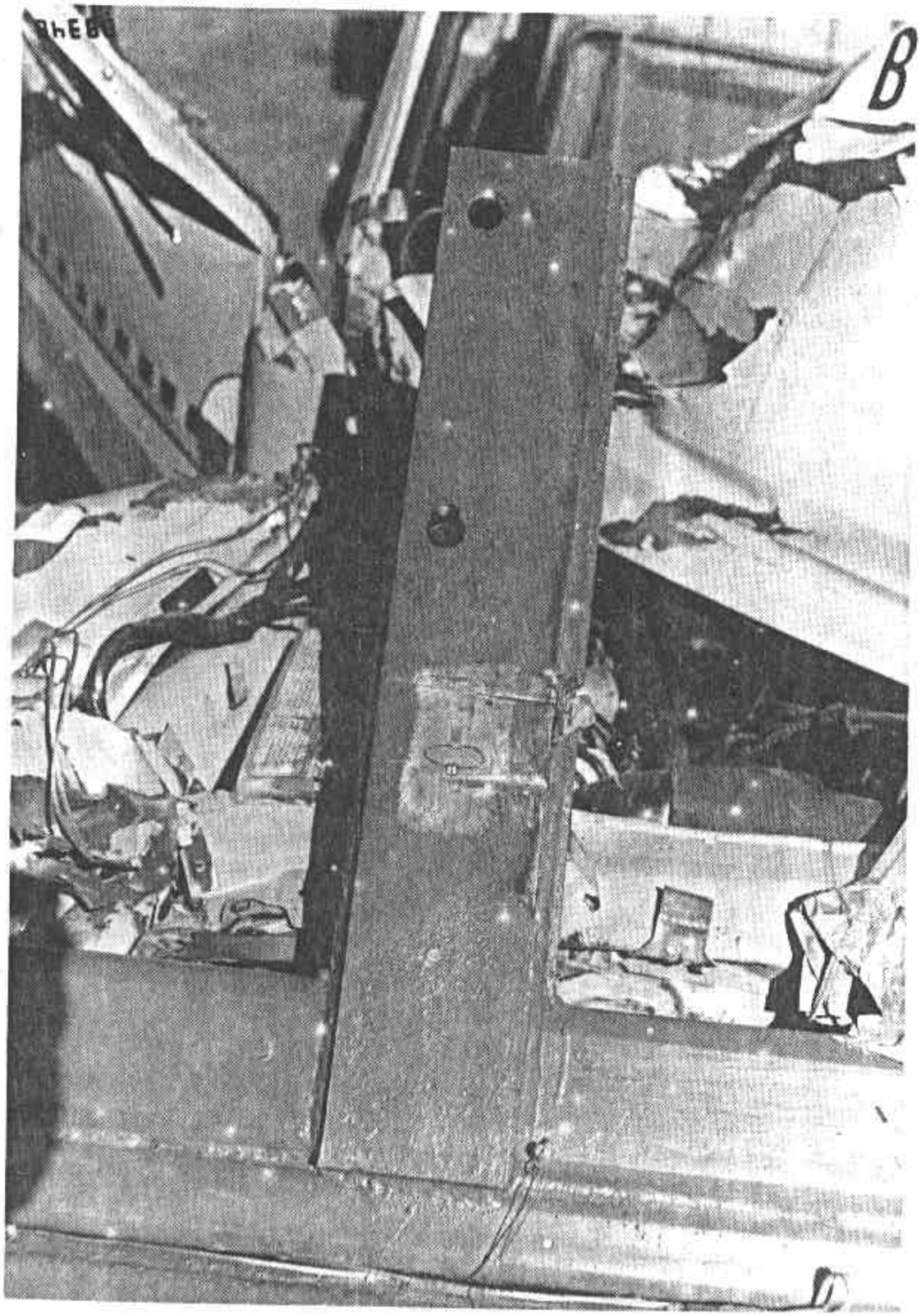
Test 5.2 Overall Post-test View of 1978 Ford Fiesta/22" High Modified Guard A Crash.



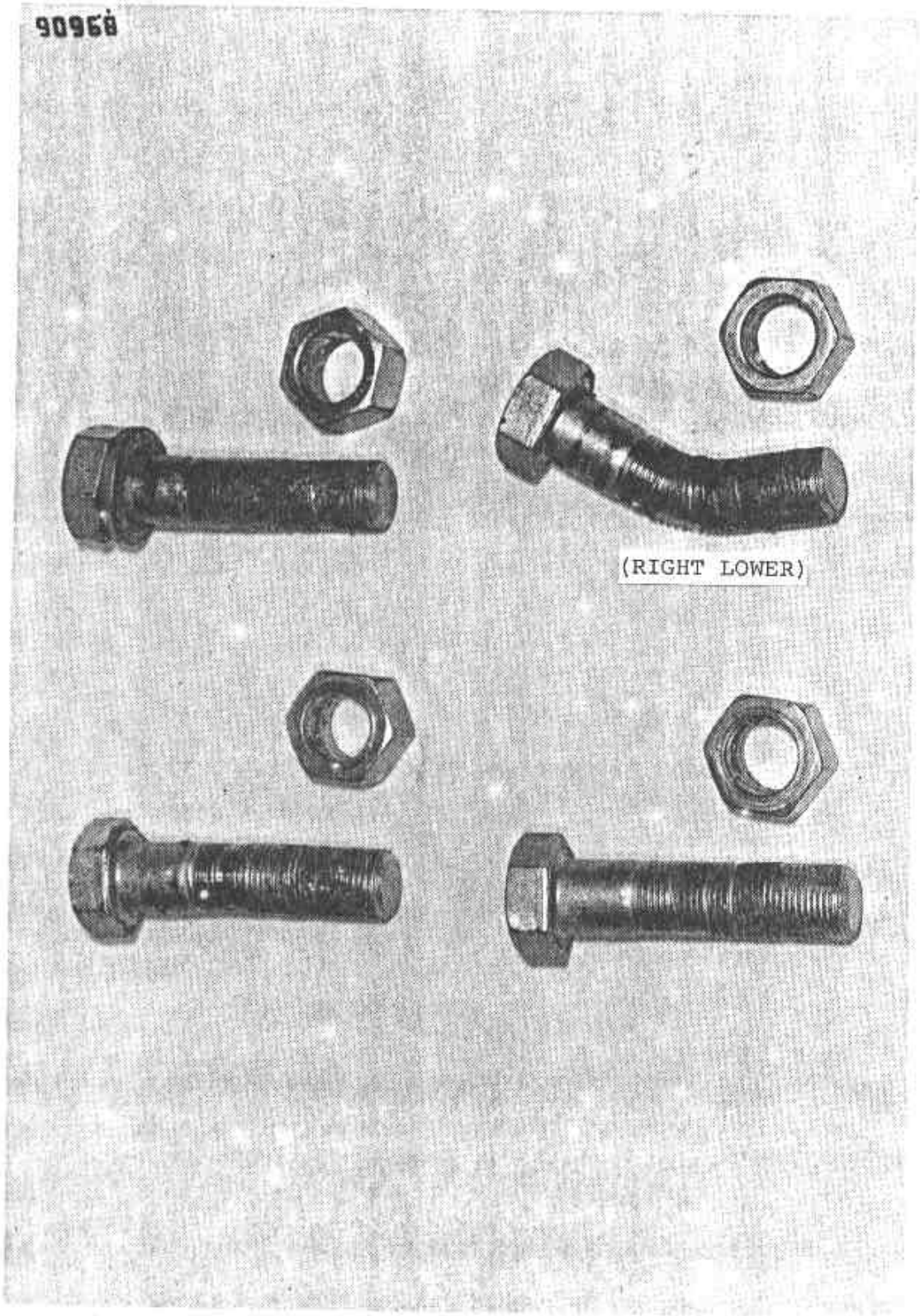
Test 5.2 Post-test View of Test Vehicle.



Test 5.2 Post-test View of Left (Driver) Side Vertical Guard Beam.



Test 5.2 Post-test View of Right (Passenger) Side Vertical Guard Beam.



Test 5.2 Post-test View of Stripped Threads on Nuts and Mating Bolts (Grade 5).

0141

SAME

AS

0158

41

APPENDIX C

TEST 5.3 TEST DATA SUMMARY

1978 VW RABBIT

SYMMETRIC IMPACT @ 40 MPH

TABLE C-1. RECEIVING INSPECTION OF VEHICLES

Contractor: Dynamic Science, Inc. Contract No.: DOT-HS-8-01905

VIN NO.: 1783408669 Make: Volkswagen

NHTSA No.:

Year: 1978 Color: White Model: Rabbit 4-door

Auto Trans:	(yes)	no	Pwr Steering:	yes	(no)	Seats: (front)	Bench:
Pwr Brakes:	(yes)	no	Auto Speed Cont:	yes	(no)		Bucket: X
Pwr Seats:	yes	(no)	Anti Skid Brake:	yes	(no)		Split Bench:
Pwr Windows:	yes	(no)	Air Conditioning:	(yes)	no		
Tinted Glass:	yes	(no)	Rear Window Def.:	(yes)	no		Split Back Bench:
Radio:	yes	(no)	Brakes: drum: R		disc: F		
Clock:	(yes)	no					

Tire Size: 155SR-13 Ply Rating: 4 Mfg. & Line: Uniroyal

Bias Ply: Belted: Radial X /Eng.HP: Cylinders: 4 Total Displ: 89 CID

Trans, # Fwd. Speeds: 3 Shipping Weight: 2822 GVWR Odometer: 39.6

Dealer (name, address, and phone number)

Aztec Volkswagen
2020 E. Indian School Rd.
Phoenix, Arizona 85016

Remarks (list additional accessories not listed above)

Date of Manufacture: 3-78 Dynamic Science No.: 712 Date Received: 5-31-78

Tilting Steering Wheel: yes (no) Telescoping Steering Wheel: yes (no)

Fuel Capacity: (from owner's manual) "Space Saver" Spare Tire yes (no)

Restraint System: Passive shoulder belt and knee bolsters

1. Is the vehicle stock throughout? Describe: Yes

2. Does vehicle show evidence of prior accident history? Describe: None

3. Does vehicle show any significant corrosion? Describe: None

4. Check condition of the front bumper and frame: Satisfactory

TABLE C-2. SUMMARY OF VEHICLE ENGINE/BUMPER/FIREWALL CHARACTERISTICS

Test No. 5.3 Type Symmetric

Car Model 1978 VW Rabbit Dynamic Science No. 712

Engine Size	89 CID
Engine Height/Width (in.)	28/31*
Bumper to Engine (in.)	26
Engine Length (in.)	10
Engine to Firewall (in.)	5.5
Bumper to Firewall (in.)	41
Bumper to "Hard Point" (A/C Comp.) (in.)	17
Initial Impact Point to Front Bumper (in.)	0.0
Height From Top of Front Bumper to Lowest Point of Underride Guard (in.)	0.1
Horizontal Dimension From Centerline of Vehicle to Extreme Left Edge of Guard (in.)	42
Horizontal Dimension From Centerline of Vehicle to Extreme Right Edge of Guard (in.)	42

*Transverse mounted engine.

TABLE C-3. SUMMARY OF CAR ACCELEROMETER DATA

Accelerometer Number	Plot Location Number	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)
1X	101	-48.1	34
1Y	101	-12.9	32
2X	102	-40.3	35
3X	103	-41.4	35
3Y	103	-6.2	31
4X	104	-87.8	48
4Y	104	-35.4	40
5X	105	-39.6	39
$6X_1$	106	-84.8	27
$6X_2$	NA	NA	-
6Z	106	-35.0	57
7X	107	-82.8	30

TABLE C-4. SUMMARY OF TRAILER ACCELEROMETER DATA

Accelerometer Number	Plot Location Number	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)
2X	202	-5.9	34.0

TABLE C-5. SUMMARY OF COMPARTMENT AND ENGINE ACCELEROMETER DATA

Accelerometer Number	Plot Location Number	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)
Average of 1X and 2X	401	-43.1	35
$6X_1$	106	-84.8	27

TABLE C-6. SUMMARY OF UNDERRIDE GUARD STRING POTENTIOMETER DATA

Displacement Potentiometer (Number)	Displacement Potentiometer (Location)	Plot Location Number	Maximum Dynamic Displacement D (in.)	Maximum Dynamic Displacement Time (msec)
SP1	Left	4301	-.4	45
SP2	Center	4302	-.4	44
SP3	Right	4303	-.4	43

TABLE C-7. COMPARISON OF TOTAL INTERFACE FORCE FROM LOAD CELL AND ACCELEROMETER DATA

Parameter	Trailer Force Data*	Car Acceleration Data**
Force (lb)	91,444	81,980
Time (msec)	35	35

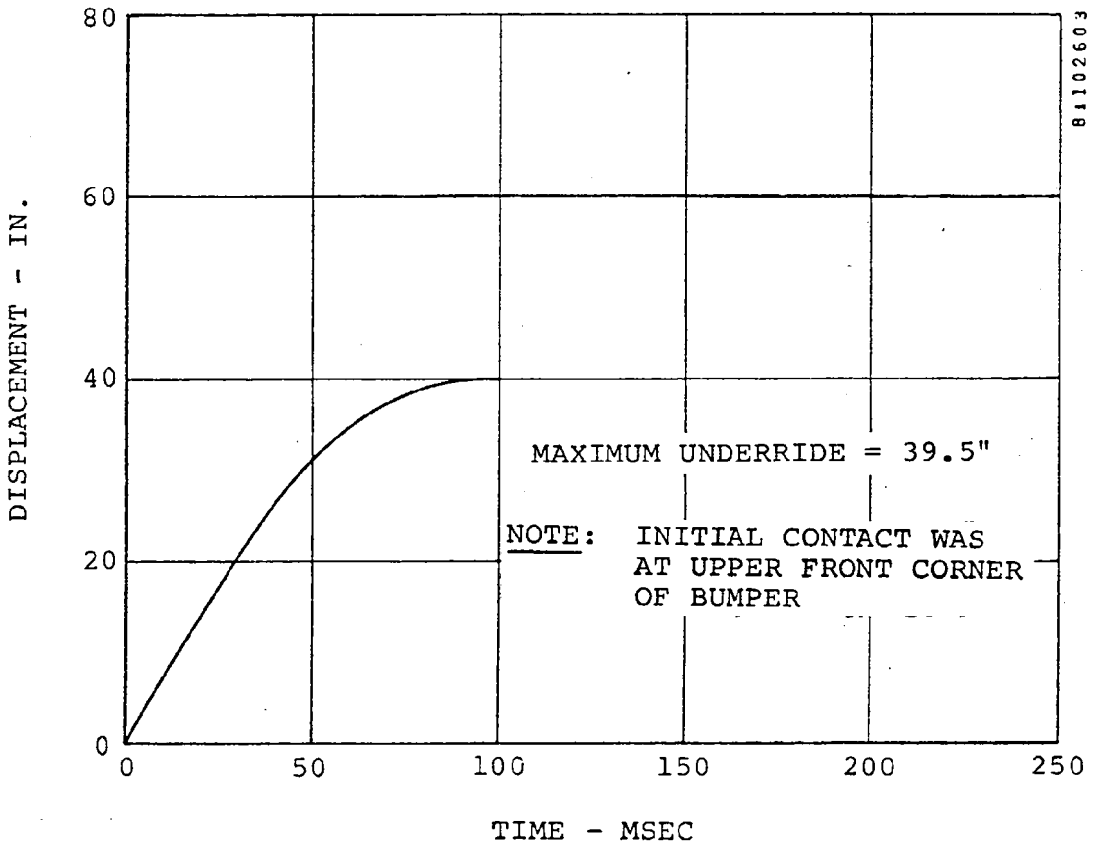
*Sum of 4 load cells.
**Average of car accelerometers 1 and 2 x (vehicle minus engine weight) + engine acceleration x (engine weight).

TABLE C-8. SUMMARY OF UNDERRIDE GUARD AND TRAILER STRAIN GAUGE DATA

Strain Gauge Number	Plot Location Number*	Maximum Strain** (μin./in.)	Maximum Time (msec)
SG1	4213	681	26
SG2	4213	-727	33
SG3	4213	902	30
SG4	Not Used		
SG5	4256	451	29
SG6	4256	167	32

*For location of strain gauges 1-3, see Figure 3-2.
For location of strain gauges 5-6, see Figure 2-3.

**Stress = strain (in./in.) x E (30 x 10^6 lb/in. for steel), tensile strain and stress are negative values.



Test 5.3 Vehicle Underride Versus Time - 1978 Volkswagen Rabbit - Symmetric Impact @ 40.44 mph.

TABLE C-9. SUMMARY OF PRE-TEST AND POST-TEST VEHICLE STATIC MEASUREMENTS

TEST NO.: 8319-5.3 VEHICLE: 1978 VW Rabbit

Location	Dimension		Reference	Difference
	Pre	Post		
Front of Engine block at valve cover	118.3	108.0	Target 144	10.3
Front edge of A/C compressor	127.0	107.0	Target 144	20.0
Front edge of shock/ strut tower (Left)	113.6	100.3	Target 144	13.3
Bottom of "A" pillar (left)	92.9	91.5	Target 144	1.4
Bottom of "A" pillar (right)	92.5	89.9	Target 144	2.6
Rear edge of dash panel (left)	86.8	86.0	Target 144	0.8
Rear edge of dash panel (right)	87.2	84.9	Target 144	2.3
Steering column hub (horizontal)	77.2	77.0	Target 144	0.2
Steering column lower rim (horizontal)	73.0	74.5	Target 144	-1.5
Steering column hub (vertical)	21.9	31.1	Rocker Sill	-9.2
Steering column lower rim (vertical)	13.0	25.4	Rocker Sill	-12.4
Top of "A" pillar (left)	77.5	77.3	Target 144	0.2
Top of "A" Pillar (right)	77.5	77.4	Target 144	0.9
Centerline of wind-shield opening (top)	80.5	80.3	Target 144	0.2
Knee bolster (left)	84.5	75.0	Target 144	9.5
Knee bolster (right)	84.7	83.2	Target 144	1.5
Firewall, driver centerline	103.4	94.4	Target 144	9.0
Firewall, passenger centerline	102.5	93.8	Target 144	8.7
Firewall, centerline of vehicle	102.5	93.9	Target 144	8.6

TABLE C-10. SUMMARY OF PRE-TEST DUMMY POSITION DATA CHARACTERISTICS

Test No. 5.3 Type Symmetric

Car Model 1978 VW Rabbit Dynamic Science No. 712

	Left Front Occupant	Right Front Occupant
Seat Range (in.)	6.3	6.3
Seat Position* (in.)	3.0	3.0
Front Seat to Firewall (in.)	24.1	24.5
Forehead to Windshield (in.)	24.6	24.1
Torso to Steering Wheel* (in.)	14.2	23.8
Left/Right Knee to Dash Panel (in.)	3.2/2.5	3.4/3.3

Dummy Type Alderson Part 572

Locations: Left Front Occupant - No. 759

Right Front Occupant - No. 760

Restraint Type: LF Passive Shoulder Belt and Knee Bolster

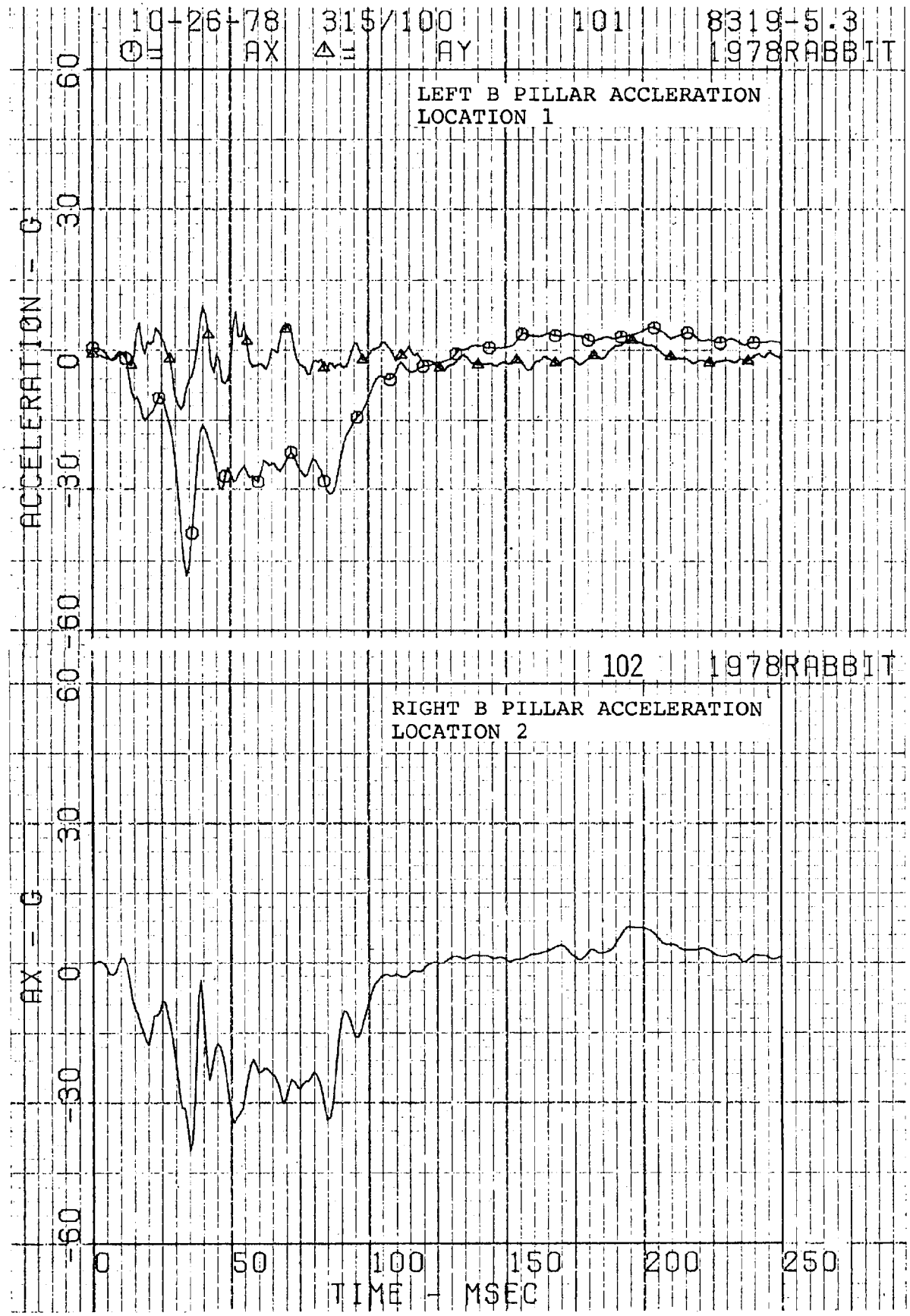
RF Passive Shoulder Belt and Knee Bolster

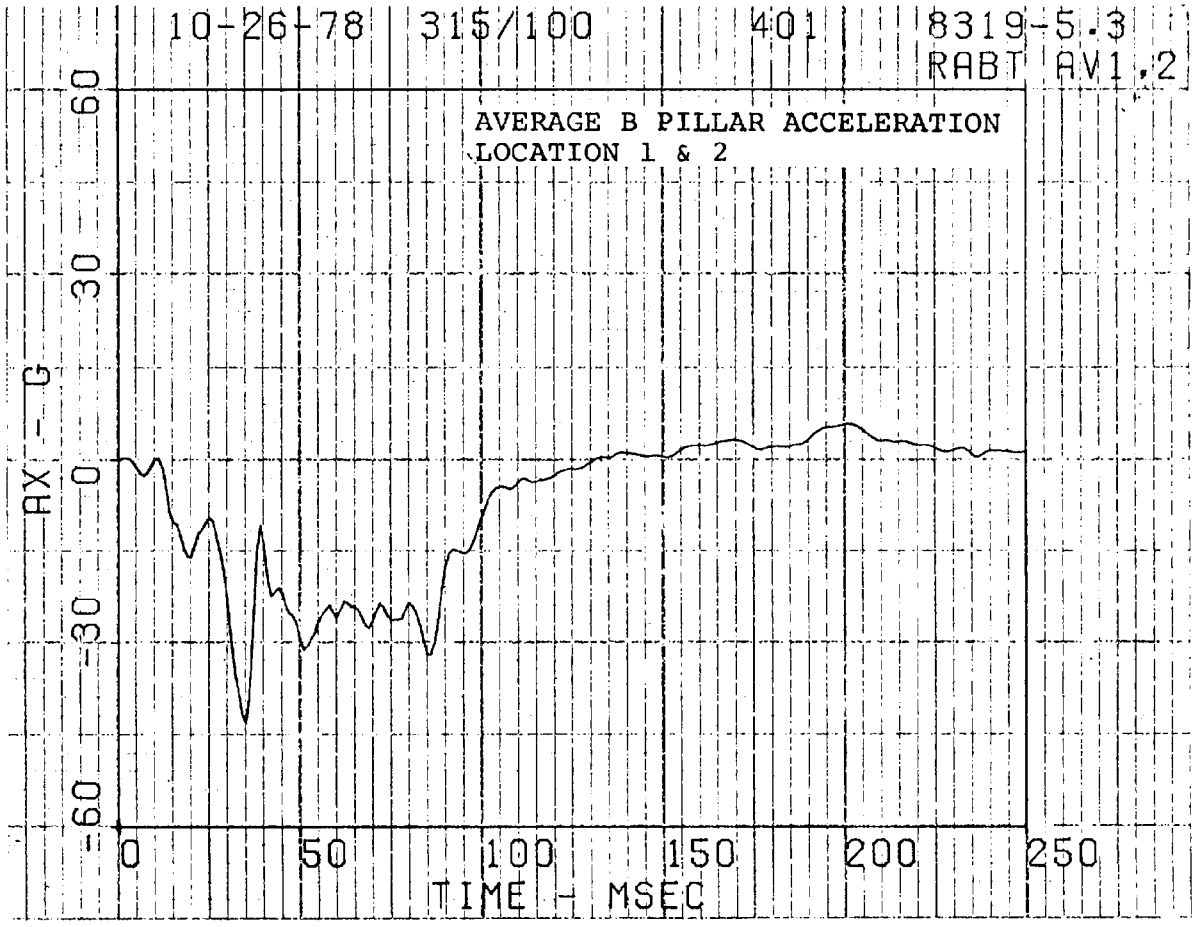
*From rearmost position to midpoint seat position.
**To dash panel for right front occupant.

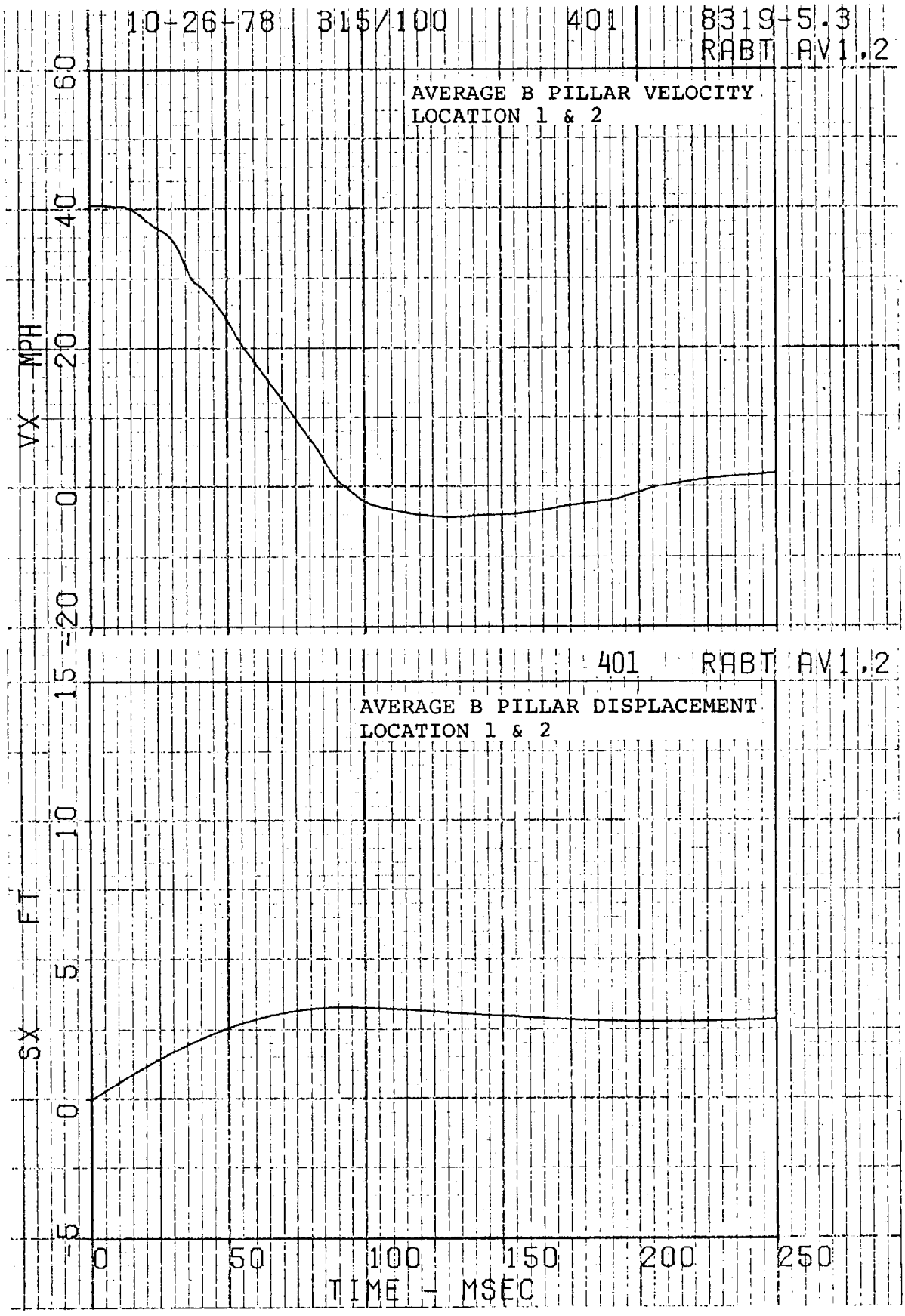
TABLE C-11. SUMMARY OF OCCUPANT RESPONSE DATA FOR TEST 5.3

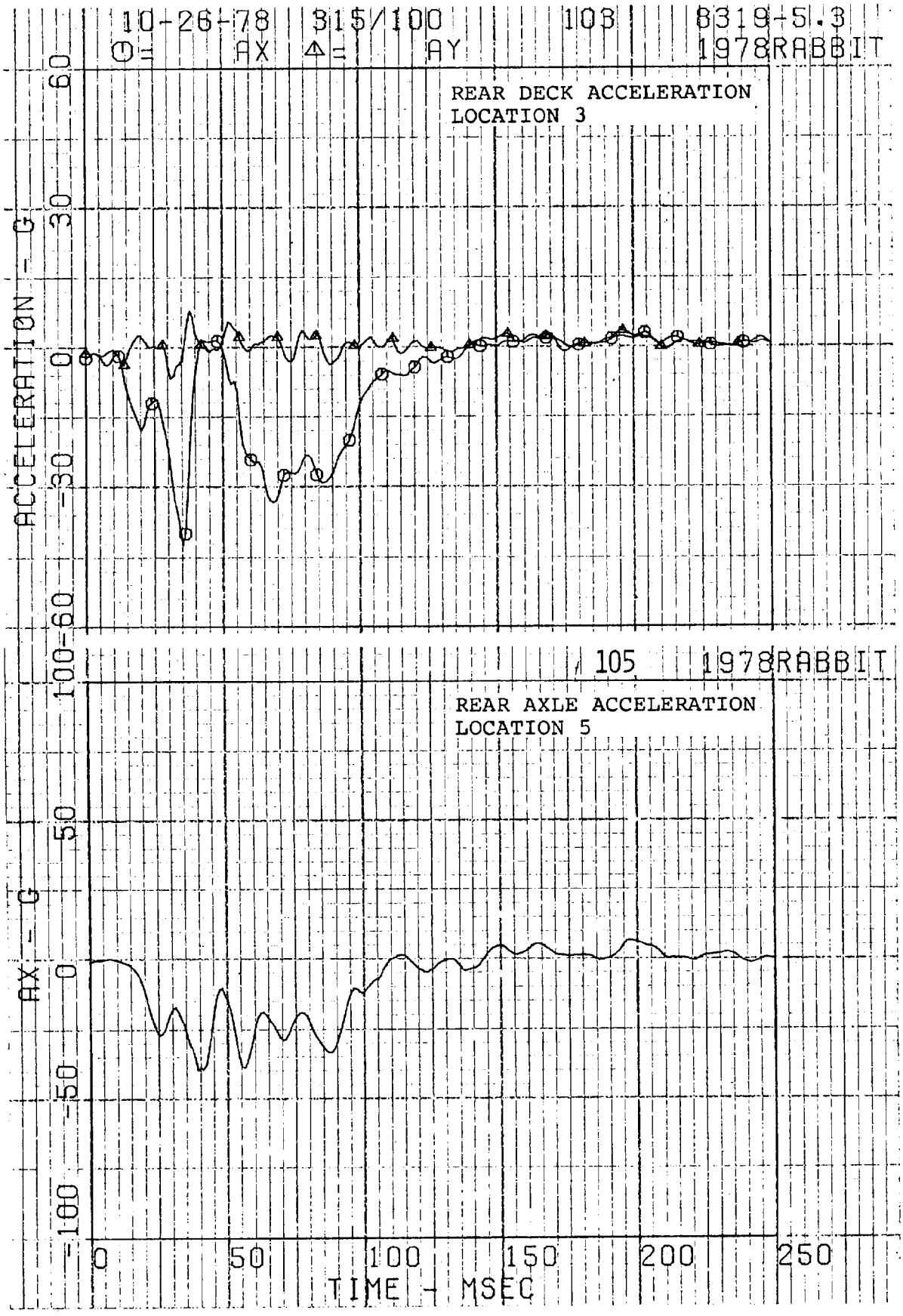
Response Parameter		Filter (Hz)	Left Front Dummy (Driver) Maximum Value A (G)	Left Front Dummy (Driver) Maximum Value T (msec)	Right Front Dummy (Passenger) Maximum Value A (G)	Right Front Dummy (Passenger) Maximum Value T (msec)
Head	X	1600	-152.3	91	-120.0	99
	Y	1600	-98.9	91	39.0	99
	Z	1600	77.3	99	122.8	103
	R	1600	181.6	91	165.0	99
SI/Time			3108	200	3270	200
HIC/Time			2401	85-103	2577	84-117
Head Acceleration*	R	1600	131*		125*	
Chest	X	315	-79.4	83	-63.2	80
	Y	315	-55.4	86	13.7	68
	Z	315	27.9	72	29.8	65
	R	315	88.7	83	63.9	80
SI/Time			799	200	714	200
Chest Acceleration*			63*	85	62*	82
Femur Loads** (lb)	L	1000	-1944	58	-2893	55
	R	1000	-2298	52	-2366	61

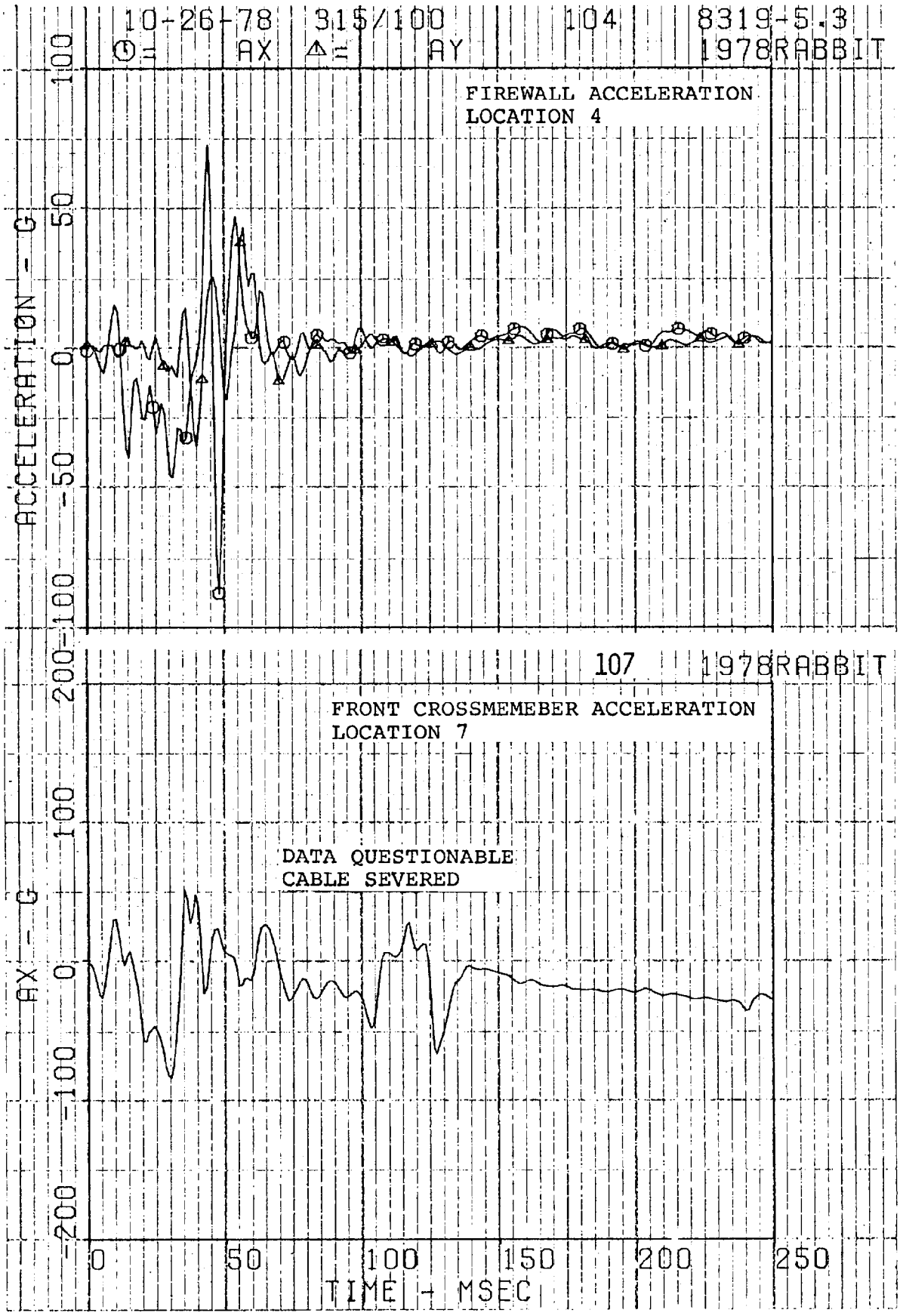
*G values defined as value for a cumulative duration of at least 3 msec.
**Negative loads are compression; positive loads are tension.

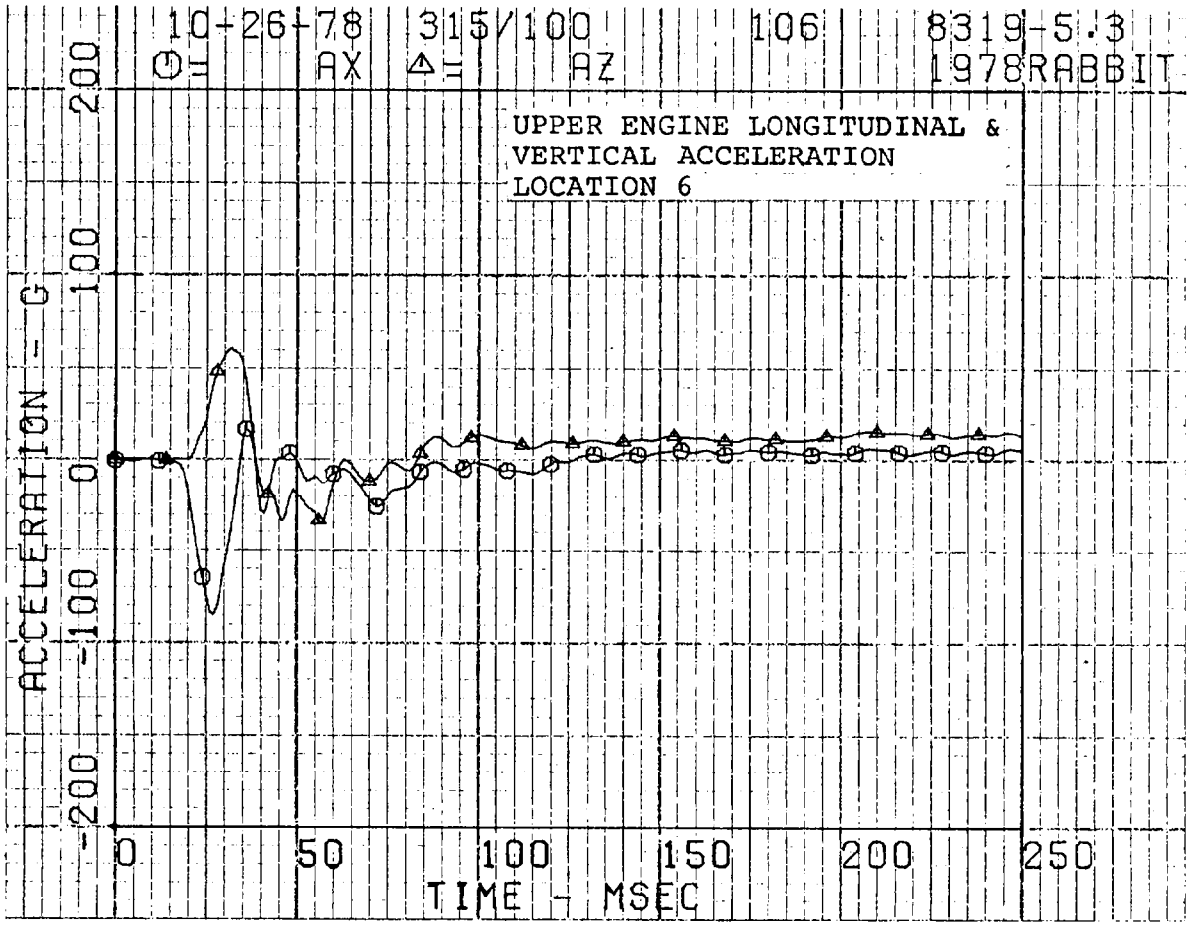

10-26-78 31$/100 101 8319-5.3
AX AY 1978RABBIT
LEFT B PILLAR ACCLERATION
LOCATION 1
ACCELERATION - G
60
30
0
-30
-60
102 1978RABBIT
RIGHT B PILLAR ACCELERATION
LOCATION 2
AX - G
60
30
0
-30
-60
0
50
100
150
200
250
TIME - MSEC

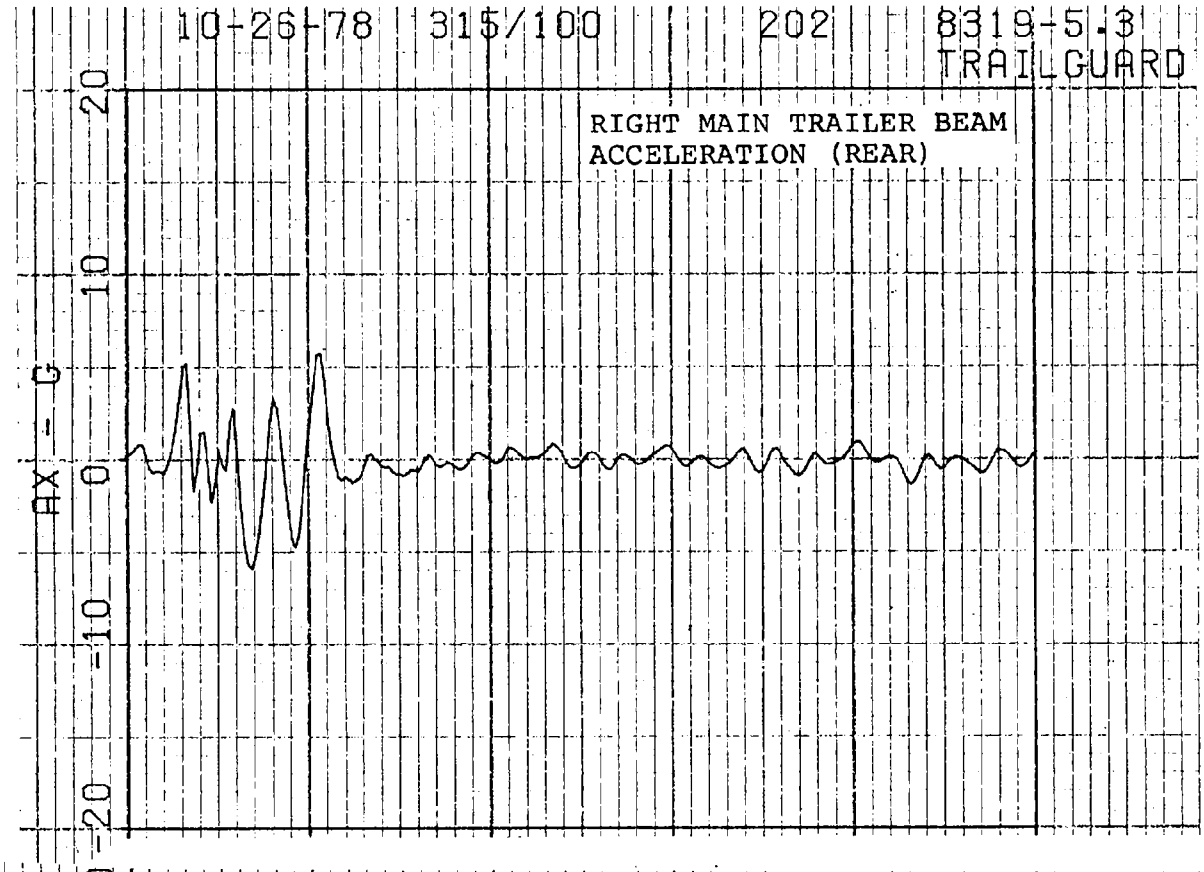

10-26-78 315/100 401 8319-5.3
RABT AV1.2
AVERAGE B PILLAR ACCELERATION
LOCATION 1 & 2
AX - G
60
30
0
-30
-60
0
50
100
150
200
250
TIME - MSEC

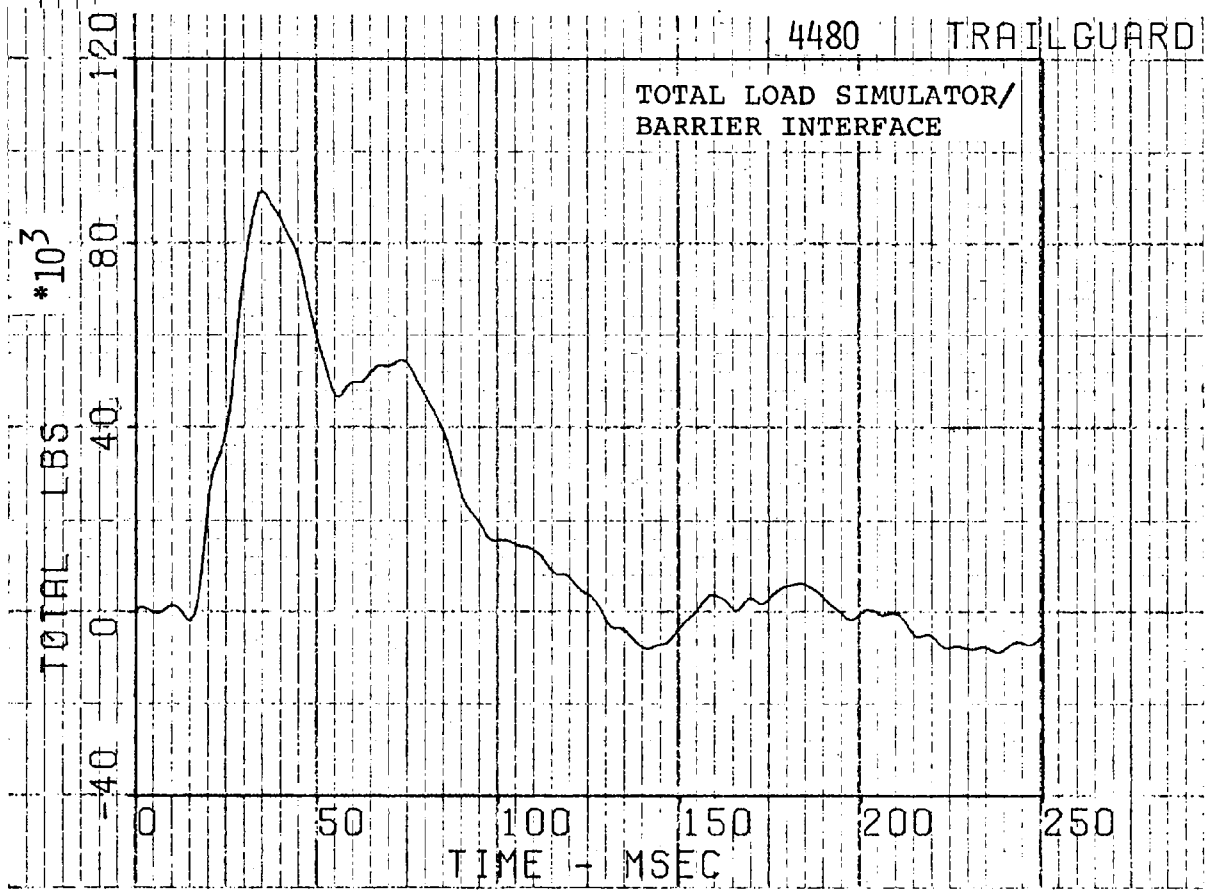

10-26-78 315/100 401 8319-5.3
RABT AV1.2
AVERAGE B PILLAR VELOCITY
LOCATION 1 & 2
VX MPH
60
40
20
0
-20
401 RABT AV1.2
AVERAGE B PILLAR DISPLACEMENT
LOCATION 1 & 2
SX FT
15
10
5
0
-5
0
50
100
150
200
250
TIME - MSEC

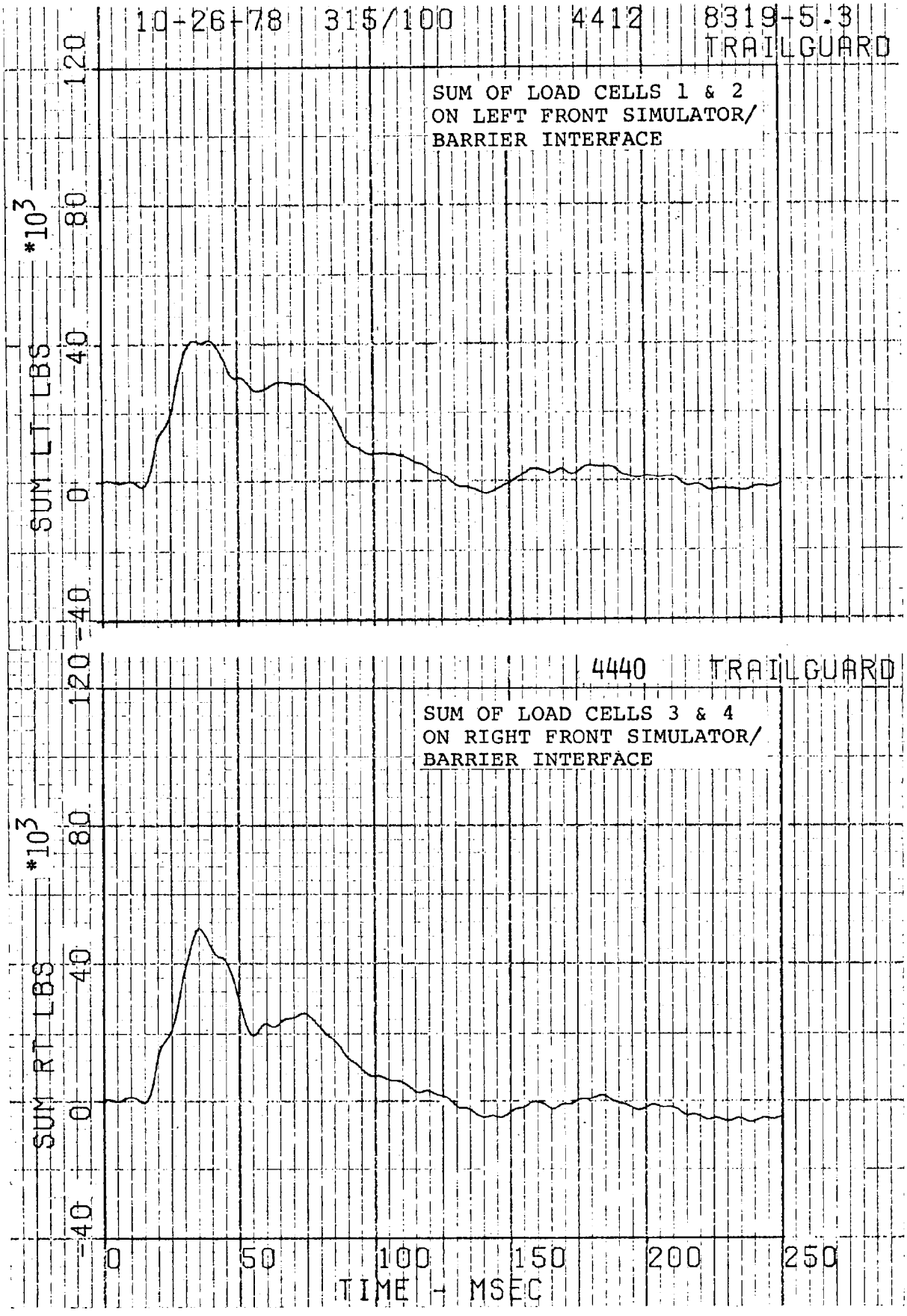

10-26-78 315/100 103 8319-5.3
⊙= AX △= AY 1978RABBIT
REAR DECK ACCELERATION
LOCATION 3
ACCELERATION = G
60
30
0
-30
-60
105 1978RABBIT
REAR AXLE ACCELERATION
LOCATION 5
AX = G
100
50
0
-50
-100
0
50
100
150
200
250
TIME - MSEC

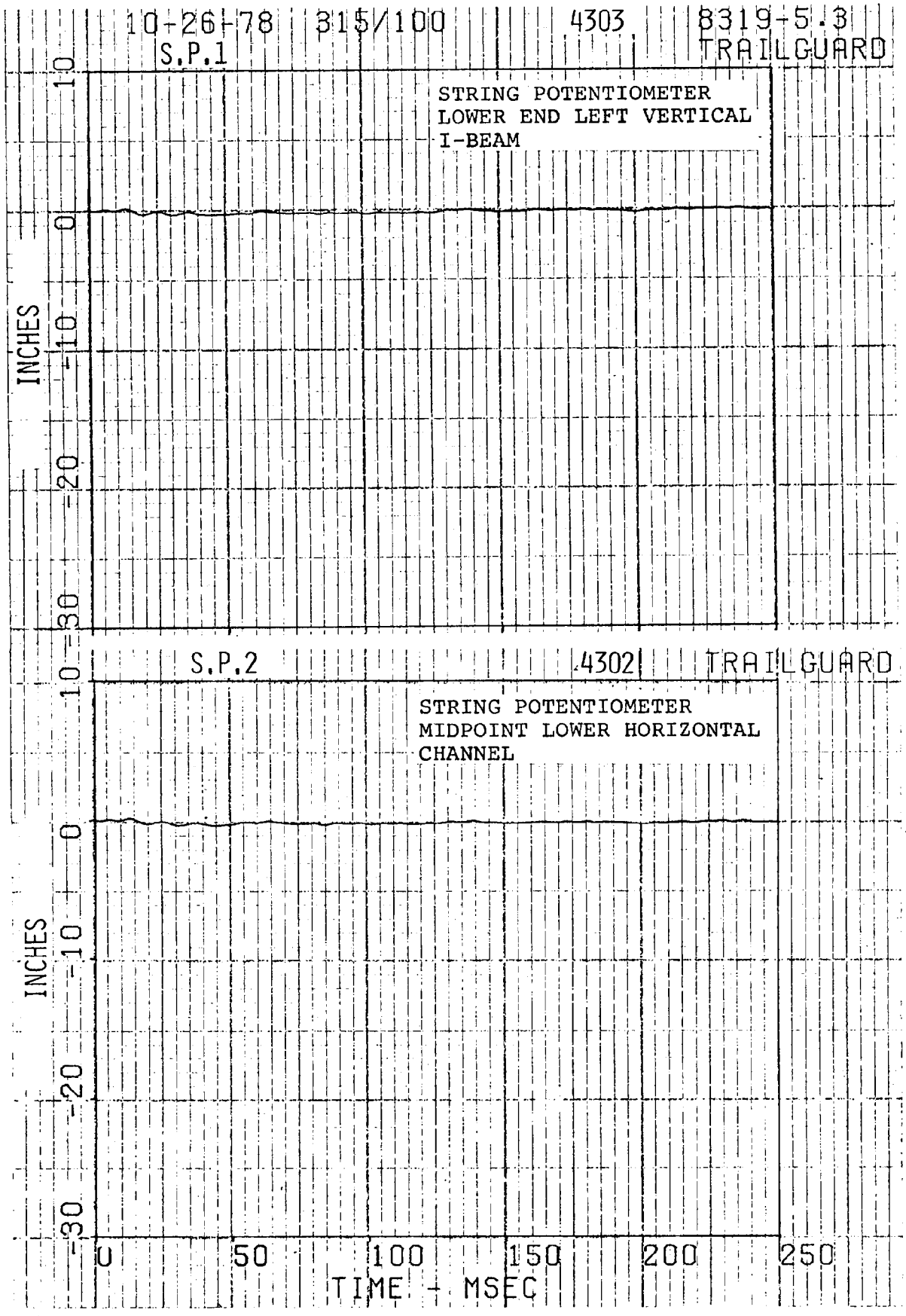

10-26-78 315/100 104 8319-5.3
AX AY 1978RABBIT
FIREWALL ACCELERATION
LOCATION 4
ACCELERATION - G
100
50
0
-50
-100
-200
107 1978RABBIT
FRONT CROSSMEMEBER ACCELERATION
LOCATION 7
DATA QUESTIONABLE
CABLE SEVERED
AX - G
100
0
-100
-200
0
50
100
150
200
250
TIME - MSEC

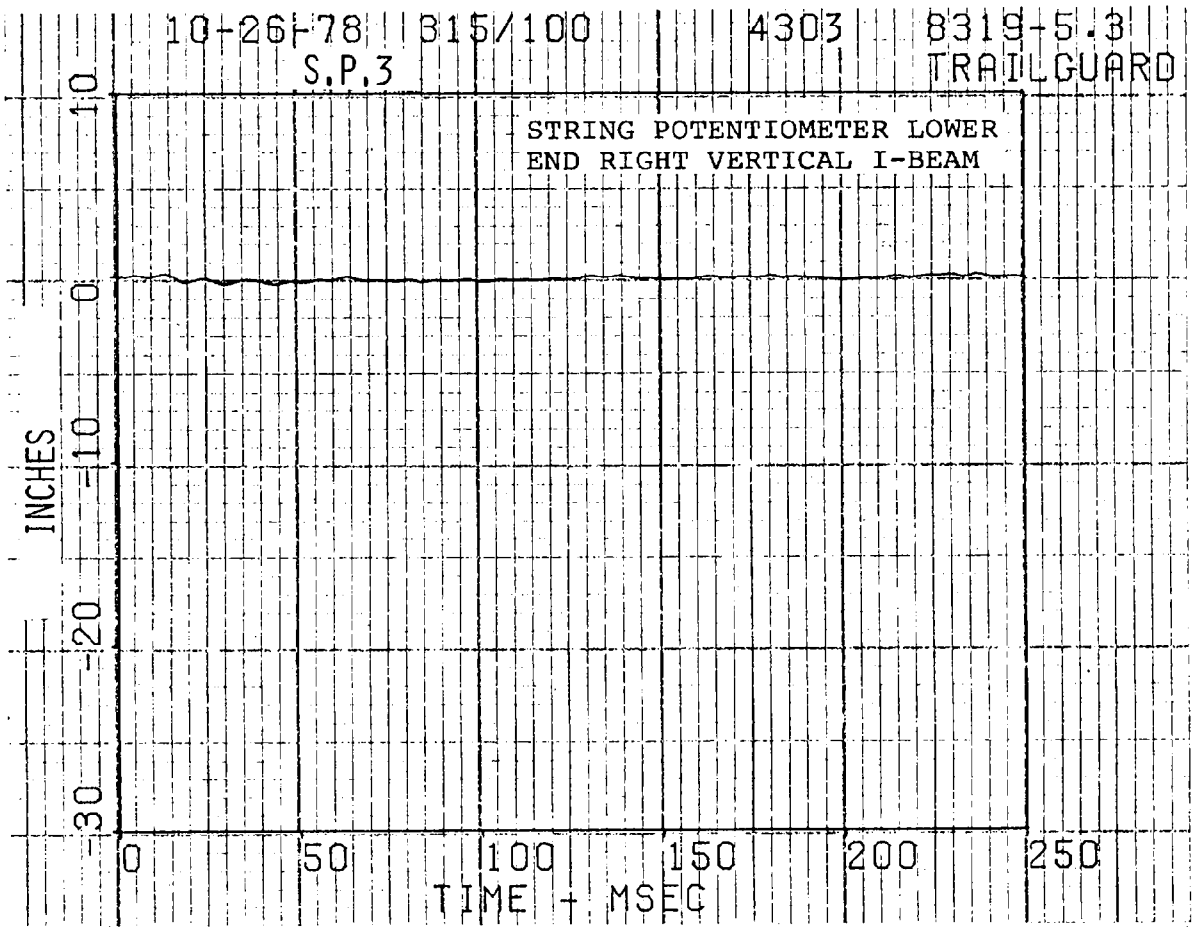

10-26-78 315/100 106 8319-5.3
AX AZ 1978RABBIT
UPPER ENGINE LONGITUDINAL &
VERTICAL ACCELERATION
LOCATION 6
ACCELERATION - G
200
100
0
-100
-200
0
50
100
150
200
250
TIME - MSEC

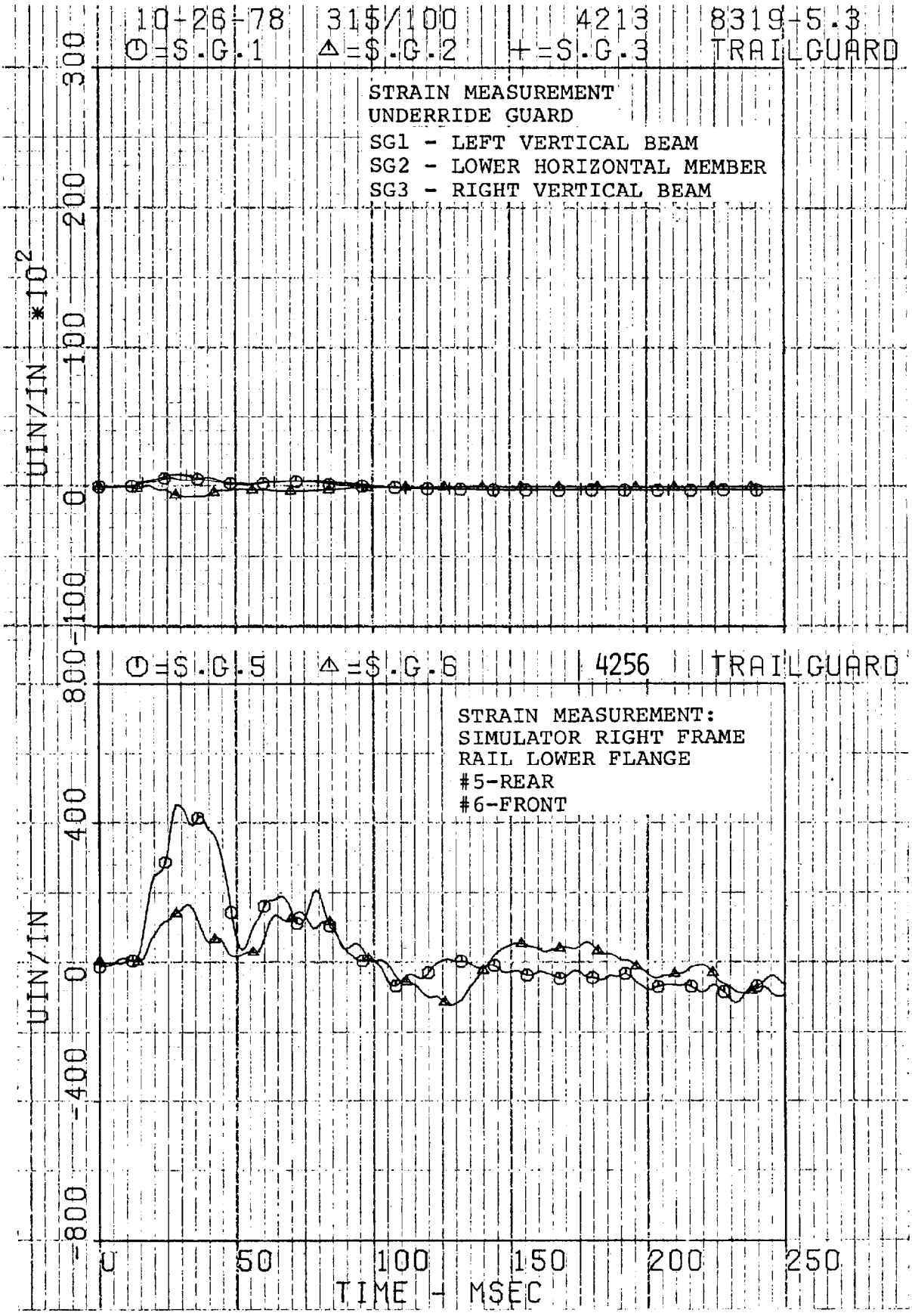

10-26-78 315/100 202 8319-5.3
TRAILGUARD
RIGHT MAIN TRAILER BEAM
ACCELERATION (REAR)
AX - G
20
10
0
-10
-20

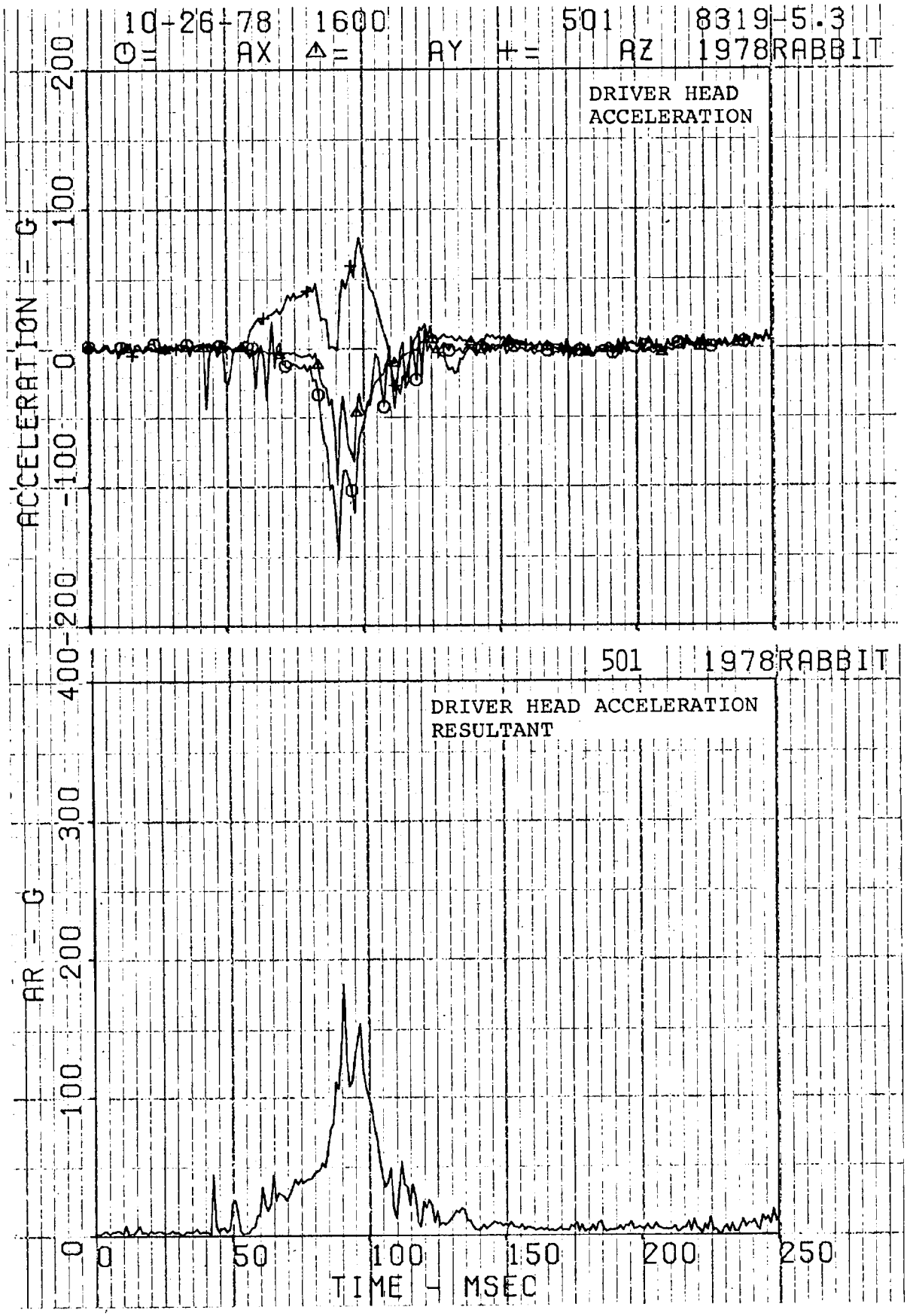

4480 TRAILGUARD
TOTAL LOAD SIMULATOR/
BARRIER INTERFACE
TOTAL LBS *10³
120
80
40
0
-40
0
50
100
150
200
250
TIME - MSEC

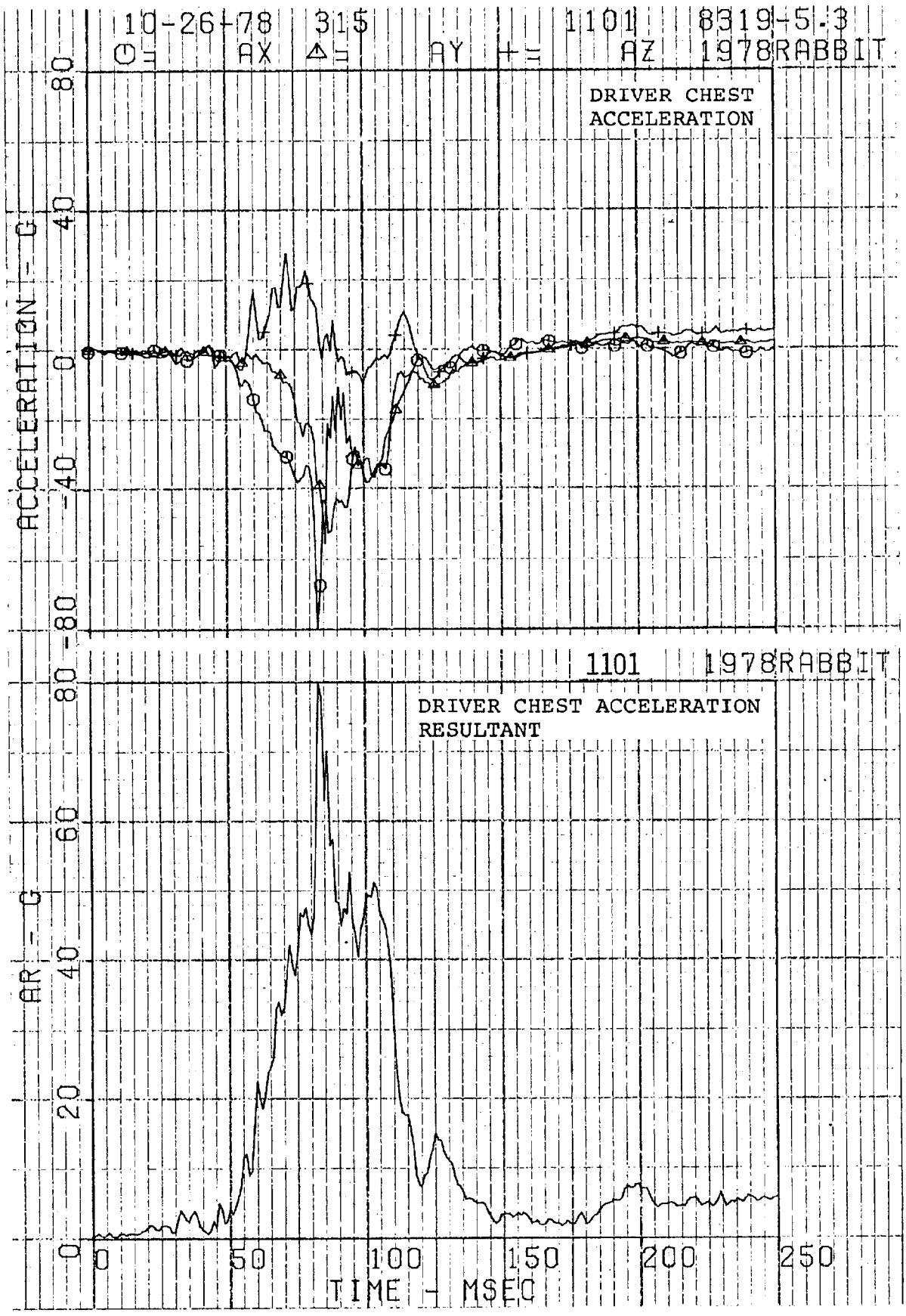

10-26-78 315/100 4412 8319-5.3
TRAILGUARD
SUM OF LOAD CELLS 1 & 2
ON LEFT FRONT SIMULATOR/
BARRIER INTERFACE
SUM LT LBS *10³
120
80
40
0
-40
4440 TRAILGUARD
SUM OF LOAD CELLS 3 & 4
ON RIGHT FRONT SIMULATOR/
BARRIER INTERFACE
SUM RT LBS *10³
120
80
40
0
-40
0
50
100
150
200
250
TIME - MSEC

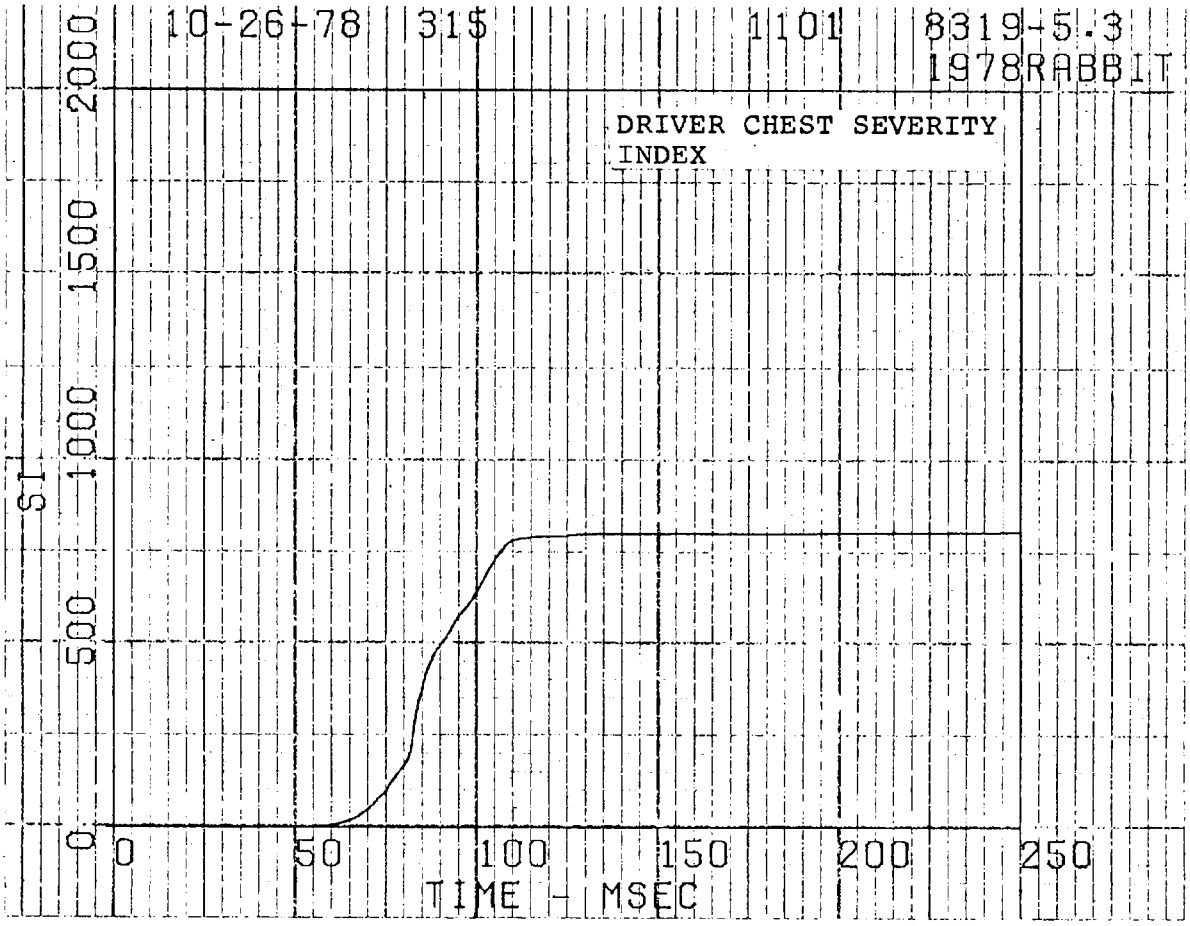

10-26-78 315/100 4303 8319-5.3
S.P.1
TRAILGUARD
STRING POTENTIOMETER
LOWER END LEFT VERTICAL
I-BEAM
INCHES
10
0
-10
-20
-30
S.P.2
4302
TRAILGUARD
STRING POTENTIOMETER
MIDPOINT LOWER HORIZONTAL
CHANNEL
INCHES
10
0
-10
-20
-30
0
50
100
150
200
250
TIME - MSEC

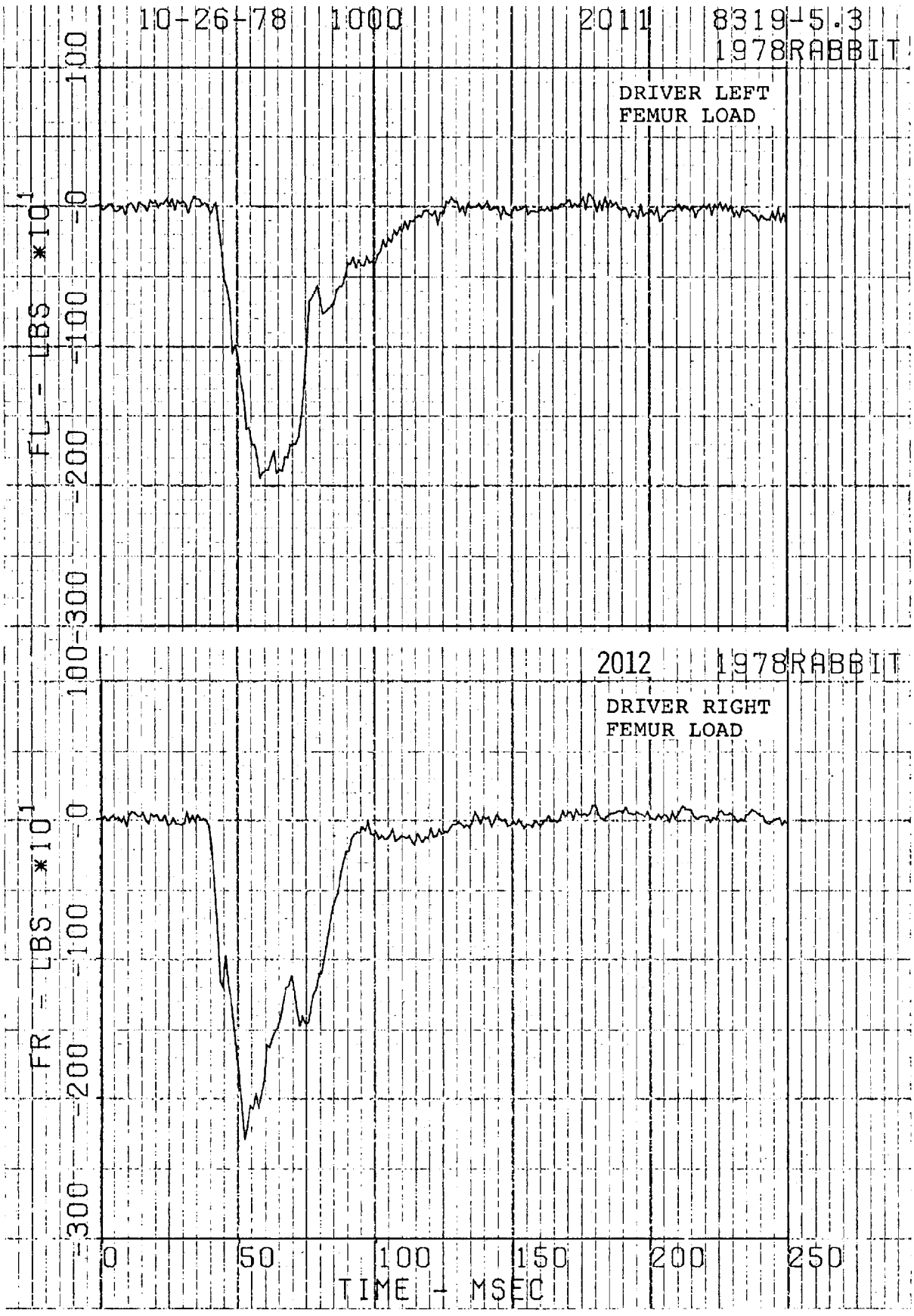

10-26-78 B15/100 4303 8319-5.3
S.P.3
TRAILGUARD
STRING POTENTIOMETER LOWER
END RIGHT VERTICAL I-BEAM
INCHES
10
0
-10
-20
-30
0
50
100
150
200
250
TIME + MSEC

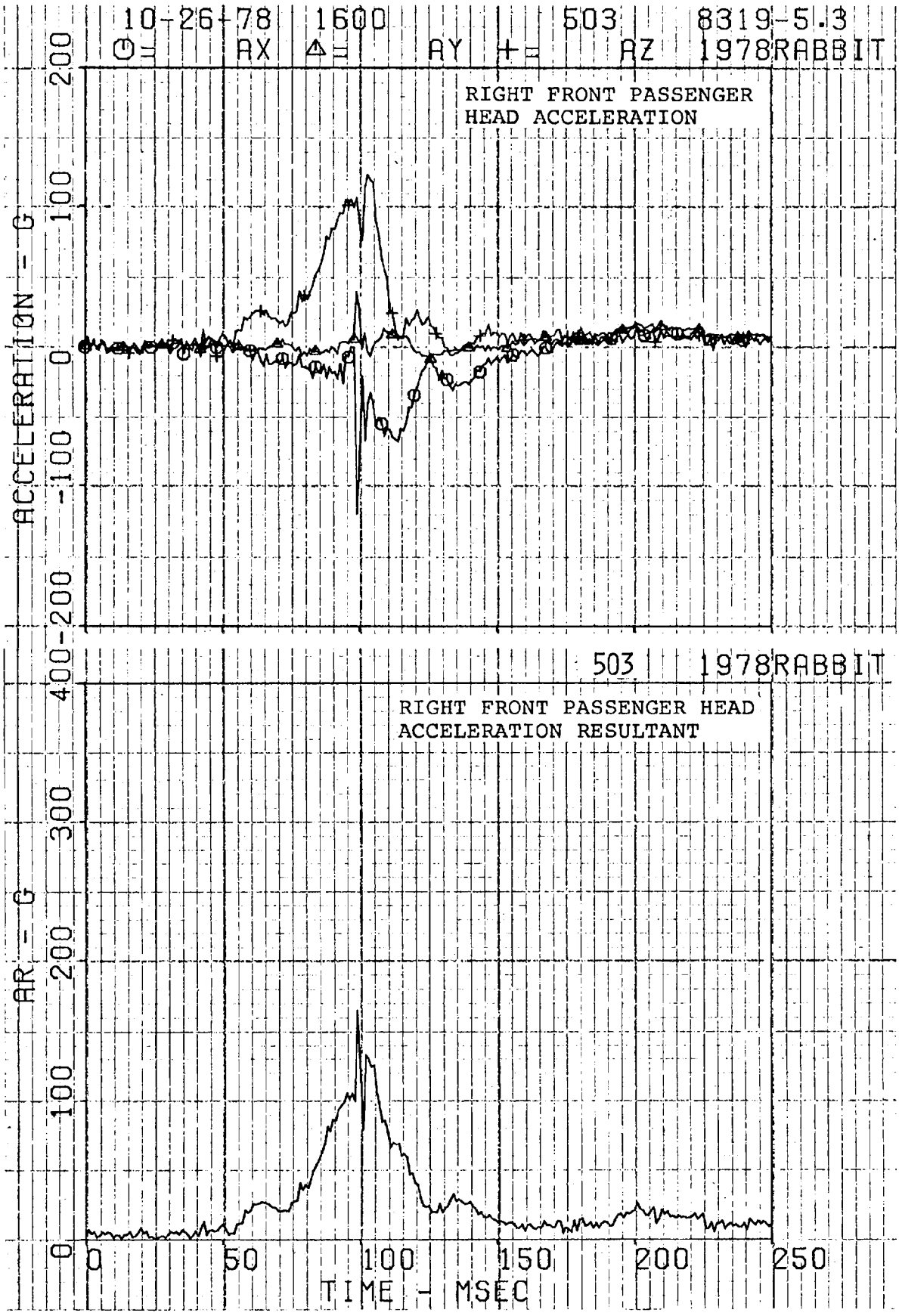

10-26-78 31$/100 4213 8319-5.3
⏱=S.G.1 △=$.G.2 +=S.G.3 TRAILGUARD
STRAIN MEASUREMENT
UNDERRIDE GUARD
SG1 - LEFT VERTICAL BEAM
SG2 - LOWER HORIZONTAL MEMBER
SG3 - RIGHT VERTICAL BEAM
UIN/IN *10²
300
200
100
0
-100
⏱=S.G.5 △=$.G.6 4256 TRAILGUARD
STRAIN MEASUREMENT:
SIMULATOR RIGHT FRAME
RAIL LOWER FLANGE
#5-REAR
#6-FRONT
UIN/IN
800
400
0
-400
-800
0
50
100
150
200
250
TIME - MSEC

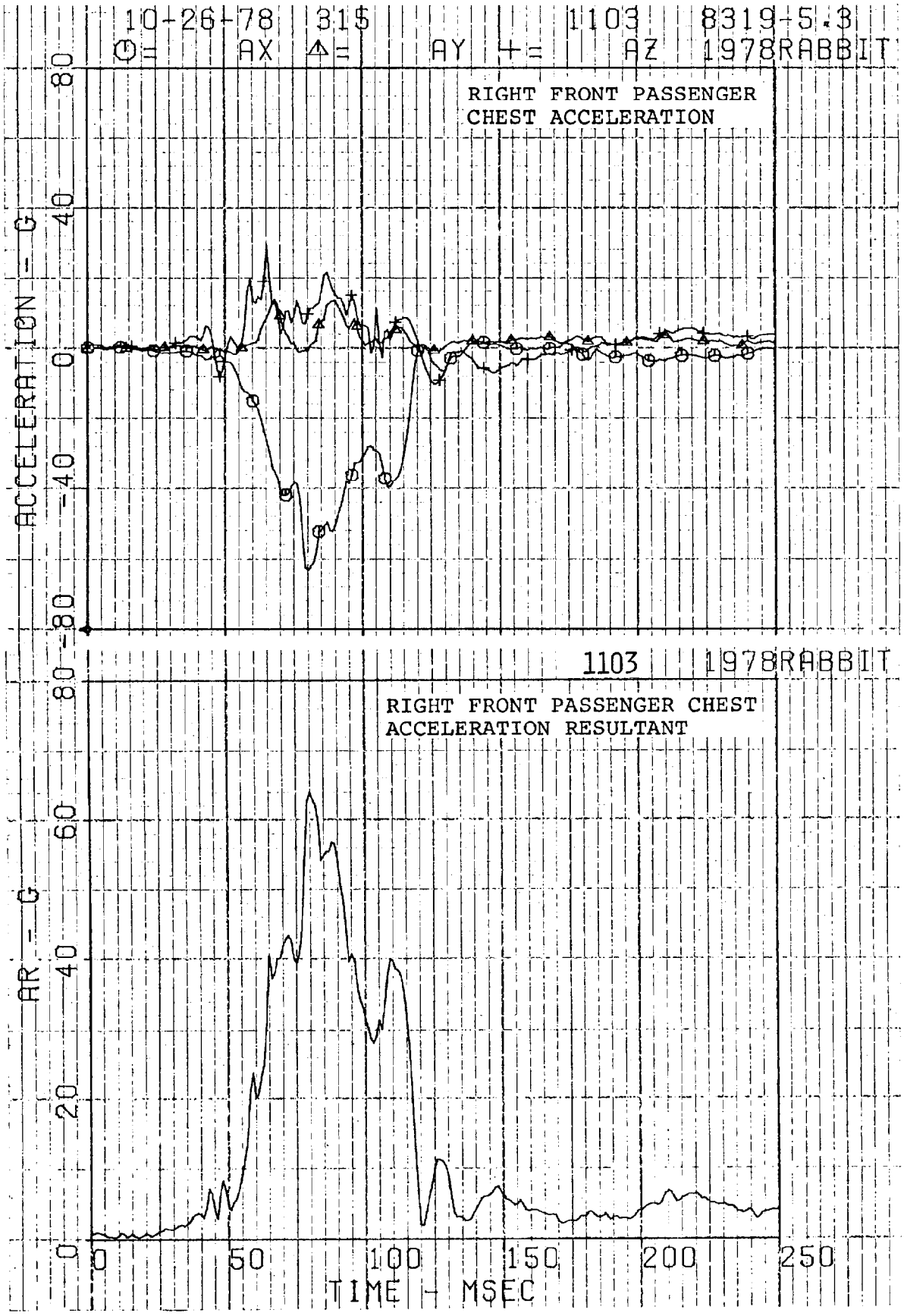

10-26-78 1600 501 8319-5.3
AX AY AZ 1978RABBIT
DRIVER HEAD ACCELERATION
ACCELERATION = G
200
100
0
-100
-200
501 1978RABBIT
DRIVER HEAD ACCELERATION RESULTANT
AR = G
400
300
200
100
0
0
50
100
150
200
250
TIME - MSEC

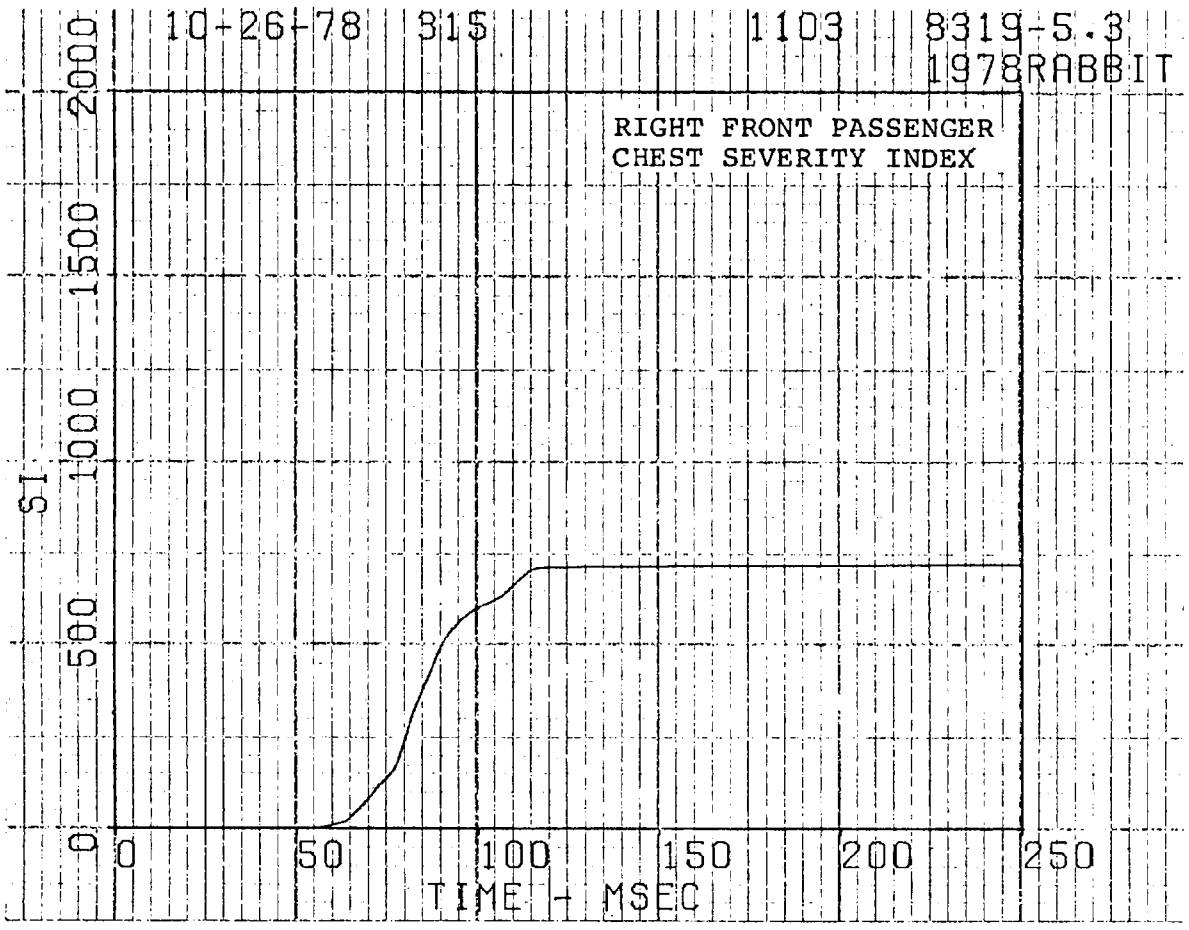

10-26-78 315 1101 8319-5-3
AX AY AZ 1978RABBIT
DRIVER CHEST ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
1101 1978RABBIT
DRIVER CHEST ACCELERATION RESULTANT
AR - G
80
60
40
20
0
0
50
100
150
200
250
TIME - MSEC

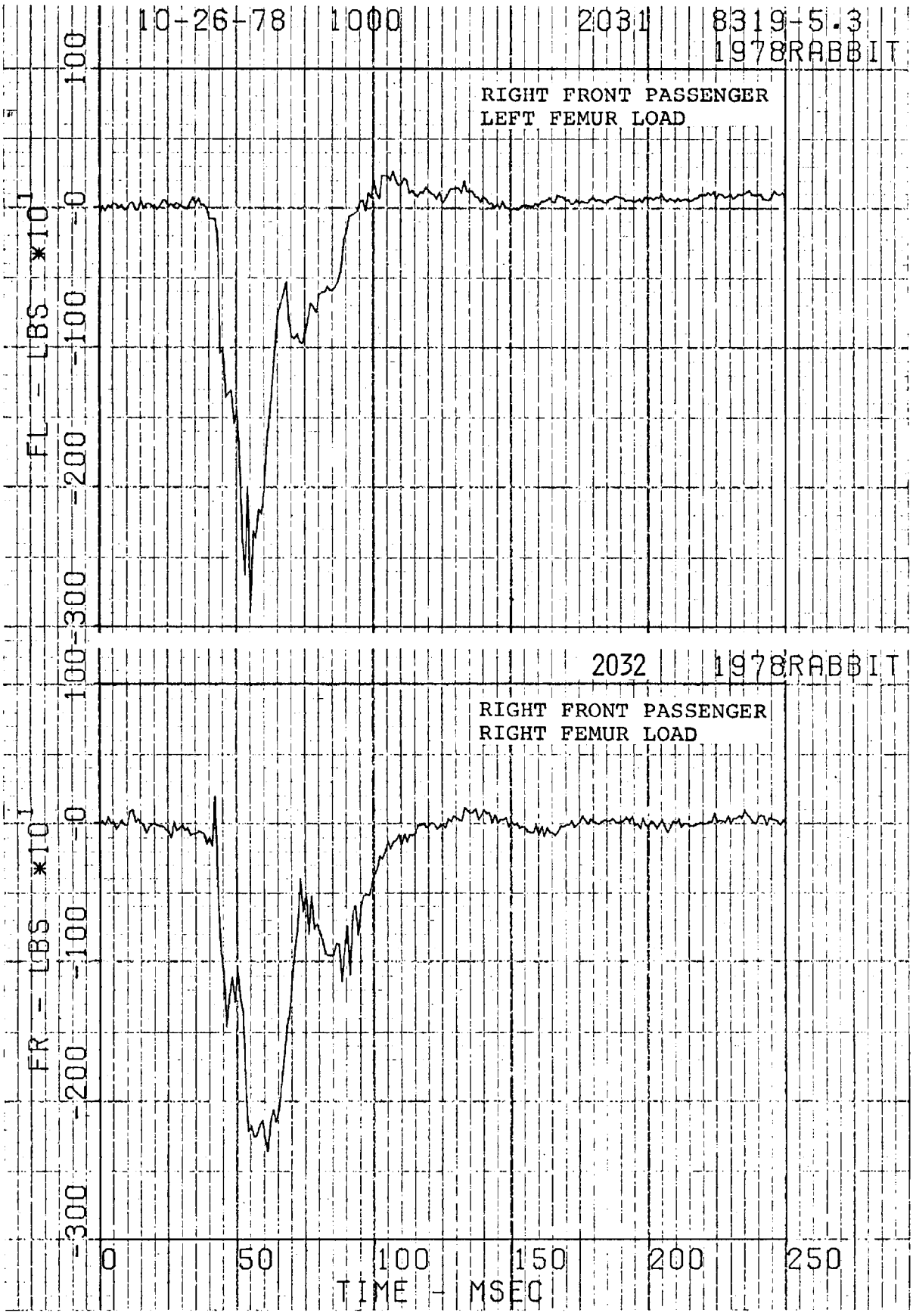

10-26-78 31$ 1101 8319-5-3
1978RABBIT
DRIVER CHEST SEVERITY INDEX
SI
2000
1500
1000
500
0
0
50
100
150
200
250
TIME - MSEC


10-26-78 1000
2011 8319-5.3
1978RABBIT
DRIVER LEFT
FEMUR LOAD
FL = LBS *10^1
100
0
-100
-200
-300
2012 1978RABBIT
DRIVER RIGHT
FEMUR LOAD
FR = LBS *10^1
100
0
-100
-200
-300
0
50
100
150
200
250
TIME → MSEC

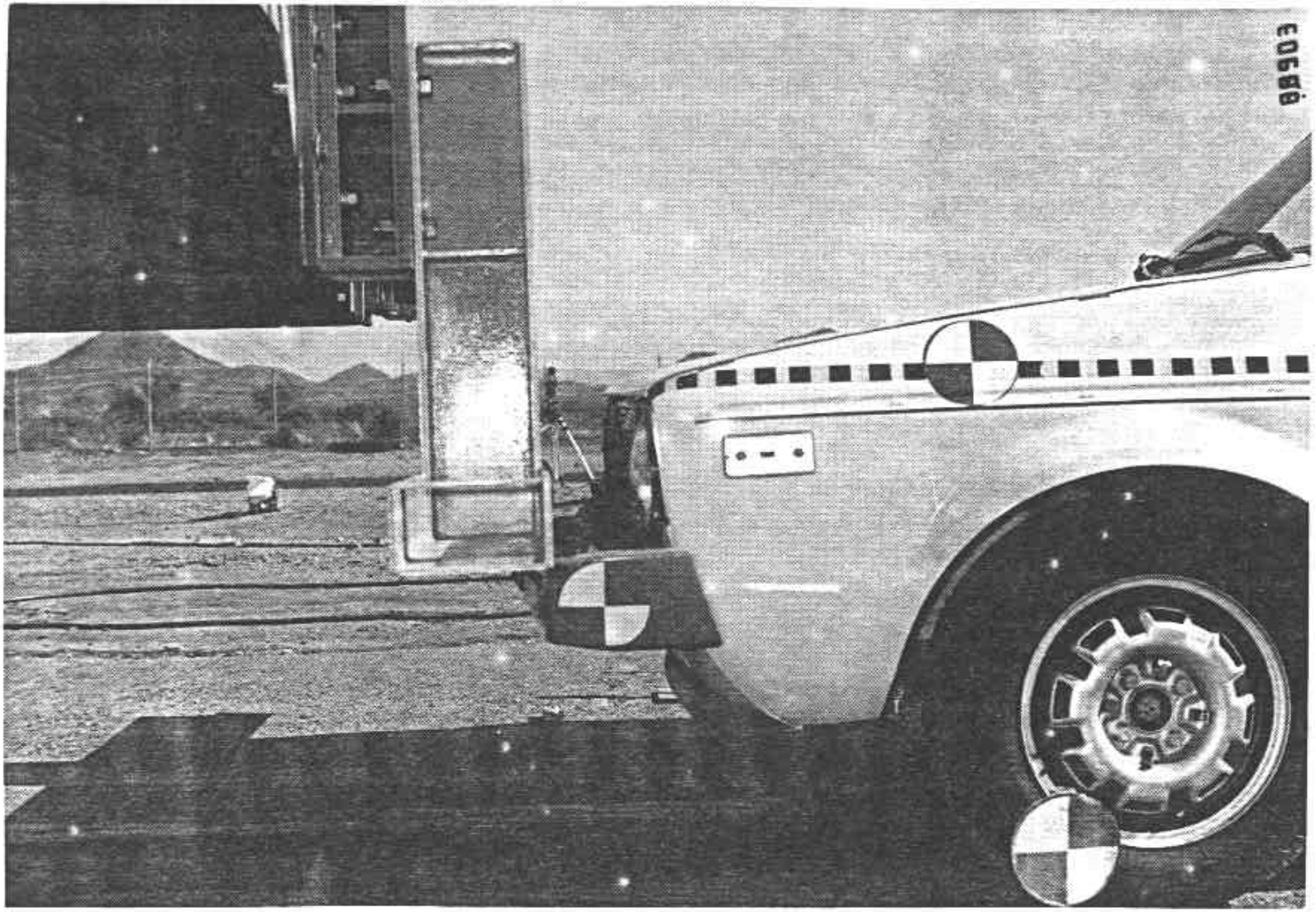

10-26-78 1600 503 8319-5.3
AX AY AZ 1978RABBIT
RIGHT FRONT PASSENGER
HEAD ACCELERATION
ACCELERATION - G
200
100
0
-100
-200
503 1978RABBIT
RIGHT FRONT PASSENGER HEAD
ACCELERATION RESULTANT
AR - G
400
300
200
100
0
0
50
100
150
200
250
TIME - MSEC


10-26-78 315 1103 8319-5-3
O= AX Δ= AY += AZ 1978RABBIT
RIGHT FRONT PASSENGER CHEST ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
1103 1978RABBIT
RIGHT FRONT PASSENGER CHEST ACCELERATION RESULTANT
AR - G
80
60
40
20
0
0
50
100
150
200
250
TIME - MSEC

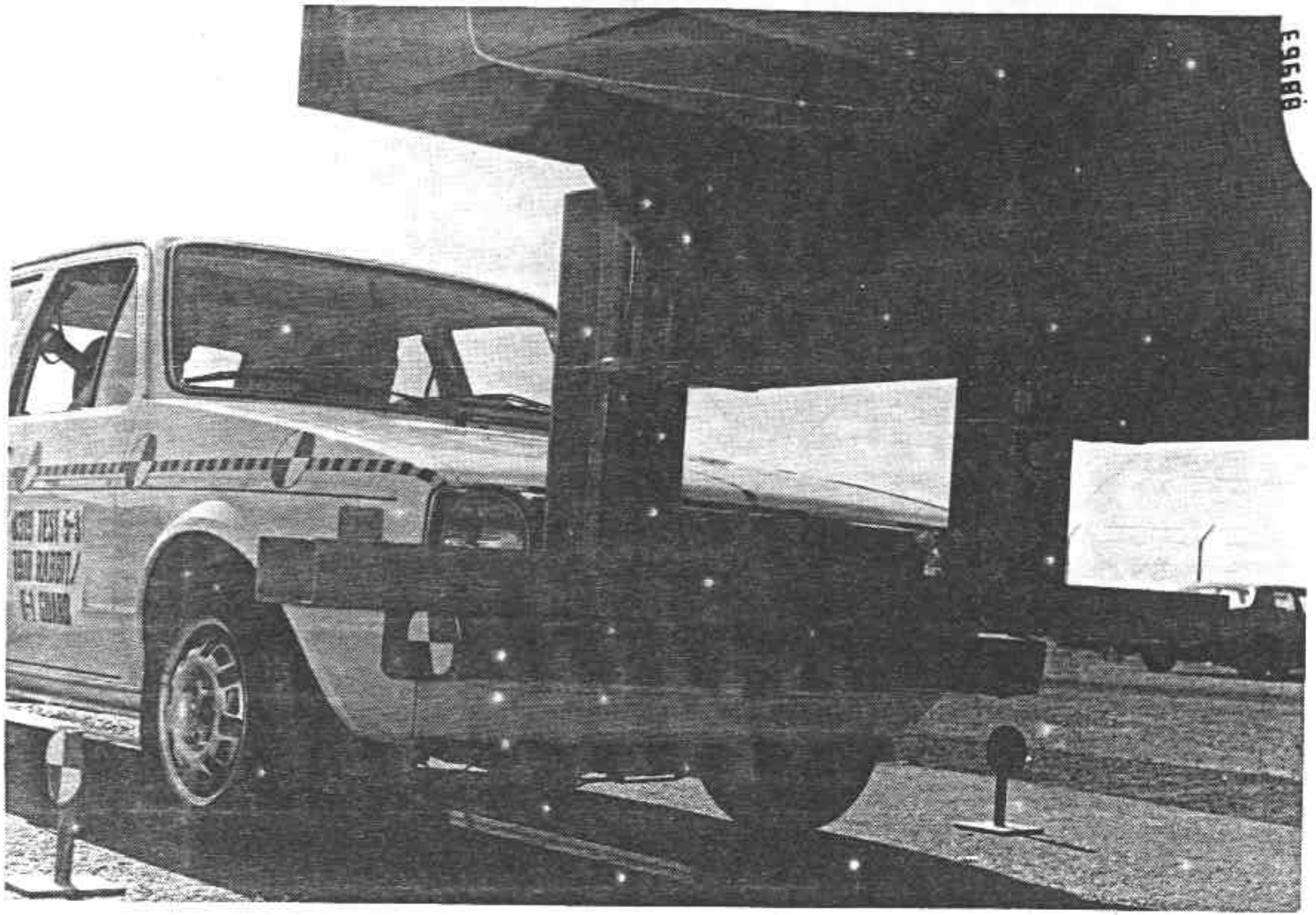

10-26-78 315 1103 8319-5.3
1978 RABBIT
RIGHT FRONT PASSENGER
CHEST SEVERITY INDEX
SI
0
500
1000
1500
2000
0
50
100
150
200
250
TIME - MSEC


10-26-78 1000
2031
8319-5.3
1978RABBIT
RIGHT FRONT PASSENGER
LEFT FEMUR LOAD
FL - LBS *10^1
100
-0
-100
-200
-300
2032
1978RABBIT
RIGHT FRONT PASSENGER
RIGHT FEMUR LOAD
FR - LBS *10^1
100
-0
-100
-200
-300
0
50
100
150
200
250
TIME - MSEC

Test 5.3 Overall Pre-test View of Test Configuration.

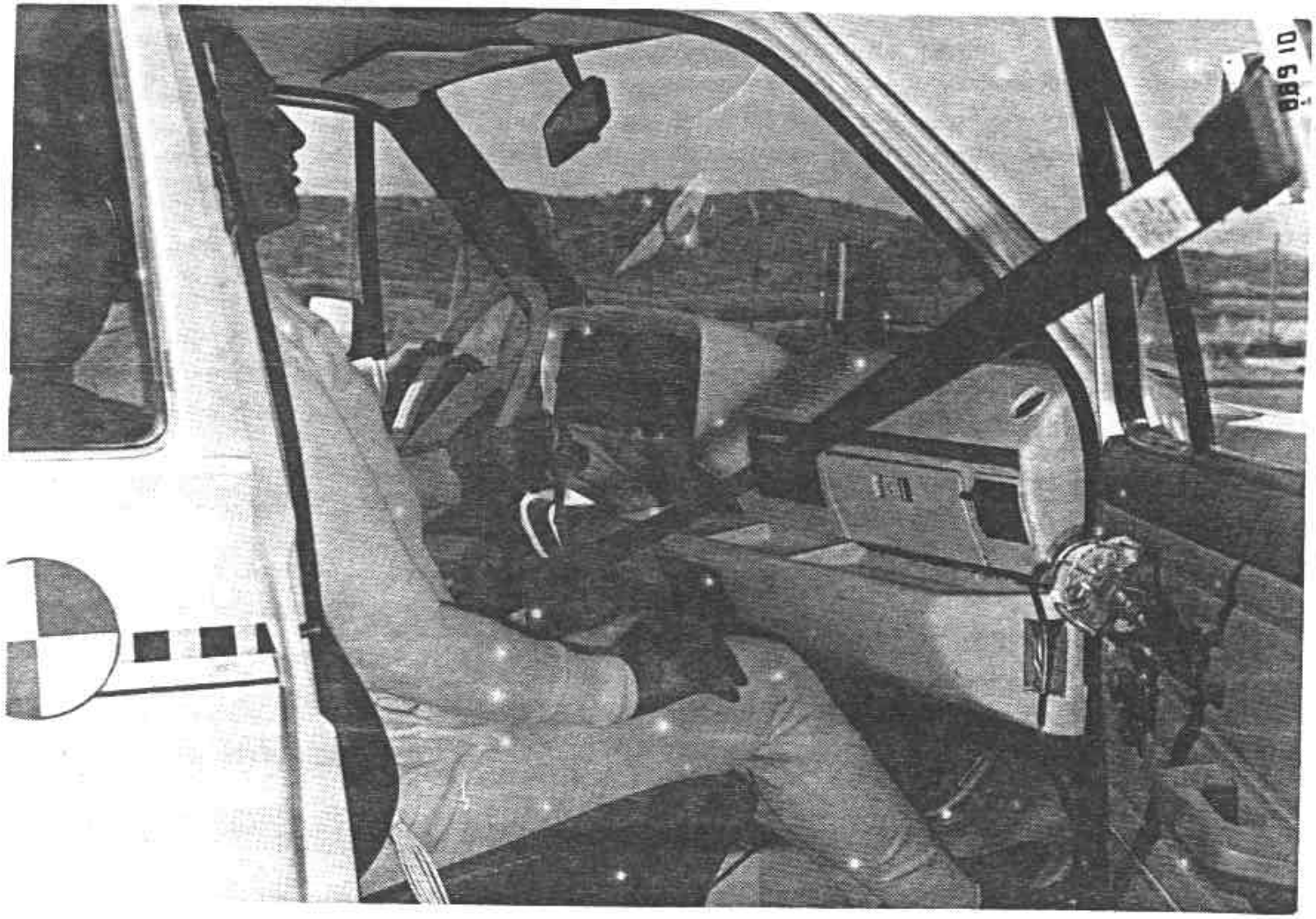


Test 5.3 Pre-test Close-up View of Vehicle/Guard Engagement.



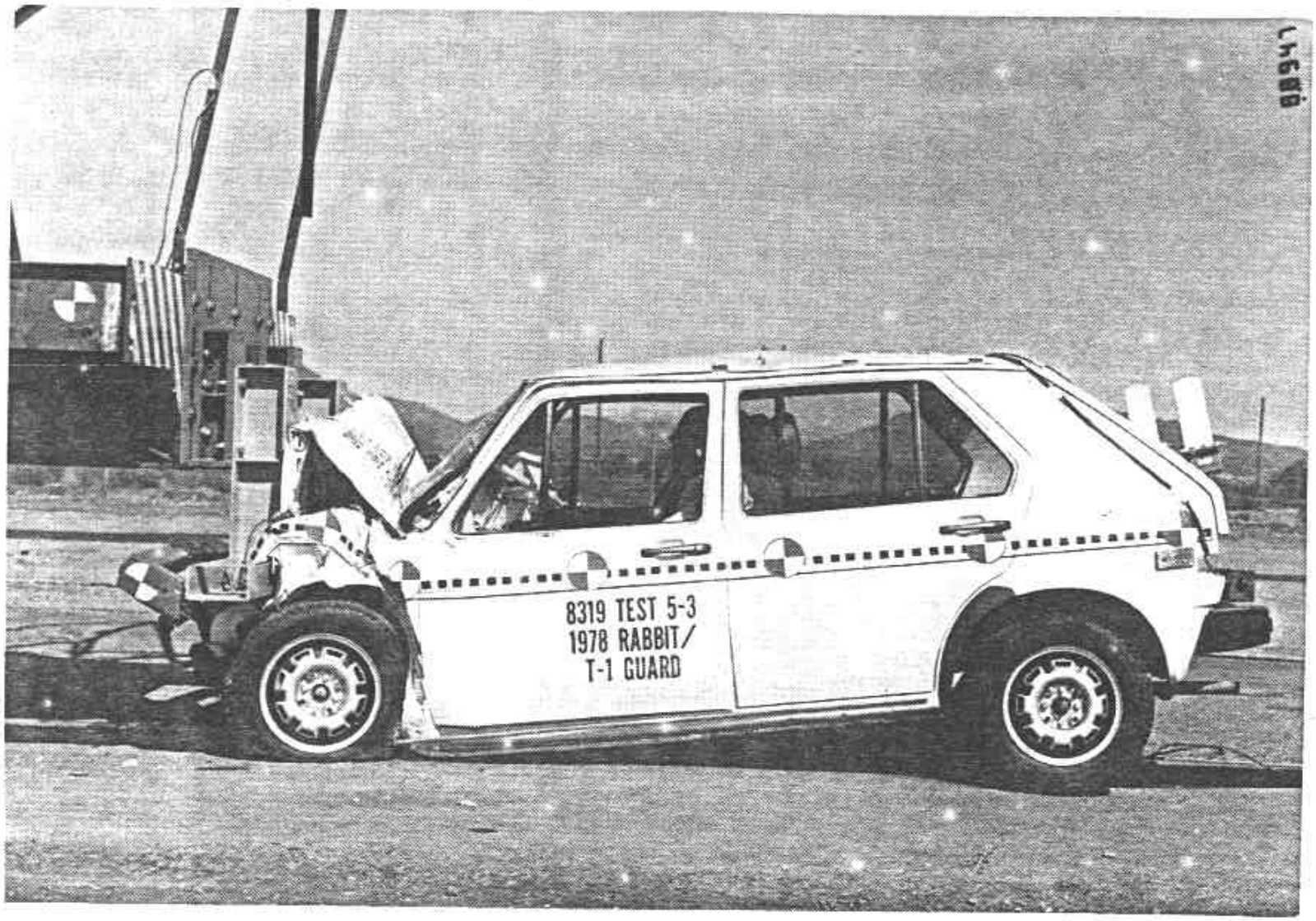
Test 5.3 Pre-test View of Vehicle and Guard (Front).

Test 5.3 Pre-test View of Driver Dummy.

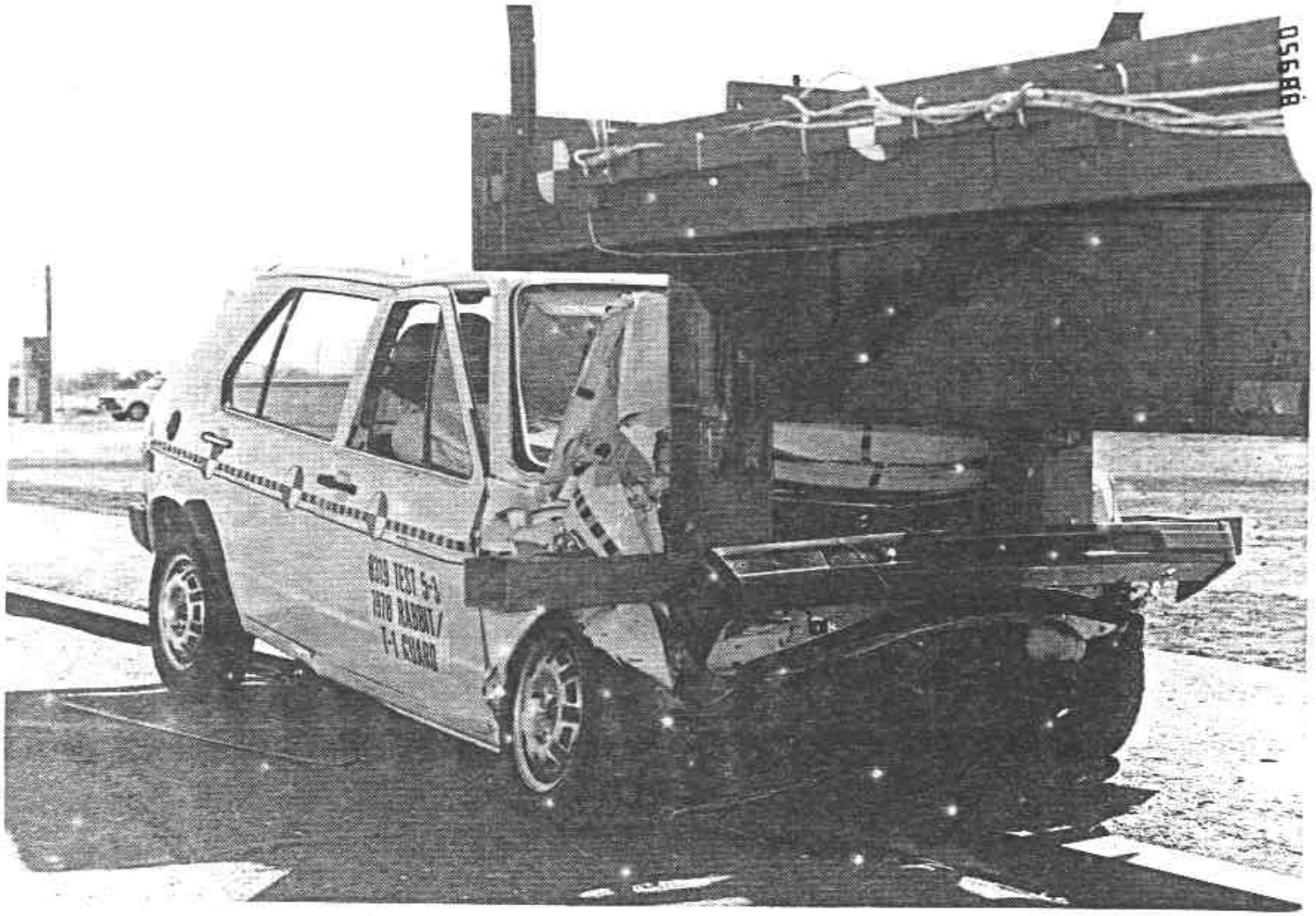


Test 5.3 Pre-test View of Passenger Dummy.

Test 5.3 Pre-test Overall View of Underride Guard.



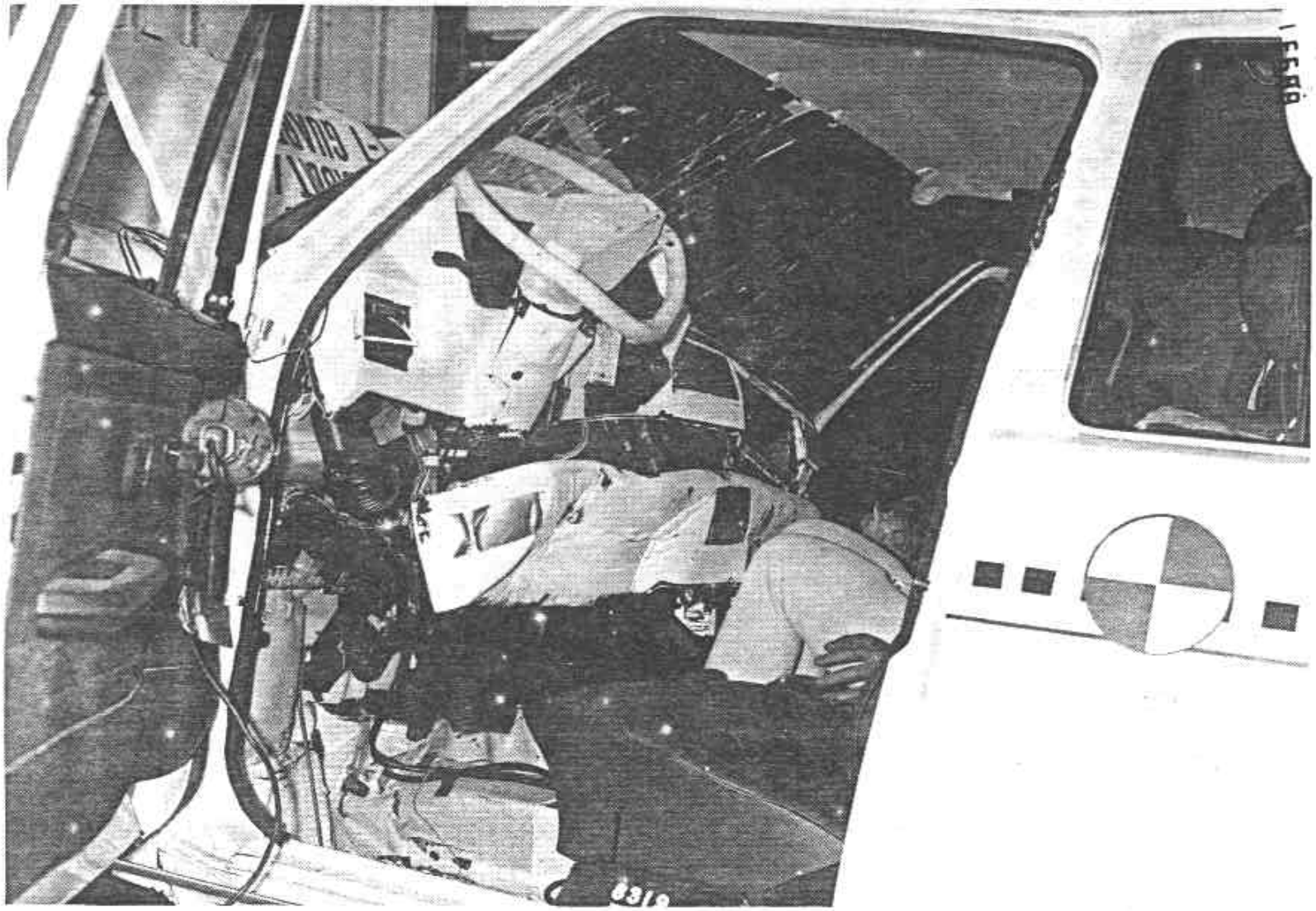
Test 5.3 Overall Post-test View of 1978 VW Rabbit/20" High T-1 Guard Crash.



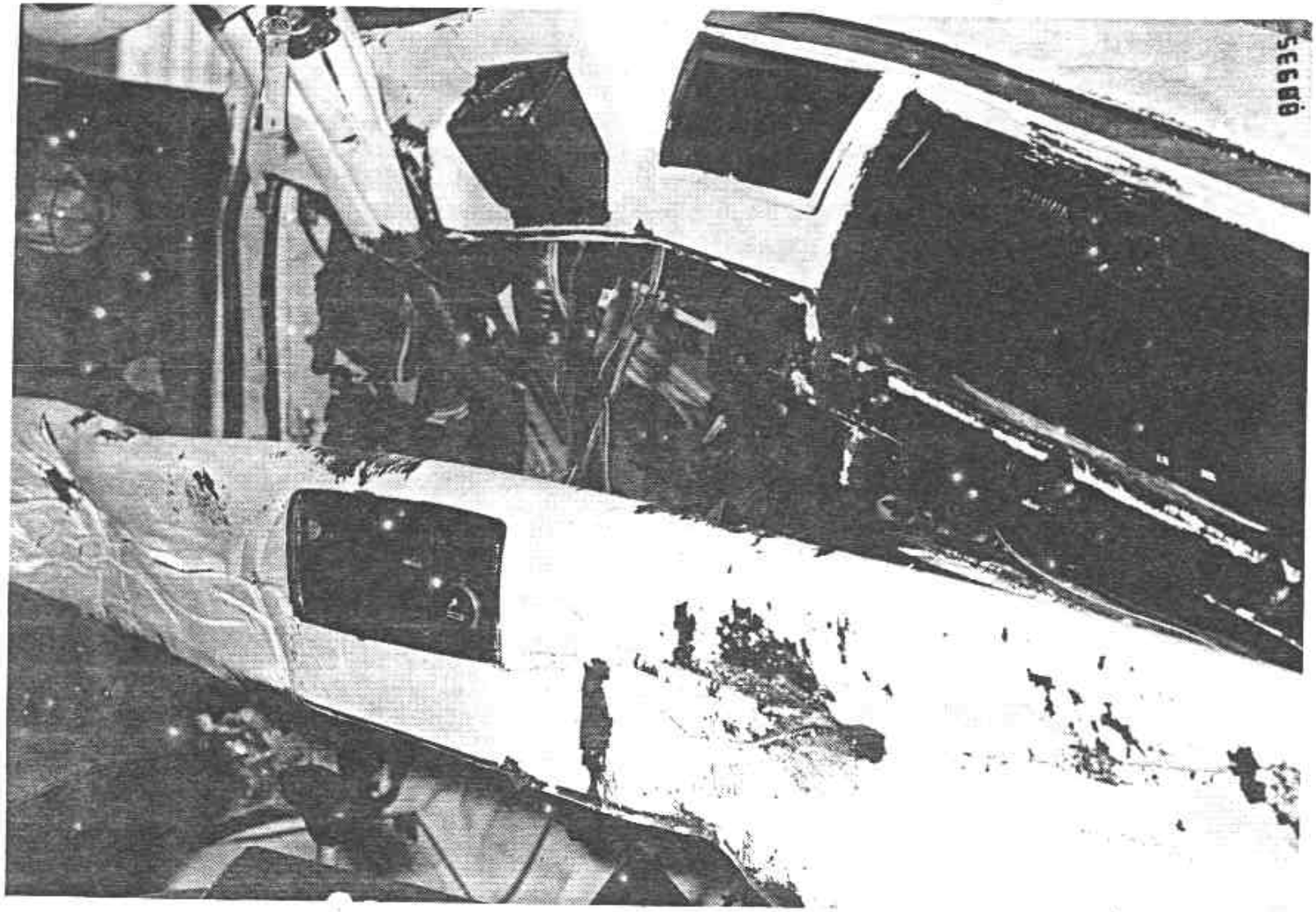
Test 5.3 Post-test View of Vehicle and Guard (Front).

Test 5.3 Post-test View of Driver Dummy.

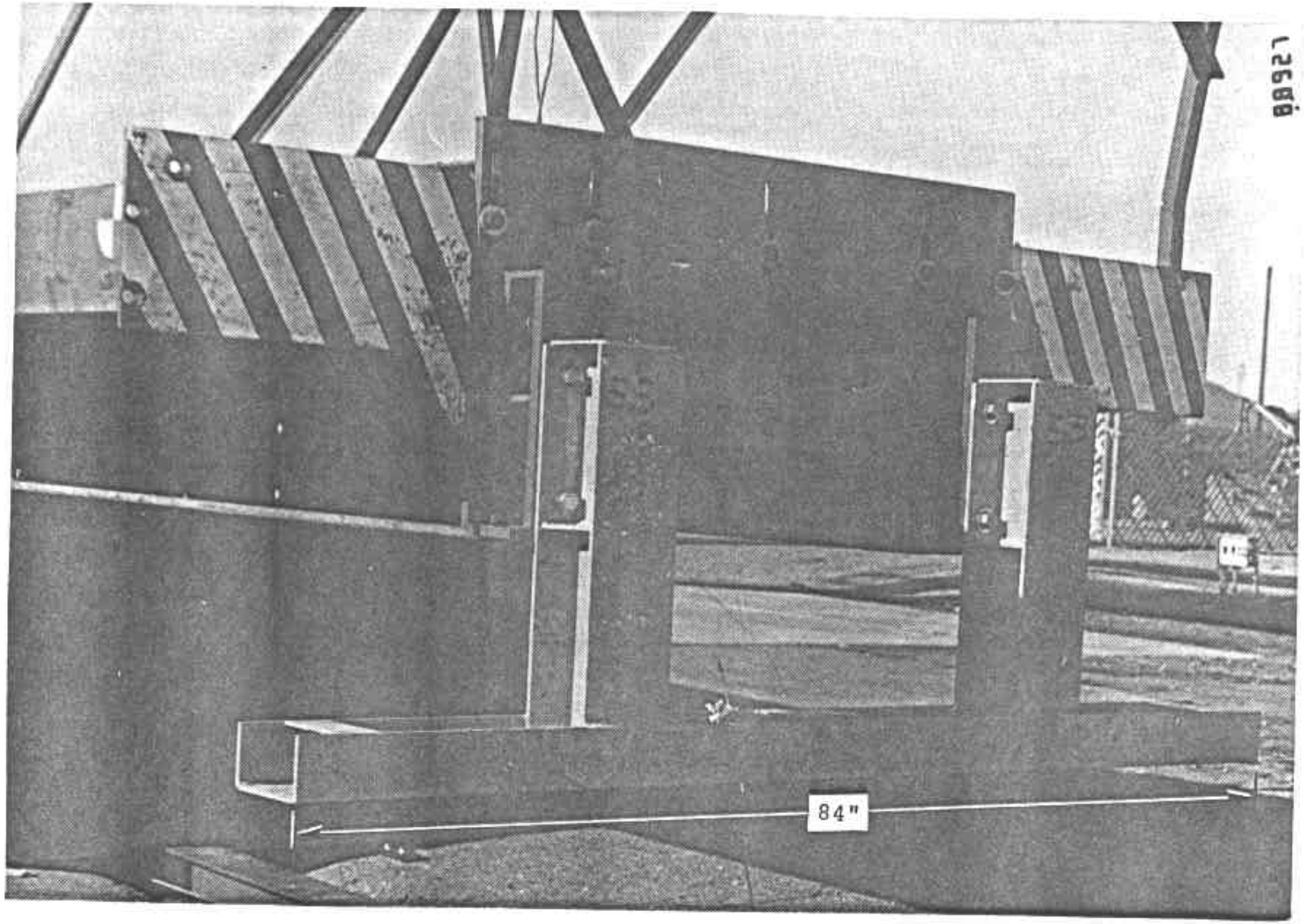
Test 5.3 Post-test View of Passenger Dummy.



Test 5.3 Post-test View of Driver Compartment Damage.



Test 5.3 Post-test View of Passenger Compartment Damage.



Test 5.3 Post-test Overall View of Underride Guard.

dsi DynamicScienceInc.
a TALLEY INDUSTRIES Company

8319

February 14, 1979

Mr. Gary Bell (NRD-12)
Contract Technical Manager
National Highway Traffic Safety
Administration
Transpoint Building
2100 Second Street, S.W.
Washington, D.C. 20590

Subject: Transmittal of Reproducible Test Reports for Task 3, Task 4, and Task 5 (Tests 5.1, 5.2, and 5.3)

Reference: Contract DOT-HS-8-01905, "Development of Compliance Test for Truck Rear Underride Protection"

Dear Gary:

In accordance with the requirements of the referenced contract, enclosed are the original reproducible and 7 copies of the Task 3, Task 4, and Task 5 (Tests 5.1, 5.2, and 5.3) reports. One copy of each report has been sent to Dr. Buth at T.T.I.

Very truly yours,

Sol

Sol Davis
Manager,
Special Projects Department

SD:ms

Enclosures

cc: Ms. Lauraline Clark (NAD-30)
Contracting Officer
Office of Contracts and
Procurement
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