

1373

CALSPAN REPORT NUMBER 7781-4

VEHICLE-TO-VEHICLE FRONTAL 90% OVERLAP
35 MPH IMPACT OF TWO
1989 HYUNDAI EXCEL 4-DOOR SEDANS

CALSPAN TEST NUMBER
Y38-4-933

October 25, 1989

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



FINAL REPORT

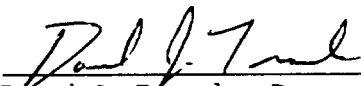
PREPARED FOR

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

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7781-4

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16 Abstract A 90% overlapped frontal vehicle-to-vehicle test of two 1989 Hyundai Excel 4-Door Sedans was performed at the Calspan Corporation Advanced Technology Center Crash Test Facility in Buffalo, New York on October 25, 1989 Impact speed was 34.2 MPH for each vehicle and the ambient temperature at the time of impact was 69°F Vehicle number one contained one Hybrid III dummy in the driver seating position. The dummy was restrained using the vehicle's automatic torso belt and manual lap belt restraint system. The driver's HIC was 1058, 3 millisecond clipped chest g's were 68.4, and femur loads of 2481 lbs on the left and 2576 lbs on the right femur were recorded. Vehicle number two contained one Hybrid III dummy in the right front seating position. The dummy was restrained using the vehicle's automatic torso belt and manual lap belt restraint system. The HIC was 682, 3 millisecond clipped chest g's were 47.3, and femur loads of 1894 lbs on the left and 1028 lbs on the right femur were recorded.					
17 Key Words Vehicle-to-Vehicle Crash Overlapped Frontal Crash			18 Distribution Statement <u>Copies of this report are available from</u> Technical Reference Division National Highway Traffic Safety Admin Nassif Building, Room 5108 400 Seventh St, S W, Washington, DC 20590		
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Section I
PURPOSE AND TEST PROCEDURE

This 35 mph offset frontal vehicle-to-vehicle impact test is part of the Crashworthiness Testing and Analysis Program sponsored by the Research and Special Programs Administration under Contract No DTRS57-87-C-00047. The purpose of this Technical Task Directive (TTD) is to obtain responses from vehicles and restrained Hybrid III dummies during car-to-car overlapped frontal crashes.

This test was performed using two 1989 Hyundai Excels. The vehicles, each traveling at 35 mph, were positioned at a 90% overlap of the vehicle width as measured at the front tires. The vehicles were aligned such that the left front (i.e., driver side) would experience full contact with the oncoming vehicle.

Vehicle number one contained one Hybrid III dummy in the driver seating position. The dummy was restrained using the vehicle's automatic torso belt and manual lap belt restraint system.

Vehicle number two contained one Hybrid III dummy in the right front seating position. The dummy was restrained using the vehicle's automatic torso belt and manual lap belt restraint system.

Section 2
SUMMARY OF TEST

Two 1989 Hyundai Excel 4-Door Sedans were impacted into each other with each vehicle traveling 34.2 mph. The vehicles were offset such that 90% of the vehicle width between front tires was engaged in this vehicle-to-vehicle frontal test. Figure 1 of this report contains a sketch of the test layout. The test was performed at the Calspan Corporation Advanced Technology Center on October 25, 1989. Pre- and post-test photographs of the vehicles and dummies can be found in Appendix A of this report.

The vehicle-to-vehicle test was documented by one real-time camera and 15 high-speed cameras. Film analysis indicated the vehicles struck 1.5 inches over from the target point in such a way as to create slightly more overlap. Camera locations and other pertinent camera information can be found in Table 9 and Figure 12 of this report.

Vehicle 1 (see Figure 1) contained one Hybrid III 50th percentile male anthropomorphic test device (ATD) in the driver seat position. Vehicle 2 contained one Hybrid III 50th percentile male ATD in the right front passenger seat position. The ATDs were restrained using the vehicle's automatic torso belt and manual lap belt restraint system after being placed in the vehicle following the dummy placement instructions specified in the Laboratory Indicant Test Procedure.

The ATDs were instrumented with a 9-axis head accelerometer package, chest triaxial accelerometers, chest potentiometer, and left/right femur load cells. In addition, the vehicle 1 ATD contained an abdominal pressure transducer.

The 91 channels of data were recorded on eight 14-channel FM tape recorders. Appendix B contains the vehicle and dummy response data traces.

The driver's head in Vehicle 1 struck the upper steering wheel rim and instrument panel, the calculated HIC was 1058. The maximum chest deceleration over 3 milliseconds was 68.4 g's. The femur loads were 2481 lbs on the left and 2576 lbs on the right. The vehicle 1 torso belt load was 2348 lbs.

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In vehicle 2, the right front passenger's (position 2) head contacted the automatic torso belt latch on rebound causing the torso belt to release. A small piece of the ATD head "skin" was found in the torso belt latch during post test inspection. The ATD's HIC was 682. The maximum chest deceleration over 3 milliseconds was 47.3 g's. The femur loads were 1894 lbs on the left and 1028 lbs on the right. The vehicle 2 torso belt load was 2758 lbs.

TEST ANOMALIES

Channel 35, V1 rear seat centerline Y, accelerometer data questionable between approximately 24 and 65 msec , accelerometer opened

Channel 39, V1 engine bottom X, accelerometer data questionable after approximately 75 msec

Channel 40, V1 front crossmember X, accelerometer data questionable after approximately 63 msec

Channel 64, V2 P2 upper neck FX, transducer data intermittent between approximately 23 and 76 msec

Section 3
VEHICLE AND OCCUPANT INFORMATION

Figure 1
VEHICLE-TO-VEHICLE OVERLAP LAYOUT

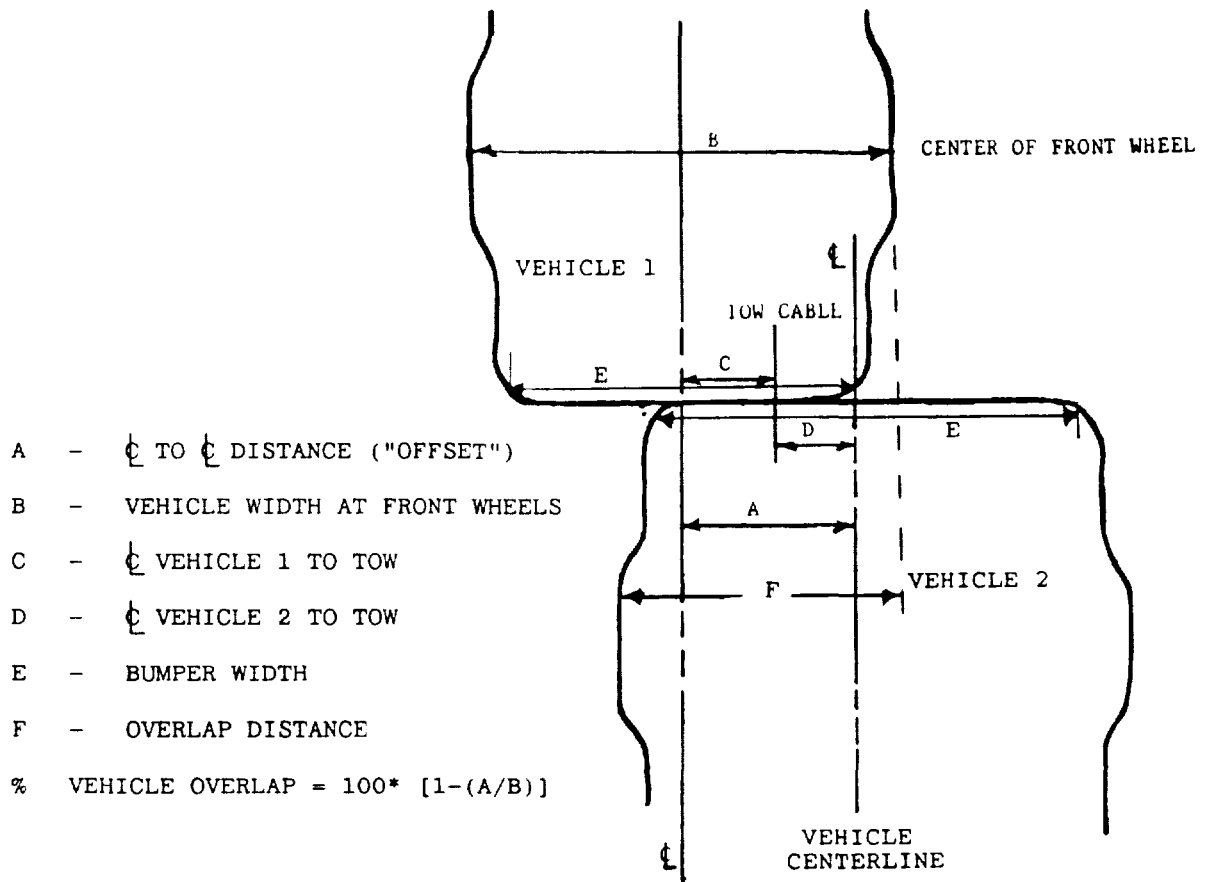


Table 1
Vehicle-to-Vehicle Overlap Measurements (in)

Measurement Code	Vehicle 1	Vehicle 2
A	6 25	6 35
B	62 5	62 5
C	3 125	-
D	-	3 125
E	59 0	59 0
% Vehicle Overlap	90%	90%

VEHICLE ONE DATA

Table 2

GENERAL TEST AND VEHICLE 1 PARAMETER DATA

Vehicle Year/Make/Model/Body Style 1989 Hyundai Excel GL 4-Door SedanVIN KMHLF22J1KU618237Body Color Red Date Of Manufacture February 3, 1989Engine 4 Cylinders, - C I D , 1 5 Liters, - CCX Gas, - Diesel, - Turbocharged- Longitudinal, X TransverseTransmission 5 Speed, X Manual - Automatic, X OverdriveFinal Drive X Front Wheel, - Rear Wheel, - Four WheelX A/C, X P/S, X P/B - P/wdo , - Tilt Wheel- P/seats, - Cruise ControlType of Occupant Restraint automatic torso belt/manual lap beltDATA RECORDED FROM VEHICLE'S TIRE PLACARD.Tire Pressure (at capacity) Front 30 psi, Rear 30 psiRecommended Tire Size P155/80R13 or P175/80R13Recommended Cold Tire Pressure Front 30 psi, Rear 30 psiTires on Vehicle P155/80R13 , Manufacturer GoodyearNumber of Occupants 2 Front, 3 Rear, - 3rd Seat, 5 TOTALType of Front Seats X Bucket, - Bench, - Split BenchType of Front Seat Back - Fixed, X Adj With X Lever - Rot KnobVehicle Capacity Weight (VCW) = 816 lbs. (A)No of Occupants x 150 lbs = 750 lbs (B)

Rated Cargo and Luggage

Weight (RCLW) A-B = 66 lbsGVWR 3185 lbs GAWR Front 1653 lbs Rear 1587 lbs

Office of Highway Safety Administration
 1339 14th St. SW
 Washington, D.C. 20550

SHIP VIA

1339 Street
 14128
 (715) 531-6920

7 TO CONTRACTOR (Name address and ZIP Code)

8 TYPE OF ORDER

☐ A PURCHASE - Reference your _____

Please furnish the following on the terms and conditions specified on both sides of this order and on the attached sheets, if any, including delivery as indicated. This purchase is negotiated under authority of

☐ B DELIVERY - Except for billing instructions on the reverse, this delivery order is subject to instructions contained on this side only of this form and is issued subject to the terms and conditions of the above numbered contract

9 ACCOUNTING AND APPROPRIATION DATA

10 REQUISITIONING OFFICE

Office of Vehicle Safety Compliance (OVSC)

11 BUSINESS CLASSIFICATION (Check appropriate box(es))

Appropriation: XU1-30-302-411-1-111

☐ SMALL ☐ OTHER THAN SMALL ☐ DISADVANTAGED ☐ WOMEN OWNED

12 F O B POINT

Destination

14 GOVERNMENT B/L NO

15 DELIVER TO F O B POINT ON OR BEFORE (Date)

16 DISCOUNT TERMS

13 PLACE OF INSPECTION AND ACCEPTANCE

Destination

N/A

7 days

NET

17 SCHEDULE (See reverse for Rejections)

ITEM NO (A)	SUPPLIES OR SERVICES (B)	QUANTITY ORDERED (C)	UNIT (D)	UNIT PRICE (E)	AMOUNT (F)	QUANTITY ACCEPTED (G)
	Year & Make <u>1979 Ford</u> Model <u>F-100</u> VIN <u>1F071111111111111</u> Color <u>Red</u> IMTSA No. <u>RK 0500</u> Tax Exempt Cert. No. <u>6-1-4-07</u> Rebate _____	1			47400	
	8/10	SPECIAL PROVISION PAYMENT Payments will be made within 20 days from receipt and acceptance of vehicle and invoice receipt at IMTSA.				
SEE BILLING INSTRUCTIONS ON REVERSE	18 SHIPPING POINT	19 GROSS SHIPPING WEIGHT	20 INVOICE NO		17(H) TOT (Cont pages)	
	21 MAIL INVOICE TO (Include ZIP Code)				17(I) GRAND TOTAL	
	National Highway Traffic Safety Administration (HEF-310Ca) OVSC, Room 6113, 400 7th St. SW, Wash., DC 20590				47400	

22 UNITED STATES OF AMERICA BY (Signature)

23 NAME (Typed)

J. Raymond Sakay

TITLE CONTRACTING/ORDERING OFFICER

Table 2

GENERAL TEST AND VEHICLE 1 PARAMETER DATA (cont'd)

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

Right Front = <u>690</u> lbs	Right Rear = <u>440</u> lbs
Left Front = <u>710</u> lbs	Left Rear = <u>460</u> lbs
TOTAL FRONT WEIGHT = <u>1400</u> lbs	(<u>61</u> % of Total Vehicle Weight)
TOTAL REAR WEIGHT = <u>900</u> lbs	(<u>39</u> % of Total Vehicle Weight)
TOTAL DELIVERY WEIGHT = <u>2300</u> lbs	

WEIGHT OF TEST VEHICLE WITH REQUIRED DUMMY.

Right Front = <u>690</u> lbs	Right Rear = <u>520</u> lbs
Left Front = <u>770</u> lbs	Left Rear = <u>580</u> lbs
TOTAL FRONT WEIGHT = <u>1460</u> lbs	(<u>57</u> % of Total Vehicle Weight)
TOTAL REAR WEIGHT = <u>1100</u> lbs	(<u>43</u> % of Total Vehicle Weight)
TOTAL TEST WEIGHT = <u>2560</u> lbs	
Weight of ballast secured in vehicle trunk area = <u>0</u> lbs	

TEST VEHICLE ATTITUDE (all dimensions in inches)

AS DELIVIERED	RF <u>25.7</u> ,	LF <u>25.6</u> ,	RR <u>25.0</u> ,	LR <u>24.6</u>
AS TESTED	RF <u>25.6</u> ,	LF <u>25.5</u> ,	RR <u>23.3</u> ,	LR <u>22.8</u>

Vehicle's Wheelbase = 93.6 inches

Location of Vehicle's C G = 40.2 inches from front wheel center.

Table 2

GENERAL TEST AND VEHICLE 1 PARAMETER DATA (cont'd)

POST-IMPACT DATA.

Type of Test VTV Frontal Impact Angle 0°
 Date of Test 10-25-89 Time of Test 12 20
 Ambient Temperature 69° °F at impact area
 Temperature in Occupant Compartment 69 °F
 Windshield Molding Temperature - °F
 Required Impact Velocity Range 34 5 to 35 5 mph
 Impact Velocity primary = 34 2 mph, secondary = 34 2 mph
 Distance From Front Bumper to Impact Point When
 Entering Speed Trap 52 inches
 Exiting Speed Trap 12 inches

VISIBLE DUMMY CONTACT POINTS.Driver

Head upper steering wheel rim, dash panel,
 & steering wheel hub
 Chest steering wheel hub
 Abdomen lower steering wheel rim
 Left Knee lower dash panel
 Right Knee lower dash panel

Table 2
GENERAL TEST AND VEHICLE 1 PARAMETER DATA (cont'd)

	<u>Front</u>		<u>Rear</u>	
	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
	closed	closed	closed	closed
Door Opening	<u>operable</u>	<u>operable</u>	<u>operable</u>	<u>operable</u>

<u>Seat Movement</u>	<u>Front</u>		<u>Rear</u>	
	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
	None	-	-	-
Seat Back Failure	<u>None</u>	<u>-</u>	<u>-</u>	<u>-</u>
Seat Shift (in)	<u>0 0</u>	<u>-</u>	<u>-</u>	<u>-</u>

Table 3
VEHICLE 1 DUMMY INJURY CRITERIA VALUES

	MAXIMUM ACCELERATION ("G")							
	HEAD (Primary)				CHEST			
	X	Y	Z	R	X	Y	Z	R*
DUMMY (1)	-96 2	-22 2	65 8	104 4	-65 6	-13 7	-21 2	68 4
DUMMY (2)	-	-	-	-	-	-	-	-
DUMMY (3)								
DUMMY (4)								

	MAXIMUM FORCE FEMUR LOAD (LBS)	
	RIGHT FEMUR	LEFT FEMUR
DUMMY (1)	2576 0	2481 0
DUMMY (2)	-	-
DUMMY (3)		
DUMMY (4)		

	MAXIMUM FORCE SEAT BELT LOADS (LBS)		
	SHOULDER STRAP UPPER BELT LOAD	LAP STRAP RIGHT BELT LOAD	LAP STRAP LEFT BELT LOAD
DUMMY (1)	2348 0	-	N/M
DUMMY (2)	-	-	-
DUMMY (3)			
DUMMY (4)			

	HEAD INJURY CRITERIA (HIC) (Primary)			
	HIC	t ₁ (SEC)	t ₂ (SEC)	Average Acceleration t ₁ TO t ₂
DUMMY (1)	1058 0	.05812	.09412	61 3 g's
DUMMY (2)	-	-	-	-
DUMMY (3)				
DUMMY (4)				

*Defined as exceeding 0.003 sec duration

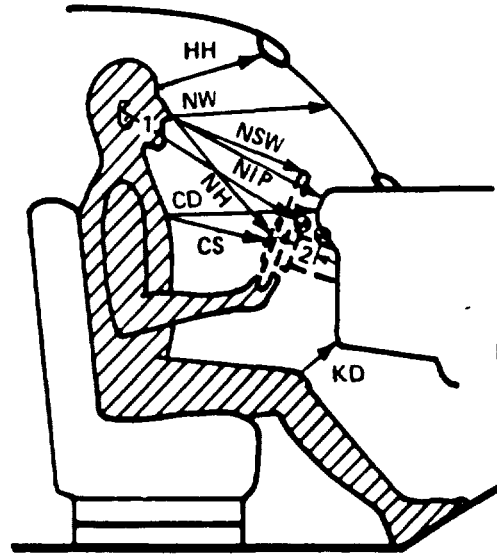
**As defined in FMVSS No. 208

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Figure 2

VEHICLE 1 OCCUPANT CLEARANCE DIMENSIONS

	DRIVER
HH	11 1
NW	20.9
NSW	14 3
NIP	20 0
NH	15 4
CD	20 1
CS	12 1
KDL	5 8
KDR	5 6
1	24 0
2	2 4
SA	23°
TA	19°
ULA	106°
LLA	228°

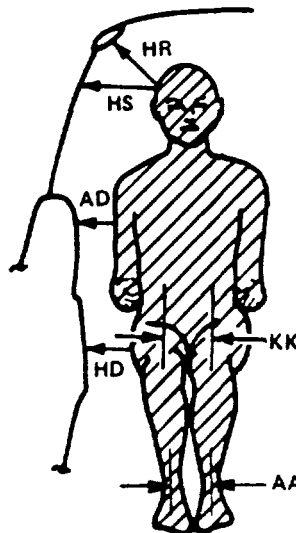


- HH = Head to Windshield Header
 NW = Nose to Windshield
 NSW = Nose to Steering Wheel
 NIP = Nose to Instrument Panel
 NH = Nose to Steering Wheel Hub
 CD = Chest to Dash
 CS = Chest to Steering Wheel Hub
 KDL = Knee to Dash Left
 KDR = Knee to Dash Right
 1 = Head Target to Steering Column Target
 2 = Distance between Steering Column Targets

Angles taken relative to vertical

- SA = Seat Back Angle
 TA = Torso Angle
 ULA = Upper Leg Angle
 LLA = Lower Leg Angle

- HR = Head to Side Roof
 HS = Head to Side Window
 AD = Arm to Door
 HD = Hip to Door
 KK = Knee to Knee
 AA = Ankle to Ankle
 DT = Dummy Temperature °F



	DRIVER
HR	5 3
HS	7.9
AD	4 0
HD	5 7
KK	8 7
AA	12 1
DT	69°F

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Table 4

ABDOMINAL DISPLACEMENT AS A FUNCTION OF ABDOMINAL PRESSURE

TEST NO Y38-4-933

CALIBRATION COEFFICIENTS FOR HYBRID III ABDOMEN

Average of 8 2' and 9 2' Displacement-Pressure Curves

Calibration Coefficients

Linear term x+1 term x+2 term x+3 term x+4 term x+5 term

53100E+1 26981E+2 - 50362E+1 53471E+0 - 26160E-1 47288E-3

Regression Equation

$$D = 0.00047288X^5 - 0.02616X^4 + 0.53471X^3 - 5.0362X^2 + 26.981X + 5.31$$

Where X = measured abdominal pressure (psi)

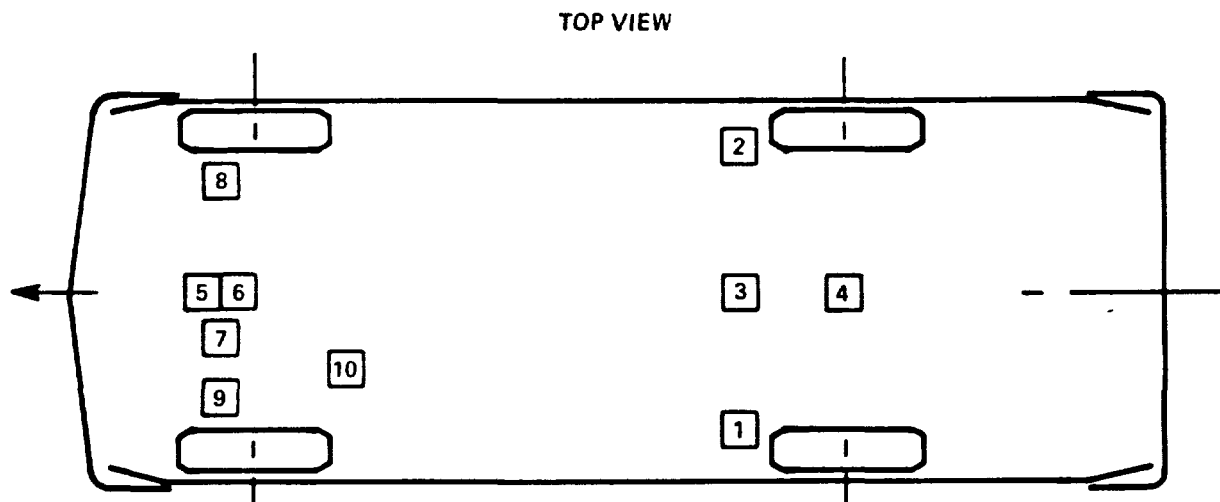
D = displacement in millimeters

Abdominal Pressure = 3 424 psi

Abdominal Displacement = 56 74 mm

= 2 2 inches

Figure 3
SUMMARY OF VEHICLE 1 ACCELEROMETER DATA



Vehicle 1989 Hyundai Excel GL 4-Door Sedan

Loc, No	Description	Axis	Maximum Value (g's)*	
			"-"	"+"
1	Rear seat crossmember left side	x	-33.1	4.3
2	Rear seat crossmember right side	x	-34.6	3.6
3	Rear seat crossmember centerline, primary	x	-33.6	3.5
3	Rear seat crossmember centerline, Y	y	**	**
3	Rear seat crossmember centerline, Z	z	-6.8	17.2
4	Rear seat crossmember centerline, redundant	x	-37.5	3.4
5	Top of engine block	x	-191.9	49.6
5	Top of engine block	z	-12.1	39.4
6	Bottom of engine block	x	-87.3	22.1
7	Front suspension crossmember	x	-120.4	**
7	Front suspension crossmember	z	-28.0	13.2
8	Right front brake caliper	x	-50.4	9.7
9	Left front brake caliper	x	-87.3	57.8
10	Steering wheel hub	x	-86.7	15.2
10	Steering wheel hub	z	-41.8	71.0

*Values filtered using SAE class 60 filter

**See Test Anomalies (Section 2)

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Figure 4
VEHICLE 1 PRE- AND POST-TEST POSITION OF TEST VEHICLE
ACCELEROMETER MOUNTING LOCATIONS

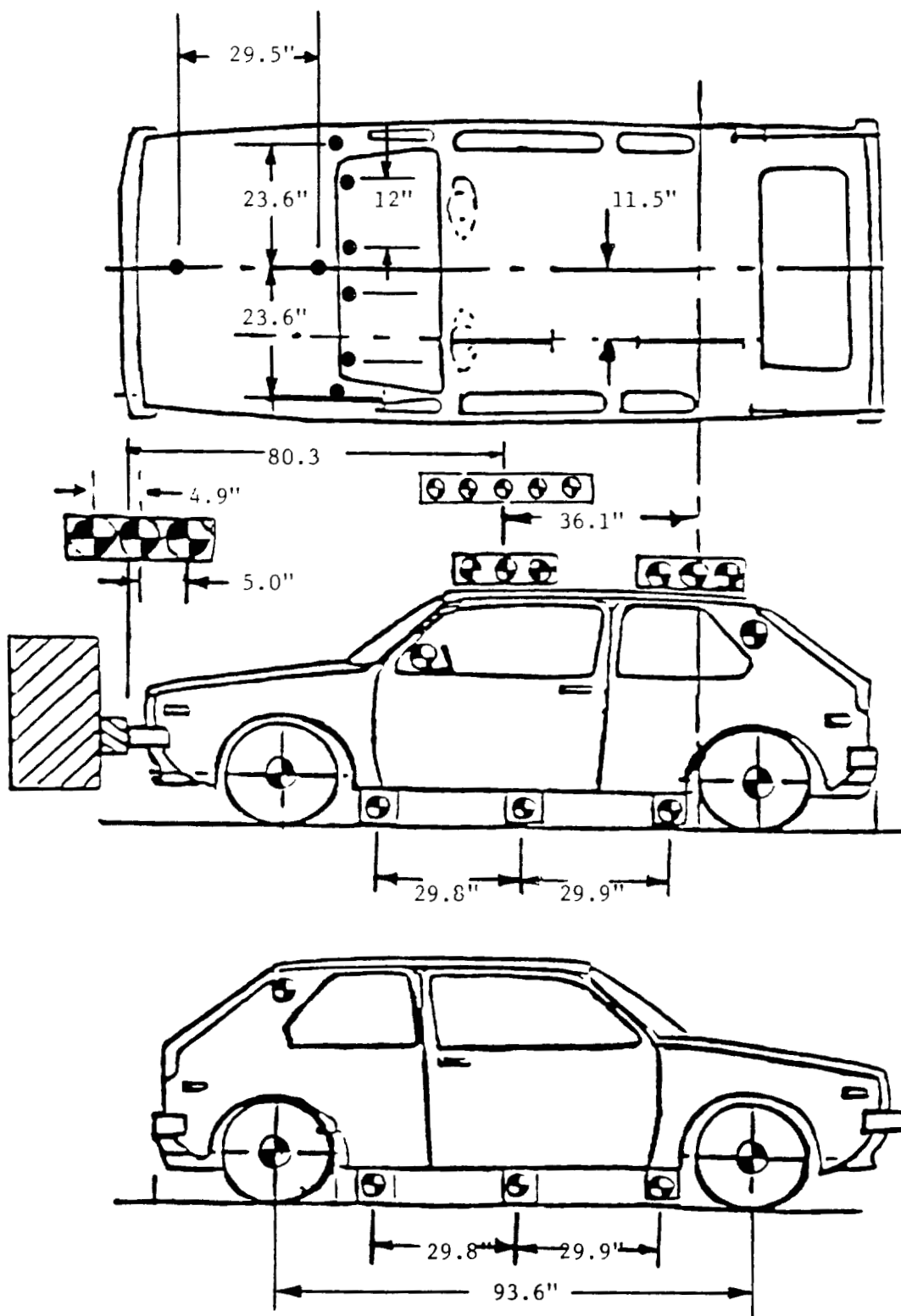
Test Description 35 mph Offset Frontal Vehicle-to-Vehicle Impact

Test Vehicle 1989 Hyundai Excel GL 4-Door Sedan

Reference Plane Vehicle plane at rear bumper

Accelerometer Description	LONGITUDINAL LOCATION		
	Pre-Test	Post-Test	Change
Rear seat crossmember left side	64 8	64 2	0 6
Rear seat crossmember right side	64 8	64 2	0 6
Rear seat crossmember centerline, primary	65 3	64 7	0 6
Rear seat crossmember centerline, redundant	65 3	64 7	0 6
Top of engine block	141 8	129.5	12 3
Bottom of engine block	142.5	135 1	7 4
Front suspension crossmember	126 6	121 8	4 8
Right front brake caliper	132 6	125 8	6 8
Left front brake caliper	131 9	124 5	7 4
Steering wheel hub	101.1	98 5	2 6

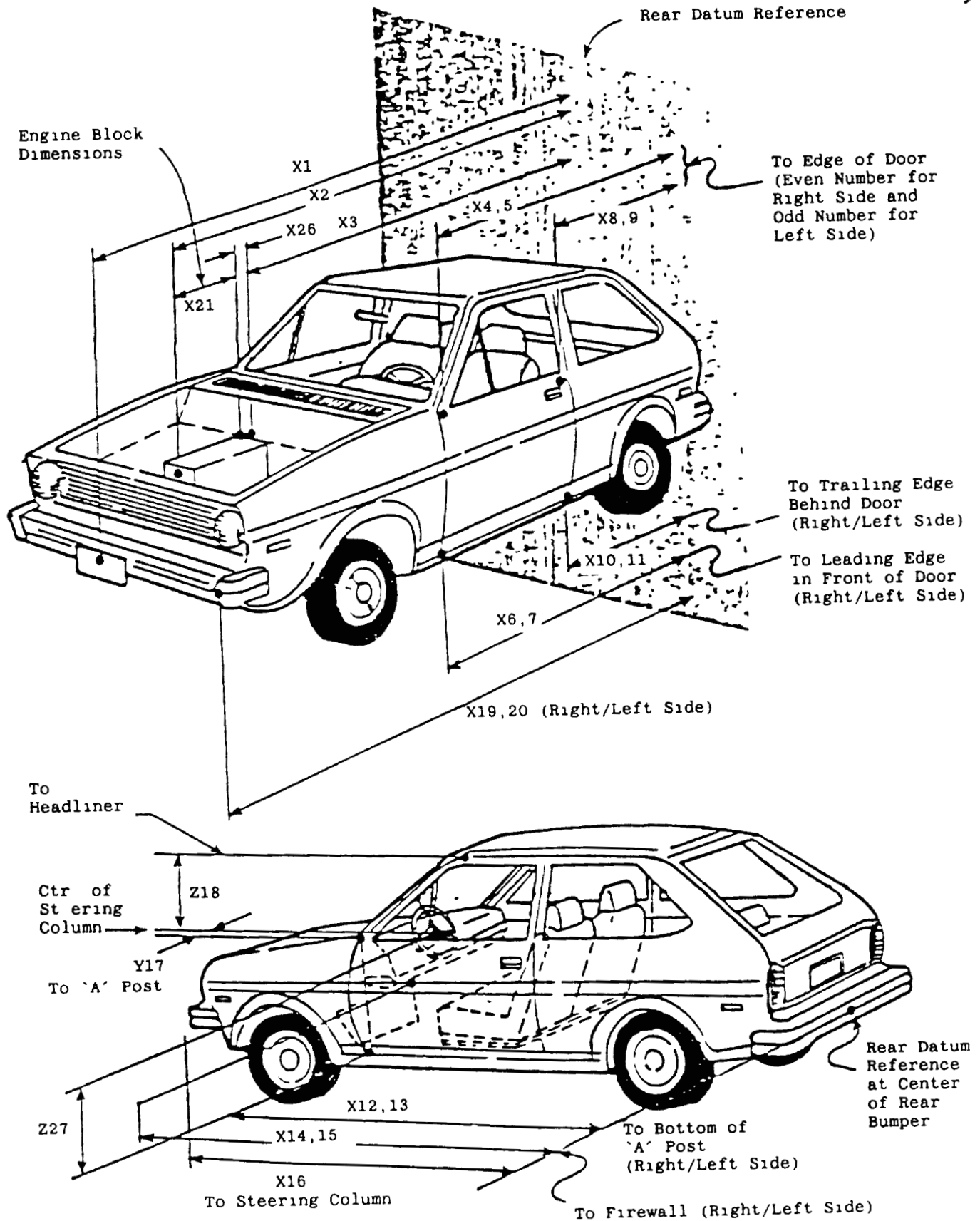
Figure 5
VEHICLE 1 TARGET LOCATIONS



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Figure 6

VEHICLE 1 MEASUREMENT POINTS



VEHICLE 1 MEASUREMENT POINTS (continued)

Figure 6

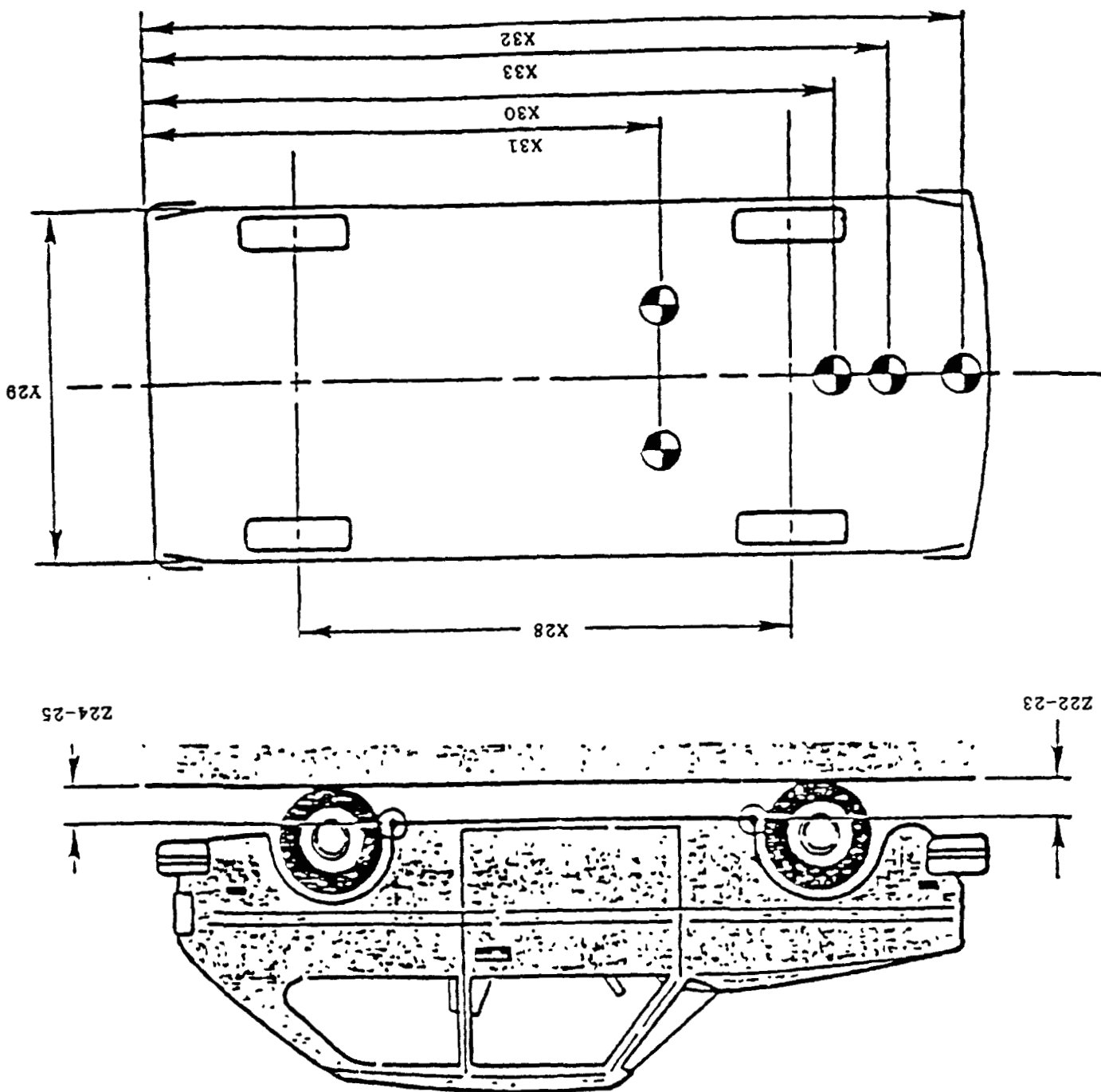


Table 5
VEHICLE 1 MEASUREMENTS

No	TYPE OF MEASUREMENT	All Dimensions in Inches	
		Pre-Test	Post-Test
X1	Total Length of Vehicle at Centerline	167.7	149 1
X2	Rear Length of Vehicle at Centerline	144 7	135 6
X3	Rear Surface of Vehicle to Firewall	125 4	122 7
X4	Rear Surface of Vehicle to Upper Leading Edge of Right Door	116 4	115 0
X5	Rear Surface of Vehicle to Upper Leading Edge of Left Door	116 4	115 5
X6	Rear Surface of Vehicle to Lower Leading Edge of Right Door	114 8	114 3
X7	Rear Surface of vehicle to Lower Leading Edge of Left Door	114 5	114 2
X8	Rear Surface of Vehicle to Upper Trailing Edge of Right Door	77 9	77 3
X9	Rear Surface of Vehicle to Upper Trailing Edge of Left Door	78 0	77 3
X10	Rear Surface of Vehicle to Lower Trailing Edge of Right Door	78 8	78 4
X11	Rear Surface of Vehicle to Lower Trailing Edge of Left Door	77 4	78 2
X12	Rear Surface of Vehicle to Bottom of "A" Post of Right Side	115 5	114 8
X13	Rear Surface of Vehicle to Bottom of "A" Post of Left Side	115 3	114 2
X14	Rear Surface of Vehicle to Firewall - Right Side	125 5	123 9
X15	Rear Surface of Vehicle to Firewall - Left Side	125 5	123 1
X16	Rear Surface of Vehicle to Steering Wheel Center	98 0	96 9
Y17	Steering Column to "A" Post	16 6	15 6

Table 5
VEHICLE 1 MEASUREMENTS (continued)

No	TYPE OF MEASUREMENT	All Dimensions in Inches	
		Pre-Test	Post-Test
Z18	Rear of Windshield Header to Steering Wheel Column	17 9	18 7
X19	Rear Surface of Vehicle to Right Side of Front Bumper	165.8	154 7
X20	Rear Surface of Vehicle to Left Side of Front Bumper	165.8	144.1
X21	Width of Engine Block	13 0	13 0
Z22	Right Front Sill to Ground Plane	9.0	8 8
Z23	Left Front Sill to Ground Plane	8 6	9 3
Z24	Right Rear Sill to Ground Plane	9 3	9 2
Z25	Left Rear Sill to Ground Plane	8 7	9 5
X26	Firewall to Engine or Transaxle	7.7	-0 0
Z27	Vertical Dim. from Door Sill to Centerline of Steering Column	20 4	21 6
X28	Wheelbase of Vehicle	93 6	90.2
Y29	Width of Vehicle at Maximum Width Point	63 6	63 0
X30	Rear Surface of Vehicle to Engine Target	141 5	132 8
X31	Rear Surface of Vehicle to Compartment Target	114 5	114 2
X32	Rear Surface of Vehicle to Bumper Target	162.8	142 3
X33	Rear Surface of Vehicle to Frame Crossmember	126 6	121 8

3-17

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VEHICLE TWO DATA

Table 6

GENERAL TEST AND VEHICLE 2 PARAMETER DATA

Vehicle Year/Make/Model/Body Style 1989 Hyundai Excel GL 4-Door Sedan

VIN KMHLF22J2KU619980

Body Color White Date Of Manufacture February 4, 1989

Engine 4 Cylinders, - C I D , 1 5 Liters, - CC
X Gas, - Diesel, - Turbocharged
- Longitudinal, X Transverse

Transmission 5 Speed, X Manual, - Automatic, X Overdrive

Final Drive X Front Wheel, - Rear Wheel, - Four Wheel
X A/C, X P/S, X P/B, - P/wdo , - Tilt Wheel
- P/seats, - Cruise Control

Type of Occupant Restraint Automatic torso belt/manual lap belt

DATA RECORDED FROM VEHICLE'S TIRE PLACARD.

Tire Pressure (at capacity) Front 30 psi, Rear 30 psi

Recommended Tire Size P15580R13 / P17570R13

Recommended Cold Tire Pressure Front 30 psi, Rear 30 psi

Tires on Vehicle P155/80R13 , Manufacturer Goodyear

Number of Occupants 2 Front, 3 Rear, - 3rd Seat, 5 TOTAL

Type of Front Seats X Bucket, - Bench, - Split Bench

Type of Front Seat Back - Fixed, X Adj. With X Lever - Rot. Knob

Vehicle Capacity Weight (VCW) = 816 lbs (A)

No. of Occupants x 150 lbs = 750 lbs. (B)

Rated Cargo and Luggage
Weight (RCLW) A-B = 66 lbs.

GVWR 3185 lbs GAWR Front 1653 lbs Rear 1587 lbs

Table 6

GENERAL TEST AND VEHICLE 2 PARAMETER DATA (cont'd)

WEIGHT OF TEST VEHICLE AS RECEIVED FROM DEALER (WITH NO FUEL FLUIDS) = UDW

Right Front =	<u>670</u> lbs	Right Rear =	<u>400</u> lbs
Left Front =	<u>700</u> lbs	Left Rear =	<u>400</u> lbs
TOTAL FRONT WEIGHT =	<u>1370</u> lbs	(<u>63</u> % of Total Vehicle Weight)	
TOTAL REAR WEIGHT =	<u>800</u> lbs	(<u>37</u> % of Total Vehicle Weight)	
TOTAL DELIVERY WEIGHT =	<u>2170</u> lbs		

WEIGHT OF TEST VEHICLE WITH REQUIRED DUMMY

Right Front =	<u>760</u> lbs	Right Rear =	<u>590</u> lbs
Left Front =	<u>690</u> lbs	Left Rear =	<u>530</u> lbs
TOTAL FRONT WEIGHT =	<u>1450</u> lbs	(<u>56</u> % of Total Vehicle Weight)	
TOTAL REAR WEIGHT =	<u>1120</u> lbs	(<u>44</u> % of Total Vehicle Weight)	
TOTAL TEST WEIGHT =	<u>2570</u> lbs		
Weight of ballast secured in vehicle trunk area =	<u>0</u> lbs		

TEST VEHICLE ATTITUDE (all dimensions in inches)

AS DELIVIERED	RF <u>26.1</u> ,	LF <u>26.0</u> ,	RR <u>25.2</u> ,	LR <u>25.0</u>
AS TESTED	RF <u>24.9</u> ,	LF <u>25.1</u> ,	RR <u>23.0</u> ,	LR <u>23.0</u>

Vehicle's Wheelbase = 93.6 inches

Location of Vehicle's C G = 40.8 inches from front wheel center.

Table 6

GENERAL TEST AND VEHICLE 2 PARAMETER DATA (cont'd)

POST-IMPACT DATA.

Type of Test VTV Frontal Impact Angle 0°
 Date of Test 10-25-89 Time of Test 12 20
 Ambient Temperature 69 °F at impact area
 Temperature in Occupant Compartment 67 °F
 Windshield Molding Temperature - °F
 Required Impact Velocity Range 34 5 to 35 5 mph
 Impact Velocity primary = 34 2 mph, secondary = 34 2 mph
 Distance From Front Bumper to Impact Point When
 Entering Speed Trap - inches
 Exiting Speed Trap - inches

VISIBLE DUMMY CONTACT POINTS.

	<u>Passenger</u>
Head	<u>chin contacted chest</u>
Chest	<u>no contact</u>
Abdomen	<u>-</u>
Left Knee	<u>dash panel</u>
Right Knee	<u>dash panel</u>

Table 6

GENERAL TEST AND VEHICLE 2 PARAMETER DATA (cont'd)

	<u>Front</u>		<u>Rear</u>	
	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Door Opening	closed	closed	closed	closed
	<u>operable</u>	<u>operable</u>	<u>operable</u>	<u>operable</u>
<u>Seat Movement</u>	<u>Front</u>		<u>Rear</u>	
	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Seat Back Failure	<u>-</u>	<u>None</u>	<u>-</u>	<u>-</u>
Seat Shift (in)	<u>-</u>	<u>0 0</u>	<u>-</u>	<u>-</u>

Table 7
VEHICLE 2 DUMMY INJURY CRITERIA VALUES

	MAXIMUM ACCELERATION ("G")							
	HEAD(Primary)				CHEST			
	X	Y	Z	R	X	Y	Z	R*
DUMMY (1)	-	-	-	-	-	-	-	-
DUMMY (2)	78 6	-22 7	56 8	83 3	-55 8	18 0	-13 4	47 3
DUMMY (3)								
DUMMY (4)								

	MAXIMUM FORCE FEMUR LOAD (LBS)	
	RIGHT FEMUR	LEFT FEMUR
DUMMY (1)	-	-
DUMMY (2)	1027 7	1894 3
DUMMY (3)		
DUMMY (4)		

	MAXIMUM FORCE SEAT BELT LOADS (LBS)		
	SHOULDER STRAP UPPER BELT LOAD	LAP STRAP RIGHT BELT LOAD	LAP STRAP LEFT BELT LOAD
DUMMY (1)	-	-	-
DUMMY (2)	2757 6	N/M	-
DUMMY (3)			
DUMMY (4)			

	HEAD INJURY CRITERIA (HIC) (Primary)			
	HIC	t ₁ (SEC)	t ₂ (SEC)	Average Acceleration t ₁ TO t ₂
DUMMY (1)	-	-	-	-
DUMMY (2)	682 0	.05812	0.9412	51 4 g's
DUMMY (3)				
DUMMY (4)				

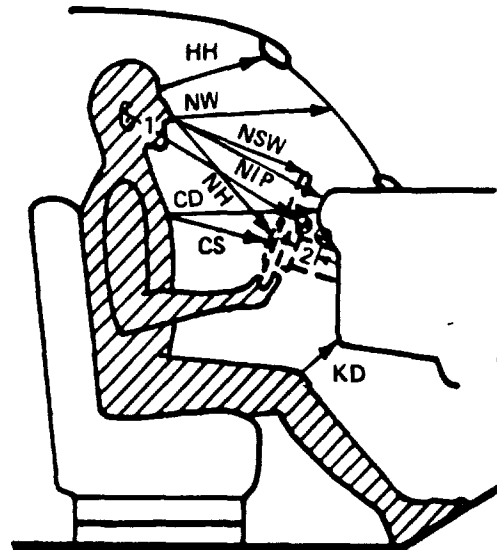
*Defined as exceeding 0.003 sec. duration

**As defined in FMVSS No. 208

Figure 7

VEHICLE 2 OCCUPANT CLEARANCE DIMENSIONS

	PASSENGER
HH	13 4
NW	23 3
NSW	-
NIP	25 6
NH	-
CD	23 4
CS	-
KDL	6 2
KDR	6 1
1	-
2	-
SA	23°
TA	23°
ULA	107°
LLA	229°

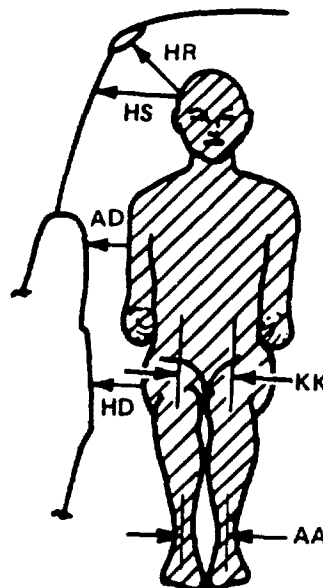


HH = Head to Windshield Header
 NW = Nose to Windshield
 NSW = Nose to Steering Wheel
 NIP = Nose to Instrument Panel
 NH = Nose to Steering Wheel Hub
 CD = Chest to Dash
 CS = Chest to Steering Wheel Hub
 KDL = Knee to Dash Left
 KDR = Knee to Dash Right
 1 = Head Target to Steering Column Target
 2 = Distance between Steering Column Targets

Angles taken relative to vertical

SA = Seat Back Angle
 TA = Torso Angle
 ULA = Upper Leg Angle
 LLA = Lower Leg Angle

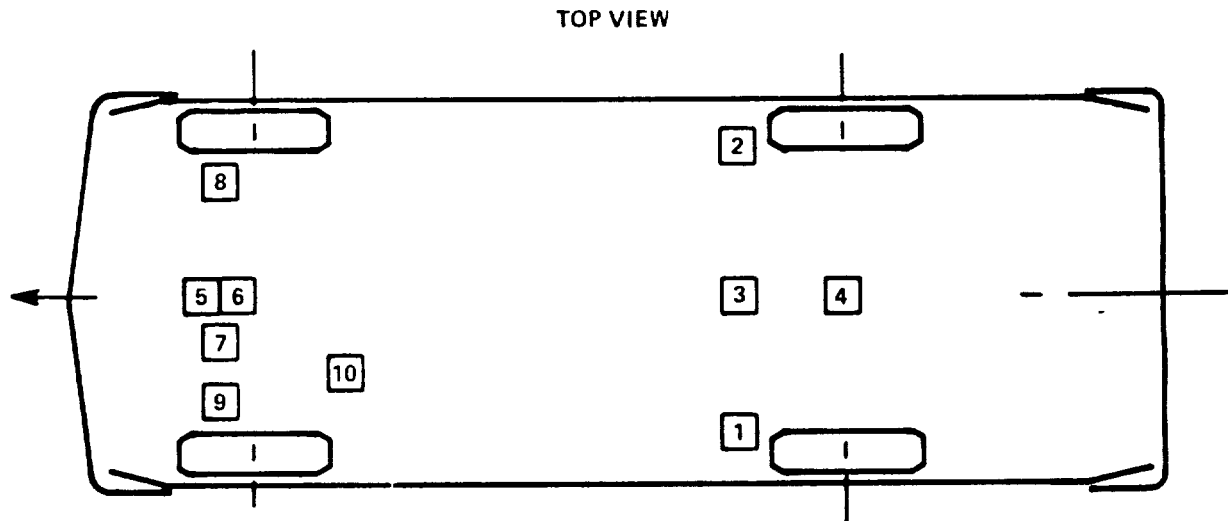
HR = Head to Side Roof
 HS = Head to Side Window
 AD = Arm to Door
 HD = Hip to Door
 KK = Knee to Knee
 AA = Ankle to Ankle
 DT = Dummy Temperature °F



	PASSENGER
HR	5 2
HS	7 7
AD	4 1
HD	6 1
KK	7 5
AA	7.8
DT	67°

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Figure 8
SUMMARY OF VEHICLE 2 ACCELEROMETER DATA



Vehicle 1989 Hyundai Excel GL 4-Door Sedan

Lot No	Description	Axis	Maximum Value (g's)*	
			"-"	"+"
1	Rear seat crossmember left side	x	-38.6	1.4
2	Rear seat crossmember right side	x	-40.8	2.4
3	Rear seat crossmember centerline, primary	x	-38.4	2.9
3	Rear seat crossmember centerline, y	y	-4.9	2.7
3	Rear seat crossmember centerline, z	z	-8.3	7.5
4	Rear seat crossmember centerline, redundant	x	-38.7	2.9
5	Top of engine block	x	-201.4	59.0
5	Top of engine block	z	-53.4	37.9
6	Bottom of engine block	x	-113.8	8.5
7	Front suspension crossmember	x	-158.8	11.0
7	Front suspension crossmember	z	-52.2	21.8
8	Right front brake caliper	x	-71.4	10.5
9	Left front brake caliper	x	-76.2	28.6
10	Steering wheel hub	x	-113.4	11.9
10	Steering wheel hub	z	-50.4	74.9

*Values filtered using SAE class 60 filter

Figure 9
 VEHICLE 2 PRE- AND POST-TEST POSITION OF TEST VEHICLE
 ACCELEROMETER MOUNTING LOCATIONS

Test Description 35 mph Offset Frontal Vehicle-to-Vehicle Impact

Test Vehicle 1989 Hyundai Excel GL 4-Door Sedan

Reference Plane Vehicle plane at rear bumper

Accelerometer Description	LONGITUDINAL LOCATION		
	Pre-Test	Post-Test	Change
Rear seat crossmember left side	64 9	64 8	0 1
Rear seat crossmember right side	64 9	64 8	0 1
Rear seat crossmember centerline, primary	64 9	64 8	0 1
Rear seat crossmember centerline, redundant	64.9	64 8	0 1
Top of engine block	141 7	131.6	10 1
Bottom of engine block	141 1	134 1	7 0
Front suspension crossmember	126 3	121 1	5 2
Right front brake caliper	132 2	127 5	4 7
Left front brake caliper	132 4	123 7	8 7
Steering wheel hub	100 9	98 2	2.7

Figure 10
VEHICLE 2 TARGET LOCATIONS

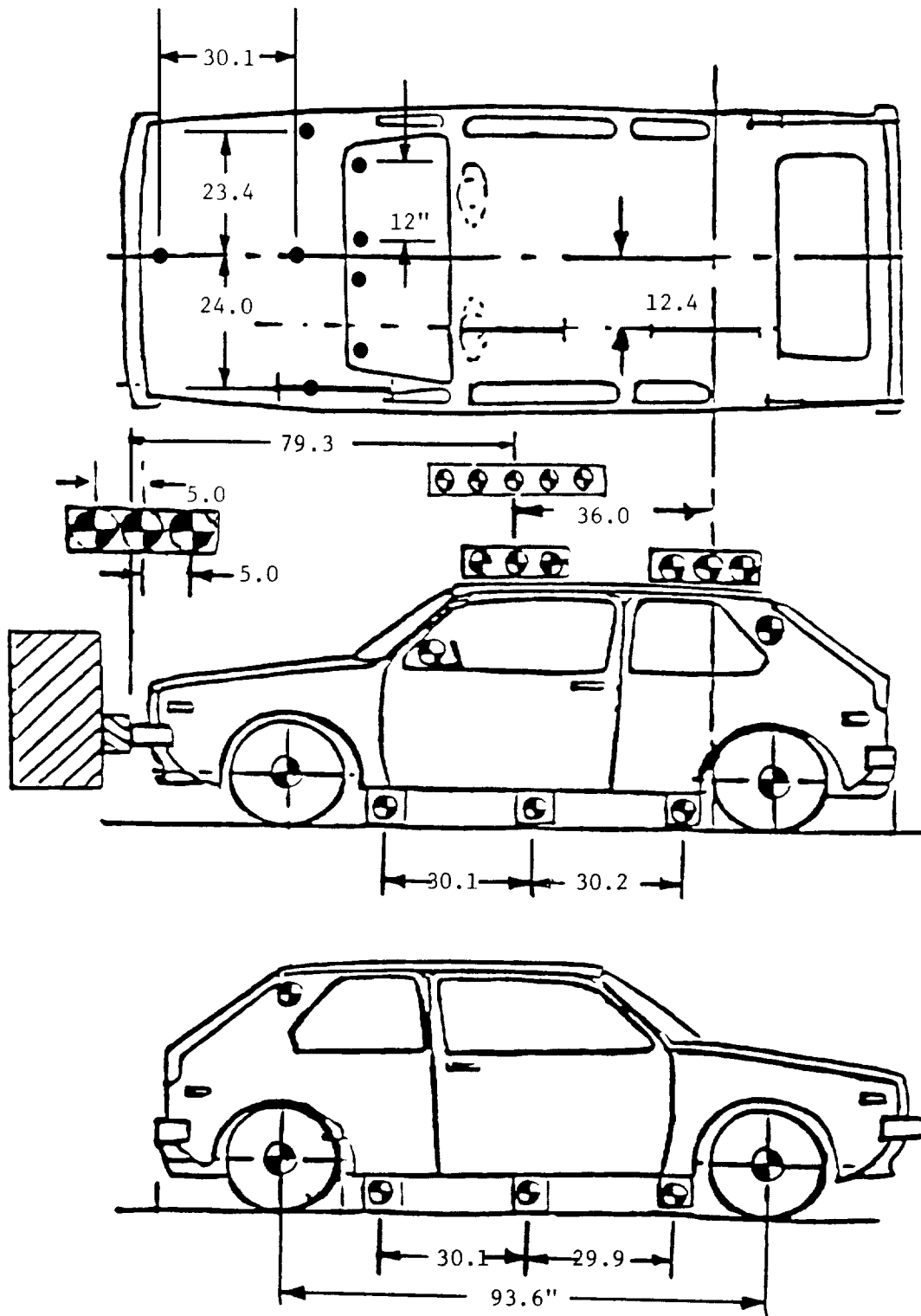


Figure 11

VEHICLE 2 MEASUREMENT POINTS

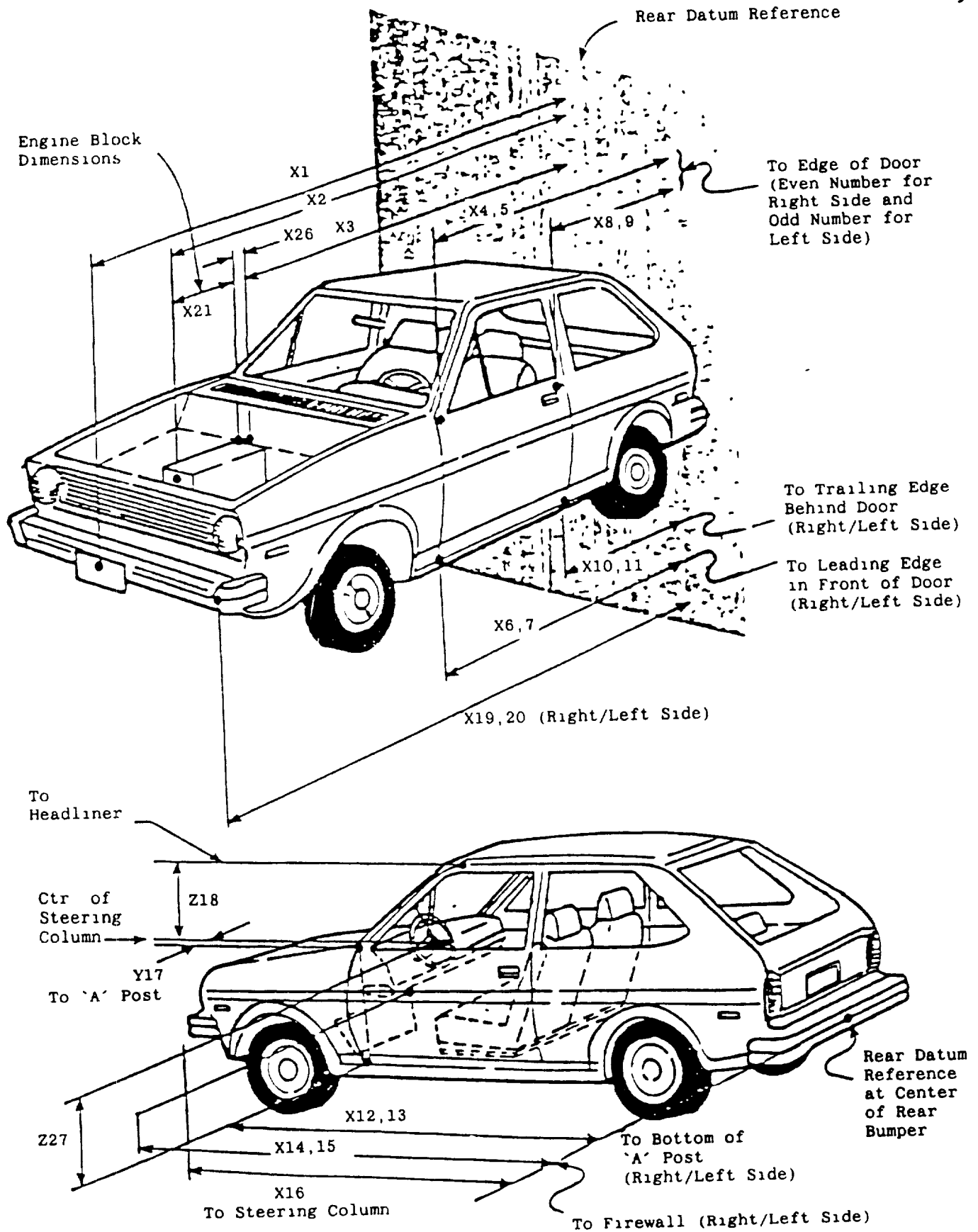


Figure 11
VEHICLE 2 MEASUREMENT POINTS (continued)

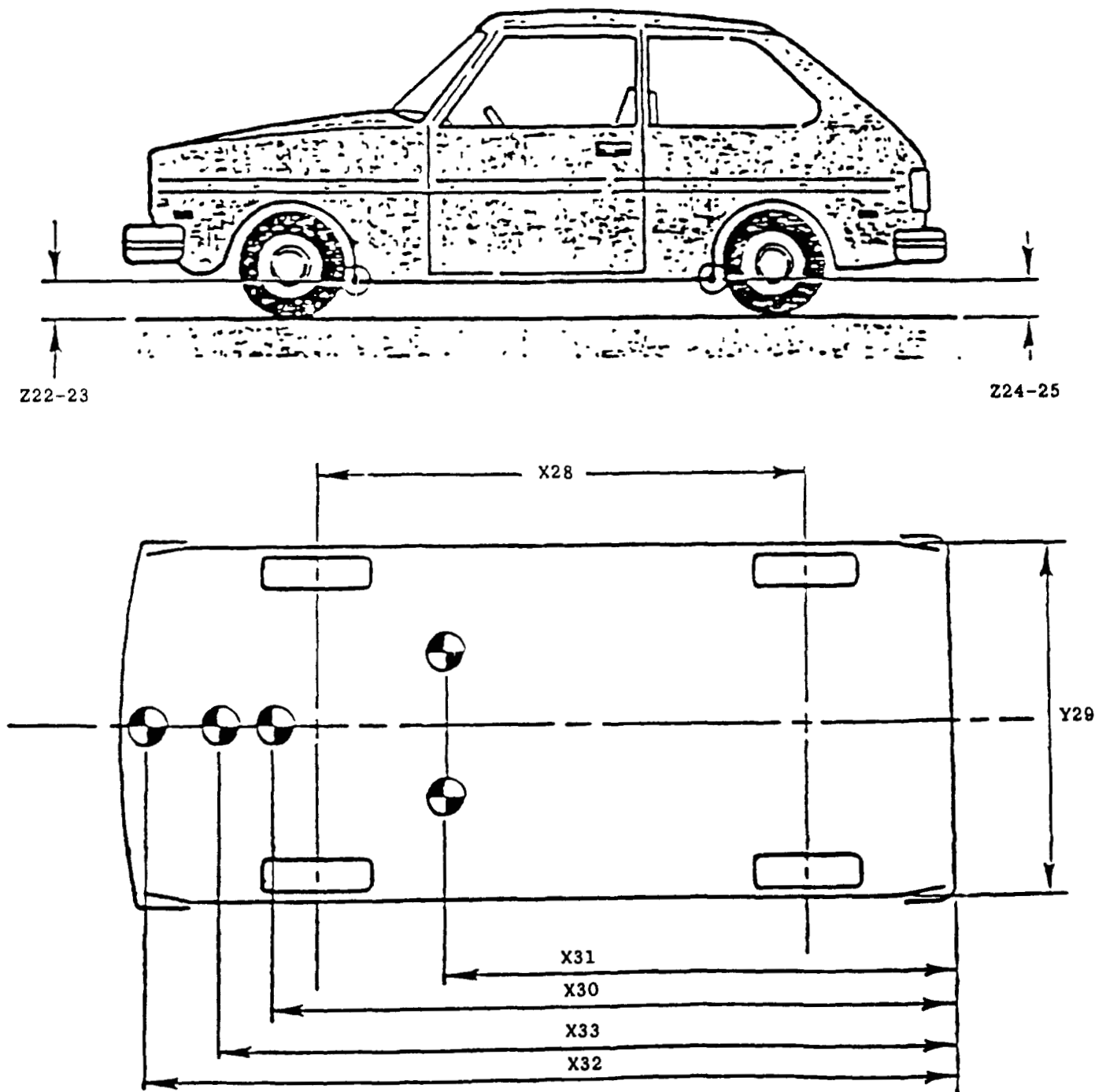


Table 8
VEHICLE 2 MEASUREMENTS

No.	TYPE OF MEASUREMENT	All Dimensions in Inches	
		Pre-Test	Post-Test
X1	Total Length of Vehicle at Centerline	167 7	148 4
X2	Rear Length of Vehicle at Centerline	144 7	136 0
X3	Rear Surface of Vehicle to Firewall	125 4	123 5
X4	Rear Surface of Vehicle to Upper Leading Edge of Right Door	116 4	115 4
X5	Rear Surface of Vehicle to Upper Leading Edge of Left Door	116 4	115 0
X6	Rear Surface of Vehicle to Lower Leading Edge of Right Door	114 8	114 4
X7	Rear Surface of vehicle to Lower Leading Edge of Left Door	114 5	114 0
X8	Rear Surface of Vehicle to Upper Trailing Edge of Right Door	77 9	77 4
X9	Rear Surface of Vehicle to Upper Trailing Edge of Left Door	78.0	76 9
X10	Rear Surface of Vehicle to Lower Trailing Edge of Right Door	78 8	78 4
X11	Rear Surface of Vehicle to Lower Trailing Edge of Left Door	77 4	77 8
X12	Rear Surface of Vehicle to Bottom of "A" Post of Right Side	115.5	114 8
X13	Rear Surface of Vehicle to Bottom of "A" Post of Left Side	115 3	114 4
X14	Rear Surface of Vehicle to Firewall - Right Side	125 5	123 9
X15	Rear Surface of Vehicle to Firewall - Left Side	125 5	121 9
X16	Rear Surface of Vehicle to Steering Wheel Center	98 0	97 3
Y17	Steering Column to "A" Post	16 0	17 5

Table 8
VEHICLE 2 MEASUREMENTS (continued)

No	TYPE OF MEASUREMENT	All Dimensions in Inches	
		Pre-Test	Post-Test
Z18	Rear of Windshield Header to Steering Wheel Center	17 9	20 3
X19	Rear Surface of Vehicle to Right Side of Front Bumper	165 8	155 1
X20	Rear Surface of Vehicle to Left Side of Front Bumper	165 8	143 8
X21	Width of Engine Block	13 0	13 0
Z22	Right Front Sill to Ground Plane	9 0	9 3
Z23	Left Front Sill to Ground Plane	8 6	8 6
Z24	Right Rear Sill to Ground Plane	9 3	10 3
Z25	Left Rear Sill to Ground Plane	8 7	9 8
X26	Firewall to Engine or Transaxle	7.7	~0 0
Z27	Vertical Dim. from Door Sill to Centerline of Steering Column	20.4	17 5
X28	Wheelbase of Vehicle	93 6	89 2
Y29	Width of Vehicle at Maximum Width Point	63 8	63 0
X30	Rear Surface of Vehicle to Engine Target	141.1	134.1
X31	Rear Surface of Vehicle to Compartment Target	114 5	114.2
X32	Rear Surface of Vehicle to Bumper Strut	164 4	145 7
X33	Rear Surface of Vehicle to Frame Crossmember	126 3	121 1

10.7"
22"

Figure 12
CAMERA POSITIONS FOR VTV OFFSET FRONTAL IMPACTS

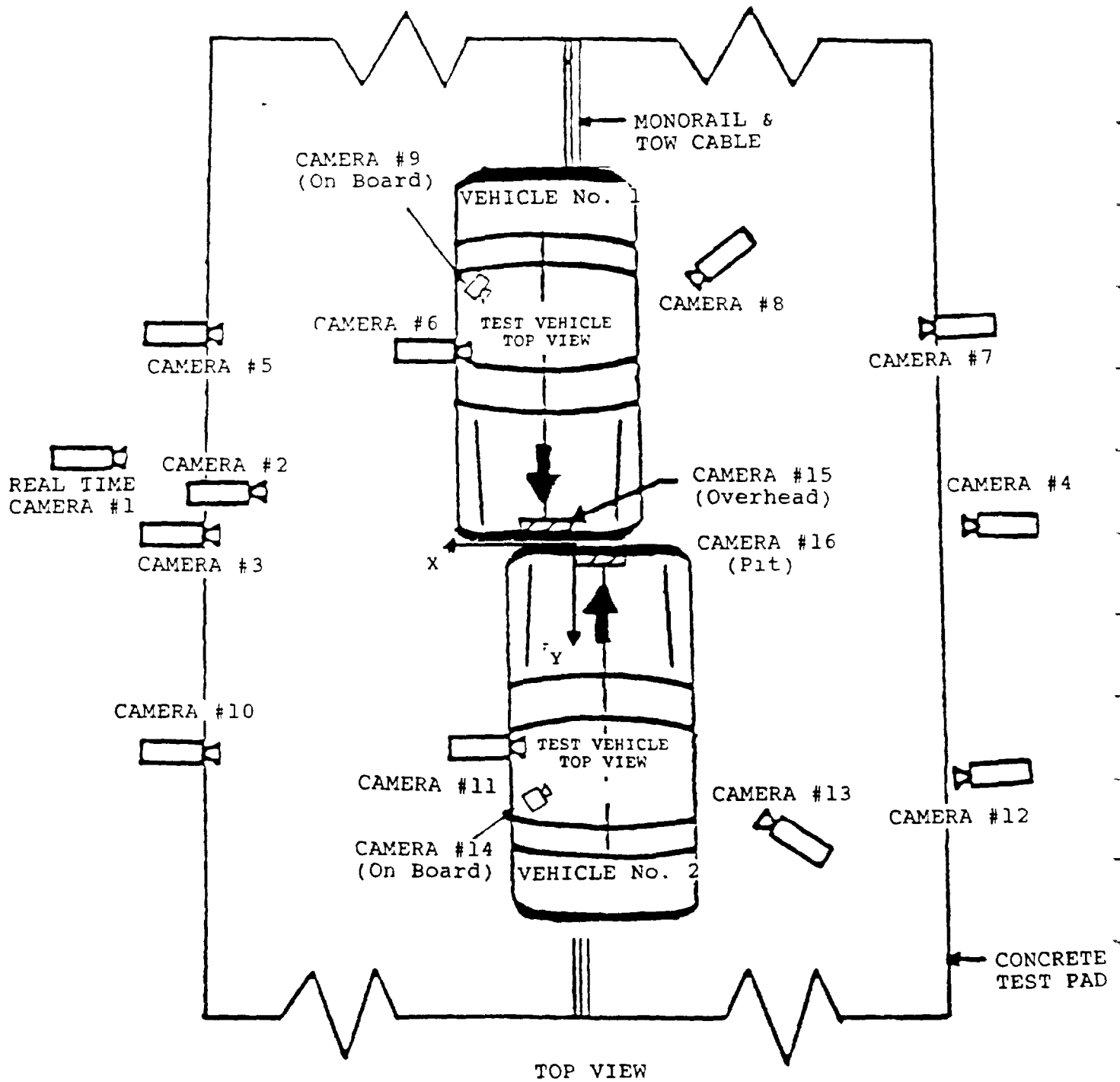


Table 9
HIGH-SPEED CAMERA LOCATIONS

Test No Y38-4-933 Vehicle: Two 1989 Hyundai Excel GL 4-Door Sedan

CAMERA NO.	VIEW	CAMERA POSITIONS (in)*			ANGLE** (deg)	LENS (mm)	SPEED (fps)
		X	Y	Z			
1	Real-Time Camera	-	-	-	-	-	24
2	Overall View	649.5	-22 0	43 0	-1°	25	550
3	Impact Point Left Side View	210 0	0	40 5	-7°	13	530
4	Impact Point Right Side View	-201 0	+6.0	41 5	-5°	13	610
5	Vehicle 1 Overall View	552 5	-67 0	43 5	-4°	25	675
6	Vehicle 1 Onboard Driver View	-	-	-	-	8	1240
7	Vehicle 1 Driver View	-383.0	-23 0	40 0	-2°	25	610
8	Vehicle 1 Driver and Steering Column View	-107 0	-102 0	70 5	-16°	13	825
9	Vehicle 1 Onboard Seat Belt View	-	-	-	-	8	950
10	Vehicle 2 Overall View	383.0	+29 5	41 0	-5°	25	555
11	Vehicle 2 Onboard Passenger View	-	-	-	-	8	560
12	Vehicle 2 Right Side Passenger View	-391.0	+41.0	44.0	-1°	25	540
13	Vehicle 2 Passenger and Interior View	-120.0	+97 0	70 5	-15°	13	555
14	Vehicle 2 Onboard Seat Belt View	-	-	-	-	8	880
15	Overhead View	6 0	+15 0	37 6	-90°	25	500
16	Underbody View	0	+6 0	-79 0	90°	13	810

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

Appendix A

PHOTOGRAPHS

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OVERALL TEST SETUP

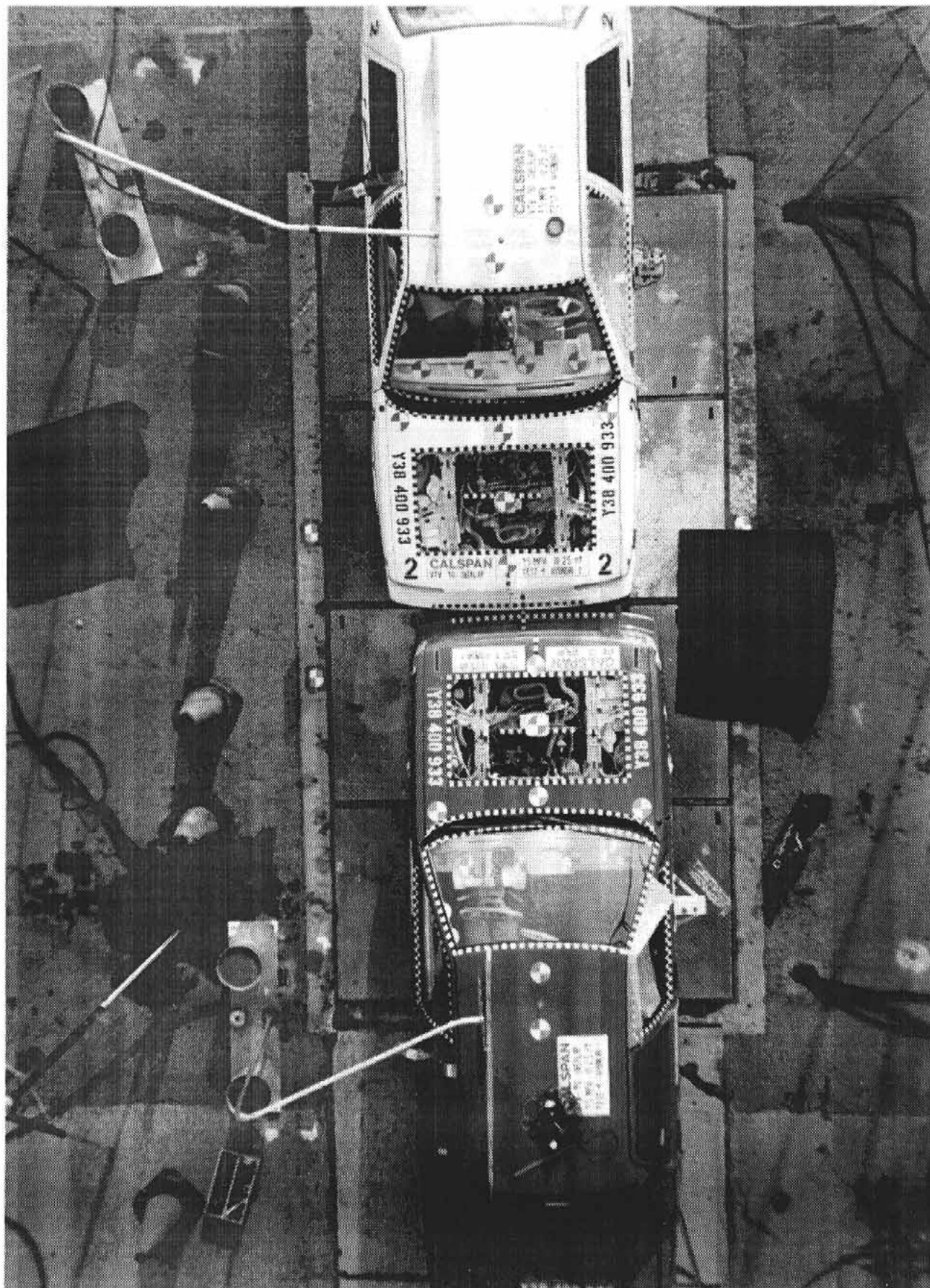


Figure A-1 PRE-TEST OVERHEAD VIEW

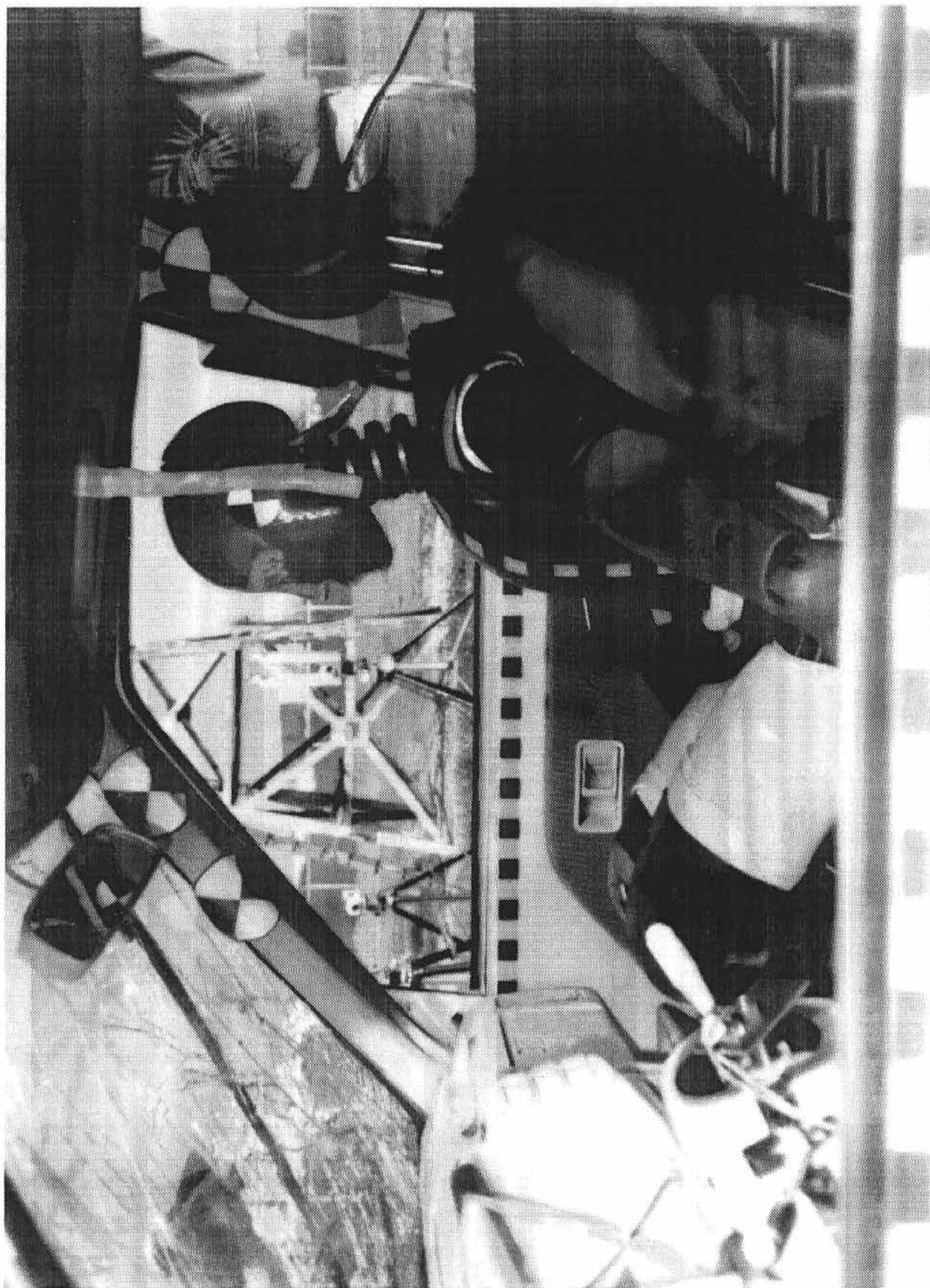


Figure A-70 VEHICLE 2 POST-TEST PASSENGER AND OCCUPANT COMPARTMENT
LEFT SIDE VIEW

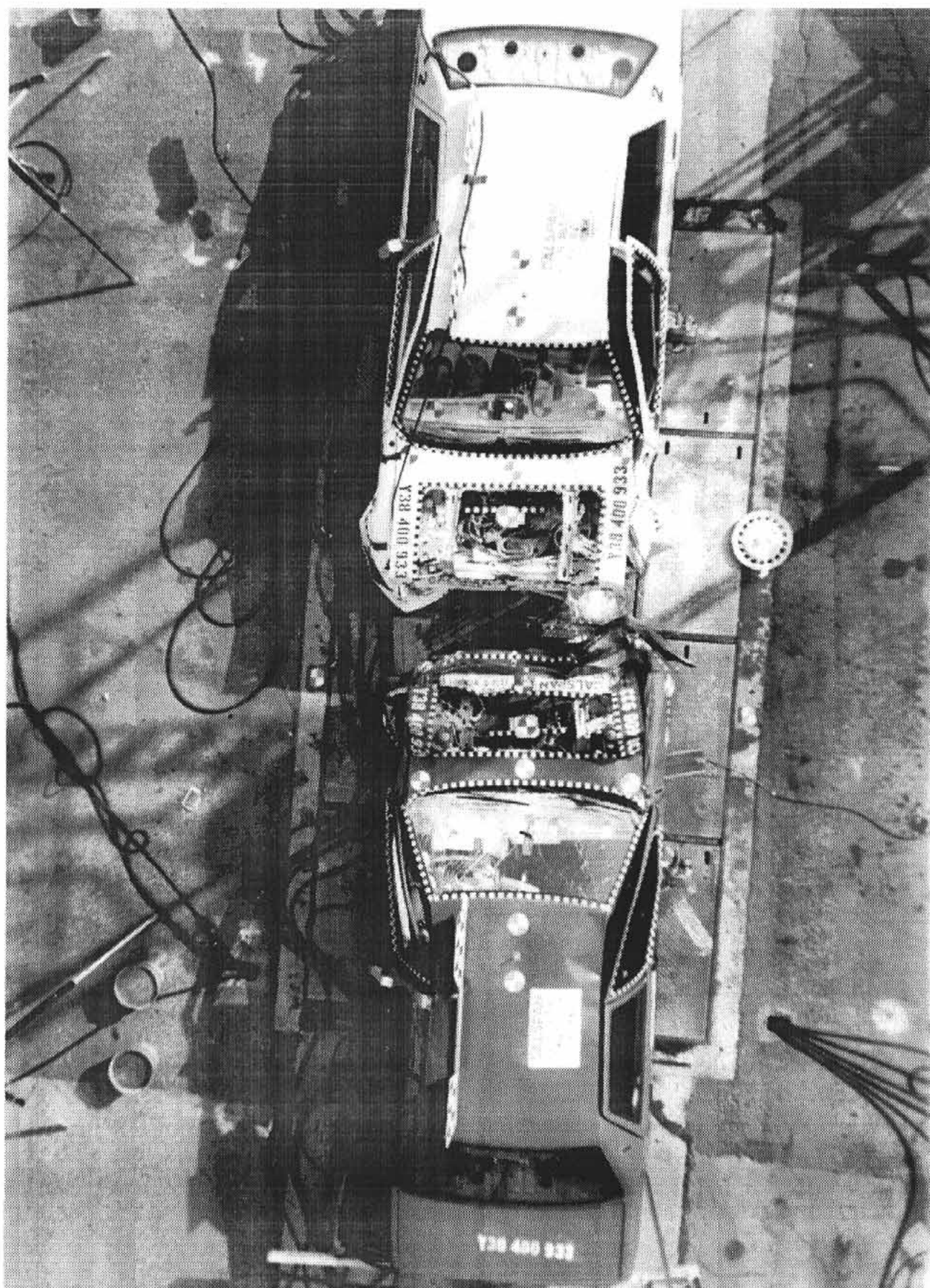


Figure A-2 POST-TEST OVERHEAD VIEW

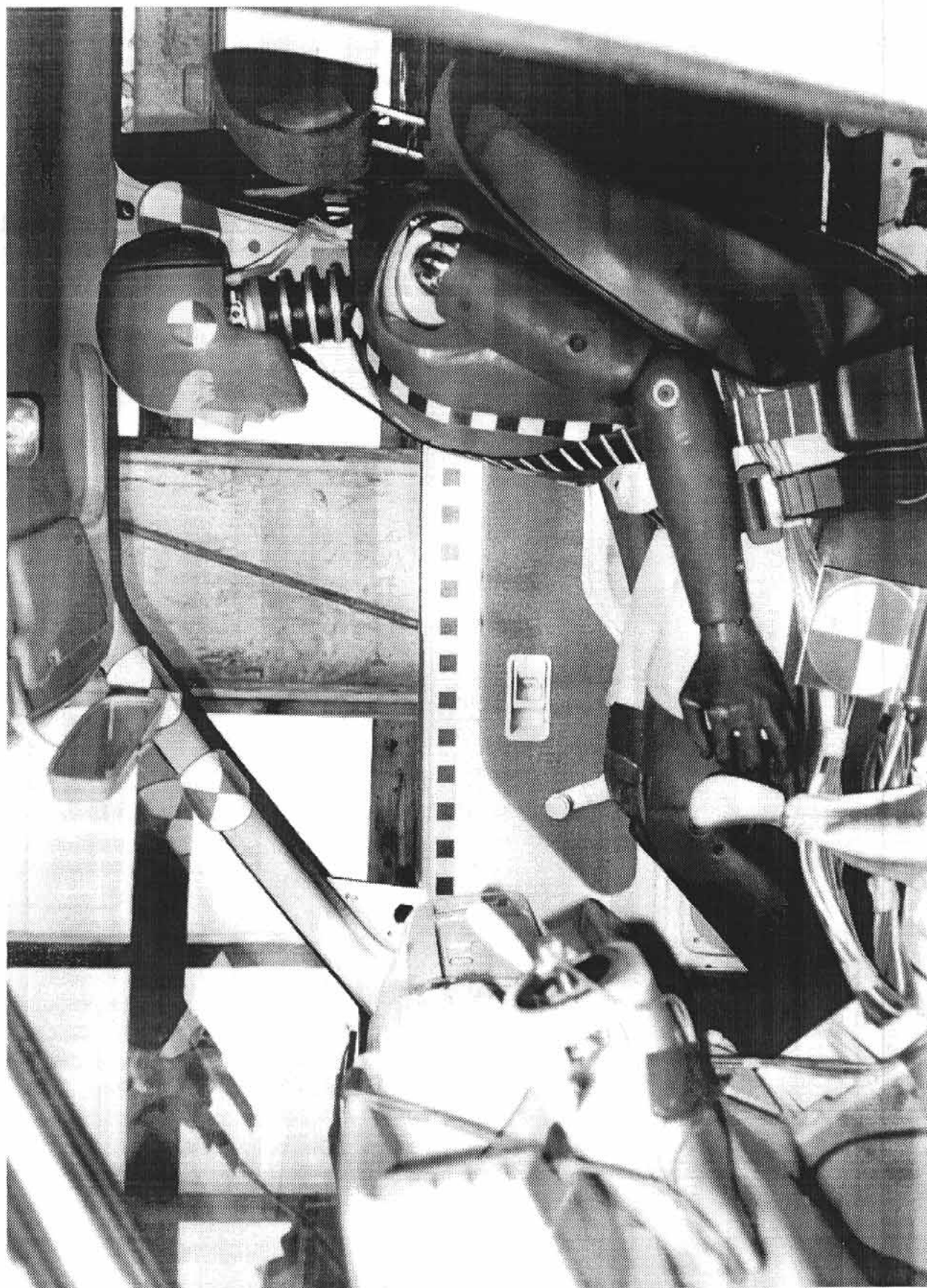


Figure A-69 VEHICLE 2 PRE-TEST PASSENGER AND OCCUPANT COMPARTMENT
LEFT SIDE VIEW

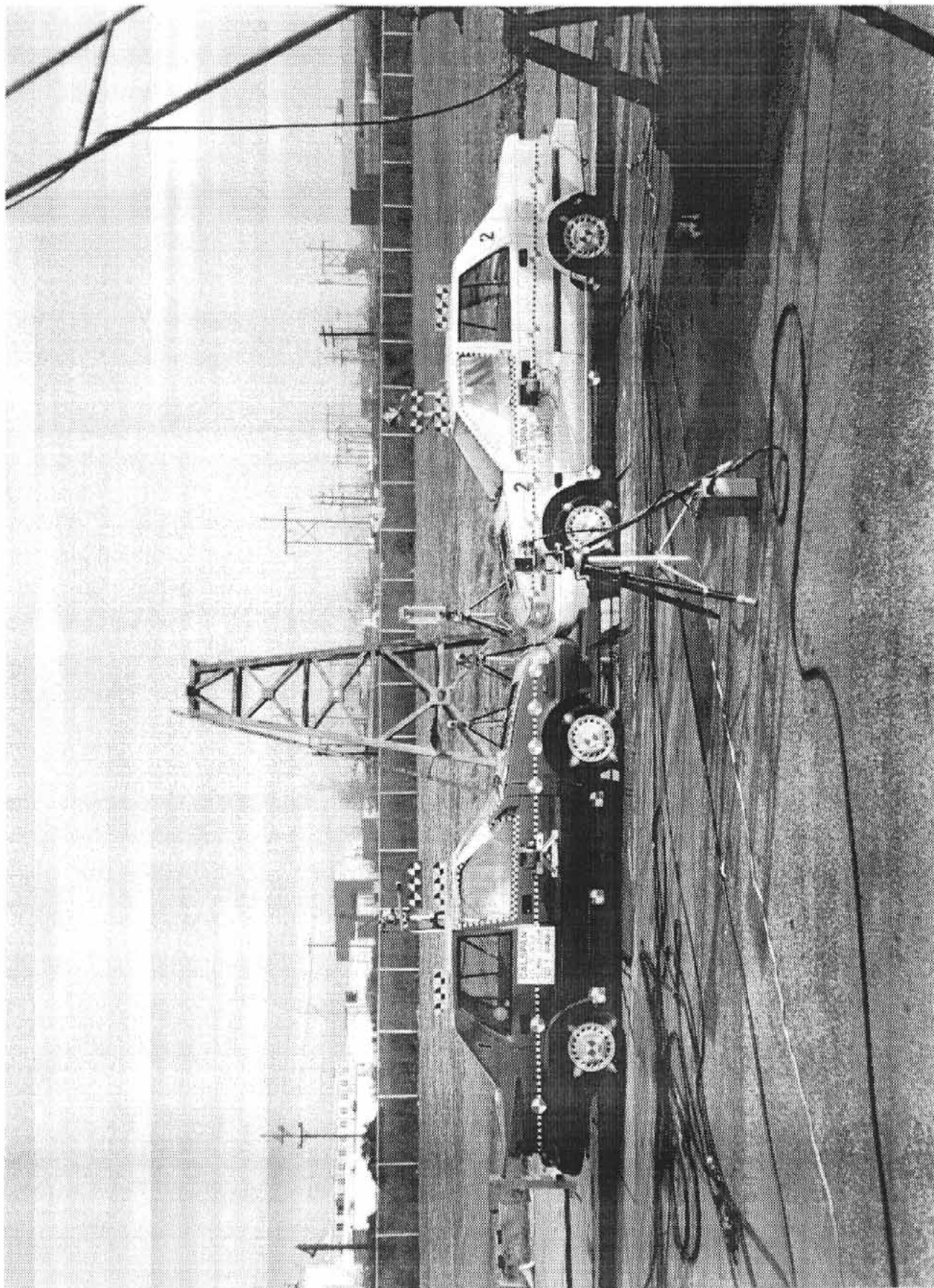


Figure A-3 PRE-TEST OVERALL SIDE VIEW

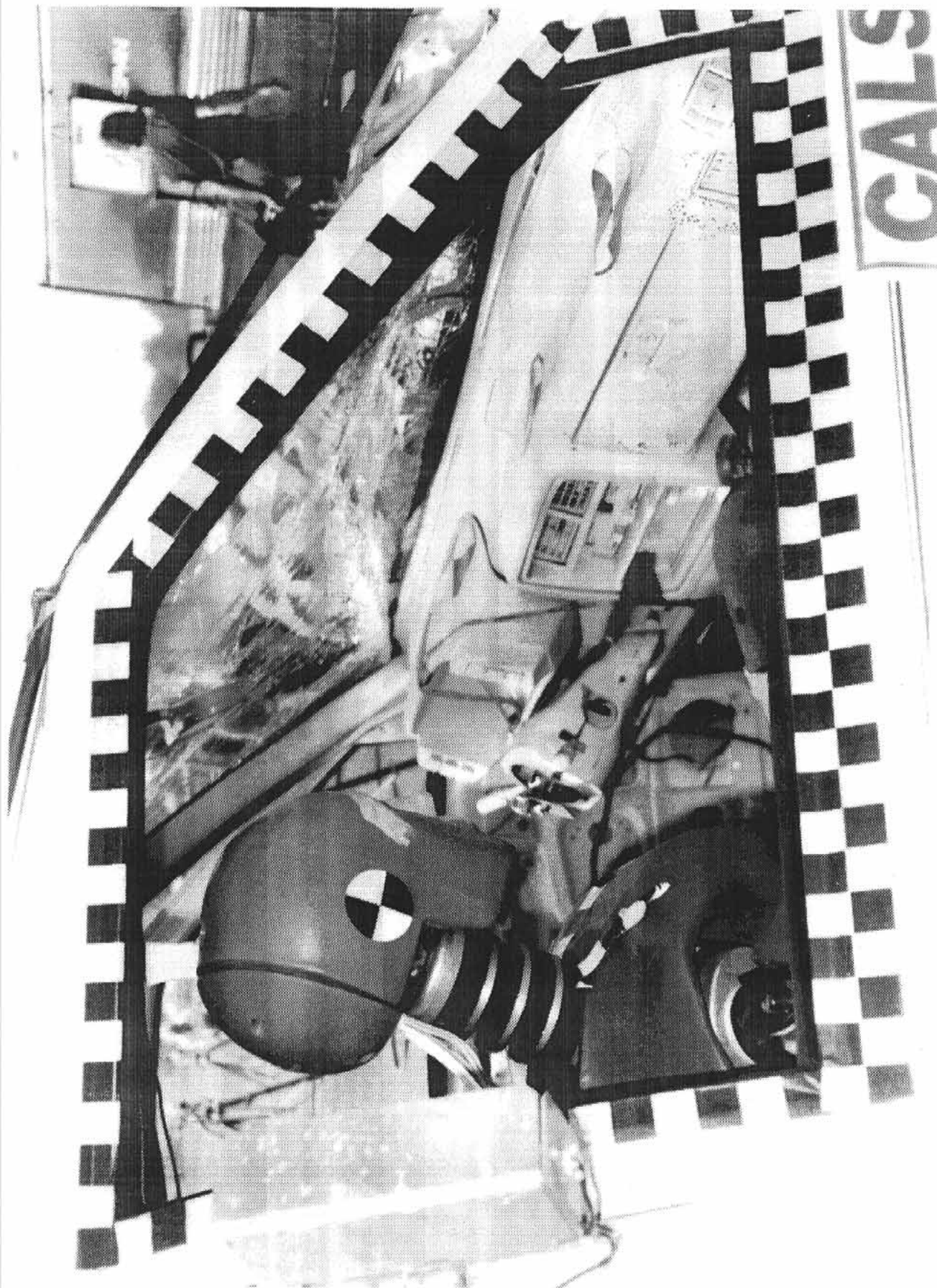


Figure A-68 VEHICLE 2 POST-TEST PASSENGER AND OCCUPANT COMPARTMENT VIEW

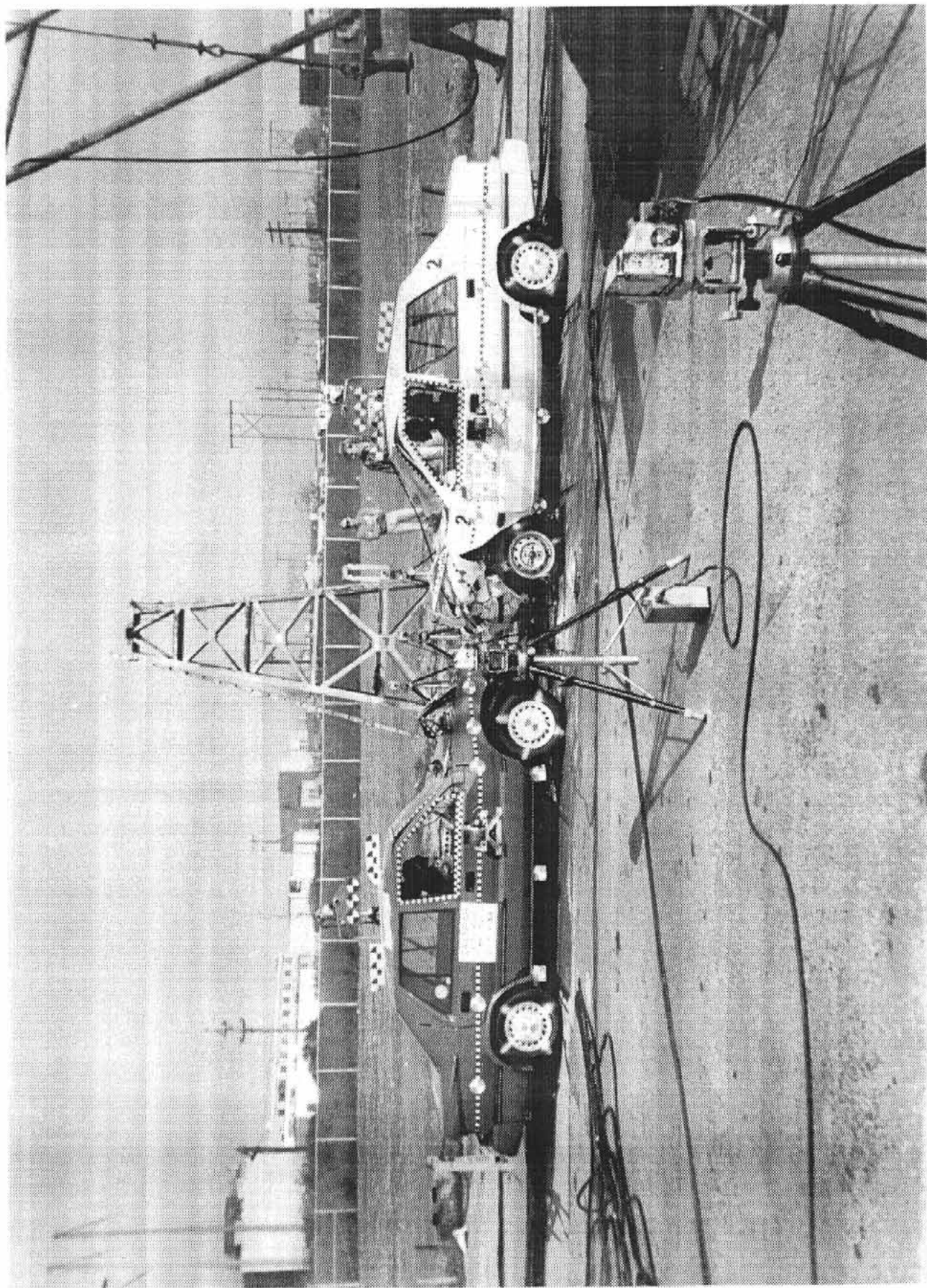


Figure A-4 POST-TEST OVERALL SIDE VIEW

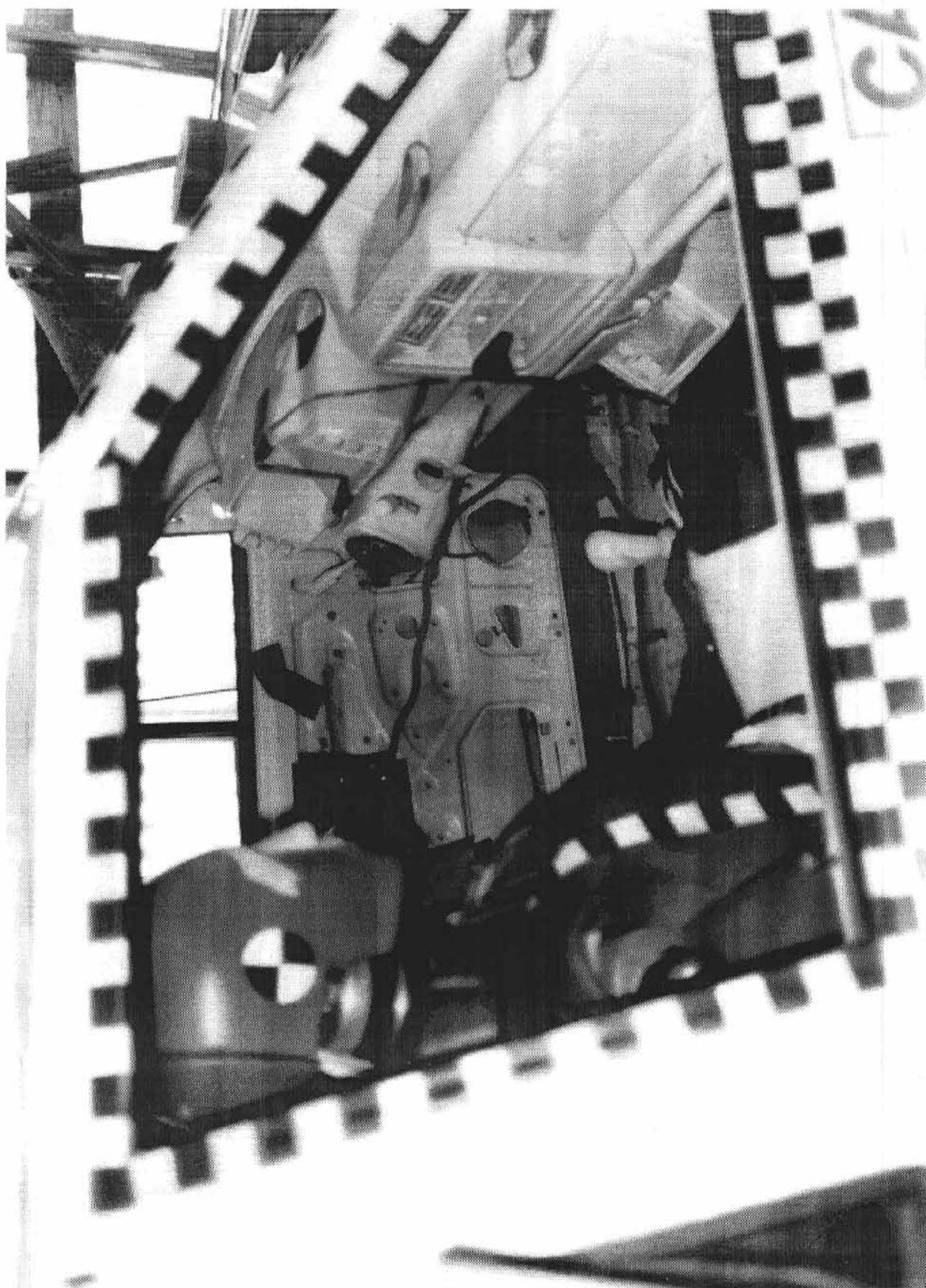


Figure A-67 VEHICLE 2 PRE-TEST PASSENGER AND OCCUPANT COMPARTMENT VIEW

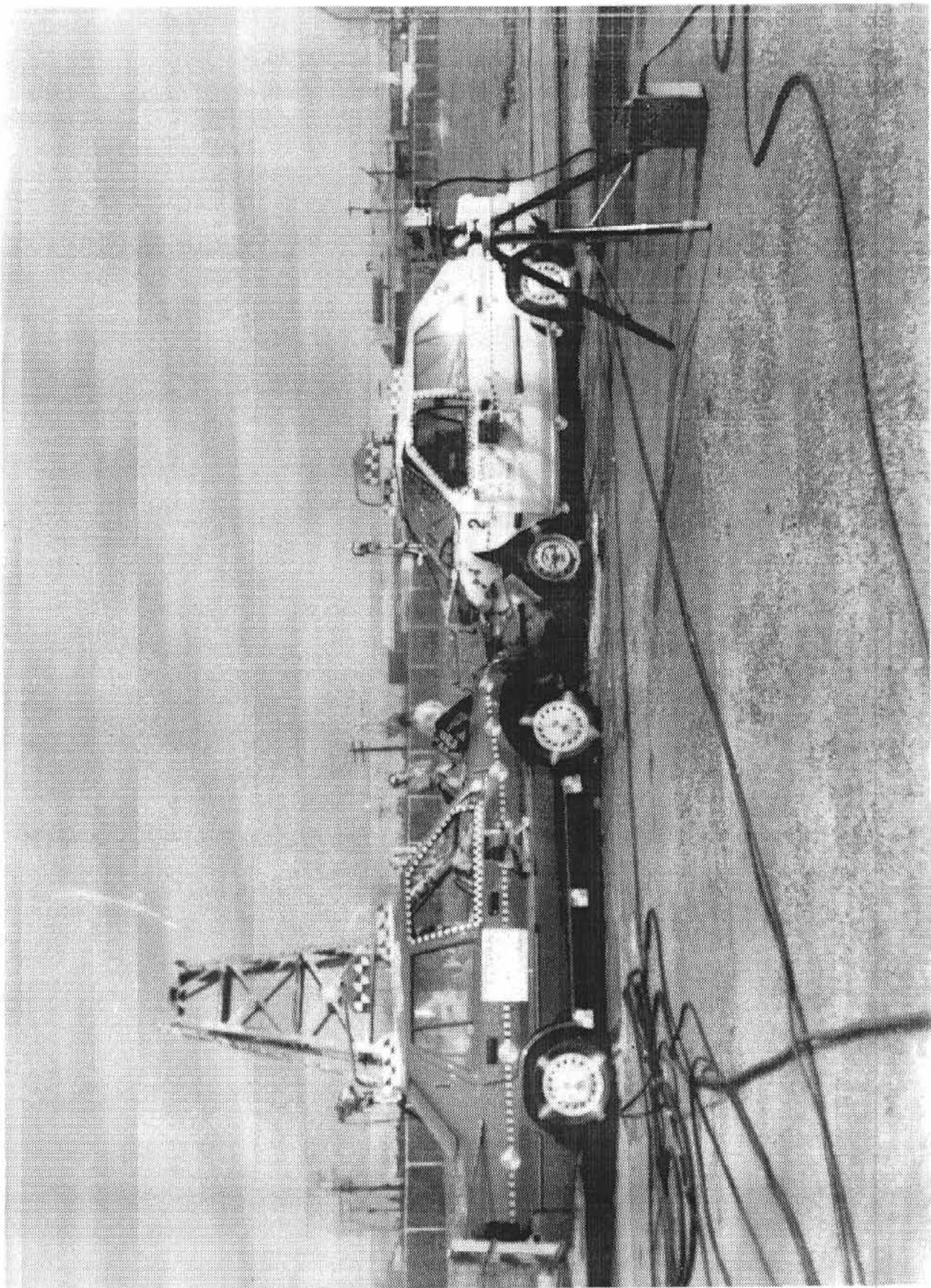


Figure A-5 IMPACT PHOTO

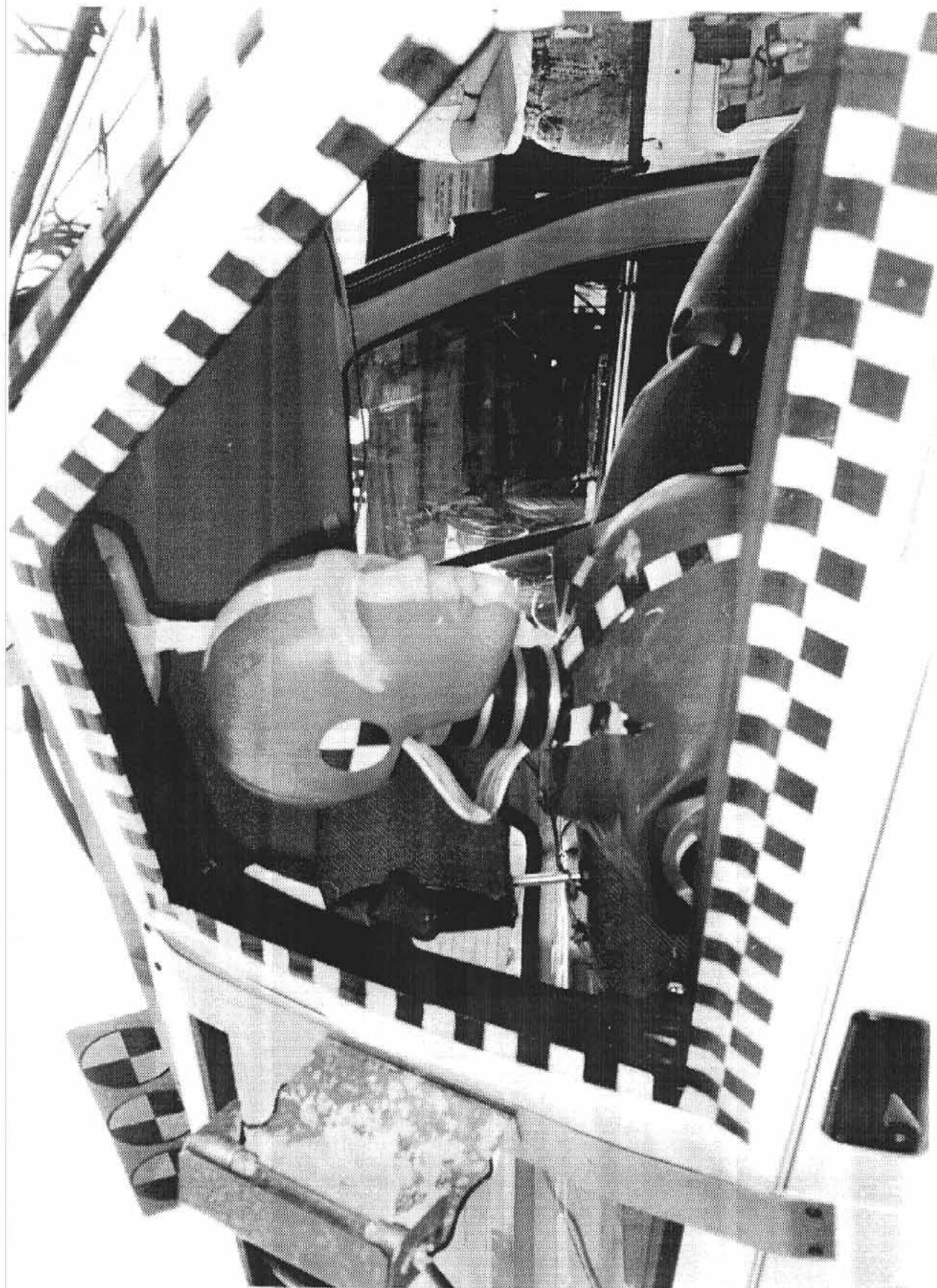


Figure A-66 VEHICLE 2 POST-TEST PASSENGER POSITION VIEW

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VEHICLE 1 PHOTOGRAPHS

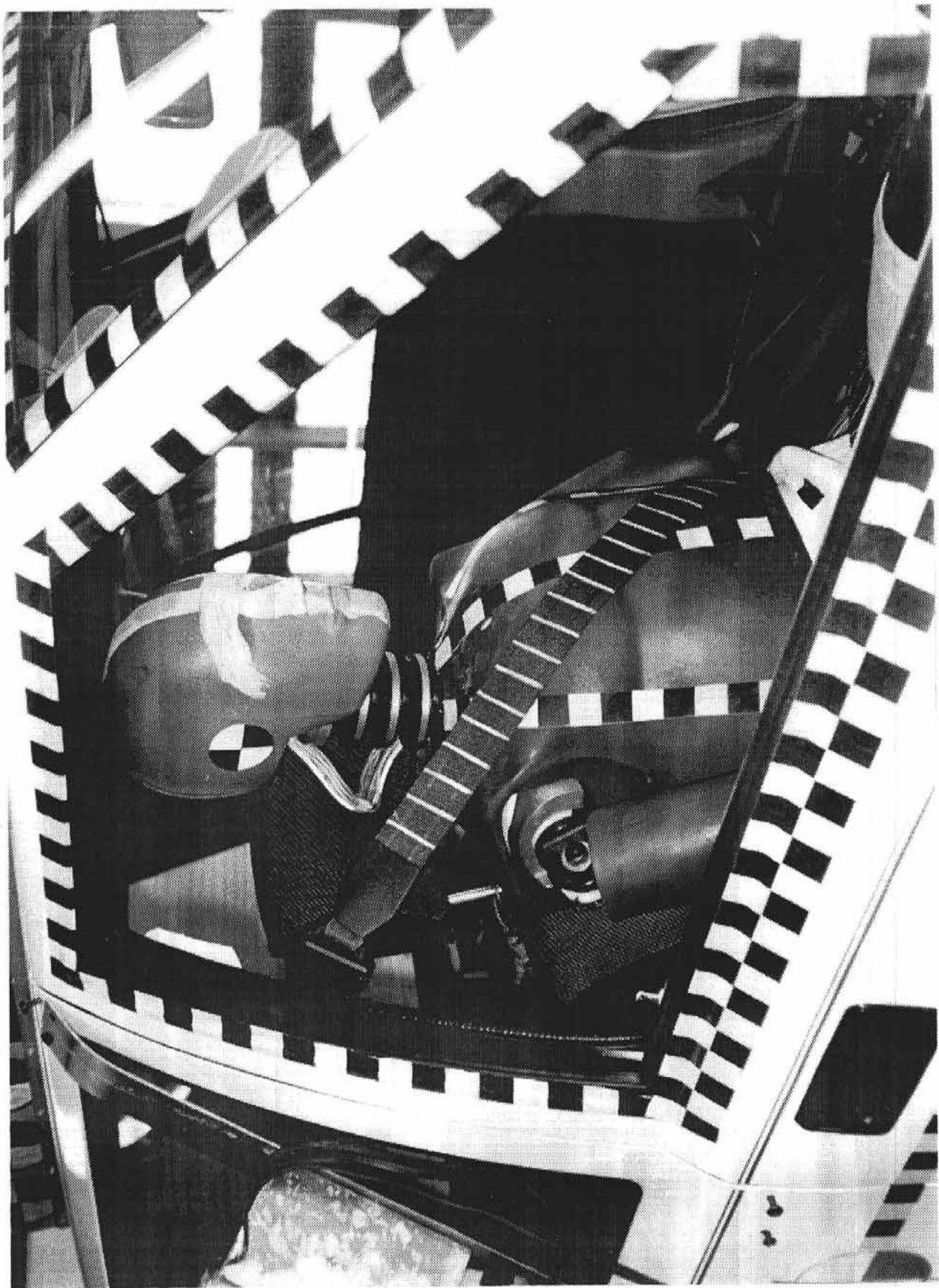


Figure A-65 VEHICLE 2 PRE-TEST PASSENGER POSITION VIEW

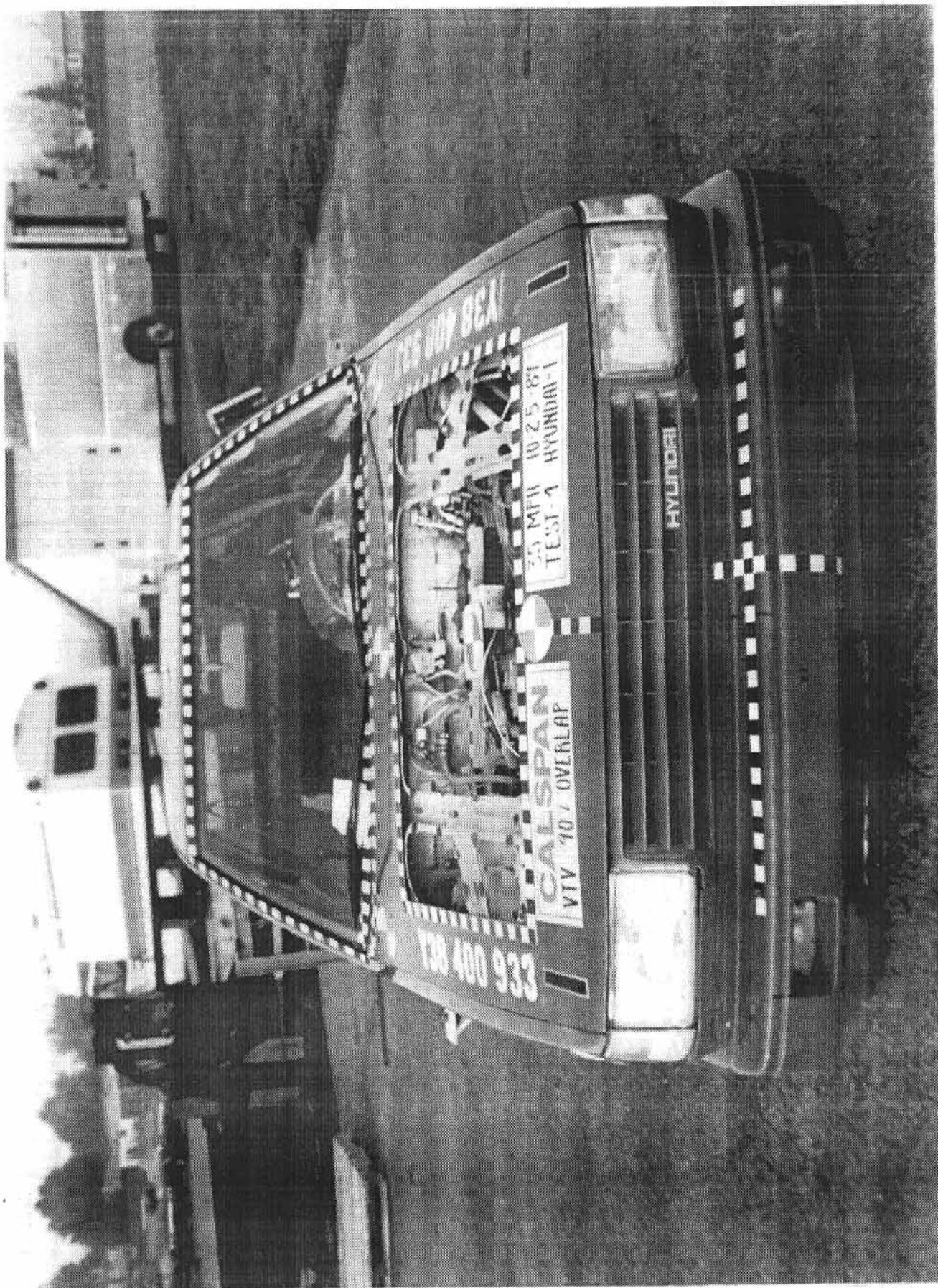


Figure A-6 VEHICLE 1 PRE-TEST FRONT VIEW

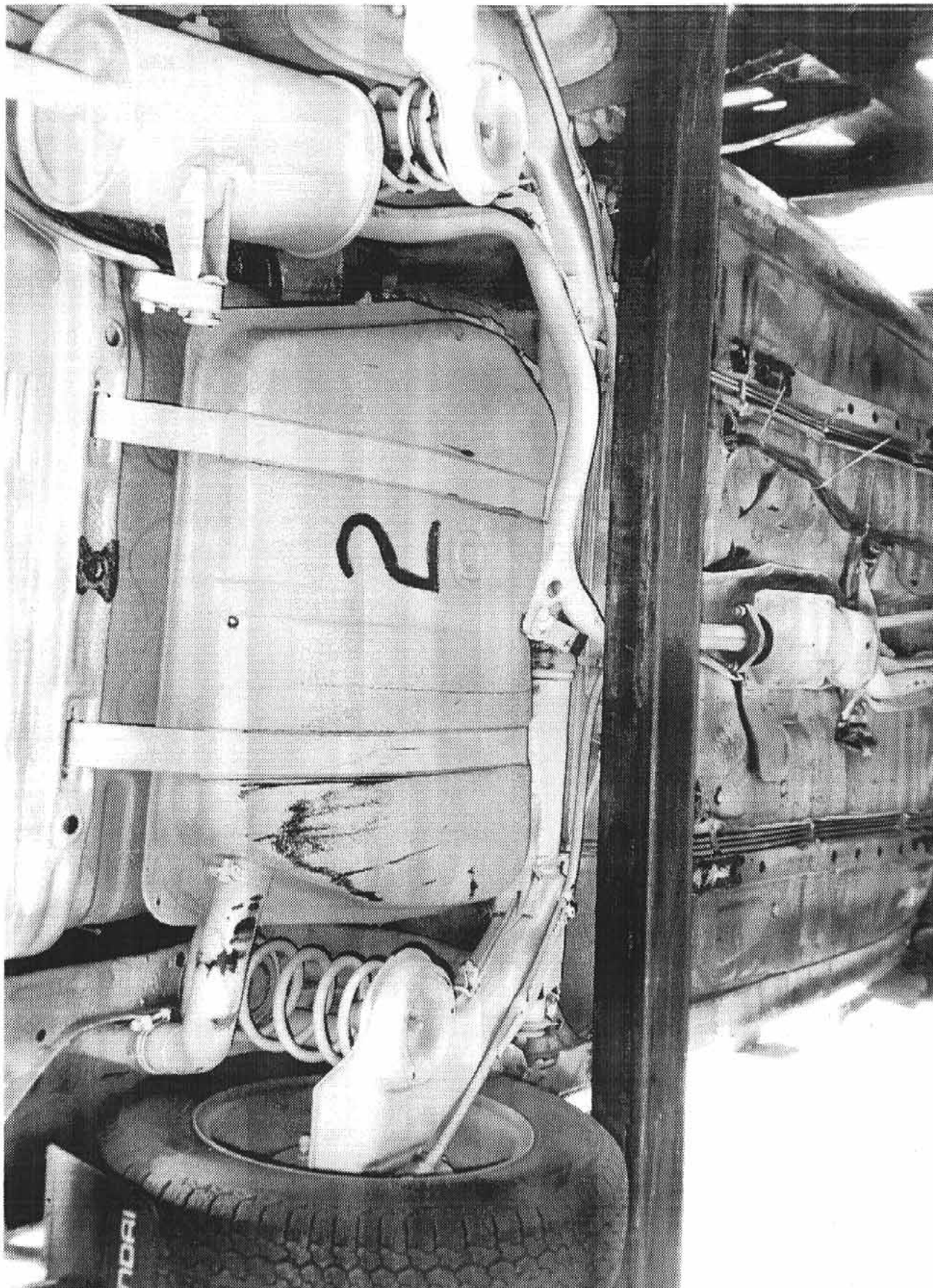


Figure A-64 VEHICLE 2 POST-TEST UNDERBODY REAR VIEW

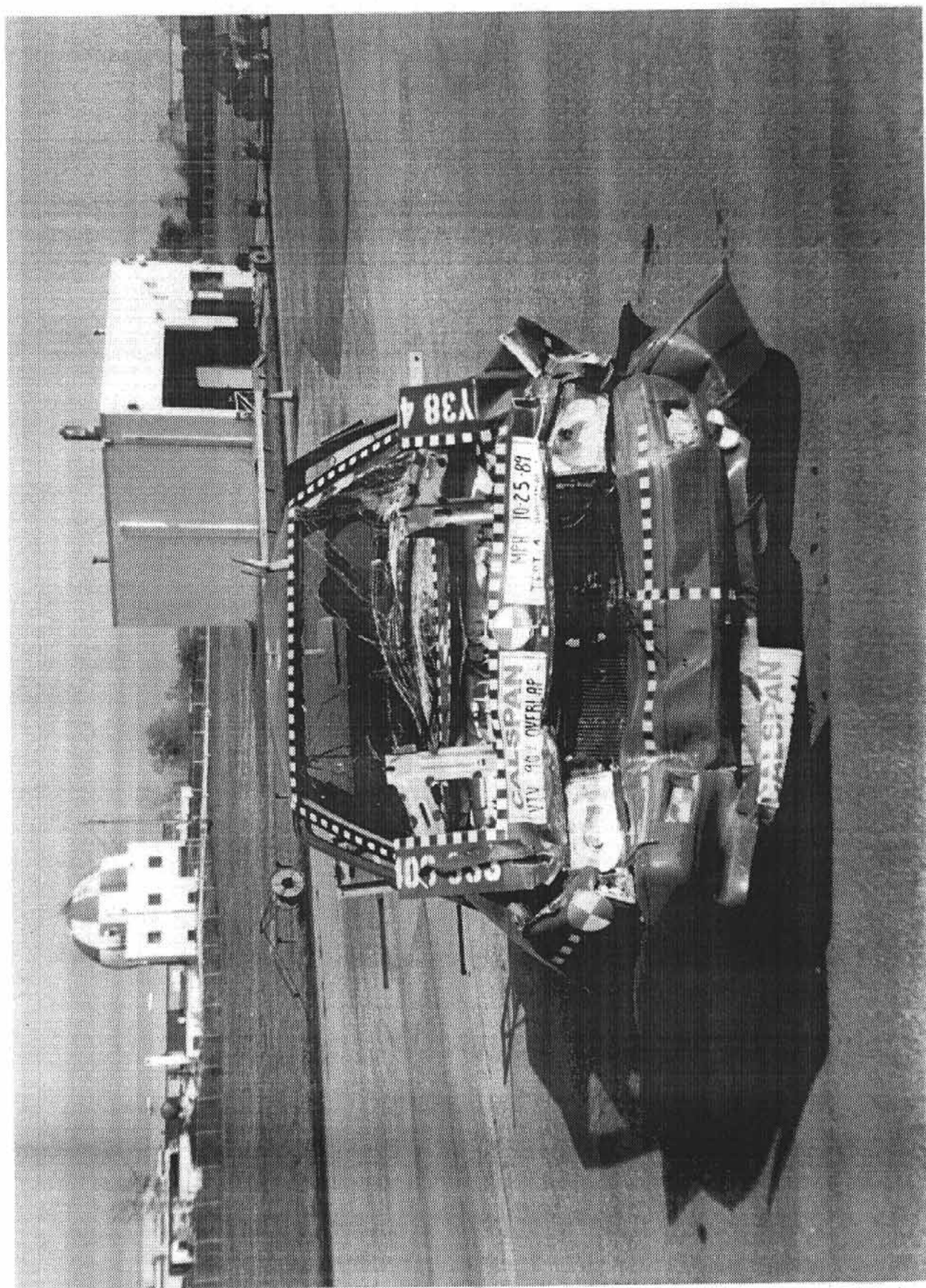


Figure A-7 VEHICLE 1 POST-TEST FRONT VIEW

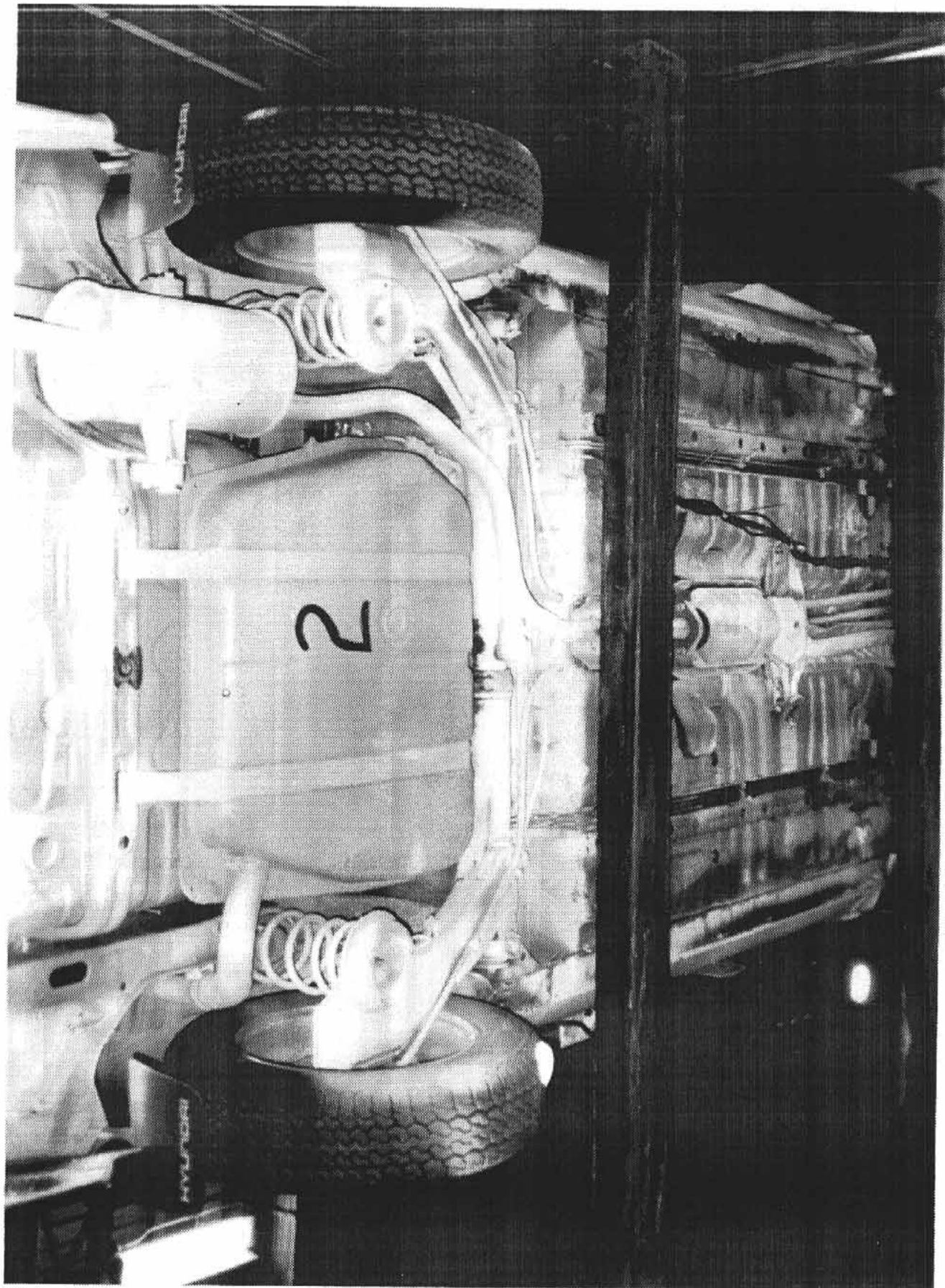


Figure A-63 VEHICLE 2 PRE-TEST UNDERBODY REAR VIEW

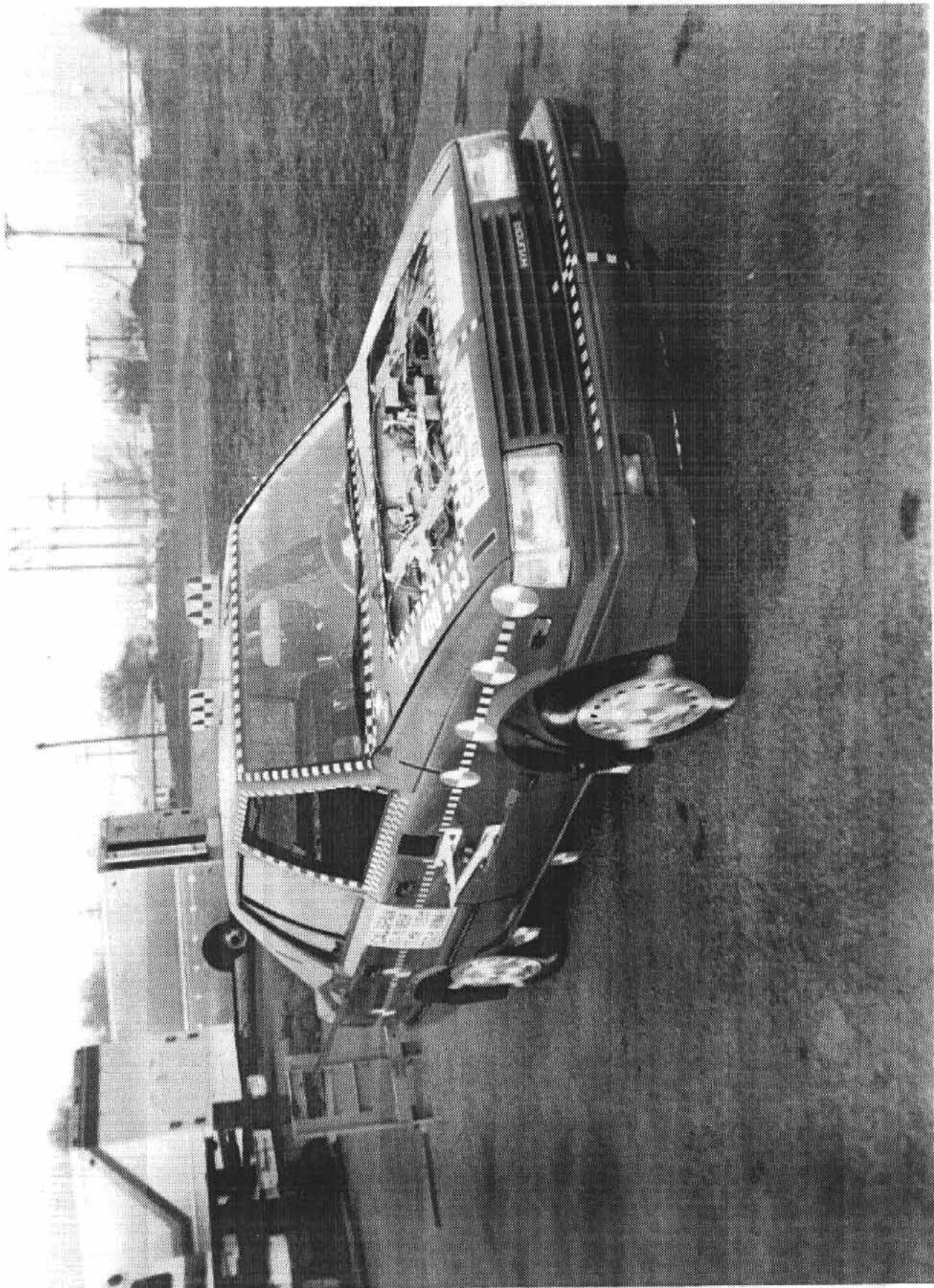


Figure A-8 VEHICLE 1 PRE-TEST RIGHT THREE QUARTER VIEW

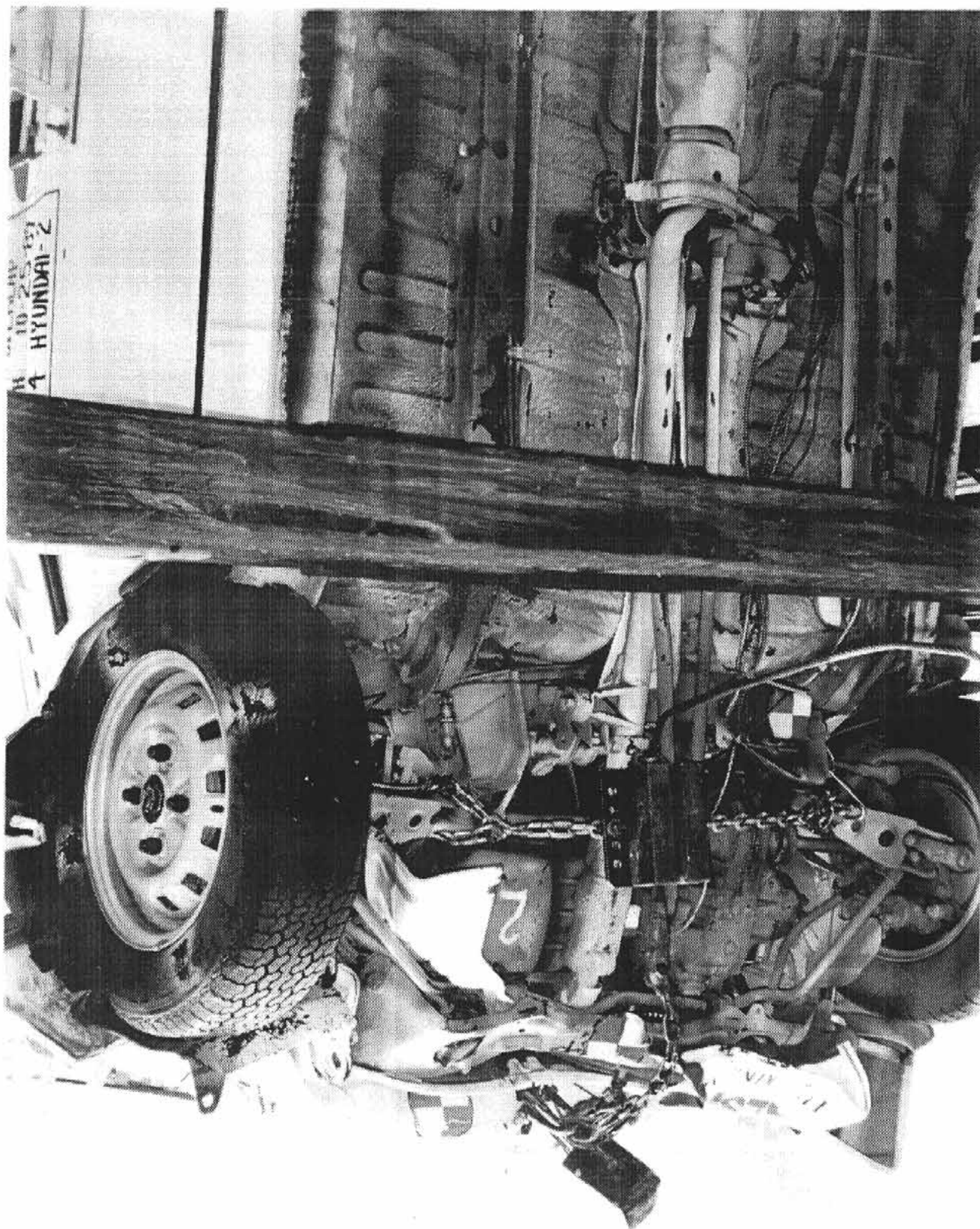


Figure A-62 VEHICLE 2 POST-TEST UNDERBODY FRONT SIDE VIEW

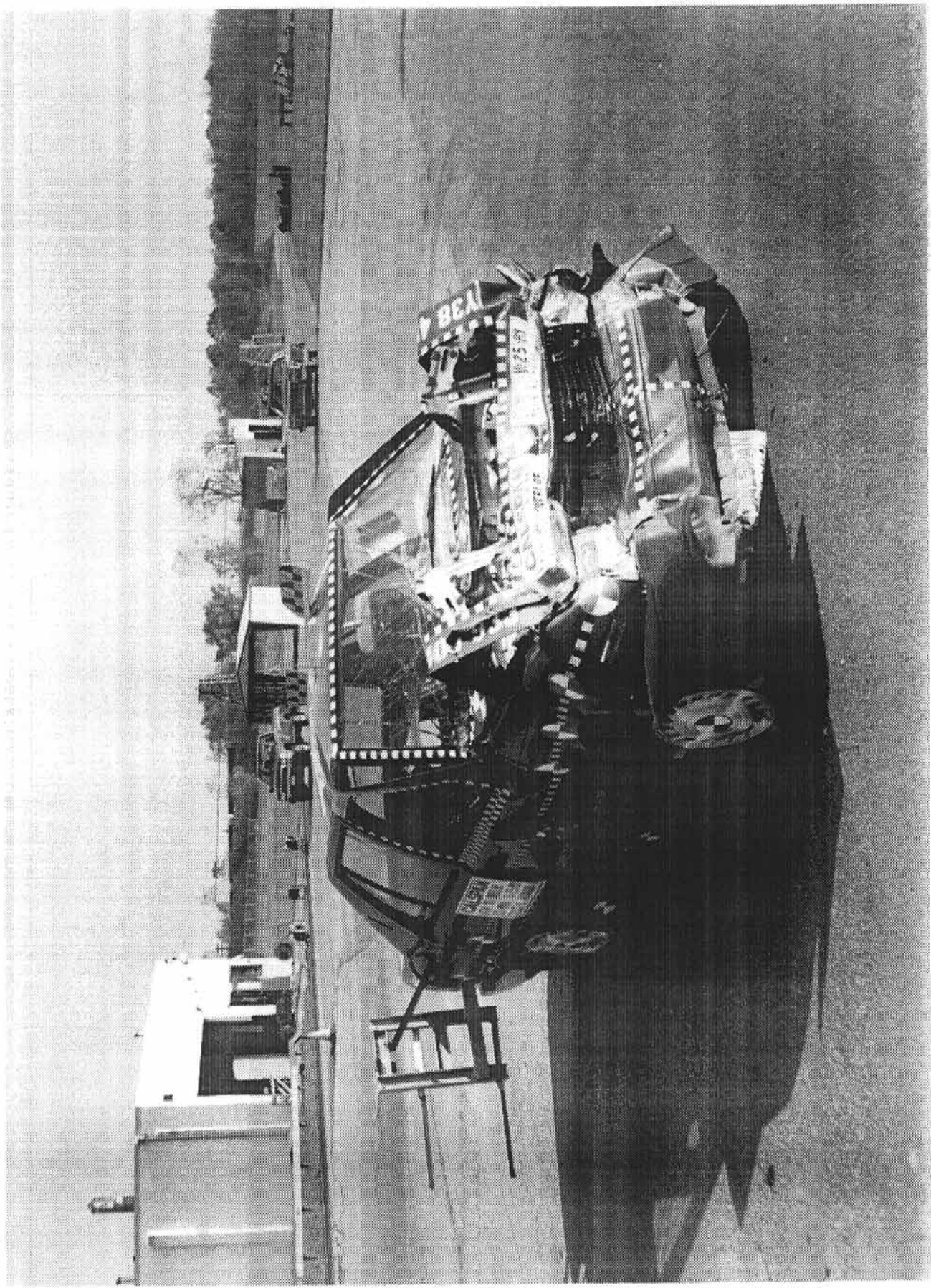


Figure A-9 VEHICLE 1 POST-TEST FRONT RIGHT THREE QUARTER VIEW

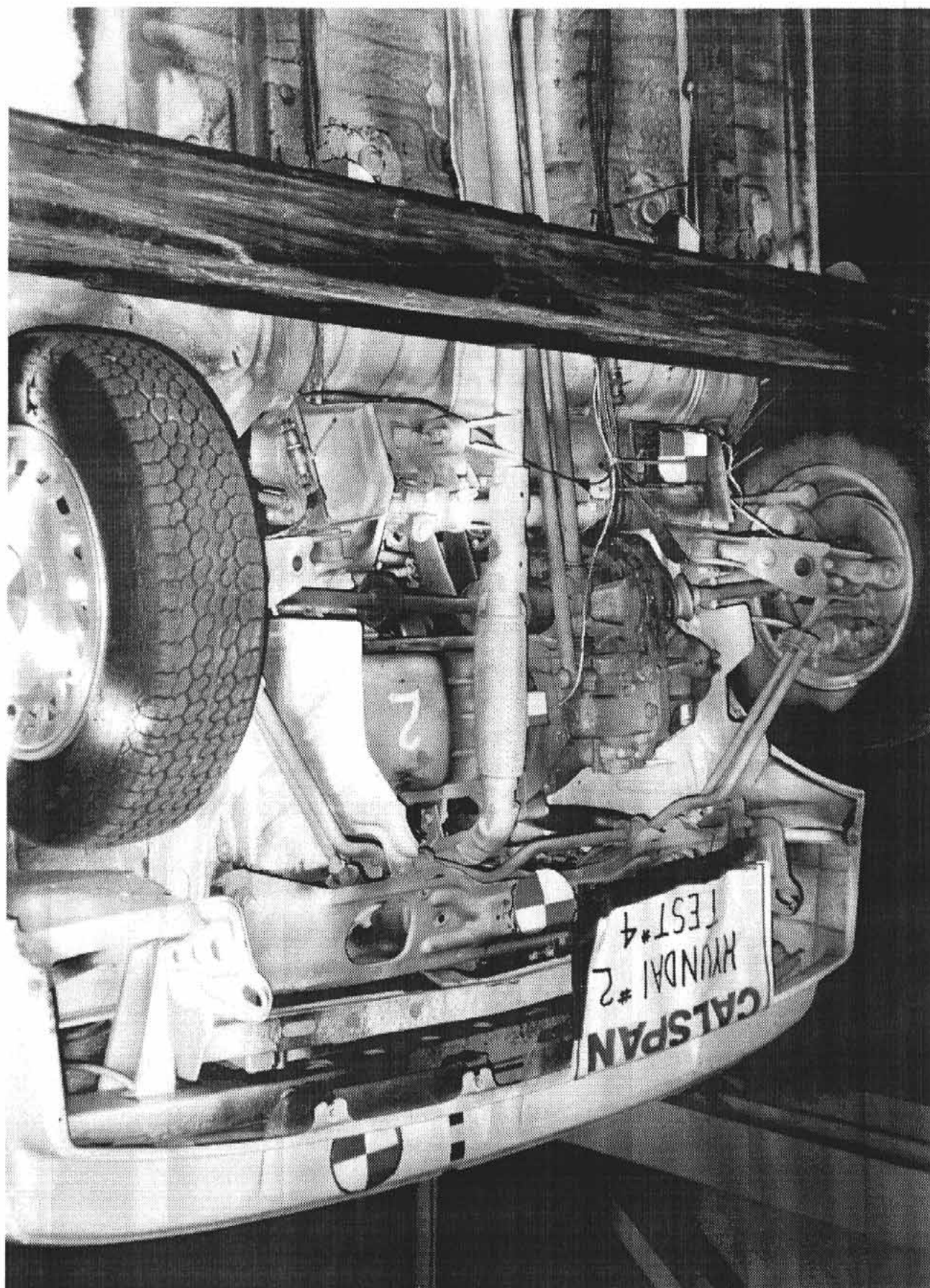


Figure A-61 VEHICLE 2 PRE-TEST UNDERBODY FRONT SIDE VIEW

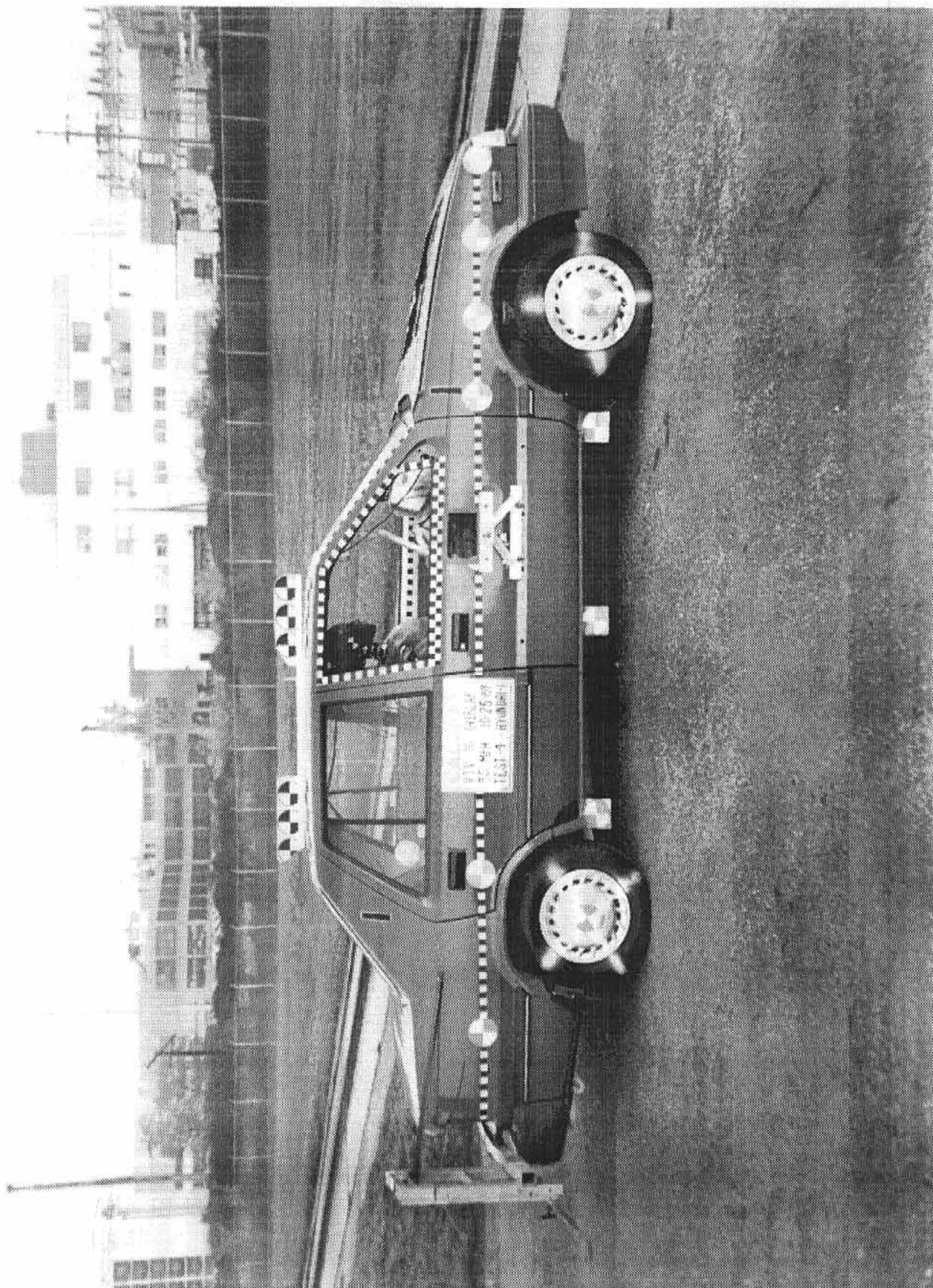


Figure A-10 VEHICLE 1 PRE-TEST RIGHT SIDE VIEW

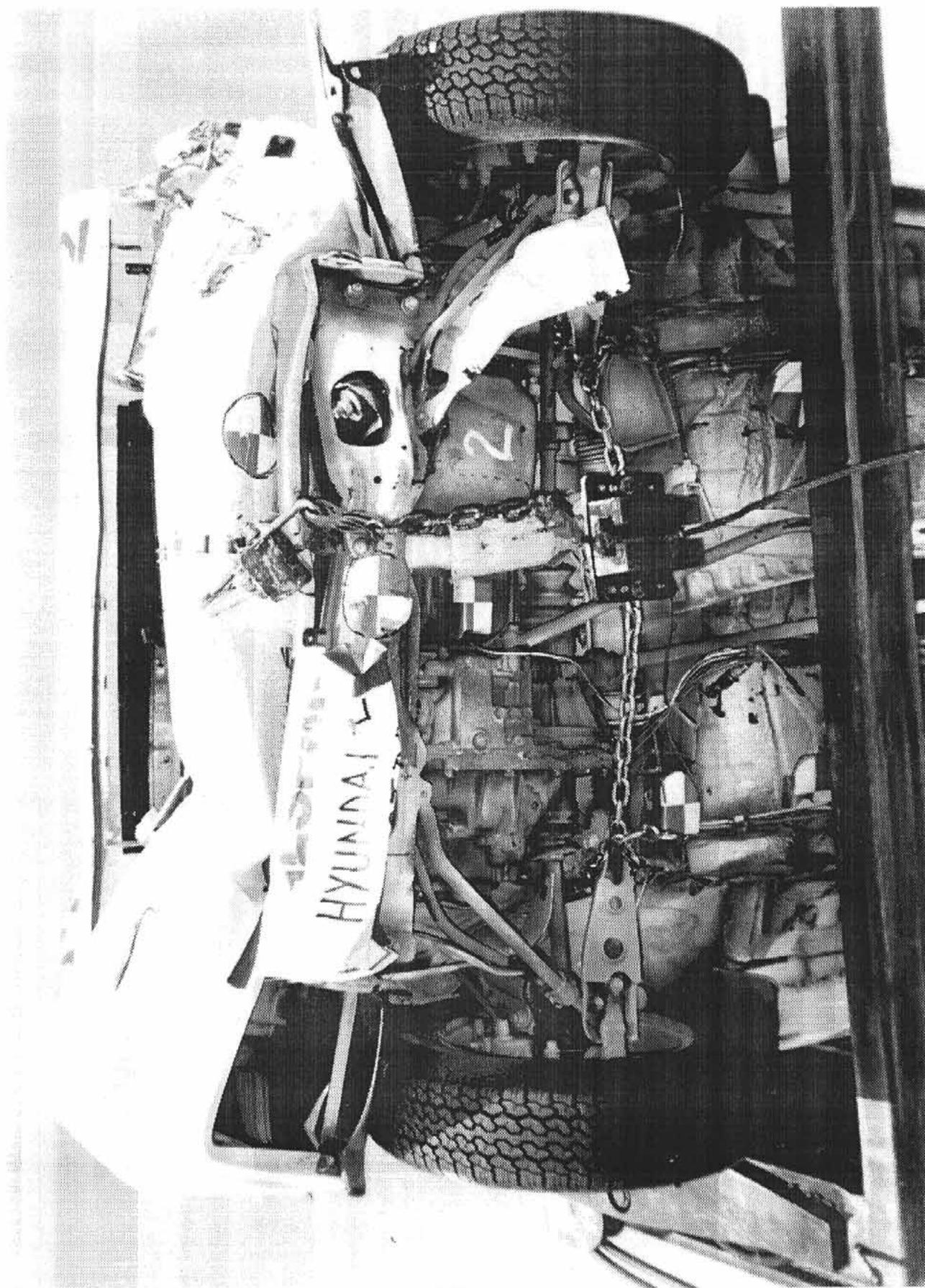


Figure A-60 VEHICLE 2 POST-TEST UNDERBODY FRONT VIEW

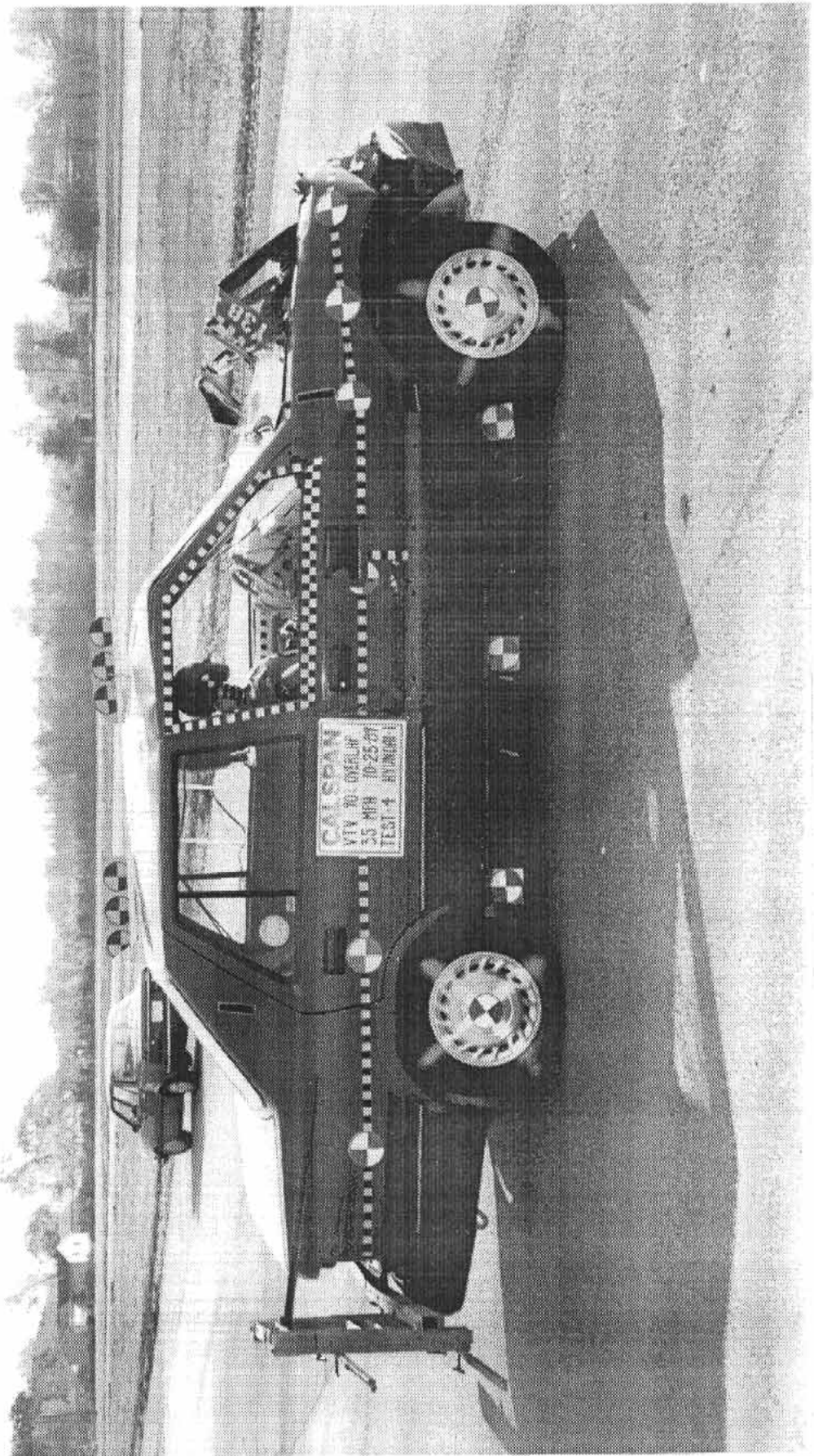


Figure A-11 VEHICLE 1 POST-TEST RIGHT SIDE VIEW

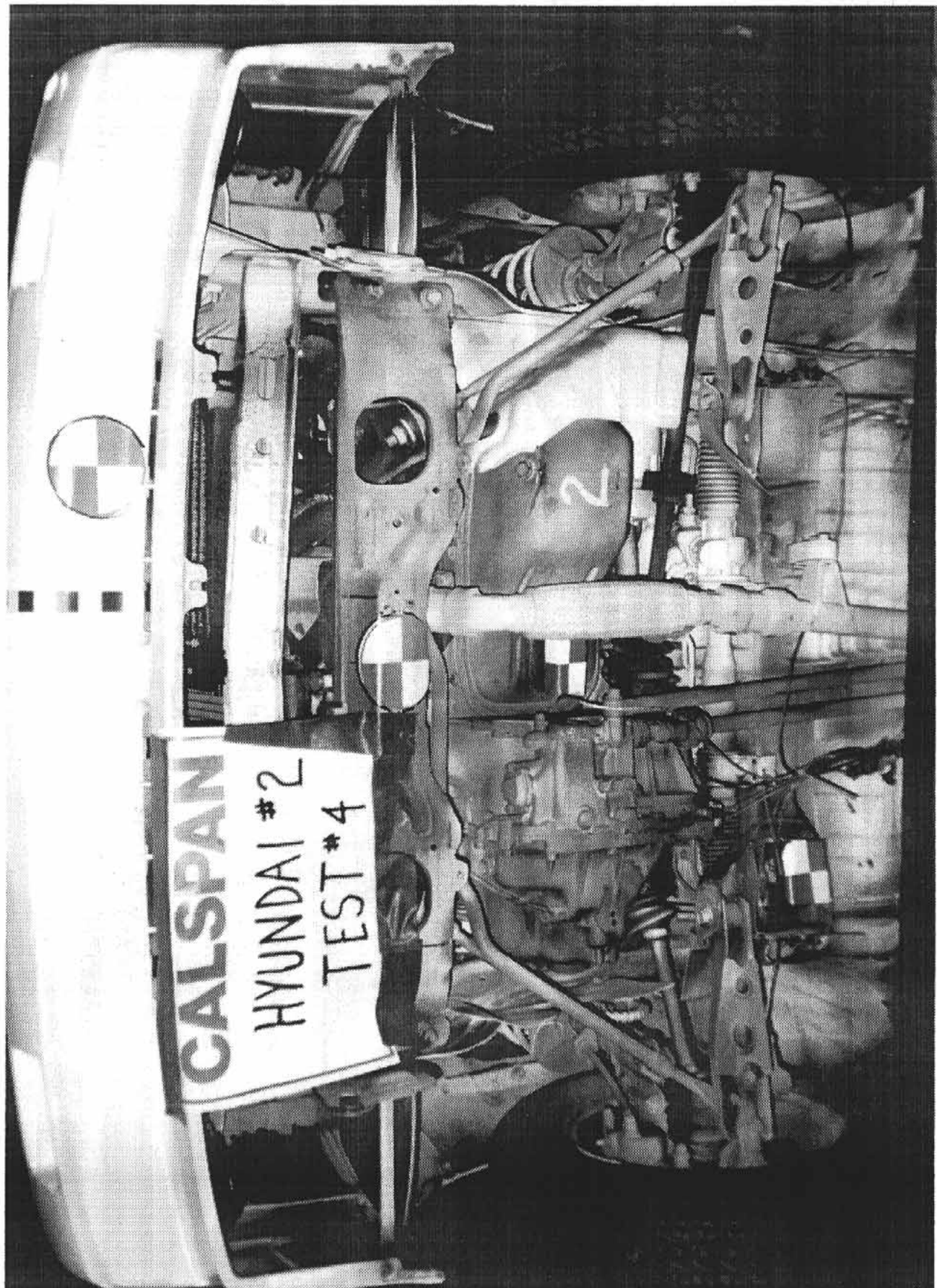


Figure A-59 VEHICLE 2 PRE-TEST UNDERBODY FRONT VIEW



Figure A-12 VEHICLE 1 PRE-TEST REAR RIGHT THREE QUARTER VIEW



Figure A-58 VEHICLE 2 POST-TEST OVERHEAD ENGINE COMPARTMENT VIEW



Figure A-13 VEHICLE 1 POST-TEST REAR RIGHT THREE QUARTER VIEW

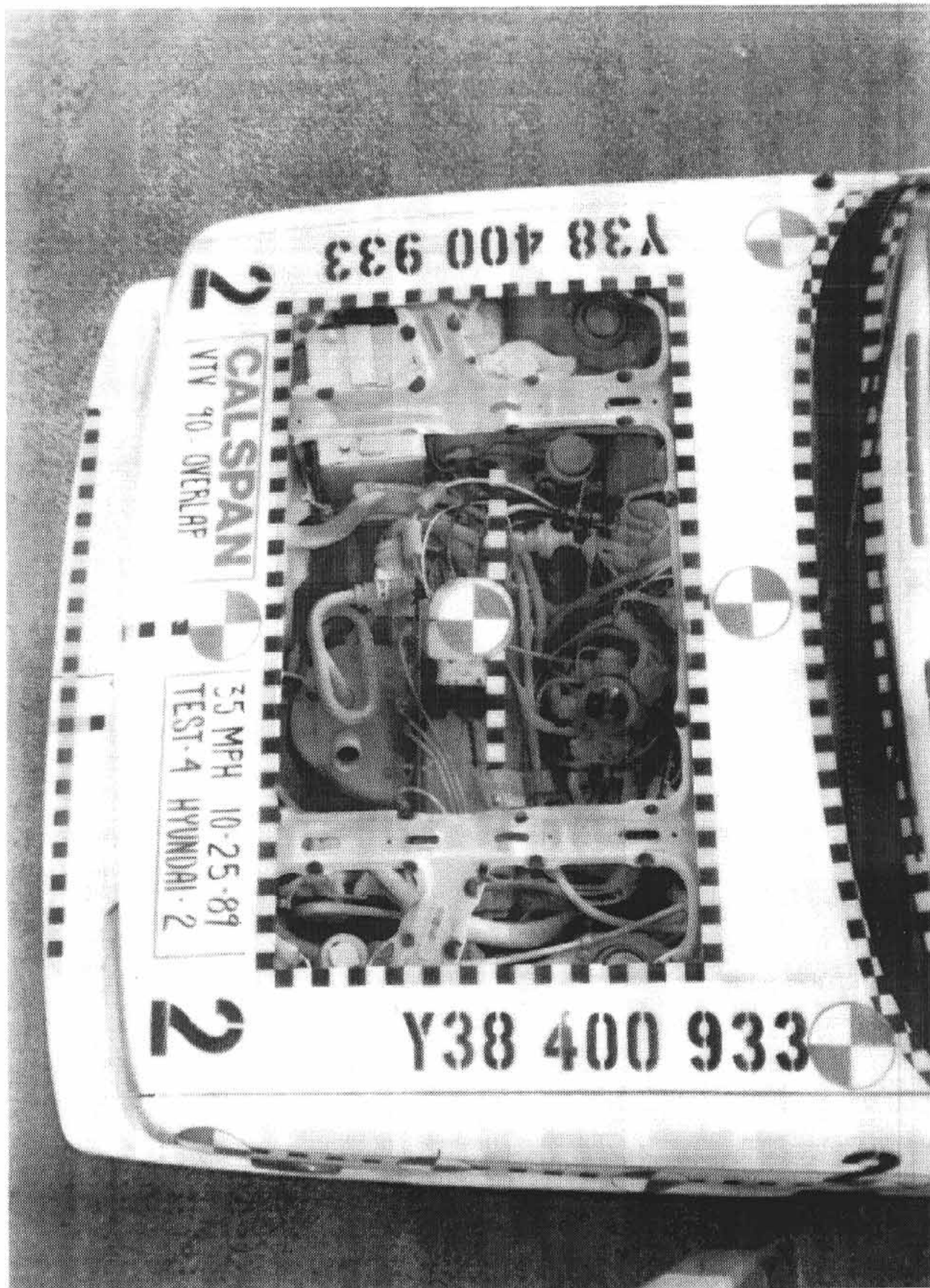


Figure A-57 VEHICLE 2 PRE-TEST OVERHEAD ENGINE COMPARTMENT VIEW

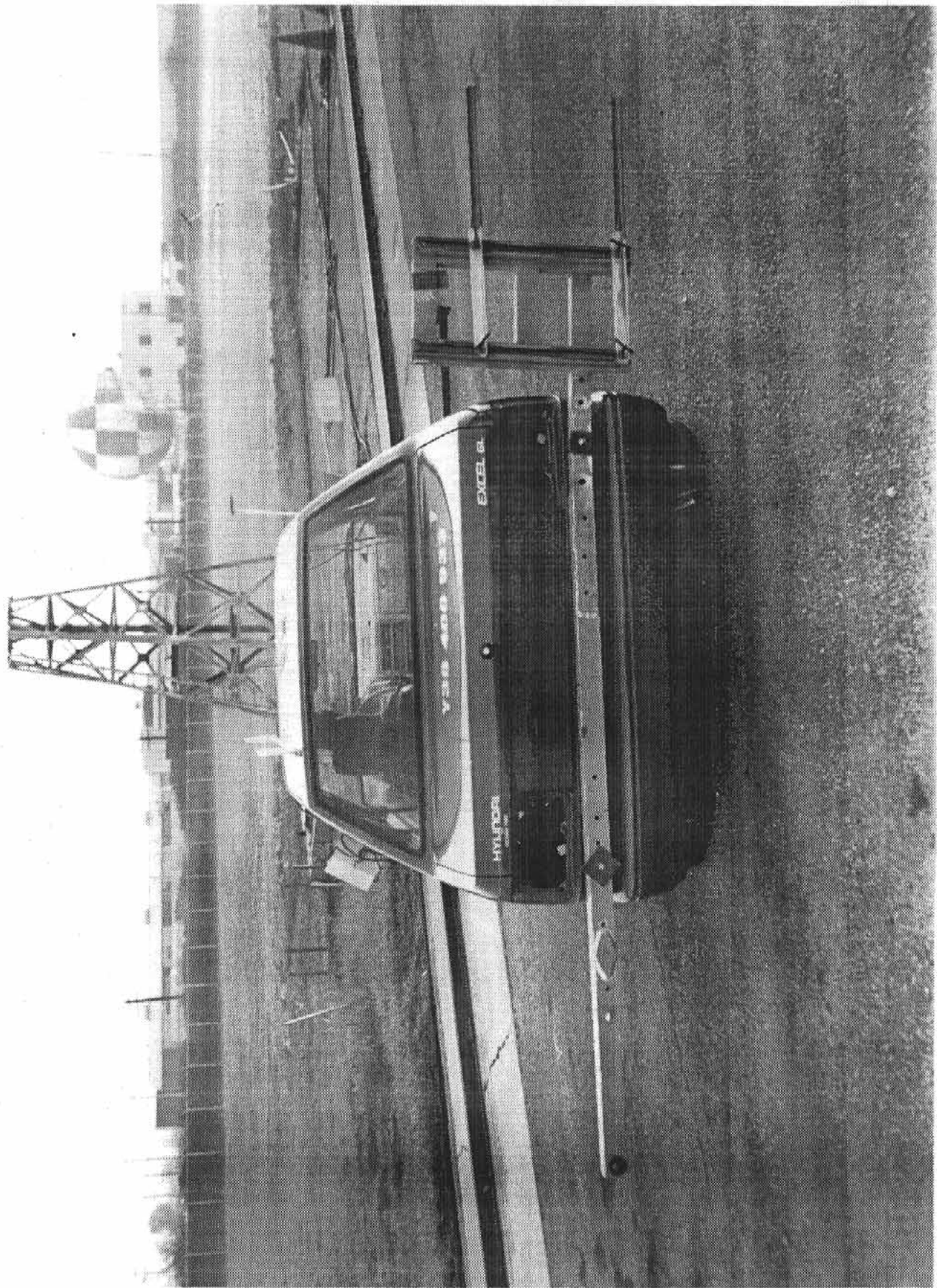


Figure A-14 VEHICLE 1 PRE-TEST REAR VIEW

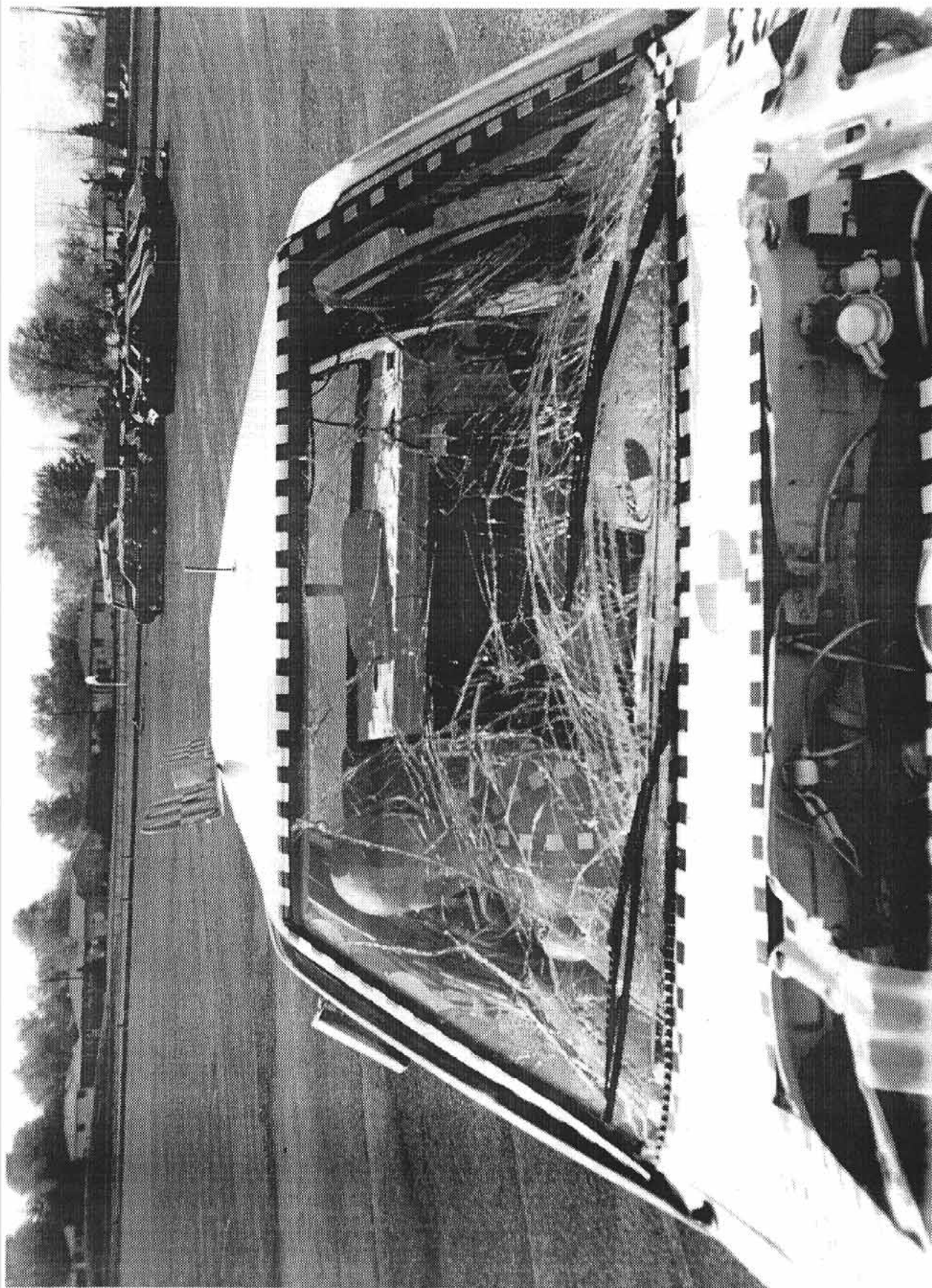


Figure A-56 VEHICLE 2 POST-TEST WINDSHIELD VIEW

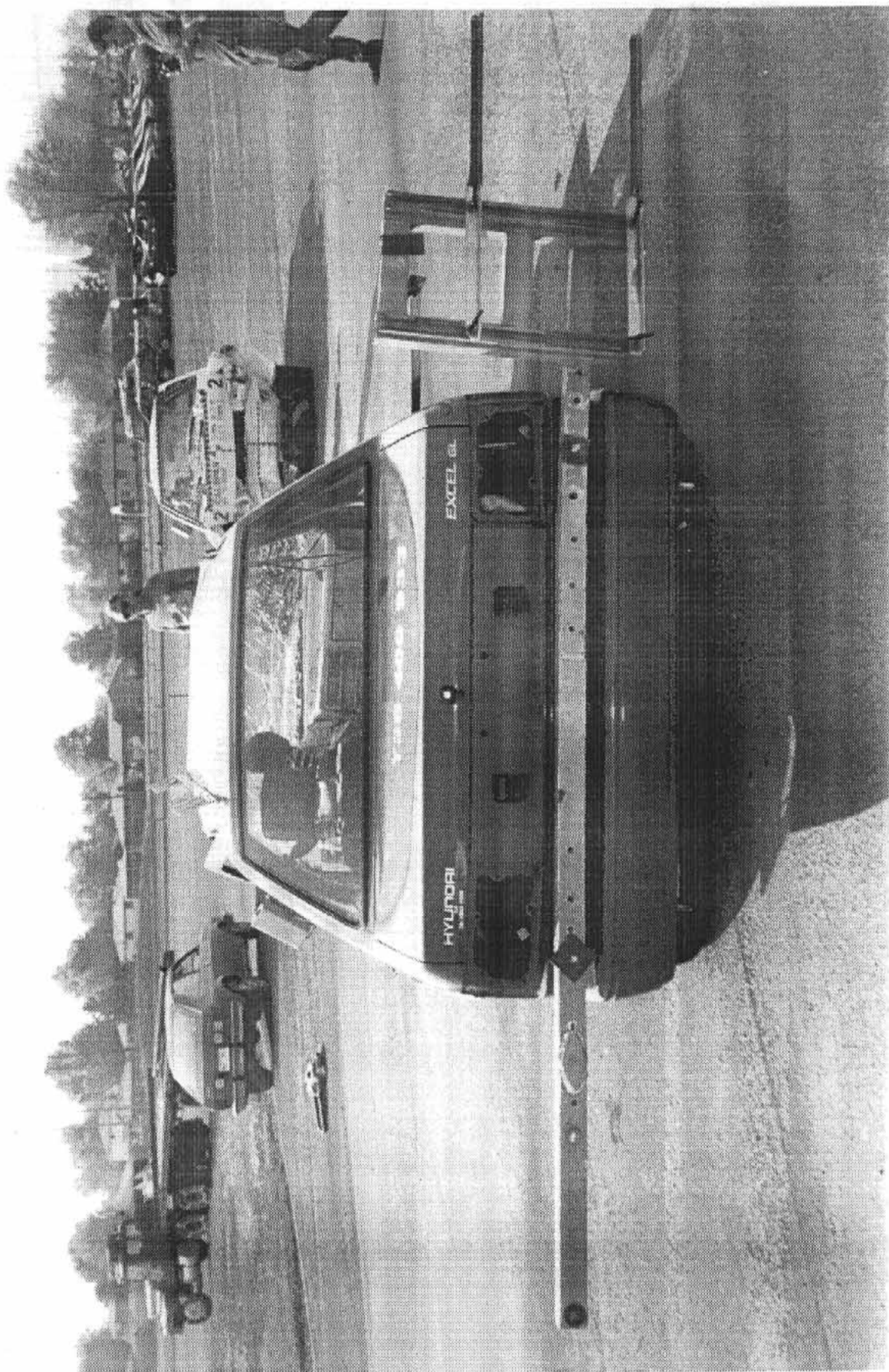


Figure A-15 VEHICLE 1 POST-TEST REAR VIEW

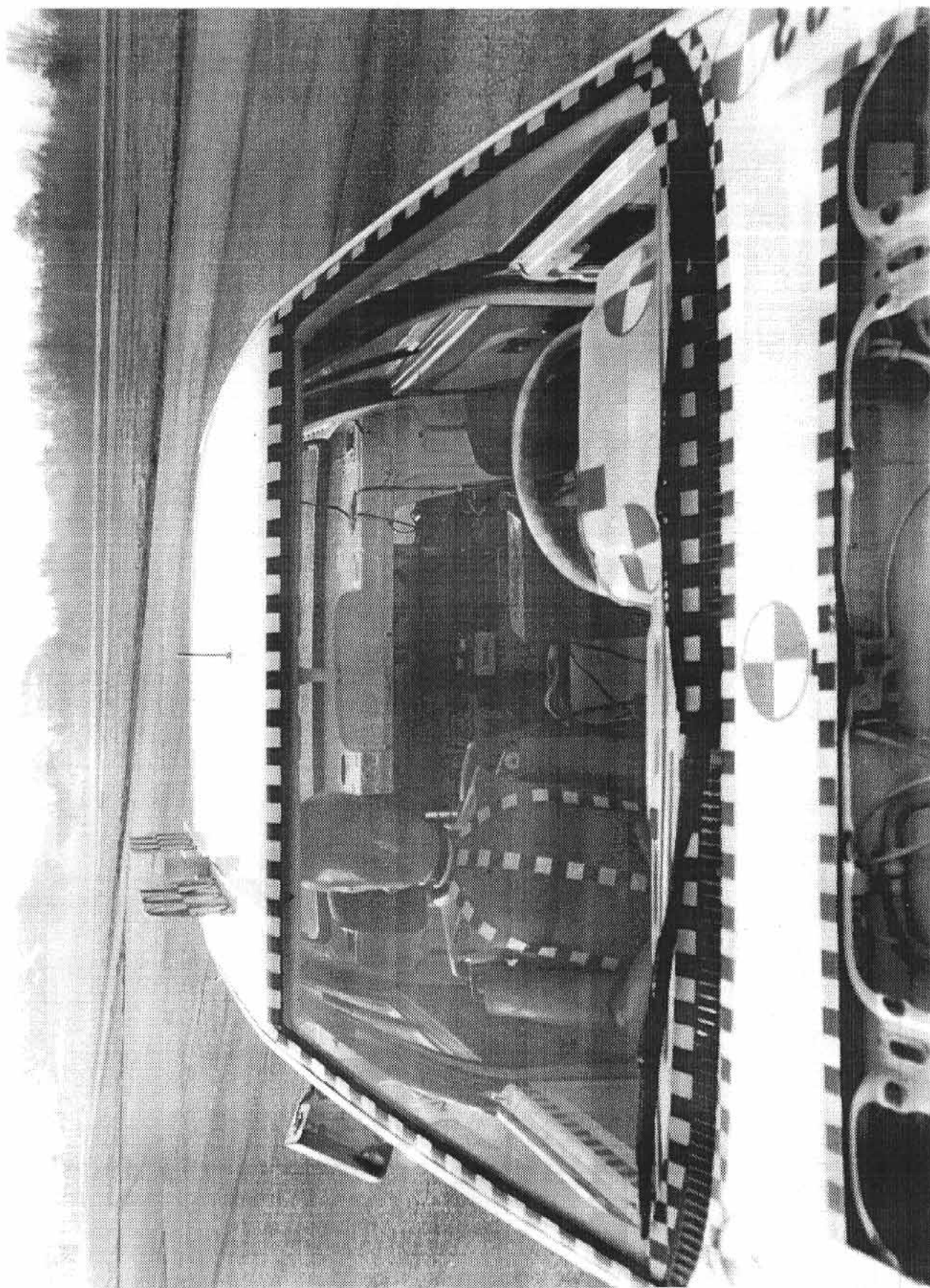


Figure A-55 VEHICLE 2 PRE-TEST WINDSHIELD VIEW



Figure A-16 VEHICLE 1 PRE-TEST REAR LEFT THREE QUARTER VIEW

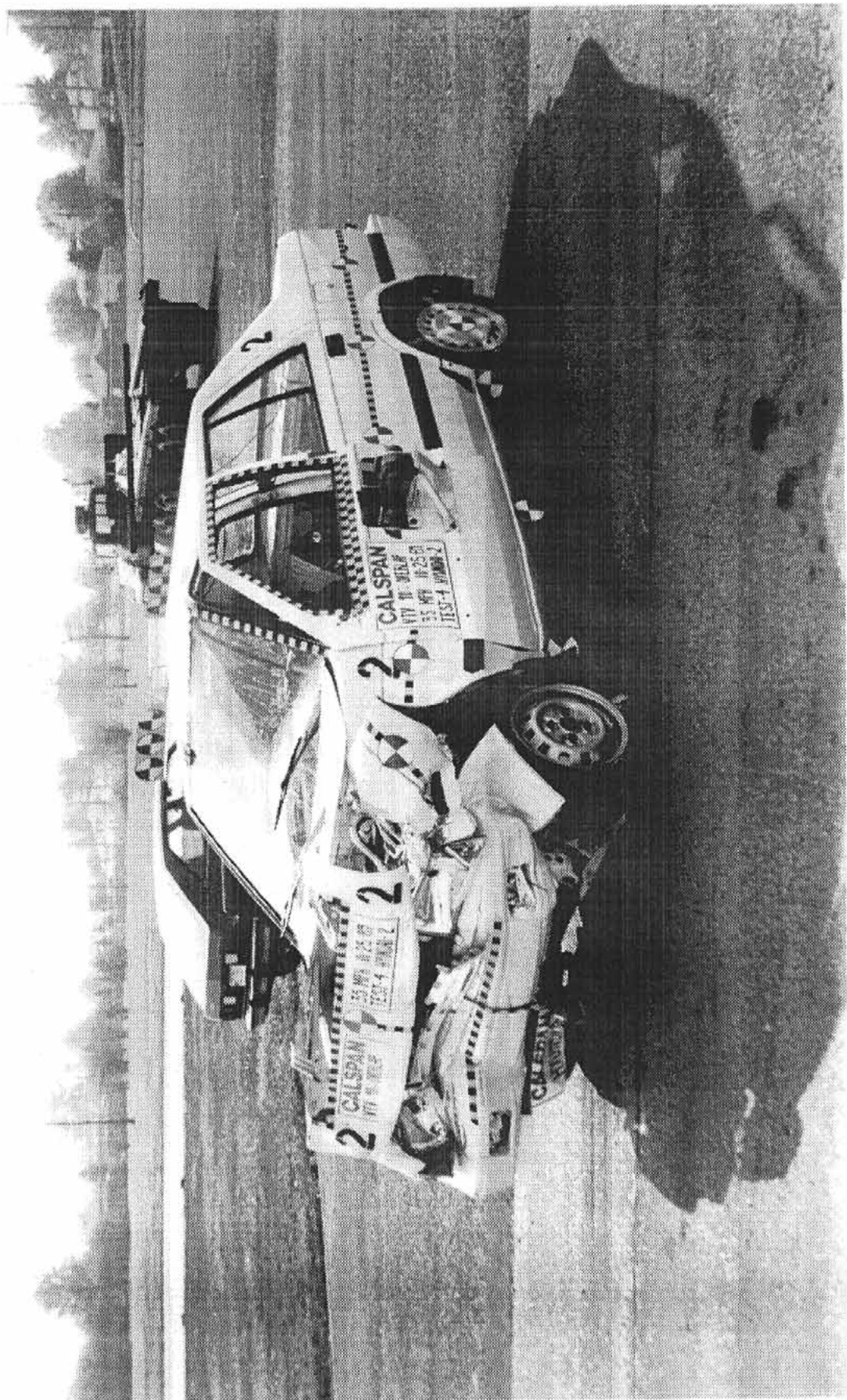


Figure A-54 VEHICLE 2 POST-TEST FRONT LEFT THREE QUARTER VIEW

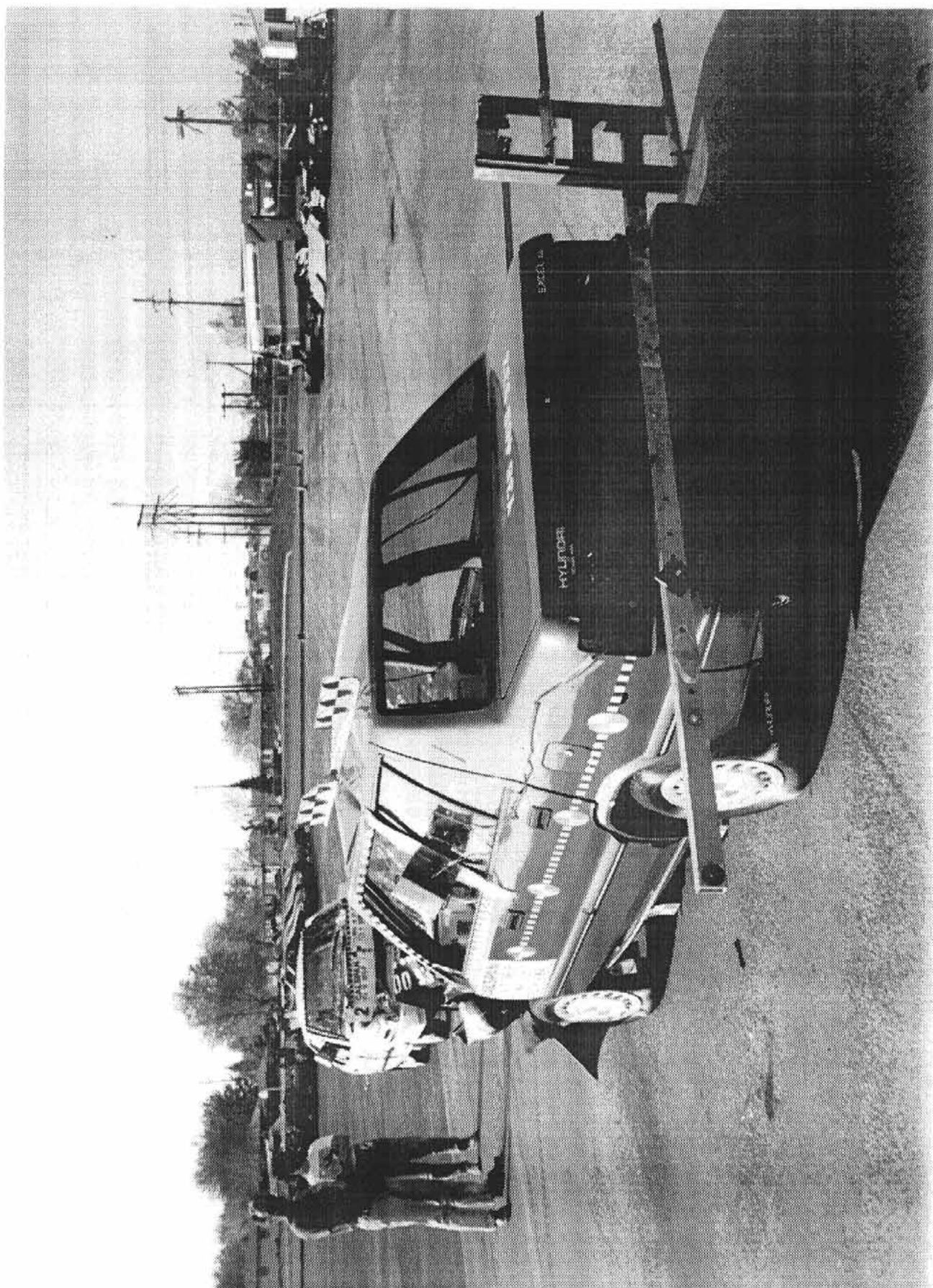


Figure A-17 VEHICLE 1 POST-TEST REAR LEFT THREE QUARTER VIEW



Figure A-53 VEHICLE 2 PRE-TEST FRONT LEFT THREE QUARTER VIEW



Figure A-18 VEHICLE 1 PRE-TEST LEFT SIDE VIEW

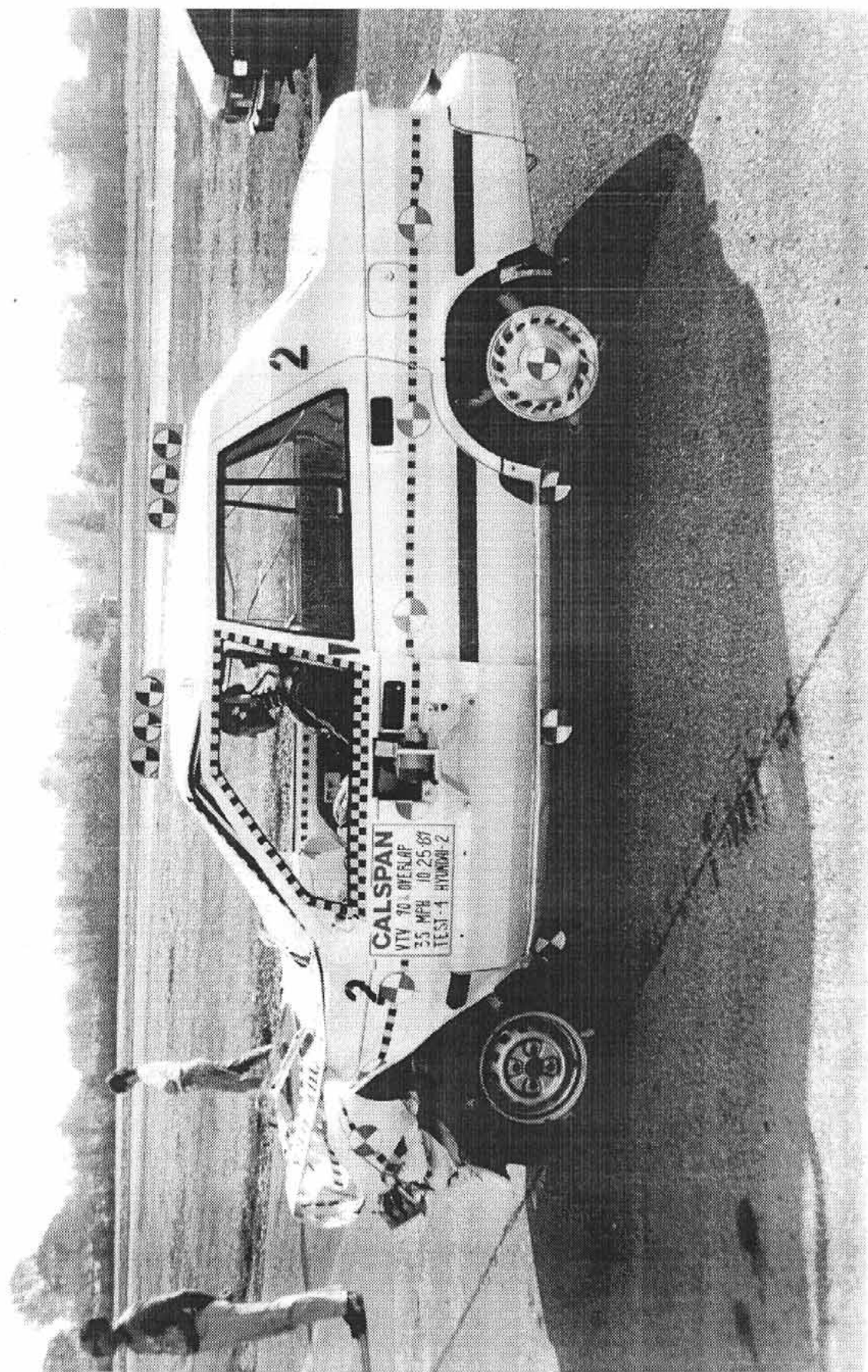


Figure A-52 VEHICLE 2 POST-TEST LEFT SIDE VIEW

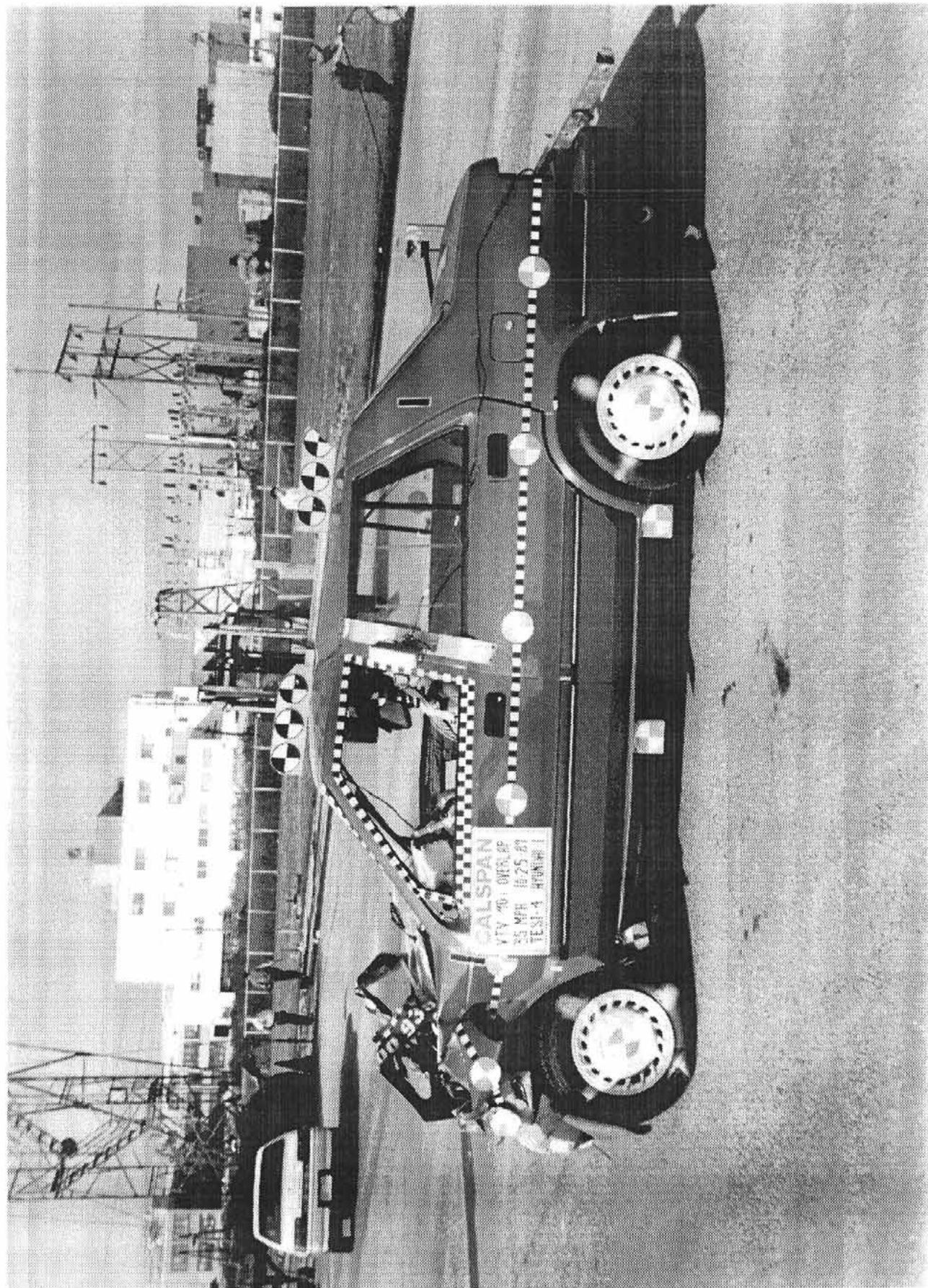


Figure A-19 VEHICLE 1 POST-TEST LEFT SIDE VIEW

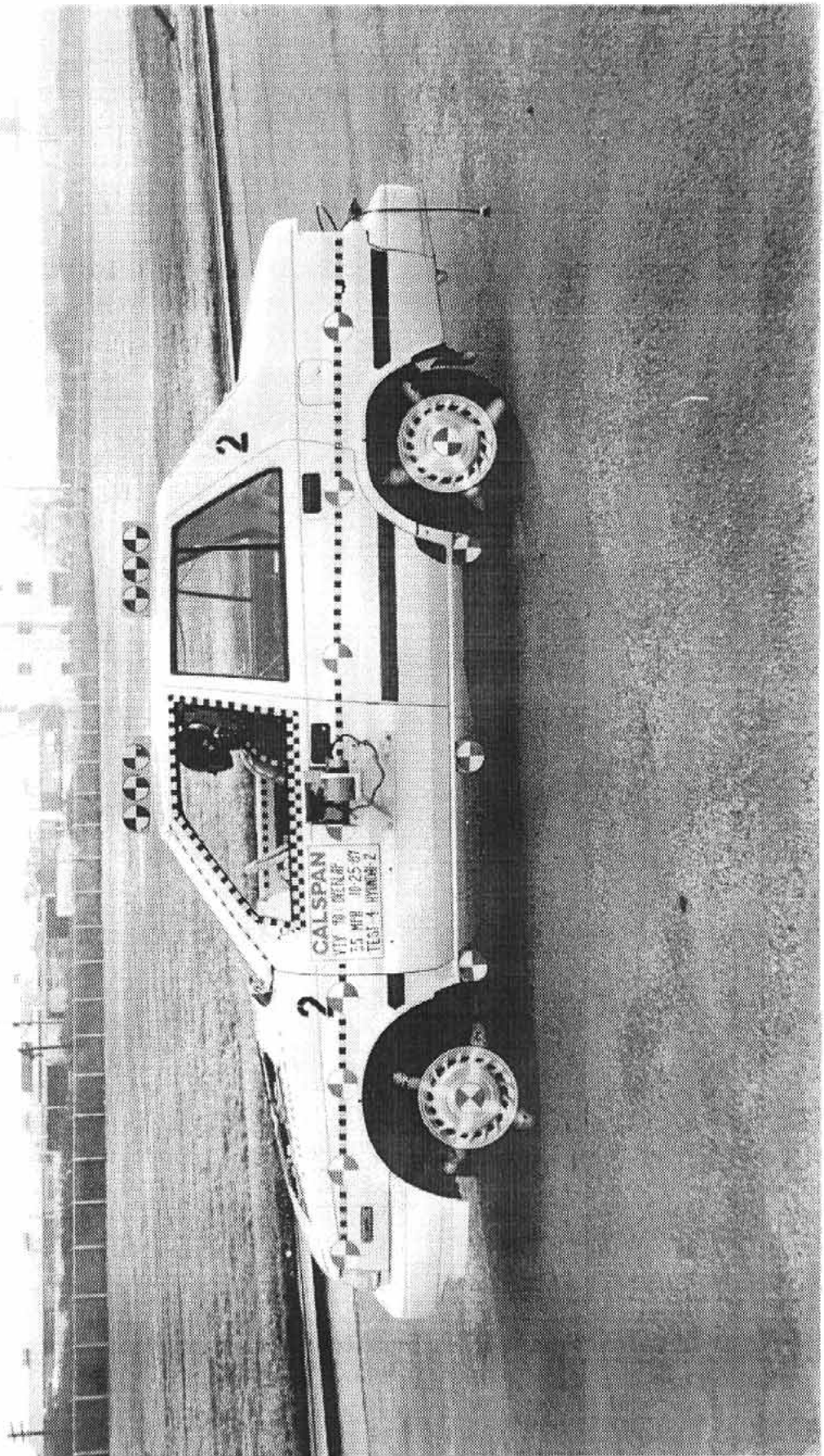


Figure A-51 VEHICLE 2 PRE-TEST LEFT SIDE VIEW



Figure A-20 VEHICLE 1 PRE-TEST FRONT LEFT THREE QUARTER VIEW

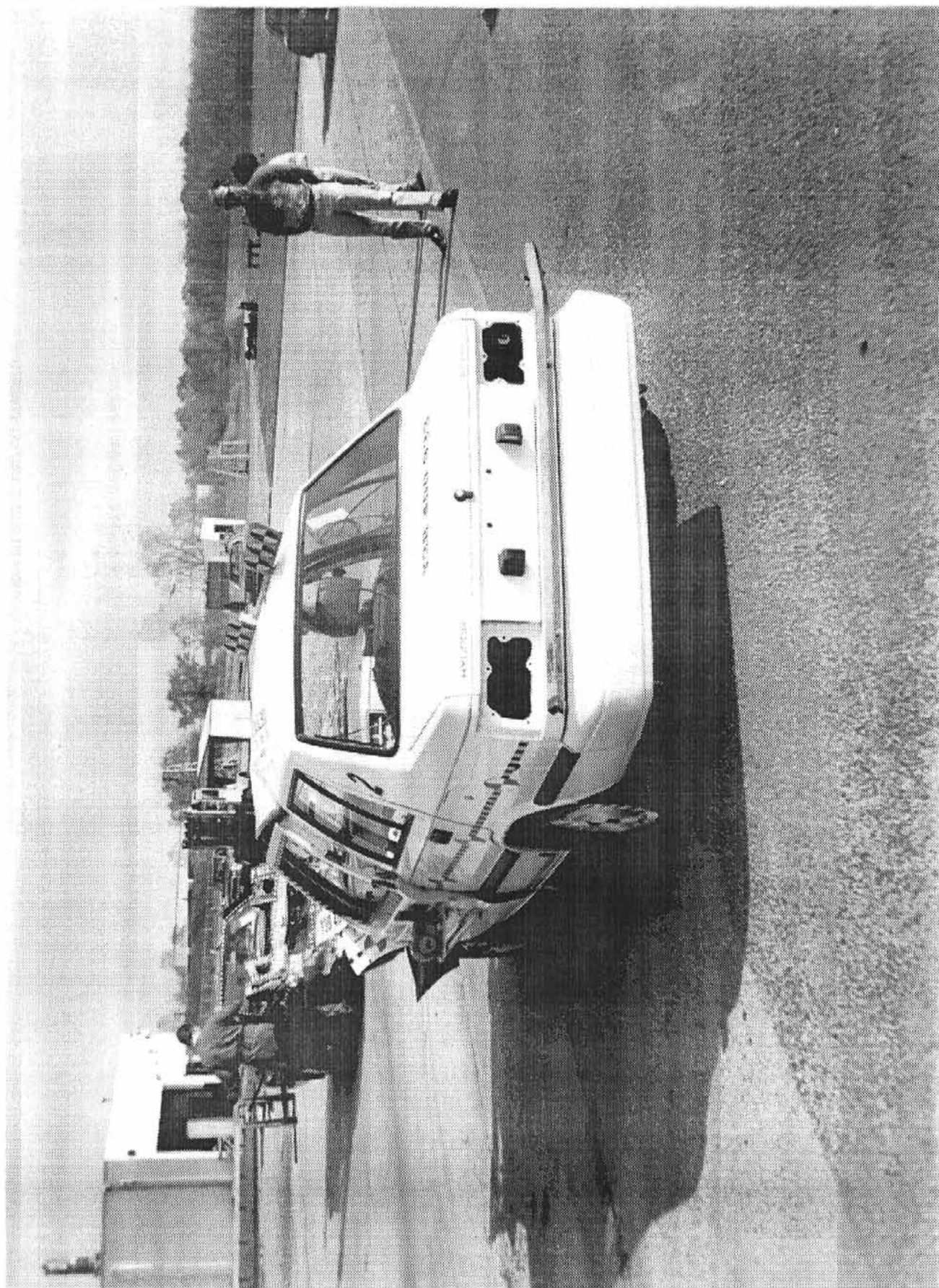


Figure A-50 VEHICLE 2 POST-TEST REAR LEFT THREE QUARTER VIEW

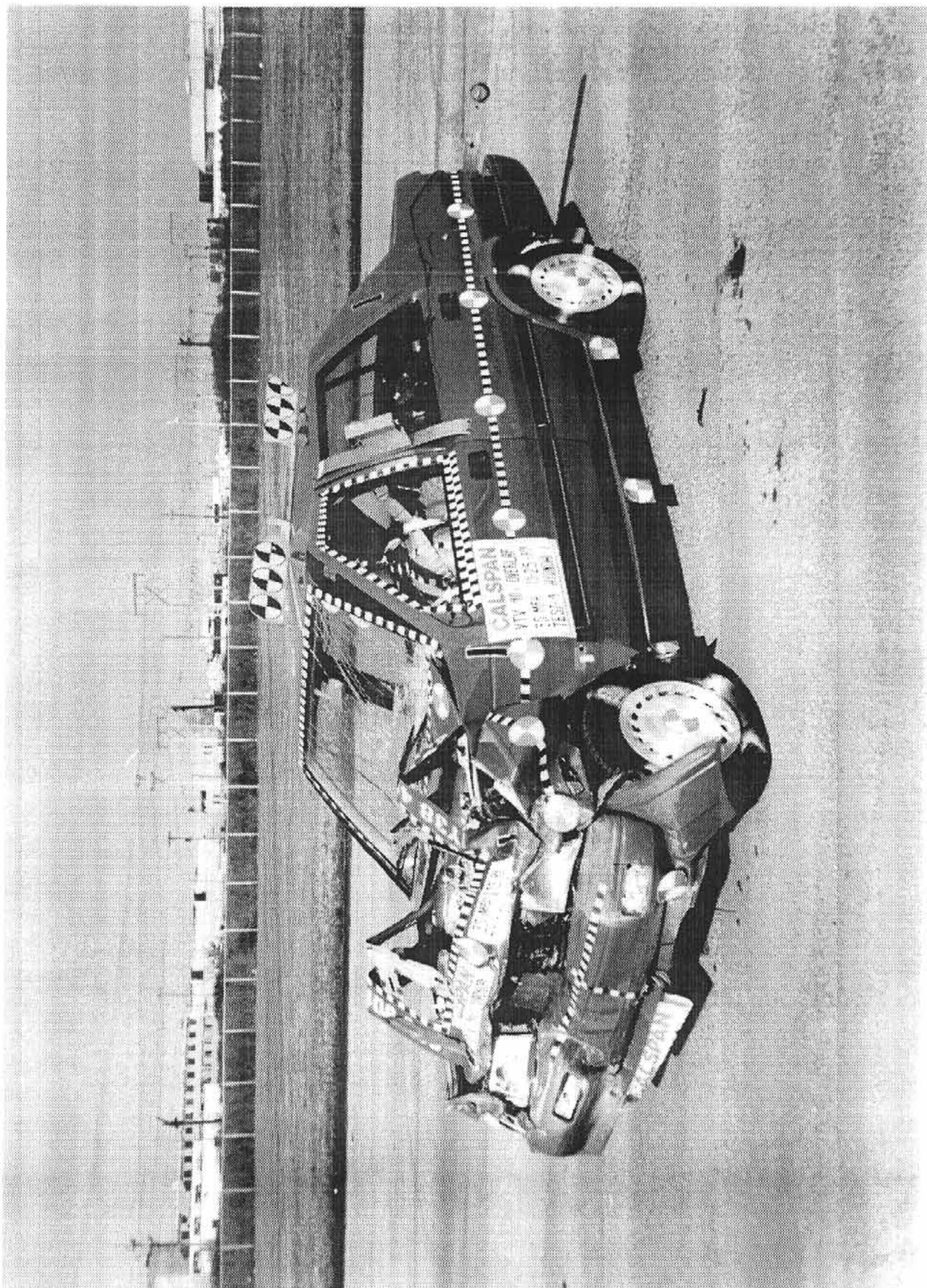


Figure A-21 VEHICLE 1 POST-TEST FRONT LEFT THREE QUARTER VIEW

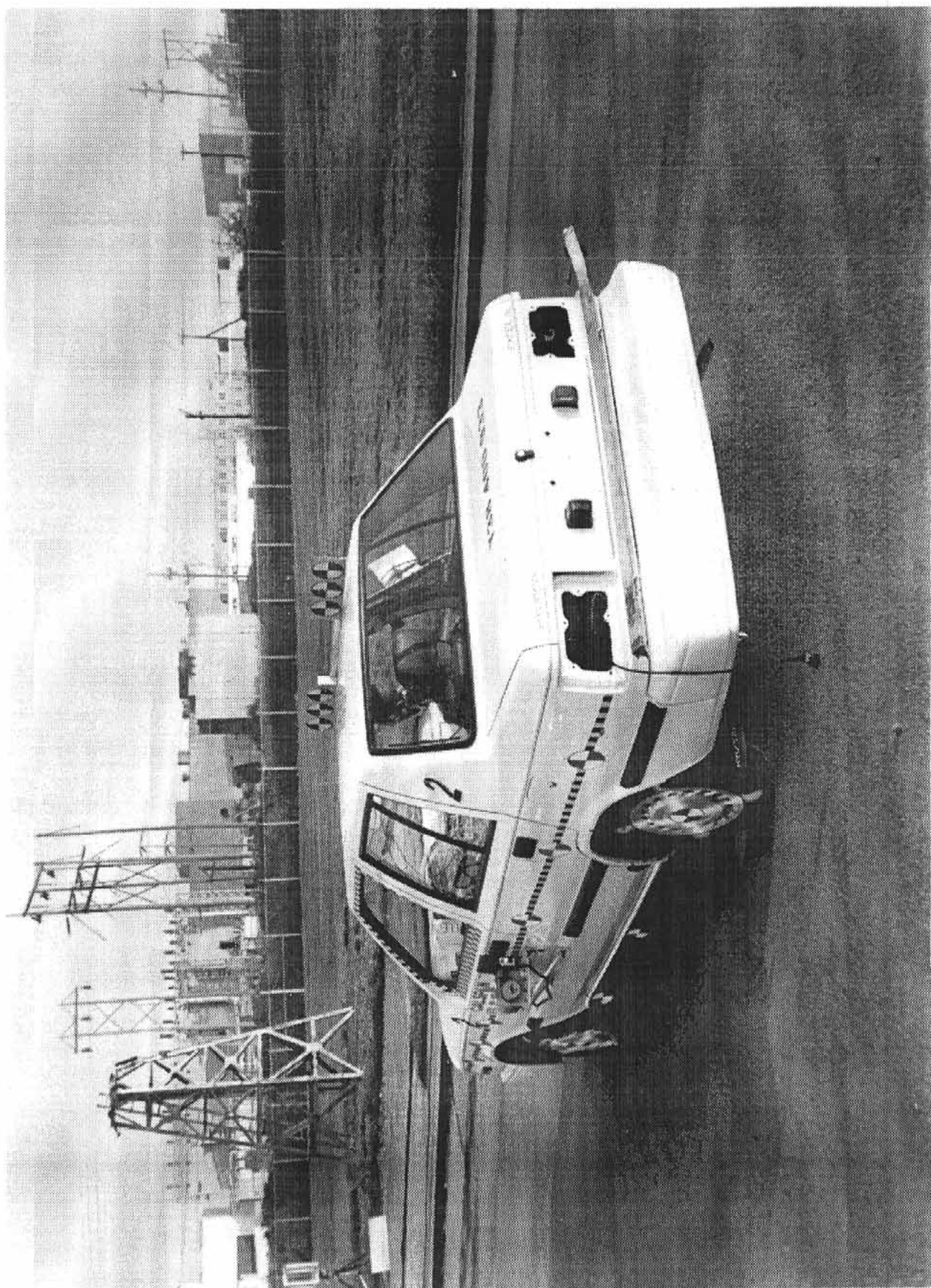


Figure A-49 VEHICLE 2 PRE-TEST REAR LEFT THREE QUARTER VIEW

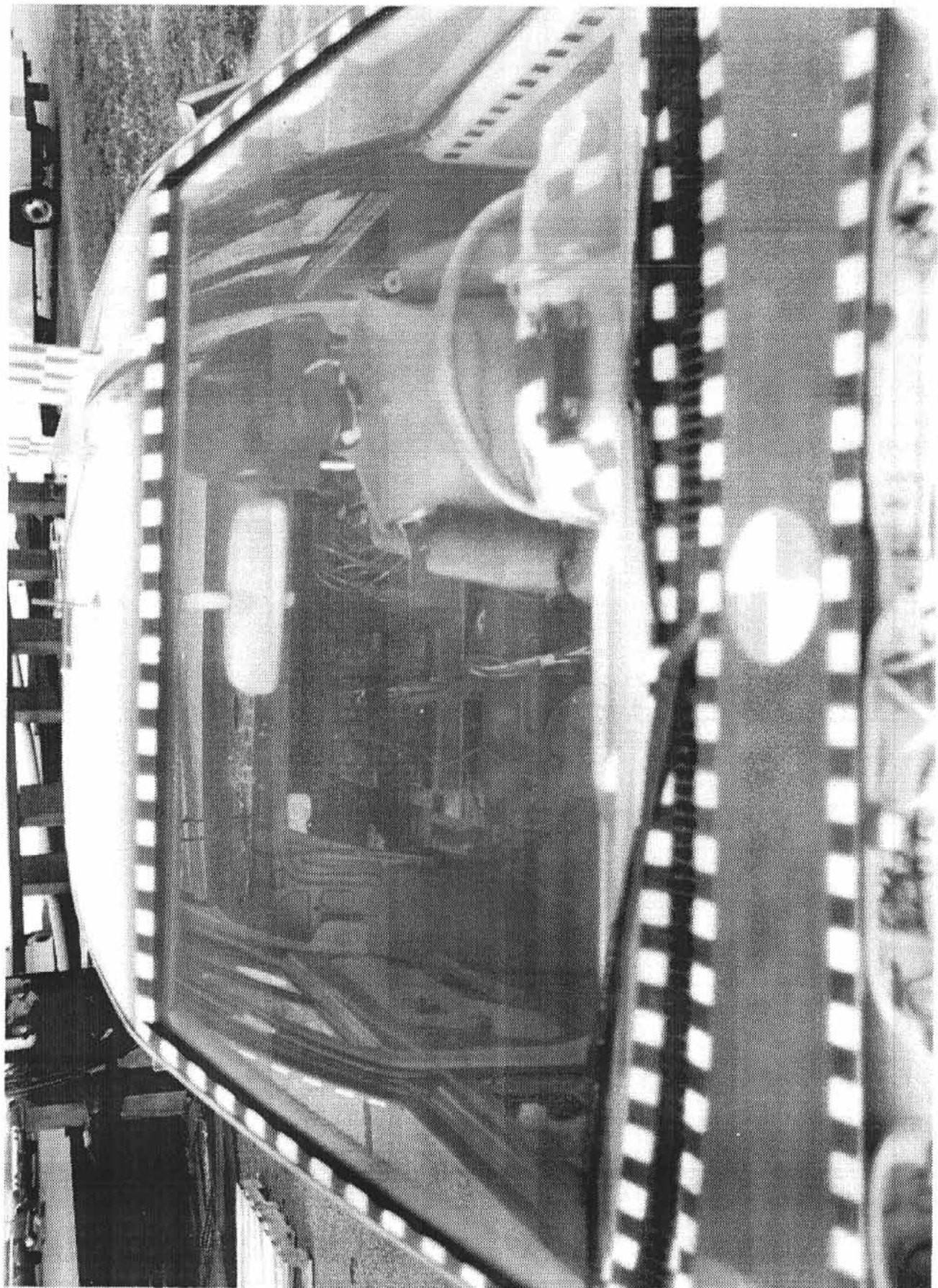


Figure A-22 VEHICLE 1 PRE-TEST WINDSHIELD VIEW



Figure A-48 VEHICLE 2 POST-TEST REAR VIEW

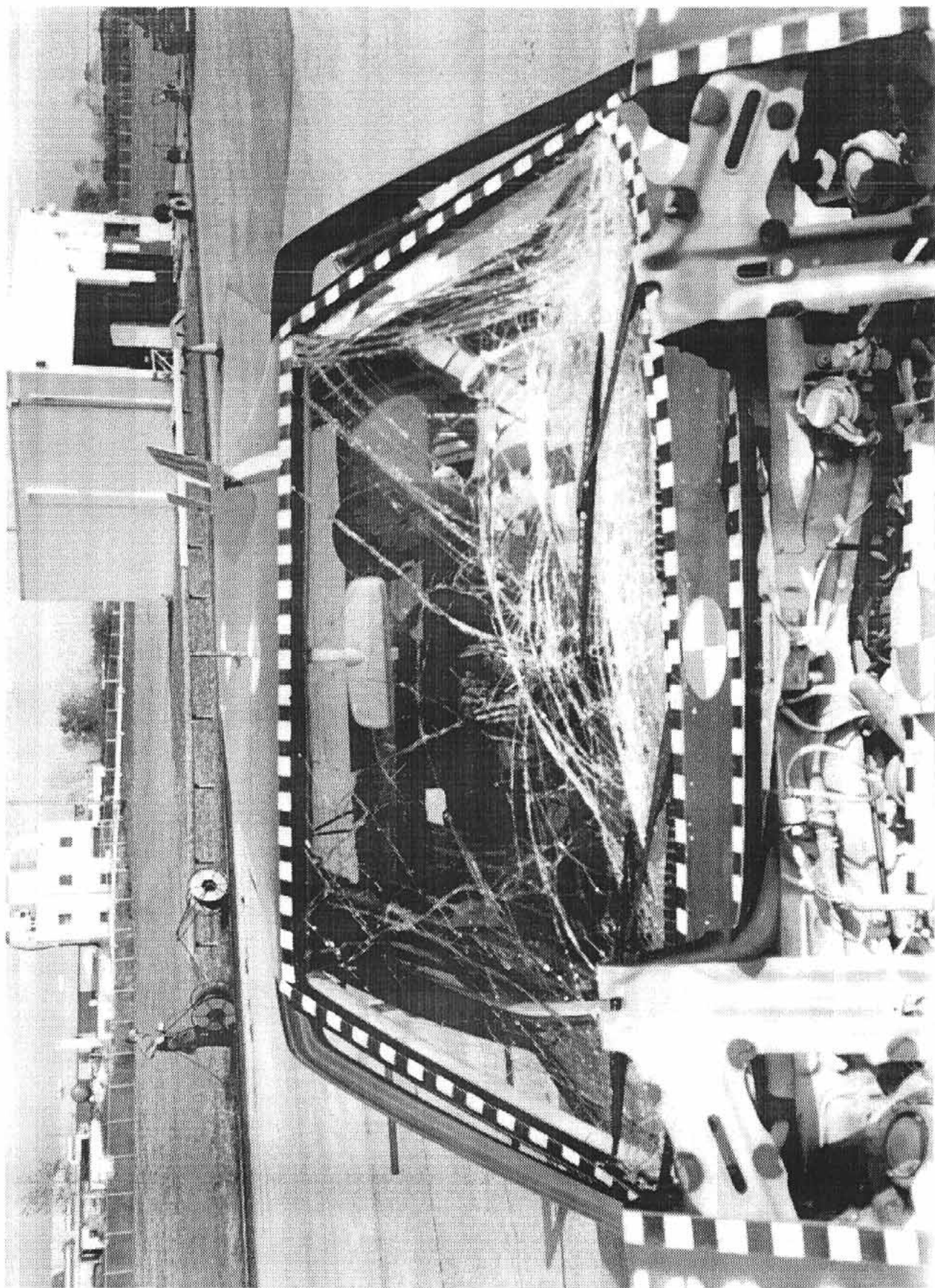


Figure A-23 VEHICLE 1 POST-TEST WINDSHIELD VIEW

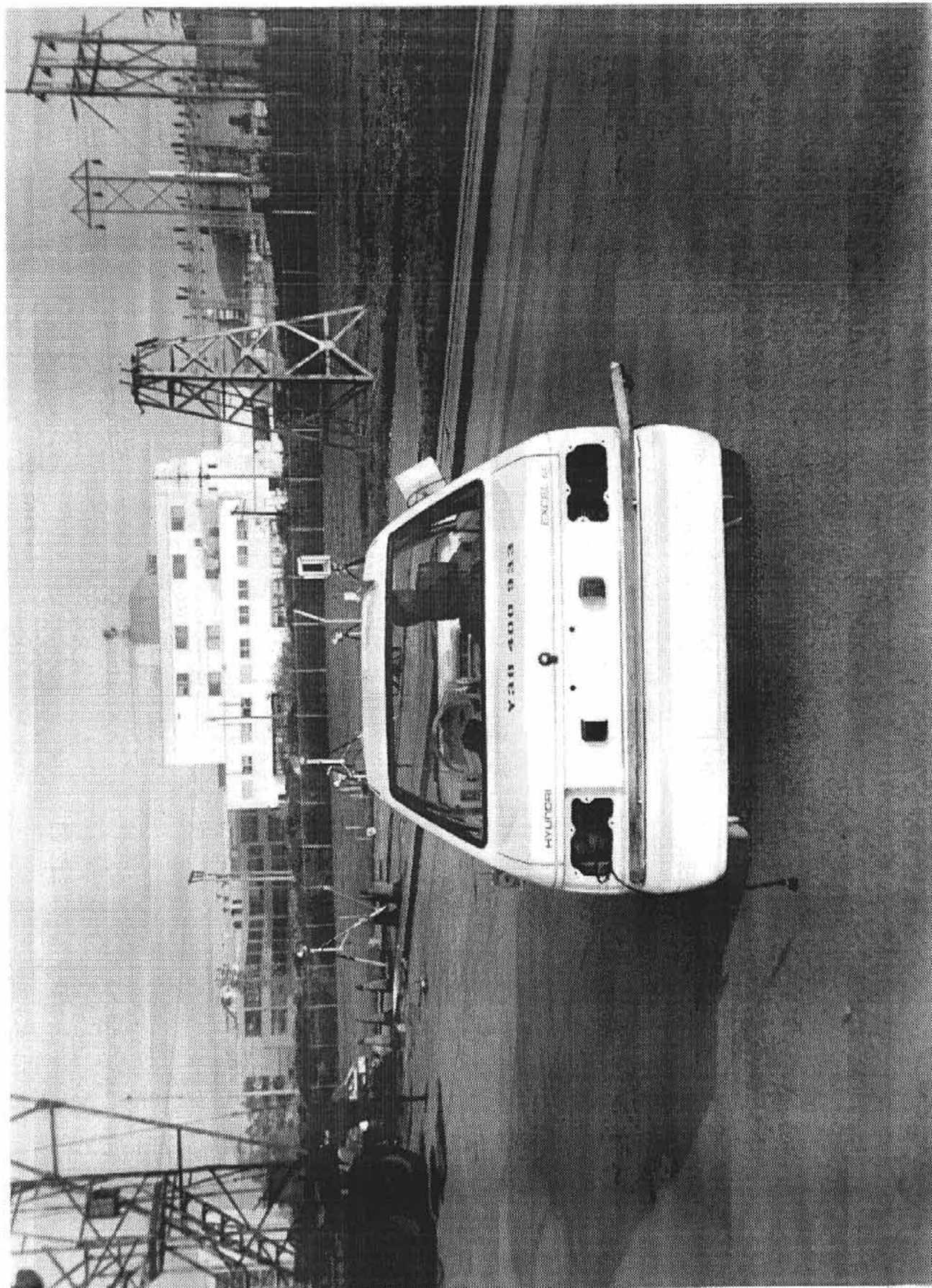


Figure A-47 VEHICLE 2 PRE-TEST REAR VIEW

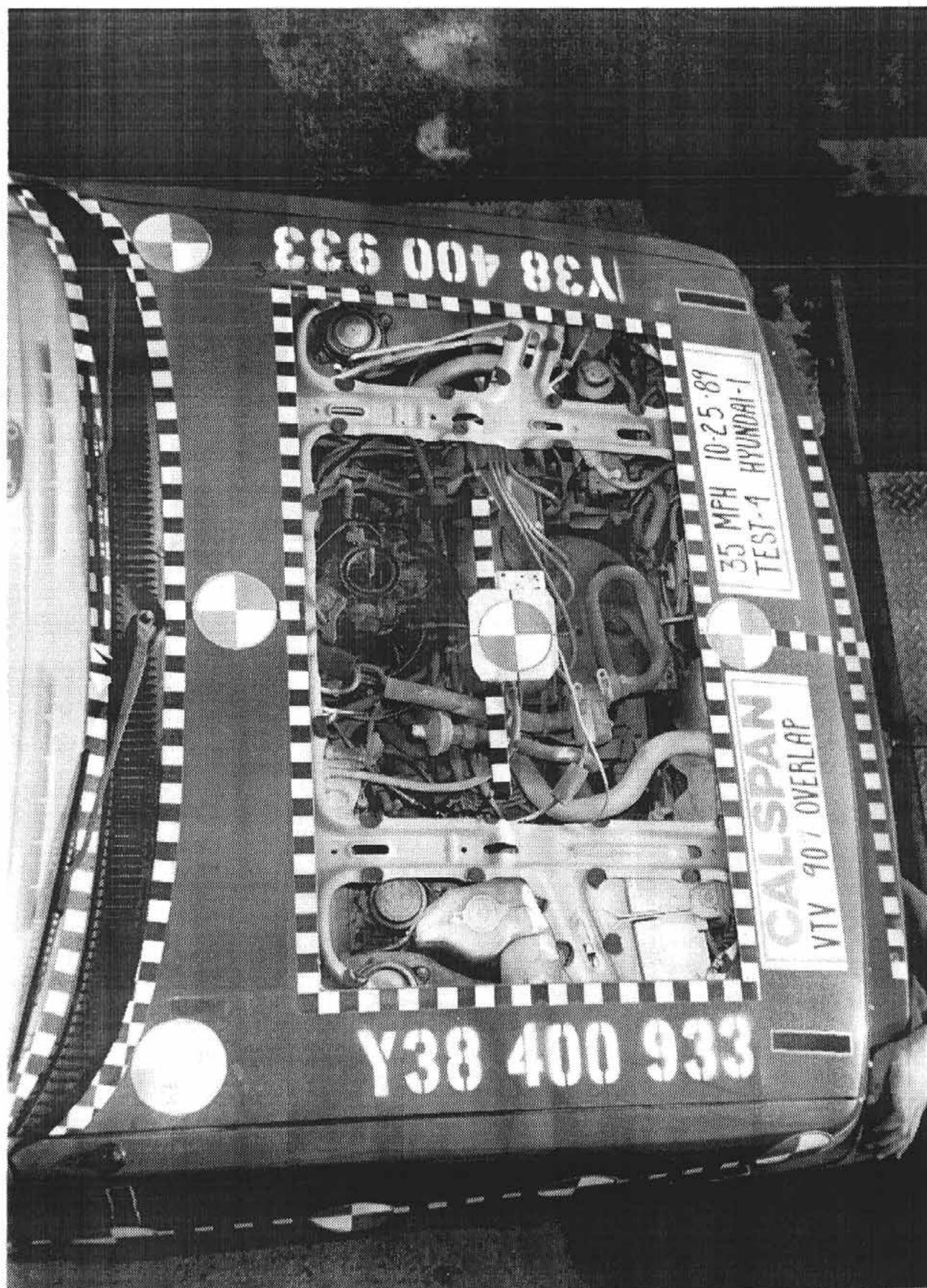
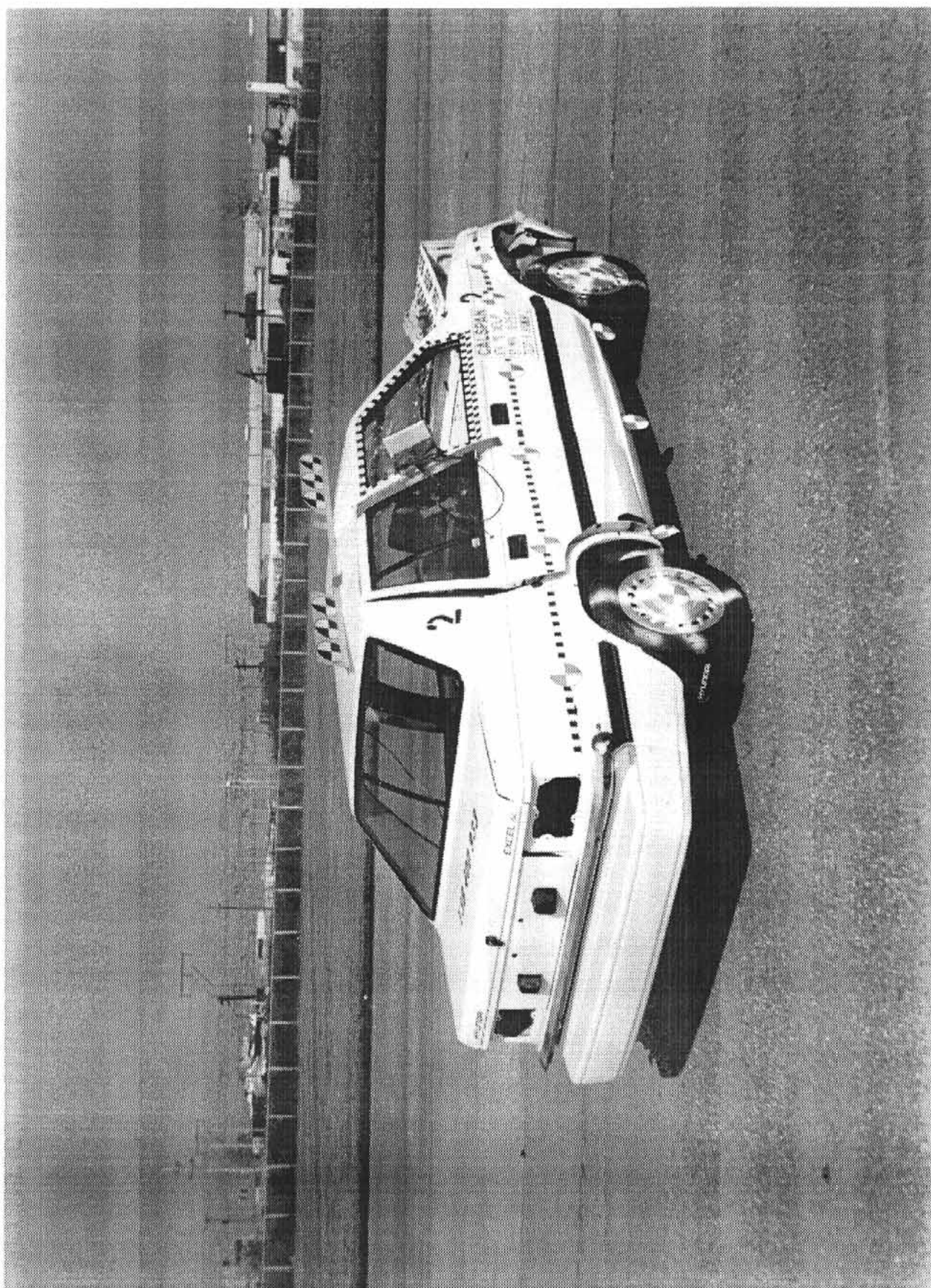


Figure A-24 VEHICLE 1 PRE-TEST OVERHEAD ENGINE COMPARTMENT VIEW



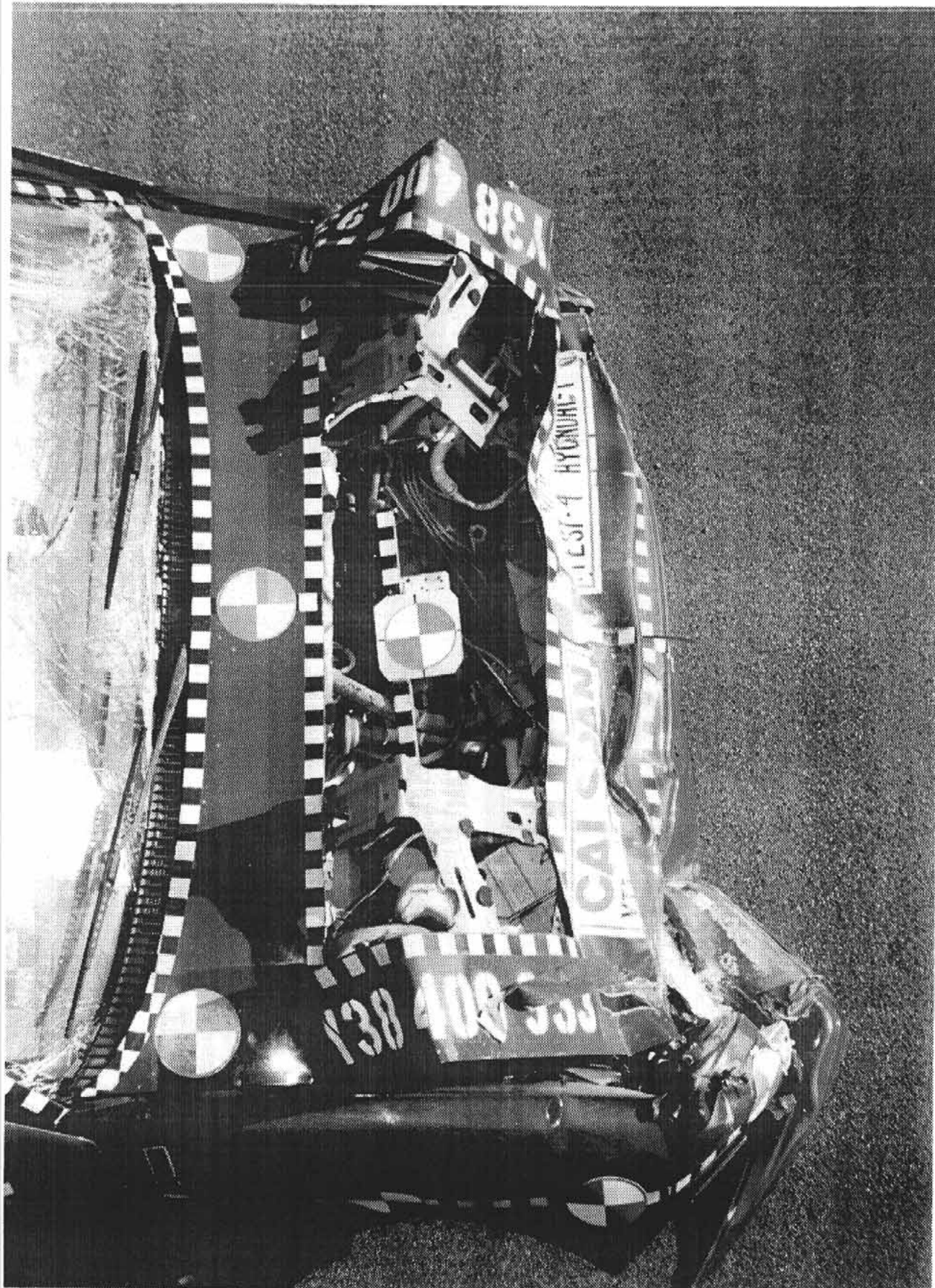


Figure A-25 VEHICLE 1 POST-TEST OVERHEAD ENGINE COMPARTMENT VIEW

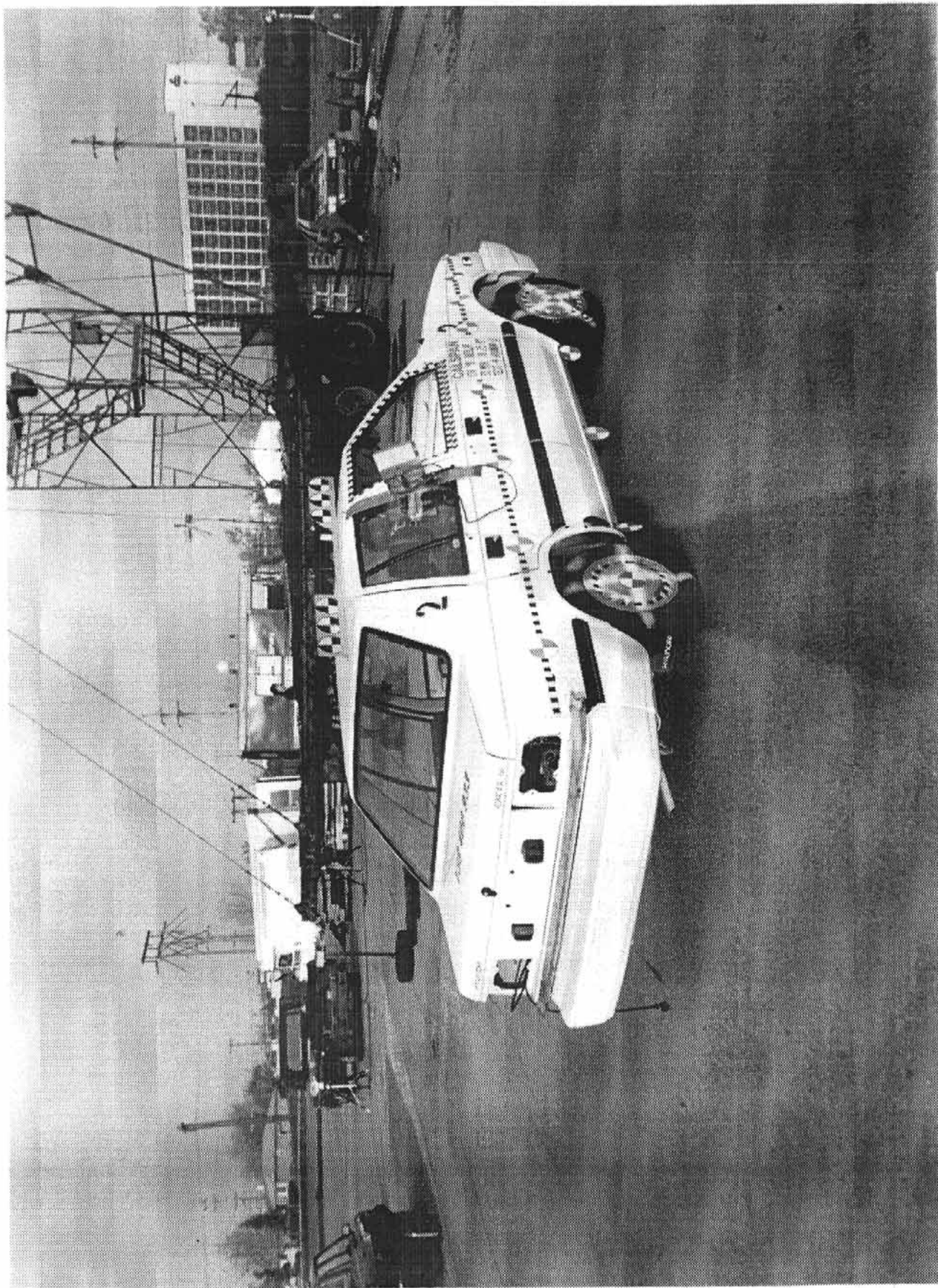


Figure A-45 VEHICLE 2 PRE-TEST REAR RIGHT THREE QUARTER VIEW

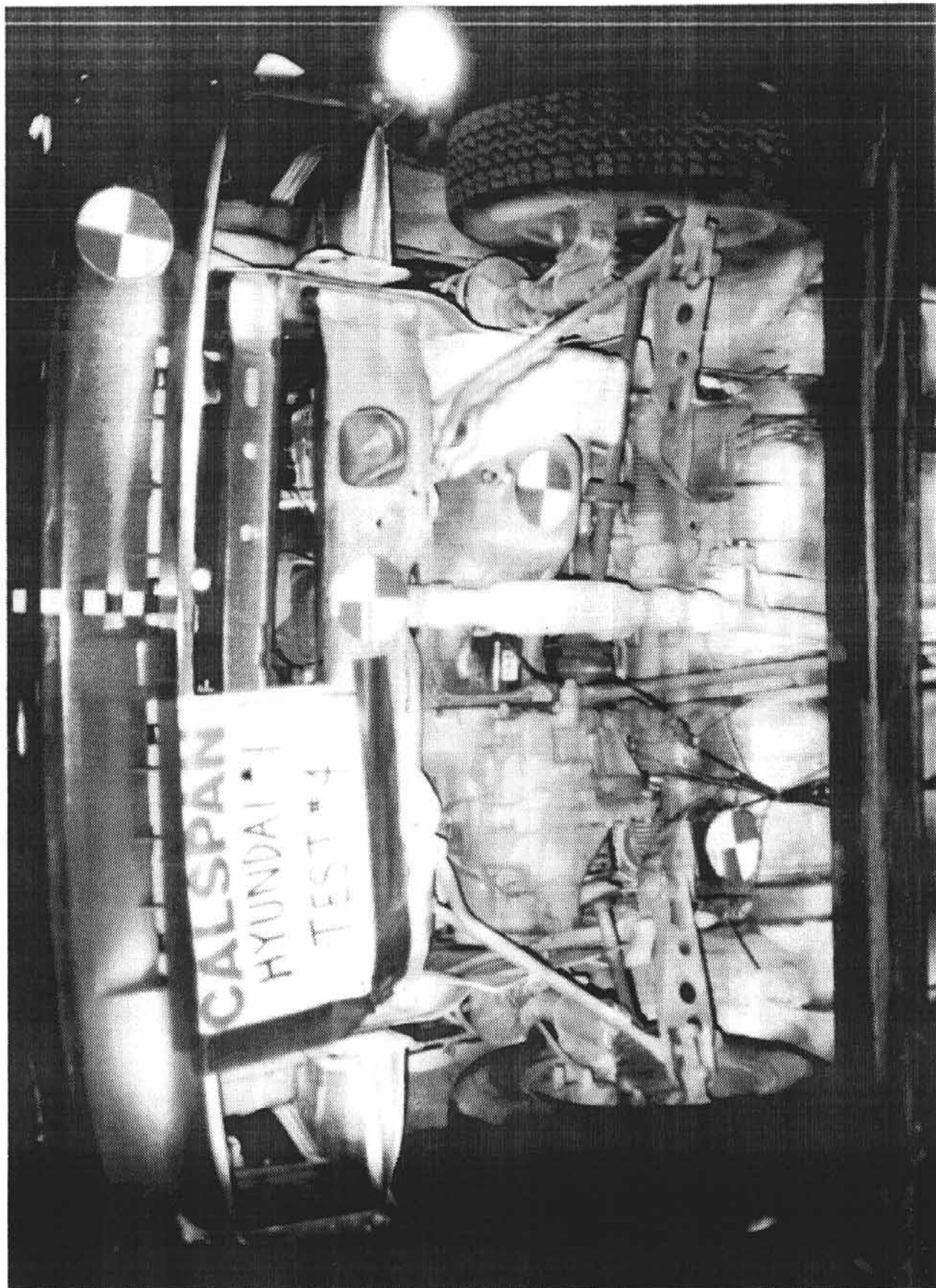


Figure A-26 VEHICLE 1 PRE-TEST UNDERBODY FRONT VIEW

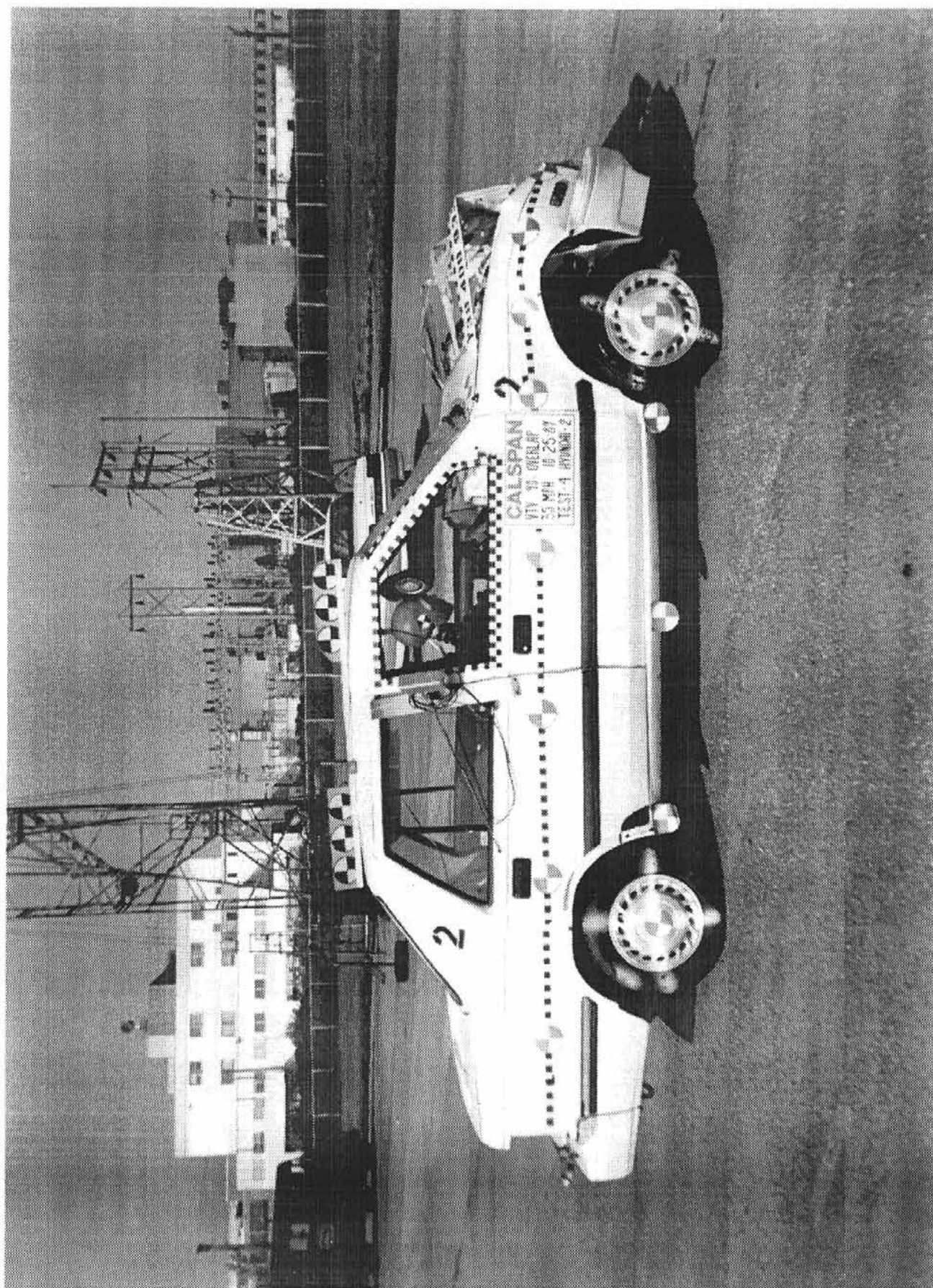


Figure A-44 VEHICLE 2 POST-TEST RIGHT SIDE VIEW

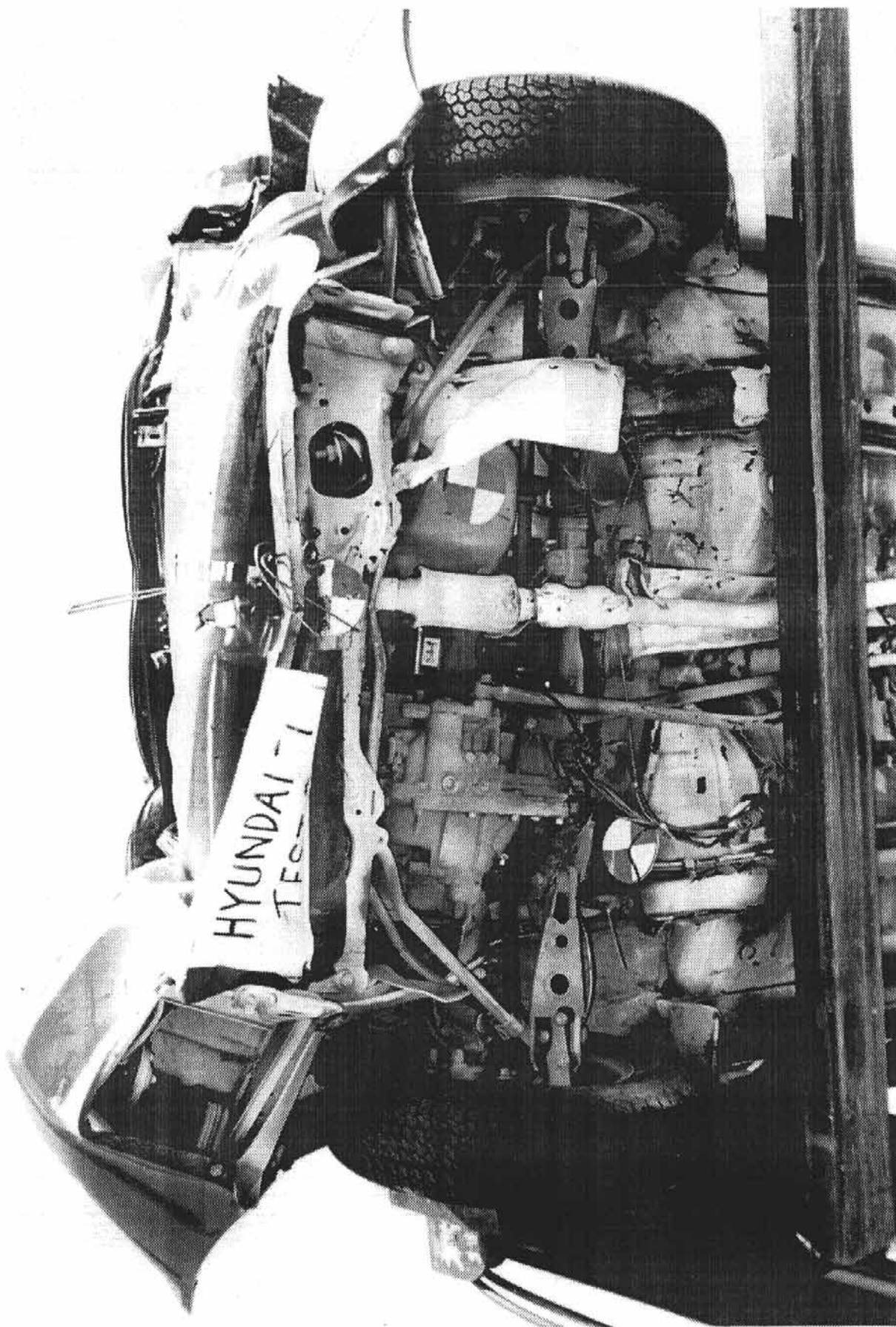


Figure A-27 VEHICLE 1 POST-TEST UNDERBODY FRONT VIEW

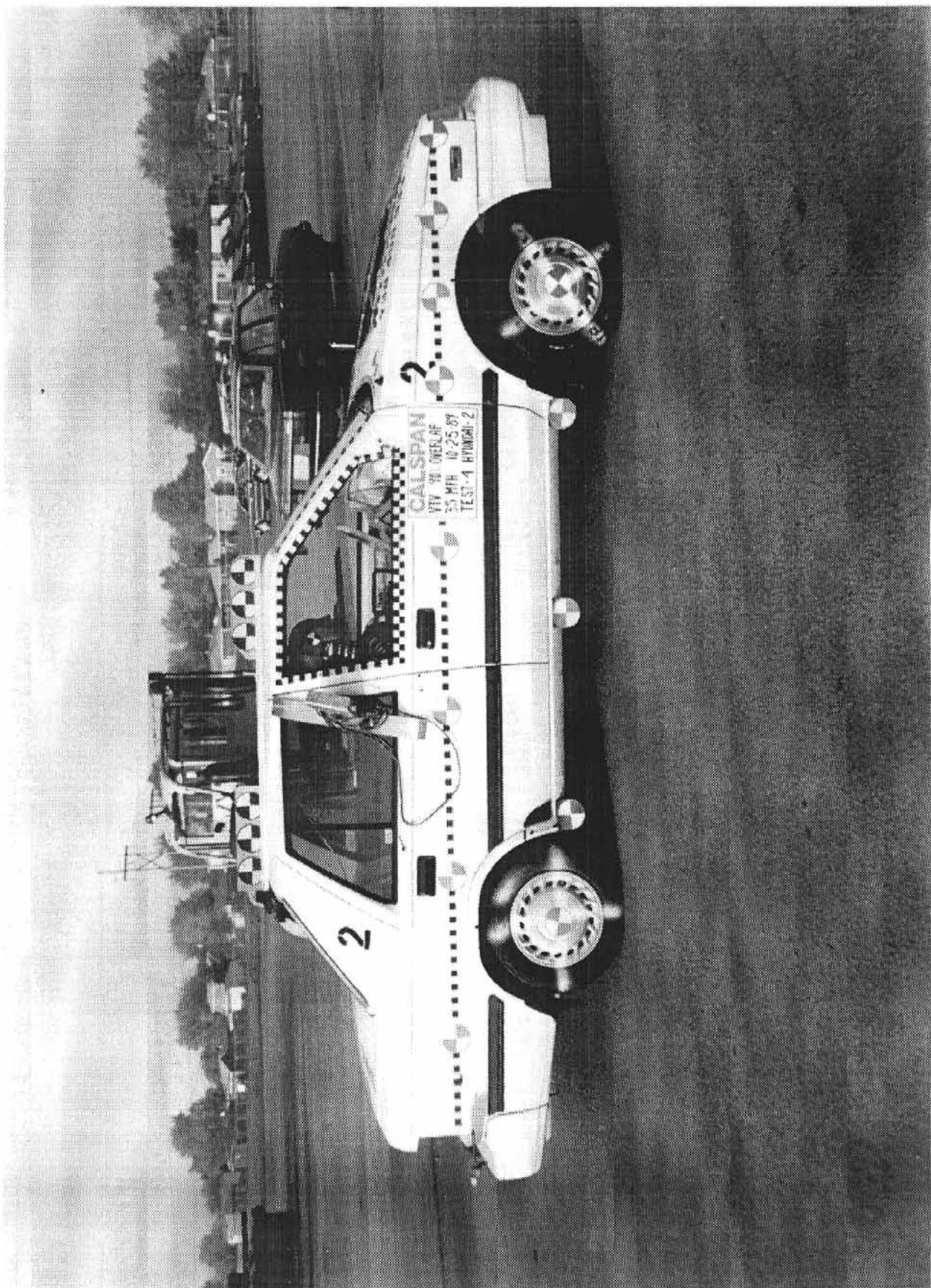


Figure A-43 VEHICLE 2 PRE-TEST RIGHT SIDE VIEW

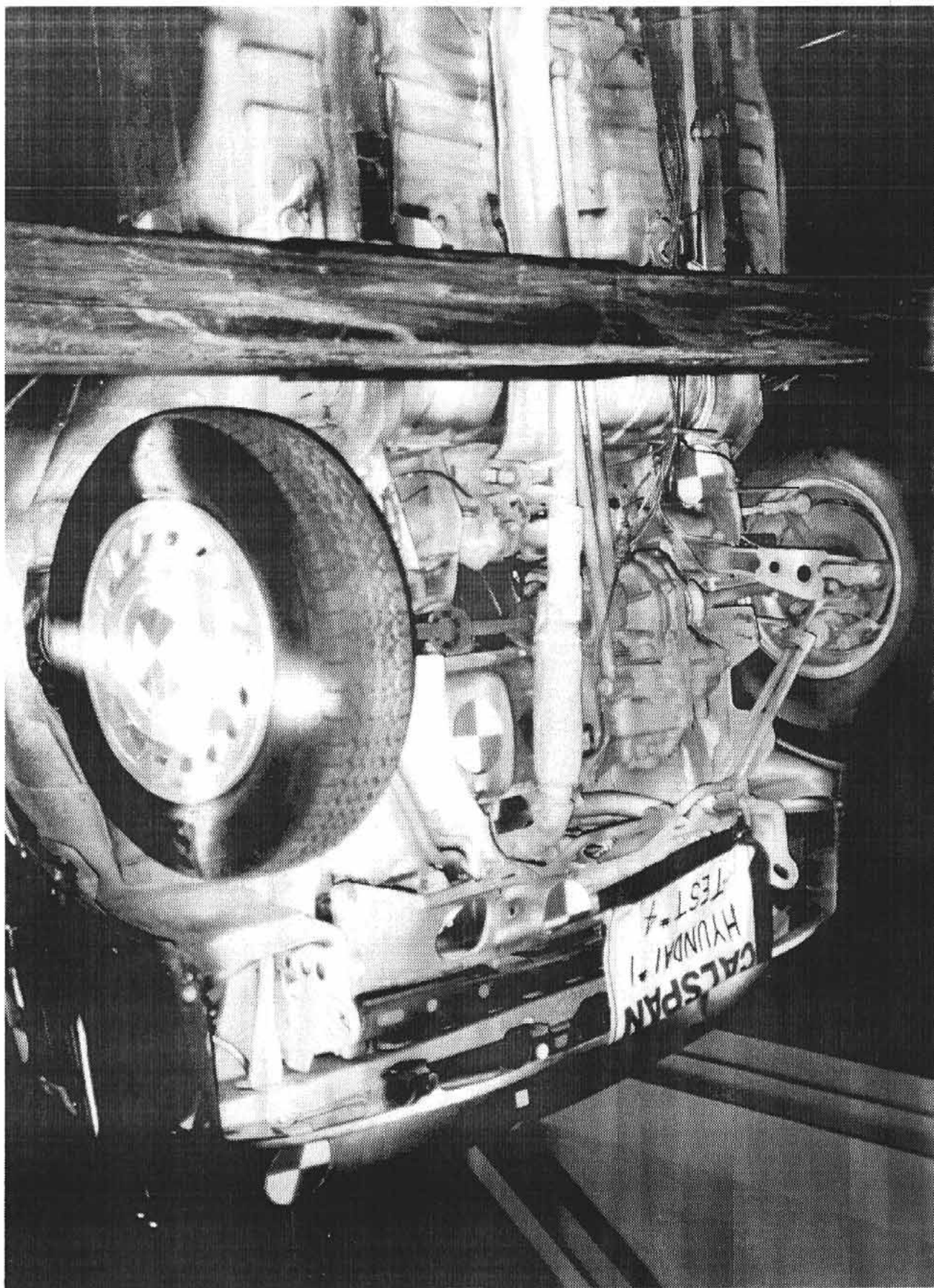


Figure A-28 VEHICLE 1 PRE-TEST UNDERBODY FRONT SIDE VIEW



Figure A-42 VEHICLE 2 POST-TEST FRONT RIGHT THREE QUARTER VIEW

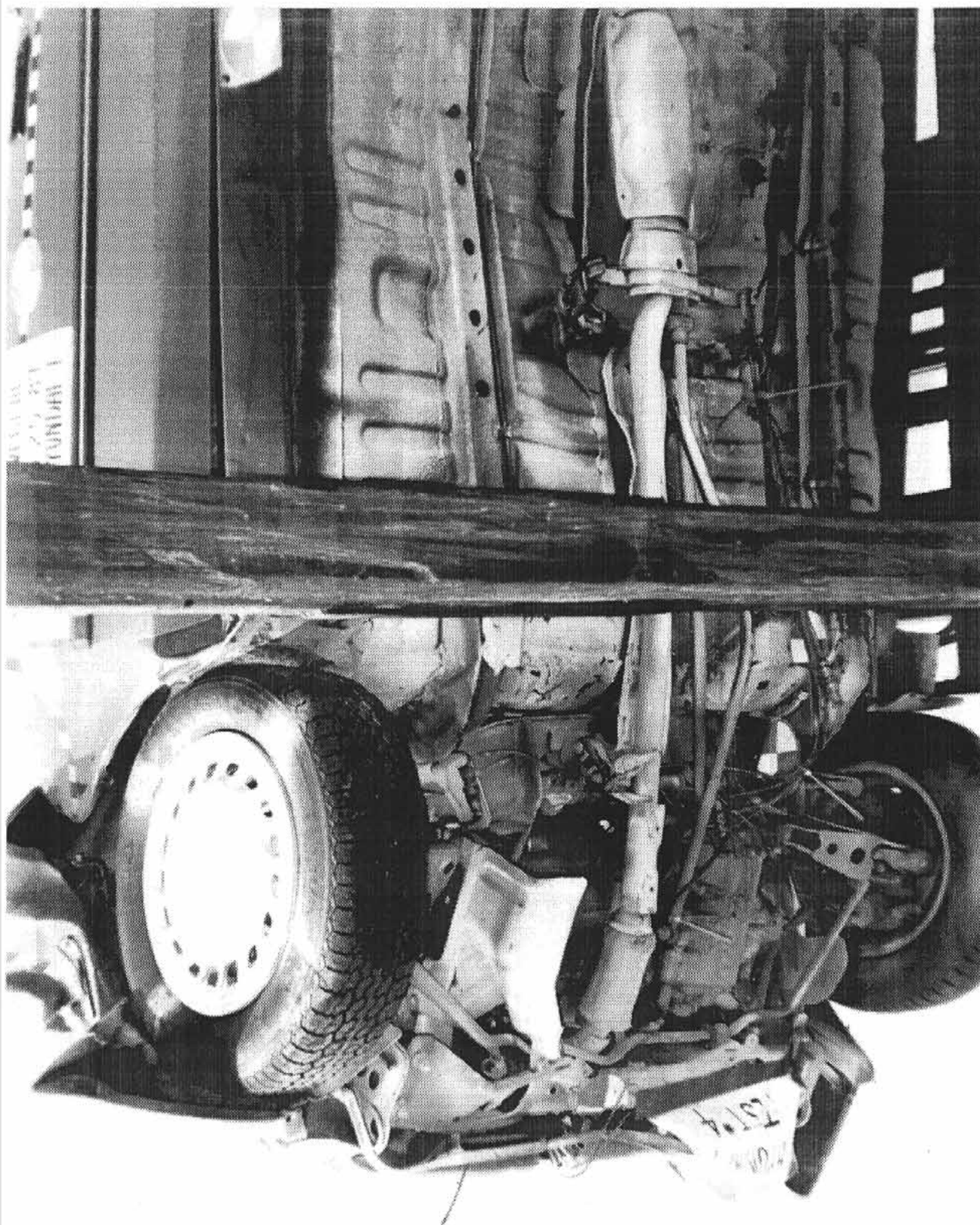


Figure A-29 VEHICLE 1 POST-TEST UNDERBODY FRONT SIDE VIEW



Figure A-41 VEHICLE 2 PRE-TEST FRONT RIGHT THREE QUARTER VIEW



FIGURE A-30 VEHICLE 1 PRE-TEST UNDERBODY REAR VIEW

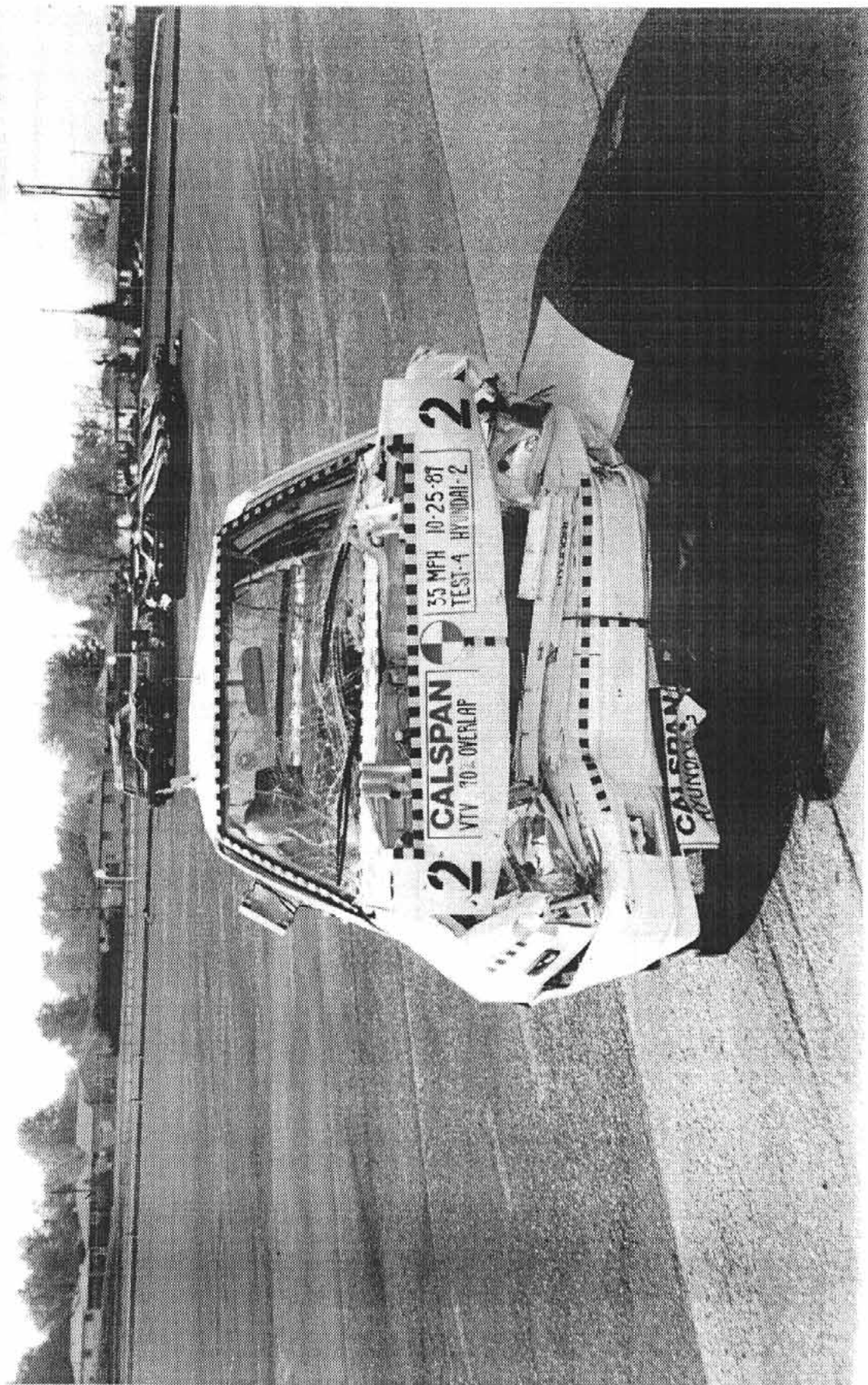


Figure A-40 VEHICLE 2 POST-TEST FRONT VIEW

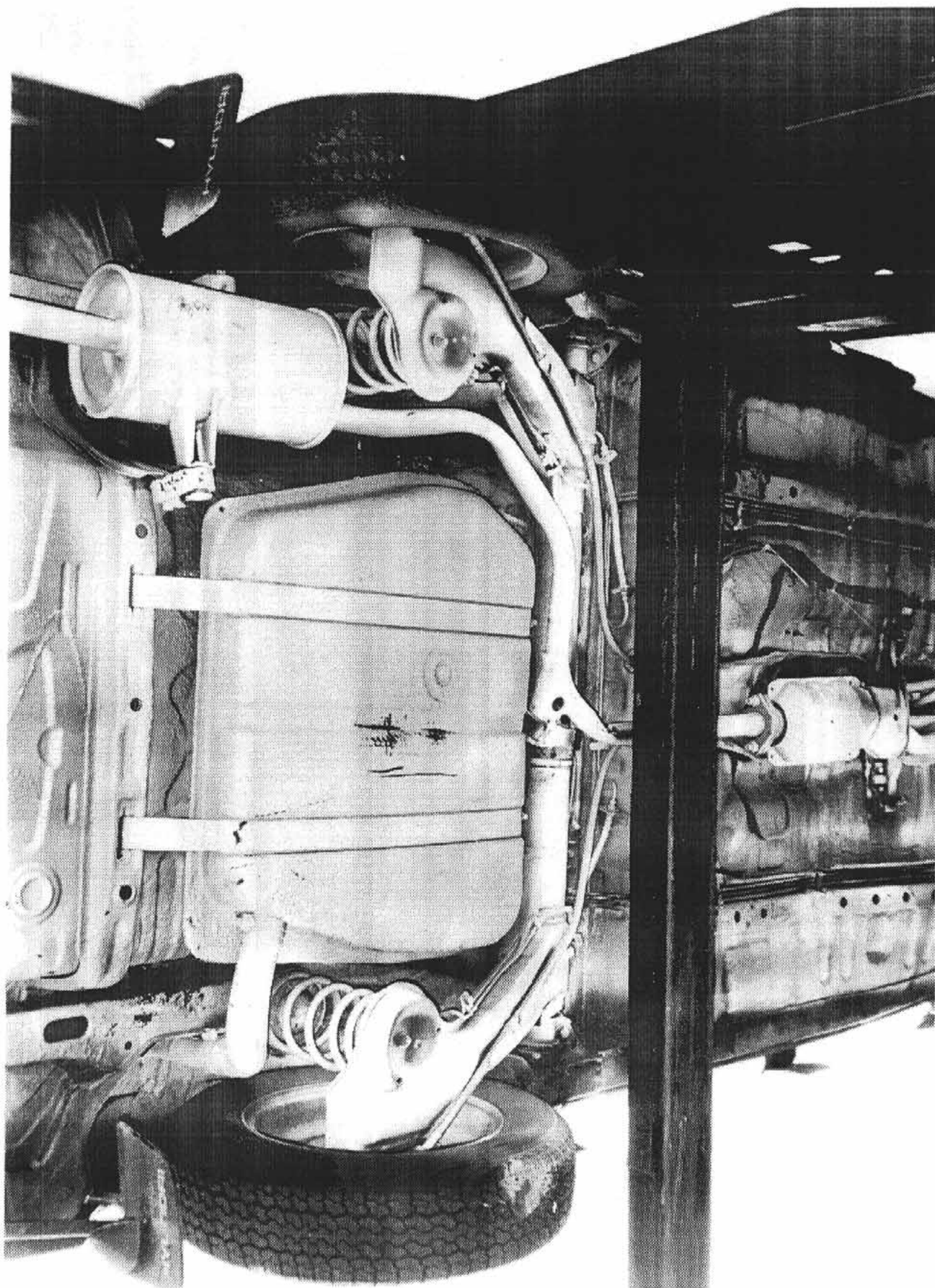


Figure A-31 VEHICLE 1 POST-TEST UNDERBODY REAR VIEW

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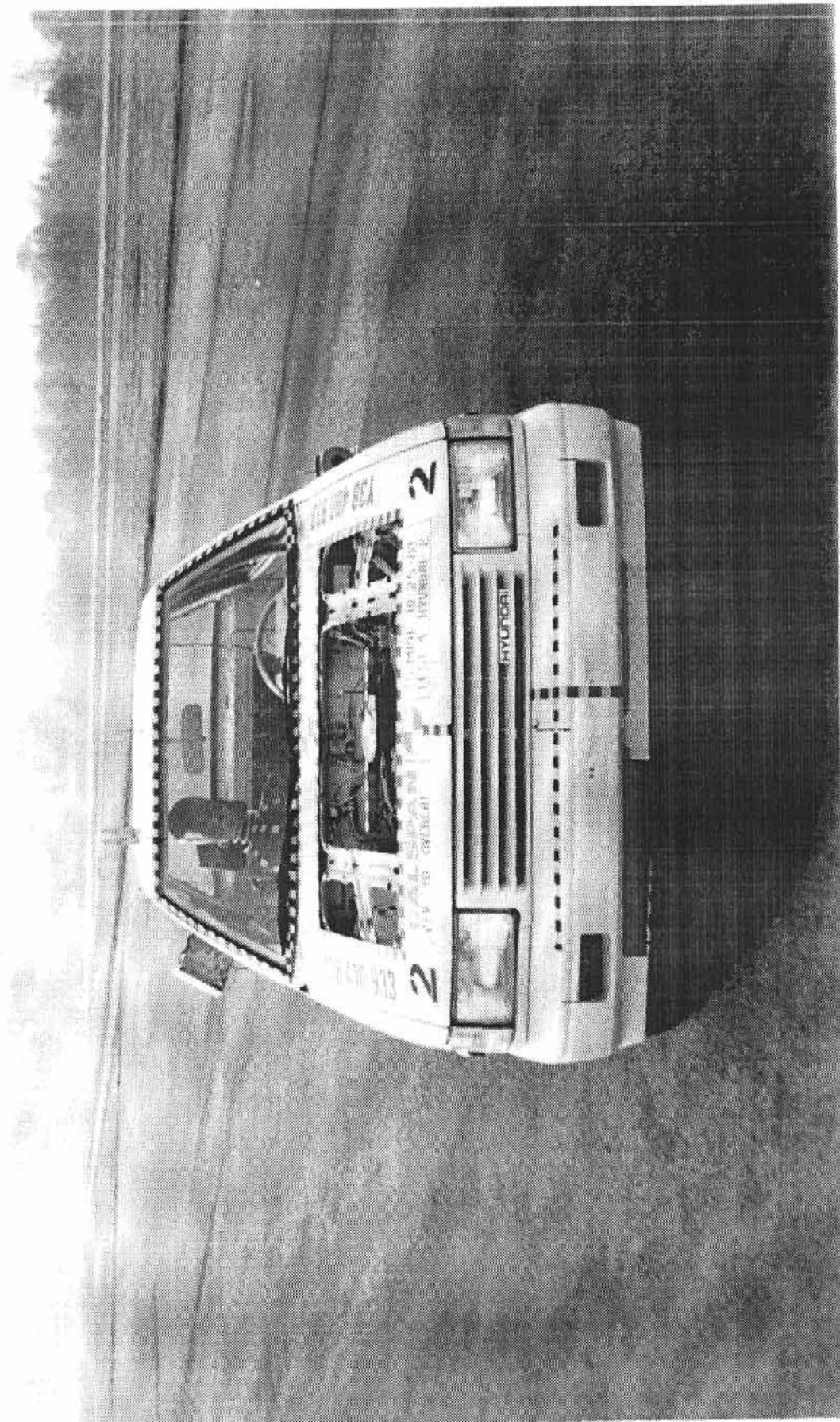


Figure A-39 VEHICLE 2 PRE-TEST FRONT VIEW

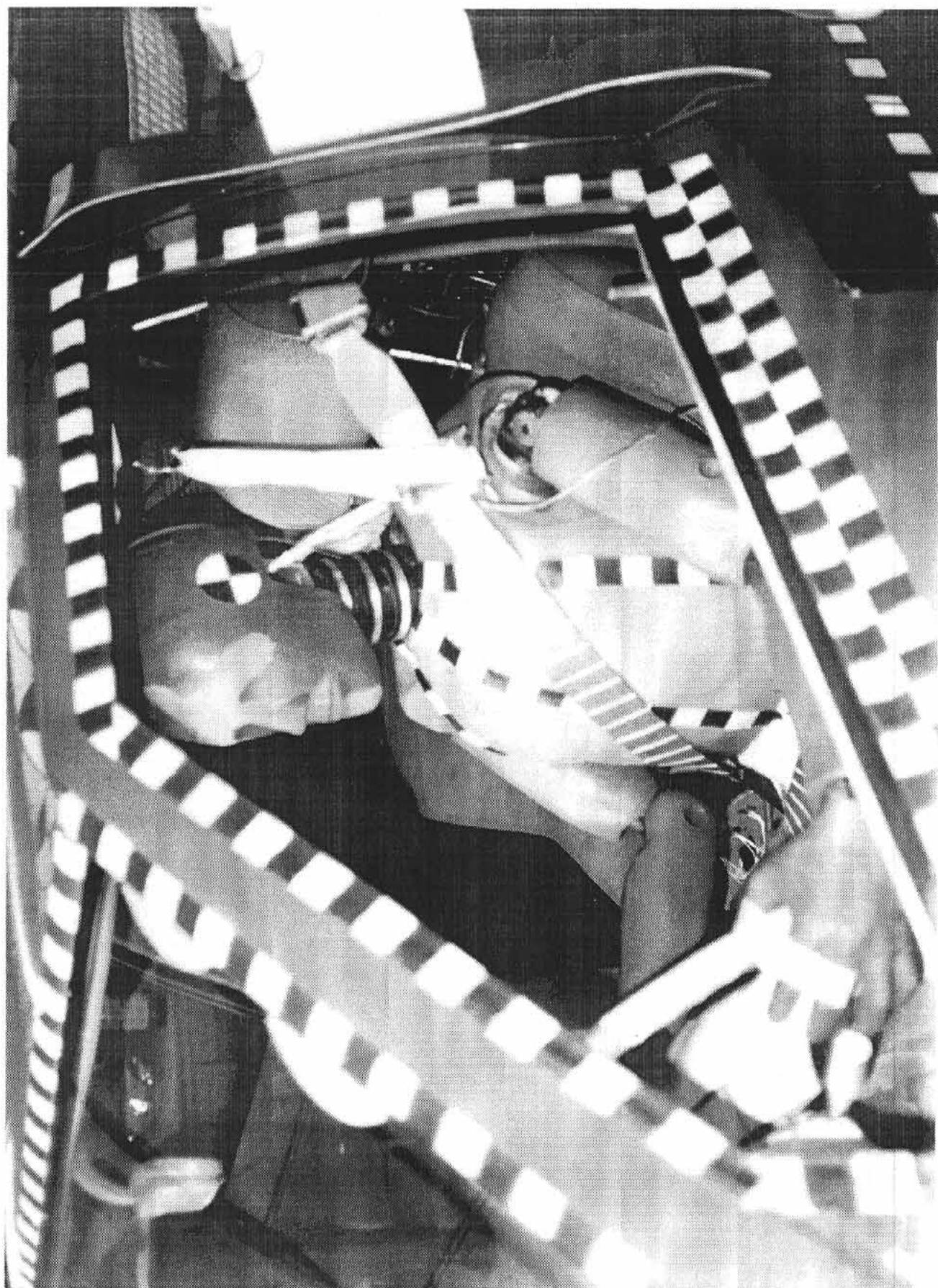


Figure A-32 VEHICLE 1 PRE-TEST DRIVER POSITION VIEW

VEHICLE 2 PHOTOGRAPHS

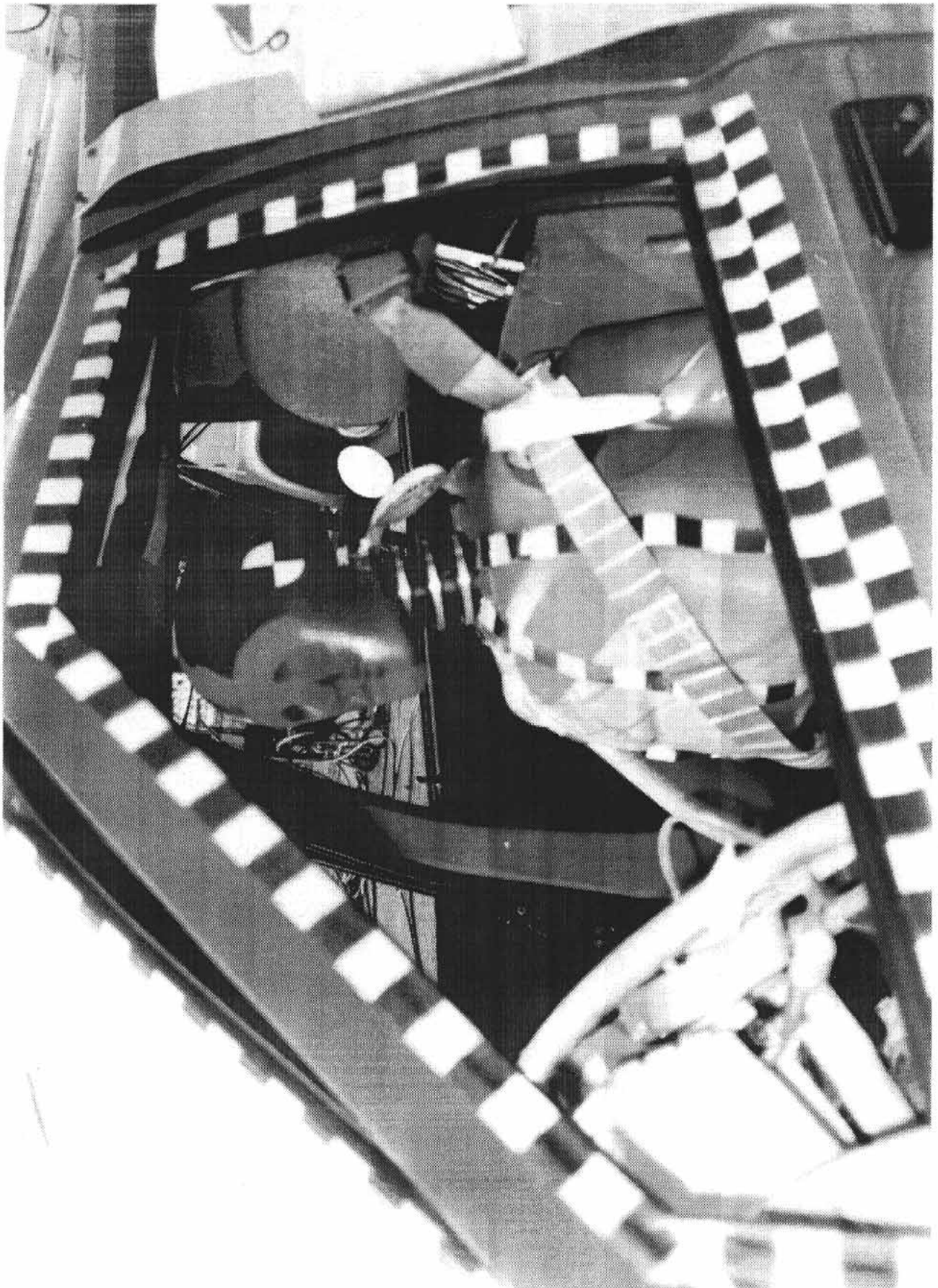


Figure A-33 VEHICLE 1 POST-TEST DRIVER POSITION VIEW

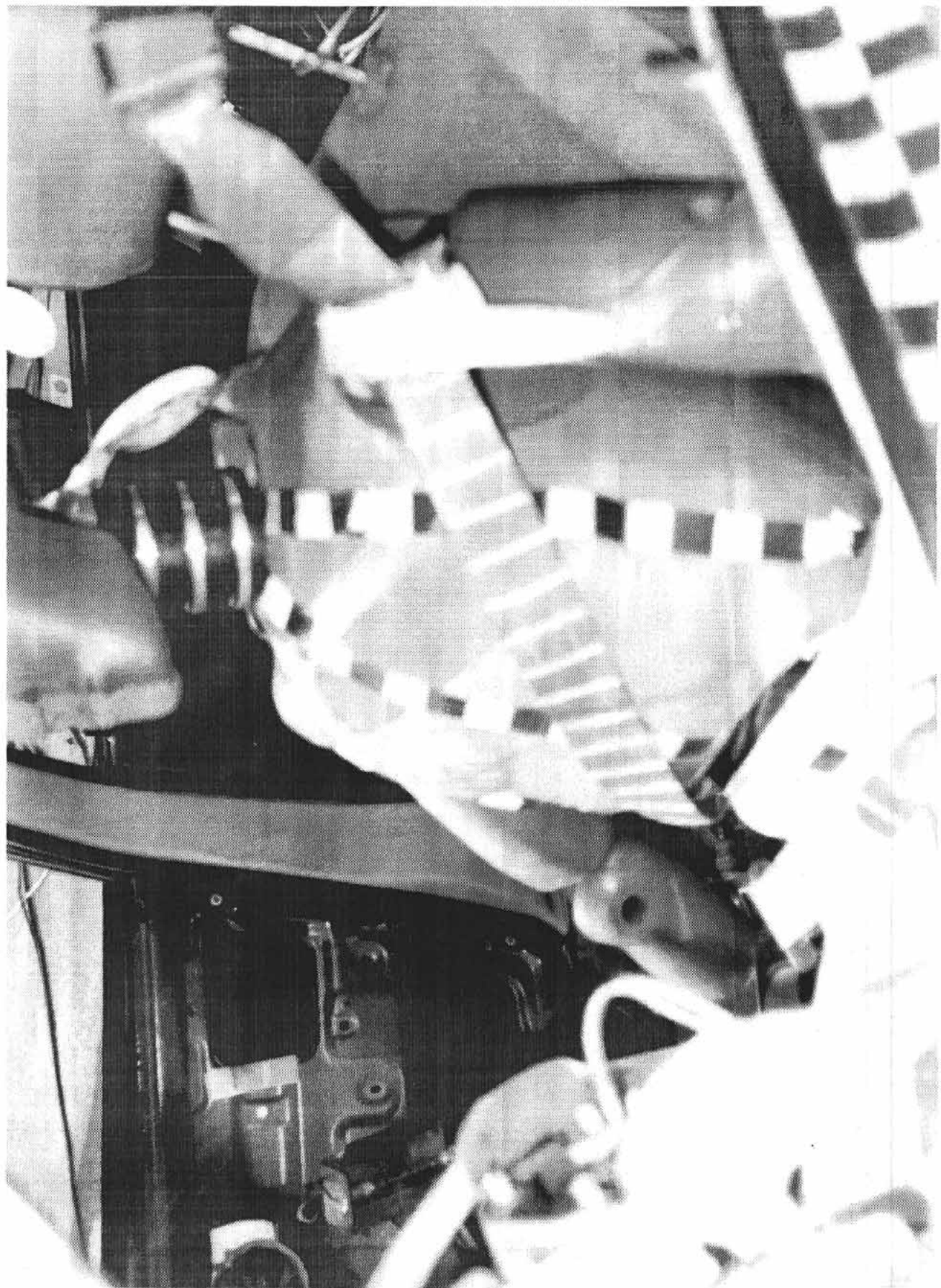


Figure A-38 VEHICLE 1 POST-TEST CHEST CONTACT VIEW

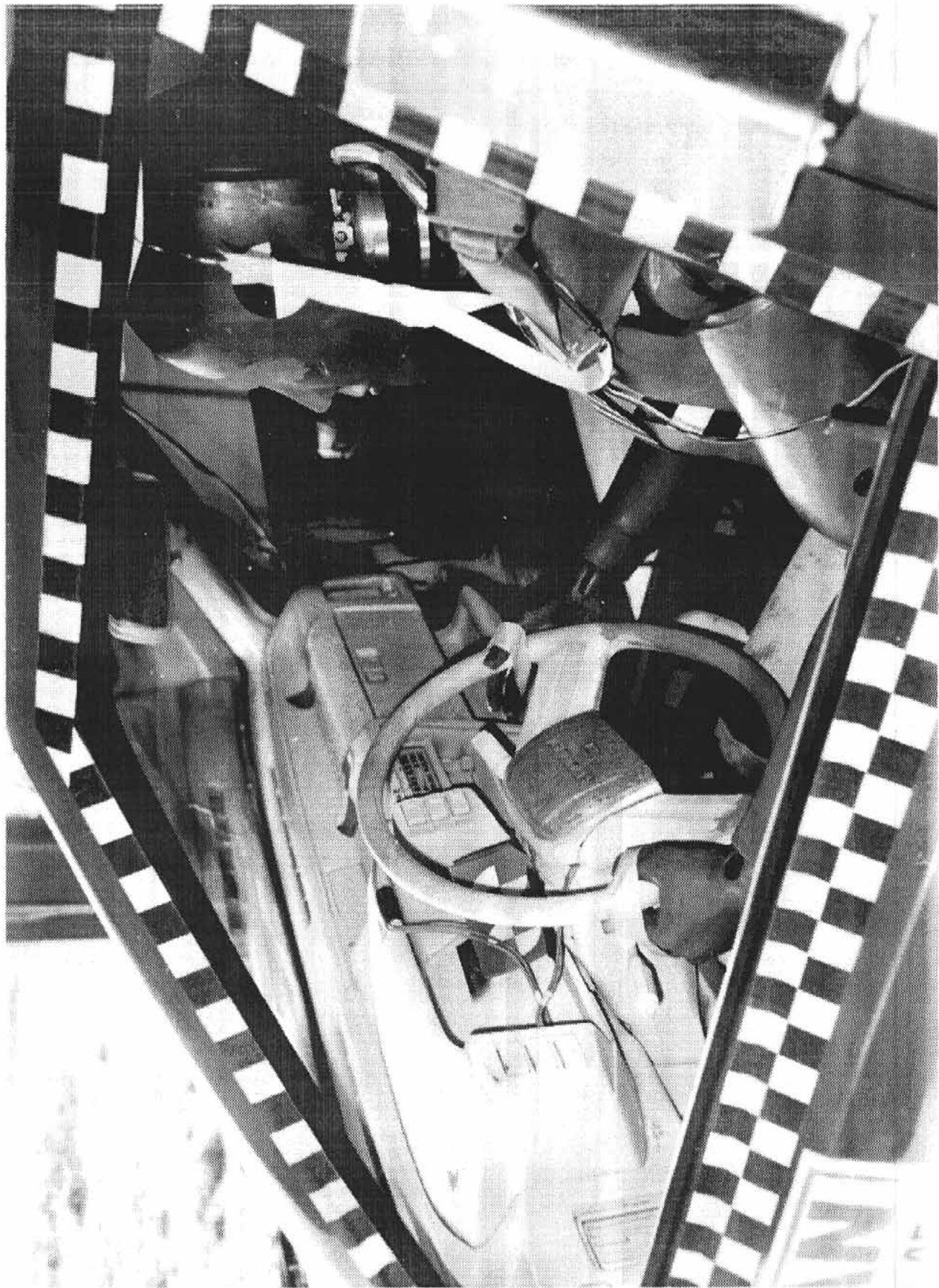


Figure A-34 VEHICLE 1 PRE-TEST DRIVER AND OCCUPANT COMPARTMENT VIEW



Figure A-37 VEHICLE 1 POST-TEST DRIVER AND OCCUPANT COMPARTMENT
RIGHT SIDE VIEW

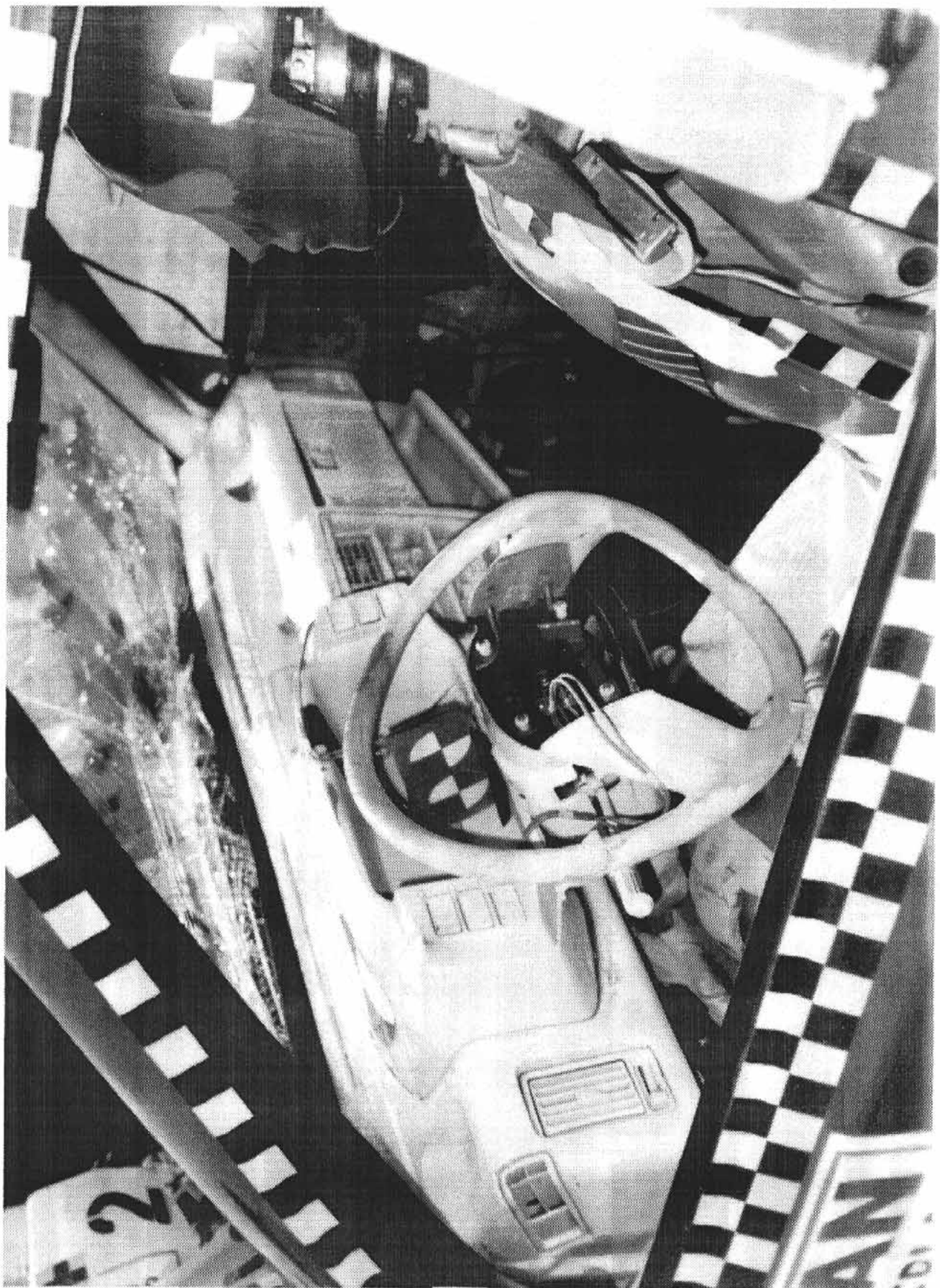


Figure A-35 VEHICLE 1 POST-TEST DRIVER AND OCCUPANT COMPARTMENT VIEW

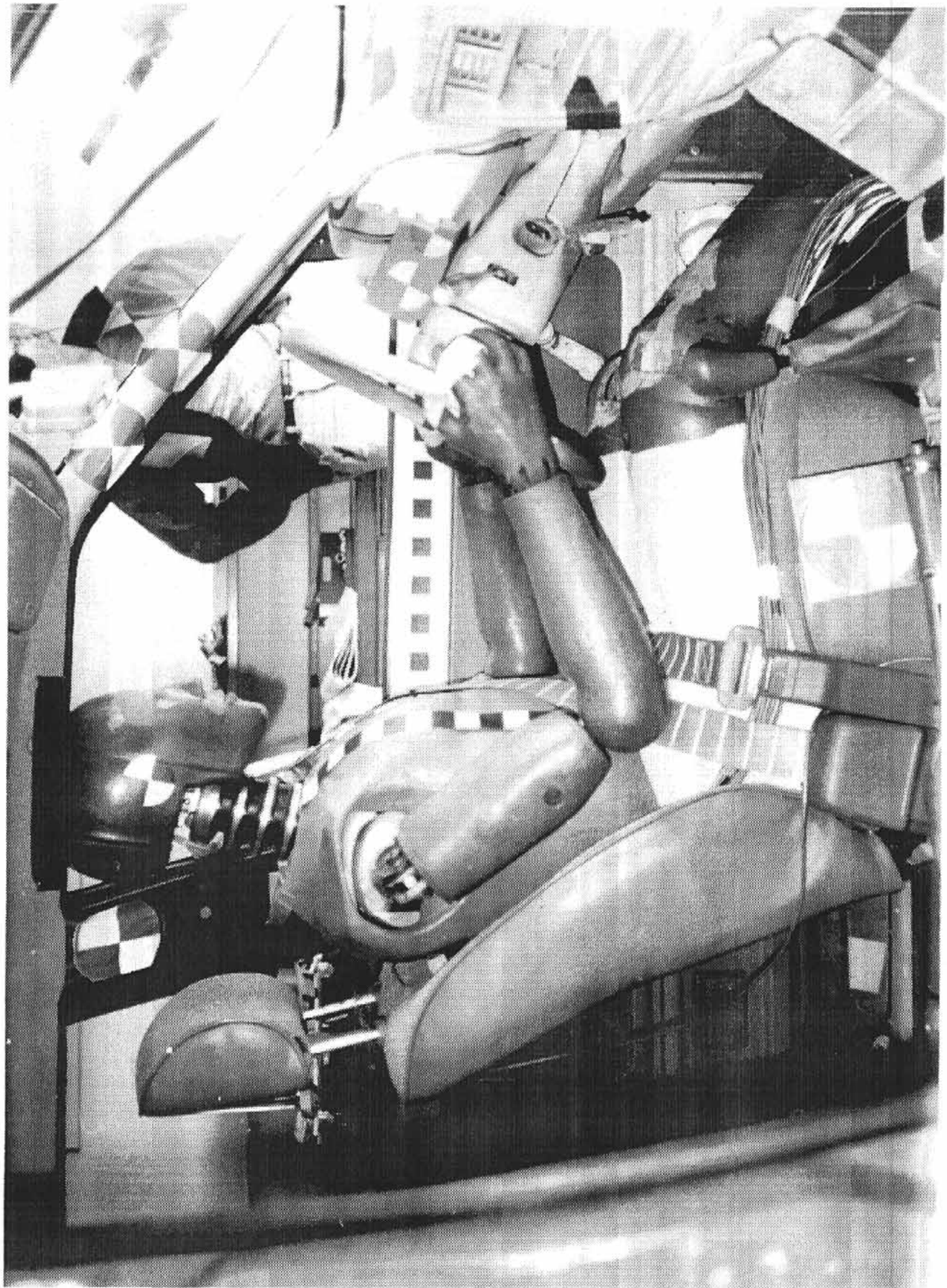


Figure A-36 VEHICLE 1 PRE-TEST DRIVER AND OCCUPANT COMPARTMENT
RIGHT SIDE VIEW

Appendix B

VEHICLE AND DUMMY RESPONSE DATA

Key V1 - Vehicle 1
 P1 - Vehicle Seat Position 1
 V2 - Vehicle 2
 P2 - Vehicle Seat Position 2

TEST NO Y38-3-932

VEHICLE DATA

FILTER CHANNEL CLASS

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VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

FUN # 933

SERIES # 4

CHAN	TITLE	MINIMUM/MAXIMUM	AT	TIME
1	U1.P1 HEAD X - PRIMARY	-96.185 G'S 15.765 G'S		81.45 MS. 200.40 MS.
2	U1.P1 HEAD Y - PRIMARY	-22.223 G'S 11.324 G'S		58.87 MS. 199.72 MS.
3	U1.P1 HEAD Z - PRIMARY	-4.052 G'S 65.774 G'S		101.47 MS. 72.30 MS.
4	U1.P1 HD1XG	-105.033 G'S 14.070 G'S		58.80 MS. 200.40 MS.
5	U1.P1 HD1ZG	-10.517 G'S 121.700 G'S		93.45 MS. 58.95 MS.
6	U1.P1 HD2YG	-17.428 G'S 10.598 G'S		58.80 MS. 85.58 MS.
7	U1.P1 HD2ZG	-9.348 G'S 66.104 G'S		104.47 MS. 72.37 MS.
8	U1.P1 HD3XG	-113.946 G'S 35.266 G'S		81.30 MS. 58.65 MS.

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1 - 100% E-100

1 - 100% E-100

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

FUN # 933		SERIES # 4	
CHAN	TITLE	MINIMUM/MAXIMUM	AT TIME
9	U1.P1 HD3YG	-14 348 G'S 16 351 G'S	62 17 MS. 103 20 MS.
10	U1.P1 CHEST Z	-65 591 G'S 10 917 G'S	68 17 MS. 154 58 MS
11	U1 P1 CHEST Y	-13 700 G'S 4 219 G'S	77 02 MS. 161 47 MS
12	U1.P1 CHEST Z	-21 206 G'S 10 111 G'S	70 73 MS. 97 87 MS
13	U1 P1 UPPER STERNUM AX	-105 110 G'S 23 980 G'S	53 70 MS. 52 35 MS
14	U1.P1 LOWER STERNUM AX	-100 276 G'S 68 447 G'S	51 90 MS. 53 55 MS.
15	U1 P1 CHEST DISPLACEMENT	-2.606 INCHES 115 INCHES	79 95 MS. 34 95 MS
16	U1.P1 ABDOMINAL PRESSURE	- .062 PSI 3.424 PSI	224 92 MS. 58 12 MS.

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

RUN # 933		SERIES # 4			
CHAN	TITLE	MINIMUM/MAXIMUM		AT	TIME
17	U1 P1 LEFT FEMUR LOAD	-85.844 LBS			98.32 MS.
		2480.994 LBS			62.92 MS.
18	U1 P1 RIGHT FEMUR LOAD	-183.252 LBS			37.12 MS.
		2576.005 LBS			59.85 MS.
19	U1 P1 UPPER NECK FX	-271.344 LBS.			83.25 MS.
		101.062 LBS			58.95 MS.
20	U1 P1 UPPER NECK FY	-43.379 LBS.			66.98 MS.
		44.108 LBS			90.67 MS.
21	U1.P1 UPPER NECK FZ	-30.565 LBS.			-35.55 MS.
		720.872 LBS.			72.90 MS.
22	U1.P1 UPPER NECK MX	-320.007 IN-LBS.			102.15 MS.
		132.042 IN-LBS			141.00 MS.
23	U1.P1 UPPER NECK MY	-374.186 IN-LBS			98.55 MS.
		214.245 IN-LBS.			65.63 MS.
24	U1.P1 UPPER NECK MZ	-70.909 IN-LBS.			149.92 MS.
		191.701 IN-LBS.			95.85 MS.

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VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

FUN # 933		SERIES # 4	
CHAR	TITLE	MINIMUM/MAXIMUM	AT TIME
25	U1.P1 LOWER NECK FX	-646 556 LBS. 131 326 LBS.	78.08 MS. 206.55 MS.
26	U1.P1 LOWER NECK FY	-273 339 LBS. 269 492 LBS.	78.08 MS. 60.82 MS.
27	U1.P1 LOWER NECK FZ	-48 727 LBS. 931 939 LBS.	109.27 MS. 68.02 MS.
28	U1.P1 LOWER NECK MX	-323 691 IN-LBS. 921 128 IN-LBS.	195.83 MS. 79.58 MS.
29	U1.P1 LOWER NECK MY	-972 713 IN-LBS. 1623.891 IN-LBS.	195.90 MS. 82.12 MS.
30	U1.P1 LOWER NECK MZ	-491 590 IN-LBS. 212 786 IN-LBS.	78.08 MS. 42.75 MS.
* 31	U1 L. REAR SEAT XMEMBER X	-33 078 G'S 4 335 G'S	53.17 MS. 141.75 MS.
* 32	U1 R. REAR SEAT XMEMBER X	-34 574 G'S 3 586 G'S	45.75 MS. 135.53 MS.

*Accelerometer locations can be found on Figure 4 Page 3-12

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

CHAN	TITLE	MINIMUM/MAXIMUM	AT	TIME
*33	U1 REAR SEAT C L X	-33 597 G'S 3 496 G'S		53.40 MS. 136.72 MS.
*34	U1 REAR SEAT C L X(R)	-37.474 G'S 3 402 G'S		53.32 MS. 143.17 MS.
*35	U1 REAR SEAT C L Y	** -11 825 G'S ** 151 392 G'S	**	47.17 MS. 56.70 MS.
*36	U1 REAR SEAT C.L. Z	-6 348 G'S 17 153 G'S		88.57 MS. 43.12 MS.
*37	U1 ENGINE TOP X	-191 876 G'S 49 346 G'S		25.72 MS. 36.15 MS.
*38	U1 ENGINE TOP Z	-12 129 G'S 39 370 G'S		48.15 MS. 81.15 MS.
*39	U1 ENGINE BOTTOM X	-87 321 G'S 22.173 G'S		27.97 MS. 49.05 MS.
*40	U1 FRONT CROSSMEMBER X	-120 425 G'S ** 39 502 G'S	**	33.45 MS. 168.45 MS.

*Accelerometer locations can be found on Figure 4 Page 3-12

**See Test Anomalies (Section 2).

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

RUN # 933		SERIES # 4		
CHAN	TITLE	MINIMUM/MAXIMUM	AT	TIME
* 41	U1 FRONT CROSSMEMBER Z	-28.306 G'S 13.203 G'S		34.57 MS. 43.35 MS.
* 42	U1 F FRONT CALIPEP X	-50.426 G'S 9.746 G'S		44.85 MS. 67.50 MS.
* 43	U1 L FRONT CALIPEP X	-87.372 G'S 57.753 G'S		37.80 MS. 55.57 MS.
* 44	U1 STEERING HUB X	-86.716 G'S 15.205 G'S		36.52 MS. 50.17 MS.
* 45	U1 STEERING HUB Z	-41.779 G'S 71.347 G'S		33.97 MS. 71.77 MS.
* 46	U1.P1 TORSO BELT LOAD	-8.958 LBS 2348.021 LBS.		199.28 MS. 63.07 MS.
47	U2.P2 HEAD X (PRIMARY)	-34.278 G'S 78.578 G'S		82.12 MS. 186.97 MS.
48	U2.P2 HEAD Y (PRIMARY)	-22.673 G'S 17.214 G'S		185.10 MS. 90.67 MS.

*Accelerometer locations can be found on Figure 4 Page 3-12

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

RUN # 933		SERIES # 4			
CHAN	TITLE	MINIMUM/MAXIMUM	AT	TIME	
49	U2.P2 HEAD Z (PRIMARY)	-2.504 G'S 56.770 G'S		-1.95 MS. 76.87 MS.	
50	U2.P2 HD12G	-45.248 G'S 79.982 G'S		82.35 MS. 186.97 MS.	
51	U2.P2 HD12G	-13.817 G'S 62.198 G'S		216.75 MS. 66.45 MS.	
52	U2.P2 HD2YG	-22.119 G'S 15.039 G'S		185.10 MS. 91.65 MS.	
53	U2.P2 HD22G	-4.132 G'S 54.960 G'S		196.65 MS. 66.52 MS.	
54	U2.P2 HD3XG	-88.137 G'S 166.279 G'S		89.10 MS. 188.10 MS.	
55	U2.P2 HD3YG	-26.900 G'S 205.533 G'S		74.33 MS. 194.03 MS.	
56	U2.P2 CHEST X	-55.803 G'S 11.812 G'S		64.35 MS. 191.40 MS.	

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

RUN # 932		SERIES # 4	
CHAN	TITLE	MINIMUM/MAXIMUM	AT TIME
57	U2 P2 CHEST Y	-6.289 G'S 17.984 G'S	177.45 MS. 178.80 MS.
58	U2.P2 CHEST Z	-13.403 G'S 8.088 G'S	75.23 MS. 62.47 MS.
59	U2 P2 UPPER STERNUM AX	-58.930 G'S 23.123 G'S	55.95 MS. 109.60 MS.
60	U2.P2 LOWER STERNUM AX	-69.821 G'S 37.258 G'S	59.92 MS. 55.87 MS.
61	U2.P2 CHEST DISPLACEMENT	-2.347 INCHES .269 INCHES	97.12 MS. 262.05 MS.
62	U2.P2 LEFT FEMUR LOAD	-71.830 LBS. 1894.335 LBS.	115.05 MS. 47.70 MS.
63	U2.P2 RIGHT FEMUR LOAD	-121.736 LBS. 1027.721 LBS.	108.15 MS. 51.75 MS.
64	U2.P2 UPPER NECK FX	** -376.802 LBS. 28.039 LBS.	** 71.77 MS. 213.00 MS.

**See Test Anomalies (Section 2)

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

RUN # 933		SERIES # 4	
CHAN	TITLE	MINIMUM/MAXIMUM	AT TIME
65	U2.P2 UPPER NECK FY	-53.389 LBS 166.914 LBS	133.42 MS. 92.25 MS.
66	U2.P2 UPPER NECK FZ	-29.365 LBS. 566.173 LBS	219.60 MS. 78.15 MS.
67	U2.P2 UPPER NECK MX	-361.190 IN-LBS 300.444 IN-LBS.	83.33 MS. 105.82 MS.
68	U2.P2 UPPER NECK MY	-666.961 IN-LBS 465.132 IN-LBS	191.78 MS. 216.30 MS.
69	U2.P2 UPPER NECK MZ	-60.399 IN-LBS. 308.062 IN-LBS.	180.53 MS. 212.33 MS.
70	U2.P2 LOWER NECK FY	-551.195 LBS. 95.431 LBS	77.17 MS. 217.72 MS.
71	U2.P2 LOWER NECK FZ	-171.979 LBS. 111.073 LBS.	49.80 MS. 153.97 MS.
72	U2.P2 LOWER NECK FZ	-278.369 LBS. 535.914 LBS.	184.65 MS. 91.95 MS.

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

CHAN	TITLE	MINIMUM/MAXIMUM	AT	TIME
73	U2 P2 LOWER NECK NX	-1337 918 IN-LBS 324 809 IN-LBS		87.67 MS. 139.80 MS.
74	U2 P2 LOWER NECK NY	-736 263 IN-LBS 3346 657 IN-LBS		184.28 MS. 90.82 MS.
75	U2 P2 LOWER NECK NZ	-553 043 IN-LBS 159 266 IN-LBS		47.85 MS. 210.75 MS.
76	U2 L REAR SEAT XMEMBER X	-38 636 G'S 1 374 G'S		35.25 MS. 126.67 MS.
77	U2 P REAR SEAT XMEMBER X	-40 817 G'S 2 396 G'S		42.67 MS. 133.42 MS.
* 78	U2 REAR SEAT C L X	-38 420 G'S 2 311 G'S		57.90 MS. 123.15 MS.
* 79	U2 REAR SEAT C L X(R)	-38 695 G'S 2 856 G'S		57.82 MS. 146.40 MS.
* 80	U2 REAR SEAT C L Y	-4 892 G'S 2.699 G'S		30.90 MS. 17.85 MS.

*Accelerometer locations can be found on Figure 9 Page 3-26

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

RUN # 933		SERIES # 4	
CHAN	TITLE	MINIMUM/MAXIMUM	AT TIME
* 81	U2 REAR SEAT C.L. Z	-8.271 G'S 7.503 G'S	59.70 MS. 71.77 MS.
* 82	U2 ENGINE TOP X	-201.378 G'S 59.018 G'S	25.80 MS. 37.42 MS.
* 83	U2 ENGINE TOP Z	-53.357 G'S 37.946 G'S	40.35 MS. 51.45 MS.
* 84	U2 ENGINE BOTTOM Y	-113.798 G'S 8.539 G'S	28.13 MS. 52.35 MS.
* 85	U2 FRONT CROSSMEMBER X	-158.841 G'S 11.026 G'S	32.17 MS. 52.20 MS.
* 86	U2 FRONT CROSSMEMBER Z	-52.165 G'S 21.755 G'S	33.07 MS. 28.50 MS.
* 87	U2 R. FRONT CALIPER X	-71.420 G'S 10.513 G'S	36.22 MS. 66.30 MS.
* 88	U2 L. FRONT CALIPER X	-76.226 G'S 28.550 G'S	39.60 MS. 54.45 MS.

*Accelerometer locations can be found on Figure 9 Page 3-28

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

PUN # 933		SERIES # 4	
CHAN	TITLE	MINIMUM/MAXIMUM	AT TIME
*89	U2 STEERING HUB X	-113 404 G'S	36.60 MS.
	acceleration (x & y)	11 925 G'S	31.27 MS.
*90	U2 STEERING HUB Z	-50 367 G'S	31.95 MS.
		74 938 G'S	37.42 MS.
91	U2 P2 TORSO BELT LOAD	-21 379 LBS	215.25 MS.
		2757 560 LBS	67.50 MS.

*Accelerometer locations can be found on Figure 9 Page 3-26

B-14

7781-4

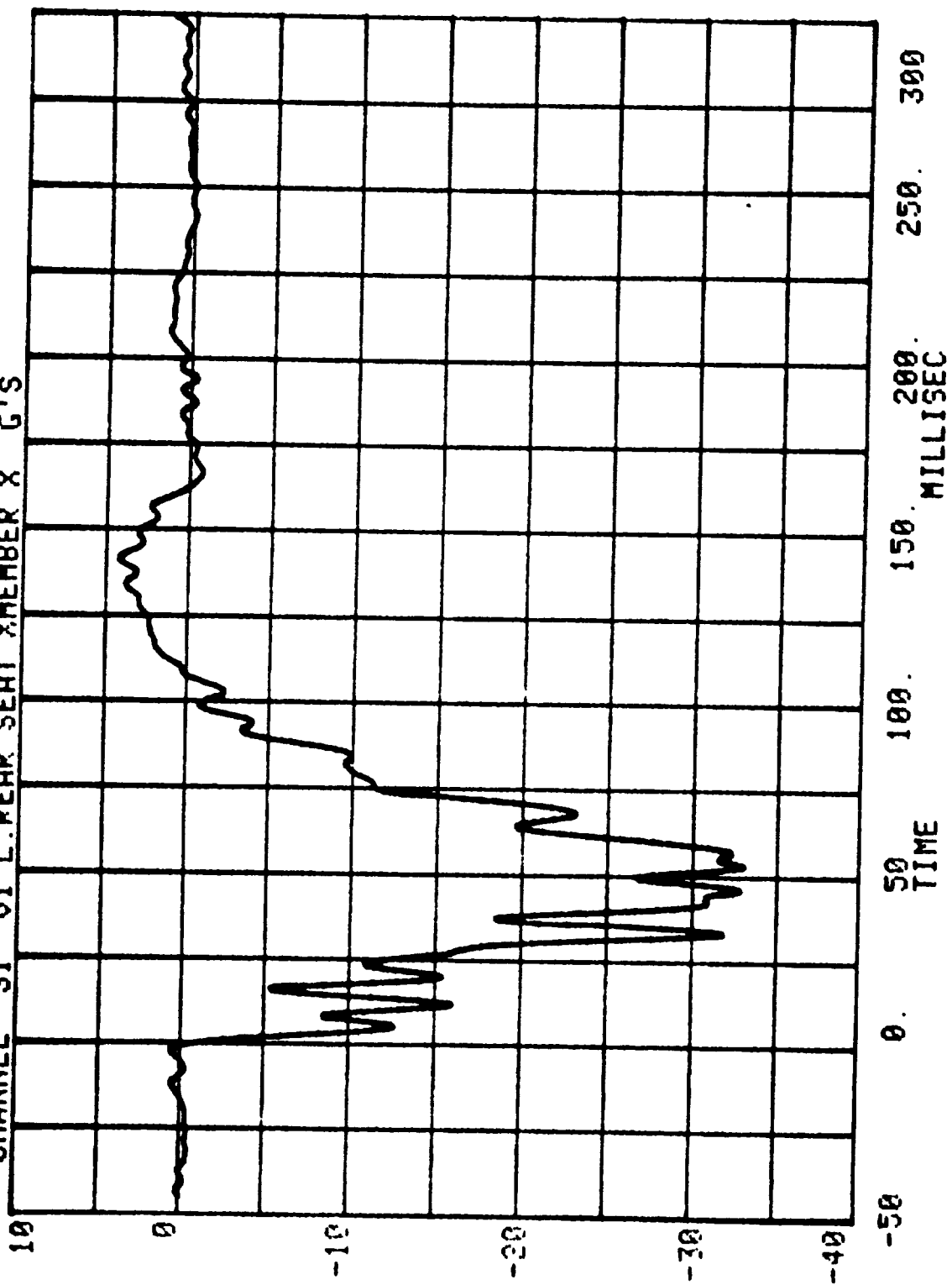
VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

PUN # 933		SERIES # 4			
CHAN	TITLE	MINIMUM	MAXIMUM	HT	TIME
1	U1 P1 HEAD R (PRIMARY)	104	241 G'S		-35.48 MS.
			375 G'S		53.87 MS.
2	U1 P1 CHEST R	68	051 G'S		13.12 MS.
			539 G'S		70.80 MS.
3	U2 P2 HEAD R (PRIMARY)	83	045 G'S		-41.25 MS.
			259 G'S		186.97 MS.
4	U2 P2 CHEST R	57	042 G'S		-45.00 MS.
			521 G'S		64.35 MS.

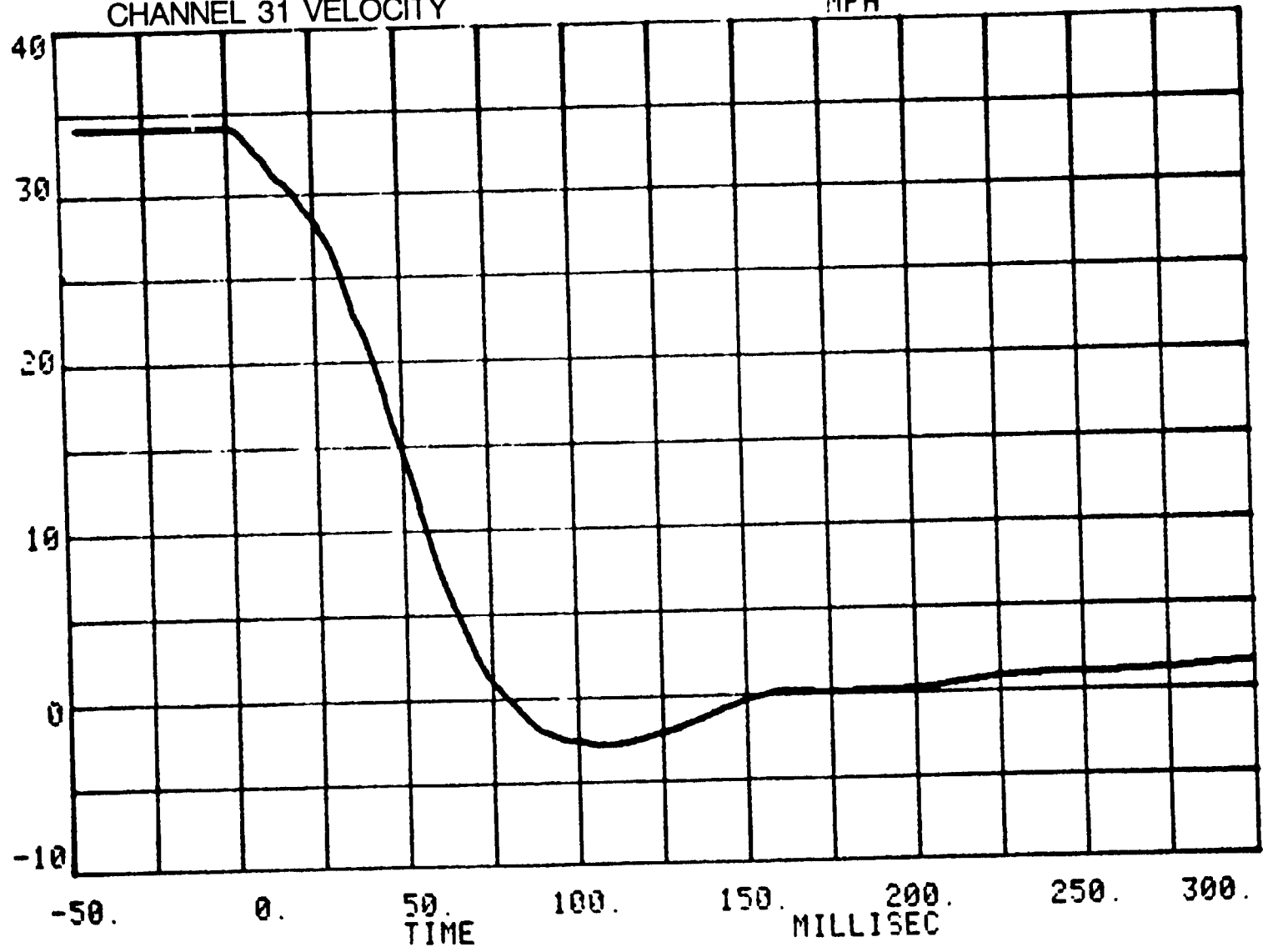
VEHICLE ONE DATA

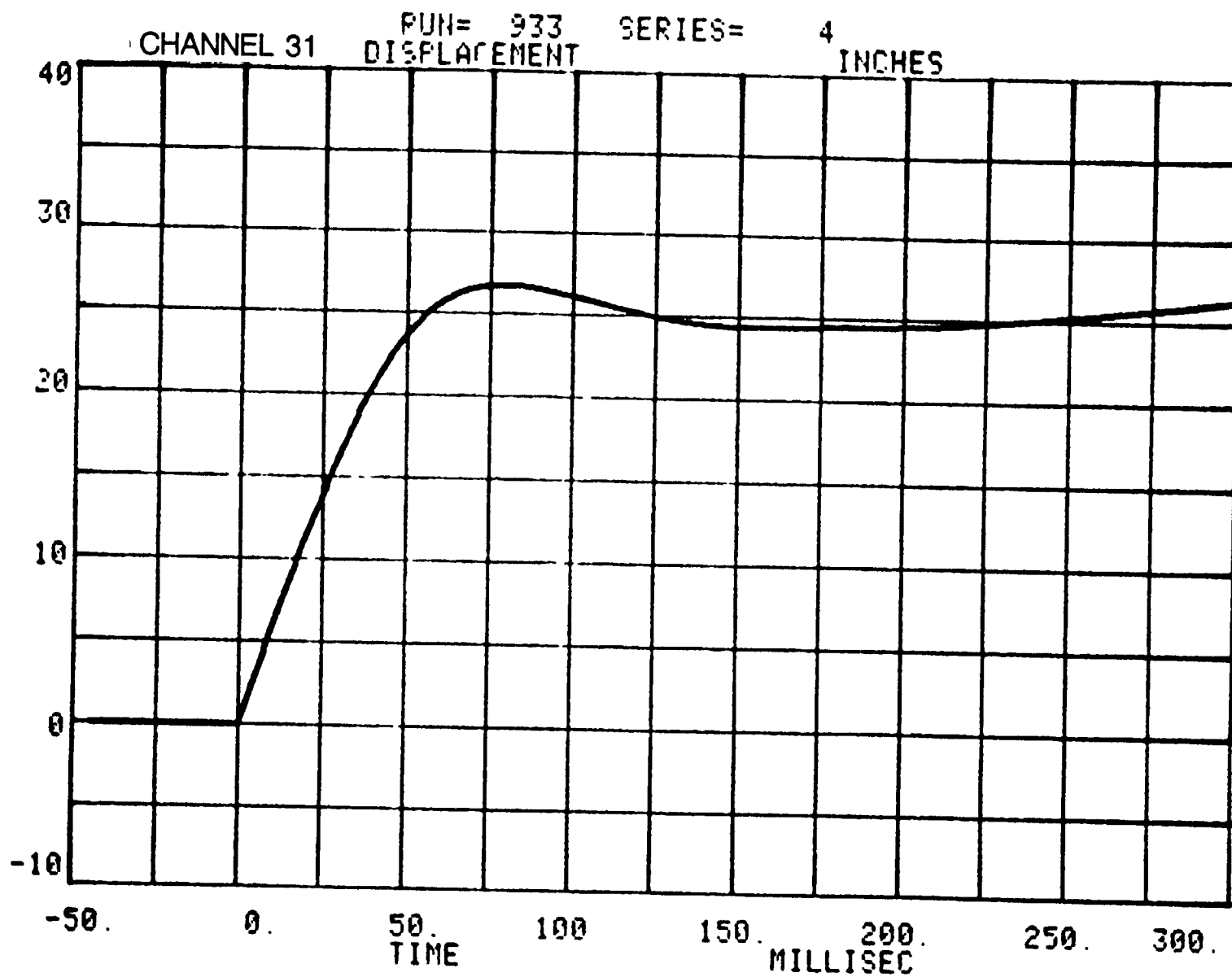
CHANNEL 31 U1 L. REAR SEAT XMEMBER X G'S

RUN= 933 SERIES= 4



RUN= 933 SERIES= 4
CHANNEL 31 VELOCITY MPH

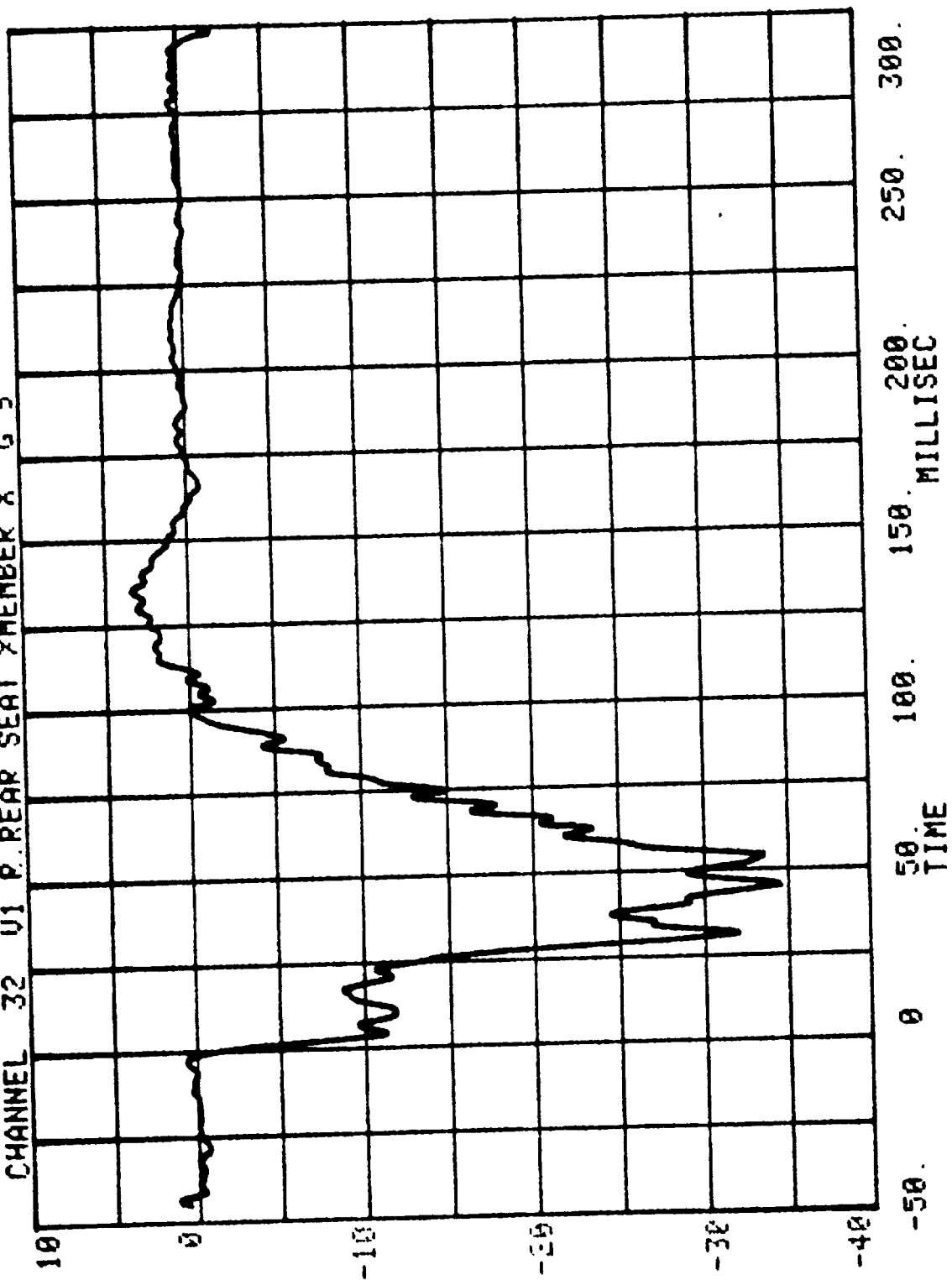


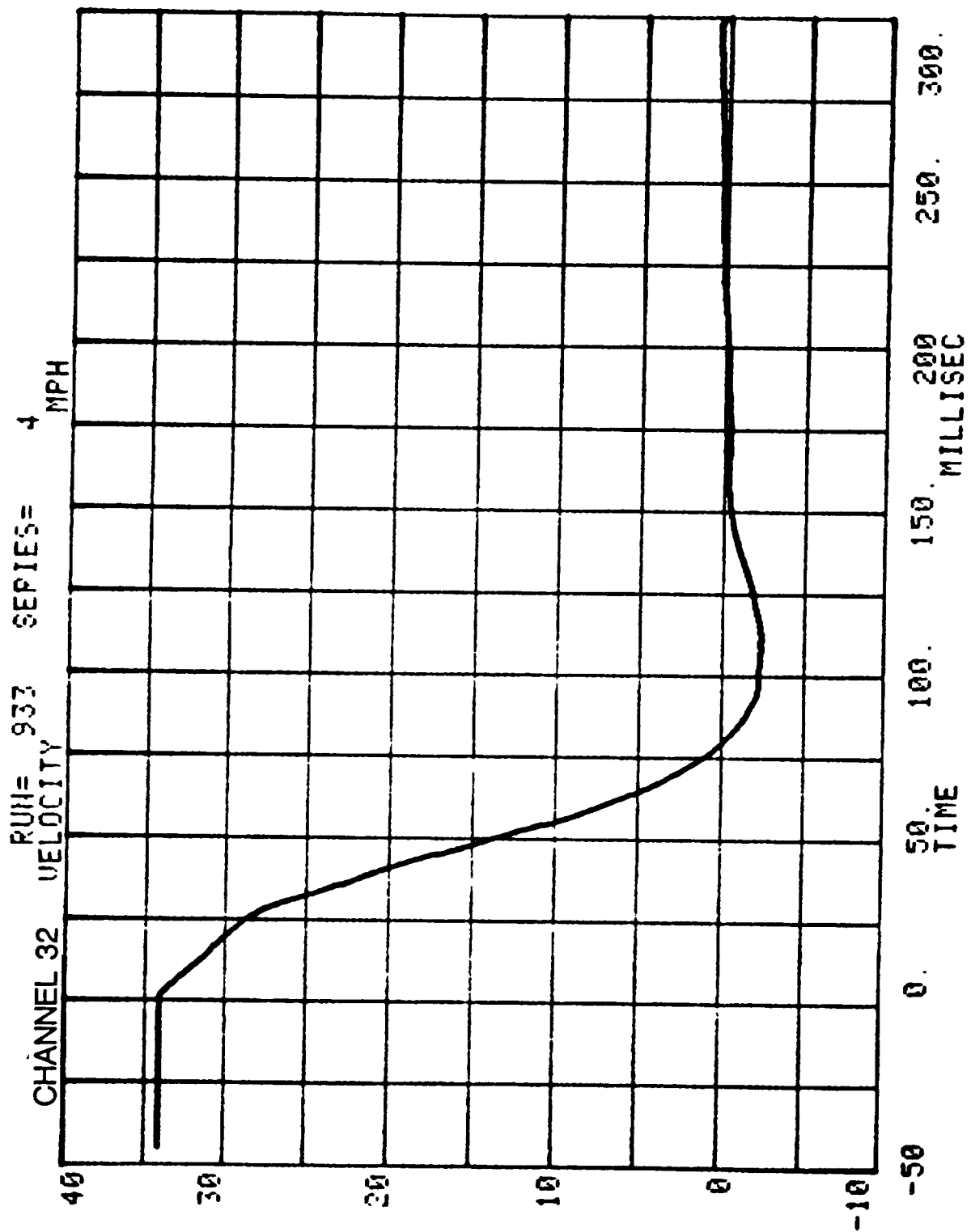


B-19

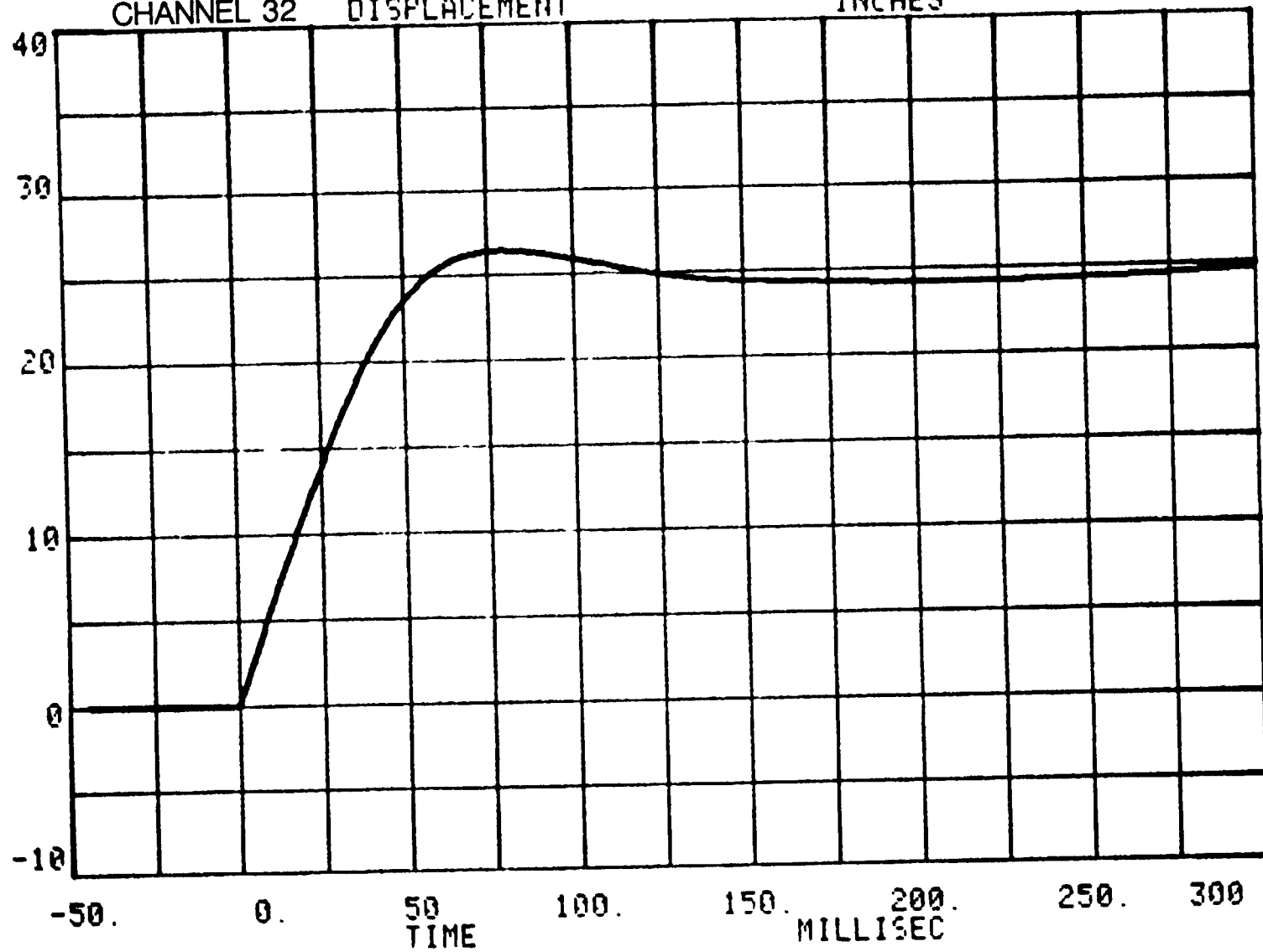
7781-4

CHANNEL 32 U1 P. REAR SEAT MEMBER X 4 G'S



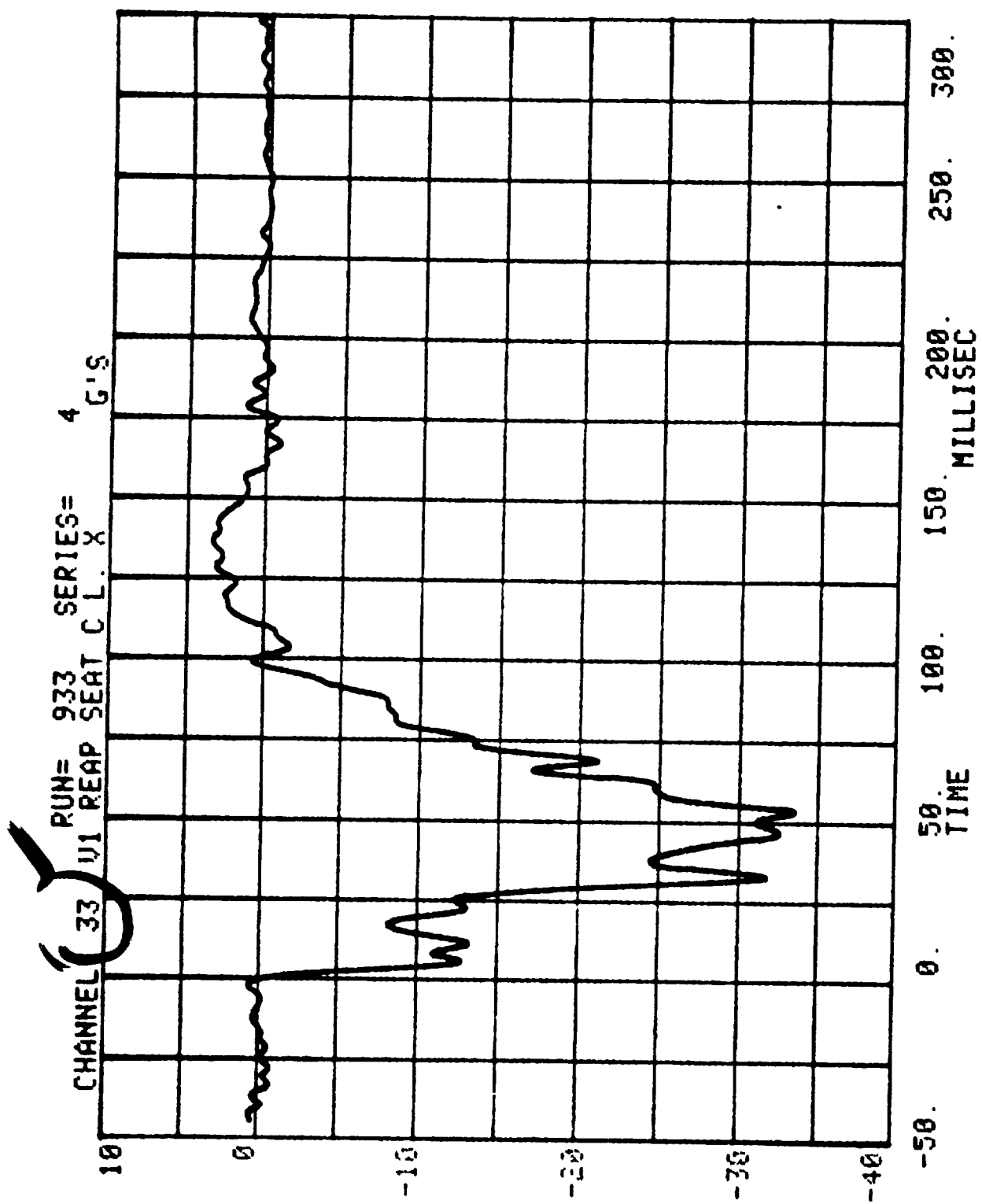


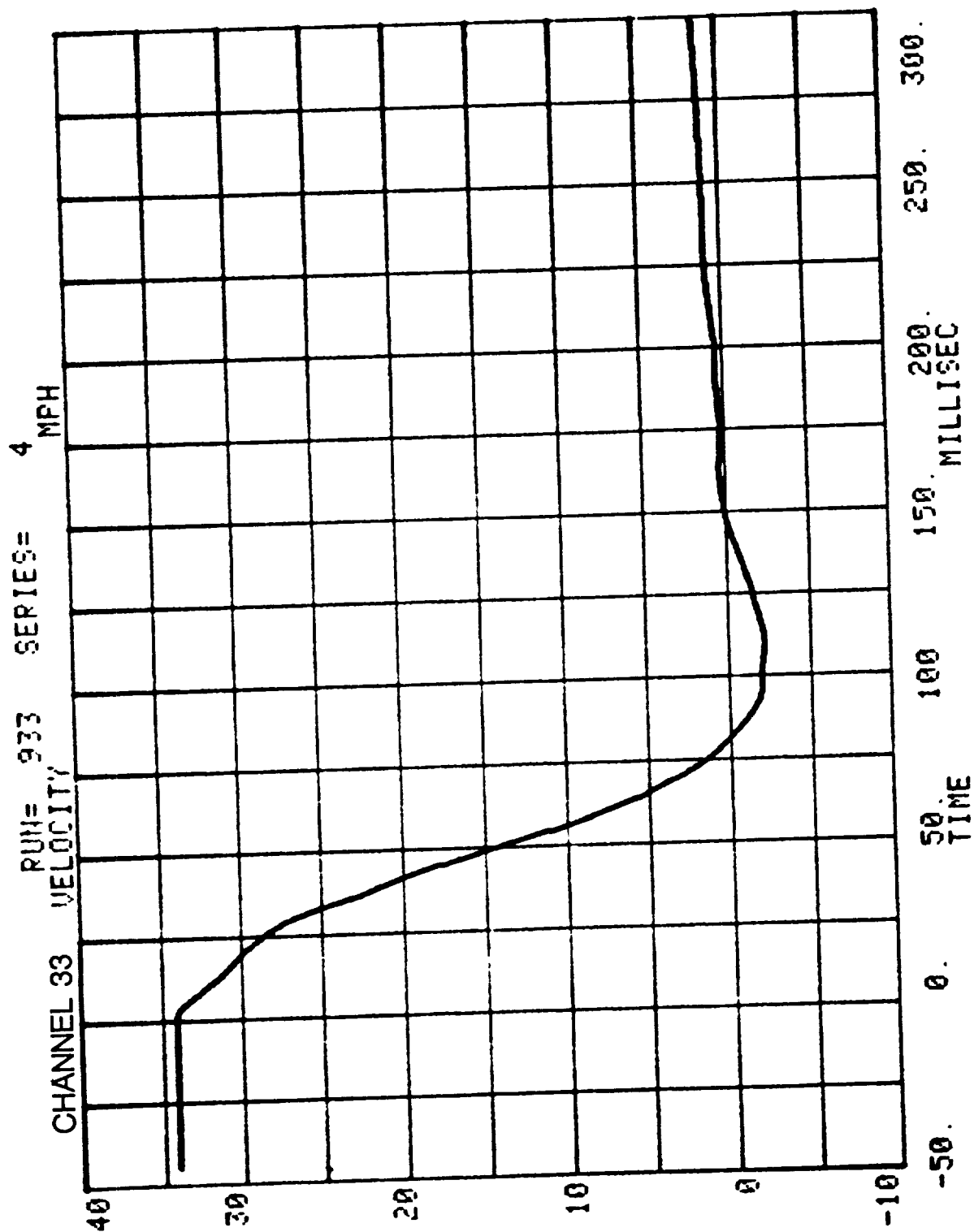
CHANNEL 32 RUN= 933 SERIES= 4 INCHES
DISPLACEMENT

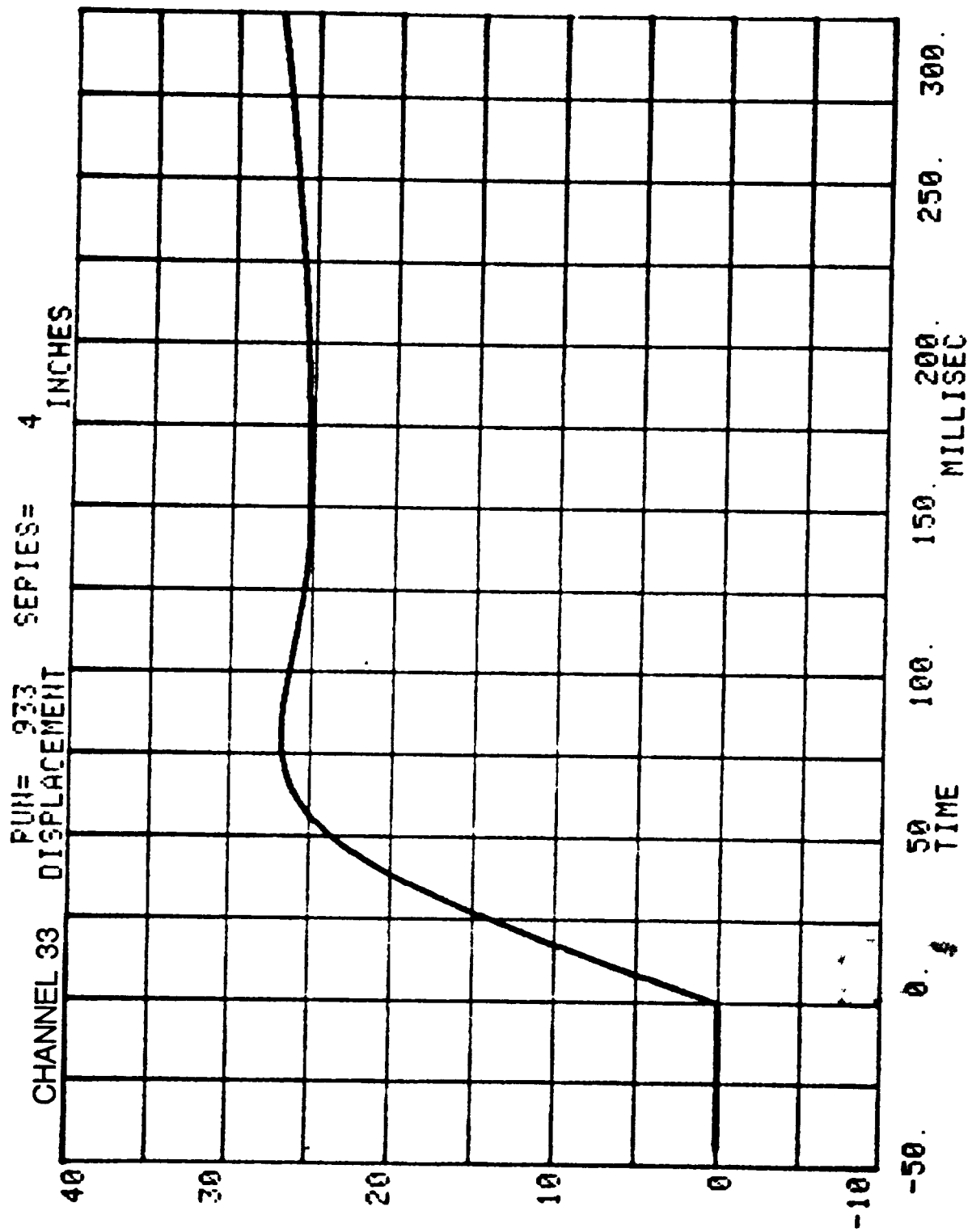


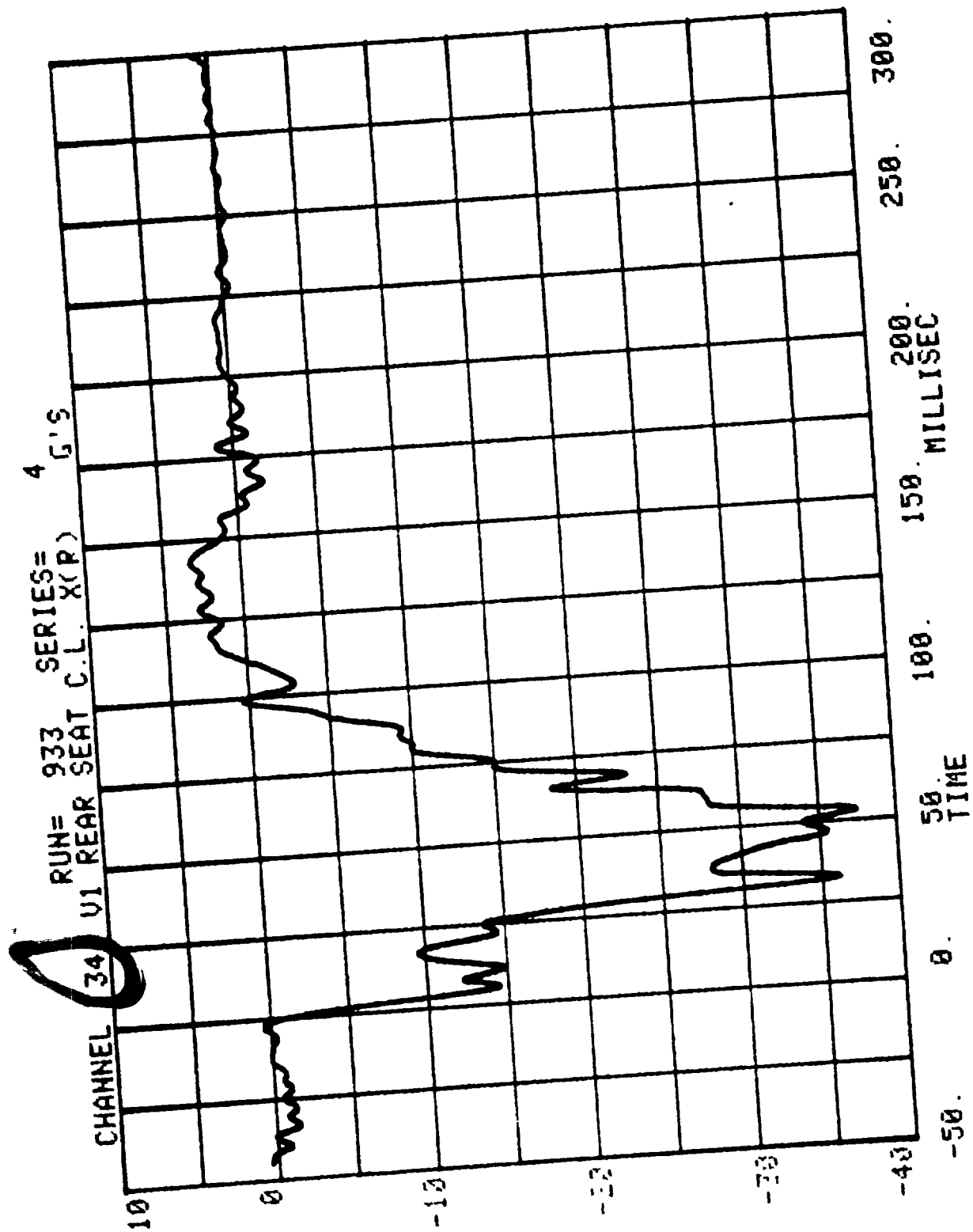
B-22

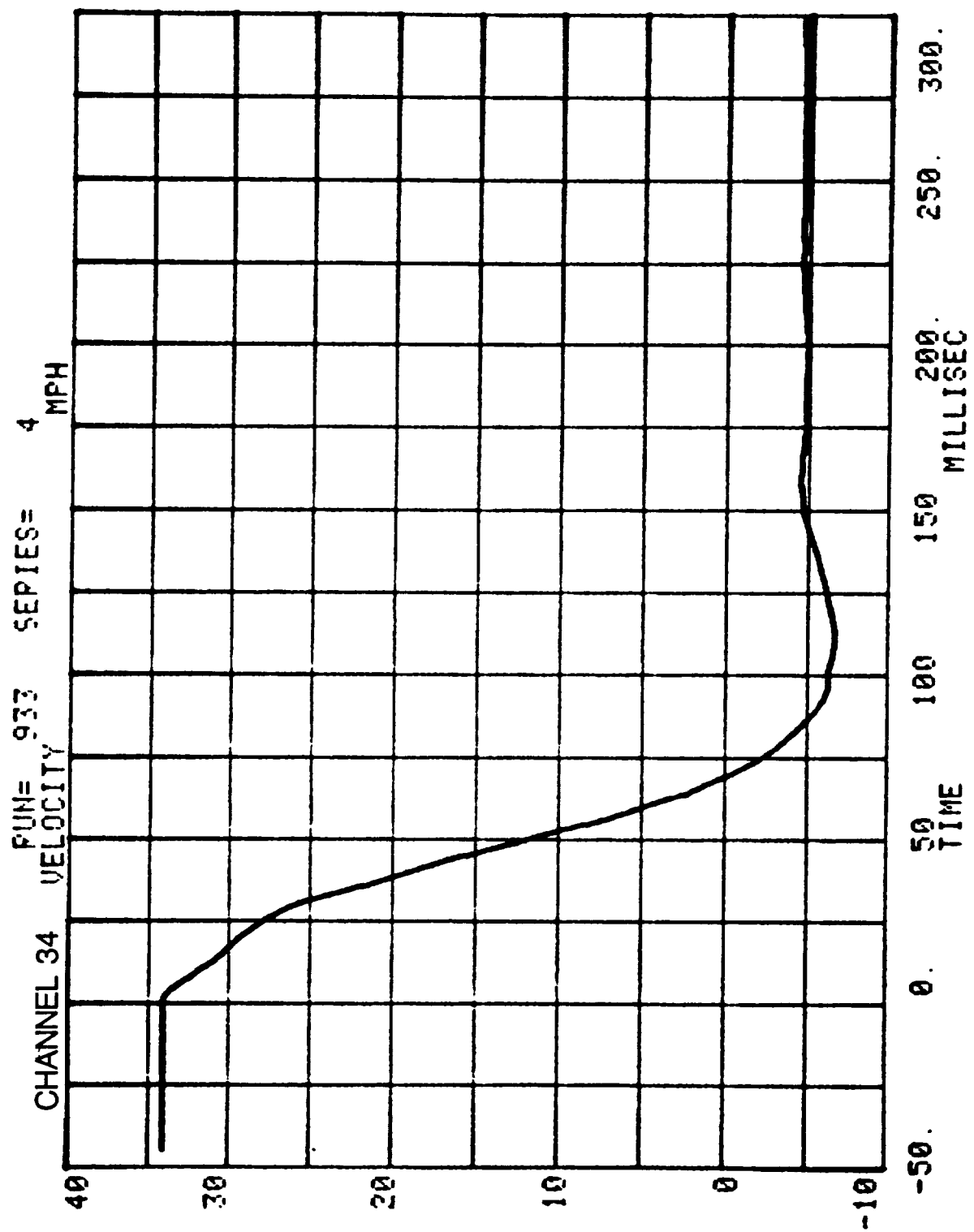
7781-4





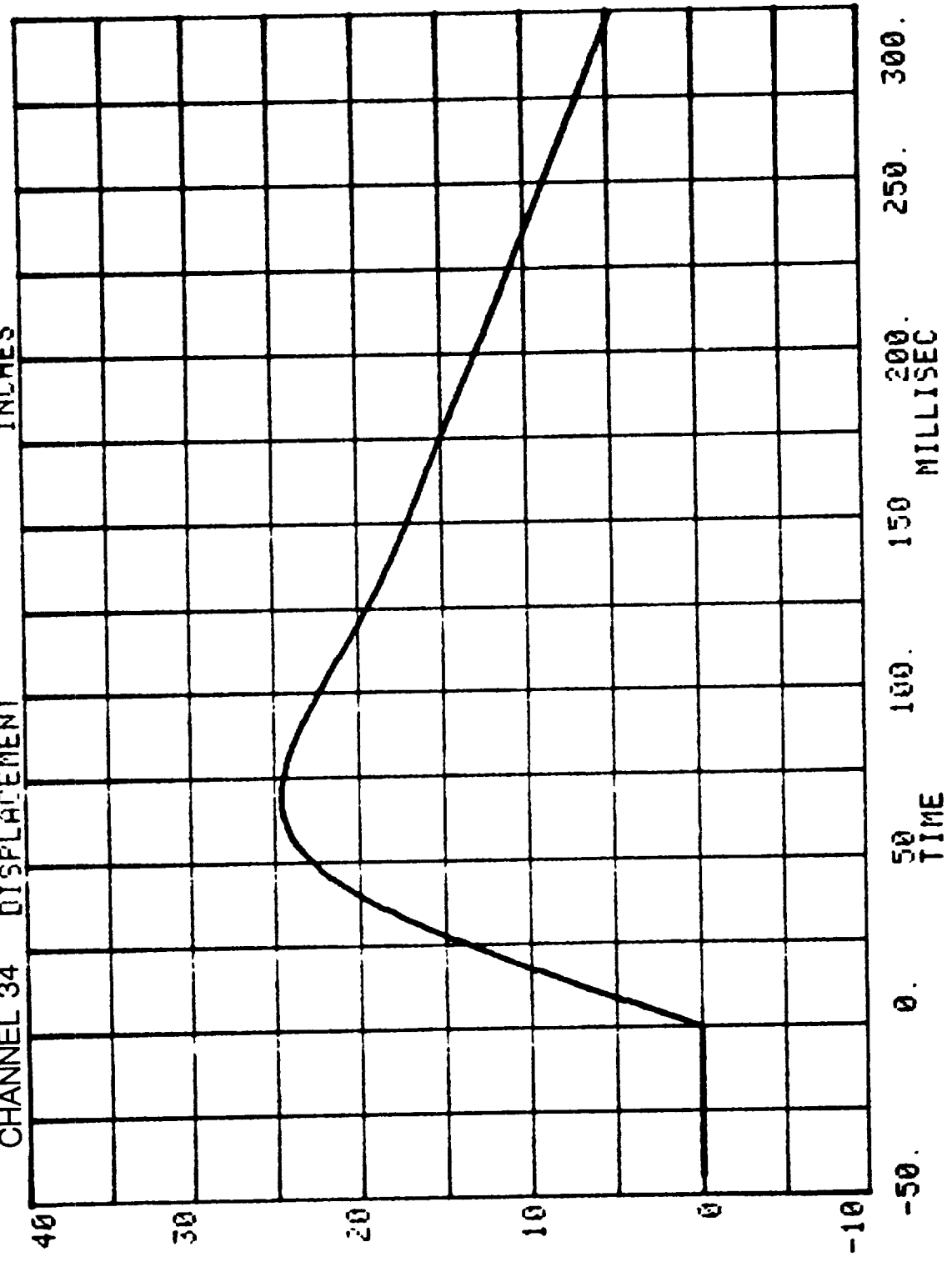


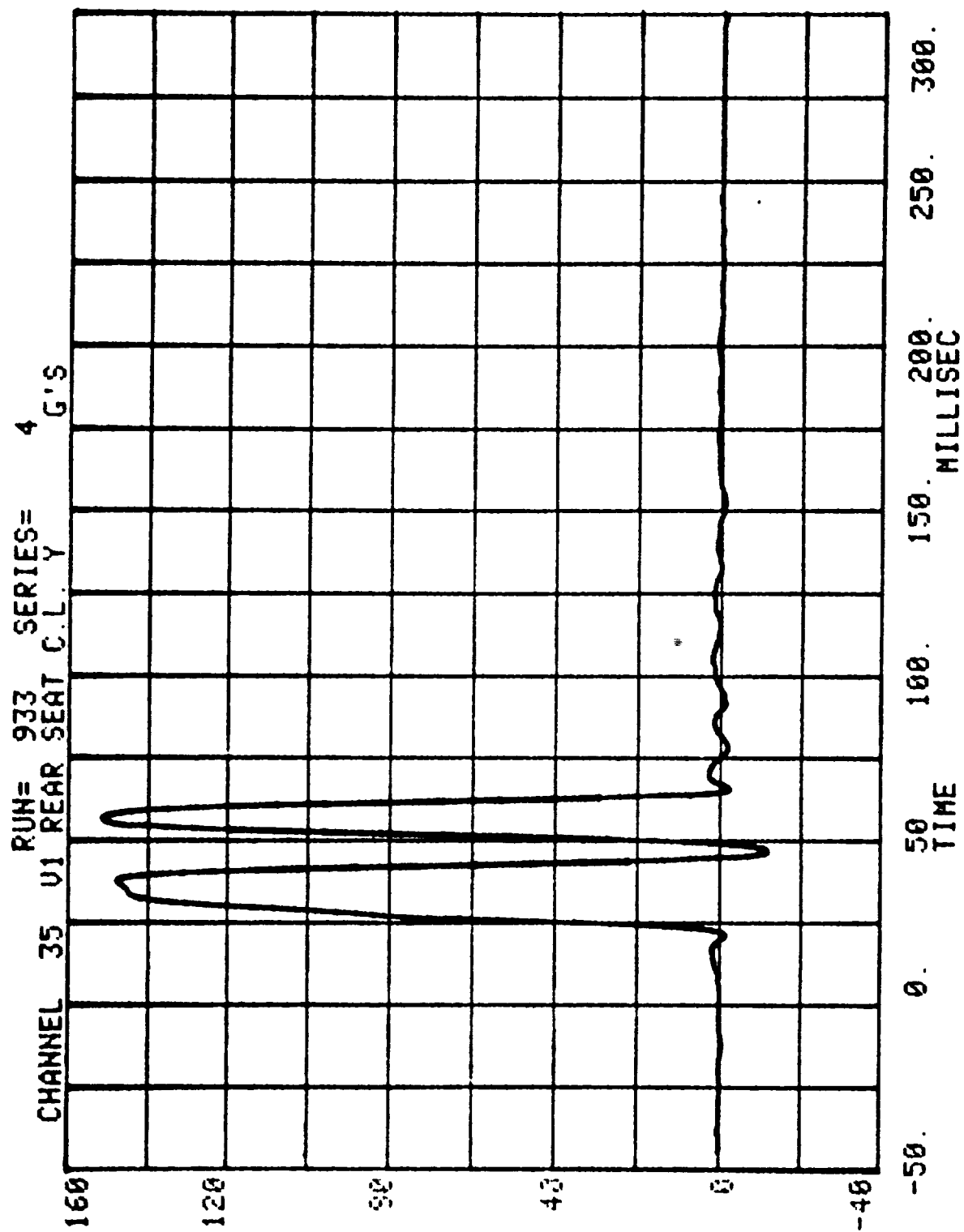




CHANNEL 34 DISPLACEMENT

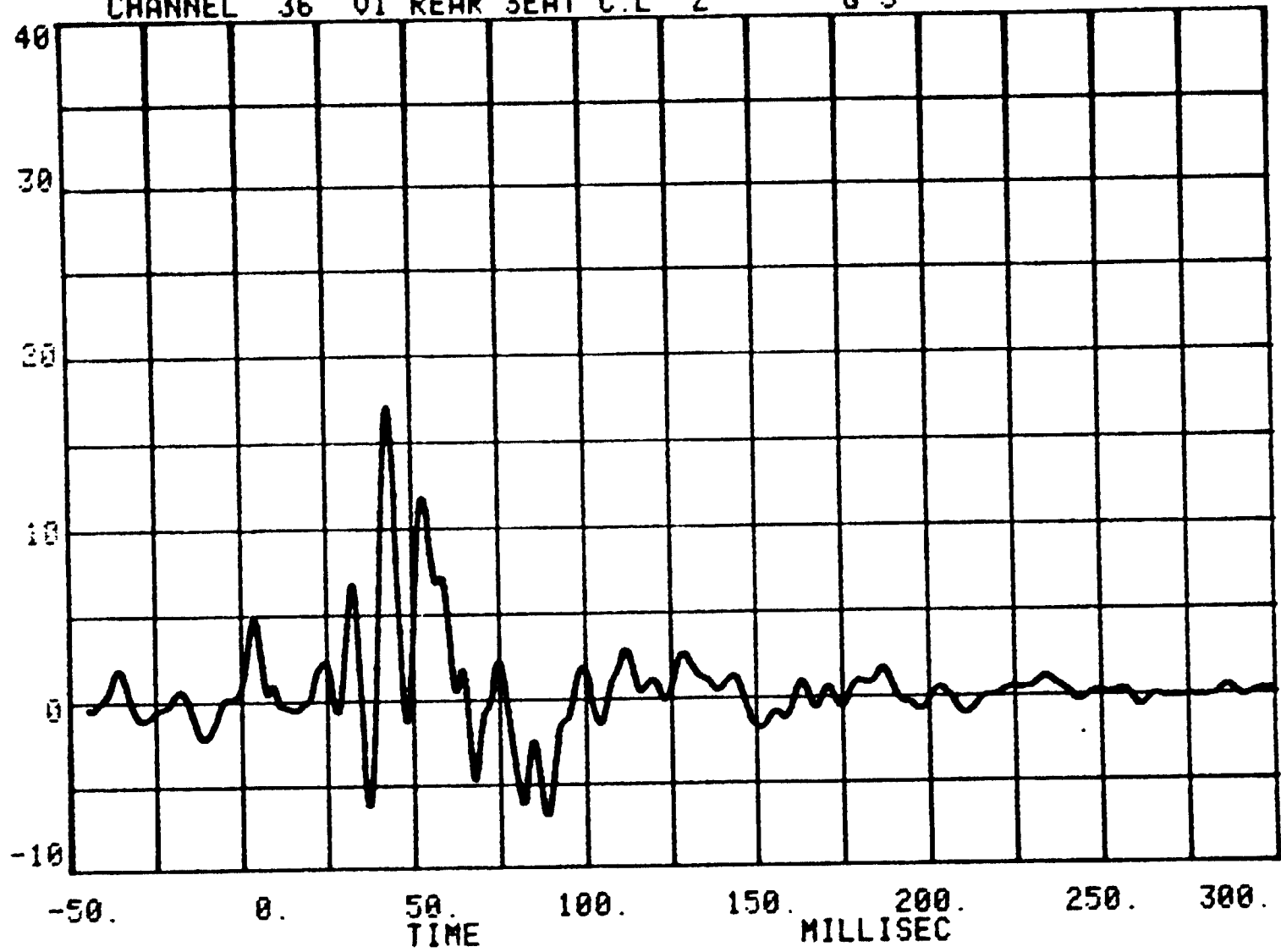
PUN= 933 SERIES= 4 INCHES





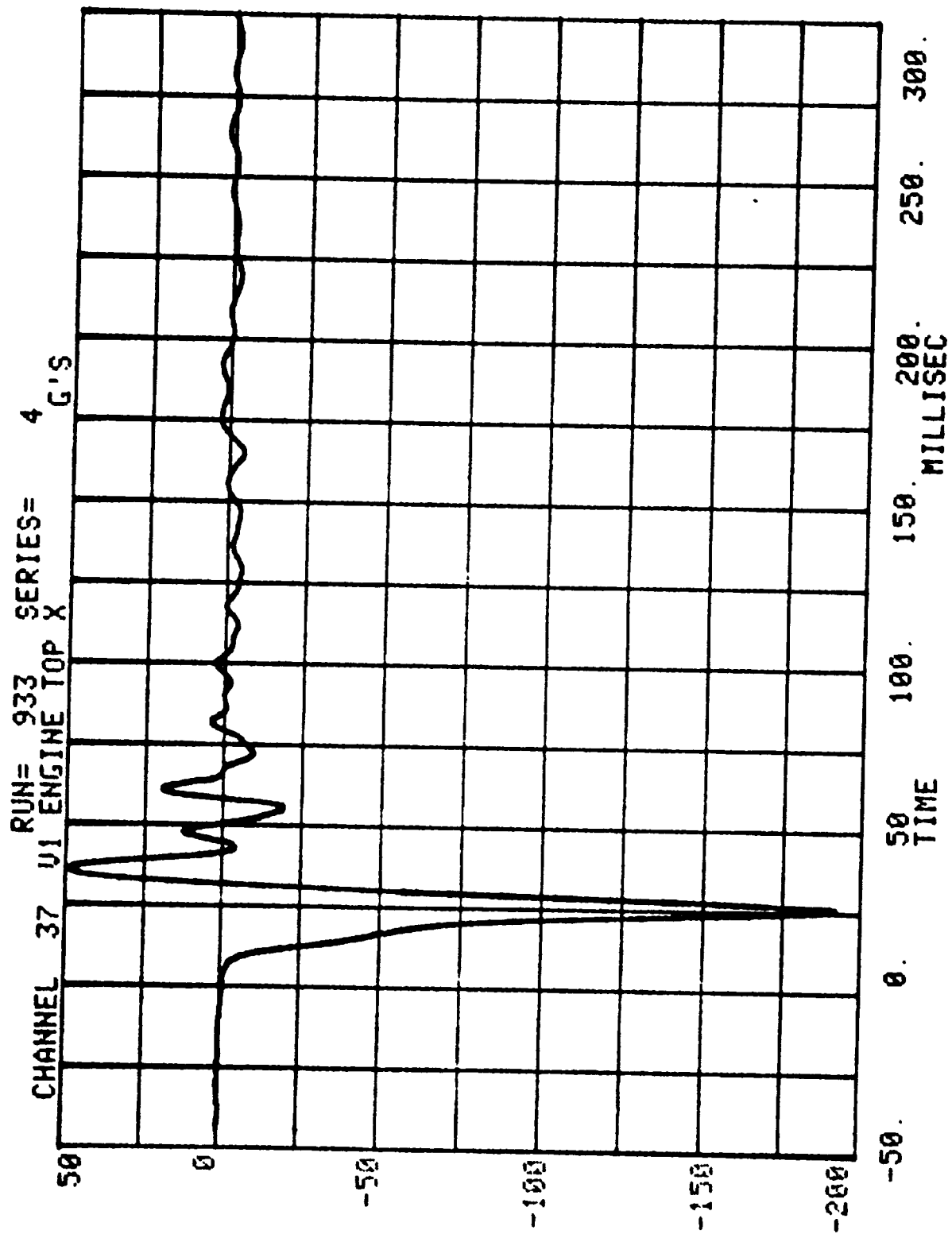
Data questionable between 24 and 65 msec

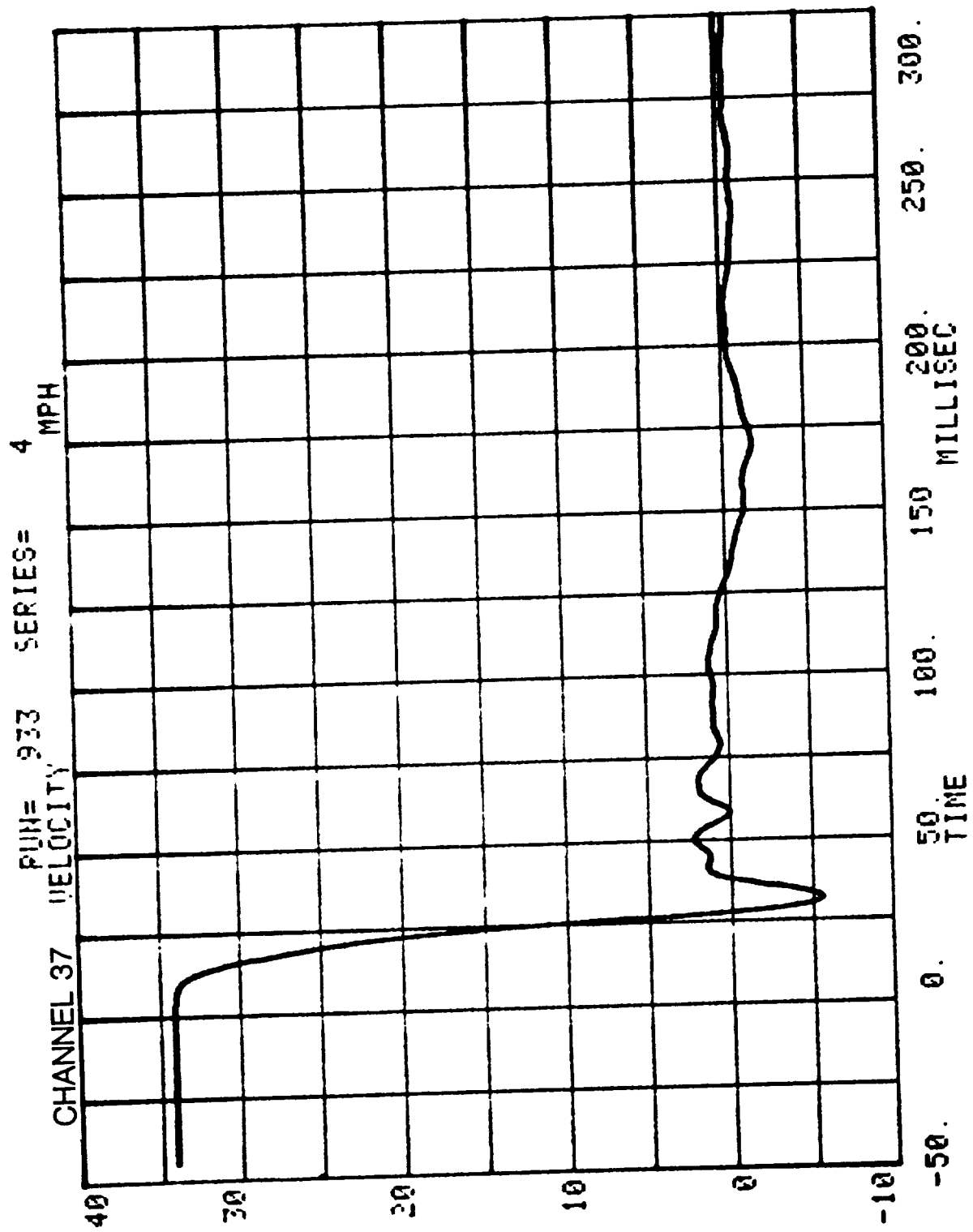
CHANNEL 36 RUN= 933 SERIES= 4
U1 REAR SEAT C.L Z G'S



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7781-4



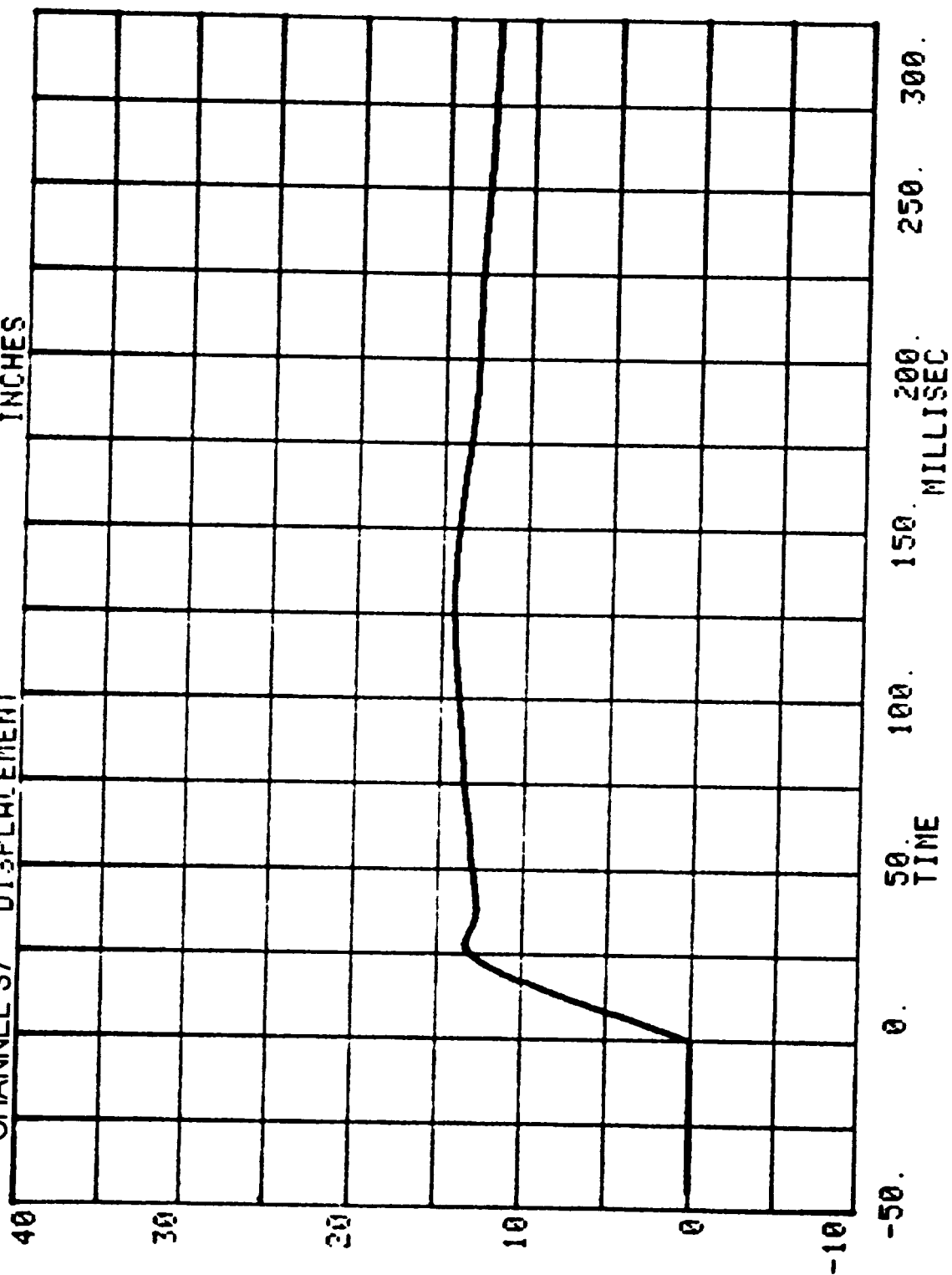


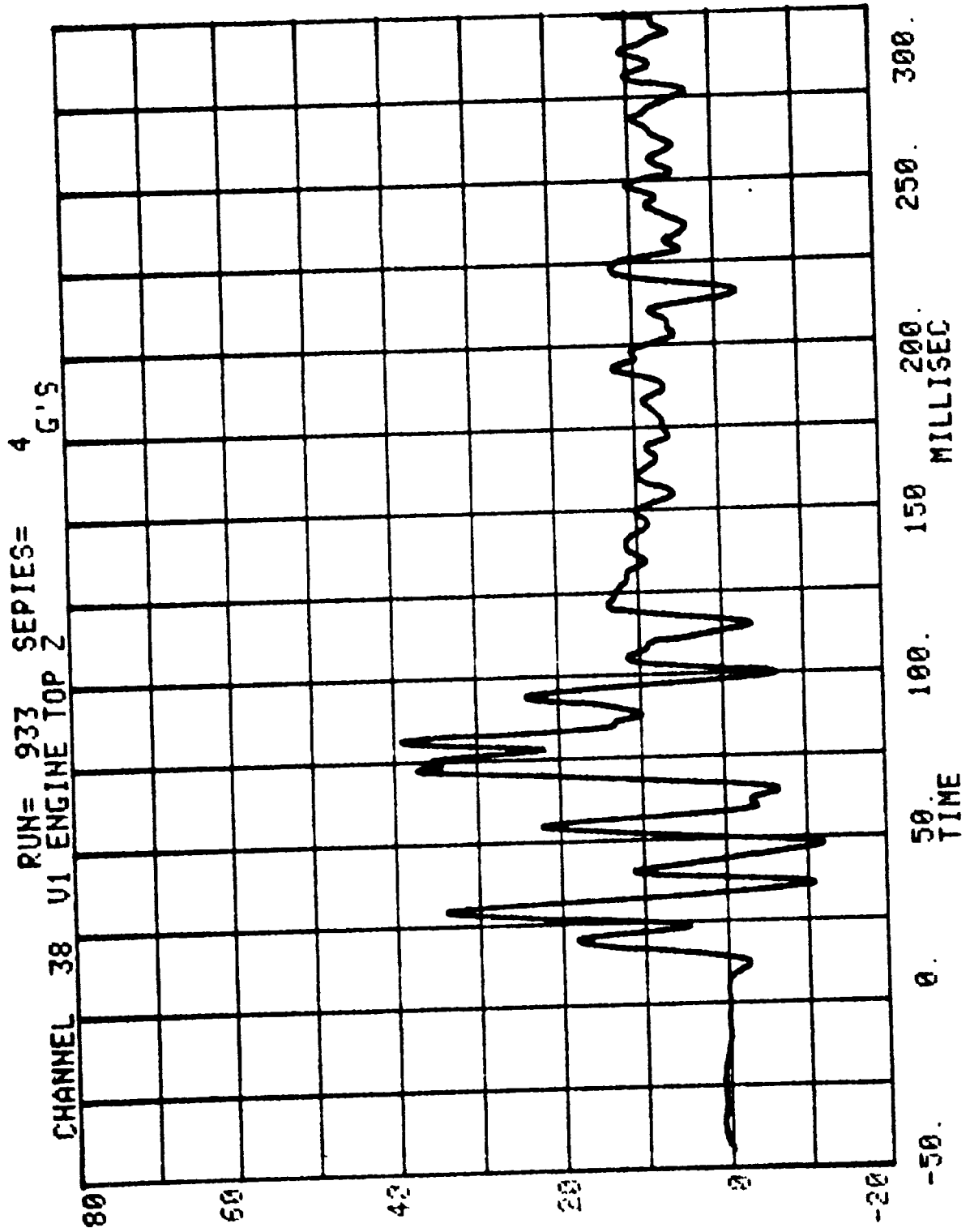
CHANNEL 37 DISPLACEMENT

RUN= 933

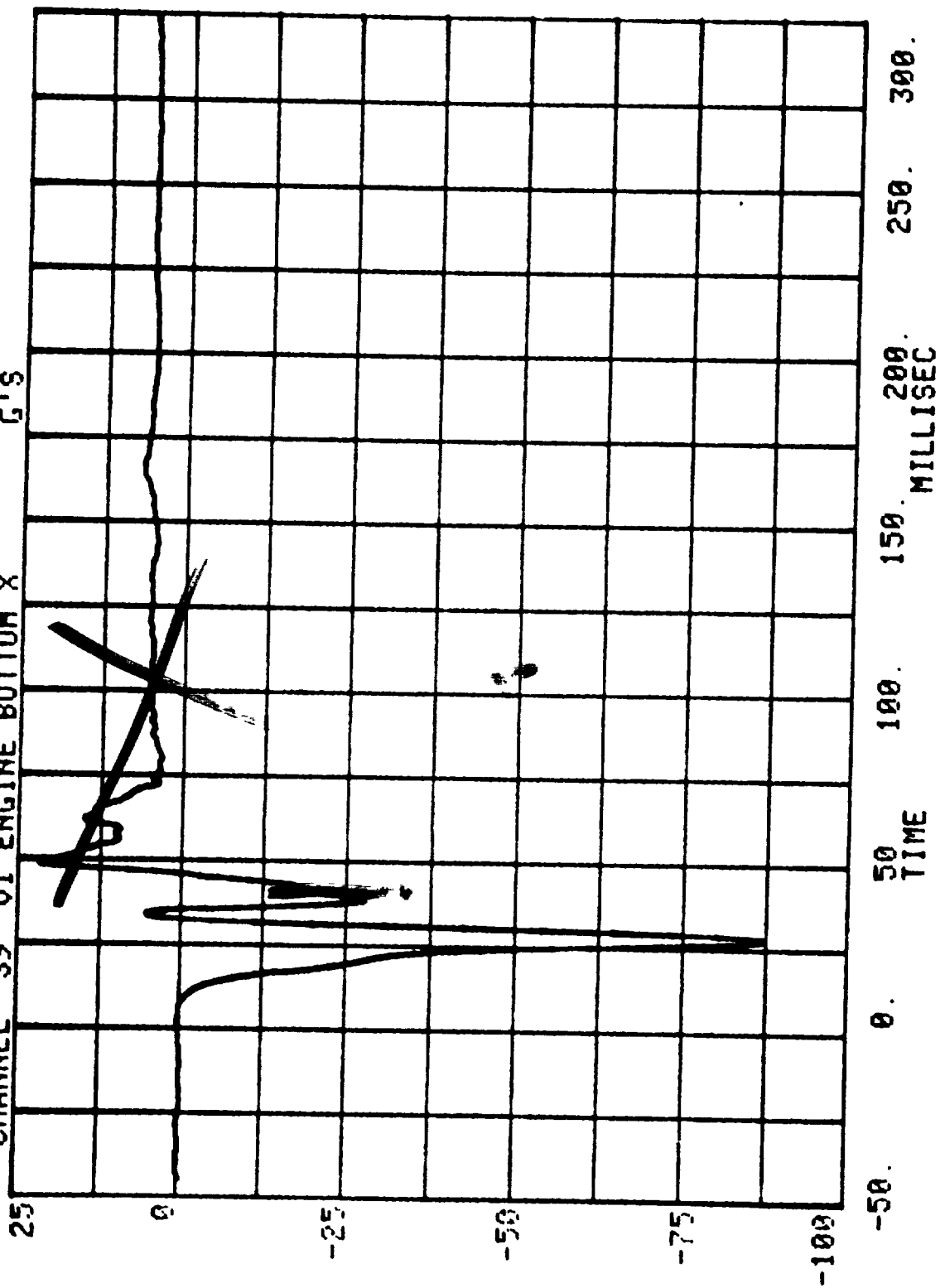
SERIES=

4 INCHES

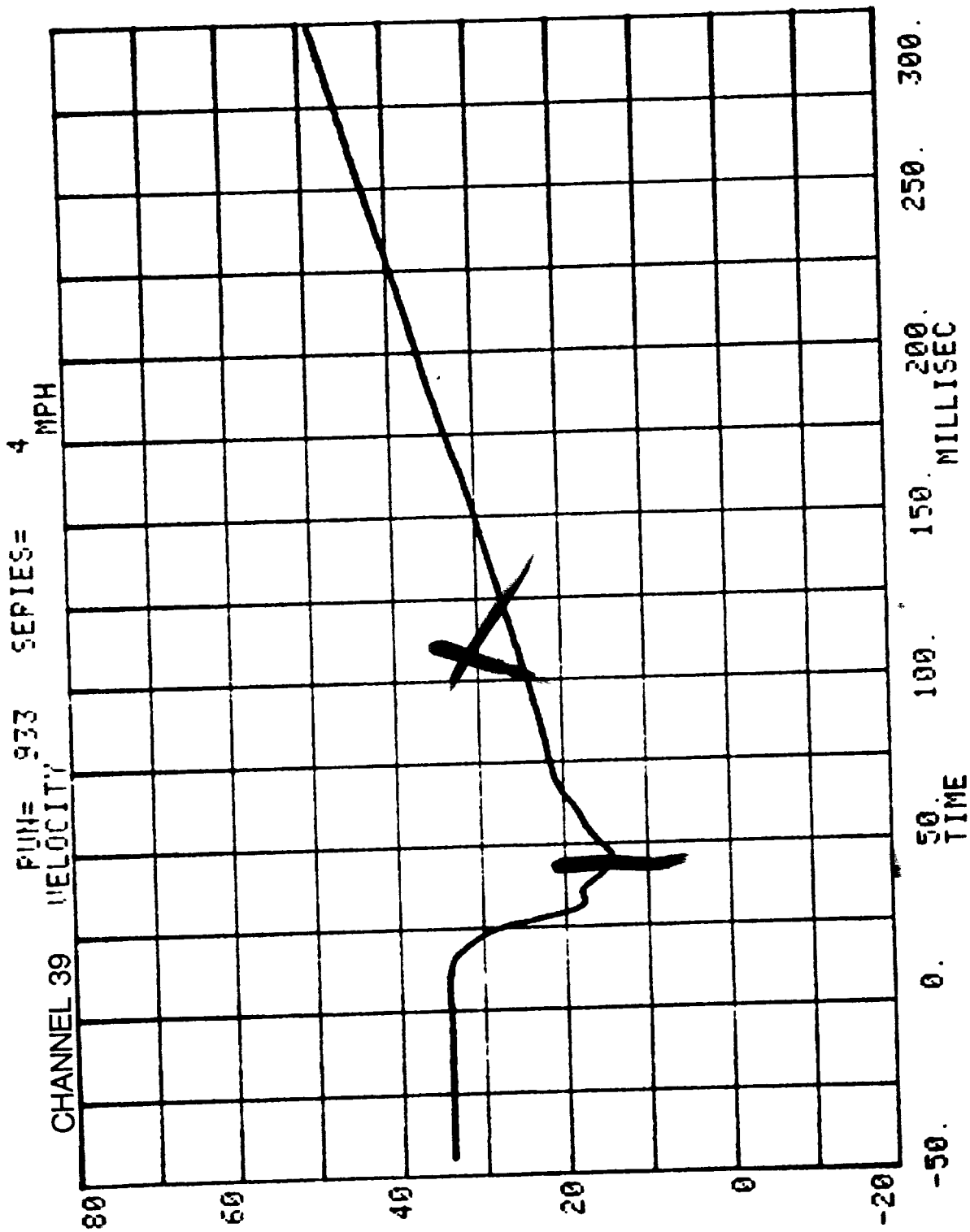




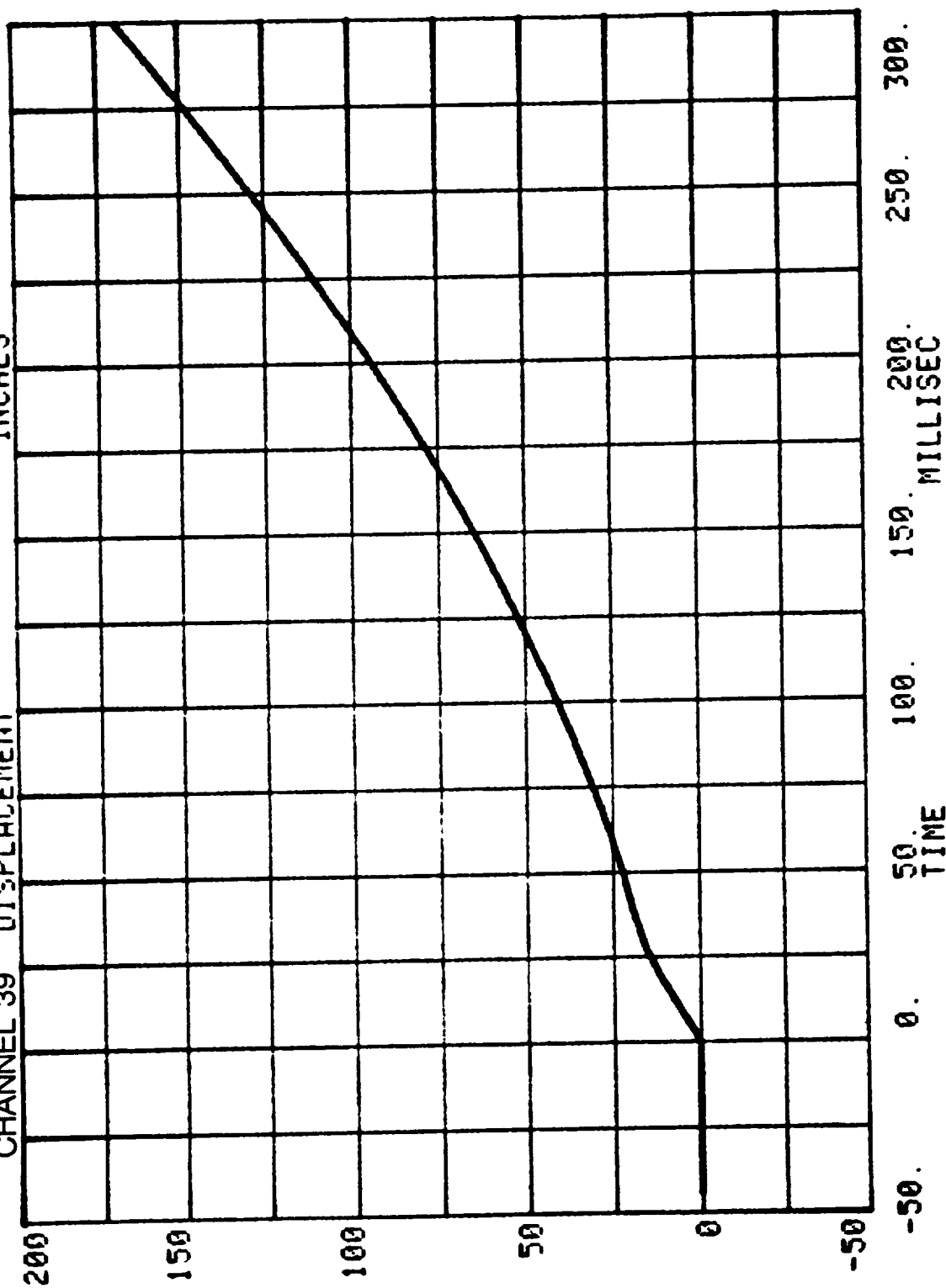
CHANNEL 39 V1 ENGINE BOTTOM X 4 G'S



Data questionable after 75 msec.



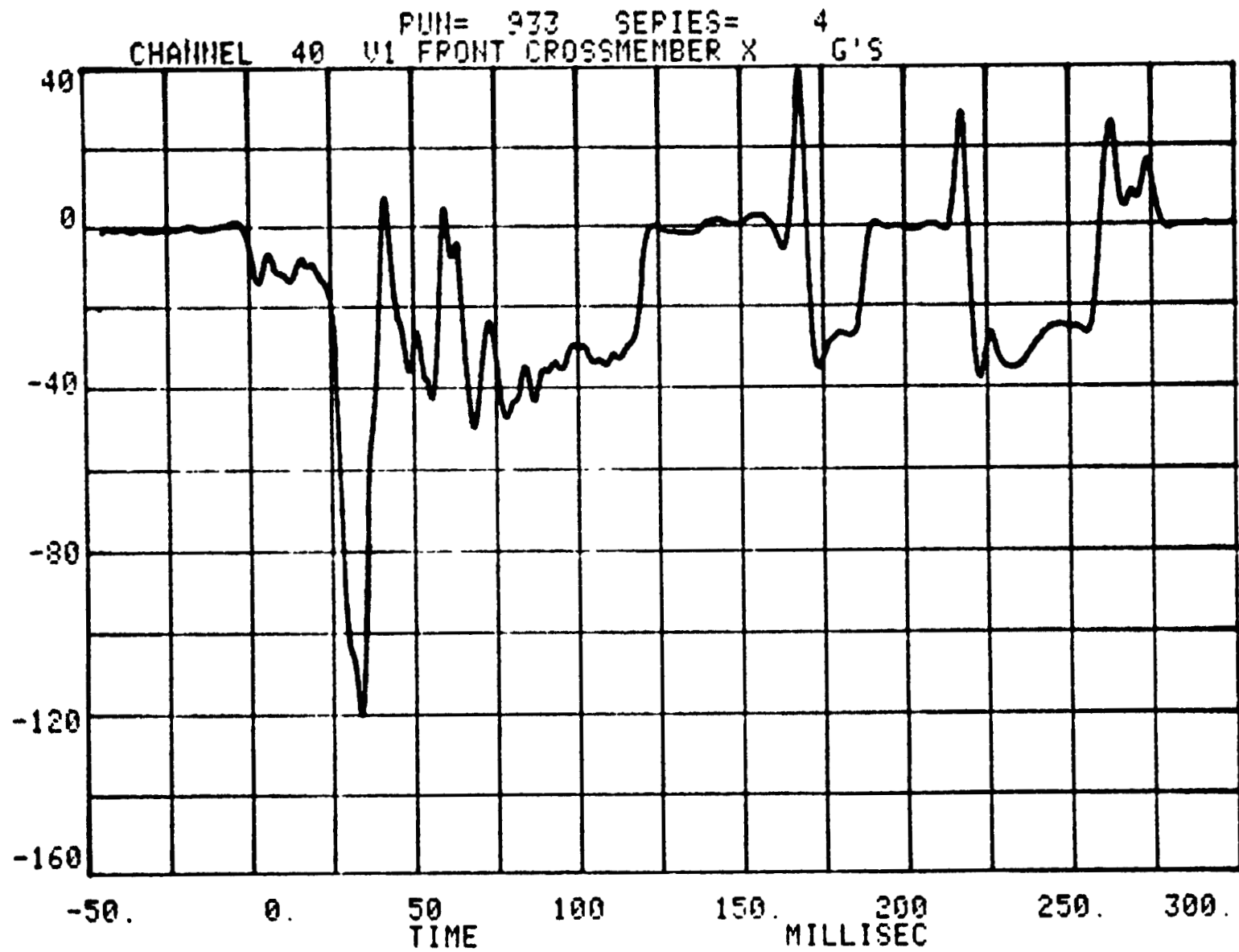
CHANNEL 39 DISPLACEMENT RUN= 933 SERIES= 4 INCHES



Data questionable after 75 msec

B-38

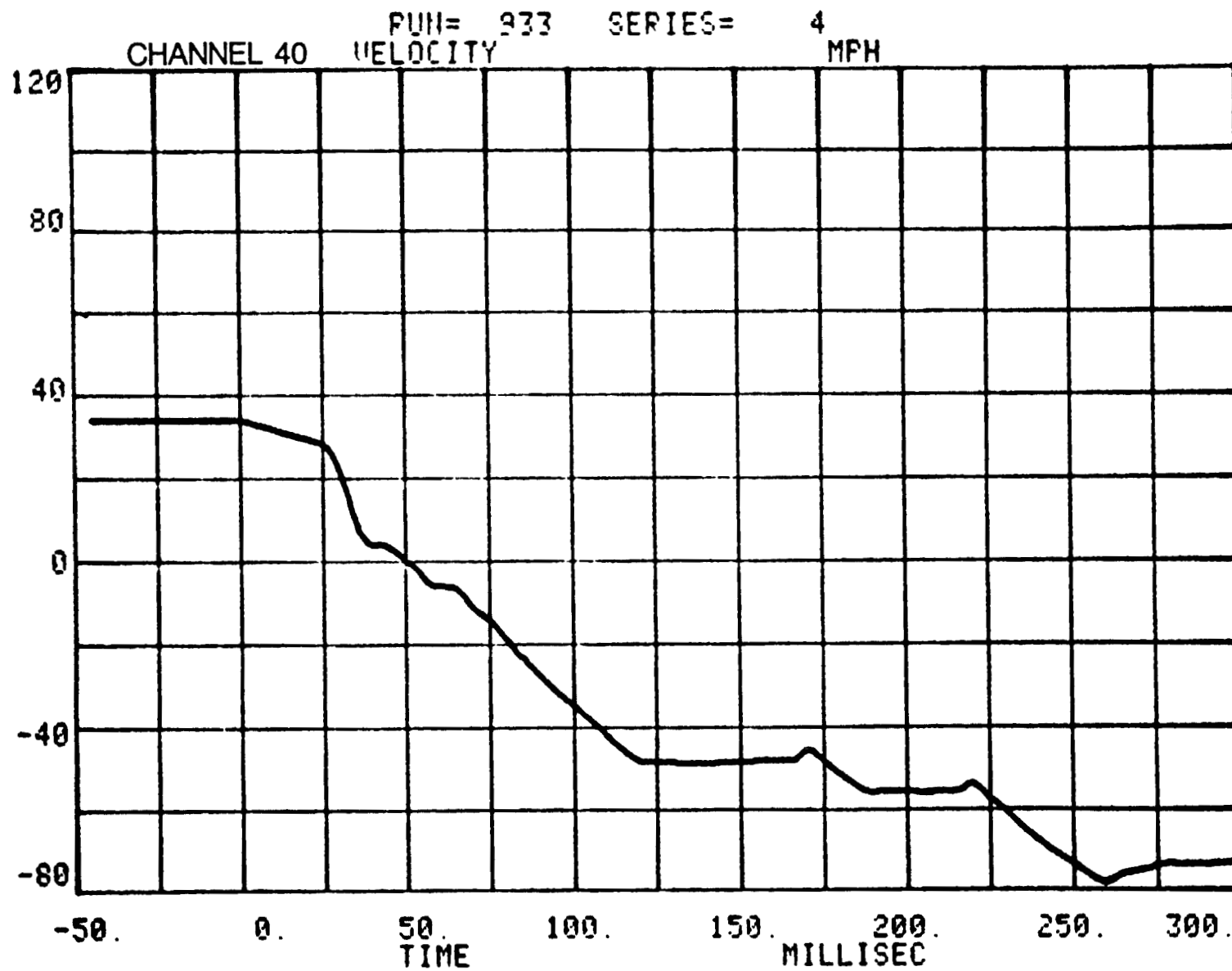
7781-4



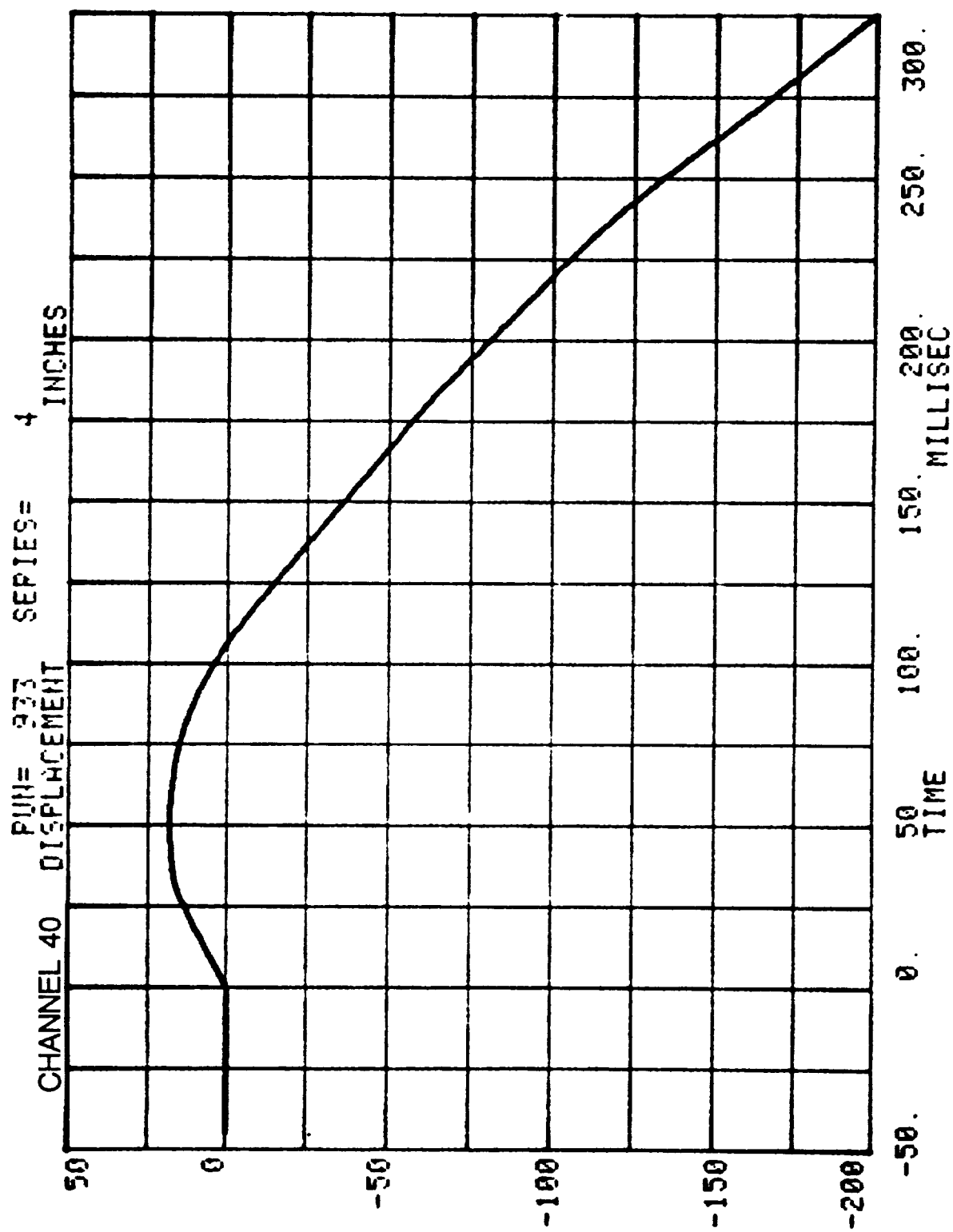
Data questionable after 63 msec

B-39

7781-4

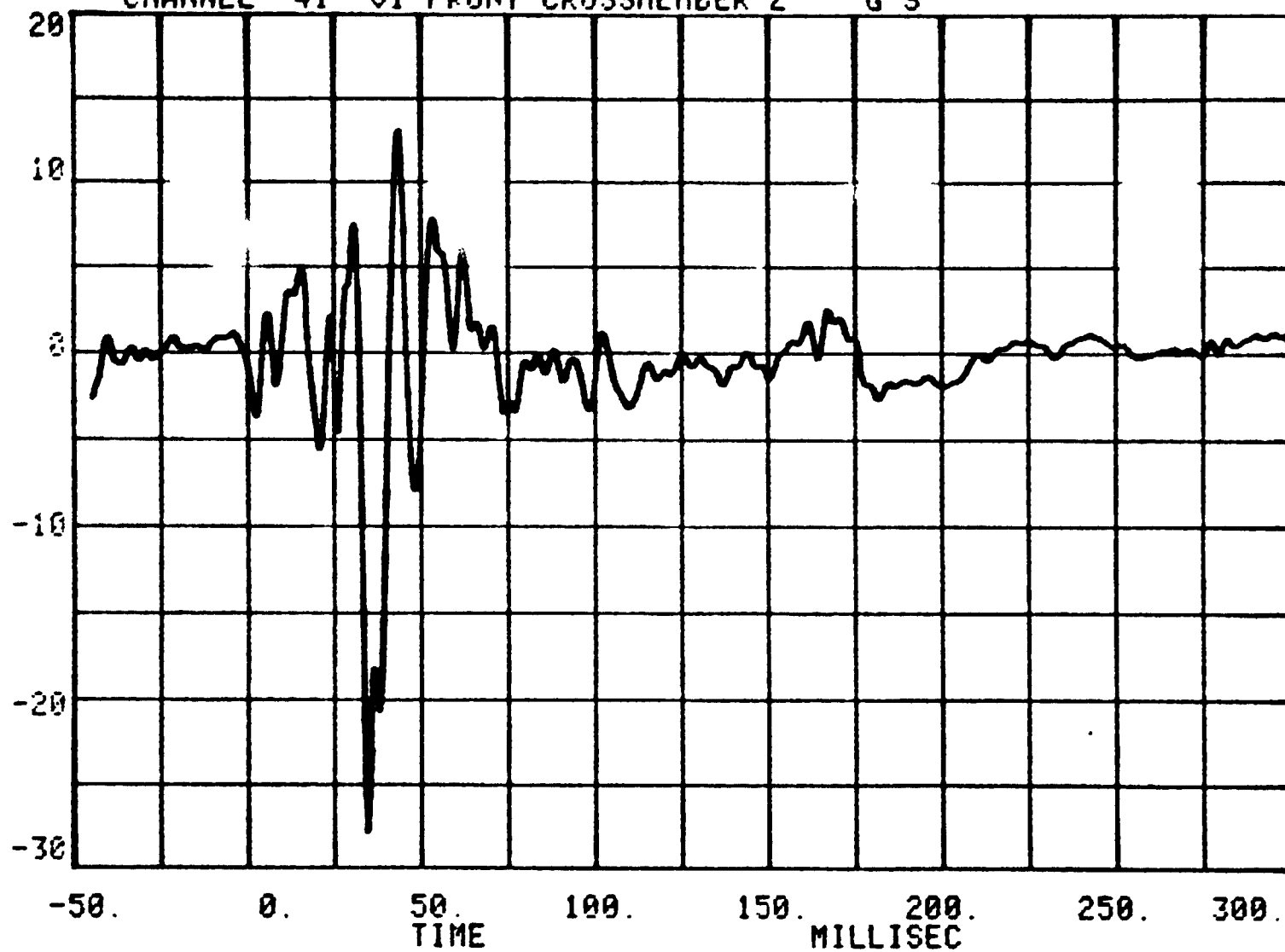


Data questionabl after 63 msec.



Data questionable after 63 msec

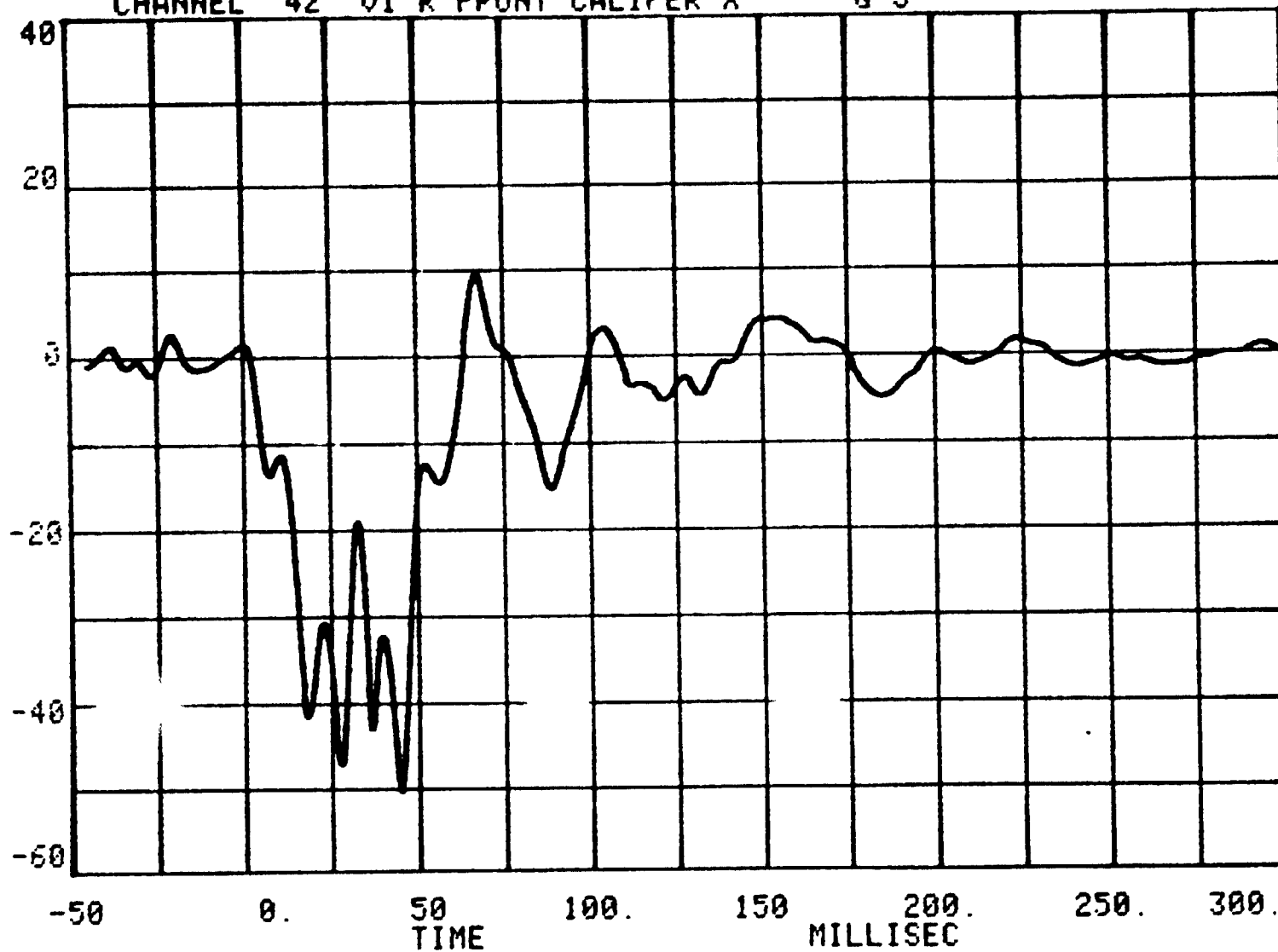
RUN= 933 SERIES= 4
CHANNEL 41 U1 FRONT CROSSMEMBER 2 G'S



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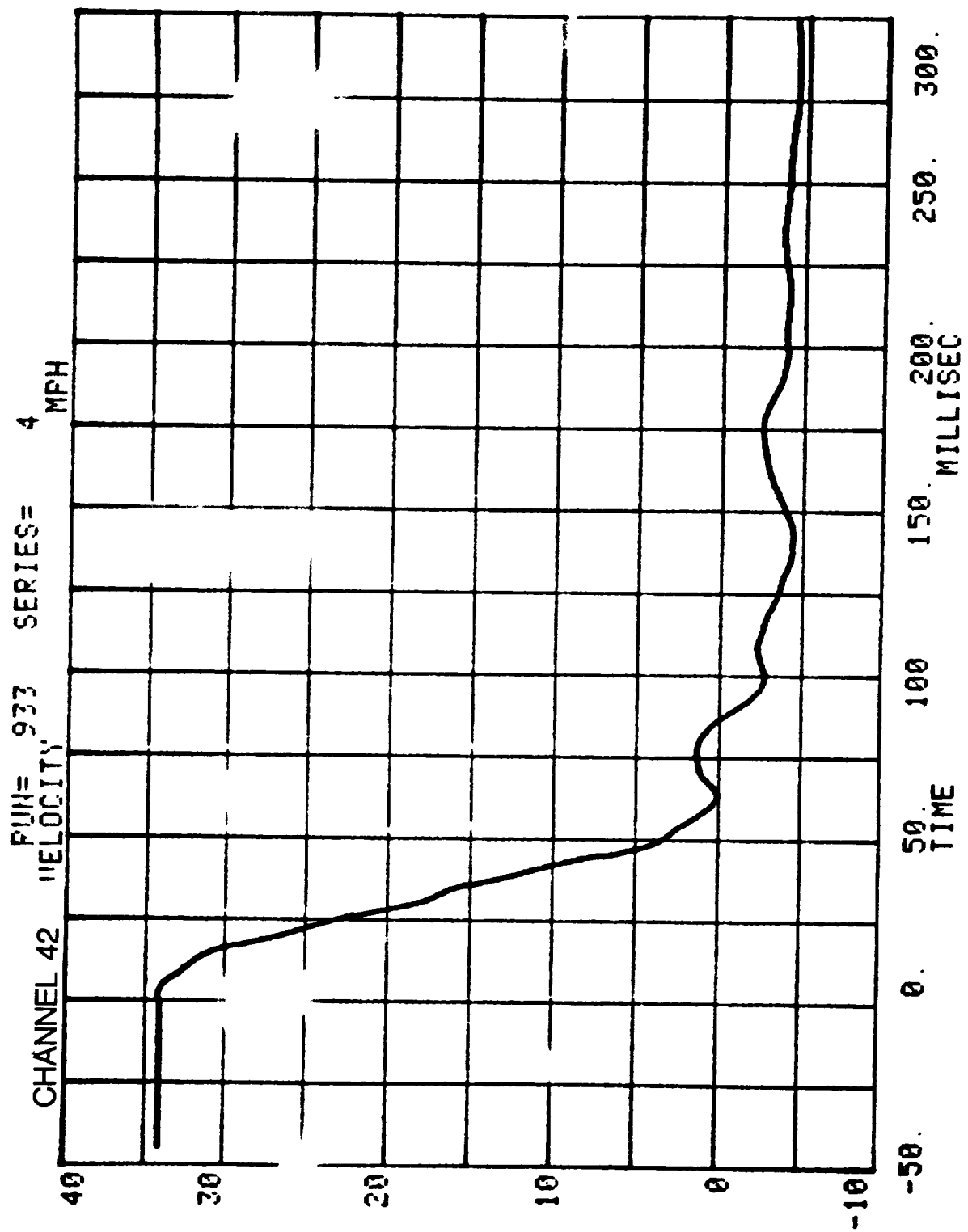
7781-4

RUN= 933 SERIES= 4
CHANNEL 42 U1 R FPONT CALIPER X G'S

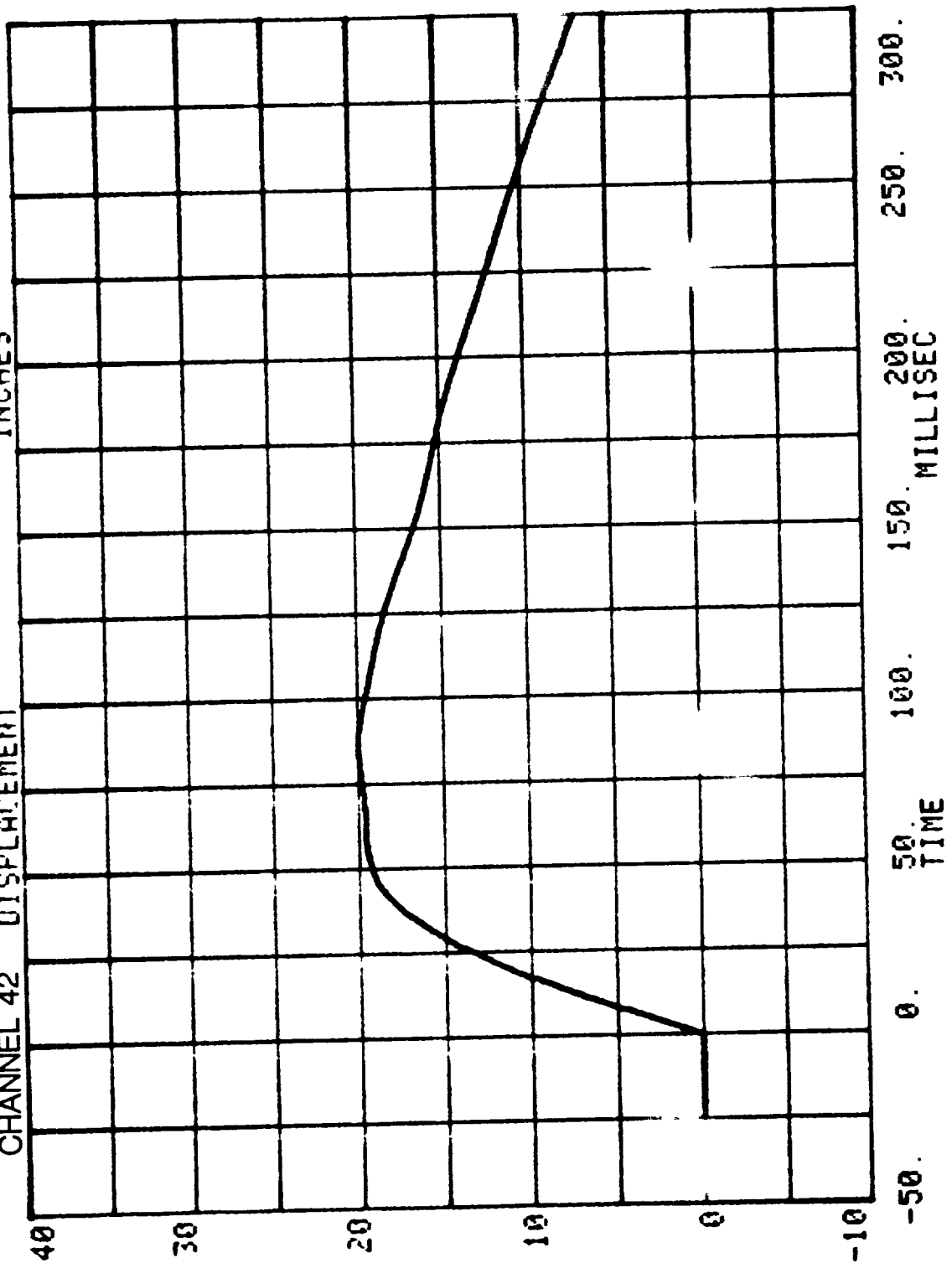


B-42

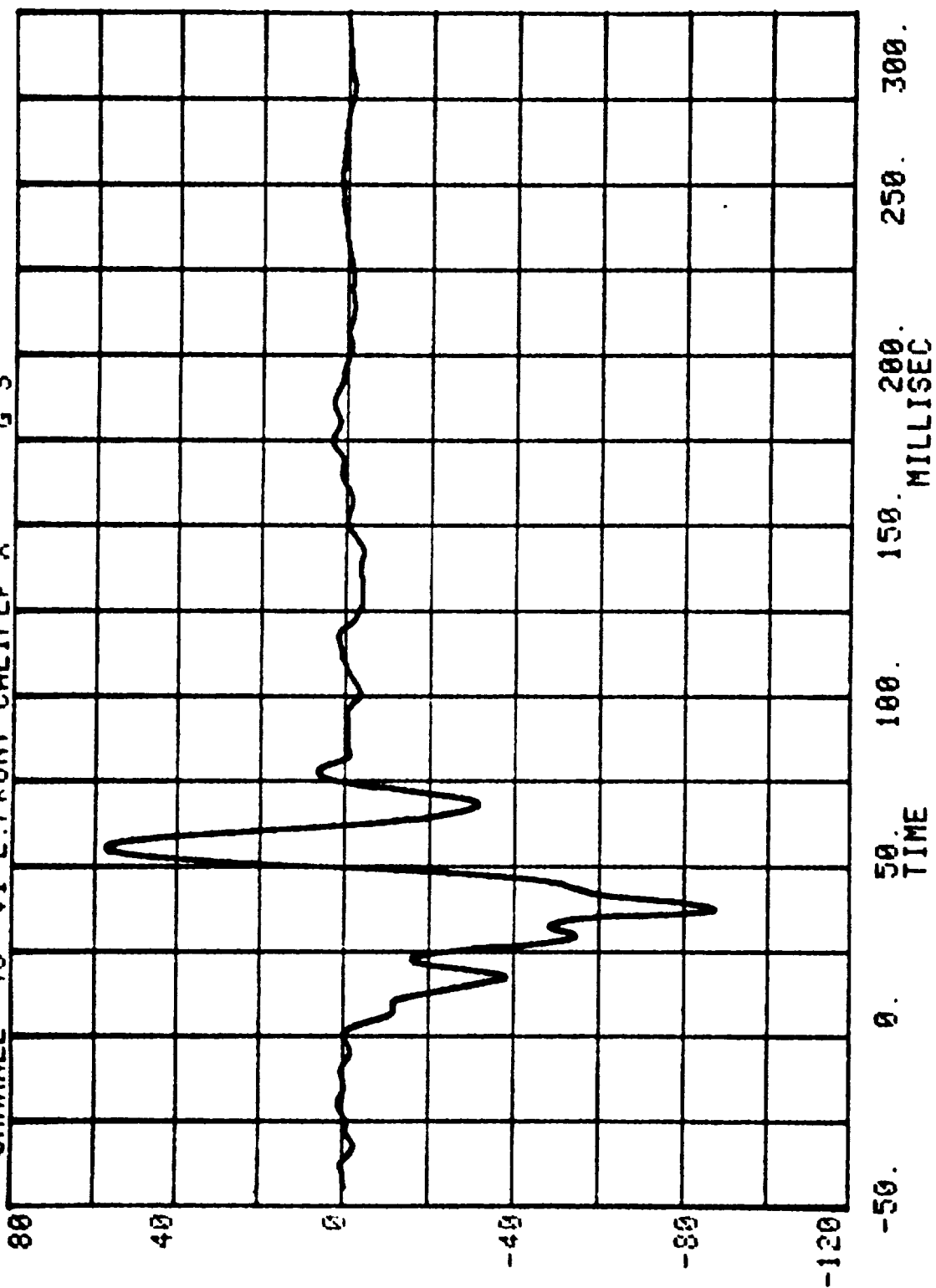
7781-4

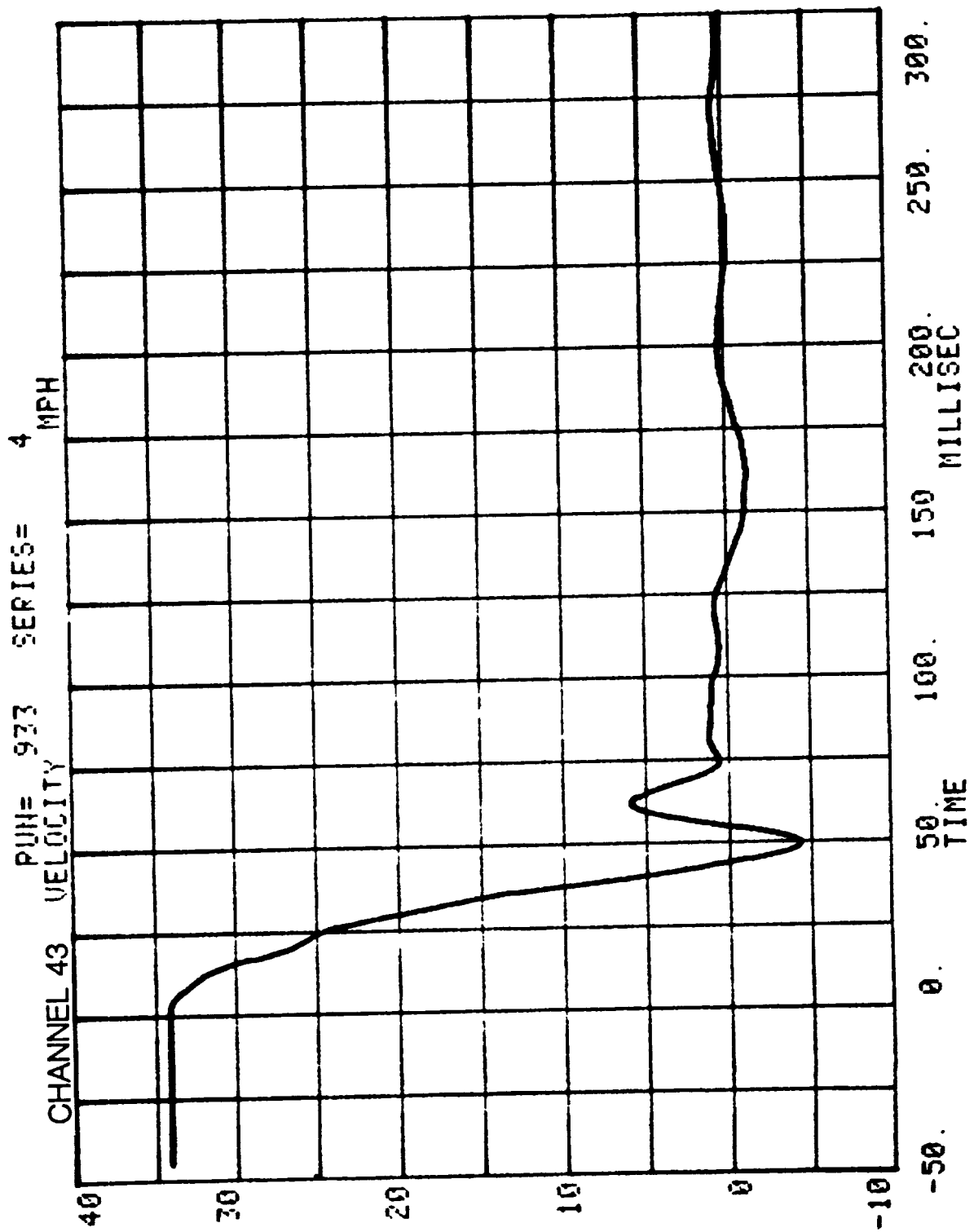


CHANNEL 42 DISPLACEMENT PUN= 933 SERIES= 4 INCHES

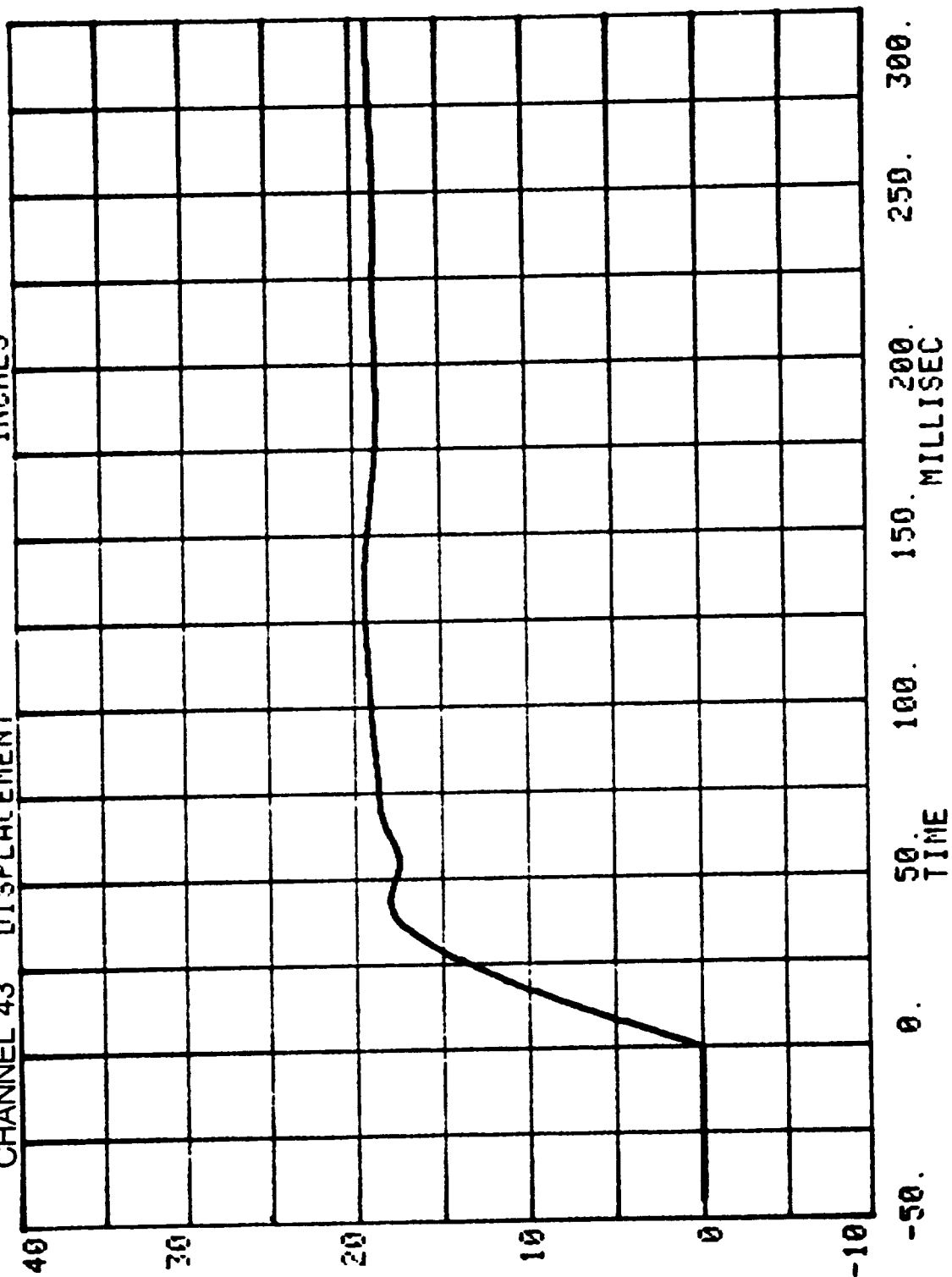


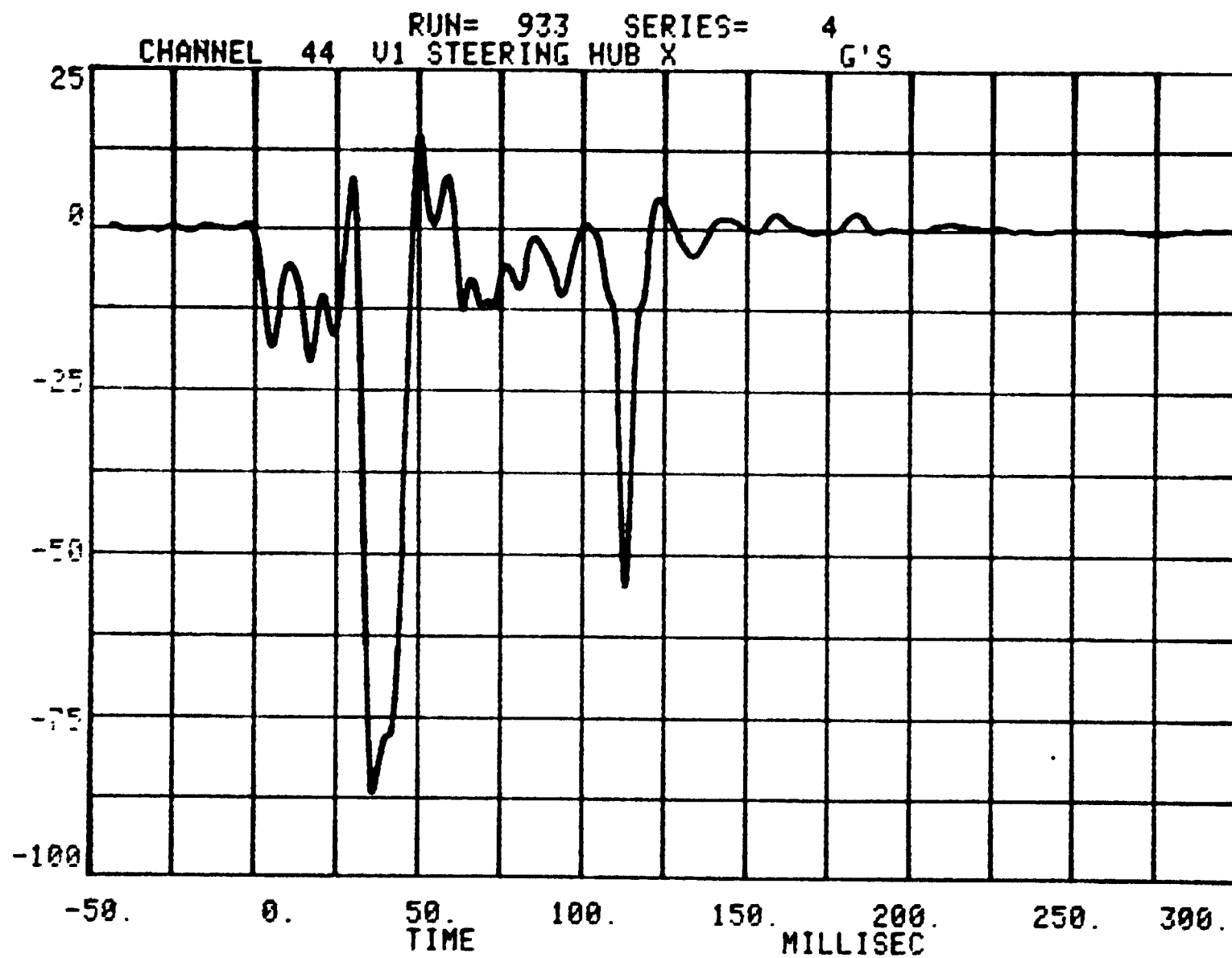
CHANNEL 43 U1 L.FRONT CALIPEP X
RUN= 933 SERIES= 4 G'S





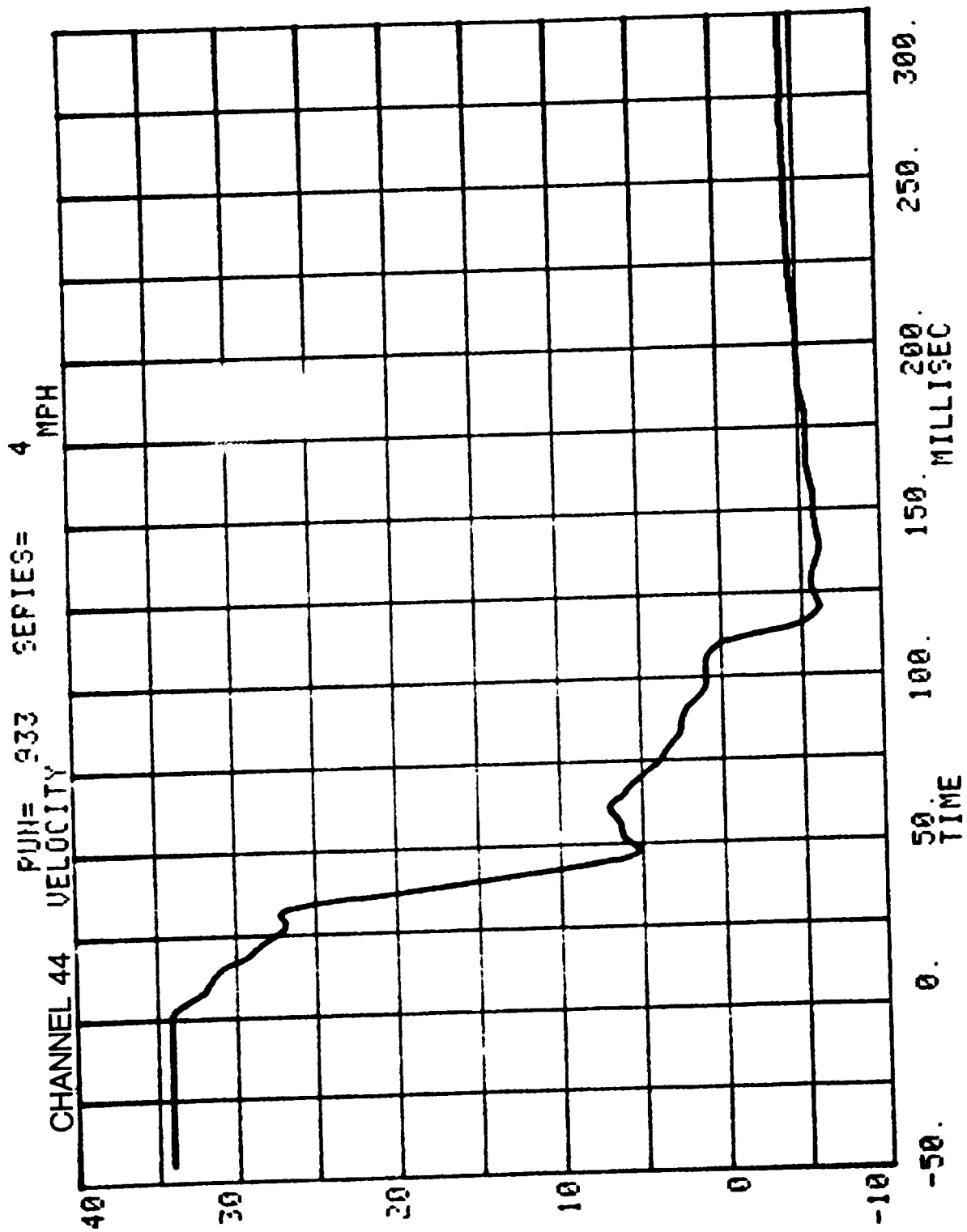
CHANNEL 43 DISPLACEMENT RUN= 933 SERIES= 4 INCHES





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7781-4

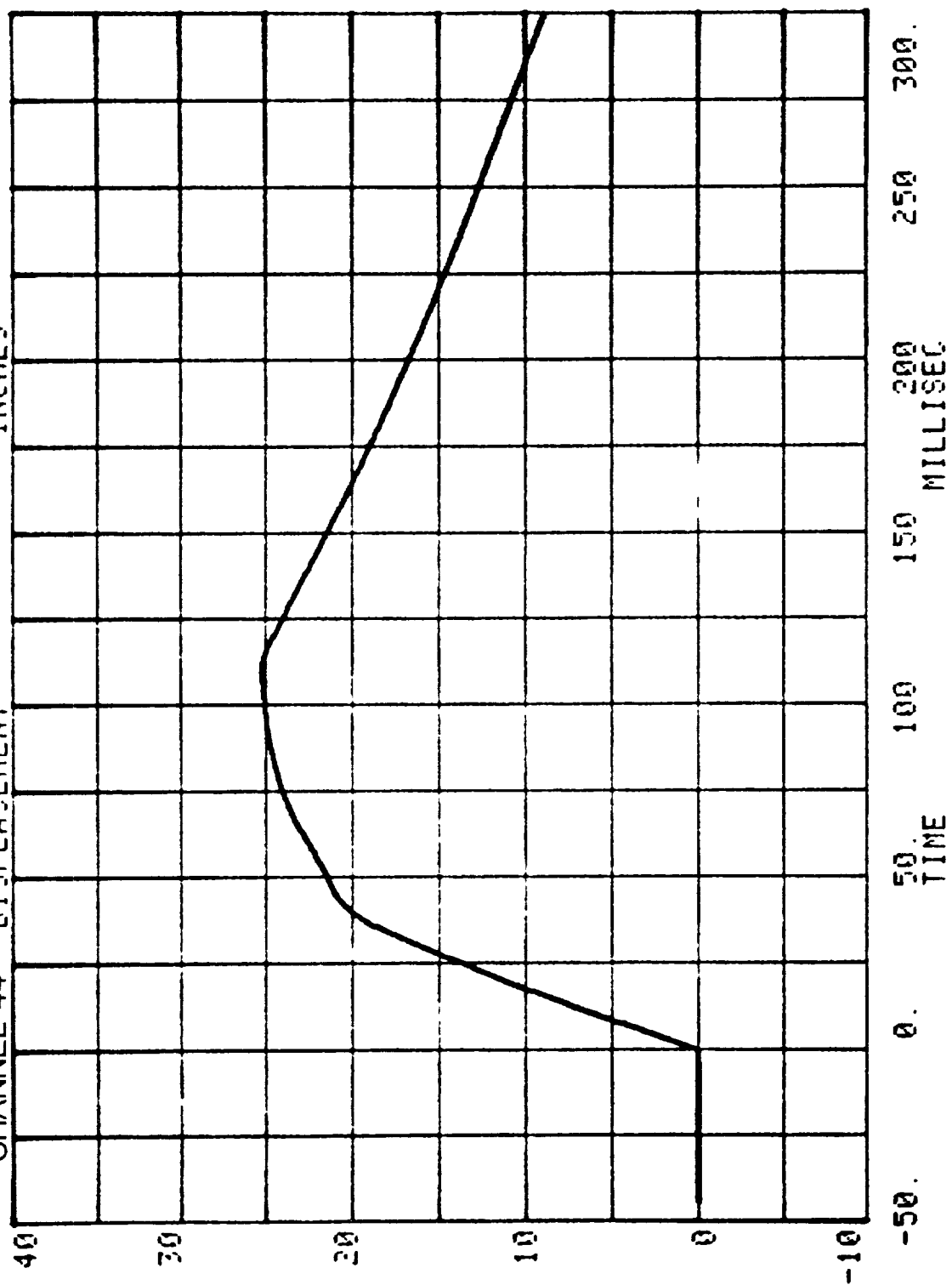


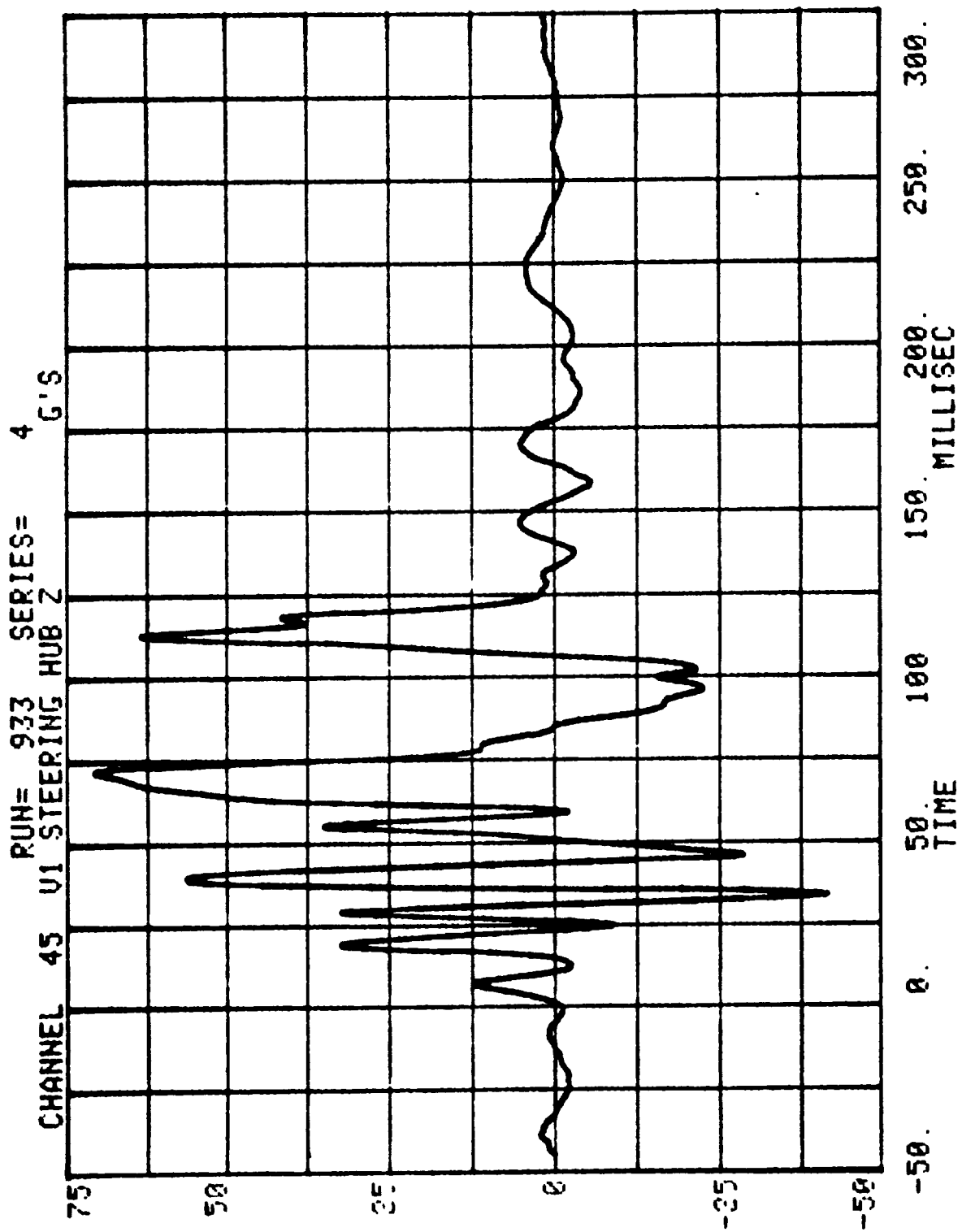
CHANNEL 44 DISPLACEMENT

FUH= 933

SERIES=

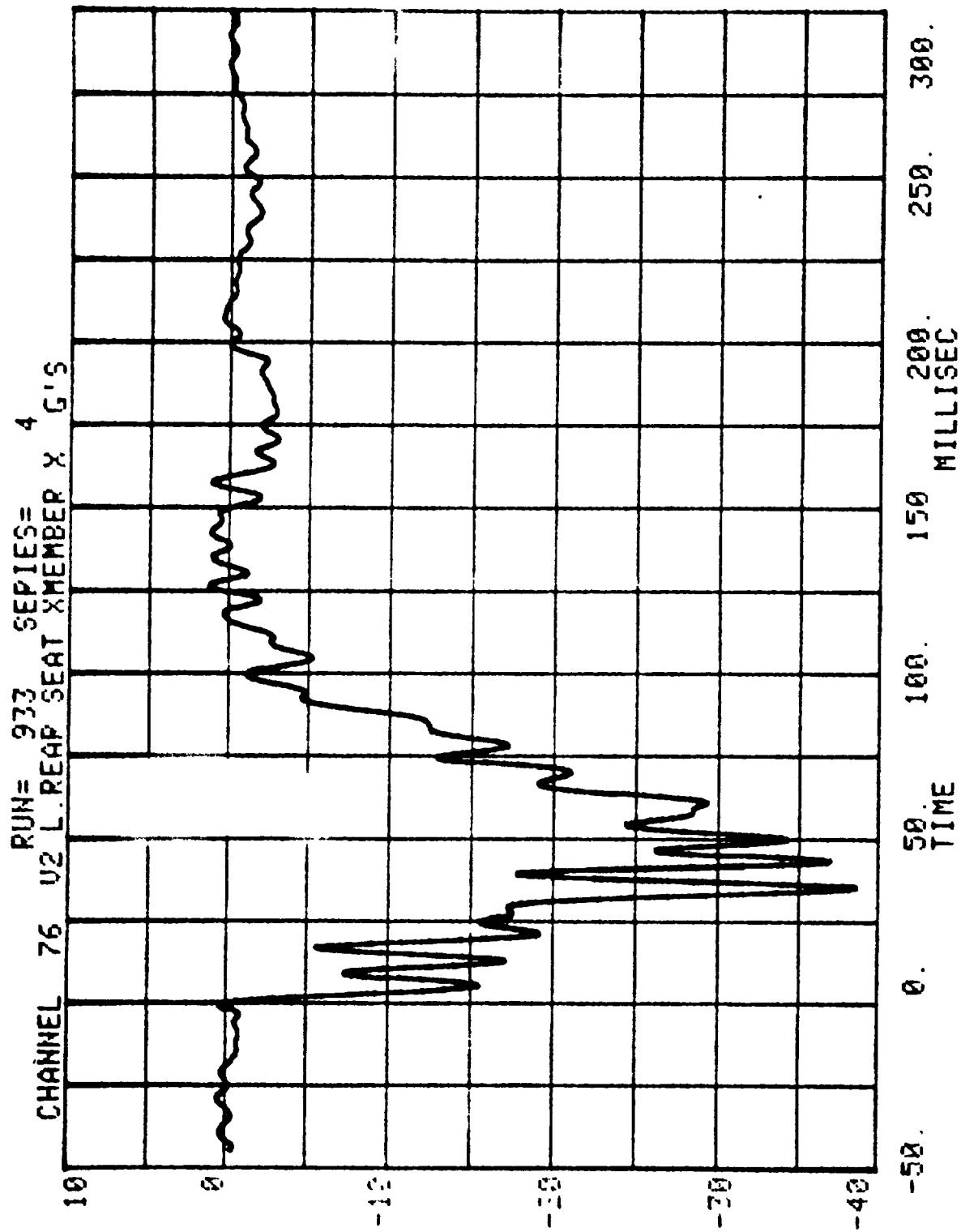
4 INCHES

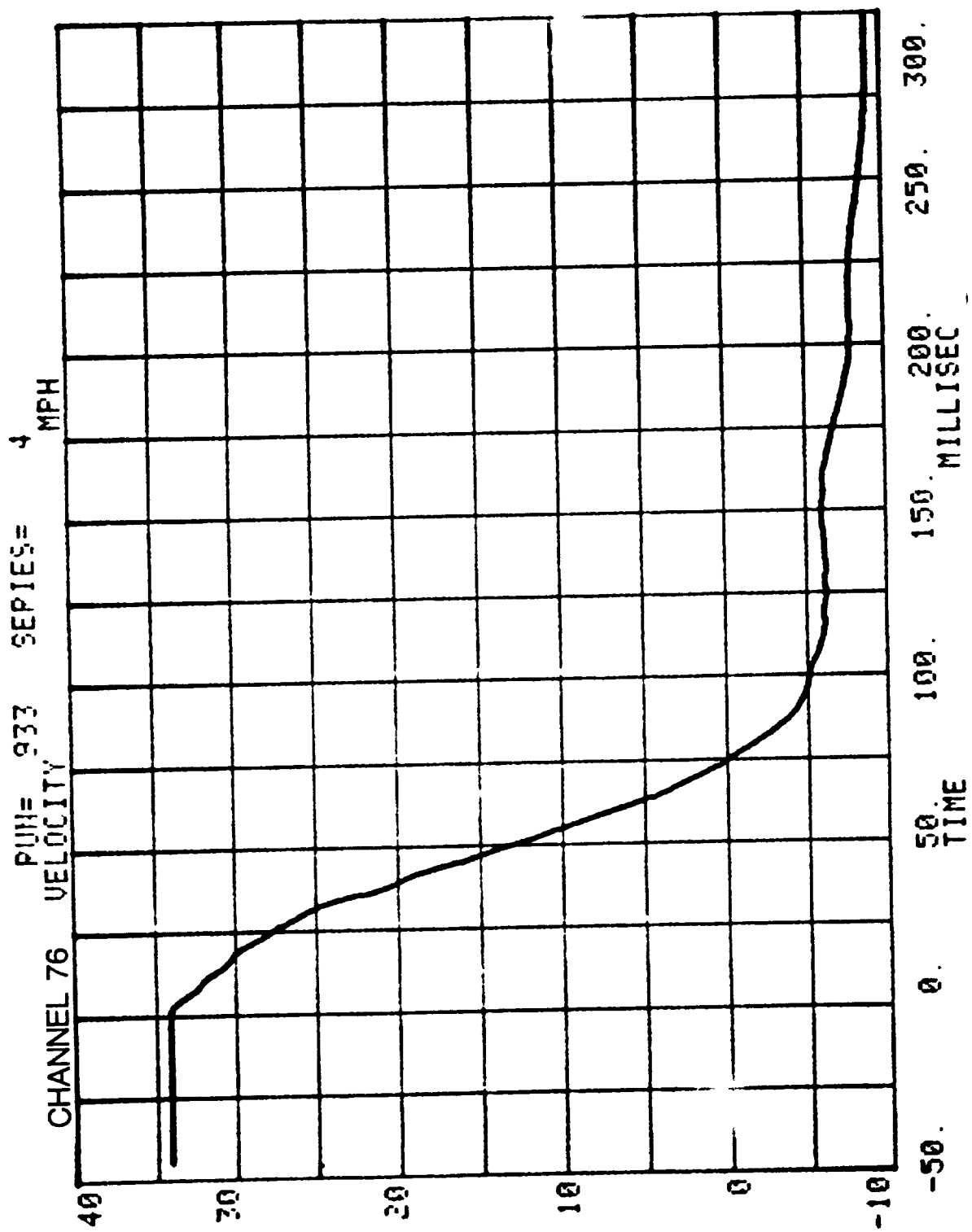


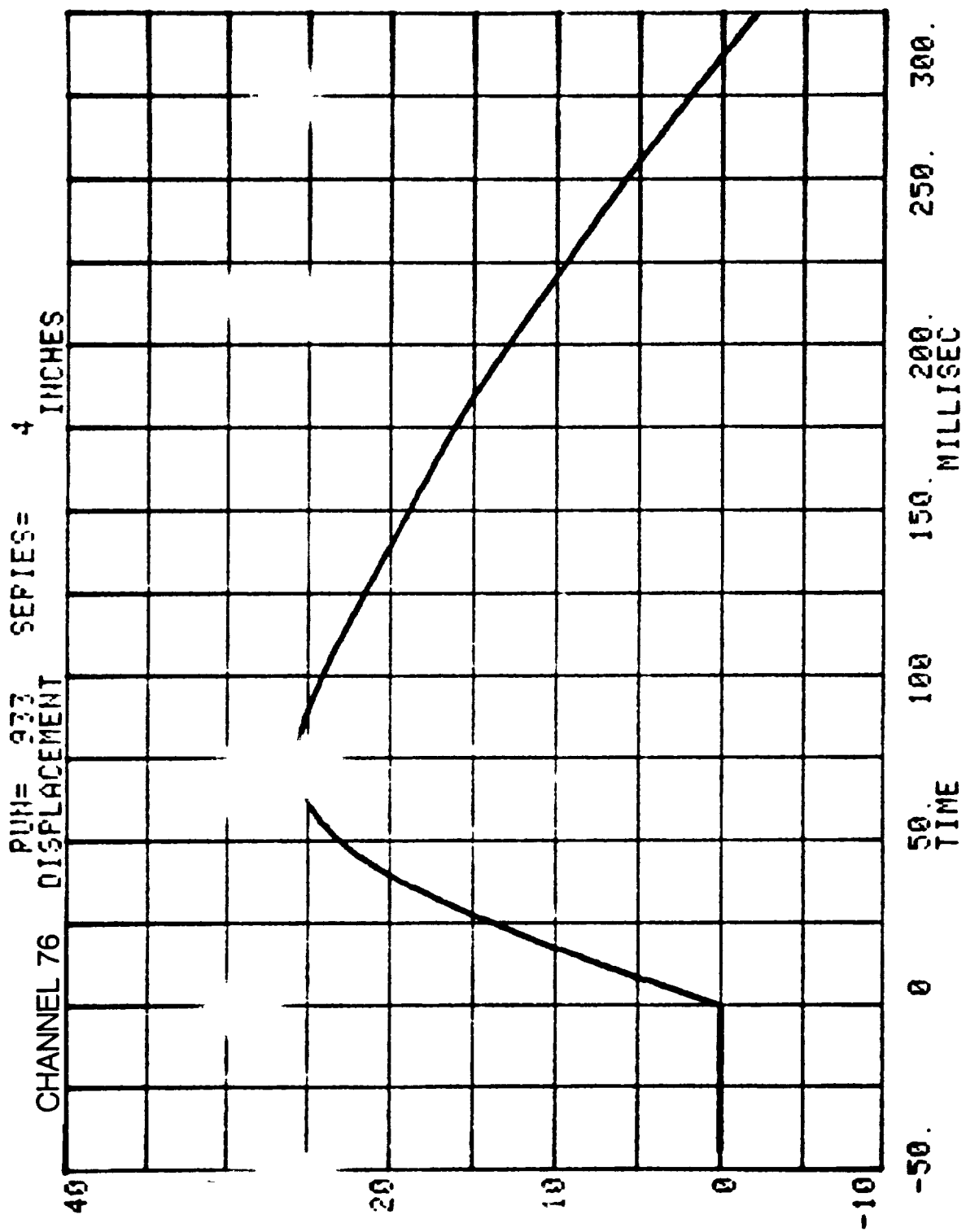


VEHICLE TWO DATA

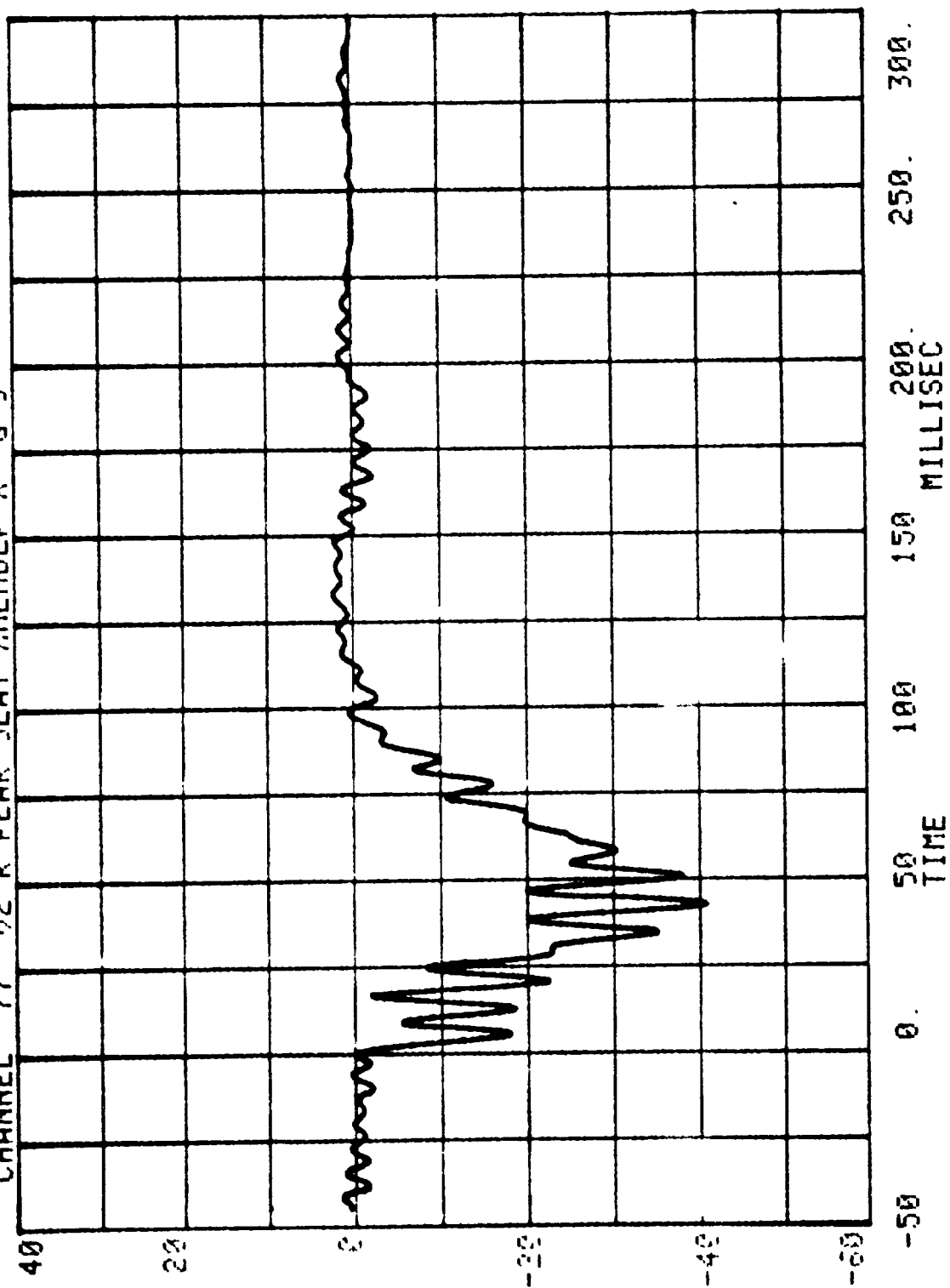
CHANNEL 76 U2 L. REAP SEAT XMEMBER X 4 G'S

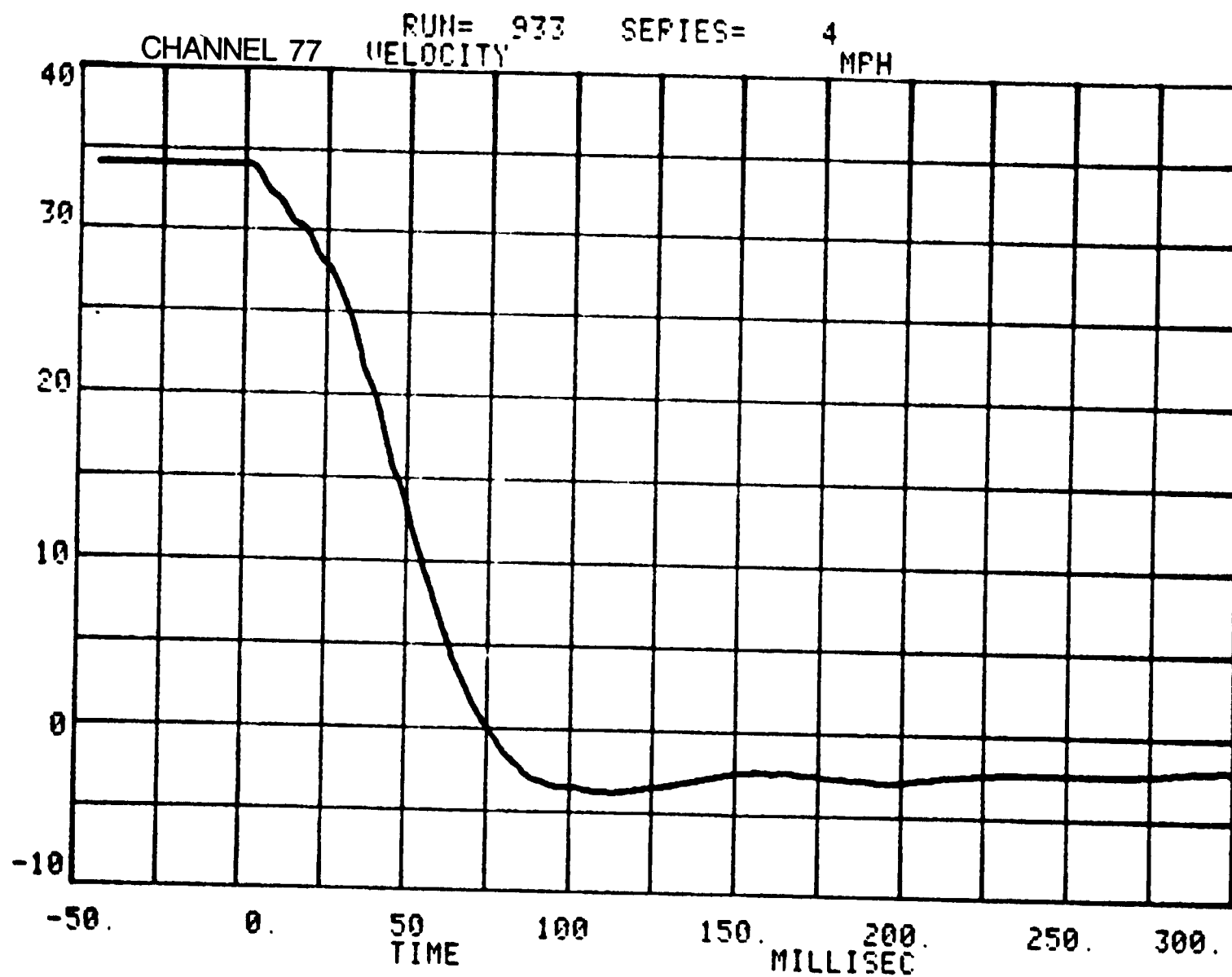






CHANNEL 77 1/2 R REAR SEAT XMEMBER X G'S RUN= 933 SERIES= 4





B-57

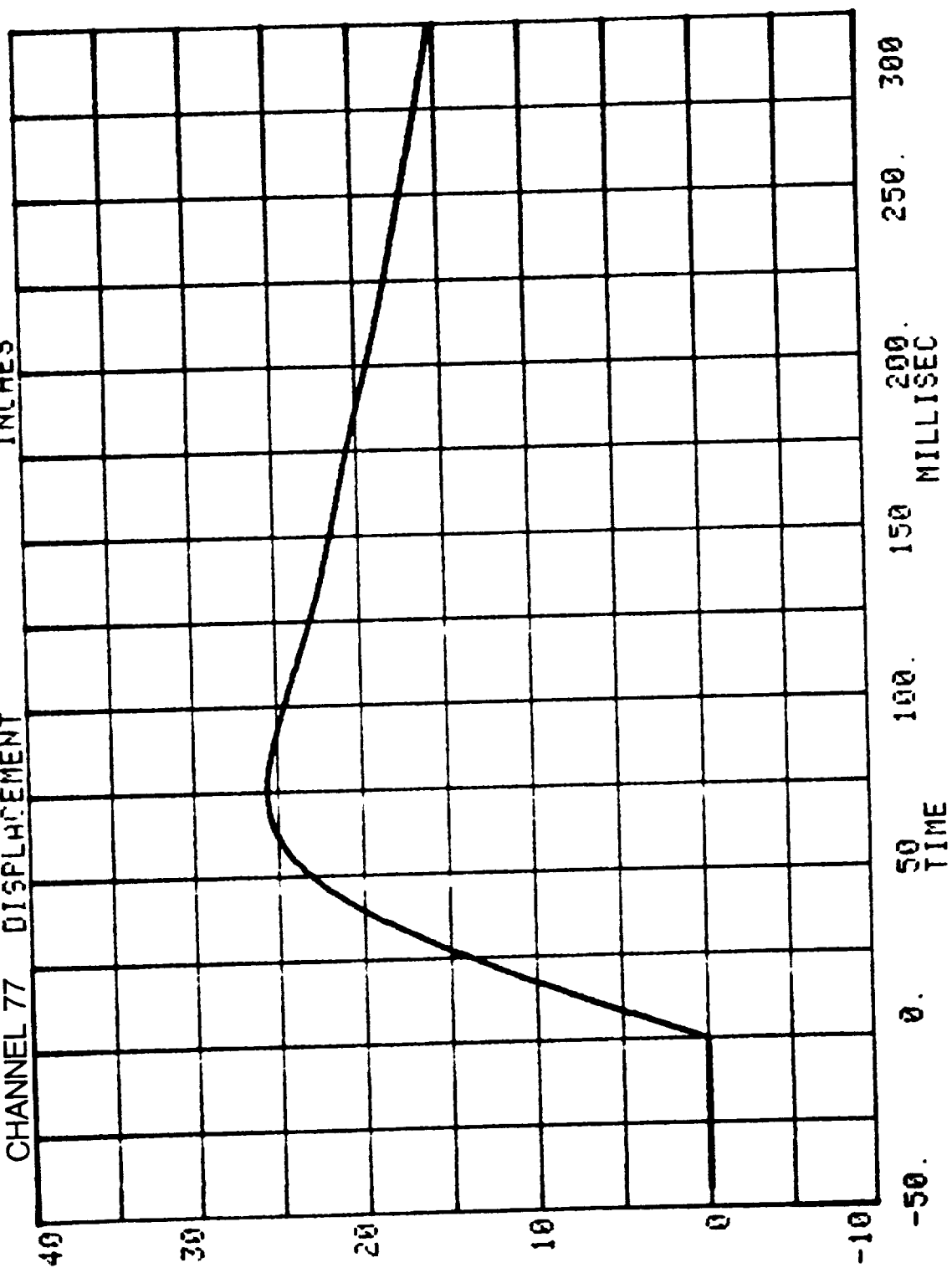
7781-4

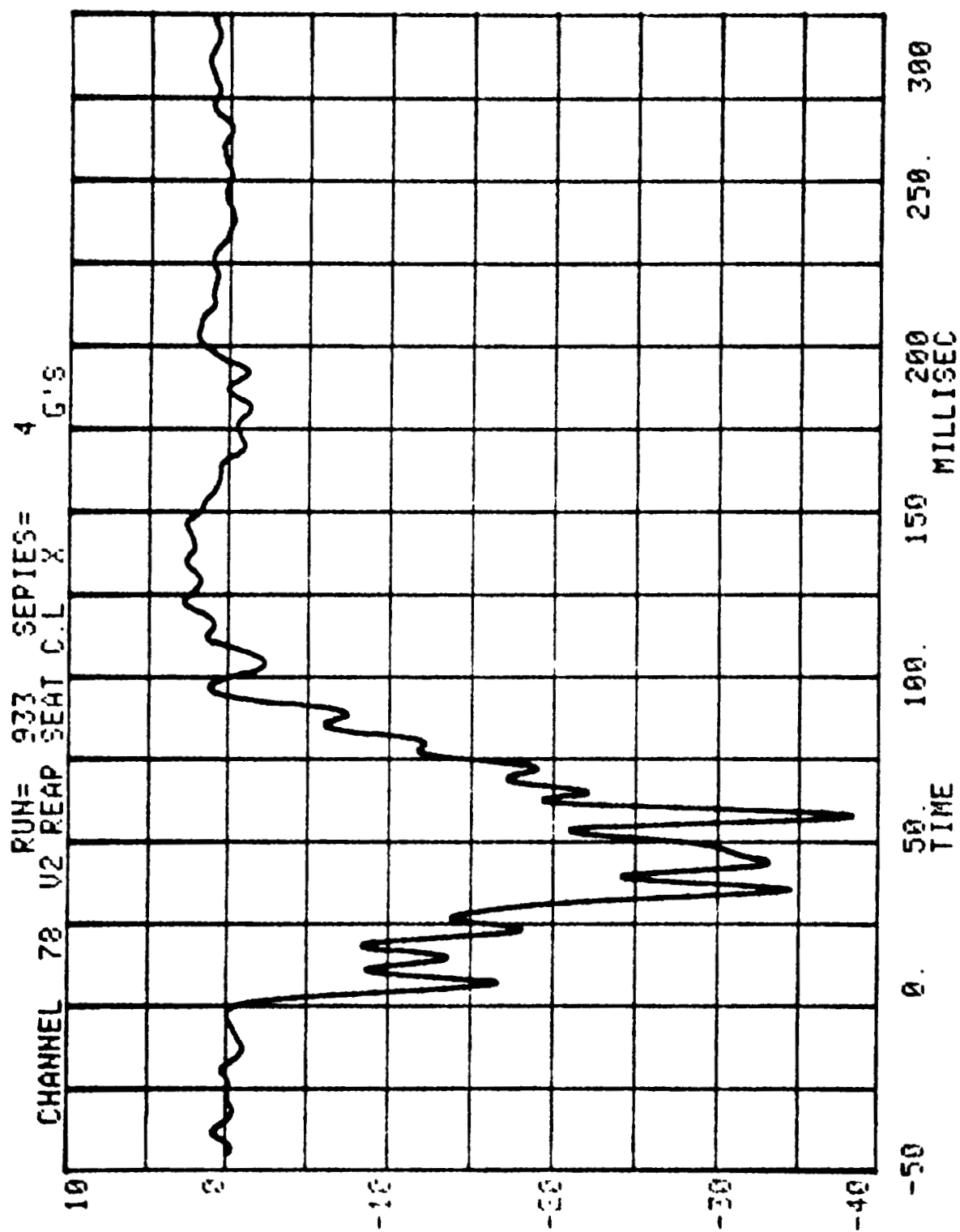
CHANNEL 77 DISPLACEMENT

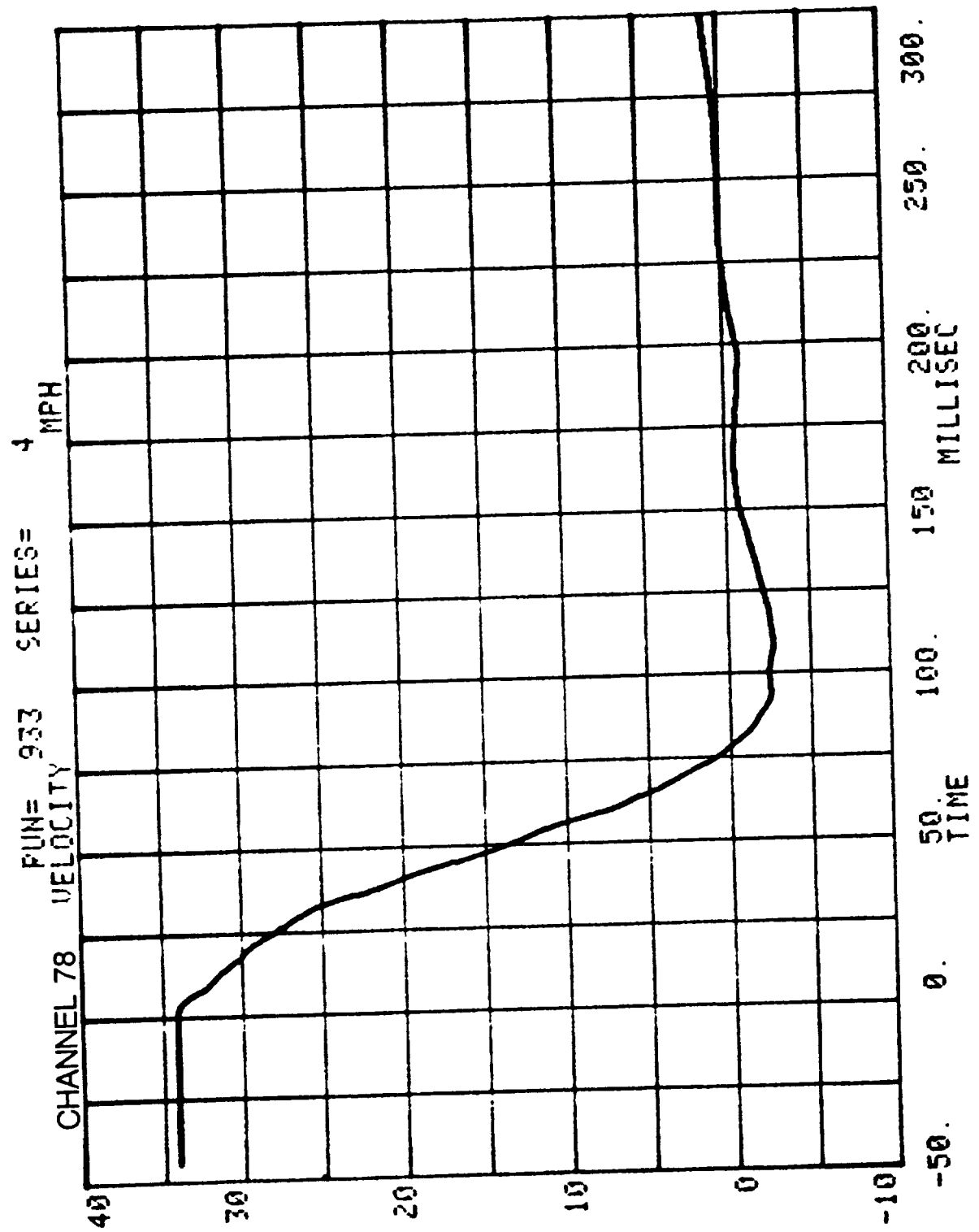
RUN= 933

SERIES=

4 INCHES







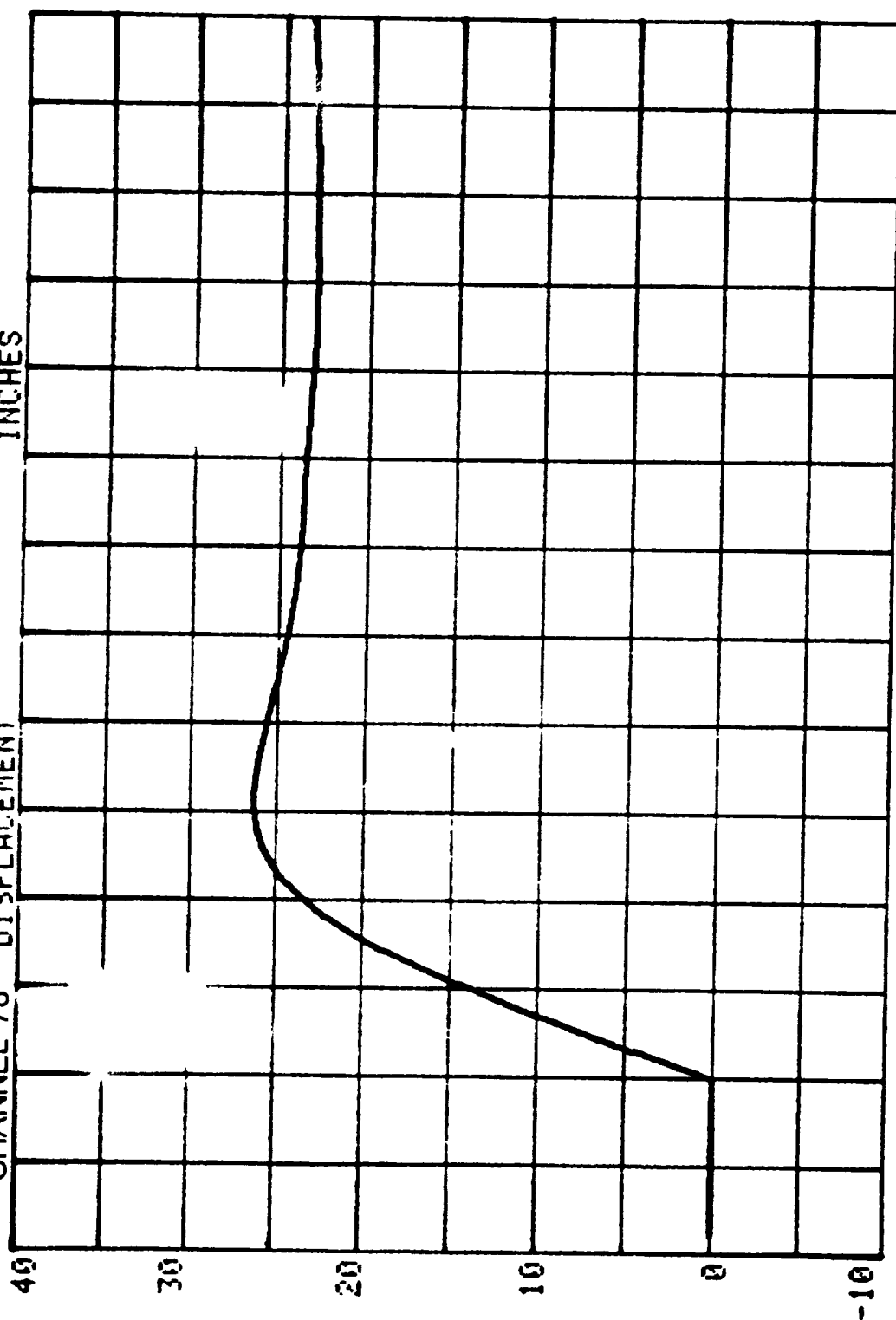
CHANNEL 78 DISPLACEMENT

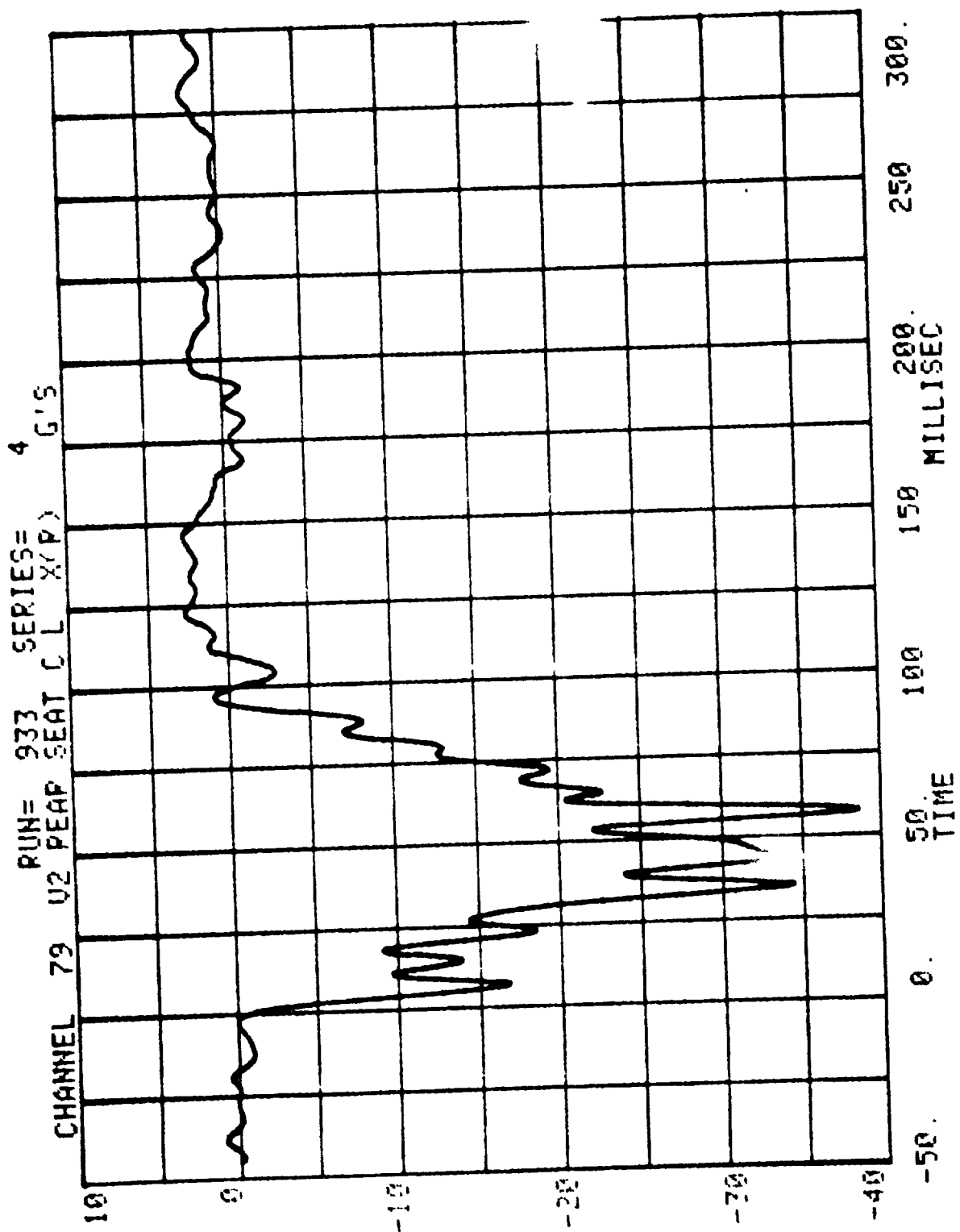
RUH= 933

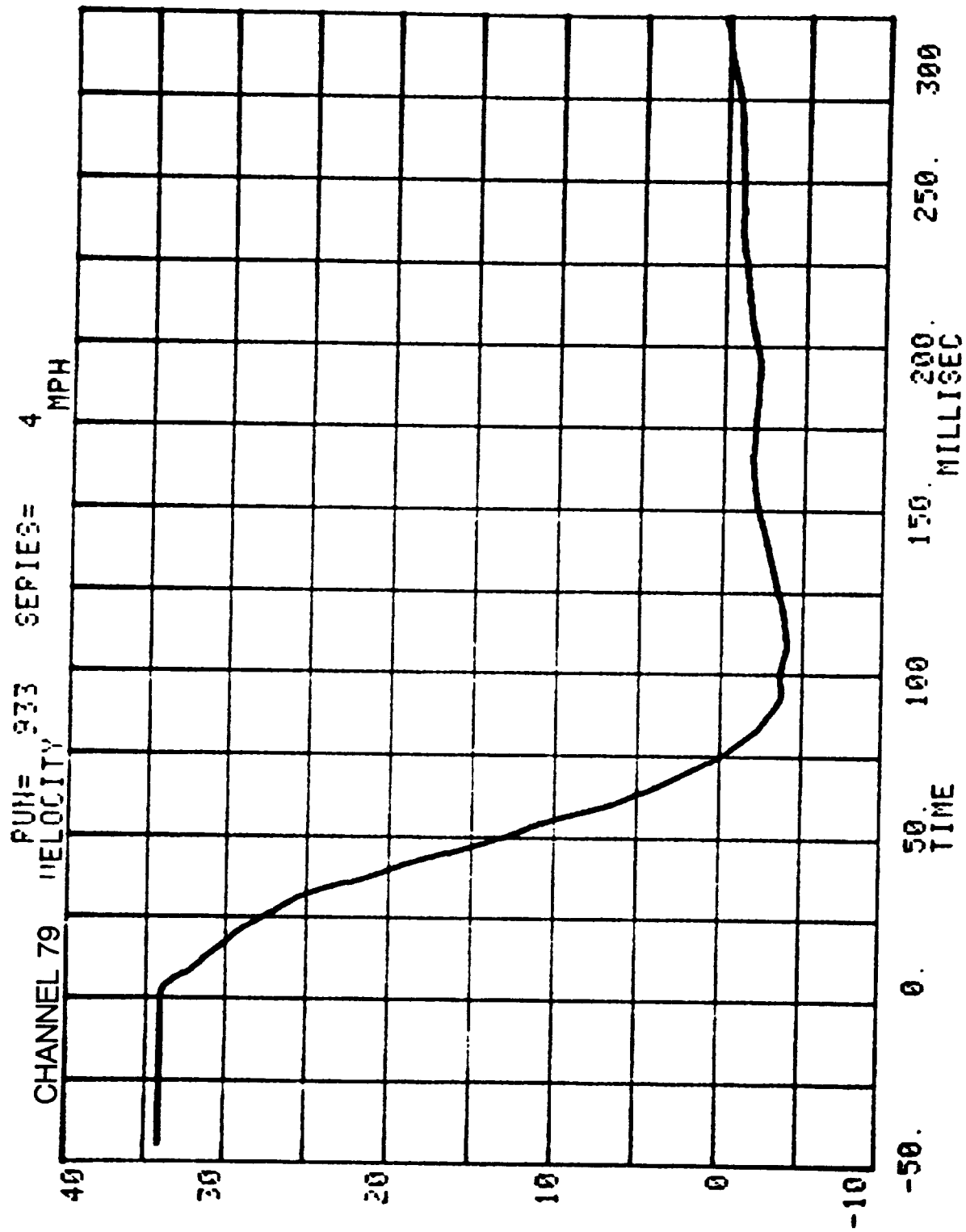
SERIES=

4

INCHES





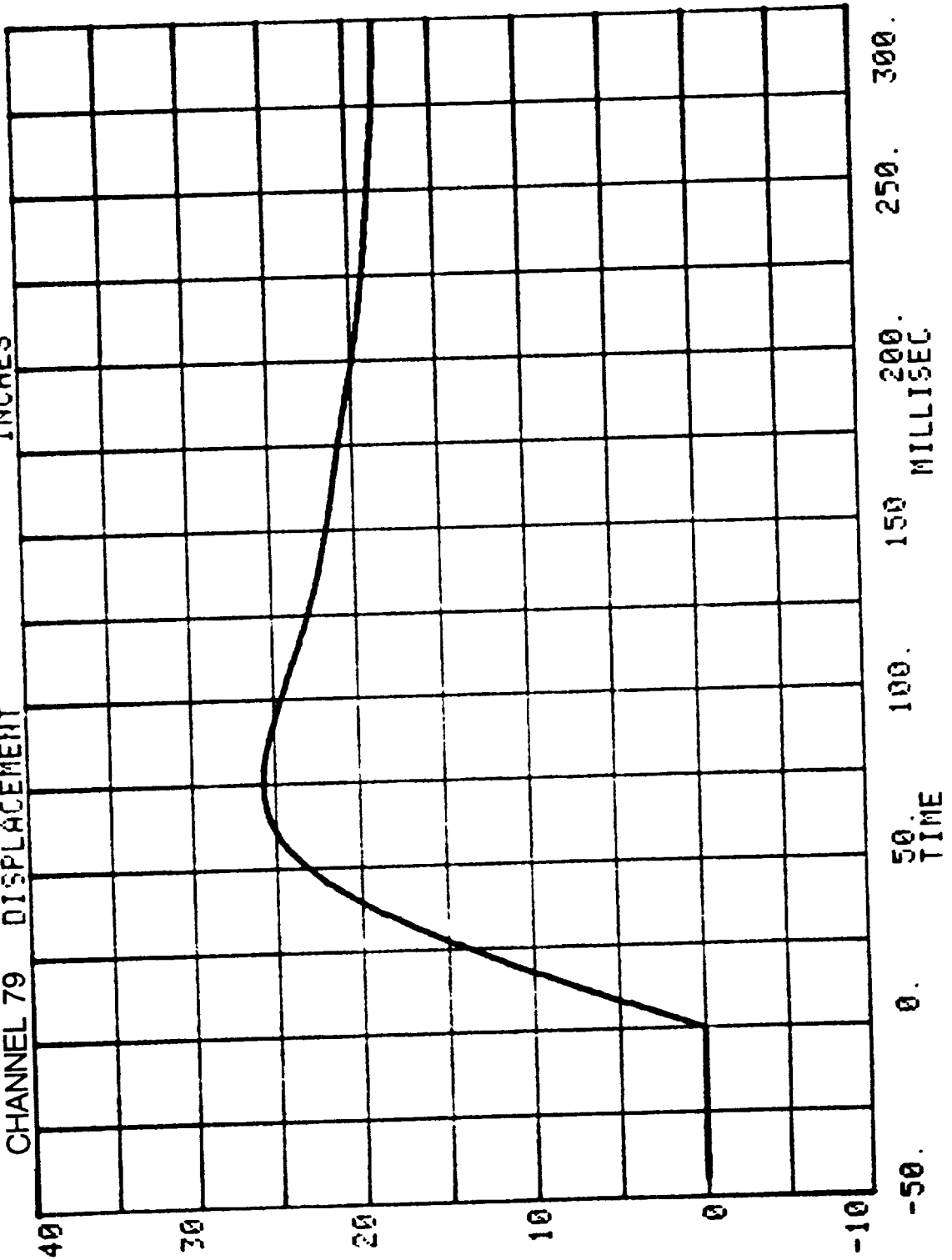


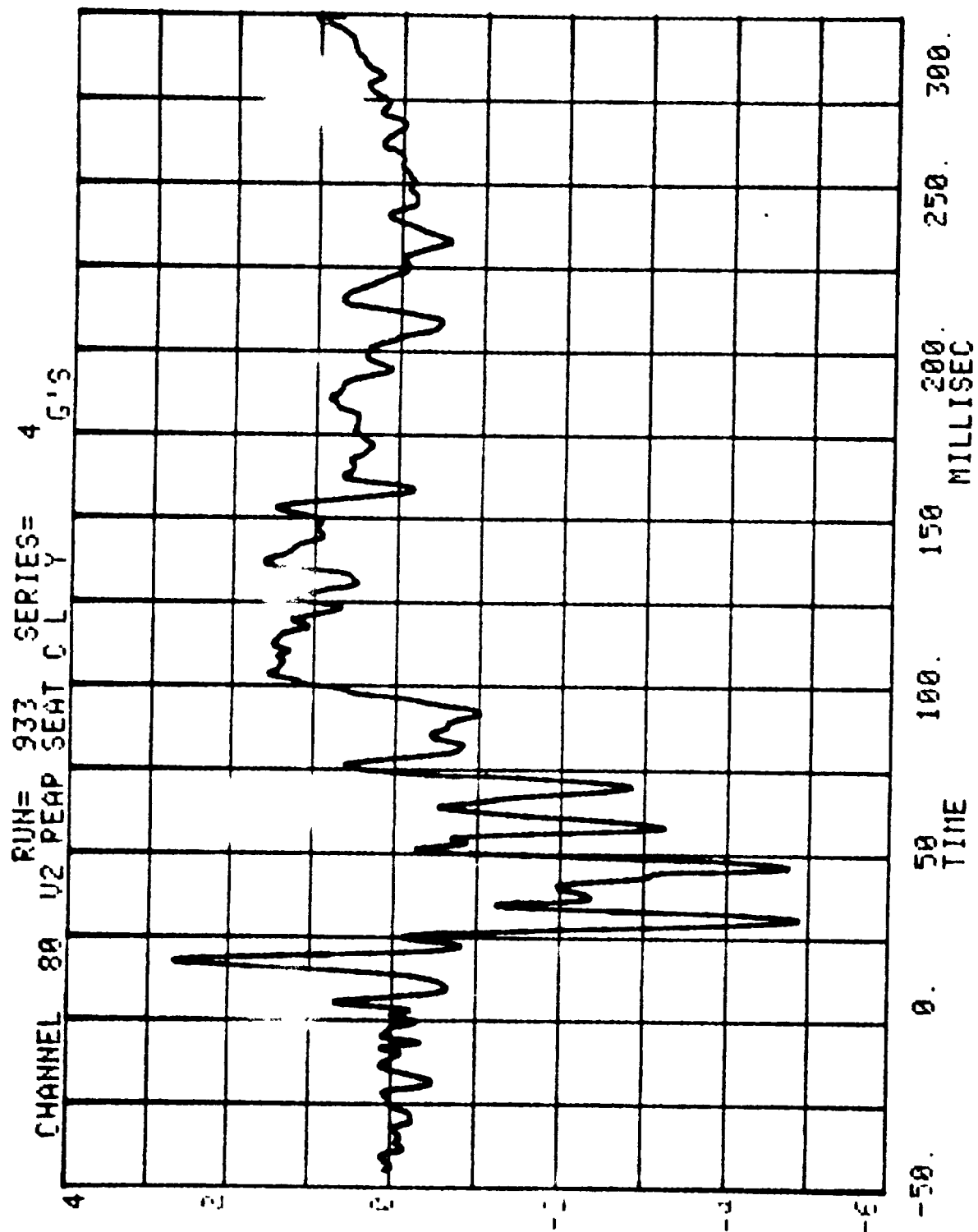
CHANNEL 79 DISPLACEMENT

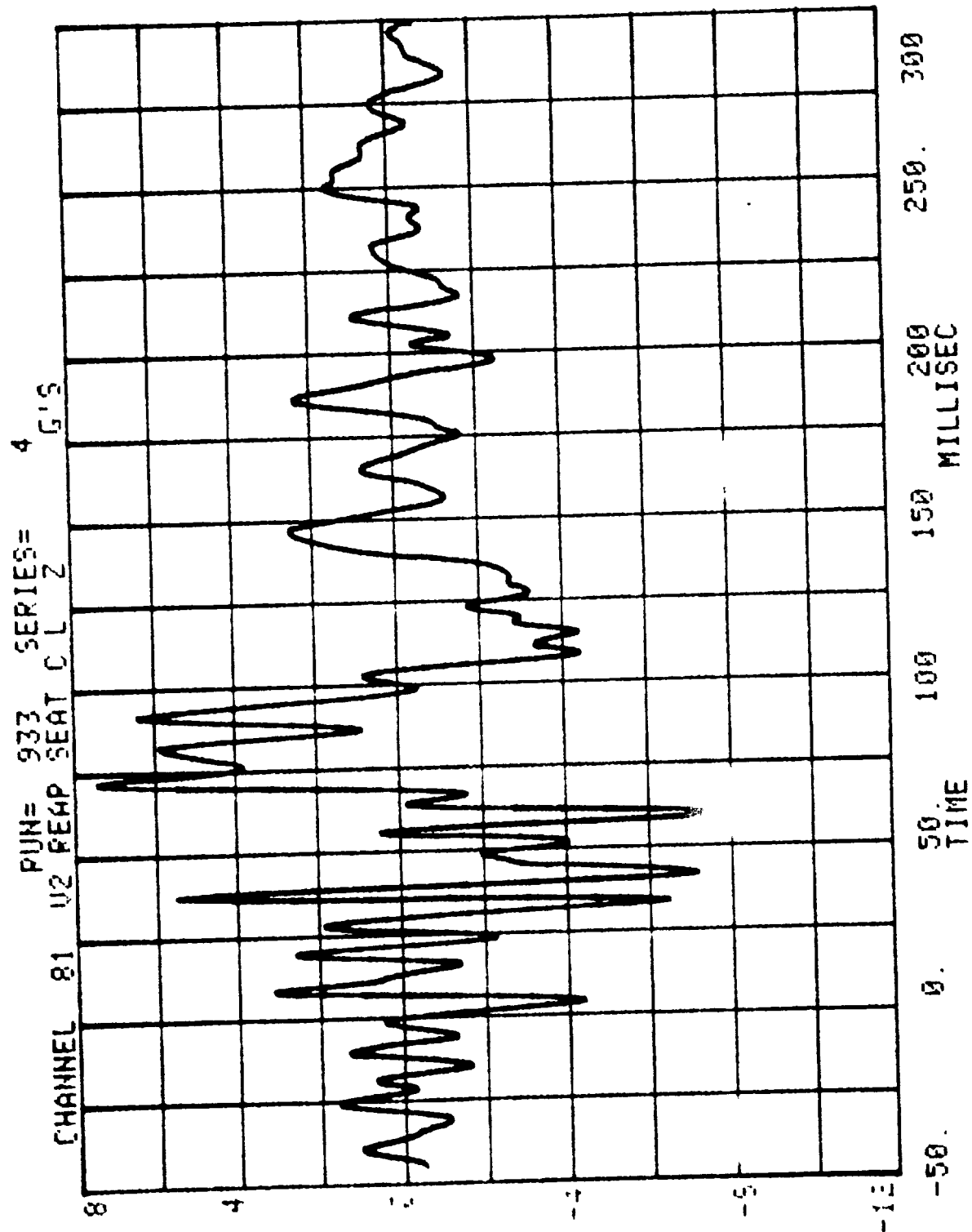
PUN= 933

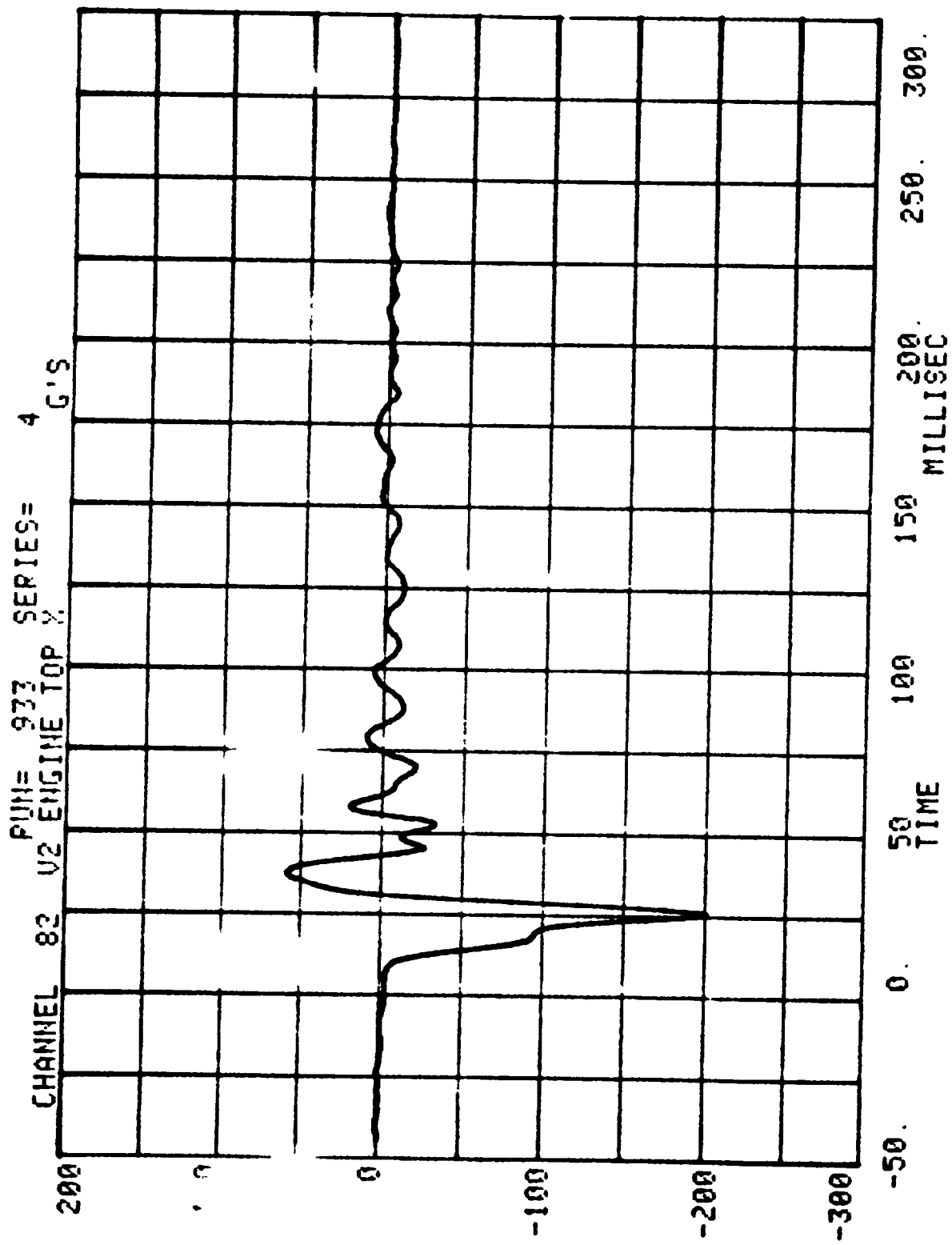
SERIES=

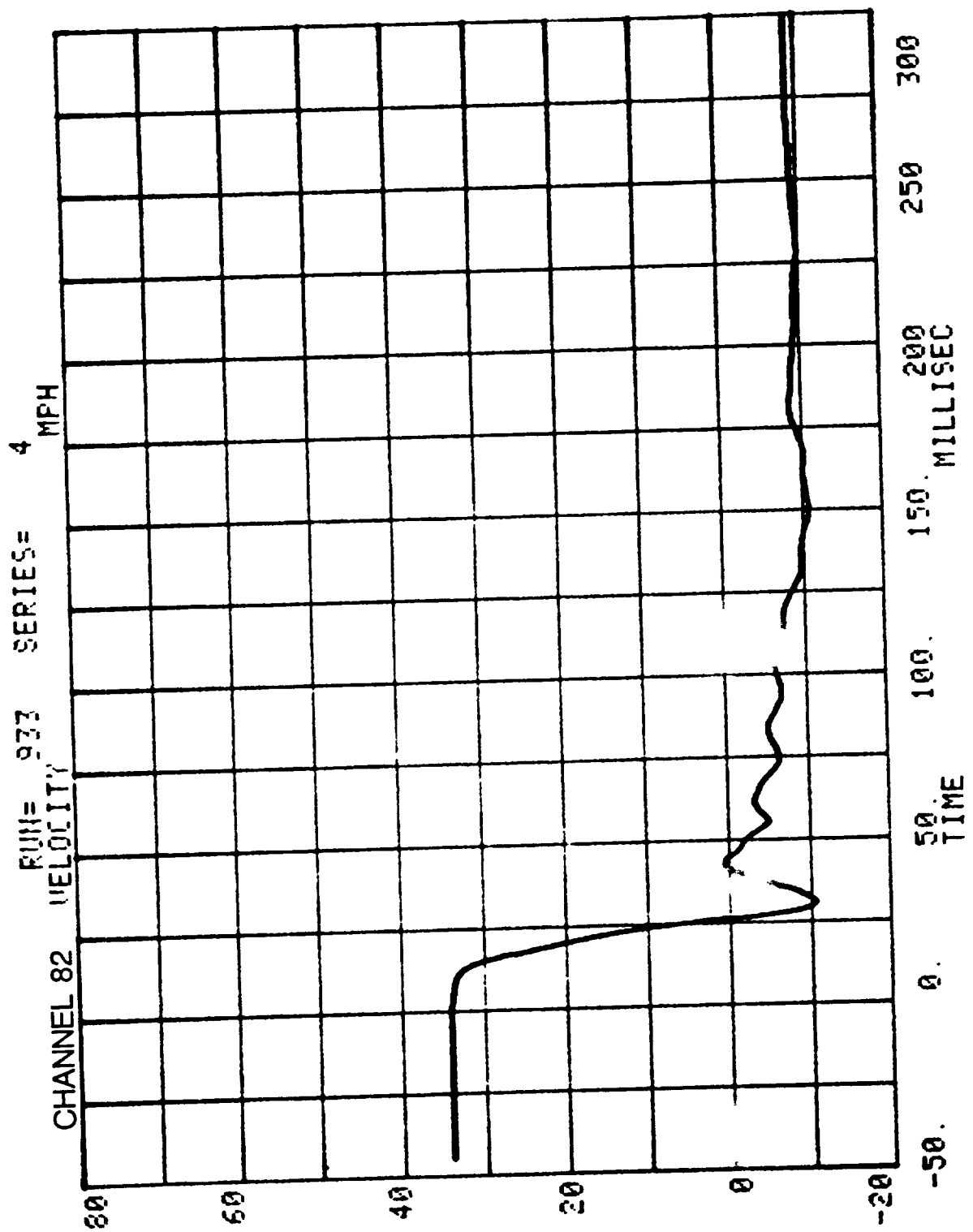
4 INCHES



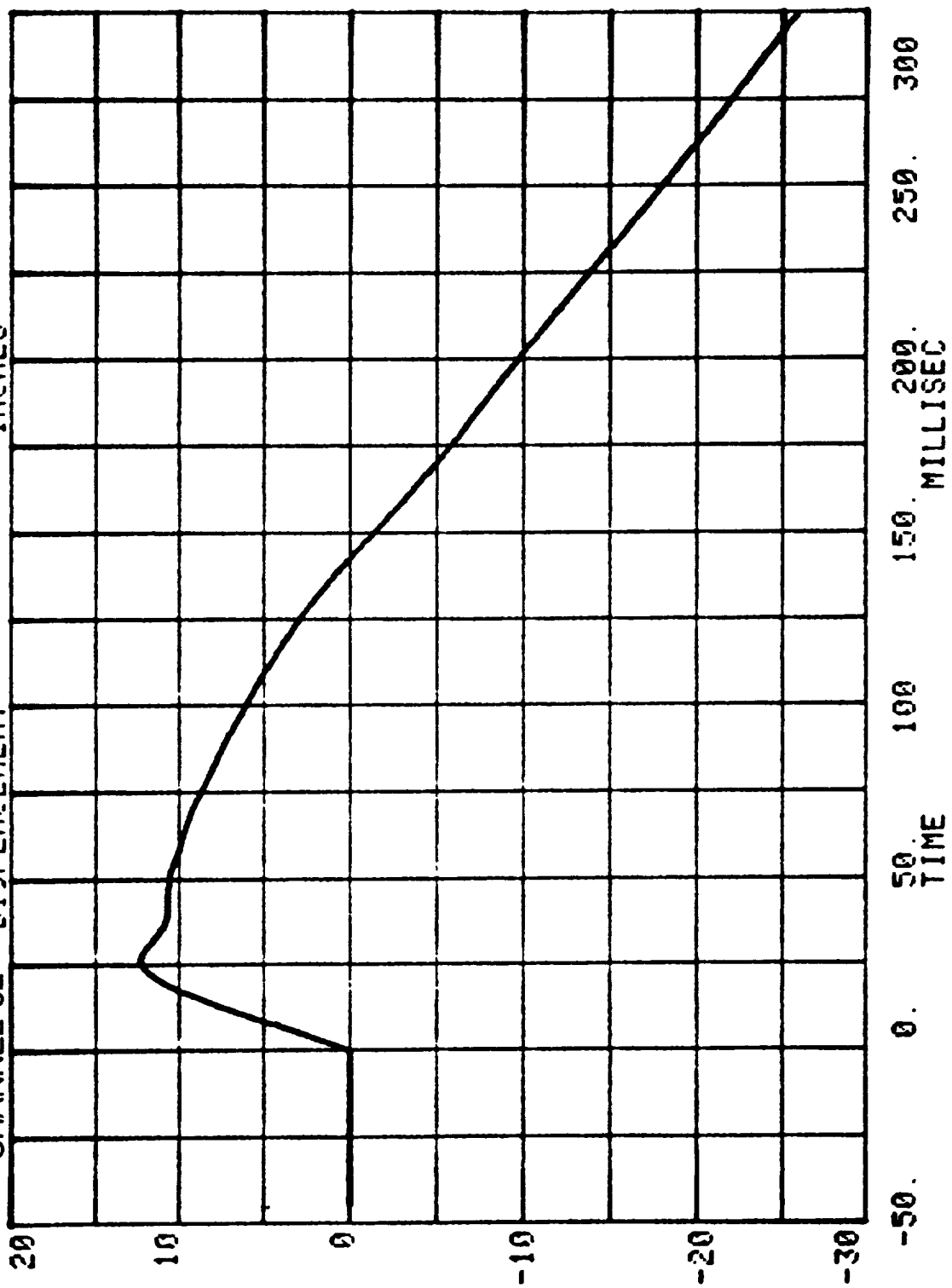


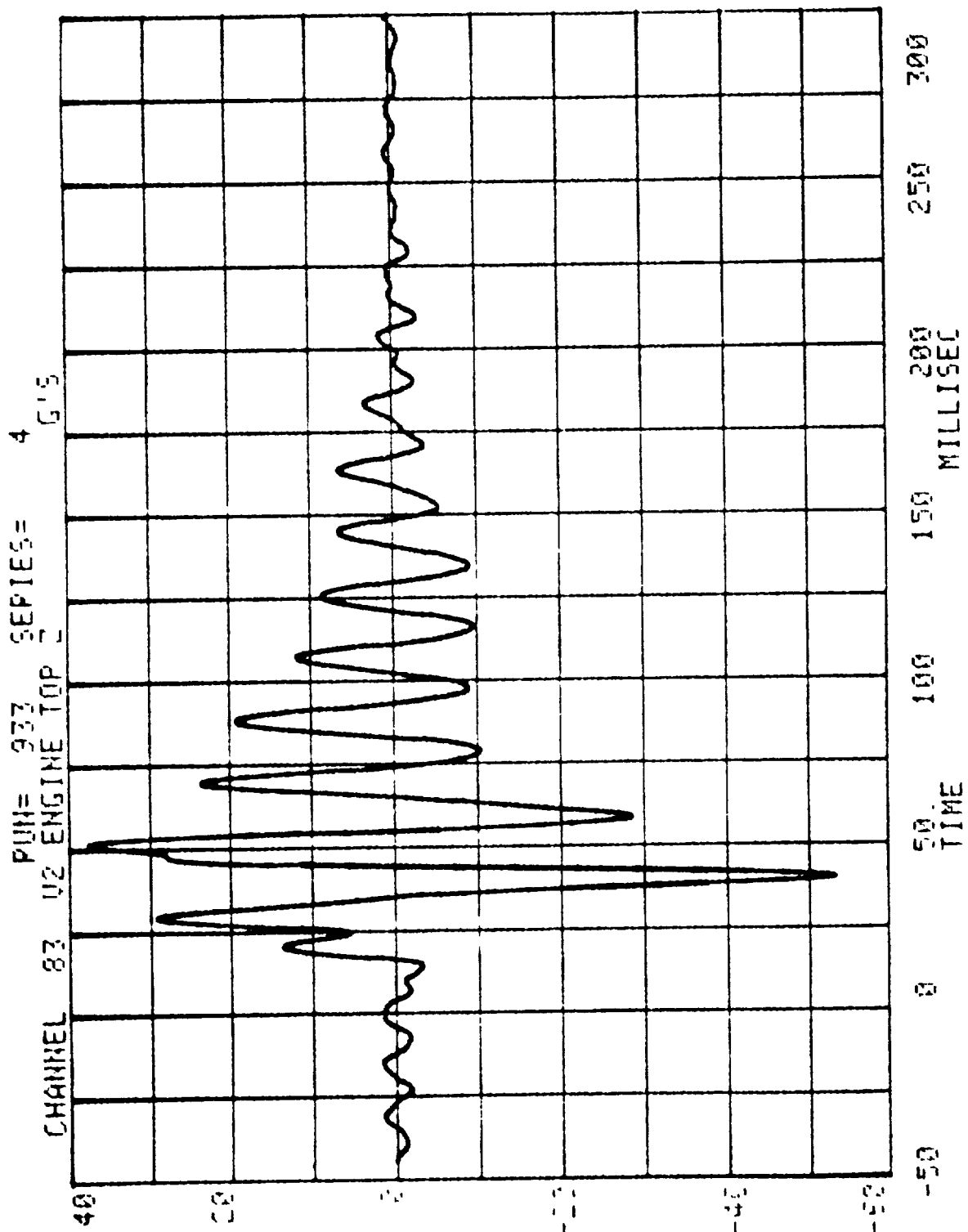


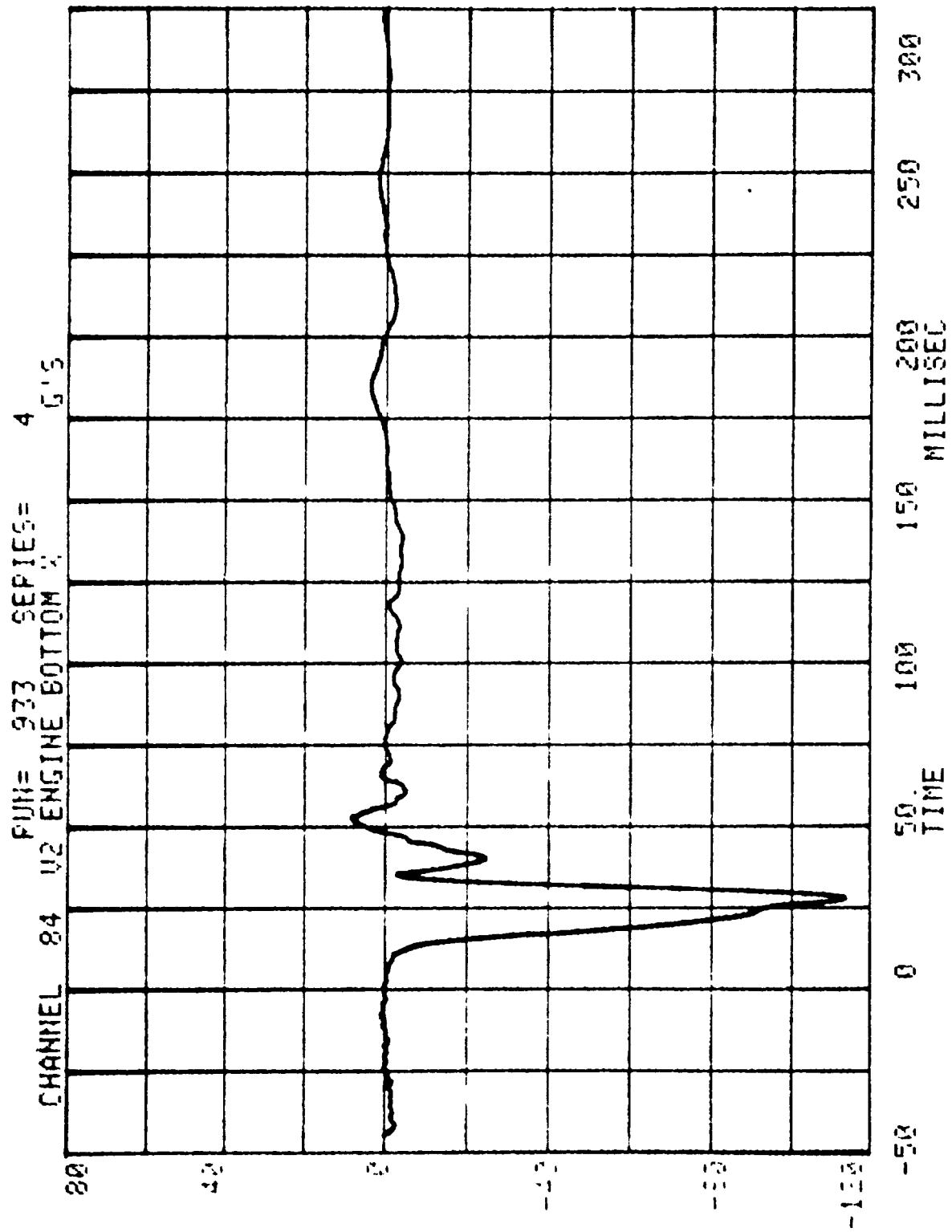


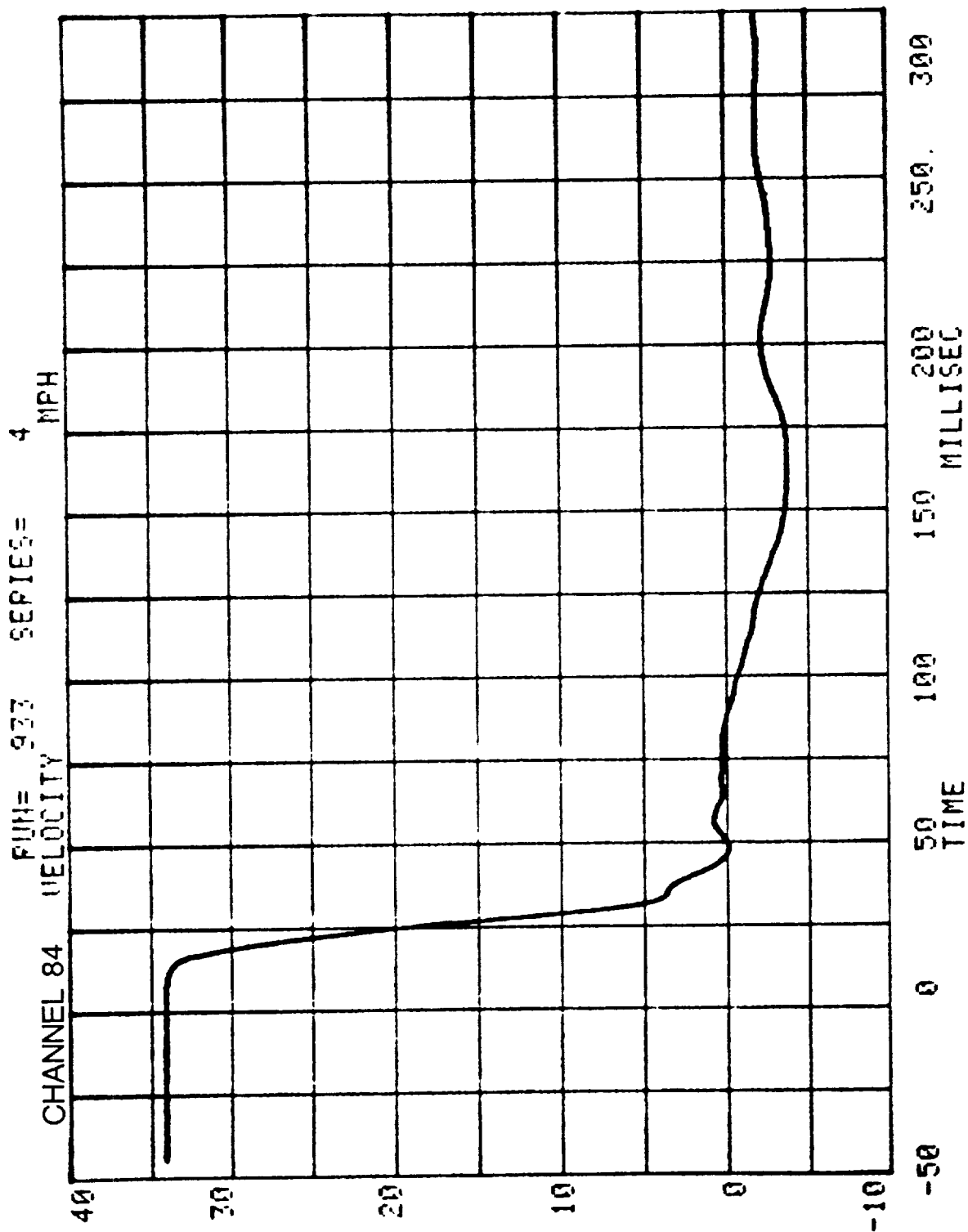


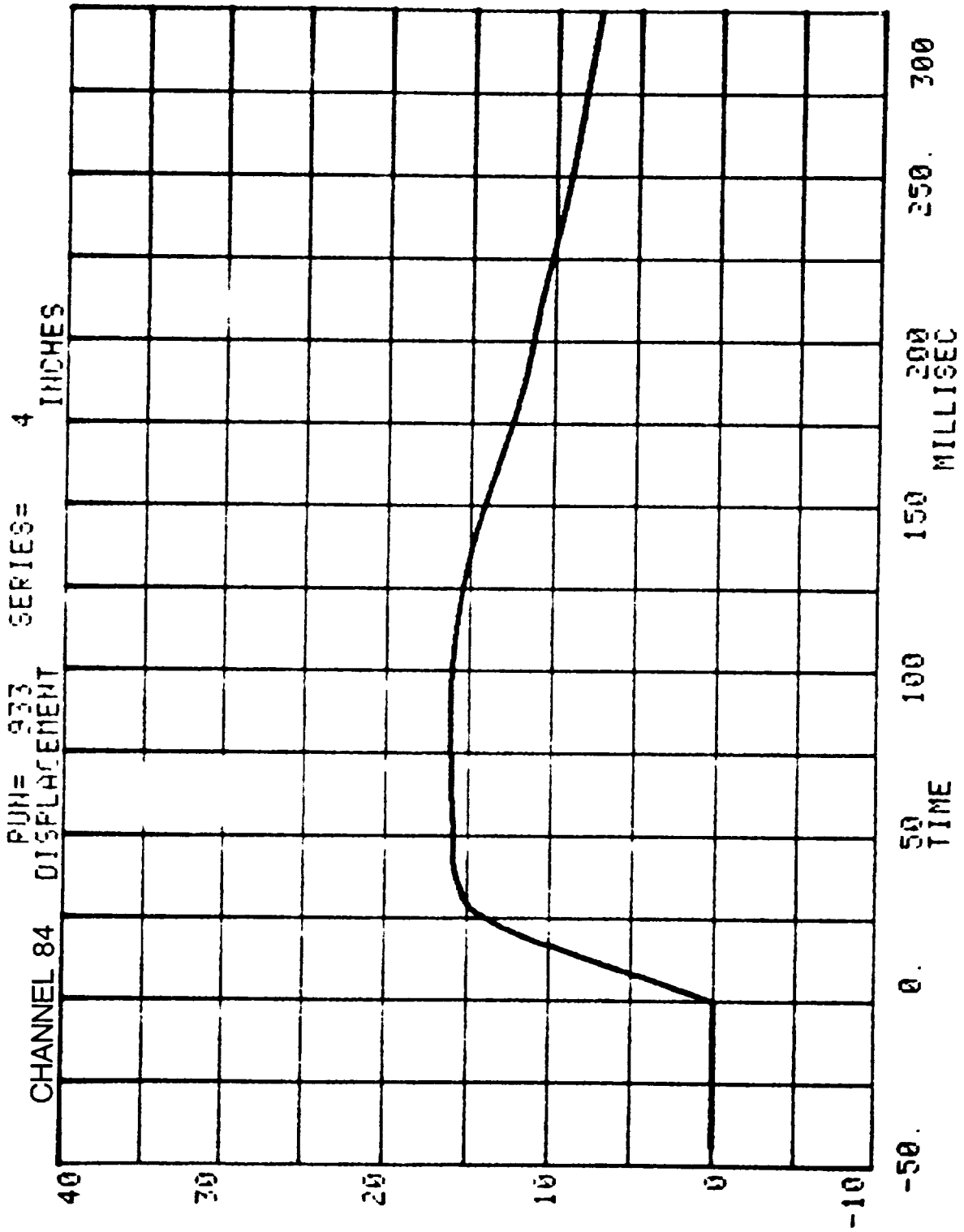
CHANNEL 82 DISPLACEMENT PUH= 933 SERIES= 4 INCHES

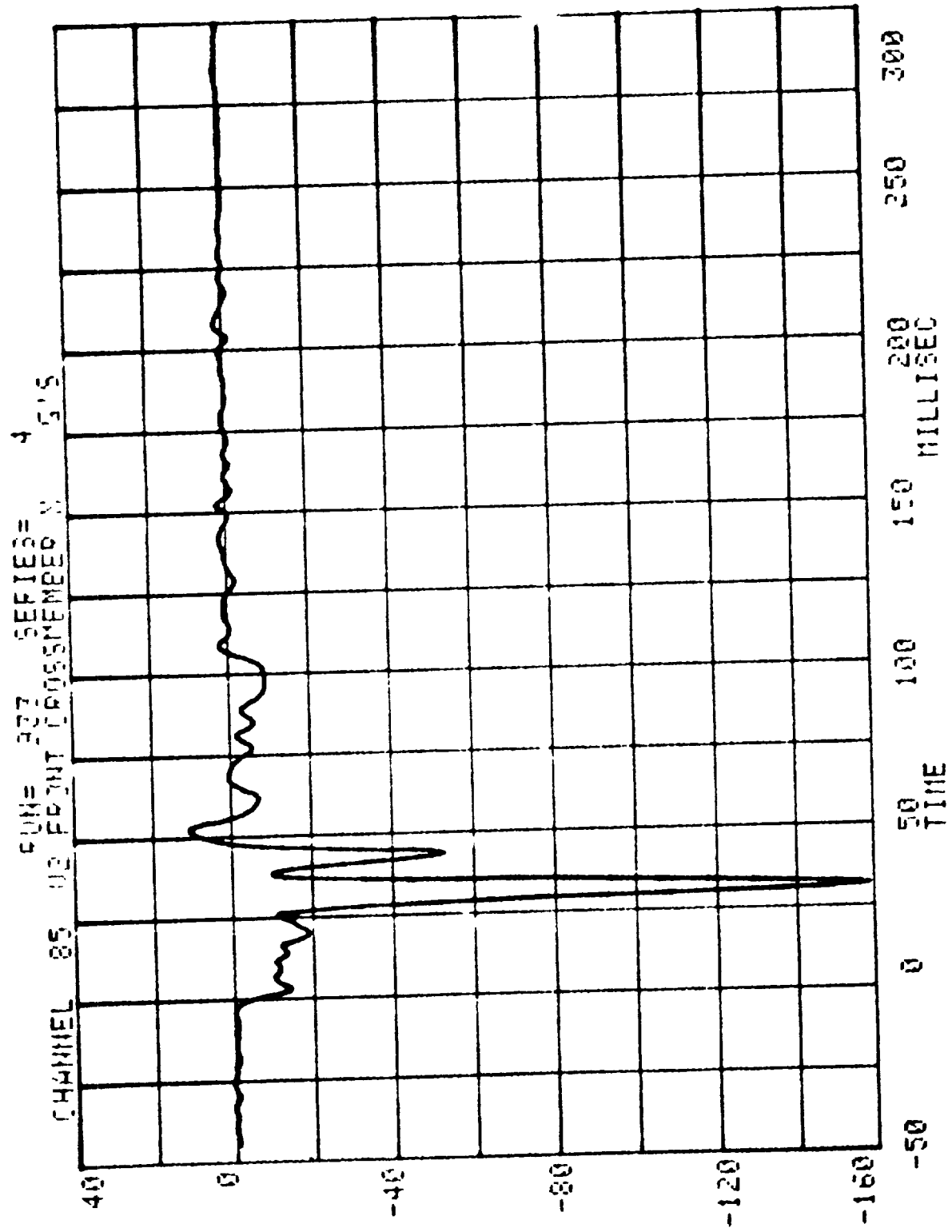


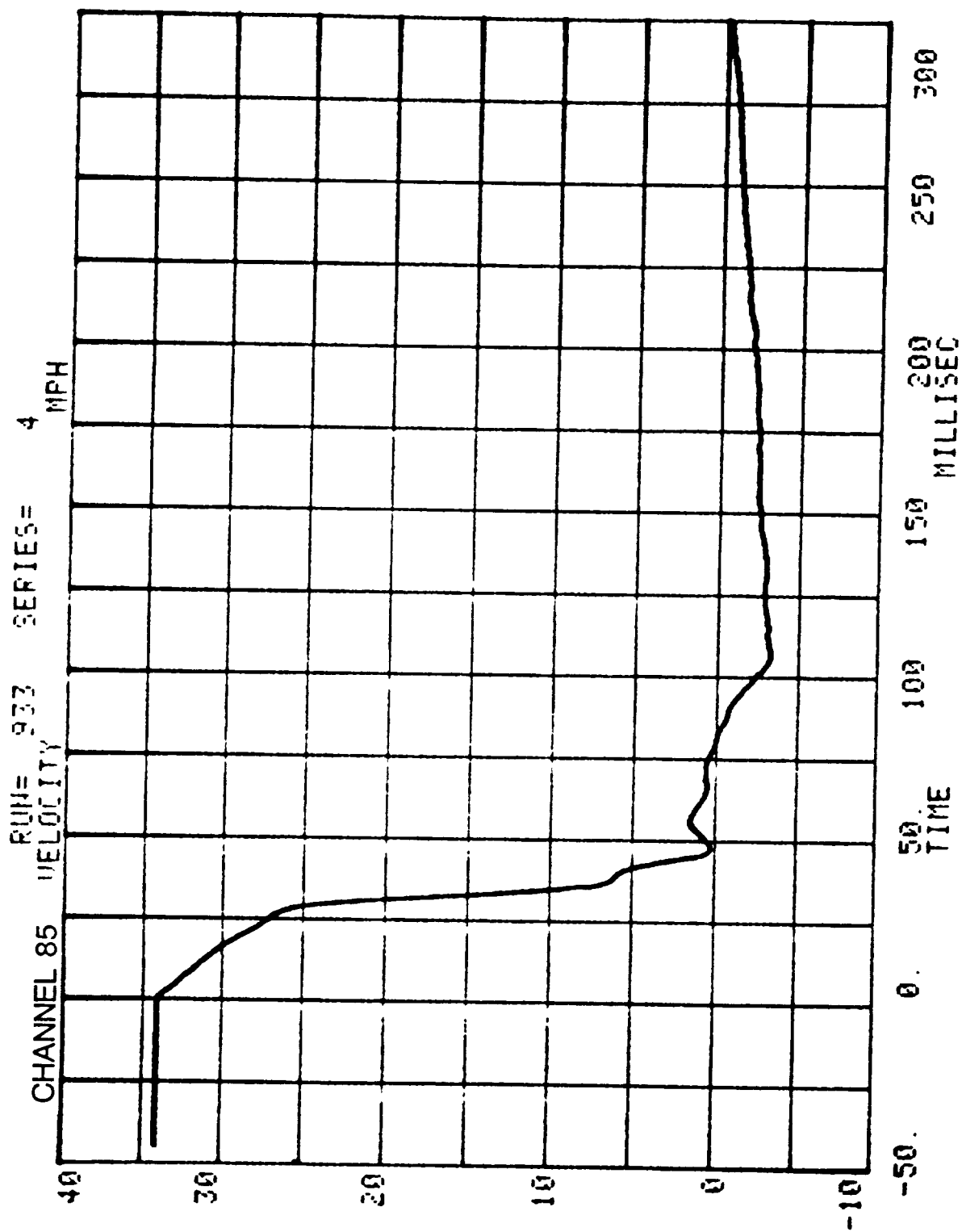


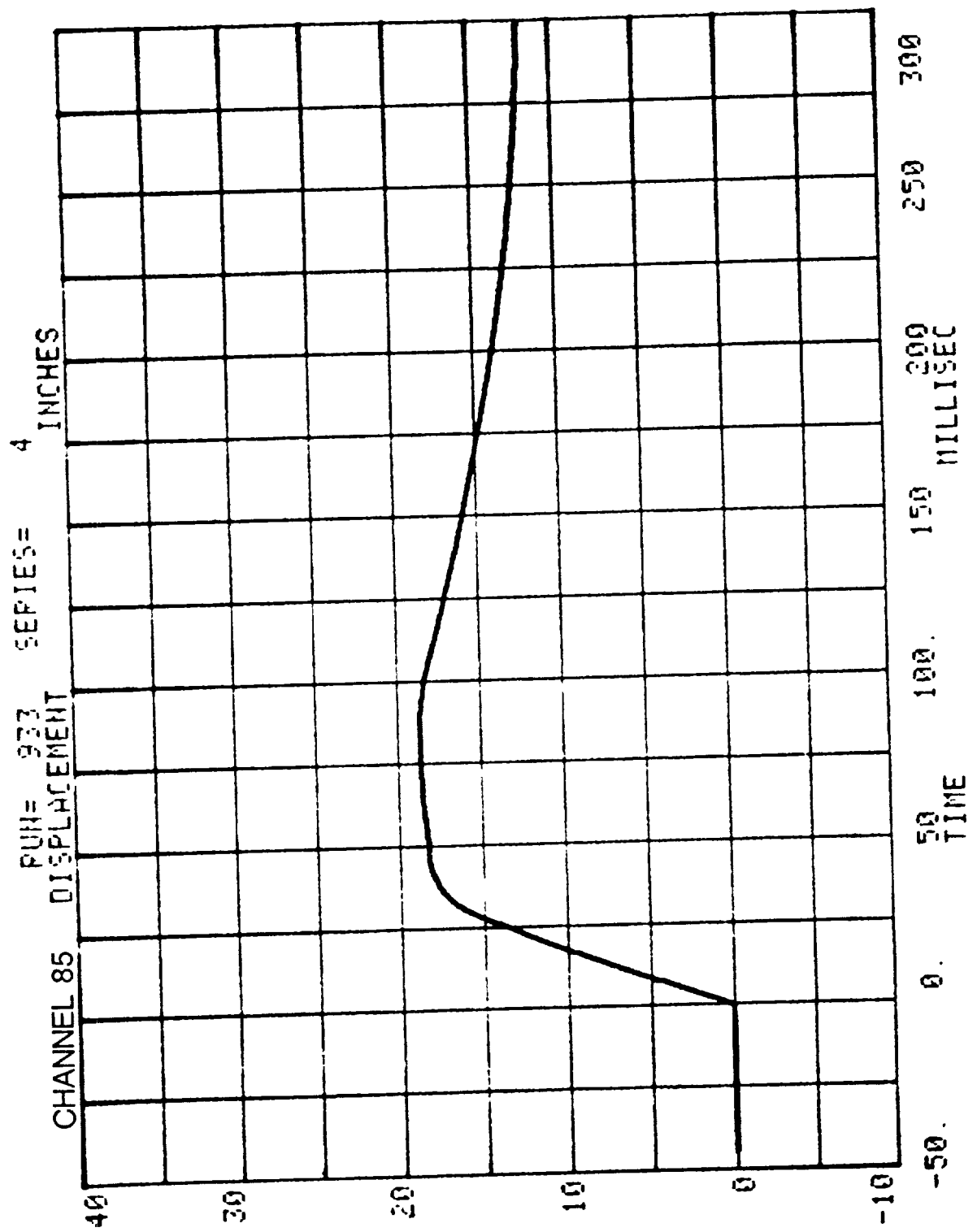


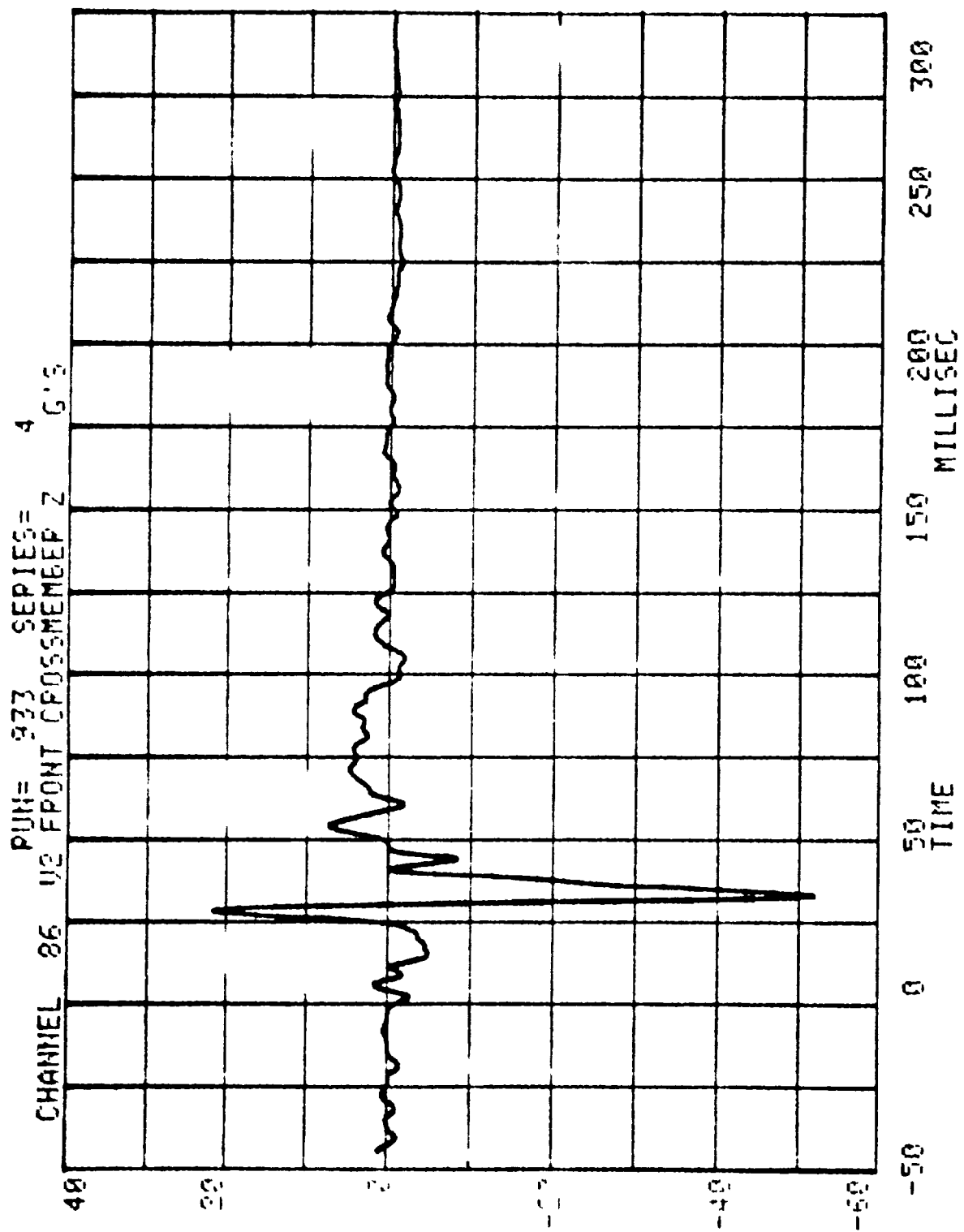


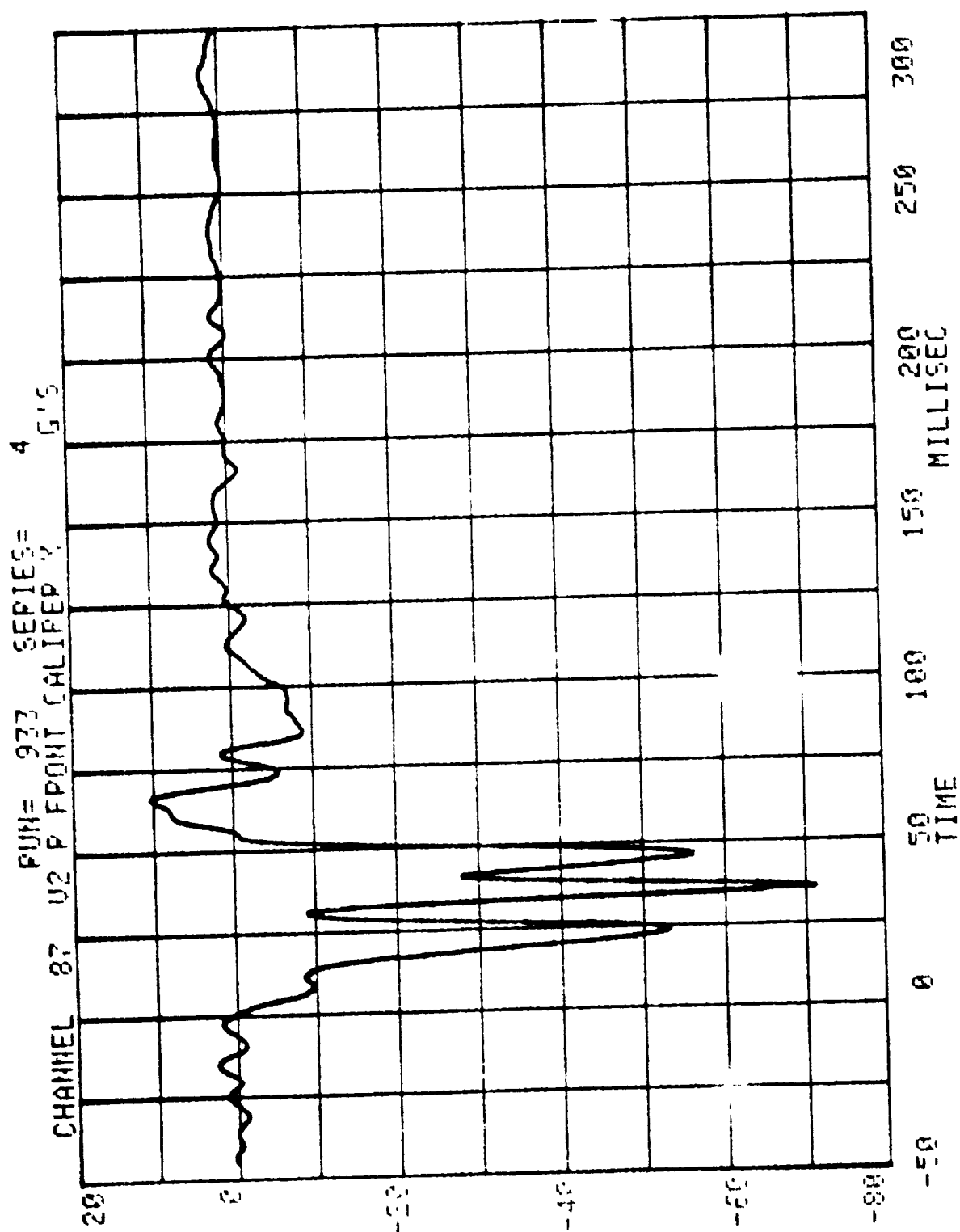


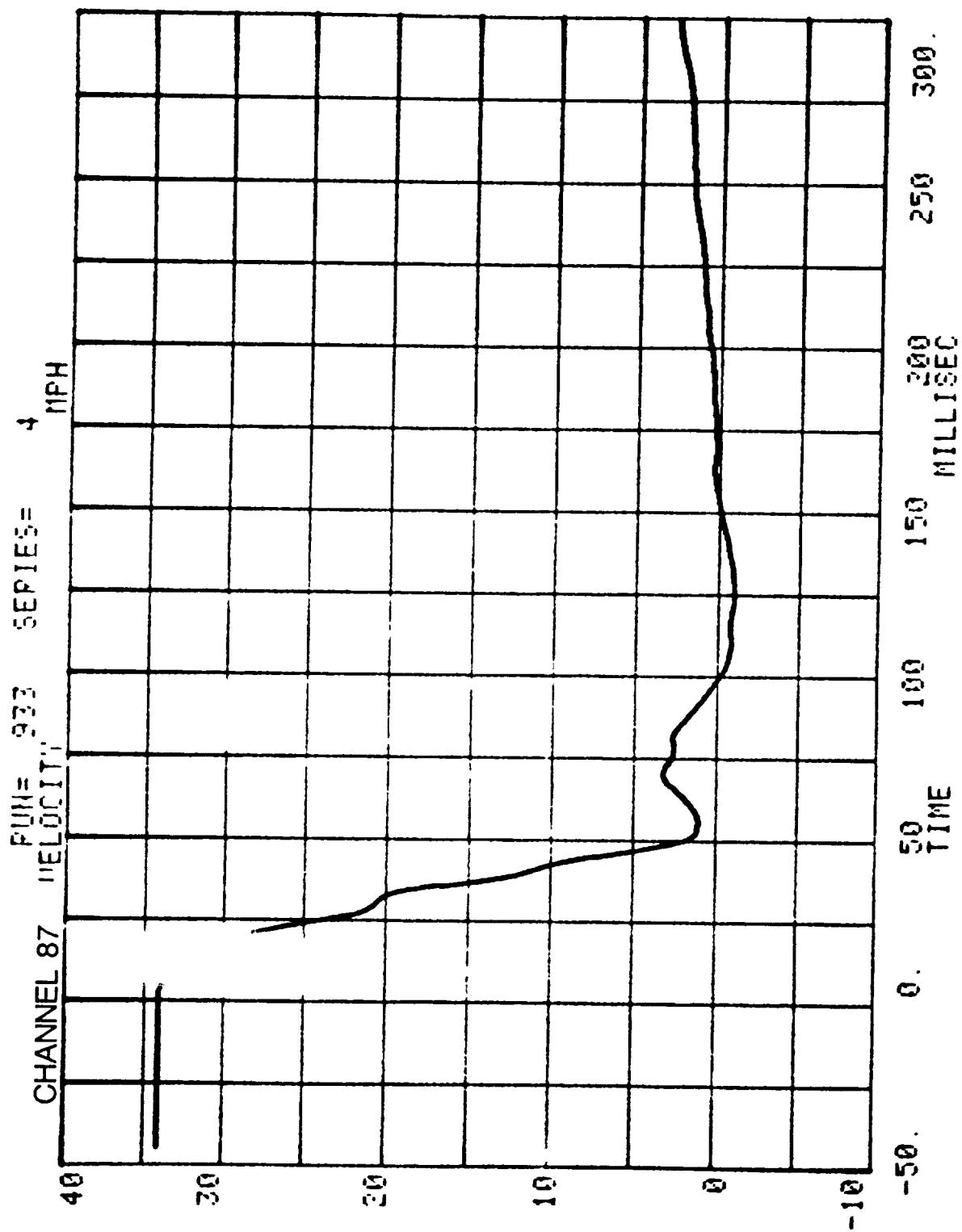


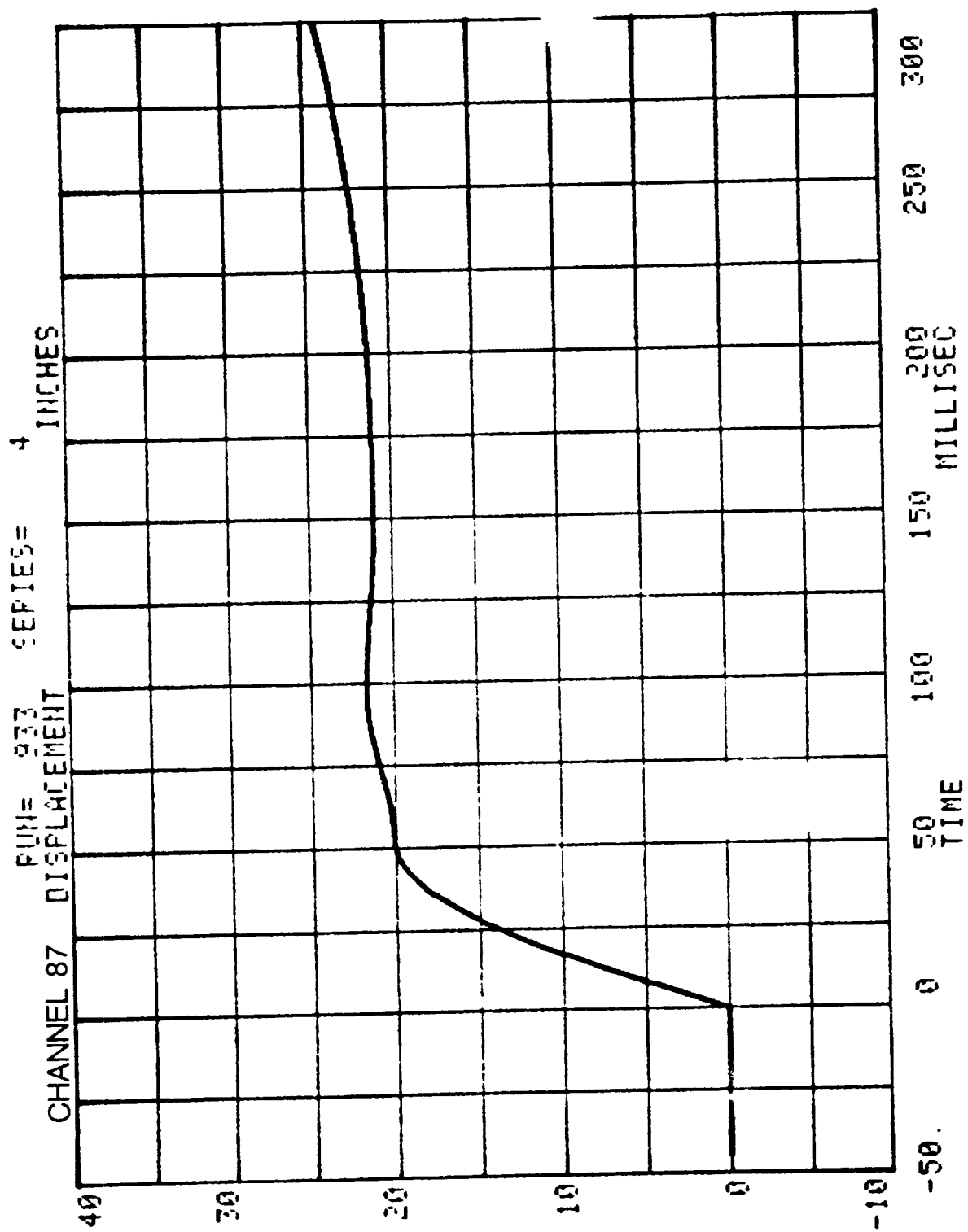




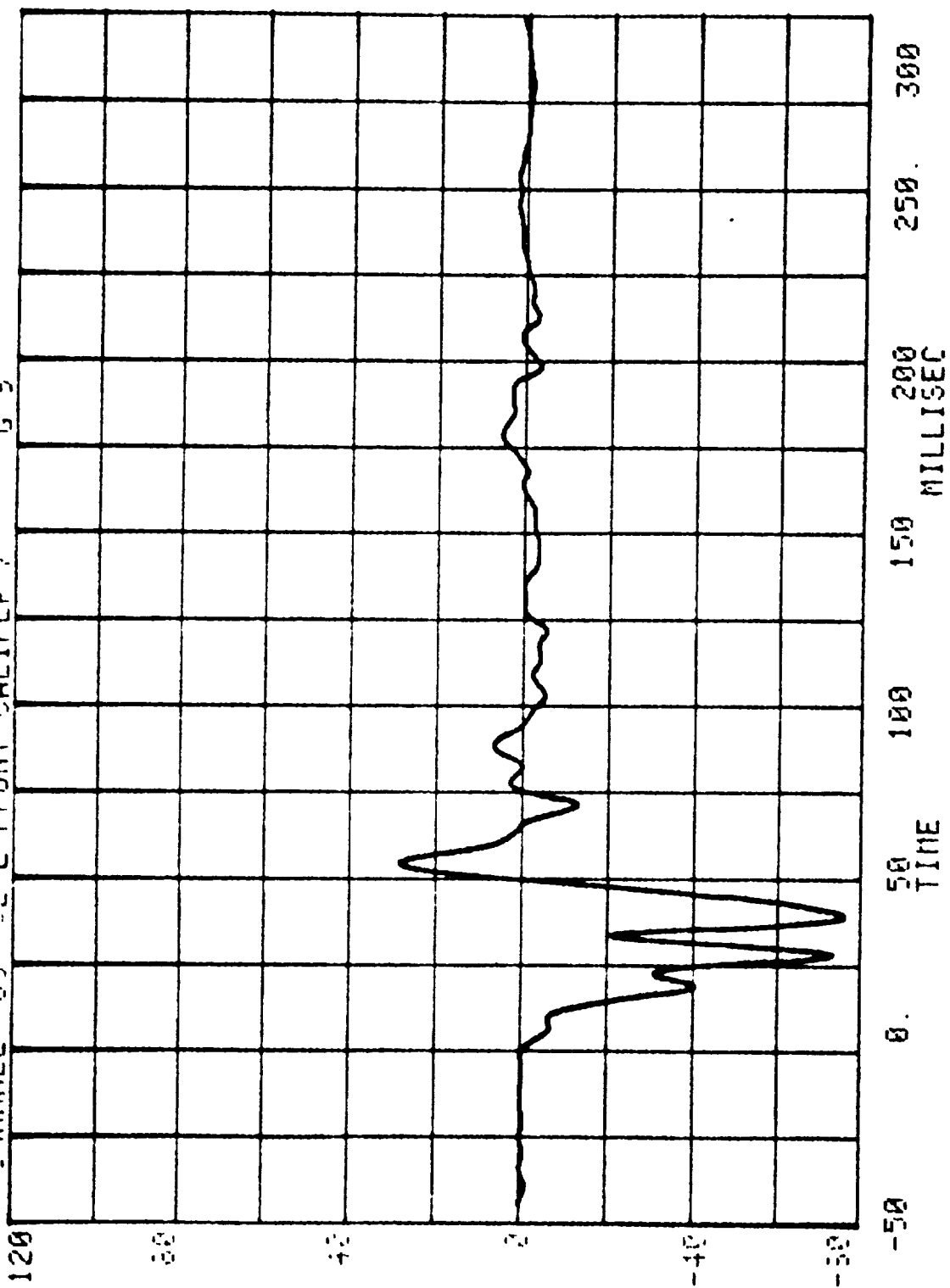


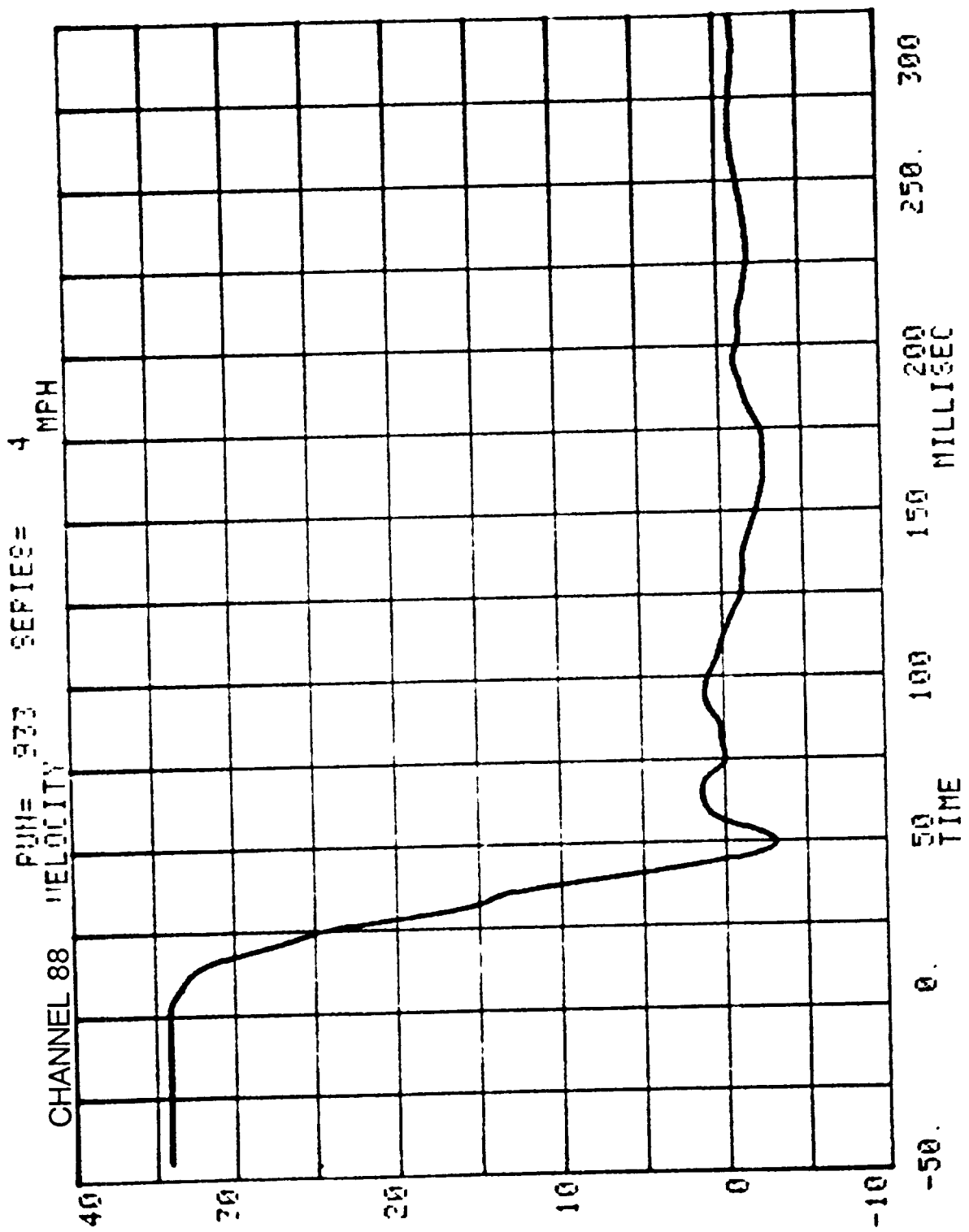






CHANNEL 83 U2 L FRONT CALIPEP Y SERIES= 4 G'S



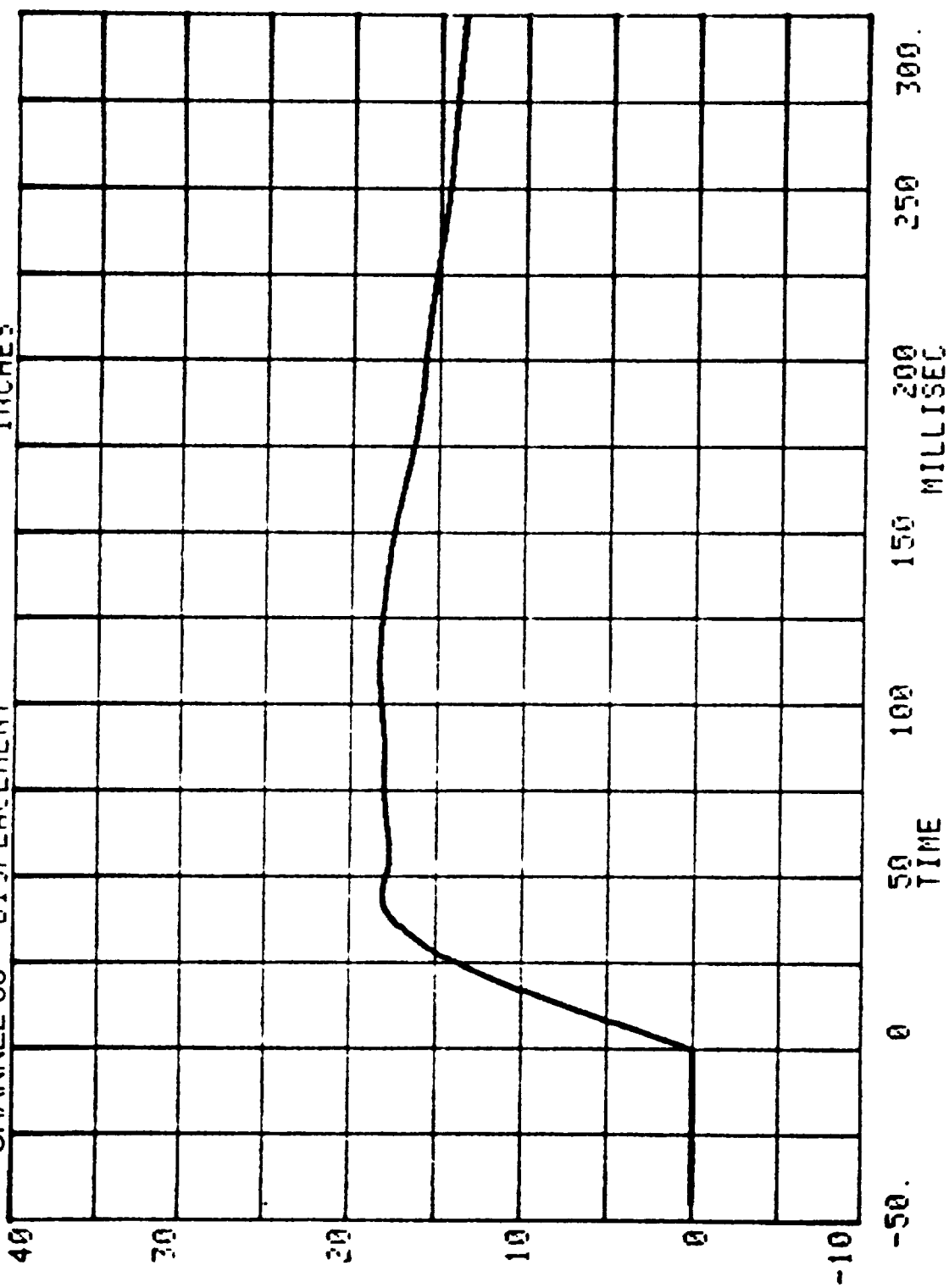


CHANNEL 88 DISPLACEMENT

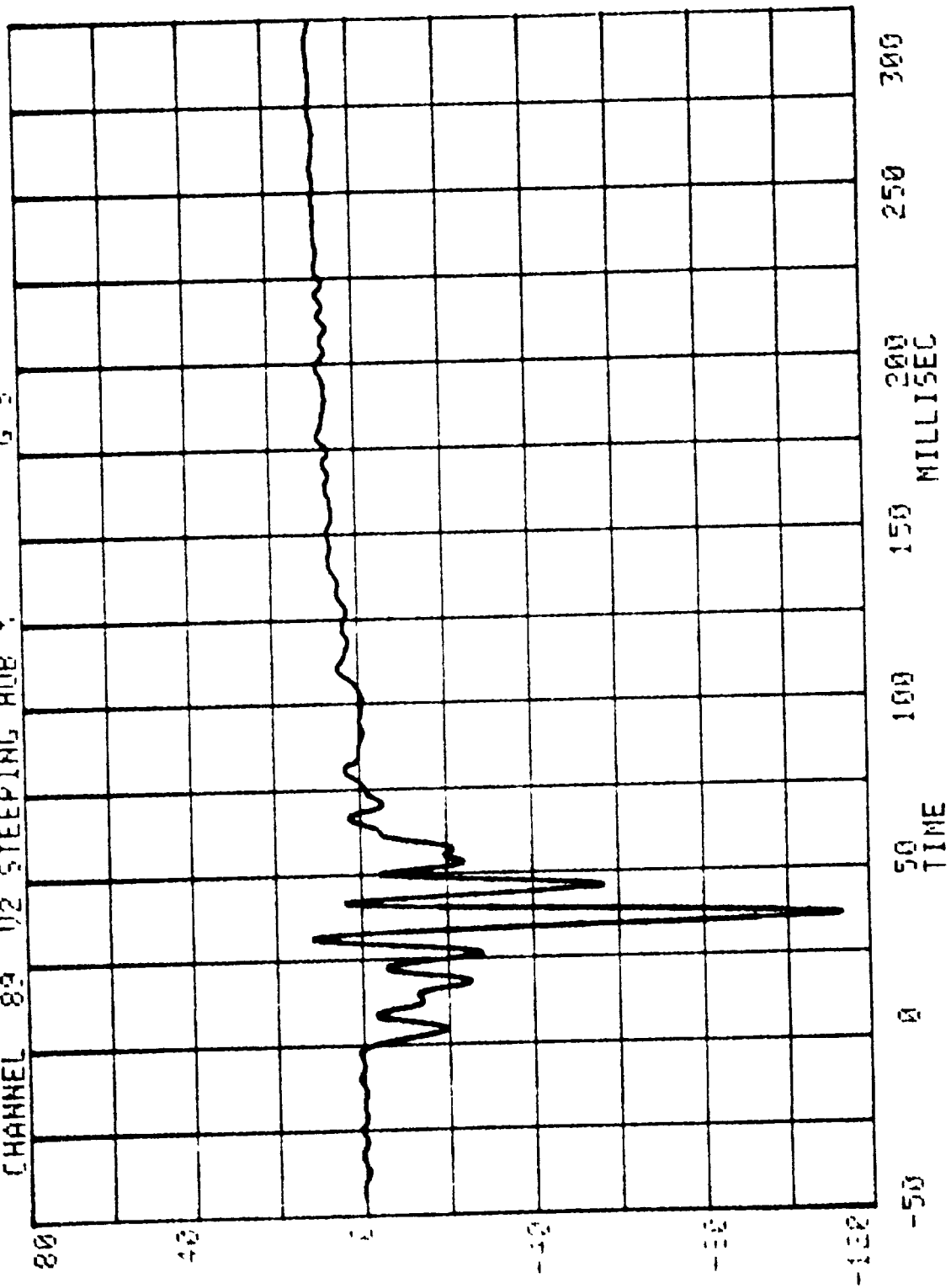
RUN= 933

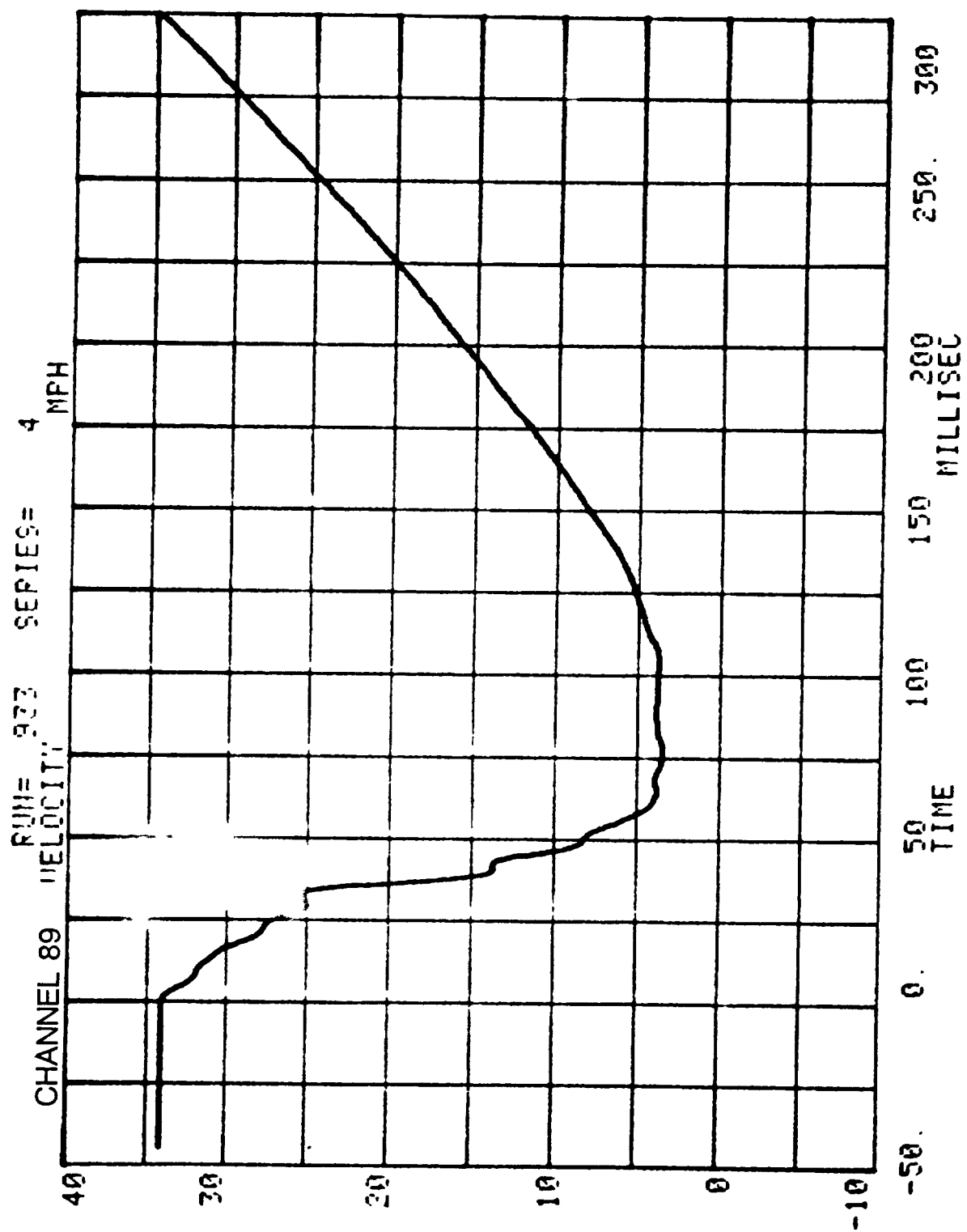
SERIES=

4 INCHES



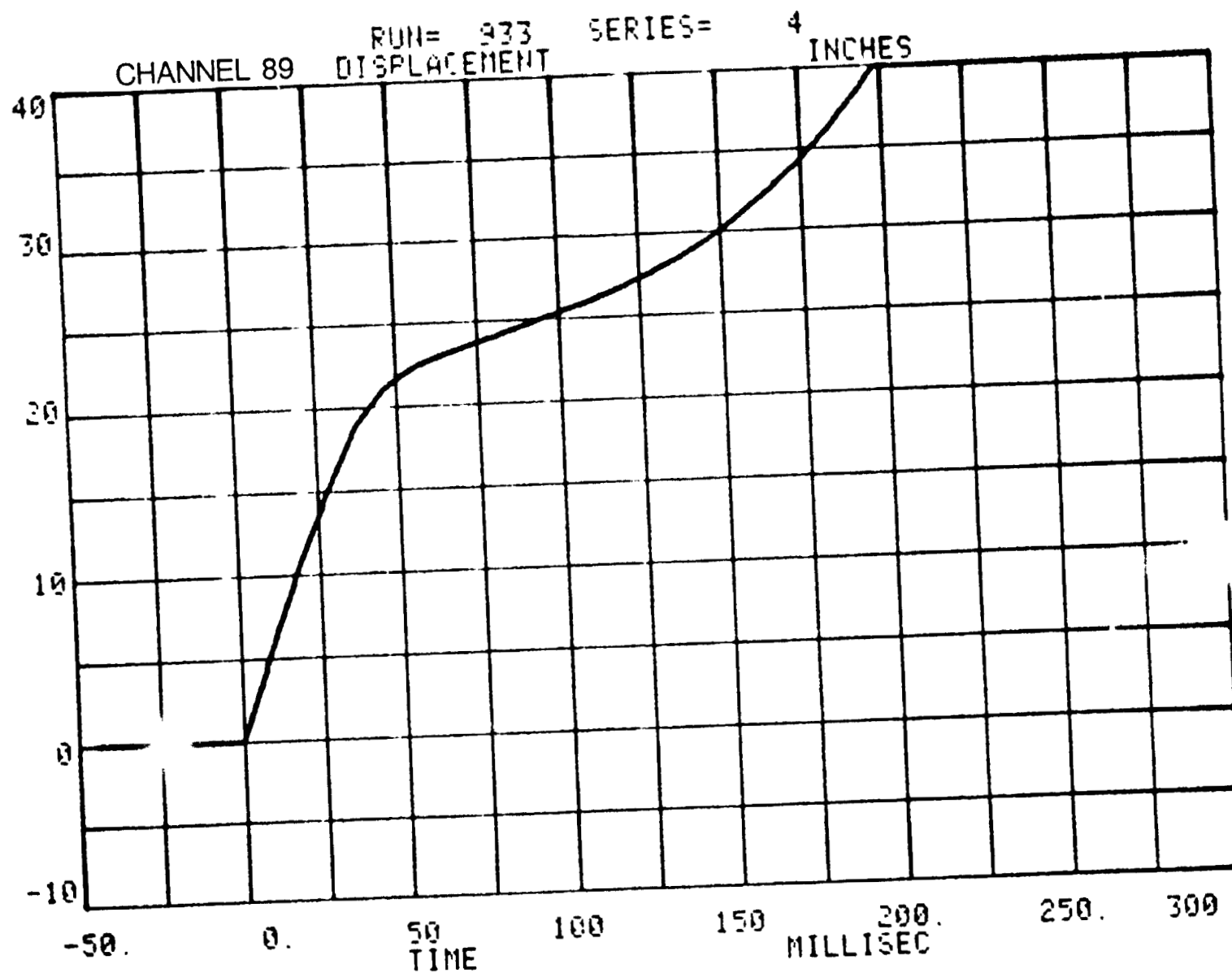
CHANNEL 83 02 STEERING HUB 4 G'S



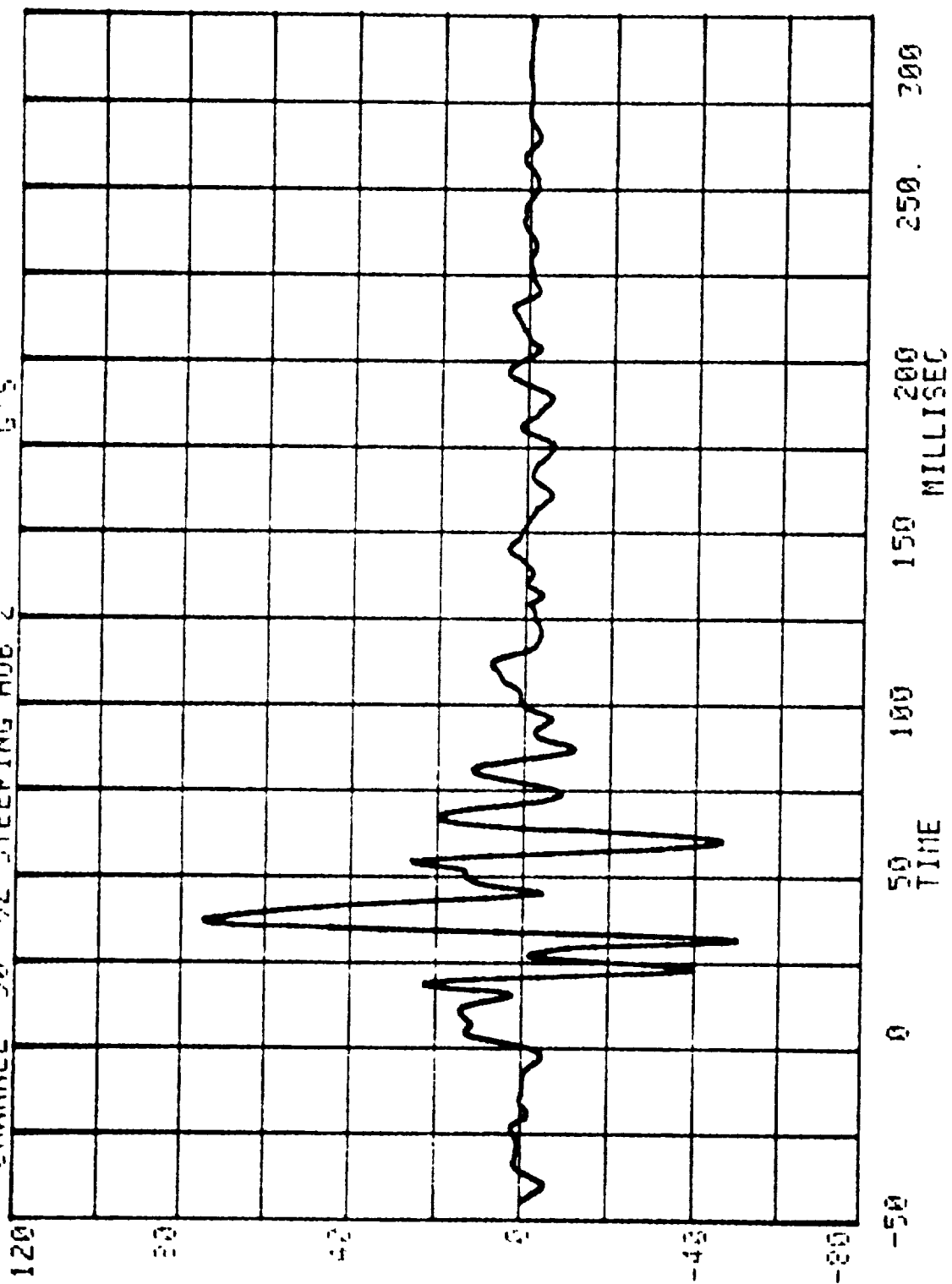


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CHANNEL 98 1/2 STEERING HUB 2 FUN= 933 SERIES= 4 G'S



TEST NO Y38-3-932

DUMMY DATA

CLASS	FILTER CHANNEL
Head Accelerations	1000
Chest Accelerations	180
Femur Forces	600

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

FUN # 932		SERIES # 4
CHANNEL	TITLE	3 MS CLIPPED PEAK
2 U1 F1 CH	P	68 351 G'S
4 U2 P2 CH	P	47 285 G'S

HEAD INJURY CRITERION
HEAD SEVERITY INDEX
GMS MAXIMUM CURVATURE

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

PUN= 933

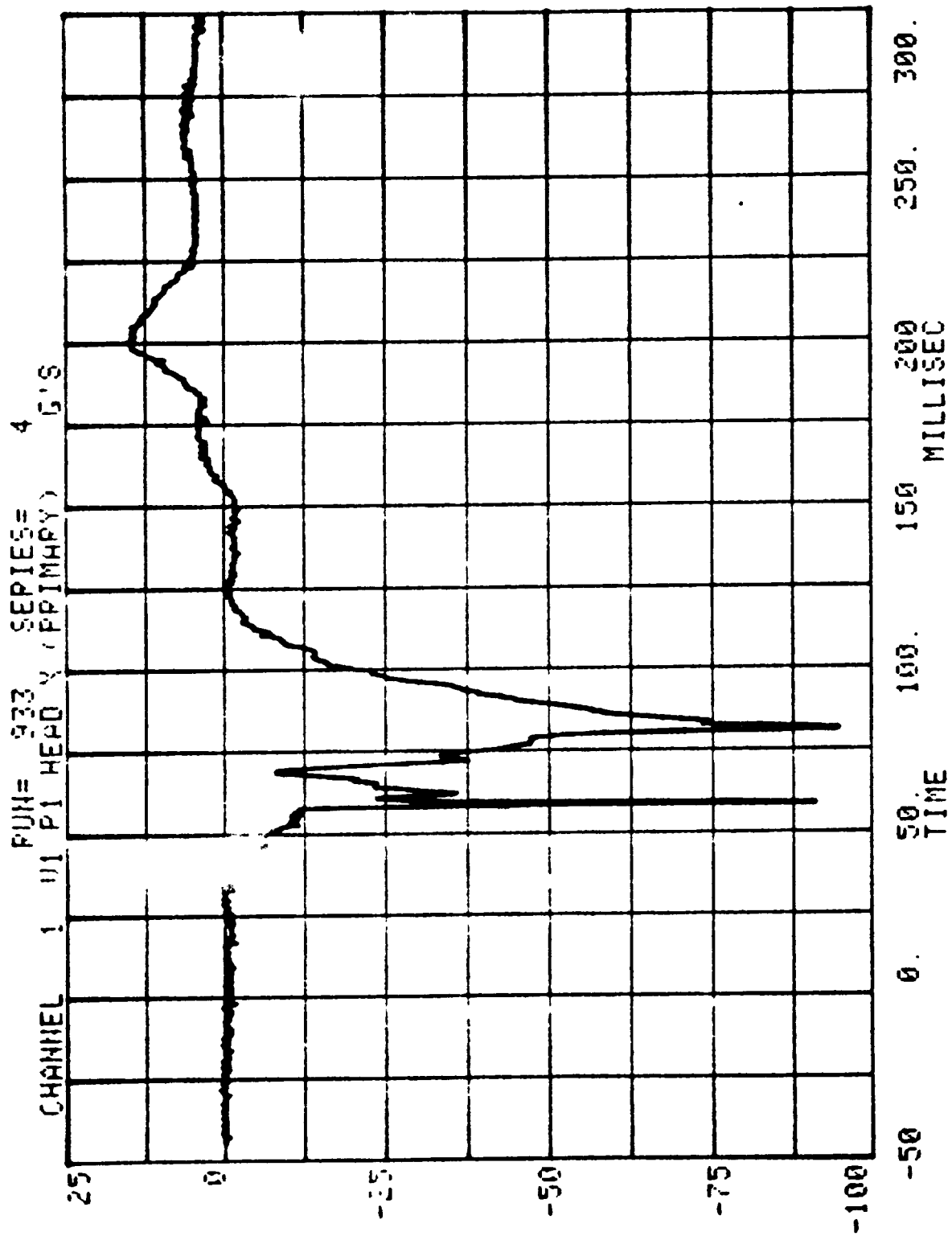
U1 P1 HEAD P (PPIMHPY)

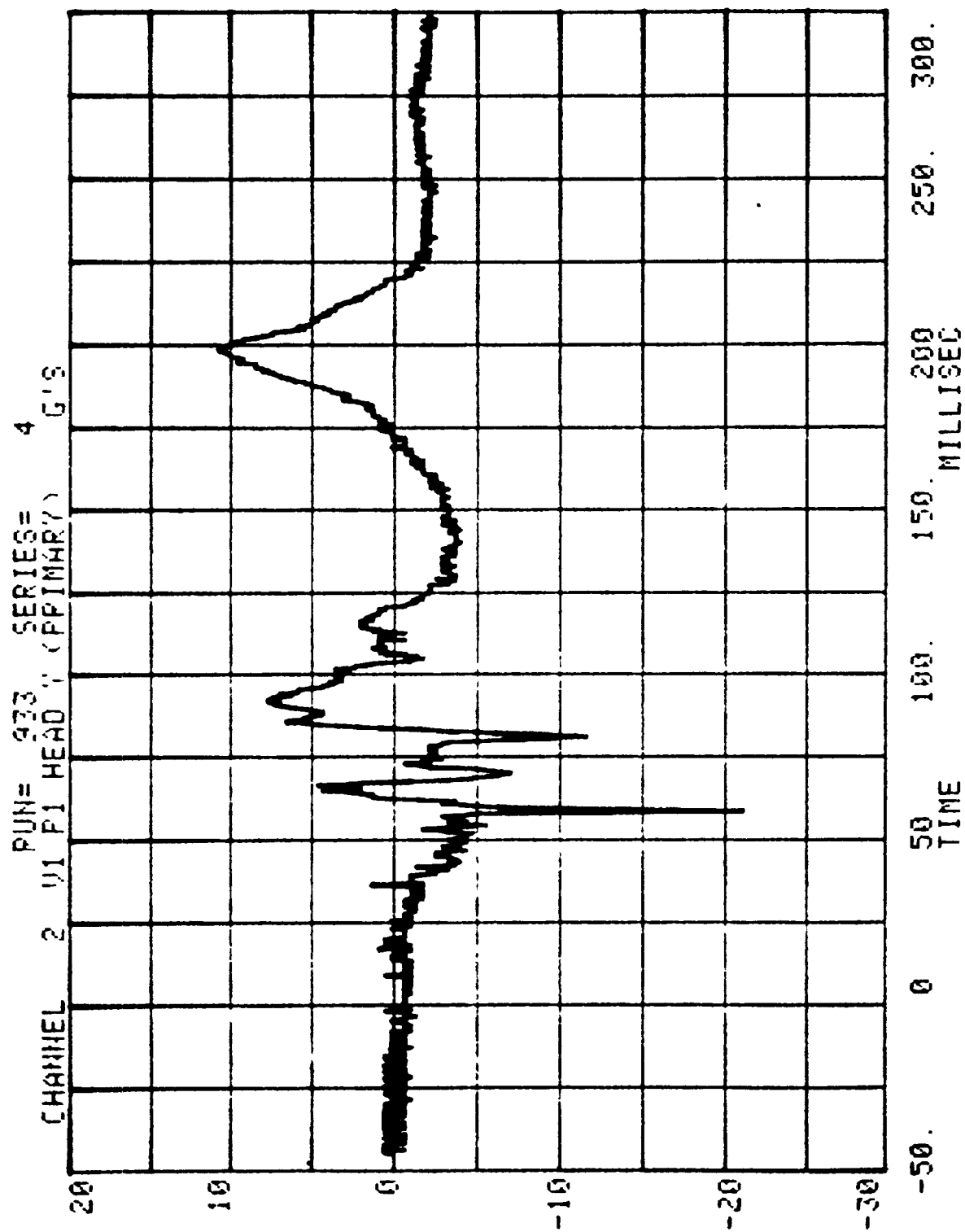
HIC=1058 0 FROM T1= 05812 TO T2= 09412

AVERAGE ACCELERATION BETWEEN T1 AND T2= 61.36'g

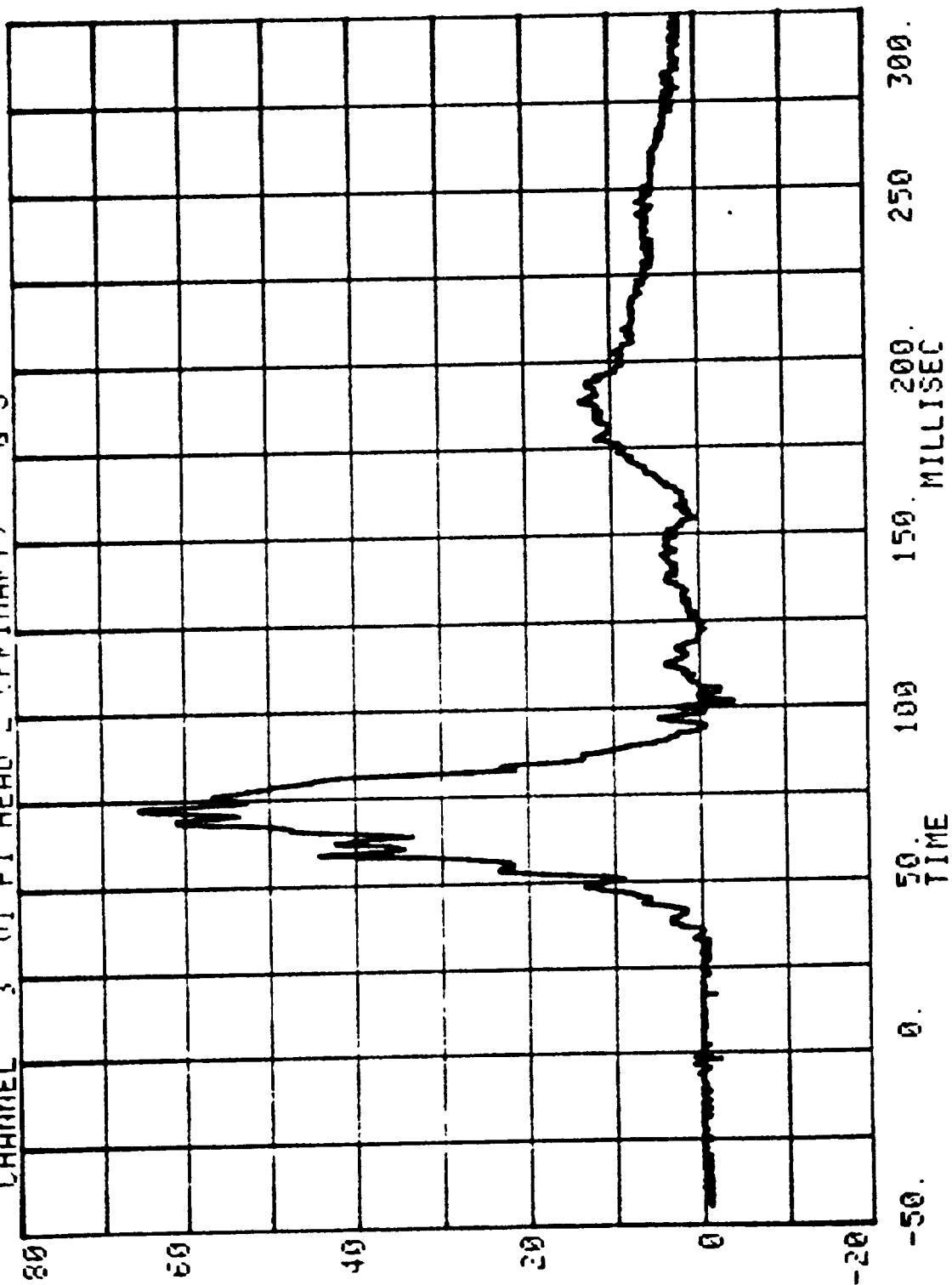
EVENT TIME= 300 0 MSEC

SEVERITY INDEX=1297 3

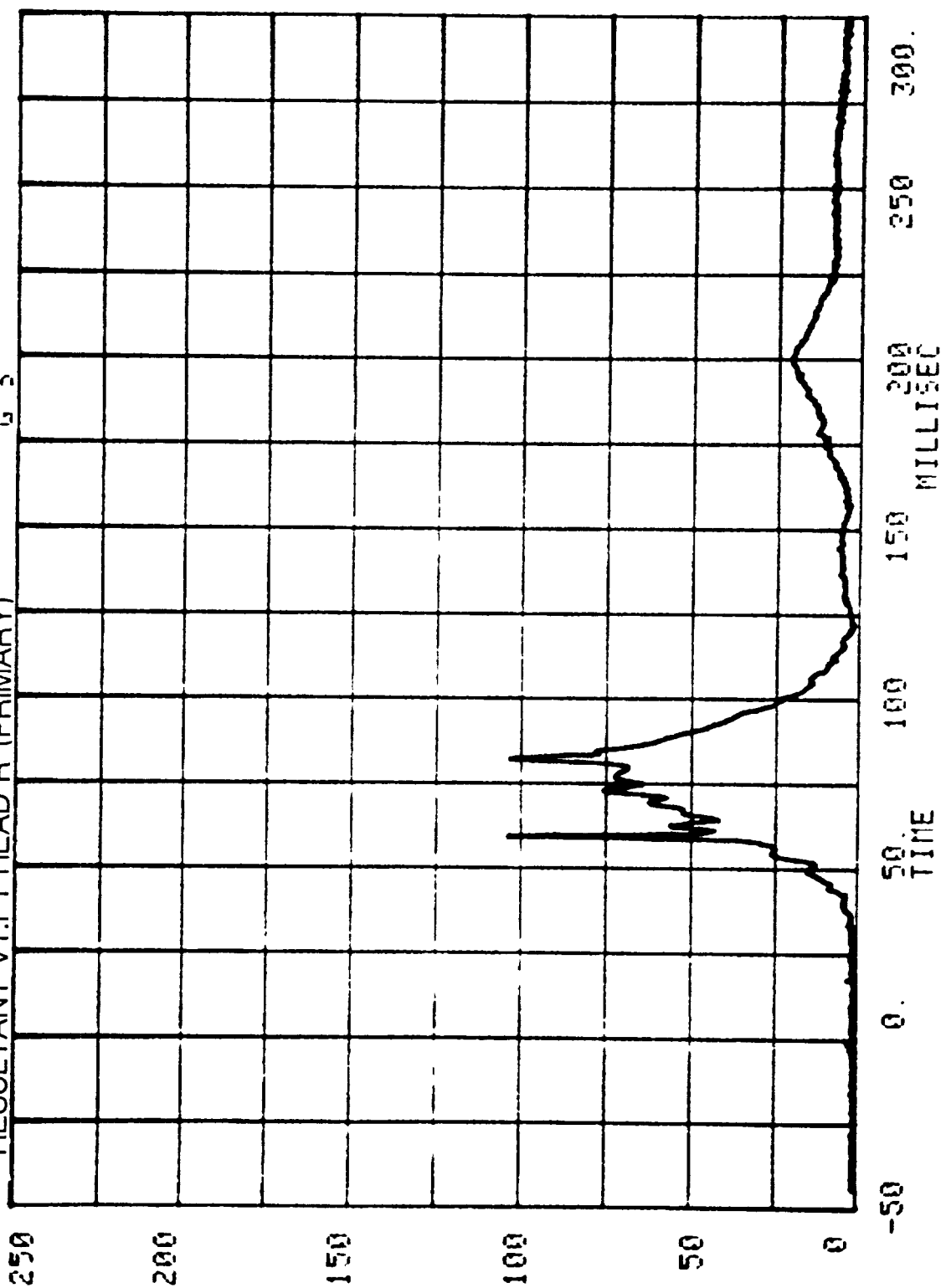


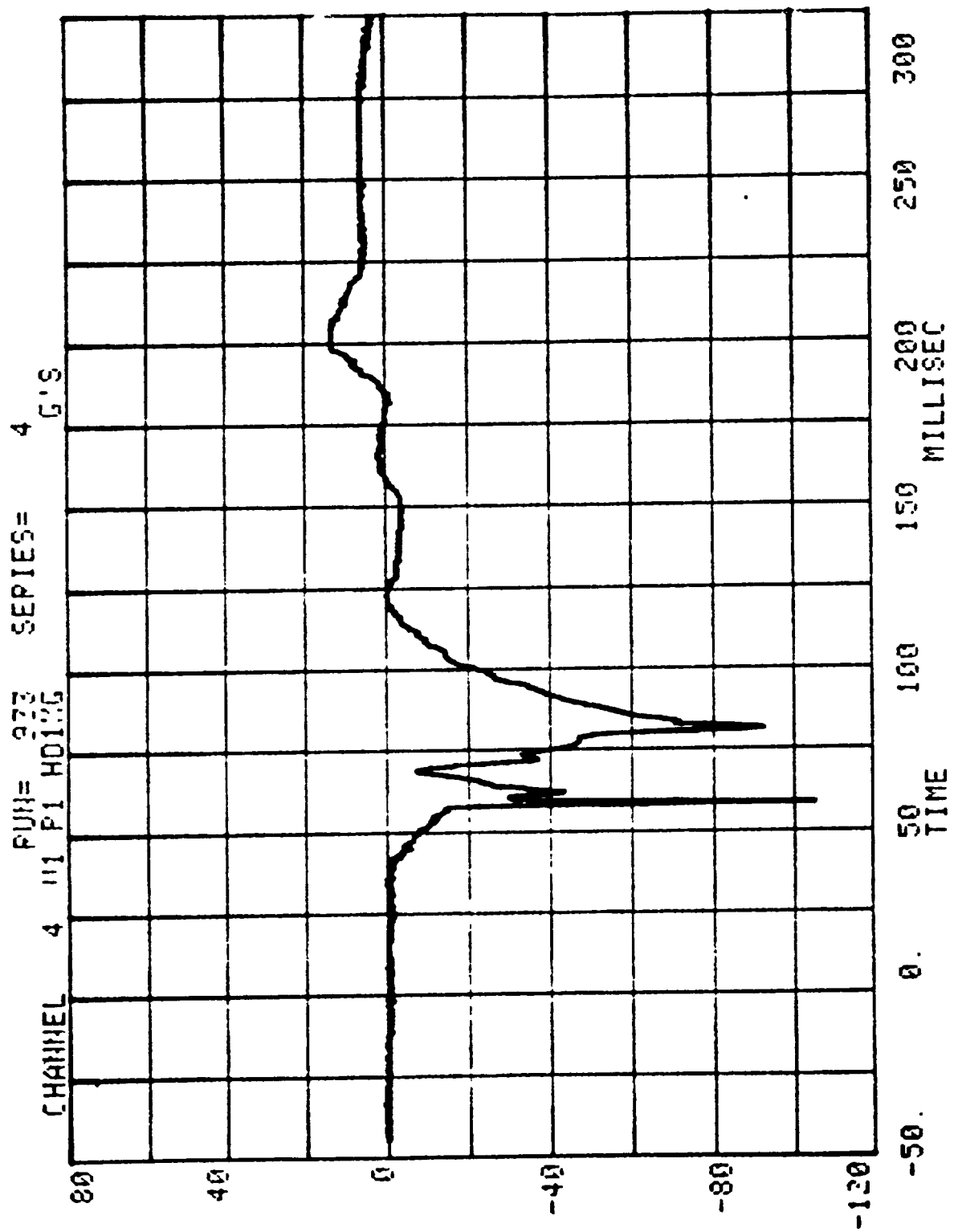


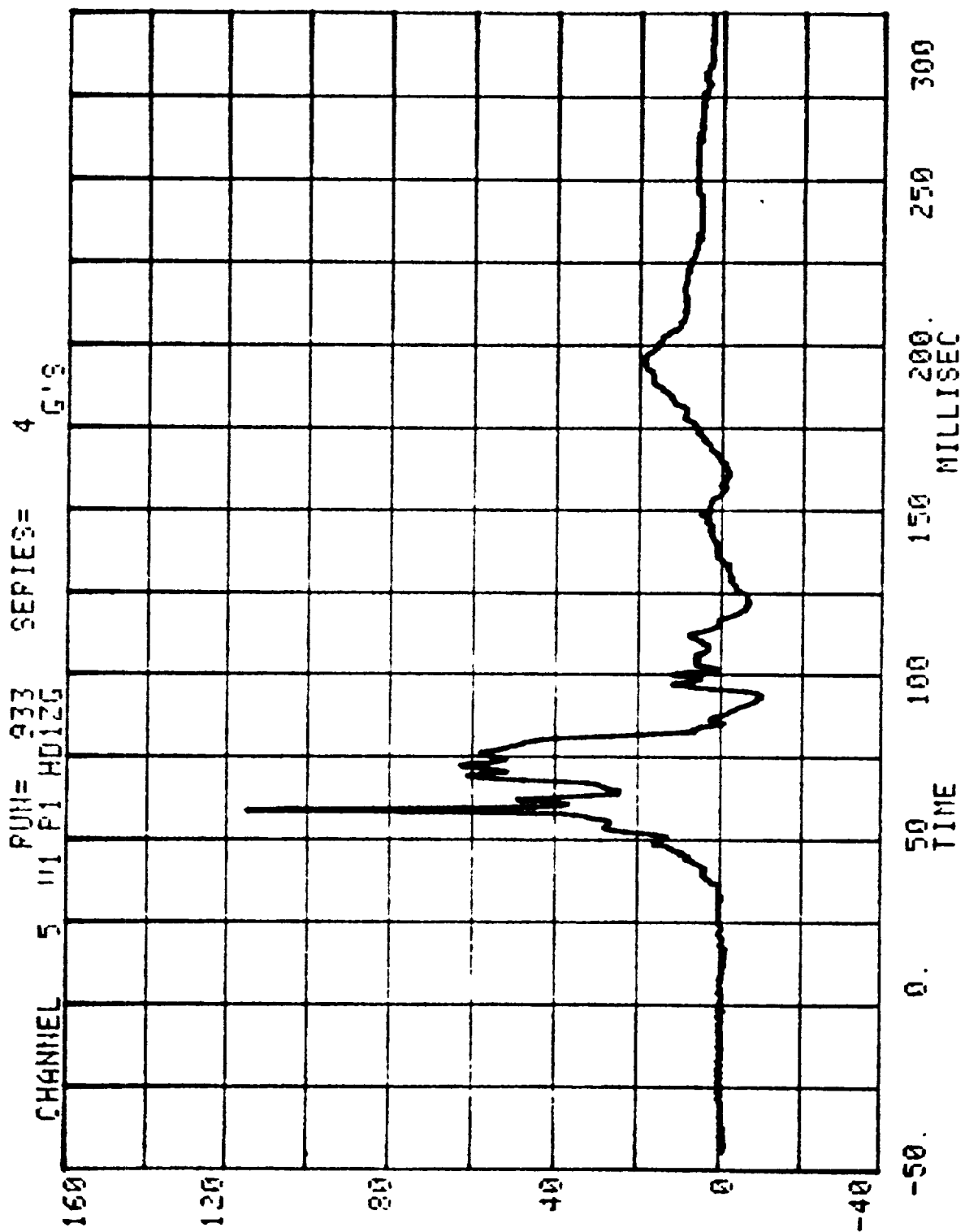
CHANNEL 3 U1 P1 HEAD 2 (PRIMARY) 4 G'S

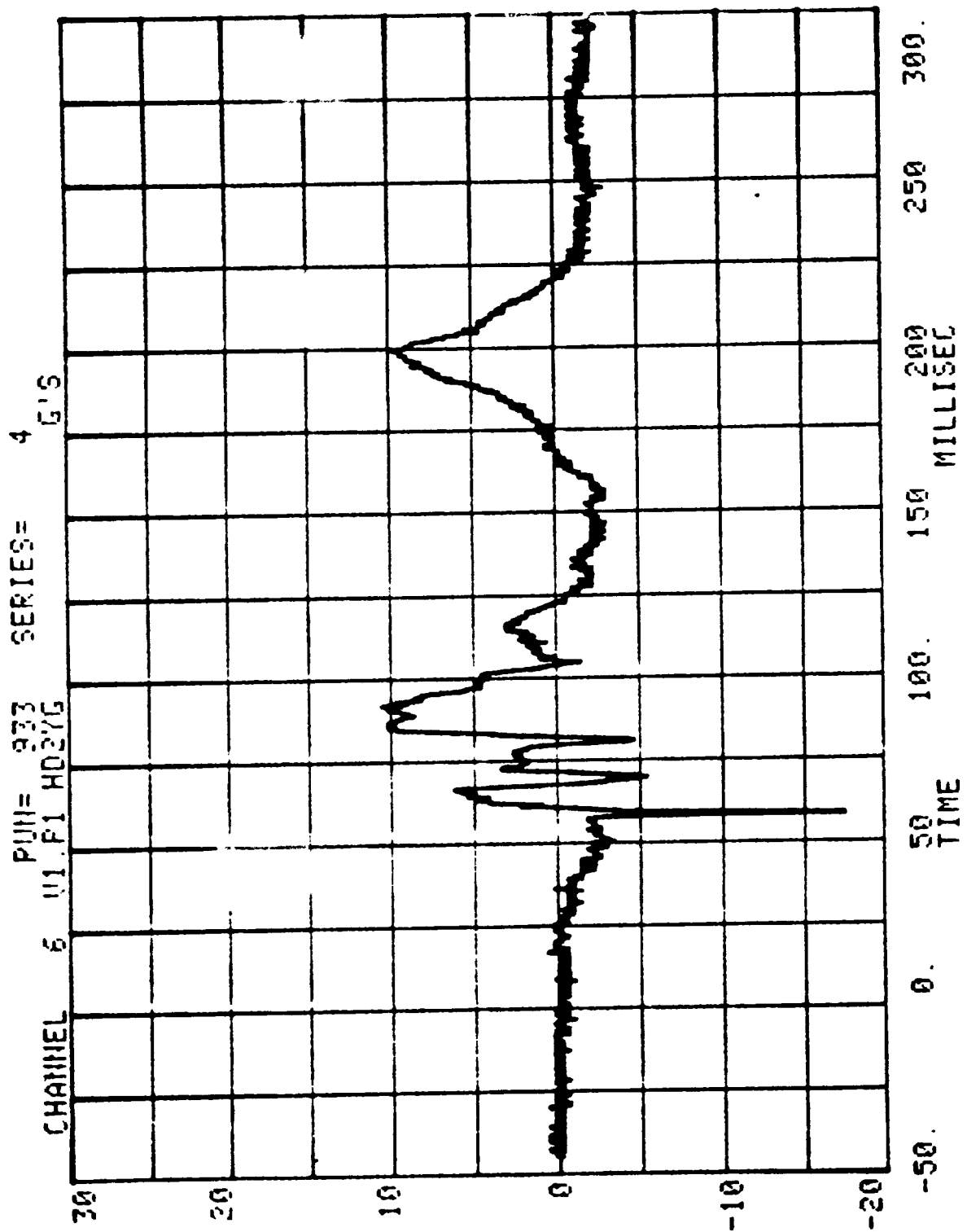


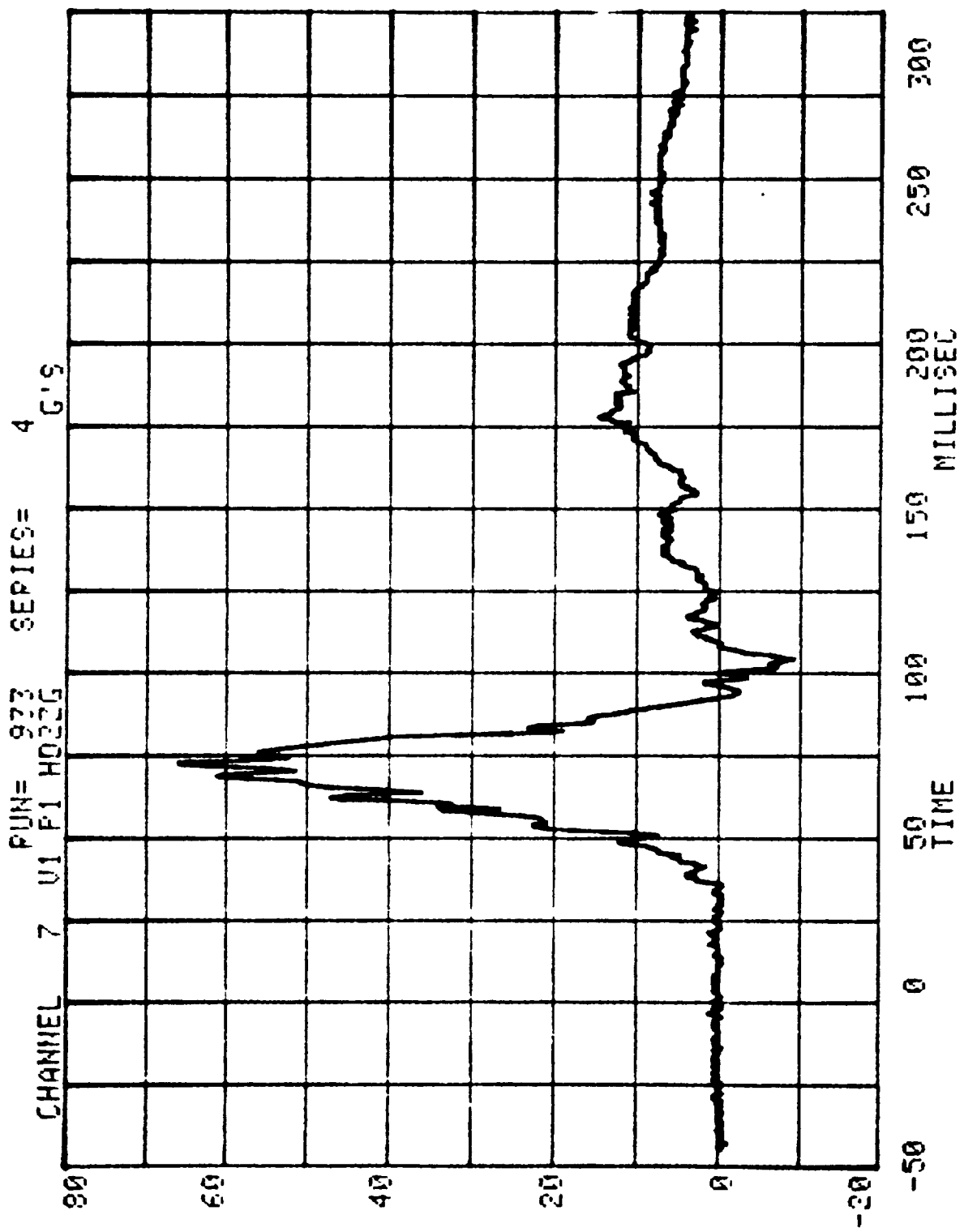
PUH= 373 SERIES= 4 G'S
RESULTANT V1.P1 HEAD R (PRIMARY)



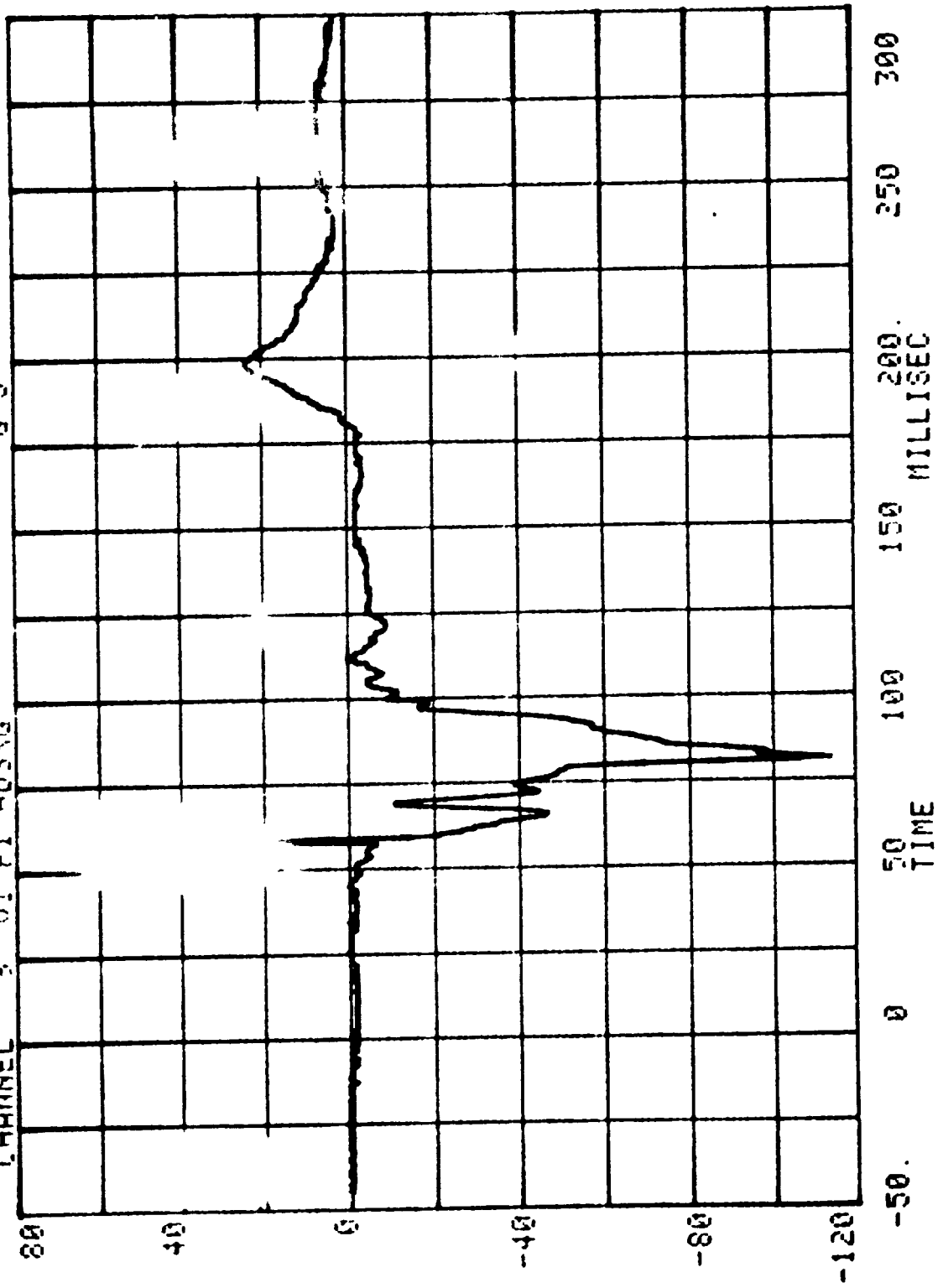


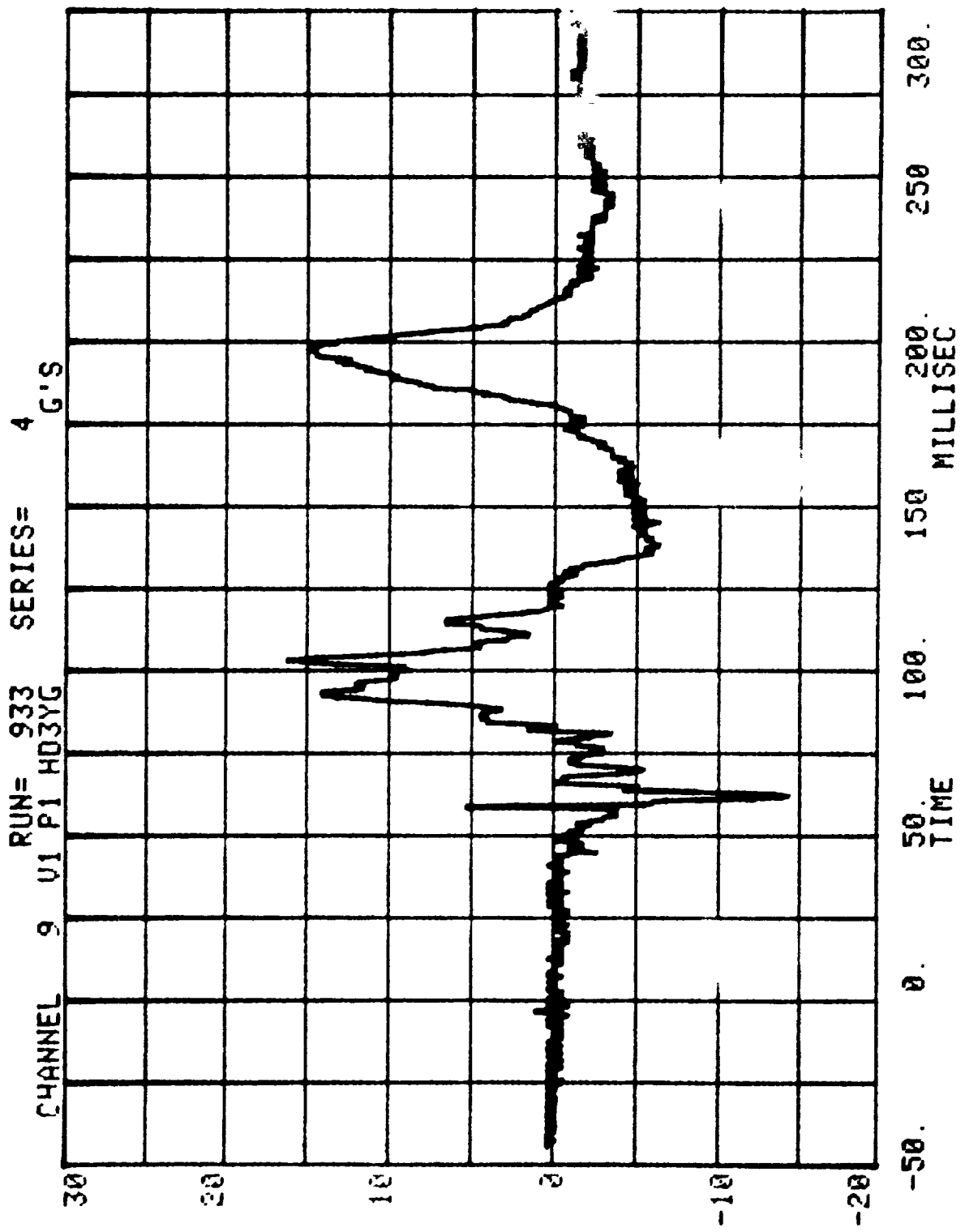




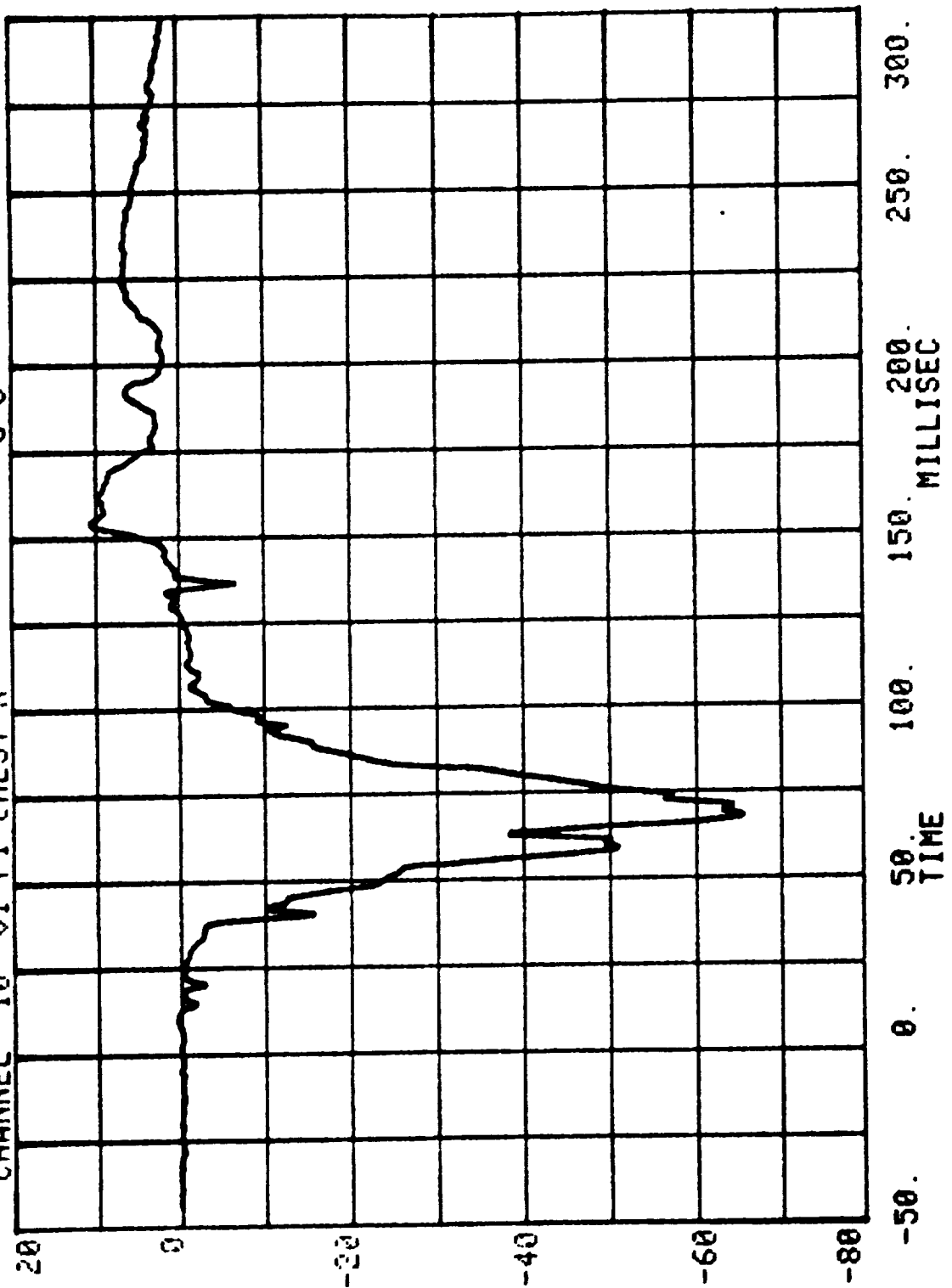


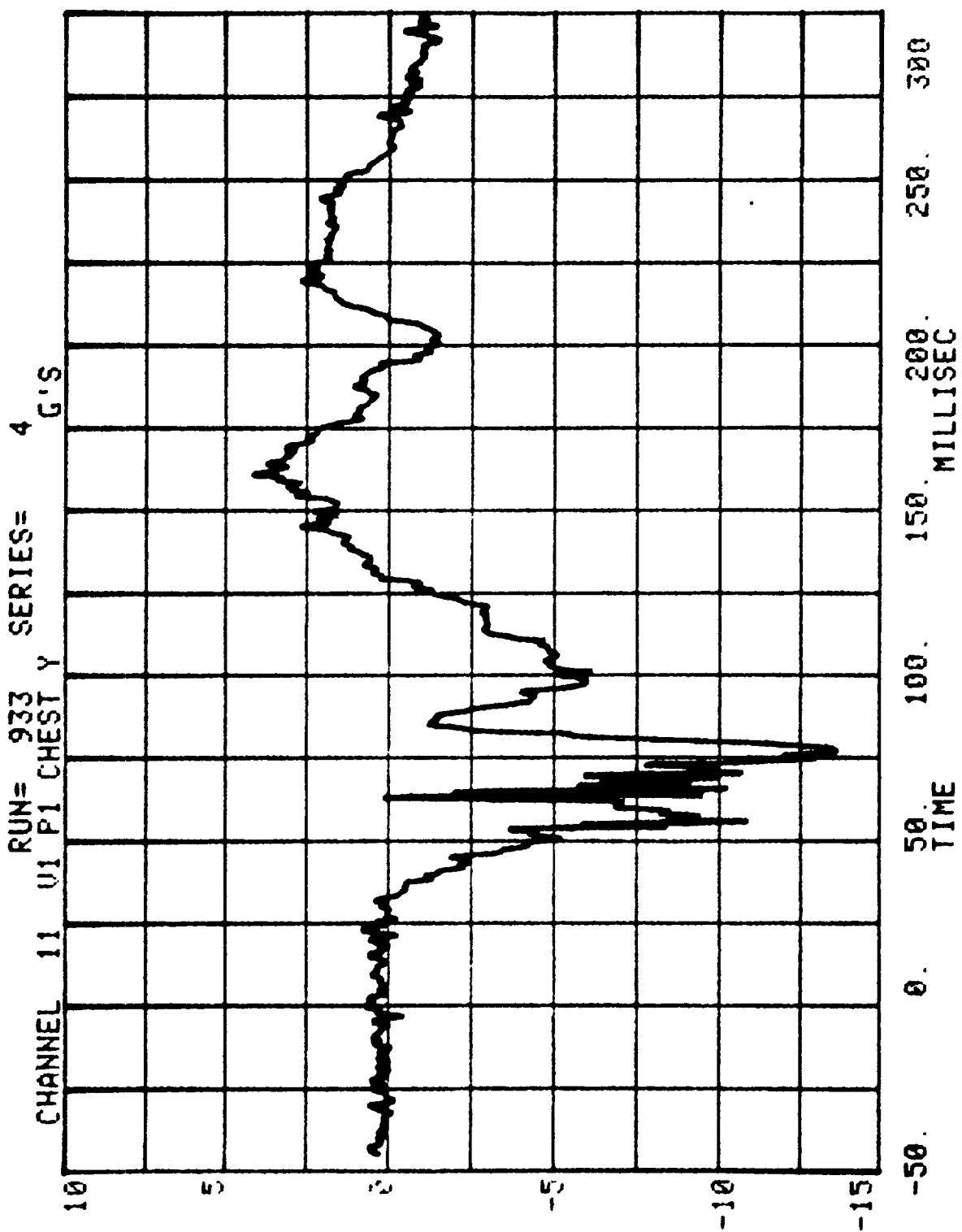
CHANNEL 3 U1 P1 403KG RUN= 933 SERIES= 4 G'S

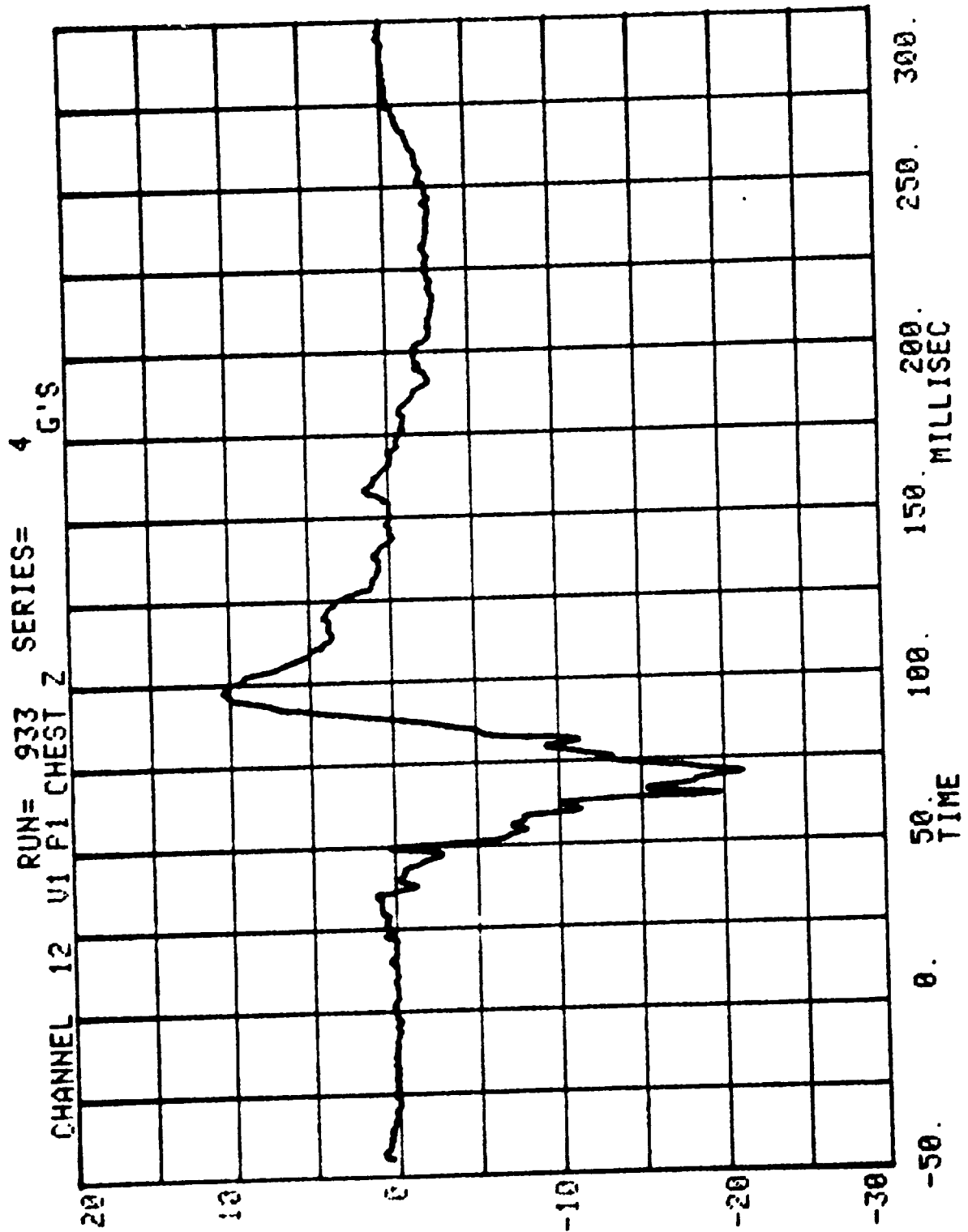


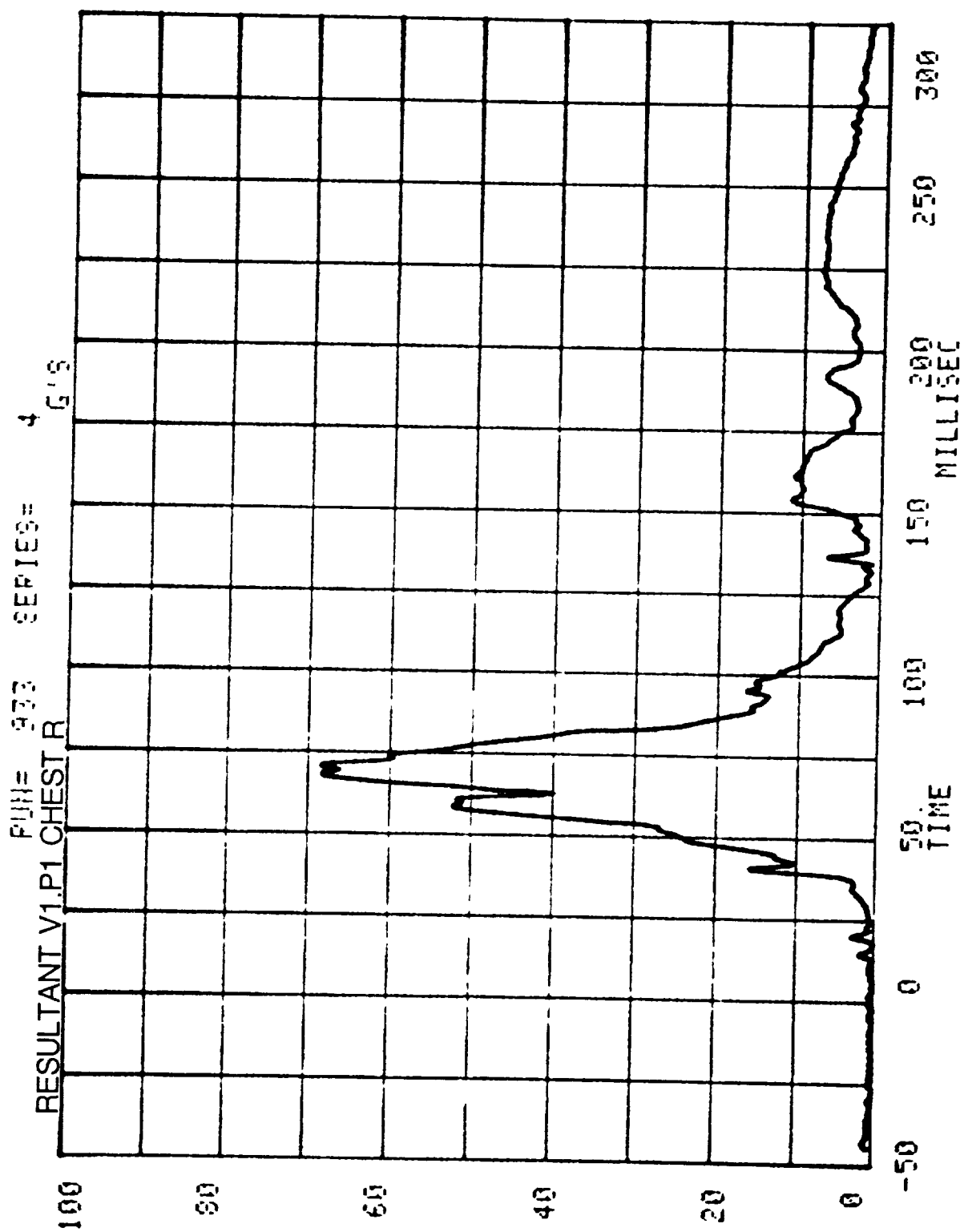


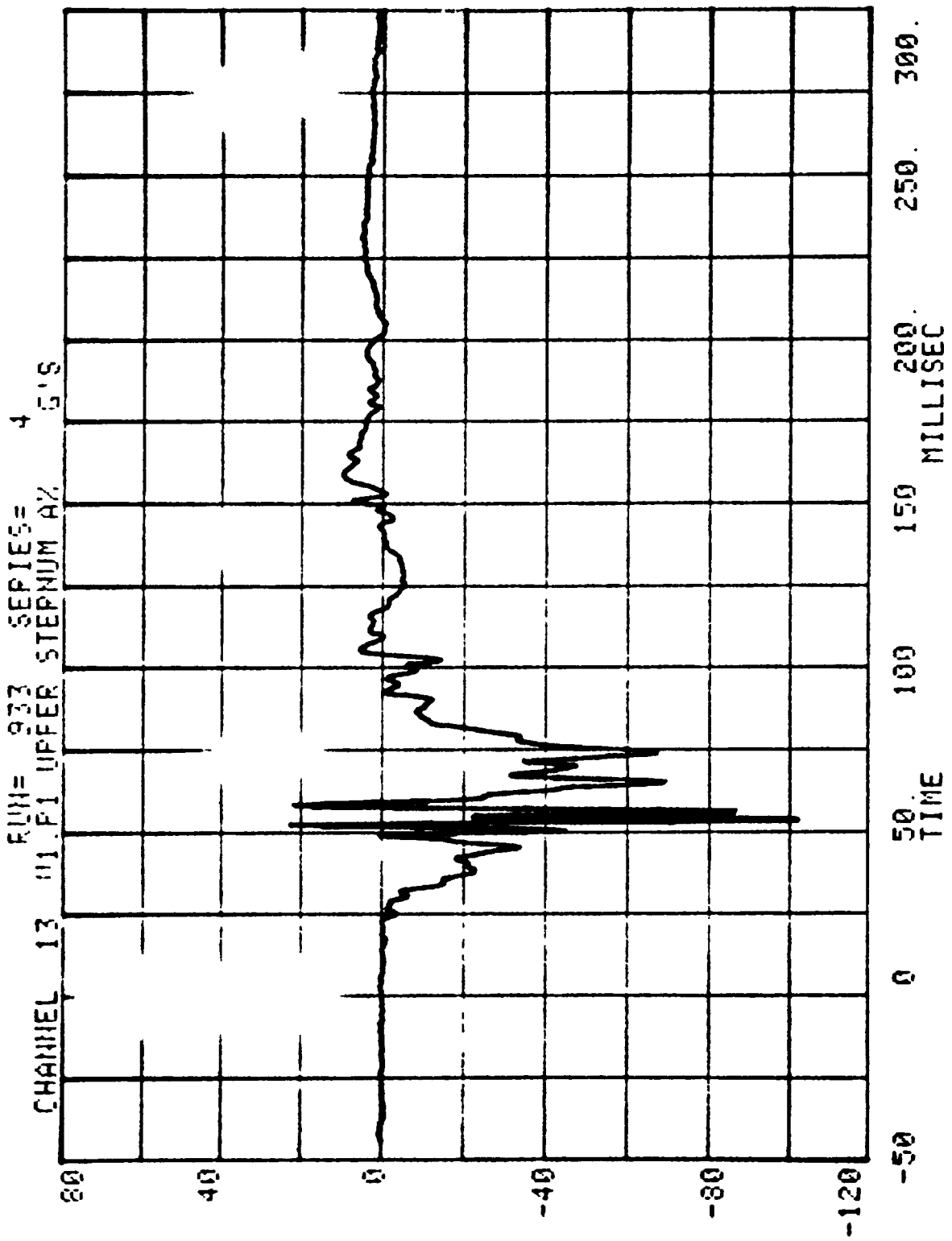
CHANNEL 10 U1 P1 CHEST X
RUN= 933 SERIES= 4 G'S

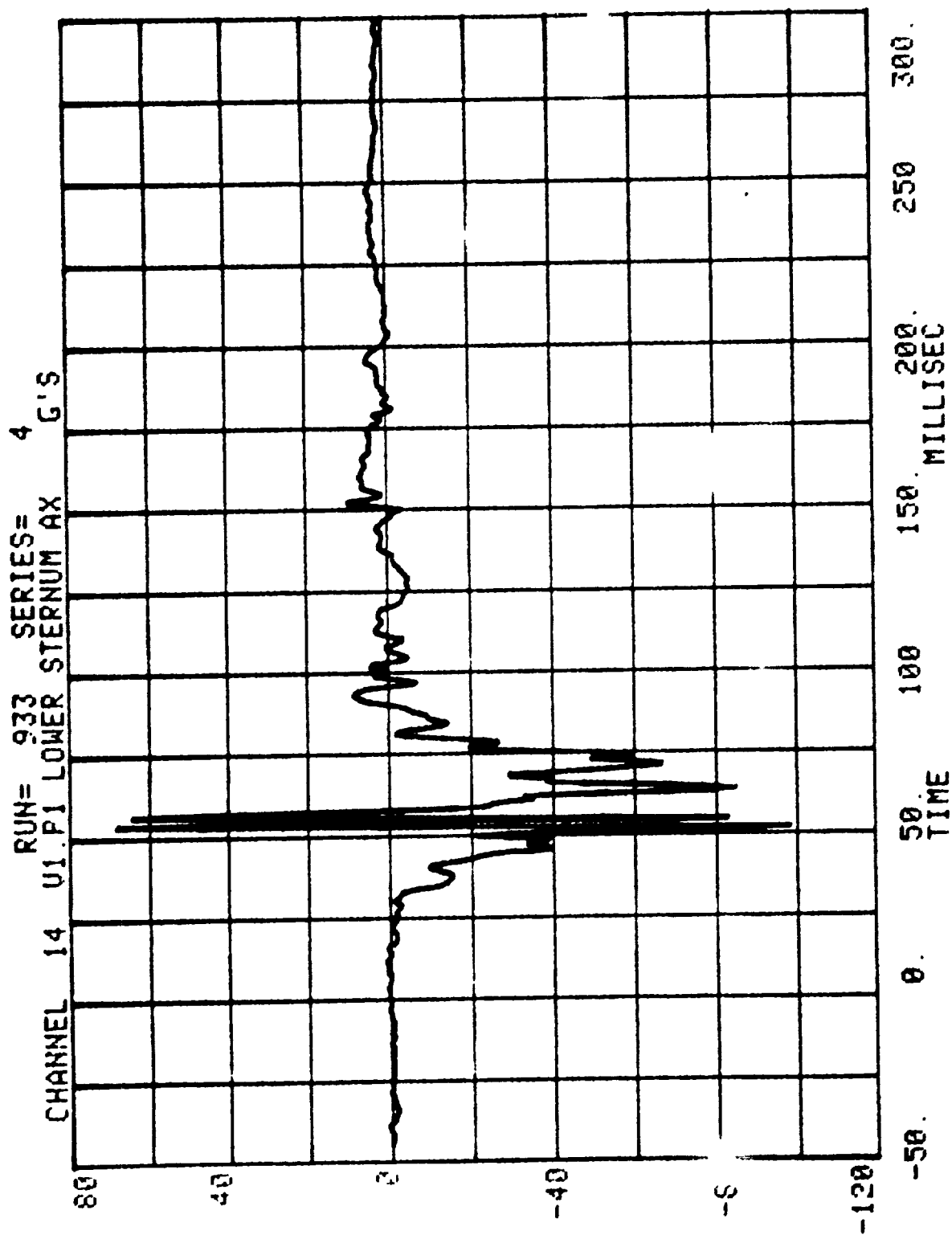




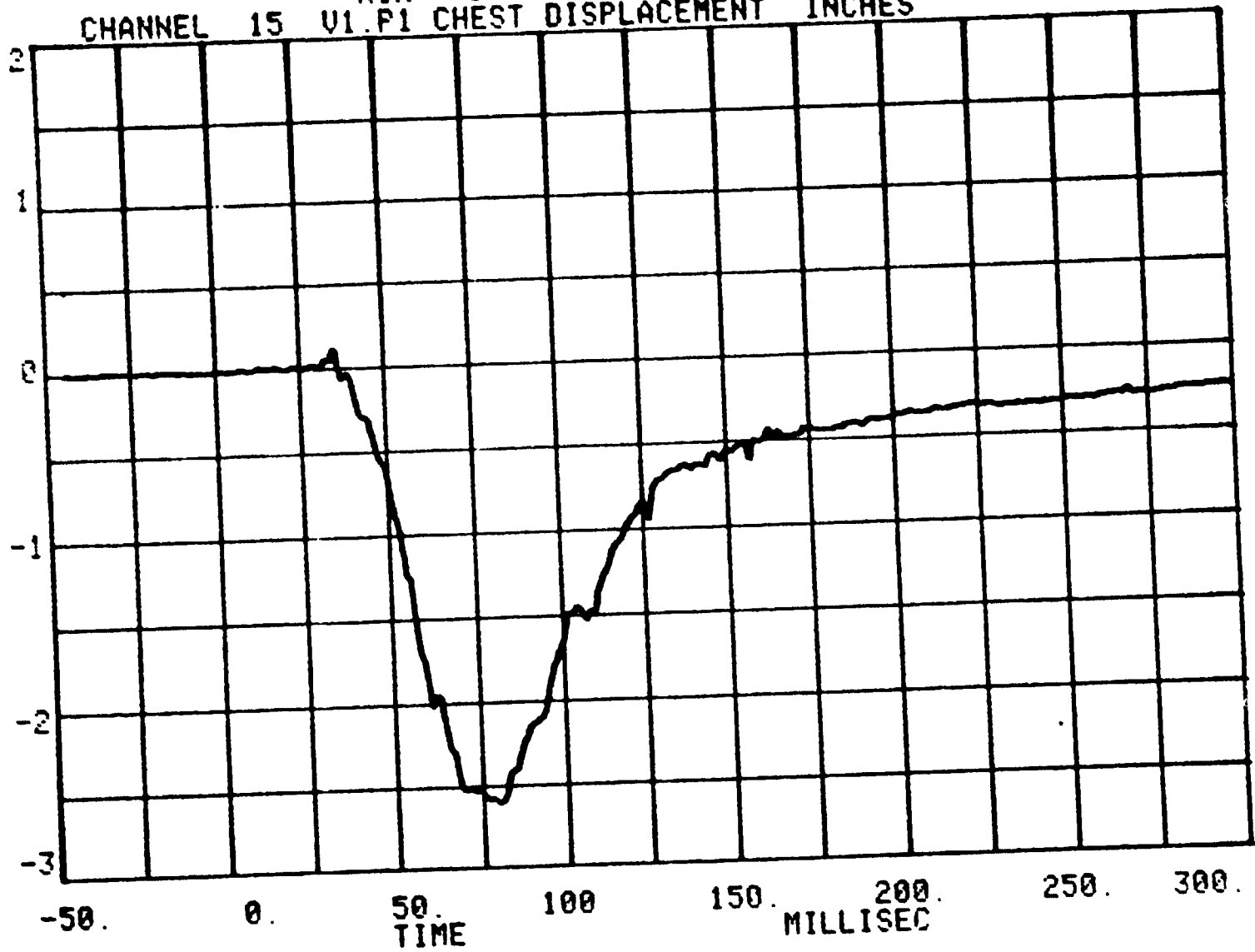








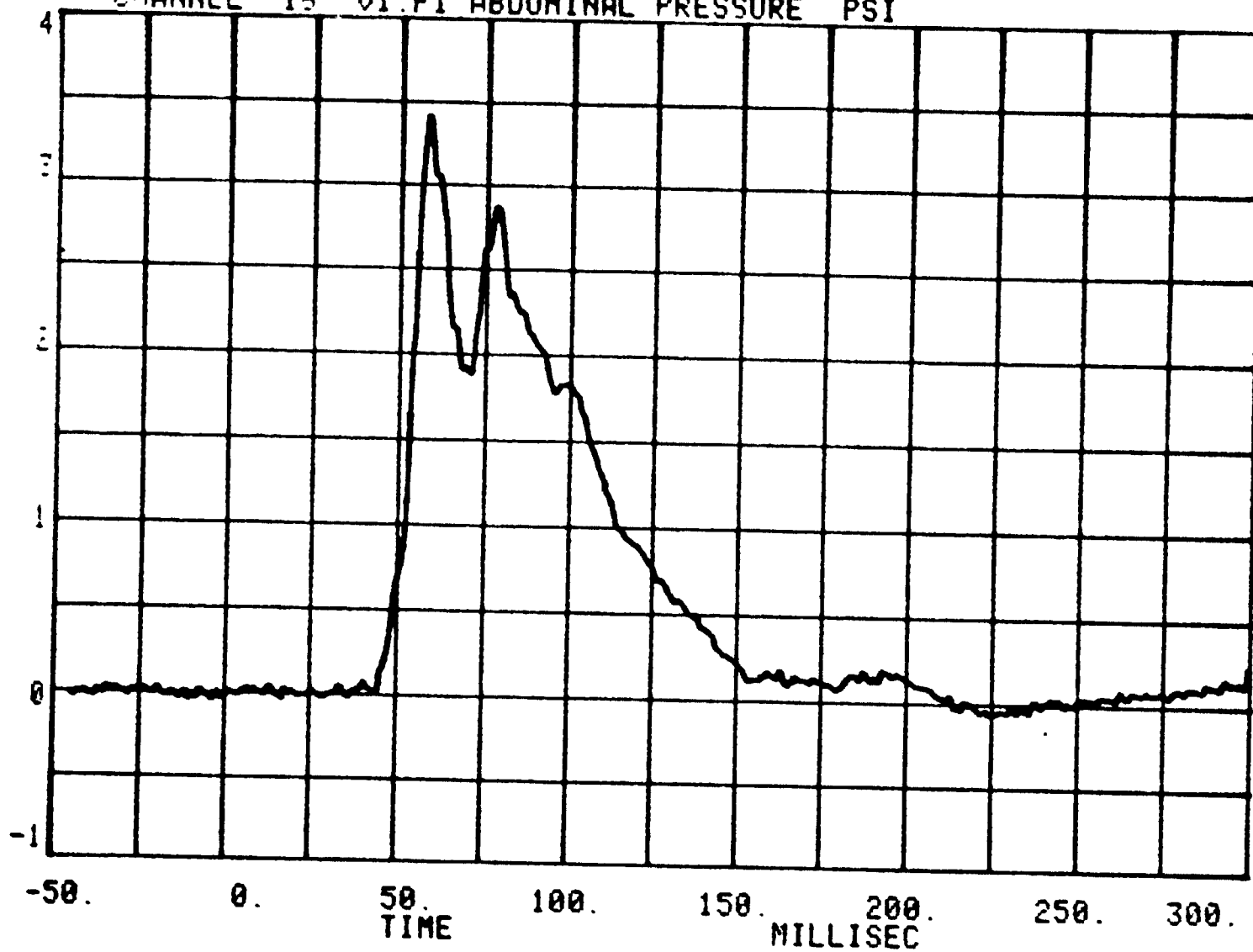
RUN= 933 SERIES= 4
CHANNEL 15 V1.P1 CHEST DISPLACEMENT INCHES



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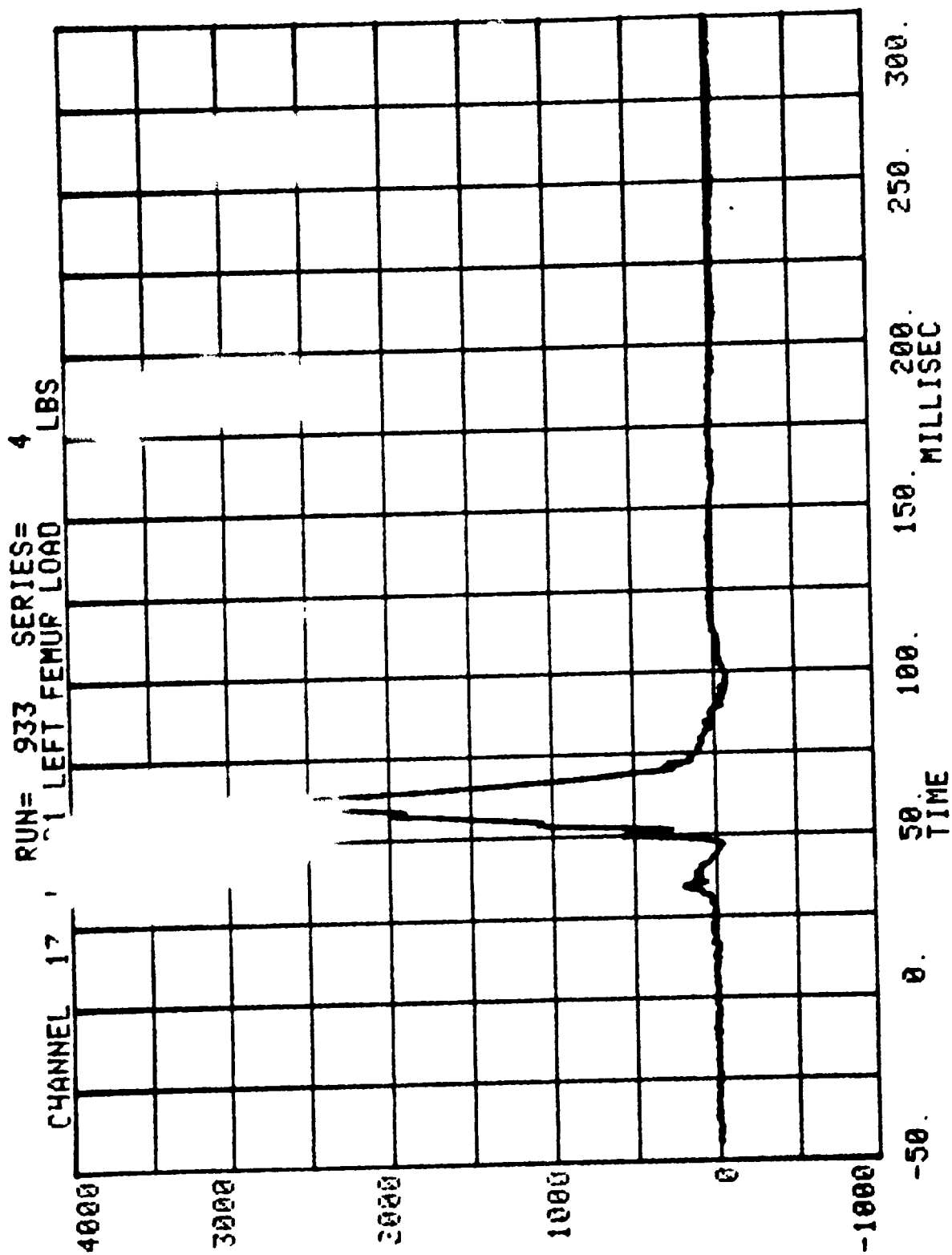
7781-4

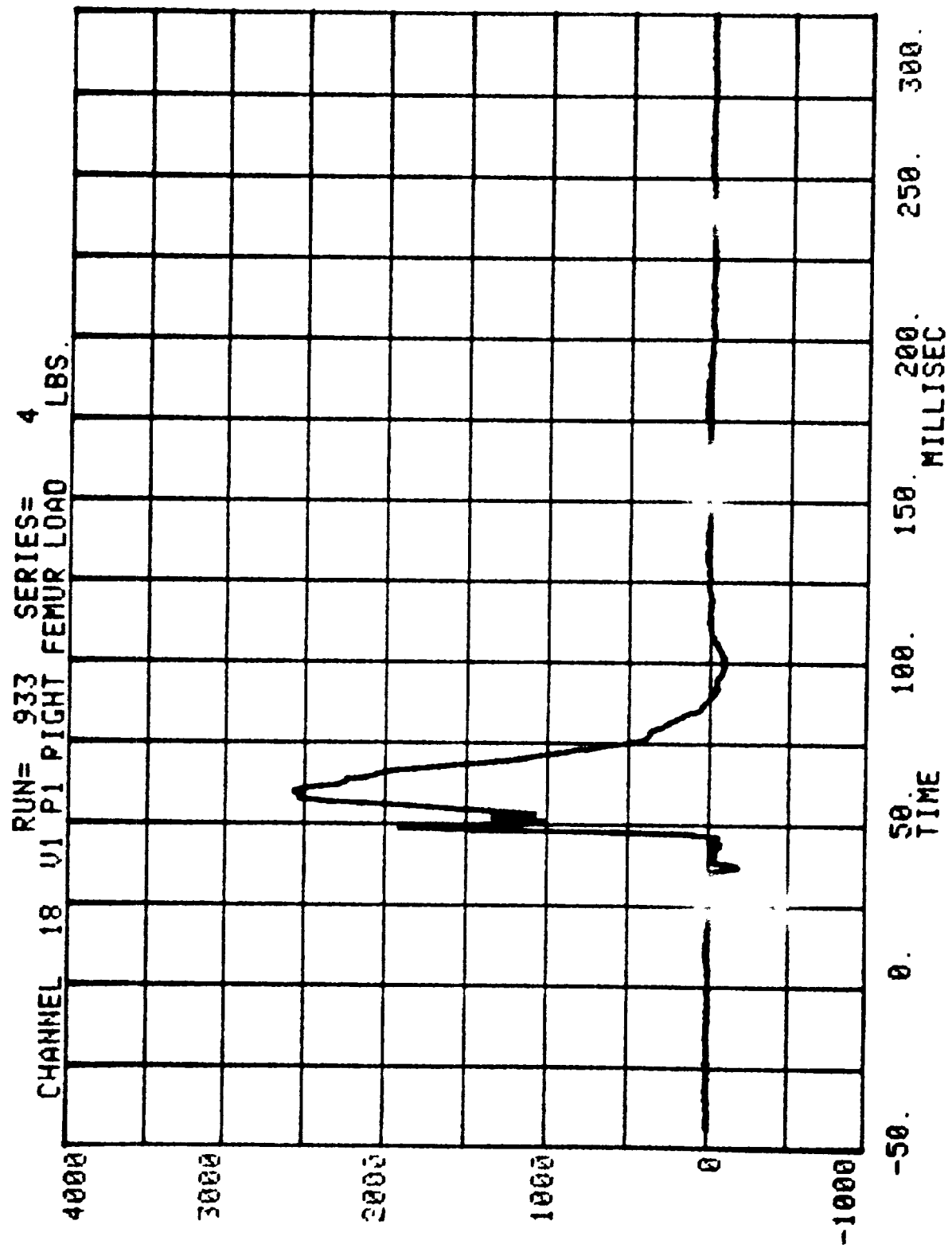
RUN= 933 SERIES= 4
CHANNEL 15 V1.P1 ABDOMINAL PRESSURE PSI

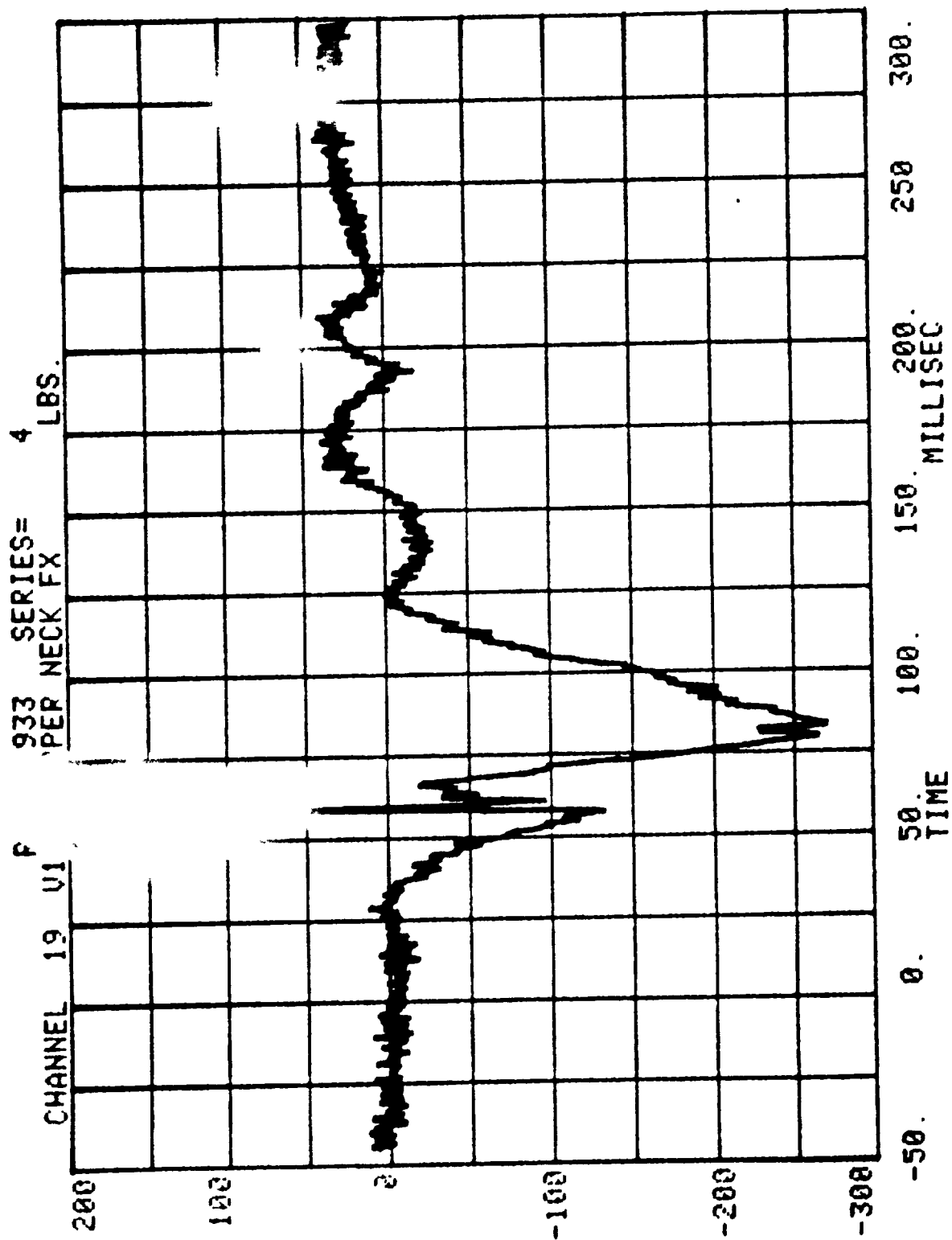


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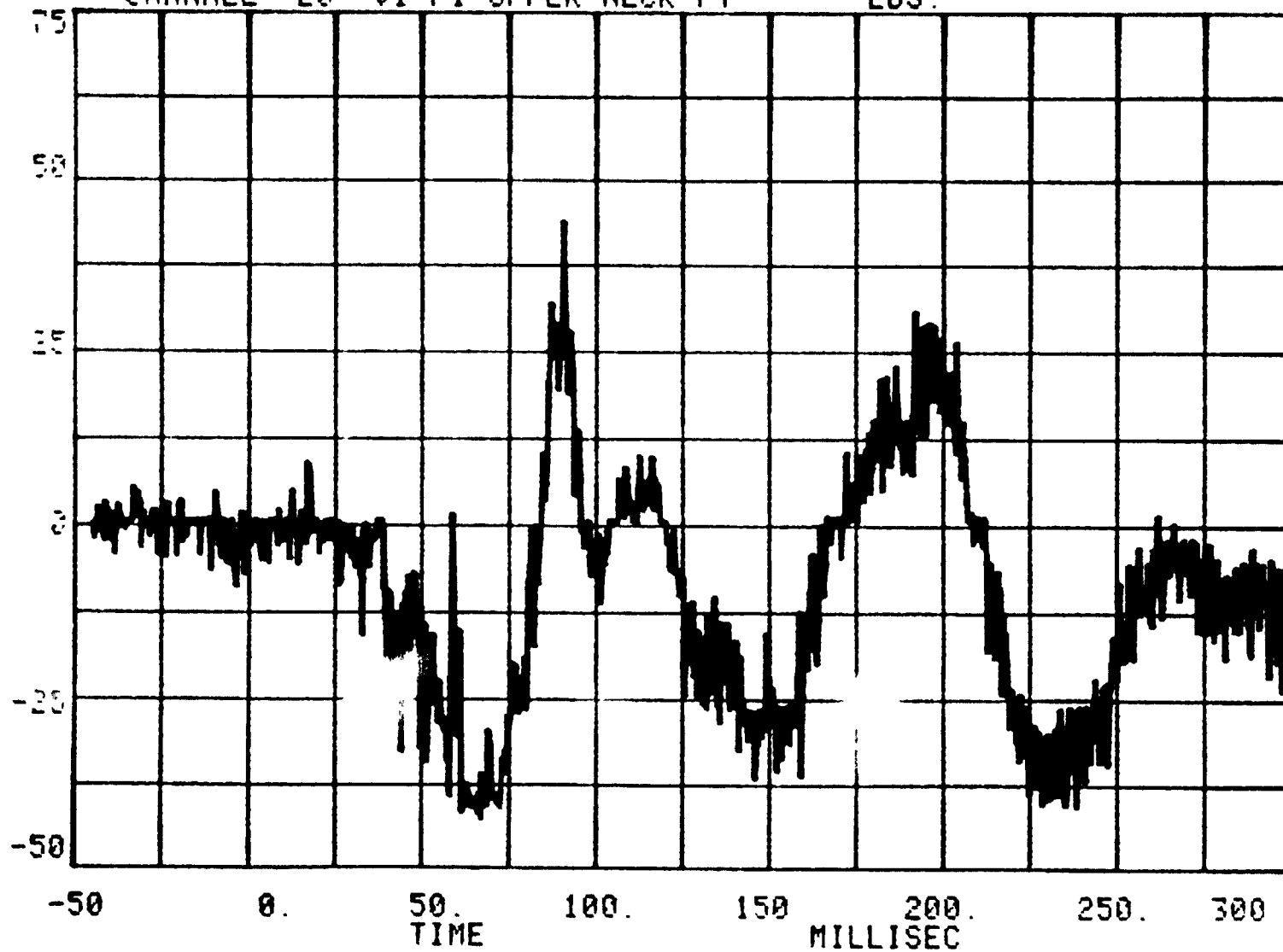
7781-4







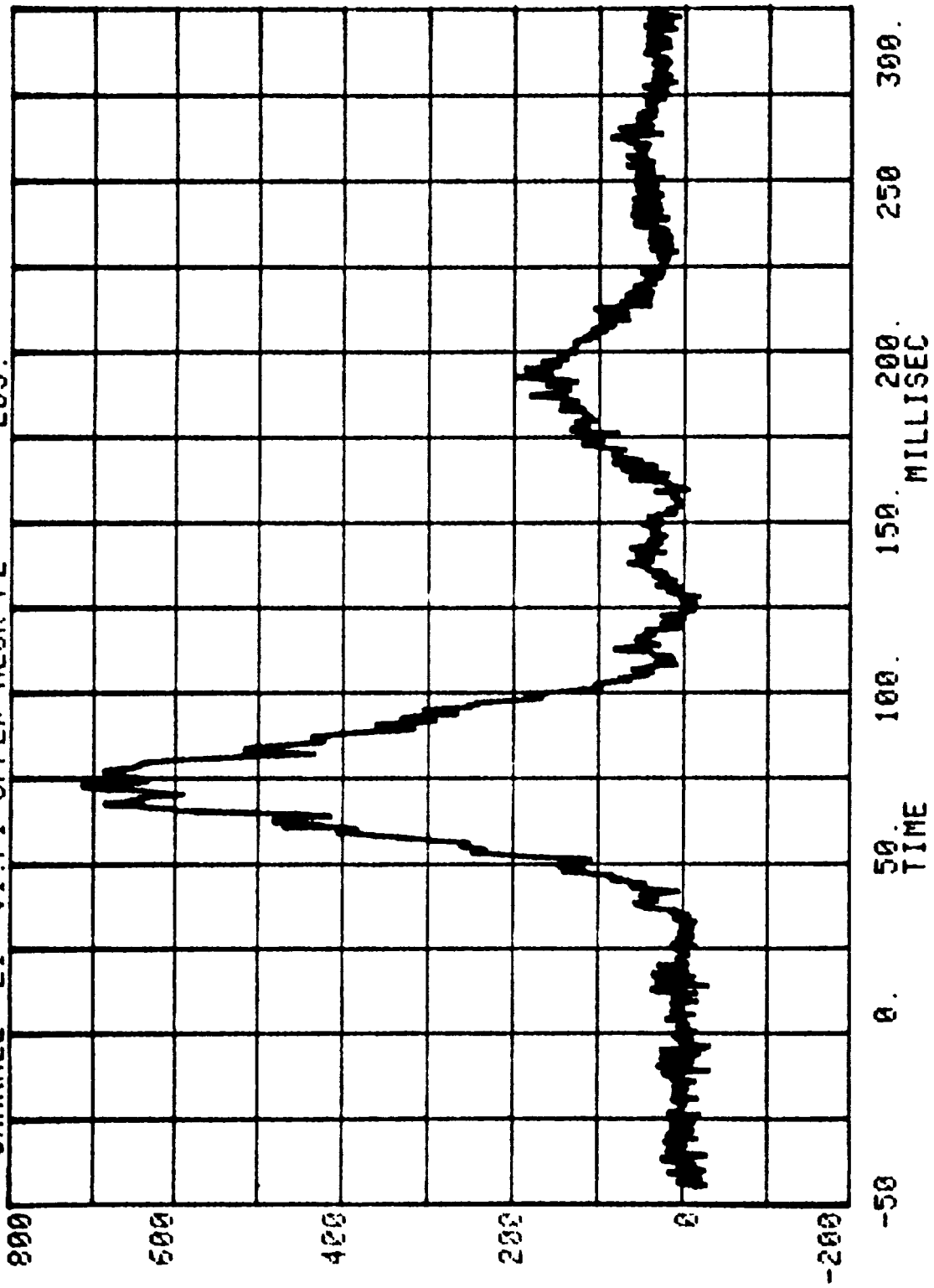
RUN= 933 SERIES= 4
CHANNEL 20 U1 P1 UPPER NECK FY LBS.



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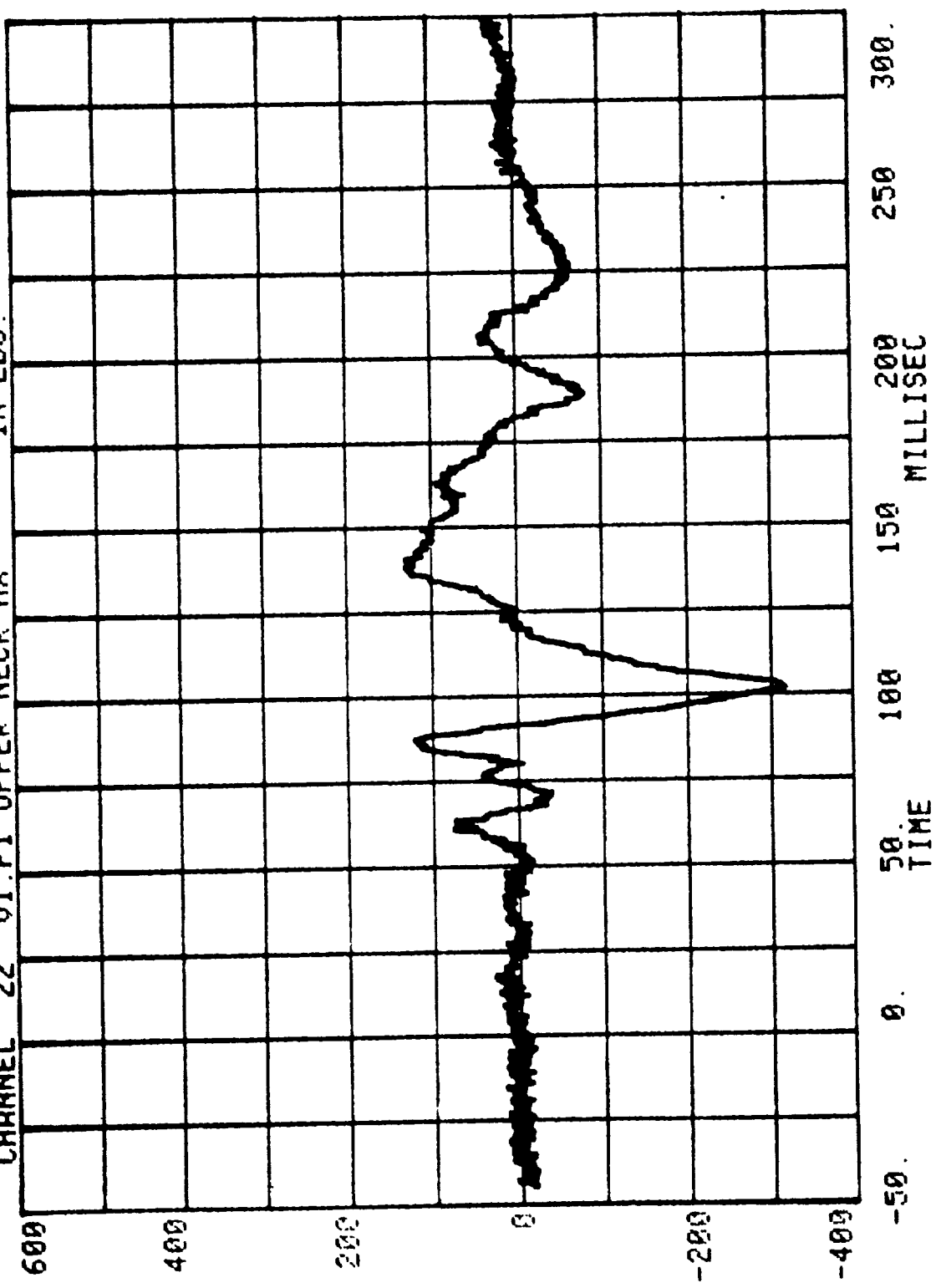
7781-4

CHANNEL 21 RUN= 933 SERIES= 4
V1.F1 UPPER HECK F2 LBS.

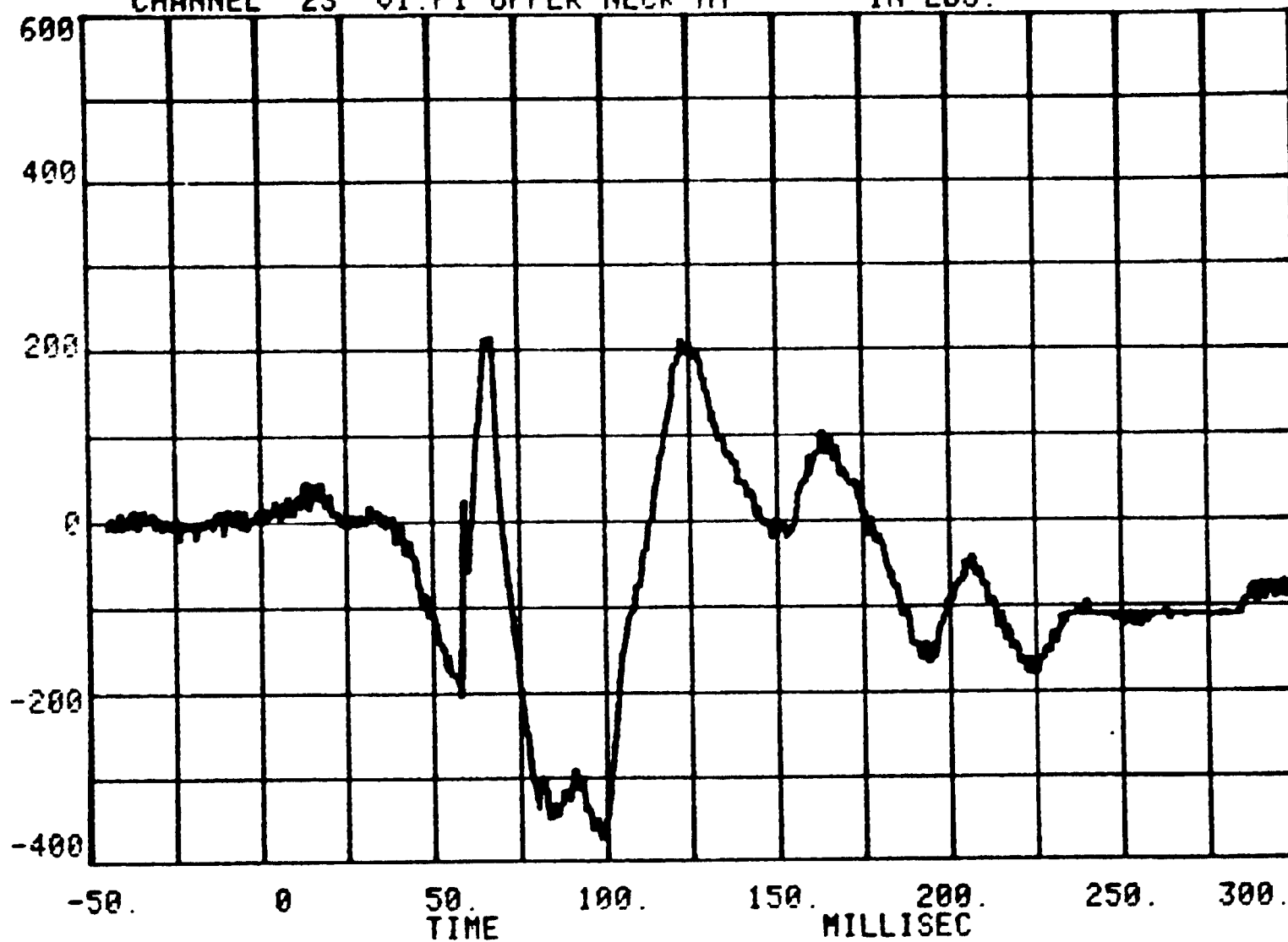


CHANNEL 22 U1.P1 UPPER NECK MX 4 IN-LBS.

RUN= 933 SERIES=



RUN= 933 SERIES= 4
CHANNEL 23 U1.P1 UPPER NECK MY IN-LBS.



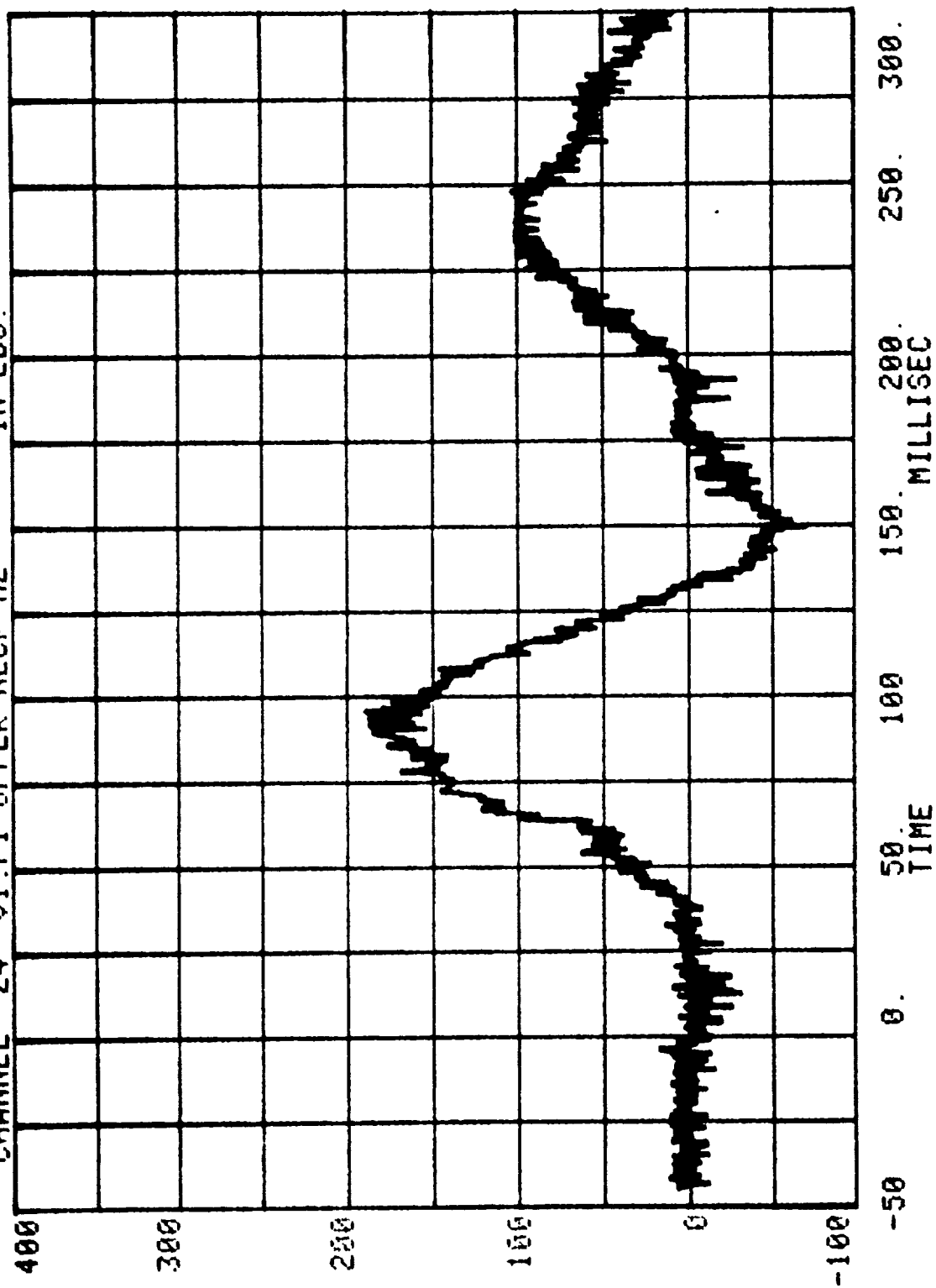
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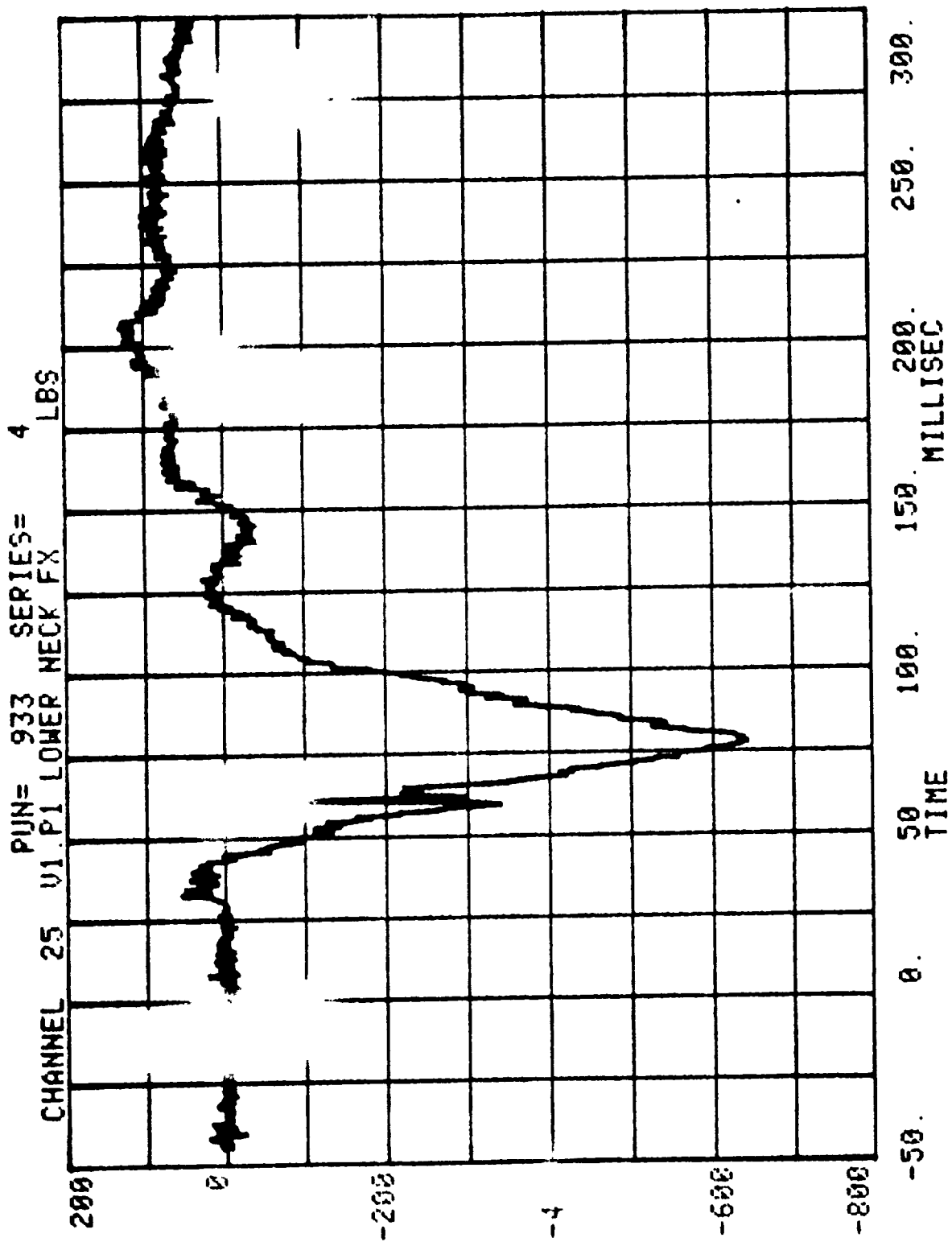
7781-4

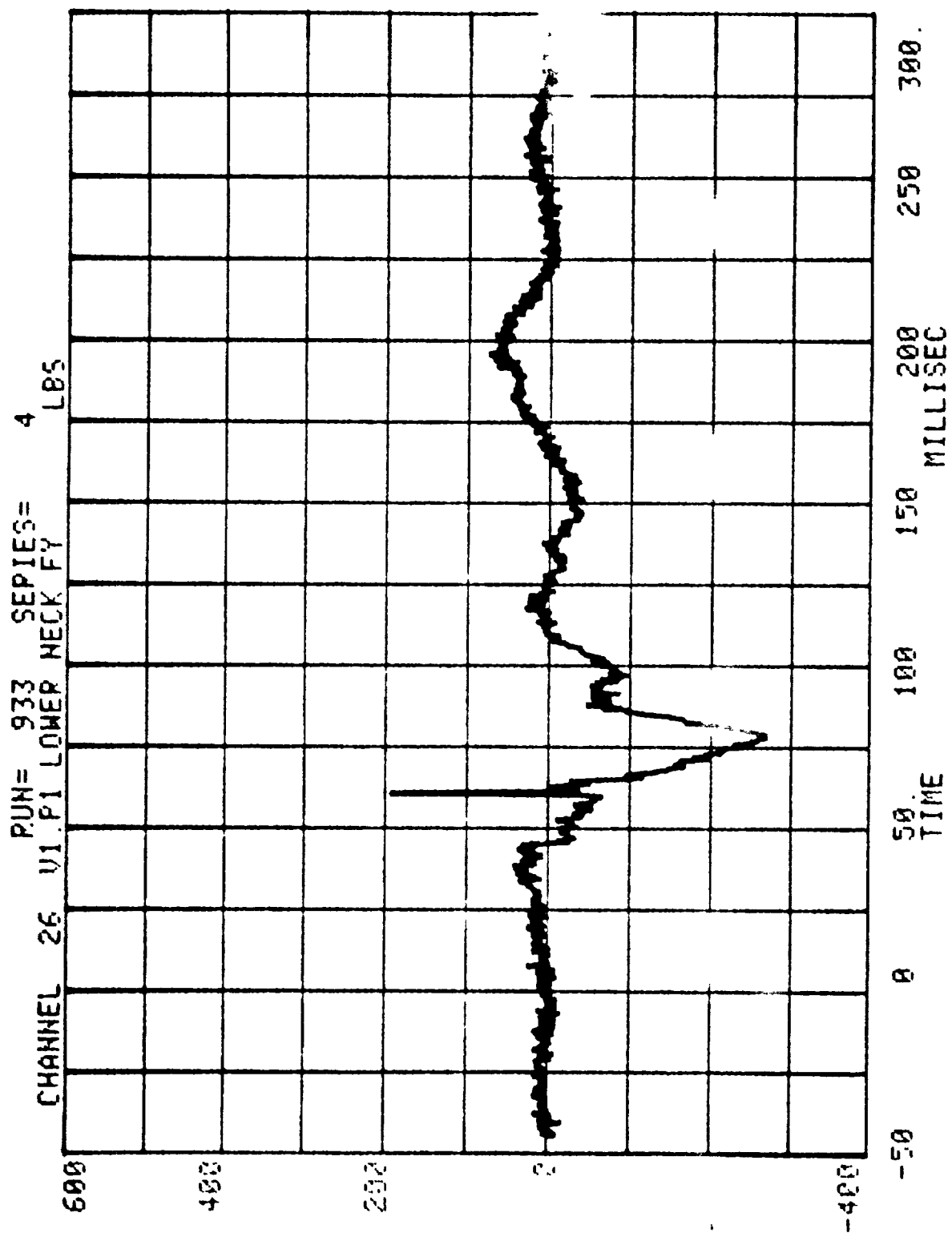
CHANNEL 24 U1.P1 UPPER NECK MZ

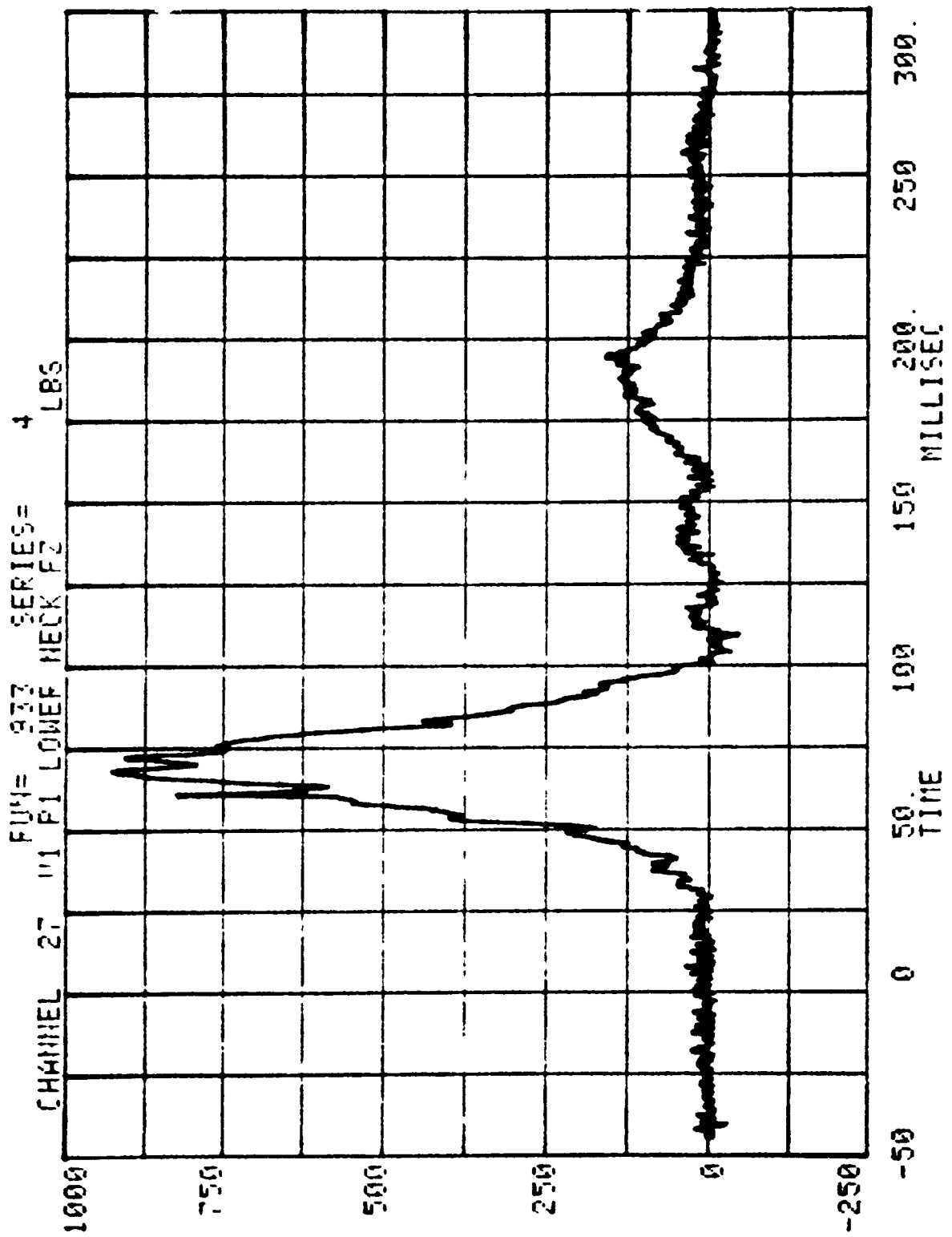
RUN= 933 SERIES= 4

IN-LBS.

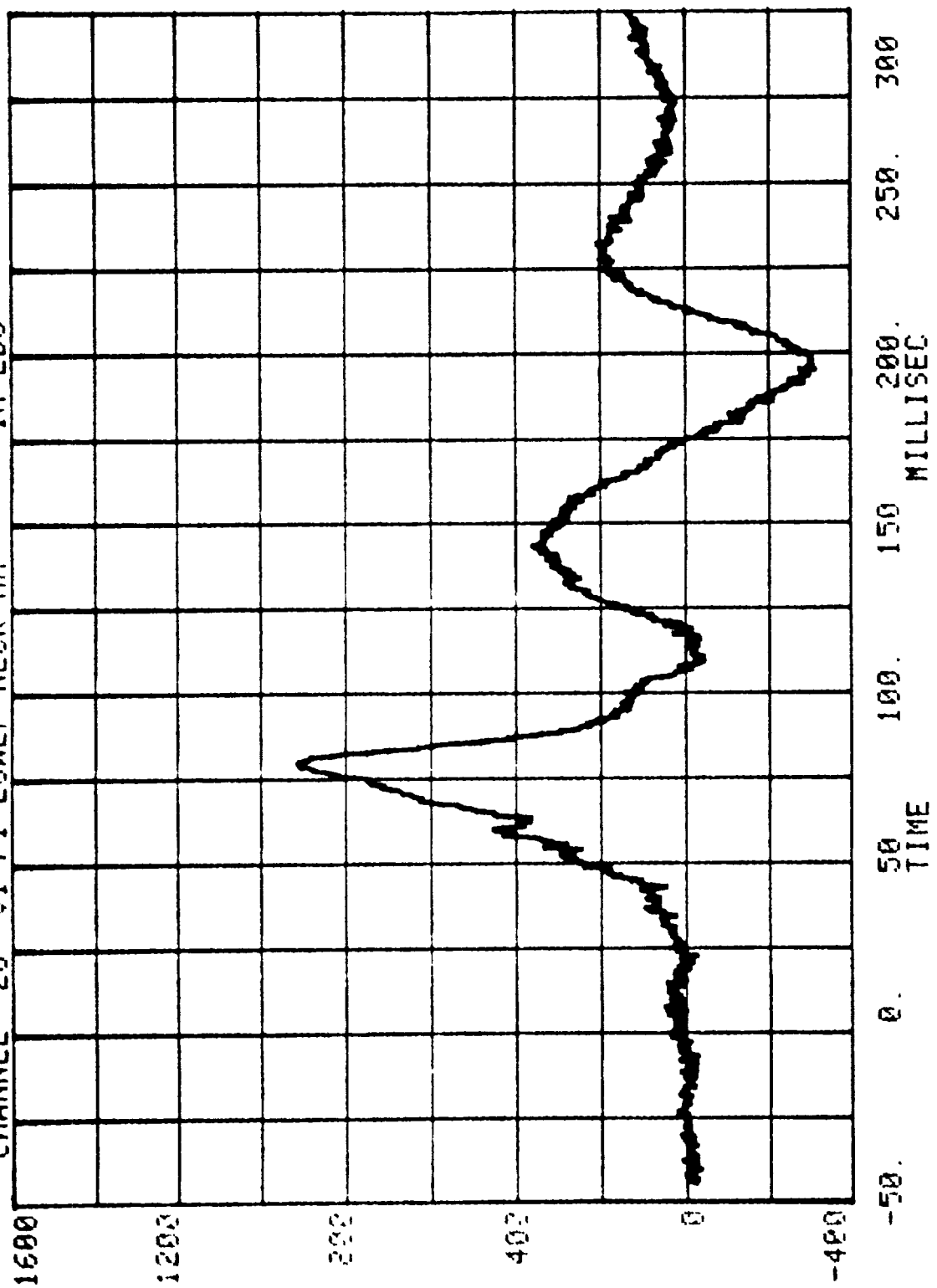






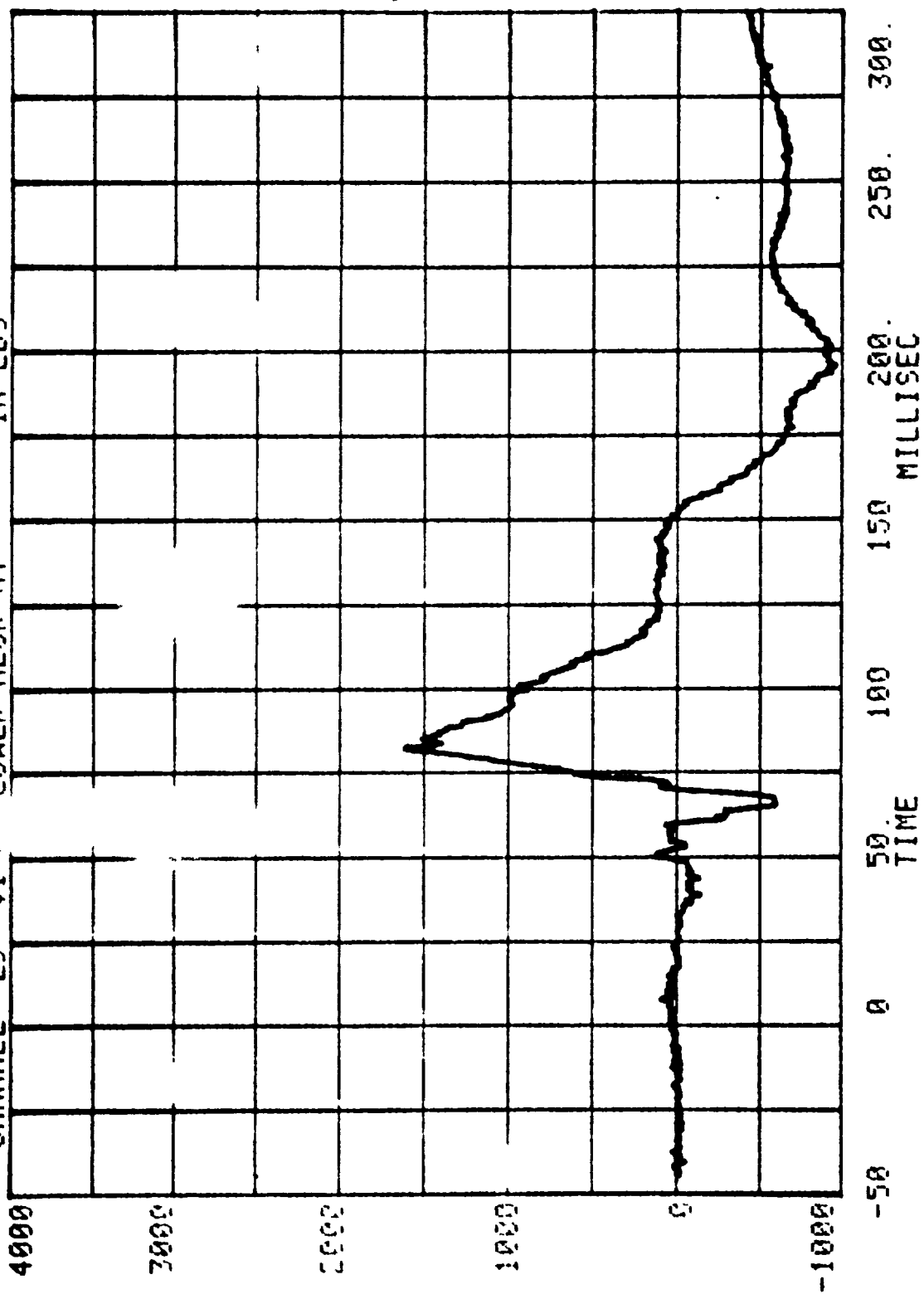


CHANNEL 28 U1 F1 LOWER NECK MX 4 IN-LBS



CHANNEL 29 V1 F' LOWER NECK MY 4 IN-LBS

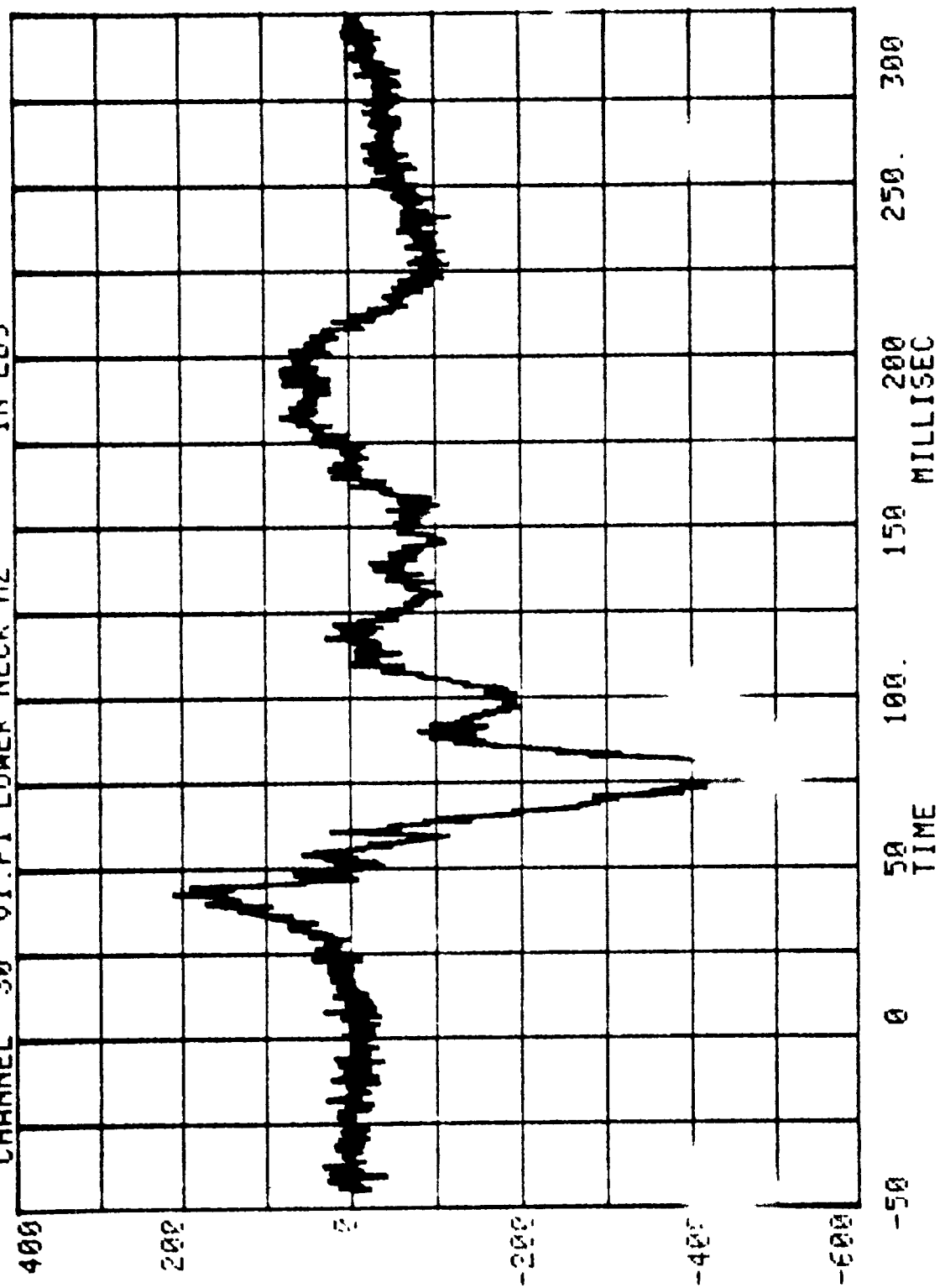
RUN= 933 SERIES=

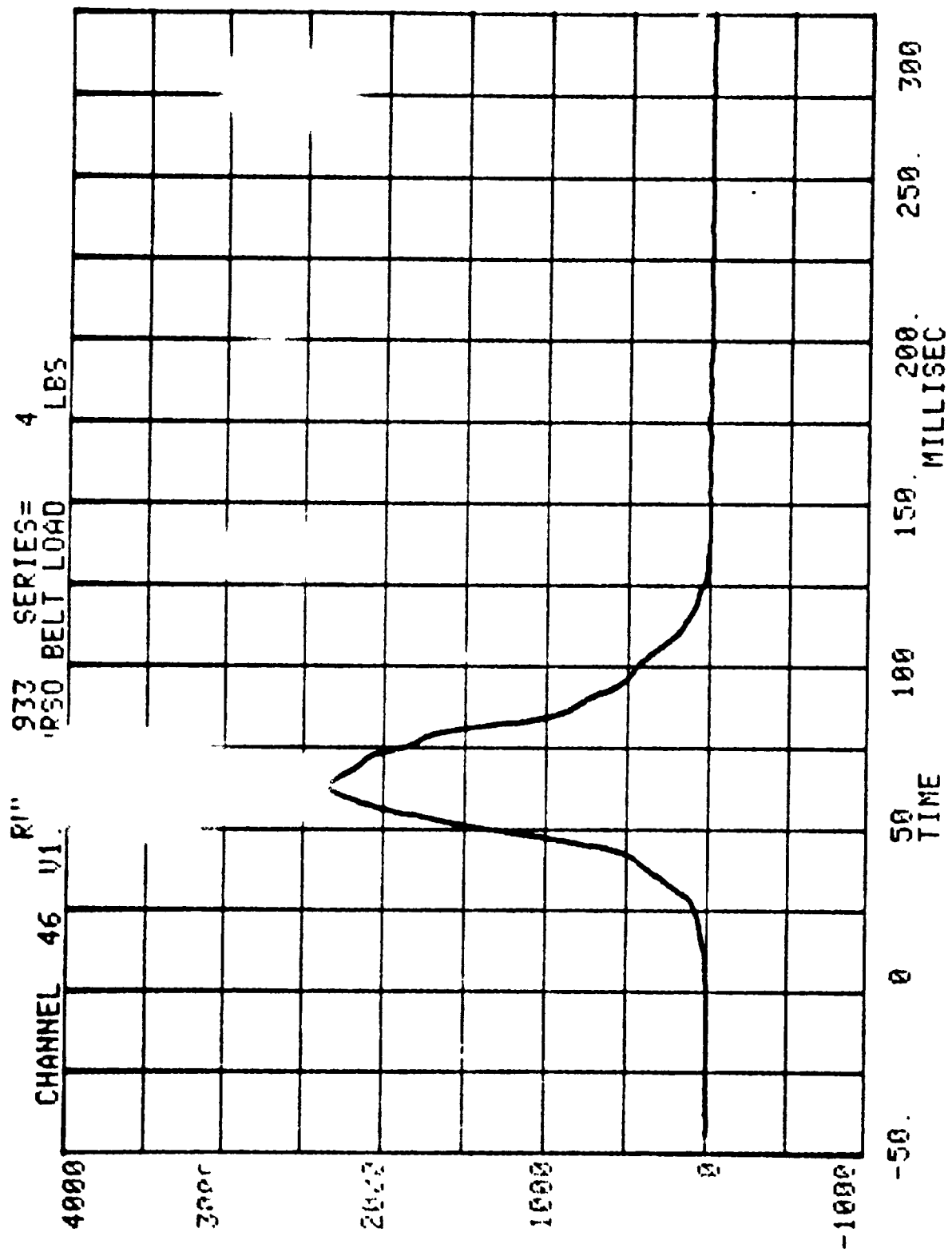


CHANNEL 30 U1.F1 LOWER NECK M2

RUN= 933 SERIES= 4

IN-LBS





HEAD INJURY CRITERION
HEAD SEVERITY INDEX
3EMS MAXIMUM DEFORMATION

VEHICLE-TO-VEHICLE FRONTAL IMPACT 90% OVERLAP

FUR= 933

112 P2 HEAD PERFORMANCE

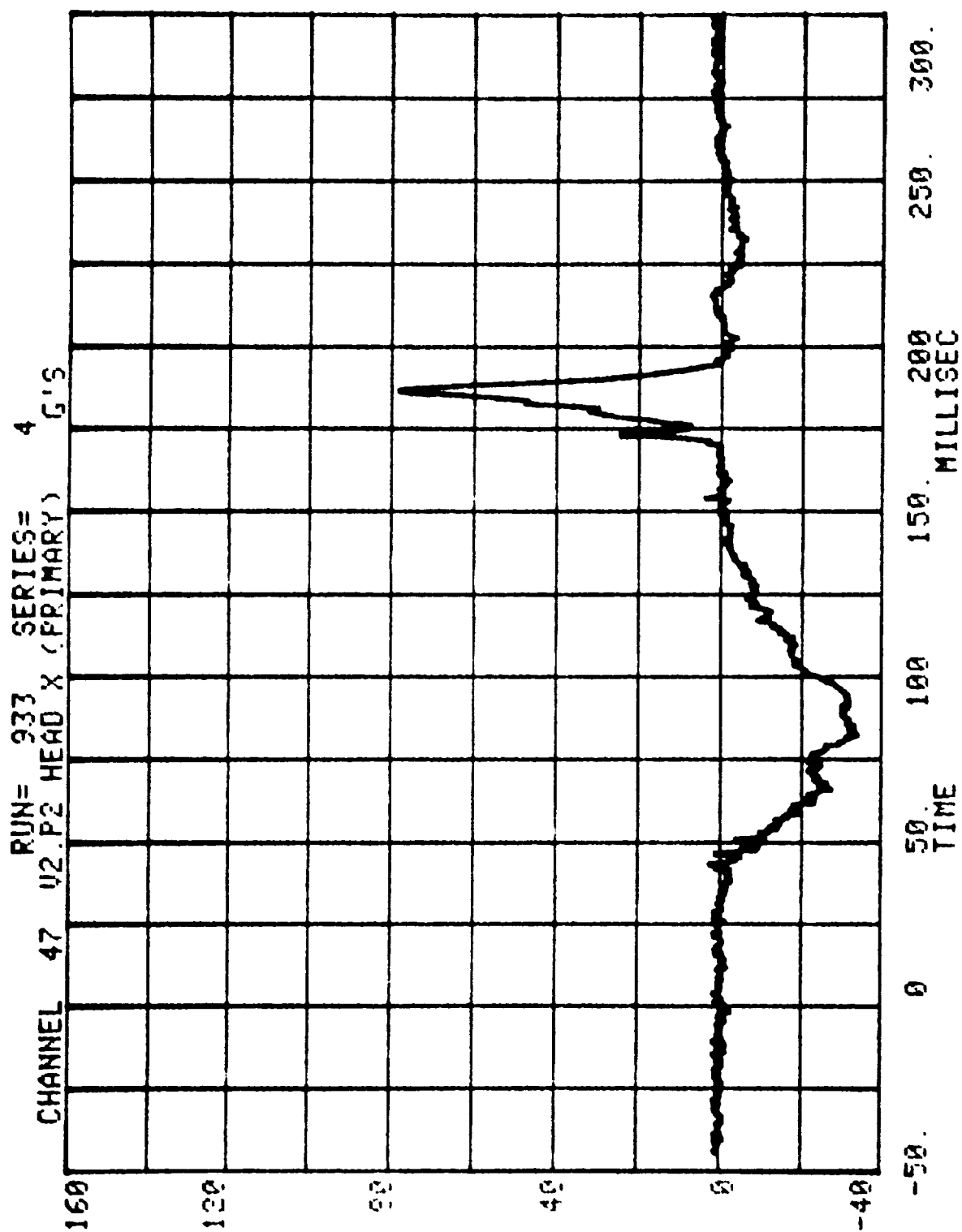
HIC= 682.0 FROM T1= 05312 TO T2= 09412

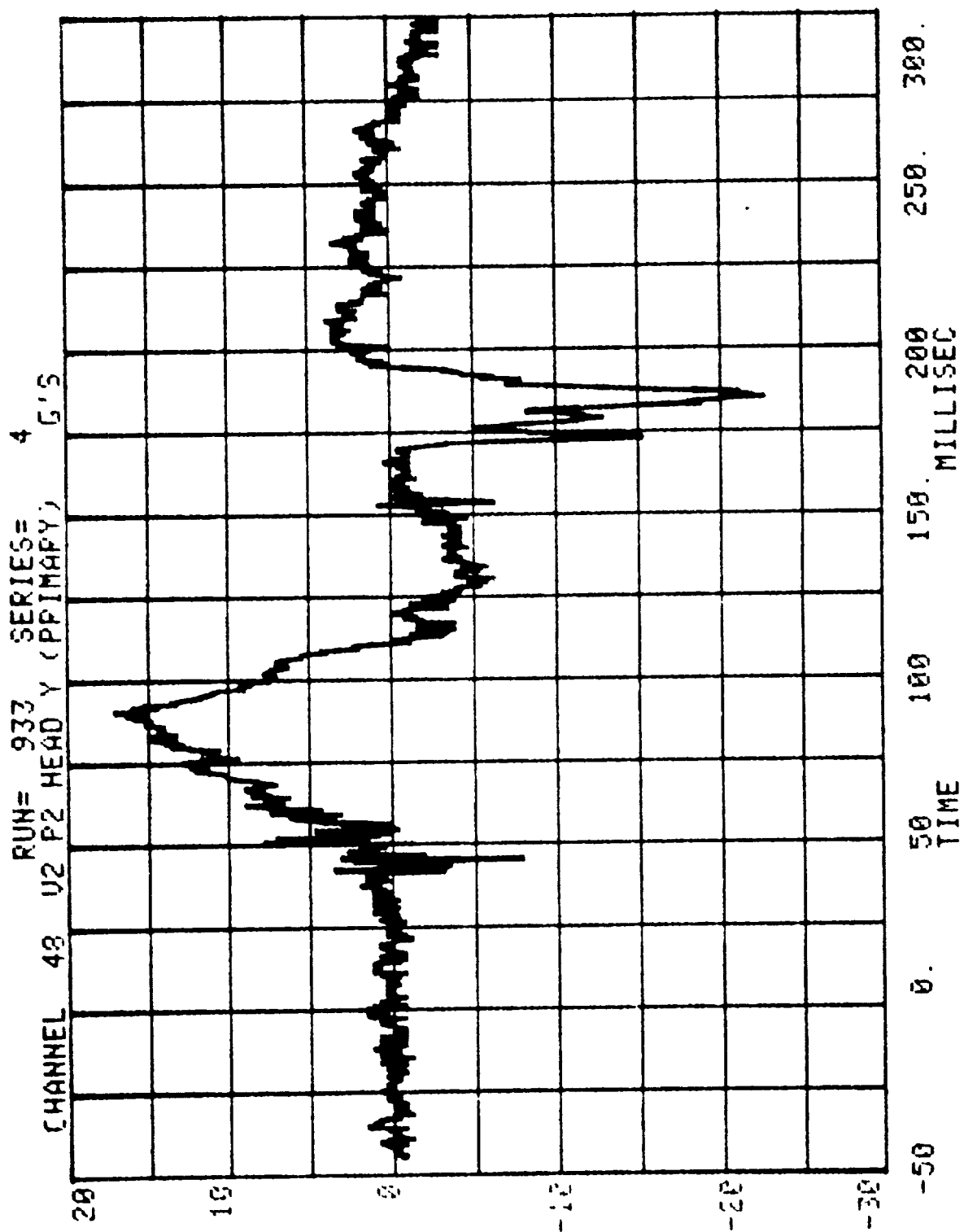
AVERAGE ACCELERATION BETWEEN T1 AND T2= 51.4G's

EVENT TIME= 300.0 MSEC

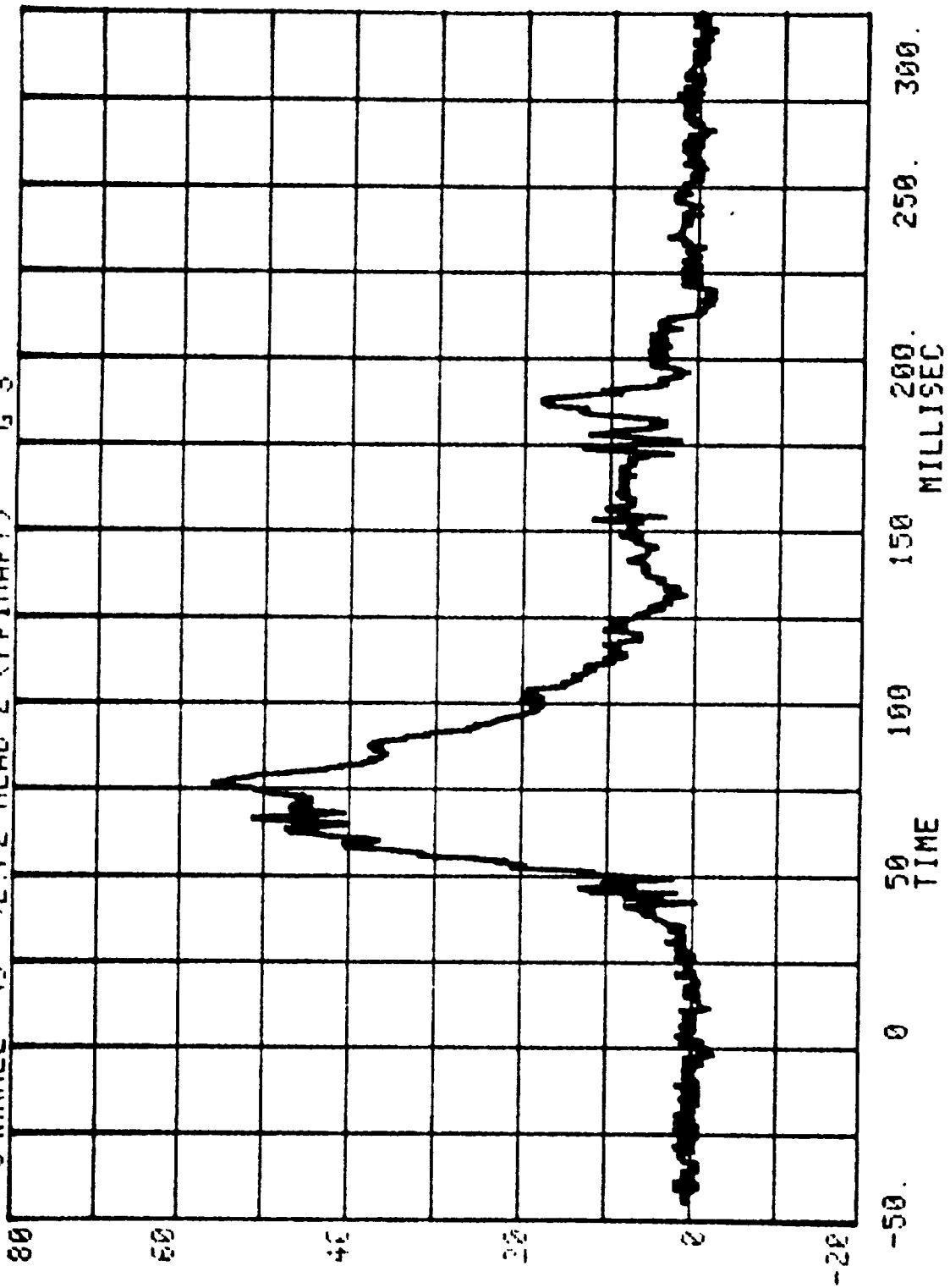
SEVERITY INDEX=1144.7

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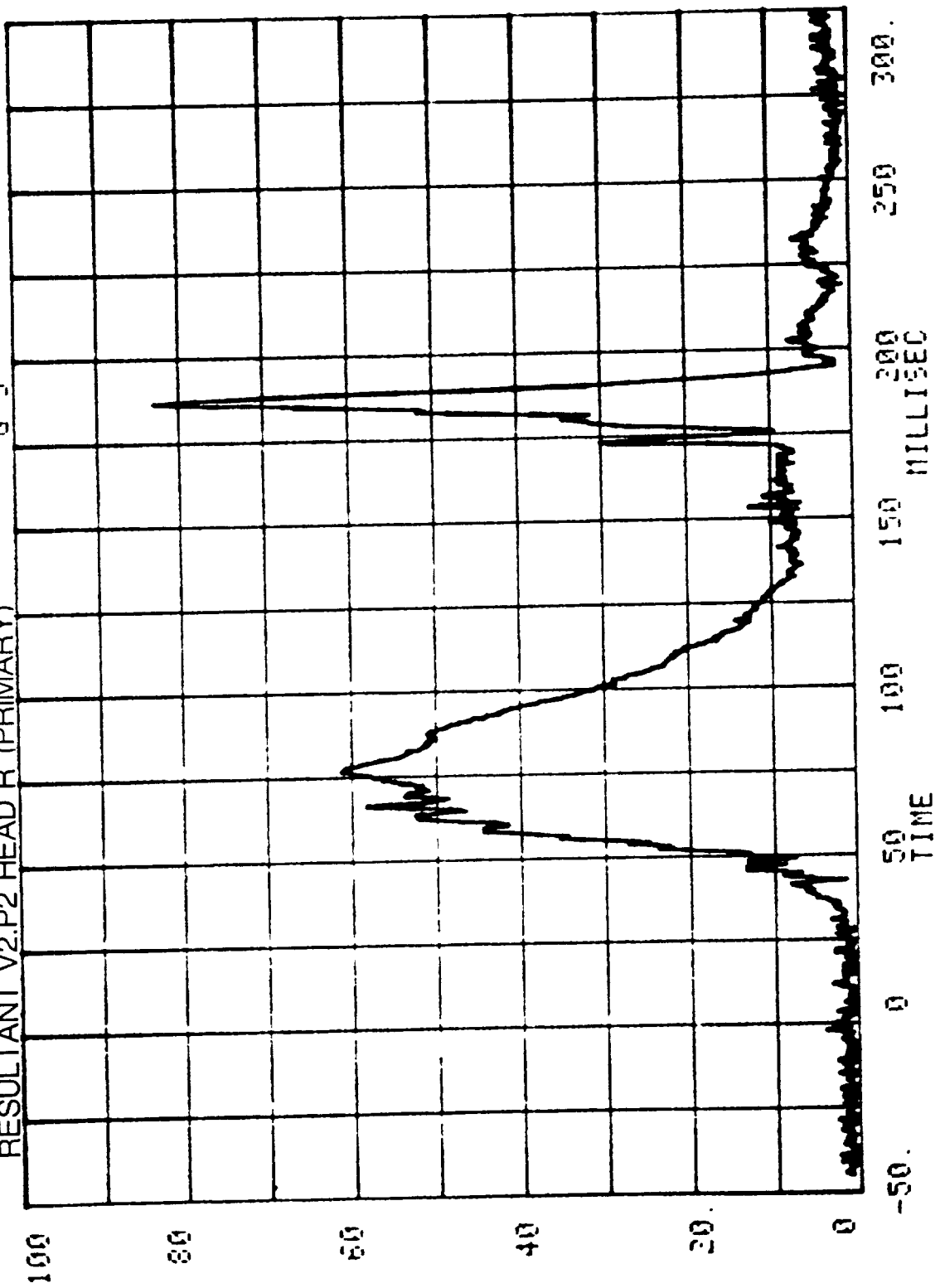


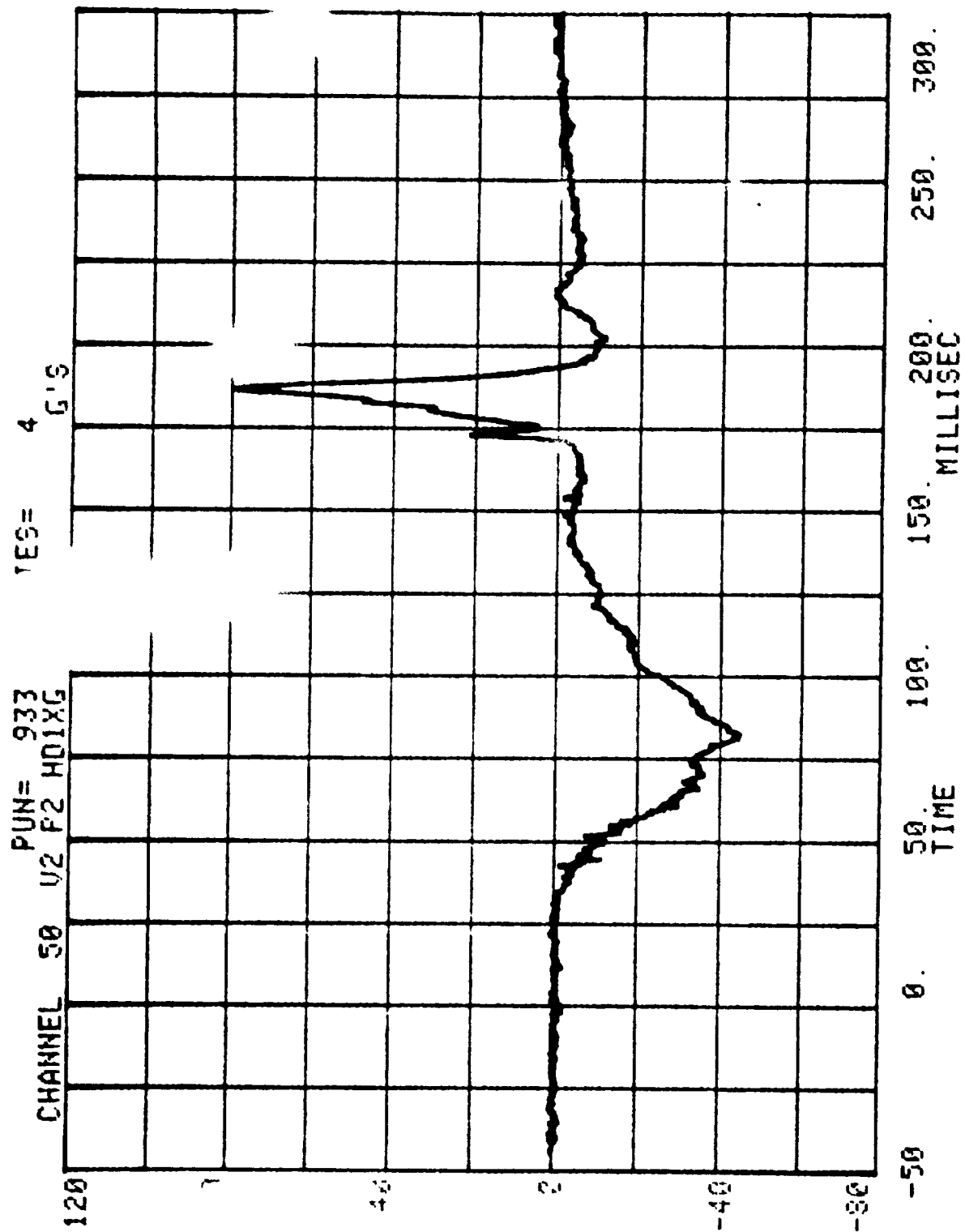


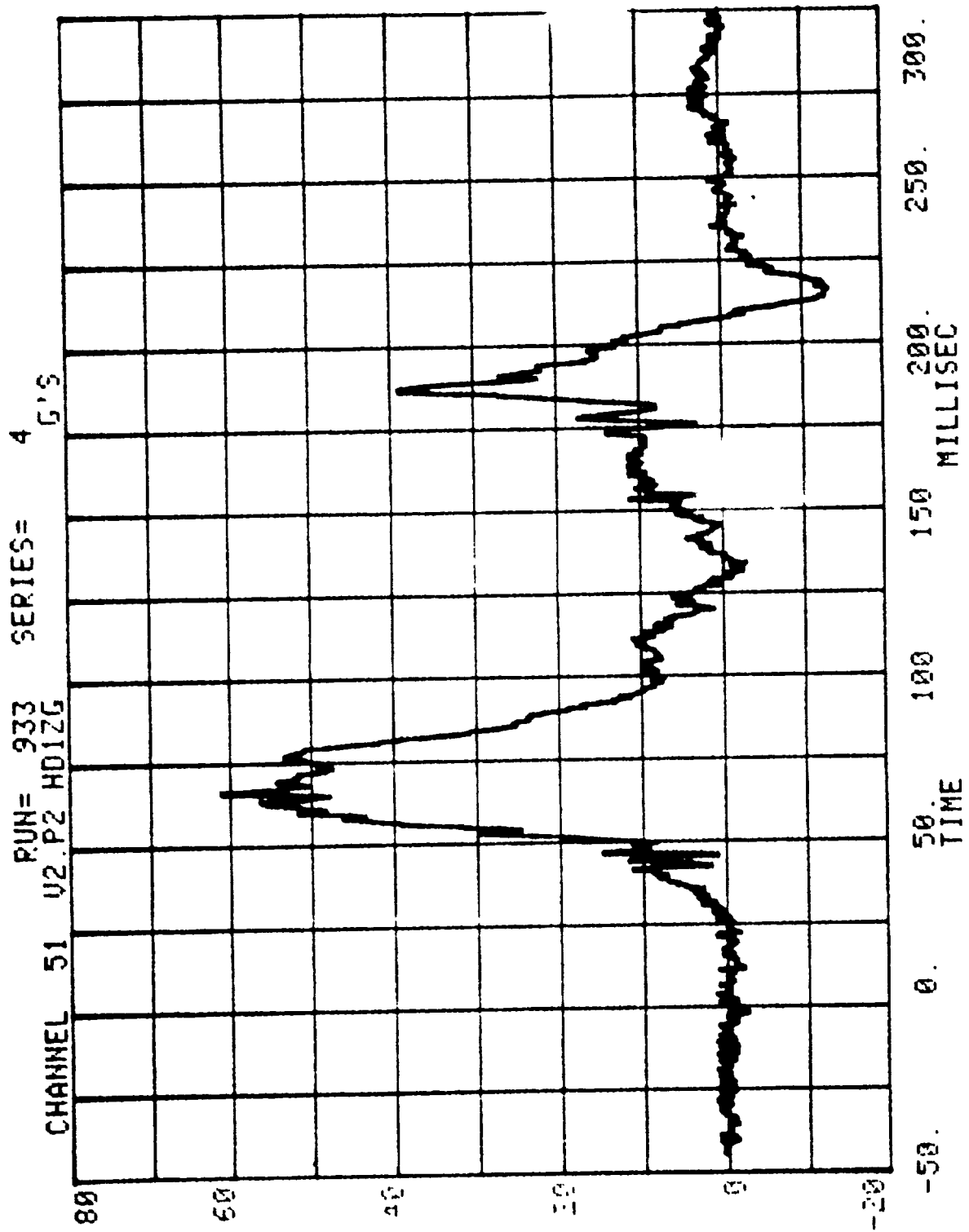
CHANNEL 49 112.P2 HEAD 2 (PRIMARY) 4 G'S

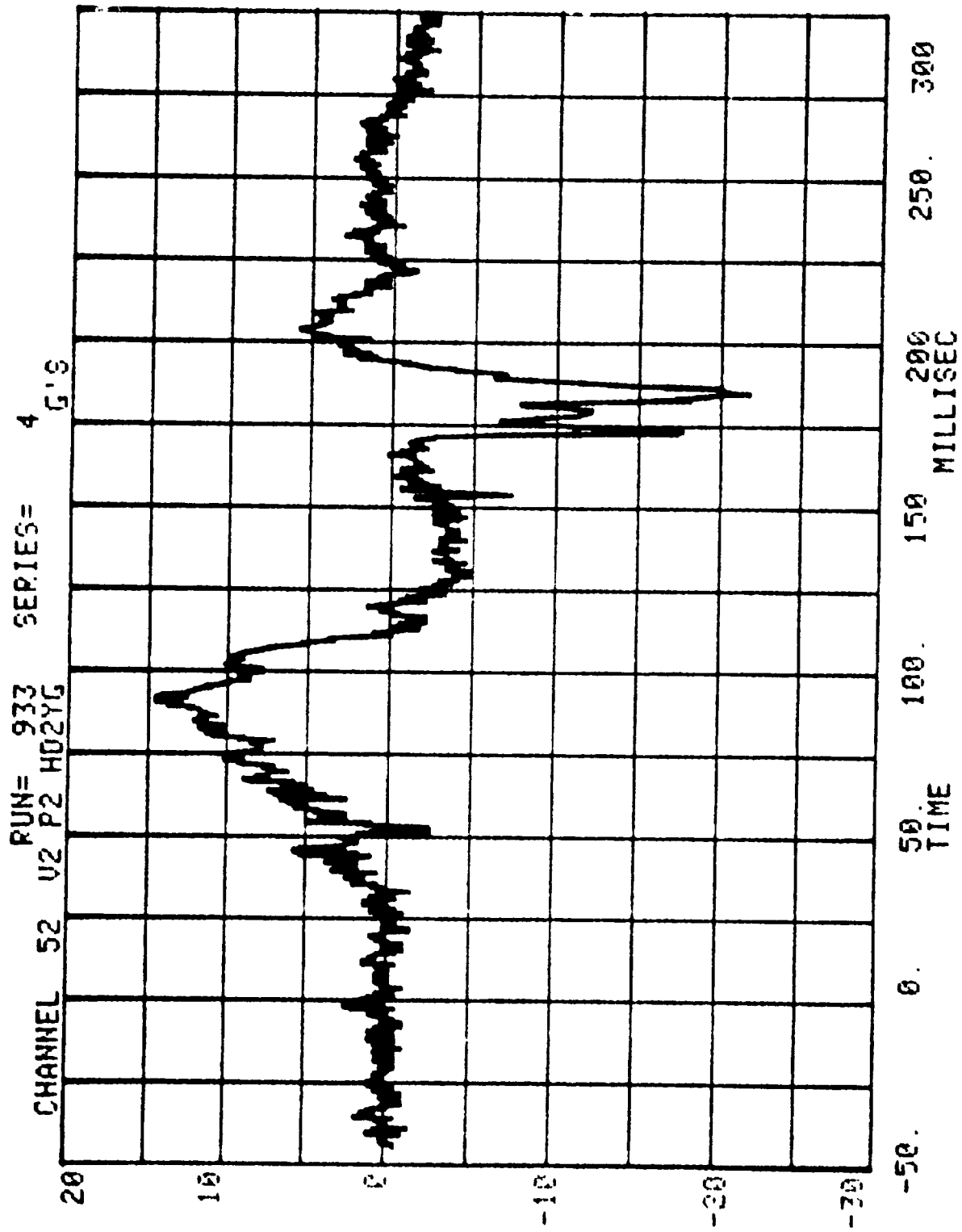


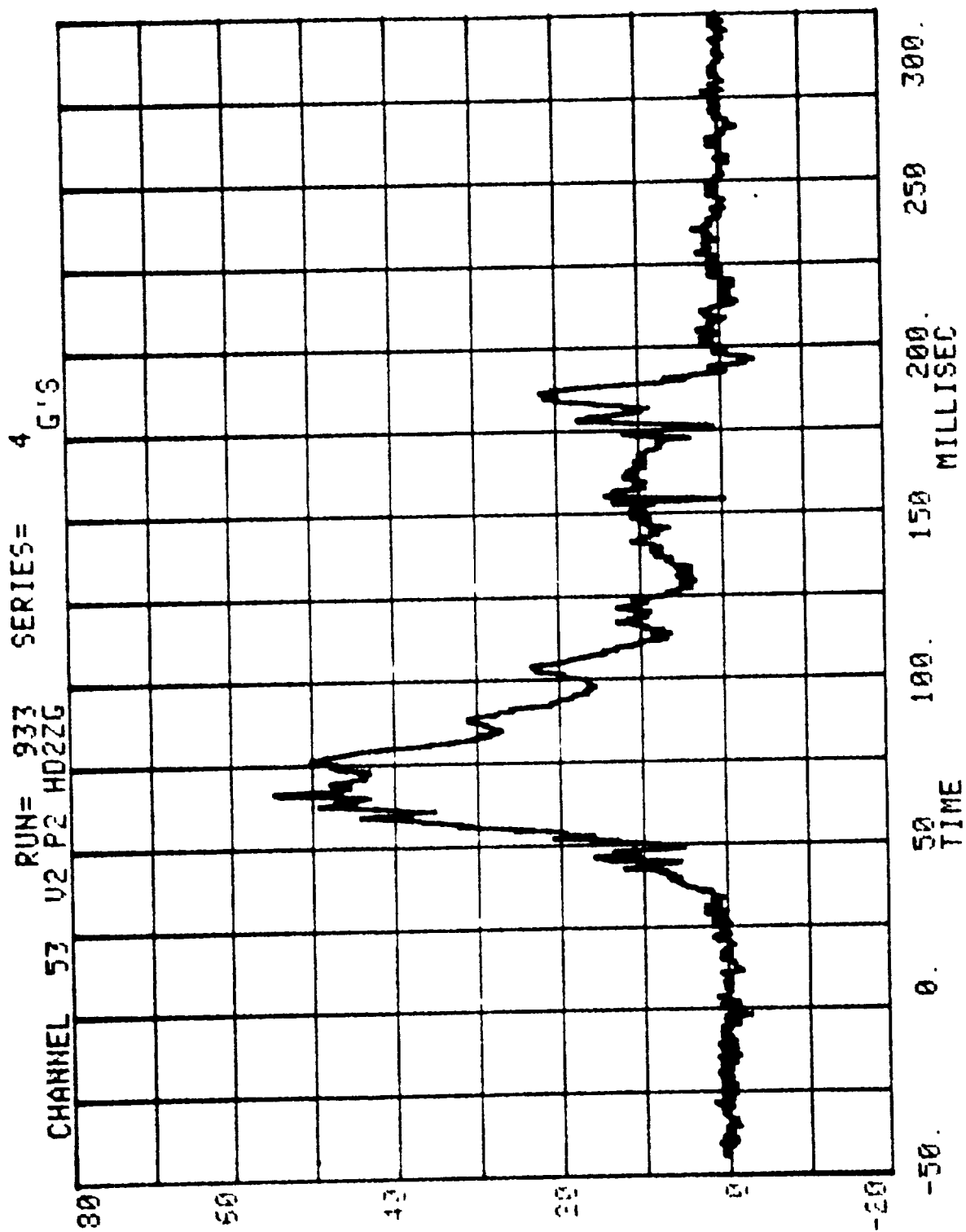
RESULTANT V2.P2 HEAD R (PRIMARY) 4 G'S

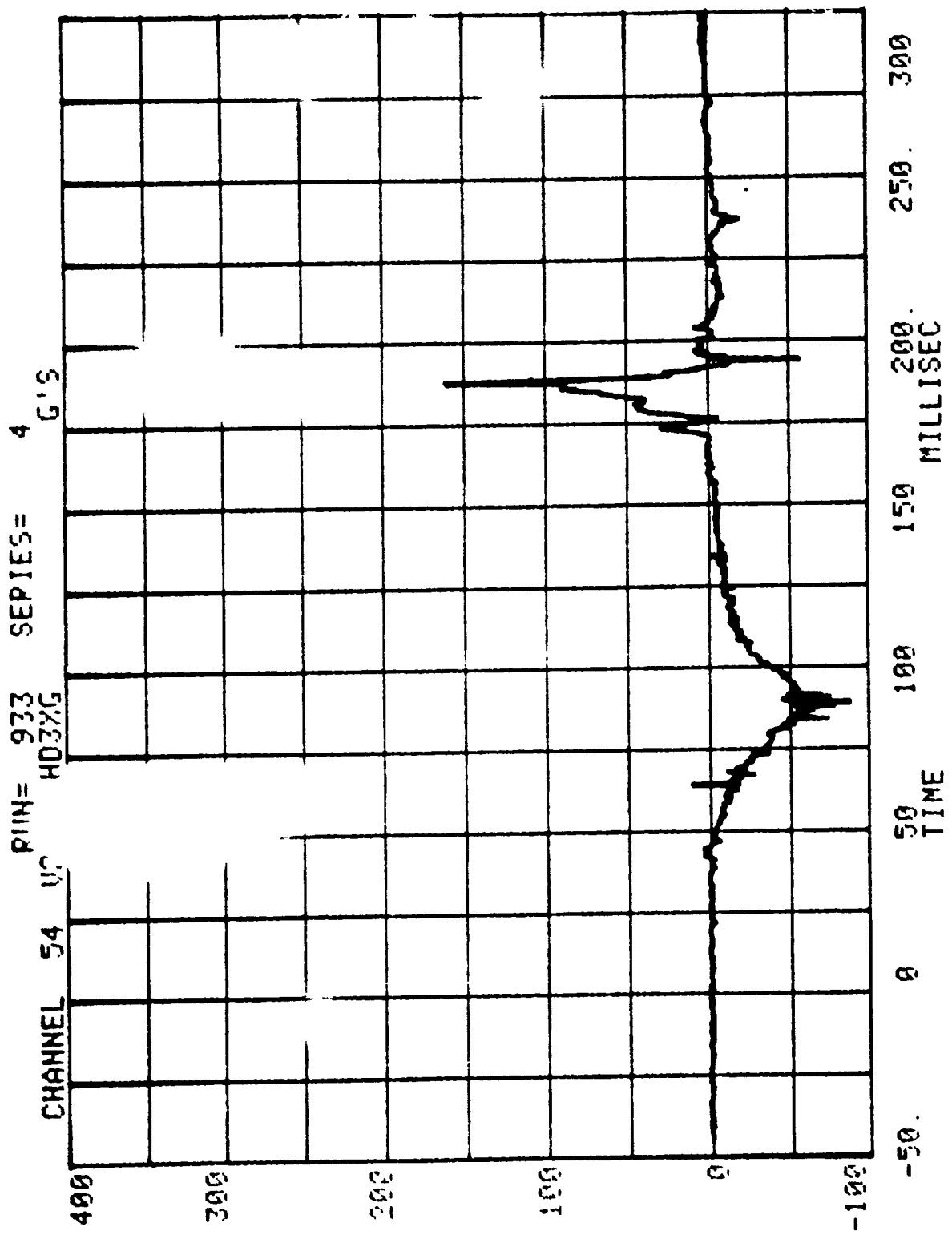


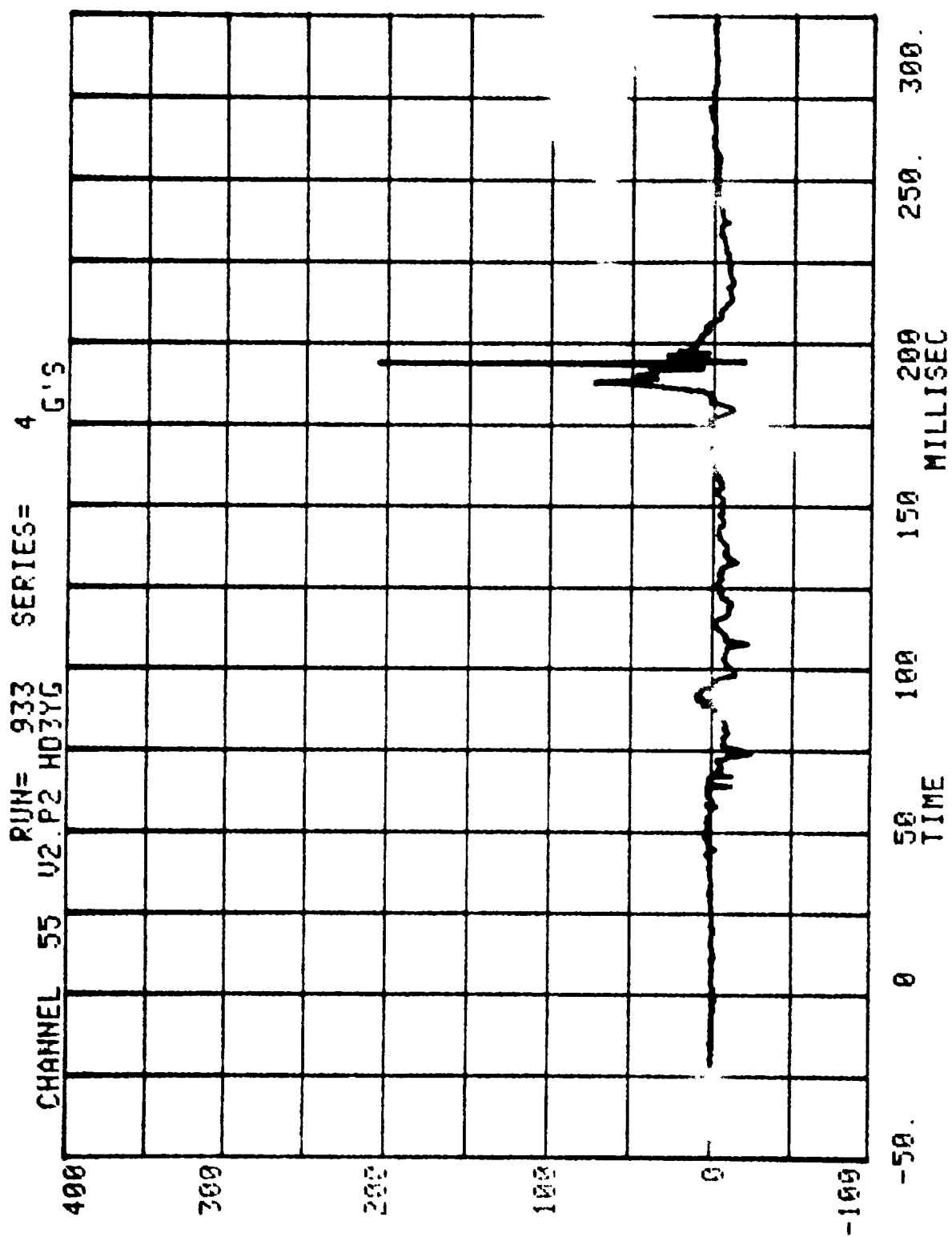


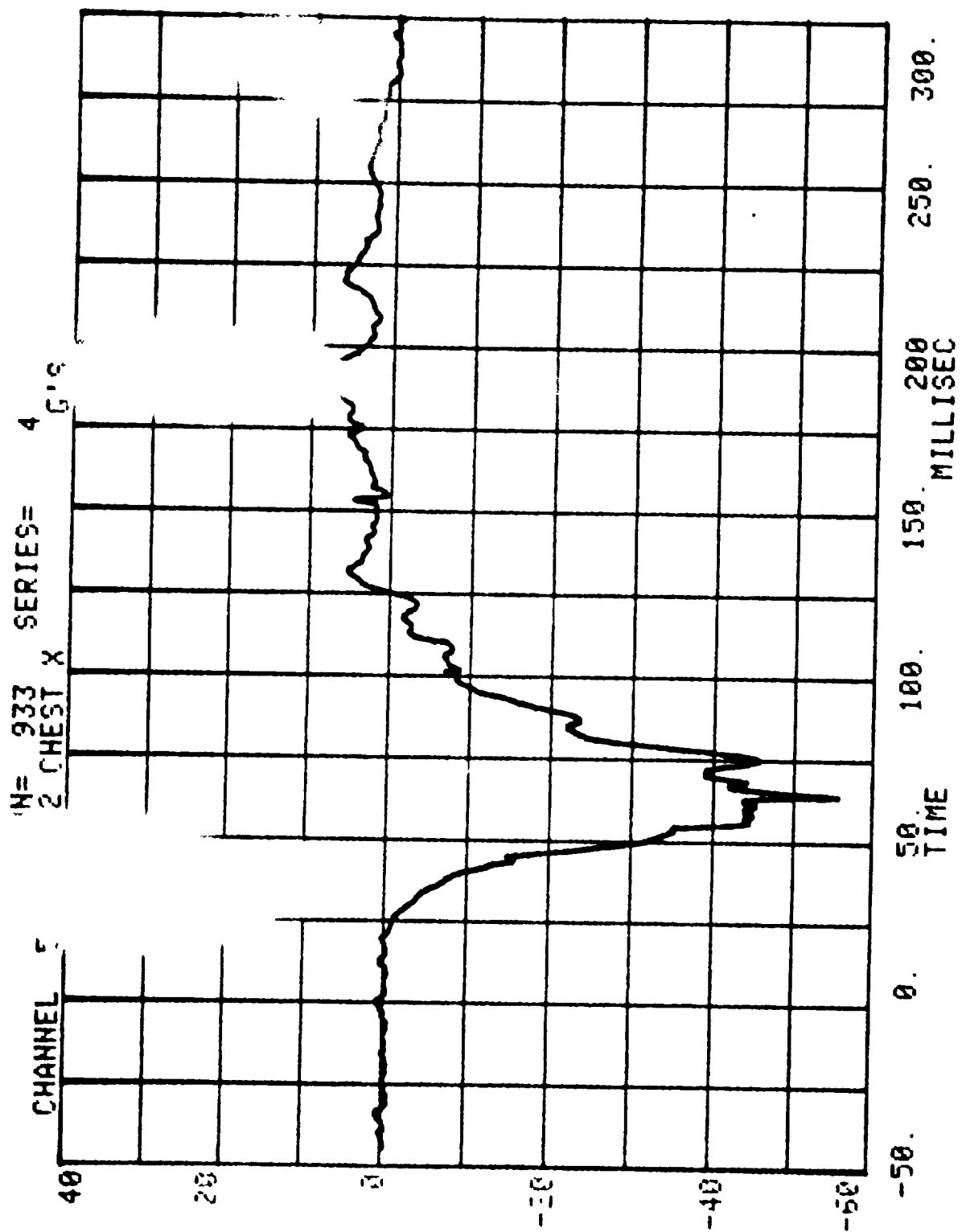




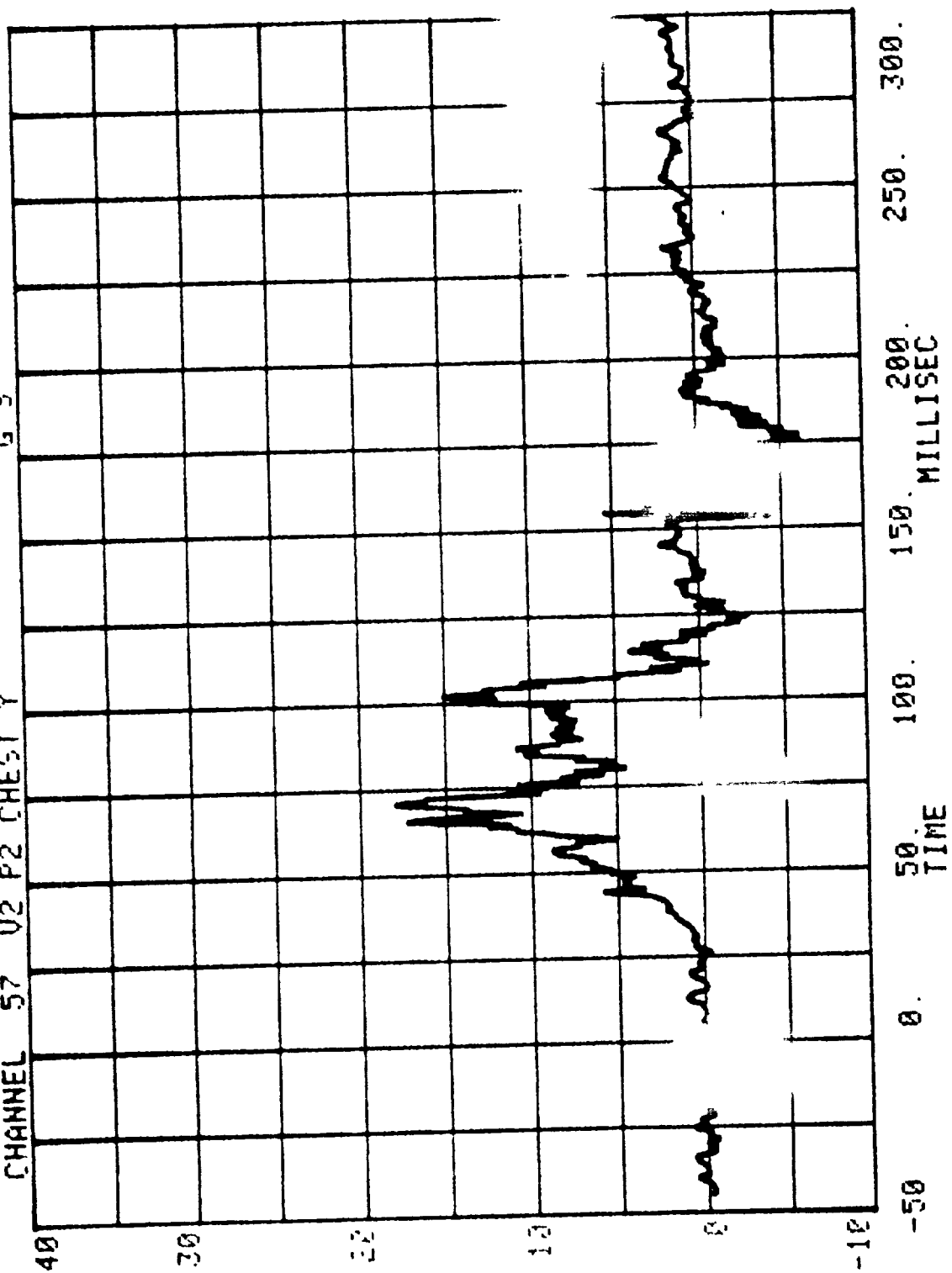


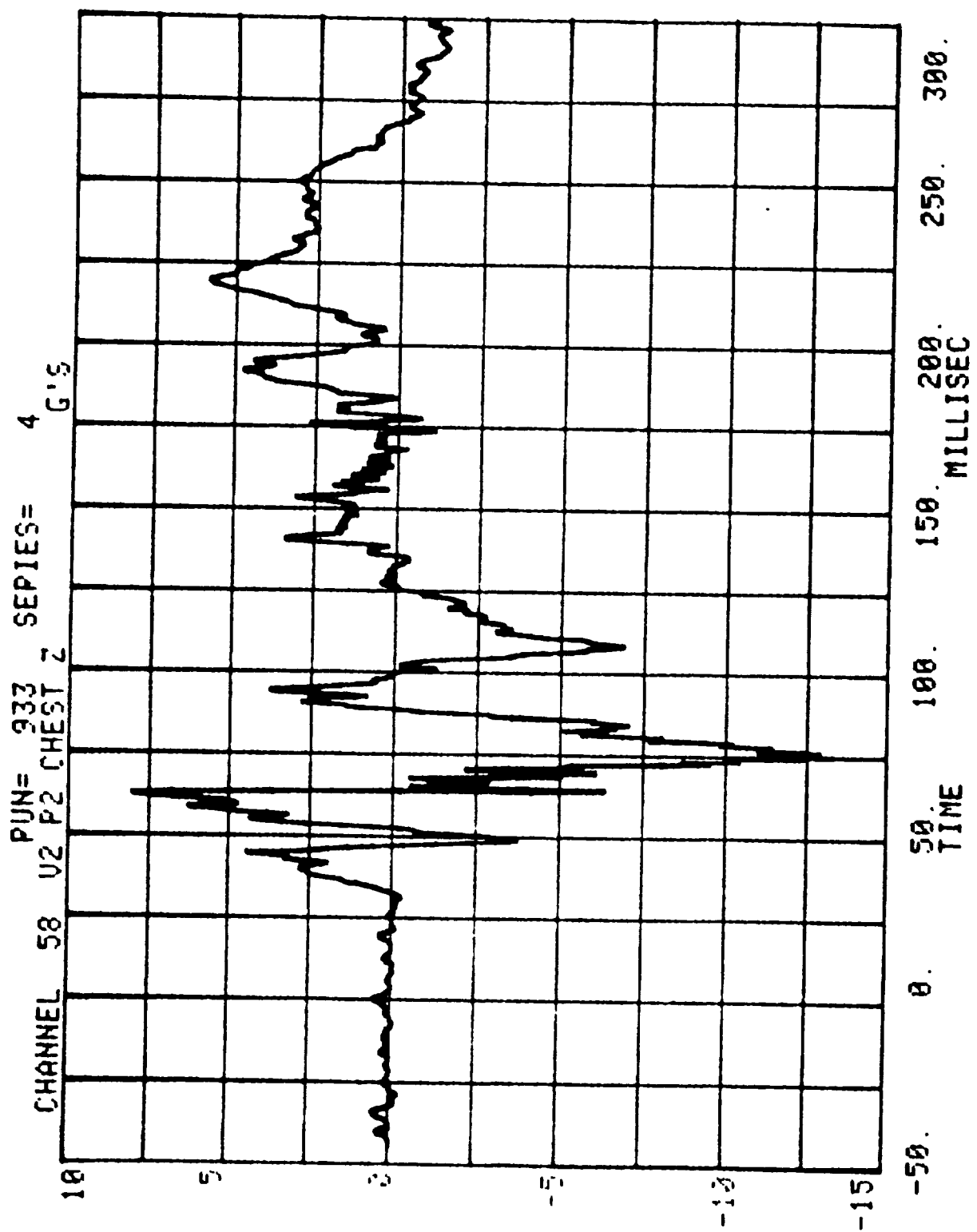




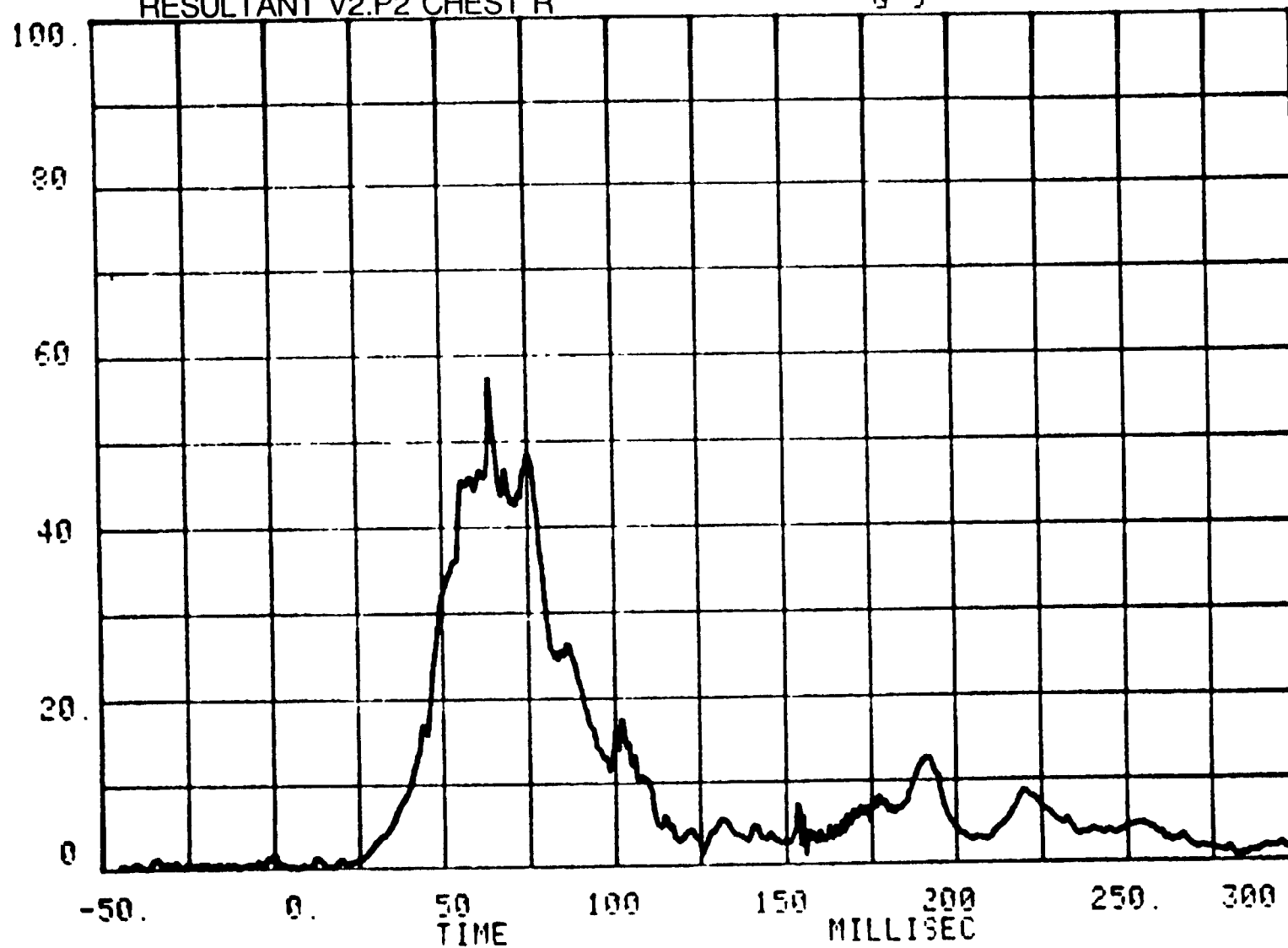


CHANNEL 57 V2 P2 CHEST Y RUN= 933 SERIES= 4 G'S



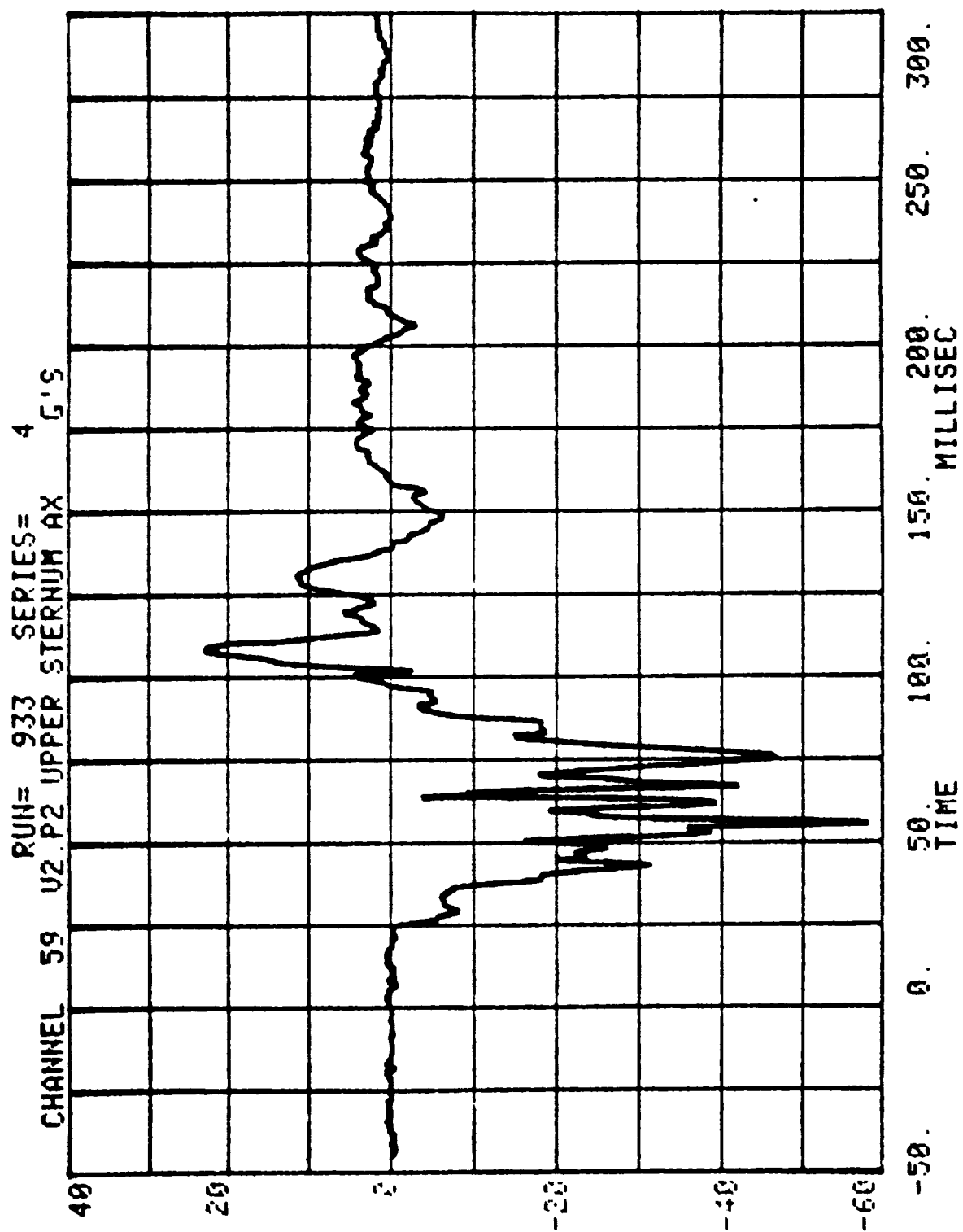


PUN= 973 SERIES= 4
RESULTANT V2.P2 CHEST R G'S

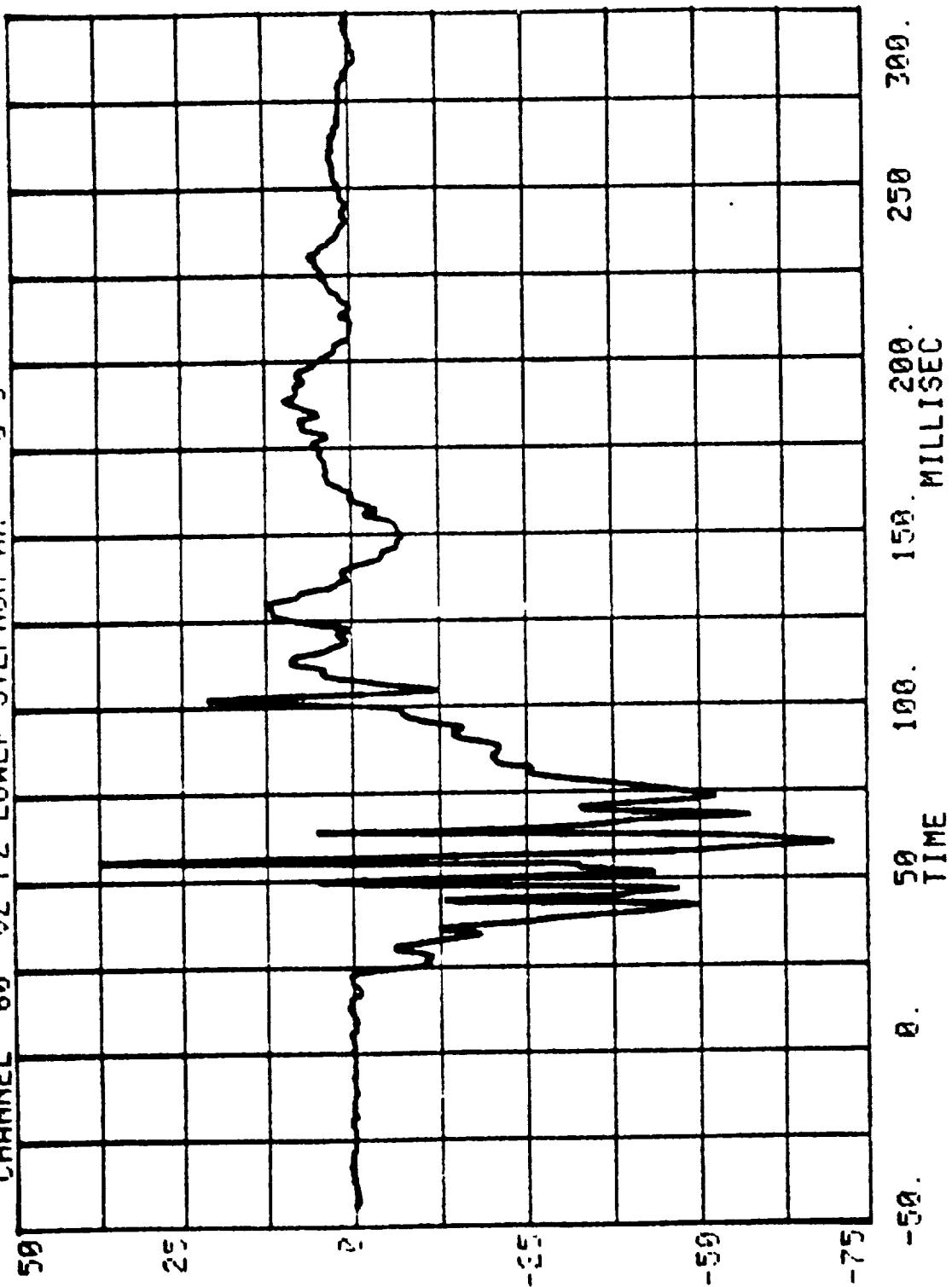


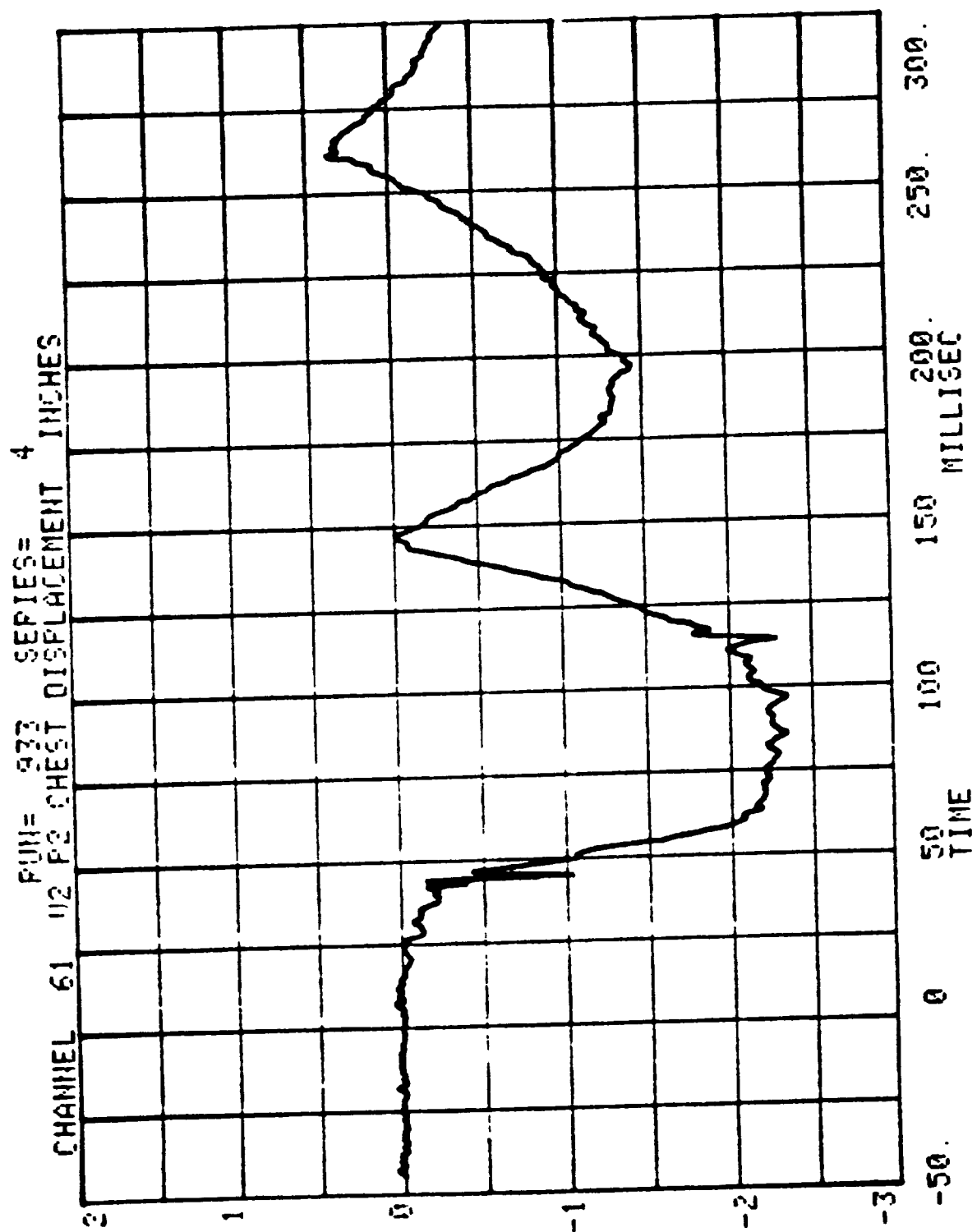
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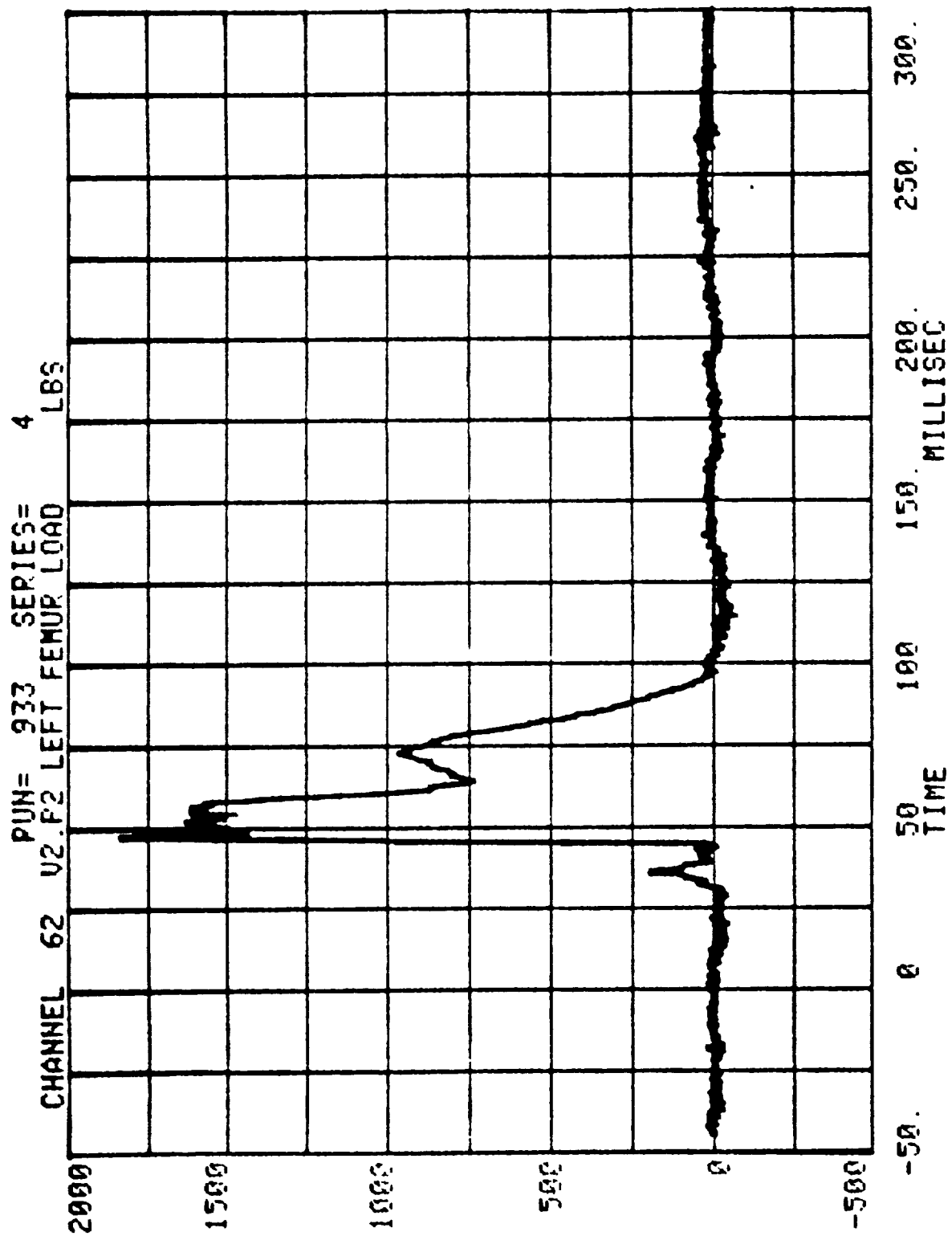
7781-4



CHANNEL 60 U2 P2 LOWER STEPNUM AX 4 G'S

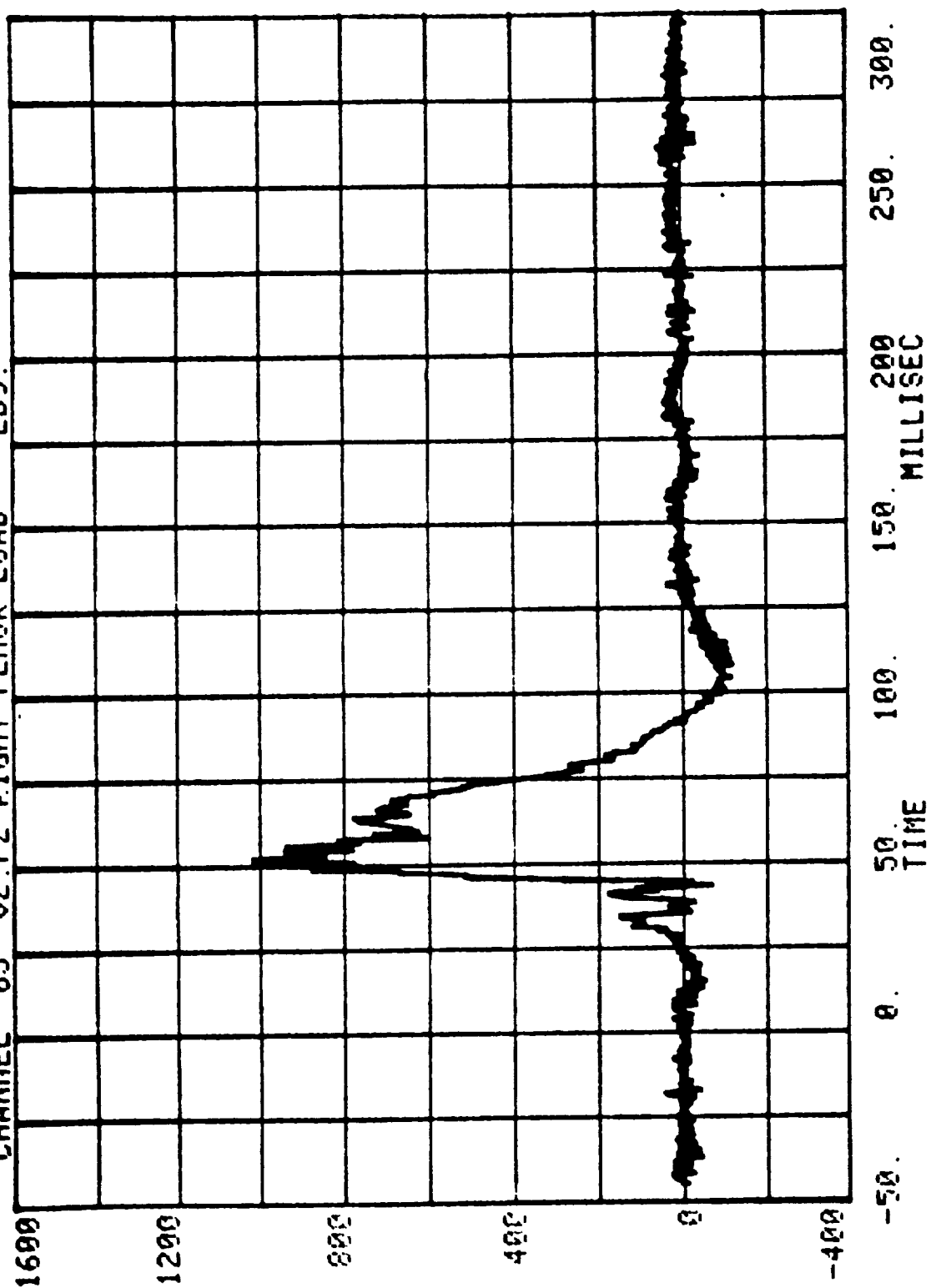


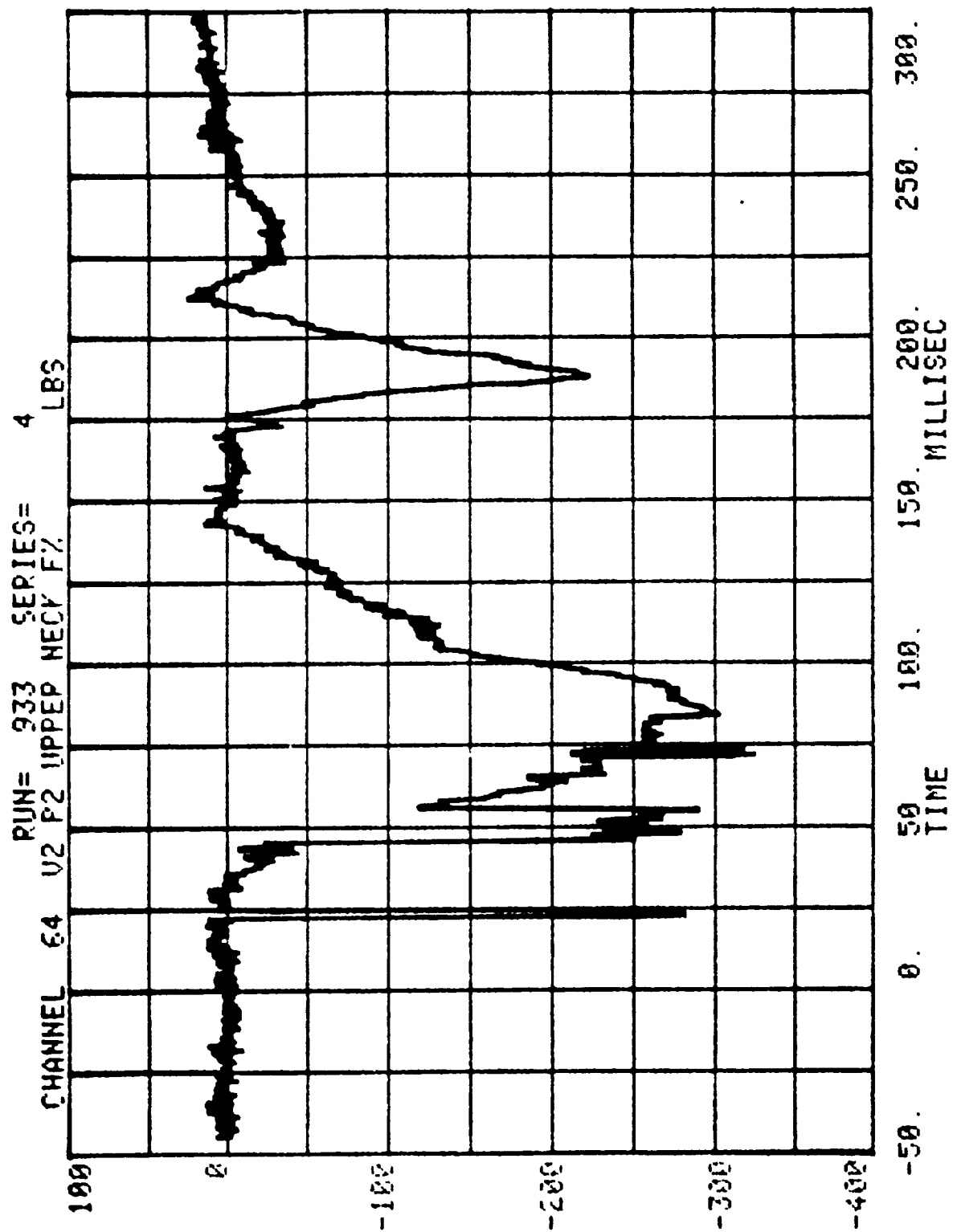




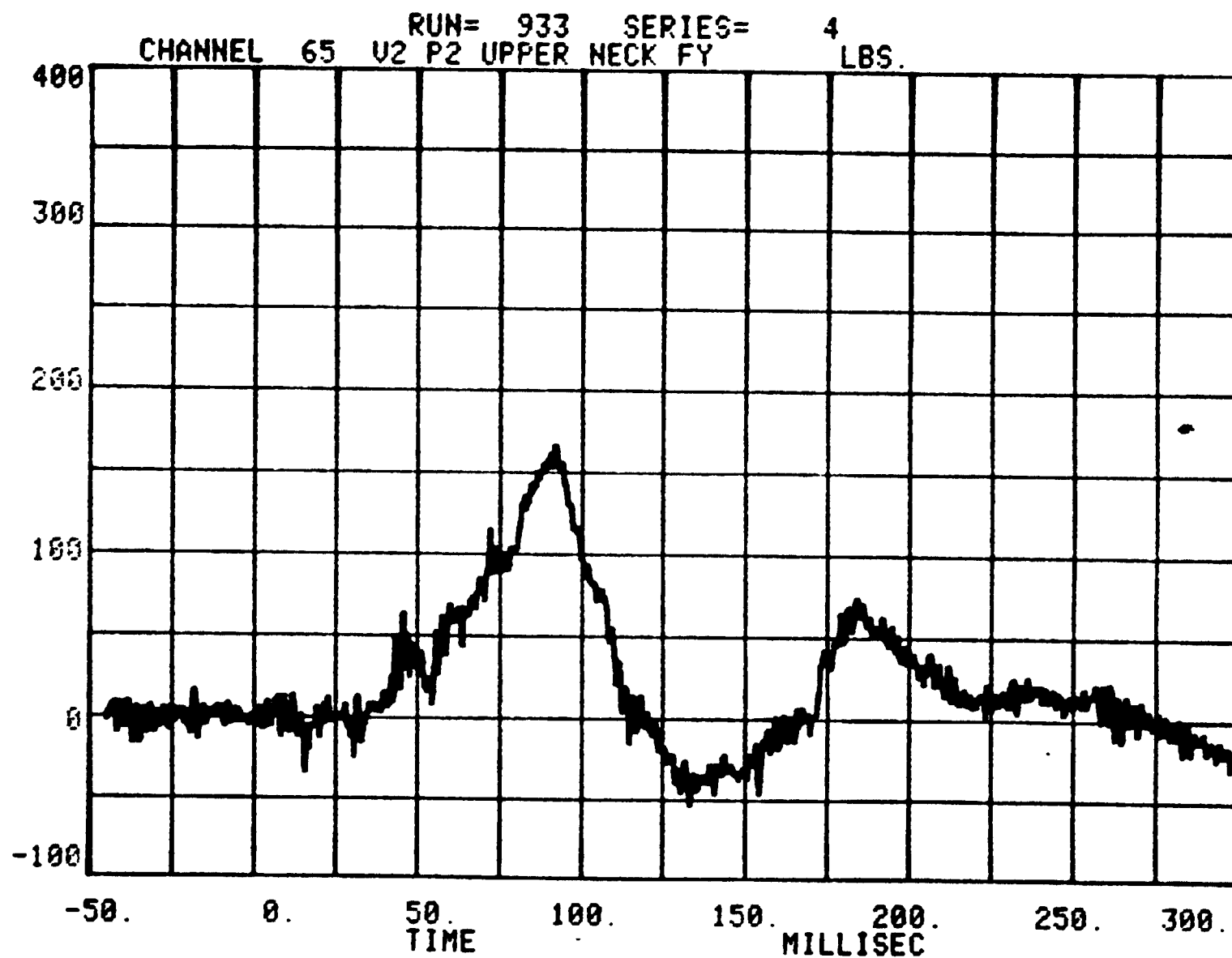
CHANNEL 63 U2.P2 RIGHT FEMUR LOAD 4 LBS. SERIES=

PUN= 933



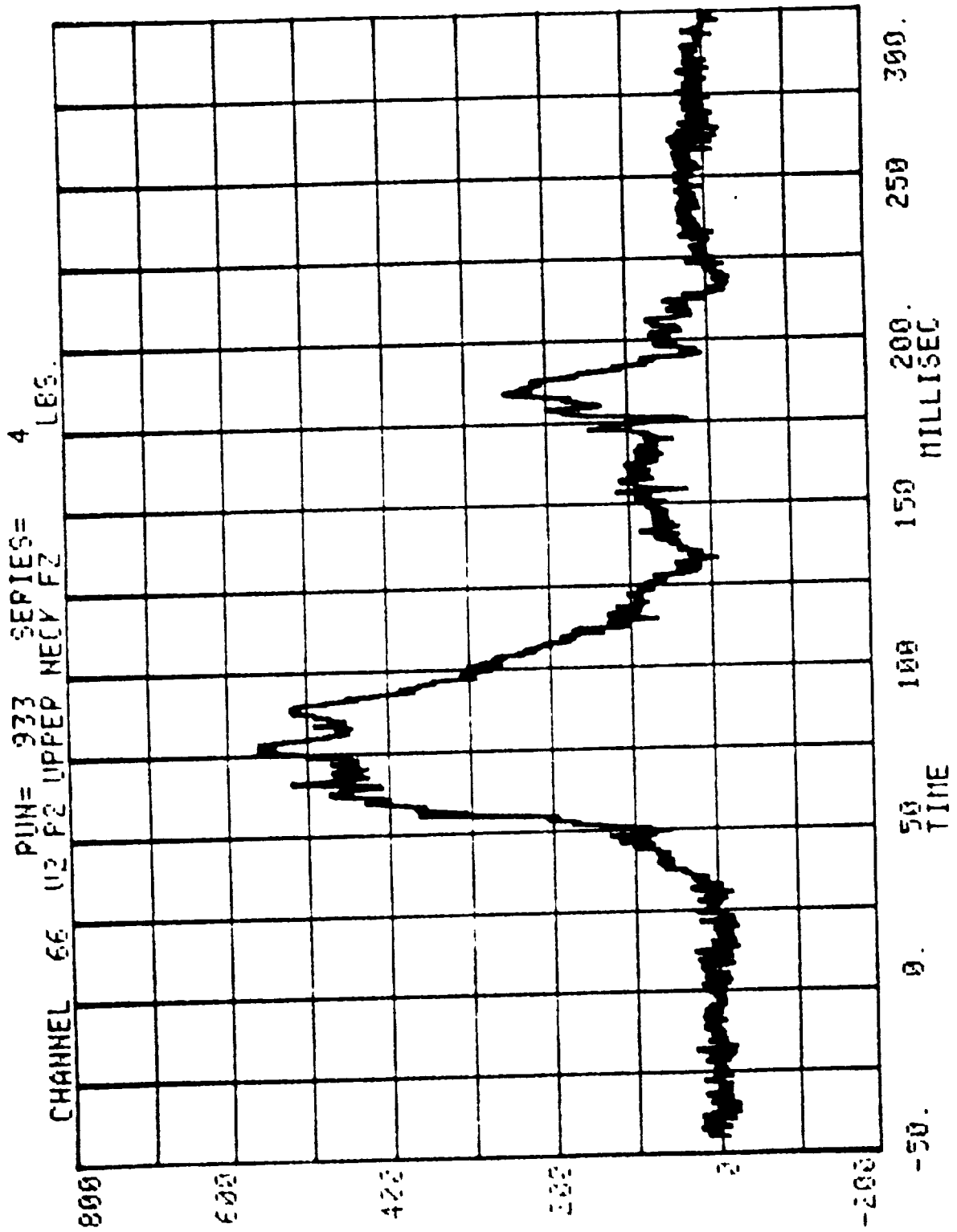


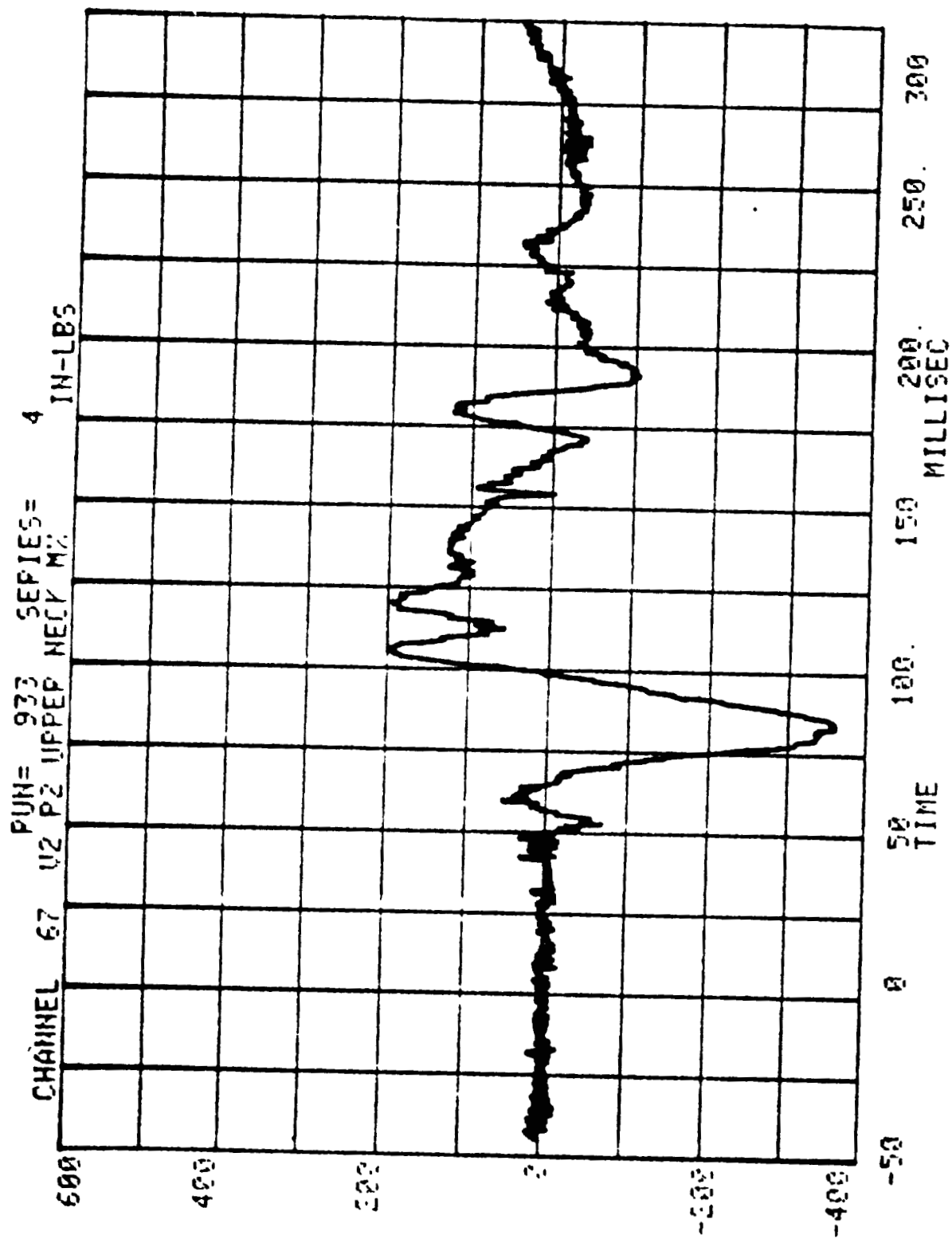
Data questionable between 23 and 76 msec

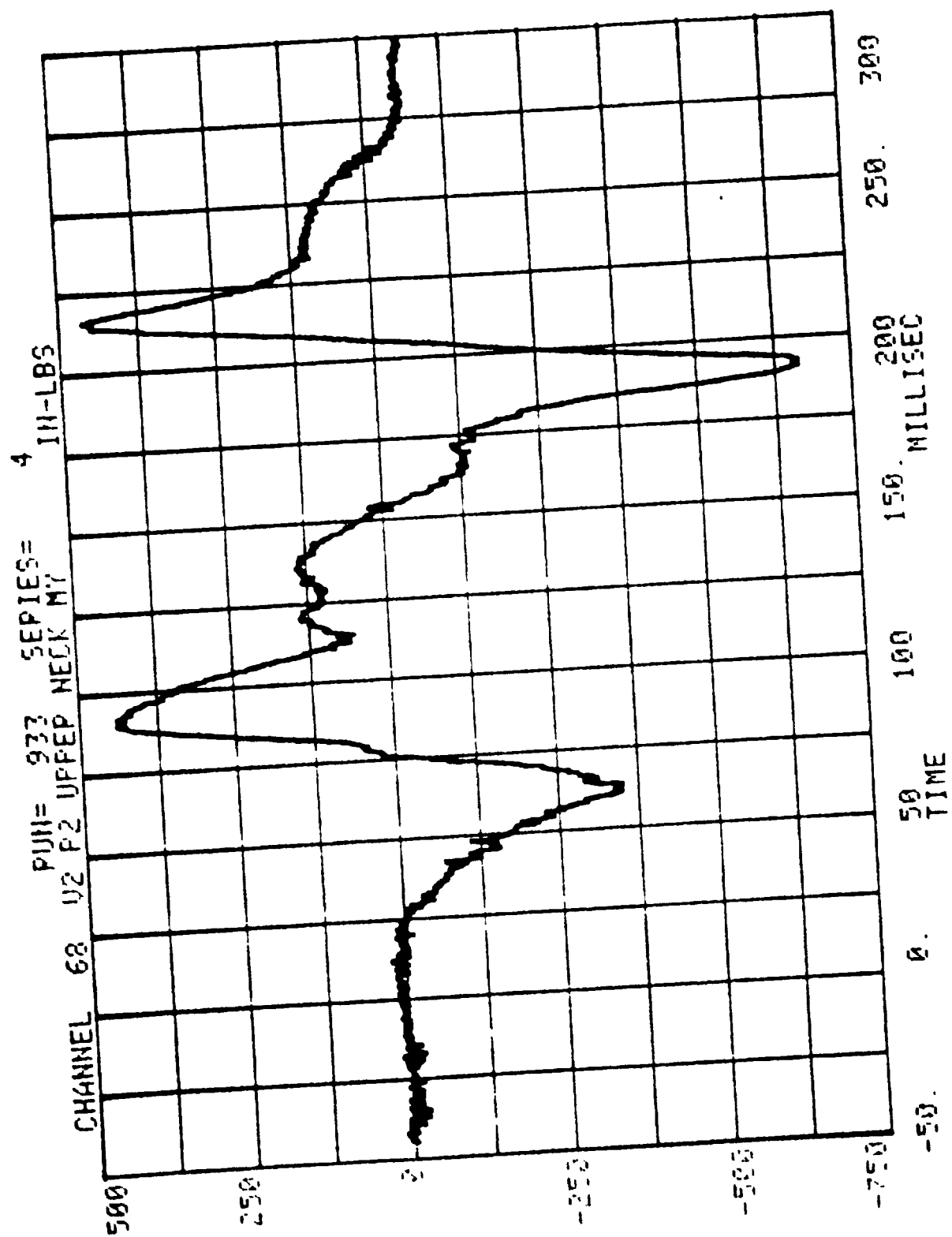


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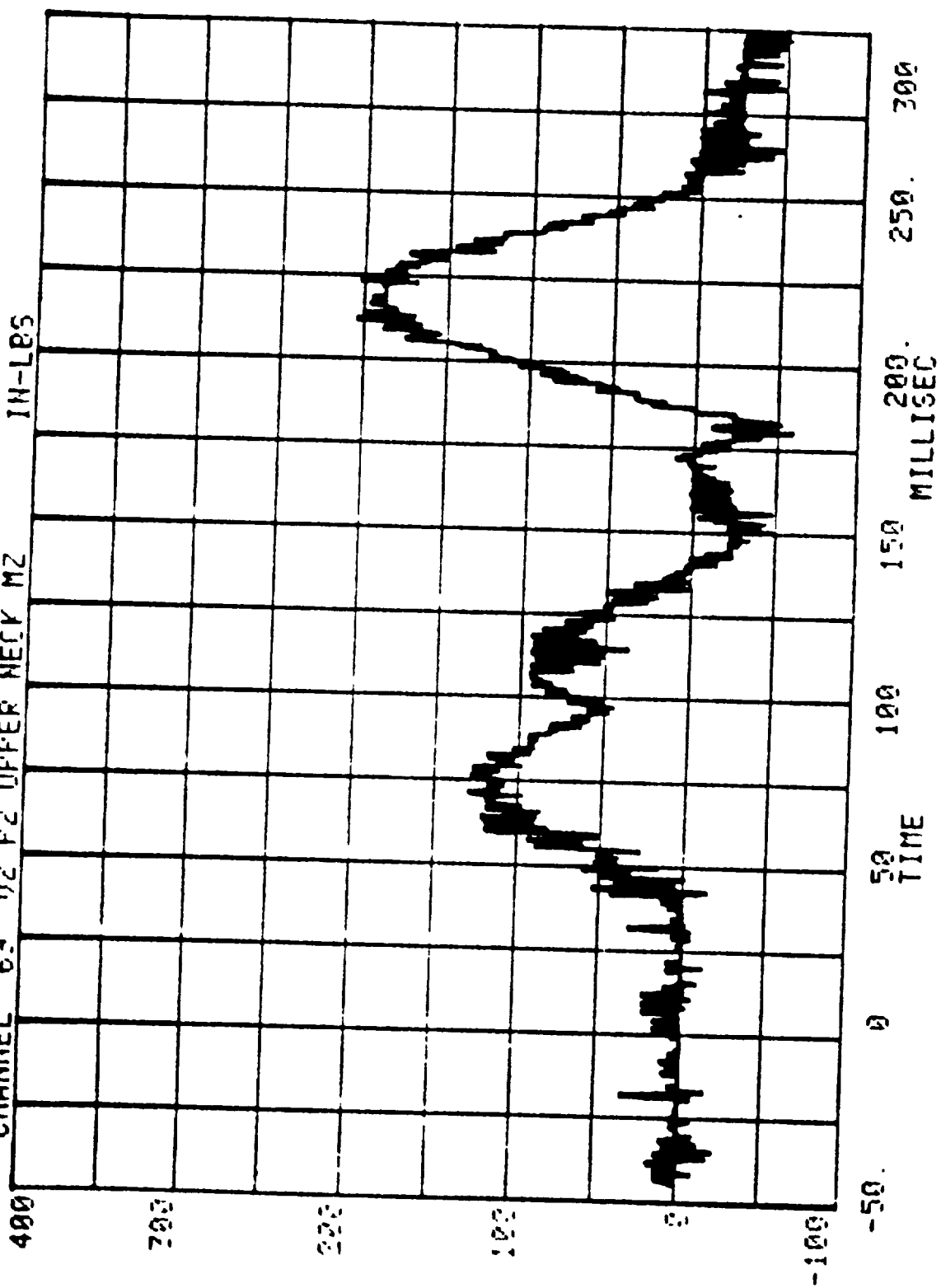
7781-4



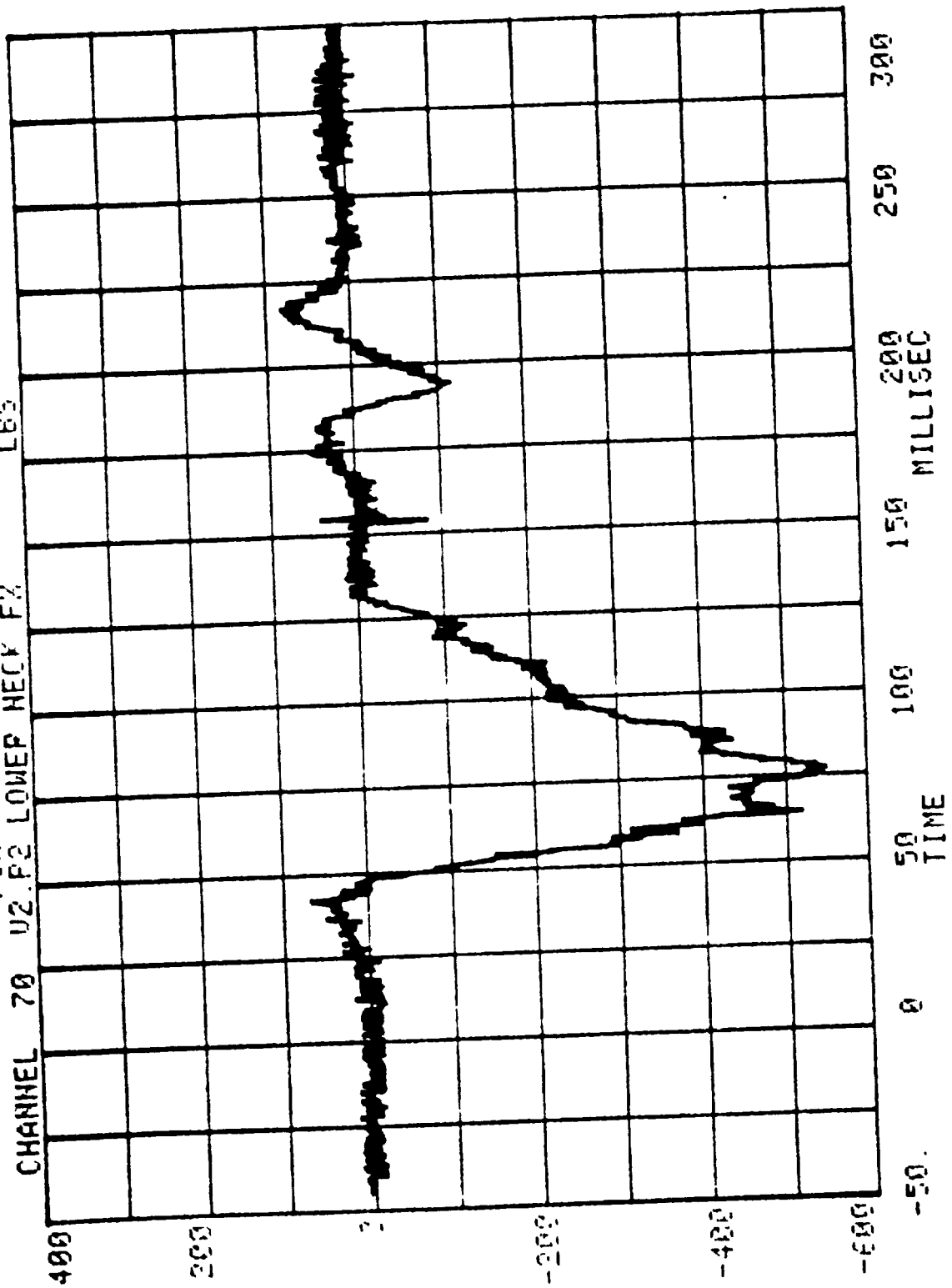


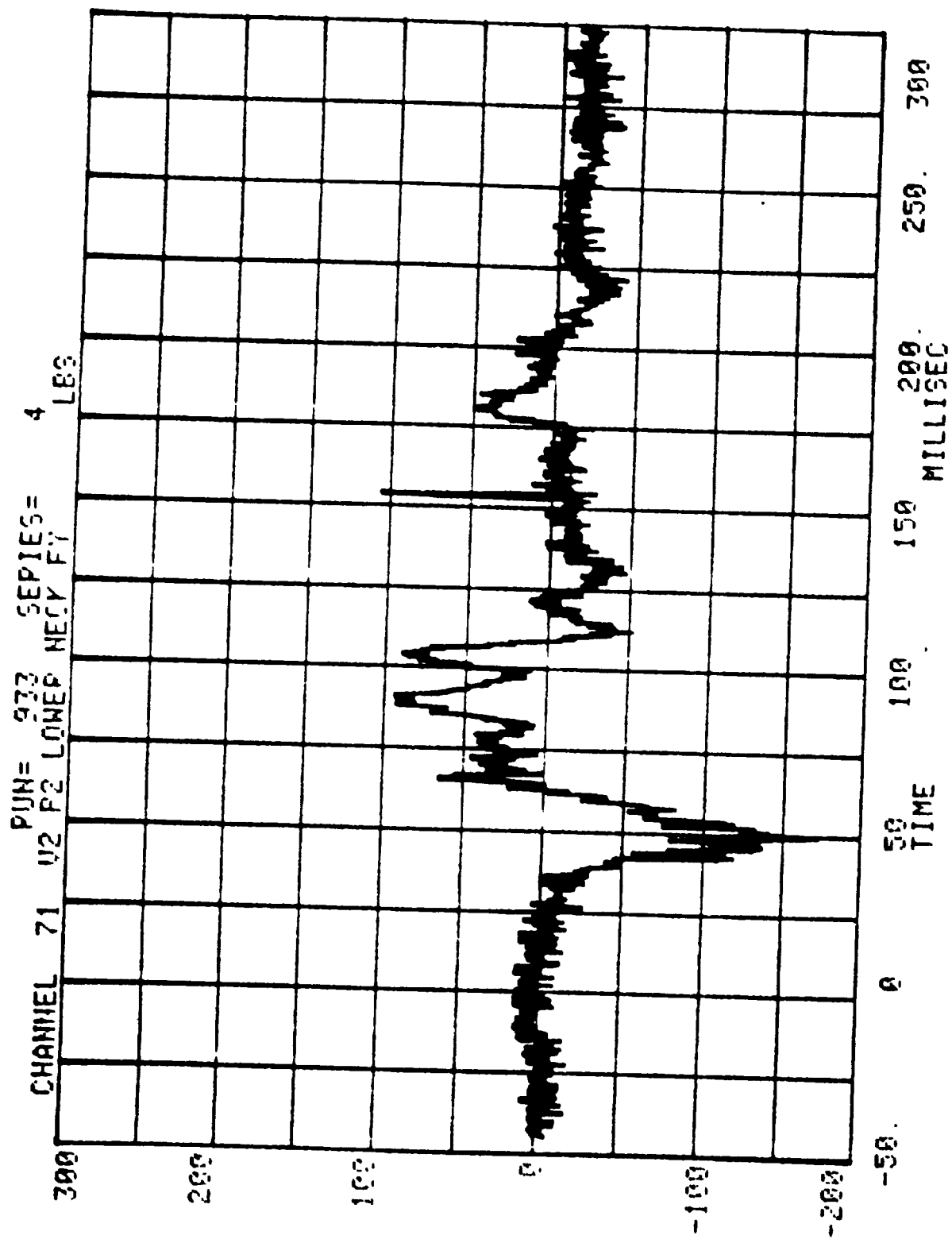


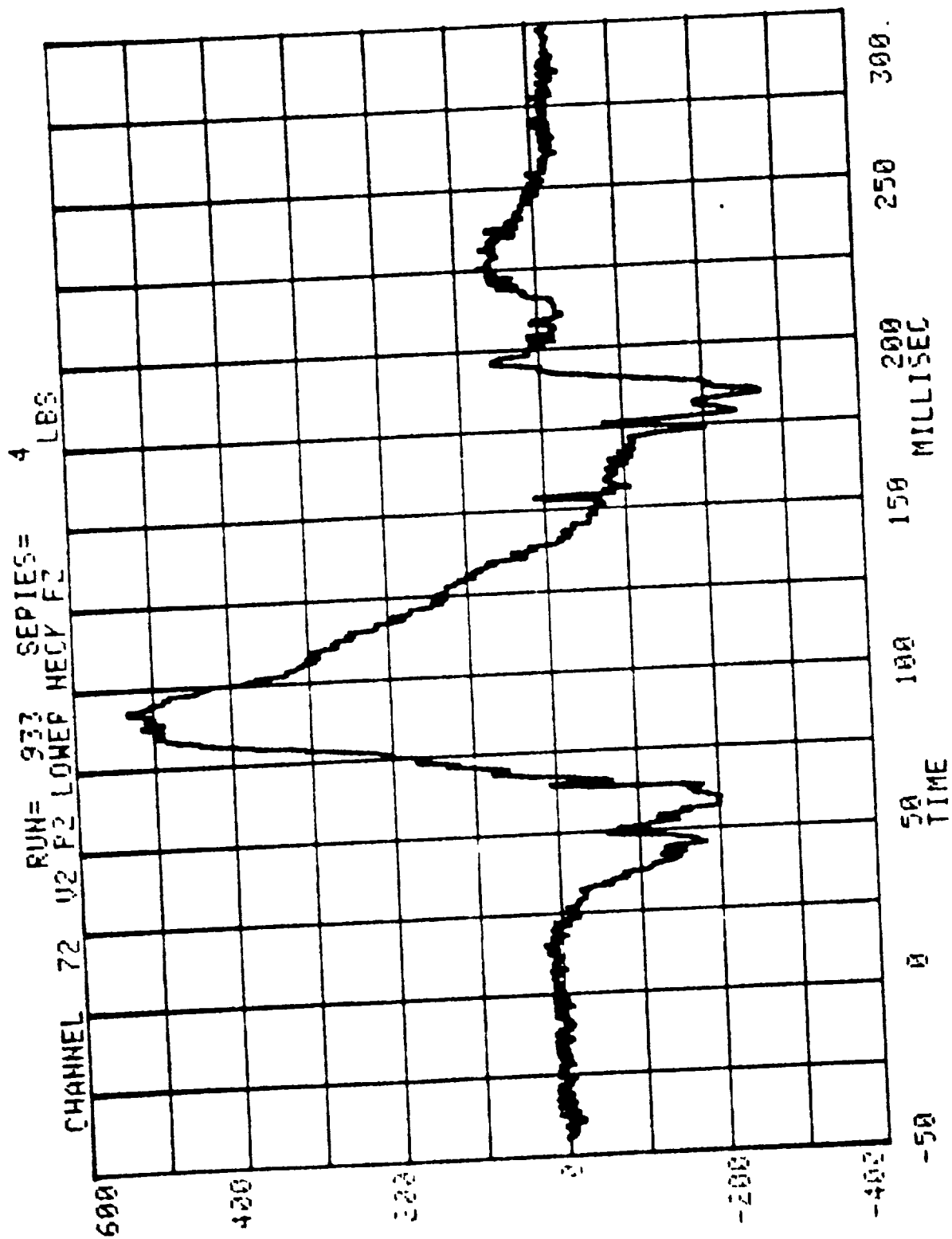
CHANNEL 69 PUN= 933 SERIES= 4 IN-LBS
1/2 F2 UPPER NECK M2

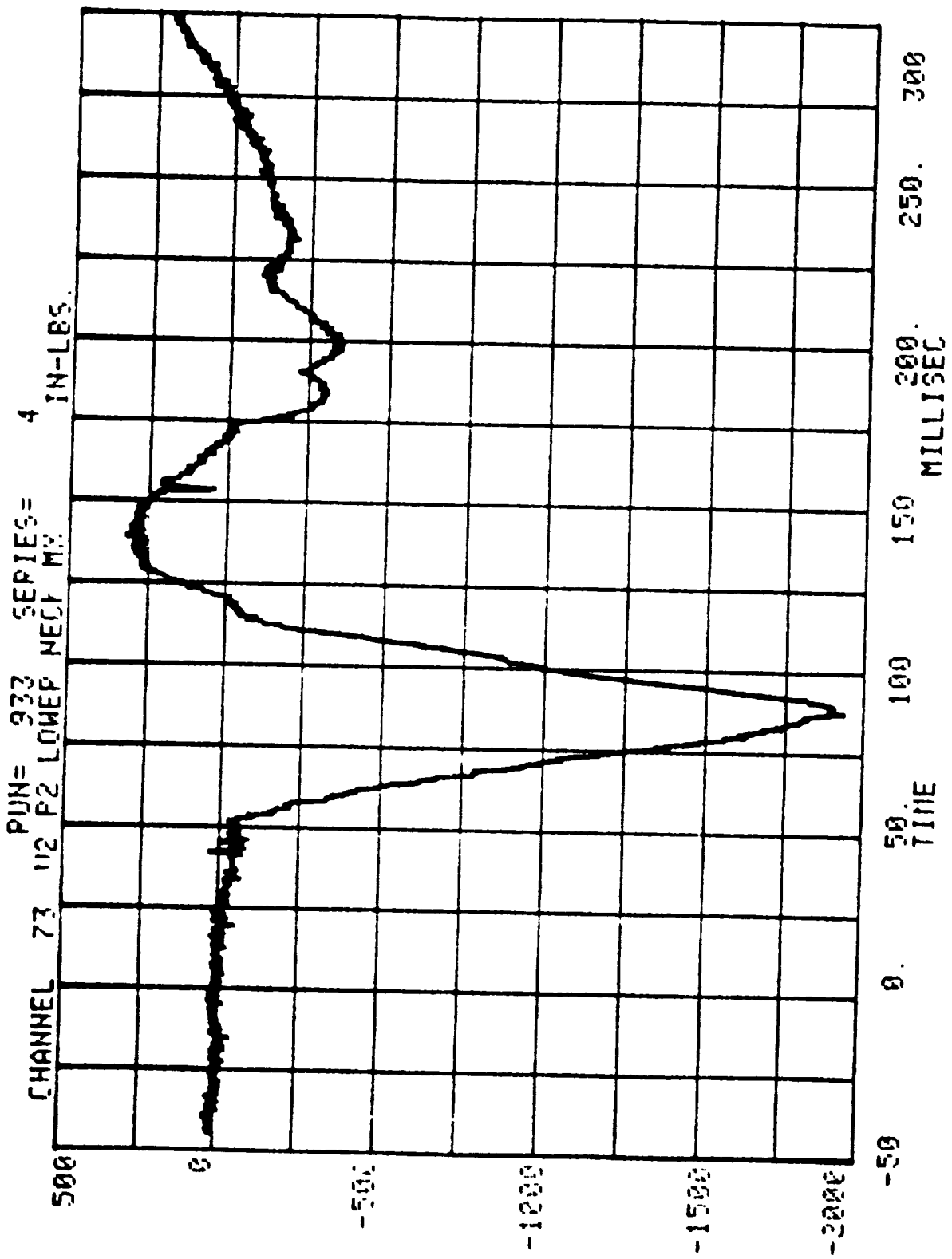


CHANNEL 70 U2.P2 LOWER HECV FZ PUN= 933 SERIES= 4 LBS









CHANNEL 74 U2 P2 LOWER NECK MY 4 IN-LBS

