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~~DOTØ205~~ REF# 833Ø-2

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Dynamic Science Report No. 8327-80-0104

Contract DOT-HS-8-01933

60-DEGREE TWO VEHICLES MOVING FRONT-TO-SIDE IMPACT TESTS USING MODIFIED VW RABBITS AS TARGET VEHICLES (TESTS 8327-4.1 AND 8330-2, PHASE II, TASK 4)

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DECEMBER 1980

TEST REPORT

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

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Tests 8327-4.1 and 8330-2

16. Abstract

This report presents the results of Test 8327-4.1 Side Impactor-to-car 60-degree side impact test. This test was required for Task 4 of Phase II of the "Test Device and Test Procedure to Assess Side Structures" program. This program is sponsored by the Department of Transportation, National Highway Traffic Safety Administration, under Contract DOT-HS-8-01933.

The objective of this test was to evaluate the Side Impactor in a Side Impactor-to-car two vehicles moving crash. These results were used to determine the ability of the Side Impactor to reproduce the environment of the baseline car crash test, 1979 Oldsmobile Cutlass-into-Modified VW Rabbit, conducted under Contract DOT-HS-9-02177, "Countermeasures for Side Impact," Test 8330-2.

This testing was conducted using the new Dynamic Science crash facility for front-to-side impact with two vehicles moving. For this test, one Humanoid hybrid side impact dummy was unrestrained in the driver position of the target test vehicle.

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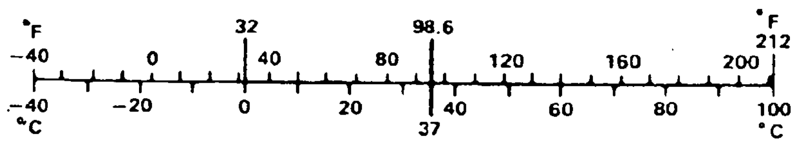
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric ton	t
		VOLUME		
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
in^3	cubic inches	16	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	degrees Fahrenheit	5/9 (after subtracting 32)	degrees Celsius	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10 000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric ton (1000 kg)	1.1	short tons	
		VOLUME		
mL	milliliters	0.03	fluid ounces	fl oz
mL	milliliters	0.06	cubic inches	in^3
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	degrees Celsius	9/5 (then add 32)	degrees Fahrenheit	°F



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1.0 INTRODUCTION

This report presents the results of Test 8327-4.1, a Side Impactor Test Device-to-Volkswagen Rabbit side impact crash test at 60 degrees. This test was required for Task 4 of Phase II of the "Test Device and Test Procedure to Assess Side Structures" program being sponsored by the Department of Transportation, National Highway Traffic Safety Administration under Contract DOT-HS-8-01933. The data is compared with a reference test (8330-2) conducted under another DOT contract.

1.1 TEST SCOPE

The original scope of Task 4 included four full-scale side impact crash tests utilizing a selected vehicle from Task 3 and the Side Impactor (modified to have the same force/crush characteristics as the selected vehicle) as the bullet vehicles. At the direction of NHTSA, the scope of Task 4 was changed to include only one side impact crash test, utilizing the Side Impactor with the (basically unmodified) Phase I Energy-Absorbing Face (EAF) as the bullet vehicle. An Oldsmobile Cutlass-to-Volkswagen Rabbit side impact crash test performed earlier under the "Countermeasures for Side Impact" program was selected as the baseline test (the Phase I EAF was modeled to Oldsmobile Cutlass force/crush characteristics).

Table 1-1 presents the test matrix for Task 4 including the baseline test 8330-2 conducted under Contract DOT-HS-9-02177.

1.2 TEST OBJECTIVE

The objective of Test 8327-4.1 was to obtain data for a Side Impactor-to-VW Rabbit front-to-side, two vehicle moving, side impact crash test. The data from this test was compared to the data from the baseline test in order to determine the ability of the Side Impactor Test Device to reproduce the environment of the Oldsmobile Cutlass-to-VW Rabbit side impact crash test. The data was analyzed to determine the appropriateness of the Side Impactor and the appropriateness of the test condition.

TABLE 1-1. TASK 4 CRASH TEST MATRIX

Test Date	Test Number	Bullet Vehicle	Target Vehicle	Bullet Vehicle Speed (mph)	Target Vehicle Speed (mph)	Impact Angle
2/11/80	8327-4.1	Side Impactor w/Phase I EAF	1976 Modified VW Rabbit	30.30	15.46	60°
10/25/79	8330-2	1979 Oldsmobile Cutlass	1977 Modified VW Rabbit	29.7	15.2	60°

1.3 TEST DESCRIPTION

Test 8327-4.1 was conducted using the Dynamic Science facility for two vehicles moving side impact crash tests. The vehicle test configuration was as shown in Figure 1-1. Test 8330-2 was conducted in a similar manner with an Oldsmobile Cutlass as the bullet vehicle. The Phase I EAF (Appendix D) was affixed to the Side Impactor Bogey vehicle. For Test 8327-4.1, the EAF was slightly modified by the addition of a tie-down cable from the non-impacted end of the bumper to the bogey structure. This was done in an attempt to stiffen the lower region of the EAF by keeping the bumper attached to the EAF, thereby spreading the load across more of the honeycomb material.

In both tests, the NHTSA Side Impact Dummy (three-rib design) was unrestrained in the driver position of the target test vehicle (Budd-modified Volkswagen Rabbit). Dummy and vehicle instrumentation is presented in Appendix E.

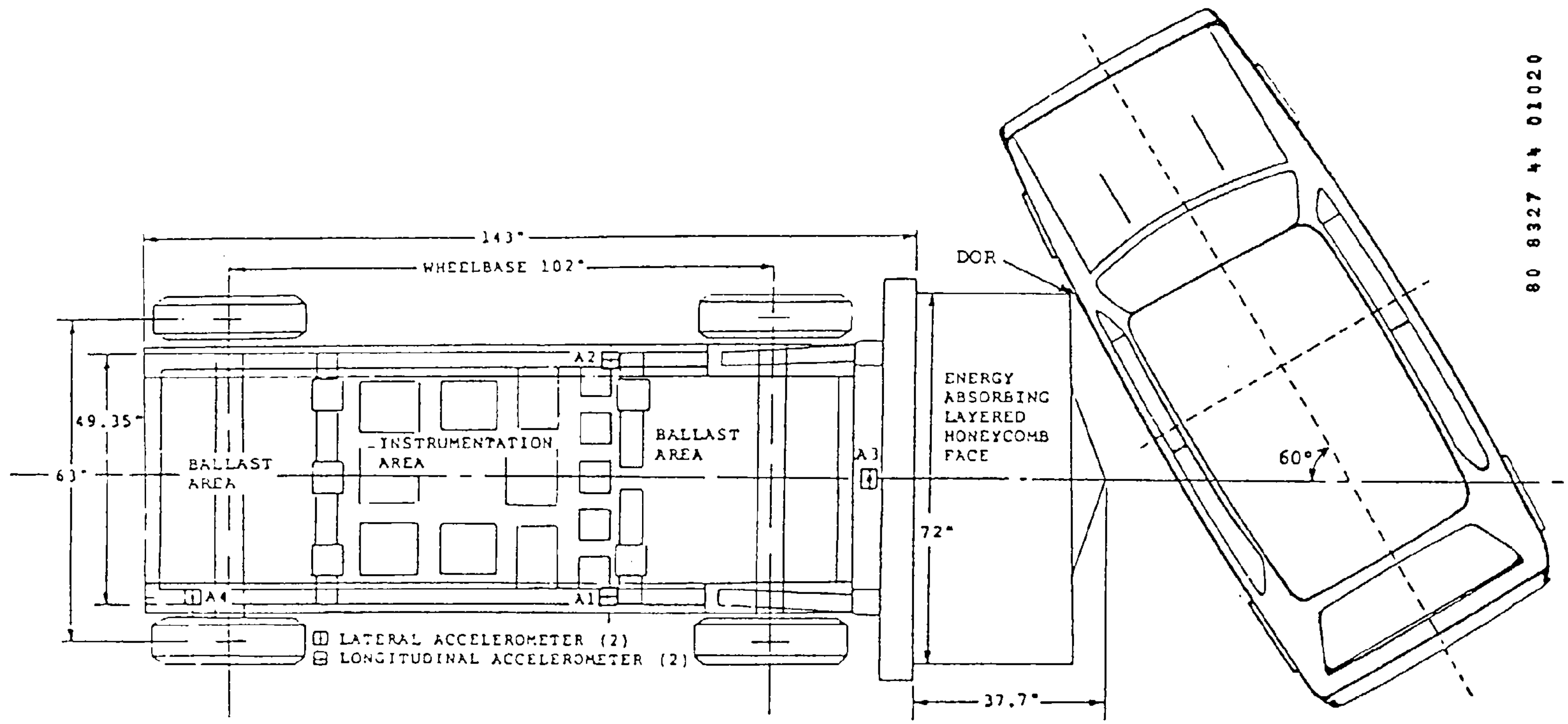

FIGURE 1-1. SIDE IMPACTOR-TO-VW RABBIT AT 60 DEGREES (TEST 8327-4.1).

2.0 PRESENTATION OF RESULTS - TESTS 8327-4.1 AND 8330-2

This section of the report presents the results of Test 8327-4.1, a 60-degree side impact crash test between the NHTSA Side Impactor (bullet vehicle) and a modified 1976 VW Rabbit two-door hatchback (target vehicle), and Test 8330-2, a 60-degree side impact crash test between a 1979 Oldsmobile Cutlass (bullet vehicle) and a modified 1977 VW Rabbit two-door hatchback (target vehicle). In both tests the bullet vehicle was traveling at 30 mph, and the target vehicle at 15 mph, with impact on the left side of the target vehicle.

Included in this document are: still photographs, vehicle damage sketches and tabulated pre- and post-test dimensions, summaries of electronic data, and summaries of the simulated occupant data, including injury criteria values. High-speed motion pictures were also obtained for this test and have been submitted to the CTM.

Appendices A, B, and C contain plots of all electronic data for Test 8327-4.1 in comparison with data for 8330-2. Appendix A contains bullet vehicle data, Appendix B contains target vehicle data, and Appendix C contains the side impact dummy data.

TABLE 2-1A. RECEIVING INSPECTION OF VEHICLES (TEST 8327-4.1)

Contractor: Dynamic Science, Inc. Contract No.: DOT-HS-8-01933

VIN NO.: 1763096704 Make: Volkswagen

NHTSA No.: None

Year: 1976 Color: Blue Model: Rabbit 2-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: 185/70SR-13 Ply Rating: 4 Mfg. & Line: Michelin X

Bias Ply: ____ Belted: ____ Radial X /Eng. Type: ____ Cylinders: 4 Total Displ: 97.2 CID

Trans, # Fwd. Speeds: 4 Shipping Weight: ____ Odometer: 43,614

Dealer (name, address, and phone number)

Budd Body Company
300 Commerce Street
Ft. Washington, PA

Remarks (list additional accessories not listed above)

Date of Manufacture: unknown Dynamic Science No.: 1013 Date Received: 1-9-80

Tilting Steering Wheel: yes ☐ no ☒ Telescoping Steering Wheel: yes ☐ no ☒

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

Restraint System: automatic shoulder belt and knee bolster

1. Is the vehicle stock throughout? Describe: No. This vehicle has received the heavy side structure modification by the Budd Company.

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.

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TABLE 2-1B. RECEIVING INSPECTION OF VEHICLES (TEST 8330-2).

Contractor: Dynamic Science, Inc. Contract No.: DOT-HS-9-02177

VIN NO.: 1773307293 Make: Volkswagen

NHTSA No.: None

Year: 1977 Color: White Model: Rabbit 2-Door

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

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

Bias Ply: ____ Belted: ____ Radial X /Eng. Type: ____ Cylinders: 4 Total Displ: 97.2 CID

Trans, # Fwd. Speeds: 3 Shipping Weight: ____ Odometer: 24,013

Dealer (name, address, and phone number)

Budd Body Company
300 Commerce Street
Ft. Washington, PA

Remarks (list additional accessories not listed above)

Date of Manufacture: unknown Dynamic Science No.: 972 Date Received: 10-1-79

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

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

Restraint System: automatic shoulder belt and knee bolster

1. Is the vehicle stock throughout? Describe: No. This vehicle has received the heavy side structure modification by the Budd Company.

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.

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TABLE 2-1C. RECEIVING INSPECTION OF VEHICLES (TEST 8330-2).

Contractor: Dynamic Science, Inc. Contract No.: DOT-HS-9-02177

VIN NO.: 3J09F9R466522 Make: Oldsmobile

NHTSA No.: None

Year: 1979 Color: Maroon Model: Cutlass Salon 4-Door

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

Tire Size: PAS/75R-14 Ply Rating: 4 Mfg. & Line: Goodyear Polysteel

Bias Ply: ____ Belted: X Steel Radial X /Eng. Type: V Cylinders: 8 Total Displ: 4.3L

Trans, # Fwd. Speeds: ____ Shipping Weight: ____ Odometer: 727.7

Dealer (name, address, and phone number)
Holiday Oldsmobile
3530 North Scottsdale Road 602-949-7600
Scottsdale, AZ

Remarks (list additional accessories not listed above)

Date of Manufacture: 03-79 Dynamic Science No.: 988 Date Received: 10-9-79

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

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

Restraint System: Standard 3 point system

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: Good - no damage.

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TABLE 2-2. CRASH TEST SUMMARY FOR TARGET VEHICLES

TEST CONFIGURATION: 60-degree Two Vehicle Moving Front-to-Side Impact

TEST 8321-4.1: Test Date: 2/11/80; Time: 1558; Temp.: 66° F

TEST 8330-2: Test Date: 10/25/79; Time: 1547; Temp.: 90° F

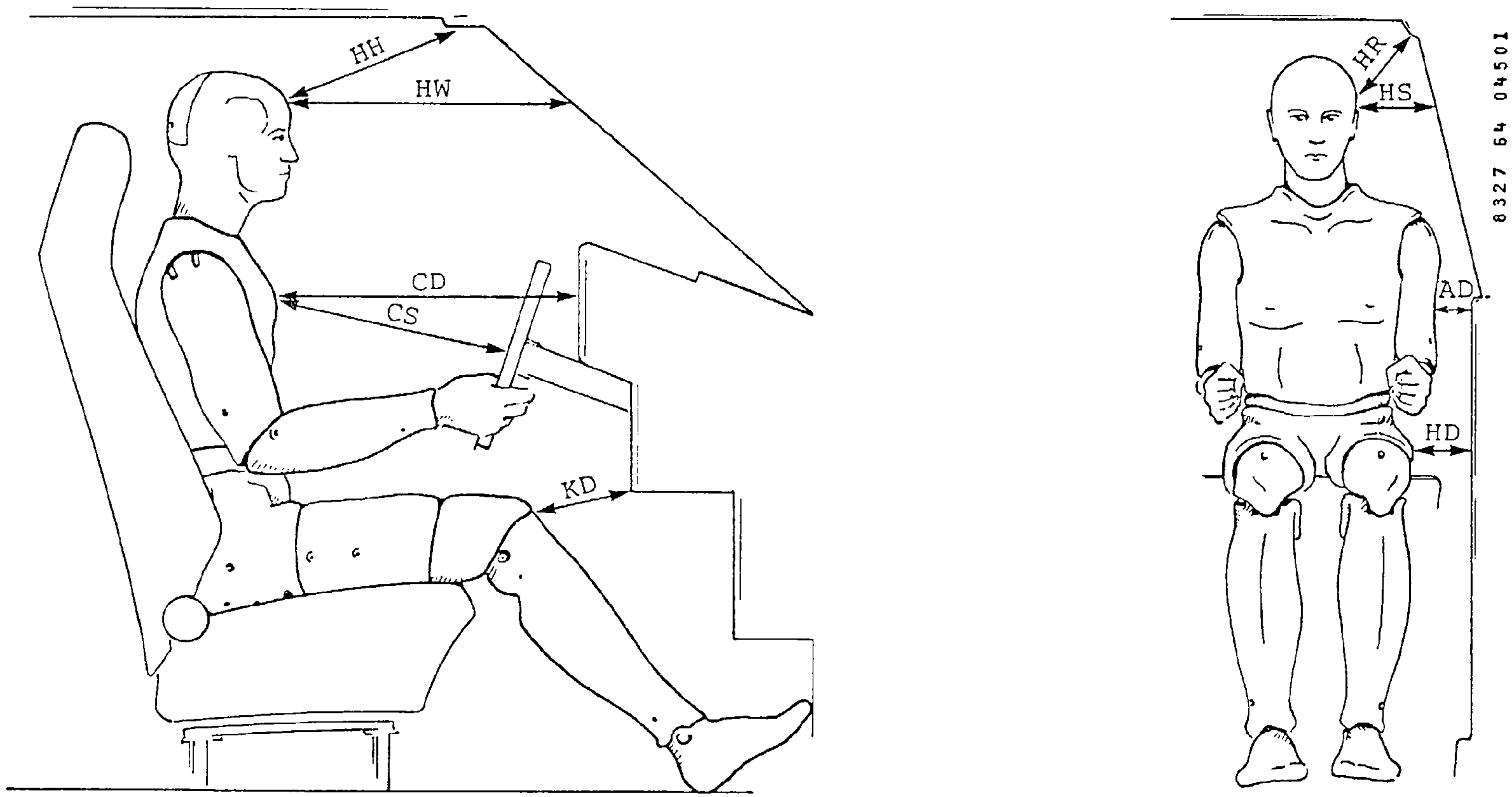
VEHICLE DATA	TEST 8327-4.1	TEST 8330-2
Test Vehicle	1976 Modified VW Rabbit	1977 Modified VW Rabbit
Overall Length/Width (in.)	154.5/63.4	154.5/63.4
Test Weight by Wheel (lb)	LF 755 RF 759 LR 485 RR 503	LF 770 RF 742 LR 492 RR 482
Total Weight (lb)	2502	2486
Wheelbase (in.)	94.6	94.6
Longitudinal C.G. (from Center of Front Axle) (in.)	37.4	37.1
Impact Angle (deg)*	60	60
Impact Speed (mph)	15.5	15.2
Maximum C.G. Resultant Velocity Change (mph @ msec)	5.1 @ 89	5.2 @ 250
Maximum C.G. Resultant Acceleration (G @ msec)	19.3 @ 36	15.4 @ 49
Maximum Door Acceleration (G @ msec)**	238.4 @ 37	347.6 @ 40
Maximum Exterior Static Crush (in.)		
• Door Handle Level (32.0")	12.9	14.9
• Upper Mid-door Level (26.0")	12.3	13.9
• Lower Mid-door Level (20.0")	11.2	13.6
• Doorsill Level (12.8")	5.6	4.7
Maximum Post-test Intrusion (in.)	12.0	11.6
OCCUPANTS		
Type	Humanoid Lateral Impact	Humanoid Lateral Impact
Location	Driver	Driver
Restraints	Unrestrained	Unrestrained
INSTRUMENTATION		
Number of Data Channels	41	41
Number of Cameras	9	9

*With respect to main tow track centerline.
**At location 8 for Test 8327-4.1, location 9 for Test 8330-2.

TABLE 2-3. CRASH TEST SUMMARY FOR BULLET VEHICLES

VEHICLE DATA	TEST 8327-4.1	TEST 8330-2
Test Vehicle	NHTSA Side Impactor(Phase I)	1979 Oldsmobile Cutlass
Overall Length/Width (in.)	180.7/78.3	198.2/71.9
Test Weight by Wheel (lb)	LF 978 RF 916 LR 798 RR 946	LF 1052 RF 1010 LR 800 RR 769
Total Weight (lb)	3638	3631
Wheelbase (in.)	102.0	108.8
Longitudinal C.G. (from Center of Front Axle) (in.)	48.9	47.0
Impact Angle (deg)*	0	0
Impact Speed (mph)	30.3	29.7
Maximum C.G. Resultant Velocity Change (mph @ msec)	11.4 @ 126	11.0 @ 186
Maximum C.G. Average Resultant Compartment Acceleration (G @ msec)	7.9 @ 63	12.3 @ 72
Maximum Static Crush (in.)		
• Row C (Hood)	9.3	3.5
• Row B (Between Bumper/Hood)	8.8	5.1
• Row A (Bumper)	11.6	10.5
OCCUPANTS		
Type	N/A	N/A
Location	N/A	N/A
Restraints	N/A	N/A
INSTRUMENTATION		
Number of Data Channels	7	14
Number of Cameras	9	9

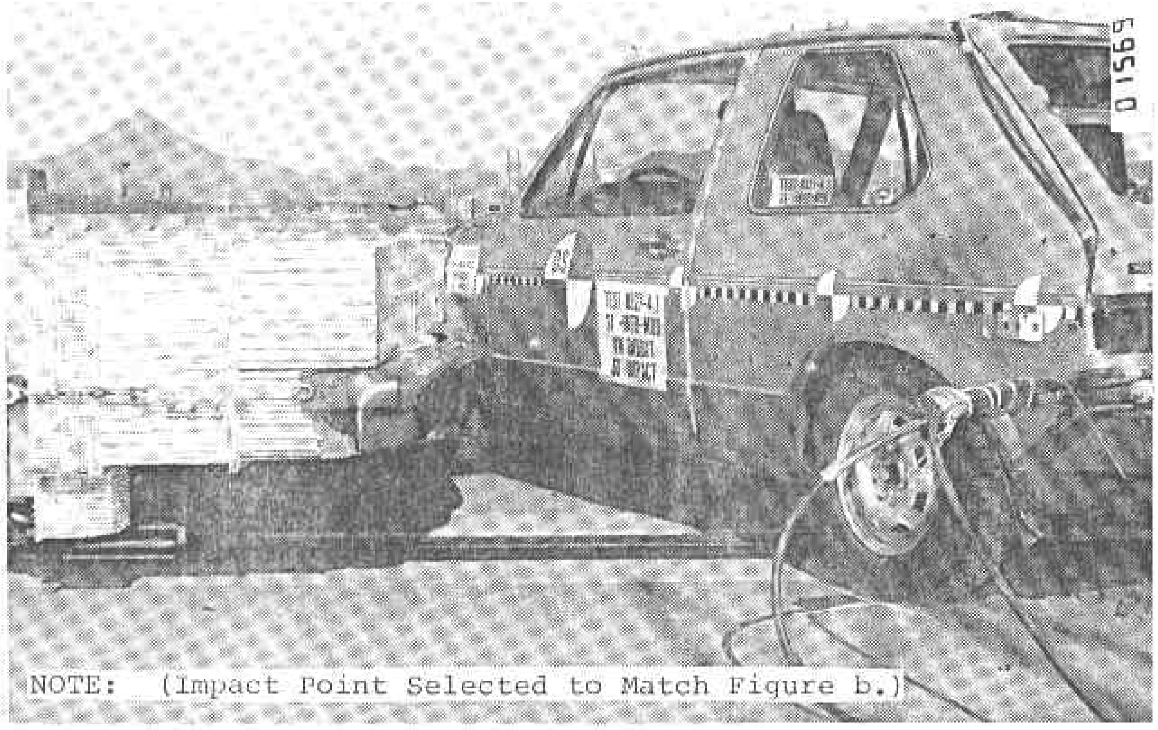
*With respect to tow track centerline.
N/A - Not Applicable.



	TEST 8327-4.1 (IN.)	TEST 8330-2 (IN.)
HH =	16.0	15.0
HW =	21.0	20.5
CD =	18.6	19.0
CS =	11.0	10.4
KD =	1.9/1.9	1.1/2.5

	TEST 8327-4.1 (IN.)	TEST 8330-2 (IN.)
HR =	8.1	5.3
HS =	8.1	7.7
AD =	5.9	5.7
HD =	6.6	6.1

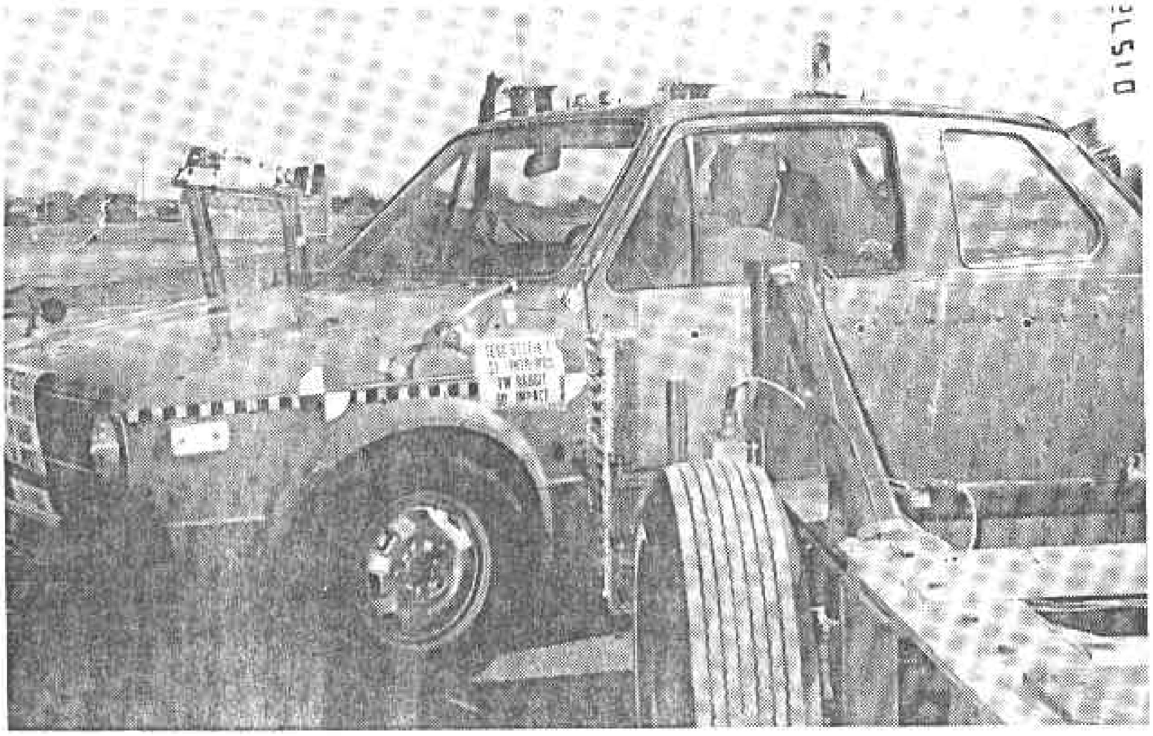
FIGURE 2-1. DRIVER PRE-TEST POSITION (TESTS 8327-4.1 AND 8330-2).


NOTE: (Impact Point Selected to Match Figure b.)

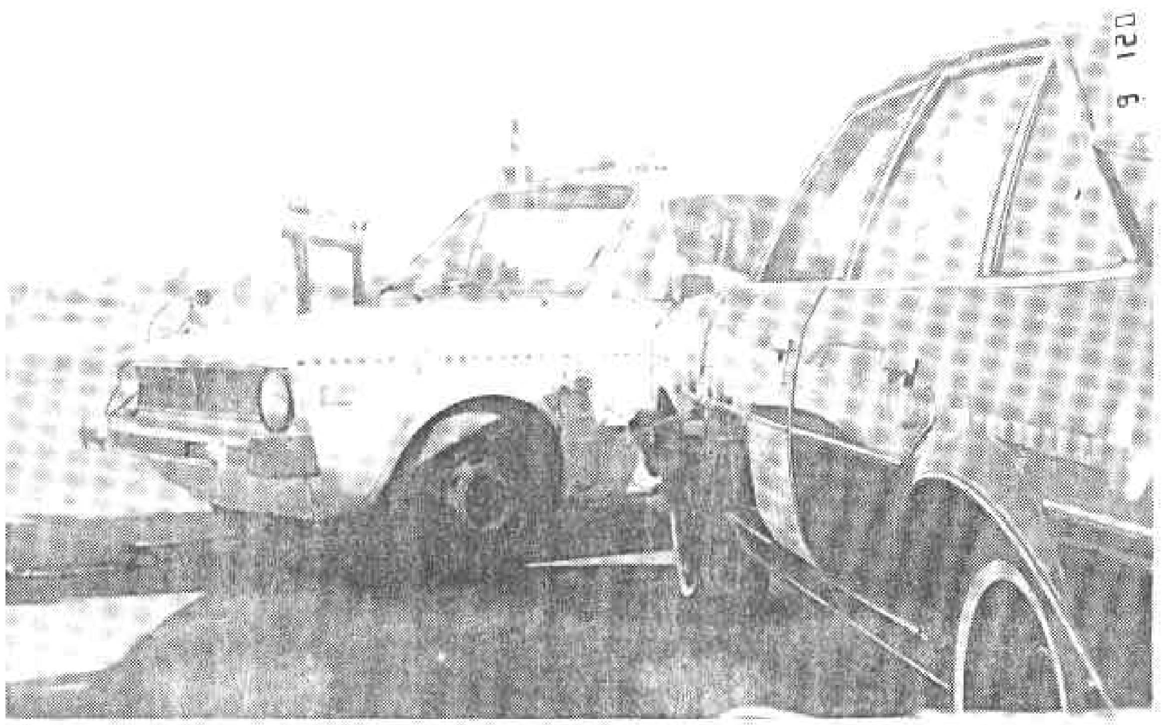
a) Test 8327-4.1


b) Test 8330-2

FIGURE 2-2. PRE-TEST VEHICLE CONFIGURATION.

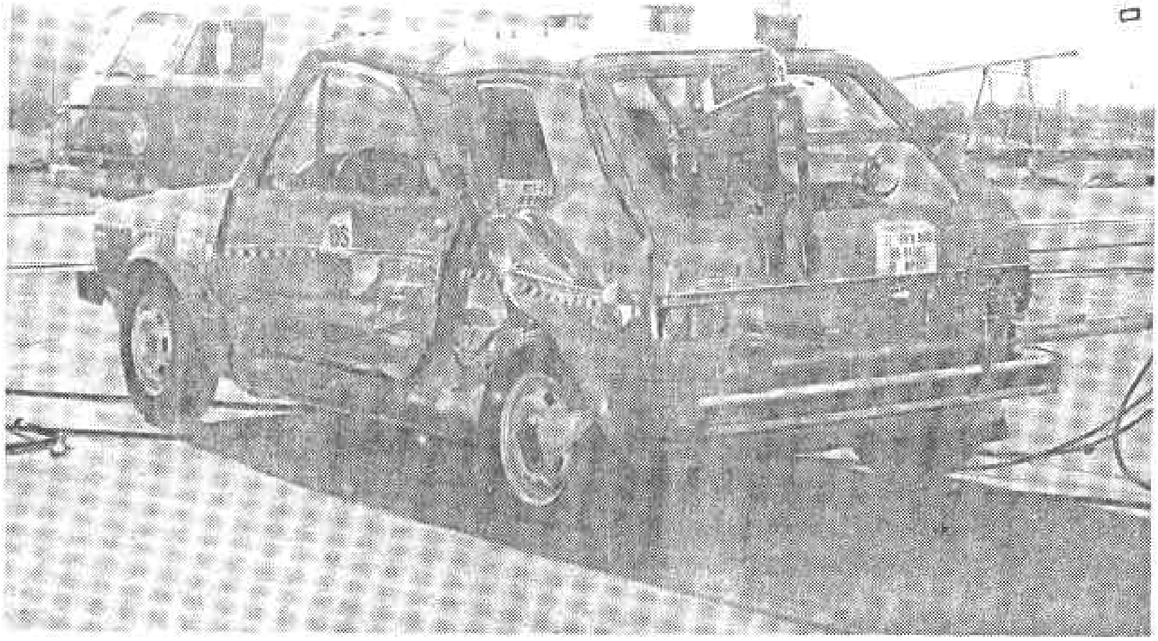


a) Test 8327-4.1



b) Test 8330-2

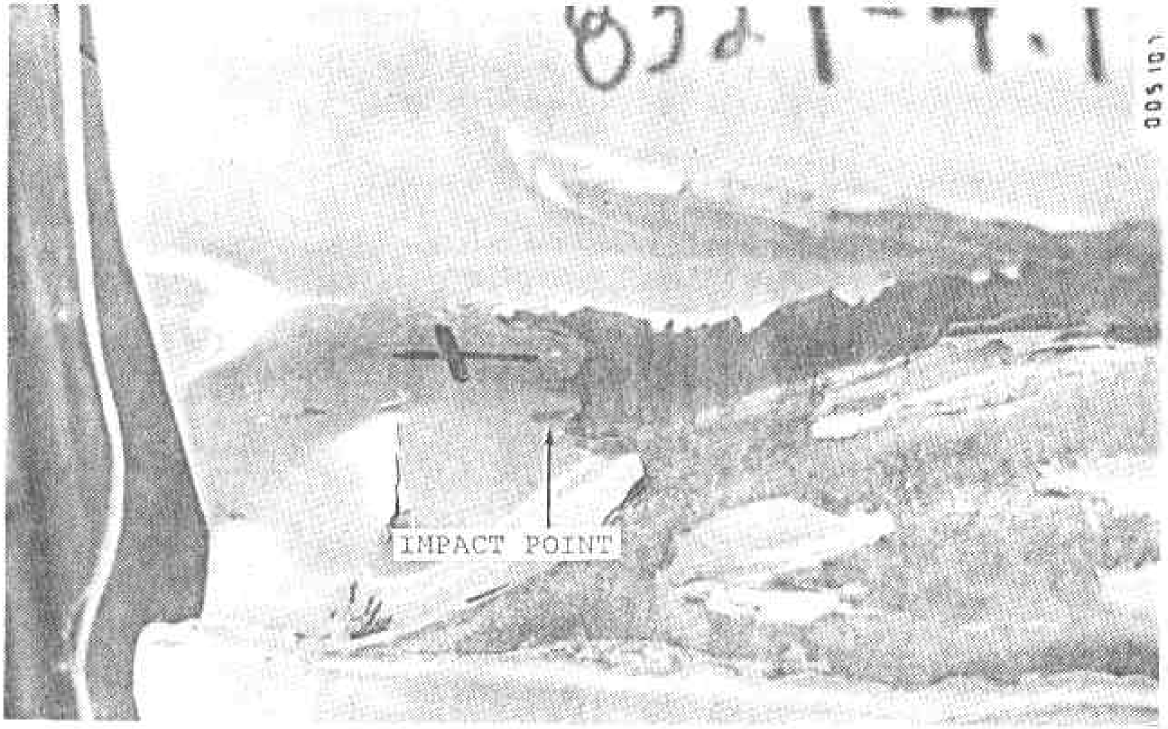
FIGURE 2-3. PRE-TEST VEHICLE CONFIGURATION.



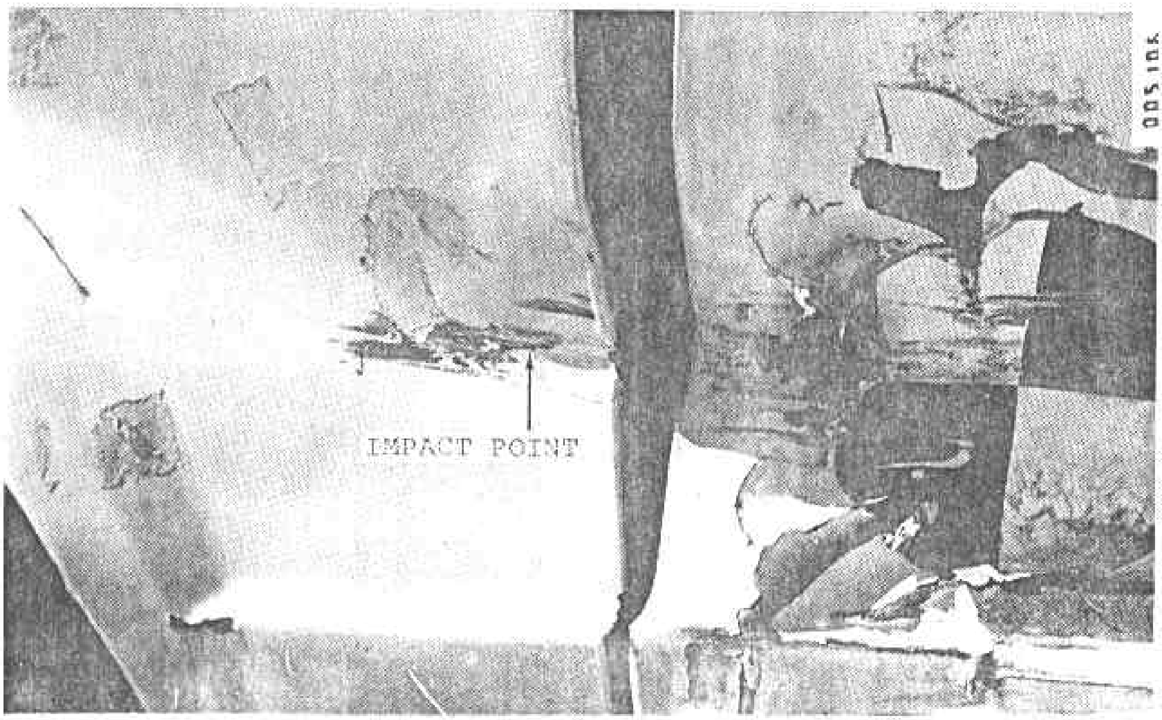
a) Test 8327-4.1

b) Test 8330-2

FIGURE 2-6. POST-TEST VW RABBIT REAR THREE-QUARTER VIEW.

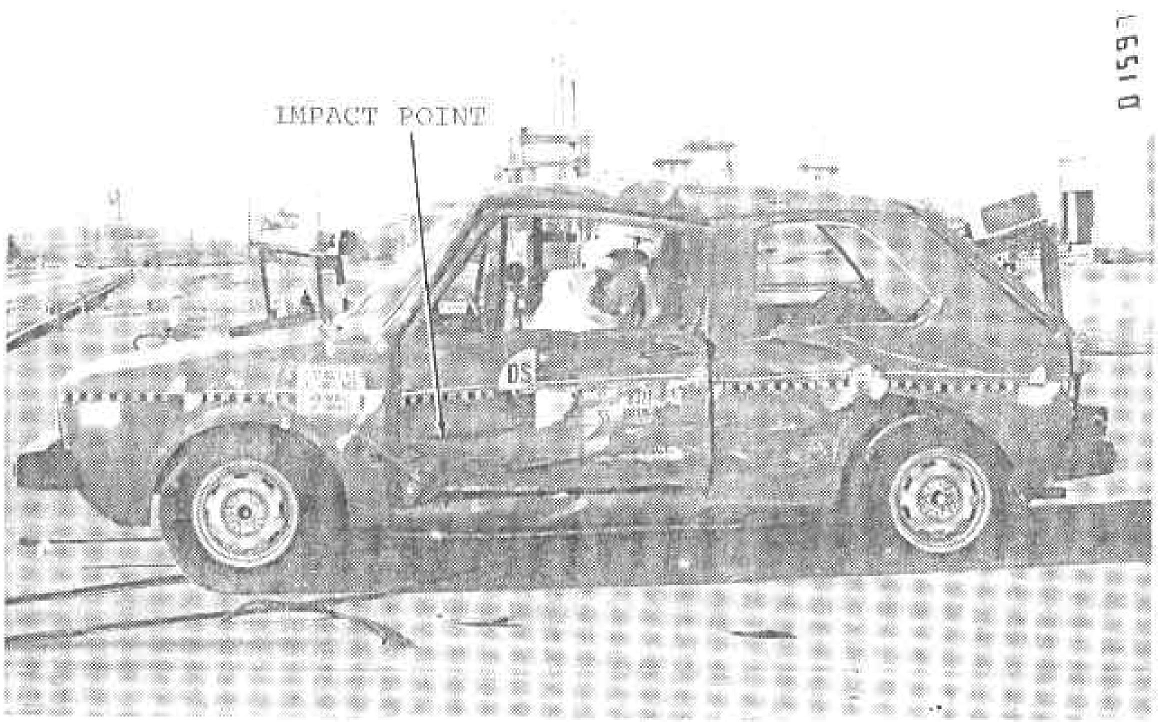


a) Test 8327-4.1

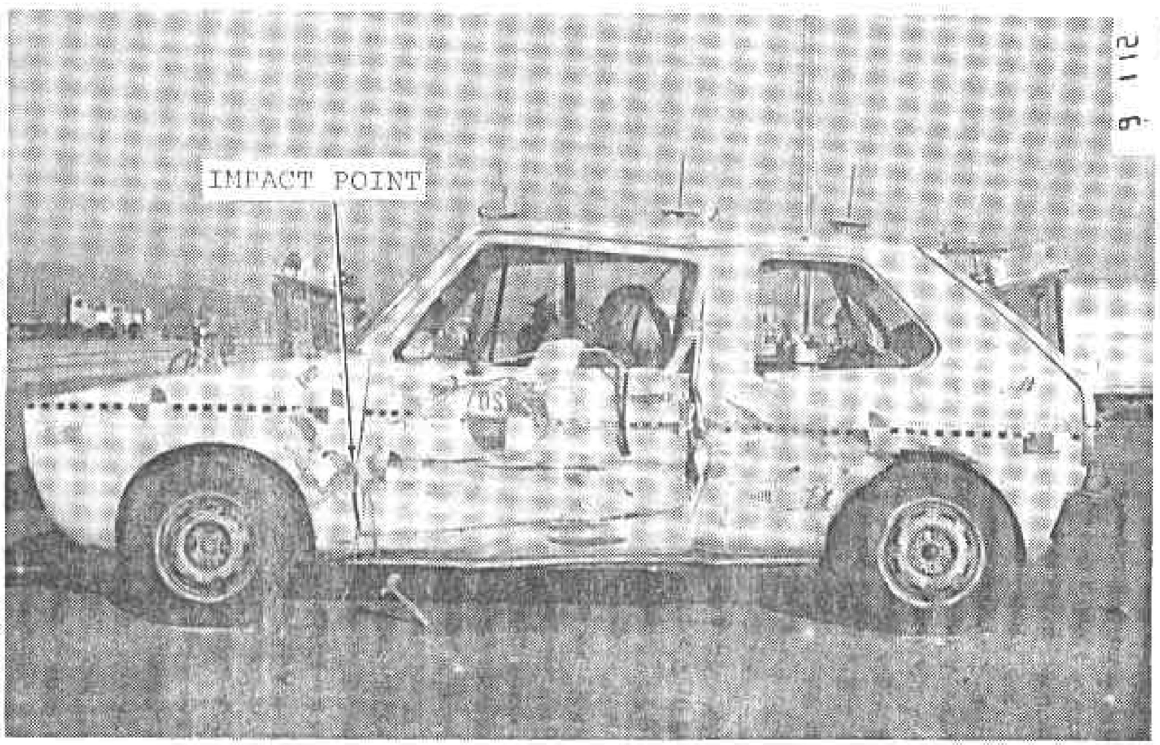


b) Test 8330-2

FIGURE 2-5. CLOSEUP OF RABBIT SIDE SHOWING IMPACT POINT (TESTS 8327-4.1 AND 8330-2).

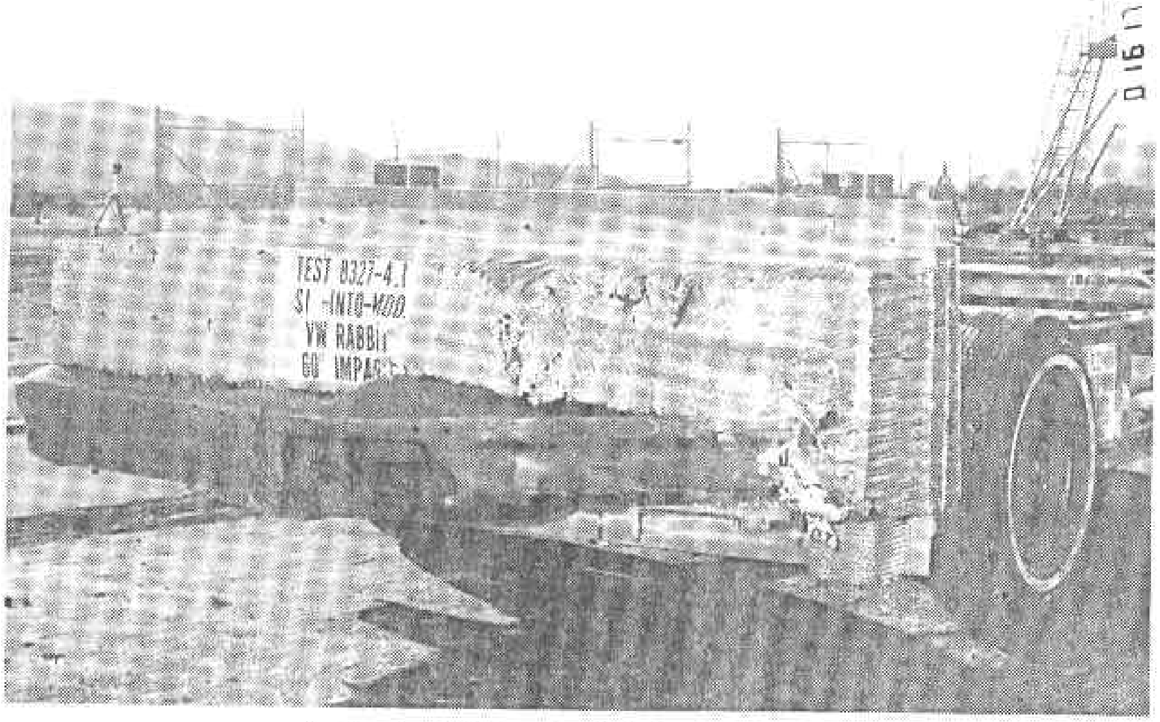


a) Test 8327-4.1

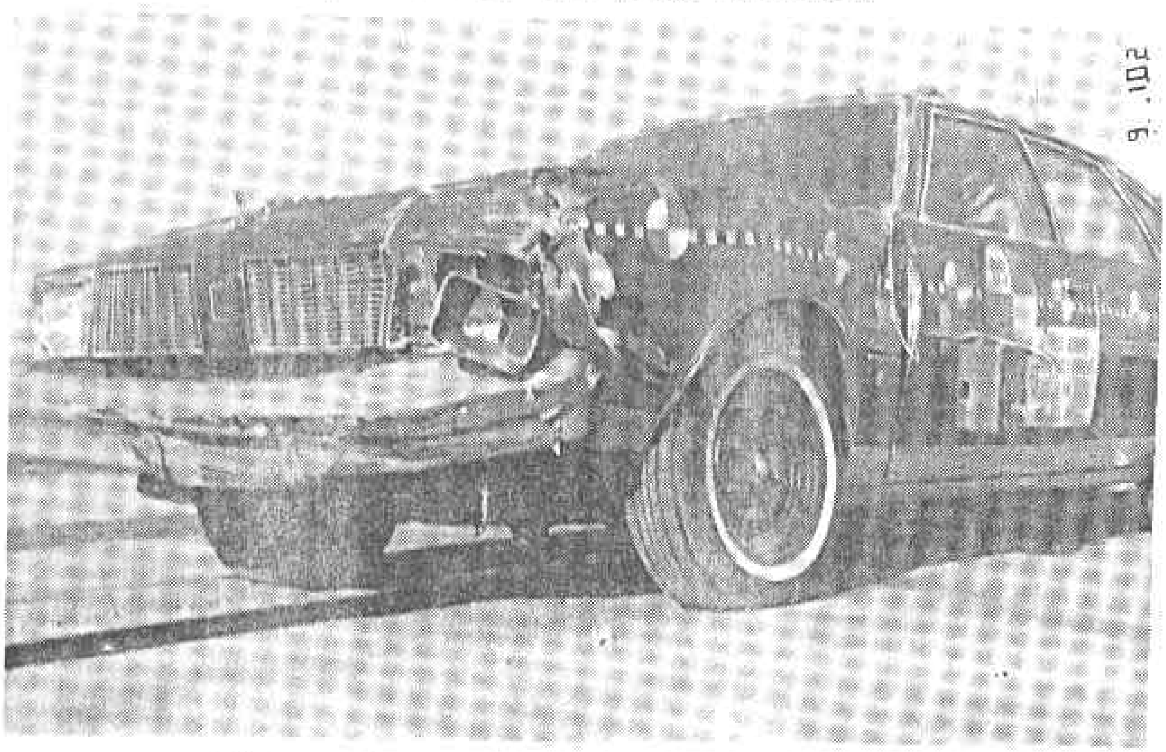


b) Test 8330-2

FIGURE 2-4. POST-TEST VW RABBIT LEFT SIDE VIEW.



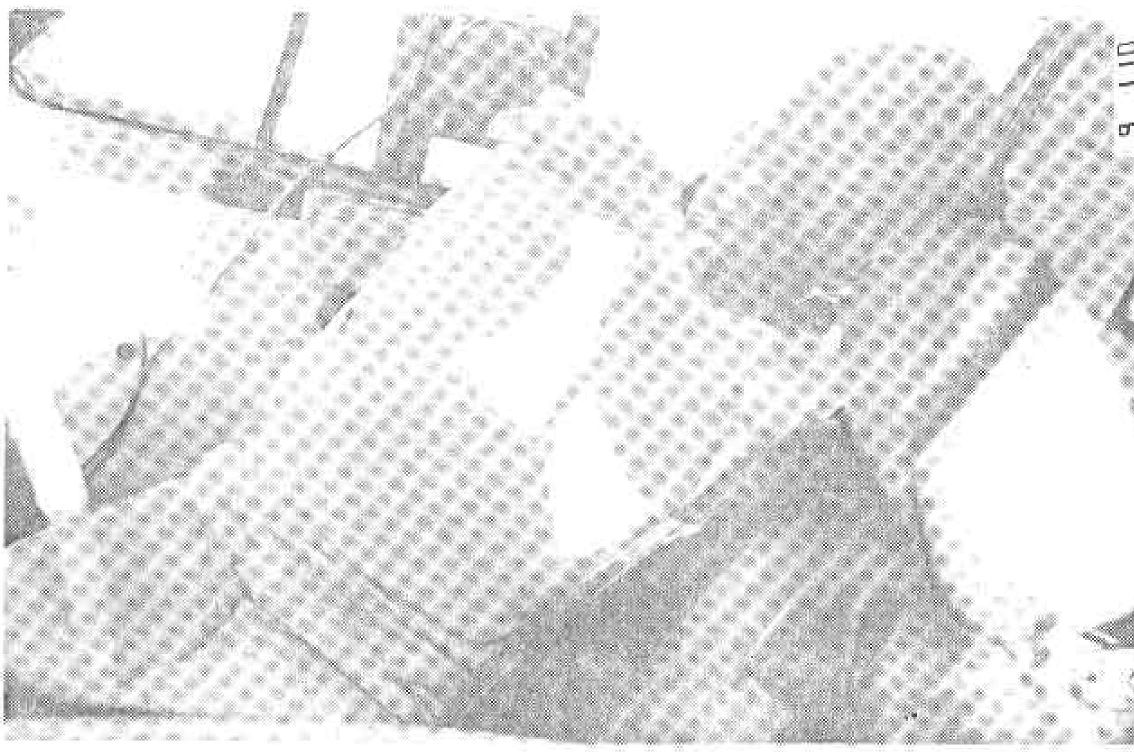
a) Test 8327-4.1 (Side Impactor)



b) Test 8330-2 (1979 Oldsmobile Cutlass)

FIGURE 2-7. POST-TEST BULLET VEHICLE FRONT THREE-QUARTER VIEW.

a) Test 8327-4.1



b) Test 8330-2

FIGURE 2-8. POST-TEST DUMMY POSITION.

TABLE 2-4A. SUMMARY OF POST-TEST OBSERVATIONS (TEST 8327-4.1)

VEHICLE: 1976 Modified VW Rabbit

Dummy Contact Points:	Left Front	Right Front
Head	None	
Shoulder	Upper door panel	
Hip	Arm rest	

Glazing: Left front side window shattered. Plastic left rear side window fell out of molding. Windshield cracked along left side, but 95% retained.

Doors: Left door would not open. Door latch failed, but door still in molding. Right door opened easily.

Seat Anchorages and Restraints: Left seat buckled in center and and pushed forward 25 inches. Seat and floor pan pushed laterally as far as right seat. Dummy unrestrained.

Fuel Leakage: None

General Observations: Rabbit was impacted 101.4 inches from rear bumper, four inches rearward of target impact point. Rabbit string potentiometer string broke. String potentiometers 1 and 3 (on Side Impactor) strings caught in honeycomb. Abort brakes on Side Impactor applied 85 feet from impact point. Rabbit left rear wheel bent, and tire flat.

TABLE 2-4B. SUMMARY OF POST-TEST OBSERVATIONS (TEST 8330-2)

VEHICLE: 1977 Modified VW Rabbit

Dummy Contact Points:	Left Front	Right Front
Head	Cutlass left front hood	
Shoulder	Upper door panel, Cutlass left front hood	
Hip	Arm rest	

Glazing: Left front side window shattered. Plastic left rear side window fell out of molding. Windshield unbroken and intact.

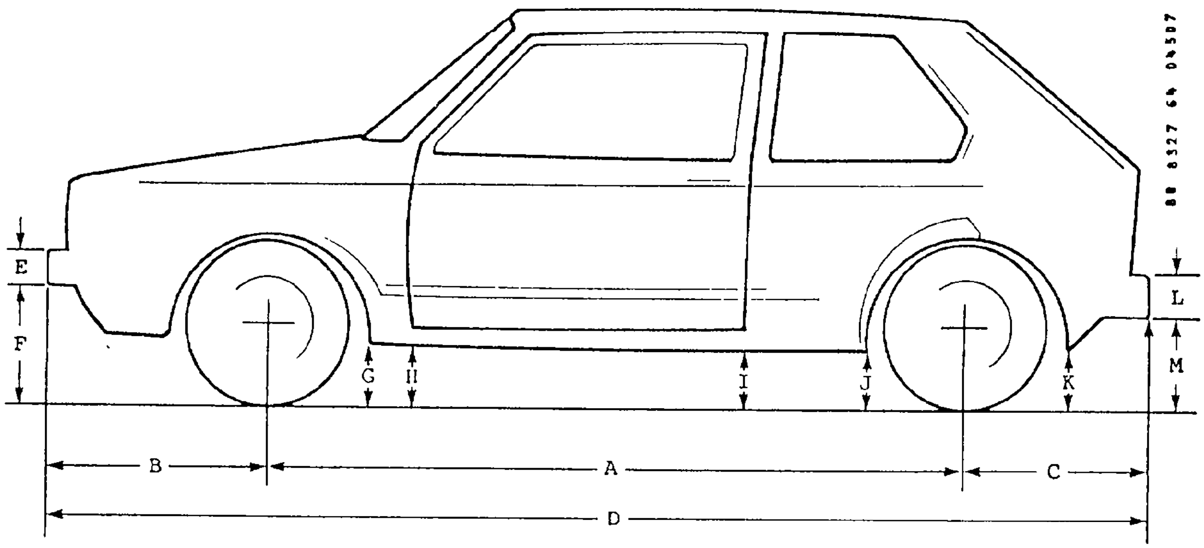
Doors: Left door would not open. Door latch failed, and door slightly pushed out of molding.

Seat Anchorages and Restraints: Dummy unrestrained.

Fuel Leakage: None

General Observations: Rabbit was impacted 105.4 inches from rear bumper. Rabbit left rear wheel bent. String potentiometer 2 (on Cutlass bumper left side) string snapped.

TABLE 2-5. PRE-TEST AND POST-TEST DIMENSION MEASUREMENTS



VEHICLE: 1976/1977 MODIFIED VW RABBIT

	Pre-Test (in.)	Post-Test (in.) Test 8327-4.1	Post-Test (in.) Test 8330-2*
A	94.6	95.0	
B	32.6	32.3	
C	27.3	25.8	
D	154.5	153.0	
E	4.5	4.5	
F	14.1	15.0	
G	7.7	7.9	
H	13.3	11.2	
I	13.9	12.4	
J	9.0	9.5	
K	11.0	9.0	
L	4.5	4.5	
M	15.5	15.1	

*Data not recorded for Test 8330-2.

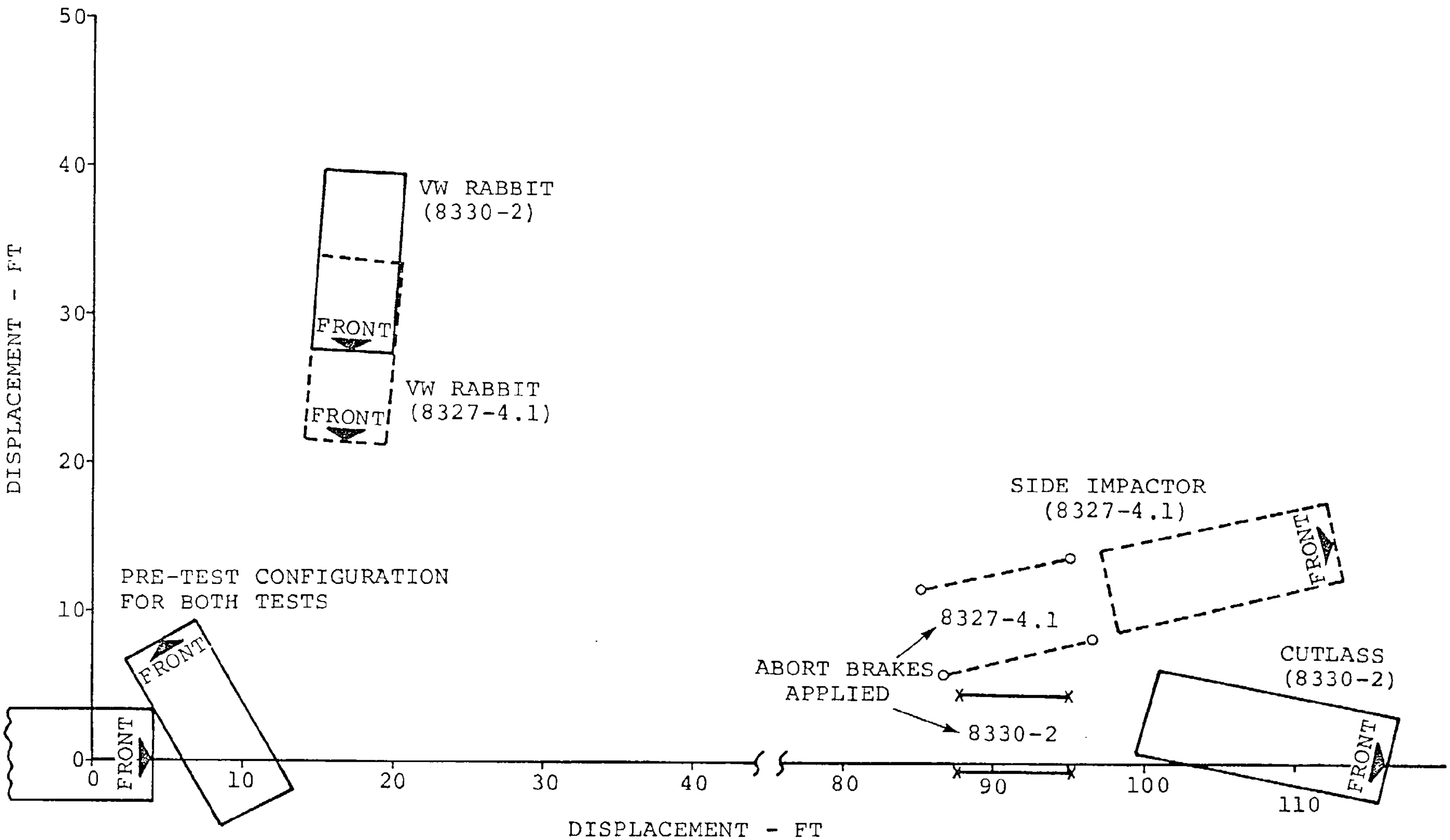
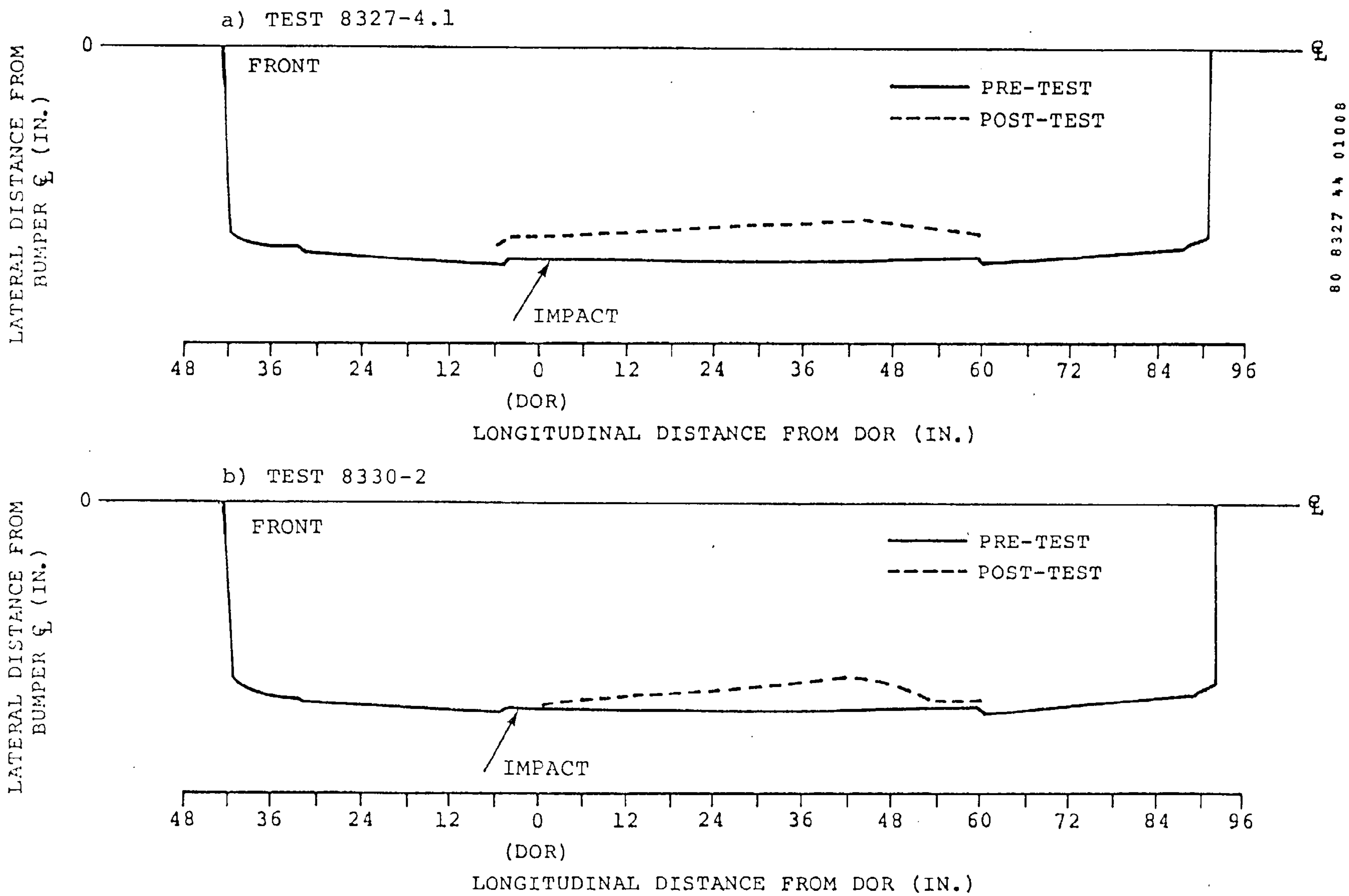


FIGURE 2-9. VEHICLE PRE- AND POST-TEST POSITIONS (TESTS 8327-4.1 AND 8330-2).

TABLE 2-6. EXTERIOR STATIC CRUSH FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2)

	Ht @										Zero Distance Starting at DOR (in.)													
Location	DOR (in.)	42	36	30	24	18	12	6	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
Static Crush - Test 8327-4.1 (in.)																								
Door Handle Level	32.0	-0.9	-0.8	-0.5	-0.3	0.1	0.5	0.8	2.1	5.1	7.2	9.6	10.5	11.3	12.9	11.2	11.9	9.8	6.9	5.4	4.3	2.4	1.3	0.9
Upper Mid-door Level	26.0	0.0	0.0	0.2	0.6	1.4	1.1	1.3	3.6	6.6	8.9	11.0	12.1	12.3	11.5	10.0	11.7	11.1	8.4	4.8	3.7	3.6	1.7	0.9
Lower Mid-door Level	20.0	0.0	0.2	-	-	-	-	1.7	4.9	8.5	10.4	10.9	11.0	11.2	10.4	9.0	10.6	9.6	7.9	-	-	-	-	1.7
Doorsill Level	12.8	-	1.5	-	-	-	-	1.5	2.2	3.7	4.1	4.6	4.7	4.9	5.1	5.6	4.8	4.1	3.4	-	-	-	-	-
Static Crush - Test 8330-2 (in.)																								
Door Handle Level	32.0	0.2	0.2	0.2	0.6	0.4	0.5	0.6	2.0	5.0	8.1	11.1	12.7	13.5	14.9	12.8	9.7	7.5	5.6	3.9	3.2	2.5	1.5	0.4
Upper Mid-door Level	26.0	-0.3	-0.1	0.0	0.5	1.0	0.8	1.3	3.2	5.6	8.3	10.9	12.6	13.5	13.9	13.9	13.0	10.6	6.9	3.7	3.4	2.7	0.6	-0.1
Lower Mid-door Level	20.0	0.2	0.2	-	-	-	-	1.7	2.9	6.1	8.4	10.5	11.9	12.9	13.6	13.5	11.5	9.5	7.2	7.5	-	-	-	-2.4
Doorsill Level	12.8		0.9	-	-	-	-	0.0	0.6	1.2	1.8	2.2	2.8	3.3	4.0	4.7	3.6	0.9	1.0	-	-	-	-	-0.9



80 8327 44 01008

FIGURE 2-10. PRE- AND POST-TEST EXTERIOR PROFILES AT DOORSILL LEVEL (12.8") FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2).

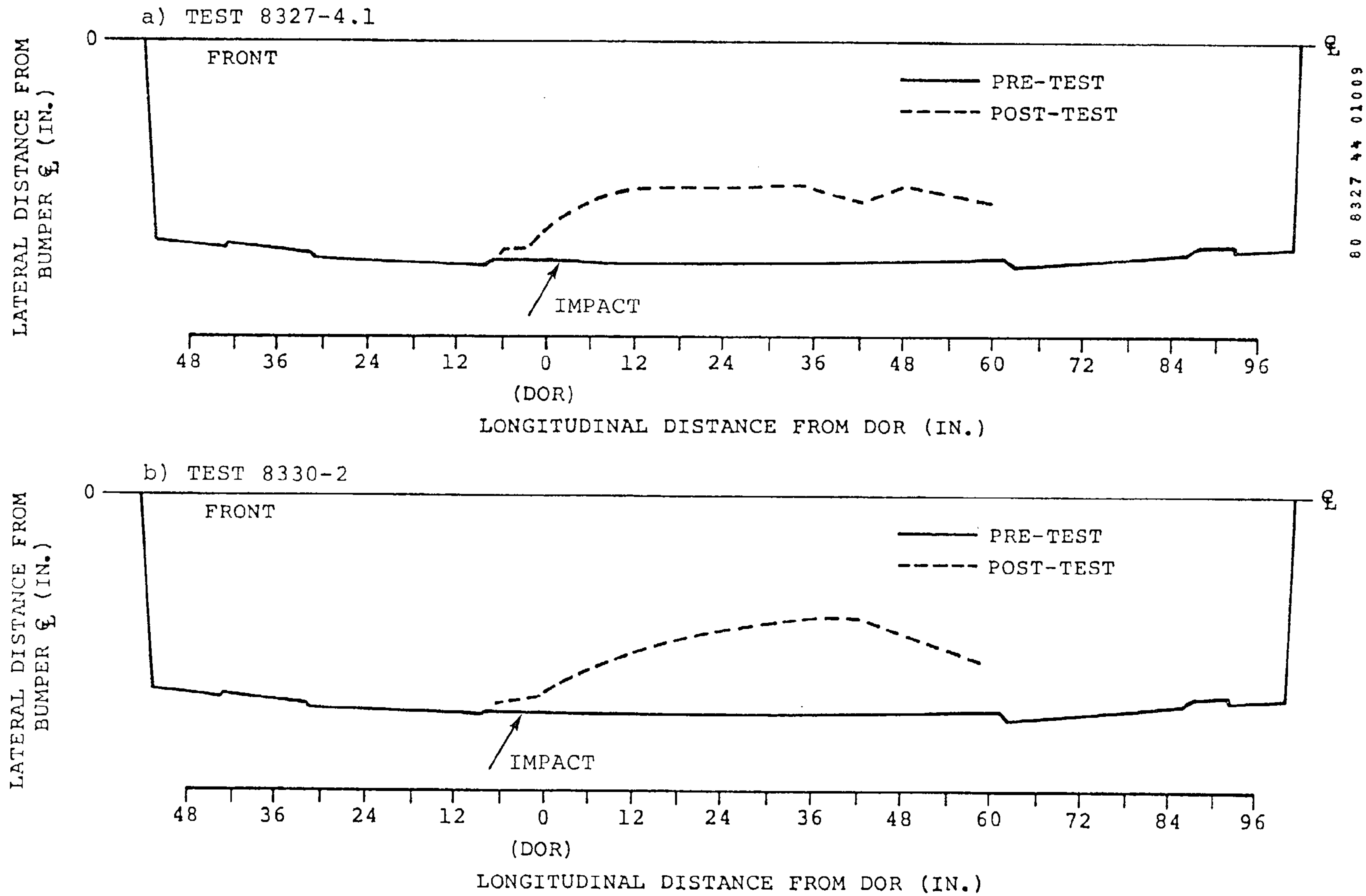


FIGURE 2-11. PRE- AND POST-TEST EXTERIOR PROFILES AT LOWER MID-DOOR LEVEL (20.0") FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2).

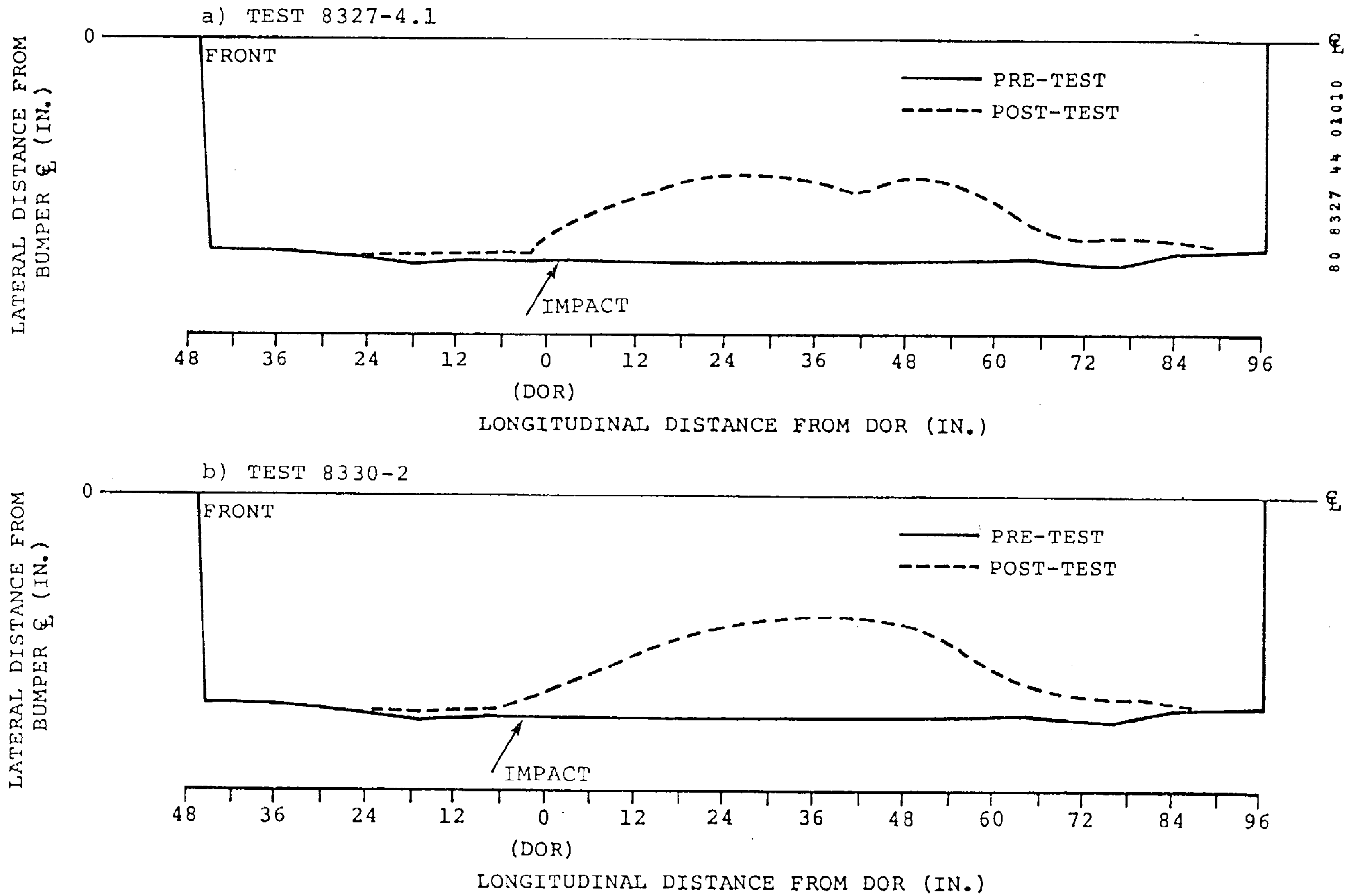


FIGURE 2-12. PRE- AND POST-TEST EXTERIOR PROFILES AT UPPER MID-DOOR LEVEL (26.0") FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2).

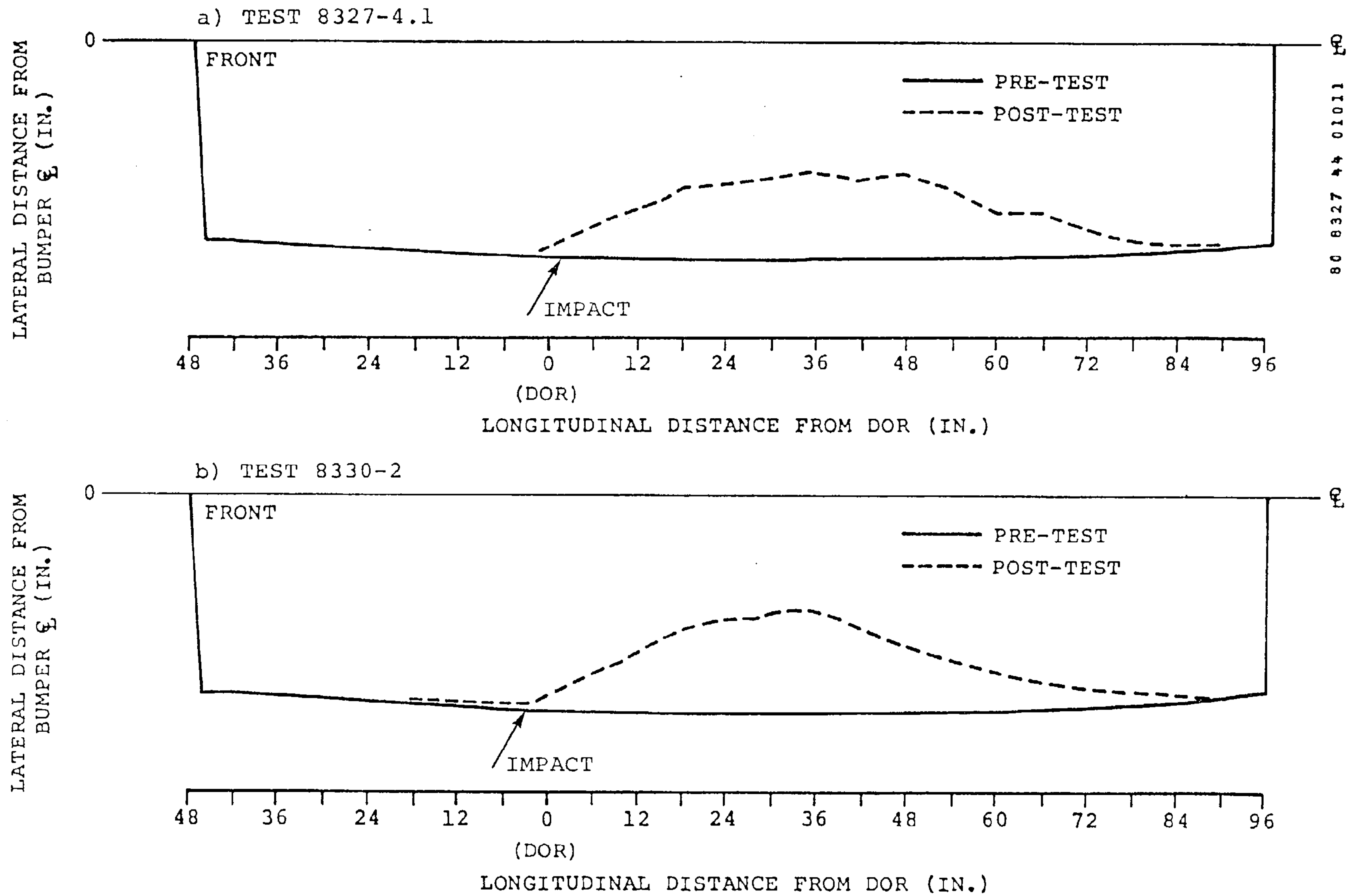


FIGURE 2-13. PRE- AND POST-TEST EXTERIOR PROFILES AT DOOR HANDLE LEVEL (32.0") FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2).

TABLE 2-7. INTERIOR STATIC INTRUSION FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2)

Location	Height @ DOR (in.)	Zero Distances Starting at DOR (in.) 0	6	12	18	24	30	36	42	48	54	60
Static Intrusion - Test 8327-4.1 (in.)												
Door Handle Level	30.0	2.3	5.2	7.2	9.0	9.6	9.5	9.4	12.0	10.0	7.9	6.4
Upper Mid-door Level	21.0	4.3	6.0	7.6	8.5	8.4	7.7	8.4	9.7	7.0	3.5	
Lower Mid-door Level	15.0	4.1	5.5	6.8	7.3	7.1	6.3	6.5	6.2	4.8	1.4	
Doorsill Level	12.8	0.5	0.4	2.5	2.6	3.0	2.6	2.9	3.4			
Static Intrusion - Test 8330-2 (in.)												
Door Handle Level	30.0	(2.3 @ 3 in.)	2.9	5.3	8.1	10.4	10.8	11.3	11.0	9.9	6.8	5.2
Upper Mid-door Level	21.0	-	3.6	6.4	9.0	10.3	10.8	11.5	10.7	8.3	5.6	
Lower Mid-door Level	15.0	1.7	2.9	5.4	7.4	9.1	10.1	10.8	10.5	8.4	5.0	
Doorsill Level	12.8	0.9	1.1	0.9	1.7	3.3	3.1	2.6	2.0			

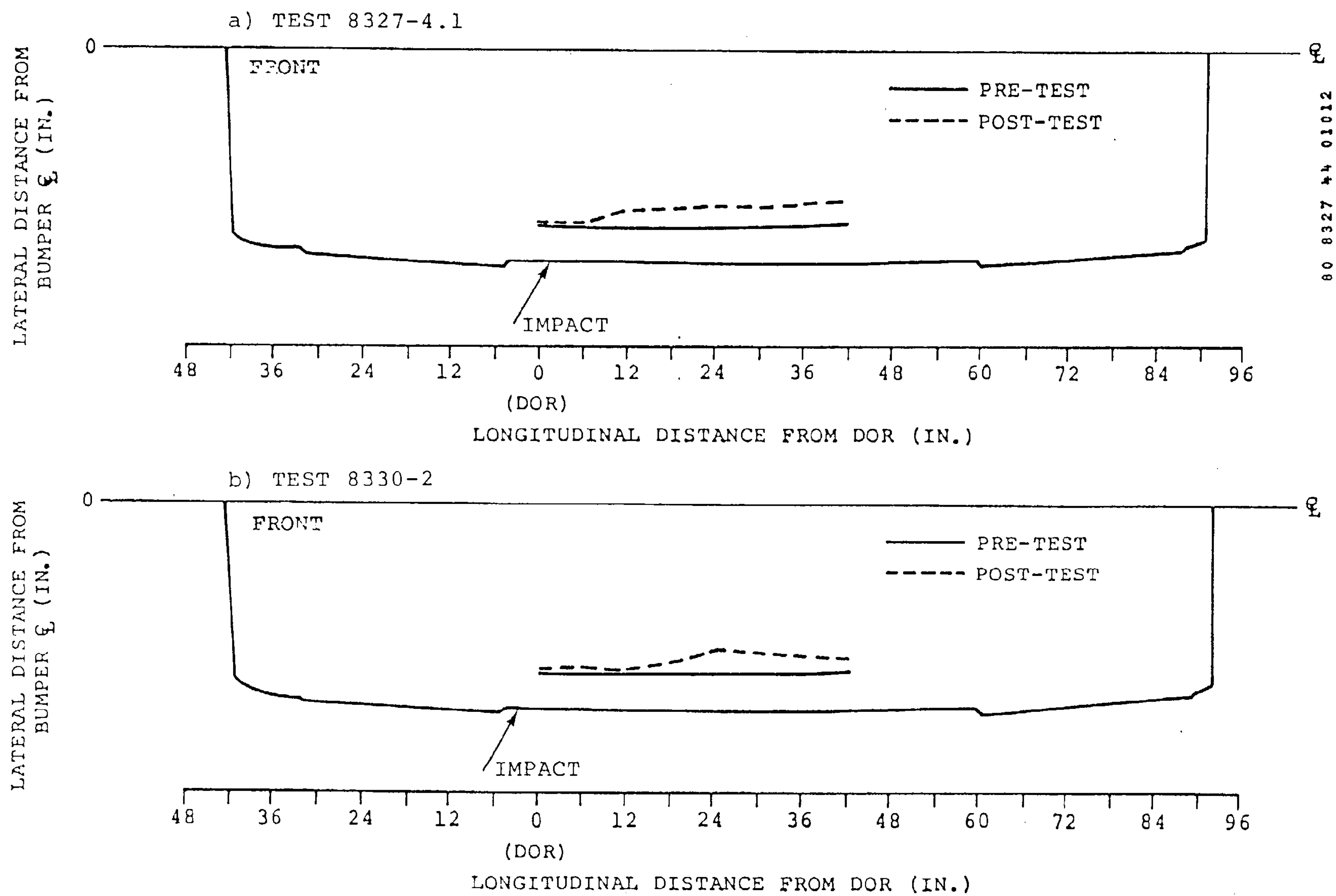


FIGURE 2-14. PRE- AND POST-TEST INTERIOR PROFILES AT DOORSILL LEVEL (12.8") FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2).

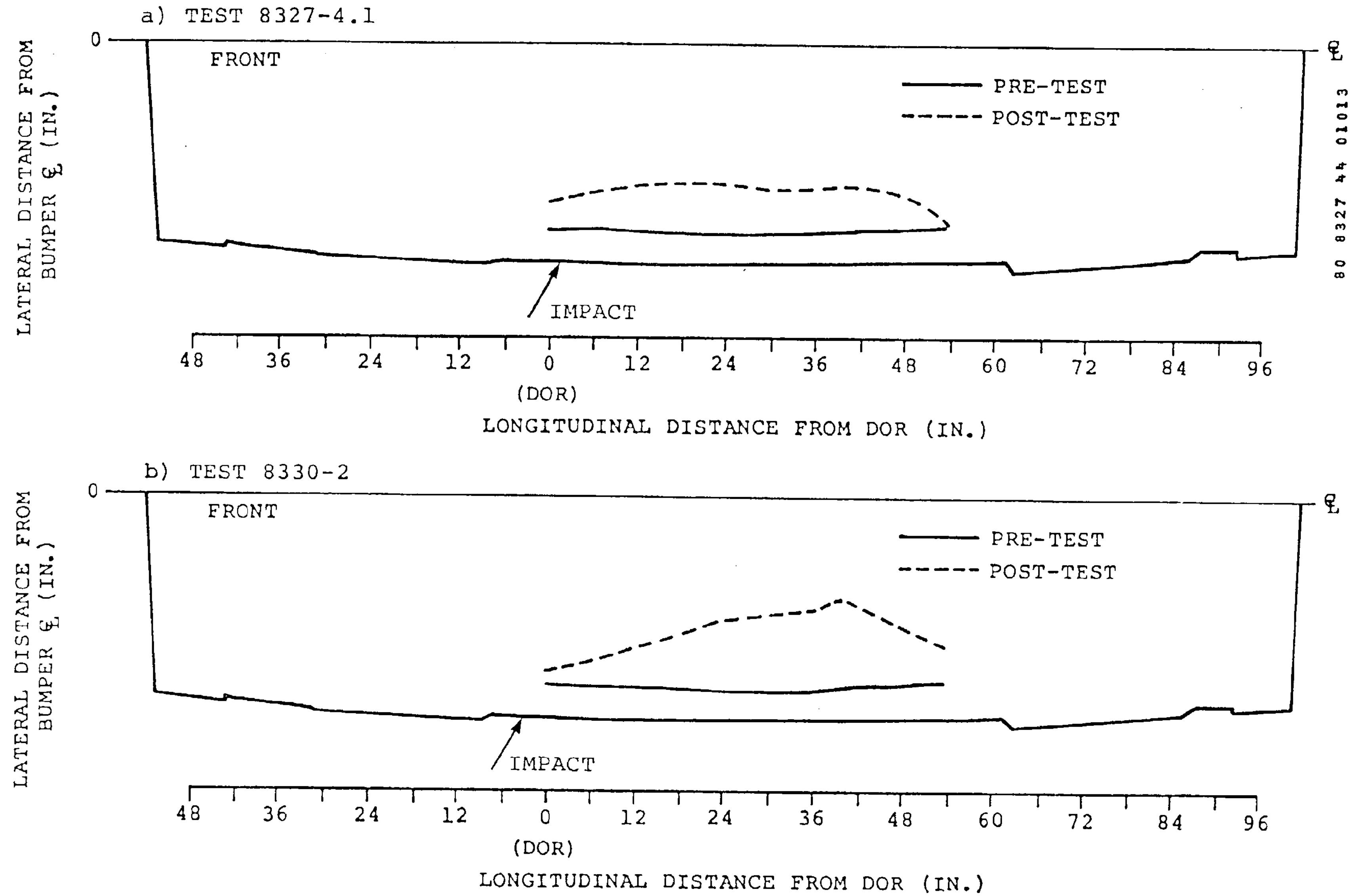


FIGURE 2-15. PRE- AND POST-TEST INTERIOR PROFILES AT LOWER MID-DOOR LEVEL (15.0") FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2).

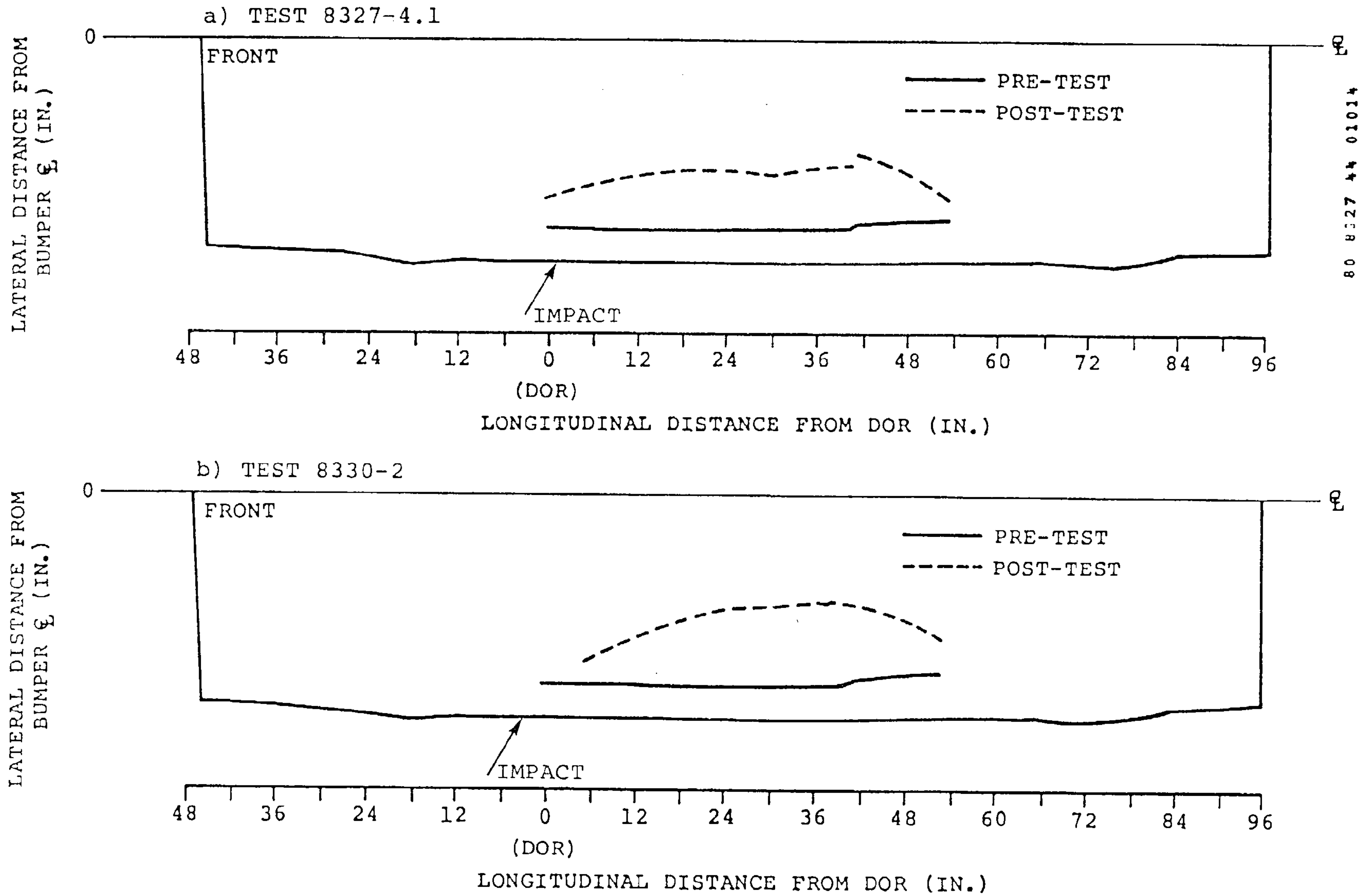


FIGURE 2-16. PRE- AND POST-TEST INTERIOR PROFILES AT UPPER MID-DOOR LEVEL (21.0") FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2).

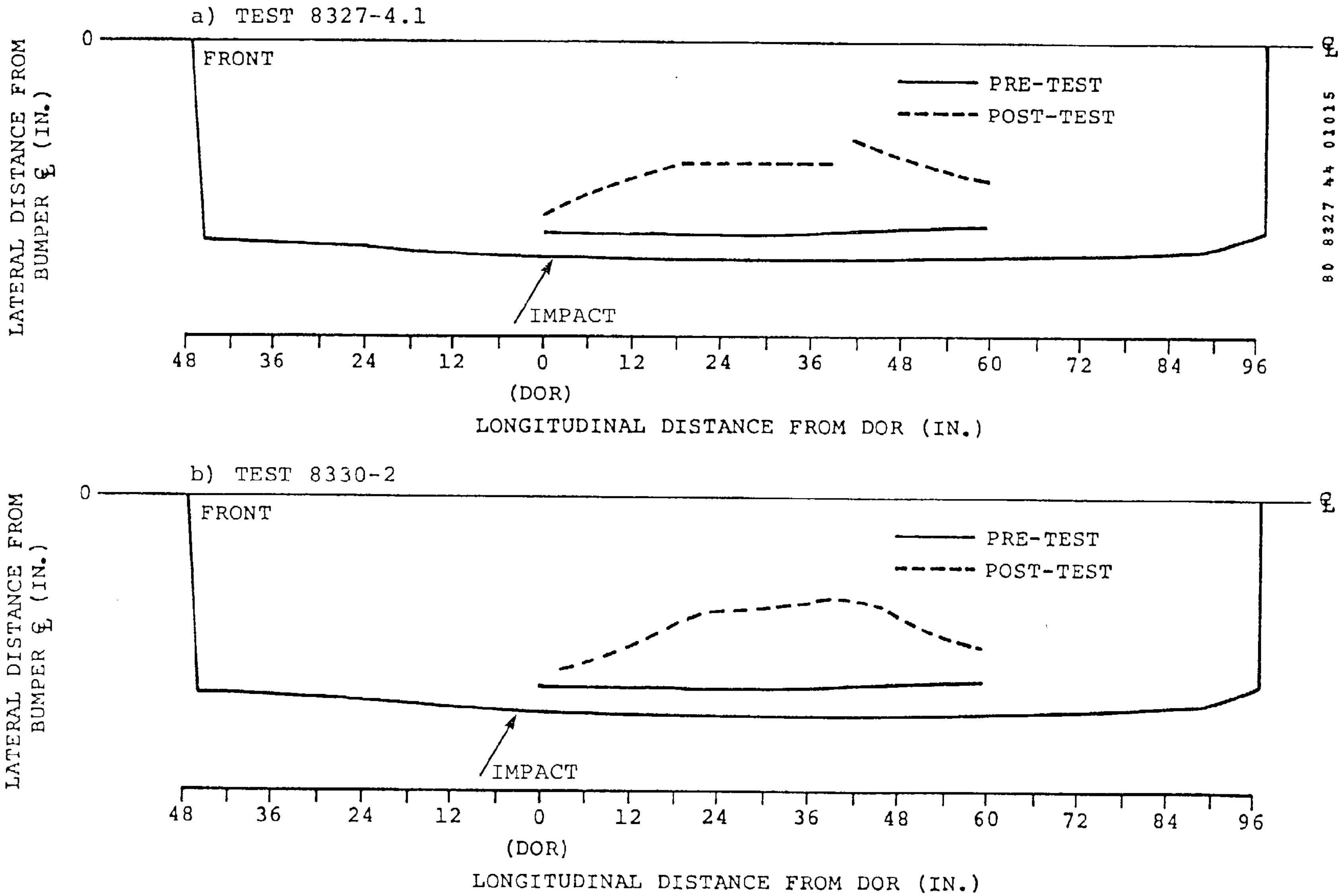


FIGURE 2-17. PRE- AND POST-TEST INTERIOR PROFILES AT DOOR HANDLE LEVEL (30.0") FOR VW RABBIT (TESTS 8327-4.1 AND 8330-2).

TABLE 2-8. EXTERIOR STATIC CRUSH FOR BULLET VEHICLES (TESTS 8327-4.1 AND 8330-2)

Location	Height at ℄ (in.)	Distance Left of Center (in.)* 36	30	24	18	12	6	0	Distance Right of Center (in.)* 6	12	18	24	30	36
Test 8327-4.1 Side Impactor (in.)														
Top of Stack Level	31.4	9.3	5.1	2.3	1.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mid-Stack Level	25.4	8.8	6.1	3.4	2.1	0.4	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1
Bumper Level	18.5	11.6	10.3	8.8	7.3	5.9	4.6	3.5	2.4	1.8	1.3	0.7	0.0	-0.3
		Distance Left of Center (in.)* 33	30	24	18	12	6	0	Distance Right of Center (in.)* 6	12	18	24	30	33
Test 8330-2 Oldsmobile Cutlass (in.)														
Hood Level	32.0	-	3.5	2.7	2.2	2.0	1.8	1.4	1.1	0.8	0.5	0.5	0.4	-
Between Bumper/Hood	26.0	-	5.1	3.9	1.4	1.8	1.4	2.4	0.8	0.3	-1.2	0.7	0.2	-
Bumper Level	20.0	10.5	9.8	7.8	5.8	5.1	4.3	2.4	2.3	1.6	0.7	-0.1	-0.8	-1.4

*As viewed from driver position in car.

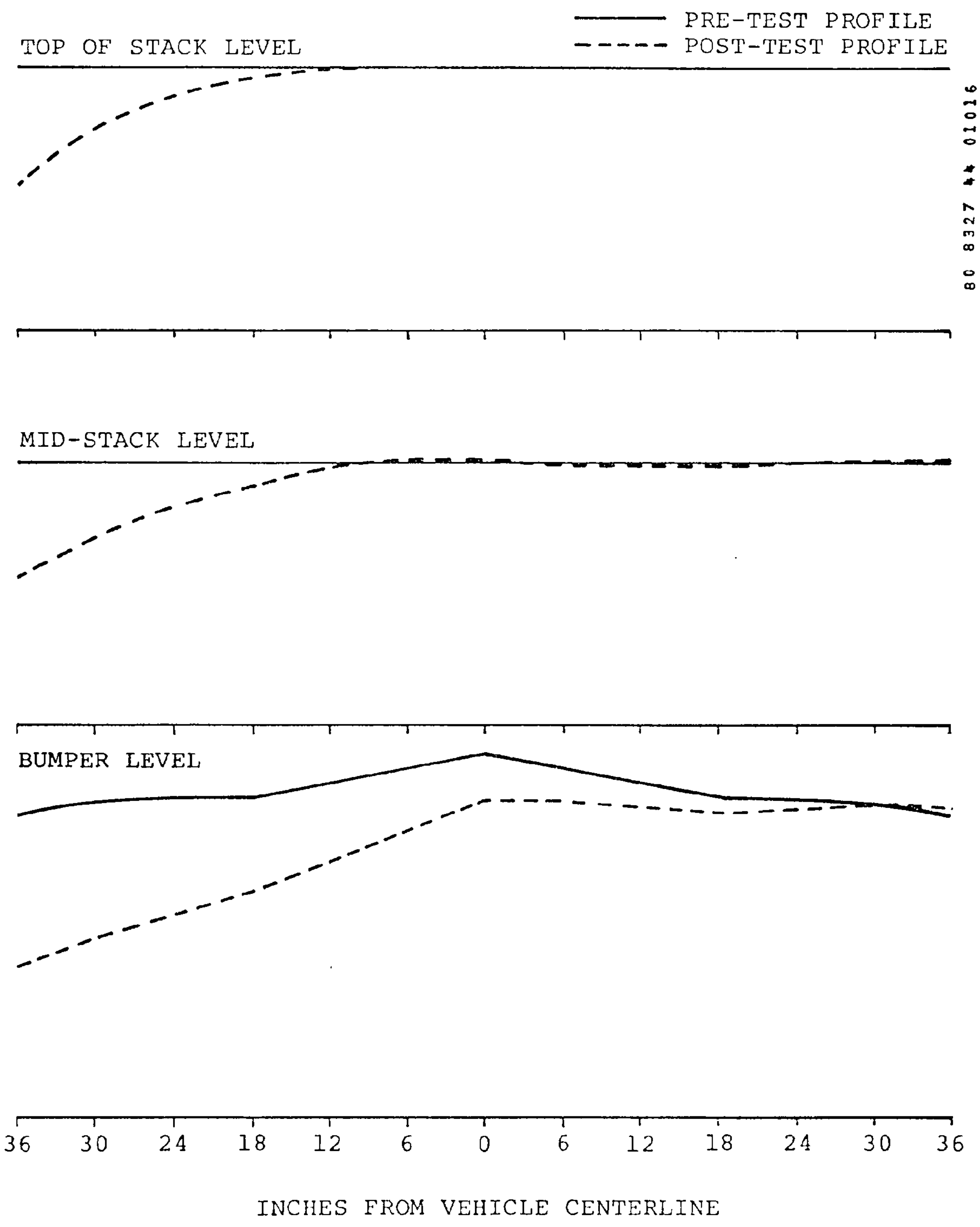


FIGURE 2-18 A. PRE- AND POST-TEST FRONTAL PROFILES FOR SIDE IMPACTOR (TEST 8327-4.1).

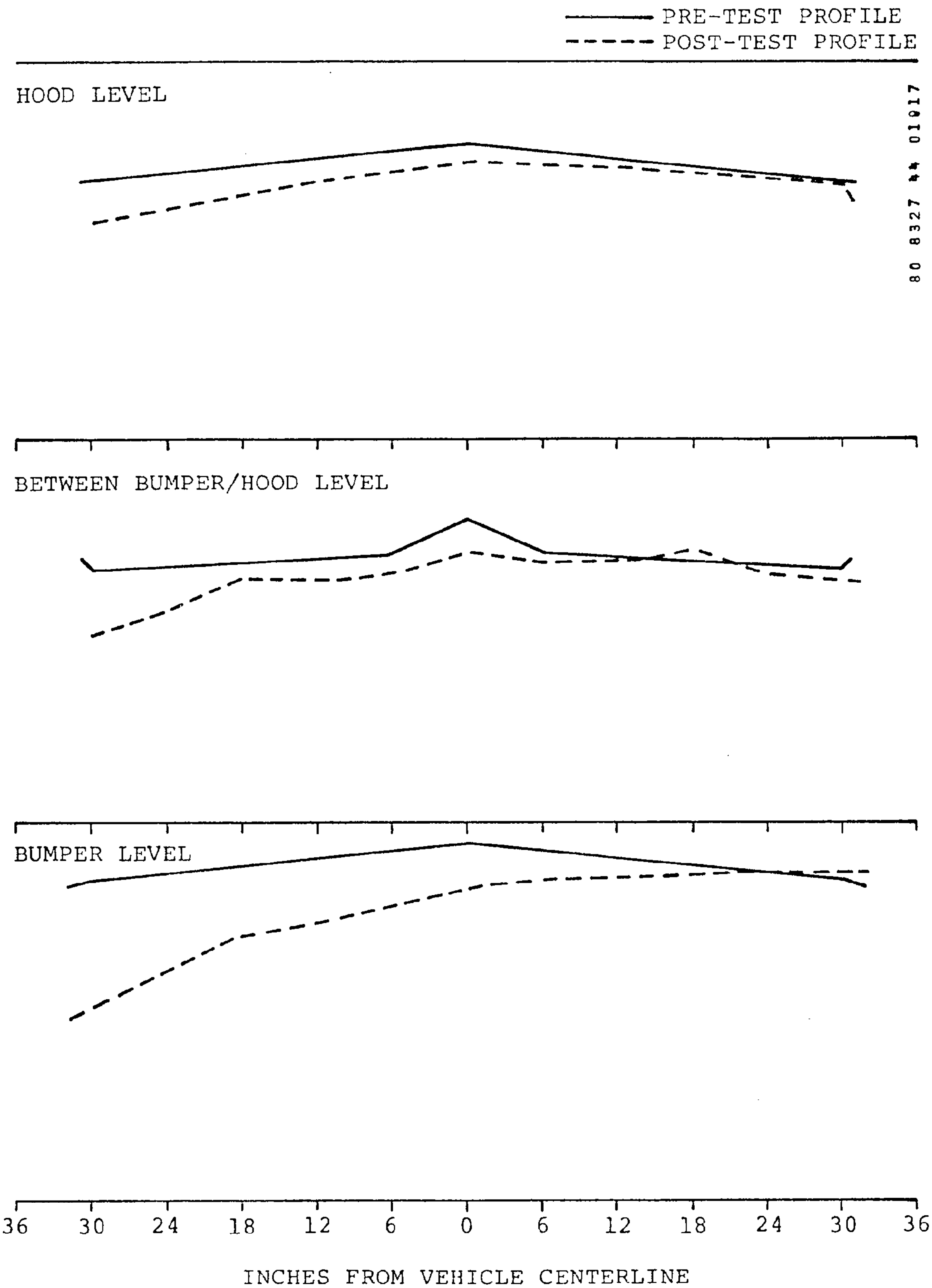


FIGURE 2-18 B. PRE- AND POST-TEST FRONTAL PROFILES FOR OLDSMOBILE CUTLASS (TEST 8330-2).

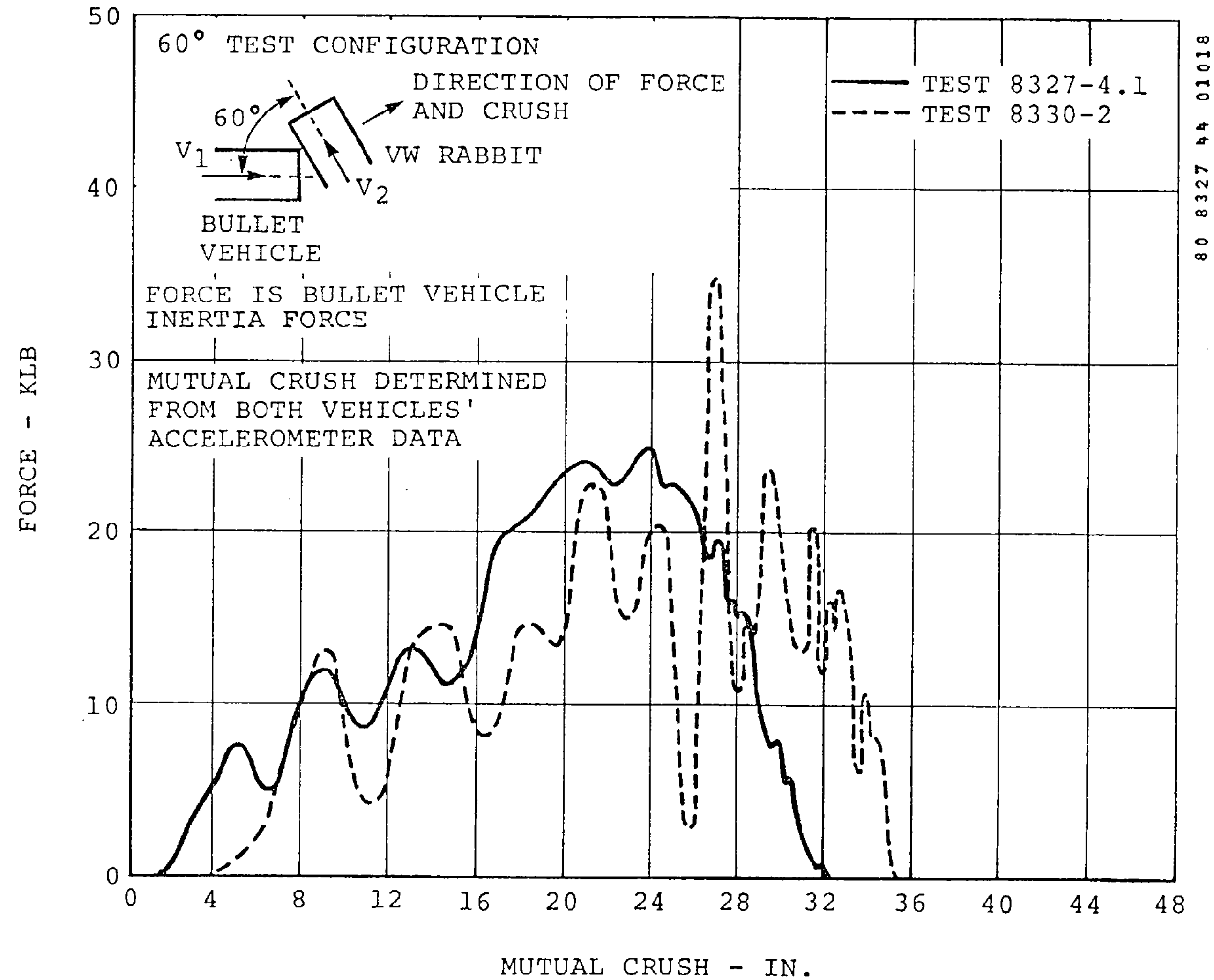


FIGURE 2-19. INERTIA FORCE VERSUS MUTUAL CRUSH IN DIRECTION OF VW RABBIT INTERIOR (TESTS 8327-4.1 AND 8330-2).

TABLE 2-9A. SIDE IMPACT DUMMY TEST RESPONSE SUMMARY (TEST 8327-4.1)

TEST NO. 8327-4.1 TEST DATE 2-11-80

TEST CONFIGURATION:

TARGET VEHICLE 1976 Mod. VW Rabbit SPEED 15.46 mph

BULLET VEHICLE Side Impactor SPEED 30.30 mph

IMPACT ANGLE 60° on Left Side IMPACT LOCATION DOR +1.5"

HEAD RESPONSE

PEAK A_R 67.4 G , HIC 297.3 @ 53-120 MS

IMPACTED OBJECT None TIME 105 MS

CHEST RESPONSE

LOCATION	PK A_R (G)	3MS CLIP (G)	SI	ΔV_Y (MPH)	TIME (MS)	CHEST DEF. (IN)
UPPER THORAX (T-1)	66.9	59.0	389	22.3	43	NA
LOWER THORAX (T-12)	71.8	69.8	553	26.0	38	NA
LUR (Y)	54.5	48.7	NA	20.1	39	NA
RUR (Y)	-48.3	-42.1	NA	-17.5	39	NA
LOWER STERNUM (X)	-62.0	-52.6	NA	NA	38	NA

COMPUTED COEFFICIENTS

LOWER STERNUM - LONG

B = 6.340 Q =-354.85 V_{15} = .00500 V_{19} = .02000 RVS = 4.0000

LEFT UPPER RIB - LAT

B = 6.630 Q =698.34 V_{15} = .00625 V_{19} = .01250 RVS = 2.0000

RIGHT UPPER RIB - LAT

B = 6.404 Q =-783.48 V_{15} = .01063 V_{19} = .02625 RVS = 2.4706

AIS = 2.682 G , AIS (BLUR) = 2.968 MAIS = 2.556

PELVIS RESPONSE

PK A_R = 84.6 G SI = NA ΔV_Y = 23.1 MPH, TIME = 37 MS

COMMENTS : None

NA = Not Applicable

TABLE 2-9B. SIDE IMPACT DUMMY TEST RESPONSE SUMMARY (TEST 8330-2)

TEST NO. 8330-2 TEST DATE 10-25-79

TEST CONFIGURATION:

TARGET VEHICLE 1977 Mod. VW Rabbit SPEED 15.16 mph

BULLET VEHICLE 1979 Olds Cutlass SPEED 29.72 mph

IMPACT ANGLE 60° on Left Side IMPACT LOCATION DOR -2.5"

HEAD RESPONSE

PEAK A_R 254.1 G , HIC 1146.8

IMPACTED OBJECT Cutlass Left Hood TIME 89 MS

CHEST RESPONSE

LOCATION	PK A_R (G)	3MS CLIP (G)	SI	ΔV_Y (MPH)	TIME (MS)	CHEST DEF. (IN)
UPPER THORAX (T-1)	92.3	78.3	702.1	28.8	50	NA
LOWER THORAX (T-12)	70.0	61.7	466.5	28.3	42	NA
LUR (Y)	62.9	55.3	NA	29.9	44	NA
RUR (Y)	-57.8	-55.0	NA	-27.2	45.6	NA
LOWER STERNUM (X)	-36.4	-32.4	NA	NA	42.5	NA

COMPUTED COEFFICIENTS

LOWER STERNUM - LONG

B = 6.018 Q = 209.02 V_{15} = .00438 V_{19} = .00687 RVS = 1.5714

LEFT UPPER RIB - LAT

B = 6.767 Q = 1304.81 V_{15} = .01063 V_{19} = .02563 RVS = 2.4118

RIGHT UPPER RIB - LAT

B = 6.758 Q = 1244.37 V_{15} = .01188 V_{19} = .02500 RVS = 2.1053

AIS = 4.098 G , AIS (BLUR) = 3.185 MAIS = 2.830

PELVIS RESPONSE

PK A_R = 90.3 G SI = NA ΔV_Y = 20.8 MPH, TIME = 39 MS

COMMENTS : Dummy hip was found broken prior to conduct of next test. Suspect crack propagation to failure during this test.

NA = Not Applicable.

3.0 COMPARISON OF RESULTS

This section compares the data from the 8330-2 test (Oldsmobile Cutlass) and the 8327-4.1 test (Side Impactor). From an overall viewpoint, Test 8327-4.1 produced a very good reproduction of Test 8330-2. There were, however, differences between the tests which need to be examined.

It should be pointed out that the Side Impactor was not designed to be an exact replica of an Oldsmobile Cutlass, although the force/crush characteristics of a Cutlass were used to model the force/crush characteristics of the Phase I Side Impactor face. The face of the Side Impactor should, theoretically, inflict forces on the side of the VW Rabbit similar to those inflicted by the Oldsmobile Cutlass, thereby causing similar VW side deformation and similar occupant response. Overall dynamic responses of the Side Impactor and Cutlass should be quite similar. However, localized responses could be considerably different because of the differences in the vehicle structures.

3.1 VEHICLE RESPONSES

3.1.1 Bullet Vehicle Response

As indicated above, bullet vehicle responses are not expected to be identical because of the differences between the vehicles. An analysis of the data in Appendix A shows the effect of these differences on the vehicle accelerations. However, the longitudinal velocities and displacements of the bullet vehicles show a very close correlation, indicating similar energy and momentum transfers and absorption characteristics, which was desired. This is also evident in the post-test vehicle positions (Figure 2-9).

One difference between the bullet vehicle responses is the apparent time lag between initial acceleration responses for the two vehicles (see page A-3). There was some speculation that the data from the 8330-2 test may have had a time delay introduced by an incorrect correlation of time of event with the data. The Oldsmobile Cutlass in Test 8330-2 was instrumented with an accelerometer on the bumper support behind the impact point. This accelerometer would be expected to register a response immediately following initial impact. The data trace from this accelerometer (Figure 3-1) does indicate some delay between time-of-event and initial response. However, the data from a similar test in the "Countermeasures for Side Impact" program, Test 8330-4 (Figure 3-2), displays a similar response. Since the same initial response was observed in two independent tests, it is reasonable to assume that there is no artificial delay and that the data of Test 8330-2 was correlated properly with the time-of-event.

The initial acceleration time lag in Test 8330-2 is responsible for the offset of the force/crush curves in Figure 2-19. An analysis of the acceleration traces on page A-4, from which the force/crush curves were generated, shows that the Side Impactor data trace records an initial acceleration level which is not evident in the Oldsmobile Cutlass trace. This difference may be due to the Cutlass' energy-absorbing bumper mechanism. It is probable that the energy from the initial Cutlass bumper impact was absorbed by the bumper energy-absorbing mechanism, thereby not registering a pulse on the Cutlass frame accelerometers until four or five msec had elapsed. On the other hand, the Side Impactor bumper was bonded directly to the honeycomb face, which allowed the initial bumper impact pulse to register on the Side Impactor frame accelerometers earlier. The presence of this initial acceleration on the Side Impactor data trace accounts for the earlier response of the Side Impactor force/crush curve.

The force/crush curves of Figure 2-19 show an apparently greater dynamic crush in the Oldsmobile Cutlass Test (8330-2),

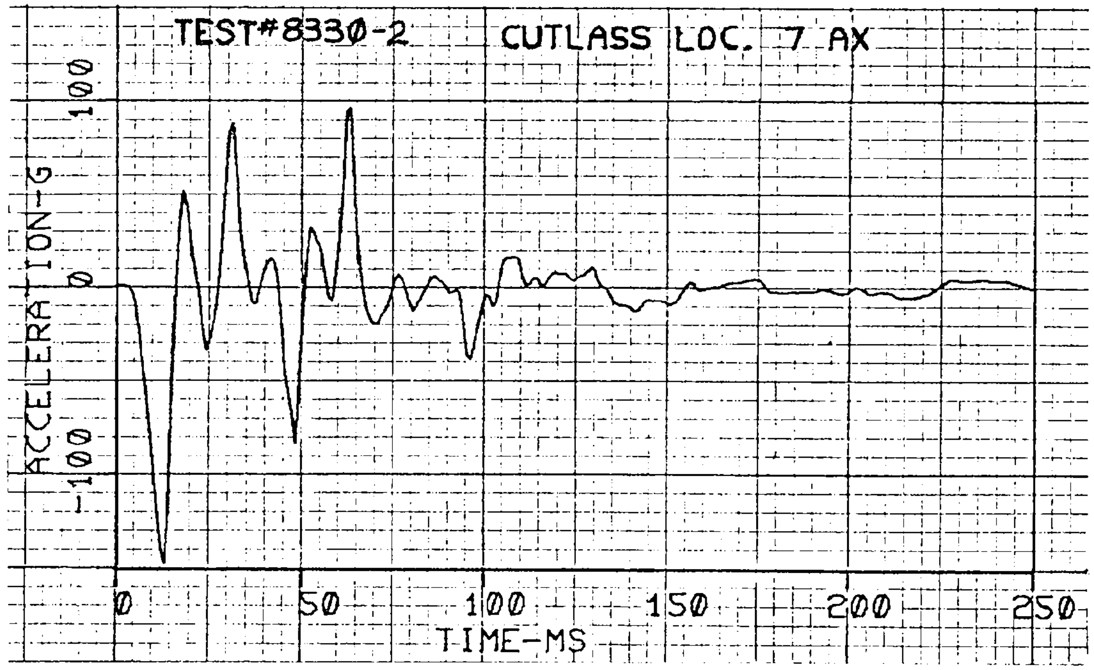


FIGURE 3-1. ACCELERATION AT IMPACTED CORNER OF BUMPER (TEST 8330-2).

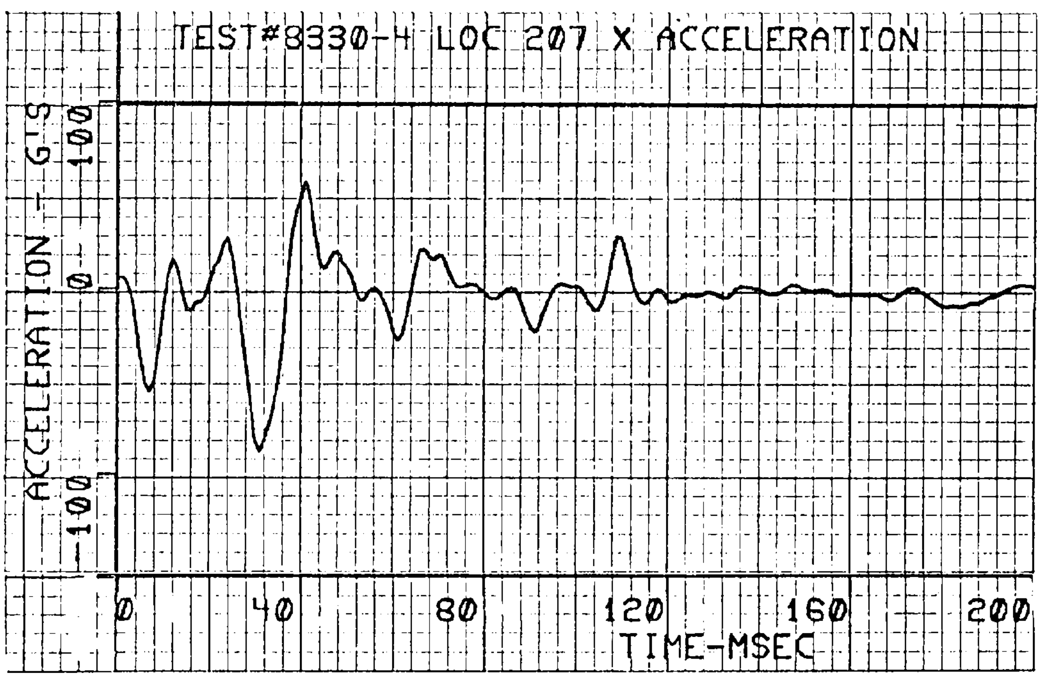


FIGURE 3-2. ACCELERATION AT IMPACTED CORNER OF BUMPER (TEST 8330-4).

although there is no correspondingly large difference in the static crush measurements. (Larger VW crush values for Test 8330-2 are offset by smaller bullet vehicle crush.) Since the Side Impactor struck the VW Rabbit rearward of the point where the Cutlass did and the Side Impactor was wider at the bumper level, the centerline (and center of gravity) of the Side Impactor was slightly further rearward on the Rabbit than was the Cutlass. As a result, the VW Rabbit in Test 8327-4.1 rotated away from the Side Impactor at a faster rate than in the Oldsmobile Cutlass test (see page B-4). This is also evident in the bullet vehicle data, wherein the Cutlass registers accelerations longer than the Side Impactor did. The faster rate of rotation increased the displacement of the Rabbit, which in turn decreased the mutual crush ($SX_{30°SI}$ minus SY_{VW}). Therefore, the dynamic crush in Test 8327-4.1 would be somewhat less than the dynamic crush in Test 8330-2.

A comment concerning the development of the force/crush curve is in order at this point. The crush for the curves of Figure 2-19 was calculated according to the methodology developed during the Phase I 30° impact tests. In those tests, the component of target vehicle displacement in the direction of the bullet vehicle was subtracted from the displacement of the bullet vehicle, yielding mutual dynamic crush. In Tests 8327-4.1 and 8330-2, the same approach was used, i.e., subtracting the displacement of the target vehicle in the Y direction from the component of the bullet vehicle displacement which parallels the Y-axis of the target.

Besides the problem caused by the VW rotation, there is another problem in applying this approach to a 60° side impact, especially when both vehicles are moving. Since the bullet vehicle slides rearward along the target vehicle after the initial intrusion, there is in reality very little more displacement of the bullet vehicle toward the interior of the target vehicle. However, the above method of crush calculation assumes a constant correlation of bullet vehicle longitudinal displacement with its displacement in the direction of the target vehicle Y-axis, when actually the relationship is constantly changing. This being the case, the calculated displacement of the bullet vehicle in the direction of the target vehicle Y-axis (which is used for the mutual crush calculation) is much larger than reality. This makes the mutual crush in the force/crush curve much too large.

As an example, the mutual dynamic crush for Test 8327-4.1 is approximately 32 inches, according to Figure 2-19. However, the maximum measured static crush is 12.3 inches for the VW Rabbit and approximately 11.0 inches for the Side Impactor in a direction 30° from centerline, for a total maximum mutual static crush of only 23.3 inches.

Additionally, the 11.0 inches for the Side Impactor is somewhat arbitrary. Although the force applied to the Side Impactor face is theoretically along a line 30° from its centerline, the impact point on the Side Impactor bumper did not displace in a 30° direction. Rather, it crushed nearly parallel to the Side Impactor centerline, due to the friction forces between the vehicles. A force/crush curve could be drawn in the direction of the bullet vehicle as well; however, the same problems would exist once the bullet vehicle began sliding along the target vehicle.

In summary, the problem is that the calculations for force/crush curves generally assume a constant interface between initial impact points. In side impacts where both vehicles are moving, there is no constant interface, so that the mutual crush calculations are inaccurate.

Although the absorbed energies, represented by the areas under the force/crush curves, are similar (406 in-klb for Test 8327-4.1, 390 in-klb for Test 8330-2), these energies are probably not representative of reality because of the inaccurate crush. However, the similarity between the shapes of these curves, and the energies they represent, illustrates a good reproduction of Cutlass Force/Crush characteristics by the Side Impactor.

Another difference between the Side Impactor and Oldsmobile Cutlass response is the opposite direction of the final lateral velocities and resulting displacements of the bullet vehicles, as displayed in the plots of pages A-11 through A-14. Although the Oldsmobile Cutlass data may appear to have been adversely affected by local accelerations (page A-9, Front AY), analysis of the high speed films shows the sudden reversal of Cutlass lateral velocity to be a fact. Shortly after impact, the Cutlass began to move laterally to its left due to the dragging force created by the movement of the VW Rabbit. Then, at about the time of maximum mutual crush (visual), the Cutlass jolted to its right. This changed its trajectory to the right, allowing it to continue on a line nearly parallel to the monorail centerline until its right rear tire caught in the tow cable trench.

The cause of the jolt to the right is unclear; however, the films also reveal that, at about the same time, the left front tire of the Cutlass came in contact with the doorsill of the VW Rabbit (verified by post-test observation of the tire marks on the VW sill). It is probable that, due to the relative angle of the Cutlass tire and VW doorsill at the time of impact, the Cutlass bounced to the right. Although the accelerations to the right (page A-9, Front AY) are too sharp to be caused by a tire collision, they could have been caused by some interaction of the Cutlass front end structural members between the tire and the firewall, where the accelerometer was located.

In the case of the Side Impactor, the wheel block on the left underside of the energy-absorbing face apparently did not come in contact with the VW doorsill. The high-speed films show that the Side Impactor began to move laterally to its left due to the dragging force of the VW and continued to rotate to its left (counterclockwise). Upon separation, the Side Impactor continued at an angle to the monorail centerline, crossed over the monorail, and came to rest as shown in Figure 2-9.

3.1.2 Target Vehicle Response

The general shapes of the exterior crush profiles of Figures 2-10 through 2-13 for the two Volkswagen Rabbits correspond fairly well. There are, however, several differences which require explanation.

To begin with, the profiles for Test 8327-4.1 exhibit a greater crush in the region 0-12 inches behind the DOR than do the profiles for Test 8330-2, particularly at the lower mid-door level (roughly bullet vehicle bumper level). This would indicate that, at least early in the crash sequence, the Oldsmobile Cutlass was absorbing more energy than the Side Impactor was during the same time frame. This phenomenon is possibly a function of the Cutlass energy-absorbing bumper stroking inward, and would suggest that the Side Impactor is initially stiffer than the Cutlass at bumper level.

Further back on the Rabbits, and particularly at the B Pillar (42 inches behind the DOR), the Rabbit from Test 8330-2 exhibits a greater static crush. This would indicate that the Cutlass is somewhat stiffer than the Side Impactor once the bumper structures have collapsed. This is substantiated by the Cutlass and Side Impactor profiles of Figures 2-18A and 2-18B, which indicate a greater static crush for the Side Impactor.

The above observations concerning bullet vehicle stiffness are also substantiated by the data obtained in Phase I testing (see Figure 3-3). The force/crush curves in Figure 3-3 indicate

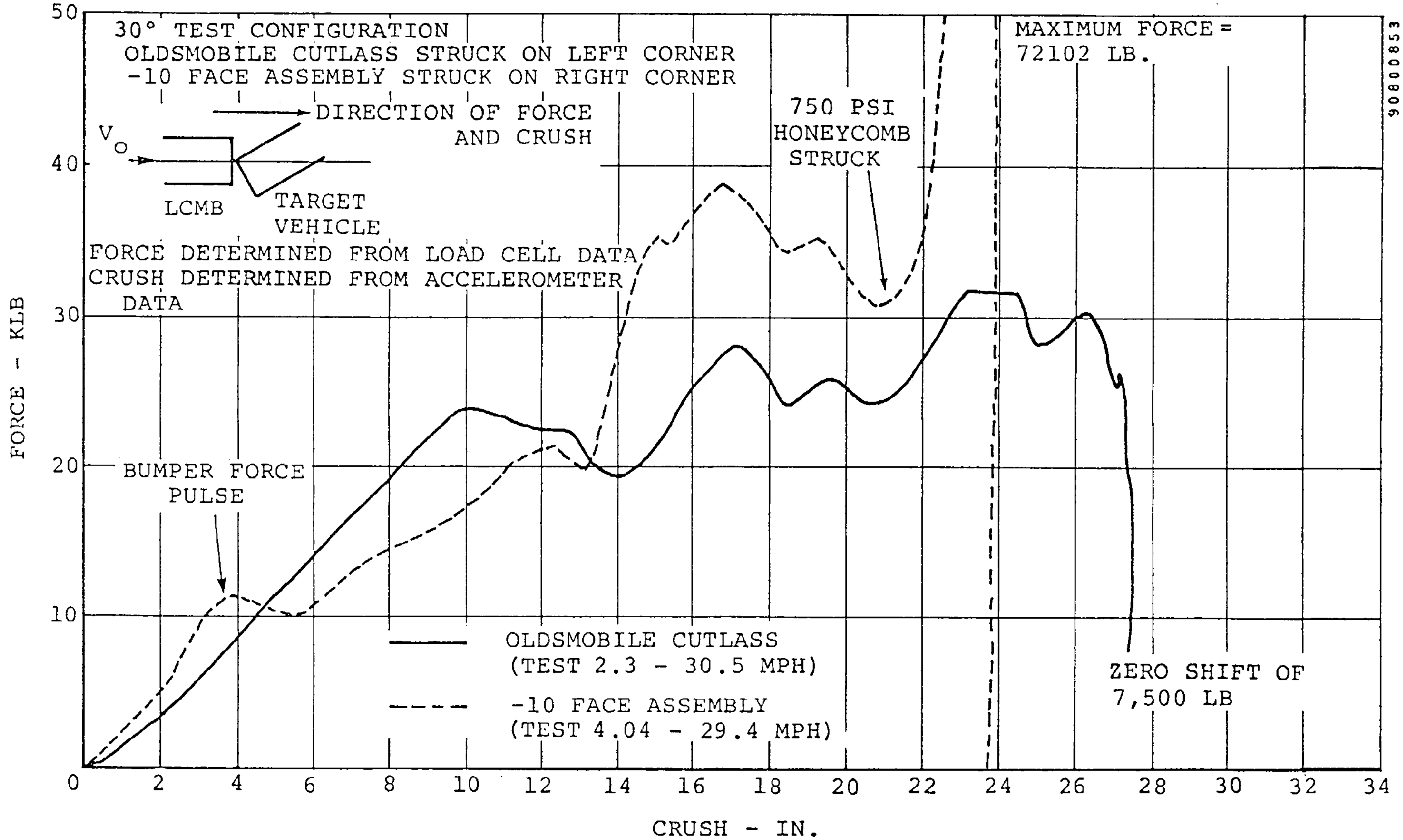


FIGURE 3-3. COMPARISON OF TOTAL FORCE VERSUS CRUSH IN DIRECTION OF TEST DEVICE (TESTS 8321-2.3 AND 8321-4.04 FROM "TEST DEVICE AND TEST PROCEDURE TO ASSESS SIDE STRUCTURES - PHASE I FINAL REPORT", PAGE 289).

an initial greater stiffness for the Side Impactor, with the Cutlass being stiffer after the bumper has stroked. (Additionally, the force/crush curve for the Oldsmobile Cutlass displays no initial "bumper force pulse", which corroborates the aforementioned conclusions regarding the stroke of the bumper energy absorber. The regions of these force/crush curves beyond 10 to 11 inches of crush are of no concern for the purposes of the 8327-4.1/8330-2 comparison since the bullet vehicles did not crush more than 10 to 11 inches.)

Toward the rear of the Rabbits, the Rabbit from Test 8327-4.1 exhibits somewhat more static crush. This greater crush was probably caused by the continuing counterclockwise rotation of the Side Impactor (as described in Section 3.1.1) which allowed more of the Side Impactor face to come into contact with the side of the Rabbit.

Film analysis of Test 8330-2 reveals that deformation of the side structures of the VW Rabbit occurred in two phases. The door and B pillar of the Rabbit deflected inward initially as the front structure (primarily plastic and fiberglass) of the Cutlass passed along the side of the Rabbit. As the corner sheet metal of the Cutlass trailed the front structure along the side of the Rabbit, there was a readily observable second "wave" of deformation down the length of the door to the B pillar. No similar effect is observable in the Test 8327-4.1 films. Comparing the two films, the initial "wave" of deformation in Test 8330-2 seems to have caused less intrusion than the single "wave" in Test 8327-4.1; however, the second "wave" accounts for the greater static crush in Test 8330-2. The second "wave" effect is also observable in the Rabbit door and B-pillar accelerometer data, notably from location 8 (page B-25), location 10 (page B-30), and location 12 (page B-34). The velocity traces for Test 8327-4.1 exhibit only one peak, while the velocity traces for Test 8330-2 exhibit two peaks. Moreover, the highest velocity for Test 8330-2 occurs during the second peak, which occurs later in the crash sequence.

The data plots of Appendix B (other than the side structure locations) show fairly good correlation between the two tests. The primary frame accelerometers (such as Location 1 and Location 2, page B-2) display the same characteristics as were noted for the bullet vehicles, i.e., an initial acceleration level in the 8327-4.1 test which is not evident in the 8330-2 test, and a longer pulse duration in Test 8330-2.

There are some additional differences between the data from the accelerometers located on the impacted side structure of the VW Rabbits, aside from those mentioned previously. These accelerometer responses in Test 8330-2 occur somewhat later than in Test 8327-4.1. However, since the Cutlass struck the Rabbit farther forward than did the Side Impactor, a time-of-response difference would be expected as the bullet moves down the side of the Rabbit. There are also differences in the magnitudes of the accelerations (and resulting velocities and displacements) at the comparable door accelerometer locations. Some of these differences are probably due to the difference in stiffness between the two bullet vehicles. However, in the "Countermeasures for Side Impact" program, data from accelerometers in these locations has been found to be generally unreliable because they experience such severe accelerations that some of the pulse is lost due to channel saturation. Additionally, these accelerometers generally become disoriented from their original coordinate system due to the deformation of the door interior.

As a check on the accuracy of the data, it is common practice to compare the final velocity at these locations to the final compartment velocity as measured at an undeformed structural location (the final velocities should be the same). Figure 3-4 compares the velocity at location 12 (left side B pillar) with the compartment velocity at location 15 (center of gravity). It is apparent that the final velocity at location 12 is somewhat low, indicating that some initial acceleration was lost.

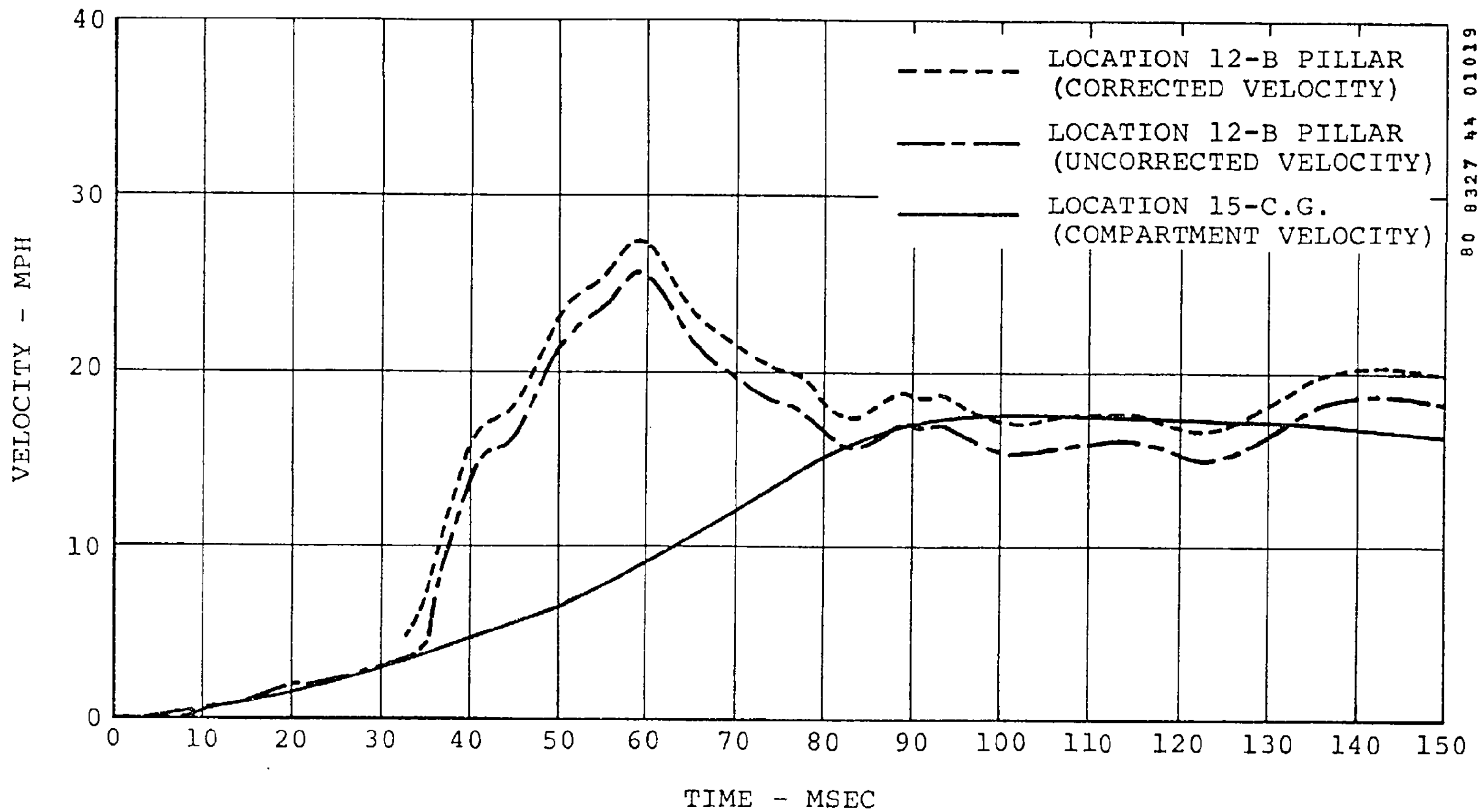


FIGURE 3-4. COMPARISON OF COMPARTMENT VELOCITY WITH VELOCITY AT ACCELEROMETER LOCATION ON IMPACTED SIDE OF VW RABBIT (TEST 8327-4.1).

The entire curve had to be shifted upward 1.8 mph to bring the final B pillar velocity into line with the final compartment velocity. Once this correction has been made, it is interesting to note that an integration of the area between the compartment velocity and corrected B pillar velocity yields a crush of 10.14 inches at this location, which compares with 9.76 inches measured by the scratch tube and 10.0 inches static crush at this location. This integration is a check on the accuracy of the correction.

3.2 OCCUPANT RESPONSES

It is apparent from Tables 2-10A and 2-10B and the data plots in Appendix C that Test 8330-2 produced much more severe dummy responses than Test 8327-4.1. One reason for the more severe environment of Test 8330-2 is the greater stiffness of the Oldsmobile Cutlass and the second "wave" of intrusion into the VW interior. Another reason for the difference in dummy response is a major structural difference between the bullet vehicles; namely, the Oldsmobile Cutlass had a hood and the Side Impactor did not. An analysis of the high-speed films for the 8330-2 test, particularly the rear-mounted on-board VW camera, revealed that the hood of the Cutlass, after bending upward, actually intruded into the VW compartment over the windowsill and struck the dummy in the left shoulder. This strike, coupled with the additional intrusion of the second "wave", accounts for the high acceleration spike at 70 msec evident in the Test 8330-2 upper and lower thorax plots. The sudden increase in dummy thorax velocity caused by this shoulder strike and the second "wave" of intrusion impacting the dummy caused the dummy's head to whip over to the left and strike the Cutlass on the hood. This head strike accounts for the high acceleration spike at approximately 90 msec evident in the Test 8330-2 head plots. These shoulder, upper torso, and head strikes are quite obviously the reason for the higher injury criteria numbers in Test 8330-2.

There are also some significant secondary peaks in both the head and upper thorax acceleration traces for the 8330-2 test. The secondary peaks in the head traces (at 130-135 msec) are apparently the result of the dummy's head, which was rebounding off the Cutlass, hitting the VW headrest, which was rebounding in the opposite direction at the time. The dummy's head remained "wrapped around" the headrest (while the rest of the dummy was still moving across the compartment) until approximately 175 msec, at which time there was apparently no more "give" in the neck assembly and the motion of the torso pulled the head away from the headrest. The snap at the end of the neck stretch may account for the peaks in the upper thorax traces at this time, although there are no large corresponding head accelerations at 175 msec.

Prior to the shoulder strike at 70 msec, the head and thorax responses correspond fairly well. The other dummy sensor locations correspond quite well throughout the test. There is a time-of-response difference between the two tests because the Side Impactor hit the VW closer to the dummy, so that the door interior impacted the dummy sooner in the crash sequence in Test 8327-4.1.

In Test 8327-4.1, there was no readily observable post-test evidence of the dummy's head impacting any object. However, there is a rather substantial longitudinal acceleration spike in the dummy head data at 105 msec (page C-3). Analysis of the 8327-4.1 film would suggest that, after the VW door had struck the dummy and the dummy had been thrown somewhat out of its seat, there was contact between the dummy's face or forehead and the VW left front windowsill. An actual head strike was impossible to verify, however, due to the quality of the film at the crucial moment. The relatively low injury criteria numbers indicate that even if there was a head strike, it was not too severe.

Figure 2-1 shows that the dummy in Test 8330-2 was positioned somewhat closer to the door than in Test 8327-4.1. (In particular, there is a substantial difference in the HR measurement in Figure 2-1 which was questioned. Examination of the HR measurements from other tests and the correlation between the HR and HS measurements led to the conclusion that the HR measurement of 5.3 inches in Test 8330-2 is not correct.) There was some early concern that the difference in dummy positioning may have been responsible for the more severe injury criteria values in the 8330-2 test, but it is apparent from the preceding discussion that other factors were responsible.

It is worth noting that there is no standard procedure for positioning the Side Impact dummy. In addition, it is very difficult to position this dummy because the torso is only attached at the spine, so that the rib cage may be offset from the centerline, which could affect the positioning from test to test. Moreover, there is no centerline setting for the dummy torso, which makes centering it a matter of judgement.

4.0 CONCLUSIONS

Test 8327-4.1 produced a good reproduction of Test 8330-2. However, differences between the bullet vehicles caused some significant differences in target vehicle and occupant response. The differences in the test conditions apparently caused no significant differences in response.

4.1 SIDE IMPACTOR TEST DEVICE

- The most significant difference between the bullet vehicles was the greater stiffness of the Oldsmobile fender structure, probably due to the reinforcing angle along the edge of the fender from top to side. This extra stiffness caused a different crushing sequence in the VW and more severe occupant responses in Test 8330-2.
- The bullet vehicle hood surface and bullet vehicle front overhang are important factors in side impacts. The hood surface contributed to more severe occupant response in Test 8330-2, and the difference in overhangs affected vehicle trajectories.
- The addition of the tie-down cable to the non-impacted side of the Side Impactor bumper did not have sufficient stiffening effect upon the energy-absorbing face to duplicate the Cutlass.

Since target vehicle response and occupant response were reasonably similar in both tests, it can be concluded that the current Side Impactor concept is an appropriate tool for side impact testing. However, several changes can be incorporated into the Energy Absorbing Face design to improve its ability to reproduce a car-to-car environment.

4.2 SIDE IMPACT TEST CONDITION

Due to the differences caused in these tests by the differences in the bullet vehicles, it is difficult to define any anomalies caused by the test condition. There were several differences that need to be addressed:

- The slight difference in the location of the impact points apparently caused no real differences other than time offsets between these tests. Although the Cutlass bumper initially struck the VW A-pillar, the impact was close enough to the door edge to make the A-pillar engagement nearly insignificant. As long as no significant A-pillar engagement is experienced and initial impact occurs well forward of the target vehicle occupant, a difference of a few inches in the impact point apparently has no notable effect other than the rate of yaw rotation noted earlier.

- The slight differences in dummy positioning had no measurable effect for the purpose of this comparison because the differences in occupant responses caused by the bullet vehicle obscured any effects that might have been caused by dummy positioning.

- The test speeds of the vehicles were slightly different; however, whatever effects the slightly greater amount of energy present in the higher velocity test (8327-4.1) may have had on the results were once again obscured by the more noticeable structural differences in bullet vehicles. Since the speed differences were so small, it is expected that there would have been very little difference due to speed, even had the bullet vehicles been identical.

Overall, the test condition of Test 8330-2 was repeated quite well in Test 8327-4.1. The small differences in the test conditions had no apparent effects on the results as far as this comparison is concerned. If at some time two identical tests are run, there could possibly be some noticeable effects due to differences in the test condition; however, a fine tuning of test procedures should result in minimizing the differences.

The test conditions for these two tests incorporate the four conditions that have been suggested as appropriate for a side impact compliance test condition based on NCSS and MDAI data, namely:

1. ΔV of the struck vehicle of 25 mph.
2. Simulation of conditions where both vehicles are moving, with the barrier moving faster that the struck vehicle.

3. Orientation angle between the barrier and the struck vehicle in the range of 40° to 100°.

4. Impact point such that the occupant compartment is damaged.

As the test conditions meet these criteria and have proven to be repeatable, it can be concluded that the test conditions represent one possible specification for side impact compliance.

5.0 RECOMMENDATIONS

The following recommendations for E/A face design modifications are based on the specific results of the tests:

- The additional stiffness of automobile fender corners should be investigated to determine whether some modification of the energy-absorbing face is necessary to provide a corresponding additional corner stiffness.

- The energy-absorbing face should be fitted with a "hood" surface in order to better simulate the crash environment of a car-to-car side impact for occupant response simulation.

- The depth of the energy-absorbing face should be modified to allow the "wheel blocks" of honeycomb to come into contact with the target vehicle as was observed in Test 8330-2.

As it is unlikely that the force/crush characteristics of an Oldsmobile Cutlass will be selected as those of the 1985 "generic car," the above design changes should be based on "generic car" data.

Additional suggestions for improved performance include:

- An alternative method of stiffening the entire energy-absorbing face should be investigated, as the bumper tie-down cable proved to be inadequate by itself. This could be accomplished by using a higher psi honeycomb or by devising a method of distributing the load across more of the face.

- As a cost-saving measure, the depth of the honeycomb face could be reduced since so little of the face is crushed. This reduction should be coordinated with the "wheel block" suggestion above.

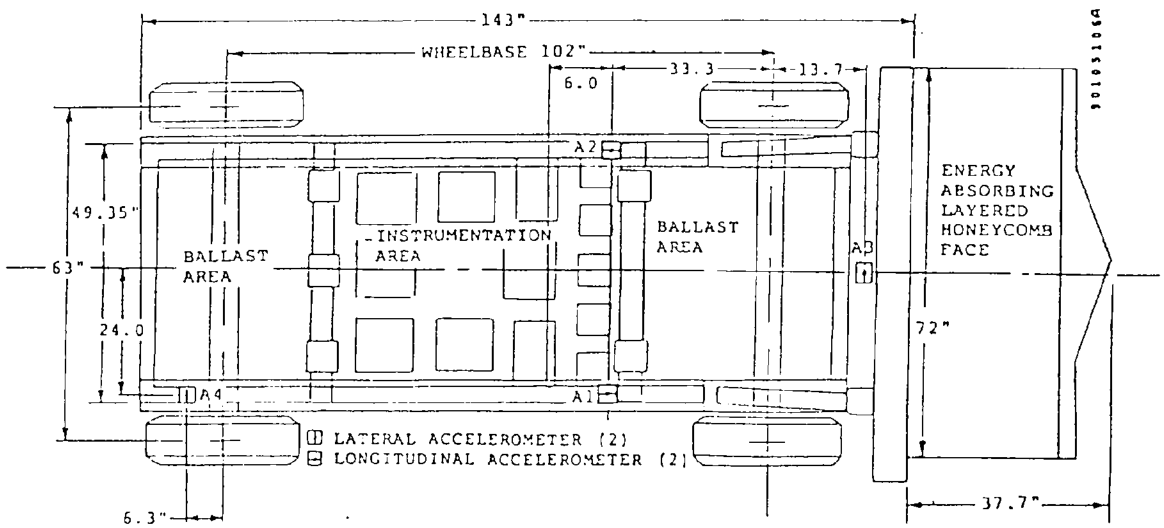
- An easily fabricated, low cost "generic" side impactor bumper should be designed. The Volare bumper may not be typical of bumpers for smaller cars of the mid-80's.

- A standardized procedure for positioning the Side Impact dummy should be developed by NHTSA.

- The current methodology of developing force/crush curves for side impacts with both vehicles moving should be reviewed, and an improved methodology should be developed.

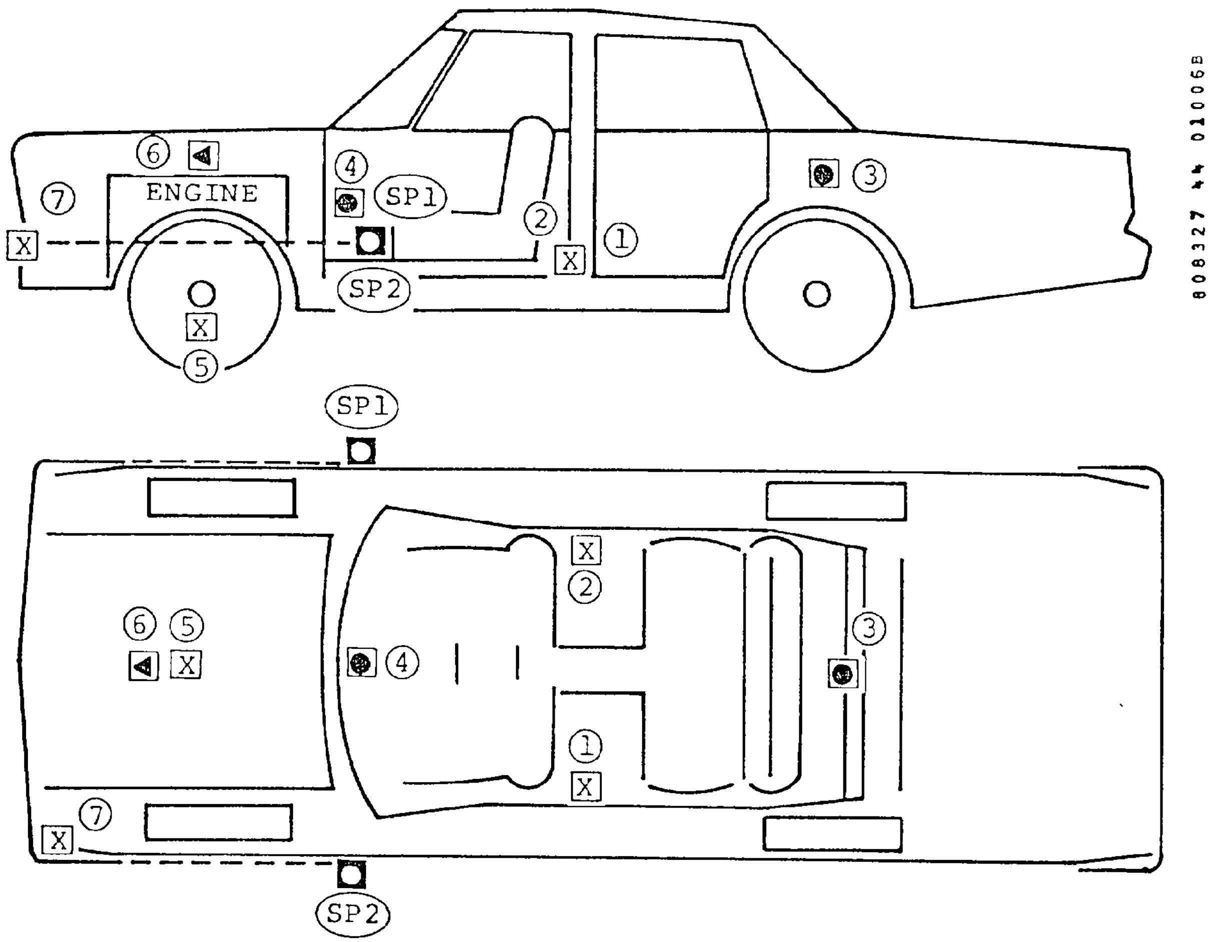
APPENDIX A

COMPARISON OF BULLET VEHICLE
DATA PLOTS FROM
TESTS 8327-4.1 AND 8330-2
(Structural Data Filter = 100 Hz)



TEST VEHICLE ACCELEROMETER LOCATIONS AND PHYSICAL COORDINATES (IN.)					MAXIMUM EXPECTED READINGS (G)		
No.	Description of Location	X	Y	Z	LONG	LAT	VERT
1	Right frame rail	84	23	20	50		
2	Left frame rail	84	-23	20	50		
3	Front crossmember at centerline	130	0	24		50	
4	Right rear vertical frame rail	9	22	16		50	

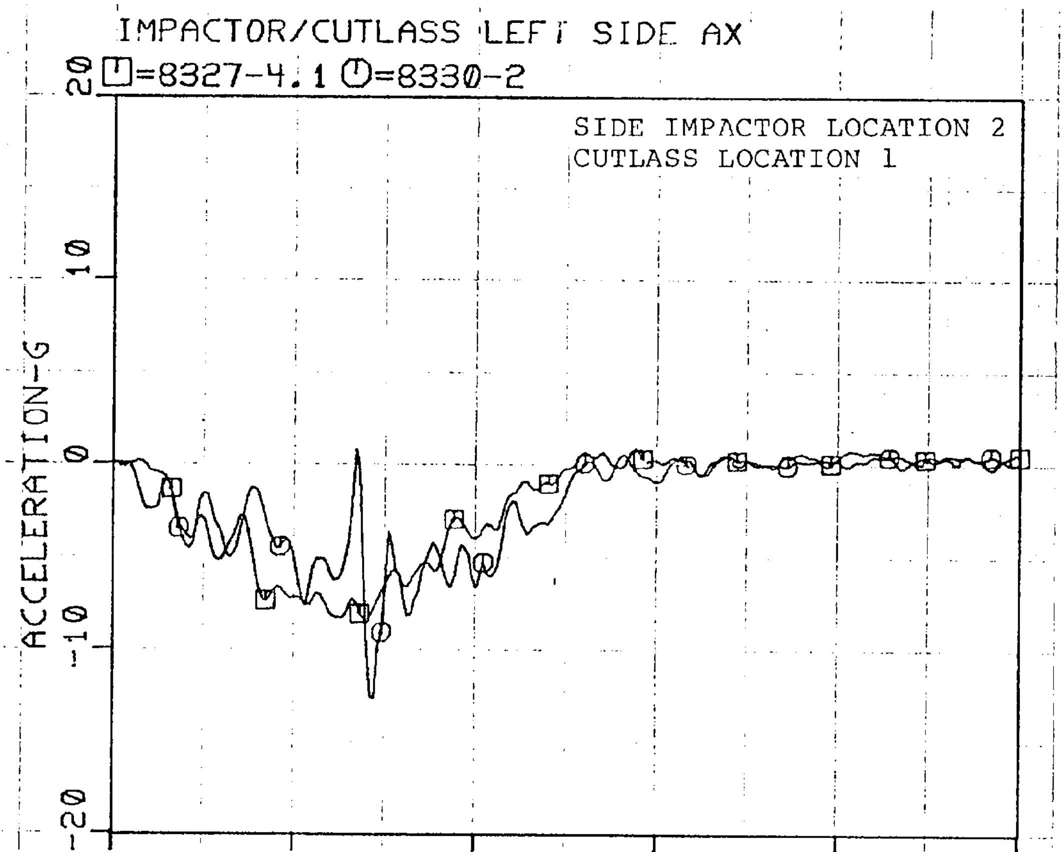
Figure A-1. Bullet Vehicle (Side Impactor) Instrumentation (Test 8327-4.1).

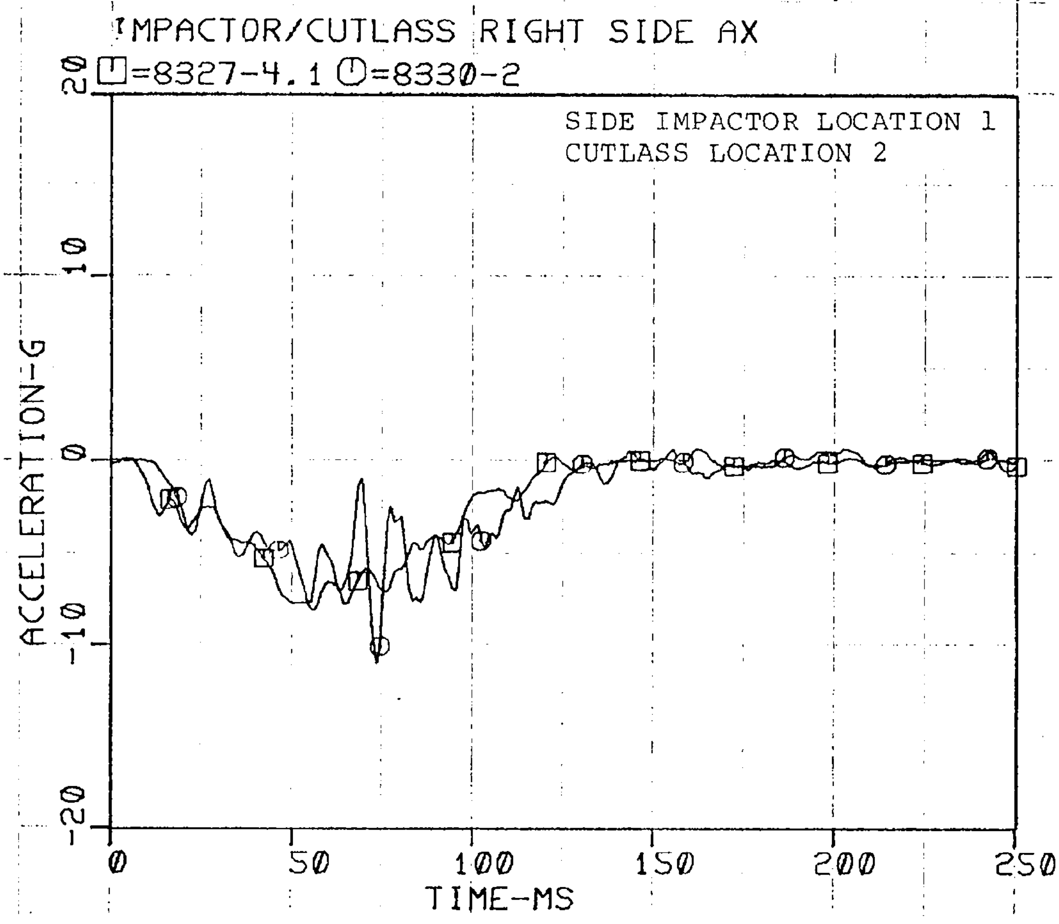


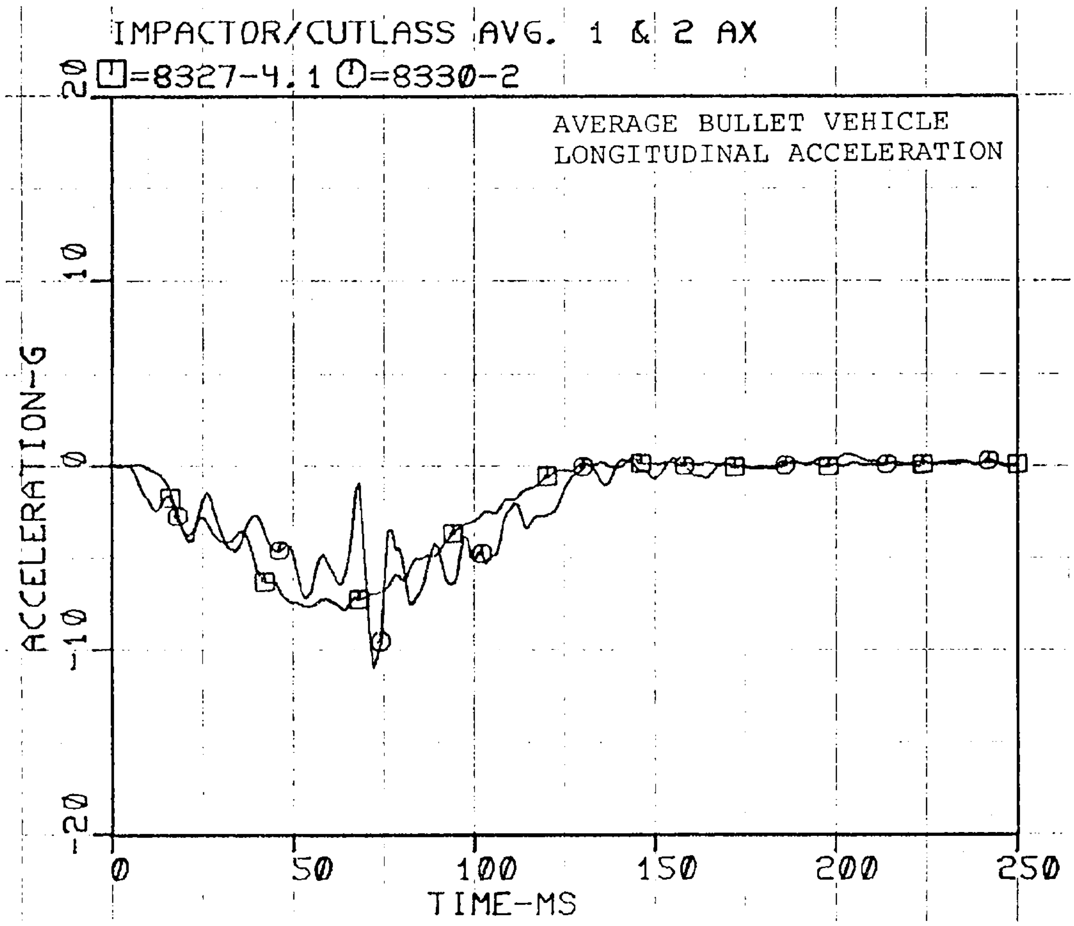
NOTE: PLOTS FOR LOCATIONS 5,6, & 7 ARE NOT PRESENTED IN THIS APPENDIX AS THERE ARE NO COMPARABLE LOCATIONS ON THE SIDE IMPACTOR

X AXIAL ACCELEROMETER (X DIRECTION)
Y AXIAL ACCELEROMETER (Y DIRECTION)
BIAXIAL ACCELEROMETER (Y,Z DIRECTION)
BIAXIAL ACCELEROMETER (X,Z DIRECTION)
TRIAXIAL ACCELEROMETER (X,Y,Z DIRECTION)
STRING POTENTIOMETER

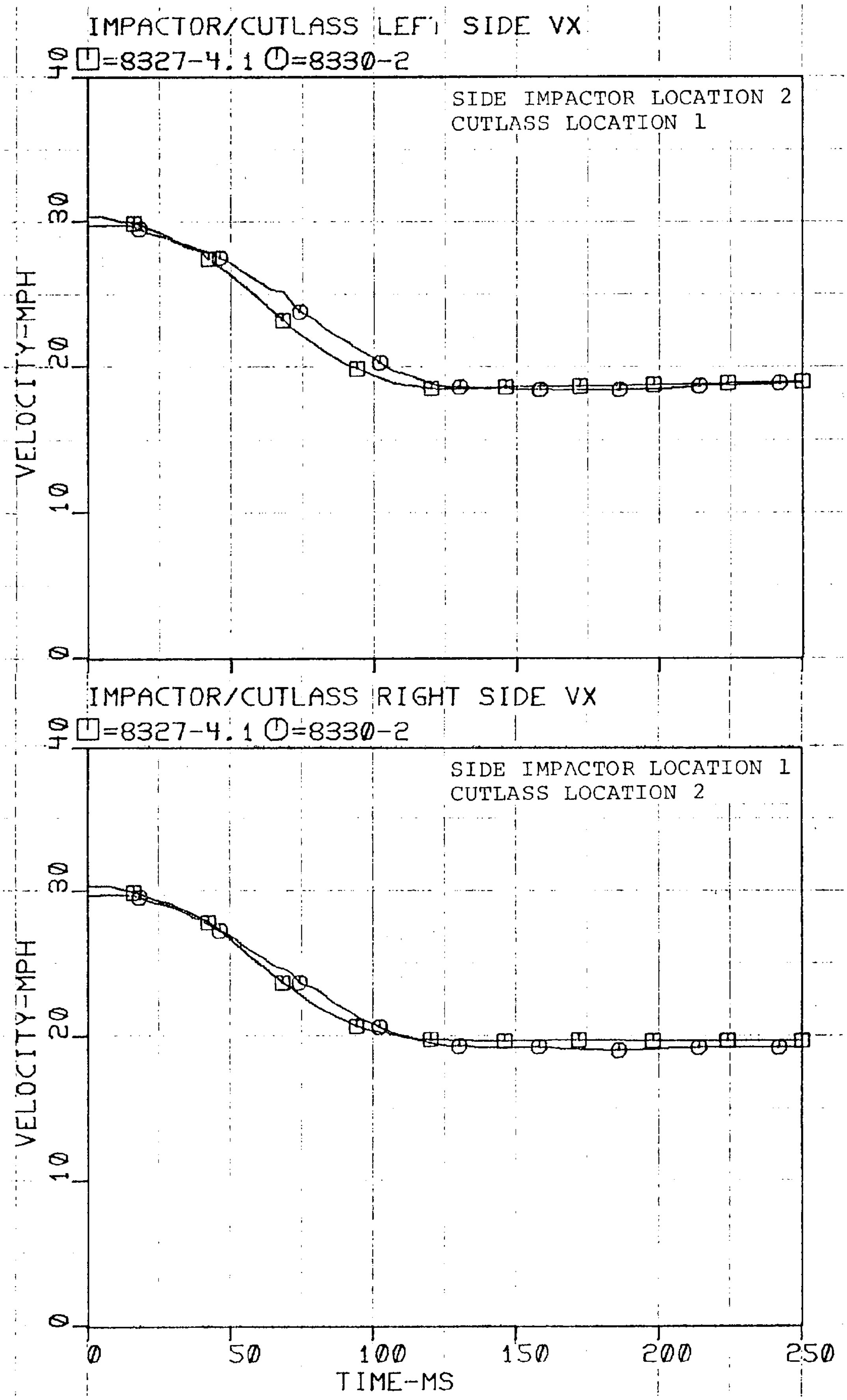
Figure A-2. Bullet Vehicle (Oldsmobile Cutlass) Instrumentation (Test 8330-2).

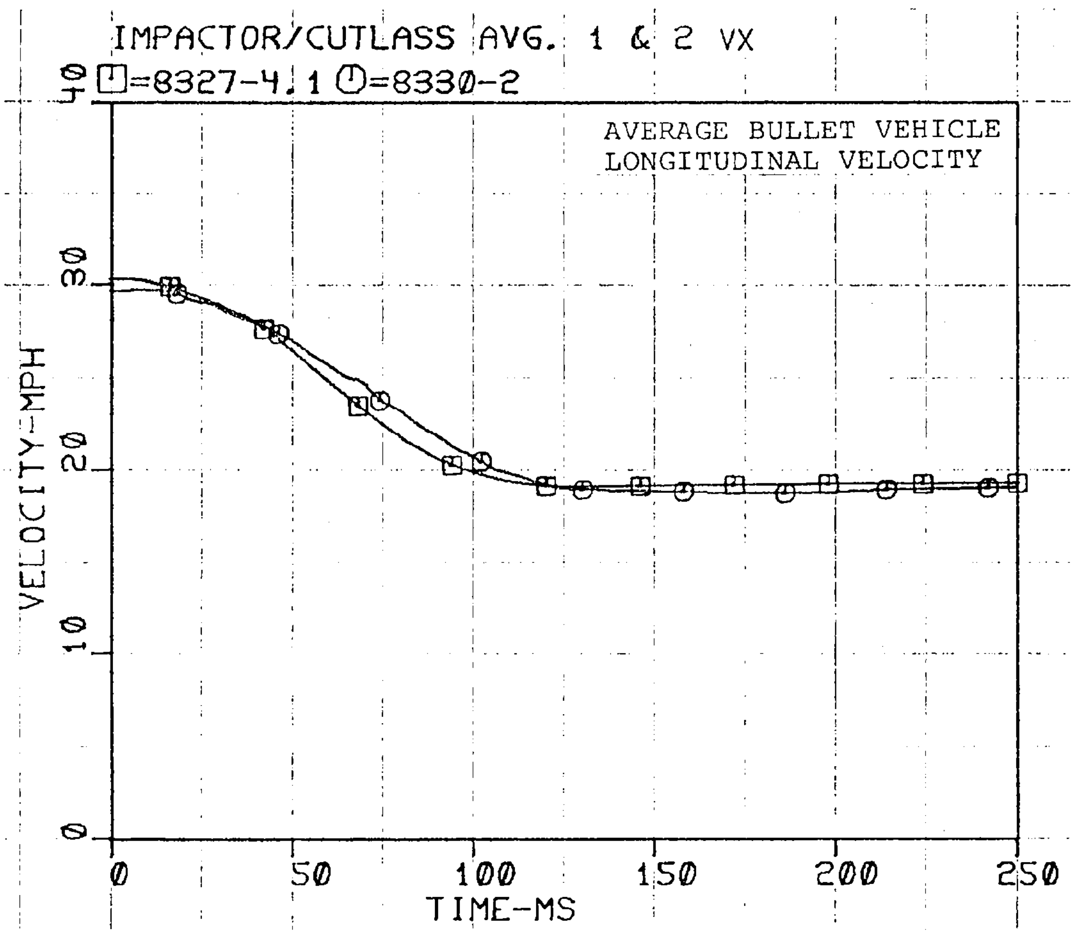

IMPACTOR/CUTLASS LEFT SIDE AX
□=8327-4.1 ○=8330-2
SIDE IMPACTOR LOCATION 2
CUTLASS LOCATION 1
ACCELERATION-G
20
10
0
-10
-20

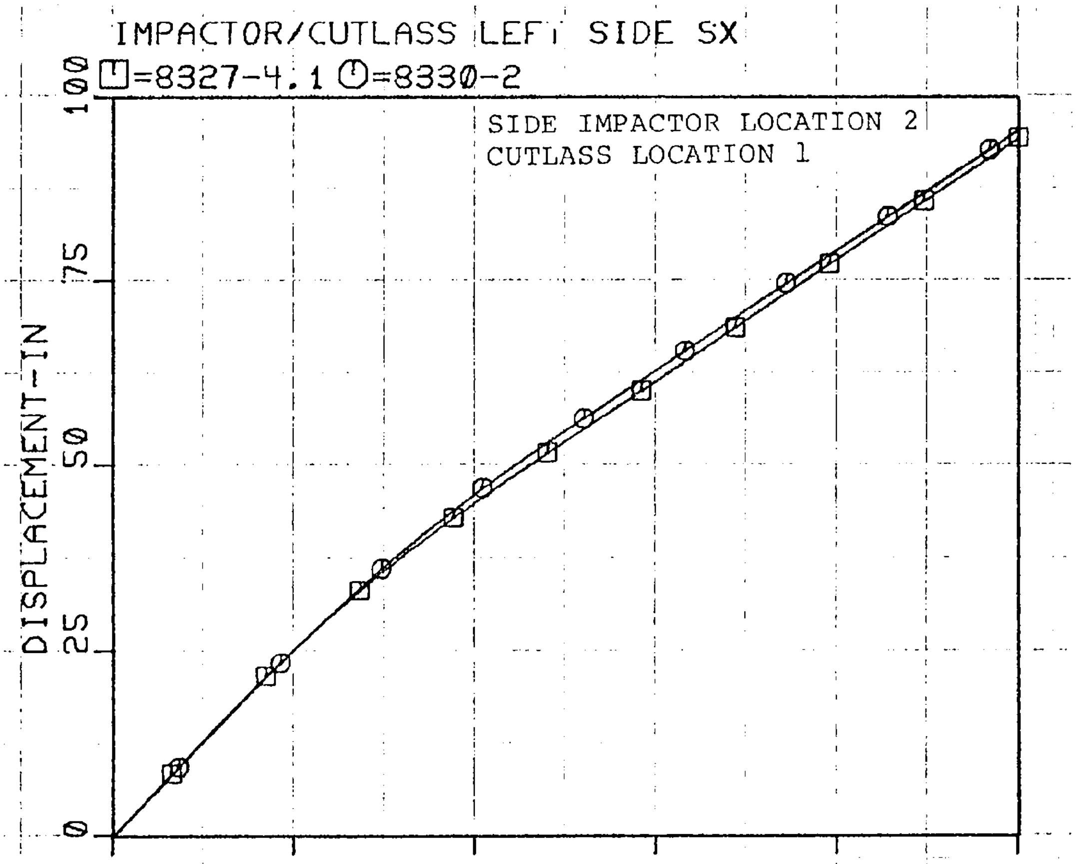

IMPACTOR/CUTLASS RIGHT SIDE AX
□=8327-4.1 ○=8330-2
SIDE IMPACTOR LOCATION 1
CUTLASS LOCATION 2
ACCELERATION-G
20
10
0
-10
-20
0
50
100
150
200
250
TIME-MS



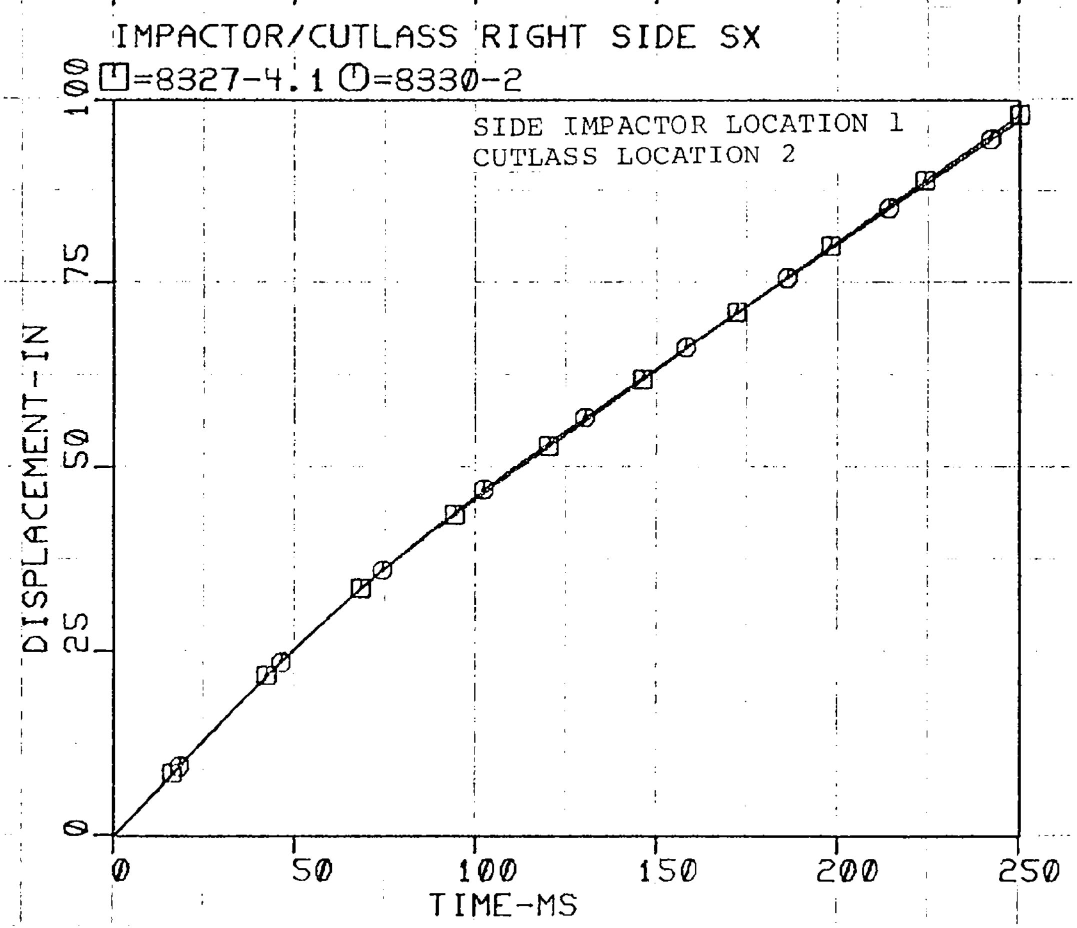
IMPACTOR/CUTLASS AVG. 1 & 2 AX
□=8327-4.1 ○=8330-2
AVERAGE BULLET VEHICLE
LONGITUDINAL ACCELERATION
ACCELERATION-G
20
10
0
-10
-20
0
50
100
150
200
250
TIME-MS


IMPACTOR/CUTLASS LEFT SIDE VX
□=8327-4.1 ○=8330-2
SIDE IMPACTOR LOCATION 2
CUTLASS LOCATION 1
VELOCITY-MPH
0
10
20
30
40
IMPACTOR/CUTLASS RIGHT SIDE VX
□=8327-4.1 ○=8330-2
SIDE IMPACTOR LOCATION 1
CUTLASS LOCATION 2
VELOCITY-MPH
0
10
20
30
40
0
50
100
150
200
250
TIME-MS

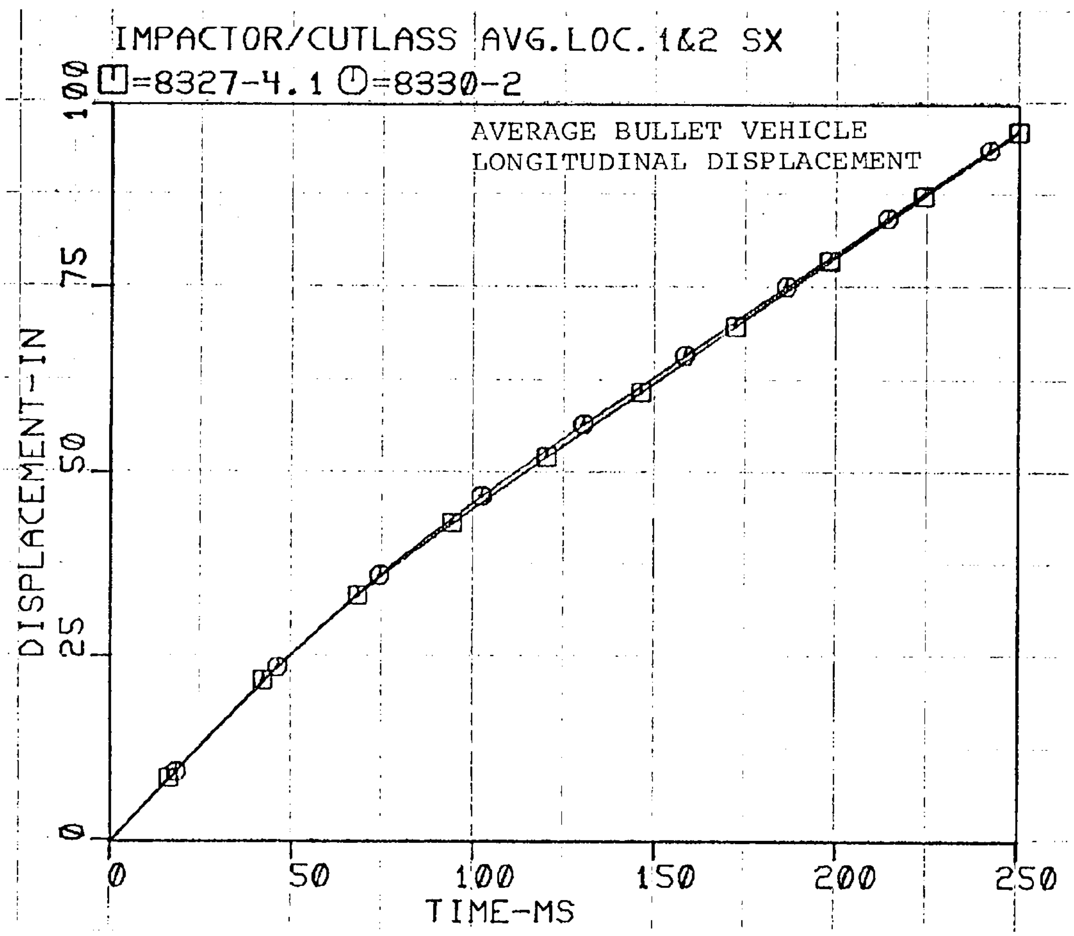

IMPACTOR/CUTLASS AVG. 1 & 2 VX
□=8327-4.1 ○=8330-2
AVERAGE BULLET VEHICLE
LONGITUDINAL VELOCITY
VELOCITY-MPH
TIME-MS
0
10
20
30
40
0
50
100
150
200
250

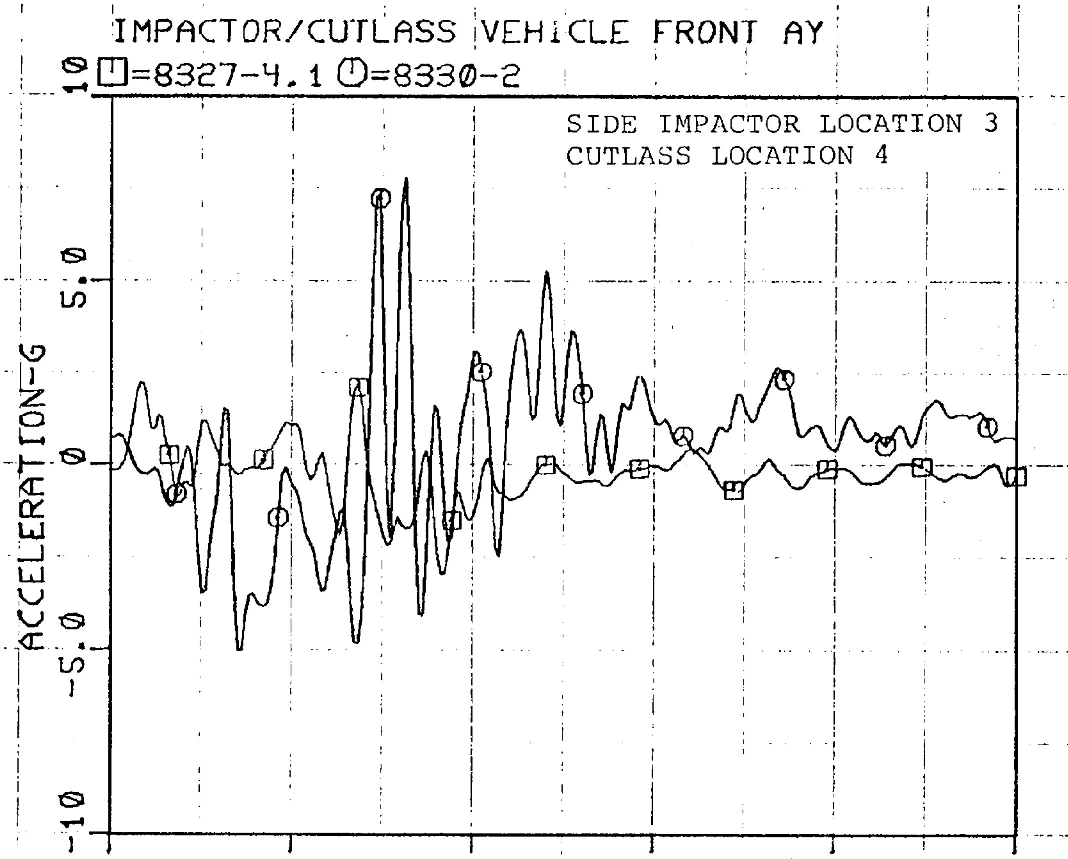


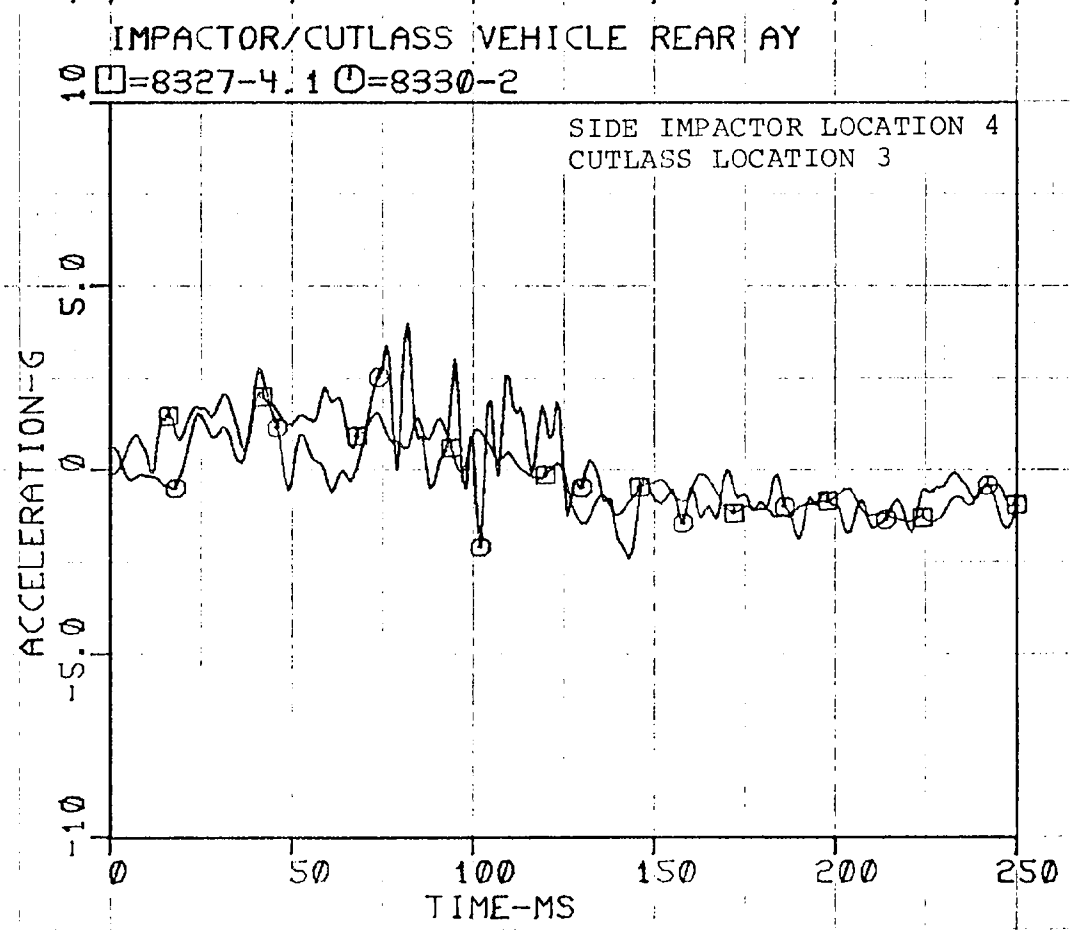
IMPACTOR/CUTLASS LEFT SIDE SX
□=8327-4.1 ○=8330-2
SIDE IMPACTOR LOCATION 2
CUTLASS LOCATION 1
DISPLACEMENT-IN
0
25
50
75
100

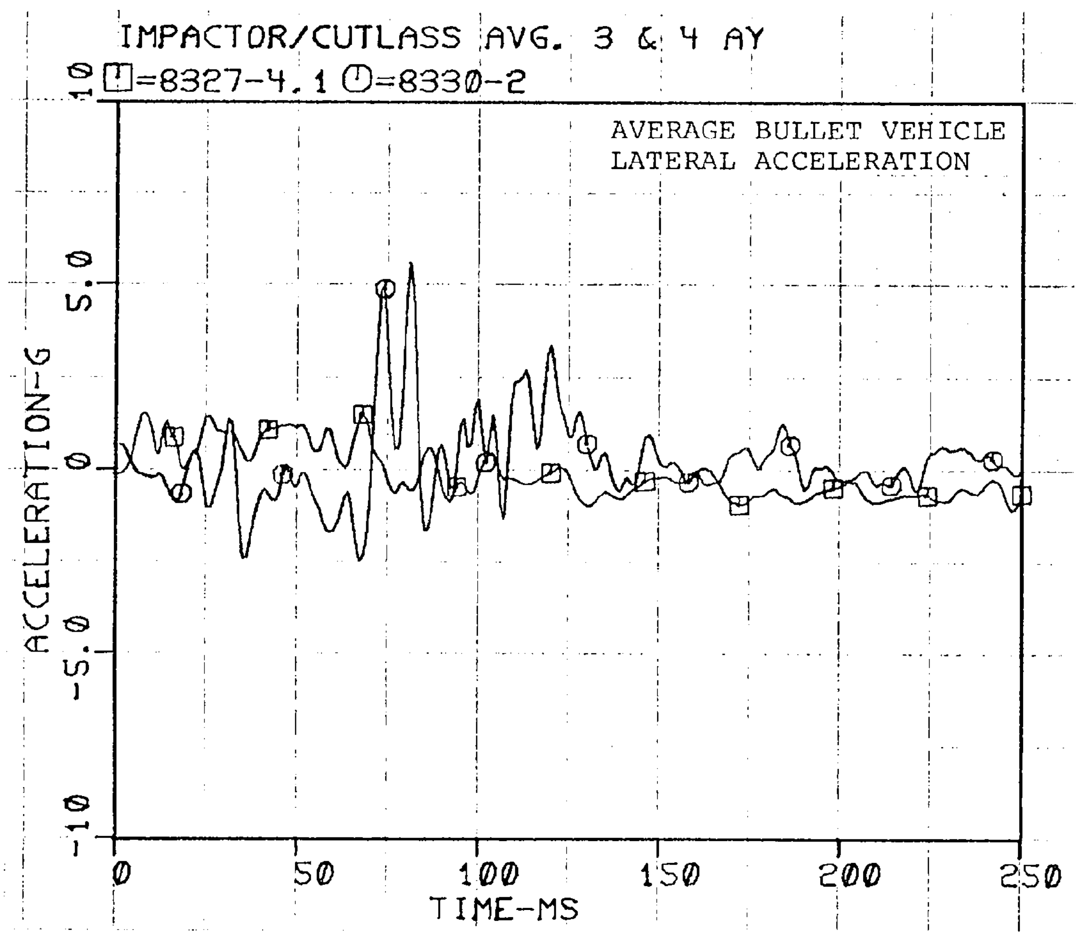


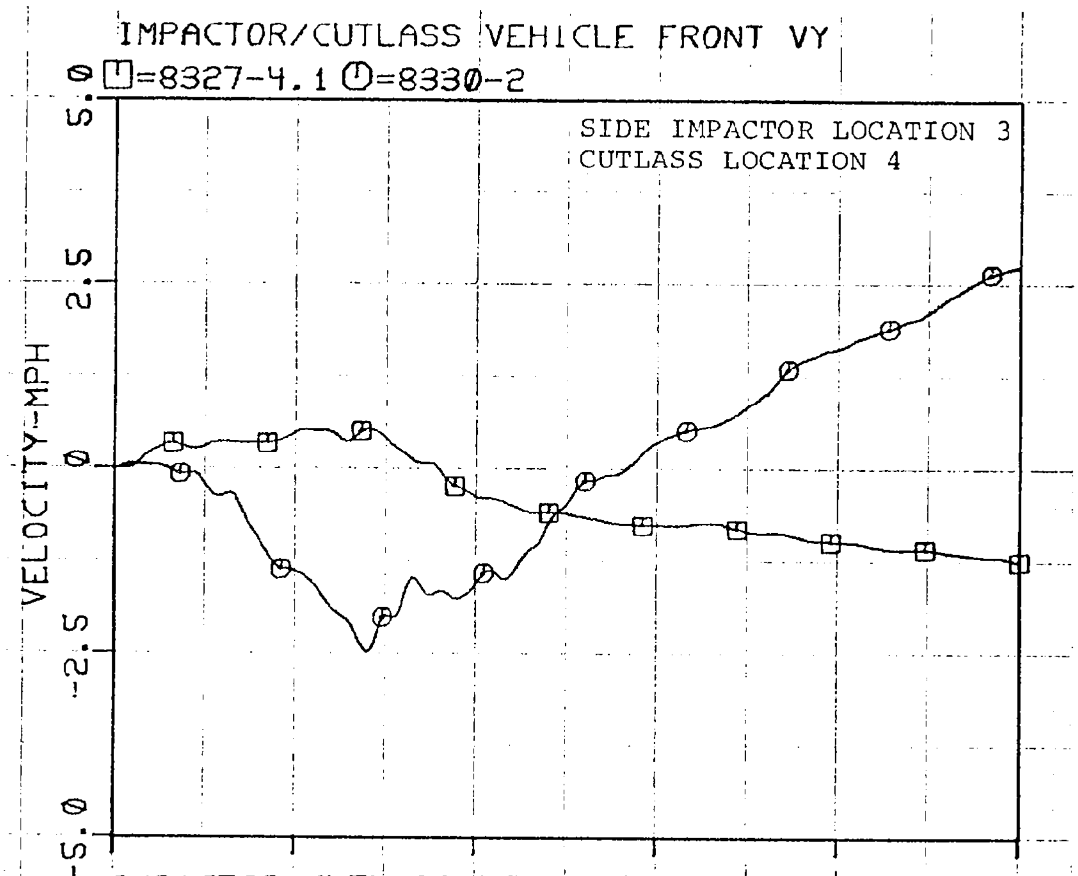
IMPACTOR/CUTLASS RIGHT SIDE SX
□=8327-4.1 ○=8330-2
SIDE IMPACTOR LOCATION 1
CUTLASS LOCATION 2
DISPLACEMENT-IN
0
25
50
75
100
0
50
100
150
200
250
TIME-MS

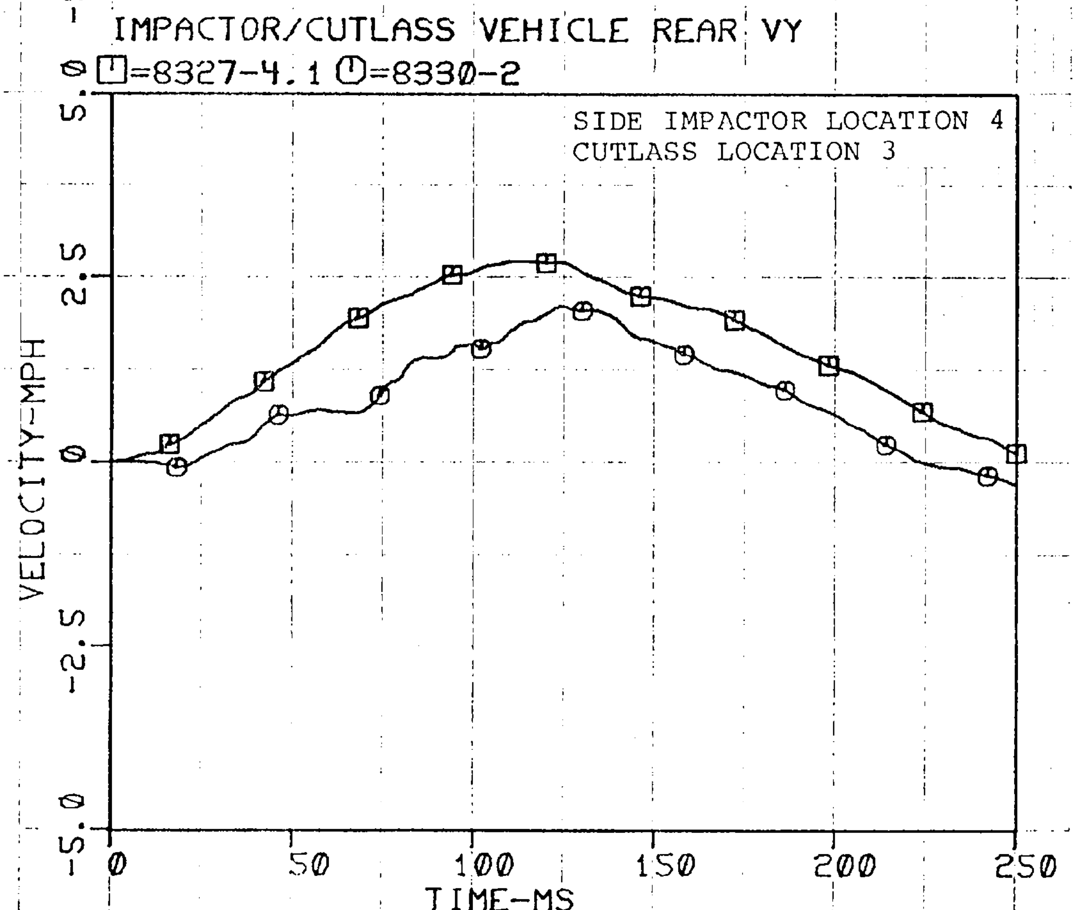

IMPACTOR/CUTLASS AVG.LOC.1&2 SX
□=8327-4.1 ○=8330-2
AVERAGE BULLET VEHICLE
LONGITUDINAL DISPLACEMENT
DISPLACEMENT-IN
TIME-MS
0
25
50
75
100
0
50
100
150
200
250

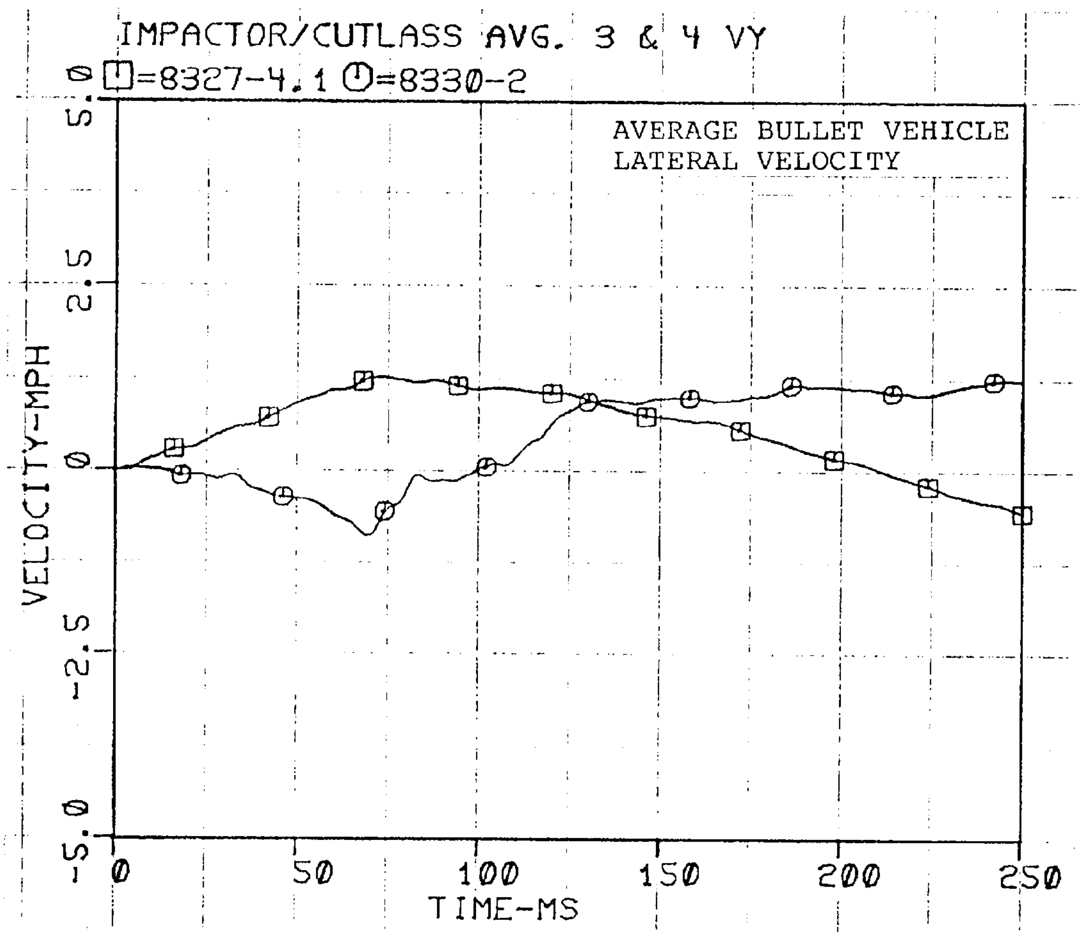

IMPACTOR/CUTLASS VEHICLE FRONT AY
□=8327-4.1 ⊙=8330-2
SIDE IMPACTOR LOCATION 3
CUTLASS LOCATION 4
ACCELERATION-G
10
5.0
0
-5.0
-10


IMPACTOR/CUTLASS VEHICLE REAR AY
□=8327-4.1 ⊙=8330-2
SIDE IMPACTOR LOCATION 4
CUTLASS LOCATION 3
ACCELERATION-G
10
5.0
0
-5.0
-10
0
50
100
150
200
250
TIME-MS

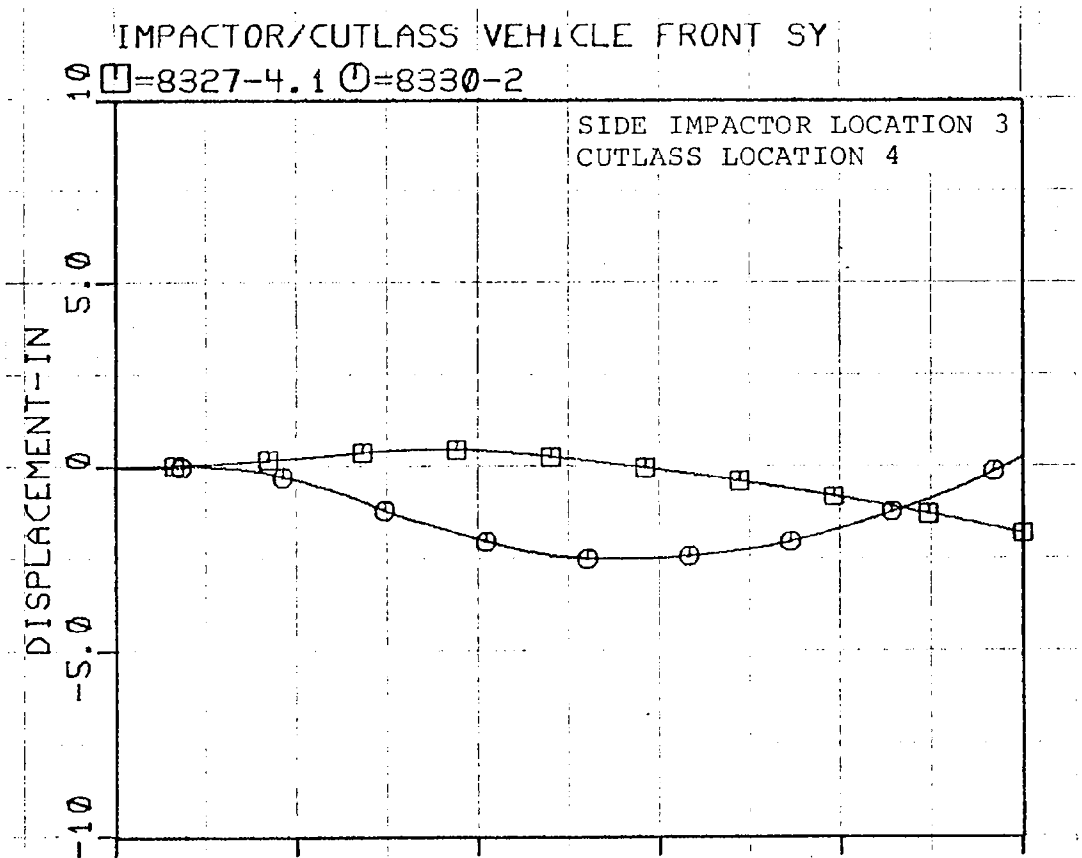

IMPACTOR/CUTLASS AVG. 3 & 4 AY
□=8327-4.1 ○=8330-2
AVERAGE BULLET VEHICLE
LATERAL ACCELERATION
ACCELERATION-G
10
5.0
0
-5.0
-10
0
50
100
150
200
250
TIME-MS

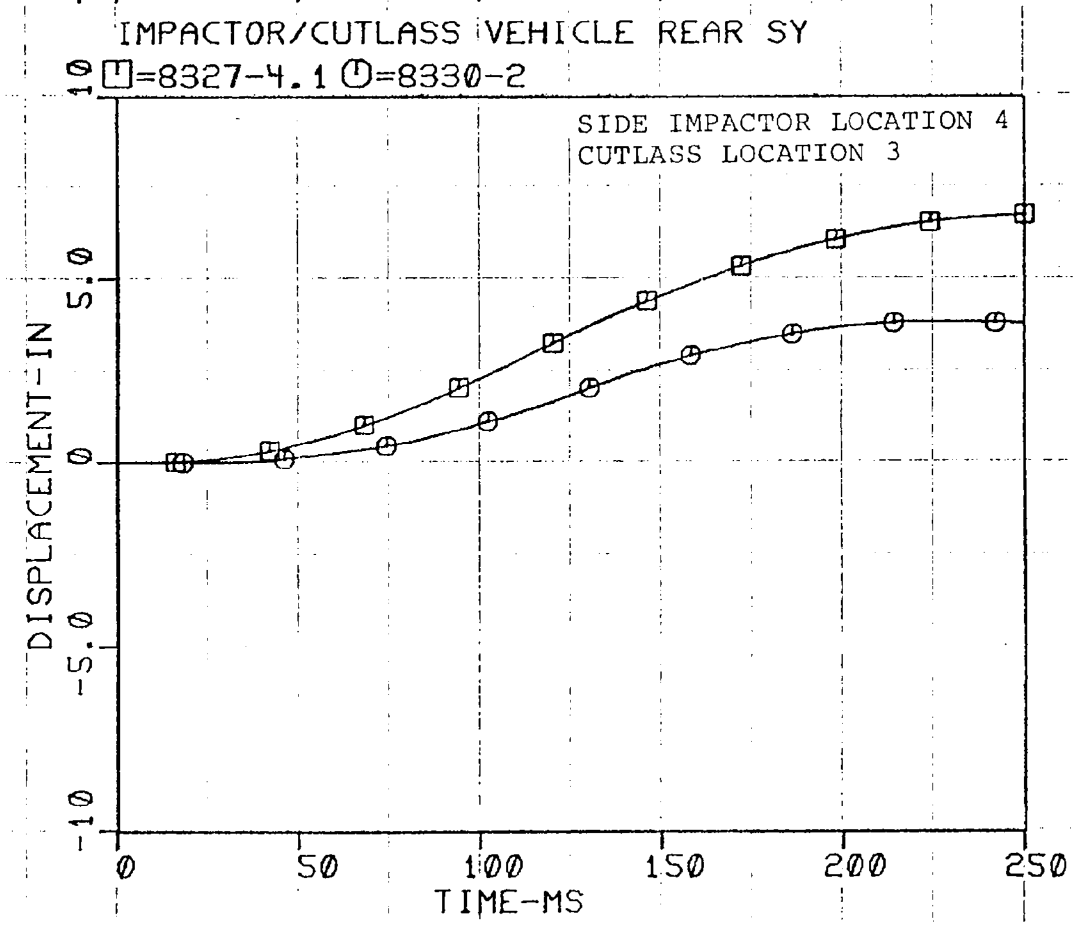

IMPACTOR/CUTLASS VEHICLE FRONT VY
□=8327-4.1 ○=8330-2
SIDE IMPACTOR LOCATION 3
CUTLASS LOCATION 4
VELOCITY-MPH
5.0
2.5
0
-2.5
-5.0

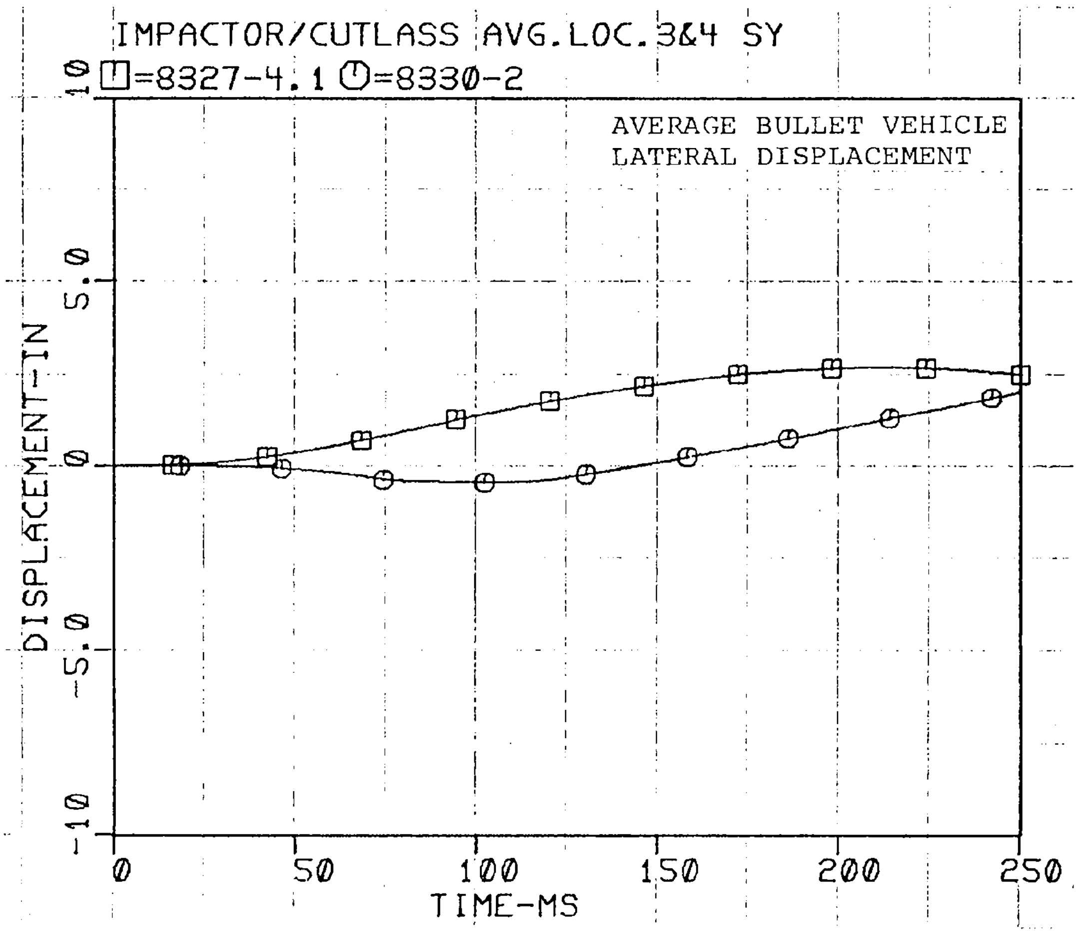

IMPACTOR/CUTLASS VEHICLE REAR VY
□=8327-4.1 ○=8330-2
SIDE IMPACTOR LOCATION 4
CUTLASS LOCATION 3
VELOCITY-MPH
5.0
2.5
0
-2.5
-5.0
0
50
100
150
200
250
TIME-MS



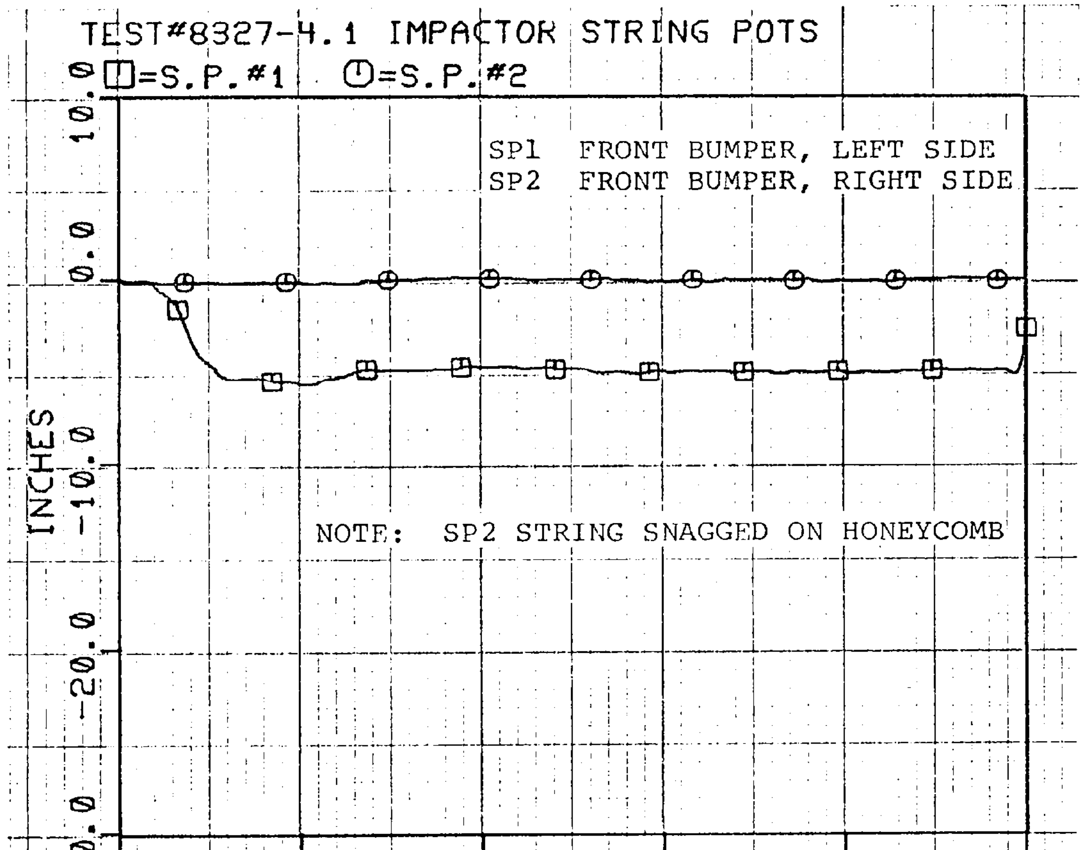
IMPACTOR/CUTLASS AVG. 3 & 4 VY
□=8327-4.1 ○=8330-2
AVERAGE BULLET VEHICLE
LATERAL VELOCITY
VELOCITY-MPH
5.0
2.5
0
-2.5
-5.0
0
50
100
150
200
250
TIME-MS

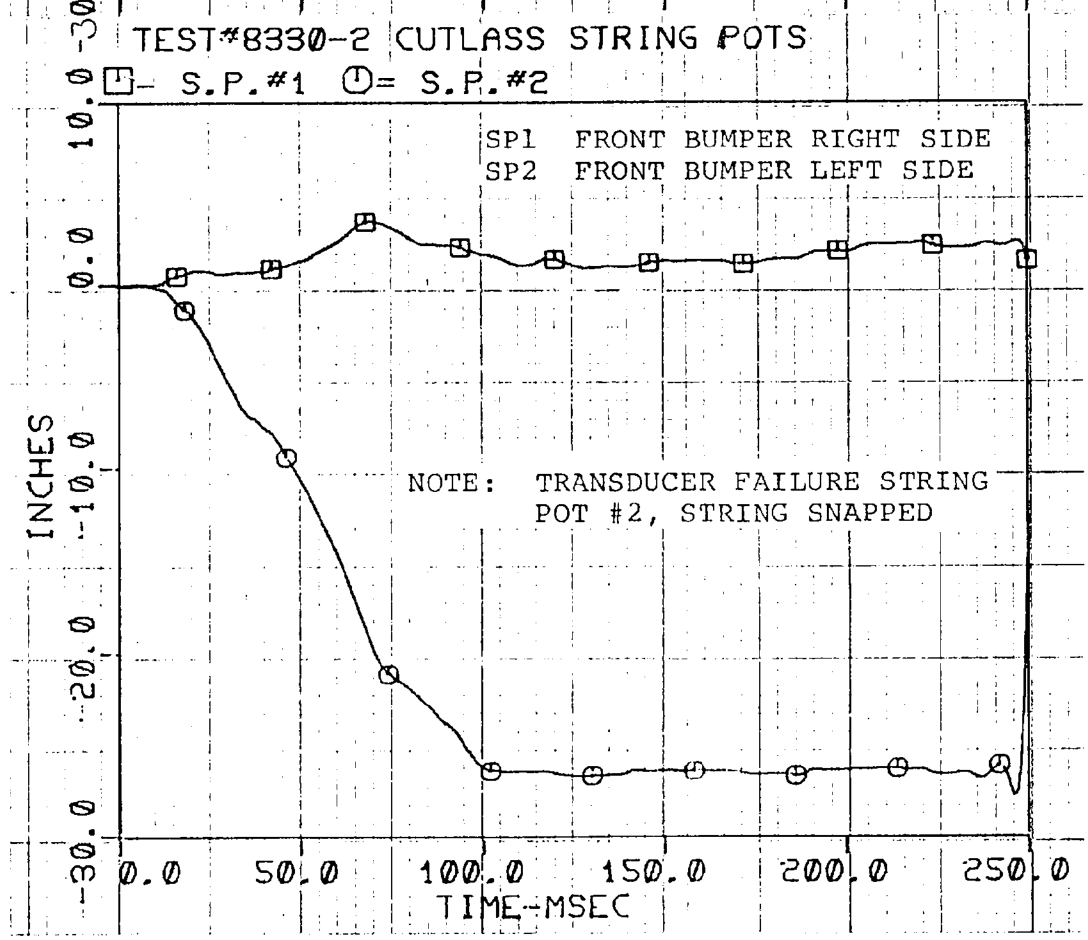

IMPACTOR/CUTLASS VEHICLE FRONT SY
□=8327-4.1 ⊕=8330-2
SIDE IMPACTOR LOCATION 3
CUTLASS LOCATION 4
DISPLACEMENT-IN
10
5.0
0
-5.0
-10

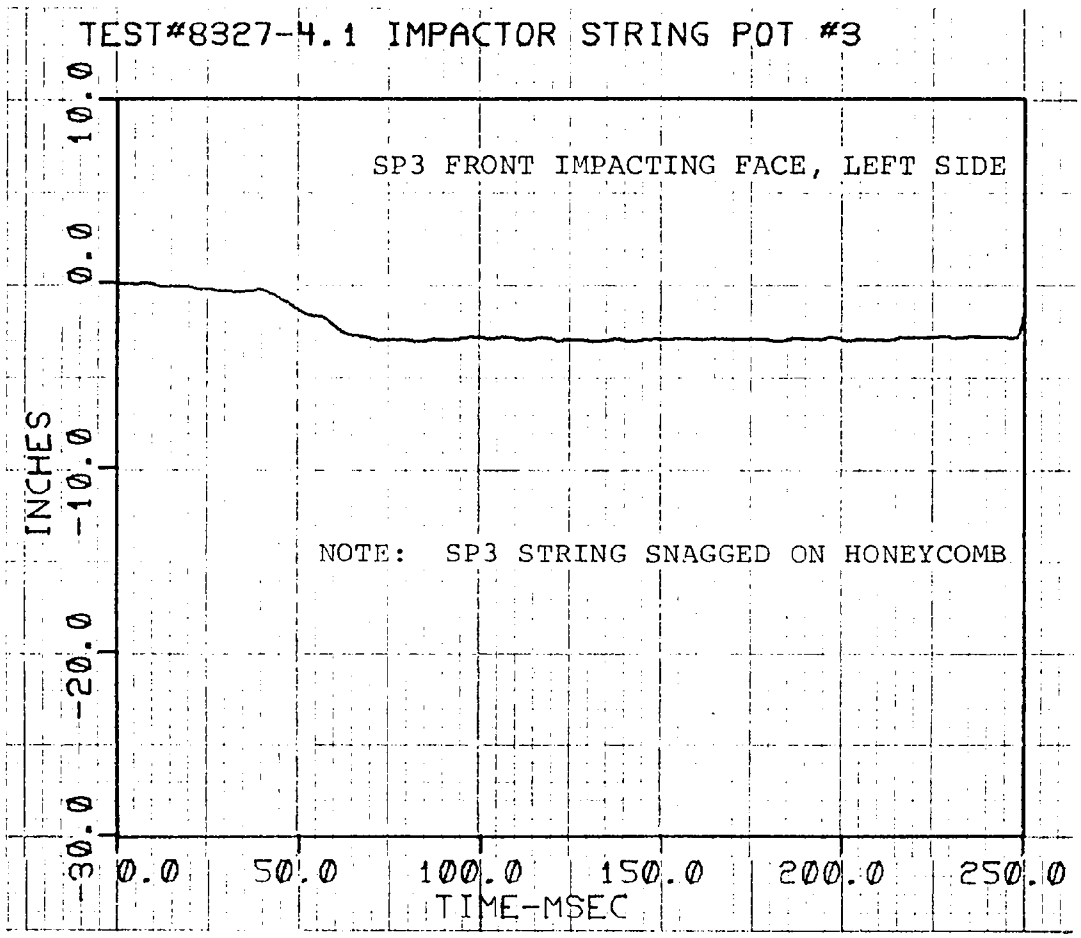

IMPACTOR/CUTLASS VEHICLE REAR SY
□=8327-4.1 ⊕=8330-2
SIDE IMPACTOR LOCATION 4
CUTLASS LOCATION 3
DISPLACEMENT-IN
10
5.0
0
-5.0
-10
0
50
100
150
200
250
TIME-MS



IMPACTOR/CUTLASS AVG.LOC.3&4 SY
□=8327-4.1 ○=8330-2
AVERAGE BULLET VEHICLE
LATERAL DISPLACEMENT
DISPLACEMENT-IN
10
5.0
0
-5.0
-10
0
50
100
150
200
250
TIME-MS

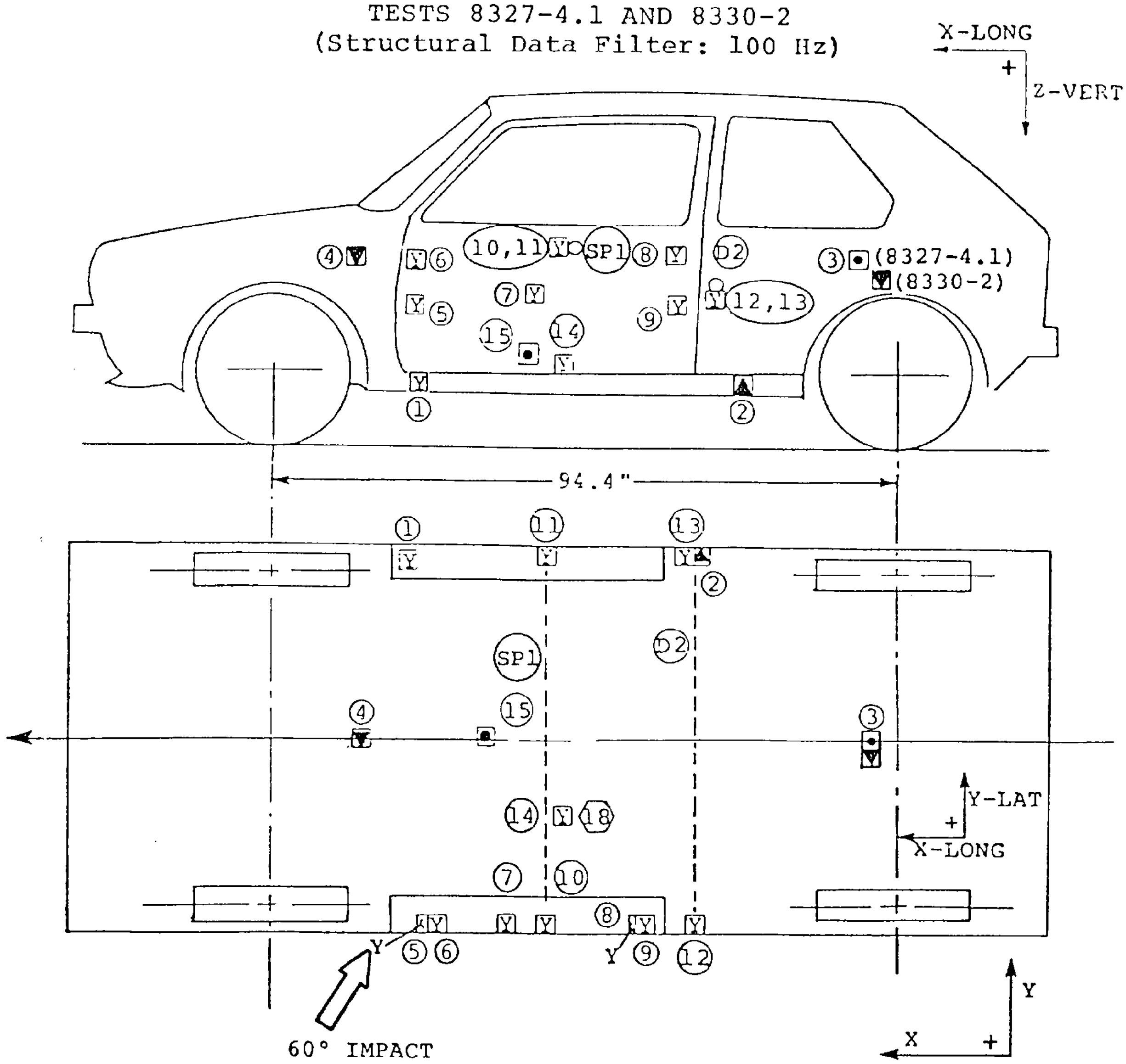

TEST#8327-4.1 IMPACTOR STRING POTS
□=S.P.#1 ○=S.P.#2
SP1 FRONT BUMPER, LEFT SIDE
SP2 FRONT BUMPER, RIGHT SIDE
NOTE: SP2 STRING SNAGGED ON HONEYCOMB
INCHES
10.0
0.0
-10.0
-20.0
-30.0


TEST#8330-2 CUTLASS STRING POTS
□= S.P.#1 ○= S.P.#2
SP1 FRONT BUMPER RIGHT SIDE
SP2 FRONT BUMPER LEFT SIDE
NOTE: TRANSDUCER FAILURE STRING
POT #2, STRING SNAPPED
INCHES
10.0
0.0
-10.0
-20.0
-30.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC


TEST#8327-4.1 IMPACTOR STRING POT #3
SP3 FRONT IMPACTING FACE, LEFT SIDE
NOTE: SP3 STRING SNAGGED ON HONEYCOMB
INCHES
10.0
0.0
-10.0
-20.0
-30.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

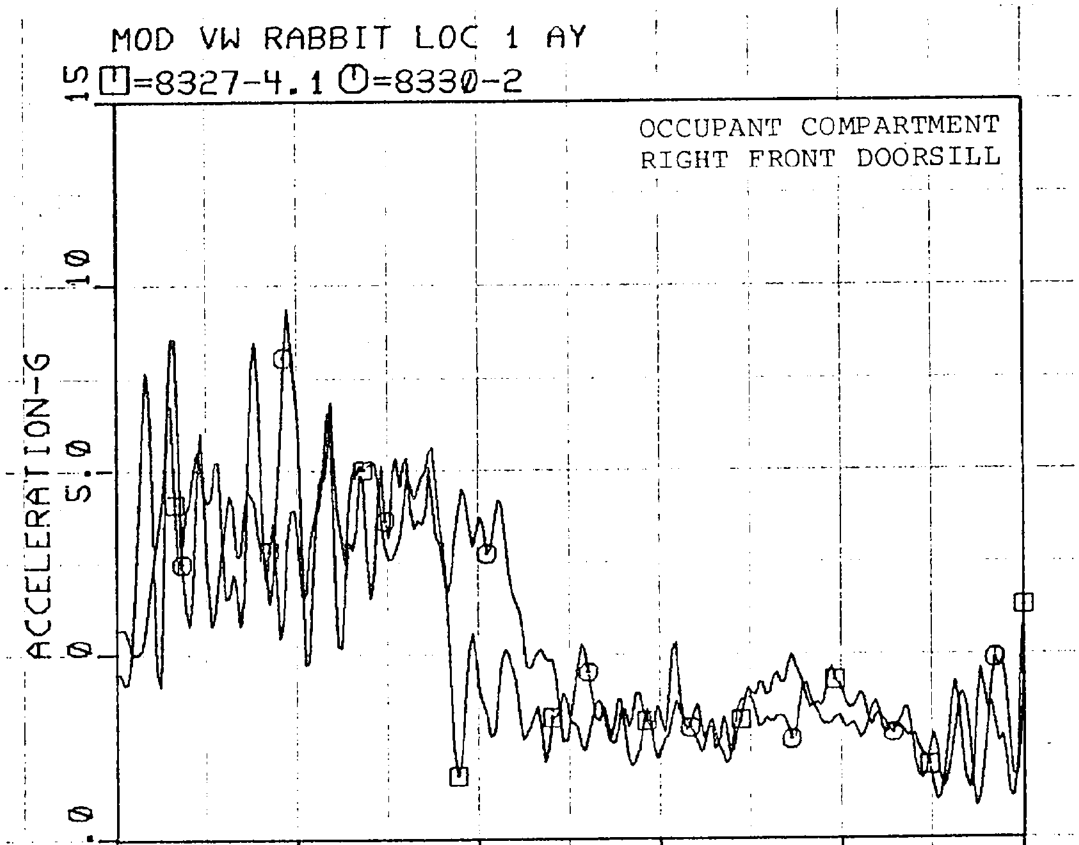
APPENDIX B

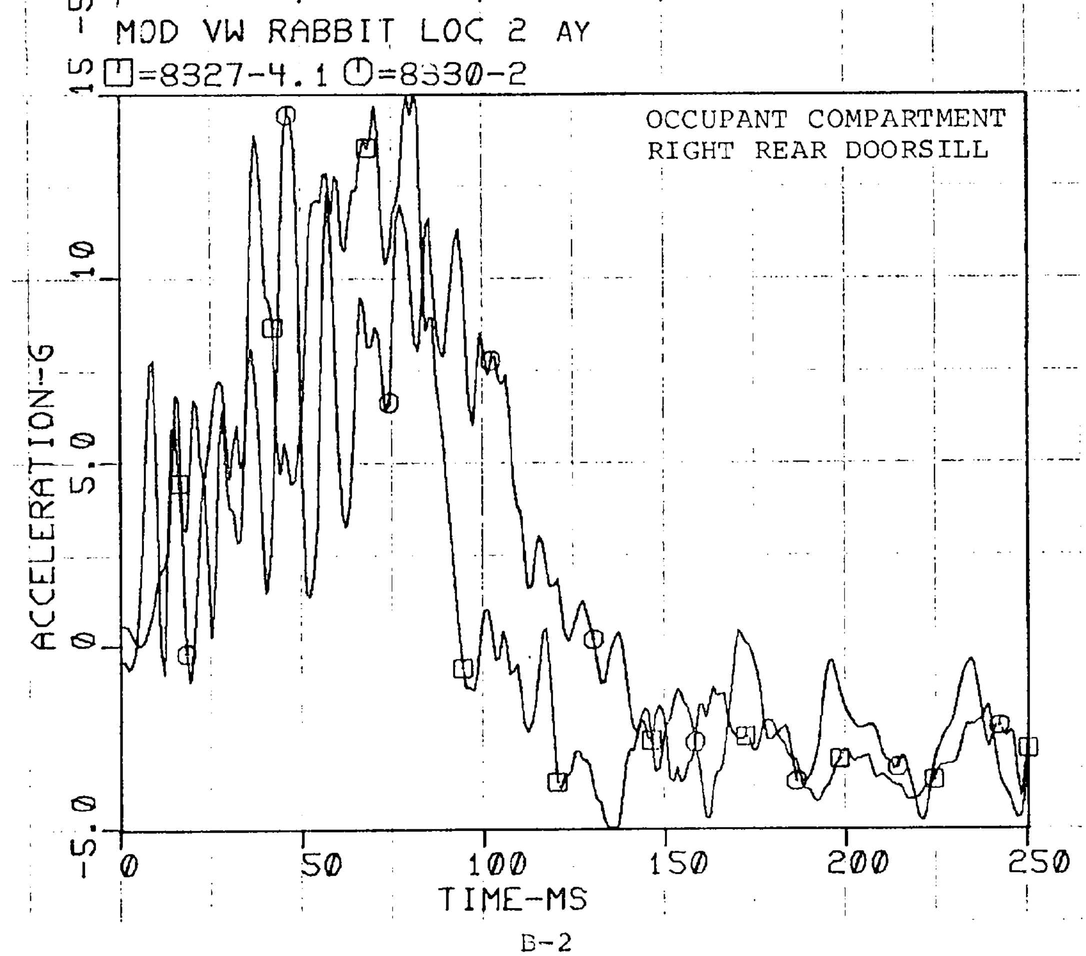
COMPARISON OF TARGET VEHICLE DATA PLOTS FROM TESTS 8327-4.1 AND 8330-2 (Structural Data Filter: 100 Hz)

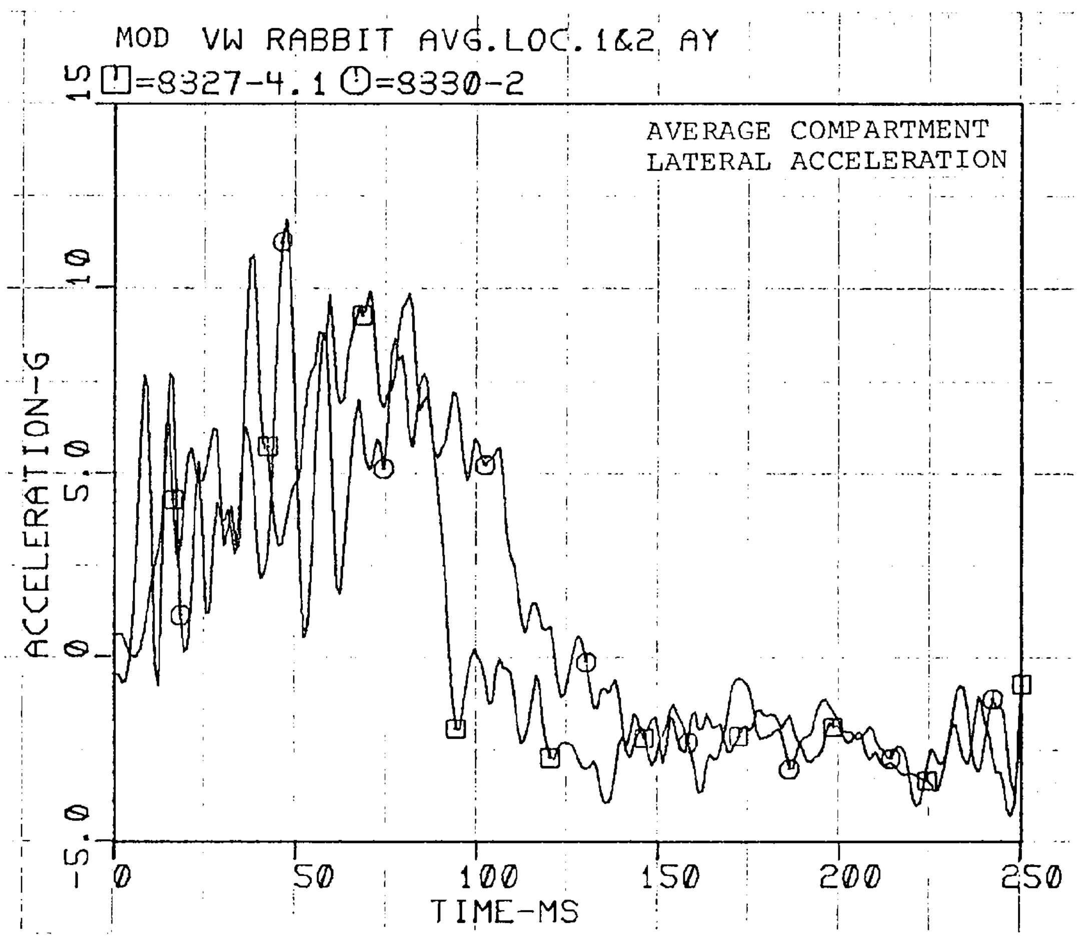


- AXIAL ACCELEROMETER (Y DIRECTION)
- BIAXIAL ACCELEROMETER (Y,Z DIRECTION)
- BIAXIAL ACCELEROMETER (X,Z DIRECTION)
- TRIAXIAL ACCELEROMETER (X,Y,Z DIRECTION)
- DISPLACEMENT TUBE OR STRING POTENTIOMETER
- 18 SIDE IMPACT SURROGATE
- BIAXIAL ACCELEROMETER (X,Y DIRECTION)

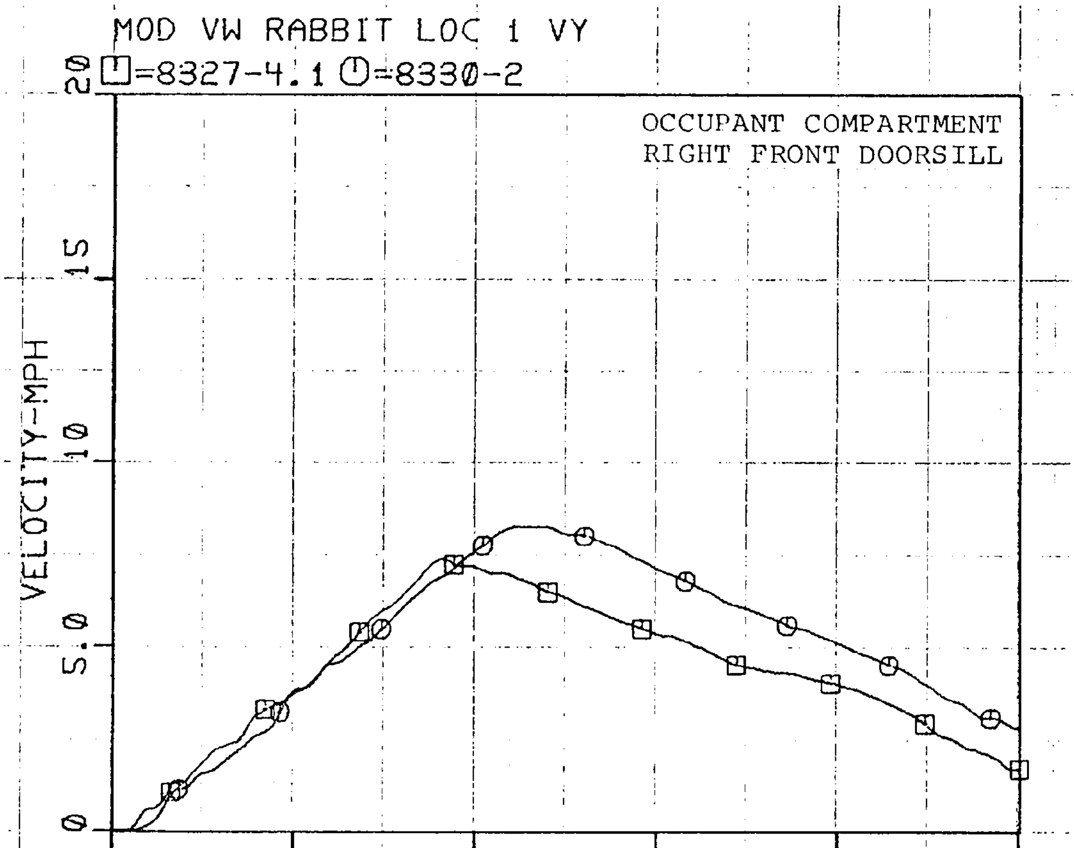
Figure B-1. Target Vehicle Instrumentation (Tests 8327-4.1 and 8330-2).


MOD VW RABBIT LOC 1 AY
□=8327-4.1 ○=8330-2
OCCUPANT COMPARTMENT
RIGHT FRONT DOORSILL
ACCELERATION-G
15
10
5.0
0
-5.0

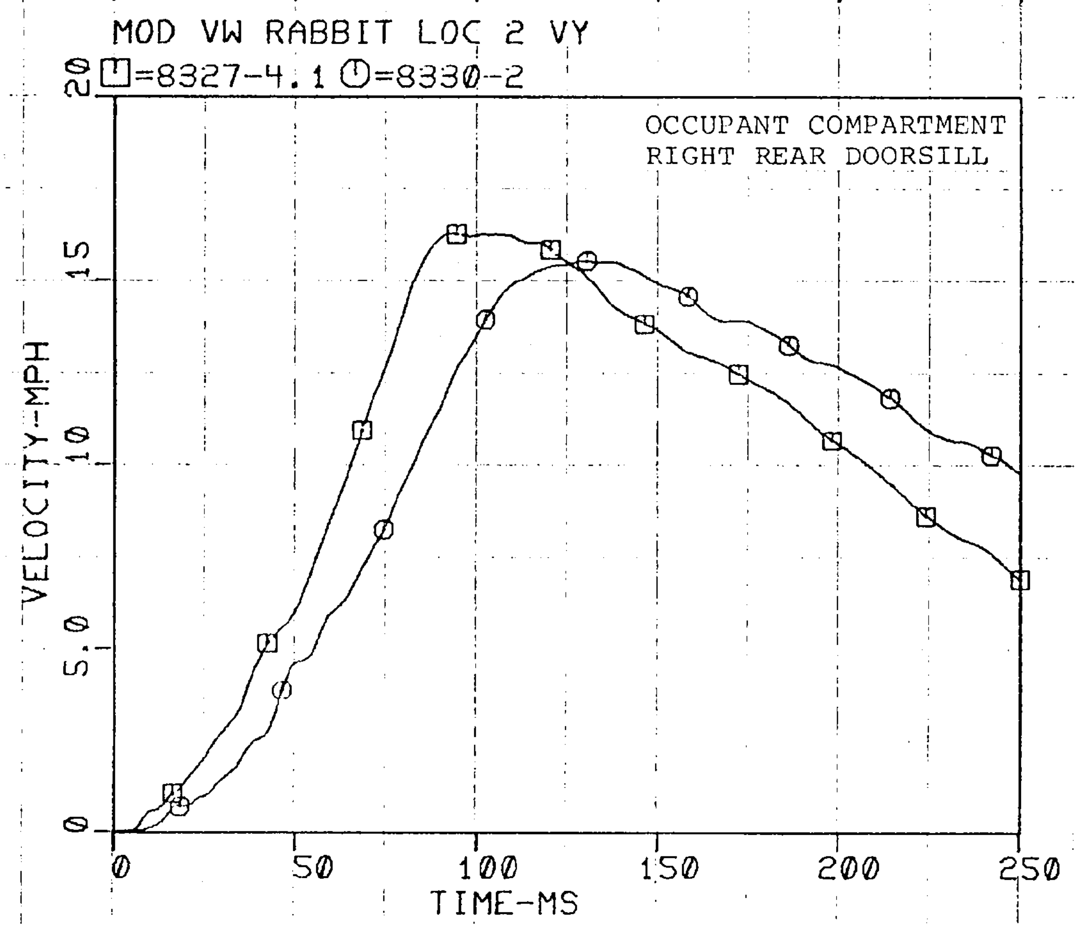

MOD VW RABBIT LOC 2 AY
□=8327-4.1 ○=8330-2
OCCUPANT COMPARTMENT
RIGHT REAR DOORSILL
ACCELERATION-G
15
10
5.0
0
-5.0
0
50
100
150
200
250
TIME-MS



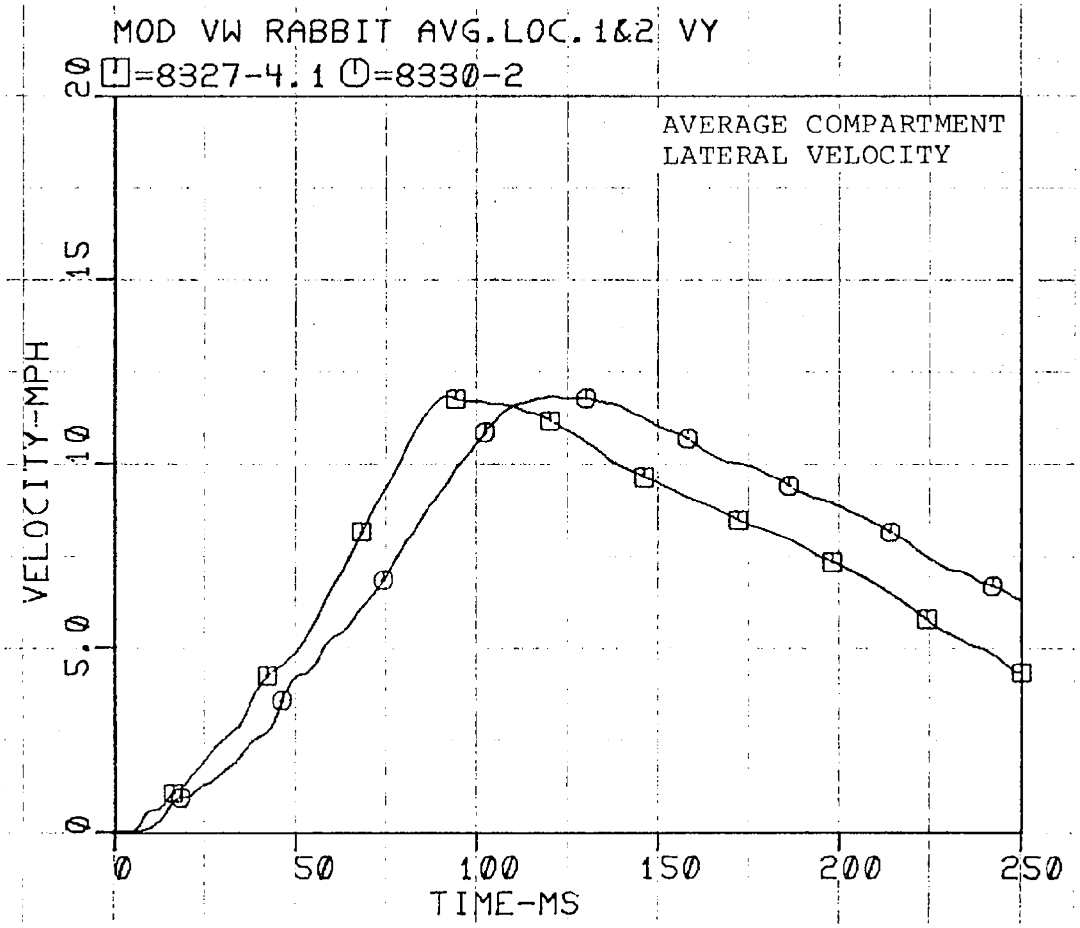
MOD VW RABBIT AVG.LOC.1&2 AY
□=8327-4.1 ○=8330-2
AVERAGE COMPARTMENT
LATERAL ACCELERATION
ACCELERATION-G
15
10
5.0
0
-5.0
0
50
100
150
200
250
TIME-MS



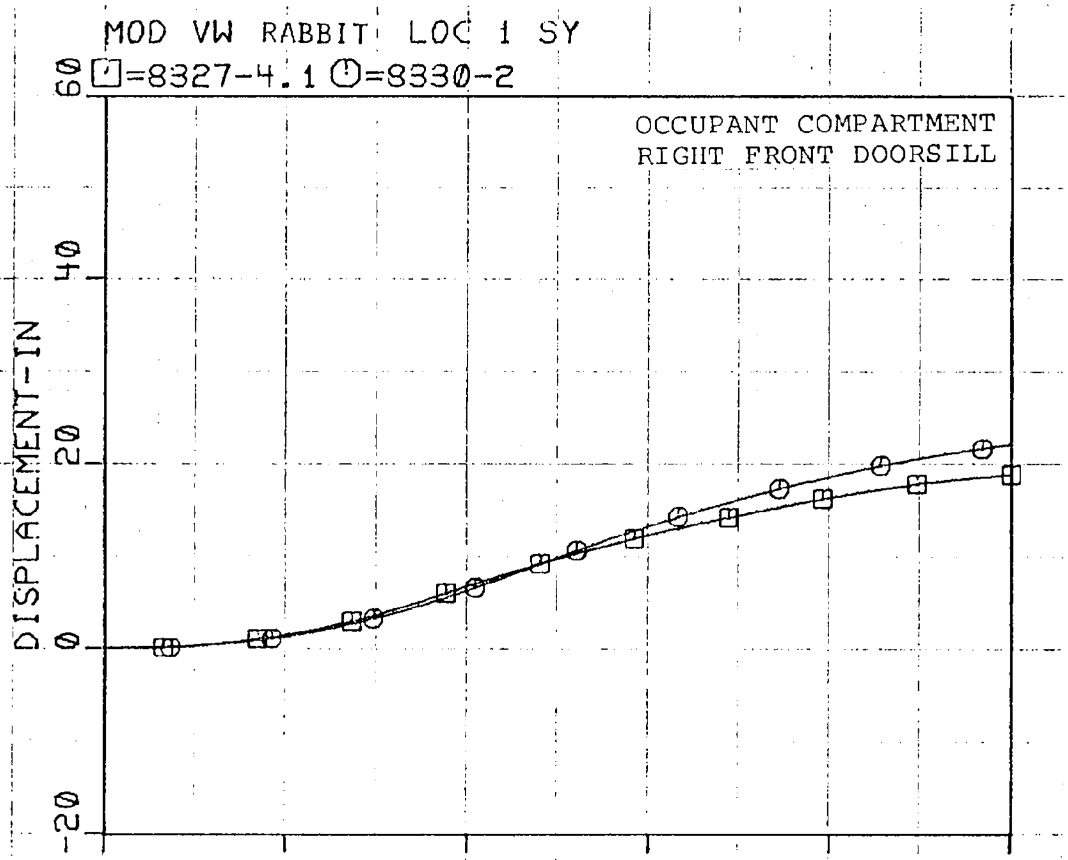
MOD VW RABBIT LOC 1 VY
□=8327-4.1 ○=8330-2
OCCUPANT COMPARTMENT
RIGHT FRONT DOORSILL
VELOCITY-MPH
0
5.0
10
15
20

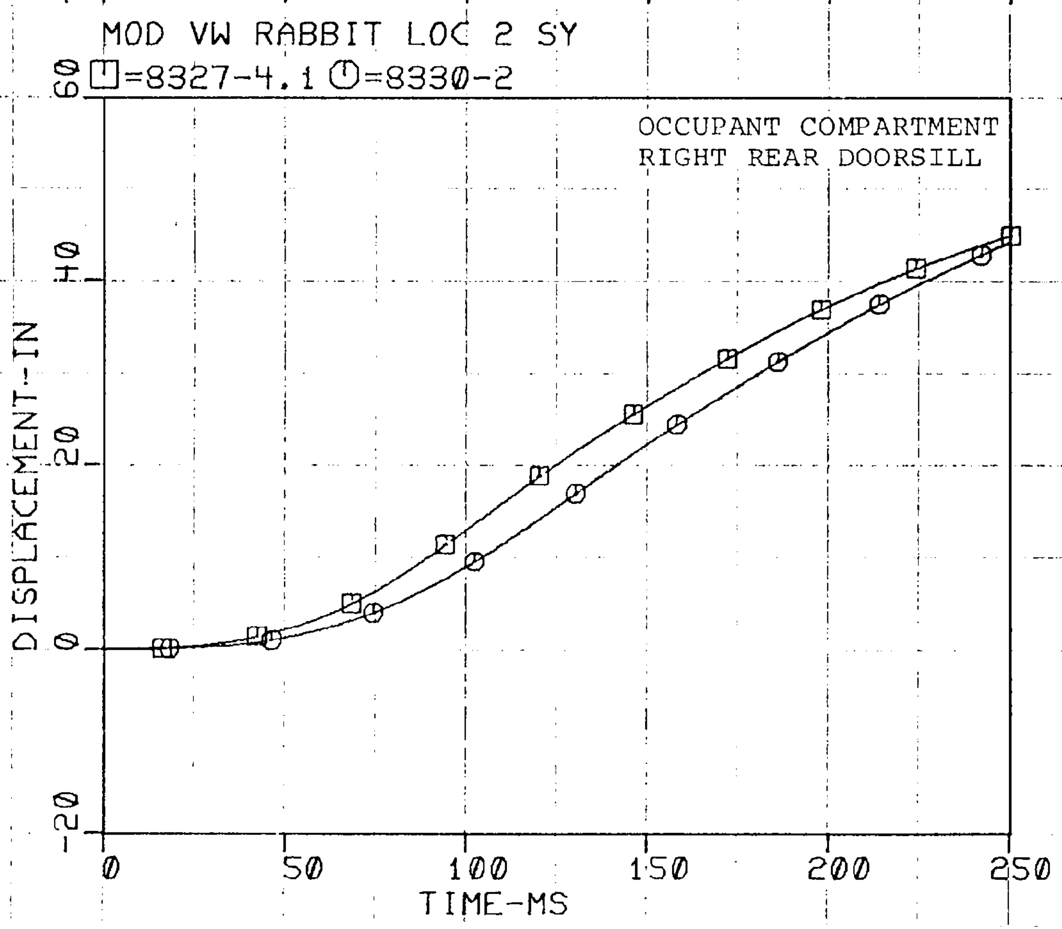


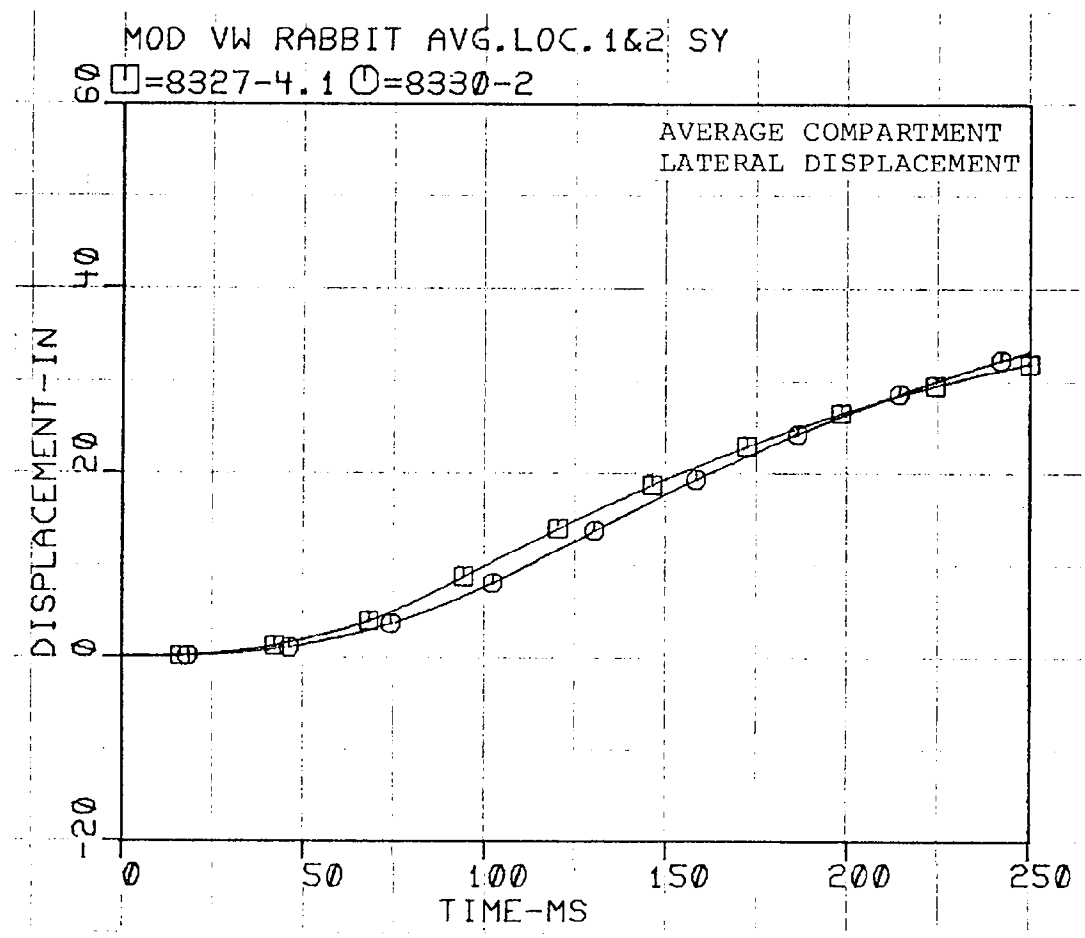
MOD VW RABBIT LOC 2 VY
□=8327-4.1 ○=8330-2
OCCUPANT COMPARTMENT
RIGHT REAR DOORSILL
VELOCITY-MPH
0
5.0
10
15
20
0
50
100
150
200
250
TIME-MS

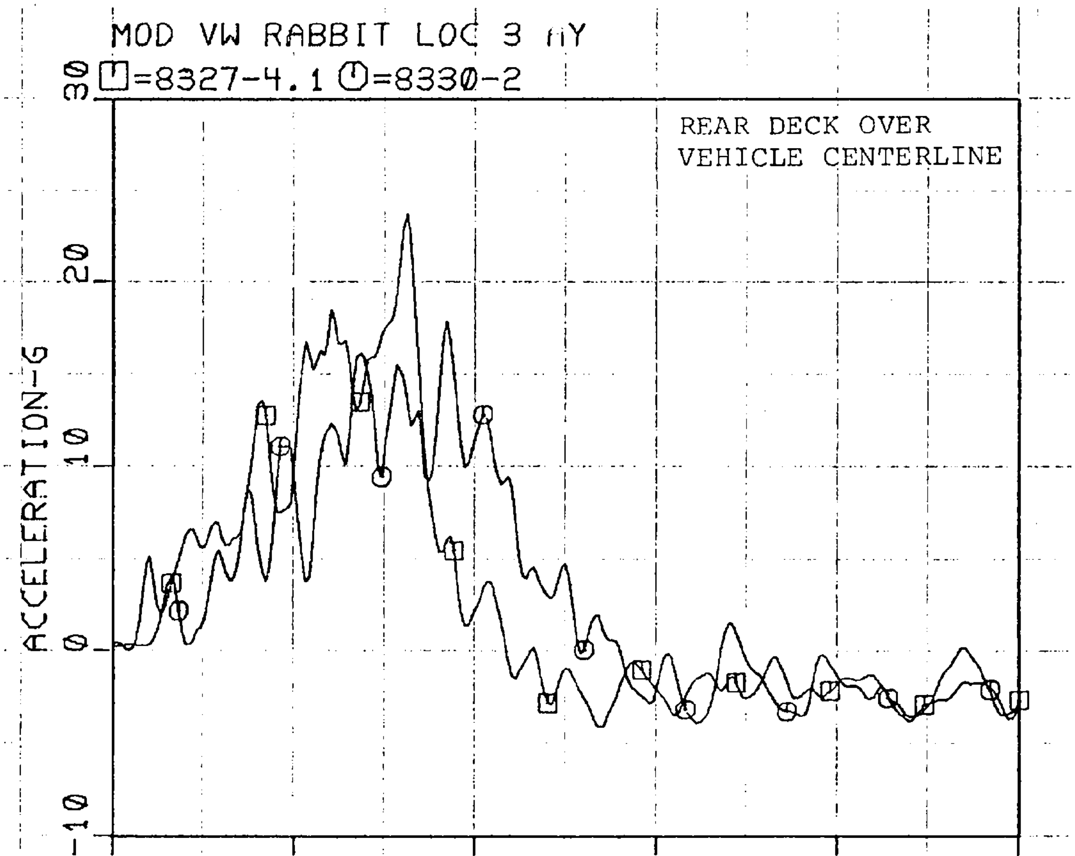


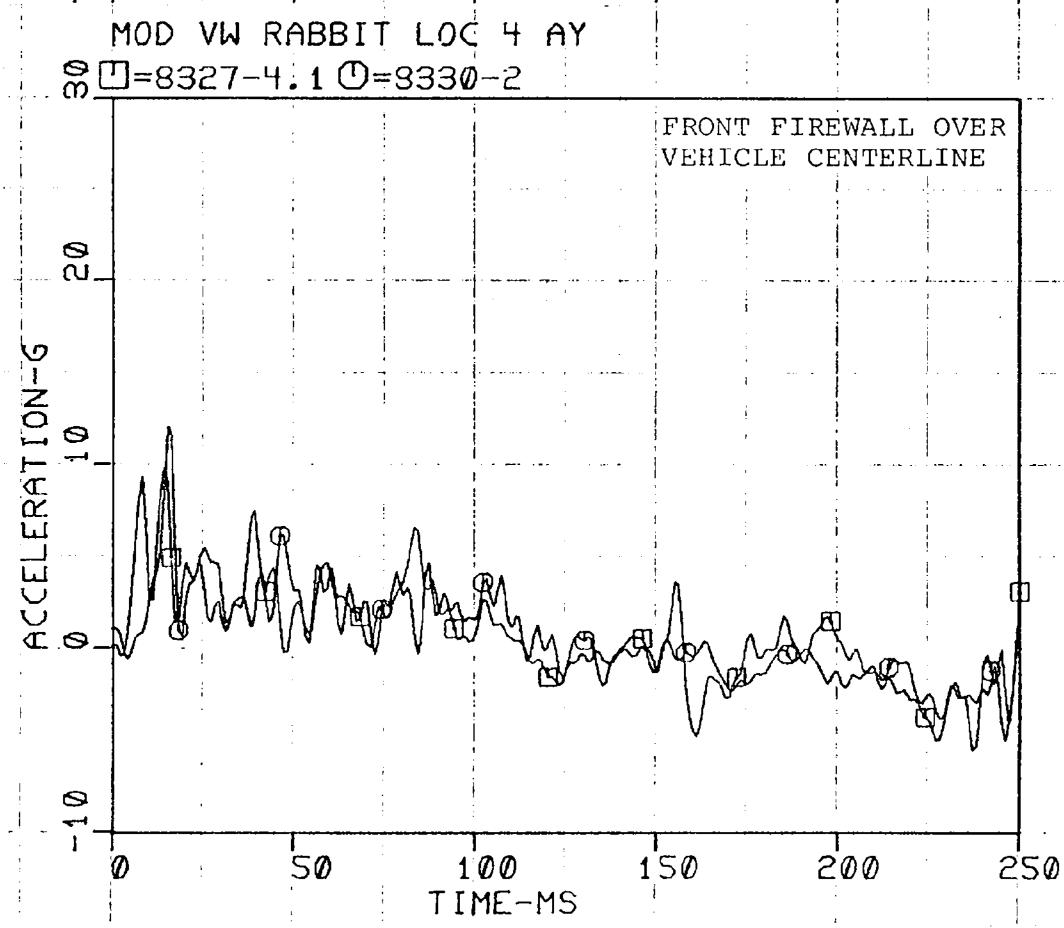
MOD VW RABBIT AVG.LOC.1&2 VY
□=8327-4.1 ○=8330-2
AVERAGE COMPARTMENT
LATERAL VELOCITY
VELOCITY-MPH
0
5.0
10
15
20
0
50
100
150
200
250
TIME-MS

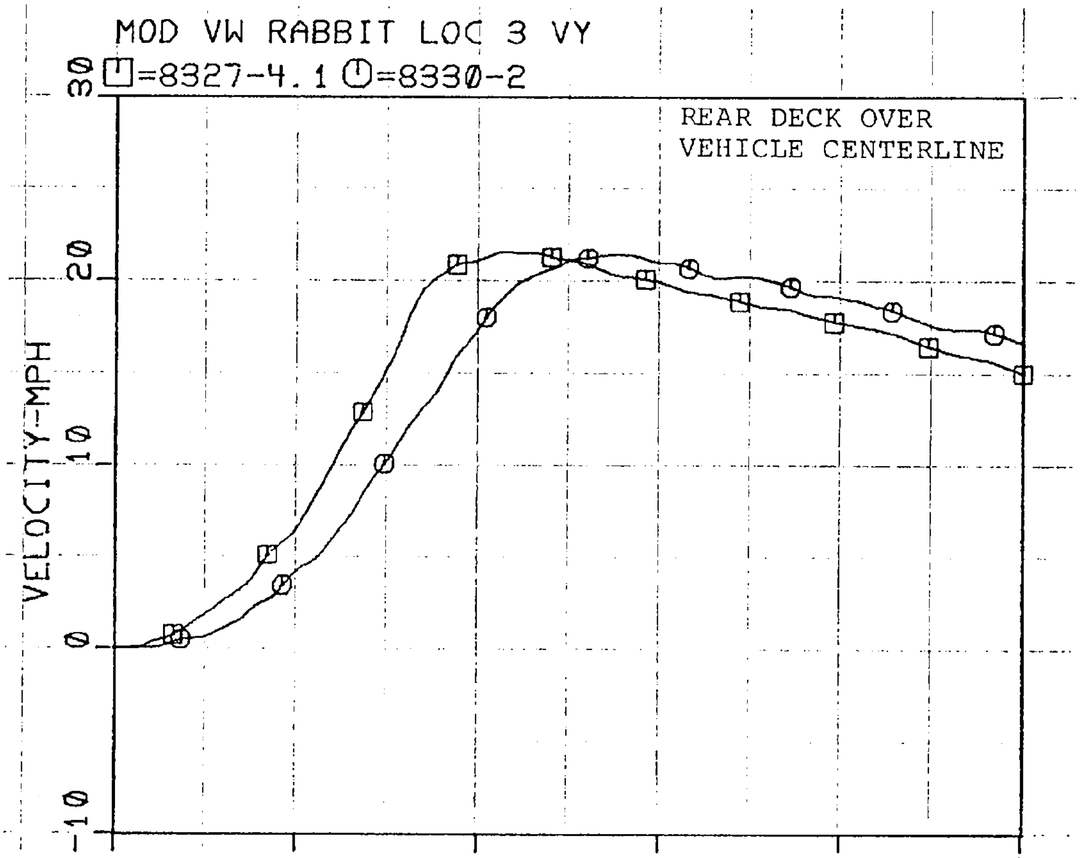

MOD VW RABBIT LOC 1 SY
□=8327-4.1 ○=8330-2
OCCUPANT COMPARTMENT
RIGHT FRONT DOORSILL
DISPLACEMENT-IN
60
40
20
0
-20


MOD VW RABBIT LOC 2 SY
□=8327-4.1 ○=8330-2
OCCUPANT COMPARTMENT
RIGHT REAR DOORSILL
DISPLACEMENT-IN
60
40
20
0
-20
0
50
100
150
200
250
TIME-MS

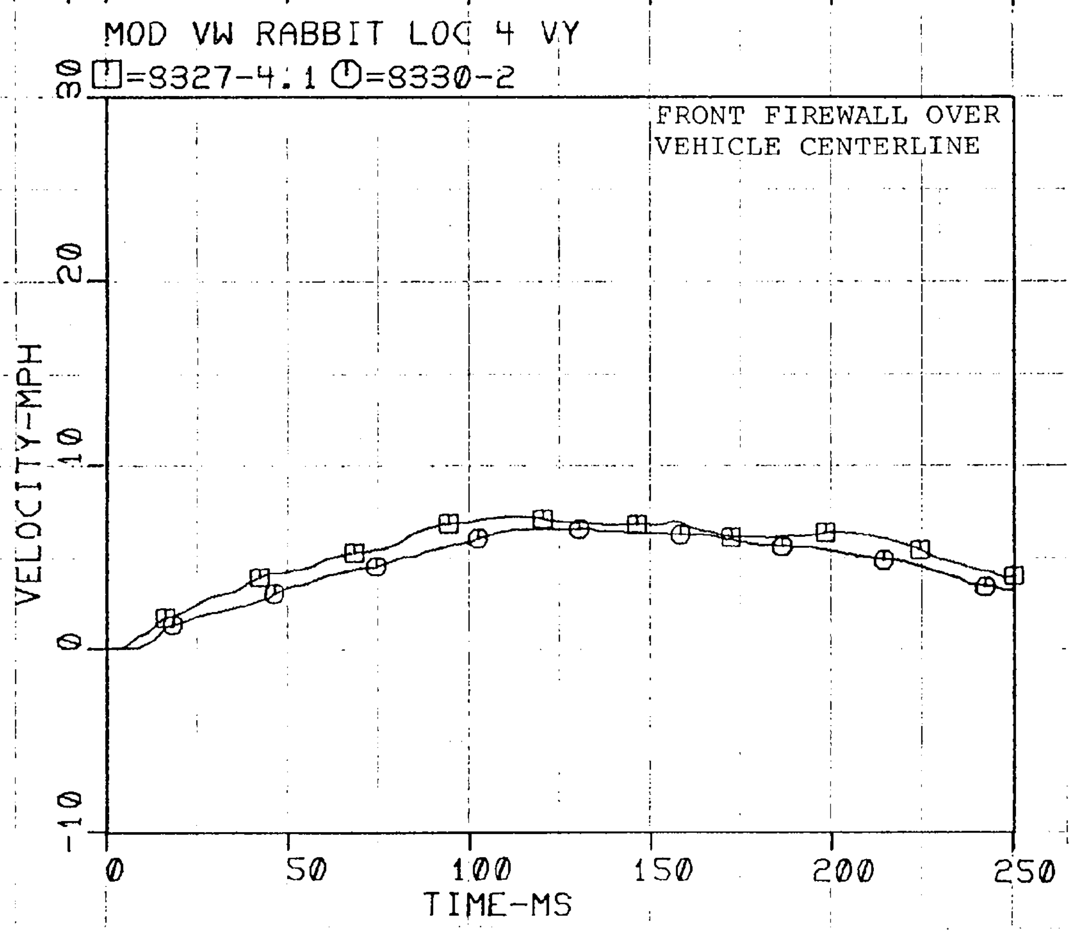

MOD VW RABBIT AVG.LOC.1&2 SY
□=8327-4.1 ○=8330-2
AVERAGE COMPARTMENT
LATERAL DISPLACEMENT
DISPLACEMENT-IN
60
40
20
0
-20
0
50
100
150
200
250
TIME-MS


MOD VW RABBIT LOC 3 AY
□=8327-4.1 ○=8330-2
REAR DECK OVER
VEHICLE CENTERLINE
ACCELERATION-G
30
20
10
0
-10

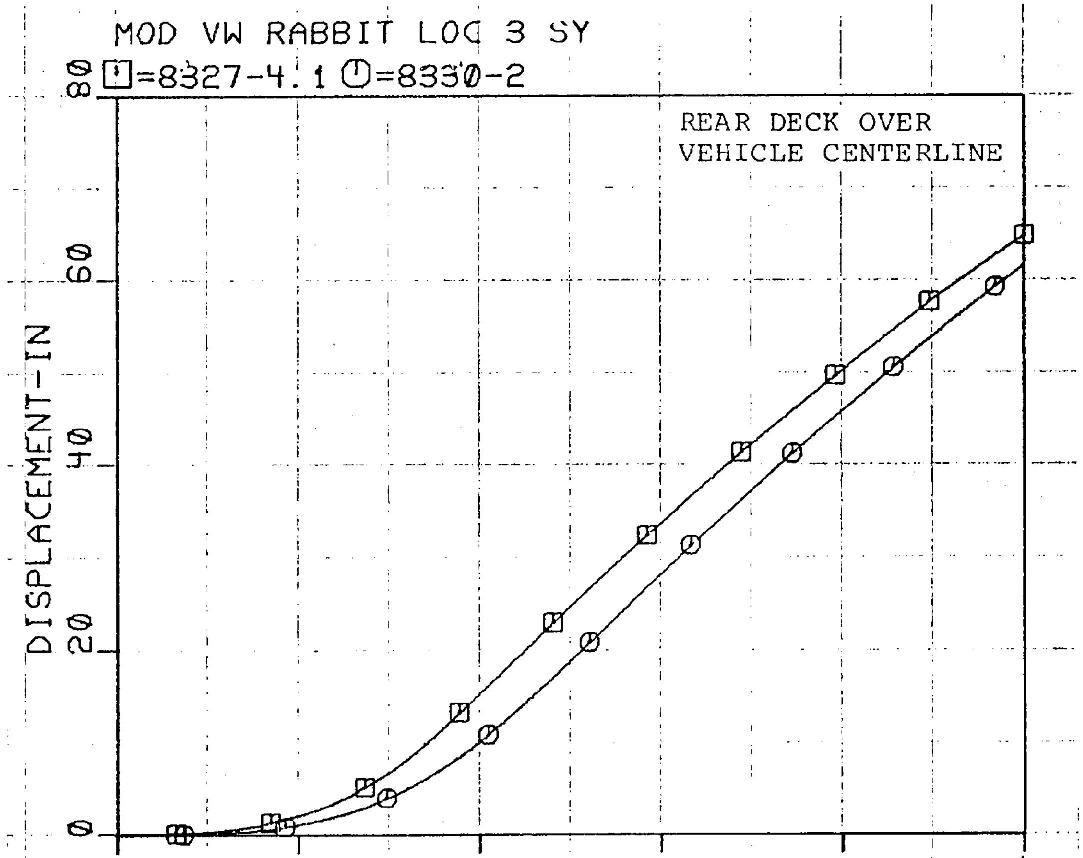

MOD VW RABBIT LOC 4 AY
□=8327-4.1 ○=8330-2
FRONT FIREWALL OVER
VEHICLE CENTERLINE
ACCELERATION-G
30
20
10
0
-10
0
50
100
150
200
250
TIME-MS

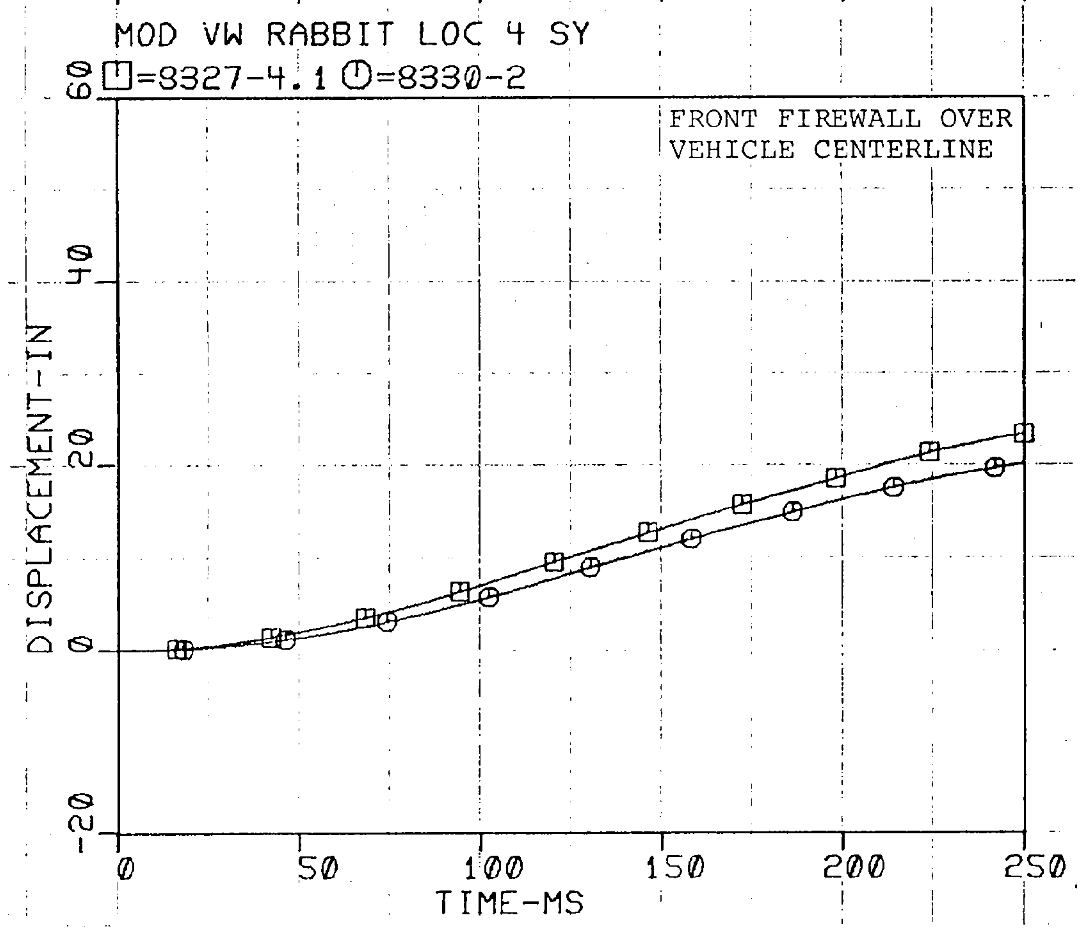


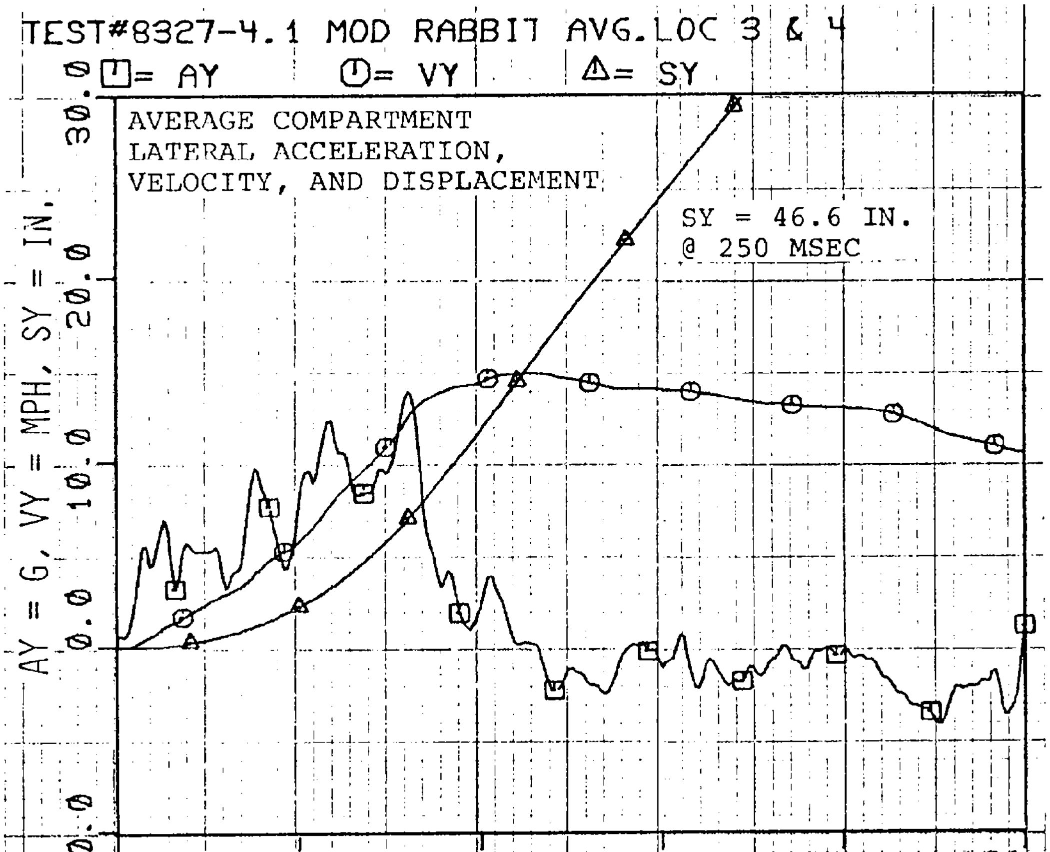
MOD VW RABBIT LOC 3 VY
□=8327-4.1 ○=8330-2
REAR DECK OVER
VEHICLE CENTERLINE
VELOCITY-MPH
30
20
10
0
-10

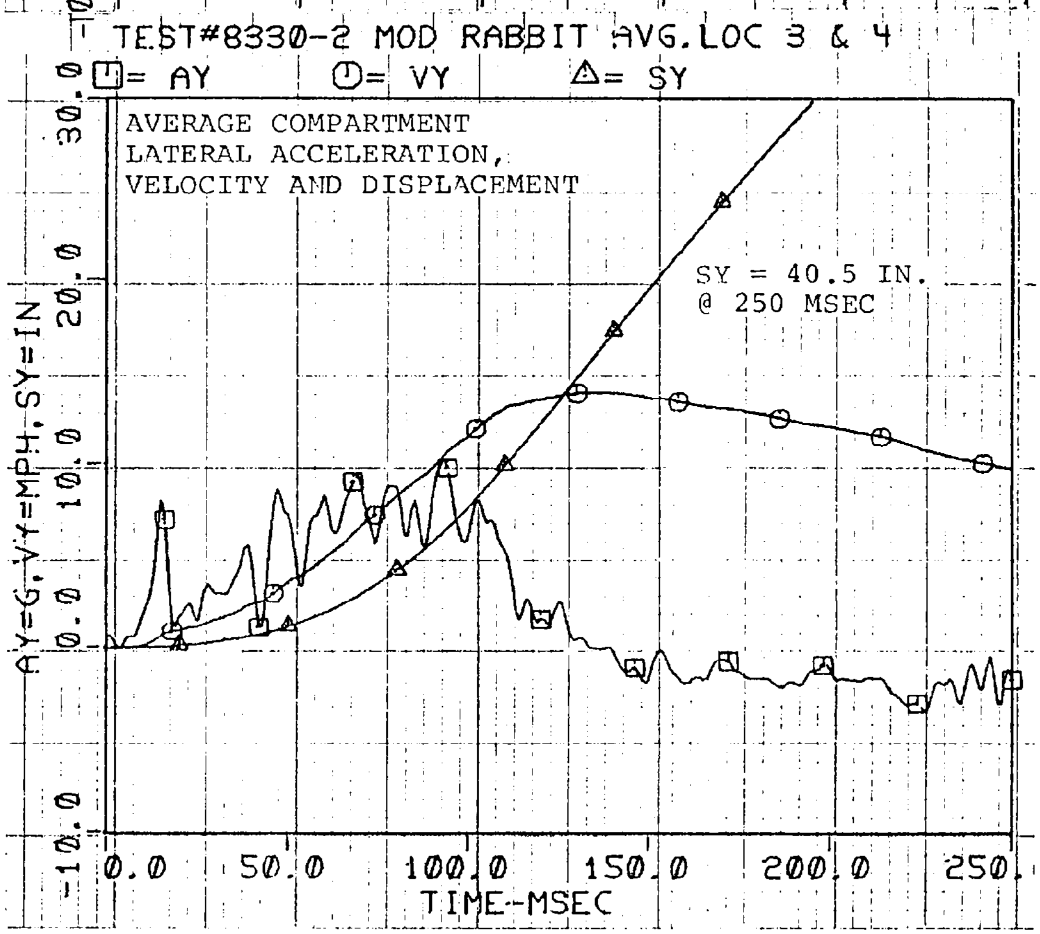


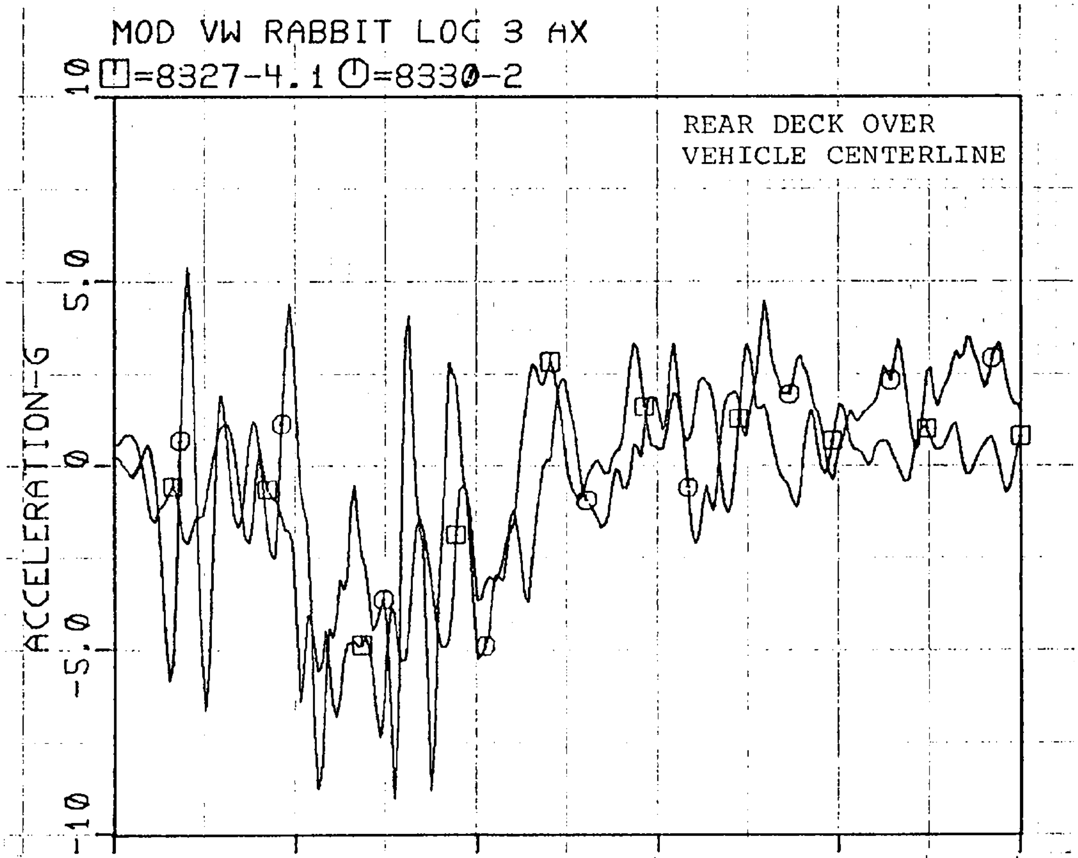
MOD VW RABBIT LOC 4 VY
□=8327-4.1 ○=8330-2
FRONT FIREWALL OVER
VEHICLE CENTERLINE
VELOCITY-MPH
30
20
10
0
-10
0
50
100
150
200
250
TIME-MS

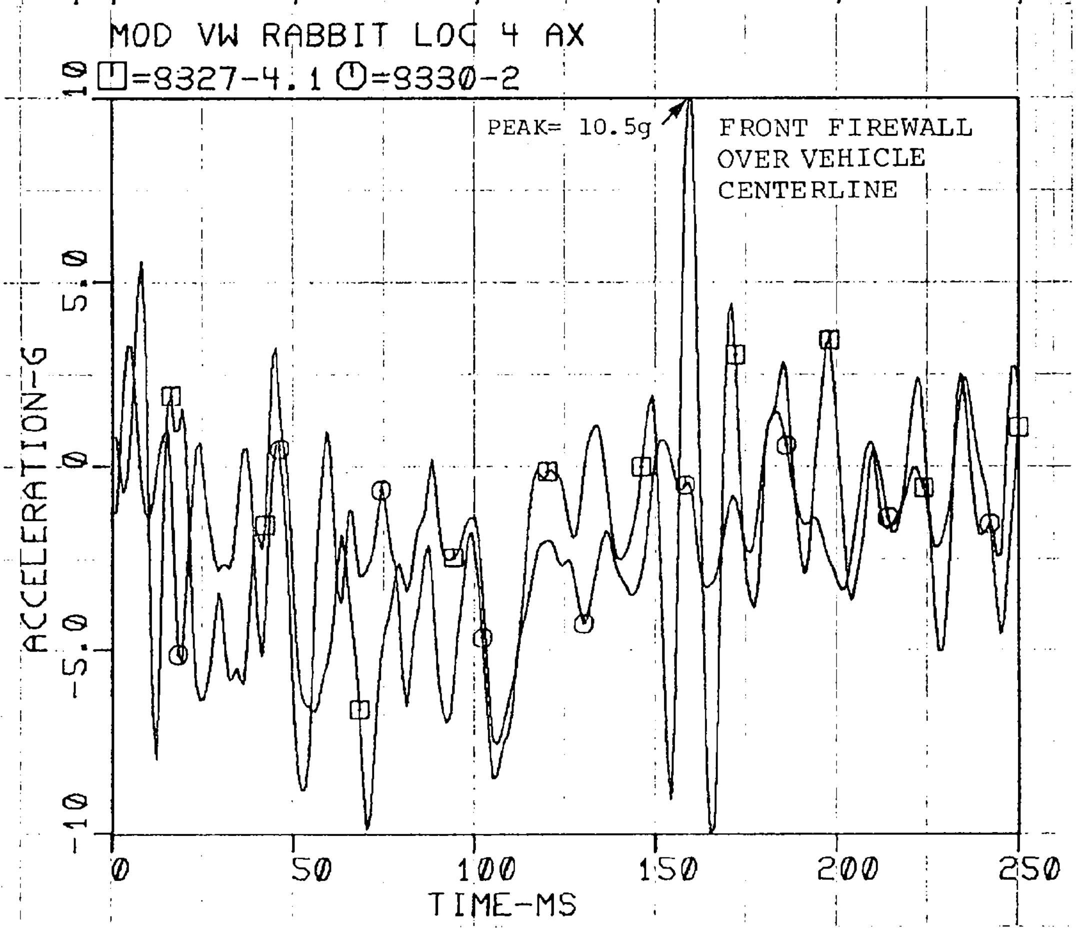

MOD VW RABBIT LOC 3 SY
□=8327-4.1 ⏀=8330-2
REAR DECK OVER
VEHICLE CENTERLINE
DISPLACEMENT-IN
80
60
40
20
0

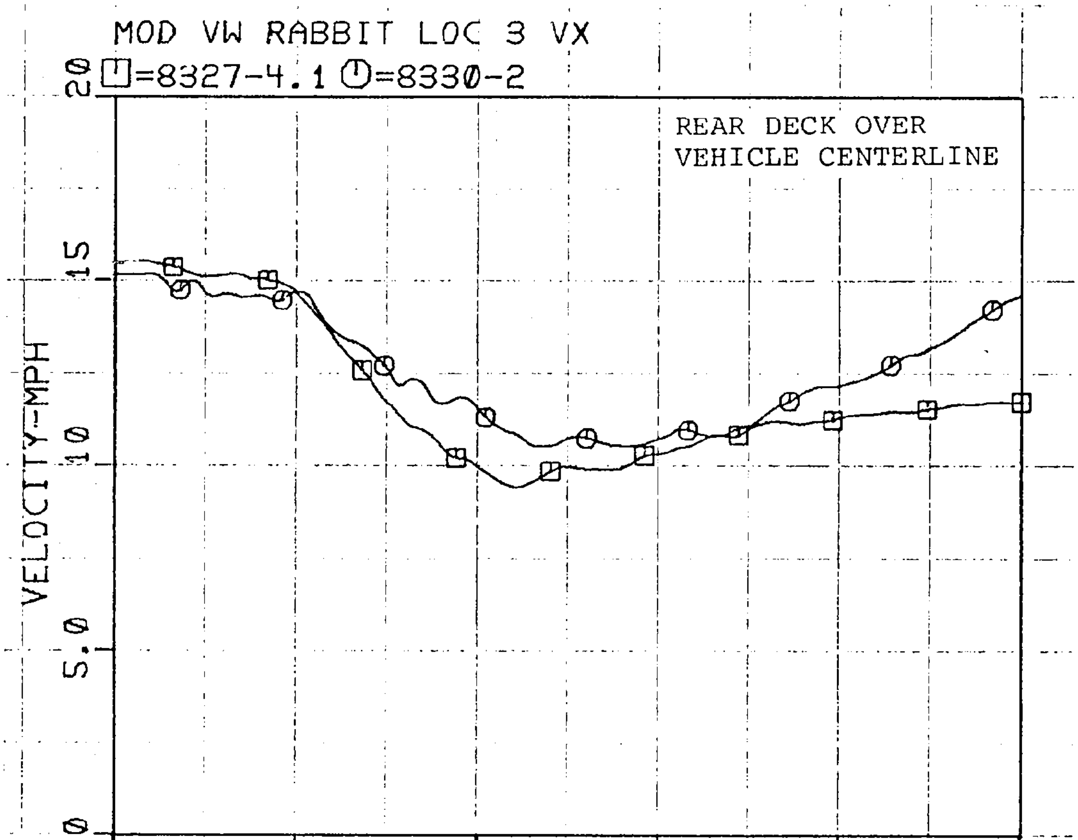

MOD VW RABBIT LOC 4 SY
□=8327-4.1 ⏀=8330-2
FRONT FIREWALL OVER
VEHICLE CENTERLINE
DISPLACEMENT-IN
60
40
20
0
-20
0
50
100
150
200
250
TIME-MS

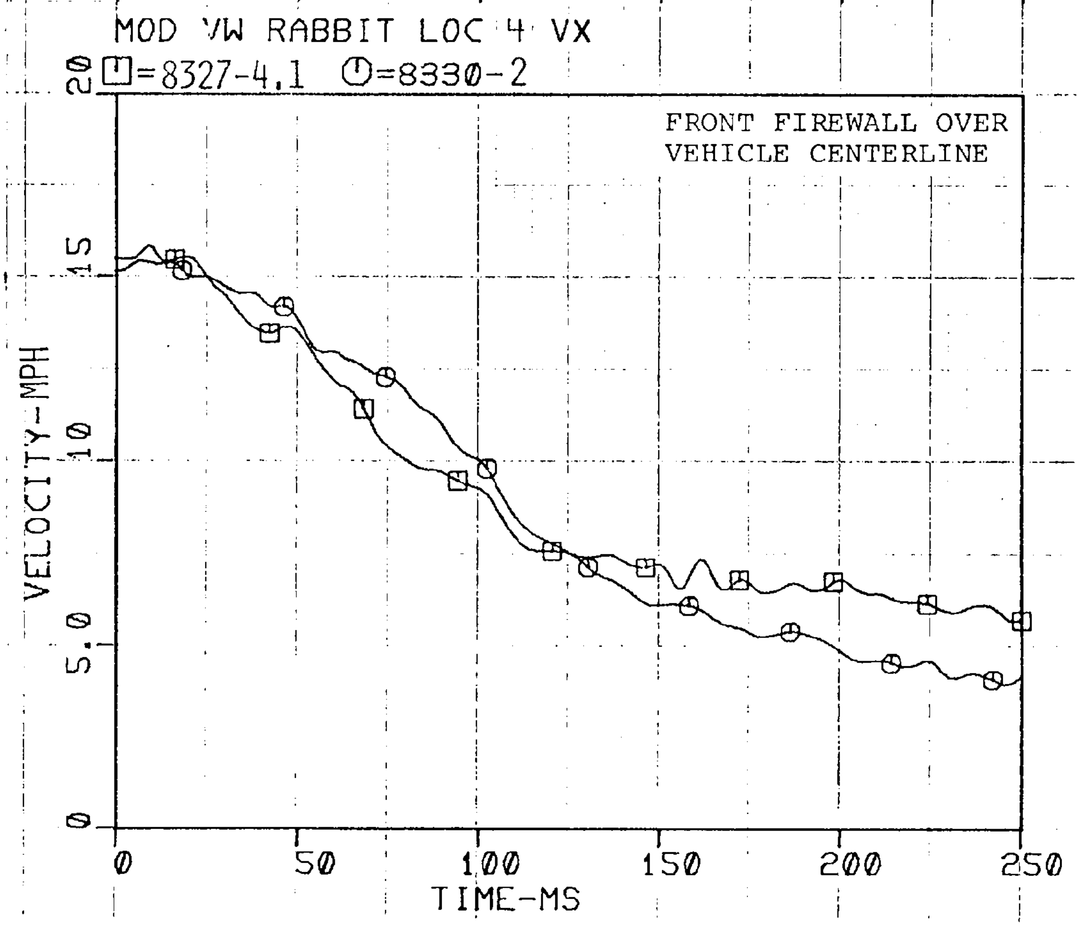

TEST#8327-4.1 MOD RABBIT AVG. LOC 3 & 4
= AY
= VY
= SY
AVERAGE COMPARTMENT
LATERAL ACCELERATION,
VELOCITY, AND DISPLACEMENT
SY = 46.6 IN.
@ 250 MSEC
AY = G, VY = MPH, SY = IN.
30.0
20.0
10.0
0.0
-10.0

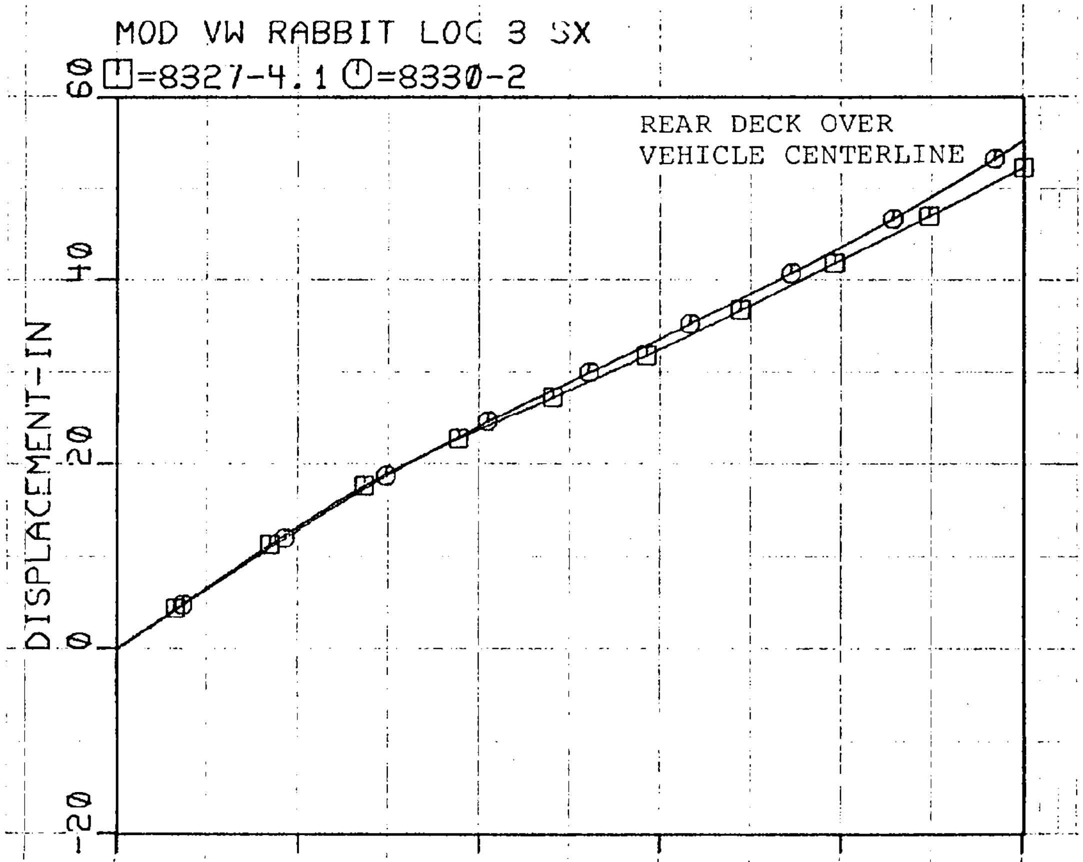

TEST#8330-2 MOD RABBIT AVG. LOC 3 & 4
= AY
= VY
= SY
AVERAGE COMPARTMENT
LATERAL ACCELERATION,
VELOCITY AND DISPLACEMENT
SY = 40.5 IN.
@ 250 MSEC
AY=G, VY=MPH, SY=IN
30.0
20.0
10.0
0.0
-10.0
0.0
50.0
100.0
150.0
200.0
250.
TIME--MSEC

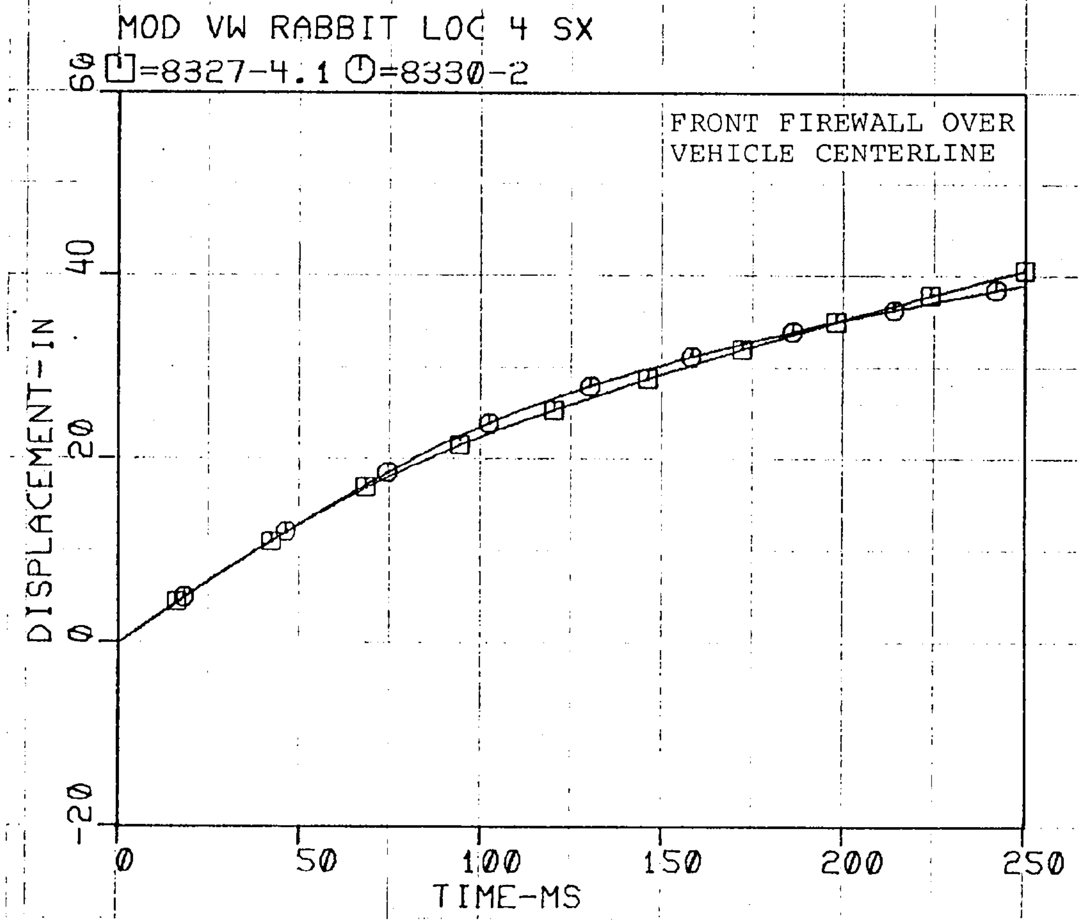

MOD VW RABBIT LOG 3 AX
□=8327-4.1 ○=8330-2
REAR DECK OVER
VEHICLE CENTERLINE
ACCELERATION-G
10
5.0
0
-5.0
-10

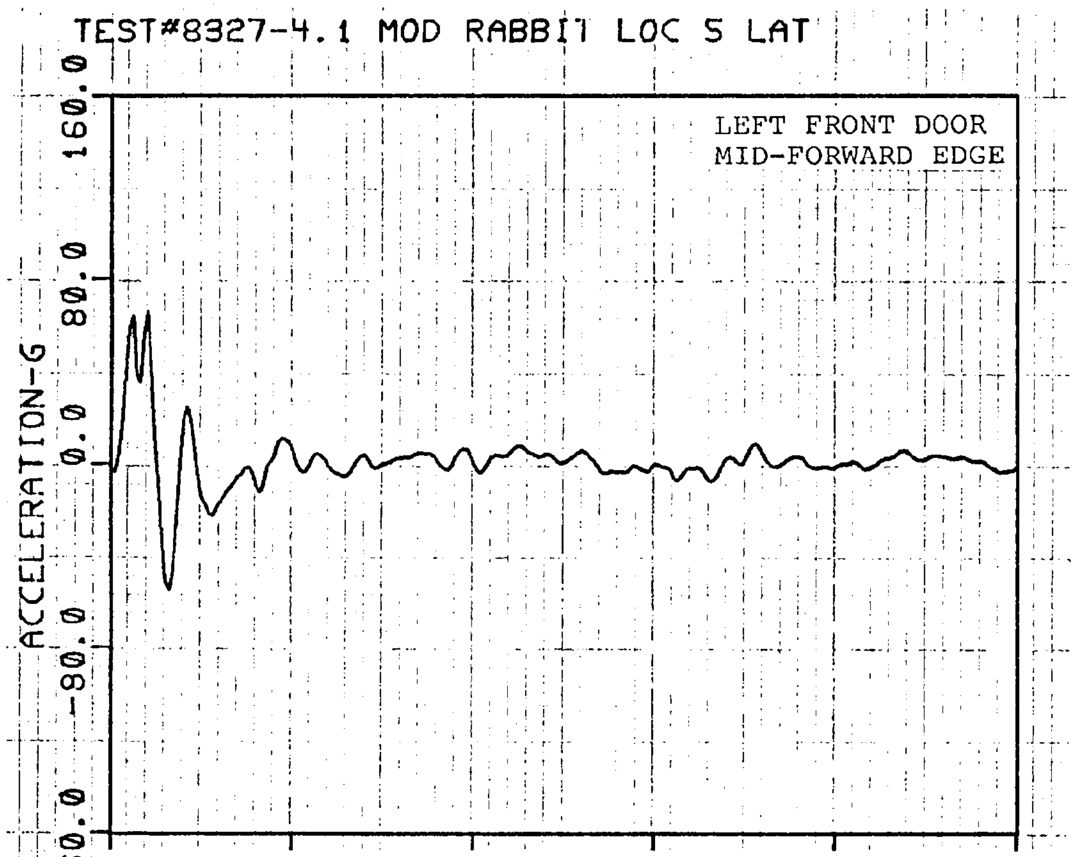

MOD VW RABBIT LOG 4 AX
□=8327-4.1 ○=8330-2
PEAK= 10.5g
FRONT FIREWALL
OVER VEHICLE
CENTERLINE
ACCELERATION-G
10
5.0
0
-5.0
-10
0
50
100
150
200
250
TIME-MS

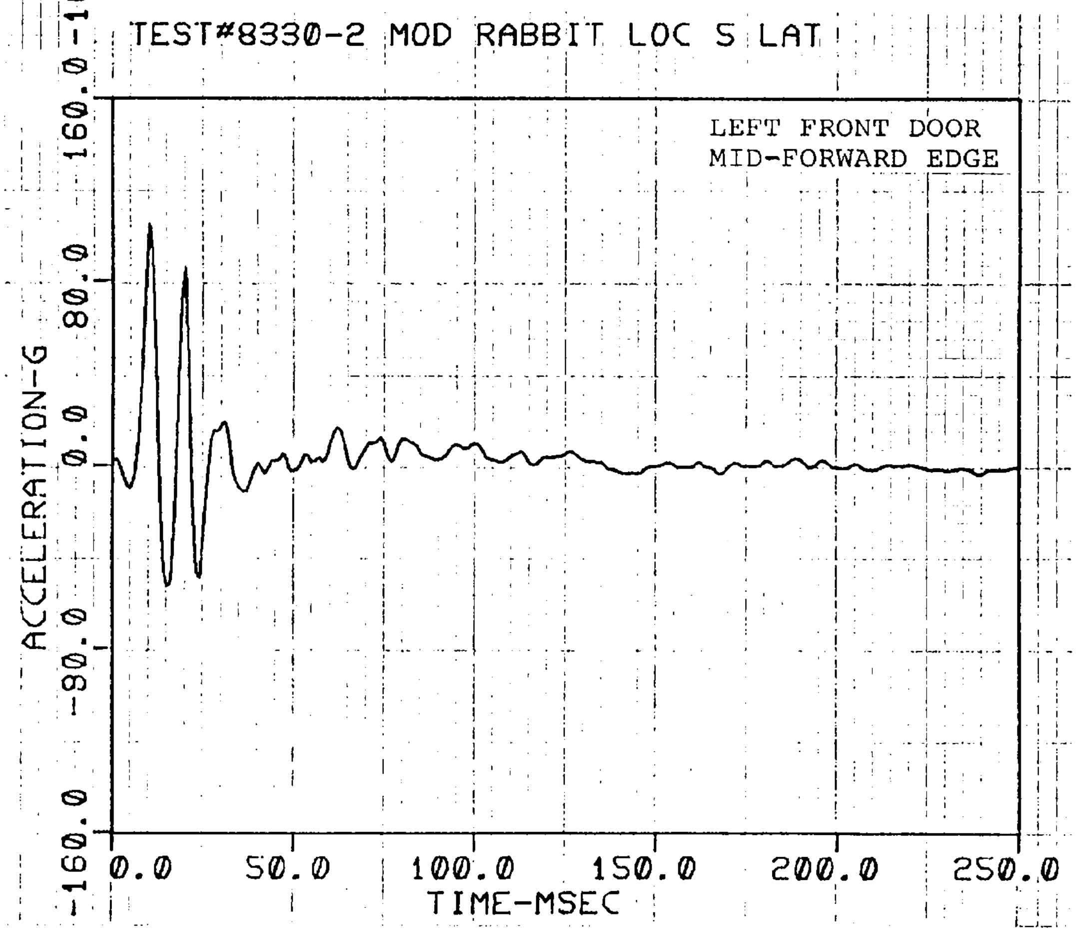

MOD VW RABBIT LOC 3 VX
□=8327-4.1 ⏀=8330-2
REAR DECK OVER
VEHICLE CENTERLINE
VELOCITY-MPH
20
15
10
5.0
0

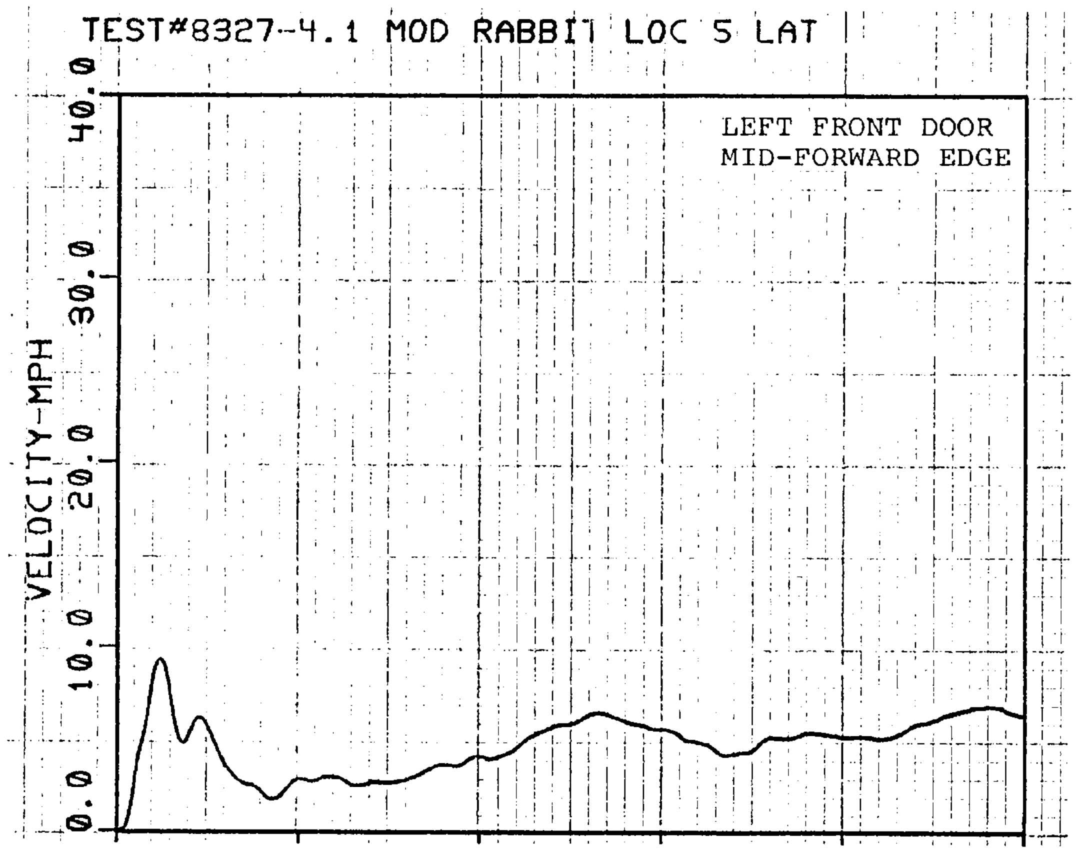

MOD VW RABBIT LOC 4 VX
□=8327-4.1 ⏀=8330-2
FRONT FIREWALL OVER
VEHICLE CENTERLINE
VELOCITY-MPH
20
15
10
5.0
0
0
50
100
150
200
250
TIME-MS

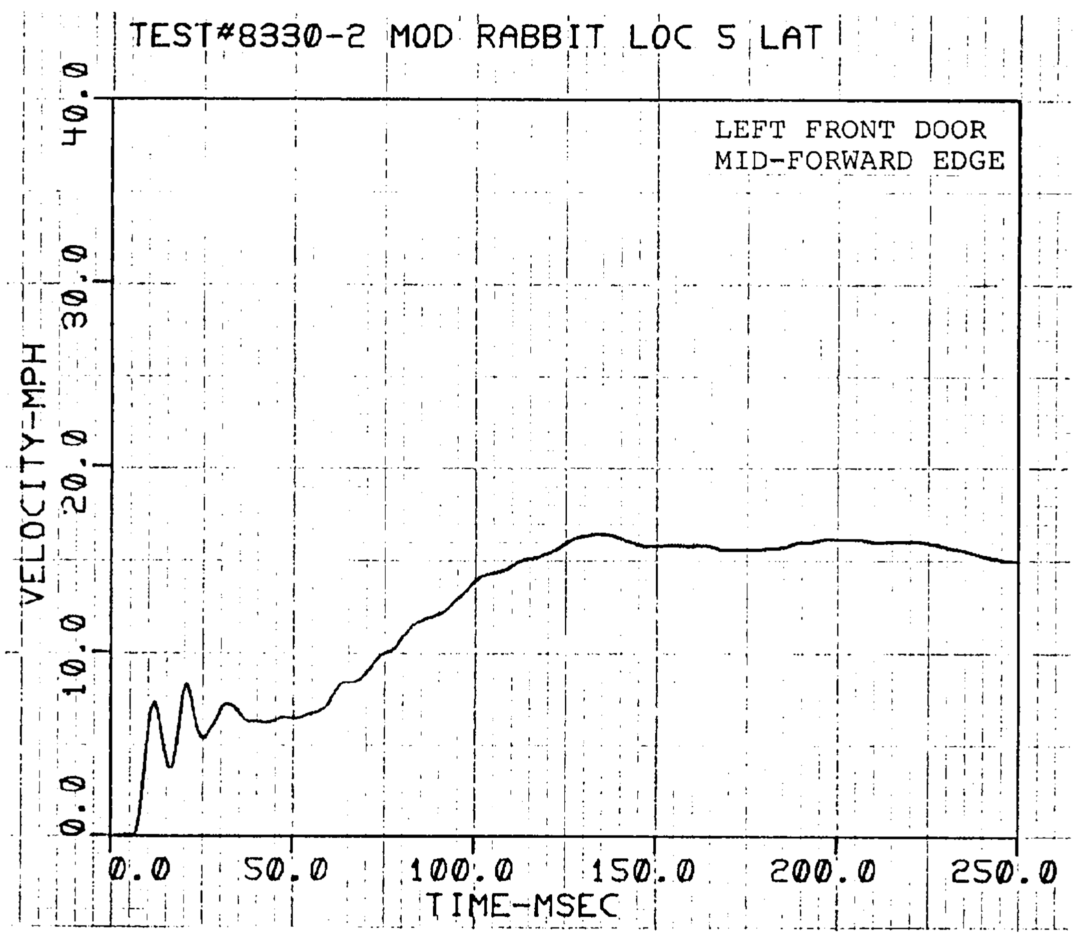

MOD VW RABBIT LOC 3 SX
□=8327-4.1 ⊙=8330-2
REAR DECK OVER
VEHICLE CENTERLINE
DISPLACEMENT-IN
60
40
20
0
-20

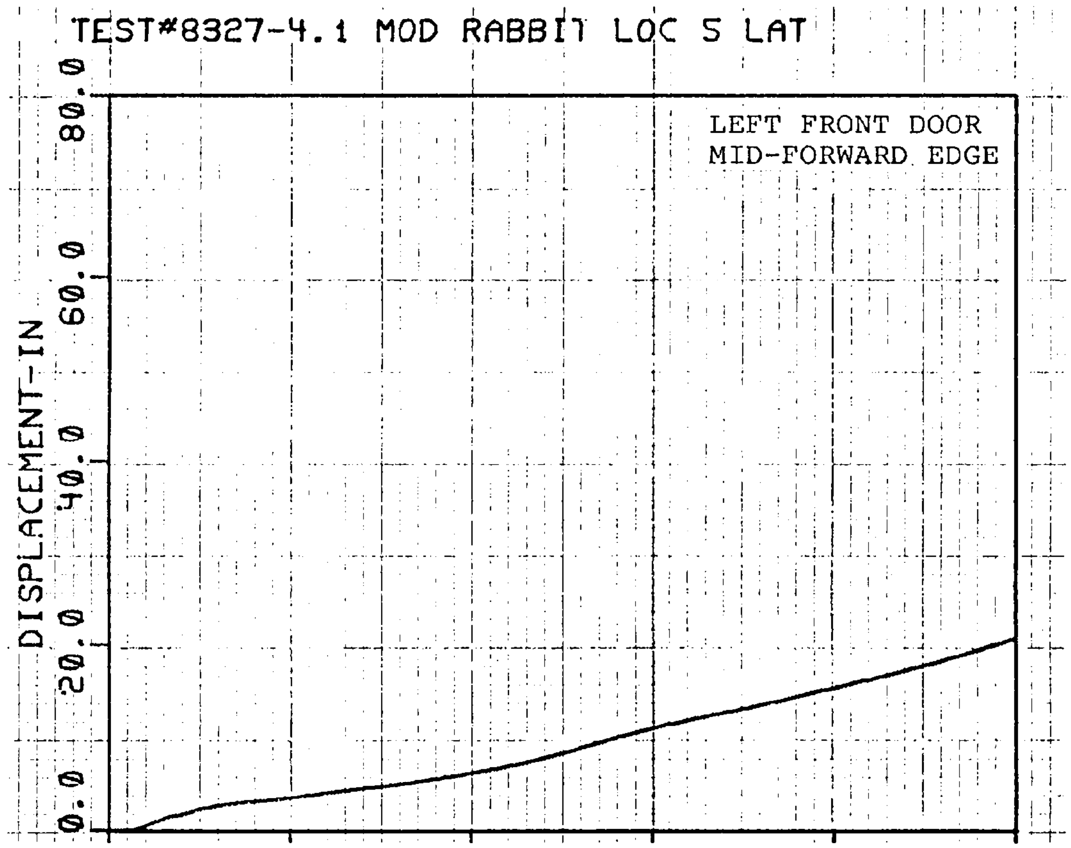

MOD VW RABBIT LOC 4 SX
□=8327-4.1 ⊙=8330-2
FRONT FIREWALL OVER
VEHICLE CENTERLINE
DISPLACEMENT-IN
60
40
20
0
-20
0
50
100
150
200
250
TIME-MS

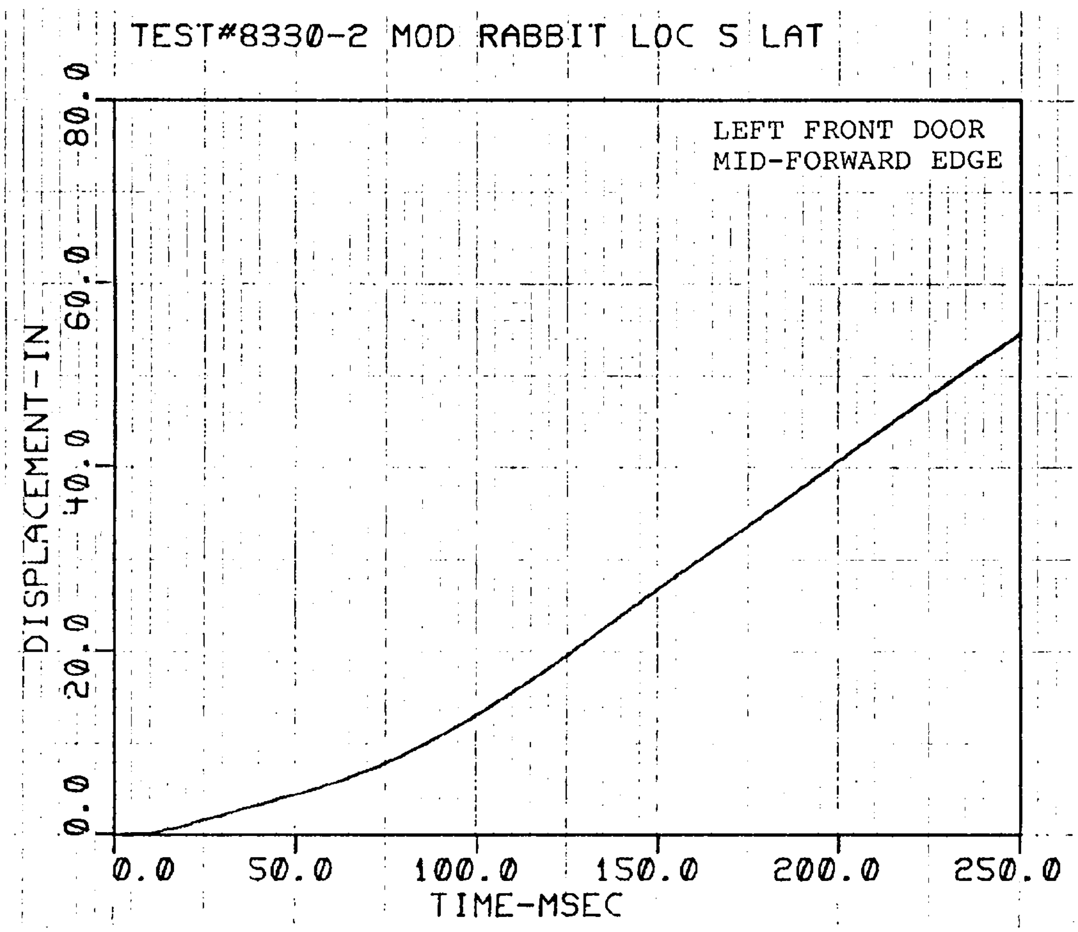

TEST#8327-4.1 MOD RABBIT LOC 5 LAT
LEFT FRONT DOOR
MID-FORWARD EDGE
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0

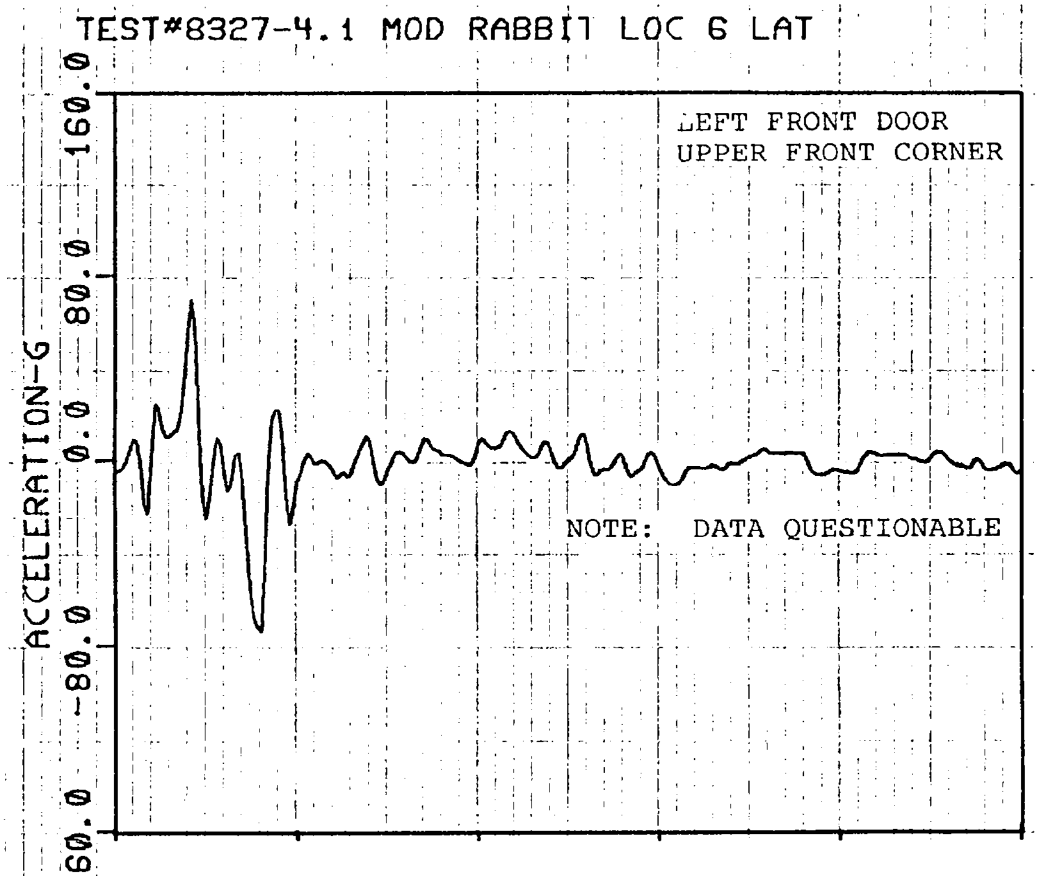

TEST#8330-2 MOD RABBIT LOC 5 LAT
LEFT FRONT DOOR
MID-FORWARD EDGE
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

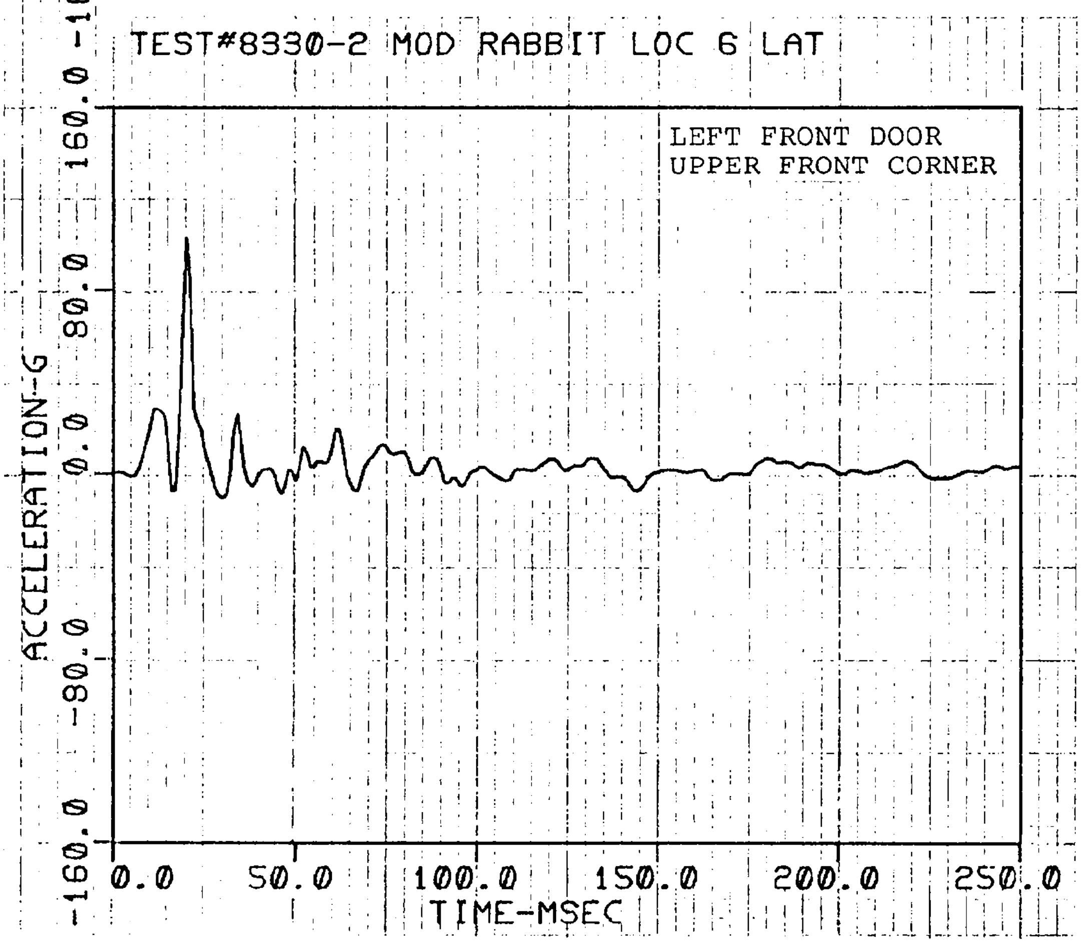

TEST#8327-4.1 MOD RABBIT LOC 5 LAT
LEFT FRONT DOOR
MID-FORWARD EDGE
VELOCITY-MPH
40.0
30.0
20.0
10.0
0.0

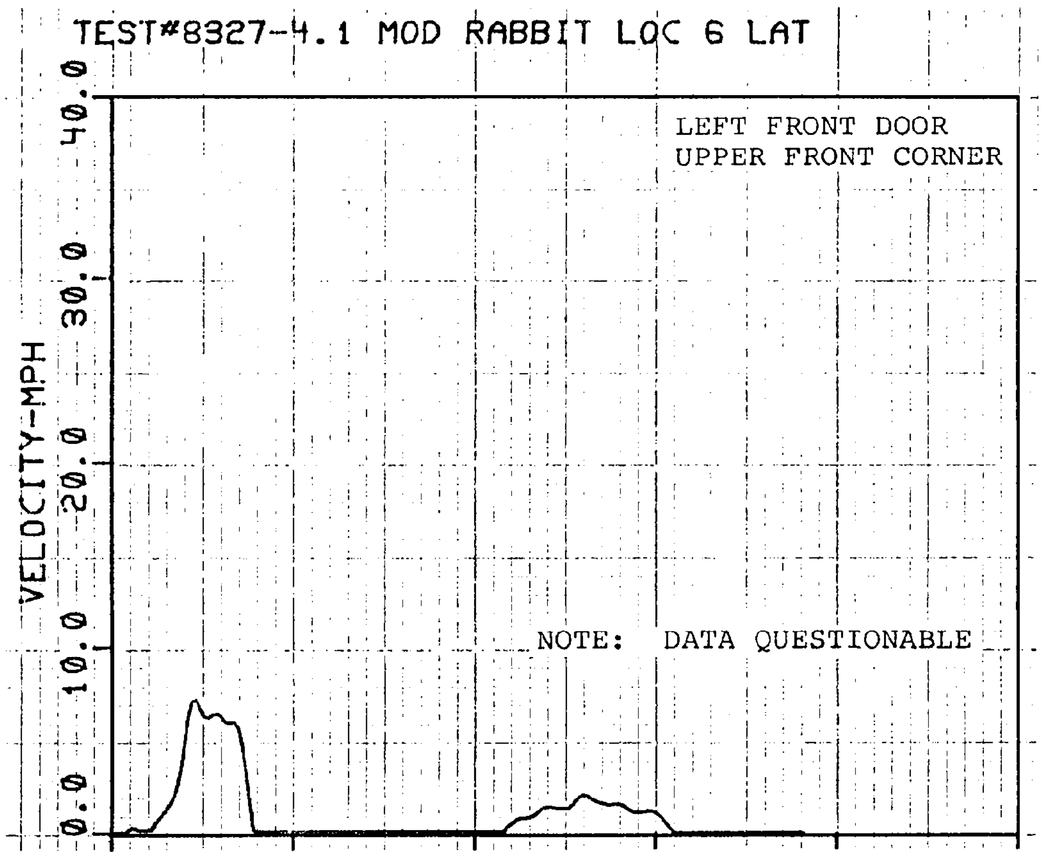

TEST#8330-2 MOD RABBIT LOC 5 LAT
LEFT FRONT DOOR
MID-FORWARD EDGE
VELOCITY-MPH
40.0
30.0
20.0
10.0
0.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

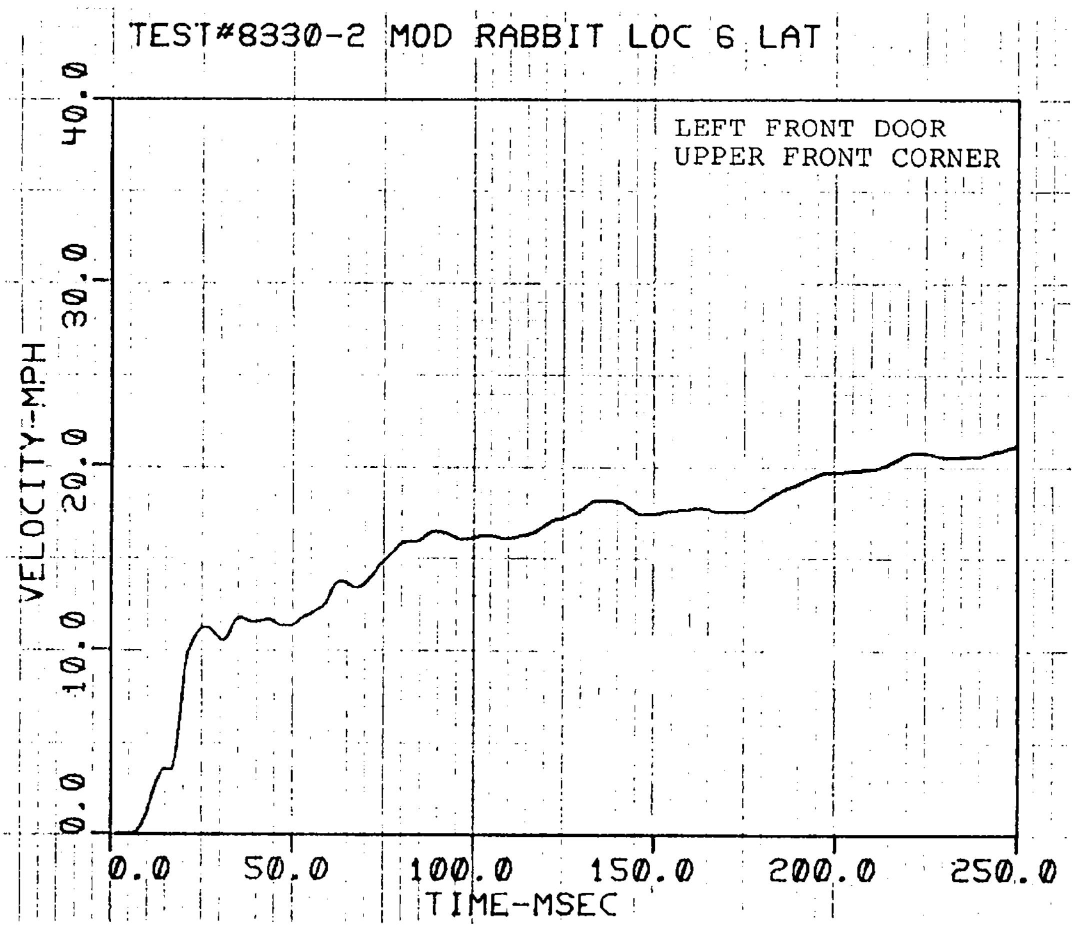

TEST#8327-4.1 MOD RABBIT LOC 5 LAT
LEFT FRONT DOOR
MID-FORWARD EDGE
DISPLACEMENT-IN
80.0
60.0
40.0
20.0
0.0

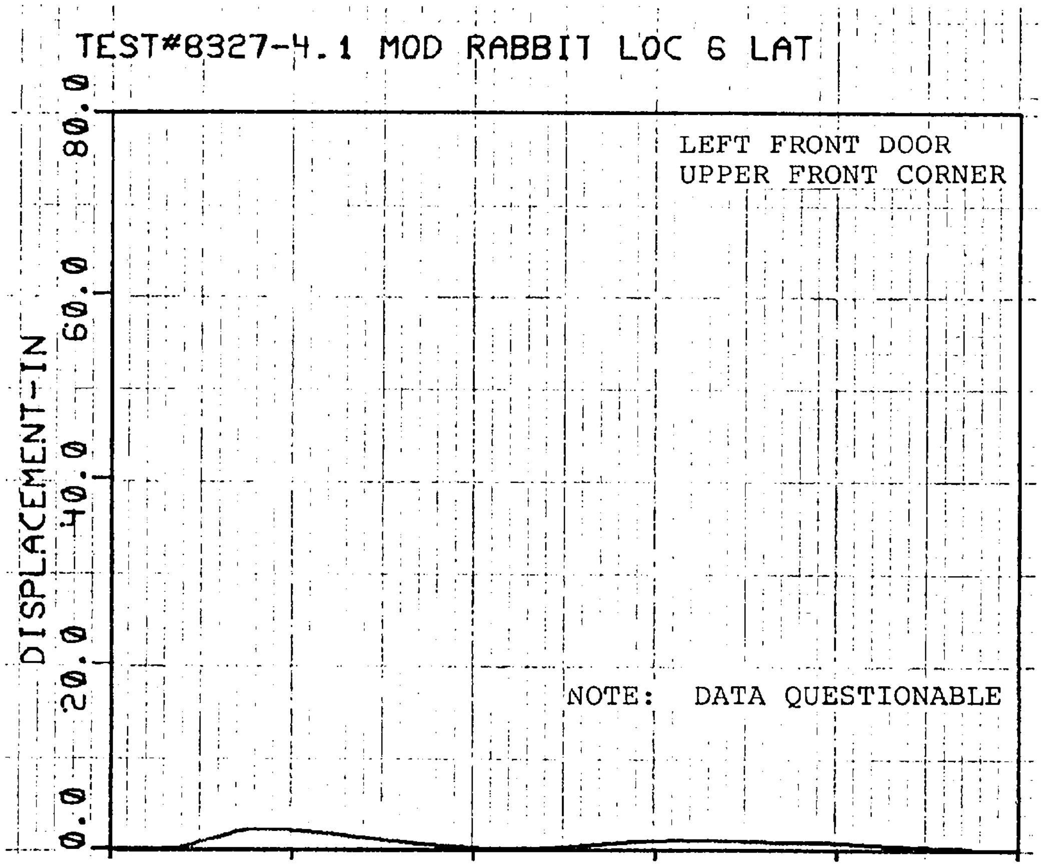

TEST#8330-2 MOD RABBIT LOC 5 LAT
LEFT FRONT DOOR
MID-FORWARD EDGE
DISPLACEMENT-IN
80.0
60.0
40.0
20.0
0.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

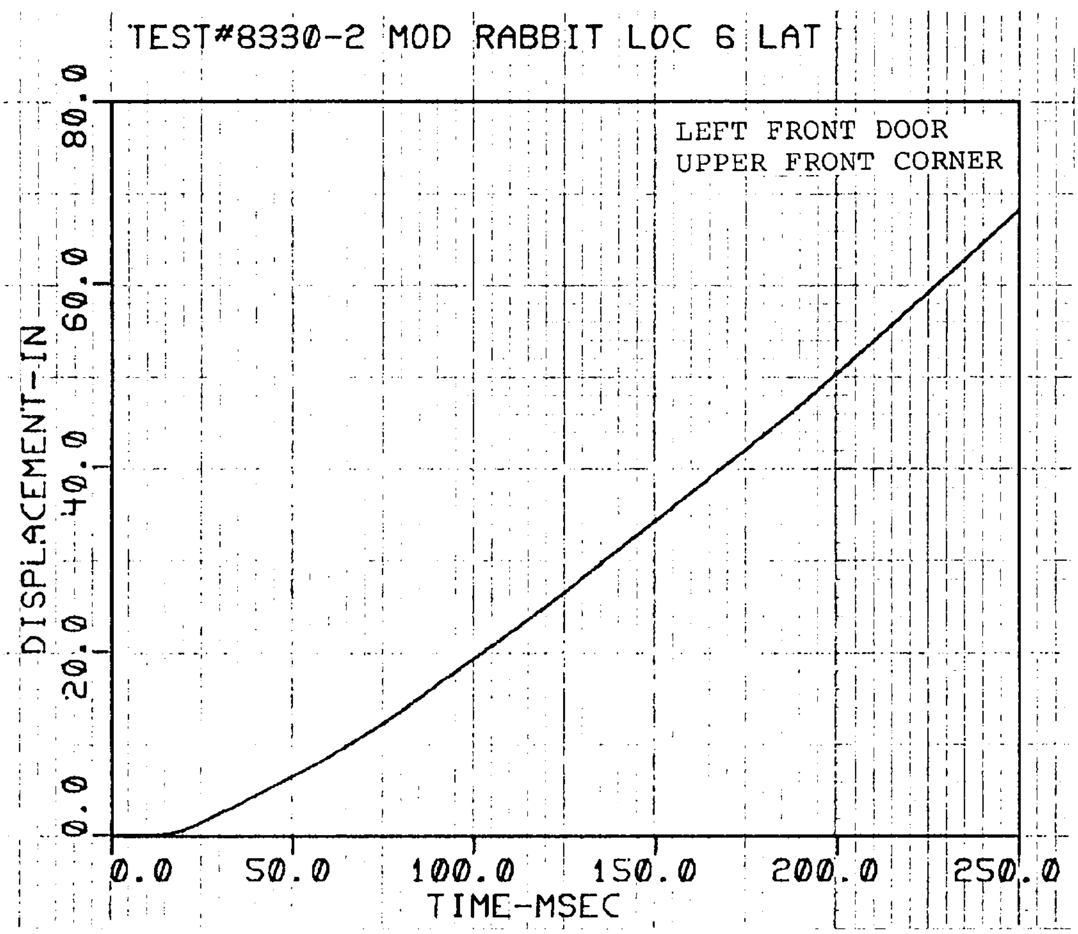

TEST#8327-4.1 MOD RABBIT LOC 6 LAT
LEFT FRONT DOOR
UPPER FRONT CORNER
NOTE: DATA QUESTIONABLE
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0

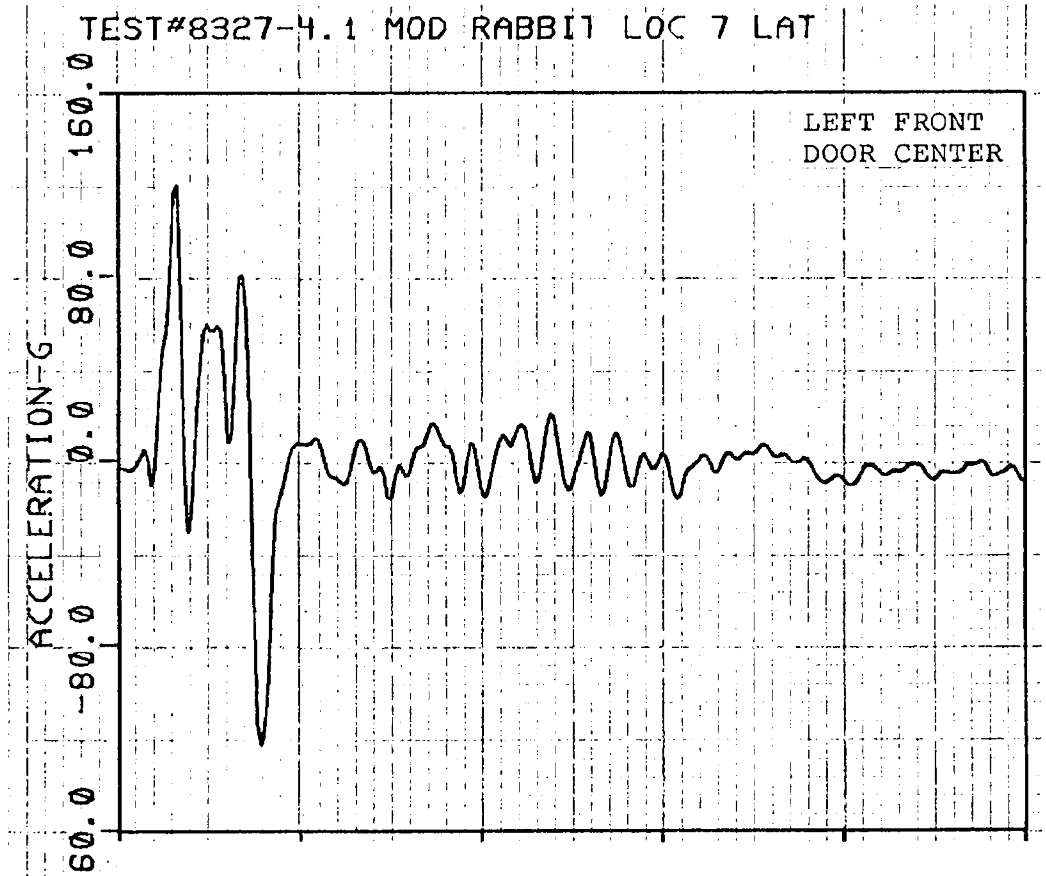

TEST#8330-2 MOD RABBIT LOC 6 LAT
LEFT FRONT DOOR
UPPER FRONT CORNER
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

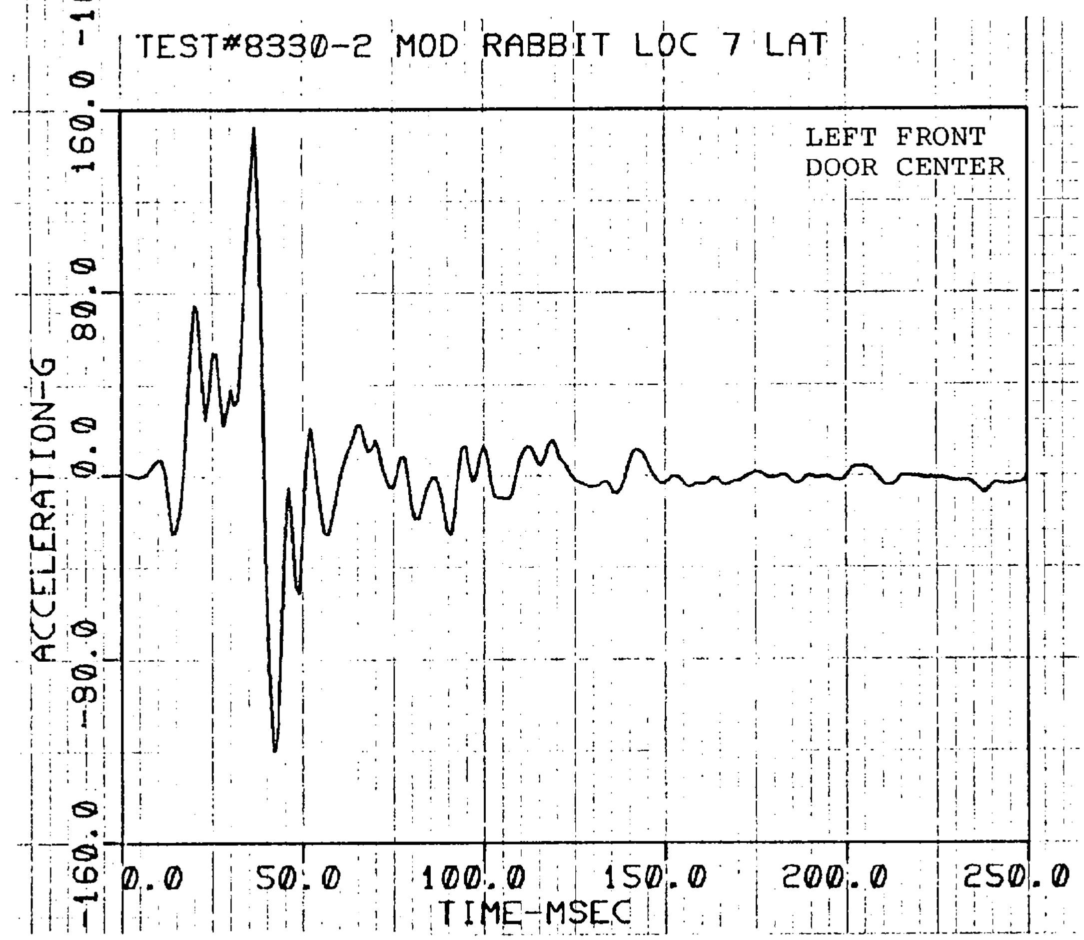

TEST#8327-4.1 MOD RABBIT LOC 6 LAT
LEFT FRONT DOOR
UPPER FRONT CORNER
NOTE: DATA QUESTIONABLE
VELOCITY-MPH
40.0
30.0
20.0
10.0
0.0

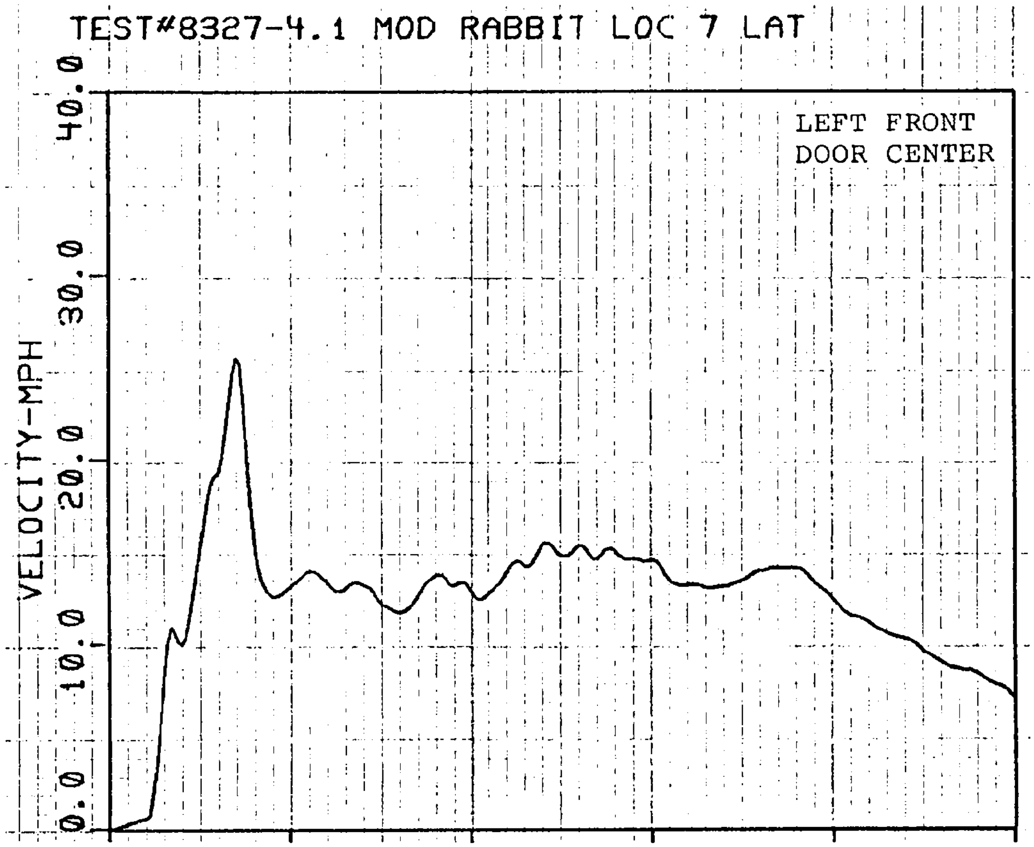

TEST#8330-2 MOD RABBIT LOC 6 LAT
LEFT FRONT DOOR
UPPER FRONT CORNER
VELOCITY-MPH
40.0
30.0
20.0
10.0
0.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

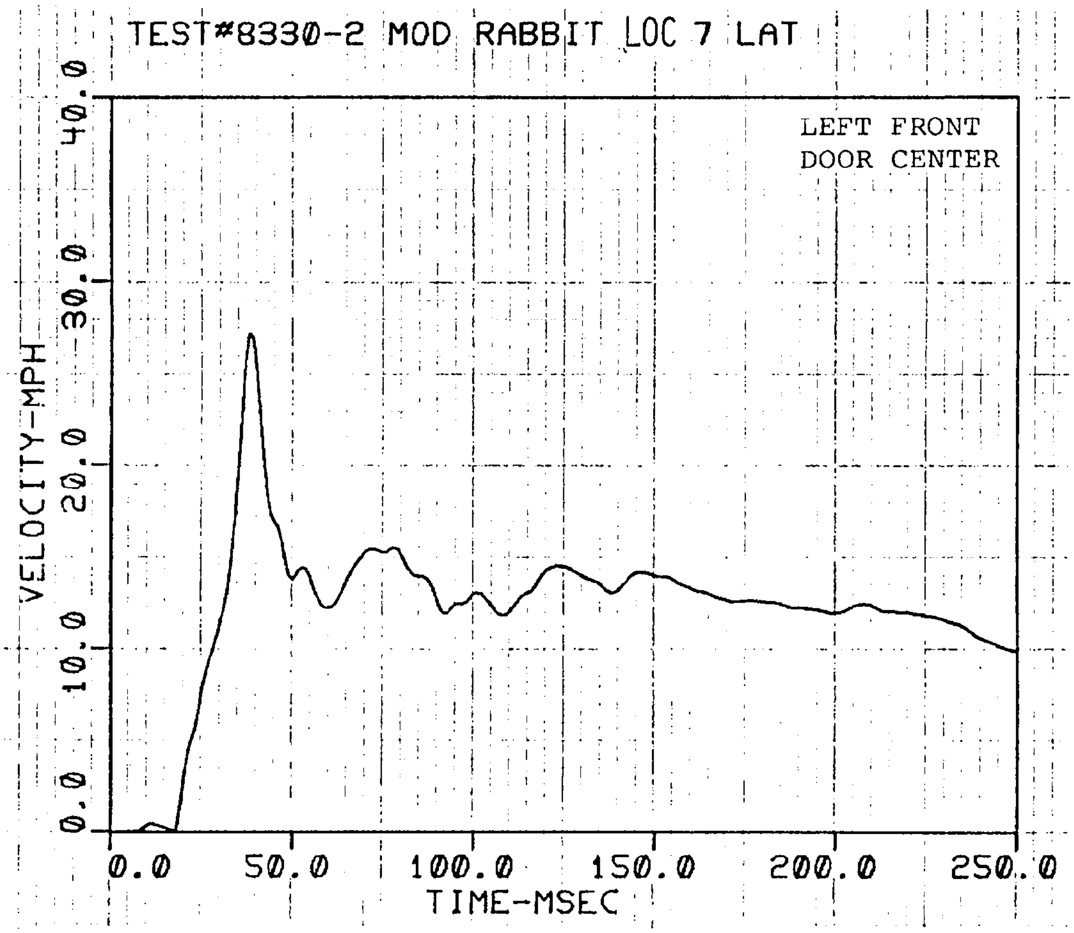

TEST#8327-4.1 MOD RABBIT LOC 6 LAT
DISPLACEMENT-IN
0.0
20.0
40.0
60.0
80.0
LEFT FRONT DOOR
UPPER FRONT CORNER
NOTE: DATA QUESTIONABLE

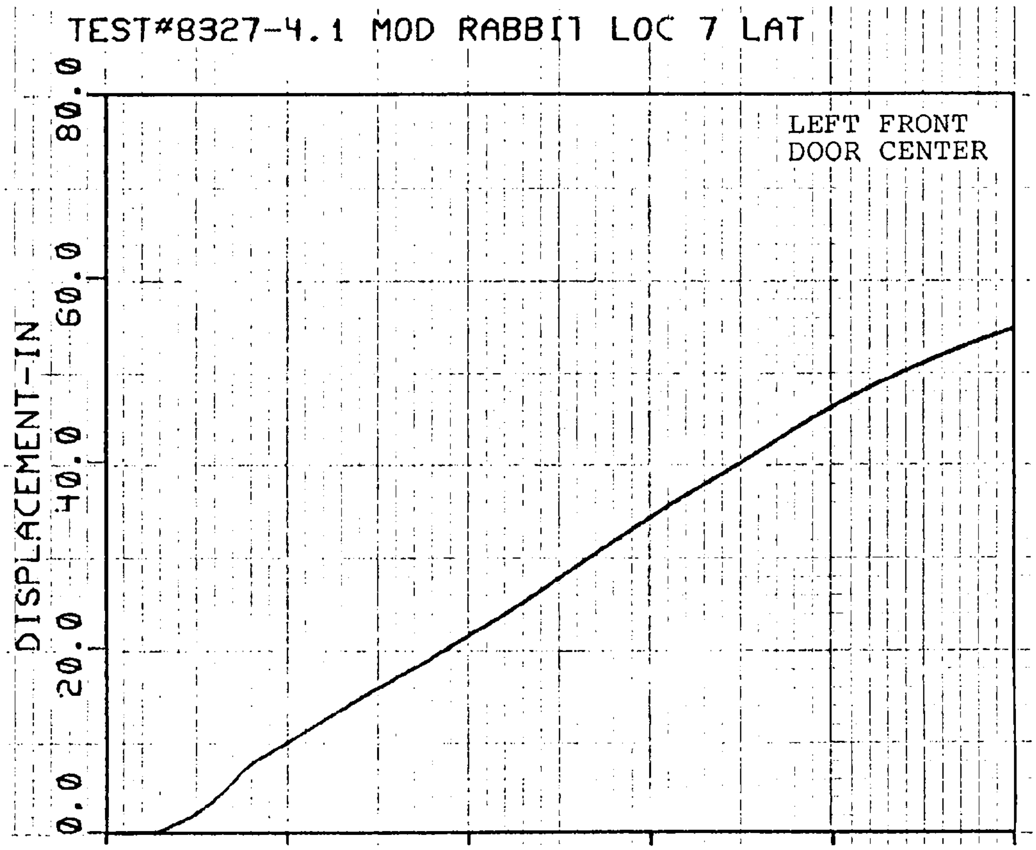

TEST#8330-2 MOD RABBIT LOC 6 LAT
DISPLACEMENT-IN
0.0
20.0
40.0
60.0
80.0
LEFT FRONT DOOR
UPPER FRONT CORNER
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

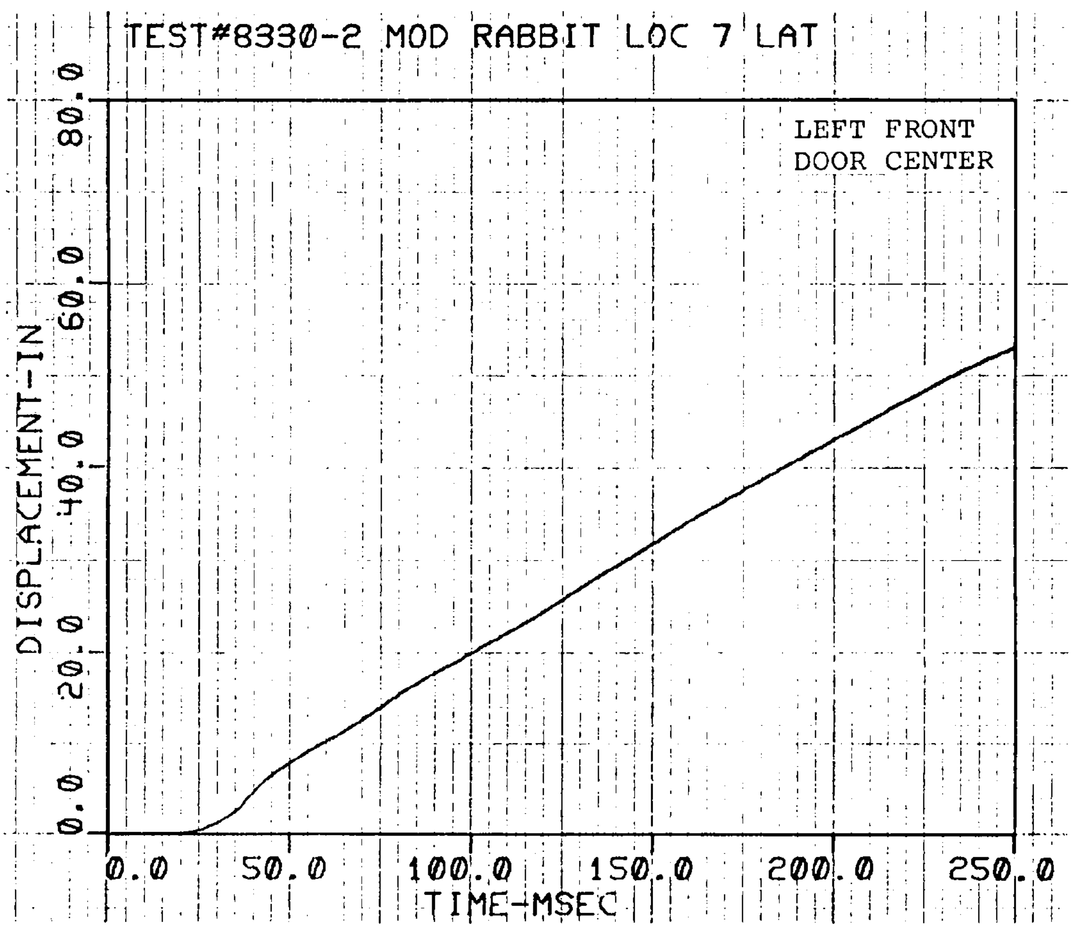

TEST#8327-4.1 MOD RABBIT LOC 7 LAT
LEFT FRONT
DOOR CENTER
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0

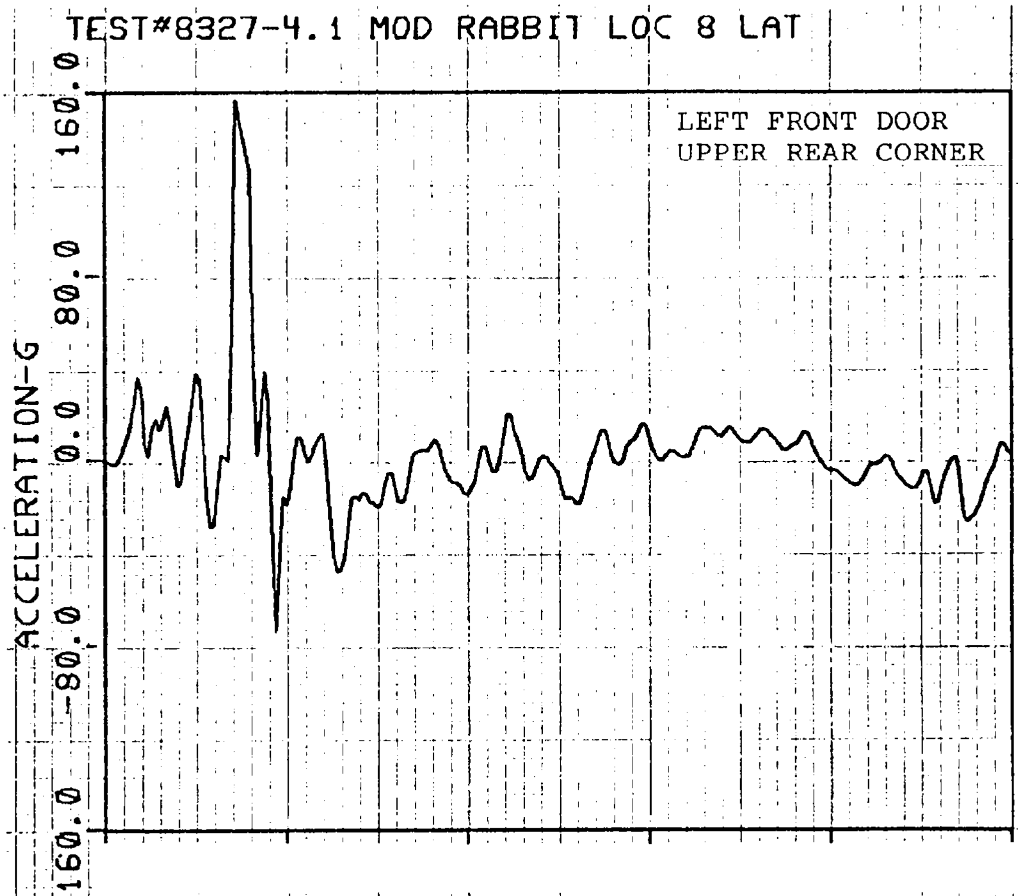

TEST#8330-2 MOD RABBIT LOC 7 LAT
LEFT FRONT
DOOR CENTER
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

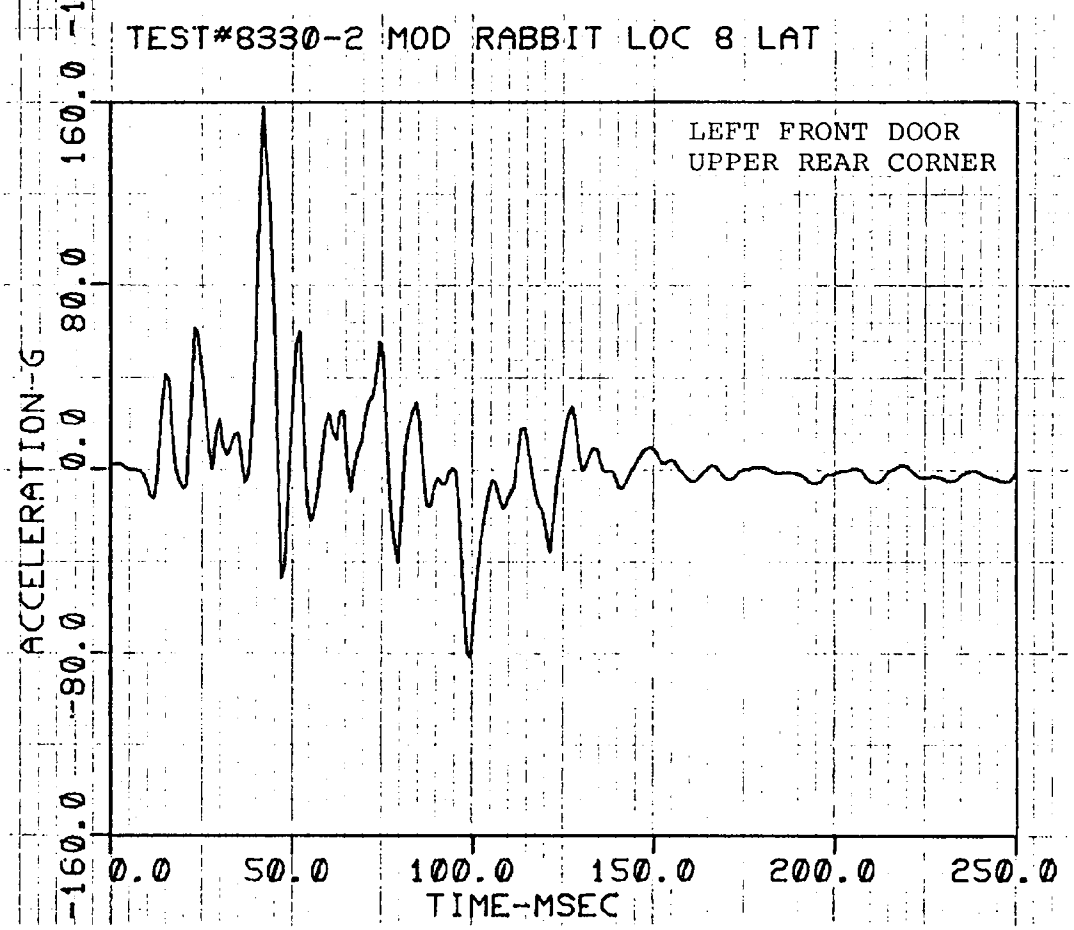

TEST#8327-4.1 MOD RABBIT LOC 7 LAT
LEFT FRONT
DOOR CENTER
VELOCITY-MPH
40.0
30.0
20.0
10.0
0.0

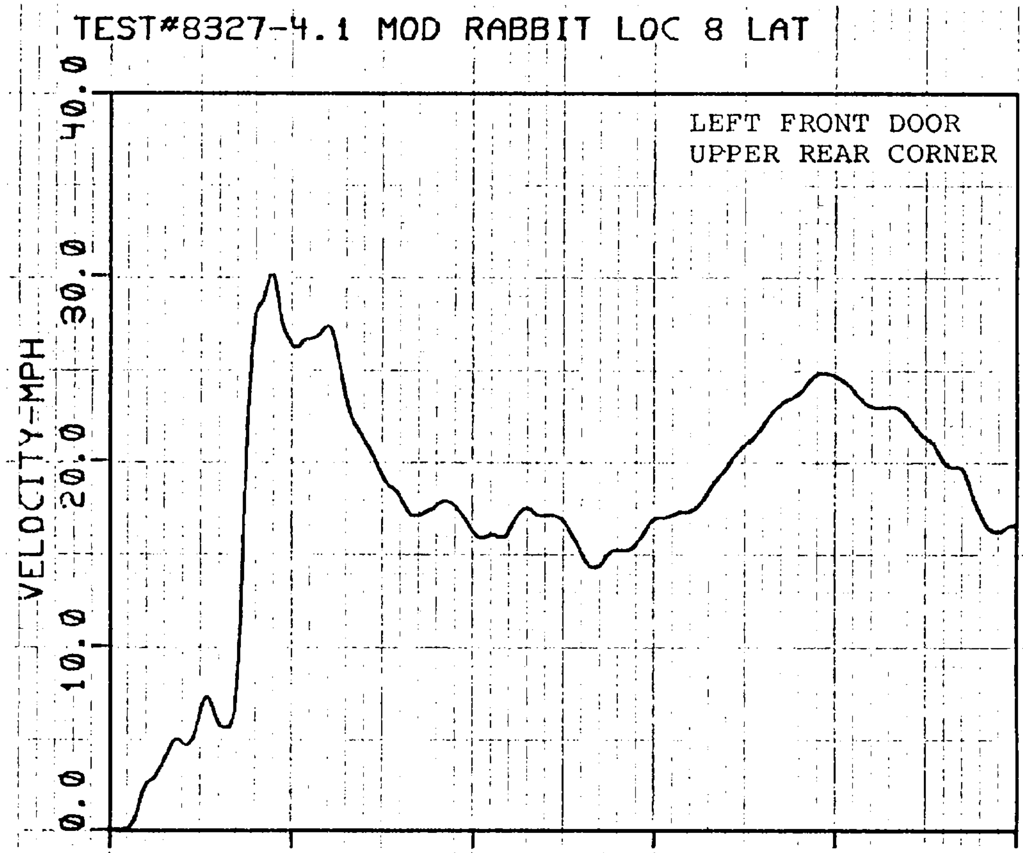

TEST#8330-2 MOD RABBIT LOC 7 LAT
LEFT FRONT
DOOR CENTER
VELOCITY-MPH
40.0
30.0
20.0
10.0
0.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

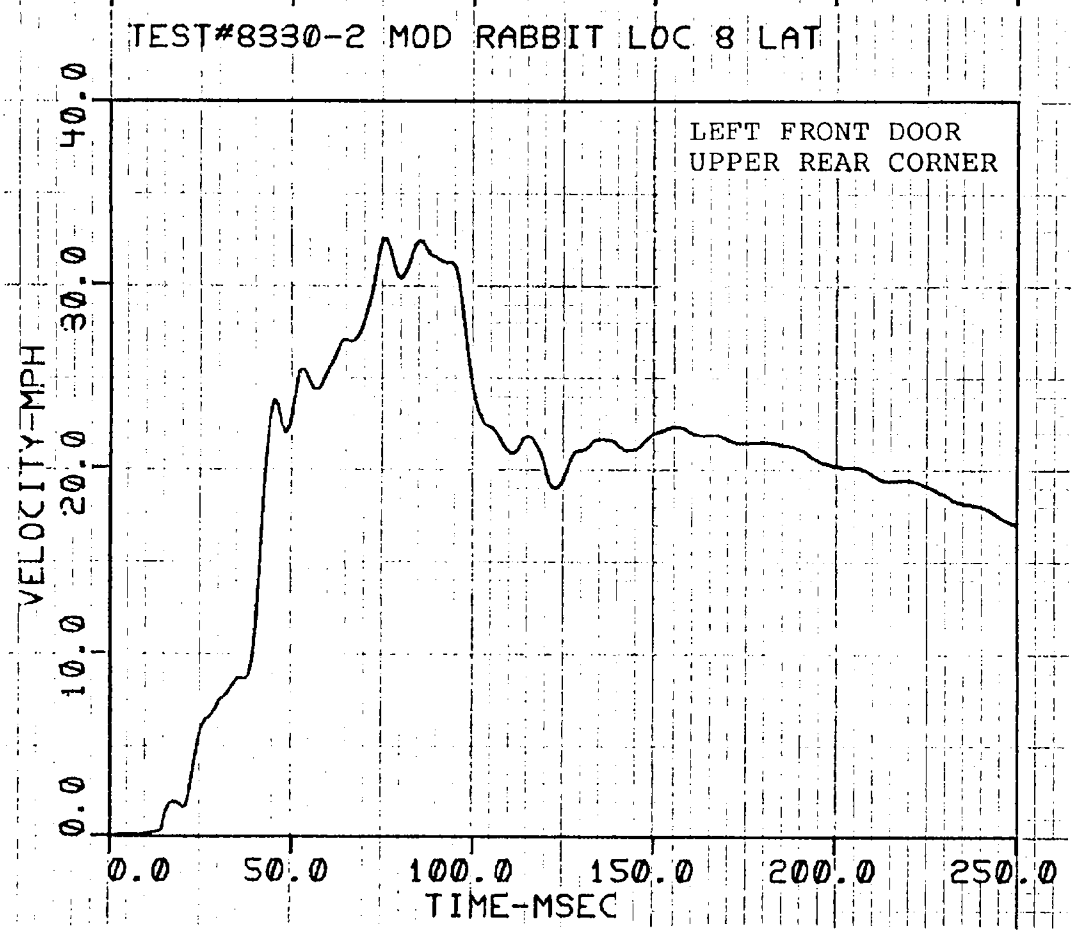

TEST#8327-4.1 MOD RABBIT LOC 7 LAT
LEFT FRONT
DOOR CENTER
DISPLACEMENT-IN
80.0
60.0
40.0
20.0
0.0

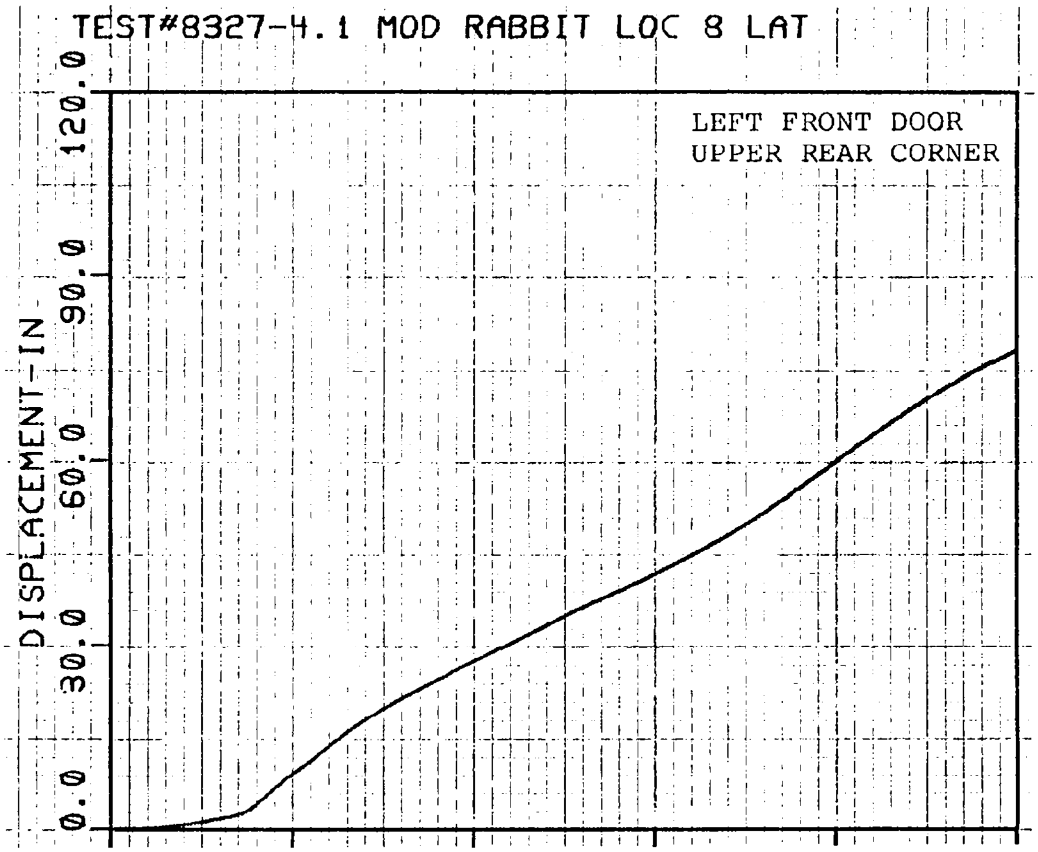

TEST#8330-2 MOD RABBIT LOC 7 LAT
LEFT FRONT
DOOR CENTER
DISPLACEMENT-IN
80.0
60.0
40.0
20.0
0.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC


TEST#8327-4.1 MOD RABBIT LOC 8 LAT
LEFT FRONT DOOR
UPPER REAR CORNER
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0

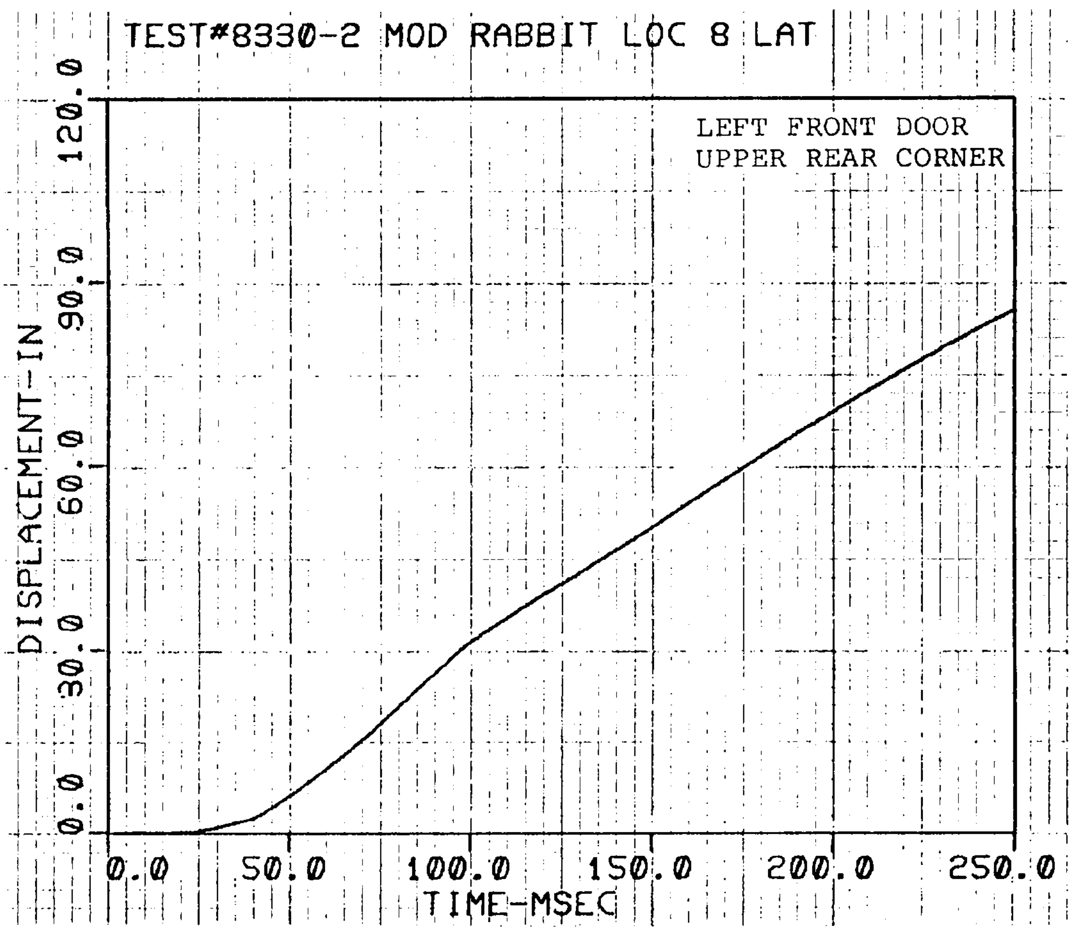

TEST#8330-2 MOD RABBIT LOC 8 LAT
LEFT FRONT DOOR
UPPER REAR CORNER
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC


TEST#8327-4.1 MOD RABBIT LOC 8 LAT
LEFT FRONT DOOR
UPPER REAR CORNER
VELOCITY-MPH
40.0
30.0
20.0
10.0
0.0

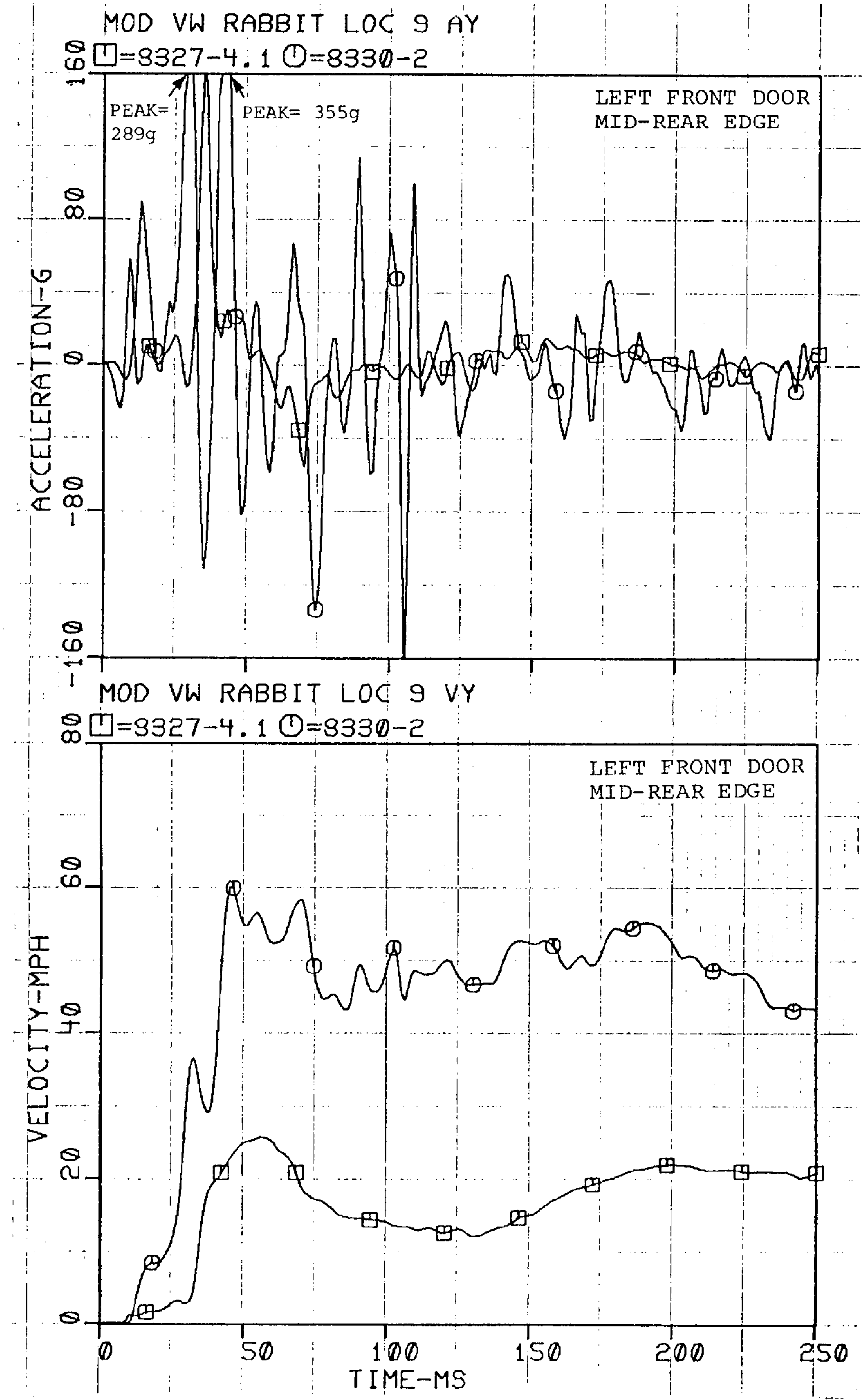

TEST#8330-2 MOD RABBIT LOC 8 LAT
LEFT FRONT DOOR
UPPER REAR CORNER
VELOCITY-MPH
40.0
30.0
20.0
10.0
0.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC



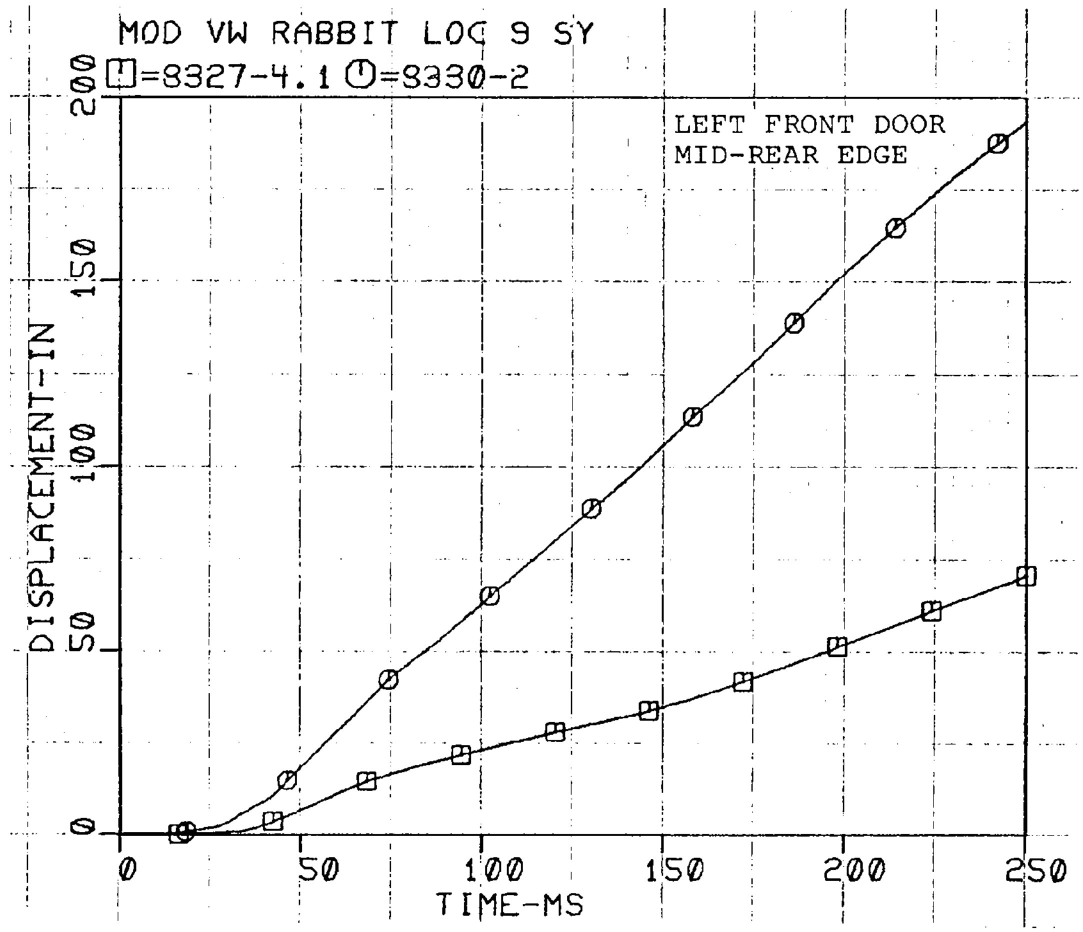
TEST#8327-4.1 MOD RABBIT LOC 8 LAT
LEFT FRONT DOOR
UPPER REAR CORNER
DISPLACEMENT-IN
0.0
30.0
60.0
90.0
120.0

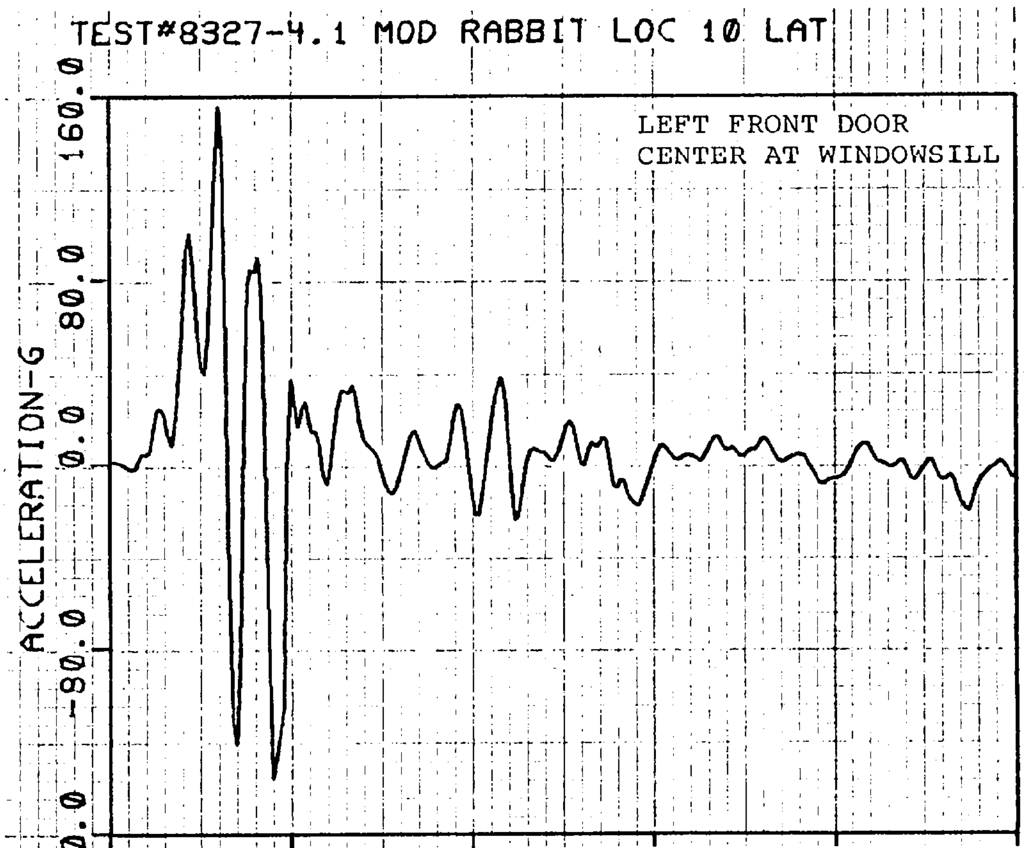


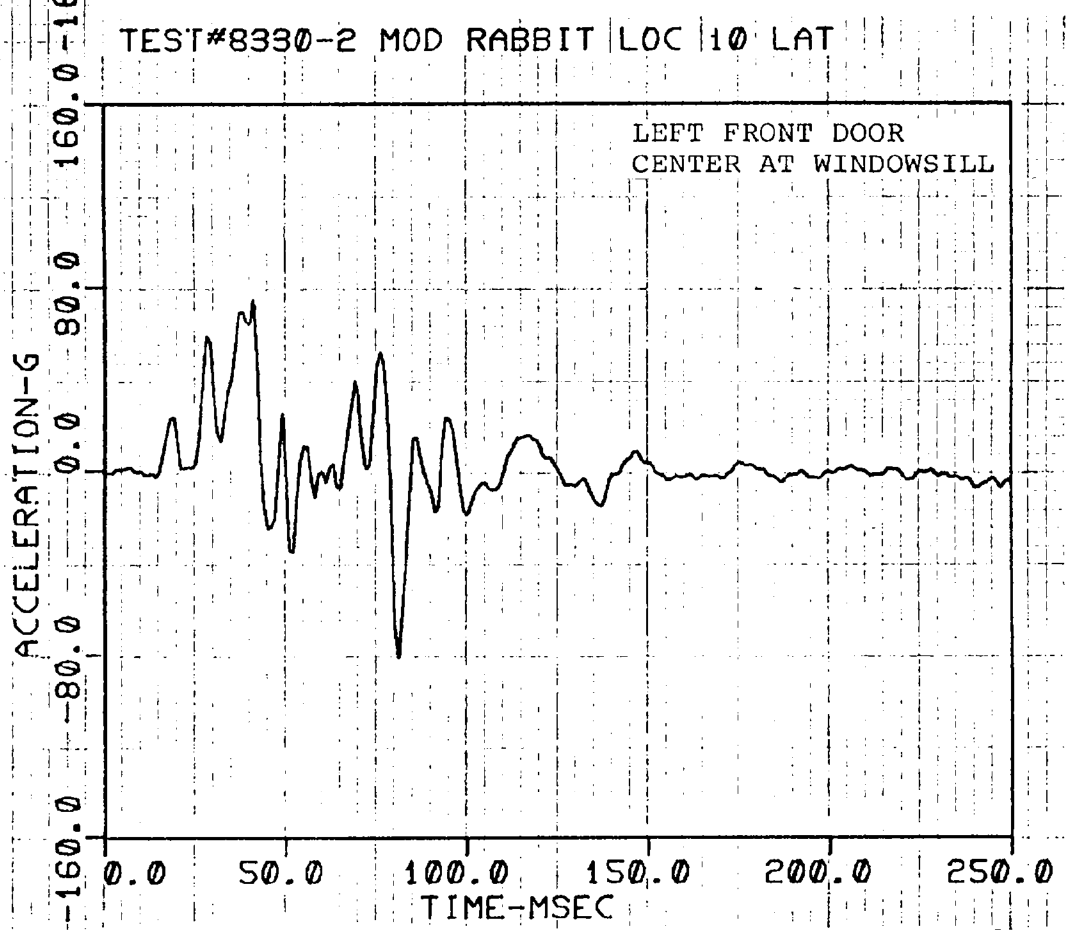
TEST#8330-2 MOD RABBIT LOC 8 LAT
LEFT FRONT DOOR
UPPER REAR CORNER
DISPLACEMENT-IN
0.0
30.0
60.0
90.0
120.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

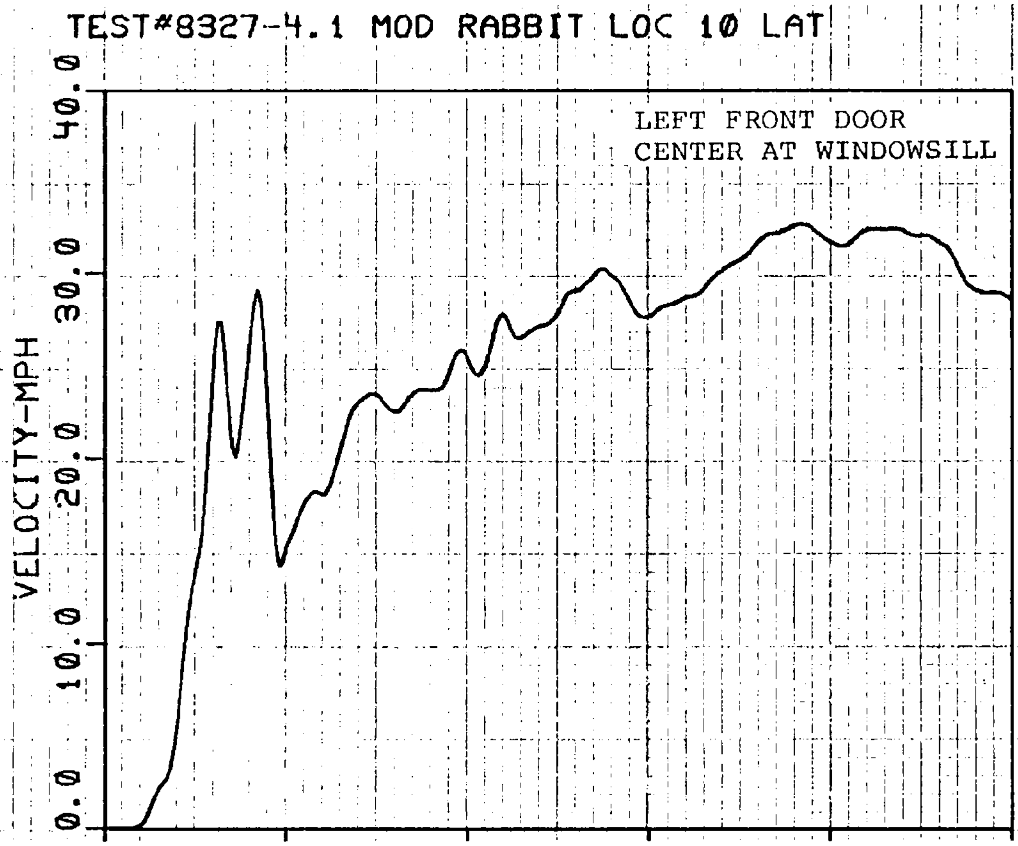


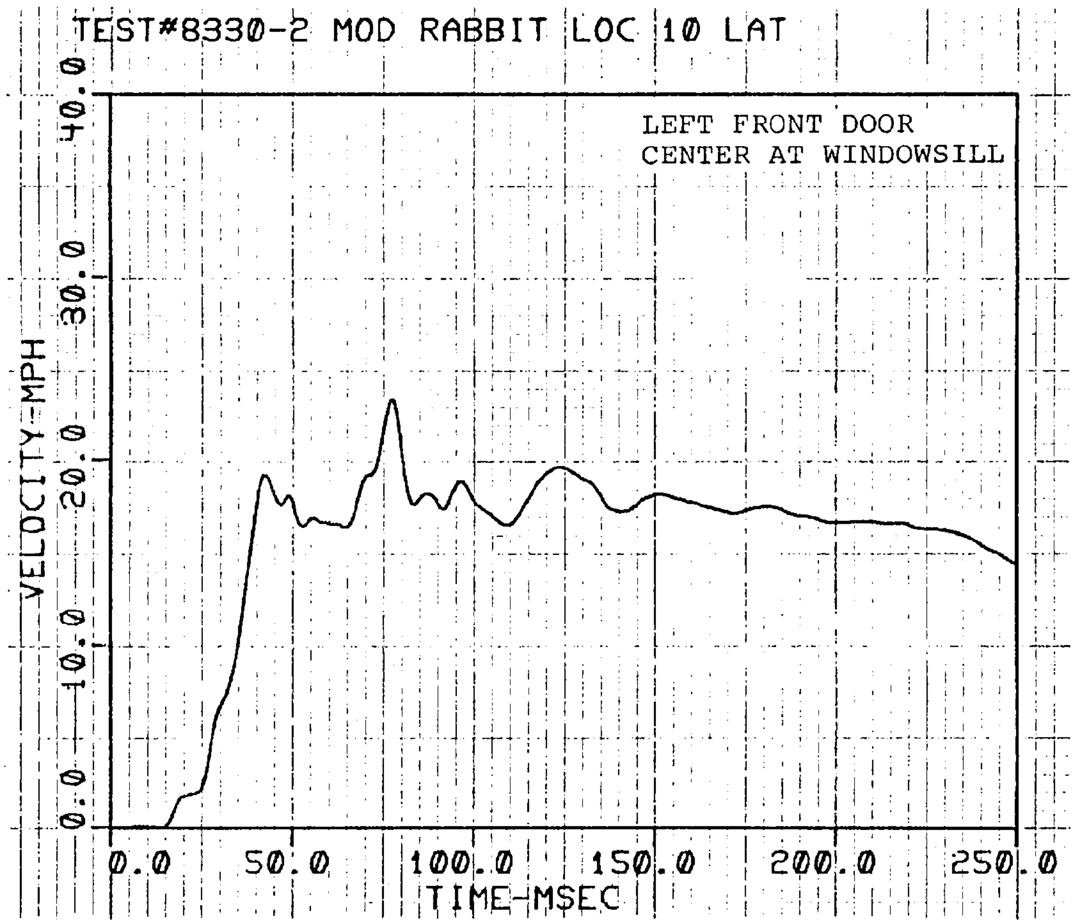
MOD VW RABBIT LOC 9 AY
□=8327-4.1 ○=8330-2
PEAK= 289g
PEAK= 355g
LEFT FRONT DOOR
MID-REAR EDGE
ACCELERATION-G
160
80
0
-80
-160
MOD VW RABBIT LOC 9 VY
□=8327-4.1 ○=8330-2
LEFT FRONT DOOR
MID-REAR EDGE
VELOCITY-MPH
80
60
40
20
0
0
50
100
150
200
250
TIME-MS

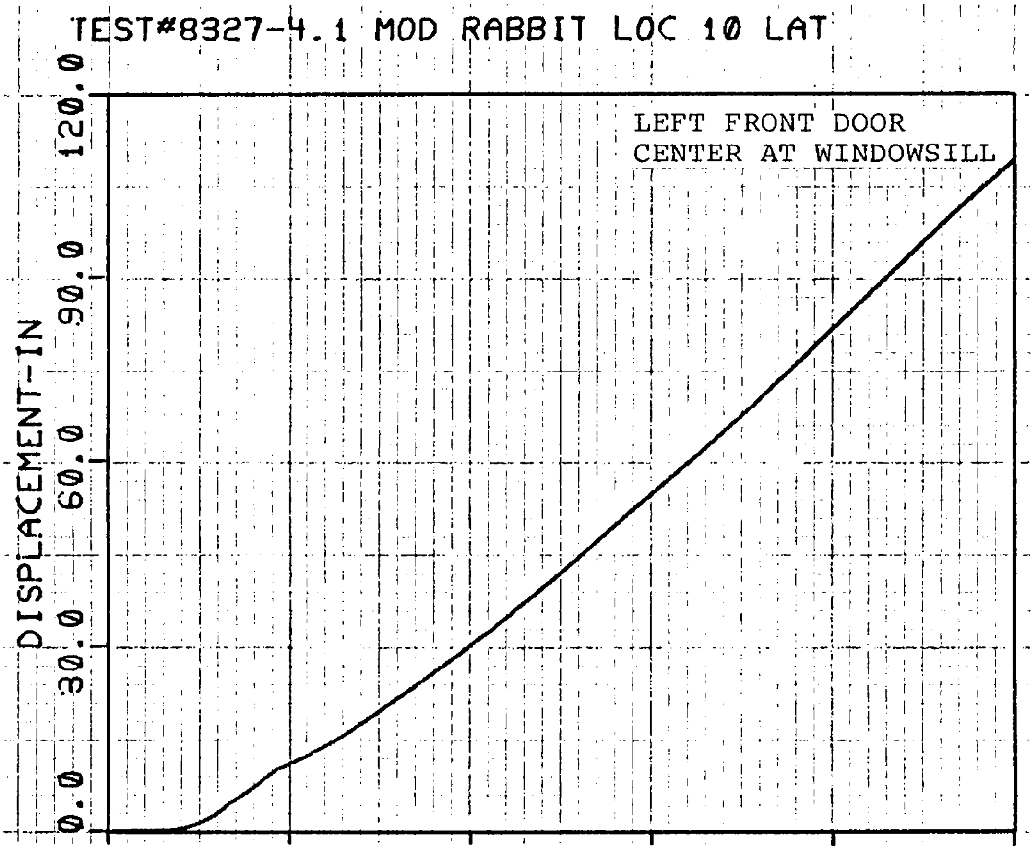

MOD VW RABBIT LOC 9 SY
□=8327-4.1 ○=8330-2
LEFT FRONT DOOR
MID-REAR EDGE
DISPLACEMENT-IN
0
50
100
150
200
TIME-MS
0
50
100
150
200
250

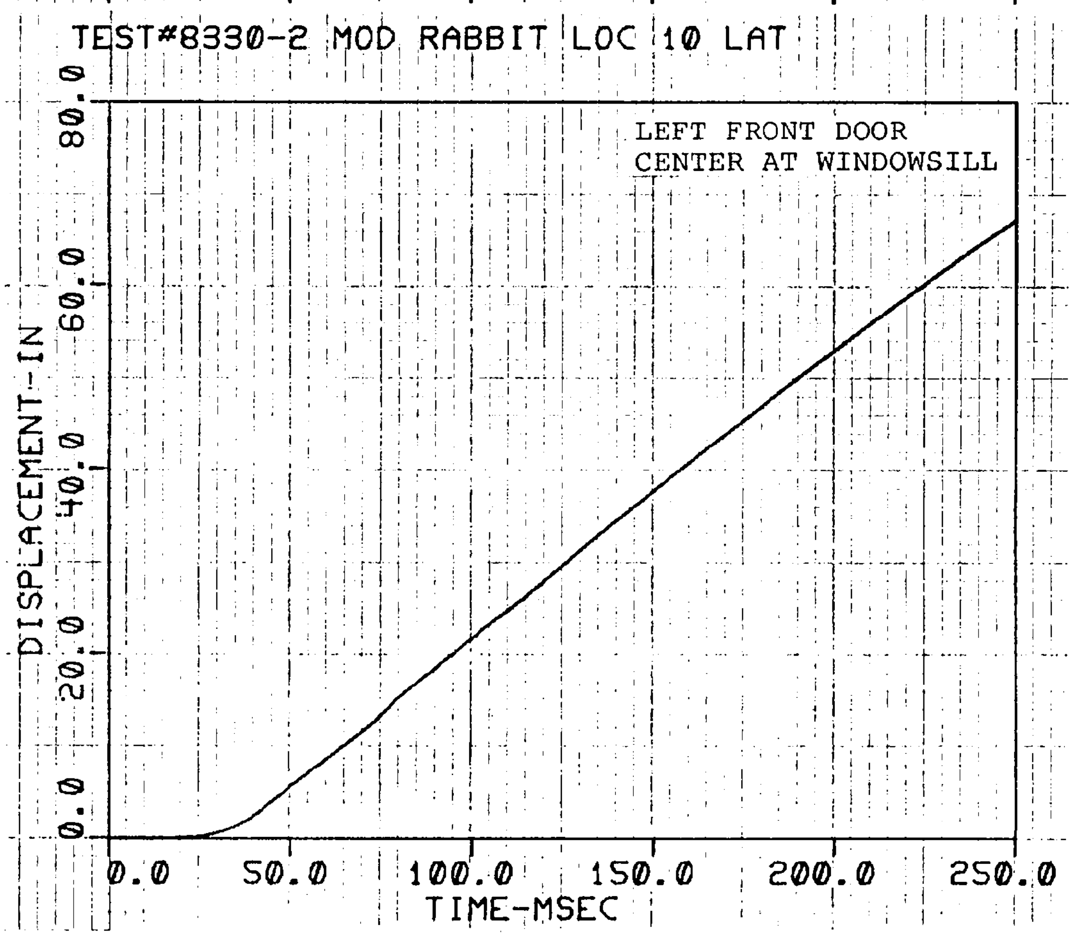

TEST#8327-4.1 MOD RABBIT LOC 10 LAT
LEFT FRONT DOOR
CENTER AT WINDOWSILL
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0

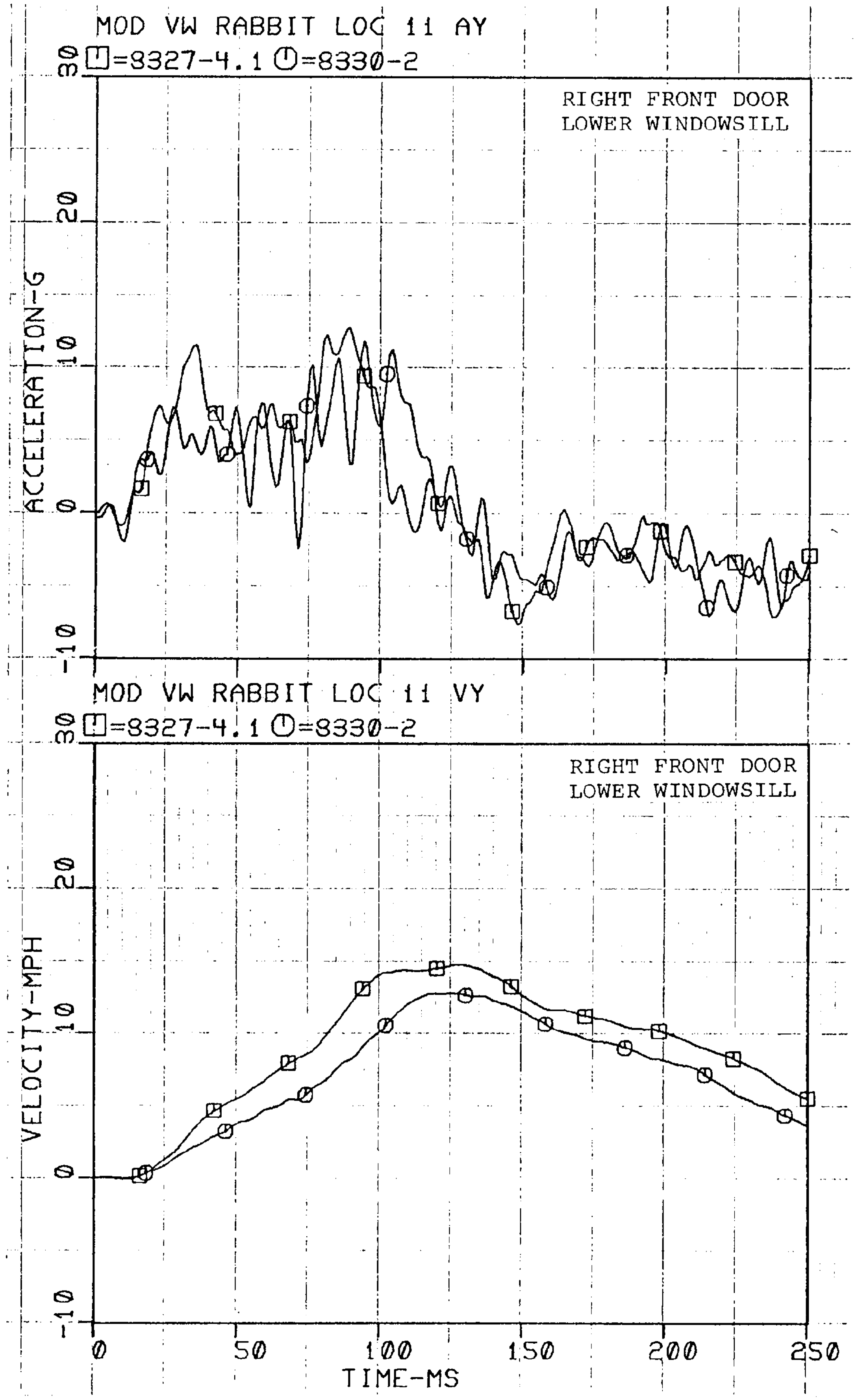

TEST#8330-2 MOD RABBIT LOC 10 LAT
LEFT FRONT DOOR
CENTER AT WINDOWSILL
ACCELERATION-G
160.0
80.0
0.0
-80.0
-160.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC


TEST#8327-4.1 MOD RABBIT LOC 10 LAT
LEFT FRONT DOOR
CENTER AT WINDOWSILL
VELOCITY-MPH
0.0
10.0
20.0
30.0
40.0

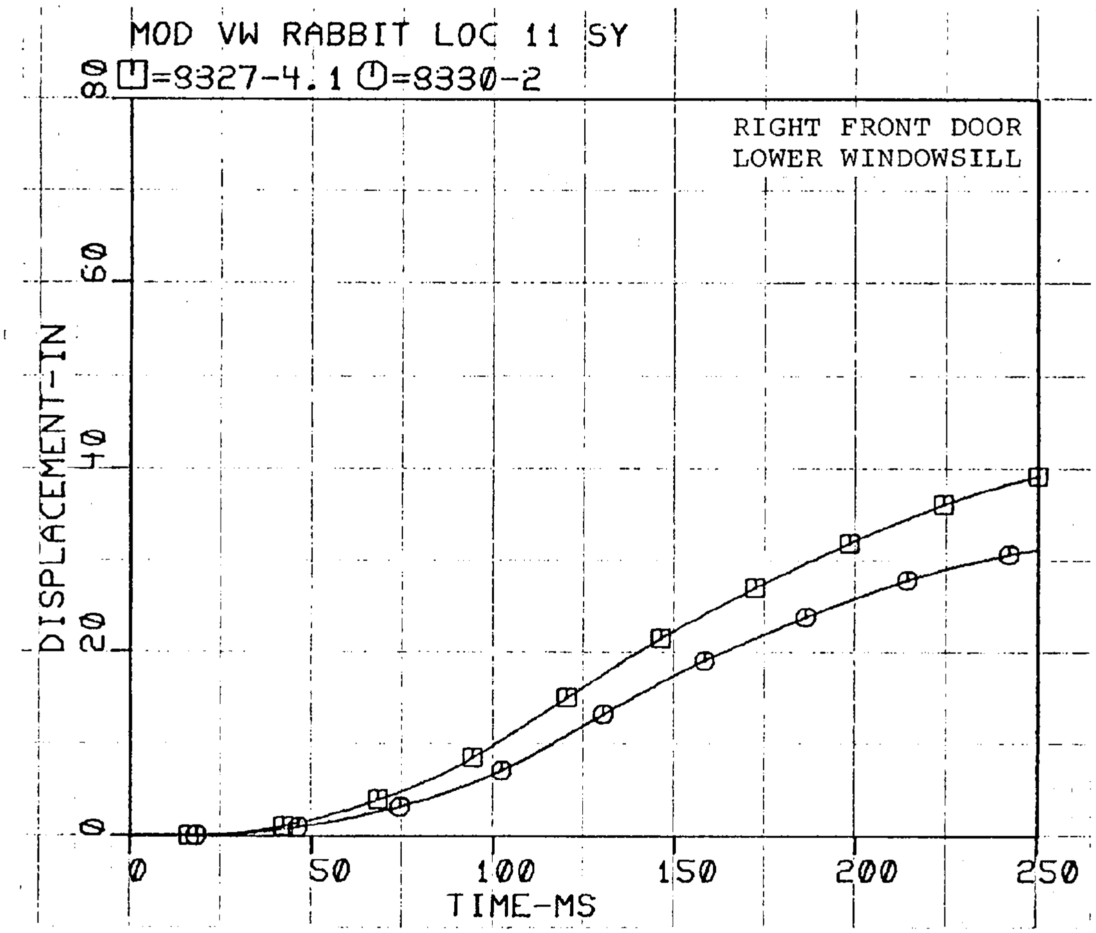

TEST#8330-2 MOD RABBIT LOC 10 LAT
LEFT FRONT DOOR
CENTER AT WINDOWSILL
VELOCITY-MPH
0.0
10.0
20.0
30.0
40.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

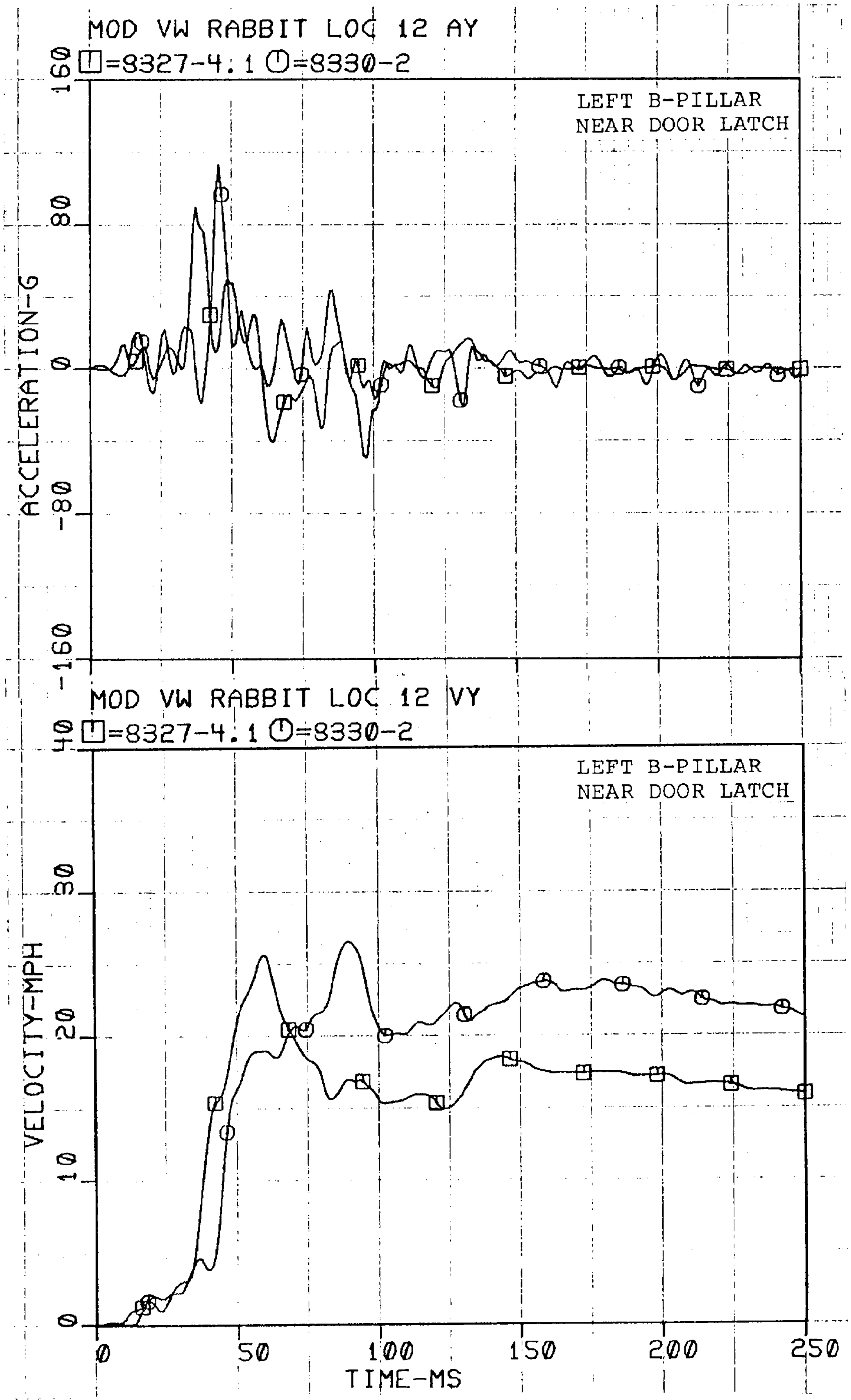

TEST#8327-4.1 MOD RABBIT LOC 10 LAT
LEFT FRONT DOOR
CENTER AT WINDOWSILL
DISPLACEMENT-IN
0.0
30.0
60.0
90.0
120.0


TEST#8330-2 MOD RABBIT LOC 10 LAT
LEFT FRONT DOOR
CENTER AT WINDOWSILL
DISPLACEMENT-IN
0.0
20.0
40.0
60.0
80.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

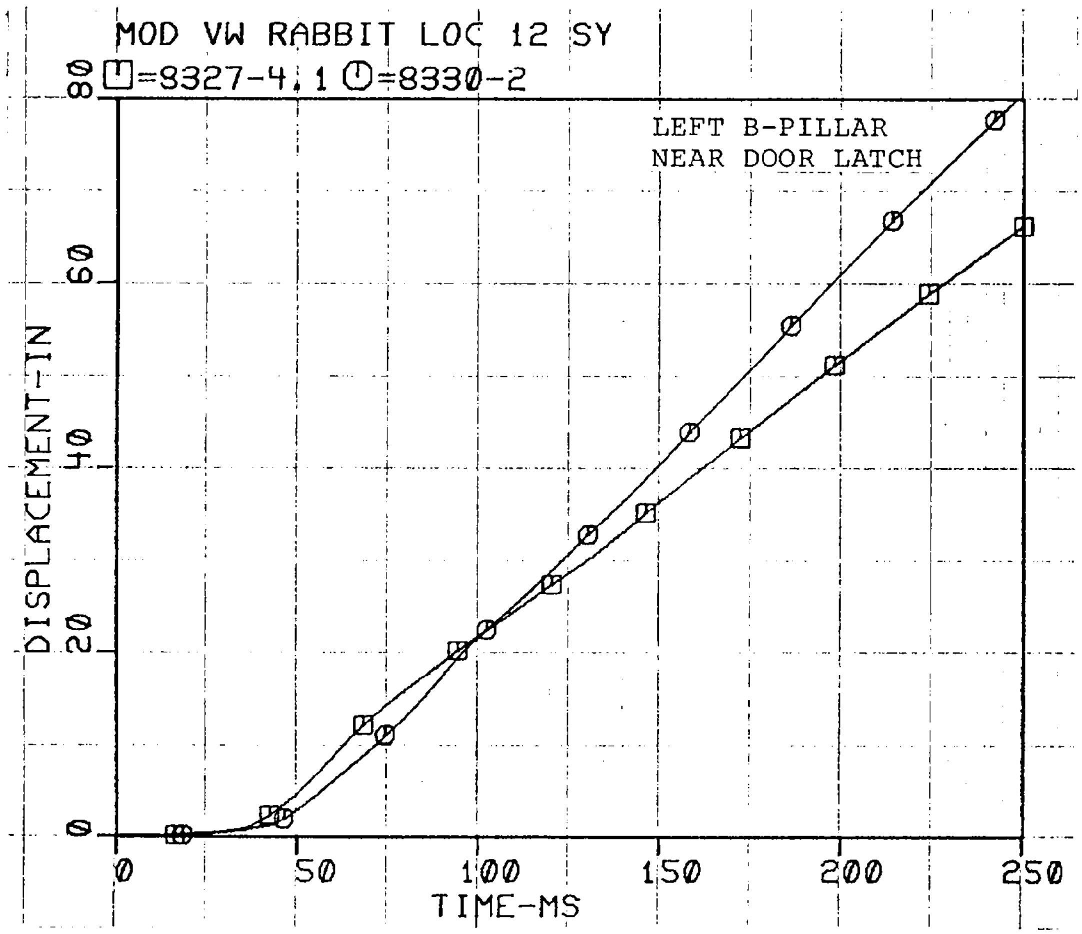


MOD VW RABBIT LOC 11 AY
□=8327-4.1 ○=8330-2
RIGHT FRONT DOOR
LOWER WINDOWSILL
ACCELERATION-G
30
20
10
0
-10
MOD VW RABBIT LOC 11 VY
□=8327-4.1 ○=8330-2
RIGHT FRONT DOOR
LOWER WINDOWSILL
VELOCITY-MPH
30
20
10
0
-10
0
50
100
150
200
250
TIME-MS

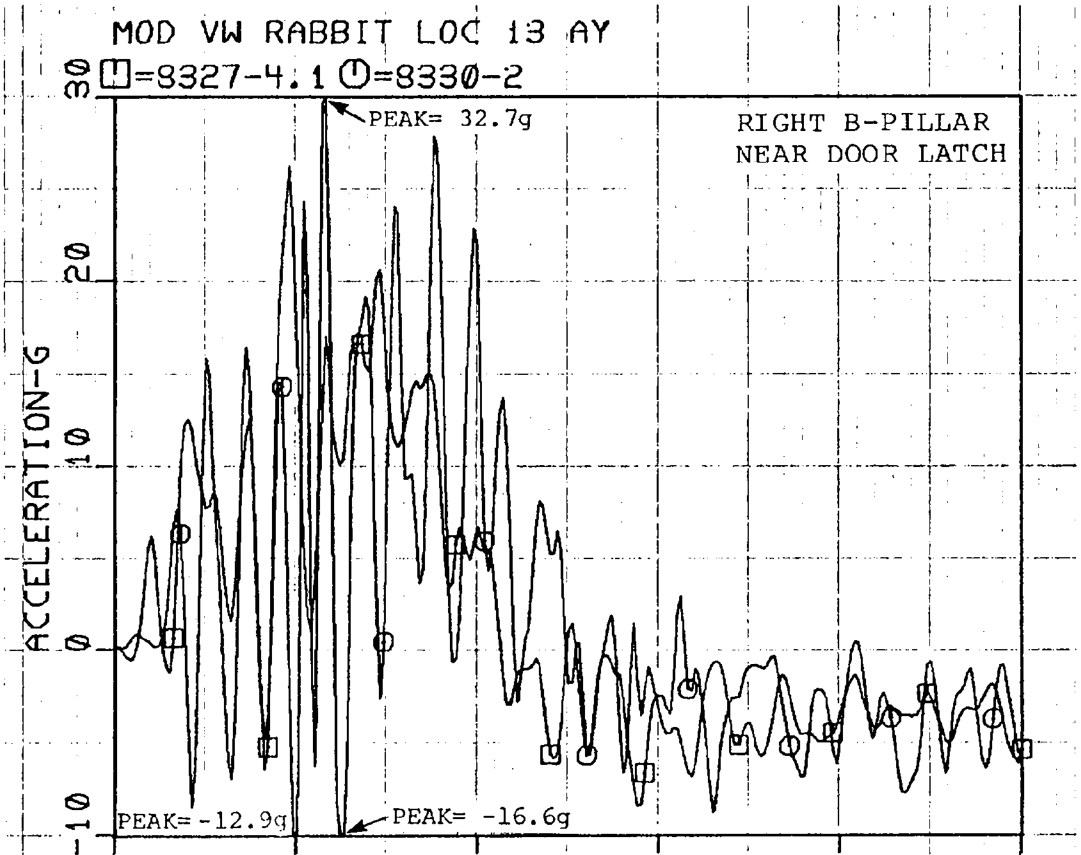

MOD VW RABBIT LOC 11 SY
□=8327-4.1 ○=8330-2
RIGHT FRONT DOOR
LOWER WINDOWSILL
DISPLACEMENT-IN
0
20
40
60
80
0
50
100
150
200
250
TIME-MS



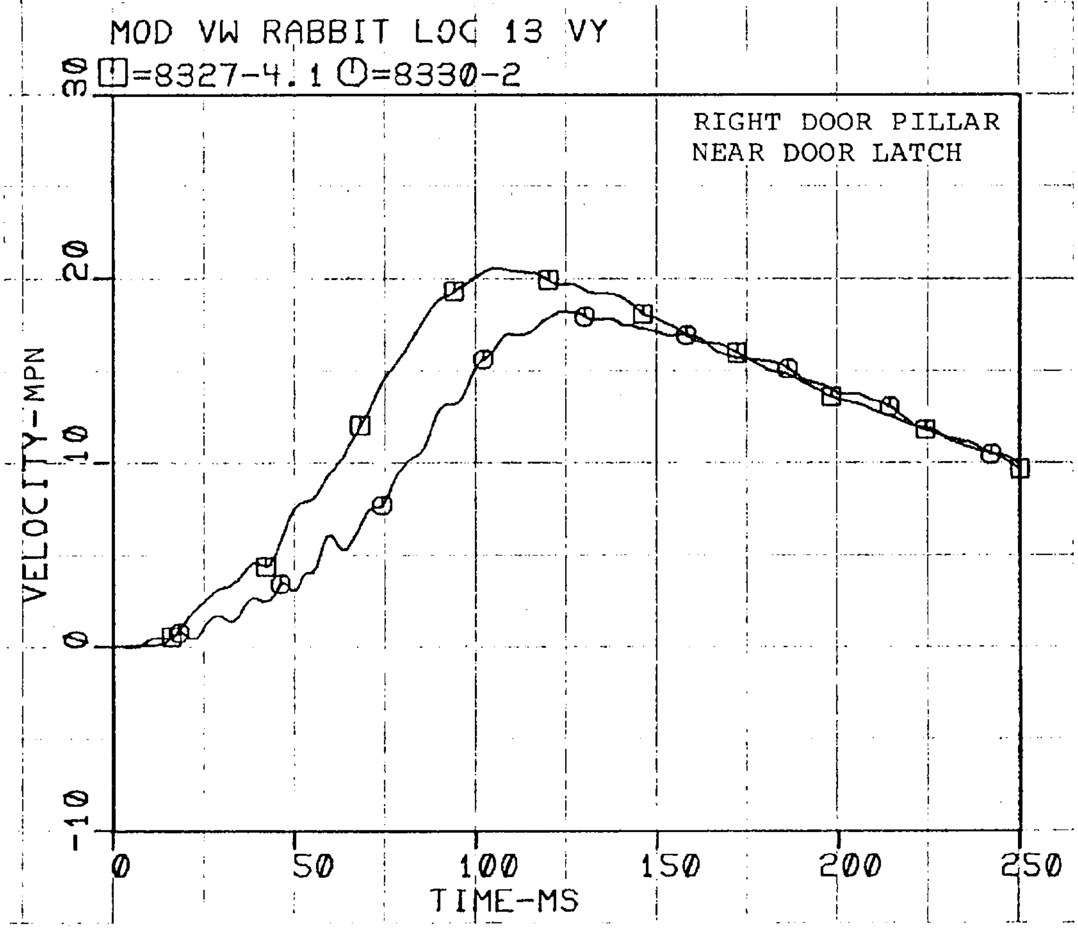
MOD VW RABBIT LOC 12 AY
□=8327-4.1 ○=8330-2
LEFT B-PILLAR
NEAR DOOR LATCH
ACCELERATION-G
160
80
0
-80
-160
MOD VW RABBIT LOC 12 VY
□=8327-4.1 ○=8330-2
LEFT B-PILLAR
NEAR DOOR LATCH
VELOCITY-MPH
40
30
20
10
0
0
50
100
150
200
250
TIME-MS



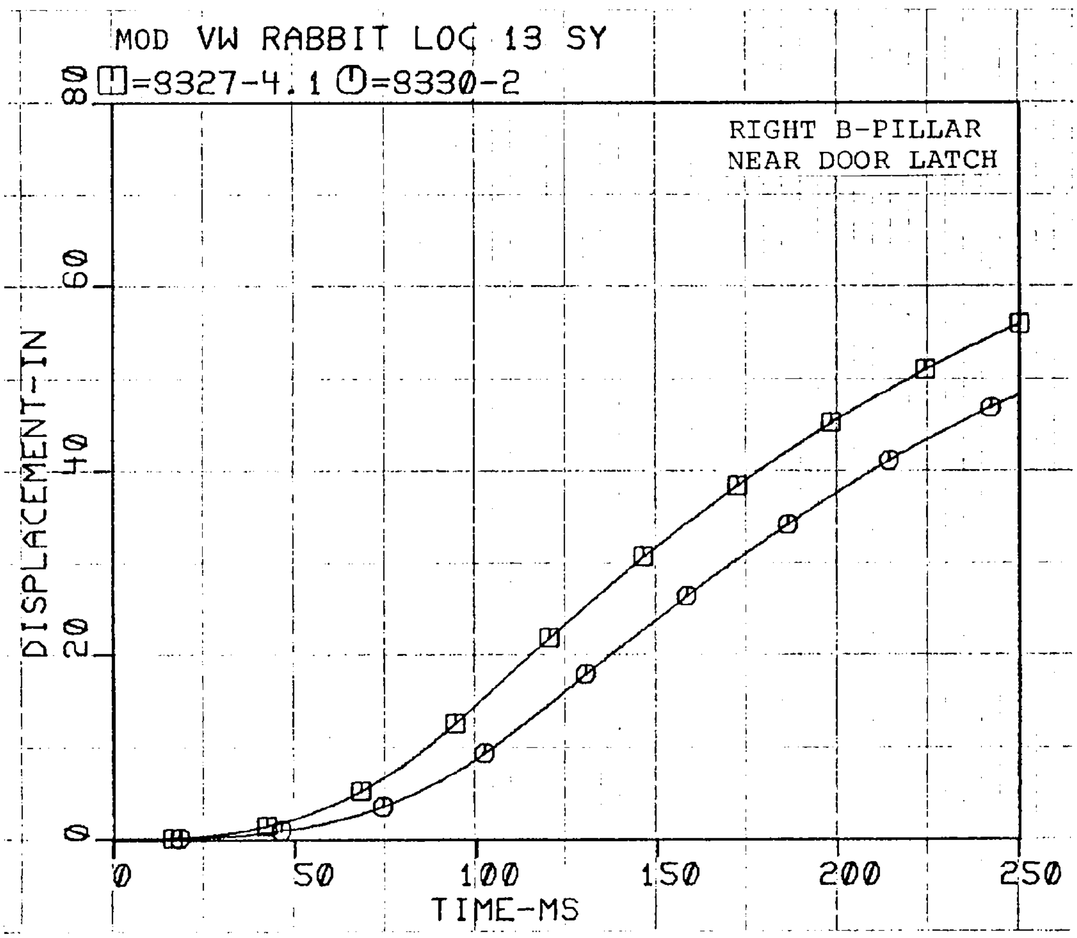
MOD VW RABBIT LOC 12 SY
□=8327-4.1 ○=8330-2
LEFT B-PILLAR
NEAR DOOR LATCH
DISPLACEMENT-IN
0
20
40
60
80
0
50
100
150
200
250
TIME-MS

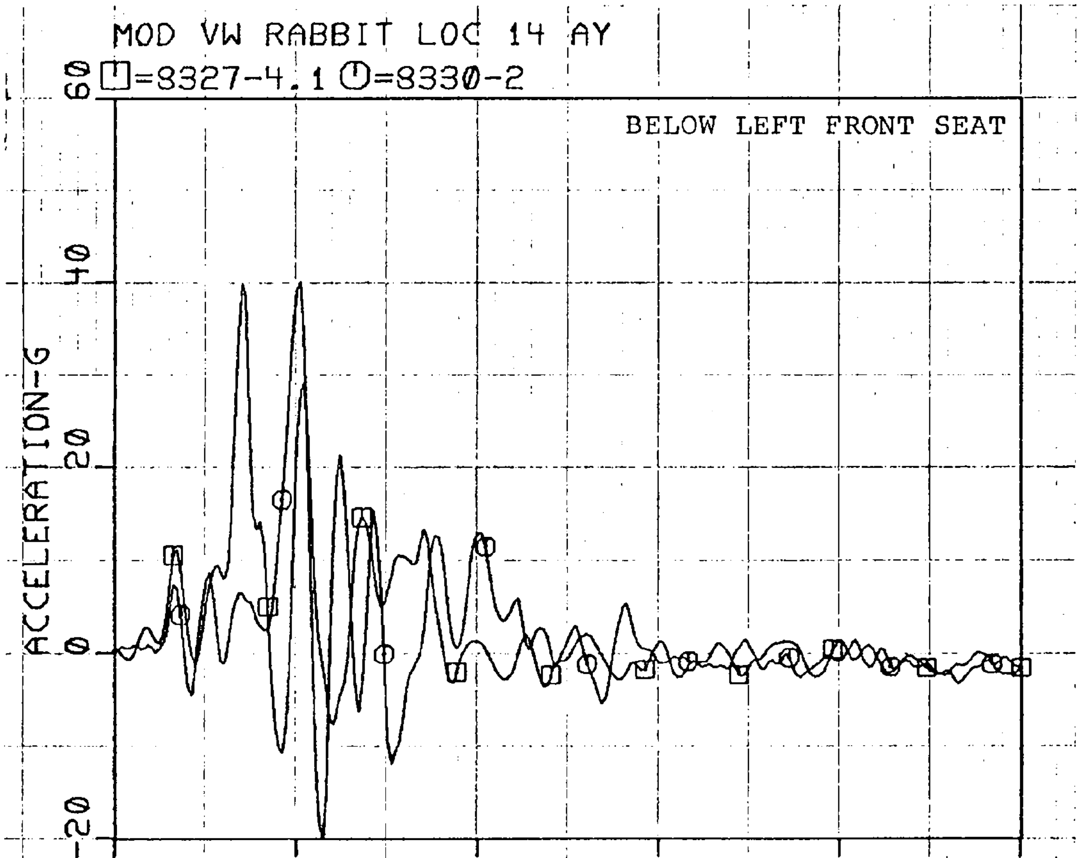


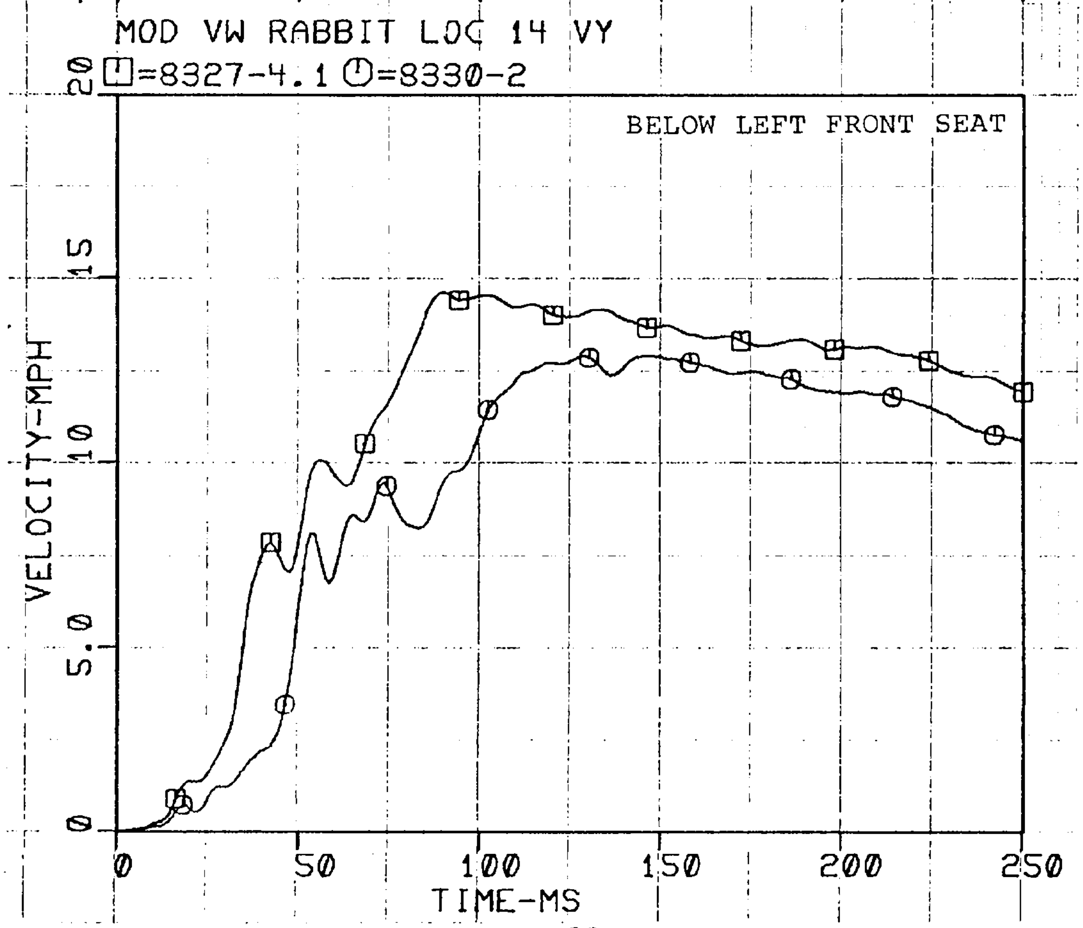
MOD VW RABBIT LOC 13 AY
□=8327-4.1 ○=8330-2
PEAK= 32.7g
RIGHT B-PILLAR
NEAR DOOR LATCH
PEAK= -12.9g
PEAK= -16.6g
ACCELERATION-G
30
20
10
0
-10

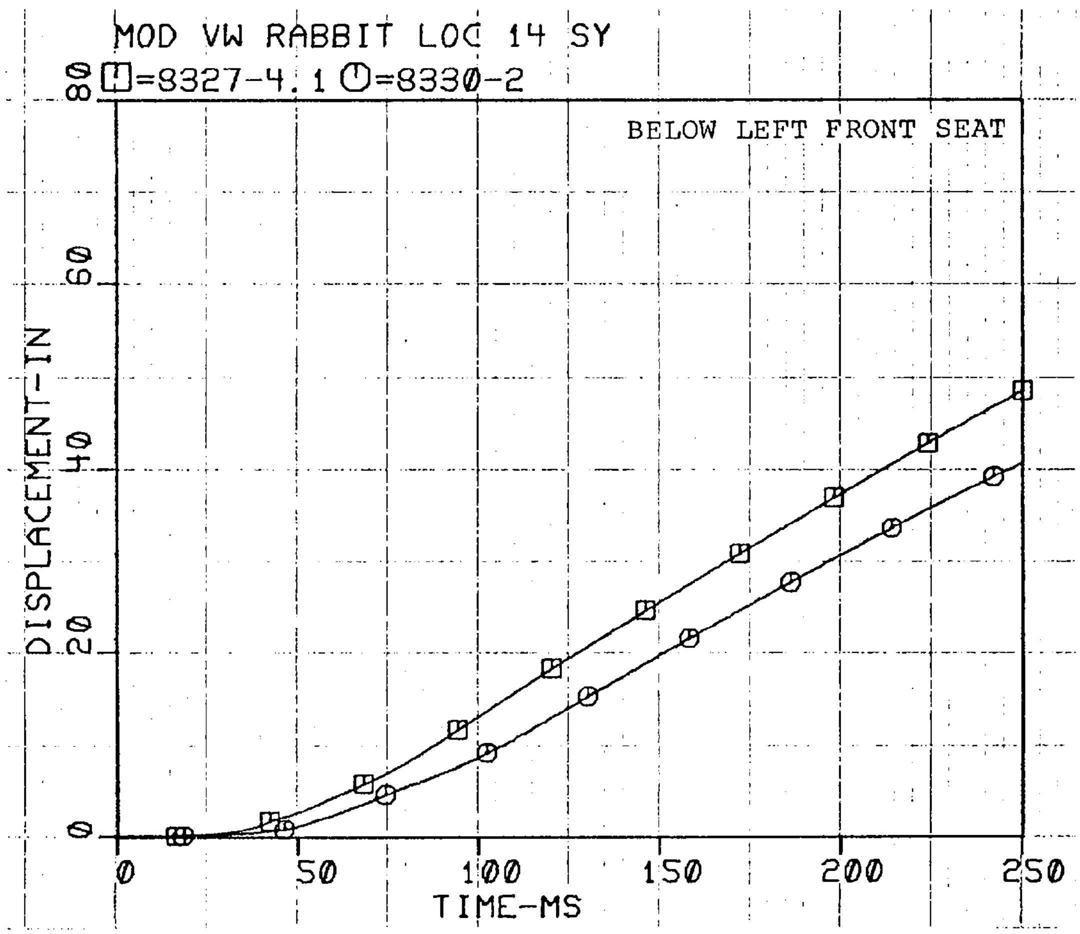


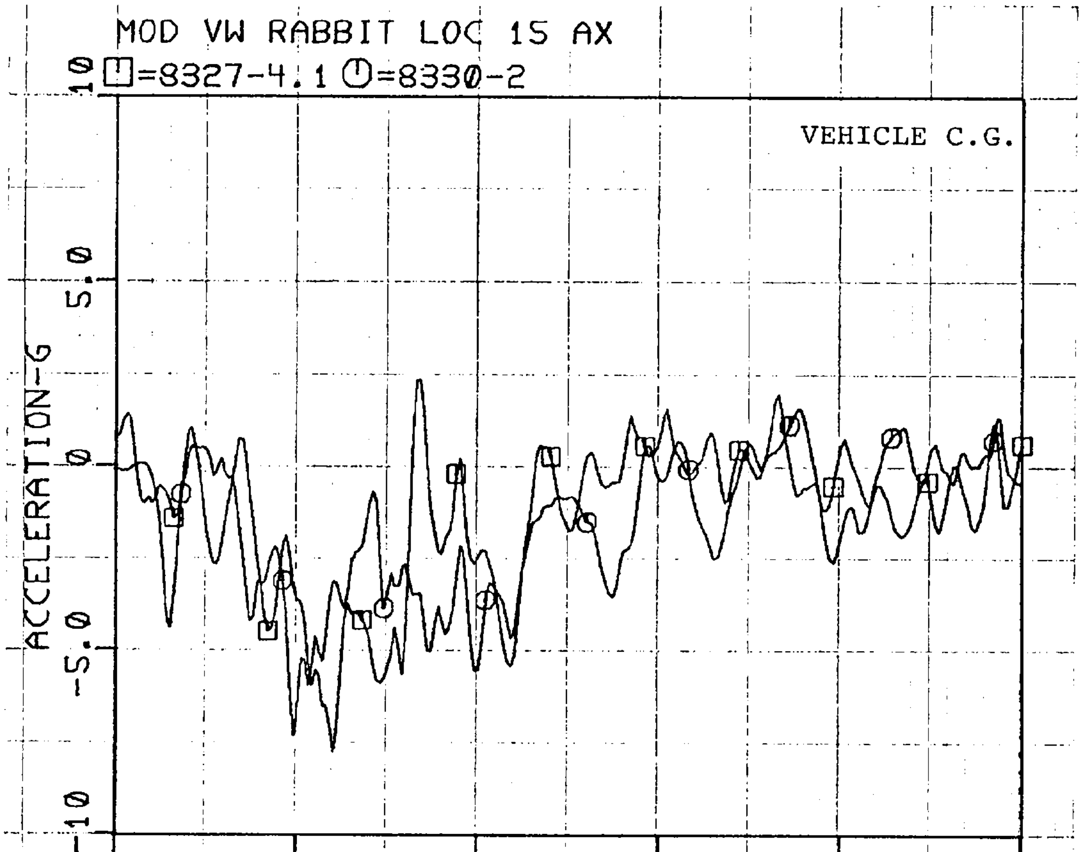
MOD VW RABBIT LOC 13 VY
□=8327-4.1 ○=8330-2
RIGHT DOOR PILLAR
NEAR DOOR LATCH
VELOCITY-MPH
30
20
10
0
-10
0
50
100
150
200
250
TIME-MS


MOD VW RABBIT LOC 13 SY
□=8327-4.1 ⦶=8330-2
RIGHT B-PILLAR
NEAR DOOR LATCH
DISPLACEMENT-IN
80
60
40
20
0
0
50
100
150
200
250
TIME-MS

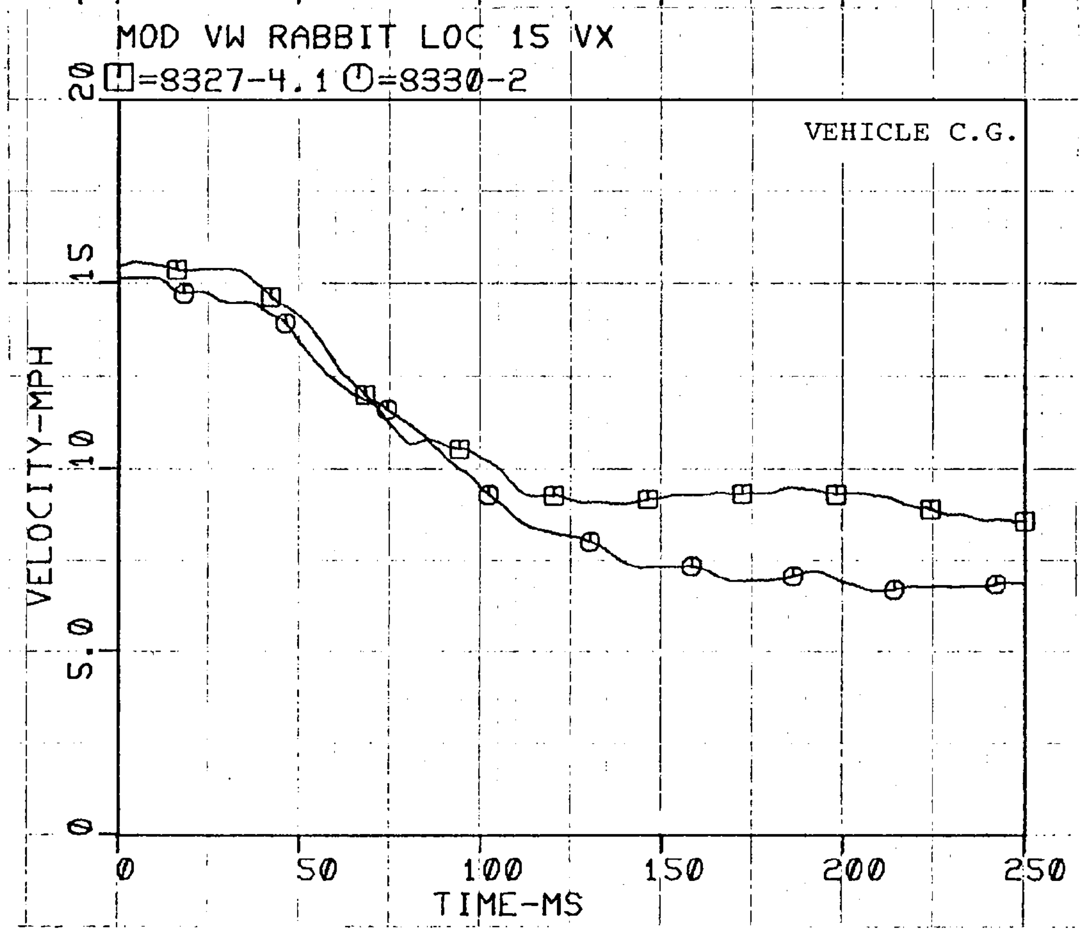

MOD VW RABBIT LOC 14 AY
□=8327-4.1 ○=8330-2
BELOW LEFT FRONT SEAT
ACCELERATION-G
60
40
20
0
-20


MOD VW RABBIT LOC 14 VY
□=8327-4.1 ○=8330-2
BELOW LEFT FRONT SEAT
VELOCITY-MPH
20
15
10
5.0
0
0
50
100
150
200
250
TIME-MS

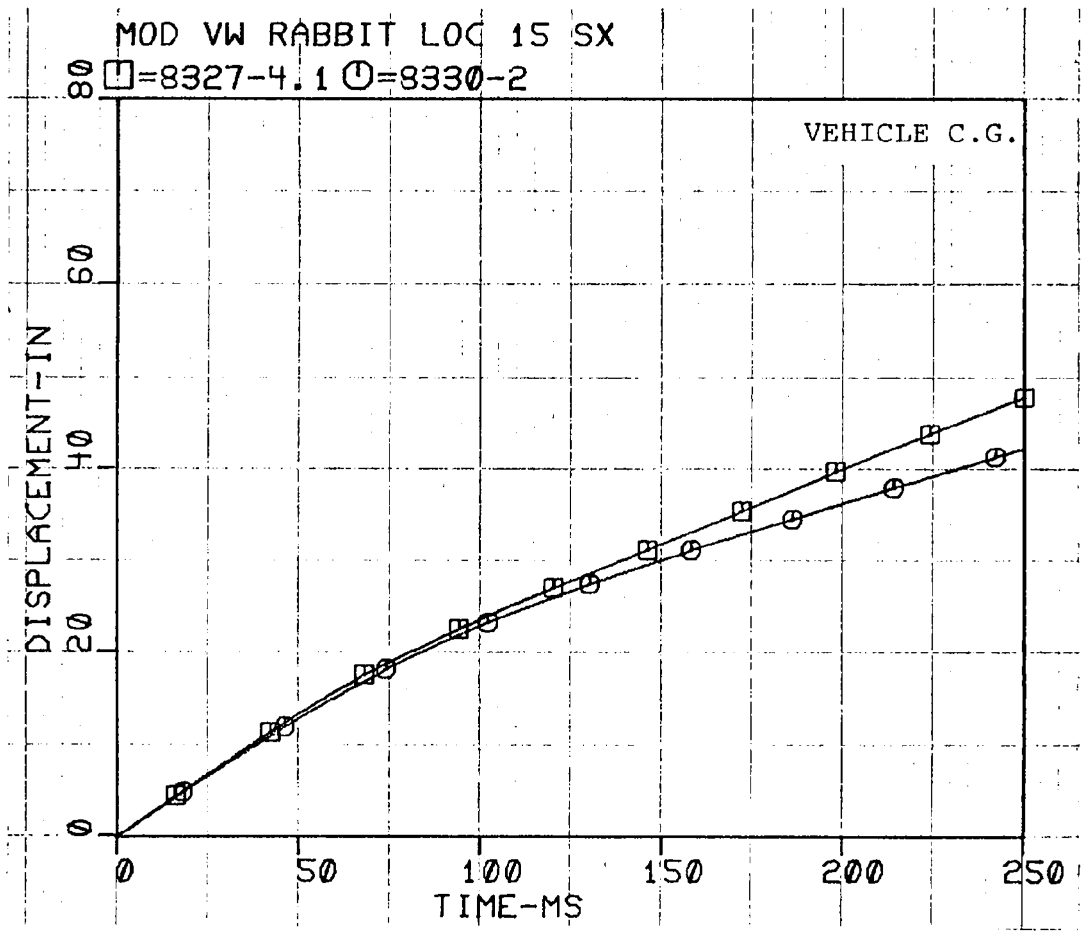

MOD VW RABBIT LOC 14 SY
□=8327-4.1 ○=8330-2
BELOW LEFT FRONT SEAT
DISPLACEMENT-IN
0
20
40
60
80
0
50
100
150
200
250
TIME-MS

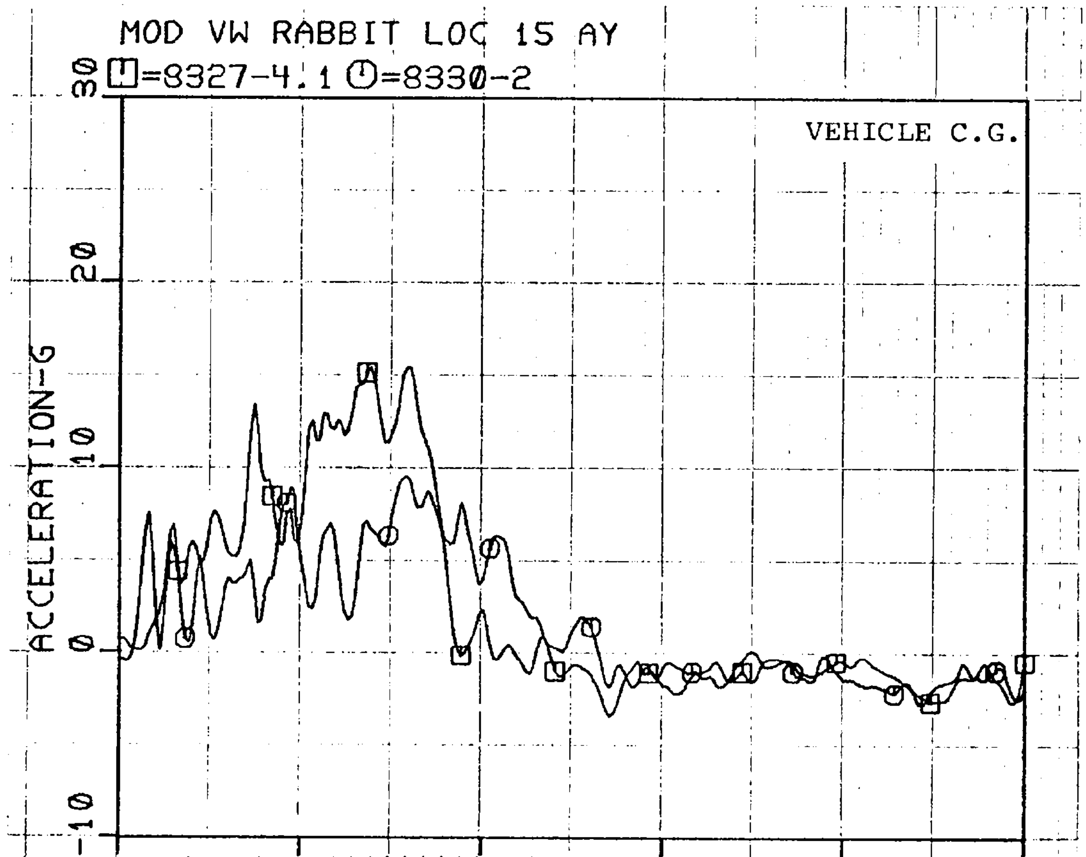


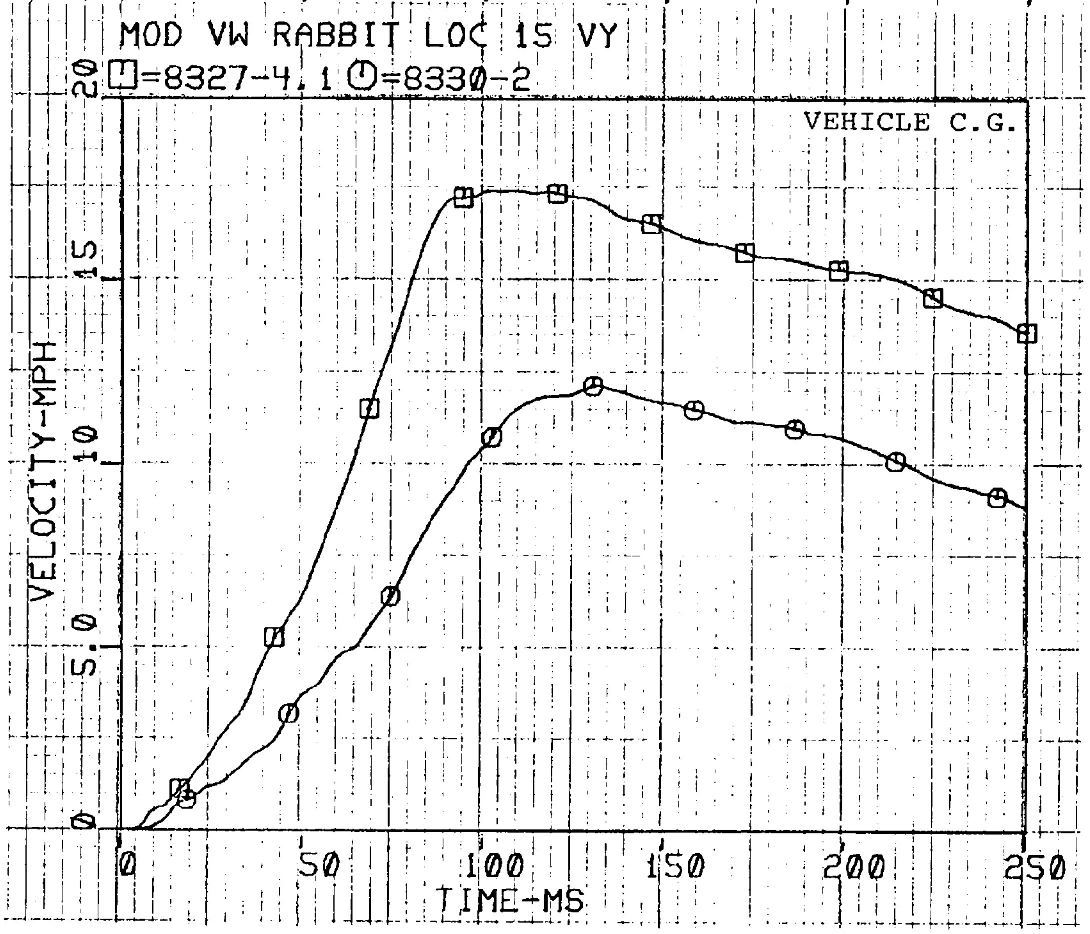
MOD VW RABBIT LOC 15 AX
▢=8327-4.1 ○=8330-2
VEHICLE C.G.
ACCELERATION-G
10
5.0
0
-5.0
-10

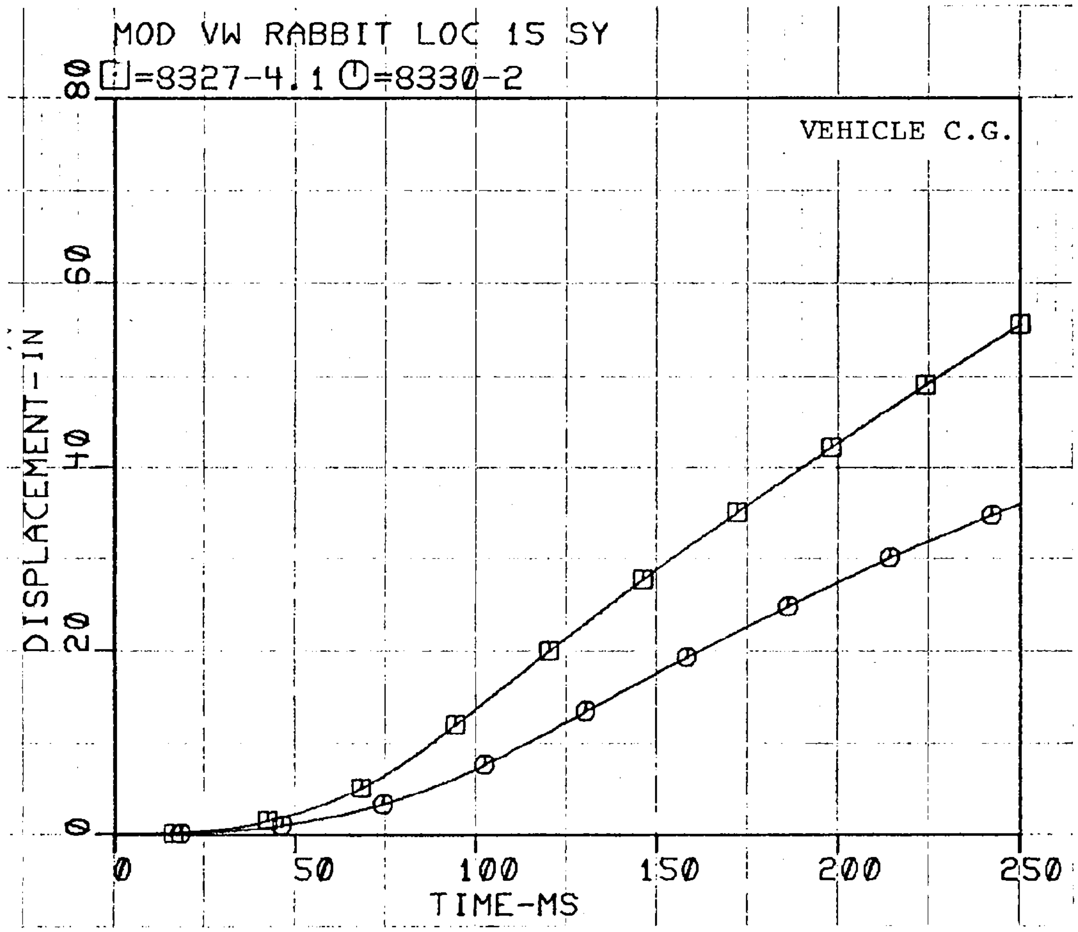


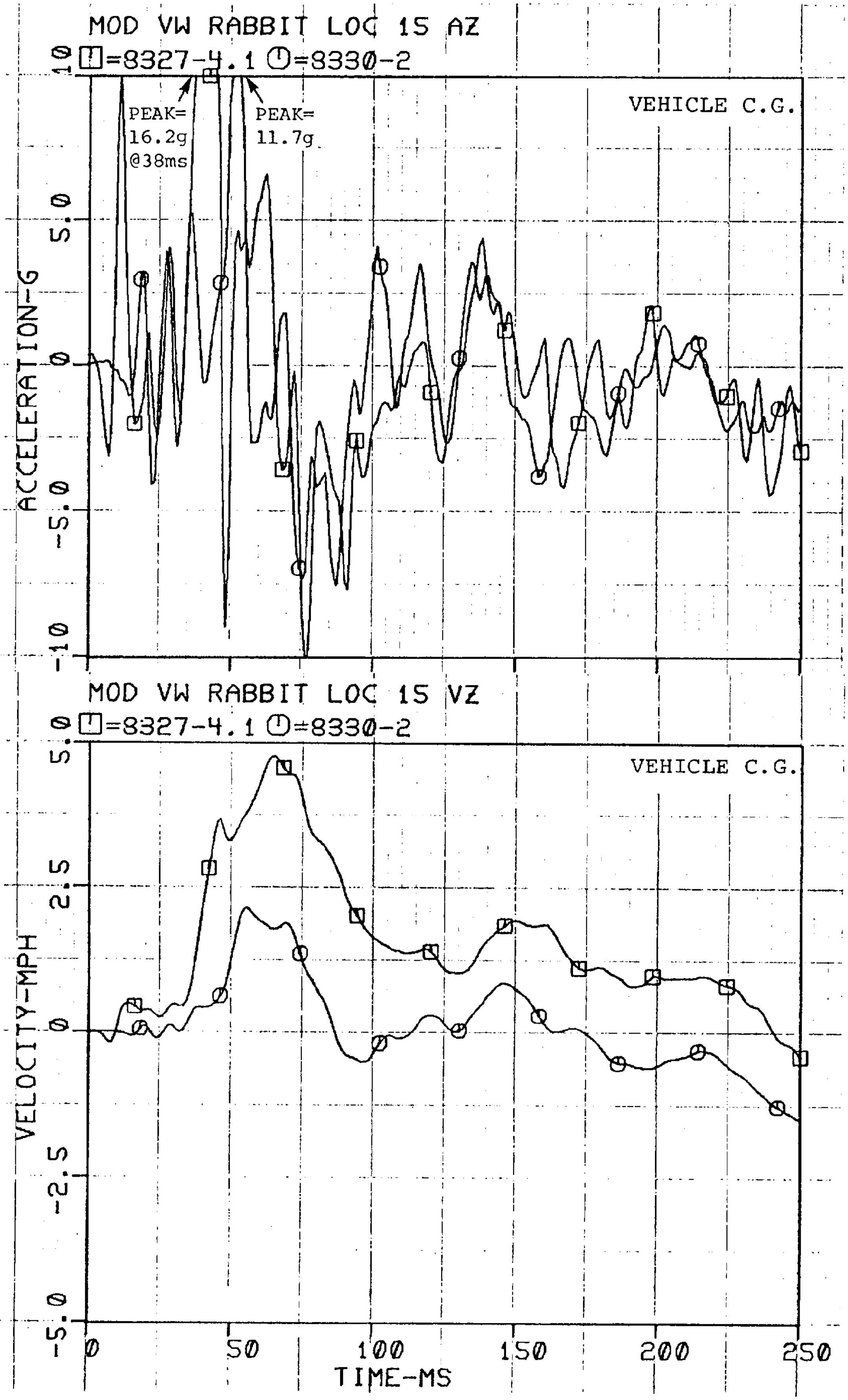
MOD VW RABBIT LOC 15 VX
▢=8327-4.1 ○=8330-2
VEHICLE C.G.
VELOCITY-MPH
20
15
10
5.0
0
0
50
100
150
200
250
TIME-MS


MOD VW RABBIT LOC 15 SX
□=8327-4.1 ⏀=8330-2
VEHICLE C.G.
DISPLACEMENT-IN
0
20
40
60
80
0
50
100
150
200
250
TIME-MS

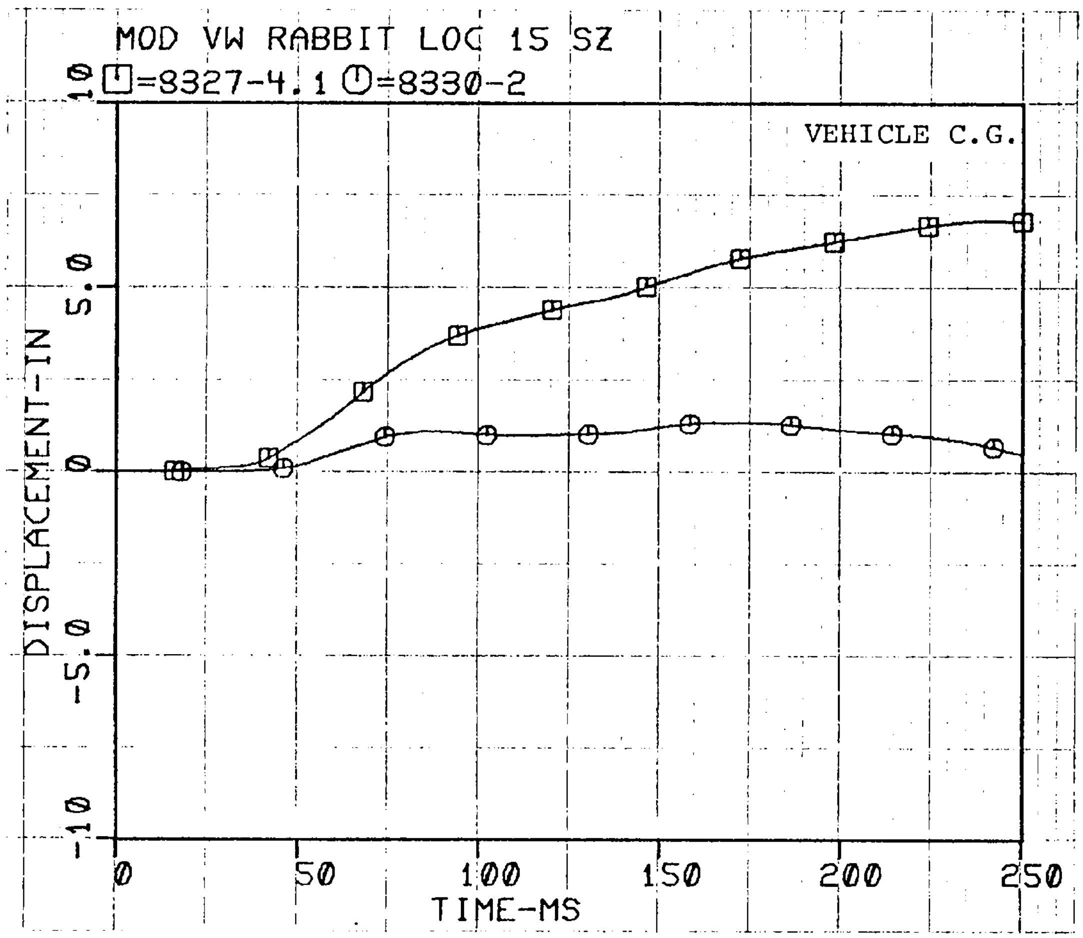

MOD VW RABBIT LOC 15 AY
□=8327-4.1 ○=8330-2
VEHICLE C.G.
ACCELERATION-G
30
20
10
0
-10


MOD VW RABBIT LOC 15 VY
□=8327-4.1 ○=8330-2
VEHICLE C.G.
VELOCITY-MPH
20
15
10
5.0
0
0
50
100
150
200
250
TIME-MS

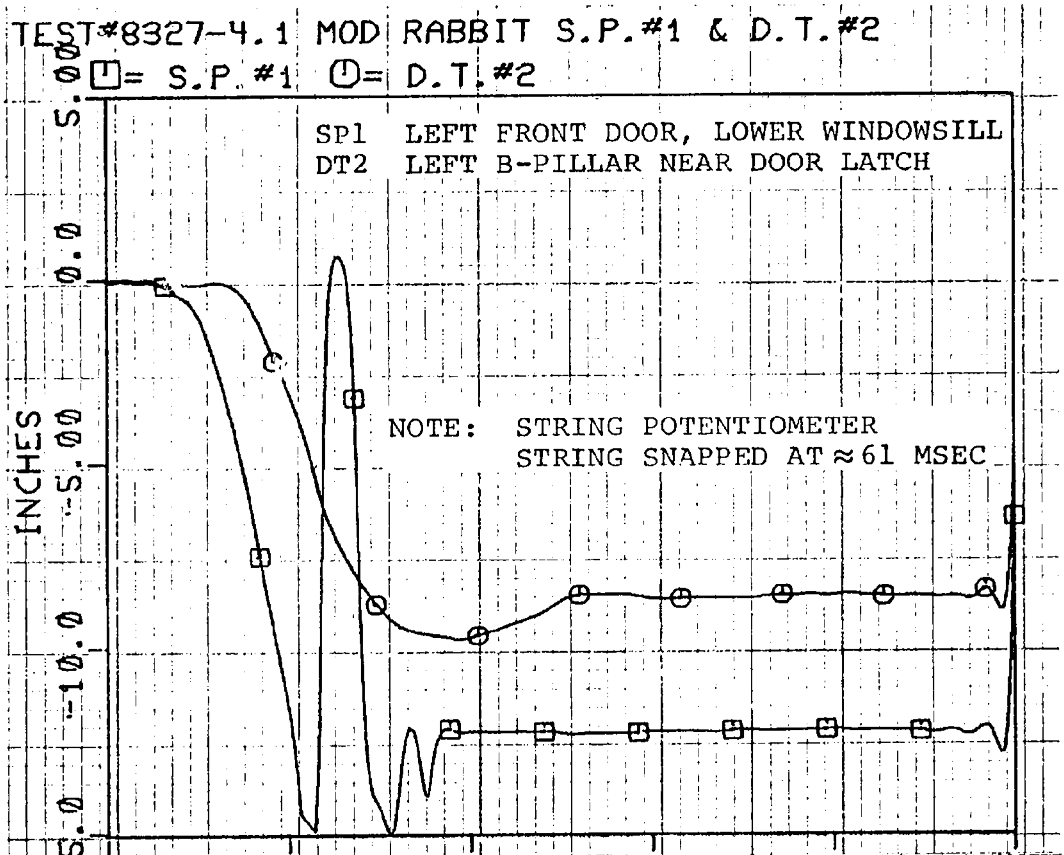

MOD VW RABBIT LOC 15 SY
□=8327-4.1 ⊘=8330-2
VEHICLE C.G.
DISPLACEMENT-IN
0
20
40
60
80
0
50
100
150
200
250
TIME-MS

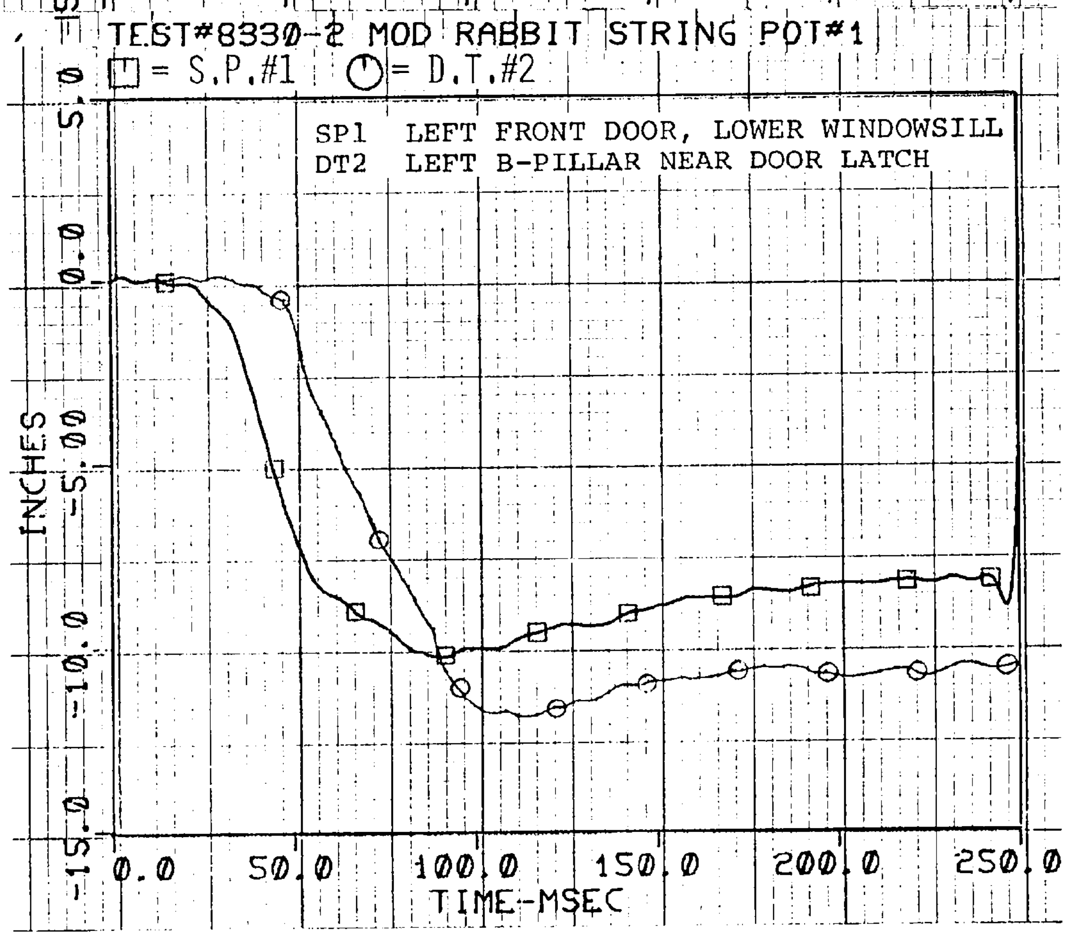


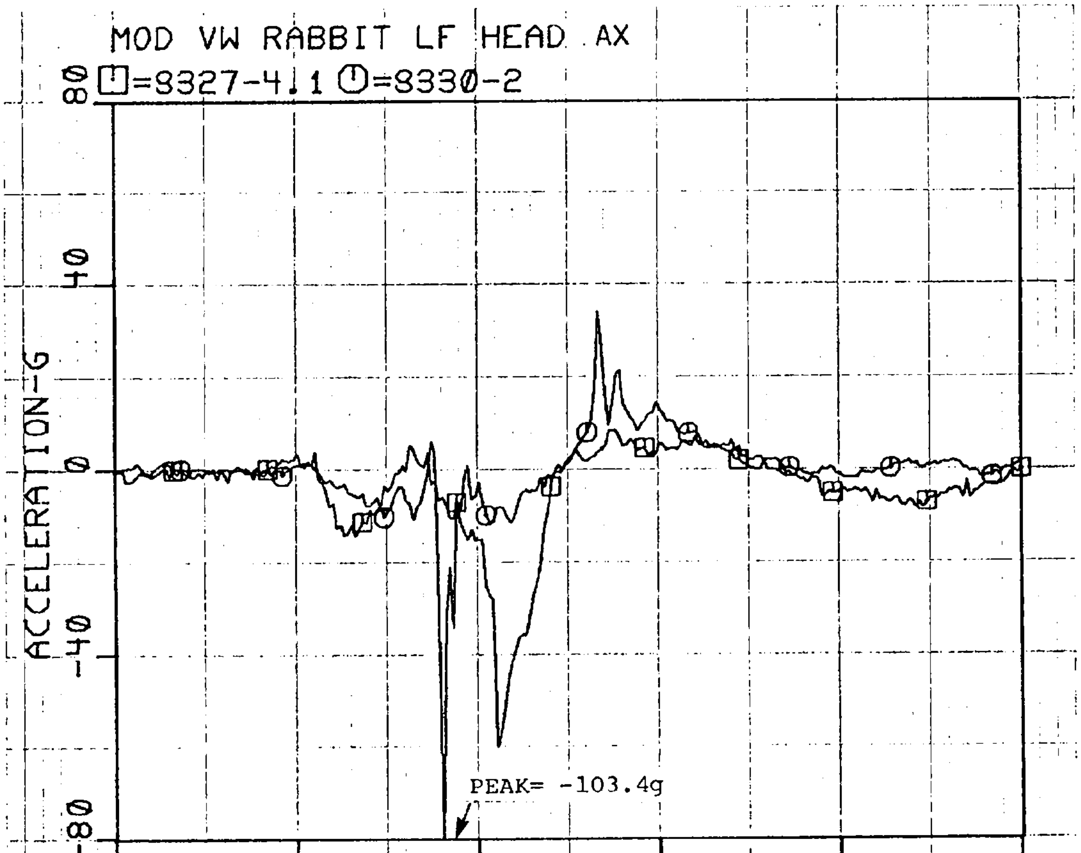
MOD VW RABBIT LOC 15 AZ
□=8327-4.1 ○=8330-2
PEAK= 16.2g @38ms
PEAK= 11.7g
VEHICLE C.G.
ACCELERATION-G
10
5.0
0
-5.0
-10
MOD VW RABBIT LOC 15 VZ
□=8327-4.1 ○=8330-2
VEHICLE C.G.
VELOCITY-MPH
5.0
2.5
0
-2.5
-5.0
0
50
100
150
200
250
TIME-MS



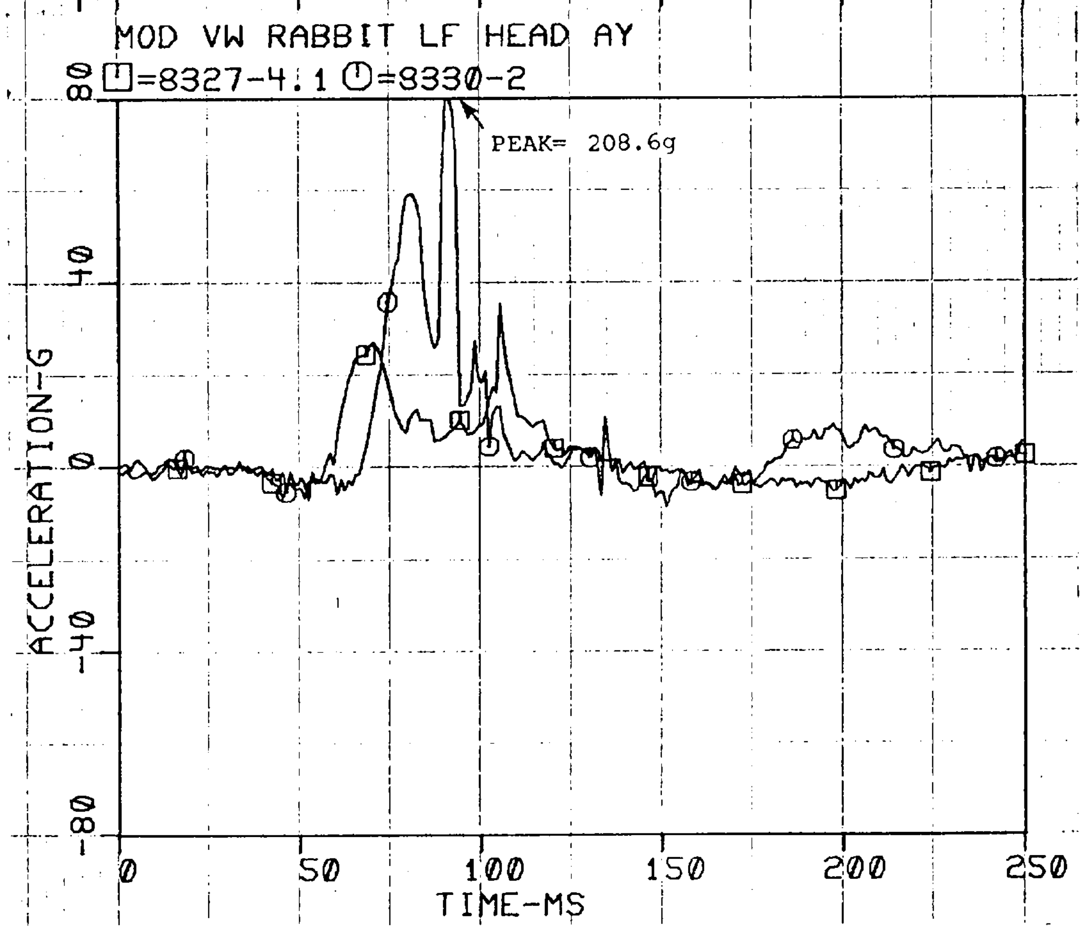
MOD VW RABBIT LOC 15 SZ
□=8327-4.1 ○=8330-2
VEHICLE C.G.
DISPLACEMENT-IN
10
5.0
0
-5.0
-10
0
50
100
150
200
250
TIME-MS


TEST#8327-4.1 MOD RABBIT S.P.#1 & D.T.#2
= S.P.#1 = D.T.#2
SP1 LEFT FRONT DOOR, LOWER WINDOWSILL
DT2 LEFT B-PILLAR NEAR DOOR LATCH
NOTE: STRING POTENTIOMETER
STRING SNAPPED AT ≈ 61 MSEC
INCHES
5.00
0.0
-5.00
-10.0
-15.0

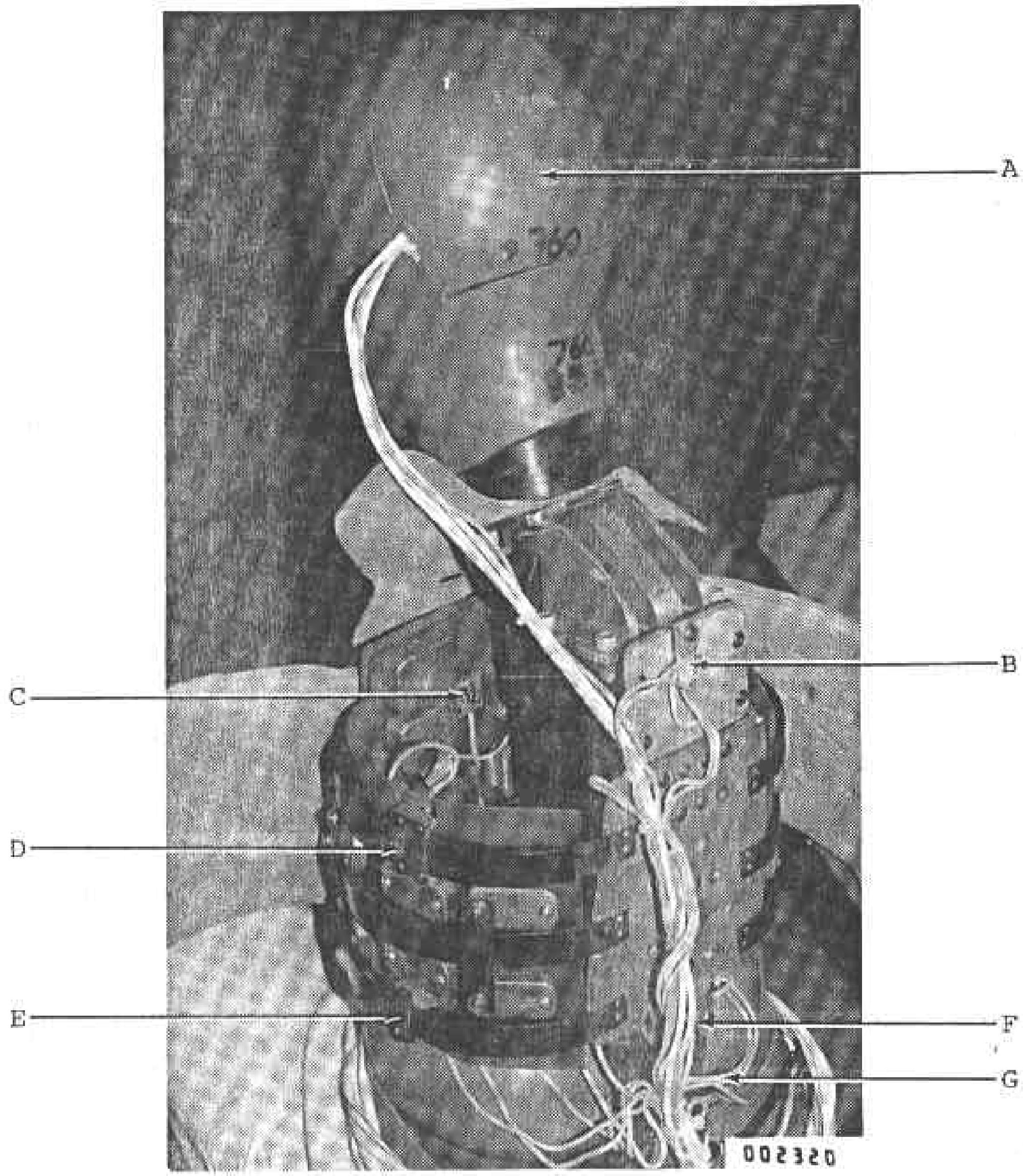

TEST#8330-2 MOD RABBIT STRING POT#1
= S.P.#1 = D.T.#2
SP1 LEFT FRONT DOOR, LOWER WINDOWSILL
DT2 LEFT B-PILLAR NEAR DOOR LATCH
INCHES
5.0
0.0
-5.00
-10.0
-15.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC



MOD VW RABBIT LF HEAD AX
□=8327-4.1 ○=8330-2
80
40
0
-40
-80
ACCELERATION-G
PEAK= -103.4g



MOD VW RABBIT LF HEAD AY
□=8327-4.1 ○=8330-2
80
40
0
-40
-80
ACCELERATION-G
PEAK= 208.6g
0
50
100
150
200
250
TIME-MS



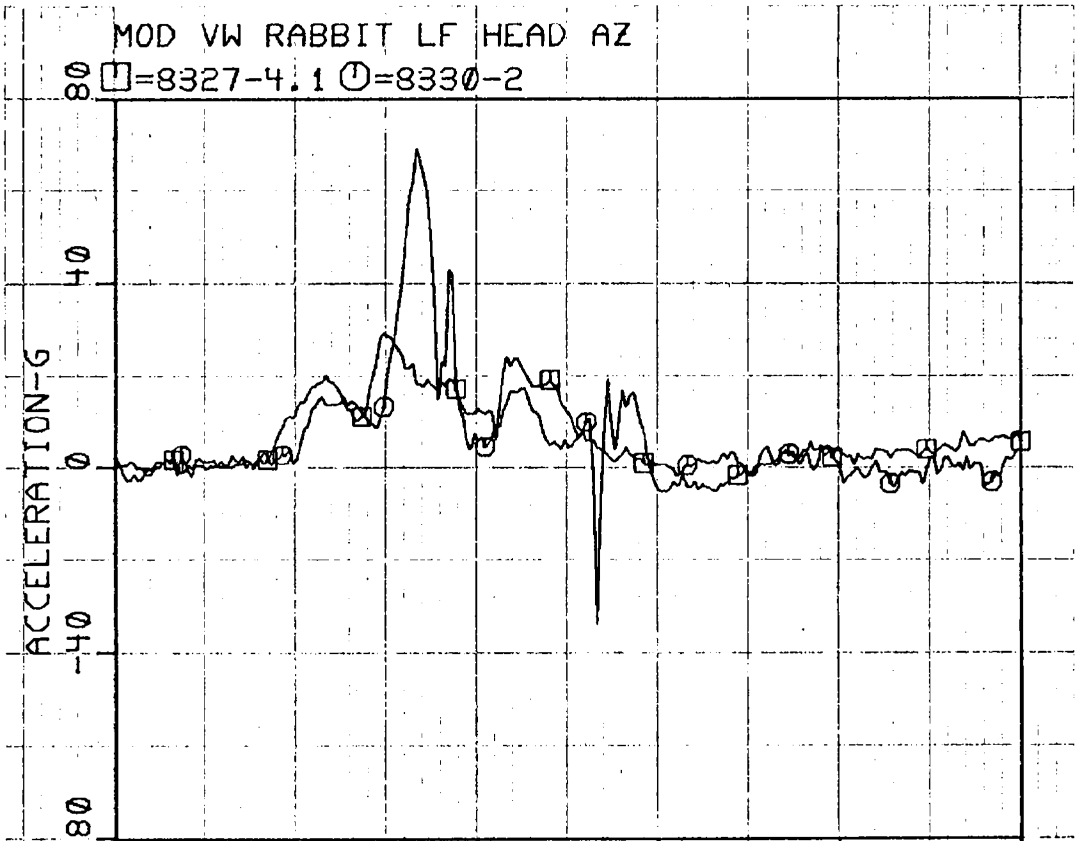
A. HEAD TRIAXIAL
B. UPPER THORAX (T-1), TRIAXIAL
C. UPPER STERNUM, LONG (LOWER STERNUM, LONG ON 3RD RIB ALSO)
D. LEFT UPPER RIB, LAT. (ALSO ON RIGHT)
E. LEFT LOWER RIB, LONG (ALSO ON RIGHT)
F. LOWER THORAX (T-12), TRIAXIAL
G. PELVIC, TRIAXIAL

Figure C-1. Locations of Eighteen Accelerometers for the NHTSA Side Impact Dummy (Three-rib Design).

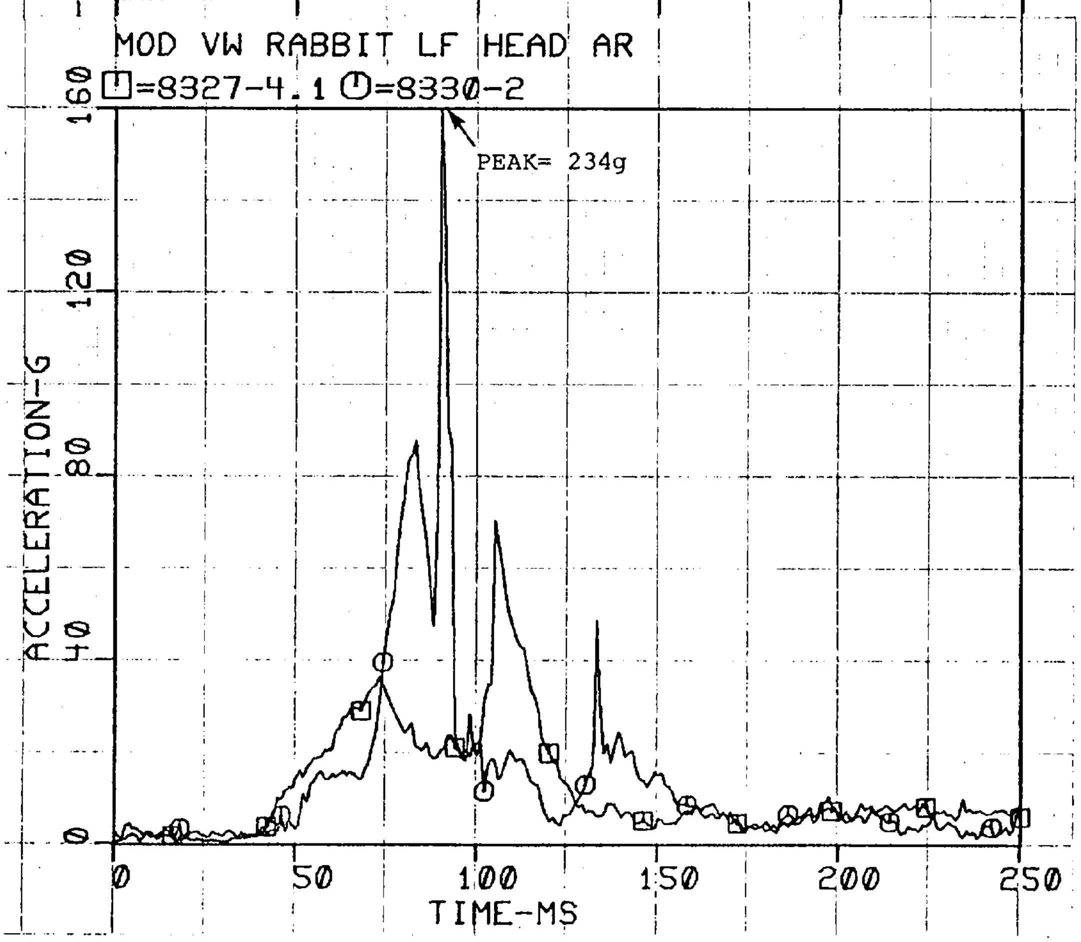
APPENDIX C

COMPARISON OF SIDE IMPACT DUMMY
DATA PLOTS FROM
TESTS 8327-4.1 AND 8330-2

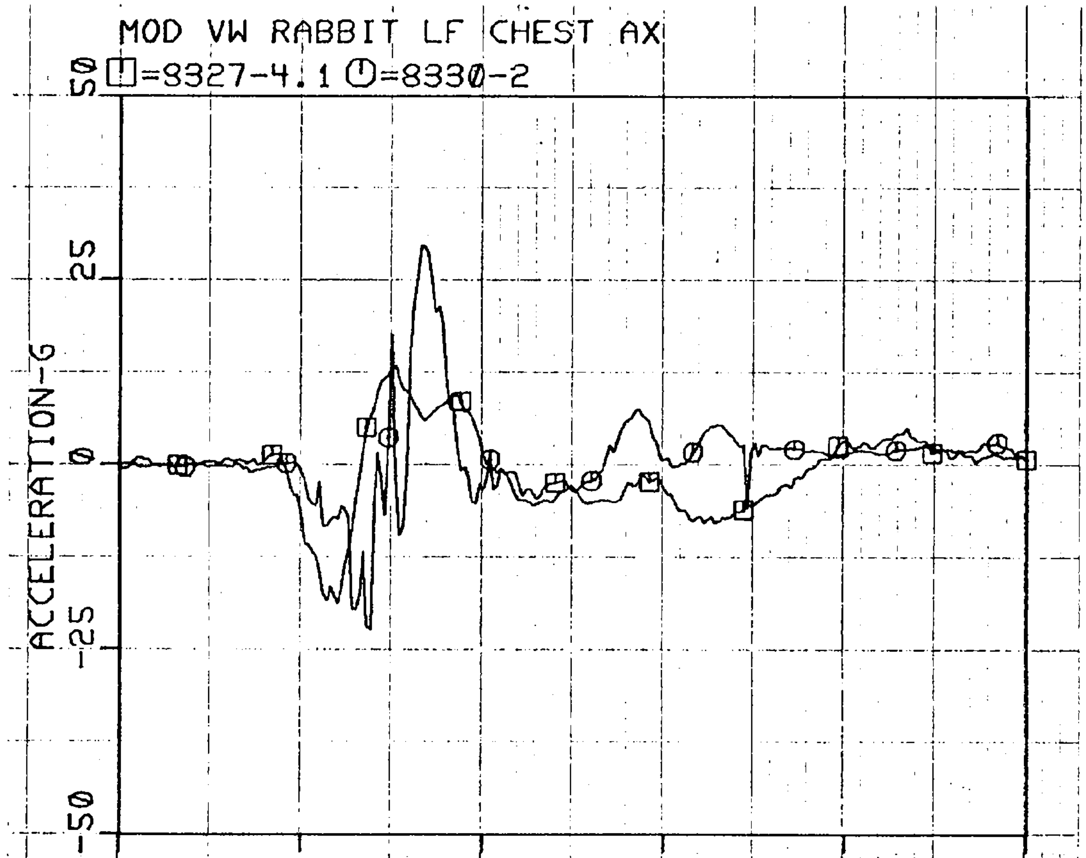
(HEAD DATA FILTER: 1600 Hz)
(THORAX DATA FILTER: 315 Hz)
(STERNUM AND RIB DATA FILTER: 100 Hz)

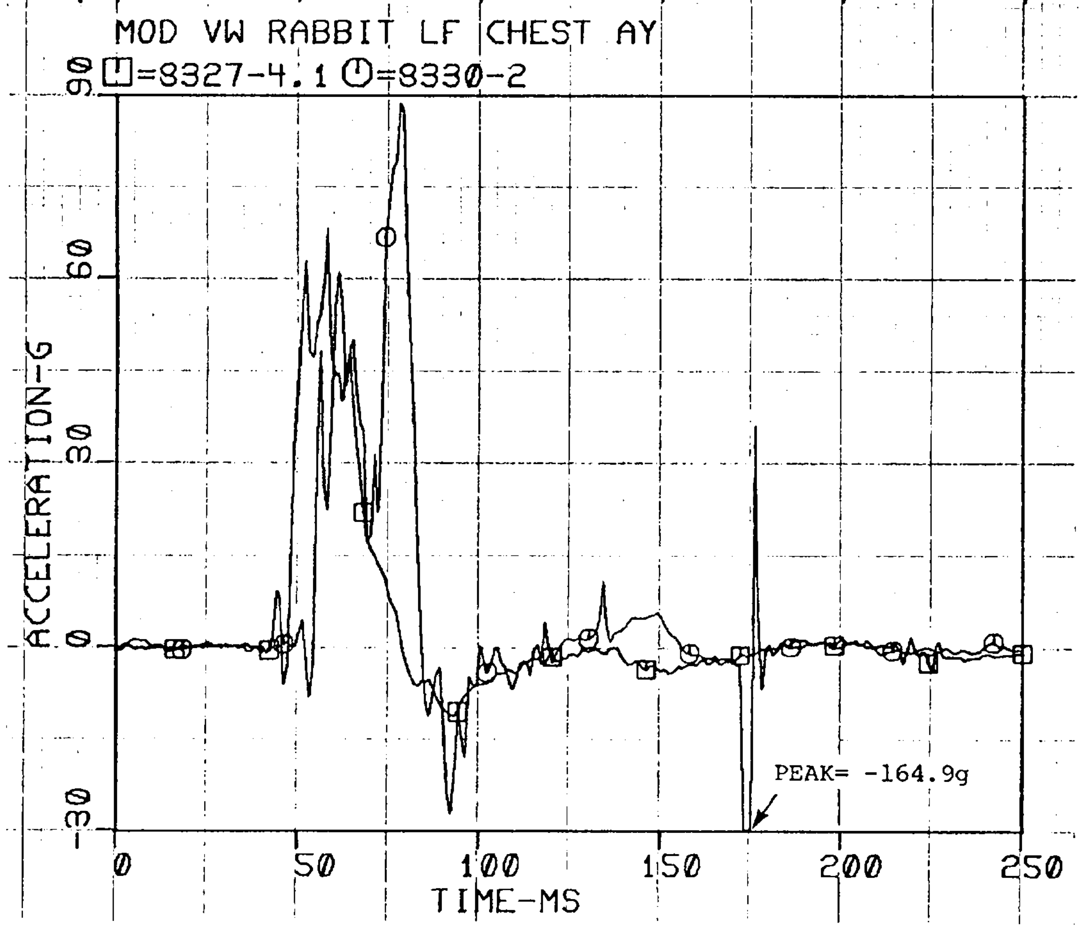


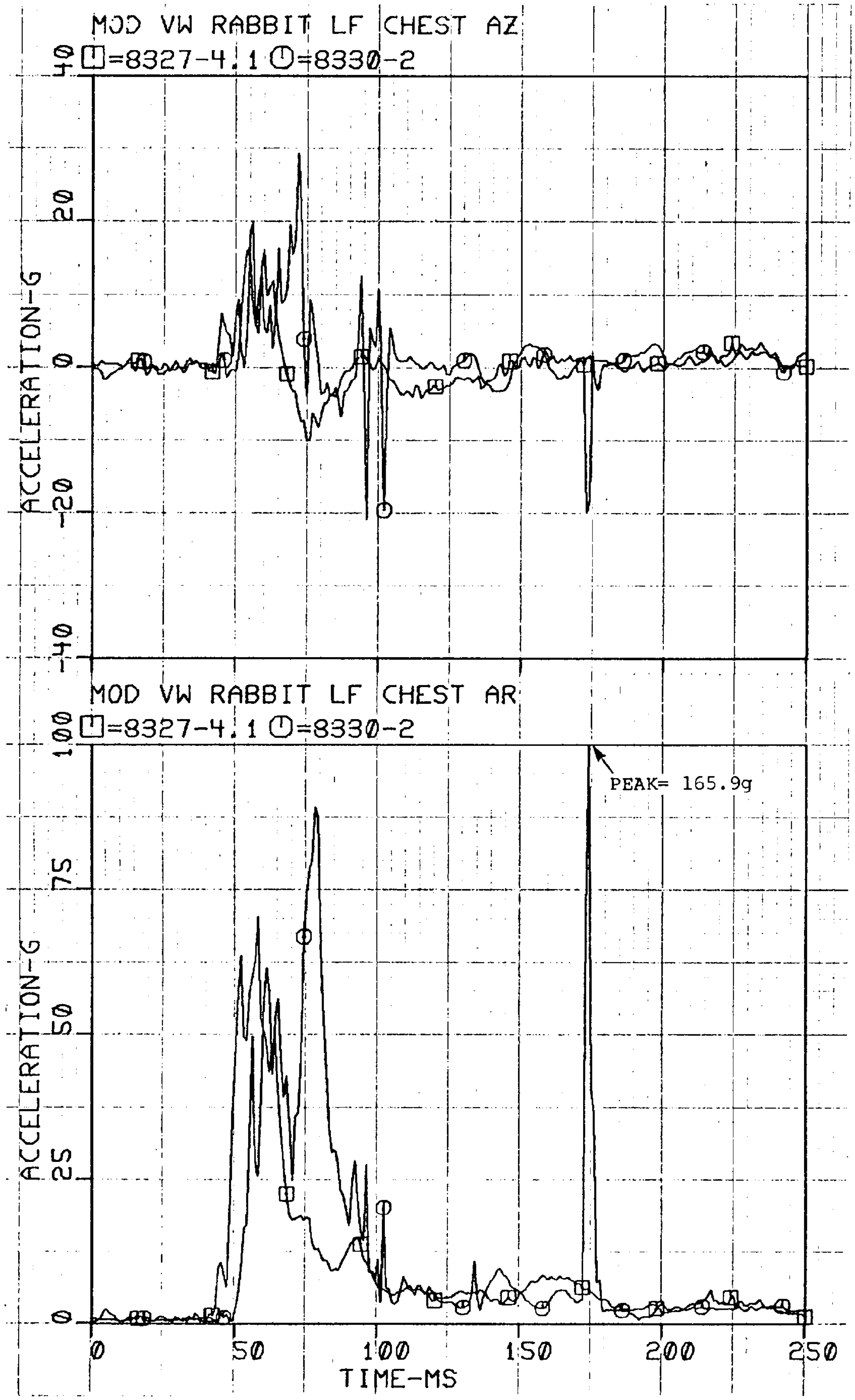
MOD VW RABBIT LF HEAD AZ
▢=8327-4.1 ○=8330-2
80
40
0
-40
-80
ACCELERATION-G

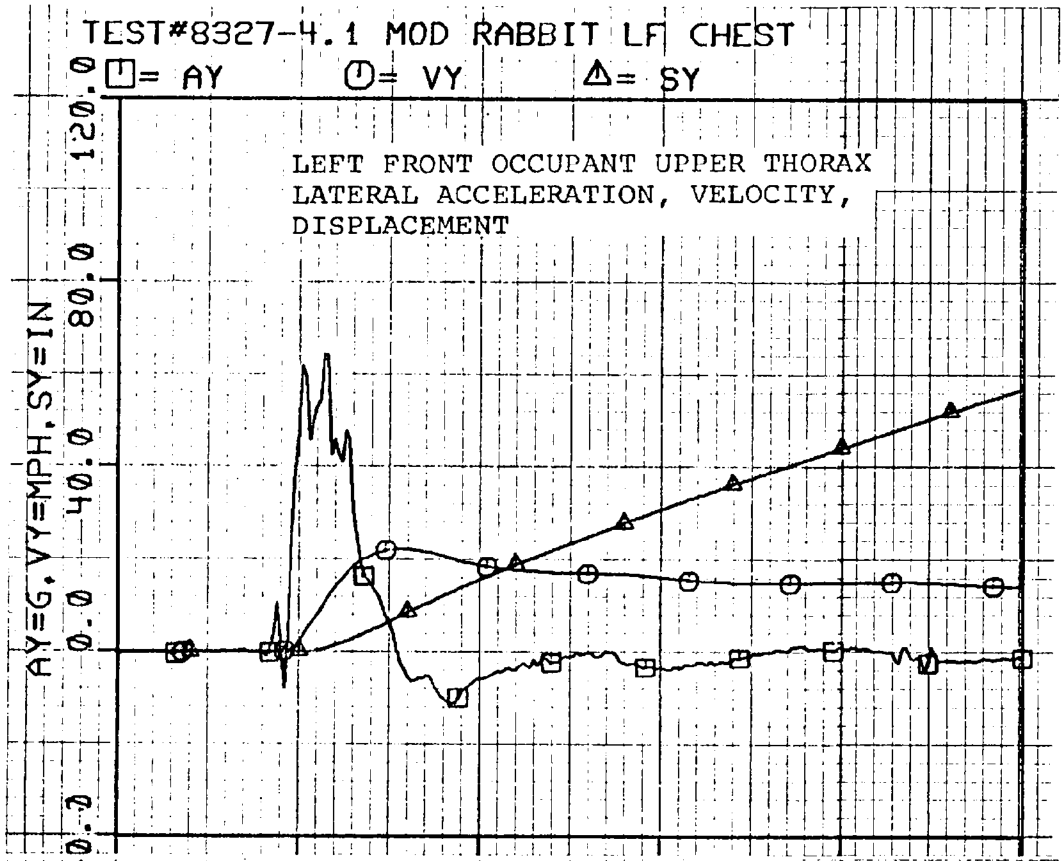


MOD VW RABBIT LF HEAD AR
▢=8327-4.1 ○=8330-2
PEAK= 234g
160
120
80
40
0
ACCELERATION-G
0
50
100
150
200
250
TIME-MS

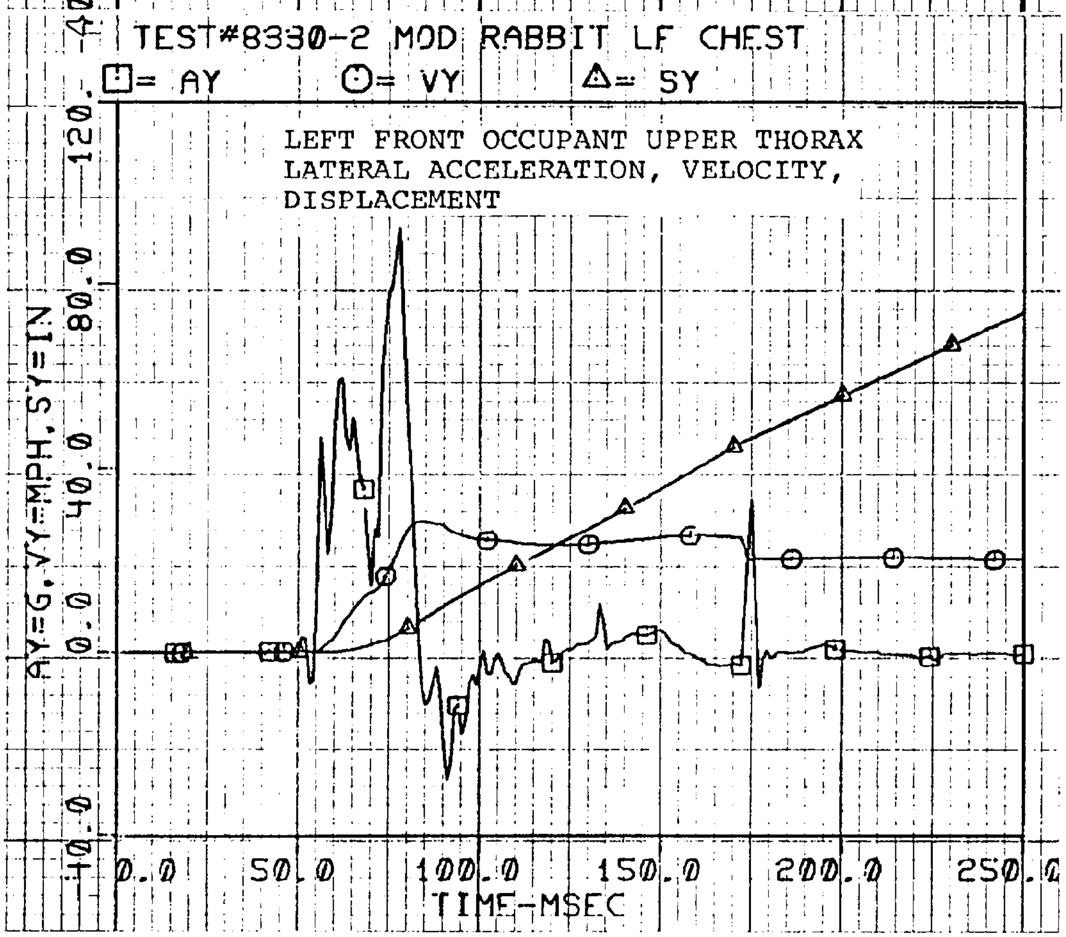

MOD VW RABBIT LF CHEST AX
□=8327-4.1 ⊙=8330-2
50
25
0
-25
-50
ACCELERATION-G


MOD VW RABBIT LF CHEST AY
□=8327-4.1 ⊙=8330-2
90
60
30
0
-30
ACCELERATION-G
PEAK= -164.9g
0
50
100
150
200
250
TIME-MS

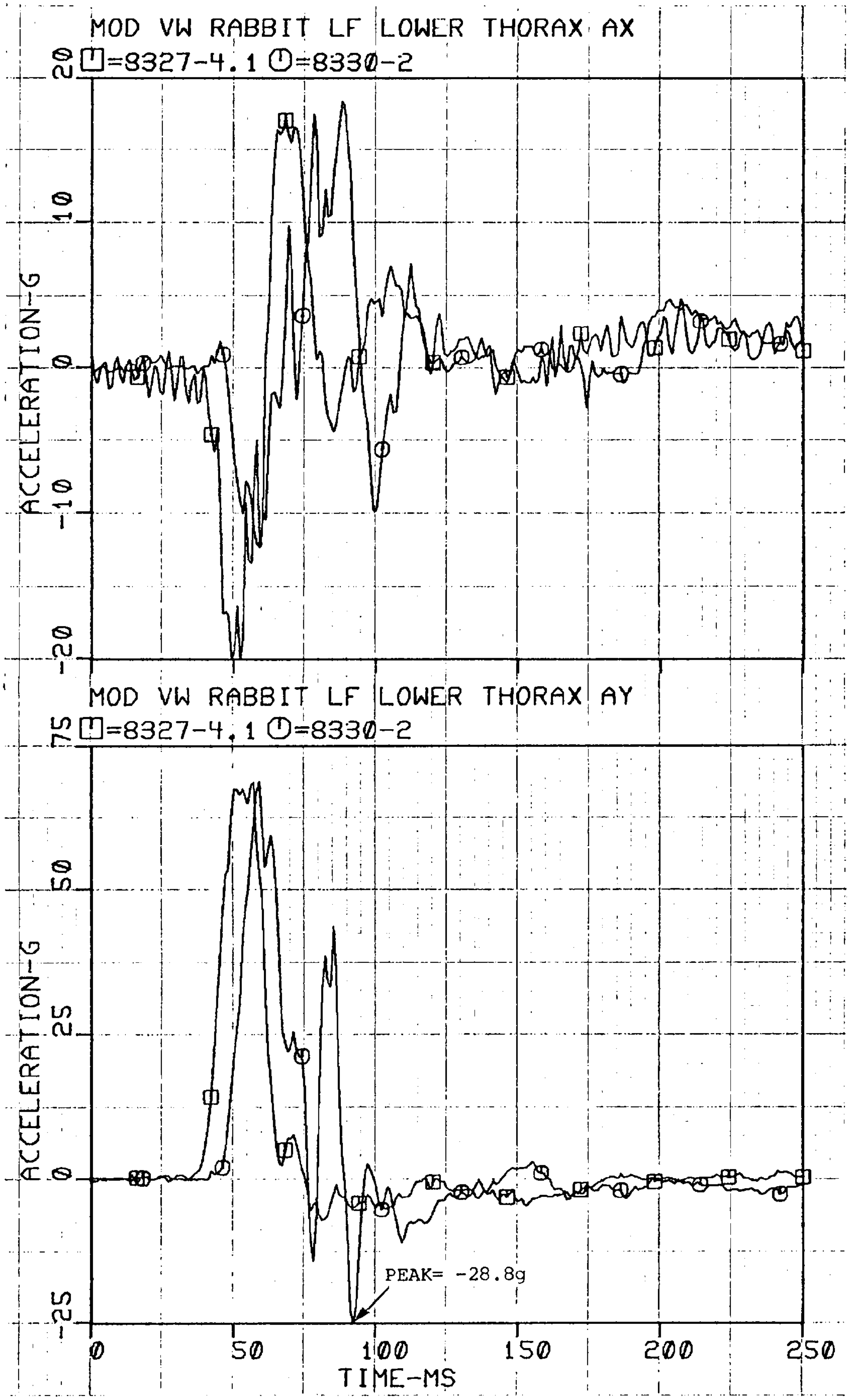

MOD VW RABBIT LF CHEST AZ
□=8327-4.1 ○=8330-2
40
20
0
-20
-40
ACCELERATION-G
MOD VW RABBIT LF CHEST AR
□=8327-4.1 ○=8330-2
100
75
50
25
0
ACCELERATION-G
PEAK= 165.9g
0
50
100
150
200
250
TIME-MS

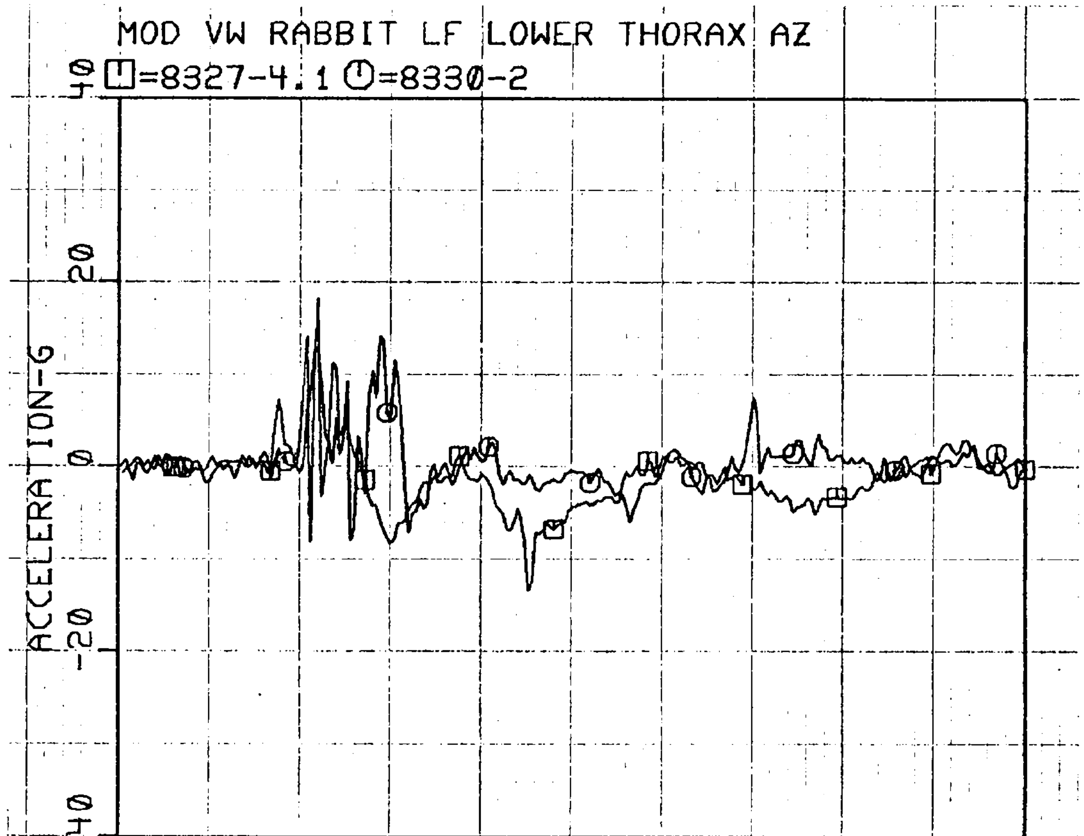


TEST#8327-4.1 MOD RABBIT LF CHEST
□= AY ⊙= VY △= SY
LEFT FRONT OCCUPANT UPPER THORAX
LATERAL ACCELERATION, VELOCITY,
DISPLACEMENT
AY=G, VY=MPH, SY=IN
120.0
80.0
40.0
0.0
-40.0

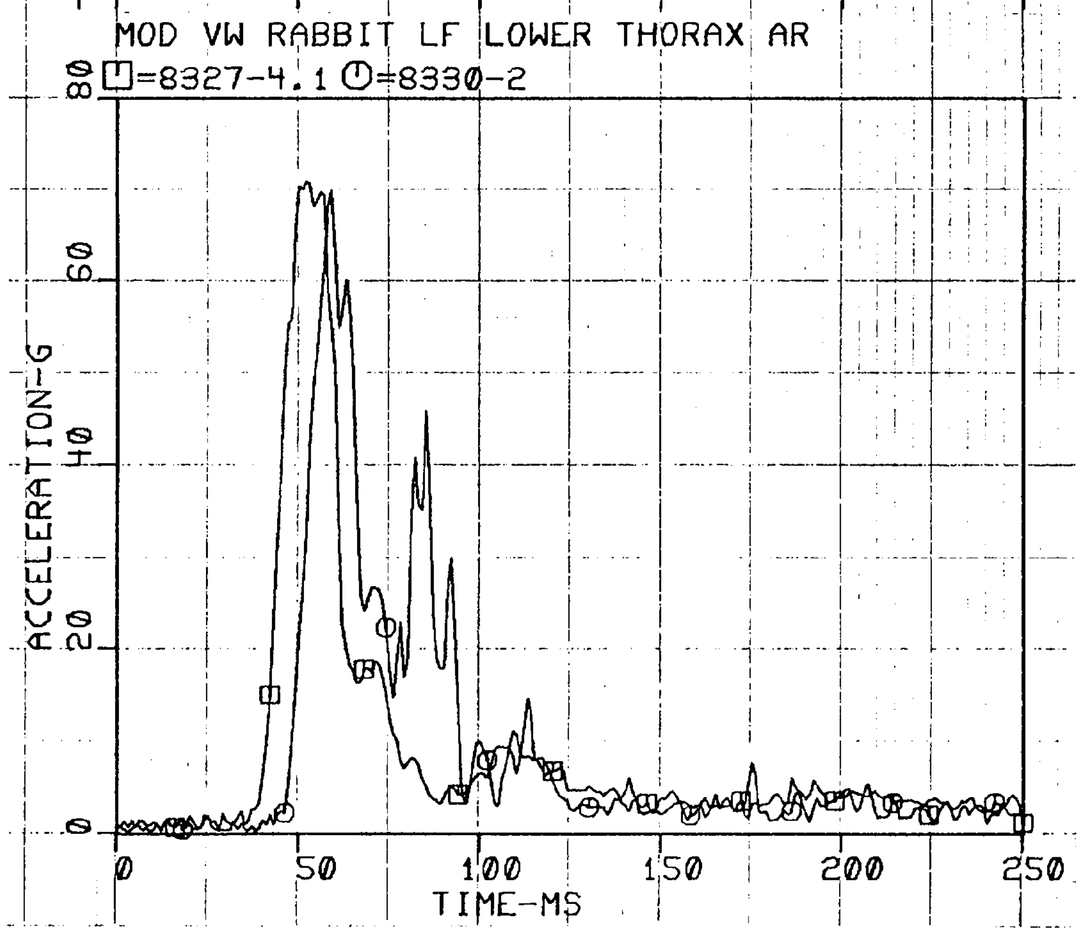


TEST#8330-2 MOD RABBIT LF CHEST
□= AY ⊙= VY △= SY
LEFT FRONT OCCUPANT UPPER THORAX
LATERAL ACCELERATION, VELOCITY,
DISPLACEMENT
AY=G, VY=MPH, SY=IN
120.0
80.0
40.0
0.0
-40.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

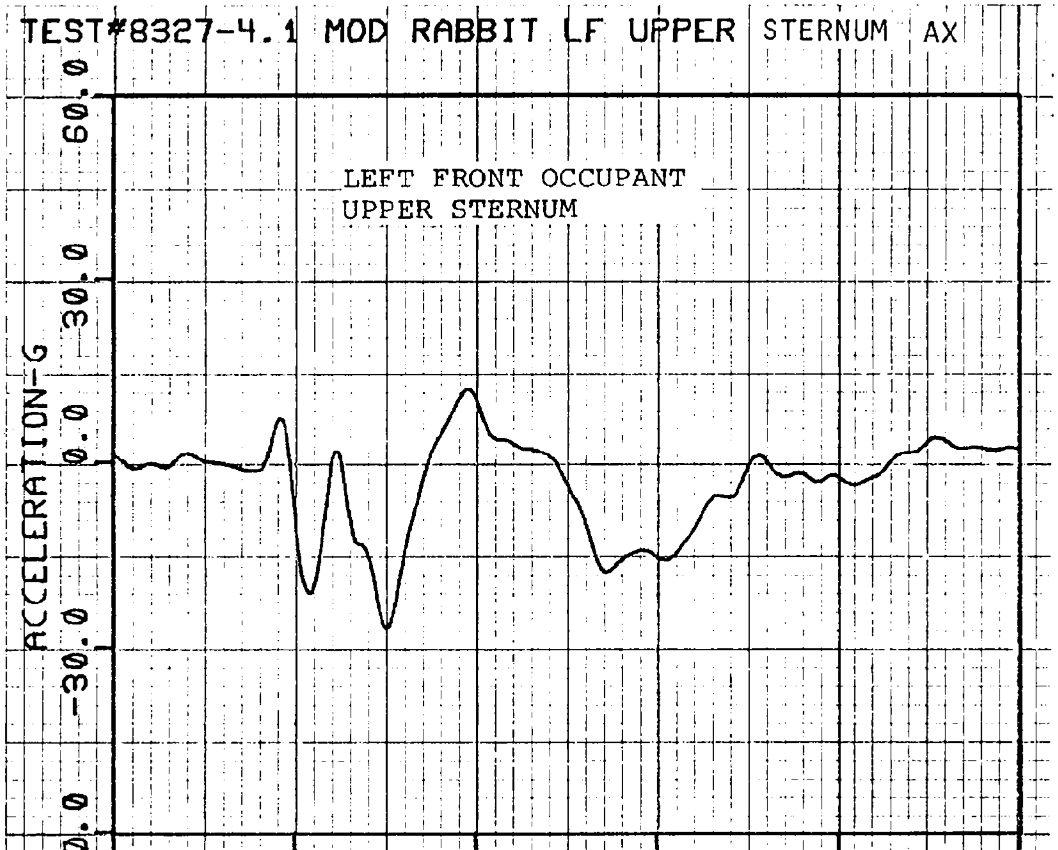

MOD VW RABBIT LF LOWER THORAX AX
□=8327-4.1 ○=8330-2
ACCELERATION-G
20
10
0
-10
-20
MOD VW RABBIT LF LOWER THORAX AY
□=8327-4.1 ○=8330-2
ACCELERATION-G
75
50
25
0
-25
PEAK= -28.8g
0
50
100
150
200
250
TIME-MS



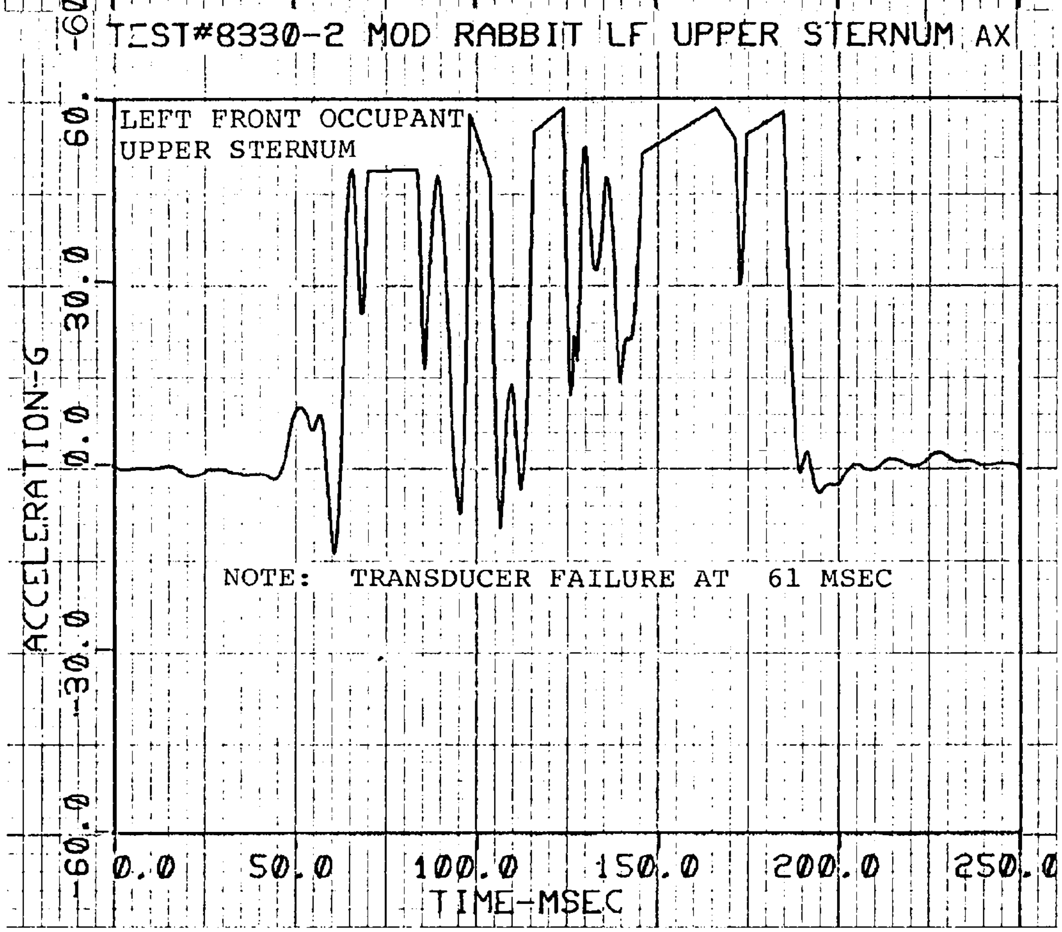
MOD VW RABBIT LF LOWER THORAX AZ
□=8327-4.1 ○=8330-2
40
20
0
-20
-40
ACCELERATION-G



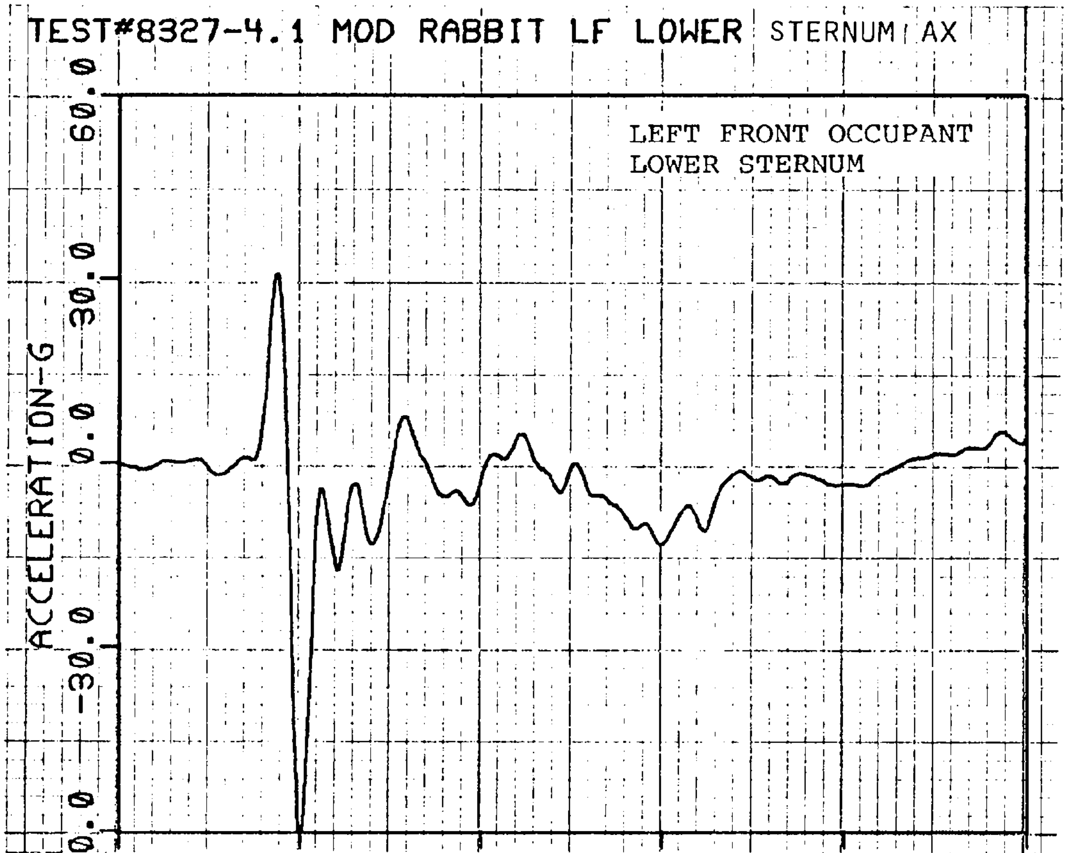
MOD VW RABBIT LF LOWER THORAX AR
□=8327-4.1 ○=8330-2
80
60
40
20
0
ACCELERATION-G
0
50
100
150
200
250
TIME-MS

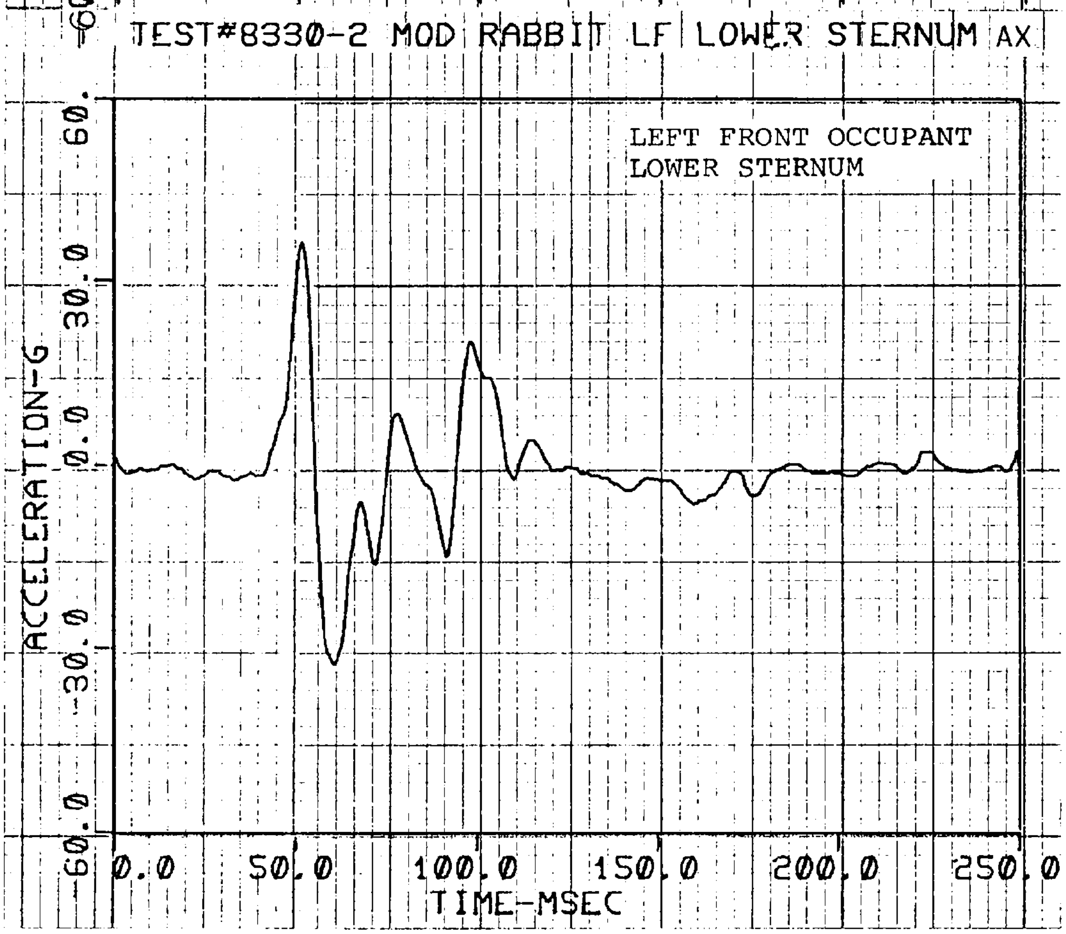


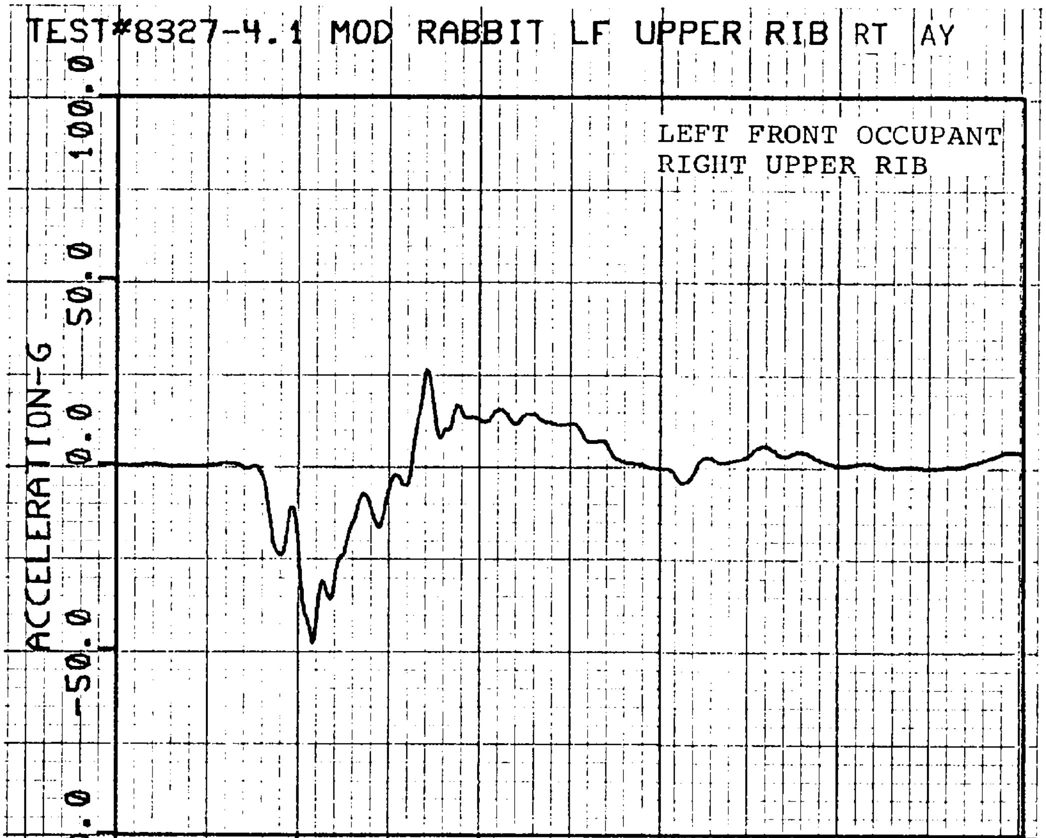
TEST#8327-4.1 MOD RABBIT LF UPPER STERNUM AX
LEFT FRONT OCCUPANT
UPPER STERNUM
ACCELERATION-G
60.0
30.0
0.0
-30.0
-60.0

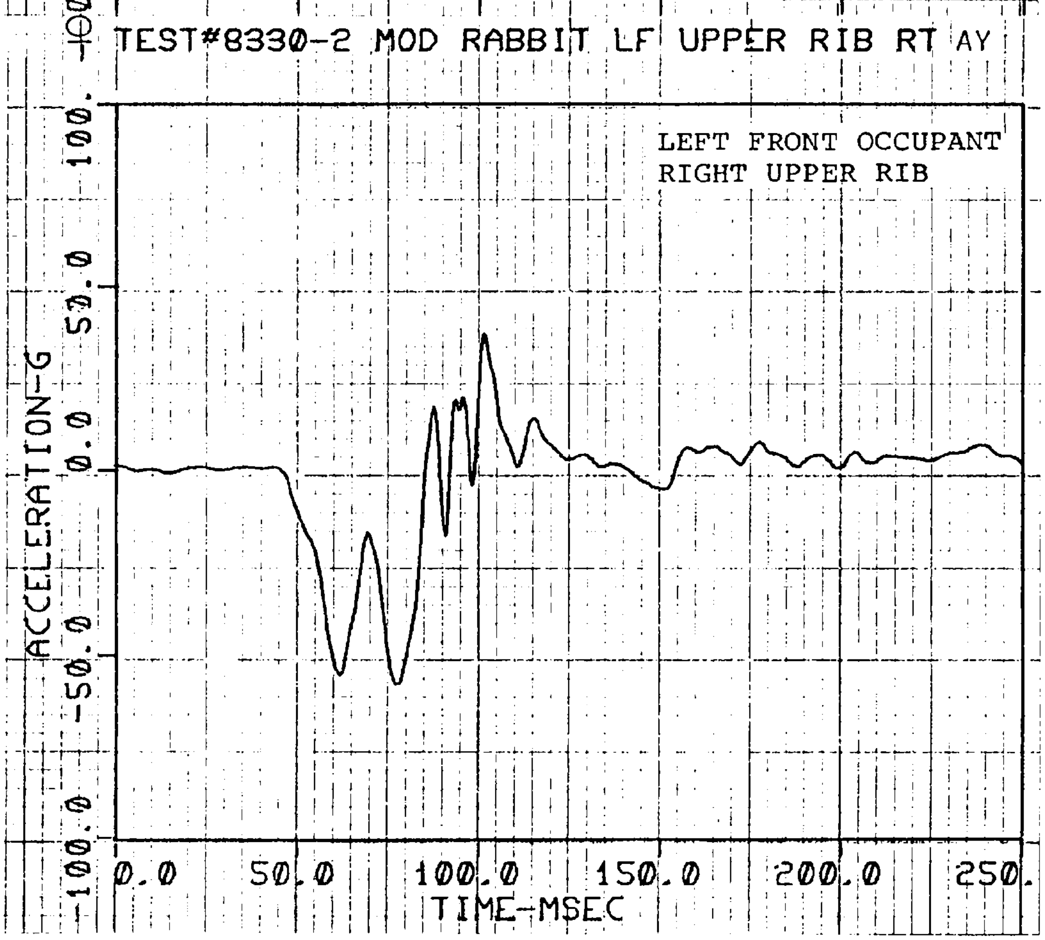


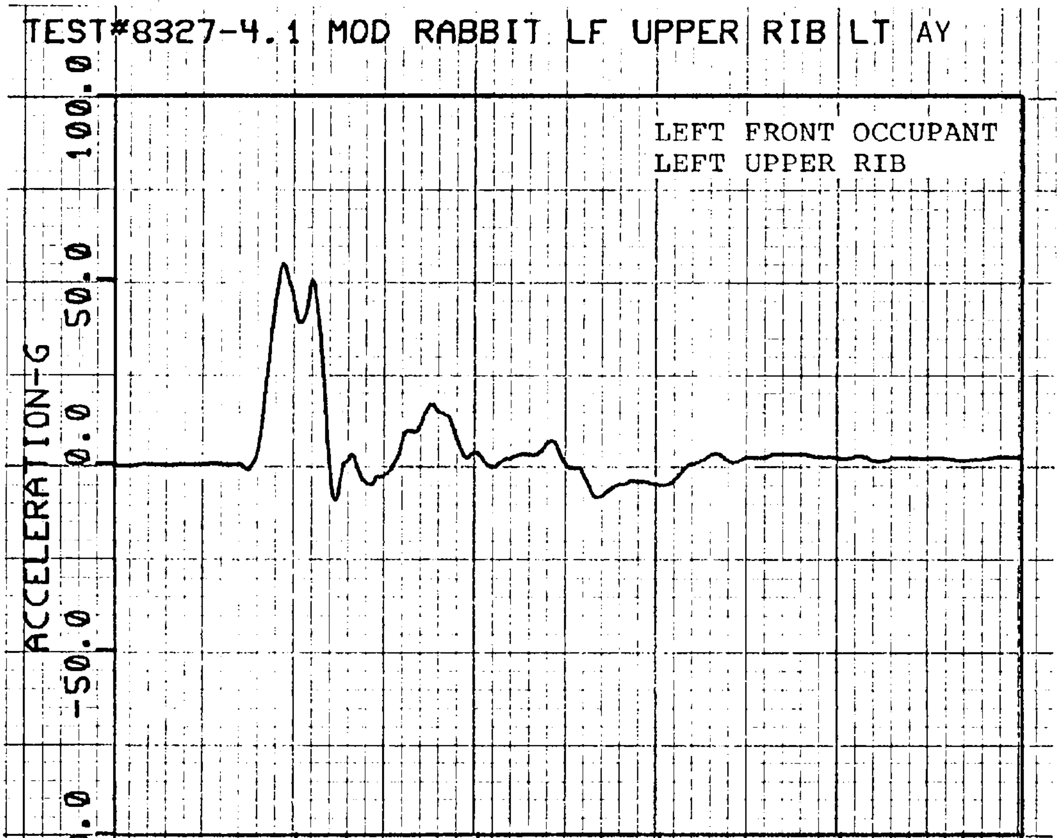
TEST#8330-2 MOD RABBIT LF UPPER STERNUM AX
LEFT FRONT OCCUPANT
UPPER STERNUM
NOTE: TRANSDUCER FAILURE AT 61 MSEC
ACCELERATION-G
60.0
30.0
0.0
-30.0
-60.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

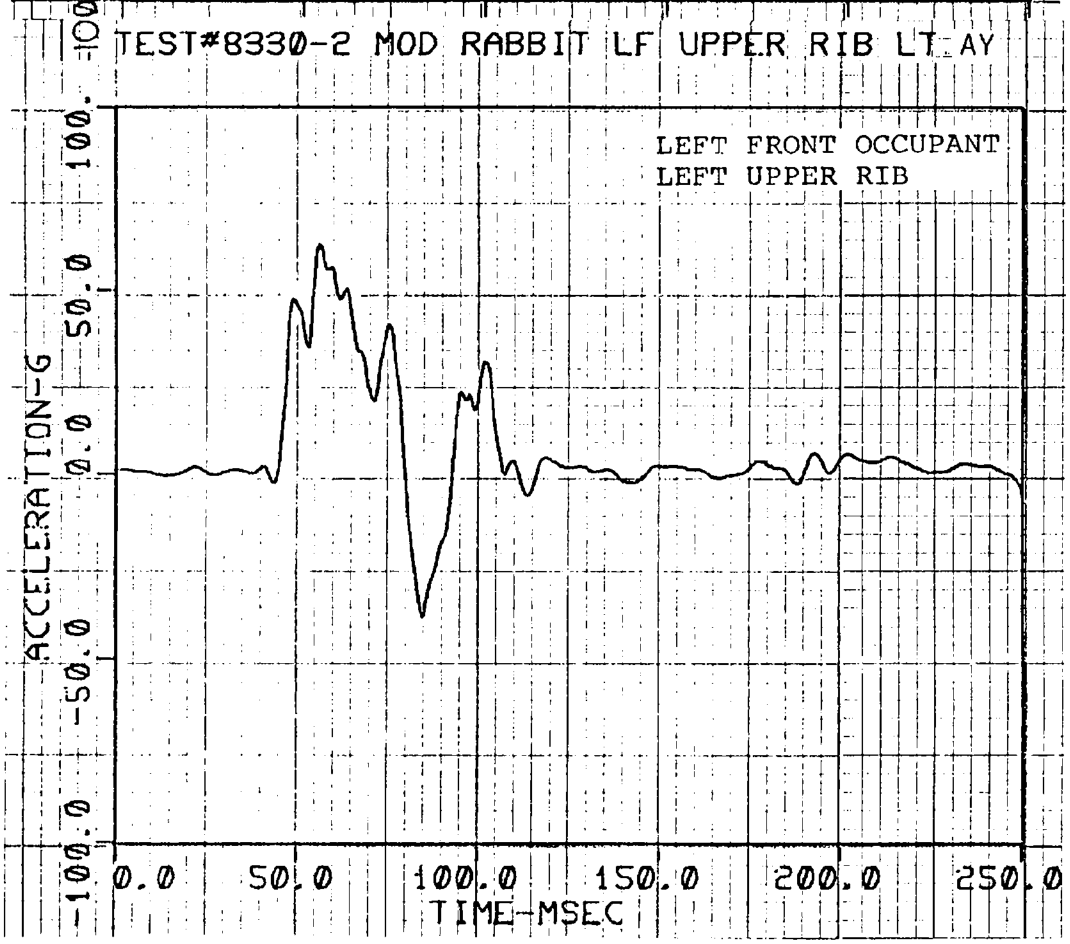

TEST#8327-4.1 MOD RABBIT LF LOWER STERNUM AX
LEFT FRONT OCCUPANT
LOWER STERNUM
ACCELERATION-G
60.0
30.0
0.0
-30.0
-60.0

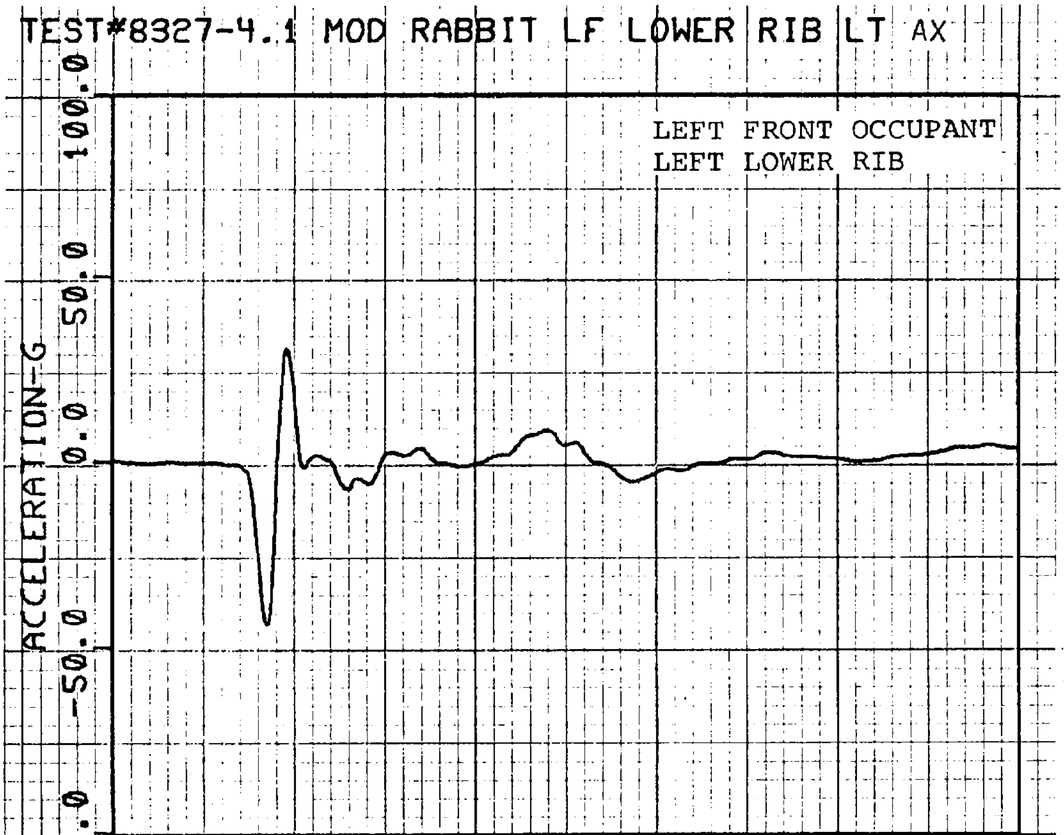

TEST#8330-2 MOD RABBIT LF LOWER STERNUM AX
LEFT FRONT OCCUPANT
LOWER STERNUM
ACCELERATION-G
60.0
30.0
0.0
-30.0
-60.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

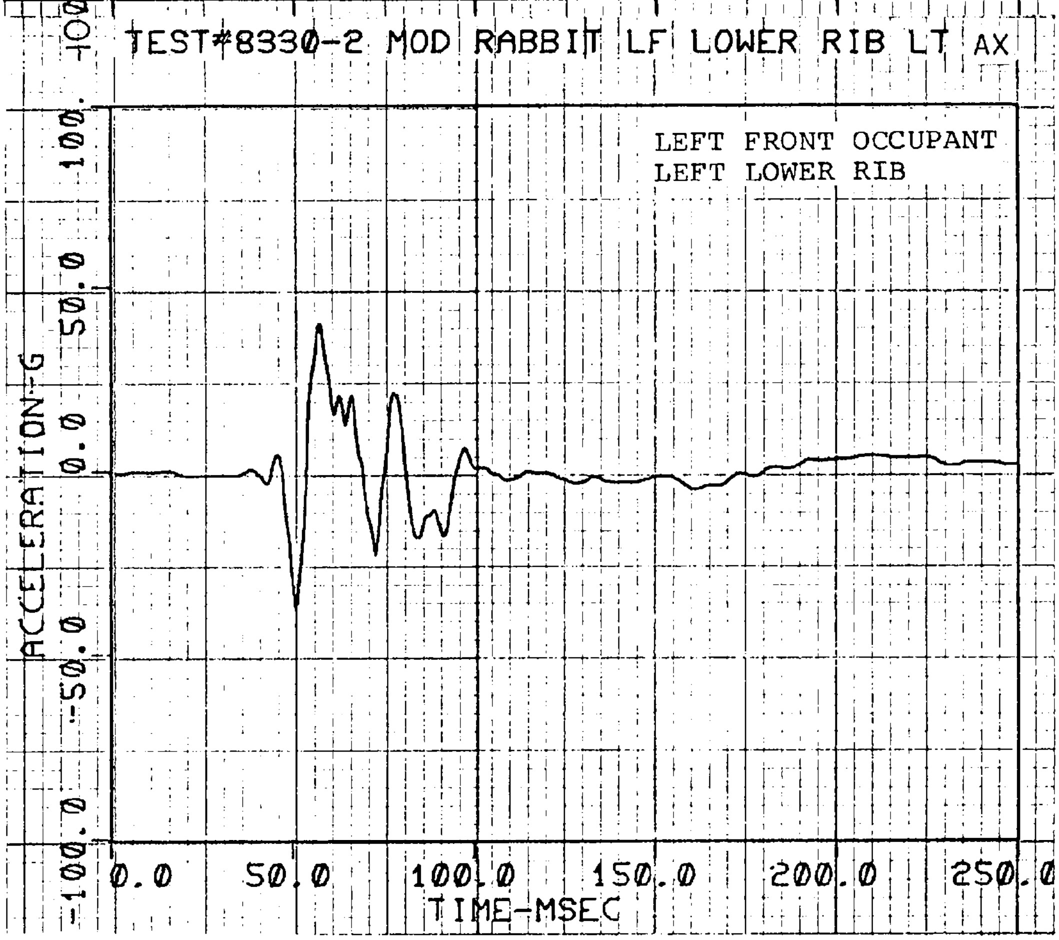

TEST#8327-4.1 MOD RABBIT LF UPPER RIB RT AY
LEFT FRONT OCCUPANT
RIGHT UPPER RIB
ACCELERATION-G
100.0
50.0
0.0
-50.0
-100.0

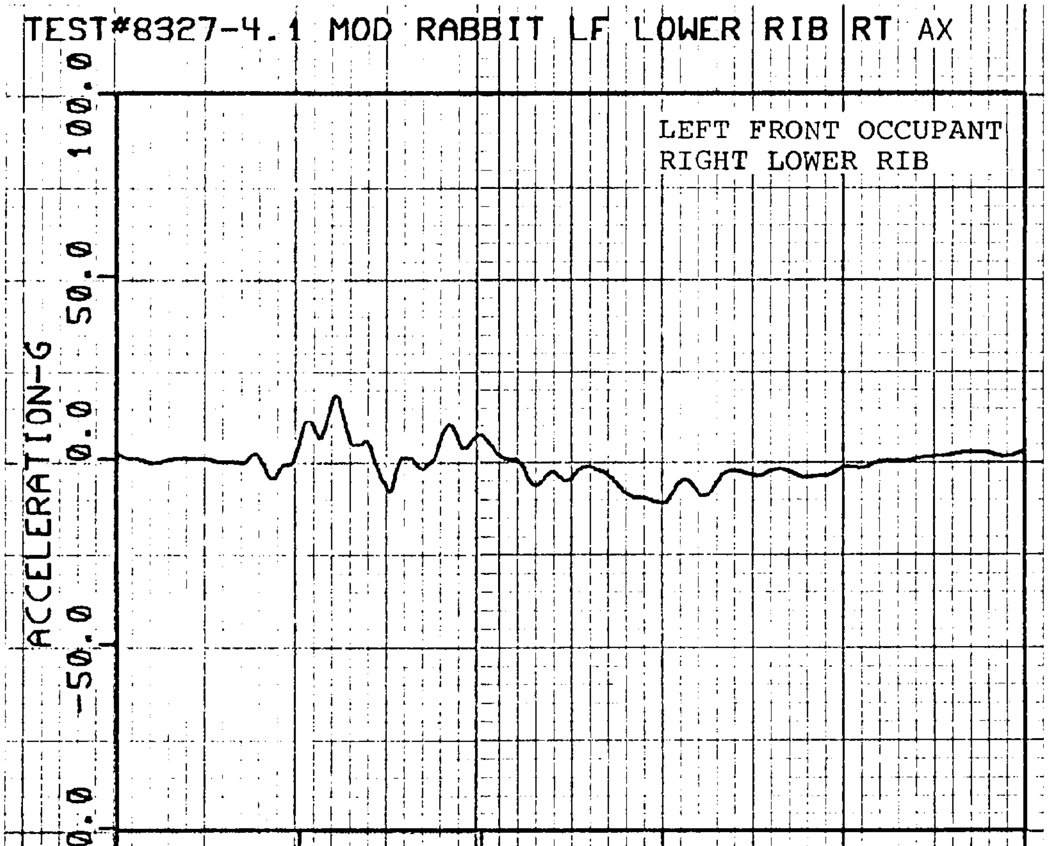

TEST#8330-2 MOD RABBIT LF UPPER RIB RT AY
LEFT FRONT OCCUPANT
RIGHT UPPER RIB
ACCELERATION-G
100.0
50.0
0.0
-50.0
-100.0
0.0
50.0
100.0
150.0
200.0
250.
TIME-MSEC

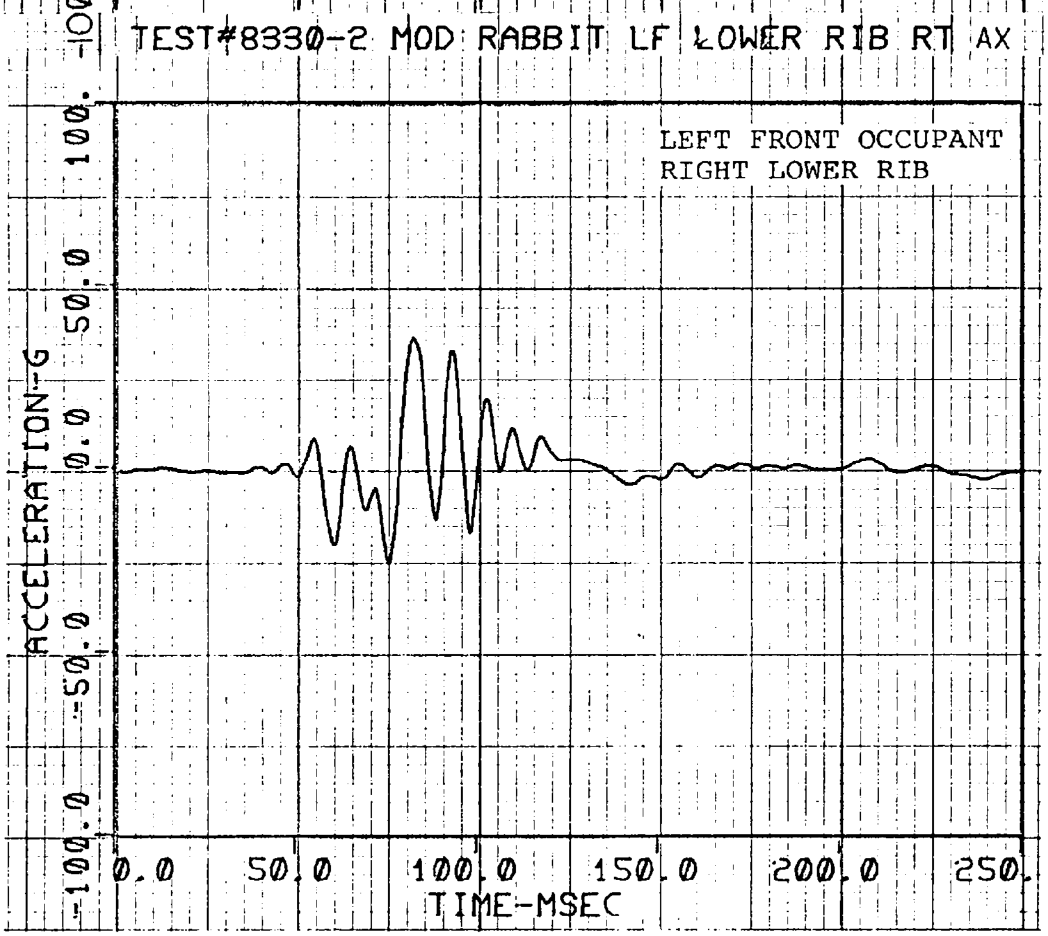

TEST#8327-4.1 MOD RABBIT LF UPPER RIB LT AY
LEFT FRONT OCCUPANT
LEFT UPPER RIB
ACCELERATION-G
100.0
50.0
0.0
-50.0
-100.0

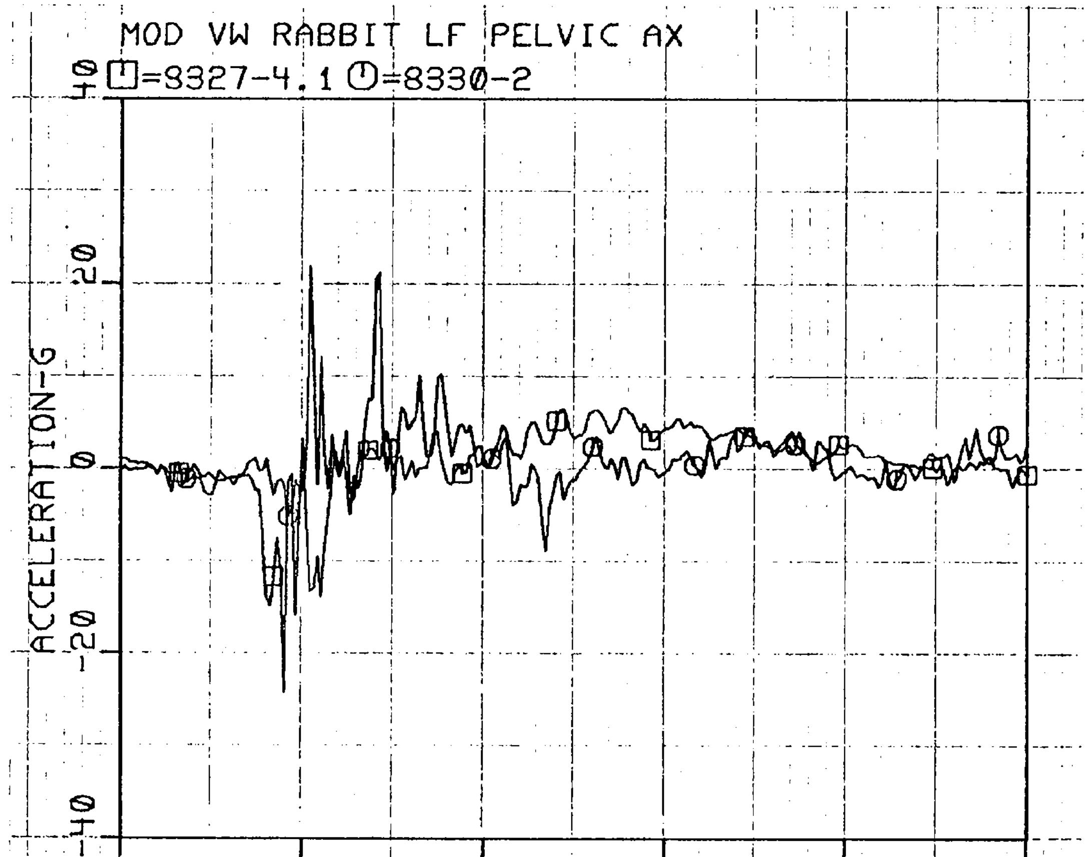

TEST#8330-2 MOD RABBIT LF UPPER RIB LT AY
LEFT FRONT OCCUPANT
LEFT UPPER RIB
ACCELERATION-G
100.0
50.0
0.0
-50.0
-100.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC


TEST#8327-4.1 MOD RABBIT LF LOWER RIB LT AX
LEFT FRONT OCCUPANT
LEFT LOWER RIB
ACCELERATION-G
100.0
50.0
0.0
-50.0
-100.0

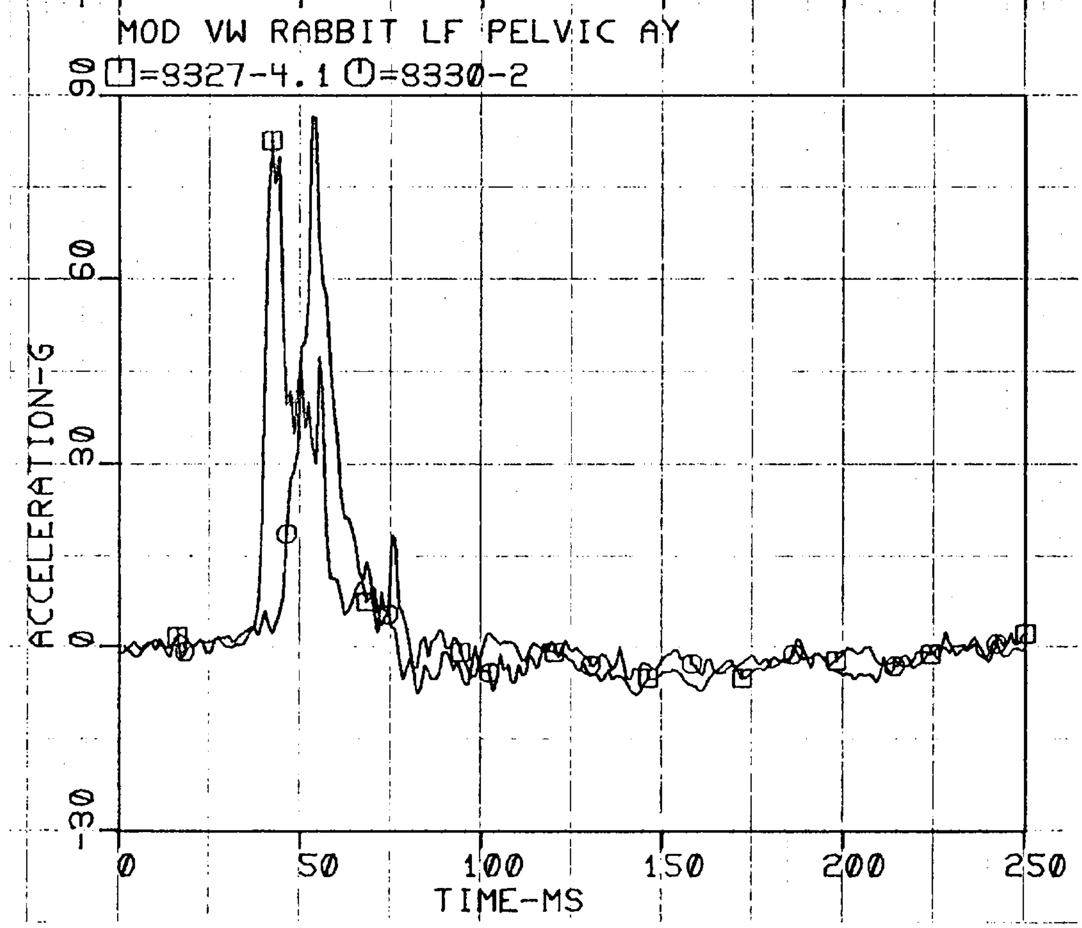

TEST#8330-2 MOD RABBIT LF LOWER RIB LT AX
LEFT FRONT OCCUPANT
LEFT LOWER RIB
ACCELERATION-G
100.0
50.0
0.0
-50.0
-100.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC


TEST#8327-4.1 MOD RABBIT LF LOWER RIB RT AX
LEFT FRONT OCCUPANT
RIGHT LOWER RIB
ACCELERATION-G
100.0
50.0
0.0
-50.0
-100.0

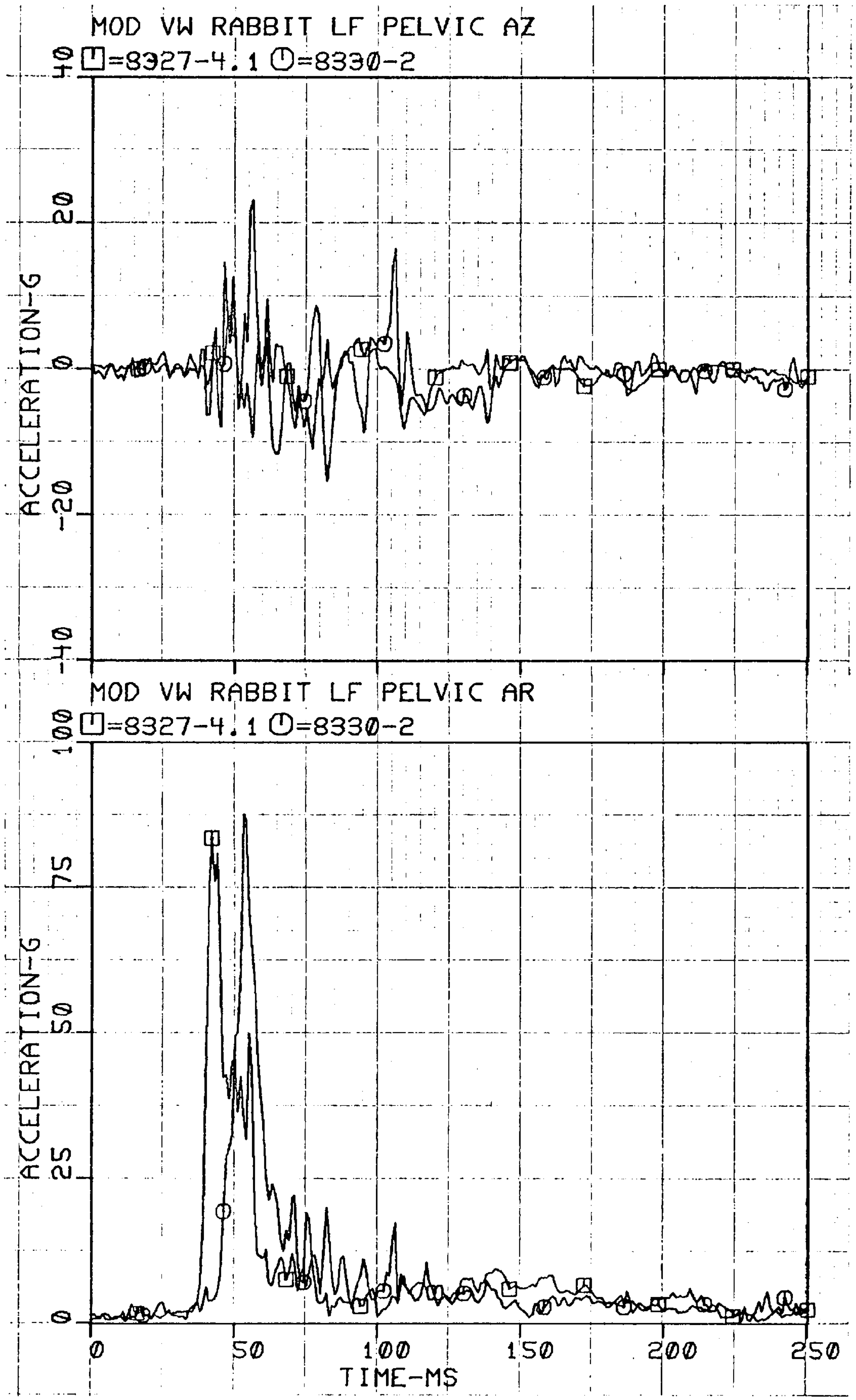

TEST#8330-2 MOD RABBIT LF LOWER RIB RT AX
LEFT FRONT OCCUPANT
RIGHT LOWER RIB
ACCELERATION-G
100.0
50.0
0.0
-50.0
-100.0
0.0
50.0
100.0
150.0
200.0
250.
TIME-MSEC

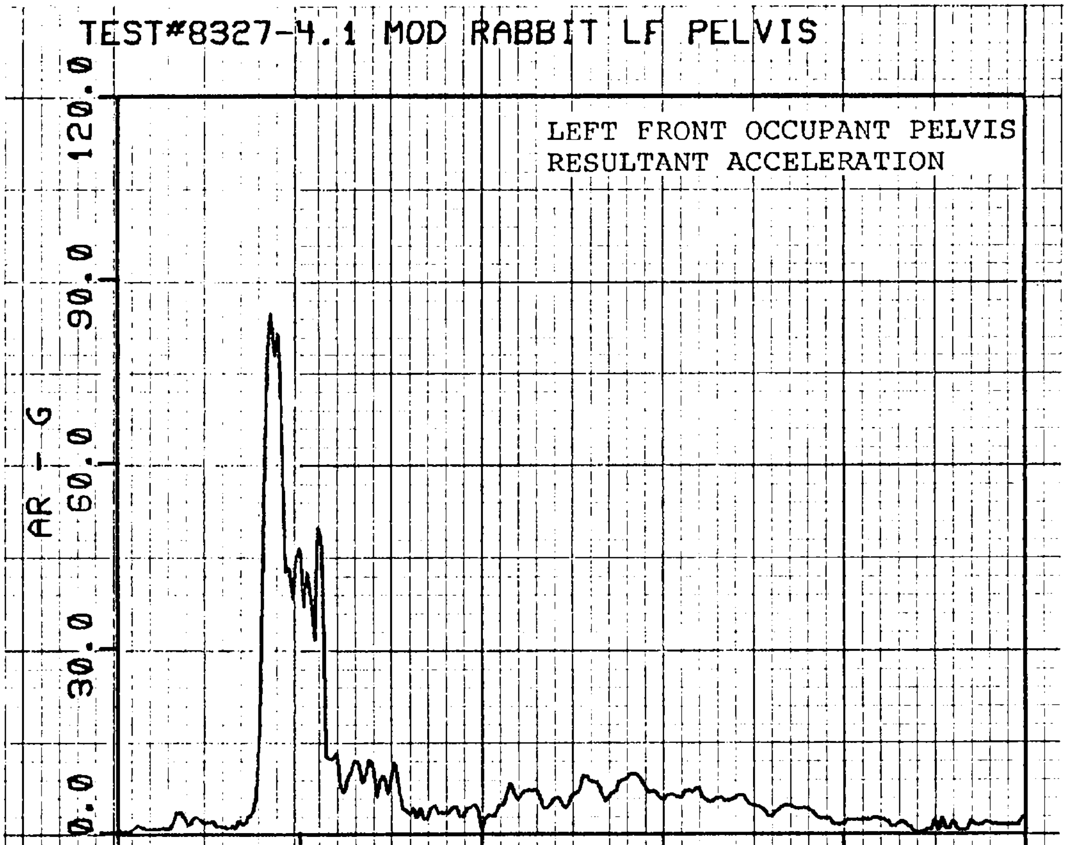


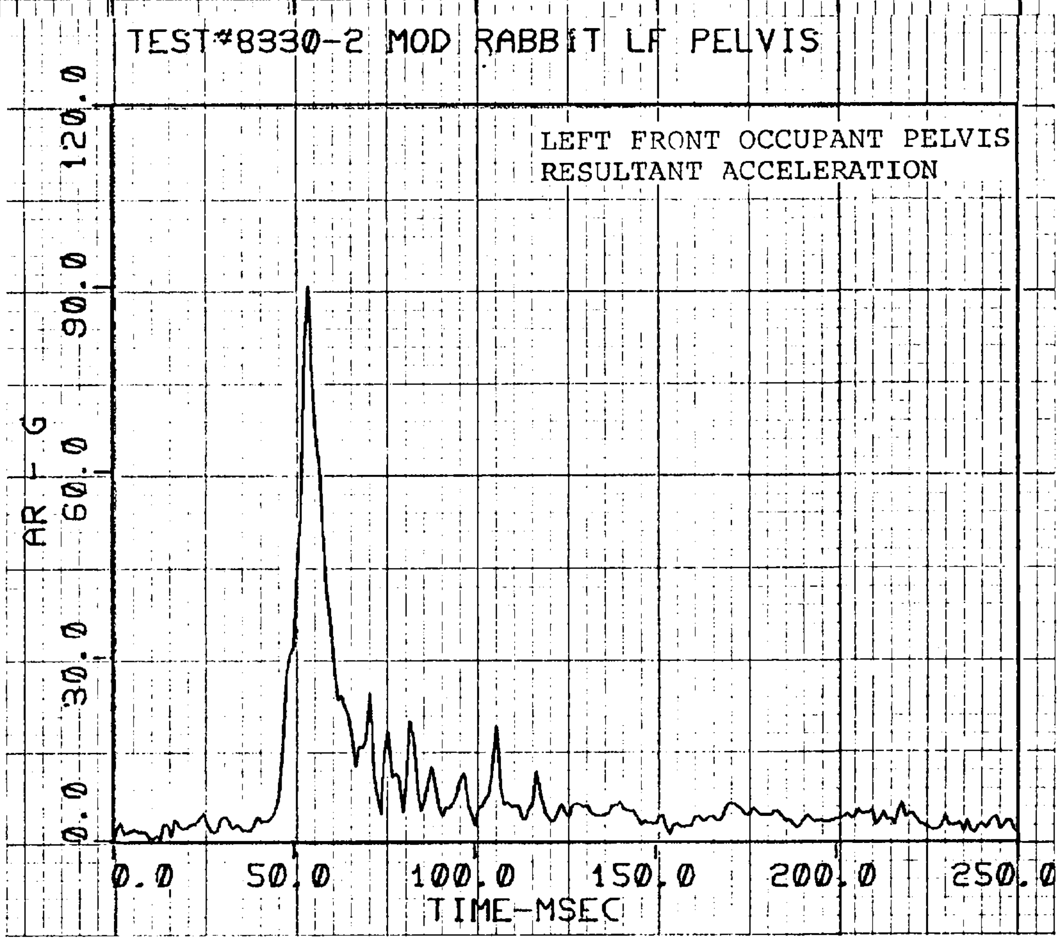
MOD VW RABBIT LF PELVIC AX
□=8327-4.1 ○=8330-2
40
20
0
-20
-40
ACCELERATION-G

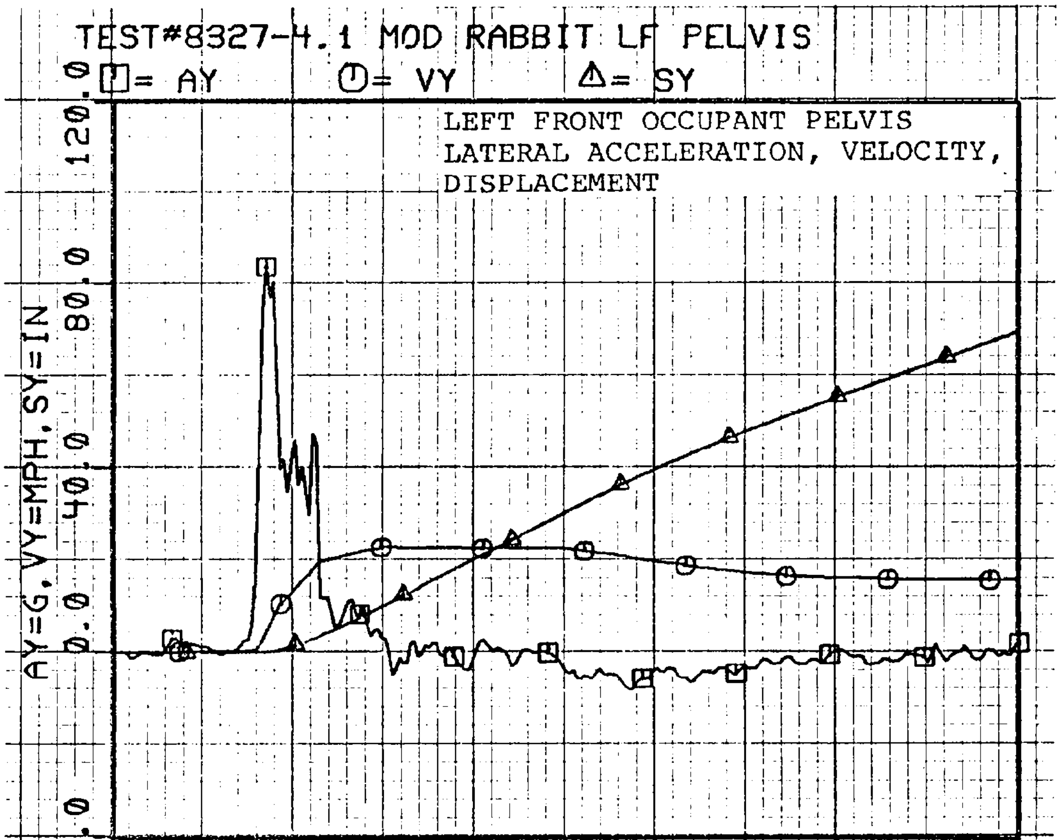


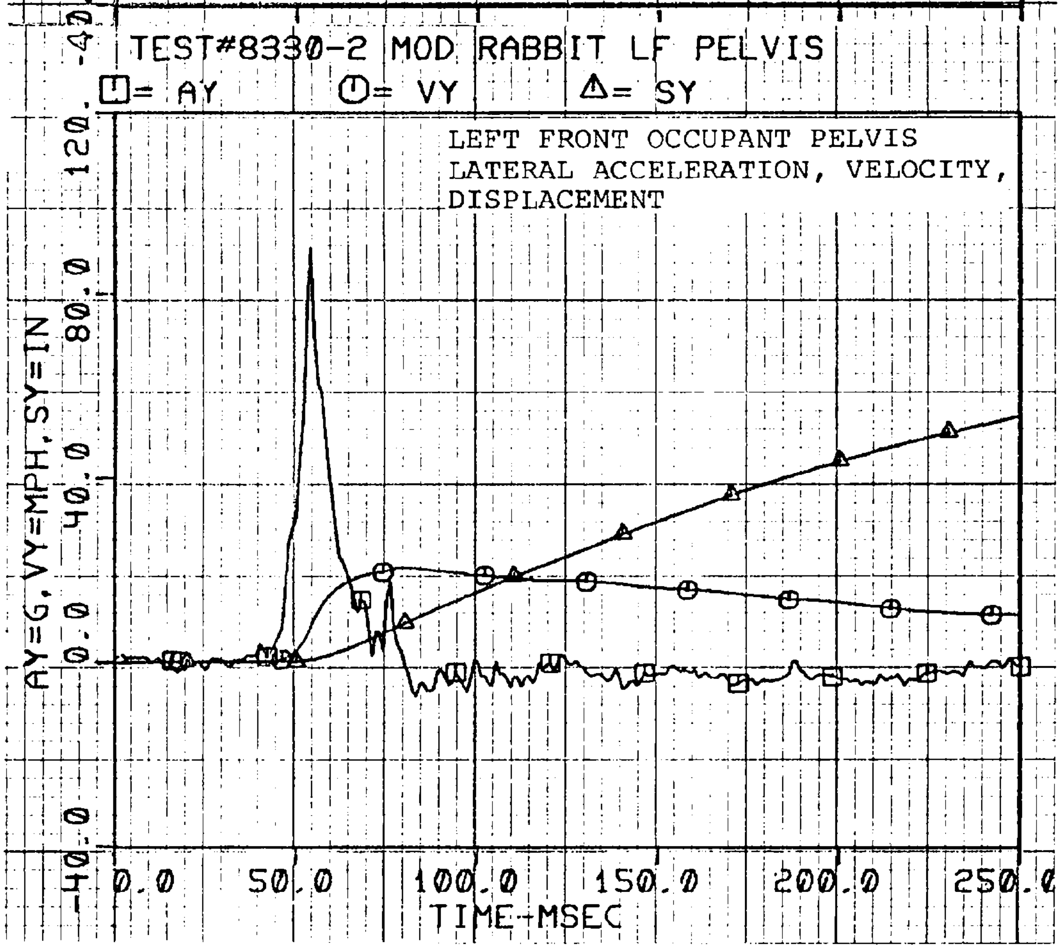
MOD VW RABBIT LF PELVIC AY
□=8327-4.1 ○=8330-2
90
60
30
0
-30
ACCELERATION-G
0
50
100
150
200
250
TIME-MS


MOD VW RABBIT LF PELVIC AZ
□=8327-4.1 ○=8330-2
ACCELERATION-G
40
20
0
-20
-40
MOD VW RABBIT LF PELVIC AR
□=8327-4.1 ○=8330-2
ACCELERATION-G
100
75
50
25
0
0
50
100
150
200
250
TIME-MS


TEST#8327-4.1 MOD RABBIT LF PELVIS
LEFT FRONT OCCUPANT PELVIS
RESULTANT ACCELERATION
AR - G
120.0
90.0
60.0
30.0
0.0


TEST#8330-2 MOD RABBIT LF PELVIS
LEFT FRONT OCCUPANT PELVIS
RESULTANT ACCELERATION
AR - G
120.0
90.0
60.0
30.0
0.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC


TEST#8327-4.1 MOD RABBIT LF PELVIS
□= AY
○= VY
△= SY
LEFT FRONT OCCUPANT PELVIS
LATERAL ACCELERATION, VELOCITY,
DISPLACEMENT
AY=G, VY=MPH, SY=IN
120.0
80.0
40.0
0.0
-40.0


TEST#8330-2 MOD RABBIT LF PELVIS
□= AY
○= VY
△= SY
LEFT FRONT OCCUPANT PELVIS
LATERAL ACCELERATION, VELOCITY,
DISPLACEMENT
AY=G, VY=MPH, SY=IN
120.0
80.0
40.0
0.0
-40.0
0.0
50.0
100.0
150.0
200.0
250.0
TIME-MSEC

APPENDIX D

ENERGY-ABSORBING FACE SPECIFICATIONS FOR TEST 8327-4.1

Figures D-1, D-2, and D-3 show the front, side, and top views of the aluminum honeycomb layers of the impactor face used in Test 8327-4.1. The honeycomb crush strengths are marked on each layer.

Table D-1 is the fabrication specification matrix used for actual fabrication of the face.

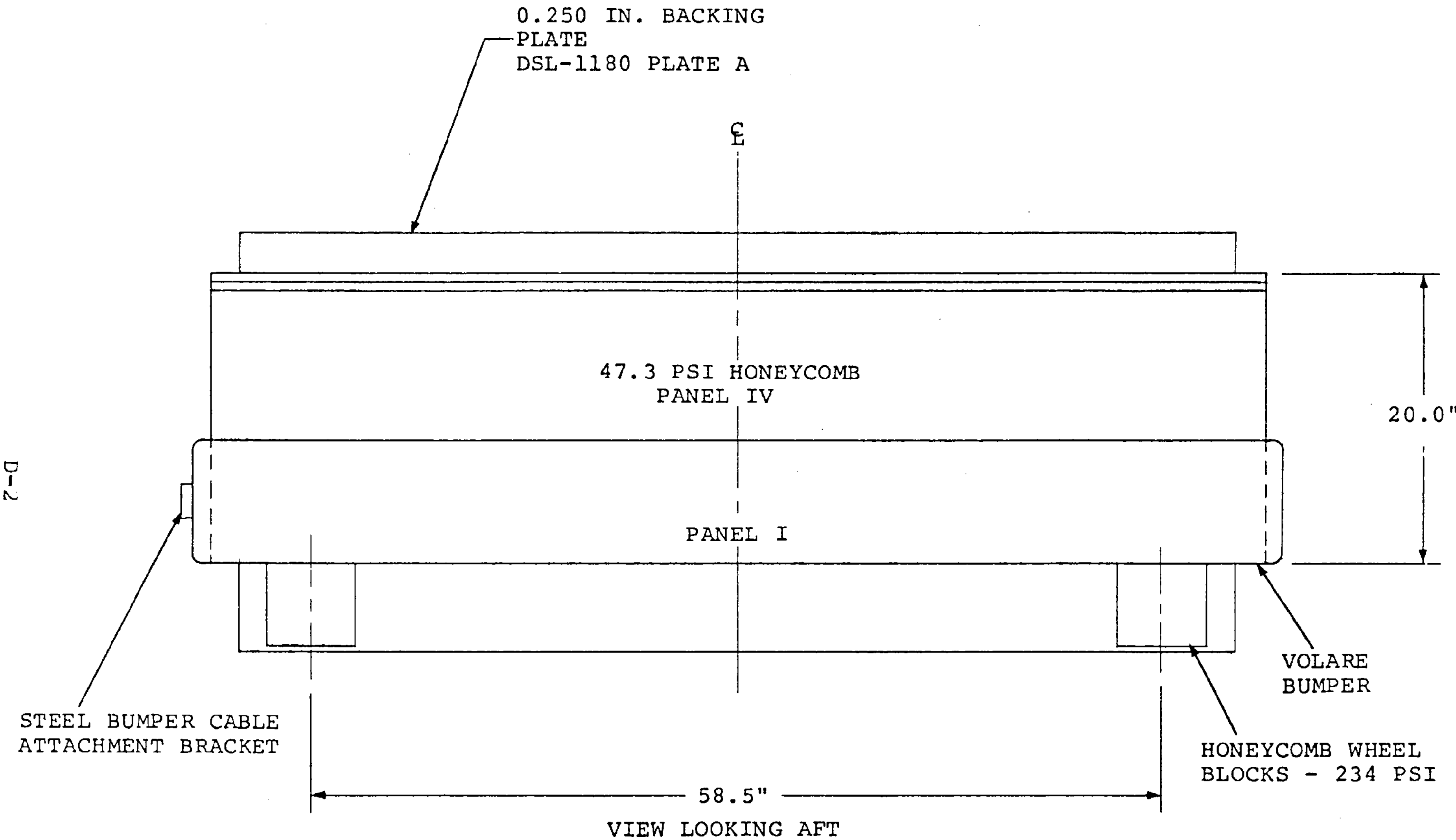


Figure D-1. Front View of -10A Assembly Honeycomb Face (Test 8327-4.1).

808327 44 01002

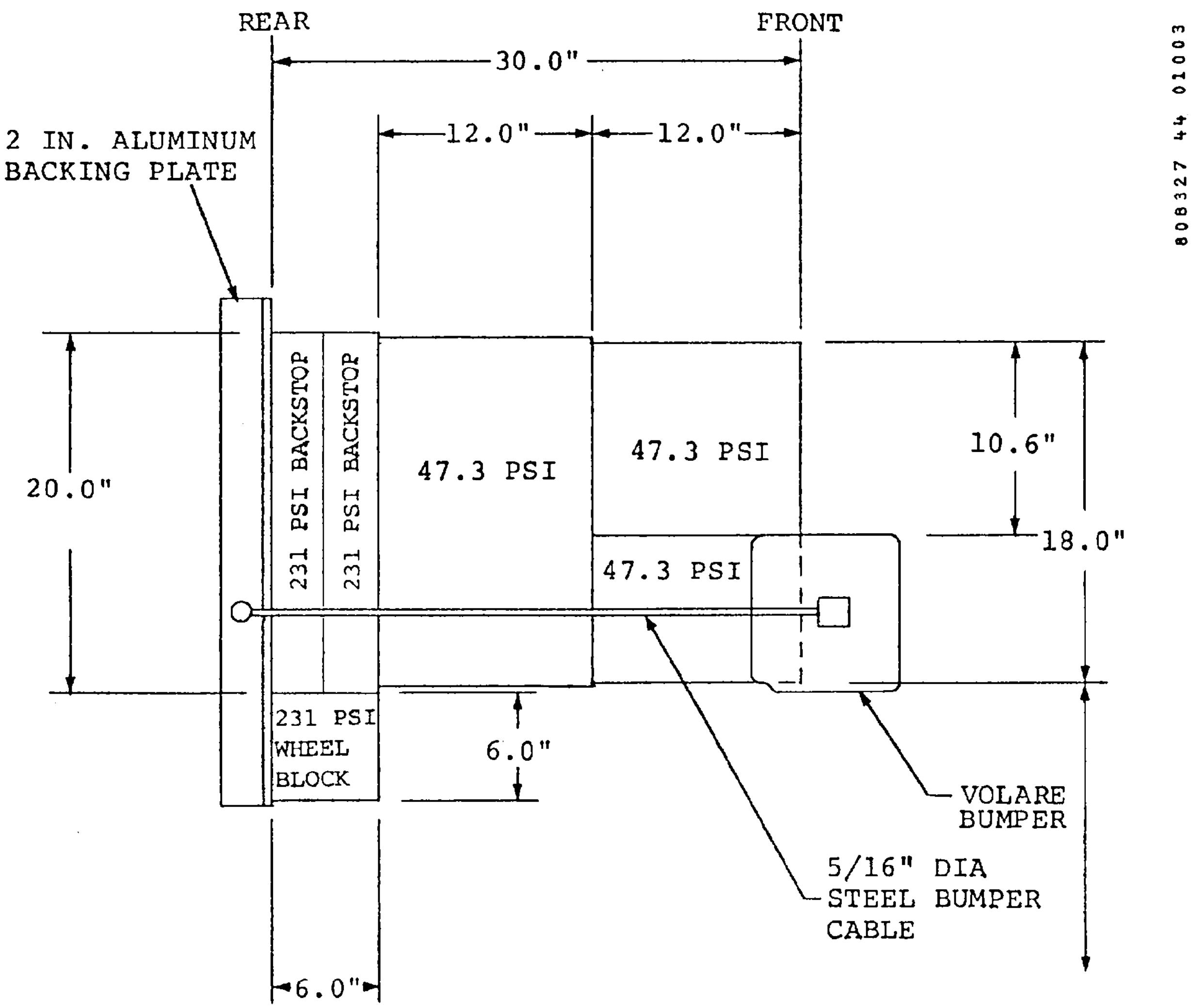


Figure D-2. Side View of -10A Assembly Honeycomb Face
(Test 8327-4.1).

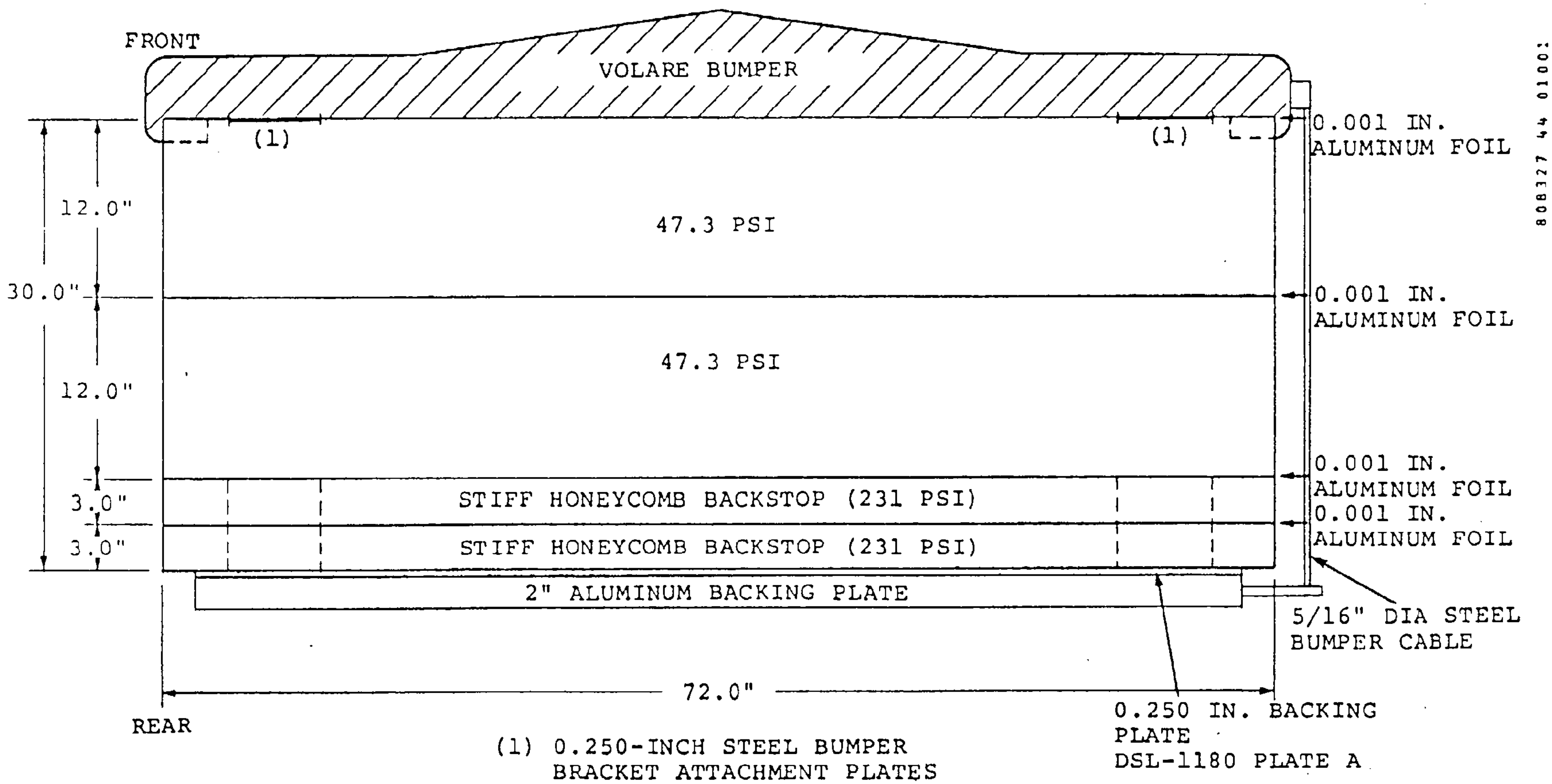


Figure D-3. Top View Schematic of -10A Assembly Honeycomb Face Showing Crush Strengths (PSI) of Honeycomb Blocks (Test 8327-4.1).

TABLE D-1. COMPONENT FABRICATION SPECIFICATION - ITEM 10A (TEST 8327-4.1)

Layer Number	Load Panel	Material	Precrush (T/B)	Face Skin Thickness (T/B) (in.)	Mat'l Comp	Dimensions* T (in.)	Dimensions* W (in.)	Dimensions* L (in.)	Coring Characteristics: Number of Holes	Coring Characteristics: Hole Pattern DSL-	Coring Characteristics: Uncored Area Left (%)	Coring Characteristics: Contour Engineering Drawing DSL-	Tapered Angle (α, β, λ) (deg)
	Plate A	6061-T6AL	NA	NA	NA	.25 (DSL 1180)							
1	I	ACG 1/4 - .003-5.2P	Yes/Yes	No/No	231 PSI	3	72	20	0				0
	II_D												
	II_P												
	III_D												
	III_P												
	IV												
	Plate B	Reynolds EHD Foil	NA	NA	NA	.001	72	20					
2	I	ACG - 1/4 - .003-5.2P	Yes/Yes	No/No	231 PSI	3	72	20	0				0
	II_D												
	II_P												
	III_D												
	III_P												
	IV												
	Plate C	Reynolds EHD Foil	NA	NA	NA	.001	72	20					

*Refer to Detail A for definition of honeycomb core orientation (of grain).

TABLE D-1. COMPONENT FABRICATION SPECIFICATION - ITEM 10A (TEST 8327-4.1) (CONTD)

Layer Number	Load Panel	Material	Precrush (T/B)	Face Skin Thickness (T/B) (in.)	Mat'l Code	Dimensions* T (in.)	Dimensions* W (in.)	Dimensions* L (in.)	Coring Characteristics: Number of Holes	Coring Characteristics: Hole Pattern DSL-	Coring Characteristics: Uncored Area Left (%)	Coring Characteristics: Contour Engineering Drawing DSL-	Tapered Angle (α,β,Δ) (deg)
3	I	ACG-3/4-.003-1.8P	Yes/Yes	No/No	47.3 PSI	12	72	19	0				0
	II_D												
	II_P												
	III_D												
	III_P												
	IV												
	Plate C	Reynolds EHD Foil	NA	NA	NA	.001	72	19					
4	I	ACG-3/4-.003-1.8P	Yes/Yes	No/No	47.3 PSI	12	72	7.4	0				0
	II_D												
	II_P												
	III_D												
	III_P												
	IV	ACG-3/4-.003-1.8P	Yes/Yes	No/No	47.3 PSI	12	72	10.6	0				0
	Plate E	Reynolds EHD Foil	NA	NA	NA	.001	72	18					

*Refer to Detail A for definition of honeycomb core orientation (of grain).

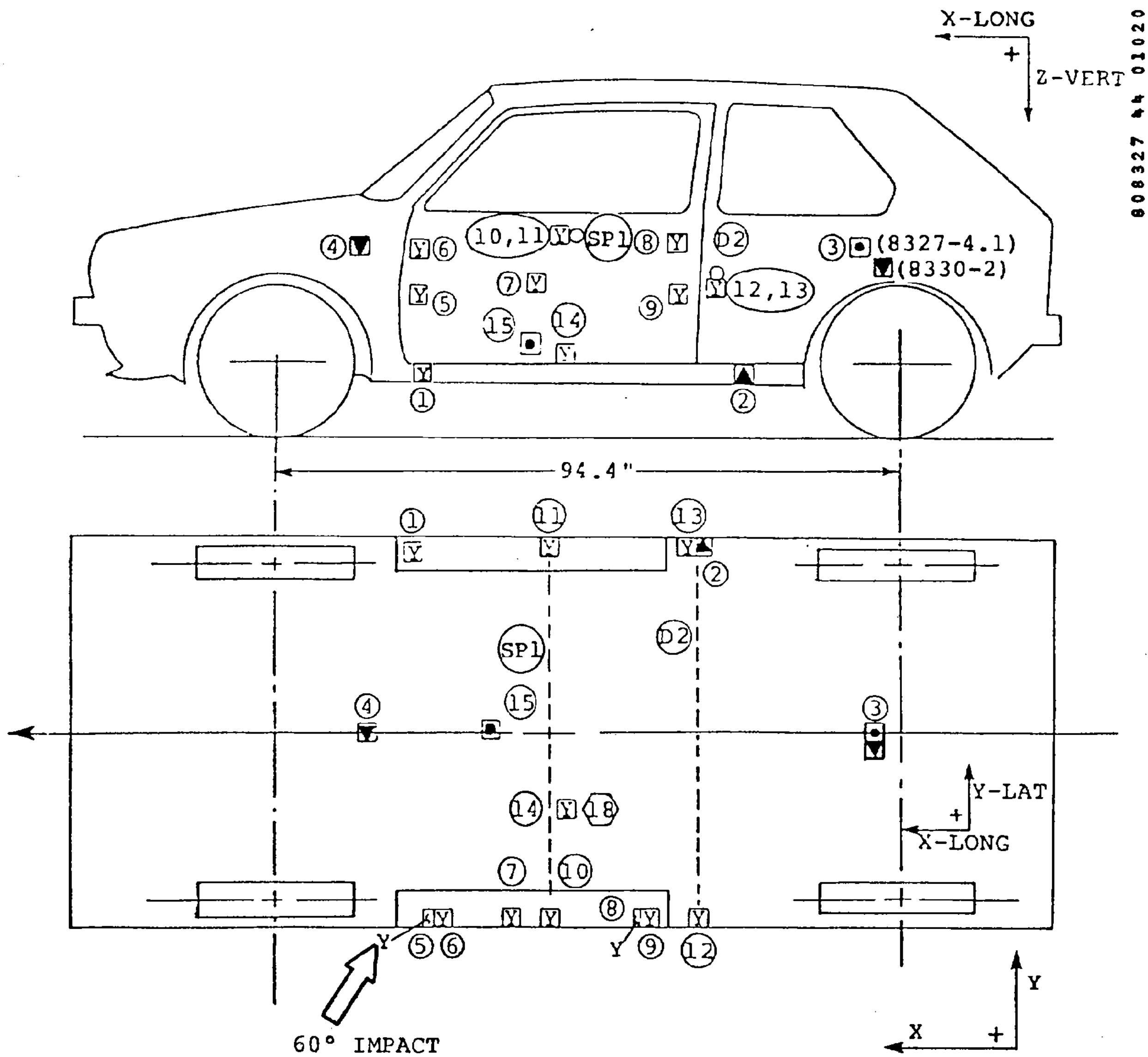
TABLE D-1. COMPONENT FABRICATION SPECIFICATION - ITEM 10A (TEST 8327-4.1) (CONTD)

Layer Number	Load Panel	Material	Precrush (T/B)	Face Skin Thickness (T/B) (in.)	Mat'l Code	Dimensions* T (in.)	Dimensions* W (in.)	Dimensions* L (in.)	Coring Characteristics Number of Holes	Coring Characteristics Hole Pattern DSL-	Coring Characteristics Uncored Area Left (%)	Coring Characteristics Contour Engineering Drawing DSL-	Tapered Angle (α, β, λ) (deg)
5	I	This layer consists of a 1976 Volare bumper with 1/4" steel support plates.											
	II_D	- attach with hexcelite epoxy (HP 326) + (steel cable on unstruck end).											
	II_P												
	III_D												
	III_P												
	IV												
	Plate F												
6	I												
	II_D												
	II_P												
	III_D												
	III_P												
	IV												
	Plate G												

*Refer to Detail A for definition of honeycomb core orientation (of grain).

APPENDIX E

INSTRUMENTATION AND CAMERA MATRIX FOR TESTS 8327-4.1 AND 8330-2



NOTE: SEE TABLE E-1 FOR ADDITIONAL INFORMATION

- Y AXIAL ACCELEROMETER (Y DIRECTION)
- BIAXIAL ACCELEROMETER (Y,Z DIRECTION)
- BIAXIAL ACCELEROMETER (X,Z DIRECTION)
- TRIAXIAL ACCELEROMETER (X,Y,Z DIRECTION)
- DISPLACEMENT TUBE OR STRING POTENTIOMETER
- 18 SIDE IMPACT SURROGATE
- BIAXIAL ACCELEROMETER (X,Y DIRECTION)

Figure E-1. Target Vehicle Instrumentation (Tests 8327-4.1 and 8330-2).

TABLE E-1. SUMMARY OF TARGET VEHICLE INSTRUMENTATION (TESTS 8327-4.1 AND 8330-2)

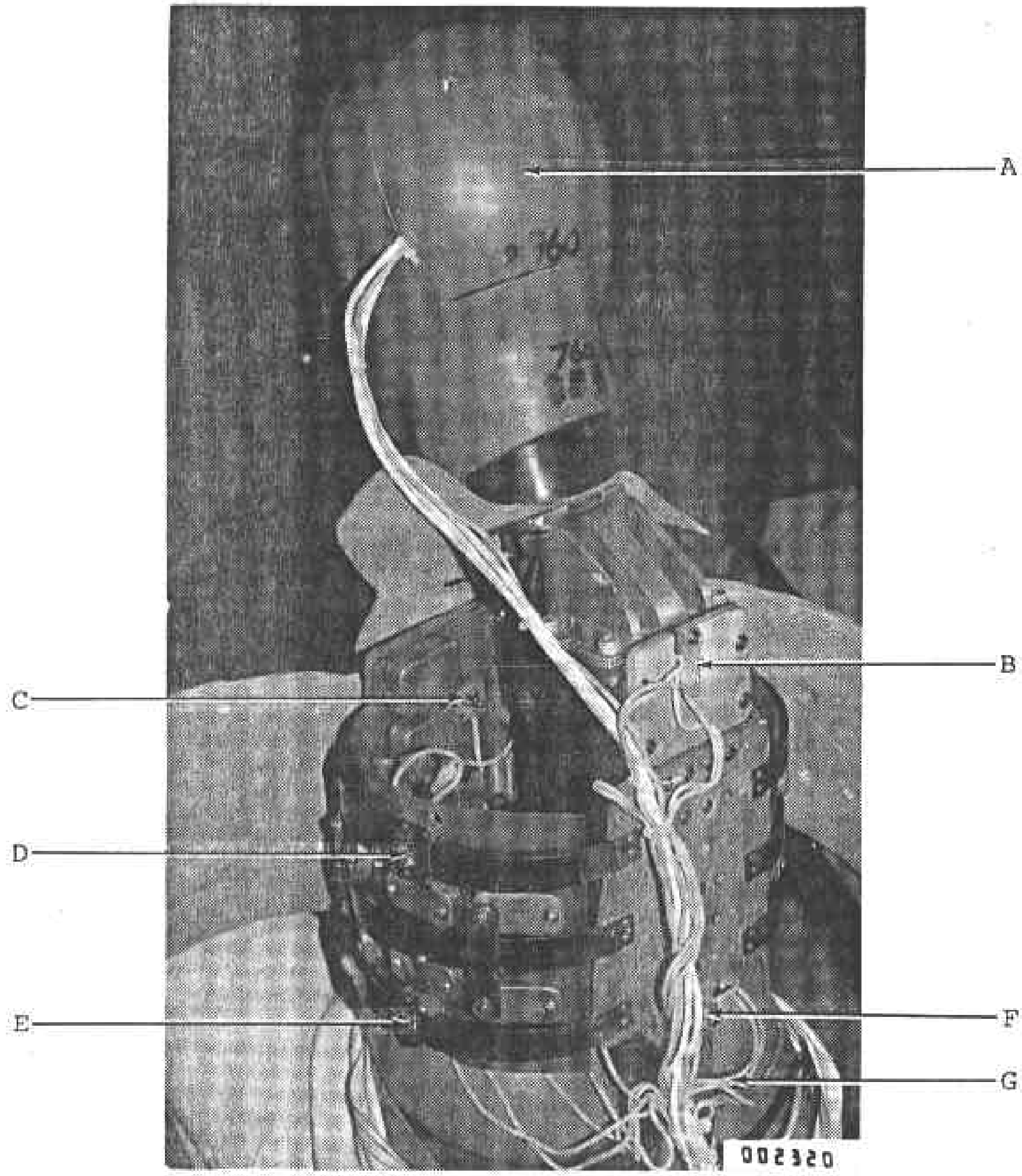
Accelerometer		Coordinates			Maximum Range		
No.	Location	X*	Y*	Z*	Long (X)	Lat (Y)	Vert (Z)
1	Occupant Compartment, Right Front Doorsill	103.5	+22.8	11.0		100G	
2	Occupant Compartment, Right Rear Doorsill	62.8	+23.0	10.5		100G	100G
3	Rear Deck Over Vehicle Centerline	38.0	0	15.0	100G	100G	(100G)
4	Front Firewall Over Vehicle Centerline	113.0	0	26.0	100G	100G	
5	Mid-forward Edge of Left Front Door	99.3	-26.0	24.5		750G	
6	Upper Front Corner of Left Front Door	96.3	-26.0	33.5		750G	
7	Middle of Left Front Door	80.8	-26.0	24.8		750G	
8	Upper Rear Corner of Left Front Door	61.0	-26.0	33.5		750G	
9	Mid-rear Edge of Left Front Door	60.5	-26.0	24.8		750G	
10	Left Front Door on Window-sill, Slightly Forward of Surrogate's Chest	80.8	-26.0	33.5		750G	
11	Right Front Door on Windowsill, Directly Across From No. 10	81.5	30.0	34.0		100G	
12	Left B-pillar Near Door Latch	57.0	-25.5	25.0		750G	
13	Right B-pillar Across From No. 12	57.0	+25.5	25.0		100G	
14	Underneath Left Front Seat Attached to Seat	72.0	-13	+13		200G	
15	Vehicle Center of Gravity				100G	100G	100G

*Reference Points:
X - Rear Bumper
Y - Vehicle Centerline
Z - Ground Level.

TABLE E-1. SUMMARY OF TARGET VEHICLE INSTRUMENTATION (TESTS 8327-4.1 AND 8330-2) (CONTD)

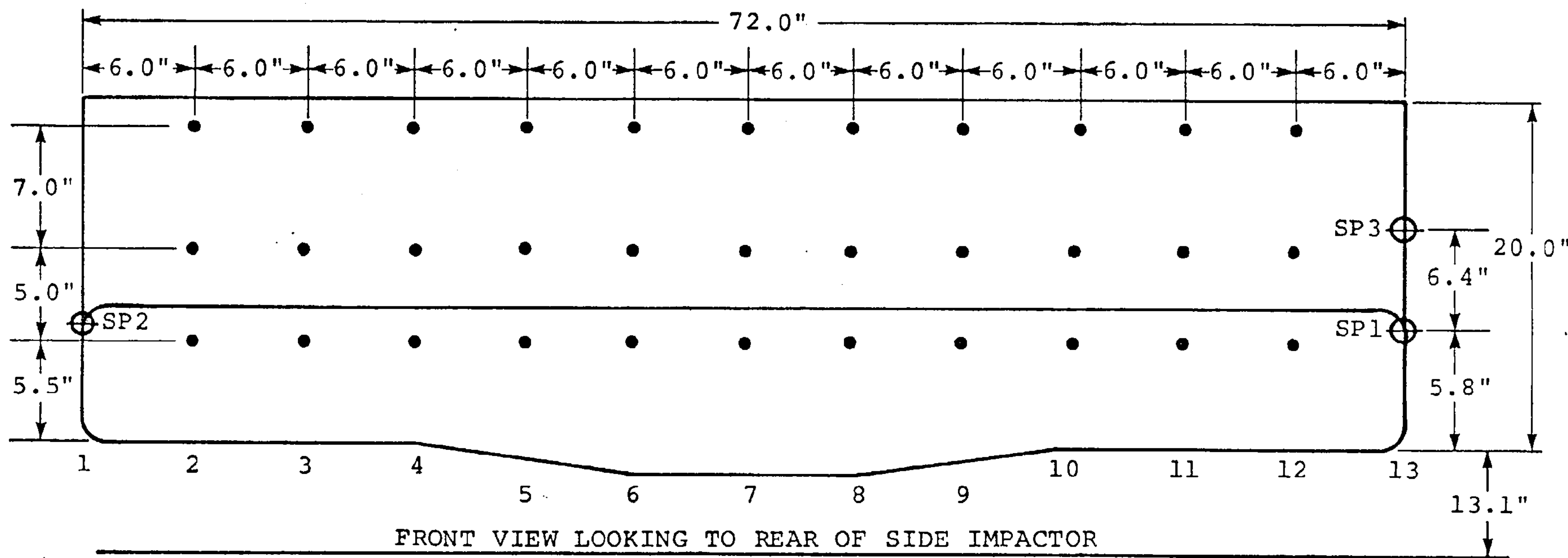
Displacement Tube		Coordinates			Maximum Range		
No.	Location	X*	Y*	Z*	Long (X)	Lat (Y)	Vert (Z)
SP1	String potentiometer	81.5		33.5	25" Retraction		
D2	B-pillar, Next to Accelerometers 12 and 13	57.0		28.3	25" Retraction		
1	Impact Switch Attached to Point of Initial Contact				Hardline		
	Side Impact Dummy Instrumentation						
Left Front Seat	Head-mounted Accelerometers (X, Y, Z)				200G	200G	200G
	Longitudinal Mounted Accelerometers (X) - 6 Locations				400G		
	Lateral Mounted Chest Accelerometers (Y) - 4 Locations					400G	
	Vertical Mounted Chest Accelerometers (Z) - 2 Locations						400G
	Pelvis-mounted Accelerometers (X, Y, Z)				200G	200G	200G
	Total Number of Required Data Channels				40(-2)	41(4.1)	
	Number of Required RSCM's					3	

*Reference Points:
X - Rear Bumper
Y - Vehicle Centerline
Z - Ground Level.



A. HEAD TRIAXIAL
B. UPPER THORAX (T-1), TRIAXIAL
C. UPPER STERNUM, LONG (LOWER STERNUM, LONG ON 3RD RIB ALSO)
D. LEFT UPPER RIB, LAT. (ALSO ON RIGHT)
E. LEFT LOWER RIB, LONG (ALSO ON RIGHT)
F. LOWER THORAX (T-12), TRIAXIAL
G. PELVIC, TRIAXIAL

Figure E-2. Locations of Eighteen Accelerometers for the NHTSA Side Impact Dummy (Three-rib Design).

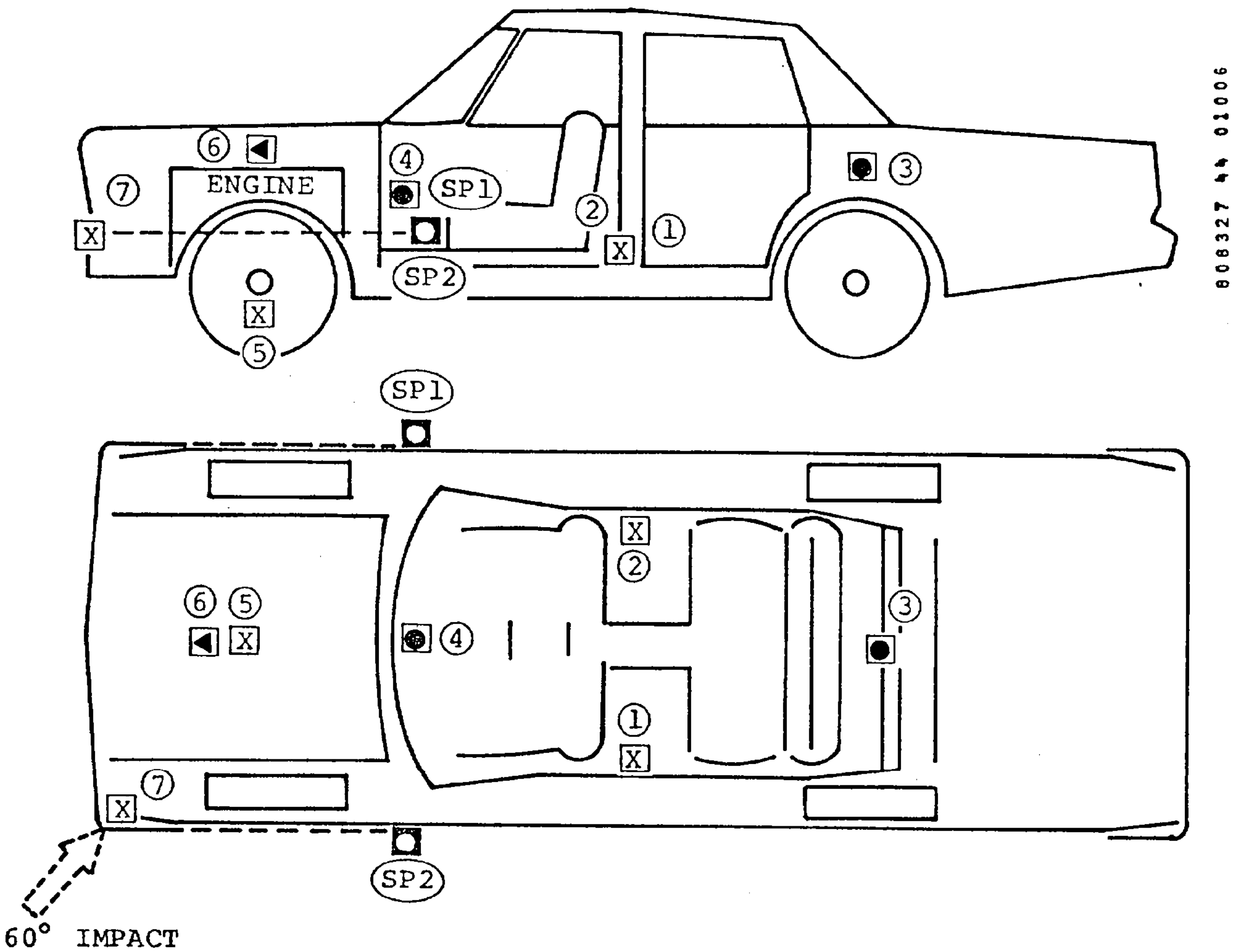


⊕ LOCATION OF STRING POTENTIOMETER

NOTE: PROFILE MEASUREMENTS ARE TAKEN USING POINTS DESIGNATED IN THE ROWS AND COLUMNS (WHEN APPLICABLE)

STRING POT NUMBER	MAXIMUM EXPECTED READING (IN.)
1, 3	-30 +10
2	-15

Figure E-4. Front View of Side Impactor Face Showing String Potentiometer Locations (Test 8327-4.1).



NOTE: SEE TABLE E-2 FOR ADDITIONAL INFORMATION

- ☒ AXIAL ACCELEROMETER (X DIRECTION)
- Y AXIAL ACCELEROMETER (Y DIRECTION)
- ▲ BIAXIAL ACCELEROMETER (Y,Z DIRECTION)
- ◀ BIAXIAL ACCELEROMETER (X,Z DIRECTION)
- ● TRIAXIAL ACCELEROMETER (X,Y,Z DIRECTION)
- ▢ STRING POTENTIOMETER

*ACCELEROMETER NO. 7 LOCATION FOR OBLIQUE IMPACTS.

Figure E-5. Bullet Vehicle Instrumentation (Test 8330-2).

TABLE E-2. SUMMARY OF BULLET VEHICLE INSTRUMENTATION (TEST 8330-2)

Accelerometer No.	Location	Coordinates X*	Y*	Z*	Maximum Range Long (X)	Lat (Y)	Vert (Z)
1	Left Occupant Compartment Near B-pillar on Doorsill	93.2	-24.0	13.0	100G		
2	Right Occupant Compartment Near B-pillar on Doorsill	93.2	+24.0	13.0	100G		
3	Rear Deck Over Vehicle Centerline	43.4	0	27.0	100G	100G	100G
4	Front Firewall Over Vehicle Centerline	143.0	0	32.5	100G	100G	100G
5	Front Crossmember Near Vehicle Centerline	158.0	0	6.5	200G		
6	Top of Engine Block	149.7	+1	32.5	200G	200G	
7	Front Bumper Near Impact Point	192	-32.0	15.0	1000G		
String Potentiometers No.	**Location**						
SP1	Vehicle Right Front Door Attaching to Front Bumper Right Side	128.0	36.0	20.0	20" Retraction 5" Extension		
SP2	Vehicle Left Front Door Attaching to Front Bumper Left Side	127.0	-38.0	19.5	20" Retraction 5" Extension		
1	Impact Switch Attached to Point of Initial Contact on Bumper				Hardline		
	Total Number of Required Data Channels				14		
	Total Number of Required RSCM's				1		

*Reference Points:
X - Rear Bumper
Y - Vehicle Centerline
Z - Ground Level.

TABLE E-3A. INSTRUMENTATION SUMMARY (TEST 8327-4.1)

1976 Modified VW Rabbit		Side Impactor	
Required Number of Channels	Channel Function	Required Number of Channels	Channel Function
21	Accelerometers	4	Accelerometers
2	String Potentiometers	3	String Potentiometers
0	Impact Switch	0	Impact Switch
18	Dummy Accelerometers [Head (3), Upper Thorax (3), Lower Thorax (3), Pelvis (3), Ribs (4), Sternum (2)]		
41		7	
42 channels available (3 RSCM's)		14 channels available (1 RSCM)	

TABLE E-3B. INSTRUMENTATION SUMMARY (TEST 8330-2)

1977 Modified VW Rabbit		1979 Oldsmobile Cutlass	
Required Number of Channels	Channel Function	Required Number of Channels	Channel Function
21	Accelerometers	12	Accelerometers
2	String Potentiometers	2	String Potentiometers
0	Impact switch	0	Impact Switch
18	Dummy Accelerometers [Head (3), Upper Thorax (3), Lower Thorax (3), Pelvis (3), Ribs (4), Sternum (2)]		
40		14	
42 channels available (3 RSCM's)		14 channels available (1 RSCM)	

TABLE E-4. CAMERA LOCATIONS - 60° SIDE IMPACT TESTS

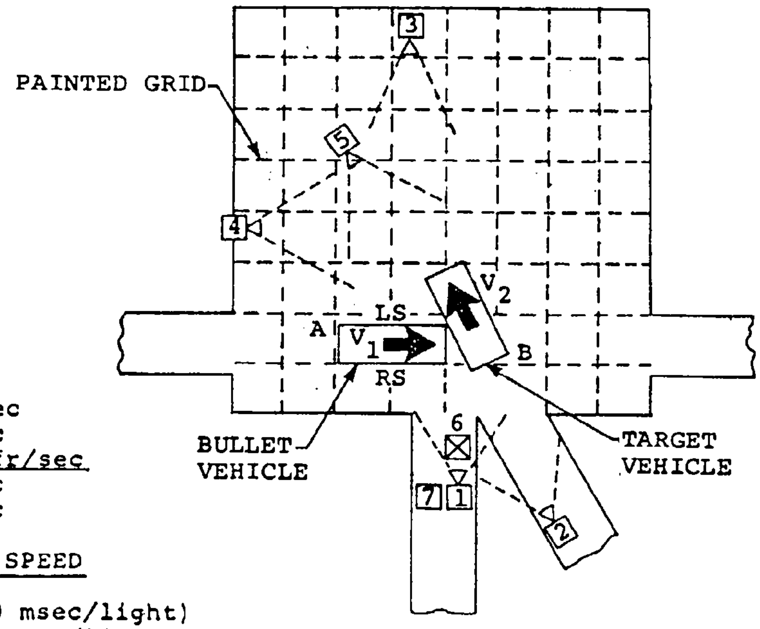
8327-4.1 2-11-80

Test No: 8330-2 Test Date: 10-25-79

Test Type: 60° Two Vehicle Moving Front-to-Side Impact

Vehicle A	NHTSA Side Impactor 1979 Oldsmobile Cutlass
Vehicle B	1976 VW Rabbit 1977 VW Rabbit

Comments: V_2 = 30 mph; V_1 = 15 mph



CAMERA	YES
STILLS	X
SLIDES	X
MOVIE	X
POLAROID	X
VIDEO	

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	Right Side Perpendicular to Bullet	Overall of both vehicles and post-test trajectory (Photosonics)	25	1000	100				
2	Right Side Parallel to Target	Overall of both vehicles and post-test trajectory (Miliken)	15	500	100				
3	Left Side Perpendicular to Bullet	Overall of both vehicles and post-test trajectory (Photosonics)	50	1000	100				
4	Left Side Parallel to Bullet	Overall of both vehicles and post-test trajectory (Miliken)	15	500	100				
5	Left Side Parallel to Target	Impact point of both vehicles (Photosonics)	13	1000	100				
6	Right Side - Boom	Elevated looking down at both vehicles (Miliken)	10	500	100				
7	Right Side	Panning test and post-test trajectory (Canon)	Zoom	24	-				

TABLE E-5. ON-BOARD CAMERA LOCATIONS - TARGET VEHICLE

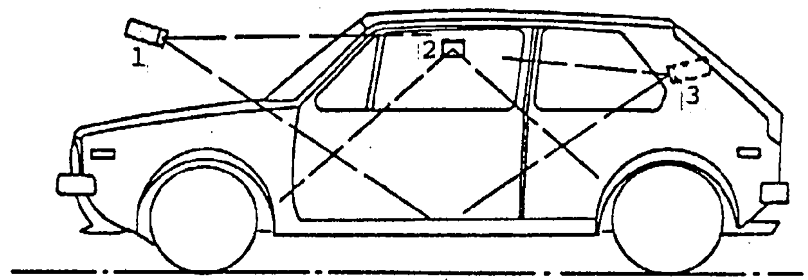
Test No: 8327-4.1 / 8330-2 **Test Date:** 2-11-80 / 10-25-79

Test Type: 60° Two Vehicle Moving Front-to-Side Impact

Vehicle A- (Away): NHTSA Side Impactor 1979 Oldsmobile Cutlass

Vehicle B (Barrier): 1976 VW Rabbit 1977 VW Rabbit

Comments:



CAMERA	YES
STILLS	X
SLIDES	X
MOVIE	X
POLAROID	X
VIDEO	

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	Vehicle Front - Left Side	Left front occupant compartment	8	1000	100				
2	Vehicle Right Front Door	Front occupant compartment	8	1000	100				
3	Int. Vehicle Rear Comp. Left Side	Left front occupant compartment	8	1000	100				